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Appreciation, Use, and Management of Biodiversity and Ecosystem Services in California's Working Landscapes

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Abstract "Working landscapes" is the concept of fostering effective ecosystem stewardship and conservation through active human presence and management and integrating livestock, crop, and timber production with the provision of a broad range of ecosystem services at the landscape scale. Based on a statewide survey of private landowners of "working" forests and rangelands in California, we investigated whether owners who are engaged in commercial livestock or timber production appreciate and manage biodiversity and ecosystem services on their land in different ways than purely residential owners. Both specific uses and management practices, as well as underlying attitudes and motivations toward biodiversity and ecosystem services, were assessed. Correlation analysis showed one bundle of ecosystem goods and services (e.g., livestock, timber, crops, and housing) that is supported by some landowners at the community level. Another closely correlated bundle of biodiversity and ecosystem services includes recreation, hunting/fishing, wildlife habitat, and fire prevention. Producers were more likely to ally with the first bundle and residential owners with the second. The survey further confirmed that cultural ecosystem services and quality-of-life aspects are among the primary amenities that motivate forest and rangeland ownership regardless of ownership type. To live near natural beauty was the most important motive for both landowner groups. Producers were much more active in management for habitat improvement and other environmental goals than residential owners. As the number of production-oriented owners decreases, developing strategies for encouraging environment-positive management by all types of landowners is crucial.

Keywords Biodiversity · California · Ecosystem services · Forest and rangeland management · Landowner survey · Working landscapes

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Introduction

Most biodiversity conservation efforts have traditionally been dedicated to the protection of large units of pristine natural environments such as wilderness areas and parks. However, it has long been acknowledged that such reserves are "too few, too isolated, too static, and not always safe from overexploitation" (Fischer and others 2006, p. 80) and therefore must be linked with adjacent landscape units to increase the survival chances of plant and animal

populations (Figueroa and Aronson 2006). If wildlife-friendly management principles are observed, agricultural and forestry commodity landscapes may effectively integrate conservation and production and complement conservation reserve strategies (Fischer and others 2006, 2008). The Millennium Ecosystem Assessment (MA 2003) has further mainstreamed the recognition that human-dominated ecosystems, such as croplands, grazed rangelands, or managed forests, are able to provide rich biodiversity and vital ecosystem services.

Various concepts have emerged to foster synergies between commodity production with the provision of publicly enjoyed ecosystem services in privately owned and human-dominated landscapes. At a landscape scale, these have been referred to (and begun to find support through land-use policies) as "multifunctional" (Jones-Walters 2008) or "cultural" landscapes (Plieninger and Bieling 2012). Recently, this notion has entered the Meeting of the Conference of the Parties to the Convention on Biological Diversity under the heading "socioecological production landscapes." These are defined as landscapes that "people have developed and maintained sustainably over a long time," and it is assumed that they maintain biodiversity and human well-being in a harmonious way (Satoyama Initiative 2011). In North America, "working landscapes" refers to effective stewardship and conservation through active human presence and management and includes the following dimensions: (1) productive activity ("working") on the land (farming, ranching, forestry, etc.), (2) large terrestrial scale ("landscape"), and (3) goods and services provided by and from the land (e.g., scenery, water) in a joint production function (Huntsinger and Sayre 2007). In a normative sense, the notion of "working landscapes" expresses the desire to combine agricultural/forestry and environmental benefits, and it has been frequently applied to meet conservation goals on private lands (Brunson and Huntsinger 2008).

The goal of this article is to foster a deeper understanding of biodiversity and ecosystem services in working landscapes as perceived by private landowners in California (USA). An ecosystem services framework (MA 2003) is used, and two antithetical landowner groups are juxtaposed: "traditional" landowners who run timber or ranching businesses with "new" landowners whose main motivation is related to amenities, in particular to live on the land (Kendra and Hull 2005; Riebsame and Robb 1997).

Compared with most current ecosystem services assessments that have focused on the biophysical quantification of ecosystem services supply (Kienast and others 2009; Seppelt and others 2011), our study systematically compares landowner appreciation of biodiversity and ecosystem services in a nonmonetarized way. The goal is to complement classic economic valuation exercises of ecosystem services and to contribute to improved decision making by incorporating the full suite of ecosystem benefits to society. The study also allows determining specific degrees of appreciation for actual or potential ecosystem services provision among different user groups. This is relevant knowledge because it has been shown that appreciation for a particular ecosystem service is a powerful determinant of land-user's management decisions (Agbenyega and others 2009). Taking specific interests and values into account should also provide better balance between those ecosystem services that are directly allocated to an individual (e.g., livestock production) and those that are enjoyed collectively (e.g., presence of wildlife) (Gómez-Baggethun and others 2010). Analysis of the appreciation of ecosystem services also accounts for ecosystem services that are difficult to capture in monetization exercises, in particular many of the cultural ecosystem services (Schaich and others 2010).

The article centers on four issues: (1) analysis of the most appreciated ecosystem services at the community level and their positive or negative relationships; (2) identification of the effective uses of ecosystem services for commercial and noncommercial purposes; (3) analysis of ranch-level cultural ecosystem services and quality-of-life aspects as drivers of forest and rangeland ownership; and (4) determination of the most common management practices for biodiversity and ecosystem services at the ranch level. We hypothesize that whether or not owners are engaged in the commercial production of forest and rangeland goods determines variation not only in specific uses and management practices but also in underlying attitudes and motivations toward biodiversity and ecosystem services.

