Landscape Ecol (2016) 31:533–545
DOI 10.1007/s10980-015-0260-y

RESEARCH ARTICLE

The inclusion of stakeholders and cultural ecosystem services in land management trade-off decisions using an ecosystem services approach

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Received: 25 January 2015 / Accepted: 17 August 2015 / Published online: 23 August 2015

Abstract
Context An ecosystem service approach for land-use or conservation decisions normally uses economic or biophysical assessments for valuating nature's services. In contrast, even though ecosystem services are required for human well-being, the actual use of services by differing stakeholder groups are rarely considered in typical ecosystem service assessments, especially the more intangible, cultural ecosystem services.
Objectives The aim of this research was to quantify different uses for 15 cultural and provisioning ecosystem service indicators across seven stakeholder groups in a watershed proposed with large hydroelectric dam development.
Methods We used a large-scale survey to quantify use and frequency of use for ecosystem services.
Results We demonstrate that different stakeholder groups use ecosystem services differently, both in terms of specific ecosystem service indicators, as well as for frequency of ecosystem service use. Across all stakeholder groups, specific cultural ecosystem services were consistently more important to participants when compared to provisioning ecosystem services, especially aesthetic/scenic values.
Conclusions This work is of global importance as it highlights the importance of considering cultural ecosystem services (e.g. aesthetic/scenic, sense-of-place values) along with multiple stakeholder groups to identify the trade-offs and synergies during decision-making processes for land-use or conservation initiatives.

Keywords Conservation · Cultural ecosystem services · Ecosystem services · Hydroelectric · Land-use planning · Provisioning ecosystem services · Stakeholder groups

Electronic supplementary material The online version of this article (doi:10.1007/s10980-015-0260-y) contains supplementary material, which is available to authorized users.

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Introduction

Ecosystem services, the products and services derived from nature that bring benefits to humans (Daily 1997), link the functioning of ecosystems to the well-being of persons living locally, regionally, and globally. Yet it is estimated that up to 60 % of global ecosystem services are degraded, overused, or have been lost to unsustainable anthropogenic activities (MEA 2005) under the continued growth of the human population and the associated consumption of natural resources (Rands et al. 2010; Cimon-Morin et al. 2013).

As such, ecosystem services are increasingly being considered in policy development, land-use decisions, and in conservation planning initiatives (Daily 1997; MEA 2005; Menzel and Teng 2010), but managing ecosystem services across different spatial scales within a dynamic landscape context is challenging because the importance of different types of ecosystem services changes with different stakeholder groups, and with spatial scale. For instance, at small spatial scales, provisioning (e.g. food, water, shelter) and cultural (e.g. recreation, aesthetic, sense-of-place) ecosystem services are important for local community members, while regulating (e.g. climate mitigation, pollination) and supporting services (e.g. nutrient cycling, photosynthesis) are important at larger, regional or even global scales.

The concept of ecosystem services inherently links social and ecological systems (Alessa et al. 2008), which can be used to identify congruent locations and land cover types that support both human needs and ecological space (Alessa et al. 2008). As the perceived value of nature varies with different land covers (Brown 2013; Brown et al. 2014) a developed understanding of the perceived and actual use of multiple ecosystem services can inform land management plans. This approach can be particularly valuable in a land-use planning context (Brown et al. 2014) where there is often strong opposition to resource development, and a strong favoring of cultural and lifestyle attributes such as wildlife viewing, and non-motorized recreation activities (Brown and Donovan 2013) associated with natural areas. Public participation in land-use planning can further elucidate attitudes towards land management, and when combined with mapping methods, can reveal areas where potential for a conflict in land-use could arise (Brown and Donovan 2013; Brown et al. 2014; Darvill and Lindo 2015).

While the ecosystem services approach can integrate land management decisions with human well-being and stakeholder values (Chan et al. 2012a), to date, this integrated approach has mainly focused on determining the market value of ecosystem services, primarily for provisioning and regulating services. The economic valuation of ecosystem services using for instance, hedonic pricing, willingness-to-pay, and the travel cost method (Hein et al. 2006; Chan et al. 2012b) has been used to make policy recommendations (Menzel and Teng 2010), and has proved useful during decision-making processes, but has been criticized as limited since economic valuations assume that all people use, and value, the same ecosystem services (Menzel and Teng 2010; Klain and Chan 2012). Public participation methods can help engage multiple interest or stakeholder groups to elucidate a better understanding for what is being used and valued locally (Brown and Fagerholm 2015). By involving multiple stakeholder groups, decision-making for land-use and conservation initiatives can lead to more legitimate and higher quality decisions, identify trade-offs and synergies, and avoid conflict through improved relationships between groups (Jones-Walters and Çil 2011). Here we define 'stakeholder group' as any group sharing common interests, and who may be affected by land-use decisions.

