Observing Canada From Space

Please Complete the Student Survey

- You should have a notification via email
- Otherwise, can access here: Canvas SEI Surveys

Learning Objectives

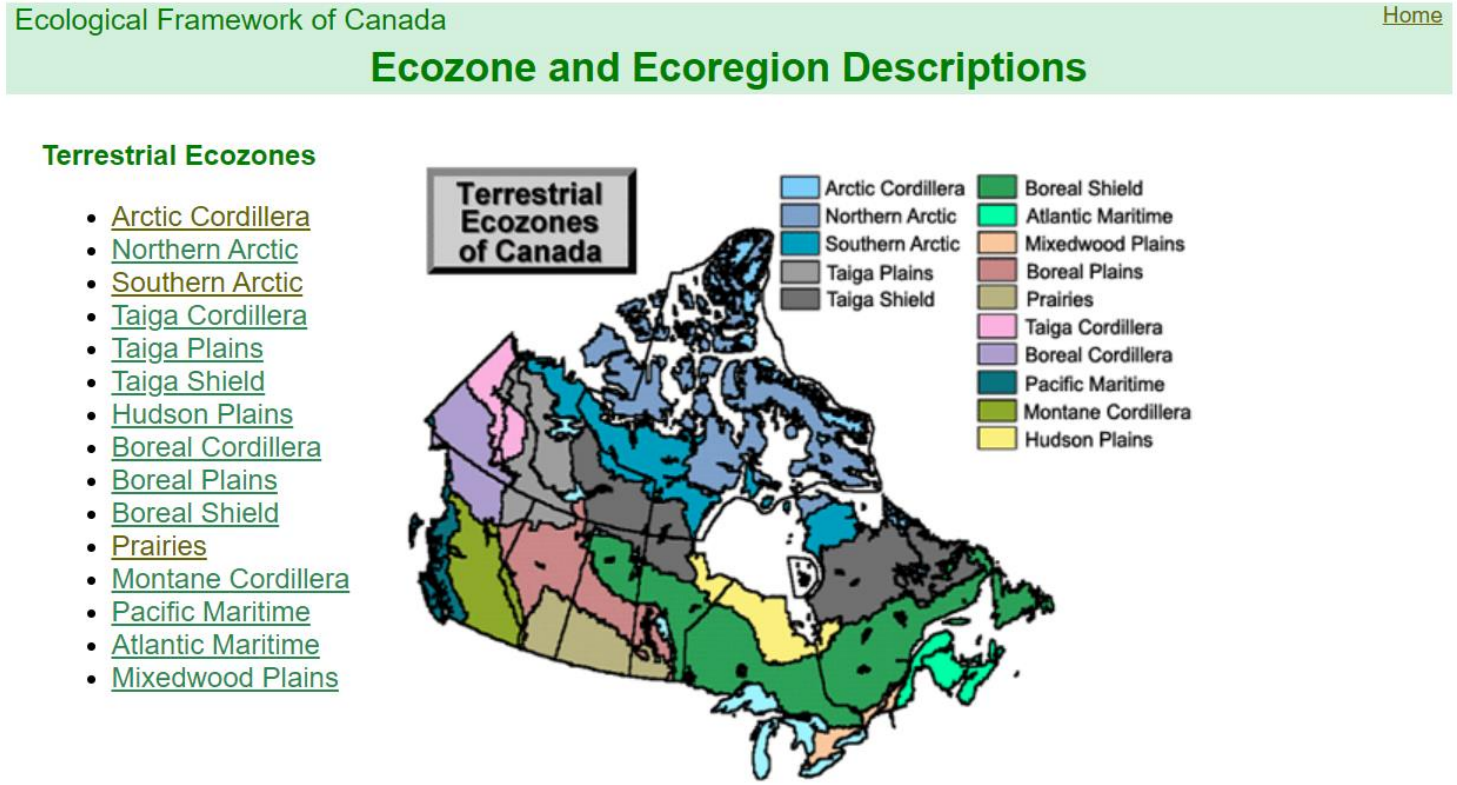
- In this lecture you will learn…
  - Introduction to Canada's ecozones
  - Researching peer-reviewed literature for blog post 5

