LECTURE 5:
MAY 12, 2014

ECOSYSTEMS ARE DYNAMIC

ECOLOGICAL SUCCESSION

Text Reference: Dearden and Mitchell (2012), Ch. 3, pp. 83-92

Geography/Environmental Studies 1120
T. Randall, Lakehead University, SA 2014

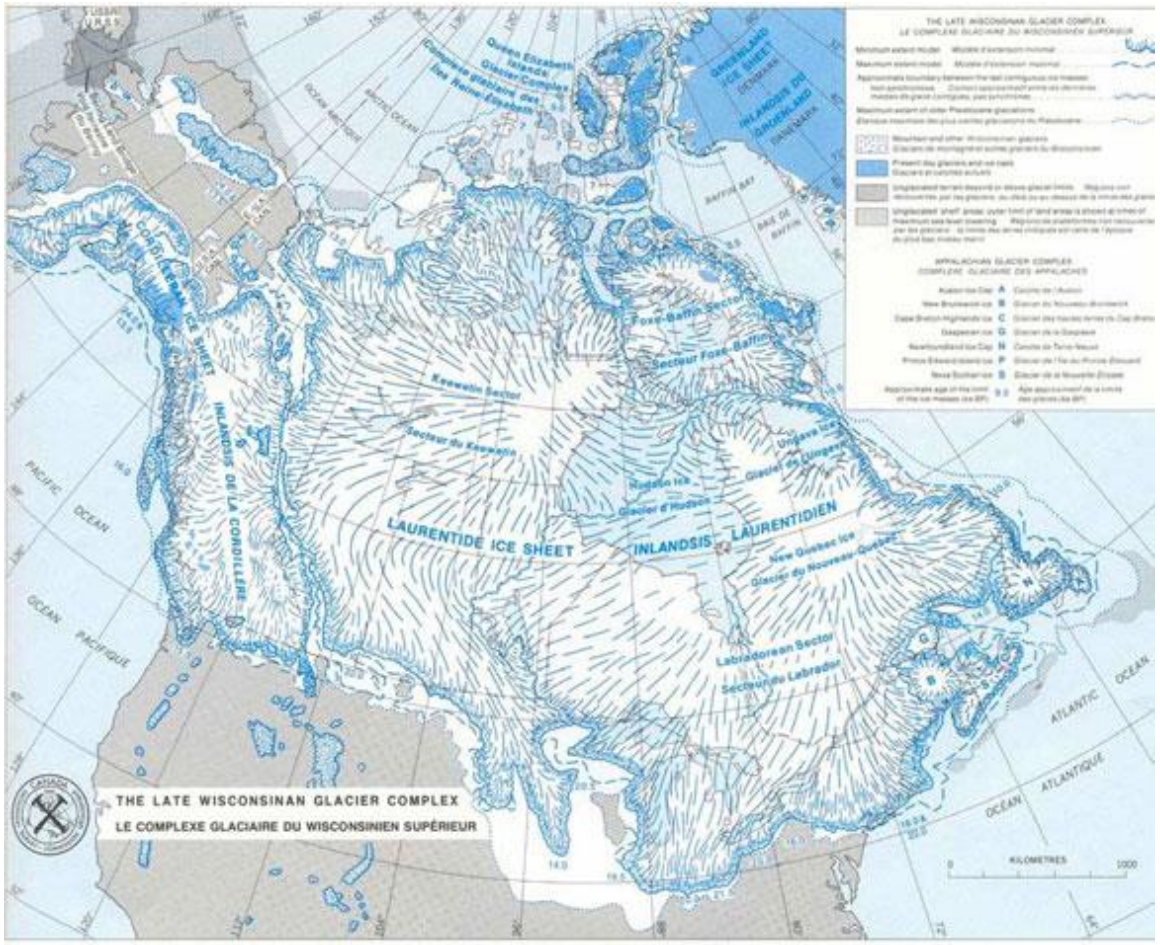
Recall from last time …

Energy Flows in Ecosystems …

Glaciation of Canadian Landscapes over the past 2 million years (the Quaternary)

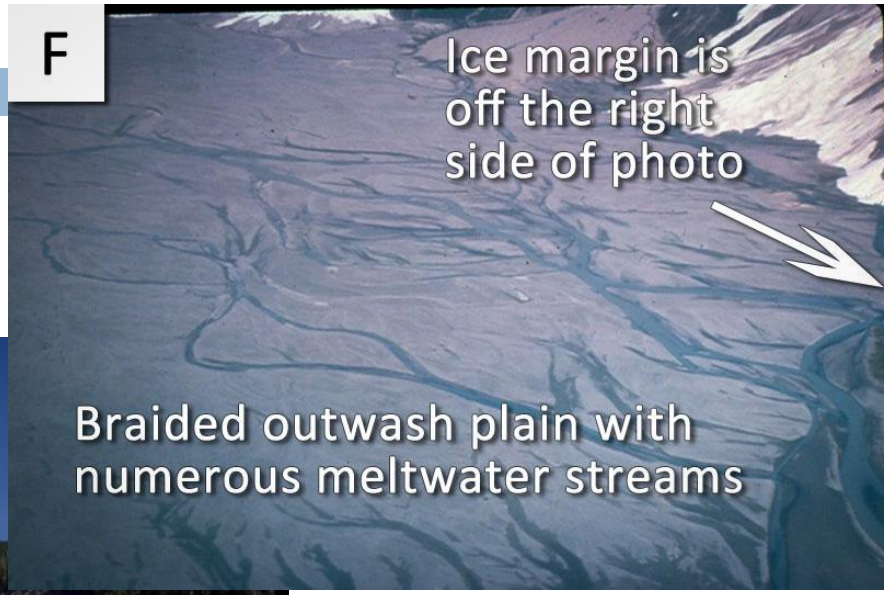
Today and tomorrow's lecture concerned with ecosystem change

Last Glacial Maximum – 2 main ice masses (Laurentide Ice Sheet and the Cordilleran Ice Sheet)



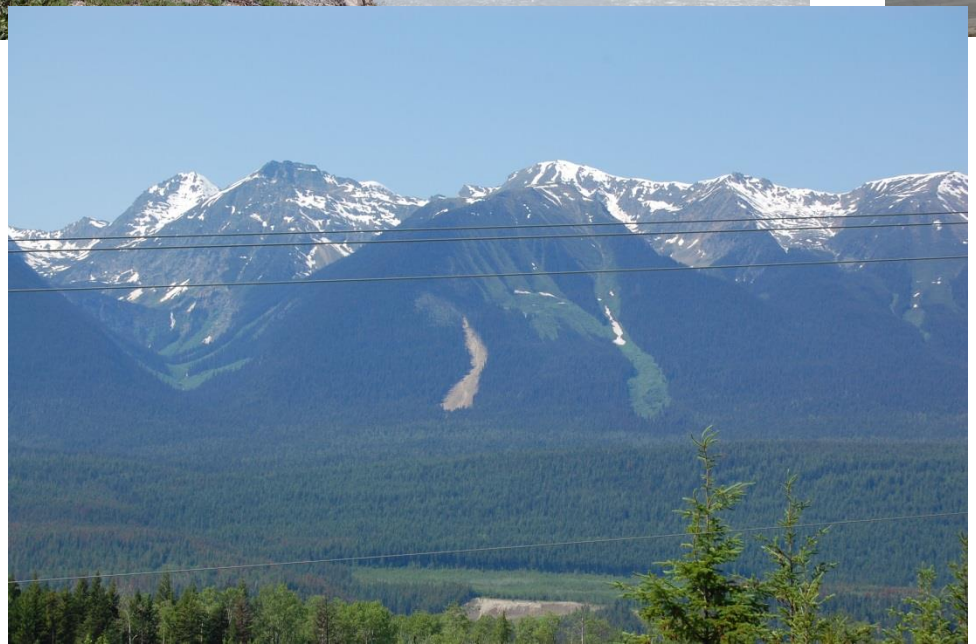
Credit to: Canadian Geological Survey; retrieved from: http://www.mikehorn.com/en/yep/pangaea-classroom-club/Nunavut,%20Canada%20-%20Canada%20Arctic/