Biodiversity and Ecosystem Services in California's Working Forests and Rangelands

In the United States West, high-intensity farmland, timber-production forests, grazing lands, and nature conservation reserves have traditionally been spatially segregated, and conflicts between wildlife conservation and extractive uses have been frequent, particularly on public lands where the management mandate fluctuates along with political and social trends (Fleischner 1994). However, California's privately owned forests and rangelands do not fit into this dichotomy because many of them support commodity production, biodiversity, and intangible ecosystem services simultaneously. Although livestock and timber have traditionally been the most iconic ecosystem goods, there is a variety of other provisioning ecosystem services that includes firewood, charcoal, growing food crops and fiber, hunting/fishing, collection of herbs and mushrooms, and renewable energy uses. Moreover, forests and rangelands

offer many less tangible regulating ecosystem services, such as carbon sequestration, soil protection, crop pollination, microclimate amelioration, and decreased water runoff in hilly areas (Kremen and others 2004; Havstad and others 2007). Recent research assesses the value of crop pollination services alone to be as much as 2.1 billion dollars from rangelands in California's central valley (Chaplin-Kramer and others 2011). A plethora of cultural ecosystem services, such as maintenance of scenic landscapes, tourism, cultural heritage, educational values, and recreation, are also produced on these undeveloped lands (Brunson and Huntsinger 2008). With a total of 4,426 plant species (among which 2,125 are endemic) and 584 vertebrate species (among which 71 are endemic), the California Floristic Province is a global biodiversity hotspot (Myers and others 2000), and most of this biodiversity, including freshwater fish, wintering birds, waterfowl, invertebrates and mammals, relies on forests and rangelands (Kroeger and others 2010). The conservation and biodiversity of private forests and woodlands has been little studied, although they frequently harbor greater ecological values than public lands in California because the former tend to be more productive, better watered, and higher in soil quality (Hilty and Merenlender 2003).

Despite growing recognition of their unique values, the future of California's forests and rangelands remains at risk. Approximately 13 million ha of forest and rangeland are in private ownership (California 2010, p. 40). An overarching direct driver contributing to their degradation is subdivision and conversion of land into residential areas, a consequence of strong exurban in-migration to rural areas (Walker and Fortmann 2003). In the Western United States, nonmetropolitan population growth has been three times greater than that in other parts of the country, and the dispersed nature of exurban development has heavily impacted forests and rangelands. This has increased wildfire hazard, decreased human-sensitive native songbird and carnivore species, and fostered expansion of invasive plant and commensal bird species (Hansen and others 2002; Underwood and others 2009). Conversion into intensively used agricultural land, such as vineyards (the extent of which doubled in the 1990s), further adds to this threat (Santos and Thorne 2010). Analysis of satellite data from 1986 to 2000 showed that an average of 14,500 ha of rangeland and forest was converted annually in California to urban development; from 1990 to 2000 approximately 30,000 ha per year of rural land were parcelized for low-density housing (California 2010, p. 47). Exurban parcelization is an imminent threat to ecosystem services and biodiversity dependent on large and contiguous areas of land (Hobbs and others 2008). This can include habitat provision for species that are migratory or have large home ranges, such as elk, fishers, kit fox, and mountain lions, or plants and animals that must be buffered from urban-associated impacts, such as the many reptile species that are depleted by the predation of domestic cats as well as recreation and landscape aesthetics.

Although some of the financial revenues of forest and rangeland ecosystem services can be captured by landowners—either in markets or by private consumption (Campos and others 2009)—a substantial portion of the overall benefits is absorbed by others off site (Kroeger and others 2010). Generally, landowners do not have an incentive to take the full value of forest and rangeland ecosystem services into account when making management decisions, *e.g.*, about conversion and development. For landowners who are motivated to resist development pressure, maintaining private forests and particularly rangelands therefore increasingly depends on public-conservation payments, cost-share programs, and markets for ecosystem services (Kroeger and others 2010; Liffmann and others 2000).

One major issue when managing land or designing payment schemes for multiple ecosystem services is the risk of trade-offs at various spatial and temporal scales (DeFries and others 2004). We understand trade-offs as negative unidirectional or bidirectional relationships between ecosystem services (Bennett and others 2009; Rodriguez and others 2006). Trade-offs occur when provision of one ecosystem service at a given location is maximized at the expense of another service at that or surrounding locations (Holling and Meffe 1996). Trade-offs may either be an explicit choice or may be unintentional in cases of incomplete or incorrect knowledge about ecosystem services interactions (Rodriguez and others 2006). The MA (2005) concluded that global increases in provisioning services, such as livestock production, have been accompanied by severe decreases in regulating, cultural, and supporting services. This phenomenon was empirically confirmed in a recent study from Quebec (Canada), which identified significant trade-offs between crop and pork production and almost all regulating and cultural ecosystem services (Raudsepp-Hearne and others 2010). Chan and others (2006) found slightly negative spatial associations between forage production and most other ecosystem services in the Central Coast ecoregion of California. However, services may also have a synergetic relationship and benefit each other (Bennett and others 2009; Foley and others 2005). For example, Kroeger and others (2010) suggest a range of synergetic cobenefits (among others carbon sequestration and drinking-water quality) that may be achieved through habitat conservation on Californian rangelands.

