LECTURE 14:
MAY 29, 2014

FORESTS

CANADA'S FOREST ECOSYSTEMS & FOREST MANAGEMENT PRACTICES

Text Reference: Dearden and Mitchell (2012), Ch. 9, pp. 282-294 & 294-302

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

Outline

- Upcoming:
  - **June 4 (Field trip):**
    - Urban/Suburban Thunder Bay;
    - MNR Research Forest
    - **Details tba**

Source: Dearden and Mitchell (2012)

- Today:
  - (lecture)
    - Part 1: Canada's Forest Ecosystems
    - Break:
    - Part 2: Forest Management Practices
  - (discussion: progress on research paper) – structure; referencing; **choice of presentation instead of paper**

Part 1: Canada's Forest Ecosystems

Boreal Forest – its value

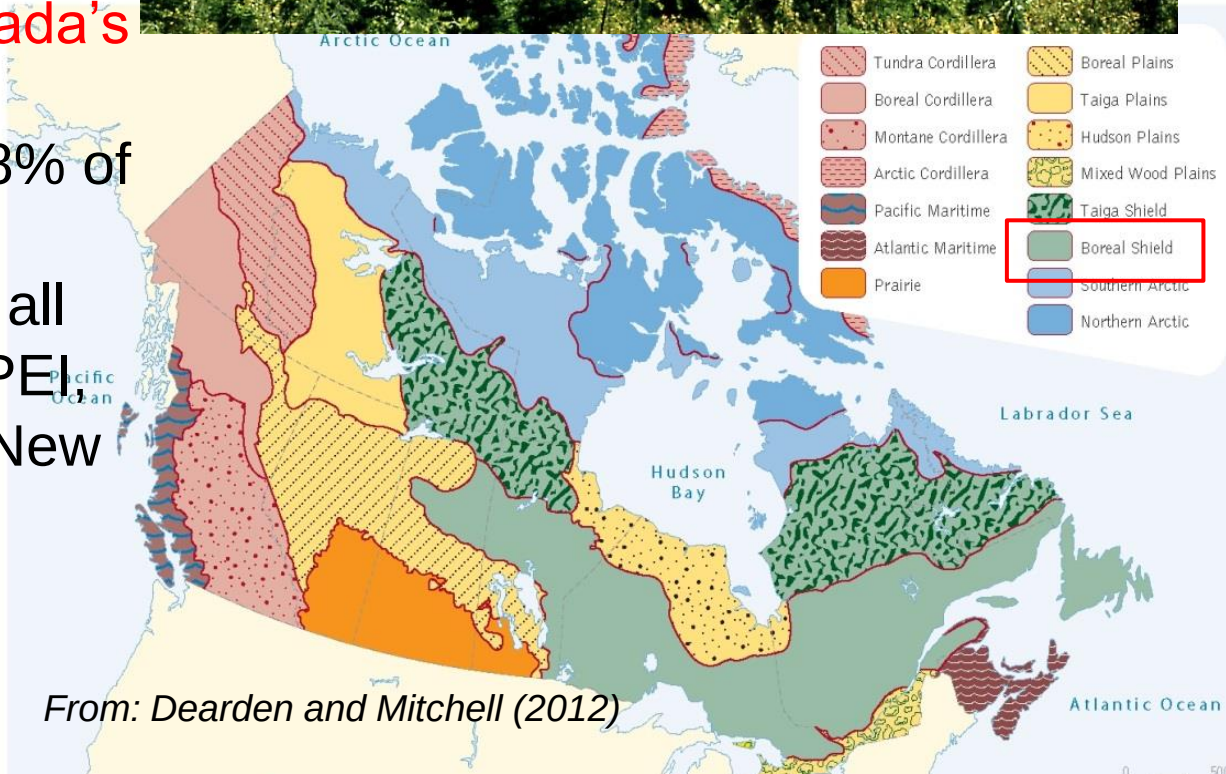
Canadian Boreal Forest Agreement

Canada's forested ecozones

Forest Ecosystem Services and Products

Preamble – Canada's Boreal Forest

- Boreal Shield contains about one quarter of the world's remaining original forests
- The Boreal is Canada's largest ecozone, covering almost 58% of our land mass and stretching through all provinces except PEI, Nova Scotia, and New Brunswick



From: Dearden and Mitchell (2012)

Value/Importance of the Boreal Forest

Environmental

- Ecosystem services to the tune of $700 billion/yr
- home to a wide diversity of terrestrial and aquatic wildlife
- Large areas are now experiencing a number of serious environmental stresses

