Ecosystem services in the proposed National Park Reserve for the South Okanagan- Lower Similkameen region

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Abstract

The South Okanagan-Lower Similkameen region of British Columbia is one of the most biologically diverse areas in Canada hosting ca. 55 endangered and threatened species. A National Park Reserve has been proposed for this area but it has been highly opposed. We conducted a spatial analysis and a literature review in order to evaluate the costs and benefits of establishing a national park in the region. Using an ecosystem services framework, we developed four management scenarios and found that the area provides ecosystem services that would be much more enhanced in the timeframe of 50 years if it becomes a national park reserve. Establishing a national park enhances habitat quality that is crucial for endangered species' longterm survival. In addition, we found that the region acts as an important carbon sink that could potentially help the provincial and federal governments meet their greenhouse gas reduction strategies. The area provides water-related ecosystem services, and provides cultural, recreational and spiritual services for local residents and First Nations. We propose a set of recommendations directed towards the Canadian Parks and Wilderness Society (CPAWS) in its campaign for the establishment of the park; our aim is to better inform a decision for the establishment of the park based on the ecosystem services provided in the region. In particular, we highlight the importance of consultation and collaboration with local stakeholders, especially First Nations and local ranchers, in the deliberation for the decision to establish a park in the region.





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1 Introduction

The South Okanagan-Lower Similkameen (SOLS) region of British Columbia (BC) is one of the most biologically diverse areas in Canada. The area includes three biogeoclimatic zones—Bunchgrass, Ponderosa Pine savannah, and Interior Douglas Fir—and supports more than 30% of the species in the province listed as extirpated, endangered, threatened or of special concern by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC) (Bezener, Dunn, Richardson, & Dyer, 2004). It supports ca. 23 Red Listed species and 35 Blue listed species (Ministry of Environment, Lands and Parks, 1999). Due to its high biodiversity, it has long been recognized that this area is special and requires conservation efforts from both the provincial and federal governments. Currently, only 13% of the SOLS land is protected, while the surrounding region has one of the fastest growing human populations in Canada ("Central Okanagan population growth soaring - Kelowna Capital News," 2012). Habitat loss and habitat fragmentation are intensifying due to increased grazing, agriculture, forestry and urban development (Bezener et al., 2004). Many of these disturbances will be exacerbated by a changing climate (Greig & Bull, 2008; Nitschke & Innes, 2012). The federal government has long been interested in establishing a National Park Reserve (NPR)⁴ to protect the Interior Dry Plateau grasslands region, which is not yet represented in Canada's system of national parks (Parks Canada, 2011).

Grasslands are "terrestrial ecosystems dominated by herbaceous and shrub vegetation and maintained by fire, grazing, drought and/or freezing temperatures" (White, Murray, & Rohweder, 2000) that provide many Ecosystem Services (ES), the supply of benefits from ecosystems to society. For instance, many food grains (e.g., wheat, corn, rice) have originated in grassland ecosystems. Also, these ecosystems remain the primary source for genetic resources to improve crop yields and pharmaceuticals (Souchère et al., 2003; Suttie, Reynolds, Batello, Food and Agriculture Organization of the United Nations, 2005). Grasslands are foraging grounds for domestic livestock, providing humans meat, milk, wool, and leather products (White et al., 2000). Grasslands also provide habitat for wildlife (e.g., birds (Fletcher & Koford, 2002)), water and nutrient cycling (Detling, 1988), erosion control (White et al., 2000), climate regulation and carbon storage (Fan et al., 2008; Ni, 2004), recreation and tourism activities (Shields, Martin, Martin, & Haefele, 2002), and they are important cultural and religious sites (Gokhale, Velankar, Chandran, & Gadgil, 1998; Louis, 2002). Establishing a NPR in the SOLS region would contribute to the maintenance and sustained provision of these ES (Dudley, MacKinnon, & Stolton, 2014; IUCN, 2008).

Initially proposed in 2002, the NPR has been opposed by various stakeholders, fearing that their current uses and access to the land will be negatively impacted, restricted, or prohibited (Grego, 2013). In the case of the SOLS NPR, controversy with stakeholders occurred in 2006 after Parks Canada released the new park concept that doubled the size of the original 2002 version. The Lower-Similkameen Indian Band also opposed the 2006 concept, citing inadequate consultation by Parks Canada (Parks Canada, 2011). Misinformation about the concept of a NPR led to the opposition of ranchers who perceived that

⁴ A National Park Reserve as defined by Parks Canada is "an area set aside as a national park pending settlement of any outstanding aboriginal land claim. During this interim period, the National Parks Act applies and traditional hunting, fishing and trapping activities by Aboriginal peoples will continue. Other interim measures may also include local Aboriginal people's involvement in park reserve management" (Parks Canada, 2011).

commercial activities, including ranching, would be forbidden in the park (Grego, 2013). This situation exemplifies a misinformed paradigm of 'protected areas' as areas set aside for conservation that require human exclusion (Eidsvik, 1980). In the past, protected areas have evicted local communities from their homelands, denied their political rights and validity of customary rights, disrupted kinship systems, increased local poverty and provoked long-term social conflicts (Bennett & Dearden, 2014; Colchester, 2004; Dowie, 2009). However, the current SOLS NPR proposal seeks to address these challenges by reducing the size of the proposed NPR, and by allowing low-level non-industrial natural resource uses (e.g., ranching) that are compatible with park management goals. The proposal also attempts to develop a co-management strategy with local First Nations, and bolster local economic opportunities by promoting tourism in the region.

