Making Rainbows out of Mad River

GSP 270
Team Hydro-squirrel

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Abstract

It is a known idea that rivers shift geographically over time. We analysed a small segment of the mad river from 2005 to 2016 and considered both the human and natural elements that would influence its shape. Including, human infrastructure and the erosive properties of soils found along the river bank. The end result was five visual representatives including the river location, diversion through human infrastructure, soil types, potential landslides, the shift distance, and rate of river change. All aspects of our analysis incorporate important features that are necessary for predicting the future of the ever-changing patterns of the Mad River.

Introduction

Many of the areas in Humboldt county are steep and erosive. One of these areas includes the Mad River, located in North Coast hydrologic region, that has undergone significant changes over the years. Changes can be assumed partially due to human impacts and varying environmental influences. The Mad River is about 100 miles long and drains about 500 square miles of coastal hills within Humboldt County. For the purpose of our analysis, we targeted a region of the Mad River that lies near quarries, farms, housing developments, Highway 299, and other infrastructure as indicated by figure 1. Humboldt County experiences a heavy rain season between the months of October to April, where the driest of regions receive at least 40 inches of rain, and over 100 inches in heavy precipitation zones.

Landslides are common within the Mad River watershed, typically caused by weakly cohesive soils coming under pressure from heavy seasonal rainfall (Rice, n.d.). Anthropogenic influence disrupts the natural balance of the Mad River hydrological system. Factors that promote accelerated erosion include: increased runoff, and sediment discharge from road building, logging, agriculture, mining, recreation and homesteading. As more alterations are made within a basin, their cumulative effects increase the potential for offsite channel damages. This imbalance causes aggradation (build-up) of the riverbed and alters the river channel itself which also changes the surrounding environment and vegetation nearby.

This project will be focusing on a section of the Mad River, located near the intersection of Highway 101 and Highway 299 as seen in figure 1 during the years of 2005, 2009, 2010, 2012, 2014, 2016. Through exploration of the Mad River meander using chronological changes in ArcMap, we will be investigating:

1. **Percent of river overlap changes from 2016**
2. **The rate of meander in meter per year at the selected transect**
3. **Infrastructure and its effects on the meander of the river**
4. **Soil types and their erosive potential**
5. **Landslides and their effects on the river**

Methods 1.

