ENVIRONMENTAL VALUES OF CALIFORNIA WINEGRAPE GROWERS AND THE USE OF BARN OWLS (*TYTO ALBA*) AS A TOOL FOR INTEGRATED PEST MANAGEMENT

By

Brooks Estes

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Committee Membership

Dr. Matthew D. Johnson, Committee Chair

Dr. Barbara Clucas, Committee Member

Dr. Gregg J. Gold, Committee Member

Dr. J. Mark Baker, Program Graduate Coordinator

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ABSTRACT

ENVIRONMENTAL VALUES OF CALIFORNIA WINEGRAPE GROWERS AND THE USE OF BARN OWLS (*TYTO ALBA*) AS A TOOL FOR INTEGRATED PEST MANAGEMENT

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Landscape conversion and impacts of synthetic pesticides from agriculture pose threats to natural habitats critical to preserving biodiversity and ecosystem services. Pest management is a concern for all agriculture, and many conventional practices can negatively affect the environment through drift, runoff, and harming non-target species. Winegrapes are particularly at risk of damage from rodents, which can girdle vines and destroy root systems.

One alternative to reduce rodent numbers that has shown promise in agriculture is the use of barn owl (*Tyto alba*) boxes. The Johnson Lab at Humboldt State University has been researching barn owl behavior and ecology in vineyards in Napa Valley, CA, and this thesis builds on this work. Seeking to better understand how farmers' underlying environmental values relate to the use of barn owl boxes and other sustainable practices, a survey was conducted of 71 California grapegrowers. Overall, more grapegrowers had mutualist value orientations (64%) than found in other populations. However, there was a disconnect between the use of barn owl boxes and environmental value orientations, with most respondents (80%) reporting the use of owl boxes regardless of underlying values.

These results suggest the use of barn owl boxes is experiencing a normalization and a diminution in their perception as a progressive practice. This opens the door for future research to examine whether this is true of other sustainable winegrowing techniques and advance our understanding of the relationships between values and sustainable farming methods.

ACKNOWLEDGEMENTS

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INTRODUCTION

Of the Earth's 104 million km^2 of ice-free habitable land, 50% is used for agriculture (51 million km^2), and 23% of this is used for the production of crops for human consumption (11 million km^2) – an area equivalent to that of the East Asia-Pacific from the northern border of China to the southern tip of Thailand (Ritchie & Roser, 2019). Crop production on this land is necessary to sustain human health and wellbeing, yet there are 820 million people on this planet that do not have access to sufficient food, and even more who suffer from nutrient deficiencies as a result of low-quality diets (Willett et al., 2019). Agricultural expansion and intensification negatively impacts the environment, contributes to global climate change, and drives biodiversity loss and species extinction (Chaudhary, Pfister, & Hellweg, 2016; Foley, 2005; Karp et al., 2012; Willett et al., 2019). In the face a projected global population of nine billion by 2050, addressing the dual crises of food security and agricultural impacts on biodiversity with status quo farming practices is simply not sustainable (Godfray et al., 2010; Tilman, Balzer, Hill, & Befort, 2011; Willett et al., 2019).

This grim reality is prompting increased attention to strategies that increase food production while decreasing environmental degradation (Kremen & Merenlender, 2018; Tilman et al., 2011). A key component to the pursuit of more sustainable crop production is the recognition and maintenance of ecosystem services, the ecological functions delivered by nature that benefit human, including agriculture. Vital ecosystem services in agricultural production include everything from crop pollination to pest control to maintenance of soil fertility (Cumming & Spiesman, 2006; Zhang, Ricketts, Kremen, Carney, & Swinton, 2007). At the core of many sustainability schemes is the leveraging of beneficial ecosystem services and decreasing the impact of ecosystem disservices, namely pests and disease (Howarth & Farber, 2002; Kremen & Merenlender, 2018; Sagoff, 2007; S. M. Swinton et al., 2015; Scott M. Swinton, Lupi, Robertson, & Hamilton, 2007; Zhang et al., 2007).

One example of this is integrated pest management (IPM), which is founded upon the idea that pest eradication is an unrealistic and unnecessary goal. Rather, agriculture can maintain profitability by leveraging ecosystem services to manage pests (Stern, Smith, van den Bosch, & Hagen, 1959). In IPM there is always a threshold below which the economic and environmental cost of synthetic pesticides is not justified, however, that means that there is a point at which such interventions are justified, making IPM a highly adaptable and universal approach (Alston, 2011; Radcliffe, Hutchison, & Cancelado, 2009; Stern et al., 1959). At the core of IPM is the idea of biological control via the use of natural pest predators, ranging from ladybugs (*Coccinellidae*) to control aphid (*Aphidoidea*) populations, to barn owls (*Tyto alba*) to control rodent pests (Cumming & Spiesman, 2006; Naranjo, Ellsworth, & Frisvold, 2015). The principles of IPM are gaining popularity across agriculture broadly, and winegrape growing has been particularly successful at promoting IPM at an institutional level (Viers et al., 2013; Winkler, Viers, & Nicholas, 2017). And in the United States, California is responsible for the lion's share of wine production.

California farms account for about 3% (~25 million acres) of US agricultural land (United States Department of Agriculture [USDA], 2019, p. 264), but California is the leading state in terms of cash receipts, accounting for 13% of the nation's agricultural value at $50 billion, nearly double the next most profitable state, Iowa at $27 billion (California Department of Food and Agriculture [CDFA], 2018). The top agricultural commodity in California is dairy products, valued at $6.37 billion, followed closely by the most valuable crop in the state, grapes, valued at $6.25 billion (CDFA, 2018).

California produces 85% of US wine, and grapes are the most valuable crop in the state, surpassing almonds in 2017 (CDFA, 2018); as such the industry has the potential to be highly influential when it comes to management strategies, including pest management. Pest management is often a highly toxic and destructive endeavor; new, innovative, and more natural options are increasingly important to prevent continued environmental degradation (Tscharntke et al., 2012). One idea that has recently gained in popularity is the use of nest boxes designed to attract barn owls (*Tyto alba*) as means of controlling harmful rodent pests (Labuschagne, Swanepoel, Taylor, Belmain, & Keith, 2016). There are currently at least 1,000 barn nest boxes in one of California's Napa Valley winegrowing region alone, and ongoing research on a sample of about 300 of them shows that between a third to a half of the boxes are being occupied by nesting barn owls each year (Huysman, 2019). Wendt and Johnson (2017) completed an exploratory survey in 2015 that suggested a generally positive attitude among Napa wine producers toward the utility of barn owls for rodent control. However, the survey was preliminary and warrants further, more in-depth research. This thesis builds on this work by completing a mixed methods research project investigating how vineyard producers in California view barn owls as a tool of integrated pest management (IPM), with a focus on knowledge, values, and attitudes.

The New World Mediterranean

Biodiversity is critical for maintaining healthy, functioning ecosystems. Protected areas intended to preserve native species are vital for protecting species in specific geographic areas, but they are insufficient to preserve diversity of ecosystems as a whole (Cox & Underwood, 2011; Karp et al., 2012; Tscharntke et al., 2012). Of particular concern are ecosystems in New World Mediterranean (NWM) biomes, regions with cool wet winters and warm dry summers, located in Chile, Australia, South Africa, and California. These areas constitute only 2% of the land on Earth but support more than 20% of all vascular plant species and harbor many species, both plant and animal, that are unique to these ecosystems (Cox & Underwood, 2011; Viers et al., 2013). Due to their mild climates and desirable locations, NWM regions feature large, densely populated metropolitan centers; California in particular is home to nearly three fourths of the 50 most densely populated metropolitan areas in the US (Maciag, 2012), and its population is increasing faster than in any other NWM region (Williams, 2013). Moreover, these regions are projected to be disproportionally impacted by climate change in the coming century (Hannah et al., 2013; Klausmeyer & Shaw, 2009; Loarie et al., 2008), with shifting conditions potentially having significant effects on habitat suitability for both wildlife and agricultural use (Viers et al., 2013).

Although 9% of land in California qualifies as category I-IV under the International Union for Conservation of Nature's (IUCN) protected areas categories system (prioritizing the protection of biodiversity), much of California is fragmented by agricultural land (Cox & Underwood, 2011; Underwood et al., 2009). Agriculture plays a significant role in decreasing biodiversity through the homogenization of landscapes for crop cultivation (Bianchi, Booij, & Tscharntke, 2006; Tscharntke et al., 2012). However, agricultural lands also have the potential to encourage valuable ecosystem services, such as pest management, if sustainably managed (Viers et al., 2013; Winkler et al., 2017). In California, one agricultural sector of particular interest is winegrape cultivation.

Importance of California Viticulture

The same mild conditions that make Mediterranean regions a hotspot for biodiversity and human activity also make them ideally suited for the cultivation of winegrapes, a practice dating back over 7000 years in the Mediterranean Basin itself (Viers et al., 2013). In California nearly 38% of land is classified as cropland (National Agricultural Statistics Service [NASS], 2014). Producing 85% of all wine in the United States, California is home to more than 4,700 wineries farming 602,000 acres of winegrapes, the most valuable crop in the state (CDFA, 2018; Wine Institute of California, 2017). Only about 2% of cropland in California is used for cultivation of winegrapes, but these accounted for nearly 6% of the total value of California's over 200 crops in 2017 (CDFA, 2019). So, while not using the most agricultural land, winegrape cultivation is particularly visible and economically important for the state as it has a high per-acre value and is intimately linked with the tourism and hospitality industries (Dyer, 2015; Mueller & Sumner, 2006).

Generally a monoculture, winegrape growing results in the simplification of landscapes, with initial cultivation frequently requiring the removal of native vegetation, often in especially sensitive areas such as riparian corridors and oak woodlands (Cox & Underwood, 2011; Merenlender, 2000). Vineyard development also leads to the degradation of remaining habitat through actions such as ground and surface water removal, which alters aquatic habitats and results in decreased ecosystem functions and biodiversity (Viers et al., 2013). However, wine also has a unique relationship with place that may mean producers are more amenable to less impactful management (Charters, 2010; Trubek, 2008).

Wine is closely linked with the concept of *terroir*; a French term with no English equivalent, it is generally understood to be the combination of environmental factors influencing the maturation of winegrapes that imbue them with a unique set of characteristics that are reflected in the wine produced from them. This includes a broad array of variables including soil composition, topography, climate, and cultivation practices (Gladstones, 2011), encapsulated by wine critic Matt Kramer as "somewhereness" (Kramer, 1990). In the United States wines are geographically classified by their federally recognized American Viticultural Area (AVA), of which there are over 100 in California alone; and above that California AVAs are located within one of six regions (Mueller & Sumner, 2006). This embedded sense of place and the association of natural conditions with wine quality and character are strong influences for farmers to pursue cultivation practices that allow them to maintain a consistent image and product. One aspect of this is the use of chemicals for pest reduction, the application of which may impact the *terroir* of the wine or at least the perception thereof (Caboni & Cabras, 2010; Willcox, 2019). For this reason, many wine producers have moved to more ecologically minded management schemes, often following guidelines from one or more of the numerous grower's associations in California (Silverman, Marshall, & Cordano, 2005; Viers et al., 2013). While these kinds of associations are not wholly unique to wine, California's wine associations play a significant role in the adoption of more sustainable practices by their members. They emerged specifically as a self-governing effort in response to sociopolitical conflicts arising as the industry was expanding in the state (Broome & Warner, 2008).

History of the California Wine Industry

The history of winemaking in California is brief compared to its European counterparts. The first vineyard in what would become the State of California was established by the first Spanish Franciscan Mission in 1769, and the industry grew in response to increasing demand through the Gold Rush of the mid-1800s and was just branching out as a global export in the early 1900s before the 1920 institution of prohibition nearly wiped it out (Borg, 2016). By the end of prohibition in 1933, less than 100 commercial wineries remained in the US, a 96% drop from pre-prohibition numbers, and by 1960 there were still only 271 (Borg, 2016; Pinney, 2005, Chapter 1).

The major turning point for the California wine industry came in 1976 when a French panel of judges ranked California wines highest in two categories in a blind taste testing over their French competitors. The subsequent press, including a Time magazine piece on the “Judgement of Paris” drastically increased demand for California wines both domestically and internationally (Borg, 2016; Warner, 2007). This surge in demand was further increased in 1991 when a medical study reported that, even with a high fat diet, moderate red wine consumption was associated with health benefits (Warner, 2007). Following these events, wine consumption among the American middle and upper classes saw a drastic uptick, coinciding with increasingly place-specific marketing by producers that allowed them to charge a premium price for what was claimed to be a premium product – which the consumers were willing to pay for (Warner, 2007).

This intensely geographic branding allowed producers to charge more for grapes grown in areas perceived to be of higher quality; but this began to create problems as the influx of vineyards began to push out other agricultural commodities in these regions, encroach on natural habitats, and run into exurban expansion (Warner, 2007). As residents witnessed winegrape monocrops increasing, concerns over land use and environmental degradation were raised. Environmental activists in Napa called for more regulations, putting them at odds with property rights activists, and residents grew frustrated over tourist traffic. There were controversies over new vineyards reconfiguring hillsides and cutting into oak woodland and riparian habitats in Sonoma, and in the Central Coast five wineries held sway over 42% of winegrape acreage in the mid-1990s (Warner, 2007). These conflicts threatened to taint the place-based marketing of wine, with the risk of regional identities being tied to environmentally damaging farming, and producers feared ever more restrictive regulations. In response, starting in the early 1990s California growers proactively addressed these issues through collective action and voluntary partnerships (Warner, 2007).