Recently deglaciated landscapes



Mt Hood, Oregon – a 'composite volcano' (White River sand bar, ready for vegetation colonization)

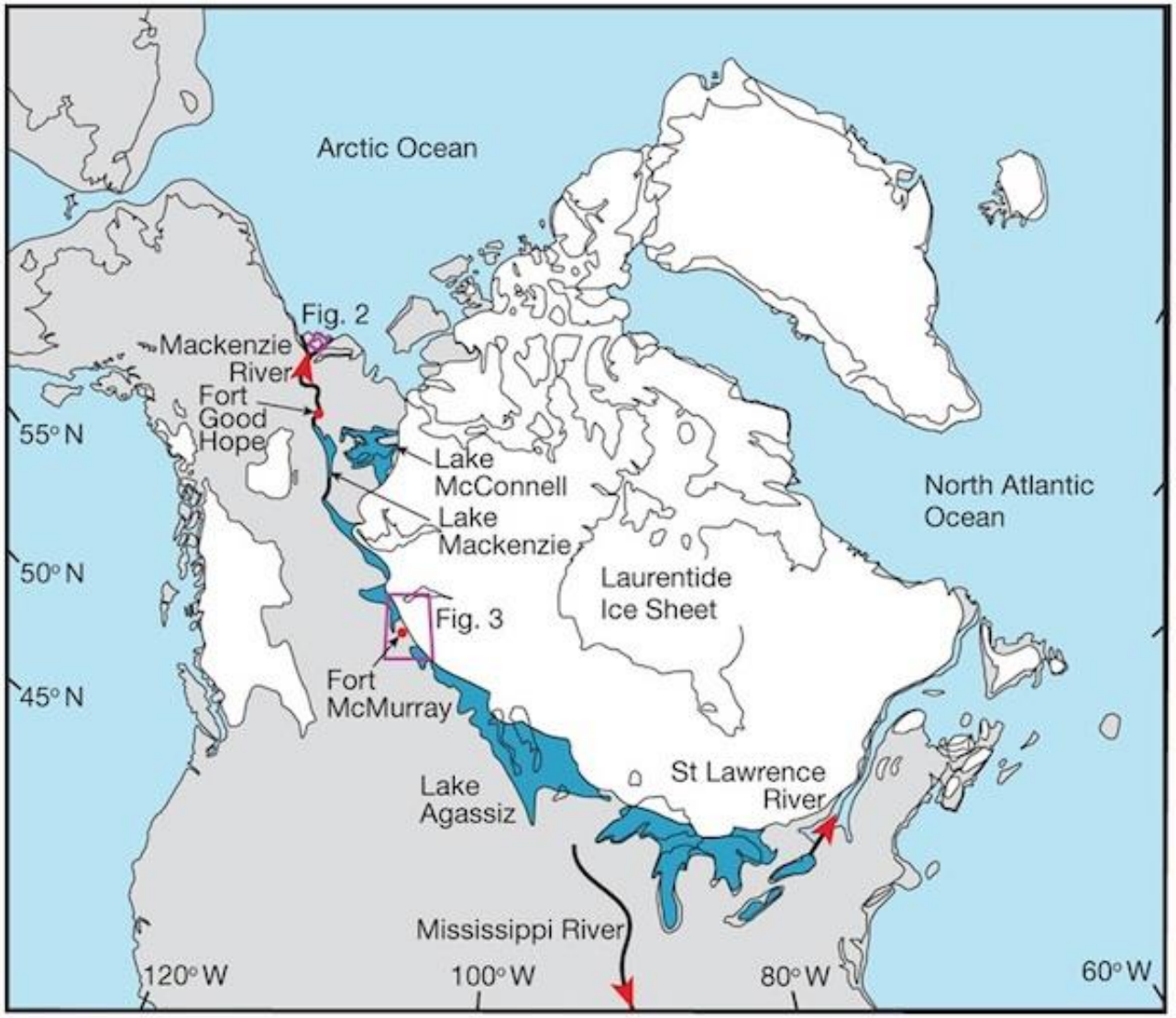
Canadian Rockies (recently deglaciated landscapes)



Athabasca Glacier at Columbia Icefields (July 2008) Photo: T. Randall

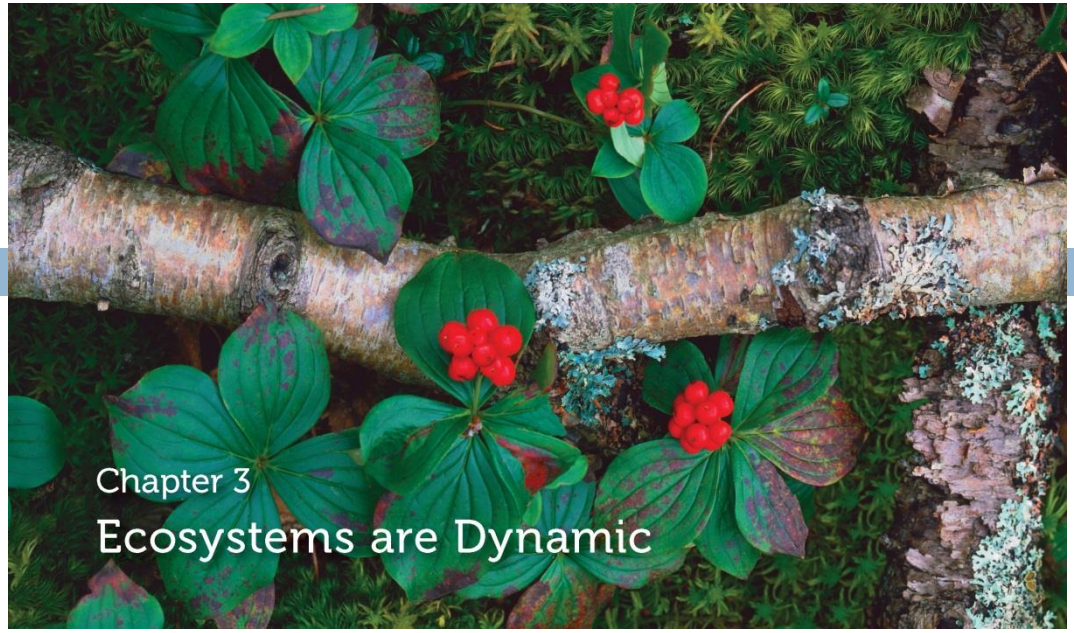
Landscape disturbance along Rocky Mountain Trench, near McBride, BC (?), July 2008. Showing 'greened' and 'fresh' slide scar ready for succession.

Vast pro-glacial lakes as ice melted.



