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Reframing food security by and for Native American communities: A case study among Tribes in the Klamath River Basin of Oregon and California

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Abstract

Native Americans make up less than 2% of the population of the USA, but suffer from some of the highest rates of food insecurity, poverty, diet-related diseases, and other socioeconomic challenges. This study examined unique attributes of food security in Native American communities in the Klamath River Basin of southern Oregon and northern California to generate a more comprehensive and culturally relevant understanding of Native American food insecurity. Through an in-depth case study among the Karuk, Yurok, Hoopa and Klamath Tribes, in which access to native foods was a central focus, our study examined the experience of food insecurity among tribal members, as well as barriers to and opportunities for building a more healthy, affordable and culturally appropriate food system. We found extremely high rates of food insecurity in participant households, greater than that documented in previous studies of food insecurity in tribal and non-tribal communities in the USA. Additionally, we found that the majority of study participants lacked access to desired native foods, due to reduced availability from restrictive laws and habitat degradation under settler colonialism, and that limited access to native foods is a strong predictor of food insecurity. There is a strong demand for increased access to and consumption of native foods and Native communities are actively engaged in eco-cultural restoration activities to enhance their cultural foodways. To understand contributions and solutions to food insecurity in Native communities, we examined predictors of food security and *native foods* security and provide new insights into the relationship between these two categories. Results from our study suggest the need to expand the way in which food security is defined and measured in Native American communities, and in indigenous communities more broadly, incorporating

more culturally relevant measures, while simultaneously calling for policy change to address the historical underpinnings of contemporary food insecurity among indigenous peoples. Our findings contribute to the growing literature on the value and importance of Native food systems in revitalizing culture and restoring community health and well-being among Native American communities, as well as sovereignty over their food systems.

Keywords HFSSM · Native foods · Food sovereignty · Native Americans · Community based participatory research

1 Introduction

> "[Native foods] are just a part of my culture and even my religion and my history. Those are things that are very important to me to hold onto and pass on to my own future children and my nieces and nephews. It's just a part of who I am. I couldn't imagine myself without those things that are important to me and to my family. There are things that have been, over the years, taken away from us intentionally, or by accident as well. There are things that people in my family and our community through the years have worked really hard to maintain and reclaim and revive, so I think that's something that should be really paid attention to and honored" (Interview #21, 11/11/2015).

It is well established that food insecurity and associated poor health outcomes disproportionately affect minority ethnic populations in the USA (Coleman Jensen et al. 2017; Leung et al. 2012; Myers and Painter 2017). Much less is understood about unique attributes of food insecurity among Native American households in the USA. Sometimes referred to as "Asterisk Nations", Native communities and their challenges are often rendered invisible due to the paucity of data (First Nations Development Institute 2017). This may help explain why, despite decades of government interventions, food insecurity in Native American communities remains at least twice the national average. What limited data does exist suggests that Native Americans suffer some of the highest rates of poverty, food insecurity, and chronic diet-related diseases, both nationally (Jernigan et al. 2017; Tomayko et al. 2017) and in California (Jernigan et al. 2013) and Oregon (O'Donnell-King and Newell-Ching 2017).

Mounting evidence suggests that native foods are more nutritious than conventional diets consisting of conventional foods (Elliot et al. 2012; Kuhnlein et al. 2009; Sheehy et al. 2014)[1]. Studies show that restricted access to native foods and increased consumption of non-traditional foods has resulted in astronomical rates of diet-related diseases such as malnutrition, diabetes, obesity, heart disease, and others among Native American communities (Elliot et al. 2012; Grey and Patel 2015; Patchell and Edwards 2014). Native foods, however, are not just a resource for sustenance, as the opening quote by a Karuk tribal member illustrates, but also need to be understood within a wider cultural framing that interweaves indigenous cultural, spiritual and environmental relations (Panelli and Tipa 2009). They are inextricably linked to the well-being of the land, culture, identity, social structure and ceremonial practices of Native American communities. Several studies raise the visibility, value and importance of native foods in restoring physical, cultural and overall health and well-being among Native American communities, as well as sovereignty over their food systems (Bye 2009; Gurney et al. 2015; Patchell and Edwards 2014; Sheehy et al. 2014). For the tribes in our case study, growing, tending for and harvesting native foods is intimately tied to cultural conceptions of responsibility, renewal, and reciprocity − taking care of and stewarding the land, waterways and their inhabitants (which these Indigenous peoples call their "relations") for the continuity of culture and for future generations. A Karuk tribal member and cultural resource manager explained this intrinsic relationship,

[1] Native foods are those of historical and cultural significance to Native Americans that have provided sustenance for thousands of years and tend to be acquired through non-market mechanisms, the physical connection to the landscape, and/or a culturally appropriate social networks. Non-traditional or conventional foods refer to market-based or store-bought foods inclusive of agribusiness products designed for global consumption, and foods not traditionally consumed by Native American communities such as dairy products, refined sugars and flours and heavily processed foods that are often more affordable but of lesser nutritional quality and more readily available.

> "There's not enough fish to go around and this is not only a nutritional issue, but more importantly, it really abbreviates our culture. The fishery is the icon of our religion. My perspective, everything we do on the landscape, everything we do in the way of our ceremonies, the bottom is all about the fish. Our ceremonies are pretty much based on the salmon run. All the management activities on the landscape - fire provides better water, provides nutrient cycling, it provides all these benefits from the landscape that goes into the water to provide a healthy fishery, and that hasn't happened for 150 years. That has had a devastating impact on our culture by way of the fish." (Interview #42, 3/5/2016).

In this article, we seek to answer the following question: *Can promoting access to native foods reduce hunger and food insecurity in Native American communities?* Through a review of the literature on Native American food insecurity and an in-depth case study in the Klamath River Basin[2] of southern Oregon and northern California among the Karuk, Yurok, Hoopa and Klamath Tribes, we explored this question by examining the experience of food insecurity among tribal members, as well as the barriers to and opportunities for building a more healthy, affordable and culturally appropriate food system. We introduce and analyze a novel indicator, *native foods security*, to understand how household access to native foods relates to food (in)security in the conventional (Euro-American) sense. We included cultural variables related to native food consumption, acquisition, exchange, and knowledge to examine what indicators predict food security and native foods security among the tribal communities and provide insights into the relationship between the two categories,

We begin this article by reviewing the literature on food security in Native American communities. We first examined how food security is defined and measured in the USA noting the limitations of its application in Native American communities. Next, we compared methods, findings and gaps in both quantitative and qualitative studies to date. We then present the methods, context and results from our case study on Native American food insecurity in the Klamath River Basin drawing on both quantitative survey and qualitative interview and focus group data. We examined what factors predict food security and *native foods* security and explored the connection between the two categories. Through the voices of tribal members, we examine the impact of colonialism on tribal food security, as well as coping strategies and community-identified barriers to achieving food security. We discuss tribal recommendations for improving food security, and the need for more research to evaluate the unique attributes of food security in Native American communities. By employing a Community Based Participatory Research (CBPR) approach, we also uncovered key limitations of the USDA Household Food Security Survey Module (HFSSM) for defining, measuring and interpreting the experience of food insecurity among tribal populations and offer some suggestions for methodological improvement.

2 Food Security in Native American Communities

2.1 Defining and measuring food security and its limitations in Native American communities

[2] Throughout this paper, we use the terms Klamath River Basin and the Basin interchangeably to reference our study region.

The USDA defines food security[3] as: "access by all people at all times to enough food for an active, healthy life" (Coleman-Jensen et al. 2017) and includes at a minimum: a) "the ready availability of nutritionally adequate and safe foods," and b) "the assured ability to acquire acceptable foods in socially acceptable ways" (e.g. "without resorting to emergency food supplies, scavenging, stealing, and other coping strategies" (USDA 2017b). Conversely, food insecure is defined as "at times unable to acquire adequate food for one or more household members because they had insufficient money and other resources for food" (Coleman-Jensen et al. 2017).

Food security, as defined by USDA, highlights the importance of having the economic means to purchase, the physical ability to acquire, and/or social infrastructure to ensure sufficient quality and quantity of nutritious food to ensure an active and healthy life. While the definition does make room for consideration of people's "food preferences" and allows for a "qualitative discussion of what food security means for differently situated individuals", it is more oriented around individuals' access to foods (Fazzino 2010, 394-395), and tends to overlook culturally appropriate traditional or native foods in their emphasis on conventional food systems (Elliot et al. 2012). Ultimately, the ability to define "food security" and decide how it should be achieved entails the ability to shape collective action in addressing food security, including deciding how billions of dollars in food aid is spent and determining who will benefit from food security related initiatives (Fazzino 2010).

Household food security is measured in the USA using a standardized 18-question questionnaire (10-questions for households without children) called the Household Food Security Survey Module [4]. This "core module" survey is distributed annually in December as a food security survey supplement to the Current Population Survey administered by the U.S. Census Bureau[5]. The survey module has also been incorporated into the National Health and Nutrition Examination Survey as well as data collection tools of many other research efforts (Jones et al. 2013). The HFSSM survey module assesses subjective household experiences of four domains of food insecurity: 1) anxiety about household food supplies; 2) perceptions that the quality or quantity of accessible food is not adequate; 3) reduced adult food intake; and 4) reduced food intake by children (Jones et al. 2013). Households are categorized along a continuum from high food security to very low food security as follows: *High food security* are households that have no problems or anxiety about consistently accessing adequate food. *Marginal food security* are households that have problems at times, or anxiety about accessing adequate food, but the quality, variety and quantity of their food intake are not substantially reduced. *Low food security* are households that reduce the quality, variety and desirability of their diets, but the quantity of food intake and normal

3 While there are other widely cited definitions of food security, including the one established at the World Food Summit in 1996, we cite the USDA definition as we are engaging with USDA measurements and evaluation of food security that are used in the context of food security in the USA, the country of our study.

[4] An abbreviated version of the core module consisting of a 6-questions was also developed (Bickel et al. 2000).

[5] The initial measurement of food security and hunger in the USA started in 1995 with the first Food Security Supplement to the Current Population Survey implemented by the National Nutrition Monitoring and Related Research Act (NNMRR) (Public Law 101-445). This Act included a ten-year comprehensive plan for the National Nutrition Monitoring and Related Research Program, directing the USDA and Health and Human Services to define and measure food security (Cohen 2002). The Federal Food Security Measurement Project, a collaboration among Federal agencies, academics, and commercial and non-profit organizations, developed the HFSSM and standardized food security measurement over several years of testing and developing measurement tools with annual food security surveys. Previously, there was minimal consensus on nationwide hunger and food (in)security trends with several varying estimates but no hard, reliable data to concur national trends of food (in)security and nutrition (National Research Council 2005; 2006).

eating patterns are not substantially disrupted. *Very low food security* are households that, at times during the year, eating patterns of one or more household members are disrupted and food intake reduced because the household lacks money and other resources for food (Coleman-Jensen et al. 2017).

The HFSSM was designed for standard and consistent national nutritional monitoring at the state and local levels with subsequent application by local groups wanting to determine the extent of food insecurity in their community (Bickel et al. 2000). In 1999, the USDA developed the Community Food Security Assessment Toolkit for local organizations, communities, government agencies and individuals to survey how their local food systems influence food security. The toolkit offers a set of standardized measurement tools for assessing various aspects of community food security with six different components: community socioeconomics and demographics, community food resources, household food security, food resource accessibility, food availability and affordability, and community food production resources (Cohen 2002).

