Paso Robles Basin Riparian Health Trend Analysis as an Indicator of SW-GW Interaction

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Attachments:	Attachment A: Enhanced Vegetation Index Trend Analyses – Riparian Areas, Paso Robles Basin
Date:	April 22, 2022

1. Introduction

GSI Water Solutions (GSI) was retained by the County of San Luis Obispo Groundwater Sustainability Director to perform an Enhanced Vegetation Index (EVI) trend analysis of riparian vegetation communities within the Paso Robles Groundwater Basin (Basin). The purpose of this analysis is to identify and evaluate trends in riparian vegetation health as an indicator of potential long-term trends in surface water-groundwater interactions.

2. Methods

An Enhanced Vegetation Index (EVI) analysis was completed for riparian vegetation areas in the Basin using Landsat data processed in Climate Engine[1]. EVI data provides an indicator of healthy, well-watered vegetation. It is calculated from the proportions of visible and near-infrared sunlight reflected by vegetation. EVI values typically range from zero to over 0.7. Healthy, or well-watered, vegetation absorbs most of the visible light that hits it and reflects a large portion of near-infrared light, resulting in a high EVI value. Unhealthy, dry, or dormant vegetation reflects more visible light and less near-infrared light, leading to a lower EVI value.

The EVI analysis was constrained to areas identified by Todd Groundwater (Todd) as 'sparse' and 'dense' riparian areas[2]. The sparse and dense riparian areas were each split up into subareas and each subarea was analyzed separately. The locations of each subarea are presented on Figure 1 and listed in Table 1.

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[1] Climate Engine (Huntington et al., 2017) is an online tool for cloud computing of climate and remote sensing data powered by Google Earth Engine (Gorelick et al., 2017) (https://app.climateengine.org/climateEngine)
[2] As presented in Figure 5-16 of the draft revisions to Paso Robles Basin GSP Section 5.5 Interconnected Surface Water.

Table 1. EVI Analysis Subareas

Sparse Riparian	Dense Riparian
Salinas River	Salinas River
Estrella River upstream of Whitley Gardens	Estrella River upstream of Whitley Gardens
Estrella River downstream of Whitley Gardens	Estrella River downstream of Whitley Gardens
San Juan Creek	San Juan Creek
Creston (Huer Huero Creek)	

The EVI analyses for each riparian subarea were processed in Climate Engine using Landsat data from January 2009 through present. This analysis period is considered representative of recent hydrologic conditions as it begins and ends with similar hydrologic conditions and includes dry, wet, and average periods. Importantly, this analysis period captures the severe drought years of 2013 and 2014 and includes the period since the January 2015 Sustainable Groundwater Management Act (SGMA) date of compliance. EVI results are based on daily statistical mean EVI values calculated over the analysis area for each day the satellites were overhead (approximately once every 8 days).

3. Results and Discussion

Key Findings:

- EVI values typically vary seasonally with observed annual minimums and maximums correlating strongly with water year type (i.e., wet, dry, normal),

- **'Dense' riparian areas**; each EVI trend analysis shows a slightly increasing trend in EVI values over the analysis period,

- **'Sparse' riparian areas**; all but one EVI trend analysis show a slightly increasing trend in EVI values over the analysis period,
    - The one exception, 'sparse' Creston area, shows essentially a flat/stable trend over the analysis period

- These stable to slightly increasing EVI trends indicate stable to slightly increasing riparian vegetation health within the identified riparian areas over the long-term.

The results of each EVI trend analysis are presented graphically in Attachment A. The graphs include total monthly precipitation recorded at the Paso Robles station (NOAA 46730) to facilitate comparison between EVI and water year type. In general, winters with higher precipitation totals correlate with higher EVI values during the following dry season. Conversely, winters with lower precipitation totals, including the exceptionally dry winters of 2013 and 2014, are generally followed by below normal dry season EVI values.

Without exception, riparian vegetation health, as indicated by EVI, recovers to 2009-2010 levels in the years following 2014. Even in the flat trend 'sparse' Creston analysis area, EVI values appear to recover to 2010 levels by 2019. These patterns show that while riparian vegetation health may decline during drought it fully recovers during subsequent wet/normal water years. The results of this study indicate that riparian vegetation health has remained stable over the analysis period and may in fact be slightly increasing throughout the majority of the 'sparse' and 'dense' riparian areas in the Basin. This stability of riparian vegetation health suggests that alluvial groundwater levels have remained consistently within the rooting

zone depth of the established riparian vegetation in the analysis areas. These results also suggest that water levels in the alluvial aquifer supporting these established riparian communities have not been affected by long-term declining water levels induced by groundwater pumping in the underlying Paso Robles Formation Aquifer.

