

Appendix 2: Evidence Supporting Insecurities Coding

The information, citations, and interpretations contained in Appendix 2 are intended to serve as a foundational source for future studies of depopulation and the insecurities associated with the 13th through 15th century period in the U.S. Southwest and Mexican Northwest (SW/NW). No comparable source of SW/NW data exists. For archaeologists, the interpretations and citations allow local conditions (settlement to community scale) to be compared to culture area and regional-scale conditions. Systematic investigations of the causes of similarities and differences in conditions within and between culture areas will be of substantial interest. We especially recommend identifying conditions associated with peoples and places that did not experience substantial depopulation.

ANCESTRAL PUEBLOAN

Note: The Ancestral Puebloan area contains at least four areas of persistence, places where people remained and in some cases population levels increased through the depopulation of the SW/NW. These areas of persistence include Hopi, Zuni, Acoma, and along the northern Rio Grande River.

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements.

Coding: High

Evidence supporting high economic insecurity preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Minimal externally produced goods:* Glowacki (2015:91-94) and sources therein note the lack of exotic materials (e.g., copper bells, macaws from northern New Mexico, obsidian, and turquoise) appearing in Ancestral Pueblo settlements during and after the collapse of Chaco. Robert Neily (1983) is also referenced by Glowacki (2015) as finding that there was “decreasing stylistic diversity” in pottery “and a decline in the frequency of exotic...lithic procurement,” both of which indicate decreasing participation in long-distance trade networks (Glowacki 2015:92).
2. *Increased local interaction.* Due to declining agricultural productivity, Kohler and Van West (1996) suggest that it was more worthwhile for populations in the Colorado Plateau to pool their resources locally instead of engaging in trade with those farther away. They also state that everyone in the region would have likely had less to trade because less food was being produced.

3. *Collapse of Chaco Canyon trading system:* As Chaco collapsed, trade within the Ancestral Pueblo region became more localized and intensified (Glowacki 2015:91-94).
4. *Archaeological syntheses:* Varien et al. (1996:99 and references therein) states that “In general, there is little evidence of interregional exchange [in their SW Colorado and SE Utah study area] during the thirteenth century in comparison to earlier centuries.”

Uncertainty: Low

A weakness of the evidence noted above is that it is dominated by work conducted in the central Mesa Verde regions with less representation from areas outside of that area. For example, in the Kayenta region (NE Arizona), Gumerman and Dean (1989:126) note that trade intensified after 1250 CE (during the depopulation interval) and was "widespread." The people in this region were also thought to have traded for luxury goods such as turquoise, copper bells, shell, and ceramics (Gumerman and Dean 1989:126).

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Food insecurity: High

Evidence supporting high food insecurity preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Declining wild and domesticated food resources.* Kuckelman et al. (2010:506) argues that the prevalence of domesticated turkeys, a main food source, declined in the later Ancestral Puebloan occupational period based on the faunal remains at Sand Canyon Pueblo. Kuckelman et al. (2010:506) also calculated turkey and artiodactyl indices which indicate an increased reliance on wild game and a declining amount of domesticated turkey. Additionally, a consequence of the lower availability of staple foods such as maize and domesticated animals was an increased reliance on non-domesticated plants and animals (Kohler et al. 2008:153; Kuckelman et al. 2010:503-509; Adams et al. 2007). Smaller game animals also became a predominant wild food source instead of artiodactyls (Muir and Driver 2002; Driver 2002 as cited in Kantner 2004:202).
2. *Declining maize productivity.* Van West and Dean (2000) detail several environmental factors that would have challenged successful agricultural productivity prior to and during the depopulation: declining alluvial water tables, floodplain degradation by stream channel entrenchment, and increasing spatial variability in climate. Schwindt and colleagues (2016),

relying on modeled maize niche size and variability developed by Bocinsky and Kohler (2014), reconstructed population densities in several sub-regions of the central Mesa Verde region. Their results demonstrate that during climate driven declines in agricultural productivity, there was not enough maize-producing land to feed people living in some sub-regions.

3. *Reduced mobility.* Warfare and the threat of violence likely prevented smaller communities from being able to hunt wild game, a steadily growing food source (Muir and Driver 2002:190).
4. *Bioarchaeological evidence of nutritional stress.* Martin (1994:100) found that bioarchaeological data shows evidence of increased nutritional stress at Canyon de Chelly and Mesa Verde during the period prior to depopulation.
5. *Water shortages.* Gumerman and Dean (1989:123) note that during the Pueblo III phase (1250-1300 C.E.), the Kayenta region experienced water shortages. This trend has also been documented at Kiet Siel in the late 1300s (Dean 2006:165).
6. *Deforestation and declining fuel wood.* Based on archaeobotanical evidence for changing fuel sources, Kohler and Matthews (1988) and Stiger (1979) have proposed that the Ancestral Puebloans' agricultural practices contributed to deforestation. Stiger (1979:139) also stresses that this deforestation was likely accompanied by increased soil degradation. Johnson et al.'s (2005:102) simulation of household fuel-wood consumption in a portion of southwestern Colorado provides additional evidence for deforestation, as the results demonstrate that areas near habitations become quickly depleted of deadwood followed by substantial areas depleted of both deadwood and living wood.
7. *Increasing food storage facilities as a response to shortages.* At Kiet Siel during the Tsegi Phase, there was an increase in the amount of food storage which Dean (2006:170-175) interprets as a response to food shortages.

Uncertainty: Moderate

In detailed investigations of archaeobotanical and faunal data from the Sand Canyon Archaeological Project involving multiple sites during the period leading up to and including depopulation, Duff et al. 2010:157 find, “overall, pressure on food and nonfood resources increased over time ...yet these impacts were relatively subtle and seem unlikely to have precipitated or required depopulation.”

Health Insecurity

Indicator: settlement aggregation, bioarchaeological evidence (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using

settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: High

Evidence supporting a high level of settlement aggregation preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Architectural evidence.* Both the architecture and the layout of Ancestral Puebloan communities indicate higher levels of aggregation in the years preceding migration out of the region (Varien 2006:41; Dean 2010:335; Varien et al. 2007:283; Glowacki 2010:209; Varien 2010:25; Lipe 2006:311, 312). Specifically, large communal structures became more prevalent than in earlier times (Glowacki 2010:209; Varien 2010:25; Lipe 2006:311, 312). There is also evidence that populations became more concentrated in the canyon regions during this time (Lipe 1995:153; Glowacki 2010:203, 214; Varien 2010:25, 27).
2. *Bioarchaeological evidence for declining health.* In her analysis of 64 skeletal remains from sites in the Dolores Archaeology Program area and 466 skeletal remains from the Mesa Verde area, Stodder (1987:366) saw declining health in Ancestral Puebloan populations towards the end of occupation. Cummings' (1994 as cited in Kantner 2004:167) analysis of coprolites at Hoy House and Lion House also found pinworms in all of the coprolites, which Kantner (1994) attributes to aggregation.
3. *Aggregation index (Total number of rooms/total number of settlements in culture area):* During the 1250-1299 interval, the index increased by 35%.
4. *Archaeological syntheses.* Varien et al. (1996:98) determined that "Between A.D. 1200 and 1250 there appears to have been an overall increase in population density, size, and degree of settlement aggregation, at least in the central [Mesa Verde] area, and there was a dramatic increase in site size and number (figure 7.8)." Kantner (2004:163-166 and sources therein) discusses the aggregation that was occurring in the Mesa Verde region and Sand Canyon in the 1200s. Gumerman and Dean (1989:122) also note that from 1250 C.E. on, the Kayenta region was organized into a few, highly dense settlements.

Uncertainty: Moderate

There is strong architectural evidence for increasing settlement aggregation prior to decline (Varien 2006:41; Dean 2010:335; Varien et al. 2007:283; Glowacki 2010:209; Varien 2010:25; Lipe 2006:311, 312). However, Kantner (2004:180) discusses the lack of aggregation occurring in the San Juan Basin during the mid-1200s. The bioarchaeological data also does not provide a definitive link between declining health and settlement aggregation. While Stodder (1989) does observe worsening health in Ancestral Puebloan populations, Martin (1994:104) concluded that health in the later occupation periods was a "continuation of the trends in poor health noted previously." Furthermore, much of the discussion surrounding declining health is focused on how changes in nutrition are associated with trends in health, rather than aggregation. Although

both Stodder (1989) and Martin (1994) state that increasing aggregation was likely a major factor in declining health due to poor sanitation, there is little skeletal evidence that directly correlates declining health with increasing aggregation in comparison to the strong association found with nutritional stress. Furthermore, Stodder (1989:409) states that "infectious conditions are rarely observed in the skeletons from the Mesa Verde area." Overall, while it is certainly possible that declining health is tied to increased aggregation, an equally plausible link can be made with nutritional stress.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: High

Evidence supporting high environmental insecurity includes:

1. *Extent of dryness index:*
 - a. Prior interval, 1194 to 1239: Average PDSI = 0.6
 - b. Depopulation interval, 1240 to 1285: Average PDSI = -0.4,
 - i. 169% drier than the prior interval
2. *Declining maize consumption.* Perhaps due to declining maize productivity caused by unfavorable climactic shifts (Van West and Dean 2000; Schwindt et al. 2016), there is also evidence of declining maize consumption toward the final years of occupation. Maize accounted for 10% of the Ancestral Puebloans' diet, a dramatic decrease from previous years where maize was the main plant food consumed by the Ancestral Puebloans (Adams et al. 2007; Kohler et al. 2008:150, 152).

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: High

Evidence supporting high conflict and violence preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Increasing evidence of skeletal remains with violence.* At Castle Rock pueblo, skeletons showed evidence of cranial fractures, broken teeth, and tibia fractures with at least forty-one individuals likely experiencing a violent death (Kuckelman et al. 2002:494; Kohler et al. 2008:153). Additionally, there are skulls with fractures on the backside, indicating that the individuals were potentially attacked while fleeing (Kuckelman 2010:190; Kuckelman 2006:132). Evidence of violent death can also be found at Salmon, where 45 to 55 individuals were found burned in a kiva, and at Sand Canyon Pueblo where disarticulated skeletal remains were found (Irwin-Williams and Shelley 1980 as cited in Kantner 2004:169, 170; Kuckelman 2010; Kuckelman and Martin 2007). There was also evidence of violent death at site 5MT993 in the larger Mesa Verde region (Lambert 1999:141 as cited in Billman 2008:65). Skeletal remains at the La Plata region also showed evidence of trauma, although it is unclear when in the occupation period those traumas occurred (Martin et al. 2008). See also sites from the Dolores Archaeological Program area (Stodder 1987:362, 363) and sites discussed by Turner (2011).
2. *Increasing prevalence of defensive architecture.* Varien et al. (1996:99) identify a “clear increase” in sites located in easily defended locations. At Sand Canyon Pueblo, defensive architecture in the form of large enclosing walls, towers for increased visibility, and an increase in cliff dwellings can be seen (Kuckelman 2010:499; Kuckelman 2006:129). Similar patterns are found throughout the Mesa Verde region and at the Kayenta site of Long House Valley (Glowacki 2015; Haas and Creamer 1996 as cited in Kantner 2004:178). Billman (2008:66) also notes an increasing use of defensive architecture in the Mesa Verde region prior to depopulation.
3. *Differing burial practices.* In conjunction with abandonment contexts and other evidence of violence, human remains that are not carefully buried and whose burials depart from traditional Ancestral Puebloan burial customs are also thought to have possibly died violent deaths even if that is not apparent in the skeletal remains (Cameron 2006:141; LeBlanc 1999; Kuckelman 2010:502; Kuckelman et al. 2002).
4. *Archaeological syntheses.* In the late period of Ancestral Puebloan occupation, violence increased significantly (LeBlanc 1999; Kohler et al. 2014; Kohler et al. 2008). Haas and Creamer (1996:205) argue “that warfare was endemic throughout the northern Southwest in the thirteenth century, and that any explanations of settlement, political relations, and abandonment must incorporate warfare as a central causal variable.” Billman (2008:64, 66, 67) also states that raiding occurred in the Mesa Verde region during the 1200s.
5. *Wall art depicting violence.* The wall art from that time period includes violent images of warriors and basket shields, a likely reflection of violence in the area at that time (Kuckelman 2006:132; Varien 2010:10). An example of this wall art can be found at Castle Rock Pueblo (Kantner 2004:171, Figure 6.5).

Uncertainty: Low

There is a consensus among archaeologists that violence increased immediately preceding demographic decline in the Mesa Verde region. Significant bioarchaeological evidence, changes in architecture, burials inconsistent with traditional customs, and wall art support this claim (see above). We have not encountered any evidence that contradicts this claim. A weakness of the evidence presented above is that it centers on a few sites mostly around the central Mesa Verde sub-region. As a known exception, Dean (2010:338) has identified no evidence of large-scale violence in the Kayenta portion of the Ancestral Puebloan region which contradicts Haas and Creamer's (1996) argument on violence in that sub-region.

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Note: Given the large geographical area of the Ancestral Puebloan region, intra-culture area migration is considered.