While the HFSSM and the Toolkit offer both national and local opportunities to assess and identify solutions to food insecurity, there is growing recognition among scholars of native/indigenous food systems on the limitations of these standard conceptualizations and measurements of food security for Native American communities. USDA monitors "the extent and severity of food insecurity in U.S. households through an annual, nationally representative survey sponsored by USDA's Economic Research Service" yet their reports do not include any data or reference to Native Americans or Native American food insecurity[6]. Furthermore, as Gurney et al. (2015) point out, "American Indian food security has been impacted by factors that have not been widely addressed in the literature and remain undertheorized." Fazzino (2010) and others (e.g. Power 2008; Ready 2016; Lambden et al. 2007) have suggested that the current paradigm of food security in the USA "focuses primarily on quantitative measures of food security in terms of physical and economic access to enough foods without consideration of actual household utilization of these foods or psychological and cultural values attached to food consumption and preparation" (Fazzino 2010: 398) as it does not take into account the importance of traditional foods and connections between food, culture and health and does not "address the unique needs of indigenous peoples who have co-created the landscapes which they have historically occupied*"* (Fazzino 2010: 414). Recommendations for supporting Native American food sovereignty call for efforts that encourage a shift in US food security policy wherein food security is determined not only for, but also by, each Native American nation (Fazzino 2010; Gurney et al. 2015). Along those lines, several studies call for the inclusion of indigenous perspectives and traditional food attributes in food security research including traditional food practices and knowledges, social support networks, and broader factors such as government policies, the physical environment/environmental variability, and dependence on the conventional food system (Coates et al. 2006; Elliott et al. 2012; Gurney et al. 2015; Lambden et al. 2007; Loring and Gerlach 2009; Power 2008). A few call explicitly for revised assessment tools for indigenous/aboriginal/Native American peoples (Fazzino 2010; Power 2008; Ready 2016) that take into account cultural considerations. For example, Power (2008) suggests that more qualitative research be done on indigenous perspectives on food security that could form the basis of a supplement tool (to the HFSSM) that would measure unique aspects of food security for Aboriginal people. Interestingly,

[6] The report does disaggregate data by race but only for Black and Hispanic populations. In a recent study, using the Current Population Survey Food Security Supplement, Jernigan et al. (2017) analyzed the food insecurity trends of Native Americans compared to other racial and ethnic groups in the USA from 2000 to 2010.

when comparing attributes of food security among 15 different countries, Coates et al. (2006) found the HFSSM generally compatible but not comprehensive across cultural groups (not including Native Americans), suggesting using the HFSSM as an adaptable framework for different populations (Coates et al. 2006). To assist Native communities in reclaiming their local food systems, The First Nations Development Institute developed the Food Sovereignty Assessment Tool in 2004, "to provide tools and a framework for Native communities to measure and assess food access, land use and food policy in their communities", and have conducted hundreds of trainings on the use of the tool (First Nations Development Institute 2014).

In the next two sections, we review both quantitative and qualitative food security studies among indigenous peoples in Canada and the USA, examining the methods employed, findings and recommendations. In general, quantitative survey research on food insecurity in Native American communities seeks to identify factors associated with food insecurity and access to healthy, affordable foods, including household characteristics, proximity to grocery stores, poverty, as well as the associated health conditions of low food security (Bauer et al. 2012; Brown et al. 2007; Gunderson et al. 2008; Jernigan et al. 2017; Mullany et al. 2012; Pardilla et al. 2013; Tomayko et al. 2017). On the other hand, qualitative and mixed-methods studies focus more on the history of colonialism and its legacy on native food systems as well as coping strategies for food insecurity (Skinner et al. 2013), experiences of food insecurity (Ford and Beaumier 2011), barriers to native food access and consumption (Cidero et al. 2015; Gaudin et al. 2015), and community-based recommendations (Natcher et al. 2016; Socha et al. 2012).

2.2. Quantitative studies using the Household Food Security Survey Module

We compared results from seven recent surveys on Native American food insecurity that utilize the USDA's HFSSM with national data to better understand attributes, trends and outcomes of food insecurity in Native American communities (see Table 1).

[Insert Table 1]

In general, most *survey* research on food security among Native American populations tends to be localized to a particular tribe (Pardilla et al. 2013) or reservation (Bauer et al. 2012; Brown et al. 2007; Mullaney et al. 2012). Recent efforts have been made to understand Native American food insecurity at the California state level (Jernigan et al. 2013) and national level (Gunderson 2008; Jernigan et al. 2017). Most of the studies measure food (in)security using the USDA's 18-question HFSSM, 6-question HFSSM, or a shortened form determined by the authors. For example, Tomakyo et al. (2017) only include two questions from the 18-question HFSSM, (worrying about running out of food, and not having enough food to last the month and money to buy more), in order to minimize the participant burden. Brown et al. (2007) made minor wording changes to improve respondent comprehension, as advised by Derrickson and Brown (2002) and Derrickson et al. (2000) based on their work with Asians, Pacific Islanders, and Native Hawaiians in Hawaii. Sampling methods vary considerably from convenience samples (Brown et al. 2007; Pardilla et al. 2013), to targeting youth program participants (Bauer et al. 2012; Mullany et al. 2012; Tomayko et al. 2017) to utilizing data from the CPS-Food Security Supplement or the California Health Interview Survey inclusive of households at or below varying income thresholds (Coleman-Jensen et al. 2017; Jernigan et al. 2013; Jernigan et al. 2017) (Table 1).

Collectively, these studies tell us that Native American households have some of the highest rates of poverty, unemployment and food insecurity in the nation relative to the general population (Beale 1996; Gunderson 2008; Jernigan et al. 2017)[7]. In a nationwide study on food security in 2016, 12.3% of *all* U.S. households were food insecure with 4.9% experiencing very low food security (Coleman-Jensen et al. 2017). Studies on Native American communities reveal staggering rates of food insecurity at least twice the national average, ranging from 25% nationally (Jernigan et al. 2017) to 76.7% in Navajo Nation communities (Pardilla et al. 2013), with several studies finding about 40% of Native participants to be food insecure (Bauer et al. 2012; Brown et al. 2007; Jernigan et al. 2013; Mullany et al. 2012). Similar to national data, poverty is one of the primary predictors of food insecurity among Native American populations (Bauer et al. 2012; Brown et al. 2007; Gunderson 2008; Jernigan et al. 2017; Pardilla et al. 2013).

Few studies differentiate among levels of food insecurity (see exceptions with Bauer et al. 2012; Gunderson 2008), precluding an understanding of the extent, depth, and severity of food insecurity among different segments of Native populations that may impact design and efficacy of interventions. Gunderson (2008) compared three different applications of the HFSSM for adults and children in order to parse out the depth and severity of household food insecurity apart from general categories applied by the HFSSM. Two studies found that Native American food insecurity is more prevalent among *urban* households (Jernigan et al. 2017; Tomayko et al. 2017) whereas Mullany et al. (2012), similar to national data, found greater food insecurity associated with *rural* Native households. Some studies found lower educational attainment associated with food insecurity (Pardilla et al. 2013; Tomayko et al. 2017), whereas others found no association (Bauer et al. 2012; Brown et al. 2007; Jernigan et al. 2017). In some cases, age of respondent was *not* associated with food security (Jernigan et al. 2017; Tomayko et al. 2017) whereas in others, older respondents tended to live in households with *lower* food security (Mullaney et al. 2012; Pardilla et al. 2013). Jernigan et al. (2013), Mullany et al. (2012), and Pardilla et al. (2013) all found no association between obesity and food insecurity, yet, Bauer et al. (2012) found that food insecurity was associated with poor general health and bodily pain (Table 1).

The relationship between food insecurity and use of food assistance is inconclusive. In some studies, households that use food assistance are also food *insecure* (Bauer et al. 2012; Coleman-Jensen 2017; Jernigan et al. 2017; Tomayko et al. 2017), whereas in others, there was no significant association (Brown et al. 2007; Mullaney et al. 2012; Pardilla et al. 2013). Recent data on the gap between SNAP benefits and the cost of low-income meals, suggests that households on food assistance may indeed be food insecure. Waxman et al. (2018) found that in 99% of all US counties, SNAP per meal benefits fail to cover the cost of a low-income meal. Most studies found that higher rates of food insecurity were associated with less knowledge about healthy eating and higher intake of fried foods, soda and sports drinks (Brown et al. 2007; Jernigan et al. 2013; Tomayko et al. 2017), with one exception (Mullany et al. 2012). In a national study of Native American access to healthy and affordable foods, many tribal households reportedly live far from full service grocery stores and supermarkets, "which sell food needed for a healthy diet" (Kaufman et al. 2014).

Few studies that employ the HFSSM consider access to and consumption of native foods or other cultural considerations in their assessment of food security. Two studies included a brief look at consumption of native foods and local sharing rituals by including each as a predictor of

[7] In their study evaluating food insecurity among California households at or below 200% of the federal poverty line, Jernigan et al. (2013) found that prevalence of food insecurity was similar among Native Americans and Whites (38.7% vs 39.3%).

food (in)security. Brown et al. (2007) found no association between food (in)security and household consumption of native foods, and Bauer et al. (2012) found the use of *Ti ole*, a Lakota tradition of sharing food to address hunger, was significantly greater for households with very low food security. Ready (2016) actually modified the HFSSM to include questions about obtaining native foods and households running out of native foods but only assessed the economic dimension of food security, that is, the financial means necessary to hunt, fish and gather or access store-bought foods. While income is critically important to food security, it is not the only component that determines food security for Native American people, particularly when considering access and availability of native foods.

2.3 Qualitative and mixed method studies

In North America, most qualitative and mixed methods studies on traditional foods and food security are focused in the Arctic regions of Canada and the USA with a few exceptions centered in the continental U.S, and in particular in the Klamath River Basin (see Alkon and Norgaard 2009; Fazzino 2010; Krohn 2010) and they often highlight important themes beyond the economic dimension of food insecurity (having enough money to buy food).

Several studies discuss *contemporary food insecurity and poor health in historical context*. Gurney et al. (2015), for example, argue that contemporary food security concerns in Native American communities can largely be explained by our nation's legacy of forced removal of Native Americans from their ancestral lands in tandem with cultural assimilation policies, which resulted in profound losses of sovereignty for Native American tribes and nations. Federal policy toward Native Americans systematically reduced their control of land, disrupted traditional land management, intergenerational transference of culture and food procurement practices, and substituted native foods with commodity foods, leading to widespread degradation of Native health and cultural foodways (Bye 2009; First Nations Development Institute 2014; Gurney et al. 2015; Mucioki et al. 2018; Norgaard 2014). In Gurney et al.'s (2015) literature review on Native American food security, access to traditional foods and the effect of declining traditional foods on human health are prominent themes.

Other studies provide rich data on the importance of *social relationships, traditional knowledge* and native foods to Native American food security in ways that are relevant to our analysis. Collings et al. (2016), for example, found that married Inuit respondents in Ulukhaktok, Northwest Territories, Canada, particularly younger married couples, had the best access to native foods with single-parent households having the worst access to native foods with no access to a partner's kin-network or adult children to assume responsibility for hunting. Additionally, households with an elder or hunter were more likely to have better access to native foods (Collings et al. 2016) emphasizing the strong sharing ethic that persists with elders. Similarly, Elliot et al. (2012) and Gaudin et al. (2015) identified interpersonal relationships and family networks as key components of native foods access; many respondents in the former study mentioned they always had access to these foods at their parent's or grandparent's homes. Gaudin et al. (2014) found that Cree households in Northern Quebec, Canada that consumed native foods three or more days of the week were more likely to be 40 years or older, walk 30 minutes or more a day, and be a hunter, emphasizing the importance of hunting and wild meats in household food security (Gaudin et al. 2014). Apart from acquiring and sharing food, *possessing and sharing traditional knowledge* is identified as an essential component of accessing native foods (Turner and Turner 2008) and food security. A few studies assert that while traditional knowledge is preserved and utilized to access

native foods, intergenerational networks and traditional knowledge are declining in some capacity over time (Elliot et al. 2012; Socha et al. 2012). However, none of the studies we reviewed present data that directly link traditional knowledge and knowledge sharing with access to native foods and food security apart from identifying it as a facilitator or barrier to native foods (Gaudin et al. 2015; Natcher et al. 2016).

Some studies evaluate *barriers to accessing native foods* among study participants. Natcher et al. (2016), for example, identified several categories of barriers that varied by region, community, age, gender, and the political environment. These include financial costs of harvesting, time limitations associated with work or school responsibilities, physical inability, lack of child care, lack of interest or knowledge of harvesting, and limited availability. Similarly, focus group participants in Gaudin et al. (2014) believed that employment was both a facilitator and deterrent to native food consumption given the money and time required to access native foods. Gaudin et al. (2015) identified barriers to native foods for Cree people in Northern Quebec including laws and regulations particularly with serving native foods in public institutions, living in a city, poor access to hunting grounds, traditional regeneration techniques in decline, high mercury levels in fish, and educational opportunities outside the community (Gaudin et al. 2015). Skinner et al. (2013) also found that traditional foods were still a very important aspect of household food security for Fort Albany First Nations in Northern Ontario but were more challenging to obtain given the high cost of hunting and numerous environmental barriers.

Access to grocery stores and healthy foods in Native communities is a focus of other studies. Chodur et al. (2016) found that in California there were significantly fewer stores with healthy foods per square mile on tribal areas compared to non-tribal areas but no difference between the density of unhealthy food outlets. Similarly, O'Connell et al. (2011) analyzed the number and types of stores on Indian Reservations in the state of Washington using the food store survey developed from the USDA Community Food Security Assessment Toolkit and found that dairy and sugary foods were most prevalent across all stores surveyed. Seventeen out of 22 reservations did not have a supermarket, with the nearest off-reservation supermarket about 10-miles from tribal headquarters (O'Connell et al. 2011). Focus group participants from Round Valley Reservation in California attributed low rates of Native-owned businesses, feeling unwelcomed at local farmers' markets, high unemployment rates, and low wages to relying on poor quality, overpriced foods from the local grocery or canned USDA foods from the Food Distribution Program on Indian Reservations (FDPIR) (Jernigan et al. 2012).