Outline

- Upcoming:
  - **May 13:**
    - paper proposal due in class;
    - be prepared to briefly discussion your topic and what you hope to learn



Source: Dearden and Mitchell (2012)

- Today:
  - Ecological Succession
  - Primary versus Secondary Succession
  - Key terminology
  - Effects of human activities on succession

Ecosystem Change

- Changes over time driven by many factors such as abiotic conditions (climate, soil) and species' tolerances for change;
- Can be rapid or slow
- There have been and will need to be responses of these to climate change

One of the region's last stands of **Carolinian forest** graces Parks Canada lands in Niagara-on-the-Lake. Photo courtesy of Harmony Residents Group.

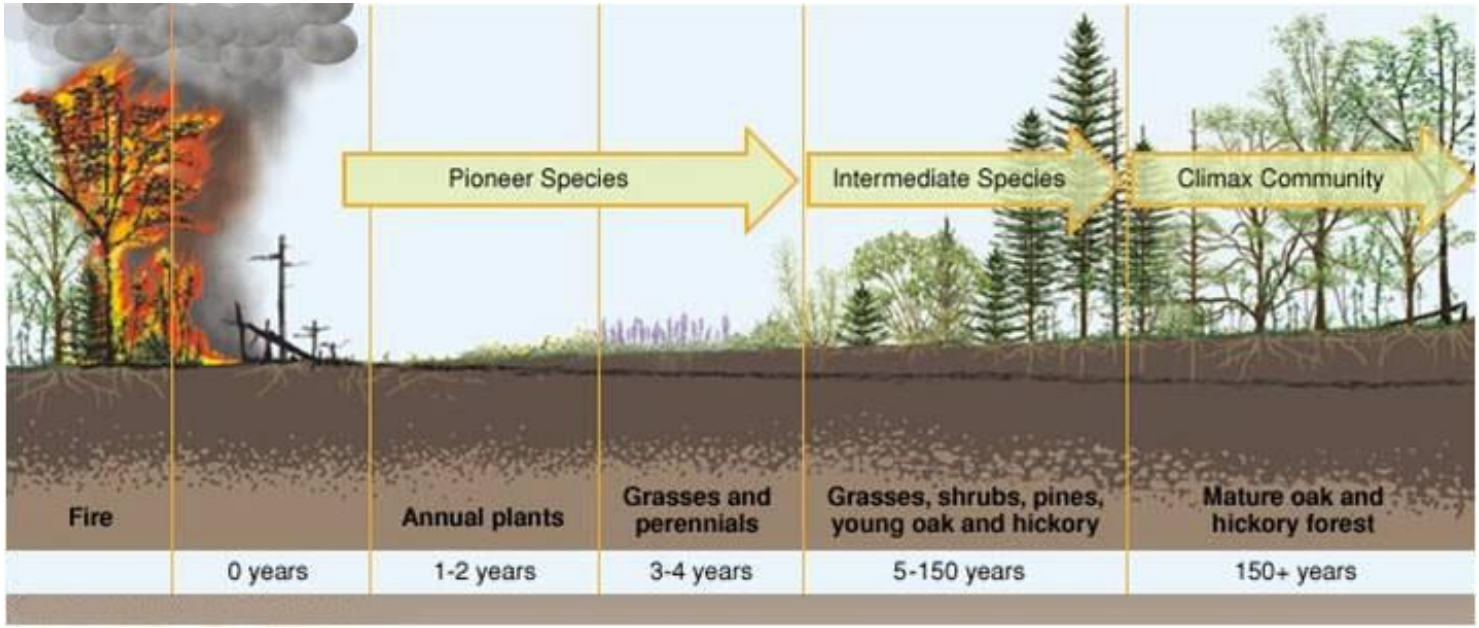
Ecological Succession (1)

- **Plant species assemblages:** collection of species living together suited to a location's biotic and abiotic factors;

- How these assemblages change over time (that is, one assemblage being gradually replaced by another) is called "**ecological succession**"

Ecological Succession (2)

- Two types of ecological succession:
  - PRIMARY
  - SECONDARY



Secondary succession occurs following a disturbance (e.g. forest fire) – that is, on surfaces having pre-existing biotic communities

Primary Succession

- Colonization of a previously unvegetated surface – having little or no soil
- Often harsh environments (cold climate, recently de-glaciated) and nutrient poor ("biological soil" development has yet to occur)

Athabasca Glacier at Columbia Icefields (July 2008) Photo: T. Randall

Athabasca River floodplain (just north of Columbia Icefields (July 2008)
Photo: T. Randall

Annual flooding and high sediment input on this type of braided channel system downstream of glaciers keeps re-vegetation at bay (for now)

Primary Succession

- **Primary colonizers:** first species to occupy the area, and must be able to withstand harsh conditions
  - e.g., lichens (and later, mosses) (grasses in dune systems)