Coding: High

Evidence supporting high immigration preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Rising population levels due to immigration in select locations within the culture area.* "In AD 1200 the Mesa Verde region [SW Colorado] was the most densely populated portion of the ancestral Puebloan world" (Ortman 2012:264). Population levels peaked in the Northern San Juan region (includes the Mesa Verde region) at about 1225 and then began to rapidly decline (Varien 2010:Table 1.1 and the Village Ecodynamics Project; see Varien et al. 2007 and Ortman 2012, Fig. 4.8 for similar results). Glowacki (2010) identifies population movements from the western portion of the northern San Juan district to eastern portions of the district and associated social changes likely stimulated by the population consolidations.
2. *Increases in population growth rates above those expected from changes in fertility and mortality:* The compound annual growth rate between the 1200 to 1249 and 1250 to 1299 intervals was 0.90 %, above a level expected from changes in fertility and mortality (Cowgill 1975). For calculation methods, see explanation in Appendix 1.
3. There is evidence of increasing immigration into Tsegi Canyon and the Kiet Siel region during the late 1200s (Dean 2006:166).

Uncertainty: Moderate

Although the northcentral portion of the Ancestral Puebloan culture area (Village Ecodynamics Project) shows substantially increased population levels during the 1225 to 1260 interval

compared to the 1180 to 1225 interval (Varien 2010:16, Table 1.1), the origins of people moving into the area may be from within the large Ancestral Puebloan area. Whether from within or outside the area, insecurities due to the influx of newcomers likely increased.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: Moderate

Evidence supporting moderate social stratification preceding depopulation in the Ancestral Puebloan sub-region includes:

1. *Architectural evidence of stratification.* There was increasing presence of multi-walled structures, which are defined as “circular or D-shaped with a courtyard for one or two kivas...surrounded by a single or double row of rooms” (Glowacki 2010:215) within the cliff dwellings (Glowacki 2010:115; Lipe and Ortman 2000:110, 111). Only certain community members were allowed to enter these areas, specifically those with ritual importance (Lipe and Ortman 2000:95; Glowacki 2010:215, 2015:170; Arakawa 2012:50; Reed 1958:55; Vivian 1959:77). For example, some people had access to these spaces based on their familial status (Glowacki 2015:170; Arakawa 2012:50). Glowacki (2015) also describes a three-tiered system of access to structures in Ancestral Puebloan sites. At Sand Canyon Pueblo, one roomblock has been suggested to represent the presence of sodalities, although if present they were likely weak (Lipe 2002).
2. *Faunal remains.* After analyzing faunal remains in middens from Sand Canyon Pueblo, Muir (1999:159) concluded that there were not significant differences in subsistence between various community members. However, he also discusses the differentiation between faunal assemblages at Sand Canyon and those at smaller sites, indicating that those at Sand Canyon may have had a certain level of prestige (1999:159). Larger birds of prey associated with ritual activities were also more commonly found at large sites, such as Sand Canyon, which has been interpreted to represent a consolidation of ritual activities at these sites (Muir 1999:160).
2. *Relegation of certain groups to poor agricultural land.* At Sand Canyon Pueblo, Adler (1996:354, 355 as cited in Kantner 2004:167) determined that those living at smaller sites were forced to use low quality land compared to those living at larger residences. He also discusses the possibility that land was passed down through families.
3. *Bioarchaeological evidence of gender differences.* Martin and Akins (2001 as cited in Kantner 2004:172) found that females from the La Plata area experienced more violence than their male counterparts and they characterize this as an “overall decrease in the status of women.”

They attribute this to an increasingly "patrilocal" social organization, where women were often moving to unfamiliar places after marriage (Martin and Akins 2001 as cited in Kantner 2004:172). This gender difference in the amount of trauma in the La Plata region is also noted by Martin et al. (2008).

4. *Evidence of social stratification through trade.* Upham (1982 as cited in Gumerman and Dean 1989:128) states that the Western Anasazi region was characterized by a group of elites controlling trade.

Uncertainty: Moderate

Studies of 13th century community organization by Varien and colleagues (1996:99), including Sand Canyon Pueblo, found "little material evidence for the presence of a well-differentiated elite." They (Varien et al. 1996:99-100) further state, "There may, however, have been important inequalities between community members that fall short of the establishment of institutionalized elites." Kantner (2004:175) contradicts the evidence that there was social stratification and states that Ancestral Puebloan communities had "leveling mechanisms" that prevented social stratification. He believes that, if present, hierarchies only existed between larger and smaller sites, not within a site (Kanter 2004:175). Gumerman and Dean (1989:100-103) also note that western Ancestral Puebloan society was "generally egalitarian" and relied on cooperation and coordination. It is important to note that the argument and evidence noted above is dominated by work conducted in the central Mesa Verde region with less representation from areas outside of that area.

FREMONT

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements.

As trade/exchange networks decrease, opportunities to engage social strategies for buffering risks decrease (e.g., alliances, reciprocity). Risks (real or perceived) that cannot be buffered can lead to strategies such as migration to mitigate risks.

Coding: Low

Evidence supporting low economic insecurity preceding depopulation in the Fremont sub-region includes:

1. *Consistent and increasing trade through time.* In a synthetic analysis of spatial patterning of local and exotic goods, Janetski (2002) finds mostly consistent and likely increasing trade in exotic goods (marine shell, turquoise, jet, Anasazi ceramics), local minerals, and non-local Fremont ceramics over time, although there are sample size biases. Specifically, Janetski

2002:365 states, “between AD 500 or so and 1300, quantities of exotics, and perhaps trade generally, increased in the Fremont region...” Based on stylistic analyses and differential distributional patterns of exotics, ceramics, and obsidian, Janetski (2011) also argues for possible community ranking of central places.

2. *Presence of non-local goods.* Stewart (2006:29) notes that the turquoise and shell found in some Fremont pithouses was not prevalent in previous years. This may indicate that trade was increasing prior to decline (Stewart 2006:29). Ure and Stauffer (2010:6) also found “pendants, various saltwater shell beads, and clay anthropomorphic figures.”
3. *Imports from the San Rafael Swell area.* In addition to other non-local goods, Madsen and Simms (1998:309) note the presence of ceramics in the Tavaputs Basin in eastern Utah and western Colorado that were made from basalt originating in the San Rafael Swell area in south-central Utah. They argue these goods represent direct evidence of trade specifically between the Fremont and the San Rafael Swell region.

Uncertainty: Moderate

In contrast to Stewart (2006) and Ure and Stauffer (2010), Gunnerson (1960:374) states that non-locally produced pottery sherds are “rare” at Fremont sites. Also, there has been limited work done in the Fremont region in comparison to other cultural groups discussed in this paper.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

As resources are depleted or degraded, food and resource insecurity increased. Perceived better conditions elsewhere can stimulate movement and insufficient food decreases fertility and increases mortality.

Coding: Moderate

Evidence supporting moderate resource depletion preceding depopulation in the Fremont sub-region includes:

1. *Bioarchaeological evidence of nutritional stress.* 33% of the 86 skeletons found in the Great Salt Lake Wetlands showed evidence of nutritional stress (Coltrain and Leavitt 2002:458, 478 and references therein). However, the remains are from a variety of time periods at each site and are not individually listed by date, therefore it is unclear whether this increased immediately preceding depopulation (Coltrain and Leavitt 2002:458).

2. *Decline in wild food sources.* After analyzing faunal remains at Fremont sites, Janetski (1997 as cited in Madsen and Simms 1998:283,284) argues that foraging became less productive for the Fremont in later periods.
3. *Transition to farming maize to compensate for decreased availability of foraged food.* Madsen and Simms (1998:279, 281) state that the Fremont transition from foraging to farming maize during the Formative period was a behavioral shift in order to accommodate the depletion of staple wild foods. However, they also note that farming is no longer visible in the archaeological record at 500 B.P, or ~1450, and bioarchaeological analysis supports the argument that the Fremont switched back to foraging (Madsen and Simms 1998:323; Simms and Stuart 2002:79). This ability to adapt by switching between farming and foraging is discussed in detail by Madsen and Simms (1998) and Simms (1986).

Uncertainty: Low

Multiple lines of evidence demonstrate that the Fremont region likely experienced resource stress prior to decline. There was no evidence found that contradicted this interpretation.

Health Insecurity

Indicator: settlement aggregation, bioarchaeological evidence (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: Moderate

Evidence supporting moderate settlement aggregation preceding depopulation in the Fremont sub-region includes:

1. *Architectural evidence of aggregation.* Allison (2010:146) notes that Fremont sites, particularly in the eastern Great Basin, show signs of aggregation. He gives the sites of Baker Village and Five Finger Ridge as examples due to the large amounts of "contemporaneous habitations" found there (Allison 2010:146, 147).
2. *Radiocarbon dates indicating increased aggregation.* Using radiocarbon dates from the area, Talbot and Wilde (1989:9) found that from AD 880 to AD 1040 the Fremont began to move out of the Uinta Basin and eastward. From AD 1250 to AD 1350, settlements were "concentrated into a few choice areas" (Talbot and Wilde 1989:9).

Uncertainty: Low

Increasing aggregation in the Fremont area has been consistently observed.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

As dryness increased, wild and cultivated food resources decreased. Resource shortfalls (real or perceived) can stimulate movement and insufficient food decreases fertility and increases mortality.

Coding: High

Evidence supporting high environmental insecurity includes:

1. *Extent of dryness index:*

- a. Prior interval, 999 to 1149: Average PDSI, -0.20
- b. Depopulation interval, 1150 to 1300: Average PDSI, -0.41
 - i. 109% drier than prior interval.

2. *Reduced maize yield due to climate shift.* Thomson et al. (2019) simulated what maize growth would have looked like for the Fremont in the Great Salt Lake and Uinta Basin subregions. He found that reduced temperatures between 1100 and 1200 AD likely slightly reduced maize production (Thomson et al. 2019:103).

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: Moderate

Evidence supporting moderate personal insecurity preceding depopulation in the Fremont sub-region includes:

1. *Presence of defensive architecture.* Boomgarden et al. (2014:27) details defensive architecture and defensive food storage systems. Defensive architecture in the form of structures built in inaccessible areas, such as rock outcrops, and isolated food storage can also be seen in the Tavaputs plateau (Spangler 1999a and 1999b as cited in Madsen and Simms 1998:306, 307).
2. *Bioarchaeological evidence.* Novak (1995, 1998) and Shields (1967) (all as cited in Madsen and Simms 1998:309) suggest that cannibalism may have occurred in the Sevier River Valley, Uinta Basin, and at the Turner-Look site. Wormington (1955:87) also notes bioarchaeological evidence for violence, such as deliberately broken bones in association with fireplaces and intentionally damaged crania, at the Turner-Look site. Excavations at Backhoe Village revealed skeletal remains with "disarticulation, broken and splintered long bones, burning, green stick fracturing, and cut and scratch marks" (Madsen and Lindsay 1977:78).
3. *Rock art depicting violence.* Madsen and Simms (1998:308) note the presence of rock art that depicts violence in the Tavaputs plateau.

Uncertainty: Moderate

Evidence is consistent but limited.

Community Insecurity

Indicator: immigration

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

As in-migration increased within and near existing communities, new social strategies were necessary for resolving tensions. These tensions likely increased due to increased resource competition in marginal areas. Out-migration lessens untenable social and environmental conditions.

Coding: Low

Evidence supporting low immigration preceding depopulation in the Fremont sub-region includes:

1. *Possible immigration of the Numic people.* The Numa people are thought to have migrated into the region and had superior subsistence and adaptative strategies, resulting in them "out-competing" the Fremont (Coltrain and Leavitt 2002:456). This interpretation is based on studies of linguistic divergence in the region, although the time period of the initial Numic expansion into the region has not been confirmed (Coltrain and Leavitt 2002:456; Lamb 1958; Madsen and Simms 1998:314). Due to the evidence relying on linguistic divergence, the exact timing is difficult to determine.

2. *Competition with foragers.* Madsen and Simms (1998:314) suggest that immigrants to the region who practiced farming were in direct competition with Fremont foragers, although they do not state who the immigrants were or what cultural tradition they were associated with.
3. *Mountain migration route.* Seymour (2012:155) discusses the possibility that when the Athabascan people migrated from the north into the Colorado Plateau, part of the Fremont region, they actually took a route through the mountains, instead of the plains, resulting in more possible contact with the Fremont.

Uncertainty: High

Allison (2019:297-300) argues there was a population influx into the Fremont area in the early 1000s from the Four-Corners area as people moved away from the expanding Chaco system. This increase in immigration is outside of the ~100 year coding window prior to depopulation but may have created rising community insecurity over time. Overall, the Fremont region does not have evidence for the standard markers of immigration such as architectural or material culture differences. Instead, most of the evidence is based on possible migration routes in the region.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

As social stratification increased, some portion of a population had less access to political, ritual, and/or socioeconomic resources. Out-migration lessens socially untenable, unequal conditions.

Coding: Moderate

Evidence supporting moderate social stratification preceding depopulation in the Fremont sub-region includes:

1. *Skeletal and burial evidence for high-status males at Site 42WB324.* Coltrain and Leavitt (2002:474) report that males at site 42WB324 ate a diet rich in C14, had more elaborate burials, and also had "reduced skeletal robusticity", all of which indicate higher status individuals.
2. *Exclusive community architecture at Wolf Village.* Johansson et al. (2014:49) concludes that some events held in communal structures at Wolf Village likely would have been exclusive spaces with some community members denied entry into the space during certain events. There is also a possible central structure which likely would have been reserved for certain religious and community leaders (Ure and Stauffer 2010:13; Johansson et al. 2014:49).