Wine Industry Regulation in California

The California wine industry provides examples of collaborative approaches to mitigating environmental impacts, but producers do still have to contend with a variety of top-down regulations. These include federal, state, and regional regulations regarding water use and quality, air quality, riparian protection, worker health and safety, energy use, and more (California Sustainable Winegrowing Alliance [CSWA], 2017; Silverman et al., 2005). The last 10-15 years has also seen an increase in regulations aimed at reducing hillside erosion, in response to increased vineyard development on steeper slopes as more ideal growing areas in valleys have already been planted (Silverman et al., 2005). The distribution, labeling, and marketing of wines are also strictly regulated by the US Bureau of Alcohol, Tobacco, and Firearms (ATF) and the Alcohol and Tobacco Tax and Trade Bureau (TTB) (CSWA, 2017).

Grower's Associations and Non-Regulatory Management

There are dozens of state and regional level viticulture associations in California. Some have direct ties to top-down systems, and some offer voluntary certifications. Post-prohibition, many wineries came together to form cooperatives in an attempt to recover from the near death of the industry. These helped bolster the industry as growers gradually moved away from cheap bulk grapes grown during prohibition, back to more quality oriented cultivation, culminating in the "Judgement of Paris" (Geraci, 2004). Post-prohibition also saw the creation of the Wine Institute in 1934 by a coalition of wine businessmen. The Institute advocated for California wines to improve quality and influence policy. By 1986, the Institute included 90% of California wineries, and focused on bolstering California wines in the international market. The group would come to the forefront again in the 1990s to advocate for the industry in the face of growing environmental activism that was pressuring lawmakers to implement policies to limit industry growth and practices. On the grapegrowing side of the industry, in 1974 the California Association of Winegrape Growers (CAWG) was formed to focus on issues affecting vineyard managers, including fair pricing, pest management, and water use, and currently represents over 60% of the state's annual grape crush. Today these are the two leading wine industry organizations in California, and together created the foundation upon which much of the current viticultural sustainability movement rests today (Zucca, 2008).

“The Code”

In 2001, the Wine Institute and the CAWG came together to form the California Sustainable Winegrowing Program (SWP), and developed the *Code of Sustainable Winegrowing Practices Workbook* in 2002, colloquially known as “The Code” (Bar-Am et al., 2016; Zucca, 2008). The Workbook, now in its third edition, was initially adapted from the Lodi Winegrape Commission’s *Lodi Winegrower’s Workbook*, built on by contributions from nine other regional organizations, and reviewed by 31 individuals from the private sector, CDFA, the California Environmental Protection Agency (Cal/EPA), the federal US EPA, United States Department of Agriculture (USDA), Pacific Gas and Electric (PG&E), a number of non-profit environmental agencies such as the Nature Conservancy, and various UC Davis faculty and extension specialists (CSWA, Wine Institute, & California Association of Winegrape Growing [CAWG], 2012, sec. Acknowledgements). In 2003 a 501(c)(3) non-profit organization, the California Sustainable Winegrowing Alliance (CSWA) was created to promote adoption of the program (Zucca, 2008). The Code Workbook is *not* a prescriptive set of guidelines or criteria to be used by external evaluators, but rather a self-assessment guide for producers to evaluate current practices and create plans for improvement. While the Workbook itself is explicitly not a set of guidelines or criteria for certification, it is designed to be readily adaptable to management plans and certification schemes.

The stated goals of the SWP are to (1) establish voluntary above-compliance standards for the entire wine community, (2) enhance peer-to-peer education on sustainable practices and the benefits of self-governing, and (3) demonstrate the mutual benefits of working collaboratively with all stakeholders (CSWA, n.d.). They define sustainability in the wine industry as:

> winegrowing and growing and winemaking practices that are sensitive to the environment (**E**nvironmentally Sound), responsive to the needs and interests of society-at-large (Socially **E**quitable), and are economically feasible to implement and maintain (**E**conomically Feasible) (CSWA et al., 2012, pp. 18–19).

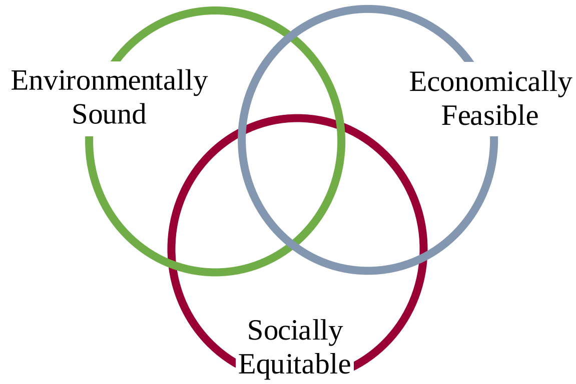

Figure 1. The three overlapping "E's" of sustainability. Adapted from *California Code of Sustainable Winegrowing Workbook*, by CSWA, Wine Institute, and CAWG, p. 165. Copyright 2012 by CSWA, Wine Institute, and CAWG.

These constitute the three "E's" of sustainability laid out by the Program and described in detail in the Code Workbook (See Figure 1) (Bar-Am et al., 2016; CSWA et al., 2012; Zucca, 2008). Since the second edition, an online tool has also been available for producers to more easily complete the assessment and track improvement over time (CSWA et al., 2012). The intention is for the Code to facilitate a cycle of continual improvement through a process of self-assessment, performance interpretation, development of an action plan,

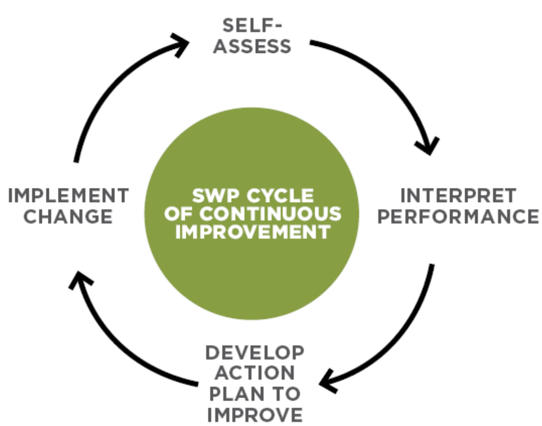

Figure 2. The cycle of continuous improvement facilitated by the Code Workbook. Adapted from California Code of Sustainable Winegrowing Workbook, by CSWA, Wine Institute, and CAWG, p. 21. Copyright 2012 by CSWA, Wine Institute, and CAWG.

implementation of change, and returning to self-assessment, usually on a yearly or bi-yearly basis (see Figure 2).

The foundational piece of this process is self-assessment, and the Code (and now its online platform) provides growers with a straightforward but very detailed method to do this. The 3rd edition of the Code includes 241 criteria, broken down into 15 assessment areas ranging from soil and pest management to human resources and energy efficiency. For each criterion, a producer identifies where their operation falls on a continuum of increasing sustainability from one to four based a number of measures (CSWA et al., 2012; Silverman et al., 2005; Zucca, 2008). An example of this from the pest management chapter of the Code Workbook is reproduced in Figure 3. As previously stated, the Code itself is not prescriptive, however, in 2010 the CSWA did create a certification program based on the Code (CSWA, 2017).

Certification

California vineyards are certified under a number of programs, some of which are open to any agriculture, such as LandSmart and Fish Friendly Farming, and some are regional, such as Napa Green. Many vineyards are also certified under programs that are not restricted to California, such as Lodi Rules, which certifies vineyards in California and Israel, and Sustainability in Practice (SIP), which certifies vineyards in California and Michigan (Smit, 2014). The only certification currently exclusive to the wine industry in California was created in 2010 by CSWA itself – Certified California

Sustainable Winegrowing (CERTIFIED SUSTAINABLE). As of 2018, more vineyard acres are Certified through CSWA than Lodi Rules and SIP combined at 149,922 acres. This is not to disregard the work done by these organizations, as each have tens of thousands of acres and thousands of wineries in their programs, but it speaks volumes to the success of CSWA and the Code that they have managed to certify 22% of the land used for winegrape growing in the state in less than a decade (CSWA, 2018).

Certified California Sustainable Winegrowing offers four certification options: Certified Sustainable Vineyard, Certified Sustainable Winery, Certified Sustainable Vineyard & Winery, and starting in 2017, they offer a logo indicating a wine has been produced in a Certified Sustainable Winery with at least 85% grapes from Certified Sustainable Vineyards (CSWA, 2017). To retain certification, wineries and vineyards are required to pass an annual third-party audit which verifies numerous practices and standards are met, including that 95 of the 244 criteria from the Code with at least 85% scoring a two or better on the four-point sustainability continuum. Wine bearing a Certified Sustainable label must also go through a chain of custody audit. Going into the certification process in detail is beyond the scope of this paper, as is exploring the dozens of other certifications available for California wineries and vineyards, but the CSWA program offers a valuable example of how the Code has influenced such programs and how they attempt to add credibility and verifiability to the use of sustainable practices as laid out in the Code. This is now also being communicated directly to customers with the recent rollout of the CERTIFIED SUSTAINABLE wine labels (CSWA, 2017).

A large component of the program is integrated pest management (IPM), which includes practices such as barn owl boxes as more sustainable methods for rodent control, and both the Code and extension groups promote the use of barn owl boxes (Baughman et al., 2000; Heaton, Long, Ingels, & Hoffman, 2008; Huysman et al., 2018; Kan et al., 2012; Kross & Baldwin, 2016; Kross, Bourbour, & Martinico, 2016). In the Code workbook (Chapter 6) farmers are required to have at least one owl box per 100 vineyard acres to reach category two, and are required to have one box per 40 vineyard acres, in addition to other bird boxes and perches, to achieve category 4 (see Figure 3; CSWA et al., 2012, p. 165). The workbook itself also provides detailed instructions for nest box creation and implementation (CSWA et al., 2012, pp. 165–167). Research in other regions suggest that barn owls can effectively reduce rodent pests, but little ecological research on this has yet been conducted in California, and little research on human dimensions has been done to examine the perception of farmers of barn owls as a tool for pest management (Johnson, Wendt, Estes, & Castañeda, 2018; Kross, Ingram, Long, & Niles, 2017; Wendt & Johnson, 2017).

6-24 Predation by Vertebrates *Vineyard*

Category 4	Category 3	Category 2	Category 1
One or more owl boxes* existed for every 40 vineyard acres ***And*** Kestrel boxes and raptor perches were provided ***And*** Bat and/or blue bird boxes were installed for insect control.	Approximately one owl box* existed for every 40-100 vineyard acres ***And*** Raptor perches were provided.	Approximately one owl box* existed for every 100 vineyard acres.	No nest boxes for birds of prey were provided.

Increasing Sustainability

*Owl box occupancy rates may be lower where numerous nearby trees or other nesting structures exist. If owl boxes are positioned in trees, occupancy rates may be higher when placed in the upper third of the tree.
See **Boxes 6-W, 6-X** and **6-Y** for more information on owl boxes.

Figure 3. Owl box inclusion in the pest management chapter in the Code Workbook. The Workbook also includes specific instructions about how to build and install nest boxes. Adapted from California Code of Sustainable Winegrowing Workbook, by CSWA, Wine Institute, and CAWG, p. 165. Copyright 2012 by CSWA, Wine Institute, and CAWG.

Barn owls and Pest Management

Quantifying economic damage from rodents is difficult because of their large numbers, below-ground activity, and sub-lethal effect on vegetative components of crops. Gebhardt Anderson, Kirkpatrick, and Shwiff et al. (2011) conducted a meta-analysis of dozens of papers that examined rodent and bird damage to 19 economically important California crops, including winegrapes. They used these data, along with unpublished data, other published estimates, and interviews with extension specialists, to run two Monte Carlo simulations that provided damage estimates for each crop while accounting for randomness. Their simulations estimated winegrapes suffer the second greatest losses, at 7.2% yield per year, after artichokes at 8.3%, and suffer losses over two percent higher than the next most impacted crops, rice and container nursery (5% each). This was calculated based on an expected 10.7% loss per acre and an expected 67.5% acres damaged (Gebhardt et al., 2011). How much of this damage is attributable to bird pests and how much to rodents is not presented, but it does highlight the particular vulnerability of winegrapes to vertebrate pests.

A growing body of evidence suggests that avian predators may reduce the need for pesticides, specifically rodenticides, on agricultural land by naturally predating problem pests (Bianchi et al., 2006; Kross et al., 2016; Paz et al., 2013). Wendt and Johnson (2017) found that about a third of the nest boxes installed on 65 vineyards in Napa Valley were occupied by nesting barn owls, and this number has crept upward to 40-50% in recent years (Huysman, 2019), demonstrating that nest boxes in the region can reliably attract barn owls. There is also evidence that nest boxes may not only be practical, but also economically viable for reducing agricultural rodenticide use (Browning, Cleckler, Knott, & Johnson, 2016; I. Kan et al., 2014; Motro, 2011). However, since the organized implementation of owl boxes is relatively new to Napa Valley vineyards, there is little information about how producers have responded to them, and how they may change their practices in the future. Consumers have demonstrated a willingness to pay more for products perceived as being environmentally friendly, and wine consumers in particular have shown an interest in such premium products (Barber, Taylor, & Strick, 2009). Previous research has found, unsurprisingly, profitability to be a driving factor influencing whether producers are willing to adopt more environmentally sustainable practices (Marshall, Cordano, & Silverman, 2005), but newer studies are finding more complex cognitive motivations for using pro-environmental choices such as installation of nest boxes (Floress et al., 2017; Sulemana & James, 2014; Thompson, Reimer, & Prokopy, 2015).

