# Mapping Canadian Wetlands

Wetlands cover millions of square kilometers of the Canadian landscape. They are essential for maintaining healthy ecosystems and provide many ecological benefits. However, the vast number of wetlands and their often remote locations makes conducting large inventories a daunting task. Creating a Canada-wide inventory using only traditional field-based techniques would be too expensive and labour intensive. Now, thanks to accessible remote sensing technology, scientists have feasible, cost effective, and accurate options available.

## Canadian Wetland Classification System (CWCS)

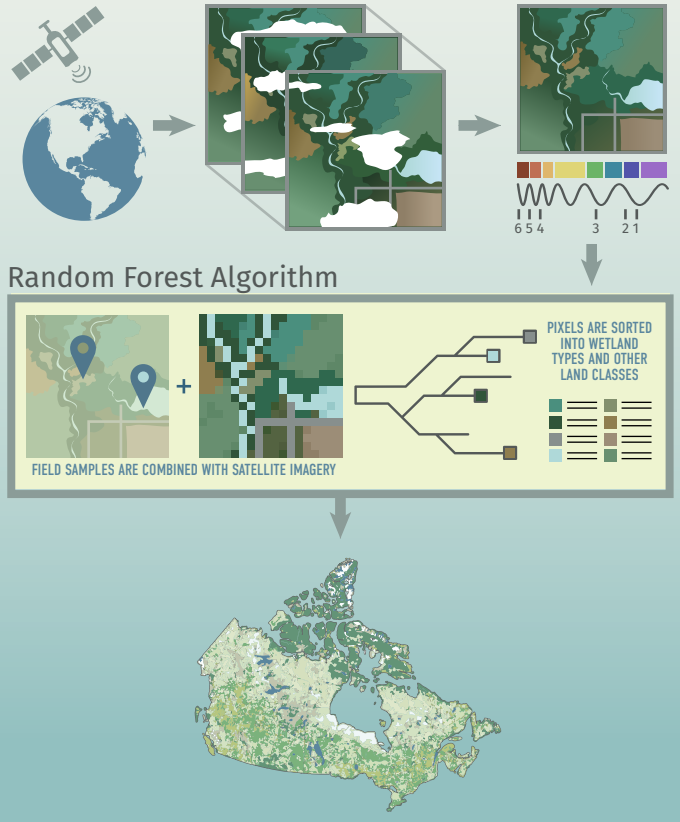
To achieve a cohesive wetland inventory over time and space, the method of classification must remain consistent. As per the Canadian Wetland Classification System, wetlands are classified into five classes using multiple characteristics such as soil type, water source, water table, vegetation, pH, and nutrient conditions.


## Making the First Canada-Wide Wetland Inventory Map

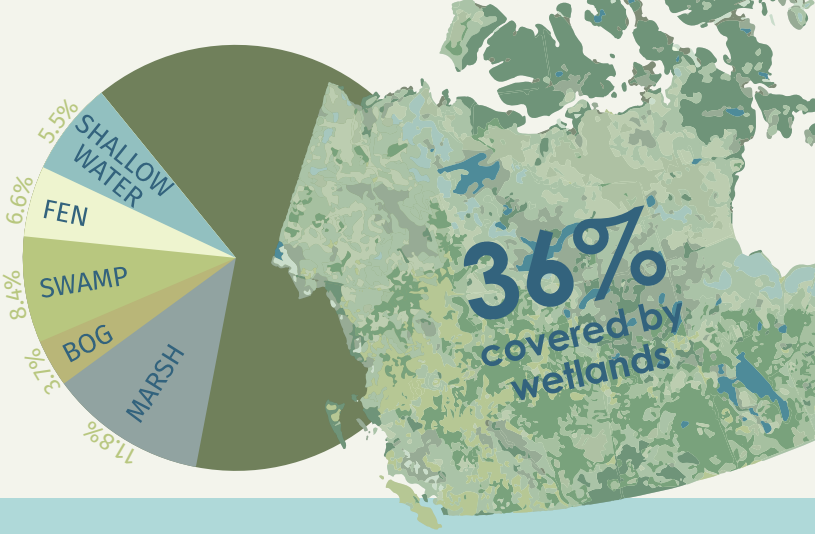
Creating a Canada-wide wetland inventory map requires the right tools. Gathering and processing imagery is time consuming and requires large amounts of data storage. Google Earth Engine (GEE) was chosen for this task because it is a cloud-based platform where large datasets can be directly combined and processed without downloading enormous quantities of data. Through GEE, users can easily access and modify a variety of processing algorithms with simple codes.

Creating the dataset involved several key steps and data sources. First, multi-date Landsat-8 satellite imagery was collected, pre-processed, and used as base data for the classification. Pre-processing includes removing areas of clouds and snow that obscure the landscape and replacing these pixels with other images around the same time of year. Removing pixels introduces holes, so multiple images over time are combined to create one intact image layer. Using more than one image improves wetland identification since it accounts for changes in water content and vegetation growth over time.

Secondly, six spectral bands from the imagery are input into an algorithm called the random forest algorithm. This algorithm uses machine learning to sort pixels from satellite images into groups — these groups being the different wetland types. Since the algorithm learns, many field samples are needed to both teach the algorithm and check for accuracy.



The resulting inventory map has a resolution of 30 meters, estimates that 36% of Canada is covered by wetlands, and has an overall accuracy of 71%. Since previous estimates place the percentage of wetlands in Canada around 13% (not including the shallow water type wetlands), this initial map may have overestimated wetland area. However, original estimations could be low, and the true value may lie somewhere between. Improving the accuracy of future maps is needed to narrow the estimated range.




## Improving the Wetland Inventory

### Using higher resolution imagery or additional spectral bands

Landsat-8 images are one of many types of satellite imagery that can be used. Other sensors or a combination could help improve accuracy. For example, incorporating higher resolution optical imagery, (10m resolution Sentinel-2 data), radar imagery (Sentinel-1 or ALOS PALSAR), and/or digital elevation model (DEM) data could greatly improve classification accuracy.

### Increasing the number of field samples

Since the algorithm needs field-based data to learn how to classify pixels, more field samples will improve accuracy. This includes samples of both wetland and non-wetland areas so the algorithm can be trained to recognize differences.

### Experimenting with algorithm classification methods

Using an object-based classification may be more accurate than pixel-based as it groups and classifies pixels based on spectral similarities.

## Future uses for wetland inventory maps

Future inventory maps could be used to model the ecological processes of wetlands such as carbon storage, methane emissions, water quality treatment, flow moderation, and biological productivity. Being able to inventory different classes of wetlands is important because they provide differing services. For example, swamps have more potential for increasing water quality than bogs, but peatlands (bogs and fens) have a higher carbon storage potential. Mapping wetlands is important not only to determine the location and extent of wetlands but also to understand gains and losses in wetland area over time.

An accurate wetland inventory will help assess wetland conditions and provide an essential resource for developing future wetland conservation and management policies.

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This first Canada-wide wetland inventory map was completed in 2019. Since then, work to improve the map has continued, and in 2021 researchers completed a third iteration of the map with an increased overall accuracy of 90.5%.

1. Amani et al., (2019). Canadian Wetland Inventory using Google Earth Engine: The First Map and Preliminary Results

2. Mahdianpari et al., (2021). The Third Generation of Pan-Canadian Wetland Map at 10 m Resolution Using Multisource Earth Observation Data on Cloud Computing Platform

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