3. *Differences in burial goods.* Janetski and Talbot (1997 as cited in Madsen and Simms 1998:310) note that several Fremont sites had burials where there was a difference in the amount of burial goods, indicating some level of social differentiation. The Median Village and Parowan Valley sites also contains burials with differing amounts of grave goods (Madsen and Lindsay 1977:78; Watkins 2010; Dodd 1982, Meighan et al. 1956, Janetski et al. 2000 as cited in Watkins 2010:7). Watkins (2016:5, 6) notes that avian remains were found in two of the burials at Evans Mound, whereas this is not present in other burials.
4. *Presence of non-local goods.* Stewart (2006:29) notes that turquoise and shell have been found in some Fremont pithouses, which may indicate that some had higher status than others. Ure and Stauffer (2010:6) also found "pendants, various salt water shell beads, and clay anthropomorphic figures" although the authors do not state if the objects indicate any form of social differentiation.
5. *Interaction with smaller villages.* Madsen and Simms (1998:323) note that smaller Fremont villages likely interacted with larger settlements and a system of exchange facilitated the development of some social stratification.
6. *Settlement hierarchy.* Fremont sites during the Late Fremont period were organized in a settlement hierarchy which is a marker of increasing organizational complexity (Talbot 2019). A settlement hierarchy likely signals increasingly differentiated political influence.
7. *Archaeological synthesis:* In a synthesis of architectural variation and layout in three Fremont villages, Richards et al. (2019:2014) summarize their results by stating, "houses vary in ways that indicate differences among households in social status or wealth; and each village includes public architecture, reflecting the organization of households into larger communities." They specifically identify "unusual residential structures in close association with communal architecture." They interpret this layout as possible evidence that leaders may have had privileged access to stored goods in the public communal structures and monitored activities in those structures.

Uncertainty: Low

There are multiple lines of evidence suggesting a moderate amount of social stratification and no conflicting evidence has been found. However, some of the evidence could have multiple interpretations besides indicating social stratification, such as the goods noted by Ure and Stauffer (2010).

HOHOKAM

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements.

As trade/exchange networks decrease, opportunities to engage social strategies for buffering risks decrease (e.g., alliances, reciprocity). Risks (real or perceived) that cannot be buffered can lead to strategies such as migration to mitigate risks.

Coding: High

Evidence supporting high economic insecurity preceding depopulation in the Hohokam sub-region includes:

1. *Decreasing communal architecture:* Communal ball courts were abandoned, and the Hohokam started to build walled platform mounds instead, indicating that communal architecture was being abandoned in favor of exclusive spaces (Abbott 2003:209, 210; Bayman 2001:285; Craig and Woodson 2017:341). Previously ball courts were indicative of a vibrant regional economy (Craig and Woodson 2017:335). Clark and Abbott (2017:359) state that platform mounds are "the most apparent emblems of that new and divided social order." The change in architecture to focus on platform mounds has also been noted by Fish (1989:31).
2. *Increasing local production:* Prior to the 13th century, the Hohokam acquired pottery, shells, and obsidian from other cultural groups, but this declined as craft making became centralized around platform mounds (Abbott 2003:209-210; Bayman 2001:285). In a process that likely continued throughout the Classic period (1200 to 1450), "The early Classic period in the lower Salt and middle Gila River valleys of the Phoenix Basin is characterized by an organization retraction from the open and hospitable networks of the Sedentary period. They were replaced by social and economic fragmentation, a kin-based structure, and dependence on locally controlled resources" (Clark and Abbott 2017:357).
3. *Less trading of Hohokam produced goods:* After 1050 CE, there is less evidence of Hohokam buff ware pottery outside of the Phoenix Basin (Craig and Woodson 2017:341; Clark and Abbott 2017:355, 358; Wallace and Doelle 2001:260). Fish (1989:33) also notes that Hohokam produced red-on-buff pottery becomes less prevalent prior to depopulation.
4. *Decreased presence of non-local goods.* During the Classic period, macaws, copper bells, mosaic mirrors, and *Strombus* trumpets were not found as frequently at Hohokam sites compared to previous periods (Crown 1991:387). Although intrusive ceramics can still be found at Hohokam sites during the Classic period, they are from fewer regions than in previous periods (Crown 1991:388). Crown (1991:388) also states that the usage of non-local minerals, except for obsidian, decreased during the Classic period.

Uncertainty: Moderate

Mills et al. (2013:5788, 5789, Figure 4) compared the prevalence of obsidian before and after 1300 in Arizona and concluded that there was more trade after 1300 C.E. Sites (1983 as cited in

Crown 1991:388) also observes that obsidian and intrusive ceramics from southern Arizona and Hopi-occupied areas continued to be found during the Civano and Polvoron phases. After analyzing pottery at Pueblo Grande, Abbott and Walsh-Anduze (1995:105-106), argued that thousands of pots were imported during the Classic period and that the Hohokam were heavily involved in pottery exchange, instead of producing most locally.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

As resources are depleted or degraded, food and resource insecurity increased. Perceived better conditions elsewhere can stimulate movement and insufficient food decreases fertility and increases mortality.

Coding: Moderate

Evidence suggesting a moderate amount of resource depletion preceding depopulation in the Hohokam sub-region includes:

1. *Degradation of irrigation systems:* Hill et al. (2015) conducted soil analysis on Salt River Adobes in the Lower Salt River Valley and found an increasing distance between habitation sites and irrigation canals. As a result of this finding, Hill et al. (2015:633-637) argues that the intense irrigation used by the Hohokam had degraded the land, possibly through increased soil salinization, and forced people to move farther away in search of viable land).
2. *Shifts in subsistence strategies:* Kwiatkowski (2003:62, 79-80) found evidence that the availability of many of the Hohokam's staple animal protein sources, such as deer, large freshwater fish, and small game, declined significantly by the Late Classic Period. Through analyzing faunal assemblages and calculating diversity indices for lagomorphs, aquatic and semi-aquatic prey, small terrestrial animals, flying birds, and artiodactyls, Dean (2007) concludes that the Hohokam did experience resource stress prior to decline. This resource stress led to "intensification of resource procurement" and the addition of wild foods outside of the normal Hohokam staples (Dean 2007:128). However, Dean's (2007:128) study was limited to the Salt and Gila river valleys and thus may not be applicable to other Hohokam communities. Similarly, based on cottontail to jackrabbit ratios it is likely that less vegetation cover existed during the Classic period (James 2003:76, 77).
3. *Bioarchaeological evidence of nutritional stress:* Through analysis of subadult skeletal remains at Pueblo Grande, Sheridan (2003) concluded that the population experienced considerable nutritional stress. Chemical analysis of the bones also supported this conclusion (Sheridan 2003:100-105).

4. *Reduction in arable land.* Waters (2006:33) notes that during the Tanque Verde Phase, the southern and western parts of the Southern Arizona floodplain were not favorable for agriculture. As a result, people moved to more productive, arable land in the northern and eastern sections of the floodplains (Waters 2006:33). This process continued into the subsequent Tucson phase where the amount of arable land was further reduced (Waters 2006:34).
5. *Reduction in tree availability:* Fewer trees were available along the lower Salt River and in the Tonto Basin during the Classic period (Kwiatkowski 2003:57).

Uncertainty: Low

Fish (1989:46) notes that the Hohokam were adept at managing their resources and were not very vulnerable to climactic shifts. After analyzing the skeletal remains from Pueblo Grande, McClelland (2015:503-506) does not believe the bioarchaeological or paleodemographic evidence is strong enough to conclude that the Hohokam experienced significant nutritional stress. In regard to a declining birth rate, McClelland (2015:505) states that there is "insufficient evidence" to attribute the decline to nutritional stress. Furthermore, much of the bioarchaeological analysis was contained to Pueblo Grande and thus may not be fully representative of Hohokam resources; however, the irrigation and subsistence strategies have been investigated in a variety of locations. If there was not considerable resource depletion, we would expect more evidence in support of this conclusion.

Health Insecurity

Indicator: settlement aggregation and bioarchaeological data

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: High

Evidence supporting high health insecurity preceding depopulation in the Hohokam sub-region includes:

1. *Archaeological synthesis.* Based on multiple bioarchaeological studies, Hill and colleagues (2004:707, see also references therein) state, "Evidence from large sites such as Pueblo Grande indicates that aggregation and agricultural intensification in the Phoenix Basin led to a severe decline in health and life expectancy." Increasing aggregation prior to decline can be

seen in the Tucson, Picacho, and Tonto areas (Fish 1989:34 and references therein; Waters 2006:42).

2. *Increasing aggregation index*: Aggregation increased 27% between the 1300 to 1349 and 1350 to 1399 intervals. Depopulation likely began during the 1350 to 1399 interval (see Appendix 3).
3. *High population density*. The Hohokam culture area “supported the largest and most concentrated population in the U.S. Southwest throughout much of the pre-contact sequence” and the highest density of population was in the Phoenix basin, near the confluence of the Salt and Gila rivers (Clark and Abbott 2017:353). Between 30,000 and 75,000 people lived in southern Arizona during the 1200 to 1450 interval (Clark and Abbott 2017:353).
4. *Canal systems and disease transmission*. Fink (1991:63, 64) argues that the structure of Hohokam irrigation, such as cross-cut canals, and the density of aggregation near these canals create an environment where disease could spread rapidly due to the vast amount of connectivity. The presence of pottery sherds and other refuse in the canal systems indicate that they may have been used for refuse disposal. If so, disease could be introduced to the canal system and traveled to many segments of the population (Fink 1991:67).
5. *Increased use of platform mounds and multi-room compound structures*. The rise of platform mounds and enclosed residential compound architecture in the lower Salt River basin (modern-day Phoenix, AZ) during the Classic period (ca. 1100 to 1375) is one indicator of increasing settlement density and aggregation (Abbott 2003). Platform mound construction also began in the Tucson Basin, specifically at the Marana site, during the Classic period (Doelle and Wallace 1991:325; Fish 1989:37). Additionally, Doelle and Wallace (1991:158, 164, 293, 325, 327) note the minimal distance between platform mounds as evidence for a “strong trend toward settlement aggregation.” Wallace and Holmlund (1984) also note that population in the Tucson Basin was “concentrated in a few locations.” Changes in architectural style resulted in the disuse of courtyards that were subsequently converted into multi-room structures, which again signals increasing aggregation (Clark and Abbott 2017:355). Cordell et al. (1994:124) also identifies changing structure styles as a signal of increasing aggregation.
6. *Oral history from the Akimel O’Odham people*: Loendorf and Lewis (2017:125-126) and Teague (1993:435-452), detail Akimel O’Odham oral histories that describe high populations, conflict, flooding, and ideological shifts all consistent with causal explanations of settlement aggregation.

Uncertainty: Moderate

See McClelland (2015) for a critique of the extent of declining health in the Phoenix basin. Architectural evidence, high population density, and the aggregation index supports the interpretation of increasing settlement aggregation occurring in the Hohokam region prior to depopulation of the culture area.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: High

Evidence support high environmental insecurity includes:

1. *Dryness index - PDSI*
 - a. Prior interval, 1299 to 1374: Average PDSI, 0.7
 - i. Depopulation interval, 1375 to 1450: Average PDSI, 0.08,
 1. 89% increase in dryness compared to the prior interval.
2. *Dryness index – Average Salt, Tonto, Verde River streamflow* (Graybill et al. 1989)
 - a. Prior interval, 1299 to 1374: Average Z scores of annual streamflow, 9.6
 - b. Depopulation interval, 1375 to 1450: Average Z scores of annual streamflow, -3.1
3. Graybill et al. (2006:89) also identified multiple periods of low streamflow at the Salt River from the mid-1200s to the mid-1300s.

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

As conflict and violence increased, mortality increased and movement away from dangerous conditions increased.

Coding: High

Evidence supporting high personal insecurity preceding the demographic decline in the Hohokam culture area includes:

1. *Architectural evidence:* Rice (2001:309; 318, 319, 322) notes the increasing use of wall compounds during the Classic period and platform mounds during the Late Classic period.

LeBlanc (1999:256) also cites raised platform mounds and walled compounds constructed at sites along the Salt and Gila rivers, such as the Casa Buena and Casa Grande sites, during the Classic period as evidence of defensive architecture. Although not widespread, there is also architectural evidence for cerro de trincheras style sites in the Hohokam region (Downum et al. 2009). These site types have been identified as defensive sites, but Downum et al. (2009) do not believe that the Hohokam cerro de trincheras were primarily used for defensive purposes. This interpretation is based on the lack of soil appropriate for defensive platform construction, the orientation of the terraces, and the location of the cerro de trincheras sites on the outskirts of larger Hohokam settlements (Downum et al. 2009:269-270). Wallace and Doelle (2001) and Wilcox et al. (2001) also present evidence for increasingly fortified settlements during the Hohokam classic period. Additional architectural evidence includes walls at hilltop settlements that had holes to shoot arrows through and small entryways (Rice 2001:321).

