Bark beetles in Arizona: history, status, public perceptions and management

A Professional Paper

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Abstract

Prolonged periods of drought, overly dense stands, recent fire activity and past management practices can be catalysts for bark beetle outbreaks. In conifer forests of the Southwest, outbreaks are often driven by one of two main disturbance events, drought and wildfire. Here we review case studies of Arizona communities recently affected by large-scale outbreaks resulting from severe drought in Prescott Valley, and extreme wildfire in the White Mountains. These forests include high-valued recreation areas and provide critical wildlife habitat. Federal funding is used to mitigate the negative effects of bark beetle activity on public lands, yet there is often a disconnection between what land managers do and what the public knows, wants and needs. The purpose of this study was to survey the public to determine what they think and know about bark beetles and their management in Arizona. Three thousand, two hundred and nine residents of Prescott Valley and of the White Mountains, Arizona were randomly selected and queried about their awareness of bark beetles. A combined total of 348 residents from the two sampled areas participated in the survey, with a response rate of 10.8%. In addition to the public surveys, interviews with forest entomology professionals from universities and the U.S. Forest Service were conducted and USDA Forest Service reports and other published literature on bark beetle management in Arizona were reviewed and summarized. We hope to increase public awareness of bark beetle management and answer questions regarding bark beetles, including what the local public perceptions are.

Keywords: bark beetles, outbreaks, public perceptions, management, forest health

Introduction

Envision the following scenario: you live near a forest in an otherwise desert-dominated state. There has been a drought for several years and wildfires are more frequent. Since your home is located near the forest, evacuation from fires is a big concern, as well as the potential loss of your physical home and belongings. A large fire recently occurred nearby, luckily contained before reaching your neighborhood. Since then, you notice that the pine trees in your neighborhood, though untouched by the actual fire are now showing signs of decline or even death. Close examination of the trees reveals that some of the trees have piles of dust, clumps, or balls of resin and a few have small streams of sap oozing out of the bark. As time passes, the needles of the tree start to fade and look more yellow or even red or brown. Within two years, most of the coniferous trees in the neighborhood have fallen victim to these insects known as bark beetles. You have a choice: spend money to remove the beetle-infested trees and potentially protect the remaining trees, or accept the risk and eyesore and leave the dead trees.

The scenario described above is the reality for many residents of western states that reside near coniferous forests or wilderness areas. Arizona is no exception: bark beetles have been a part of these lands for millennia (Wood 1982) and have played an important role in natural forest disturbance but sometimes have profound negative impacts on humans (Vega and Hofstetter 2015). For example, an anonymous resident of Prescott Valley, AZ shared their experience in making the above choice, "“I know that bark beetles destroyed my two blue spruce trees and didn't touch my ugly pine, so I cut them down as well as the pines.”

Bark beetles that pose a threat to forest health are generally known as “tree killers” and are often species of *Dendroctonus* and *Ips* (DeGomez and Young 2002, Schmitz and Gibson 1996). Contrary to their name, they are ecologically important. Land managers (Schmitz and Gibson 1996) do not recommend their removal or eradication. Their actions contribute to

nutrient cycling and encourage regeneration in forests by indirectly creating gaps in the canopy as they colonize old or weakened trees (Raffa et al. 2015, Cognato and Grimaldi 2009). The removal of weakened or unhealthy trees reduces competition for the remaining trees and improves overall forest health (Raffa et al. 2015). A tree that dies from bark beetle activity can then become a haven for tree-roosting wildlife such as birds, squirrels and bats, and also home to many wood-infesting insects, bacteria and fungi (Hofstetter et al. 2015).

Under endemic conditions (i.e. low beetle population size), bark beetles are not harmful to forests. However, during epidemic conditions, bark beetle activity can have devastating results. Bark beetle populations can build up in trees weakened after fire injury or water stress particularly in stands with other insect and disease issues and in overly dense stands. Once beetle populations are sufficiently large, healthy trees will also be attacked. During an outbreak, mass attacks by bark beetles overwhelm individual trees across a landscape, which causes the death of millions of acres of trees per year in North America (Raffa et al. 2008, Samman et al. 2000).

A pine tree's primary defense against bark beetles is resin, encountered when a beetle begins to bore into or attack a tree (Raffa et al. 2015). Resin defense is limited when a tree is under water stress, such as during drought conditions. Reduced tree defense capabilities during prolonged drought facilitates attacks on trees at a larger scale.

Trees that have been successfully attacked by bark beetles can have recognizable piles of frass or boring dust, clumps or balls of resin or by streams of sap or hardened sap (called pitch tubes) that the tree produces, depending on the tree species. Small 1-2 mm size holes where beetles exited the tree can also be seen. Beetle-killed trees can be very visible when the needles turn red or bark begins to fall of the tree trunk. There are many bark beetle species and each

attack particular types of trees such as pine, spruce, Douglas-fir and true fir, as well as hardwood tree species (Raffa et al. 2015). However, most bark beetle species attack one type of tree (e.g., pines) or even one particular species (e.g. piñon pine) (Vega and Hofstetter 2015).

Although most bark beetles are native species and have been a part of forest ecosystems for millions of years (Cognato and Grimaldi 2009), it is only since the early 1900s that the public began to view bark beetles as a forest pest (Furniss and Carolin 1977). In Arizona, bark beetles have contributed to the mortality of thousands of ponderosa pines per year (DeGomez and Young 2002). In other western states, beetle epidemics have claimed millions of lodgepole pine, spruce, ponderosa pine and Douglas-fir trees of high timber value (Simard et al. 2011). In addition to the losses of healthy trees on federally managed lands, beetle attacks have affected privately owned forested lands (Markels and Marek 2003). For example, fire events in San Bernardino County, California sparked a focus on efforts to remove beetle-killed trees from residential areas nested within beetle-impacted forested lands. Severe fires occurred in many of those areas despite efforts to remove the beetle-killed logs, which has given rise to doubts of the effectiveness of sanitation cuts as a good management tool in areas needing wide scale fuel reduction treatments (Markels and Marek 2003, Carswell 2014).

Public perception of bark beetle activity and management thereof appears to be dependent upon the proximity of those affected by this issue to areas that are actively affected by beetle activity or management efforts (Flint and Luloff 2007). This paper seeks to address the questions of what the current public opinions of bark beetles are in areas of Arizona that have undergone bark beetle outbreaks in addition to provide an overview of bark beetle history and management in the Southwest. To address this question, randomly selected residents of Prescott Valley and the White Mountains of Arizona were invited to participate in a survey that asked

about their knowledge and opinions regarding bark beetles. Questions included if they knew what bark beetles are, if they believed that bark beetles were a problem where they live, if they felt that land managers should intervene to reduce the impact of bark beetles and if they would pay to prevent bark beetles on their property (see Appendix VII for full survey). In addition to the public surveys, reports, literature and media on the topic were explored, and interviews with forest entomologists and entomology professors were conducted. The literature provided sources of supporting documents, which also include topics that were identified as points of interest by survey participants. Among the topics were concerns of fire risk, forest ecology and tree health, safety for those in or near the forest, economics of forest products and the cost of treating outbreaks, aesthetic and scenic beauty issues, and finally what management options exist for prevention and suppression of bark beetle outbreaks. Hopefully, the survey results presented in this report can both increase public awareness of the need to manage for bark beetles and provide information to land management agencies about what the public views are regarding bark beetles when planning to educate the public or implement management strategies.

Most survey participants reported that they knew what bark beetles were (Figure 1), most said that they visit a forested area for recreation regularly (Figure 2) though not all felt that bark beetles should be managed (Figure 3). Similarly, many viewpoints were expressed in the literature, with reported opinions ranging from the position that bark beetles should not be important drivers of management (Carswell 2014), to the belief that active management is necessary to allow bark beetles to return to their historic beneficial role to forest ecosystem health (Samman et al. 2000, Jenkins et al. 2008).

Bark Beetle Biology

Survey participants said they knew what bark beetles are, however a better understanding of basic bark beetle biology may help the public understand management actions on federal lands and how to identify and possibly mitigate negative impacts of bark beetles on privately owned parcels. Key items the public should know to help them better understand bark beetles and how to avoid there impacts are related to host defense, host selection and damage they caused during development. The general lifecycle and behavior of a bark beetle is described below.

Young adult bark beetles emerge from a tree in the spring or summer, at which point they fly through a forest stand searching for a new home. The search is an awkward flight, as beetles will sometimes randomly land on a given tree that may or may not be the right tree species for the specific beetle. If the beetle is in a recently burned forest stand, the fire-injured trees may emit a chemical signal that helps the beetles locate a suitable host. The bark beetles emerge in large groups at a time, all in search of a mate, home and food source. (Raffa et al. 2015)

Once a bark beetle lands on an appropriate tree, it chews an entrance into the crevices of the tree's bark. If it can overcome the tree's defenses (i.e. resin, sap), it continues to chew a tunnel into the inner bark and if it has not mated, waits to mate inside the tree. To be sure that others of the same species will find it, a pheromone is produced from the beetle that will attract potential mates (Powell and Raffa 2011).

In the meantime, other bark beetle species are also in flight, attracted to the presence of pheromones from conspecific beetles, which also resembles the signals produced by the fire-damaged trees. For *Dendroctonus* species, the males find the tree(s) producing the signals and enter the holes produced by the females. Some beetles are flushed out of the tunnels, as the tree's defensive pitch fluids fill the openings that the females excavated and drown out the

invaders (Raffa et al. 2015). Other beetles on the surface of the tree may become prey to predators such as clerid beetles that wait for them on the bark surface.

Although the beetles that initiate colonization are often repelled and killed by the tree defenses, the mass attack of bark beetles is a tactic used by many bark beetle species to ensure successful colonization of a tree. This process involves pheromone communication between beetles and the concentration level of the pheromones. At lower concentrations, the pheromones are considered aggregate, as the signal encourages more bark beetles to enter the tree. When a sufficient number of beetles are present inside the tree, the level of the pheromone is very high and it becomes anti-aggregate, and repel beetles from the tree. It is especially easy for beetles to overcome the tree's defenses when drought, fire or other diseases, insects or injury, have previously stressed the host tree. (Powell and Raffa 2011)

Mated bark beetles that make it into the inner bark of the host tree are rewarded by passing genetic information to future generations of bark beetles. Females, once fertilized, will then dig tunnels within the tree's inner cambium and deposit eggs along the way. Eggs hatch a week or so later and the new larvae begin to eat the nutrient-rich phloem of the tree or fungi which were introduced by the parent beetles in the phloem. Larvae continue to eat as they grow larger, undergoing slight size changes called instars. If winter happens to occur when a larva is still inside a tree, it will stay there during the winter, and pupate. In the spring, it will transition to an adult beetle, continue feeding and then exit the tree as an adult when temperatures are warmer. When many beetles of the same species emerge at the same time, the search for new trees to colonize in begins again. (Raffa et al. 2015, Harrington 2005)

On average, a female bark beetle can lay approximately 60 eggs, but over 130 eggs have been recorded (Amman 1972). A single mature pine tree can have several hundred female bark

beetles inside of it when being attacked (Vega and Hofstetter 2015). When there are enough bark beetles inside the tree and most of the females have mated, the aggregation pheromone turns into an anti-aggregation pheromone that communicates the message that the tree is "full" and deters further bark beetles from entering that tree. The tree, unfortunately cannot withstand the presence of so many tunnels and fungi, and will eventually die as the flow of water and nutrients is cut off (Powell and Raffa 2011, Harrington 2005).

During times of low bark beetle populations, tree mortality is confined to less than two percent of a forest (Samman et al. 2000) as beetles survive by colonizing weakened trees. Only a few scattered trees are killed by bark beetles under endemic conditions. During outbreaks, however, bark beetles may cause widespread tree mortality of healthy trees, which may last for several years.

History and Current Status

Fossil evidence of petrified wood indicates that forests were in Arizona as far back as 214 million years ago (Riggs et al. 2003). Evidence of bark beetle galleries have been found in petrified wood fossils, indicating that bark beetles attacked and killed some of those ancient trees (Ash 2004). Further evidence of bark beetles coevolving with specific pine species dates back to approximately 100 million years ago from bark beetle fossils in amber (Cognato and Grimaldi 2009), with origins from tropical and neotropical zones (Ash 2004). In fact, the sparse temperate forests surrounded by desert that we see now in Arizona were ancient tropical forests that were geographically located closer to present-day tropical zones (Ash 2004). Hundreds of millions of years of tectonic shifting, volcanic eruptions and the receding of ancient water bodies have resulted in the current geographic placement of Southwestern U.S. states to higher latitudes (Riggs et al. 2003, Ash 2004).

Today, Arizona's forested lands make up over 21 million acres, which are surveyed annually by the U.S. Forest Service to determine the status of diseases and insects through aerial detection (USDA

2014). Of the surveyed lands, ~3 million acres have undergone bark beetle outbreaks in the past 16 years (Figure 4). The areas surveyed include national forests, tribal, state and privately owned forestlands throughout Arizona. There are six national forests in Arizona, all managed by the United States Department of Agriculture Forest Service. The Apache-Sitgreaves National Forests and the Prescott National Forest have undergone bark beetle outbreaks that have required attention and significant financial investments to reduce the negative impacts caused by bark beetles in areas that include habitat for endangered birds as well as in established sites for recreation (USDA 2014).

Since 1998, the Prescott National Forest has observed periods of high bark beetle activity that peaked in the years 2002-2003 (USDA 2002 and 2003) following years of extreme drought (NOAA 2014). Subsequently, forested areas near Prescott Valley, AZ underwent bark beetle outbreaks of native ponderosa and piñon *Ips*, which affected pines within 39,995 and 123,255 acres in 2002 and 2003 respectively (Figure 5, USDA 2002 and 2003). Impacts on piñon and ponderosa pine trees from 2002-03 can still be seen today. To that regard, an anonymous survey participant stated, "All of the forest trees on our street have died," and another commented, "[I would like to know] how to take care of our forest, what is being done and not just…talk, I have seen thousands of acres of trees dead from those beetles and nothing done." The risk level for bark beetle outbreaks in the Prescott National Forest for the next 15 years is projected to be 16-20% losses of host basal area (Forest Health Forest Insect risk map for the years 2013-2027, Figure 6).

Residents of the White Mountains of eastern Arizona have seen their fair share of bark beetle activity, often associated with severe wildfire events. The 2002 Rodeo-Chediski fire and the 2011 Wallow Fire were the largest wildfires in Arizona history (AZCentral.com 2012, USDA 2011). Bark beetles, such as the Douglas-fir beetle, were already present at endemic levels in the Apache-Sitgreaves National Forests prior to the Wallow Fire. There were concerns that pre-burn presence of the beetles would lead to outbreaks, which were proven correct (USDA 2011, USDA 2014). Bark beetle activity in the years following those two fires influenced over a hundred thousand acres of various pine, Douglass-fir and true fir trees in the Apache-Sitgreaves National Forests (Figure 5, USDA 2014). Following these

devastating fire events, the remaining trees had increased susceptibility to damage from other forest insects, pathogens, and declines in health due to other abiotic and biotic stresses (USDA 2011). Such pressures can lead to a decrease in tree vigor, impact scenic beauty and can lower recreation value due to the visibility of individual bark beetle killed trees (Raffa et al. 2015, Larsen 2014, Czaja et al. 2012, Buyoff et al. 1982).

Case Study: Public Surveys of Arizona Residents

Residents of Prescott Valley and of the White Mountains are two populations of interest (circled in blue and pink in Figure 6), as their communities have experienced bark beetle outbreaks in the forests near them. "Only last week a fellow remarked that bark beetles were destroying trees throughout the west. We were riding the Kachina trail at the time. I'm not sure if I had ever heard of them before this," commented an anonymous Prescott Valley survey participant.

The outbreaks of Prescott Valley happened nearly 13 years ago (2002-03) and the White Mountains' most recent outbreaks occurred in 2002 and in 2013 (Figure 5). Active management efforts are currently employed by the U.S. Forest Service to monitor and mitigate bark beetle activity in the Apache-Sitgreaves National Forests. Management actions such as trapping beetles and placing anti-aggregation pheromone pouches on individual trees in high-use recreation areas have been noticed by forest users.

Although there was a public notice for the management project (USDA 2013) including a public review process and notices in a local newspaper, not all forest users were aware of the efforts or they were not supportive. Some of the bark beetle traps had been vandalized in 2014 and 2015. This was observed by the presence of bullet holes in collection cups, traps that had been vandalized with empty beer bottles and eggs, and pheromone pouches being torn down from some of the trees.

With the goal to increase awareness of bark beetle outbreaks, subsequent management, and to assess general knowledge of bark beetles, a random sample of 3,209 listed addresses in the two areas were sent invitations to participate in an anonymous survey (see Appendix B. IV for methods). A total of

348 residents returned the survey: 176 from Prescott Valley and 172 from the White Mountains (which included the municipalities of Springerville, Eager, Nutrioso and Alpine, Arizona).

The survey included fifteen questions, which inquired about the participants' knowledge and attitudes towards bark beetles as a forest disturbance agent, whether they felt that land managers should intervene to reduce the impacts of bark beetles, and whether they would pay to prevent bark beetles on their property. Basic demographic information about the participants' age group and political preferences was also collected from the surveys, in order to perform statistical analyses to look for any explanatory patterns related to their responses to other questions (see Appendix B. VI for full list of survey questions).

Survey Results

Most survey recipients indicated that they knew at least "a little," or more about bark beetles (Figure 7). One participant commented, "Yes. Bark beetles are a natural part of the forest life. Bark beetles are a nuisance yes but part of it…"). Furthermore, most participants indicated that they live in or near a forested area (Figure 8). More participants of the White Mountains (95 %) than Prescott (31 %) identified as being property owners (Figure 9) and a higher proportion of participants (77 % vs. 43 %) from the White Mountains said that they felt that bark beetles are a problem in their area (Figure 10).

When asked what they would like to learn if they could learn more about bark beetles, survey participants from both populations asked common types of questions. The hand-written questions of the participants were considered individually and assigned to categories listed in Table 2. The categories included history and general bark beetle information, what the current status of bark beetles are in their area, ways to identify, prevent and control bark beetles and what the costs are to treat for bark beetles (Figure 11). For example, a question such as, "What over-the-counter beetle chemicals are available to help protect my own property?" were classified in the "Control" category. The top three question categories of the White Mountains were "Control," "Prevention" and General bark beetle information, "(31 %, 22 % and 21 %, respectively). In a slightly different order, the top three listed question categories for the Prescott Valley participants were, "General bark beetle information," "Control," and, "Prevention" (22 %, 17 % and 15 %, respectively) (Figure 11).

There were mixed responses from participants when asked if they would pay to prevent bark beetles on their property (Figure 12), with responses in all three categories of "yes," "no," and "don't know," for both populations. 44% of Prescott Valley participants said that they would pay to prevent bark beetles on their property and 44 % of White Mountains participants said that they would as well. Of those that said, "yes," to that question, 47 % from Prescott Valley and 34 % from the White Mountains said that less than one hundred dollars is acceptable to pay to manage bark beetles on their property. There were an additional 45 % from Prescott Valley and 45 % from the White Mountains whom said that $100 to $500 is acceptable (Figure 13).

For those participants whom indicated that they believe bark beetles are a problem, the follow up questions of how severe the problem is and what bark beetle related topics are important were asked. A majority of participants from both Prescott Valley and the White Mountains rated the severity of the bark beetle problem in their areas as a "major disturbance," (62 % and 59 %, respectively) (Figure 14). Furthermore, the top two most important bark beetle-related topics to participants from both populations were effects on tree health (29 % for PV, 29 % for WM) and increased fire risk (27 % for PV, 24 % for WM) (Figure 15). Also included in the important bark beetle related topics was aesthetics/scenery, wildlife and other topics such as economic impacts of bark beetles on wood products and the costs of treating for bark beetles.

Approximately 95% of participants chose to answer the question about age class, but only about 80% elected to share their political preferences (Figures 16 and 17). Age class groups three and four combined (comprising of the ages 51 and older) were represented by 75 % and 86 % of Prescott Valley and White Mountains participants. Of the portion whom responded to the political preference question, the distribution of political preferences was as follows: the most preferred political party was "Republican," (42 % for Prescott Valley, 49 % White Mountains). The second most preferred party for both populations was "Independent/Other," (40 % for Prescott Valley and 32 % for the White Mountains) and the least noted was "Democrat."

Alpha/2 = 0.25 was chosen so that two-tailed t-tests could be performed on the data to test for statistically significant differences between the mean responses to each question from the two populations (see appendix for full methods and SAS output of all results). The effect of population was of interest in this study, as the two study areas have slightly different histories of bark beetle damage and subsequent risk levels (Figures 5 and 6). There were no statistical differences for responses to the questions, "do you feel that land managers should intervene to reduce the impact of bark beetles," (p-value =0.0501, $\alpha<0.05$), "if given the opportunity, would you pay to prevent bark beetles on your property," (p-value = 0.0456 >0.025=alpha/2), "what is your age group," (p-value= 0.1607, $\alpha<0.05$) and, "what is your preferred political party," (p-value=0.5499, $\alpha<0.05$) (Appendix VI, SAS Output).

Responses that showed significant differences at the 0.05 significance level included answers to the questions, "do you live in or near a forested area," (p-value=0.0029, $\alpha<0.05$), "do you know what bark beetles are," (p-value<0.0001, $\alpha<0.05$), "do you visit a forested area for recreation," (p-value<0.0001 <0.025=alpha/2) and, "in your own opinion, what is your level of knowledge of bark beetles," (p-value<0.0001 <0.025=alpha/2). These differences can be observed by the trends in the data shown in the figures for each question. For example, a higher proportion of participants from the White Mountains said that they know what bark beetles are when compared to Prescott Valley participants (93 % vs. 79 %). Additionally, more participants identified as living in or near a forested area from the White Mountains (95 %) than did in Prescott Valley (85 %) (Figure 8). Further, the distribution of knowledge levels were slightly different between populations. A majority of participants from both populations indicated that their level of bark beetle knowledge was "a little" (56 % for PV and 49 % for WM), but more participants from the White Mountains identified as having a "moderate" amount of knowledge than from Prescott Valley.

Further analyses were performed using ANOVA methods in SAS to assess statistical differences attributed to political preference with all responses. There was no evidence for statistical differences in responses to questions of belief that bark beetles are a problem, belief that management should occur nor for willingness to pay to prevent bark beetles (p-values were equal to 0.1068, 0.5339 and 0.0816,

respectively, and were all greater than $\alpha=0.05$. Since there were no significant differences observed from age class by population, no further analyses of age class were performed (Appendix VI, SAS output).

Impacts on Human Life

The participants of the public surveys were concerned with many topics related to bark beetles, including increased fire risk, impacts on tree/forest health, aesthetics/scenic beauty, wildlife, economic impacts and control efforts. From other literature, bark beetle outbreaks appear to have impacted society in similar ways: increased fire risks (or hype associated with increased fire risks), economic and aesthetic losses, and ecological shifts of balance (Buhyoff et al. 1982, Czaja et al. 2012, Hicke 2012, Carswell 2014). However, from interviews conducted with entomologists that work with bark beetle and other forest insects, the consensus appears to be that only those whom are affected by this issue are aware enough to be concerned. Dr. Ken Raffa (University of Wisconsin- Madison) offered some insight to the issue:

> "With bark beetles in the west, it really depends on a person's economy and education, and a number of sociological factors. [It] can be heartbreaking to see a stand of dead lodgepole pines, because they think the forest is dead. Some see wasted products, some see a healthy, changing forest; the forest is always changing like everything in life. Some people take it as a warning sign that we have messed with climate and habitat fragmentation too much." (Raffa 2014, Appendix A. IV)

There are contradictory viewpoints on how to manage for bark beetles or if management is appropriate (Carswell 2014, Samman et al. 2000, Six and Wingfield 2011) related to fire risk and efforts to reduce fuels following beetle outbreaks in densely populated forested communities. It is important to note, however, that fire prevention management can also help prevent bark beetle outbreaks (Jenkins et al. 2008). One of the most important bark beetle related topics to the participants in the public surveys was increased fire risk (Figure 15). In contrast to present concerns from Arizona residents today, Czaja et al. (2012) found that their respondents were willing to accept the risk of recreating in beetle-killed forests. Many follow the common belief that beetle-killed trees increase the risk of more intense crown fires, which could cause devastating losses of homes and human life. San Bernardino County, for example, issued an Emergency Proclamation for a bark beetle emergency and renewed it monthly for nearly ten

years in response to a period of extreme fires, drought and beetle-killed forest stands (Associated Press 2013).

Wildfire Risk

Fire and bark beetles have been previously thought to be directly related; however, bark beetle-killed trees may not always increase the risk of crown fire. Fire risk is highest in beetle-killed trees when the trees still have the dead needles (Hicke et al. 2011, Simard et al. 2011). After those needles are dropped, crown fire risk decreases, and fuel loads increase in the soil litter layer (Larson 2014, Hicke et al. 2011, Jenkins et al. 2008). Several years following bark beetle mortality, a fire within this area would likely occur as a ground or surface fire, and may burn through the litter layer instead of carrying throughout the delicate canopy of the forest stand (Hicke et al. 2011). Ground fires can be beneficial to a forest, as fire is an important part of a healthy forest. When the litter layer is burned in a surface fire, there are many pine species that are able to withstand such flames; the ashes that remain are full of nutrients that add to the soil profile.

Effect of Bark Beetles on Forest Health and Ecology

Another topic of importance to the participants of the public surveys in Arizona were the effects of bark beetle outbreaks on tree/forest health (Figure 15). Ecologically speaking, bark beetle outbreaks can have a lasting effect on a forest stand, especially in stands that are also undergoing other disturbances such as fires, insects or disease issues. Further, bark beetles are some of the few beetle species that have been known to exhibit strong selective pressure on tree species (Raffa et al. 2015, Cognato and Grimaldi 2009). When several trees succumb to bark beetles, it can have a great impact on the landscape, including changes in tree species composition. During outbreaks, bark beetles can kill many trees in an area, which is of great concern in places where a local seed source for regeneration is not available. However, standing dead trees become habitat for wildlife. Birds, other insects, squirrels and bats use these trees as shelter and protection for their young. The forest floor will also have a thicker litter layer, which may improve water retention.

Safety Concerns

Safety concerns regarding trees that have bark beetle activity center on hazard trees and increased fire risk. Hazard trees are any trees that may fail (fall down) with the potential to cause personal injury or property damage (National Park Service 2005). This is of big concern to forest users, especially those whom enjoy camping, and for residents of forested areas that have had bark beetle activity. The National Park Service has identified that safety hazards of bark beetle infested or killed trees lies in the risk of tree failure from causes such as blow down (effect of high winds) (National Park Service 2005).

The U.S. Forest Service has a list of bark beetle safety guidelines that are included in safety training for Forest Service employees found at the following link: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5192711.pdf (USDA 2010). These guidelines may be useful for general forest users to consider when entering a forested stand that has had bark beetle outbreaks, extreme fires or just in general cases. Some tips from these guidelines include checking the weather report prior to entering the forest, being aware of potential hazards associated with the recent history of the forest, having proper equipment and reliable means of communication (i.e., radio, spot device or something other than a cell phone). Another helpful tip is to inform someone else that you will be in the forest and then check in with them when you return from the forest (USDA 2010).

Economic Impacts

A portion of participants had questions about the economic impacts of bark beetle outbreaks due to the costs of containment and treatment of infested trees (Figure 11). Economic losses from actual bark beetle outbreaks can be large when considering the loss of timber volume and the high cost of treating bark beetle-killed stands. Preventative and containment treatments can also be very expensive. Losses of merchantable wood products, water quality, and fires were on the list of concerns from residents of areas near the Uinta-Wasatch-Cache National Forest, where 80 to 90 percent of lodgepole pine was lost to bark beetles (Larson 2014). The issue is prevalent on privately owned forested lands, as the cost of removing a

single beetle-killed tree can be several hundred dollars per tree (Larson 2014). Furthermore, residents of those areas were reported to have been concerned that fire activity following the beetle outbreaks may impact ecosystem services such as water purification. If an intense fire destroys vegetation, it increases sedimentation and char accumulation in drinking water supplies (Larson 2014). Those citizens were concerned with the indirect effects that epidemic levels of bark beetles have on watershed quality for concerns of the high cost associated with cleaning water downstream of high intensity burns.

Impacts to Scenic Beauty

Aesthetic disturbances and loss of individual trees on private property also contributed to public annoyance of bark beetles, and was listed as important by 18% of Prescott Valley survey participants and 20% of participants from the White Mountains (Figure 15). Communities of people whom chose to reside in the forest must live with the view of beetle-killed trees (Wright 2014, Buhyoff 1982, Markels and Marek 2003). Similar to Arizonans, property owners in California that were impacted by a bark beetle outbreak in the late 1990s and were faced with having to sacrifice the novelty of having trees on their property and cut down trees that had beetle damage (Markels and Marek 2003, Associated Press 2013). Damages to scenic beauty of forest vistas contributed to negative views of insect damaged stands (Buhyoff 1982). Areas were described to have "towering dead trees [that were] unsightly," (Wright 2014). Interestingly though, Buhyoff (1982) found that tourists that were informed of the beetle activity had less of a negative view than those whom were not informed. This gives rise to questions of how increased public knowledge of forest pests' ecology may impact public perceptions of scenic beauty which contain dead trees (Buhyoff 1982).

Bark Beetle Management

Management of bark beetles begins with detection and assessment of bark beetle activity, usually by annual aerial detection surveys. Prevention, suppression, and restoration are three methods recommended by Samman et al. (2000) to manage bark beetles. Schmitz and Gibson (1996) recommend that the best control of bark beetles involves proactive management to prevent outbreaks from developing. Preventative actions are generally silvicultural treatments that change the conditions of a

given stand to reduce favorability for beetles. Prevention is ideal, when the beetles are at low, endemic levels (mortality < 2%) only a few, scattered trees are affected (Samman et al. 2000).

Thinning of beetle-killed stands is often practiced to reduce the viability of future beetle populations and to contain the spread. Clear cutting was a traditional alternative employed, however, as managers attempt to include multiple objectives, selective harvesting (although much more expensive and time consuming) is the preferred method. The removal of beetle-killed trees from a stand also improves detrimental effects on scenic beauty. Logs from beetle-killed trees must be removed after harvest (prior to the next spring) or need to be covered with plastic to prevent any new generations of beetles from emerging from those logs (DeGomez and Young 2002).

