

# COASTAL DOUGLAS-FIR & ASSOCIATED ECOSYSTEMS CONSERVATION PARTNERSHIP



Photo by Tom Whitford – Brown Property  
Preservation Society

*A Regional Framework for Nature-based Solutions on BC's South Coast*

## **Spatial Data Review**

**Compiled Interview Results – Round 1 DRAFT**



Compiled by Kelly Chapman  
June 2022

This project was undertaken with the financial support of:  
Ce projet a été réalisé avec l'appui financier de :



Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada

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# Executive Summary

The Coastal Douglas-fir Conservation Partnership (CDFCP) obtained Priority Places Funding from Environment and Climate Change Canada in 2021 to undertake a round of in-depth interviews with key stakeholders to begin identifying:

- Gaps and limitations in biodiversity and ecosystem-related mapping/spatial data for the CDFCP study area (the CDFmm and CWHxm biogeoclimatic subzones), for the purpose of land-use decision-making by local governments, Firsts Nations, land trusts and ENGOS.
- Opportunities for pooling knowledge and resources to innovate, improve, and update data and mapping products that currently exist, and to integrate them with nature-based carbon mitigation and adaptation objectives.

The body of this report provides a rough outline of the issues, opportunities and recommendations raised by interviewees. These were drawn from the raw interview results, which are compiled (anonymously) and sorted under themes in **Appendix A**. The report also contains a table of potentially useful spatial data layers suggested during the process, and their relevance to different ecosystem service categories (**Appendix B**).

**The interview data compiled in this report will be used to inform a second round of targeted interviews in Spring 2022**, as part of the CDFCP's new Nature Smart project, titled: *A Regional Framework for Nature Based Climate Solutions in Southwest BC*. This second interview round will have a stronger focus on key subject matter experts. Key issues, opportunities and recommendations generated from the two rounds of interviews will be collaboratively refined in a series of follow-up workshops and in year-end project reporting.

**Table 1** provides a summary outline of the issues, opportunities and recommendations (organized by theme) put forward by this first round of interviewees.

**PLEASE NOTE, the comments in this document are the recorded *opinions* of those interviewed and do not necessarily represent fact or reflect the positions of the CDFCP or any other particular agencies, organisations or sectors.**

*(This report will remain in a rough draft format. It is intended for information sharing among those who are contributing their thoughts and ideas to the project, and will not be publically posted)*

**Table 1.** Summary outline of issues, opportunities and recommendations (organized by theme) put forward by first round of interviewees.

THEME	ISSUES & OPPORTUNITIES	SUMMARY RECOMMENDATIONS
<b>General</b> <i>(relevant to multiple themes)</i>	<ul style="list-style-type: none"> <li>• A coordinated, objective oriented approach to mapping in the region would be beneficial</li> <li>• Ecosystem service layers should be stacked with biodiversity layers.</li> <li>• Local governments will use all available data, the more detail the better</li> <li>• First Nations are interested in the same spatial layers as local governments</li> <li>• Maps are ineffective without persuasive and credible supporting information</li> <li>• Lack of capacity is a barrier to finding, interpreting and using maps, especially for smaller local governments, First Nations and ENGOS.</li> <li>• Perfect data isn't the answer – there needs to be political will to use it effectively</li> </ul>	<ul style="list-style-type: none"> <li>• Define users' needs and goals/objectives first, then work backwards to determine appropriate spatial data.</li> <li>• Encourage a coordinated approach to updating, improving and filling mapping/spatial data gaps across the region, to enable pooling of resources, expertise and data.</li> <li>• Develop a stacked set of spatial layers representing different categories of natural assets and the ecosystem services they provide, to identify areas of overlap and conflict and to balance trade-offs.</li> <li>• Support mapping with boilerplate text, guidance and policy.</li> <li>• Provide a suite of legal perspectives and case studies that support best practices for using spatial data.</li> <li>• Build capacity of First Nations, local governments and ENGOS to use mapping layers.</li> </ul>
<b>Land Cover</b>	<ul style="list-style-type: none"> <li>• Land cover data is inconsistent across the region</li> <li>• Lidar coverage used for land cover mapping is inconsistent and often unavailable</li> </ul>	<ul style="list-style-type: none"> <li>• Explore options for developing a regionally consistent and regularly updated land cover data set that can be used to track change and update other mapping layers</li> <li>• Explore options for collating Lidar data sets across the region, to develop regional layers for forest canopy cover, forest connectivity and impervious surfaces</li> </ul>
<b>Biodiversity</b>	<ul style="list-style-type: none"> <li>• Scale, quality and coverage of ecosystem mapping varies widely across the region</li> <li>• Keeping mapping up to date is a challenge &amp; conversion rates are not being tracked</li> <li>• SEI is ideally back-ended with TEM (TEM should not be used for public interface)</li> <li>• Ecosystem mapping misses small ecosystem patches</li> <li>• Ecosystem mapping misses at-risk ecosystems that are in-filled</li> <li>• Many at-risk ecological communities are not picked up in Conservation Data Centre (CDC) mapping</li> <li>• SEI is out of date - many sensitive and at-risk ecological communities are not captured</li> <li>• Ecological communities at-risk are not picked up in site level assessments by QEPs</li> <li>• The habitats of Species at-Risk (SAR) are not well mapped</li> <li>• First Nations and local governments are interested in estuary and intertidal mapping, which are missing from most SEI maps.</li> <li>• There is a lack of mapping/models that reflect climate driven shifts in ecological communities.</li> <li>• Ecological corridors require cross-jurisdictional mapping</li> <li>• Optimization tools have limited application</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on updating and improving SEI and TEM.</li> <li>• Collaboratively work to enhance ecosystem mapping and capitalize on new technologies.</li> <li>• Support ecosystem/biodiversity mapping with boilerplate text, guidance and policy.</li> </ul>
<b>Culturally Significant Ecosystems</b>	<ul style="list-style-type: none"> <li>• Data on culturally significant ecosystems is a big gap.</li> <li>• Navigation of issues around consent, confidentiality and cultural sensitivity will be required.</li> <li>• Lack of capacity is a barrier.</li> <li>• Extent of culturally significant ecosystems has shrunk with cessation of indigenous</li> </ul>	<ul style="list-style-type: none"> <li>• Improve cultural sensitivity of project team</li> <li>• Focus on providing data and support rather than extracting information.</li> <li>• Build on existing partnerships and successes</li> </ul>



THEME	ISSUES & OPPORTUNITIES	SUMMARY RECOMMENDATIONS
	management practice.	
<b>Carbon</b>	<ul style="list-style-type: none"> <li>• There is inconsistency in methods being used to map carbon storage and sequestration across the region</li> <li>• Managing for carbon can conflict with biodiversity and climate change adaptation values</li> <li>• Local government carbon accounting (to meet carbon neutrality goals) does not take into consideration the loss of carbon caused by land conversion</li> </ul>	<ul style="list-style-type: none"> <li>• Explore options for mapping and valuing ecosystem-based carbon</li> <li>• Determine whether carbon emissions from land conversion are included in accounting protocols</li> </ul>
<b>Watershed Resilience</b>	<ul style="list-style-type: none"> <li>• The hydrological sensitivity of different ecological features is contested</li> <li>• Important ecological variables are not typically captured in models and mapping</li> <li>• Required data is often inadequate, out of date or not available</li> <li>• Storm water management is often not tied to municipal natural asset management</li> </ul>	<ul style="list-style-type: none"> <li>• Work to build agreement on what ecosystem variables are 'hydrologically sensitive'.</li> <li>• Extend study area boundaries and mapping to include watershed extents</li> <li>• Explore options for improving and extending wetland and riparian area mapping</li> <li>• Explore options for using Lidar to improve mapping of watercourses and watershed boundaries</li> <li>• Explore options for creating valuations of watershed-related natural assets</li> <li>• Prioritize watersheds with high capacity to support fisheries</li> <li>• Partner with watershed organizations</li> </ul>
<b>Wildfire Resilience</b>	<ul style="list-style-type: none"> <li>• BC Forest Service's fire risk mapping does not extend to large parts of the study area, because most of the forested land is private.</li> <li>• Restoring wildfire resilience requires complex and costly analysis of multiple data sets</li> </ul>	<ul style="list-style-type: none"> <li>• Engage with key informants to explore options for mapping fire risk</li> <li>• Look at fire hazard mapping being undertaken by Edward Nichols at Metro Vancouver</li> <li>• Look into Bowen Island's mapping work related to wildfire</li> </ul>
<b>Natural Assets</b>	<ul style="list-style-type: none"> <li>• Local governments are becoming increasingly interested in natural asset management programs, especially for water related assets</li> <li>• Municipal Natural Assets Inventory (MNAI) captures the attention of local government counselors and operations and budget driven departments.</li> <li>• For the average person, arguments for ecosystem services are more effective than for biodiversity and species at risk.</li> <li>• Focus messaging more strongly on natural assets.</li> </ul>	<ul style="list-style-type: none"> <li>• Show the overlap between biodiversity and natural assets</li> <li>• Connect sustainably managed forest with long term logging jobs</li> <li>• Identify natural assets in Crown forests for consideration in the Old Growth Strategic Review community consultation process</li> </ul>
<b>Cumulative Effects</b>	<ul style="list-style-type: none"> <li>• Cumulative effects are a data gap and are of particular concern to First Nations.</li> <li>• The Province's cumulative effects frameworks should be incorporating impacts on carbon storage and watershed and wildfire resilience</li> </ul>	<ul style="list-style-type: none"> <li>• Look into the cumulative effects project in Howe Sound</li> </ul>
<b>New Technologies</b>	<ul style="list-style-type: none"> <li>• There is a risk of going down technology rabbit holes, before the kinks are worked out.</li> <li>• Lidar can be very useful for accurately determining drainage, relief, forest canopy and structure, buildings, etc.</li> <li>• Lidar can be a misleading indicator of what's on the ground, and is not that useful when identifying watercourses on flat terrain and forest understory.</li> <li>• Lidar is inconsistent across the region in terms of coverage and type, and costly for local governments to fly.</li> </ul>	<ul style="list-style-type: none"> <li>• Document Provincial Lidar coverage and point density for the study area</li> <li>• Explore opportunities for using Lidar to determine relief, drainage, watercourses, forest canopy and land cover, and to track landscape change over time</li> <li>• Develop decision-trees showing pathways of what to do when Lidar data is available for an area, and what to do when its not</li> <li>• Get a remote sensing specialist on the project team, to help explore opportunities for using new technologies</li> </ul>

THEME	ISSUES & OPPORTUNITIES	SUMMARY RECOMMENDATIONS
	<ul style="list-style-type: none"> <li>• Free satellite imagery is increasingly available at higher resolutions, allowing rapid and easy tracking of landscape changes, and automated approaches for updating spatial data.</li> <li>• Automated approaches still require training algorithms to interpret data; human interpretation may be just as efficient in some cases</li> <li>• Engines are using free satellite imagery and cloud processing to generate global land change analyses using cloud processing, but because BC land cover is complicated, lots of field data is needed for training and accuracy</li> </ul>	<ul style="list-style-type: none"> <li>• Connect with Metro Van Regional District and Nicholas Coops at UBC, to discuss their work on using new technologies and automated methods for updating mapping layers and tracking change.</li> <li>• Connect with Nicholas Coops at UBC on upcoming opportunities associated with cloud processing engines</li> <li>• Follow up on CWS report on automated vs. manual methods of tracking ecosystem conversion</li> <li>• Look into the data format migration support and free software (e.g. Feature Mapping Engine) offered by SAFE (in Surrey), who does data format migration</li> </ul>

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# Summary Results

## 1 INTRODUCTION

The Coastal Douglas-fir Conservation Partnership (CDFCP) obtained Priority Places Funding from Environment and Climate Change Canada in 2021 to undertake a round of in-depth interviews with key stakeholders to begin identifying:

- Gaps and limitations in biodiversity and ecosystem-related mapping/spatial data for the CDFCP study area (the CDFmm and CWHxm biogeoclimatic subzones), for the purpose of land-use decision-making by local governments, Firsts Nations, land trusts and ENGOS.
- Opportunities for pooling knowledge and resources to innovate, improve, and update data and mapping products that currently exist, and to integrate them with nature-based carbon mitigation and adaptation objectives (as per Objective 1.3 in the CDFCP's updated Conservation Strategy).

The body of this report provides a rough outline of the issues, opportunities and recommendations raised by interviewees. These were drawn from the raw interview results, which are compiled (anonymously) and sorted under themes in **Appendix A** (look here for a detailed account of what others said). The report also contains a table of potentially useful spatial data layers suggested during the process, and their relevance to different ecosystem service categories (**Appendix B**).

**The interview data compiled in this report will be used to inform a second round of targeted interviews in Spring 2022**, as part of the CDFCP's new Nature Smart project, titled: *A Regional Framework for Nature Based Climate Solutions in Southwest BC*. This second interview round will have a stronger focus on key subject matter experts. Key issues, opportunities and recommendations generated from the two rounds of interviews will be collaboratively refined in a series of follow-up workshops and in year-end project reporting.

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## 2 GENERAL

### 2.1 Issues & Opportunities

**A coordinated, objective oriented approach to mapping in the region would be beneficial**

- There are a huge number of siloed data sets available. This leads to the fragmentation of data, different data standards, databases, and scales.
- A coordinated approach to mapping would be much better than the current piecemeal approach, and would allow pooling of resources, expertise and data.
- It would be worth investing and pooling resources to develop a pan-local government set of inventory standards that everybody can agree to, because of the long-term benefits of having regionally consistent baseline data.

- Because there are so many data layer available, define users' needs and goals/objectives first, then work backwards to determine spatial data needed to meet these needs. Then go to relevant experts to determine what layers might best represent these goals.

**Ecosystem service layers should be stacked with biodiversity layers.**

- Natural assets have more traction with local governments than biodiversity and Species and Ecosystems at Risk (SEAR).
- Local governments have a growing interest in ecological services, natural assets and natural asset management, especially those related to drinking water and flood control. Departments such as water services have the funding to pay to identify and manage these assets. From a conservation perspective, these are high leverage opportunities.
- Stacking spatial layers representing ecosystem services related to biodiversity, carbon mitigation, culturally important ecosystems, watershed resilience and wildfire resilience, would be useful for decision-making by local governments, First Nations and land trusts.

**Local governments will use all available data, the more detail the better**

- Most statutory decision-making agencies don't invest in collecting additional data. Rather, they invest in making decisions with *available* data.
- Local governments are focused on making land use decisions. They'll use all the available data they can access to support their land use decisions, even if it's old and of poor quality.
- Local government works at a finer scale than the Province. Delivering mapping at the scale local governments want is a challenge: they want a lot of detail, 1:5,000 or better; they want it to be up to date; and they want it now.
- Don't create another data hub, there are enough already

**First nations are interested in the same spatial layers**

- First Nations are interested in the same layers as local government, for their own work and for referrals.
- First Nations are overwhelmed with referrals.

**Maps are ineffective without persuasive and credible supporting information**

- Even with detailed maps, planners and decision-making bodies may fail to act on information in maps if they don't understand what the mapping means and why an ecosystem should be protected.
- Developers often don't trust mapping and related information produced by local governments; more supporting documentation and guidance from the Province would be helpful.
- There is a lack of regionally consistent, credible and legally defensible boilerplate policies on sensitive ecosystems that can easily be incorporated into local government planning documents.
- Ecological communities at risk are often viewed as being disposable, even by QEPs/biologists in their biological reports for development applications.
- An important message that gets lost is that matrix/zonal forest communities in the CDFmm and CWHxm are just as important as other ecological communities at-risk. (i.e. the Coastal Douglas-fir - Dull Oregon Grape community and the Western hemlock–Douglas-fir–Oregon beaked moss community).

**Capacity Issues**

- Having the capacity to find, interpret and use mapping/spatial data is an issue for organizations without the necessary resources and in-house expertise, including many ENGOs, First Nations and smaller local governments.
- Training for First Nations to actually use mapping/spatial layers is a barrier.

**Perfect data isn't the answer**

- Coming up with perfect data/maps won't solve the problem or be as valuable as relevant effort spent elsewhere. We'd be better off with something that says you can't cut down anything, rather than this elaborate process of identifying all these different little pieces.



- Having the data is one thing - whether there is political will to use it effectively is another. It comes down to being able to show local government something that convinces them an area is worthy of protection.
- Perfect mapping will not stop development when pressure is high.

## 2.2 Synthesis of Interviewee Recommendations<sup>1</sup>

- Because there are so many data layers available, define users' needs and goals/objectives first, then work backwards to determine spatial data needed to meet these needs. Then go to relevant experts to determine what layers might best represent these goals.
- Foster a coordinated approach to updating, improving and filling mapping/spatial data gaps across the region, to break down data silos and enable pooling of resources, expertise and data. This should include exploring options and opportunities for:
  - collaborating and pooling resources to align and improve data and fill gaps;
  - using new technologies to update and improve detail and resolution of spatial data;
  - establishing the best pathways for meeting local government objectives using existing data; and
  - improving regional data integration and standardization, to provide consistent time stamped baseline data for defensible monitoring and change tracking across the region.
- Develop a stacked set of spatial layers explicitly representing different categories of natural assets and the ecosystem services they provide (e.g. biodiversity, carbon mitigation, culturally important ecosystems, watershed resilience and wildfire resilience), to identify areas of overlap and conflict, determine conservation priorities, and help decision-makers to understand and balance the trade-offs of different land use decisions.
- Develop plain language supporting information and policy tools to accompany mapping layers, including boilerplate information that can be inserted into planning documents, regionally consistent messaging on the importance of mapped features, and guidance and best practices for using spatial data.
- Provide a suite of legal perspectives and case studies that support best practices for applying spatial data in a planning context.
- Provide spatial data in a way that makes it easier to find, interpret and use, and provide training opportunities for First Nations, local governments and ENGOs, to build their capacity to use mapping layers.

# 3 LAND COVER

## 3.1 Issues & Opportunities

### Land cover data is inconsistent across the region

- Having a land cover layer is important, especially if you are going up to the height of land.
- Multi-spectral satellite imagery and Lidar can be used to classify the landscape into broad classes and inform tree canopy and impervious surfaces data sets.
- A good land cover data set can be regularly updated and used to track change and update other mapping layers (e.g. ecosystem mapping) by excising converted areas.
- Land cover mapping derived from satellite imagery does not delineate species or forest structural characteristics (to distinguish mature and old forest). Lidar can be used to determine forest structure.
- Land cover data is inconsistent across the region, in terms of vintage, pixel size, coverage, land cover classes and methodologies used to derive it.
- North American Land Change Monitoring System (NALCMS) land cover mapping only distinguishes between coniferous, deciduous and mixed forests, and is based on Landsat which has relatively large pixels (30m), whereas Sentinel 2 satellite imagery gets down to 10m pixels, and private satellites are

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<sup>1</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

getting down to 3m pixels. Local governments who can afford it are looking into investing in better resolution imagery for their land cover mapping.

**Lidar coverage is inconsistent and often unavailable**

- The most suitable Lidar data is held by forest companies, but they do not share their data. Publicly available Lidar is patchy, and often not of a type or scale that is useful for this purpose. It is expensive for local governments to fly their own Lidar. (See more on Lidar in **Section 11**).

### 3.2 Synthesis of Interviewee Recommendations<sup>2</sup>

- Explore options and methods for developing a regionally consistent land cover data set, that can be regularly updated using automated methods, and used to track change and update other mapping layers.
- Explore options for collating Lidar data sets across the region, to develop regional layers for forest canopy cover, forest connectivity and impervious surfaces.

## 4 BIODIVERSITY DATA

### 4.1 Issues & Opportunities

**Scale, quality and coverage of ecosystem mapping varies widely across the region**

- The scale of ecosystem mapping varies across the region and is often too coarse for local/site level analysis. Local governments would prefer 1:5,000 or finer scale – the more detail the better.
- Many local governments would like wall-to-wall terrestrial ecosystem mapping (TEM) and Sensitive Ecosystem Inventory (SEI) mapping, but there are large gaps, particularly in the Fraser Valley and the CWHxm. The 2008 Provincial TEM mapping excluded approximately 42,000 hectares within the Fraser Valley.
- Local governments are trying to fill gaps in the ecosystem-mapping themselves. The result is mapping at different scales and developed using different methods and categories.

**Keeping mapping up to date is a challenge & conversion rates are not being tracked**

- Ecosystem mapping is difficult and resource intensive to update; as a result it is inaccurate and out of date in many areas, particularly where rates of ecosystem conversion are high.
- Ecosystem mapping is often very out of date spatially and temporally patchy across the CDFCP study area, and as a result ecosystem conversion rates are not being tracked for most areas or across the region.

**SEI is ideally back-ended with TEM**

- TEM is more accurate than other ecosystem mapping. But when working on a property scale it becomes inherently inaccurate because of the complex polygons.
- Local government planners don't have the background to read a TEM code and know what it means.
- Local governments rely heavily on SEI; having up-to-date SEI back-ended by TEM (for more in-depth analysis) is considered the ideal.

**Ecosystem mapping misses small ecosystem patches**

- The Vancouver Island Sensitive Ecosystem Inventory (SEI) was mapped at a two-hectare resolution (1:20,000), so it underrepresents Savannah and Garry Oak ecosystems, because there are few patches of these ecosystems that are large enough to be picked up. These ecosystems are meant to be captured in the mature forest, old forest and woodland SEI categories.

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<sup>2</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

- Because of the mapping resolution, SEI misses small ecosystems, including remnant forest patches and small wetlands. Municipalities are often trying to incorporate small remnant ecosystem fragments and tree canopy cover into their green infrastructure planning and urban forest plans. However, ecosystem/tree patches are often so small, especially in more heavily urbanized areas, that at least 1:5,000 scale (preferably 1:1,000 or better) is required to pick them up.
- The Provincial Garry Oak mapping does not capture most of the best condition Garry Oak sites because they are on private land and are relatively inaccessible. Those in the Province's portfolio of Garry Oak sites are typically easily accessible sites near roads, so they tend to be in poor condition with lots of invasive species.
- Wetlands under tree canopy are under-represented in ecosystem mapping, and may not be picked up by Lidar. Lidar can be a misleading indicator of what's on the ground, because it cannot penetrate canopy and therefore misses understory vegetation, weeds, etc.
- We may never get spatial data to a level of accuracy that satisfies local government users; local level analysis is required to fill in the gaps.

#### **Ecosystem mapping misses at-risk ecosystems that are in-filled**

- 90% of the rare Douglas-fir/Arbutus Savannah and Garry Oak ecosystems have been masked by in-filling trees, so they are no longer visible on aerial photography and are subsequently missed in mapping process. These habitats have been in-filled by Douglas-fir as a result of cessation of indigenous management practices.

#### **Many at-risk ecological communities are not picked up in Conservation Data Centre (CDC) mapping**

- Almost all the ecological communities in the Moist Maritime Coastal Douglas-fir Subzone (CDFmm) and Eastern Very Dry Maritime Coastal West Hemlock (CWHxm) are considered to be at-risk. However, this is not reflected in the CDC mapping, which only picks up a portion of these communities in the CDFmm and few in the CWHxm.
- The CDC ecological communities at-risk mapping is often inaccurate, and sometimes doesn't line up with the TEM mapping from which it was derived.

#### **SEI is out of date - many sensitive and at-risk ecological communities are not captured**

- The SEI was intended as generalized mapping that would pick up most ecosystems at-risk. However, it only picked up old and mature forest at the time of mapping (the intent was to capture at-risk forest communities most likely to be in relatively good condition). Because the SEI is out of date in many places (original mapping was in 1997), it fails to pick up large areas of forest that are now mature, and therefore should be considered sensitive.
- Because most SEI does not highlight young forest, it creates the impression that these ecosystems have no value, despite being mostly comprised of at-risk ecological communities (e.g. zonal forest), and being important for ecological connectivity and accommodating future climate driven shifts in the distribution of plant and animal communities. Metro Vancouver has included these young forest ecosystems in their SEI.
- In the CDFmm and CWHxm there are areas of 'farm timber' in the Agricultural Land Reserve (ALR), which were logged in the 1920s and 30s. Therefore, many of these forests were too young to be captured in all but the most recent SEI mapping. Most of these forests would now be classified as mature, but are not picked up in out-of-date SEI mapping and are not protected.
- Out of date data can create public distrust of ecosystem mapping. SEI data rapidly becomes out of date in areas with high development pressure (e.g. lower mainland).

#### **Ecological communities at-risk are not picked up in site level assessments**

- Qualified Environmental Professionals (QEPs) / biologists hired by the development community often fail to identify forested ecological communities at-risk in their bio-inventory assessments, because they do not believe logged ecosystems can still be at-risk ecological communities. They don't understand that these are still ecological communities at-risk - they're just in poor condition.
- Because upland forests/ecological communities at risk are not tied to federal or provincial legislation, some local governments (especially those outside eastern Vancouver Island or the Gulf Islands) don't

recognize them as sensitive (whether or not they're mapped as such), and applications for their development therefore does not trigger assessment.

#### **The habitats of Species at-Risk (SAR) are not well mapped**

- SAR Inventory generally is a gap; because getting permissions from private landowners is difficult, predictive SAR modeling with some groundtruthing might be a better way to go.
- CDC SAR mapping presents an incomplete and skewed picture of where SAR and their potential habitats might occur. Observation data over-represents species that have been intensely sampled. Observations are also over-represented on Crown land and in more easily/frequently accessed areas. 85% of the CDFmm is on private land, but private lands are seldom inventoried, and owners often won't allow SAR surveys on their lands.
- Federal species at-risk critical habitat maps are not comprehensive. They have only been prepared for species with a completed Federal recovery or action plan, and reflect limitations in inventory, observations and mapping scope.

#### **FLNRORD & Stó:lō Nation COVIST project is working on SAR analysis**

- The COVIST project started by Surrey FLNRORD Stó:lō Nation is a SAR gap analysis looking at small home ranges, starting with the Fraser Valley. It's a prioritizer, software that can help identify priority areas – an optimization tool. They have some funding to do additional TEM mapping.

#### **First Nations and local governments are interested in estuary and intertidal mapping**

- Provincial SEI and TEM does not usually include estuarine and intertidal ecosystems. These are of interest to local governments and First Nations. Some local governments, such as Metro Vancouver and Capital Regional District (CRD), are now including these ecosystems in their SEI inventory.

#### **Lack of mapping/models that reflects climate driven shifts in ecological communities.**

- There is a lack of mapping and models showing how ecological communities are likely to shift with climate change.
- Most undeveloped greenfield sites will play an important role in accommodating climate driven shifts in plant and animal communities. This isn't reflected in current SEI mapping or supporting text.

#### **Ecological corridors require cross-jurisdictional mapping**

- Mechanisms aren't well established for collaboration between municipalities and regional partners.
- Lack of consistency in scale, methods and quality of ecosystem mapping across jurisdictions makes it difficult to identify regional conservation corridors.

#### **Optimization tools have limited application**

- The CDFCP Marxan mapping is limited to the CDF and is now out of date.
- Optimization tools are good for bringing people together for discussing priorities, but are often not practical for conservation land securement decisions, which are largely opportunity driven.
- Prioritizing using optimization models only works practically if each jurisdiction and/or organization implements the results. The models have to be dynamic (rerun), because new conservation properties are always being added and important areas are being lost, which changes the optimization priorities.

## **4.2 Synthesis of Interviewee Recommendations<sup>3</sup>**

### **Focus on updating and enhancing SEI and TEM**

- The ideal ecosystem mapping coverage for local government would be similar to what Saanich has - SEI and TEM, combined with finer scale mapping for specific areas.

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<sup>3</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

- Use the TEM as the underpinning of wall-to-wall ecosystem mapping coverage in the CDFCP area. Keep the TEM data at the backend for ecologists to interpret. Don't use TEM as the public facing output – use the SEI for this.
- The SEI mapping is widely accepted and used by planners and developers. It would be better to update, extend and improve on it<sup>4</sup>, than to discard it in favour of an alternative. Work out how to enhance it in ways that improve its usefulness to local governments and First Nations (e.g. use a finer scale) and improve its capture of sensitive and at-risk ecosystems and related natural assets.
- The SEI should not be used to draw hard lines in the sand. Rather it should be used to flag areas that need field inspections to determine what's on the ground.
- With respect to forested ecosystems, focus on those that are likely to be in good condition, meaning 80+ year old stands. Prioritize updating the SEI to make sure these stands are captured.
- There are lessons to be learned from revisiting the SEI on Vancouver Island, by showing where areas of critical importance have since been developed. It's important to have that information to create public accountability.

### **Collaboratively work to enhance ecosystem mapping and capitalize on new technologies**

- Engage and collaborate with ecosystem mappers, ecologists and planners to **explore options and feasibility** for:
  - Conducting Georgia-basin-wide updates of TEM, SEI and Vegetation Resource Inventory (VRI) that will extend existing mapping to fill gaps, identify converted areas and update structural stage categories to capture second growth forests that are now mature.
  - Applying technologies that allow for faster more cost effective updates and tracking of ecosystem conversion rates. Engage and coordinate with Metro Vancouver and Nicholas Coop at University of British Columbia (UBC).
  - Improving ecosystem mapping resolution.
  - Applying new technologies to more accurately map small ecosystems patches, large trees, forest structural stage, canopy cover, etc. (e.g. Lidar, high resolution imagery, animal models).
  - Including new SEI classes and subclasses to better capture important biodiversity features (e.g. young forests, estuaries, intertidal areas). Review CRD and Metro Vancouver's recent SEI mapping methodologies, and Howe Sound Marine Reference Guide.
  - Integrating new ecosystem layers being developed for the CDFCP region, e.g. Joint Ventures' National Wetland Inventory Mapping (once completed), Pacific Estuary Conservation Program (PECP) estuary mapping, and topographically defined riparian area mapping (held by The Nature Trust of British Columbia (TNT)).
  - Better identifying in-filled Garry Oak and Savannah ecosystems in spatial data (e.g. using methods that predict where they're likely to occur using composite distribution models, bird models, etc., such as those used in the CDFCP Marxan Tool and the North Pacific Land Conservation Cooperative Tool).
  - Enhancing mapping accuracy of important biodiversity features (e.g. wetlands, old forest, savannah, etc.), by augmenting ecosystem mapping with composite distribution models, bird models, etc.
  - Developing predictive mapping showing habitats likely to support different SAR or assemblages of SAR using similar habitats, including aquatic species at-risk. See recent range mapping the Province has completed for amphibians and reptiles, CRD's sharp-tailed snake habitat mapping, and Surrey FLNRORD's COVIST project.
  - Developing cross-walk tables linking TEM (and other relevant mapping) to CDC's ecological communities at-risk, and producing predictive mapping which shows where at-risk ecological communities are likely to occur.
  - Developing predictive mapping showing likely future distribution/range of important biodiversity features under climate change scenarios, including novel climate niches. (see Province's 'flying BEC zones', work being done by Mahoney *et al.*).
  - Mapping ecosystem features or classes that would also assist with carbon valuations, watershed analyses, and wildfire risk assessment.

<sup>4</sup> For reference, see recommendations in Madrone (2008) documentation for Provincial SEI conducted by Province outlined in Appendix 2.



- Quantifying ecosystem alterations over the last 20 years, and associated losses/gains of ecosystem services. Consider incorporating change data into a regularly issued regional report card.
- Developing regional scale ecological corridor mapping that transcends local government boundaries, incorporates natural assets for carbon storage and watershed resilience, and accommodates climate-driven ecosystem shifts. See Metro Vancouver's plans to develop a regional green infrastructure network.
- Engage with remote sensing specialists (e.g. Nicholas Coops UBC, Environment Canada Ottawa) and tech providers to explore opportunities for using high resolution satellite imagery and applying cloud processing and engines (e.g. SAFE's Feature Mapping Engine) to assist with analyzing land cover changes, and translating, manipulating and analyzing data from different formats.
- Engage with First Nations to determine their interest in using biodiversity-related data to assist with their referrals and land use planning, and how to best provide it. Seek opportunities to address potential capacity issues.
- Look for opportunities to pool resources and expertise of local governments, Provincial government and ENGOs, to update and improve sensitive ecosystem mapping in a regionally standardized way.
- Compare speed and cost-effectiveness of automated versus manual methods of updating ecosystem mapping (i.e. training algorithms vs. training an army of student air photo interpreters). Consult CWS about a report they are planning to develop on this topic.
- Prioritize spatial data updates in the areas the CDFCP Marxan tool shows as having highest biodiversity value, and where conservation action is also considered likely/feasible (i.e. where data is in demand by First Nations, local governments and land trusts).

#### **Support ecosystem/biodiversity mapping with boilerplate text, guidance and policy**

- In the absence of more detailed ecosystem mapping, explore how other planning tools can be applied to pick up rare and sensitive small patch ecosystems at the site level. For example, develop a reference guide for QEPs and planners, clarifying what is and isn't an ecological community at-risk in the CDFCP study area, and detailing at-risk and other sensitive ecosystems likely to be found in each of the SEI categories (broken down by subregion if needed). Include crosswalk table showing links between SEI categories and ecosystems at-risk. Build on existing SEI documentation.
- Support mapping with plain language boilerplate policy statements about the importance of biodiversity and sensitive and at-risk ecosystems in the CDFCP area, and their value with respect to carbon mitigation and climate change adaptation (i.e. natural assets/ecosystem services). Prepare versions of statements designed to be 'nested' and cut and pasted into different levels of planning policy (e.g. Regional Growth Strategies, OCPs, EDPAs, DPA permit conditions, bio-inventory checklists, etc.). Have statements vetted by legal experts, to ensure they defensible and effective. Types of development that are compatible/incompatible with different ecosystem types should also be described in plain language.

## **5 CULTURALLY SIGNIFICANT ECOSYSTEMS**

### **5.1 Issues**

#### **Data on culturally significant ecosystems is a big gap**

- Data showing culturally significant ecosystems is a big gap, particularly traditional ecological knowledge (TEK), and locations of species and places of specific importance to First Nations.
- Culturally modified trees are poorly inventoried, and seldom protected.
- The COVIST project started by Surrey FLNRORD and Stó:lō Nation is working with First Nations to get information about culturally important areas.

#### **Navigation of issues around consent, confidentiality and cultural sensitivity will be required**

- Data related to cultural resources with respect to Indigenous communities ought *NOT* be shared openly unless the data was thoroughly vetted by the Indigenous community - and explicit consent has been

given. Openly sharing culturally sensitive data runs counter to an Indigenous communities data sovereignty goals which is usually data that directly supports individual communities Indigenous rights.

- Representing cultural resources is complicated and will be dependent on First Nations engagement.
- Lack of cultural sensitivity presents a barrier by risking colonial behaviour, cultural appropriation, and cultural intrusion. Figuring out how to work appropriately with First Nations and this data will be important.

**Extent of culturally significant ecosystems has shrunk with cessation of indigenous management practice.**

- The Garry Oak and Douglas-fir/Arbutus Savannah ecosystems are where many of the culturally important food plants are found, but botanists often fail to understand that the historic extent of red-listed Garry Oak and Savannah ecosystems has shrunk significantly due to infilling by Douglas-fir with the decline of management activity by indigenous people.

## 5.2 Synthesis of Interviewee Recommendations<sup>5</sup>

### Improve cultural sensitivity of project team

- Undertake cultural sensitivity training prior to engaging with First Nations.
- Contract indigenous consultants to provide guidance on engaging First Nations, and mainstreaming cultural sensitivity into project design, work plan and deliverables.

