



Climate Action Initiative
BC AGRICULTURE & FOOD



Okanagan

BC Agriculture & Climate Change
Regional Adaptation Strategies series

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Contents

1	Introduction	12	Priority Impact Areas, Strategies & Actions	41	APPENDIX A: Weather, Climate & Variability
	Project Delivery				
	Project Methodology	13	IMPACT AREA 1: <i>Warmer & drier summer conditions</i>	42	APPENDIX B: Future Projections: Climate Maps & PCIC Tables
3	Regional Context	21	IMPACT AREA 2: <i>Changes to pest populations</i>	45	APPENDIX C: Definitions
	Geography, Climate & Production Capacity				
	Economic & Institutional Context	27	IMPACT AREA 3: <i>Increase in extreme precipitation events</i>	46	APPENDIX D: Adaptive Management of Climate Change Impacts
	Agricultural Production	31	IMPACT AREA 4: <i>Increasing wildfire risk</i>	47	Endnotes
6	Regional Climate Science	36	Implementation & Monitoring		
	Okanagan Regional Climate Projections: 2020s to 2050s				
	Related Effects				
9	Agricultural Impacts				

Introduction

In the coming years, climate change will impact the agriculture sector in British Columbia in a range of different ways.

Although agricultural producers are accustomed to adjusting their practices to manage through difficult conditions, the scope and scale of climate change is anticipated to exceed anything previously experienced. Strategies and actions that will enhance agriculture's ability to adapt to climate change are the focus of this plan.

In 2011–2012, a province-wide assessment of climate change-related risks and opportunities evaluated the potential impacts of climate change on agricultural production and the sector's capacity to adapt.¹ The assessment made evident that, due to British Columbia's diversity (with respect to agriculture, ecology and climate), a regional approach to climate change adaptation is required. In addition, while some adaptation will occur at the farm level, the context beyond the farm and collaborative approaches are critical for supporting agricultural adaptation.

Building on these findings, in 2012–2013 a pilot project was initiated with agricultural producers, agricultural organizations and local governments in Delta and the Peace River and Cowichan Valley regions. Each planning process resulted in a distinctive set of local sector impacts and priorities, as well as a series of strategies and actions for adapting and strengthening resilience. The plans are intended to offer clear actions suited to the specifics of the local context, both with respect to anticipated changes and local capacity and assets.

Following completion of the pilot, in 2013–2014 the *Regional Adaptation Enhancement Program* was launched. The Program is delivered by the BC Agriculture & Food Climate Action Initiative (CAI) and is part of the BC Ministry of Agriculture's Growing Forward 2 programming. Since the Program's inception, additional adaptation plans have been completed for the Cariboo region (2014), the Fraser Valley region (2015), and now the Okanagan region.

Once regional adaptation plans are completed, up to \$300,000 in Growing Forward 2 funding is available to regional partners (working with the CAI) to develop and implement collaborative priority projects. Implementation is underway in five regions and details are available at www.bcagclimateaction.ca.

PROJECT DELIVERY

A local Advisory Committee for the Okanagan region was formed to provide input throughout the project. This Committee included participants from the three regional districts in the Okanagan, the BC Ministry of Agriculture, Agriculture and Agri-Food Canada (AAFC) and a number of agricultural organizations. The agricultural producer participants volunteered their time throughout the project, representing five distinct local production systems. The regional district partners provided staff time and expertise and covered costs associated with the workshops.

With funding from Growing Forward 2, the BC Agriculture & Food Climate Action Initiative provided core management and human resources for project delivery. Please see Acknowledgements for more details.

PROJECT METHODOLOGY

The development of the Strategies involved three key stages:

1 Project Development

A project plan was drafted and background research was conducted through a review of relevant documents and related activities. Ten preliminary meetings were held with producer organization and local government staff, to discuss local issues and priorities. Two initial meetings were held with the local Advisory Committee to receive input on the project outline and the proposed approach for the first workshop.

2 Workshops

Two sets of workshops were held (each set held in two locations — Penticton and Vernon) for a

total of four workshops. The first set of workshops focused on reviewing climate change projections, discussing the associated agricultural impacts and identifying priority areas of risk. Developing strategies and actions for adapting to these priority areas then became the focus of the second set of workshops.

Prior to the second set of workshops, a series of overarching goals, strategies and sample actions was developed and reviewed by the Advisory Committee. These materials provided support for the workshop action planning process (which also incorporated consideration of local priorities, context and resources). 117 individual participants attended one or both of the project workshops.

3 Implementation Meeting

An implementation meeting was held with 26 participants representing many of the key local partners. The meeting involved prioritization of draft actions based on which were most important, which were easiest to implement and which would support enhancement of capacity for additional adaptation. The meeting also included discussion of steps to implement prioritized actions.

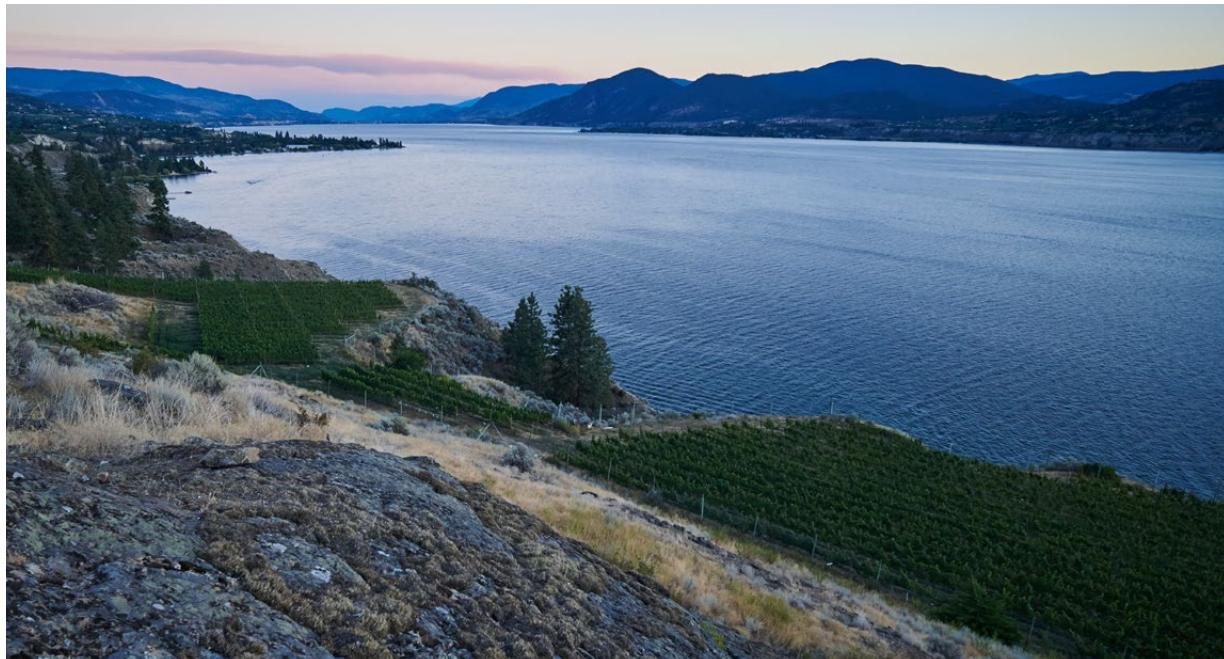


photo by Emrys Damon Miller, vineyards in Naramata

Regional Context

GEOGRAPHY, CLIMATE & PRODUCTION CAPACITY

THE GEOGRAPHIC SCOPE of the Okanagan Adaptation Strategies includes the Regional District of North Okanagan (RDNO), the Regional District of Central Okanagan (RDCO) and the Regional District of Okanagan-Similkameen (RDOS). This area is located between the Columbia and Cascade mountain ranges in south-central British Columbia and covers a total area of 20,822 square kilometres.²

Within these three regional districts there are sixteen municipalities and fifteen electoral areas.³ There are also eight member communities of the Okanagan Nation Alliance.⁴ The combined population of the RDNO, RDCO and RDOS is 341,818.⁵ The Okanagan region contains the largest concentration of population in the province's interior (7.8% of BC's total population).⁶

The Okanagan region has a warm growing season with high accumulations of growing-degree days and



FIGURE 1 Map of three Okanagan regional districts

sunshine-hours, as well as relatively mild winters and springs characterized by long frost-free periods.⁷ The Okanagan region lies in the rain shadow of the Coast and Cascade mountains, creating a hot, sunny, dry climate that is classified as semi-arid, with the lowest average (annual) precipitation in southern Canada.⁸

Precipitation in the Okanagan region ranges from an average of 250 mm per annum in the drier, southern part of the region to 400 mm per annum in the northern part of the region and at higher elevations.^{9,10} In general, it is cooler and the growing season is shorter in the northern part of the region.¹¹ The lack of adequate growing season precipitation in some parts of the region (in particular at the lowest elevations) is the major climatic limitation for agriculture. Irrigation is required for most production, with the exception of limited early season pasture and forage crops.¹²

Soil types and agricultural capability vary across the region and by elevation.¹³ It is estimated that there are 31,160 hectares (77,000 acres) of arable land in the Okanagan Basin.¹⁴ The majority of agricultural land is adjacent to Okanagan Lake and some of its tributaries. There are also portions of the Agricultural Land Reserve (ALR) to the north of Okanagan Lake and surrounding Princeton.¹⁵ Five major soil groups exist within the Okanagan Basin.¹⁶ There are widespread differences in soil types throughout the Basin; the southern part of the Basin has deep sandy soils, whereas the northern area around Kelowna is mainly composed of clay and gravel.¹⁷ Unimproved soils are Class 4 or 5 due to aridity and topography, but soils can be improved to Class 1, 2 or 3 depending on the severity of limitations.¹⁸

ECONOMIC & INSTITUTIONAL CONTEXT

In addition to region's climatic and environmental advantages, the Okanagan region is located in proximity to large markets and has well developed transportation infrastructure and educational and research institutions. Linkages between tourism and agriculture are strong in the region. Direct farm gate sales to visitors are an important source of income for some operations, along with other diversification opportunities afforded by agri-tourism.¹⁹ The Okanagan region contributed 12% of total provincial gross farm receipts in 2010, generating over \$355

million.²⁰ In 2011, there were 10,740 farm workers employed in the Okanagan; this was 24% of the provincial total of agriculture sector employees, working on only 3.6% of the province's Agricultural Land Reserve.²¹

Land prices are high in the Okanagan region, largely due to the rate of residential development. The high price of farmland limits expansion, renovation and investment in farming.²² However, opportunities do exist for entrants from other locations around the globe with similar land prices.²³ Up until recently, the wine grape industry has continued to attract new entrants but has struggled to secure qualified labour.²⁴

The Regional District of Central Okanagan (2005) and the Regional District of North Okanagan (2015) have both completed Agriculture Area Plans and have Agricultural Advisory Committees (AAC) in place to guide plan implementation, and to review land use applications and other planning decisions that may affect agriculture. Many regional district member municipalities have also completed agriculture plans and established AACs.

The three regional districts had partnered on various initiatives before jointly contributing to this plan. RDNO, RDCO and RDOS are currently partnering on the Okanagan Kootenay Sterile Insect Release Program,²⁵ and each region is represented on the Okanagan Basin Water Board. Starting in 2015, the three regional districts began a project to identify, monitor and evaluate common indicators pertaining to their Regional Growth Strategies.²⁶ The regional districts also contributed to the Ministry of Agriculture Agricultural Land Use Inventory (ALUI), which has been used as input for the Agriculture Water Demand Model for the Okanagan Basin (AWDM). The AWDM is used to determine current and future water demands for agriculture in the region.²⁷

There is a long history of agricultural research in the Okanagan, with tree fruit breeding and variety trials underway as early as 1914.²⁸ Research facilities in the region include: the (AAFC) Summerland Research and Development Centre, UBC Okanagan and Okanagan College.²⁹ The Okanagan Basin Water Board and the Okanagan Water Stewardship Council are spearheading research around water resources and management. A number of commodity-specific

industry associations and organizations representing members' interests are based in the Okanagan. These groups provide a broad range of services for their members, including marketing, research and informational resources, and program delivery.³⁰

AGRICULTURAL PRODUCTION

Only 8.5% (176,692 hectares) of the Okanagan region's overall area is included in the Agricultural Land Reserve.³¹ There are 3,693 farms in the region (19% of farms in BC) and the average age of producers is 56.³² The agriculture industry grew steadily in the Okanagan between 2001 and 2011. The total amount of land farmed in 2011 was 199,765 hectares, an increase of 10,699 hectares from 2006, and an increase of 26,224 hectares from 2001.³³ The average farm size in the Okanagan is 54 hectares, significantly lower than the province-wide average of 132 hectares.³⁴ 53% of the farms in the Okanagan are under four hectares.³⁵



photo by Emrys Damon Miller, Okanagan apple orchard

The type of agricultural production is not uniform across the Okanagan region. In the northern areas, forage, dairy and cattle ranching are common, while tree-fruit, grape and vegetable production dominate the central and southern areas.³⁶ Today, 90% of BC's apples, 89% of BC's grapes and 85% of BC's cherries are grown in the south-central Okanagan. In recent years there has been a steady shift away from many types of tree fruit (apples, pears, peaches, plums and apricots), largely due to challenges with profitability.³⁷ However, in the summer of 2015 the BC Fruit Growers' Association reported a very slight expansion of acreage devoted to apple growing in the Okanagan (after decades of decline).³⁸ Also, the land in sweet cherry production has increased substantially, from 781 hectares in 2001 to 1,429 hectares in 2011.³⁹

As some types of tree fruit production have been shrinking, acreage has been shifting into wine grapes and there are now almost 3,491 hectares in grape production across the region.⁴⁰ In the Regional District of Central Okanagan alone, the period between 1991 and 2006 saw a 346% increase in land devoted to grape production.⁴¹ Much of the conversion from orchard to vineyard has been concentrated in the southern portion of the region.⁴² Today the Okanagan is one of the largest producers of fruit and wine in Canada.⁴³

The north Okanagan has a well-established dairy industry, and its poultry production has also grown in recent years. Field crops, particularly alfalfa but also barley and tame hay/fodder crops are predominant in the north Okanagan, with 17% of the provincial total acreage of winter wheat and 20% of the provincial acreage of forage corn grown in the RDNO.⁴⁴ The Okanagan region as a whole contributes significantly to organic production in the province across a range of crops, including fruits, vegetables and greenhouse products. Thirty-nine percent of the province's certified organic farms are located across the three regional districts (with 26% of the province's certified organic farms located in the RDOS). There is also apiculture, greenhouse and nursery production, vegetable and melon farming and sheep/lamb production in the Okanagan region. Many of these production types have experienced growth over the last decade.⁴⁵

Regional Climate Science

An evaluation of adaptation options must be based on the best possible understanding of the nature, magnitude and speed of climate change. Climate scientists began developing computer simulations of the Earth's climate in the 1960s and these models have become increasingly sophisticated and refined.⁴⁶

In the past decade, climate scientists have successfully downscaled global climate models to regional scales by taking into account the variability in temperature and precipitation introduced by topography.⁴⁷ The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change, in support of long-term planning.⁴⁸ PCIC was a key partner in developing the regional adaptation strategies that preceded the Okanagan strategy, and has assisted in the production of the agriculturally relevant regional climate projections for the 2020s and 2050s that are presented in this document.

Additional information about regional climate projections, maps, and related definitions may be found in Appendix B and Appendix C, and in PCIC's Thompson-Okanagan climate summary at: https://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-Thompson-Okanagan.pdf

OKANAGAN REGIONAL CLIMATE PROJECTIONS: 2020s TO 2050s

Key climate projections for the Okanagan region in the 2020s to 2050s are summarized here. Projections were generated by PCIC using data available through

Temperature Projections

- Annual average is 1.4°C warmer by 2020s (+2.4°C by 2050s)
- 21 more frost-free days annually by 2020s (+38 days by 2050s)
- 249 more growing degree-days annually by 2020s (+453 days by 2050s)

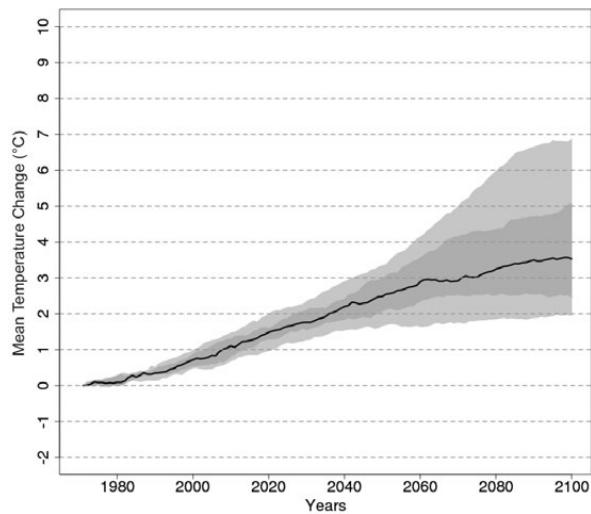


FIGURE 2 Mean Annual Temperature change, 1970s to 2090s

their “Regional Analysis Tool.” Numbers provided are the median of all model runs (black line in the graphs), and the shaded area on the graphs shows the range of projected possible future conditions.⁴⁹

Temperature

Projections for key temperature variables show a strong increasing trend, with all models projecting warming in all seasons (see text box and Figure 2, previous page). This trend is significant compared to historical variability, and summer is projected to warm slightly more than other seasons.

