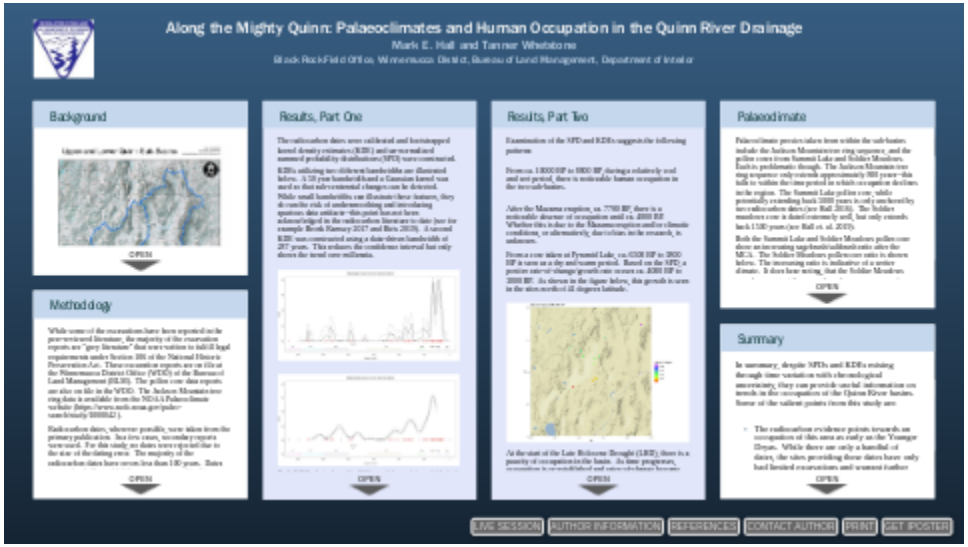
Along the Mighty Quinn: Palaeoclimates and Human Occupation in the Quinn River Drainage



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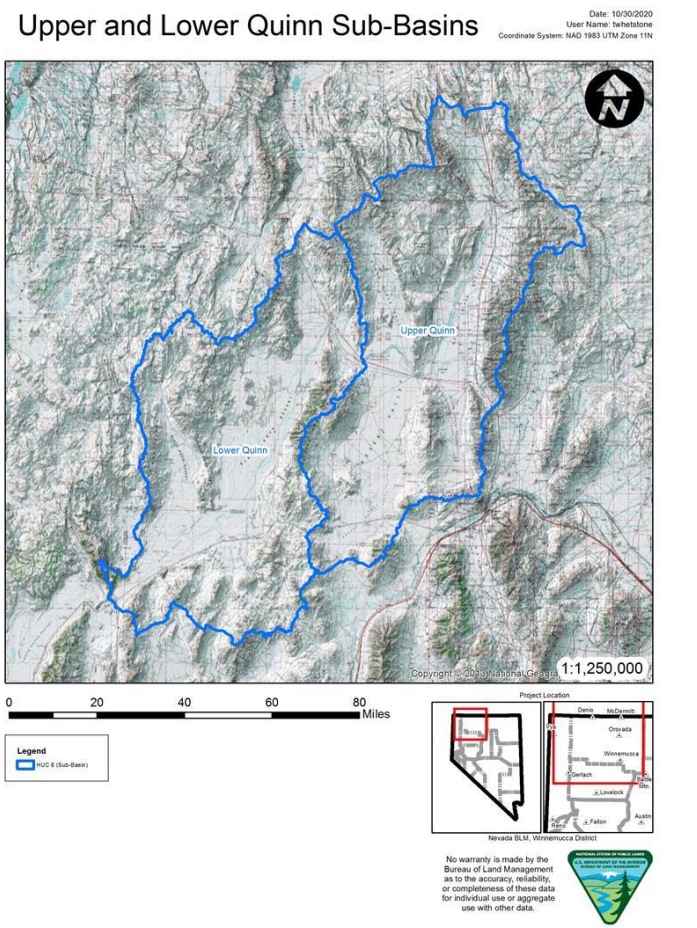
BACKGROUND



The Upper and Lower Quinn River sub-basins (HUC-8 16040201 and 16040202) comprise one of the single largest drainages in northwest Nevada. These two sub-basins cover approximately 1.7 million hectares. With tributaries originating in Oregon in the Montana Mountains and the Santa Rose Range, the Quinn river flows 180 km to the Black Rock Desert playa and forms a seasonal lake in the Quinn River sink. The elevational gradient across these two sub-basins ranges from 2000 m to 1100 m. Sagebrush and perennial grasses dominate the higher elevations, with the lowlands being dominated by greasewood, saltbrush and desert scrub. The Black Rock desert playa is an alkaline basin that was once part of Lake Lahontan.

This study examines human occupation in the drainage over the past 12.5 kya in context ofa variety of palaeoclimate records from the drainage and adjoining areas. The drainage contains over 1100 prehistoric sites. Out of these, approximately 50 sites have been excavated, but only 19 sites have had suitable materials radiocarbon dated. The database for this study consists of 108 radiocarbon dates from charcoal, plant matter (from basketry), some wood and animal bone.

METHODOLOGY

While some of the excavations have been reported in the peer-reviewed literature, the majority of the excavation reports are "grey literature" that were written to fulfill legal requirements under Section 106 of the National Historic Preservation Act. These excavation reports are on file at the Winnemucca District Office (WDO) of the Bureau of Land Management (BLM). The pollen core data reports are also on file in the WDO. The Jackson Mountain tree ring data is available from the NOAA Palaeoclimate website (https://www.ncdc.noaa.gov/paleo-search/study/1000042).

Radiocarbon dates, wherever possible, were taken from the primary publication. In a few cases, secondary reports were used. For this study, no dates were rejected due to the size of the dating error. The majority of the radiocarbon dates have errors less than 100 years. Dates from tufa, shells, and fish bone were not used in this study. The location of the sites were confirmed in either the WDO's cultural database or the State Historic Preservation Office's database.