Community-based strategies to minimize food insecurity in Native households are highlighted in other studies. Skinner et al. (2013) found that sharing food, especially with family, was the most significant strategy to deal with food shortages used by households from Fort Albany First Nations in Northern Ontario. Study participants reported buying food in bulk, stocking up on non-perishable provisions, buying cheaper foods (e.g. rice or pasta), or eating smaller meals to deal with not having enough food or money to buy food (Skinner et al. 2013). Ford and Beaumier (2011) also found that Inuit in Igloolik, Nunavat purchased cheap staples, drank more tea or coffee, or liquidated assets to cope with food insecurity. Likewise, participants in a talking circle in an Aboriginal community in Northern Ontario cited grocery stores as an essential part of their food security given the decline of traditional foods; however store-bought food from the sole local grocery store was unaffordable. Despite this, people desired more traditional foods but recognized challenges in obtaining these foods as well as declining food sharing networks (Socha et al. 2012). Food sharing was also used as a food security strategy; Skinner at al. (2013) found that 63% of Fort Albany First Nations study participants used food sharing to cope with food insecurity.

Whiting and Ward (2010) found that many members of the Northern Cheyenne Nation in South Eastern Montana used food assistance and entitlement programs as food provisioning strategies and those on food assistance programs, particularly SNAP, were 2.5 times more likely to experience high levels of stress than those not reliant on SNAP. However, food provisioning strategies that were embedded in the community, giving more control to the individual user, were associated with lower-stress.

Interestingly, *recommendations to improve Native American food insecurity* from both quantitative and qualitative/mixed method studies tend to focus on policy and program interventions that largely address economic barriers to food insecurity such as a) increasing access to fresh, healthy, high quality, affordable foods and food assistance programs, b) decreasing health disparities, and c) increasing living wages. Some highlight the need for more research on health and Native American food security (Jernigan et al. 2013;), on food security disparities among urban, rural, and reservation settings (Jernigan et al. 2017), on specific food and outlet choices of tribal individuals and households specifically (Kaufman et al. 2014), and on the context of food security in Native communities in general (Collings et al. 2016). Several qualitative and mixed-methods studies included community-based recommendations focused on Native foods from interviews and focus group discussions. Specifically, Talking Circle participants in Northern Ontario described how increased access to traditional foods and related knowledge would improve the food security and health of their community (Socha et al. 2012). Natcher et al. (2016) suggested more flexible work schedules with two-weeks on and two-weeks off or job-sharing between two people to allow for time to earn money as well as harvest native foods. They also recommend youth-elder programs, culture camps, and school breaks during harvesting times to revitalize and heal knowledge pathways and relationships with food and land. Respondents from Skinner et al.'s (2013) study desired sustainable, local food systems to improve community food security, including more community gardens and farms, continued support for local farmers' market, larger grocery with more healthy foods, and a community subsidy to offset the cost of hunting, fishing, and gathering as well as an all-season road to access more affordable grocery stores. Lastly, focus group respondents from Gaudin et al. (2015) suggested teaching traditional foods in school, promoting traditional foods on the radio, revisiting laws and regulations, and selling native foods locally to revitalize the use of and knowledge about native foods.

In summary, as Gaudin et al. (2015), Fazzino (2010), and others (Coates et al. 2006; Elliot et al. 2012; Lambden et al. 2007; Loring and Gerlach 2009; Patel 2009; Power 2008; Ready 2016) have discussed, the current conceptualizations of food security in the USA "may not meet the unique needs of Native Americans" (Fazzino 2010, 412) and other indigenous communities, as they do not take into account the importance of traditional foods and connections between food, culture, tribal lands and community health (see also Grey and Patel 2015). Our study aimed to address this gap by incorporating and testing more culturally appropriate measures of food security, that take into account native foods and other cultural dimensions defined by the tribal communities in the study area.

3 Case study context

The Klamath River Basin comprises over four million hectares of land along the 253-mile Klamath River that originates in southern Oregon and flows into the Pacific Ocean near the town of Klamath, California. The Basin includes expansive Tribal ancestral territories of the Karuk, Yurok,

Hoopa, and Klamath[8] Tribes and prominent Tribal communities who sustain the practice and maintenance of native food traditions, ancestral lands, and ceremony. While relegated by social scientists in the early to mid 20th Century into the ill-fitting category of the "hunter-gatherer," tribes in the Klamath Basin historically secured a sustainable abundance of native foods through tending the forests and fisheries largely through cyclical and ritual fire, pruning and coppicing, tilling, transplanting, reseeding and ceremony (Anderson 2005; Buckley 1988; Lake et al. 2017; Ray 2006). They had abundant cultural foods available at all times, eating some foods fresh and preserving the bulk of their food through smoking, drying, and fermenting for the winter months (Heizer and Elasser 1980).

Although Klamath Basin tribes stewarded resources across large territories and moved to short-term seasonal camps to manage, harvest and process certain types of foods, they were settled peoples, having permanent homes in villages of varying populations and tribally recognized rights to specific resources at specific locations (Castillo 2018). Common native foods still consumed today include Roosevelt elk (*Cervus canadensis roosevelti*), black tailed deer (*Odocoileus hemionus*), wildfowl (e.g. *Callipepla californica*, *Dendragapus fuliginosus*, and *Aix sponsa*), many species of fish (e.g. *Oncorhynchus tshawytscha*, *Oncorhynchus kisutch*, *Acipenser transmontanus*, and *Oncorhynchus mykiss)*, Pacific lamprey (*Entosphenus tridentatus*), mussels (e.g. *Anodonta californiensis*), mushrooms (e.g. *Tricholoma magnivelare*, *Cantharellus subalbidus*, *Hericium coralloides*), acorns (e.g. *Notholithocarpus densiflorus* and *Quercus kelloggii*) and other nuts (e.g. *Corylus cornuta* var. *californica*, *Chrysolepis chrysophylla*, and *Umbellularia californica*), fruits (e.g. *Prunus subcordata*) and berries (e.g. *Vaccinium ovatum*, *Sambucus nigra*, and *Rubus ursinus*), geophytes (e.g. *Dichelostemma capitatum*, *Allium* spp., and *Lilium pardalinum*), greens (e.g. *Claytonia perfoliate*, *Urtica dioica*, and *Nasturtium officinale*), seeds (e.g. *Centromadia pungens* and *Wyethia angustifolia*), and wocus (*Nuphar polysepala*) and other marsh plants (e.g. *Schoenoplectus acutus* and *Typha latifolia*). However, access to and consumption of these culturally important foods today are severely limited, and the impact on human, social, cultural and spiritual health has been profound.

Social relations are built on reciprocity for the collective good, steward food systems, and these guide economic exchange (Hormel and Norgaard 2009). Regulated by tribal code, access to food was ensured by the social import placed on sharing foods – especially with those unable to procure them on their own, as well as on the principal of reciprocity, including habitat stewardship and seasonal, measured harvest that would ensure the continued flourish of desired species. Kinship relations within families inform social networks of native food procurement, exchange and knowledge transference with clearly defined family rights to gathering, hunting, and fishing sites and responsibility to manage and care for land, plants, fish and animals, and each other. Networks of trade support the exchange of resources between families and tribes rich in different native foods up and down the river corridor.

Under settler colonialism, dramatic changes in the management of the lands and waterways related to mining, hydroelectric dams, agriculture, logging, and fire suppression have resulted in the near loss of Native fisheries, and drastic reduction in the abundance and availability of Native foods. Forced removal from the land was accompanied by government sanctioned genocide and cultural assimilation policies, which devastated traditional kinship structures, customary family roles and responsibilities, languages, cultural practices, and subsequent processes of knowledge and food acquisition and exchange (Madley 2016; Norgaard 2005). Intergenerational historical trauma caused by these tragic events continues to affect the health and well-being of many within

[8] The Klamath Tribes today consist of the Klamath, Modoc, and Yahooskin Tribes.

Native communities as they struggle to overcome mental health issues, alcoholism and drug dependency, diet-related diseases, poverty and unemployment (Karuk Climate Change Projects 2016). All four tribes, however, are actively engaged in eco-cultural revitalization and youth development efforts, focused on restoring knowledge, ceremony, relationships and indigenous stewardship practices, to heal their lands and people.

Food insecurity among Native American populations in California and Oregon[9] is poorly understood. In our study area, county level food assessments conducted over the last 10 years by food banks, community organizations and food system advocates, revealed important food system assets and major challenges in meeting food needs of their communities. However, very little data on tribal communities and few tribal voices were included in these assessments, despite the relatively high concentration of Native American communities in the region (nearly 4,000 households). One notable exception was a report including data from a four-county rural health information survey conducted by the California Center for Rural Policy in the Redwood Coast region of California (12.8% response rate), in which 5.1% (148) of respondents were Native American. Of those respondents, 22.5% reported very low food security (Van Arsdale and Barry 2006).

4 Methods

4.1 Research approach

In partnership with the Karuk, Yurok, Hoopa and Klamath Tribes we co-designed a Klamath River Basin-wide food security study focusing explicitly on Native American communities and their priorities. The scope included tribal lands in Humboldt, Del Norte, Siskiyou (CA) and Klamath (OR) counties as well as tribal members and descendants living regionally but outside ancestral territories. We employed Community Based Participatory Research (CBPR) methodologies engaging tribal colleagues and community members as active and equal participants throughout the research project (Chambers 1994; Wilmsen 2008). More than a set of research methods or a community outreach strategy, CBPR "represents a systematic effort to incorporate community participation and decision making, local theories of etiology and change, and community practices into the research effort" (Wallerstein and Duran (2006); it involves capacity building (training community members in research), co-learning and an authentic commitment to research that generates knowledge of benefit to all partners and effectively reduces disparities (Israel, et al. 2003).

Guided by CBPR principles, our research attempted to engage in authentic partnerships and tribal input in the following ways: 1) Establishing relationships of trust and identifying research topics with tribal communities prior to the release of the request for proposal, 2) Co-designing the research goals, objectives and expected outcomes of the project at the grant writing stage together with tribal and community partners and acknowledging their intellectual contributions by inviting them to serve as co-project directors on the grant 3) allocating equitable funds through subawards to each tribe and community partner organization to support participation in and administration of the project, capacity building through job creation and on-the-job training, as well as tribal-led food security programming, 4) co-creating and signing research protocols with

[9] Oregon is consistently one of the most food insecure states in the nation with rates of food insecurity higher than the national average and the highest rates of hunger in the late 20th century. In 2016, Native American rates of food insecurity in Oregon were about twice the state average (O'Donnell-King and Newell-Ching 2017).

the Karuk Tribe to protect their intellectual property rights as part of the guiding principles of the Karuk-UC Berkeley collaborative[10]; obtaining approval for the research from three tribal councils as well as the Yurok Elder Council and Karuk Resources Advisory Board, 5) identifying a tribal oversight representative for each objective to provide guidance and ensure compliance with tribal protocols, 6) adapting research tools through an iterative participatory design process to include questions prioritized by the tribes, 7) engaging tribal and community partners in the research (interviews and focus groups) and data analysis, and interpretation by sharing results and inviting feedback at community town-halls and other fora, and 8) engaging tribal and community partners in the evaluation design, 9) inviting tribal partners to serve as co-authors on publications, 10) sharing reports of results to each tribe that can be leveraged to apply for future grants, projects, and policy work.

4.2 Data collection

The team collected qualitative and quantitative data from May 2015 to October 2016, through: 1) a household survey distributed to all listed Karuk, Yurok, Hoopa, and Klamath tribal member and descendent households, 2) key informant interviews with tribal cultural practitioners and food system stakeholders and experts[11], and 3) focus groups with adults, low-income adults, and youth from the Karuk Tribe, Yurok Tribe, and Klamath Tribes.

The household survey was adapted from the USDA community food security assessment toolkit (Cohen 2002) in collaboration with tribal colleagues to capture a comprehensive snap-shot of the food system from a tribal perspective in the Klamath River Basin. Themes covered included *household demographics; preferences, habits, knowledge and barriers to healthy food acquisition and consumption (including shopping, use of food assistance, home grown and raised foods); preferences, habits, knowledge and barriers to native foods acquisition and consumption*; and *recommendations for improvement*. The 60-question survey was distributed through the mail using home-address listings maintained by each Tribe's enrollment office. We sent three mailings to each household – a pre-survey post card, the survey, and post-survey reminder postcard. In total, we received 711 completed surveys out of 3,851 surveys distributed[12], a 18.46% response rate.