Canada From Space

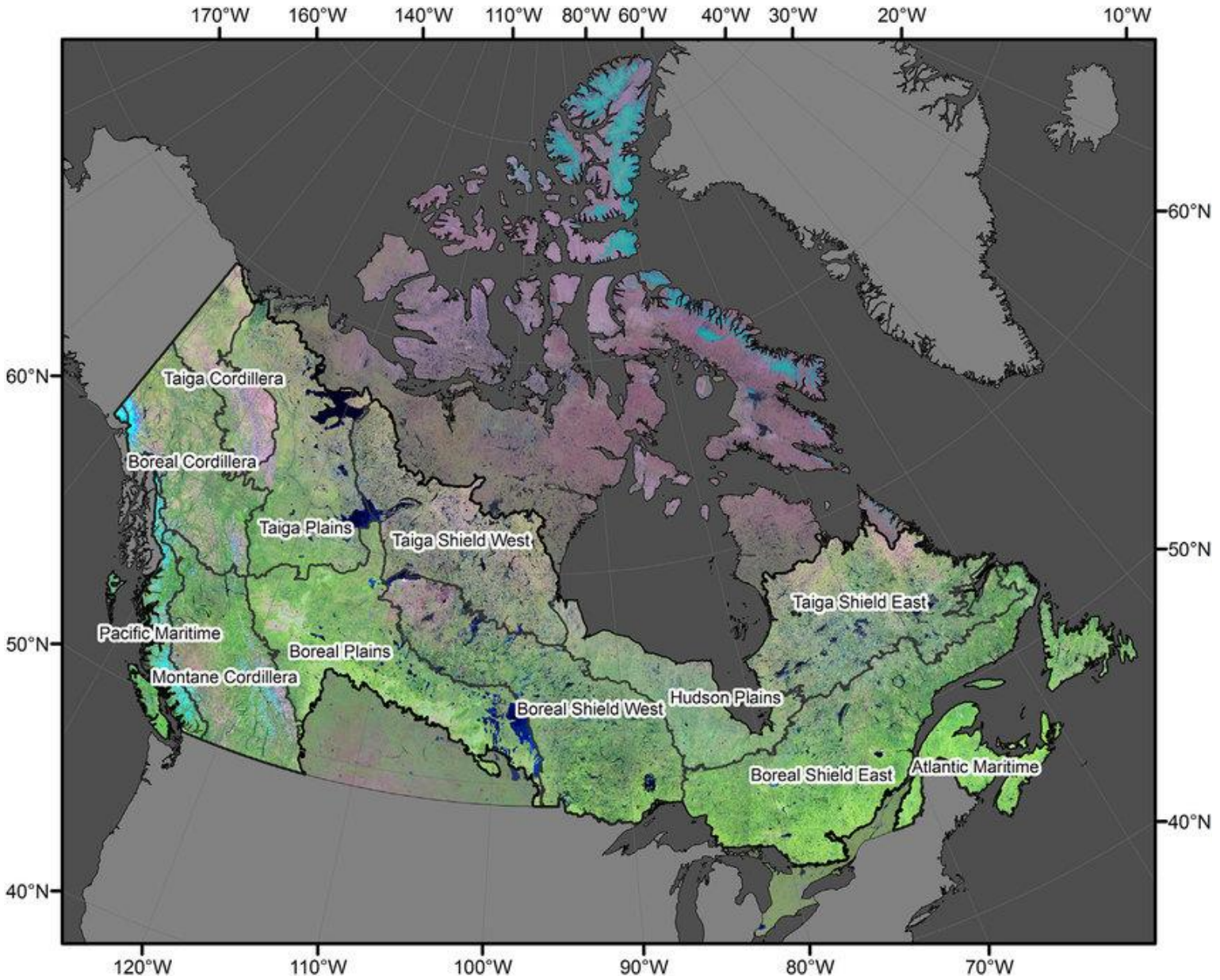
- Second largest country in the world after Russia
  - 60% of the world's lakes
  - 10% of the world's forest
  - Nearly 10 million km^2 in land mass
- Large size leads to a diversity of landscapes and climate