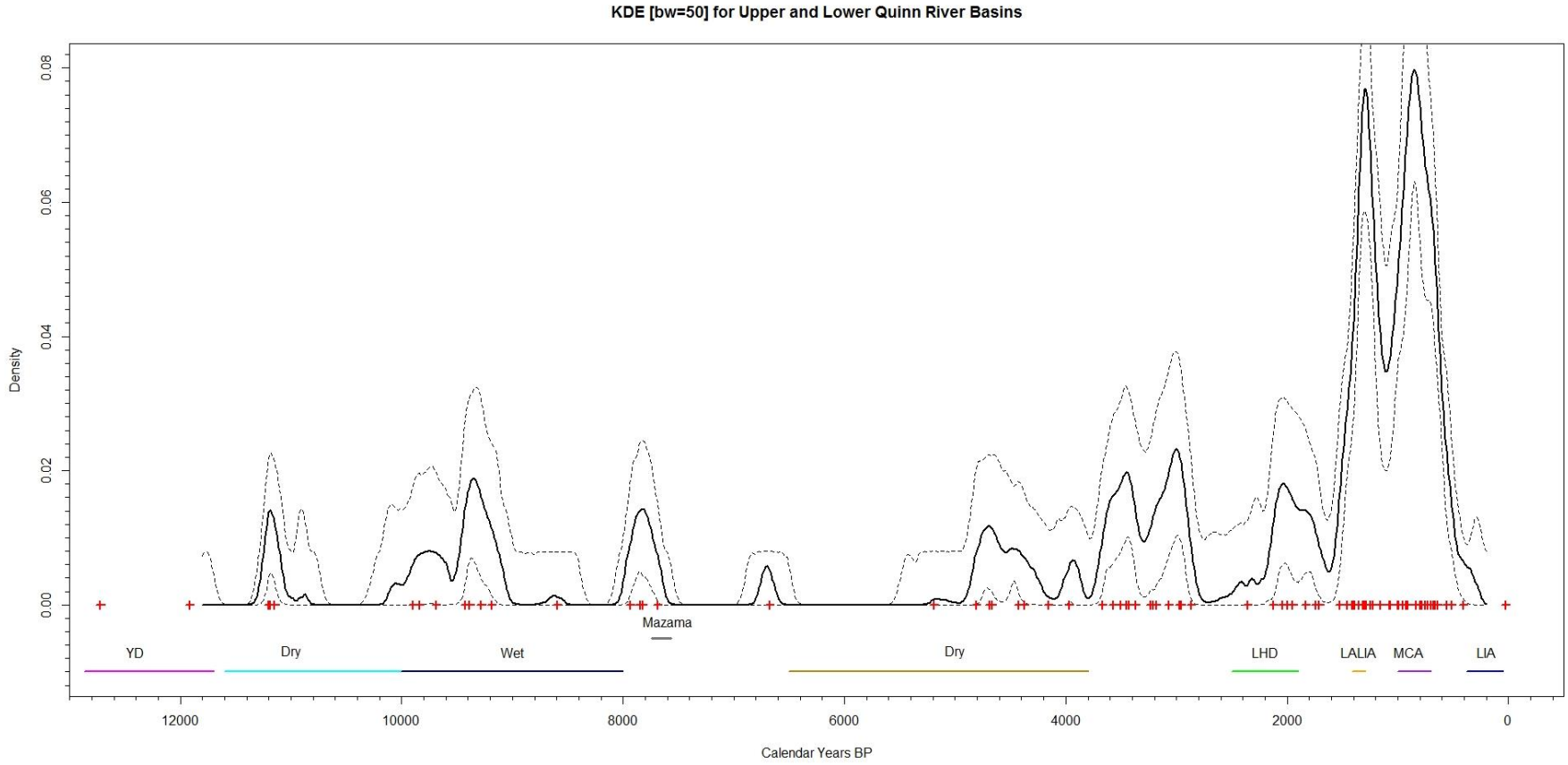
While "old wood" could be an issue, juniper growth is confined mainly to the Granite Range and the Jackson Mountain areas. In the case of the Jackson Mountains, there are currently junipers growing there that are over 1000 years old.

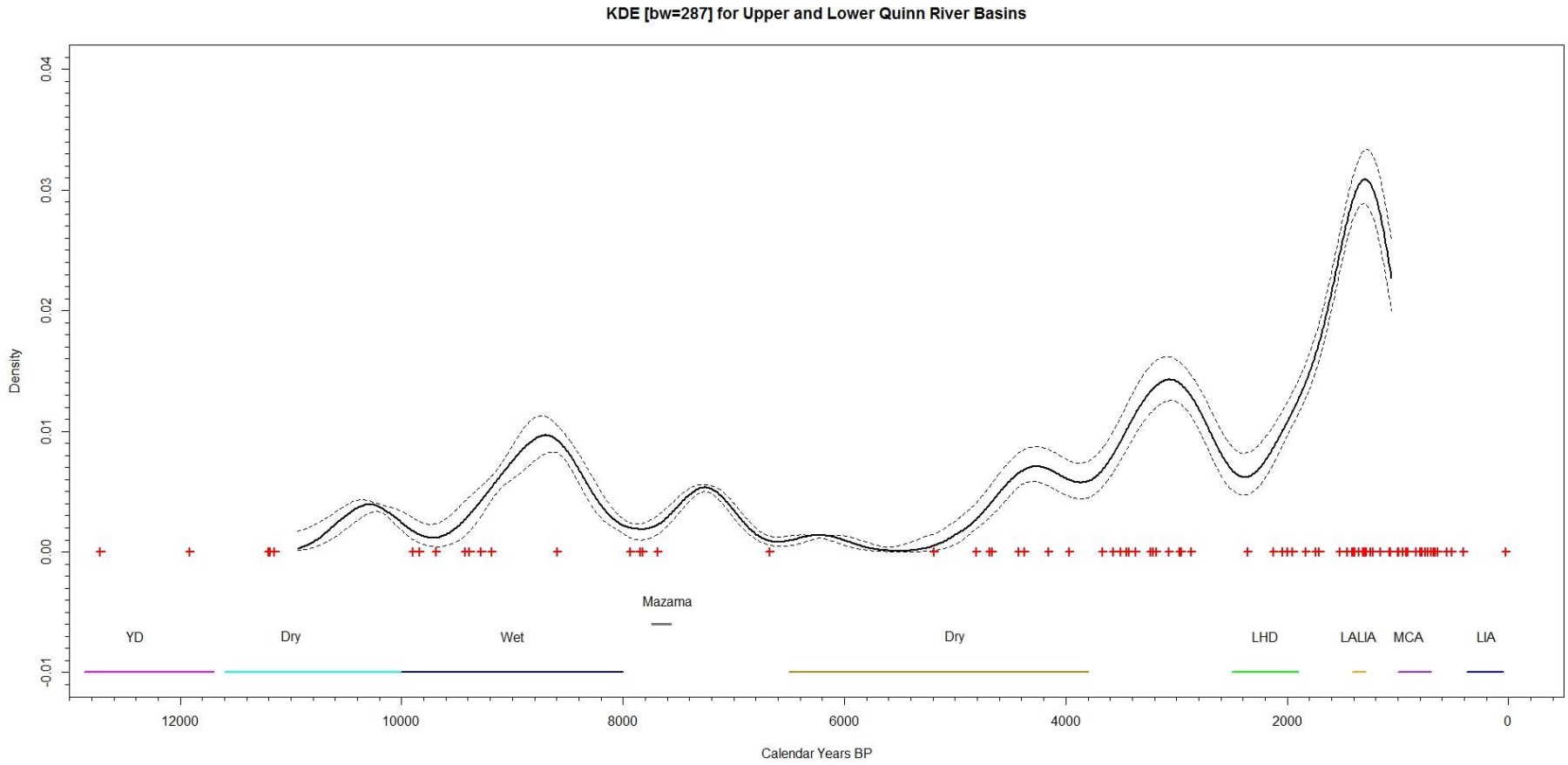
Statistical analyses are done in R (R Core Team 2020). In addition to utilizing scripts written by Blarquez (2019), Carleton (2020), and McLaughlin (2019), the following R packages were used: Bacon (Blaauw and Christen 2011), Bchron (Haslett and Parnell), clam (Blaauw 2010), dplR (Bunn 2008), ggmap (Kahle and Wickham 2013), and rcarbon (Crema and Bevan 2020). Radiocarbon calibrations utilized the InterCal20 calibration curve, while age-depth modelling for dating the pollen cores was done using Bacon and Bchron.