As stand density appears to be linked to increased susceptibility to insect and disease caused mortality, wide-scale forest treatments to reduce such risk become a necessity (Fettig et al. 2015). The Prescott National Forest responded to the bark beetle outbreaks of the early 2000s by implementing thinning projects in the beetle impacted areas to remove the beetle-killed trees to reduce the spread of the outbreak and to reduce hazards and fuels (USDA 2004). Similarly, the Four Forest Restoration Initiative (4FRI) in Arizona is a collaborative effort of the Apache-Sitgreaves, Coconino, Kaibab and Tonto National Forests with the goal of improving forest health by restoring natural fire regimes. This process includes plans to thin nearly half a million acres of National Forest lands over the next 20 years. Hopefully, the thinning will improve overall tree vigor, as all of the proposed "restoration units" of the Coconino National Forest portion of 4FRI treatment areas have been identified as having high levels of bark beetle mortality risk (Noble et al. 2014).

Anti-aggregation pheromones such as MCH and Verbenone have been identified as effective means to deter some beetle attacks on individual trees of some conifer species (Ross and Daterman 2009, Hofstetter 2014 Appendix A.II). The pheromones are relatively cheap (just a few dollars per unit) and come in small pouches, which are tacked to a tree and then operate by releasing a chemical that deters bark beetles from colonizing that particular tree. This method is generally employed as a grid application to protect stands or on individual trees in high-use recreation areas and areas near urban developments

that could be at risk for an outbreak. Applications of the pheromones have shown to be successful with a positive reaction from the public in campgrounds of the Apache-Sitgreaves National Forest, AZ, and on the San Francisco Peaks at the Arizona Snowbowl (Gaylord 2014, Appendix A.III, Hofstetter 2014, Appendix A.II, DeGomez 2014, Appendix A.V). Pesticides have also been applied to treat bark beetle infested trees, however, this method is not being widely used in contemporary bark beetle management plans.

Ogden and Innes (2008) identified that management priorities for community-directed goals and objectives include: reduced fire risks, promoting forest renewal, providing for economic activity and preserving wildlife. Adaptive management that includes regular evaluations and modified practices is one way to create management scenarios that truly address all aspects of multiple resource management objectives (Ogden and Innes 2008). Cooperation at the national, community and private land-owner levels lead to successful management (Larson 2014).

In summary, land managers in Arizona use direct and indirect approaches to manage bark beetles. Through large collaborative landscape-level projects like 4FRI, the Forest Service is accelerating the scale and pace of these restoration activities to improve forest health and increase resiliency to disturbance that would often perpetuate bark beetle activity. The direct control methods are normally short-term and include prevention and suppression techniques such as the use of pesticides, pheromone technologies and sanitation cuts (Fettig and Hilszański 2015). Indirect methods include restoration techniques, thinning (like the 4FRI project), and silvicultural prescriptions for tree species composition and age classes. Hopefully, if there are any bark beetle-killed trees harvested during 4FRI, there will be efficient timing in the removal of the logs. This is important because prevention of bark beetle spread is improved when felled logs are removed before new beetle generations can emerge from them(Fettig and Hilszański 2015).

Management Discussion

There are always difficulties to be expected with making management decisions and faced with conflicting objectives. For example, trying to protect water quality or to adjust forest management plans

for uncertain drought conditions adds complexity to management alternatives (Larson 2014). Some believe that education is a way to improve public perception on thinning projects, "I think most educated members of the community see the thinning projects in the community as a viable bark beetle management tool" (DeGomez 2014, Appendix A.V). However, thinning projects also face opposition from those concerned with wildlife habitat preservation. To that regard, one entomologist reflected, "Thinning treatments were constantly opposed and there were no options for treating forests in owl PACs" (Appendix A. I). Further, distrust of the public toward the Forest Service was still in the early 2000s, as indicated by media snippets as this, "Environmentalists oppose the measure, think it's a ploy to allow the timber industry to cut healthy, mature trees-less prone to fire than dead brush" (Markels and Marek 2003). Additionally, thinning projects may experience difficulties in implementation as it is an expensive endeavor and commercial loggers are not as prevalent as they were in the past. Many loggers have gone out of business or moved away as a result of litigation that shut down logging operations in many federal lands (Larson 2014).

Both survey participants and professionals that were interviewed identified a need for public outreach and education. The public may not be educated on the complex interactions within a forest system that are dependent on seral succession and diversity of ages and classes within a stand (Grady 2014, Appendix A.I, Gaylord 2014, Appendix A. III). Similarly, survey participants from both study areas of the public surveys indicated that they would like to learn about existing educational opportunities (Figure 11). The Apache-Sitgreaves National Forest managers had some success with public outreach. In addition to public notices and public hearings regarding bark beetle management and thinning plans, there were efforts to educate the campers, the camp hosts and the concessionaires that run the campgrounds in areas that were being treated with anti-aggregation pheromones to deter bark beetle attacks on local trees. There was an overall positive reaction to the implementation of anti-aggregate pheromones to the campsites and some campers inquired about how to purchase the packets for their own trees (Gaylord 2014, Appendix A. III). The positive reaction to the pheromone treatments could have been a response to

education and outreach efforts. It could have also been related to the a lack of pesticide use; the pheromones mimic signals that the beetles already send out to inform other beetles not to colonize a specific tree (Hofstetter 2014, Appendix A. II). Perhaps the public may be more receptive of similar treatments that are less obtrusive to the forest ecosystem (less impacts on wildlife and forest structure) than mechanical thinning treatment options. Unfortunately, however, the pheromone packets have only been developed for a few species of bark beetles and the general public may have to wait for more bark beetle-repellant technologies to develop.

Collaboration, public education and adaptive management techniques appear to be the most recommended methods. A truly holistic management plan that meets all of the dimensions of forestry (social, urban, ecological, economic) is more feasible when community involvement level is high. When examining the data from the public surveys, more participants from both populations said that they knew what bark beetles were and also that they felt that land managers should intervene to reduce the impact of bark beetles than said that they did not (Figures 1 and 3). Further, informed members of the public may tend to have less negative opinions towards management activities if they are given the opportunity to become more connected to what happens in our National Lands. By inviting Arizona residents from areas that have directly undergone bark beetle outbreaks and management efforts, we have at least inspired the participants to reflect upon what they would like to learn about bark beetles. We have also shared those results in this report, which can be read by both land managers and the public. Bark beetle epidemics impact forested communities in many ways, from aesthetic qualities to harsh economic consequences and even the loss of human life or property for those in close proximity to unhealthy forest stands as a result of fire or falling trees.

The surveyed residents of Prescott Valley and of the White Mountains of Arizona were aware of bark beetles, supported intervention by land managers to reduce the impact of bark beetles and expressed their interests in learning more about bark beetles (Figures 1, 3 and 11). A prime opportunity for increased public awareness presents itself with the results from this study. Since the participants of the sampled populations were included in this study only recently (September to November of 2015), it is

possible that any outreach efforts regarding bark beetles happening in the near future may have increased interest within the two study areas while bark beetles are still fresh on the mind. It is recommended that land managers read this report if possible, and include the topics listed in Figures 11 and 15 (most important bark beetle-related topics and categories of bark beetle questions that the participants had) when conducting educational or outreach events related to forest health issues like bark beetle management.

Opposing views and the multitude of objectives to meet certainly pose a challenge to land managers in the present and future. However, with increased outreach and efforts to prevent bark beetle outbreaks those challenges can be minimized. As increased periods of drought, subsequent beetle and fire events are predicted for the west, it is vital for land managers to continue educating communities about bark beetles in order to more effectively bridge the gap between current scientific knowledge and those whom are affected by bark beetle outbreaks.

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Tables and Figures

Table 1. Codes for possible responses for each survey question

White Mountains Public Perceptions of Bark Beetles Survey Responses - raw data

Key for response codes:

Question		Possible response codes:
1	live in forest	yes=1, no=0
1a	property owner	yes=1, no=0
1b	property forested	yes=1, no=0
2	Recreation user	yes=1, no=0
3	know what bark beetles are	yes=1, no=0
4	knowledge of bark beetles	1=none, 2=a little, 3=moderate, 4=expert
5a	feel that bark beetles are a problem	yes=1, no=0, don't know=2
5b	severity of the problem	1=tolerable, 2=minor nuisance, 3=major disturbance
5c	important bark beetle related issues	n=n/a, 1=aesthetics/scenery, 2=increased fire risk, 3= wildlife, 4=treehealth, 5=recreaction/hunting, 6=other (specify)
6	feel that land managers should intervene to reduce the impact of bark beetles	yes=1, no=0, don't know=2
7a	would pay to prevent bark beetles on their property	yes=1, no=0, don't know=2
7b	$amount that is acceptable to spend on managing bark beetles on public lands	n=n/a, 1=less than $100, 2=$100-$500, 3= $500-$1,000, 4=more than $1,000
8	Would like to learn about	Specify
9	age range	1=18-30, 2=31-50, 3=51-65, 4=65+
10	preferred political party	1=Democrat, 2=Republics, 3=Independent/Other

Table 2. Codes for observed response categories for question 8

Categories for questions	Code:
General bark beetle information	**G**
Detection	**D**
Control	**C**
Economics	**ECON**
Damage to forest/ tree health/environment	**TH**
Educational opportunities	**EDU**
Risk Factors	**R**
Other	**O**
Prevention	**P**
Non-response	**N**

Definitions of Categories	
General bark beetle information	**Control**
Life cycle/biology/appearance of bark beetles	How they are being addressed now
How to care for the forest/forest health	Chemical control
Bark beetle species present in AZ	Natural tree defense
Natural role in the ecosystem	Bird predation on bark beetles
Where bark beetles are found	Fungal methods of control
Detection	How to treat felled bark beetle trees
Early detection	Eradication/how to get rid of them
What a bark beetle infested tree looks like	Management options
Risk Factors	**Prevention**
Factors that lead to outbreaks	Prevention and reduction of threat/impact that bark beetles pose
Tree species affected	Prevention of spread to non-infested trees
Relation to climate and drought	**Effect on tree/forest health/ENVIRONMENT**
Current population and risk/threat status	Damage that they cause to trees
Economics	interactions with other forest insects
Dollar cost to treat for bark beetles	**Educational opportunities**
Economic damage caused by bark beetles	existing opportunities for education
Dollar cost to prevent/reduce the spread	
Impact on wood products (firewood and building materials)	
impact on structures made of wood	

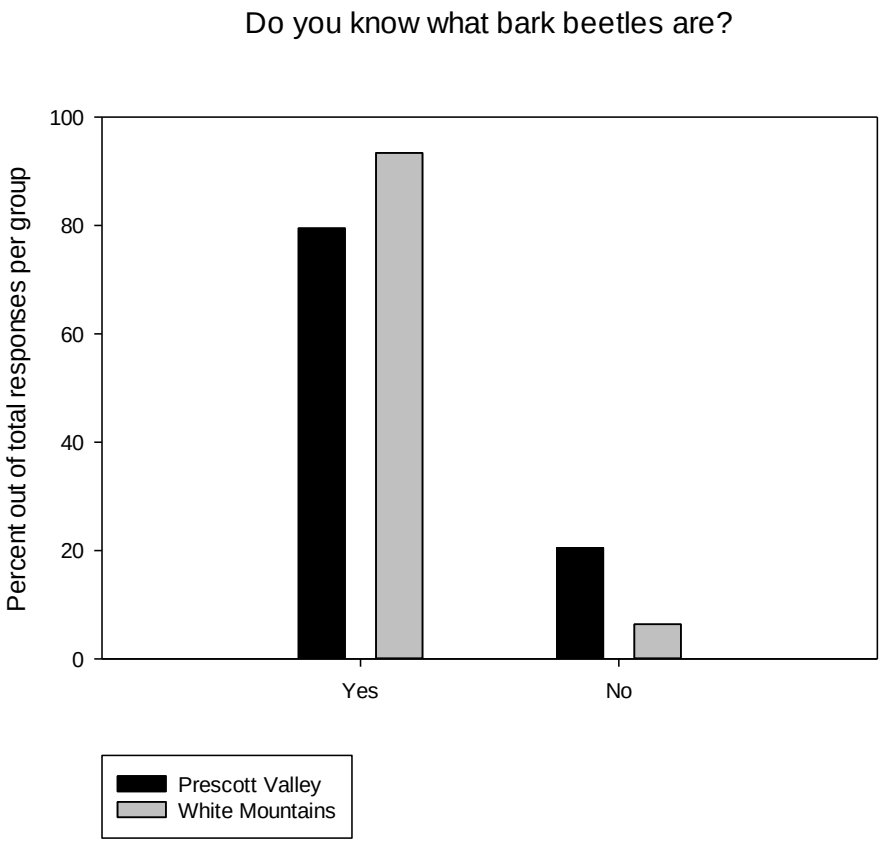


Figure 1. Response to survey question 3. Percentage of participants that either know or do not know what bark beetles are. Sample size n=176 for Prescott Valley and n=172 for the White Mountains. P-value<0.0001.

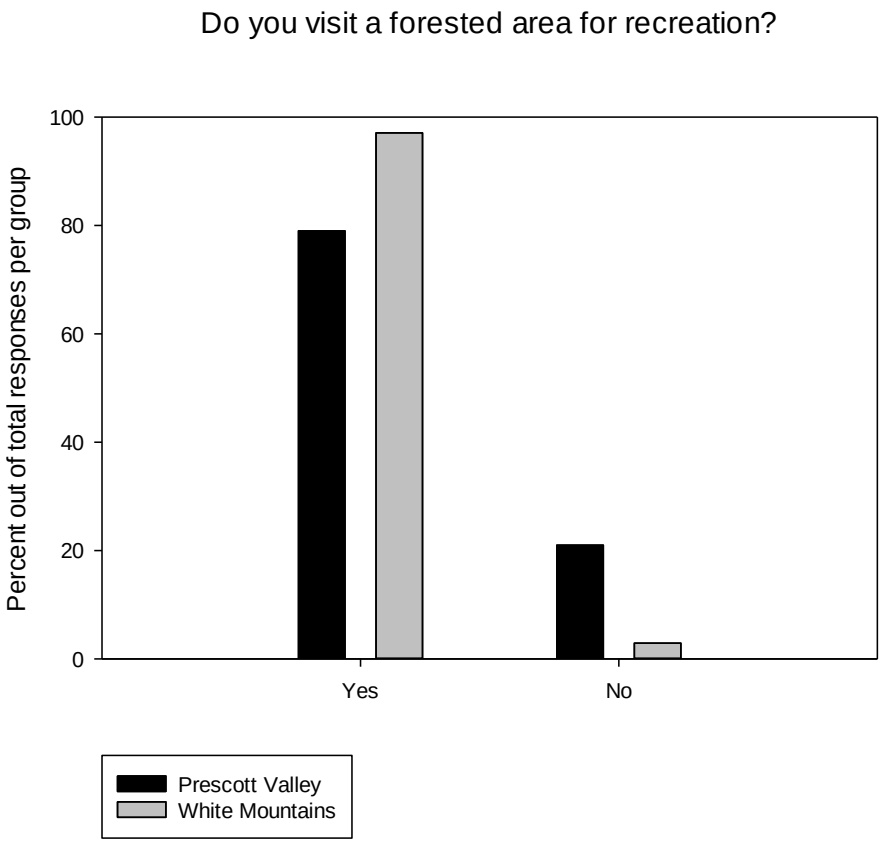


Figure 2. Response to survey question 2. Percentage of participants that visit a forested area for recreation (i.e., camping, hunting, hiking, bird watching, etc.). Sample size n= 176 for Prescott Valley and n=172 for the White Mountains. Note that both populations have a higher percentage of participants that responded "yes," to the question. P-value<0.0001.

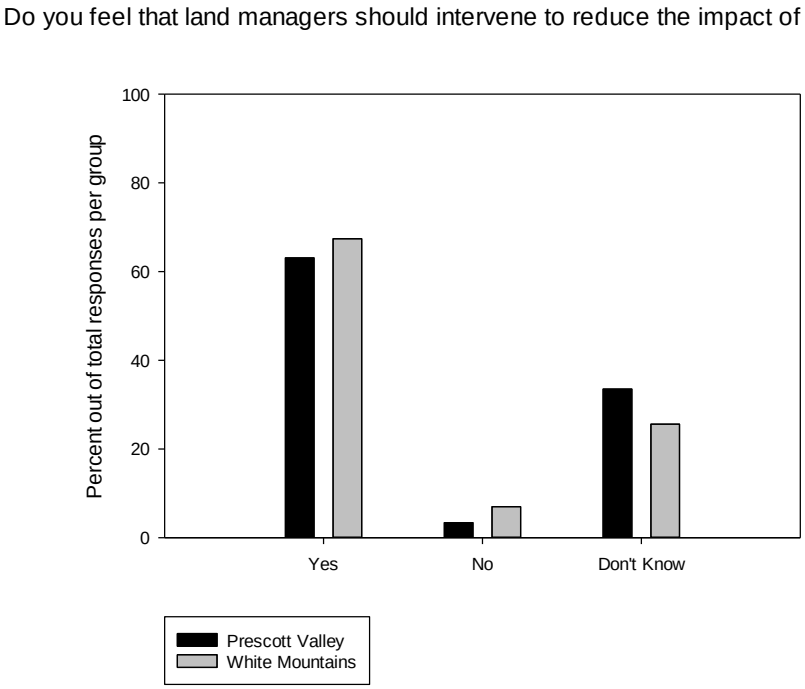


Figure 3. Response to survey question 6. Percent of participants that believe that land managers should intervene to reduce the impact of bark beetles. Sample size n= 176 for Prescott Valley and n=172 for the White Mountains. Note a sizeable portion of each sample responded as, "Don't know." P-value=0.0456.

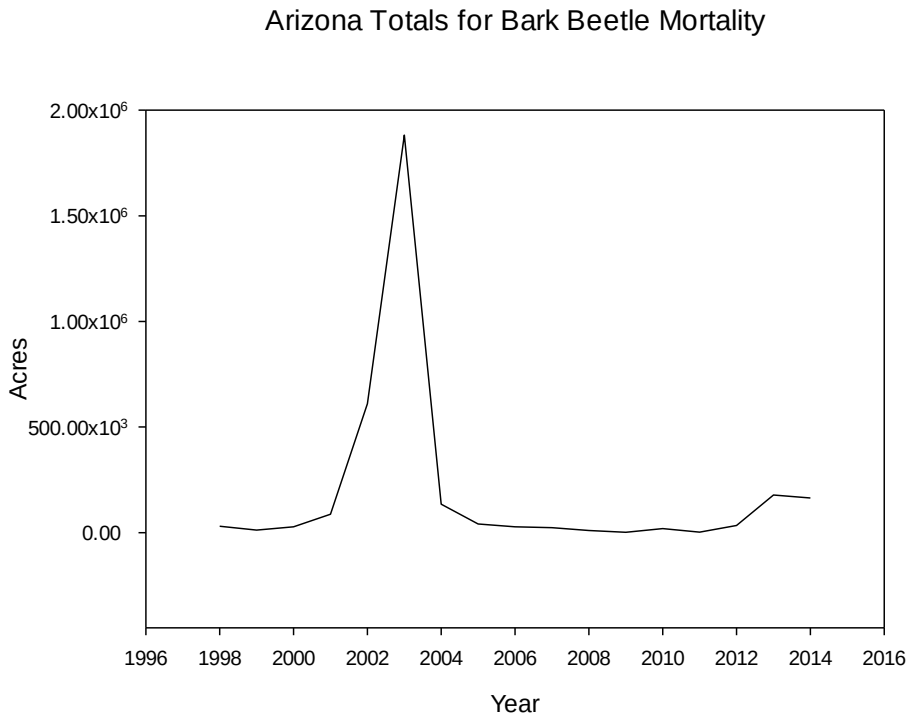


Figure 4.

Total acres of forest land impacted by bark beetles in the state of Arizona. Note total damage of 1,882,245 acres in 2003, mostly damage reported to have occurred in the Apache-Sitgreaves National Forests and the Prescott National Forest (see Figure 5). Source: USDA Forest Service Forest Health Annual Forest Insect and Disease Conditions in the Southwestern Region, years 1998 – 2014 (USDA 2014).

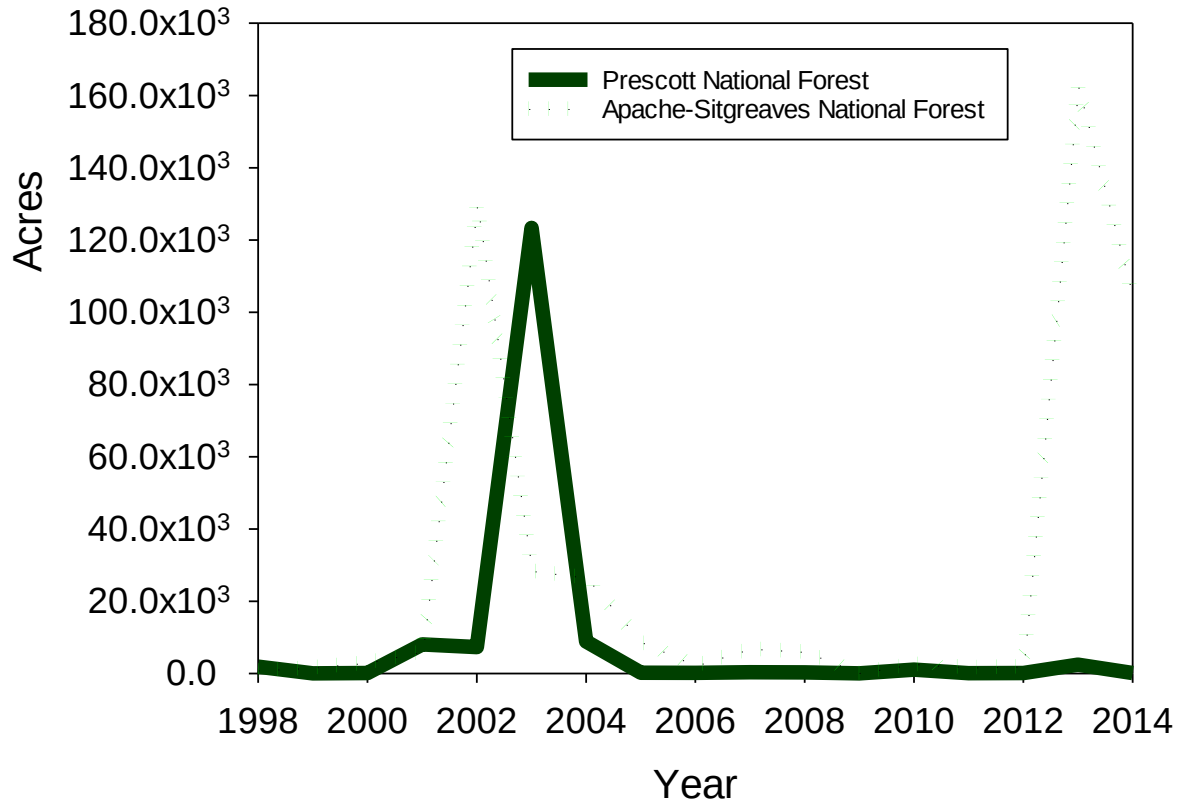


Figure 5. Total acres of bark beetle damage observed from 1998 to 2014 in the Apache-Sitgreaves National Forests and in the Prescott National Forest. Spikes in acreage from the early 2000s mostly represent damage from Ponderosa and Piñon Ips; the large spike for the Apache-Sitgreaves National Forests after 2012 represent beetle damage following the 2011 Wallow Fire. Source: USDA Forest Service Forest Health Annual Forest Insect and Disease Conditions in the Southwestern Region, years 1998 – 2014 (USDA 2014).

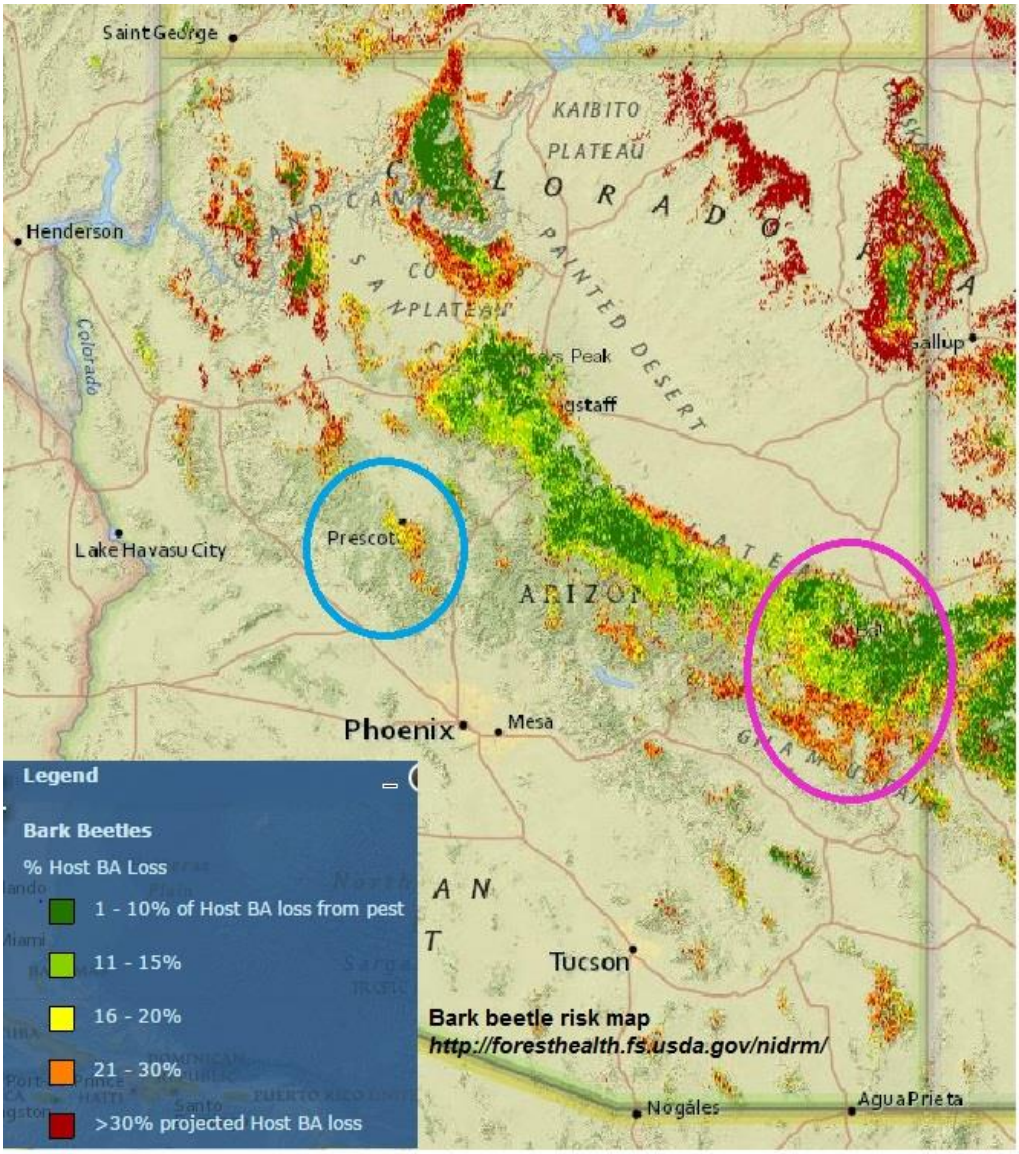


Figure 6. Projected losses of basal area (BA) in forested stands of Arizona related to foreseen bark beetle risk. Prescott Valley is circled in blue, the White Mountains circled in pink. The relative risk appears to be higher in the White Mountains for the current time frame. Data source: http://foresthealth.fs.usda.gov/nidrm/.

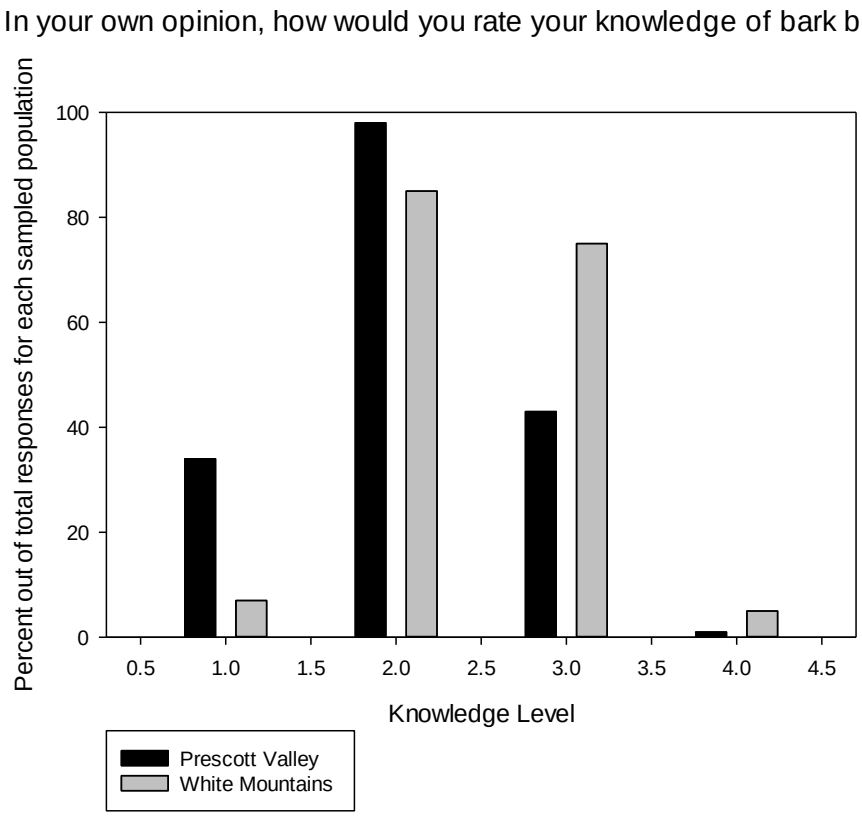


Figure 7. Results from survey question 4. Self-assessed levels of knowledge about bark beetles. Sample size n=176 for Prescott Valley and n=172 for the White Mountains. Knowledge level codes: 1 = none, 2= a little, 3=moderate, 4=expert. P-value < 0.0001.