A 2007 survey showed that 63% of respondents favored the idea of establishing a NPR in the SOLS region while 26% opposed it (Parks Canada, 2011). Despite this, in 2011, the Province withdrew from the park development process⁵ citing local opposition and flawed public consultation. Since then, the BC chapter of the Canadian Parks and Wilderness Society (CPAWS) has led a campaign to: (1) examine the local support for the creation of a national park; (2) consider the economic and conservation benefits that it would deliver, and (3) reengage the province in the discussion with the federal government and local First Nations to create the NPR. The purpose of this study is to contribute to the CPAWS campaign by applying an ES framework to evaluate the social, economic and environmental costs and benefits of a NPR in the SOLS region.

2 Research questions and objectives

In this research project we hope to answer the following questions: how do different management scenarios for the SOLS region affect the provision of ES? What are the costs and benefits of establishing a NPR in the SOLS region? And how can the Province benefit from this?

Our research objectives are:

- 1. To evaluate the spatial patterns of long-term ES provision in the SOLS region under four management scenarios: No Land-Use Change; Conservation (establishment of a NPR); Partial Development (of private lands); and Complete Development (of private lands).
- 2. To identify costs and benefits associated with the establishment of the NPR with regards to potential economic benefits for local communities (e.g., revenues from tourism activities).

3 Methods

3.1 Spatial analysis

In order to evaluate the spatial patterns of long-term provision of ES in the SOLS region (Objective 1), we used the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) toolset. InVEST is a package of software models designed to aid decision-makers to map and value ES in landscapes and forecast changes under different management scenarios (Sharp et al., n.d.; Tallis & Polasky, 2009). A

⁵ In December 2011, the Liberal BC Minister of the Environment Terry Lake released a statement saying: "The province is not convinced there is enough local support to move forward with this proposal at this time." (Sharkey, 2012)

common requirement for all ES models is the Land Use/Land Cover (LULC) spatial data. We used LULC data from Hectares BC (The province of British Columbia et al., n.d.), and the park concept area (284 km²) provided by CPAWS. We used ArcGIS to create the layers for the models. Each cell within the LULC dataset was one hectare in size. In order to run the models, additional information on threats, habitat sensitivities and carbon storage was obtained from interviews with local stakeholders, literature reviews and the feasibility report (Parks Canada, 2011). We developed four scenarios: (1) <u>No Land-Use Change</u>: no establishment of a NPR, and no change in the LULC; (2) <u>Conservation</u>: NPR is established; grazing, logging, and urban development are restricted; (3) <u>Partial Development Scenario</u>: southern private lands in the SOLS region are urbanized due to the proximity to urban centers and their susceptibility to sprawl; and (4) <u>Complete Development Scenario</u>: all private lands in the SOLS regions are urbanized 50 years from when the models were initially ran in 2014.

Eight LULCs were identified within the park concept area: agriculture, fresh water, old forests, rangelands, recently logged, wetlands, young forests, and private land areas. In the No Land-Use Change scenario we assumed that all land classes stayed the same as the current land use scenario. In the Conservation scenario, we assumed that young forests became old forests, and that recently logged forests became young forests. Finally, in both development scenarios (Partial and Complete) we assumed that private lands within the NPR concept area were at risk of being developed (Table 1). In the Partial Development scenario, we assumed that the private lands closest to the southern urban centers were developed, while in the Complete Development scenario, all private lands were at risk of development.

We utilized two ES InVEST models: the Habitat Quality Model (HQM) and the Carbon Storage and Sequestration Model (CSSM). The HQM evaluated habitat quality as a proxy for biodiversity and the relative extent of different habitat types (Sharp et al., n.d.). The CSSM estimated the amount of carbon stored in the landscape and the amount sequestered over time. It also provided market values of sequestered carbon.

