

A Methodological Approach for Documenting Historic Apple Orchards on Steptoe Butte

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Introduction

- The Palouse region of Southeast Washington was the location of a thriving tree fruit agricultural community from the late 1800s to the early 1900s. **Remnant apple orchards** dating back to the 1880s persist on the slopes of Steptoe Butte State Park today¹.
- In 2018, David Bencoter, the founder of the Lost Apple Project, created a set of legacy paper maps and notes with the GPS locations of 244 apple trees at 10-15m accuracy. Suspected **lost cultivars** were recorded with many of the trees found to be in decline.
- The Temperate Orchard Conservancy identified samples from several trees as being lost cultivars.
- Historic apple cultivars may contain genetic diversity lost through the century-long breeding and selection efforts of modern apple cultivars².
- Additional remnant orchards may exist in the surrounding areas of the Palouse. This project aims at developing efficient methods for cataloging the historic orchards.



Figure 1
Steptoe Butte as viewed towards western face. The Southwest Orchard is seen in the midground



Figure 2
Immature fruit on one of the apple trees in the Southwest Orchard.

Legacy GPS Points and Boundaries

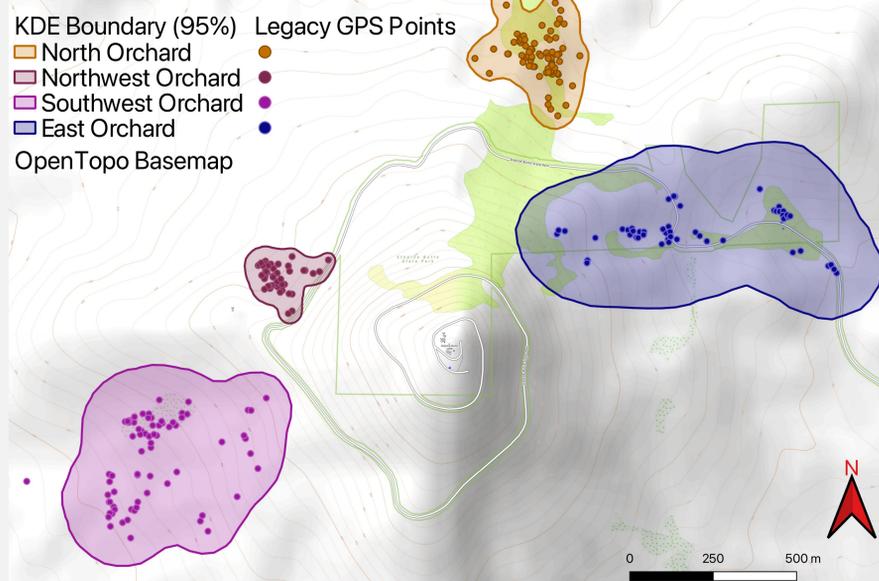


Figure 3

The Kernel Density Estimation (KDE) boundaries for each of the four orchards using a 95%-point inclusion to account for extreme outliers.

Objectives

- Develop a **methodology** for documenting the historic orchards using the Southwest orchard (SWO) as a case study.
- Establish **sub-5-meter accuracy** tree locations of the Southwest orchard for later scion wood and fruit collection.
- Identify and prioritize likely cultivars (excluding seedlings) for **Kompetitive Allele-Specific PCR (KASP) genotyping**.

Methods

Bencoter's 2018 legacy GPS tree locations and data served as a starting point to compute orchard clusters and delineate extents (Figure 3).

- Data from the legacy maps were digitized into **Rstudio** for data cleaning.
- Three locations were clustered using **k-means** and **Density-Based Scan** clustering algorithms.
- Three methods were used to compute orchard boundaries.
 - Minimum Convex Polygons (MCP)**
 - Kernel Density Estimation (KDE)**
 - Local Convex Hull (LoCoH-k)**
- The KDE boundaries were chosen as the boundaries for this project as this project focused on overall orchard extents.