Precipitation

While models show the possibility for both increasing and decreasing future annual precipitation, the median annual trend is an increase of 1.2% above the 1990 baseline by 2020, and increasing by 4.4% by 2050.

The majority of models show a decrease in summer precipitation. There may be a slight increase in the amount of winter precipitation, with a marked decrease in the amount falling as snow (see Figure 3).

The distribution of these temperature and precipitation changes is greatly influenced by local geographic settings — temperature by elevation, and precipitation by topography. As Figure 4 shows, temperatures are higher in the valley bottoms of the Okanagan region, with cooler temperatures and wetter conditions around the Okanagan range to the south and the Beaverdell Range to the east. Many agricultural operations in the Okanagan are located in valleys — or on the benches above — and would therefore be affected by the greater temperature increases.

RELATED EFFECTS

The magnitude, frequency and intensity of extreme events, for both temperature and rainfall, are also forecast to increase with climate change. Unusually warm temperatures are very likely to occur more often, and cold temperatures less frequently. Projections are for 2.2 times the number of summer “warm days” (days in June, July and August that are warmer than the 90th percentile historic baseline

Precipitation Projections

- Annual precipitation: +1.2% by 2020s (+4.4% by 2050s)
- Summer: -8% by 2020s (-9% by 2050s)
- Winter: +6% by 2020s (+9% by 2050s)
- Winter Snowfall: -9% decrease by 2020s (-19% by 2050s)

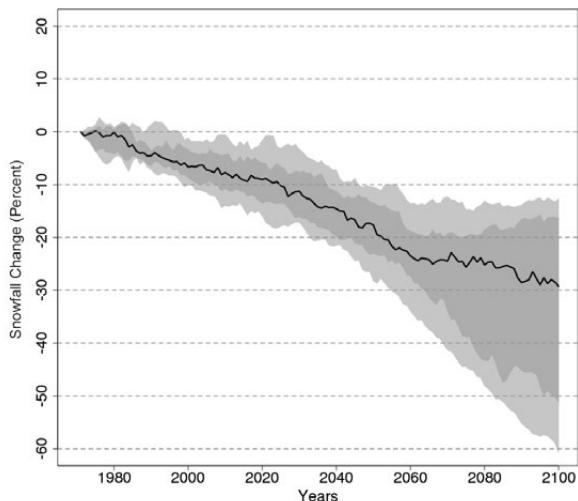


FIGURE 3 Precipitation as Snow, 1970s to 2090s

temperature for that day) and 6.8 times the number of extremely hot days (days so hot they used to occur only once every 10 years). The intensity and magnitude of extreme rainfall events are also projected to increase. Detailed projections for 2050s may be found in the Extremes text box on the following page.⁵⁰

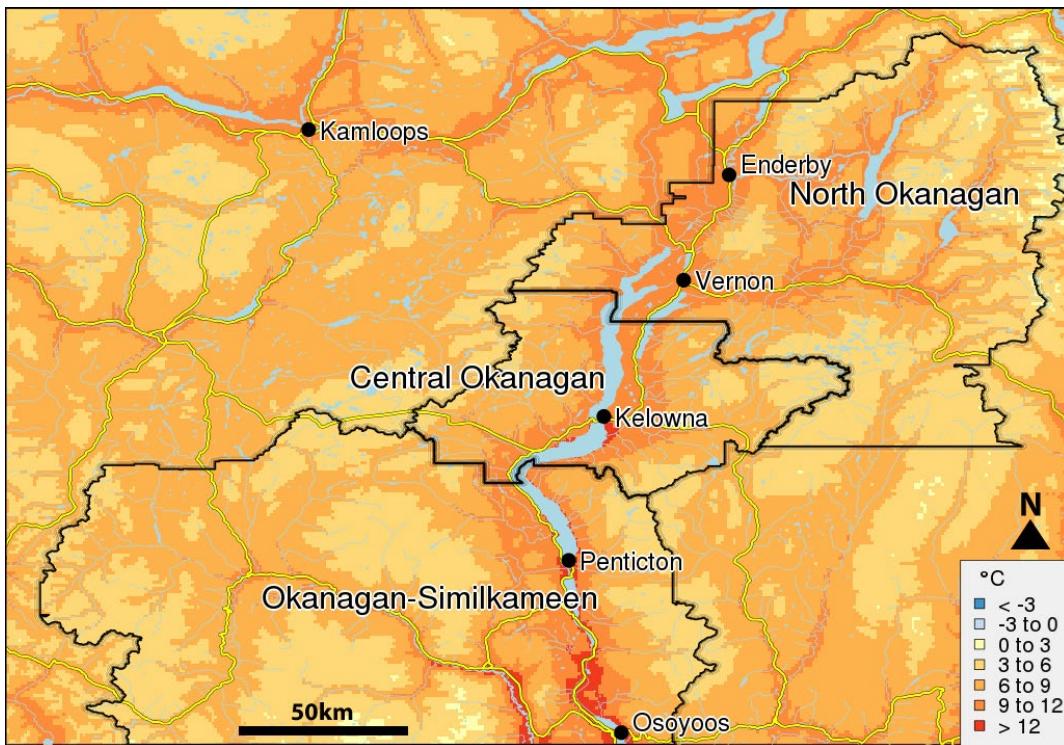


FIGURE 4 Okanagan Region Mean Annual Temperature, 2050s

This map illustrates the spatial distribution of the median value of all models of 2050s mean average temperature. The global model data has been down-scaled to reflect regional temperature variation, driven largely by topography. As temperatures varied historically, so too will they vary in the future, with the mountainous zone to the south and east cooler (yellow-white), and valley zone — where most agricultural lands are located — warmer (red). Note that more local effects, such as vegetation changes and dropping snow elevation, may add to the trend in the valley.

As precipitation in the Okanagan and in upstream areas changes, river systems in the region will likely shift to a more rain-dominated pattern, with less predictability and increased variability in timing and volume of flows. With changes to snowpack and temperatures, runoff peaks are likely to occur earlier in the season, with lower discharge later in the summer.

The projected changes outlined in this section will affect the Okanagan's agricultural sector. The ecological effects and resulting agricultural impacts of these projected climate changes are summarized in the next section.

Extremes

- **2.2 times** the number of summer “*warm days*” (days in June, July and August that are warmer than the 90th percentile historic baseline temperature for that day)
- **6.8 times** the number of *extremely hot days* (days so hot they used to occur only once every 10 years)
- **Increased frequency, intensity and magnitude of extreme rainfall**
- **2.4 times** the number of *extremely wet days* (days so wet that in the past they would only occur once every 10 years)

Agricultural Impacts

The changes in climate projected for the Okanagan region will have a range of impacts on the agriculture sector. These impacts are summarized in the table immediately below.

TABLE 1 Potential impacts of climate change on agricultural production in the Okanagan region

Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
<ul style="list-style-type: none">▪ Increase in average temperatures▪ Decrease in summer precipitation▪ Increase in number of warm and extremely hot days▪ Reduction in snowfall (and associated snowpack)	<p><i>Warmer & drier summers:</i></p> <ul style="list-style-type: none">▪ More frequent and extended dry periods in summer▪ Lower summer stream flow levels (more rapid and earlier spring melt)	<ul style="list-style-type: none">▪ Reduction in water supply availability▪ Increase in irrigation demand and draw down of water storage▪ Impacts to crop yields and quality (particularly non-irrigated crops)▪ Increase in plant stress/damage▪ Impacts to livestock health/productivity▪ Changes to timing and use of rangelands for grazing cattle▪ Increase in costs associated with water (e.g., water supply infrastructure)
<ul style="list-style-type: none">▪ Increase in precipitation in winter▪ Increase in frequency, intensity and magnitude of extreme rainfall	<p><i>Extreme precipitation events:</i></p> <ul style="list-style-type: none">▪ Increase in runoff▪ Potential for more rain-driven flood events▪ Increase in excess moisture	<ul style="list-style-type: none">▪ Increase in risk of soil erosion and landslides▪ Damage to riparian areas (e.g., erosion, washouts, silting)▪ Damage to infrastructure (e.g., dams)▪ Increase in site-specific flood risk and drainage issues▪ Reduced windows for crop development and seasonal tasks (pollination, planting, germination and harvesting)▪ Negative impact on crop productivity and quality▪ Increase in crop damage and losses (e.g., hail storms)

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
<ul style="list-style-type: none"> Increase in average temperatures Increase in growing degree days Increase in frost free days Increase in minimum winter temperatures 	<p><i>Changing crop suitability ranges:</i></p> <ul style="list-style-type: none"> Changing seasonal conditions Changing production windows 	<ul style="list-style-type: none"> Increase in suitability of late maturing varieties and decrease in suitability of early maturing varieties Expansion or relocation of some operations northward and to higher elevations Changes to irrigation needs and possible land use competition Inconsistent yield and quality of previously suitable crops Difficulty in identifying suitable varieties for crops with long time horizons as change continues (e.g., tree fruit) <p><i>Potential opportunities:</i></p> <ul style="list-style-type: none"> Increase in suitability for new varieties and new crops Opportunity for season extension and additional harvest of certain crops
<ul style="list-style-type: none"> Increase in annual temperatures Increase in winter minimum temperatures Shifting precipitation patterns Drier summer conditions 	<p><i>Changes in pests, diseases, invasive species:</i></p> <ul style="list-style-type: none"> Increasing winter survival rates Increasing number of cycles in a year Introduction of new pests and diseases Changing range/distribution of pests, diseases and invasive species 	<ul style="list-style-type: none"> More frequent and increased damage to crops Impacts to livestock health due to pests/diseases Reduction in forage quality Increase in costs for management of pests, diseases, invasive species Less effective pest models (i.e., pest models calibrated for past climate)
<ul style="list-style-type: none"> Increase in average and seasonal temperatures Increase in extreme weather events 	<p><i>Increase in extreme heat events:</i></p> <ul style="list-style-type: none"> Increasing number (and frequency) of consecutive warm and hot days 	<ul style="list-style-type: none"> Increase in irrigation demand Reduction in productivity, size and quality of some crops Increase in crop damage and loss Increase in some pest and disease damage Pressure on cooling and storage technologies/infrastructure (particularly at harvest) Impacts to livestock health and productivity
<ul style="list-style-type: none"> Increase in variability of conditions 	<p><i>Increasing variability:</i></p> <ul style="list-style-type: none"> Fluctuating and unpredictable seasonal conditions Increased uncertainty of frost risk timing (spring/fall) 	<ul style="list-style-type: none"> Damage to crops and increase in susceptibility to disease Reduction in productivity and quality Earlier season for all agricultural activities Changing labour needs (timing/volume)

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
<ul style="list-style-type: none"> Increase in average temperatures and extreme heat events Decrease in summer precipitation (longer, warmer and drier summers) 	<i>Increasing wildfire risk:</i> <ul style="list-style-type: none"> More frequent and intensive wildfire events 	<ul style="list-style-type: none"> Damage and losses to agricultural assets and infrastructure Loss of production and decrease in quality (e.g., due to smoke) Impacts on livestock health Reduction in agri-tourism Increasing costs associated with preparing for, managing and responding to wildfire Impacts on agricultural water supply (competing use for fighting fires)
<ul style="list-style-type: none"> Increase in average temperature Increase in average precipitation 	<i>Changing ecosystems & wildlife populations/distribution</i>	<ul style="list-style-type: none"> Increase in pressure on agricultural lands from distribution of deer, elk, wild sheep and other species Impacts to grazing areas in northern Okanagan from wolf populations Increasing challenge with maintaining environmental flows (and potential impacts on agricultural water)

This set of “impact areas” (groupings of projected climate changes and their associated effects and agricultural impacts) formed the basis for discussions at the first set of workshops. These impact areas were explored in detail with participants, and ranked in order of importance for both the individual farm and regional level. Based on this input, the highest priorities were identified and some impact areas in the table above were excluded from consideration at the second workshops. Those impacts that were excluded may prove to be problematic or advantageous in the Okanagan region in the future, and should continue to be monitored. Adaptation strategies may still be needed for agriculture to address excluded impact areas.

Priority Impact Areas, Strategies & Actions

The following four impact areas were identified as the highest priorities with respect to agricultural adaptation in the Okanagan region:

- **IMPACT AREA 1**
Warmer & drier summer conditions
- **IMPACT AREA 2**
Changes in pest populations⁵¹
- **IMPACT AREA 3**
Increase in extreme precipitation events
- **IMPACT AREA 4**
Increasing wildfire risk

For each of the priority impact areas, background description and adaptation goals are included. Following the description are the strategies and actions to support the Okanagan region agriculture sector with adapting to climate change.

The strategies and actions presented were developed to:

- Address the highest priority impact areas
- Reduce vulnerability to these impacts, and/or build capacity to adapt and respond to these impacts; and
- Define practical steps forward that address gaps and build on existing assets in the Okanagan region context.

Following the strategies and actions, the final section highlights those actions identified for near-term implementation. Implementation details, key participants, timeframes and cost ranges are provided for these near-term priority actions.



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IMPACT AREA 1: *Warmer & drier summer conditions*

THE OKANAGAN BASIN relies entirely on local precipitation (in the form of rain and snow) to replenish its streams, rivers, highland reservoirs and lakes.⁵² With climate change, the Okanagan will experience an overall increase in average annual temperature, along with warmer winter temperatures, which will lead to a decrease in snowpack and earlier peak stream flows. Snowmelt generated run-off is the most significant determinant of the timing and amount of water available in the Basin, resulting in an increased risk of water supply disruption under climate change.⁵³

Okanagan summers are also anticipated to become warmer and drier. Surface water constitutes two-thirds of the Okanagan Basin's total water supply and is an important contributor to water supply during the summer.⁵⁴ This source is particularly vulnerable to impacts from prolonged drought.⁵⁵ The Okanagan region experienced a Level 4 drought during the summer of 2015, creating the potential for regional water managers to take regulatory actions (such as temporary suspension of water licences) if this had been deemed necessary.⁵⁶ The region also experienced droughts during the summers of 2003 and 2009.⁵⁷ The 2003 drought forced the District of Summerland to declare a state of emergency.⁵⁸

While water supply is being adversely impacted by climate change, water demand is expected to increase, partly driven by greater irrigation needs due to hotter and drier conditions.⁵⁹ Surface water sources supply 75% of the 18,416 hectares of irrigated agricultural land in the Okanagan.⁶⁰ About 21% of irrigated agricultural land draws on groundwater and the remaining 4% relies on reclaimed water.⁶¹ For Okanagan producers, ensuring access to sufficient water for irrigation and livestock was a primary concern during the *Adaptation Strategies* workshops.

An important tool for managing water scarcity is drought planning. Drought planning is currently gaining momentum in the region, with the Okanagan Basin Water Board providing facilitation and support

Relevant Climate Change Effects

- Increasing annual and seasonal temperatures
- Increasing number of summer warm days and extremely hot days
- Decreasing snowfall
- Decreasing precipitation in the summer

(including a recent assessment of drought readiness of Okanagan water suppliers). Since agriculture currently utilizes 55% of the water used in the Okanagan⁶² it is critical that the sector is engaged in, and aware of, local drought planning initiatives — both to ensure resilience and for effective implementation of these plans during drought conditions.

Within the Okanagan context, additional water storage may provide some supplementary supply.⁶³ However, the limitations of potential for supply expansion mean that managing demand will be critical for ensuring agricultural water needs can be met in the future. A range of tools and supports are needed to encourage adoption of suitable water management practices (that will enhance sector resilience to future conditions). A number of priority actions — including knowledge transfer, applied research and demonstration and public education — are outlined in the strategies and actions that follow.

