Regional adaptation strategies: Vancouver Island

BC Agriculture & Food Climate Action Initiative

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CLIMATE CHANGE ADAPTATION PROGRAM

Regional Adaptation Strategies: Vancouver Island

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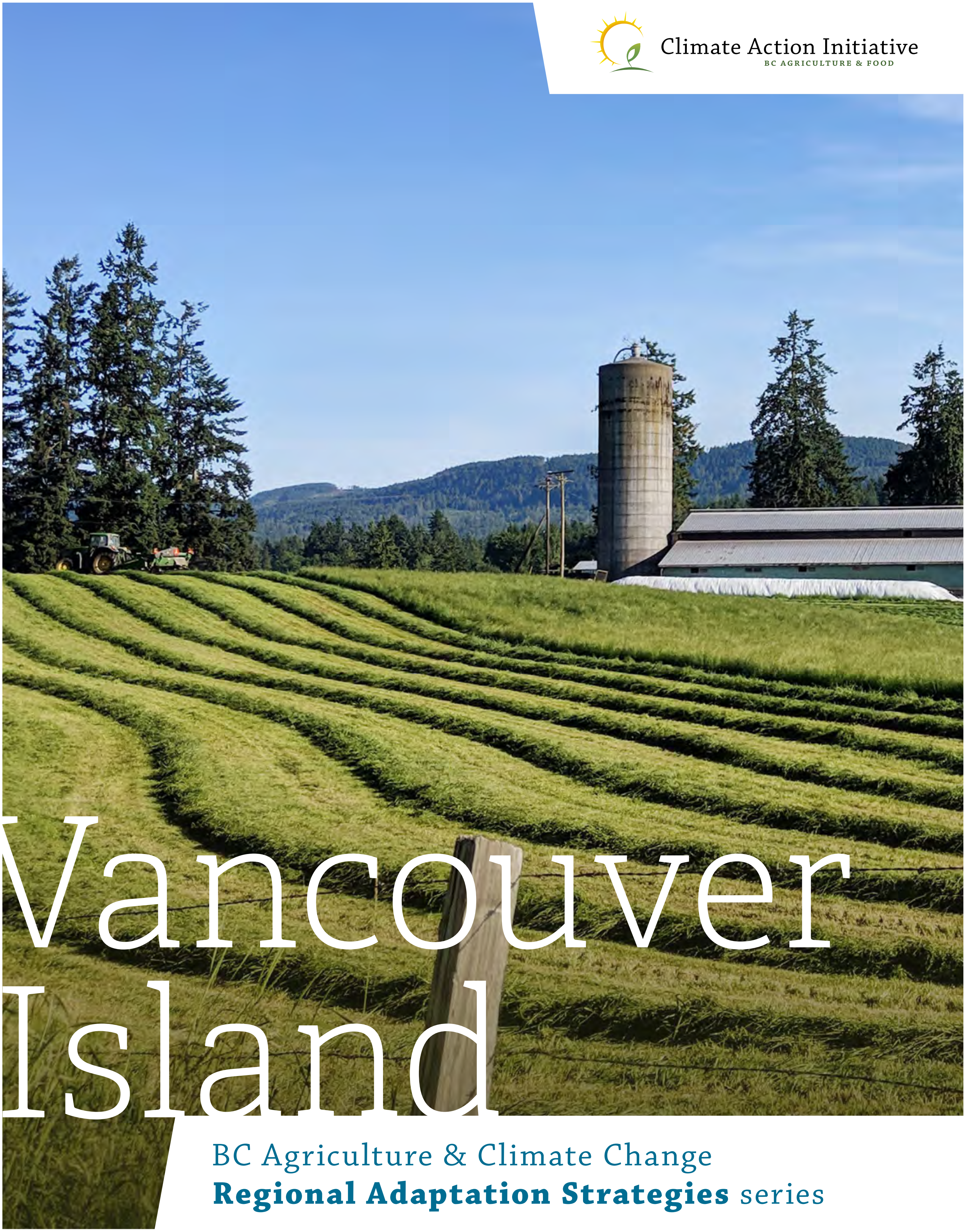

Vancouver Island

BC Agriculture & Climate Change
Regional Adaptation Strategies series

Regional Adaptation Program

BC Agriculture & Food Climate Action Initiative

Vancouver Island Adaptation Strategies

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Additional support has been provided by the Alberni-Clayoquot Regional District, *the* Capital Regional District, *the* Comox Valley Regional District, *the* Cowichan Valley Regional District, *the* Regional District of Nanaimo *and the* Strathcona Regional District.

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The BC Agriculture & Food Climate Action Initiative (CAI) develops tools and resources that increase the capacity of agriculture to adapt to climate change. Guided by industry, CAI brings together producers, government and researchers to develop a strategic, proactive and pan-agricultural approach to climate adaptation. The Regional Adaptation Program is part of the BC Ministry of Agriculture's ongoing commitment to climate change adaptation in the agriculture sector while enhancing sustainability, growth and competitiveness.

www.BCAgClimateAction.ca

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The cover photo is in Cobble Hill, by Foster Richardson.

Contents

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.

In 2013–2014, following completion of the pilot, the ***Regional Adaptation Program*** was launched. The Program is delivered by the BC Agriculture & Food Climate Action Initiative (CAI). Since the Program's inception, additional adaptation plans have been completed for the Cariboo region (2014), the Fraser Valley region (2015), the Okanagan region (2016), the Bulkley-Nechako & Fraser-Fort George region (2019), Kootenay & Boundary region (2019) and the Vancouver Island region (2020). Between 2017 and 2018, five of the plans (Peace, Delta, Cariboo, Fraser Valley and Okanagan) were updated to reflect implementation progress and near-term priorities.

From 2018 through to 2023, the Regional Adaptation Program is funded by the governments of Canada and British Columbia through the Canadian Agricultural Partnership. Once regional adaptation plans are completed, Canadian Agricultural Partnership "seed" funding is available to regional partners (working with the CAI) to develop and implement collaborative priority projects.

Completed plans and details regarding projects (completed and underway) are available at *www.bcagclimateaction.ca*.

Project Delivery

A local Advisory Committee for the Vancouver Island region was formed to provide input throughout the project. This Committee included participants from the six regional districts, the BC Ministry of Agriculture and eight local/regional agricultural organizations. The agricultural producer participants volunteered their time throughout the project, representing several distinct production systems and localities. The regional district partners provided staff time and expertise and covered costs associated with the workshops. With funding from the Canadian Agricultural Partnership, the BC Agriculture & Food Climate Action Initiative provided core management and human resources for project delivery. Please see Acknowledgements for more details.

photo by Foster Richardson

Project Methodology

The development of the ***Vancouver Island Adaptation Strategies*** plan involved three key stages:

Stage 1 – Project Development

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

Stage 2 – Focus Groups

Two sets of focus groups were held (each set held in three locations — Merville, Coombs and Saanich) for a total of six focus groups.

The first set of focus groups reviewed 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 focus groups.

Prior to the second set of focus groups, a series of over-arching goals, strategies and sample actions was developed and reviewed by the Advisory Committee. These materials provided support for the focus group action planning process (which also incorporated consideration of local priorities, context and resources). 89 individual participants attended one or more of the project focus groups.

Stage 3 – Implementation Meeting

An implementation meeting was held in Cedar with 32 participants representing many of the local partner organizations. 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.

Regional Context

Geography, Climate & Production Capacity

The six regional districts included in the *Vancouver Island Adaptation Strategies* plan have a geographic scope of 34,430 square kilometres.[2] The area encompasses 32 municipalities, 32 electoral areas and 41 First Nations communities.[3] The combined population of the six regional districts is 764,976, or 16% of BC's total population.[4] Across the region, there is increasing interest from First Nations in agriculture and aquaculture opportunities, and in ensuring reliable access to food for their communities.[5] While beyond the scope of this strategy, there was also significant interest raised from the Advisory Committee and focus group participants in examining climate change impacts on aquaculture, and looking at how this sector can adapt.

FIGURE 1 Map of the six Vancouver Island regional districts included in this plan (with ALR shown in green). Islands within these regions that contain ALR land are also included within the plan.

photo by Emrys Damon Miller

Through much of the region, the climate consists of a relatively long and rainy winter season and water deficits during the summer (especially on the southeast coast).[6] The region includes Coastal Douglas-fir, Coastal Western Hemlock and Mountain Hemlock Biogeoclimatic (BGC) Zones. The Coastal Douglas-fir BGC Zone, on a thin section of land along southeastern Vancouver Island and portions of the Gulf Islands, exists in the rain shadow of nearby mountains and has a Mediterranean-like climate.[7] Most of the agricultural production in the region takes place in this zone. The Coastal Western Hemlock Zone occurs at mid-elevations on Vancouver Island and is one of Canada's wettest climates. Temperature varies relatively little from summer to winter in this zone, and there is typically an abundance of rainfall.[8] The Mountain Hemlock Zone is a maritime mountain climate, still mild and wet but at subalpine elevations, so more of the precipitation falls as snow.[9]

There are sub-regional climatic differences across Vancouver Island that have implications for agricultural production. The Capital Regional District and Cowichan Valley Regional District have comparatively longer average growing seasons (250 days) than the other four regional districts (239 days in the mid-island[10] and 196 in the regional districts further north[11]). The Alberni-Clayoquot Regional District has higher average summer maximum temperatures (34°C) than anywhere else on the Island. There are also micro-climatic differences in precipitation within each region. For example, based on data from 1981–2010, Campbell River received an average of 1,408 mm annual precipitation compared with 1,154 mm in Comox, located only 58 km south.

Much of the agricultural land in the region is found in valleys and lowlands along the east side of Vancouver Island[12] as well as in the Alberni Valley and on the Saanich Peninsula. There are also pockets of agricultural land on the Southern and Northern Gulf Islands and around Metchosin.[13] The majority of the agricultural production in the region (i.e., gross farm receipts and number of farms) is concentrated in the Capital and Cowichan Valley Regional Districts.[14]

Glacial till soils (with a stony-sandy-loam texture) cover most of the lowland areas of Vancouver Island.[15,16] On southeast Vancouver Island and the Gulf Islands, most soils are class 3 and 4.[17] Much of the rest of the farmland within the region has soil classes ranging from 1 to 3.[18,19] There is also a considerable amount of farmland on Vancouver Island that is improvable to classes 1 to 3 through either irrigation and/or drainage.[20] Combined, the six regional districts have 6,097 hectares of agricultural land under irrigation, accounting for 5.3% of BC's total irrigated area.[21]

Economic & Institutional Context

Major economic drivers across the Vancouver Island region include health care and social assistance, wholesale/retail, construction, accommodation and food services, professional, scientific and technical services, educational services and public administration. The goods producing sector makes up a smaller portion of the economy than the services sector (80% services and 20% goods), although the primary economic drivers vary from one regional district to another.[22] Aquaculture is rapidly expanding in economic value within a few of the regional districts in the plan area,[23] but is out of scope for this program.

Agriculture in the region contributed 5.3% of total provincial gross farm receipts in 2016, generating over $198 million. The small average farm size on Vancouver Island correlates to relatively low average farm revenues and farm income with 59% of farms in the region generating under $10,000/year in gross farm receipts (the BC average is 42%).[24] In 2016 there were 4,585 farm operators in the region, just over 17% of total farm operators.[25]

In 2019, Vancouver Island had the largest average farmland value increase in the province at +13.1%, compared to +5.5% in the Okanagan and +7.8% on the South Coast. The Saanich Peninsula has experienced the greatest increase in farmland values on Vancouver Island, with smaller increases in the Cowichan and Comox Valley regions and values remaining stable further north.[26]

There is a shift away from commodity production, towards production for niche markets, agri-tourism, and direct farm marketing across the Vancouver Island region.[27,28] There is good potential to increase agri-tourism activities and there are strong farmers' markets and public support for local agriculture across much of Vancouver Island and the Gulf Islands. There are 30 farmers' markets in the region covered by this plan, but only three are year-round markets that support the region's twelve-month growing season.[29] There are various on-going efforts to increase local markets, such as the Vancouver Island Economic Alliance's *Island Good* local food branding campaign launched in March 2018.

photo by Samantha Charlton

Local markets are economically important, in part due to the production scale of many of the region's farms, as well as the costs and complexities associated with transportation to the mainland.[30] However, for producers who are exporting products to the mainland, and those relying on imported inputs, the vulnerability of the transportation system to poor weather conditions can be problematic. There are also on-going challenges with labour shortages and loss of local food processing and storage capacity, all of which affect the resilience of the Vancouver Island region's agriculture sector.[31]

A number of regional districts across Vancouver Island have undertaken agricultural planning and, in some cases, plan implementation. The Capital Regional District (CRD) has completed a Regional Food and Agriculture Strategy (2016) and has a food and agriculture task force. Separate agriculture plans have also been completed for a number of municipalities and jurisdictions within the CRD.[32] The Cowichan Valley Regional District and the District of North Cowichan both completed agriculture plans several years ago (in 2001). The Regional District of Nanaimo completed and adopted an Agricultural Area Plan (2012) followed by an Implementation Plan (2013) which is overseen by an Agriculture Advisory Committee.

The Alberni-Clayoquot Regional District adopted the Alberni Valley Agricultural Plan in 2011, and in 2014 hired a team of two agricultural support workers to assist with its implementation. A Coastal addendum focusing on the west coast of the region was completed in 2018, and numerous priorities highlighted in the plans have been addressed. The Comox Valley Regional District completed an agricultural plan in 2002, and has an Agricultural Advisory Planning Commission in place. Ensuring that agricultural plans are up to date, and providing dedicated resources for implementation is an ongoing challenge for each region.

Agricultural Land Use Inventories and Water Demand Models have been completed for Nanaimo Electoral Area F (Errington, Coombs and Hilliers) (2019), Capital Regional District (2018), Salt Spring Island (2017), South Gulf Islands (2014), Strathcona Regional District (2017), Regional District of Alberni-Clayoquot (2016), Comox Valley Regional District including Denman and Hornby Islands (2013), Nanaimo Regional District (2012) and Cowichan Valley Regional District (2012).[33]

With limited local capacity, undertaking research and accessing locally relevant informational resources is challenging for the sector. With respect to applied government/institutional supports for agriculture, there are two Ministry of Agriculture regional agrologists serving the region. Mentorship opportunities exist through the Young Agrarians, Ministry of Agriculture programs for young farmers, and support from the Ministry of Agriculture's New Entrant Agrologist. In terms of formal agricultural education, Vancouver Island University offers a horticulture technician program, and North Island University will be launching a new small-scale sustainable farming program in 2020.

Local research and extension initiatives include farm-based forage trials in Port Alberni, grain trials (through the Coombs Farmers' Institute), the Islands Agriculture Show (rotating its annual location) and Farmer2Farmer in the Capital Regional District. There are eleven Farmers' Institutes in the Vancouver Island region.[34] The level of activity and capacity varies between farmers' institutes, ranging from holding periodic meetings through to hosting workshops and providing local delivery of provincial programs.[35] Producers who aren't members of a commodity-based organization (e.g., dairy, poultry, blueberries) tend to rely on their local farmers' institute for information, or look for relevant resources from outside the region.

Agricultural Production

There are 2,678 farms in the Vancouver Island region (15% of farms in BC) and the average age of producers is 57. The region is also home to 14% of BC's producers under 35 years of age.[36] In 2016, the total amount of land under production was 48,351 hectares, including 18,106 hectares in crops.[37,38] The region includes approximately 2.3% of the Province's total Agricultural Land Reserve (ALR).[39,40] Only 3% (104,575 ha) of the region's overall land base is included in the Agricultural Land Reserve (ALR).[41]

Forage production is the most common agricultural activity in the region (in productive acreage). The region's production is very diverse and includes beef cattle, dairy and other livestock (sheep, goats and hogs), poultry and egg production, horticultural crops (vegetables, tree fruit, berries, greenhouse and nursery production) and apiculture.

The Islands' livestock industry has declined in the last decade, and there are only a few commercial scale pork producers remaining on the Island.[42] Between 2011 to 2016, the number of cattle farms in the region decreased by 14%.[43] Livestock production is in decline on Vancouver Island and has been shifting to other of areas of BC due to rising input costs, reduced access to slaughter facilities, and the increased price of processing[44] (in part due to the Meat Inspection Regulation enacted in 2004[45]). Forage producers interviewed indicated that due to the decline in the cattle sector, underutilized or former hay fields and pasture lands require more intensive management, or transition to new uses. In 2016, the Cowichan Valley and Comox Valley Regional Districts reported the largest number of cattle operations (90 and 52 census farms[46]) in the Vancouver Island region.[47]

photo by Emrys Damon Miller

The Vancouver Island region's proportion of BC's dairy farms has remained steady since 2007 at 10–11% of the BC total. However, a trend of consolidation continues to occur in the industry with the number of overall farms in the region decreasing by 3% between 2011 and 2016.[48] The majority of dairy production in the Vancouver Island region is located in the Cowichan Valley (59%) and the Comox Valley (17%).[49] Interviewees indicated that lack of irrigation is a constraint for producing consistent forage (feed) yield and quality.