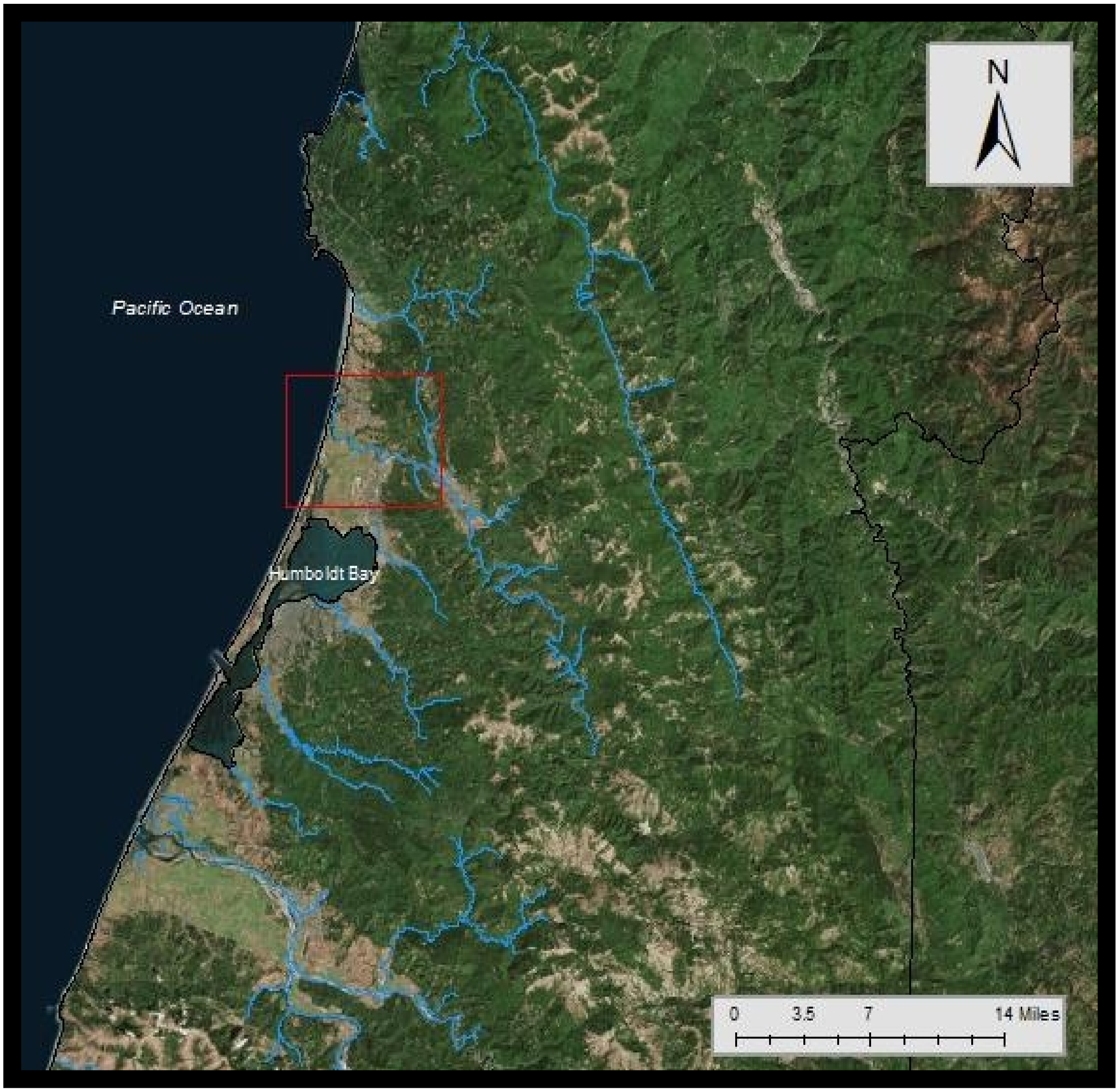

***Figure 1**. Mad River in Humboldt County Locator Map*

NAIP imagery was collected from USGS Earth Explore and further manipulated using ArcMap version 10.5.1. The data retrieved was from the years 2005, 2009, 2010, 2012, 2014, and 2016. Five various environmental factors for each year were investigated and attempted to find significant relationship. Each segment of the report will be addressed separately.

Methods 1.

The goal of this part of the analysis was to determine a rate for how much the river was changing from the year 2016 river by meters squared per year going backward in time. To do this we digitized about a mile of the river for the years of 2016, 2014, 2012, 2010, 2009, and 2005. We overlapped every other year with the 2016 layer and this gave us how much area each year had in common with 2016 by area in meters squared. We took these overlap values and plotted them on a line graph.

Results 1.

The average rate of change for the Mad River of the years of 2016 to 2005 has been 8,470 m^2/yr. as indicated in Figure 1.