The public participatory approach has been most successful at acknowledging cultural ecosystem services (Brown and Fagerholm 2015) and incorporating non-economic valuation methodologies (e.g. Klain and Chan 2012; Fagerholm, et al. 2012). Cultural benefits such as aesthetic values and sense-of-place can be considered irreplaceable in a landscape (Plieninger et al. 2013), and are often tightly linked to specific geographic features and land cover (e.g. forested areas and water bodies) (Brown 2013). Cultural ecosystem services can be more important to people than ecosystem services from other categories (Raymond et al. 2009; Ruiz-Frau et al. 2011; Brown et al. 2012; Martín-López et al. 2012; Darvill 2014), and be more socially relevant in addressing real-world issues (Milcu et al. 2013), potentially leading to enhanced sustainability of local communities (Plieninger et al. 2015) and their overall well-being.

Several studies have used a multiple stakeholder approach for assessing ecosystem services (see Raymond et al. 2009; Ruiz-Frau et al. 2011; Lamarque et al. 2011; Klain and Chan 2012), but none to our knowledge have ranked the needs (perceived, and actual) of multiple ecosystem services (including cultural ecosystem services) on a regional scale for multiple stakeholder groups. In this study we collected information on the use and frequency of use for fifteen ecosystem services indicators across seven stakeholder groups using a rural watershed in northeastern British Columbia, Canada, a portion of which was under consideration for a large hydroelectric dam development at the time of the study. We focus on cultural and provisioning ecosystem services as these are the local and regional scale services directly utilized by the communities residing on the land base. Since starting this study, the hydroelectric project (Site C) has been approved for development in the Upper Peace River Watershed, our study area.

Methods

Study site

The Upper Peace River Watershed (UPRW) encompasses 581,994 hectares including an 82 km stretch of riparian valley bottom following the Peace River between the town of Hudson's Hope (population: 1012) and Fort St. John (population: 19,000) in northeastern British Columbia, Canada (56°13′41″0.03 N; 121°24′26″0.05 W) (Fig. 1). The majority of the study area is boreal forest ecosystem. Human land-use activity in the watershed comprises oil and gas development and privately held agricultural land. There are two Provincial Parks and a proposed protected area within the UPRW (natural preserves). The study area is within a large (84,000,000 ha) First Nations (indigenous peoples on the geographic land known as Canada) territory (Treaty 8), and there are two First Nations reserves located within in the study area (populations: 205 and 840). There are multiple recreation sites, a cultural use area, and archeological evidence dating back 5830 ± 80 years (Valentine et al. 1980), with historic human occupation estimated to 10,500 B.P. directly adjacent to the study area boundary (Driver et al. 1996). Expanding resource developments include oil and gas exploration (BC Oil and Gas Commission 2013), wind power turbine farms, and coal mines, in addition to the Site C proposal for a hydroelectric dam (North Peace Economic Development Commission 2011). The Site C project will be the third hydroelectric dam in this region on the Peace River; the W.A.C. Bennett dam is located 19 km west of Hudson's Hope, while the Peace River Canyon Dam is located 6 km southwest of Hudson's Hope (Fig. 1).

Survey data collection

Survey participants were recruited using convenience and purposive sampling in addition to snowball sampling (see Brown et al. 2014). Posters (65) describing this research project were distributed throughout the study communities; advertisements were placed in the local newspaper, and presentations were offered to all identified stakeholder groups residing within the study area in May 2013 (e.g. Rod and Gun Club, municipal town councils). First Nations participation was requested through a meeting held at the Treaty 8 Land Office (www.treaty8.bc.ca) with two Treaty 8 First Nations representatives, and informal consent to involve First Nations was granted. Invitations (259) were sent out using FluidSurveys® software version 4.0, which encouraged people to distribute the online survey link to other interested participants. Some stakeholders (e.g. Boating club, Regional District) sent emails to their membership/employees with a research description and link to the online survey.

Online survey questions were designed to elicit responses regarding ecosystem service indicators that fit within two major ecosystem services categories: provisioning and cultural ecosystem services. As it is not possible to measure all ecosystem services within an area, we use the term 'indicator' to mean a measureable representation of human benefits (material or non-material) that are utilized or valued within a landscape (based on Fagerholm et al. 2012; Müller and Burkhart 2012; Reyers et al. 2013). Indicators are mostly straight forward for provisioning ecosystem services as they are readily measurable, but focus strongly on delivery and economic value, while cultural ecosystem service indicators for well-being are still lacking. Cultural ecosystem services are harder to apply indicator status to (Hernández-Morcillo et al. 2013), but can be quantified as supply (e.g. areas that provide aesthetic views), delivery (e.g. collection rates of plants for cultural use), contributions to well-being (e.g. frequency of cultural activities), or economic value (e.g. revenues derived from tourism). We used a slightly modified MEA (2005) typology where we chose ecosystem service indicators that we assumed would be most relevant to the study region and its social dynamics (Raymond et al. 2009; Fagerholm et al. 2012). For instance, the 'wildlife used for viewing' was added to our working ecosystem

