Ecosystem Status Report for *Purshia tridentata / Hesperostipa comata* (antelope-brush / needle-and-thread grass) in British Columbia

by Kristi Iverson

Victoria, British Columbia

December 2012

Recommended citation:

Iverson, Kristi. 2012. Ecosystem Status Report for *Purshia tridentata* / *Hesperostipa comata* (antelope-brush / needle-and-thread grass) in British Columbia. Prepared for: B.C. Ministry of Environment, Conservation Data Centre, Victoria, B.C. 35 pp.

Cover Photo:

Ted Lea, early 1990s

Additional copies

Additional copies can be downloaded from:

http://a100.gov.bc.ca/pub/eirs/viewDocumentDetail.do?fromStatic=true&repository=BDP&documentId=11480

Publication information

Library and Archives Canada Cataloguing in Publication

Iverson, Kristi

Ecosystem status report for Purshia tridentata / Hesperostipa comata (antelope-brush / needle-and-thread grass) in British Columbia [electronic resource] / by Kristi Iverson.

Includes bibliographical references.
Electronic monograph in PDF format.
ISBN 978-0-7726-6655-0

1. Purshia tridentata--Ecology--British Columbia. 2. Purshia tridentata--Ecology--British Columbia--Okanagan Valley (Region). 3. Ecosystem health--British Columbia--Okanagan Valley (Region). 4. Endangered ecosystems--British Columbia. I. British Columbia. Ministry of Environment II. Title.

SB207.P93 I98 2012 333.95'32 C2013-980002-6

Executive Summary

Purshia tridentata / *Hesperostipa comata* (antelope-brush / needle-and-thread grass), when in excellent ecological condition, is a shrub-steppe community characterized by an open shrub layer dominated by *Purshia tridentata* and a herb layer dominated by native bunchgrasses including *Hesperostipa comata*, *Aristida purpurea* var*. longiseta* (red three-awn), *Pseudoroegneria spicata* (bluebunch wheatgrass), and *Sporobolus cryptandrus* (sand dropseed). It occurs on coarse, sandy soils that were deposited by melting glacial waters or on sandy aeolian veneers over these materials. Within British Columbia, it occurs at low elevations in the southern Okanagan Valley. The ecological community occurs in an area where, historically, there were frequent, low-intensity fires.

The B.C. Conservation Framework (2012) ranks this ecosystem as priority one in both goal one (contribute to global efforts for species and ecosystem conservation) and goal three (maintain the diversity of native species and ecosystems). It has a G2 (imperilled) Global status and S1 (critically imperilled, red-listed) Provincial status. Additionally, it supports one of the highest densities of provincial red- and blue-listed species for any ecosystem in British Columbia.

In 1800, there were approximately 9863 ha of *Purshia tridentata* / *Hesperostipa comata* ecosystem. By 2008, only 3217 ha remained, representing a loss of 67.4% of the original extent of this ecosystem.

Within British Columbia, none of the area of existing *Purshia tridentata* / *Hesperostipa comata* was estimated to have excellent ecological integrity. Fifty-four percent was assessed as having good ecological integrity; 46% have fair or poor ecological integrity. The ecological integrity and condition of *Purshia tridentata* / *Hesperostipa comata* grass have been severely reduced by the following primary factors: fragmentation by various types of development (particularly urban/suburban and agricultural development), alteration to fire regimes, disturbance by domestic livestock, and the spread and continued introduction of invasive alien plants. These factors continue to threaten the remaining occurrences of this ecological community.

About 17% of the remaining *Purshia tridentata* / *Hesperostipa comata* is protected by the Canadian Wildlife Service National Wildlife Areas (3%), provincial Protected Areas (6%), and private conservation lands (8%). The remaining 83% occurs in unprotected lands on Indian Reserves (56%), private land (20%), and provincial crown land (6%).

Technical Summary

Ecosystem Name: common and scientific names	*Purshia tridentata* / *Hesperostipa comate* antelope-brush / needle-and-thread grass
Estimated Extent of Occurrence	254 km^2
Estimated Area of Occupancy	32 km^2
Number of Occurrences	72
Number of Occurrences with Good Ecological Integrity	7
Is there an (observed, inferred, or projected) continuing decline in the area of occupancy?	Yes, 67.4% of original extent has been lost; see 'Trends' Section
Is there an (observed, inferred, or projected) continuing decline in the number of occurrences?	Yes
Is there an (observed, inferred, or projected) continuing decline in Ecological Integrity?	Yes, ecological integrity is projected to continue to decline through ongoing fragmentation from agricultural and suburban conversions, continued spread of invasive plants, and continued alterations to fire regimes; see section 'Ecological Integrity and Condition'.
Threats (of Very High and High Impact): Residential and commercial development, annual and perennial non-timber crops, particularly grapes, and invasive and other problematic species & genes.	

Table of Contents

List of Figures

List of Tables

1. Ecosystem Description and Significance

1.1. Name and Classification

The *Purshia tridentata* / *Hesperostipa comata* (antelope-brush / needle-and-thread grass) ecological community occurs on coarse, sandy soils that were deposited by melting glacial waters, or on sandy aeolian veneers that occur on top of these. Within British Columbia, it occurs at low-elevations in the southern Okanagan Valley. The ecological community, in excellent ecological conditions, is characterized by an open shrub layer dominated by *Purshia tridenta*ta (antelope-brush) and a herb layer dominated by native bunchgrasses including *Hesperostipa comata* (needle-and-thread grass), *Aristida purpurea* var*. longiseta* (red three-awn), *Pseudoroegneria spicata* (bluebunch wheatgrass), and *Sporobolus cryptandrus* (sand dropseed). The herb layer also includes *Opuntia fragilis* (brittle prickly-pear cactus), and scattered forbs. The soil surfaces between shrubs, grasses and forbs are covered by a mixture of *Selaginella* spp*.* (selaginella) and a microbiotic crust of lichens, mosses and cyanobacteria dominated by *Tortula ruralis* (rusty steppe moss) (Figures 1 and 2). The ecosystem occurs in an area where there were historically frequent, low-intensity fires (Daigle 1996).

The classification source for this ecosystem is the provincial Biogeoclimatic Ecosystem Classification (BEC) *Purshia tridentata* / *Hesperostipa comata* plant association (Meidinger 1992) and the only site series in this plant association is the Very Dry Hot Bunchgrass Subzone, Okanagan Variant, site series BGxh1/02 (Lloyd et al. 1990). The *Purshia tridentata* / *Hesperostipa comata* ecological community occurs as late seral and climax vegetation occurrences of this plant association[1]. The central concept is a shrub-steppe ecosystem dominated by antelope-brush and occurring on sandy glaciofluvial or aeolian soils in lower elevations of the southern Okanagan Valley.

Sampling data in this ecosystem were collected as part of a biophysical mapping project in the early 1990s (Lea and Maxwell 1995) and as part of the provincial Biogeoclimatic Ecosystem Classification program (BECMaster 2010).

The condition of *Purshia tridentata* / *Hesperostipa comata* was assessed and integrated into terrestrial ecosystem mapping for the South Okanagan in 2005 by Iverson et al. (2005). In the winter of 2004 – 2005, brief field assessments were conducted at 120 sites to describe dominant plant species, invasive plants, slope, aspect, landform, and ecological condition (given the late season, detailed vegetation data were not collected). These data together with aerial photograph interpretation were used to map the condition of all *Purshia tridentata* / *Hesperostipa comata* occurrences (Iverson et al. 2005).

[1] The classification is currently being revised with a proposed "antelope-brush – bluebunch wheatgrass" site series with an "antelope-brush – cheatgrass – needle-and-thread grass" plant community as a seral stage of this site series (Michael Ryan, pers. comm. 2012). However, soil texture also influences the plant community composition as discussed in Section 1.2.

Figure1. Overview of a former occurrence of the *Purshia tridentata* / *Hesperostipa comata* ecological community in the 1990s (this site is now a vineyard). Photo by Ted Lea.

Figure 2. Detailed view of an area of the *Purshia tridentata* / *Hesperostipa comata* ecological community. Photo by Kristi Iverson.

1.2. Vegetation Description

The *Purshia tridentata* / *Hesperostipa comata* ecological community is characterized by an open shrub layer dominated by *Purshia tridentata* with *Artemisia tridentata* (big sagebrush), *Chrysothamnus nauseosus* (rabbit-brush) and a herb layer dominated by native bunchgrasses

including *Hesperostipa comata*, *Aristida purpurea* var*. longiseta*, *Pseudoroegneria spicata*, and *Sporobolus cryptandrus*. The herb layer includes *Selaginella densa* (compact selaginella) and scattered forbs such as *Opuntia fragilis*, *Balsamorhiza sagittata* (arrowleaf balsamroot), *Plantago patagonica* (woolly plantain), *Eriogonum niveum* (snow buckwheat), and other diverse but infrequent forbs (Lloyd et al. 1990, Krannitz 2008, Biogeoclimatic Ecosystem Classification data, British Columbia Ministry of Forests, Lands and Natural Resource Operations 2011; see Appendix A). A microbiotic crust of lichens, mosses, liverworts, and cyanobacteria covers much of the space between vascular plants. It is dominated by species such as *Tortula ruralis*, *Ceratodon purpureus* (fire-moss), *Bryum argenteum* (silver moss), *Brachythecium albicans* (lawn moss), *Polytrichum piliferum* (awned haircap moss) and *Cladonia* spp. (clad lichens; Atwood 1998). Scattered *Pinus ponderosa* (ponderosa pine) trees may occur. Full vegetation data are included in Appendix A.

Some vascular plants are only visible in the spring and may be under-represented in the vegetation data. These include species such as *Ranunculus glaberrimus* (sagebrush buttercup), *Fritillaria pudica* (yellow bells), and *Lewisia rediviva* (bitterroot).

Due to an extensive history of livestock grazing and the spread of alien invasive plants, almost no pristine examples of the plant community exist within Canada. There are only a few areas that have not been grazed since the late 1800s (Krannitz 2008). All sampled occurrences include alien invasive plants such as *Bromus tectorum* (cheatgrass) and *Centaurea diffusa* (diffuse knapweed) (Appendix A). *Centaurea diffusa* seeds are prominent in the seed banks of grazed sites and *Bromus tectorum* has large seed banks in both grazed and ungrazed sites (Clements et al. 2007). On severely disturbed sites, alien invasive plants such as *Bromus tectorum* and *Centaurea diffusa* may dominate (Clements et al. 2007); these sites are still recognizable by the presence of sandy soils and antelope-brush.

Species such as *Pseudoroegneria spicata*, a native bunchgrass preferred by livestock and sensitive to over-grazing (Daubenmire 1940), *Hesperostipa comata*, *Purshia tridentata* and *Selaginella* spp. have been depleted by grazing (Krannitz 2008). Conversely, the cover of *Sporobolus cryptandrus*, which is less preferred and more tolerant of grazing, has increased in cover, as have some native annuals including *Phacelia linearis* (thread-leaved phacelia)*, Polygonum douglasii* (Douglas' knotweed)*, Phlox gracilis* (pink twink) and alien invasive annuals including, *Draba verna* (common draba)*, Holosteum umbellatum* (umbellate chickweed)*,* and *Filago arvensis* (field filago) (Krannitz 2008)*.* The native perennials or biennials *Poa secunda* ssp. *secunda* (Sandberg's bluegrass), *Phlox longifolia* (long-leaved phlox)*, Arabis holboellii* (Holboell's rockcress)*,* and *Antennaria dimorpha* (low pussytoes) have increased with grazing by domestic livestock (Krannitz 2008).

The cover of the microbiotic crust has also been depleted by the mechanical damage of livestock trampling on sensitive sandy soils (Muscha and Hild 2006, Krannitz 2008). Atwood (1998) observed similar covers of crust in grazed and ungrazed areas, but increased cover of mosses and decreased cover of lichens and overall decreased number of species in areas with domestic livestock use.