Lichen

Moss

Primary Succession

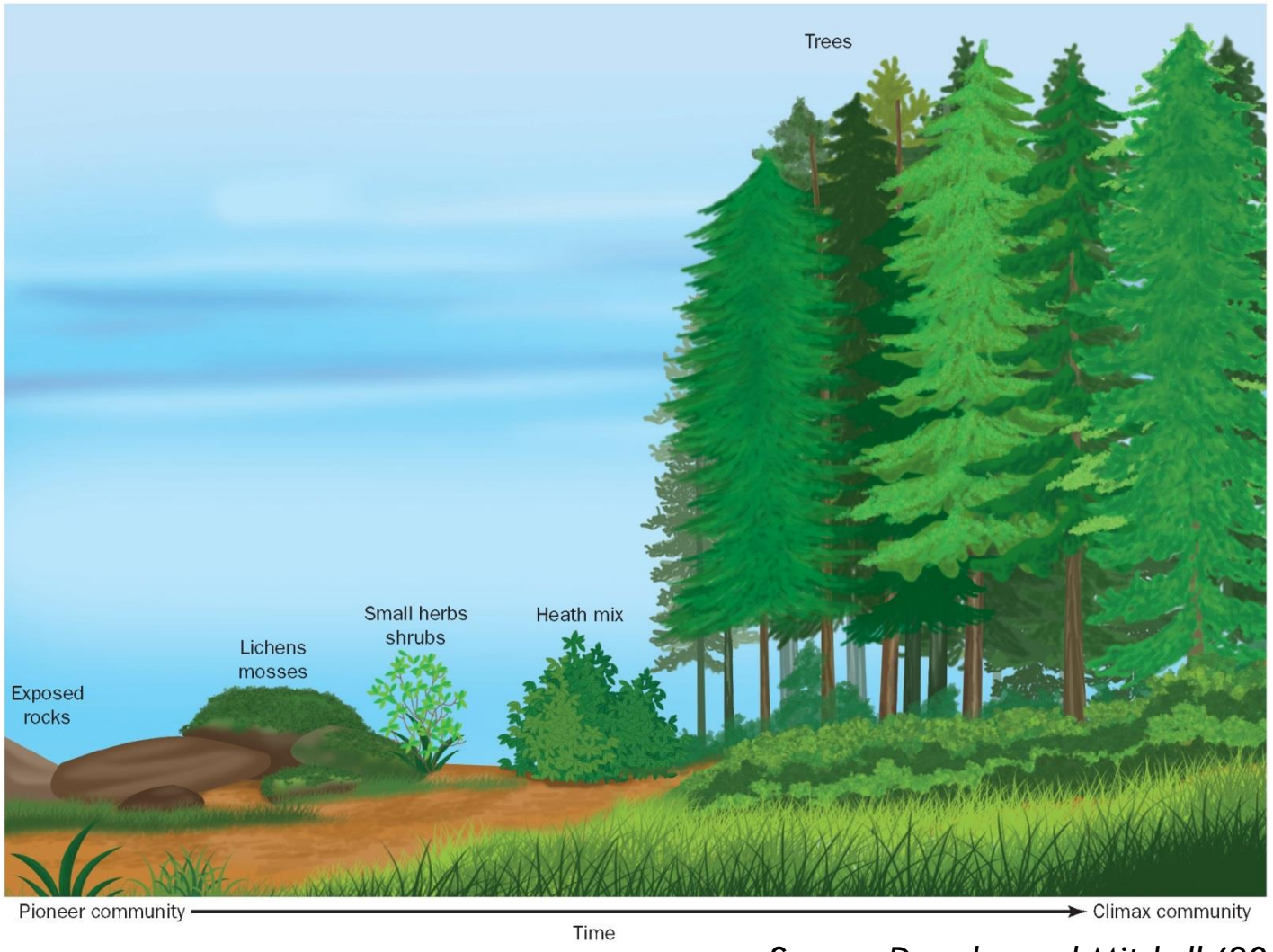
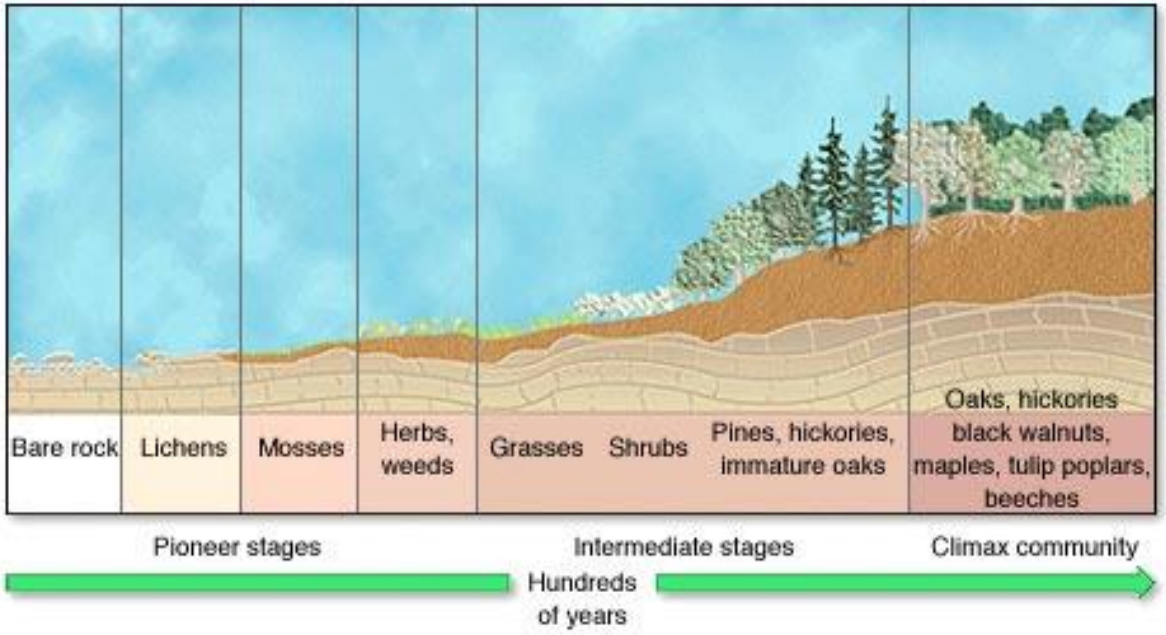


Figure 3.1 | A general model of primary succession over time, from a bare rock surface to a forest community.

Source: Dearden and Mitchell (2012)

Seral Stages in Succession … following colonizers:

- Herbaceous plants (such as grasses and 'weed' species);
- Hardy shrubs and light tolerant trees (e.g., Alder a common early shrub/tree)
- Trees dominating the final stage ('climax stages')



http://www.mhhe.com/biosci/esp/2001_gbio/folder_structure/ec/m2/s3/

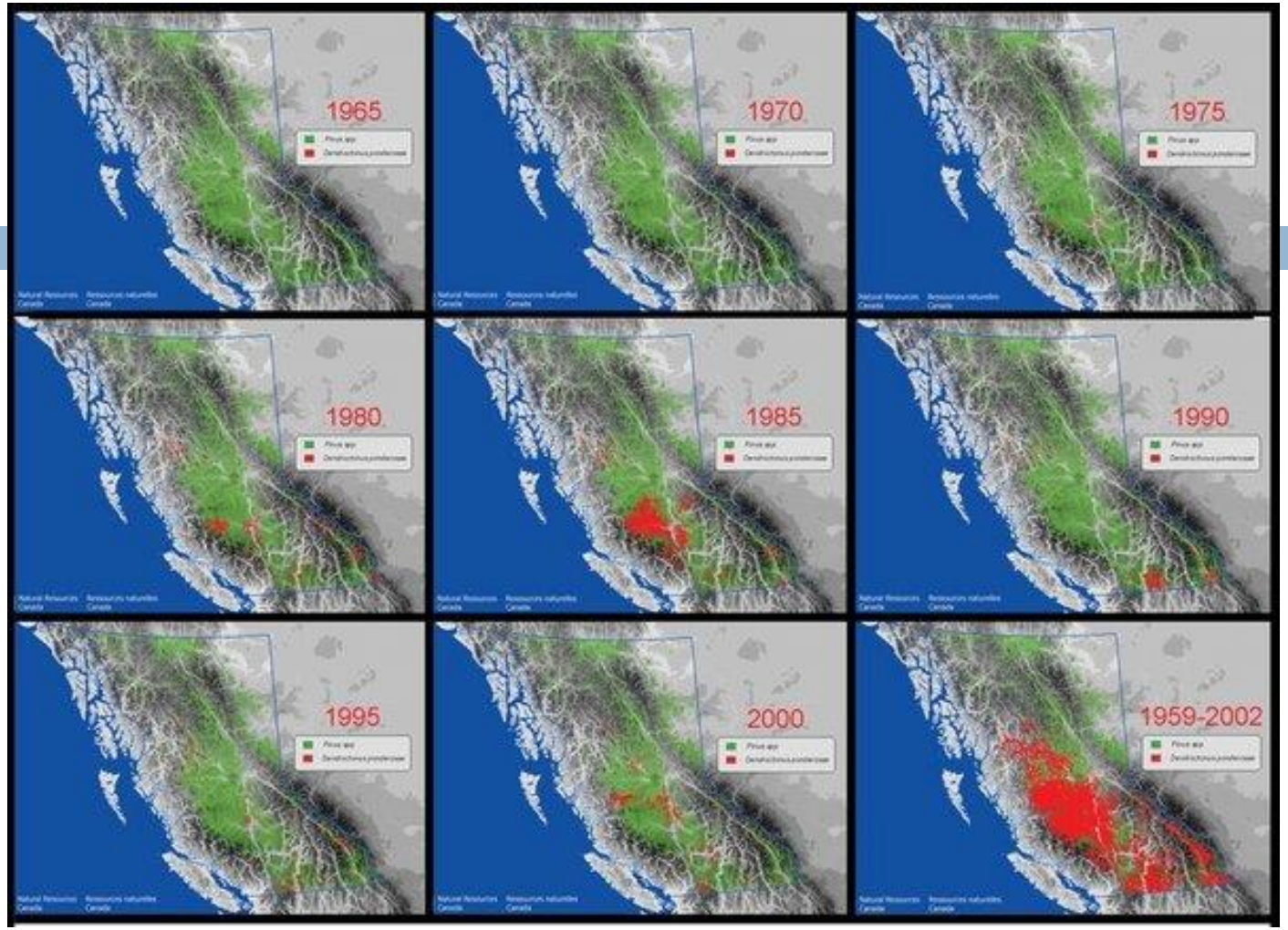
Climax Communities (end of succession)

- Well-defined 'stable' stage … once thought to represent equilibrium conditions (1/2 half of 20th Century)
- Such equilibriums, however, are rare:

One of the region's last stands of Carolinian forest graces Parks Canada lands in Niagara-on-the-Lake. Photo courtesy of Harmony Residents Group.