Semi-structured interviews and focus groups focused on native food and healthy food access and consumption, the experience of food insecurity and use/opinion of community food resources, land and ecosystem management, and recommendations. In total, 115 interviews were conducted, 47 were with Tribal cultural practitioners. Twenty focus groups (with 128 Tribal participants) were conducted with adults, low-income adults, and youth from the Karuk Tribe (five groups), Yurok Tribe (eight groups), and Klamath Tribes (seven groups). Combined groups (e.g. low-income adults and adults or adults and youth) were conducted at the preference of the Tribal liaison or when attendance was limited. Groups ranged in size from two to 20 participants with an average of seven people per group. The age of participants in each group ranged from 14 to 62 years with an average age of 44, and most focus groups had more female than male participants,

[10] The Karuk-UC Berkeley collaborative, established in 2007, seeks to support the Karuk Tribe in their eco-cultural restoration efforts, youth development, and sovereignty over their knowledge and cultural resources (https://nature.berkeley.edu/karuk-collaborative/).

[11] Food system stakeholders and experts include the U.S. Fish and Wildlife Service, the U.S. Forest Service, local NGOs, school lunch programs, Tribal TANF, Tribal environmental programs, Cultural Heritage Officers, local food vendors, local food distributors, food assistance programs, local community and school gardens, and local health clinics.

[12] Based on delivered surveys, we had a 19.8% response rate.

but each group included at least one person of each gender. Focus groups and interviews were carried out with the assistance of a Tribal liaison and were audio recorded with prior consent from participants. If audio recording was declined, detailed notes were taken. All audio files were transcribed.

4.3 Study limitations

In spite of our best outreach efforts, partnering with commodity food distribution programs and tribal TANF departments, we likely missed some of the most vulnerable households due to our inability to reach them. Nearly 6.6% (254 surveys) were returned as undeliverable illustrating one of the many challenges in reaching out to tribal communities. Native American households may be experiencing substance abuse, incarceration, and poverty that places them at risk of becoming homeless, and/or moving residence. Households that lack transportation or are elderly may have been prevented from responding to surveys in a timely manner and participating in focus groups or interviews. In spite of these challenges, as our results show, we still reached a high percentage of households struggling with poverty and food insecurity, and as such, our data is likely to have underreported the severity. Tribal enrollment offices face similar challenges obtaining tribal data. In our efforts to obtain census level data from tribal governments for comparison, we learned that tribal enrollment offices track total households and members by gender, but beyond that have little data given low census survey return rates present in the communities. One tribal enrollment office described having census data for only 12.5% of their enrolled tribal members.

4.4 Measuring food security in our study area

Similar to other researchers, we found that the USDA's HFSSM has limitations when administered among Native American communities, particularly concerning respondent burden and absence of culturally relevant questions (Ready 2016; Gunderson et al. 2008). Based on stakeholder input sessions, our tribal collaborators expressed concern about respondent burden and likelihood of non-response, given the length and perceived intrusiveness of highly personal questions about experiences of hunger and forgoing meals, particularly for those experiencing very low food security. As such, we selected and adapted a sub-set of questions commonly used in the HFSSM that were agreeable to our Tribal collaborators (see Table 2). The questions included considered access to healthy foods, running out of food, running out of money for groceries, buying less expensive meals, reducing the size of or skipping meals, and accepting food assistance (Table 2). In addition, we included culturally relevant questions suggested by our tribal collaborators related to the acquisition, exchange and consumption of native foods and native foods-related knowledge.

[Insert Table 2]

In our study, we followed USDA guidelines and sorted households into categories of high, marginal, low, and very low food security (see Coleman-Jensen et al. 2017) based on varying degrees of food insecurity including relative access to healthy foods, anxiety and experience of running out of food and running out of money for food, use of food assistance programs or lack of use despite eligibility, buying less expensive foods, and reducing food intake in the last 12 months (see Table 3). Households with high food security report no indications of food access problems or limitations and are considered food secure. Households with marginal food security report some

level of change in food sufficiency such as not always have access to healthy foods, sometimes running out of money for groceries, using food assistance and/or buying less expensive food. Low food security households are those that report greater reduction in quality but do not yet utilize severe coping strategies found among very low food secure households[13]. Households with very low food security face severe challenges, reporting never having access to healthy foods, often running out of money for food, and reducing food intake (Table 3). Given the vulnerability of many Native American households, to be included in marginal, low, or very low food security categories, households must meet *at least one* of the criteria listed for each category and no unique criteria for a more severe category (see Table 3). For example, a household in the marginal category may *usually* have access to healthy foods, buy less expensive foods, but not use food assistance in the last 12 months. High food security households must meet *all* criteria for that category (Table 3). In categorizing households, we found that most food insecure households have more than one attribute of food insecurity with the average frequency of food insecurity attributes increasing with severity of food insecurity. The average number of food insecurity attributes for very low food secure households was 5.23, for low food secure households, 3.43, and for marginally food secure, 2.44. Only 34 households out of 201 in the marginal category had only one indicator of food insecurity. We also found that very low food secure households experienced not only more indicators but more severe indicators of food insecurity, as one might expect.

Table 3 Characteristics of food security categories used in this study. Households in the high food security category are characterized by no indication of food insecurity and thus must meet *all* the criteria in the "high food security" row of the table. Households in subsequent categories must meet *at least one* criterion in a given category *and* no unique criteria for a more severe category (in italics)

	Access to healthy foods	Ran out of money for groceries	Coping strategies	Ran out or worried about running out of food	Used food assistance[a]	Qualified for food assistance but did not use
High food security	Always	Never	None	No	No	No
Marginal food security	*Usually*	*Rarely*	*Buy less expensive foods*	*Yes*	*Yes*	No
Low food security	*Rarely*	*A few times a year*	Buy less expensive foods	Yes	Yes	No
Very low food security	*Never*	*At least once a month or once a week*	Buy less expensive foods	Yes	Yes	*Yes*

[13] Low food security households may report that they *rarely* have access to healthy foods, run out of money for groceries several times a year, depend on food assistance and/or buy less expensive foods.

	Reduce size of meals Adults and children skip meals

[a.] Excluding free school lunches and senior meals

In response to tribal input, we also developed an indicator for *native foods security* in order to understand how access to and consumption of native foods relates to food security for tribal households. We examined the extent to which households were able to obtain all their desired native foods throughout the year, categorized by four levels (never, rarely, usually, and always).

4.5 Statistical analysis

Bivariate and multivariate Generalized Ordered Logit Models (GOLM) were conducted with food security and native foods security acting as dependent variables to explain respective relationships with a suite of independent variables (see Table 4). In our case, each model predicts greater food security or greater native foods security, indicative of correlation or association between variables and not causation. In the model explaining food security, we combined very low and low security households into a single category and marginal and high security households into a single category to resolve model convergence issues caused by disproportionately fewer households in the high food security category.

The GOLM, carried out by gologit2 procedure in Stata (Williams 2006; 2016), is the best model for our data because it accommodates both proportional odds-models and the partial proportional odds-models, a necessity for our data (Long and Freese 2014; Williams 2006; 2016), and is appropriate for categorical, ordinal dependent variables. The analysis was carried out in two phases: first, bivariate analysis was conducted to identify independent variables significantly ($p<0.05$) related to food security or native foods security in binary relationship. Next, multivariate GOLMs were conducted using significant independent variables from bivariate analysis, the second phase of analysis (Tomayko et al. 2017). A stepwise backward elimination algorithm was used to eliminate independent variables from the multivariate models that did not change the overall fit of the model upon exclusion and had a p-value ≥ 0.05 (see Ahn et al. 2014). The Likelihood Ratio Statistic was used to test the statistical significance of the models.

For variables that fit the proportional odds-model, we report a single combined model as all parameter estimates are identical; for variables that fit the partial proportional odds-model, we report three separate models. Odds ratios (OR) are used to explain the odds (chances or probability) of greater food security or greater native foods security given a one unit increase of a continuous independent variable or the occurrence of a categorical independent variable. Odds ratios greater than one mean the chances of having greater food security or native foods security are higher with a unit increase (or the occurrence) of the independent variable while ORs less than one mean the chances of having greater food security or native foods security are lower with a unit increase (or occurrence) of the independent variable. Multicollinearity of independent variables was checked by examining correlations among variables in our models and the variance inflation factor (VIF) using the "collin" package in Stata. VIF for independent variables included in our GOLM showed no indication ($VIF < 2.5$) of multicollinearity among variables. statistical analyses were conducted in Stata (Version 14.2).

[Insert Table 4]

4.6 Coding qualitative data

Interview and focus group data were coded using content analysis (Schreier 2014). A codebook was developed using inductive and deductive thematic coding (Fereday and Muir-Cochrane 2006). In this paper we draw on the codes titled "legacies of colonialism, "experiences of food insecurity", "food security strategies", "barriers" and "recommendations" to support our quantitative data. All qualitative analysis was conducted in NVivo (Version 11.4.3).

5 Results

5.1 Household demographics and health data

Collectively, 97.26% of survey respondents identified with at least one Native American Tribe, the majority identifying as Karuk, Yurok, Hoopa, Klamath, Modoc, or Yahooskin. Poverty is prevalent in the region with 42.74% of households falling under the Federal poverty line for 2015 (Table 5). This was comparable with other tribal regions, but a rate three-times greater than the national poverty level for the same year (Semega et al. 2016). Nearly a quarter (24.55%) of respondents had completed some form of higher education, a rate 12% higher than rates of higher education reported for Native Americans nationally from 2006-2010 (Ogunwole et al. 2012). Respondents with the least education experienced higher rates of poverty, food insecurity and native foods insecurity than more educated respondents (Table 5). The majority of survey respondents were female (62. 81%), which is slightly higher than the average male/female ratio of tribal households in the study area. The median age of respondents was 55 years (i.e. over half of the respondents are considered elders) and on average older than the national demographic of Native Americans (U.S. Census Bureau 2015) and older than the local Native population data provided by one tribe. The mean household size was found to be 2.96 people, slightly larger than 2.58 for Native households nationwide (U.S. Census Bureau 2014).

The data shows that there is a high prevalence of diet-related diseases among households in the region with 50.29% of households having at least one member with high blood pressure, 42.04% with obesity, 28.76% with cavities, and 21.86% with type II diabetes. Incidence of diabetes was more than twice the national average (Centers for Disease Control 2017), high blood pressure is 20% higher than national rates (Centers for Disease Control 2016), and obesity is 5% higher than national rates for adults (Ogunwole et al. 2012).

[Insert Table 5]

5.2 Prevalence of food insecurity

About 92% of households in the Basin suffer from some level of food insecurity, with more than half experiencing the most severe indicators of food insecurity (that is, a reduction in the quality and quantity consumed) at a rate more than ten times the national average. Specifically, (out of 703 respondents) 52.49% experienced very low food security, 10.81% low food security, 28.59% marginal food security, and 8.11% high food security. About a quarter of all households never or

rarely have access to desired healthy foods, 28% of households run out of money for groceries at least once a month, and 39% of households run out or worry about running out of food (Fig. 1). These numbers represent a much higher rate of food insecurity among Native American people than any other published study to date (see Table 1).

Native American people in the Klamath River Basin utilize a range of strategies to cope with acute and chronic food insecurity conditions (see Fig. 1). Households experiencing very low food security employ all strategies more than the collective average; this was particularly so for relying on food assistance, reducing the size of meals, and adults skipping meals. Collectively, all households in the study utilized adaptive coping strategies to manage chronic food insecurity over time. For instance, households in our study most commonly purchased less expensive foods (73.40%), and 64% used food assistance (although necessary for many, there was reluctance expressed by respondents[14]). Forty per cent of all households reduced the size of their meals, an acute strategy, (compared with nearly 70% for households with very low food security). Additionally, 35% of all households relied on relatives for food, about 32% have an adult that skips meals (nearly 60% for households with very low food security), and about 4% of households have adults *and* children that skip meals as acute coping strategies in times of extreme need. Many depend on strategies such as fishing, hunting, and gathering native foods as an adaptive strategy to cope with chronic food insecurity. About 40% of households fish (3rd most utilized coping strategy), about 37% of households hunt, and 28% of households gather native foods (Fig. 1), as we discuss further in the next section. This was a common theme in focus group discussions as well. As one respondent stated, "I know that this last winter we were pretty scarce on food, and my uncle went and got deer for us. We survived a lot off that" (Focus Group #19, 5/16/2015).