The composition of the plant community may depend partly on soil texture (Krannitz 2008, Iverson pers. obs.2004-2009). The grass cover on very coarse sandy and gravely soils may be more dominated by *Hesperostipa comata* and finer-textured sandy soils may be more dominated by *Pseudoroegneria spicata* (Iverson pers. obs. 2004-2009). Similarly, Krannitz (2008) observed more *Selaginella* spp. on siltier soils and found that *Aristida purpurea* var*. longiseta* may also be

associated with siltier soils as it occurred more commonly with *Selaginella* spp. Atwood (1998) observed a higher cover of lichens in the microbiotic crust of sites with finer-textured soils. However, M. Ryan (pers. comm. 2010) hypothesised that *Pseudoroegneria spicata* is more prominent on later seral sites and *Hesperostipa comata* is a seral species.

1.3. Environment Description

The *Purshia tridentata* / *Hesperostipa comata* ecological community occurs from 280-760 m and in the hottest and driest climate in British Columbia. Mean annual precipitation is 284 mm; the mean annual temperature is 9.2°C (data for the BGxh1; Lloyd et al. 1990). This ecological community occurs most commonly on level to gently sloping terraces, but also on lower to upper slopes on all aspects along the edges of terraces. Soils are typically deep, rapidly drained and dominated by coarse sands, often with some gravel or cobblestones. Atwood (1998) observed sand content ranging from 69 to 94% at her sample sites. Soil moisture regimes are subxeric to very xeric. Soils are typically classified as Brown Chernozems. The humus form is characteristically a rhizomull. Parent materials are either deep glaciofluvial deposits, typically as terraced landforms, sometimes with aeolian veneers, or deeper aeolian deposits. Nutrient conditions are typically very poor or poor because of the sandy substrate (Lloyd et al. 1990).

1.4. Ecosystem Dynamics

The primary historical disturbances of *Purshia tridentata* / *Hesperostipa comata* ecological communities were fire and grazing by native ungulates. *Purshia tridentata* / *Hesperostipa comata* occurs in an area where there were frequent, low-intensity fires historically (Daigle 1996). There are no fire-frequency data available for *Purshia tridentata* / *Hesperostipa comata*, but wildfires were likely historically more common throughout antelope-brush habitats (Young and Clements 2002). Mean fire-return intervals for ponderosa pine forests in the United States vary from 2-15 years (Agee 1993); *Purshia tridentata* / *Hesperostipa comata* may have had similar fire-return intervals. Fires were likely ignited by both lightning and First Nations peoples. First Nations peoples used fire to improve root crops such as *Lewisia rediviva* (bitterroot), *Calochortus macrocarpus* (sagebrush mariposa lily), and *Balsamorhiza sagittata* (Daubenmire 1968, Pokotylo and Froese 1983, Turner 1994, Cannings and Durrance 1998). All of these species occur in *Purshia tridentata* / *Hesperostipa comata* ecosystems. Although lightning probably struck infrequently in antelope-brush ecosystems, mid-slope lightning strikes in the wooded slopes above could be carried into the valley bottom by night time down-slope winds.

Purshia tridentata is very susceptible to fire-kill; few plants re-sprout following fire (Zlatnik 1999). Most other native grassland plants are well adapted to fire because they can re-sprout from buds just at or below the ground surface where fire temperatures typically are lower (Daubenmire 1968). Often fire favours perennial forbs for at least a few years after a burn (Daubenmire 1968). Fuels for wildfires may have been variable in *Purshia tridentata* ecosystems on coarse-textured soils in valley bottoms, resulting in less frequent fires or patchy burns where many *Purshia tridentata* shrubs were not killed (Krannitz and Mottishaw 2003). Some *Purshia tridentata* plants may have survived fire or been skipped in a burn. Other shrubs could have re-established after a fire from seed (Shatford 1997). *Purshia tridentata* plants growing in fire refugia (dry, rocky sites) could have provided a seed source to re-establish *Purshia tridentata* in adjacent areas. Thus, the bunchgrass composition was probably only slightly changed by fires, forbs were perhaps more abundant for a few years after a fire, and *Purshia tridentata* cover may have been patchier, depending on the time between fires and how patchy the fire was in killing *Purshia tridentata* shrubs.

Historically, the principal grazing and browsing animals were likely *Odocoileus hemionus* (mule deer), *Cervus canadensis* (Rocky Mountain elk) and *Ovis canadensis californiana* (California bighorn sheep; Peek et al. 1978, Krannitz and Hicks 2000). They likely grazed in a similar pattern to their grazing patterns today, grazing forested areas in the summer and fall and grazing grasslands in spring and winter. Historical abundance of native ungulates is not known, but it is believed that it was not sufficient to cause overgrazing, except in localised areas, particularly during drought years (Tisdale 1947).

1.5. Spatial Pattern

Purshia tridentata / *Hesperostipa comata* is distributed on the coarse outwash plains and glaciofluvial terraces that dominate the lowest elevations of the South Okanagan Valley. It occurs below cliffs, rocky outcrops, and coniferous woodlands, and above lakes, wetlands, and cottonwood floodplains of the Okanagan River. Often occurrences are bisected by riparian communities along creeks and gullies that generally run perpendicular to the main valley. *Purshia tridentata* / *Hesperostipa comata* can be intermixed with the less abundant *Pinus ponderosa* / *Aristida purpurea* var*. longiseta* (ponderosa pine / red three-awn) in the very dry hot Bunchgrass zone (Lloyd et al. 1990). Historically, it occurred as a large patch ecosystem, dominating the lowest portions of the valley. Presently it is extensively fragmented by vineyards, orchards, rural and urban development, roads and Highway 97 (Lea 1996).

The historical spatial pattern of *Purshia tridentata* / *Hesperostipa comata* seral stages has been altered. Extensive domestic livestock grazing beginning in the 1800s and the spread of invasive alien plants has converted most areas to early or mid-seral plant communities. Historically the landscape was likely dominated by climax and late seral stages, with some areas slightly altered by low-intensity surface fires.

1.6. Special Significance

In Canada, this ecosystem occurs only in the south Okanagan Valley of British Columbia. Dyer and Lea (2003) and Dyer (2002) documented that this ecological community supported 88 red- and blue-listed species at risk including 33 invertebrates, 32 vertebrates, and 23 plants; 17 of these taxa had been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being threatened, endangered, or of special concern. Species experts reviewed the B.C. Conservation Data Centre *Purshia tridentata* / *Hesperostipa comata* element occurrences (B.C. Conservation Data Centre 2012b) for overlapping occurrences of provincial red- and blue-listed species (Table 1; A. Haney, pers. comm. 2012, J. Penny, pers. comm. 2012, M. Sarell, pers. comm. 2012, J. Heron, pers. comm. 2012). Table 1 also includes species associated with *Purshia tridentata* / *Hesperostipa comata* listed in the Sensitive Ecosystems Inventory of the Okanagan Valley (Iverson et al. 2008). Based on this review, 1 invertebrate species, 26 vertebrate species, and 13 plant species were identified as being associated with *Purshia tridentata* / *Hesperostipa comata*. Species associated with different ecological communities (e.g., pocket wetlands) in the *Purshia tridentata* / *Hesperostipa comata* representation area, or where only the element occurrence buffer distance overlapped with *Purshia tridentata* / *Hesperostipa comata* element occurrence, were eliminated from the list. These additional overlapping species are listed in Appendix B.

Table 1. Conservation status ranks for provincial red and blue-listed species and species federally assessed as threatened, endangered or of special concern associated with *Purshia tridentata / Hesperostipa comata* (B.C. Conservation Data Centre 2012a).

Scientific Name	Common Name	Provincial Status	COSEWIC Status
Invertebrates			
Callophrys affinis	Immaculate Green Hairstreak	S3	
Satyrium behrii	Behr's Hairstreak	S1	
Satyrium californica	California Hairstreak	S3	
Vertebrates			
Ambystoma mavortium	Blotched Tiger Salamander	S2	E
Ammodramus savannarum	Grasshopper Sparrow	S1S2B	
Antrozous pallidus	Pallid Bat	S2	T
Athene cunicularia	Burrowing Owl	S1B	E
Buteo regalis	Ferruginous Hawk	SNRN	T
Chondestes grammacus	Lark Sparrow	S2B	
Chordeiles minor	Common Nighthawk	S4B	T
Coluber constrictor	Racer	S3	SC
Crotalus oreganus	Western Rattlesnake	S3	T
Falco mexicanus	Prairie Falcon	S1S2B	
Hypsiglena chlorophaea	Desert Night Snake	S1	E
Lepus townsendii	White-tailed Jackrabbit	SH	
Melanerpes lewis	Lewis's Woodpecker	S2B	T
Myotis ciliolabrum	Western Small-footed Myotis	S2S3	
Myotis thysanodes	Fringed Myotis	S2S3	Data Deficient
Ovis canadensis	Bighorn Sheep	S3	
Perognathus parvus	Great Basin Pocket Mouse	S2	
Phrysoma douglasii	Pygmy Short-horned Lizard	SX	Extirpated
Pituophis catenifer deserticola	Gopher Snake, deserticola subspecies	S2S3	T
Plestiodon skiltonianus	Western Skink	S3	SC
Reithrodontomys megalotis	Western Harvest Mouse	S2S3	SC
Sorex merriami	Merriam's Shrew	S1	
Sorex preblei	Preble's Shrew	S1S2	
Spea intermontana	Great Basin Spadefoot	S3	T
Sylvilagus nuttallii	Nuttall's Cottontail	S3	SC
Taxidea taxus jeffersoni	*Jeffersoni* American badger	S1	E
Plants			
Achnatherum thurberianum	Thurber's needlegrass	S1	
Astragalus sclerocarpus	The Dalles milk-vetch	S2	
Brickellia oblongifolia ssp. *oblongifolia*	narrow-leaved brickellia	S2S3	
Bryoerythrophyllum columbianum	Columbian carpet moss	S2S3	SC
Chamaesyce serpyllifolia ssp. *serpyllifolia*	thyme-leaved spurge	S2S3	
Cryptantha celosioides	cockscomb cryptantha	S1	
Cuscuta campestris	field dodder	S2S3	
Erigeron poliospermus var. *poliospermus*	cushion fleabane	S2S3	
Gilia sinuata	shy gilia	SH	
Oenothera pallida ssp. *pallida*	pale evening-primrose	S1	
Orthocarpus barbatus	Grand Coulee owl-clover	S2	E

Scientific Name	Common Name	Provincial Status	COSEWIC Status
Sphaeralcea coccinea	scarlet globe-mallow	S1	
Sphaeralcea munroana	Munroe's globe-mallow	SH	

Although most invertebrates have not been formally evaluated, Scudder (1996) noted that 104 species of rare invertebrates are confined to this ecological community. Within Canada, 72 of these rare invertebrates are found only in south Okanagan antelope-brush ecological communities (Scudder 1996). This ecological community is considered critical habitat for Behr's hairstreak (*Satyrium behrii*), which relies on antelope-brush as a larval host-plant (Southern Interior Invertebrates Recovery Team 2008).

Orthocarpus barbatus (Grand Coulee owl clover) has only five known populations in B.C., several of which are associated with this ecological community (Southern Interior Rare Plants Recover Team 2007). This ecosystem supports one of the highest densities of species-at-risk of any habitat in British Columbia.

This ecosystem has been assigned priority one under the B.C. Conservation Framework goal one to "contribute to global efforts for species and ecosystem conservation" (B.C. Conservation Framework 2012).

2. Distribution

2.1. North American Range

Purshia tridentata / Hesperostipa comata occurs in the Columbia Basin and Owyhee Uplands of western Idaho, central and eastern Washington, eastern Oregon, and in the southernmost portion of the Okanagan Valley in British Columbia (Lea et al. 2004).

2.2. Canadian Range

Within Canada, *Purshia tridentata / Hesperostipa comata* only occurs in the southernmost portion of the Okanagan Valley in British Columbia from the United States border north to Penticton (Figures 3, 4).

