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Sustaining Working Rangelands: Insights from Rancher Decision-Making

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Abstract:	Grazed rangeland ecosystems encompass diverse global land resources, and are complex social-ecological systems from which society demands both goods (e.g., livestock and forage production) and services (e.g., abundant and high quality water). Including the ranching community's perceptions, knowledge, and decision-making is essential to advancing the ongoing dialogue to define sustainable working rangelands. We surveyed 507 (33% response rate) California ranchers to gain insight into key factors shaping their decision-making, perspectives on effective management practices and ranching information sources, as well as their concerns. First, we found that variation in ranch structure, management goals, and decision-making across California's ranching operations aligns with the call from sustainability science to maintain flexibility at multiple scales to support the suite of economic and ecological services they can provide. The diversity in ranching operations highlights why single-policy and management "panaceas" often fail. Second, the information resources ranchers rely on suggest that sustaining working rangelands will require collaborative, trust-based partnerships focused on achieving both economic and ecological goals. Third, ranchers perceive environmental regulations and government policies—rather than environmental drivers—as the major threats to the future of their operations.

Rebuttal Letter

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Sustaining Working Rangelands: Insights from Rancher Decision-Making

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ABSTRACT

Grazed rangeland ecosystems encompass diverse global land resources, and are complex social-ecological systems from which society demands both goods (e.g., livestock and forage production) and services (e.g., abundant and high quality water). Including the ranching community's perceptions, knowledge, and decision-making is essential to advancing the ongoing dialogue to define sustainable working rangelands. We surveyed 507 (33% response rate) California ranchers to gain insight into key factors shaping their decision-making, perspectives on effective management practices and ranching information sources, as well as their concerns. First, we found that variation in ranch structure, management goals, and decision-making across California's ranching operations aligns with the call from sustainability science to maintain flexibility at multiple scales to support the suite of economic and ecological services they can provide. The diversity in ranching operations highlights why single-policy and management "panaceas" often fail. Second, the information resources ranchers rely on suggest that sustaining working rangelands will require collaborative, trust-based partnerships focused on achieving both economic and ecological goals. Third, ranchers perceive environmental regulations and government policies—rather than environmental drivers—as the major threats to the future of their operations.

Key Words: agricultural policy, biodiversity, coupled human and natural systems, ecosystem services, sustainability science, working landscapes.

INTRODUCTION

Rangelands are biologically diverse working landscapes that include complex ecosystems ranging from arid deserts and shrublands to mesic grasslands and woodlands. Covering approximately 50% of the world's terrestrial surface (Lund 2007), rangelands support nearly one-third of the world's population and provide multiple ecosystem goods and services—including food and fiber production, water resource protection, and biodiversity (MA 2005; Havstad et al. 2007; Neely et al. 2009). With the global population expected to reach 10.9 billion by 2100 (UN 2013), providing these goods and services into the future will continue to be a fundamental challenge—especially under the mounting pressures of uncertain economic, social, and climate changes (FAO, IFAD, and WRP 2013; Sayre et al. 2013; UN 2013). The long-term sustainability and stewardship of rangeland systems around the globe has been the subject of increasing public debate (NRDC 2010; Briske 2011; FAO, IFAD, and WRP 2013; Sayre et al. 2013; UN 2013).

Growing societal demand for sustainable food production and expanding expectations for land conservation (e.g., Briske 2011) are increasingly complicating management of rangelands (Boyd and Svejcar 2009). In answer to the growing challenges for these and other social-ecological systems, recent reviews on landscape planning, natural resource management, and policy decision-making have highlighted needs for enhanced partnerships and communication among land managers, conservationists, policy makers, and scientists (Daily et al. 2009; de Groot et al. 2010; Briske 2011; Bestelmeyer and Briske 2012; Briske 2012; Ban et al. 2013). There is a critical need to include the ranching community in this dialogue on sustaining multifunctional working rangelands. Ranchers have unique knowledge, experiences, perceptions and values that influence their individual goal setting, decision-making, and adaptive

management strategies (Kreuter et al. 2006; Knapp and Fernandez-Gimenez 2009; Sorice et al. 2012; Kachergis et al. 2013; Kachergis et al. 2014). They also have insights into the impacts of these decisions on economic and ecological aspects of their agricultural enterprises (Berkes et al. 2000). Finally, ranchers are the actors expected to participate in policy partnerships and comply with regulations, and so it is crucial to understand how they view the policy and regulatory landscape.