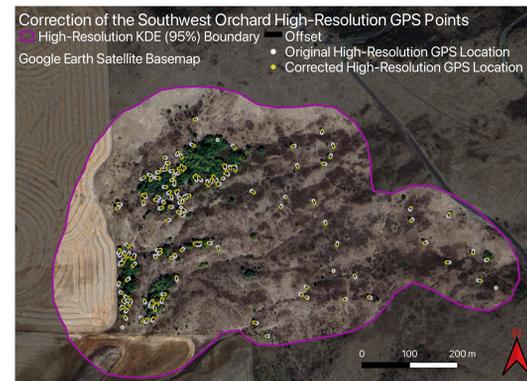


Figure 4

High-resolution GPS points (<1m accuracy) collected of the southwest orchard



- Data cleaning, clustering, and boundary algorithms and were computed in Rstudio (Posit Team, 2025) using the packages adehabitatHR, DBScan, sf, and sp.
- Map layers were exported into **QGIS** (QGIS Association) for compilation and building of maps.
- Data collection of the Southwest orchard was recorded under open canopy conditions using a **BOSCH GML 20** laser rangefinder (Robert Bosch GmbH, Gerlingen, Germany), the Android app **MGRS & UTM Map** (DakikTech, Istanbul, Turkey), and a **SXBlue II** GPS receiver (Geneq Inc., Montréal, Québec, Canada) with **Uinta Software** (Juniper Systems, Inc., Logan, Utah, USA).
- GPS points were recorded offset from the actual location of the tree to maintain high accuracy. Corrections to the points were later accounted for in R (Figure 4).
- Leaf tissue samples were collected for KASP genotyping.

Results

- Four orchards were identified through clustering algorithms.
- Our high-resolution mapping recorded a total of 157 individual apple trees in the Southwest Orchard (Figure 5).
- Fifty leaf samples identified as candidate cultivars by WSU experts were submitted for KASP genotyping (results pending).

Table 1

Computations of statistics of the legacy and new GPS points and boundaries (Figure 5).

Dataset	KDE Area (ha)	Points	Area Difference (ha)	Point Difference	Area % Change	Point % Change
Legacy SWO	31.13	75	NA	NA	NA	NA
High Resolution SWO	38.04	157	6.91	82.00	22.19	109.33

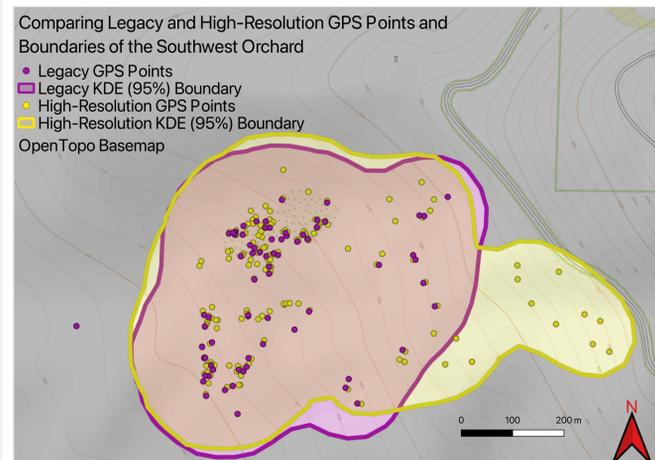


Figure 5

Comparison of the legacy and high-resolution GPS points and KDE boundaries for the Southwest Orchard.

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Next Steps

- Document the remaining three orchards using the methodology developed through this project.
- Submit remaining 107 samples from the SWO for KASP genotyping.

References

¹ Bencoter, D. & Hackbarth L. (2024). *Lost Apples: In search for rare and heritage apples in the Pacific Northwest*. Keokee Books, 96.

² Dunbar-Wallis, A., Volk, G. M., Johnson, A. M., Schuenemeyer, A., Bunker, J., Castro, D., ... & Peace, C. P. (2022). What's in a name? The importance of identity in heirloom apple tree preservation. *Plants, People, Planet*, 5(1), 39-46. <https://doi.org/10.1002/ppp3.10307>