2.3. British Columbia Range

Within British Columbia, *Purshia tridentata / Hesperostipa comata* only occurs in the southernmost portion of the Okanagan Valley. It occurs within the following classification units and jurisdictions:

Ecosection: Southern Okanagan Basin

Biogeoclimatic units: BGxh1, PPxh1

Ministry of Forests, Lands and Natural Resource Operations Region: Thompson/Okanagan

Forest District: Okanagan Shuswap (DOS)

Regional District: Okanagan-Similkameen (RDOS)

Ministry of Environment Region: 8 - Okanagan

2.4. Distribution Map

The potential range of *Purshia tridentata* / *Hesperostipa comata* within British Columbia is shown in Figure 3. The historical distribution of *Purshia tridentata* / *Hesperostipa comata* within British Columbia in 1800 (based on data used for Lea 2008) is overlaid with the range of *Purshia tridentata* / *Hesperostipa comata* in 2008 (from Iverson and Haney 2010a) and shows a much reduced range (Figure 4).

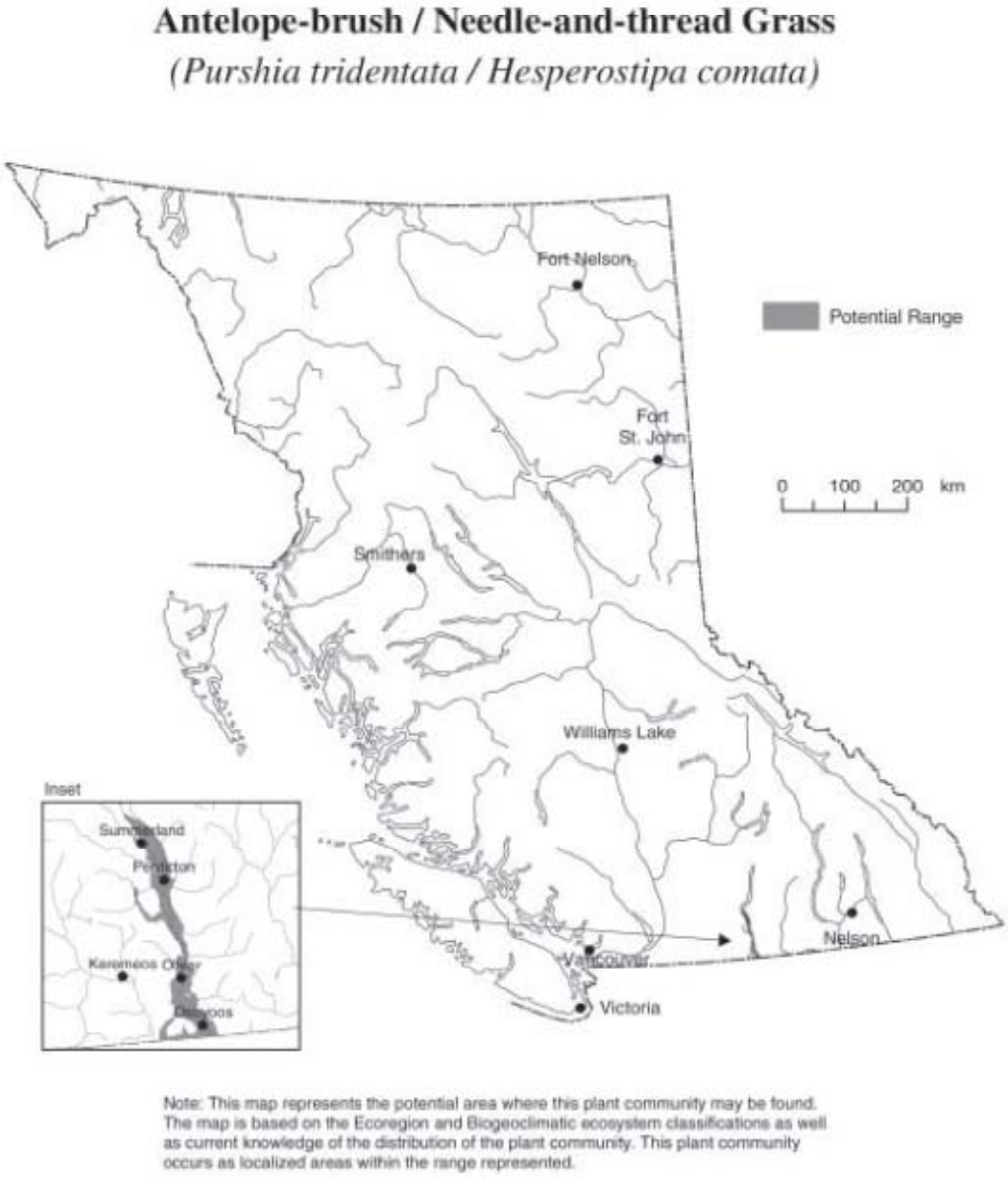

Figure 3. Potential range of *Purshia tridentata* / *Hesperostipa comata* ecological community in British Columbia (from Lea et al. 2004).

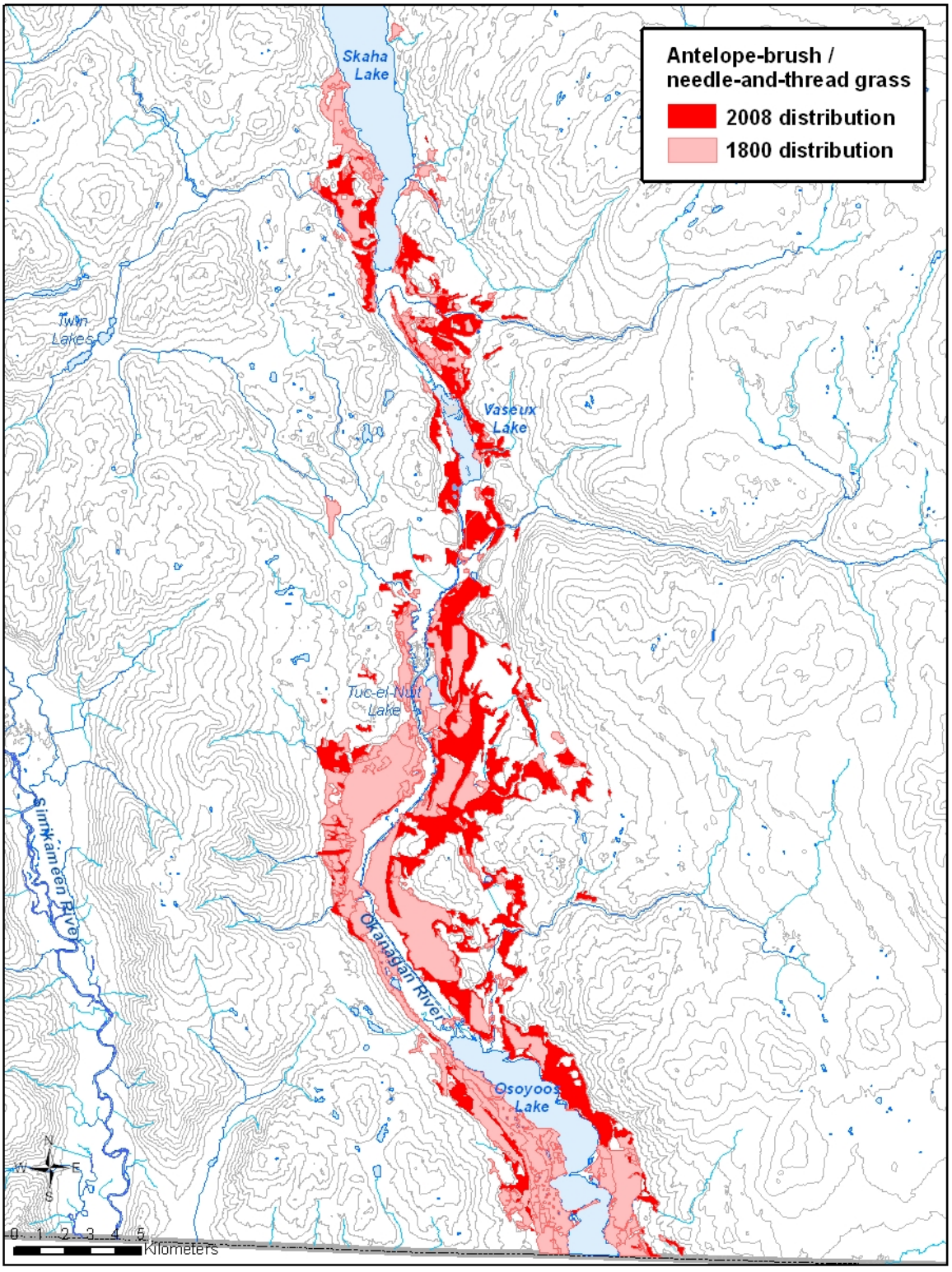

Figure 4. Historical (1800 - pink) and 2008 (red) distribution of *Purshia tridentata* / *Hesperostipa comata* in BC. Map is derived from data associated with Lea (2008) for 1800 and Iverson and Haney (2010a) for 2008. All polygons containing *Purshia tridentata* / *Hesperostipa comata* are shown; portions of some polygons are occupied by other ecological communities.

2.5. Search Effort/Map Analysis

The entire range of *Purshia tridentata / Hesperostipa comata* in British Columbia has been mapped using Biophysical Ecosystem mapping and non-spatial data were updated to the current Terrestrial Ecosystem Mapping standard (Resources Inventory Committee 1998; Iverson and Haney 2010a, 2010b). Additional field verification was completed within this ecosystem mapping in 2005 and the mapping is considered very reliable for this ecosystem (Iverson et al. 2005). The mapping was updated for new occurrences of agricultural and urban development in 2009 based on 2008 orthophotos (Iverson and Haney 2010a). The area of occupancy is considered reliable for 2008. Polygons mapped as *Purshia tridentata / Hesperostipa comata* (map code AN) were extracted from this data. Historical mapping of the distribution of this ecosystem prior to European settlement was used for the historical area of occupancy (Lea 2008).

3. Rarity

3.1. Range Extent

Within British Columbia, *Purshia tridentata / Hesperostipa comata* occurs within an area of 254 km^2 (derived from Iverson and Haney 2010a).

3.2. Area of Occupancy

Within British Columbia, *Purshia tridentata / Hesperostipa comata* occupies 32 km^2. The ecosystem mapping covering the range of *Purshia tridentata / Hesperostipa comata* was updated in 2009 based on orthophotos dating from 2008. Thus the area of occupancy is considered accurate for 2008.

3.3. Area of Occupancy with Good to Excellent Ecological Integrity

Ecological integrity[2] assessment of element occurrences[3] is comprised of three factors: abiotic and biotic condition[4], size, and landscape context (NatureServe 2002). Criteria for assessing these factors and calculating ecological integrity are provided in the element occurrence specification for *Purshia tridentata / Hesperostipa comata* (Cadrin and Iverson 2012). In the assessment these three factors are weighted by priority in the following sequence: (1) condition, (2) size, and (3) landscape context.

---

[2] Ecological integrity is defined as "the likelihood that if current conditions prevail an occurrence will persist for a defined period of time, typically 20-100 years" (NatureServe 2002) and more recently has been defined as "the structure, composition, and function of an ecosystem operating within the bounds of natural or historic disturbance regimes" (Rocchio and Crawford 2011). The element occurrence rank reflects the "degree of negative anthropogenic impact to a community (i.e., the degree to which people have directly or indirectly adversely impacted community composition, structure, and/or function, including alteration of natural disturbance processes)." (NatureServe 2002).