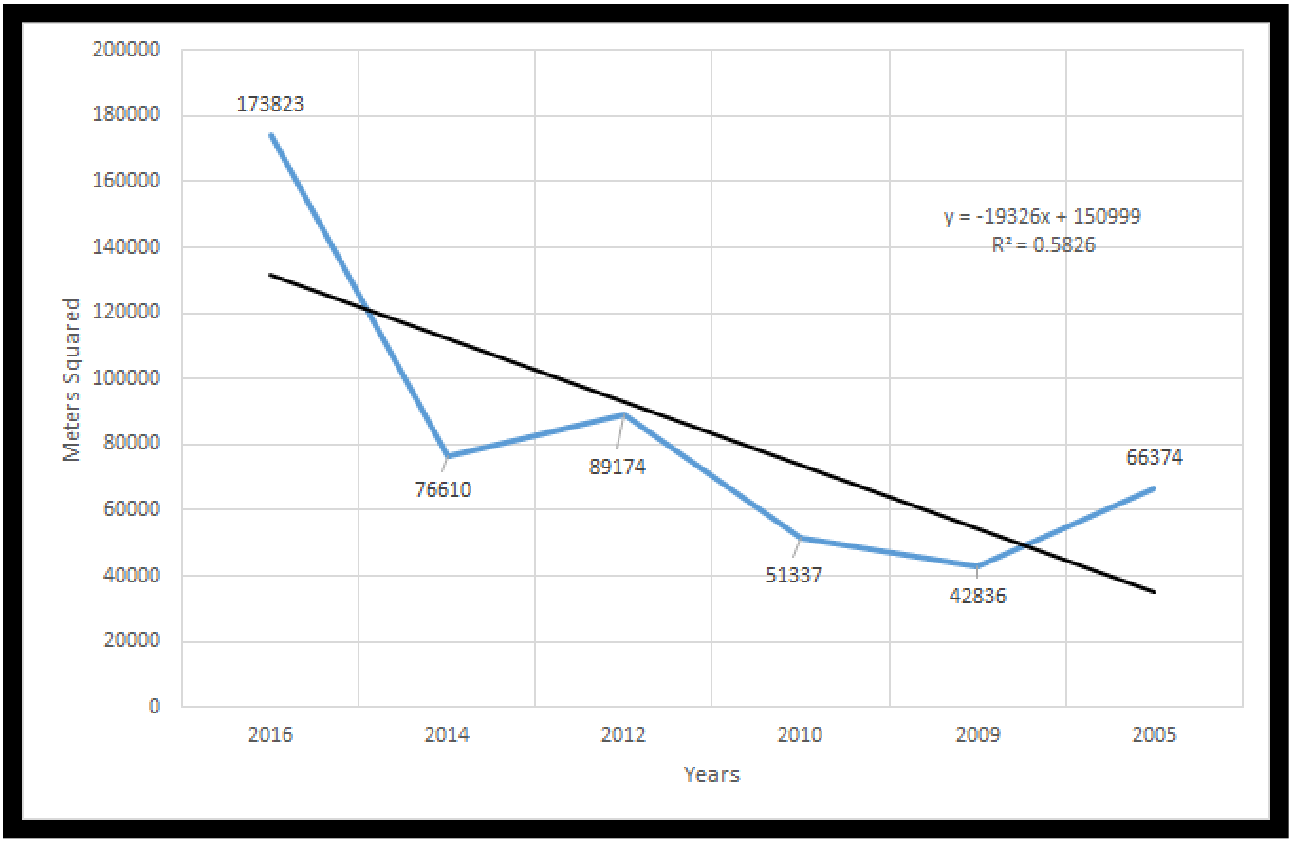

Figure 2. *The black trend line shows that the amount of overlap from 2005 to 2016 and is decreasing as you look further into the past.*

Methods 2.

To find an average rate of meander for the Mad River we picked a location where the river was gradually cutting into the bank at an outside edge of a bend. At that location, we put in a single transect that cut across all river years and calculated the distance the river had eroded the bank away from 2005 to 2016. We used that distance and divided it by the number of years from 2005 to 2016, and it gave us the equation (156 m/11 yr.) = # m/yr. This equation would tell us the rate the river was cutting into the bank in meters per years.

Results 2.

The average meander rate along the transect that we determined is 14.2 m/yr. from 2005 to 2016 as indicated by figure 3.

