Research Partnerships and Projects in the Greater Victoria Water Supply Area

Water Advisory Committee
November 25, 2025

Purpose of the Presentation

Making a difference...together

To highlight the importance and benefits of research partnerships, collaborations, and projects in risk management, climate adaptation, watershed and water supply planning, and advancing watershed protection and stewardship.

Overview of Presentation

Making a difference...together

- Direction Relevant to Research from IWS Strategic Plans
- Types of Research Partnerships and Projects and the Benefits of Research
- Overviews of Key Research Undertaken with Partners
- A Listing of Other Research Projects Undertaken in the GVWSA
- How Research Results Have Informed Watershed Protection and Stewardship and Could Inform Major Infrastructure Projects

Research in the GVWSA Prior to 1999

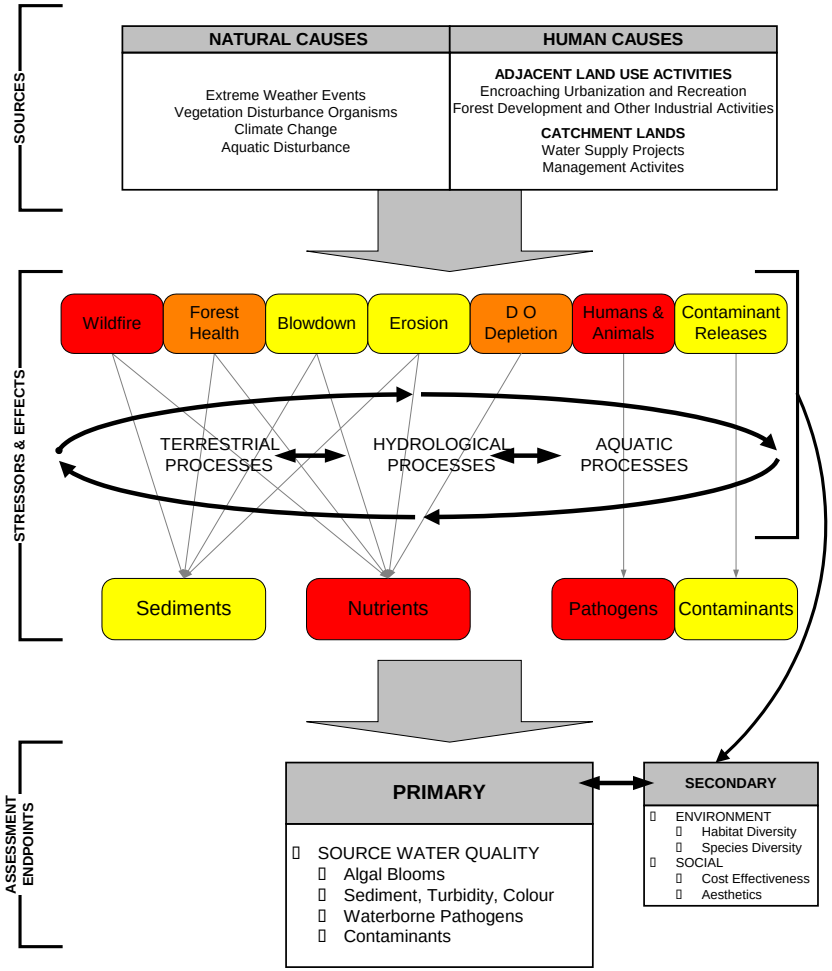
Making a difference...together

Research areas included:

- Genetic trials of tree species
- Forest growth
- Use of hyperspectral satellite imagery and LiDAR to characterize forests

Research Direction from RWS Strategic Plans

Making a difference...together

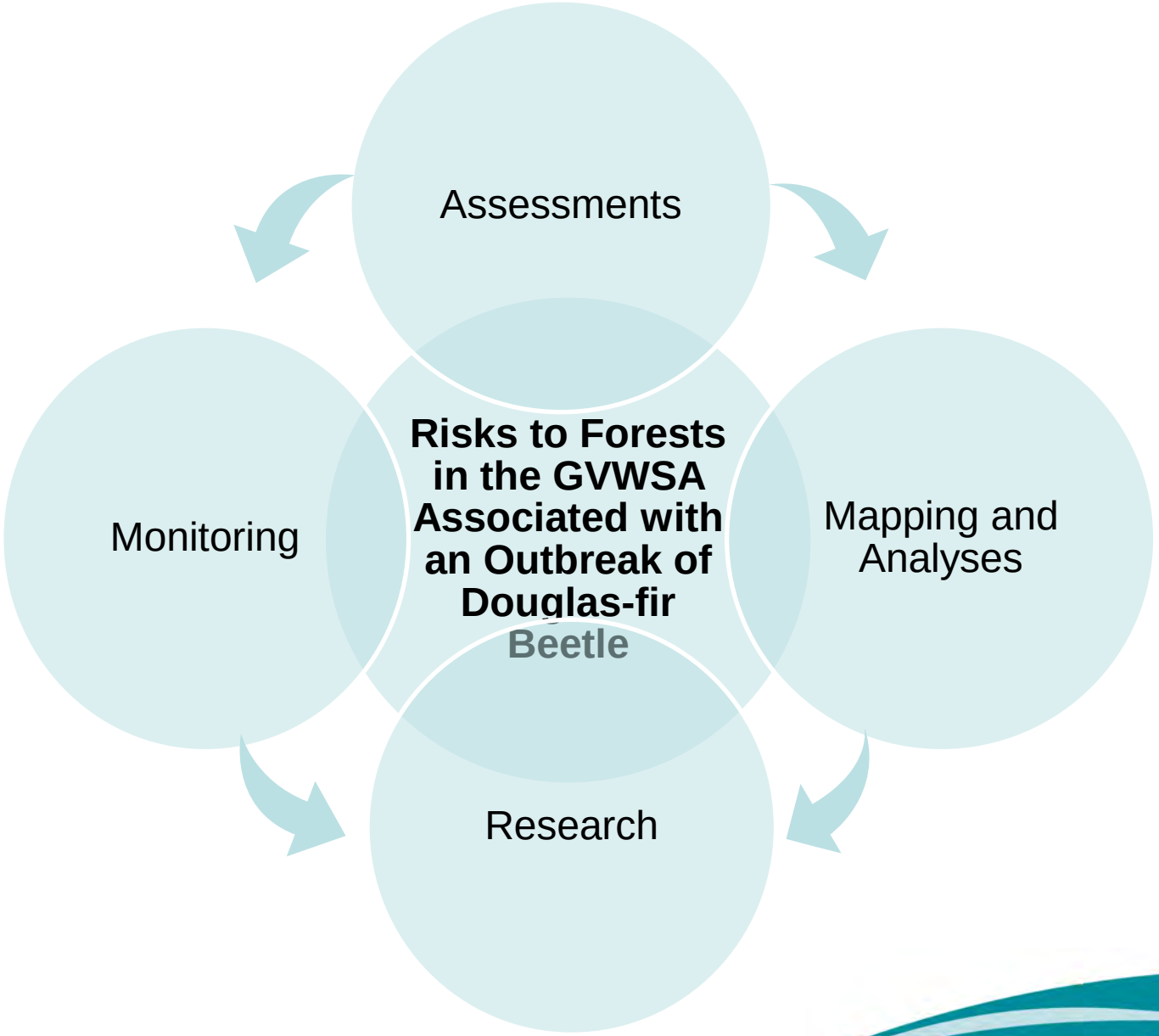


- Direction from the 1999 Strategic Plan focused on information needed to reduce risks to water quality and supply.
- Direction from the 2012 Strategic Plan focused on assessing the potential effects of climate change on the water supply area and identified risks and the importance of collaborative partnerships in research.
- The encouragement of collaborative partnerships for research and stewardship has continued in subsequent strategic plans.