[3] An element occurrences is "an area of land and/or water in which a species or ecological community is, or was present". http://www.env.gov.bc.ca/atrisk/glossary.html

[4] "Condition is an assessment of the biotic and abiotic composition, structure, and ecological function of the ecological community. Condition can be thought of as the degree of departure from the structure, function, and distribution of late seral ecological communities prior to European settlement. Successional stage, stability, ecological processes, disturbance regimes, alteration of physical or chemical processes, and changes in species composition are all factored in to the assessment of condition." (Ministry of Environment Ecosystems Branch 2006)

The B.C. Conservation Data Centre (CDC) has mapped 72 element occurrences of *Purshia tridentata / Hesperostipa comata.* None have excellent ecological integrity, 7 have good ecological integrity, 38 have fair ecological integrity and 27 have poor ecological integrity. Most of the area of element occurrences is in fair to good ecological integrity (Table 2; B.C. Conservation Data Centre 2012b).

Table 2. Area of *Purshia tridentata / Hesperostipa comata* element occurrences (ha) by ecological integrity class (B.C. Conservation Data Centre 2012b).

Ecological Integrity Class	Area (ha)	Percent of total
Poor	152	4.7
Fair	1327	41.3
Good	1734	54.0
Excellent	0	0.0
Total	3214	100

3.3.1. Historical context of Ecological Integrity Results

Human history has influenced the condition, size, and landscape context of the remaining element occurrences of *Purshia tridentata / Hesperostipa comata.*

Following the discovery of gold in British Columbia, low-priced land encouraged land settlement and ranchers from western Oregon to come to the dry interior valleys of British Columbia (Mather 1996). The deterioration of the grassland condition due to over-grazing was first recognised in the 1870s (Mather 1996). The construction of the Canadian Pacific Railway in the early 1880s brought a new market for cattle and resulted in increased human settlement. Forage crops were cultivated for winter feed for cattle and this seed for forage crops introduced seeds of invasive alien plants (Mather 1996). The condition of *Purshia tridentata / Hesperostipa comata* has been strongly influenced by invasive alien plants. Many areas have been overtaken by knapweed and introduced annual brome grasses such as *Bromus tectorum*; many other invasive alien plants are present and new ones continue to appear.

Domestic grazing has influenced condition through reduced cover of more grazing-sensitive species such as *Pseudoroegneria spicata* to more grazing-resistant native grasses such as *Hesperostipa comata* and *Poa secunda* ssp. *secunda* (Sandberg's bluegrass) (Daubenmire 1940, Dormaar et al.1989, McLean and Wikeem 1985, Krannitz 2008). Domestic grazing probably also increases the susceptibility of the site to the introduction and spread of invasive alien plants (Clements et al. 2007). Improvements in range management and shifts to grazing of higher elevations have allowed some recovery; however, the hot, dry climate and moisture- and nutrient-limiting soils make recovery very slow. Sites that have been ungrazed for nearly 20 years still show signs of grazing disturbance compared to sites ungrazed for more than 70 years (Krannitz 2008). However, some areas (128 ha) that appeared to be abandoned fields on aerial photographs taken in 1984 had recovered substantial cover of *Purshia tridentata* based on aerial photographs taken in 2008 (Iverson and Haney 2010a, 2010b).

Fire regimes have been altered through extensive livestock grazing, fire suppression, and the spread of alien invasive plants. Both cattle and horse grazing removed the fine fuels from native bunchgrasses and effectively excluded fire from some areas where grazing levels were severe (Madany and West 1980, Moore et al.1999). *Bromus tectorum* is often the primary fuel source in

many present-day antelope-brush ecosystems (Clements et al. 2007, Krannitz 2008). It cures much earlier in the year than native bunchgrasses, thus *Purshia tridentata* and native bunchgrasses may now be much more susceptible to extensive fire-kill in areas with dense cheatgrass (Krannitz and Mottishaw 2003). Fire suppression has allowed trees to encroach onto some sites and reduced nutrient input into soils (Turner and Krannitz 2001).

The size and landscape context of *Purshia tridentata* / *Hesperostipa comata* has been primarily influenced by land conversion. In the early 1900s most of the large ranches in the Okanagan were sold to development companies for conversion to orchards (Mather 1996). Today, many areas are being converted to vineyards and industrial, rural, and urban development (Lea 2008). This has resulted in fragmented occurrences of *Purshia tridentata* / *Hesperostipa comata* either partially or wholly surrounded by altered landscapes.

3.3.2. Condition Factor

The condition of *Purshia tridentata* / *Hesperostipa comata* (Tables 3 and 4) has been severely reduced by the following primary influences: disturbance by domestic livestock, alterations to fire regimes, and the spread and continued introduction of invasive alien plants (Figure 5).

Table 3. Area of remaining *Purshia tridentata* / *Hesperostipa comata* element occurrences (ha) by condition class (B.C. Conservation Data Centre 2012b).

Condition Class	Area (ha)	Percent of total
Poor	561	17.5
Fair	2524	78.5
Good	129	4.0
Excellent	0	0.0
Total	3214	100

Table 4. Area of remaining *Purshia tridentata* / *Hesperostipa comata* TEM polygons (ha) by condition class (Iverson and Haney 2010a).

Condition Class	Area (ha)	Percent of total
Poor	694	21.6
Fair	2295	71.3
Good	224	7.0
Excellent	4	0.1
Total	3217	100

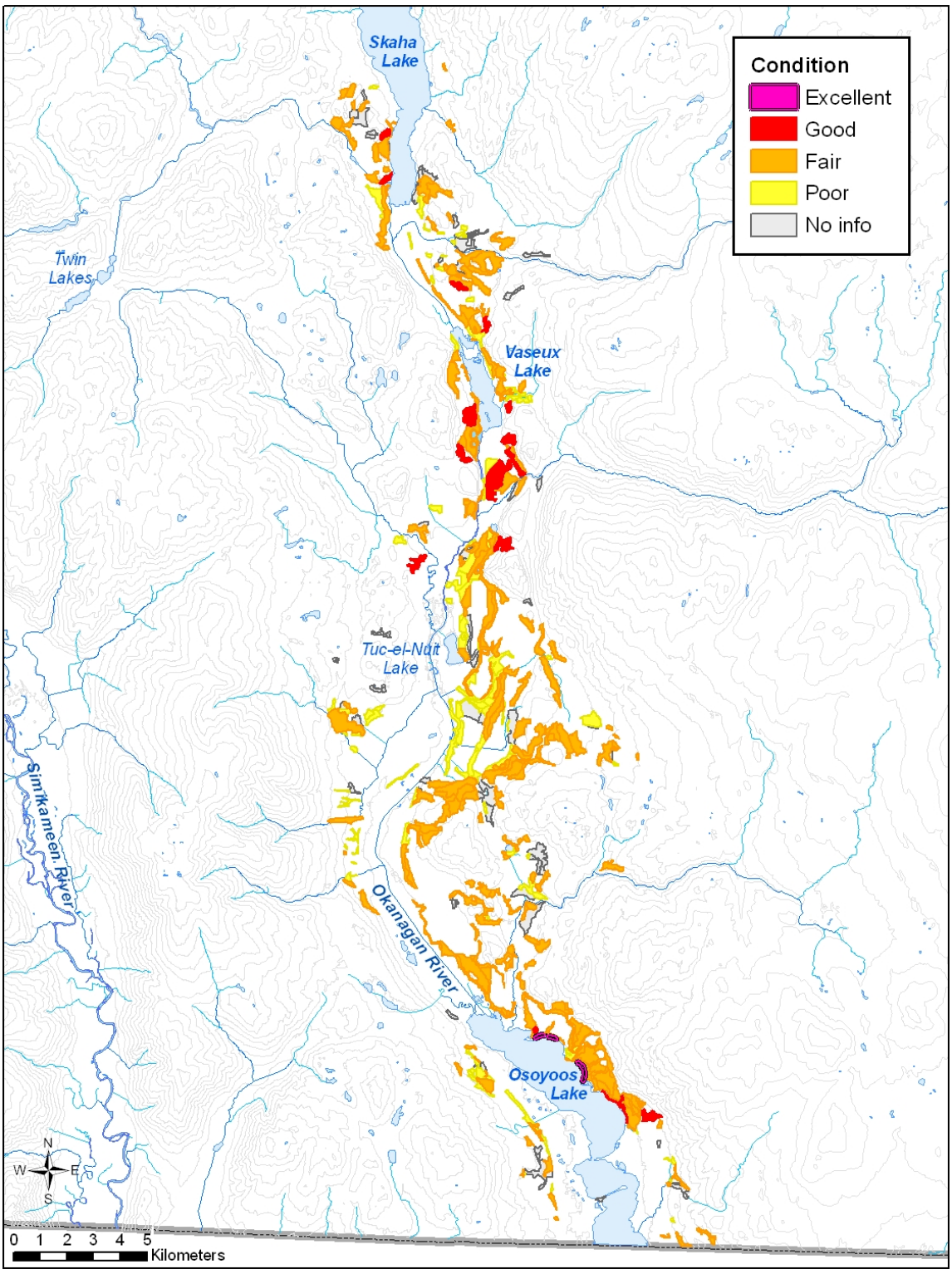

Figure 5. Current (2005) mapped condition of Terrestrial Ecosystem Mapping (TEM) polygons mapped as *AN* (antelope-brush / needle-and-thread grass) within B.C. Condition on the map reflect the condition of the first component of a TEM polygon. Polygons with 'no info' are those where *AN* was the second or third component of the polygon. Polygons were derived from Iverson and Haney (2010a); condition was mapped in 2005 (Iverson et al. 2005).

3.3.3. Size Factor

Size is represented by the area (ha) of each element occurrence. Large to very large sizes are considered to increase the chances of long-term ecological integrity. Sizes of individual element occurrences have been influenced by fragmentation, and conversion of occurrences to urban, rural and agricultural development. More than half of the area of this ecological community remains in very large occurrences (Table 5).

Table 5. Area of *Purshia tridentata* / *Hesperostipa comata* element occurrences (ha) by size class (B.C. Conservation Data Centre 2012b).

Size Class	Area (ha)	Percent of total
Small (<10 ha)	118	3.7
Average (10-50 ha)	573	17.8
Large (51-100 ha)	639	19.9
Very Large (>100 ha)	1883	58.6
Total	3214	100

3.3.4. Landscape Context Factor

The assessment of landscape context is an integrated measure of the biology, processes and disturbances in the landscape surrounding each element occurrence, and the level of influence these have on the long-term existence of the occurrence (NatureServe 2002). Successional stage, changes in species composition of the surrounding natural ecosystems, proportion of anthropogenic conversion in the landscape, fragmentation of the area by transportation corridors, converted areas, and whether or not the natural disturbance regime is maintained in the region, are all factored into the assessment of landscape context. Most of the area of this ecosystem have fair to good landscape context (Table 6).

Table 6. Area of *Purshia tridentata* / *Hesperostipa comata* element occurrences (ha) by landscape context class (B.C. Conservation Data Centre 2012b).

Landscape Context Class	Area (ha)	Percent of total
Poor	138	4.3
Fair	1462	45.5
Good	1615	50.2
Excellent	0	0.0
Total	3214	100

3.4. Environmental Specificity

Environmental Specificity is defined as the dependency of an ecosystem on certain climates, topographic conditions, soil characteristics and/or regular natural disturbance regimes (Master et al. 2009). *Purshia tridentata* / *Hesperostipa comata* is quite specific to a particular substrate (coarse, sandy glaciofluvial or aeolian deposits), is specific to a hot, dry climate, and dependant on some periodic low intensity fire disturbance (see Section 5.2). This ecological community's environmental specificity is ranked *Narrow: Community with a narrowly distributed requirement that is relatively common within its distribution* (B.C. Conservation Data Centre 2012c).

4. Trends

4.1. Long-term Trend

Long-term trend is the degree of past directional change (%) in extent of occurrence, area of occupancy, number of occurrences, and/or ecological integrity of occurrences over a long time period (ca. 200 years) (Faber-Langendoen et al. 2009, Master et al. 2009). The southern Okanagan Valley has a long history of agricultural and urban development. Most of the lands with *Purshia tridentata / Hesperostipa comata* are unprotected, allowing a diversity of land uses which may contribute to continued degradation, losses and fragmentation.