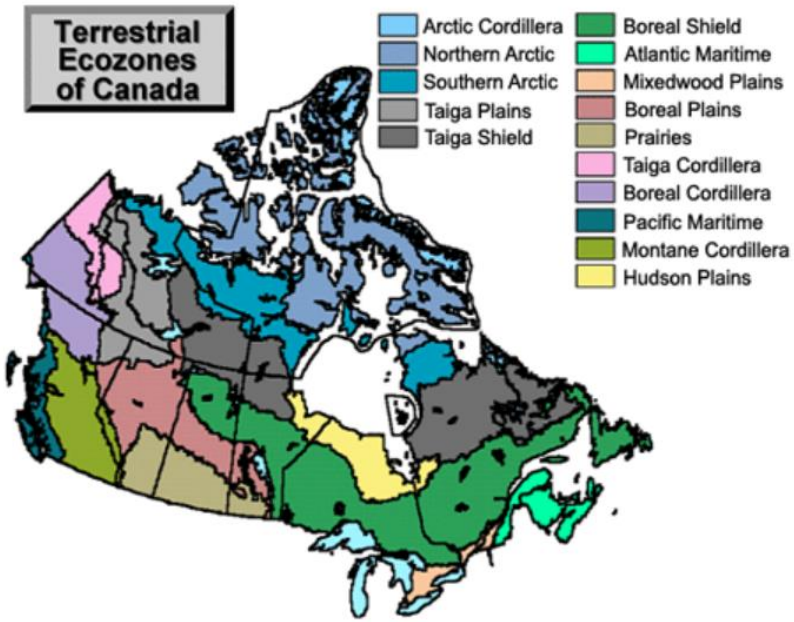
Ecozones of Canada

- Method used to describe ecosystems
- 15 terrestrial ecozones in Canada
- The largest ecozone is the Boreal Shield
  - 20% of Canada's land mass
  - 10% of its fresh water



http://www.ecozones.ca/english/zone/index.html





False color composite of forested Canadian ecozones derived from Landsat

Blog Post 5

- For blog post 5 we want you to do some research about how earth observation remote sensing is being used in one of Canada's **terrestrial** ecozones
- Specifically you need to find a peer-reviewed journal article about remote sensing and describe the article:
  - What is the unique feature of the ecozone that the authors are monitoring?
  - What is the specific process/phenomena that earth observation is being used to measure?
  - What is the specific satellite/sensor/dataset being used

Peer-reviewed Literature

- In scientific literature, articles that are published in journals undergo a rigorous peer-review process
  - This means that before an article is published, it must be reviewed by other well established scientists in that field
  - And they must approve it for publication

- This is essentially how the scientific community performs quality control on articles before they are published

Finding an Article

- Combine some research on different ecozones and your knowledge from class to search articles
- Using an academic search engine like google scholar is recommended
  - https://scholar.google.com/