California's forests and rangelands are exemplary of the possibilities of fostering sustainable rural development through allowing landscapes to be more multifunctional in terms of ecosystem services provision. First, they offer abundant potential and proven synergies between

management for biodiversity and ecosystem services (Kroeger and others 2010). Second, forests and rangelands in the American West are extremely vulnerable to amenity-driven ex-urban migration processes and may thus be a harbinger of changes prevalent in many developed countries (Hansen and others 2002; Walker and others 2003). Third, California's working landscapes provide lessons on how to foster the viability of ranching enterprises and conservation demands through land stewardship (Brunson and Huntsinger 2008; Walker 2006).

Framework and Methods

We followed MA (2003) by defining ecosystem services as "the benefits that people derive from ecosystems" and by dividing final ecosystem services into provisioning, regulating, and cultural services. Because the ultimate decision regarding ecosystem services to be considered depends on the particular context (Costanza 2008), we based the selection of relevant forest and rangeland ecosystem services on previous research among California landowners (Campos and others 2009; Huntsinger and others 2010). Our focus was on final ecosystem services (Haines-Young and Potschin 2009). In the results listed in Tables 1 and 2, we consider livestock, crops, and timber (provisioning services); fire prevention (regulating services); hunting/fishing, recreation, and rural housing (cultural services); and wildlife habitats (biodiversity). We look at tangible ecosystem services (hunting/fishing, timber, livestock, fuel wood, etc.) in Table 3 and more intangible cultural services (aesthetics, cultural heritage, recreation, sense of place, spiritual) in Tables 4 and 5. Here, we also delve into the determinants and constituents of quality of life (basic material for a good life, good social relations). As the MA (2003) points out, there is a variety of strong linkages between ecosystem services and quality of life, and, as such, they often play a critical role in landscape-related decision making. Table 6 lists management practices for a broad range of ecosystem services.

A total of 1,730 forest and rangeland landowners from 10 counties in California were sent a mail-in questionnaire in 2008. A group of field- and campus-based University of California Cooperative Extension specialists and faculty selected a minimum of one county from each of California's six forest and/or rangeland-containing bioregions of similar environmental and demographic characteristics as identified by the Cal Fire's statewide Forest and Rangeland Resource Assessment Program (California 2010, p. 6). The

Table 2 Expressed appreciation of biodiversity and ecosystem services at the community scale among California forest and rangeland owners in 2008

Biodiversity and ecosystem services	Producer owners (n = 152–167)	Residential owners (n = 212–232)	P (Mann–Whitney U) [df = 1]
Timber	3.6	2.5	<0.001
Livestock	3.6	3.1	<0.001
Wildlife habitats	2.4	3.0	<0.001
Recreation	2.0	2.2	0.011
Housing	2.1	1.9	0.034
Crops	2.8	2.8	NS
Hunting/fishing	2.1	2.2	NS
Fire prevention	3.1	3.0	NS

Mean values of four-scale assessment = 1 (strongly no demand) to 4 (strong demand)

NS not significant

Table 1 Spearman rank correlations between appreciation for biodiversity and ecosystem services at community scale among California forest and rangeland owners in 2008

	Livestock	Crops	Timber	Housing	Fire prevention	Hunting/fishing	Recreation	Wildlife
Livestock	–							
Crops	0.414***	–						
Timber	0.380***	0.170**	–					
Housing	0.280***	0.209***	0.230***	–				
Fire prevention	0.096	0.213***	0.111	–0.085	–			
Hunting/fishing	0.018	0.114*	0.055	0.018	0.262***	–		
Recreation	–0.133*	0.155**	–0.125*	–0.166**	0.325***	0.476***	–	
Wildlife	–0.289***	0.065	–0.279***	–0.363***	0.370***	0.236***	0.408***	–

n = 297–348

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

Table 3 Use of tangible ecosystem services at the ranch scale among California forest and rangeland owners in 2008

Use of tangible ecosystem services	Producer owners ($n = 171$)	Residential downers ($n = 242$)	P (χ^2) [$df = 1$]
Personal use (%)			
Any personal use	78	87	0.007
Residential home	52	52	NS
Hunting	40	22	<0.001
Vacation home	13	28	0.001
Fishing	25	12	<0.001
Fuel wood	42	52	0.048
Crops	14	21	NS
Livestock	10	17	NS
Timber	3	10	0.017
Commercial use			
Any commercial use	100	13	<0.001
Timber	69	0	NA
Livestock	47	0	NA
Selling grazing leases	30	5	<0.001
Fuel wood	22	1	<0.001
Hunting	17	2	<0.001
Crops	11	4	0.012
Vacation home	2	0	NS
Fishing	1	0	NS

NS not significant, *NA* not applicable

counties included in the study were Humboldt, Sonoma, Mendocino, Shasta, Sierra, Plumas, El Dorado, Santa Barbara, San Diego, and Contra Costa (Fig. 1). The sparsely populated and adjacent Sierra and Plumas counties were combined into one sampling unit. Within each county, a stratified random sampling design was used to select addressees and parcel sizes derived from county tax-assessment records for the statewide land parcel database created in 2003 for the Forest and Rangeland Assessment (California 2010). Parcel vegetation types are identified at the parcel center.