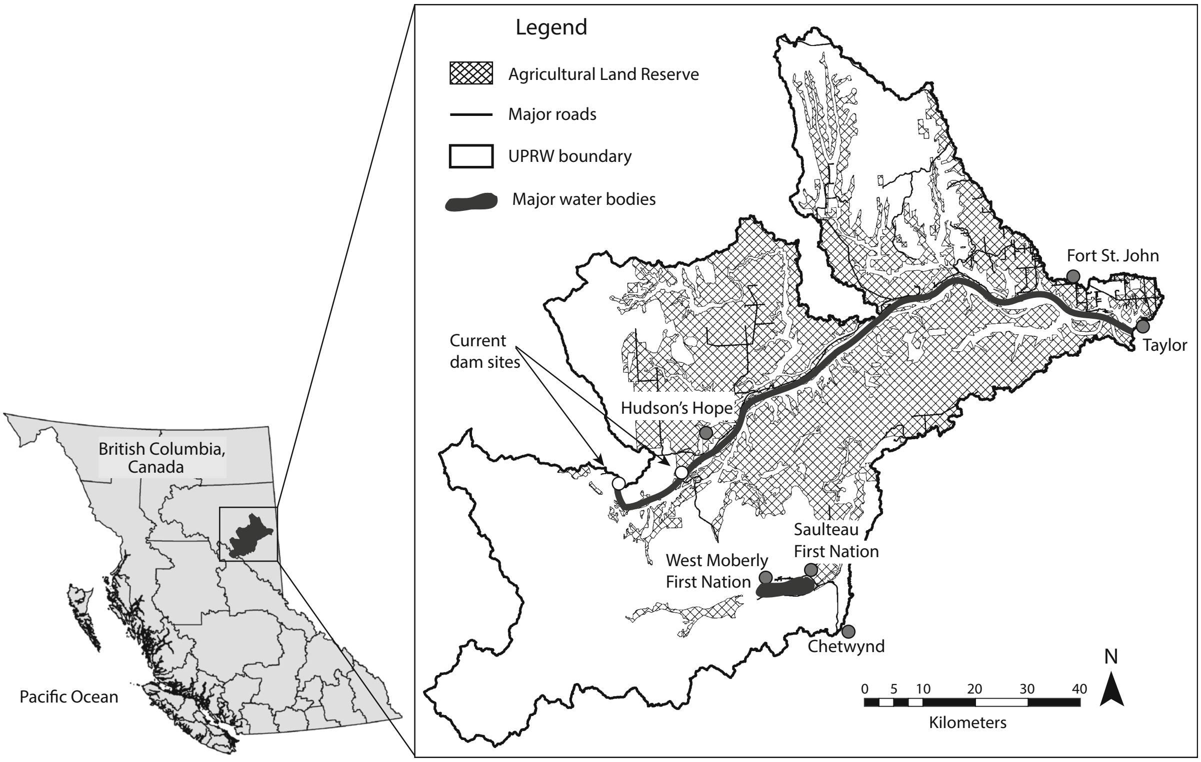

Fig. 1 Location of study area in the Upper Peace River Watershed, British Columbia, Canada. Hatched bar area is the Agricultural Land Reserve, an area recognized as an important land base of the agricultural sector. Agricultural Land Reserves are generally protected from residential, commercial or industrial development

services typology, since wildlife is plentiful in the study area and can be a prominent and highly valued feature of the landscape (Klain and Chan 2012).

To test the suitability and effectiveness of the survey, preliminary sampling was completed with seven individuals who reside outside of the study area. The final online survey comprised five sections: (1) respondent characteristics (i.e. length of residency, community type (e.g. rural, urban), occupation, primary and secondary stakeholder group association, age group, gender, ecosystem services concept familiarity); (2) provisioning ecosystem services indicators including frequency of use (categorical); (3) cultural ecosystem services indicators including frequency of use (categorical); (4) listing ecosystem services indicators in order of highest to lowest use (rank order), and (5) self-perceived changes in the ecosystem services use using two Likert-scale questions. Participants self-identified their stakeholder affiliations (see Table 1 for summary of participants). A map outlining the study area was provided on every page of the online survey for easy reference. Additionally, a widely accepted definition for the term 'ecosystem services' was provided at the beginning of the survey: "Ecosystem Services are the resources that come from nature and bring benefits to humans (Daily 1997), and that contribute to making human life both possible and worth living (Díaz et al. 2006). They are necessary in order for human well-being to persist." Short descriptions for cultural and provisioning ecosystem services were also given prior to any questioning.

