



**Credit Valley  
Conservation**

**How Healthy is the Credit River watershed?  
Assessing Ecological Health Through CVC's  
Integrated Watershed Monitoring Program**

**Presented by: Loveleen Clayton**

**October 4, 2014**



What has changed? Land use/cover is the obvious answer.

.....political climate, fiscal responsibility, efficiency, climate change, grey hairs!

In this presentation I will exploring how we monitor for the ecological health of the Credit River watershed.

## Executive Summary

- What is IWMP?
- What does IWMP measure?
- IWMP: Then and Now
- Redesigned IWMP
- Results to date
- Future Plans for IWMP
- Input from stakeholders



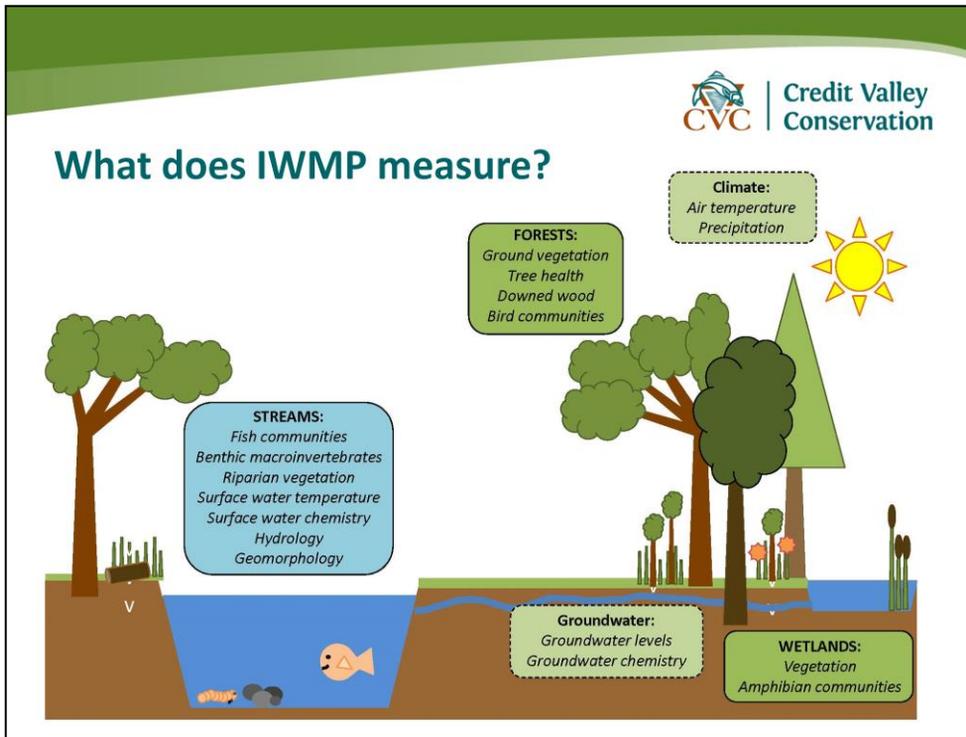
## What is IWMP?

- CVC's **Integrated Watershed Monitoring Program (IWMP)** is designed to take the pulse of the watershed
- Initiated in **1999** as a high priority in spite of significant budget cuts
- IWMP has:
  - Rigorous standard protocols
  - Highly trained staff
  - Well-maintained equipment
  - Strong data management



Similar to the annual physicals we take at the doctors' office. We may feel and look good, but if we get checked regularly, we hope to diagnose an issue early on and treat it before its too late.

CVC now has over 10 years of data at several sites across the watershed. This gives us a powerful dataset to start to analyze, integrate and make conclusions and potentially recommendations at a landscape scale as well potentially at a site level.



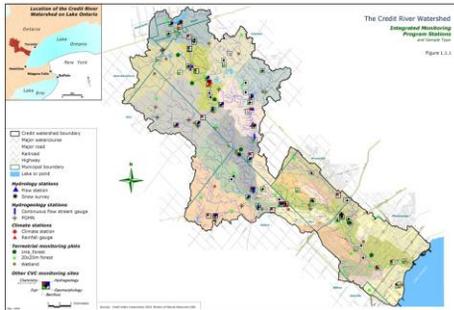
Blue – instream

Darker green – land-based

Hatched – complementary things we monitor to help explain what we're seeing in the other attributes.