3.1.1 Habitat Quality Model (HQM)

This model evaluated the relative extent of different habitat types in the proposed NPR and the changes over time (Sharp et al., n.d.) using LULC data, current threats in the area and the sensitivity of each land cover type to each threat. LULC was classified using a binary approach as either a habitat or non-habitat for grassland and forest-affiliated communities of species⁶ without including species' specific analyses. We included future LULC scenario maps into the model to identify key areas where habitat was more likely to be affected. We ran the model three times, once per future scenario. After speaking with local residents, we identified seven main threats for habitat quality: grazing, fires, all terrain vehicle (ATV) use, hunting, fishing, agriculture, and urban development. Spatial data was used to determine the extent and possible locations within the proposed NPR for each threat. Each threat was assigned a weight rating relative to other threats ranging from 0 to 1 (lowest to highest). Threats and sensitivity ratings differed for each future scenario. The main threats were grazing, fires and ATV use for the No Land-Use Change scenario; fires and grazing for the Conservation scenario; and urban development, grazing and fire for both development scenarios.

⁶ By grassland communities species we refer to a variety of invertebrates, vertabrates and rare plants that occur only in the B.C. Grasslands, such as the blue bunch wheatgrass (*Elymus spicatus*), and Idaho fescue (*Festuca idahoensis*). By forest species we refer to species that are generally forest-affiliated such as tiger salamander (*Ambystoma tigrinum*), and canyon wren (*Catherpes mexicanus*).

Outputs from the model were habitat quality maps for the current and future scenarios. Habitat quality refers to the ability of the ecosystem to provide conditions appropriate for individual and population persistence (Sharp et al., n.d.). We re-categorized the habitat quality output ratings as low quality habitats <0.5; medium 0.51-0.75; and high >0.76. These categories are empirical and were reclassified relative to each other. By this we assumed that habitat with >0.76 of quality could potentially support more species than habitats with <0.5 quality because they have fewer threats. We do not mean to imply that habitats with <0.5 quality would not support any species. We understand that adding other ecological concepts such as carrying capacity could enhance the categories proposed here, but we believe that our analysis is a first step to evaluate areas that are more ecologically sensitive to threats.

3.1.2 Carbon Storage and Sequestration Model (CSSM)

We used the CSSM to evaluate the amount of carbon stored and sequestered, and the value of carbon storage under our three future scenarios (Sharp et al., n.d.). To run this model, we used LULC data and carbon storage values from aboveground biomass (Mg/ha), belowground biomass, soil storage, and amount stored in necromass as suggested by the IPCC (Aalde et al., 2006). We considered a value of US\$33.84 per tonne of carbon (Carr, 2014) for the valuation of carbon storage. We did not consider discounts and predictions for carbon prices. The model produces a present carbon storage map (Mg/ha) and future carbon storage maps (Mg/ha) for each scenario. This allows a direct comparison between current and future scenarios under different management conditions. Carbon sequestration output links a value to the carbon stored per grid cell. We categorized carbon storage into three ranges: 1-100 Mg/ha; 101-250 Mg/ha; and > 250 Mg/ha. Areas with zero carbon storage or sequestration were categorized separately since land classes with no carbon storage potentials would be considered to have zero carbon sequestration over time (unless reclaimed). Our future Conservation scenario utilized the current LULC dataset, while the development scenarios utilized the Partial and Complete Development LULC datasets.

3.2 Non-spatial analysis

We did a literature review to identify the potential economic and environmental costs and benefits of the establishment of a NPR, including the review of grey literature (e.g., Parks Canada reports) and scientific articles. We reviewed how protected areas in Canada contribute to local and national economies, and how the Province would benefit from the carbon sinks within the NPR. We also evaluated the potential provision of other ES that were not considered in the spatial analysis, such as water provision and those related to cultural and spiritual practices.

The Okanagan Nation Alliance (ONA) has expressed its support for the establishment of an NPR on its traditional lands if a consensus based model seeking cooperative management of the park between First Nations and Parks Canada - similar to that of Gwaii Haanas - is implemented (Okanagan Nation Alliance, 2013). Several conditions have been laid out by ONA to ensure their ongoing support of the NPR. For example, the park must not diminish Aboriginal Title and Rights, that access is ensured to allow for spiritual practices and harvesting and hunting, that park related employment opportunities are given to local First Nations, that Traditional Ecological Knowledge (TEK) is incorporated into the management of the park. The area has and continues to provide First Nations with ES ranging from food and water provision to cultural and spiritual services. The latter in particular are extremely difficult to quantify, and challenge the one-way, consumptive narrative proposed by much of the ES literature. First Nations people espouse a deep philosophy and reciprocal relationship with nature, where

ecosystems provide humans with life-supporting services, and humans give back so that these services are maintained (Cajete, 1999).

3.3 Assumptions and caveats

We decided to apply an ES framework to characterize the potential costs and benefits of the establishment of a NPR in the SOLS region because we believe that it frames the argument for protecting the area in a lens that is recognizable and relevant to decision-makers (e.g., carbon storage/sequestration in the SOLS NPR relevant to provincial GHG reduction targets). However, we recognize that many people can view an ES approach as a framing of the nature-human relationship in a one-way, consumptive manner. We recognize that this may conflict with indigenous epistemologies that need to be considered if the NPR is established and co-managed at a high level. An ES analysis, and valuation in particular, might undervalue the intrinsic value of the area. Hence, we believe that in addition to our analysis, there needs to be an integration of Traditional Ecological Knowledge (TEK) that can help identify areas of ecological and cultural importance in the region that might not be included in our analysis nor in traditional cost-benefit analysis of the province or Parks Canada.