We examined results of a mail survey of California ranchers within the context of a social-ecological framework for adaptive decision-making (Fig. S1; available online at [insert URL]). The framework provides a conceptual approach that integrates existing decision-making theories to address challenges and opportunities in complex agro-ecological systems (e.g., California's working rangelands (Lubell et al. 2013)). Grazed rangelands in California cover approximately 13.8 million hectares (CALFIRE-FRAP 2010) and support cattle production—the state's fourth leading commodity (3.2 billion U.S. dollars for cattle and calves) (USDA NASS 2012; CDFA 2013). These lands also preserve open space, encompass highly valued ecosystems, and provide habitat for a diversity of common, threatened, and endangered species (GAO 1994; Maestas et al. 2003; Huntsinger et al. 2007; Brunson and Huntsinger 2008; Ferranto et al. 2013; Huntsinger and Oviedo 2014; Plieninger et al. 2012.

Long-term sustainability of individual ranches, and thus working rangeland ecosystems, lies within ranchers' abilities and desires to make adaptive management decisions to cope with changes in ways that attain agricultural goals and conserve essential ecosystem functions (Fig. S1; available online at [insert URL]). Sustaining working rangelands is thus, in part, dependent upon ranchers' social values, management goals and resource options and capacity, and management strategy and practice adoption (Walker et al. 2002; McAllister 2012; Lubell et al.

2013; Marshall and Smajgl 2013). In this context, the goal of this paper is to document and report 1) operator and operation demographics; 2) management goals, practices, and information resources; 3) and operator values and beliefs across California's working rangelands. We argue that including the ranching community's perceptions, experiential knowledge, and decision-making is essential to advancing the ongoing dialogue to define sustainable working rangelands.

METHODS

Survey Design and Sampling

We developed a mail survey of ranchers using the membership list of the California Cattlemen's Association (CCA). CCA is a non-profit trade organization serving cattle ranchers, beef producers, and private owners of cattle-grazed properties across California. The survey included sections on operator and operation demographics, management goals, practices, information resources, and operator values and beliefs. Survey questions were informed from the literature and discussions with collaborating ranchers, and were then pilot tested. The final survey was administered via a multi-contact approach, including both print and online advertisements endorsed by local agricultural organizations (Dillman 2007). Producer members of CCA received four waves of contact from March to June 2011: the initial mail survey and return envelope, a reminder letter including the option to refuse the survey or note ineligibility, a second mail survey packet, and a final reminder card. The survey was delivered to 1727 addresses.

Survey response rate was 33% (American Association of Public Opinion Research, Response Rate 4), with little indication of non-response bias across successive response waves of the survey (Lubell et al. 2013). There were 507 eligible surveys for this analysis; number of

responses (n) per question ranged from 332 to 507 (Table S1; available online at [insert URL]), and is noted throughout.

Data Collection and Analysis

To provide social and ecological insights into the key factors shaping ranch decision-making, we used descriptive statistics to characterize key components adapted from the rangeland decision-making framework (Fig. S1; available online at [insert URL]): operator and operation demographics; management goals, practices, and information resources; and individual social values. Detailed information on each survey question is provided in Supplementary Table S1.

Operator and Operation Demographics. We asked survey respondents about a number of operator characteristics and structural features of the operation, including age, gender, education, number of generations ranching, income, financial dependence on ranch, state of succession planning, other agricultural production activities, land base of ranching operation (owned by individual, private leased, public leased, paid to graze), total acres, and number of grazing animals (i.e., cow-calf pairs, stockers, dairy cattle, sheep, other).

Management Goals, Practices, and Information Resources. We provided respondents with a list of nine potential agricultural and natural resource management goals (livestock production, forage production, carbon sequestration, invasive weed management, recreation, riparian/meadow health, soil health, water quality, and wildlife) and asked them to rank (1–9) each goal as it related to the priorities of their operation. We assigned a rank of "10" to goals that were not ranked by each individual respondent, and therefore not identified as a priority. For common rangeland and ranch management practices, we asked respondents about their experience with, and perceived effectiveness of, ranch facilities and infrastructure, herd management, vegetation management, and landscape enhancements; in particular, we focused on

management practices prominent in conservation planning and incentive programs (see Table S1; Briske 2011). For each practice, we asked 1) if the practice had been used in the past 5 years; 2) whether the practice was key, helpful, or not effective in moving toward management goals; and 3) if additional information on the practice would be useful to future management decisions.

For information needs and networks, we asked respondents to rank (1 = "*Never Use*", 2 = "*I use this, and the quality is poor*", 3 = "*I use this, and the quality is good*", 4 = "*I use this, and the quality is excellent*") the quality of information they received from local government agencies, non-governmental organizations, and independent sources (Table S1). We also asked about internet accessibility and preferred methods of accessing information resources.

Operator Values and Beliefs. We posed statements on basic social values, including views on private property rights, natural resource conservation, environmental protection, ranching lifestyle, and the role of government in rangeland conservation. Respondents were asked the extent to which they agreed or disagreed with each statement using a five-point scale (1 = "*fully disagree*" to 5 = "*fully agree*").