Fig. 1 Experiences of and coping strategies for food insecurity in the Klamath Basin, USA. Black bars represent the proportion of all households that used a given strategy or had a given experience and the grey bars are the proportion of households with very low food security that used a given strategy or had a given experience. The numbers in parenthesis on the y axis are the numbers of households sampled for that strategy or experience

[Insert Fig. 1]

5.3 Predictors of food (in)security

Significant predictors of food (in)security, based on our multivariate GOLM model, were age of respondent, poverty, owning a vehicle, sharing knowledge about native foods with children, and receiving native foods through trade (Table 6). Households with older respondents (about 8-10 years older) were significantly more likely to have better food security (OR 1.03; p = 0.002); while, not surprisingly, households in poverty were significantly less likely to be more food secure (OR 0.25; p = 0.000) (Table 6). Households that own a vehicle were nearly ten times more likely to be food secure (OR 9.98; p=0.031) reflecting the necessity of having transportation given the remote location of many Native households in the Klamath River Basin. Markedly, respondents that share knowledge related to native foods with their children were almost three times more likely to be

[14] About 21% of survey respondents said they use food assistance because native foods are not available.

more food secure (OR 2.87; p = 0.016) while households that received native foods through trade were more likely to be less food secure (OR 0.53; p=0.048) (Table 6). This may suggest that food insecure households with less economic means are less able to procure their own hunted native foods (a particularly costly and time-consuming venture) and in general depend more heavily on networks of friends and trade networks for native foods than do food secure households. Certainly, food sharing and trading fulfills a practical need for food in food insecure households but these networks also sustain customary exchange relationships and tribal values of caring for each other and dispersing wealth. This follows a traditional Karuk world view and value system, which supports sharing of food and holds contempt for stinginess: "Indians say that if you divide an article of food and take the bigger half of a portion, you will be out of luck" (Karuk Ethnographic Notes 2004). Economic means are important for assuring household food security, but our results, particularly pertaining to knowledge sharing, suggest that the legacy of genocide and cultural assimilation, which disrupted traditional knowledge and kinship relations, are also strong predictors of *food insecurity* (e.g. households that share knowledge with their children are more food secure). Importantly, over 10% more households with greater food security share native-food-related-knowledge with their children than low or very low food security households. This points to the importance of continuity of native food traditions from one generation to the next, sharing knowledge and skills of hunting, fishing and gathering, that not all households have been able to retain due to the devastating losses from genocide and cultural assimilation (see section 5.6 for more context on the impact of colonization).

[Insert Table 6]

5.4 Native foods security − a component of Native American food security

Only 7% of all households in our study reported being native-foods-secure (i.e. always having access to desired native foods), whereas nearly 70% of all households never or rarely had access to all desired native foods throughout the year. Out of 696 respondents, 16.24% said they never have access to all the native foods they desired in the past year, 50.86% said rarely, 26.15% said usually, and 6.75% said they always have access. In an additional GOLM, while controlling for poverty we found native food security significantly predictive of overall food security (OR 3.20; p=0.00) with households that usually or always have access to desired native foods three times more likely to have high or marginal food security. This suggests that supporting improved access to native foods will likely improve household food security.

In some ways, attributes of food (in)security and native foods (in)security are similar. For example, having economic means to access native foods and store-bought foods as well as strong social networks of trading and sharing contribute to native foods security and food security. Furthermore, sharing knowledge with and learning from family also contributes to both food security and native foods security. There were some notable differences, however. As shown in the table of means, smaller sized households tended to be more food secure, whereas larger households have better access to native foods (Table 5) suggesting that larger households have more people that can help acquire and process native foods, but also have more mouths to feed. Additionally, more food secure households have older survey respondents (on average about 58 years old) while younger respondents tended to have better access to native foods (Table 5). Households that have not eaten native foods at all in the past year are older than those that have eaten some native foods, supporting the need, expressed by many in focus group discussions, to

prioritize providing native foods for elders and to facilitate the exchange of knowledge and cultural foods between youth and elders.

Rurality is a strong predictor of native foods security with no significant bearing on food security; although generally those with greater food security are rural residents (see also Jernigan et al. 2017). Households living in rural areas are almost two times more likely to have greater native foods security (OR 1.95; p = 0.009) than those living in urban areas, indicating that proximity to the resource and connection to tribal homelands are important attributes of native foods security. Poverty is the *only* variable predictive of both food insecurity and native foods insecurity in multi-variate models (Table 6), confirming the results of other food security studies (Bauer et al. 2012; Brown et al. 2007; Coleman-Jensen et al. 2017; Jernigan et al. 2017; Pardilla et al. 2013) that economic means is strongly linked to both food security and access to native foods.

Perhaps most interesting are the ways in which cultural variables associated with acquisition and exchange of traditional knowledge and native foods are also strong predictors of food security or native foods security. Households that share native foods with others (OR 2.57; p = 0.001) or share native foods at tribal events (OR 2.57; p= 0.001), were over two times more likely to have better access to native foods (Table 6) while households that receive native foods from friends are significantly less likely to always have access to native foods (OR 0.31; p = 0.011). Additionally, regardless of food security status, all households share and trade native foods with others at similar rates, illustrating the deep-rooted culture of sharing native foods and "taking care of one's own", even when experiencing food scarcity. Over half of all households share native foods with others while about 10% of households trade with others, with a greater portion of respondents that share with others residing in rural areas. Not surprisingly, poor households tend to share less with others, and trade less with others, but receive native foods from family slightly more (71.08%) than non-poor households (68.81%). Focus group respondents repeatedly emphasized the importance of relying on family relations particularly during times of food scarcity and native foods scarcity, "It's impossible for one person to provide for their whole family all on their own completely, without any help" (Interview #13, 11/3/2015). Furthermore, "If you have family or close friends, you don't go without. Somebody gives you something. That's just the way it is" (Focus Group #6, 6/23/2015). Interestingly, while receiving native foods through friends and trade improves access to native foods, it is also associated with greater food *insecurity*. These results suggest that many households are still practicing traditional methods of sharing and trading native foods (more sharing than trading) within their community, despite high rates of food insecurity. But because of the limited supply of native foods there is simply not enough native foods available and accessible in sufficient quantities and quality to support overall food security, thus contributing to the high rate of dependency on food assistance programs.

Correspondingly, learning and sharing knowledge about native foods *with/from family members* is associated with greater native foods security and food security, whereas learning from an *unrelated person* (25.06% of all respondents) is associated with having lesser native foods security (OR 0.46; p= 0.006). Thus, households and broader family networks that retain and share knowledge about native foods tend to experience overall greater food security. Collectively these results suggest the importance of thinking outside of the "commodity food distribution" box (Mucioki et al. 2018) to combat food insecurity and poverty by investing in strengthening *the native food system* including intergenerational knowledge transference, native food exchange networks, and prevalence of households engaged in hunting, fishing and gathering. This is consistent with interview and focus group respondents expressing a desire for increased access to

native foods, and to revitalize connections with elders and teach youth about customary hunting and fishing norms and practices.

5.5 Community food resources

Taking a closer look at food resources available in the communities as a measure of food access, survey respondents relied on a diversity of food sources including grocery stores, hunting, fishing, and gathering native foods, gardens and orchards, fast food/restaurants, food assistance programs, and neighbors, friends, or family. Although grocery stores are the most common food source, access to grocery stores was a major challenge with 61.66% of all respondents experiencing at least one barrier to grocery shopping (e.g. distance, lack of money for fuel, no transportation, no time). Distance and transportation are particularly challenging with about 20% of households traveling more than two hours round trip to get to a grocery store, and 21.96% of households in poverty not owning a vehicle. Food at local grocery stores was reportedly too expensive; over 50% of households find fresh fruits and vegetables, red meat, fish or seafood, cheese, and organic foods too expensive at the grocery store closest to their home. That perhaps helps to explain why 41.01% of households grew or raised food at home, 46.80% of households got a portion of food from hunting, fishing, or gathering native foods, and 63.77% of households (80% of households with children) relied on some form of food assistance (e.g. tribal commodities, SNAP, WIC, school lunch program, food banks, etc.) in the past year. One might expect that this high rate of food assistance might result in greater food security. However, focus group participants repeatedly expressed concern about making ends meet at the end of the month once their "food stamps" or "commods" run out. In fact, 84.23% of households that ran out of food or worried about running out of food used food assistance "in the past year." This corresponds with county-level data on the gap between SNAP benefits and the cost of meals. In Siskiyou County, for example, the average cost of a meal is US$2.57, which is 38% more than the SNAP benefit (Urban Institute 2018). It is clear that in spite of the creativity, foresight and thriftiness of tribal members, food shortages are chronic.

5.6 Enduring impact of settler colonialism on food security

> "Books…termination and boarding schools. …They were meant to take the Indian out of us and it worked on some of 'em' " (Focus Group #20, 5/15/2015)

Our survey, interview and focus group results all point to the enduring impacts of colonization including genocide, termination[15] of federal recognition as a tribe, misguided resource management policies, boarding schools, and food assistance on Native American food security,

[15] Indian termination was a policy of the USA from the mid-1940s to the mid-1960s designed to assimilate Native Americans into mainstream U.S. society by ending U.S. recognition of sovereignty of tribes. The intention was to terminate specific "Indian nations" by granting Native Americans all the rights and privileges of citizenship, reduce their dependence on a bureaucracy whose mismanagement had been well documented, and remove government trust responsibility to provide services for Native people (Wunder 1999). Overall 109 tribes were terminated between 1953 and 1958 (Wunder 1999), including the Klamath Tribes (the latter reinstated as a tribe in 1985). The policy was overturned, yet the damage was done. Even as many tribes fought to reclaim their sovereign status, much of their land base had been sold to private parties, and hundreds of tribes are still petitioning for federal recognition status today.

food sovereignty and overall health, well-being and cultural survival of Native peoples in the Klamath, events which similarly occurred to tribes throughout the nation during settler colonization and expansion.

Beginning with the arrival of settlers into the Klamath River Basin in the 1840s set to extract fur, gold and timber for economic gain, followed by the construction of hydroelectric dams on the Klamath River, colonization brought swift degradation of the resource base, and legal restrictions set by the newcomers' system of law that was superimposed upon the existing tribal hunting, fishing and gathering rights. Historically, it was common in the 1800s for a Yurok family to dry a ton of salmon for the winter (Heizer and Elsasser 1980) or for the upper Basin Klamath Tribes to harvest tens of thousands of pounds of sucker fish and cover tens of thousands of acres when harvesting wocus (Carter and Kirk 2008; Colville 1897). Salmon populations have plummeted as a result of the decline in water quality, with the population of fall Chinook salmon so low in 2017 that all Tribal fisheries were closed (Bland 2017). A Karuk interview respondent in Happy Camp said,

> "I mean for right now you talk about food security- I got one, one salmon all year this year. Now that's supposed to feed me and my family all winter, until the spring run comes in, and that's (the spring run) not going to happen" (Interview #30, 12/8/2015).

Land management policies, including fire suppression, continue to degrade terrestrial habitat resulting in limited availability of deer, elk, acorns and other terrestrial foods. Numerous respondents cited lack of fire as a major barrier to native foods. As one respondent stated,

> "A barrier was the illegalization of cultural burns. That was a big barrier to food. The land's all overgrown now, so a lot of things we can't access or isn't growing. It creates (conditions for spread of) disease and stuff. We're just starting to take control of that by doing prescribed burns and allowing those seeds to flourish again" (Focus Group #11, 6/22/2015).

Today, 50% of all survey respondents consume most native foods 10 days or less throughout the year with median days of consumption ranging from 3 to 17.5 for surveyed native foods. Tanoak acorns are one of the most important plant foods in the Basin, historically comprising up to half of California Indians' diets (Heizer and Elsasser 1980). Yet today they are consumed on average less than two weeks out of the year. Deer is consumed about 30 days out of the year, salmon 22 days, acorns 12 days, and eel about 11 days. Although quantity and quality of and access to some native foods may limit their frequency of consumption, 82.95% of survey respondents consumed native foods in the past year and 99.56% of respondents desire access to more native foods.

Removal and relocation of Native Americans from their ancestral lands onto reservations and allotments, and subsequent tribal termination and land privatization has magnified the loss of cultural foods. One respondent connected The Klamath Termination Act of 1953 in the upper Basin to the decline in deer populations,

> "You know back in the day when we were kids the deer were everywhere, thickest they've ever been and you shoot by the thousands. Now you have to drive around sometimes all day just to go find a deer. That is because of the state when they terminated

> our reservation and our tribe. They wanted to wipe us out like they did to buffalo. They came up with big nasty doe hunts and they killed thousands and thousands of does in order to get the breeders. They said there was too many deer here for the habitat but we know that was just a way to try to wipe out the tribes" (Focus group #15, 5/17/2015).