For selection, parcel vegetation type was categorized into two general categories: (1) forest with commercial timber potential or (2) rangeland, including oak woodland and savanna, shrublands, and grasslands. Parcel size was then subcategorized into four groups: 3 to 9 acres (approximately 1.6 to 3.6 ha), 10 to 49 acres (approximately 4.0 to 19.8 ha), 50 to 499 acres (approximately 20.2 to 201.9 ha), and ≥500 acres (approximately 202.3 ha). A random sample of ≤30 parcels was drawn from each subcategory to yield a total of approximately 240 parcels per county. All duplicate landowner addresses were dropped from the sample so that each individual landowner only received one survey. A modified version of the Dillman Total Design Method (Clendenning and others 2004; Dillman 2007) was used in designing and mailing the survey. In all, 670 questionnaires were received, which—after adjusting for undeliverable questionnaires and questionnaires sent to nonforest or rangeland owners—corresponds to a response rate of 42.5 %.

Unless otherwise indicated, all data were weighted proportionally to sampling intensity to adjust for the disproportionate sampling intensity between different sampling strata and counties. Proportional survey weights were calculated by multiplying the reciprocal sampling ratio by the overall sampling ratio. The reciprocal sampling ratio is the total number of landowners in each sampling strata compared with the number of landowners sampled from each strata. The overall sampling ratio is the overall sample size compared with the overall population (Maletta 2007). Reported results are thus representative of true landowner population proportions.

The survey was primarily designed to better understand the goals, needs, and opinions of the clientele of the University of California Cooperative Extension (Ferranto and others 2012). In this study, survey results related to

Table 4 Cultural services and quality of life as motives for owning land among California forest and rangeland owners in 2008

Motivation for owning land	Related to cultural service and quality of life	Producer owners ($n = 155$–171)	Residential owners ($n = 214$–239)	P (Mann–Whitney U) [$df = 1$]
To live near natural beauty	Aesthetics	3.9	4.5	<0.001
To continue a family tradition or business	Cultural heritage	3.9	2.8	<0.001
It provides recreational opportunities	Recreation	3.4	3.7	NS
To live in a small community	Sense of place	3.0	3.7	<0.001
It provides a source of my income	Basic material for a good life	2.9	0.6	<0.001
To help the local economy	Good social relations	2.9	2.1	<0.001
To connect with a higher power	Spiritual	2.7	2.8	NS

Mean values of five-scale assessment: 1 (strong disagreement) to 5 (strong agreement)

NS not significant

Table 5 Spearman rank correlations between pairs of cultural ecosystem services/aspects of quality of life at ranch scale among California forest and rangeland owners in 2008

	Natural beauty	Family tradition	Recreation	Income source	Small community	Higher power	Local economy
Natural beauty	–						
Family tradition	0.022	–					
Recreation	0.377***	0.007	–				
Income source	–0.176**	0.479***	–0.113*	–			
Small community	0.599***	0.050	0.313***	–0.134*	–		
Higher power	0.329***	0.159*	0.088	–0.032	0.258***	–	
Local economy	0.115*	0.469***	0.056	0.542***	0.219***	0.172**	–

$n = 321$–360

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

Table 6 Management techniques for biodiversity and ecosystem services practiced by California forest and rangeland owners in 2008

Management techniques	Producer owners ($n = 157$–164)	Residential owners ($n = 229$–237)	P (χ^2) [$df = 1$]
Overall (%)			
Regular inspection of land condition	94	90	NS
Use of "organic" or "natural" production processes	26	33	NS
Development of written management plan	50	9	0.001
Biodiversity (%)			
Improvement of wildlife habitat	73	55	<0.001
Management of streams and ponds for wildlife benefit	59	45	0.004
Plantation of native plant species	38	38	NS
Removal of nonnative plant species	62	35	<0.001
Provisioning services (%)			
Pruning or cutting down of trees to improve forest health	64	52	0.026
Clearing of brush to improve rangeland	42	28	0.004
Plantation of high-value trees for timber	56	13	<0.001
Changes in livestock grazing to improve rangeland health	27	9	<0.001
Regulating services (%)			
Pruning or cutting down of trees to decrease fire risk	58	59	NS
Building of erosion control structures	77	46	<0.001
Implementation of water-quality management practices	79	42	<0.001
Testing of soils	30	21	0.043
Use of prescribed fire	30	15	<0.001

n.s not significant

ecosystem services were analyzed. Results from owners of parcels ≥8.1 ha in size (corresponding to 20 acres, which is a threshold for open space as defined in the California Land Conservation Act) were selected. Responses from "producer owners," i.e., those who participate in the production and marketing of livestock or timber products ($n = 171$ respondents) and "residential owners," i.e., those not marketing such goods ($n = 242$ respondents), were compared.