To identify key challenges and risks to sustainability as perceived by ranchers, we used word cloud analysis (Cidell 2010) of the open-ended question, "*What is your biggest concern for the future of your operation?"* Content clouds, or word clouds, assess the relative frequency of words used in analyzed text. We also coded individual response text using an iterative coding process of summarizing and organizing text passages (Neuman 2004; Knapp and Fernandez-Gimenez 2009). We then computed the number of individually coded responses under each theme, and the number of survey respondents addressing each theme.

RESULTS

Operator and Operation Demographics

Median respondent age was 62 (range 25-93; n = 491), and most respondents were male (83%; n = 494). In terms of formal education, 63% had an associate college degree or beyond and an additional 21% reported at least some college training (n = 496). Although first generation ranchers made up 19% of survey respondents, the majority of respondents were from multigenerational ranching families—71% were third or more generations (n = 493). Over 70% of respondents had a succession plan in place (45%; n = 456) or in progress (26%) that identified a strategy for keeping the land in ranching.

Nearly two-thirds of the respondents (64%; n = 487) identified ranching as a critical source of income. Median annual household income category—including on-ranch and off-ranch sources—was $100,000-149,999 (n = 463), with many survey respondents reporting diversified income sources. Almost one-third of respondents reported other agricultural production activities (e.g., timber, vineyards, row crops) within their operation. More than three-quarters of survey respondents (79%) reported some level of off-ranch employment (n = 479), and 56% of these respondents (n = 379) relied on off-ranch employment for more than half of their total household income.

Responding operations spanned a range of sizes and land ownership types (Table 1). Survey respondents (n = 494) represented 4.6 million hectares of rangeland, approximately 33% of California's grazed rangeland (CALFIRE-FRAP 2010). In terms of total ranch land resources, 75% of total rangeland area reported by all respondents (n = 494) was publicly leased (held by 19% of respondents), 14% was privately leased (held by 60% of respondents), and 11% was privately owned (held by 87% of respondents). Operation sizes (i.e., including all private and public rangeland utilized by a ranch) widely varied—ranging from one to more than two million

hectares, with a median operation size of approximately 970 hectares. Individual operation structure was approximately divided between those with a single land ownership type (47% of respondents, n = 494) and those with two or more types of land ownership (e.g., privately owned land and publicly leased land) (53% of respondents, n = 494). Irrigated pastures played a role in half (50%) of operations represented (n = 494)—amounting to more than 70,000 ha (2% of the total land reported), which were primarily privately owned (60%) or privately leased (35%).

The majority of operations were cow-calf based, with a median cow-calf herd size of 145 (Table 1). In total, respondents reported more than 300,000 head of livestock (beef and dairy cattle, sheep, horses, goats, etc.). Ninety-one percent of total livestock reported were beef cattle (evenly divided between cow-calf pairs and stockers (yearling cattle)); sheep represented less than 6% of total livestock reported, and less than 10% of the respondents grazed sheep. Nearly two-thirds of operations grazed only cow-calf pairs, one-third grazed both cow-calf pairs and stocker cattle, and less than 5% grazed only stocker cattle. Survey respondents were from a diversity of bioregions across California—spanning 49 of the state's 58 counties (Fig. 1). Approximately 3% of survey respondents had < 20 cattle and calves; 30% had 20 to 99; 52% had 100 to 499; 13% had 500 to 2,499 and 2% had 2,500 or more. For comparison, the 2007 Census of Agriculture (USDA NASS 2007) reports 52%, 23%, 12%, 9%, and 3% for the same categories, respectively.

Management Goals, Practices, and Information Resources

Respondents (n = 488) rankings of goals fell into three observable tiers: 1) highest priority, agricultural production goals (livestock and forage production); 2) mid-level priority, conservation and environmental goals (weed management, water quality, soil health, riparian

health, and wildlife); and 3) low-level priority, recreation and carbon sequestration (Fig. 2). The most highly rated key practices (Fig 3. "primary practices": match calving to the environment, livestock water development, consult veterinarian on heard health plan, cross fencing, supplemental feeding, match cattle genetics to environment) clearly link to ranchers' highest priority goals, livestock and forage production. Across all practices, respondent interest in additional information to guide future use of practices ranged from 12 to 39% (Fig. 3).

Survey respondents' identified other ranchers and industry organizations (e.g., California Cattlemen's Association, California Farm Bureau Federation) (99% rated these combined resources as good or excellent; n = 502) as their most valued sources of information (Fig. 4). University of California Cooperative Extension and University information resources were rated second highest (80% rated these combined resources as good or excellent; n = 485), and USDA NRCS was rated third highest (56% rated quality as good or excellent; n = 470). Respondents (n = 500) reported using a diversity of methods to access these information resources. The top preferred source of communication was print publications (55%), followed by word-of-mouth and face-to-face interactions (42%), and e-mail and other electronic sources (25%). Eighty-two percent of respondents noted they had internet access—with 68% connecting via high-speed connections, 16% connecting via smartphones, and 14% connecting via dial-up connections. Twenty percent indicated a preference for a combination of information access options.