Economic

- Supports commercial activities such as logging, wood fibre, and sawlog production, pulp and paper mills, and fibreboard production
- Almost 50% of the boreal forest is currently allocated to industry
- Recreation / Tourism

Boreal Forest as a Carbon Sink

- 186 billion tonnes of carbon stored in Boreal soils, water, trees and peat;
- Equivalent to 913 years' worth of Canada's greenhouse gas emissions
- Viewed as more than double what is stored in tropical rain forests (see Schindler and Lee 2010);

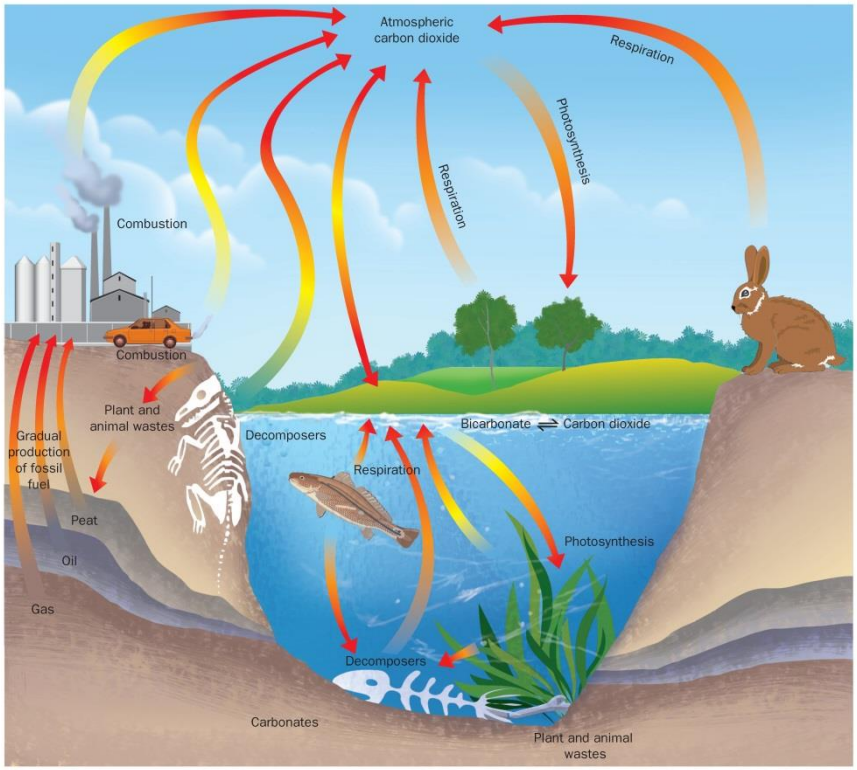


Figure 4.7 | The carbon cycle.

Figure 4.7 The carbon cycle. *From: Dearden and Mitchell (2012)*

Canadian Boreal Forest Agreement

- signed on May 21, 2010, brought together environmental activists and the forestry industry for the first time;
- 21 of Canada's largest forest companies and 9 national environmental organizations;
- Has 6 strategic goals:

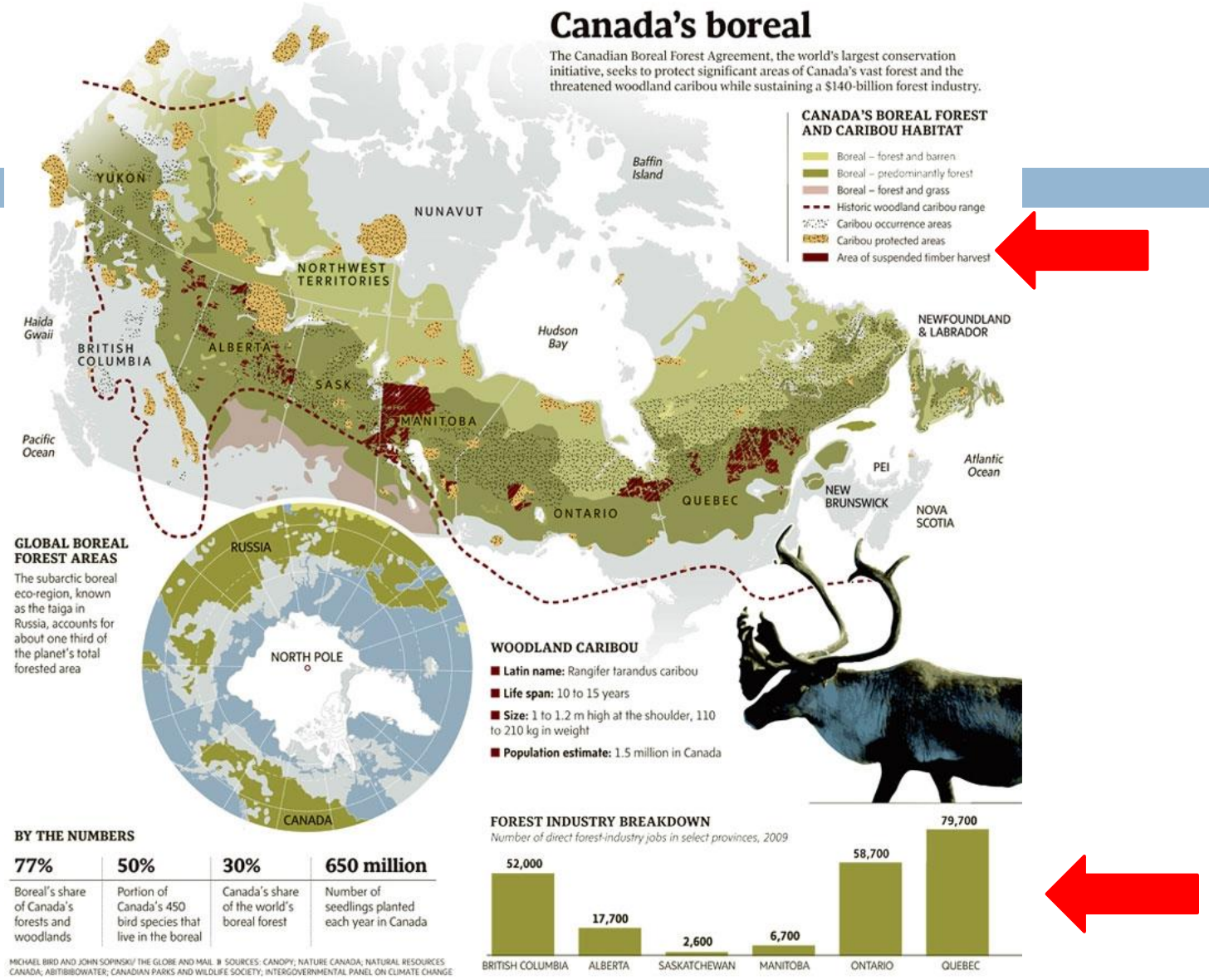
1. development of world-leading boreal "on-the-ground" sustainable-forest management practices;
2. completion of a network of protected areas that, taken as a whole, represent the diversity of ecosystems within the boreal region;
3. protecting species at risk in the boreal forest, including the woodland caribou;
4. reduction of greenhouse-gas emissions along the full life cycle, from the forest to the end of product life;
5. improvement in the prosperity of the Canadian forest sector and the communities that depend on it;
6. recognition by the marketplace (e.g., customers, investors, consumers) of the agreement.

http://www.canadiangeographic.ca/

Canadian Boreal Forest Agreement – extent and relationship to range of Woodland Caribou

http://www.canadiangeographic.ca/

FPAC = Forest Products Association of Canada member companies — the 21 signatories to the Canadian Boreal



Canadian Parks and Wilderness Society – Manitoba Chapter
http://cpawsmb.org/upload/0419_rb_boreal_2_1394150a.JPG

Canadian Boreal Forest Agreement

- 72 million hectares of forest land included in the agreement
- Forest companies have committed to practice 'sustainable harvesting' – preserving large tracts of old growth;
- Environmental organizations will end their campaigns against Canadian forest products;

NE of Teslin River (YK)