## IWMP: Then and Now

### Then



### Now



### Then

- Not all sites where not all disciplines were together
- Frequency: annually

### Now

- Some different sites, different frequencies.

In order to understand what has changed, I'm going to walk you through the process we went through.

## IWMP redesign process

1. Outlined the goals and scope of IWMP

## IWMP: Goals and Scope

### GOALS

To monitor and assess **status and trends** in the integrity of **aquatic and terrestrial** indicators for the Credit River **watershed** and its **physiographic zones**, and to guide **adaptive management**

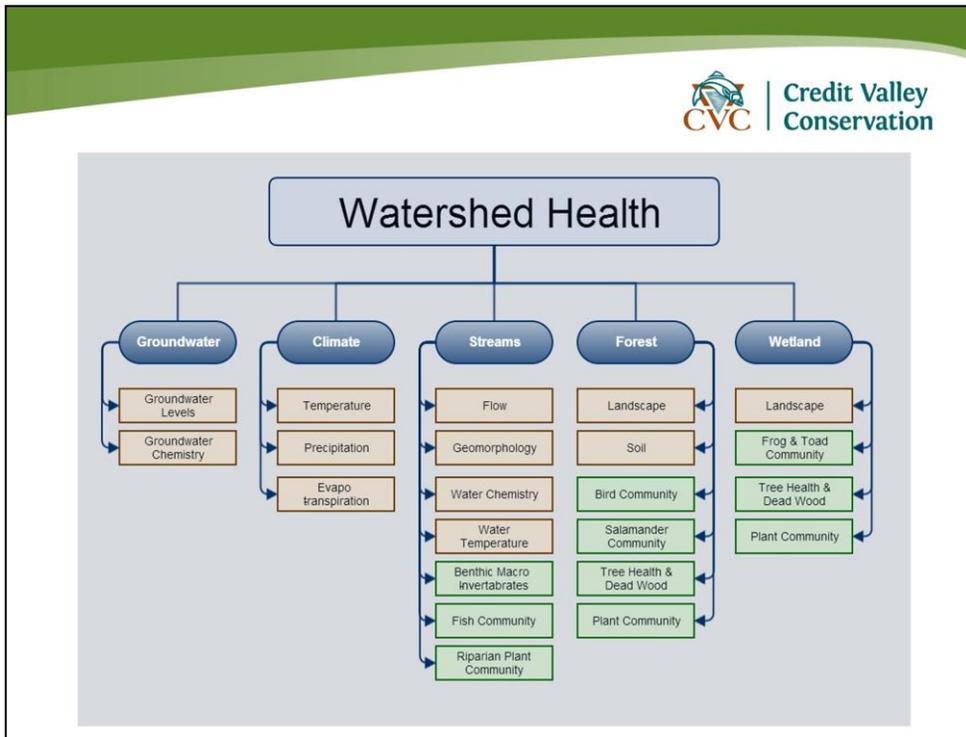
### SCOPE

Conditions at the level of the watershed and/or physiographic zone (*i.e.* upper, middle, lower)

But can be used to understand subwatershed if instream sites generally are found at bottom end of the most subwatersheds. Can therefore represent overall contributions to the main Credit River.

## **IWMP redesign process**

1. Outlined the goals and scope of IWMP
2. Defined terminology (e.g. indicator, metric)



System –

Attribute –

Indicator -

Metric -

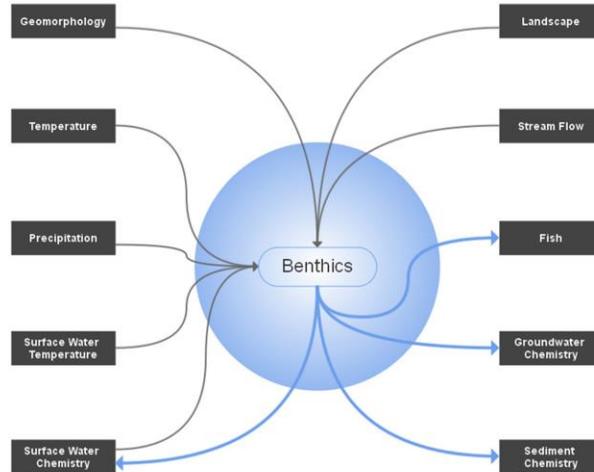
Measure -

## IWMP redesign process

1. Outlined the goals and scope of IWMP
2. Defined terminology (e.g. parameter, metric)
3. Developed a list of ideal discipline needs
4. Determined how parameters measured by one discipline are used by others
5. Created conceptual models