Landowners were asked about (1) their appreciation of ecosystem services at the community level, (2) the ecosystem services they use commercially and noncommercially at the property level, (3) cultural ecosystem services and quality-of-life aspects they consider important reasons for owning land, (4) specific management practices for ecosystem services on their property, and (5) general information related to their person and property. Although

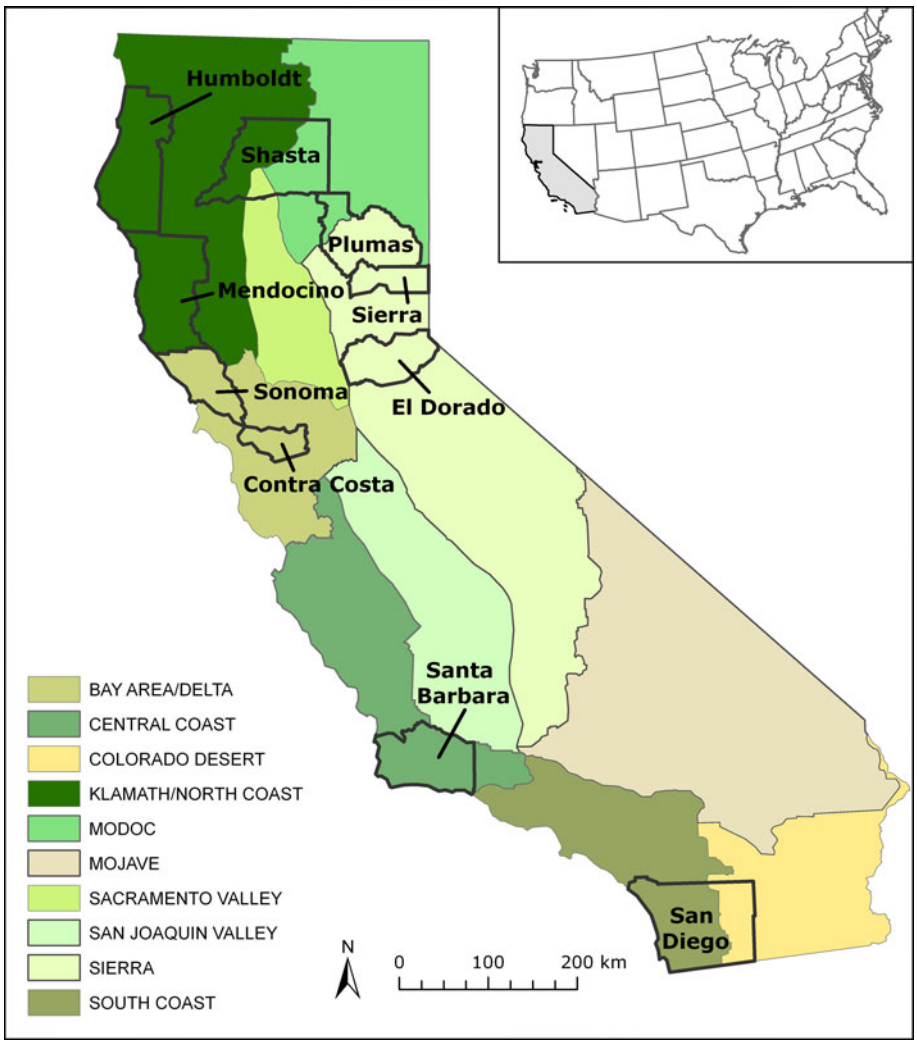

Fig. 1 Study area map with sampling counties and bioregions of California

the ranch scale is clearly delimited by property boundaries, the questionnaire was less specific regarding the definition of the "community scale." "Community" is understood as the level beyond a single property that usually comprises a rural town and at which usually cooperation between landowners (e.g., fire-prevention management) takes place. Respondents may exhibit different understandings of the extent of a community. Appendix 1 (Electronic supplementary material) presents those questions of the survey that were evaluated in this study.

Data analysis was performed with PASW 18.0 (2009) software (SPSS, Chicago, IL). Comparisons between results are reported as percentages of the total number of people who responded to each question. Response choices for several questions were based on Likert scales and ranged from "not at all important" to "highly important". Differences between producer owners (i.e., those engaged in commercial production of livestock or timber) and residential owners (i.e., all others) were calculated using Pearson chi-square analysis for categorical data and Mann–Whitney *U* test for ordinal and continuous data (which were not normally distributed in most cases). Relationships between expressed appraisals, uses, and management practices were assessed through Spearman rank correlation analysis and chi-square analysis. It should be noted that correlations do not suggest causalities but are indicative of the degree of positive or negative relationships between two factors (appreciation of an ecosystem service in this case). A *P*-value of 0.05 was used for detecting significance.

Results

Landowner Characteristics

Landowner characteristics differed markedly between producer and residential owners, although they also had much in common. There was enormous variability in property sizes,

Table 7 Land-ownership characteristics among respondent California forest and rangeland owners in 2008

Land-ownership characteristics	Producer owners (n = 138–171)	Residential owners (n = 222–242)	P (χ^2) [df = 1]
Property size (ha)[a]	3741 ± 10,677	286 ± 734	<0.001[b]
Forest [mean cover (%)]	63	34	<0.001[b]
Grassland [mean cover (%)]	21	17	NS[b]
Oak woodland [mean cover (%)]	14	24	<0.001[b]
Shrubland [mean cover (%)]	5	17	<0.001[b]
Cropland [mean cover (%)]	3	4	NS[b]
Developed land [mean cover (%)]	2	3	<0.001[b]
Years land has been in family[a]	52 ± 41	27 ± 22	<0.001[b]
Has a paid manager	14	2	<0.001[c]
Participation in public programs (%)	28	31	NS[c]
Land-management advice received (%)	83	41	<0.001[c]
Has subdivided land in past 20 years (%)	24	5	<0.001[c]
Has been approached to sell land (%)	63	47	0.001[c]
Plans to sell land (%)	10	15	NS[c]
Plans to pass land on to children (%)	77	62	NS[c]