RESULTS, PART ONE

The radiocarbon dates were calibrated and bootstrapped kernel density estimates (KDE) and un-normalized summed probability distributions (SPD) were constructed.

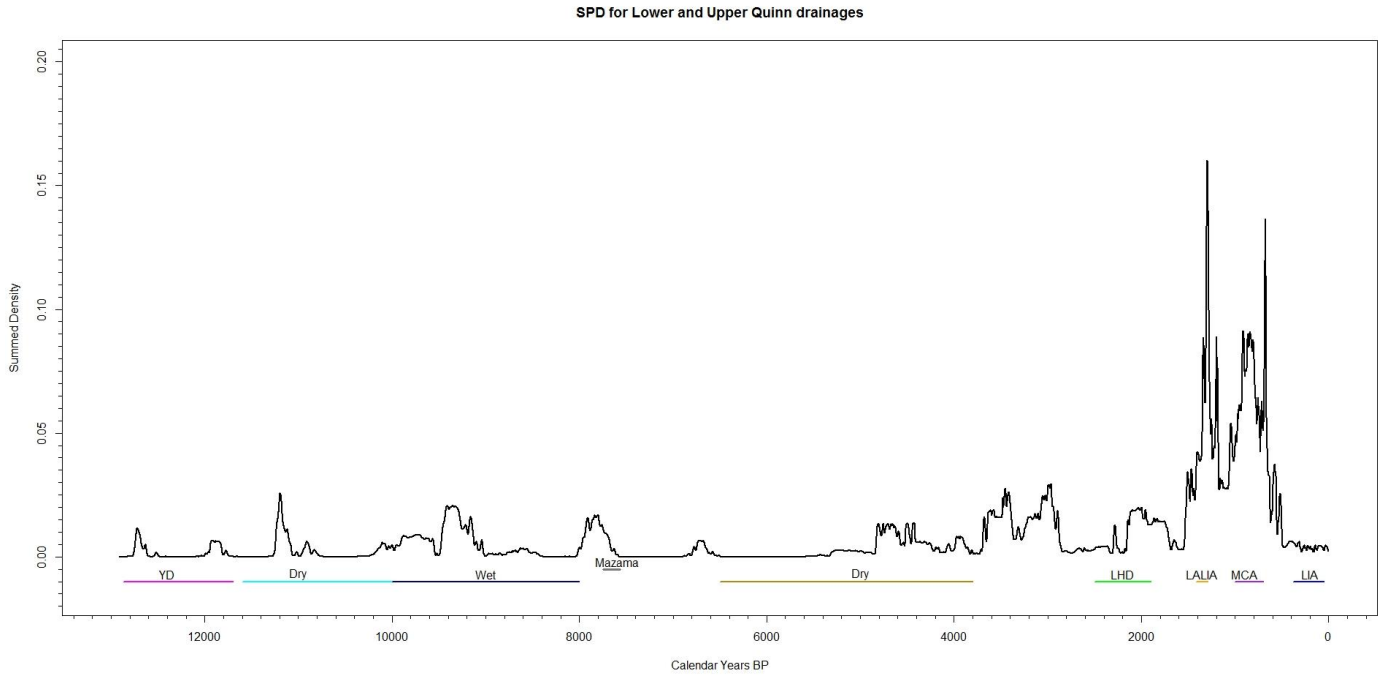
KDEs utilizing two different bandwidths are illustrated below. A 50 year bandwidth and a Gaussian kernel was used so that sub-centennial changes can be detected. While small bandwidths can illustrate these features, they do run the risk of undersmoothing and introducing spurious data artifacts--this point has not been acknowledged in the radiocarbon literature to date (see for example Bronk Ramsey 2017 and Riris 2019). A second KDE was constructed using a data-driven bandwidth of 287 years. This reduces the confidence interval but only shows the trend over millennia.


KDE [bw=50] for Upper and Lower Quinn River Basins
Density
0.00
0.02
0.04
0.06
0.08
Mazama
YD
Dry
Wet
Dry
LHD
LALIA
MCA
LIA
12000
10000
8000
6000
4000
2000
0
Calendar Years BP



Both KDE plots show the 95% confidence interval (dotted line) around the median density estimate (solid line). The red crosses are the medians of the calibrated dates. Various climatic phases are also illustrated, plus the 95% HPD estimate for the date of the Mazama eruption.

The SPD is illustrated below.