Native foods insecurity was exacerbated by government policies of genocide and forced cultural assimilation, often referred to as cultural genocide. Beginning in the mid 1800's, Native American children were forcibly taken from their homes and families and sent to boarding schools, to "educate, assimilate and civilize" Native American children. While the first schools were primarily located on tribal reservations, by 1869 it had become federal policy to remove children from reservation settings through the so-called "Peace Policy" (Native American Rights Fund 2013), effectively disrupting intergenerational knowledge pathways and introducing generations of trauma that have influenced all aspects of the food system. It wasn't until the passing of the Indian Child Welfare Act in 1978, that Native American parents gained the legal right to deny their children's placement in off-reservation schools.

As access to native foods has declined, government welfare in the form of food assistance including "food stamps", food banks, commodity food boxes, Food for the People, as well as the summer lunch program (targeting school children) has become a vital safety net to stave off hunger; yet there is an undercurrent of resigned acceptance, reluctant dependence, and at times outright repudiation of the programs. Food assistance is perceived as part of the enduring legacy of colonialism that continues to suppress Native sovereignty, dignity and well-being. One respondent described his ambivalence,

> "Even though I don't agree with the welfare system, just giving somebody something for nothing, it's very important that, obviously, people have food. Poor people, people in poverty, need food. I just think that it does a disservice to our community members, not just tribal, our community members just to have that welfare-based reality" (Interview #42, 5/3/2016).

Asserting tribal sovereignty over ancestral lands and foods, some households continue to exercise their customary hunting/fishing and gathering rights. There is both a sense of pride and responsibility in carrying on tradition, as well as remorse and frustration that their customary ways have been criminalized. Repeatedly, people described how they have been labeled as poachers, outlaws, and criminals trying to provide native foods for their family in a system that requires costly permits and restricts the time, volume, and method of take. A Yurok Tribal member explained that:

> "Our food source, our main food source was the elk and the deer. Of course, we ate off the river too. The limitations are we don't have no elk or deer no more. We have to go off of the reservation, so basically, they call us outlaws, poachers, whatever. We're not poachers or outlaws. We are providers. Native man is a provider. He goes out and he gets food for his family. He ain't out there looking for trophies. He's looking for meat to feed his family. Then they turn around and label us as an outlaw, when we're doing what ... The Creator give us these animals so we can live. Now you got to go buy a ticket, a tag, a license to go out and be who you are. I don't agree with it. I've never bought a license in

> my life, and I never will. If I ever get caught, I'll just have to take it to court and stand on my traditional right as Native American to hunt. To provide for my family" (Interview #19, 11/10/2015).

It's clear from our study that in order to understand high rates of food insecurity in Native American communities, and begin to look for solutions, it is important to look to the past and engage with communities in the present.

5.7 Barriers and recommendations identified by the tribal community

> "I think of restored justice in all the atrocities that have been done. There's a big gaping wound in our culture, our people, the land that we live on. We're in restoration efforts. There're more people here now, and they're not going to go anywhere. We have to restore the land. We want justice. We're all working together to restore the land. If we want to live with this, we need to emphasize in legislation this is an act of justice, over processes, knowledge and restore justice to our people that are healing from people who have been wronged. There're atrocities that happened across the land that we're all now trying to restore everything. It drives me. Restoring them for the next seven generations because we're struggling now to make it. Getting our deer and stuff like that" (Focus Group #11, 6/22/2015).

Participants in both the survey and interviews shared extensive knowledge on both the barriers to native foods, and recommendations on how to improve access to healthy and native foods coalescing around important themes of justice, sovereignty and eco-cultural revitalization. Survey results show that limited access to and decreased consumption of native foods over time are outcomes of a range of environmental, economic, social, and policy barriers, outcomes of the enduring legacy of colonialism. Respondents were asked to rank barriers to native foods as "strong," "medium," "weak" or "no barrier". Rules and permits restricting access (40.67%), limited availability (34.44%), and degradation of the environment (30.39%) are reported as the *strongest* barriers to accessing native foods; as well as the most frequently cited barriers by the most respondents. Other highly ranked strong barriers include the lack of social relations (29.13%) (i.e. "no one brings it to me"), physical (in)ability (26.52%), lack of transportation (25.68%), and lack of knowledge of where to find native foods (24.78%). Climate change, while not ranked as one of the *strongest* barriers (20.95%), is cited as a barrier by 68.8% of all respondents, fourth behind limited availability, degraded environment (perhaps in part influenced by climate change), and rules and permits. Conversely, barriers that pose relatively less of a concern (no barrier) are lack of space or equipment for processing (75.30%), not familiar with eating native foods (67.69%), and not knowing how to prepare (63.37%), suggesting that with increased access to and availability of native foods, there will be more consumption.

Focus group and interview participants responded to questions posed on how to improve community health and food resources, food assistance programs, and access to native foods. Recommendations focused on improving quality and cultural relevance of community food resources including food assistance programs, strengthening relationships and knowledge within the tribal community, improving access to native foods through eco-cultural revitalization, and improving laws and policies to support tribal sovereignty over their foods systems. We explore their responses more fully below.

5.7.1 Improve community health and food resources

Consistently, people expressed a desire for more healthy, affordable and better-quality foods at their local stores rather than junk/convenience foods, and more opportunities for gardening. While primarily dependent on grocery stores for their food security, many wish to increase their consumption of native and locally grown foods. Specific recommendations included investing in fully-stocked local grocery stores with more affordable foods; offering transportation to grocery stores, integrating more healthy, fresh and native foods into the school lunch program and removing sodas, providing home garden mentors to provide one-on-one gardening support, hire paid staff to manage community gardens, promote local on-farm slaughtering by revising USDA rules.

5.7.2 Improve food assistance programs

Tribal members prefer to have their hunting, fishing and gathering rights restored over receiving government commodities. Yet given the circumstances, there is a strong desire to improve the quality and nutritional value of foods in commonly used food assistance programs including SNAP, tribal commodities, WIC, school and summer lunch, and elder meal programs, with a strong desire for more fresh fruits and vegetables and the integration of native foods (see Mucioki et al. 2018). There is a desire for programs to better meet tribal needs and realities, allow more flexibility for cultural values and perspectives, and be more accommodating to recipients in rural and remote areas where transportation and communication can be a barrier to accessing food assistance. Specifically, they request to eliminate unhealthy processed foods (flour, processed cheese) and replace with healthy, fresh and native foods (e.g. frozen venison) in the commodity food distribution program; allow Supplemental Security Income (SSI) recipients to receive tribal commodities; improve communication and organization for administering WIC in remote tribal communities and address the unique needs of small, remote stores to increase WIC vendors in tribal areas; offer healthy eating and budgeting classes for SNAP recipients; and establish more emergency food supplies in the very remote communities.

5.7.3 Strengthen tribal relationships, knowledge and community

There is a sense of urgency to support intergenerational knowledge transference before it is lost, bringing elders together with youth to learn about traditional hunting, gathering, fishing, processing and cultural story telling. When asked about what needs to change to ensure native food traditions continue, one respondent stated,

> "Well we need to know that we have access to the food. We need to be able to revitalize our traditional knowledge practice and belief pathways. People hold pieces of knowledge, so if people could come together to share the knowledge in the context of practice and utilization that's ... I don't know. That's unrestricted by outside actors, then we ... I think that that's what ultimately needs to happen in order for us to make the most efficient use of our time now, within this generation, because if we wait another generation and expect others to pick it up after we're gone, then they're going to have to rely solely on books

> rather than to be able to actually talk with people that have done it. We're kind of at a critical point right now to where it's got to get easier" (Interview #43, 5/3/2016).

There was also a strong desire to care for each other and share within the tribal community − seeking tribal unity, eliminating isolation of some tribal members, particularly elders and former felons, and setting tribal politics aside. Teaching and mentoring youth not only about their rights but respect and responsibility, and promoting relationships between youth and elders are prioritized as essential components of a strong tribal community that translates to greater food security. Carving out time and space through seasonal school breaks, or in the form of community native foods classes and workshops to allow youth to hunt, fish and gather, and learn complementary sources of knowledge on topics such as canning traditional foods, preparation for fishing and hunting season, native plant medicines, deer butchering, wocus gathering and processing, and cultural burns on private properties are all highly desired. Offering community services such as motorized acorn grinding or smokehouses, communal butchering areas, refrigerators or shops, community meat or fish canning or packing machines will help people consume more native foods as well. Finally, tribal members see the importance of educating non-native allies and agencies on the importance of native foods to Native people.

5.7.4 Improve access to and consumption of native foods through eco-cultural restoration and increased tribal participation in management of resources

Overwhelmingly, people expressed the desire to eat more native foods on a regular basis. Currently, that is not possible because of limited access due to restrictive rules and regulations, as well as availability and poor quality or productivity of native foods, which have resulted from the inability to manage for native foods over a long period of time. Respondents repeatedly expressed that the goal is to restore and revitalize native foods to harvestable populations and they shared many recommendations on how to do so, with an emphasis on reintroducing fire as the primary management tool for tribes to the landscape. As one respondent exemplified,

> "Give an Indian an artistic license to go out and do the ceremonies that we're meant for, and to maintain our land, and our forest, and our vegetation, and our wildlife, everything. It's all cyclical, everything. The fire helps. It helps the deer. The deer help the plants. The plants help everything, from fire and water. Just let us do what we need to do to get it done" (Interview #45, 5/23/2016).

Additional recommendations include removing dams on the Klamath to restore fish and eel populations; restoring rivers, lakes, wetlands, marshes and riparian areas; reducing water use and fertilizer application; increasing and sustaining deer and elk populations through fire and tribal-led management of populations and tribal take; restoring native plant populations through cultural resource management techniques; applying restrictions on cattle grazing and hay production; reducing herbicide applications on fiber material used for basketry; monitoring the overharvesting and commercialization of native foods, particularly by non-Natives; promoting authentic collaboration among tribes and agencies for co-management of ancestral lands and resources; as well as promoting synergies between western science and traditional ecological knowledge and management to optimize management for different resources.

5.7.5 Improve laws and policies that support Tribal sovereignty over native lands and foods

> "I believe that Native Americans should be able to harvest their foods wherever, within their ancestral territories. We always have since time immemorial. The government itself is basically tying our hands to being able to live off the lands. I think there should be a policy change where we should be able to take care of our own lands and glean off of them" (Interview # 19, 11/10/2015).

Legal access to native foods varies by resource and tribe throughout the Basin. Collectively, respondents expressed the need and desire to freely hunt, fish and harvest native foods, according to tribal seasons, cultural values, and cultural methods of take, throughout their ancestral territory for home consumption. While there are some Federal and State agreements and policies supportive of tribal members' access to and co-management of cultural foods (e.g. the BLM/USFS traditional foods gathering policy (see USDA-USFS/USDoI-BLM memo Nov. 29, 2006 Re Interagency Traditional Gathering Policy); the 2011 Master Stewardship agreement for the management of the Fremont-Winema forest (11-SA-11060200-017) and 2008 "Plan for the Klamath Tribes' Management of the Klamath Reservation Forest" (Johnson et al. 2008.), as well as Supreme Court cases that reaffirmed certain tribal hunting and fishing rights for the Yurok and Klamath Tribes[16], there are issues with interpretation or misunderstandings by agency law enforcement officers. There are a myriad of other laws and policies that restrict the harvest and consumption of native foods, as well as cultural land management practices (i.e. cultural burning) depending on the resource (permit requirements), agency jurisdiction and public land use designation (regional, state national park vs. federal forest), as well as season. In addition to law and policy change, law enforcement must be knowledgeable and respectful of tribal peoples' rights to harvest native foods. Almost all study participants provided recommendations on policy changes that must be made to support Tribal food security and sovereignty over their lands and cultural resources including, for example, changing laws, facilitating government to government consultation over tribal hunting, fishing and gathering rights, and establishing cooperative agreements with private land owners.

Restoring hunting, fishing and gathering rights plays a vital role in restoring food sovereignty and food security. As one respondent stated,

> "[It would] basically allow the tribe to have some opportunities to still hunt and fish how they want in places, but do it under contemporary governance at a tribal government to government level with these state and federal agencies that recognizes that certain locations and certain ways. I think that would go a long way, that you could do it without threat of prosecution or either as a tribal person, representing your tribal and community interests with that right. You take your best hunters, who are now outlaws, and turn them into valued food service employees" (Interview #29, 12/2/2015).

6 Discussion

[16] For example, Mattz v. Arnett, 412 U.S. 481 (1973)- where the Supreme Court reaffirmed the continued existence of the Yurok land base and fishing rights and Kimball (tribal members) v. Callahan (Oregon State Game Commission members), 493 F.2d 564 (9th Cir. 1974) (Kimball I) and Kimball v. Callahan, 590 F.2d 768 (9th Cir. 1979) (Kimball II), where the Ninth Circuit held that the Klamath Tribe retained their treaty hunting, fishing, and trapping rights on the former Klamath Reservation as it existed at the time of termination (1954).