The strategies and actions in this section address the following *adaptation goals*:

- *Supporting sector capacity to prepare for, and respond to, drought conditions*
- *Maximizing conservation and efficiency in agricultural water management*

IMPACT AREA 1 > STRATEGY 1.1

Support the agriculture sector's participation in drought planning

As INCREASINGLY WARM and dry summer conditions create greater potential for drought in the Okanagan, developing water management plans has become a high priority.⁶⁴ Although most of the communities in the Okanagan (with the exception of the Similkameen Valley) share a common watershed, water management in the Basin is highly fragmented and does not reflect this hydrological interdependency.

The Okanagan's water supply is managed by over 50 water purveyors that vary considerably in size.⁶⁵ Even within individual municipalities, there can be multiple water providers; for example, the City of Kelowna has five large water purveyors.⁶⁶ Water purveyors are encouraged to develop Drought Management Plans that reflect local water supply dynamics and community water needs, and define both the trigger conditions for drought stages and corresponding regulatory responses that might be imposed at each stage.⁶⁷ These plans can be augmented with Water Use Plans, which are formal agreements for how water will be shared between licensees, while still providing adequate flows for fish and wildlife.⁶⁸

Some purveyors, such as the Greater Vernon Water Utility⁶⁹ and the District of Summerland,⁷⁰ have developed comprehensive Water Use Plans with meaningful input from the agricultural sector. Other purveyors have completed little to no drought/water use planning. Furthermore, there is limited consistency across the plans with respect to content and outcomes.⁷¹ The Okanagan Basin Water Board is in the early stages of working with local water authorities to improve local drought planning and response.⁷²

For agriculture — the Okanagan's largest water user⁷³ — the primary concern is ensuring sufficient water supply for sector activities, but it is also critical that agricultural users provide input into drought plans and have knowledge of their content and implications. Ensuring that producers — including the range of water users — are engaged is important to equitable outcomes. For example, some agricultural producers hold independent water licences and may be particularly vulnerable to having their licences suspended during drought.⁷⁴

Following the drought in 2015, the BC Fruit Growers' Association endorsed eight policies to protect orchards during drought and pledged to promote these policies to municipalities and purveyors in the district.⁷⁵ There would be value in supplementing this effort with a broader (pan-agricultural) initiative to ensure that agricultural concerns are consistently and effectively incorporated in planning.

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ACTION 1.1A Consult with the agricultural sector to determine cross-sector objectives for drought planning	ACTION 1.1B Develop a framework for (consistent and structured) engagement of agricultural water users in local drought planning processes
<ul style="list-style-type: none">▪ Determine the most appropriate method of consultation with the agricultural sector to achieve planning objectives▪ Engage in consultation with the agricultural sector in order to:<ul style="list-style-type: none">- Share information about the current and projected future state of water supply (to inform priority development)- Facilitate dialogue to develop shared priorities on key water issues (e.g., managing scarcity, water metering and pricing)- Include a diverse group of producer participants (cross-section of production types, water/purveyor sources)- Support incorporation of adaptation – to increase resilience and minimize impacts – in drought planning (i.e., not just drought response)▪ Develop a shared vision for the agriculture sector's participation in drought planning (to inform Action 1.1B), identifying critical needs and priorities across different production types/water sources	<ul style="list-style-type: none">▪ Identify sector representatives for drought planning processes and determine ways to maintain consistent sector participation▪ Partner with key organizations (e.g., Okanagan Basin Water Board, water purveyors and irrigation districts) involved in drought planning to pilot, evaluate and implement the framework for agricultural engagement▪ Convene a forum with the agricultural sector to share results of this pilot

IMPACT AREA 1 > STRATEGY 1.2

Develop and implement agriculture-specific drought outreach

IN BRITISH COLUMBIA, drought management and outreach is highly complex, due in part to the micro-climatic and geographic diversity at the basin level, and also to the large number of stakeholders and coordinating bodies involved in drought evaluation and communication.⁷⁶

As noted previously, the extremely hot and dry conditions during the summer of 2015 led the provincial government to declare a Level 4 (hydrological) drought for the Okanagan.⁷⁷ Although this triggered a high-level set of responsibilities for local purveyors and governments, purveyor responses across the region were varied, with most implementing only basic watering restrictions.⁷⁸

This mixed response partly reflects local circumstances, as the Province's drought levels do not always correspond to the status of reservoirs at the purveyor level.⁷⁹ This distinction can lead to confusing messaging to local water users surrounding the health of the water supply and related water restrictions. There is a risk that, over time, these inconsistencies could lead to water users becoming desensitized to drought messaging, creating greater risks around long-term water management and the state of water supply.

Most water purveyors (in collaboration with regional districts and local governments) communicate with their water users via direct mail, as well as through print and digital media.⁸⁰ Independent agricultural licensees — those who are not connected to a purveyor — receive direct communication from the provincial government.⁸¹ During the summer and early fall of 2015, the Okanagan Basin Water Board also played an active role in communicating weekly drought updates, as well as hosting drought workshops and webinars.⁸²

Despite the range of existing communication methods, there is need to implement a communication strategy that results in consistent, timely and accurate information about water supply and the expected or required reductions. In particular, producers emphasize the need for reliable information that is based on the state of their *local* water supply, so they can make appropriate water management decisions. If water users trust that information and notifications pertain to their own water sources, this is also likely to enhance implementation of voluntary conservation measures in the future.

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ACTION 1.2A Create a consistent (and data driven) system for disseminating source-specific water supply information	ACTION 1.2B Establish and implement sector-appropriate outreach mechanisms
<ul style="list-style-type: none">▪ Consult with producer groups, local water authorities, municipal and provincial governments to assess:<ul style="list-style-type: none">- Effectiveness of existing approaches for drought communications- How/if communication differs by water source and purveyor- Relationship between Provincial drought levels and local drought levels in relation to different water sources- Communication gaps (e.g., are water users that aren't connected to a utility receiving drought information?)▪ Partner with local water authorities (along with agricultural groups and relevant government agencies) to develop approach and options for dissemination of source-specific drought information	<ul style="list-style-type: none">▪ Identify effective/preferred mechanisms for distribution of drought communication materials by sector group (element of consultation in 1.2A)▪ Incorporate information about how climate change will impact water supply▪ Pilot and evaluate communication options in two to three areas with local and source-specific focus identified in Action 1.2A▪ Identify suitable mechanisms and partners for broader and longer-term distribution of drought information to agriculture sector (incorporating findings of pilot)

IMPACT AREA 1 > STRATEGY 1.3

Provide knowledge & technology transfer for agricultural water management

ALTHOUGH THE OKANAGAN is considered to have one of the most favourable climates for agricultural production in the province, in many cases moisture deficiency during the late spring and summer make irrigation a necessity.⁸³ Agricultural operations rely on a broad range of irrigation methods to maintain the productivity and quality of their crops.⁸⁴

The Agriculture Water Demand Model for the Okanagan Basin indicates that approximately 20% (3,787 hectares) of the total irrigated land base area is in horticultural crops that are serviced by efficient irrigation systems (i.e., drip, microspray and microsprinkler systems). In total, it is estimated that 52% of irrigated acreage (primarily fruits and vegetables) could be utilizing more efficient systems than are currently used.⁸⁵

Increasing awareness and uptake of existing (BC-specific) tools such as irrigation scheduling calculators,⁸⁶ irrigation manuals and guides could assist some producers with taking steps to improve

water management practices.⁸⁷ Cost-shared irrigation management plans are also available (for qualifying producers) through the Environmental Farm Plan and Beneficial Management Practices Programs.⁸⁸ The Beneficial Management Practices Program also includes cost-share opportunities for water saving technologies such as weather stations, soil moisture sensors and moisture meters.⁸⁹

A range of new mechanisms (to complement existing resources) could also encourage adoption of adaptive water management technologies and practices. Development of cost-benefit analyses for various technologies and practices and commodity-specific water management guides would assist producers in determining how to optimize water use for their production systems. Piloting a “water field agent” for Okanagan agriculture — an individual dedicated to working with producers to evaluate and improve their water management — may also be a very effective means for cross-sector water-related knowledge transfer.

ACTION 1.3A Share and promote existing (BC-specific) water and irrigation management tools and resources	ACTION 1.3B Develop (new) knowledge transfer resources to provide information about water management best practices
<ul style="list-style-type: none">▪ Assess opportunities to improve adoption of existing tools and resources▪ Promote irrigation assessments – and related cost-share opportunities – available through and the Environmental Farm Plan (EFP) and Beneficial Management Practices (BMP) programs▪ Provide workshops and/or presentations at sector meetings and events to share and demonstrate tools (e.g., irrigation calculator and manuals, soil moisture sensors)	<ul style="list-style-type: none">▪ Develop (full) cost-benefit evaluations of water management technologies/practices to inform producers and encourage adoption▪ Develop commodity-specific water management guides focusing on optimizing water use▪ Promote and enhance informational resources about practices for preserving and enhancing soil moisture▪ Pilot a dedicated field/extension agent for cross-sector agricultural water knowledge transfer

IMPACT AREA 1 > STRATEGY 1.4

Undertake applied research and demonstration for practices and technologies to improve resilience to hot and dry conditions

OKANAGAN PRODUCERS ARE experienced at managing through hot, dry summers, but increased evapotranspiration and reduced soil moisture retention (due to warmer and drier summer conditions) will create new management challenges.⁹⁰ Demonstrating and evaluating innovative technologies and management practices (within the Okanagan context) to build resilience to these conditions will assist producers with on-farm decisions and investments.

Applied research creates opportunities to test practices and trial varieties, while minimizing the risk for individual producers. There is a strong history of agricultural research in the Okanagan, due largely to the presence of government research agencies, active industry organizations and post-secondary institutions. For many decades, Agriculture and Agri-Food Canada's Summerland Research and Development Centre has been conducting Okanagan-specific research. However, this research is not always accessible to producers and may not include an economic analysis component.

Okanagan-based industry organizations are also active in research and dissemination. For example,

the BC Wine Grape Council collects a levy from growers to undertake research and education on viticulture and enology.⁹¹ Similarly, the BC Cherry Growers undertake (5–6) priority research projects annually through grower cost-shared funding.⁹² Many other industry organizations support research and/or share findings with their members through their websites, newsletters and meetings. The new Farm Adaptation Innovator Program is partnering with organizations in the Okanagan to support demonstration, evaluation and knowledge transfer of farm practices to improve resilience and/or reduce weather-related risk.⁹³

Local research is critical to the agriculture sector's capacity to adapt — particularly applied research that includes demonstration and knowledge transfer components. The diversity of Okanagan agriculture creates a broad range of research priorities.

Adaptation challenges are increasing the value of research that crosses commodity lines, addresses shared priorities and benefits a wide range of producers. Two priority areas emerged out of the *Adaptation Strategies* workshops, and these are highlighted in actions below.

ACTION 1.4A Demonstrate and evaluate options for increasing crop resilience (to hot and dry conditions)	ACTION 1.4B Demonstrate and evaluate options for innovative agricultural water management technologies and practices
<ul style="list-style-type: none">▪ Ensure distribution of information regarding research already completed in the region (e.g., AAFC research results)▪ Support demonstration/applied research (in areas such as variety and crop selection trials, root stock selection, soil/mulch management and crop protection technologies) and incorporate data collection on (full) cost-benefit and payback period▪ Partner with industry groups to disseminate information (field days, interpretive signage at project sites, fact sheets, web-based information)	<ul style="list-style-type: none">▪ Ensure distribution of information regarding research already completed in the region (e.g., AAFC research results)▪ Support demonstration/applied research (in areas such as precision irrigation, deficit irrigation, soil moisture management) and incorporate data collection on (full) cost-benefit and payback period▪ Partner with industry groups to disseminate information (field days, interpretive signage at project sites, fact sheets, web-based information)

IMPACT AREA 1 > STRATEGY 1.5

Undertake education and outreach (for Okanagan residents) to increase understanding of agricultural water use and climate change

THE OKANAGAN, KNOWN for its extensive system of lakes and rivers, suffers from a ‘myth of abundance’ relating to its water supply.⁹⁴ Located in the rain shadow of the coastal mountains, the region receives very modest amounts of annual precipitation and over 80% of this is lost to evapotranspiration throughout the year.⁹⁵ What is remaining supplies the region’s water users.

The Okanagan Basin has very high per capita water use compared to other communities in BC and Canada, due in large part to outdoor residential water use during the summer which comprises 24% of the region’s water demand.⁹⁶ Residential indoor water use makes up 7% of water demand, golf courses 5% and commercial/industrial 6%.⁹⁷ Agriculture is the largest water user in region, comprising 55% of water demand.⁹⁸ Agricultural production is also one of the largest economic drivers for the Okanagan region and water is an essential input for the sector.⁹⁹

Agricultural water use — for irrigation, livestock watering and crop protection — is essential to maintain the health and viability of crops and animals. However, the non-farming public doesn’t necessarily understand agricultural water use or the potential impacts of climate change on local water sources that are critical for agricultural production. Improving this understanding is important, both to maintain the social license for the sector, and so that communities opt to prioritize agricultural water in times of scarcity.

Climate change and local population growth (and corresponding increases in water demand) will put pressure on the Okanagan’s water supply. All water users will be required to maximize their water use conservation and efficiency. Existing local initiatives to promote water conservation and education about local water resources are not focused on education about agricultural water use.¹⁰⁰ A targeted strategy could enable communication about the importance of water to agriculture and the shared responsibility for management of water demand in the Basin.

ACTION 1.5A Develop information materials to improve public knowledge of agricultural water use/practices and climate change

- Bring potential partner organizations (e.g., producer organizations, OBWB/Okanagan WaterWise, local governments) together to develop a collaborative outreach strategy that includes:
 - The importance of water for agriculture and how this water is used
 - Agricultural actions/innovations for water conservation and efficiency
 - Linkages to domestic water use and domestic water conservation
 - Impacts of climate change to the local water supply
- Determine the most suitable mechanisms for reaching Okanagan residents (e.g., videos, websites, mail-outs, public events and workshops)
- Implement outreach over a period of time, including evaluation mechanisms and a plan for ongoing communications

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IMPACT AREA 2: *Changes to pest populations (insects, diseases, weeds & invasive species)*

AS AVERAGE ANNUAL temperatures increase, the range and prevalence of insect pests, diseases and invasive species are anticipated to shift. Climate change may result in an increase in the number and distribution of existing problem species, while enabling new species to become established in the Okanagan region. Extreme weather events also have the potential to introduce new pests from distant areas.¹⁰¹ In combination, these changes will result in an increase in management complexity and the cost of agricultural production.

Spotted wing drosophila (SWD) — which can affect berries, cherries and soft fruits — is an example of a new insect pest that was first detected in the Okanagan in 2009.¹⁰² Due to mild winter and warm spring conditions, SWD was particularly problematic during the summer of 2015.¹⁰³ Other emerging insect pests in the Okanagan include Pacific flathead borer, grasshoppers, apple clearwing moth, apple maggot and balsam woolly adelgid.¹⁰⁴ Climate change is also anticipated to bring about shifts in the distribution, virulence and frequency of disease outbreaks — both in crops and livestock — and to impact the distribution and winter survival of weeds and invasive plants.

The Okanagan's regional districts and producer groups already have experience collaborating with monitoring and managing agricultural pests through the Okanagan-Kootenay Sterile Insect Release Program (SIR). SIR is a codling moth control program targeted at commercial and residential properties with pear, apple, crabapple and quince trees.¹⁰⁵ The program has been operational since 1992 and is credited with suppressing codling moth populations, thereby significantly reducing fruit damage,¹⁰⁶ and with reducing organophosphate pesticide applications for codling moths by 93%.¹⁰⁷

Relevant Climate Change Effects

- Increasing overall average temperatures
- Increasing frequency and intensity of extreme rainfall events
- Shifting precipitation patterns (increasing rain in winter, spring and autumn, rain on snow)

In addition to SIR, other local resources include Agriculture and Agri-Food Canada's Summerland Research and Development Centre (which conducts locally relevant pest research) and sector organizations which provide their members with various types of pest-related information. The BC Ministry of Agriculture issues pest alerts and assists with production guides that include information about commodity specific pest management options. Invasive species are monitored and managed on a sub-regional basis by the three Okanagan Regional Districts, along with non-profit organizations such as the Okanagan and Similkameen Invasive Species Society (OASISS).