Poultry production on Vancouver Island declined considerably following the closure of the last large poultry processing plant in 1999 and the subsequent removal of price premiums and lifting of the freeze on transferring quota.[50] There are only eleven quota holders on Vancouver Island (compared to 220 in the Lower Mainland and 50 in the Interior) and an average poultry farm on Vancouver Island is less than half the size of the average Lower Mainland poultry operation.[51] However, small-scale poultry production is on the rise in the region. The number of poultry farms increased by 6.5% between 2011 and 2016. In 2016, the Capital Regional District and Cowichan Valley Regional District reported the largest number of poultry and egg operations (107 and 59 farms respectively).[52]

From 2011 to 2016, there was almost a 30% increase in the number of vegetable farms[53] in the region, with production increasing across all six regional districts. The Capital Regional District had the largest increase, with 22 new farms. The greatest percentage increase was in Alberni-Clayoquot, where the number of farms doubled to eight.[54] The number of hectares in vegetable production (excluding greenhouse vegetables) also remained stable or increased across all six regional districts.[55] However, in some areas of Vancouver Island, there was a reduction in the area dedicated to greenhouse vegetables; for example, greenhouse production area in the Capital Region decreased by 47%, from 47,516 to 25,040 square metres, and the in the Comox Valley it dropped by 47%, from 16,522 to 8,738 square metres.[56]

The portion of BC's fruit and tree nut farming occurring in the region remained relatively steady in the latest census, despite the amount of land producing fruit, berries and nuts decreasing across most of the regional districts (with the exception of the Alberni-Clayoquot Regional District where an increase in production occurred, from 19 to 21 hectares). Apiculture (responsible for assisting with pollination for the fruit and nut sector) also remained steady between the last two census periods. Apiculture in the Vancouver Island region accounts for almost 20% of the provincial total.[57]

Regional Climate Science

Accessing the best possible information about climate change is the first step in determining the options for adaptation.

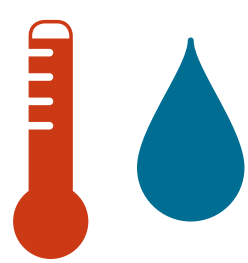
For many years, climate scientists have been improving and refining climate models to produce more accurate future projections. These models have been validated against observed climate records.[58] The resolution of the data and models continues to increase, enabling the kinds of regional projections that follow.

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 climate change, in support of long-term planning.[59] PCIC has assisted in the production of the agriculturally relevant regional climate projections for the 2020s to 2080s that are presented below.

Additional information about regional climate projections, maps, and related definitions may be found in Appendix B and Appendix C, and in PCIC's *Climate Summary for the West Coast Region*.[60] The Capital Regional District[61] and Cowichan Valley Regional District[62] have also worked with PCIC to develop regionally specific climate projections.

Climate Projections

Key climate projections for the Vancouver Island region from the 2020s to 2080s are summarized here. Projections are derived from PCIC's *Statistically Downscaled Climate Scenarios*[63] at a gridded resolution of 300 arc-seconds (roughly 6 km by 10 km) for the simulated period of 1950–2100.[64] Numbers provided are the median of all model runs under the Representative Concentration Pathway 8.5 (RCP 8.5) high GHG emissions scenario (red and blue solid lines for temperature and precipitation, respectively, in the graphs that follow). The shaded areas on the graphs show the range of projected possible future conditions.[65] RCP 8.5 assumes minor reductions in emissions leading to roughly a 3.5°C increase in global annual average temperatures from a preindustrial climate. It is standard practice, when planning for future conditions at the local level, to focus planning around the worst case-scenario occurring at the middle of the century (2050s); if global emissions instead follow the much lower trajectory of RCP 4.5, these conditions will still be experienced but not until closer to the 2060s or 2070s. The climate projections in this report follow this convention.[66]



Temperature

Projections for key temperature variables show a strong warming trend with all models projecting warming in all seasons (see sidebar and Figure 2). This trend is considerable compared to historical variability represented by the black line in Figure 2. Average summer temperatures are projected to increase slightly more than average temperatures in other seasons, while daytime high and nighttime low temperatures are also projected to increase across all seasons.

By the 2050s summer maximum temperatures will be approximately 3°C warmer and summer minimum temperatures (night time lows) will be 2.5°C warmer. Both winter maximum and minimum temperatures will warm by 2.5°C by the 2050s, and outside of high elevation areas, winter temperatures in the future will remain well above freezing.

Temperature Projections

- Annual average[67]
  + **1.3°C** *by 2020s*
  + **2.6°C** *by 2050s*
  + **4.2°C** *by 2080s*
  BASELINE[68] *of 7.5°C*

- Annual frost-free days[69]
  + **28 days** *by 2020s*
  + **48 days** *by 2050s*
  + **67 days** *by 2080s*
  BASELINE *of 277 days*

- Growing degree-days[70]
  + **308 days** *by 2020s*
  + **660 days** *by 2050s*
  + **1,154 days** *by 2080s*
  BASELINE *of 1,410 days*

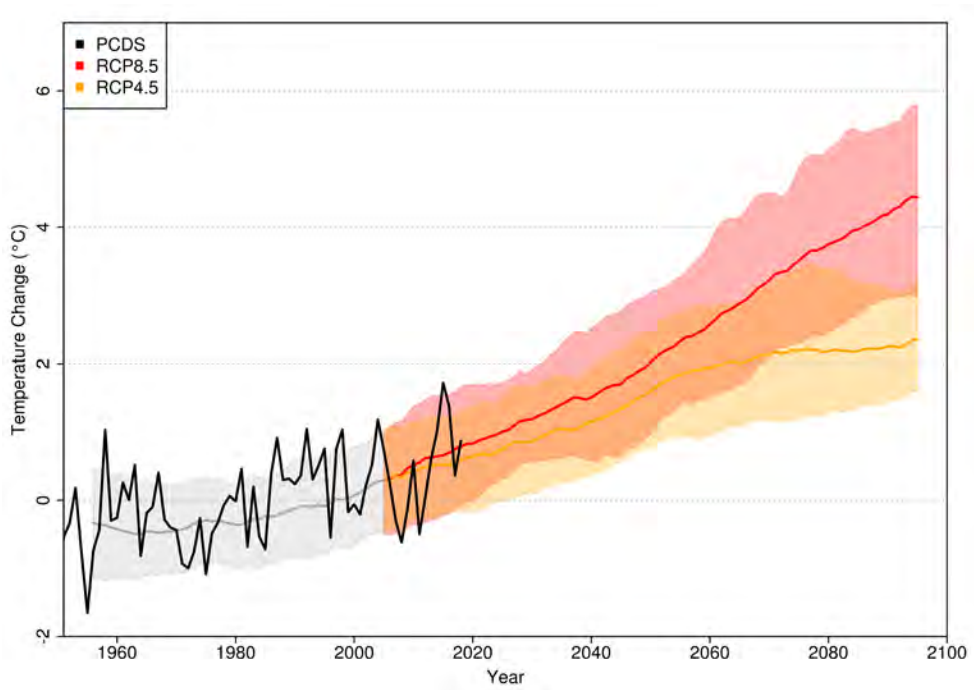
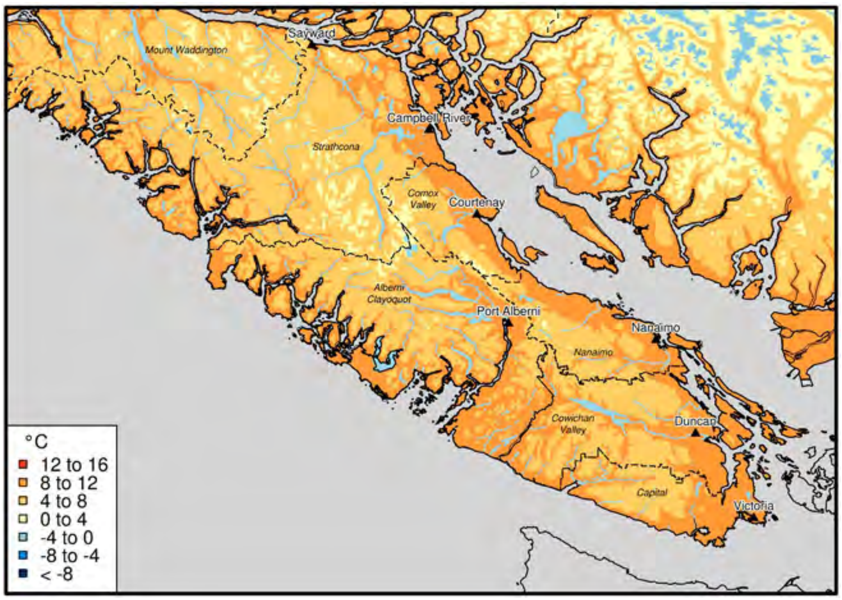


FIGURE 2 Average Annual Temperature Change, 1960s to 2080s

RCP (Representative Concentration Pathway) 8.5 is a high GHG emissions scenario. RCP 4.5 is a medium GHG emissions scenario that results in approximately half the amount of greenhouse gas concentration by the end of the century as RCP 8.5. The bold coloured lines indicate the mid-point of the ensembles of 12 different climate models while shading indicates the projected model range. The black line represents PCDS (Provincial Climate Data Set) and is historic climate data collected from BC.

As shown in Figure 3, geographic proximity to the ocean and mountains creates variation in the baseline temperatures for different areas of the region, with warmer baseline temperatures (including average temperatures, maximum and minimum temperatures) closer to the coast and along the valley floors, and cooler temperatures at higher elevations. Projected warming (i.e., the change from the baseline) are consistent across the region's coastline, valleys and mountains, even when the baselines vary due to topography (see Appendix B for sub-regional baselines and future projections).



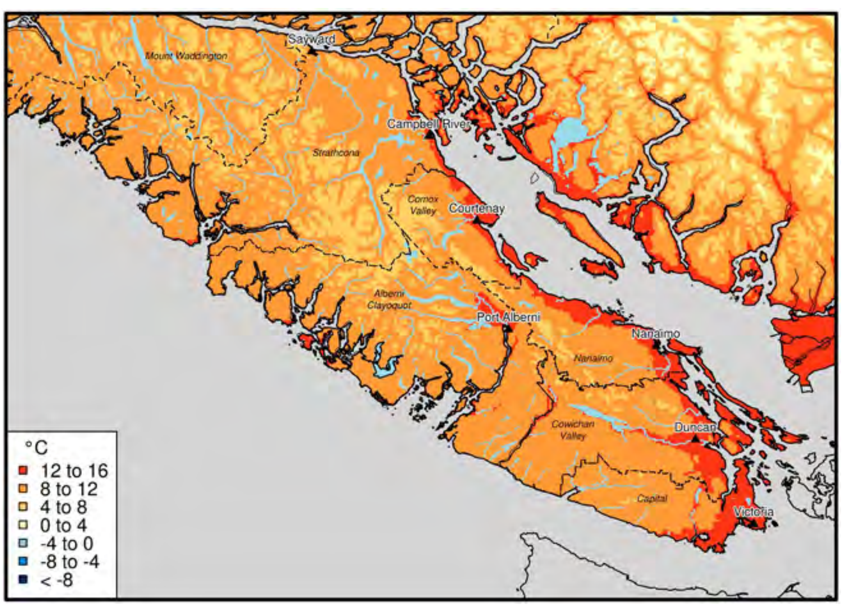


FIGURE 3 Average Annual Temperature
TOP: Historic baseline, 1971–2000
BOTTOM: Projected, 2041–2070

These maps illustrate the spatial distribution of median values for annual temperature.

The baseline map (top) provides a visualization of historic annual temperature, while the 2041–2070 map (bottom) illustrates the projected change in average temperature over a 30-year future period. The global model data has been down-scaled to reflect regional temperature variation, driven largely by topography.

Precipitation

There is considerable variation in average annual precipitation across the region with the majority of precipitation falling in the Vancouver Island Ranges, which extend along the length of Vancouver Island.

The Regional District of Alberni-Clayoquot (RDAC) and the Regional District of Strathcona (RDS) receive the largest amount of annual rainfall at approximately 4,000 mm annually, and this precipitation is largely concentrated in the mountainous areas. The agricultural areas of these regional districts receive considerably less annual precipitation. For example, annual average rainfall in Port Alberni (in RDAC) is 2,200 mm, and Sayward (in RDS) receives 2,100 mm annually. This is comparable to average annual rainfall in the Comox Valley Regional District (2,200 mm), Cowichan Valley Regional District (2,500 mm), Regional District of Nanaimo (1,800 mm) and the Capital Regional District (2,100 mm).

Climate models project a small increase in average annual precipitation of 2% above the regional baselines by the 2020s, and an average annual increase of 5% by the 2050s. While these annual increases are relatively modest, they are not distributed evenly across seasons. Projections show a notable decrease in summer precipitation in contrast to the projected increase in precipitation during spring, fall and winter (see sidebar and Figure 4).

While winter will continue to be the wettest season, projected increases in fall precipitation are more pronounced than in winter and spring. In the future, average precipitation in the fall will more closely resemble average winter precipitation today.[71] While local topography creates considerable variation in sub-regional precipitation, seasonal relative precipitation projections (i.e., percentage change from the baseline) for the sub-regions closely follow the regional trends.

Precipitation Projections

- SUMMER
  - **–7%** *by 2020s*
  - **–13%** *by 2050s*
  - **–22%** *by 2080s*
  - BASELINE *of 285 mm*
- FALL
  - **+4%** *by 2020s*
  - **+12%** *by 2050s*
  - **+20%** *by 2080s*
  - BASELINE *of 985 mm*
- WINTER
  - **+5%** *by 2020s*
  - **+4%** *by 2050s*[72]
  - **+12%** *by 2080s*
  - BASELINE *of 1,180 mm*
- SPRING
  - **+0%** *by 2020s*
  - **+2%** *by 2050s*
  - **+5%** *by 2080s*
  - BASELINE *of 670 mm*

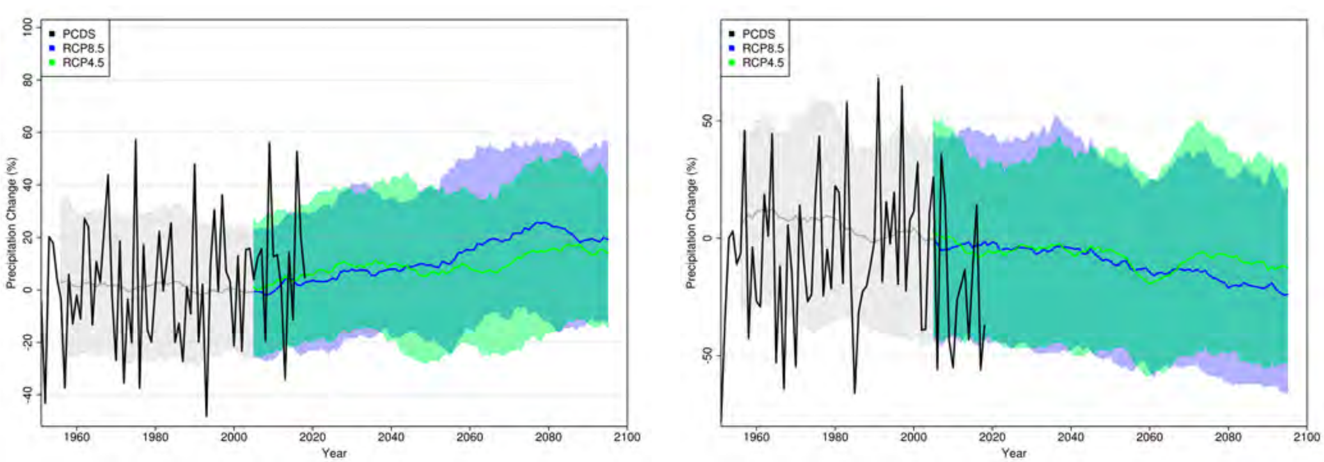


FIGURE 4 Average (Seasonal) Precipitation Change, 1960s to 2080s
LEFT: Autumn RIGHT: Summer

Related Effects

The magnitude and frequency of extreme events, related to both temperature and rainfall, are also projected to increase with climate change. Unusually warm (compared to historical) temperatures are very likely to occur more often, and unusually cold temperatures less frequently. Projections are for nearly triple the number of days per year over 25°C and six times the number of days over 30°C by the 2050s.[73] Extremely hot days (defined as a hot day expected to occur only once in 20 years, on average)[74] previously reached 32°C. By the 2050s, these days are expected to reach 36°C, and 37°C by the 2080s.

The frequency and magnitude of extreme rainfall events are also projected to increase. Detailed projections for the 2050s extremes are provided in the sidebar.[75]

Winter and spring warming will reduce snowpack throughout much of the region, particularly at low and middle elevations.[76] Warmer temperatures in some of Vancouver Island's watersheds (such as the Campbell River watershed) are expected to drive a transition from mixed rain-and-snow hydrology to one that predominantly experiences only rainfall.[77] In current rain-dominated watershed (such as the Capital Region and Cowichan Valley), changes to precipitation patterns and snowpack will affect groundwater resources unevenly, with some aquifers experiencing lower recharge values and with others potentially becoming more productive.[78] These rain-dominated watersheds will also experience a significant decrease in snowpack (up to 90% for the Capital Region).[79]

Increasing seasonal precipitation in fall, winter and spring, when combined with rapid late winter/spring snowmelt and an increase in extreme precipitation events, may increase stream flows in some waterways and increase the risk of flooding. Summer stream flows across the region will be affected by reduced snow melt in spring (transition to rain-dominated watersheds discussed above) as well as warming summer temperatures (increased evaporation) and decreased summer precipitation. Hydrological modeling of coastal watersheds completed for Environment Canada indicates that the dry season — the onset of which is marked by decreased stream flows — will become drier (due to increasing temperatures) and longer (due to low stream flows persisting further into the fall).[80]

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

Extremes

- Days per year over 25°C are expected to occur nearly three times as often by 2050s.
  BASELINE of 11 days per year
- Days per year over 30°C are expected to occur six times as often by 2050s.[81]
  BASELINE of 1 day per year
- 12% increase (+4°C) in "1-in-20 hottest day" temperature by 2050s.[82]
  BASELINE of 32°C
- Increase in frequency and magnitude of extreme rainfall.
- Days with heavy rain[83] are expected to occur up to 20% more often by 2050s.
- 27% more of the rain falling will fall in heavy rain events by 2050s.