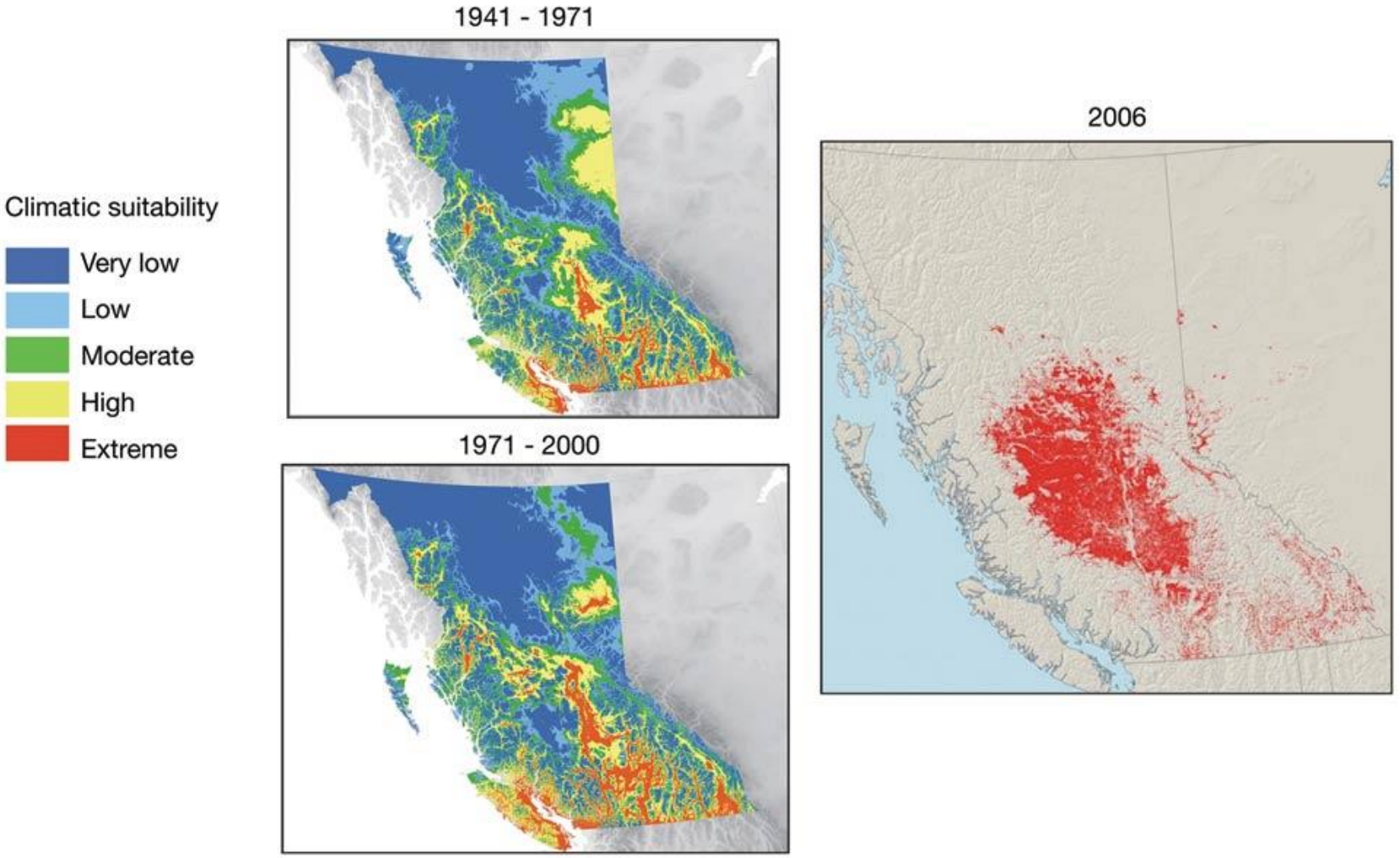
Climax Communities (end of succession)

- More common are **disturbances** that prevent an ecosystem reaching it climax stages, re-setting it to an earlier seral stage:
  - Examples: Fire, Insect Infestations, Flooding, Ice Storms
- Many disturbances are integral parts of ecosystem function (e.g. Douglas-fir trees and their cones in BC Coastal forests have resistance to fire, giving them a competitive advantage)

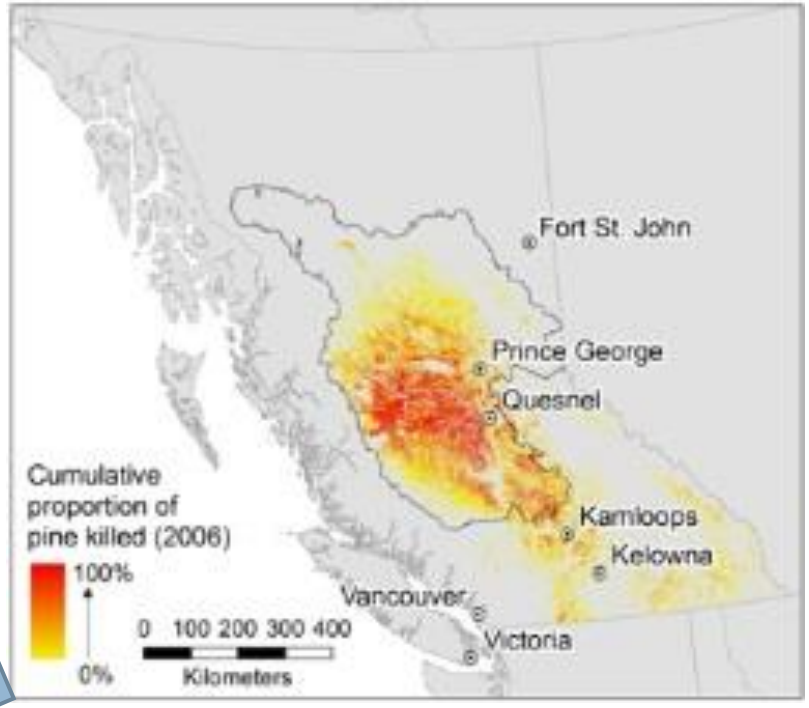


British Columbia is ground zero for mountain pine beetles with rapid increases in infestations starting in the late 1990s and early 2000s.The final image shows all the areas where infestations have been recorded between 1959 and 2002. Image: Natural Resources Canada

(Read more at: http://phys.org/news190275053.html#jCp)