While the above resources provide valuable knowledge and institutional capacity, there remain a number of gaps in surveillance, monitoring and management for economically significant pests. To prepare for and respond appropriately to pest threats, Okanagan producers require timely information about existing, new and emerging pests. Resources for pest identification, as well as suitable options for management and control, are also needed. In addition, distinct management approaches are required for BC's organic operations (a large proportion of which are located in the Okanagan) that face a unique set of challenges relating to pest management.¹⁰⁸

The strategies and actions in this section address the following *adaptation goals*:

- *Supporting integrated and cross-sector approaches to pest monitoring and management*
- *Enhancing informational resources about pests and climate change*

IMPACT AREA 2 > STRATEGY 2.1***Enhance cross-commodity approaches to monitoring and management for critical insect pests***

As noted in the previous section, there is already foundational capacity in the Okanagan region to address future pest-related challenges. However, this capacity could be significantly strengthened through coordinated and collaborative approaches — particularly those aimed at early detection and management of new and emerging pests.

There remains (an understandable) tendency for commodity group to work independently of one another due to their distinct interests and priorities. In addition, particular approaches to pest and disease management may be an element of export requirements, marketing strategies or industry standards. The Wine Grape Council's encouragement of adoption of Integrated Pest Management through their initiative for Sustainable Winegrowing British Columbia (eventually intended to be a certification program) is one example.¹⁰⁹

In many cases, daily monitoring and management of pests is undertaken by individual producers to protect their crops and/or livestock. These efforts could be bolstered with improved informational resources and management tools, particularly to address high-risk emerging pests such as spotted wing drosophila.

The experience and success of the SIR Program points to the efficacy of broad cooperative initiatives for managing key pests, and a similar approach could be applied to both a broader range of existing pests and to ensuring effective monitoring and early response for new pests. Coordinated cross-regional and cross-sector approaches have the potential to strengthen monitoring and management, and to improve the cost-effectiveness of both activities.

ACTION 2.1A Develop a cross-sector plan for shared monitoring, management and knowledge transfer	ACTION 2.1B Pilot implementation of new cross-sector approaches for monitoring and management
<ul style="list-style-type: none">▪ Confirm priority (common) pest threats for monitoring and management▪ Identify critical monitoring gaps and/or shared management priorities▪ Develop a framework or protocol for early detection and rapid response for new pests	<ul style="list-style-type: none">▪ Develop partnerships to deliver cooperative pilot project(s)▪ Pilot priorities for monitoring and management identified through Action 2.1A, such as:<ul style="list-style-type: none">- Knowledge transfer/outreach to improve land owner and producer awareness for effective and integrated management of priority pests- Early detection/rapid response approaches- Enhanced support for multi-producer (group) implementation through existing programs (e.g., Environmental Farm Plan, Sterile Insect Release)

IMPACT AREA 2 > STRATEGY 2.2

Improve linkages between climate change projections and weather and pest monitoring data

As noted above, producers in the Okanagan are already experiencing an increasingly complex set of challenges with pest management. New approaches are required to support producers with management — including better decision-making tools that incorporate climate change projections, and improved methods for distribution of existing information.

An accessible (online) information source that includes local weather data, along with information about pests and local production systems, would support time-sensitive and seasonal decisions, while creating the potential for stronger linkages between weather and pest information. A resource that combines weather data with information about pest and disease phenology¹¹⁰ — and suitable management — creates the potential for a highly integrated approach to pest management, increasingly valuable as decisions become more complex and costly.

To maximize its effectiveness, such a tool requires a comprehensive weather monitoring network and the integration (and maintenance) of suitable decision-support tools.

Through the Farmwest website (www.farmwest.com) data is currently accessible for 32 weather stations across the Okanagan. This website also provides production decision support tools, but is very limited with regards to Okanagan and pest-specific tools.¹¹¹ In addition to development of decision-support tools for the Okanagan context, pest management models may need to be recalibrated to incorporate new climate information.

There are strong models for this type of online resource. Of particular relevance to the Okanagan context is the University of Washington's Decision Aid System which provides ten insect, four disease and four horticultural models for the Washington tree fruit industry.¹¹² The Decision Aid System combines real-time weather data and estimates on the status of pests; alerts and management recommendations are sent directly to subscribers. Another example of a tool that encompasses both soft fruit and wine grapes is "Vine and Tree Fruit INnovations" an online resource for producers in Ontario, offering a range of decision support tools (although less pest-focused than the previous example).¹¹³

Any tools or informational resources will only be as effective as their adoption by producers allows, so an equally critical activity will be knowledge transfer. Supporting education and training for existing extension agents, as well as sharing information through sector groups, would enable efficient transmission of information about new and emerging pests, as well as new tools and resources.

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ACTION 2.2A Develop resources to link weather and pest/disease data with decision support tools (e.g., pest phenology predictions, disease pressure tools)	ACTION 2.2B Integrate climate change considerations into pest research and analysis	ACTION 2.2C Disseminate pest information and resources broadly to producers and specialists
<ul style="list-style-type: none">▪ Determine the most suitable tools/models for local needs by:<ul style="list-style-type: none">- Conducting a scan of existing tools for linking pest/disease monitoring data and weather data;- Assessing current monitoring in the region and identifying key gaps and priorities; and- Identifying cooperator/partner organizations.▪ Address critical weather monitoring gaps in agricultural areas (to provide locally relevant data)▪ Develop an online source for producers to access weather and pest information, along with decision support tools for local production systems	<ul style="list-style-type: none">▪ Enhance and support research to improve understanding of pest phenology and climate change as well as management options▪ Revisit and recalibrate existing pest management models to incorporate climate change (if/as needed)	<ul style="list-style-type: none">▪ Provide training/education for local extension agents (e.g., BC Tree Fruit, independent consultants etc.) about pests and climate change▪ Promote available tools and resources through sector organization events/meetings and publications

IMPACT AREA 2 > STRATEGY 2.3

Strengthen partnerships and knowledge transfer for management of invasive species

AS NOTED PREVIOUSLY, regional governments and local non-government organizations are already engaged in activities to monitor and manage invasive species in the Okanagan. Invasive species are defined as non-native plants and animals that have been introduced to an area outside of their natural range and, lacking local enemies to control them, these species are able to rapidly outcompete local (native) plants and animals.¹¹⁴ While a range of human activities makes management of invasive species an ongoing issue, climate change will further alter the dynamics of invasive and native species.

Invasive plant species such as puncturevine and longspine sandbur already create challenges for producers in the Okanagan — both by interfering with cropping systems and by creating health hazards for livestock.¹¹⁵ Although not yet established in BC, even water-borne species such as zebra and quagga mussels — have the potential to create management issues and costs for producers by colonizing irrigation systems.¹¹⁶

Early detection and suitable management are extremely important to preventing the spread of any new invasive species in the region. An increased level of vigilance and monitoring is required both within agriculture, and more broadly with non-agricultural landowners. Minimizing negative impacts of invasive species on the agriculture sector will be more effective through cooperative and coordinated efforts across organizations and geography within the Okanagan.

This could include creating more opportunities for groups (from across the Okanagan region) to come together and share information, as well as focused efforts to transfer information to producers and other landowners about agriculturally significant species (e.g., identification, control). As many producers aren't sure where to turn for information, a centralized (Valley-wide) online resource for information and exchange about invasive species could assist producers and strengthen coordination of efforts.

ACTION 2.3A Enhance knowledge transfer for monitoring and management of agriculturally significant invasive species	ACTION 2.3B Create a centralized (Valley-wide) online information source for outreach/knowledge transfer regarding invasive species/pests
<ul style="list-style-type: none">▪ Bring sector organizations and other agencies together for annual "roundtable" to share information▪ Increase (region and sector-wide) outreach about agriculturally significant species through mechanisms such as:<ul style="list-style-type: none">- Email notifications or alerts- Fact sheets and management guides- Workshops- Updates/information at agricultural events/ meetings▪ Increase knowledge transfer to (non-producer) landowners about managing agriculturally significant species	<ul style="list-style-type: none">▪ Develop an online mechanism to provide information about invasive species (and potentially all agricultural pests)▪ Create a digital forum for producers/experts to exchange information (e.g., producer can send photo of pest for identification and/or seek management advice)

IMPACT AREA 3: *Increase in extreme precipitation events*

Although annual precipitation is anticipated to increase only slightly in the Okanagan region, the timing and distribution of precipitation is expected to shift. Summer precipitation is projected to decrease while winter precipitation increases, with a higher proportion of winter precipitation falling as rain rather than snow. Rain will be concentrated in more frequent and intense precipitation events, resulting in challenges with managing run-off (both onto and off) the agricultural land base.

Warmer winter temperatures will also cause more rapid snowmelt and earlier peak stream flows, creating excessive run-off that can be exacerbated by upland activities such as logging.¹¹⁷ This excessive run-off can result in erosion and, in extreme cases, debris flows, washouts and landslides. Anticipated hydrological changes also increase the risk for run-off related flooding which, while a localized impact, highlights the need for preparation and mitigation activities.

Extreme precipitation events can cause damage to riparian areas (e.g., bank erosion, silting) and loss of productive agricultural lands near riparian corridors. Riparian rehabilitation and the creation of riparian buffers — consisting of planted landscapes between cultivated areas and a waterway — can enhance waterway health and serve as flood control infrastructure.¹¹⁸ Maintaining and/or rehabilitating both upland areas and riparian areas is likely to be an important mechanism for reducing excess runoff and flood-related damage as stream flows become more unpredictable.

Resources and incentives encouraging installation and stewardship of riparian buffers already exist, but are limited in their reach and capacity. The Environmental Farm Plan and Beneficial Management Practices Programs offer planning and cost-share supports for practices related to riparian areas and erosion management.¹¹⁹ The BC Cattlemen's Association also operates the Farmland-Riparian Interface

Relevant Climate Change Impacts

- Increasing overall average temperatures
- Increase in frequency and intensity of extreme precipitation events
- Shifting precipitation patterns (increasing rain in winter, spring and autumn, rain on snow)

Stewardship Program (FRISP) to assist cattle producers with all of the steps involved in protection and enhancement of riparian areas.¹²⁰

In spite of these resources, addressing runoff and riparian related issues remains a substantial challenge. There is frequently the need for multiple land owners (on or above a watercourse) to work together to reduce runoff and flood risk. Individual producers are often unclear about the benefits to their operation and may find the institutional and regulatory context around riparian activities to be daunting.

Managing run-off and ensuring that riparian areas improve flood control functions requires information and investment. Enhancing knowledge-based and financial tools to support producers with taking appropriate action will reduce the impacts of runoff, erosion and localized flooding, and this will serve both agricultural operations and the broader public interests in the Okanagan.

The strategies and actions in this section address the following *adaptation goals*:

- *Strengthening partnerships for the purposes of reducing runoff, minimizing erosion and enhancing riparian areas*
- *Improving knowledge transfer and resources to reduce runoff, minimize erosion and enhance riparian areas*

IMPACT AREA 3 > STRATEGY 3.1

Improve processes and supports for individual producers to implement runoff and erosion management and riparian rehabilitation activities

AS NOTED ABOVE, there are existing resources available to producers wishing to undertake activities to reduce runoff, minimize erosion and/or rehabilitate riparian areas. These programs have created options for producers to seek both technical and financial assistance. However, the existing programs do not address the complexity involved in undertaking activities in riparian areas.

This complexity is largely the result of environmental, habitat and biodiversity values and the requirements of various agencies pertaining to riparian areas. A brochure from the Farmland-Riparian Interface Stewardship Program (FRISP) maps out the steps toward riparian project approval.¹²¹ While this brochure isn't updated to reflect recent changes in regulations, it points to an ongoing issue with a multi-stage and multi-agency process that is likely to be overwhelming for many individual producers.

Producers participating in the *Okanagan Adaptation Strategies* workshops also expressed concern that this type of activity is both labour and cost-intensive, but

will not necessarily create sufficient benefits for the individual producer. This is particularly true when considering the ongoing maintenance of riparian areas. At present, there is no mechanism in place to formalize integration of agricultural production objectives or values into riparian rehabilitation and maintenance approaches and standards.

Greater flexibility around design and maintenance would likely increase the interest of agricultural producers in riparian rehabilitation initiatives. Establishing a riparian framework for agriculture — providing guidelines and sector-specific strategies — might be one way to address this issue. A more thorough assessment of these challenges is warranted — including follow-up with key agencies and stakeholders — to determine how best to enable and enhance implementation of runoff reduction and riparian maintenance and restoration activities.

ACTION 3.1A Assess existing and alternative processes (policy, programmatic and financial tools) to support implementation of runoff/erosion management and riparian rehabilitation	ACTION 3.1B Facilitate dialogue between producer groups and key agencies to determine preferred options to improve processes/supports
<ul style="list-style-type: none">▪ Assess the current process and programmatic supports (for producers undertaking riparian rehabilitation) including:<ul style="list-style-type: none">- Identifying existing supports (e.g., human resources, cost-share incentives, key organizations)- Documenting the regulatory process/steps- Identifying gaps, issues and opportunities- Consulting with producer organizations, government agencies and specialists to identify key issues and/or opportunities	<ul style="list-style-type: none">▪ Coordinate participation of sector groups and agencies in structured, facilitated workshops (to review assessment from 3.1A)▪ Determine steps for strengthening coordination and support for runoff/erosion management and riparian restoration▪ Explore the potential for a riparian framework for agriculture

IMPACT AREA 3 > STRATEGY 3.2

Strengthen cooperative runoff/erosion management and riparian restoration on individual watercourses

A SUBSTANTIAL CHALLENGE in addressing runoff, erosion and riparian issues on an individual farm or ranch, is that they are frequently affected by broader watercourse and/or upland management practices. While individual producers may undertake work on their own properties, they cannot address the broader systemic issues on a watercourse without cooperation from other landowners. These landowners may include other producers, non-farming neighbours and (particularly in upland areas) government or industry (e.g., forestry companies).

Taking collective action on watercourses is difficult, but can be facilitated through a structured process to bring people together with information and expertise to improve their riparian areas (and reduce local risks associated with climate change). A group in Alberta that enables this type of action is Cows and Fish: Alberta Riparian Management Habitat Society.¹²² This organization is the result of a multi-agency partnership and one of its areas of focus is supporting a proactive and community-driven approach to riparian health and management. Collaborative approaches are created through a hands-on and grassroots method that engages producers and community members.¹²³

A similar cooperative approach could be tested in the Okanagan. This could involve partnering with local groups to identify areas for piloting and then determining and implementing suitable actions to reduce runoff and improve riparian function. However, for this type of process to be successful in BC, it would likely need to be preceded by actions identified in Strategy 3.1. Any group processes would require engagement and support from key agencies and local governments prior to implementation.

The above approach could be supplemented or facilitated by building on existing programs in BC (that are focused on agricultural stakeholders). The Environmental Farm Plan and Beneficial Management Practices Programs already offer an opportunity for groups of producers to work together to accomplish shared goals. Promotion of group implementation of runoff reduction, erosion control or riparian restoration activities could increase uptake through the EFP/BMP. Additional support and resources for FRISP could also increase its capacity to assist groups of producers to take collective action.

ACTION 3.2A Pilot approaches to bring landowners (and key agencies) together to plan and implement runoff/erosion management and riparian restoration activities

- Identify models and best practices for joint planning processes that enable effective implementation
- Identify suitable local pilot locations (and interested cooperators) to test and evaluate group implementation
- Pilot joint planning and implementation in identified areas (that includes a range of land owners/agencies/actors on a water course)

ACTION 3.2B Enhance existing tools/programs (e.g., FRISP, EFP) focused on multi-producer (group) implementation of runoff/erosion management and riparian restoration

- Update existing program materials to reflect the current regulatory context (and any other relevant changes)
- Seek partners with an interest in bolstering funding opportunities and resources for runoff/erosion and riparian management activities
- Develop an engagement strategy with agencies/local governments to support group implementation plans
- Strengthen outreach and promotion of the incentives and benefits associated with implementation

IMPACT AREA 3 > STRATEGY 3.3

Support knowledge transfer for effective management of runoff and erosion and riparian areas

IMPROVING THE DISTRIBUTION and transfer of existing informational resources is a relatively low cost option for supporting increased levels of adoption. Actions to reduce runoff and improve riparian areas hasn't necessarily been widely promoted with the sector. There may be some hesitation to promote these activities if the human resources/financial supports for implementation aren't sufficient. Therefore, the value of any knowledge transfer would be greatly multiplied if it follows the actions identified in Strategy 3.1.