2. *Burned buildings and artifacts.* At the Marana cluster of sites both buildings and wooden artifacts were burned, which Rice (2001:324) interpreted as a sign of warfare. Burned buildings have also been observed in the Tonto Basin and Globe-Miami areas (Waters 2006:42; LeBlanc 1999:257).
3. *War as a means of water distribution.* Rice (2001:305, 306) argues that the organization of the Hohokam's irrigation system prompted the use of war as a means to "manage the distribution of water" and that settlements along the same canal system would band together. He notes that the Hohokam were engaged in warfare into 12th, 13th, and 14th centuries, although the intensity gradually decreased due to changes in settlement patterns and the increased use of defensive architecture (Rice 2001:305).
4. *Bioarchaeological evidence.* At the Las Colinas and La Ciudad sites LeBlanc (1999:260) details skeletal remains that show evidence of a violent death, such as embedded projectile points. Wilcox and Haas (1994) also note that of the five Hohokam platform mounds that have been excavated, 40% of the skeletal remains they found showed evidence of a violent death. Skeletal remains found at Brazaletas Pueblo also had evidence of violent death and trauma (Valehrach and Valehrach 1971 as cited in Wilcox et al. 2001; Rice 2001:322). In the Tonto Basin, a site contained skeletal remains of three people with cranial trauma in an intentionally burned room (Whittlesey 1994; Turner et al. 1994 as cited in Waters 2006:42).
5. *Possible presence of war clubs.* Rice (2001:324, 325) also noted the presence of burned wooden artifacts at the Marana cluster sites and interpreted these to be war clubs. He discusses these artifacts' similarity to Maricopan and Piman war clubs.
6. *Oral History from Akimel O'Odham people.* Teague (1993) recounts oral traditions that describe violence during the Hohokam Classic period. See also Hill et al. (2015:640-641) and references therein.

Uncertainty: High

Differing interpretations of the evidence (and lack thereof) of violence has resulted in varying beliefs as to the extent of conflict and violence. For example, Hill and colleagues (2015:614) point out that “little material evidence has been recovered from the lower Salt relative to other parts of the Southwest, raising questions about the role of conflict in demographic decline.” Similarly, Wallace and Doelle (2001:273) note the lack of bioarchaeological evidence for violent death, although they cite the limited excavation of platform mounds as a possible reason for the lack of evidence. We were persuaded by the rise of compound architecture, which signals at least the perception of personal insecurity, if not actual conflict and violence as well as by the oral histories containing stories of violence.

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

As in-migration increased within and near existing communities, new social strategies were necessary for resolving tensions. These tensions likely increased due to increased resource competition in marginal areas. Out-migration lessens untenable social and environmental conditions.

Coding: Moderate

Evidence supporting moderate community insecurity preceding depopulation in the Hohokam sub-region includes:

1. *Archaeological synthesis:* Hill et al. (2010:44-45) states that "The presence of Pueblo migrants is mostly clearly documented in the Tonto and Safford basins and the lower San Pedro Valley, along the eastern perimeter of the largest Hohokam concentrations in the Phoenix basin." Evidence for migrants also includes changing architectural and ceramic styles and technology and changing land use (Hill et al. 2010:44-45 and references therein).
2. *Population increase.* Loendorf and Lewis (2017:130) note a two to threefold population increase as a result of migration along the Salt and Gila, such as in the Tonto Basin area and at Pueblo Grande. However, they also believe that migrants likely came from within the Hohokam cultural area and this interpretation is supported by the Hohokam region's cultural continuity (Loendorf and Lewis 2017:130).
3. *Immigration into the Tonto Basin.* Stark et al. (1995) concluded that early Classic period [1150 to 1350] migrations into the Tonto Basin involved a 25% increase in the local population.
4. *Immigration into the Tucson Basin.* Hill et al. (2004:706) notes the increasing presence of perforated plates, Maverick Mountain series ceramics, and mealing bins and suggest that these indicate northern groups immigrating to the Tucson Basin. Additionally, they suggest

that groups from the northern Tucson Basin eventually moved south and joined the populations there (Hill et al. 2004:706).

5. *Changes in material culture.* Previous interpretations of immigration to the region have cited changes in material culture, such as the appearance of Salado pottery, to represent intrusion by distinct cultural groups (Abbott 2003:9). For example, the increased prevalence of Roosevelt Red ware, perforated plates, Maverick Mountain series ceramics, obsidian, and new architectural styles is presented as evidence of immigration from the Kayenta/Tusayan region into the lower San Pedro Valley, Safford Basin (Hill et al. 2004:702, 706). However, the attribution of “Salado” polychrome pottery and mortuary practices to indigenous Hohokam rather than migrants is strong evidence that population growth due to immigration at sites like Pueblo Grande was caused by settlement aggregation rather than immigration from a different cultural group (Abbott 2003:9). The interpretation of aggregation over immigration is also supported by cultural continuity in the region (Loendorf and Lewis 2017:130).
6. *Increases in population growth rates in the Phoenix basin, Canal System 2.* Through an analysis of all documented “houses” associated with Canal System 2 (the best documented Hohokam system), Ingram (2008:148-149) identified decreasing population growth rates between the Sacaton (975 to 1174 CE) and Soho (1175 to 1324) temporal/cultural phases followed by increasing population growth rates implying immigration between the Soho (1175 to 1234) and Civano (1325 to 1450) phases.
7. *Increases in population growth rates in the Hohokam culture area:* The CCD data (Hill et al. 2012) identify the 1250 to 1299 and 1300 to 1349 intervals as period of substantial immigration, with 0.66 and 0.42 compound annual growth rates, respectively. Growth rates declined during the 1350 to 1399 (-0.36) and 1400 to 1449 intervals (-3.14). For calculation methods, see explanation in Appendix 1.

Uncertainty: Low

Immigration from the Kayenta/Tusayan region into the Lower Salt River Valley, Tonto Basin, Lower San Pedro Valley, and Safford Basin has been well documented and described (Clark et al. 2019). Total numbers of immigrants, however, were relatively small compared to total population levels in the Hohokam culture areas, especially the densely populated Phoenix basin.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: High

Evidence supporting high political insecurity preceding depopulation in the Hohokam sub-region includes:

1. *Differentiated ballcourts, increasing use of platform mounds, and restricted ceremonial spaces:* The prevalence of platform mounds themselves are indicative of a political or religious stratification, with access to ritual sites more limited than during the Preclassic Period, where ritual ballcourts were publicly accessible (Bayman 2002:78). LeBlanc (1999:199) and Rice (2001:319) also note that some lived on top of platform mounds where others were relegated to pit houses. Elite platform mounds were also typically more fortified (Rice 2001:319). Crown and Fish (1996) and Elson (1998) argue that ceremonial spaces were becoming increasingly exclusive during the Classic period.
2. *Differential burial treatment:* Cremation burials were common, and some were adorned with marine shells and “stylized craft goods,” potentially representing inequality and reflecting “increased social distinctions” (Bayman 2001:273, 279, 287). At Snaketown, prestige goods were present at 3 out of 24 cremation burials (Nelson 1981:468 as cited in Fish 1989:50).
3. *Social Network Analysis:* Pailes (2014) conducted social network analysis by calculating both the Lorenz curve-based Gini coefficient and centrality scores. His analysis indicated an emerging elite class and increasing differentiation as well as overlap between ritual and economic inequality (Pailes 2014:482).
4. *Elite control of trade.* The similar type of prestige items and their concentration at Hohokam sites, such as Snaketown, led Nelson (1981) and McGuire (1983) to interpret that the elites controlled the influx of exchange items (both as cited in Fish 1989:49).

Uncertainty: Low

According to Pailes (2014:468), archaeological findings suggest a lack of the material inequality that is generally taken as evidence of social inequality or class stratification, such as differences in the types of artifacts burial sites. This contradicts the majority of the evidence we found, which does detail material inequality and status differentiation.

SINAGUA AND CENTRAL ARIZONA

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements

Coding: Low

Evidence supporting low economic insecurity preceding depopulation in the Sinagua/Central Arizona sub-region includes:

1. *Presence of non-locally produced goods.* Reid and Whittlesey (1997:224) and Plog (1989:276) note the presence of non-local pottery and artifacts in the southern Sinagua region from 1100 CE on. Kamp and Whittaker (1990) also analyzed the clay composition of ceramics found at Sinagua sites and determined they originated outside the local area. Turquoise, shell jewelry, and lithic raw materials from other areas was documented at the Lizard Man site (Kamp and Whittaker 1990:110-113). Turquoise originating from New Mexico and Colorado, rather than Arizona, has also been identified at other Sinagua sites (Plog 1989:274). It is also thought that the “Hopi Macroeconomy” (Wilcox and Holmlund 2007) linked the Verde Confederacy with the Hopi as well as the Chavez Canyon settlement. This allowed for the regular movement of resources, particularly Hopi yellow-ware and Obsidian (Wilcox and Holmlund 2007:101), into Perry Mesa. This active trade lasted well into the 14th century, dissolving with the Hopi Macroeconomy by 1400 (Wilcox and Holmlund 2007). Multiple non-local ceramic styles and non-local shells have also been found throughout Tuzigoot sites and Tuzigoot-era burials (Pilles 2015:108, 109; Spurr and Deats 2015:38). In the Perry Mesa region, approximately 25% of plain-ware pottery was likely made elsewhere and brought into the region (Abbott et al. 2012:56).
2. *Agricultural surplus for trade.* By estimating the potential agricultural yield of the land in the Sinagua area compared to the population size, Pilles (2015:109-111) argues that the Sinagua could have produced a surplus for trade.
3. *Obsidian trade.* Hantman (1983 as cited in Plog 1989:274) describes how obsidian from as far away as Chihuahua and Utah was found at Sinagua sites in Arizona.

Uncertainty: Low

There is significant evidence of non-locally produced goods at a variety of Sinagua sites. We have not encountered evidence that contradicts this interpretation that the Sinagua cultural group was engaged in extensive trade prior to demographic decline.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Coding: Low

Evidence supporting low resource depletion preceding depopulation in the Sinagua sub-region includes:

1. *Degradation of floodplain.* Increased aggregation along the Verde Valley floodplain resulted in overuse of the land for agricultural production (Pilles 2015:102).
2. *Population-resource imbalance.* Berlin et al. (1990:13) suggests that the growing population during the Elden phase could have reached the carrying capacity of the area and resulted in a population-resource imbalance. He also posits a relationship between agricultural intensification during this period and the increasing pressure of a population-resource imbalance (Berlin et al. 1990:13).
3. *Tree death.* Kamp and Whittaker (2009:289) note that the modern-day Flagstaff region experienced drought and tree death in the later years of Sinagua occupation.
4. *Increased hunting and gathering.* Pilles (2015:102) suggests that due to an increasingly sparse agricultural environment, the Sinagua likely had to increase the amount of hunting and gathering to compensate for the resource deficit.

Uncertainty: Moderate

Pilles (2015:109-111) calculated the potential yield and consumption figures for areas in the Verde Valley and concluded that the available land would have been able to support the population; however, this conclusion is not in alignment with the archaeological evidence presented throughout the rest of the paper.

Health Insecurity

Indicator: settlement aggregation, bioarchaeological evidence (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: Moderate

Evidence supporting moderate levels of settlement aggregation preceding depopulation in the Sinagua sub-region includes:

1. *Architectural evidence.* The New Caves site had approximately 200 rooms which is an increase in site size from previous periods (Kamp and Whittaker 2009:286). The layout at the New Caves site is also comprised of clusters which Kamp and Whittaker (2009:287) interpret as a signal of aggregation. The Stone Camp Pueblo site also has a very high density of habitations with one occurring “every 50 to 100 m” (Courtright and Neily 2012:229, 239).
2. *Archaeological syntheses.* Pilles (2015:102-105) provides the data and summarizes aggregation in the Verde Valley during the Tuzigoot phase (1300 to 1400 CE). Descriptions of growing pueblos can also be found in Reid and Whittlesey (1997:218), Doyel (2006:140), and Kruse-Peoples and Strawhacker (2012:264-268).
3. *Multiple burials.* Pilles (2015:112) discusses how pot-hunters at some Sinaguan sites have found burials with multiple bodies stacked together, which may be an indication that the community suffered from infectious disease.
4. *Aggregation index.* Comparing the extent of aggregation during the 1300 to 1349 interval to the 1350 to 1399 interval (the period when depopulation began) the extent of aggregation is the same. Aggregation during the 1300 to 1349 period was less than during the 1250 to 1299 interval.