Our models are the first spatial analysis that attempts to quantify the ES in the region. Because we used LULC data from 2006 and information for the threats that drew from interviews with local residents, we recognize that these models are only a first attempt to understand the actual provision of ES. Our HQM assumes that protection of the land is effective and that all threats in the area are additive. Therefore, our HQM model should be considered as representing a minimum amount of threat posed to the various habitats within the proposed NPR. In reality, threats are much more diverse, and there may be cumulative impacts to the landscape that are not accounted for in our model. We also assumed that the private lands in the southern region of the concept area were more susceptible to development in the Partial Development scenario due to its close proximity to the communities of Osoyoos and Oliver. In the Complete Development scenario, we assumed a "worst-case" scenario where all private lands could be developed. In reality, it is unlikely that all private lands will be developed into urban uses, but this provides an understanding on how the provision of ES might change due to urbanization. Also, our CSSM assumed an oversimplified carbon cycle, an assumed constant rate of carbon sequestration over time (Sharp et al., n.d.). More information with local stakeholders, more interviews, and scientific research (e.g., field sampling, remote sensing) could help to better inform the models to provide outputs that reflect the local realities at a finer scale. However, we believe that our models are a good attempt to quantify ES and show the importance of the region as an ES provider.

4 Results: InVEST models

4.1 Land Use/Land Cover

Our analysis shows that currently rangelands and forests (young and old) are the most common LULC in the area representing >50% and 44% respectively. After the analysis under the four management scenarios we found that forest cover (young and old) would still remain ca. 44% in both the No Land-Use Change (Figure 1), and Conservation (Figure 2) scenarios, but the difference is that in the Conservation scenario most forests would become old forests. In addition, under the Partial Development scenario, we found that 17% of rangelands would be converted to developed areas. Thus, in total 23% of the concept park area would be developed (Figure 3). Likewise, the Complete Development scenario would experience a development of 24% of rangelands. In this scenario, over one-third of the park would be developed (Figure 4).

LULC	No Land-Use Change Scenario (Current LULC)	Conservation scenario	Partial Development Scenario	Complete Development Scenario
Old forest	12.5%	44.1%	11.8%	11%
Young forest	31.7%	1.3%	29%	27%
Recently logged	1.3%	0%	1.3%	0.8%
Rangelands	51%	51%	34.7%	26.8%
Fresh water	0.1%	0.1%	0.1%	0.1%
Wetlands	0.2%	0.2%	0.1%	0.1%
Agriculture	3.2%	3.3%	0.4%	0.4%
Developed areas	0%	0%	22.6%	33.8%

Table 1. LULC under four management scenarios



Figure 1. Future LULC under the No Land-Use Change scenario (also representing current LULC)



Figure 2. Future LULC map for Conservation future scenario



Figure 3. Future LULC map for the Partial Development scenario



Figure 4. Future LULC map for the Complete Development scenario

4.2 Habitat Quality Model

4.2.1 No Land-Use Change scenario

In the No Land-Use Change scenario, the HQM predicted that habitat quality would generally be of medium to high habitat quality, with small pockets of low quality areas (Figure 5). Rangelands would be generally medium quality habitats, with small pockets of low quality habitats within the rangeland territories, while forests would be of high habitat quality. The landscape would remain relatively unfragmented, with high levels of connectivity between medium and high quality habitats.



Figure 5. Future habitat quality model results for the No Land-Use Change scenario

4.2.2 Conservation scenario (NPR)

In the Conservation scenario, the HQM predicted that much of the rangeland areas would have medium to high quality habitats (Figure 6). Since the Conservation scenario assumed that grazing, ATV use, and hunting are restricted; the model predicted no habitats of low quality. As with the results of the No Land-Use Change scenario, the higher quality habitats would be forested areas, and most of the medium quality habitats would be in the rangelands.



Figure 6. Future habitat quality model results for the Conservation scenario

4.2.3 Partial Development scenario

The HQM predicted that much of the northern part of the concept area would have high habitat quality, while the southern private lands would be noticeably affected by development (Figure 7). Developed areas were assumed to be non-viable as habitats and were separately classified. In the northern part of the proposed park area, forests and rangelands are expected to provide quality habitats. Results show that the landscape in the northern regions of the proposed concept area for the park would have high quality habitat, with the exception of two small pockets of low quality habitat. The anticipated development of private lands in the southern portions of the park area indicates that the landscape would be highly fragmented. Development would mostly affect southern rangelands (of the current LULC) leading to a significant loss of medium quality habitats in the south of the concept area.