Providing workshops and outreach at times when agricultural producers are available is likely to be effective, as well as linking knowledge transfer into existing sector meetings and events and targeting information to specific commodities. One of the most valuable tools for hands-on education is demonstration. Existing programs (e.g., FRISP/EFP) have implemented projects in the Okanagan that resulted in demonstration sites that can be shared with other producers. However, present capacity to document, share and distribute results is limited, so bolstering the ability of these programs to broaden their demonstration and knowledge transfer activities would be helpful.

Existing materials could be supplemented by cost-benefit analyses (based on case studies) that identify, evaluate and promote a range of benefits that have not necessarily been considered or quantified. One such evaluative project, led by the University of British Columbia Okanagan, is already underway with a group of producers the Okanagan.¹²⁴

It would also be valuable to share results, benefits and challenges of agriculture-focused riparian and runoff management initiatives with local governments and other relevant agencies. This would build understanding about the priorities, issues and needs of agricultural partners in riparian rehabilitation.

ACTION 3.3A Promote cross-agency and sector sharing of key resources and demonstration opportunities

- Undertake a scan of existing activities across the region (to support runoff/riparian management activities) including demonstration sites
- Develop cost-benefit analyses of activities to reduce runoff and/or improve riparian area function
- Bring potential partners together to share information about current activities and resources
- Enhance coordination of knowledge transfer resources and demonstration sites

IMPACT AREA 4: Increasing wildfire risk

WILDFIRES, AND WILDFIRE related evacuations, are a regular occurrence in the Okanagan region, due largely to the arid climate and extensive development on the wildland-urban interface.¹²⁵ However, the past decade has been marked by a number of severe fire years, including in 2009, 2014, and 2015. The 2003 Okanagan Mountain Park fire was the most significant wildfire interface event in BC history, resulting in large-scale evacuations and the loss of over 200 homes.¹²⁶ The fire also completely destroyed St. Hubertus winery and many other wineries in the region lost their crops due to smoke taint.¹²⁷ In 2015, wildfires led to a number of evacuations and evacuation alerts for agricultural operations in the Oliver area.¹²⁸

With projections for more prolonged warm and dry periods, and an increase in the number of extremely hot days, it is anticipated that the Okanagan will experience larger and more frequent wildfires¹²⁹ and an extension of the wildfire season.¹³⁰ Forest die-off due to pine beetle — and logging practices that leave fuel behind — are also increasing wildfire risk.¹³¹

Wildfires jeopardize crop production and quality, livestock health and agricultural infrastructure.¹³² Agricultural operations not immediately threatened by fire can be adversely affected by ash and smoke, with smoke taint being of particular concern for wine grape producers. Some longer lasting agricultural impacts of wildfire include changes to soil characteristics and species composition where intensive burns have occurred. Flooding, soil erosion and landslide risk may also increase in burned or adjacent areas.¹³³

Wildfire response in the Okanagan is managed by the BC Wildfire Service — in conjunction with local fire authorities. Effective mitigation of interface fire risk requires collaboration between multiple levels of government and individual landowners.¹³⁴ Fuel management is a critical element of wildfire mitigation and is the focus of a number of the actions below. A range of resources is available to producers

Relevant Climate Change Impacts

- Increasing number of summer warm days and extremely hot days
- Decreasing precipitation in summer
- Increasing variability of conditions

and landowners to help mitigate risk to their properties and livestock. However, there are presently no resources tailored to the BC agriculture sector, or to the specific types of agricultural operations and conditions in the Okanagan.

Developing and promoting locally suitable resources would support increased adoption of preparedness and mitigation actions. Strengthening initiatives for fuel management, as well as sector-level, community-level and individual producer preparedness, will all play a part in reducing the impacts associated with future wildfires.

The strategies and actions in this section address the following *adaptation goal*:

- *Enhancing tools and resources for wildfire preparedness and mitigation*

IMPACT AREA 4 > STRATEGY 4.1
Support cooperative approaches to fuel management activities

AS NOTED IN the previous section, preparing for and mitigating wildfire risk to agricultural operations relies on action at various levels, but particularly on private properties and in interface areas. Ranchers are also concerned about impacts to fencing infrastructure and rangeland and pasture areas. Fuel management is a critical element of wildfire mitigation and refers primarily to reducing the “fuel load” (vegetation) — and the accompanying level of risk — within the agricultural/wildland interface.

Fuel management along fence lines or property edges (which often abut onto Crown land) is a complex activity. It is not only expensive and time consuming to reduce fuels through pruning or falling trees, but the regulations regarding maintenance of these areas are also challenging for individual producers to interpret. In addition, there are requirements for proper removal of fuels once they are felled.¹³⁵

Burning fuel piles requires expertise and even permitted open burning includes liability risks for

producers. While converting felled fuels into wood chips is a high cost option for individual producers, there may be opportunities to revisit, modify and reinitiate previous chipping programs such as the Agricultural Wood Waste Chipping Program,¹³⁶ with a new focus on supporting fuel management.

Building on existing resources and knowledge, a relatively low cost first step to enhance fuel management would be to identify the highest priority geographic areas and/or issues where collaborative solutions are needed. This planning would require producer participation and engagement from local and provincial government agencies. Implementation of fuel management in these prioritized areas would also require cooperation and partnerships. It will be necessary to work closely with the BC Wildfire Service, regional districts, or directly with licensees to resolve barriers to fuel management, determine the most effective and efficient treatments, and reduce liability concerns for the private property owner or agricultural business.

ACTION 4.1A Identify common threats/issues and specific (geographic) areas where collaborative solutions are needed	ACTION 4.1B Support implementation of priority (selected) fuel management activities
<ul style="list-style-type: none">▪ Define priority areas and appropriate cooperative management activities by:<ul style="list-style-type: none">- Engaging BC Wildfire service (and other wildfire management professionals) for input- Identifying high/extreme risk level areas on agricultural land base from Community Wildfire Protection Plans (CWPPs)¹³⁷- Coordinating focus group discussions in agricultural areas to confirm priority locations▪ Determine resources, expertise, partners and approvals required to implement activities	<ul style="list-style-type: none">▪ Implement priority activities (identified through Action 4.1A) that may include:<ul style="list-style-type: none">- Training, demonstration and/or piloting of silvo-pasture projects in wildfire risk areas- Convening key partners (BC Wildfire Service, forest licensees, Ministry of Agriculture range staff) to discuss options for removal of forest fuels near agricultural operations- Determining the feasibility of a multi-stakeholder or cross-region chipping program (review lessons learned from earlier studies/programs)- Identifying the extent of producer demand for logging slash as an input (for mulch/compost) and linking producers to logging waste supply

IMPACT AREA 4 > STRATEGY 4.2

Support individual operations with planning for wildfire preparedness and mitigation

WHILE WILDFIRE RESPONSE is largely the responsibility of government agencies, there is a need for individual producers to prepare, and take steps to mitigate potential impacts, in advance of a wildfire. There is a broad range of operation types in the Okanagan and this diversity means that appropriate strategies are likely to vary considerably. Recent experiences with fires in this region provide a strong base of knowledge for producers to incorporate into preparedness and mitigation planning.

The primary existing approach to mitigation and preparedness on private property is through the FireSmart program. This program enables groups of residents to plan for wildfire safety on their own properties and in their community (which can be a rural area or a group of farms or ranches).¹³⁸ All-hazard emergency planning guides have been developed for some BC commodities and the (high-level) wildfire sections of these documents provide additional materials.¹³⁹ While the above opportunities are available, it appears that many producers are not aware of them (and therefore uptake is minimal). Collaborating with Partners in Protection Canada, local governments and local fire departments to promote agriculture-focused knowledge transfer is a logical step.

A pilot project is also underway (anticipated completion in June of 2016) in the Cariboo region that has the potential to be adapted for the Okanagan context.¹⁴⁰ This project is developing a template for individual ranch operators to identify priority assets, key risks and possible actions for wildfire preparedness/mitigation. Common costs, issues and barriers around implementation of mitigation measures are also being identified through this project. Additional steps would be required for this tool to be applicable to the range of Okanagan operations.

ACTION 4.2A Pilot wildfire preparedness and mitigation planning tools for individual operations	ACTION 4.2B Undertake knowledge transfer and training to support individual operation preparedness/mitigation
<ul style="list-style-type: none">▪ Develop two pilot approaches (one for ranches, one for other commodity types) for developing individual operation wildfire plans; build on the Cariboo region wildfire pilot project▪ Assist producers to identify and implement fuel management strategies on their own properties	<ul style="list-style-type: none">▪ Partner with local governments and Partners in Protection Canada to provide knowledge transfer and education around existing resources and technologies (e.g., FireSmart workshops, demonstration sites and print/web-based materials)▪ Develop effective distribution/communication for planning tools resulting from Action 4.2A▪ Facilitate <i>ongoing</i> agriculture sector access to, and uptake of, FireSmart tools and resources resulting from 4.2A

IMPACT AREA 4 > STRATEGY 4.3

Support regional-scale planning and implementation for wildfire preparedness and mitigation

IN BRITISH COLUMBIA, local fire departments, regional emergency and protective services and the provincial Wildfire Management Branch are responsible for different aspects of fire prevention and management. Regional districts play a coordination and administrative role, providing consistency across local fire departments, which positions them well to lead wildfire planning and preparedness initiatives.¹⁴¹

Community Wildfire Protection Plans (CWPPs) are developed by local governments to define wildfire risk areas, to identify measures to mitigate risks, and to outline a plan of action and associated costs for implementation.¹⁴² However, at the landscape level, the focus of wildfire mitigation and fuel management activities is on areas of high and extreme risk on Crown land.¹⁴³ Existing planning processes and implementation programs do not necessarily include the agriculture/wildland interface and areas of high priority for the agriculture sector.

The Regional District of Okanagan Similkameen and the Regional District of Central Okanagan — along with Kelowna and West Kelowna — have completed CWPPs. Revisiting CWPPs to include more agricultural values would also enable local governments to pursue funding for fuel management treatments in agricultural areas. Despite their limited scope, CWPPs often contain recommendations that are of value to the agriculture sector. Fostering partnerships to drive implementation of these actions would be a valuable step.

In addition to extending the scope of CWPPs, livestock relocation and management planning is another priority area for Okanagan producers. This type of planning is of particular concern to the dairy sector but also to other types of livestock operations. For such plans to be effective, they require engagement of the sector during their development and following completion (to ensure producers provide input and are aware of the implementation steps). A completed plan can also provide a mechanism to share information (with key agencies) in advance of an emergency, and to support more effective lines of communication in the event of a wildfire.

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<p>ACTION 4.3A Support development of Community Wildfire Protection Plans (CWPPs) – in partnership with agricultural stakeholders – and implement recommendations of benefit to agriculture in existing CWPPs</p> <ul style="list-style-type: none">▪ Encourage and support development of Regional CWPPs (where they do not exist) and highlight the need for recommendations pertaining to agriculture sector▪ Support implementation of actions from completed CWPPs, such as:<ul style="list-style-type: none">- Developing a database of water supply sources and locations in agricultural areas (stored and natural)- Developing landscape level fuel breaks adjacent to the Regional District wildland interface, prioritizing high value agricultural operations (see 4.1A and 4.1B)▪ Foster periodic direct dialogue between high-risk range tenure holders and BC Wildfire Service to exchange information (e.g., size of operations, locations of grazing / grazing plans, locations of access roads)<ul style="list-style-type: none">- Link meeting to local and/or BC Cattlemen's Association Annual General Meeting- Ensure that local protection office/ fire departments and relevant provincial government agencies receive information	<p>ACTION 4.3B Establish regional livestock emergency relocation and management plans</p> <ul style="list-style-type: none">▪ Determine geographic scope of planning and confirm which commodity groups wish to be included▪ Develop emergency/relocation management plans that include:<ul style="list-style-type: none">- Consideration of the various emergency and relocation needs of different types of producers/ operations- Designations of levels of relocation required for different areas▪ Coordinate a workshop between local governments and BC Wildfire Service to ensure pertinent information about livestock plans is provided in advance of emergency situations
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Implementation & Monitoring

While all of the actions contained in this plan are important for the Okanagan sector to adapt to climate change, the actions on the following pages are identified as “next steps.” This is due to their importance and may also reflect their relative ease of implementation, or their potential to build capacity for further adaptation actions (see text box on this page). Building momentum and capacity for collective action, and addressing the most important issues, will help to ensure implementation of all of the identified actions.

As the final stage in plan development, an implementation meeting was held with key partners (30 individuals) to prioritize actions and determine how to move forward with them. The input received at this meeting informs the content below.

In some cases, individual actions have been merged into single projects because this is the most effective and efficient way to accomplish them. Implementation conditions, such as potential partners and cost range, are identified for each of the next steps.

In order to move forward with project implementation, members of the Advisory Committee that supported the development of this plan will transition into a local working group to oversee the implementation and monitor progress. This group will continue to include agricultural organizations, local government and provincial government representatives. The Climate Action Initiative will function as the overall coordinator for this group and will also lead project

development and assist with monitoring progress and reporting.

For each action in the Next Steps below, potential partners are identified. Potential partners were determined through workshops and subsequent draft development, but no formal commitments have been made regarding roles in various strategies and actions. Development of partnerships will be a preliminary activity in project development.

- **Important** actions are those that address the highest priority impacts or critical gaps for building resilience.
- **Ease of implementation** refers to actions that can be initiated without delay because there is a window of opportunity, there are clear co-benefits with other actors or programs, or there are minimal barriers to address. These actions can also create momentum to help move more difficult or longer-term actions forward.
- **Capacity building** actions support the sector by strengthening the ability of producers and producer organizations to take effective action. This may include filling knowledge gaps or developing resources that strengthen the ability to act collectively or individually.

NEXT STEPS FOR ACTIONS 1.1A & 1.1B

Actions

- Consult with the agricultural sector to determine cross-sector objectives for drought planning
- Develop a framework for (consistent and structured) engagement of agricultural water users in local drought planning processes

Implementation details

- These actions will be most effective if executed in a step-wise manner, as buy-in is needed for project credibility and effective progress
- Consultation with the agricultural sector may involve a forum, small group consultations, a cross-commodity working group or some other mechanism
- There are existing examples of effective drought planning processes in the region and this project may be linked into (or build on) these

Potential partners

- Agricultural organizations
- Water utilities and irrigation districts
- Independent water licensees
- Okanagan Basin Water Board
- Ministry of Agriculture
- Ministry of Forests, Lands and Natural Resource Operations
- Regional districts and municipal governments
- Okanagan Nation Alliance

Timeframe

- Phase 1 (consultation with agricultural sector) = Short term (**LESS THAN 2 YEARS**)
- Phase 2 = Short-term (**LESS THAN 2 YEARS**)

Cost

- Phase 1 = Low (**LESS THAN \$50,000**) to medium (\$50,000-\$100,000)
- Phase 2 = Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTION 1.2A

Actions

- Create a consistent (and data driven) system for disseminating source-specific water supply information

Implementation details

- Success of this project will depend on collaboration between many partners
- Okanagan Basin Water Board is currently working on filling data gaps regarding water supply and water use
- Focus on supplying the agricultural sector with 'source-specific' information and then consider feasibility of communication targeted to commodity type
- Will need to develop and test new outreach mechanisms

Potential partners

- Agricultural organizations
- Water utilities and irrigation districts
- Ministry of Agriculture
- Ministry of Forests, Lands and Natural Resource Operations
- Regional districts and municipal governments
- Okanagan Basin Water Board

Timeframe

- Medium-term (**2-4 YEARS**)

Cost

- Medium (**\$50,000-\$100,000**)

NEXT STEPS FOR ACTION 1.3B

Actions

- Support a range of knowledge transfer resources to provide information about existing water management best practices

Implementation details

- This action is intended to be broken down into individual projects (e.g., cost-benefit analysis, water extension pilot, knowledge transfer)
- First step is to determine highest priority knowledge transfer approaches
- Explore opportunities to "piggy-back" on current industry field services and/or partner across groups to pilot water extension agent

Potential partners

- Agricultural organizations
- Ministry of Agriculture
- Agriculture and Agri-Food Canada (Summerland)
- Post-secondary institutions

Timeframe

- First few projects = Short-term (**LESS THAN 2 YEARS**)
- Multiple projects = Medium-term (**2-4 YEARS**)

Cost

- First few projects / knowledge transfer = Medium (\$50,000-\$100,000)
- Multiple projects = High (\$100,000+)

NEXT STEPS FOR ACTION 2.2A

Action

- Develop resources to link weather and pest/disease data with decision support tools (e.g., pest phenology predictions and disease pressure tools)