Agricultural Impacts

The changes in climate projected for the Vancouver Island 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 Vancouver Island region

Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in average temperatures ▪ Increase in summer average and maximum temperatures ▪ Increase in number of days above 25°C and 30°C ▪ Decrease in summer precipitation	***Warmer & drier summers*** *(changing hydrological regime):* ▪ Lower summer stream flows ▪ More frequent and extended dry periods in summer	▪ Increase in agricultural water demand ▪ Negative impacts to water quality (e.g., algal blooms) ▪ Reduction in water supply availability and increase in likelihood of temporarily losing access to water ▪ Increase in need for new/improved water storage and irrigation infrastructure ▪ Negative impacts to crop yields and quality (particularly non-irrigated crops)
▪ Increase in annual average and minimum temperatures ▪ Increase in seasonal (winter, fall, spring) precipitation ▪ Drier summer conditions	***Changes in pests, diseases, invasive plants:*** ▪ Increasing number of cycles in a year ▪ Introduction of new pests and diseases ▪ Changing range/ distribution of pests, diseases and invasive species	▪ More frequent and increased damage to crops ▪ Inability to rely on previous pest management schedules and practices ▪ Increase in management costs and complexity

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in variability of conditions (including temperatures, precipitation and extremes) ▪ Increase in extreme events (precipitation, heat, wind)	***Increasing variability:*** ▪ Fluctuating and unpredictable seasonal conditions (temperature/ moisture) ▪ Increased uncertainty over frost timing (spring/fall)	▪ Loss of perennial crops to winterkill in cold/dry winters ▪ Damage to crops from extreme temperature fluctuations in late winter and early spring (e.g., negative impacts to blossom set) ▪ Shifting/unpredictable schedule for farm activities (seeding, germination, harvesting, etc.) ▪ Increase in costs to adopt new farm practices/install infrastructure to mitigate risk ▪ Changes to pollinator behavior and in extreme cases, pollinator die-off ▪ Damage to infrastructure and disruption to supply chains from severe winter storms
▪ Increase in average and maximum summer temperatures	***Increase in extreme heat events:*** ▪ Increasing number of days over 25°C and 30°C	▪ Increase in evapotranspiration and crop water demand ▪ Risk of crop damage and loss (e.g., fruit scald and leaf burn) ▪ Negative impact to crop productivity and crop quality ▪ Impacts to livestock health and productivity ▪ Shifting timing of animal husbandry
▪ Warmer winter and spring temperatures ▪ Increase in winter, spring and fall precipitation ▪ Increase in frequency and intensity of extreme precipitation events	***Increase in extreme precipitation (changing hydrological regime):*** ▪ Potential for more rain-driven flood events ▪ Increase in excess moisture ▪ Increase in run off ▪ Increasing flows in major rivers in winter and spring (and in some cases autumn)	▪ Increase in site-specific flooding (and associated crop/ infrastructure losses) ▪ Increase in risk of soil erosion (particularly on stream or river banks) and landslides ▪ Decrease in access to fields and risk of soil compaction ▪ Increase in pressure on flood-protection infrastructure and on-farm water storage infrastructure ▪ Increase in pressure on farm drainage systems (exacerbated by run off from upland development, forestry)
▪ Increase in summer temperatures, reduction in summer rainfall and periods of extreme heat (longer, warmer and drier summers) ▪ Increase in winter and spring temperatures (less snow accumulation, more rapid snowmelt, drier conditions)	***Increasing wildfire risk:*** ▪ More frequent and intensive wildfire events	▪ Negative impacts to animal and crop health and productivity/ yield from smoke ▪ Disrupted access to local services/supply chains/ transportation networks ▪ Damage and losses to agricultural assets and infrastructure (including loss of power for irrigation pumps) ▪ Increase in costs associated with preparing for, managing and responding to wildfire ▪ Lost production during active wildfire and recovery period

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in average temperatures ▪ Increase in growing degree days ▪ Increase in frost free days ▪ Increase in winter minimum temperatures ▪ Shift in precipitation patterns	***Changing crop suitability ranges:*** ▪ Changing seasonal conditions ▪ Changing production windows	▪ Increase in risk and costs to take advantage of opportunities ▪ Inconsistent yield and quality of previously suitable crops ▪ Difficulty in identifying suitable crops for changing conditions ***Potential Opportunities:*** ▪ Increase in suitability for new varieties and new crops ▪ Season extension and additional harvest of certain crops
▪ Increase in annual average temperatures ▪ Increase seasonal (winter, fall spring) precipitation and extreme precipitation events ▪ Sea-level rise	***Increasing coastal flood risk:*** ▪ Potential sea level rise of 26–98 cm above mean sea level	▪ Increase in salinity of water table and soil ▪ Migration of salt wedge upstream[84] ▪ Increase in risk of coastal inundation

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 focus groups.

These impact areas were explored in detail with participants and ranked in order of importance for both the individual farm and at the 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 set of focus groups. Those impacts that were excluded may prove to be problematic or advantageous in the Vancouver Island region in the future, and should continue to be monitored.

For some of the impacts of concern identified by Vancouver Island producers, tools and resources that have broad application are evolving through the BC Agriculture & Food Climate Action Initiative's adaptation programs (and through efforts of other agencies/groups). For example, farm and ranch wildfire preparedness resources have been delivered province-wide. Because there is transferable work completed and/or underway, a dedicated set of strategies pertaining to wildfire impacts are not detailed in this plan. However, there will be on-going effort to deliver these resources to Vancouver Island producers.

Priority Impact Areas, Strategies & Actions

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

- **Impact Area 1**
  Warmer & drier summer conditions
- **Impact Area 2**
  Changing pest & beneficial insect populations[85]
- **Impact Area 3**
  Increasing variability & shifting crop suitability
- **Impact Area 4**
  Increasing precipitation & extreme rainfall events

In the sections that follow, background descriptions and adaptation goals are provided for each of the Impact Areas. Following the descriptions, are the strategies and actions to support the Vancouver Island region agriculture sector with adapting to climate change.

The selected strategies and actions presented are intended 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 Vancouver Island 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.

Impact Area 1
Warmer & drier summer conditions

Summer dry periods create productivity limitations for much of the agriculture on Vancouver Island that is located in the rainshadow of nearby mountains.[86] The percentage of agricultural land under production that relies on irrigation varies across the Vancouver Island region, from approximately 51% in the Capital Regional District, to 32% in the Alberni-Clayoquot Regional District.[87] There is extensive dryland farming in the region, particularly forage and pasture.

As the climate changes, higher average winter temperatures are expected to result in a substantial decrease in spring snowfall and on overall decrease in snowpack. Combined with decreased summer precipitation this will result in lower summer streamflows in some major rivers and tributaries.[88] This combination of changes will result in reduced water supply during the periods of greatest agricultural water demand.[89] Demand for irrigation is expected to increase with drier conditions, and with more frequent extreme heat events.

Some of the key agricultural water sources that are already challenged to meet peak demand include the Koksilah (in the Cowichan Valley Regional District) and the Tsolum (in the Comox Valley Regional District). In June of 2019, a level 3 drought was declared for Vancouver Island.[90] In August of 2019 low flows in the Koksilah River prompted the Province to restrict water use in order to protect fish populations. This required 32 people on about 50 parcels of land to restrict the irrigation of crops.[91]

Relevant Climate Change Effects

- Increasing average summer temperature
- Increasing number of days per year above 25°C and 30°C
- Increasing winter minimum temperatures
- Decreasing precipitation in the summer

Building on the efforts of local partners including the Cowichan Watershed Board, in February of 2020 the BC government and the Cowichan Tribes signed an interim letter, the first step towards a Water Sustainability Plan for the Koksilah watershed.[92] The Comox Valley Regional District is engaged in an agricultural watershed planning process for the Tsolum River to address current and future concerns about water availability for agriculture, instream and community needs.[93]

The Agricultural Water Demand model enables quantification of increases in demand resulting from the combined effects of warmer and drier summer conditions, and higher rates of evapotranspiration. As shown in Table 2, agricultural water demand is projected to increase by 2053 (over demand during a baseline hot, dry year) by varying degrees for different areas of the Vancouver Island region. Agricultural water demand goes up dramatically if future increases in agricultural production are included.

TABLE 2 Projected increase in agricultural water demand by 2053 due to climate change.

	Regional District of Nanaimo[94]	Comox Valley Regional District[95]	Cowichan Valley Regional District[96]	Salt Spring Island[97]	Capital Regional District
Increase in agricultural water demand by 2053 (climate change)	+ 30%	+ 50%	+ 22%	+ 20%	+ 19%

A large amount of the private forest land in BC is located on southeastern Vancouver Island, which has implications for adjacent land uses, including agriculture.[98] Land uses and industrial activity upstream and/or adjacent to agricultural operations, including forest cover removal, also impact hydrology on adjacent farms and on the overall watershed and can accelerate the rate and volume of runoff.[99]

A number of approaches will be required to adapt to changing water supply and demand in the region — some will focus on enhancing water availability and others on supporting water management innovations and best practices. As noted above, collective water planning is becoming an important strategic response to increased pressure on limited water resources. Producers are interested in strengthening the sector's capacity to engage fully in local water planning and policy development.

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

- ***Supporting the establishment of farm water supply/storage***
- ***Supporting adoption of water management best practices***
- ***Bolstering planning initiatives related to water supply***

Impact Area 1 > Strategy 1.1
Facilitate the development of farm water supply and storage infrastructure

In order to supply agricultural water needs into the future, improved water storage is required at all scales — from farm to community-level storage. Due to the complexity of developing broader regional-scale storage, this strategy relates to water storage on an individual farm, or shared between a small group of farms. Depending on their production type and the specifics of their operation, producers require different types of storage (e.g., dams, dugouts, ponds, cisterns) for irrigation and livestock water. However, installation of most water storage infrastructure is costly and complicated. There are some cost-share opportunities through the Beneficial Management Practices Program for farms with an up to date Environmental Farm Plan, but availability is limited.[100]

While climate change may improve the cost/benefit of water storage investments, barriers will remain substantial.[101] One option for reducing the associated burdens for individual producers would be collaborative development of water storage by a small group of neighbouring farms. This model may also require shared water licenses, or alternate water sharing agreements. Examples of comparable shared water systems should be sought as models to learn from.[102] To strengthen collaborative approaches for agricultural water storage, documenting and quantifying the benefits for non-agricultural stakeholders may be a valuable step. Water storage can be an important contributor to stable food production in drier conditions (i.e., food security) and other benefits of water storage might include: fire control, flood control, creation of wildlife habitat and recreational opportunities. Clear documentation of co-benefits could aid in securing support and funding (for agricultural water storage) from various beneficiaries.

Rainwater harvesting has fewer financial and regulatory barriers than most other forms of storage, but is also a relatively small-scale storage option. Nonetheless, rainwater can provide a small supplementary water source for such activities as washing produce, or feeding a small number of drip lines. Previous efforts on Vancouver Island — including rainwater harvesting guidelines and rebate programs — can be built on to generate additional informational and financial supports aimed at producers.

In addition to addressing financial barriers, there is also a need to provide informational resources (on technical considerations and requirements) that are tailored to local conditions and production types. Knowledge transfer activities could include field days and presentations, pilot water storage installations, and resources to highlight the payback period and cost/benefit of various types of water storage. Collaborating with existing organizations for knowledge transfer delivery will help to reach a greater number of producers (e.g., Islands Agriculture Show, CR-Fair Farmer2Farmer and Farmers' Institute outreach events).

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ACTION 1.1A Support efforts to develop shared (small group) water storage

- Explore and confirm shared storage licensing or water sharing agreement options (e.g., requirements of Water Sustainability Act).
- Identify suitable locations (with water availability) and partners for a shared storage.
- Reach out to partners to identify willing participants to develop shared storage.
- Facilitate shared water storage development in one or more locations by:
  - identifying potential management structures for shared infrastructure;
  - integrating water quality and source protection considerations;
  - applying for funding; and
  - overseeing implementation of infrastructure.
- Document process for replicating at other locations through a case study, fact sheet or report.

ACTION 1.1B Investigate co-funding mechanisms for developing on-farm water storage

- Measure and document co-benefits (e.g., flood protection, ecological values, fire protection, food security) of water storage.
  - Integrate water quality and source protection considerations.
- Communicate co-benefits to potential partners through a series of facilitated stakeholder meetings and/or an action-planning forum.
- Develop and pilot a co-funding partnership approach (provincial, local, development community etc.).

ACTION 1.1C Deliver knowledge transfer for all types of farm water storage

- Enlist a qualified professional to share options and best practices for design and safety.
- Gather and summarize information on accessing existing cost shares.
- Host field days and presentations on water storage (technical and regulatory aspects).
  - Include a live demonstration of key steps of the water storage installation (e.g., excavation, installing membrane, filling the storage).
  - Model field days/presentations after the Cowichan Water Storage & Management Knowledge Transfer project.
  - Distribute information on cost-share supports.
  - Structure field days and/or presentations to provide opportunities for producer-to-producer knowledge sharing.
- Compile and share Return-on-Investment information for water storage infrastructure.

ACTION 1.1D Provide support for rainwater harvesting

- Consolidate existing rainwater harvesting resources on key topics for an agricultural audience including:
  - site specific considerations;
  - system design;
  - using rainwater and greywater (for farm activities); and
  - infrastructure components.
- Explore development of an agricultural rainwater harvesting rebate program (ACRD scoped one for agriculture. RDN has one for residential).
  - Identify gaps and challenges of similar programs.
  - Determine how to improve, adapt and expand similar programs.
  - Coordinate cross-regional and multi-stakeholder conversations around findings (including opportunities for ACRD and RDN to share their experiences with other RDs and/or other interested entities).

Encourage producers to plan for future water availability limitations and to employ precision management techniques

Because investing in water storage infrastructure is costly, a first step is for producers to ensure that they are optimizing their available water with best management practices. Many producers are already efficient water users, but increased uptake of the latest research and technologies could support adoption of precision management of water on more farms. Adapting practices to adjust to water availability limitations will aid producers in managing through more prolonged dry periods.

Where farm operations are using irrigation, there may be opportunities to optimize water use, either through improvements to the existing systems or transitioning to more automated precision irrigation systems. Resources for irrigation efficiency and water management already exist in BC (e.g., Irrigation Management Guides, Irrigation Scheduling Calculators) and there is an opportunity to improve water use efficiency through irrigation management. Within the Environmental Farm Plan Program there are supports for irrigation upgrades and precision irrigation technologies.[103]

Precision irrigation practices focus on the application of a precise quantity of water to crops at precise locations and at precise times — resulting in uniform application across the field.[104] Precision irrigation relies heavily on soil moisture monitoring for accuracy. Soil moisture monitoring also enables producers to track the relationship between soil moisture holding capacity and soil management practices.[105] Providing information by utilizing existing resources, new research and farmer-to-farmer sharing will help to close information gaps on best management practices.

Developing new resources — or adapting and improving existing resources — with locally relevant and/or commodity-specific water management options and opportunities would also be beneficial. Providing information that captures the payback period of irrigation investments, or that details the "true cost" of overwatering may also incentivize producers to improve their systems or practices. Overwatering can increase system maintenance and repairs, increase labour costs and increase management costs for some crops (e.g., wine grapes). Resources outlining these costs would need to be specific to Vancouver Island production systems.

Producers who can only make minimal improvements to water optimization (and don't have an option to enhance storage) may be seeking information on changing crops/varieties. A research scan or modelling process could be completed to determine which crops and/or livestock would be better suited to future Vancouver Island climates (factoring in changing water availability). The results of such an assessment could help to inform near-term demonstration activities and/or longer-term producer investments.

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ACTION 1.2A **Implement knowledge transfer for optimal and precision irrigation**

- Provide information and resources on improving current irrigation systems:
  - Provide information on economics/payback period for irrigation improvements.
    - In locations where water is low cost, this could also include "true cost" of water (e.g., costs of labour, crop health etc.).
    - Reconcile risk posed from climate change with cost of potential investment.
  - Share information on the Environmental Farm Plan irrigation planning and improvement supports.
- Share water management best practices information from related CAI work in other regions and from the Farm Adaptation Innovator Program.

ACTION 1.2B **Provide knowledge transfer on measuring soil moisture to improve soil and irrigation management**

- Provide training/information for producers about moisture monitoring equipment and connecting soil moisture technology with automated irrigation systems.
- Share existing information and research results on key topics including:
  - cover crops;
  - reduced till;
  - organic matter; and
  - practices to slow, sink, and spread water (e.g., swales, berms, keyline design).
- Support and build on existing farmer-to-farmer knowledge transfer through field days, workshops and/or webinars that include farmer-to-farmer networking opportunities.
- Invite local government representatives responsible for organics/compost programs to knowledge transfer sessions to build relationships and facilitate producer priority access to inputs.

ACTION 1.2C **Complete crop/livestock suitability modelling that incorporates future water supply**

(This action is particularly important for forage systems)

- Conduct a scan of crop/livestock suitability information from similar climates (if available).
  - Identify locations that currently have a climate similar to Vancouver Island's projected future climate (in 2030, 2040 and/or 2050).
  - Identify which crops/livestock are being produced that could thrive in the Vancouver Island region.
- Refine or adapt available information for local conditions, or, initiate new modelling.
  - Identify appropriate existing crop suitability models or develop new models that combine crop suitability modelling with projected water availability.
  - Incorporate information on water availability and soil types.
  - Consider economic/social elements such as market demand.