Figure 7. Future habitat quality model results for the Partial Development scenario

4.2.4 Complete Development scenario

The HQM shows that a Complete Development scenario would yield a very fragmented landscape in the concept park area (Figure 8). Except for small patches of medium quality habitats, the concept area would be divided between developed areas and high quality habitats. The fragmented landscape would reflect the sudden changes in land use for urban developments. The Complete Development scenario assumed that all private lands would be developed. This would result in a significant loss of medium and high quality habitats. Forests (young and old) would remain as high quality habitats throughout the park area. But under this scenario, most of the rangelands would be converted for development, leaving little fringe habitats for niche species.



Figure 8. Future habitat quality model results for the Complete Development scenario

4.3 Carbon Storage and Sequestration Model (CSSM)

4.3.1 Carbon storage

4.3.1.1 No Land-Use Change and Conservation scenarios

For the CSSM, No Land-Use Change and Conservation scenarios were analyzed together because the LULC map was the same for both scenarios. Our results show an increase in carbon storage in the future Conservation scenario. Grasslands, young forests and old forests are important carbon sinks and these are reflected in the maps. Old forests show the highest value of carbon storage (Figure 9). Compared to the current LULC, carbon storage potential may rise by between 1.5 and 2 times.



a) Current No Land-Use Change and Conservation scenario

b) Future Conservation scenario

Figure 9. Carbon storage for No Land-Use Change and Conservation scenarios

4.3.1.2 Partial Development scenario

In the Partial Development scenario, results show that the natural landscape would retain much of the carbon storage potential. There would be a significant loss of carbon storage in the newly developed areas, where approximately a third of the carbon storage potential may be lost to development (Figure 10). Compared to the No Land-Use Change and Conservation scenarios, the Partial Development scenario will have considerably less carbon storage, especially in the southern regions of the park.



a) Current

b) Future

Figure 10. Carbon storage for the Partial Development scenario

4.3.1.3 Complete Development scenario

In the Complete Development scenario, the carbon storage potential would be reduced further as a result of development (Figure 11). Some of the northern parts of the concept area could be developed and as a result, more carbon storage potential would be lost. However, natural areas would still retain their carbon storage potential. A future scenario with Complete Development may see about half of the carbon storage potential lost from the No Land-Use Change/Conservation scenario.



a) Current*

b) Future*

Figure 11. Carbon storage for the Complete Development scenario

4.3.2 Carbon sequestration

Our results show that under the Conservation scenario, when young forests turn to old forests they experience moderate gains in carbon sequestration (i.e., future carbon storage>current (Figure 12) while the rest of the area experiences no gains. We recognize that restored grasslands could potentially sequester carbon, but one of the most significant roles of native grasslands is that they could act as a repository of carbon that is already stored, providing less opportunities for sequestering carbon (Sapozhnikova, 2012). Comparatively, under both development scenarios, the areas that could be developed would experience losses of 50-150 Mg/ha and losses exceeding 150 Mg/ha in carbon storage (i.e., negative carbon sequestration). The areas with predicted high losses would be the current old forests that are threatened by development. The Partial Development scenario would experience a carbon

sequestration loss in the southern parts of the concept area, while the Complete Development would trend northwards as well.



a) Conservation scenario

b) Partial Development scenario



c) Complete Development scenario



4.3.3 Carbon valuation

In the Conservation scenario, the gains in carbon storage could potentially yield revenue from carbon trading. Much of the area is valued between \$200 and \$1500 per hectare for its carbon sequestration (Figure 13). Areas with a value of \$0 per hectare represent areas that would experience no gains or losses in carbon storage under future scenarios. In both development scenarios, developed areas would experience high losses in economic revenue derived from carbon storage. The areas with medium and high carbon sequestration losses could experience losses between \$500 and \$2500 per hectare or >\$2500 respectively. Like the other cases, losses were only anticipated where developed areas were predicted.



a) Conservation scenario



b) Partial Development scenario



c) Complete Development scenario



5 Discussion

Overall, our analysis shows that the area provides ES that would be much more enhanced in the timeframe of 50 years if it becomes a NPR. Our results also show that under a NPR, there would be a dramatic increase in habitat quality, having important repercussion for species-at-risk conservation efforts. The NPR would result in increased carbon storage and sequestration, improved water provision, increased recreation and tourism opportunities, and maintaining or enhancing services related to cultural and spiritual practices. In addition to the provision of these services, a NPR could generate employment at local scales. There is also opportunity to co-manage the NPR with First Nations and maintain cultural practices and recreation services in the area. It is important to note that all of these services are interrelated and that the creation of a NPR will result in feedback effects. For example, an increase in habitat quality and presence of endangered species could result in increased tourism. Conversely, pressures to decrease ranging could negatively impact cultural practices for the ranching community. We believe that our results attempt to show the ecological and cultural significance of the region and we acknowledge that making a NPR in the area would enhance the provision of all these ES. However, the importance of these ES could be perceived differently, depending on the audience who interprets them. For example, the potential value of carbon storage in the NPR may stand out for decision makers with strict budgetary constraints, while the sustaining of cultural practices may be of highest concern for local ranchers and local First Nations, and conservationists might be interested in increased habitat quality. Therefore, it's important to consider the provision of ES from multiple perspectives. Below we discuss how creating a NPR would affect the provision of each ES individually.