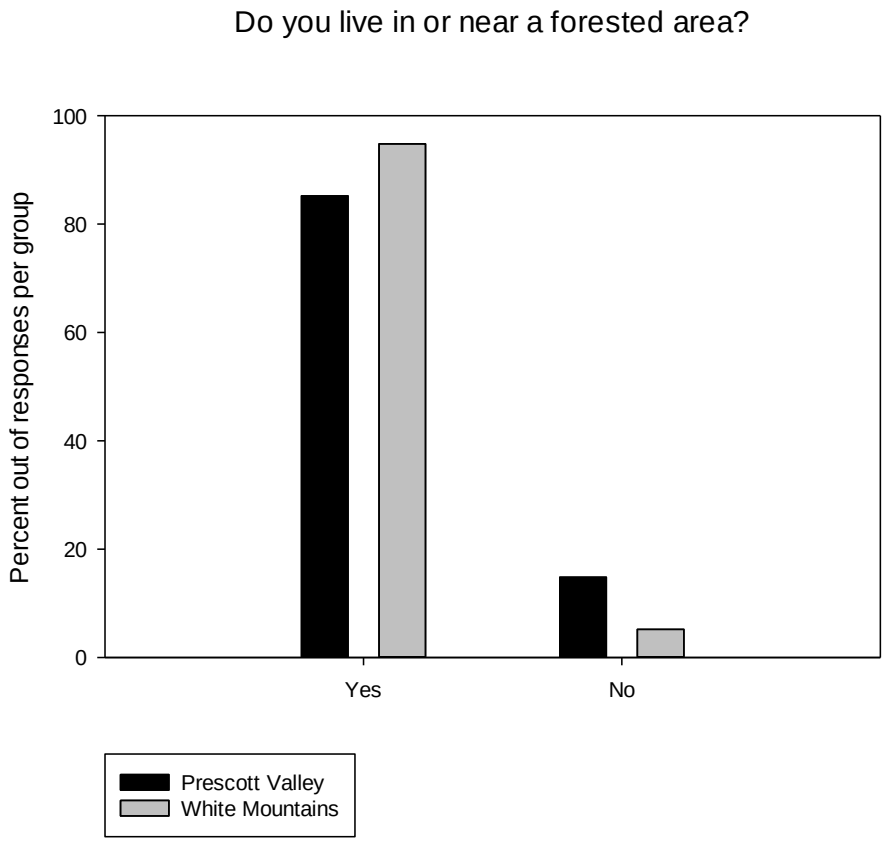


Figure 8. Results from survey question 1. Percentage of participants that identified as living or not living in a forested area. Sample size n=176 for Prescott Valley and n=172 for the White Mountains. P-value = 0.0029.

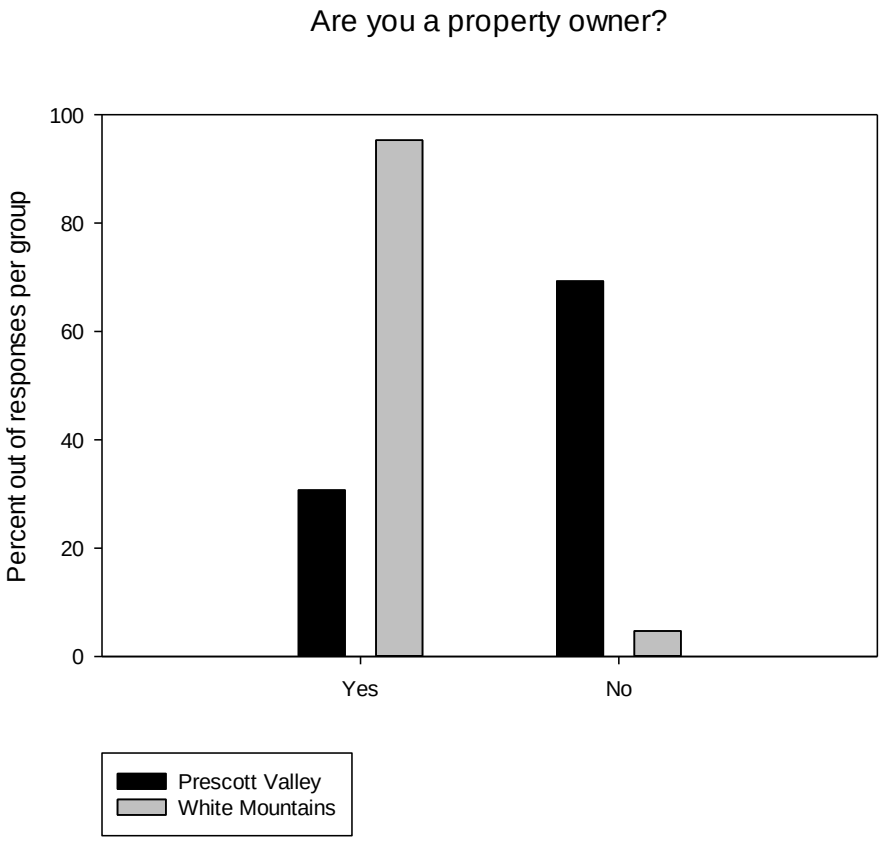


Figure 9. Results from survey question 1A. Percentage of participants that identified as owning property. Sample size n=176 for Prescott Valley, n=172 for the White Mountains. Note a higher proportion of participants said that they own property in the White Mountains than in Prescott Valley. P-value<0.0001.

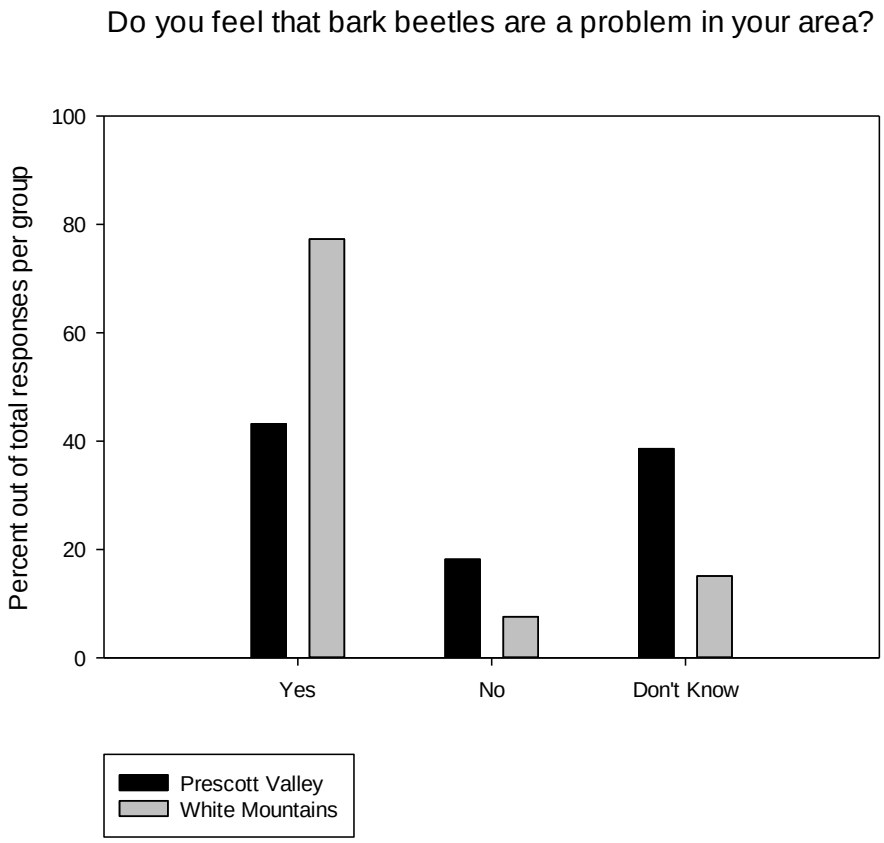


Figure 10. Results from survey question 5. Percentage of participants that said they felt that bark beetles are a problem where they live. Sample size n=176 for Prescott Valley and n=172 for the White Mountains. Note there were more participants that answered "yes," than "no," or "don't know" from both samples. P-value=0.0501.

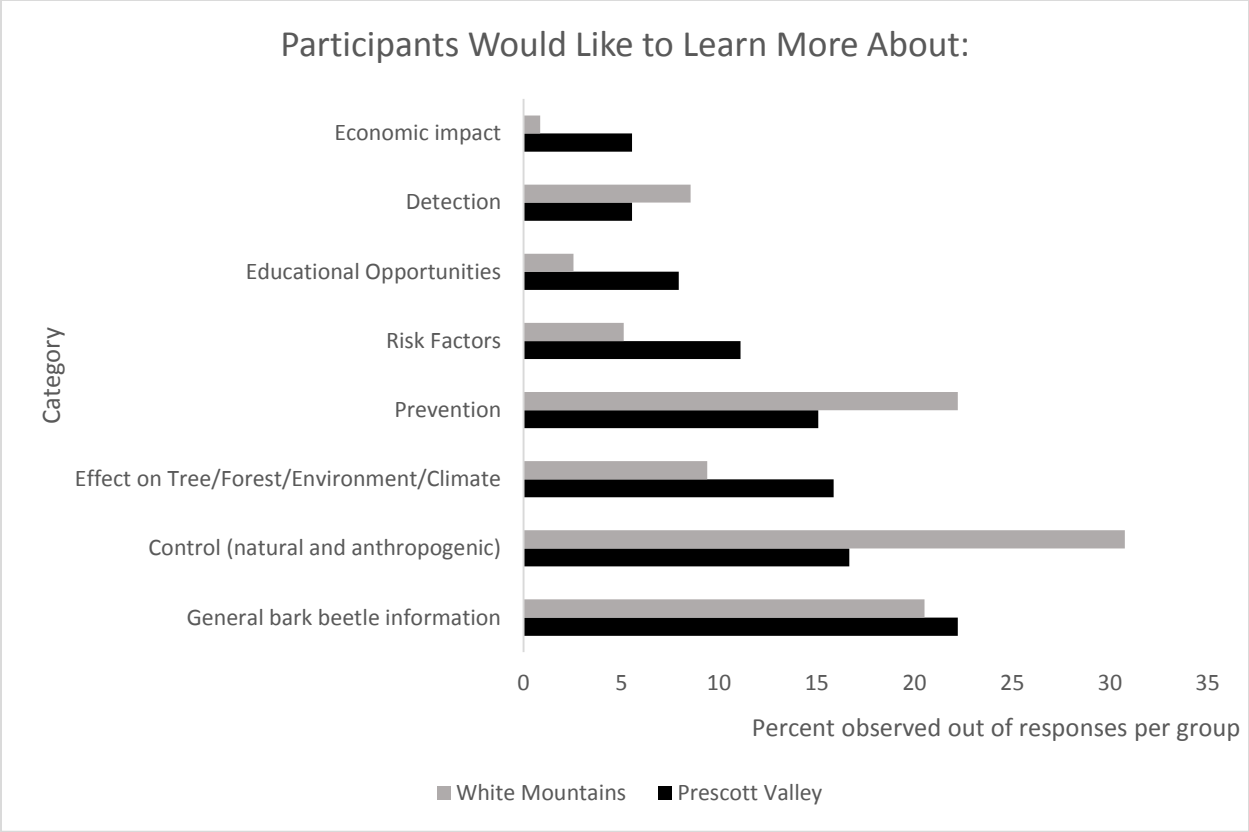


Figure 11. Results from survey question 8: If given the opportunity to learn more about bark beetles, what would you like to learn? Categories of topics that participants identified as wanting to learn more about with regards to bark beetles. Values are presented to represent a percentage of the frequency each category appeared from those participants whom chose to answer question eight. General bark beetle information, control and the effect of bark beetles on tree health, etc. were the top three categories listed from both samples. Table 2 provides a detailed description of the codes used for this figure as well as defining topics identified by the participants that were assigned to each category.

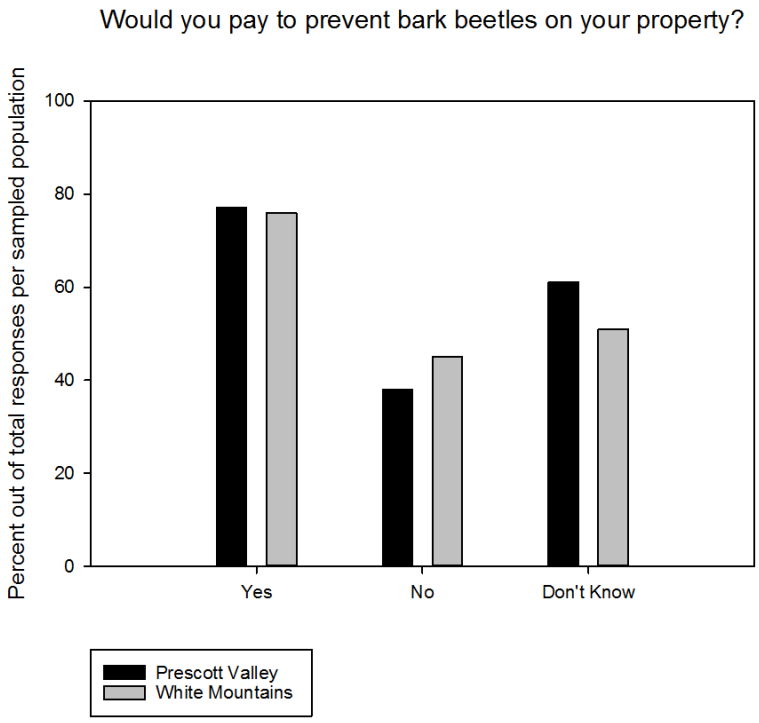


Figure 12. Survey results (question 7) from the two sampled populations for whether or not they would pay to prevent bark beetles on their property; possible responses were "no"=0, "yes"=1 and "don't know"=2. P-value = 0.1607.

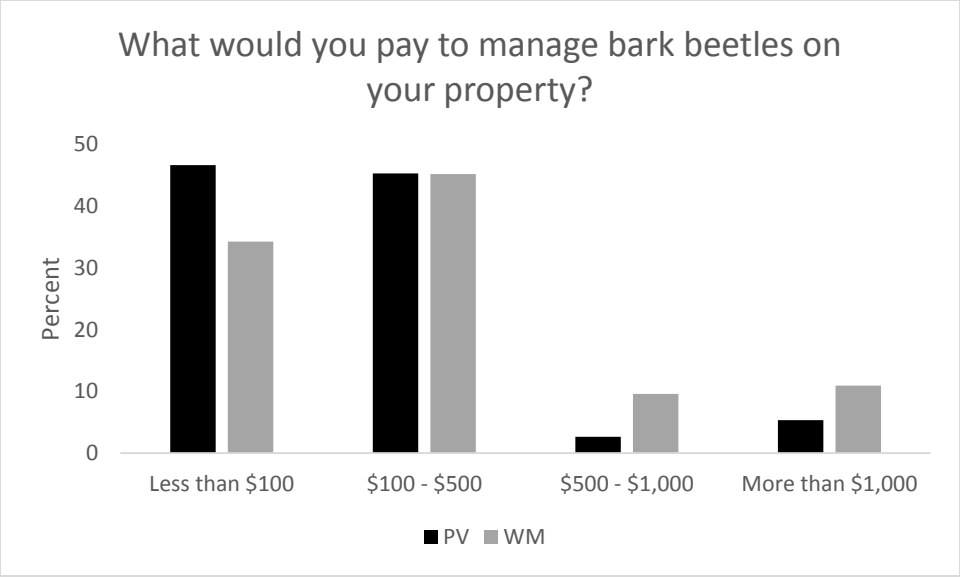


Figure 13. Responses to question 7b, "If yes [to 7a], how much is an acceptable amount of money to pay to manage bark beetles on your property?" Percent values expressed as sums divided by total number responses respective to population; sample size n= 75 for Prescott Valley and n=73 for the White Mountains.

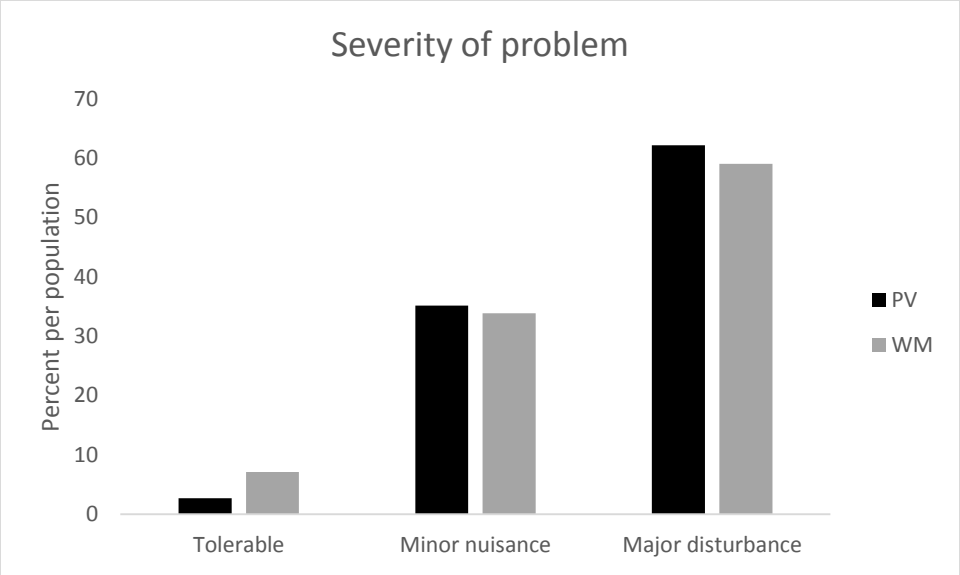


Figure 14. Responses to question 5b, "if 'yes' [to 5a], how severe do you think the problem is?" Percent values are expressed over the sum of total responses respective to each population; sample size n=74 for Prescott Valle, n=127* for the White Mountains.*Although there were 76 participants who said yes to 5a from Prescott Valley and 133 for the White Mountains, some participants did not answer all of the survey questions.*

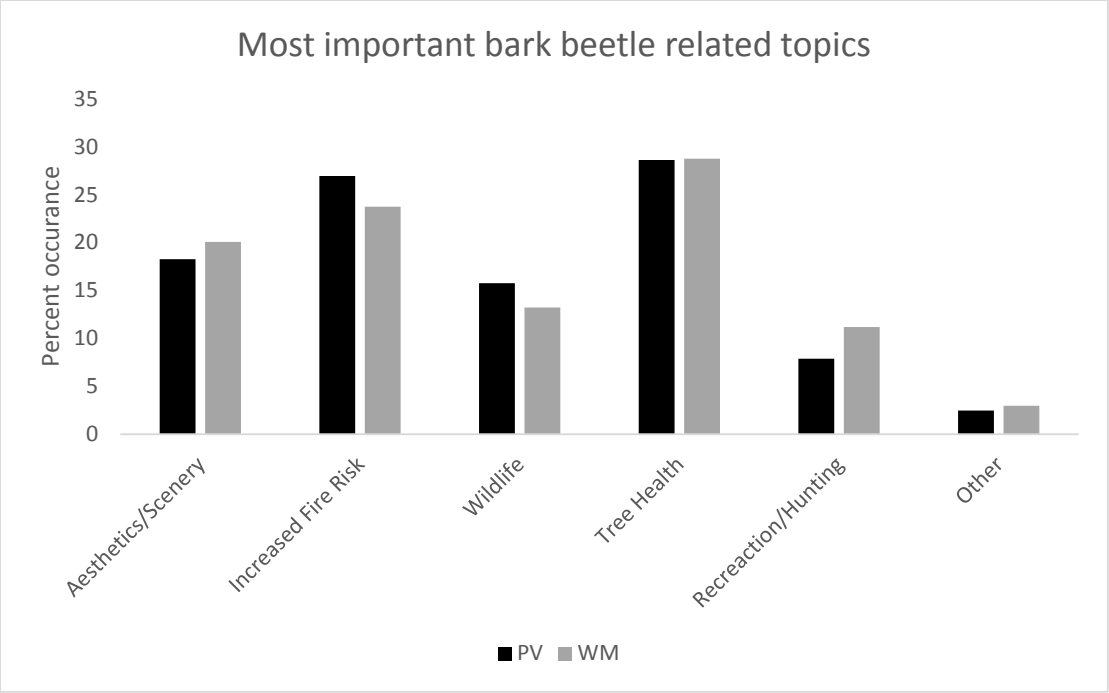


Figure 15. Responses to question 5c, "if 'yes'[to 5a] which bark beetle related topics are most important to you? (Check all that apply)." Percent values are expressed as sums of each category divided by the total sum of all categories per population; sample size n=76 for Prescott Valley, n=133 for the White Mountains. "Other" category includes: control techniques, property values, economic costs, effect on wood harvest and timber value, loss of forested areas, effect on watershed, impacts on green energy and spread to non-infested trees.

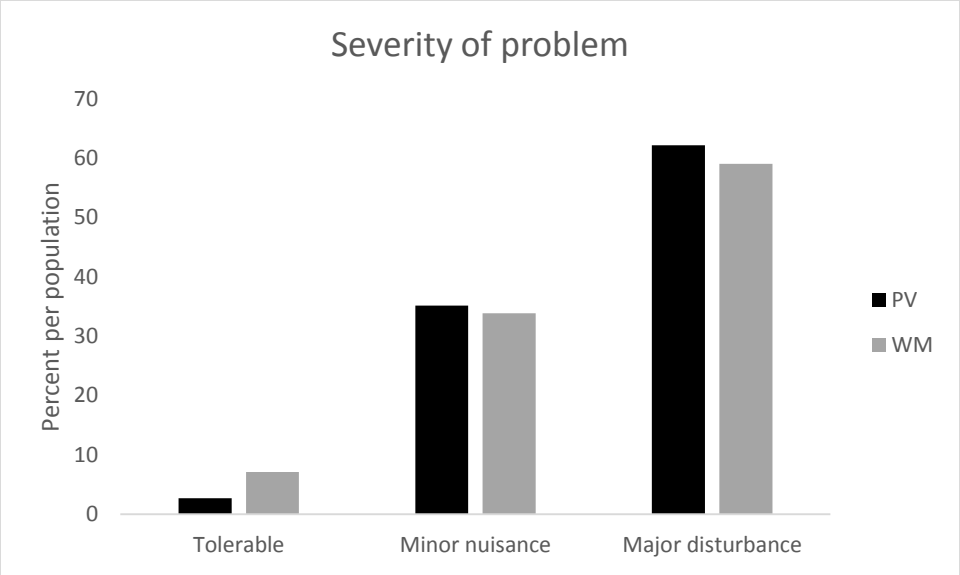


Figure 16. Responses to question 5b, "if 'yes' [to 5a], how severe do you think the problem is?" Percent values are expressed over the sum of total responses respective to each population; sample size n=74 for Prescott Valle, n=127* for the White Mountains.*Although there were 76 participants who said yes to 5a from Prescott Valley and 133 for the White Mountains, some participants did not answer all of the survey questions.*

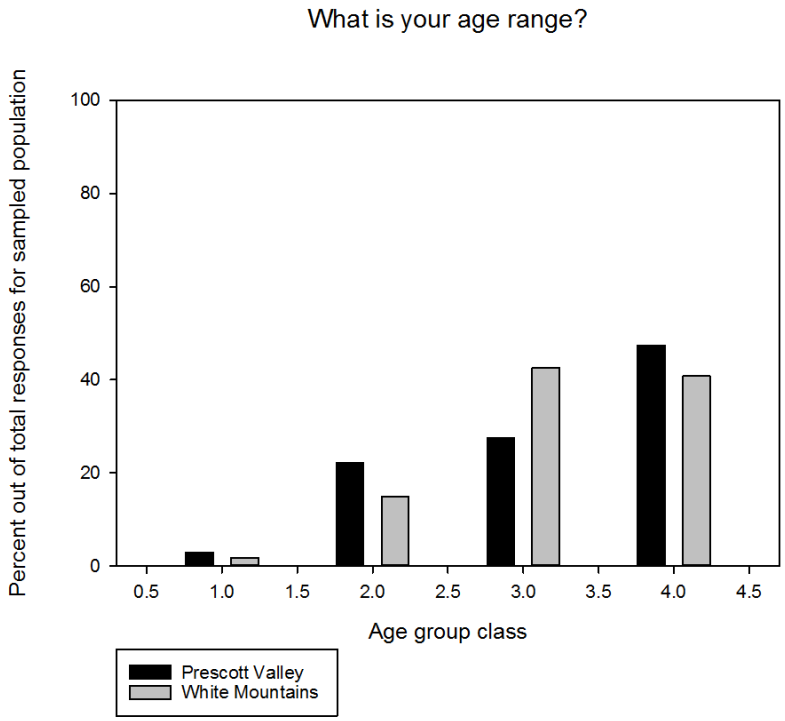


Figure 17. Distribution of age classes from the two sampled populations; age classes (in years) are 1=18 to 30, 2=31 to 50, 3=51 to 65 and 4=65 or older. Sample size n=171 for Prescott Valley and n=169 for the White Mountains. P-value=0.5492.

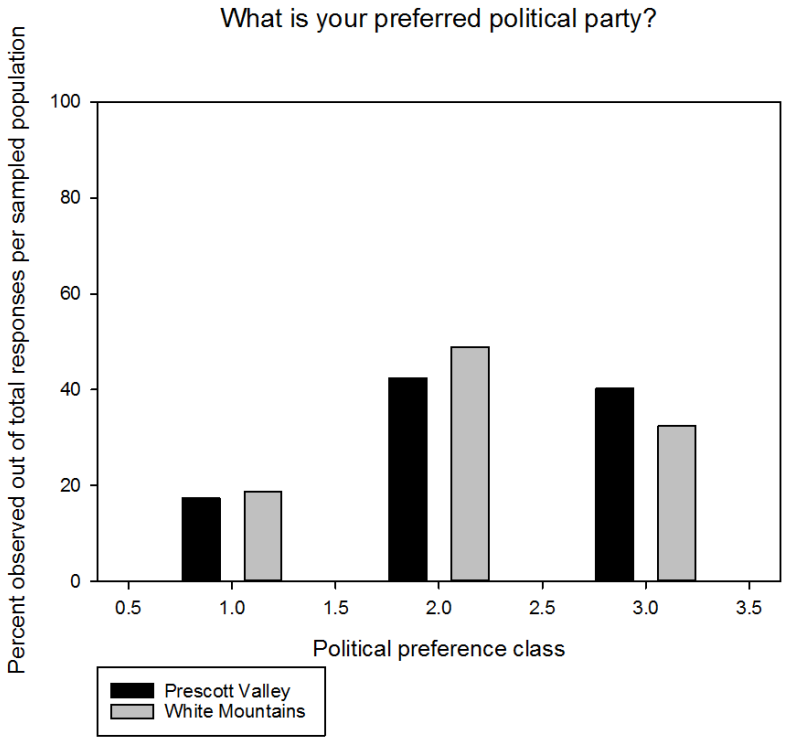


Figure 18. Political preferences response codes: 1=Democrat, 2=Republican, 3=Independent/Other. Approx. 20% of the participants from each sampled population chose not to respond to this question, so of the 80% that did respond, the distribution of preferred parties appears to be very close. Sample size n= 139 for Prescott Valley and n=139 for the White Mountains. P-value=0.9225.

Appendix

A. I-V: Interview transcripts and questionnaire results from land managers and professional entomologists

B. VI –VIII: Case study methods, survey materials, and raw data from public surveys

A. I-V: Interview transcripts and questionnaire results from land managers and professional entomologists

I. Interview with Amanda Grady, Entomologist, Forest Health Protection Southwestern Region, Zone 3 United States Department of Agriculture Forest Service. Conducted on **27 October** 2014, in-person by Clairisse Nash:

Q: Based on your experience with Forest Health Protection, what are your general thoughts on how the public reacts to bark beetles and management attempts?

A: It depends on the level of education of those involved…some of the public don't know or are uneducated about forest heath… I don't assume that they know anything about it. There is a long relationship of distrust with our agency so outreach is incredibly important. People don't know the science, so fears may be illegitimate.

Q: Have there been successful outreach efforts in AZ?

A: The A-S did a good job. The A-S had public meetings and educated campers and concessionaires, campground hosts... It was a good way to bridge the information circle between the forest service and the public.

Q: What were the reactions from the public to some of the management options that you have seen?

A: Thinning treatments in general were constantly opposed… people do not understand how competition and species composition is impacted by density. If we take no action it may burn down anyway. Like in owl PACs, there is no room for treatment due to litigation. The ideal state to manage for includes concepts of succession and multiple stages of forest development for a forest to be healthy. It is important for the public to understand that the forest is not stagnant.

Q: What can be done by the FS to improve public awareness of bark beetles as an issue in forest health**?**

A: The Forest Service needs to educate on the importance of succession and stand heterogeneity.

Q: Where in AZ are beetle mortality levels considered to be epidemic?

A: The A-S is in an outbreak, in need of suppression implementation projects.

II. Questionnaire results from Dr. Richard Hofstetter, Northern Arizona University School of Forestry Entomology Lab. Received via email on 23 October 2014.

Interview Questions regarding the public perceptions of bark beetle management:

1) What is the current public opinion on the application of anti-aggregate pheromones for bark beetle management? Has this view changed over time?

Anti-aggregation pheromones are one of the few landscape level control options available. Most citizens seem to be in favor of this approach since it is not a pesticide and likely more environmentally friendly. I am not sure views have changed, other than that this application appears to be working with some bark beetle species, in some areas.

2) What have been the overall results of the MCH and Verbenone application projects in your area? Were the application successful in deterring attacks?
MCH has been very success on Humphrey's peak and likely has reduce the likelihood of high tree mortality around Snow Bowl ski area. Verbenone has been less successful and not commonly used in Arizona.

3) What type of outreach or public education did you do before starting this project?
For the Snow Bowl project, there were notices put up around the lodge and the staff were told what the project was about. Many of them also participated and helped with the project.

4) How did the public initially respond to outreach efforts? How did they respond to the implantation of the MCH and Verbenone applications?
The owners of Snow Bowl reached out to the FS to help with the beetle issue. So their response was very positive. I am not sure about the general public, but they probably found the project interesting and positive.

5) What are the growing edges of this project? What could be done to improve public perception/involvement? Is this necessary?
I am not sure anything is necessary at the moment. Most citizens are generally interesting in controlling bark beetles and probably respond positively to such control measures.

6) Anything else you would like to add?
Most of our bark beetle issues occur during drought years or in high elevation sites where not many people live (but do hike and camp). I think most people are positive about bark beetle management particularly if there are no pesticides involved.

III. Questionnaire results from Dr. Monica Gaylord, Entomologist Forest Health Protection, Southwestern Zone, Region 3. USDA Forest Service. Received via email on 23 October 2014:

Interview Questions regarding the public perceptions of bark beetle management:

1) What is the current public opinion on the application of anti-aggregate pheromones for bark beetle management? Has this view changed over time**? I think the public opinion is generally pretty good. My impression is based on rather limited interactions with the people camped at the campgrounds on the A-S during the time I was doing the bark beetle surveys. Most of them were curious about the packets and overall seemed to react favorably to the idea that the pheromones were "saving" the trees. I also know that some ranger districts had the public calling and asking where they could purchase the packets so they could hang them on their own trees. I can't speak to how opinions have changed over time because this is really the first summer where I have interacted with the public on this issue.**

2) What have been the overall results of the MCH and Verbenone application projects in your area? Were the application successful in deterring attacks**? I would say yes, overall the application projects were successful. It's a little difficult to state conclusively that the treatments were successful, mainly because we did not design the project as an experiment and therefore we don't have similar sample sizes of treated and untreated areas to compare. In general,**

many trees in the campground and MSO-PACS are not currently impacted by bark beetles, despite the high populations present on the landscape (as evidenced by our trap catches).