Operator Values and Beliefs

The majority (63%; n = 486) of respondents agreed that the ranching lifestyle was more important than economic return. Ninety-seven percent of survey respondents (n = 490) agreed with the statement *"Whenever possible, I try to conserve natural resources"*. If confronted with

conflict between economic viability and environmental protection, 68% (n = 484) agreed that it would be more important to protect economic viability. However, nearly half (47%) of respondents (n = 481) disagreed with the statement *"My landowner rights allow me the absolute right to do whatever I want with my land"* (29% agree; 31% neutral).

Trust in government involvement in conservation was divided among respondents. Thirty-six percent of respondents (n = 484) agreed, 31% were neutral, and 33% disagreed with the statement *"Government involvement in conservation has helped ranchers"*. Similarly, 35% of respondents (n = 470) agreed, 29% were neutral, and 36% disagreed with the statement *"In the future, government incentives will be the best way to improve voluntary conservation on actively ranched lands"*. The vast majority of respondents (90%; n = 488) viewed the most important role of government was upholding the private property rights of individual citizens.

In response to the open-ended question, "*What is your biggest concern for the future of your operation?*", respondents (n = 415) primarily identified socio-economic threats (Fig. 5), encompassing three main themes: 1) government regulations and environmental policies (50%); 2) economic viability (43%), with 25% of these respondents voicing concerns for continued funding of the Williamson Act (i.e., California Land Conservation Act of 1965)—a widely used program in California (Lubell et al. 2013) that enables the preservation of open space by providing reduced property tax rates for landowners maintaining land in agricultural or related uses (DOC 2013); and 3) succession planning (21%), with 49% of these respondents specifically noting estate taxes as a challenge. The only commonly emerging biophysical concern was security of water supply (21%), for which respondents also identified interrelated policy and weather issues.

DISCUSSION

Relative to the Census of Agriculture (USDA NASS 2007) for California, the Rangeland Decision-Making Survey respondents represent larger production operations. This is one important segment of the ranching population to understand because of their high levels of activism, prevalence on rangelands, and long-term connections to rangelands (i.e., as largely multi-generational ranching families) (Ferranto et al. 2011). Our results highlight broad differences in ranch structure, management goals, and adaptive decision-making across California's ranching operations, which have also been reflected in other grazed rangelands (Rowan and White 1994; Coppock and Birkenfeld 1999; Coppock 2011; Kachergis et al. 2013; Marshall and Smajgl 2013; Sayre et al. 2013; Huntsinger and Oviedo 2014). This landscape-level heterogeneity (e.g., variation in operation structures, sizes, and ownership types reported by 507 ranchers spanning 49 California counties) potentially accommodates the breadth of opportunities necessary to provide the continuum of food, water, and habitat goals increasingly demanded by society. Furthermore, ranch-level diversification in resources and response options enhances individual abilities to cope with and adapt to economic and ecological variability and uncertainty (Walker et al. 2002; Folke et al. 2005; McAllister et al. 2006; Fazey et al. 2010; Brunson 2012; Sayre et al. 2012; Lubell et al. 2013; Kachergis et al. 2014).

Differences in ranch structure, preferences, and perceptions further reveals why single-policy and simple management "panaceas" often fail (Ostrom et al. 2007). The social, economic, and ecological outcomes of different management practices will vary depending on the structural features of the individual operation; likewise, different ranching operations will be affected by different policies (Lubell et al. 2013; Huntsinger and Oviedo 2014). This suggests some type of

portfolio approach to defining sustainable policies and practices, enabling ranchers to maintain flexibility and adaptive capacity to produce economic and ecological services.

Like other agricultural communities, California ranchers seek information from a diversity of trusted sources (median number of "good" or "excellent" information sources used = 6), including peers and recognized opinion leaders (Fig. 4) (Rowan et al. 1994; Kachergis et al. 2013; Lubell et al. 2013; Lubell and Niles 2014). This survey was based on the membership of the California Cattlemen's Association (CCA), and so rankings of producer groups were high, as expected; however, previous work has also found similarly favorable rankings of industry organizations by agricultural landowners (Ferranto et al. 2012). In general, there is a lot of work to do to build trust and enhance the relevance of information from conservation and environmental groups to the ranching community (Fig. 4). Individuals and institutions that can effectively span different social networks have the opportunity to link diverse knowledge sources and goals, and bring multiple groups together for the co-production of knowledge (Cutts et al. 2011; Briske 2012; Lubell et al. 2013). Among our respondents, UC Cooperative Extension, Universities, and the USDA Natural Resources Conservation Service appear to be recognized and trusted boundary organizations (Fig. 4). These organizations have a long history of connecting science-based management and conservation with the needs of local communities. In the past decade, there has been an increasing number of new collaboratives and organizations with vested interests in the stewardship and conservation of working rangelands. Building cooperation among these diverse and growing interests can potentially bring new opportunities to the table for rangeland management and conservation.