5.1 Habitat quality

Habitat quality would be enhanced under the Conservation scenario and decrease under both development scenarios (Partial and Complete). The major difference we see under the Conservation scenario is the increase in forest cover (from 12% to 44% old forest, Table 1). This change has important benefits to endangered and threatened species that live within the NPR concept area and could benefit from increased forested areas that are of higher quality habitats. Some of these species (e.g., spotted owl and canyon wren) require high quality habitat for their survival. Therefore, establishing a NPR, could build on existing National recovery strategies such as the Species at Risk Act (SARA). It is worth mentioning that SARA is applicable only to federal lands and under the NPR all land in the park would become federal. Several species in the region are the focus of the BC species recovery strategies, including the tiger salamander, the great basin spadefoot and the South-Okanagan shrub steppe. Implementation of the species recovery strategies could be greatly advanced by creating a NPR.

Human activities in the region and the NPR boundaries contribute to habitat loss and habitat fragmentation (Hessing, 2010). Under the Conservation scenario, the entire region is expected to have medium and high quality habitats, providing a connected landscape for different wildlife species to thrive and migrate. Comparatively, a highly fragmented landscape is expected to occur under the Partial and Complete development scenarios. However, the full effects of habitat fragmentation were not presented in the habitat quality models. A fragmented landscape directly correlates to increased edge effects that may negatively impact wildlife species by dividing a large habitable region into smaller pockets of habitats. Fragmentation cuts off habitat connectivity and can be detrimental to species that require large areas of space to maintain viable populations (Dudley, MacKinnon, & Stolton, 2014). Alternatively, edge effects may provide niche habitats for species that are tolerant to perturbations that can outcompete more vulnerable species (e.g., forest-affiliated species) such as some species at risk.

5.2 Carbon storage and sequestration

BC has introduced legislation that sets targets to reduce greenhouse gas emissions by 33% below 2007 levels by 2020, and 80% by 2050. A significant economic benefit provided by the SOLS NPR is the provision of carbon storage and sequestration that could manifest as tradable credits on BC's carbon market. Our results show that establishing a NPR in the SOLS region could enhance carbon sequestration in the long-term. We found that most of the area could store medium quantities of carbon (101-250 Mg/ha) that are valued between \$200 and \$1500 per hectare. These results can be translated to potential carbon credits that could be traded by the Province to make up for the production of greenhouse gases generated by industry, transportation, or other activities. The provincial government set a price of \$25 per tonne of CO_2 for carbon offsets (Pacific Carbon Trust, 2014) and stated that one carbon credit represents the reduction of one metric tonne of CO_2 or its equivalent in other greenhouse gases (The Nature Conservancy Canada, 2013).

Based on our analysis, if the NPR is created it has the potential to store approximately 5.9 Million tonnes of carbon over 50 years. To get this value we used the total grid cells from our carbon storage model for low, medium and high categories and multiplied them by the average carbon storage within each category (Mg/cell). If the province is willing to buy an offset for \$25 per tonne, the park could create up to ca. \$147 million over the 50 years for the Province. Therefore, NPR in the SOLS region could be critical for helping meet provincial and/or federal GHG reduction targets, under optimum management conditions. However, carbon sinks (i.e., forests and rangelands) need to be actively managed by Parks Canada staff, in particular through fire management and prevention of overgrazing. Our analysis does not account for the presence of fire on the landscapes, which in concert with projected climate change, will likely turn some forests into net sources of carbon emissions rather than sinks. In an arid climate, with an average of only 30cm of rainfall per year, the SOLS is susceptible to a high return rate for fires that could affect the ecosystems. In order to plan for fire management, historical fire patterns and changes in precipitation need to be considered (Nitschke & Innes, 2012). In addition, controlling fire through prescribed burns also poses a cost (average of \$80.00/Ha) (Parks Canada, n.d.), but the costs of fighting fires are higher (\$1250-125,000/Ha). Thus, we suggest that a precautionary approach for fire management through controlled burning might be more effective.

Our analysis shows that forests are more effective carbon sinks compared to grasslands. But as much as 34% of global terrestrial carbon is stored in grassland ecosystems (Sapozhnikova, 2012). We understand that carbon storage in grasslands is complex and affected by many factors, including grazing (negative impacts) and precipitation patterns (positive impacts) (Sapozhnikova, 2012) but our carbon storage models only used a limited number of threats. Grasslands with higher relative growth rates store more carbon than ones with lower growth rates. Thus, overgrazing significantly affects grasslands' ability to store carbon (De Deyn, Cornelissen, & Bardgett, 2008), as well as soil degradation, erosion, and compaction, which may be more important factors than grazing. In the SOLS region, overgrazing has been recognized as a major threat to the grasslands; hence, implementing new grazing strategies for livestock owners, and restricting grazing pressures can maximize carbon storage in the proposed NPR. Actively managing both forests and grasslands in the SOLS region presents a significant opportunity for both the provincial and federal governments to meet GHG reduction targets.