In total, there were 36 closed-ended, 2 open-ended and 1 ranking question in the survey. However, it was unlikely that participants would be brought to all 39 questions due to variation in responses and corresponding branching options within the survey. In total, 138 respondents started the online survey with 101 participants self-identifying with a stakeholder group, of which 93 participants gave responses that were useful for analysis (Supplementary Information S1).

Table 1 Final stakeholder group categorization used for survey analysis and a description of stakeholder groups

Agriculturalist (15 %)	These participants self-identified as agriculturalists with primary occupations being ranching. Many were retired, or still worked part-time at other jobs.
Environmentalist (27 %)	These participants self-identified as environmentalists with primary occupations varying (e.g. artists, science/education), or were retired.
First Nations (7 %)	These participants were members of the Saulteau, Doig and West Moberly First Nations. Two participants were regional biologists for the area.
Government (14 %)	These participants had primary occupations associated with municipal or provincial government, or as a consultant to local government offices.
Hunter/Angler (9 %)	These participants self-identified as being active in hunting and fishing in the area. Most had primary occupations working for local industries (e.g. oil and gas).
Recreationist (13 %)	These participants self-identified with the recreational group in either a motorized or non-motorized category. Participants had primary occupations working or managing for local companies or were retired.
Community (16 %)	These participants were often retired or students without a full-time job, or worked locally for small businesses and companies (e.g. carpenter).

During survey deployment participants self-identified their stakeholder groups, which were subsequently pooled for statistical comparisons. From a total of 100 participants, 93 surveys were deemed usable for final analysis

Data management and statistical analysis

Participants selected and self-identified with 16 stakeholder groups from the original list of 19 options, which were subsequently pooled into seven stakeholder group categories to satisfy statistical assumptions (Table 1). A detailed summary of stakeholder characteristics status based on gender, age, where they reside in the area, and the length of time they have lived in the area is available in Supplementary Information S1. Chi squared tests were used to ensure that socioeconomic characteristics of the participants were not statistically different among the stakeholder groups such that there were no confounding effects of stakeholder group and socioeconomic status (Supplementary Information S1).

Chi square tests of independence were performed to test association between stakeholder group affiliation and ecosystem services indicator use for the 15 questions that solicited a binary (yes/no) or nominal response. Adjusted residual values from the test were further used to explain trends; adjusted residual values higher or lower than $\pm$ 1.96 indicated that the observed value is significantly larger or smaller than expected. Kruskal–Wallis tests were used to determine any significant differences in the frequency of use for specific ecosystem services indicators across stakeholder groups. For significant results of the Kruskal–Wallis test, pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. For the ranked data, all non-ranked ecosystem services were given an arbitrary value of 10. All ranks were summed within groups across all stakeholders, and the five ecosystem services with the lowest values were selected for further analysis. These were: landscapes used for their aesthetic/scenic values; outdoor (non-motorized) recreation; landscapes for sense of place; freshwater personal use; and wildlife viewing. Average rank of each ecosystem service was analyzed using non-parametric Kruskal–Wallis tests. Software used for all analysis was IBM SPSS Statistics, Version 21 (2012).

Results

Perception of local ecosystem services

The wide majority (66 %) of participants were not familiar with the ecosystem services concept prior to participating in the research project (27 % were familiar; 8 % were unsure). However, after being provided with a definition for ecosystem services, 69 % of participants thought that ecosystem services use should play an important role in major land-use decisions. At the same time, many of participants (47 %) thought there had been a decrease in ecosystem services during the time that they had lived in the study area, while 11 % thought there had been an increase;

31 % felt no change or were unsure. Decreases in ecosystem services were anticipated by 67 % of the participants for the next 10 years due to increased industrial developments (oil/gas, coal mines) and/or specifically, the proposed Site C hydroelectric dam project. For the 9 % of participants that did not perceive any past, or anticipate any future loss of ecosystem services, they cited access to recreational opportunities available through road development into previously inaccessible areas as increasing ecosystem services.

Ecosystem service use and perception across stakeholder groups

Chi square tests revealed five statistically significant relationships between stakeholder group self-affiliation and ecosystem services use (Table 2). These ecosystem services were landscapes used for: historical/cultural heritage, wildlife viewing purposes, hunting/fishing purposes, wild edible plants used for food and/or medicinal use, and use of inspirational landscapes. In all cases, 100 % of First Nations participants claimed use of these five ecosystem services indicators. For landscapes used for historical/cultural heritage and inspirational purposes (e.g. art, song, story-telling, dance, photography, etc.), First Nations participants use was significantly greater than the Recreationalists group: 25 % of Recreationists used landscapes for historical/cultural heritage, while only 17 % of Recreationists used landscapes for inspirational purposes. With respect to landscapes for wildlife viewing, hunting/fishing purposes, and using wild edible plants, First Nations use was greater than Government participants; only 25 % of participants from Government used landscapes for wildlife viewing, 23 % of participants from Government used landscapes for hunting/fishing purposes, while Government used wild edible plants the least across all groups (46 %).