Environmental Values and Producer Behavior

Traditionally, agricultural policies and programs have focused largely on the economic self-interest of producers, assuming economic factors to be the primary drivers behind any willingness to adopt environmentally friendly practices (Chouinard, Paterson, Wandschneider, & Ohler, 2008; Floress et al., 2017; Gifford & Sussman, 2012; Sheeder & Lynne, 2011). However, these narrow models have proven insufficient to describe and predict conservation behaviors (Sheeder & Lynne, 2011; Thompson et al., 2015) and many researchers have turned to studying wildlife and environmental values orientations (Chase, 2016; Jacobs, Vaske, & Sijtsma, 2014). These take into account crucial psychosocial variables that acknowledge the complexity of human decision making. However, there is a significant discrepancy in the measurement of these cognitive variables across the environmental literature, making comparisons between studies difficult (Gifford & Sussman, 2012). One framework that has been gaining recognition is the dual-interest approach, which recognizes the conflicting motivations farmers face between self/financial-interests and other/empathetic-interests, whether that be for the environment, their community, or other factors (Floress et al., 2017; Sheeder & Lynne, 2011; Sulemana & James, 2014; Thompson et al., 2015).

While the dual-interest approach demonstrates a great deal of utility in building an understanding of producer behavior, the two facets are often poorly integrated, with self/financial interests being the primary focus, and other/empathetic interests being tacked on ad-hoc (Sheeder & Lynne, 2011). Another, complimentary, approach that has also been gaining popularity is the values-attitudes-behavior cognitive hierarchy (Cook & Ma, 2014; Czap, Czap, Khachaturyan, Lynne, & Burbach, 2012; Floress et al., 2017). In this framework, values are the most basic, fundamental beliefs, norms, and mental constructs by which individuals evaluate how desirable they find a given action or outcome (See Figure 4; Chase, 2016; Cook & Ma, 2014; Fulton, Manfredo, & Lipscomb, 1996). These values are the basis upon which attitudes are formed and attitudes then influence behavior. There is no perfect predictor of behavior, but there is evidence suggesting that understanding the core values and attitudes of individuals, and how these interact with each other is critical for predicting and potentially influencing their decision making (Ajzen & Fishbein, 1977; Honig, Petersen, Shearing, Pintér, & Kotze, 2015).

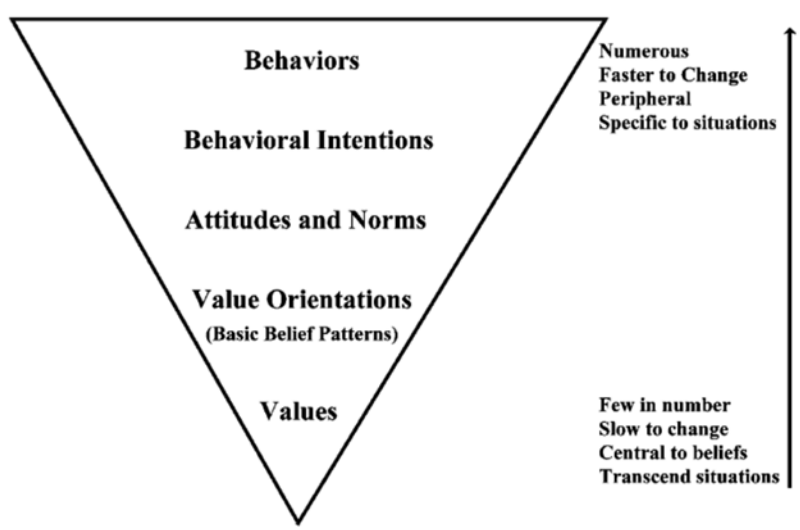

Figure 4. Visualization of the cognitive hierarchy model. From "A Value-Attitude-Behavior Model Predicting Wildland Preservation Voting Intentions" by J. Vaske and M. Donnelly, 1999, Society & Natural Resources, 12, p. 252. Copyright 1999 by Taylor & Francis.

Research Questions

This research used the framework of the cognitive hierarchy to begin to address the gap in the literature documenting the environmental values of winegrape vineyard farmers and how these relate to integrated pest management practices with a focus on barn owl boxes. Specifically, this research aimed to answer research questions in three realms: environmental values, farming practices – with a focus on rodent management and barn owl boxes specifically, and how value and practices interrelate.

Environmental Values

How do farmers' responses distribute along previously described wildlife values axes?

How do farmers' responses reflect utilitarian vs. mutualist environmental values?

Farming Practices

What methods do farmers currently use to control rodent pests?

What sources do farmers trust for information on pest control methods?

Of those who use owl boxes:

How effective do they feel owls are at controlling rodents?

How do they perceive owls affecting their farms overall?

Environmental Values and Behaviors

What would influence producers to incorporate more environmentally friendly practices?

How do farmers view surrounding habitat?

Do farmers' behaviors associate or align with utilitarian and mutualist environmental values?

METHODS

Survey

The survey was developed for this project primarily to measure value orientations regarding wildlife and the environment in relation to the use of barn owl boxes and other pest management techniques. Following guidelines and practices developed in the human dimension of wildlife literature, starting with the foundational 1996 study that was a collaboration between David C. Fulton and Michael J. Manfredo from the Human Dimensions of Natural Resources Unit at Colorado State University and James Lipscomb from the Colorado Division of Wildlife (Fulton et al., 1996), the survey was modified version of the survey instrument developed by Fulton, Manfredo, and Lipscomb (1996). Respondents were presented with 20 statements and asked to evaluate the extent to which they agreed or disagreed with them based on a 7-point Likert scale.

These statements were intended to measure five wildlife and environmental belief dimensions: (1) wildlife rights, (2) wildlife use, (3) wildlife appreciation, (4) environmental protection concerns, and (5) willingness to use environmentally friendly farming techniques. These five measures were then combined to measure two environmental value orientations, (1) domination and (2) mutualism; see Table 1 for statement sorting. In this context, those with a domination value orientation are more likely to prioritize human well-being over the environment and welfare of wildlife and are more likely to find environmentally damaging behaviors to be acceptable if they serve a utilitarian purpose. Those with a mutualist value orientation are more likely to empathize with wildlife, find intrinsic value in the environment, and oppose environmentally damaging behaviors (Brodt, Klonsky, & Tourte, 2006; T. L. Teel & Manfredo, 2010). The items in this instrument were adapted from similar surveys by Brodt, Klonsky, and Tourte (2006); Fulton et al. (1996); Teel and Manfredo (2010); Thompson, Reimer, and Prokopy (2012); and Whittaker, Vaske, and Manfredo (2006). Most of the items for the belief dimensions environmental protection and farming practices were adapted from Brodt et al. (2006), modified to address agriculture specific issues in place of the more residential or personal statements included in strictly wildlife-focused studies like Fulton et al. (1996) (see Table A1 for a breakdown of statement sources).

In addition to the questions aimed at ascribing value orientations, the survey also included additional questions intended to document respondents' actions and perceptions relating to the use of barn owl boxes. The survey also included some basic demographic questions about respondents (e.g. age, gender) and their property (e.g. acreage), and Likert scale questions about pest species, rodents control methods, farming techniques, and levels of trust in different sources of pest control information (the full survey instrument can be found in Appendix C).

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Confirmatory Factor Analysis (CFA) and Reliability Scores for Items Used to Measure Wildlife and Environmental Value Orientations

Wildlife/Environmental Value Orientations, Basic Belief Dimensions, and Scale Items[a]	Factor Loading[b]	Cronbach's alpha
Domination value orientation (2nd order factor)		0.88
Wildlife Rights belief dimension (1st order factor)	0.769	0.89
The needs of humans should take priority over fish and wildlife protection	0.882	
Although wildlife may have certain rights, most human needs are more important than the rights of wildlife	0.896	
The needs of people are always more important than any rights that wildlife may have	0.814	
The rights of people and the rights of wildlife are equally important[c]	0.714	
Wildlife Use belief dimension (1st order factor)	1.057[d]	0.71
Humans should manage fish and wildlife populations so that humans benefit	0.634	
It is acceptable for people to kill wildlife if they think it poses a threat to their life	0.683	
It is acceptable for people to kill wildlife if they think it poses a threat to their property	0.801	
We should strive for a world where there is an abundance of fish and wildlife for hunting and fishing	0.415	
Mutualism value orientation (2nd order factor)		0.87
Wildlife Appreciation belief dimension (1st order factor)	0.657	0.91
Wildlife is an important part of my community	0.914	
I'm interested in making the area around my farm attractive to wildlife	0.943	
Having wildlife around my farm is important to me	0.963	
Environmental Protection belief dimension (1st order factor)	1.012[d]	0.76
I want to increase biodiversity on my farm even if it takes land out of production	0.732	
I strive to learn how to manage resources in cooperation with nature	0.519	
The environmental value of my farm is just as important as its agricultural value	0.641	
It is important to maintain biodiversity for future generations	0.834	
Farming Practices belief dimension (1st order factor)	0.89	0.75
I consider a decrease in pesticide use one way to improve living and working conditions on my farm	0.763	
I use whatever fertilizers and pesticides are necessary to get the job done[c]	0.635	

Wildlife/Environmental Value Orientations, Basic Belief Dimensions, and Scale Items[a]	Factor Loading[b]	Cronbach's alpha
I am not willing to sacrifice farm profitability to conserve water or other resources[c]	0.454	
I cannot see using environmentally friendly management techniques if they sacrifice yield or crop quality[c]	0.631	

Note. See Appendix A for original sources

[a]Item response scale: 1 (strongly disagree) to 7 (strongly agree).

[b]Standardized factor loadings from CFA. Fit statistics: $\chi^2 = 223.41$ (df = 146; $p < .001$); CFI = .90; GFI = .77; RMSEA = .08; SRMR = .08.

[c]Item was reverse coded prior to analysis

[d]Factor loadings greater than 1 likely reflect high multicollinearity (Jöreskog, 1999).

Data Collection

All data collection was done in compliance with federal regulations on the use of human subjects. This research was approved by Humboldt State University's Institutional Review Board for the Protection of Human Subjects on July 6th, 2018 and renewed on June 17th, 2019 (IRB 16-231). Participants had to indicate they agreed to the consent form preceding the survey.

Surveys were administered electronically via SurveyGizmo to California winegrape growers, primarily members of winegrower organizations in the state. Dillman, Smyth, and Christian (2014) was referenced for methods of internet survey design, but due to financial and time constraints most of their distribution methods could not be followed. Instead, wine industry groups, starting with the Napa Valley Grapegrowers (NVG) were solicited. Their CEO and Executive Director, Jennifer Putnam, was interested in assisting with survey distribution and brought in their Industry and Community Relations Manager Molly Williams. Ms. Williams was instrumental in helping to finalize the survey instrument by providing feedback from the perspective of someone in the industry. After the survey was finalized, she included a link in their weekly member newsletter. This garnered about a dozen responses and it was shortly thereafter that the decision was made to broaden to the whole state in hopes of receiving enough responses to run valid analyses even with a low response rate.

The second distribution went out in a newsletter from the statewide California Association of Winegrape Growers. Despite generous support from their Director of

Member Relations, Natalie Collins, only a couple of responses came in. A more targeted effort was made to reach out to AVA associations and smaller sub-appellation groups, starting with those in Napa and expanding to any of the over 150 AVAs with an association for which contact information was available. In all, 35 groups were emailed, and the survey was distributed to the members of 14 of the groups, including the NVG (see Appendix B for a full list of participating groups). It was up to the discretion of the collaborating agencies if and when to resend a link or reminder as they were the ones with direct contact to participants and had a better understanding of how such communications were likely to be received. The first distribution went out to the members of the Napa Valley Grapegrowers (NVG) as a link in their weekly newsletter. While the original intention of the survey was to focus on Napa county, building on the special ecology research of the Johnson Lab, low response rates necessitated widening to include more of California. A small number of surveys were obtained after emailing some vineyards directly, but ultimately the majority of responses came in from members of smaller appellation and sub-appellation groups who were emailed a link to the survey.

Analysis

This survey was conducted to obtain preliminary data from wine producers and inform future research. As such, an inductive approach was used, with numerous exploratory analyses to compare the attitudes of participating growers with existing wildlife and environmental values literature. There were 20 values statements in the survey, one of which, regarding wildlife suffering, was discarded for analysis due to poor fit with any Okay (see Table B1 for a complete list of items). Following the method pioneered in Fulton et al. (1996), the remaining 19 items were put through a two-stage confirmatory factor analysis (CFA) in AMOS (Arbuckle, 2019) to test for internal consistency and goodness of fit. The first order analysis sorted statements into one of five factors corresponding to basic belief dimensions about (1) wildlife rights, (2) wildlife use, (3) wildlife appreciation, (4) environmental protection, and (5) farming techniques. These were then run through another CFA to separate these factors into two second-order factors corresponding to corresponding to domination (factors 1 and 2) and mutualistic (factors 3-5) value orientations. These second order factor models had a chi-square of 223.41 (df = 146; $p < 0.001$). Several analyses were used to assess goodness of fit, CFI = 0.90, GFI = 0.77, RMSEA = 0.08, SRMR = 0.08, and while most did not reach suggested thresholds (CFI $\geq$ .95, GFI $\geq$ 0.90, RMSEA and SRMS $\leq$ 0.08; Hooper, Coughlan, & Mullen, 2008; Kline, 2011) this may be due to the small sample size and as this is an exploratory study the models were not discarded. While useful, these fit indices are biased toward large sample sizes and there is evidence that they may not generalize well outside the narrow set of models from which they were developed (Barrett, 2007; Kline, 2011, p. 205). Reliability analyses were also run in SPSS (IBM Corp, 2017), and they indicated high inter-item consistency with Cronbach's alpha scores between 0.71 and 0.95 (see Table 1).