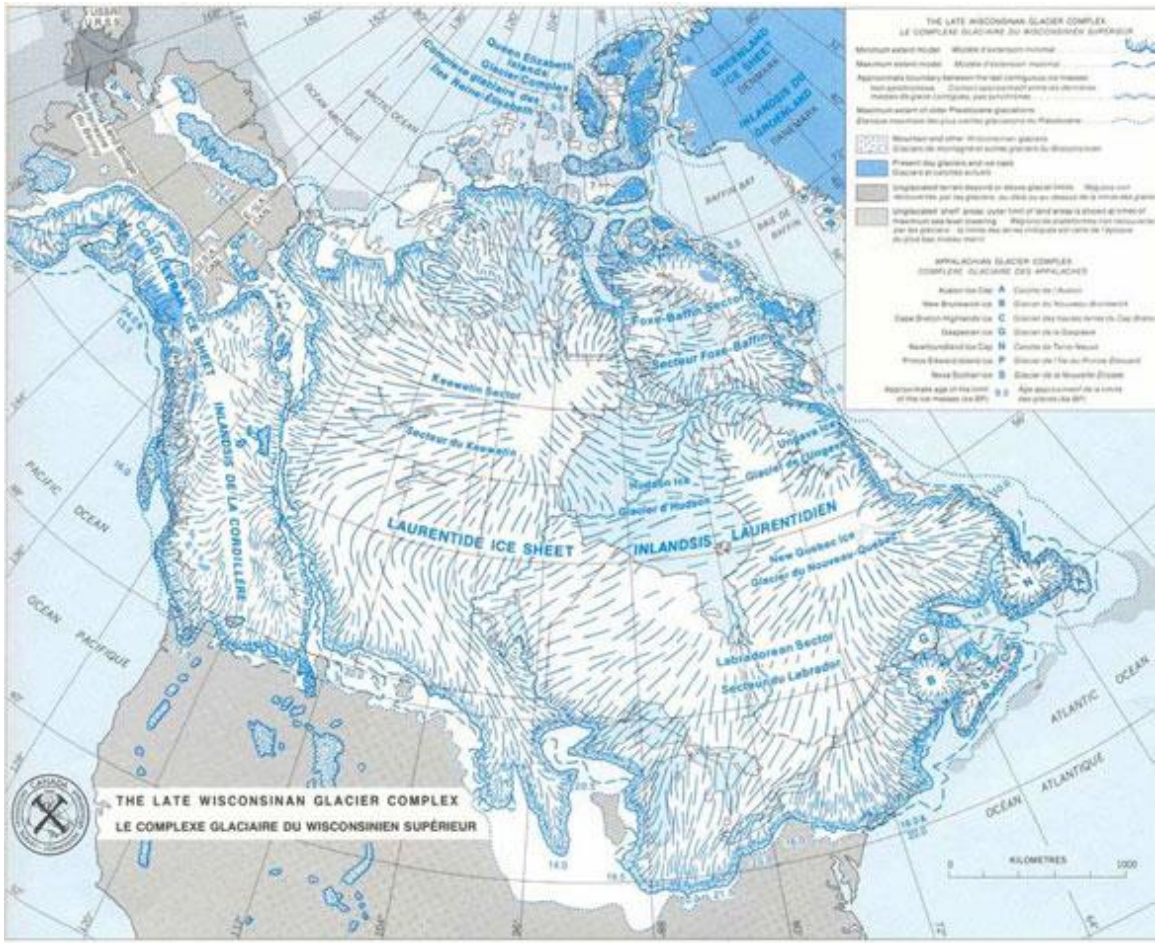
http://www.davidsuzuki.org/blogs/panther-lounge/201
forest-agreement-turns-one-year-old/

Trembling Aspen (typical of Boreal Plains)