3. Ideal for each discipline to get from other disciplines
4. Ranking system
  1. Will use in analysis and some reporting
  2. Has explanatory power based on known relationships (literature)
  3. Value in exploring relationships
5. To visualize linkages and integration

## IWMP: Discipline Needs Model Example



Example of what benthics needs from others, and what others needs from benthics

Grey lines – what benthics needs from others

Blue lines – what others need from benthics

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6. Performed a preliminary power analysis
7. Agreed on a set of instream integration stations

Power analysis – statistical exercise to help us determine # of sites needed to give us CONFIDENCE in our results and enough POWER to detect trends

Exercise was run with real IWMP data. Will be run again in a couple of years following new design to check on the power

## Site selection criteria

- IWMP history
  - make use of long-term data
- Stream order (2)
  - e.g. main, tributary
- Physiographic region (10)
  - e.g. Oak Ridges Moraine
- Physiographic zone (3)
  - e.g. Upper watershed
- Major land use (2)
  - e.g. urban, rural
- Subwatershed (22)
  - meet supporting program needs



## Status and trends at different scales

Groundwater quality & levels  
Meteorology (climate)

} *Watershed conditions*

Hydrology (flow)  
Riparian  
Fish  
Benthic macroinvertebrates  
Surface water quality & temperature  
Geomorphology

} *Watershed, site and zone conditions*

} *Integrated analysis*

Land use cover  
Forests  
Wetlands

} *Watershed, site and zone conditions*

## Integration at different spatial scales

Notice something happening with fish, can look at riparian veg or benthics

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↓  
*Watershed, site and zone conditions*

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↑  
*Watershed, site and zone conditions*

Don't have well or climate at every stream site and forests/wetlands not always right beside stream sites

But can still make comments about how GW is doing at a w/s level or forest health at w/s and zone levels and then relate to instream observations.

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7. Agreed on a set of instream integration stations
8. Produced the recommended study design

## IWMP redesign: Number of Sites

- Network of **39 core** integration sites with all instream disciplines

### **SAME PLACE    SAME YEAR**

Water chemistry, water temperature, fish, benthics, streamflow, riparian, geomorphology

Frequency to be discussed after

## IWMP redesign: Number of Sites

- Network of **39 core** integration sites with all instream disciplines
- Supporting network of **53 sentinel** sites for fish, benthics, water temperature, & geomorphology

At sentinel sites: Disciplines that need a larger number of sites to make confident comments on status and trends (higher power)

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- Groundwater at **22 wells**
- Meteorology at **9 climate stations\***

Meteorology: Data is collected outside of IWMP (other CVC programs and EC), but we use it

## IWMP redesign: Sentinel sites

- Integration: fish, benthics, water temperature and rapid geomorphic assessment
- Greater power to detect trends in watershed and physiographic zones
- Tributaries
  - Early warning capability (sensitive)
  - Greater spatial coverage of watershed (variable)
- Efficient use of field crews

Allow us to do more integration. As such, they include some of the instream disciplines that are the focus of our integrated analysis – fish and benthics

These were also disciplines that were identified as needing more sites to get enough power to detect trends and are disciplines that are affordable to add more sites and sampling

Includes headwater, mid-reach sites

Headwater sites are more variable and more sensitive –main rivers are slower to respond (e.g. climate change)

## IWMP redesign: Frequency

### Panel Design:

- Some sites are visited annually, some every other year
- Trade-off: increased sample size for reduced frequency
- Annual sites ensure consistency in monitoring

Panel	Year									
	1	2	3	4	5	6	7	8	9	10
Annual	X	X	X	X	X	X	X	X	X	X
A	X		X		X		X		X	
B		X		X		X		X		X