Acres International et al. 1999

Research is Part of an Integrated Approach to Risk Management

Making a difference...together



Types of Research Projects

Making a difference...together

Projects without Direct CRD Involvement

Facilitated – Research Triggered by CRD Sharing Information with Agencies

Proposals with Funding Requests Based on Known CRD Interests

Collaborative – CRD Works with Researchers to Develop Project

CRD Participation in a National Research Network

Research Partnerships – more comprehensive research project involving multiple partners

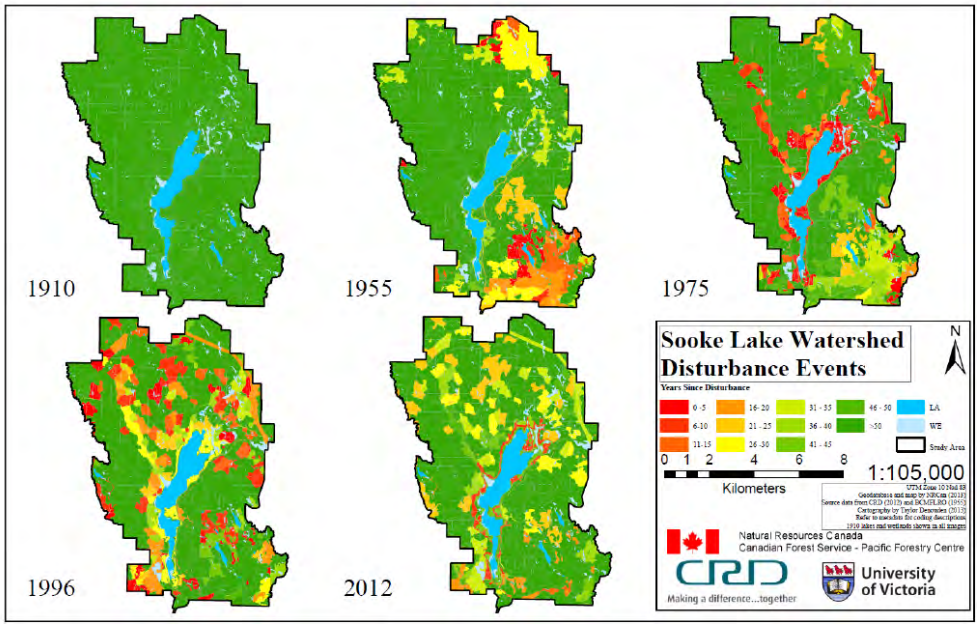
Benefits of Research

Making a difference...together

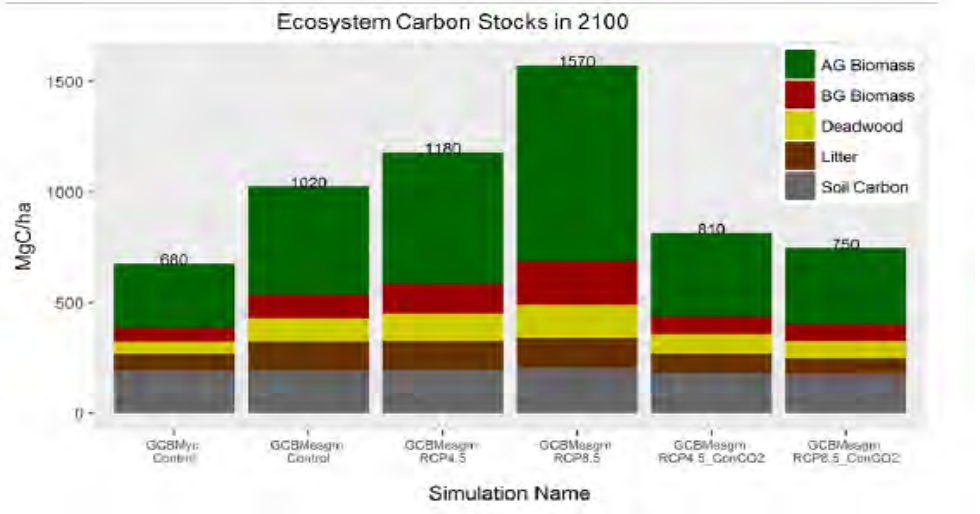
- Provides information needed for watershed protection and stewardship and risk management
- Contributes to the multiple lines of evidence needed to reduce uncertainty
- Often much more cost effective than consultants
- Generates products which can be used in other projects
- Beneficial syntheses of scientific literature
- Interactions with researchers often provide added information of value

Carbon Budget with Forest Disturbance and Growth 2011-2012 and with Projected Climate Change

Making a difference...together



Smiley 2015



Trofymow et al. 2017

Research in two phases:

1. Using the CFS carbon model (CBM-CFS3) to develop a retrospective and current climate budget for the Sooke WSA

   Proposal and funding request from CFS based on a recommendation from the 2012 IWS Strategic Plan. Undertaken by a Master's student at UVic.

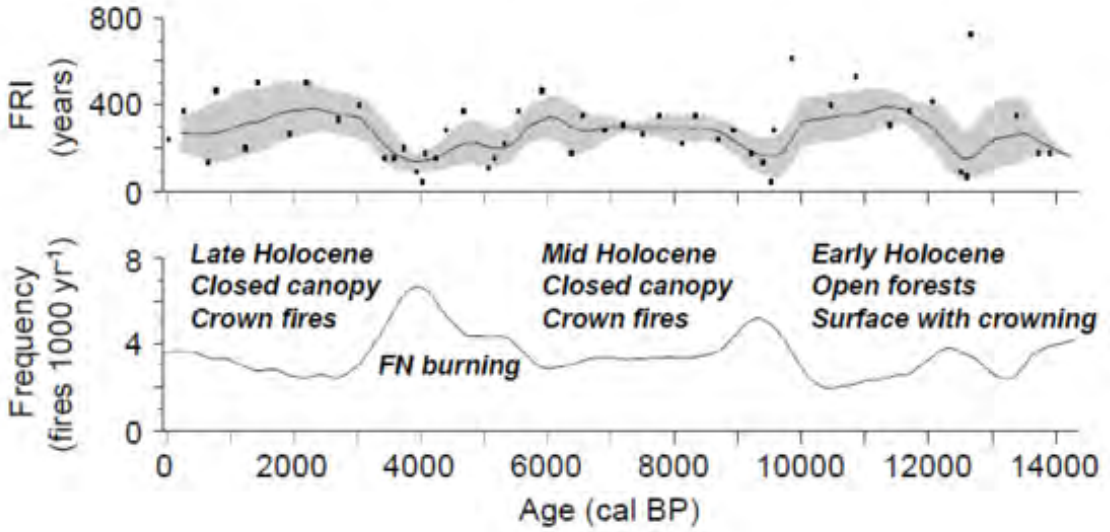
   Generated an important disturbance data set for the Sooke WSA as well as the research results.

2. Expanding the carbon budget model to 2100 under projected climate change. Modelling carried out by scientists at CFS. Study included the effect of carbon fertilization.