NS not significant

[a] Mean ± SD

[b] Mann–Whitney test applied

[c] Chi-square test applied

Table 8 Socioeconomic characteristics among respondent California forest and rangeland owners in 2008

Socioeconomic characteristics	Producer owners (n = 140–166)	Residential owners (n = 207–213)	P (χ^2) [df = 1]
Mean age[a]	65 ± 12	58 ± 12	<0.001[b]
Female (%)	37	34	NS[c]
Income $200,000 or more (%)	41	32	NS[c]
At least bachelor degree (%)	66	66	NS[c]
Employment in timber/agriculture/range (%)	12	11	NS[c]
Type of area respondent lived in most of the time (%)			
Metropolitan area	8	19	0.002[c]
Large city	9	6	NS[c]
Medium-sized city	11	15	NS[c]
Smaller city	13	11	NS[c]
Town/village	2	6	0.037[c]
In the country or a small town	9	8	NS[c]
Rural farm/ranch	31	17	0.001[c]

NS not significant

[a] Mean ± SD

[b] Mann–Whitney test applied

[c] Chi-square test applied

but the mean property size of producer owners was approximately 13 times greater than that of residential owners (Table 7). The largest properties were 92,673 ha for producers and 7,689 ha for residential owners. Altogether, respondents owned 489,914 ha of land (producers = 439,511 ha; residential owners = 50,403 ha). Although there were no differences in participation in programs, such as the California Land Conservation Act (Williamson Act), the Environmental Quality Improvement Program, or a forest-certification program, producer owners had been significantly more frequently advised by public agencies, extension services, or nongovernmental industry, professional, or conservation organizations within the last 5 years. Residential owners were younger and much more likely to have lived longest in metropolitan areas and producers have spent most of their life on a rural farm or ranch (Table 8).

Appreciation of Biodiversity and Ecosystem Services at the Community Scale

Correlation analysis showed many relationships between appraisals for biodiversity and ecosystem services among the respondents (Table 1): Out of 28 possible combinations between pairs of ecosystem services, 21 showed significant correlations. None of these correlations were high ($r \geq 0.5$): 7 correlations were moderately high ($r \geq 0.3$), and 14 relationships were only weak ($r < 0.3$). Two clear patterns of positive correlations could be identified: Livestock, timber, crops, and housing were consistently correlated in a positive way. Wildlife habitat, recreation, hunting/fishing, and fire prevention also showed consistent positive correlations among each other. Significant negative correlations became visible between wildlife and recreational interests on the one side and livestock grazing, timber harvesting, and housing on the other. Nonparametric analysis showed that the producer owner group attached significantly more importance to timber and livestock production. In contrast, the residential owner group showed stronger appreciation of wildlife services (Table 2).

Use of Biodiversity and Ecosystem Services

Both producer and residential owners used tangible ecosystem services from their land for noncommercial purposes (Table 3). These uses were complemented by commercial interests but to a much lower degree for residential owners. Fuel wood collection, hunting/fishing, and vacation homes were the most frequent personal ecosystem uses, with hunting/fishing being more common among producer owners and fuel wood and vacation homes being more frequent among residential owners. All commercial uses were more prominent among producers, with significant differences in grazing leases, fuel wood selling, for-fee hunting, and commodity-crop production. The strong differences in the frequency of commercial timber and livestock uses are an artifact of the grouping of producer and residential owners and therefore were not statistically evaluated (Table 3).

Cultural Ecosystem Services and Quality of Life as Reasons for Owning Land

Cultural services and components of quality of life as motivators for owning land were diverse, with many clear differences existing between producer and residential owners (Table 4). Important differences between both groups were a much stronger appreciation of family tradition, land as income source, and local economic development among the producer group. Residential owners had greater appreciation for landscape aesthetics and life in a small community. Many significant relationships between pairs of reasons were identified (15 of 21 possible relationships) (Table 5). Twelve of the significant relationships were positive, and 3 were negative. Two pairs were highly correlated ($r \geq 0.5$); 5 were moderately correlated ($r \geq 0.3$); and 8 were slightly ($r < 0.3$) correlated. The analysis identified two bundles of consistently positive correlations: The first bundle includes family tradition, land as income source, and local economic development, whereas the second comprises natural beauty, recreation, and life in a small community. Significant negative relationships existed between land as income source on one side and natural beauty, recreation, and life in a small community on the other side.

Management Practices for Biodiversity and Ecosystem Services

A large number of respondents reported performing management practices related to ecosystem services. Most of the techniques were much more frequently practiced by producer than by residential owners (Table 6). Producer owners were significantly more active in three of four areas of biodiversity management, in four of four techniques for enhancing provisioning services, and in four of five practices that were related to soil and water protection.

Discussion

Producer and Residential Owners

California's forests and rangelands are owned by landowners with a diverse set of interests in their land. When exploring ecosystem services appreciation by the landowners who will ultimately determine the functionality of the "working landscapes" concept, this study explored the distinction between owners using their land for commercial purposes and other owner types. Landowner surveys in other areas of the American West have similarly identified distinctions between owner producers and other groups (Gosnell and others 2006), although amenity motivations usually are highly represented in both groups (Gentner and Tanaka 2002; Huntsinger and others 2010). The group here termed "residential owners" are expected to grow significantly in most parts of rural California (Walker and Fortmann 2003) and in this study comprised 59 % of respondents (a figure similar to that found by Walker and others 2003). Commercial ranching is in decline (Huntsinger and others 2010), and traditional land users "appear to be poised on a trajectory toward extinction" (Walker 2006, p. 129). This prediction is supported by our finding that a quarter of producer owners have subdivided their lands in the past 20 years, and almost two thirds of them have been approached by developers. In Colorado, only approximately one quarter of ranches were sold to full-time ranchers from 1990 to 2001, whereas 50 % went to hobby ranchers and 25 % to developers (Gosnell and others 2006). In California, this has been termed an "invisible transition" to an increasingly fragmented landscape (Walker and others 2003).