While other Chi Square tests did not reveal significant relationships between stakeholder group and ecosystem services indicators, overall trends were seen that are supported by the adjusted residual values (Table 2). For instance, Agriculturalists had an adjusted residual value > 1.96 suggesting they use land for food, and collect and use freshwater from sources other than from a municipal water system significantly more than other groups (85.7 % and 92.9 %, respectively). Similarly, Hunters/Anglers had a residual value > 1.96 for fishing, suggesting that they fish significantly more than any other stakeholder group (100 %), while using ornamental resources significantly less than other groups (37.5 %). The top three ecosystem services indicators used across all groups were all within the cultural ecosystem services category: landscapes used for aesthetic/scenic beauty, sense-of-place, and recreation (Table 2).

Differences for frequency of ecosystem services indicator use among stakeholder groups

Three cultural ecosystem service indicators (aesthetic/scenic use, recreational use, and sense of place) were cited as the most frequently used ecosystem services indicators across all participating stakeholder groups. Landscapes used to purposefully observe wildlife were used significantly more frequently by Agriculturalists than Government participants ($\chi^2_{6,\,88} = 15.792$. $P = 0.015$), and Agriculturalists cited landscapes for their cultural/historical heritage more frequently than Recreationists ($\chi^2_{6,\,90} = 16.429$, $P = 0.012$). First Nations participants more frequently used landscapes for spiritual or religious purposes than Hunter/Anglers, or Recreationists ($\chi^2_{6,\,90} = 15.406$, $P = 0.017$). Similarly, First Nations had significantly greater use of wild edible plants for food and/or medicinal purposes than all other groups except Agriculturalists and Hunter/Anglers ($\chi^2_{6,\,91} = 17.737$, $P = 0.007$). The frequency of hunting and/or trapping was greatest in the Hunter/Angler group ($\chi^2_{6,\,93} = 16.390$, $P = 0.012$). The top three ecosystem services indicators used most frequently across all stakeholder groups were: (1) aesthetic/scenic landscapes, (2) landscapes used for non-motorized recreation, and (3) landscapes used for sense-of-place (Table 3). Kruskal–Wallis tests for the rank order of the top 5 ecosystem services suggest that only non-motorized outdoor recreation ($H_{7,\,93} = 16.811$, $P = 0.019$) and landscapes that give a sense of place ($H_{7,\,93} = 13.774$, $P = 0.055$) differed among stakeholder groups. Multiple comparison tests did not strongly resolve pairwise stakeholder differences, but suggest that Recreationists differed in their valuation of outdoor recreation differently from First Nations, while Environmentalists ranked landscapes for sense of place higher than Hunter/Anglers.

Table 2 Cultural and provisioning ecosystem service indicator use among seven different stakeholder group categories for the Upper Peace River Watershed, in northeastern British Columbia, Canada

ES indicator (category)	χ^2 (*P*)	Agriculture (n = 14) (%)	Environment (n = 25) (%)	First Nations (n = 6) (%)	Govern (n = 13) (%)	Hunter/Angler (n = 8) (%)	Recreation (n = 12) (%)	Community (n = 15) (%)	Total (n = 93) (%)
Cultural ecosystem service indicators									
Aesthetic/Scenic	5.990 (0.424)	100.0	100.0	100.0	92.3*	100.0	100.0	100.0	98.9
Sense of place	6.573 (0.362)	100.0	100.0	100.0	100.0	100.0	91.7*	100.0	98.9
Cultural/historic heritage	17.069 **(0.009)**	85.7	76.0	**100.0**	61.5	85.7	**25.0**	71.4	70.0
Wildlife for viewing	17.408 **(0.008)**	85.7	76.0	**100.0**	**25.0**	85.7	58.3	57.1	67.4
Educational/scientific	7.437 (0.282)	78.6	80.0	60.0	53.8	71.4	41.7*	64.3	66.7
Spiritual/religious	8.723 (0.190)	71.4	72.0	100.0	61.5	42.9	41.7	50.0	62.2
Inspiration	17.219 **(0.009)**	78.6	64.0	**100.0**	46.2	71.4	**16.7**	42.9	56.7
Recreation	2.053 (0.915)	92.9	88.0	100.0	92.3	100.0	91.7	85.7	91.1
Provisioning ecosystem service indicators									
Ornamental resources	11.125 (0.085)	64.3	76.0	100.0	92.3	37.5*	66.7	57.1	70.3
Wood (for fuel/ building)	10.326 (0.112)	85.7	60.0	100.0	61.5	87.5	66.7	46.7	67.7
Freshwater	11.451 (0.075)	92.9*	60.0	80.0	38.5*	75.0	58.3	78.6	67.0
Wild edible plants	15.335 **(0.018)**	92.9*	48.0	**100.0**	46.2	87.5	50.0	64.3	63.7
Fish	8.805 (0.185)	71.4	52.0	83.3	53.8	100.0*	50.0	60.0	62.4
Hunting/fishing/trapping	16.021 **(0.014)**	71.4	44.0	**100.0**	**23.1**	75.0	33.0	53.3	51.6
Food (crops/livestock)	8.687 (0.192)	85.7*	52.0	50.0	38.5	37.5	41.7	46.7	51.6