Lea (2008) reported that there were approximately 9895 ha of *Purshia tridentata / Hesperostipa comata* in 1800. The area mapped by Lea (2008) was adjusted to 9863 ha based on two updates to the mapping. In 2005,190 ha of *Purshia tridentata / Hesperostipa comata* were re-identified as sagebrush steppe (Iverson et al. 2005). In 2009, 128 ha were newly identified as *Purshia tridentata / Hesperostipa comata* (Iverson and Haney 2010a and 2010b). This included some areas previously mapped as dry pastures/cultivated fields that had recovered some cover of *Purshia tridentata*. It also included some small occurrences of *Purshia tridentata / Hesperostipa comata* that were recently delineated as separate polygons. Previously these areas were too small to be included in the polygon label. This resulted in a net area of 62 ha subtracted from the Lea (2008) area estimate. There were an estimated 3217 ha of *Purshia tridentata / Hesperostipa comata* remaining in 2008 representing a loss of 67% of the original extent of this ecological community (Figure 6).

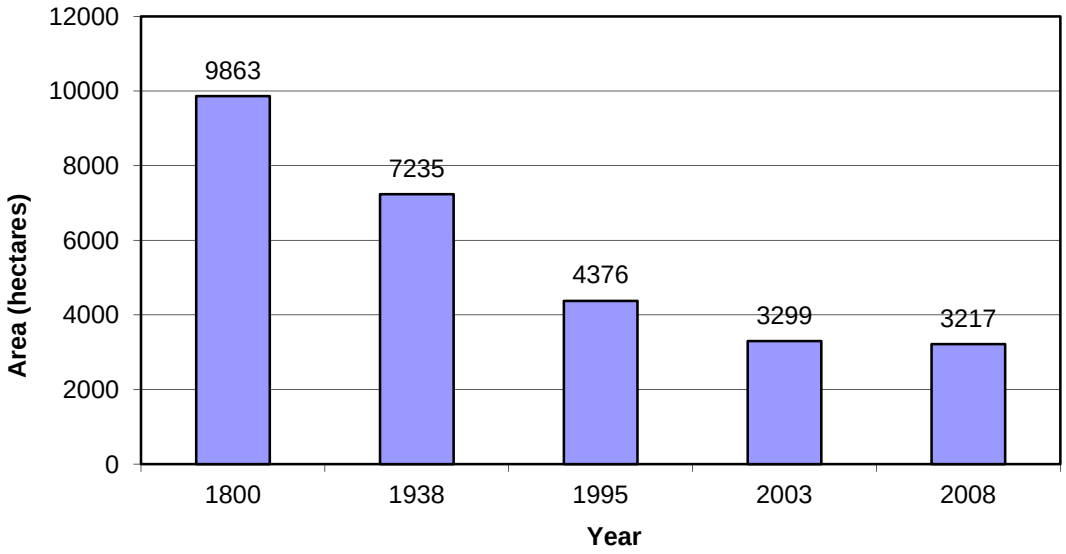

Figure 6. Area (ha) of *Purshia tridentata / Hesperostipa comata* ecological community mapped in British Columbia for the years 1800, 1938, 1995, 2003, and 2008. Sources: Lea (2008, adjusted) and Iverson and Haney (2010a).

Purshia tridentata / Hesperostipa comata has already been extensively fragmented. Continuing losses will further fragment and degrade remaining areas. Contributing factors include climate change, recreation use, extensive linear corridors such as roads, and projected long-term trends for invasive alien plants. Most lands formerly occupied by *Purshia tridentata / Hesperostipa comata*

have been converted to agricultural (79%) and urban areas (14%) (Table 7). The Long-Term Trend Score is a substantial decline of 50-75% (B.C. Conservation Data Centre 2012c).

Table 7. Percent of historical *Purshia tridentata / Hesperostipa comata* conversion into different land uses. Data were derived by overlaying mapping by Iverson and Haney (2010a) to the area of historical (1800) *Purshia tridentata / Hesperostipa comata* data associated with Lea (2008).

Current Land Use	Percent of total area lost since 1800
Cultivated field	17
Orchard	40
Vineyard	22
Urban	14
Rural	2
Roads	2
Miscellaneous (exposed soil, gravel pits, mines)	2
Golf Courses	1

4.2. Short-term Trend

Short-term trends are the degree (%) of past directional change in extent of occurrence, area of occupancy, number of occurrences, and/or ecological integrity of occurrences in the short term, considered to be typically within 30 years for shrub steppe and grassland ecological communities (Faber-Langendoen et al. 2009, Master et al. 2009). The short-term trend for *Purshia tridentata / Hesperostipa comata* is continued loss. From 1995 to 2008 there was a 26% loss of *Purshia tridentata / Hesperostipa comata* (Figure 6). The BC CDC Short-Term Trend Score is Declining (10-30%) (B.C. Conservation Data Centre 2012c).

4.3. Predicted Future Declines

Purshia tridentata / Hesperostipa comata occurs in a climate and on soils highly desirable for vineyards. Additionally the population of the Okanagan Valley continues to grow, placing continued settlement pressures on this ecological community. From 1995 to 2008, 1159 ha of *Purshia tridentata / Hesperostipa comata* were lost, representing a rate of about 90 ha per year. This is projected to continue into the future until the ecological community may be extirpated on all unprotected sites.

5. Threats and Limiting Factors

5.1. Threat Impact

There are numerous threats to *Purshia tridentata / Hesperostipa comata*. Threat scope, severity, impact, and timing are summarized using the International Union for Conservation of Nature (IUCN) and Conservation Members Partnership (CMP) Threat Classification (Salafsky et al. 2008, IUCN 2009) (Table 8). The combined overall threat impact was calculated using the NatureServe rank calculator (NatureServe 2012) as Very High to High (C. Cadrin pers. comm. 2012, O. Dyer pers. comm. 2012).

The primary overall threat to *Purshia tridentata / Hesperostipa comata* is the continued loss, degradation and fragmentation of occurrences. Areas of *Purshia tridentata / Hesperostipa comata*

are rapidly being converted to vineyards as the ecological community is considered an indicator for high grape crop production and are targeted by the wine industry for development (O. Dyer, pers. comm. 2010). Continued human population growth also threatens this community with conversion to rural and urban development.

There has been extensive habitat degradation through ongoing livestock grazing, fire suppression, and the spread of alien invasive plants. Cattle and horse grazing remove fine bunchgrass fuels, disturb soils and the microbiotic crust, and alter plant species composition (Madany and West 1980, Atwood 1998, Moore et al.1999, Krannitz 2008). Reduced cover of microbiotic crust can also reduce the establishment and survival of *Purshia tridentata* seedlings and trampling by cattle, horses and deer can kill seedlings (Shatford 1997).

With many years of fire suppression and the spread of alien invasive plants, wildfires can be detrimental to *Purshia tridentata / Hesperostipa comata*. *Bromus tectorum*, often the primary fuel source in some present-day *Purshia tridentata* ecosystems, cures early and burns intensely killing many *Purshia tridentata* shrubs and native bunchgrasses (Clements et al. 2007). After a fire, *Bromus tectorum* reduces the establishment of native bunchgrasses (Krannitz and Mottishaw 2003) and *Purshia tridentata* (Updike et al. 1990), primarily by sequestering moisture early in the spring (Melgoza et al. 1990). However, some intense fires may reduce the cover of *Bromus tectorum* for a few years after a fire and allow for the establishment of native bunchgrasses, as documented at the Haynes lease ecological reserve (burned by a wildfire in 1993; Krannitz and Mottishaw 2003). If the fire is very intense, it may eliminate *Purshia tridentata* shrubs from the site and re-establishment will then depend on the distance from an existing seed source. On level sites, *Perognathus parvus* (pocket mice) are the key agent of dispersal for the seeds of *Purshia tridentata* (Shatford 1997), which means the seeds will be dispersed a maximum of 50m from the shrub that produced the seeds (Longland and Clements 1995). This may prevent the regeneration of *Purshia tridentata* on isolated sites severely burned by fires. *Purshia tridentata* shrubs are more likely to re-sprout if fire occurs during a cooler season or when shrubs have higher moisture content (Zlatnik 1999). After an intense fire, sites are more susceptible to the introduction and spread of alien invasive plants (Iverson, pers. obs. 2006). Fire suppression can also alter the site by facilitating the encroachment of ponderosa pine trees (Turner and Krannitz 2001). On sites that have not been burned for decades *Purshia tridentata* shrubs can become decadent with increased amounts of dead wood, declining seed production, fewer seedlings and eventual death of some shrubs (Young and Clements 2002, Krannitz and Mottishaw 2003). *Purshia tridentata* shrubs with more dead wood are more likely to burn completely in a fire (Krannitz and Mottishaw 2003).

Recreational use, particular all terrain vehicles (ATVs) or off-road vehicles have severely damaged some sites with *Purshia tridentata / Hesperostipa comata* (O. Dyer, pers. comm. 2012). Sandy soils are readily disturbed and vehicles can also transport alien invasive plants. Site degradation has resulted in 46% of the area of *Purshia tridentata / Hesperostipa comata* with fair to poor ecological integrity (see Section 3.3; Table 2). Site degradation and fragmentation is likely to continue given the extent of threats (Table 8).

Table 8. Impact, scope, severity and timing of threats to *Purshia tridentata / Hesperostipa comata*.

Threat and sub-threat		Impact (calculated)		Scope	Severity	Timing	Comments
1	Residential & commercial development	D	Low	Small	Extreme	High	The scope of the ongoing threats of rural, urban, and suburban residential
1.1	Housing & urban areas	D	Low	Small	Extreme	High	

Threat and sub-threat		Impact (calculated)		Scope	Severity	Timing	Comments
							developments is small. However small, the threat will continue to deplete the extent of the ecological community, further fragment it, and reduce ecological integrity.
2	Agriculture & aquaculture	BD	High - Low	Pervasive	Serious - Slight	High	Vineyard development and expansion are a
2.1	Annual and perennial non-timber crops	D	Low	Small	Extreme	High	major threat to this ecological community.
2.3	Livestock farming & ranching	CD	Medium-Low	Pervasive	Moderate - Slight	High	Livestock farming & ranching is pervasive on public, private and Indian Reserve lands. The severity is based on the intensity of grazing which can be high in some areas. This results in moderate degradation in some areas and slight degradation where grazing intensity is low (Krannitz 2008).
6	Human intrusions & disturbance	CD	Medium - Low	Restricted - Small	Serious	High	Recreation impacts include motorized activities such as ATV
6.1	Recreational activities	CD	Medium-Low	Restricted - Small	Serious	High	riding occur primarily on crown land, Indian Reserve and private lands that do not restrict access or use ATVs as part of a ranching operation. Soils are very sensitive to disturbance. Impacts are severe at some sites such as Oliver Mountain and have a serious impact when only a few sites are protected (O. Dyer pers. comm., 2010).

Threat and sub-threat		Impact (calculated)		Scope	Severity	Timing	Comments
7	Natural system modifications	CD	Medium - Low	Restricted	Serious - Slight	High	Fire frequency has been reduced by fire
7.1	Fire & fire suppression	CD	Medium - Low	Restricted	Serious - Slight	High	suppression and fire intensity is more severe in some areas with the spread of cheatgrass. Turner and Krannitz (2001) demonstrated post-settlement increased conifer densities and reduced fire frequency within the BGxh1. Although fire suppression is pervasive, its effects are slight and thus the threat rating is based primarily on the more serious affects of intense wildfires.
8	Invasive & other problematic species & genes	BC	High - Medium	Pervasive	Serious - Moderate	High	Cheatgrass and diffuse knapweed are widespread. Areas with
8.1	Invasive non-native/alien species	BC	High - Medium	Pervasive	Serious - Moderate	High	dense cheatgrass can result in severe fire effects. Sites disturbed by livestock grazing, off-road vehicles and other recreational uses are very vulnerable to the spread of invasive plants. The ecosystem is highly fragmented and crossed by numerous linear corridors such as roads, pipelines, and power lines, all of which tend to be conduits for the spread of invasive plants.
11	Climate change & severe weather	D	Low	Pervasive	Slight	High	Multiple effects of climate change including changing temperature,
11.1	Habitat shifting & alteration	D	Low	Pervasive	Slight	High	rainfall and drought. Climate change may exacerbate invasive plant spread. Drought may be more common, increasing the frequency and severity of fires. Habitats could expand to a few suitable sites.