Compared with common assumptions of land-rich but cash-poor full-time ranchers, both ownership groups were relatively well-off in socioeconomic terms: Income and educational levels were generally high, and slightly more than one third of both groups were women. Both groups had a mean age of approximately 60 years. This increased mean age may suggest that greater changes in ownership (for example sale or transfer to heirs) may be expected in the immediate future. However, mean age was remarkably stable in a longitudinal study of California oak woodland owners from 1982 to 2004 (Huntsinger and others 2010). The finding that significantly more residential owners have spent most of their lives in metropolitan areas confirms that many of them are ex-urban residents (Walker and Fortmann 2003). The geographies of both groups were also

strikingly different: Lands dedicated to commercial livestock and timber production were much larger and seemed to be concentrated in forests and grasslands, whereas residential lands included more oak woodlands and shrublands, which are often more attractive in aesthetic terms and are situated closer to major population nuclei in California. The land of owner producers has been owned longer, and many more of these owners have lived on a farm or ranch most of their life, which may help justify describing them as "traditional" (Walker and Fortmann 2003).

Appreciation and Use of Ecosystem Services by Private Landowners

This study showed that landowner appraisal does not single out individual ecosystem goods or services; instead, it is more likely to center on a bundle of jointly generated ecosystem services (Table 4). Clearly more synergies than trade-offs between ecosystem services were perceived, which indicates that most landowners embrace multifunctional land use up to a certain extent. In particular, correlation analysis showed a joint interest in livestock, timber, crops, and housing, which is expressed by the same landowners at the community level. Another closely related bundle of ecosystem services includes recreation, hunting/fishing, wildlife habitats, and fire prevention. Still, perceived incompatibilities became visible between some resource- and amenity-based uses of ecosystem services because some respondents who expressed appreciation for more livestock, timber, or housing provision in their community did not support management for wildlife and more areas for recreation and vice versa. The only ecosystem service that was widely supported and appears without tensions is fire prevention. Owner producers generally showed stronger support for provisioning services and residential owners for cultural ecosystem services and biodiversity. However, differences in appreciation, although statistically significant, were in most cases not fundamental between the two groups.

Tangible ecosystem services were also produced and consumed in distinct ways by the two landowner groups. For producers, livestock raising, timber harvesting, grazing leases, and personal uses of game, fish, and firewood were the dominant uses. Residential downers rarely sold products, but personal use was frequent. Residential use was paramount, but agricultural and forest uses have been retained up to a certain degree. The widespread use of vacation homes was one of their most conspicuous differences compared with producer owners.

The survey confirmed the general finding that cultural ecosystem services and quality-of-life aspects are among the primary amenities that motivate forest and rangeland ownership (Jones and others 2003; Shumway and Otterstrom 2001). As in the case of ecosystem services appraisal at the community level, relationships between these intangible factors were largely synergetic. Again, two different bundles could be identified, with the first bundle framed around understandings of ranching and logging as cultural heritage, of deriving income from land as material basis of a good life, and of fostering good social relations through commitment to local economic development. The second bundle comprised wishes to live in a rural environment as an expression of sense of place, landscape aesthetics, recreation, and security that scenic rural places offer. Producer and residential owners each tended toward a different bundle. Despite these differences, life near natural beauty was the most important motive for both ownership groups.

Land-Management Implications

Land management is the primary mechanism safeguarding the resilient provision of ecosystem goods and services from rangelands. Management includes practices to maintain current capacities and to restore capacities that have been degraded (Havstad and others 2007; Walker and others 2004). This study shows that producer and residential owners manage their lands in different ways. Common management practices were classified according whether they target overall sustainability, biodiversity, provisioning services, or regulating services. Producer owners practiced management much more frequently in each of these sectors. Although many owners actively engaged in commercial livestock and timber production were not positive toward more land dedicated to wildlife management, they actively improve wildlife habitat, manage water bodies for biodiversity, and care for native vegetation. A growing body of research indicates that management of livestock grazing is a powerful tool for the targeted fostering of biodiversity and ecosystem services, from the plant to the community scales (e.g., by supporting species of concern) to ranch scales (e.g., by maintaining stock ponds and vegetation mosaics) and landscape scales (e.g., by preserving contiguous habitat) (Huntsinger and Hopkinson 1996; Huntsinger and others 2007; Barry 2011). Residential owners are likewise committed to most of these management activities but generally to a much lower degree. Our findings allow two insights. First, there is a discrepancy between attitude and action on the side of producer owners: They do not speak out for wildlife conservation but on the ground they indeed practice conservation-oriented management. This discrepancy has been confirmed in preceding studies (Bartlett and others 1989). It may be related to landowner concerns about the Endangered Species Act and other regulations associated with wildlife (Bean 1998). These are often perceived

Fig. 2 California's hardwood rangelands support commodity production, biodiversity, and intangible ecosystem services and thus come close to the ideal of a working landscape

as a threat to income and landowner autonomy. Second, although residential owners are much more supportive of biodiversity and cultural ecosystem services, they undertake significantly less action to foster them on their land. Although further growth of the residential owner group may thus positively influence societal awareness for intangible ecosystem services, it may actually imply less management for biodiversity and ecosystem services on private lands. However, the question of whether a broader suite of management techniques actually indicates better care of the landscape cannot easily be answered. It may be argued that producer owners might need to do more of these techniques to offset negative impacts that result from extractive uses (e.g., water-quality management practices, erosion-control structures, or clearing brush to improve rangeland). In addition, our questionnaire only asked whether or not certain techniques are practiced; it did not consider the frequency and quality of management actions.