3) What type of outreach or public education did you do before starting this project?
I did not participate in any outreach/public education efforts because I came on mid-stream. I know they had information sheets at the campgrounds; posted on bulletin boards and also handed out to people when they checked in.

4) How did the public initially respond to outreach efforts? How did they respond to the implantation of the MCH and Verbenone applications? **Again, I can't speak to this aspect because the project was already underway when I arrived.**

5) What are the growing edges of this project? What could be done to improve public perception/involvement? Is this necessary? **Not sure what you mean by growing edges-spatially or into the public sphere?**
I think education is always important, since most people are pretty positive about the treatments it may not be as urgent as other areas, other than to let people know not to tear them off trees. My other concern is that people will try to hang them in areas where they won't be effective and some unscrupulous salesperson might sell them in areas where they won't work. For instance trying to hang packets in piñon pine stands isn't likely to decrease the likelihood of Piñon Ips attacks since the anti-aggregation pheromones aren't effective for this species

6) Anything else you would like to add?

IV On the phone interview with Dr. Ken Raffa, entomologist at the University of Wisconsin

Conducted 10/28/2014 over the phone with Clairisse Nash at 11:15 am.

Interview Questions regarding the public perceptions of bark beetle management:

1) What is the current public opinion on the application of anti-aggregate pheromones for bark beetle management? Has this view changed over time?

Not really a big problem in WI b/c they don't really have the big killers, mostly awareness is focused on emerald ash borer, from Asia. It is the main problem here. Biggest impact is in urban centers – street trees being removed, injected with pesticide. People know they are going to lose their backyard ash. This is a big diff because EAB is an invasive pest so mgmt. is hard, no resistance. Most of Wisconsin mortality occurs in the forest, but most people don't really fathom that, they are most concerned with trees on their land. People have been okay with pesticide use. Injections (systemic pesticides with low environmental effects. Spraying not acceptable in the public. Still use anti-aggregation pheromones in camping sites or hazard areas if it is less expensive to protect a tree than to take it down. Use this in whitebark pine stands of high mountains. WPBR resistance, don't want those stands to be impacted by beetles, so will use verbenone to protect those trees.

"With Bark beetles in the west, it really depends on a person's economy and education and a number of sociological factors. Can be heartbreaking to see a stand of dead lodgepole pines, because they think the forest is dead. Some see wasted products, some see a healthy,

changing forest the forest is always changing like everything in life. Some people take it as a warning sight that we have messed with climate and habitat fragmentation too much."

I believed that bark beetle outbreaks increased fire risk, thought I was standing in a tinder box. With the exception of that 2 year period fire risk does not increase. There will always be a sizeable group of people that don't believe the data no matter what...then people that believe the theory but are concerned with fire if it is near their own property."

V Questionnaire results from Tom DeGomez, received 10/29/14 via email to Clairisse Nash

Tom DeGomez

Interview Questions regarding the public perceptions of bark beetle management:

1) What is the current public opinion on the application of anti-aggregate pheromones for bark beetle management? Has this view changed over time?
    a. **Probably over 99% of the general public have no idea what an anti-aggregation pheromone is. Of those that know what they are the majority would be favorable towards their use as a management tool.**
    b. **Over the past 10 years less people are aware of AAP's because their use and educational opportunities have waned. This is due to the fact that the pine bark and spruce beetle outbreaks have not been a big problem in recent years.**
    c. **If SPLAT Verb was to be registered in Arizona public opinion would change. In the states where SPLAT is registered I think people will have a very positive view of AAP, so long as it performs as well in the field as it has it tests.**
2) What have been the overall results of the MCH and Verbenone application projects in your area? Were the application successful in deterring attacks?
    a. **I conducted a verbenone flake study to assess its effectiveness in reducing Ips attacks in fresh ponderosa pine slash. There was no significant (in management terms) response by the beetles to the verb.**
    b. **USFS used an AAP at Snowbowl to deter spruce beetle. The project was successful at deterring attacks in the protected areas.**
3) What type of outreach or public education did you do before starting this project?
    a. **I did no public education on the verb flake project.**
    b. **I have had multiple outreach programs (1-2 per year) educating the public on the possible benefits of AAP.**
4) How did the public initially respond to outreach efforts? How did they respond to the implantation of the MCH and Verbenone applications?
    a. **The public has always been interested in hearing about non-chemical pesticide management techniques for management of BB.**
5) What are the growing edges of this project? What could be done to improve public perception/involvement? Is this necessary?
    a. **I am currently not involved with AAP. I did consider writing a pub on SPLAT but since it is not registered in AZ I felt we would have to wait until its use became legal in the state.**
6) Anything else you would like to add?

a. I think most educated members of the community see the thinning projects in the community as a viable bark beetle management tool.

B. VI –VIII: Case study methods, survey materials and raw data from public surveys

VI Case Study Methods

Sample Selection

Prescott Valley and the White Mountains of Arizona were chosen as populations to draw from for the public surveys because those two areas have undergone bark beetle outbreak activity within the past 14 years (Figure 5). According to the National Census, the population of residents the age of 18 or older in Prescott Valley was 31,194 as of 2010 and included the zip codes 86314 and 86315 (United States Census Bureau 2010). For the purposes of this study, the White Mountains included the municipalities of Springerville, Eager, Nutrioso and Alpine, AZ with a total 18 or older population of 5,837 from zip codes 85938, 85925, 85932, and 85920 respectively (United States Census Bureau 2010). A random sample of listed addresses (listed household sample) from Prescott Valley and the White Mountains was purchased from the sampling company called Genesys Marketing Systems Group, located at 155 Gaither Drive Suite A, Mount Laurel, NJ 08054, telephone (215) 653-7100, website: http://www.m-s-g.com/Web/genesys/householdsample.aspx.

During consultation regarding the generation of the sample, the sampling company reported an average of nine percent return rates on mailed survey correspondence. The minimum desired sample size from each population for 95% confidence with +/- ten percent sampling error was determined to be 96 for Prescott Valley and 95 for the White Mountains, assuming that the populations were 50/50 split (the population is relatively varied) (Salant and Dillman 1994). To meet the expected return rate of nine percent, it was determined that approximately 2,000 addresses from Prescott Valley and 1,336 from the White Mountains would be adequate for each initial sample of survey invitations.

The samples were randomly drawn from each zip code proportional to their respective population sizes to meet the original sample sizes for residents from each of the two groups. However, after sorting through the sample some addresses did not have a listed name attached to the address and some were found to be repeated; addresses without names attached were addressed to "Head of Household," and the repeated addresses were removed from the master sample list, so that each only occurred once in the sample. The lists of names and addresses from each group were used in a mail merge document using Microsoft Word that generated personalized cover letters to invite each resident included in the sample to participate in the survey (see sample cover letter in Appendix B VII). A cover letter, with a link to complete the survey online using Survey Monkey, a hard copy of the survey and a self-addressed, postage-paid return envelope was then sent to each resident included in each of the two samples. The survey invitations were sent on 17 September 2015, originating from Flagstaff, Arizona. The final number of sent invitations was 1,889 for Prescott Valley and 1,330 for the White Mountains, after subtracting any that were sent back as, "return to sender."

Data Collection

The online surveys were anonymously collected by Survey Monkey at the following links: https://www.surveymonkey.com/r/barkbeetlesurveyprescott for Prescott Valley and https://www.surveymonkey.com/r/BeetleSurveyWhiteMountains for the White Mountains. Only 13 participants chose to complete the survey online for Prescott Valley and six completed it online from the White Mountains. In order to ensure anonymity, secure options were employed with the Survey Monkey links; no personal data was collected or stored, however, Survey Monkey did not allow more than one response per computer's IPM to avoid repetition of a particular individual's response. In order to

participate in the online survey, a cover letter of informed consent was provided first and had to be checked for acceptance in to continue to complete the survey. Online responses were received from September 23, 2015 to November 3, 2015. The responses from Survey Monkey were downloaded as an Excel file and then combined with the results received by mail.

A majority of participants chose to complete the surveys by U.S. mail (163 for Prescott Valley and 166 for the White Mountains). To ensure anonymity, participants were informed that the results would be kept anonymous and instructed to return the completed surveys in the provided envelopes that had no identifiable features associated with the individuals whom completed the surveys. Completed surveys began to arrive in the mail from September 28, 2015 to November 21, 2015. Responses from the online and mailed completed surveys were added to a database created with Microsoft Excel. The total sample size of completed surveys (online and by mail) was 176 for Prescott Valley and 172 for the White Mountains.

The observed return rate for each sampled population was 9.4 % for Prescott Valley and 12.9% for the White Mountains.

Data Analysis

Possible responses for each question was assigned a code (Table 1) and codes were entered into the original Excel database verbatim for each population. Later, categories and codes were assigned to question 8, which asked, "If given the opportunity to learn more about bark beetles, what would you like to know?" The codes for question 8 are listed in Table 2. Some of the questions had follow-up questions that were asked if the participant had answered "yes" to the previous question. Some participants, however, answered "no" or "don't know" to questions 5a and 7a, and still provided responses to the follow-up questions 5b, 5c and 7b. The data was therefore adjusted to remove any invalid answers to follow up questions that were provided for more accurate analysis of trends in responses. To adjust the data, non-response answers were recorded as "no" or "none" responses, usually coded with the number zero.

After organizing the data with appropriate codes to match the completed responses, the data was imported in to SAS 9.4 for statistical analyses. Graphs were created to assess the trends for each population to compare the groups. Since this was an observational study, there was no random assignment of treatments to observations, therefore, ANOVA or general linear regression modeling would not be appropriate for these data. Analyses with two-sample t-tests on the data allowed for determination of statistical differences between the responses based on population (see SAS code and SAS output of results). The same null hypothesis was used for each t-test as follows: H_0: μ(Prescott Valley) - μ(White Mountains) = 0 versus and alternative hypothesis H_a: μ(Prescott Valley) - μ(White Mountains) ≠ 0 (a two-tailed test). The alpha level was set at $\alpha/2 = 0.025$, for two-tailed tests. The null hypothesis was rejected when the observed p-value was less than to $\alpha/2 = 0.025$, indicating the presence of statistical differences between the mean responses of the two sampled populations. A failure to reject the null hypothesis would indicate that there was no evidence of statistical differences from the observed samples.

ANOVAs: although ANOVA methods were not exactly appropriate for these data, a few One-Way Analysis Of Variance were performed to see if there was evidence for statistical differences attributed to political preference for all of the combined participant responses for belief that bark beetles are a problem, belief in management and willingness to pay to prevent.

SAS Output

The SAS System

The TTEST Procedure

Variable: liveF

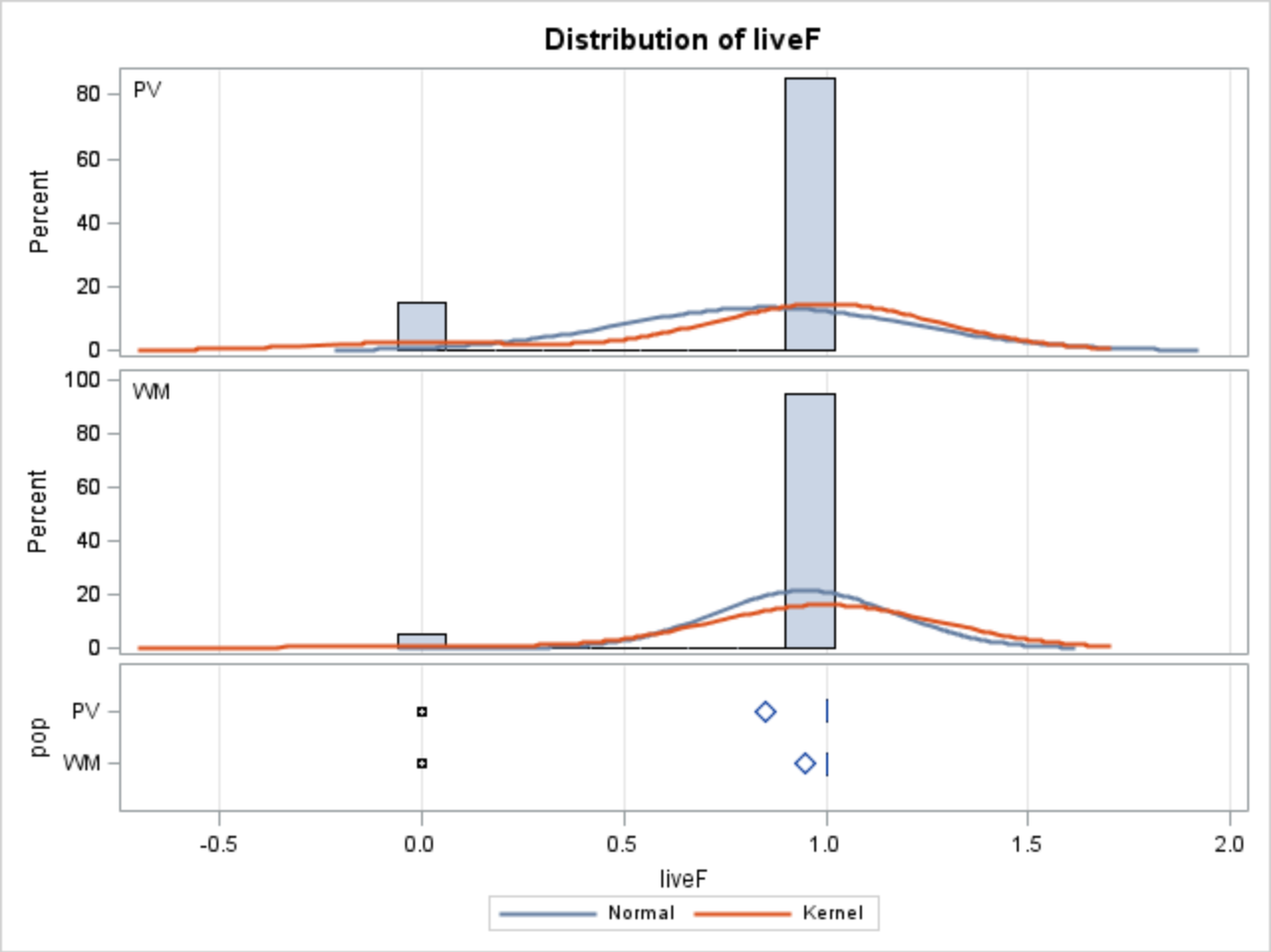
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	0.8523	0.3558	0.0268	0	1.0000
WM	172	0.9477	0.2233	0.0170	0	1.0000
Diff (1-2)		-0.0954	0.2978	0.0319		

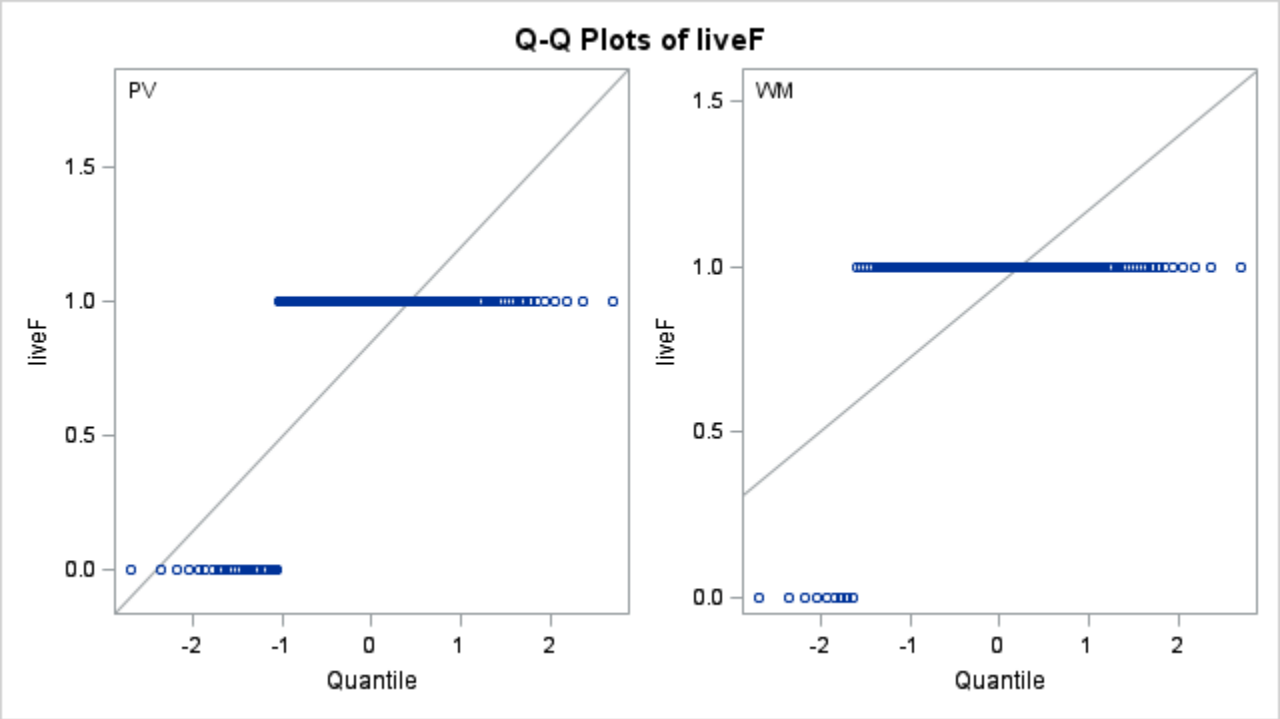
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		0.8523	0.7916	0.9129	0.3558	0.3177	0.4040
WM		0.9477	0.9092	0.9862	0.2233	0.1991	0.2539
Diff (1-2)	**Pooled**	-0.0954	-0.1673	-0.0235	0.2978	0.2744	0.3254
Diff (1-2)	**Satterthwaite**	-0.0954	-0.1670	-0.0238			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-2.99	0.0030
Satterthwaite	Unequal	295.39	-3.00	0.0029

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	2.54	<.0001


Distribution of liveF
PV
WM
Percent
pop
liveF
Normal
Kernel


Q-Q Plots of liveF
PV
WM
liveF
Quantile

The SAS System

The TTEST Procedure

Variable: PropOwn

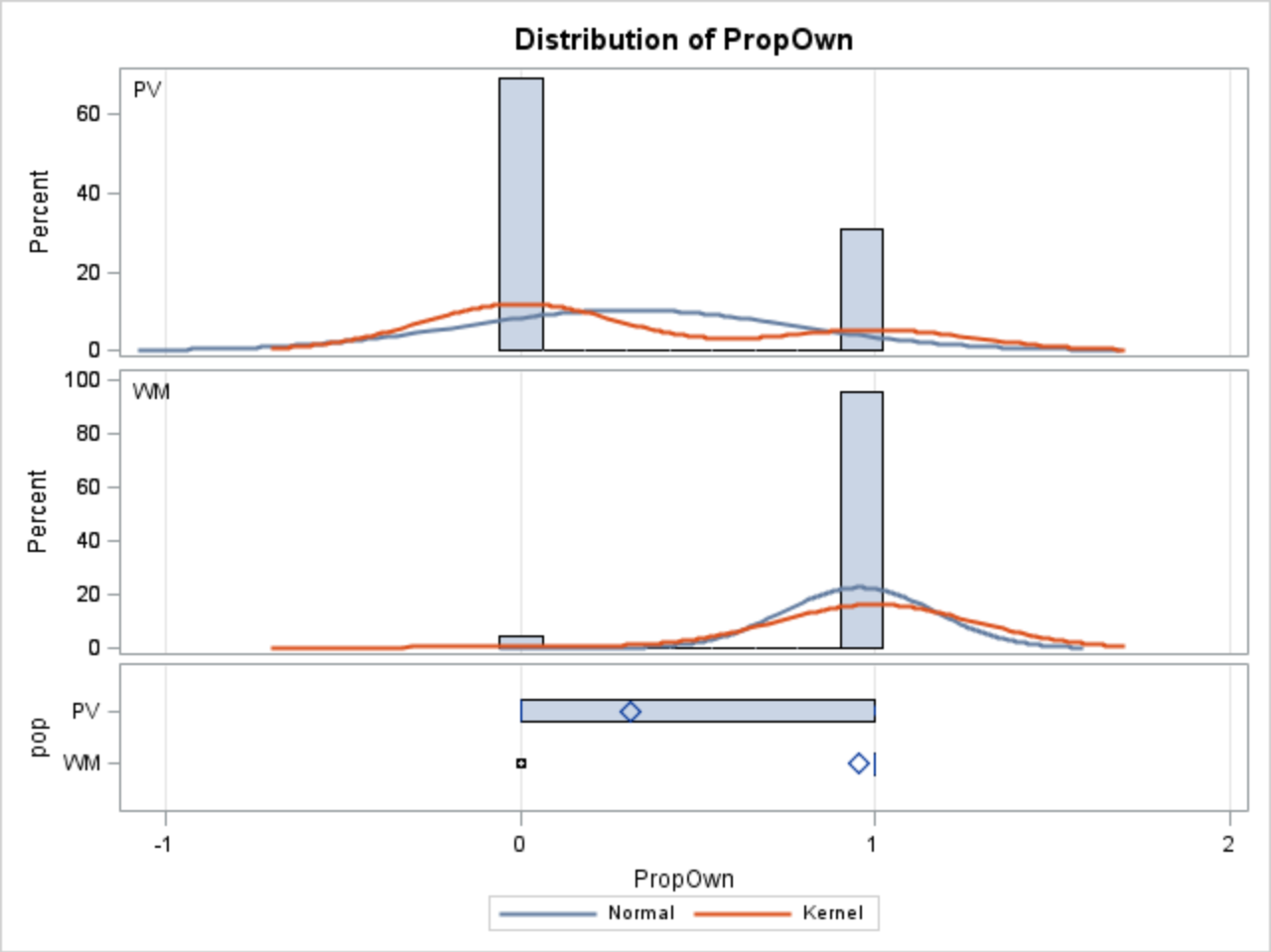
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	0.3068	0.4625	0.0349	0	1.0000
WM	172	0.9535	0.2112	0.0161	0	1.0000
Diff (1-2)		-0.6467	0.3609	0.0387		

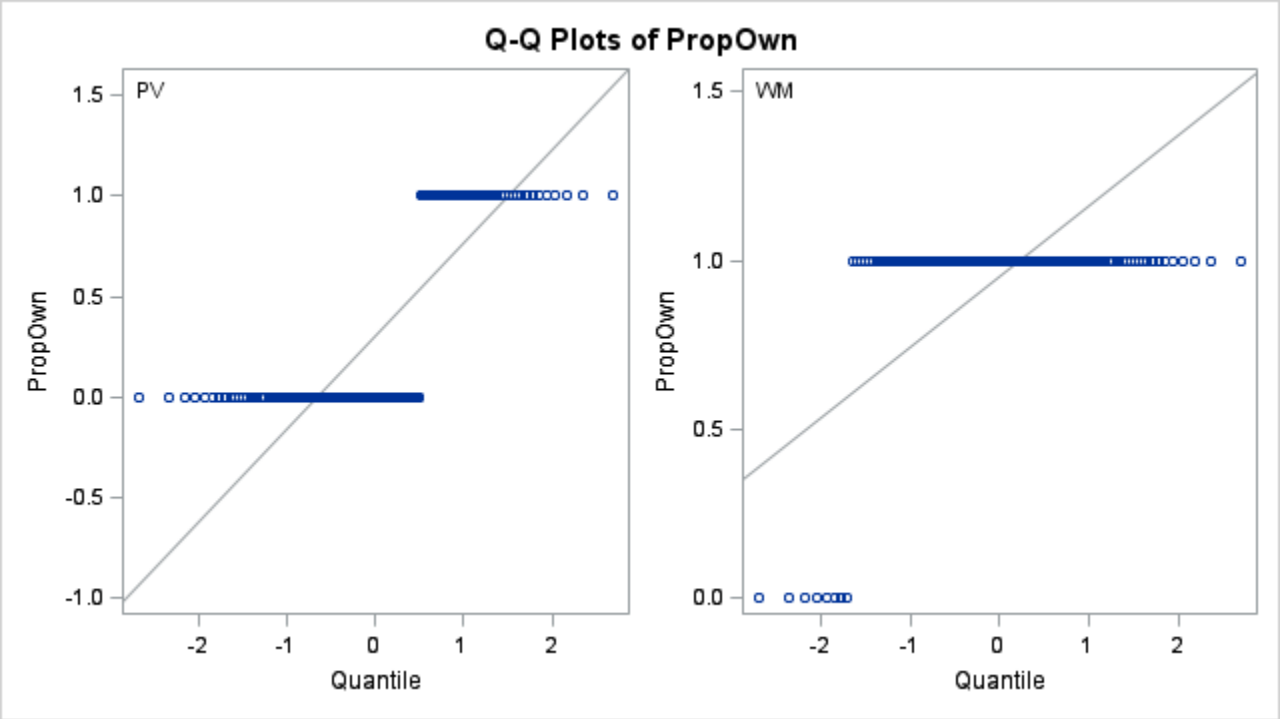
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		0.3068	0.2280	0.3856	0.4625	0.4129	0.5251
WM		0.9535	0.9171	0.9899	0.2112	0.1883	0.2402
Diff (1-2)	**Pooled**	-0.6467	-0.7338	-0.5596	0.3609	0.3325	0.3944
Diff (1-2)	**Satterthwaite**	-0.6467	-0.7333	-0.5601			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-16.71	<.0001
Satterthwaite	Unequal	246.19	-16.84	<.0001

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	4.80	<.0001


Distribution of PropOwn
PV
WM
Percent
pop
PV
WM
PropOwn
Normal
Kernel


Q-Q Plots of PropOwn
PV
WM
PropOwn
Quantile

The TTEST Procedure

Variable: VisFor

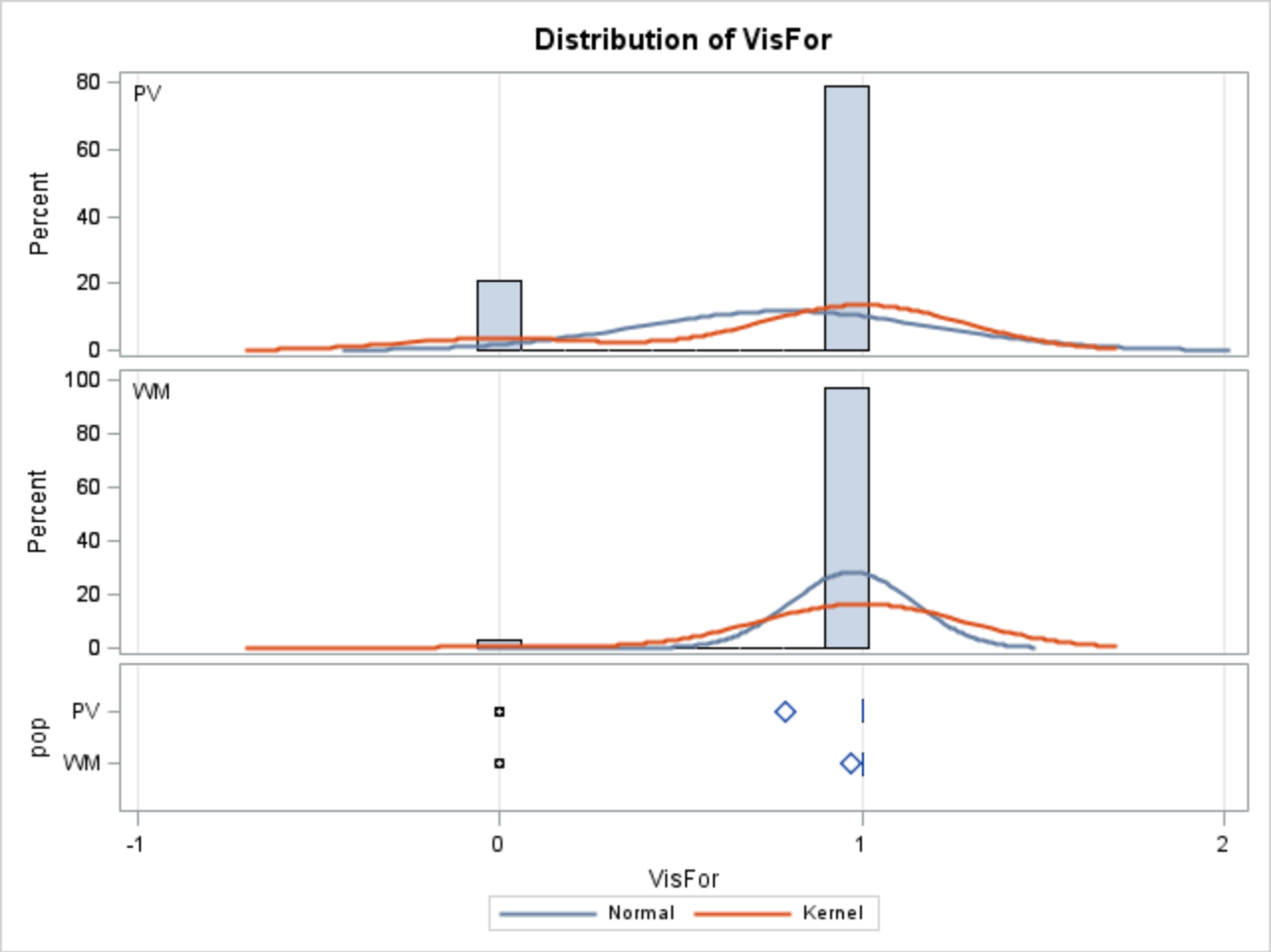
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	0.7898	0.4086	0.0308	0	1.0000
WM	172	0.9709	0.1685	0.0128	0	1.0000
Diff (1-2)		-0.1812	0.3138	0.0336		