Uncertainty: Moderate

While there is architectural evidence that suggest settlement aggregation was occurring, there is little to no direct evidence of increased disease transmission prior to decline. More bioarchaeological investigation in the region is needed in order to identify patterns of disease transmission, although this type of work presents many ethical challenges.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: High

Evidence supporting high environmental insecurity includes:

1. *Extent of dryness index:*
 - a. Prior interval, 1299-1374: Average PDSI, 0.8
 - b. Depopulation interval, 1375-1450: Average PDSI, 0.01
 - i. a 99% increase in dryness from the prior interval

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods*, *Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: Moderate

Evidence supporting moderate conflict and violence preceding depopulation in the Sinagua sub-region includes:

1. *Increasing presence of defensive architecture.* Kamp and Whittaker (2009:288, 289) note the Great Wall, a large enclosing wall at the New Caves site, and infer that it served a defensive purpose due to the isolated location and the large boulders used to construct the wall. Guebard (2016) has documented oral histories of violence at Montezuma's Castle and Castle A. Defensive architecture in the form of hilltop sites can be seen in both the Agua Fria and Perry Mesa regions during the Pueblo III period (Wilcox et al. 2001a; Wilcox et al. 2001b). There was also an increased building of hill-top forts, roof entries, and defensive walls which have been interpreted as defensive strategies. Multiple communication outposts as well as perimeter walls with loopholes were also present at the Horseshoe Peak site in the Perry Mesa region (Russell et al. 2012:171-173, 175).
2. *Skeletal evidence of violent death.* Several skeletons at the Castle A site at Montezuma Castle National Monument had cut marks and fractures, which Guebard (2016) provides as examples of violent death.
3. *Evidence of burned structures.* Guebard (2016:261, 262) states that the Castle A structure was destroyed in a large fire. He also notes that skeletal remains with trauma were found within the burned structure (Guebard 2016:262). Rooms at Montezuma Castle also had evidence of burning (Guebard 2016:265).
4. *Oral histories.* Guebard (2016:262, 264) describes Native American oral histories recount violence occurring at Montezuma's Castle and Castle A, and this oral history corresponds with the archaeological record at Castle A. A member of the Hopi tribe also associates the burning of buildings with violence (Guebard 2016:265). These oral histories cite violence as a main motive for emigration out of the region (Guebard 2016:266, 270).

Uncertainty: Moderate

Guebard (2016) does not demonstrate mass violence at Castle A, rather there are a few skeletons with evidence of violent death. Pilles (2015:111) also notes the variety of other reasons, besides defense, why elevated sites and other architectural characteristics may be preferable.

Additionally, he identifies a Sinaguan tradition of burning structures, such as at Elden Pueblo,

which casts doubt on the interpretation that the fire at Castle A was associated with violence (Pilles 2015:111). Pilles (2015:111) also challenges the presence of warfare based on the continuing existence of trade networks, which are relationships that normally weaken during times of violence. Furthermore, it is uncertain how much of the visible archaeological record at the Horseshoe Peak site is within the pre-Hispanic period, versus later occupation by other groups (Russell et al. 2012:176).

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Community insecurity: High

Evidence supporting high immigration preceding depopulation in the Sinagua sub-region includes:

1. *Migrants from the north and central Southwestern regions.* Immigration from northeastern Arizona into the Sinagua and Central Arizona areas was substantial during the late 1200s and early 1300s (Ingram 2014:32). Immigrants from the Tusayan and Kayenta subregions of the Ancestral Puebloan culture are thought to have migrated into the area (Clark 2001). Immigration from these areas has also been noted in the Perry Mesa region (Abbott et al. 2012:48).
2. *Planned immigration.* Wilcox, Roberston, and Wood (2001a) believe immigration into the Sinagua area to be a deliberate, coordinated, and planned act on the part of the people who made up the Central Arizona Tradition (CAT) in the late 1200s CE.
3. *Use of integrative practices.* Russell and Nez (2012) discuss how the people living in the Perry Mesa region practiced “reductive reorientation” as a way to try and integrate immigrants into the larger community. An example of this is the use of ritual racetracks.
4. *Increases in population growth rates:* The compound annual growth rate between the 1250 to 1299 and 1300 to 1349 intervals was 0.49 %, indicating moderate population growth rates with declining rates occurring during the 1350 to 1399 interval. For calculation methods, see explanation in Appendix 1.
5. *Immigration after the eruption of Sunset Crater, 1085 CE.* People are thought to have moved into the region after the eruption of Sunset Crater (Reid and Whittlesey 1997:215, 216; Colton 1946 as cited in Preucel 2005:181). This immigration precedes the insecurities coding period but is important to note.

Uncertainty: Low

Multiple sources attribute the high population growth rates to increasing immigration in the region. While immigration is not disputed, the exact origin of migrants is unclear.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: Moderate

Evidence supporting moderate social stratification preceding depopulation in the Sinagua sub-region includes:

1. *Differential burial treatment.* Kamp and Whittaker (1990), citing Hohmann (1983), detail the varying number of offerings present at Sinagua, with some burials receiving upwards of twenty offerings whereas the majority received between zero and three offerings. Subadult burials with multiple offerings are also presented as evidence of hereditary status (Kamp and Whittaker 1990:114). Spurr and Deats (2015:39) also cite Anderson (1992) who states that some burials had increased amounts of jewelry or other artifacts, indicating some level of status, but overall, he does not believe there was a "strict social ranking." Hohmann's (1983 as cited in Plog 1989:277) analysis of burials in the Flagstaff area also revealed differential burial practices.
2. *Presence of rare goods.* Kamp and Whittaker (1990) posit that the "the sorts and quantities of goods" present at Lizard Man Village indicate that the site was influential in the larger Sinagua system.
3. *Agricultural surplus.* Berlin et al. (1990:13) suggests that the agricultural intensification that occurred during the Elden Phases was in order to create a food surplus due to the development of social hierarchies.
4. *Archaeological synthesis.* Pilles (1996:71) states that "Concomitant with the aggregation process, there is also evidence for the development of clans, societies, and high-status individuals."

Uncertainty: Low

There appears to be an archaeological consensus that some amount of social stratification was present, although it was likely not a strict hierarchy.

PATAYAN

Note: According to Rogers (1945) and Aaron Wright (2020, personal communication) the Patayan culture area did not experience depopulation similar to other culture areas within the SW/NW. Environmental insecurities can be coded, however, for descriptive purposes using the North American Drought Atlas PDSI data used to measure the extent of dryness in other culture areas. People of the Patayan culture area interacted with people in the adjacent Hohokam area; therefore, we use depopulation intervals there to calculate the extent of dryness.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see

Coding: Moderate

Evidence supporting moderate environmental insecurity includes:

1. *Extent of dryness index:*

- a. Prior interval, 1299 to 1374, Average PDSI, 0.8
- b. Depopulation interval, 1375 to 1450, Average PDSI, 0.23
 - i. A 71% increase in dryness compared to the prior interval

Uncertainty: Moderate.

Many people in the Patayan culture area lived nearby or had access to the perennial Colorado River. Summer PDSI may, therefore, be a weaker measure of environmental insecurity than variation in Colorado River streamflow (see Meko et al. 2007). See also uncertainties, discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

MOGOLLON

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements

As trade/exchange networks decrease, opportunities to engage social strategies for buffering risks decrease (e.g., alliances, reciprocity). Risks (real or perceived) that cannot be buffered can lead to strategies such as migration to mitigate risks.

Coding: Moderate

Evidence supporting moderate economic insecurity preceding depopulation in the Mogollon sub-region includes:

1. *Presence of non-local goods.* Macaws, copper bells, and shell ornaments from outside the Mogollon region have been found at Grasshopper Pueblo, although in low quantities which is indicative of an "informal" trading system (Reid 1989:88). Gilman et al. (2014) also note that macaw skeletal remains and macaw imagery were found at multiple Classic period sites and discusses their importation from Mesoamerica.
2. *Presence of non-local ceramics.* Ceramics from the Ancestral Puebloan, Hohokam, and Chihuahua area, as well as White Mountain Redware have been found in Mogollon ceramic assemblages from the Late Late Pueblo period (Nisengard 2006:89; Reid 1989:88, 89).
3. *Archaeological synthesis.* Compared to the Classic phase, which had a distinct lack of non-local pottery, trade increased during the Postclassic Phase (Hegmon et al. 1998:151; Hegmon et al. 2016:58). LeBlanc (1999) and Nelson and LeBlanc (1996 as cited in Nisengard 2006:83) note that during the Late Pueblo Period there was increased interaction with non-Mogollon communities.
4. *Scale of Grasshopper Pueblo.* Reid (1989:79) states that, due to its size, Grasshopper Pueblo would have likely had the means to import items.

Uncertainty: High

Hegmon et al. (2016:61) also suggest that the Mogollon began to remove themselves from the Hohokam trading network and were not involved in the Chacoan trading system. Nelson and Hegmon (2001:216) classifies non-local goods as "rare." For example, at the NAN Ranch Ruin, Shafer (2003:187) found that "less than one half of 1 percent" of the pottery was non-local. There is significant conflicting evidence as to the extent that the Postclassic Mogollon participated in trade and exchange.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Coding: Moderate

Evidence supporting moderate resource depletion preceding depopulation in the Mogollon sub-region includes:

1. *Reduction in agricultural land.* By determining the predicted amount of agricultural land available using GIS, Schollmeyer (2011) found that after 1120 A.D., the Mogollon would have had to use less desirable and/or more distant land to grow crops. However, although the land was less desirable, there was still enough arable land to support the population (Schollmeyer 2011:7).
2. *Shift to agriculture.* At Chodistaas Pueblo, there was a shift from hunting and gathering to an increased emphasis on agriculture in the late 13th century (Reid 1989:77, 78).
3. *Bioarchaeological evidence of nutritional stress.* During the Dispersion Period (1330-1400 CE), skeletal remains at Grasshopper Pueblo showed signs of “increased physical stress” (Hinkes 1983 as cited in Reid et al. 2006:131).
4. *Increased hunting of immature deer.* Olsen (1990 as cited in Reid et al. 2006:132) notes that during the Dispersion Period at Grasshopper Pueblo, the inhabitants began to hunt increasingly younger mule deer due to declining agricultural productivity.

Uncertainty: High

Nisengard (2006:87) does note a decrease in agricultural production during the Early Late Pueblo period but suggests this is simply due to less people living in the area than due to environmental causes. During the Late Late Pueblo period, the larger sites, such as Grasshopper Pueblo, were still successfully cultivating foods (Nisengard 2006:92). Reid (1989:82) also states that in the Grasshopper Pueblo region, the Mogollon did not change their technology in an attempt to increase food production. LeBlanc (1989:199, 200) also does not see evidence that the Mogollon experienced resource stress during the Late Pueblo period and notes that even if there was a climactic shift, the Mogollon had sufficient land available to adapt to those changes.

Health Insecurity

Indicator: settlement aggregation, skeletal indicators (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: Moderate

Evidence supporting moderate health insecurity preceding depopulation in the Mogollon sub-region includes:

1. *Decreasing prevalence of communal structures.* Nisengard (2006:119) looked at the prevalence of communal structures and concluded that the period from 1300 to 1450 had less communal structures than the previous periods. In general, Mogollon sites during the Late Pueblo period appeared to be smaller than in previous periods (Anyon and LeBlanc 1984 and Nelson and LeBlanc 1986 both as cited in Nisengard 2006:84; Nisengard 2006:86, 89).
2. *Larger distance between sites.* The Postclassic period featured more spread out habitation sites compared to the Classic Mimbres period where Blake et al. (1986:460, 461) describes how sites in the valley-bottom began to increase in size, potentially even doubling in size (Hegmon et al. 1998:157, 158).
3. *Increasing health.* Compared to the Classic period, Lippmeier (1991 as cited in Hegmon et al. 2016:57) argues that Postclassic populations were healthier.
4. *Concentration in the Mimbres Valley.* During the Black Mountain and Cliff phases, Blake et al. (1986:461) states that the "very large sites were abandoned", but that the remaining population was concentrated in the Mimbres Valley.
5. *Increasing aggregation index.* Between the 1350 to 1399 and 1400 to 1449 interval, aggregation increased 22%. The index is the total number of rooms in the culture area divided by the number of settlements.

Uncertainty: Moderate

Site size is highly variable between the Mimbres Valley and Mogollon sites in Arizona, with the sites in Arizona being larger than in the previous period and the Mimbres Valley sites are smaller (Cordell 1997:378; Reid 1989 as cited in Nisengard 2006:85). For example, Grasshopper Pueblo, Turkey Creek pueblo, and Point of Pines Pueblo are large sites that were occupied during the Late Late Pueblo period (Nisengard 2006:90, 91; Reid 1989:75, 80). Reid (1989:80) believes that a major architectural shift and aggregation was occurring during the Late Pueblo Period but notes that this aggregation occurred at different times depending on the site. Hinkes (1983:184) also did see bioarchaeological evidence that subadults living in the later period at Grasshopper Pueblo did show some increase in stress markers, which contradicts the improving health identified by Lippmeier (1991 as cited in Hegmon et al. 2016:57).