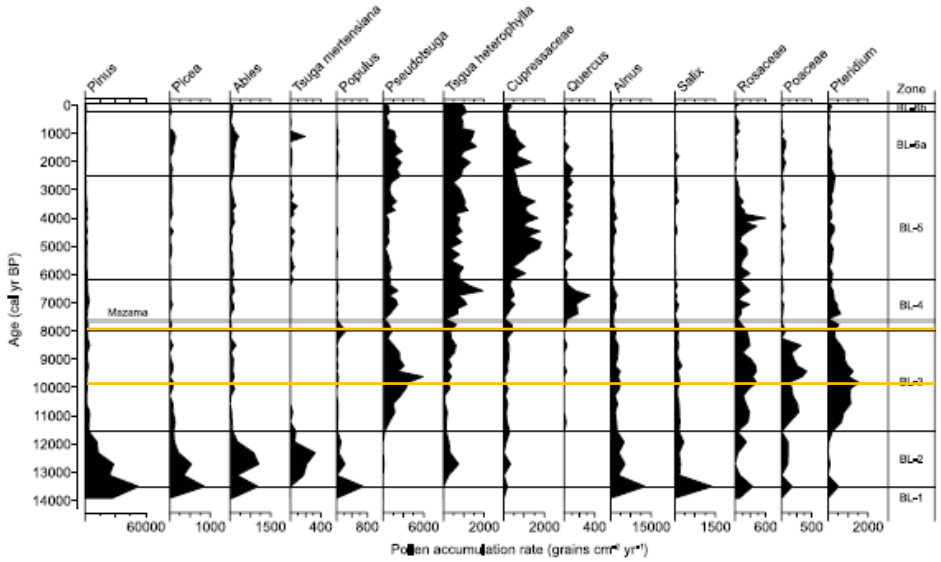
   Provided important insights on the effects of climate change on forest growth and mortality and the allocation of carbon.

Vegetation and Wildfire History in the Sooke WSA
(Brown et al. 2019)

Making a difference...together



Fire Return Interval, Frequency and Type in the Sooke Water Supply Area Over the Last 14,000 Years (based on analysis of charcoal and pollen in a sediment core taken from Begbie Lake just north of Sooke Lake Reservoir). Figure taken from Brown and Trofymow 2016.



Research carried out by the Canadian Forest Service, funded by IWS

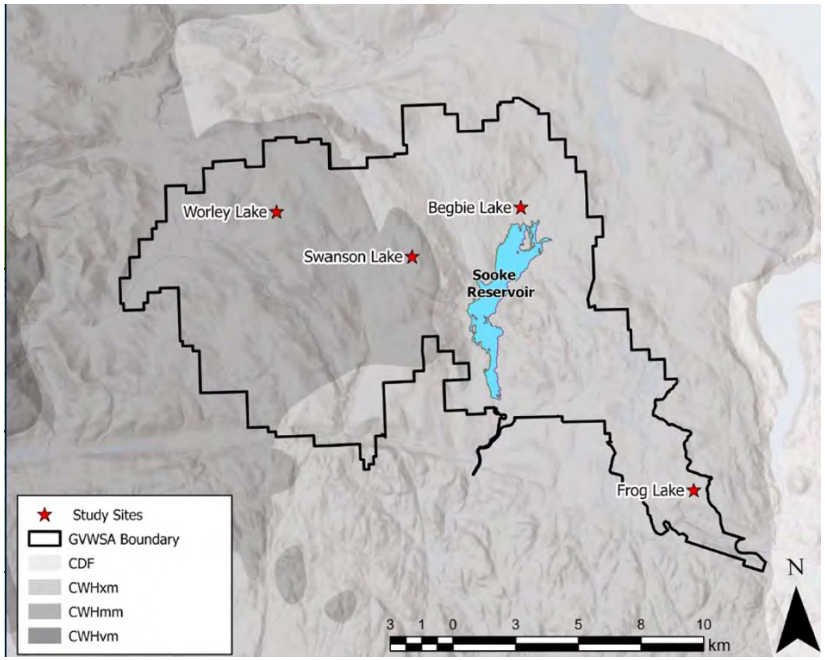
Based on the analysis of a 4.5 metre sediment core from Begbie Lake north of Sooke Lake Reservoir

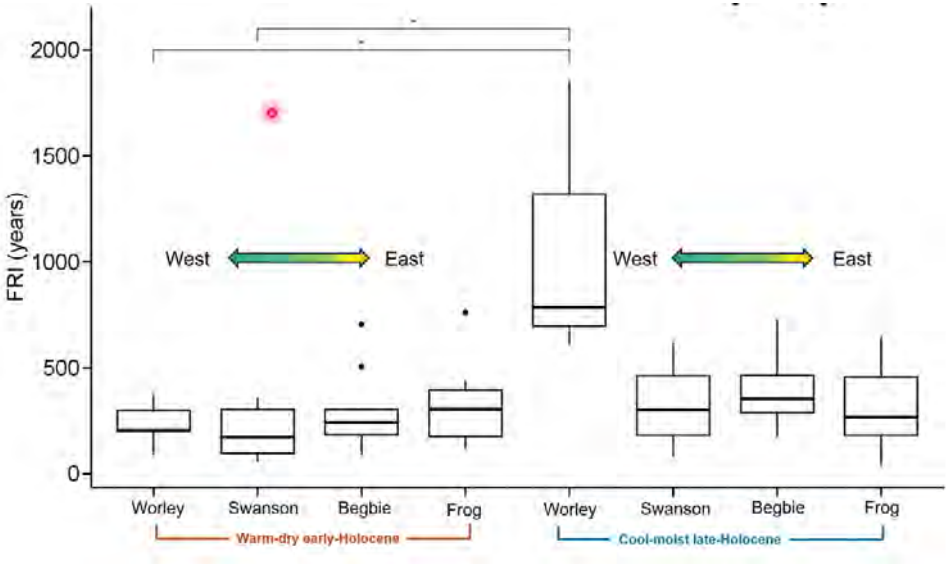
Characterized vegetation change and wildfire frequency during changing climatic conditions from the end of the last ice age to present day.

Suggested that the warmer drier period between 8,000 and 10,000 years before present may provide an analogy for future climate conditions.

Comparison of Early Holocene and Modern Vegetation and Wildfire History within the GVWSA (Herralt 2024)