Once values items were sorted by factor, an average for each first order factor belief dimension (e.g. wildlife appreciation) was calculated for each participant by averaging the corresponding Likert-scale responses. Then, the second order value orientations were calculated by taking the means of the corresponding belief dimension items. Based on these scores, respondents were then sorted into four types by adapting the method used by Teel, Dayer, Manfredo, and Bright (2005). Value orientation (second order factor) scores above 4.5 were considered “high” and less than or equal to 4.5 were considered “low.” Participants who scored high on domination and low on mutualism were classified as “utilitarians,” those who scored low on domination and high on mutualism were classified as “mutualists,” those who scored high on both were classified as “pluralists,” and those scoring low on both “distanced.” (see Figure 5).

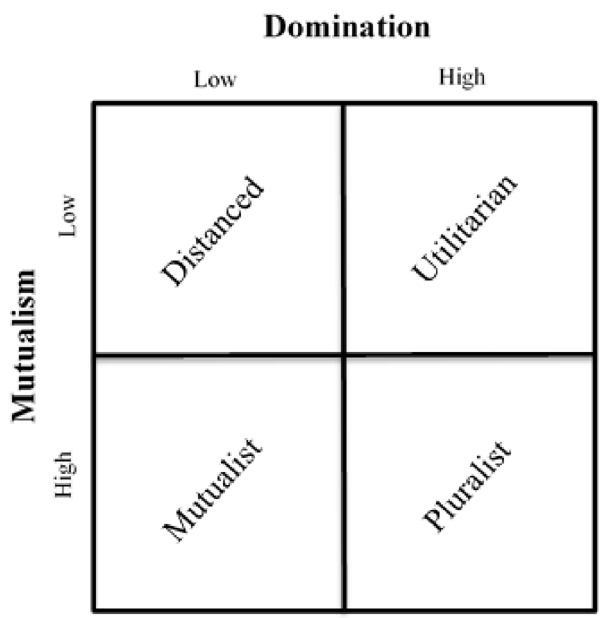

Figure 5. Visualization of the categorizing of respondents based on mutualist and domination value scores. Adapted from “Regional Results from the Research Project Entitled ‘Wildlife Values in the West’” by T. L. Teel, A. A. Dayer, M. J. Manfredo, and A. D. Bright, 2005, p. 8. Copyright 2005 by Colorado State University.

In subsequent analyses, the distanced category was excluded because there were only three individuals in the group, and the utilitarian and pluralist groups were combined to facilitate substantive analyses because each group was small, 10 and 13 respondents respectively. This combined group then represented the 23 respondents that had a high domination score to compare to the mutualist group of 45 respondents with low domination scores. These two categories were then used as independent variables in cross-tabulations for categorical response variables, and in independent sample t-tests for scaler response variables, to assess the differences in responses to other survey questions, such as percent non-crop habitat and use of pest control techniques. Binary responses, such as those who do and do not use owl boxes, were also used as independent variables to compare participants' domination and mutualism scores.

Caveats

Garnering responses to the electronic survey was extremely challenging for a number of reasons. Likely a significant underlying factor is survey fatigue on the part of many growers as they have been solicited to complete a growing number of surveys in recent years, some of which are mandatory forms for government agencies such as the USDA (P. Johnson, personal communication, April 2019; N. Collins, personal communication, March 2019). Another challenge for distribution that is somewhat unique to the winegrowing industry is the difficulty identifying the correct individuals to reach out to. Unlike most agricultural products, there is a separation between grapegrowing in vineyards and winemaking in cellars and wineries that may or may not be operated by the same company or family. When looking online, it is significantly easier to find information on wineries than vineyards, as wineries are more often tied to end consumers and tourism, frequently featuring tasting rooms, tours, event spaces, or even full-service restaurants. However, to further complicate matters, companies and properties in the wine industry do not always use consistent branding. There may be a location with “vineyard” in the name that is in fact a tasting room serving wines made from grapes from numerous locations, and there may also be a place with “cellars” in the name that in fact hosts an active grapegrowing operation.

So, it is challenging to identify locations that are cultivating winegrapes, and while there are still many vineyards that have a web presence, individual contact information is frequently not available. Even when some individuals do have a direct email address, it is still not always clear who the appropriate point of contact is to address pest control issues. The most senior individuals, usually owner(s) and/or proprietor(s), a president, or an executive director may not deal with such on the ground decision making. These concerns may be outsourced to an external management company, or an internal staff member or vineyard manager. These individuals very rarely have any contact information available, if they are acknowledged at all. So much to say that it was most prudent to go through other groups that have established relationships with members who are directly involved with grapegrowing operations.

RESULTS

There were 113 surveys submitted, of these 71 were complete and included in analyses. As the surveys were distributed by local and regional agencies to maintain their members' anonymity, a precise response rate cannot be calculated; however, it was likely less than 5% because the agencies' collective email distribution lists exceeded 2,000 recipients. Napa County was the most heavily represented, with 43.7% of respondents, the rest being spread across 10 other counties (see Figure D1). Of the respondents included in the analyses, 77.5% were self-identified male (n=55) and 18.3% as female (n=13); 64 respondents provided their age, of these the average age was 56 (SD = 12.54) (see Figure D2). A majority of respondents identified their role as owner/operator (87%) with the remainder identifying as either part of a management company, a winemaker, or staff. The vineyards addressed in the survey were also mostly small, with 91.5% being 200 acres or less (see Figure D3).

In response to a question about reliability of various sources of information on pest management strategies on a scale of 1 (very unreliable) to 5 (very reliable), respondents found personal observation to be the most reliable (M = 4.04, SD = 0.98), followed by research groups (M = 3.90, SD = 0.97), and meetings or workshops (M = 3.64, SD = 0.99). Respondents found owl box experts (M = 2.79, SD = 0.86) and social media (M = 2.81, SD = 1.17) to be the least reliable, however, all other sources averaged above neutral (see Figure D4).

Value Orientations and Belief Dimensions

Overall, over 80% of the 71 respondents scored high (> 4.5) on the mutualism axis, with 63.4% classified as mutualists and 18.3% classified as pluralists; 14.1% and 4.2% were classified as utilitarian and distanced, respectively (see Table 2). Due to the small sample size, for subsequent analyses the three distanced respondents were dropped, and pluralists merged with utilitarians, making a classification representing anyone with low domination values scores vs. anyone with high domination scores. Some separate descriptive statistics for utilitarians and pluralists can be found in Table D1.

Table 1
Wildlife and Environmental Value Orientation Types

Value orientation and belief dimension	Utilitarian (n=10, 14.1%)		Pluralist (n=13, 18.3%)		Mutualist (n=45, 63.4%)		Distanced (n=3, 4.2%)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Domination	5.54	0.67	5.60	0.65	3.48	0.76	4.13	0.13
Human priority	5.30	1.00	5.29	1.04	2.61	0.90	3.50	0.43
Wildlife use	5.78	0.49	5.90	0.55	4.35	1.00	4.75	0.50
Mutualism	3.80	1.16	5.47	0.69	5.93	0.64	4.39	0.10
Wildlife appreciation	4.16	0.24	5.85	0.81	6.21	0.92	5.00	0.00
Environmental protection concerns	4.58	0.67	5.27	0.87	5.96	0.74	4.17	0.29
Farming techniques	4.10	0.92	5.29	0.90	5.56	0.98	4.00	0.00

Note. Adapted from “Understanding the Diversity of Public Interests in Wildlife Conservation,” by Tara L. Teel and Michael J. Manfredo, 2008, *Conservation Biology, 24*, p.132. Copyright 2009 by the Society for Conservation Biology.

Associations

Several significant differences emerged between the mutualist and utilitarian/pluralist groups. Mutualists tended to be younger, 54 (SD = 13.33) years on average vs. 61.1 (SD = 9.44) for utilitarian/pluralists ($t(51) = 5.15,\ p =\ .03$), and they reported a higher percentage of non-crop habitat on their farms, 45% vs. 25% for utilitarian/pluralists ($t(65) = 3.21\ \ p = .01$). There was a comparatively higher proportion of mutualist females than males, however this difference was not statistically significant, possibly due to the overall male skew of respondents ($\chi^2 = 3.79, df = 2, p = .15$). There was also no statistically significant difference in farm size between mutualists and utilitarians/pluralists, though the former tended to have somewhat smaller farms ($\chi^2 = 12.93, df = 7, p = .07$; see Table 3).

Table 2

Comparison of Wildlife and Environmental Value Orientation Types and Participant Demographics and Selected Responses

Variable	Utilitarian or Pluralist[ab]	Mutualist[a]	χ^2 or F *(df)*[b]	*p*	ES[c]
Age ($\bar{X}$)	61.05	54.02	4.8(61)	.03	
Percent Non-crop Habitat ($\bar{X}$)	24.83	44.9	6.67(65)	.01	
Gender (%)			3.79(2)	.15	.24
Female	8.7	24.4			
Male	91.3	71.1			
Farm Size in Acres (%)			12.93(7)	.074	.44
Less than 1	13	8.9			
1-10	47.8	20			
10-50	17.4	22.2			
50-100	8.7	6.7			
100-200	4.3	33.3			
200-500	4.3	4.4			
500-1,000	4.3	0			
1,000+	0	4.4			
At least one certification (%)			7.95(1)	.005	.34
Yes	26.1	62.2			
No	73.9	37.8			
Uses non-conventional techniques (%)			.46(1)	.032	.26
Yes	34.8	62.2			
No	65.2	37.8			
Attract birds for pest management (%)			.44(1)	.507	
Yes	82.6	75.6			
No	17.4	24.4			
Owl Box (%)			.51(1)	.477	
Yes	87	80			
No	13	20			
Uses Rodenticides (%)			3.27(1)	.07	.22
Yes	34.8	15.6			
No	65.2	84.4			

Note.

[a]Distanced value orientation type was excluded due to small sample size (n = 3) and utilitarians and pluralists were combined for a more balanced comparison with mutualists, indicating any respondents with high domination value orientation scores.

[b]Descriptive statistics for utilitarians and pluralists separately can be found in Table D1.

Values from chi-squared or independent samples t-tests (two-tailed) with degrees of freedom.

[c]Effect sizes. Cramer's V was used for chi-squared analyses.

A majority of respondents, 50.7% (n = 36), reported having at least one form of environmentally friendly certification, with Fish Friendly Farming being the most common at 29.6% (n = 21). However, this does not necessarily reflect how respondents are actually farming. For example, only 8.5% (n = 6) of respondents were certified organic by USDA or California Department of Food and Agriculture (CDFA), but 26.8% (n = 19) reported using organic techniques. Similarly, only 4.2% (n = 3) reported being certified biodynamic, but 11.3% (n = 8) reported using biodynamic techniques. There were also 14 respondents (19.7%) who wrote in "sustainable" as the "other" option for techniques, while only 11.3% (n = 8) reported being certified sustainable by CSWA (see Figure D5 and D6).

Mutualists were more likely to have at least one certification than were utilitarian/pluralists $(62.2\%, \text{vs.}\ 26.1\%, \chi^2 = 7.95, df = 1, p = .005)$, and they were more likely to use non-conventional techniques at $(62.2\%, \text{vs.}\ 34.8\%\ , \chi^2 = 4.6, df = 1, p = .032$; see Table 4). The proportion of respondents attracting birds as a pest control technique and using owl boxes specifically were similar between mutualists and utilitarian/pluralists (p = .51, and p = .48, respectively, Table 3). Utilitarians were somewhat more likely to use rodenticides at 34.8% vs. 15.6% of mutualists, but this difference was statistically marginal ($\chi^2 = 3.27, df = 1, p = .07$; see Table 3).

Barn Owl Boxes

On a scale of 1 (not concerned) to 4 (very concerned), respondents were most concerned about rodent and insect pests, with an average response of 3.04 (SD = 0.96) and 3.0 (SD = 0.92) respectively. When asked about rodent pest control techniques, 77.5% (n = 55) of respondents reported attracting birds (see Figure D7 and D8). When asked specifically asked about owl boxes a majority of respondents reported using barn owl boxes (81.7%, n = 58), which limited capacity to statistically compare responses to other questions by those who did and did not use boxes. While the overall use of rodenticides was low, 21.1% (n = 15), all but one of these respondents also report using owl boxes. Of those using boxes, 13.5% also reported using some form of chemical rodenticide.

In response to the question on the effects of owl boxes on a scale of 1 (very harmful) to 5 (very beneficial), respondents on average rated them positively on five metrics: bird pests, grape yields, rodent pests, tourism, and vine health. The effect on rodent pests scored the highest (M = 4.25, SD = 0.99), followed by tourism (M = 3.93, SD = 1.78), vine health (M = 3.47, SD = 0.66), grape yield (M = 3.32, SD = 0.60), and bird pests (M = 3.12, SD = 0.47).