Canada's Ecozones

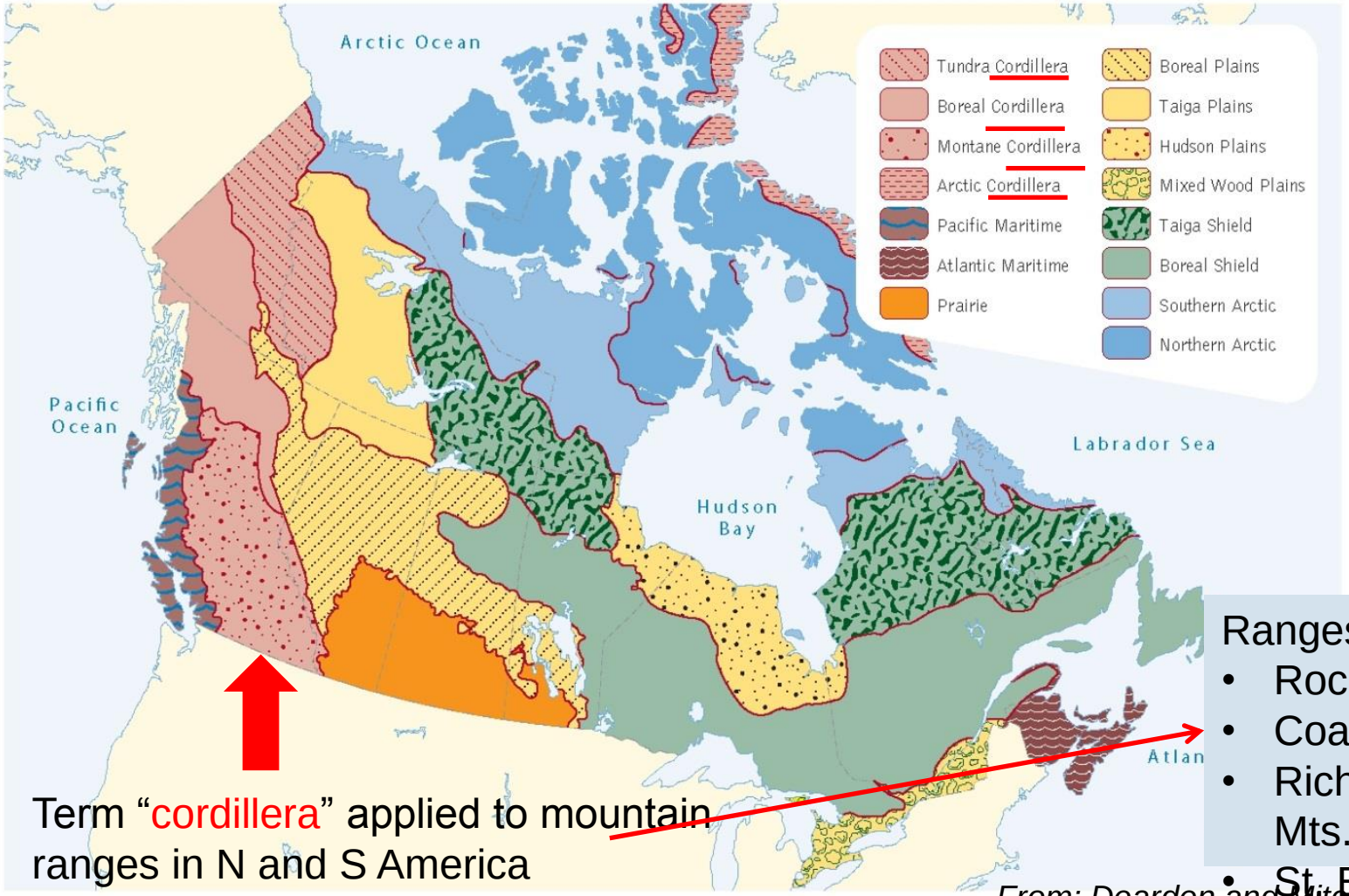
- There are 15 ecozones (Figure 9.2) although the majority of Canada's forests lie within 8 of them.
- *Details:* location; characteristic flora, fauna and climate; supports commercial forestry operations?
- Relationship to recent glaciations…

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/

Terrestrial Ecozones of Canada



Term "cordillera" applied to mountain ranges in N and S America

Ranges:
- Rockies
- Coast Mts.
- Richardson Mts.
- St. Elias Mts.

From: Dearden and Mitchell (2012)

Figure 9.2 | Terrestrial ecozones of Canada. *Source: Wiken (1986).*

Boreal Cordillera

- SW Yukon; NE Brit. Col.
- St. Elias Range and Northern Rockies, separated by intermontane plains;
- Vegetation cover varies widely due to aspect (S vs. N) and elevation; tundra vegetation at higher elevations;
- Rich in resources: mining, forestry, tourism, hydro development (WAC Bennett Dam on Peace R, NE BC);
- Communities: Whitehorse, Dawson City, Ft. Nelson;