Making a difference...together

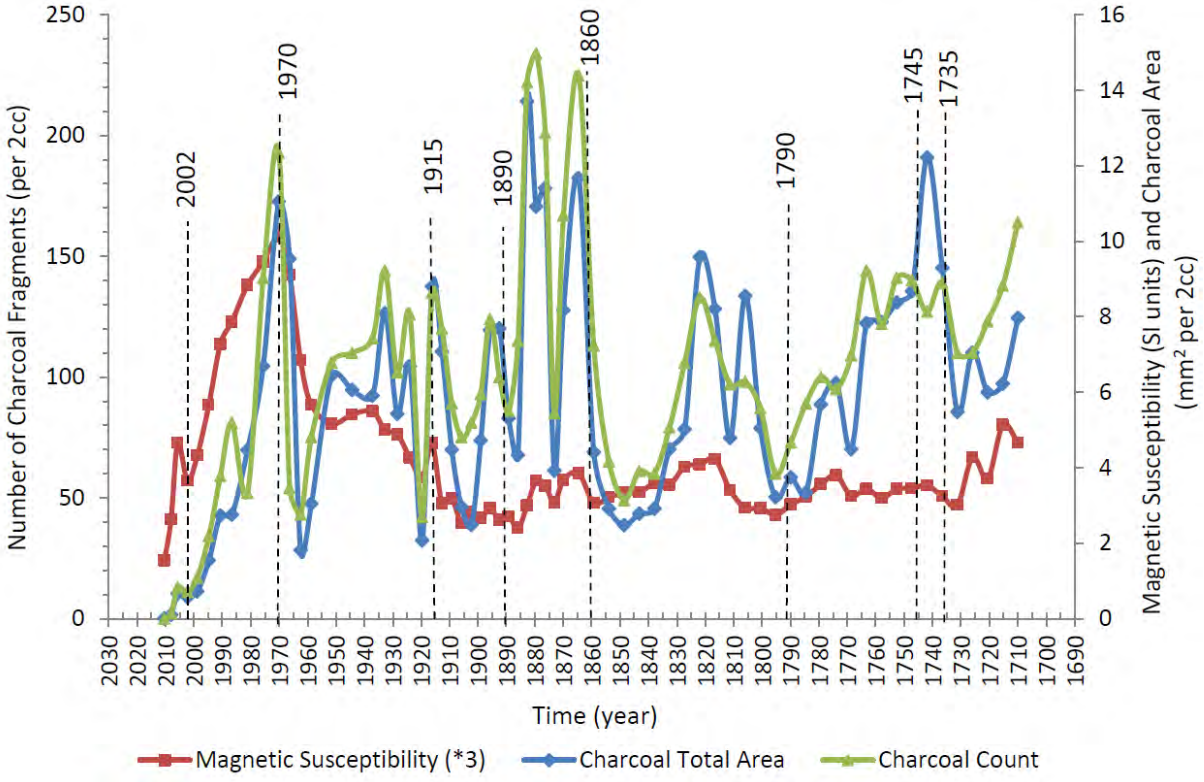




- A paleo-ecological study undertaken as part of the NSERC Alliance Research Partnership on Climate Change, Forests and Wildfire funded by the CRD and the Natural Sciences and Engineering Research Council
- Sediment cores taken from small lakes distributed throughout the GVWSA were used to compare past warm dry climate and current climate to assess potential landscape and watershed level effects of climate change
- Results suggest that climate change could result in a major shift in vegetation and wildfire frequency in the cooler and moister Leech WSA

Initial Evidence of Wildfire and Reservoir Expansion Impacts in Sooke Lake Reservoir (Brown and Trofymow 2015)

Making a difference...together



Trends in the Amount of Charcoal and Sedimentation within the North Basin Sample Site in Sooke Lake Reservoir in Relation to Years with Recorded Wildfire and Reservoir Raising Events (graph from Charpentier et al. 2015)

- An expansion of the paleo-ecological study at Begbie Lake funded by the CRD.
- A sediment core was taken from the north basin of Sooke Lake Reservoir and analyzed to identify wildfire events and associated inputs of organic and inorganic material to the reservoir.
- Results suggest that reservoir expansions contributed more inorganic sediment to the reservoir than any of the wildfires since 1690.

Analyses of Sediment Cores to Assess the Effects of Wildfire in Sooke Lake Reservoir (Hebda 2022)

Making a difference...together

An extension of the paleo-ecological study that examined the history of vegetation and wildfire since the last ice age. A PhD candidate at the University of Victoria carried out this new study with CFS. The research was funded by the CRD.

Two sediment cores were taken from the north and south basins of the reservoir. Evidence of specific wildfire events were selected for detailed analyses of the sediment cores immediate above and below the event. Diatoms, nutrients, and organic and inorganic elements in the sediments were examined to identify changes that could indicate changes to water quality in the reservoir from the wildfire. Results suggest these effects could last for decades and challenge existing water treatment processes.

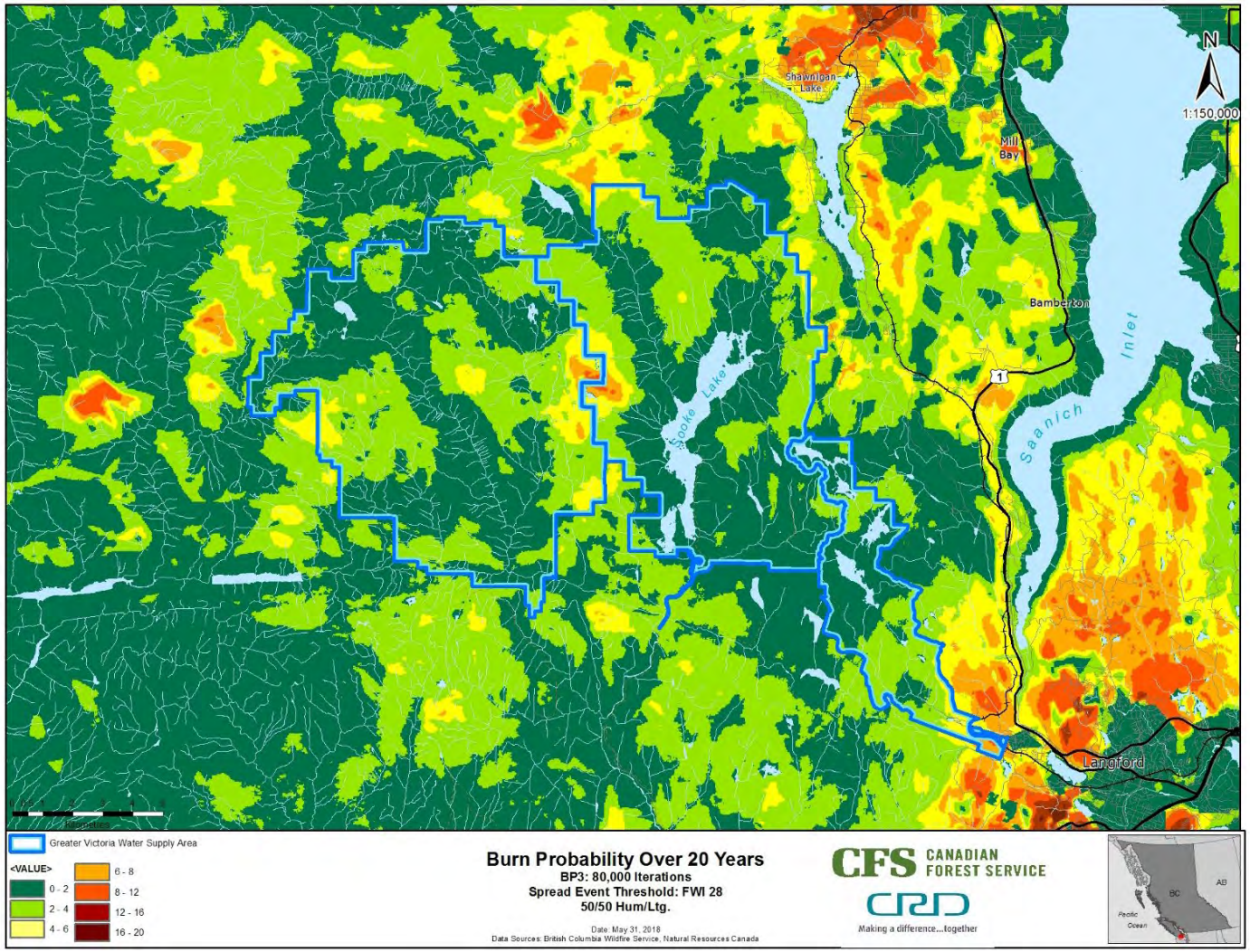
An example of a figure from on the fires is provided below.