### Focus on providing data and support rather than extracting information

- Rather than looking to extract information from First Nations, focus on how existing datasets could be used to supply ecological information in a format that is useful and of interest to First Nations, and how to support First Nations in conducting their own inventories/mapping without expectation that this information be shared.
- Engage with First Nations to determine if there are non-culturally sensitive ecosystems of cultural significance they would like to see mapped using available data layers, in accordance with proper protocols for vetting, consent and guarding confidentiality. Ideas to explore could include:
  - Predictive mapping layer which identifies where culturally important plants are most likely to occur, e.g. by applying Nancy Turner's work to TEM or SEI mapping.
  - Mapping that highlights fisheries and aquaculture areas important to First Nations.
  - Mapping that highlights important ungulate winter range and breeding habitat.
  - Predictive mapping showing how plant and animal communities important to First Nations will likely shift with climate change.
- Identify opportunities for supporting First Nations in conducting their own inventories of culturally important ecosystems/resources.

### Build on existing partnerships and successes

- Look for opportunities to supplement the work of existing partnerships with First Nations in piloting the above. For example, Comox Valley Conservation Partnership's (CVCP) plans to approach Comox Nation about partnering to build a layer showing cultural resources, and Surrey FLNRORD partnering with Stó:lō Nation, to develop information about culturally important areas.
- Look to success stories in other areas, such as the Great Bear Rainforest, as examples of how First Nations have been engaged in mapping culturally important ecosystems/resources.

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<sup>5</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

## 6 CARBON

### 6.1 Issues & Opportunities

#### **Different methods being used to map carbon storage and sequestration.**

- There are a number of emerging methods and spatial layers used for displaying carbon storage and sequestration capacity. Different agencies, organizations and local governments are using widely different methods to map carbon storage and sequestration and capacity.
- VRI site index has been used to assess site productivity for carbon analysis. However, it can be complicated because a site can be enormously productive but not have trees on it. (e.g. if a site has been burned, it might be highly productive in terms of saskatoons instead of trees).

#### **Managing for carbon can conflict with other values**

- If you manage these sites for carbon values it might conflict with other biodiversity and climate adaptation values (e.g. wildfire resilience, food security).

#### **Carbon analyses not accounting for land conversion emissions**

- Carbon analyses undertaken by local governments typically don't account for emissions released by ecosystem/land conversion.

### 6.2 Synthesis of Interviewee Recommendations<sup>6</sup>

#### **Explore options for mapping and valuing ecosystem-based carbon.**

- Engage with carbon specialists to identify what ecosystem features or classes should be mapped, to assist with carbon valuations and other data requirements.
- Engage with Climate Action Secretariat (CAS) and the Ministry of Land, Water and Resource Stewardship Economics Unit, to explore options and opportunities for mapping and valuing nature-based carbon storage and sequestration.
- Consider the merit of adding carbon storage as an attribute column in the SEI. Follow up with Tim Ennis on the method CVCP is developing to rank SEI categories in terms of carbon storage.
- Engage with carbon specialists, local governments and the Climate Leaders Caucus to explore interest and needs around mapping carbon storage/sequestration mapping, the pros and cons of different carbon mapping options, and the possibility of developing standardized approaches and guidelines for carbon mapping for the CDFCP study area.

#### **Determine whether carbon emissions from land conversion are included in accounting protocols**

- Engage with the Sustainable Solutions Group, to better understand how ecosystem-based carbon storage is or isn't factored into global protocols for carbon accounting by local governments. (E.g. are carbon emissions from land/ecosystem conversion accounted for?).

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<sup>6</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

# 7 WATERSHED RESILIENCE

## 7.1 Issues & Opportunities

### **The hydrological sensitivity of different ecological features is contested**

- The meaning of the term ‘hydrologically sensitive’ as it applies to different ecosystems is an emerging discussion.
- Some research is showing that the effects of forestry on flood hazard have been dramatically underestimated, and that important information about stand age etc. has been ignored. Provincial foresters and classic hydrologists will be reluctant to admit this.
- Defining what elements represent watershed resilience opens Pandora’s box between experts who have strong divergent opinions. The controversy will be around what model to apply to the terrain and what weather data to use.
- The importance of small headwater streams has been underestimated by traditional models used in BC Forestry.

### **Important ecological variables are not typically captured in models and mapping**

- Local governments are mapping watershed-related natural assets such as riparian areas, water courses, wetlands and lakes. However, other important ecological variables that influence watershed functioning - such as soil types, evapotranspiration rates of different tree species, tree height, forest structure, snowpack, etc. - are often not incorporated into mapping, modelling and natural asset management programs.
- Local governments often use older watershed/hydrological models that fail to consider the full range of important ecological variables (e.g. Hec-HMS and Hec-RES models). Those wishing to improve the sensitivity of their watershed models to these variables often cannot do so because of lack of data (relevant data is often held by private forestry companies who don’t usually share).
- There does not appear to be a local government framework for addressing cumulative effects of development and resource extraction on watershed functioning.

### **Required data is often inadequate, out of date or not available**

- Riparian area mapping is a gap, especially where there is no SEI or TEM. It doesn’t usually extend to watershed headwaters.
- Wetlands are a good example of a data gap (especially small and/or forested wetlands)– where are they, and how productive are they?
- Freshwater Atlas data is often out of date, and its accuracy diminishes at finer scales, particularly when defining small watercourses and watershed boundaries.
- Terrain Resource Information Management (TRIM) data outlining lake boundaries, watercourses, etc. is often inaccurate because it’s out of date.
- Lidar imagery is good for defining topography and defining patterns in areas where the topography has elevation changes of many meters. However, it is poor in flat areas and agricultural fields (e.g. Fraser Valley). Drainage in flat areas can only be accurately defined in the field.
- Lidar data can accurately delineate watershed boundaries, watercourses and water bodies, depending on the type of data and scale, and tree canopy cover. But it is expensive for local governments. Forest companies hold Lidar data, but they do not share their data. Lidar data is a patchwork across the region, differing in spatial and temporal scales, and the type of data collected.
- Beyond the areas of TEM and SEI mapping coverage, the VRI is the main source of vegetation cover mapping. However, for much of the study area and adjoining watersheds it’s often very out-dated and inaccurate. Alternatives are required.
- Evidence is lacking for the historical productivity of many of our rivers because settlers wiped out the fish populations before they were counted.

### **Storm water management not tied to municipal natural asset management**

- Integrated storm water planning isn't always tied in with Municipal Natural Assets Inventory, and ecological features that moderate run-off are not always thought of in terms of natural assets.

## **7.2 Synthesis of Interviewee Recommendations<sup>7</sup>**

### **Work to build agreement on what ecosystem variables are 'hydrologically sensitive'.**

- Solicit information and facilitate discussions between hydrologists representing divergent opinions, and attempt to gain some agreement on:
  - What types of areas/ecosystems in the Salish Sea basin should be considered 'hydrologically sensitive' natural assets from a watershed point of view (beyond just riparian areas and wetlands, e.g. old growth stands in mountain headwaters, small headwater streams, fluvial and glaciofluvial sediments, high bank flood plains, forested slopes in proximity to streams and rivers, etc.), in terms of their influence on surface flows and water quality as well as groundwater (for both water supply and healthy fish/aquatic habitat).
  - What sorts of activities should generally be avoided or minimized in hydrologically sensitive areas? (e.g. tree cutting, harvesting mature or old growth forest, creating impervious surfaces, vegetation clearing or disturbance, development, etc.)
  - How can we best identify and map these areas for local government planning purposes? Are there ways of pulling this information from existing data sets? Can the VRI be updated? Contact Malcolm Grey, who developed automated ways of using remote imagery for landscape analysis and watershed assessment.
  - What are the data requirements (and likely gaps) for doing so?
  - Are there simple models that can be used (or developed) to show conceptually how modifying ecosystems/vegetation cover on hydrologically sensitive areas influences water flows, and how better managing or protecting ecosystems/vegetation cover in hydrologically sensitive areas can help buffer the impacts of climate change on water supply and aquatic/fish habitat? These conceptual models would be targeted at planners and elected officials.
  - How to address cumulative effects on watershed functioning? See aquatic ecosystems cumulative framework<sup>8</sup> being developed by the Province (Monica Pearson).
- Engage a respected and relatively neutral hydrologist to refine the questions above, and to help solicit and interpret input from other hydrologists.
- Engage with watershed specialists, to see if there are additional ecosystem features or classes that should be mapped, to assist watershed analyses.

### **Extend study area boundaries and mapping to include watershed extents**

- Consider extending the study area boundaries to the tops of watersheds adjoining the CWHxm (i.e. include Georgia Basin uplands).

### **Explore options for improving and extending wetland and riparian area mapping**

- Use The Nature Trust of BC's topographical riparian mapping to extend coverage beyond the extent of TEM and SEI, into higher elevation areas and watershed (the mapping is BC wide, so extends into watershed headwaters beyond the lowland areas that have ecosystem mapping).
- Augment wetland mapping (in SEI, TEM and the Freshwater Atlas) with Joint Ventures' National Wetland Inventory Mapping (once completed), and recent wetland mapping completed by the The Nature Trust of BC.
- Explore options for improving capture of small and forested wetlands, and for standardizing wetland delineation and assessing wetland condition at the site level.

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<sup>7</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

<sup>8</sup> <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework/value-assessments-protocols/aquatic-ecosystems>



### **Explore options for using Lidar to improve mapping of watercourses and watershed boundaries**

- The Lidar is good for digital elevation models and determining the shape of the landscape. If you have topography with significant elevation changes, Lidar can define ravines and drainage patterns in ways that are helpful. See **Section 10.2**.

### **Explore options for creating valuations of watershed-related natural assets.**

- Engage with (previous) Ministry of Environment Environmental Economics Unit, to explore options for creating valuations of watershed ecosystem services.
- Consider the merit of adding a column to the SEI attribute table showing the relative contribution to ecological services from the perspective of storm water management or drinking water supply, for each of the SEI categories. Follow up with Tim Ennis on the method CVCP is developing to rank watershed services supplied by different SEI categories.

### **Prioritize watersheds with high capacity to support fisheries**

- Prioritize watersheds with high capacity to support fish (as indicated by their history of producing fish, First Nations oral history, TEK etc.)

### **Partner with watershed organizations**

- Initiate discussions with Watersheds BC – they have \$40million in funding.
- Engage the Watershed Sustainability Partnership of BC, as they have excellent local government networks, are advancing Nature Based Solutions, and are working to integrate watershed protection with biodiversity and culture.

## **8 WILDFIRE RESILIENCE**

### **8.1 Issues**

- BC Fire Service doesn't extend its detailed fire risk mapping to large parts of the CDFCP study area, because most of the forested land is private.
- Ecological restoration for wildfire resilience requires complex analysis of multiple data sets, which is impossibly complicated and costly for individual municipalities and researchers to do.

### **8.2 Synthesis of Interviewee Recommendations<sup>9</sup>**

- Engage with key informants to explore options for improving wildfire risk mapping.
- Look at fire hazard mapping being undertaken by Edward Nichols at Metro Vancouver.
- Look into Bowen Island's mapping work; they're looking at wildfire, as well as wetland and groundwater resources.

## **9 NATURAL ASSETS**

### **9.1 Issues & Opportunities**

- Local governments are becoming increasingly interested in natural asset management programs, especially for ecosystem services associated with water supply and storm water management.

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<sup>9</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

- The MNAI is very good at capturing the attention of counselors and asset managers at the city level, and those departments that are more operations and budget driven.
- focusing on the messaging as being natural capital assets and not complicating it too much with other values, like biodiversity, it may be easier to absorb into local government planning.
- For the average person, arguments around the services ecosystems provide in terms of mitigating temperature, managing water supply etc. are far more effective than talking about biodiversity and species at risk.

## 9.2 Synthesis of Interviewee Recommendations<sup>10</sup>

- Show the overlap between biodiversity and natural assets. By focusing messaging on natural assets without complicating it too much with other values, like biodiversity, it may be easier to absorb into local government planning
- Connect sustainably managed forest with long term logging jobs.
- Crown forests that are important for carbon storage and watershed and wildfire resilience should identified for consideration in the Old Growth Strategic Review community consultation process.

# 10 CUMULATIVE EFFECTS

## 10.1 Issues

- Cumulative effects are a data gap and are of particular concern to First Nations.
- The Province's cumulative effects frameworks should be incorporating impacts on carbon storage and watershed and wildfire resilience. It's no surprise that there are carbon impacts and mega fire impacts coming up.

## 10.2 Synthesis of Interviewee Recommendations<sup>11</sup>

- Look into the cumulative effects project in Howe Sound. It is a view into something bigger that the Province is building – a Stewardship Biological Objectives tool. They're trying to categorize landscapes in a way that they can see trends over time.

# 11 NEW TECHNOLOGIES

## 11.1 Issues & Opportunities

### Technology rabbit holes

- There are tremendous opportunities right now to produce good products, but I'm worried about going down rabbit holes of technology, instead of having the patience to wait for someone else to work out the kinks.

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<sup>10</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

<sup>11</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

## Lidar

- The Lidar is good for drainage and digital elevation models and landscape relief. But habitats are best described by the imagery they shoot at the same time. Combined they're very powerful.
- Not all Lidar is the same. It's a point density thing, and it might be good for one purpose but not another. Lidar can be a misleading indicator of what's on the ground.
- Lidar data is patchy across the region. The province flies Lidar at certain scales over certain areas. It would be great if the Province flew Lidar across jurisdictional boundaries, because it's expensive for local governments to purchase and not available for some areas (e.g. Comox Valley, Crown Land, private managed forest land).
- Lidar products such as the Bare Earth DEM, and vegetation Canopy Height Model (CHM) provide a wealth of information, even more can be dug out of the Lidar Point Cloud data.
- Lidar can be used to look individual trees, shrub cover, etc. It can be used to pick up big trees, shrub cover, and canopy cover (including forest height, composition and density).
- Lidar is useful for elevations and capturing relief, including buildings and forest.
- Lidar is not that useful for picking out small water courses in flat areas (cannot distinguish between roads and ditches). When there is elevation change of many meters Lidar finally defines ravines and the drainage patterns in ways that are helpful.

## Remote sensing, cloud processing & engines

- With the satellite imagery coming in regularly and being free, it is possible to create more up to date products faster, that are very credible. Sentinel 2 satellite is free, and its resolution is 10-metre pixels. It's similar to Landsat, which is 30-metre pixels – that's what CEC and NRCAN use right now. It goes over Vancouver every five days. There are more and more countries putting up satellites that are cranking out free data.
- Today's satellite imagery is so much finer, if you can afford to purchase it. Its getting closer to the resolution of aerial imagery (1 or 2m pixels or better, whereas it used to be 5 and 10). Maybe some of it's even better now, but of course you'll pay more for it.
- The finer the resolution, the narrower the path of image collection and the greater the volume of data gathered, so the cost goes up and up.
- Google imagery is at a good scale, but provides a dumbed down image. If you're doing analysis, you'd probably want to get the source data from the provider. Its important to make a distinction between Google Earth coverage which has ortho photos (basically air photos), versus its coverage in more remote areas, where it's all satellite imagery.
- If you go with an automated approach to ecosystem mapping using satellite images, you still have train the algorithm to interpret the imagery. A human being trained to search for ecosystem features can use Google Earth, which has higher resolution up to date orthophotos for many areas, with 20 cm pixels. The students can do the photo interpretation – it's old school, but it gets the job done.
- Engines are using free satellite imagery to generate global land change analyses. They use cloud processing to do a satellite image analysis in a split second – press a button and the analysis is done. But often there is not enough training data for our area, so there is a lot of inaccuracy; you need to be really careful about products that others are producing.
- BC is very complicated land cover-wise, and the bottom line is garbage in, garbage out. You need to have a lot of field data for that training, and then you'll get fabulous results.

## 11.2 Synthesis of Interviewee Recommendations<sup>12</sup>

### Lidar

- If somebody's going to deliver you a unified sheet of Lidar for the whole area, then just say yes.

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<sup>12</sup> These recommendations were collated during the in-depth interviews. These include potentially contradictory opinions. The purpose is to represent the comments that were made.

- Find someone who knows Lidar to determine what the Provincial Lidar coverage and point density is for the study area; document when it was shot, and what the point density is. Use this as starting point to explore its suitability for the project purposes and how it can be best used.
- Explore opportunities for:
  - Using Lidar to determine relief, drainage, water courses, forest canopy, and other land cover.
  - Delineating habitats from the imagery shot at the same time as Lidar.
  - Repeating Lidar surveys at 5 or 10 year intervals to provide a clear picture of land cover and forest structure change.
  - LidarBC providing CHM in addition to the DEM and DSM, for all their data areas
- Develop decision-trees showing pathways of what to do when Lidar data is available for an area, and when its not.
- Connect with Metro Vancouver about their work with Nicholas Coops from UBC.

#### **Remote sensing, cloud Processing & engines**

- Get a remote sensing specialist on the project team, to help explore opportunities for using remote sensing satellite imagery and cloud processing for higher resolution, quicker and more affordable landscape analysis and change tracking.
- Connect with Metro Van Regional District, on the work they're doing with Nicholas Coops at UBC on finding cheap, fast, and accurate way of updating their SEI and land cover mapping, and the possibility of developing an automated way of updating the data, and tracking changes into the future.
- Follow up with CWS on the results from their report on automated vs. manual methods of tracking ecosystem conversion and updated maps.
- Connect with Nicholas Coops at UBC on upcoming opportunities associated with cloud processing engines.
- Look into the support and free software (e.g. Feature Mapping Engine) for NGOs through a company called SAFE in Surrey, which does data format migration. Their business focus is taking geospatial/attribute data in one format and manipulating it, analyzing it, or just transferring it to another useable format.

## **12 ADDITIONAL RECOMMENDED NEXT STEPS**

- As a first step, ask questions and engage local governments to find out what the scope is. Refine the process as you begin to see where the commonalities in responses are and take it from there.
- Have a big conversation at the scale of the CDFCP operating area with some of the key players to get everybody on the same page about what would be useful at a regional scale for everyone.
- Host in-person working groups with knowledge people and people experienced with the spatial layers, to decide on which are sufficiently reliable/accurate to map the goals you are interested in. Ask whether/if the kinds of layers are appropriate, available and useful for the goals identified.
- Devise projects with post-secondary schools and forestry departments to develop data collection methods and build databases.
- Develop a central repository for all the stakeholders to access the information and spatial layers that you've been finding.
- Talk to the UBCM and the development community.
- Don't create another data hub – there are too many already.
- Get in touch with Metro Van's Laurie Bates, and Nicholas Coops with UBC, and with Caslys Consulting, who completed a lot of remote sensing and mapping work, and have some ideas about automating the change detection.
- Speak with Agnieszka Sztaba and Josh Malt (FLNRORD) about their partnership with Stó:lō Nation, and working with First Nations to get information about culturally important areas.
- Engage with other related initiatives taking place in the region, including:
  - Metro Vancouver's Regional Green Infrastructure Mapping (potential).
  - Water Sustainability Partnership of BC
  - Watershed Strategic Fund

- COVIST project
- South Coast Conservation Partnership
- Fraser Valley Conservancy
- Community Mapping Network
- Howe Sound Bioregion
- Bowen Island resource mapping
- Sustainable Solutions Group
- Ducks Unlimited
- Birds Canada
- Land trusts
- UBCM

DRAFT



# APPENDIX A:

## Raw Interview Results

DRAFT

# Raw Interview Results

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# Raw Interview Results

## 1 GENERAL

### 1.1 Spatial data needs

#### 1.1.1 Start with users' goals

- Questions about what kind of mapping is needed really depends on what your goal is. You need to define all the values on which the decisions are going to hinge.
- Biodiversity, carbon storage, climate adaptation, watershed resilience, etc., all these words need to be defined in a way that links them to map elements. You need to define these things with enough precision that people actually believe in them
- I think you will benefit by not directly asking what data sets are available now. You should come up with the list of goals/values that everyone (e.g. local governments, planners) has, then give the goals to people who are very experienced at mapping, etc. and ask them to come up with the modelling/spatial information that represents these goals. People like Richard Schuster, Andy McKinnon, Oscar Ventner (UNBC), Jan Kirkby (Garry Oak sites). You get everyone in the room and you start talking about what layers might best represent these goals.
- Start with the goals, then work backwards toward the necessary data.
- People won't use maps if they don't see their interests reflected in them.
- *[KC: People have to understand local government processes in order to understand what kind of mapping is needed, at what scale, etc.]*. That is the bottom line, exactly right – that's your most rigorous need. How do we at least deliver that? There will be some things you can't realistically do. For example, while doing their marine planning, DFO asked for all the data that's been collected in the marine environment, from the high water mark to low. They ended up with thousands of different records, huge spreadsheets, because there are so many stakeholders. Then there's the hell of figuring out how to use it all. So I think you got to be really clear. This is what we can produce, and this is what we can't produce.
- The biggest problem this stuff is not making the mistake of thinking about everything you can do.
- It sounds like what we're trying to do is make sure local governments recognize the values that the CDFCP think are important. So there are potentially two levels. First you need to gather the CDFCP types or experts to determine what ecological values are really important. Then you need to figure out the best way to convey that information to the people/local governments who need it, and give them some flexibility in how they incorporate those values that are really important to their planning processes. I think some surveys have already been done with local governments to figure out what they need. But if not, it's probably the first thing we need to figure out - what would they use? Do they want something more than just SEI mapping? If they don't, then we need to figure out how to add the ecological values that we want to see considered in local government planning into something similar to a SEI map, rather than providing several outputs/layers that each on their own may or may not get used.
- Getting local government involved with regional planning and mapping would be good. We would almost need a representative from all of the local governments in the CDFCP area, or at least a good portion of them. *[KC: The problem is there are so many local governments in the CDFCP area. But we could probably put it out there through CDFCP members. Or maybe through the SEAR LWG working group. Or maybe involve a selection of representatives who report back to all the local governments in the region and give them the opportunity to provide comment on what's happening].*



- This gap analysis is so complex, because of the time and spatial attribute gaps. A better approach, as you suggested would be to put some effort into the mapping objectives rather than focusing on gap analysis.
- The message you get from local government staff varies depending on the current council. With some councils staff will be held back and do the minimum. Then when a more green council is elected, staff push ahead a bit more.

### 1.1.2 Local Governments use whatever mapping is available

- We'll always use whatever mapping is available - if its old we'll still use it. We still use mapping from our floodplain bylaws in the early 90s, and make decisions about development in floodplains based on it. We use what's available, and if there's new stuff we'll use that too.
- Local governments are in the business of making land use decisions. They'll use the best available data to justify their land use decisions. It might be shitty data, but it's the best available. This is true of most statutory decision making agencies: they don't invest in good data. Rather, they invest in making decisions with *available* data. There are exceptions, because of new people in the inventory and mapping aspects of the local governments.
- But I'd rather have the data than not have anything, or have half baked information available. My job is to push for biodiversity conservation, but I can't do that effectively without evidence.

### 1.1.3 First Nations decision-making

- The data that you are looking for would be of interest to Musqueam Indian Band (MIB) as well in our own work and would like to see the same gaps filled.
- [KC: I'm assuming First Nations get referrals for certain development applications from the City?]. Yes, and they're over overwhelmed with them. [KC: Do they have reasonable access to all the mapping?]. I don't deal with that directly, but we would likely either share what mapping the City has directly, or they would have access to it through the City's data portal and/or public mapping interface.

## 1.2 Stacking & Comparing Ecosystem Service Values

- *(KC: Do you see value in stacking spatial layers in the rough categories of carbon mitigation, watershed resilience and wildfire resilience, to help local governments with prioritizing their decision-making).* I agree. I think the carbon storage and sequestration pieces maybe the easiest, whereas in principle biodiversity is very tough to deal with. Everyone has a very different idea of what it is. And usually I think they're wrong.
- Stacking layers showing how the different ecosystem service categories overlap area would be good. For example, with riparian areas, you could show how their biodiversity value overlaps with their climate adaptation value, in terms of lowering water temperatures to help save salmon.
- You need to help the decision makers understand that these are the things that they are sacrificing, or that they're balancing against each other. So when they make big decisions they know what's on the line.
- For the Island Trust Conservancy the main gaps are pieces that would help us with our strategic conservation priorities, and figuring out the conservation priority of individual properties. For example, we want to adapt our conservation planning to be more comprehensive in terms of a property's suitability or applicability with respect to climate change adaptation and mitigation, so it would be useful to have something that would help us understand and compare a property's carbon storage or sequestration potential. I know there is this new WWF mapping showing carbon storage in forests and soils. But I don't have GIS capability to pull it up and look at it.
- From the IT Conservancy's perspective, our work is very opportunistic. Someone comes to us for money to protect a space. It could be helpful to have the resources to be able to say more precisely 'this is what these nature reserves are providing in terms of carbon storage, or lowering stream water temperatures, etc. This is value the world is getting by us protecting these areas. One of our board members is pushing for us to show how our properties are helping with climate change mitigation and adaptation.
- You should broaden your ecosystem service categories into smaller subcategories.
- CVCP will have another student look at the SEI polygons to add a layer/column to the attribute table showing the relative contribution to ecological services from the perspective of stormwater management

or drinking water supply, for each of the SEI categories. Another student is going to add another new attribution column indicating the relative contribution of that SEI polygon to carbon sequestration, so we can do some better modeling that way. What we are always looking to do is stack values on the landscape.

- Biodiversity is where I'm coming from, and what I'm learning is that ecological services have bigger bank accounts behind them, and that there are other bank accounts, also big, for carbon. So let's stack the biodiversity, the carbon and the ecological services on top of each other, and make a three pronged argument to a variety of different potential donors as to why a particular project should be a priority for their funding. I'm quite happy to align our programs using GIS-based modeling and conservation planning tools to highlight which places are the most important.
- CVCP will have another student look at the SEI polygons to add a layer/column to the attribute table showing the relative contribution to ecological services from the perspective of stormwater management or drinking water supply, for each of the SEI categories. Another student is going to add another new attribution column indicating the relative contribution of that SEI polygon to carbon sequestration, so we can do some better modeling that way. What we are always looking to do is stack values on the landscape.
- It's often easier to use raster-based data than vector data when combining and stacking different types of data. It depends on how the mapping is done, because the raster analysis stacks the overlapping values based on a common unit. With vector data, you actually have to merge/union layers, and you end up with different sized spatial units which can complicate analyses as well. If you're going with polygons, polygons can be different sizes, and you can end up with units that are almost nonsense in some cases depending on what data was used to create them, because some are really big and some are really small. Unit size can affect any kind of prioritization analysis you undertake. So having a standard sized unit is much better. But of course, most ecosystem mapping is vector data.
- *[KC: It was suggested that having all your different layers in raster allows for easier analysis and comparison between the data layers].* Yeah, I've heard that as well. The thing is when you're looking at small areas the raster is kind of disappointing; people like polygons when you zoom in. We mulled this over as well for the Joint Ventures, and went with Raster for our land cover map.

### 13 Pooling resources & standards

- *[KC: Do you think it would be useful to pool mapping resources and standards across local governments?]* It would be very valuable, because if you have a pan local government set of inventory standards that everybody can agree to, the long term benefits and having the baseline data are worth it. With all this fragmentation of data, different data standards, databases, and sample sizes, it just becomes a dog's breakfast. That's what I've been seeing for 30 years.
- *[KC: Do you think there are opportunities for pooling mapping resources to do this across the board in the CDFCP area?]* I think that would be huge. And I think that people will really want that. For example, I'm also working for Saanich, and the regional district, and the local governments up here, and they all want this stuff. Let's just do it for everybody the same way - economies of scale, everybody pools their resources.
- *[KC: What are the spatial data gaps in the George Basin and opportunities for pooling resources, or innovating, rather than having all these different local governments and scientists running in separate directions to do their own mapping?]* That's the grand vision, for sure definitely. Unfortunately I think I'm in the running away, doing my own thing category at this point, out of necessity.
- *[KC: Do you have any thoughts on the value of developing some sort of standardized framework for mapping in the CDFCP region, covering things like ecosystems at risk, ecosystems, carbon storage/sequestration, hydrologically sensitive areas, etc.?)* That would be really good - more coordination. For example, it was really good to hear that there is a way to collaborate with MNAI. Having a coordinated approach to mapping is definitely way better than having everything happen piecemeal.
- Seems like the starting point would/should be on data integration and standardization. Also explicitly date stamping content will be very important to allow producing defensible monitoring and change results.
- *[KC: Is Metro Van using the same methodologies as the municipalities?]* I don't believe so. *[KC: Would that be helpful?]* It would be helpful if everyone used the same methodology, but agreement on

methodology may be difficult to achieve with 23 member jurisdictions. That's one of the reasons why Metro Vancouver compiles the SEI, to ensure a consistency across the region. Metro Vancouver has a rigorous SEI process that adheres to standards and involves advisors. For example, Nicholas Coop is providing input on what he thinks are the best remote sensing, land cover classification update, and automation methodologies. Our SEI advisor, Meidinger Consultants, consistently provides third party advice on SEI update methodology. We think it's important to have this third party review.

- *[KC: Does methodological inconsistency ever come down to differing view of what is important, or areas they don't want identified as sensitive – e.g. mature forest?]* I suspect that some local mapping may not include all ecosystems (e.g. young forests).
- *[KC: Do you think there would be an appetite for, and mechanisms in place, to allow local governments to pool resources if they could agree with some sort of standardized methodology for creating/updating ecosystem mapping across the Georgia Basin? And thoughts on how to do that?]* We did it for the SEI in Metro Vancouver. Most local governments these days will have some level of land cover and land use mapping and many local governments are moving to open data portal systems. So I guess it's just an issue of inconsistency, a bit of disparity as to what different local governments have available to share, and then there's also the equity piece - if you're a small village of 5,000, your mapping needs in terms of extent are not going to be the same as Surrey, which is a giant municipality. So there needs to be some sort of a sliding scale to make things equitable if there's a monetary component to doing the mapping. If its just requesting data, coming to us and saying we're going to pay for this mapping, but you need to give us the data to make the model work properly, then that's probably less of an issue.

## 14 Data silos, quality and gaps

- You'll often run into the crappy data issue. To get data accuracy to a level that will satisfy the people who are asking that question might require a local analysis, as there may not be adequate global data.
- There is a lot of work to do with this spatial data gap analysis. I find it kind of boggling when I think about how many silos there are out there.
- There are so many gaps out there, depending on your area of focus.
- Now that you know there are all these gaps you need a shortlist. *[KC: And what would your short list be?]* I think you've got a good handle on that.

## 15 Scale

- More specific information on user's requirements would be helpful, the often expressed desire for finer resolution is sometimes misplaced as present data can provide useful answers, especially for regional questions.
- What is the spatial unit on which you need to provide the information? It won't get used if it's not right. When we built the CDFCP map we built it down to one hectare. But then we talked to the NGOs and found none work on properties smaller than about two hectares.
- One real important question is the scale in which you need to do the mapping. So many data sets simply are not mapped at a scale that is useful - so you have to decide ahead of time what you're going to use it for.
- My general impression from the data layer matrix you provided is that most tend to be 1:20,000 scale or coarser, because that's what's available from the Province. They don't get much higher resolution except for SEI, which tends to be 1:15,000 or even closer, depending on who does it. The Whistler SEI was done at 1:5,000 for their local government area. It's not included with the Province's list of SEI projects <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/ecosystems/search-ecosystem-info>
- People tend to trade off mapping scale for cost, not realizing the initial investment will save them money in the long run. Mapping at a finer scale can always be generalized for peanuts, if that's all you want to look at. But you can't go the other way around.
- *[KC: From a local government planning perspective, what scale should mapping be at? 1:5,000?]* Yes, a pencil line on a piece of paper is about five meters wide at 1:5,000 scale. And much of the imagery you can get now can be viewed in reasonable detail at 1:1,000. So you're getting pretty good and relatively current imagery now, from Bing, Google, etc. Ten years ago it was nowhere near that good. We used to

have a ton of ortho imagery. But now we get the free layers from Microsoft and Google as industry backdrop.

- [KC: In some areas where the sensitive ecosystem mapping is at a coarser scale (e.g. 1:15,000), local governments require site specific 1:5000 mapping be done by a QEP if someone wants to develop within an EDPA]. That's a good way of pushing it back on the developer. But, it doesn't bode well for a long term, larger scale land use planning, just blocking it off and hoping for the best.
- I looked through your spatial data matrix with interest. There is so much tantalizing data, if only the pixel sizes were small enough for use on a small island like Salt Spring.

## 1.6 Data availability

- I feel certain most of the mapping and data we need is out there somewhere - I just don't know where to look for it.
- Just figuring out who to talk to about the products, what information the Province has and in which department – you could spend weeks trying to figure all that out, because none of it is easily found on one government website. Maybe you could get lucky and find the one person who has the time to give you the list of provincial people working on different things. But I have no idea who is doing what. Sharing Data
- [KC: Would it be useful to have access to a repository of data layers for the area?]. A data hub? Yes, that would be useful. Metro Vancouver has regional datasets, but many other organizations also have spatial data. Keep in mind that many people don't have ArcGIS or a GIS platform to look at the data, which is why Metro Vancouver created the SEI map viewer so everyone can look at it.
- There's tons of information, including wildlife information, that's held by industry and which we can't access.

## 1.7 Supporting policies and information

### 1.7.1 Regionally consistent messages & guidance

- The development community likes to state that development will go to where it's easiest to develop, and by putting in strong environmental protection measures local governments will chase development away, and our community will not be able to meet our affordable housing goals and will stagnate. They say if we have high environmental standards, development will just go to places with low standards. But developers, except the very big ones, often work within a particular region, e.g. Campbell River, or Courtenay, or maybe the Island. So if we had regional consistency in our environmental protections that argument would not hold water. I'm thinking Tree Policy, for instance. So I think regional consistency in environmental protections and messaging would help.
- [KC: You say the local development community respects the RAPR, which is regulatory. Hypothetically, if there was in future a Provincially-supported regional NBS policy framework that included guidance (rather than regulations) saying that in greenfield areas there should be 30m riparian buffers regardless of RAPR calculations for these reasons, would that help?] Yes, planners could then point to this guidance. Inherently the development industry does not trust local government staff. They think we're pursuing our own ideas of what community should be, when our role should only be that of facilitators. They don't realize how much planners are hearing about how important these ecosystems are. To have those views represented in a document would be helpful, for us to point to and share with the community.
- [KC: What would help local governments increase protections for ecosystems at risk?] One thing would be raising the profile of these issues. Long ago I imagine it was challenging to get recognition of the importance of creeks, similar to the challenges we're now facing in getting the importance of upland ecosystems recognized. Today everybody understands creeks are special, so there's been an evolution, an acceptance. The development community does not complain about the Riparian Area Regulation anymore. They know it exists, and its part of the system they're used to administrating. For local governments with our reduced resources - and I know every single jurisdiction has reduced resources - it would be great to be able to rely on the Province to say 'these are areas are important, they need these protections'. Regional consistency in that messaging would be very helpful.