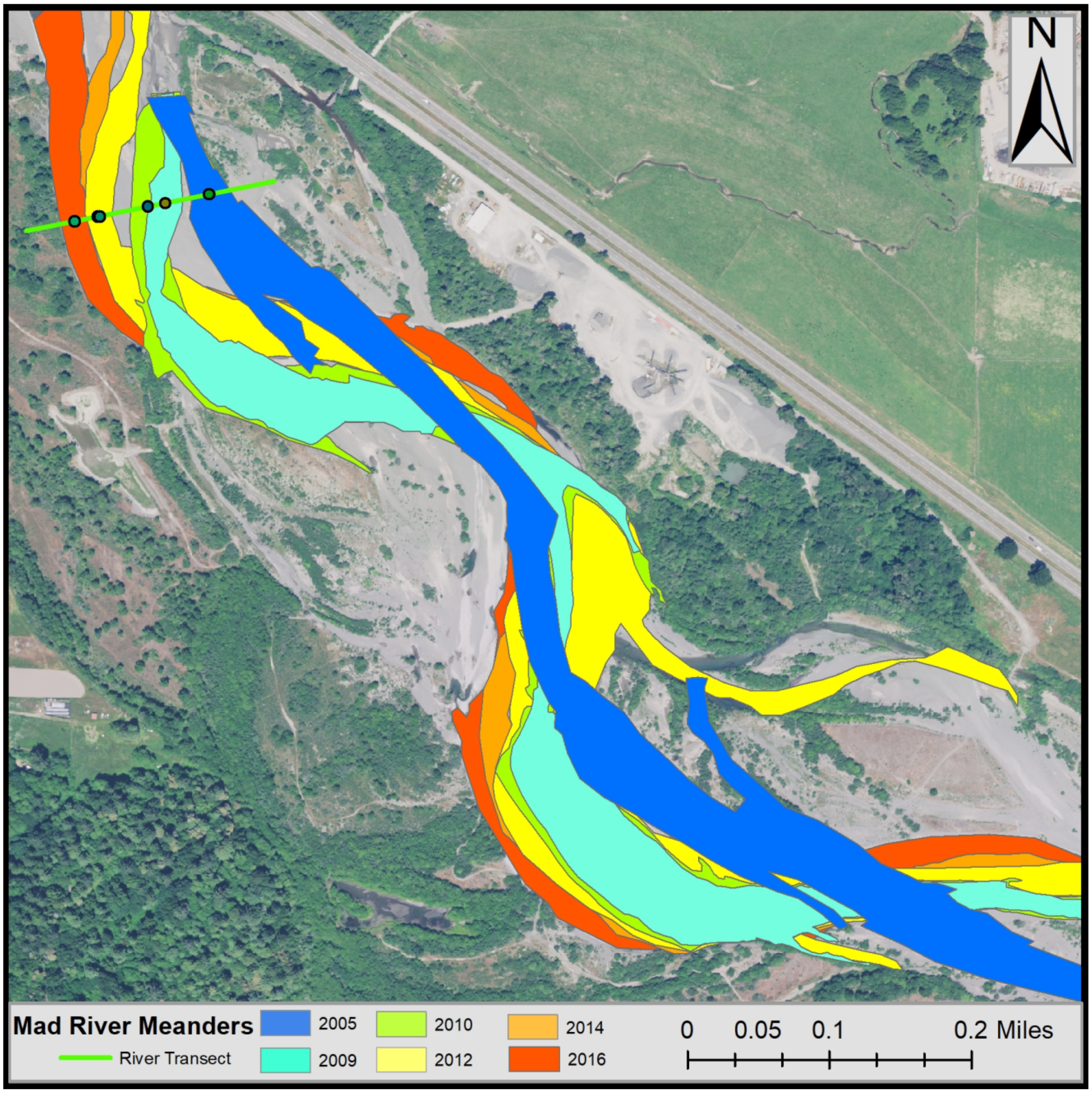

Figure 3. *It is easy to see at the location of the transect the rivers curve has been eroding the west bank of the river at a rate of 14.2 m/yr. Points indicate the center of the river*

Methods 3.

The three features in figure 4 were made by using NAIP imagery through Earth Explorer. The location chosen was further South where agricultural, residential, and commercial areas reside. Shapefiles and digitizing was made to the features to emphasize the meander change. These features include the riprap retaining wall that protects the Blue Lake Casino water treatment ponds, the highway, and various homes, riparian remnants of where the Mad river meander use to be, and a historic oxbow lake.

Results 3.

Further investigation identifies the riprap retaining wall installation clearly altered the meander of river. The riparian remnants show the historic meander was much bigger before anthropogenic influence and the river channel changed over time from the oxbow lakes shown in figure 4.