Impact Area 1 > Strategy 1.3

Build agricultural capacity to engage in water and watershed planning

Increasing average annual temperatures and changing precipitation patterns are affecting aquifer recharge rates and dynamics.[106] Surface water sources that have historically been used by agriculture can no longer be relied on for the duration of the production season due to seasonal low stream flows (combined with environmental flow needs). In some areas of the Vancouver Island region, planning initiatives are underway to preserve the integrity and stability of vulnerable water bodies. As water planning initiatives evolve and expand, it's important for the agriculture sector to engage and be well-represented. There are broad benefits for the sector in participating in multi-stakeholder communications related to water planning, management and policy.

All of the Regional Districts in the area covered by this plan are involved in some degree of watershed planning and water management, and some showcase innovative approaches to working with agriculture. A few of the Regional Districts directly manage water resources and serve as water purveyors to agricultural users. There may be opportunities for Regional Districts across the Vancouver Island region to share their successes and benefit from one another's experiences. For example, in the Cowichan Valley Regional District, planning is taking place across four watersheds and there is an active Water Board and aquifer monitoring. In the Alberni-Clayoquot Regional District the development of a Council for Agricultural Water Supply is being explored. In the Regional District of Nanaimo, there is a Drinking Water and Watershed Protection (DWWP) program that includes: school education, watershed monitoring, water budget data collection, groundwater monitoring, a working group for small water purveyors, a water use reporting centre and other initiatives.[107] The CRD runs an Integrated Watershed Management Program (IWMP) with the objective to maintain healthy watersheds. One of the goals of the program is to pursue effective and collaborative watershed management and stewardship.[108]

While various types of water planning and water management activities have been undertaken across the region, more planning and collaboration will be needed to effectively manage vulnerable water resources into the future. Ensuring that the Ministry of Forests, Lands, Natural Resource Operations & Rural Development's Water Authorizations Branch is engaging in collaborative efforts will be important for addressing agricultural water issues and priorities. It can be challenging for agricultural producers to find the time to participate effectively in planning, particularly in multi-year processes. Therefore, it is important to build the sector's capacity for this engagement, particularly over the longer-term, to ensure that agricultural concerns are represented and addressed.

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ACTION 1.3A **Support watershed planning in agricultural areas**	ACTION 1.3B **Create/support multi-stakeholder roundtables/councils with focus on water**
▪ Engage with agricultural stakeholders (e.g., through a forum) to: - Discuss options and identify their preferred mechanism to connect with government (local, provincial). - Identify key priorities (water management topics of most importance to agriculture). - Share information with agriculture sector on Water Sustainability Plans provision with the Water Sustainability Act to increase knowledge. ▪ Build capacity and opportunities for the agriculture sector to engage effectively in watershed planning including: - Coordinating sector participation in watershed monitoring and data collection. - Providing financial supports for agricultural engagement. - Utilizing remote/online access options. - Developing and sharing resources to build agriculture sector's capacity to engage in planning (e.g., briefing notes for agricultural audiences, prepared presentations about agricultural water issues etc.). - Engaging in the planning processes of water works development to enhance agricultural water conveyance and supply. ▪ Build the capacity of Regional Districts (or others doing water planning) to work effectively with the sector by: - Testing a variety of approaches/tools. - Developing a set of guidelines to share outcomes.	▪ Document active water stewardship groups in the region, including mandates, activities/projects and current links with the agriculture sector. ▪ Assess options for: - Strengthening integration of agricultural representation/concerns with existing water stewardship groups. - Creating a single agricultural water advisory committee to interface with existing watershed stewardship groups. ▪ Establish new groups by: - Identifying priority locations for water planning (based on producer interest and/or risk). - Identifying potential participants and organizations. ▪ Support existing and new agricultural water groups by: - Providing facilitation and coordination. - Providing training to build the agriculture sector's capacity to engage. - Assisting with development of terms of reference, scope and other documents.

Impact Area 2
Changing pest & beneficial insect populations

(Pests includes insect pests, weeds, diseases and invasive species. Beneficial insects include wild and managed pollinators.)

With climate change, shifts in the distribution, lifecycles and prevalence of agricultural pests (insects, diseases, weeds and invasive species) are anticipated. Increasing annual temperatures (in particular winter minimum temperatures) combined with shifting precipitation patterns are already magnifying pest impacts, pest management complexity and associated costs.

Variability and extremes are also likely to increase pest pressure in the region. Extreme precipitation can result in an increase in plant/livestock diseases, while drier summer conditions enable specific pest species to thrive. Climate change may result in an increase in the number and distribution of existing problem species, and may create favourable conditions for new species to become established. A recent and rare outbreak of true armyworm on Vancouver Island may have been partially attributable to shifting climate conditions.[109] Spotted wing drosophila and apple maggot are two other examples of pests of growing concern for tree fruit and berry producers in the Vancouver Island region.[110]

Climate change may negatively impact pollinator and beneficial insect populations by reducing windows for pollination, affecting availability of habitat and/or nectar, and affecting predator populations. Understanding how pollinator populations will be affected by climate change and better supporting ally insect species through measuring biodiversity and incentivizing habitat retention could support farm resilience. Currently, mixed forage is the dominant crop on much of the agricultural land base, providing food for pollinators. Changes to this cropping system could have substantial implications for pollinator populations and this would need to be considered in the event of a major crop shift.[111]

Relevant Climate Change Effects

- Increasing annual average temperature
- Increasing winter minimum temperature
- Increasing average summer temperature
- Decreasing summer precipitation
- Increasing frequency and magnitude of extreme rain events

Filling baseline data gaps related to both pest populations and beneficial insect populations is a high priority for producers in the region, along with enhancing pollinator and beneficial insect habitat and improving pest identification, monitoring and management information.[112] Improving early detection of pests, identification skills for both pests and beneficial insects (including pollinators), and access to existing management resources are baseline tools that are needed to support more resilient agricultural production.

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

- ***Strengthening ecosystem resilience to support pollinators and beneficial insects***
- ***Enabling early detection and management of existing and emerging pests***

Fill baseline data gaps pertaining to pollinator and beneficial insect populations

Climate change (including increasing variability, changing precipitation patterns, increasing temperatures and more frequent extreme events) may impact the health of pollinator and beneficial insect populations. These impacts are likely to compound current threats including loss of habitat, proliferation of disease and susceptibility to pollution and pesticides. An improved understanding of the health and distribution of pollinators and beneficial insect populations (and how they are impacted by climate change) will assist in the development of programs and farm practices to support healthy and resilient populations.

Pollinators include both managed honeybees and native pollinators. The number of honeybee colonies is not declining, but colony health is being impacted by the issues identified above. Native pollinators include native bees (850 species in Canada), butterflies, flies, wasps and beetles. These pollinators are facing serious threats and some species are declining or have gone extinct. Pollinators play a critical role in seed and fruit production, and influence crop yield and quality. Vancouver Island region producers grow many pollinator-dependent foods including squash, peppers, apples and blueberries.[113]

The specific effects of climate change on different species of pollinators and beneficial insects are not well understood. However, warming temperatures and more extreme conditions (precipitation and heat) will influence both plants and pollinators and may alter critical windows for interaction.[114] An improved understanding of climate change effects on pollinators of key interest (and the crops that they pollinate) would provide valuable baseline information. Some pollinators may be more resilient to projected changes (e.g., native pollinators vs. honeybees).

The role and plight of pollinators is a compelling topic for broad-based engagement and this Strategy provides opportunities to build collaboration to leverage funding and implement solutions.

ACTION 2.1A **Gather baseline information on pollinators and beneficial insects**	ACTION 2.1B **Undertake a vulnerability assessment of climate change impacts on pollinators**[115]	ACTION 2.1C **Raise awareness about the importance of pollinators**
▪ Summarize existing data and knowledge through consultation/ literature review. ▪ Develop methodology for new data collection. ▪ Identify farm sites and partners. ▪ Conduct monitoring and training with farmer cooperators. ▪ Incorporate local data into broader research underway (provincially and/or nationally).	▪ Summarize existing data on climate change/weather impacts to pollinators. ▪ Incorporate/overlay additional data including land-use parameters. ▪ Use pre-established framework to evaluate vulnerability of pollinator species.	▪ Develop presentations and new resources, OR actively distribute existing resources[116] (based on findings from ACTIONS 2.1A and 2.1B). ▪ Coordinate seminars in partnership with pollinator-focused organizations. ▪ Provide outreach to non-producer audiences utilizing forums such as beekeeper and gardener meetings and local government events.

Impact Area 2 > Strategy 2.2
Enhance supports for creation/maintenance of pollinator and beneficial insect habitat[117]

As pollinator and beneficial insect habitats are depleted, and climate change further alters these habitats, quantifying their value may support and encourage habitat creation and retention. Specific values can be assessed for producer cost-savings (on pesticides, beneficial micro-climate effects) and ecological goods and services (i.e., broader societal values) associated with pollinator and beneficial insect habitat on the agricultural land base.

Vancouver Island could pilot or develop a program to compensate producers for retaining or creating biodiversity and habitat on their farms. Programs exist elsewhere in BC and beyond which could serve as models. The Delta Farmland and Wildlife Trust Hedgerow and Grass Margin Stewardship Program provides funding and cost-shares for producers to plant native trees, shrubs & grasses on their farms.[118] ALUS Canada is active in six provinces (Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Nova Scotia), supporting agricultural stewardship of wildlife and pollinator habitat. Through projects funded by ALUS Canada, ALUS farmers and ranchers are compensated for producing ecosystem services on the working landscape.[119] Through the Environmental Farm Plan and Beneficial Management Practices Programs[120] producers can access funding towards Vegetative Buffer or Biodiversity Management planning and related eligible planting costs.[121]

Some Vancouver Island region producers are already committed to creating and maintaining habitat and are seeking high quality information on beneficial insects (including pollinators) and their habitats. Pollinator Partnership Canada has specific ecoregion planting guides for Eastern Vancouver Island, Western Vancouver Island and the Gulf Islands. There are also specific resources for Saanich in the Capital Regional District. On Southern Vancouver Island, the Habitat Acquisition Trust has initiated a number of planting projects including pollinator hedgerows and a Pollinator Learning Garden. They have also produced a fact sheet on pollinator habitat stewardship.[122] Other tools to build on, distribute, or to evaluate for their local applicability, include the Canadian Honey Council Planting Guide and the Xerces Society resources.

Tools to measure baseline farm-level biodiversity, and to assess change after habitat creation, could be piloted across Vancouver Island. Tools developed in other locations could be tested and adapted for local conditions, or new tools suitable for the local agriculture sector may be required. There are a number of potential partners and groups with an interest in pollinator health, and/or biodiversity both locally and provincially.[123]

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ACTION 2.2A **Investigate opportunities to remunerate provision of beneficial insect habitat**	ACTION 2.2B **Implement knowledge transfer for beneficial insect habitat development**	ACTION 2.2C **Create and/or deliver tools to assist producers with assessing farm-level biodiversity**
▪ Conduct a scan of ecosystem services programs and payments from other jurisdictions and within BC to establish: - habitat benefits that can be quantified and potential methodologies; - local applicability of approaches; and - potential for integration of pollinator habitat into existing initiatives. ▪ Share results of the scan, communicate benefits of farm habitat areas and initiate dialogue to leverage results into a program or funding opportunities.	▪ Identify local case studies to use as demonstration sites for case studies and/or field tours. ▪ Evaluate existing informational resources for their applicability and share those deemed to be relevant. ▪ Include farm-adjacent landowners and local government in knowledge transfer (case studies, field tours and sharing of resources). ▪ Provide site-specific advice/ consultation on plantings to a sample of varied farm types through a pilot project.	▪ Evaluate existing tools and projects for applicability to Vancouver Island region. ▪ Gather any existing (local) data related to farm productivity effects related to biodiversity. ▪ If needed, develop and test a locally relevant tool (that is relevant for all farm sizes/types). ▪ Pilot tool on various types of farms and share results.

Improve information for pest identification, monitoring and management

Increasing growing season length, extended hot/dry conditions and increasing winter minimum temperatures are just a few of the climate change impacts that can lead to increased pressure from existing and new pests. Early detection of emerging pests is essential for successful management, particularly for pests that may do substantial damage in a short time (e.g., armyworm). Increasing awareness of, and ability to identify, key pests of concern is an important aspect of effective management. Establishing regional monitoring to detect emerging pests, track shifting pest patterns and coordinating pest management will enable a collaborative, landscape level approach.

The majority of cropping acreage on Vancouver Island is in forage, making it a high priority for enhancing pest management support. Forage production is also more vulnerable to negative pest impacts because it is often not irrigated, which means it is more vulnerable to drought and associated pest impacts in a drought year.[124] Also, as a perennial cropping system it is a costly and slow (potentially multi-season) process to transition to an alternate crop (which might become necessary with more frequent or severe pest outbreaks).[125]

A regional pest scan could aid in determining the best way to focus detection and management efforts. A project in the Cariboo region combined climate projections and shifting Biogeoclimatic (BGC) zones with other data sources to determine emerging and priority pests (for the Cariboo-Chilcotin);[126] a similar methodology could be utilized for the Vancouver Island region.

Targeted pest monitoring is already occurring on Vancouver Island through both the Canadian Food Inspection Agency and the Ministry of Agriculture, and some larger operations undertake monitoring through private consultants. However, current monitoring tends to focus on a few key pests. Existing monitoring efforts could be "networked" to consolidate information from different sources and various pest threats (insect and fungal) into a baseline data set. This data set could then form a collective resource, and enable additional efforts to be directed toward prominent gaps. Building on the efforts of the Ministry of Agriculture, which is partnering with local groups and producers on Vancouver Island to monitor specific pests, there may be an opportunity to expand both which species are monitored and the number of trapping sites. Independent monitoring information and informal independent pest sightings could also be fed into a baseline data set.

To support their individual monitoring and/or management efforts, producers require up-to-date information. Currently, some producers access information about pests through their agricultural organizations. However, finding timely and relevant information is more challenging for small-scale or mixed crop/production operations. Summarizing the existing resources and reporting mechanisms (e.g., reporting apps) in an accessible format would be help to address this gap.[127]

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Local tools, programs and resources could be leveraged to bolster existing knowledge sources. For example, both the Coombs Farmers' Institute and the Comox Valley Farmers' Institute have provided workshops addressing pest topics. These efforts could be enhanced and expanded. Resources developed through CAI supported projects in other regions have also developed transferable resources that could be promoted and shared widely across the Vancouver Island region.

ACTION 2.3A **Complete an emerging pests scan**	ACTION 2.3B **Increase monitoring for emerging pests**	ACTION 2.3C **Improve access to producer-focused pest management resources**[128]
▪ Summarize activities and needs of existing organizations and agencies involved in pest monitoring. ▪ Explore options and willingness for consolidation/sharing of monitoring data including: - one-time analysis of baseline information; and - on-going data sharing arrangement complete with framework for data-sharing infrastructure and protocols. ▪ Develop and implement methodology to project future pest risks including: - mapping to connect climate change projections to current pest populations; - local (qualitative data) to determine emerging pests of concern; and - factors related to movement and transportation of goods. ▪ Apply scan results to scoping of monitoring and/or knowledge transfer activities (2.3B and 2.3C).	▪ Refer to emerging pests scan (ACTION 2.3A) to determine priority needs or complete a high-level gap analysis. ▪ Partner with monitoring agencies to expand scope of monitoring and fill gaps with activities such as: - broadening AGRI monitoring to include additional pests; - Training producers on trap use and ID and building capacity of Farmers' Institutes; and - completing pan-agricultural monitoring via a neutral party (e.g., a summer student). ▪ Provide training and/or other forms of support (e.g., access to monitoring equipment) for producers to monitor their land for high priority pests. ▪ Encourage additional partners to contribute to overall agricultural pest monitoring (naturalists, volunteers, regional districts, etc.).	▪ Host workshops or seminars (in-field and crop specific training) to teach identification and management for priority species emerging from scan in ACTION 2.3A. ▪ Develop resources (e.g., fact sheets) to clarify reporting protocols (what to report to which agency and how) and: - ensure the resources are visual, and can be easily printed; and - link to related supportive (industry and government) resources.

Impact Area 3
Increasing variability & shifting crop suitability

Climate change is affecting growing conditions on Vancouver Island by shifting seasonal average temperatures and precipitation patterns, and increasing growing degree days and growing season length. Climate change is also increasing variability within and across production seasons (e.g., timing of frosts, timing/quantity of precipitation). In order to be resilient and minimize production losses, producers need to be prepared to respond to a range of conditions.

Actions to reduce risk and/or take advantage of emerging production opportunities resulting from climate change could include investing in infrastructure, adopting new farm practices and/or adjusting crops or varieties grown. Locally relevant information is needed to support producer decision-making — both from a production and financial/ business management standpoint.

Facilitating research to demonstrate and evaluate adaptation options to mitigate or manage variability will aid producers in making informed decisions. Increased support for crop/variety selection (and possibly local trials and demonstration) for both annual and perennial crops is also needed. Climate change will also bring opportunities to produce novel commercial crops, but changing crops can be costly and risky. Enhanced research on crop suitability and market potential would support producers with assessing, and transitioning their operations to take advantage of, new opportunities presented by season extension and/or warmer average temperatures.

Incorporating climate change considerations into business planning resources is another tool that could assist producers to better plan and prepare for increasing variability. Business planning is an opportune time for producers to evaluate climate risks and opportunities, and to integrate these considerations into their investment decisions. Producers are also keen to improve/optimize their use of farm management tracking tools and processes (e.g., record keeping, farm input management) to both improve current operational procedures and to better prepare for future climate conditions.