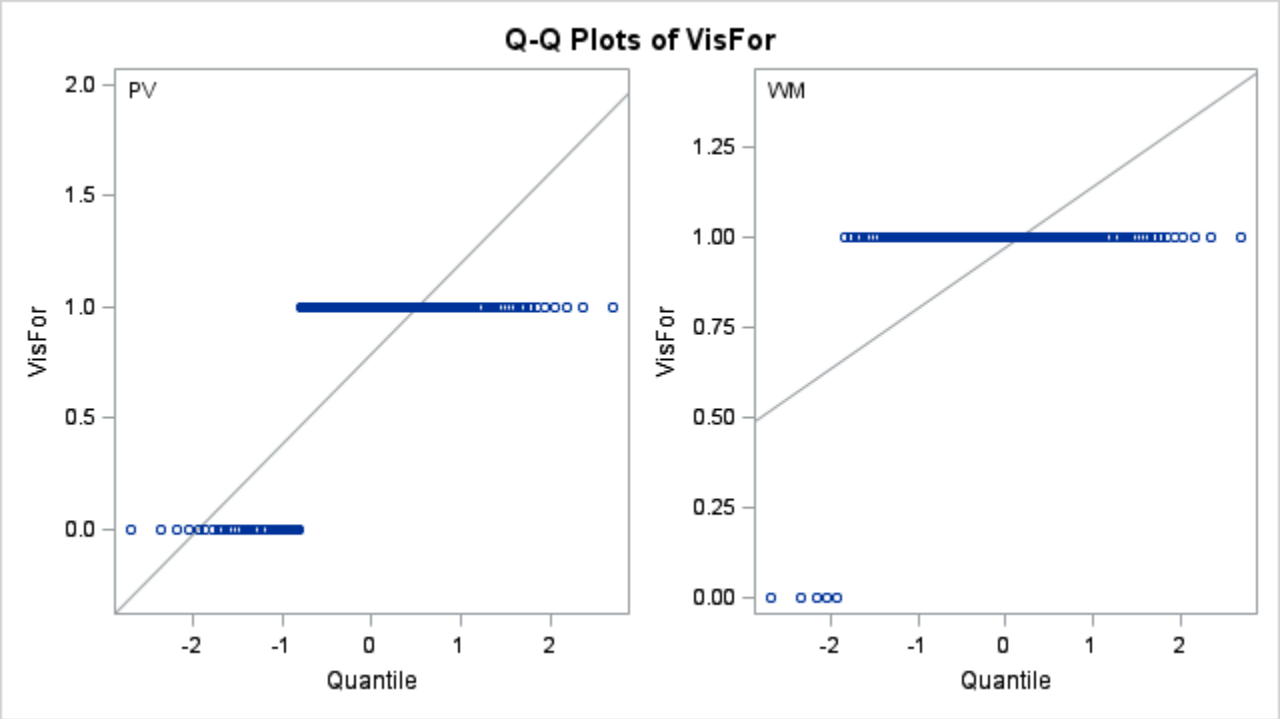
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		0.7898	0.7201	0.8594	0.4086	0.3648	0.4639
WM		0.9709	0.9419	1.0000	0.1685	0.1502	0.1916
Diff (1-2)	**Pooled**	-0.1812	-0.2569	-0.1054	0.3138	0.2891	0.3429
Diff (1-2)	**Satterthwaite**	-0.1812	-0.2564	-0.1059			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-5.38	<.0001
Satterthwaite	Unequal	233.94	-5.43	<.0001

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	5.88	<.0001


Distribution of VisFor
PV
WM
Percent
pop
VisFor
Normal
Kernel


Q-Q Plots of VisFor
PV
WM
VisFor
Quantile

The SAS System

The TTEST Procedure

Variable: KnowBB

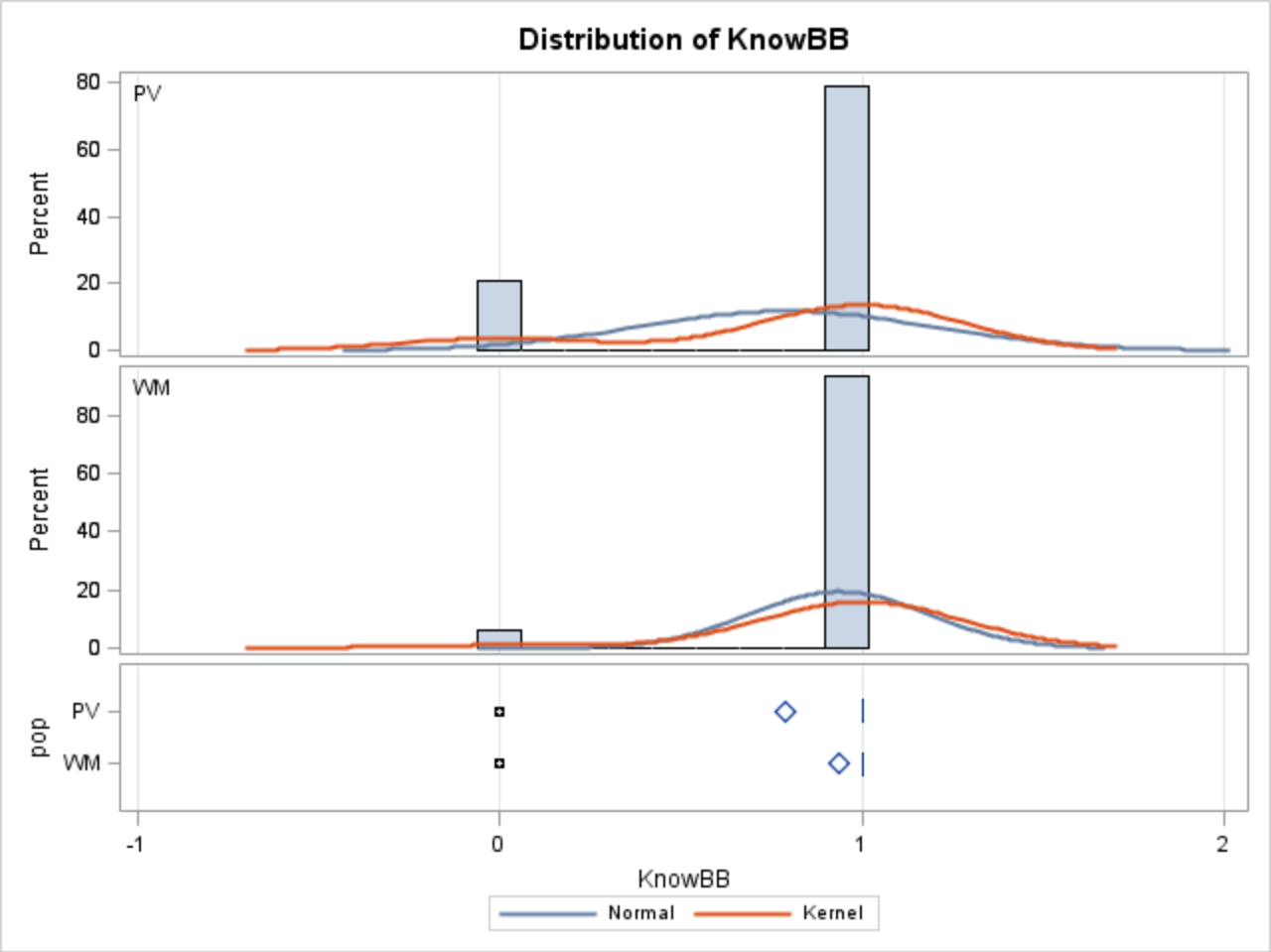
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	0.7898	0.4086	0.0308	0	1.0000
WM	172	0.9360	0.2454	0.0187	0	1.0000
Diff (1-2)		-0.1463	0.3380	0.0362		

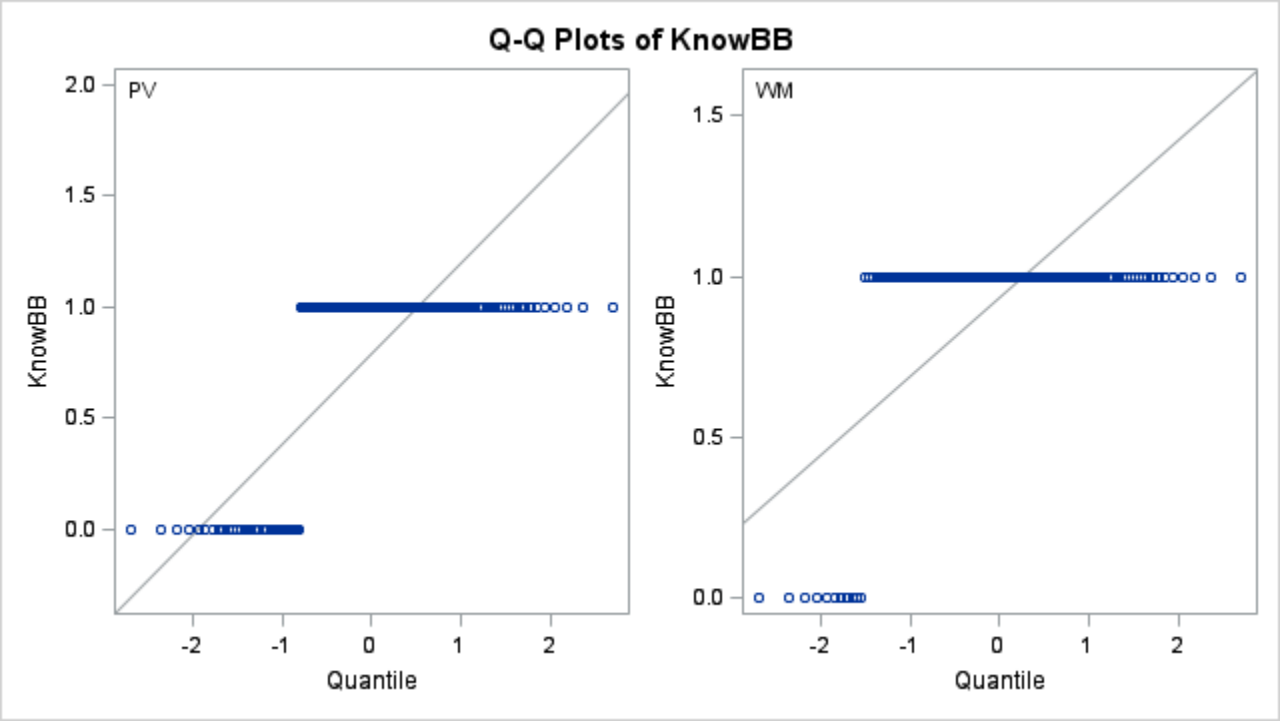
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		0.7898	0.7201	0.8594	0.4086	0.3648	0.4639
WM		0.9360	0.8937	0.9784	0.2454	0.2188	0.2790
Diff (1-2)	**Pooled**	-0.1463	-0.2278	-0.0647	0.3380	0.3114	0.3693
Diff (1-2)	**Satterthwaite**	-0.1463	-0.2275	-0.0651			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-4.04	<.0001
Satterthwaite	Unequal	287.86	-4.06	<.0001

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	2.77	<.0001


Distribution of KnowBB
PV
WM
Percent
80
60
40
20
0
pop
PV
WM
-1
0
1
2
KnowBB
Normal
Kernel


Q-Q Plots of KnowBB
PV
WM
KnowBB
2.0
1.5
1.0
0.5
0.0
-2
-1
0
1
2
Quantile

The TTEST Procedure

Variable: Klevel

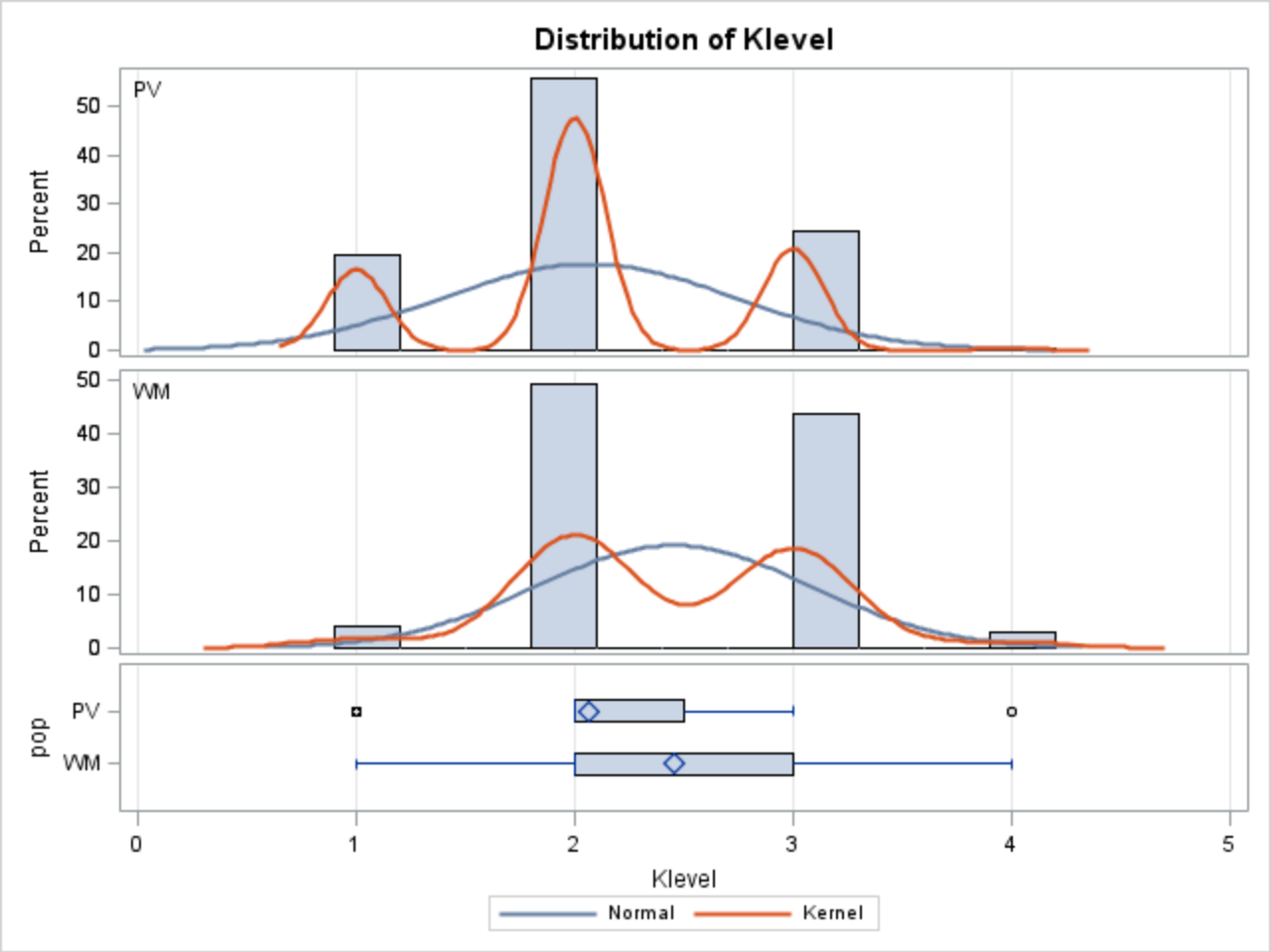
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	2.0625	0.6774	0.0511	1.0000	4.0000
WM	172	2.4535	0.6242	0.0476	1.0000	4.0000
Diff (1-2)		-0.3910	0.6517	0.0699		

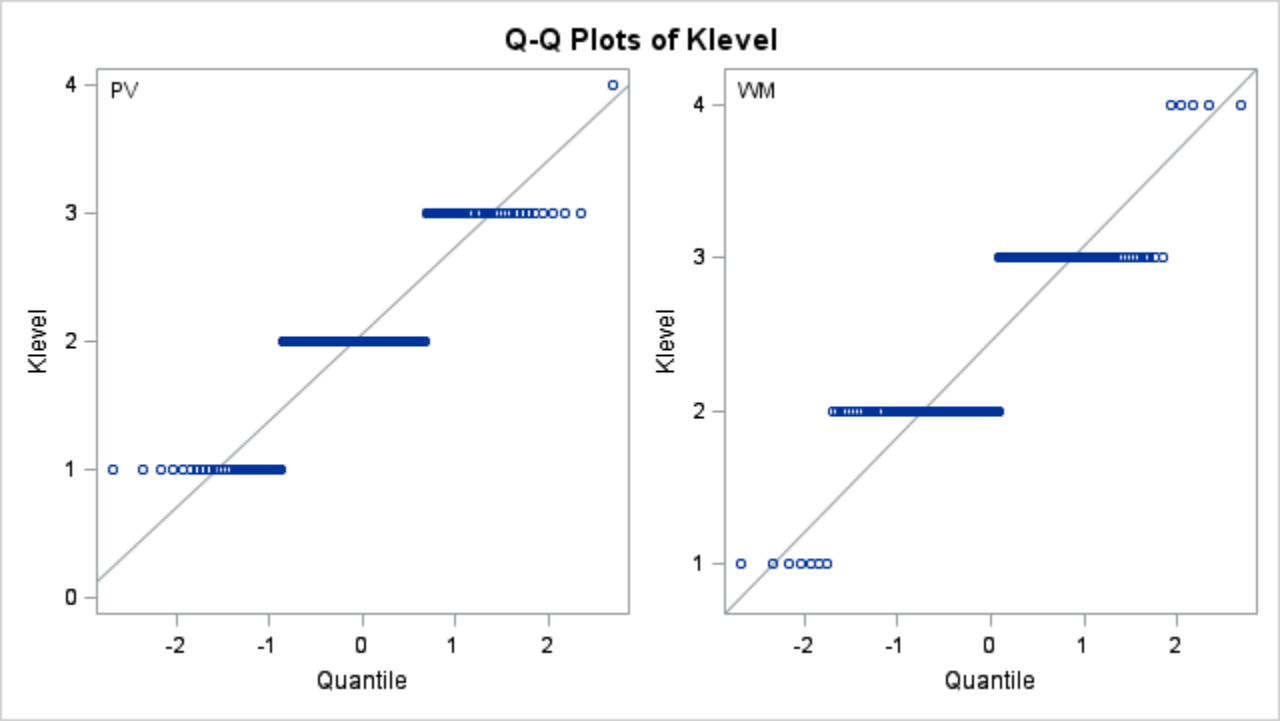
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		2.0625	1.9471	2.1779	0.6774	0.6048	0.7691
WM		2.4535	2.3459	2.5611	0.6242	0.5565	0.7098
Diff (1-2)	**Pooled**	-0.3910	-0.5483	-0.2337	0.6517	0.6004	0.7121
Diff (1-2)	**Satterthwaite**	-0.3910	-0.5481	-0.2338			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-5.60	<.0001
Satterthwaite	Unequal	344.81	-5.60	<.0001

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	1.18	0.2831


Distribution of Klevel
PV
WM
Percent
pop
PV
WM
Klevel
Normal
Kernel


Q-Q Plots of Klevel
PV
WM
Klevel
Quantile

The TTEST Procedure

Variable: BBProb

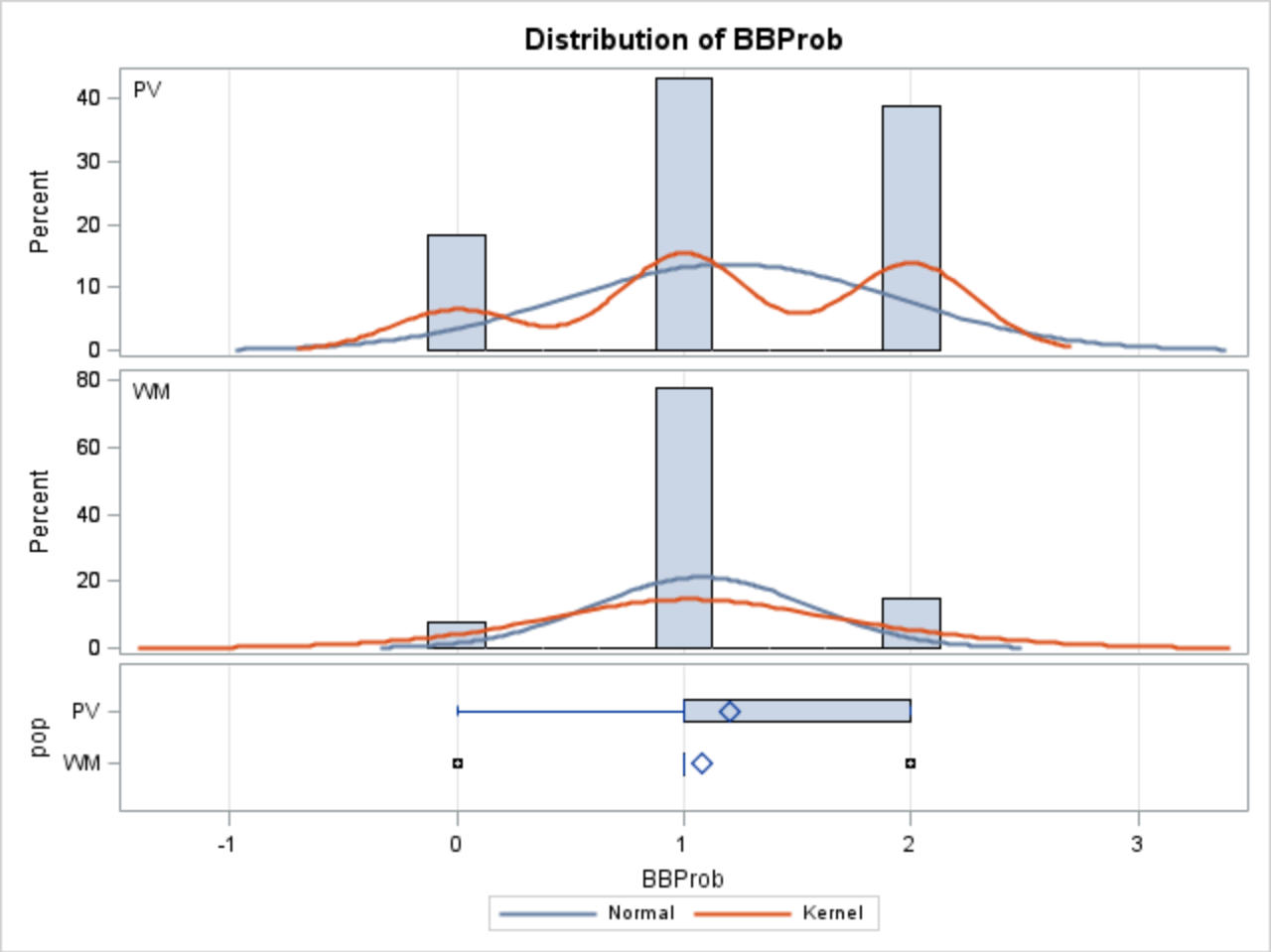
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	1.2045	0.7276	0.0548	0	2.0000
WM	172	1.0756	0.4715	0.0360	0	2.0000
Diff (1-2)		0.1290	0.6145	0.0659		

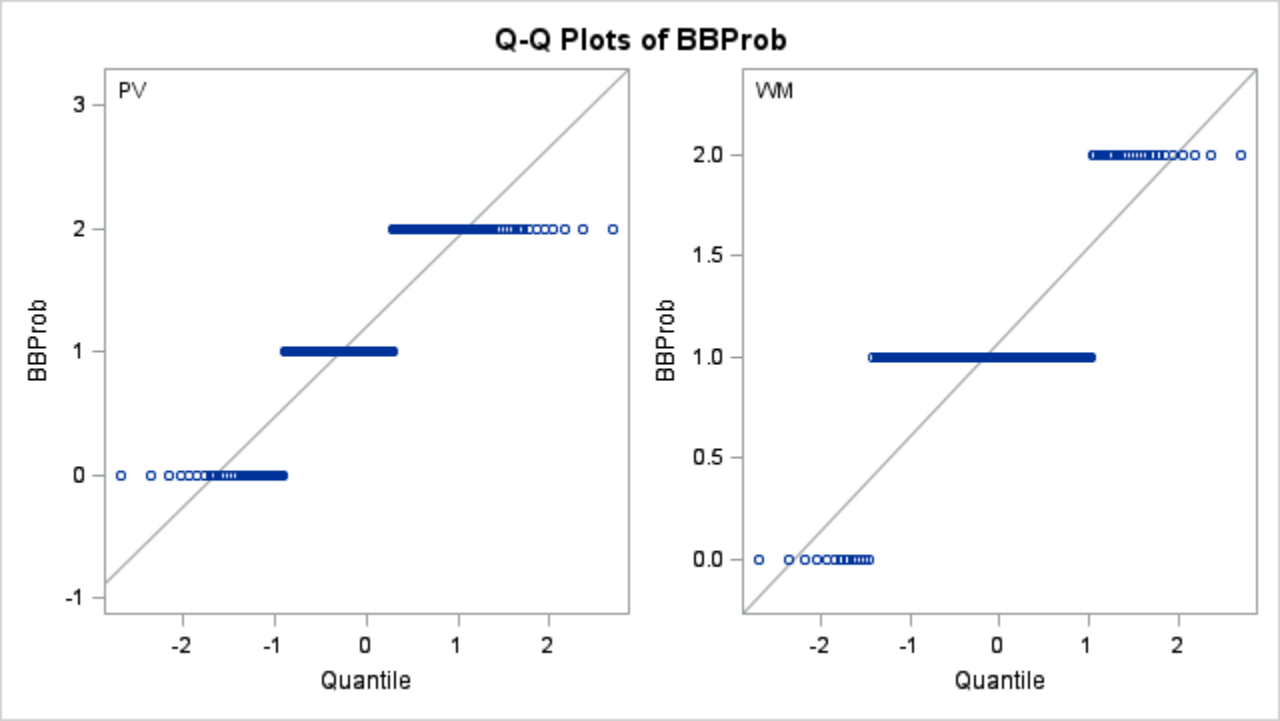
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		1.2045	1.0806	1.3285	0.7276	0.6495	0.8260
WM		1.0756	0.9943	1.1569	0.4715	0.4204	0.5361
Diff (1-2)	**Pooled**	0.1290	-0.0194	0.2773	0.6145	0.5661	0.6715
Diff (1-2)	**Satterthwaite**	0.1290	-0.0188	0.2767			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	1.96	0.0511
Satterthwaite	Unequal	300.87	1.97	0.0501

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	2.38	<.0001


Distribution of BBProb
PV
WM
Percent
pop
BBProb
Normal
Kernel


Q-Q Plots of BBProb
PV
WM
BBProb
Quantile

The SAS System

The TTEST Procedure

Variable: BBmgmt

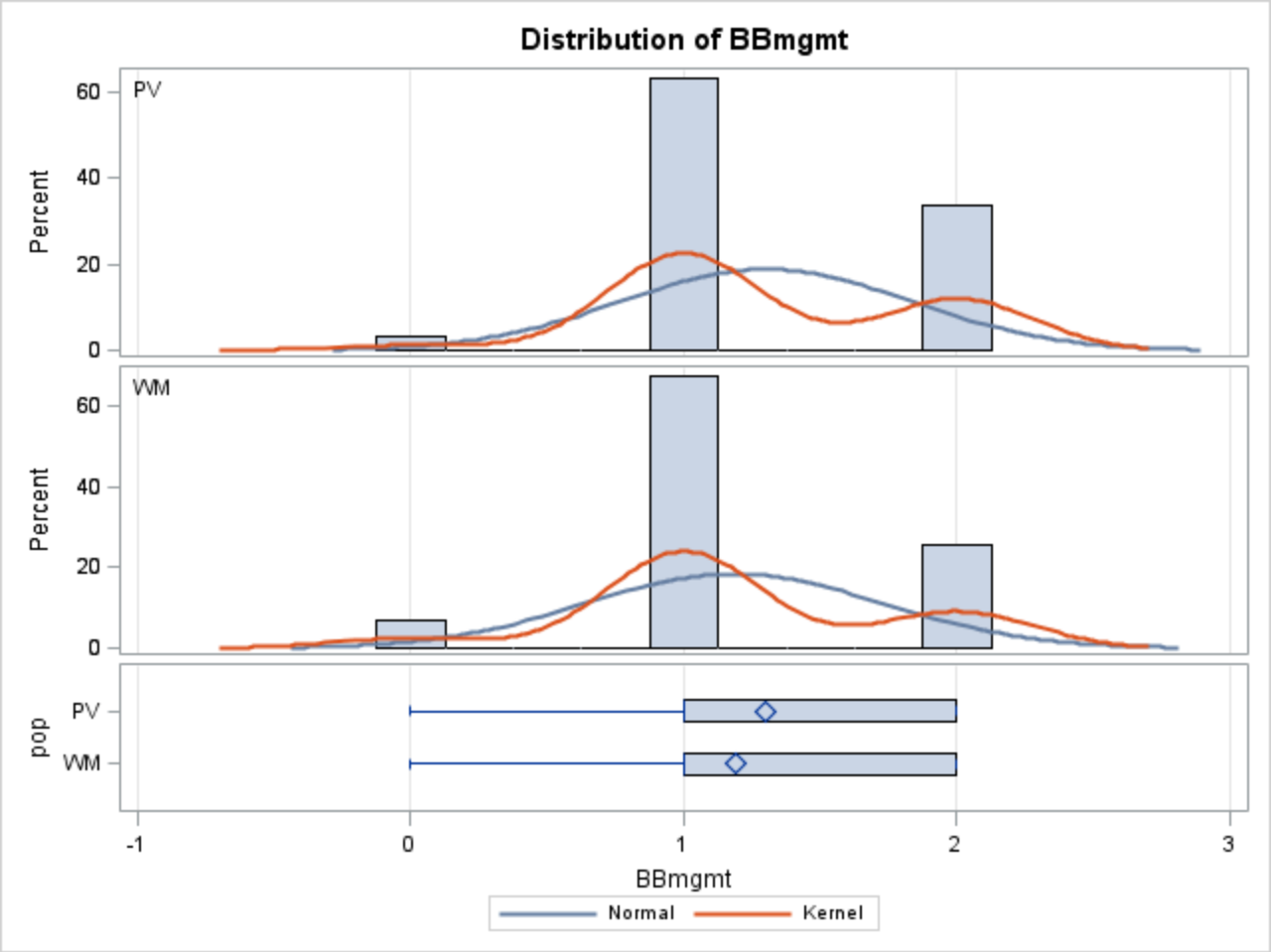
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	1.3011	0.5294	0.0399	0	2.0000
WM	172	1.1860	0.5410	0.0413	0	2.0000
Diff (1-2)		0.1151	0.5351	0.0574		