Numbers contributing to overall significant Chi square tests (*P* value < 0.05) are highlighted in bold

Numbers with an asterisk represent interest groups with the furthest deviation of the observed count from the expected count according to adjusted residual values of ± 1.96

Stakeholder group names shortened for space

Table 3 Stakeholder group participants self-ordering of 19 ecosystem service indicators for frequency of use

Ecosystem service indicator	Ecosystem service category	Selected #1	Selected #2	Selected #3	Total no. of times selected
Aesthetic/scenic	Cultural	10	17	7	47
Recreation (Non-motorized)	Cultural	12	10	9	41
Sense of place	Cultural	8	5	8	37
Food (Fruit/veg)	Provisioning	6	3	6	31
Wildlife for viewing	Cultural	8	5	4	31
Freshwater	Provisioning	14	5	5	29
Wildlife for food	Provisioning	7	5	5	27
Recreation (motorized)	Cultural	8	5	6	25
Wood (for fuel/building)	Provisioning	1	5	5	24
Educational/scientific	Cultural	0	7	2	21
Fish	Provisioning	3	1	3	18
Inspiration	Cultural	3	3	0	17
Wild edible plants	Provisioning	1	2	6	16
Cultural/historic heritage	Cultural	0	2	2	15
Livestock	Provisioning	1	5	0	14
Spiritual/religious	Cultural	2	1	3	11
Ornamental resources	Provisioning	0	0	1	10
Natural medicines	Provisioning	0	1	0	6

Ecosystem service indicators are listed in order of overall highest to lowest use based on number of times selected as first, second or third frequency of use among all stakeholder group participants

Discussion

Ecosystem services for consideration in land management decisions

Recognizing differences and similarities in ecosystem service use and perception across stakeholder groups is important for understanding priorities during land-use and conservation decision-making processes. We found that the ecosystem services concept was not widely disseminated among the general population, which may limit the public's ability to effectively communicate points-of-view during land management decisions. That said, when provided with the definition of the ecosystem services concept, there was an overwhelming stated understanding for the importance of ecosystem services and for considering them during land-use decisions. This professed importance of the ecosystem services concept may be linked to a stated perceptible decrease in the availability of the cultural and provisioning ecosystem services in the region, which was overwhelmingly attributed to ongoing and proposed industrial activity and development.

Ecosystem service decline has previously been linked to changes in land cover and land management (Reyers et al. 2009). Over-industrialization, and specifically the impending development of a large hydroelectric dam in this study, was cited as the main reason for potential loss of ecosystem services in future years, while the past decrease in available ecosystem services was perceived due to previous natural resource developments (oil and gas cited most frequently), leading to habitat loss, habitat fragmentation, reduced opportunities for other land uses, decreased wildlife populations, and lowered water quality. At the time of survey, public hearings for the proposed hydroelectric development had not occurred. Subsequently, a summary of the Joint Review Panel Report is now available (http://www.ceaa-acee.gc.ca/050/documents/p63919/99173E.pdf), which outlines recommendations based on comments that reflect many results found here; specifically heritage resources, cultural and provisioning use of biodiversity, recreation, and habitat preservation as an underpinning of regulating and supporting ecosystem services, are important considerations in land-use planning. Acting on outcomes and information generated from public participation in land-use planning (such as the Joint Review Panel) can be instrumental in reducing stakeholder conflict and easing outcomes (Brown and Donovan 2013; Brown et al. 2014) related to potential effects on human well-being due to decreased ecosystem services. However, as trade-offs exist in managing for multiple ecosystem services as well as potential power inequity among stakeholder groups, a more standardized criteria for incorporating public participation is warranted (Fürst et al. 2014), especially when the concept of ecosystem services is not well known.