Let’s look at an example

- We live somewhere around here
- The ecozone we live in is the Pacific Maritime

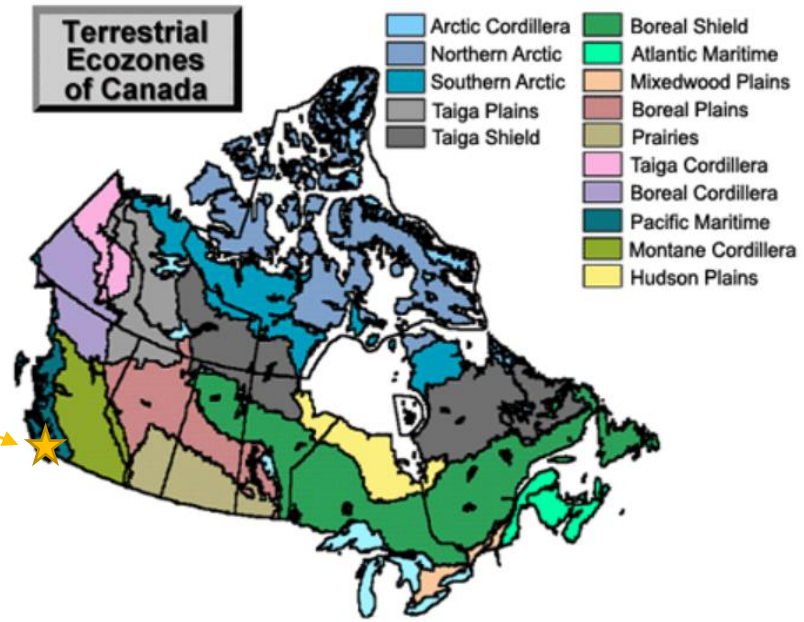
Ecological Framework of Canada

Home

Ecozone and Ecoregion Descriptions

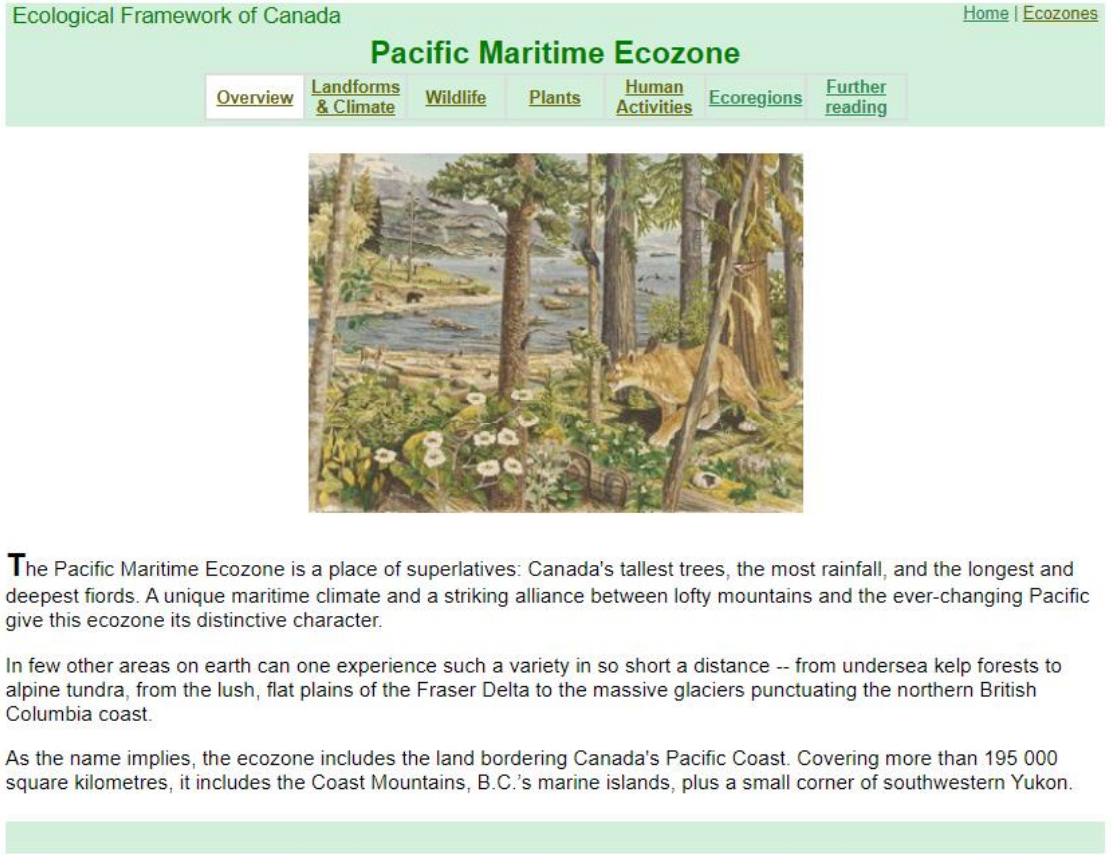
Terrestrial Ecozones

- Arctic Cordillera
- Northern Arctic
- Southern Arctic
- Taiga Cordillera
- Taiga Plains
- Taiga Shield
- Hudson Plains
- Boreal Cordillera
- Boreal Plains
- Boreal Shield
- Prairies
- Montane Cordillera
- Pacific Maritime
- Atlantic Maritime
- Mixedwood Plains