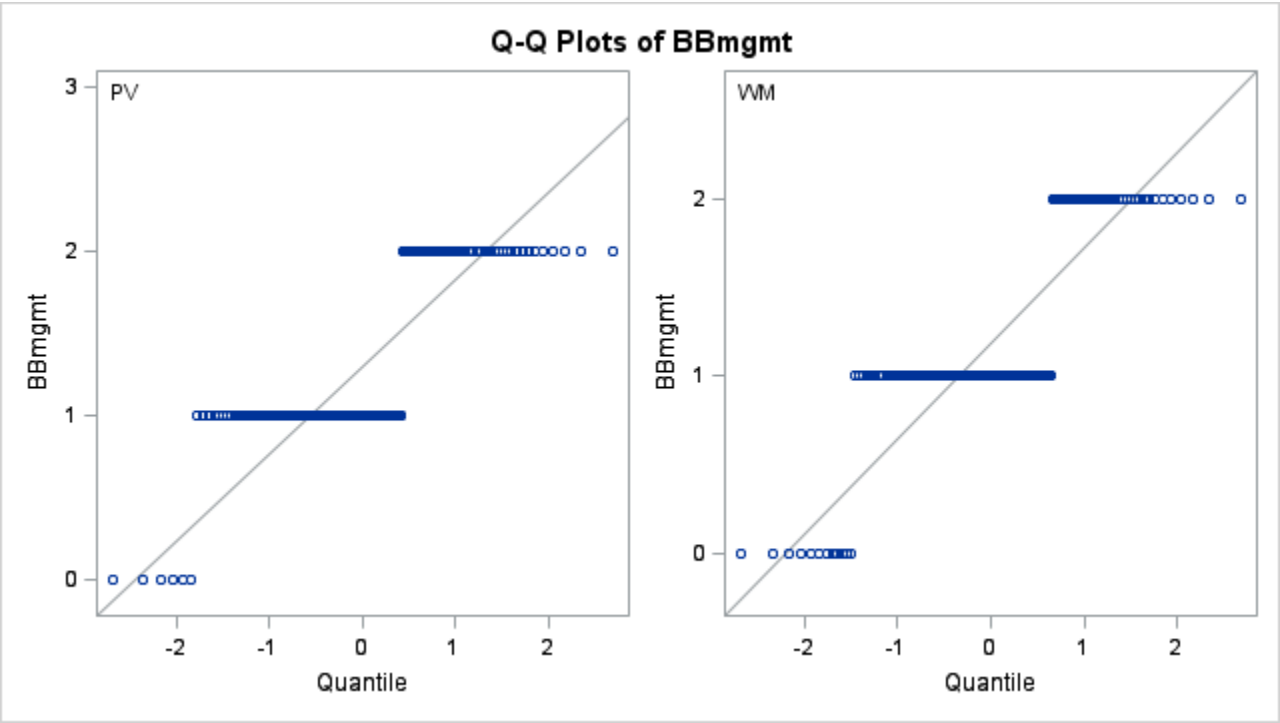
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		1.3011	1.2109	1.3913	0.5294	0.4726	0.6010
WM		1.1860	1.0928	1.2793	0.5410	0.4824	0.6151
Diff (1-2)	**Pooled**	0.1151	-0.0141	0.2443	0.5351	0.4930	0.5848
Diff (1-2)	**Satterthwaite**	0.1151	-0.0141	0.2443			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	2.01	0.0456
Satterthwaite	Unequal	345.31	2.01	0.0457

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	171	175	1.04	0.7750


Distribution of BBmgmt
PV
WM
Percent
60
40
20
0
pop
PV
WM
-1
0
1
2
3
BBmgmt
Normal
Kernel


Q-Q Plots of BBmgmt
PV
WM
BBmgmt
3
2
1
0
-2
-1
0
1
2
Quantile

The SAS System

The TTEST Procedure

Variable: PayPrev

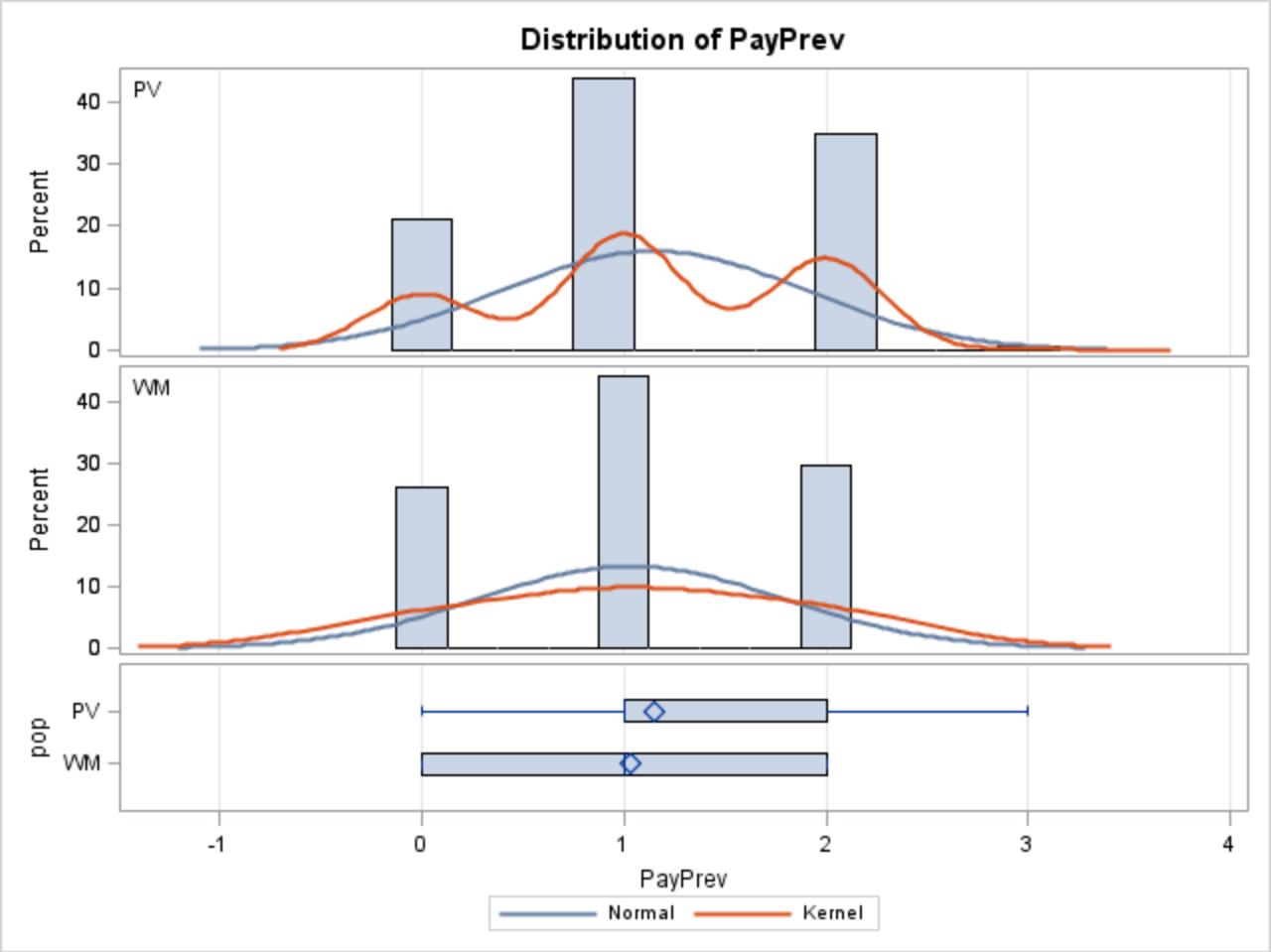
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	1.1477	0.7489	0.0565	0	3.0000
WM	172	1.0349	0.7485	0.0571	0	2.0000
Diff (1-2)		0.1128	0.7487	0.0803		

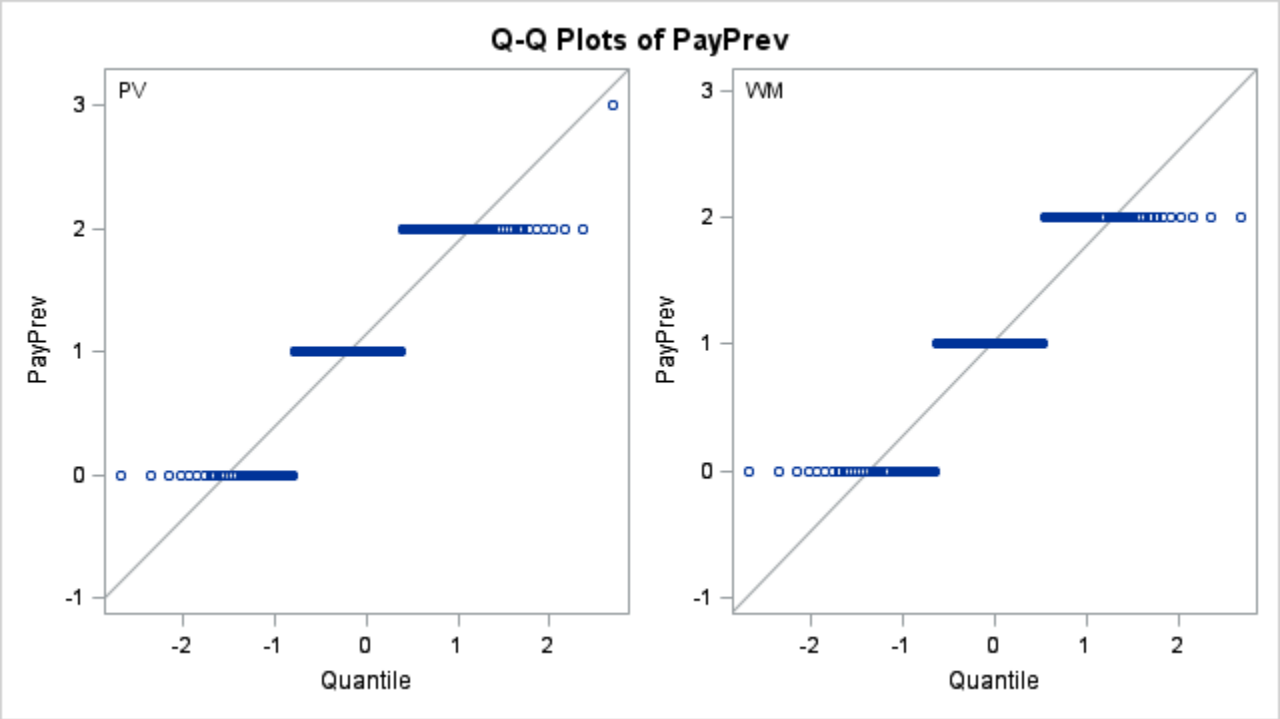
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		1.1477	1.0201	1.2754	0.7489	0.6686	0.8503
WM		1.0349	0.9058	1.1639	0.7485	0.6673	0.8510
Diff (1-2)	**Pooled**	0.1128	-0.0679	0.2936	0.7487	0.6898	0.8182
Diff (1-2)	**Satterthwaite**	0.1128	-0.0679	0.2936			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	1.41	0.1607
Satterthwaite	Unequal	345.83	1.41	0.1607

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	1.00	0.9936


Distribution of PayPrev
PV
WM
Percent
pop
PV
WM
PayPrev
Normal
Kernel


Q-Q Plots of PayPrev
PV
WM
PayPrev
Quantile

The SAS System

The TTEST Procedure

Variable: AgeGrp

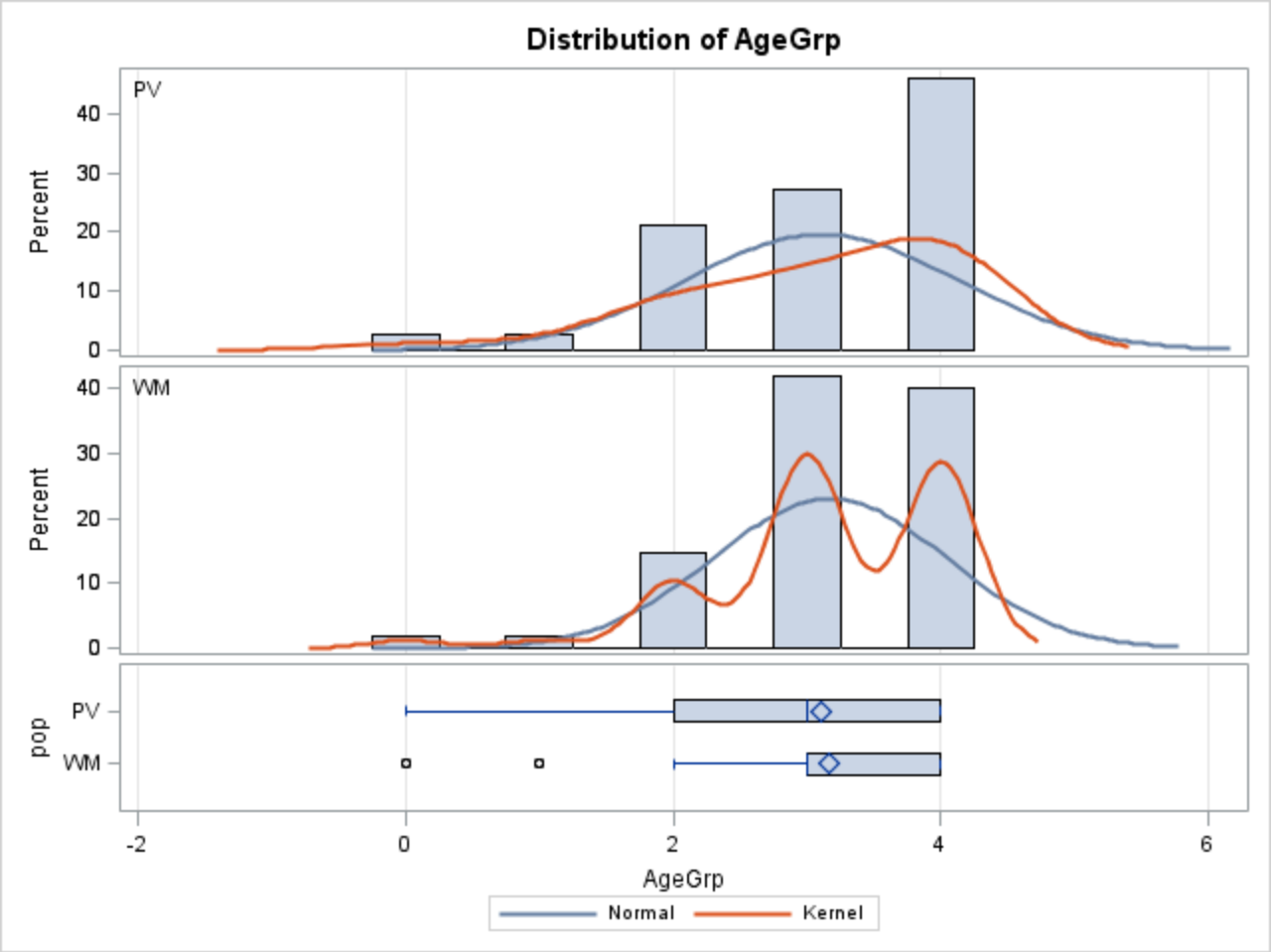
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	3.1080	1.0169	0.0766	0	4.0000
WM	172	3.1686	0.8656	0.0660	0	4.0000
Diff (1-2)		-0.0607	0.9451	0.1013		

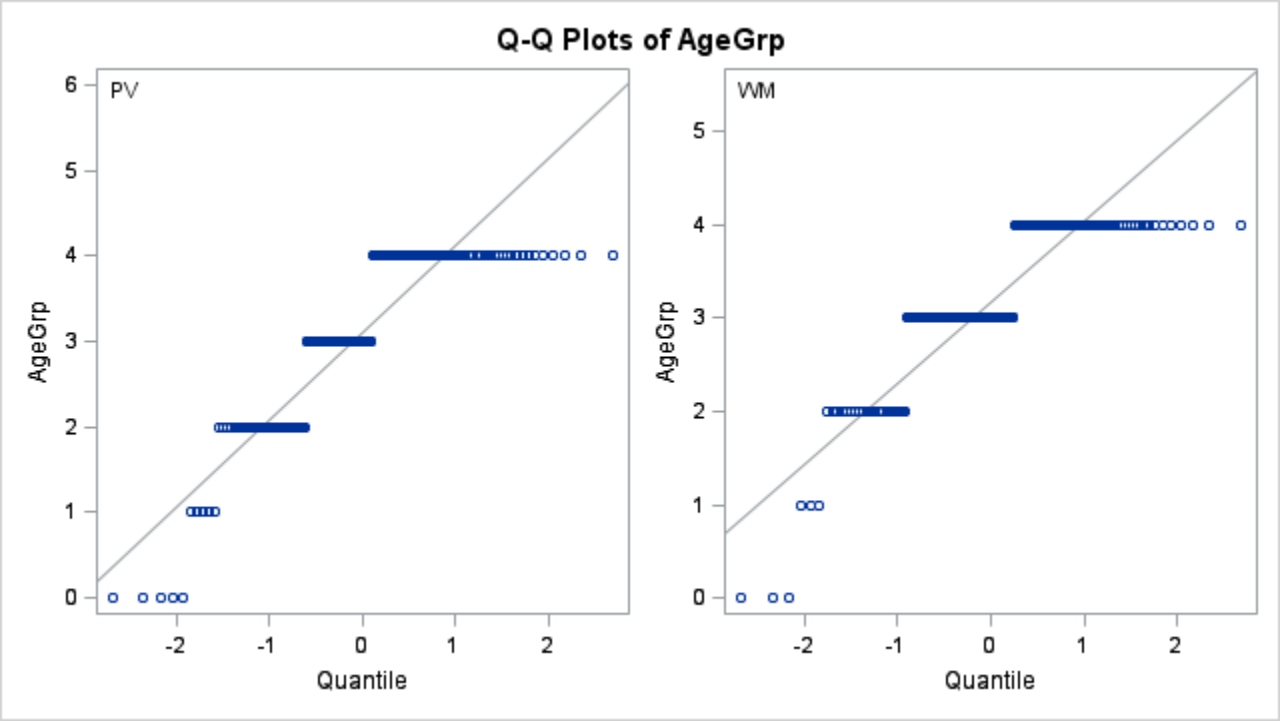
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		3.1080	2.9347	3.2812	1.0169	0.9078	1.1544
WM		3.1686	3.0194	3.3178	0.8656	0.7717	0.9842
Diff (1-2)	**Pooled**	-0.0607	-0.2888	0.1675	0.9451	0.8707	1.0328
Diff (1-2)	**Satterthwaite**	-0.0607	-0.2884	0.1671			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	-0.60	0.5499
Satterthwaite	Unequal	339.63	-0.60	0.5492

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	1.38	0.0349


Distribution of AgeGrp
PV
WM
Percent
pop
AgeGrp
Normal
Kernel


Q-Q Plots of AgeGrp
PV
WM
AgeGrp
Quantile

The SAS System

The TTEST Procedure

Variable: PolPref

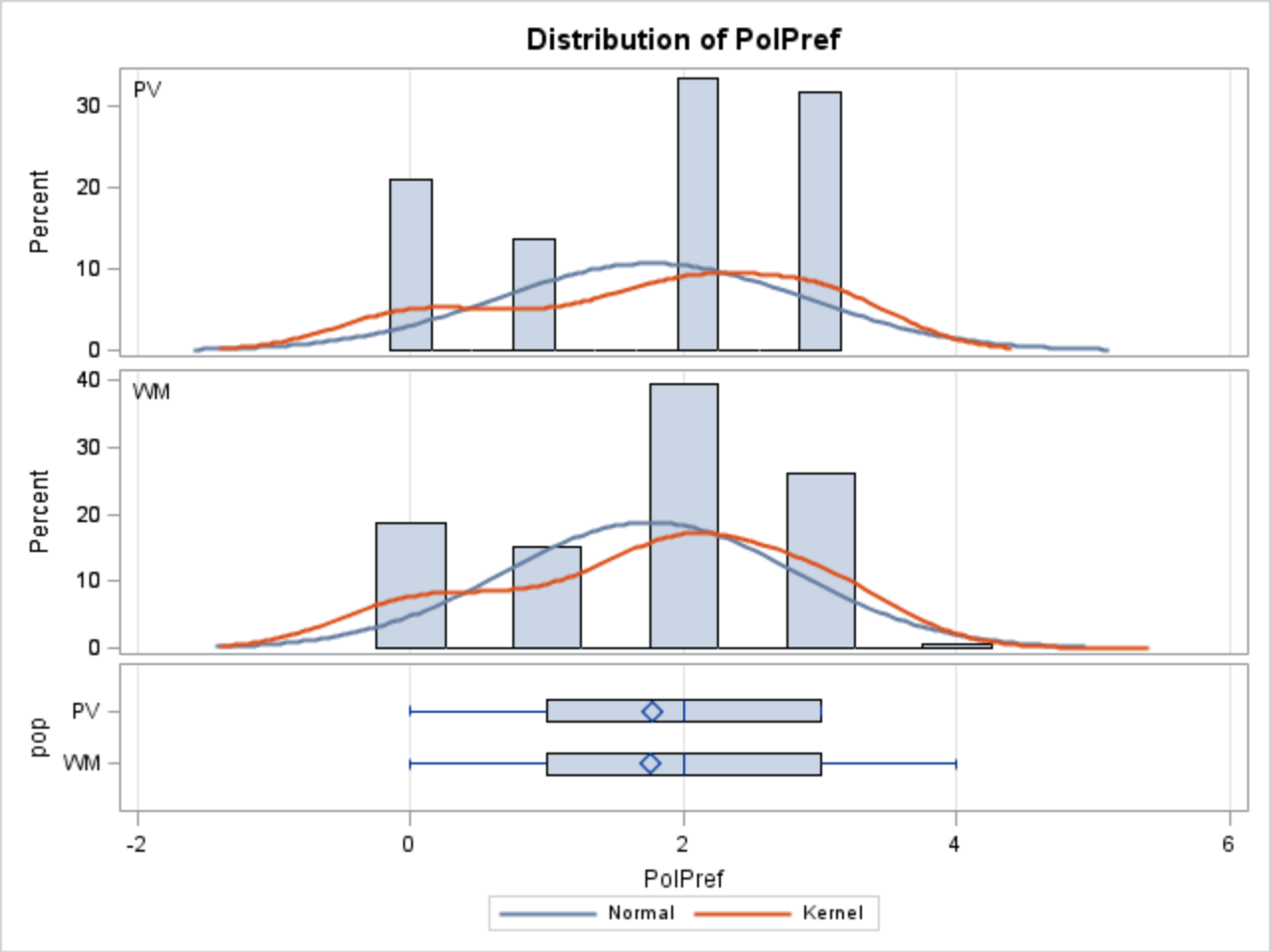
pop	N	Mean	Std Dev	Std Err	Minimum	Maximum
PV	176	1.7614	1.1161	0.0841	0	3.0000
WM	172	1.7500	1.0603	0.0808	0	4.0000
Diff (1-2)		0.0114	1.0889	0.1167		

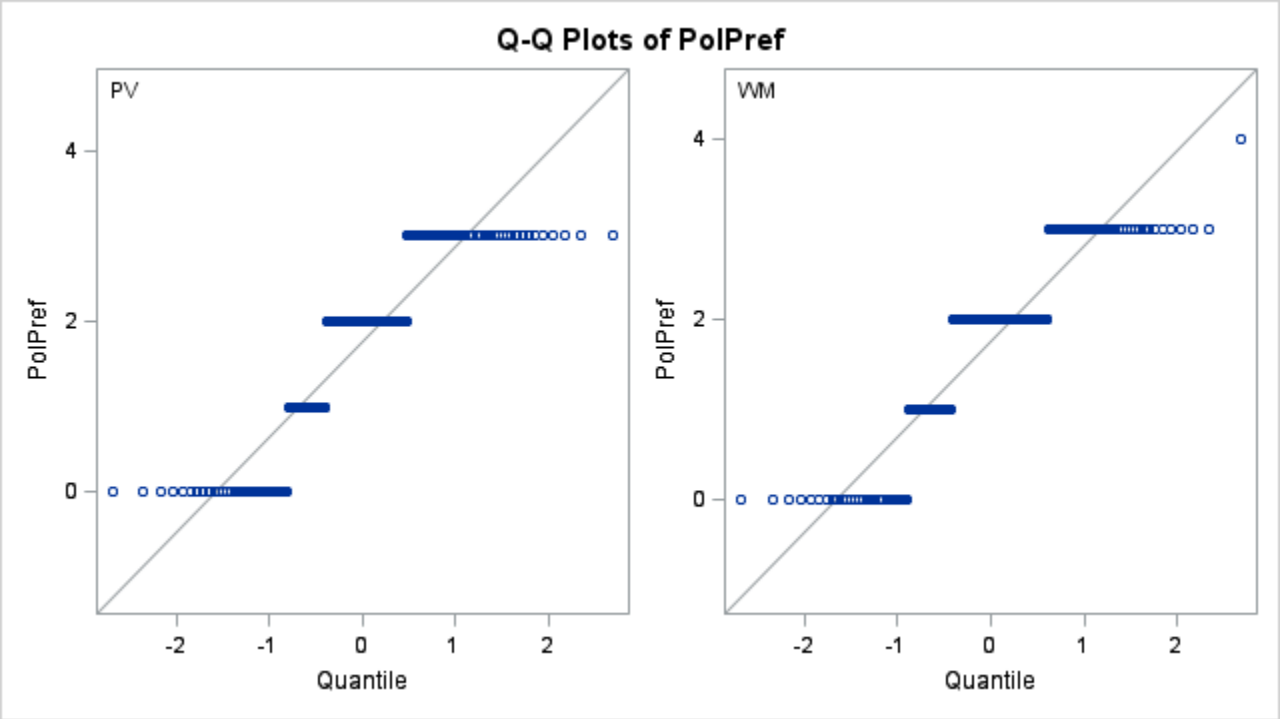
pop	Method	Mean	97.5% CL Mean		Std Dev	97.5% CL Std Dev	
PV		1.7614	1.5712	1.9516	1.1161	0.9963	1.2671
WM		1.7500	1.5672	1.9328	1.0603	0.9454	1.2057
Diff (1-2)	**Pooled**	0.0114	-0.2515	0.2742	1.0889	1.0032	1.1899
Diff (1-2)	**Satterthwaite**	0.0114	-0.2513	0.2740			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	346	0.10	0.9225
Satterthwaite	Unequal	345.73	0.10	0.9225

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	175	171	1.11	0.5016


Distribution of PolPref
PV
WM
Percent
pop
PV
WM
PolPref
Normal
Kernel


Q-Q Plots of PolPref
PV
WM
PolPref
Quantile

The ANOVA Procedure

Class Level Information

Class	Levels	Values
pop	2	PV WM

Number of Observations Read	348
Number of Observations Used	348

The SAS System

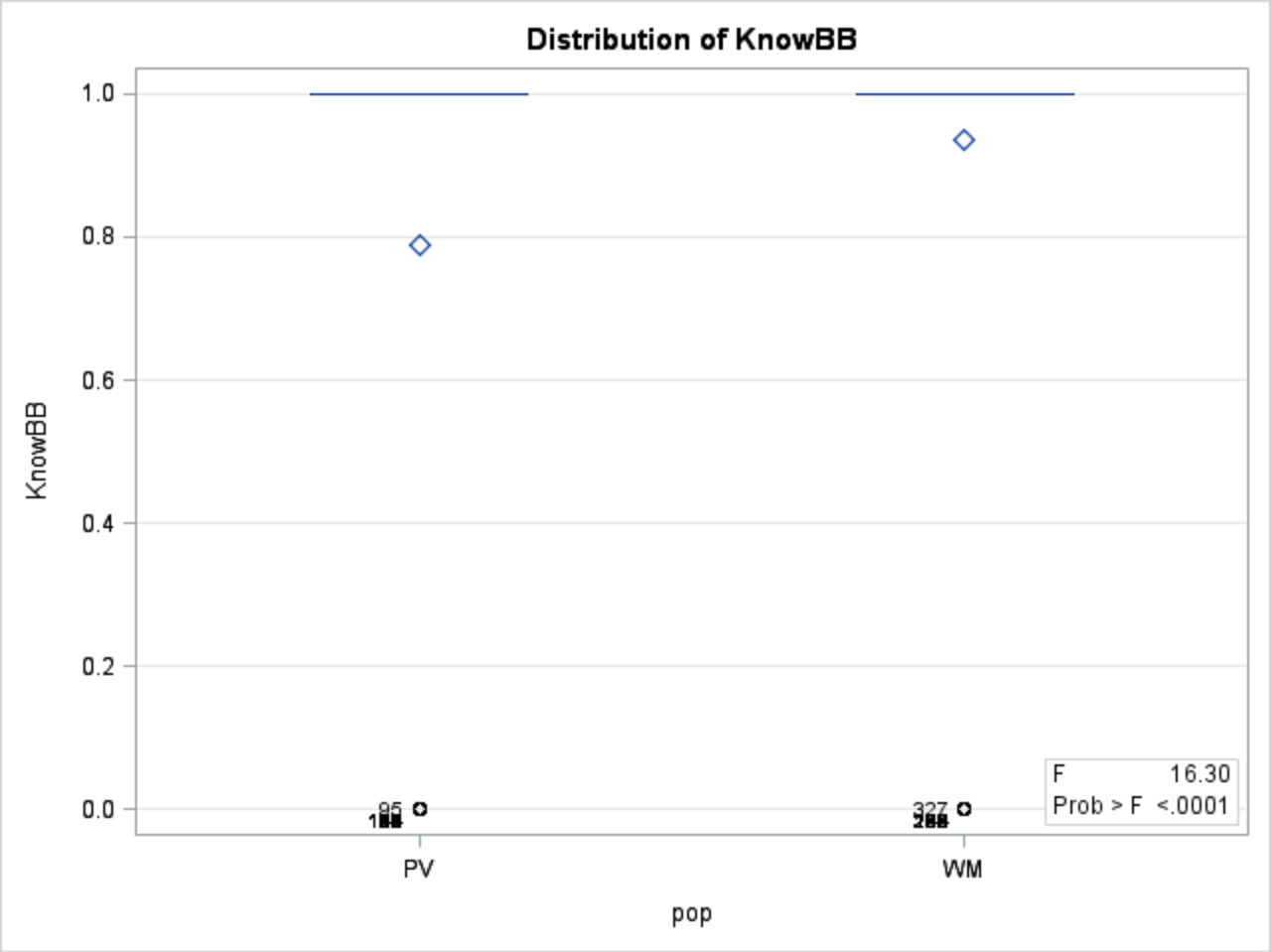
The ANOVA Procedure

Dependent Variable: KnowBB

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.86120781	1.86120781	16.30	<.0001
Error	346	39.51810254	0.11421417		
Corrected Total	347	41.37931034			

R-Square	Coeff Var	Root MSE	KnowBB Mean
0.044979	39.20288	0.337956	0.862069

Source	DF	Anova SS	Mean Square	F Value	Pr > F
pop	1	1.86120781	1.86120781	16.30	<.0001