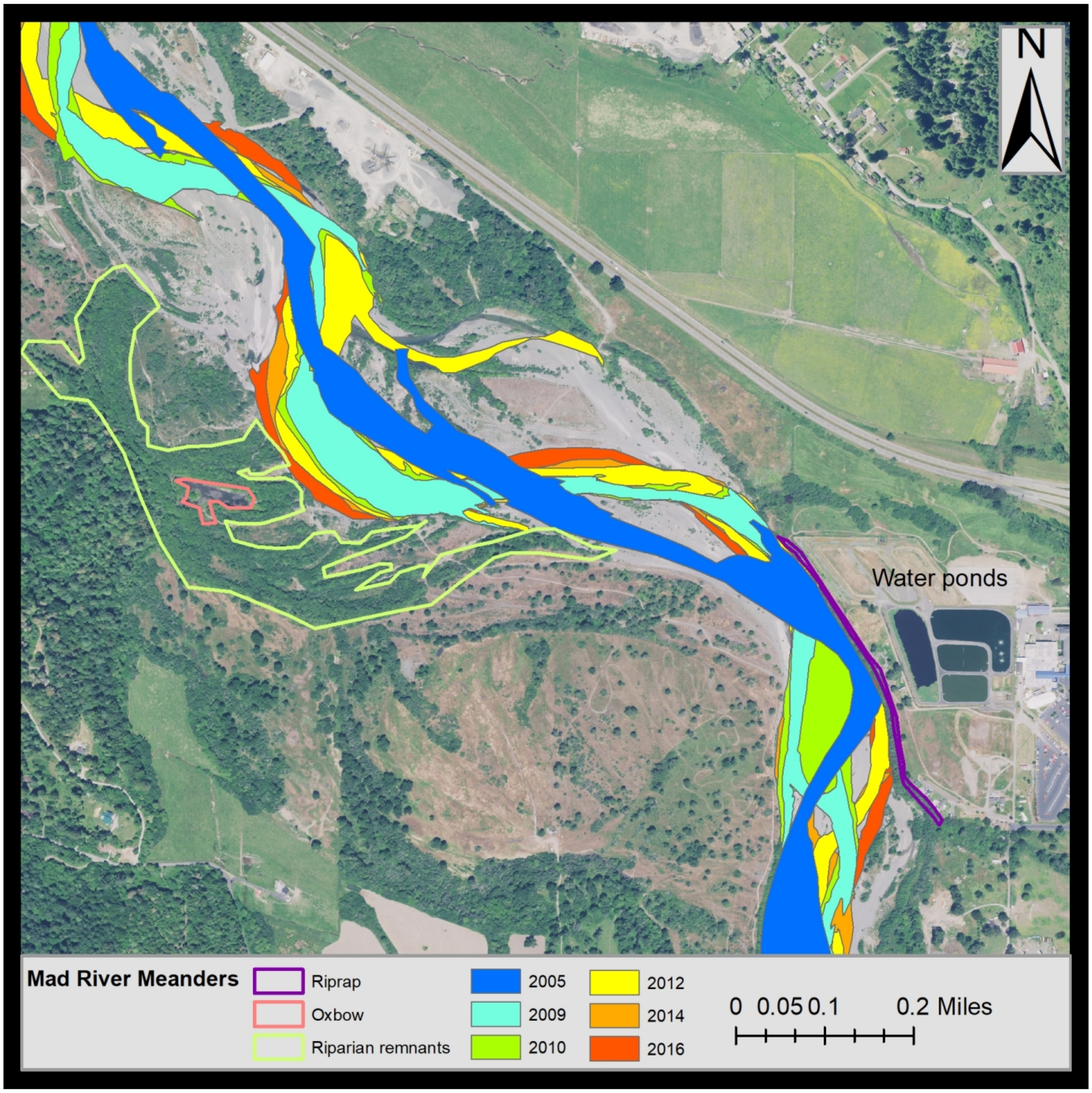

Figure 4. *Riparian remnants (lemon green), historic oxbow lakes (salmon outline) and implementation of a retaining wall (riprap, purple outline) for the water ponds and residential/commercial lands show the effects of the shifting meander of the Mad River in Humboldt county.*

Methods 4.

Shapefile data of Humboldt County's Agricultural land soils was retrieved from Stanford Library's "Earthwork's". Overlaying these shape files on the 2016 NAIP image of the chosen river segment, we were able to categorize each polygon's soil type, provided through the attribute data of the given polygons.

Results 4.