Results from our study indicate that having access to native foods in the desired quantity and quality (in addition to other cultural variables) are significantly predictive of food security. As such, we argue that any understanding of food security in Native American communities must consider native foods and attendant knowledge, acquisition, management and exchange patterns as well as the historical context which gave rise to food insecurity, namely the colonization and degradation of the Native food system and associated natural and social environments. More specifically, our study results suggest the need to expand the way in which food insecurity is defined and measured in Native American communities, as well as an urgent call for more comprehensive research not only on food insecurity and *native foods* insecurity but more centrally on food sovereignty in Native American communities.

In our case study among four tribes in the Klamath River Basin, we employed both quantitative and qualitative methods using a CBPR approach to describe and explore unique attributes of Native American food (in)security by adding a focus on native foods, and other cultural variables. In our household food security survey, we included a new indicator called *native foods security* to measure access to all desired native foods at all times, as well as other cultural variables that may affect access to native foods. Our study found that Native households in this region experience some of the highest rates of food insecurity in the country and have extremely limited access to the native foods they desire. We differentiated categories of food (in)security in order to better understand the extent and depth of food insecurity and identify unique attributes of households with the most severe food insecurity. Not surprisingly, we found that poverty is the most significant predictor of both food insecurity and native foods insecurity. However, controlling for poverty, we found native foods security is significantly predictive of food security, suggesting that improvements in native foods security may improve overall food security in Native communities.

We identified many cultural variables, associated with traditional knowledge and native food acquisition/exchange strategies, that are also significant predictors of native foods security *and* food security. Namely, the ways in which traditional knowledge is learned or transferred, and how native foods are acquired and exchanged and by whom, are associated with greater or lesser food security and native foods security. As we might expect, native foods security is greater among households living in rural areas that are actively engaged in hunting/fishing and gathering and sharing or receiving both native foods and native food related knowledge, especially from family. Conversely, households more heavily impacted by the legacy of colonialism (i.e. high rates of poverty, reliance on food assistance, lacking traditional knowledge of native foods within the immediate household, nor family relations upon whom they can rely on to receive native foods) are more likely to be food insecure *and* native foods insecure. We are not de-emphasizing the importance of extra-familial learning networks (e.g. schools, tribal social programs, NGOs) or food assistance programs. Rather, these findings highlight how households that retain vibrant native food traditions and strong kinship ties, both cornerstones of cultural health, are more likely to be food secure. This suggests that food security surveys in mixed-economy food systems spanning urban-rural-agrarian and forested landscapes must be evaluated beyond economic dimensions of food security as captured by the HFSSM (see also Ready 2016).

It is important to note that food assistance users were experiencing some of the highest levels of food insecurity associated with anxiety and skipping meals. In fact, 84.23% of households that ran out of food or worried about running out of food in the past year relied on food assistance. This suggests that perhaps food assistance should be considered an indicator of, rather than a solution to food insecurity. This is supported by evidence that SNAP benefits do not cover the cost

of low-income meals (Waxman et al. 2018), and that food prices in rural Native communities are higher than similar items in urban areas, having a direct effect on household economies, particularly on the most financially vulnerable households (First Nations Development Institute 2018a). Furthermore, as food insecurity in the USA has remained relatively constant since the advent of nationwide measurement in 1995 (USDA 2017a), this suggests that food assistance programs should be considered merely as stop-gap measures, not a long-term solution to chronic issues of household food insecurity (Fisher 2017).

Our qualitative research found that key barriers to food security are directly related to the legacy of colonialism, namely the confiscation of lands and associated hunting/fishing/gathering rights, and the ongoing legal barriers that inhibit native food procurement and management or stewardship of the lands and waterways for native foods and fibers. They also include the enduring legacies of genocide and cultural assimilation through boarding schools and ongoing erasure of Native history in California school curricula that resulted in and continues to reinforce the loss of traditional ecological knowledge and associated relations of procurement and exchange of native foods.

Inability to hunt, fish, and gather in ancestral territory and culturally manage the resources to maintain quality and abundance of native foods contributes significantly to high rates of food insecurity and native foods insecurity, as reported in this study. Forest and aquatic ecosystem health has been compromised by the prohibition of cultural fires and other traditional stewardship techniques including thinning and pruning of trees which enhances the health and productivity of certain native food plants as well as safeguards the forest and neighboring communities against catastrophic forest fire. The introduction of invasive plants and pathogens, as well as federal management priorities for timber and agriculture, have resulted in substantial degradation of habitat for native foods, decreasing the availability, access, and quality of native foods and severely limiting consumption. Forced relocation of tribal members to cities also affects native foods security. Households that live in rural areas, hunt, gather and fish, and share native foods with others and at tribal events are more likely to be native foods secure, suggesting the importance of enabling tribal members to stay in their ancestral lands and have rights to hunt, fish and gather.

How food security is framed, and by whom, shapes not only our understanding of the experience and predictors of food security, but also the kinds of interventions or solutions that are proposed. Our results suggest that current measures of food security in the USA, which do not consider mixed-economy food systems inclusive of native foods and cultural practices of food acquisition/exchange and knowledge transference must be revised. Without consideration of the structural and historical causes of food insecurity, as well as culturally relevant indicators, interventions may continue to address symptoms of food insecurity (hunger) while denying more transformative change (food sovereignty as means to achieve food security and native foods security). Integrating indigenous measures of food security into standardized national food security survey modules, and engaging communities in defining solutions to food insecurity are critical first steps toward improving food security in Native American communities. It can also contribute toward changing national discourse away from neoliberal and arguably paternalistic narratives and investments in Native American communities that reinforce negative stereotypes and dependency on federal aid, toward one that acknowledges historical injustices, elevates indigenous values and priorities, and promotes Native American food sovereignty through direct investments defined by and for Native communities (see First Nations Development Institute 2014).

Our study both contributes to the growing body of literature calling for a revision of standardized tools and frameworks used to measure food security among Native American

communities and provides a method for others to survey and describe food systems and security in Native communities inclusive of native foods and related cultural institutions. We also seek to contribute to discussions about the limitations of the current food security definition in relation to Native American communities. Power (2008), for example, proposes the concept of "cultural food security" as an additional level of food security beyond individual, household and community levels that includes unique cultural attributes related to harvesting, sharing and consumption of traditional foods. Similarly, Fazzino (2010) introduces "traditional food security" as an extension of the community food security concept, drawing on the rich history of indigenous peoples' interactions with the landscape. "Traditional food security" for the Tohono O'odham Nation in Arizona and Mexico, he proposes, would include a) availability of local, healthy *and* traditional foods, b) revitalization of traditional farming systems to enhance interaction of individuals with their environmental companions, c) enhancement and spread of household and community knowledge of traditional foods and procurement and preparation methods, d) adequate time and financial resources to acquire and prepare traditional foods, e) equivalence of desired and actual consumption of traditional foods. Based on the results of our study, we propose a definition of "native foods security" as *having physical, economic, social and legal access to all desired native foods in the appropriate quality and quantity throughout the year, and the continuity of the cultural institutions that sustain them including traditional ecological knowledge, social support networks, and cultural resource stewardship.*

Recommended next steps include revising the USDA Community Food Security toolkit and standardized HFSSM module to take into account native foods and cultural variables that affect food security/native foods security. Working closely with a wide range of Native American communities to develop, pilot and analyze the results of food security assessments, inclusive of cultural indicators, are imperative in order generate more culturally relevant and generalizable data on food security in Native American communities. Second, dedicated funding to support more CBPR with tribal communities leading the inquiry is needed to identify challenges and successes related to achieving food security and native foods security, and identify tribal-led solutions in order to advance efforts and funding to support Native American food security and sovereignty.

A First Nations Development Institute report evaluating the impact of 39 Native Food Sovereignty assessments (utilizing their Food Sovereignty Assessment Tool) underscores the importance of tribal engagement in the research process, "A process that allows Native communities to define their own data-collection process and areas of focus for their food assessment [leads] to very unique community-specific outcomes". New tools and initiatives are being developed by and for Native communities to assess and improve their food systems (First Nations Development Institute 2018b), yet they remain severely underfunded[17]. Native American organizations are elevating the goals, desires, and wishes of tribal communities to define their own community food systems, revitalizing both traditional and contemporary food systems to achieve greater food security, food sovereignty and overall health of the people and the land. It is clear that systematic national and regional research in general and community based participatory research specifically is needed in order to understand the historically specific, place-based and socio-

[17] The new report (First Nations Development Institute 2018b), notes that since NAFSI began in 2002, First Nations has awarded 307 grants totaling more than US$7.58 million to Native organizations dedicated to increasing food access and improving the health and nutrition of Native children and families. This number, however, pales in comparison to the more than 1,450 requests received totaling more than US$49.7 million over that time, illustrating that a huge unmet need for funding for these types of projects continues in Native communities.

cultural attributes of food security and to design culturally relevant solutions to food insecurity in Native American communities.

Engaging in CBPR to co-define the research, analysis and interpretation of results, can help addresses a common critique of research in Native communities that tends to privilege western science over traditional ecological knowledge and perspectives (Elliot et al. 2012; Smith 1999). It can also generate community-led solutions beyond conventional strategies such as food assistance that serve as important safety nets, but often undermine the very sovereignty of the communities they seek to support. For example, in our case study, participants consistently voiced the desire to feed themselves, wanting hunting, fishing, and gathering rights, improved quality of native foods through restoration efforts and prescribed fire, strong community and family relationships to facilitate transfer of food and knowledge, and more affordable healthy foods in local grocery stores. Without taking into account such tribal community perspectives, current solutions to food insecurity through food assistance programs merely reproduce colonizing tendencies, overlooking tribal desires to remove legal barriers that prohibit hunting/fishing and gathering, and restore traditional knowledge, social relations, and native food traditions − all of which are associated with greater food sovereignty.

6 Conclusion

In order to achieve transformative food system change in Native American communities, one must examine the structural causes of poverty, acknowledge the historical injustices and ongoing legacy of the colonial period, as well as develop and apply more culturally relevant measures associated with access to native foods and food security. It is important to work with tribal communities to inform a more culturally nuanced understanding of food security that includes measures beyond access or distance to grocery stores, availability or affordability of healthy foods, poverty levels or financial resources to include culturally relevant measures such as access to traditional foods and the knowledge and social relations of stewardship, procurement, and exchange to support the sustainability of such practices. When considering solutions to food insecurity, attention to the unique history of each tribe is important to understand not only specific tribal assets, knowledges and customs, but also unique challenges imposed by the specific circumstances of colonization on their peoples, lands, relationships, knowledge, rights and food systems. Bringing a cultural and historical dimension to food security research suggests that food sovereignty is indeed a necessary precondition for achieving true food security among Native American populations (Grey and Patel 2015; Patel 2009). As Elizabeth Hoover (2017: 39) describes, “the concept of indigenous food sovereignty is not just focused on the *rights* to land and food and the ability to control a production system, but also *responsibilities* to them, which encompass culturally, ecologically, and spiritually appropriate *relationships* with elements of those systems.”

Results from our case study suggest that increasing access to native foods and the rights and responsibilities to manage for them along with strengthening appropriate relationships are vital steps to achieving food security and food sovereignty. This calls for taking bold steps toward revising laws and policies that restrict hunting, fishing and gathering and exploring opportunities for co-management of public lands and water bodies for cultural food resources. This includes augmenting federal and state funding for programs to create jobs and hire Tribal Stewards to restore native ecosystems to enhance the quality, abundance and accessibility of cultural foods and fibers, educate tribal youth and support intergenerational exchange and continuity of traditional ecological knowledge. Ultimately, Native American communities are calling for greater

acknowledgement of their sovereignty over their food systems and diets as well as their territories, cultural resources and knowledge. We argue that revising the tools and indicators for assessing food insecurity, integrating cultural measures, and addressing food insecurity among tribal communities according to tribal community priorities and concerns can play an important role in facilitating tribal food security, food sovereignty, eco-cultural revitalization and ultimately tribal self-determination.

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Compliance with ethical standards

Ethical approval All study procedures and ethical considerations for human subjects were approved by the University of California at Berkeley's Ethics Review Board #2012-07- 4484 and each Tribe's respective research review. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Specifically, informed consent was obtained from all individual participants included in the study; all study participants remain anonymous with private and culturally sensitive information protected; and all tribal collaborators have had the opportunity to read and comment on this article prior to publication.

Conflict of interest The authors declare they have no conflict of interest.