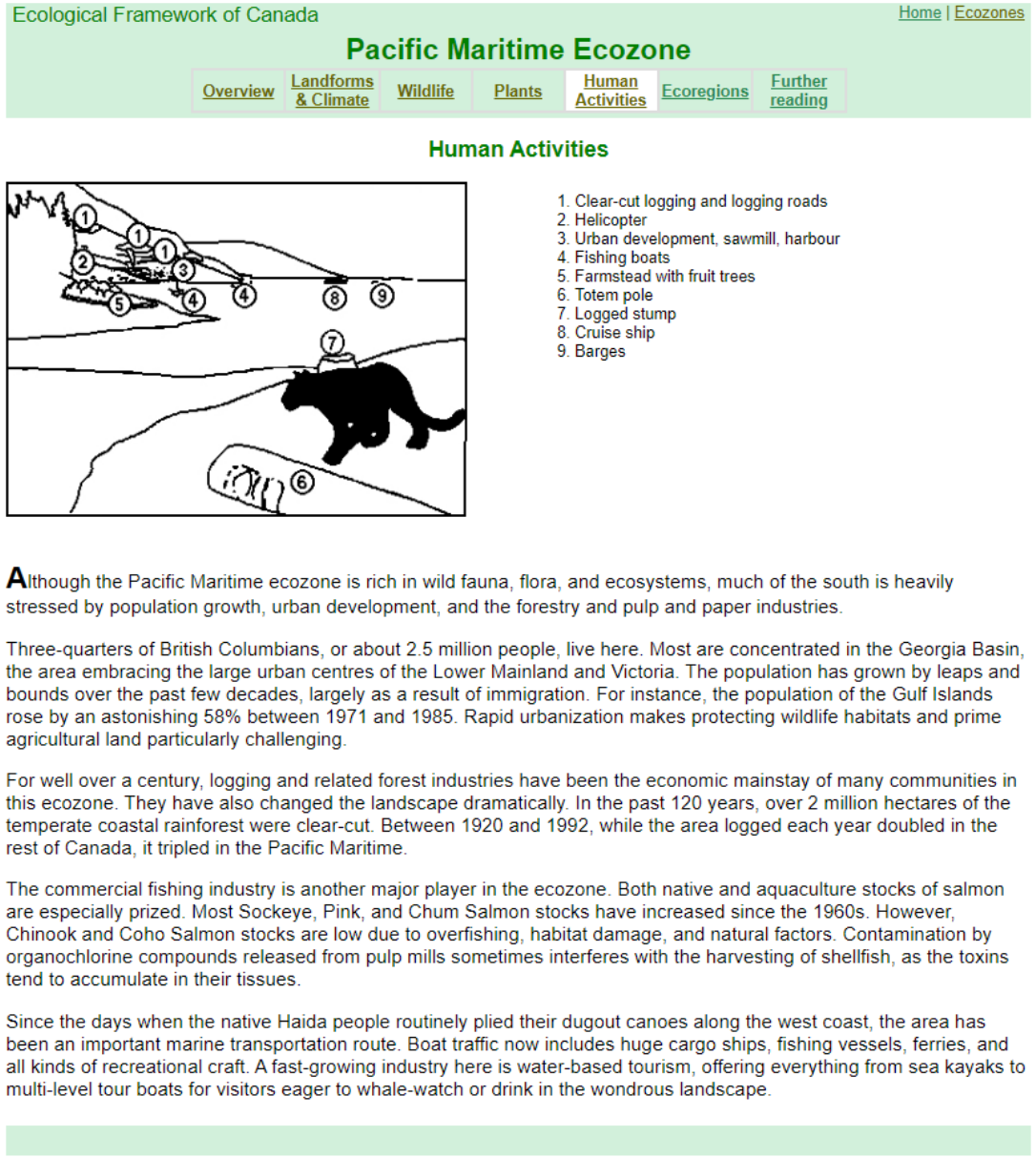
Pacific Maritime

- I can go to the ecozone website and click on the Pacific Maritime ecozone
  - That will pull up a page like this
  - Where I can read about landforms, climate, plants, human activities, etc.



Pacific Maritime

- One of the things I notice in the human activities is that forestry is very very common!
- I know from class forest harvesting is often monitored and detected with Landsat
- So I use that to go search some key words in google scholar
  - https://scholar.google.com/
  - Note using the ecozones as keywords is not very helpful
    - Try real geographic regions or locations in your search instead that are within that ecozone



Ecological Framework of Canada

Home | Ecozones

Pacific Maritime Ecozone

Overview | Landforms & Climate | Wildlife | Plants | Human Activities | Ecoregions | Further reading

Human Activities

1. Clear-cut logging and logging roads
2. Helicopter
3. Urban development, sawmill, harbour
4. Fishing boats
5. Farmstead with fruit trees
6. Totem pole
7. Logged stump
8. Cruise ship
9. Barges

Although the Pacific Maritime ecozone is rich in wild fauna, flora, and ecosystems, much of the south is heavily stressed by population growth, urban development, and the forestry and pulp and paper industries.

Three-quarters of British Columbians, or about 2.5 million people, live here. Most are concentrated in the Georgia Basin, the area embracing the large urban centres of the Lower Mainland and Victoria. The population has grown by leaps and bounds over the past few decades, largely as a result of immigration. For instance, the population of the Gulf Islands rose by an astonishing 58% between 1971 and 1985. Rapid urbanization makes protecting wildlife habitats and prime agricultural land particularly challenging.

For well over a century, logging and related forest industries have been the economic mainstay of many communities in this ecozone. They have also changed the landscape dramatically. In the past 120 years, over 2 million hectares of the temperate coastal rainforest were clear-cut. Between 1920 and 1992, while the area logged each year doubled in the rest of Canada, it tripled in the Pacific Maritime.

The commercial fishing industry is another major player in the ecozone. Both native and aquaculture stocks of salmon are especially prized. Most Sockeye, Pink, and Chum Salmon stocks have increased since the 1960s. However, Chinook and Coho Salmon stocks are low due to overfishing, habitat damage, and natural factors. Contamination by organochlorine compounds released from pulp mills sometimes interferes with the harvesting of shellfish, as the toxins tend to accumulate in their tissues.