Association between respondents' value orientations (second order factor scores) and use of barn owl boxes were mixed. Respondents who used owl boxes had a higher average domination score of 4.22 (SD = 1.30), compared to those who did not (M = 4.0, SD = 0.63; $t(69) = 6.19 \ p = \ .015$). This difference is statistically significant, but so small as be substantively meaningless. Those who used owl boxes also had an average mutualism score of 5.52 (SD = 0.9), compared to 5.59 (SD = 0.84) for those who did not, but this difference was not statistically significant ($t(69) = 0.36,\ p = .55$; see Table 4).

Differences in value orientation scores were not statistically significant between those who did and did not use rodenticides. Those who used rodenticides had an average domination score of 4.78 (SD = 1.02), whereas those who did not averaged 4.03 (SD = 1.2; $t(69) = 0.1,\ p = \ .75$), and those who did use rodenticides had an average mutualism score of 4.82 (SD = 0.66) compared to 5.72 (SD = 0.84) for those who did not ($t(69) = 1.33,\ p = .25$; see Table 4).

In contrast, value orientation scores did differ significantly based on certifications and sustainable technique use. Participants with at least one certification had a lower domination score on average than those without, 3.77 (SD = 1.1) vs. 4.60 (SD = 1.2; $t(69) = 0.41,\ p = \ .005$), and those with at least one certification had a higher average mutualism score of 5.8 (SD = 0.86) compared to those without, 5.30 (SD = 0.81; $t(69) = 0.04,\ p = \ .007$; see Table 3). Similarly, participants who reported using sustainable techniques had a lower domination score on average than those who did not, 3.88 (SD = 1.31) vs. 4.53 (SD = 1.0; $t(69) = 0.68,\ p = \ .02$), and those who used sustainable techniques had a higher average mutualism score compared with those who did not, 5.89 (SD = 0.87) vs. 5.14 (SD = 0.73; $t(69) = 0.41,\ p = < .001$; see Table 4).

Table 3

Average Second-Order Factor Value Orientation Score Comparisons

	Dominance	Mutualism
Use owl boxes		
Yes (SD)	4.22 (1.3)	5.52 (0.9)
No (SD)	4.0 (0.63)	5.59 (0.84)
F(df)	6.19 (69)	0.36 (69)
p	.015 (one-tailed)	.55 (one-tailed)
Use rodenticides		
Yes (SD)	4.78 (1.02)	4.82 (0.66)
No (SD)	4.03 (1.21)	5.72 (0.84)
F(df)	0.1(69)	1.33(69)
p	.75 (one-tailed)	.25 (one-tailed)
Has at least one certification		
Yes (SD)	3.8 (1.11)	5.81 (0.86)
No (SD)	4.59 (1.18)	5.25 (0.81)
F(df)	0.41(69)	0.04(69)
p	.005 (two-tailed)	.007 (two-tailed)
Use non-conventional techniques		
Yes (SD)	3.89 (1.29)	5.88 (0.86)
No (SD)	4.53 (1.01)	5.14 (0.73)
F(df)	0.68(69)	0.41(69)
p	0.023 (two-tailed)	<0.001 (two-tailed)

Napa Valley

Napa winegrowers accounted for about 44% (n = 31) of all responses (see Figure D1). This makes it difficult to draw any meaningful comparisons between Napa and any other individual counties as the next most represented county was Riverside with about 13% (n = 9). However, splitting the responses into two groups, Napa, and all other counties, allows some comparisons.

A higher proportion of respondents from Napa reported having at least one certification compared to the other counties (74.2% vs. 32.5%; $\chi^2 = 12.14, df = 1, p < .001$). Also, there was also a significantly higher proportion of mutualist respondents from Napa (86.7%, n = 26) than from the other counties (50.0%, n = 19; $\chi^2 = 10.07, df = 1, p = .002$). Looking specifically at values dimensions scores, an independent sample t-test found that respondents from Napa had significantly higher scores for mutualism, 5.76 (SD = 0.72) vs. 5.35 (SD = 0.96) for all other counties ($t(69) = 5.79,\ p = .02$), and lower scores for domination, 3.73 (SD = 1.07) vs. 4.54 (SD = 1.19) for all other counties, although this difference was not statistically significant ($t(69) = 0.51,\ p = .48$).

DISCUSSION

According the cognitive hierarchy theory, values are the most basic and inflexible foundation upon which people form attitudes which in turn influence behaviors (Ajzen & Fishbein, 1977). When looking at sustainable farming this makes it critically important to understand what these underlying values are and how they relate to the use of environmentally friendly practices. Analyses in this thesis suggest that winegrape growers are more likely to have a mutualist value orientation than other groups. And while the results did show a positive association between mutualism and most environmentally friendly behaviors, such as the use of non-conventional farming techniques, this pattern did not hold for barn owl box use, which has important practical and theoretical implications.

Farmers' Environmental Values and Belief Dimensions

A central research question of this study focused on how the environmental values of California winegrape growers compare to existing research on other groups. There is no one-to-one comparison that can be made as the values index in this survey was composed of items from multiple existing surveys. However, the values index is conceptually founded on well-established wildlife value orientations (WVO) research, which focuses on measuring individuals' basic beliefs about wildlife. The composite values index in this study suggests that most winegrape growers surveyed tend more toward mutualist environmental values, with high mutualist and low domination scores (63% of respondents), than to utilitarian values, with high domination and low mutualism scores (14% of respondents), or to pluralist values, with both high utilitarian and mutualism scores (18% of respondents). The proportion of respondents in this study that aligned with mutualist values is higher than most WVO research has found in the past. For example, in a report of a large 2005 survey of 7,388 respondents from 19 western states, only 35% were classified as mutualists, with 28% classified as utilitarians (called "traditionalists"), 21% as pluralists, and 15% as distanced (M. J. Manfredo et al., 2018). However, in the full report on this study, Teel et al. (2005) did find a higher percentage of mutualist respondents in California at 47.6%, with 17% utilitarian, 14.5% pluralist, and 20.9% distanced (M. J. Manfredo et al., 2018). This study was extensive but did not include any questions that could distinguish farmers' responses specifically.

A recent study of landowners in the upper Midwest found even more utilitarians, at about 59% compared with only 11% mutualist and 15% each of pluralists and distanced (Gigliotti & Sweikert, 2019). The surveys for this study did include a question to categorize respondents as farmers, ranchers, both, or neither. They found similar WVO profiles for the three agricultural groups, which were all more utilitarian than the respondents not involved in agriculture.

In a small study (n = 40) of almond and winegrape growers in the Central Valley region of California, Brodt et al. (2006) had participants rank statements addressing economic and social values, resulting in the classification of respondents into three groups based on management styles. In a similar fashion to the WVO research, Brodt et al. categorized respondents based on their priorities, with “Environmental Stewards” placing the highest priority on cooperation with nature, “Production Maximizers” prioritizing crop quality and yields, and “Networking Entrepreneurs” primarily interested in off-farm and social activities. These categories do not map directly onto those used here, but Environmental Stewards can be inferred to be more closely aligned with mutualists than Production Maximizers or Network Entrepreneurs. About half of their participants were selected from the general farming population and half from participants in either the “Biologically Integrated Orchard Systems” (BIOS) program for almonds or the “Biologically Integrated Farming Systems (BIFS) program for winegrapes; both programs involve university-farmer partnerships aimed at assisting farmers in implementing integrated pest management practices.

Brodt et al. (2006) found that nearly half of participants were Environmental Stewards, who tended to be younger, in-line with WVO findings for mutualists. While a majority of this group was unsurprisingly involved in the BIOS/BIFS programs (76%), a moderate number of the other two groups were also involved with the program (29% of Production Maximizers and 44% of Network Entrepreneurs). The authors highlight that this is indicative of a broad appeal of these programs. In the light of the present study’s findings on the high use of environmentally friendly techniques even in those who are not independently certified, it would be interesting to see how these findings would differ over ten years later, and how the investment in the BIOS/BIFS programs correlated with specific management techniques.

Wine is a unique commodity within agriculture, and these results support the common perception of winegrape growers as more mutualist in their environmental values. Further qualitative research may give a better idea as to why this seems to hold true, but there are a couple of potential contributing factors worth mentioning. There is some evidence from the field of economic geography suggesting that the way some of California wine country developed plays a role in the unique value orientations of its producers. For example, Guthey and Whitman (2009) point out that much of the current premium wine boom in California can be traced back to the largely progressive and environmentally minded “back to the landers” of the 1960s and 70s, many of whom got into winegrape growing out of a desire to build a relationship with place. Many of these individuals also came with significant economic capitol, having left behind positions in large organizations out of frustration with bureaucracy. Looking at Napa as a case study, they found that the current sustainable culture of viticulture there arose because of local and industry pressures that pushed for changes that protected and valued land for agricultural use over development. This in effect codified the supremacy of wine in Napa county, and because those who pushed to make this happen were likely more mutualistic, this may be at least one factor that predisposed the industry to attract like-minded individuals.

This foundation in the “back to the land” movement also reinforces the importance of place to wine. Many of the early investors in the modern California wine industry bought in specifically to foster a connection with a physical place, something already in line with traditions around wine production (Guthey, 2008; Guthey &

Whiteman, 2009). Where grapes are grown defines the characteristics perceived in the finished product, the *terroir,* from the larger region down the micro-climate of a specific hill. Looking back toward sustainability, it seems logical to assume that this value of place and *terroir* are in some way influenced by, or at least associated with mutualist values. Further, it may be speculated that sustainable practices are complementary to both mutualism and preserving the *terroir* of grapes by minimizing external influences on effect of place.

This all speaks to the common intuition that winegrape growers, as a group, tend to be more pro-environmental than farmers of other crops or the general public. While there are doubtless numerous other factors that contribute to the decision-making process behind deciding on pest management and other farming practices, this research suggests that fundamental mutualist values may play a role. One reason for this may be the stronger focus of winemakers on quality over quantity. Wine is valuable because it is unique, so much so that many view wine drinking as an experience in and of itself, and consumers will travel great distances to see where their wine comes from (Montella, 2017).

Farmer' Use of Barn Owl Boxes and Other Non-Conventional Techniques

Reported use of non-conventional farming techniques was high in the survey at 53.5% (n = 38) of respondents indicated using at least one non-conventional farming technique. It is difficult to draw direct comparisons to the literature for these values as there are so many different certifications that can vary by location and crop, and there are no comprehensive surveys of the use of different non-conventional techniques on a large scale. However, it is reasonable to conclude that the winegrowers in this study fall above the average for agricultural producers in general. For example, less than 0.01% of farms in the US were certified organic in 2016, although California was higher at 0.04% (NASS, 2017). Certified organic farms are the most straightforward to quantify because they are highly regulated, and while it is not indicative of wider sustainable practices, the orders of magnitude difference from the growers in this survey is at least suggestive.

There is some ambiguity in these results, however, as the responses for various sustainable techniques do not line up with certifications. For example, 23% of respondents (n = 16) indicated they used some kind of sustainable techniques but did not have any certifications. Conversely, 20% of respondents (n = 14) reported having at least one certification but did indicate the use of any sustainable farming techniques. This particular discrepancy may be due to the fact that some of the certifications listed do not necessarily focus specifically on crop production (e.g. soil erosion, irrigation, habitat restoration, etc.), but the former discrepancy is potentially important when considering how the perception of some sustainable techniques may increasingly be somewhat divorced from their “sustainable” connotations.

Looking more specifically at rodent management practices, it is striking that the most frequently reported strategy was attracting birds, at 77.5% (n = 55). More interesting, an overwhelming 82% (n = 58) of respondents reported using barn owl boxes specifically. This discrepancy is due to six participants who indicated they used owl boxes but did not indicate that they attract birds to their property for rodent control. This may be simple error, but it may also be evidence of the commonplace and normalization of owl boxes in vineyards, a point discussed in more detail below.

Rodenticide use was low, at 21% (n = 15), but nearly all of these responses overlapped with barn owl box use. This is potentially concerning as the primary strategy for deploying rodenticides is via bait stations, which allow rodents to disperse after consumption to potentially be predated by barn owls and other predators (Elliott, Rattner, Shore, & Van Den Brink, 2016). This secondary exposure can cause these toxins to accumulate in tissues of owls, particularly the liver (Hindmarch, Rattner, & Elliott, 2019; Huang et al., 2016). Such exposure can be fatal, but potentially more concerning is the unknown number and quality of sub-lethal effects, such as decreased clotting ability and long-term impacts of incubating chicks exposed to anticoagulant residues deposited in their eggshells (Elliott, Rattner, Shore, & Van Den Brink, 2016; Hindmarch, Elliott, Mccann, & Levesque, 2017; Huang et al., 2016). That said, assuming all reported applications were done legally, it is unlikely that the producers in this survey are applying rodenticides cavalierly. In California, as of 2014, four common Second Generation Anticoagulant Rodenticides (SGARs) are classified as restricted materials and may only be applied by professionals with permits issued by a county commissioner and above ground bait may only be placed with 50 feet of a humanmade structure or a feature harboring or attracting target species (Office of Administrative Law, 2014). In 2019, based on reports that even with the 2014 restrictions there is evidence of population-level effects on secondary and non-target species, a ban on SGARs was proposed. However, successful lobbying by the pesticide industry and concerns over disease risk due to increasing rodent populations lead to the bill being pulled and suspended until 2020 (Harbison, 2019; Prichard, 2019).