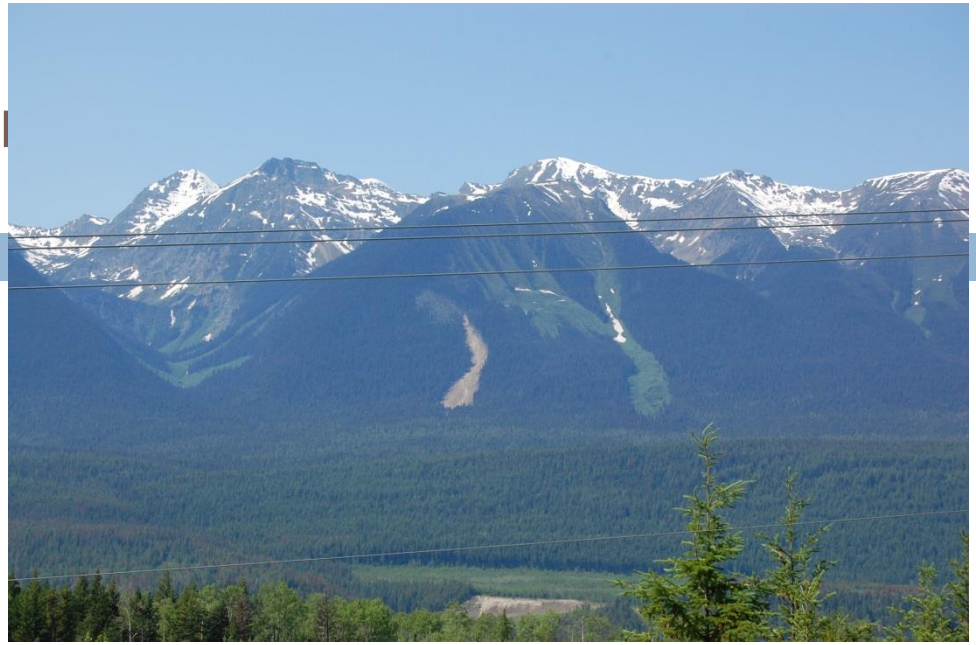
(Left) Historical distributions of climatically suitable habitats for the mountain pine beetle (MPB) in British Columbia (adapted from Carroll et al., 2004). Areas with 'very low' suitability are unsuitable for MPB, where as 'extreme' areas are those considered climatically optimal. (Right) Total area affected by mountain pine beetle in British Columbia in 2006 (Natural Resources Canada, 2007a)



http://science.natureconservancy.ca/centralinterior/central.php

Socio-economic impacts

Landslide Disturba



Landscape disturbance along Rocky Mountain Trench, near McBride, BC (?), July 2008. Showing 'greened' and 'fresh' slide scar ready for succession.

Avalanche tracks (bottom left);
Earth flow (bottom Right)
Photo credit : June Ryder.

Succession on recent (new) alluvial sediments (new floodplains)

- Example from: Mayo, YK
- Mayo Vegetation Project (Randall 1992)

Mayo, YK (Stewart River)

- River flow (right to left)
- Aggrading point bars on the 'downstream' side
- Vegetation patterns can be used to infer a relative age of point bars

Mayo, YK (Stewart River)

Mayo, YK (Stewart River)

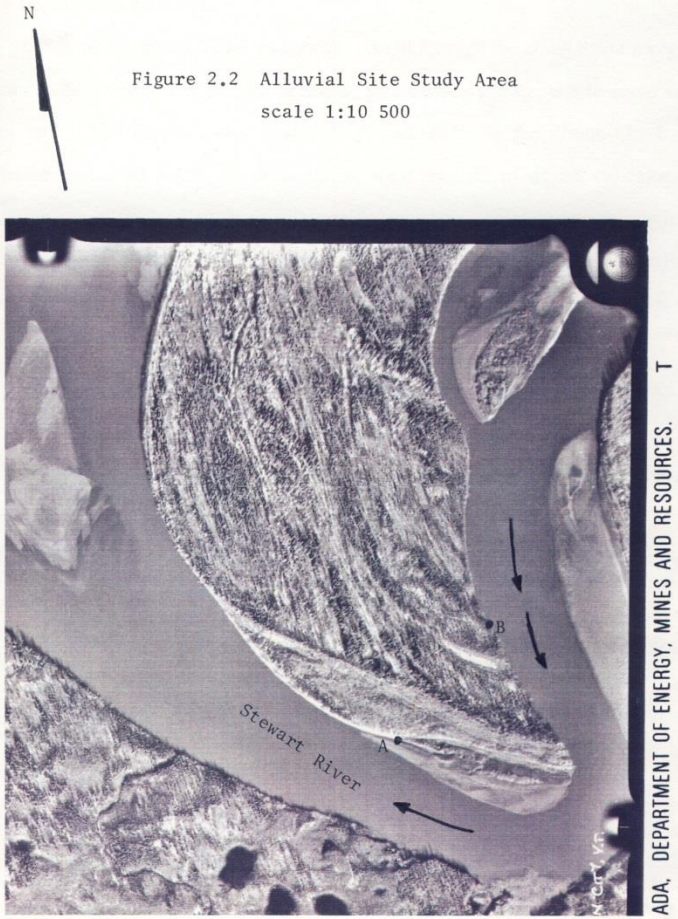


Figure 2.2 Alluvial Site Study Area
scale 1:10 500

Base Map source: Air Photo A 22201-9 Sept 30, 1970

(visible is the ribbon-banding of successively younger vegetation units. Youngest bank (aggrading) at A; Older bank (eroding) at B.)

The first task was to provide some indication of the age of the various ground surfaces. The migration of the point bar between 1949 and 1989 was plotted using an air photo sequence by Karen Chiang. This migration is shown in Figure 4.1.

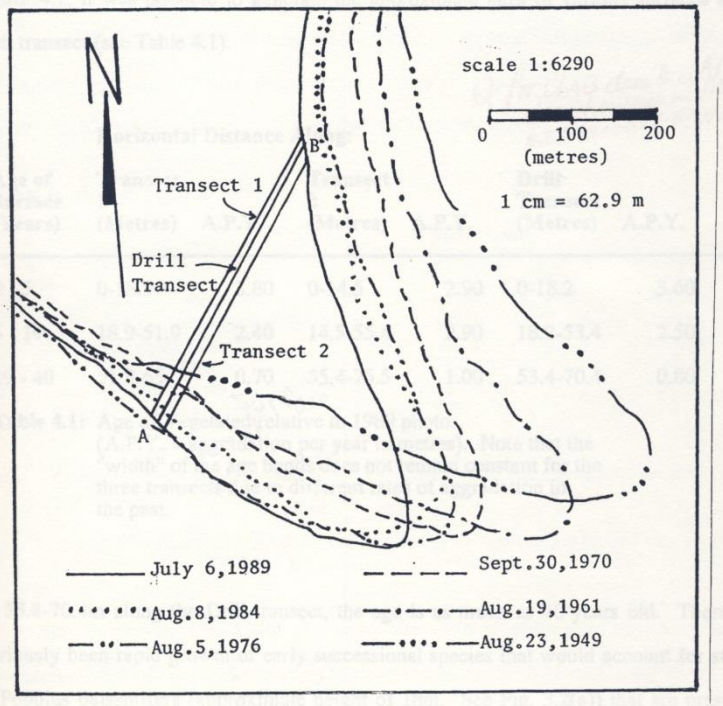


Figure 4.1: Point Bar Position as determined by air photo analysis. Shown also is the exact location of transects as they would have been in 1989. (Youngest surface at A; oldest at B).

The entire feature is surely not a point bar? The A end is but not the B end as it is obviously being eroded. So what is the title of this feature?