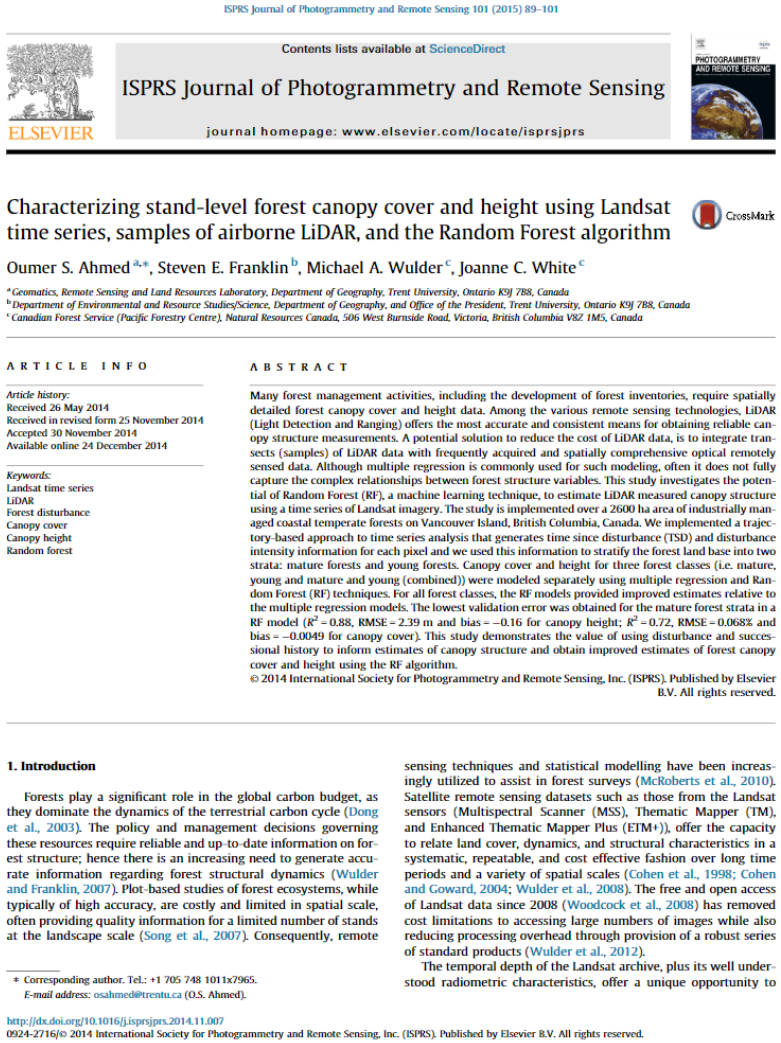
Since the days when the native Haida people routinely plied their dugout canoes along the west coast, the area has been an important marine transportation route. Boat traffic now includes huge cargo ships, fishing vessels, ferries, and all kinds of recreational craft. A fast-growing industry here is water-based tourism, offering everything from sea kayaks to multi-level tour boats for visitors eager to whale-watch or drink in the wondrous landscape.

- Let’s search: “landsat forest harvest vancouver island”

- https://scholar.google.com/

Dissecting the Article you Find

- The study area of this paper is located within the Pacific Maritime ecozone
- They are looking at monitoring forest inventories in areas with active forest management (harvesting)
- They are combining Landsat and Lidar data to derive better metrics of forest canopy cover and height across mature and young forest stands
- *Include a screenshot of the first/title page like this



ISPRS Journal of Photogrammetry and Remote Sensing 101 (2015) 89–101

Contents lists available at ScienceDirect

ISPRS Journal of Photogrammetry and Remote Sensing

journal homepage: www.elsevier.com/locate/isprsjprs

Characterizing stand-level forest canopy cover and height using Landsat time series, samples of airborne LiDAR, and the Random Forest algorithm

Oumer S. Ahmed [a,*], Steven E. Franklin [b], Michael A. Wulder [c], Joanne C. White [c]

[a] Geomatics, Remote Sensing and Land Resources Laboratory, Department of Geography, Trent University, Ontario K9J 7B8, Canada
[b] Department of Environmental and Resource Studies/Science, Department of Geography, and Office of the President, Trent University, Ontario K9J 7B8, Canada
[c] Canadian Forest Service (Pacific Forestry Centre), Natural Resources Canada, 506 West Burnside Road, Victoria, British Columbia V8Z 1M5, Canada

ARTICLE INFO

Article history:
Received 26 May 2014
Received in revised form 25 November 2014
Accepted 30 November 2014
Available online 24 December 2014

Keywords:
Landsat time series
LiDAR
Forest disturbance
Canopy cover
Canopy height
Random forest