INORGANIC ELEMENTS

- Concentrations of many elements change significantly around 1815 CE
- Timing matches changes in other key fire indicators
- Strong evidence of fire disturbance
- Changes last for >25 years

Burn Probability in the GVWSA (Perrakis et al. 2019)

Making a difference...together

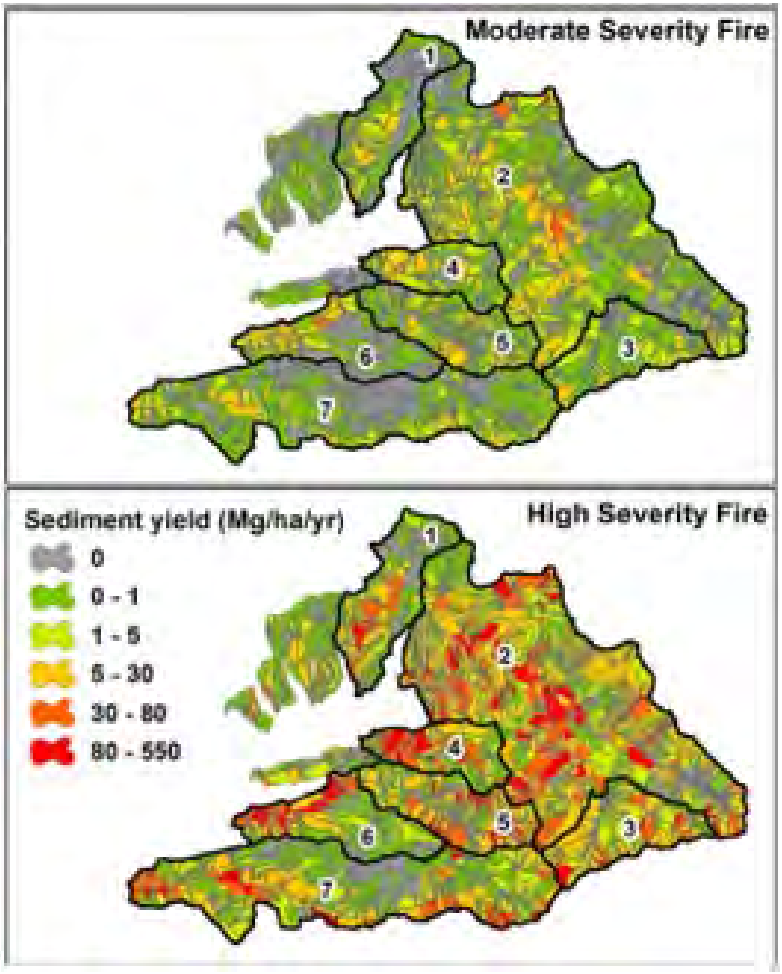


- Research carried out by wildfire scientists at the Canadian Forest Service and funded by IWS
- Modelling based on the distribution of past fire starts and current fire weather and forest fuel types
- Provided valuable insights into potential wildfire sizes and the fire weather indices where large wildfires were possible
- Validation for existing focus on landscape level fuel breaks at or near boundaries of GVWSA

Probability of Areas Within and Adjacent to the Greater Victoria Water Supply Area Burning During A Wildfire Using Existing Data on Wildfire Starts and Fire Weather Conditions (Perrakis et al. 2019) The map output is based on 80,000 iterations of modelling randomly generated human and lightning-caused wildfire starts (based on past patterns) and area burned given existing forest fuel types without suppression. Burn probability is expressed as likelihood of an area burning over a 20-year period. The greatest threat of wildfire to the GVWSA in this simulation is from lightning strikes within the area and wildfires spreading into the area from surrounding lands.

Research on Wildfire, Post-Wildfire Impacts, and Forest Fuel Management in Water Supply Catchment Areas

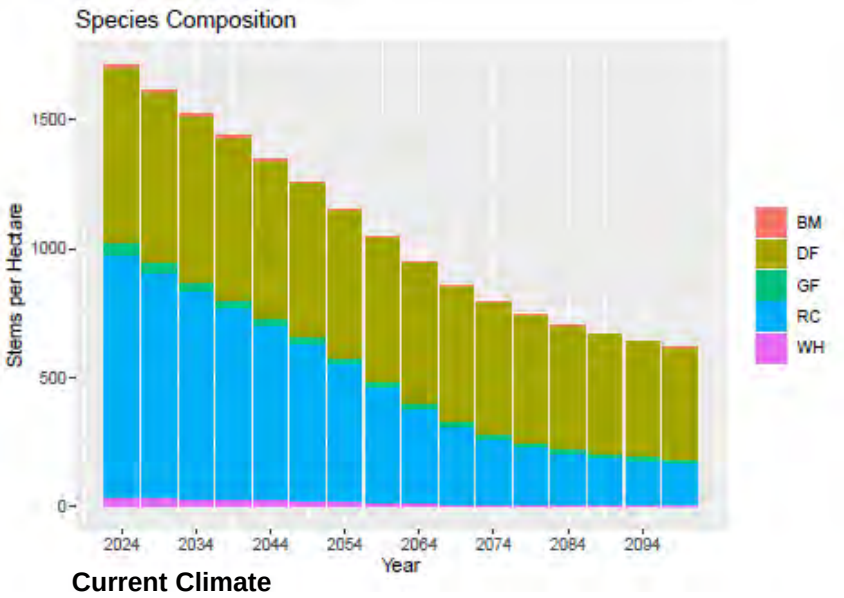
Making a difference...together



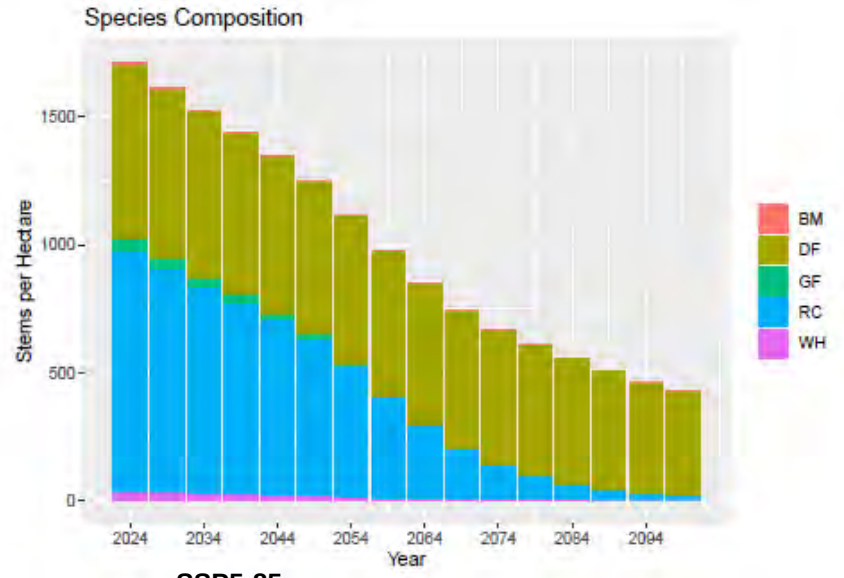
- A consortium of US Researchers, funded by NASA is developing a decision support tool to help water supply utilities make decisions on forest fuel management and post-wildfire risk mitigation.
- IWS was interviewed on its level of interest in the decision tool, and because suitable data were available for the GVWSA, was selected to participate in its testing.
- The US researchers will be using scenarios provided by IWS to model wildfire, post-wildfire impacts, and how forest fuel management and post-wildfire emergency stabilization can be used to reduce potential impacts to water supply reservoirs.
- The product of the research will be an online tool, with data for the GVWSA loaded, to test a range of model scenarios in the Sooke, Goldstream and Leech WSAs.