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Table 1 A summary of quantitative studies on food (in)security in Native American communities in the United States of America

	All households nationally *(Coleman-Jensen et al. 2017)*	Native Americans (NA) nationally *(Jernigan et al. 2017)*	Native Americans in California *(Jernigan et al. 2013)*	Navajo Nation communities *(Pardilla et al. 2013)*	Northern Plains Reservation Montana *(Brown et al. 2007)*	Pine Ridge Reservation, South Dakota *(Bauer et al. 2012)*	Reservations in Arizona and New Mexico *(Mullany et al. 2012)*	Urban vs. rural Native Americans *(Tomayko et al. 2017)*
N=	39,948 households	1,513 individuals	592 households	276 individuals	187 households	432 families	425 families	450 pairs of adults and children
Target population	Households that filled out the Current Population Survey Food Security Supplement in 2015[a]	NA households who filled out the Current Population Survey Food Security Supplement in 2000-2010	NA households that responded to the California Health Interview Survey with an income at or below 200% of the federal poverty level	Members of the Navajo Nation visiting food stores or other public locations	Northern Plains Reservation residents attending health fairs and school events	NA families with kindergarten age children that attend Bright Start School	NA families with young children receiving emergency food from Menu for Life	NA families with children in the Healthy Children, Strong Families program
Food security methods	18-question HFSSM[b]	18-question HFSSM	Six-question HFSSM	The ten-item Radimer/Cornell Hunger and Food Insecurity instrument[c]	Four-question HFSSM	Six-question HFSSM	NHANES for adult food (in)security[d] and USDA's children's food security module[e]	Two-question HFSSM

Food insecurity	12.7% of households	25% of households were consistently food insecure from 2000-2010	38.7% of households	76.7% of households	44% of households	39.9% of families	29% of children and 45% of adults	61% of households
Very low food security	5.0% of households	-	-	-	-	10.5% of families	-	-
Poverty/income	Households earning 185% of the poverty line were more food insecure	Households earning 185% or less of poverty line about 3 times more likely to be food insecure	-	Food insecurity associated with unemployment and lower material lifestyle	Food insecurity associated with low income	Food insecurity associated with low income and unemployment	-	-
Health	-	-	No association with obesity	No association with obesity	Food insecurity associated with poor general health and bodily pain.	No association with adult or youth obesity	-	-
Rural/urban	Rural households more food insecure	Urban households over 2 times more likely to be food insecure than rural households	-	-	-	-	Rural communities more food insecure	Urban households more food insecure

Education	-	No association	-	Lower education associated with food insecurity	No association	No association	-	Respondents with higher education less likely to be food insecure
Age		No association		Older respondents significantly more food insecure		-	Older respondents more likely to have food insecure children and less likely to have healthy foods available	No association
Use of food assistance	59% of food insecure households used food assistance. SNAP users had twice the rates of very low food security than non-SNAP users in the same income bracket.	Food stamp recipients 3 times more likely to be food insecure	-	No association with use of all food assistance programs	No association with use of FDPIR	Food insecurity associated with use of food stamps and getting food from other families	Consumption of food from food banks not associated with food insecurity	WIC participation associated with greater odds of food insecurity

[a.] This includes households with income at or below 185% of the federal poverty level and households that are identified as food insecure based on answers to select questions.
[b.] see Bickel et al. 2000; Coleman-Jensen et al. 2017
[c.] see Radimer et al. 1992
[d.] see National Center for Health Statistics 2016
[e] see Nord and Bickel 2002

Table 2 Comparison of questions used to categorize food security in our study and the HFSSM

Our food security survey questions	Comparable HFSSM questions [b]
FOOD SECURITY	
Does your household get all the healthy foods you want, at all times, throughout the year? *(yes, always, usually, rarely, never)*	We couldn't afford to eat balanced meals. *(often, sometimes, or never true for you in the last 12 months)*
Has your family either run out or worried about running out of food at any time during the past year? *(yes, no)*	We worried whether our food would run out before we got money to buy more. *(often, sometimes, or never true for you in the last 12 months)*
How often do you run out of money to buy groceries? *(never, rarely, at least once a week, at least once a month, a few times a year)*	The food that we bought just didn't last and we didn't have money to get more. *(often, sometimes, or never true for you in the last 12 months)*
In the past year, has your household bought less expensive foods to deal with not having enough money for food? *(yes, no)*	We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food. *(often, sometimes, or never true for you in the last 12 months)*
In the past year, has your household reduced the size of meals to deal with not having enough money for food? *(yes, no)*	In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food? *(yes, no)* (If yes to question above) How often did this happen? *(almost every month, some months but not every month, or in only 1 or 2 months)*

In the past year, have adults skipped meals to deal with not having enough money for food? *(yes, no)*	In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food? *(yes, no)* (If yes to question above) How often did this happen? *(almost every month, some months but not every month, or in only 1 or 2 months)*
In the past year, have adults and children skipped meals to deal with not having enough money for food? *(yes, no)*	In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food? *(yes, no)* (If yes to question above) How often did this happen? *(almost every month, some months but not every month, or in only 1 or 2 months)*
In the past year, did anyone take part in a food assistance program? *(yes, no)*[a]	None
NATIVE FOODS SECURITY	
Does your household get all the traditional Native foods, such as salmon, acorns, deer meat, and others, you want throughout the year? *(yes, always, usually, rarely, never)*	None

[a]The use of free school lunch and elder's lunch was not considered use of food assistance in this question as the use of these programs is not contingent on the income of the household or always indicative of food insecurity. A secondary use of this question and a component of our food (in)security categories considered households that qualified for food assistance, based on reported household income, but did not use any form of food assistance.
[b]see Coleman-Jensen et al. 2017

Table 4 Definitions of independent variables used in this study

Independent variables	Definition
HOUSEHOLD DEMOGRAPHICS	
Age of respondent(years)	The age, in years, of person filling out the survey.
Completed higher education	The proportion of respondents that completed an Associate's degree, Bachelor's degree, or graduate studies.
Size of household	The number of people in the household.
Poverty	The household fell below the 2016 Federal Poverty Guidelines based on annual income and household size.
Rural	The household lived in a town more than 20 miles from an urban cluster (2,500 people or more).
HOUSEHOLD FOOD ACCESS	
Hunt/gather/fish	A portion of the household food supply was obtained through hunting, fishing, or gathering Native foods.
Garden/orchard	A portion of the household food supply was obtained from gardens or orchards (home, community, school, or tribal).
Food distribution programs	A portion of the household food supply was obtained from food distribution programs (commodity foods, food banks, free meals, etc.).
Neighbors, friends, family	A portion of the household food supply was obtained from neighbors, friends, or family.
Shop at least once a week	Someone from the household grocery shopped at least once a week.
Own a vehicle	Someone in the household owned a vehicle.

Travel an hour or more to the store	The grocery store where the household purchases most of its food is an hour or more one-way drive from the home.
NATIVE FOOD RELATED KNOWLEDGE	
Shared knowledge	The respondent shared knowledge about Native foods or materials with others.
Shared with children	The respondent shared knowledge about Native foods or materials with their children.
Shared with other family	The respondent shared knowledge about Native foods or materials with their other family members.
Shared with non-tribal members	The respondent shared knowledge about Native foods or materials with their non-tribal members.
Learned from family	The respondent learned knowledge about Native foods or materials from family members.
Learned from unrelated person	The respondent learned knowledge about Native foods or materials from an unrelated person.
Self-taught	The respondent taught himself about Native foods or materials.
NATIVE FOOD ACQUISITION	
Family shares	Household obtained Native foods through family.
Friends share	Household obtained Native foods through friends.
Trade	Household obtained Native foods through by trading for other items.
Hunt	Household obtained Native foods by hunting the food themselves.
Fish	Household obtained Native foods by fishing for the food themselves.

Gather	Household obtained Native foods by gathering the food themselves.
	NATIVE FOOD EXCHANGE
Family eats	The household eats the Native foods they obtain.
Share with others	The household shares the Native foods they obtain with others.
Share at tribal events	The household shared the Native foods they obtain at tribal events.
Trade	The household trades the Native foods they obtain for other items.

Table 5 Means of independent variables (defined in Table 4) by food security and native foods security categories, respectively. The data displayed for categorical variables is based on affirmative response (equivalent of a "yes" response) for each variable.

	FOOD SECURITY			NATIVE FOODS SECURITY				
		Very low and low food security	Marginal and high food security		Never	Rarely	Usually	Always
Independent variables	N	Mean		N	Mean			
HOUSEHOLD DEMOGRAPHICS								
Age of respondent(years)	*686*	50.03	58.37	*679*	58.83	52.28	54.75	51.33
Completed higher education	*658*	21.24	30.54	*651*	20.95	21.58	31.40	31.11
Size of household	*689*	3.07	2.77	*682*	2.56	2.93	3.21	3.40
Poverty	*613*	56.33	16.67	*607*	48.98	49.03	31.06	27.50
Rural	*691*	44.42	48.02	*685*	27.27	43.30	58.10	60.00
HOUSEHOLD FOOD SOURCES								
Hunt, gather, fish	*699*	41.89	55.29	*694*	15.04	37.78	75.82	85.11
Garden/orchard	*698*	37.02	45.88	*693*	26.55	35.23	56.91	48.94
Food distribution program	*698*	39.50	14.90	*693*	38.05	32.10	24.86	23.4
Neighbors, friends, family	*698*	32.73	28.63	*693*	26.55	29.83	38.67	25.53
Shop at least once a week	*672*	55.82	65.34	*664*	57.94	60.65	53.14	79.55
Own a vehicle	*692*	84.90	96.47	*685*	85.84	87.03	95.00	88.89
Travel an hour or more to the store	*686*	19.21	22.05	*679*	15.18	19.53	25.14	17.78
NATIVE FOOD RELATED KNOWLEDGE								
Shared knowledge	*676*	55.92	61.63	*670*	33.02	55.75	70.79	78.72
Shared knowledge with children	*416*	78.63	88.96	*411*	82.93	79.80	85.71	82.05
Shared knowledge with other family	*417*	68.32	70.32	*412*	51.22	64.65	79.10	74.36

Shared knowledge with non-tribal members	*417*	27.86	22.58	*412*	19.51	25.76	29.10	28.21
Learned from family	*432*	91.88	93.17	*428*	80.00	92.31	94.12	100.00
Learned from unrelated person	*433*	29.78	17.39	*429*	26.67	30.43	21.17	10.00
Self-taught	*433*	39.34	40.37	*429*	44.44	37.20	43.07	35.00
NATIVE FOOD ACQUISITION								
Family shares	*560*	71.88	64.90	*555*	50.82	69.07	74.85	77.50
Friends share	*560*	63.25	52.63	*555*	40.98	61.51	63.19	55.00
Received though trade	*548*	22.67	13.24	*543*	10.00	15.62	27.85	21.62
Hunt	*554*	45.24	54.59	*549*	21.67	41.32	67.08	77.50
Fish	*556*	50.86	58.17	*551*	33.90	46.53	68.9	75.00
Gather	*554*	46.53	50.00	*549*	27.12	42.36	60.74	64.10
NATIVE FOOD EXCHANGE								
Family eats	*576*	76.99	78.20	*571*	79.37	80.60	71.08	81.40
Share with others	*575*	52.47	58.77	*570*	33.33	49.66	69.28	65.12
Share at Tribal events	*574*	18.46	15.64	*569*	3.23	10.07	31.93	32.56
Trade with others	*573*	11.60	7.58	*568*	4.92	6.38	16.87	16.28

Table 6 The results of multivariate generalized ordered logistic models for food security and native foods security. Only variables included in the final models are listed

	FOOD SECURITY		NATIVE FOODS SECURITY			
	VL and L → M and H [a]		N → R, U, A[b]	N, R → U, A	N, R, U → A	
Independent variables	Odds ratio (standard error)	Likelihood Ratio (N)	Odds ratio (standard error)			Likelihood Ratio (N)
Age of respondent(years)	1.03(0.01)**	68.50(306)***				141.81*** (294)
Poverty	0.25(0.08)***		3.03(1.65)*	0.47(0.15)*	0.57(0.32)	
Rural				1.95(0.50)**		
Hunt/gather/fish				7.00(2.27)***		
Food distribution programs				0.41(0.12)**		
Shop at least once a week			1.07(0.52)	0.71(0.21)	3.95(2.16)*	
Own a vehicle	9.98(10.63)*					
Shared knowledge with children	2.87(1.25)*					
Learned knowledge from unrelated person				0.46(0.13)**		
Friends share			1.68(0.82)	0.67(0.211)	0.31(0.14)*	
Share with others				2.57(0.74)**		
Share at Tribal events				2.57(0.75)**		
Receive through trade	0.53(0.17)*					

[a]VL = very low food security, L = low food security, M = marginal food security, H = high food security
[b]N = never has access, R = rarely has access, U = usually has access, A = always has access
* p <0.05; ** p<0.01, *** p <0.0