ABSTRACT

Many forest management activities, including the development of forest inventories, require spatially detailed forest canopy cover and height data. Among the various remote sensing technologies, LiDAR (Light Detection and Ranging) offers the most accurate and consistent means for obtaining reliable canopy structure measurements. A potential solution to reduce the cost of LiDAR data, is to integrate transects (samples) of LiDAR data with frequently acquired and spatially comprehensive optical remotely sensed data. Although multiple regression is commonly used for such modeling, often it does not fully capture the complex relationships between forest structure variables. This study investigates the potential of Random Forest (RF), a machine learning technique, to estimate LiDAR measured canopy structure using a time series of Landsat imagery. The study is implemented over a 2600 ha area of industrially managed coastal temperate forests on Vancouver Island, British Columbia, Canada. We implemented a trajectory-based approach to time series analysis that generates time since disturbance (TSD) and disturbance intensity information for each pixel and we used this information to stratify the forest land base into two strata: mature forests and young forests. Canopy cover and height for three forest classes (i.e. mature, young and mature and young (combined)) were modeled separately using multiple regression and Random Forest (RF) techniques. For all forest classes, the RF models provided improved estimates relative to the multiple regression models. The lowest validation error was obtained for the mature forest strata in a RF model (R^2 = 0.88, RMSE = 2.39 m and bias = −0.16 for canopy height; R^2 = 0.72, RMSE = 0.068% and bias = −0.0049 for canopy cover). This study demonstrates the value of using disturbance and successional history to inform estimates of canopy structure and obtain improved estimates of forest canopy cover and height using the RF algorithm.
© 2014 International Society for Photogrammetry and Remote Sensing, Inc. (ISPRS). Published by Elsevier B.V. All rights reserved.

1. Introduction

Forests play a significant role in the global carbon budget, as they dominate the dynamics of the terrestrial carbon cycle (Dong et al., 2003). The policy and management decisions governing these resources require reliable and up-to-date information on forest structure; hence there is an increasing need to generate accurate information regarding forest structural dynamics (Wulder and Franklin, 2007). Plot-based studies of forest ecosystems, while typically of high accuracy, are costly and limited in spatial scale, often providing quality information for a limited number of stands at the landscape scale (Song et al., 2007). Consequently, remote sensing techniques and statistical modelling have been increasingly utilized to assist in forest surveys (McRoberts et al., 2010). Satellite remote sensing datasets such as those from the Landsat sensors (Multispectral Scanner (MSS), Thematic Mapper (TM), and Enhanced Thematic Mapper Plus (ETM+)), offer the capacity to relate land cover, dynamics, and structural characteristics in a systematic, repeatable, and cost effective fashion over long time periods and a variety of spatial scales (Cohen et al., 1998; Cohen and Goward, 2004; Wulder et al., 2008). The free and open access of Landsat data since 2008 (Woodcock et al., 2008) has removed cost limitations to accessing large numbers of images while also reducing processing overhead through provision of a robust series of standard products (Wulder et al., 2012).

The temporal depth of the Landsat archive, plus its well understood radiometric characteristics, offer a unique opportunity to

* Corresponding author. Tel.: +1 705 748 1011x7965.
E-mail address: osahmed@trentu.ca (O.S. Ahmed).

http://dx.doi.org/10.1016/j.isprsjprs.2014.11.007
0924-2716/© 2014 International Society for Photogrammetry and Remote Sensing, Inc. (ISPRS). Published by Elsevier B.V. All rights reserved.

Important Note

- You cannot use the paper that I have given today as an example!
- No plagiarism
  - Must written in your own words

- Other than that have fun with it, try to find some interesting research!

Due Dates

- Blog post 5 – Thursday April 6th
- Assignment 7 – Thursday April 13th
- Blog post 6 – Thursday April 13th

Office Hours for Assignment 7

- Tuesday, April 4th 11am
- Thursday, April 6th 2pm
- Tuesday, April 11th 11am
- Wednesday April 12th 3pm

Final Exam Review Session

- Final exam review session is tomorrow
  - This is the last class!
  - No class next week

- Please post what you would like me to go over on the final exam discussion board: https://canvas.ubc.ca/courses/115854/discussion_topics/1686115

- Without topics to cover it will mostly just be Q&A