## 1.7.2 Supporting explanations & policy (also see Section 3.5.7)

- [KC: would it be worth developing some related policy statements that could be cut and pasted by local governments into OCPs, EDPAs, and other planning documents? Maybe vetted by Deb Curran or someone else with a law background, to make sure they'll hold up legally?]. We did that in CVCP's Nature Without Borders document – it contains recommended policy and regulations, etc. For example if you look at the Cumberland EDPA, they cut and pasted it directly out of Nature Without Borders. It was updated in 2013 and we're doing another update shortly, using five summer students, so it will be available for the regional growth strategy update. For it we're leaning in to the SEI again, because that's all we really have. One of the students is a policy wonk, and she's going to do an environmental scan of all current and cutting edge environmental policies in the region and see if our policy section needs to be improved.
- From the CDFCP's perspective and this Nature Smart Solutions funding, maybe what's needed are supporting policy tools and elaborations and explanations, but also expert input, maybe some sort technical committee that includes planners. This is the stage they need to be brought in.
- The OCP is the point at which you need to be working with local governments, to get them on board. To make the mapping useful, we need the corollary elaborations explaining why these areas are important. [KC: I've been thinking that along with identifying gaps in spatial data, through the Nature Smart project we could explore creating some kind of manual with that corollary information, tailored to be cut and pasted into an OCP or an EDPA, and into the development permit conditions]. Yes, like the tree cutting bylaws that GOERT created.
- SEI has supporting text about their polygons. But it's not necessarily useful for what you're trying to do. But you may be able to build on what they have. Have you looked at the SEI publications on interpreting the SEI? Go to their website. You should be able to find half a dozen publications about updates and interpreting the SEI.
- From a very, very simple perspective, something that would be useful for all of our communications would be something that explains thoroughly (not just the 2 or 3 sentences you can find on the website) but thoroughly explains how BEC defines things, how the CDC defines things, and how the average person on the ground sees things. Because when I'm trying to explain something to Trust Council, do I tell them that there are 5 ecosystems at risk on the property, because those are the ones that are listed by the CDC, or do I tell them that there are 7, because there are also these other ecosystems that are considered at risk by other experts. It would be helpful to have one poster or something that explains why they're different, what they each mean, and how they interact.
- [KC: For the Nature-based Climate Solutions project we now have under way, we'll be looking at regional opportunities to collaboratively develop nature-based policies for climate change mitigation and adaptation, as well as mapping, for the Georgia Basin lowlands area. Would it also be helpful if we had standard region-wide policy statements that were written and designed to be cut and paste it into OCPs, EDPAs, etc.? For example, within this particular category of sensitive ecosystem, these are the ecological communities that risk, or species at risk habitat, that are likely or probable to occur there, recognizing that we may not be able to map every one of those, at least not now.] Sure, it would be an addition to the many tools that are out there, like what the Province and Federal government are doing, what Metro Vancouver Regional District is doing. We have the re-vamped Green Bylaws toolkit, and the Natural Assets component – which is another reason to get the detailed mapping done – to fill in the gaps on that.
- Policies in the draft [Metro 2050](#) are much stronger on ecological health than *Metro 2040* (regional growth strategy). The new policies encourage and support member jurisdictions to work collaboratively to protect, restore, enhance, and connect ecosystems.
- [KC: Would it be helpful to have boiler plate language around the mapping - suitable to cut and paste into an OCP or EDPA, or into a list of conditions for QEPs undertaking site level bioinventory - explaining how different ecosystems provide important services from the perspective of biodiversity, carbon, watershed resilience and cultural resources? ]. As a planner, this is something I would like to advocate the Province for. I'm mystified as to why little local governments with our stretched resources don't have more boilerplate assistance. Because its incredible, the amount of effort local governments put into wordsmithing, making sure we're clear so things won't be misinterpreted, and determining whether we have the legislative authority to do protect things. I think: are you serious? Am I really sitting



at my desk figuring this out while my counterparts in other local governments are doing the same thing? What a waste of effort!

- [KC: *What if we were able to identify this as a priority for future funding – developing the supporting boilerplate language?*]. It would be great, especially if it already had agency sign off. Because we have to refer to certain agencies, like DFO, FLNORD, Ministry of Environment. If they signed off on the boilerplate language in recognition that it supports their mandates, I wouldn't have to deal with the uncertainty of whether or not they will like what we've cobbled together or whether there are gaps. It would make the process more streamlined. I would still have to refer to these agencies, but they would automatically see their mandate reflected in what we've put forward.
- One of the planners was looking at a property that a mapped rare species occurrence that was masked; he came to me to ask what it was. Of course I couldn't say, because I'm not allowed to share that kind of information. So all he could do was note this masked occurrence in his report to the local trust committee. All it says in the OCP and the guidelines in the Islands Trust policy is that they have to consider it. So there's nothing for the planner or the local trust committee to fall back on, to say sorry, you can't you can't put a resort there because its home to a rare species. Its private land, so nothing Federal applies, there's no provincial species at risk legislation, and there's no local level protection, so there are no teeth anywhere. I don't know if that's true in all places, maybe some areas have something that say if there's a rare species there you can't build.
- We need to come at this from both sides. From the planner's perspective it doesn't do any good to have the best mapping in the world showing an endangered species needs this critical habitat in this specifically defined area, if the planners don't have the planning tools to protect it. All they can do is make a report that goes to the decision-making body, recommending it not be developed, or that a biologist be hired to assess the impact. But the decision-making body has no requirement to follow any of those recommendations and no guidelines. [KC: *But what if it's in an EDPA?*]. What the EDPA says may not be precise enough.
- The OCP needs to include that philosophy of what you're protecting, and why and how. We need to create whatever is needed as foundation for an OCP – these are the discussions where planners need to be involved. I don't know what the value would be in having elected representatives involved.

### 1.7.3 Messaging/marketing

- [KC: *We're not necessarily going to be building new tools. It's more about figuring out how to best navigate the growing array of spatial data*]. That's right and marketing it. Our stakeholder groups include the development industry, and they're not hearing these messages about the importance of ecosystems as much as our planning staff are. So they question staff's motivations, thinking we're being too cautious on environmental concerns.
- We're balancing a wide range of objectives. So being able to get that message out to a wider audience beyond local governments would be really useful.
- Providing information in simple, plain language is very important. Information should be easily understandable, so it doesn't need to be reread three or more times, and gets across core concepts and comprehension at first glance. Lengthy documents do not get read. We need snappy messages –we all need to speak more on marketing terms.

### 1.7.4 Legal perspectives

- From a local government staff and planning perspective, whatever the Province produces, or whenever we get guidance from lawyers on how to interpret things in the Local Government Act, in terms of what you can and can't do (e.g. legal seminars, tools or guidebooks, etc.) is in very high demand among planners. So if the Province did create a guidebook on policy for energy conservation, water, conservation, reduction of greenhouse gas emissions, with very clear guidelines on what local governments can and cannot do, it would be very helpful. [KC: *Maybe it would be worth addressing some of this in a webinar series?*] You will get senior staff if you include the word 'legal' in your webinars – the term legal makes them think they should listen.

### 1.7.5 Case Studies/examples

- [KC: Would it be worth having up to date spatial data for each of these ecosystem service categories and supporting text that can be cut and pasted into OCPs, etc. And at a parcel scale, would it be worth having guidance or standardized methodologies for doing say, hydrological modeling, etc.]. As you say, you can't map every thing to the parcel level, but if you at least had the tools, as part of the green bylaws toolkit, and maybe some examples or case study/test areas that you can show people, to say for example, Comox did this, and this is how it worked or didn't work.
- If there are more examples that could be shown for the lower mainland region, that would be great – there are so many for the Island, but sometimes i feel like we're in the stone age in the Fraser Valley. So showing more good examples from the Fraser Valley would be great.

## 1.8 Capacity issues

- One of my biggest problems is not having GIS ability myself. That's a barrier, because I'm dependent on a mapping department that is way over capacity. For example, that WWF carbon mapping - I can't look at it although I'd love to be able to use it.
- I know that you can go to Habitat Wizard, or iMap, or the CDC. [KC: But it's not easy to use, and there are hundred's of layers you have to sort through, etc.] Yes it's a massive barrier, you're right.
- Training for First Nations to actually use mapping/spatial layers is a barrier.
- First Nations have limited capacity, even the larger ones with fairly well developed organizational infrastructure. They have to prioritize based on where their particular needs sit at any given time. So getting their input is sometimes challenging, although it would be remiss if there wasn't an indigenous voice contributing or at least providing some guidance to what you're doing. But the reality is maybe you don't get that. But at least take the steps of speaking to it – don't ignore it in what you're reporting out on. Try to capture something about it, that its something that needs to be fleshed out in next steps.
- I've been listening to the CDFCP webinars, and they've certainly planted some more seeds in my brain. SCCP were trying to become more like the SOSCP, which has shared environmental planner. We didn't go down that road, but wanted to provide support to local governments when they were enabling new bylaws or OCPs. But that was few years ago, and we've lost capacity to do that, and there wasn't much interest or pick up by the local governments. It's an odd region here, where local governments are like 'thanks we're good'. They get a lot of pressure from different sides.

## 1.9 Perfect data isn't the answer

- I feel like we can keep chasing in circles coming up with the perfect data, and it's not going to be nearly as valuable or as relevant effort spent elsewhere.
- I think we have this false belief that if we're able to provide perfect information that everyone else will look at it and say 'I get it, this is important, we have to look after it', but that's not the case.
- I feel like trying to get 'one map to rule them all' is a problem; we're never going to get to that place. Because we can lay it all out, and we can explain it all, but its never going to convince people who have a fundamentally different value system and understanding of what's there and what's left.
- [With reference to matrix of compiled layers] What's the end point of this process? Do you get an uber layer out of all this? Even with all of these pieces you still need you need planners and decision-making bodies to understand what it all means, because they're the ones with the legislative authority to make decisions. At the end of the day we'd be better off with something that says you can't cut down anything, rather than this elaborate process of identifying all these different little pieces.
- I get sucked into wanting these fabulous maps, but it comes back to whether you have something you can show the municipality which convinces them an area is worthy of protection. If you have a map showing lots of sensitive areas, you also need something that will dissuade councilors from thinking 'look at how much of it is here, it won't be a problem to take away a few hectares of it'.
- It's one thing to have the data, whether or not there's the political will to use it effectively is another.

## 1.10 Strong development pressures

- Metro Vancouver is redoing their regional plan, and the Fraser Valley Regional District is starting the process of redoing theirs as well. In these plans they identify various development nodes, e.g. urban areas vs rural, agricultural, etc. There's an area in South Surrey that they decided to rezone to industrial, because that's what people wanted. It was a huge fight and in the end it went to a vote by the MetroVan board, and it was close, but they voted to ignore the urban containment boundary and allow that zoning change. We were all quite horrified. So all the mapping in the world wouldn't have stopped it. It's the Little Campbell Watershed, and people fought, and tried to say they didn't have enough First Nations consultation, but it still went through. Private Landowners Won't allow SAR surveys
- The McKee neighborhood plan is being developed right now, which is on Sumas Mountain in Abbotsford. The plan has been 20 years in the making, it's an area chalk full of species at risk, it's also a popular mountain biking place full of trails, and it's all private land. Old School Development
- In the McKee neighborhood plan they came up they've allowed trails in the riparian areas, thinking why not? That would be a great compromise! Of course we believe it's a very bad idea: they're trying to have their cake and eat it too – which is what defines this region. People care passionately about the environment, but its very old school development here and they can't seem to break out of it. So more data really isn't likely to help.

# 2 LAND COVER

## 2.1 Coverage

- Having a land cover layer is important, especially if you are going up to the height of land - you're not going to get that when the local governments are only mapping to their boundaries. You will have all this Crown Land where there's no land cover mapping, and you won't have a consistent map.
- There's a new land cover atlas for the Fraser Valley that was completed in 2021 – or the Land Cover Atlas for Urban and Rural BC.
- The Metro Vancouver [land cover classification dataset](#) is a contiguous layer that classifies the landscape into broad classes, such as buildings, pavement, trees, grass/herbs. It was developed using multi-spectral satellite imagery and Lidar, so we have vertical information that informs the tree canopy cover dataset. We're currently updating the land cover classification dataset.
- Monica Pearson with the Province has just sent out links to pilot land cover mapping for all of the Metro Vancouver and Fraser Valley Regional Districts. Our GIS technician is going to create a web map for me to take a look. I think it's just South Coast related – what she sent me was strictly Metro Vancouver and Fraser Valley regional districts. She also mentioned that they have started a pilot test using Lidar for a wetland inventory layer. She said some of the results are promising, but only where there's wall to wall decent Lidar data available. We have multiple years of Lidar data, and we often use that when there's a dispute about whether or not there's a wetland there. I'm going to see what layers Monica Pearson sent me look like. They're not publicly available so you'll need to contact her directly to get access to the Province's internal file transfer system. I think eventually there will be a publicly available viewer.

## 2.2 BC land cover Frankenmap

- The Pacific Birds Habitat Joint Venture, covers the whole coast, American and Canadian sides, and our interest is around migratory birds in their habitat with a lot of emphasis on wetlands. We went through a huge exercise of finding different kinds of data sets, land cover especially, that we could use for reporting and planning purposes. That's why we've done a deep dive on all these data sets.
- For land cover, we ended up creating a BC 'frankenmap' for the Habitat Joint Ventures. We looked at the pros and cons of each data set and tried to put them together and supplement the deficiencies. So we wound up with a 'frankenmap' of land cover largely using the CEC land cover (i.e. the North

American Land Cover data from 2015, hopefully they'll be cranking out another one soon; there's also a land cover change data set that goes with it).

- Its not bad but it had some deficiencies, so we augmented it with some other data sets like the Freshwater Atlas wetlands. We were also interested in agricultural land because its important habitat (in the land cover data it just gets vaguely categorized as herbaceous). So we augmented it with the Agriculture Canada data. But Ag Canada's crop information kind of sucked too, because it tends to over-emphasize the urban areas. So, we piled on the data sets in a particular order, depending on what was the stronger data set, and ended up with this crazy land cover Frankenmap which isn't bad. It includes intertidal as well.
- We have metadata for this Frankenmap. But we weren't working at that really fine scale that the CDFCP is particularly interested in, and that's where it can fall apart when you're stitching things together. It becomes really obvious when you zoom in and see "that's from 2015, that doesn't work, anymore". Whereas we for the Joint Venture implementation plan we were not worried about that. I can send you the a link to the implementation plans where we discuss a little bit about the data sets, but it will only be a couple of paragraphs.
- For your project, even if you can get all the land cover mapping done by the local governments, you'll still have Crown land etc. that's not covered, and so you'll probably wind up with a 'Frankenmap'. [KC: *but the NRC Can landcover data covers the country?*] Yes, it was used in the CEC product for Canada, but while its great for some things its poor for others, which is why we wound up with a Frankenmap. And the NRC Can landcover data stops in 2015.

## 2.3 Urban Areas

- The other data layer CWS has been working on recently is an urban area layer. The municipal boundaries don't necessarily represent where there's actual urban area. They have a lot of non-urban areas within their boundaries as well. We have a GIS analyst here who is using the digital road atlas to identify actual urban cores. We're still doing a bit of finessing on it. It does a nice job identifying what is actually urban. But it's not quite ready yet.

## 2.4 Tree canopy cover & impervious surfaces

- Metro Vancouver has [tree canopy cover and impervious surfaces layers](#), derived from the regional land cover classification dataset. Tree canopy cover and imperviousness is summarized by census block, by municipality, by region, outside and within the urban containment boundary (UCB - in our Regional Growth Strategy is a stable, longterm, regionally-defined area for urban development that protects Agricultural, Conservation and Recreation, and Rural lands from developments requiring utility infrastructure and from auto-oriented, dispersed development patterns) in [this report](#).
- Metro Vancouver will continue to track tree canopy and imperviousness over time.

# 3 BIODIVERSITY

## 3.1 Ecosystem mapping

### 3.1.1 Scale

- Local governments tend to want 1:5,000. But given the incredible detail of aerial photo coverage now, most municipalities have 1 to 1m or 1 to 10cm, so having something finer scale than 1:5,000 would be better. I don't know what the scale was for the SEI [KC: *I think it varies from 1:5,000 to 1:20,000 depending on the area. The Metro Vancouver SEI mapped sites are as small as 0.5ha, but didn't include young forest patches smaller than 5ha*].
- I can't think of a landscape or terrestrial landscape level mapping initiative that's finer than 1:20,000. VRI is based on TRIM. SEI pushed the limit a bit, but it was based on traditional photo interpretation with a subsample groundtruthed.



- I'm wondering about a minimum mapping unit, or scale, especially land cover. The NRCAN data is 30 metre pixels, 30 metre by 30 metres. Whereas with VRI or TEM you get polygons its typically 1:20,000 or sometimes 1:10,000. Some of the TEM mapping is 1:10,000, [KC: that's part of the problem, people have been doing SEI or TEM in different places in slightly different ways at different scales.]
- I see value in identifying the required mapping scale, resolution and vintage. But it is hard to capture because TEM and SEI vary widely in these attributes. So maybe you don't want to get too much into the weeds about the specific data sets. [KC: the suggestion has been made that we focus more on what the objectives are and work backwards in terms of what kind of spatial data is required, at what scale, how current, etc. It's been suggested to me that for local government planning ideally everything would be at 1:5,000 or better]
- Local government works at a finer scale than the Province typically does. I know that's what the local governments would like, but delivering mapping at that scale is a challenge. They want a lot of detail, and they want it to be up to date, they want it now, and they want it for free. But who can provide that?
- Local government fussed over those SEI polygons being too big and too coarse, because they're composite. They want thousands of hectares mapped at a micro scale. But it's just not available. [KC: I'm thinking there could be opportunities to pool resources among local and provincial governments, and with the help of this Nature Smart project, to support this kind of work]. Yes, I agree - lets try doing that.
- The local government part is very demanding: 1: 5,000, that's what they want. [KC: Sure – and some people have raised concerns that the current mapping doesn't pick up small ecosystems, like small wetlands and Garry Oak patches. My question is: doesn't the 1:20,000 SEI mapping, if its up to date, capture most of these things, even if you don't know exactly where those features are within those polygons? If they are there, shouldn't they be captured at the site level, when a QEP goes in and does 1:5,000 mapping as part of a field assessment, as long as they have well defined parameters of what they should be looking for?]. Exactly, yes
- The often expressed desire for finer resolution is sometimes misplaced as present data can provide useful answers, especially for regional questions.
- We could bring in my colleagues in Ottawa, the other remote sensing folks, to talk about these crazy opportunities with the satellite image stuff. But what it all comes down to is this: is 10 metres good enough for you? Is 3 metres good enough for you? Have you got the money for this if you want to buy better imagery? Or let's hire a bunch of co-op students instead and perform manual photo interpretation using orthophotos which is 20cm pixels.
- [KC: However, maybe with these new technologies, there could be a future opportunity to get 1:5,000 or better mapping, so there's less reliance on a potentially biased or inexperienced QEP picking up these small ecosystem features and producing maps that don't necessarily capture the values we want them to.]. I know exactly. So I think there are different approaches.
- Metro Vancouver developed finer scale SEI for their area of responsibility.

### 3.1.2 Keeping maps up to date

- Keeping ecosystem data up to date is a challenge. Municipal community/development planners have recently questioned the MetroVan SEI dataset because it is from 2014 and it doesn't capture recently converted/lost areas. Some insist that they will use their own ecological datasets.
- This is part of the distrust that we encounter with members of the public. They look at something and say, well this area was logged two years ago, and you're still showing it as an intact forest. We could spend every year constantly updating and refining the mapping because it's always going to be out of date, especially when there's so much development happening throughout the CDF. I know in the Islands Trust area clearing of trees for development removes way more trees than actual forestry.
- [KC: What if there was an automated way of converting satellite imagery into land/vegetation cover mapping, in a way that could be almost self-updating, or could be cheaply and easily updated on a regular basis]. That would be the gold standard for something that essentially is real time, based on the frequency of your high quality photos. But around the Comox Valley area, what's most needed is to look at the SEI polygons that were originally created and understand whether they're still there or not. Not to add new ones. Those polygons are all originally from 1992, so much has changed with respect to coverage by mature (80+ year old) and old forest. There's probably a whole lot of forest out there which is now mature, which is invisible to people looking at the old SEI data (which won't pick it up). My

goal for the summer is to use some sort of remote sensing to figure out where those places are, and add them in as new SEI polygons. That should take care of the question about blue and red listed ecosystems not captured by the SEI, because that will cover most of them. Except for wetland ecosystems at risk, which are already dealt with in SEI in the wetland and riparian categories. Although it won't work for things like sand spit communities at risk.

- See **Section 10.3** for more on automated remote sensing approaches vs. manual approaches for updating spatial data.

### 3.1.3 Accuracy & coverage

- One of the biggest things the CDFCP needs is mapping that covers the entire CDF and CWHxm1 region rather than just portions of it. Otherwise it's really difficult to make decisions for the CDFCP area as a whole.
- The CDF seems to have been given priority in terms of sensitive ecosystems, so there's a lot more detailed mapping for areas within it.
- I'm doing some work to compare Saanich environmental mapping with SEI, TEM mapping and the CDC element occurrence mapping. The CDC mapping is terrible. It doesn't even line up with the TEM mapping, which is what it's derived from the first place. Bizarre how wrong it is. The SEI is the second worst, the Saanich environmental mapping is close to second best. But the TEM is still better than anything else in terms of being accurate. But when you are working on a property scale it becomes inherently inaccurate because of the complex polygons.
- The land cover maps you're showing as basemaps in your matrix are fine, but they vary in quality. We've looked at a lot of these so we know Vegetation Resource Inventory (VRI) mapping has huge gaps in your area, the same with TEM, and the SEI is old.
- Lack of mapping and lack of updated mapping is a barrier, especially for the Fraser Valley. The ecological values in Metro Van aren't quite as high because it's more urbanized.
- We don't have a terrestrial ecosystem mapping layer in Surrey either. And the Metro Van SEI layer doesn't pick up many of them because they are too small – when we did the Municipal Natural Assets Inventory we discovered there were a bunch of gaps.
- We have dribs and drabs in Surrey– many pieces that potentially can be threaded together. But we don't have a comprehensive wall-to-wall detailed assessment of what the ecosystems across the city landscape are.
- Has there been any discussion about wanting the TEM data to be of a certain vintage? I've been told by Metro Van that they're planning to shoot orthophotos this summer, and then they're going to update their SEI and land cover mapping, which is wall to wall for the Metro Van Regional District. What I don't know is if they'll be updating the TEM. But their SEI is pretty good, and pretty up to date.
- As humans we have a strong tendency to think that maps are entirely accurate, and it's easy to forget that everything we have is based on imagery from 2017.
- Courtenay's environmental mapping will be updated with the adoption of its OCP (this summer) so there will be a link to that. It is based on desk-based work and will not be groundtruthed. This is acceptable for local governments, as they are not required to 'prove' the features on such a map. However, I must caveat that, as the City is not in the position to generate such mapping, with the exception of the urban forest canopy info, which the City generates via consultants.
- Mapping of riparian areas is a gap; see **Section 6.5** for details.

#### 3.1.3.1 Sensitive Ecosystem Inventory (SEI)

- The SEI has issues with scale and being out of date. It's also really sparse in a lot of areas in terms of what it captures.
- SEI is all we have to go on (Comox area), and at least its not wrong most of the time, its just not as extensive in coverage as it should be.
- We've updated our SEI (Comox area)- the data is only nine years old, everybody else's is 19 years old. We're going to update it again to be current, because our local governments, our development community, even our informed voting public, all know what it is, how to find it, and how to use it. That's why I've been making this commitment to the SEI, because it's the lingua franca of the Comox Valley when it comes to ecosystem mapping. But the SEI cuts off at Comox and it only includes about half of Cumberland.



- Metro Vancouver also have 2014 SEI and land cover: SEI for the pristine areas and then land cover, which also includes the rest (more urbanized areas).
- The original MetroVan SEI was created in 2009 and updated in 2014. The 2020 update is underway, using a similar approach as 2014, but with updated LiDAR data (where available), satellite imagery and orthophotos.
- *Metro 2050* policies require member jurisdictions to refer to a map of the Sensitive Ecosystem Inventory “or more detailed local ecological and cultural datasets”. The latter recognizes that some have more detailed and up to date local data.
- You can compare SEI to the Islands Trust sensitive ecosystem mapping, which picks up much more.

### 3.1.3.2 Terrestrial Ecosystem Mapping (TEM)

- Metro Vancouver Regional District has their own TEM data for their regional parks and watersheds, and they’re going to make this data public pretty soon. The TEM mapping is probably of varying years.
- We don’t have anything like the Saanich environmental mapping up here (Comox), and we don’t have TEM.
- My impression is that TEM hasn’t been as much of a priority in the lower mainland/Fraser Valley, which is unfortunate.
- Once the TEM mapping is developed for our area its going to show that there is a lot more ecological sensitivity on our lands than what we imagined, and this will be a powerful communication tool. Right now we’re relying on older and limited information that only captures certain values.
- *[KC: There is talk about populating the TEM mapping for the CWHxm. This is going to be expensive – should it be a priority, or should they be looking at something else?]* If the Province is doing some updating and categorization, it’ll likely take decades.
- Different organizations/regions have done terrestrial ecosystem mapping. I don’t know how standardized it is across the different organizations. Metro Vancouver has done a fairly good TEM map. So that would cover some of the TEM mapping for the CDFCP area.
- *[KC: So one of the questions is whether we should be investing in attributing the TEM for the CWXm1. Or are there other ways of doing this, such as automated methods using satellite imagery?]* With the satellite imagery now you can get down to unbelievable resolutions, if you’ve got the means to get that data, but then you need somebody to interpret it as well. So I think you probably could map ecological communities that way.
- Mapping, including TEM, is definitely lacking for the more eastern areas of the lower mainland. If you talk to FLNRORD Surrey office, they had some funding to do some TEM mapping in Crown areas. I recommend you talk to them about what they’ve been working on. I’m not sure how much the different FLNRORD offices talk to each other.
- There is no terrestrial ecosystem mapping for large chunks of the Fraser Valley.
- TEM is available on parts of the Island and Sunshine Coast that fall within the CDF BEC zone. But TEM wasn’t done for the lower mainland or the CWHxm.
- Surrey has a lot of large forested ecosystems that are in parkland and for which ecological assessments and park management plans have been developed, so detailed TEM mapping has been done specifically for some of these areas.
- There’s very recent TEM mapping for our National Wildlife Areas, so Rosewall Creek, Marshall - Stevenson and Nanoose Bay in the Qualicum NWA. And Wigeon Valley in the Lower Mainland.
- In 1990 or before that, the Canadian Wildlife Service was doing ecosystem mapping, and the province of British Columbia was independently doing something similar, and they decided to get together to jointly do the TEM project. CWS was coming at it from wetlands specifically, while the province wanted to do other things besides just wetlands, so they got together and hammered out this TEM protocol. People like Jan Kirkby were at the forefront developing these things. Its all written up in manuals and methods, but I’m pretty sure it was straight up air photo interpretation, with almost 100% of ground truthing by CWS for the wetland polygons, and something like 20% groundtruthing by the Province for the other polygons. So we all know that could always be better. But you’re never going ground truth every single polygon, especially on private land where you need the owner’s permission to go in and ground truth.

### 3.1.3.3 Forest cover / Vegetation Resource Inventory (VRI)

- For a lot of your area there is no Vegetation Resource Inventory mapping [KC: *and what there is on private land seems to be very out of date and often wrong*]. Clearly we need an alternative. Another group in my office has a contract with Dr. Nick Coops – a remote sensing expert with the UBC Faculty of Forestry. He knows all this stuff and he's looking into options and some out of the box ideas. So we're waiting to hear some results from that. There are so many challenges here.
- The land cover maps you're showing as basemaps in your matrix are fine, but they vary in quality. We've looked at a lot of these so we know Vegetation Resource Inventory (VRI) mapping has huge gaps in your area.
- [KC: *Are you familiar with the name Malcolm Gray? Apparently back around 2000 he managed a project where they used an automated approach to turn imagery into forest cover for watershed analysis?*]. Yes, CWS have all that data. But he had to do a fair amount of manual interpretation of the forest. He had an old forest category in his baseline thematic mapping. He did it in the 1990s then did an update for the Georgia Basin in 2002. We have that data – it would be great to update it.

### 3.1.4 SEI back-ended with TEM

- I think Saanich has the ideal mapping compilation that I would love to see. They have the SEI data that was done a number of years ago for the Island, and they also have TEM data.
- Saanich couple the SEI and TEM layers. When you're in local government and you have to make critical decisions around where your money is going to have to be spent, you do have to make trade offs. Not all wetlands are created equal, and the same goes for a lot of different ecological associations or ecosystems. So having more of that fine detail provided by the TEM can be very helpful to the decision-making process.
- Ideally, having coverage similar to what Saanich has (SEI, TEM combined with any finer scale mapping done for specific sites). All of this information will be essential if the City is to be able to achieve its objectives around biodiversity conservation and protecting our [Green Infrastructure Network](#).
- I'm a diehard fan of TEM, it's my favourite data layer. It should be the underpinnings of the whole wall-to-wall ecosystem mapping coverage in the CDFCP area. My beef is that we don't have TEM for the CWHxm, so we get cut out of the ability to do Marxan modelling, etc. But don't use TEM as the public facing output. Use the SEI for public facing, it's the lingua franca of the developers and planners. Keep the TEM data on the backend for ecologists to understand. That would be my dream. With our little budget in our region we don't have the ability to do TEM for our regional district, so we're going to keep supporting what we do have, which is the SEI.
- SEI is derived from photo interpretation. I gather you can derive it from TEM mapping. Honestly, the TEM is old now too, its 2008. But my recommendation to the Resilient Saanich Technical Committee (who wanted to throw the TEM baby out with the bathwater) was to lean back on the TEM, and update it to find out which polygons have been converted since 2008, then use that layer to pull updated SEI polygons from. And that SEI layer will be the layer that the public and developers can see. Don't put the TEM out there because they don't know how to use it – you need a college degree to figure out how it works. TEM is good for the back-end, for conservation professionals etc., but to make it accessible as the main layer for lay people is inappropriate. And I think that's what created the Saanich issue.
- I can't get my head around this TEM mapping, it doesn't mean anything to me – I can relate to SEI or wetland mapping, but not TEM. So we're having someone go through the process of crosswalking those TEM categories to descriptions translated into English.
- This TEM stuff is weird, but its very authoritative [KC: *Its been suggested to me that TEM should not be used for public facing information, or you could end up with a Saanich situation where they repealed their EDPA because of controversy with the mapping. But you can derive SEI from TEM. With a crosswalk table, you can use the TEM help predict where ecological communities at risk potentially occur; it can also be mined for key aspects of the ecosystem services we're interested in (e.g. ecosystems at risk, carbon storage/sequestration, watershed resilience, etc.), and be translated into useable products, like SEI mapping. But it needs to be kept in the background*]. I think that's the way you want to do it - you want to crosswalk the TEM. What I understand is there's a crazy amount of

detail in the TEM mapping, and that while there are certain attributes in it that maybe is useless for SEI purposes, these attributes might be great for other kinds of ecological analysis. TEM is the gold standard but difficult for planners to understand

### 3.1.5 Capturing small ecosystem patches & forested wetlands

- The SEI misses small rare ecosystem patches, and as a result they don't get identified in local government planning. We've had five extinctions on the island because local governments won't look at little ecosystem patches missed by the SEI. We've been trying to solve this problem for 20 years.
- These Savannah and Garry Oak ecosystems are meant to show up in the SEI as mature old growth and woodland, but because the SEI mapping is so bad and was only mapped to two hectare resolution, these ecosystems are massively underrepresented - there are hardly any patches that big anymore, because they've been infilled with Douglas-fir. That's what botanists don't realize. The SEI misses small patch Garry Oak systems.
- *[KC: A point made to me was that if we update the SEI we'll be capturing most of the good condition CDF ecosystems that are left. Maybe we don't necessarily have to identify exactly where all those remnant patches are].*
- I think we now have better technology for capturing forested wetlands. Apparently one of the biggest gaps in TEM and also in the SEI is capturing wetlands under canopy.
- So a large chunk of Surrey is in the CDFmm BEC variant. The real issue we have is that the SEI mapping for Metro Vancouver has a lot of gaps in Surrey, because a lot of our habitat areas are smaller than the SEI filter (0.5 ha). Surrey had a natural asset inventory done in partnership with MNAI last year, for the Little Campbell watershed. We cobbled together as many layers as we could, based on what the city of Surrey had, which included a significant amount of land cover information. But it doesn't have detailed mapping for terrestrial ecosystems - it's really more detailed mapping for stream areas, because that's where a lot of the legislative or regulatory compulsion lies. When we actually amalgamated the SEI data we realized there were a lot of gaps.
- *[KC: What specifically would help you in terms of filling gaps?]* Much finer scale mapping that picks up small habitats missed by SEI mapping.
- We also undertook a natural asset inventory pilot project last year for the Little Campbell Watershed. It merged the mapping we had available with Metro's SEI and any relevant provincial mapping we could add, but there were still lots of gaps. Mainly because much of the land cover/habitat attributes are too small to have been mapped, or large urban areas are just lumped.
- Mapping for small wetlands is a gap; see **Section 6.4.1** for details.

### 3.1.6 Capturing Old Forest

- As far as mapping old and mature forests and how to do it, I don't have a solution. Is knowing whether a forest is coniferous or deciduous good enough? Or do you need to know the actual species mix? It depends on what you're looking for.
- *[KC: Because the SEI is what the developers and planners are familiar with and it's what they use, some are saying that rather than reinventing the wheel with new kinds of ecosystem mapping, it would be better to improve the SEI and bring it up to date. And that when the SEI was done, much of the forest was young and so it wasn't captured in the SEI mapping. These forests are now in the 80+ year old mature forest category, and would be captured if the mapping was updated, as would many of the ecological communities at risk that weren't previously captured. Also if we identified which ecological communities at risk are potentially found in each of the SEI categories (recognizing this will vary somewhat between the different parts of the Georgia Basin), it could be used as guidance in environmental development permits to flag what QEPs should be on the look out for when they conduct their finer scale site level mapping and assessments].* If there's an interest in age class of forests, then that's a different kind of mapping, but I totally agree. Identifying those mature second growth stands that are ready for their rotation, that kind of mapping is different than what NRCan or CEC does with their land cover mapping, which only distinguishes between coniferous, deciduous and mixed. So its important to specify what kind of detail is required in order to identify the ecosystem service of interest.