There are also numerous other factors that are not taken into account by this survey; for example, farmers may be using rodenticides only during non-breeding seasons, or in fields that are netted to keep out smaller bird pests, or they may be compensating for a drop in box occupancy, all of which would at least reduce the risk of exposure. Qualitative research is needed to clarify the issue and discern how aware these farmers are of the potential hazards of overlapping rodenticides and owl boxes.

Associations Between Barn Owl Box Use and Value Orientations

Examining the associations between respondents' value orientations (2nd order factors) suggests that while some behaviors did differ between mutualists and utilitarian/pluralists, the use of barn owl boxes was widespread among all participants. For example, there were strong differences in the proportion of mutualists and others in their reported use of non-conventional practices and some form of certification, but the use of barn owl boxes was over 80% regardless of respondents' value orientation (Table 4). This was a surprising result, and several lines of evidence suggest this result may reflect a normalization of the use barn owl boxes and a diminution in their perception as a progressive farming practice, at least among winegrape growers. Barn owls have been used by winegrape growers for several decades, and while some studies have suggested skepticism toward their effectiveness in controlling rodents (Heaton et al., 2008; Moore, Van Vuren, & Ingels, 1998), more recent research, such as that of Wendt and Johnson (2017), suggest that most winegrowers believe they do reduce rodent numbers.

The idea that some rodent management practices, such as owl boxes may be decoupling from their "sustainable" perception is further supported by this study's finding that there was no significant association between owl box use and environmental value orientations (EVOs). Mutualists were slightly less likely to report using owl boxes, at 80% vs. 87% of utilitarian/pluralists, and the domination and mutualism scores for those who did and did not use owl boxes differed by only 0.2 (out of 7). None of these differences were statistically significant. It is difficult to draw conclusions because so few respondents did not use owl boxes, but these results are consistent with the notion that owl boxes may now be perceived as mainstream by winegrowers.

The reason for this lack of association may, at least in part, relate back to the cognitive hierarchy. This approach asserts that values are the most fundamental, least changeable part of an individuals' cognitive foundation; they are the basis for decision making and are embedded not only within the individual, but within families, groups, and society at large. As discussed in an essay in *Conservation Biology* by Manfredo et al. (2017), this makes it impractical to focus on trying to change values to reach conservation goals. While it is useful and important to understand how values influence behavior, changes in values happen slowly and are only minimally influenced by behavioral changes. Manfredo et al. (2017) suggest focusing higher up on the cognitive hierarchy; on attitudes, behaviors, and norms. This may be where owl boxes fit in.

There are likely mutualist winegrowers who use owl boxes because they are in-line with their core values, but there must be other influences that can account for the high degree of adoption across the board. For example, Wendt and Johnson (2017) found that many farmers believe the nest boxes truly help reduce pest problems, and evidence is accumulating, especially in other regions, to suggest that their use can reduce rodent numbers in fields (Johnson et al., 2018). Thus, the value of the pest control service provided by barn owls appears widely recognized among winegrape growers. Moreover, there is a low barrier to entry for this practice. Owl boxes are relatively cheap and easy to install, with little government oversight, as there is no monitoring or recording that needs to be reported to regulators. Owl boxes also count toward many certifications that may allow growers to charge more for their products or attract more eco-minded consumers. Taken together, the increasing recognition of the practical value of owl boxes coupled with other benefits and low barrier to entry may have now encouraged their use well beyond those who may have initially adopted the practice partially out of principle and alignment with their core values. This argument corresponds to the well-researched theory of "diffusion of innovation" (Lubell, Hillis, & Hoffman, 2011; Tomas-Simin & Jankovic, 2014) apparent in other environmental practices that extended from a small number of early adopters to become widespread among other users following the documentation and recognition of those practices' economic utility (e.g., use of LED light bulbs).

While this is not the place for an in-depth dissection of the topic, it bears mentioning the possible roll of "the code," that is the Sustainable Winegrowing Practices

(SWP) workbook that forms the foundation of the extremely successful third-party certification program of the California Sustainable Winegrowing Association (CSWA). One driving factor behind the universal appeal of barn owl boxes may be the social norms shaped by the industry itself, a driver that may hold more sway over both mutualist and utilitarian farmers than their core environmental values. Unlike most other agricultural commodities, the California winegrape industry has been strongly shaped by the industry created and led “code” which has requirements far more robust than those of any regulators and may arguably be the most comprehensive agricultural initiative of its kind in the US (Broome & Warner, 2008; Warner, 2007). The rapid proliferation of the CSWA certification is indicative of its influence. Launching in 2010 the program has, as of 2018, certified 25% of vineyard acreage in the state, and 70% of wine cases are produced in certified wineries. They also saw a 44% increase in vineyard certifications from 2017 to 2018 (CSWA, 2019). It warrants future research into not only the program’s success, but what other practices it promotes mirror owl boxes in their uptake by producers across the spectrum of values orientations. This is a path that just might glean insights into how “the code” influences behavior and, critically, what lessons can be learned that may apply to other agricultural commodities.

Respondents in this study skewed male at a higher rate, 77.5% (n = 55), than research suggests would be expected from those in decision-making positions within the California wine industry, around 75% (Hobbs & Cooper, 2017) or within agriculture more broadly, about 76% (NASS, 2019). However, the value orientation results indicating higher mutualism among women and younger participants is in line with existing research (Gigliotti & Sweikert, 2019; T. Teel, Dayer, Manfredo, & Bright, 2005; T. L. Teel & Manfredo, 2010). In this study a higher percent of female respondents was likely to have at least one certification, 62% versus 50% of males, and report using non-conventional farming techniques, 69% versus 49% of males. Respondents who reported using non-conventional techniques were slightly younger on average at 55, versus 58 for those who did not, however those with at least one certification were significantly younger on average, 50 years old versus 62 for those without any certifications.

Because this project grew out of barn owl research in Napa Valley, a disproportionate number of respondents came from Napa County. When responses were split into Napa (44%) and all other counties (56%), analyses revealed that Napa growers were significantly skewed for some metrics. Specifically, 74% of Napa respondents reported having at least one certification, vs. 33% of those from other counties, and 87% were mutualists, to 50% of those from other counties. This fits with Napa's premium image, and the value of Napa grapes may be one of the reasons this discrepancy exists – Napa growers may have more financial flexibility to use practices that potentially reduce yield because the value per ton of their grapes is so high. There is also likely a cultural component tied to this as well, future and more qualitative research could elucidate some the differences in sustainable practices across counties or even at the sub-appellation level. Such research could further clarify what other factors may be influencing a shift in values, or vice versa.

Caveats

As discussed in the methods section, these results are very preliminary. Because participants were recruited indirectly through industry organizations the response rate is unknown and there is no way of analyzing non-response bias, though it certainly exists. For example, it may be that mutualists were more likely to complete the survey, or more individuals who use owl boxes participated because “barn owls” was in the title of the survey. The small response size and the consequent combining of utilitarians and pluralists also limits the validity of the analyses. It is worth noting as well that most respondents represented smaller vineyards of less than 200 acres. This further limits the generalizability of the results as operators of large vineyards are underrepresented and the influence of management companies is unaccounted for. Parsing these differences, particularly the roles of specific individuals in making pest management decisions, warrants future research.

CONCLUSIONS

California is an economic juggernaut, growing to the fifth largest economy in the world at $2.82 trillion in 2017 (Bureau of Economic Analysis, 2019). The wine industry is a significant part of that; a 2015 Economic Impact Report found that the industry generated $57.6 billion that year, in addition to $7.2 billion in tourism alone (Wine Institute & California Association of Winegrape Growers, 2017), and winegrapes surpassed almonds as the most valuable cash crop in the state in 2017 (CDFA, 2018). As the industry continues to expand it is ever more important to promote sustainable practices to mitigate the damage of growing this kind of long-growing monocrop. Sustainability is crucial for all of agriculture, but the California wine industry has made this a core tenet from the ground-up and has created a framework for success that may facilitate similar movements in other agricultural industries. And key to promoting sustainable practices is understanding how underlying values shape the attitudes and behaviors of individual farmers.

This study focused on one part of the larger sustainability agenda of the industry and found overwhelming adoption of barn owls as a tool of integrated pest management by more than 80% of participants. Interestingly though, while other indicators of pro-environmental behaviors were strongly associated with mutualist environmental values, such as using non-conventional farming techniques and having environmental certifications, barn owl box use was not. As discussed above, there are numerous possible explanations for this that suggest fruitful avenues for future research, but for this study the key takeaways are twofold; First, as a group, winegrowers seem to be much for mutualistic than the general population, even within the mutualist leaning state of California. Secondly, the disconnect found between barn owl box use and value orientations suggests there may be certain approaches to promoting the adoption of sustainable practices that can influence farmers' attitudes and behaviors toward more mutualist ends than their core values might otherwise predict. This suggestion is encouraging as we increasingly recognize the need to protect our planet's imperiled natural resources through sustainable agriculture.

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APPENDIX A

Groups that assisted with survey distribution:

Anderson Valley Winegrowers Association

Appellation St. Helena

Atlas Peak Appellation

California Association of Winegrape Growers (CAWG)

Coombsville Vintners & Growers

Howell Mountain Vintners & Growers Association

Mt. Veeder Appellation Council

Napa Valley Grapegrowers (NVG)

Napa Valley Vintners

Paso Robles Wine Country Alliance

Petaluma Gap Winegrowers Alliance

Sierra Wine & Grape Growers Association

Stags Leap District Winegrowers

Temecula Valley Winegrowers Association

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Jennifer Putnam – Executive Director and CEO, NVG

Molly Williams – Industry and Community Relations Manager, NVG

Natalie Collins – Director of Member Relations, CAWG

Appendix B

Table B4

Value Orientation Statement Sources

Value Orientation Statement	Source
Humans should manage fish and wildlife populations so that humans benefit.	Fulton, Manfredo, and Lipscomb (1996)
The needs of humans should take priority over fish and wildlife protection.	Teel, Dayer, Manfredo, and Bright (2005)
People should not treat wildlife in ways that may cause pain and suffering, regardless of how much we may benefit.[a]	Whittaker, Vaske, and Manfredo (2006)
It is acceptable for people to kill wildlife if they think it poses a threat to their life.	Teel et al. (2005)
It is acceptable for people to kill wildlife if they think it poses a threat to their property.	Teel et al. (2005)
The rights of people and the rights of wildlife are equally important.	Whittaker et al. (2006)
Although wildlife may have certain rights, most human needs are more important than the rights of wildlife.	Whittaker et al. (2006)
We should strive for a world where there is an abundance of fish and wildlife for hunting and fishing.	Teel et al. (2005)
The needs of people are always more important than any rights that wildlife may have.	Whittaker et al. (2006)
I'm interested in making the area around my farm attractive to wildlife.[b]	Fulton et al. (1996)
Having wildlife around my farm is important to me. [b]	Fulton et al. (1996)
Wildlife is an important part of my community.	Fulton et al. (1996)
I consider a decrease in pesticide use one way to improve living and working conditions on my farm.	Brodt, Klonsky, and Tourte (2006)

Value Orientation Statement	Source
I want to increase biodiversity on my farm even if it takes land out of production.	Brodt et al. (2006)
I can not see using environmentally friendly management techniques if they sacrifice yield or crop quality.	Brodt et al. (2006)
I am not willing to sacrifice farm profitability to conserve water or other resources.	Brodt et al. (2006)
I strive to learn how to manage resources in cooperation with nature.	Brodt et al. (2006)
I use whatever fertilizers and pesticides are necessary to get the job done.	Brodt et al. (2006)
The environmental value of my farm is just as important as its agricultural value.[c]	Thompson, Reimer, and Prokopy (2015)
It is important to maintain biodiversity for future generations.	Whittaker et al. (2006)

[a]Item excluded from final analysis due to poor fit in factor analyses.
[b]Statement wording altered for consistency or to better apply to participants (e.g. “farm” instead of “home”).
[c]Statement inspired by, but not directly adapted from Thompson et al. (2015).

Appendix C

Barn Owl Boxes and Vineyard Pest Management

Dr. Johnson and the students of the Wildlife Habitat Ecology Lab at Humboldt State University (HSU) have been conducting studies aimed at understanding how barn owl nest boxes can help the winegrape industry in Napa County. Currently, two students are using video cameras to document rodent removal and using GPS transmitters to see how owls respond to the recent fires.

We are now interested in better understanding of how Napa wine producers perceive barn owls as potential tools for pest control and how their perspectives on wildlife and the environment in general relate to various vineyard practices. As much of the other research in the area has focused on producers of other crops, we are also interested to see how winegrape growers differ from other agricultural producers. With your help, the results of this survey will allow us to more effectively direct future extension and research.

There are no foreseeable risks to participating, and this survey is entirely anonymous. Each survey will be identified by a number and is in no way associated with any identifying information. Any question after the first can be skipped at any time. Survey results and this consent form will be securely maintained for at least 3 years. We value your time and have tried to keep the survey as short as possible, it should take about 10 minutes to complete. If you have any questions about this research at any time, please call or email Brooks or Matt (info below). If you have any concerns with this study or questions about your rights as a participant, contact the Institutional Review Board for the Protection of Human Subjects at irb@humboldt.edu or (707) 826-5165.