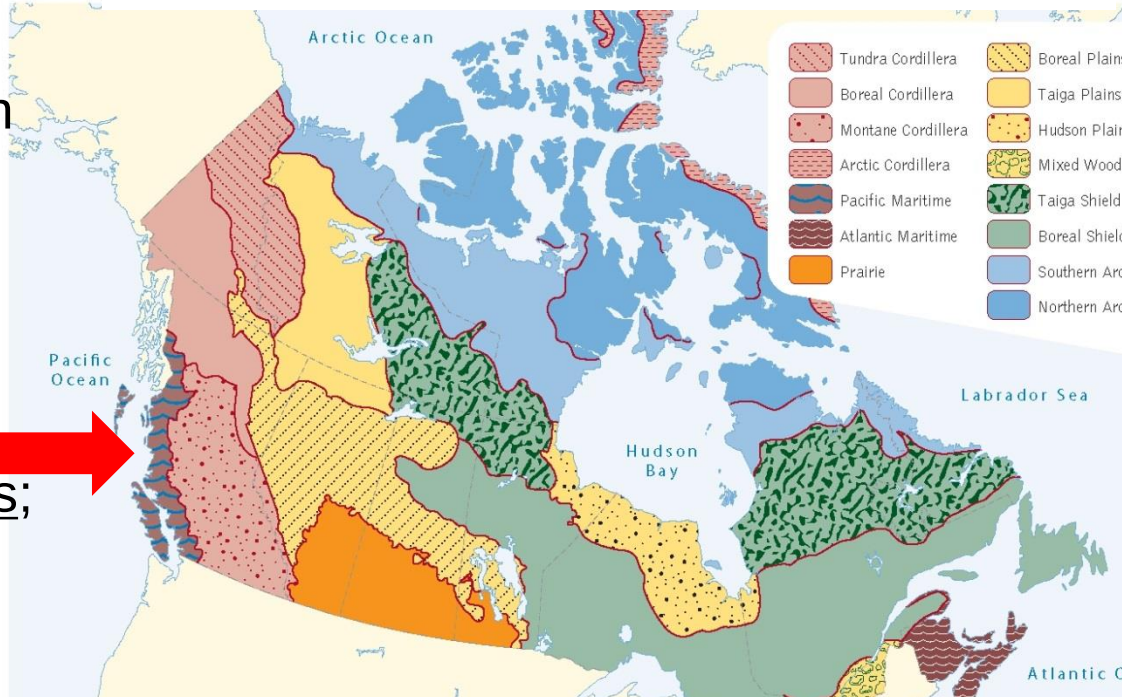
NE of Teslin River (YK)

http://www.davidsuzuki.org/blogs/panther-lounge/201
forest-agreement-turns-one-year-old/

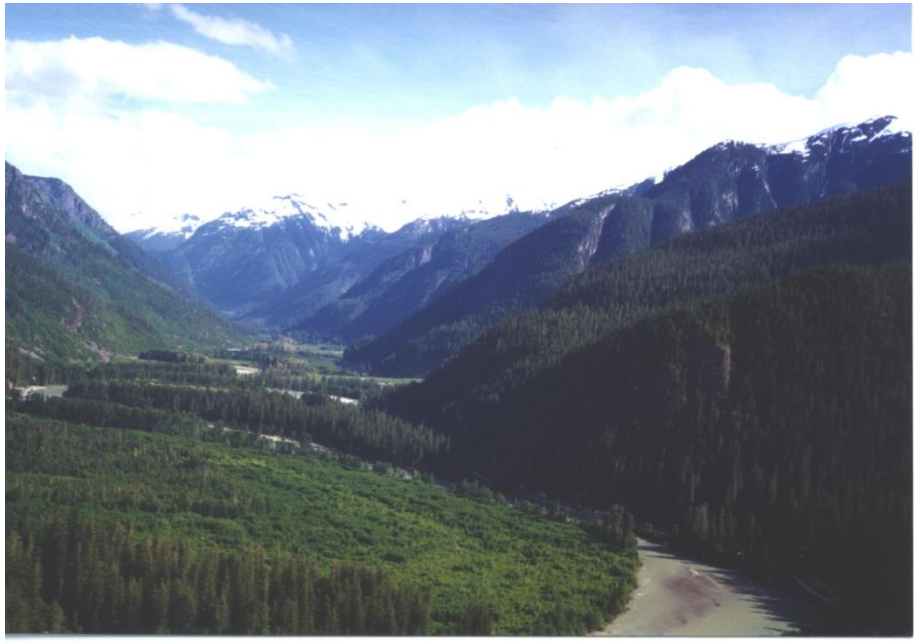
Pacific Maritime

- Coastal BC
- Coast Mountains;
- Temperate Rain Forest (up to 3000 mm precip annually) – mild wet winters; cool summers;
- Canada's most productive forests; several species can live hundreds of years; low risk of fire;
- Dominant industry: forestry, tourism,
- Communities: Vancouver; Victoria; Tofino; Ocean Falls; Nanaimo;