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: High

Evidence supporting high environmental insecurity includes:

1. *Extent of dryness index:*
 - a. Prior interval, 1299 to 1374, Average PDSI: 0.8
 - b. Depopulation interval, 1375 to 1450, Average PDSI: 0.1
 - i. An 85% increase in dryness compared to the prior interval

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: Moderate

Evidence supporting moderate resource depletion preceding depopulation in the Mogollon sub-region includes:

1. *Archaeological syntheses.* LeBlanc (1999:250, 251) notes that warfare was occurring in the Southern Mogollon area during the Late Pueblo period.
2. *Sites build in easily defensible locations.* LeBlanc (1999:245) has noted that some Late Late Pueblo period sites were constructed at easily defensible locations. Reid (1989:81, 89) and LeBlanc (1999:245) also describe smaller settlements in the Grasshopper Pueblo area that were built on hills and with clear vantage points. Tuggle and Reid (2001 as cited in Reid et al. 2006:131) also noted that sites were increasingly built in defensible locations.
3. *Bioarchaeological evidence.* Baustian et al. (2012) conducted an analysis of skeletal remains at Grasshopper Pueblo and found that a high proportion of the remains had cranial depression fractures. They have suggested an attack on Grasshopper Pueblo as the cause of these injuries (Baustian et al. 2012:109). Additionally, Cordell (1997:375-383 as cited in Nisengard 2006:93) notes skeletal evidence of violence during the Late Late Pueblo period. LeBlanc (1999:245) describes unburied bodies found at the Kinishba site. At Nuvakwewtaqa, Allen et al. (1985 as cited in Martin et al. 2008:120, 121) found evidence of scalping.
4. *Burned buildings.* At Point of Pines Pueblo, seventy rooms are thought to have been burned as a way to forcefully remove the people living there (Haury 1985 as cited in Reid 1989:75). Chodistaas Pueblo was also burned at the time of abandonment, although it is not known whether this was a result of violence (Reid 1989:77, 78; LeBlanc 1999:245). Of three

excavated sites dating from the 1300 C.E. to the 1400s C.E., all three were burned (Reid 1989:81).

Uncertainty: Low

Allen et al. (1985 as cited in Kantner 2004:222) only found 3 skeletal remains that suggested violent death at Grasshopper Pueblo.

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Coding: High

Evidence supporting high community insecurity preceding depopulation in the Mogollon sub-region includes:

1. *Possible immigration from the Ancestral Puebloan region.* Evidence of site unit intrusions have been found in the Mogollon highlands, which have been attributed to immigration from the Kayenta region (Cameron and Ortman 2017:716). Haury (1985:388) notes that during the Carrizo phase (from approximately 1100 C.E. to 1200 C.E. [Nisengard 2006:65]), the Tla Kii site began to incorporate more Puebloan cultural elements and he suggests that Ancestral Puebloan immigration into the region may be the cause of this growing influence. At the Point of Pines Pueblo, Haury (1985 as cited by Reid 1989:75) states that immigrants from the Ancestral Puebloan region were living there in the late 1200s. In general, Reid (1989:80) also notes that aggregation during the Late Pueblo Period was partially due to immigration from the Ancestral Puebloan region. Burials at Grasshopper Pueblo also indicated that people from the Ancestral Pueblo region had migrated there (Reid 1989:87). The presence of Ancestral Puebloan immigrants has also been documented by Ezzo and Price (2002), Riggs (2001), Lowell (2010), and Longacre (1975) (all as cited in Baustian et al. 2012:103). Stone (2003) and Kantner (2004:209-212) also discuss immigration from the Kayenta region into Silver Creek, Grasshopper Pueblo, and Point of Pines Pueblo.
2. *Switch from kivas to plazas.* Graves and Van Keuren (2011 as cited in Baustian et al. 2012:103) have argued that the Mogollon's switch from using kivas to plazas was an attempt to integrate the community.
3. *Growth of Grasshopper Pueblo.* Reid (1989:83) notes that the growth of Grasshopper Pueblo from 1300 C.E. to 1330 C.E. is due to immigration.
4. *Bioarchaeological evidence of immigration.* Based on cranial deformation, it is thought that at least Ancestral Puebloan and Mogollon groups resided at Grasshopper Pueblo (Reid

1989:87). Strontium isotope analysis of tooth enamel at Grasshopper Pueblo also indicated that some of the residents had moved there (Price et al. 1994 as cited in Stone 2003:51).

1. *Substantial increases in population growth rates:* The compound annual growth rate between the 1250 to 1299 and 1300 to 1349 intervals was 0.65 %, at the high end of what can be expected from internal changes in fertility and mortality (Cowgill 1975). In-migration (0.7 and above annual growth rates) is greater in the southern portion of the large Mogollon culture area (Ingram 2014:32). For calculation methods, see explanation in Appendix 1.

Uncertainty: Moderate

Although immigration has been suggested by a variety of sources as the reason for more Ancestral Puebloan elements, trade may also explain this (Haury 1985).

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: Moderate

Evidence supporting moderate political insecurity preceding depopulation in the Mogollon sub-region includes:

1. *Differential burial treatments.* At Grasshopper Pueblo, males were buried with more artifacts than women and ritual items were only found with male burials, which Reid interprets as a sign that males had a higher status (Reid 1989:86, 87). One male burial at Grasshopper Pueblo, had a high number of ceremonial artifacts and has been interpreted to have been a community leader (Reid 1989:87; Kantner 2004:223).
2. *Sodality system.* Reid (1989:87) details the gender-exclusive sodalities that existed at Grasshopper Pueblo, although it is unclear if there was a status difference between the sodalities. The sodality system is thought to be a part of the larger sequential hierarchy system that existed at Grasshopper Pueblo (Reid 1989:88). See also Kantner's (2004:230, 231) description of this system at Grasshopper Pueblo.
3. *Exclusionary religious architecture.* At Grasshopper Pueblo, Whittlesey and Reid (2001:69 as cited in Kantner 2004:225, 226) found that some groups had private ritual spaces and that only select spaces were open to the entire population for ceremonial use.
4. *Presence of lineage households.* Reid (1989:86) describes a hierarchy of kin groups at Grasshopper Pueblo and describes them as "structuring major divisions of the community".

5. *Status of Ancestral Puebloan immigrants.* The Ancestral Puebloan population residing at Grasshopper Pueblo was thought to have "greater wealth and prestige" than most Mogollon residents at the site (Reid 1989:88).

Uncertainty: Moderate

In the southern Mogollon area, there did not appear to be an elite group or sodalities during the Cliff phase and the time period is categorized as "egalitarian" (LeBlanc 1989:197, 198). Additionally, a bioarchaeological analysis of skeletons from Grasshopper Pueblo did not indicate that any subgroups were present or that one sex experienced more violent trauma than the other (Baustian et al. 2012). Baustian et al. (2012:108, 109) also did not see large differences in the amount of grave goods between burials. Overall, Baustian et al. (2012:109) did not think that the Mogollon at Grasshopper Pueblo used violence in order to maintain social stratification. A weakness of this data is that it is only drawn mainly from Grasshopper Pueblo and the surrounding area. There is limited data available from many other Postclassic Mogollon sites and we have used Grasshopper Pueblo as a representative site.

TRINCHERAS

Note: Most of the data used to characterize the Trincheras culture area is from the Cerro de Trincheras site, the largest site in the tradition, founded sometime between 1250 and 1300. There is little knowledge of the tradition in the years immediately preceding the founding of this central place.

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements

Coding: High

Evidence supporting a low level of trade and exchange preceding depopulation in the Trincheras sub-region includes:

1. *Minimal non-local goods.* Based on excavations at Cerro de Trincheras, the largest and most thoroughly documented site in the sub-region, McGuire and Villalpando (1998; 2011; 2016) found few exotic, imported ceramic sherds at the site. Although evidence of craft production is present at the site, McGuire and Villalpando (1998; 2016:19) interpret jewelry production as primarily for local consumption.
2. *Lack of control of trade.* Vargas (2004:75) states that "Given the lack of evidence for control of shell acquisition, production, or distribution by the inhabitants of the Cerro de

Trincheras, it appears that this economic realm of activity was not a significant basis of power for residents of the center." Rather, she argues it was more likely in the ritual realm, based on relatively higher frequencies of Conus tinklers compared to surrounding sites and the relationship between Conus tinklers and ritual elsewhere.

3. *Trincheras pottery found at other sites.* At Playa Noriega, a contemporaneous ancestral Comca'ac site, there was Trincheras red-on-purple pottery, which Carpenter et al. (2015:250) take as evidence for trade between the two communities.

Uncertainty: Moderate

The largest and best documented site is Cerro de Trincheras. Because inter-regional trade was low, we are assuming it was low in this culture area prior to the ca. 1300 CE formation of this site. Contrary to McGuire and Villalpando (1998; 2016), Gallaga and Newell (2004:7) state that the production of locally decorated ceramic types ceased because archaeologists have found only foreign types originating mostly from the southern portion of the American Southwest and the Paquimé area.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Coding: Low

No evidence has been identified to suggest resource depletion or degradation. The most extensive work has been conducted at Cerros de Trincheras (McGuire and Villalpando 2011; 2016)

Uncertainty: High

Health Insecurity

Indicator: settlement aggregation, bioarchaeological evidence (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total

number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: High

Evidence supporting high community insecurity preceding the demographic decline in the Trincheras sub-region includes:

1. *Settlement aggregation.* McGuire and Villalpando (2015:431) state that the construction of Cerro de Trincheras was a result of aggregation into the Rio Magdalena area in Sonora. Cerro de Trincheras was estimated to have a population of over 1,000 (McGuire and Villalpando 1998:3). Settlement aggregation is thought to have begun during the 1300 to 1450 period, as the number and variety of sites decreased and sites that persisted were larger in size (Gallaga and Newell 2004:7; McGuire and Villalpando 2015:437)--this is when Cerro de Trincheras was built and the El Cerro phase began (McGuire and Villalpando 2015:437).

Uncertainty: Low

Only one site, Cerro de Trincheras, informs this assessment. There is also no bioarchaeological evidence of declining health.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: Low

Evidence supporting high environmental insecurity includes:

1. *Extent of dryness index:*
 - a. Prior interval, 1399 to 1424, Average PDSI, -0.4
 - b. Depopulation interval, 1425 to 1450, Average PDSI, -0.09
 - i. A 79% increase in wetness, toward average conditions, compared to the prior interval.

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: Moderate

Evidence supporting moderate personal insecurity preceding depopulation in the Trincheras sub-region includes:

1. *Defensive motivation for hilltop and cerro de trincheras construction:* Hill top terraces and walls are interpreted as defensive works by McGuire and Villalpando (2015, 2016:19). This interpretation relies on the expectation that if terraces, walls, and other features increased the costs of movement for domestic purposes, they can be inferred to be defensive. GIS least-cost movement analysis at several sites determined that the significantly increased the cost of climbing and moving through the hills made communities more defensible. They also argue for the presence of redoubts as refuges. Kowalewski (2007) also notes the defensive aspects of cerro de trincheras and believes specific sites' role in larger social structures may have played a role in their usage.

Uncertainty: High

Trincheras architecture is only an indirect indicator of conflict and violence. Other functions and benefits (e.g., ritual/ceremonial, agricultural) have been argued and documented (e.g., Downum et al. 1994 and Phillips 2009). Trincheras sites span almost three millennia (1250 to 1450 CE) and are found in a large geographical area, beyond the Trincheras culture area (Fish et al. 2018).

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Community insecurity (immigration): Moderate

Evidence supporting moderate community insecurity preceding depopulation in the Trincheras sub-region includes:

1. *Site formation due to Hohokam immigration.* McGuire and Villalpando (2016) interpret the construction of the Cerro de Trincheras site as a response to the arrival of Hohokam immigrants in Sonora's Altar valley.
2. *Possible presence of captive Hohokam women.* Sells Plain, a Hohokam ware, is present at Cerro de Trincheras but produced with local materials and the local manufacturing method. A hybrid pottery type, Lisa 3A, blends paddle-and-anvil and coil-and-scrape manufacturing techniques in the same vessel. Chiykowski (2016:20) interprets this as evidence of the

presence of Hohokam women producing pottery at Cerro de Trincheras and their efforts to fit in to their new homes.

3. *Attraction to agricultural land.* Fish and Fish (2004:63) speculate that a major portion of population growth near Cerro de Trincheras during the El Cerro phase (1300 to 1450) "was the result of in-migration to irrigable floodplains and lower basin alluvial fans where intensification could be most readily achieved."

Uncertainty: Low

The presence of Hohokam pottery techniques indicates that a unique cultural group migrated into the region and brought aspects of their culture with them. We have found no contradicting evidence that suggests immigration was not a factor in the forming of the primate center.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: High

Evidence supporting high political insecurity preceding depopulation includes:

1. *Intrasite settlement patterns.* Villalpando and McGuire (2017:389) argue that the site of Cerro de Trincheras was home to elites who exerted control over agriculture, craft production, and ritual activities in the region. They interpret sites at the top of the hill as elite homes and/or specialized ceremonial areas (McGuire and Villalpando 2016:19; McGuire and Villalpando 1998:5; McGuire and Villalpando 2015:440, 448).
2. *Elaborate architecture styles at Cerro de Trincheras.* Fish and Fish (2004:63) state that the "Expanded hierarchy and institutions cross-cutting social constituencies appear to be reflected by the elaboration and complexity of residential, public, and ceremonial precincts at the Cerro de Trincheras."
3. *Presence of prestige items.* In homes on the top of hills, McGuire and Villalpando (2016:19; 2015:448) note the presence of prestige items such as parrots, shell, polychrome pottery, cloud-blower pipes, and animal remains.