The SAS System

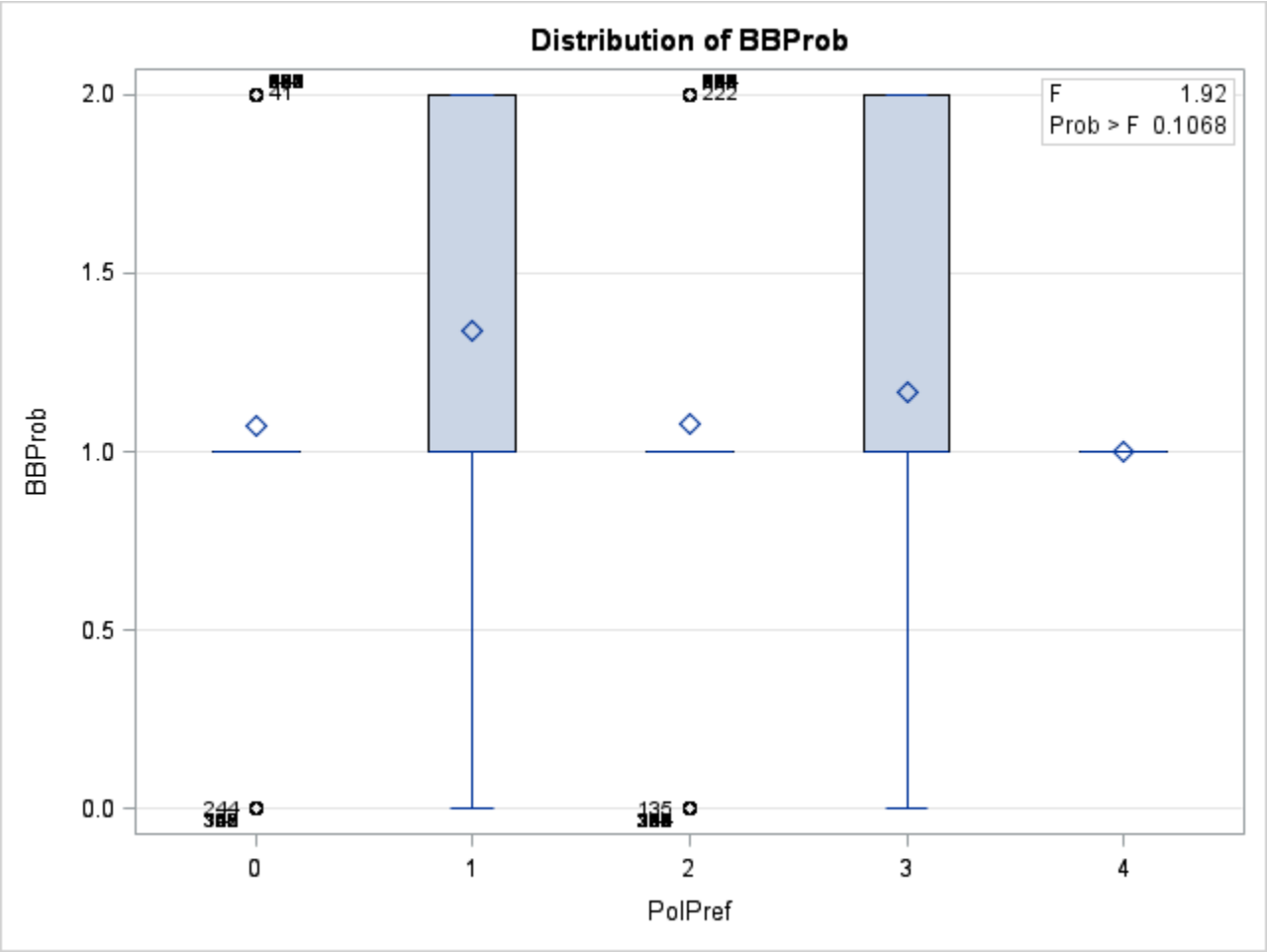
The ANOVA Procedure

Dependent Variable: BBProb

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	2.8916813	0.7229203	1.92	0.1068
Error	343	129.2088934	0.3767023		
Corrected Total	347	132.1005747			

R-Square	Coeff Var	Root MSE	BBProb Mean
0.021890	53.80069	0.613761	1.140805

Source	DF	Anova SS	Mean Square	F Value	Pr > F
PolPref	4	2.89168127	0.72292032	1.92	0.1068



The ANOVA Procedure

Class Level Information

Class	Levels	Values
PolPref	5	0 1 2 3 4

Number of Observations Read	348
Number of Observations Used	348

The SAS System

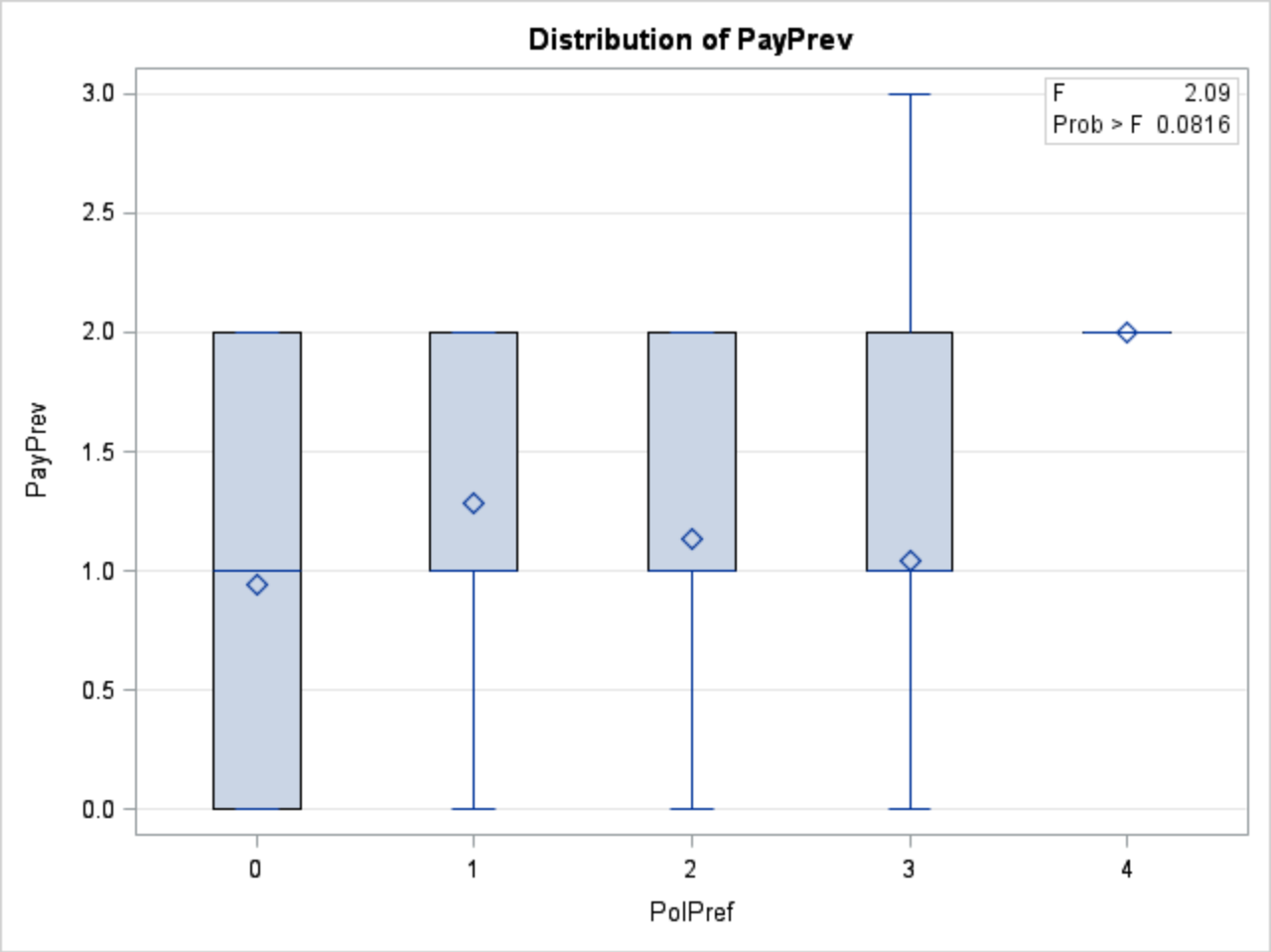
The ANOVA Procedure

Dependent Variable: PayPrev

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	4.6433617	1.1608404	2.09	0.0816
Error	343	190.4141095	0.5551432		
Corrected Total	347	195.0574713			

R-Square	Coeff Var	Root MSE	PayPrev Mean
0.023805	68.23358	0.745079	1.091954

Source	DF	Anova SS	Mean Square	F Value	Pr > F
PolPref	4	4.64336172	1.16084043	2.09	0.0816



The ANOVA Procedure

Class Level Information

Class	Levels	Values
PolPref	5	0 1 2 3 4

Number of Observations Read 348

Number of Observations Used 348

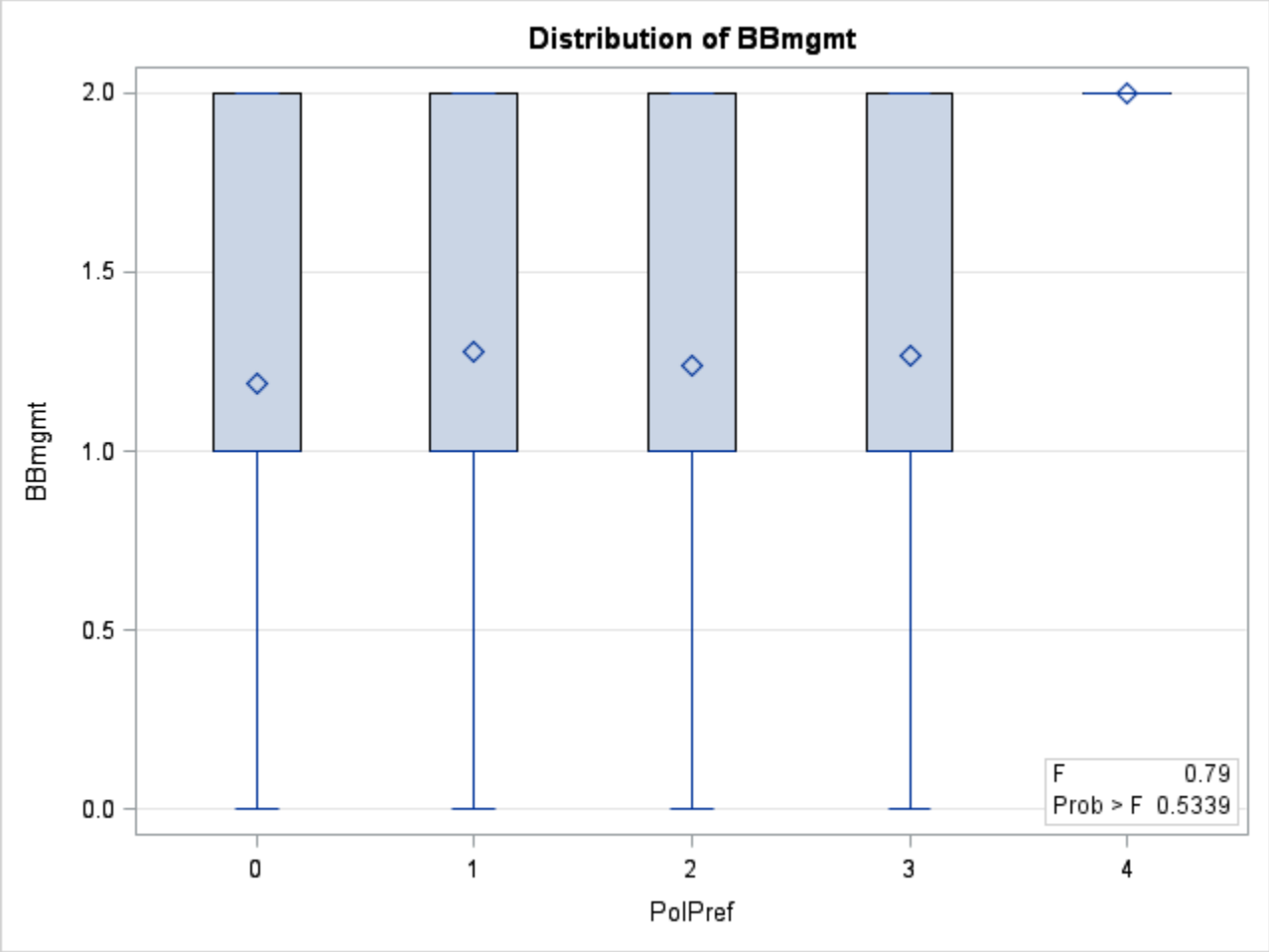
The ANOVA Procedure

Dependent Variable: BBmgmt

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.9122171	0.2280543	0.79	0.5339
Error	343	99.3262887	0.2895810		
Corrected Total	347	100.2385057			

R-Square	Coeff Var	Root MSE	BBmgmt Mean
0.009100	43.24903	0.538127	1.244253

Source	DF	Anova SS	Mean Square	F Value	Pr > F
PolPref	4	0.91221706	0.22805427	0.79	0.5339



SAS Code

```
data surveys;
```

```
input pop$ liveF PropOwn VisFor KnowBB Klevel BBProb BBmgmt PayPrev AgeGrp PolPref;
cards;
PV 1 0 1 1 3 2 1 2 2 2
PV 0 0 1 0 1 2 1 0 4 3
PV 1 0 1 1 3 1 1 0 4 3
PV 1 1 1 1 2 1 1 1 4 2
PV 1 0 1 1 2 1 1 0 4 2
PV 1 0 1 0 1 2 2 1 3 2
PV 1 0 1 1 3 1 1 1 4 0
PV 1 1 1 1 2 1 1 1 4 3
PV 0 0 1 1 2 0 1 1 2 3
PV 1 0 0 0 1 2 2 2 4 1
PV 1 0 1 1 2 2 1 2 4 1
PV 1 0 1 1 3 0 1 0 0 0
PV 1 1 1 1 2 1 2 0 2 0
PV 1 0 0 0 2 0 1 0 4 2
PV 1 0 1 1 2 2 1 2 3 0
PV 1 0 1 1 3 2 1 0 4 3
PV 1 1 0 1 2 1 1 1 4 0
PV 1 1 1 1 3 1 1 1 2 3
PV 1 0 1 1 1 1 1 1 1 0
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PV 1 0 1 1 2 2 1 1 4 2
PV 1 1 1 1 2 0 2 2 3 1
PV 1 1 1 1 3 1 1 1 3 2
PV 1 1 1 1 3 2 1 2 3 3
PV 1 1 1 1 2 0 2 1 3 0
PV 0 0 1 1 2 2 1 0 0 3
PV 1 1 1 1 3 0 1 1 3 3
PV 1 1 1 1 3 1 2 2 4 3
PV 1 0 1 1 2 1 1 1 3 2
PV 1 0 1 1 2 1 2 0 2 0
PV 1 1 1 1 3 2 1 0 3 2
PV 1 0 0 0 1 2 1 2 4 0
PV 1 1 1 1 2 2 2 2 3 3
PV 1 1 1 1 3 1 1 1 3 2
PV 1 0 1 1 2 2 1 1 1 1
PV 0 0 1 1 2 1 1 2 2 2
PV 1 0 1 1 2 1 1 0 4 0
PV 1 0 1 1 3 0 1 1 4 2
PV 1 0 0 1 2 2 1 1 4 0
PV 1 0 1 0 2 1 1 1 4 3
PV 1 0 0 0 1 2 2 2 0 0
PV 1 1 1 1 2 1 2 2 3 2
PV 0 0 1 1 2 0 0 0 2 3
PV 1 0 1 1 3 0 1 1 2 1
PV 1 1 0 1 2 2 2 2 2 3
PV 1 0 0 0 3 0 1 1 4 3
PV 1 0 1 1 2 2 1 2 4 3
PV 1 0 1 1 3 2 2 2 3 0
PV 1 0 0 1 2 1 1 2 4 0
PV 1 0 1 1 2 2 2 0 3 0
PV 1 0 1 1 2 0 2 2 4 2
PV 1 0 1 1 2 1 1 1 4 2
PV 1 1 1 1 2 1 1 1 3 2
PV 1 0 0 1 2 2 2 1 4 1
```

PV	1	0	0	1	2	1	1	2	3	2
PV	1	0	1	1	2	1	1	1	4	2
PV	1	0	1	0	2	1	1	2	4	3
PV	1	0	1	0	2	2	1	1	4	2
PV	1	0	1	0	2	1	2	1	2	3
PV	1	1	0	0	1	2	2	2	3	3
PV	1	1	1	0	1	2	1	2	4	1
PV	1	0	1	0	1	2	2	2	3	0
PV	1	0	1	1	2	2	1	1	4	3
PV	1	0	0	1	2	0	1	1	3	3
PV	0	0	1	1	2	2	1	2	1	3
PV	1	1	1	1	3	1	1	1	4	0
PV	1	1	1	1	2	1	1	0	3	0
PV	1	0	1	1	2	0	1	1	3	0
PV	1	0	1	1	2	1	1	2	3	0
PV	1	0	0	1	2	2	2	0	4	3
PV	1	1	1	1	2	1	2	0	3	2
PV	1	1	1	1	3	1	1	1	2	1
PV	1	1	1	1	3	1	1	1	4	0
PV	1	0	1	1	2	1	2	0	3	0
PV	1	0	1	1	2	1	1	1	2	3
PV	1	0	1	1	2	1	1	0	4	2
PV	0	0	1	1	2	1	1	0	2	3
PV	1	1	1	1	3	1	1	0	3	2
PV	1	0	0	1	2	2	1	0	2	3
PV	1	0	1	1	2	2	1	2	4	2
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PV	1	0	0	1	1	0	2	0	4	3
PV	1	0	1	1	3	2	1	2	4	0
PV	0	0	1	1	2	1	2	2	4	3
PV	1	0	1	1	2	1	2	2	3	2
PV	1	0	1	1	2	2	1	2	2	2
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PV	1	0	1	0	1	2	1	1	3	3
PV	0	0	0	1	1	1	1	0	4	0
PV	1	0	1	1	2	1	2	2	4	3
PV	0	0	0	0	1	2	2	2	2	3
PV	1	1	1	1	2	1	1	1	3	0
PV	1	0	1	1	2	0	1	2	2	3
PV	1	0	0	1	1	0	1	1	4	2
PV	1	0	0	0	1	2	2	1	4	3
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PV	1	1	1	1	3	1	1	2	4	2
PV	1	0	1	1	4	2	1	0	4	2
PV	1	0	0	1	2	1	1	1	4	1
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PV	1	0	1	1	3	0	1	1	2	3
PV	1	0	1	1	1	0	2	2	3	2
PV	1	0	1	1	2	1	1	1	4	3
PV	1	0	0	1	3	2	1	0	4	0
PV	1	0	1	1	2	1	1	1	2	2
PV	0	0	0	1	2	1	1	1	4	3
PV	1	1	1	1	2	2	1	2	2	2
PV	1	1	1	1	3	1	1	1	4	2
PV	1	0	1	1	3	1	1	2	3	1

PV	1	0	1	1	2	2	1	1	4	1
PV	1	0	1	1	2	0	1	1	3	0
PV	0	0	1	1	2	1	1	1	2	1
PV	1	0	1	1	1	2	1	2	4	3
PV	1	0	1	1	2	1	1	2	4	2
PV	1	1	1	1	2	0	2	0	3	0
PV	1	0	1	1	2	0	1	0	4	2
PV	1	0	0	0	1	2	2	2	2	3
PV	1	0	1	0	1	2	1	1	3	3
PV	1	1	1	1	3	2	2	3	4	3
PV	1	0	0	0	2	2	2	2	4	1
PV	1	1	1	1	3	1	1	0	4	2
PV	1	0	1	0	1	0	1	2	3	2
PV	0	0	1	1	2	1	2	2	3	2
PV	1	1	1	1	3	1	2	2	3	1
PV	1	0	1	1	3	0	1	2	2	0
PV	1	1	0	0	1	2	1	2	4	3
PV	1	1	1	1	3	1	1	1	0	0
PV	1	0	1	1	3	1	1	1	4	1
PV	0	0	1	1	2	0	0	2	2	3
PV	1	0	1	1	2	1	1	1	2	1
PV	1	0	1	1	2	1	1	2	2	2
PV	1	0	1	1	2	1	2	1	3	2
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PV	1	0	0	1	2	0	1	1	4	2
PV	1	0	1	1	2	2	1	1	4	1
PV	1	1	1	1	2	1	2	2	2	3
PV	1	1	1	1	2	2	2	2	4	2
PV	1	1	1	1	2	1	1	1	3	2
PV	0	0	1	1	2	2	2	1	4	2
PV	1	0	1	0	2	2	1	1	3	0
PV	1	1	1	1	3	1	1	1	4	3
PV	1	1	1	1	3	1	1	1	2	3
PV	1	1	1	1	3	1	2	1	3	0
PV	1	0	1	1	2	0	2	2	1	0
PV	1	0	1	1	3	1	1	1	4	3
PV	1	1	1	1	2	0	1	1	4	2
PV	1	1	1	0	1	2	1	2	4	3
PV	0	0	1	1	2	1	2	2	4	2
PV	0	0	0	0	1	2	2	2	4	2
PV	1	0	0	0	2	2	2	0	0	0
PV	1	0	1	0	1	2	1	1	2	2
PV	1	0	1	1	3	0	2	0	4	3
PV	1	1	1	1	2	1	1	1	4	0
PV	1	1	1	1	2	1	2	2	2	2
PV	1	1	1	1	2	1	2	2	3	2
PV	0	0	1	1	3	0	0	1	4	0
PV	0	0	0	1	2	2	2	0	4	2
PV	1	1	0	1	2	1	1	1	4	2
PV	1	1	0	0	1	2	1	1	4	3
PV	1	1	1	1	3	1	1	1	4	3
PV	1	0	1	1	2	1	1	1	2	1
PV	0	0	0	0	1	2	2	1	2	1
PV	1	0	1	1	2	1	2	0	2	0
PV	1	0	1	0	1	2	1	0	3	1
PV	1	0	1	0	1	2	2	1	2	1

PV	1	0	1	0	1	2	2	1	3	3
PV	0	0	1	1	2	0	0	0	1	2
PV	1	1	1	1	3	1	1	1	3	3
PV	1	1	1	1	2	2	1	1	2	1
PV	1	1	1	1	2	1	2	0	3	3
PV	0	0	1	1	3	2	1	1	3	3
PV	1	1	1	0	1	2	2	0	4	2
PV	1	0	1	1	2	2	2	1	4	2
PV	1	0	1	1	3	1	1	1	3	3
PV	1	0	0	0	1	2	2	2	4	3
WM	1	1	1	1	4	1	1	0	3	2
WM	1	1	1	1	2	1	1	1	4	3
WM	1	1	1	1	3	2	1	0	3	0
WM	1	1	1	0	2	2	2	2	4	1
WM	1	1	0	1	2	1	2	1	3	3
WM	1	1	1	1	2	2	2	2	3	0
WM	1	1	1	1	3	2	1	1	3	2
WM	1	1	1	1	2	1	1	2	4	2
WM	1	1	1	0	2	1	2	2	3	0
WM	1	1	1	1	2	2	0	0	3	0
WM	1	1	1	1	3	2	1	2	4	0
WM	1	1	1	1	2	1	1	2	3	2
WM	1	1	1	1	4	1	1	0	4	2
WM	1	1	1	1	3	1	1	0	4	3
WM	1	1	1	1	2	1	1	2	4	3
WM	1	1	1	1	2	1	1	2	3	1
WM	0	1	1	1	2	0	1	0	4	0
WM	1	1	1	1	3	1	1	1	4	2
WM	1	1	1	0	2	1	1	2	4	1
WM	1	1	1	1	3	1	1	1	4	3
WM	1	0	1	1	3	1	1	2	2	2
WM	1	1	1	1	3	1	1	1	3	3
WM	1	1	1	1	2	1	2	0	2	2
WM	1	1	1	1	2	1	2	1	2	2
WM	1	1	1	1	2	2	2	2	2	2
WM	1	1	1	1	2	1	1	1	4	3
WM	1	1	1	1	2	1	1	0	2	0
WM	1	1	1	1	3	1	0	1	2	0
WM	1	1	0	1	2	1	2	2	3	0
WM	1	1	1	1	2	1	0	1	2	2
WM	1	1	1	1	3	1	1	1	3	2
WM	1	1	1	1	2	1	1	2	1	2
WM	1	1	1	1	2	1	2	0	2	3
WM	1	1	1	1	3	1	1	0	3	1
WM	1	1	1	1	2	1	1	2	4	2
WM	0	1	1	1	3	1	2	1	4	3
WM	1	1	1	1	3	1	1	1	4	0
WM	1	1	1	1	3	1	1	2	4	2
WM	1	1	1	1	2	1	1	2	4	2
WM	1	1	1	1	2	1	1	1	3	3
WM	1	1	1	1	3	1	1	1	4	3
WM	1	0	1	1	2	1	1	1	3	1
WM	1	1	1	1	2	1	2	1	4	2
WM	1	1	1	1	3	1	1	1	4	0
WM	1	1	1	1	2	1	1	1	1	3
WM	1	1	1	1	2	2	1	0	4	2

WM	1	1	1	1	3	1	2	2	3	3
WM	1	1	1	1	2	1	1	1	4	2
WM	1	1	1	1	2	0	1	1	4	1
WM	1	1	1	1	2	1	1	1	3	1
WM	1	1	1	1	2	1	1	1	4	3
WM	1	1	1	1	3	1	1	1	3	3
WM	1	1	1	1	2	1	1	1	4	2
WM	1	1	1	1	3	1	1	1	4	3
WM	1	1	1	1	3	1	1	0	3	3
WM	1	1	1	1	2	2	1	2	3	3
WM	1	1	1	1	2	1	2	0	3	2
WM	1	1	1	1	3	1	1	1	3	2
WM	1	1	1	1	2	2	2	2	2	3
WM	1	1	1	1	3	1	0	1	4	3
WM	0	1	0	0	1	2	2	2	4	0
WM	1	1	1	0	2	1	1	2	3	2
WM	1	1	1	1	3	1	2	2	3	4
WM	1	1	1	0	2	1	2	0	3	0
WM	1	1	1	1	2	1	1	1	3	1
WM	1	0	1	1	3	1	1	0	2	2
WM	1	1	1	1	2	1	2	2	3	2
WM	1	0	1	1	3	0	0	0	4	0
WM	1	1	1	1	2	1	1	1	4	3
WM	1	0	1	1	3	1	1	1	3	3
WM	1	1	1	1	3	1	1	0	3	3
WM	1	1	1	1	2	2	1	2	4	1
WM	1	1	1	1	3	1	2	1	3	3
WM	1	1	1	1	3	1	2	1	4	1
WM	1	1	1	1	3	1	1	0	4	2
WM	0	1	1	0	1	2	1	2	2	1
WM	1	1	1	1	2	1	2	0	3	2
WM	1	1	1	1	2	1	1	1	4	3
WM	1	1	1	1	2	2	0	0	2	1
WM	1	1	1	1	2	1	1	2	4	2
WM	1	1	1	1	3	1	1	1	3	0
WM	1	1	1	1	2	1	1	0	4	3
WM	1	1	1	1	3	1	1	1	3	1
WM	1	1	1	1	2	2	2	1	0	1
WM	0	1	0	1	3	1	1	0	3	3
WM	1	1	1	1	3	1	1	1	3	3
WM	1	1	1	1	2	1	1	1	4	3
WM	1	1	1	1	2	1	1	1	4	2
WM	1	0	1	1	2	1	1	2	4	2
WM	1	1	1	1	2	0	2	0	4	2
WM	1	1	1	1	3	1	1	0	3	3
WM	1	1	1	1	3	1	1	2	3	0
WM	1	1	1	1	2	1	1	2	4	2
WM	1	1	1	1	2	2	1	0	3	0
WM	1	1	1	1	2	1	2	2	4	3
WM	1	1	1	1	3	1	2	1	4	1
WM	1	1	1	0	2	2	1	1	2	3
WM	1	1	1	1	3	1	1	2	4	0
WM	1	1	1	1	3	1	1	1	3	2
WM	1	1	1	1	2	1	2	2	3	2
WM	1	1	1	1	3	1	1	1	4	1
WM	1	1	1	1	3	1	1	2	4	1

WM	1	1	1	1	3	1	1	0	2	0
WM	1	1	1	1	3	1	1	1	4	2
WM	1	1	1	1	2	1	2	1	4	1
WM	1	1	1	1	3	1	2	2	4	3
WM	0	1	1	1	1	1	1	1	4	2
WM	1	0	1	0	1	2	2	2	3	1
WM	0	1	1	0	1	2	1	2	2	2
WM	1	1	1	1	3	1	1	1	4	2
WM	1	1	1	1	3	1	1	0	0	0
WM	1	1	1	1	4	1	1	0	3	3
WM	1	1	1	1	3	1	1	1	3	0
WM	1	1	1	1	2	1	2	0	4	3
WM	1	1	1	1	3	1	2	2	2	2
WM	1	1	1	1	3	1	1	1	3	0
WM	1	1	1	1	3	0	1	1	4	3
WM	1	1	1	1	3	0	1	1	3	2
WM	1	1	1	1	3	1	1	0	2	2
WM	1	1	1	1	4	1	1	0	3	0
WM	1	1	1	1	3	1	1	1	3	0
WM	1	1	1	1	2	1	2	2	4	0
WM	1	1	1	1	2	1	1	0	3	3
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WM	1	1	1	1	2	0	1	2	3	2
WM	1	1	1	1	2	1	1	1	4	1
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WM	1	1	1	1	3	0	1	1	3	2
WM	1	1	1	1	3	1	1	1	3	0
WM	1	1	1	1	3	1	1	1	4	2
WM	1	1	1	1	2	0	1	2	3	0
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WM	1	1	1	1	3	0	1	0	4	3
WM	1	1	1	1	2	1	1	1	3	1
WM	1	1	1	1	1	0	2	1	2	2
WM	1	1	1	1	2	2	2	0	4	2
WM	0	1	1	1	2	2	1	1	3	2
WM	1	1	1	1	3	0	0	0	3	0
WM	1	1	1	1	3	1	1	1	3	1
WM	1	1	1	1	2	1	1	2	3	2
WM	1	1	1	1	4	1	2	0	3	0
WM	1	1	1	1	3	1	1	1	3	3
WM	1	1	1	1	2	1	2	2	3	2
WM	1	1	1	1	2	2	2	2	4	1
WM	1	1	1	1	3	1	1	1	3	1
WM	1	1	1	1	3	1	2	1	4	3
WM	1	1	1	1	2	1	1	0	3	3
WM	1	1	1	1	3	1	1	1	3	2
WM	1	1	1	1	3	1	1	1	3	1
WM	1	1	1	0	1	2	2	2	2	2
WM	1	1	1	1	2	1	2	0	3	2
WM	1	1	1	1	3	1	1	2	4	2
WM	1	1	1	1	2	1	2	2	3	3
WM	1	1	1	1	2	1	0	2	2	2
WM	1	1	1	1	3	1	1	1	4	2
WM	1	1	1	1	3	1	2	0	2	2
WM	1	0	1	1	2	1	1	2	4	2

```
WM  1  1  1  1  2  2  1  1  3  1
WM  1  1  1  1  3  1  1  1  2  2
WM  1  1  1  1  3  1  1  0  3  3
WM  1  1  1  1  3  1  0  0  4  2
WM  1  1  1  1  3  1  1  0  2  2
WM  1  1  1  1  2  1  1  1  3  2
WM  1  1  1  1  3  1  1  1  3  2
WM  1  1  1  1  2  0  0  0  1  2
WM  1  1  1  1  2  2  2  1  4  3
WM  1  1  1  1  3  1  1  0  4  0
WM  1  1  1  1  2  1  1  1  3  2
WM  1  1  0  1  2  1  0  2  0  0
WM  1  1  1  1  2  1  0  2  4  0
WM  1  1  1  1  2  2  1  2  4  2
;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var liveF;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var PropOwn;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var VisFor;
run;

proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var KnowBB;
run;

proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var Klevel;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var BBProb;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var BBMgmt;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var PayPrev;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var AgeGrp;
run;
proc ttest h0=0 alpha=0.025 data=surveys;
class pop;
Var PolPref;
```

```
run;
proc anova data=surveys;
class pop;
Model KnowBB=pop;
run;

proc anova data=surveys;
class knowBB;
model BBProb=KnowBB;
run;
proc anova data=surveys;
class pop;
model BBProb=pop;
run;
proc anova data=surveys;
class pop;
model BBMgmt=pop;
run;
proc anova data=surveys;
class PolPref;
model BBProb=PolPref;
run;
proc anova data=surveys;
class PolPref;
model PayPrev=PolPref;
run;
proc anova data=surveys;
class PolPref;
model BBMgmt=PolPref;
run;
proc anova data=surveys;
class PropOwn;
model BBProb=PropOwn;
run;
proc anova data=surveys;
class PropOwn;
model PayPrev=PropOwn;
run;
proc anova data=surveys;
class PropOwn;
model BBMgmt=PropOwn;
run;
proc anova data=surveys;
class pop;
model BBMgmt=pop;
run;
proc anova data=surveys;
class pop;
model LiveF=pop;
run;
proc anova data=surveys;
class pop;
model PropOwn=pop;
run;
proc anova data=surveys;
class pop;
```

```
model VisFor=pop;
run;
proc anova data=surveys;
class pop;
model KnowBB=pop;
run;
proc anova data=surveys;
class pop;
model Klevel=pop;
run;
proc anova data=surveys;
class pop;
model BBProb=pop;
run;
proc anova data=surveys;
class pop;
model PayPrev=pop;
run;
proc anova data=surveys;
class pop;
model AgeGrp=pop;
run;
proc anova data=surveys;
class pop;
model PolPref=pop;
run;
proc anova data=surveys;
class KnowBB;
model BBProb=KnowBB;
run;
proc anova data=surveys;
class KnowBB;
model BBMgmt=KnowBB;
run;
proc anova data=surveys;
class KnowBB;
model PayPrev=KnowBB;
run;
proc anova data=surveys;
class BBProb;
model BBMgmt=BBProb;
run;
proc anova data=surveys;
class BBProb;
model PayPrev=BBProb;
run;
```

VII Survey Materials

I. Institutional Review Board Approval Letter

II. Survey Cover Letter

III. Survey

Institutional Review Board for the Protection of Human Subjects in Research

Northern Arizona University
PO Box 4087
Flagstaff, AZ 86011-4087

928-523-4340
928-523-1075 fax
www.research.nau.edu/vpr/IRB

To:	Clairisse Nash-Loucks, M.F.
From:	John McGregor
Date:	June 26, 2015
Subject:	New Project
Review Type:	Exempt Review
Project:	Public perceptions and management of bark beetle outbreaks in Arizona
Project Number:	749350-1
Expiration Date:	None - Exempt
Review Category/ies:	*Exempt 2 - survey*

Your application of New Project materials has been approved by the Institutional Review Board (IRB) at NAU. Your approval will expire on the date listed above. If you need to **extend** your research beyond the approval expiration date above, you must file an Application for Continuing Review at http://www.research.nau.edu/vpr/IRB/irb_forms.html.