4. Conclusions

GSI performed an EVI trend analysis of riparian vegetation communities within the Basin for the purpose of identifying and evaluating trends in riparian vegetation health as an indicator of potential long-term trends in surface water-groundwater interactions within reaches of the adjacent streams. The results of this study indicate that riparian vegetation health has generally remained stable to slightly increasing over the analysis period suggesting that alluvial groundwater levels have remained consistently within the rooting zone depth of the established riparian communities. The patterns of increasing and decreasing riparian vegetation health typically vary seasonally with annual minimums and maximums correlating strongly with water year type. These observations indicate that water levels in the alluvial aquifer are independent from the long-term declining water levels induced by groundwater pumping in the underlying Paso Robles Formation Aquifer. This suggests the presence of a clay layer at the base of the alluvial aquifer supporting these riparian communities. Based on the results of this study there does not seem to be any long-term trend in surface water-alluvial aquifer groundwater interactions within the Basin. Further investigations are required to evaluate any potential surface water-groundwater interactions with the Paso Robles Formation Aquifer.

FIGURES
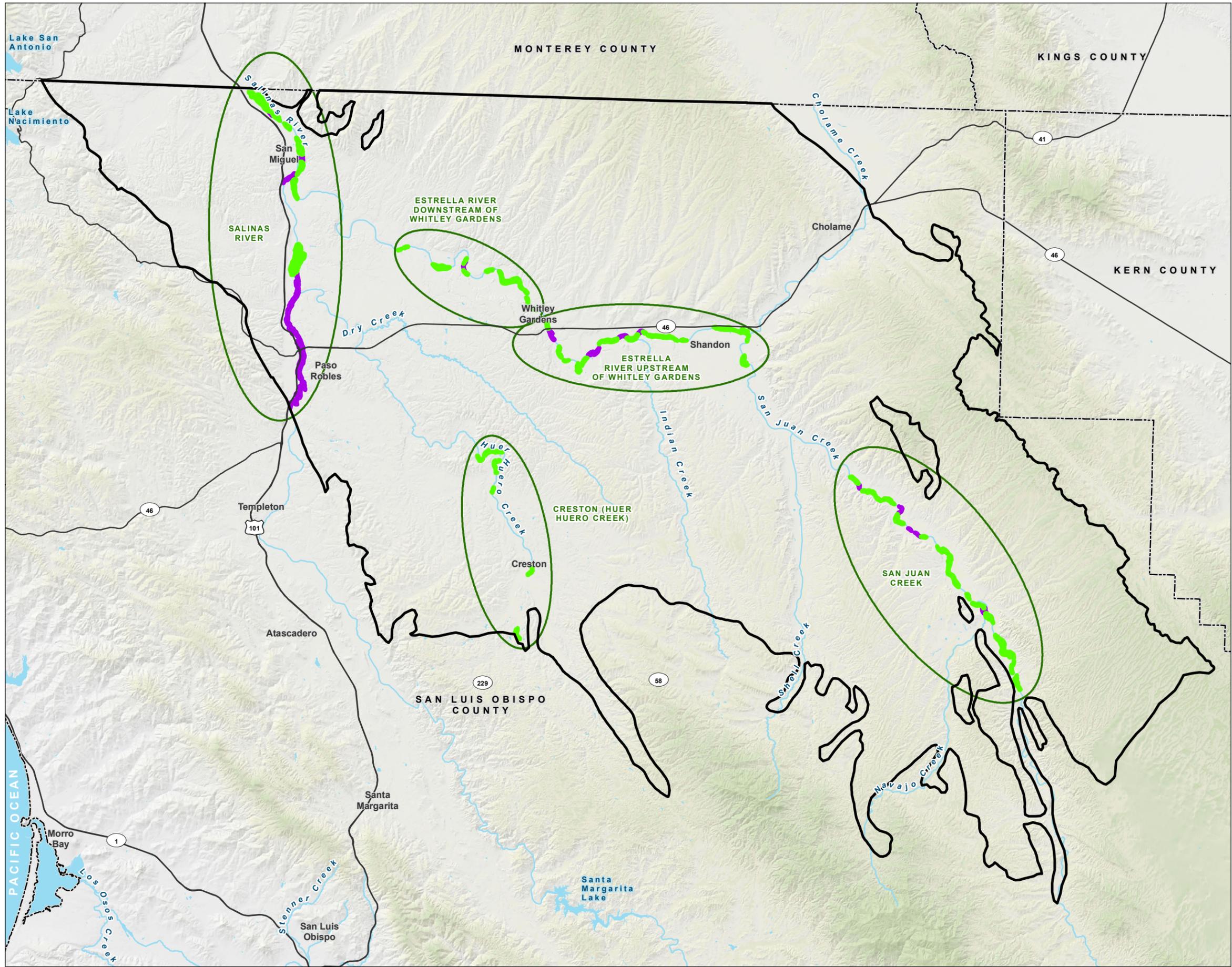
FIGURE 1

Riparian EVI Analysis Subareas

Paso Robles Basin
Riparian Health Trend Analysis
as an Indicator of
SW-GW Interaction

LEGEND
- Sparse Riparian Area
- Dense Riparian Area
- Riparian Subarea

All Other Features
- Paso Robles Subbasin
- County Boundary
- Major Road

N

0   10,000   20,000   30,000
Feet
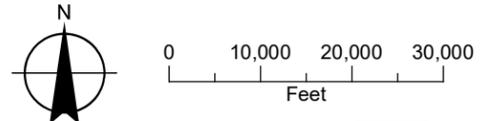
Date: April 25, 2022
Data Sources: CA DWR, SLO Co.,
City of Paso Robles, USGS

GSI
Water Solutions, Inc.