Uncertainty: High

Gallaga's (2004:91) research on shell ornaments and polychrome ceramics "fail[ed] to support the existence of a central power or sector at the site that controlled the acquisition, production, and distribution of the shell and the acquisition-distribution of the polychrome ceramics..."

When discussing Trincheras burial rituals, Cerezo-Roman (2016:22) notes that burial goods did not appear to differ between burials of different ages, sexes, or genders. At the Tio Benino and La Hormiga sites, McGuire and Villalpando (2015:437, 438) did not find evidence of social differentiation in the form of elite residences or artifacts.

RIO SONORA AND SERRANA

NOTE: Based on the best available evidence, populations persisted in the Rio Sonora and Serrana culture areas without evidence of significant population loss (Matthew Pailes, personal communication 1 February 2020; see also Pailes 2017). Thus, this culture area is a case of persistence and demographic stability. We coded the conditions for the ca. 1200 to 1450 period for their descriptive value and to contribute to the geographical comprehensiveness of this study. Those conditions documented in the Rio Sonora area identified low or moderate insecurities, as expected based on the continuity without substantial depopulation in the area.

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements

Coding: Moderate

Evidence supporting moderate economic insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *No evidence for extensive long distance exchange; mostly intra-regional exchange.* Marine shells, Paquimé polychrome pottery, and obsidian from the northern regions was found at the Buenavista site (Carpenter and Sanchez 2016:13). While in the Moctezuma Valley, some imported goods have been found, Pailes (2016:15) notes that trade, specifically of obsidian, may have been restricted to a few sites. Newell and Gallaga (2004:10 and references therein) have also noted turquoise, pottery, shells, and copper bells that indicate some long-distance trade was occurring, mostly with Paquimé and the American Southwest. Pailes et al. (2021:9, 18-22) did find pottery originating from Casas Grandes in the Sahuaripa valley, however it only comprised 1.5% of that assemblage, and in the Fronteras valley. Pailes (2015:538-540) also notes that obsidian was also imported to the Rio Sonora area and, at Teonadepa, at least 25% of the ceramics there were imported. R. A. Pailes (1984:321-323) and Doolittle (1988) have also found evidence of imported goods in the Rio Sonora region. When discussing projectile point morphology, Pailes et al. (2021:12) also find further evidence of regional variability in the intensity of trade with other communities. Overall, Pailes et al. (2021:7) describe “discontinuous patterns” of regional activity and exchange, which likely accounts for the intraregional variation in artifact prevalence.

2. *Possible centralized trade centers.* Doolittle (1984 and sources therein) discuss the possibility that larger settlements developed due to a need for regional trading centers based on their relative location to other sites. Doolittle (1988:41, 60) also discusses this possibility, but notes that many of the sites do not conform to how regional trading centers normally develop. Overall, Doolittle (1984:23; 1988:60) thinks that the trading aspects of this sites were a secondary development.
3. *Association with Casas Grandes and Trincheras.* Villalpando and McGuire (2017:392) state that the Rio Sonora culture traded with Casas Grandes and functioned as an "intermediary in the exchange between the Paquimé and Cerro de Trincheras."
4. *Cranial modification similar to West Mexican practices.* Pailes et al. (2021:11-12) note a skeleton with evidence of cranial modification found at the Rancho Los Zopoquis site in the Onavas valley by Hernández-Espinoza (2017 as cited in Pailes et al. 2021:12). The type of cranial modification has been likened to that found in the West Mexican area of Huatabampo (Watson and Garcia 2016:228-230; Ekholm 1939 as cited in Pailes et al. 2021:11-12) and this similarity has been inferred to represent possible interaction between the two communities (Pailes et al. 2021:12).

Uncertainty: High

Despite his conclusion that obsidian was brought into the region, Pailes (2015:545) later states that there is "no evidence" that the people in Rio Sonora participated in long-range trade. Doolittle (1988:59) also critiques R. A. Pailes' (1980) and R. A. Pailes and Reff's (1985) earlier interpretations of ceramics found in the Sonoran area and believes that Pailes overestimated the amount of non-local ceramics found in the Valley of Sonora. Pailes et al. (2021:23) also note that some sites in the northern area of Sonora are "fully Casas Grandes in character." Overall, there is substantial variability in the types of trade occurring within the Rio Sonora area (Pailes et al. 2021:7- 14, 22) and the data is limited.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Coding: Low

Evidence supporting low food insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *High artiodactyl indices.* Pailes (2017) analyzed the faunal assemblages present at the El Nogal, Teonadepa, and Los Mineros sites and calculated an artiodactyl index. In the Moctezuma Valley the index was .85 and in the Sonora Valley it was .66 (Pailes 2017:140). These high indices are associated with a low level of resource insecurity (Pailes 2017:145, 146).
2. *Double cropping.* Pailes (personal communication, 2020) notes that double or triple cropping was practiced in the region. R.A. Pailes (1984:315) also notes that the Rio Sonora area was “easily amenable to double cropping.” Double cropping enhances food production and possibly food security and is an indirect indicator that resource depletion/degradation was likely not threatening food security in the area.
3. *Approaching the area's carrying capacity.* Doolittle (1980:341) argues that the region was beginning to approach carrying capacity during the late phase of occupation. Population growth has also been cited as a possible stressor by Grigg (1976) and Cohen (1977) (both as cited in Doolittle 1988:51).
4. *Increased use of floodplain agriculture.* Doolittle (1988:51) states that the increased use of floodplain agriculture in the later years of occupation would have resulted in the decreased availability of wild food resources. However, he does think that there was enough agricultural productivity to compensate (Doolittle 1988:51).
5. *Shift to northern part of the valley due to resource stress.* In the early phase of occupation, Doolittle (1988:58) suggests that resource stress prompted the population to migrate to the northern half of the valley.

Uncertainty: High

Evidence is minimal to interpret food insecurity in the culture area.

Health Insecurity

Indicator: settlement aggregation.

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Health insecurity: Moderate

Evidence supporting moderate health insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *Change in settlement patterns.* In eastern Sonora, two large, late phase sites were identified and included large-scale public architecture (Doolittle 1984). Most sites, however, were composed of eight or fewer houses (Doolittle 1984:19). 2.5% of sites were also determined to be nucleated villages comprised of 26 to 100 habitations (Doolittle 1984:20). Doolittle (1988:39) notes a decrease in the amount of settlements but an increase in site size which he interprets as aggregation.

Uncertainty: High

Doolittle (1984; 1988; 2008) interprets the presence of two-story structures in some settlements. McGuire and Villalpando (1989) question this interpretation. Refined settlement data supported by excavation will clarify the extent of settlement aggregation in this culture area.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: Low

Evidence supporting low environmental insecurity includes:

1. Extent of dryness index:
 - a. Prior interval, 1299 to 1349, Average PDSI, 0.5
 - b. Depopulation interval, 1350 to 1400, Average PDSI, 0.3
 - i. A 45% increase in wetness compared to the prior interval.

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: Moderate

Evidence supporting moderate personal insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *Archaeological synthesis*: “Warfare was likely a primary characteristic of the inferred balkanized landscape from approximately AD 1100 until contact” (Pailes 2017:395). Although warfare was common, it was not necessarily lethal (Pailes 2020, personal communication).
2. *Spanish accounts of war*. Based on early Spanish accounts, people of the Moctezuma valley frequently fought small wars (Pailes 2016).
3. *Presence of defensive sites and cerro de trincheras*. Phillips (1989:389) states that there were some defensive sites in the region with Doolittle (1988:33) also noting the presence of cerros de trincheras and in the Valley of Sonora. Pailes et al. (2021:5, 6) also infer that walled compounds in the Sahuaripa area were increasingly built as a response to a perceived need for defense.
4. *Communication system used for defensive purposes*. Doolittle (1988:32-33) discusses the possibility of a communication system in the valley that could have been used for defensive purposes.

Note: Although conflict and violence appear to be endemic to the culture area, there is no evidence that insecurities due to conflict/violence increased during the late precontact period. Thus, we code this variable as moderate rather than high.

Uncertainty: Moderate

Evidence for conflict and violence is primarily inferred rather than direct. Pailes et al. (2021:22) also characterize the interactions between the Rio Sonora and Casas Grandes areas as “relatively peaceful.” Pailes further states that there is “essentially no” bioarchaeological evidence of warfare (Pailes 2020:9).

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Coding: Low

Evidence supporting low community insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *Archaeological analyses*. Doolittle (1984:23-24; 1997) states that the Rio Sonora area was increasing in population without immigration as a contributing factor. Pailes (2015:545) also

notes that it is unlikely that "substantial immigration" occurred in the Rio Sonora area. However, in a previous article, R. A. Pailes (1984:321) determined that immigration did play a role in the development of social hierarchy in the Rio Sonora area.

Uncertainty: Low/Moderate

Doolittle (1988:55) critiques R. A. Pailes (1984) interpretation that immigration was a factor of the population growth of the Rio Sonora region and concludes that Pailes did not fully understand the source he was basing his interpretation on. Doolittle (1988:55) further states that immigration "need not be interjected to explain population growth."

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: Moderate

Evidence supporting moderate political insecurity in the Rio Sonora culture area during the period of SW/NW depopulation includes:

1. *Prestige goods.* After analyzing the potential trade networks, Pailes (2016:15) concluded that although there likely were high-status individuals, they did not use the exchange of prestige goods as a way to exert control. However, Pailes (2015:539) does argue that only certain people in the Rio Sonora area were able to procure obsidian due to the item's status as a prestige good. Pailes (2020:44) also infers that "competitive gifting" was used by elites to demonstrate power.
2. *Statelet system.* Doolittle (1984:19) concluded that the Rio Sonora area was comprised of statelets, with one larger settlement surrounded by smaller settlements who took part in cultural activities at the larger site (c.f., Pailes below).
3. *Ceramic analysis.* Through ceramic analysis, Pailes (2015:540) suggests that high-status individuals were constrained to either El Nogal or Teonadepa given the "exclusive traditions" seen in ceramic design.

Uncertainty: Moderate

Pailes (2015:536) concluded that there was a lack of primate centers in the Rio Sonora area based on rank-size correlation analysis. He also notes that it is unlikely a few people were able to control agriculture in the region and that religion was also not an area controlled by only a few people (Pailes 2015:545). The region also lacks public architecture normally associated with exclusion and inequality (Pailes 2015:545). Pailes et al. (2016:7) state that there were likely only "weak institutional mandates for positions of authority."

CASAS GRANDES

Economic Insecurity

Indicator: trade and exchange.

Question: What was the extent of interregional trade/exchange relative to previous periods?

Sample proxies: extent of non-local pottery and other goods in settlements

Coding: Low

Evidence supporting low economic insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Presence of imported goods.* Exotic items such as parrots, copper, turquoise, shell, and decorated pottery were found at Casas Grandes (Minnis and Whalen 2003:1; Douglas 1992 and sources therein; Whalen 2013; Doolittle 1993:133). Douglas (1992:13) analyzed 214 rooms at Casas Grandes and found that a mean of 2.1% of the ceramics there were non-local. The majority of the shells found at Casas Grandes likely originated in the Gulf of California, meaning that they had to have been brought into Casas Grandes (Whalen 2013:625). Ravesloot (1988:72) also noted the presence of non-locally produced goods in burials at Casas Grandes. Kelley and Searcy (2015:36-38) also discuss Casas Grandes' increased control over the flow of exotic goods into the region during the Medio period.
2. *Exported Ramos polychrome.* While Ramos polychrome was produced at Paquimé, it appears to have been circulated throughout the larger region (Whalen and Minnis 2017).

Uncertainty: Low

Minnis (1989 as cited in Douglas 1992) has argued that prestige items were more likely for internal elite consumption than for trade with other groups. Whalen (2013:629) also suggests that while Casas Grandes was receiving large amounts of shell, they were not then exporting worked shell as had previously been stated by Di Peso.

Food Insecurity

Indicator: resource depletion/degradation.

Question: What was the extent and severity of resource depletion and degradation?

Sample proxies: declining diet breadth, change in previous resource procurement strategies (for example, shifting from cultivated to wild foods or vice versa), increased reliance on smaller or more immature mammals, increasing soil degradation, bioarchaeological indicators of food stress.

Coding: Low

Evidence supporting low food insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Archaeological synthesis*: During their discussion of Casas Grandes' food economy, Minnis and Whalen (2015) did not note that Casas Grandes experienced food stress during the Medio period.
2. *Soil degradation*. There is no evidence to show that the Casas Grandes region suffered from soil degradation (Minnis and Whalen 2015:55). After conducting chemical and physical analyses on the soil, none of the classic markers of soil degradation were found (Minnis and Whalen 2015:55).
3. *Deforestation*. There is no evidence to suggest that the region experienced deforestation. Wood charcoal from a variety of species is frequently found at sites along the Rio Casas Grandes, which one would not expect to find if large-scale deforestation had occurred (Minnis and Whalen 2015:55).
4. *Presence of food surpluses*. Minnis and Whalen (2015:47, 55) credit the availability of food surpluses as part of the reason Casas Grandes was able to grow into such a large site. Minnis and Whalen (2003:3) also note that people at Casas Grandes were able to produce large amounts of crops, such as corn and agave and that elites during the Medio period were still able to produce large amounts of food for feasts.