5.3 Recreation and tourism

The proposed NPR is purported to have significant benefits to the local economies, including \$72 million in investments, \$120 million in expenditures, and \$40 million in government taxes (CPAWS, 2014). Government investment in developing park infrastructure will benefit local residents through

buying local supplies, providing local wages, and stimulating the local economy. Based on the averages of other protected areas in British Columbia, the NPR could generate 571 permanent full-time jobs, \$37 million in GDP, \$25 million in annual labor income, and \$49 million in annual visitor spending (BC Chamber of Commerce, 2014; Canadian Parks Council, 2011). Additionally, there are opportunities for co-management with local First Nations that could increase their participation in decision-making concerning the management of resources in their territories, and their stewardship on the land (Berkes, 2004). If the level of co-management is high, there is also potential for generating economic benefits to First Nations communities by splitting the revenues generated between the provincial government and the First Nations government through a well established government-to-government collaboration (McGee, Cullen, & Gunton, 2010).

A major benefit for the province by establishing a NPR in the SOLS region is that the financial costs for establishing the park would only draw from Federal budgets and would not require Provincial money. However, we also recognize that there are important trade-offs that need to be considered. For example, the restriction of agriculture uses could represent economic losses at a provincial scale, but the revenues generated by tourism activities could mitigate those losses. In addition, the area is a significant provider of recreational ES; organizations such as the South Okanagan Trail Alliance and the South and Central Okanagan Naturalists Clubs currently rely on the park area for hiking, trail walking, and running. Locals and tourists also engage in many recreational opportunities within the park boundaries such as canoeing, kayaking, fishing, camping, and wildlife tours. We believe that establishing a NPR in this region would ensure the long-term provision of these recreational ES.

5.4 Water-related ecosystem services

In the SOLS region, most towns and cities, as well as agricultural users, draw water straight from the region's big lakes, including Okanagan Lake, Kalamalka Lake, and Skaha Lake (Okanagan Waterwise, 2014). Despite these lakes are located outside of the NPR concept area, the fresh water bodies within the proposed NPR (i.e., Kilpoola Lake, Blue Lake, Frank Lake, Richter Lake, Spotted Lake, and Conifryd Lake) provide other ES such as water retention, sediment regulation, and natural water filtration (Vigerstol & Aukema, 2011). Fresh water makes up only a tiny fraction of the world's water, yet supports almost 6% of all described species (Dudgeon et al., 2005). These freshwater bodies in the proposed NPR are crucial for the survival of many species, especially those adapted to riparian habitats such as dragonflies, damselflies, amphibians, and some reptiles (Stevens, Backhouse, & Eriksson, 1995).

Freshwater ecosystems are susceptible to changes in climate and threats imposed by human activities, such as: overexploitation, water pollution, flow modification, destruction or degradation of habitat, and invasion by exotic species (Dudgeon et al., 2005). Stakeholders in the SOLS region are already concerned about the water quality and availability (Shepherd, Tansey, & Dowlatabadi, 2006) which is explained by the combination of a dry climate and the threats explained above. Reducing the risk imposed by those threats is therefore crucial for long-term water provisioning. For example, minimizing the runoff of fertilizers used for agriculture can reduce water pollution. In addition, LULC changes, such as the conversion of forested areas to agriculture, affect the hydrological flow and timing (Schilling, Jha, Zhang, Gassman, & Wolter, 2008). Thus, under our future development scenarios (Partial and Complete) where we consider the conversion of forest areas to urban areas, water provision would be significantly impacted.

6 Conclusions and recommendations

Our findings show that the proposed NPR in the SOLS region is an important provider of ES, including but not limited to habitat quality, carbon storage, water purification, recreational services, and cultural services. More data is needed to better understand which services are most important to local communities, how they are provided, and best practices to manage and sustain them. Our future scenarios indicate that the establishment of an NPR can clearly help to ensure the ongoing provision of habitat quality and carbon storage. The enhancement of habitat quality is crucial for the conservation of endangered and threatened species that live within the area, while enhancing carbon storage is an important opportunity for both the provincial and federal governments to meet their GHG reduction targets. Our literature review suggests that the region provides significant cultural, spiritual and recreational ES. In addition, we found that establishing a NPR could bring economic benefits to local communities derived from tourism and employment generation. Additionally, a meaningful consultation process with local First Nations and local communities, as well as a communication strategy that informs people about the potential benefits of a NPR in the SOLS region is needed to convince opponents and important stakeholders. We believe that some stakeholders have been misinformed of the actual concept and management of the proposed NPR. Thus, a clarification of the concept and the restriction of the activities could help inform the deliberation for establishing the park. A regional watershed plan under the recent Provincial Water Sustainability Act would also help in maintaining proper land use and land management to ensure the health of the watershed. We believe that using an ES framework helps explain the benefits associated with the creation of a NPR in the SOLS region in terms that can be better understood by local stakeholders and the Province. We propose the following interconnected set of recommendations that incorporate ES-based thinking for consideration by CPAWS in their outreach efforts to the Province and Parks Canada:

6.1 Prioritize effective grazing management strategies in consultation with local ranchers.

Our research shows that grasslands provide high quality habitat that could be used by many endangered and threatened species. In addition, results show that grasslands also represent a significant opportunity to store carbon. However, under all of our scenarios, rangelands are also the most degraded land use type in the park area (excluding developed areas), due mostly to overgrazing. Research suggests that ecosystem based management of grazing patterns can actually improve grasslands health and their ability to store carbon (Sapozhnikova, 2012). Parks Canada is committed to sustainable grazing; however, some existing grazing operations will continue under the proposed NPR. It is vitally important that new grazing techniques and patterns are introduced that will benefit rather than harm existing grasslands, that invasive plants are managed and removed, and that degraded grasslands are restored. Ranching is an important historical and cultural practice in the area; thus, in order to implement such a strategy, a collaborative approach needs to be taken with local ranchers. CPAWS should advocate that Parks Canada staff provide capacity building tools for ranchers to implement new grazing patterns, and to help determine what indicators to use in the monitoring and evaluation of such grazing patterns; for example, the amount and distribution of grassland species, and the amount of carbon being stored and released by grasslands, among others.

6.2 Through meaningful consultation with local First Nations, develop a comanagement strategy for the NPR.

Cultural and spiritual uses of the land are central to many First Nations identities, and owing to a history of colonization and cultural appropriation, many First Nations are not eager to share these facets of their

culture with outsiders. It is imperative that a healthy relationship is established and maintained between stakeholders and local First Nations based on trust and respect. CPAWS should advocate for continuing involvement with the member bands of ONA, and recognize that their work to establish an NPR with co-management is part of a broader reconciliation between First Nations and Canadians.

6.3 Develop a carbon storage and fire management strategy that aligns with and fulfills provincial greenhouse gas reduction targets.

The carbon storage benefits provided by the proposed NPR are significant, both through the forests and grasslands. However, increased risks of forest fires due to climate change are changing the forestry landscape in Canada. Forests are becoming net sources of carbon emissions, rather than sinks. Under our Conservation scenario, the percentage of land covered by forests increases after 50 years, adding carbon storage potential but also increasing risks of large forest fires. Forest fires are likely to be a threat to the area regardless if a park is established or not; establishment of an NPR would thus bring increased staff and capacity to manage for fire risks through fuel removal and controlled burning. First Nations have been practicing controlled burning for generations, and a fire management strategy would be an effective way to revive TEK through co-management (recommendation 6.2). Alternative grazing practices (recommendation 6.1) would also contribute to grasslands' ability to store carbon. Importantly, the provincial government has committed to GHG reductions, and the carbon storage potential of the proposed NPR could help the Province achieve these goals and receive carbon credits through the Pacific Coast Action Plan on Climate and Energy. However, since the NPR would be a national park, more research is needed to determine whether or not the biophysical gains would eligible to count towards provincial targets. Regardless, the carbon storage benefits provided by the NPR are significant, and CPAWS should utilize the efficacy of this ES in its campaign.

6.4 Develop a communication strategy that incorporates ES to involve, inform, and educate local residents & park visitors of the benefits provided by the park.

An effective communication strategy that incorporates ES would provide educational opportunities for park users to better understand how they benefit from the landscape, and to create buy-in on why park management strategies are important. Such an attempt to frame the park in terms of the services it provides may also be a useful strategy to educate opponents of the NPR to better understand the benefits provided by the park relative to the costs. CPAWS should utilize these findings to promote the benefits of nature in a quantifiable way to inform decision-making.

6.5 Develop a watershed management plan in collaboration with all stakeholders

Managing the freshwater resources in the proposed NPR is critical not only for human benefit, but for wildlife as well. BC's new Water Sustainability Act (WSA) provides legislative impetus to create local watershed plans. Although the land will be under federal jurisdiction, the existence of an NPR will provide important water provision services to the area; stakeholders outside the NPR who benefit from those ES should be encouraged to develop a watershed plan under the WSA. If and when the NPR is established, CPAWS should continue its campaign in the area, and seek collaborative opportunities with other organizations and stakeholders to build momentum and support for a watershed plan that calls for appropriate land use and management (e.g. invasive and exotic species control) for the SOLS region in order to manage and plan for a sustainable watershed.

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