Enhanced Vegetation Index Trend Analyses
Riparian Areas - Paso Robles Basin

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Sparse Riparian - Salinas River
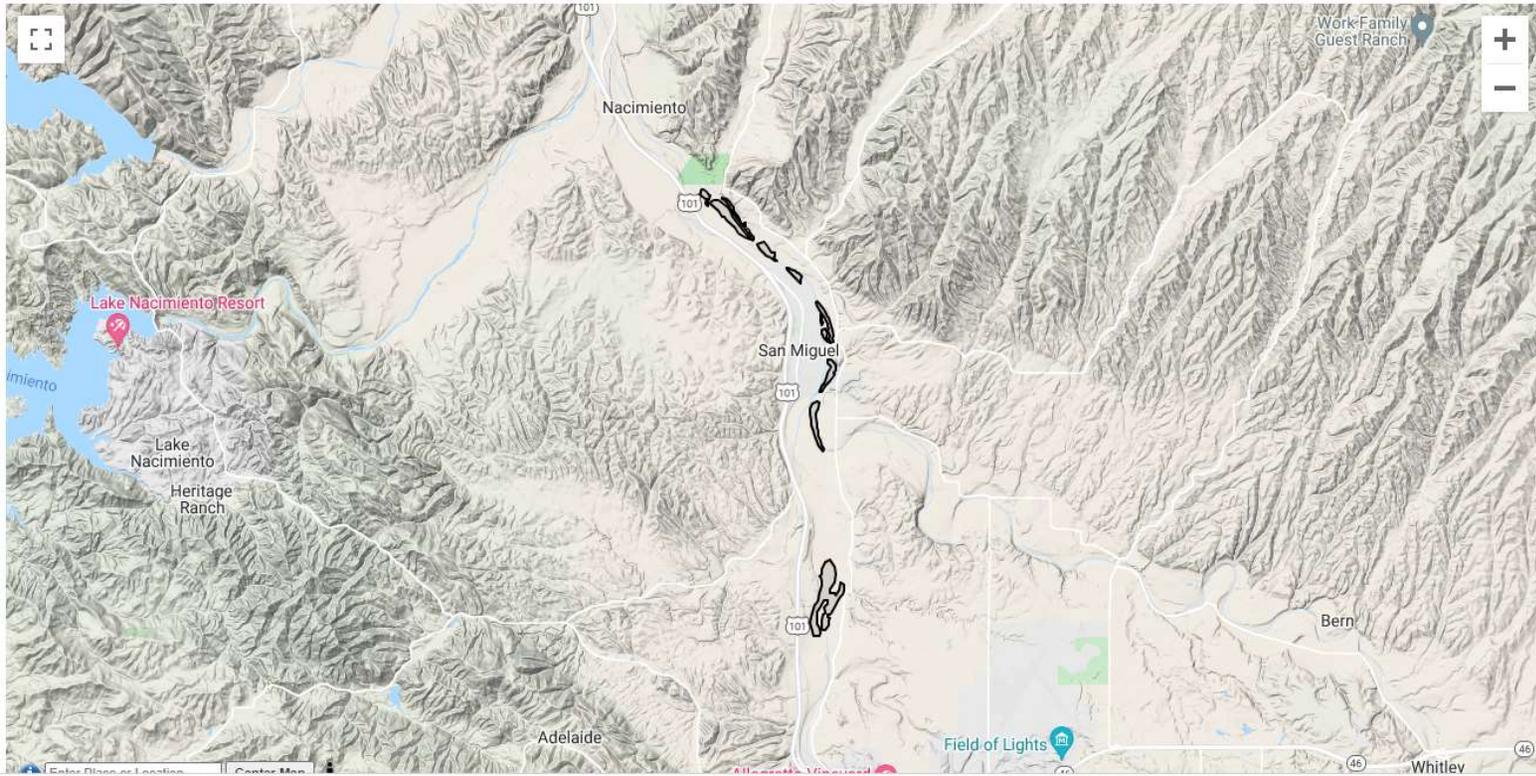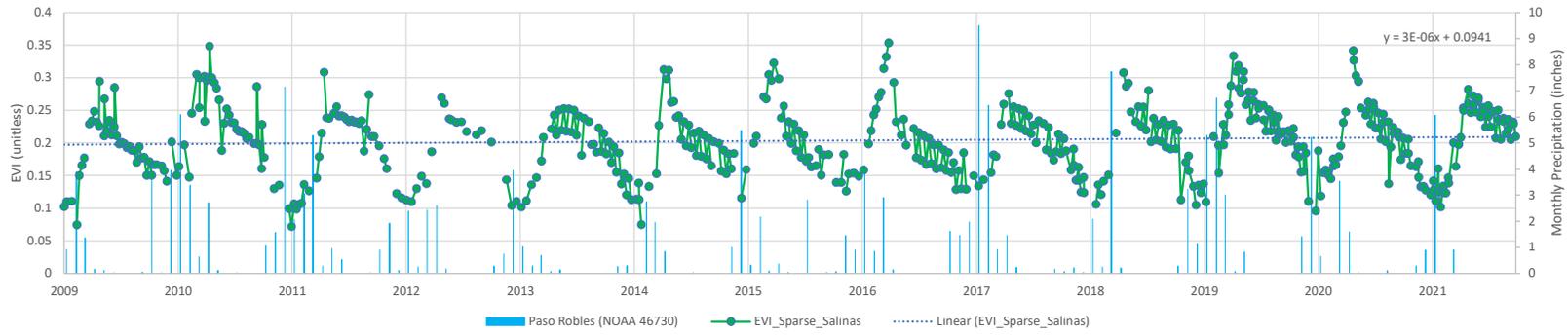
$y = 3E\text{-}06x + 0.0941$