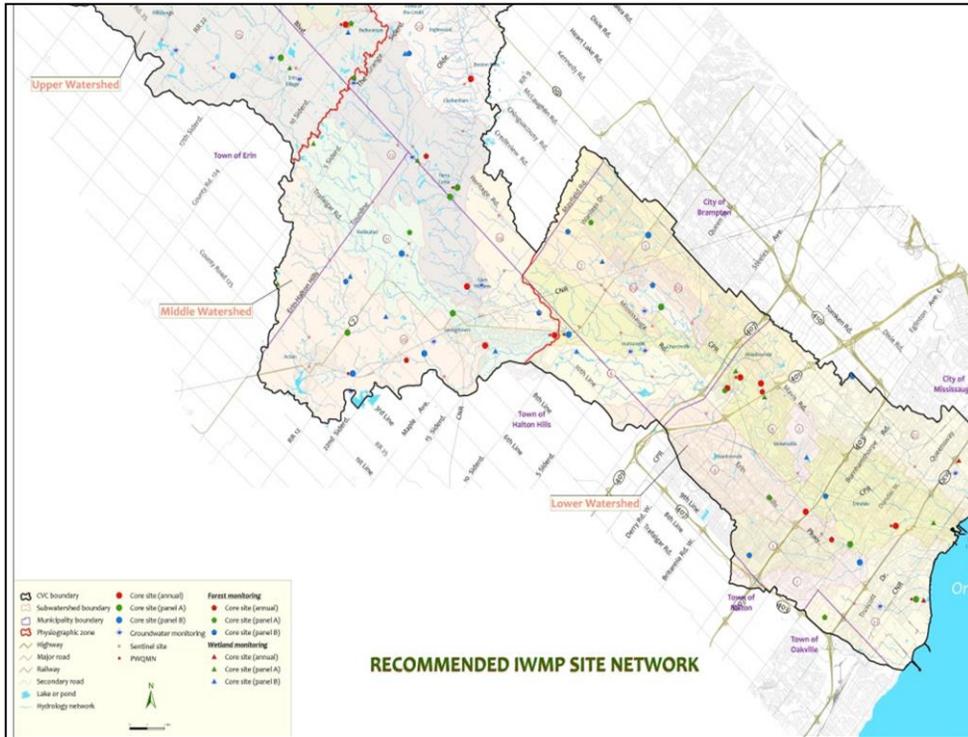
Covered off numbers, now talk about how often we'll be sampling

Important component of our redesign: adopting a panel design

Graph at bottom = example

Some annually, some every other year or even less

Reduced frequency .....also benefit of site exhaustion



## IWMP redesign: Major Changes

**Integrated** data collection for all instream disciplines at core instream sites

Benefit: greater capability for analysis, detection and interpretation of trends.

## IWMP redesign: Major Changes

**Integrated** data collection for all instream disciplines at core instream sites

**Panel design** for instream sites, forests, wetlands

Reminder: additional wells are already drilled – we are taking on their monitoring as a part of IWMP

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<b>More tributary sites</b> vs. main river in core sites

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Reduction in frequency of riparian and geomorphology monitoring

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<b>Focused monitoring</b> to address <b>goals</b> of program
<b>Reduction</b> in frequency of <b>riparian</b> and <b>geomorphology</b> monitoring
<b>Removal</b> of <b>sediment chemistry</b> from program

Reminder: additional wells are already drilled – we are taking on their monitoring as a part of IWMP

## Criteria used in IWMP redesign

- Science needs
  - Questions IWMP data is used to address
- Professional knowledge
  - Representation across watershed, site types
- Power analysis
  - Adequate number of sites for each discipline
- Budget
  - Recommended plan approximately at current budget

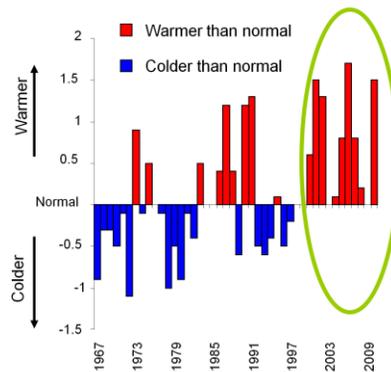


➤ **Confidence in reporting of status & trends**

## Interesting Findings.....

### Climate:

- Since 1999, annual air temperatures in the Credit River Watershed have **averaged 1.4°C higher than the long-term average (i.e. normal).**



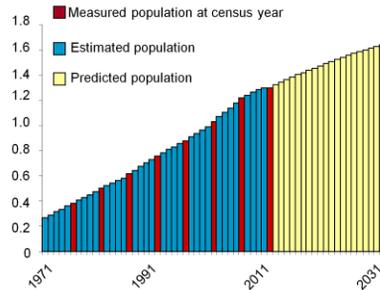
Results match those across the globe that air temperatures are increasing.