5.2. Intrinsic Vulnerability

Purshia tridentata / Hesperostipa comata ecological communities are considered moderately vulnerable to disturbance (B.C. Conservation Data Centre 2012c). Recovery after disturbance is expected to occur between 10 and 100 years, depending on nature of disturbance and restoration actions. This vulnerability is primarily due to the soil characteristics of the sites and the integrity of

the microbiotic crust on the soil surface. The microbiotic crust facilitates the absorption and retention of moisture from both rain and snowmelt, and acts as a barrier to evaporation at the soil surface. Breaching of the soil crust, and exposure to the mineral soil beneath, results in these sandy soils being easily disturbed and eroded by wind and water and by any activity disturbing the surface of the soil. The hot, dry climate and the slow recovery of plant species that occur in the climax plant community makes recovery from any disturbance slow and restoration difficult (Atwood and Scudder 2003). This slow recovery increases the susceptibility to invasive alien plants, which tend to germinate readily in exposed mineral soil and subsequently outcompete the native perennial species requiring increased soil moisture retention (Melgoza et al. 1990, Symonds 2011).

This ecological community is also intrinsically vulnerable because its natural fire regime can no longer be restored or mimicked in most occurrences. The close proximity of human settlement, and the unnaturally high fuel loads in dense adjacent forests make the use of prescribed fire too costly, risky, and unpopular with local residents. Changes in fuels such as the presence of *Bromus tectorum*, which will burn earlier and hotter than native grasses, and the reduction of bunchgrass fuels through grazing would create more variable fire effects in this ecological community. However, prescribed fires in cool seasons can mimic some natural fire effects and reduce vulnerability to wildfires (Krannitz and Mottishaw 2003). Some areas of the ecological community have been degraded by very hot uncontrolled fires fuelled by higher covers of *Bromus tectorum* that have further promoted the expansion of invasive alien plants such as *Bromus tectorum* and the loss of most *Purshia tridentata* shrubs (Krannitz and Mottishaw 2003, Iverson pers. obs. 2004).

6. Climate Change Vulnerability

No direct information is available for the vulnerability of *Purshia tridentata* / *Hesperostipa comata* to climate change. The Province of B.C. has broadly assessed interior grasslands as being vulnerable to climate change through loss of vegetation to summer drought, soil impacts including desertification erosion, and disturbance regime impacts through increased fire frequency, soil erosion, and increases in invasive plant species (FFEI Vulnerability Assessment Working Group 2009). However, the vulnerability of an ecosystem to climate change can be estimated by looking at its exposure to climate change, its sensitivity to climate change, and its adaptive capacity to respond to climate change (Comer et al. 2012).

The exposure of *Purshia tridentata* / *Hesperostipa comata* to climate change can be looked at broadly within the exposure of southern interior of BC to climate change (summarized in Utzig and Holt 2009). In the southern interior of BC climate change is predicted to result in a longer fire season, particularly in the spring, and larger and more severe fires resulting from warmer drier conditions. Invasive alien plant species are expected to increase in number and density after fire events. The growing season is predicted to lengthen, but with reduced growing season moisture availability. Grasslands are predicted to shift to desert conditions and modelling suggests the expansion of shrub steppe ecosystems into what now supports open woodland ecosystems. Thus, the area that could potentially support *Purshia tridentata* / *Hesperostipa comata* is unlikely to decrease by 2050. However, the substrate required for the ecological community will prevent range expansion upwards in elevation where there are fewer and less continuous occurrences of sandy glaciofluvial and aeolian deposits, and northwards, where materials shift from glaciofluvial to fine-textured glaciolacustrine. Anthropogenic barriers such as urban settlements and agricultural developments will also limit its expansion. Some expansion is possible within the southern

Okanagan Valley into the *Pinus ponderosa* / *Purshia tridentata* / *Aristida purpurea* (ponderosa pine / antelope-brush / red three-awn) site series (BGxh1/04; Lloyd et al. 1990) There were 823 ha of this site series remaining in 2008 (based on mapping by Iverson and Haney 2010a). This site series occurs on the same substrate in the same ecological zones. It may represent areas of *Purshia tridentata* / *Hesperostipa comata* that have been encroached by ponderosa pine trees over the more than 100 years of fire exclusion. With climate warming these sites may not be able to support trees. Turner and Krannitz (2001) documented increased density of *Pinus ponderosa* on unburned sites in the BGxh1 from 1938 to 1996 supporting this hypothesis.

There is also some possibility for expansion in the Similkameen Valley. The *Artemisia tridentata* / *Hesperostipa comata* (big sagebrush / needle-and-thread grass) map unit (SN) occurs on similar substrates to *Purshia tridentata* / *Hesperostipa comata* within the BGxh1 and PPxh1 in the Similkameen Valley (Lloyd et al. 1990). There were 746 ha of this ecosystem remaining in 2008 (Iverson and Haney 2010a). Where *Purshia tridentata* plants occur adjacent to the Similkameen River near the US border and further up-river, there is a possibility for expansion of *Purshia tridentata* to create *Purshia tridentata* / *Hesperostipa comata* occurrences (T. Lea, pers. comm. 2010).

Increased vulnerability to wildfires is likely. Fire effects are likely to be more severe than historically. If fire seasons extend further into spring, as predicted, *Purshia tridentata* / *Hesperostipa comata* would be very vulnerable to severe fire effects as native plant species are much more vulnerable to fire-kill and fire damage at this time of year than invasive species such as *Bromus tectorum*.

Reduced growth of native bunchgrasses resulting from a longer, hotter summer would increase the vulnerability of the ecological community to damage by domestic grazing. The overall reduced condition of these ecological communities likely reduces their capacity to respond to climate change. Some occurrences may be vulnerable to intensive storm events through soil erosion or through flooding on adjacent creeks or rivers. Other possible effects include reduced pollination of some component species, and possible reduced fall seed germination of native plants under drought conditions.

7. Protection, Status, and Ranks

7.1. Legal Protection and Status

Purshia tridentata / *Hesperostipa comata* is legally designated in British Columbia as Identified Wildlife under the *Forest and Range Practices Act* (BC Ministry of Water, Land and Air Protection 2004). Under this Act, Wildlife Habitat Areas (WHAs) can be defined which provide some protection from range activities. Currently there are eight WHAs that protect 176 ha of *Purshia tridentata* / *Hesperostipa comata*.

7.2. Non-Legal Status and Ranks

Global status: G2 (B.C. Conservation Data Centre 2012a)

Provincial status: S1 (reviewed Sept 2012; B.C. Conservation Data Centre 2012a)

BC list: Red (B.C. Conservation Data Centre 2012a)

Conservation Framework Priority Rank: 1 (B.C. Conservation Framework 2012)

Global Stewardship Responsibility: high (>50% of range or only in 1 other jurisdiction; B.C. Conservation Framework 2012)

7.3. Ecosystem Protection and Ownership

About 22.9 % of *Purshia tridentata / Hesperostipa comata* is protected including 3.5% in National Wildlife Areas (Canadian Wildlife Service; 111 ha), 5.7% in Protected Areas (Province of BC; 184 ha), 5.5% in Wildlife Habitat Areas (Province of BC; 176 ha) and 8.3% in private conservation lands (266 ha). The remaining areas of *Purshia tridentata / Hesperostipa comata* (77.1%) occur on Indian Reserve lands (1808 ha, 56.2%), provincial crown land (29 ha, 0.9%), and private land (642 ha, 20.0%; South Okanagan Similkameen Conservation Program 2008, The Nature Trust 2009, Iverson and Haney 2010a)[5].

8. Acknowledgements and Authorities Contacted

Allison Haney provided maps and area calculations from Iverson and Haney (2010a) spatial and non-spatial data. Carmen Cadrin provided advice on determining and assessing element occurrences. Carmen Cadrin and Orville Dyer assisted with completion of the threats assessment. Jenifer Penny, Allison Haney, and Mike Sarell provided species at risk information. Ted Lea, Orville Dyer, Kim Everett, Dave Fraser and Jennifer Heron reviewed a draft version of this report and provided many helpful comments and personal observations. Michael Ryan provided information and vegetation tables from the proposed BEC classification of the BGxh1.

9. Information Sources

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C.

Atwood, L.B. 1998. Ecology of the microbiotic crust of the antelope-brush (*Purshia tridentata*) shrub steppe of the South Okanagan, British Columbia. M.Sc. Thesis, University of British Columbia, Vancouver, Canada.

Atwood, L.B. and G.E. Scudder. 2003. Experimental restoration in the South Okanagan shrub-steppe. *In*: Seaton, R. 2003 Proceedings of Ecosystem at Risk: Antelope Brush Restoration. Society for Ecological Restoration, B.C. Chapter.

B.C. Conservation Data Centre. 2012a. BC Species and Ecosystems Explorer. B.C. Ministry of Environment http://a100.gov.bc.ca/pub/eswp/ (accessed September 28, 2012).

B.C. Conservation Data Centre. 2012b. Biotics database: Element Occurrences: *Purshia tridentata / Hesperostipa comata.* B.C. Ministry of Environment. http://a100.gov.bc.ca/pub/eswp/ (accessed March 15, 2012).

B.C. Conservation Data Centre. 2012c. Conservation Status Report: *Purshia tridentata / Hesperostipa comata*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Dec 14, 2012).

[5] Terrestrial ecosystem mapping (Iverson and Haney 2010a) was overlaid with cadastral and ownership data compiled by the South Okanagan Similkameen Conservation Program (2008) and private conservation properties compiled by the Nature Trust (2009).

B.C. Conservation Framework. 2012. Conservation Framework Summary Report: *Purshia tridentata* / *Hesperostipa comata*. B.C. Ministry of Environment. http://a100.gov.bc.ca/pub/eswp/ (accessed Mar 15, 2012).

B.C. Ministry of Forests, Lands and Natural Resource Operations. 2011. Vegetation classification hierarchy: BECMaster (accessed October 23, 2011).

B.C. Ministry of Water, Land and Air Protection. 2004. Identified wildlife management strategy: accounts and measures for managing identified wildlife. http://www.env.gov.bc.ca/wld/frpa/iwms/accounts.html (accessed March 15, 2012).

Cadrin, C., pers. comm. 2012. Threats Assessment Consultation, May 25, 2012. Program Ecologist, B.C. Conservation Data Centre, B.C. Ministry of Environment.

Cadrin, C. and K. Iverson. 2012. *Purshia tridentata* / *Hesperostipa comata* element occurrence specification. B.C. Ministry of Environment. Unpub. Manuscript.

Cannings, R.J. and E. Durance. 1998. Human use of natural resources in the South Okanagan and Lower Similkameen valleys *in* Smith, I.M., and G.G.E. Scudder, eds. Assessment of species diversity in the Montane Cordillera Ecozone. Burlington: Ecological Monitoring and Assessment Network, 1998.

Clements, D.R., P.G. Krannitz, and S.M. Gillespie. 2007. Seedbank responses to grazing history by invasive and native plant species in a semi-desert shrub-steppe environment. Northwest Science 81:37-49.

Comer, P. J., B. Young, K. Schulz, G. Kittel, B. Unnasch, D. Braun, G. Hammerson, L. Smart, H. Hamilton, S. Auer, R. Smyth, and J. Hak.. 2012. Climate Change Vulnerability and Adaptation Strategies for Natural Communities: Piloting methods in the Mojave and Sonoran deserts. Report to the U.S. Fish and Wildlife Service. NatureServe, Arlington, VA.