Validity of Results and Remaining Uncertainties

Because this study is the first to apply an ecosystem services framework onto California forest and rangeland owners' motivations and actions, the validity and remaining uncertainties must be scrutinized. Critics might question whether the indicators that we used for assessing landowners' motivations, uses, and management actually measure appreciation of and action for ecosystem services (understood as "the benefits people obtain from ecosystems"). Most of the cultural ecosystem services (e.g., the cultural heritage of landscapes) are not generated by an isolated, undisturbed ecosystem but through multiple interactions of ecosystems and humans. The question of who generates a service—Is it the ecosystem? Or is it the human who shapes an ecosystem?—is an important one, in particular in the context of working landscapes. The ecosystem services framework is powerful in conceptualizing the linkages between humans and their natural environment; however, at the same time it draws a boundary between the two spheres of "ecosystems" and "humans" (Lugo 2008). In human-shaped landscapes, such as California's forests and rangelands, this boundary is artificial and cannot be clearly delimited. Hence, working landscapes should not be understood as "natural" ecosystems but as coupled social–ecological systems in which human agency is always present (Berkes and Folke 1998). In

addition, it could be questioned whether positive and negative statistical correlations can be interpreted as synergies and trade-offs. Chan and others (2006), Raudsepp-Hearne and others (2010), Bai and others (2011), and other investigators paved the way for using correlation analysis to detect synergies and trade-offs between ecosystem services at particular spatial scales. One particular aim of our study was to show synergies and trade-offs between various ecosystem services and biodiversity not just on the ground but also in landowner perceptions. Although our results point to some important perceived compatibilities and incompatibilities between ecosystem services, they should be considered a first approximation. More research on synergies and trade-offs as perceived by landowners must follow to improve our ability to sustainably manage landscapes for a broad range of ecosystem services (Bennett and others 2009).

Conclusion: Prospects for Biodiversity and Ecosystem Services on Working Landscapes

Due to the diversity of uses and public benefits provided, California's forests and rangelands seem to come close to the working landscapes ideal (Fig. 2). Correspondingly, this study identified many synergies between the appreciation for different ecosystem goods and services. However, these were clustered in two different sets of services. Competing visions for the future of rangelands and forests highlight that the synergetic "working landscape" remains an ideal, whereas tensions between natural-resource extraction and conservation of intangible ecosystem services and biodiversity continue to be "the overarching political and cultural struggle in much of the rural American West today" (Walker 2006, p. 130). Commercial livestock and timber producers show little preference for wildlife and other ecosystem services beyond natural resources extraction, whereas residential owners are supportive of conservation but often do not provide the active work input required by working landscapes to be maintained or restored.

With most geographies in the world grappling with invasive species, climate change, and population expansion, the idea that "hands off" management will conserve native biodiversity is severely outdated (Millar and others 2007). Therefore, better targeted strategies are needed for "working" forests and rangelands to enhance joint production of commodities and ecosystem services and to cope with the ongoing changes (Wossink and Swinton 2007). Producers will respond best to programs that consider production goals, and they have showed responsiveness to education and incentive programs that contribute to such goals (Huntsinger and others 2010). In contrast, planning and zoning as a way to conserve landscapes is notoriously weak in California. The unintended consequences of costly regulations urge caution in their application to private lands (Bean 1998). As has been said, "local people cannot be forced to protect or restore habitat—they must want to do it" (Walker 2006, p. 132). Long-term conservation requires incentive-based approaches at both the landscape and enterprise scales: At present, property tax relief for landowners who agree not to develop their land for a set period, and conservation and mitigation easement programs where the development rights are sold or donated to a nonprofit land trust, seek to prevent the conversion to urban or residential development that threatens such lands; incentives, payments for ecosystem services, cost-sharing and technical assistance can help sustain the enterprise that manages the land. More tools are needed. In the late 1990s, ranchers surveyed in north-central California overwhelmingly reported that they felt that "society's hostility to ranching" was an important reason that they might quit ranching (Liffmann and others 2000). Resource-based owners should be more acknowledged as principal stewards of working forests and rangelands because they are the ones who perform on-the-ground management of biodiversity and ecosystem services. Such feedback is likely to encourage more management effort because this study has shown that ecosystem services are important to all types of landowners. Residential owners and developers must be encouraged to more active management of their land for biodiversity and ecosystem services, e.g., through "conservation development" approaches that allow limited development while protecting certain environmental features of the land (Anella and Wright 2004). Overall, it is critical that products and services that best fit with local, regional, and global needs are targeted for enhancement (Havstad and others 2007; Prager 2010; Ferranto and others 2012).

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