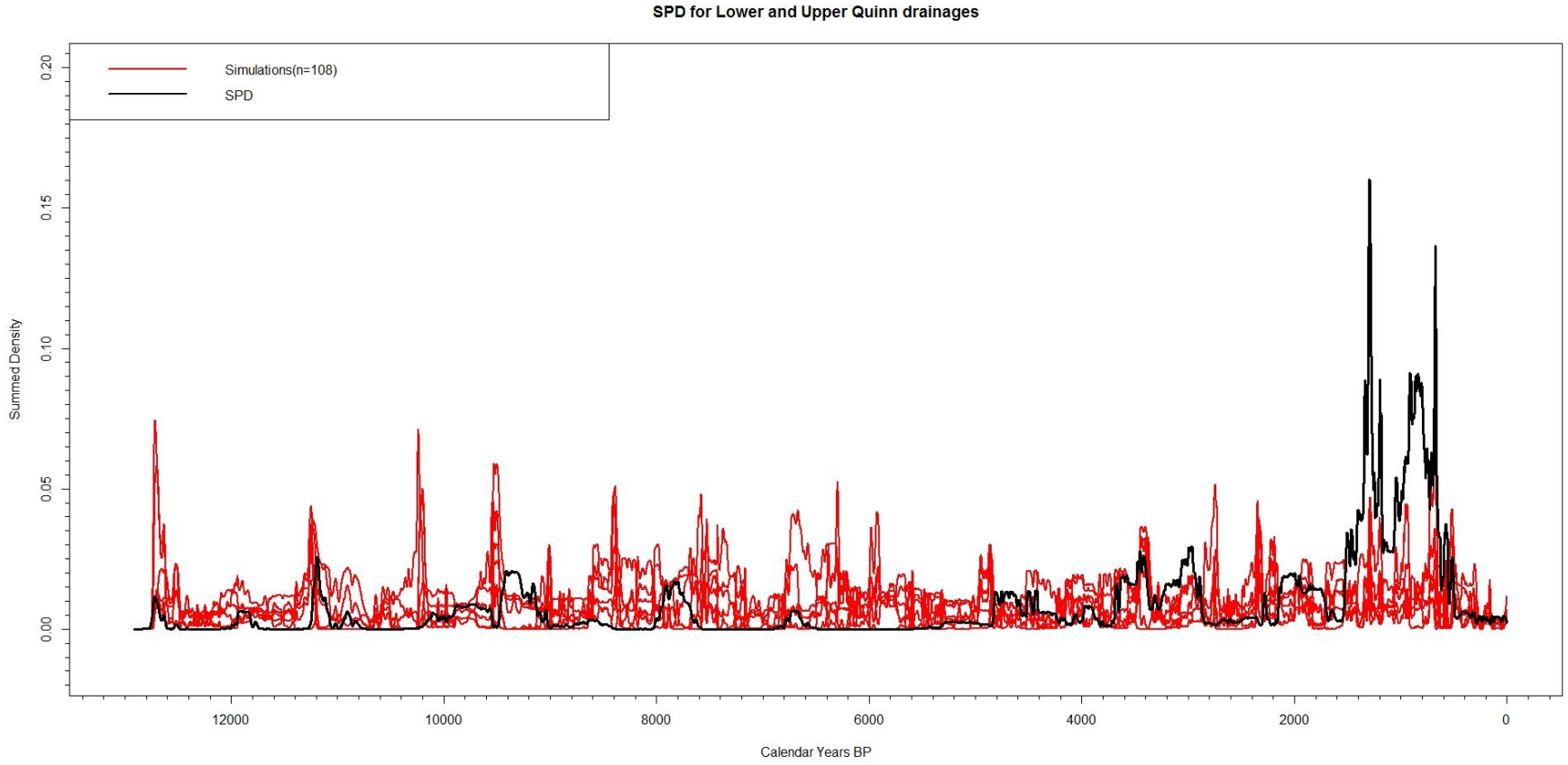


Like the KDEs, various climatic phases are also illustrated, plus the 95% HPD estimate for the date of the Mazama eruption.

Before discussing a variety of features in the KDEs and SPD, a few points need to be kept in mind:

1. This data set is small, and can only be treated as an approximation of the temporal frequency distribution (tfd)(Brown 2015).
2. The calibration curve and its uncertainities can introduce artifacts into the SPD. Simulation (Brown 2015) has shown thatthe regions between 7500-7100 cal BP, 6500-6200 cal BP, 5600-5400 cal BP, 2900-2750 cal BP, and 1500-500 cal BP are problematic. Simulations as exemplified by Armit et. al. (2013) and Bronk Ramsey (2017) are possible ways around this.
3. Both the SPD and KDE mix through-time variation with chronological uncertainty (Carleton 2020). KDEs do have an advantage of lowering the spurious calibration effects.

With the above in mind, following Armit et. al. (2013), ten simulations were performed by randomly selecting 108 radiocarbon dates from the range of 10500 bp and 200 bp. A standard deviation of 40 years bp was assumed. These simulated radiocarbon dates were then calibrated and SPDs constructed. These simulations are plotted against the actual SPD in the figure below.



From the examination of the above figure and the KDEs, it is clear that:

- The paucity of dates between ca. 7600 BP and 4800 BP is real and not due to the calibration curve. It is uncertain whether this represents a bias in excavation and/or preservation, or a lack of human occupation is uncertain.
- Likewise, the paucity of dates after 600 BP is real and not due to the calibration curve.
- The KDEs illustrate there is a number of calibrated determinations falling into this range. The peaks between ca. 2000 BP and 600 BP are due in part to the calibration curve, but the simulations do not demonstrate a similar intensity.
- Finally, a taphonomic process may be in play for materials older than 8000 BP.

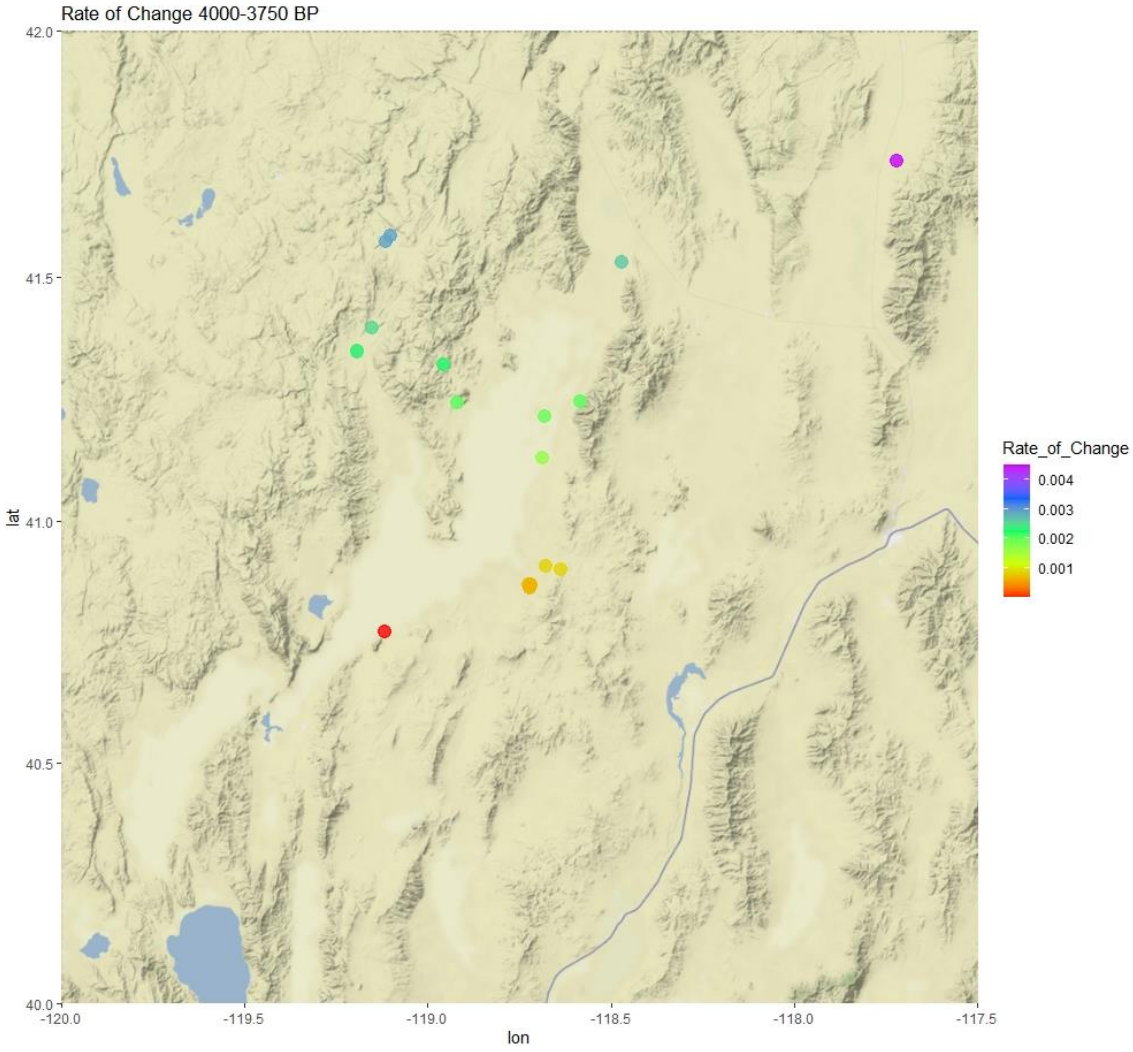
RESULTS, PART TWO

Examination of the SPD and KDEs suggests the following patterns:

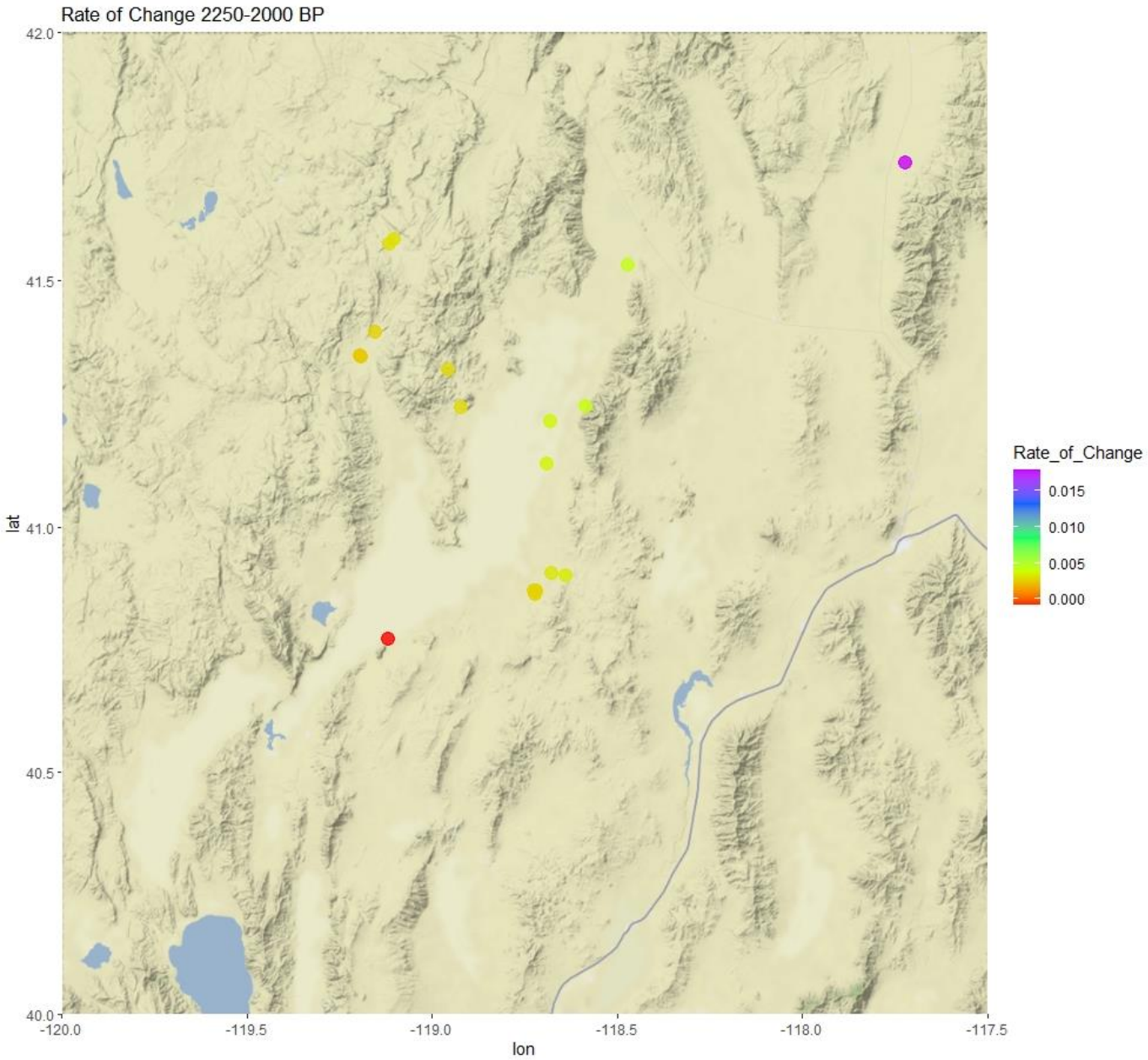
From ca. 10000 BP to 8800 BP, during a relatively cool and wet period, there is noticeable human occupation in the two sub-basins.

After the Mazama eruption, ca. 7700 BP, there is a noticeable absence of occupation until ca. 4800 BP. Whether this is due to the Mazama eruption and/or climatic conditions, or alternatively, due to bias in the research, is unknown.

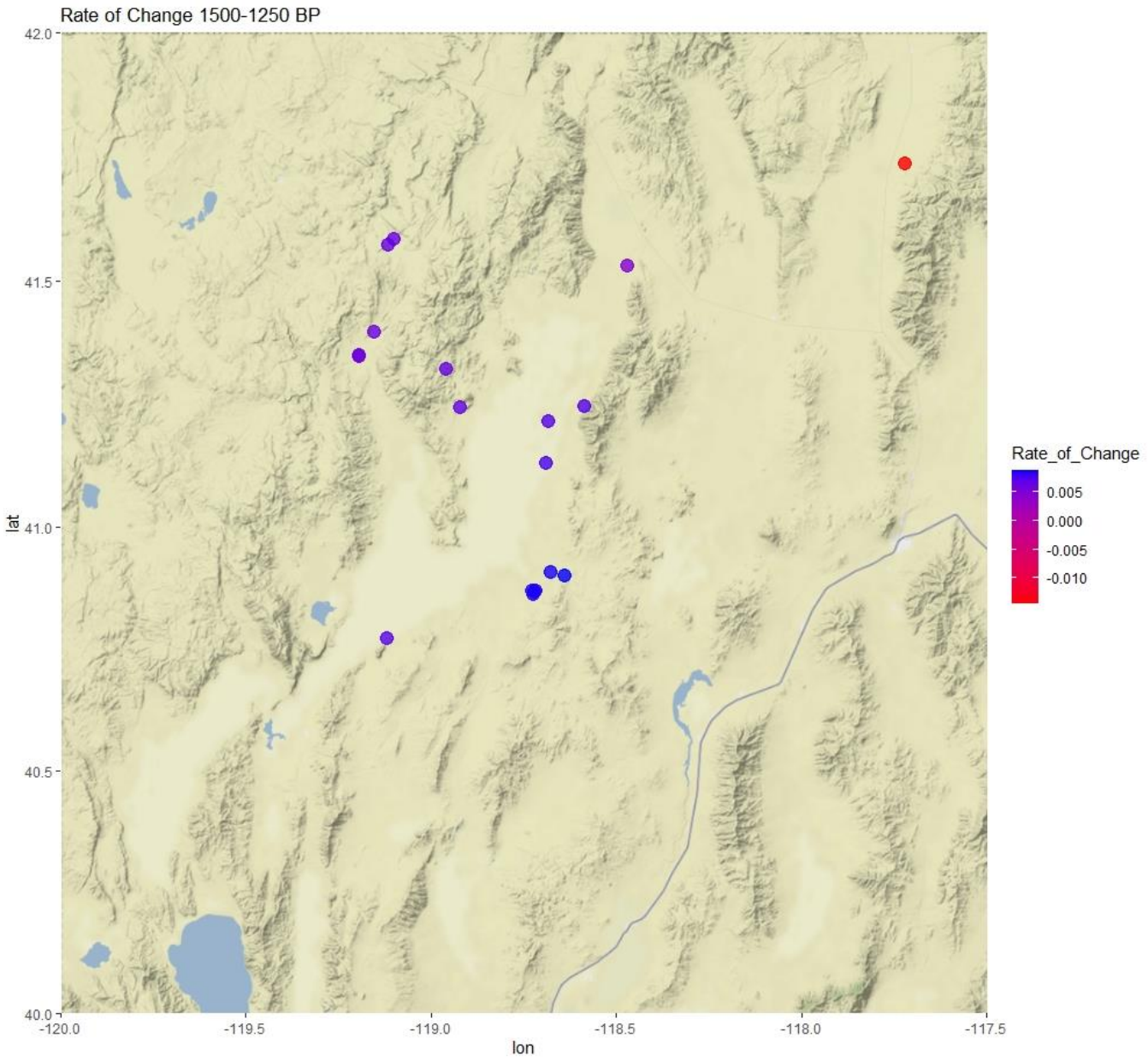
From a core taken at Pyramid Lake, ca. 6500 BP to 3800 BP is seen as a dry and warm period. Based on the SPD, a postive rate-of-change/growth rate occurs ca. 4000 BP to 3800 BP. As shown in the figure below, this growth is seen in the sites north of 41 degrees latitude.