Paso Robles (NOAA 46730) — EVI_Sparse_Salinas — Linear (EVI_Sparse_Salinas)

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Dense Riparian - Salinas River

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Sparse Riparian - Estrella River downstream of Whitley Gardens

$y = 2E\text{-}06x + 0.1183$

Paso Robles (NOAA 46730) — EVI_Sparse_Estrella ds Whitley ····· Linear (EVI_Sparse_Estrella ds Whitley)
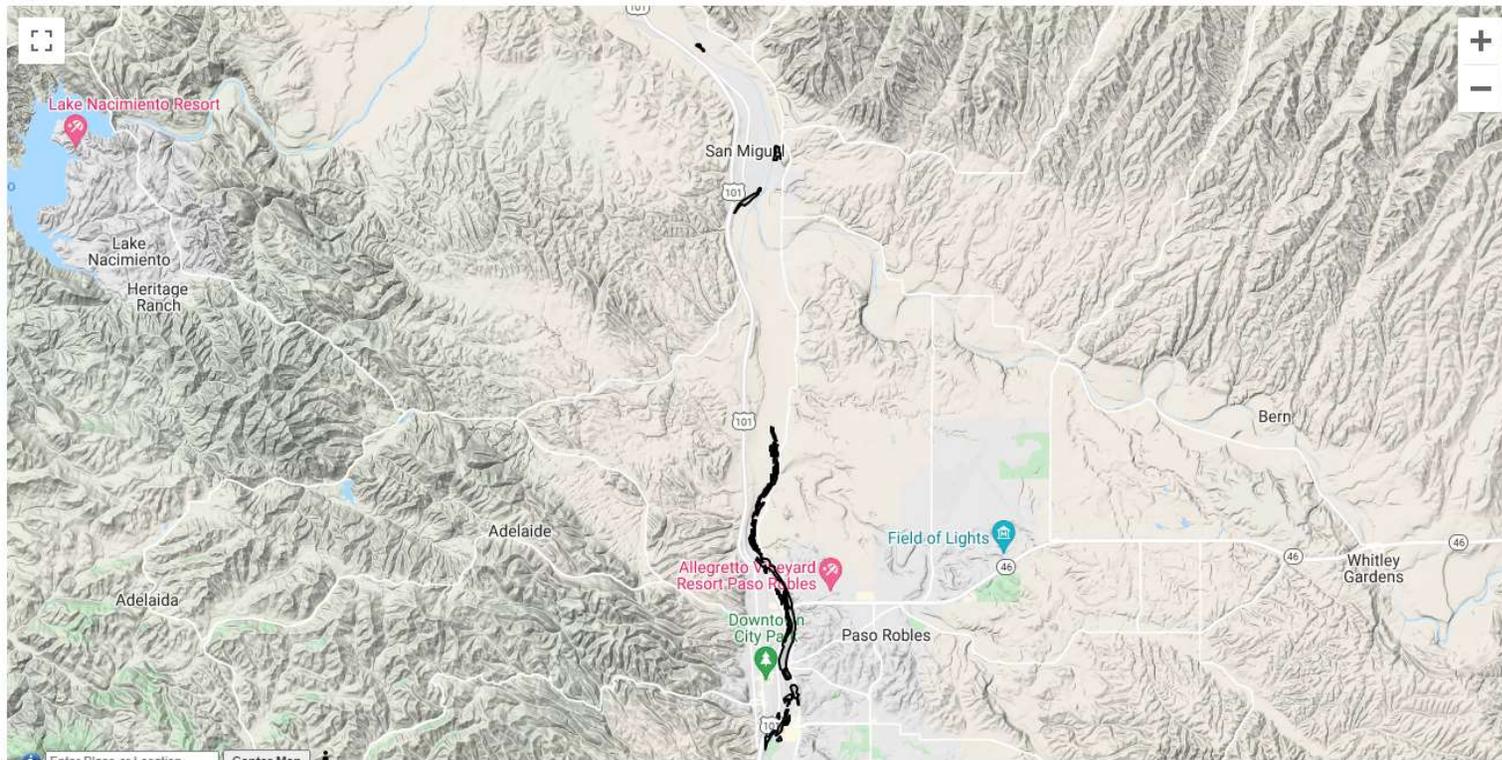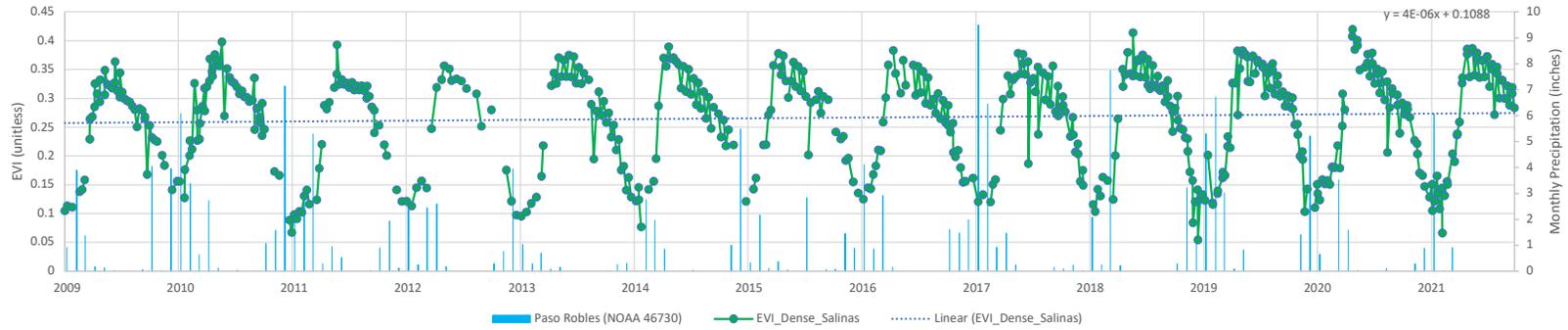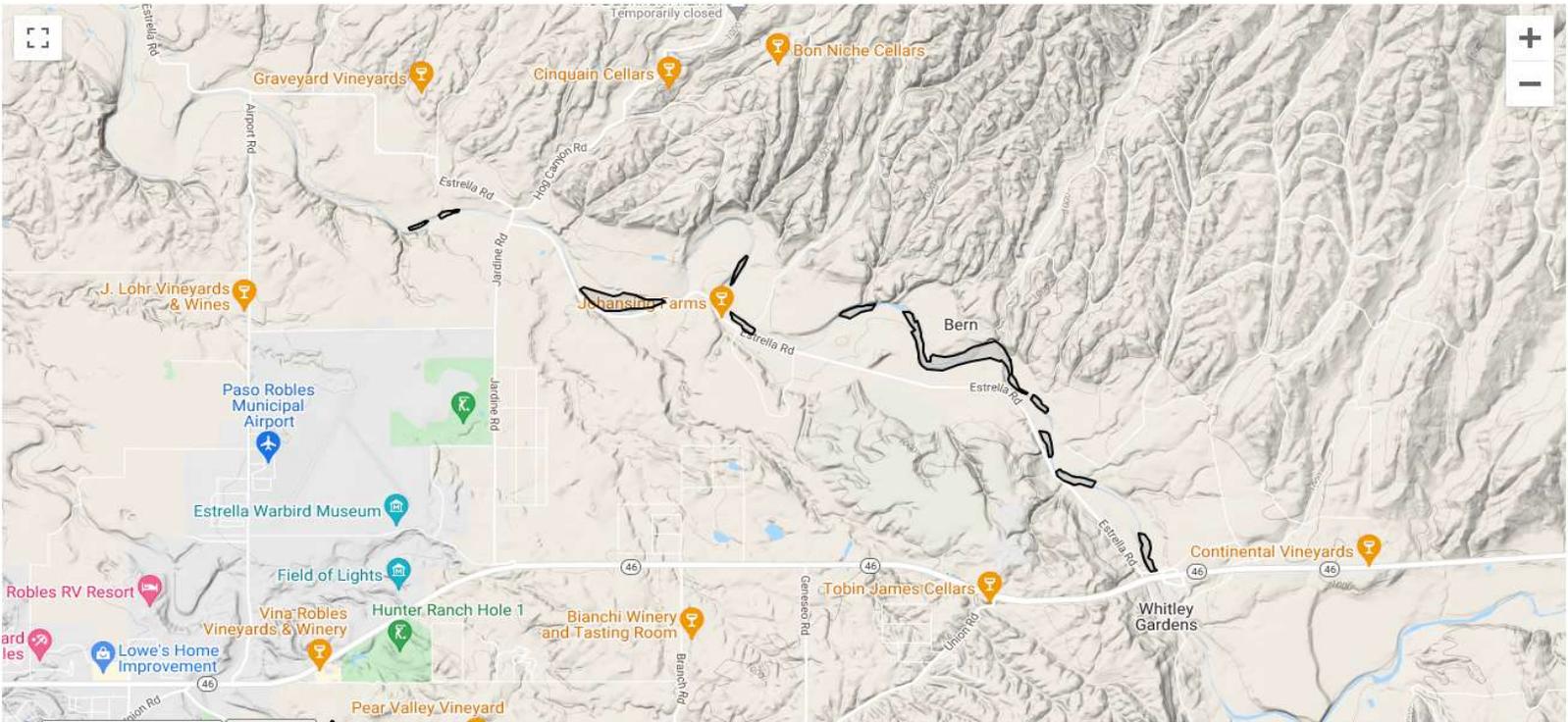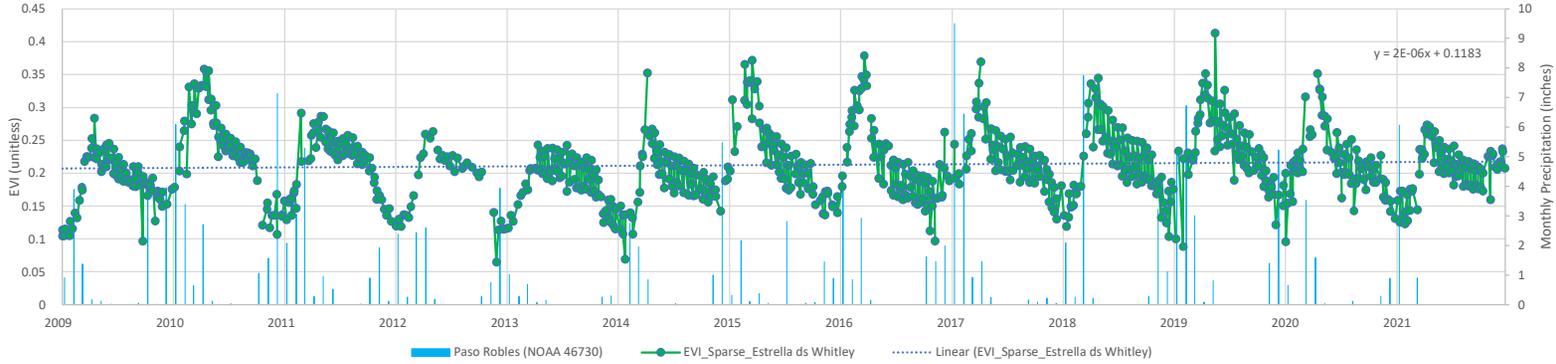
EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Dense Riparian - Estrella River downstream of Whitley Gardens