### 3.1.6.1 Farm Timber

- Looking at the logging history, there was a point when the logging companies were running out of close by wood for their mills, so they started accessing what they called farm timber. In the 1930s era, they bought all these trees from farmers and cleared huge tracts of forests on ALR land, instead of logging on their own forestry lands. Now all those trees have grown back, and are 80+ years old. I think they're all at risk again from the same thing happening: logging companies are going to come in and pay farmers to liquidate harvestable timber on those ALR lands. There was a report done here on how to expand agriculture in the Comox Valley. The analysts said that only about 50% of the ALR land is cleared and used for agriculture, the other 50% is in natural condition, so there's tons of room to make more farmland. These are all the remaining valley bottom forests that aren't riparian – if all this forest was converted to farmland we'd be in dire straits from a biodiversity perspective. We're already in dire straits, but that would make things much worse.
- I've wondered: why aren't those farm timber areas protected, and how come they aren't on the radar? I realized it's because they weren't yet mature forests when the original 1992 SEI mapping was done, so they weren't captured. They are mature forests now, and the mapping needs to be updated to fix the problem. 30 years ago they might have been 50-year-old forests. And it's really hard to delineate between young and mature forest when they're right on that edge. It takes a keen eye to be able to look for the specific tree features that would distinguish one from the other, like self thinning, mature bark, larger diameter branches, etc. So right at 80, it's difficult to make a call sometimes between young and mature forest, and from satellite imagery it's even harder. But once they get to 100 year old it's a lot easier to distinguish the two. There was a lot of young forest in 1992, and now that it's matured, it's sitting out there unprotected. That's why, I say let's not reinvent the wheel, let's just make the wheel better. Municipal planners, developers and informed public understand the SEI.
- [KC: The other issue that was raised to me is that there's all this so-called farm timber on agricultural land that was cut 80+ years ago, and now is now getting to an age where it's suitable for another rotation. And a lot of the ALR is still under native vegetation cover, often around 50%, which is where this 'farm timber' is located. So we may have a situation where the forestry companies start going after that farm timber again, and there's zero protection for that stuff. Nor is most of this forest captured by SEI, because it wasn't mature when the mapping was done.] That's right and in fact, they would invoke their right to farm legislation. In the ALR they have a right to remove those trees to make it farmable. Which has implications to biodiversity.

### 3.1.7 Capturing species & ecosystems at risk (SEAR)

- The development community gets this wrong all the time: you read a development report from a biologist that they've hired, and it says there are no red-listed communities because it's been logged. This is incorrect, they are still red-listed communities, just in very poor condition. The SEI doesn't pick these ecosystems up when they're in poor condition (i.e. logged), although it starts picking them up when they turn 80 years old, on their 80th birthday, after which they fall into the SEI mature forest category. Almost all of the ecosystems in the CDF and CWHxm are at risk, except for a couple wetland types – the CDFCP area is nearly 100% wall-to-wall coverage by red and blue listed ecosystems. The question is, are they in poor or good condition? From a protection perspective, unless it's a corridor, let's focus on getting the stuff that's in good condition, and when it comes to forested ecosystems, that means 80 years or older, and the SEI should capture that. So let's make sure the SEI is up to date and actually capturing those 80+ year old forests, and I don't believe it is here, right now.
- [KC: Is the SEI adequate for capturing species at risk and the values you think are important?] It's better than nothing, I do like it. It seems a bit out of date - MetroVan's is from 2014. But I think it's still good. I know you guys have used to great success on the Island. The Sumas Mountain SEI dates to 2010.
- [KC: Are you finding SEAR outside the mapped SEI areas?] There's a lack of information in this area (lower mainland). When I think of ecological communities at risk, coastal, sandy ecosystems and things like that have had some focus, certainly in our region more to the west.
- [KC: Does the SEI do a good job at capturing SEAR values?] It doesn't specifically include SEAR, but the classifications would potentially be inclusive of SEAR. It has broad classifications like riparian, woodland, intertidal, and sub-classes, but it doesn't indicate areas within these broad classifications



where you'd most likely find SEAR. *[KC: Another approach would be to augment SEI descriptions with a table outlining the types of EAR that would be found in this SEI category]* That may be helpful

- *[KC: One my concerns about the SEI is that it can send the message that the ecosystems that are not highlighted aren't important. We feel need to send a message that all native vegetation cover is important.]* Well, that's right.
- I don't know that the rare species argument is the one to use anymore. I think a more powerful argument might be that we need to keep common species common.
- See also **Section 3.2**.

### 3.1.8 Refined/expanded SEI categories

- For the Metro Vancouver SEI, the input data came from several sources, including the regional land cover classification dataset, a contiguous layer of broad land cover classes that was created using LiDAR (where available) and Rapid-eye satellite imagery. TEM data from Metro Vancouver watersheds and Regional Parks were cross-walked into SEI categories. Some SEI polygons were as small as 0.5ha. The minimum size of the polygons depended on the size threshold for each particular class. The open dataset also includes small young forest areas, but those are not officially part of the SEI.
- Metro Vancouver's SEI maps both sensitive (e.g. wetlands, older forests, woodlands) and modified ecosystems (i.e. human modified but with significant ecological and biological value), and classifies them into ecosystem classes and sub-classes.
- *[KC: the SEI mapping seems to miss many of the ecological communities at risk – is there a better alternative?]*. Maybe the place to start is redefining the SEI habitat types they're willing to map. It has an established framework and base mapping that could be added to, rather than reinventing the whole thing. I'm not sure why decisions were made to focus on the specific polygons they captured for the SEI. I suppose they were seen as the most at risk, the most important for species at risk.
- *[KC: We're getting criticism from some quarters that the SEI is too blunt, it's out of date. But what we've heard from local government people is that the SEI is what developers and local governments are comfortable using, and that they won't necessarily use more sophisticated mapping. Is SEI good enough, would it be better to have other mapping that captures more features,?]* The SEI could be enhanced by adding more categories, e.g., seasonal agricultural lands and terrestrial bluffs. At least it's a framework that people understand. So I could see keeping but enhancing it. But I don't think local governments want less information, not unless they want to stick their heads in the sand about what features are out there. We're becoming more sensitive to more features needing more protection than they did. In the past, it was primarily water, then riparian areas. Now we're expanding out to recognize these other ecological communities have value, too, so it's a natural progression of our understanding of ecosystems.

### 3.1.9 Planners want more information

- As much as the City says we recognize that we don't know all the features in a particular area, that they're not all mapped, the public focus is still drawn to the maps. Deborah Curran, with University of Victoria Environmental Law, reminds us to be careful about including too much detail in maps and suggesting we know exactly where features are, because there might be a shed where there used to be trees. People can be led to think your whole scheme must be faulty because of one mistake. I do always take her points seriously. But at the staff level, when we're actually evaluating applications or trying to decide where to focus growth, the more mapped information the better.
- So the more that the SEI (or other mapping framework) flags to a staff person at the front counter, who is not ecologically educated, that there might sensitive ecological features on a site, the more it empowers them to see if those features have been captured by the QEP in the environmental report. So we're not just necessarily just trusting the QEPs. And those people at the front counter, they are touching the lives of hundreds of people every day, so the more they're empowered with mapping tools the better. They're a big audience for the maps.
- So we've mapped out the green infrastructure network (GIN), but its often too costly to acquire and protect all of it for a given area. We have to pick out what pieces of the GIN we're going to be able to pay for at any given time. And because we don't have the detailed ecosystem information to make informed decisions its also based on whether the existing landowner is willing to sell.

- If we had better ecological information/mapping to make informed decisions, when our planning and development department receives development applications, it would be able to point to this layer and say 'at some point we should be considering these things'. Having the detailed information is better than not having it at all, even if we don't have the planning tools in place to use it effectively. The more we know the more accountable we are for it. Which is a big challenge for most local governments, because there are a lot of extenuating factors around knowledge and decision-making - we're reluctant to know more, because then we're responsible for it. What do we do with that knowledge? But my role in the city is to ensure that we're making informed choices around achieving our biodiversity conservation objectives, and the only way that we can do that is to understand the biodiversity related assets that we have.
- Yes, it would be nice to have more data. I'm sure there's a lot of information collected by environmental consultants, but whether that ends up where it needs to be, I don't know. We just don't have access to a lot of this.
- Basically, any time you see a map in a report (and almost any report these days has a map of some kind) that shows relevant information to what you are looking for – I would immediately be asking if there is GIS data that could be shared.
- The more data the better even if we're not ready to use it. It's better than working in the dark about our natural assets.

### 3.1.10 Decision-makers & developers want certainty

- As a planner mapping helps. I've got a developer meeting tomorrow about our OCP. Our OCP highlights opportunities for ecosystem connectivity and protecting CWHxm ecosystems. This developer is asking the City to disclose whether environmental assessments prepared by QEPs were used to derive the ESA mapping boundaries. For developers certainty is so important. But we don't have to prove with certainty where these ecosystems are - we are allowed to have mapped areas where we can request more detailed biological information before issuing a development permit. But developers believe that if the City is going to put in environmental regulation, they should be sure there is something special there to protect.
- In response to developers' demands for more certainty, the City's fallback is to state that it's within local government's rights to ask for biological information, even if we don't know for certain where those imperilled ecosystems are. But that's where developers' minds are at.
- I imagine that we're not going to be able to give local government what they really want, which I suspect would be something where they plug in the data for a proposed development, and it does a computation to say there is a 30% probability that grizzly bears will be lost if the development is put there. They want a level of certainty for decision-making that is not possible.
- We need input from planners about what's needed. But I can envision that maybe we are making it way too complicated because we're people who like to understand all the variables and what's behind the model. What local government councils want is just lines on a map. They don't want gray zones; they just want a list of rules and lines on a map, and to be able to trust that the process that went into it is something that can be defended.

### 3.1.11 Flagging tool for site level assessment

- *[KC: When I've looked at the SEI mapping in various places, it fails to pick up a lot of the ecological communities at risk (based on the CDC mapping from iMap). Should we be rethinking how we do SEI mapping, for e.g. what the habitat parameters are, or how we derive it? For example we don't have available LiDar for all of our area, but maybe that's coming; and high resolution satellite imagery is increasingly available. Would local governments etc. be better served by pooling resources and investing in something like that? Or should we be investing in expanding the TEM to the CWHxm, knowing it may take many years?].* Yes, that's not wrong, but my thinking is rather than reinvent the wheel, let's just make the wheel better. SEI is understood, it's what people know how to use. I think the problem with the Saanich EDPA going off the rails is because they have all these layers available to people - SEI, Saanich Ecosystem Mapping, TEM - and people are able to argue that on at a property level, none of them are accurate – which is true at that scale, or whatever scale. It shouldn't be used to draw hard lines in the sand. It should be used to flag areas that need ground-based inspections to figure out what's actually there, and that's probably never going to change. So let's figure out which is



the best one for CDFCP's scale of operation, and use it in a way that will actually be used and taken up by the target audience, which I understand is local government and First nations. Local government planners don't have the background to read a TEM code and know what the hell it means.

- We've structured our environmental development permitting (EDP) to be uncoupled from the map, so if the bioinventory shows you have a feature, then the development application enters the environmental permitting stream. So we don't need the best mapping to do that. But mapping helps, because it's one more thing for staff to point to.
- The ESA mapping is a tool to help us all flag and discuss what is/could be there. We've also written that protection of important features is still required, even if the features are unmapped. That's why when development includes land clearing on properties over an acre in size we require that they do the bioinventory and apply Develop With Care. Only if they show there are no features on their site can they proceed without an environmental development permit.
- Throughout the Islands Trust area, we have environmental development permit areas, to protect forest and Garry Oak woodlands. But its set up so you can still cut forest down in the EDPAs, you just need to ask first and get a permit to do it.
- *[KC: I understand some municipalities have blanket EDPAs for most of the remaining natural areas in their areas, whereby development of any greenfield parcel over a certain size (e.g. an acre or a hectare) automatically triggers the need for a development permit and environmental assessment or a bioinventory. In their OCPs and other policy documents they recognize that almost all ecological communities of the CDF and CWHxm BEC subzones are at risk, whether they're mapped or not (which fills in the gaps in Provincial ecosystem mapping). So these municipalities don't necessarily require detailed mapping of small habitat/ecosystem features, rather these are to be identified by QEPs during site level bioinventories, and addressed through conditions laid out as part of the permitting process.]* We don't have that here – its a huge giant machine. It took years to get the Biodiversity Conservation Strategy completed and endorsed by Council in 2014. It took another two years before the Sensitive ecosystem development permit area (SEDP) process was put in place, through an amendment to the OCP. If there's a stream riparian area, or something that would typically trigger Provincial legislation through the Riparian Areas Regulation (RAR) or the Water Sustainability Act, then an assessment will be required.
- The City of Abbotsford has DPAs for environmentally sensitive areas, and I know they did some SEI mapping, and probably did a good job. Township of Langley does have DPAs and a Treebylaw – both abbotsford and Langley are creating an Urban/Community Forest Strategy. City of Surrey just blew through Metro Van's urban containment boundary with the South Campbell Heights Development.
- Listening to your webinars got me thinking about the local government pressures in the Fraser Valley/Lower mainland, and where the gaps are in terms of EDPAs etc. I don't think anyone has really looked at this.
- Have a look at Courtenay's draft OCP that's out for review. The mapping CDFCP provided last year was relied on heavily to develop their environmental development permit areas, etc. So kudos to you - that got a lot of traction on the policy.

#### 3.1.11.1 Upland ecosystems are a gap

- If a proposed development is inside the Green Infrastructure Network (GIN), the sensitive ecosystem development permit area process is triggered, or if it's near a watercourse. But we have a lot of really important ecological features that are not in the GIN, and which are not watercourses. And they're often not mapped.
- We have all the mapping layers for Critical Habitat for species at risk, where its been defined and published by the Federal Govt, and that's another trigger we could leverage for an assessment. We can also address the standard bird nesting issues. But if it's an upland patch of forest not tied to the GIN or provincial or federal legislation, then we don't have a mechanism to trigger an assessment. We don't recognize those upland CDF and CWHxm ecological communities as being sensitive – it's an eastern Vancouver Island thing, or a Gulf Islands or Islands Trust thing. If you come to Surrey on any given day you can see the development application signs up all over the place, or see the hectares of forest being cut down. They may have been required to do a bird nesting survey or SEDP ahead of time. But we don't hold up development over the summer.

- One of the core underpinnings of our biodiversity strategy, which was endorsed in 2014, is a static layer called the Green Infrastructure Network (GIN). Development applications that fall within the GIN trigger the sensitive ecosystem development permit area requirements. All watercourses would normally trigger some sort of review, because they're associated with Provincial and Federal legislation. But we don't have a good natural assets database for the upland terrestrial components, even those within the GIN.

### 3.1.11.2 QEPs & site level assessments

- People point to the SEI mapping all the time. To acknowledge that the SEI mapping is old, poor and incomplete, our language is now that development on any property over an acre in the City, whether or not it's mapped as an ESA, requires a biological assessment. There's still pushback on that, where people say 'But there's no feature on your map – What do you mean?!'
- In our area, the landscape itself is hugely disconnected, with small habitat areas that haven't been mapped. That creates a lot of problems because we're heavily reliant on QEPs and our sensitive ecosystem development permit area process. When it's triggered a sensitive ecosystem development plan, prepared by a QEP is required. So that's often where a lot of detailed ecological information comes out, through the development application process. But that information doesn't get mapped anywhere – it remains in a static report.
- *[We've got these generalized SEI categories which don't necessarily reflect ecological communities at risk. Do you think there would be any value in coming up with a list of the types of ecological communities that are likely to be found in the different SEI categories? To add to the list of things QEPs should be looking for, or to present to elected officials as one of the reasons for protecting sensitive ecosystems?]* City of Courtenay requires that RPBios complete bioinventories and reports – that's our framework, because we wanted to have a professional association that we could make complaints to if we encountered professionals that were not exercising their ethical responsibility. Using QEPs without RPBio status doesn't provide that option – not that we don't think QEPs can be very good at their jobs – and we wanted that enforcement capability. We're very familiar with getting shoddy environmental reports, where we question whether they really did good sampling and captured what was on site.
- QEP reports are required for these areas [within Green Infrastructure Network] prior to development, but there is often contention about ecological sensitivity, especially for isolated wetlands, there are often disputes as to whether or not they are actually wetlands.
- *[KC: Do you have a sense of what local governments need in terms of decision support - for the biodiversity piece in particular?]* I would need to talk to my partners, like the Fraser Valley Conservancy, I didn't get a chance to before this meeting. Fraser Valley is where most of the habitat is. There is some in Metro Vancouver, like Langley and Maple Ridge and Pitt Meadows. The pressure to develop in this region is so big and so strong. Developers have their processes, e.g. DPAs for environmentally sensitive areas. Usually QEPs are hired on a project to collect information about where the critical habitat is, where the species at risk occurrences are, etc. Abbotsford requires developers to hire the Fraser Valley Conservancy to compile this basic information and create a report.
- So it's the QEPs that need this information/ mapping. Then it depends on the bylaws and regulations that each municipality follows, and whether they have a DPA or not, whether its in the ALR, etc. The mapping layers help, but it still depends on the regulations that local governments follow, and the pressure to develop is very high, so they're looking for more places to develop and trying to figure out how they're going to do that with all the environmental concerns.
- *[KC: Is the information compiled by QEPs for development applications adequate?]* Good question. Its adequate for what is required under the development proposals, based on the conditions of the development permits. *[KC: Do the conditions in the development permits, presumably written by planning staff, adequately capture what's needed to protect biodiversity on the site? Does the planner have adequate information to do this?]* That's a really good question. You mean when an OCP is being created? *[KC: Yes their OCP, policy statements, how they write their EDPAs, and then what conditions they put into development permits.]* I'm thinking of all the different municipalities - have they been doing a good job? We haven't explored that lately, so I don't know.

### 3.1.12 Parkland acquisition & biodiversity strategies

- When you look Surrey's development patterns, we're doing a laudable job in regards to parkland acquisition. With our green infrastructure there is still a chunk we need to acquire because there's no other way to convey it through existing mechanisms, so we're going to have to outright buy it. We have a development cost charge that is specific to the green infrastructure network that was approved last year, but it's going to take a few years before there's enough money in the bank, and it gets drained very quickly when we're talking about parcels that cost \$20 to 35,000,000, because we have to pay market value. It's crazy how much assessment values have shot up from 10 years ago. So we've mapped out the green infrastructure network (GIN), but it's often too costly to acquire and protect all of it for a given area. We have to pick out what pieces of the GIN we're going to be able to pay for at any given time. And because we don't have the detailed ecosystem information to make informed decisions it's also based on whether the existing landowner is willing to sell – we can't appropriate land for the GIN. We also purchase land outside of the GIN for parkland.
- Only about 28% of local governments in Canada have biodiversity strategies of any sort, and only a handful of local governments in BC have these dedicated processes. I know more local governments lean towards having some sort of environmental development permit area process, but Surrey was one of the first out the gate to have something that was a little more focused in that regard.

### 3.1.13 Using Lidar & remote sensing technologies

- See Section 10.1

## 3.2 Species and Ecosystems at Risk (SEAR)

### 3.2.1 Species at risk data & mapping

- *[KC: How about species at risk mapping?]* There is a tremendous focus on species at risk but we need to also be mindful of other species in steep decline that are not yet listed, and simply keeping common species common.
- With SAR, you check the occurrence data, you check iNaturalist, talk to a few experts, and then you might get a good idea. And there's not much funding for actual inventory and monitoring work. There was a wave of SAR work done in the past, and it comes and goes. I did a study on what recovery activity has been done for different SAR. Ten years ago it was the Pacific Water Shrew. Right now it's Screech Owls, Oregon Spotted Frog and Western Painted Turtle. Some species have a lot of focus, then it ebbs and flows. For example, the Phantom Orchid had tons of work years ago, but it seems not much has been done on plants at risk since. It depends somewhat on how easy the SAR are to find and how recently people have looked.
- SAR Inventory generally is a gap, and with the difficulties getting permissions from private landowners, maybe predictive SAR modeling is the way to go, with a bit of groundtruthing if possible. There's been so much focus and funding for habitat enhancement, especially for fish, which get all the attention. There's been a lack of regular information. I just saw an incredible detailed inventory report on a property by the Naturalists in Langley, but you almost never see anything that detailed.
- In the Fraser Valley we have a Frog Finders project, where you get people to send in their frog sightings, and that has led to some new occurrence data, for e.g. for the Western Toad. We don't know where all the breeding wetlands are.
- A big gap is not knowing where at risk communities and species are located - that's really important. Especially since private lands are never really surveyed, unless the owner is pro-conservation. If there was some way to get reliable predictive mapping of where the rare species and ecosystems could be, I think that would be really useful.

### 3.2.2 Ecological communities at risk

- *[KC: Are all the ecological communities at risk mapped?]* I'm not sure. They are continually working on this mapping, but the majority of them likely are mapped. *[KC: I had the impression that most of the CDF/CWHxm is comprised of listed communities. Although I guess there are certain criteria that have*

to be met to qualify as an ecological community at risk.] I think most of the natural ecosystems are at risk, but I think there are some that are not.

- Ecosystems at risk are such a sad thing. I've worked in environmental permitting for a long time. The bioinventory reports would come in saying there's a red listed ecological community on a parcel, but that didn't carry a lot of weight, and often they were modified, particularly if they weren't in riparian areas. Some degree of profile is needed for ecological communities at risk themselves, rare plant assemblages, etc. which are seen as disposable, even in biological reports where they are identified by biologists. I guess that comes back to the lack of legislation and the province not having a strong species at risk framework.
- The message that gets lost is that the zonal CDF forest is just as important as all these other ecological communities at risk. This creates the same situation with Garry Oak, especially in Victoria, where people saying 'there are Garry Oak everywhere, why are you worried?' Its that it's that inability to explain the difference between a bunch of trees and an ecosystem and a forest. The only thing I found worked was to say 'how many young Garry Oak have you seen? And the same with Arbutus – how many young arbutus do you see?' People see what they want to believe. That's what we're battling against: people don't want to believe that they can't carry on the way they've always done.
- It would be a good for the CDCP to come up with some kind of statement to this effect, even if it's just a one-pager or something, because I keep having the same fight over and over again with the development community's biologists around what is and isn't red and blue listed; they just continue to get it wrong – 'oh it's been clear cut so its not a listed community'. I've talked to Jason Straka, Emily Cameron and Carmen Cardrin, and all the ecosystem specialists, and they all agree that no it is listed, its just in poor condition because its at an early seral stage. So a statement with a description explaining why everything is listed (even if its been logged, or not captured by the CDC mapping or the SEI because its not mature enough), and then a cross-walk table showing the links between the SEI categories and ecosystems at risk.

### 3.2.3 Savannah/Garry Oak mapping

- We know that the current extent of Savannah and Garry Oak ecosystems, and even the 1920 extent, was nothing like the historic 1850 extent, because of forest ingrowth. To limit your mapping to existing areas would be ridiculous – you would be giving up the 90% of these ecosystems which have disappeared below the trees. The CDF was much more open and but most people don't know that. I'm at odds with most of the botanists who often don't seem to know the history of the area as well as they claim they do.
- A problem with the Garry Oak mapping is that the accessible sites that the botanists are familiar with are over-represented. All these places are near rural residential areas, roads and mountain biking, so they're in bad shape and full of invasive plants. So the portfolio of Garry Oak sites being used by the Province misses all the best Garry Oak sites, which are mostly on private land. You can find the best sites by looking for woodland away from roads, and observations of birds that use Garry Oak communities.

### 3.2.4 Crosswalk tables

- *[KC: Clear referenced statements indicating that virtually all relatively intact native ecosystems in the CDF and CWHxm are red and blue listed seems to be missing, in both the SEI descriptions and elsewhere].* A crosswalk table would be good thing to do. We've done that with conservation plans that span international borders and use different types of mapping. So, for example showing that when we're talking about mature second growth forest, it potentially hosts the following at risk ecological communities. That would take about an hour to do!
- You can use TEM in some places to identify whether or not a polygon contains a rare ecological community. For example, with the Islands Trust TEM mapping they've tried to do the crosswalking so you can identify the potential for the occurrence of a rare ecological community. It's often difficult to make assumptions on whether a rare ecological community is present based on TEM units. Since there is no TEM for the CWHxm1, it wouldn't be possible to identify the locations of rare ecological communities within the CDFCP area as a whole using TEM as a base.



- *[KC: Would predictive mapping using TEM and a crosswalk table to predict where SEAR might occur be useful?]* YES! It would be useful.

### 3.2.5 Predictive SEAR modeling & mapping

- Capital Regional District has predictive modelling showing where sharp-tailed snakes are likely to occur – it's in their mapping.
- *[KC: Do you find that the mapping, whether it's SEI or the CDC SAR mapping, is capturing the species at risk? Or are they captured at the site assessment level?]* We've talked about this, Doing more habitat modeling is the way to go – like the mapping for the Oregon Forest Snail that was done a few years ago. Brian Durand mapped the Fraser Valley (not publicly available) in terms of high low and medium habitat for Oregon Forest Snail, and I use that sometimes.
- The SCCP put on a reptiles and amphibians event recently. The Province has been working with various amphibian and reptile experts and have mapped ranges for all of BC based on ecosections, observations and expert review. These will be available for public download in April I believe. I can send you the website.

### 3.2.6 COVIST

- In terms of actual data sets, the Surrey FLNRORD started a project called COVIST. It's a SAR gap analysis looking at small home ranges, starting with the Fraser Valley. It's a prioritizer, software that can help identify priority areas – an optimization tool. It started a few years ago, through Priority Places funding. They collected a lot of biodiversity data and data on small home range SAR, primarily with a Crown land focus. They have created some products around that. The Fraser Valley Conservancy provided them with their priorities are,
- The other side of the COVIST project involves engaging First Nations in conservation and SAR protection. They have a partnership now with the Stó:lō Nation, and working with First Nations to get information about culturally important areas. The FLNRORD contact is Agnieszka Sztaba. Joanna Berger who was working on it has now moved to Victoria. Josh Malt with the terrestrial ecosystem side is also potentially a contact. With the whole ministry shake up it might not be the best time to try and talk to them.
- They have some funding to do additional TEM mapping. Again, that's Agnieszka Sztaba. She's in the Surrey office. But otherwise I think you have your finger on most of the other data sources. They did do TEM mapping for Vedder Mountain in Chilliwack.

### 3.2.7 Composite distribution maps and bird analogs

- We use birds as biodiversity analogs. No information on other organisms (e.g. spiders) at any scale is as useful and reliable. When you map bird diversity, especially if we map native communities, they're the best indicator of what ecosystem was there in the past. There is no hope of finding an unmodified ecological community in the CDFCP. All you can do is ask what would it look like if it existed, and figure out the indicators we would see.
- Birds represent dimensions of the environment that we cannot measure with anything else. Somehow we just haven't been effective at getting people to understand this. All species have niches. We call those hyper volumes: multi dimensional places occupied by a species. If we know the species found in a place, we can describe the habitat (e.g. running water, types of trees, forest structure, etc.) with a degree of accuracy you cannot in any other way. That's why modern people who are who are mapping things around the world are using this kind of method.
- For the CDFCP Marxan Tool, <https://arcese.forestry.ubc.ca/marxan-tool-cdfcp/> the likely occurrences of important biodiversity features were identified using 'composite distribution' maps to infer native species abundance. These were created using a combination of 1) presence/absence data for plant and bird species from various sources, and 2) associated landscape and/or climate features to predict species occurrence. From this the predicted distribution of Old Forest, Savannah, Wetland, Shrub and Human biodiversity features were mapped.
- The so-called Savannah sites are found at the interface between old growth forest and shallow-soiled Gary oak meadows. They are transitional areas, the arbutus and Douglas fir slopes. These are also the areas where biodiversity is maximized. We've showed it with birds and we can show it with plants.

- The CDFCP Marxan Tool includes a number of biodiversity feature layers, including old forest birds, savannah birds, wetland birds, human commensal birds, and bird beta diversity. It also has layers for standing carbon and carbon sequestration potential. We've shown how you can jointly maximize biodiversity and carbon.
- *[KC: So how did you map Savannah ecosystems?]* We used a map created from TEM. The data is from 2008 so it's quite old. We have loads of maps, including many bird layers, plus all the stuff we did for the NPLC (North Pacific Landscape Cooperative, which include an indicator tree species layer and a plant community layer (natives vs exotics).

### 3.2.8 Aquatic species & ecosystems at risk

- Don't forget DFO and aquatic species at risk in streams (and associated Critical Habitat); they can be used as tools to help conserve aquatic ecosystems and associated riparian areas.
- When it comes to data on Fraser Valley habitats or species that are tied to aquatic features, you're probably best to go to Community Mapping Network, because of all the detailed watercourse mapping. The compilation data is only 2001. It's a snapshot of all the Fraser Valley local governments that keep their particular datasets relatively up to date. Most of the field validation was done in the eastern part of the valley, because that's all we could afford, and because it's where most of the important habitats are, and where most of the change happens.

### 3.2.9 Greenfield development & ecosystems at risk

- I work in a municipality, so our regional direction is to focus community growth in the municipal areas, so there is inherent tension between wanting to create infill developments, where people can walk, have 10 min neighborhoods, not rely on a car, etc. But then every single patch of unmodified land within the City is within the endangered CWHxm BEC subzone, which means no greenfield development if we want to preserve those red listed ecological communities.
- There is a direct conflict between preserving red-listed ecosystems and trying to grow within our municipal boundaries. Now we are trying to grow within existing brownfield and grey field and infill low areas with big lawns and single family homes - we're definitely trying to focus growth away from greenfield areas. But there is still greenfield within our boundaries and inevitably there will be development of those green fields, especially because we want to reduce the pressure in the rural areas. But what's the role of the municipality in prioritizing the protection of those ecosystems versus the regional district having a stronger role in doing so. But the regional districts have working landscapes, and are meant to accommodate agriculture, wood lots and things like that, so they have their tensions too.

### 3.2.10 Perceived overstressing of CDF rareness

- Some residents of the islands are complaining because they believe that Islands Trust and the IT Conservancy, are exaggerating the rarity of the CDF for our own purposes. Ultimately, does it matter whether the CDF is the most rare or the third most rare?
- The Islands Trust is trying to put out a little mythbuster video about what's in the CDF policy statement, and what isn't?

## 3.3 Tracking change

### 3.3.1 Change analysis

- We have these island profiles that were created a number of years ago, based on information in the regional conservation plan, which shows for each of the Trust areas how much remains natural, how much has been lost to development, etc. But there's limited capacity to update it regularly so it's pretty static, and might only get updated every 5 or 10 years. And as we're seeing throughout the CDF, there is an awful lot of change on the landscape in 5 years these days.
- Do you have interest in change analysis? You can't beat having stats on how many SEI polygons have been converted over the last 20 years. I was wondering if there was any discussion about that?
- *[KC: I've had discussion with others about the possibility of using free imagery and developing an automated process or using an army of students to do imagery interpretation, to regularly update the*



*SEI or other land cover mapping on a regional scale, to show what's been lost.]* It would be a really striking visual for decision-making bodies to see what's been lost on an annual basis, especially if you had a map of their region showing where all the current development proposals are, because normally they're considered individually. But even simply looking at how the SEI changes year to year would be helpful.

### 3.3.2 Regional report card

- *[KC: Maybe we could have some kind of annual report card for the Georgia Basin].* Sometimes I feel like that's all ecologists do, is track extinction. *[KC: Maybe having some feedback would be a bit of a check, especially if we tie in carbon storage and other natural assets. We could say we've lost x percent of carbon storage capacity this year, or y percentage of hydrologically sensitive areas].* I think that would be a powerful tool. I like the report card update idea, instead of a media release, which may or may not get picked up and which you can't control. You take out ads, buy space and say what you need to - I like this idea.

### 3.3.3 MetroVan SEI change data

- The 2020 SEI update will look for loss, gain, or change. The [SEI map viewer](#) shows Sensitive Ecosystems, Modified Ecosystems and loss between 2009 and 2014 (hatched areas). The 2020 data set will also show change over time.
- There is a summary of ecosystem change in Metro Vancouver [between 2009 and 2014](#), for the different types of ecosystems. Overall, the region lost 1600 ha of sensitive and modified ecosystems between 2009 and 2014, equivalent to four Stanley Parks.
- *[KC: How do elected officials react to change data?]* There is a broad range of responses. Some will say "of course, we're developing so that's expected" while others are shocked and say "we shouldn't be losing ecosystems". There are many different voices and perspectives on the Metro Vancouver Board but elected officials on the Climate Action Committee, which reports to the Board, are generally very supportive of any initiatives that will protect, enhance, restore, and connect ecosystems.

## 3.4 Corridors & Climate

### 3.4.1 Corridors & connectivity

- Ecological Connectivity – this dataset is not yet on the Metro Vancouver website. Diamondhead Consulting conducted [the analysis and mapping](#), which focused on habitat connectivity for eight species, identifying patch connectedness, stepping-stones, etc. It will be useful as one of the inputs for the regional green infrastructure network (RGIN) mapping planned next year. Will your project involve mapping?*[KC: our funding is not to do the mapping, rather its to coordinate resources, but maybe we can help with identifying opportunities to pool resources with other jurisdictions and source funding on a bigger scale]* That's good to know. To retain and enhance connectivity across the landscape Abbotsford, Fraser Valley, Squamish Lillooet Regional Districts, Whatcom County and many other organizations will need to be involved in the RGIN discussions as well.
- *[KC: How is Metro Van's data shaping what's happening?]* Some members are using Metro Vancouver's datasets. The RPAC-ENV will have some initial discussions in May about objectives for a RGIN. I'd like to overlay all of our datasets - the connectivity mapping, updated SEI and land cover classification, carbon storage, tree canopy cover and imperious surfaces, and any other ecological datasets our members have (e.g. data sets used by Surrey, Richmond, Vancouver and others used to create their local green infrastructure networks) – next year.
- On the one hand I feel like it would be incredibly useful us to have a better understanding of true ecological connectivity for contiguity. But that require very detailed analysis, involving so many layers. At the end of the day, I don't know how much it would help us, because I feel like we just need to protect everything regardless.
- We often have habitat patches that are less than one hectare, and sometimes more like 300 m<sup>2</sup>. In an urban area they are really important for connectivity. They act as steppingstones and the more fragmented the landscape the more important they are.

- In the absence of detailed wall-to-wall ecosystem mapping, the City of Surrey relies on its green infrastructure mapping, which has some information for certain hubs and corridors, but not for the whole of Surrey. And the information about the hubs is typically only a couple of sentences, and for the corridors it's just high, medium or low, in terms of rating. There's not a lot of detailed information about what ecosystems are there, or their condition.
- From an ecological corridor perspective, the more mapping the Province can do the better, especially because the Province can look beyond local government boundaries. Local governments only look at their own jurisdictions, but nature knows no boundaries. And the public is savvy to this as well. They'll point out that it's silly to do a growth planning exercise, or biodiversity corridor exercise only within your jurisdiction.
- Municipalities always say we want to collaborate with our regional partners, but the truth is the mechanisms for that aren't very well established. If the Province could show on a map that there is a really important corridor extending beyond jurisdictional boundaries, I wouldn't have to talk to neighboring jurisdictions to figure out where the important corridors are, I could just look at the map produced by higher authorities and see for myself.
- A regional scale corridor map that transcends local government boundaries would be very useful, especially looking at the Georgia Basin and down the Island. It makes me think of the International Bird Areas Network. Our naturalists always remind us that we're in an Important Bird Area, that we are part of a global network. Don't forget we play a piece in the bigger picture. That's something that can be communicated on the Georgia Basin scale, too.