Daigle, P. 1996. Fire in the dry interior forests of British Columbia. Extension Note 08. B.C. Ministry of Forests Research Branch. Victoria, B.C.

Daubenmire, R. 1940. Plant succession due to overgrazing in the *Agropyron* bunchgrass prairie of southeastern Washington. Ecology 21:55-64.

Daubenmire, R. 1968. Ecology of fire in grasslands. Adv. Ecol. Res. 5:209-266.

Dormaar, J.F., S. Smoliak, and W.D. Willms. 1989. Vegetation and soil responses to short-duration grazing on fescue grasslands. J. Range Mange. 42:252-256.

Dyer, O. 2002. List of Species at Risk: South Okanagan-Similkameen Conservation Program Study Area, Updated to November, 2001. Ministry of Water, Land and Air Protection. Working Report. Penticton, B.C.

Dyer, O., pers. comm. 2010. Emails to K. Iverson, March, 2010. Ecosystem Biologist, Ministry of Forests, Lands and Natural Resource Operations.

Dyer, O., pers. comm. 2012. Threats Assessment Consultation, May 25, 2012. Ecosystem Biologist, Ministry of Forests, Lands and Natural Resource Operations.

Dyer, O. and E. C. Lea. 2003. Status and importance of the antelope-brush / needle-and-thread grass plant community in the South Okanagan Valley, British Columbia. *In*: Seaton, R.

2003 Proceedings of Ecosystem at Risk: Antelope Brush Restoration. Society for Ecological Restoration, B.C. Chapter.

Faber-Langendoen, D., L. Master, J. Nichols, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, and B. Young. 2009. NatureServe Conservation Status Assessments: Methodology for Assigning Ranks. NatureServe, Arlington, VA.

FFEI Vulnerability Assessment Working Group. 2009. Interdisciplinary assessment of the implications of climate change on British Columbia's forest and range ecosystems and their stewardship. Year 1 Final Report Working Group 2008/09 accomplishments. http://www.for.gov.bc.ca/HFP/future_forests/ (accessed March 19, 2012).

Haney, A., pers. comm. 2012. Email correspondence to K. Iverson June 23, 2012. Consulting wildlife biologist.

Heron, J. pers. comm. 2012. Email correspondence to C. Cadrin. October 22, 2012. Invertebrate at Risk Specialist. B.C. Ministry of Environment.

IUCN 2009. International Union for Conservation of Nature Proposed classification of direct threats. http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme. (accessed May 25, 2012).

Iverson, K., D. Curran, T. Fleming, and A. Haney. 2008. Sensitive Ecosystems Inventory Okanagan Valley: Vernon to Osoyoos 2000 - 2007. Methods, Ecological Descriptions, Results and Conservation Tools. Technical Report Series No. 495, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Iverson, K., and A. Haney. 2010a. Refined and updated ecosystem mapping for the South Okanagan Valley and Lower Similkameen. 1:20,000 spatial data and associated attribute data.

Iverson, K., and A. Haney. 2010b. Refined and updated ecosystem mapping for the South Okanagan Valley and Lower Similkameen. Unpub. report prepared for the Regional District of the Okanagan Similkameen and South Okanagan - Similkameen Conservation Program.

Iverson, K., A. Haney, and M. Sarell. 2005. Updated antelope-brush mapping for the South Okanagan Valley. Unpub. report prepared for the Ministry of Water, Land and Air Protection.

Krannitz, P.G. 2008. Response of antelope bitterbrush shrub steppe to variation in livestock grazing. Western North American Naturalist 68:138-152.

Krannitz, P.G. and S.L. Hicks. 2000. Browsing of antelope bitterbrush (*Purshia tridentata*:Rosaceae) in the South Okanagan Valley, British Columbia: age preferences and seasonal differences. American Midland Naturalist 144:109-122.

Krannitz, P. and J. Mottishaw. 2003. Fire effects and antelope-brush: fire not as detrimental as might be expected. *In*: Seaton, R. 2003 Proceedings of Ecosystem at Risk: Antelope Brush Restoration. Society for Ecological Restoration, B.C. Chapter.

Lea, T. 1996. The antelope-brush ecosystem: endangered in the Okanagan Valley. Cordillera 27:22-27.

Lea, T. 2008. Historical (pre-settlement) ecosystems of the Okanagan Valley and Lower Similkameen Valley of British Columbia - pre-European contact to the present. Davidsonia 19(1): 3-36.

Lea, T., pers. comm. 2010. Emails to K. Iverson. March, 2010. Plant Ecology Consultant.

Lea, T., S. Flynn, and C. Cadrin. 2004. Antelope-brush / Needle-and-thread grass (*Purshia tridentata* / *Hesperostipa comata*). *In*: British Columbia Ministry of Water, Land and Air Protection. 2004. Accounts and measures for managing identified wildlife. Version 2004. Biodiversity Branch, Identified Wildlife Management Strategy, Victoria, B.C. http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Plant%20Communities/pc_antelopebrushneedleandthreadgrass.pdf (accessed Jan 16, 2012).

Lea, E.C. and R.E. Maxwell. 1995. Ecosystem mapping for the South Okanagan and Similkameen Valleys, British Columbia. 1:20,000 maps. B.C. Ministry of Environment, Lands and Parks. Victoria, B.C.

Lloyd, D., K. Angove, G. Hope, and C. Thompson. 1990. A guide to site identification and interpretation for the Kamloops Forest Region. B.C. Ministry Forests, Research Branch, Victoria, B.C. Land Manage. Handbook No. 23 399pp.

Longland, W.S. and C. Clements. 1995. Use of fluorescent pigments in studies of seed caching by rodents. J. Mammalogy 76:1260-1266.

Madany, M.H. and N.E. West. 1980. Fire history of two montane forest areas of Zion National Park. *In*: M.A. Stokes and J.H. Dieterich (tech. cords.). Proceedings of the fire history workshop. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. RM-81, Ogden, Utah.

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe Conservation Status Assessments: Factors for Assessing Extinction Risk. NatureServe, Arlington, V.A.

Mather, K. 1996. Bunchgrass and beef: bunchgrass ecosystems and the early cattle industry in the Thompson Okanagan. http://www.livinglandscapes.bc.ca/thomp-ok/article-LL/index-beef.html (accessed January 2012).

McLean, A., and S. Wikeem. 1985. Rough fescue response to season and intensity of defoliation. J. Range Manage. 38:100-103.

Meidinger, D. 1992. Vegetation classification hierarchy: DBASE September 1992. B.C. Ministry For. Res. Branch, Victoria.

Melgoza, G., R.S. Nowak, and R.J. Tausch. 1990. Soil water exploitation after fire: competition between *Bromus tectorum* (cheatgrass) and two native species. Oecologia 83: 7-13.

Ministry of Environment Ecosystems Branch. 2006. Standard for mapping ecosystems at risk in British Columbia: an approach to mapping ecosystems at risk and other sensitive ecosystems. Version 1.0. Victoria, B.C.

Moore, M.M., W.W. Covington, and P. Z. Fulé. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. Ecol. Appl. 9:1266-1277.

Muscha, J. M. and A. L. Hild. 2006. Biological soil crusts in grazed and ungrazed Wyoming sagebrush steppe. Journal of Arid Environments 67:195-207.

NatureServe. 2002. Draft Element Occurrence Data Standard. Available at http://www.natureserve.org/prodServices/eodata.jsp (accessed November 2012).

NatureServe. 2012. NatureServe Conservation Status Assessments: Rank Calculator, Version 2.0. https://connect.natureserve.org/index.php?q=publications/StatusAssess_Download (accessed May 2012).

Peek, J. M., F. D. Johnson, and N. N. Pence. 1978. Successional trends in a Ponderosa pine/bitterbrush community related to grazing by livestock, wildlife, and to fire. J. Range Manage 31:49-53.

Penny, J., pers. comm. 2012. Emails to K. Iverson July 20-23 2012. Program Botanist, B.C. Conservation Data Centre, B.C. Ministry of Environment..

Pokotylo, D.L. and P.D. Froese. 1983. Archaeological evidence for prehistoric root gathering on the southern interior plateau of British Columbia: a case study from Upper Hat Creek Valley. Can. J. Archaeology 7:128-156.

Resources Inventory Committee (RIC). 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. The Province of British Columbia, Victoria, B.C.

Rocchio, F. J. and R. C. Crawford. 2011. Applying NatureServe's ecological integrity assessment methodology to Washington's ecological systems. Natural Heritage Report 2011-10. Washington Department of Natural Resources. http://www1.dnr.wa.gov/nhp/refdesk/communities/pdf/eia/applying_eia.pdf (accessed March 15, 2012).

Ryan, Michael., pers. comm. 2010. Email to K. Iverson dated March 29, 2010. Research ecologist, Kamloops Forest Sciences Section in the Ministry of Forest, Lands and Natural Resources Operations.

Ryan, Michael., pers. comm. 2012. Email to K. Iverson dated November 19, 2012. Research ecologist, Kamloops Forest Sciences Section in the Ministry of Forest, Lands and Natural Resources Operations.

Salafsky, N., D. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. H. M. Butchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications. Cons. Biol. 22:897-911.

Sarell, M., pers. comm. 2012. Email to K. Iverson dated 23 June 2012. Wildlife biologist. Ophiucus Consulting.

Scudder, G.G.E. 1996. Personal Communication *In*: Dyer, O. and E. C. Lea. 2003. Status and importance of the antelope-brush – needle-and-thread grass plant community in the South Okanagan Valley, British Columbia. Unpub. report prepared for the Ministry of Water, Land and Air Protection.

Shatford, J.P.A. 1997. Seed dispersal, seed attributes and edaphic factors: their role and impact on the regeneration of antelope bitterbrush (*Purshia tridentata*, Rosaceae). M.Sc. Thesis, University of British Columbia, Vancouver, Canada.

Southern Interior Invertebrates Recovery Team. 2008. Recovery strategy for Behr's hairstreak (*Satyrium behrii*) in British Columbia. British Columbia Ministry of Environment, Victoria, British Columbia, Canada. 16 pp.

Southern Interior Rare Plants Recovery Team. 2007. Recovery strategy for the Grand Coulee owl-clover (*Orthocarpus barbatus*) in British Columbia. British Columbia Ministry of Environment, Victoria, British Columbia, Canada.

South Okanagan Similkameen Conservation Program. 2008. Compiled cadastral and ownership data for the South Okanagan - Similkameen Regional District. Data file dated July 2008.

Symonds, J. E. 2011. Patterns and ecological consequences of exotic plant invasion in Canada's endangered antelope-brush ecosystem. M.Sc. Thesis, University of British Columbia (Okanagan).

The Nature Trust. 2009. Compiled cadastral and ownership data for all fee simple conservation lands in the South Okanagan - Similkameen Regional District. Data file dated November 2009.

Tisdale, E.W. 1947. The grasslands of the southern interior of British Columbia. Ecology 28:346-382.

Turner, N.J. 1994. Burning mountain sides for better crops: aboriginal landscape burning in British Columbia. Int. J. Ecofor. 10:116-122.

Turner, J.S. and P. G. Krannitz. 2001. Conifer density increases in semi-desert habitats of British Columbia in absence of fire. Northwest Science 75:176-182.

Updike, D.R., E.R. Loft and F.A. Hall. 1990. Wildfires on big sagebrush/antelope bitterbrush range in northeastern California: implications for deer populations. Pages 41-46 *In*: E.D. MacArthur, E.M. Romney, S.D. Smith, and P.T. Tueller, editors. Proceedings - Symposium on Cheatgrass Invasion, Shrub Die-off and Other Aspects of Shrub Biology and Management. General Technical Report INT-276, Intermountain Research Station, Ogden, UT.

Utzig, G.F., and R.F. Holt. 2009. Background report: integrated ecological impact assessment: climate change and BC's forest and range ecosystems. http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs2010/463415/draftintegratedecolassessment.pdf (accessed January 18, 2012).