The map created can be seen in figure 5. A deeper analysis of soil type can be seen in the discussion portion. With thanks to Professor Marshall of Humboldt State University, we were able to understand the soil typing system, having the soil series first then classification number second, for example: Ru10, Russ soil series classified 10. The numbers associated with the soil series are for descriptors only and contain information of slope, soil texture, etc.

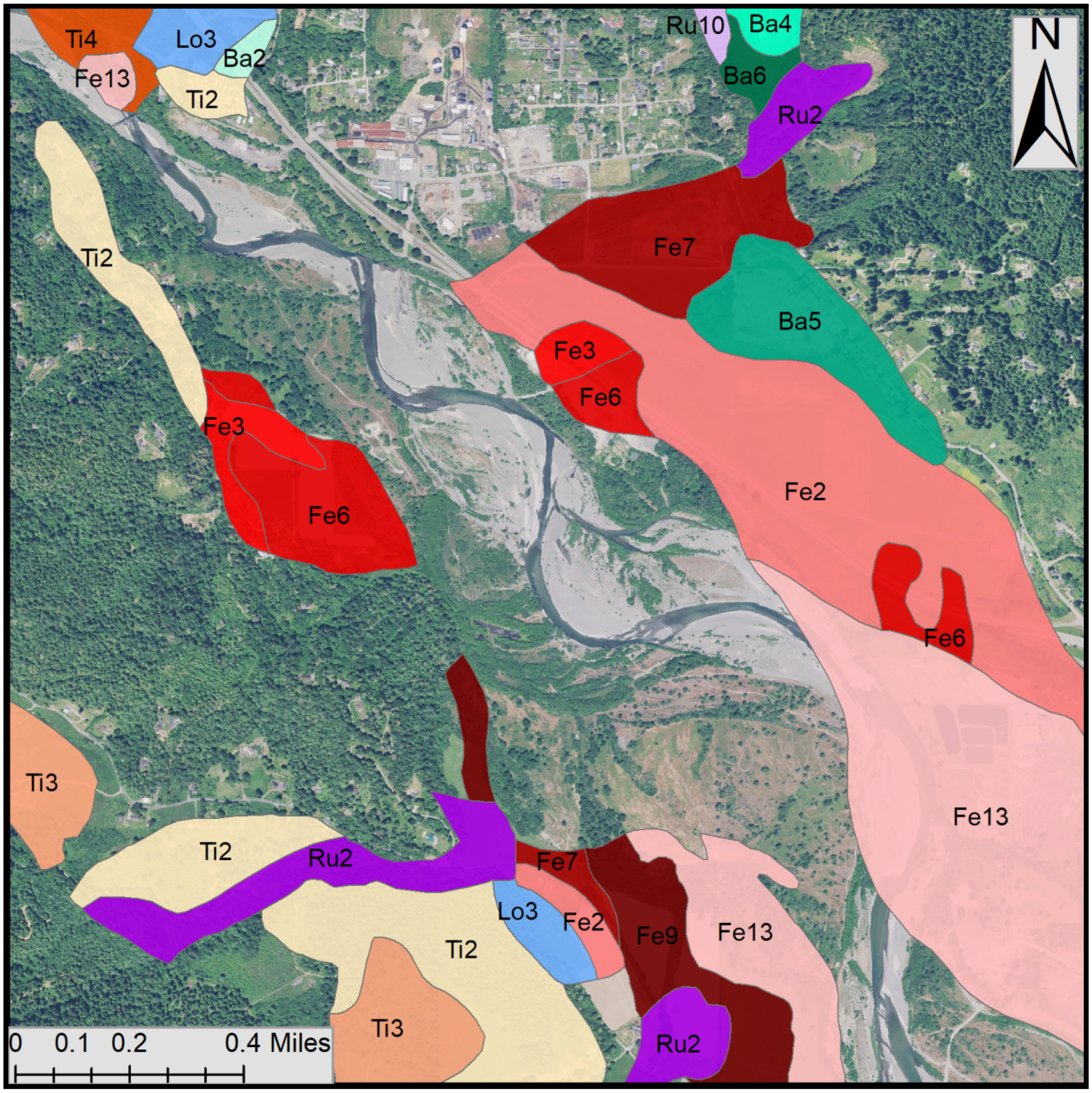

Figure 5. Locations of soil type regions of the Mad River in Humboldt County, identified by soil series

Methods 5.