### 3.4.2 Climate corridors

- *[KC: The issue of water and watershed resilience in the face of climate change is becoming a strong theme].* That's one of the reasons we did the riparian mapping. We're hoping to identify climate corridors to aid in conservation decisions and that mapping is coming, but it's still a way off before we can use it for conservation planning. So we're using riparian corridors as a climate adaptive approach for conservation decisions, among other ecological reasons.
- One of the important conservation considerations is figuring out how to mitigate for climate related changes. We need to not only identify locations that are important now, but areas that will be important in the future, and look at how to connect those areas. We need to identify corridors that are going to be really critical in the future. *[KC: its one of the reasons why it would be nice to see mapping that goes up to the tops of the watersheds, because we're going to be seeing this elevational as well as latitudinal migration].*

### 3.4.3 Novel ecosystems & range shifts

- There are some groups looking at novel ecosystems, and using BEC to figure out how things are likely to move across the landscape with climate change. They can identify what the climate is right now in particular places, and through different climate projections predict where those suite of characteristics are likely going to move, in some cases creating novel ecosystems. I'll send you what I've seen of the novel ecosystem modeling.
- I would love to have (and I believe the Province has them) maps of predicted range change for different species. I've heard a rumor they're calling them 'flying BEC zones'. This is the kind of mapping I think would be really helpful to have, and have it publicly available. Whether or not it would be at a scale that we need or want, I don't know.
- From the perspective of figuring out what we need to protect for the next 50 years and the next 100 years, it would be really interesting to have predictive range maps, which show where things are going to move. For examples, these cedars are going to die out here, what do we need to plant to maintain or enhance carbon storage and sequestration, etc.. [ME: Site index in the VRI data could be used to give an indication of high productivity sites that would produce trees with the highest sequestration capability.] I've never been able to look at the VRI data either, I just don't have the technical capacity to look at it.

## 3.5 Prioritizing/Optimizing Tools

### 3.5.1 Scoring properties for conservation

- There is a notion is that we need systems to assess whether a conservation proposal for a particular property is a priority for our time and resources. But it's not as though we're comparing A and B and deciding to pursue A and sacrifice B. Rather we need to know if the property is worth securing at an individual level, whether it meets a certain threshold value. I tend to be of the opinion that everything with natural habitat is of value at the moment. We do have a scoring system where if a property has a red-listed species it gets 10 points, if its blue listed it gets slightly less, etc. There's an attempt to make it somewhat objective. But I don't know if it helps.
- But I can see local governments wanting some kind of conservation scoring system, because they're getting a ton of development proposals, and they want to be able to make a defensible decision around what they approve, but also to provide guidelines for developers and landowners around what's likely to be acceptable and what isn't. They don't want grief from a developer who buys a chunk of land to be later told no, they're not allowed to do something, despite it being allowed by the zoning.

### 3.5.2 CDFCP Marxan project

- One of the benefits of optimization models is the potential to bring diverse stakeholders together to identify common priorities for conservation/protection. This process needs to happen at the building stage of the optimization process, so that there is some level of support and confidence in the outputs from the intended users.
- *[KC: What are your thoughts on optimizing models like Marxan?]* I've been trying to get that done. We did an initial project last year that created a dashboard for a biodiversity atlas. As part of that we used Metro Vancouver's more recent connectivity analysis, to do a deeper dive into connectivity in Surrey using the available layers. But my ultimate goal is to revisit our green infrastructure network and run modeling software like Marxan or Linkage Mapper. We'll need to compare them and figure out which one will provide us with the best outputs, that's the first step. But we can't do that without the mapping to start with.
- The CDFCP prioritization mapping is fairly out of date now. One of the issues with this mapping is that it only covers the CDF. The approach used was to build consensus among the people/organizations involved in terms of what each thought was important. I think it's a good way to get people together and talking and trying to come up with a solution everybody might agree on and support. But it doesn't necessarily produce the best output in terms of what is the most important from an ecological perspective. *[KC: Its an optimization model right? I think there's a place for both types of modelling, but they seem to be getting muddled]* Yes, optimization models are really good at being efficient, but are difficult to implement practically for conservation decisions occurring as opportunities arise. So it is also really important to have mapping layers that identify the ecological values directly to aid in conservation decisions.
- Prioritizing using optimization models only works practically if everyone (each jurisdiction and/or organization) follows and implements the results. Additionally, the models have to be dynamic (rerun), because new conservation properties are being added and important areas are being lost, which changes the optimization priorities. The optimization results are tied to the region for which it was run. You can miss out on the most valuable places in a particular jurisdiction within the larger optimized region, because the model might be assuming those values are being captured in another jurisdiction. Ideally the optimization process would need to be run for each jurisdiction that was interested in implementing the results. The CDFCP level optimization outputs are useful to guide the conservation priorities regionally, but are not necessarily relevant to the individual jurisdictions within the CDFCP area.
- The CDFCP Marxan Tool is an optimizing tool to help determine priority land parcels for biodiversity conservation. The results you get depend on what you put in, in terms of objectives and targets. We ran optimizing scenarios for the whole of the CDFmm (minus the lower mainland), and for various subregions (Islands Trust Area, Capital Region District, and the Cowichan Valley District). A map pop up showing where ecosystems at risk are. See report at [https://peter-arcese-lab.sites.olt.ubc.ca/files/2016/09/CDFCP\\_tutorial\\_2017\\_05.pdf](https://peter-arcese-lab.sites.olt.ubc.ca/files/2016/09/CDFCP_tutorial_2017_05.pdf)

- The CDFCP model provides a portfolio of sites which meet all the goals of the project participants. But these are not decision models –the data will not make decisions for you, because no data that we have is at sufficient scale to do that.
- In terms of updating spatial layers, do you want to spend \$100,000 updating the model for the whole of the CDF, or do you want to take the highest priority 30% of the places that we identified, and focus on getting a better model for those places.
- We need to look at the places that are left and ask what's the capacity/likelihood of bringing these places back to what we want, and whether these are places worth investing in for the future. Do we really need to update that historic CDFCP map or should we just take our high priority areas and refine them with new data?
- We used cadastral maps for the CDFCP Marxan tool – it took us a long time to get the permission to get that data from the government. Its very tightly held and they tried to charge us \$10,000 for the data. We finally got it, minus certain codes, from a UBC Professor in real estate economics, who was the only person who had permission from the government to access that kind of data.

### **3.5.3 North Pacific Land Conservation Cooperative (NPLC) Tool**

- The NPLC Marxan Tool is an optimizing tool to help determine priority land parcels for biodiversity conservation within the whole Georgia Basin (Canadian & US sides).
- Instead of the CDFCP Marxan model, we could use the NPLC model clipped to the CDF area, because the NPLC model is much more accurate, with newer data. We could extrapolate all the way to Oregon for that one, to identify high profile areas for biodiversity (you get different results depending on the geographic area you run the model over).
- [https://peter-arcese-lab.sites.olt.ubc.ca/files/2015/03/NPLCC-Douglas-fir-Savannah-Prioritization-Tutorial\\_v1.1.pdf](https://peter-arcese-lab.sites.olt.ubc.ca/files/2015/03/NPLCC-Douglas-fir-Savannah-Prioritization-Tutorial_v1.1.pdf)
- <http://nplcc.labs.ecotrust.org/>; <https://www.sciencebase.gov/catalog/item/4f6a3d64e4b0e7aaea01dbfb>

### **3.5.4 BC Marxan Tool**

- Oscar Ventner and Peter Arcese are building a Marxan tool for all of BC, which will be available in a few months. We've got lots of layers, 230 species - mammals, birds, everything. It's going to be slightly coarser than the CDFCP model (which is 1ha) because its for the whole province, and we also want to have speed. Right now the resolution is 2.5km, but we are not sure exactly what resolution we'll end up with. It could be ok for regional planning. Oscar is doing this kind of work for the whole world.

## **3.6 Coastal Ecosystems**

### **3.6.1 Estuaries**

- We think estuaries are the most important feature – I would emphasize that they need to be in here because they are the transition between the upland and the marine ecosystems. You may not be interested in the intertidal area, but estuaries, and the footprint on them should be part of the equation.
- A lot of municipalities and First Nations are very proud of their estuaries. They are a transitional link between the upland and the marine, so on that basis alone they should be included.
- The Pacific Estuary Conservation Program (PECP) has the best mapping for estuaries. We've ranked estuaries up and down the coast. I can send you a link to the GIS files and to the report.

### **3.6.2 Coastline**

- Coastal and Ocean Resources - <http://www.coastalandoceans.com/> and ShoreZone - <https://www.shorezone.org/> They have a huge database of imagery and video of the coastlines from Washington State, through BC (and all the islands), and up into Alaska. The imagery and video timestamps can be found here at: <https://mcori.maps.arcgis.com/apps/Viewer/index.html?appid=c76377500f814914ad90149f229d4d66> They also have a more extensive data base on more granular information on shorelines like invasive



species, oil spill shoreline assessments, shoreline development analysis but this more detailed information may be gated behind a pay-for-service.

### 3.6.3 Marine ecosystems (currently out of scope for this project)

- Marine ecosystems are really underrepresented; the exception is in Howe Sound, where Suzuki and other UBC graduates focused on the marine resources within the UNESCO Bioregion. They've developed a Howe Sound ocean reference guide, which has rich layers of mapping and story mapping, and community collaboration knowledge. <https://howesoundguide.ca/map/> They might be worth talking to. Their terrestrial mapping lags behind their marine mapping, however.

#### 3.6.3.1 Monitoring marine pollution and shipping

- The people I work with are often talking about having independent monitoring systems, so they don't have to rely on the federal or provincial government to monitor their lands. They're mostly concerned with their values, which are often very different from what I would have thought, like monitoring shipping activity.
- Noise and light pollution these are not often mapped. The Salish Sea Marine Emissions Tool - <https://ssme-eems.ca/> is a real-time public map, administered by the Government of Canada, of ships in the Salish Sea and their emissions over the year, as well as other data related to boat emissions.
- Information on pollutants affecting whales and their prey can be found at : [PAWPIT-OIPABP](#)
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## 4 CULTURALLY SIGNIFICANT ECOSYSTEMS

### 4.1 Consent, confidentiality and cultural sensitivity

- Data related to cultural resources with respect to Indigenous bands and communities ought *NOT* be shared openly unless the data was thoroughly vetted by the Indigenous band and community - and explicit consent has been given. From Musqueam Indian Band's (MIB) perspective – openly sharing culturally sensitive data runs counter to an Indigenous communities data sovereignty goals which is usually data that directly supports individual communities Indigenous rights.
- Barriers to using mapping/data sources include cultural sensitivity and transparency.
- *[KC: Its complicated, because obviously Nations are concerned about being mined for their traditional knowledge.]* Exactly. And it's gonna be like, Oh, God, white people are asking me for stuff again. *[KC: Yes. So I'm less interested in getting information/data from the Nations, and more interested in seeing if there is something useful we can offer to assist them with their decision-making.]*
- We are working with Inlailawatash on understanding cultural areas and mapping those areas both in our mapping system and in a database. Some of this information will be public and some will be used to create model bylaws to strengthen preservation and protection in the sensitive ecosystems and cultural areas of the Trust.
- Jason Youmans will be working with the cultural advisors that the Islands Trust has on understanding the CDF areas and importance. We had before COVID planned a site visit to one location with a culturally modified CDF and it might be that Jason can work with the cultural knowledge holder and arrange that site visit to identify and outline the area.
- With regard to cultural resources, reconciliation is a very important topic. We have a commitment to reconciliation from our current council, although I'm very aware that we have to be very careful how



much we promise, because it's going to be challenging to derive clarity and deliver to meet expectations. Frankly I'm worried that by saying we're all going to advance reconciliation while not being clear on how to do it, that we're going set ourselves up for cynicism. But it is a banner under which to begin saying areas are culturally important - people's ears will prick up because that carries a lot of weight.

- Indigenous people don't normally put cultural sites on a map. It has to come from them otherwise its classic colonial behaviour, cultural appropriation. Asking First Nations for information about what resources they consider to be culturally significant can also be viewed as cultural intrusion.
- This will be a sticky one, and totally dependent on indigenous engagement - if they wish to be engaged and what they bring to the table if they are. But there are models for it. For example, those involved in the Great Bear Rainforest successfully solicited First Nations to map out traditional hunting areas, traditional berry collecting areas, etc.

## 4.2 Data on culturally significant ecosystems

- Lastly, Indigenous communities. Specifically from Musqueam Indian Band's perspective, I could see there being some value in a data exchange of some kind (that was non-culturally sensitive), but we would need to review internally what data could be offered in exchange or shared openly.
- We are striving to integrate our management and planning with cultural resources. We need to keep exploring ways to include cultural resources along with building Indigenous relationships.
- As far as I know, the only way to do this is to find people in indigenous communities who can help list what sorts of things are considered culturally significant.
- It was our plan to build in a layer showing cultural resources, traditional foods and medicines, but I just didn't have the time to get in front of Comox Nation to get them to partner with us on that data layer. And they are very busy too, and wouldn't have the time right now.
- The layers that I feel like we don't get but would be great to have is culturally important places. Its proprietary knowledge, and there are a lot of complications with it, but I feel like its an important piece. Not just for reconciliation as its own intrinsic process, but also for moving forward in a way that protects what's important.
- [KC: Do you think there would also be any value in using ecosystem mapping to highlight potential occurrences of culturally important ecosystems in a more generic way, if there was a way of doing so that would be of interest to First Nations and with their consent? For example, it might be possible to create a cross-walk table between the ecosystems mapped in the TEM (where it exists) and culturally important plant communities, e.g. cedar stands or camas meadows. It would basically involve creating descriptions for relevant TEM elements that reflect what's important to First Nations communities.] Personally, I would say yes, this would be critically important, because it would help make us accountable on these issues. It has been done before – I've seen books and maps for the Fraser Valley and the north shore in the lower mainland, more prescriptive on traditional uses or traditional knowledge about those areas and a lot of indigenous place names are tied to that relationship, and we're beginning to consider renaming places based on that approach. But it's still pretty hit or miss. If there was the ability to work with First Nations and develop this type of mapping, realistically it would take a very long time, and there would be gaps. And it's a different host of plants for the Lower Mainland/Fraser Valley (as opposed to Vancouver Island). And some of the hereditary wealth systems are based on different plants.
- [KC: *Theoretically could the TEM be used to predict where some of these plant communities are likely to occur?*] Yes, theoretically, but the issue is that the landscape has been so modified, that areas which historically supported culturally important plants may no longer do so. You'd still need the elder knowledge to identify those areas which no longer exist. You'd have a historical account segment, then if you're lucky, some of these plants would still be there [KC: *and I understand these plants were prolific in certain areas because they were actively tended and cultivated by indigenous people prior to being displaced by settlers*]. Yes, the landscape was anthropogenically modified long before white people arrived, but it was done in a much more sustainable and less intrusive way. Wapato is a good example of a wetland plant that was cultivated by some First Nations in matrilineal family plots. But yes, two thumbs up for exploring the possibility of this kind of mapping.
- Mapping and data on cultural resources is a huge gap. Draft policies in *Metro 2050* require member jurisdictions to refer to the SEI "or more detailed local ecological and cultural datasets". Mention of

cultural datasets was requested by several First Nation representatives as a way to encourage the incorporation of Indigenous values. At this time, Metro Vancouver has not compiled any cultural datasets. [KC: We wondered if TEM could be used as way of identifying where important food/cultural plants etc. might be located, but we don't know if First Nations even wants this mapped]. The policy will encourage conversations with Indigenous Peoples, but there may be concerns about Indigenous sovereignty.

- There might be a lot of resources already available. There are Tribal Councils that act as umbrella organizations for a number of First Nations. For example, the Naut'sa mawt Tribal Council includes a number of nations on Vancouver Island and a couple on the Lower Mainland, the Sto:lo Nation Tribal Council includes members in the Fraser Valley-Greater Vancouver region, and the Sto:lo Nation Chiefs Council includes members from Fraser Valley.
- <http://viea.ca/wp-content/uploads/2016/04/8-ContactListofFirstNationandAboriginalOrganizationsonVI.pdf>
- I've mapped hundreds of culturally modified trees that are not in the register. I've been on people's cases because even though it's illegal they're cut down all the time.
- The archaeological records are hidden from the public. Most information is confidential, and even Provincial people are very reluctant to speak about things. Information used in land claims is in the public realm. But even with publicly available information there are issues with using it without permission [KC: we wouldn't be looking at archaeology for this project, rather we'd be exploring whether there are culturally significant ecosystems/habitats that First Nations would like to see mapped, so they can be considered as important values during planning processes]. This will be easier, as there are synergies between biodiversity and resources valued by indigenous communities. Arcese et al (2014) put out a paper on aboriginal food values which uses Nancy Turner's 1988 work/method for evaluating the cultural significance of plants.
  - <https://www.taramartin.org/wp-content/uploads/2015/01/arcese-et-al-2014.pdf>, [https://www.researchgate.net/publication/227837321\\_The\\_Importance\\_of\\_a\\_Rose\\_Evaluating\\_the\\_Cultural\\_Significance\\_of\\_Plants\\_in\\_Thompson\\_and\\_Lillooet\\_Interior\\_Salish](https://www.researchgate.net/publication/227837321_The_Importance_of_a_Rose_Evaluating_the_Cultural_Significance_of_Plants_in_Thompson_and_Lillooet_Interior_Salish)
  - Nancy Turner has also written about this extensively in her 2014 book on ethnobotany of the Pacific Northwest <https://www.mqup.ca/ancient-pathways--ancestral-knowledge-products-9780773543805.php>
- Cultural resource mapping and information are definitely a gap. Cedars of significance interfaced with our Urban Forest Strategy. When we consulted with the local First Nation, and they said they'd be interested in knowing if there are special trees in the city that might be of value to them. They didn't identify specific trees, but recognized them as a feature they might wish to be consulted on were the City to create a system. So we don't have a real sense of the cultural piece. We don't know all that is culturally important within the city's boundaries, although we know the estuary is very important to the Nation, and few other things. Once you get onto the land, we know less and conversations with First Nations are needed.
- Data gaps include Traditional Environmental Knowledge (TEK) and First Nation specific important species/ places
- [KC: I'm imagining, as a possibility, a set of spatial layers that can be stacked on top of each other, one showing where ecologically sensitive different ecosystems are, another showing how much carbon is stored in different ecosystems, another showing how hydrologically sensitive they are, and if appropriate maybe another highlighting which ecosystems are culturally significant to First Nations. Something suitable for use by local governments and First Nations during their planning and referral processes. Are you looking at ecosystems that are culturally significant to First Nations when you're developing priorities for what to protect?]. Yes and no. We are driven to do it when First Nations compel us to. For example, we're doing a traditional use study for a high profile greenfield local area plan that's been proposed for development. But typically we have not factored in indigenous cultural uses or traditional uses when looking at areas to acquire or protect, unless its very high profile. Even having a preamble about pre-contact context has only entered our lexicon in the last few years. We do have policies around culturally modified trees and archaeological components.
- High profile developments might trigger an archeological or traditional use survey. There's a lot of traditional ecological knowledge or traditional wisdom (which is proprietary) around various sites that can come into play. Not for every development though. For the average development, the City is not considering the potential historical, traditional use of the area by local indigenous communities.

- We have not traditionally done place-based mapping centered on indigenous relationships with the landscape. But we do have a working group building on existing reconciliation and indigenous partnerships, so that we're starting to be a little more woke about these issues, and starting to be more integrated with regard to capturing that. To me, seeing the City's landscape through that lens would be invaluable.

### 4.3 Indigenous management practice

- Darcy Matthews, the Provincial anthropologist (he's a UVic prof now) and Nancy Turner have worked together a fair bit, and they've done some basic work on cultural restoration, camas harvest, etc.
- The rare ecosystems of the CDF and associated culturally important food plants, like camas, are largely found in the so-called Savannah landscape: the Arbutus-Douglas-fir slopes found in the interface/transition zone between the old growth Douglas-fir forests and the shallow-soiled Garry Oak meadows (The extent of Garry oak ecosystems is also only a fraction of what it used to be). We know that the goal of indigenous communities was to manage culturally important food plants to maximize harvest. We don't have the camas meadows we used to have in part because of the decline in indigenous management activity.

## 5 CARBON

### 5.1 Carbon Inventory & Mapping

- *[KC: Does Metro Van include emissions from converted ecosystems as part of your inventory for tracking carbon?]* Metro Vancouver's [regional carbon storage dataset](#) was compiled [by 3GreenTree](#). They calculated carbon by ecotype, in soil, and biomass.
- *[KC: WWF recently released soil and forest carbon storage maps for Canada. I'm curious as to how Metro Van's carbon mapping compares].* I'm not familiar with the WWF data, so I don't know how they compare. Some local governments are using iTree for their analysis. Several municipalities will probably use their own carbon accounting data.
- NGOs can have a lot of self-generated mapping info. In the Comox Valley, Project Watershed does a lot of that work. We often go to them for info! <https://projectwatershed.ca/maps/>. This particular organization was also at one point (may be still) leading some work on 'blue carbon' which was to measure the carbon sequestration of salt marshes, which I understand is significant.
- I think local governments want the data showing carbon sequestration/storage. *[KC: is there data to do that right now?]* No, but yes. I've hired Ira Sutherland to do that particular job. He's doing his PhD in the UBC Forestry Department. He's really clever, and thinks this crazy idea I have for adding carbon storage as an attribute column in the SEI is feasible. We're not going to get into how many tons of CO<sub>2</sub> are sequestered per year per habitat type. We don't have that level of data, although it probably wouldn't be terribly hard to come up with it. For the scope for this project and we're going to develop a rating scale of high, medium, low, or a similar number of categories. It will help us understand the difference between how much carbon is sequestered by an intact wetland versus forest. Its basic, but it will at least shine a light on it, and it's a place to start. It would be great if someone takes that and improves it, but we've only got this student for three months.
- *[KC: I've talked to another area without detailed ecosystem mapping, and they're looking at developing basic mapping that gives different SEI categories high, medium or low rankings for carbon storage capacity].* Well, I can do that now - I can look at patch of mature coniferous forest and say its probably going to have a higher carbon storage value than the neighboring mixed forest, or a younger forest, and that going to evolve over time. Once again, having the detailed mapping is essential for decision-making. We have a number of initiatives underway around climate change adaptation and mitigation. Our Urban Forest Management Strategy is nearing finalization as well. It had a more detailed look at canopy coverage.

- For natural asset planning, the more detailed the layer the better. The natural asset inventory also does CO<sub>2</sub> equivalency mapping – it looks at biomass etc. So having detailed mapping is the cornerstone for these evaluations. There is a proprietary methodology for doing the natural asset inventory analysis, which I think is based on the iTree system, they use the data which is publicly available and which you provide to do the natural asset inventory. Which is where we found we had a lot of gaps. And its not just tree cover, because wetlands, grasslands and soils are also important for carbon sequestration, as well as being important from a biodiversity perspective. [KC: *do you need to know species of tree, age classes, etc.?*] That's the nitpicky stuff that the Federal Government likes. I know because we applied to the 2 Million Trees Program and the Nature Smart Climate Solutions Fund, and it was very helpful to have that natural asset inventory mapping, because we could actually speak to the biomass and carbon sequestering and storage values of the parcels we're focusing on. We were seeking to get reimbursed for the carbon storage/sequestration values of the lands we've recently acquired. [KC: *So are you looking for actual tons of carbon stored by different ecosystems/parcels?*] That would be the benefit of having detailed mapping - we'd probably be able to do that type of modeling and calculation.

## 5.2 Maximizing biodiversity as a co-benefit

- Staff are seeking feedback on a series of Roadmaps as part of Metro Vancouver's *Climate 2050*. One of those Roadmaps is focused on Nature and Ecosystems. Although carbon storage and sequestration are noted as one desired outcome, the Roadmap is careful to note that biodiversity and a host of other ecosystem services should be maximized as well.

## 5.3 Cross-walking carbon with ecosystem mapping

- [KC: it would be nice if the ecosystem/carbon valuations were somehow designed to be crosswalked with the different ecosystem types in the CDF]. I'm not sure that you could use the same units. It might be difficult to align ecosystem mapping with carbon using the same units, because it depends what methodology is being used, resolution, etc. for each type of mapping. You've already started showing the different layers and how they overlap. The ecosystem/carbon crosswalking is the sort of thing you could do after the fact. And it's often easier to do that kind of analysis with raster-based data than with vector data, combining different types of data, stacking etc.

## 5.4 Site Productivity & Carbon

- Three Green Tree, who did carbon analysis for the Municipality North Cowichan community forest used the VRI to help determine site productivity.
- The highest productivity sites will be the bottom lands where soils are deep, where there's a lot of moisture and where it's generally warm –we know that. There are also other factors. If a place has been burned, it will really productive Saskatoon habitat and the Douglas-fir may not get in. So a site can be enormously productive but it might not have trees on it so depends on how you manage it. This is where things get complicated. If the goal is to simply grow trees for carbon storage, then yes, you might focus on planting trees on high productivity sites, but it might conflict with other kinds of values.
- [KC: *Would local governments have interest in mapping which shows the potential for sites to grow trees that sequester more or less carbon, to help with priorities on replanting?*] Its one more GIS layer in the whole analysis exercise – yes it would be of interest.

## 5.5 Including ecosystem conversion in carbon analyses

- The Metro Vancouver *Climate 2050* team in Air Quality and Climate Change also commissioned a modelling study to assess sequestration in natural systems toward a carbon neutral region.
- When the City did its carbon analysis we followed the global protocol – there's a global standard on how municipalities measure carbon, and it is territorial based. It looks at the emissions generated from activities within our boundaries that local government has influence over, so transportation buildings and waste are the main ones. It does not capture embodied carbon of let's say an electric vehicle, or



acknowledge that that the carbon footprint of producing that vehicle is now occurring elsewhere. This is a challenge in the way the municipal territorial emissions are tracked.

- From what I understand the City's carbon analysis doesn't have an ecological storage/sequestration piece in it. We hired consultants for this and I'd be happy to connect you with them because they're leaders in Canada on this – the Sustainable Solutions Group. It would be nice if every time they were hired by local government to do carbon analyses they followed a protocol that also accounted for carbon stored in ecosystems, and the potential of planting to increase sequestration. I don't believe emissions from cutting trees down and converting ecosystems are captured in anyway. When we hired Sustainable Solutions Group to do our carbon modeling we were at the mercy of their best practices. If they'd had emissions from ecosystem conversion as a line item in their spreadsheets we would've accepted that as state of the art. So I'm not sure why it doesn't show up in that global protocol.
- Looking at the consultants' scope for their carbon analysis, it does include something called agriculture, forestry, and other land use. But I don't recall them asking us about land conversion stats when they were collecting data. In my mind, if they had been wanting an answer to how much carbon has been emitted from land conversion, they would have asked how much forest land etc. has been converted since 2016, which was our baseline. So I'm assuming that that's not accounted for.
- The principal of Sustainable Solutions Group will understand that global carbon analysis protocol for local government and where it comes from. That protocol gets used in communities across Canada, and his company is used across Canada. I'd sit on local government climate talks with people across Canada, and they were always talking about his organization
- In 2010 the Province added local government powers for climate, energy conservation and water conservation and the reduction of greenhouse gases. I haven't seen it employed in terms of protecting ecosystems for carbon storage. You might want to ask staff at Municipal Affairs who work on development permitting and the Local Government Act what can be done with these powers.
- [KC: Could you see ecosystem conversion as being something local governments would consider important in terms of their contribution to carbon emissions, if it was brought to their attention, or if it was built into some sort of policy framework?] Yes. There's a group called the Climate Leaders Caucus (<https://www.climatecaucus.ca>). It's meant to be elected officials who are passionate about climate action. What we're finding is people are looking for every tool in the box, and nature-based solutions are intuitively understood by the public. Fortunately, when we did our OCP consultation the top theme aside from needing affordable housing was that people love nature. So you've already got the love thing; if you can then show the bean counters the value of nature, people will start feeling more comfortable with the idea that there are many important reasons for protecting nature. And so, yes, if a local government has committed to climate action, which a lot of them have, then they're looking for every tool they can use
- The Climate Leaders Caucus (<https://www.climatecaucus.ca>) are quite buildings and carbon focused but as you'll see, they are partnering with UVIC on a 'regenerative' systems type of approach to policy making as well. Help Cities Lead is another initiative that partners with (emerged from?) Climate Caucus. They have focused buildings emissions objectives. <https://www.helpcitieslead.ca/>. A Counsellor in Courtenay – Will Cole-Hamilton – is a leader in these initiatives.

## 5.6 Carbon storage & environmental development permitting

- [KC: Would you consider carbon storage capacity of different ecosystems in your bio-inventory and environmental permitting process?]. I'd have to review the powers for environmental development permitting. The legislation says that we have the ability to protect the environment, its ecosystems, its biodiversity, etc. That's where we get the authority to ask for more information – its quite broad and in terms of biodiversity its great. I'm not sure if we have the authority under the Local Government Act to include carbon storage under Environmental Development Permit Area (EDPA) powers, but it would definitely be worth investigating.



## 6 WATERSHED RESILIENCE

### 6.1 Watershed resilience & planning

- Watershed resilience is Pandora's box. I don't think you're going to get there by talking to people individually. You need to get the experts in the room to discuss it, because just defining what elements represent watershed resilience is at least a half-day workshop between people who have strong divergent opinions.
- Watershed resilience is kind of a horrible term. So rather, the ecological and environmental health the watersheds in terms of water quality, flow, biodiversity, fish, etc. is enormously important in our area, and clearly important to indigenous people.
- Dan Moore, FRBC chair of hydrology at UBC, had a whole plan about what they need to do to protect headwater streams on southern Vancouver Island, and they talked a lot about land/forest cover. Lynn Campbell would probably know about this.  
[https://www.for.gov.bc.ca/hfd/library/FIA/2007/FSP\\_Y073017a.pdf](https://www.for.gov.bc.ca/hfd/library/FIA/2007/FSP_Y073017a.pdf)
- [KC: Is there an interest among local governments in having maps showing hydrologically sensitive areas, etc.?] I would say they would be, especially water related information. It's more their language, and it's on everyone's minds right now. Every landowner I've talked to near where it flooded has been telling me nightmare stories of what happened in the fall. So it's a good time to start hitting the lower mainland with that, given the fall flooding. It's very hard for us to know, because we don't even know where to get that information. Maybe that's an area where you guys could help us answer these types of questions at the local scale.
- There should be some new bridge funding available before the Watershed Strategic Fund is established through Watershed BC. They got another \$40 billion for the second year of bridging.
- FLNRORD and MOE are beginning to realize watersheds in the urban landscape are important too – there are natural assets in these watersheds that are still working, and worth understanding better and making sensible decisions about. They've had a tendency to focus on undeveloped watersheds, because there are not a lot of gains in ecosystem values to be made in watersheds that are fully developed, and they don't have the time to do everything.
- Prioritize those watersheds that have the capacity to produce fish, and that's usually indicated by their history of producing fish, and the likelihood that you can acquire the necessary land to improve things. Then hold reverse auctions for 100s of meters of stream buffer, to plant willows and cottonwoods along every tributary that's fish bearing. We don't even know what our rivers produced historically because we wiped out the fish populations before we counted them. People say we don't have historical evidence of some creeks/rivers having much salmon, but you'd have to be a nutcase to think many of those watersheds with their fabulous estuaries weren't productive. There's a problem with distinguishing between what could be there, what was there, and what is there now.
- Edward Nichol is starting a project similar to yours with respect to hazard, risk, and vulnerability data in Metro Vancouver. That project may evolve into a mapping exercise, overlaying multiple hazards. One map will likely include the SEI.

### 6.2 Watershed mapping & analysis

#### 6.2.1 Standardization & data availability

- [KC: would it be useful to have, a standardized/accepted watershed model that local governments could apply in in our area?]. It makes sense, but most of the land is owned and managed by forestry companies and they don't share their data. So it's really difficult to get the quantity and quality of data that you need to do sophisticated modeling. Without that data you're going to have to fall back on some basic parameters, and default to the same old ways of doing watershed modelling.

## 6.2.2 Watershed boundaries

- *[KC: Because we're interested in watershed resilience and hydrology, and because it seems to be a fast emerging concern for local government, we're wondering whether we should be setting our project boundaries to the tops of the watersheds rather than cutting them off at the BEC subzone boundaries.]* I agree, and you're probably dealing with Crown Land as well, so it's not just in the areas administered by the municipalities, its outside the BEC zone and its elevation based, so you might want to use the watershed boundaries. You might need a little hybrid.
- *[KC: I've had the suggestion to use the Georgia Basin].* We've used the Georgia basin for the Georgia Basin Action Plan in the past, but even then it was a hybrid of administrative boundaries as well as watersheds. The purists in your group might prefer to go with just watersheds.
- Do you want that old Georgia Basin Polygon layer? I think you might need to look at plain old watersheds. Its very obvious the CDF/CWHxm BEC subzones end – we could also capture the watersheds by going up the slope to the height of land.
- The National Wetland Inventory will cover your whole area, but it might not get that height of land at the tops of the watersheds. *[KC: That's too bad, because in my area, for example, where they've logged out most of the lower elevation old growth, the forestry companies are now targeting 1-2000 year old ancient forest for yellow cedar in the high elevation Mountain Hemlock zone, in the headwaters of our watersheds, which are full of small wetlands, cirques etc.; I've been told by some experts that these areas are some of the last places you'd want to log under climate change scenarios because of the effect it will have on stream flows]* You've just made a really strong compelling argument for mapping to the height of land.
- *[KC: I'm wondering if we should be pushing out our lowland study area boundaries to include the adjoining upper watersheds, e.g. to include the Georgia Basin. It doesn't seem to make sense to be looking at watershed or wildfire resilience without including these areas. Also, ecological communities will be migrating up in elevation as a result of climate change].* That's what Metro Vancouver Regional District did with their SEI mapping.

## 6.2.3 Using Lidar

- See **Section 10.2**

## 6.2.4 Provincial Watershed Analysis 2000/2001 (Malcolm Gray's work)

- Malcolm Gray, who's now retired from the provincial government, is particularly good at using remote imagery for landscape analysis. He did a Province wide analysis of Landsat, which is coarse, but he enhanced it with 5m black and white satellite photography. He created a set of watershed statistics, and provided estimates of percent logging and roads within 30m of mapped watercourses. The scale of the polygons for these statistics was third order TRIM (Terrain Resource Information Management), which is maybe a first order 1:50,000 base map. And with third order TRIM - even with first order TRIM – there are small connecting streams that can only be picked up on the ground.
- Malcolm did this watershed analysis province-wide in 2000 or 2001. The same methods were subsequently used on the west coast of Vancouver Island a few years later. Unsurprisingly the analysis results had a lot of pushback from the forest industry. The Forest Service didn't want people to know what percentage of watersheds have had logging within 30m of a stream. So what he eventually published had that dataset removed.
- Because of the forestry pushback, he sent the whole study and method to a couple of academic institutions in the United States for peer review. They validated his results. So I have a lot of confidence in it.
- The Community Mapping Network got the unsanitized version of Malcolm's work, and used it for one of our web analyses. It's found under Aquatic Information Partnership – AIP, the first project in our website gallery list (its under fish and watershed statistics). <https://cmnmaps.ca/AIP/>
- This data layer is province-wide so it takes a long time to load the third order watershed polygons. There are some attributes tied to a mouse-over pop-up window, but there's more. Those watershed

statistics are also in tabular form here. 2000 to 2004 is the vintage of the Landsat and Spot imagery that was used.