We feel strongly that it is important to share results of this survey, as well as our ongoing studies of barn owl diets and hunting behavior, with producers and farmers. We will therefore work with regional organizations to share the results of this project and our barn owl research with you.

Please print this informed consent form now and retain it for your future reference. If you agree to voluntarily participate in this research as described, please check the box below to begin the online survey. Thank you for your participation in this research, your input is extremely valuable.

Dr. Matthew Johnson
Professor, Wildlife Habitat Ecology
Department of Wildlife
Humboldt State University
mdj6@humboldt.edu
707-826-3218

Brooks Estes
Master's Candidate
Environment & Community Program
Humboldt State University
bre14@humboldt.edu
206-949-7812

Please check below to continue.*
[ ] I have read and understood this consent information and agree to participate in this study.

Vineyard Overview

How would you describe your role in relation to vineyard operation? (please check all that apply)
[ ] Owner/Operator
[ ] Working for a management company
[ ] Other - Write In: ____

About how many properties do you manage?
____

In which county is your farm located? (Select county with majority acreage if overlapping multiple counties)
( ) Alameda
( ) Amador
( ) Contra Costa
( ) El Dorado
( ) Humboldt
( ) Lake

( ) Los Angeles
( ) Madera
( ) Mendocino
( ) Monterrey
( ) Napa
( ) Nevada
( ) Placer
( ) Riverside
( ) Sacramento
( ) San Benito
( ) San Diego
( ) San Joaquin
( ) San Luis Obispo
( ) San Mateo
( ) Santa Barbara
( ) Santa Clara
( ) Santa Cruize
( ) Siskyou
( ) Solano
( ) Sonoma
( ) Stanislaus
( ) Trinity
( ) Yolo
( ) Yuba
( ) Other

How would you classify your farming techniques? (please check all that apply)
[ ] Conventional
[ ] Organic
[ ] Biodynamic
[ ] Regenerative
[ ] Other - Write In: ____

How large is your vineyard?
( ) Less than 1 acre
( ) 1-10 acres
( ) 10-50 acres

( ) 50-100 acres
( ) 100-200 acres
( ) 200-500 acres
( ) 500-1,000 acres
( ) 1,000+ acres

Approximately what percent of the property is used for grape cultivation?

____

Pests

To what extent, if at all, are you concerned about the following potential pests?

	Not concerned	**Somewhat concerned**	**Slightly concerned**	**Very concerned**
Insects	( )	( )	( )	( )
Rodents	( )	( )	( )	( )
Small birds	( )	( )	( )	( )
Deer	( )	( )	( )	( )
Larger predators (eg. coyotes)	( )	( )	( )	( )

What methods are used to control rodent pests on your property? (please check all that apply)
[ ] Rodenticides
[ ] Kill traps
[ ] Attracting birds of prey (owls, hawks, falcons, eagles, and vultures)
[ ] Other - Write In: ____

What techniques are used in an effort to attract birds of prey? (please check all that apply)
[ ] Nest boxes

[ ] Planting or maintaining native vegetation
[ ] Non-removal of existing native vegetation
[ ] Raptor perches
[ ] Other - Write In: ____

How reliable do you find the following sources for information on rodent management?

	Very unreliable	**Somewhat unreliable**	**Neutral/No opinion**	**Somewhat reliable**	**Very reliable**
Personal observation	( )	( )	( )	( )	( )
Other landowners and growers	( )	( )	( )	( )	( )
Local organizations	( )	( )	( )	( )	( )
Meetings or workshops	( )	( )	( )	( )	( )
Personal communication with government agencies (eg. USDA)	( )	( )	( )	( )	( )
Published information from government agencies (eg. USDA)	( )	( )	( )	( )	( )
Research affiliated groups (eg. UC Davis Extension)	( )	( )	( )	( )	( )
Social media	( )	( )	( )	( )	( )
General online information	( )	( )	( )	( )	( )

Owl Boxes

Are there owl boxes on your property?
( ) Yes
( ) No

Owl Boxes – Those who do not use boxes

Why do you not use owl boxes on your property? (please check all that apply)
[ ] Did not know about them
[ ] Do not know how to build/where to buy
[ ] Interested but have not installed any yet
[ ] Do not think owls would be attracted to the property
[ ] Do not think owls would be helpful
[ ] Other - Write In: ____

Owl Boxes – Those who do use owl boxes

About how many boxes are on your property?
____

How do you perceive owls affecting the following?

	Very harmful	**Somewhat harmful**	**Neutral**	**Somewhat beneficial**	**Very beneficial**
Rodent pest reduction	( )	( )	( )	( )	( )
Bird pest reduction	( )	( )	( )	( )	( )
Vine health	( )	( )	( )	( )	( )
Grape yields	( )	( )	( )	( )	( )
Tourism/public opinion	( )	( )	( )	( )	( )

Wildlife and the Environment

Are there cover crops planted under and/or between vine rows?
( ) Yes
( ) No

For what reason(s)? (please check all that apply)
[ ] Wildlife habitat
[ ] Aesthetics
[ ] Reduce soil erosion
[ ] Reduce environmental impacts of chemicals
[ ] Other - Write In: ____

Do you use any animals, such as goats or sheep, to manage weeds on your property?
( ) Yes
( ) No

About what percent of your farm is non-crop habitat (eg. wetland, oak trees, streams, etc.)?

____

Please indicate the extent to which you agree or disagree with the following statements:

	Strongly disagree	**Disagree**	**Somewhat disagree**	**Neutral/No opinion**	**Somewhat agree**	**Agree**	**Strongly agree**
Humans should manage fish and wildlife populations so that humans benefit.	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	Disagree	Somewhat disagree	Neutral/No opinion	Somewhat agree	Agree	Strongly agree
The needs of humans should take priority over fish and wildlife protection.	( )	( )	( )	( )	( )	( )	( )
People should not treat wildlife in ways that may cause pain and suffering, regardless of how much we may benefit.	( )	( )	( )	( )	( )	( )	( )
It is acceptable for people to kill wildlife if they think it poses a threat to their life.	( )	( )	( )	( )	( )	( )	( )
It is acceptable for people to kill wildlife	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	**Disagree**	**Somewhat disagree**	**Neutral/No opinion**	**Somewhat agree**	**Agree**	**Strongly agree**
if they think it poses a threat to their property.							
The rights of people and the rights of wildlife are equally important.	( )	( )	( )	( )	( )	( )	( )
Although wildlife may have certain rights, most human needs are more important than the rights of wildlife.	( )	( )	( )	( )	( )	( )	( )
We should strive for a world where there is an abundance of fish and wildlife for	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	Disagree	Somewhat disagree	Neutral/No opinion	Somewhat agree	Agree	Strongly agree
hunting and fishing.							
The needs of people are always more important than any rights that wildlife may have.	( )	( )	( )	( )	( )	( )	( )
I’m interested in making the area around my farm attractive to wildlife.	( )	( )	( )	( )	( )	( )	( )
Having wildlife around my farm is important to me.	( )	( )	( )	( )	( )	( )	( )
Wildlife is an important part of my community.	( )	( )	( )	( )	( )	( )	( )
I consider a decrease in	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	**Disagree**	**Somewhat disagree**	**Neutral/No opinion**	**Somewhat agree**	**Agree**	**Strongly agree**
pesticide use one way to improve living and working conditions on my farm.							
I want to increase biodiversity on my farm even if it takes land out of production.	( )	( )	( )	( )	( )	( )	( )
I can not see using environmentally friendly management techniques if they sacrifice yield or crop quality.	( )	( )	( )	( )	( )	( )	( )
I am not willing to sacrifice farm profitability	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	Disagree	Somewhat disagree	Neutral/No opinion	Somewhat agree	Agree	Strongly agree
to conserve water or other resources.							
I strive to learn how to manage resources in cooperation with nature.	( )	( )	( )	( )	( )	( )	( )
I use whatever fertilizers and pesticides are necessary to get the job done.	( )	( )	( )	( )	( )	( )	( )
The environment al value of my farm is just as important as its agricultural value.	( )	( )	( )	( )	( )	( )	( )

	Strongly disagree	**Disagree**	**Somewhat disagree**	**Neutral/No opinion**	**Somewhat agree**	**Agree**	**Strongly agree**
It is important to maintain biodiversity for future generations.	( )	( )	( )	( )	( )	( )	( )

General Demographics

Do you have any of the following certifications for your property or the wine you produce? (please check all that apply)
[ ] Organic (USDA)
[ ] Biodynamic (Demeter USA)
[ ] Bay Area Green Business
[ ] Fish Friendly Farming (FFF)
[ ] Napa Green - Land
[ ] Napa Green - Winery
[ ] Lodi Rules
[ ] Sustainability in Practice (SIP)
[ ] ISO 14001
[ ] Certified California Sustainable Winegrowing
[ ] Other - Write In: ____

What is your gender?
( ) Female
( ) Male
( ) Prefer not to say
( ) Prefer to self-describe: ____

What is your age?
____

What format would you find useful for communicating the results of this study? (please check all that apply)

[ ] Presentation at a workshop or conference
[ ] Printed brochure/leaflet
[ ] Electronic brochure
[ ] Webpage
[ ] Segment in an existing newsletter
[ ] Other - Write In: ____

Thank You!

Appendix D

Supplemental results figures

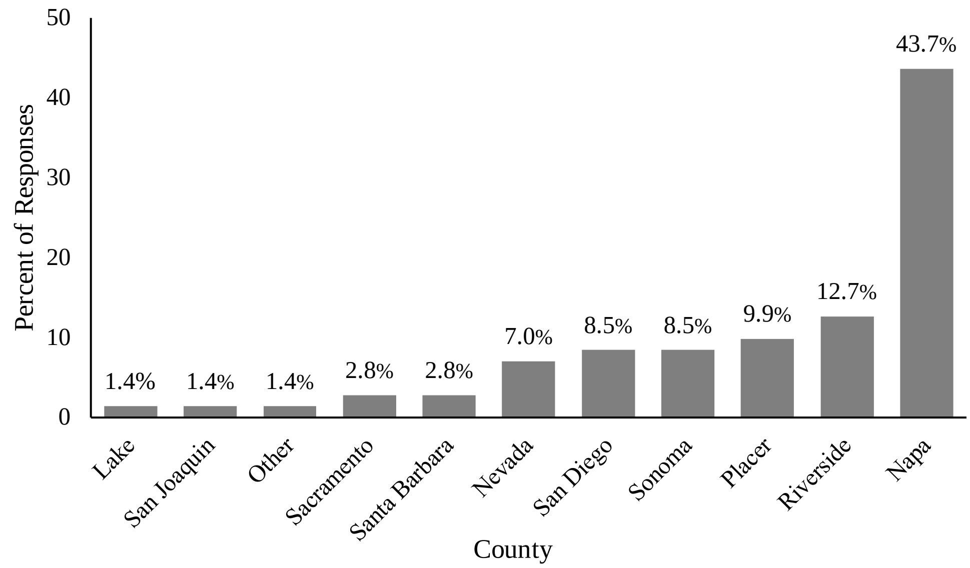

Figure D6. Percent of respondents by county. N = 71.

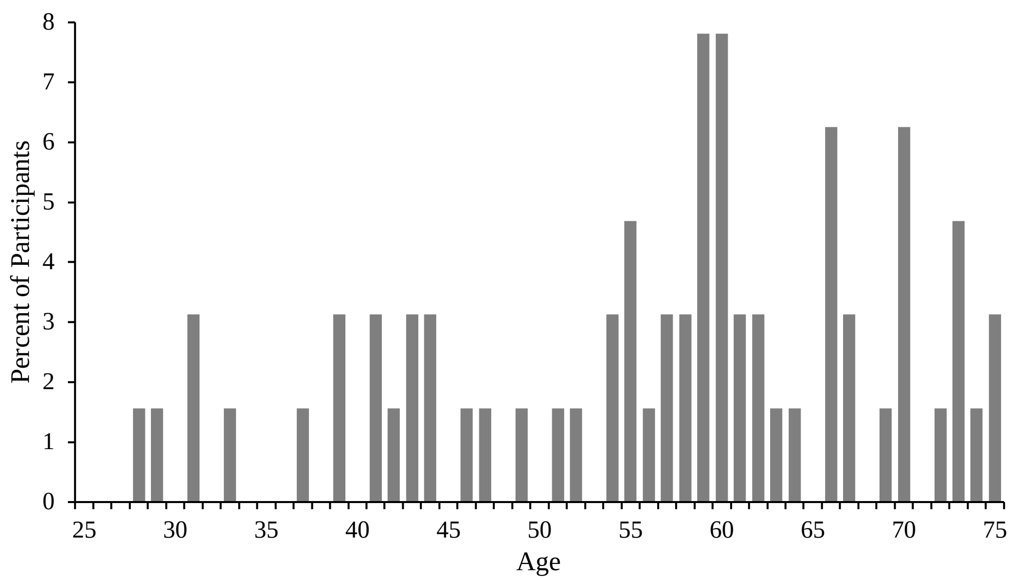

Figure D7. Participants age frequency histogram. M = 56 (SD = 12.54).