Implementation details

- First step is to determine potential for transferability of existing tools (e.g., applicability/accessibility of Washington State University tool for Okanagan context)
- Costs will depend on extent of investment required to develop relevant decision support tools (and to close any weather monitoring gaps)
- Project will be required to incorporate sustainability planning (for maintaining and updating resources/tools)

Potential partners

- Agricultural organizations
- Ministry of Agriculture
- Sterile Insect Release Program
- Agriculture and Agri-Food Canada
- Post-secondary institutions
- Farmwest

Timeframe

- First pilot = Medium-term (**2-4 YEARS**)

Cost

- High (\$100,000+)

NEXT STEPS FOR ACTION 2.3A

Action

- Enhance knowledge transfer for monitoring and management of agriculturally significant invasive species

Implementation details

- For monitoring, proper identification is crucial and will require specialized training/knowledge transfer
- Focus on broadening reach of existing materials (e.g., OASISS has a strong presence/role in the southern portion of the region but not in north)
- Annual “roundtable” or extension committee will strengthen linkages but there will also be a need to distribute information through established sector communication channels

Potential partners

- Okanagan and Similkameen Invasive Species Society
- Sector organizations
- Ministry of Agriculture
- Agriculture and Agri-Food Canada
- Regional districts

Timeframe

- Phase 1: Initial roundtable meeting, materials development and outreach = Short-term (**LESS THAN 2 YEARS**)
- Phase 2: Knowledge transfer to producers and non-producer landowners = Medium-term (**2-4 YEARS**)

Cost

- Phase 1 = Medium (\$50,000-\$100,000)
- Phase 2 = Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTIONS 3.1A & 3.2B

Action

- Assess existing and alternative processes (policy, programmatic and financial tools) to support implementation of runoff/erosion management and riparian rehabilitation
- Facilitate dialogue between producer groups and key agencies to determine preferred options to improve processes/supports

Implementation details

- Actions will require leadership, partnerships and broad cooperation to succeed (agricultural groups, provincial and regional governments)
- Need strong facilitation/guidance to find constructive solutions
- Models for effective processes exist in other jurisdictions and could inform BC's future approach

Potential partners

- Agricultural organizations
- Ministry of Agriculture
- Ministry of Forests, Lands and Natural Resource Operations
- Ministry of Environment
- Fisheries and Oceans Canada
- Regional districts

Timeframe

- Short-term (**LESS THAN 2 YEARS**)

Cost

- Assessment and facilitated dialogue = Low (**LESS THAN \$50,000**) to medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTION 4.1B

Action

- Support implementation of priority (selected) fuel management activities

Implementation details

- Cariboo pilot project (for wildfire preparedness and mitigation) could inform this action
- Union of BC Municipalities funding is available for fuel management prescriptions and fuel management treatments (for areas identified in Community Wildfire Protection Plans)
- Funding may be available through BC's new Forest Enhancement Program

Potential partners

- Regional districts and municipalities / fire departments
- BC Wildfire Service
- Forest licensees
- Ministry of Forests, Lands and Natural Resource Operations range staff
- Ministry of Agriculture
- Agricultural producers

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Range in costs depending on which fuel management option(s) are pursued, for example:
 - Slash as mulch/compost feasibility study = Low (*LESS THAN \$50,000*)
 - Silvo-pasture pilots = Medium (\$50,000–\$100,000)
 - Chipping program = High (\$100,000+)

NEXT STEPS FOR ACTIONS 4.2A & 4.2B

Action

- Pilot wildfire preparedness and mitigation planning tools for individual operations
- Undertake knowledge transfer and training to support individual operation preparedness/mitigation

Implementation details

- Cariboo pilot project (for wildfire preparedness and mitigation) could inform these actions
- In 2015/2016, FireSmart grants available for local governments for wildfire preparedness knowledge transfer, planning and public engagement activities
- Tools and resources should reside with the agencies who have the most capacity to share and communicate the information

Potential partners

- Agricultural organizations and producers
- Partners in Protection Canada (FireSmart Program)
- Local governments
- Local fire departments
- Agricultural Advisory Committees

Timeframe

- Pilot planning tools = Short-term (*LESS THAN 2 YEARS*)
- Knowledge transfer / access to existing tools = Short term (*LESS THAN 2 YEARS*)

Cost

- Pilot planning tools = Low (*LESS THAN \$50,000*) to medium (\$50,000–\$100,000)
- Knowledge transfer / access to existing tools = Low (*LESS THAN \$50,000*)

APPENDIX A: Weather, Climate & Variability

WEATHER IS WHAT happens on a particular day at a particular location. Farmers are continually required to adapt to weather conditions to effectively plan and manage their businesses. In contrast, climate refers to long-term trends, patterns and averages over time. These are more difficult to notice through day-to-day or year-to-year experiences, or short-term records of weather. However, over a period of decades, recorded observations can characterize the climate and identify trends.

Anyone who pays close attention to weather forecasts appreciates that predictions of weather are often limited in their accuracy. This is partly because of the many factors that impact weather. Turning to longer, climate-related timescales, in BC we are familiar with the 3–7 year cycles of El Niño and La Niña (“ENSO”), which dramatically impact the climate of individual seasons and years (see Figure 5). Compared to La Niña years, conditions in BC during El Niño years are typically warmer and drier in winter and spring, and less stormy in southern BC.

Adding to the complexity, the Pacific Decadal Oscillation (PDO) is a known pattern that shifts over longer time periods (20 to 30 years) and this is associated with different temperature and precipitation conditions here in BC. It also has a warm and cool phase, and so it can either enhance or dampen the impacts of El Niño and La Niña conditions in a given year.

Figure 5 shows the difference between climate variability, oscillations, and climate change. The many factors that impact the weather create significant variation in what we experience from year to year. However, we are still able to chart averages over long periods of time.

For additional resources see *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment Series* (www.bccagclimateaction.ca/regional/overview/risks-opportunities/).

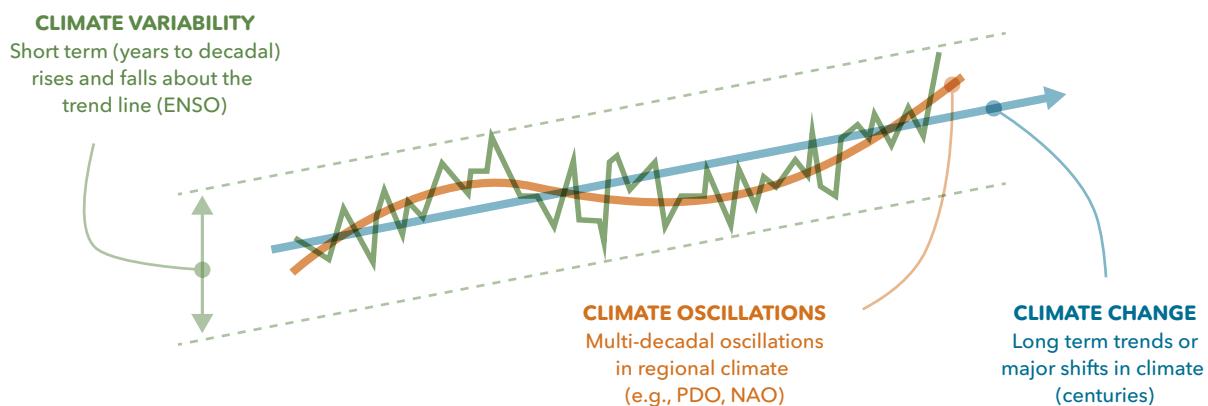


FIGURE 5 Climate Variability, Oscillations & Change

Diagram showing difference between climate variability, oscillations, and climate change.
Adapted from original, courtesy of Pacific Climate Impacts Consortium, www.pacificclimate.org

APPENDIX B: Future Projections: Climate Maps & PCIC Tables

TABLE 2 Okanagan Climate Projections — 2020s
(SOURCE: Pacific Climate Impacts Consortium, www.Plan2Adapt.ca)

Climate Variable	Time of Year	Projected Change from 1971-2000 Baseline to 2020s			
		Okanagan (Range)		Okanagan (Average)	BC (Average)
Mean Temperature (°C)	Annual	+0.9 °C	to	+1.9 °C	+1.4 °C
Precipitation (%)	Annual	-1.7%	to	+7.6%	+1.2%
	Summer	-22.2%	to	+6.7%	-8.4%
	Winter	-1.7%	to	+15.9%	+6%
Snowfall (%)	Annual	-15%	to	0%	-9%
Growing Degree Days (degree days)	Annual	+249	to	+386	+249
Heating Degree Days (degree days)	Annual	-642	to	-304	-458
Frost-Free Days (days)	Annual	+14	to	+31	+21
					+10

TABLE 3 Okanagan Climate Projections — 2050s
(SOURCE: Pacific Climate Impacts Consortium, www.Plan2Adapt.ca)

Climate Variable	Time of Year	Projected Change from 1971-2000 Baseline to 2050s			
		Okanagan (Range)		Okanagan (Average)	BC (Average)
Mean Temperature (°C)	Annual	+1.3 °C	to	+3.5 °C	+2.4 °C
Precipitation (%)	Annual	-1.3%	to	+11.9%	+4.4%
	Summer	-31.2%	to	+3.2%	-9.2%
	Winter	-3.1%	to	+19.1%	+9.2%
Snowfall (%)	Annual	-27%	to	-7.2%	-19%
Growing Degree Days (degree days)	Annual	+221	to	+741	+453
Heating Degree Days (degree days)	Annual	-1,104	to	-452	-800
Frost-Free Days (days)	Annual	+22	to	+59	+38
					+20

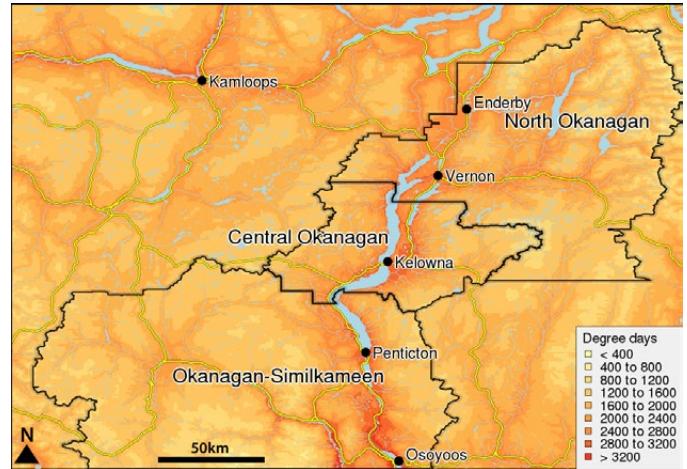
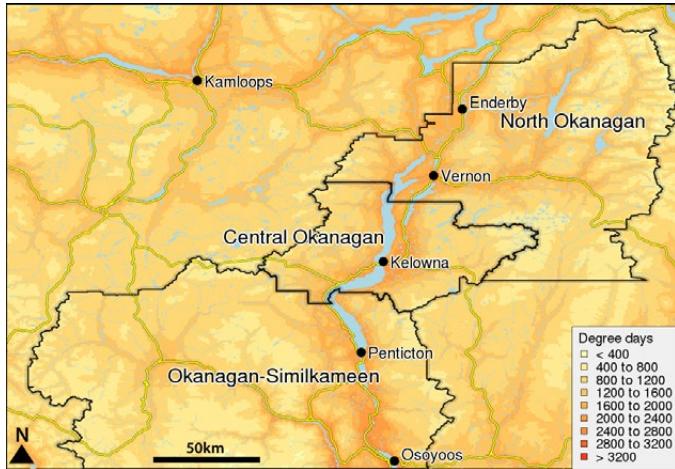


FIGURE 6 Growing Degree Days,
Baseline 1971–2000 (left) and 2050s Projection (right)

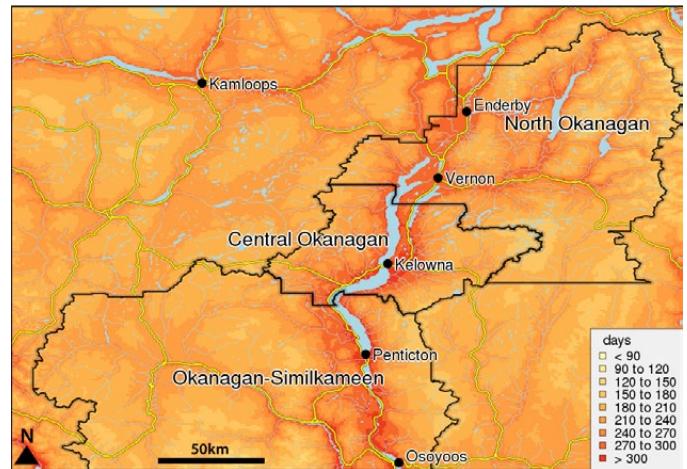
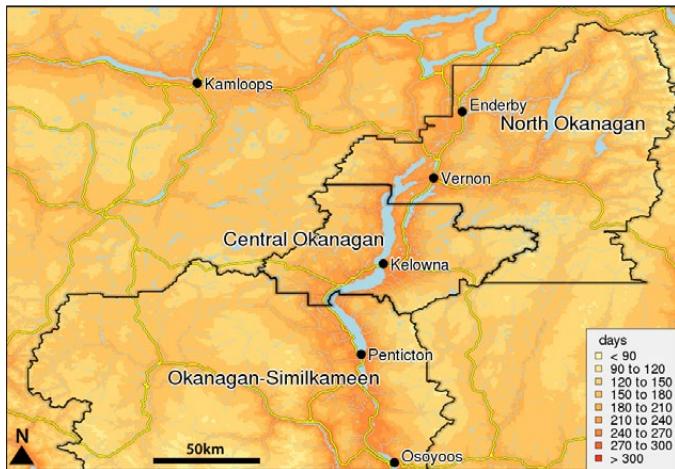


FIGURE 7 Frost-Free Period,
Baseline 1971–2000 (left) and 2050s Projection (right)

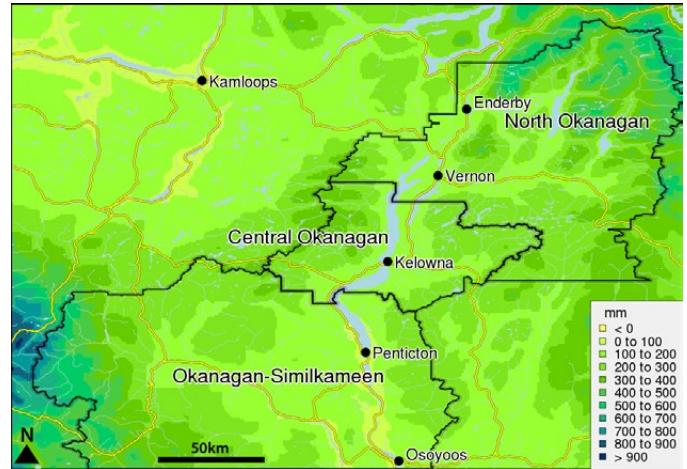
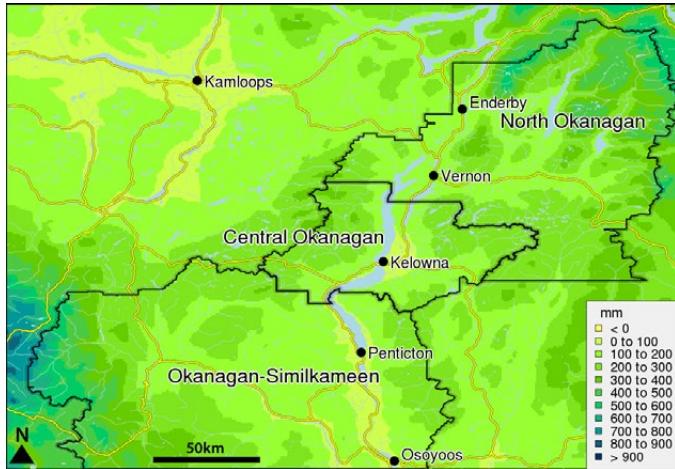


FIGURE 8 Winter Precipitation (mm),
Baseline 1971–2000 (top) and 2050s Projection (bottom)

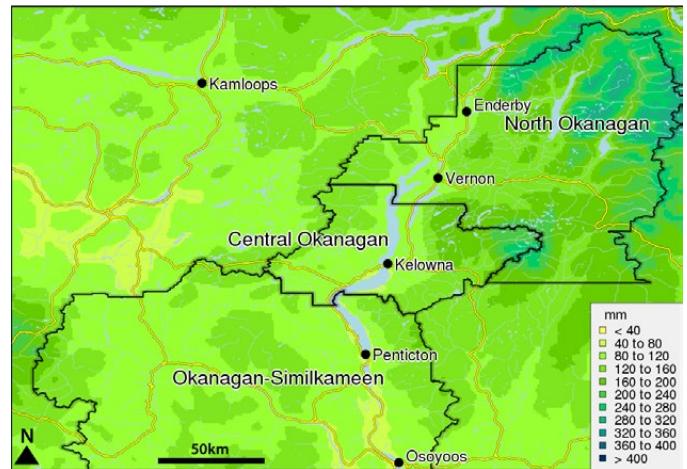
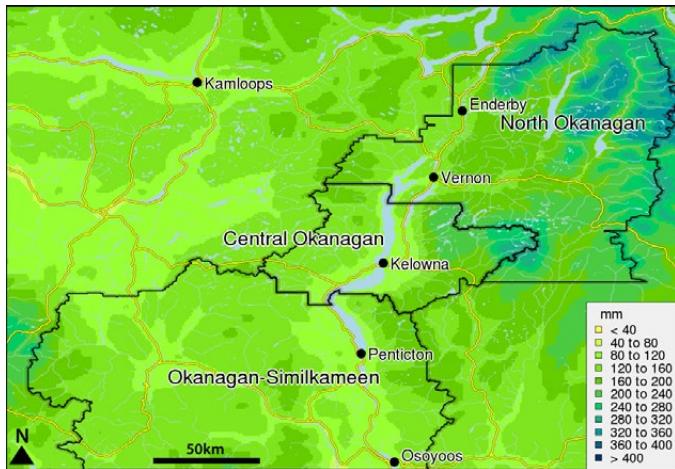


FIGURE 9 Summer Precipitation (mm),
Baseline 1971–2000 (top) and 2050s Projection (bottom)

Note that for legibility, winter and summer use different legends and so cannot be directly compared.