- Land Sat was the primary reference layer. But if you combine it with Spot, you can get more resolution even though it's still colorized. The image analysis he used was able to use higher resolution pixels with the colorization that comes from Landsat, but I don't know how it works.
- A while ago we had Malcolm do some pilot land cover mapping in one watershed in the Upper Fraser Valley (maybe the Chilliwack watershed?). I don't know where that information has gone, it might still be somewhere in our thousands of CMN layers. There's a whole host of statistical numbers that was used to make different layers, with colour theming for different sets of stats for particular third order watersheds.
- *[KC: This was done in 2001, but now that we have higher resolution satellite photography, could similar methodology be applied for an update? And could there be a way of automating updates?]* If your area of interest is the CDF/ Georgia basin, if you processed it in a similar way, you could have a higher resolution.
- Malcolm has decades of experience, and probably a lot of good advice. I think I found him on LinkedIn. I'm pretty sure he's retired, so he's probably interested in something like this.
- I'd contact Malcolm Gray – he's done this at so many different scales. Let me know if you contact him. It's good if you can get someone who's recently retired like Malcolm. You'll get a lot of insight that they couldn't necessarily provide when they were on staff.
- Provincial Priorities
- FLNRORD and MOE are beginning to realize watersheds in the urban landscape are important too – there are natural assets in these watersheds that are still working, and worth understanding better and making sensible decisions about. They've had a tendency to focus on undeveloped watersheds, because there are not a lot of gains in ecosystem values to be made in watersheds that are fully developed, and they don't have the time to do everything.

### 6.2.5 Georgia Basin Habitat Atlas

- There's a Georgia Basin Habitat Atlas that we built and maintained after Environment Canada abandoned the whole Georgian Basin initiative. The CDFPC study area actually follows much closer to the Georgia lowlands boundary used by Sensitive Ecosystem Inventory for their work in the 2000s. The Community Mapping Network already has many of the layers that you have expressed an interest in. <https://cmnmaps.ca/GBHA/>

### 6.2.6 Hydrologically sensitive areas & natural assets inventory

- CVCP will have another student look at the SEI polygons to add a layer/column to the attribute table showing the relative contribution to ecological services from the perspective of stormwater management or drinking water supply, for each of the SEI categories. Another student is going to add another new attribution column indicating the relative contribution of that SEI polygon to carbon sequestration, so we can do some better modeling that way. What we are always looking to do is stack values on the landscape.
- Municipal Natural Assets Inventory (MNAI) is very good at capturing the attention of counselors and asset managers at the city level, and those departments that are more operations and budget driven. So it would be helpful to talk more about hydrologically sensitive areas fulfilling some sort of function related to rainwater management and drainage, and how we can use nature to provide those services.
- *[KC: Would you be interested in mapping that identified hydrologically sensitive features, beyond the obvious riparian areas and wetlands, in upland forest, for example?]* Yes.
- The ecological assets that we're mapping are riparian areas, lakes, wetlands. Those are typically the functions that we're most involved with. There are others that are much more difficult to map, so don't necessarily get mapped, like snow cover and depth. Snow cover is a key natural asset to help managing water supply and watersheds, which you manipulate by not logging areas. So having Old Forest as a component would maybe be one way of getting at it. So these are the services that are of most interest.
- The analysis tells us the overall watershed condition, and the condition of the assets within it, like the condition of the forest overall. If it's pristine, change isn't required. But if it's impaired, we can we argue effectively to get money to buy parts of it that are hydrologically sensitive, and protect them or restore

them, to improve the overall asset quality. [KC: *what do you mean by 'hydrologically sensitive'?*]. The meaning of the term 'hydrologically sensitive' is still an emerging discussion. We can't buy or protect the whole watershed so we hone in on the parts that are most important. For example, we asked Mosaic to not log the slopes above the [water supply] lake again, and to leave large buffers around a tributary we believe is one of lake's main inputs (though we don't have data for it, because its located on PMFL). We're working with Mosaic because we're working towards a common vision and they have a lot more data than we do.

- Our MNAI project for Comox Lake watershed has recently been re-scoped. Now we're just doing it for Perseverance creek sub basin, as an example for the overall Comox Lake watershed. We have more data there, and it serves as two different water supply watersheds and it contributes to Comox Lake, the CVRD system, and also the Village of Cumberland. So there are two water supply systems coming from that one watershed. We're actively doing that right now and it will hopefully be completed in a couple of months. We looked at: What are the assets? What condition are the assets in? Those kinds of questions. We have mapping for riparian areas and wetlands, based on modeled data that Ecofish Research Limited pulled together for the Fish and Wildlife Compensation Program. So it's better I think than the TRIM or Freshwater Atlas data, which isn't bad, its just wrong in lots of things.
- They've been critical of the way we've done the riparian and wetland areas, because there are better ways to do it. [KC: *so how did you do it?*] The Fish and Wildlife Compensation Program fund conservation work in watersheds that contribute to their electrical generation system. One of the things that came out of the Puntledge River Action Plan was the need to protect riparian areas and wetlands to compensate for those that were inundated with the dam. So they wanted someone to tell them where all the category one and two wetland and riparian areas were in the watershed. Ecofish did that analysis. They came up with two categories: category 1= intact, category 2=likely degraded. They noted that the TRIM data for the watershed wasn't that hot. So they got a very detailed digital elevation model (I forgot where from) and used GIS analysis on cost distance algorithms to figure out where wetlands actually were in the watershed. Then they overlaid road layers and recent harvest layers, etc., to determine whether or not a wetland was likely degraded. Then they field verified a bunch, and produced a huge map. We borrowed that GIS data and said if it's a category 1 wetland its in high condition, if its category 2 its in low condition, and put nil for medium. Some people said that's not very sensitive, but it was the best we could do because Mosaic didn't want to publish their data, which would have allowed us to something more sensitive if we could have accessed it. So that's why we're using what we are.

## 6.3 Current watershed initiatives

### 6.3.1 Water Sustainability Partnership of BC

- When you're talking about Georgia Basin it made me think of the Water Sustainability Partnership for BC (WSP BC). You should connect with them. They're in their 20<sup>th</sup> year. In the 90s this non-profit funded by the Province, and now partly funded by local government, responded to a salmon crisis in the Georgia Basin by looking for upstream interventions, particularly in the local government context. They started by looking at what land-based activities were harming salmon, and it's now spun off into all these green infrastructure nature-based solutions projects.
- WSP BC have a whole regular set of communications that go out across the Georgia basin
- to local governments on how to advance nature-based solutions. They speak from the watershed scale and are focused on water. But they're also tying in biodiversity and culture.
- WSP BC is good at its recognizing who the power players are in different jurisdictions. E.g. in a local government, the chief administrative officer is a key figure needed to enable a city to partner on things – without senior staff support attempts at partnering will be hamstrung. So WSP work strategically at that network piece. I'll connect you and them.
- Look into the Partnership for Watershed Sustainability in BC. It's big and well-organized in the Vancouver Island and the South Coast area. Kim Stevens from Bowen Island is the chair. There's an ex Minister of Agriculture /biologist who is also very active in the organization, and they're interested in water conservation in all its forms. Ted Van deGuik, the president, would also be a good contact.



### 6.3.2 Watershed Strategic Fund

- There should be some new bridge funding available before the Watershed Strategic Fund is established through Watershed BC. They got another \$40 billion for the second year of bridging.

## 6.4 Hydrology

### 6.4.1 Flooding and water security are Intertwined

- Flooding and water security are intertwined. For example, in Cumberland we have four dams in a series for water supply, and they each have failed at some point in history. And when one fails, it wipes out the next one and wipes out next, putting the whole town at risk, because its downstream of it all.

### 6.4.2 Watercourse mapping

- I think the TRIM data was used as the basis for the freshwater atlas, with only the latter being publicly available. I don't know what they're doing with TRIM now, in terms of keeping it up to date.
- We've tried to establish pan-local government standards in some specific areas of interest. We just did a 1:5000 scale watercourse inventory of the true first order streams of the Fraser Valley. We also gathered together local government datasets that are quite variable and rolled them into a very simplified fish presence- absence for the Fraser Valley. Some of the data is old, some of its new, and we had a field crew ground-checking, because streams come and go. Agriculture takes out a lot of streams.
- The one thing that does have an influence on local government is information about water, creeks, fish, etc. Having good information about water, water flow, storm water management, etc. seems to be the one thing we can hang our hat on over here in the lower mainland.
- See **Section 10.2 on using Lidar for watercourse mapping.**

### 6.4.3 Watershed/hydrological modelling

- *[KC: We're talking about potentially identifying a best practices approach to watershed modeling on the south coast – apparently there is debate around this].* Indeed, 'watersheds' mean different things to different people. Another connection regarding watershed management is Metro Vancouver's Watershed Environmental Management group within the Water Services Department. They are planning to update their TEM analysis, possibly next year, within the Capilano, Seymour and Coquitlam watersheds. The TEM analysis for these watersheds is 30 years old, so I'm sure their updated TEM will capture a lot of tree growth in these pristine watersheds.
- With hydrology you'll get many different opinions. My opinion is that Younes Alila at UBC is correct. He has all kinds of models showing that classic hydrologists, particularly ones who worked for BC forestry, ignore most of the important information about stand age, and don't correctly calculate floods. His work shows that the history of logging in a watershed can have huge effect on stream flow, which we've seen with the severity of recent floods in BC. If you're asking about what hydrological models to use you could be mired in these professional battles around what the truth is. This is just a heads up to warn you, not saying you shouldn't do it. Many people who've been saying logging doesn't matter are trying to defend their reputations.
- Work being done in Oregon and Younes Alila's work are showing that people have dramatically underestimated the effects of forest removal on stream flows etc. So if you get into this issue, I think you have to think about assembling groups of experts, knowing some will have strong opinions, to find people who can provide input and ideas watershed models. The controversy will be around what model to apply to the terrain and what weather data to use.
- Younes Alila isn't always viewed well, partly because he comes on very strong and tells people they're doing things wrong and he's right. He's shown that people have dramatically underestimated the effects of forestry on flood hazard. And every time we have big floods the data shows he's right. So finally people are starting to say we've underestimated the effects of logging. But because the Chief Foresters approve those logging plans, the government won't admit it because it will set legal precedent if they do.



- In order to respond to local governments primary concern and support hydrological modeling, the modelers are going to need to look at interactions between surface and subsurface water flows, as well as vegetation cover, which requires looking at things at a watershed scale.
- A while ago, FORREX published an issue where a bunch of hydrologists compared all of the different watershed models that were out there. They did a literature review and decided which ones were the best for which application. So I'm leaning in on that document, and we're leaning towards a different model from the University of Switzerland, developed by a guy who I believe is now in BC. Its got much better inputs to the model, to capture things like infiltration, soils types, evapotranspiration for different types of trees, tree height, the things that actually matter.  
<https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.695.9840&rep=rep1&type=pdf>
- We're going to do watershed modeling. The village of Cumberland is interested in getting better at watershed management even though they don't own the land. They own about ¼ of the watershed, and the remainder is owned by Mosaic. It's a combination of private land and PMFL. The village has hired a company called Tetra Tech to do some work for them on their dams and their infrastructure, because there are four dams in series that are part of the village's drinking water distribution. Tetra Tech has used the Hec-HMS model (Hydrology Engineering Centre, division of the US Army Corps of Engineers). It's very basic when it comes to land cover – they blend everything down to one number on a curve. It's really insensitive and I think it's fraught with problems so it probably works from a dam engineering perspective, but from a watershed management and governance perspective it doesn't. When Ecofish were working with the Comox Valley Regional District on their water supply modeling they used another model called something Hec-Res, which the US Army Corp uses for reservoirs. I don't like that one either.
- So for the first run of the MNAI project we just defaulted to the same methods that were being done a decade ago. We've had others review it, like people from Aquatech and the Timberwest Forest hydrologist. They've all agreed this is probably the best we can do with the data we can easily get. And that's fine for this particular project.

#### 6.4.4 Flood mapping

- NGOs can have a lot of self-generated mapping info. In the Comox Valley, Project Watershed does a lot of that work. We often go to them for info! <https://projectwatershed.ca/maps/> .
- Floodplain mapping will be very important to your work, I expect. The Province has funding for local governments to conduct flood mapping, and may even be doing some mapping themselves – I'm not sure. Our Environmental Engineer likely knows. In the Comox Valley we now have publically available flood mapping. The GIS Regulatory flood mapping data prepared by the CVRD can be accessed here: <https://cvrd.maps.arcgis.com/apps/webappviewer/index.html?id=66ecab2d84c04195a4018096aa4ab9c8>
- Many regional districts/municipalities within the province have done their own floodplain mapping projects. For example:
  - Cowichian Valley Regional District: <https://www.cvrd.ca/DocumentCenter/View/100315/2021-04-21---Schedule-O---Floodplain-and-Dam-Maps>
  - Squamish: [https://squamish.ca/assets/IFHMP/1117/5dbb51bad9/20171031-FINAL\\_IFHMP\\_FinalReport-compressed.pdf](https://squamish.ca/assets/IFHMP/1117/5dbb51bad9/20171031-FINAL_IFHMP_FinalReport-compressed.pdf)
  - Province wide maps (Pre-1998, many do not account for climate change): <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/floodplain-maps-by-region>

#### 6.4.5 Storm water management

- We would do hydrological modeling for Integrated Storm Water Management Plans for our various watersheds and sub watersheds. Back in the mid 2000s, Metro Vancouver began requiring all municipalities to do integrated stormwater planning. It is not tied in with the Municipal Assets Inventory. Integrated stormwater management plans probably do talk about natural assets – they talk about natural features (e.g. how their modification could affect storm water, such as clearing a patch of forest), but storm water is the core, dealing with run-off and managing the landscape for run-off. So

there is a lot of ecological information captured in those plans. But these features are not thought of in terms of natural assets. Even the term – natural assets - is a recent thing.

- [KC: It seems local governments are more responsive to language around natural assets versus biodiversity] Exactly. Water flows off the key peak on Sumas Mountain down to an area called Clayburn watershed, and Clayburn is one of the areas that flooded out last fall.

## 6.5 Wetland inventory & mapping

### 6.5.1 Wetland mapping

- The [Nature Trust riparian] mapping also includes wetlands. We have a report describing the methodology. We had help from an intern through the BRITE Program, who was working with Peter Arcese - she was really good. She did a lot of work for us and she also worked on the Marxan and Prioritize R projects for the CDFCP and CRD. We used provincial data sets to get an idea of water associated ecosystem quality by including the stressors on water quality. She reviewed research literature to figure out what made sense to include. The assumptions about what we thought could affect the water values or riparian values are included in the report. The base layers identify where the riparian and wetlands are located, which is what we would make public on DataBC. The stressor data helps to identify how one wetland might have better water associated ecosystem quality than another, based on what is happening around it.
- Wetlands are a good example of a data gap– where are they, and how productive are they?
- Wetlands are another big problem. Surrey has a lot of very small, forested wetlands or areas that, if they're not connected to a watercourse, haven't been mapped in detail. We have SHIM mapping that was done a number of years ago, but it focuses on fish bearing watercourses. We do have a classification system where streams are mapped then classified based on whether they're fish bearing, provide food and nutrients, or are completely disconnected from fish bearing watercourses. But we essentially don't have many of our natural wetlands mapped.
- One of the core underpinnings of our biodiversity strategy, which was endorsed in 2014, is a static layer called the Green Infrastructure Network (GIN). Development applications that fall within the GIN trigger the sensitive ecosystem development permit area requirements. All watercourses would normally trigger some sort of review, because they're associated with Provincial and Federal legislation. But we don't have a good natural assets database for the upland terrestrial components, even those within the GIN. QEP reports are required for these areas prior to development, but there is often contention about ecological sensitivity, especially for isolated wetlands, there are often disputes as to whether or not they are actually wetlands. [KC: does your local government have a specific definition of what constitutes a wetland?]. I believe we at least use the RAPR and WSA definitions, and individually (some of us) use the standard North American classification system as well as whatever has been developed through the Province. We have an external professional reliance process for reviewing development applications, but we're not doing detailed peer review for every application anymore, or gatekeeping the sensitive ecosystem development process.
- In Surrey, we don't have any wetlands mapped, unless they are constructed detention ponds.

### 6.5.2 National Wetland Inventory

- CWS have TEM mapping for National Wildlife Areas on Vancouver Island and Wigeon Valley in the Lower Mainland. We're using it as an example for this crazy crosswalk table. We have someone doing a deep dive on this, and she has a student helping her, at least for the wetland site series, and translating them into the Canadian Wetland Classification system. [KC: was there a plan to also include the wetland ecological communities at risk in the crosswalk table?]. No we weren't planning to. However, we are working with the Provincial staff and I know they have an interest in that.
- CWS is involved in a National Wetland Inventory, which is another nature-based climate solutions program, and we've elevated your project area as a priority area for this National Wetland Inventory. We don't have anything for you yet, but we're working on it and it's coming. It's state of the art. It's got its own funding. We may have all wetlands mapped, or some progress towards that, within your three year window. But, it will be the Canadian categories: bog, fen, swamp, marsh.

- The plan is to mine the TEM data to help with the training the satellites for their mapping, and they've now have a pretty good procedure for doing that. But the TEM data needs to be crosswalked to the Canadian Wetland classification system, and even crosswalking the TEM data to the provincial Wetland classification system is a pain.
- If we use Sentinel 2 it will be at 10 metre pixels, and the question is whether that is good enough for local governments. There might be some areas where we'll pay for imagery from a private satellite and do it at a finer scale like 3 metre pixels. CWS is exploring some options, as is MetroVan Regional District. There might be some solutions over this three-year period that cover off the wetland piece, or MetroVan might figure out with Nick Coops how to do this for more than just wetlands. But we don't have the answers right now. But I think within your three-year plan it should be possible to see how these things play out.
- With the National Wetland inventory we're going to do change analysis as well, so it's not just an inventory. We are looking into how to do that, possibly using LiDar as well, but we're at an early stage.
- *[KC: Are you aware of the National Wetland Inventory that's being undertaken by CWS? Its meant to be completed in about 3 years.]* Yes, somebody told me about it recently. But in three years isn't useful considering the amount of development pressure that we have.

### 6.5.3 Wetland definitions

- *[KC: does your local government have a specific definition of what constitutes a wetland?]* I believe we at least use the RAPR and WSA definitions, and individually (some of us) use the standard North American classification system as well as whatever has been developed through the Province. We have an external professional reliance process for reviewing development applications, but we're not doing detailed peer review for every application anymore, or gatekeeping the sensitive ecosystem development process.

## 6.6 Riparian areas

### 6.6.1 Riparian area mapping

- *[KC: Are there any other glaring mapping gaps, in your opinion?]* Yes, riparian areas.
- The Nature Trust of BC developed a riparian mapping layer based on the freshwater stream atlas. We used slope along the stream corridor to model what would realistically be considered as riparian. So on steeper slopes the riparian area was determined to be narrower, and wider in flatter areas. The data was summarized to 20m resolution rasters, but I don't know what the original mapping scale was for input datasets. For our purposes, we needed to know what you would call riparian area around a stream, and simply putting a 30m buffer around streams was not useful. So we used this modeling approach to try and more realistically identify likely extents of riparian areas.
- It hasn't been ground-truthed, but it seemed to be acceptable to the people that are part of the Habitat Joint Venture system: DUC, CWS, NCC, etc. We spot-checked it with the SEI where SEI was available, but there are no stats available to indicate how well they matched up. We're using it to help identify property ecological value. Riparian areas are one of the values that we look for, and if a property contains riparian habitat it scores higher than one which doesn't. We intended to put the data on the DataBC website, but I'm not sure how far we've gone in that process. It is publicly available, but right now it resides with The Nature Trust. I'm happy to share the data with you.
- *[KC: Do you know if any local governments have used it?]* I have let CDFCP partners know about it but I don't think anyone has requested the data.
- A new map layer showing topographically defined riparian areas for BC has been developed by CWS and The Nature Trust, working through the Joint Ventures. It's topographically defined using the Digital Elevation Model, and it's at regional scale. You can get it from TNT.
- For this layer you need to spell out that the riparian zone is topographically defined, so it's distinguished from riparian zone as defined by the Riparian Area Regulation (RAR), because there are legal implications around the RAR, where every centimeter makes a difference. This mapping doesn't say if a property is subject to RAR, and is not a tool applying RAR on legal parcels at the local government level.

- It's a regional scale map showing topographically defined riparian zones. The Joint Venture partners are quite comfortable using this layer to help guide our conservation planning. *[KC: Have you compared it to riparian areas shown in the SEI mapping?]* No we haven't got to that stage.

### 6.6.2 Riparian setbacks

- Many local governments like RAR because that's all they are required to deal with by the Provincial government. However, progressive local governments are exceeding the requirements of RAR regulations in many of their land development decisions.
- Developers are also pushing back on the 30m setback we're proposing on all streams. One reason we're asking for that is we get a little bit extra CHWxm forest ecosystem adjacent to a stream feature that is already protected under the Riparian Area Regulation. Under the RAPR a QEP can spit out a number for a setback. We're saying we want 30m if there's greenfield development. The development community has responded by saying that 'a blanket policy' that doesn't consider site features is detrimental, and suggesting the City shouldn't define 30m setbacks without a biologist being on site. So they feel that the City is overstepping. They're questioning the basis City staff have to extend setbacks beyond SPEAs prescribed by environmental professionals through the RAPR system. So there's a very strong reluctance, and particularly articulated concerns around local governments trying to do anything beyond minimum standards.

### 6.7 Water quality (out of scope for this project)

- *[KC: Is Metro Van interested in the hydrology/watershed mapping side of things?]* Water quality is one of the indicators that UBC (Sarah Gergel and students) investigated a few years ago using local water quality data and imperviousness mapping base on the regional land cover classification dataset. It was a very academic exercise. UBC has published several journal articles, including this [recent paper](#).
- There is a pacific region initiative starting up. I think it's called the Collaborative Monitoring Initiative. Their focus is on assembling surface water and groundwater quality monitoring results from various initiatives into an open data portal. They're setting up partnerships with gazillions of contributors, and they've done the Mackenzie Delta and other provinces in Canada, so it's a country wide initiative. They're developing the database design for the Pacific region. Generally they're focused on surface flows now, but they are interested in groundwater quality as well.
- The Raincoast Foundation has a new program and a new director who is focusing on the water quality of surface flow as it pertains to human health, but there's a whole watershed sustainability component as well. The focus is on long term monitoring.
- Salish Sea Marine Emissions Tool - <https://ssme-eems.ca/b> A real-time public map, administered by the Government of Canada, of ships in the Salish Sea and their emissions over the year, as well as other data related to boat emissions.

## 7 WILDFIRE RESILIENCE

### 7.1 BC Forest Service fire risk mapping coverage is incomplete for study area

- We'll also have a student look at the climate adaptation and mitigation side of things, particularly around forest fire risk. I haven't yet selected that candidate yet, and I would want a collaborative approach. I don't have much detail around how we're going to do it right now, but in a few months we'll have more to say about it. Part of the thinking is that BC Forest Service publishes these fire risk maps that are quite detailed, quite brilliant, for the whole province. Except for here, because it's the Private Managed Forest Land Reserve— they don't want to touch it. So that doesn't help us in our community I think it probably doesn't help anyone in the CDFmm, because that seems to be the area that's never mapped.
- <https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/vegetation-and-fuel-management/fire-fuel-management/wui-risk-class-maps/wui-downloads>

## 7.2 Ecological restoration for wildfire resilience requires complex analysis of multiple data sets

- In general, the issue of data gaps for our ecological and restoration work *[related to wildfire resilience]* lies with the need to piece together what has happened in the past (land use and cover change), including logging information/records of harvested wood, and changes to wetlands through roads and drainage. These require photographic imagery, including historic records by watershed. Similarly, we need historic weather/climate records by day, and downscaled, validated, climate model projection data. It is impossibly complicated and costly for individual municipalities and researchers to do, and when they do it, it is not public and could require a team to recreate analysis that has already been done. So, what we need is some form of time series records for the following information:
  - archival aerial imagery (historic, annual)
  - logging inventories, site descriptions and maps of cut blocks
  - Lidar data (biannual) raw and/or processed at regular intervals and different seasons
  - hydrological, soil and bedrock (geology) data
  - roads, culverting, diversions, and other such data
  - historic weather station data calibrated to watershed scale (hourly)
  - downscaled, validated climate projection weather data (hourly)
  - satellite and forest cover imagery (annual or biannual)
  - detailed geological map/inventories
  - hydrologic maps showing drainage basins and surface features
  - somewhere to get and share ecological and taxonomic information as people are collecting it - to increase data sharing.

## 7.3 Metro Vancouver hazard and risk analysis

- Edward Nichol is starting a project similar to yours with respect to hazard, risk, and vulnerability data in Metro Vancouver. That project may evolve into a mapping exercise, overlaying multiple hazards. One map will likely include the SEI.

## 7.4 Bowen Island Mapping

- I live on Bowen Island. It's a municipal government that is investing in new natural resource mapping. It's a good thing and I'm surprised they're doing it. They don't have to worry about adjacent land use because it's an island, but at least they're thinking ahead. So now they'll have more information to base decisions on. They're looking at wildfire, but focusing on wetland and groundwater resources. I think they're worrying about long term water supply issues. There's a good chunk of harvestable Crown forest on the island that's not currently allocated, but it was two years ago. This caused a community uproar and BC Timber Sales backed off for a while, but they're coming back. I think the local government is thinking ahead about that.

# 8 NATURAL ASSETS

## 8.1 Ecological services

- Up here our local governments are really interested in ecological services these days. We call them natural assets or natural asset management programs. The Comox Valley Conservation Partnership has a bunch of pilots going with the Municipal Natural Assets Initiative, really focusing in on ecological services. The ones that the local governments here are the most interested in are associated with the services that they have to provide their citizens. So drinking water, primarily, and storm water



management, which we are now normally calling rainwater management. But some people get thrown off by that term.

- Those are functions that local governments are required to provide. So those are the services that we have found them to be the most interested in, and are paying money to help us protect, not from parks budgets, but from actual water services budgets and things like that, which have much deeper pockets. So, from a conservation perspective, these are very high leverage opportunities.
- Local government is interested in protecting natural assets for ecological services, such as drinking water, and all the pieces that affect it are high interest to them, including the Comox Valley Regional District, who manages the whole lake.

## 8.2 Natural asset mapping/inventory

- That Natural Asset Inventory is the first step in doing a natural asset management plan. Local governments have typically done asset management planning for engineered assets, but its only recently becoming popular to do them for natural assets, to treat them on par as an investment, the same way we would treat capital projects and engineered assets. But you can't do natural asset management planning without knowing what natural assets you have.
- For more on carbon mapping see **Section 5.1**
- For more on mapping/modeling watershed/hydrology based natural assets see **Section 6.**

## 8.3 Natural asset valuation

- *[Response to KC's summary of the CDFCP Nature Smart project and the thinking behind it, and how it's a bit pie in the sky].* That would be great – its what's needed right now in this region. There are a lot of development pressures and we're about to lose some ecologically sensitive areas to development. Biodiversity and species at risk aren't enough to stop it. Development plans try and make everyone happy but they don't make anyone happy. With the fall flooding and Sumas Lake coming back, we're trying to think of how we can leverage this event to explain how taking out all these trees, these natural assets, can lead to a world of hurt. But costing these natural assets is a really good tool, so even though its pie in the sky, your timing on this great.
- *[KC: The Ministry of Environment economics unit is part of this CDFCP Nature Smart project. They were hoping to begin developing ecosystem service valuations for different ecosystem types. And the Comox Valley folks are looking to hire summer student to add columns to their SEI attribute tables, which provide some sort of valuation for carbon storage potential and other ecosystem services.]* If you're going to be doing that mapping in the first place, there are so many methods and modeling that could be applied as an extra calculation in an additional column in the attribute table.

## 8.4 Integration with forest management & Old Growth Strategic Review

- If the Old Growth Strategy community consultation takes place to work out how we're going to manage forest on Crown Lands for more values, we should really be identifying areas that are important for carbon storage and watershed and wildfire resilience. Identifying where these areas are should feed into decision-making about where we should be leaving and recruiting old and mature forest on the landscape. It would be a lost opportunity to do all this planning for the Old Growth Strategy without considering these other categories of ecosystem services as well, especially for the local governments who are trying to service their communities and manage climate impacts lower down on the landscape, at the bases of watersheds.
- And *[with respect to natural assets]* don't forget some of that old forest is on private land, so you're not just dealing with Crown land but private land and Private Managed Forest Land as well.

## 8.5 Connection to biodiversity/species at risk

- I think local governments are onboard with the concept of natural capital assets, and it's finally coming into their discussions and planning. So we do need to show the overlap between biodiversity and natural

assets. But I think by focusing on the messaging as being natural capital assets and not complicating it too much with other values, like biodiversity, it may be easier to absorb into local government planning. If we do some of the front end work and provide the natural capital assets mapping, that also includes biodiversity values, then we can go back to them and say 'here are the areas that are not only high in natural capital asset value, but these other biodiversity values are there as well, which can allow you to source other funding, etc.'. The less complicated we make it for local governments the better.

- *[KC: Biodiversity can be a hard sell. Would it be helpful if there was more focus on conveying how these ecosystems important from the perspective of carbon storage, hydrological sensitivity, and cultural significance?]* Yes. The MNAI is very good at capturing the attention of counselors and asset managers at the city level, and those departments that are more operations and budget driven. So it would be helpful to talk more about hydrologically sensitive areas fulfilling some sort of function related to rainwater management and drainage, and how we can use nature to provide those services.
- As much as I find it unpalatable I think for the average person, arguments around the services ecosystems provide in terms of mitigating temperature, managing water supply etc. are way more effective than talking about all these species at risk. It's also important to connect sustainably managed forest with long term logging jobs.
- But even with the natural assets arguments, and even with last couple of years of extreme weather, I worry that it's still too far in the future and too intangible for people to really truly get it. But that's the best we can do.
- *[KC: so I think it makes a lot of sense to be highlighting where the important areas are on the landscape for water security, wildfire resilience and increasingly carbon mitigation. Biodiversity seems to always be of lesser interest].* Yes, I agree that biodiversity is often of lower interest, and it's definitely worth highlighting those other ecosystem services. But some of those areas host species at risk or potential species of risk and that's a powerful tool.
- *[KC: Do you have any thoughts on the effectiveness of the standard biodiversity argument versus natural assets argument, in terms of getting traction with local governments?]* I would say both. Municipal Natural Assets Initiative did have an initiative last year, focusing on connecting the dots between species at risk and natural asset management. I don't know if any local governments here took them up on the offer. There are many efforts underway around the ecosystem goods and services or nature-based solutions, modeling aspect of things. We talk about it quite a bit in our integrated storm water management plans. We do talk about the important services that all of these ecological components provide for us in terms of flood, air, water provisioning, etc.
- *[KC: The biodiversity argument, in my experience, is a hard sell; hopefully it will be made easier by couching it in terms of the importance of ecosystems for climate change mitigation and adaptation.]* Yes, I found the same thing.

## 9 CUMULATIVE EFFECTS

- Cumulative effects are a data gap.
- Are you aware that the provincial government is focusing on cumulative effects assessments within fairly large watersheds - they've done all of Howe Sound. They're working on some other dashboard views of landscape habitat characteristics that you can use for cumulative effects assessment in the Fraser Valley. The Surrey office of resource stewardship is probably the location where that work will continue. <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework/regional-assessments/south-coast/howe-sound-cumulative-effects-project>
- *[KC: from what I've the Province's cumulative effects framework is largely focused on road density, riparian disturbance, stand age, etc, but their biodiversity/at risk ecosystems piece seems limited, there's no carbon storage component, and limited aspects relating to watershed and wildfire resilience. This seems to be something that's missing within forestry/provincial watershed planning processes].* It should be included. It's no surprise that there are carbon impacts and mega fire impacts coming up, and why the Ministry has not been doing what you're suggesting five plus years ago is beyond me.
- The cumulative effects project in Howe Sound is a view into something bigger that the Province is building – a Stewardship Biological Objectives tool. They're trying to categorize landscapes in a way that

they can see trends over time. <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/resource-stewardship-tools/sbot>

## 10 NEW TECHNOLOGIES

### 10.1 Technology rabbit holes

- There are tremendous opportunities right now to produce good products, but I'm worried about going down rabbit holes of technology, instead of having the patience to wait for someone else to work out the kinks.

### 10.2 Lidar

- Another question is whether you should do Lidar everywhere, or just apply it to those portfolios of priority place, to help you sort out things in more detail. However, if somebody's going to deliver you a unified sheet of Lidar for the whole area, then just say yes.
- You referenced various agencies doing Lidar mapping. They capture imagery at the same time as they're flying the Lidar - combined, they're much more powerful. For the most part, what you need is the imagery. The Lidar is good for drainage and digital elevation models and the shape of the landscape. But habitats are best described by the imagery, the color spectrum and their location.
- In terms of gap analysis, I don't think that Lidar is the answer to your questions. It's often the imagery that they gather while shooting Lidar that's most valuable.
- You need a method saying what you do when you have Lidar data, and another saying what you do when you don't. And not all Lidar is the same. It's a point density thing, and it might be good for one purpose but not another. Also, you can shoot Lidar from a drone. But if you're doing a bigger area then you should just use a plane.
- Even Lidar can be a misleading indicator of what's on the ground. For example, it might pick up Beacon Hill Park as a priority, because it misses that Beacon Hill is full of invasive weeds and you're never going to get that place back no matter how much management you do.
- Do you have the latest Lidar maps from the Province? We just got the Fraser Valley Layer, which I've been trying to figure out how to use with QGIS. It's new and looks great.
- Updating mapping data is a challenge and each of the may not be aligned temporally. It would be helpful to have region-wide Lidar. Hopefully soon.

#### 10.2.1 Cost & availability

- The Province has all this free Lidar data now, but I don't know if there's 100% coverage for your area. I'm pretty sure Metro Vancouver and Fraser Valley have good Lidar coverage, because there was a Federal-Provincial flood program that paid for that Lidar to be shot. But if you're going to the height of land of the Georgia Basin it may not be covered.
- It would be great if the Province flew Lidar across jurisdictional boundaries, because it's expensive. Its been estimated at \$20,000 estimated for us to do it.
- But the province flies Lidar at certain scales over certain areas. There's a web interface where you can see what they have and the coverage isn't bad. But unfortunately it doesn't cover the Comox Valley, like everything else, like TEM mapping etc, because we're not in the CDF BEC zone, we're in the CWHxm, so we don't have any of that stuff, which is a real bummer.
- Lidar BC Portal:  
<https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=d06b37979b0c4709b7fcf2a1ed458e03>
- Someone needs to look at the Lidar data that's available from the province for your study area to see what coverage there is, and then find out what the point density is. Its a matter discussing with somebody who knows Lidar, to help determine if the point density of the available data is adequate for

what you're wanting to do. You can document when it was shot, and what the point density is. But the bigger question is whether its suitable for what you want to do with it? How are you going to use it?