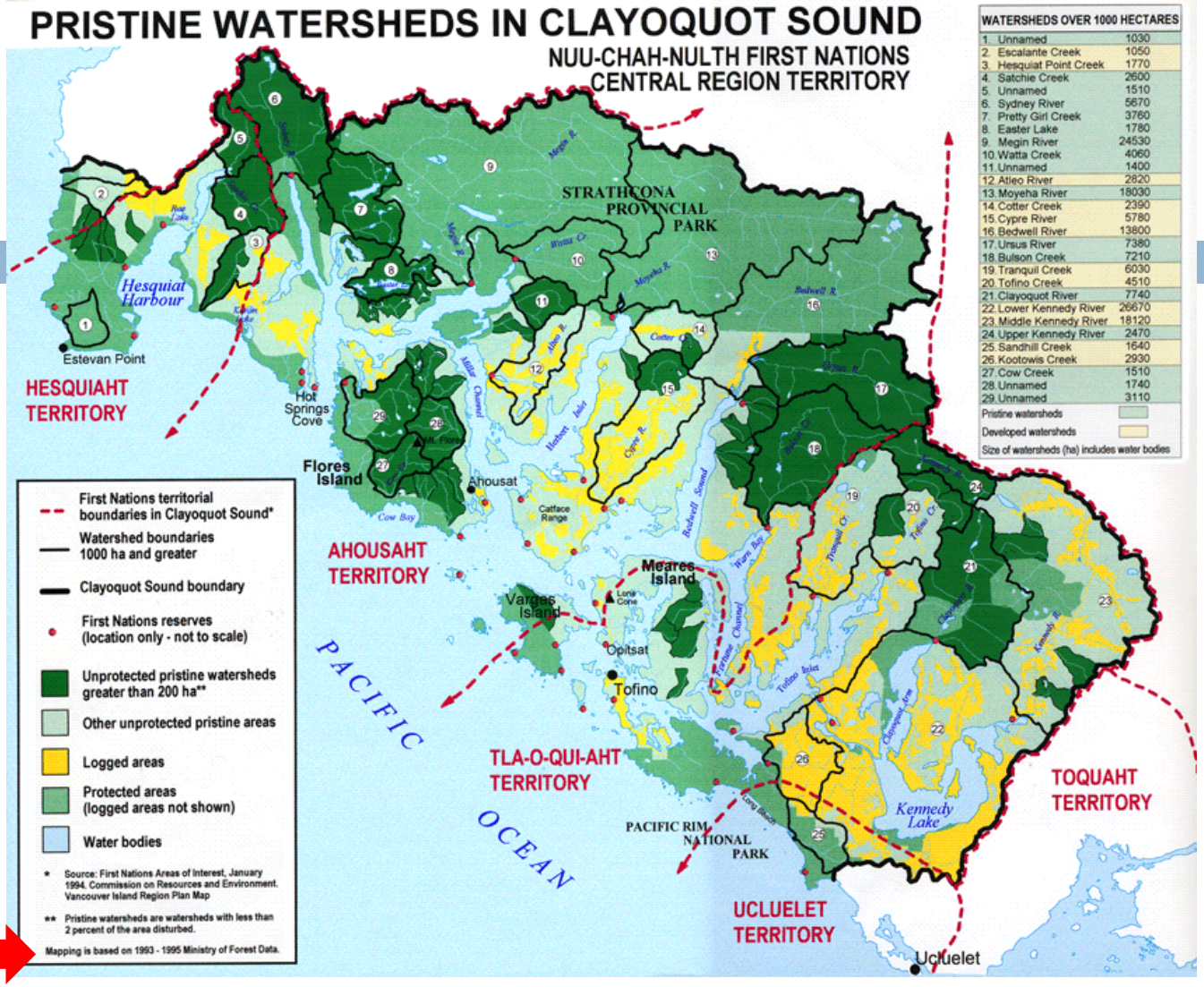
Cathedral Grove (Vancouver Island) – stands of Douglas Fir *Source: Dearden and Mitchell (2012)*



Clayoquot Sound, near Tofino
Credit: Dearden and Mitchell (2012)



Elaho River valley, NW of Squamish, BC – range of relief, floodplains in second growth (easy to reach)
Credit: TR (circa 1994)