Using the soil map as a base map, we created a new shapefile to create point features indicating landslide locations. The locations are based on research of soil textures that affect the chances of a landslide occurring.

Results 5.

From the soil texture information found online, we were able to hypothesize landslides occurring in areas with soil Fe2, Fe3, Fe6, or Fe13. An in-depth explanation as to how these locations were chosen can be found in part 5 of the discussion.

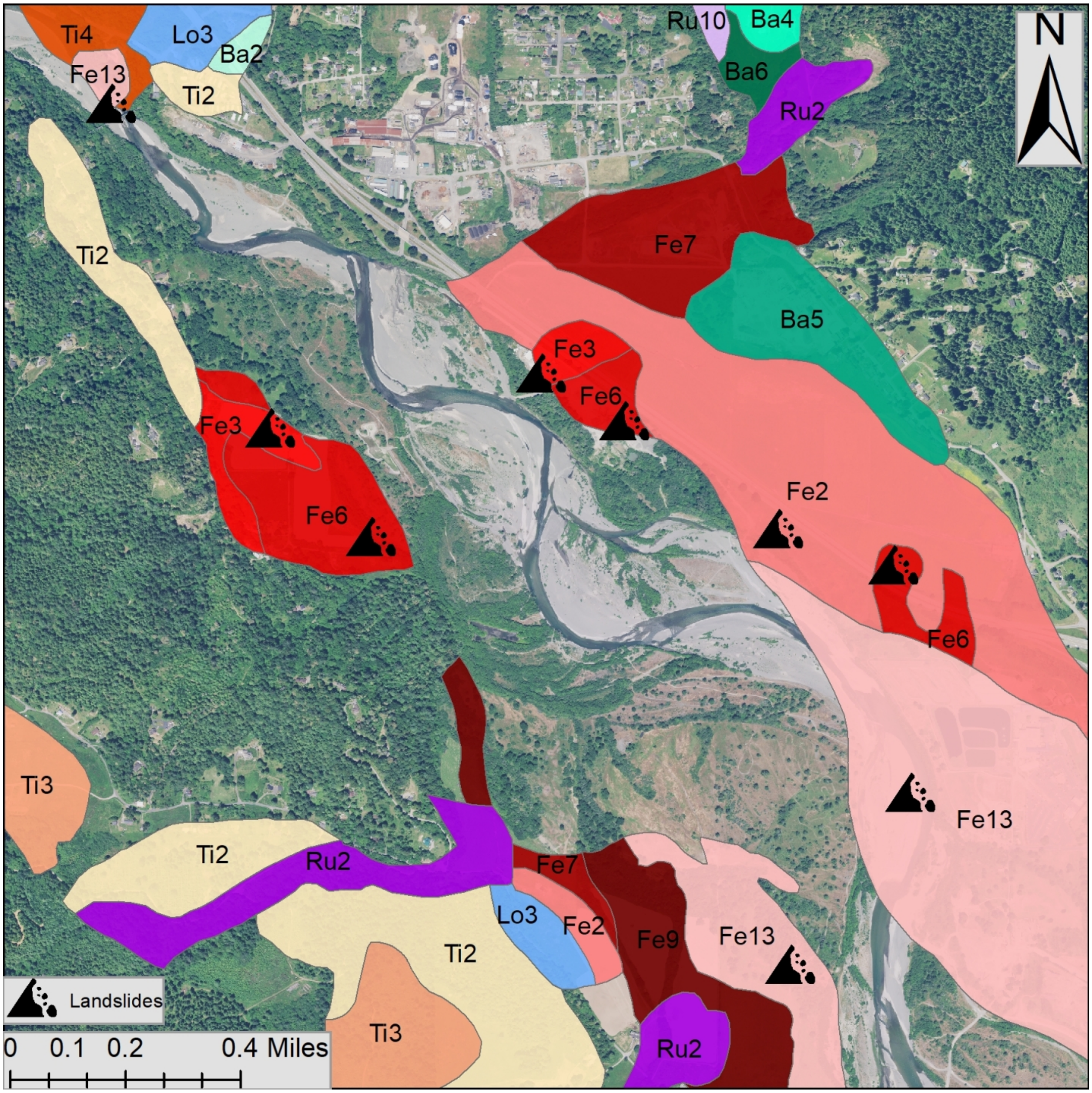

Figure 6. Potential landslides based on soil textures along the Mad River in Humboldt County. Soil data same as Figure 5.