### 10.2.2 Forest structure & relief

- Lidar products such as the Bare Earth DEM, and vegetation Canopy Height Model (CHM) provide a wealth of information, even more can be dug out of the Lidar Point Cloud data. Repeat Lidar surveys at 5 or 10 year intervals would give a very clear picture of land cover and forest structure change. It would be wonderful if LidarBC provided CHM in addition to the DEM and DSM, for all their data areas.
- Lidar is capable of deriving information about the forest canopy (e.g. tree size), but I don't know how you actually analyze the point cloud data. My experience with it has mostly been on landscapes lacking tree canopy - marshlands, agricultural lands, etc.
- The National Wetland inventory is supposed to help with the carbon offset accounting, so we've been having discussions about the classes we are mapping and what else they need to know – they mentioned whether or not there are trees in the wetlands, for example. So we're trying work out what else they need and whether these things are can be mapped. This is where Lidar would be very helpful, because it can show the top of the canopy and the bare earth. But if you don't have Lidar data what can you do?
- Lidar is useful for elevations, capturing relief (buildings, heights of forests, composition, density etc.). We used Lidar for our Urban Forest Strategy.
- *[KC: With respect to land cover, do you know if Lidar could be trained to identify sensitive ecosystems? Calculate carbon storage? Would it have any more value than the carbon mapping that's already been done:?] It might be that the Lidar tells you about the structural complexity of an area. I just don't have enough background to say. We need to talk to someone actually knows what they're talking about. Talking to Metro Vancouver would be a good starting point, because its in your study area, and because you've got the same issues. Their contract with UBC is sorting out the Lidar part of things, and they might come up with some results from that that can help guide you.*
- Using LiDar we can look at individual trees, shrub cover, etc. It can be used to pick up big trees.

### 10.2.3 Watercourses & drainage

- When we did our fine scale stream mapping in the Fraser Valley, we looked at using the recently available Lidar to try and pick out watercourses missed in previous mapping. These were ground-truthed to see if they were actually still drainages. We found Lidar wasn't that useful. When you get in flat agricultural areas, you don't know from the Lidar whether you're looking at a road or a ditch. However, as soon as you get some topography with elevation changes on the order of many meters, the Lidar can finally define the ravines and the drainage patterns in ways that are helpful. But again, it depends on what part of the Lidar they're using, because Lidar can reflect different levels of vegetation as well (e.g. identify a significant shrub layer underneath a tree canopy, if it can get through – Lidar is visual light not radar).
- *[KC: So does all this high quality satellite imagery mean you don't need to go out and fly the area again for Lidar?]. Yes, if you're not worried about ravines and watercourse mapping and the shape of the landscape, and just want to see land cover, which is primarily what reflects the ecosystem values. But for watercourses and topography, Lidar is really useful– it provides useful fine scale detail, until you get into the flatlands, like the Fraser Valley or wide open parts of the Comox Valley. Then it's gumboot time if you want to identify watercourses in detail.*

## 10.3 Remote sensing/satellite imagery

### 10.3.1 Satellite vs orthophotos

- *[KC: Is Google Earth or other relatively recent satellite imagery sufficient?] Yes, its pretty good scale, but you get a kind of a dumbed down image. So it depends whether you're interpreting it or not. If you were doing analysis, you'd probably want to get the source data from the provider. Google is really good at getting imagery for free from whoever buys it or pays for it, within a year or two.*
- According to our colleagues in Ottawa some crazy satellites will be going up in the next couple of years which will provide really valuable data, a lot which will be collected for free (although some of its private



and you'll have to pay for it). There are more and more countries putting up satellites that are cranking out free data. And that's huge, because it was always the impediment in the past.

- I'm a fan of the satellite thing. But I'm still a fan old school of orthophotos, which are basically air photos. More and more of those are on Google Earth. But it's important to make a distinction between Google Earth coverage which has ortho photos, versus its coverage in more remote areas, where it's all satellite imagery. Google Earth have historical imagery as well, especially in urban areas. They'll often have orthophotos back to the 2000s or late to mid nineties, when the orthos started becoming available.
- Yes, hi-res imagery can be used to enhance other data sources like Sentinel-2: [Super-Resolution on Sentinel-2 Imagery](#). Not something I have tried to do. I haven't seen a toolkit for it. You need a remote sensing specialist on your team.

### 10.3.2 Resolution

- Today's satellite imagery is so much finer, if you can afford to purchase it. It's really good stuff. *[KC: How does it compare to the aerial imagery?]* I think it's getting closer. I've seen 1 or 2m pixels, whereas it used to be 5 and 10. Maybe some of it's even better now, but of course you'll pay more for it. And the finer the resolution, the narrower the path of image collection and the greater the volume of data gathered, so the cost goes up and up.
- Sentinel-2 with its small pixel size and high revisit time offers so much potential. One excellent QGIS tool for remote sensing data training is the [Semi-Automatic Classification Plugin](#).
- [Sentinel-3](#) was launched to measure sea and land surface temperature for environmental monitoring and climate monitoring. It will be interesting to see if its data is applicable to our projects.

### 10.3.3 Updating layers & tracking change

- *[KC: We're interested in ways of updating data layers, with an eye on opportunities for getting better resolution, better quality data in the future. Making the jump to automated ways of updating data would be amazing, so we're not constantly dealing with the issue of out of date spatial data].* Exactly. The challenge in the past was that they had to buy the landsat imagery at \$2,000 to \$3,000 a scene, and that's in dollars for those years. And then you had to process it, and it was hugely expensive. That's why we've had these static products for such a long period of time. But now, with the satellite imagery coming in regularly and being free, it is possible to create more up to date products faster, that are very credible.
- *[KC: you're talking about mining the TEM to train algorithms to come up with different wetland categories. Would it be possible to do something similar, using free satellite imagery and some kind of algorithm to track changes in the SEI and TEM polygons, to come up with an automated way of updating them? This would also be useful for tracking tree canopy coverage for the Urban Forest Strategies and carbon mitigation.]* Metro Van Regional District has exactly the same interest and they are looking for a cheap, fast, and accurate way of updating their SEI and land cover mapping. So they've engaged Nicholas Coops at UBC to explore the possibility of developing an automated way of updating the data, and to track changes into the future. Resolution is the issue. Sentinel 2 satellite is free, and its resolution is 10-metre pixels. It's similar to LandSat, which is 30-metre pixels – that's what CEC and NRCAN use right now. It goes over Vancouver every five days. *[KC: does it cover the whole CDFCP area?]* Oh yes. So that's what CWS is planning on using for the National Wetland Inventory – Sentinel 2 along with some other data sets. Nick is looking at this versus acquiring some private satellites, which are 3-metre pixels, for Metro Van. Because we're in the middle of looking at this, we don't have a solution yet. We want an automated way of doing change analysis so we don't have to go through hell every time we do it.
- *[KC: I understand Metro Van is working with Nicholas Coop at UBC on updating spatial data with new automated technologies].* Yes, exploration of automation is included in the scope for the land cover classification and SEI update project.
- Our consultant (Caslys) is investigating options for new multi-spectral satellite imagery because Rapid-eye is no longer available. Planet may be an option. It may not get us to 2m resolution, but will hopefully get us to 5m. Lidar data is patchy across the region. Caslys will try to do what they can to automate the process so it's easier and cheaper to update in the future.



- *[KC: What about trying to develop an automated process for updating the TEM and SEI, based on satellite imagery, by removing the pieces that have been converted, and then calculating ecosystem conversion rates from that as well?]* We did that for the Islands Trust years ago. In 2017 Madrone compared 2014 imagery with 2004 imagery. But they didn't feel very confident with it, and I don't remember why.
- *[KC: what about the possibility of applying automated methods to something like Google time series to come up with a relatively easy way to track ecosystem conversion rates over time?]* You're dealing with different resolutions, so it would be difficult. You'd probably have to default to the poorest resolution you have for the older inventory. I think it's better to use polygon mapping that was done at a scale that you could define, because the metadata that was done by the province is pretty solid. Then look at those same areas in a more recent inventory. That's how CWS did wetland change in the Fraser Valley. They looked at older imagery that was turned into vector and then compared it to new imagery, re-interpreting it.
- Some Google imagery is 2018 - at the bottom of Google or Bing you can usually see the date of the imagery. Sometimes it's not the right date, because they might generalize the date for an area. Google Earth's time series images are useful.
- *[KC: Do you have any ideas or thoughts around applying automated methods and high resolution imagery as a means of developing new mapping or updating and improving existing mapping, to improve its resolution and accuracy, etc.? Particularly the SEI, which seems to be the layer favoured by many local government. ]* I know there are lessons to be learned from revisiting the SEI on Vancouver Island, by showing where areas of critical importance have since been developed. It's really important to have that information so that we can create public accountability.
- I'm not a purist - whatever tools work: automated methods, machine learning tools and hyperspectral analysis, etc. Whatever helps reach the desired outcome. If it's remote sensing analysis and then you have to do some ground truthing to train it. I was looking at hyperspectral analysis back in the early 2000s, to help develop wall-to-wall biodiversity mapping in Metro Vancouver which eventually led to the SEI. It was so cost prohibitive that no local governments would have bought into it. But with the tools available today, like open source software, there are so many opportunities that could be tapped.

#### 10.3.4 Manual updating vs. automated remote sensing methods

- I question whether an automated big data computerized approach using really high resolution satellite photos would actually do a better job at mapping ecosystems than expert ecologists with lots of field experience using stereograph 3D imagery. Because those ecosystem mappers really knew their shit back in that day and age. It was a golden era where people like Ted Lea were really good at what they were doing, especially given the scale of the task. There's not a whole lot of people like that walking/working on earth anymore.
- CWS is trying a manual updating approach in the Okanagan. We hired a co-op student and had him photo-interp Google Earth images to create a bunch of polygons. We've been trying different approaches with this, but landed on identifying areas that have gone from natural to non-natural. So we're not interested in going from one kind of agriculture to another. We're only interested in natural vs. non-natural, although it can be hard to distinguish between low intensity agriculture and natural vegetation in the Okanagan lowlands. So it's an alternative to the automated approach Nicholas Coops is looking at.
- We've figured out the key thing is having a good guide with good images, to help classify different features, whether they are natural or non-natural. Our student is using Google Earth because Environment Canada doesn't have a subscription to access the latest imagery. He jumps back and forth between Arc Pro and Google Earth, doing his photo interpretation in Google Earth, and then moving the .kml file into Arc Pro to define the polygons. But it's doable. The vintage of the image you're looking at is shown in Google Earth, plus or minus a year or so. We'll have a report out on the guide and some statistics soon. We've been refining the methodology and we've learned a lot. So I think it's doable with a student or two following a good guide, because then you're using orthophotos in Google Earth and you can get much smaller polygons.
- *[KC: how does this compare to automated approach?]* If you go with an automated approach using satellite images, you still have to train the algorithm to interpret the imagery. But if you have a human being who's got some training to search the images for these kinds of places, instead of satellite

imagery they can use Google Earth, which has higher resolution up to date orthophotos for many areas, with 20 cm pixels. The students then do their photo interpretation – it's old school, but it gets the job done. I had another set of students at UBC do a comparison of manual method versus automated methods. They said that if you have the time, the manual methods give you that finer resolution in polygon sizes. I could send you the report. For quality control you could have students with oversight by an experienced ecologist.

## 10.4 Cloud Processing & Engines

- Make sure to distinguish between Google Earth and Google Earth Engine. Google Earth Engine is contained cloud processing, with 40 years of landsat images; they're even putting sentinel images in there. Google Earth Engine cloud processing and other pre-made analytical tools can be used to spit out land cover change, etc.
- Having free satellite imagery, and then having these cloud processing systems which suck in that imagery, and have pre-made processes that produce stuff. That's the way things are going. Cloud storage and cloud processing with these Google Earth engine type things, and there are other ones being created, offer a lot of opportunity for people to get products that they need. Nick Coops at UBC has a good sense of what is coming down the pipe.
- *[KC: There was mention of another organization out of lower mainland called SAFE, who host something called FME – Feature Mapping Engine].* It's a kind of a utility. All these new engines have become a thing in the last couple of years; there's Google Earth Engine and Amazon is also going to do one. Basically they put landsat images in a cloud-based system, and bundle typical satellite image analysis processes. You just press a button and it does an analysis. They're trying to make satellite imagery and analysis easier for people to use.
- These are pre-made processes, which is why you'll see a lot of global land change analyses that mention Google Earth Engine, because they can do thousands of satellite image analysis in a split second, because they're using cloud processing.
- My remote sensing colleagues are familiar with Google Earth Engine (GEE) and recognize it has value but more advanced analysis needs to be done outside of GEE. There are a lot of these engines that are producing land cover change analyses. But the question is how good it would be for our area? We've seen various authors and groups produce products and they'll have an accuracy rate of say 85%, for example. But when you look just at our area the accuracy sucks because they didn't have enough training data for our area, so the 15% inaccuracy is largely concentrated in our area. So you need to be really careful about products that others are producing.
- BC is very complicated land cover-wise, and the bottom line is garbage in, garbage out. You need to have a lot of field data for that training, and then you'll get fabulous results. And that's what we're aiming for with the National Wetland Inventory. We're working with the BC Wildlife Federation and dispersing armies of people to collect field data, which goes in and produces a wonderful result.
- There is a lot of support and free software for NGOs through a company called SAFE in Surrey, which does data format migration. Their business focus is taking geospatial/attribute data in one format and manipulating it, analyzing it, or just transferring it to another useable format. They have a product called Feature Mapping Engine or FME. Their business model is to allow people to use the engine without being coders. You work with visuals and set parameters in pick lists. It's still very technical. But they seem to bend over backwards to help new and interesting projects and challenges. They claim to currently support about 400 different data formats, and they probably have the lion's share of the global market for this. It's quite an amazing company. They do all their training and marketing education virtually through webinars. They're also getting into augmented reality stuff. Google them - you'll discover a universe of information about it.
- We've done SHIM inventory for years, Sensitive Habitat Inventory Mapping. Its 1:5,000 fish habitat mapping, so small streams. It's done with gumboots, GPS, tape measure and a camera. Surrey has done a lot of it, because they really like the method, and it serves their watershed planning process. The inventory includes all these georeferenced attributes for fish habitat. I suggested they apply augmented reality to a chunk of SHIM data, so you can walk out into a stream and have a visual pop up of the recorded attributes (represented by icons) for the site— like a drainage pipe or bank erosion – so you can see how its changed. There are technical problems with augmented reality when you get

into terrain with a lot of elevation changes. It would work better in the flatland or gentle elevations. FME jumped on it, and they built some sets of what they call transformers to do this work, but I haven't tried it myself yet. It's the kind of novel challenge FME like. So if you've got a lot of gaps, and a lot of data, and you're trying to roll it all together, when you get to the stage when you know exactly what you want, they might be able to help you put it all together.

- If you buy SAFE's FME software in the retail market, the subscription rates are around 20 grand. But they've given us a one year trial license year after year, no problem.
- The Yukon has watercourse data comparable to 1:15,000 to 20,000, but it was just a bunch of line segments that were not really well connected, with no meaningful information. They also have points observations for fish, but you couldn't really do anything with the data. DFO worked with FME to develop ways of manipulating the data. They took the stream layer for the Yukon, connected all those long segments into a network and then used the fish observation locations to infer that each observed fish species was present from that point downstream. This network is now used as a framework for hanging all sorts of other attributes onto, in terms of data from fish habitat projects and assessments for resource extraction proposals. FME was used as the processing power to make this product that DFO now uses. I think there was a contractor actually doing the work, but their cost was minuscule compared to having to sort out the whole problem themselves. For the Province, we do have fish presence information at the 1:20,000 watercourse level for the Pacific region. But I'm not sure it's adequately done.
- FME have a host of what they call transformers, small components of code that you can manipulate to analyze point data from LiDar. I have seen visualizations of Lidar data in a host of different ways: vegetation mapping, 3D views showing transmission lines and trees at oblique angle. Point cloud data analysis and visualization is one of their specialties. So if you do go down the road of using LiDar, there will be situations where SAFE's FME will come in handy. You can learn more through SAFE's webinars.

## 11 RELATED INITIATIVES

### 11.1 South Coast Conservation Partnership

- The South Coast Conservation Program and the Fraser Valley Conservancy have been doing various mapping related things. I'm curious as to where there's overlap with what you are doing, in terms of trying to provide information to local governments and First Nations, partnerships and working together to help local government make good decisions – all that is really interesting to me because we certainly have our challenges here.
- The CDFCP and SCCP areas do overlap a bit, but it seems CDFCP do most of their work on the Sunshine Coast, Vancouver Island and the Gulf Islands. But how much into the Metro Vancouver - Fraser Valley area are you? That's the area where I can provide more information on.
- *[KC: We seem to be doing similar work in different geographic areas].* This whole climate change, natural assets side of things is an area that we haven't been involved in – as I said we're not landscape based. But I'm definitely willing to be involved, and be the connection for our area, although I only have funding for one day a week at the moment. You also have Rob Knight from the Community Mapping Network, who is on our Steering Committee. Its good for me to know what you're doing, so I can pass this information on to my steering committee and partners, and vice versa.
- Depending on when you're more ready to present, SCCP do events. I see the SCCP currently as primarily an information hub, we want to share what's happening out there, and yours is a really exciting project. In the fall we do our Conservation Connect Event maybe we could have one of Lyndsey, come into speak and provide an overview. I'm all about sharing what's going on – there's so much.
- I'm on the committee for SCCP. I've been there since day one. Its focus has been SEAR, outreach and engagement and supporting local governments. The people on the steering committee are very knowledgeable, and fairly logical about some of these larger issues you're talking about. John Richardson is a UBC forestry researcher, with a wide scope of knowledge. We have a quarterly meeting coming up with the steering committee fairly soon. If you get in touch before that, we could talk about

this. The SCCP shied away from Vancouver Island because the Garry Oak folks were the main players. There's a lot of networking that could be done through the SCCP.

- *[With respect to KC's comments on opportunities to partner with other organization including the SCCP, to coordinate projects and capitalize on their networks].* I agree it seems like a lot of people running in different directions with these things. And I'm only currently with the SCCP one day a week, and I'm really hoping to build up its capacity again. SAR Focus
- Our mandate is around species at risk, that's what we were formed to do. The steering is still interested in us continuing to do that. We're unlike the other conservation partnerships that are landscape based, SCCP is not ecosystem based. So that's where there's some separation. We were set up back when species at risk was a hot topic, but things are evolving, and are species at risk really the end all to be all? So it has its challenges. But I'm still hearing from my steering committee that it's a focus they still want, but we're also trying to also figure out our role in things.
- I see the SCCP currently as primarily an information hub, we want to share what's happening out there,
- There's a lot of funding out there right now. Its great, because its allowing us to actually talk more to each other than we have. I can be a megaphone to get information out there to the people here, down the road.
- Information hubs are not the things people like to fund – hard to track effectiveness. Funders are more interested in shovels in the ground and tangible outcomes. Outreach and education isn't as appealing to funders.
- So I'm working on building SCCP capacity. I knew that would take a couple years to rebuild because things got quiet for a while and we had no funding. But now things are good and restarting. I'm trying to get a better sense of what our partners want, and how to fill those gaps in the region. I read the CDFCP strategic plan, and showed my steering committee last week. I told them to look at the layout and how few pages it is. It's more of an action plan than a conservation plan, and I love that because I've been involved in writing strategies that sit on a shelf.

## 11.2 Fraser Valley Conservancy

- I deal with the Fraser Valley Conservancy, and they just got some climate change funding too. I'm curious if there's some overlap between what you and the FVC are working on. There seem to be a lot of groups now working on this.
- I do stewardship and other contract work for the Fraser Valley Conservancy, with Priority Places Funding, and analysis for different neighborhood conservation plans. That's why our timing is good, because it will involve looking at hot spot areas to see if they're worth conserving, in terms of what species are on the ground and what would be lost. This will help us talk to our partners and have our discussions in a smaller, neighborhood-based and local government way – so much smaller than a regional scale. So this has me more focused on small areas on the ground, rather than the big picture.
- The Fraser Valley Conservancy has a side project to develop a working group to look at how to increase protection and conservation activity in the ALR, such as encouraging green space protection. It's getting some traction.

## 11.3 Community Mapping Network (CMN)

- When we started CMN in 2000, the idea was to get hold of government layers that no one else had at the time. The goal was to bring together and visualize data from different silos, to improve awareness of what was out there and maybe help.
- CMN have local government specific applications. We did a habitat mapping exercise for the Sunshine Coast Regional District, but they subsequently did their own. *[KC: Why is that?]* Ours was too environmentally focused. They only needed a smaller subset of data to do with land use in the regional district. But I think they might be coming back to our work.
- If you need some interactive web mapping for public view, that's what the CMN does. It's not an open data portal, so we're not designed to push out spatial data for anybody to take. But we're capable of publishing web map services. If you're interested in any of our layers you can talk to us about displaying them. We may be able to provide something as a layer to view in context of your own layers.



- I'd be willing to chip in to this process now and again, just because I've been kicking around so long. I've been upset about these issues for a long time.

## 11.4 Howe Sound Bioregion

- The business model for the Howe Sound Bioregion Initiative sounds like what you're considering for the whole Georgia Basin Lowlands – a collaborative land use planning support mission. Like other UNESCO Bioregions, they have to spend a lot of energy in defining and mapping core areas for conservation, transition areas and then the settlement areas. The transition area are meant to be land-use planning buffer between conservation areas and the more heavily used settlement areas. For Howe Sound, much of the core area is fragmented little patches of marine and terrestrial ecosystems, with peripheral protected areas in high elevation parks. But they were still able to convince UNESCO that it is a significant priority. So for the next decade, they have to show progress in coordinated land use planning and decision-making by all of the agencies and local governments businesses in the bioregion. Ruth Simons has been leading this for several years now, along with her supporting committees.

# 12 ADDITIONAL NEXT STEPS

## 12.1 General

- *[KC: we're hoping that by starting these conversations and trying to bring people together, things will be more coordinated. There's a lot of new technology and new projects running off in all different directions].* The technology is changing immensely. So I totally agree. But it's promising.
- Given the diversity of your stakeholders you're dealing with have interests all across the spectrum. With my experience working on the Joint Venture we dealt with a relatively narrow area of interest and it was still very challenging. Doing this for a larger area with a wider group of stakeholders will be very challenging.
- The more collaborations the better. I'll follow up with the Water Sustainability Partnership and Jeremy Murphy, the principal at Sustainable Solutions Group and make introductions. I'll do that this week and then I'm away next week.
- Something that I'm sure you guys are already doing, but CDFCP ought to target working with various forestry departments at universities and colleges, and maybe even those places of learning in general. Some of their ideas may run counter to a conservancy ideology, but some ideas may align better. There are many people, in particular grad students, working and studying at these schools that may have values that align with CDFCP. Projects could also be devised with post-secondary schools to develop data collection methods and build databases. If not the forestry departments, then maybe more community minded groups.
- Societies that align with CDFCP goals. These groups may be collecting their own data, or hiring contractors to collect data related to what you are looking
- *[KC: Any thoughts on the process for moving forward? We're going to continue with more interviews, and will be sharing the results in summary documents, then hope to use this information to find pathways for bringing strategic groups of people together, to collaborate and pool resources on potential projects.]* You've got a standard set of questions and there are a lot tangential ideas that will fall out during the conversation that someone maybe hasn't thought about, and can potentially take root. I can't think of any way that you'd want to refine the process, at least at this stage, until you begin to see where the commonalities in responses are – then you can take it from there. Your first step is really asking the questions and engaging local governments to find out what the scope is.
- *[KC: Any other key people you think would be imperative and beneficial to speak to in particular?]* Maybe some of the key NGOs that are working with local governments, like Ducks Unlimited and Birds Canada, and the land trusts.



## 12.2 Further discussion/expert input

- *[KC: I have this idea of trying to get some people in a room for a mapping workshop/webinar once I assemble everyone's comments.]* I think having a big conversation at the scale of the CDFCP operating area with some of the key players would be a really good idea. I don't know if its possible, but it would be fabulous if we could get everybody on the same page. It would be so good to see something happen at that scale that's useful and consistent for everybody.
- While I get the goals you note below, my experience is that it takes an in person working groups with experience with those layers to decide on those which are sufficiently reliable/accurate to map those kinds of goals. While I do think they can be mapped, I will note that I think the precision with which it can be done is limited and because of that, there will be many 'naysayers' to maps if based on layers people don't trust. All in all, I think the goals are excellent, but that the nitty-gritty of making those maps selections is best done with multiple inputs.
- You seem to have developed a highly detailed and comprehensive list of feature layers potentially available to planners. But I personally think there needs to be detailed in person work to define the specific questions that are being addressed, and then ask whether/if the kinds of layers are appropriate, available and useful for the goals identified. What I have found regularly is that when you dig into the layers, there is a ton of work required to make them usable in many cases, and/or the creators/users indicate doubts about their reliability (like TEM). For that reason, its very hard to comment without a precise statement about goals.
- I guess one suggestion I'd have would be to take a matrix like the one presented, and use it to discuss with a knowledgeable group whether and how each layer ID's might be included to represent particular goals noted, like ecosystem services, Carbon potential. etc. The latter, however, is do dependent on age-class that it will of course be subject to change.
- From the CDFCP's perspective and this Nature Smart Solutions funding, maybe what's needed are supporting policy tools and elaborations and explanations, but also expert input, maybe some sort technical committee that includes planners. This is the stage they need to be brought in.

## 12.3 Local Government Representation

- *[KC: We're thinking of setting up some sort of umbrella advisory group, for our NBS project, so that we can be more coordinated about what we're doing. Any suggestions on who could represent local government? UBCM?].* There is an Island version of the UBCM – I can't remember the acronym – but it only captures the Island side. It depends on what your goals are. If you're looking to know what each regional community wants, you may want to have regional districts represented all along the Georgia Basin But if your looking for what local governments think in general, then UBCM would be very helpful.
- *[KC: We're hoping to keep the umbrella advisory group to a manageable number, under 12].* You might want to speak to the Water Sustainability Partnership because they literally have been doing road shows up and down the Georgia Basin for 20 years, and they're proud of their work and are celebrating their 20<sup>th</sup> year. They might know people and might have an answer to that.
- Looking at CDFCP's website and their members list, I see many conservancy groups, but not many local governments or municipalities (particularly on the mainland). I could see potential relationships being built with local governments through various parks boards, or more ecologically minded arms of these local governments.

## 12.4 Development community

- It is very important to talk to the development community, that you understand how they talk about things, what language they use, what assumptions they work from. As a local government staff member talking to all these stakeholders, it's almost like we're speaking different languages across the different disciplines. Sometimes there isn't even a common baseline understanding from which to have a conversation. So talking to them is important for your market and focus group research, so you can understand how to talk to them and so they can see themselves in your conversation - that's really

important. Otherwise its going keep feeling like its them against us. That's how it feels now and there has to be different way.

- *[KC: Do you have suggestions on who to talk to?]*. I mainly speak to development people who are busy and frustrated, but let me think about it. I'm thinking about Crown Isle, our golf course community. They might actually be good, they're saying they're trying to be more pro environment, so they might be more willing to talk from a PR perspective. McElhanney is a civil consulting firm who often represent the local development community because they are hired by the local developers. You may want to talk to them and signal that other people are taking this seriously in the City.

## 12.5 Sharing data and planning tools

- *[In response to KC's outline of CDFCP's plan to identify gaps and try to develop a NBS policy framework for Georgia Basin]* These neighborhood conservation plans we're looking at, if we go ahead with some of them, it will involve bringing together various partners and maybe we'll roll ahead with you guys. We'll need some more tools in our toolbox, and we'll be looking for some specific wins. I'm looking for a tangible action list for the SCCP that we can really sink our teeth into. I think your idea of starting to compile a repository of information and planning tools, and encouraging people to use and share it— that would be great.
- What are the CDFCP's plans – are you going to have a central place for all the stakeholders to access the stuff that you've been finding, etc.? *[KC: we're considering developing a central repository to share information, like Sharepoint, as we're trying to use a collaborative approach]*. We're not fans a Sharepoint, and there are also file size limits. But one option is looking into One Drive.
- When we first saw your email we thought, Yikes, yet another initiative to cobble together a bunch of data for another data hub. I'm glad to know you're not, with so many groups getting their money and going off to do their own thing. It just creates another layer of silos.
- Surrey has a range of layers, including some detailed aquatic and terrestrial habitat coverage, and through our Biodiversity Conservation Strategy habitat suitability mapping (see our [open data portal](#) for various layers). That includes a detailed watercourse layer.
- Metro Vancouver's datasets can be retrieved and downloaded online at: <http://www.metrovancouver.org/data>. These datasets are intended to support Metro Vancouver's member jurisdictions with data to inform decision-making. Metro Vancouver's Regional Planning Advisory Committee - Environment Subcommittee (RPAC-ENV), consultants, academics, Environment Canada, and non-profit organizations are the biggest users of Metro Vancouver's datasets. It's a big job to keep these datasets up to date. The RPAC-ENV includes the environmental managers, parks, or sustainability staff from most member jurisdictions in the region. Josephine Clark, now in Regional Parks, led the creation of the Sensitive Ecosystem Inventory, land cover classification, tree canopy cover and impervious surfaces, carbon storage, and ecological connectivity datasets over the past decade.

## 12.6 Metro Vancouver

- Contact Laurie Bates. Tell her that you and I were chatting, and you've got exactly the same questions as Metro Van, the same desires of the municipalities, and would like to be plugged in as to what Metro Van is doing with Nick Coops and the technical miracle that he's going to perform, and that might help local governments on Vancouver Island, and the mainland. She may not be aware of the CDFCP. She's in the planning part of metro Van.
- I think we need to be in contact with Metro Van about their work with Nick, and maybe also to hear about his work on old growth forest as well. Lets see what Nick is able to do in the next couple months, and then perhaps give a presentation on his conclusions.
- *[RE workshop/webinar]*. You might want the Metro Van folks there - they're in the same boat as you: they want change statistics, they want an updated layer, etc.
- *[KC: Do you have thoughts on opportunities for pooling resources and collaborating?]*. I think it would be valuable to connect you with the Metro Vancouver RPAC-ENV. That group is a wealth of knowledge and they are local data keepers, or at least they know the municipal staff who are maintaining the data. There is opportunity to seek collaboration through that forum.
- Metro Vancouver will soon be reigniting conversations about a RGIN, so there could be an opportunity to collaborate on mapping, etc.. We hope to identify a draft RGIN map in 2023.

- I will send an email to the RPAC-ENV with your questions and ask them to follow up.
- *[KC: I'm very interested in the outcomes from Nicholas Coops' work.]* Caslys Consulting will be conducting the 2020 land cover classification and SEI update. Nicholas Coops is providing remote sensing advice. Caslys has completed a lot of remote sensing and mapping work and they have some ideas about automating the change detection. We can share any lessons learned from that exercise, but the update won't be completed until the end of 2022.