Ranchers clearly ascribed value to ecological services linked to rangeland health (e.g., weed management, soil health) (Fig. 2); however, they prioritized economic aspects of sustainability

(i.e., livestock and forage production) over general environmental and social goals (Fig. 2). Conservation organizations looking to advance conservation goals on working rangelands should focus on joint solutions for both economic and ecological sustainability. To enhance adoption, voluntary approaches to advancing conservation goals should 1) highlight win-win scenarios for achieving conservation and agricultural goals; 2) include education and outreach to demonstrate any long-term economic benefits of conservation activities; and 3) mitigate potential economic tradeoffs.

Lastly, identifying the most salient challenges perceived by ranchers can aid translation among science, policy, and management in establishing common goals, identifying barriers to effective partnerships, and finding win-win solutions for management and conservation of working rangelands. More than a century of rangeland science has focused on the ecological complexity and biophysical aspects of rangeland ecosystems (as reviewed in DiTomaso 2000; Herrick et al. 2010; Briske 2011; Sheley et al. 2011; Ash et al. 2012; Belnap et al. 2012). Contrary to this ecological focus, the dominant concerns for sustainability among surveyed ranchers were socio-economic (Fig. 5). Most notably, ranchers commonly identified environmental regulations and governmental policies—rather than environmental drivers—as the major threats to the future of their operations, a sentiment that has been echoed in other agricultural communities (Smith and Martin 1972; Liffmann et al. 2000; Conley et al. 2007; Niles et al. 2013). Although respondents were divided on trust in government involvement in conservation, a considerable fraction of respondents perceived some government agencies as barriers to their flexibility and management capacity—rather than as facilitators and partners in sustaining multifunctional rangelands.

IMPLICATIONS

The California Rangeland Decision-Making Survey revealed substantial variation in ranch structure, management goals, and decision-making across the state's ranching community. Ranch and landscape-scale heterogeneity provide opportunities to support the full suite of social-ecological services rangelands provide (Huntsinger and Oviedo 2014)—but also highlights the challenge of one-size-fits-all approaches of linking management practices and policies to adaptive capacity and long-term sustainability. To effectively support flexibility across these scales, rangeland policy and outreach strategies should actively engage opinion leaders, local social networks, and trusted organizations. Among landowners in general, ranchers who value a combination of agricultural and environmental goals are more proactive managers, more motivated to adopt conservation practices, and likely to engage in collaborative approaches (Smith and Martin 1972; Liffmann et al. 2000; Didier and Brunson 2004; Fernandez-Gimenez et al. 2005; Conley et al. 2007; Ferranto et al. 2011; Oviedo et al. 2012). Collaborative partnerships can capitalize on different knowledge sources and build trust and cooperation among the growing diversity of stakeholders interested in the stewardship and conservation of rangelands. Such boundary-spanning (Guston 2001; Briske 2012) partnerships are key in negotiating potential conflicts between groups and addressing individual fears of regulation. These partnerships will also be critical in developing creative and flexible mitigation and adaptation strategies for environmental change, and thus enhance resilience, adaptive capacity, and sustainability of rangeland social-ecological systems.

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LIST OF FIGURES

TABLES

Table 1. General operation characteristics for surveyed California ranches.

	Mean	Median	Range
Total area[1] (ha)	9,405	971	0 – 2,059,852
Private owned[1] (ha)	1,075	251	0 – 16,187
Private leased[1] (ha)	1,306	101	0 – 40,469
Public leased[1] (ha)	7,001	0	0 – 2,023,430
Irrigated lands[1] (ha)	144	1	0 – 4,856
Total livestock[2]	643	200	4 – 22,000
Cow/Calf pairs[2]	288	145	0 – 8,000
Stockers[2]	295	0	0 – 15,000
Sheep[2]	181	0	0 – 8,200

[1]n = 494.
[2]n = 492.