Relevant Climate Change Impacts

- Increasing number of growing degree days
- Increasing growing season length
- Shifting precipitation patterns
- Increasing frequency and intensity of extreme events

The Vancouver Island region's agricultural production is unusually diverse and the relatively small average farm incomes[129] and large proportion of producers farming on leased land (one fifth of farms)[130] create distinctive constraints in relation to investment in climate-risk management solutions. Research and business planning resources must support the full range of farm types, scales and capacities.

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

- ***Increasing sector capacity to manage/mitigate variability***
- ***Seizing opportunities associated with changing crop suitability***

Create and share resources on farm practices, crop selection and low-cost technologies to reduce climate risks

Producers on Vancouver Island are accustomed to adjusting to variable seasonal growing conditions and many producers experiment with new crops and practices. Some of the region's agricultural organizations are active in trialling crop varieties and in testing farm practices. For example, the Coombs Farmers' Institute is conducting trials to assess the viability of grains and pulses;[131] the Alberni Farmers' Institute is planning farm trials to assess forage varieties and farm practices for mitigating wildfire risk, and the Vancouver Island Forage Committee — along with the Island Farmers' Alliance — undertook a three-year demonstration project (now completed) to assess drought tolerant forage varieties.[132] The Canadian Organic Vegetable Crop Improvement Variety Trials Network (formerly the BC Seed Trials) also has several vegetable farm cooperators across Vancouver Island and the Gulf Islands.[133] Further enhancing and enabling this culture of experimentation is the focus of the actions within this strategy.

The increasing variability of seasonal conditions necessitates the adoption of new management practices, technologies and infrastructure to reduce risk to crops and production capacity. Some Vancouver Island region producers are interested in taking a holistic approach by assessing the role that farm design and systems (e.g., farm diversification, increased biodiversity, biodynamic production) play in enhancing resilience. Evaluating the feasibility of risk mitigation options (e.g., infrastructure/farm practices) for differing farm scales and types, including leased farmland, will ensure broader applicability.

Producers are interested in both diversifying their operations by experimenting with new crops and in taking advantage of favourable climate related production opportunities. Enhanced information on selecting suitable and resilient (seed) varieties and saving climate-adapted seed are of particular interest. There is also a need for crop trials and local demonstration for new/climate-adapted seed varieties. At present there is no academic or government led research occurring in the region, but (as noted previously) there is some research occurring through local agricultural organizations and some producers undertake their own on-farm research.

Coordinating trials with agricultural organizations and with producer cooperators, and improving dissemination of research results (both from local trials and academia) is a priority for local producers. *The Guide to On-Farm Demonstration Research*[134] provides a structured approach for producers to develop their research questions, gather data and analyze results and may be a helpful resource to support coordinated producer-led research.

A focus on opportunities for novel commercial production could capitalize on both near-term and long-term opportunities. Existing technologies to enhance production capacity (e.g., season extension techniques) will be valuable in the short-term. Longer-term, Vancouver Island producers are interested in options to increase protein production (e.g., legumes, amaranth, quinoa, and nuts), fibre crops (jute, hemp) and crops on the verge of climate viability such as kiwis, figs and olives. Climate suitability modelling and market analysis, followed by local trials will improve understanding of the types of commercial production that will be possible in the future.

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ACTION 3.1A **Summarize, synthesize and share information on farm practices, infrastructure and farm design**

- Undertake background research and analysis to:
  - identify and prioritize vulnerabilities to impacts from variability (across sectors);
  - conduct a scan of relevant technologies and practices to address vulnerabilities (including cost and applicability to local context);
  - assess the potential of farm design to increase resiliency (e.g., crop diversification, increased biodiversity on non-farmed land, hedgerows and shelterbelts, etc.); and
  - create a shortlist of farm practices, technologies and farm designs for further investigation.
- Conduct research to quantify how prioritized farm practices, technologies, farm design can enhance resilience to future climate variability (linked to 3.1C and 3.1D).
- Develop resources (e.g., what to expect and how to prepare for variability) for farms of varying scales.

ACTION 3.1B **Provide information regarding crop selection**

- Identify varieties that are most resilient to variability and changing climate conditions.
- Create a mechanism (e.g., winter seed forum) to share variety/seed selection information.
- Improve availability of local climate adapted seeds (e.g., collaborative seed saving, establishment of seed libraries, knowledge transfer on seed saving, etc.).
- Activities could be linked to crop trials under ACTION 3.1C.

ACTION 3.1C **Support crop trials/research to determine crop viability under future conditions**

- Disseminate results from existing local research/trials and relevant academic research on crop selection/new varieties for future conditions.
- Identify opportunities (and partners) to undertake small-scale trials with focus on future climate and economic considerations.
- Coordinate trials across different farms and promote the use of rigorous research methodology (to increase robustness of results).
- Share results from relevant trials via knowledge transfer resources.

ACTION 3.1D **Modelling, research and knowledge transfer for changing suitability**

NEAR-TERM FOCUS

- Document relevant research and identify immediate opportunities to capitalize on changing suitability. Topics might include:
  - season extension techniques;
  - greenhouse growing opportunities; and
  - examining the commercial viability of crops that are becoming more favourable to produce under current conditions.

LONG-TERM FOCUS

- Determine suitability modelling parameters which might include:
  - matching crops with water availability;
  - crop resilience to variable and future climate conditions (e.g., wet falls or drought);
  - crop production to minimize agricultural GHG emissions;
  - crop diversification; and
  - options for increasing protein production (nuts, etc.).
- Undertake crop and livestock suitability modelling with selected parameters.
- Conduct market analysis on the crops identified as having strong suitability to assess market viability and/or to identify marketing obstacles.

Impact Area 3 > Strategy 3.2

Develop and promote farm business planning resources for managing through climate variability

Climate change will increase financial risk for producers as events such as droughts, unexpected hard frosts, excessive precipitation and storms threaten crop yields and productivity. Agriculture is projected to be the second most economically damaged sector by the effects of climate change according to a recent report by the Canadian government.[135] Within this broader context, it is increasingly important for producers to factor climate change into farm decisions and business planning.

Vancouver Island producers can access a range of business planning services and risk management programs through the BC Ministry of Agriculture.[136] However, many of these programs/supports are not tailored to the small farms and diversified production systems which are characteristic of Vancouver Island agricultural production. Some local agencies (such as Comox Valley Economic Development and Cowichan Economic Development) provide agri-business support, resources and training, while local agricultural organizations (such as the Alberni Farmers' Institute) offer periodic workshops and training on business related topics.

Existing business planning resources (which cover topics such as production economics, business strategy and marketing) do not incorporate climate change considerations, making it very difficult for producers to adequately assess their climate risk. Incorporating information about how climate change is expected to affect agricultural production would help producers to better understand their risk profile and evaluate risk management options and strategies best suited to their operations and financial situation. Developing resources and supports targeted specifically to producers who lease land would also fill an important knowledge gap.

Producers are also looking for ways to improve their tracking systems and record keeping, both to improve efficiencies (and farm profitability) and to better track and understand the costs/impacts of investments in farm practices, inputs and infrastructure to build climate resilience. Assessing existing record-keeping resources and sharing the best tools with producers would be a helpful step. Producers are also interested in improving their understanding of how to use weather station data to analyze how climate change is affecting farm operations and to improve decision making related to risk-mitigation options.

ACTION 3.2A **Incorporate climate change resilience planning into business planning programs/resources**

- Complete a scan of existing programs and resources and identify opportunities to add climate change information/risk management options.
- Partner with agencies who provide agri-business support (e.g., Ministry of Agriculture New Entrant Program) to incorporate information on climate change risk mitigation/resilience planning into business planning resources (drawing on results from 3.1A if completed).
- Create knowledge transfer resources with adaptation options suitable for farms on leased land (possible linkages with Young Agrarians Land Matching Program).
- Improve producer awareness of, and access to, these resources through outreach/communication activities.

ACTION 3.2B **Encourage use of farm operations tracking tools and climate data**

- Enhance access to record keeping tools and resources to better track farm activities and their relationship to variability (e.g., UBC LiteFarm app, spreadsheets, journal records).
- Provide information about how to access, interpret and utilize weather station data (historic and forecast).

Impact Area 4

Increasing precipitation & extreme rainfall events

Historically Vancouver Island has had relatively dry summers, with annual precipitation concentrated in the autumn, winter and spring. Climate change is increasing average annual precipitation in the region with this increase concentrated in the winter and shoulder seasons, while the summers are becoming drier. Warming temperatures are also reducing annual snowfall, and the frequency and severity of extreme rainfall events is expected to increase. These combined factors are resulting in greater challenges in managing runoff and drainage on farmland.

Due to the variable topography of Vancouver Island, there are a range of slope and soil conditions on farmland that can complicate drainage and runoff management. Low-lying farmland is vulnerable to seasonal inundation that can cause damage to crops in the winter and affect productivity, planting and harvest windows, and nutrient input management during the shoulder seasons.[137] Opportunities associated with lengthening growing seasons may not be realized in areas where field access is limited by excess moisture and producers may need to consider investing in infrastructure or adopting practices to manage runoff and improve drainage.

In addition to on-farm measures, effective runoff management within watersheds is needed to reduce negative impacts to agricultural lands. Changes to the landscape associated with urban or industrial development, forestry, and/or other agricultural operations can increase runoff, impacting nearby farmland.[138] Addressing these impacts requires collaboration across a range of agencies and organizations, including all levels of government and industry stakeholders. There is also potential for localized producer-led collaboration to address specific areas of concern.

An opportunity also exists to highlight the important role that agricultural land fulfills in hydrological systems. On-farm riparian enhancement can provide beneficial impacts for fish populations and other wildlife, while also providing the on-farm benefits of reduced runoff and erosion control. There are both existing local expertise and provincial level initiatives to support producers to undertake riparian enhancement on their operations. The Environmental Farm Plan and Beneficial Management Practices Programs offer planning and cost-share supports for practices relating to riparian areas and erosion management.[139] However, access to supports is limited and producers still face challenges when planning and undertaking riparian enhancement projects.

Relevant Climate Change Impacts

- Increasing average annual precipitation
- Increasing autumn, winter and spring precipitation
- Increasing frequency and intensity of extreme rainfall events

Solutions proposed for managing the impacts of increasing precipitation and extreme rainfall events include improved information, collaboration, and investment. Actions are needed at a range of scales, but the cumulative benefits will serve agricultural operations and broader public interests on Vancouver Island.

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

- ***Mitigating and managing effects to agriculture from upland run off***

Impact Area 4 > Strategy 4.1
Build awareness of (off-farm) runoff impacts to agricultural land

The agricultural impacts of runoff associated with changes to the surrounding landscape are not currently well documented. This makes it difficult for producers to provide clear evidence of this problem, which is now being exacerbated by changing precipitation patterns. There is a lack of baseline information and data, and an absence of tools and methods for documenting (and therefore effectively communicating) impacts on agriculture.

Regional governments play an integral role in overseeing many of the landscape changes within their jurisdictions and managing related information and data resources. Digital mapping is an important regional resource but can vary in its level of detail and the types of information it incorporates. For example, the Capital Regional District provides two metre topographic contours that can assist individual land managers with drainage and runoff decision-making and to assess broader erosion or flood risk. This data could also be used by producers at the farm scale (e.g., in implementing keyline design). Increasing the availability and precision of topographic mapping, and using GIS-based analysis to assess specific vulnerabilities, would strengthen baseline knowledge, and improve understanding/ assessment of options for managing the impacts of runoff on agricultural land.

The historical and observational knowledge of agricultural producers who have successive years of experience managing land is a vital source of information in highlighting the impacts of increasing runoff onto farmland. However, this knowledge does not always provide sufficient evidence for affecting land management decisions or changing policies. Establishing mechanisms to systematically document and/or empirically measure runoff impacts will improve understanding of how development and land management practices are impacting agricultural productivity.

Another important step in building awareness of runoff impacts is engaging directly with those involved in land management upstream. The Peninsula and Area Agricultural Commission regularly takes local government staff and elected officials on farm tours in the region, often focusing on a specific challenge or issue. This activity could be replicated in other jurisdictions and could incorporate sites that demonstrate runoff impacts. Broad engagement and dialogue with other industries should also be encouraged as has occurred in the Alberni-Clayoquot Regional District where a local agricultural water round table has brought together various stakeholders, including private forestry companies and BC Hydro.

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ACTION 4.1A **Create flood and erosion vulnerability maps**	ACTION 4.1B **Document how runoff management (from off-farm sources) affects agricultural land**	ACTION 4.1C **Expand awareness of runoff impacts to agriculture to encourage multi-stakeholder collaboration**
▪ Complete an inventory of local government flood mapping/ risk assessments (completed, underway, and planned). ▪ For areas not addressed by local governments, identify and rank vulnerable agricultural areas from lowest to highest risk. ▪ Use GIS-based analysis to produce vulnerability maps based on slope, soil type, land use, and other parameters. The maps would document: - where agricultural land is at highest risk of losing soil; and - where agricultural land is most at-risk for inundation and flooding. ▪ Showcase and share mapping results via on-farm field days or tours in high vulnerability areas.	▪ Develop mechanisms to measure and document runoff and the associated impacts on agricultural lands. This may include: - consulting with producers about where they are experiencing upland run off; - setting up gauges at key locations to measure run off quantities and timing; and - mapping topography, land use and stormwater infrastructure to confirm key sources of run off. ▪ Develop case studies that highlight/document impacts (utilizing data gathered through sub-actions above). ▪ Generate materials that summarize and present mapping products and case studies in transferable formats (fact sheets, videos).	▪ Host forums with upstream land managers, and other stakeholders in select prioritized areas in order to: - share documentation and mapping products/results from ACTIONS 4.1A and 4.1B; and - share and consider information about related land use best practices/policies. ▪ Hold farm tours for targeted groups (elected officials, land managers, etc.) to highlight key vulnerabilities and land use impacts on agriculture. ▪ Support agricultural representation in multi-stakeholder collaboration efforts to address water, runoff and drainage challenges by: - providing the sector with data/ information from 4.1A and 4.1B; and - facilitating multi-stakeholder conversations.

Support producers with mitigation and management of excess water on the farm

Agricultural producers on Vancouver Island have always managed seasonal flooding and runoff through a variety of on-farm practices, techniques and infrastructure. However, as the impacts of excess water (precipitation/runoff) increase, there will be added incentive to expand systems and explore novel practices that can assist with maintaining or improving productivity on sites vulnerable to excessive moisture or inundation. Where the benefits are proven, producers are keen to undertake on-farm improvements that do not rely on cooperation or action from other stakeholders.

Vancouver Island producers are interested in a range of field and land management practices that address runoff and drainage concerns but are seeking regionally appropriate information on which solutions are best suited to their topography, soils and farm operations. Reviewing and compiling existing research and resources on practices including cover cropping and tillage management, drainage installation and improvement, and assessing the appropriate application of sub-soiling or keyline ploughing[140] would be an important first step. Where possible, economic information should be included to better inform decision-making.

In addition to methods for improving productivity on lands vulnerable to runoff impacts, there is interest in investigating and adopting adaptive crops for locations where other improvements may not be feasible. This could include identifying new crop varieties such as inundation resistant forage crops, finding new markets and opportunities for existing crops (e.g., reed canary grass seed), or identifying novel crops with production and marketing potential (e.g., meadowfoam).[141]

Investing in on-farm drainage infrastructure — ditching improvements and subsurface drainage — is known to improve productivity on poorly drained sites. However, there is a need for a regionally appropriate overview — grounded in research — of best practices. Previously completed projects in the Fraser Valley (to evaluate adaptive drainage practices) and in Delta, to assess drainage installation approaches under regional conditions, could provide helpful models.[142] Additionally, the regulatory context related to undertaking drainage works is not currently well understood and could be summarized and clarified for producers. There is also opportunity to encourage producers to work together on collaborative drainage management plans in areas where several farms would benefit from a shared approach; group EFPs have previously been initiated as a solution to this challenge.

Identifying and summarizing the options available to producers for managing excess water is an important first step in increasing adoption but transferring this information through effective and accessible mechanisms is also essential. Some of the preferred options include field days, local demonstration sites and generation of regionally relevant case studies.

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ACTION 4.2A **Conduct background research on soil quality and deliver knowledge transfer activities**	ACTION 4.2B **Support producers with selecting crops and crop varieties that are viable on vulnerable land**	ACTION 4.2C **Support producers with implementation of run off and drainage management practices**
▪ Conduct a scan to identify most promising on-farm practices, techniques and tools to manage runoff and erosion through soil quality improvement. ▪ Establish regionally relevant parameters/guidelines, based on local soils data and erosion risk (building on Action 4.1A), for practices that support improved soil quality, including: - cover cropping; - reduced/no-till approaches; - contour/keyline field management; - soil amendments (compost, manure & fertilizer) application. ▪ Develop knowledge transfer materials (fact sheets, webinars, etc.) that specifically highlight the soil quality metrics that improve runoff/drainage management, including: - soil organic matter; - moisture holding capacity; - soil structure and erosivity; and - infiltration rate. ▪ Host field days, farm tours and workshops to highlight the outputs of the preceding actions, and to encourage farmer-to-farmer knowledge sharing and networking.	▪ Conduct background research to identify potential new crops and crop varieties that are resilient to seasonal inundation. ▪ Support local research and farm trials to test novel crops/varieties ▪ Develop complementary economic information (e.g., crop enterprise budgets) on the new crops/varieties. ▪ Conduct knowledge transfer activities (e.g., case studies and field days) to share results from local research/trials.	▪ Establish regionally appropriate best practices for on-farm drainage management and installation including: - summarizing/clarifying drainage works regulatory context; - updating guidelines for (subsurface) drainage spacing for different crop and soil types; and - identifying regionally available and appropriate materials and methods. ▪ Provide demonstration and knowledge transfer that includes economic information. ▪ Encourage/support collaborative drainage management at local scales (among neighbours, with involvement from relevant ministries) – potentially through a field day and/or case study of successful implementation.