APPENDIX C: Definitions

- **Growing Degree Days (GDD)**

are a measure of heat accumulation, and represent the cumulative number of degrees that the average daily temperature is above a base temperature of 5 degrees, for all days of the year.

- **Frost-Free Days (FFD)**

are the number of days the temperature is above freezing.

- **Frost-Free Period (FFP)**

is the consecutive number of days between first frost in fall and last frost in spring.

- **Heating Degree Days**

are a measure of energy demand, and represent the cumulative number of degrees that the average daily temperature is below a base temperature of 18 degrees (when heating is required), for all days of the year.

- **Cooling Degree Days**

represent the cumulative number of degrees above a base temperature of 18° Celsius (when cooling is required), and is the opposite of Heating Degree Days.

APPENDIX D: Adaptive Management of Climate Change Impacts

CLIMATE CHANGE ADAPTATION decision-making is an inherently complex task that requires ongoing learning and reflection to adjust to changing information, events and conditions. As learning progresses, new solutions as well as new challenges will be identified. The following questions are provided as tools for navigating this evolving landscape and determining priorities for action.

Additional considerations when determining how to implement priority actions would include:

- Barriers (e.g., legislation, lack of working relationships)
- Assets/Enablers (e.g., leadership, integrating into existing plans/programs)
- Implementation costs
- Operation and maintenance costs
- Financing and resources
- Timeframe

TABLE 4 Developing & Prioritizing Adaptation Actions

Effectiveness	To what degree does this action reduce risk/vulnerability, and/or enhance resilience?
Adaptability	Can this action (and resources dedicated to it) be changed or redirected as conditions change?
Urgency	When does action need to be taken on this issue, in order to be effective by the time an impact is projected to occur?
Gaps & Assets	How does this action address identified gaps or barriers? How can it build on existing assets and resources?
Co-benefits ("no-regrets")	What other benefits would this action have, even if climate change impacts do not occur as projected?
Consequences	What could be the unintended and/or undesirable effects of taking this action? Can these be avoided or mitigated?
Extent	Do the benefits apply broadly in the region, or to specific individuals?
Relevance	Does this action have the support of the agricultural community?

ENDNOTES

- 1 Climate Action Initiative. (2012). *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment Series: Fraser Valley & Metro Vancouver Snapshot Report*. <http://www.bcaplimateaction.ca/wp/wp-content/media/AdaptR0series-FraserMetroVan.pdf>
- 2 Statistics Canada. (2012). *Okanagan-Similkameen, British Columbia (Code 5907), North Okanagan, British Columbia (Code 5937) and Central Okanagan, British Columbia (Code 5935)* (table). *Census Profile 2011 Census*. Statistics Canada Catalogue no. 98-316-XWE. Ottawa. <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- 3 Regional District of Okanagan-Similkameen <http://www.rdos.bc.ca/regional-government/what-we-do/what-we-do/> and Regional District of North Okanagan <http://www.rdns.ca/index.php/about/rdno> and Regional District of Central Okanagan <http://www.regionaldistrict.com/about-the-rdco/what-we-do.aspx>
- 4 Okanagan Nation Alliance. <http://www.syilx.org/who-we-are/organization-information/ona-member-bands/>
- 5 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.
- 6 Okanagan Valley Economic Development Society. (2015). Okanagan Valley Economic Profile. <http://www.investkelowna.com/sites/default/files/uploads/OVEDS-Eco-Profile%202015r1.pdf>
- 7 Canada – British Columbia Okanagan Basin Agreement. (1974). Main Report of the Consultative Board: Chapter 1 http://www.obwb.ca/obwrid/docs/055_1974_Main_Report_Consultative_Board.pdf and Central Okanagan Regional District. (2005). Agricultural Plan http://www.regionaldistrict.com/media/51864/AgPlan_final_June2005.pdf
- 8 Cohen, Stewart and Tanuja Kulkarni (eds.). (2001). *Water Management & Climate Change in the Okanagan Basin*. Environment Canada & University of British Columbia. P 9. http://www.nrcan.gc.ca/earth-sciences/projdb/pdf/46_e.pdf
- 9 Okanagan Valley Economic Development Society. (2015). Okanagan Valley Economic Profile. <http://www.investkelowna.com/sites/default/files/uploads/OVEDS-Eco-Profile%202015r1.pdf>
- 10 Based on review of four agriculturally relevant stations located across the three regional districts. Environment Canada. (2015). *Canadian Climate Normals 1981–2010 Station Data*. http://climate.weather.gc.ca/climate_normals/
- 11 Canada – British Columbia Okanagan Basin Agreement. (1974). Main Report of the Consultative Board: Chapter 1 http://www.obwb.ca/obwrid/docs/055_1974_Main_Report_Consultative_Board.pdf
- 12 Central Okanagan Regional District. (2005). Agricultural Plan http://www.regionaldistrict.com/media/51864/AgPlan_final_June2005.pdf
- 13 Canada – British Columbia Okanagan Basin Agreement. (1974). Main Report of the Consultative Board: Chapter 1 http://www.obwb.ca/obwrid/docs/055_1974_Main_Report_Consultative_Board.pdf
- 14 Note: Arable is defined as having productive capacity; not all of this land is necessarily in the ALR, nor necessarily under production. Canada – British Columbia Okanagan Basin Agreement. (1974). Main Report of the Consultative Board: Chapter 1 http://www.obwb.ca/obwrid/docs/055_1974_Main_Report_Consultative_Board.pdf
- 15 van der Gulik, Ted., Neilsen, Denise., and Fretwell, Ron. (2010). *Agriculture Water Demand Model Report for the Okanagan Basin*. http://www.obwb.ca/wsd/wp-content/uploads/2015/11/500300-3_agric_water_demand_model-okanagan_report.pdf and Provincial Agricultural Land Commission. (2016). Okanagan Panel Region Map http://www.alc.gov.bc.ca/assets/alc/assets/alr-and-maps/maps-and-gis/okanagan_panel.pdf
- 16 Canada – British Columbia Okanagan Basin Agreement. (1974). Main Report of the Consultative Board: Chapter 1 http://www.obwb.ca/obwrid/docs/055_1974_Main_Report_Consultative_Board.pdf
- 17 BC Wine Institute. (2016). Regions: Okanagan Valley. http://www.winebc.org/about_bcwi/regions/
- 18 Soil limitations may include: root restriction imposed by the clayey subsoils, late spring frosts, stoniness. BC Wine Institute. (2016) Regions: Okanagan Valley. http://www.winebc.org/about_bcwi/regions/
- 19 Central Okanagan Regional District. (2005). Agricultural Plan http://www.regionaldistrict.com/media/51864/AgPlan_final_June2005.pdf
- 20 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.
- 21 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.
- 22 Beesley, Kenneth B. (2010). The rural urban fringe in Canada: conflict and controversy. Rural Development Institute Brandon University. Canada, pp.165.

- 23 Okanagan Valley Economic Development Society. (2015). Okanagan Valley Economic Profile. <http://www.investkelowna.com/sites/default/files/uploads/OVEDS-Eco-Profile%202015r1.pdf>
- 24 Central Okanagan Economic Development Commission. (2015). Central Okanagan Economic Profile for Agriculture. http://www.investkelowna.com/sites/default/files/uploads/agriculturalprofile_centralokanagan_2015-11-20.pdf
- 25 The Okanagan-Kootenay Sterile Insect Release Program (OKSIR) is an area-wide, environmentally-friendly approach to the management of codling moth populations in the fruit-growing areas of the Okanagan, Similkameen and Shuswap Valleys. Central Okanagan Economic Development Commission. (2015). Central Okanagan Economic Profile for Agriculture. http://www.investkelowna.com/sites/default/files/uploads/agriculturalprofile_centralokanagan_2015-11-20.pdf
- 26 The Monitoring and Evaluation: Building on Experience towards an Inter-regional Framework project will identify common indicators to use across the three Regional Districts. One or more of the indicators will pertain to the strength and viability of the agriculture sector. Laura Frank, personal communication, March 11, 2016.
- 27 van der Gulik, Ted. Neilsen, Denise, and Fretwell, Ron. (2010). Agriculture Water Demand Model Report for the Okanagan Basin http://www.obwb.ca/wsd/wp-content/uploads/2015/11/500300-3_agric_water_demand_model-okanagan_report.pdf
- 28 Cannings, Richard J. and Durance, Eva. (1988). 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. http://www.naturewatch.ca/eman/reports/publications/99_montane/humans/humans07.html
- 29 For example, the Okanagan Water Supply and Demand Study (<http://www.obwb.ca/wsd/>) and the multi-stakeholder decision support tool "Okanagan Fish/Water Management Tool" (<http://essa.com/tools/okfwm/>). Also see Cohen, S., D. Neilsen, and R. Welbourn (eds.). (2004). Expanding the Dialogue on Climate Change & Water Management in the Okanagan Basin, British Columbia. Final Report for project A463/433, Climate Change Impacts and Adaptation Program, Natural Resources Canada.
- 30 British Columbia Agriculture Council. <https://www.bcac.bc.ca/>
- 31 Samson Lee, Spatial Data Analyst, Ministry of Agriculture Innovation and Adaptation Services, personal communication, March 11, 2016.
- 32 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.
- 33 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE and Statistics Canada (2006). 2006 Census of Agriculture, Farm Data and Farm Operator Data, catalogue no. 95-629-XWE.
- 34 Okanagan Valley Economic Development Society. (2015). Okanagan Valley Economic Profile. <http://www.investkelowna.com/sites/default/files/uploads/OVEDS-Eco-Profile%202015r1.pdf>
- 35 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.
- 36 Government of BC. (2016) Okanagan – Overview. <http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-regions/okanagan>
- 37 BC Ministry of Agriculture & Lands. (2007). 2006 Census of Agriculture and Historical Comparisons. http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/census/agricensus_2006_bchighlights.pdf
- 38 Central Okanagan Economic Development Commission. (2015). Central Okanagan Economic Profile for Agriculture. http://www.investkelowna.com/sites/default/files/uploads/agriculturalprofile_centralokanagan_2015-11-20.pdf
- 39 BC Ministry of Agriculture & Lands. (2007). 2006 Census of Agriculture and Historical Comparisons. http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/census/agricensus_2006_bchighlights.pdf
- 40 British Columbia Grape Growers Association. (2014). BC Grape Acreage Report. <http://grapegrowers.bc.ca/pdf/2014AcreageSurveyReport.pdf>
- 41 BC Ministry of Agriculture & Lands. (2009). Regional District of Central Okanagan Agricultural Overview. <http://www.investkelowna.com/documents/RDCentralOkAgOv.pdf>
- 42 Beesley, Kenneth B. (2010). The rural urban fringe in Canada: conflict and controversy. Rural Development Institute Brandon University, Canada, pp.166.
- 43 Central Okanagan Economic Development Commission. (2015). Central Okanagan Economic Profile for Agriculture. http://www.investkelowna.com/sites/default/files/uploads/agriculturalprofile_centralokanagan_2015-11-20.pdf
- 44 BC Ministry of Agriculture & Lands. (2008). Regional District of North Okanagan Agricultural Overview. http://www.agf.gov.bc.ca/resmgmt/sf/agoverviews_2006census/RD_North_OK_Ag_Overview.pdf and Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE
- 45 Statistics Canada. (2012). 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE and Statistics Canada (2006). 2006 Census of Agriculture, Farm Data and Farm Operator Data, catalogue no. 95-629-XWE.

- 46 Walsh, J. (2012). Climate Models. Encyclopedia of Global Warming and Climate Change, S. George Philander (Editor), pp. 292
- 47 Daly, C., Halbleib, M., Smith, J.I., Gibson, W.P., Doggett, M.K., Taylor, G.H., Curtis, J., and Pasteris, P.A. (2008). Physiographically-sensitive mapping of temperature and precipitation across the conterminous United States. *International Journal of Climatology*, 28: 2031–2064.
- 48 Pacific Climate Impacts Consortium <http://www.pacificclimate.org>
- 49 For more explanation of model outputs and ranges, see <http://www.plan2adapt.ca>
- 50 Source for extremes projections: Regional Climate model projections from the North American Regional Climate Change Assessment Program, analyzed by PCIC.
- 51 Pests refers to insects, weeds, diseases and invasive species with potential to negatively impact agricultural production.
- 52 Okanagan Water Stewardship Council. (2008). Okanagan Sustainable Water Strategy – Action Plan 1.0. p.5
- 53 Meritt, W. et al. (2006). Hydrological response to scenarios of climate change in sub watersheds of the Okanagan Basin, British Columbia. *Journal of Hydrology*. 326, 79–108.
- 54 Okanagan Basin Water Board (2011). Local Government User Guide: Okanagan Water Supply and Demand Project.
- 55 Okanagan Basin Water Board. (2012). Phase 3 Okanagan Basin Water Supply and Demand Project: Projected Water Supply and Use in the Okanagan Basin (2011–2040) – Okanagan Basin Water Accounting Model Results. Note: five consecutive years of drought are expected to result in up to 50% less surface water run-off being produced relative to normal conditions.
- 56 CBC News. (August 5, 2016). BC drought: Okanagan region issued Level 4 rating. CBC News: British Columbia. <http://www.cbc.ca/news/canada/british-columbia/bc-drought-okanagan-region-issued-level-4-rating-1.3180760>
- 57 Ministry of Environment. (2015). British Columbia Drought Response Plan. <http://www.summerland.ca/docs/default-source/works-and-utilities/bc-drought-response-plan.pdf?sfvrsn=0>
- 58 District of Summerland. (2003). State of Local Emergency Declaration. <http://www.dist.summerland.bc.ca/docs/Water%20Restrictions/extension%20state%20of%20emergency.pdf>
- 59 Okanagan Basin Water Board. (2008). Okanagan Sustainable Water Strategy: Action Plan 1.0. Prepared for the Okanagan Water Stewardship Council.
- 60 There are approximately 100,000 hectares of ALR land in the Okanagan Region. The *Agriculture Water Demand Model: Report for the Okanagan Basin* reports that of this total ALR land base, 34,951 hectares, are primarily used for agricultural purposes of which 52% was under irrigation in 2003 (equaling 18,416 hectares).
- 61 van der Gulik, T., Neilsen, D., Fretwell, R. (2010). Agriculture Water Demand Model: Report for the Okanagan Basin. p.29.
- 62 Okanagan Basin Water Board (2011). Local Government User Guide: Okanagan Water Supply and Demand Project. p.10. http://www.obwb.ca/wsd/wp-content/uploads/2011/08/OBWB_Local_Government_Guide_OWSD_Project.pdf
- 63 Harma, K., Johnson, M., Cohen S. (2012). Future Water Supply and Demand in the Okanagan Basin, British Columbia: A Scenario-Based Analysis of Multiple, Interacting Stressors. *Water Resource Management*. 26, p.667–689.
- 64 Okanagan Water Stewardship Council. (2008). Okanagan Basin Sustainable Water Strategy 1.0. Okanagan Basin Water Board. p.ix.
- 65 van der Gulik, T., Neilsen, D., Fretwell, R. (2010). Agriculture Water Demand Model – Report for the Okanagan Basin. p.45–47.
- 66 Kelowna water users are supplied by one of five water purveyors (unless they have an independent water licence); the City of Kelowna, Rutland Waterworks District, Black Mountain Irrigation District, South East Kelowna Irrigation District, and Glenmore-Ellison Improvement District. These five large purveyors participate in The Kelowna Joint Water Committee (KJWC), a coordinating organization that promotes standardization of methods and materials, improves communications, and provides an integrated approach to water supply within the City boundaries. <https://www.kjwc.org>
- 67 Okanagan Water Stewardship Council. (2008). Okanagan Basin Sustainable Water Strategy 1.0. Okanagan Basin Water Board. p.51.
- 68 Ibid.
- 69 The Greater Vernon Water Utility Master Water Plan (MWP) is document that provides direction for the next 40 years to ensure compliance with Provincial standards to safeguard health and to meet future water needs based on predicted growth. <http://www.rdns.ca/index.php/services/engineering/water/greater-vernon-water/master-water-plan>
- 70 The District of Summerland developed The Trout Creek Water Use Plan — an operating agreement for the Trout Creek reservoirs — through a consultative process in 2004/05 with representatives from the District of Summerland, Ministry of Water, Land and Air Protection, Ministry of Agriculture, Food and Fisheries, Fisheries and Oceans Canada, Agricultural Water Users and the Penticton Indian Band. [http://www.summerland.ca/docs/default-source/works-and-utilities/water/water-availability-report-\(march-2014\).pdf?sfvrsn=2](http://www.summerland.ca/docs/default-source/works-and-utilities/water/water-availability-report-(march-2014).pdf?sfvrsn=2)
- 71 Okanagan Water Stewardship Council. (2008). Okanagan Basin Sustainable Water Strategy 1.0. Okanagan Basin Water Board. p.51