Modelling the Effects of Climate Change on Forests
(Bone et al. in preparation)

Making a difference...together



Current Climate

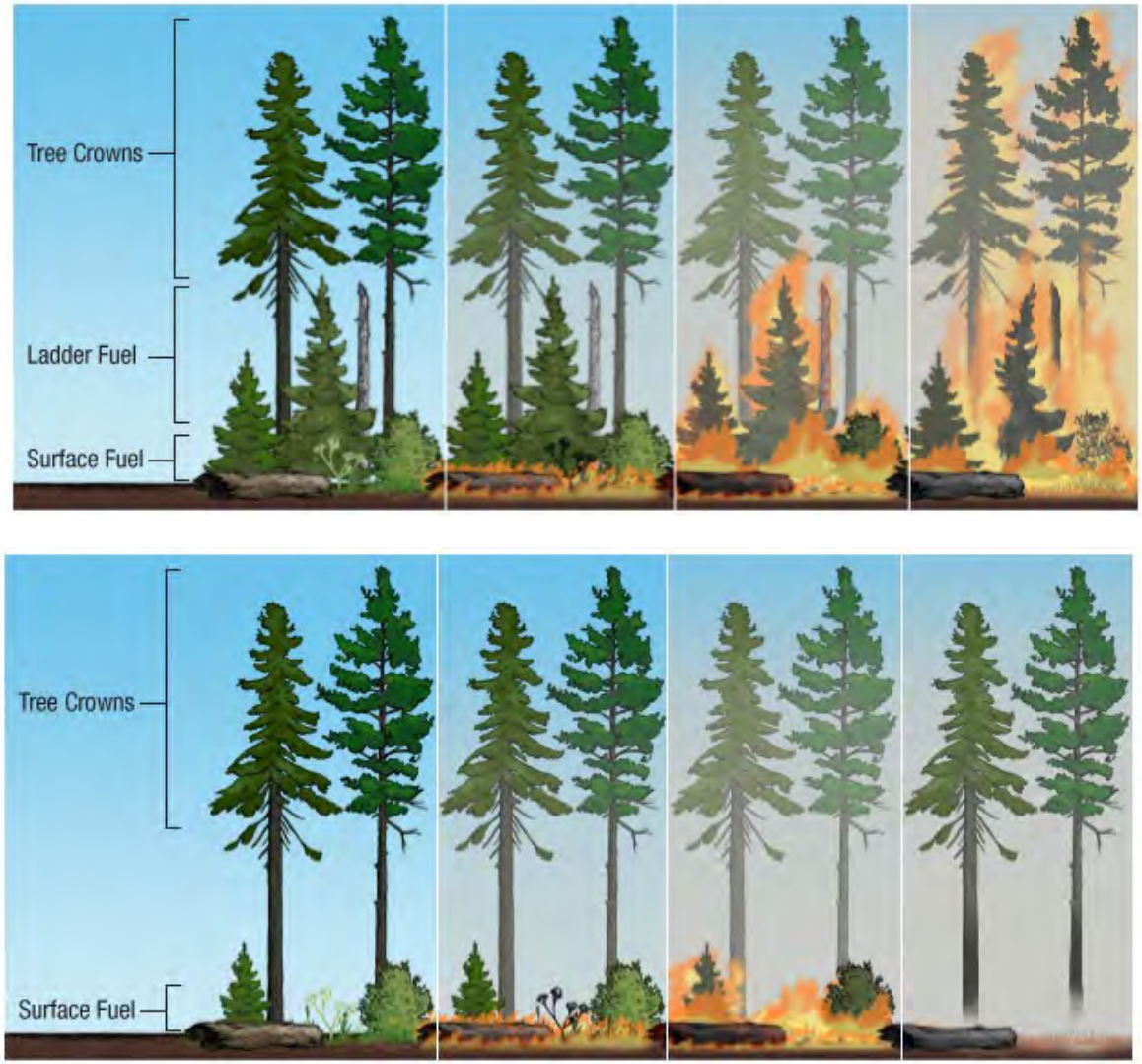


SSP5-85

- NSERC Alliance Project with the University of Victoria, Canadian Forest Service, ESSA Ltd., and the CRD.
- Funded by the CRD (1/3) and Natural Science and Engineering Research Council (2/3)
- Validating and applying the US Forest Vegetation Simulator to SE Vancouver Island forest
- Using actual forest plot data from the GVWSA
- Modelling forest change between 2024-2100 using nine climate models and three greenhouse gas scenarios
- Phase 1 compares forest growth and mortality under different climate change scenarios and examines how forest management (thinning) could be used to reduce tree mortality and improve forest resilience.

Modelling Wildfire Behaviour Potential and Fuel Management in a Changing Climate (Bone et al. in preparation)