Figure1
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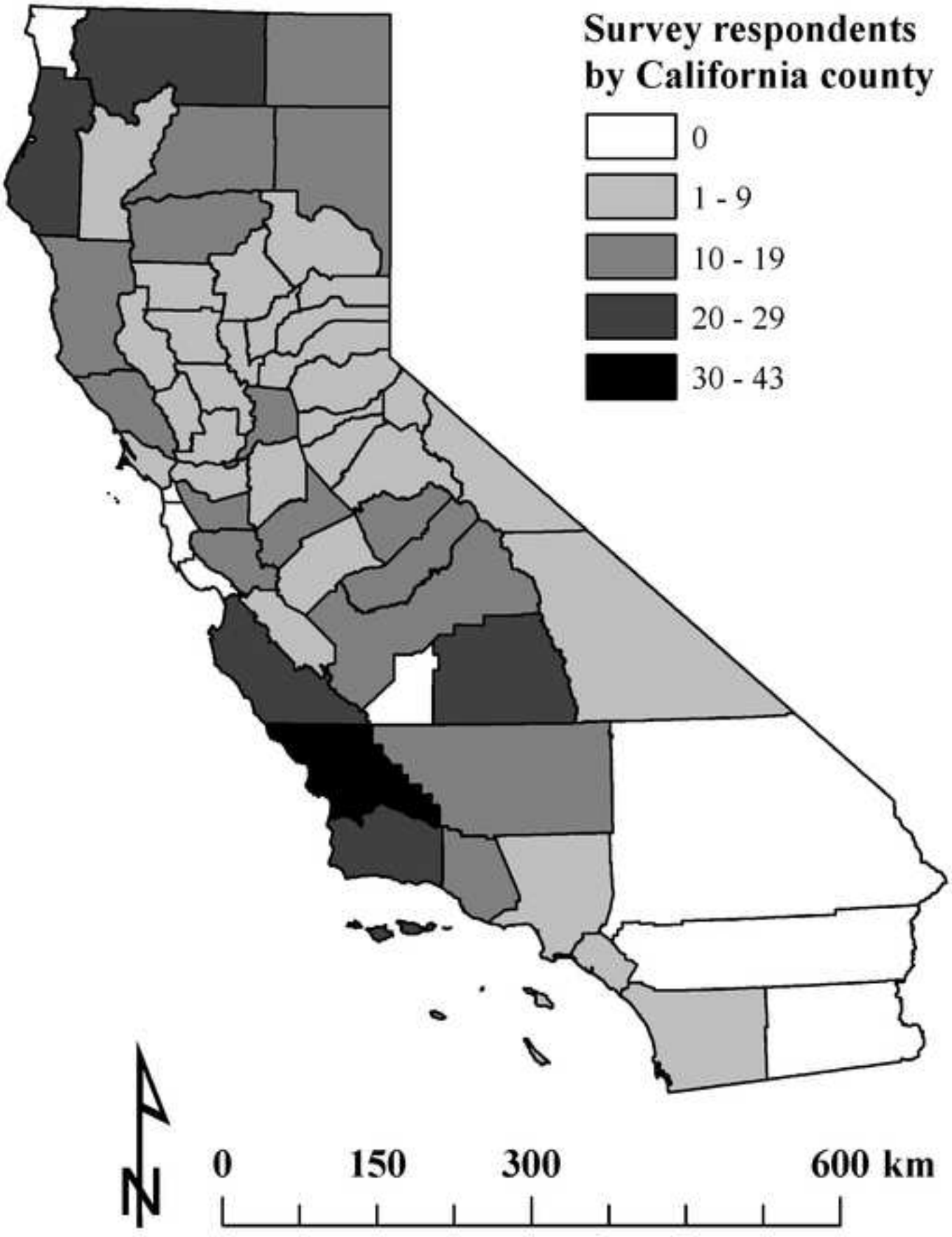

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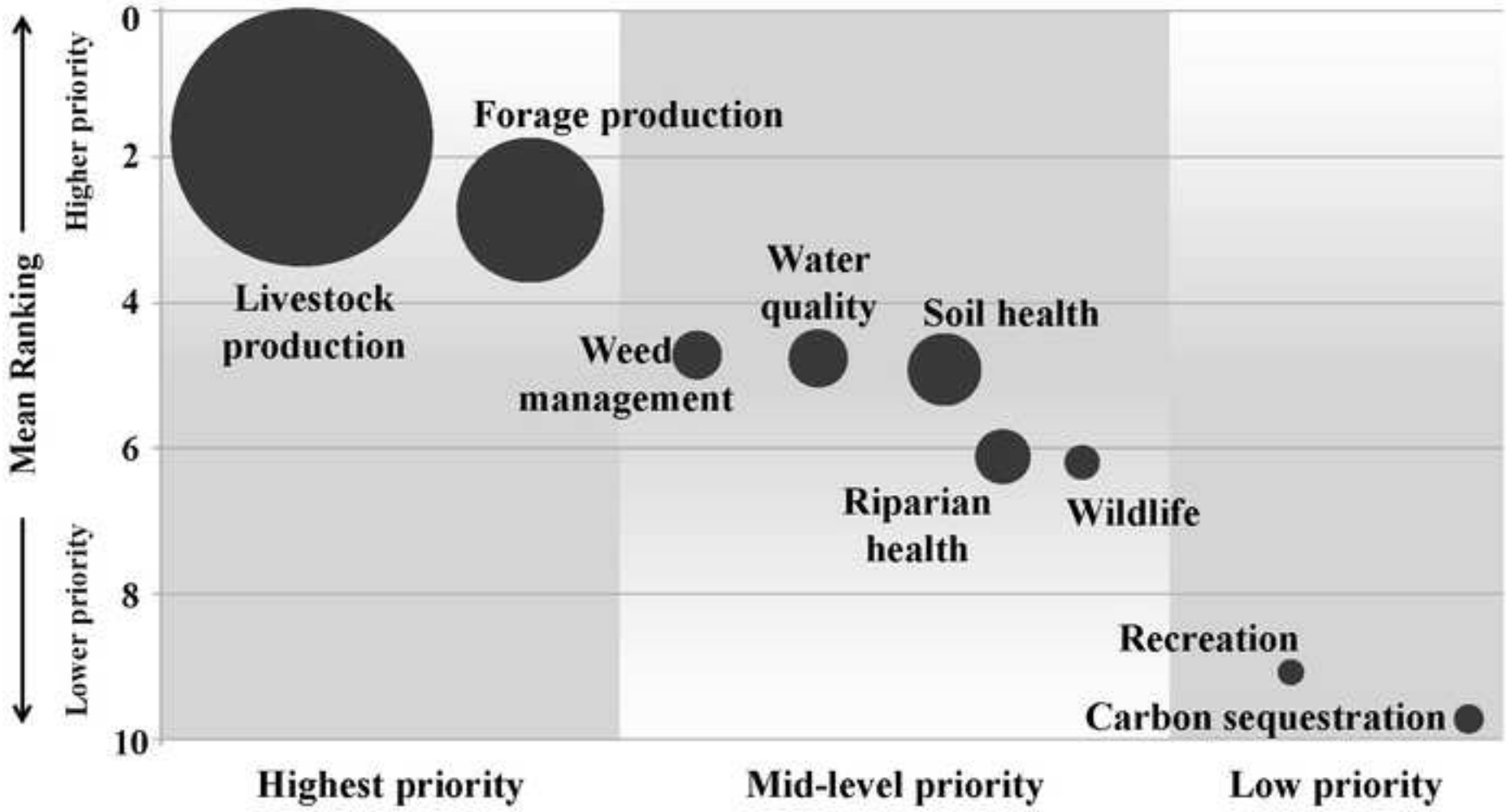