Uncertainty: Low

The Casas Grandes region has been the subject of many studies and we have not found evidence that indicates a moderate or high amount of resource depletion prior to decline. However, a weakness of this evidence is that most of the research focuses on the Paquimé site, rather than the whole Casas Grandes region.

Health Insecurity

Indicator: settlement aggregation, bioarchaeological evidence (where/when available)

Question: What was the extent of settlement aggregation and bioarchaeological evidence of disease, if any?

Sample proxies: spatial clustering of households into larger communities; skeletal indicators of health/disease. In addition to coding this insecurity based on published scholarly assessments of the extent of aggregation, we calculated an aggregation index for each culture area using settlement data in the Coalescent Communities Database (Hill et al. 2012). Our index is: total number of rooms in a culture area divided by the total number of settlements in each area. The percent change in the index from one 50-year interval to the next, informs the coding.

Coding: Moderate

Evidence supporting moderate health insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Large site size inferred from architectural elements.* Whalen et al. (2010:547) estimated the population of Paquimé based on the site's architecture and concluded that it was an "outstandingly large population." Casas Grandes has also been proposed to be a main site in the middle of a larger, regional cluster (Minnis 1989 as cited in LeBlanc 1999:252; Whalen and Minnis 1996).
2. *Increased population growth encouraged by agricultural practices.* According to Douglas and MacWilliams (2015:144), aggregation increased during the Medio period and this trend was encouraged by agricultural choices such as "a combination of moderate-scale irrigation in the river valleys and widespread expansion of runoff agricultural field systems."
3. *Bioarchaeological evidence of disease.* Of 238 Medio period burials, Rakita (2001:211) found that 26% had some sort of pathology, although he does not attribute a specific origin to the diseases.
4. *Increased presence of outdoor burials.* Rakita (2001:276) also associated an increase in indoor burials in private locations with aggregation of outside groups into the region. He argues that these groups were trying to maintain a group identity through their burial practices.
5. *Archaeological analysis.* Phillips (2008:7-8) notes that aggregation was occurring in the region and cites this as a possible reason for decline. LeBlanc (1999:62) also notes that Casas Grandes was "much larger than any other contemporary site in the region."
5. *Aggregation index (Total number of rooms/total number of settlements in culture area):* Comparing the extent of aggregation during the 1350 to 1399 interval to the 1400 to 1449 interval (the period when depopulation began) the extent of aggregation is virtually unchanged (1% increase).

Uncertainty: Moderate

Many lines of evidence demonstrate that Casas Grandes was one of the largest sites in the Southwest/Northwest and was also surrounded by a cluster of many, smaller sites. There is evidence for disease in the population, but a link between this and settlement aggregation cannot be established.

Notes:

Paquimé was a large urban center but substantial changes and increases in aggregation at Paquimé or within the Casas Grandes culture area prior to depopulation, the focus of the coding, was not documented.

Although they agree that Paquimé was still a major cultural center, Whalen et al. (2010:547-548) did conclude that Paquimé was actually a smaller site in terms of population than previously

thought and notes that a smaller population size is more in line with the organizational strategies seen at the site.

Environmental Insecurity

Indicator: drought and dryness.

Question: What was the extent of drought/dryness coincident with the decline, relative to drought/dryness during the period preceding decline?

Proxy: Comparison of prior interval dryness to depopulation interval dryness (see Environmental Insecurity in *Insecurities, Archaeological Indicators, Coding Questions and Definitions* above).

Coding: Low

Evidence supporting low environmental insecurity includes:

1. *Extent of dryness index:*
 - a. Prior interval, 1399 to 1424 Average PDSI, -0.8
 - b. Depopulation interval, 1425 to 1450 Average PDSI, 0.3
 - i. A 177% increase in wetness compared to the prior interval

Uncertainty: Moderate.

Discussed above in *Insecurities Coding: Definitions and Methods, Environmental insecurity* section.

Personal Insecurity

Indicator: conflict and violence.

Question: What was the extent and trajectory of conflict and violence within the culture area?

Sample proxies: skeletal trauma, unburied bodies, fortified and defensive structures/settlements

Coding: High

Evidence supporting high personal insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Use of warfare to acquire non-local goods.* Douglas (1992:20) theorizes that, given the unexpected patterning of nonlocal ceramics at Casas Grandes, their prestige may have come from how they were acquired. It has been argued that goods procured from warfare are inherently more valuable (Helms 1979 as cited in Douglas 1992:20)
2. *Presence of watchtowers.* During his investigation of Casas Grandes, Di Peso (1974 as cited in Swanson 2003:753) noted a regional system of watchtowers (*atalayas*) that he inferred to have been used for fire signaling. Spanish explorers and other visitors to the region also saw watchtowers in the region (Hammond and Rey 1928, Bartlett 1854, Blackiston 1906, 1908,

Brand 1933 as cited in Swanson 2003:755-756). A survey by Swanson (2003:758, 764) identified 24 possible signaling structures in the Casas Grandes region that were likely used for defensive and ritual purposes.

3. *Bioarchaeological evidence for post-mortem processing, skeleton trophies, and cannibalism.* Casserino (2009:72, 89, 94-97) found that 28.6% of the skeletal remains he analyzed at Paquimé had evidence of post-mortem processing, which he presents as evidence of endo and exo-cannibalism. At Burial 44-13, the skeletal remains had evidence of cut marks, peeling, spiral fracturing, and pot polish (White 1992 and Turner and Turner 1999 as cited in Waller et al. 2018:415). This type of post-mortem processing can be seen in Mesoamerican sacrificial victims as well (Graulich 2000; Medina Martin and Sánchez Vargas 2007; Tiesler 2007:Table 2.1 as cited in Waller et al. 2018:416). Through isotopic analysis, one of the people interred was determined to have only come to Paquimé a few years prior and it has been suggested that they were a captive from raiding (Offenbecker 2018:199; Offenbecker et al. 2015 as cited by Waller et al. 2018:418). DiPeso (1974 as cited in LeBlanc 1999:87) also found skulls with holes drilled in the top which were inferred to be used to suspend the skulls as trophies, and Rakita (2001) also noted this. Ravesloot (1988:76) describes skeletal remains with trauma and who had likely been hit in the head. LeBlanc (1999:252), using Di Peso's (1974) data, calculated the number of unburied bodies to be around 1,000 people. Rakita (2001:63, 64, 192-195) notes that a large period of violence is thought to have occurred around the end of occupation at Paquimé, and the shift in burial age ratio aligns with this idea. An increase in corpse processing is also seen during this time period (Rakita 2001:266).
4. *Goods made from human bone.* Di Peso (1974 as cited in LeBlanc 1999:87) found jewelry and utilitarian items such as dishes made from human bone during his exploration of Casas Grandes. Ravesloot and Spoerl (1987 as cited in Ravesloot 1988:71) also notes the presence of artifacts made from human bone and discusses their association with warfare.
5. *Oral history.* Phillips (2008:6, 7) details an indigenous narrative that describes the people of Casas Grandes being pushed to the north due to violence and other populations entering the area.

Uncertainty: Moderate

Casserino (2009:69, 70) analyzed the skeletal remains at Paquimé and found that only 7% showed signs of ante or peri-mortem fractures. Ravesloot (1988:76) does mention that there is evidence of skeletal trauma and unburied bodies, but if those were results of warfare he says is "impossible to evaluate." There are also no paintings or murals of violence found at Casas Grandes (Ravesloot 1988:76). In dealing with control of exchange routes, Douglas and MacWilliams (2015:147) do speculate that force could have been used but ultimately state that "less violent...tactics were the norm."

Community Insecurity

Indicator: immigration.

Question: What was the extent of in-migration from people outside the culture area?

Sample proxies: rising population levels above changes in internal population growth rates, intra-community, ethnic-based architectural and material cultural differences.

Coding: Low

Evidence supporting low community insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Archaeological analysis.* Whalen and Pietzel (2015) analyzed the settlement patterns of the larger Casas Grandes area and did not report any evidence of outside populations moving into the region.
2. *Increase in indoor burials.* Rakita (2001:276) associated an increase in indoor burials in private locations with immigration of outside groups into the region. He argues that these groups were trying to maintain a group identity through their burial practices.
3. *No evidence of substantial immigration based on settlement data.* Based on the limited settlement data available in the Coalescent Communities database (Hill et al. 2012), compound annual growth rates between the 1350 to 1399 and 1400 to 1449 intervals were declining (-0.33 %). For calculation methods, see explanation in Appendix 1.

Uncertainty: High

Douglas and MacWilliams (2015:146) note that “direct evidence of pilgrimage from communities across the region to Paquimé is intrinsically difficult to demonstrate.” We also did not find evidence of non-local architectural or material culture styles entering the region as one would expect to find if substantial immigration was occurring.

Political Insecurity

Indicator: social stratification.

Question: To what extent did individuals/groups have different levels of access to structural, ritual, or socioeconomic resources? Was it increasing?

Sample proxies: architecture within settlements increasingly differentiated, exclusive spaces, differential burial treatments.

Coding: High

Evidence supporting high political insecurity preceding depopulation in the Casas Grandes sub-region includes:

1. *Differential architecture indicating social stratification.* Whalen and Minnis (2001a) identify two distinct types of domestic architecture in the Casas Grandes core and immediately surrounding area (within ~30 km). Differences are identified by thick vs. thin walls and room elaboration. They argue that thick-walled architecture in the hinterlands represents nodes of power and authority connected to the core area. They also argue that

the over-building of the Casas Grandes primate center in addition to its sheer size and Mesoamerican-style ritual architecture conveyed a strong symbolic message of authority. Whalen and Minnis (2001b:335, 338) also note that the Casas Grandes core area had more ovens and architecture relating to food production than other settlements and this high amount of public architecture indicates centralization.

2. *Prestige good distribution.* Elite households are presumed to have existed at Casas Grandes due to the large amount of hoarded shell artifacts (Minnis and Whalen 2003:1; Whalen 2013; Whalen and Minnis 2001b). Whalen and Minnis (2001b:339) suggest that the hoarded prestige goods were then distributed by the elite. Exotic items also appeared most frequently at the primate center of Casas Grandes and less so in settlements in the Middle and Outer Zones (Whalen and Minnis 2001b:325, 335). Settlements in the Middle and Outer zones had more common and crudely worked shells, indicating that the settlements in the periphery did not receive as prestigious of items as those in the Inner zone (Whalen and Minnis 2001b:349).
3. *Presence of ball courts.* Whalen and Minnis (1996) argue that the presence of multiple ball courts around Casas Grandes are evidence for rivalry and competition between elites as a method of building power and prestige.
4. *Differential burials.* The items associated with Burial 44-13 at Paquimé have been interpreted to indicate a high-status burial (Ravesloot 1988:32-34; VanPool and VanPool 2007 both as cited by Waller et al. 2018:413). There was also a difference in the amount of grave goods between the articulated and disarticulated remains, which suggests a differentiation in status (Waller et al. 2018:416). Rakita (2001:230, 231) also notes that during the Medio period, males often had more grave goods than females and speculates that this difference is indicative of "perceived status." Based on analysis of grave good frequency, Rakita (2001:272, 273) and Ravesloot (1988) concluded that the distribution of burial goods during the Medio period was indicative of a hierarchical society. Within burials, Ravesloot (1988) also notes that status differentials at Casas Grandes can be reflected through the differing locations of burials and post-mortem processing.
5. *Bioarchaeological evidence of health differentiations according to social status.* The articulated remains at Burial 44-13 showed evidence of less nutritional stress and overall better health due to their higher status (Waller et al. 2018:417). The disarticulated remains at Burial 44-13 also appeared to be of lower status (possibly of non-local origin) and had significant trauma that indicated ritual violence on the part of an elite class (Waller et al. 2018 and sources therein).
6. *Higher prevalence of administrative functions in the Inner Zone.* Whalen and Minnis (2001b:321-322) identified a pattern in the Inner Zone of the Casas Grandes region where higher-order settlements had more administrative functions than other settlements in the area. They also identified a scalar hierarchy of the sites surrounding Casas Grandes.
7. *Iconography used to support power.* Rakita (2009 as cited in Munson and Hays-Gilpin 2017:670) states that elites used imagery in order to support their power. Mesoamerican

motifs are also cited as evidence of control by high status individuals (Whalen and Minnis 2017; Whalen and Minnis 2001b:344, 356, 357).

8. *Spanish accounts of differential burials.* Bartolome de las Casas described special burial treatment for high-status members of society (de las Casas 1967 as quoted in Ravesloot 1988:75).

Uncertainty: Moderate

Douglas (1992:18) analyzed the distribution of non-local ceramics in rooms at Casas Grandes and found that there was "limited variability in nonlocal ceramic distribution that can be related to social differences." Whalen (2013:631) does not believe that the large amounts of shells at Casas Grandes had other uses besides simply being a prestige item. Whalen and Minnis (2001b:336) also note that there is no pattern for exclusive use of areas at Casas Grandes, although the practice did occur. Based on Ravesloot's (1988) mortuary data, Whalen and Minnis (2001b:336, 357, 358) do not believe that the system of social differentiation, although present, was not very elaborate. However, the vast majority of the evidence does suggest that there was social stratification at Casas Grandes.

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