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# APPENDIX B:

## Data Layer Types And Sources for Targeted Ecosystem Services

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**APPENDIX B**  
**Data Layer Types And Sources for Targeted Ecosystem Services**  
*(from suggestions made during interviews and in written feedback)*

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<b>LAND COVER</b>							
<ul style="list-style-type: none"> <li>Land Cover (Base map)</li> </ul>	<ul style="list-style-type: none"> <li>Satellite imagery</li> <li>Orthophotos</li> <li>Lidar/multispectral</li> <li>North American Land Cover (NALCMS) &amp; Land Cover Change (2010-2015) (30m pixels)</li> <li>Satellite Forest Information For Canada (30m) <a href="https://opendata.nfis.org/mapserver/nfis-change_eng.html">https://opendata.nfis.org/mapserver/nfis-change_eng.html</a> <ul style="list-style-type: none"> <li>Landcover</li> <li>Agricultural/forest land cover</li> </ul> </li> <li>UN Biodiversity Lab <ul style="list-style-type: none"> <li>ESA CCI Land Cover 1992-2000 (300m pixels)</li> <li>ESA CGLS Land Cover 2015-2019 (100m pixels)</li> <li>Esri 2020 Land Cover 10m</li> </ul> </li> <li>Agriculture Canada (AAFC) semi-decadal land use time series</li> <li>Trends Earth Tracking Land Change – Land cover (QGIS download) – 1992-2018 (300m)</li> <li>Joint Ventures BC Land Cover Map (not public)</li> <li>UBC Sustainable Agriculture Landscapes Lab – Land use-land Cover Change in Lower Fraser Valley 1978-2018 (30m) <a href="https://sal-">https://sal-</a></li> </ul>	<ul style="list-style-type: none"> <li>Regional baseline conditions.</li> <li>Ecosystem conversion rates/ human footprint</li> <li>Monitoring land use changes</li> <li>Overall ecological resilience (amount and contiguity of remaining natural habitat).</li> <li>Ecological corridors and stepping stones</li> <li>Land cover diversity</li> </ul>	<ul style="list-style-type: none"> <li>Baseline conditions</li> <li>Conversion rates</li> </ul>	<ul style="list-style-type: none"> <li>Baseline conditions</li> <li>Conversion rates</li> </ul>	<ul style="list-style-type: none"> <li>Cumulative impacts on traditional territories and Aboriginal Rights</li> </ul>	<ul style="list-style-type: none"> <li>Overall watershed health/run-off moderation</li> <li>Hydrological/ watershed modelling</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>



DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems (only as defined by and with First Nations consent)	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<a href="http://lab.landfood.ubc.ca/projects/spatiotemporal-analysis-of-land-use-land-cover-and-soil-organic-carbon-in-lower-fraser-valley/">lab.landfood.ubc.ca/projects/spatiotemporal-analysis-of-land-use-land-cover-and-soil-organic-carbon-in-lower-fraser-valley/</a>						
VEGETATION COVER / ECOSYSTEMS	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Terrestrial Ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>TEM/BEC site series,</li> <li>VRI</li> <li>SEI</li> <li>Analogs (bird guilds, animal models)</li> <li>Lidar/multispectral</li> <li>Marxan (CDFCP mapping layers)</li> <li>Islands Trust Contiguous Forest Cover Mapping</li> <li>Parks Canada Mapping</li> <li>WWF Max canopy height in Canada 2019 (250m)</li> <li><a href="https://data.4tu.nl/collections/_/5421810/3">https://data.4tu.nl/collections/_/5421810/3</a></li> <li>Biodiversity Lab – global intertidal change</li> <li>Global Forest Change 2000-21 (30m); Global Land Analysis &amp; Discovery, derived from <a href="https://www.science.org/doi/10.1126/science.1244693">https://www.science.org/doi/10.1126/science.1244693</a></li> <li>Satellite Forest Information For Canada (30m) <a href="https://opendata.nfis.org/mapser">https://opendata.nfis.org/mapser</a></li> </ul>	<ul style="list-style-type: none"> <li>Sensitive ecosystems</li> <li>Priorities for retention or restoration:(e.g. Garry oak meadows, wetlands, woodlands, riparian areas, etc.).</li> <li>Freshwater fish habitat</li> <li>Habitat for species at risk</li> <li>Ecological corridors and stepping stones</li> <li>Priority restoration areas (to link up larger ecosystem patches and reduce ecosystem fragmentation)</li> </ul>	<ul style="list-style-type: none"> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> <li>Heights, BA, CC, SPH info can be highly improved with LiDAR</li> </ul>	<ul style="list-style-type: none"> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Ecosystems that potentially support culturally important plants (e.g. camas, cedar, sitka spruce, devils club, etc.)</li> <li>Habitats that potentially support culturally important wildlife</li> <li>Priorities for retention and cultural restoration/ management</li> </ul>	<ul style="list-style-type: none"> <li>Watershed health/run-off moderation (e.g % forest cover)</li> <li>Hydrologically sensitive ecosystems (wetlands, riparian areas, floodplain systems, etc.)</li> <li>Hydrological/watershed modelling</li> <li>Priority retention and restoration areas (e.g. riparian areas, wetlands, floodplains)</li> </ul>	<ul style="list-style-type: none"> <li>Forest types at higher (eg dry conifer) vs lower (e.g. broadleaf) fire risk</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<a href="#">ver/nfis-change_eng.html</a> <ul style="list-style-type: none"> <li>Forest change and change type</li> </ul>						
<ul style="list-style-type: none"> <li>Ecosystem Productivity</li> </ul>	<ul style="list-style-type: none"> <li>VRI (site index),</li> <li>Provincial Site Productivity Layer</li> </ul>	<ul style="list-style-type: none"> <li>Site productivity – how fast vegetation grows, and how big it gets</li> <li>Priorities for retention/restoration (e.g. productive 'big tree' old growth, estuaries)</li> </ul>	<ul style="list-style-type: none"> <li>Capability of ecosystem to store carbon.</li> <li>Priorities for retention (i.e. ecosystems currently storing high amounts of carbon)</li> <li>Priorities for restoration (degraded ecosystems on productive sites, capable of storing high amounts of carbon in the future)</li> </ul>	<ul style="list-style-type: none"> <li>Capability of ecosystem to sequester carbon.</li> <li>Priorities for retention (ecosystems sequestering high carbon at high rates)</li> <li>Priorities for restoration (degraded ecosystems on productive sites, capable of sequestering at high rates in the future)</li> </ul>	<ul style="list-style-type: none"> <li>Priority cultural plant areas for retention and restoration (e.g. productive sites capable of growing monumental cedars)</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Can higher productivity forests be used as an indicator of fire resilience?</li> <li></li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>Forest Structural Stage/Integrity</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation Resource Inventory (VRI)</li> <li>Lidar,</li> <li>Analog:(bird guilds, animal models)</li> <li>Satellite Forest Information For Canada (30m) <a href="https://opendata.nfis.org/mapserver/nfis-change_eng.html">https://opendata.nfis.org/mapserver/nfis-change_eng.html</a> <ul style="list-style-type: none"> <li>Wildfire year</li> <li>Harvest year</li> <li>Post disturbance recovery</li> <li>Forest elevation height</li> <li>Basal area</li> <li>Urban Greenness score</li> <li>And more</li> </ul> </li> <li>Canadian Forest Service forest disturbance mapping 1984-2015 (30m) <a href="https://open.canada.ca/data/en/dataset/add1346b-f632-4eb9-a83d-a662b38655ad">https://open.canada.ca/data/en/dataset/add1346b-f632-4eb9-a83d-a662b38655ad</a></li> <li>Global Forest Height 2019 (30m); Global Land Analysis &amp; Discovery <a href="https://glad.umd.edu/dataset/ged/">https://glad.umd.edu/dataset/ged/</a></li> <li>UN Biodiversity Lab – <ul style="list-style-type: none"> <li>Forest Landscape Integrity Index (300m)</li> </ul> </li> <li>Global Forest Change 2000-21 (30m); Global Land Analysis &amp; Discovery, derived from <a href="https://www.science.org/doi/10.1126/science.1244693">https://www.science.org/doi/10.1126/science.1244693</a></li> </ul>	<ul style="list-style-type: none"> <li>Sensitive/priority areas for retention (e.g. old and mature forest)</li> <li>Ecological corridors/connectivity</li> <li>Forest integrity/condition and change in integrity</li> <li>Old/mature forest climate refugia (shadier/lower temperatures)</li> </ul>	<ul style="list-style-type: none"> <li>Cross walk with carbon valuation models for each structural stage, to determine priority areas for retention, restoration, or improved management</li> </ul>	<ul style="list-style-type: none"> <li>Cross walk with carbon valuation models for each structural stage, to determine priority areas for retention, restoration, or improved management</li> </ul>	<ul style="list-style-type: none"> <li>Potential cultural plant areas (e.g. large cedars for canoe building)</li> </ul>	<ul style="list-style-type: none"> <li>Hydrological/watershed modelling</li> <li>Hydrologically sensitive areas, e.g. <ul style="list-style-type: none"> <li>old forest in watershed headwaters (affects water flows via snowpack accumulation and melting rates)</li> <li>Old and mature forest in riparian areas , floodplains, alluvial fans,, etc.(affects water flows and quality)</li> </ul> </li> <li>Shade from old/mature forest lower's water temperatures</li> <li>Priority retention areas</li> </ul>	<ul style="list-style-type: none"> <li>Forest stages at higher risk (e.g. dense pole sapling) vs lower fire risk (e.g. mature-old with separated crowns, uneven age)</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
Biodiversity	<ul style="list-style-type: none"> <li>UN Biodiversity Lab – Biodiversity intactness Index (2000-2015)</li> <li>iBird</li> <li>iNaturalist</li> <li>Composite distribution maps used for CDFCP Marxan and NPLCC Tool, <a href="https://ncc.carleton.ca/app/wheretowork_advanced?sp_hide_navbar=true">https://ncc.carleton.ca/app/wheretowork_advanced?sp_hide_navbar=true</a> <ul style="list-style-type: none"> <li>Old Forest communities</li> <li>Savannah communities</li> <li>Wetland communities</li> <li>Shrub communities</li> <li>Beta biodiversity</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Biodiverse ecological communities</li> <li>Species diversity and richness</li> <li>Ecosystem diversity</li> <li>Biodiversity intactness;</li> <li>Forest integrity;</li> <li>Human footprint</li> <li>Land cover diversity</li> <li>Priorities for retention, management and restoration</li> </ul>					
SPECIES & ECOSYSTEMS AT RISK	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Species at risk</li> </ul>	<ul style="list-style-type: none"> <li>CDC element occurrences,</li> <li>First Nations/local knowledge</li> <li>Goshawk models, nesting and foraging habitat maps</li> <li>Marbled Murrelet models and suitability mapping</li> <li>W. Screech owl models under development</li> <li>Composite distribution maps used for CDFCP Marxan and NPLCC Tool, <ul style="list-style-type: none"> <li>Old Forest communities</li> <li>Savannah communities</li> <li>Wetland communities</li> </ul> </li> <li>iNaturalist</li> <li>iBird</li> <li>Federal Species at Risk Range</li> </ul>	<ul style="list-style-type: none"> <li>Known records of species at risk</li> <li>Potential habitat for species at risk</li> <li>Priority areas for retention, restoration and management</li> </ul>	•	•	<ul style="list-style-type: none"> <li>Cultural hunting considerations?</li> </ul>	•	•

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<ul style="list-style-type: none"> <li>Maps</li> <li>BC Reptile &amp; Amphibian Range maps</li> <li>CRD potential sharp-tailed snake habitat</li> <li>Biodiversity Lab – Threatened Species Richness/Rarity/</li> </ul>						
<ul style="list-style-type: none"> <li>Ecological communities at risk</li> </ul>	<ul style="list-style-type: none"> <li>CDC element occurrences,</li> <li>TEM</li> <li>CWHXm1 TEM project</li> <li>Garry Oak mapping</li> <li>SEI</li> <li>PEM</li> <li>Garry Oak TEM data</li> </ul>	<ul style="list-style-type: none"> <li>Known locations of ecological communities at risk</li> <li>Likely occurrences of ecological communities at risk (e.g. extrapolated from TEM polygons)</li> <li>Priority areas for retention/ restoration/ management</li> </ul>	•	•	<ul style="list-style-type: none"> <li>Potential culturally important plants</li> <li>Priority areas for retention/ cultural restoration/ management</li> </ul>	•	•
<ul style="list-style-type: none"> <li>Critical Habitat</li> </ul>	<ul style="list-style-type: none"> <li>Federal government's Critical Habitat mapping</li> </ul>	<ul style="list-style-type: none"> <li>Critical habitat for species at risk, as mapped by the Federal Government</li> <li>Priority areas for retention/ restoration/ management</li> </ul>	•	•	•	•	•
<b>REGIONALLY SIGNIFICANT FISH &amp; WILDLIFE</b>	<b>POSSIBLE DATA SOURCES</b>	<b>BIODIVERSITY</b>	<b>CARBON STORAGE</b>	<b>CARBON SEQUESTRATION</b>	<b>CULTURALLY SIGNIFICANT ECOSYSTEMS</b>	<b>WATERSHED RESILIENCE</b>	<b>WILDFIRE RESILIENCE</b>



DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>Fish sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Fish observations</li> <li>Freshwater Atlas (fish bearing streams)</li> <li>Pacific Salmon Foundation Salmon Explorer; <a href="https://www.salmonexplorer.ca/#/vancouver-island-mainland-inlets">https://www.salmonexplorer.ca/#/vancouver-island-mainland-inlets</a></li> <li>First Nations/local knowledge</li> <li>CMN-Fraser Valley Watershed Atlas <a href="https://cmnbc.ca/atlasgallery/fraser-valley-watersheds-atlas/">https://cmnbc.ca/atlasgallery/fraser-valley-watersheds-atlas/</a></li> </ul>	<ul style="list-style-type: none"> <li>Fishbearing streams and water bodies,</li> <li>Streams feeding into fishbearing streams</li> <li>Priority areas for retention/ restoration/ management</li> </ul>	•	•	<ul style="list-style-type: none"> <li>Important fishery streams/sites</li> <li>Priority areas for retention/ cultural restoration/ management</li> </ul>	<ul style="list-style-type: none"> <li>Priority areas for retention/ restoration/ management</li> </ul>	•
<ul style="list-style-type: none"> <li>Ungulate sensitive areas (winter range etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Ungulate winter range maps;</li> <li>First nations and local knowledge</li> <li>FLNRORD Deer and Elk models (TEM)</li> </ul>	<ul style="list-style-type: none"> <li>Important ungulate habitat and movement corridors</li> <li>Priority areas for retention/ restoration/ management</li> </ul>	•	•	<ul style="list-style-type: none"> <li>Important game areas</li> <li>Priority areas for retention/ cultural restoration/ management</li> </ul>	•	•
<ul style="list-style-type: none"> <li>Important Bird Areas</li> </ul>	<ul style="list-style-type: none"> <li>IBA Canada Important Bird Areas map</li> </ul>	•	•	•	•	•	•
ESTUARINE/ INTERTIDAL SYSTEMS	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Estuaries</li> </ul>	<ul style="list-style-type: none"> <li>PECP Ranked estuaries <a href="https://pacificbirds.org/2021/02/an-updated-ranking-of-british-columbias-estuaries/">https://pacificbirds.org/2021/02/an-updated-ranking-of-british-columbias-estuaries/</a></li> <li>BEC site series</li> <li>TEM/ SEI in some places</li> <li>Georgia Basin Habitat Atlas (lower mainland tidal habitat)</li> </ul>	<ul style="list-style-type: none"> <li>Sensitive ecosystems</li> <li>Important fish and wildlife habitat</li> <li>Important bird areas</li> <li>Biodiversity hotspots</li> <li>Priority habitats for retention/ restoration/managem</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon storage capability</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon sequestration capability</li> <li>Cross walk with carbon valuation models for each ecosystem type</li> </ul>	<ul style="list-style-type: none"> <li>Estuaries and associated marshes support culturally important plants (e.g. springbank clover, silverweed)</li> <li>Sensitive salmon habitat</li> </ul>	<ul style="list-style-type: none"> <li>Crosswalk with ecosystem service valuations (flood control, water quality &amp; quantity, etc.), to determine priority areas for retention/ restoration/managem</li> </ul>	•

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<a href="https://cmnmaps.ca/GBHA/">https://cmnmaps.ca/GBHA/</a>	ent	priority retention and restoration areas	to determine priority retention and restoration areas	<ul style="list-style-type: none"> <li>• Sensitive wildlife habitat</li> <li>• Priority areas for retention/ cultural restoration/managem ent</li> </ul>	ent	
<ul style="list-style-type: none"> <li>• Intertidal</li> </ul>	<ul style="list-style-type: none"> <li>• ShoreZone (high resolution imagery &amp; video)</li> <li>• SEI mapping</li> <li>• CMN – BC Eelgrass Inventory</li> <li>• UN Biodiversity Lab – Global Distribution of Seagrasses</li> <li>• BCMCA: Marine Atlas of Pacific Canada (2011) <a href="https://cmnbc.ca/atlasgallery/bc-marine-conservation-analysis-atlas/">https://cmnbc.ca/atlasgallery/bc-marine-conservation-analysis-atlas/</a></li> <li>• Georgia Basin Habitat Atlas (lower mainland eelgrass &amp; tidal habitat) <a href="https://cmnmaps.ca/GBHA/">https://cmnmaps.ca/GBHA/</a></li> </ul>	<ul style="list-style-type: none"> <li>• Sensitive ecosystems</li> <li>• Important intertidal habitat</li> <li>• Important fish habitat</li> <li>• Biodiversity hotspots</li> <li>• Priority habitats for retention/ restoration/managem ent</li> </ul>	<ul style="list-style-type: none"> <li>• Productive sites with high carbon storage capability</li> <li>• Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>• Productive sites with high carbon sequestration capability</li> <li>• Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>• Clam gardens</li> <li>• Fish traps</li> <li>• Sensitive aquaculture areas</li> <li>• Priority areas for retention/ cultural restoration/managem ent</li> </ul>	•	•
HYDROLOGY, TOPOGRAPHY & TERRAIN	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>• Watersheds</li> </ul>	<ul style="list-style-type: none"> <li>• Freshwater Atlas- watershed boundaries</li> <li>• PSF Salmon Explorer</li> <li>• Lidar (topography)</li> <li>• Topography/contour mapping</li> <li>• CMN – Aquatic Information Partnership Atlas - Watershed statistics <a href="https://cmnmaps.ca/AIP/">https://cmnmaps.ca/AIP/</a></li> <li>• Terrain stability mapping</li> </ul>	•	•	•	•	<ul style="list-style-type: none"> <li>• Watershed boundaries</li> <li>• Areas vulnerable to erosion and landslides.</li> </ul>	•

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems (only as defined by and with First Nations consent)	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<ul style="list-style-type: none"> <li>• Terrain hazard mapping</li> </ul>						
<ul style="list-style-type: none"> <li>• Floodplains/fluvial deposits</li> </ul>	<ul style="list-style-type: none"> <li>• Terrain mapping,</li> <li>• BEC site series ?</li> <li>• Lidar</li> <li>• Province wide flood plain maps (Pre-1998, many do not account for climate change); <a href="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/floodplain-maps-by-region">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/floodplain-maps-by-region</a></li> <li>• Regional Districts' flood plain mapping, e.g.:               <ul style="list-style-type: none"> <li>○ Cowichan Valley regional district: <a href="https://www.cvrld.ca/DocumentCenter/View/100315/2021-04-21---Schedule-O---Floodplain-and-Dam-Maps">https://www.cvrld.ca/DocumentCenter/View/100315/2021-04-21---Schedule-O---Floodplain-and-Dam-Maps</a></li> <li>○ Squamish: <a href="https://squamish.ca/assets/IFHMP/1117/5dbb51bad9/20171031-FINAL_IFHMP_FinalReport-compressed.pdf">https://squamish.ca/assets/IFHMP/1117/5dbb51bad9/20171031-FINAL_IFHMP_FinalReport-compressed.pdf</a></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Rare and sensitive ecosystems</li> <li>• Important fish and wildlife habitat</li> <li>• Biodiversity hotspots</li> <li>• Climate refugia</li> <li>• Priority habitats for retention/restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>• Productive sites with high carbon storage capability</li> <li>• Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>• Productive sites with high carbon sequestration capability</li> <li>• Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>• Areas likely to support culturally important plant areas (e.g. cedar, salmonberry, spruce, springbank clover)</li> <li>• Priority areas for retention/ cultural restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>• Hydrologically sensitive areas (store groundwater water, affect water flows and quality)</li> <li>• Sensitive ground water areas</li> <li>• Crosswalk with ecosystem service valuations (flood control, water quality &amp; quantity, etc.), to determine priority areas for retention/restoration/management</li> <li>• Areas vulnerable to erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Wetter microclimate with lower fire risk</li> <li>• Fire break (more broad leaf trees)</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>Riparian ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>TEM/BEC site series</li> <li>SEI</li> <li>FWA buffer</li> <li>Joint Ventures-TNT Topographic Riparian Area mapping</li> </ul>	<ul style="list-style-type: none"> <li>Rare and sensitive ecosystems</li> <li>Important fish and wildlife habitat and corridors</li> <li>Climate refugia</li> <li>Biodiversity hotspots</li> <li>Priority habitats for retention/restoration/management</li> <li>Large woody debris recruitment (fish habitat)</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon storage capability</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon sequestration capability</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Areas likely to support culturally important plants (e.g. cedar, elder, mock orange, saskatoons)</li> <li>Priority areas for retention/ cultural restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (store groundwater water, affect water flows and quality, reduce water temperature)</li> <li>Crosswalk with ecosystem service valuations (flood control, water quality &amp; quantity, etc.), to determine priority areas for retention/restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>Wetter microclimate with lower fire risk</li> <li>Fire break (more broad leaf trees)</li> </ul>
<ul style="list-style-type: none"> <li>Wetlands &amp; lakes</li> </ul>	<ul style="list-style-type: none"> <li>Freshwater Atlas,</li> <li>TEM/BEC site series</li> <li>CWS ranked wetlands 2018</li> <li>CWS National Wetland Inventory (under development)</li> <li>Satellite Forest Information For Canada - wetlands (30m) <a href="https://opendata.nfis.org/mapserver/nfis-change_eng.html">https://opendata.nfis.org/mapserver/nfis-change_eng.html</a></li> <li>Georgia Basin Habitat Atlas (lower mainland/ Fraser Valley wetlands) <a href="https://cmnmaps.ca/GBHA/">https://cmnmaps.ca/GBHA/</a></li> </ul>	<ul style="list-style-type: none"> <li>Rare and sensitive ecosystems</li> <li>Important fish and wildlife habitat</li> <li>Climate refugia</li> <li>Biodiversity hotspots</li> <li>Priority habitats for retention/restoration/management</li> <li>Important bird areas</li> </ul>	<ul style="list-style-type: none"> <li>Sites with high carbon storage capability (e.g. wetlands)</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Ecosystems with high carbon sequestration capability (wetlands with tree canopies)</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Sensitive fish habitat</li> <li>Areas likely to support culturally important plants (e.g. springbank clover, silverweed, Labrador tea)</li> <li>Sensitive wildlife habitat</li> <li>Priority areas for retention/ cultural restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (store water, affect water flows and quality)</li> <li>Crosswalk with ecosystem service valuations (flood control, water quality &amp; quantity, etc.), to determine priority areas for retention/restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>Wetter microclimate with lower fire risk</li> <li>Fire break</li> </ul>
<ul style="list-style-type: none"> <li>Watercourses</li> </ul>	<ul style="list-style-type: none"> <li>Freshwater Atlas</li> <li>CMN-Fraser Valley Watershed Atlas</li> <li>Lidar</li> </ul>	<ul style="list-style-type: none"> <li>Sensitive ecosystems</li> <li>Important fish and wildlife habitat</li> <li>Biodiversity hotspots</li> <li>Priority habitats for retention/restoration/management</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Sensitive fish habitat</li> <li>Priority areas for retention/ cultural restoration/management</li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (affect water flow and quality)</li> <li>Crosswalk with ecosystem service valuations (flood</li> </ul>	<ul style="list-style-type: none"> <li>Create wetter microclimates with lower fire risk</li> <li>Fire break</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
		<ul style="list-style-type: none"> <li>ent</li> <li>Climate refugia</li> </ul>				<ul style="list-style-type: none"> <li>control, water quality &amp; quantity, etc.), to determine priority areas for retention/restoration/management</li> </ul>	
<ul style="list-style-type: none"> <li>Gullies</li> </ul>	<ul style="list-style-type: none"> <li>BEC site series,</li> <li>Lidar</li> </ul>	<ul style="list-style-type: none"> <li>Sensitive ecosystems</li> <li>Important wildlife habitat and corridors</li> <li>Priority habitats for retention/restoration/management</li> <li>Climate refugia</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Areas likely to support culturally important plants (e.g. devil's club, red cedar)</li> </ul>	<ul style="list-style-type: none"> <li>Sensitive terrain feature, vulnerable to erosion and landslides.</li> <li>Sediment recruitment and transport</li> </ul>	<ul style="list-style-type: none"> <li>Wetter microclimate with lower fire risk</li> <li>Fire break (more broad leaf trees)</li> </ul>
<ul style="list-style-type: none"> <li>Alluvial Fans</li> </ul>	<ul style="list-style-type: none"> <li>TEM, BEC site series,</li> <li>Terrain mapping</li> <li>Lidar</li> </ul>	<ul style="list-style-type: none"> <li>Rare and sensitive ecosystems</li> <li>Important wildlife habitat</li> <li>Biodiversity hotspots</li> <li>Climate refugia</li> <li>Priority habitats for retention/restoration/management</li> <li>Important sediment recruitment processes affecting fish and benthic invertebrates</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon storage capability</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Productive sites with high carbon sequestration capability</li> <li>Cross walk with carbon valuation models for each ecosystem type to determine priority retention and restoration areas</li> </ul>	<ul style="list-style-type: none"> <li>Areas likely to support culturally important plants (e.g. spruce, berries)</li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (store groundwater, affect water flow and quality)</li> <li>Highly erodible terrain</li> <li>Sediment deposition</li> </ul>	<ul style="list-style-type: none"> <li>Wetter microclimate with lower fire risk</li> <li>Fire break (more broad leaf trees)</li> </ul>
<ul style="list-style-type: none"> <li>Small headwater streams</li> </ul>	<ul style="list-style-type: none"> <li>Freshwater Atlas - Stream Order</li> </ul>	<ul style="list-style-type: none"> <li>Important organic matter recruitment and transport area for downstream fish and aquatic invertebrates</li> <li>Important aquatic invertebrate habitat</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Areas likely to support culturally important plants (e.g. devil's club, salmonberry)</li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (affect water flow and quality, affect downstream water temperature)</li> <li>Sediment recruitment and transport</li> </ul>	<ul style="list-style-type: none"> <li>Wetter microclimate with lower fire risk</li> <li>Fire break (more broad leaf trees)</li> </ul>



DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>Groundwater recharge areas</li> </ul>	<ul style="list-style-type: none"> <li>Islands Trust Groundwater Recharge Mapping <a href="https://islandstrust.bc.ca/wp-content/uploads/2021/02/2019-17-gws-ssi_groundwater-recharge_final.pdf">https://islandstrust.bc.ca/wp-content/uploads/2021/02/2019-17-gws-ssi_groundwater-recharge_final.pdf</a></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (recharge and store groundwater)</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<ul style="list-style-type: none"> <li>Karst landscapes</li> </ul>	<ul style="list-style-type: none"> <li>BEC site series</li> <li>Bedrock geology</li> <li>Provincial Karst Dataset</li> </ul>	<ul style="list-style-type: none"> <li>productive forests</li> <li>climate refugia</li> <li>Rare cave fauna</li> </ul>	<ul style="list-style-type: none"> <li>High carbon storage areas</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Hydrologically sensitive areas (store groundwater, affect water flow and quality)</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<ul style="list-style-type: none"> <li>Water quality</li> </ul>	<ul style="list-style-type: none"> <li>Salish Sea Marine Emissions Tool</li> <li>Government of Canada Pollutants Affecting Whales and their Prey Inventory Tool (PAWPIT-OIPABP)</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
CULTURAL NATURAL ASSETS	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Culturally important ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>First Nations/local knowledge</li> <li>AOA data (not public)</li> <li>Musqueam Place Names Map</li> <li>Stó:lō Research &amp; Resource Management Centre</li> <li>TEM/SEI</li> <li>CDC ecological communities at risk mapping</li> </ul>	<ul style="list-style-type: none"> <li>Fish, game and cultural plants</li> <li>Ecological communities at risk that are enhanced/restored by traditional management practices (including many at risk CDF ecosystems)</li> <li>Priority areas for retention and traditional</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Areas supporting or likely to support culturally important plants and animals.</li> <li>Priority areas for retention/ cultural restoration/management</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Areas traditionally thinned and burned for food production (reduced fire risk)</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
		management/restoration					
NATURAL DISTURBANCE	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Wildfire risk</li> </ul>	<ul style="list-style-type: none"> <li>Wild and Urban Interface Fire Risk maps (strategic level; based on VRI; does not include private land) <a href="https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/vegetation-and-fuel-management/fire-fuel-management/wui-risk-class-maps/wui-downloads">https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/vegetation-and-fuel-management/fire-fuel-management/wui-risk-class-maps/wui-downloads</a></li> <li>Hazardous fuels mapping (based on VRI with groundtruthing)</li> <li>Community wildfire risk mapping</li> </ul>	<ul style="list-style-type: none"> <li>Areas with high wildfire risk to biodiversity</li> <li>Priority areas for fuel management</li> <li>Priority areas for harvest/retention (e.g. mature and broadleaf forest)</li> </ul>	<ul style="list-style-type: none"> <li>Areas with high wildfire risk to carbon storage</li> <li>Priority areas for fuel management</li> <li>Priority areas for harvest/retention</li> </ul>	<ul style="list-style-type: none"> <li>Areas with high wildfire risk to carbon sequestration</li> <li>Priority areas for fuel management</li> <li>Priority areas for harvest/retention</li> </ul>	<ul style="list-style-type: none"> <li>Wildfire risk to culturally significant ecosystems</li> <li>Priority areas for fuel management</li> <li>Priority areas for cultural management</li> <li>Priority areas for harvest/retention</li> </ul>	<ul style="list-style-type: none"> <li>Areas with high wildfire risk to watersheds</li> <li>Priority areas for fuel management</li> <li>Priority areas for harvest/retention</li> </ul>	<ul style="list-style-type: none"> <li>Areas at high/low risk of wildfire</li> </ul>
<ul style="list-style-type: none"> <li>Wildfire Magnitude</li> </ul>	<ul style="list-style-type: none"> <li>Satellite Forest Information For Canada (30m) <a href="https://opendata.nfis.org/mapserver/nfis-change_eng.html">https://opendata.nfis.org/mapserver/nfis-change_eng.html</a> <ul style="list-style-type: none"> <li>Wildfire change magnitude</li> <li>Post disturbance recovery rate</li> </ul> </li> </ul>	Restoration potential					
<ul style="list-style-type: none"> <li>Insect disturbance mapping</li> </ul>		Restoration potential					

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
CLIMATE	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
Carbon mapping	<ul style="list-style-type: none"> <li>• WWF Carbon Storage &amp; Distribution in Terrestrial Ecosystems of Canada (250m) <ul style="list-style-type: none"> <li>• <a href="https://data.4tu.nl/collections/5421810/3">https://data.4tu.nl/collections/5421810/3</a></li> </ul> </li> <li>• Trends Earth Tracking Land Change – soil carbon (250m)</li> <li>• GSOC Global Soil Organic Carbon map</li> <li>• Metro Vancouver carbon mapping</li> <li>• UN Biodiversity Lab carbon mapping (above/below ground, change in woody carbon) (300m)</li> <li>• Pacific Climate Impact Consortium Data Portal (<a href="https://pacificclimate.org/data">https://pacificclimate.org/data</a>)</li> <li>• UBC Sustainable Agriculture Landscapes Lab -Soil Organic Carbon mapping in Lower Fraser Valley (30m?) (<a href="https://sal-lab.landfood.ubc.ca/projects/spatiotemporal-analysis-of-land-use-land-cover-and-soil-organic-carbon-in-lower-fraser-valley/">https://sal-lab.landfood.ubc.ca/projects/spatiotemporal-analysis-of-land-use-land-cover-and-soil-organic-carbon-in-lower-fraser-valley/</a>)</li> <li>• Composite distribution maps used for CDFCP Marxan and NPLCC Tool, <a href="https://ncc.carleton.ca/app/wheretowork_advanced?sp_hide_navbar=true">https://ncc.carleton.ca/app/wheretowork_advanced?sp_hide_navbar=true</a> <ul style="list-style-type: none"> <li>○ Standing Carbon</li> <li>○ Carbon potential</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• High productivity areas</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon inventory and tracking</li> <li>• Priority areas for carbon storage</li> <li>• Priority areas for retention/management to maintain carbon storage</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon inventory and tracking</li> <li>• Priority areas for retention/management/restoration, to maintain and enhance carbon sequestration</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Priority areas for wildfire risk management</li> </ul>

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
Future ecosystems and climate refugia & corridors	<ul style="list-style-type: none"> <li>Novel Climate Mapping (Mahoney et al.)</li> <li>Adapt West – <ul style="list-style-type: none"> <li>Connectivity between current and future climate analogs in North America</li> <li>Integrated refugia and corridor priorities</li> </ul> </li> <li>Climate Resilience Data Explorer</li> <li>UN Biodiversity Lab – <ul style="list-style-type: none"> <li>Forest Landscape Integrity Index (300m)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Corridor analysis and placement</li> <li>Priority areas for conservation/management</li> </ul>			<ul style="list-style-type: none"> <li>Culturally important ecosystems at risk due to ecosystem changes</li> <li>Fish refugia,</li> <li>Refugia for cultural plants and other resources</li> </ul>		<ul style="list-style-type: none"> <li>Future changes in wildfire risk</li> <li>Priority areas for fuel management</li> </ul>
<ul style="list-style-type: none"> <li>Hydrological models</li> </ul>	<ul style="list-style-type: none"> <li>Adapt West -Watershed Climate Data Explorer</li> <li>Pacific Climate Impacts Consortium Gridded Hydrologic Model Output (Fraser Valley)</li> </ul>	<ul style="list-style-type: none"> <li>Impacts on fish and other aquatic life and related management priorities</li> <li>Impacts on riparian systems and related management priorities</li> </ul>	•	•	<ul style="list-style-type: none"> <li>Impacts on important fish populations caused by climate related changes in hydrology.</li> </ul>	<ul style="list-style-type: none"> <li>Projected climate impacts on watershed functioning</li> <li>Water security – planning for future drought and flood mitigation</li> <li>Priority areas for retention/restoration/management</li> </ul>	•
<b>OPTIMIZER/TRADE OFF /VALUATION TOOLS</b>	<b>POSSIBLE DATA SOURCES</b>	<b>BIODIVERSITY</b>	<b>CARBON STORAGE</b>	<b>CARBON SEQUESTRATION</b>	<b>CULTURALLY SIGNIFICANT ECOSYSTEMS</b>	<b>WATERSHED RESILIENCE</b>	<b>WILDFIRE RESILIENCE</b>
<ul style="list-style-type: none"> <li>Conservation Planning</li> </ul>	<ul style="list-style-type: none"> <li>Sites Conservation Canada Where to Work (web based tool for conservation prioritization – biodiversity &amp; carbon) <a href="https://ncc.carleton.ca/">https://ncc.carleton.ca/</a></li> <li>CDFCP Marxan Tool</li> </ul>		•	•	•	•	•

DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>Ecosystem Valuation</li> </ul>	<ul style="list-style-type: none"> <li>Costing Nature Policy Support System (web-based tool for ecosystem services) <a href="http://www.policysupport.org/costingnature">http://www.policysupport.org/costingnature</a></li> </ul>		<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
ADDITIONAL	POSSIBLE DATA SOURCES	BIODIVERSITY	CARBON STORAGE	CARBON SEQUESTRATION	CULTURALLY SIGNIFICANT ECOSYSTEMS	WATERSHED RESILIENCE	WILDFIRE RESILIENCE
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Metro Vancouver environmental mapping <a href="http://www.metrovancouver.org/data">http://www.metrovancouver.org/data</a></li> </ul>	<ul style="list-style-type: none"> <li>Land cover classification (5m hybrid raster)</li> <li>Sensitive ecosystems</li> <li>tree canopy</li> <li>regional greenway corridors</li> </ul>	<ul style="list-style-type: none"> <li>carbon biomass</li> <li>carbon ecotype</li> <li>carbon soil</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li>Tree canopy &amp; Impervious surfaces</li> <li>watershed boundaries</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>CRD Environmental mapping <a href="https://mapservices.crd.bc.ca/arcgis/rest/services/Environmental/MapServer">https://mapservices.crd.bc.ca/arcgis/rest/services/Environmental/MapServer</a></li> </ul>	<ul style="list-style-type: none"> <li>Sensitive ecosystems</li> <li>Potential sharp-tailed snake habitat</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Surrey environmental mapping <a href="https://data.surrey.ca/dataset?groups=environment">https://data.surrey.ca/dataset?groups=environment</a></li> </ul>	<ul style="list-style-type: none"> <li>habitat suitability</li> <li>terrestrial hubs</li> <li>ecosystem corridors</li> <li>ecosystem sites (smaller sites 0.25-10ha in size)</li> <li>Green infrastructure network</li> <li>Aquatic hubs</li> <li>watercourses</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Saanich environmental mapping <a href="https://www.saanich.ca/EN/main/community/natural-">https://www.saanich.ca/EN/main/community/natural-</a></li> </ul>	<ul style="list-style-type: none"> <li>Saanich environmental reference guide</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>



DATA LAYER TYPE	POSSIBLE DATA SOURCES	ECOSYSTEM SERVICE REPRESENTED/DERIVED					
		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
	<a href="#">environment/environmental-planning/saanich-ecosystem-mapping.html</a>	<ul style="list-style-type: none"> <li>Environmentally sensitive areas (under development)</li> </ul>					
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Courtenay environmental mapping</li> </ul>	<ul style="list-style-type: none"> <li>Environmentally sensitive areas</li> <li>Tree canopy cover</li> </ul>	•	•	•	•	•
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Islands Trust environmental mapping <a href="http://maps.islandstrust.bc.ca/ar-cgis/rest/services/Dynamic">http://maps.islandstrust.bc.ca/ar-cgis/rest/services/Dynamic</a></li> </ul>	•	•	•	•	•	•
<ul style="list-style-type: none"> <li>Local government mapping</li> </ul>	<ul style="list-style-type: none"> <li>Vancouver GIS data - <a href="https://opendata.vancouver.ca/pages/home/">https://opendata.vancouver.ca/pages/home/</a></li> <li>North Vancouver GIS data - <a href="https://geoweb.dnv.org/data/">https://geoweb.dnv.org/data/</a></li> </ul>	•	•	•	•	•	•
<ul style="list-style-type: none"> <li>Climate change</li> </ul>	<ul style="list-style-type: none"> <li>Pacific Climate Impacts Consortium Data Portal <a href="https://www.pacificclimate.org/data">https://www.pacificclimate.org/data</a></li> <li>Pacific Climate Impacts Consortium Climate Explorer <a href="https://www.pacificclimate.org/analysis-tools/pcic-climate-explorer">https://www.pacificclimate.org/analysis-tools/pcic-climate-explorer</a></li> </ul>	•	•	•	•	•	•
<ul style="list-style-type: none"> <li>Other data portals</li> </ul>	<ul style="list-style-type: none"> <li><a href="#">iMapBC</a></li> <li><a href="#">DataBC</a></li> <li><a href="#">HectaresBC</a></li> <li><a href="#">EcoCat</a></li> <li><a href="https://open.canada.ca/en/open-data">https://open.canada.ca/en/open-data</a></li> <li><a href="https://www.sentinel-hub.com/explore/eobrowser">https://www.sentinel-hub.com/explore/eobrowser</a></li> </ul>	•	•	•	•	•	•

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		Biodiversity	Carbon Mitigation		Culturally Significant Ecosystems <i>(only as defined by and with First Nations consent)</i>	Watershed Resilience	Wildfire Resilience
			Storage	Sequestration			
<ul style="list-style-type: none"> <li>• QGIS tool for remote sensing data training</li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">Semi-Automatic Classification Plugin</a>.</li> </ul>	•	•	•	•	•	•

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