Making a difference...together

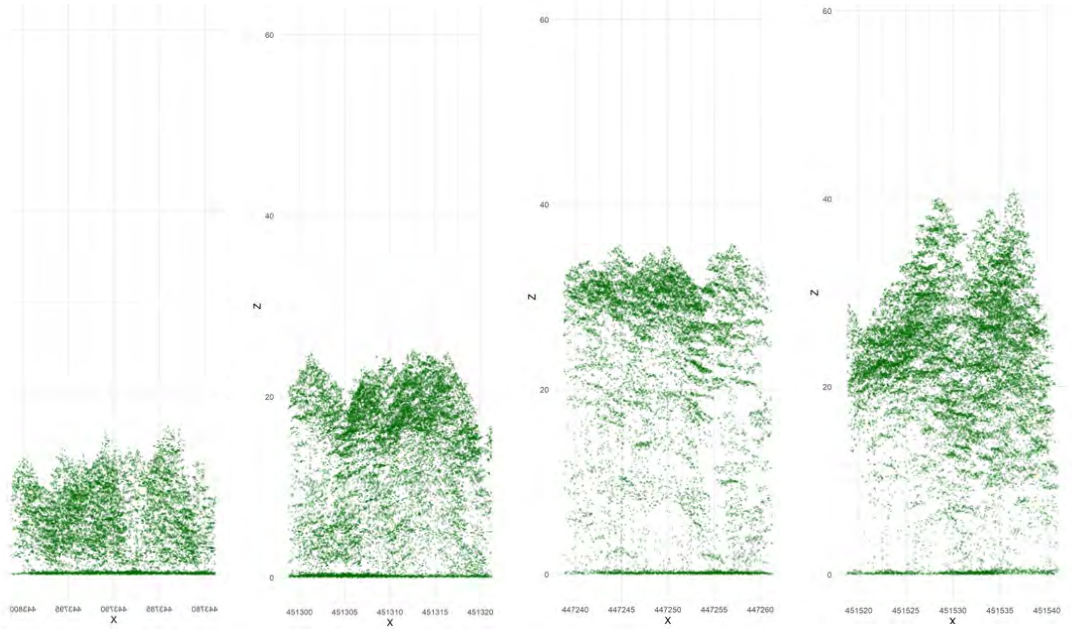


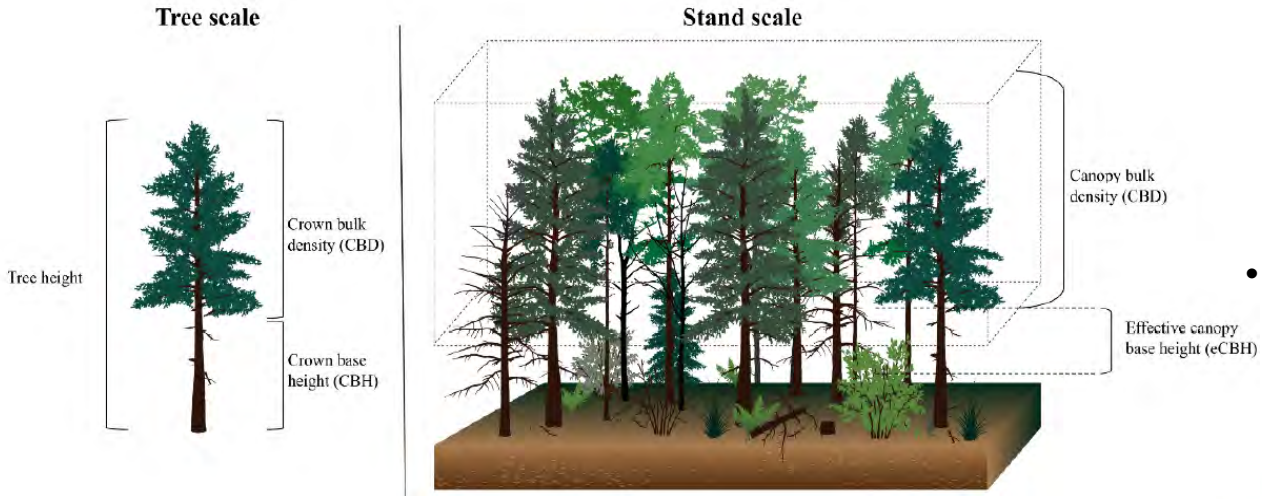
Source: U.S. Forest Service
Credit: Adam Cole, Nelson Hsu / NPR

- Phase 2 of the NSERC Alliance Study examines how climate change affects forest stands with different tree densities and structure potential in dry and moist sites.
- The Fire and Fuels Extension of FVS will be used to model how these changes relate to key indicators of wildfire behaviour.
- The modelling will then examine how forest management and forest fuel reduction treatments could reduce wildfire hazard.

Deriving Forest Metrics for Wildfire Hazard and Behaviour Modelling (Kelley et al. in preparation)

Making a difference...together

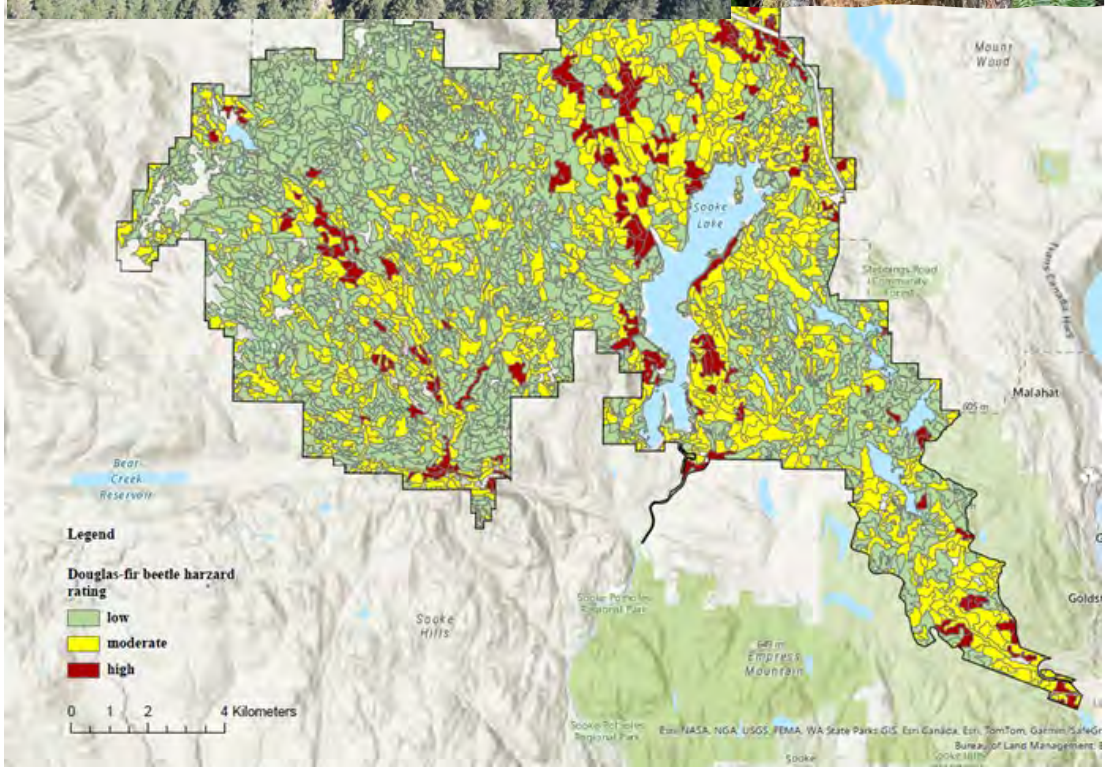




- A research Partnership with UVic with the participation of the Ministry of Forests.
- Funded by the CRD with in kind support from MOF
- LiDAR data collected for the GVWSA are being modelled to identify forest stand types with common characteristics relating to height, density, and vertical continuity.
- Those parameters, and the results of the NSERC Alliance modelling, will be used to identify forest stands in the GVWSA with specific forest fuel hazard levels of concern.
- The model outputs also generate the forest metrics that will be inputs to the next generation of the Canadian Wildfire Behaviour System.

Evaluating the Dynamics of Douglas-fir Beetle Populations in Forests in the GVWSA (Tobiasz 2025)

Making a difference...together



- A research partnership with the Forest Insect Disturbance Ecology Lab at the University of British Columbia.
- A Master's research project funded by the CRD.
- The research evaluated annual forest health monitoring data and the retrospective mapping of tree mortality from Douglas-fir beetle in the GVWSA between 2005 and 2023.
- The student reviewed the ecology of Douglas-fir beetle and developed models identifying the forest stands associated with the endemic population of the beetle in the GVWSA and those stands likely to be attacked if the beetle population reached outbreak level.

Additional Research Projects in the GVWSA

Making a difference...together

There are a wide range of additional studies in the GVWSA that are helping to inform Watershed Protection and Stewardship. They can be grouped into several categories:

- Wildfire
- Forest Health
- Forest Ecology
- Hydrology and Water Quality
- Wildlife Domestic Animals and Pathogens
- Species at Risk
- Wildlife Movement Corridors

These studies are listed in the following slides for reference but will not be described individually.

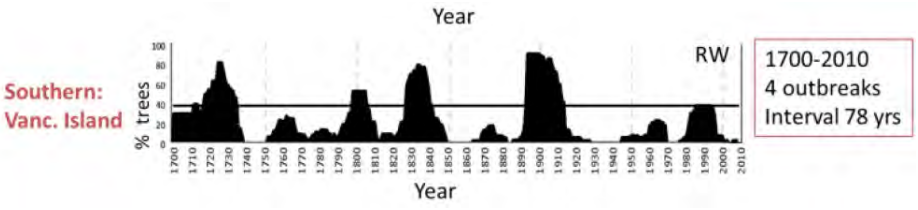
Additional Research Projects - Wildfire

Making a difference...together

- BC Wildfire Service and Forest Innovations and the Canadian Forest Service examining the effects of forest fuel management on within stand microclimate and surface fuel moisture.
- IWS, UVic and CFS examining the effects of mechanical thinning on within stand microclimate and soil moisture.
- CFS examining how within stand forest weather and fuel moisture compares to the fire weather indices generated by weather stations in forest clearings.