Ecosystem service trade-offs: within and among stakeholders

Hydroelectric power is often viewed as a provisioning ecosystem service in itself (Guo et al. 2000), derived from natural hydrological cycles, as well as being reliant on other ecosystem services (water quality and prevention of soil erosion) for optimal operations. Hydropower development can come with trade-offs to other industry sectors that also gain benefit from nature such as forestry or agriculture, but the full cost and accounting of economic benefits/trade-offs is not fully understood or incorporated into many land management decisions (Wang et al. 2010). Management decisions such as this evoke trade-offs between ecosystem service types, where there can be many unforeseen and undesired trade-offs considering provisioning ecosystem services against other ecosystem service types (i.e. cultural, regulating or supporting) (Howe et al. 2014). Trade-offs are often amplified when multiple stakeholder groups are considered, when there is discrepancy between competing interests involving financial gains, or where there are stakeholders that act and mobilise at local spatial scales relevant to the management plans (Howe et al. 2014). Further, our work suggests that most participants who perceived an increase in ecosystem services were in favour of increased road development to access ecosystem services. Many previous studies suggest road access is important for many provisioning ecosystem services (Chan et al. 2006; Wang et al. 2010; Fagerholm et al. 2012; Cimon-Morin et al. 2013), yet roads are known to negatively impact regulating and supporting ecosystem services through degradation to plant, animal, soil and hydrologic processes (Benítez-López et al. 2010; Duniway and Herrick 2013).

Different stakeholder groups may have different influence in management decisions despite all having strong interest, value or use of ecosystem services. Garćia-Nieto et al. (2015) suggests that stakeholder groups with links to policy such as environmentalists, government members, or scientists have a stronger potential to influence management decisions compared to stakeholder groups with direct associations to the land base (e.g. farmers, hunters, etc.), and these differences are reflected in ecosystem service use, and the link between different ecosystem service types. We suggest that similar trends can be seen in our study where Environmentalists, Government, and Recreationists stakeholder groups ranked provisioning ecosystem services lower in value, use or perceived use than First Nations, Hunter/Anglers, and Agriculturalists. These differences in regional use may ultimately highlight the specific ecosystem service trade-offs among stakeholder groups that could occur in management decisions in order to bring the most benefit to the greatest number of people (i.e. maintain services that are most important overall).

Avoiding conflict among stakeholder groups is an important part of environmental decision-making for land management (de Chazal et al. 2008; Brown and Donovan 2013; Brown et al. 2014), and consultation with different stakeholder groups can pin-point potential conflicts before they occur, or that might arise from poorly-directed land-use change decisions. Here we demonstrate that stakeholder groups use ecosystem services differently, both in terms of specific ecosystem service indicators, as well as the frequency of specific ecosystem service use. As such, implementing a payment for ecosystem services approach to balance conservation, agricultural and industrial interests (Tallis et al. 2011; Cimon-Morin et al. 2013), may be an appropriate consideration for specific locations within this study area. For instance, a portion of the study area was previously identified as being an ecosystem services hotspot location (Darvill and Lindo 2015); this area of high intensity, richness and diversity of ecosystem services indicated a priority location for ecosystem services delivery, suggesting that it should be considered a conservation priority area (Martínez-Harms and Balvanera 2012) to maintain human well-being for all stakeholders. Unfortunately this ecosystem services 'hotspot' coincides with the proposed location of the hydroelectric dam project.

Congruence among stakeholders in ecosystem services

Consistently, cultural ecosystem services were cited and ranked as the most important ecosystem services indicators across all participating groups. In particular, landscapes used for their aesthetic and scenic value were highly cited, both in terms of the number of participants using this service, and also in terms of highest frequency of utilization. Despite the recognized importance of cultural ecosystem services, the incorporation of these sometimes intangible services into the ecosystem services approach lags far behind others, with recreation and ecotourism being an exception (Chan et al. 2012a; Plieninger et al. 2013). The high importance of cultural ecosystem services for most stakeholder groups has been observed in other studies (e.g. Raymond et al. 2009; Bryan et al. 2010), further suggesting that neglecting social values during decision-making may result in decisions that exclude the uses, needs and values that matter the most to the majority of people (Schaich et al. 2010).

Even though several cultural ecosystem services ranked highest in use and importance, all provisioning ecosystem services were still heavily used across all groups, especially by First Nations, Hunters/Anglers and Agriculturalists. Lower priority and use frequency by other participants may be due to the ability to purchase substitutes for local products (e.g. water, wood products, food grown elsewhere) in nearby urban centres. The MEA (2005) suggests that the loss of ecosystem services on human well-being will vary across communities, with more serious consequences felt by developing nations, persons with lowered incomes, and those whom are directly reliant upon land-based personal economies. While we did not collect economic or education data in our study, there is a potential economic divide among socioeconomic classes in our study region, as well as other complex factors such as age, individual needs, access to ecosystem services (i.e. rural vs. urban living), and time spent living in the region, which may help explain some of our results. For instance, the Agriculturalists group not only had the highest percentage of people living rurally, they also had the highest number of participants belonging to the 65 and above age category, and many were born in the area. Martín-López et al. (2012) showed that elderly people living rurally had a greater awareness of provisioning ecosystem services as they were more likely to have been dependent on ecosystem services related to traditional farming practices throughout their lifetime.