At the start of the Late Holocene Drought (LHD), there is a paucity of occupation in the basin. As time progresses, occupation is re-established and rates-of-change become positive, with a general trend of increasing as one moves further north.

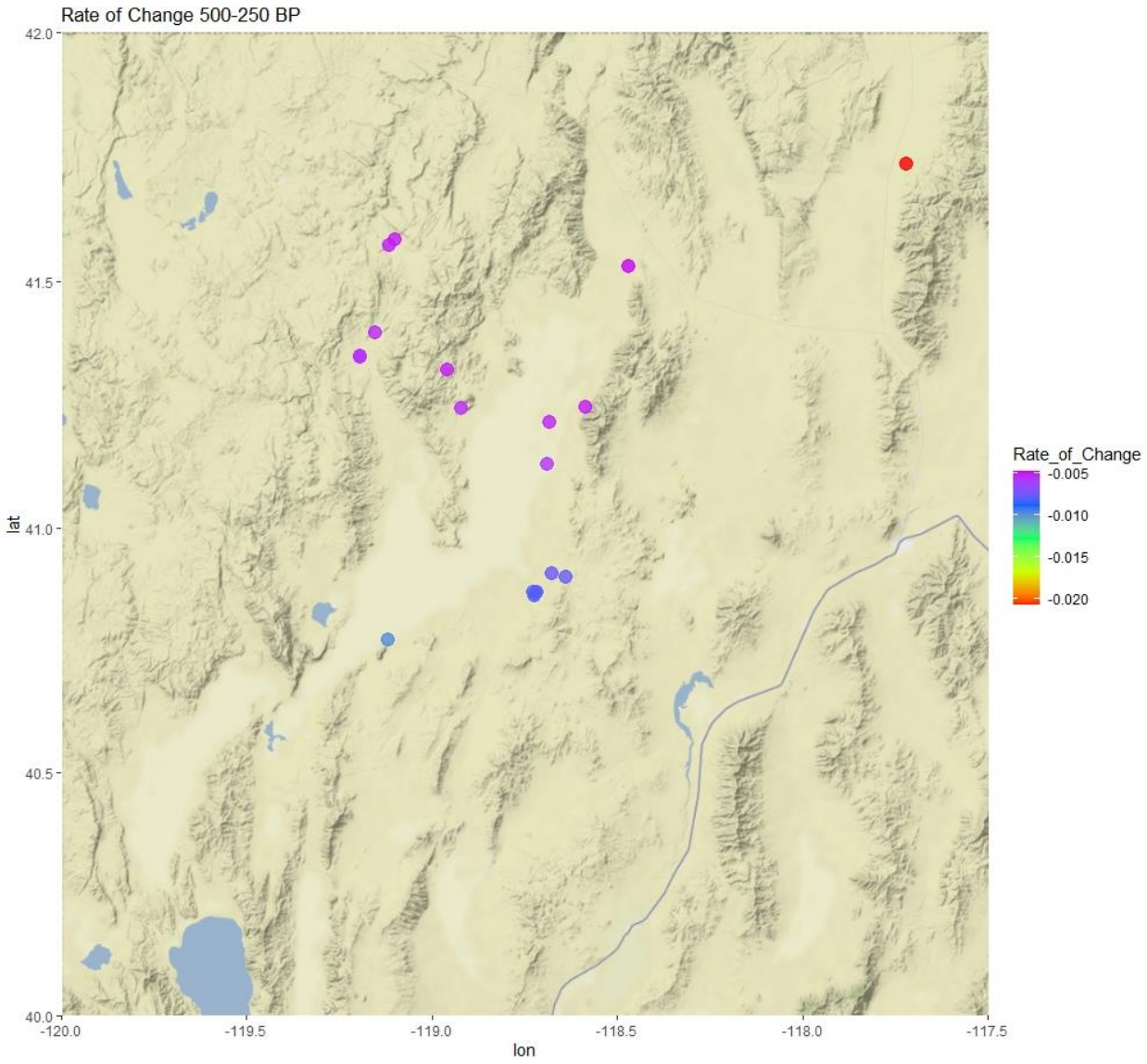

Rate of Change 2250-2000 BP
42.0
41.5
41.0
40.5
40.0
lat
-120.0
-119.5
-119.0
-118.5
-118.0
-117.5
lon
Rate_of_Change
0.015
0.010
0.005
0.000

Positive rates-of-change/growth rate are seen during the Late Antique Little Ice Age (LALIA) and the Medieval Climatic Anomaly


Rate of Change 1500-1250 BP
42.0
41.5
41.0
40.5
40.0
lat
-120.0
-119.5
-119.0
-118.5
-118.0
-117.5
lon
Rate_of_Change
0.005
0.000
-0.005
-0.010

(MCA).

Negative rates-of-change/growth rates are seen after ca. 750 BP.