Facilitate collaboration for on-farm riparian enhancement

Riparian areas and wetlands provide a range of valuable services to farms and adjacent properties including reducing potential for erosion and enhancing flood control, while also contributing to the overall health of aquatic ecosystems. There are many organizations (local streamkeepers, wildlife/habitat groups and land trusts) on Vancouver Island that undertake riparian enhancement, but there is no sustained and coordinated engagement with agricultural producers or support for activities on agricultural lands. The Environmental Farm Plan and Beneficial Management Practices Program include supports for riparian management planning and implementation, but there remains opportunity to expand this scope and foster collaboration with other programs or initiatives.

Undertaking riparian enhancement planning, installation and maintenance entails substantial investment of both human and financial resources for the landowner. The environmental services provided by riparian improvements are not always evident or acknowledged. Establishing and assigning monetary value for these benefits would help to build support for greater financial incentives to be provided through existing mechanisms, and/or for implementing novel mechanisms.

An additional challenge for producers is the regulatory complexity related to any riparian works and the historically strained relationship between land managers and regulatory bodies. Documenting the broader co-benefits of on-farm riparian enhancement could serve as the starting point for engagement and dialogue with relevant agencies and assist with defining the key issues and challenges. This process could be further supported by establishing or identifying demonstration sites and case studies of successful riparian enhancement.

ACTION 4.3A **Support improved valuation and cost-share opportunities for riparian enhancement**

- Review existing approaches (e.g., green infrastructure, ecosystem services) for assessing the value of riparian enhancement and test these methods at existing sites.
- Review and summarize existing knowledge on the benefits of riparian enhancement to the farm; include consideration for climate risks, and provide high-level cost-benefit information.
- Assess existing financial supports and identify gaps or challenges with obtaining financial support/cost-shares.
- Identify and evaluate feasibility of options for additional or expanded financial support/cost-shares. Options could include:
  - novel mechanisms for incentivization (e.g., BC Assessment and property tax benefits); and
  - reviewing the outcomes of the historic Salmon Enhancement Program.

ACTION 4.3B **Facilitate information exchange about barriers to agricultural riparian enhancement**

- Consult with producers and key agency staff to document the issues and challenges with implementing riparian enhancement.
- Host dialogue sessions between producers and agency staff to generate options that respond to these challenges.
- Identify, or establish, on-farm demonstration sites to facilitate riparian best management practices knowledge transfer.
- Host knowledge transfer activities at demonstration sites to encourage information exchange between producers and agency staff.

Implementation & Monitoring

While all of the actions contained in this plan are important for the Vancouver Island region agriculture 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 (32 individuals) to prioritize actions and determine how to move them forward. The input received at this meeting informs the content below.

In some cases, multiple actions have been merged into single projects because this is the most effective and efficient way to accomplish them. Implementation considerations, 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 implementation and monitor progress. This group will continue to include agricultural organizations, local government and provincial government representatives. The BC Agriculture & Food 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 ACTION 1.1C

Action

→ ***Deliver knowledge transfer for all types of water storage.***

Implementation details

- Use existing examples of water storage – from a range of scales – as the basis for fact sheets and fields tours.
- Information regarding the regulatory context of water storage should be communicated to producers directly from FLNRORD whenever possible.
- Provide implementation supports with knowledge transfer wherever possible (e.g., technical expertise, coordination assistance and/or cost-shares).

Potential partners

- Agricultural producers (with existing water storage)
- BC Ministry of Agriculture
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- Capital Region Food and Agriculture Initiatives Roundtable
- Environmental Farm Plan Program
- Islands Agriculture Show Society
- Pond/water storage designers and contractors
- Regional Districts

Timeframe

- Short term (LESS THAN 2 YEARS)

Cost

- Low ($50,000–$100,000)

Next Steps for ACTION 1.2B

Action

→ ***Provide knowledge transfer on measuring soil moisture to improve soil and irrigation management.***

Implementation details

- Use information / fact sheets from BC Ministry of Agriculture soil moisture sensor projects.
- Target information to relevant production types and scales.
- Incorporate consideration of soil types across the Vancouver Island region – could use the Soil Information Finder Tool (SIFT).
- In order to demonstrate the costs of over or under watering crops, information on related variables will need to be gathered (e.g., yield/productivity, labour, irrigation repairs and pest control).

Potential partners

- Agricultural organizations
- BC Agriculture and Climate Adaptation Research Network (BC-ACARN)
- BC Ministry of Agriculture
- Certified Organic Associations of BC
- Precision agriculture technology companies
- Farmers' Institutes
- North Island College: Small Scale Sustainable Farming program
- University of British Columbia: Sustainable Agricultural Landscapes Lab

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Medium ($50,000–$100,000)

Next Steps for ACTION 1.3A

Action

- → ***Support watershed planning in agricultural areas.***

Implementation details

- Ensure producers have access to a variety of methods to engage in watershed planning activities (e.g., options to attend meetings in-person and remotely, summaries of meetings tailored to agricultural interests).
- Water Sustainability Plans have potential to significantly change water management and allocations, the Koksilah River watershed may be the focus of a plan and this process should be monitored closely as it could be precedent setting.
- The cost of watershed planning can be high, and the agriculture industry should be a participant and contributor rather than the leader; one benefit to undertaking planning with multiple stakeholders is to share costs.

Potential partners

- Agricultural Advisory Committees
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (Water Authorizations Branch in particular)
- BC Ministry of Agriculture
- BC Ministry of Environment
- Farmers' Institutes
- First Nations
- Local Water Boards/Committees
- Regional Districts (especially ACRD Council for Agricultural Water) Agricultural organizations

Timeframe

- New resources/framework for agricultural engagemen
  = Short-term (LESS THAN 2 YEARS)
- Planning support/s
  = Medium-term (2–4 YEARS)

Cost

- New resources/framework
  = Low (LESS THAN $50,000)
- Planning support/s
  = Medium ($50,000–$100,000)

Next Steps for ACTIONS 2.2A & 2.2B

Actions

- → ***Investigate opportunities to remunerate provision of beneficial insect habitat.***
- → ***Implement knowledge transfer for beneficial insect habitat development.***

Implementation details

- Investigate the potential to provide tax breaks tied to habitat provision (e.g., via BC Assessment).
- Most habitat enhancement could be designed and implemented to benefit a range of beneficial insects including pollinators.
- New resources should not be created unless needed (i.e., a number of resources exist).
- There is an opportunity to identify the beneficial insect benefits of annual crops (such as cover crops).

Potential partners

- Agricultural organizations
- BC Honeybee Producers' Association
- BC Ministry of Agriculture
- Educational Institutions (e.g., University of Victoria, University of BC)
- Environmental Farm Plan Program
- Island Pollinator Initiative
- Habitat Acquisition Trust
- Local/regional beekeeper associations
- Pollinator Partnership Canada

Timeframe

- Investigate remuneration opportunities
  = Medium-term (2–4 YEARS)
- Implement knowledge transfer
  = Short-term (LESS THAN 2 YEARS)

Cost

- Investigate remuneration opportunities
  = Medium ($50,000–$100,000)
- Implement knowledge transfer
  = Medium ($50,000–$100,000)

Next Steps for ACTIONS 2.1A & 2.3B

Actions

→ ***Gather baseline information on pests, pollinators and beneficial insects.***

→ ***Increase monitoring for emerging pests, pollinators and beneficial insects.***

Implementation details

- Base methodology on best practices and methods used by similar projects elsewhere (to allow for consolidation of data in larger data sets).
- Explore feasibility and effectiveness of combining monitoring for pollinators/ beneficials to also include pest monitoring.
- Privacy of information may be a challenge to consolidation of data from individual operations.
- Data quality control and verification can be a challenge when relying on data obtained through citizen science (naturalists, volunteers, etc.).

Potential partners

- Agricultural organizations
- BC Honeybee Producers' Association
- BC Ministry of Agriculture
- Educational Institutions (e.g., University of Victoria, University of BC)
- Environmental Farm Plan Program
- Habitat Acquisition Trust
- Island Pollinator Initiative
- Local/regional beekeeper associations
- Pollinator Partnership Canada

Timeframe

- Gather baseline information = Short-term (LESS THAN 2 YEARS)
- Increase monitoring = Long-term (4 YEARS +)

Cost

- Gather baseline information = Low (LESS THAN $50,000)
- Increase monitoring = High ($100,000+)

Next Steps for ACTION 3.1C

Action

→ ***Support crop trials/research to determine crop viability under future conditions.***

Implementation details

- Any projects should augment existing research and support/ coordinate new research (and train agricultural organizations/ producers to undertake new research).
- Strong oversight and coordination, as well as linking to BC's research community, will be needed to ensure robust research results.
- Integrate research into farm design systems (not just crop/livestock selection).
- Knowledge transfer may include:
  - field days and farm tours;
  - events with speakers/experts;
  - producer "field trips" (e.g., to AAFC research station in Agassiz); and
  - "virtual" knowledge transfer (e.g., webinars, filming field days, etc.).

Potential partners

- Agricultural organizations
- Agriculture producer cooperators
- Agriculture and Agri-food Canada
- BC Ministry of Agriculture
- BC Agriculture and Climate Adaptation Research Network (BC-ACARN)
- BC Seeds (Bauta Initiative on Canadian Seed Security)
- Cowichan Agricultural Seed Hub Educational Institutions
- First Nations
- Seed Companies (e.g., Salt Spring Seeds, West Coast Seeds)
- Young Agrarians

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Supporting existing research, knowledge transfer = Medium ($50,000–$100,000)
- Undertaking new research = Medium ($50,000–$100,000)

Next Steps for ACTION 3.1D

Action

- → ***Modelling, research and knowledge transfer for changing suitability.***

Implementation details

For near-term opportunities:

- Include assessment of opportunities for different scales of farms, as well as farms on leased land.
- Local research/demonstration of new crop varieties may tie to 3.1C.

For longer-term opportunities:

- Crops of interest (listed on page 33).
- Crop/livestock suitability must be combined with market analysis.
- Local trialing will be needed to validate modelling results, this may be identified as a follow-up activity and not be embedded in the project (to reduce costs).

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- Agriculture and Agri-food Canada
- Educational Institutions

Timeframe

- Evaluation of near-term opportunities
  = Short-term (LESS THAN 2 YEARS)
- Crop/Livestock modelling for future conditions
  = Medium-term (2–4 YEARS)

Cost

- Evaluation of near-term opportunities
  = Medium ($50,000–$100,000)
- Crop/Livestock modelling for future conditions
  = Medium ($50,000–$100,000)

Next Steps for ACTIONS 4.1B & 4.1C

Actions

- → ***Document how runoff management (from off-farm sources) affects agricultural land.***
- → ***Expand awareness of runoff impacts to agriculture to encourage multi-stakeholder collaboration.***

Implementation details

- Documentation (4.1B) should focus on locations where it is feasible to measure impacts; in many circumstances documentation will be too costly/extensive.
- Documentation must be followed by engagement with relevant parties (Regional Districts, FLNRORD, Ministry of Transportation and Infrastructure, etc.).
- Link stakeholder engagement (4.1C) to specific desired outcomes (e.g., encouraging Regional Districts to include runoff impacts in agricultural area plans, highlighting forestry-related impacts to FLNRORD).

Potential partners

- Agricultural Advisory Committees (and Council for Agricultural Water)
- Agricultural organizations
- BC Ministry of Agriculture
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- BC Ministry of Transportation and Infrastructure
- Local and regional governments (planning departments and elected officials)
- Qualified Environmental Professionals

Timeframe

- Documentation
  = Medium-term (2–4 YEARS)
- Awareness
  = Medium-term (2–4 YEARS)

Cost

- Documentation
  = Medium ($50,000–$100,000)
- Awareness
  = Low (LESS THAN $50,000)

Next Steps for ACTION 4.2C

Action

- → ***Support producers with implementation of runoff and drainage management practices.***

Implementation details

- Drainage installation guidelines specific to the topography, soils and crops of the Vancouver Island region would be beneficial (utilizing information from Fraser Valley and Delta research, see page 39).
- A previous CAI project that explored options for coordinating approaches to agricultural drainage in the Fraser Valley could be assessed for transferable lessons.
- Experience and knowledge of drainage installation companies should be utilized.
- Practices and techniques that are lower cost and easier to implement than drainage installation and ditching should be assessed for their applicability.

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- BC Ministry of Environment
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- BC Ministry of Transportation and Infrastructure
- Regional Governments

Timeframe

- Short-term (LESS THAN 2 YEARS)

Cost

- Medium ($50,000–$100,000)

Next Steps for ACTION 4.3A

Action

- → ***Support improved valuation and cost-share opportunities for riparian enhancement.***

Implementation details

- There are strong local organizations with expertise in riparian enhancement that may provide support.
- Streamlining and understanding parts of the regulatory context that can disincentivize riparian management and enhancement would be useful.
- Explore opportunities for increasing uptake of the Environmental Farm Plan Program and Beneficial Management Practices Program riparian management planning and implementation supports.

Potential partners

- Agricultural organizations
- Environmental Farm Plan Program
- Environmental organizations:
  - Ducks Unlimited
  - BC Wildlife Federation
  - Northwest Wildlife Preservation Society
  - Nature Trust of BC
  - Local streamkeeper/naturalist societies (e.g., Peninsula Streams Society)
- Department of Fisheries and Oceans
- First Nations
- Regional governments

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Low (LESS THAN $50,000)

Appendix A
Weather, Climate & Variability

Weather is what happens on a particular day at a particular location. Producers 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* at *www.BCAgClimateAction.ca/risks-opportunities*.

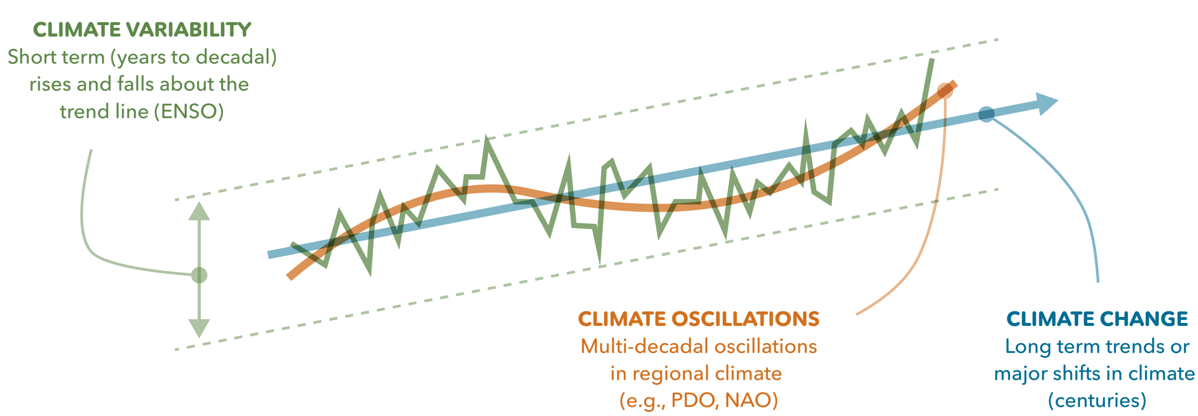

FIGURE 5 Climate Variability, Oscillations & Change

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 3 Vancouver Island Climate Projections — 2020s
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

		Vancouver Island (1971–2000 Baseline)	Projected Change from Baseline to **2020s**				
			Vancouver Island (Range)			Vancouver Island (Average)	BC (Average)
Mean Temperature *(°C)*	**Annual**	*7.5°C*	+ 0.9°C	to	+ 1.7°C	+ 1.3°C	+ 1.0°C
Precipitation *(%)*	**Winter**	*1,180 mm*	– 1%	to	+ 12%	+ 5%	+ 8%
	Spring	*668 mm*	– 11%	to	+ 9%	0	+ 6%
	Summer	*286 mm*	– 23%	to	+ 14%	- 7%	+ 2%
	Fall	*984 mm*	– 4%	to	+ 11%	+ 4%	+ 6%
Growing Degree Days *(degree days)*	**Annual**	*1,410*	+ 180	to	+ 412	+ 308	+ 153
Frost Free Days *(days)*	**Annual**	*277*	+ 22	to	+ 33	+ 28	+ 10
Growing Season Length *(days)*	**Annual**	*234*	+ 21	to	+ 39	+ 30	n/a

TABLE 4 Vancouver Island Climate Projections — 2050s
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

		Vancouver Island (1971–2000 Baseline)	Projected Change from Baseline to **2050s**				
			Vancouver Island (Range)			Vancouver Island (Average)	BC (Average)
Mean Temperature *(°C)*	**Annual**	*7.5°C*	+ 1.6°C	to	+ 3.6°C	+ 2.6°C	+ 1.8°C
Precipitation *(%)*	**Winter**	*1,180 mm*	– 2%	to	+ 10%	+ 4%	+ 9%
	Spring	*668 mm*	– 5%	to	+ 11%	+ 2%	+ 15%
	Summer	*286 mm*	– 32%	to	+ 6%	- 13%	– 1%
	Fall	*984 mm*	+ 3%	to	+ 25%	+ 12%	+ 17%
Growing Degree Days *(degree days)*	**Annual**	*1,410*	+ 390	to	+ 940	+ 660	+ 283
Frost Free Days *(days)*	**Annual**	*277*	+ 36	to	+ 60	+ 48	+ 20
Growing Season Length *(days)*	**Annual**	*234*	+ 36	to	+ 72	+ 57	n/a

TABLE 5 Vancouver Island Sub-Regional Baselines
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