**CLICK:**

## Interesting Findings.....

### Population:

- Between 1996 and 2006 the population in the Credit River Watershed grew from 573,000 to 758,000 (George Morris Centre 2009). That's an **increase of 32 percent over ten years.**



Population: projected to grow at the same rate to 2031, according to Region of Peel figures. With population comes urbanization....used as a surrogate in this case to demonstrate rate of urbanization.

## Interesting Findings.....

Urbanization is impacting  
the health of the  
watershed

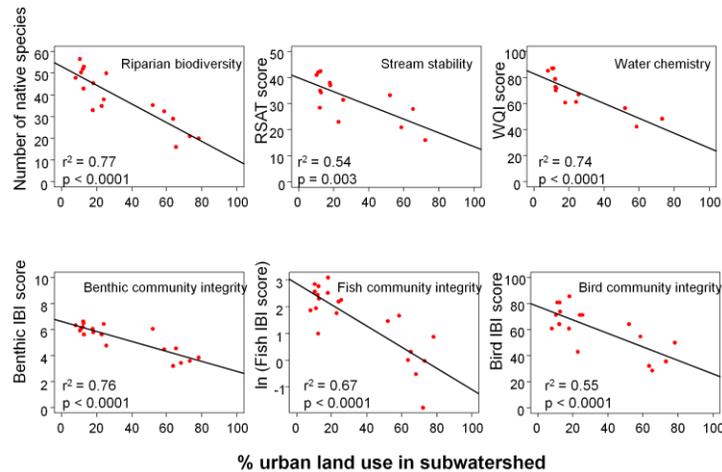


Chapter 5-16: indicators of ecological health vary from poor to excellent depending on the indicator and location in the watershed.

One general trend: **CLICK** while not surprising nice to see that our data is confirming this concept. We can use this baseline information to potentially track improvements to these impacts.

As the CRWMS produced in 2007 showed that if the Upper and Middle watershed reached the same level of urbanization as the lower it is likely that the health of the CRW would be substantially reduced....having negative consequences for the Watershed, lake Ontario. Therefore, protection plans such as the GB, ORM, NEP and the newly released CVC Natural Heritage Strategy (presented right now in a concurrent session by Dr. Aviva Patel) are particularly important

## Urbanization and Watershed Health



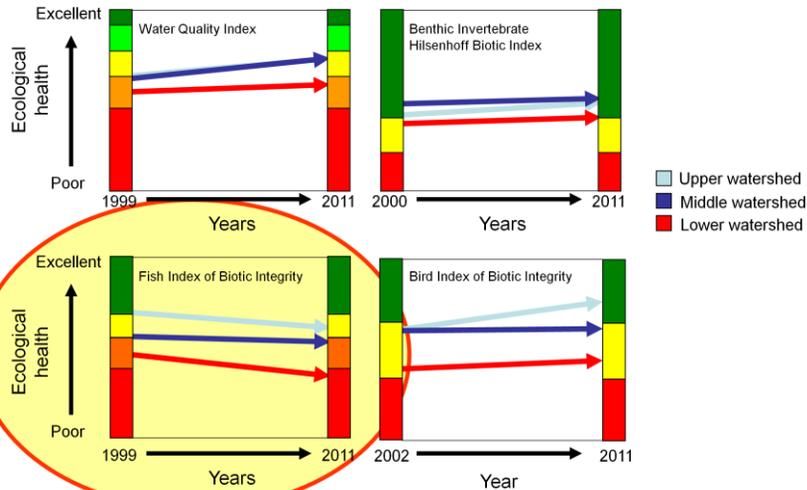
This slide supports the finding that urbanization is impacting the health of the watershed.