If your project **changes** in any way, you must file a Research Amendment form (also available at website above) PRIOR TO implementing any changes. You may not implement the changes until you have written approval for the change from the IRB, unless the change is necessary to eliminate immediate hazards to participants. Failure to do so will result in noncompliance and possible suspension or termination of your research project.

Any unanticipated problems or unexpected **adverse events** must be reported to the IRB within 5 business days (within 24 hours for serious adverse events) of your becoming aware of the event by filling out an Adverse Reaction or Event Reporting form (also available at website above).

Quality Assurance/Quality Improvement Program: In an effort to improve quality and consistency across human subjects research at NAU, you may be contacted by the IRB Director to meet and discuss your procedures and methods of recruiting participants, providing informed consent, collecting and storing data, and other details of your research protocol.

Two copies of your informed consent form, which has been approved and stamped by the IRB, must be given to each study participant - one for them to keep and one for them to sign and return to you.

As you conduct your research, please remember that:
1. Participants are volunteers or are involved in regular educational programs; they are free to withdraw from the research at any time without penalty.

2. Participants must be informed through written or oral explanation and must sign or approve electronically or verbally an informed consent form (for minors and children the parent or guardian must sign, and, in medically related cases, a physician must sign for consent).

3. Unless the participants agreed to an alternative arrangement, the participants' anonymity and confidentiality must be protected. They should not be able to be identified through the responses. The

presentation of the data should not put them at risk of any negative consequences. Access to the data is specified and restricted by the researcher and the department.

Additional IRB information may be found at http://www.research.nau.edu/vpr/IRB/index.htm.

NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry & Natural Sciences

School of Forestry

Northern Arizona University
PO Box 15018
Flagstaff, AZ 86011-5018

928-523-3031
928-523-1080 fax
nau.edu/forestry

Dear Prescott Valley Resident,

Bark beetles are a natural part of forest ecosystems that sometimes get out of control and require intervention by land management agencies such as the U.S. Forest Service. Although public funding is used for such efforts, there is often a disconnection between what land managers do and what the public knows, wants and needs.

We would like to learn what you know about bark beetles and how bark beetles may affect the lives of residents in forested areas surrounding Prescott Valley, Arizona. You live in an area that has had bark beetle outbreaks in the past and as a resident of Prescott Valley you have been randomly selected to participate in this survey.

We understand that your time is valuable and ask that you take a few moments to fill out the enclosed questionnaire about bark beetles and return it in the postage-paid return envelope provided OR, if you prefer, you can use a computer with internet access to visit the following webpage link and complete the questionnaire on-line:

https://www.surveymonkey.com/r/barkbeetlesurveyprescott

Even if you do not know what bark beetles are, your input is very important, as you are a part of a select group of individuals whose responses will represent the population of Prescott Valley. Participation in this study is completely voluntary. If you choose to participate, your responses will be kept anonymous and there will be no documents linking your survey responses to your name. Feel free to contact me if you have any questions about the survey. My contact information is below.

Sincerely,

C. Nash-Loucks
Nash-Loucks Research
Northern Arizona University
School of Forestry Entomology Lab
cen36@nau.edu

NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry & Natural Sciences

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nau.edu/forestry

Dear White Mountains Resident,

Bark beetles are a natural part of forest ecosystems that sometimes get out of control and require intervention by land management agencies such as the U.S. Forest Service. Although public funding is used for such efforts, there is often a disconnection between what land managers do and what the public knows, wants and needs.

We would like to learn what you know about bark beetles and how bark beetles may affect the lives of residents in forested areas surrounding the White Mountains, Arizona. You live in an area that has had bark beetle outbreaks in the past and as a resident of the White Mountains you have been randomly selected to participate in this survey.

We understand that your time is valuable and ask that you take a few moments to fill out the enclosed questionnaire about bark beetles and return it in the postage-paid return envelope provided, OR, if you prefer, you can use a computer with internet access to visit the following webpage link and complete the questionnaire on-line:
https://www.surveymonkey.com/r/BeetleSurveyWhiteMountains

Even if you do not know what bark beetles are, your input is very important, as you are a part of a select group of individuals whose responses will represent the population of the White Mountains. Participation in this study is completely voluntary. If you choose to participate, your responses will be kept anonymous and there will be no documents linking your survey responses to your name. Feel free to contact me if you have any questions about the survey, my contact information is below.

Sincerely,

C. Nash-Loucks

C. Nash-Loucks
Nash-Loucks Research
Northern Arizona University
School of Forestry Entomology Lab
cen36@nau.edu
928-814-3627

1. Do you live in or near a forested area? Yes [ ] No [ ]

(a) Are you a property owner? Yes [ ] No [ ]

(b) If you answered "yes" to the question above, is your property located in or near a forested area?
Yes [ ] No [ ]

2. Do you visit a forested area for recreation (i.e. camping, hunting, hiking, bird watching, etc)?

Yes [ ] No [ ]

3. Do you know what bark beetles are? Yes [ ] No [ ]

4. In your own opinion, how would you rate your knowledge of bark beetles? (Please check one):

None [ ] A little [ ] Moderate [ ] Expert [ ]

5. (a) Do you feel that bark beetles are a problem in your area? Yes [ ] No [ ] Don't Know [ ]

(b) If you answered "yes" to the question above, how severe do you think the problem is?

Tolerable [ ] Minor nuisance [ ] Major disturbance [ ]

(c) If "yes," which bark-beetle related topics are most important to you? (Check all that apply):

Aesthetics/Scenery [ ] Increased Fire Risk [ ] Wildlife [ ] Tree Health [ ]

Recreation/Hunting [ ] Other (please specify) [ ]_____

6. Do you feel that land managers should intervene to reduce the impact of bark beetles?

Yes [ ] No [ ] Don't Know [ ]

7. (a) If given the opportunity, would you pay to prevent bark beetle activity on your property?

Yes [ ] No [ ] Don't Know [ ]

(b) If yes to the above, how much is an acceptable amount of money to pay to manage bark beetles on your property? (Please check one):

Less than $100 [ ] $100-$500 [ ] $500-$1,000 [ ] More than $1,000 [ ]

8. If given the opportunity to learn more about bark beetles, what would you like to know? (Please describe):_____
_____

9. What is your age range? (Please check one) 18-30[ ] 31-50[ ] 51-65[ ] 65+[ ]

10. What is your preferred political party? Democrat [ ] Republican [ ] Independent/Other [ ]

Thank you for your time! The results of this survey will allow land managers to consider your point of view when managing for bark beetles. By returning this survey, you are agreeing that you consent to participate and that you are at least 18 years of age.

PO Box 15018, Flagstaff, AZ 86011-5018 (928) 523-6452 www.for.nau.edu

1. Do you live in or near a forested area? Yes [ ] No [ ]

(a) Are you a property owner? Yes [ ] No [ ]

(b) If you answered "yes" to the question above, is your property located in or near a forested area?
Yes [ ] No [ ]

2. Do you visit a forested area for recreation (i.e. camping, hunting, hiking, bird watching, etc)?

Yes [ ] No [ ]

3. Do you know what bark beetles are? Yes [ ] No [ ]

4. In your own opinion, how would you rate your knowledge of bark beetles? (Please check one):

None [ ] A little [ ] Moderate [ ] Expert [ ]

5. (a) Do you feel that bark beetles are a problem in your area? Yes [ ] No [ ] Don't Know [ ]

(b) If you answered "yes" to the question above, how severe do you think the problem is?

Tolerable [ ] Minor nuisance [ ] Major disturbance [ ]

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Yes [ ] No [ ] Don't Know [ ]

7. (a) If given the opportunity, would you pay to prevent bark beetle activity on your property?

Yes [ ] No [ ] Don't Know [ ]

(b) If yes to the above, how much is an acceptable amount of money to pay to manage bark beetles on your property? (Please check one):

Less than $100 [ ] $100-$500 [ ] $500-$1,000 [ ] More than $1,000 [ ]

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_____

9. What is your age range? (Please check one) 18-30[ ] 31-50[ ] 51-65[ ] 65+[ ]

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Thank you for your time! The results of this survey will allow land managers to consider your point of view when managing for bark beetles. By returning this survey, you are agreeing that you consent to participate and that you are at least 18 years of age.

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VIII Raw Data

I. Verbatim Raw Data
II. Adjusted Raw Data

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0	1		0	1	1	2	1	3	1,2,3,4,5	
0	1		0	0	1	2	2	n	n	
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1	1		1	1	1	3	1	3	2,3,4,6-clin	
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0	1		0	1	1	2	0	n	n	
1	0	n		1	1	2	1		2	4
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0	1			0	0	0	0	2	n	n	

White Mountains

1	1a		1b		2	3	4	5a		5b	5c	
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1	1	1	1	1	2	1	3	1,2,3,4,5
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1 n		1	1	1	2	1	1	2,4
1	1	1	1	1	2	1	1	1,2,3,4,5
1	1	1	1	1	3	1 n		1,2,4,5
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1	1	0	1	1	3	1	2	4,5
1	1	1	1	1	2	1	3	1,2,4
1	1	1	1	1	3	1	3	2,4
1	1	1	1	1	3	1	3	2,4

1	1	1	1	1	2	2	n	2
1	1	1	1	1	2	1	3	1,2,3,4,5
1	1	1	1	1	3	1	2	1,2,3,4
1	1	1	1	1	2	2	n	n
1	1	1	1	1	3	1	3	2,4
0	1	n	0	0	1	2	n	n
1	1	1	1	0	2	1	2	1,2,3,4,5
1	1	1	1	1	3	1	n	2,4
1	1	n	1	n	2	1	3	2,4
1	1	1	1	1	2	1	3	1,2,3,4,5,6-
1	0	n	1	1	3	1	3	2,4
1	1	0	1	1	2	1	1	1,2,4
1	0	n	1	1	3	0	n	n
1	1	1	1	1	2	1	3	1,2,4
1	0	n	1	1	3	1	3	1,2,3,4,5,6-
1	1	1	1	1	3	1	2	1,4
1	1	1	1	1	2	2	n	n
1	1	1	1	1	3	1	2	1,2,3,4
1	1	1	1	1	3	1	2	2
1	1	1	1	1	3	1	3	1,2,4
0	1	0	1	0	1	2	n	n
1	1	1	1	1	2	1	2	4
1	1	1	1	1	2	1	1	2,4
1	1	1	1	1	2	2	n	n
1	1	1	1	1	2	1	3	1,2,3,4,5
1	1	1	1	1	3	1	n	2,4,5
1	1	1	1	1	2	1	3	1,2,3,4,6-w
1	1	1	1	1	3	1	3	1,4
1	1	0	1	1	2	2	3	1,2,3,4
0	1	0	0	1	3	1	3	4
1	1	1	1	1	3	1	3	2,4
1	1	1	1	1	2	1	2	1,4,5
1	1	1	1	1	2	1	2	1,2,3,4
1	0	n	1	1	2	1	3	2,4,5
1	1	1	1	1	2	0	n	n
1	1	1	1	1	3	1	3	2,4
1	1	1	1	1	3	1	3	1,2,4
1	1	1	1	1	2	1	3	1,2,3
1	1	1	1	1	2	2	n	n
1	1	1	1	1	2	1	2	n
1	1	1	1	1	3	1	2	4
1	1	1	1	0	2	2	n	n
1	1	1	1	1	3	1	1	1,2,3,4,5
1	1	1	1	1	3	1	3	4
1	1	1	1	1	2	1	2	4
1	1	1	1	1	3	1	1	1,2,4
1	1	1	1	1	3	1	3	1,2,3,4

1	1	1	1	1	3	1	3	2,3,4
1	1	1	1	1	3	1	3	1,2,4,6-pot
1	1	1	1	1	2	1	3	1,2,3,4,5
1	1	1	1	1	3	1	2	1,4
0	1	0	1	1	1	1	3	2,4
1	0	n	1	0	1	2	n	2
0	1	0	1	0	1	2	n	n
1	1	1	1	1	3	1	3	1,2,3,4,5,6-
1	1	0	1	1	3	1	n	1,2,3,4,5
1	1	1	1	1	4	1	3	2
1	1	1	1	1	3	1	2	1,2,3,4,5
1	1	n	1	1	2	1	2	2,3,5
1	1	1	1	1	3	1	3	2,3,4
1	1	1	1	1	3	1	3	1,4,5,6-pro
1	1	1	1	1	3	n	2	1,3,4
1	1	1	1	1	3	0	n	2,4,5
1	1	0	1	1	3	1	3	1,2,3,4,5
1	1	1	1	1	4	1	3	1,2,3,4,5,6-
1	1	1	1	1	3	1	3	1,2,3,4,5
1	1	1	1	1	2	1	3	4
1	1	1	1	1	2	1	3	1,2,3,4
1	1	1	1	1	3	1	3	1,2,3,4
1	1	1	1	1	2	1	2	1,2,4
1	1	1	1	1	2	0	n	n
1	1	1	1	1	2	1	2	1,2,4,6-wo
0	1	0	1	1	2	1	n	1,3,4,5
1	1	1	1	1	3	0	n	n
1	1	1	1	1	3	1	3	1,2,4
1	1	1	1	1	3	1	3	2,3,4,5
1	1	1	1	1	2	0	n	n
1	1	1	1	1	3	1	3	1,2,3,4,5
1	1	1	1	1	3	n	n	n
1	1	1	1	1	2	1	2	2,4
1	1	1	1	1	1	0	n	n
1	1	1	1	1	2	2	n	n
0	1	0	1	1	2	2	n	n
1	1	1	1	1	3	0	n	n
1	1	1	1	1	3	1	2	1,2,4
1	1	1	1	1	2	1	1	1,2,3,4,5
1	1	1	1	1	4	1	1	4
1	1	1	1	1	3	1	3	1,2,3,4,5
1	1	1	1	1	2	1	3	1,2,4
1	1	1	1	1	2	2	1	4
1	1	1	1	1	3	1	3	4
1	1	1	1	1	3	1	3	1,2,4
1	1	1	1	1	2	1	3	2,3,4,5
1	1	1	1	1	3	1	3	1,2,4

1	1	1	1	1	3	1	3	1,2,3,4,5
1	1	1	1	0	1	2	n	n
1	1	1	1	1	2	1	3	1,2,4
1	1	1	1	1	3	1	2	4
1	1	1	1	1	2	1	3	1,2,3,4
1	1	1	1	1	2	1	2	1,2,3,4
1	1	1	1	1	3	1	3	2,3,4,5,6-p
1	1	0	1	1	3	1	3	2,4
1	n	1	1	1	2	1	3	1,2,4
1	1	1	1	1	2	2	n	n
1	1	1	1	1	3	1	3	1,2,4,6-dec
1	1	1	1	1	3	1	2	1,2,4,6-too
1	1	1	1	1	3	1	2	2,3,4
1	1	0	1	1	3	1	2	1,4,5
1	1	1	1	1	2	1	3	1,2,3,4,5
1	1	1	1	1	3	1	2	1,2,3,4
1	1	1	1	1	2	0	n	n
1	1	1	1	1	2	2	n	n
1	1	1	1	1	3	1	2	2
1	1	1	1	1	2	1	3	1,2,4,5,6-p
1	1	1	0	1	2	1	3	1,2,3,4,5
1	1	1	1	1	2	1	2	1,2,3,4,5
1	1	1	1	1	2	2	n	n

6	7a	7b	8	9	10
1		2	1 Do they afl	2	2
1		0 n	n	4	3
1	n	n	n	4	3
1		1	2 How to tak	4	2
1	n	n	general inf	4	2
2		1	2 n	3	2
1		1	2 n	4 n	
1		1	2 n	4	3
1		1	1 n	2	3
2		2 n	Are they fc	4	1
1		2 n	If they are	4	1
1		0 n	n n	n	
2		0 n	n	2 n	
1		0	2 n	4	2
1		2 n	How seriou	3 n	
1		0 n	n	4	3
1		1	1 n	4 n	
1		1	4 It appears	2	3
1		1	1 How to pre	1 n	
2		2 n	n	4	1
1		1	1 What they	4	2
2		2 n	population	3	1
1		1	3 n	3	2
1		2 n	n	3	3
2		1	1 n	3 n	
1		0 n	n n		3
1		1	2 n	3	3
2		2	1 What are t	4	3
1		1	2 Prevention	3	2
2	n	n	n	2 n	
1		0 n	I am retire	3	2
1		2 n	n	4 n	
2		2 n	General int	3	3
1		1	2 All things g	3	2
1		1	2 I will googl	1	1
1		2 n	n	2	2
1	n	n	n	4 n	
1		1	1 n	4	2
1		1	2 n	4 n	
1		1	1 Which and	4	3
2		2 n	n n	n	
2		2	2 What signs	3	2
0		0 n	Sure would	2	3
1		1	2 Everything	2	1
2		2 n	n	2	3
1		1	1 n	4	3

1		2	n		**What is be**	4	3
2		2	n		**n**	3	n
1		2	n		**The area w**	4	n
2		0	n		**Are they n**	3	n
2		2	n		**n**	4	2
1		1		1	**n**	4	2
1		1		2	**n**	3	2
2		1		2	**Do birds pr**	4	1
1		2		1	**n**	3	2
1		1		2	**n**	4	2
1		2	n		**How much**	4	3
1		1		1	**Appearanc**	4	2
2		1		2	**n**	2	3
2		2	n		**What they**	3	3
1		2	n		**n**	4	1
2		2	n		**n**	3	n
1		1		1	**Are these t**	4	3
1		1		4	**n**	3	3
1		2		1	**If they are**	1	3
1		1		1	**n**	4	n
1	n			1	**n**	3	n
1		1		1	**n**	3	n
1		2	n		**Park servic**	3	n
2		0	n		**n**	4	3
2		0	n		**If you cut d**	3	2
1		1		2	**Estimated**	2	1
1		1		2	**I am forest**	4	n
2		0	n		**n**	3	n
1		1		1	**Would like**	2	3
1		0	n		**n**	4	2
1		0	n		**n**	2	3
1		0	n		**n**	3	2
1		0	n		**n**	2	3
1		2	n		**What it tak**	4	2
0		0	n		**I would like**	2	2
2		0		1	**n**	4	3
1		2		2	**n**	4	n
2		2	n		**n**	4	3
2		2	n		**To what ne**	3	2
1		2	n		**n**	2	2
1		2		2	**n**	4	1
1		1		1	**What they**	3	3
1		0	n		**nothing**	4	n
2		2	n		**I know tha**	4	3
2		2	n		**What they**	2	3
1		1		1	**Not really**	3	n
1		2	n		**What are t**	2	3

1		1		2	Naure of th		4		2
2		1		2	What are b		4		3
2		2	n		A public av		4		2
2		2	n		n		4		2
1		2	n		n		4		2
1	n		n		n		4		2
1		1		1	How to kee		4		1
2		2	n		Not at this		3		2
1		1		1	n		2		3
2		2	n		n		3		2
1		1		4	Description		4		3
1		0	n		n		4	n	
1		1		3	Yes it woul		2		2
1		1	n		Yes		4		3
1		2	n		n		2		2
1		1		2	n		4		2
1		2		1	By the time		3		1
1		1	n		n		4		1
1		1		2	n		3	n	
1		1		1	I would like		2		1
1		2		2	Only last w		4		3
1		2	n		n		4		2
2		0	n		n		3	n	
1	n		n		n		4		2
2		2	n		n		2		3
1		1		2	What do th		3		3
2		3		2	type of tree		4		3
2		2	n		Their appe		4		1
1	n		n		Where do t		4		2
1		2	n		n		3		2
2		2		1	Which one		3		2
2		2	n		n		3		1
1		2	n		n		2	n	
1		2	n		n		4		3
1		1		1	n	n		n	
1		1		2	What we a		4		1
0		2	n		n		2		3
1		1		2	Yes-how to		2		1
1		2	n		How to pre		2		2
2		1		2	How to spo		3		2
0		1		1	Yes-maybe		2		2
1		1		1	n		4		2
1		1		2	How to ide		4		1
2		2	n		Life cycle a		2		3
2		2	n		n		4		2
1		1		2	n		3		2
2		1		1	Which tree		4		2

	1		1		2	**Normal act**		3	n	
	1		1		2	**Is there an**		4		3
	1		1		2	**How to kill**		2		3
	2		1		1	**How would**		3	n	
	2		2	n		**Prevention**		1	n	
	1		1		1	**too late no**		4		3
	1		1		1	**How to cat**		4		2
	1		2	n		**What is a b**		4		3
	2		2		2	**n**		4		2
	2		2	n		**Interested**		4		2
	2		0	n		**n**	n		n	
	1		1		1	**n**		2		2
	2	n		n		**Maybe we**		4		3
	1		1		1	**n**		4	n	
	2		2	n		**More infor**		2		2
	2		2		1	**If I could p**		3		2
n			1		4	**n**		4	n	
	2		0	n		**n**		4		2
	1		1		1	**n**		4		2
	1		1		1	**n**		4		3
	1		1		1	More abou		4		3
	1		1		2	all aspects		2		1
	2		1		2	How they a		2		1
	2	n		n				2	n	
	1	n		n		how are th		3		1
	2		1		1	ok.		2		1
	2		1		1	How do the		3		3
	0		0	n		Easiest way		1		2
	1		1		2	Their role i		3		3
	1		1		2	Is there a w		2		1
	2	n		n				3		3
	1		1		2			3		3
	2	n		n		(1.) What t		4		2
	2		1		1	**n**		4		2
	1		1		1	**n**		3		3
	2		2	n		**n**		4		3

6	**7a**	**7b**	**8**	**9**	**10**
1	0 n		I think the	3	2
1	1	1	How to get	4	3
1	0 n		n	3 n	
2	2 n		Are they do	4	1
2	1	2	A little - wh	3	3
2	2 n		More impo	3 n	
1	1	2	I would like	3	2
1	2 n		How to get	4	2

	2	2	n		n	3	n
	0	0	n		Yes	3	n
	1	2	n		n	4	n
	1	2		2	Not sure	3	2
	1	0		2	n	4	2
	1	0	n		more abou	4	3
	1	2		1	n	4	3
	1	2	n		n	3	1
	1	0	n		n	4	n
	1	1		2	What, if an	4	2
	1	2	n		What areas	4	1
	1	1		1	How can I p	4	3
	1	2		3	n	2	2
	1	1		2	How can I c	3	3
	2	0	n		Why we ha	2	2
	2	1		2	Yes-how ha	2	2
	2	2	n		n	2	2
	1	1		1	How to sto	4	3
	1	0	n		Maybe	2	n
n		1		2	Other than	2	n
	2	2	n		n	3	n
	0	1		1	Yes. Bark b	2	2
	1	1		1	FYI - If you	3	2
	1	2	n		n	1	2
	2	0	n		Have a clas	2	3
	1	0	n		Good stew	3	1
	1	2	n		n	4	2
	2	1		2	n	4	3
	1	1		4	n	4	n
	1	2	n		Is the sprea	4	2
	1	2	n		n	4	2
	1	1		2	n	3	3
	1	1		1	Who is lice	4	3
	1	1		1	How to ide	3	1
	2	1		2	n	4	2
	1	1		4	n	4	n
	1	1		1	Why they'r	1	3
	1	0	n		Where the	4	2
	2	2	n		n	3	3
	1	1		2	n	4	2
	1	1		2	n	4	1
	1	1		4	n	3	1
	1	1		2	n	4	3
	1	1		2	Need to rel	3	3
	1	1		2	n	4	2
	1	1		2	How to elir	4	3
	1	0	n		In history h	3	3

1		2	n		They shoul	3	3
2		0	n		n	3	2
1		1		1	n	3	2
2		2	n		n	2	3
0		1		1	n	4	3
2		2	n		How destru	4	n
1		2		1	How to spc	3	2
2		2	n		The reprod	3	4
2		0	n		n	3	n
1		1		4	How to try	3	1
1		0	n		n	2	2
2		2	n		What a be	3	2
0		0	n		Bark beetle	4	n
1		1		1	What good	4	3
1		1		3	What is the	3	3
1		0	n		I would like	3	3
1		2	n		n	4	1
2		1		2	Yes - need	3	3
2		1		1	n	4	1
1		0	n		Why bark b	4	2
1		2	n		Read on int	2	1
2		0	n		n	3	2
1		1		2	How to ide	4	3
0		0	n		Yes, if I nee	2	1
1		2	n		n	4	2
1		1		3	n	3	n
1		0	n		How to cor	4	3
1		1		1	n	3	1
2		1		2	How to ide n		1
1		0	n		n	3	3
1		1	n		n	3	3
1		1		2	How can a	4	3
1		1		2	n	4	2
1		2	n		Anything I	4	2
2		0	n		Don't know	4	2
1	n		n		n	3	3
1		2	n		I have 9 acı	3	n
1		2	n		Affected ar	4	2
1		0	n		n	3	n
2		2	n		n	4	3
2		1		4	Short of m	4	1
1		1		1	How to ide	2	3
1		2		2	How to sto	4	n
1		1		3	Life cycle, r	3	2
2		2	n		n	3	2
1		1		2	n	4	1
1		2		2	Any reason	4	1

1	0	n		n	2	n	
1	1		4	How to pro	4		2
2	1		2	How to era	4		1
2	2	n		A: the abilit	4		3
1	1		1	I only have	4		2
2	2	n		n	3		1
1	2	n		n	2		2
1	1		2	We must th	4		2
1	0	n		n	n	n	
1	0	n		n	3		3
1	1		2	How do you	3	n	
2	0	n		n	4		3
2	2	n		n	2		2
1	1		3	All advance	3	n	
1	1		1	n	4		3
1	1		3	n	3		2
1	0	n		How to get	2		2
1	0	n		Why the tr	3	n	
1	1		2	Why has it	3		0
2	2	n		n	4	n	
1	0	n		What they	3		3
1	1		1	How they b	2		2
1	1		1	n	4		2
1	2	n		n	3		2
1	1		3	The life cyc	4		1
2	0	n		How they g	2		2
1	1		2	What can b	3		2
1	1		2	Why we ca	3	n	
1	1		1	n	4		2
1	2		2	How to rec	3	n	
1	1	n		n	3		3
1	0	n		Is there an	4		3
1	1		3	n	3		1
2	1		1	no, not unl	2		2
2	0	n		n	4		2
1	1		1	n	3		2
0	0	n		no	3	n	
1	1		2	What's the	3		1
1	2	n		How bad th	3		2
2	0	n		What can b	3	n	
1	1		1	How to sto	3		3
2	2	n		What they	3		2
2	2		1	n	4		1
1	1		3	n	3		1
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1	0	n		n	3		3
1	1		2	How to kill	3		2

	1		1		1	What are e		3	1
	2		2	n		n		2	2
	2		0	n		n		3	2
	1		2	n		not at this		4	2
	2		2		1	n		3	3
	0		2		1	How to nat		2	2
	1		1		4	Their breec		4	2
	2		0	n		n		2	2
	1		2	n		How can th		4	2
	1		1		1	n		3	1
	1		1		2			2	2
	1	n		n				3	3
	0		0	n				4	2
	1		0	n		No		2	2
	1		1		4	How to get		3	2
	1		1		2	What can b		3	2
	0		0	n		What the h		1	2
	2		1		2	n		4	3
	1		0		1	n		4	n
	1		1		2	Prevenativ		3	2
	0		2	n		n	n	n	
n			2	n		n		4	n
	1		2	n		n		4	2

P1	W1	P1A	W1A	P2	W2	P3
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W3	P4	W4	P5	W5	P6	W6	
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