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Sparse Riparian - Estrella River upstream of Whitley Gardens

$y = 6E\text{-}06x - 0.0368$

Paso Robles (NOAA 46730) — EVI_Sparse_Estrella us Whitley ⋯⋯ Linear (EVI_Sparse_Estrella us Whitley)

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Dense Riparian - Estrella River upstream of Whitley Gardens

$y = 4E\text{-}06x + 0.0964$

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Sparse Riparian - San Juan Creek

$y = 1E\text{-}06x + 0.1635$

Paso Robles (NOAA 46730) ━●━ EVI_Sparse_San Juan ┈┈┈┈┈ Linear (EVI_Sparse_San Juan)

EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Dense Riparian - San Juan Creek

$y = 6E\text{-}06x - 0.0331$

Paso Robles (NOAA 46730)   EVI_Dense_San Juan   Linear (EVI_Dense_San Juan)
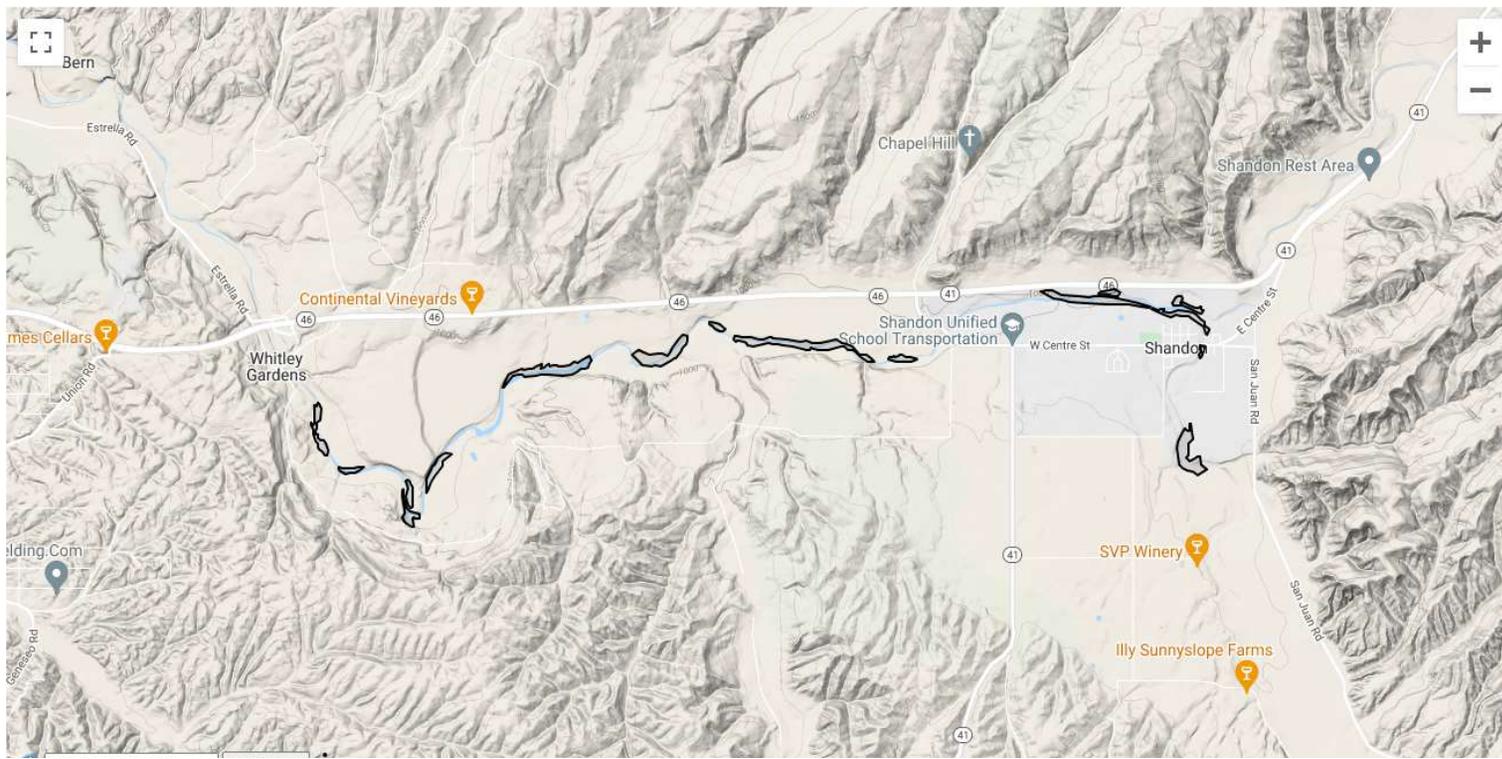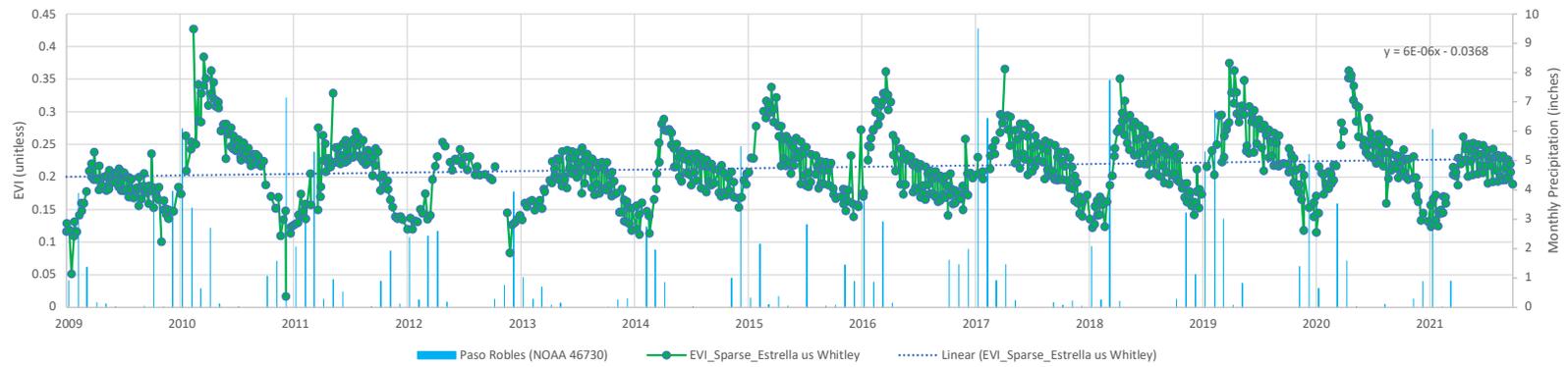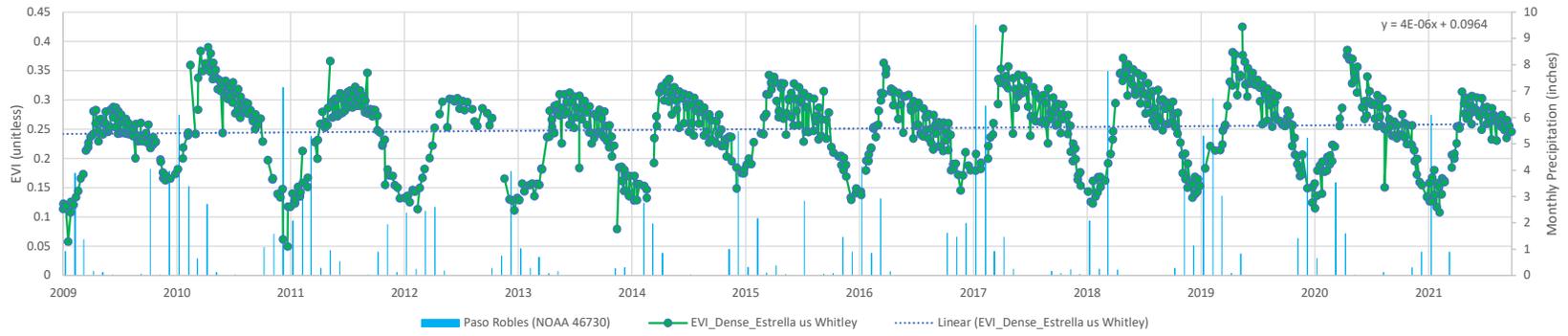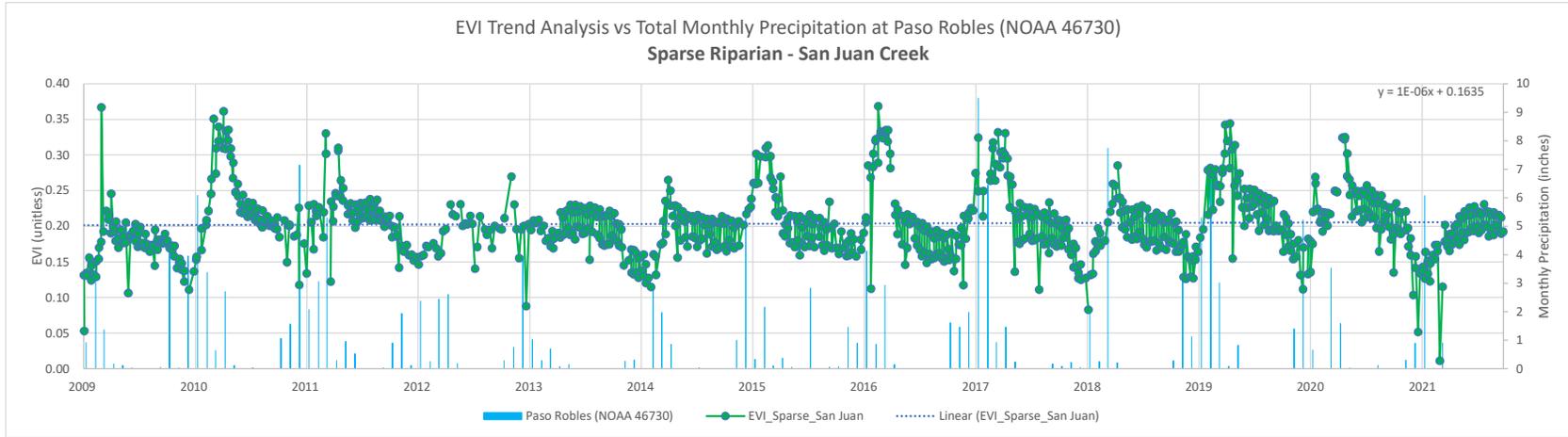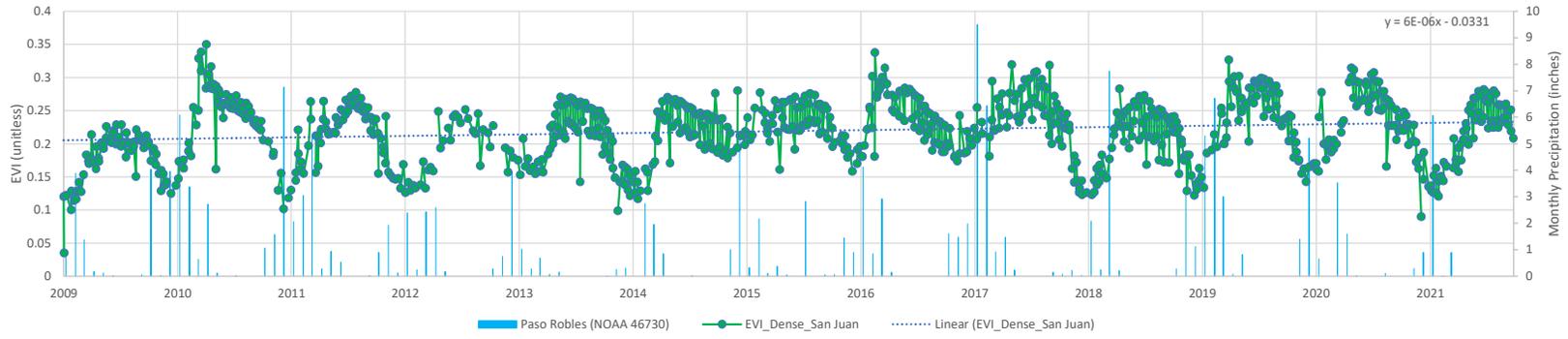
EVI Trend Analysis vs Total Monthly Precipitation at Paso Robles (NOAA 46730)
Sparse Riparian - Creston (Huer Huero Creek)

$y = -2E\text{-}06x + 0.28$