- 72 Associated Environmental Consultants Inc. (2016). *Building Drought Resilience in the Okanagan: Phase 1 Gap Analysis & Recommendations*. Prepared for the Okanagan Basin Water Board.
- 73 Okanagan Basin Water Board (2011). Local Government User Guide: Okanagan Water Supply and Demand Project. p.11
- 74 Ministry of Forests, Lands and Natural Resource Operations Bulletin. (August 5th, 2015). Water conservation urged as final Okanagan area increases drought rating.
- 75 BC Fruit Growers' Association Drought Policy. (2015). http://www.obwb.ca/newsite/wp-content/uploads/BCFGA_DroughtPolicy.pdf
- 76 Ministry of Environment. (2015). British Columbia Drought Response Plan. p.4–6. <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/drought-info/drought-response-plan-update-june-2015.pdf>
- 77 Okanagan Basin Water Board Drought Update #6. (August 6th 2015). <http://www.obwb.ca/obwb-drought-update-6/>
- 78 Moore, Wayne. (August 7th, 2015). Confused about drought? Castanet. <http://www.castanet.net/news/BC/145516/Confused-about-drought>
- 79 Ministry of Forests, Lands and Natural Resource Operations. (August 5th, 2015). Water conservation urged as final Okanagan area increases drought rating. BC Government News: Information Bulletin. <https://news.gov.bc.ca/releases/2015FLNR0224-001253>
- 80 Reported communication methods relating to water restrictions based on information gathered at Okanagan Adaptation Workshops in December and February, and confirmed by purveyor, municipal and regional district websites.
- 81 Reported communication methods relating to water restrictions for independent licensees based on information gathered at Okanagan Adaptation Workshops in December and February.
- 82 Archived Okanagan Basin Water Board Drought Updates can be accessed at <http://www.obwb.ca/category/drought/>
- 83 City of Kelowna Planning and Development Services. (1998) Agriculture Plan. <http://apps.kelowna.ca/CityPage/Docs/PDFs/Strategic%20Planning/Agriculture%20Plan.pdf>
- 84 van der Gulik, T., Neilsen, D., Fretwell, R. (2010). Agriculture Water Demand Model – Report for the Okanagan Basin. p.43&49
- 85 van der Gulik, T., Neilsen, D., Fretwell, R. (2010). Agriculture Water Demand Model – Report for the Okanagan Basin. p.29
- 86 The Irrigation Scheduling Calculator is available on the website <http://www.irrigationbc.com>. The calculator provides users with an irrigation schedule using real-time climate data from Farmwest (<http://www.farmwest.com>).
- 87 The Irrigation Industry Association of BC's (IIAB) website <http://www.irrigationbc.com> provides irrigation guides and manuals and the IIAB also offers irrigation courses. The Irrigation Scheduling Calculator is also available on the website. Other resources can be found at Waterbucket <http://www.waterbucket.ca> and Farmwest <http://www.farmwest.com>
- 88 The Environmental Farm Plan irrigation assessment guide assists BC farmers with water use optimization water use, thereby improving water management during times of drought, long-term climate change, and competing uses of the water resource. Online at <https://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program>
- 89 Environmental Farm Plan Beneficial Management Practices 2015/2016. p.16. https://www.bcac.bc.ca/sites/bcac.localhost/files/Ardcorp_Program_Documents/2016-17%20BMP%20List%20APPROVED.pdf
- 90 Climate Action Initiative. (2012). *BC Agriculture Climate Change Adaptation Risk + Opportunity Assessment – The Okanagan Region*. p.14. <http://www.bcagclimateaction.ca/wp/wp-content/media/AdaptROseries-Okanagan.pdf>
- 91 BC Wine Grape Council. <http://www.bcwgc.org/about-bcwgc>
- 92 BC Cherry Association. About the BC Cherry Association. <https://bccerry.com/association/about-okcga/>
- 93 Farm Adaptation Innovator project descriptions and deliverables are available on the website of the BC Agriculture & Food Climate Action Initiative. *Farm Adaptation Innovator Program*: <http://www.bcagclimateaction.ca/farm-level/adaptation-innovator-program/>
- 94 Okanagan Water Stewardship Council. (2008). Okanagan Basin Sustainable Water Strategy 1.0. Okanagan Basin Water Board. p.5,6
- 95 Ibid.
- 96 Okanagan Basin Water Board (2011). Local Government User Guide: Okanagan Water Supply and Demand Project. p.10.
- 97 Ibid.
- 98 The remaining 1% and 2% of water use in the basin are institutional and parks and open spaces, respectively.
- 99 Okanagan Valley Economic Development Society. (2015) Okanagan Valley Economic Profile 2015. p.25.
- 100 The Okanagan Basin Water Board operates the Okanagan Water Wise program (which includes the One Valley One Water campaign) and aims to increase awareness among residents about water use and that the interconnectedness of the region's water supply. <http://www.okwaterwise.ca>
- 101 Plant Health Unit, Plant and Animal Health Branch, Ministry of Agriculture. British Columbia Plant Health Strategy for Agriculture. 2013–2018. p.1.

- 102 Acheampong, S. (February 20, 2013). Spotted Wing Drosophila in the Southern Interior Valleys of British Columbia (2010–2012). PowerPoint slides from Ontario Fruit and Vegetable Convention 2013. http://www.ofvc.ca/SessionDownloads_2103/Tender%20Fruit/WTFruit_930_Acheampong.pdf
- 103 Quote from Susanna Acheampong, Entomologist with BC Ministry of Agriculture. Global News (July 2015) SWD numbers increase in Okanagan. <http://www.agannex.com/production/swd-numbers-increase-in-okanagan>
- 104 Acheampong, S. (February 11, 2016). Insect Pest Issues in the Southern Interior of British Columbia. PowerPoint slides from Okanagan Adaptation Workshop.
- 105 Okanagan Kootenay Sterile Insect Release Program Website. <http://www.oksir.org/>
- 106 SIR's initial program goal was complete eradication of codling moth in the program's service area, but this was eventually deemed unfeasible and suppression of moth populations below a threshold became the new objective. Today's threshold is less than 0.2% codling moth damage on at least 90% of all commercial pome acreage in the service area.
- 107 Sterile Insect Release Program. (2011). Sterile Insect Release Program: Guide to the SIR Program. p.20. <http://www.oksir.org/docs/SIRGuide042011FINAL.pdf>
- 108 Macey, A. (2013). Organic Agriculture in British Columbia – Organic Statistics 2012. p.9 https://www.cog.ca/uploads/BC_Organic_Production_Statistics_2012.pdf
- 109 BC Wine Grape Council. (2016). Sustainable Practices for BC Vineyards: Condensed Guidebook, February 2016. <http://www.bcwgc.org/sustainable-winegrowing-british-columbia>
- 110 Phenology refers to key seasonal changes in plants and animals from year to year — such as flowering, emergence of insects and migration of birds — especially their timing and relationship with weather and climate.
- 111 Tools available on the site include Growing Degree Days, evapotranspiration, ammonia loss from manure, corn heat units: <http://www.farmwest.com/climate/weather>
- 112 Washington State University Decision Aid System: <http://treefruit.wsu.edu/tools-resources/wsu-decision-aid-system-das/> and <https://www.decisionaid.systems>
- 113 Weather INnovations Consulting LP. Vine and Tree Fruit INnovations. <http://www.vineandtreefruitinnovations.com/index.cfm?devUse=full>
- 114 Invasive Species Council of British Columbia. "Invasive Species." <http://bcinvasives.ca/invasive-species>
- 115 Scott, Lisa. (February 10, 2016). Presentation provided at Workshop #2: Climate Change Strategies and Actions. Okanagan and Similkameen Invasive Species Society.
- 116 Okanagan and Similkameen Invasive Species Society. Aquatic Invasive Species. <http://www.oasiss.ca/aquaticinvasives.html>
- 117 Scherer, R., Pike, R. (2003). Management Activities on Streamflow in the Okanagan Basin: Outcomes of a Literature Review and a Workshop. FORREX – Forest Research and Extension Partnership.
- 118 Cohen, Russell. (June 11, 2014). Fact Sheet #1: Functions of Riparian Areas for Flood Control. Division of Ecological Restoration, Massachusetts Department of Fish and Game. <http://www.mass.gov/eea/docs/dfr/der/riverways/riparian-factsheet-1.pdf>
- 119 Producers that have a completed and current EFP are eligible to apply for cost-shared incentives through the Growing Forward 2 Agreement "On-Farm Action" Beneficial Management Practices (BMP) Program to implement actions identified in their on-farm environmental action plans. BMP categories and practices eligible for cost-share funding can be found at <https://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program>
- 120 British Columbia Cattlemen's Association. Farmland-Riparian Interface Stewardship Program. <http://www.cattlemen.bc.ca/frisp.htm>
- 121 Campbell, Clay and Lee Hesketh. (2009). Can I Restore an Unhealthy Riparian Corridor? Farmland-Riparian Interface Stewardship Program, BC Cattlemen's Association. http://www.cattlemen.bc.ca/docs/frisp_brochure_july_20_2009.pdf
- 122 <http://cowsandfish.org/index.html>
- 123 Cows and Fish. Getting Past the Talk: Working with Communities. Cows and Fish Fact Sheet. http://cowsandfish.org/pdfs/getting_past_the_talk.pdf
- 124 Through the Farm Adaptation Innovator Program, the University of British Columbia Okanagan is working with a group of producers near Armstrong BC, to quantify the social, economic and bio-physical results of a group process to rehabilitate a riparian corridor. Project results will be posted to the BC Agriculture & Food Climate Action Initiative website: www.bcgclimateaction.ca
- 125 The wildland-urban interface is characterized as any area where structures and other human development meet with wildland areas containing flammable vegetation such as trees and grasses. Much of the rural development in the Okanagan exists within the interface; interface fuel management has become a significant priority for local governments in the Okanagan since the fires of 2003.

- 126 BC Wildfire Service website. <http://bcwildfire.ca/history/largefires.htm>
- 127 Alley, Lynn. (October 11, 2003). After the Fire, for Okanagan Wineries, It's Business Almost as Usual. The Wine Spectator. http://www.winespectator.com/webfeature/show/id/After-the-Fire-for-Okanagan-Wineries-Its-Business-Almost-as-Usual_21775
- 128 St. Denis, Jen. (August 25, 2015). Wildfire close call sparks wildfire rethink in BC's Okanagan. Business Vancouver. <https://www.biv.com/article/2015/8/bc-wildfires-spark-wine-region-rethink/>
- 129 Nitschke, C., Innes, J. (2013). Potential effect of climate change on observed fire regimes in the Cordilleran forests of South-Central Interior, British Columbia. *Climatic Change*, 116, 579–591.
- 130 Nitschke, C., Innes, J. (2007). Climatic change and fire potential in South-Central British Columbia, Canada. *Global Change Biology*, 14, 841–855.
- 131 BC Wildfire Service. (2010). Wildland Fire Management Strategy. p.7. <http://bcwildfire.ca/Prevention/PrescribedFire/docs/BCWFMS.pdf>
- 132 The University of Idaho Rangeland Center and the Idaho Rangeland Resource Commission. (2011). Rangelands: An Introduction to Wide Open Spaces. http://www.envirothon.org/files/Rangeland_Ecology.pdf
- 133 Ministry of Forests and Range. (2011). Landslide and flooding risks after wildfires in British Columbia. Wildfire Management Branch and Forest Science Program. <https://www.for.gov.bc.ca/hfd/pubs/docs/bro/Bro91.pdf>
- 134 Sandlink, D. (2009). The Resilience of the City of Kelowna: Exploring mitigation before, during and after the Okanagan Mountain Park Fire. Institute for Catastrophic Loss.
- 135 *Forest and Range Practices Act*, S.B.C. 2002 c. 69. Range Planning and Practices Regulation, B.C. Reg. 19/2004. *Forest Act*, R.S.B.C. 1996 c. 157
- 136 Regional Air Quality Program, City of Kelowna Regional Services, Agricultural Wood Waste Chipping Program Information Package. http://www.rdosmaps.bc.ca/min_bylaws/ES/AQ/2013/General_Information_ProgramSteps-web.2013_4pgpdf.pdf and Regional District of Okanagan Similkameen. Agricultural Wood Waste Chipping Program: Program Guidelines and Registration. https://www.regionaldistrict.com/media/117420/AQ_WoodChippingBrochure.pdf
- 137 CWPPs serve to identify high-risk areas, provide recommendations to local governments for mitigation and preparedness and prioritize areas for fuel management projects.
- 138 Union of BC Municipalities. (October 14, 2015). Wildfire Prevention Funding & Resources. <http://www.ubcm.ca/EN/meta/news/news-archive/2015-archive/wildfire-prevention-funding-and-resources.html>
- 139 The BC Ministry of Agriculture has partnered with industry associations to develop all-hazard planning guides for beef producers, dairy producers and pork producers. Government of British Columbia. (2016). Emergency Preparedness. <http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/farm-management/emergency-preparedness>
- 140 BC Agriculture and Food Climate Action Initiative. (2016). Cariboo. <http://www.bcgclimateaction.ca/regional/cariboo/>
- 141 District of Central Okanagan. (2016). Fire-Protection: What we do. <http://www.regionaldistrict.com/your-services/fire-protection.aspx> and Regional District of North Okanagan. (2016). Fire Protection. <http://www.rdno.ca/index.php/services/community-services/fire-protection> and Regional District of Okanagan-Similkameen. (2014). Fire Services. <http://www.rdos.bc.ca/departments/community-services/emergencyprotective-services/fire-services/>
- 142 What is a Community Wildfire Protection Plan? http://fnness.bc.ca/uploads/pdfs/forest/What_is_a_CWPP.pdf Upon completion of a CWPP, local governments can apply to the Union of BC Municipalities Strategic Wildfire Prevention Initiative for funding for fuel management prescriptions and for operational fuel treatments <http://www.ubcm.ca/EN/main/funding/lgps/strategic-wildfire-prevention/2016-swpi-program.html>
- 143 In accordance with the British Columbia Emergency Response Management System (BCERMS) goals, the priorities of the Wildfire Management Branch in descending order are: human life and safety, property, high environmental and cultural values, and lastly, resource values. Much of agricultural land and operations fall under the latter resource values category.
- 144 NOAA/National Weather Service. (2016). El Nino/Southern Oscillation (ENSO) Diagnostic Discussion. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html

Urls in these Endnotes were current as of March 2016.