Discussion

Part 1. For this small part of the Mad River, the rate of change is 8,470 m^2/yr. As the trend line in figure 1 shows the graph shows the overlap footprint area decrease as we go backward in time from 2016. This is what we expected would be happening. There are many variables that we didn't take into consideration like rainfall levels and date the data was collected, but in future research, these aspects should be investigated. The general overlap lost would not continue forever, after enough time we speculate that the graph would change and the trend line would have a positive slope as the river came back across the meander belt.

Part 2. The rate the river is meandering is an always changing thing. If we had put out transect anywhere else the rate would be different. The rate also increases as the bend ages. As the bend ages, it becomes curvier and this steeper curve forces the water into the bank faster which cause it to erode faster. The curve in a river will continue to extend until it cuts itself off and becomes an oxbow lake.

Part 3. Wall structures that protect the Blue Lake Rancheria (tribal lands) & casino, in addition to residential infrastructure nearby have affected of the meander of the Mad river. This information is useful in consideration of it would be wise to move nearby residential and commercial buildings elsewhere to restore the Mad river to its original state. The impacts to consider are future entrenchment shifts in natural meanders and the possibility of water table decline that will harm all species and residents near the Mad river.

Part 4. The map seen in figure 5, is labeled by soil typing. The soil type consists of the soil series and a number, which identifies characteristics. Attribute data associated with the original shape file also include soil texture and slope. The river channel is composed mainly of Fluvent, a sub-order of Entisol. This soil is easily drained and of course texture that is common in river channels. Moving outward on either side from the channel towards Fe (Ferndale series) the texture turns to a fine-silty or coarse loamy texture. Continuing further the soil transitions to a fine loam. The smaller the particle size of any texture has the great the risk of erosion (Better Soils).

Part 5. The Mad River watershed has a history of landslides occurring in the area due to heavy precipitation and seismic activity (Tolhurst, 1995). Although no written record was found of landslides occurring during the years we were analyzing, the effect past and future landslides have on the river are still important to discuss. Most commonly, the Mad River experiences shallow or deep-seated landslides (Stillwater Sciences, 2010). Shallow landslides include “debris slides, debris flows, rock falls, and channel bank failures;” different from deep seated landslides that are a bigger type of mass wasting spread over large areas (Stillwater Sciences, 2010). Both of these types of landslides increase the amount of sediment entering the river. An increase in sedimentation can affect the water quality of the river by increasing its’ turbidity and can also widen the river channel over time. In Figure 6, soils Fe13 and Fe3 are made of coarse grain and sandy material (Von Dohlen, 2015). Shallow landslides occur more often in soils with this kind of texture (California Department of Conservation,2018). Also located in the same Figure, Fe2 and Fe6 have a silt loam texture (Von Dohlen, 2015). Soils with high silt amounts are prone to erosion (Conners, 2018), therefore with a mix of either heavy precipitation or seismic activity, shallow or deep-seated landslides can occur in these locations as well.

The elements that we analyzed where all relevant locations to begin research on the Mad River. Organizations like the USGS use analysis techniques similar to ours that look at landslide potential, sediment movement, maps, and its dynamics in order to monitor river ecosystems (River Sediment Dynamics, n.d.).

Conclusion

We analyzed and researched for each of our proposed concepts; percent the river overlaps changes from year to year, the rate of meander in meter per year at the selected transect, the retaining wall and its effect on the meander of the river, soil types and their erosive potential, potential landslides and their effect on the river. Several maps were created for a visual representation of our analysis and mush of our research can be found with our discussion. Own analysis and conclusions with be a good place to start for future research.

Acknowledgments

Susan Marshal, Dr. David Gwenzi, Humboldt State University, National Oceanic and Atmospheric Administration, Joint effort between U.C. Davis and Humboldt County

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