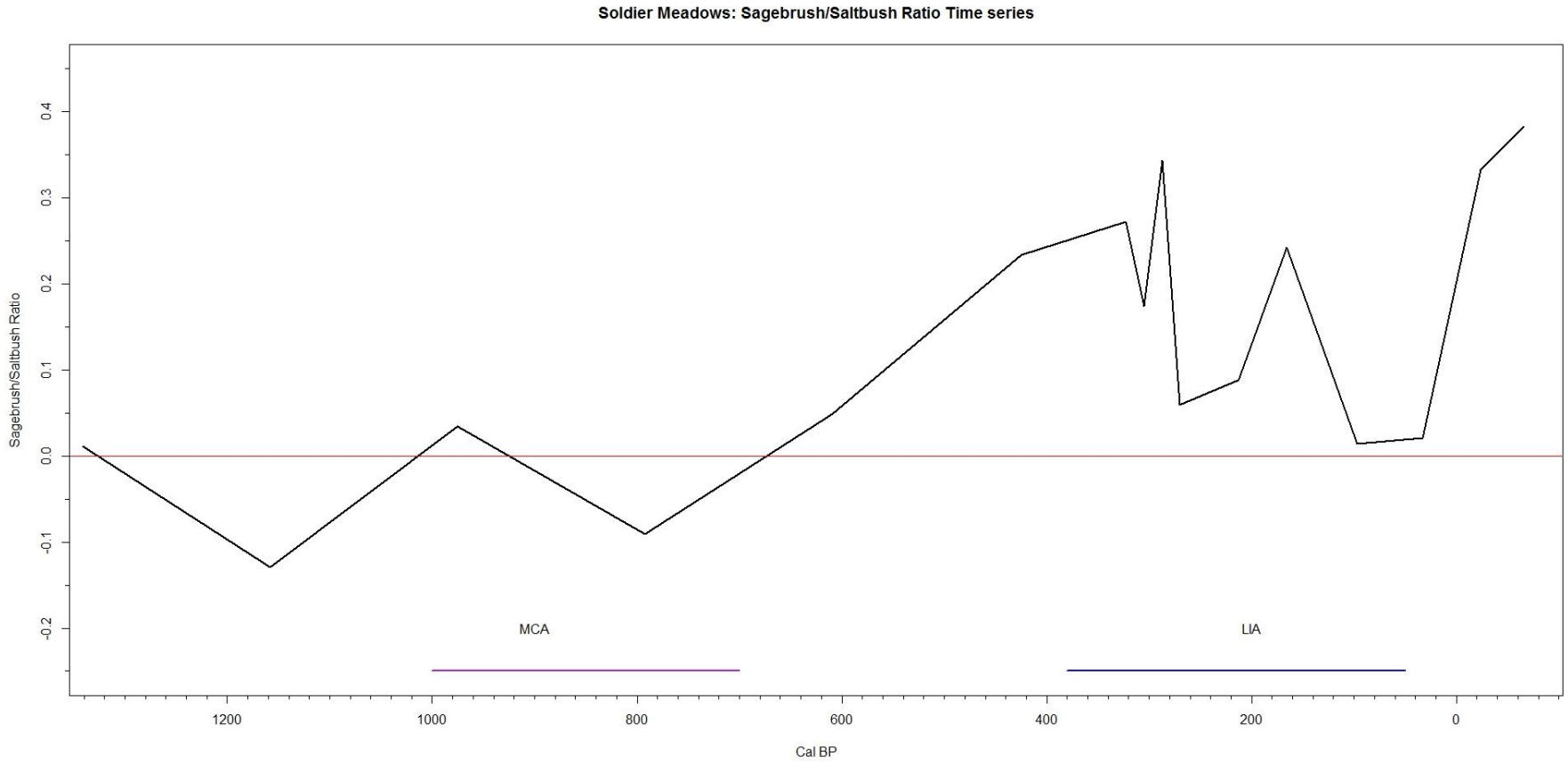


This decline in settlement/occupation after the MCA is seen elsewhere in the northwest Great Basin (see Hildebrandt et. al. 2016; McGuire et. al. 2018). While the climate is ameolirated at this time (see next section), the paucity of sites that post-date the MCA suggests a possible subsistence shift to smaller family groups exploiting new ecological zones/habitats.

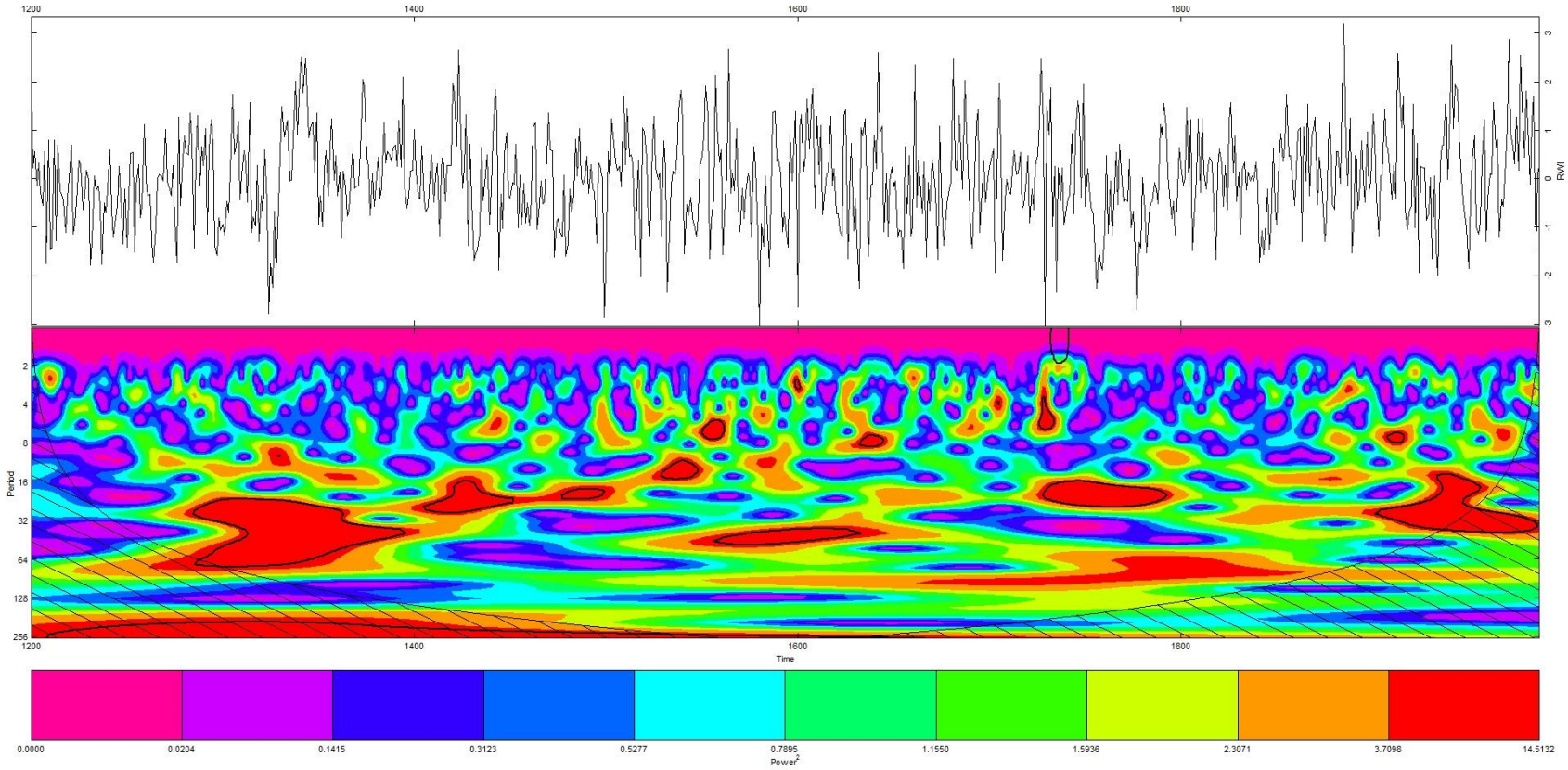
PALAEOCLIMATE

Palaeoclimate proxies taken from within the sub-basins include the Jackson Mountain tree ring sequence, and the pollen cores from Summit Lake and Soldier Meadows. Each is problematic though. The Jackson Mountain tree ring sequence only extends approximately 800 years--this falls to within the time period in which occupation declines in the region. The Summit Lake pollen core, while potentially extending back 5000 years is only anchored by two radiocarbon dates (see Hall 2016). The Soldier meadows core is dated extremely well, but only extends back 1500 years (see Hall et. al. 2019).