Limitations, caveats, and future directions

The work presented here follows the basic steps of stakeholder analysis: we identify stakeholder groups, gathered information regarding cultural and provisioning ecosystem service use and perception, and analyse the information gathered to understand whether specific groups differ in frequency and/or priority of ecosystem service use. While we do not incorporate a full stakeholder analysis that would identify which stakeholders have power and leadership abilities to influence outcomes on land-use planning, our analysis does help identify which stakeholder groups could be at risk of being impacted by land-use change in this region with respect to ecosystem service loss.

When the public is uninformed on certain topics, it is harder to elicit and extract reliable information using public participation methods. However, we do not feel that in this case the public was unable to adequately participate in the survey because we provided a standardized definition of ecosystem services to all participants prior to starting the survey, and the survey mostly focused on tangible entities that all participants could understand (e.g. how often do you fish?). That said, participation numbers were not as high as we would have liked, which can be problematic for public participation-based research; despite a huge effort to obtain participants for this study, many groups and residents were standoffish in our attempts to contact them. However, our results are consistent with recent findings from several studies in other countries and study systems (e.g. Brown and Donovan 2013; Raymond et al. 2014; Garćia-Nieto et al. 2015). In particular, the number of First Nations participants was small for this study, but it is clear that First Nations involvement and high use of ecosystem services highlights the importance of including First Nations in discussions regarding land management and land-use planning. First Nations recognition and use of ecosystem services indicators is not surprising given First Nations long-standing occupancy on the land, their environmental guardianship, strong relationships with the land, and how they pass on traditional ecological knowledge and wisdom from generation to generation (Turner et al. 2000). In a similar case-study of a proposed oil and gas pipeline in north-west Canada, Raymond et al. (2014) found that strong cultural identity of First Nations created unique potential impacts of proposed land-use (i.e. loss of cultural identity and threat to cultural survival).

This study chose to focus on tangible and personalised ecosystem service use and perception that are encapsulated in the provisioning and cultural ecosystem service categories. However, quantifying regulating and supporting ecosystem service use and valuation is much more difficult, especially from a public participation perspective that could be compared across stakeholder groups. Plieninger et al. (2015) suggest that while provisioning ecosystem services are often a tangible focus, cultural ecosystem services could provide proxies of regulating and supporting services as they "incentivize the multifunctionality of landscapes". If multifunctionality is the goal, then returning to a biodiversity conservation perspective may be the key to preserving and enhancing ecosystem services (Hector and Bagchi 2007; Lefcheck et al. 2015). All ecosystem services are intricately linked to biodiversity (MEA 2005), as a regulator of ecosystem processes underpinning ecosystem services (e.g. decomposers), as an ecosystem service itself (e.g. pollinators), or as a direct provisioning ecosystem service (e.g. fish and game) (Mace et al. 2012). While it is unclear how much biodiversity is needed in order to maintain ecosystem function required for delivering ecosystem services (Isbell et al. 2011), there is a significant and growing body of evidence that provides links between biodiversity, ecosystem function and resulting ecosystem services (Balvanera et al. 2014). However, whether biodiversity monitoring can be a surrogate for ecosystem service monitoring still remains unclear (Geijzendorffer and Roche 2013).

Conclusions

The balance between managing habitats for human development interests, conservation, and ecosystem services often involves trade-offs. Since the concept of ecosystem services is based on the ability of humans to interact with natural surroundings and to gain health and well-being directly or indirectly from ecosystems, the full economic and non-market costs of losing habitat has been largely underestimated, largely because resulting ecosystem service losses have historically not been accounted for (Postel and Carpenter 1997). Therefore, in order to support sustainable management and conservation decisions, short-term interests (e.g. electricity generation, oil/gas extraction) need to be accurately weighed and measured according to the long-term impact on all affected stakeholders and their well-being. This includes full cost accounting for all ecosystem services (material and non-material benefits) using stakeholder groups during decision-making processes.

Acknowledgments The authors would like to thank all survey participants whom reside in the study area of the Upper Peace River Watershed. The comments of two anonymous reviewers were gratefully appreciated. Funding is from the Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grants Program to ZL (#418241-2012). RD was funded by the NSERC Industrial Postgraduate Scholarships Program, the McLean Foundation, and was supported by Wildsight Golden and Wildsight Regional. Our funding sources had no involvement in study design, data collection, analysis or interpretation of data, nor in writing of the report or in the decision to publish these results.

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