**CLICK:** Looked at % urban land use (ELC layer) and 2011 data points.....**current status**. Show 6 major indices used by IWMP. All statistically significant. Weakest relationship was  $R^2$  of 0.54 for stream stability.

While this strong trend is evident in current condition, we need to recognize importance of long-term data vs. a snapshot in time.

We also have reason to be hopeful about the long term future or resilience of the Credit River watershed. Some indicators have improved or at the very least did not decline over the length of the entire monitoring record. **CLICK**

## Long-term Watershed Health



**CLICK:** Trends in a subset of indicators with >10years of data by Upper, Middle and Lower.

**CLICK:** One concerning trend is the fish IBI. We are investigating this now to see why other indicators aren't showing the same results, and testing out other methods of interpreting the fish community data, beyond IBI...e.g. species level data, community shifts over time.

## Why declining fish IBI?

- May be responding to metrics either not measured at same locations as fish stations or measured at all by IWMP
- May provide an indication that the **cumulative impact** of these stressors are having a negative impact on the Credit River ecosystem
- Declining trends mimic increasing pressure from stressors (i.e. climate change and urbanization)

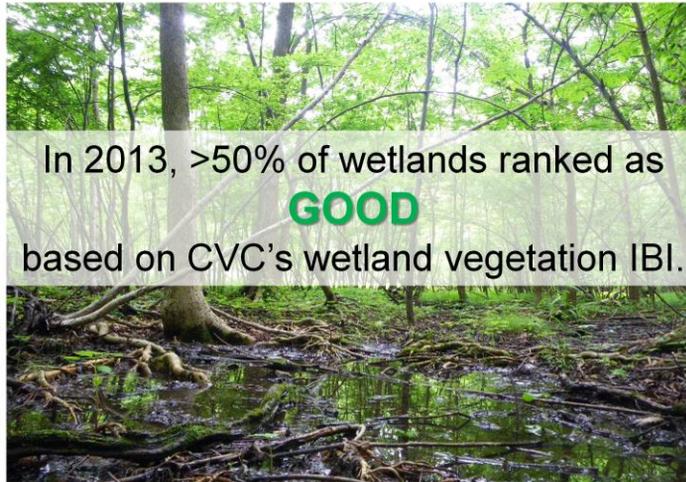


Cumulative impacts is something that we are interested in exploring more.....in fact we have just started to conduct analysis such as variance partitioning to estimate how of a given change can be attributed to a specific factor

For example: benthics responding directly to water quality issues. Water quality is stable or improving.

Fish are responding may be responding to things, not direct reflection of water quality.

## Wetland Vegetation Community Integrity



11 of 20 sites.

All good sites located in the upper or middle.

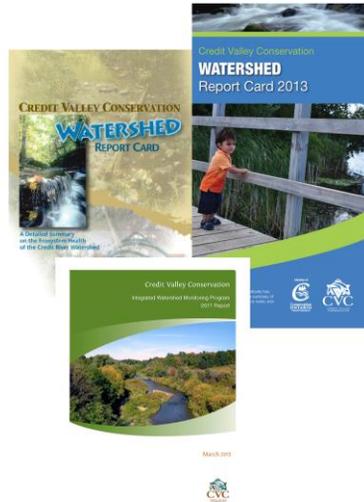
## Future Plans for IWMP

- Understand how data are used internally and externally
  - 3 journal articles published in last 2 years with IWMP data
- Integrated analysis
- Communicating results



## Communicating Results

- Annual Program Report
- Site factsheets on web
- Watershed status report
- Long-term watershed monitoring report
- Bulletins & Notes
- Journal articles



### Annual program report

- 2 pages per disciplines
- Annual
- Key findings

### Site factsheets

- Interactive info on web.
- Site level analysis not scope of IWMP, but necessity and able

### Watershed Status Report

- Every two years due to panel design
- Current status

### Long-term watershed monitoring report

- About every 5 years on status and trends

### Bulletins and Notes

- Addressing specific questions or regions, e.g. urban forest management recommendations, methodology review

### Journal articles

- Published with CVC as authors/co-authors, or academia as authors

## Input from stakeholders

- How would you like to learn about our results?
- Questions?