Young, J.A. and C.D. Clements. 2002. *Purshia* the wild and bitter roses. University of Nevada Press, Reno, NV.

Zlatnik, E. 1999. Purshia tridentata. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). http://www.fs.fed.us/database/feis/ (accessed March 10, 2010).

9.1. Data and Mapping Examined

Plot data from Biogeoclimatic Ecosystem Classification and Biophysical Habitat Mapping were examined. Ecosystem mapping dating to 1800, 1938, 1995, 2003, and 2008 for the entire range of *Purshia tridentata / Hesperostipa comata* in British Columbia was examined.

10. Biographical Summary of Author

Kristi Iverson, R.P.Bio. is a plant ecologist living in Lac la Hache, British Columbia. Kristi worked for the Ministry of Forests' Cariboo Research Section for several years on ecology, research and

grasslands classification. Kristi has consulted to a variety of clients in the interior of British Columbia in grassland, forest, and wetland ecosystem mapping, management, inventory, and research.

Appendices

Appendix A. Vegetation data (n=28 plots) collected as part of the provincial Biogeoclimatic Ecosystem Classification and biophysical habitat mapping (British Columbia Ministry of Forests, Lands and Natural Resource Operations, 2011).

Species Name	Mean % Cover	Percent of plots with species present
Overstory trees		
Pinus ponderosa	0.4	11
Tree Stratum	(Min–Mean–Max % cover)	
	(0–5–11% cover)	
Woody shrubs and regenerating trees		
Purshia tridentata	16.4	100
Artemisia tridentata var. *tridentata*	4.3	43
Ericameria nauseosus	1.8	57
Rhus glabra	1.3	21
Ribes cereum	0.4	11
Pinus ponderosa	0.2	7
Rosa nutkana	0.1	4
Rosa sp.	0.1	4
Amelanchier alnifolia	0.1	11
Chrysothamnus viscidiflorus	0.1	7
Toxicodendron rydbergii	0.1	7
Shrub Stratum	(Min–Mean–Max % cover)	
	(1–25–46% cover)	
Herbs and dwarf shrubs		
Pseudoroegneria spicata	18	71
Selaginella densa	12	57
Bromus tectorum	10	96
Hesperostipa comata ssp. *comata*	6.7	75
Sporobolus cryptandrus	3.3	61
Aristida purpurea var. *longiseta*	3.1	50
Poa sp.	3.0	86
Poa secunda	3.0	75
Opuntia fragilis	1.6	71
Phlox longifolia	0.9	75
Eriogonum heracleoides	0.9	25
Eriogonum niveum	0.9	75
Achnatherum occidentale	0.9	14
Balsamorhiza sagittata	0.8	29
Phacelia linearis	0.8	39
Plantago patagonica	0.8	50
Koeleria macrantha	0.7	18
Centaurea diffusa	0.6	54
Erigeron pumilus	0.6	39
Carex sp.	0.5	4
Achillea millefolium	0.5	50
Lomatium sp.	0.5	50
Tragopogon dubius	0.5	50

Species Name	Mean % Cover	Percent of plots with species present
Antennaria dimorpha	0.5	32
Artemisia frigida	0.4	14
Senecio canus	0.3	11
Antennaria parvifolia	0.3	7
Lomatium macrocarpum	0.3	39
Ranunculus glaberrimus	0.3	18
Artemisia tripartita	0.3	11
Gaillardia aristata	0.2	29
Collinsia parviflora	0.2	14
Astragalus collinus	0.2	7
Arenaria sp.	0.2	4
Lomatium dissectum	0.2	7
Zigadenus venenosus	0.2	25
Centaurea sp.	0.1	7
Arabis holboellii	0.1	25
Crepis atribarba	0.1	46
Astragalus miser	0.1	7
Eriogonum umbellatum	0.1	14
Heuchera cylindrica	0.1	11
Geum triflorum	0.1	4
Potentilla glandulosa	0.1	4
Calochortus macrocarpus	0.1	29
Lewisia rediviva	0.1	21
Astragalus purshii	0.1	25
Erigeron filifolius	0.1	7
Comandra umbellata	0.1	14
Vulpia octoflora	0.1	29
Woodsia sp.	0.1	14
Woodsia oregana	0.1	14
Rumex acetosa	0.1	7
Festuca idahoensis	0.1	4
Artemisia dracunculus	0.1	4
Festuca brachyphylla	0.1	7
Haplomitrium sp.	0.1	4
Lithospermum ruderale	0.1	11
Fritillaria pudica	0.1	14
Arnica fulgens	0.1	7
Lesquerella douglasii	0.05	14
Collomia linearis	0.05	18
Chaenactis douglasii	0.04	11
Sisymbrium altissimum	0.04	7
Erigeron linearis	0.04	11
Heterotheca villosa	0.04	7
Polygonum douglasii	0.04	18
Cirsium arvense	0.04	4
Linaria genistifolia	0.04	7
Oenothera pallida	0.04	4
Cystopteris fragilis	0.04	7
Achnatherum hymenoides	0.04	4
Festuca sp.	0.03	11
Lithospermum incisum	0.02	7
Draba verna	0.02	14
Taraxacum officinale	0.02	7

Species Name	Mean % Cover	Percent of plots with species present
Descurainia pinnata	0.02	7
Dodecatheon pulchellum	0.02	7
Polygonum sp.	0.02	7
Lupinus sericeus	0.02	4
Poa cusickii	0.02	4
Descurainia incana	0.02	4
Antennaria sp.	0.02	4
Lomatium geyeri	0.02	4
Draba sp.	0.02	4
Cerastium sp.	0.02	4
Sonchus asper	0.02	4
Arenaria capillaris	0.02	4
Atriplex sp.	0.02	4
Convolvulus sp.	0.02	4
Delphinium nuttallianum	0.01	7
Verbascum thapsus	0.01	7
Nothocalais troximoides	0.01	7
Tetradymia canescens	0.01	4
Polemonium micranthum	0.01	4
Sisymbrium loeselii	0.01	7
Opuntia polyacantha	0.01	4
Galium aparine	0.01	7
Panicum sp.	0.01	4
Tragopogon sp.	0.01	7
Saxifraga sp.	0.01	4
Astragalus sclerocarpus	0.01	4
Artemisia michauxiana	0.01	4
Oryzopsis sp.	0.01	4
Orobanche uniflora	0.01	4
Ipomopsis aggregata	0.004	4
Castilleja thompsonii	0.004	4
Lomatium triternatum	0.004	4
Astragalus sp.	0.004	4
Epilobium brachycarpum	0.004	4
Salsola kali	0.004	4
Holosteum umbellatum	0.004	4
Potentilla recta	0.004	4
Lepidium densiflorum	0.004	4
Claytonia perfoliata	0.004	4
Stellaria sp.	0.004	4
Myosotis stricta	0.004	4
Poa bulbosa	0.004	4
Myosurus sp.	0.004	4
Polygonum convolvulus	0.004	4
Herb Stratum	(Min–Mean–Max % cover) (10–70–100% cover)	
Bryophytes and lichens		
Tortula ruralis	5.7	57
Cladonia sp.	1.2	25
Polytrichum sp.	0.8	29
Polytrichum piliferum	0.8	25
Cladonia symphycarpia	0.7	7
Diploschistes muscorum	0.2	4

Species Name	Mean % Cover	Percent of plots with species present
Peltigera sp.	0.1	11
Ceratodon purpureus	0.1	18
Cladonia pyxidata	0.1	14
Bryum caespiticium	0.1	14
Peltigera ponojensis	0.1	4
Diploschistes sp.	0.1	11
Phascum cuspidatum	0.1	11
Brachythecium sp.	0.04	7
Peltigera rufescens	0.04	7
Diploschistes scruposus	0.04	7
Encalypta vulgaris	0.04	7
Physcia adscendens	0.04	4
Homalothecium sp.	0.02	4
Pohlia sp.	0.02	4
Polytrichum juniperinum	0.02	4
Coscinodon calyptratus	0.02	4
Cladonia coccifera	0.02	4
Cladonia coniocraea	0.02	4
Cephalozia sp.	0.02	4
Cephaloziella sp.	0.02	4
Cladonia rei	0.02	4
Pterygoneurum ovatum	0.02	4
Bryophyte – Lichen Stratum	(Min–Mean–Max % cover) (0–10–60% cover)	

Site/Soil characteristics n = 28 Plots	
Elevation range (m)	(min–mean–max) 332–388–555
Terrain	*(% Frequency)*
FG (glaciofluvial)	60.7
E (aeolian)	14.3
F (fluvial)	3.6
C (colluvial)	3.6
missing data (% of plots)	17.9
Moisture regime	*(% Frequency)*
xeric	14.3
subxeric	28.6
submesic	50.0
mesic	3.6
missing data (% of plots)	3.6
Nutrient regime	*(% Frequency)*
very poor	17.9
poor	21.4
medium	21.4
missing data (% of plots)	39.3

Appendix B. List of at-risk species occurrences overlapping with *Purshia tridentata* / *Hesperostipa comata* element occurrences where only the buffer distance overlaps, or species are using adjacent or associated pocket habitats only (B.C. Conservation Data Centre 2012b).

Scientific Name	Common Name	Provincial Status	COSEWIC Status
Invertebrates			
Gonidea angulata	Rocky Mountain Ridged Mussel	S1	E
Vertebrates			
Acrocheilus alutaceus	Chiselmouth	S3S4	
Buteo swansoni	Swainson's Hawk	S2B	
Catherpes mexicanus	Canyon Wren	S3	
Corynorhinus townsendii	Townsend's Big-eared Bat	S3	
Euderma maculatum	Spotted Bat	S3S4	SC
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	S2?B	SC
Icteria virens	Yellow-breasted Chat	S1S2B	E
Megascops kennicottii macfarlanei	Western Screech-owl, *macfarlanei* subspecies	S2	T
Oreoscoptes montanus	Sage Thrasher	S1B	E
Picoides albolarvatus	White-headed Woodpecker	S1	E
Spizella breweri breweri	Brewer's sparrow, *breweri* subspecies	S2B	
Plants			
Agastache urticifolia	nettle-leaved giant-hyssop	S3	
Ammannia robusta	scarlet ammania	S1	E
Berula erecta	cut-leaved water parsnip	S3	
Bolboschoenus fluviatilis	river bulrush	S1S2	
Brickellia oblongifolia ssp. *oblongifolia*	narrow-leaved brickellia	S2S3	
Camissonia andina	Andean evening-primrose	S1	
Carex comosa	bearded sedge	S2	
Carex sychnocephala	many-headed sedge	S3	
Centaurium exaltatum	western centaury	S1	
Cyperus squarrosus	awned cyperus	S3	
Gaura coccinea	scarlet gaura	S1	
Leptosiphon septentrionalis	northern linanthus	S3	
Lipocarpha micrantha	small-flowered lipocarpha	S1	E
Marsilea vestita	hairy water-clover	S1	
Orobanche corymbosa ssp. *mutabilis*	flat-topped broomrape	S3	
Phacelia ramosissima var. *ramosissima*	branched phacelia	S2	E
Potentilla paradoxa	bushy cinquefoil	S1	
Pterygoneurum kozlovii	alkaline wing-nerved moss	S2	T
Rotala ramosior	toothcup meadow-foam	S1	E
Salix amygdaloides	peach-leaf willow	S2	

Scientific Name	Common Name	Provincial Status	COSEWIC Status
Schoenoplectus saximontanus	Rocky Mountain clubrush	S1	
Sporobolus airoides	hairgrass dropseed	S2S3	
Sporobolus compositus var. *compositus*	rough dropseed	S3	
Symphyotrichum frondosum	short-rayed aster	S1	E
Thelypodium laciniatum var. *laciniatum*	thick-leaved thelypody	S2S3	
Triglochin debilis	slender arrow-grass	S2?	
Verbena hastata var. *scabra*	blue vervain	S2S3	