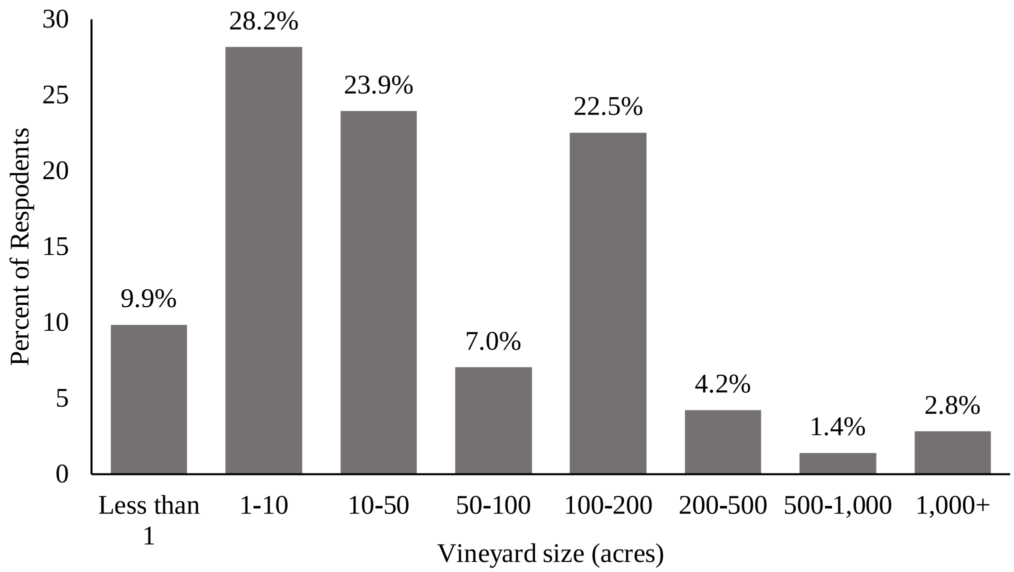

Figure D8. Participant reported vineyard sizes frequency histogram. Most vineyards 200 acres or less (92%).

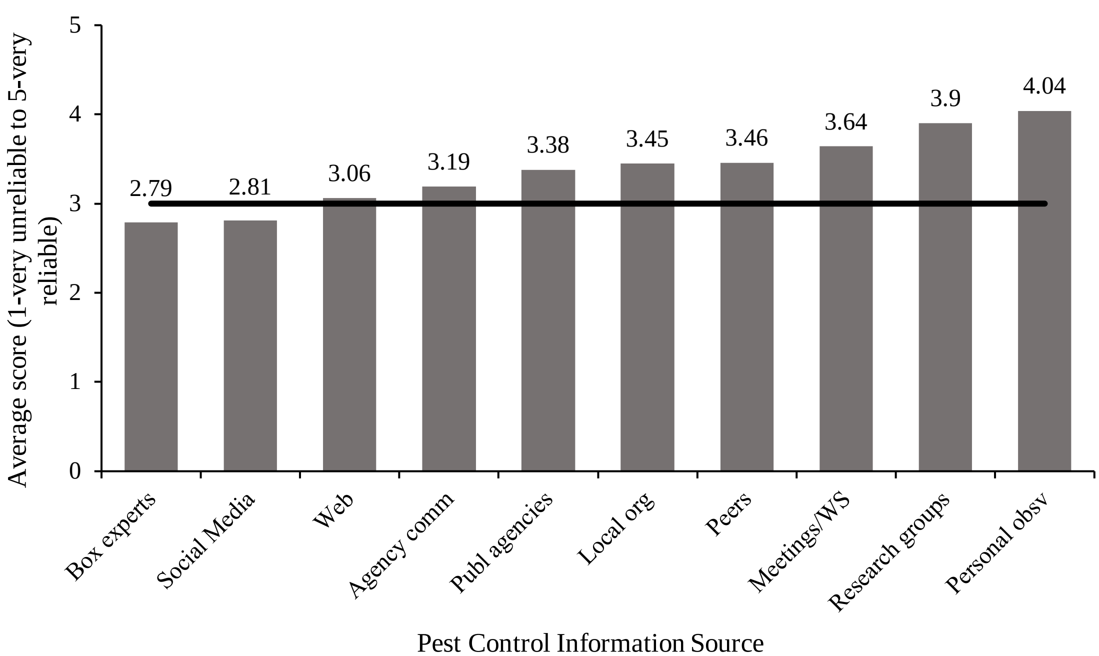

Figure D9. Average perceived reliability of pest control information sources from 1-very unreliable to 5-very reliable. Horizontal line indicates an average score of 3-neutral.

Table D5.
Comparison of Wildlife and Environmental Value Orientation Types and Participant Demographics and Selected Responses with Utilitarians and Pluralists Separated

Variable	Utilitarian[a]	Pluralist[a]	Mutualist[a]
Age ($\bar{X}$)	41[b]	63.5	54.02
Percent Non-crop Habitat ($\bar{X}$)	26.7	30	44.9
Gender (%)			
Female	10	7.7	24.4
Male	90	92.3	71.1
Farm Size in Acres (%)			
Less than 1	20	7.7	8.9
1-10	30	61.5	20
10-50	10	23.1	22.2
50-100	20	0	6.7
100-200	10	0	33.3
200-500	0	7.7	4.4
500-1,000	10	0	0
1,000+	0	0	4.4
At least one certification (%)			
Yes	20	30.8	62.2
No	80	69.2	37.8
Uses non-conventional techniques (%)			
Yes	30	38.5	62.2
No	70	61.5	37.8
Attract birds for pest management (%)			
Yes	80	84.6	75.6
No	20	15.4	24.4
Owl Box (%)			
Yes	80	92.3	80
No	20	7.7	20
Uses Rodenticides (%)			
Yes	50	23.1	15.6
No	50	76.9	84.4

Note.
[a]Distanced value orientation type was excluded due to small sample size (n = 3).
[b]Value is from one response.

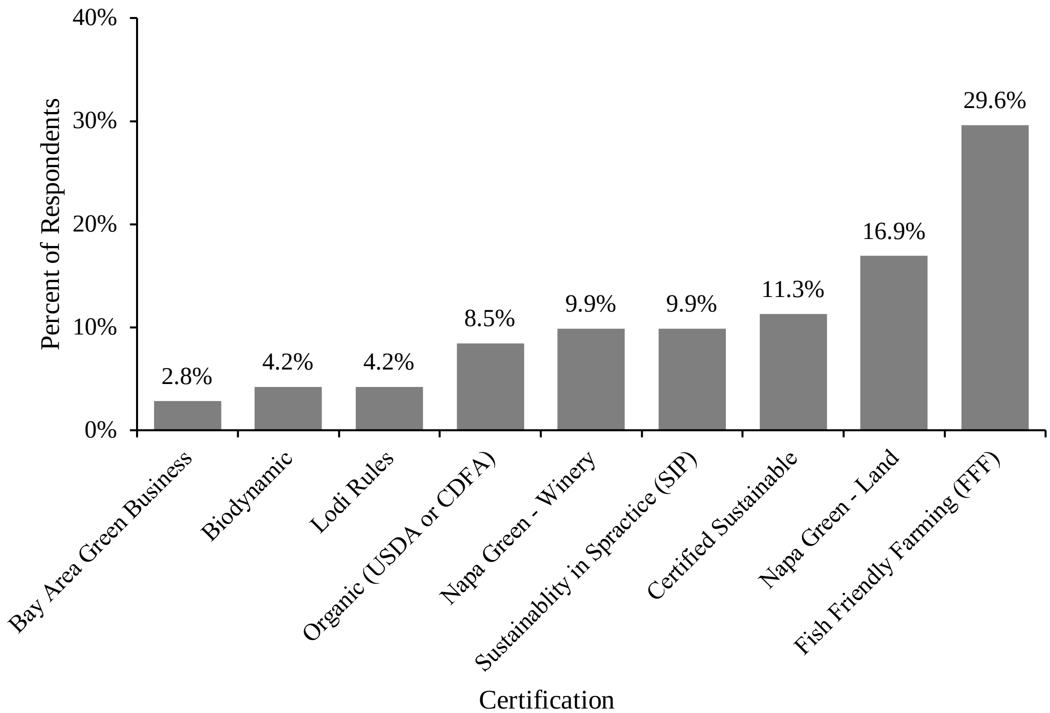

Figure D10. Percent of respondents with each certification.

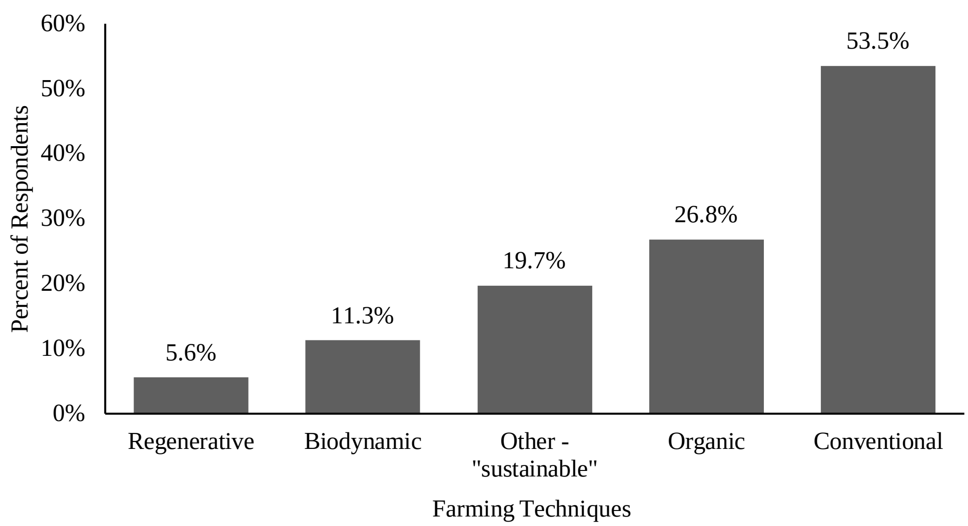

Figure D11. Percent of respondents who reported using different farming techniques. Other – “sustainable” refers to a write-in option for which 20% of respondents specified “sustainable.”

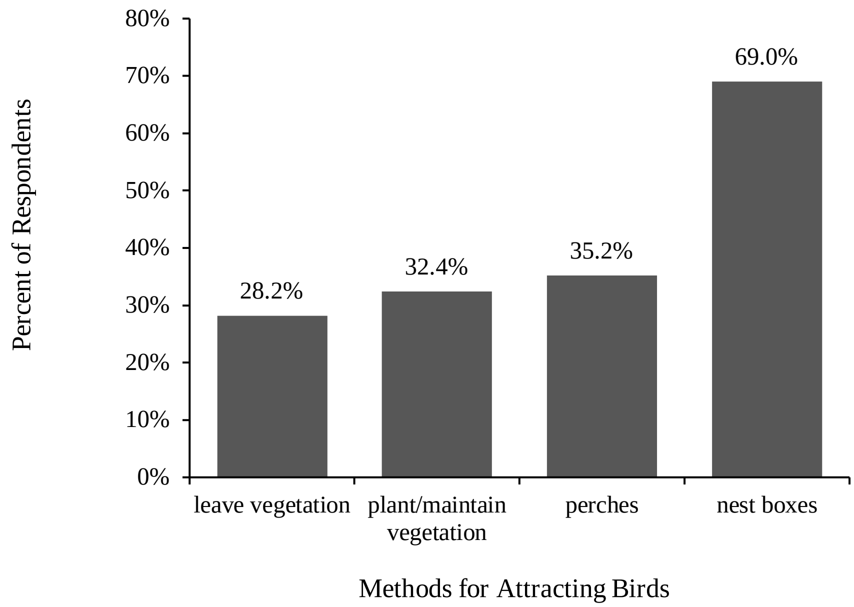

Figure D12. Percent of respondents who reported using different rodent management techniques.

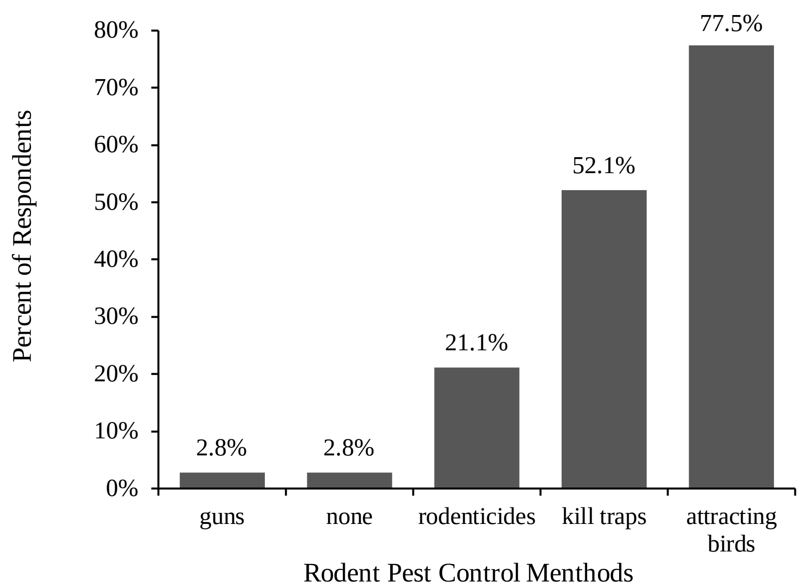

Figure D13. Percent of total respondents, from the subset who reported attracting birds, who used specific techniques to attract birds for rodent control.