Younger versus Older Plant Communities

(Mayo Vegetation Project, photos 1991 by TR)

Willow Aspen Zone

Balsam Poplar Zone

Younger versus Older Plant Communities

(Mayo Vegetation Project, photos 1991 by TR)

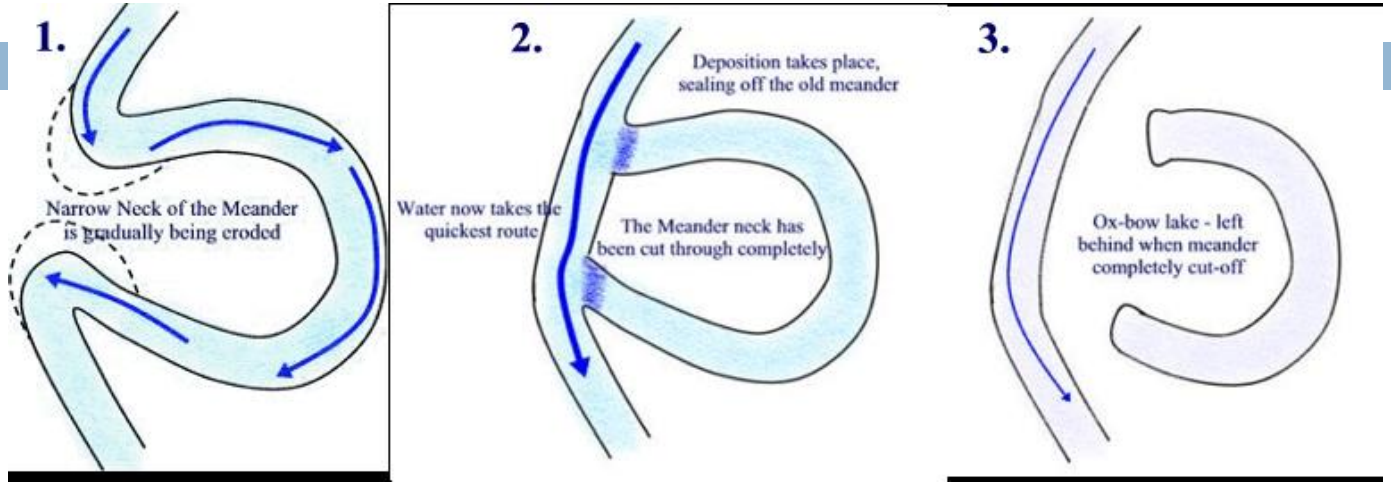
White Spruce Zone

White Spruce – Paper Birch Zone

Secondary Succession

- the sequential development of biotic communities on previously vegetated surfaces that have soil cover, and that have been disturbed, e.g., abandoned farm fields
- Faster than primary succession, and initiated by invading species such as annual 'weeds'
  - Similar processes also occur in aquatic environments; the natural aging process is called eutrophication
- Can be a challenge for farmers and resource managers

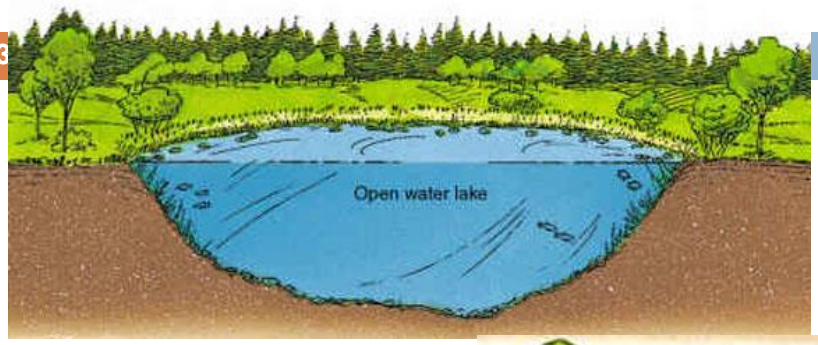
Oxbow Cut-off

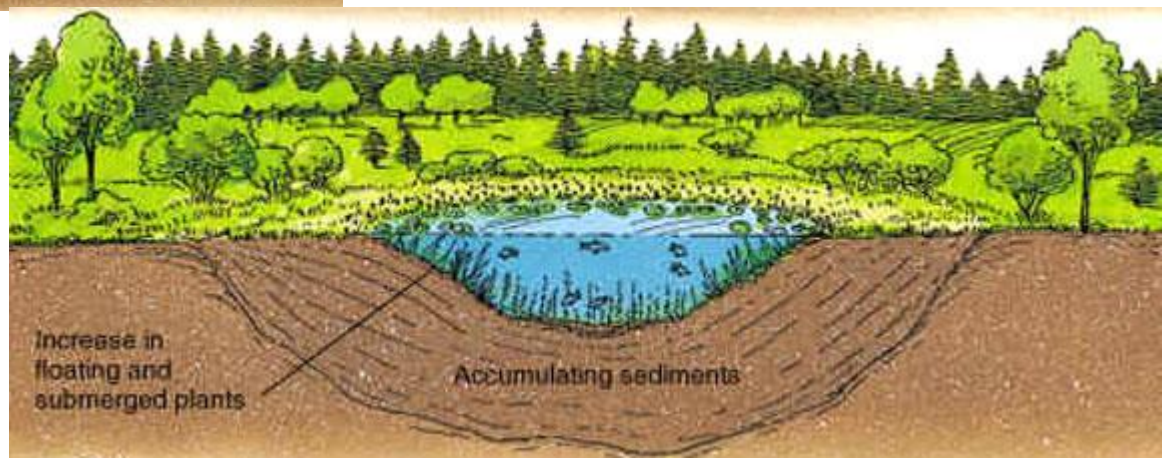


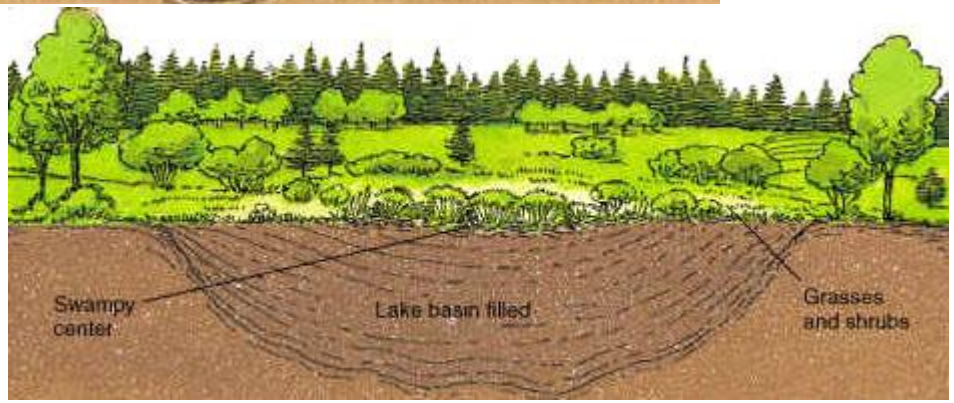
Nechako River (west of Prince George)

Nechako River (west of Prince George)

Pond Succession (lake → bog → meadow)







Indicators of Immature and Mature Ecosystems

- As succession occurs, several trends emerge:
  - NPP (net primary production) declines
  - Biodiversity increases

- **Intermediate Diversity Hypothesis:**
  - diversity will not increase indefinitely;
  - moderately disturbed ecosystems have higher biodiversity than those that experience either high or low disturbance