Additional Research Projects – Forest Health

Alder Bark Beetle – D. Wertman photos

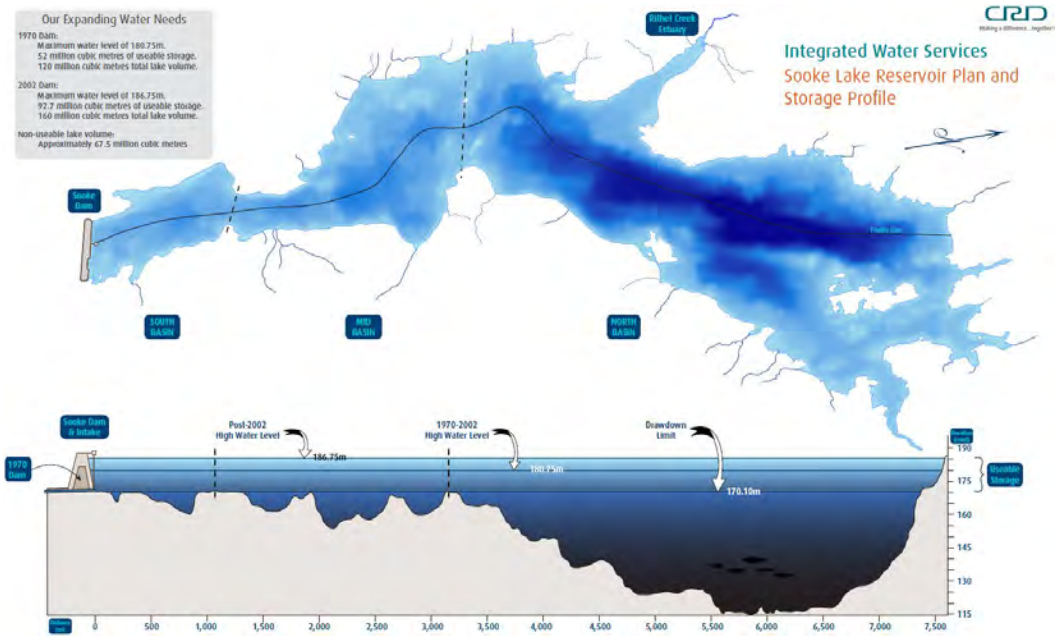


Spruce Budworm Outbreaks – Alfraro et al. 2017

- UBC/Mitac/CRD Research on the distribution, health and resilience of red alder in the GVWSA (Wertman in process).
- UBC research on alder bark beetle and an associated fungi on red alder mortality (Wertman
- CFS research on the endemic Vancouver Island mountain pine beetle and how its life history compares with the beetle in other parts of BC. (Bleiker in process).
- CFS research on spruce budworm outbreaks in the GVWSA since 1700 (Alfraro et al. 2017)
- CFS Research on the dynamics of spruce budworm in the GVWSA and the role of predators in keeping the population in check (Van Hezewijk et. al 2023).
- UVic Research on the use of LiDAR and spectral analysis to detect forest stands with root disease (Quinn 2016).

Additional Research Projects – Watershed Hydrology and Water Quality

Making a difference...together



Cross section of Sooke Lake Reservoir, the primary water source for the Regional Water Supply System

- Establishing relationships amongst stream flow and water quality parameters in the Sooke WSA (Watershed Hydrology and Water Quality Operations programs in process).
- Variation in Organic Matter in the Leech River (McSorley 2020)
- Potential Effects of Climate Change on Water Quality and the Ecology of Sooke Lake Reservoir (Aquatex 2019).
- Food Web Study for Sooke Lake Reservoir (Ecofish Research Ltd. and Minnow Aquatic Environmental Services 2024 for the Water Quality Operations Program)
- Reservoir Drawdown Study to Assess Risks to Water Quality (Ecofish Research Ltd. and Minnow Aquatic Environmental Services CRD Water Quality Group in process)
- Reservoir Circulation Model for Sooke Lake Reservoir (Water Quality Operations Program in process)

Additional Research Projects – Forest Ecology

Making a difference...together

- CFS using the GVWSA for some of their forest plots designed to characterize different forest development stages regenerating after forest harvest in relation to old forest stands (Trofymow et al. 1999)
- CFS/University of Alberta expanding the CFS plots to track the fate of all trees within one-hectare plots to better understand forest development and within stand disturbances (Schurmann 2017).
- Long-term forest monitoring plots established by IWS in old forest stands in the Sooke WSA (2015-2019).
- UVic studies using analyses of tree rings to investigate moisture variability and drought over the last several hundred years (Jarrett 2008 and Farmer 2020)
- BC Ministry of Forests studying soil moisture and climate change (Klassen and Saunders 2016)
- BC Ministry of Forests studying the diversity and relative distribution of mycorrhizal fungi in Douglas-fir forests in the GVWSA (Kranabetter et al. 2018).
- Ministry of Forests studying nutrient levels in soils and vegetation in relation to past disturbances (Kranabetter and Meeds 2017)
- CFS/University of Victoria study on the effect of tannins, nitrogen and climate on decay, nitrogen mineralization, and microbial communities in forest tree leaf litter (Shay 2016)

Additional Research Projects – Domestic Animals and Wildlife

Making a difference...together

- Ecology of Pathogenic Protozoa in the GVWSA (Aramini et al. 1997)
- Examining the potential impacts of bullfrogs on water quality in Sooke Lake Reservoir (Centre for Coastal Health 2009)
- Assessment of the probability of waterborne pathogen contamination of Capital Regional District water supply areas by domestic dogs, horses and llamas (Centre for Coastal Health 2019)
- Assessing the distribution of marten, mink and other Wildlife within the GVWSA (Proulx 2020)
- BC Ministry of Forests studying nesting habitat characteristics of marbled murrelet (Waterhouse et al. in process)
- Wildlife camera study of wildlife and wildlife movement corridors in the Goldstream WSA (Bone et al. in process)

Conclusions and Next Steps

Making a difference...together

The research carried out in the GVWSA has provided the CRD with a wealth of knowledge about the area, the type and effects of natural and human caused disturbances and how climate change may affect identified threats to water quality and supply and other the important ecosystem services provided by these watersheds.

The results of these research projects, and applicable inventories, assessments, and monitoring will be brought together to help inform the proposed forest management/stewardship plan for the GVWSA.

In addition to the forest management plan, the application of these results will inform other projects and initiatives in the GVWSA and provide important information for future environmental assessments in the GVWSA in support the implementation of Master Plan infrastructure projects.

Thanks to our many research partners

Making a difference...together

Natural Resources Canada | Ressources naturelles Canada

Canada

Canadian Forest Service / Service canadien des forêts

Tony Trofymow
Kendrick Brown
Nicholas Hebda
Daniel Perrakis
Steve Taylor
Werner Kurz
Robbie Hember
Brian Van Hezewijk
Rene Alfaro
Katherine Blieker
Derek van der Kamp
Luke Collins

UBC

Allan Carroll
Debra Wertman
Anna Tobiasz

University of Alberta

Fangliang He
Kaitlyn Schurmann

British Columbia Ministry of Environment and Climate Change Strategy

Robin Pike
Jon Goetz

University of Victoria

Olaf Niemann
Geoff Scudder
Gordon Frazer
Geoff Quinn
Byron Smiley
Patricia Jarrett
Dan Smith
Lauren Farmer
Chris Bone
Roger Stephen
Jason Kelley
Ben Milligan

British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Andy MacKinnon
Sari Saunders
Heather Klassen
Marty Kranabetter
Louise Waterhouse
Jenna Craig
Robbie Hember
Geoff Quinn
Scott MacKinnon

forWater

NSERC Network for Forested Drinking Water Source Protection Technologies

Hannah McSorley
Bill Floyd
Mark Johnson
Suzanne Tank
Monica Emelko
Uldis Silins
Jennifer Hall
Erin Humeny

Questions?

Making a difference...together