		Capital Regional District	Cowichan Valley Regional District	Nanaimo Regional District	Comox Valley Regional District	Alberni Clayoquot Regional District	Sayward (Strathcona Regional District)
Mean Temperature *(°C)*	**Annual**	9°C	8°C	8°C	7°C	8°C	9°C
Precipitation *(mm)*	**Winter**	839 mm	1,037 mm	736 mm	824 mm	1,528 mm	710 mm
	Spring	439 mm	546 mm	371 mm	422 mm	864 mm	442 mm
	Summer	164 mm	201 mm	139 mm	177 mm	347 mm	242 mm
	Fall	666 mm	777 mm	538 mm	648 mm	1243 mm	729 mm
Growing Degree Days *(degree days)*	**Annual**	1,634	1,542	1,539	1,433	1,489	1,743
Frost Free Days *(days)*	**Annual**	303	284	280	257	282	320
Growing Season Length *(days)*	**Annual**	268	240	234	220	241	274

TABLE 6 Vancouver Island Sub-Regional Climate Projections — 2050s
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

		Capital Regional District	Cowichan Valley Regional District	Nanaimo Regional District	Comox Valley Regional District	Alberni Clayoquot Regional District	Sayward (Strathcona Regional District)
Mean Temperature *(°C)*	**Annual**	+ 3°C	+ 3°C	+ 3°C	+ 3°C	+ 3°C	+ 3°C
Precipitation *(mm)*	**Winter**	+ 3%	+ 4%	+ 4%	+ 4%	+ 4%	+ 5%
	Spring	+ 3%	+ 3%	+ 3%	+ 3%	+ 2%	+ 3%
	Summer	– 17%	– 17%	– 17%	– 16%	– 15%	– 14%
	Fall	+ 9%	+ 10%	+ 11%	+ 12%	+ 11%	+ 13%
Growing Degree Days *(degree days)*	**Annual**	+ 778	+ 717	+ 712	+ 665	+ 665	+ 793
Frost Free Days *(days)*	**Annual**	+ 40	+ 50	+ 51	+ 54	+ 47	+ 32
Growing Season Length *(days)*	**Annual**	+ 52	+ 58	+ 58	+ 56	+ 55	+ 54

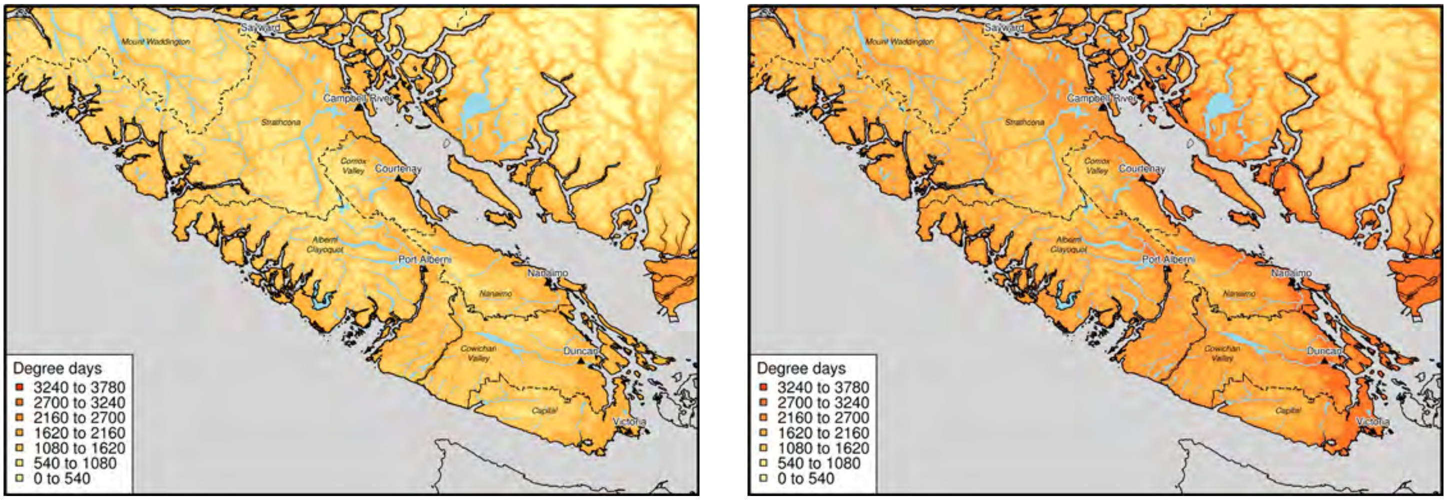

FIGURE 6 Growing Degree Days,
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

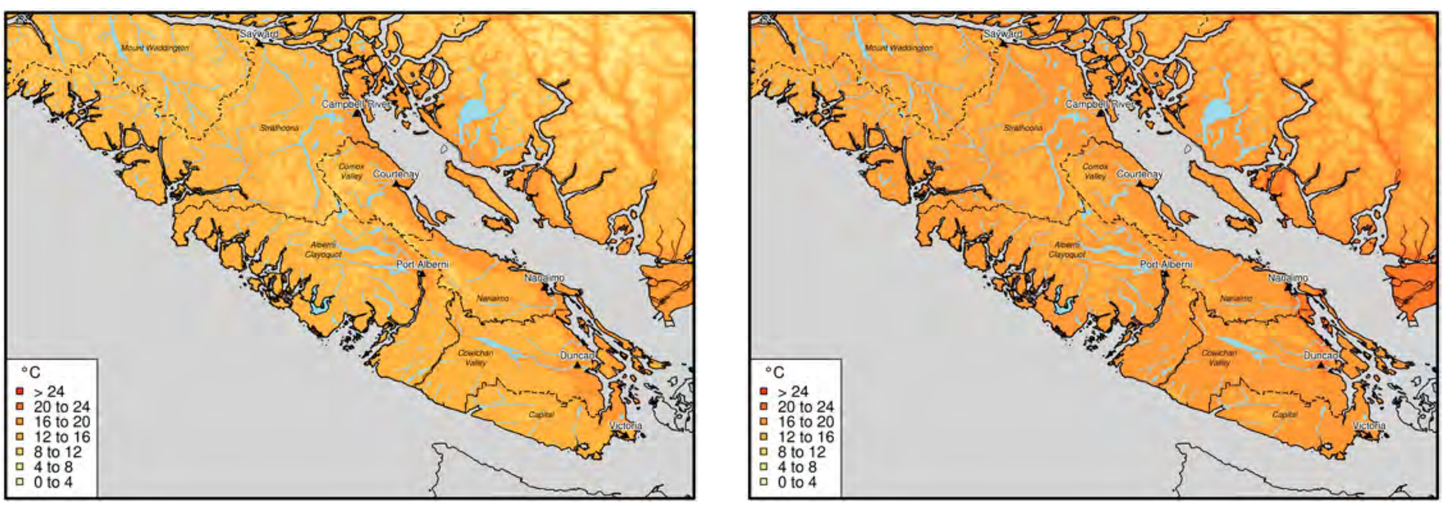

FIGURE 7 Average Summer Temperature,
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

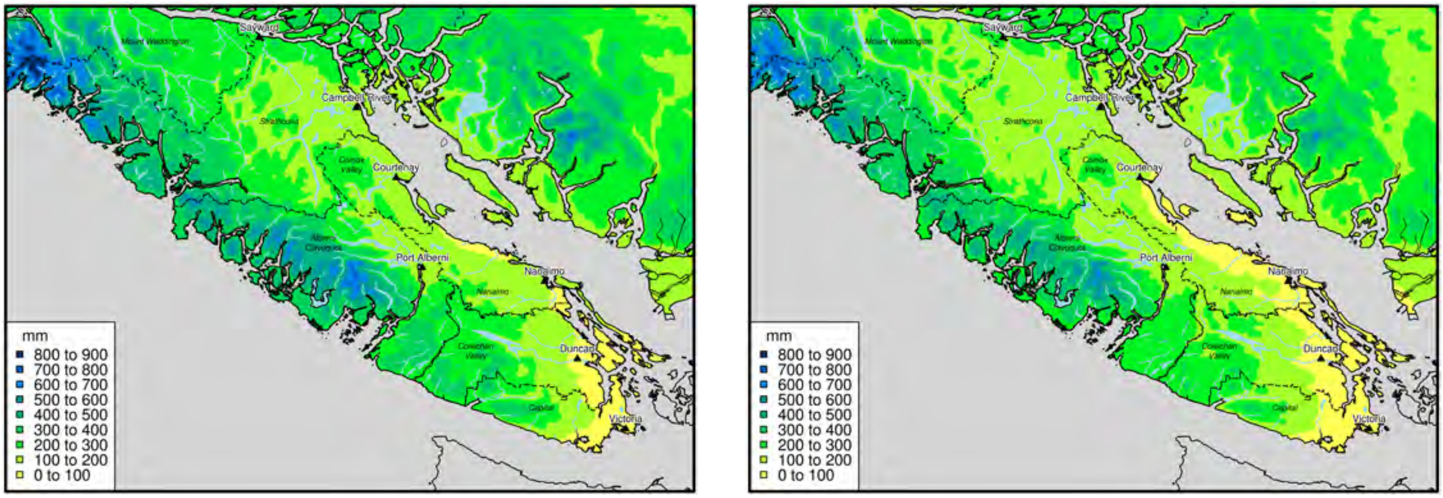

FIGURE 8 Summer Precipitation (mm),
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

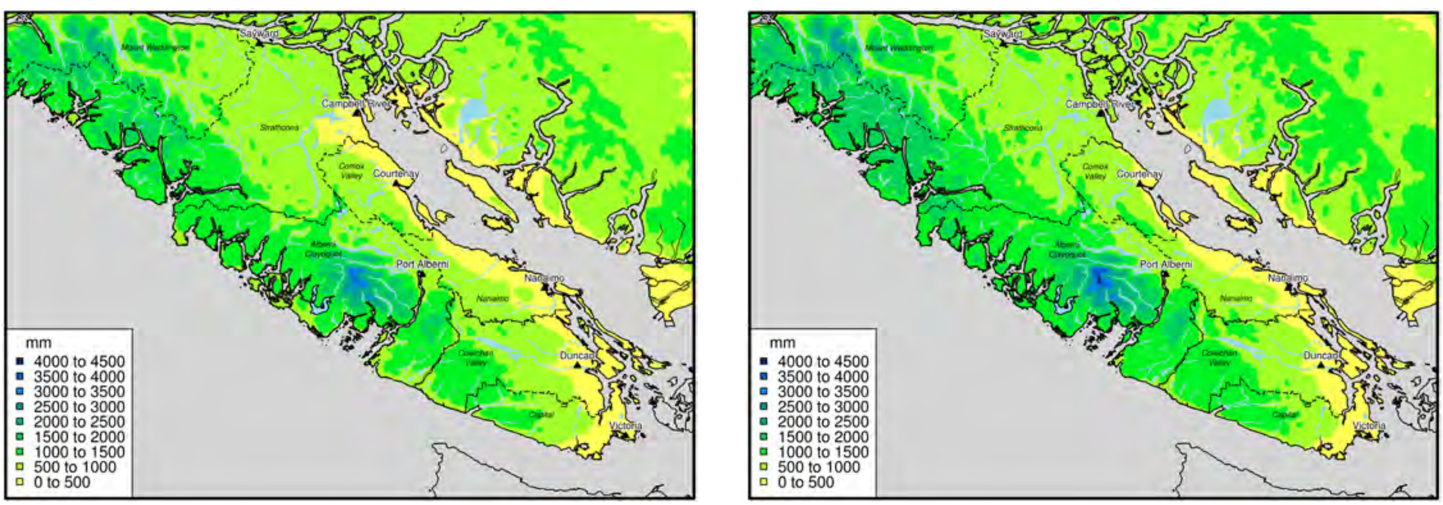

FIGURE 9 Fall Precipitation (mm),
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

For legibility, summer and fall maps use different legends, and so cannot be directly compared.

Appendix C
Definitions

- ***Annual Average Temperature***
  refers to the average of the nighttime low (minimum temperature) and the daytime high (maximum temperature) over a calendar year.

- ***Frost-Free Days (FFD)***
  refers to the number of days (in a calendar year) that the minimum daily temperature stayed above 0°C.

- ***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 5ºC, for all days of the year.

- ***Growing Season Length (GSL)***
  represents the number of days between the first span of six consecutive days with a daily mean temperature above 6°C and the last day with a daily mean temperature above 6°C.

- ***Heavy rain days***
  (i.e., the 95th percentile wettest days)
  represents the total amount of rain that falls on the wettest days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th percentile of wet days during the baseline period (1971–2000).

- ***Historic Baseline***
  is the average of the variable from 1971 to 2000 (variables are averaged over this 30-year period to smooth out annual variability).

- ***1-in-20 hottest day***
  refers to a day so hot that it has only a one-in-twenty chance of occurring in a given year. That is, there is a 5% chance in any year that temperatures could reach this magnitude.

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 7 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?

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39 BC Ministry of Agriculture. 2016. *Agriculture in Brief. British Columbia.* *https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/census/census-2016/aginbrief_2016_british_columbia.pdf*

40 BC Ministry of Agriculture. (n 37)

41 BC Ministry of Agriculture. (n 37)

42 BC Agriculture & Food Climate Action Initiative. (n 35)
and
BC Pork Producers Association. 2020. *About us.* *http://www.bcpork.ca/about-us/*

43 Statistics Canada. 2017. Comox Valley, RD; Nanaimo, RD; Cowichan Valley RD; Capital RD; Alberni-Clayoquot, RD; Strathcona, RD [Census division], British Columbia and Canada [Country] (table). Census Profile. 2016 Census. Statistics Canada. *Table 32-10-0403-01. Farms classified by farm type.* *https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210040301*

44 Alberni-Clayoquot Regional District. (n 28)

45 Martin, W. L, Ostry, A. and MacDonald, M. 2010. *Inequities in Food Safety Regulations.* *https://www.uvic.ca/research/groups/cphfri/assets/docs/Inequities%20in%20food%20safey%20regulations.pdf*

46 The definition of a *census farm* is a farm, ranch or other agricultural operation that produces (the listed) products intended for sale. Sales in the previous 12 months are not required, but there must be the intention to sell.

47 Statistics Canada. (n 43)

48 Statistics Canada. (n 43)
and
BC Agriculture & Food Climate Action Initiative. (n 35)

49 Statistics Canada. (n 43)

50 BC Agriculture & Food Climate Action Initiative. (n 35)

51 British Columbia Chicken Marketing Board. 2020. *BC Chicken Facts.* *http://bcchicken.ca/wp-content/uploads/2020/03/2020-BC-Chicken-Facts-Winter.pdf*

52 Statistics Canada. (n 43)

53 The exact census category is vegetables and melons.

54 Statistics Canada. (n 43)

55 Statistics Canada. 2017. Comox Valley, RD; Nanaimo, RD; Cowichan Valley RD; Capital RD; Alberni-Clayoquot, RD; Strathcona, RD [Census division], British Columbia and Canada [Country] (table). Census Profile. 2016 Census. *Table 32-10-0418-01. Vegetables (excluding greenhouse vegetables)* *https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210041801*

56 Statistics Canada. (n 43)

57 Statistics Canada. (n 43)

58 Stocker, T. F., Qin, D., et al. (2013). *Climate Change 2013: The Physical Science Basis.* Cambridge University Press. *http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf*

59 Pacific Climate Impacts Consortium. *http://www.pacificclimate.org*

60 Pacific Climate Impacts Consortium. *Climate Summary for West Coast Region*. (nd). *https://pacificclimate.org/sites/default/files/publications/Climate_Summary-West_Coast.pdf*.

61 Capital Regional District. 2017. *Climate Projections for the Capital Region*. *https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2017-07-17_climateprojectionsforthecapitalregion_final.pdf*

62 Cowichan Valley Regional District. 2017. *Climate Projections for the Cowichan Valley Regional District*. *https://www.cvrd.bc.ca/DocumentCenter/View/81884/Climate-Projections-Report*

63 PCIC's Statistically Downscaled Climate Scenarios are available for download through the PCIC data portal at *https://pacificclimate.org/data/statistically-downscaled-climate-scenarios*. This data can also be viewed through the "PCIC Climate Explorer" tool at *https://pacificclimate.org/analysis-tools/pcic-climate-explorer* .

64 The BCCAQ is a technique developed at the Pacific Climate Impacts Consortium for downscaling daily temperature and precipitation projections, and indices of extremes. It was tested for robustness according to three main criteria: day-to-day sequencing of events, distribution of values, and spatial structure. For more information see:
Cannon, A., Sobie S., Murdock, T. 2015. *Precipitation by Quantile Mapping: How Well Do Methods Preserve Changes in Quantiles and Extremes? Journal of Climate.* 28 (17). p 6,938–6,959. doi:10.1175/JCLI-D-14-00754.1
or visit *https://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios* .

65 To view the Vancouver Island modelling and outputs in detail, use the PCIC Climate Explorer tool at *https://pacificclimate.org/analysis-tools/pcic-climate-explorer*. An excellent (general) description of climate modelling, outputs, ranges and variables can be found in the report Climate Projections for metro Vancouver (developed with PCIC) and accessible at *http://www.metrovancouver.org/services/air-quality/AirQualityPublications/* .

66 For a detailed explanation, see the presentation by Trevor Murdoch from the *Pacific Climate Impacts Consortium* at *https://youtu.be/EqV9-jgFFeg* (21 minute mark).

67 Annual average temperature refers to the average of the nighttime low (minimum temperature) and the daytime high (maximum temperature) over a calendar year.

68 The historic baseline (used for all climate variables) is the average of the variables from 1971 to 2000. Variables are averaged over this 30-year period to smooth out annual variability.