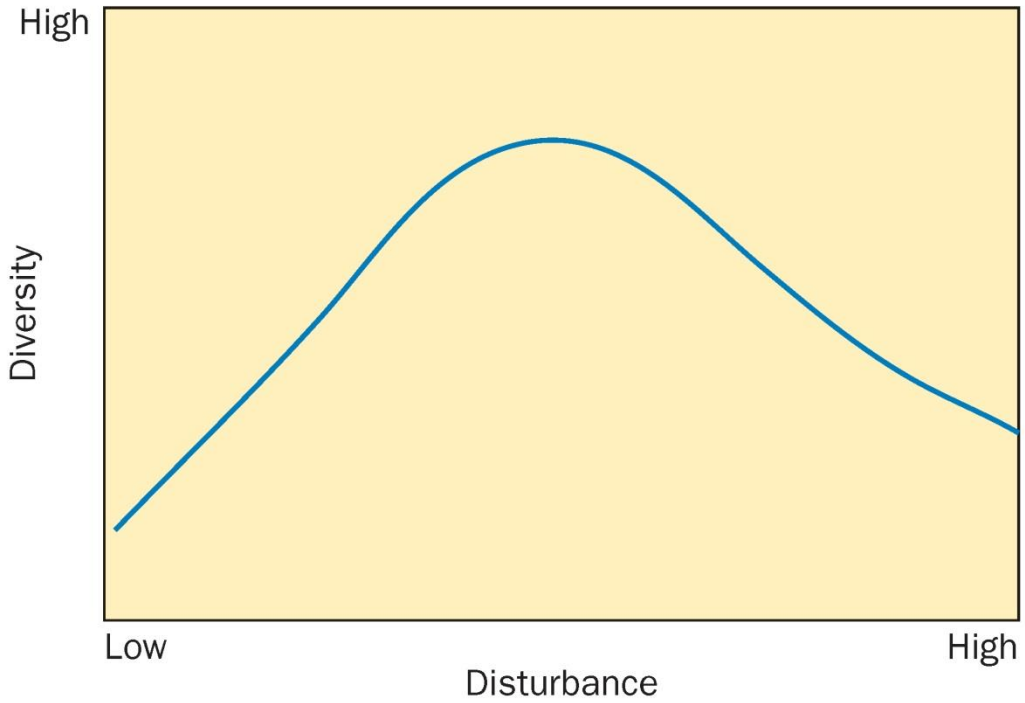


Figure 3.5 | The intermediate disturbance hypothesis.

Source: Dearden and Mitchell (2012)

Effects of Human Activities on Ecological Succession

- We often keep ecosystems in an early stage
  - Agriculture, forestry
- Increased productivity
- Faster nutrient and water cycling, with greater losses
- Reduced biodiversity, especially at higher trophic levels, and an increase in pioneer species

Looking Ahead to the next lectures

May 13: Continue with Ecosystem Change (chpt 3) and Map Literacy 1 (ML.1): **Print a blank base map** *(see next page)*

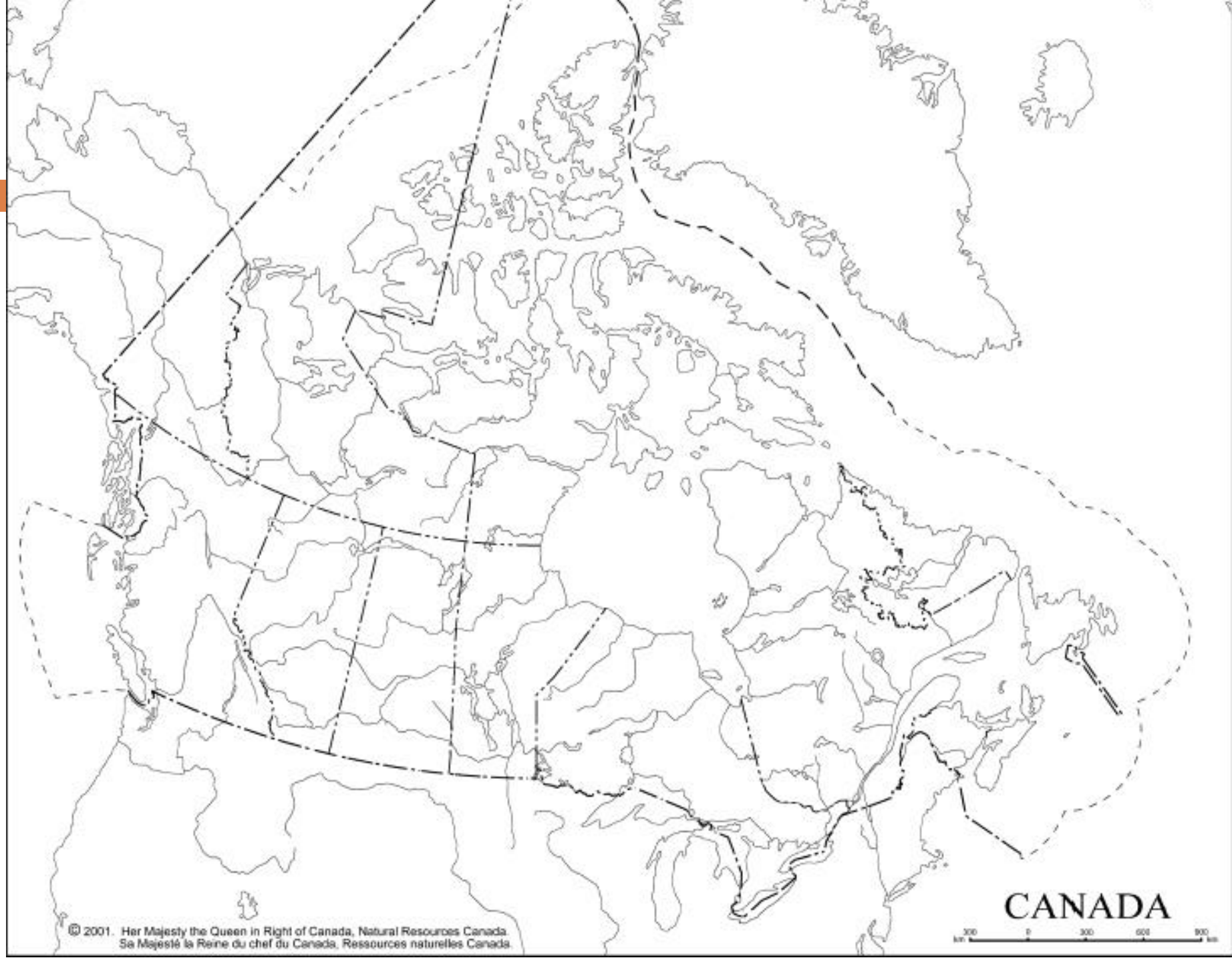
May 14: (Field trip): ***North Core Waterfront***

May 15 & 20: Ecosystems & Material Cycling: Biogeochemical Cycles and Human Activity & Impacts

Read ahead (Chpt. 4, pp. 114 →)

May 21:(Field trip, **to be confirmed**): ***Atlantic Street WWTP, East End and Neebing Spillway***

May 22: Mid-term exam (**covers material to end of Chapter 4**)


CANADA
© 2001. Her Majesty the Queen in Right of Canada, Natural Resources Canada.
Sa Majesté la Reine du chef du Canada, Ressources naturelles Canada.

References

- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {Chapter 3: 'Ecosytems are Dynamics'}