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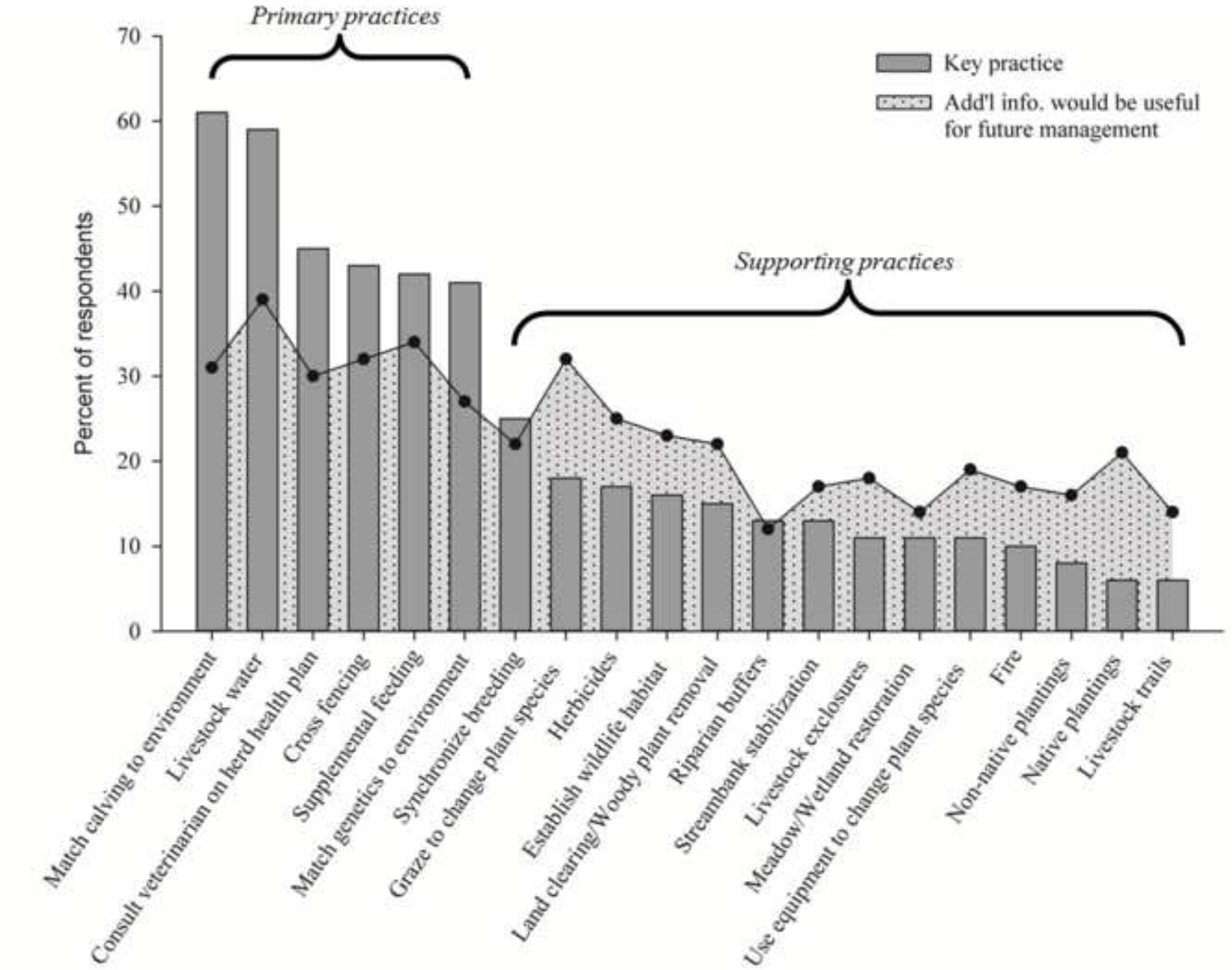