Both the Summit Lake and Soldier Meadows pollen core show an increasing sagebrush/saltbrush ratio after the MCA. The Soldier Meadows pollen core ratio is shown below. The increasing ratio is indicative of a wetter climate. It does bear noting, that the Soldier Meadows core does suggest there may have been some years of drought in the LIA, given the drops in the ratio.

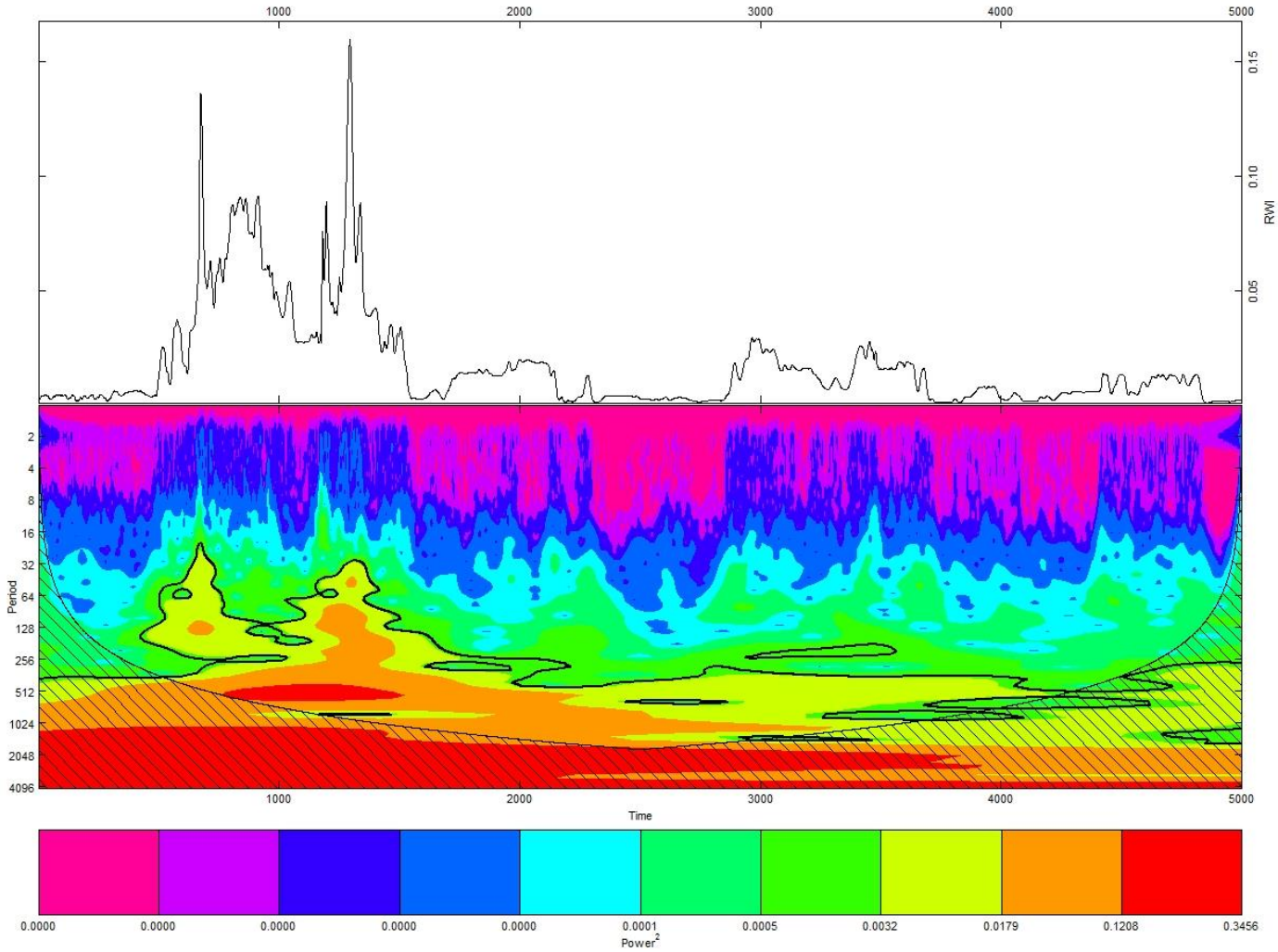


Morlet wavelet analysis of the Jackson Mountain tree ring data is below.



The 99% significance level (black line) suggest a 64 to 20 year cycle in the tree ring data. The 20 some odd-year cycle could be arising from the winter precipitation Pacific Decadal Oscillation (PDO) (Gedalof et. al. 2002).

Wavelet analysis was also performed on the SPD of the calibrated radiocarbon dates. Due to the paucity of dates before 5000 BP, the time period of interest was limited to 5000 to 100 BP. The plot is below.



At the 99% siginificance level (black line) there appears to be a cycle of 256 to 64 years in the data set. A 50 to 70 year cycle would correspond to the PDO (Gedalof et. al. 2002; MacDonald and Case 2005). This significance level also includes the DeVries-Suess cycle and the Gleissberg cycle. Further investigations need to be pursued on this topic.

SUMMARY

In summary, despite SPDs and KDEs mixing through time variation with chronological uncertainty, they can provide useful information on trends in the occupation of the Quinn River basins. Some of the salient points from this study are:

- The radiocarbon evidence points towards an occupation of this area as early as the Younger Dryas. While there are only a handful of dates, the sites providing these dates have only had limited excavations and warrant further research.
- There is a paucity of dates post-dating the Mazama eruption until ca. 5000 BP. Whether this is due to the eruption and a drier climate, or the lack of research on relevant sites, remains uncertain.
- Before the LHD, ca. 3800-2800 BP, there is widespread occupation throughout the basins. The LHD sees a drop in occupation, but before 2000 BP, occupation is re-established north of 41 degrees N.
- The intensity of the peaks during the LALIA and the MCA are due in part to the shape of the calibration curve, but also the number of calibrated radiocarbon dates falling into these two periods.
- While the climate is ameolirated in the LIA, there is a paucity in dated sites. Whether this is due to a shift in settlement to ecological zones that have received only cursory excvation and survey, or an actual depopulation of the NW Great Basin, is a subject of debate and further research.

Questions? Mark and Tanner would like to hear from you--email us at mehall@blm.gov

Alternatively, for North American participants, you can join the session's roundtable by calling in to 1-888-827-8501, passcode 8695550# on December 7th, 2020 at 4:30-5:30 PM PST.

AUTHOR INFORMATION

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