69 Frost-free days is a derived variable referring to the number of days that the minimum daily temperature remained above 0°C, useful for determining the suitability of growing certain crops in a given area. The method used to compute this on a monthly basis is from (Wang et al, 2006).

70 Growing Degree-Days (GDDs) is a derived variable that indicates the amount of heat energy available for plant growth, useful for determining the growth potential of crops in a given area. It is calculated by multiplying the number of days that the mean daily temperature exceeded 5°C by the number of degrees above that threshold. For example, if a given day saw an average temperature of 8°C (3°C above the 5°C threshold), that day contributed 3 GDDs to the total. If a month had 15 such days, and the rest of the days had mean temperatures below the 5°C threshold, that month would result in 45 GDDs.

71 Baseline average winter precipitation is 1,180 mm while baseline average fall precipitation is 980 mm. By the 2050s average fall precipitation will be 1,100mm.

72 There is a range of uncertainty associated with climate projections due to model uncertainty and natural variability. For precipitation, the climate change "signal" is smaller relative to the natural variability "noise." Also the 2020s isn't very far from when the model simulations start (2005) so there also isn't much time for that small signal to emerge from the noise.

73 There is significant sub-regional variance in the "days above 25°C and 30°C" metric and some areas already experience a much larger number of these "days" than the baseline reflects. These areas can expect an increase in the number of "days above 25°C and 30°C", although not necessarily the 3 or 6 fold increase that Vancouver Island (as a whole) can expect.

74 1-in-20 hottest day refers to a day so hot that it has only a one-in-twenty chance of occurring in a given year. That is, there is a 5% chance in any year that temperatures could reach this magnitude.

75 Based on climate projections for Vancouver Island provided by Trevor Murdoch and Steven Sobie at the Pacific Climate Impacts Consortium. 2019.

76 Pacific Climate Impacts Consortium. 2013. *Climate Summary for the West Coast Region*. *https://pacificclimate.org/sites/default/files/publications/Climate_Summary-West_Coast.pdf*

77 Zwiers, F., Schnorbus, M., Maruszeczka, G. 2011. *Hydrologic Impacts of Climate Change on BC Water Resources: Summary Report for the Campbell, Columbia and Peace River Watersheds.* Pacific Climate Impacts Consortium. *https://www.pacificclimate.org/sites/default/files/publications/Zwiers.HydroImpactsSummary-CampbellPeaceColumbia.Jul2011-SCREEN.pdf*

78 Capital Regional District (n 61)
and
Cowichan Valley Regional District (n 62)

79 Capital Regional District (n 61)

80 Whitfield, P. 1998. *Linked Hydrological and Climate Variations in BC and Yukon.* Environment Canada. *https://www.obwb.ca/obwrid/docs/173_2001_Linked_Hydrologic_and_Climate_Whitfield.pdf*

81 Use caution when interpreting changes from a low baseline value which can result in deceptively large percent changes. In this case, a 6 fold increase in Days over 30°C is only a total of 6 days (since the baseline was 1 day).

82 A 1-in-20 hottest day refers to the day so hot that it has only a one-in-twenty chance of occurring in a given year. Individual locations could be considerably warmer than the regional average but an increase of about 4°C (by 2050) in the 1-in-20 year hottest day is quite consistent around most of the region.

83 Heavy rain days (i.e., the 95th percentile wettest days) represents the total amount of rain that falls on the wettest days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th percentile of wet days during the baseline period (1971–2000)

84 This is a risk in select locations along the east coast of Vancouver Island. Specific rivers at risk can be seen in the Government of BC Coastal Flood Hazard Area maps, *https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/integrated-flood-hazard-management/flood-hazard-land-use-management/floodplain-mapping/coastal* .

85 "Pests" includes insects, weeds, diseases and invasive species.

86 Coastal Douglas Fir and Associated Ecosystems Conservation Partnership. 2020. *What is the Coastal Douglas-fir Biogeoclimatic Zone? http://www.cdfcp.ca/index.php/about/what-is-the-cdf*

87 Statistics Canada. 2017. Capital Region, RD [Census division], British Columbia. Census Profile. 2016 Census. *Table 32-10-0413-01: Irrigation in the year prior to the census. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210041301*
and
Statistics Canada. 2017. Alberni-Clayoquot, RD [Census division], British Columbia. Census Profile. 2016 Census. *Table 32-10-0413-01: Irrigation in the year prior to the census. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210041301*

88 Zwiers, F., Schnorbus, M., and Maruszeczka, G. 2011. *Hydrologic Impacts of Climate Change on BC Water Resources: Summary Report for the Campbell, Columbia and Peace River Watersheds.* Pacific Climate Impacts Consortium *https://www.pacificclimate.org/sites/default/files/publications/Zwiers.HydroImpactsSummary-CampbellPeaceColumbia.Jul2011-SCREEN.pdf*

89 Ibid.
and
Capital Regional District. (n 61)
and
Cowichan Valley Regional District. (n 62)

90 MacDonald, Glenn. 2019. *Level 3 drought warning issued for Vancouver Island, Gulf Islands.* CTV News. *https://vancouverisland.ctvnews.ca/level-3-drought-warning-issued-for-vancouver-island-gulf-islands-1.4456806*

91 Bell, Jeff. 2019. "Low water levels prompt restrictions on Koksilah River." *Times Colonist. https://www.timescolonist.com/news/local/low-water-levels-prompt-restrictions-on-koksilah-river-1.23920279*

92 Ministry of Forests, Lands, Natural Resource Operations and Rural Development. 2020. *Partnership supports management of Koksilah Watershed. https://news.gov.bc.ca/releases/2020FLNR0015-000248*

93 Comox Valley Regional District. 2020. *Tsolum River Agricultural Watershed Planning. https://www.comoxvalleyrd.ca/projects-initiatives/past-current-projects/tsolum-river-watershed*

94 van der Gulik, Ted et al. 2013. *Agriculture Water Demand Model: Report for Regional District of Nanaimo. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/agriculture-water-demand-model/500300-9_agriculture_water_demand_model-nanaimo_report.pdf*

95 van der Gulik, Ted et al. 2014. *Agriculture Water Demand Model: Report for the Comox Valley Regional District. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/agriculture-water-demand-model/500300-13_agric_water_demand_model_-_comox_report.pdf*

96 van der Gulik, Ted et al. 2013 *Agriculture Water Demand Model: Report for the Cowichan Valley Regional District. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/agriculture-water-demand-model/500300-8_agriculture_water_demand_model-cowichan_report.pdf*

97 Tam, Stephanie and van der Gulik, Ted. 2017. *Agriculture Water Demand Model Report for Salt Spring Island. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/agriculture-water-demand-model/500300-25_agric_water_demand_model_-_capital_rd.pdf*

98 Government of British Columbia. 2020. *Private Managed Forest Land Program Review. https://engage.gov.bc.ca/privatemanagedforest/history/*

99 National Research Council. 2008. *Hydrologic Effects of a Changing Forest Landscape. https://doi.org/10.17226/12223*

100 2020/2021 BMPs cost shares include: well protection, construction of agricultural water storage, construction of dugouts, installation of rainwater harvest systems, alternative livestock water systems. ARDCorp. 2020. *Canadian Agricultural Partnership Beneficial Management Practices 2020/2021. https://ardcorp.ca/wp-content/uploads/2020/03/BMP-List-2020-21-March-2020-1.pdf*

101 Other barriers include regulatory, potential liability, increased management complexity and loss of potential productivity of land if converted to water storage.

102 Anecdotally, there are examples of shared water systems in the region to model from (e.g., in Bowser area, and Doukhobor water tower in Coombs).

103 Producers who have completed a current Environmental Farm Plan and an Irrigation Management Plan through Canadian Agricultural Partnership Beneficial Management Practices (BMP) Program are eligible to apply for cost-shared incentives to implement irrigation systems improvements identified in their plans. BMP categories and practices can be found at *https://ardcorp.ca/wp-content/uploads/2020/03/BMP-List-2020-21-March-2020-1.pdf* .

104 Smitha, R. J., & Baillie B, J. N. 2009. *Defining precision irrigation: A new approach to irrigation management.* *https://api.semanticscholar.org/CorpusID:26327014*

105 A project completed by the BC Agriculture & Food Climate Action Initiative in the Okanagan developed a fact sheet on the full cost of water. BC Agriculture & Food Climate Action Initiative. 2020. *Okanagan – Vineyard Water Use Efficiency & Knowledge Transfer Project.* *https://www.bcagclimateaction.ca/project/ok04/*

106 Detailed hydrological studies would be needed to determine the effects of climate change to each relevant aquifer. In general, changes in the snow regime are a large factor in aquifer recharge (the quantity of precipitation falling as snow versus rain, timing of snow melt, and pace of snowmelt). BC Ministry of Environment. 2016. *Indicators of Climate Change for British Columbia: 2016 Update.* BC Ministry of Environment, Canada. *http://www.env.gov.bc.ca/soe/indicators/climate-change/snow.html*

107 The Regional District of Nanaimo. 2019. *Drinking Water and Watershed Protection: Projects.* *https://www.rdn.bc.ca/dwwp-projects*

108 Capital Regional District. 2020. *Watershed Stewardship.* *https://www.crd.bc.ca/education/our-environment/watersheds/integrated-watershed-management*

109 Hanson, Kendall. 2017. *Vancouver Island farmers see second armyworm infestation this summer.* Chek News. *https://www.cheknews.ca/vancouver-island-farmers-see-second-armyworm-infestation-this-summer-366426/*

110 BC Agriculture & Food Climate Action Initiative. 2020. *Focus Group #2 Summary for Vancouver Island region* (unpublished).

111 Jill Hatfield, Regional Agrologist, Ministry of Agriculture, personal communication, February 13, 2020.

112 Implementing pest management actions (within Strategy 2.3) must consider and avoid conflict with actions to support health of pollinators and beneficial insects and biodiversity. Lora Morandin, Western Canada Program Director and Senior Pollinator Specialist, Pollinator Partnership, personal communication, February 11, 2020.

113 Island Pollinator Initiative. 2020. *About Pollinators.* *https://islandpollinatorinitiative.ca/about-pollinators*

114 Kjohl, M., Nielsen, A. and Stenseth, N.C. (2011). *Potential Effects of Climate Change on Crop Pollination. Food and Agriculture Organization of the United Nations.* *http://www.fao.org/fileadmin/templates/agphome/documents/Biodiversity-pollination/Climate_Pollination_17_web__2_.pdf*

115 This action would rely on the data from Action 2.1A

116 Useful resources available on the Island Pollinator Initiative website include: Planting Guides, Identification tools and other guides. *https://islandpollinatorinitiative.ca/resources*

117 These habitats could include: green manures/cover crops, wetlands, riparian areas, shelterbelts, forested areas and other non-farmed spaces.

118 Delta Farmland & Wildlife Trust. 2017. *Hedgerow and Grass Margin Stewardship Program.* *https://deltafarmland.ca/our-programs/hedgerow-grass-margin-stewardship-programs/*

119 ALUS Canada. 2020. *What are ecosystem services?* *https://alus.ca/what-we-do/ecosystem-services/*

120 BCAC. 2019. *Environmental Farm Plan.* *http://ardcorp.ca/programs/environmental-farm-plan/*

121 ARDCorp. 2020. *Canadian Agricultural Partnership Beneficial Management Practices 2020/2021.* *https://ardcorp.ca/wp-content/uploads/2020/03/BMP-List-2020-21-March-2020-1.pdf*

122 Habitat Acquisition Trust. 2020. *Pollinators: protection & stewardship.* *https://www.hat.bc.ca/images/Pollinator-Guide-Final-Web.pdf*

123 Local stakeholders could include beekeeper associations, the Island Pollinator Initiative, berry producers and the Habitat Acquisition Trust. Potential partners from outside of the region include: the BC Honeybee Producers' Association, Canadian Honey Council, the Bee BC Program and Pollinator Partnership Canada.

124 The combined effect of drought and heat waves on insect-plant interactions is complex and not fully understood. However, there are many ways that insects may directly or indirectly benefit. Beetge, L., and Krüger, K. 2019. *Drought and heat waves associated with climate change affect performance of the potato aphid Macrosiphum euphorbiae.* Scientific Reports 9. *https://www.nature.com/articles/s41598-018-37493-8*

125 Jill Hatfield. (n 111)

126 BC Agriculture & Food Climate Action Initiative. 2020. *Cariboo-Priority Pests: Scan, Consultation & Action Plan.* *https://www.bcagclimateaction.ca/project/cb09/*

127 A variety of tools are available to report invasive species, depending on the nature of the siting. These include: Report-Invasives BC Mobile App, Report-A-Weed BC Mobile App, Report-A-Weed tool in an online IAPP Map Display application, phoning 1-888-933-3722, completing the Invasive Species Council of BC's online form, or contacting the relevant regional invasive species organization or local government.

128 Key gaps exist for farmers that are not accessing information via a commodity association/council.

129 Vancouver Island farms report the second lowest "total gross farm receipts" in BC and (on average) earn only 33% of mean BC "total gross farm receipts". See the *2016 Census of Agriculture for BC* for Vancouver Island statistics and regional comparisons. *https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/census/census-2016/aginbrief_2016_regional_profiles.pdf*

130 While actual numbers may vary annually, approximately 17% of farmland (representing 19% of agricultural acreage) on Vancouver Island is leased from government, leased from others, or farmed under a crop share agreement. Statistics Canada. *Table 32-10-0407-01: Tenure of land owned, leased, rented, crop-shared, used through other arrangements or used by others.* *https://doi.org/10.25318/3210040701-eng*

131 Press release: *Qualicum Beach Chamber of Commerce partners with Coombs Farmers Institute: Expanding Local Food Production – A Feasibility Study.* *https://qualicum.bc.ca/cfi/*

132 Fowler, G. 2019. *Vancouver Island Forage Demonstration Project Summary Report 2006–2009.* *https://farmwest.com/images/clientpdfs/VIForageDemonstrationFinalReport.pdf*

133 Canadian Organic Vegetable Improvement (CANOVI) is a five-year collaborative project launched in 2018 by the UBC Centre for Sustainable Food Systems, the Bauta Family Initiative on Canadian Seed Security, and FarmFolk CityFolk. The goal of CANOVI is to contribute to the resilience and growth of Canada's organic vegetable sector through the characterization and development of varieties that excel in Canadian organic farming systems. *https://ubcfarm.ubc.ca/canovi/*. Information on farm cooperators can be found at *http://www.bcseedtrials.ca/*.

134 The BC Forage Council and BC Agriculture & Food Climate Action Initiative *Guide to On-Farm Demonstration Research* includes step-by-step instructions on developing research objectives and formulating a research question, deciding what to measure and how to measure it, scouting for relevant research, collecting data and analyzing results. While developed by the forage council, the methodology can be applied to any production system. *https://www.bcagclimateaction.ca/documents/FI03-On-Farm-Demonstration-Research-Guide.pdf* . Taking this work a step further, a Farm Adaptation Innovator Project (underway from 2019–2022) is developing research templates (with accompanying Case Studies) for a range of commodities/research questions. Information on the project Enabling Climate Change Adaptation through Grab & Go On-Farm Research Templates can be accessed at *https://www.bcagclimateaction.ca/project/fi19/* .

135 Senate Committee on Agriculture and Forestry. 2019. *Feast or Famine: Impacts of climate change and carbon pricing on agriculture, agri-food and forestry.* Senate of Canada. *https://sencanada.ca/content/sen/committee/421/AGFO/reports/Climate-Change_E_web.pdf*

136 The BC Ministry of Agriculture offers a wide range of programs and resources to support farmers and food processors to start, grow and innovate their business and more effectively market their products. These programs include AgriStability, Agri-Invest and crop insurance, as well as specialized business planning services and grants for research into innovative practices. *https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs*

137 BC Agriculture & Food Climate Action Initiative. 2013. *Cowichan Adaptation Strategies.* *https://www.bcagclimateaction.ca/documents/RegionalStrategies-Cowichan.pdf*

138 Jackson, D. A., Barraclough, C. L., Gauld, J. 2009. *Integrated Stormwater Management Plan Watershed* Reports: Hagan-Graham, Tetayut, McHugh-Noble. Prepared for the District of Central Saanich. *https://www.centralsaanich.ca/sites/default/files/uploads/documents/integrated_stormwater_management_plan.pdf*

139 Producers who have completed a current EFP through Canadian Agricultural Partnership Beneficial Management Practices (BMP) Program are eligible to apply for cost-shared incentives to implement actions identified in their on-farm environmental actions plan. BMP categories and practices can be found at *https://ardcorp.ca/wp-content/uploads/2020/03/BMP-List-2020-21-March-2020-1.pdf* .

140 Duncan, S., Krawczyk, T. 2018. *Keyline Water Management: Field Research & Education in the Capital Region Soil Indicators Monitoring Program.* Report prepared for Capital Regional District: Keyline Water Management: Field Research & Education in the Capital Region Report. *http://crkeyline.ca/wp-content/uploads/2018/08/FI09_report_final_March2018_approved.pdf*

141 BC Agriculture & Food Climate Action Initiative. 2020. *Focus Group #1 Summary for Vancouver Island region* (unpublished) and *Focus Group #2 Summary for Vancouver Island region* (unpublished).

142 Wilson, T. 2018. *Enhancing Runoff and Drainage Management in the Fraser Valley Agriculture Sector.* Report prepared for the BC Blueberry Council and the BC Agriculture & Food Climate Action Initiative. *https://www.bcagclimateaction.ca/documents/FV06-CADMF-2018-report.pdf*

and

Thiel, B., et al. 2015. *Climate Change Adaptation and On-Farm Drainage Management in Delta, British Columbia: Current Knowledge and Practices.* Report prepared for Delta Farmers' Institute.

Urls in these Endnotes were current as of January 2020.