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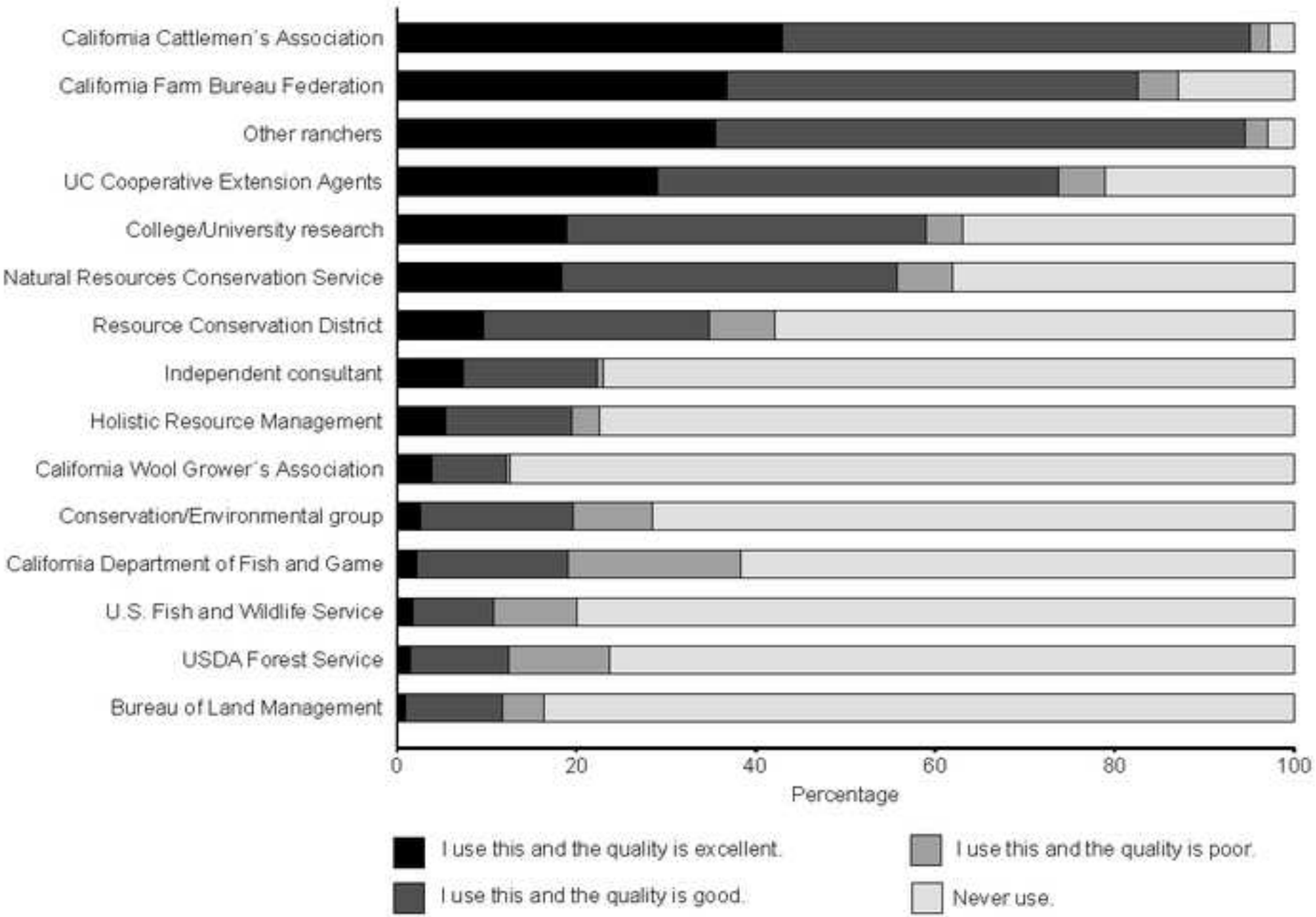

Figure5
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Supplemental Figure1

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TableS1

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