Based on 1993-95 Min. of Forest Data

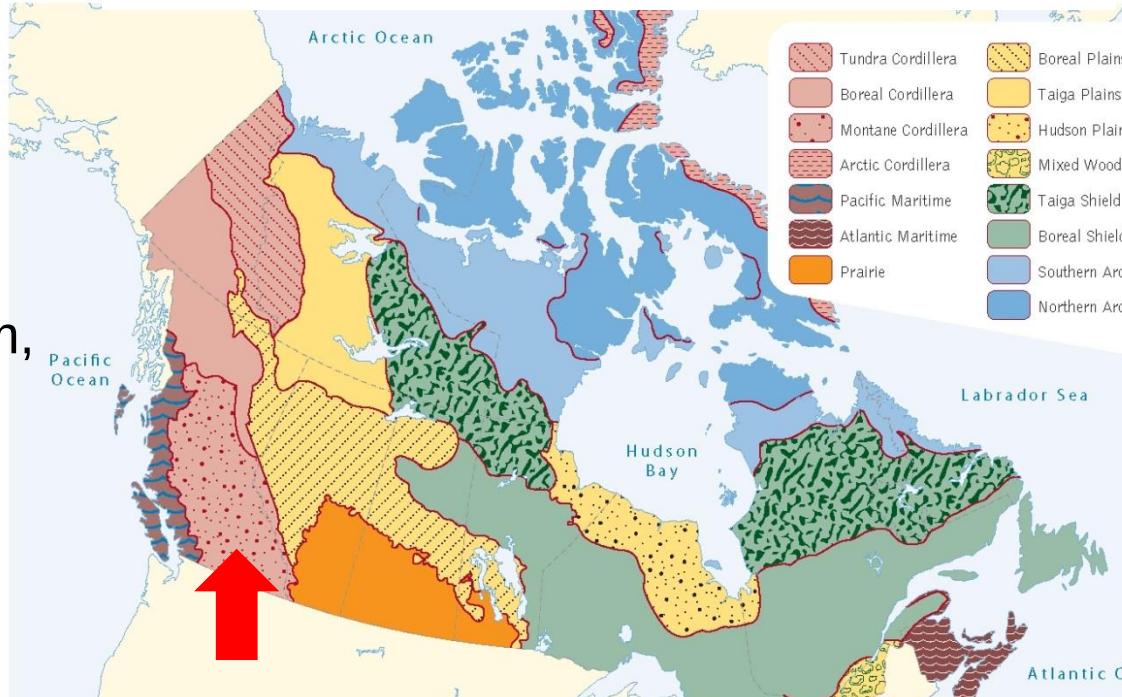
Clayoquot Sound on the west coast of Vancouver Island is a UNESCO world heritage site. Home to some of the most intact marine and estuarine habitats in western Canada, and the highest density of fish farms in the entire province of BC.

http://ospreysteelheadnews.blogspot.ca/2011/05/new-fish-farm-proposal-for-clayoquot.html

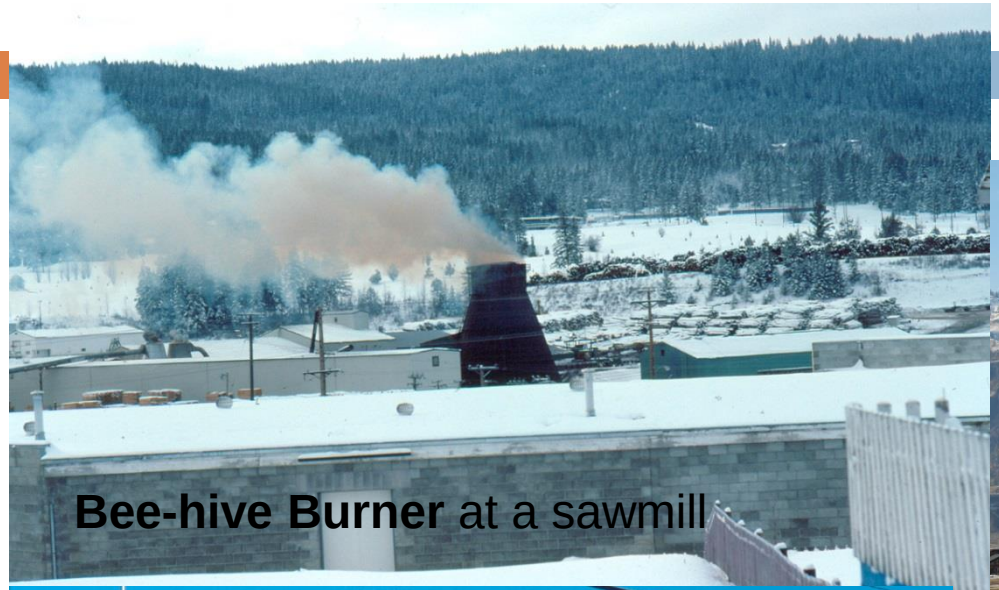
Montane Cordillera

- Interior Plateau; Okanagan; Southern Rockies
- Great range of elevation → strong contrast in temperature and moisture conditions; (semi-arid Okanagan; orographic precipitation and heavy mountain snowfalls)
- Dominant industry: forestry (north/east), mining, tourism, and agriculture
- Communities: Kelowna; Prince George, Trail, Banff

Montane Cordillera ecozone, near Banff, AB
Source: Dearden and Mitchell (2012)



Montane Cordillera



Bee-hive Burner at a sawmill

Semi-arid landscapes of north Okanagan valley, near Kamloops *photo credit: T. Randall (2008)*

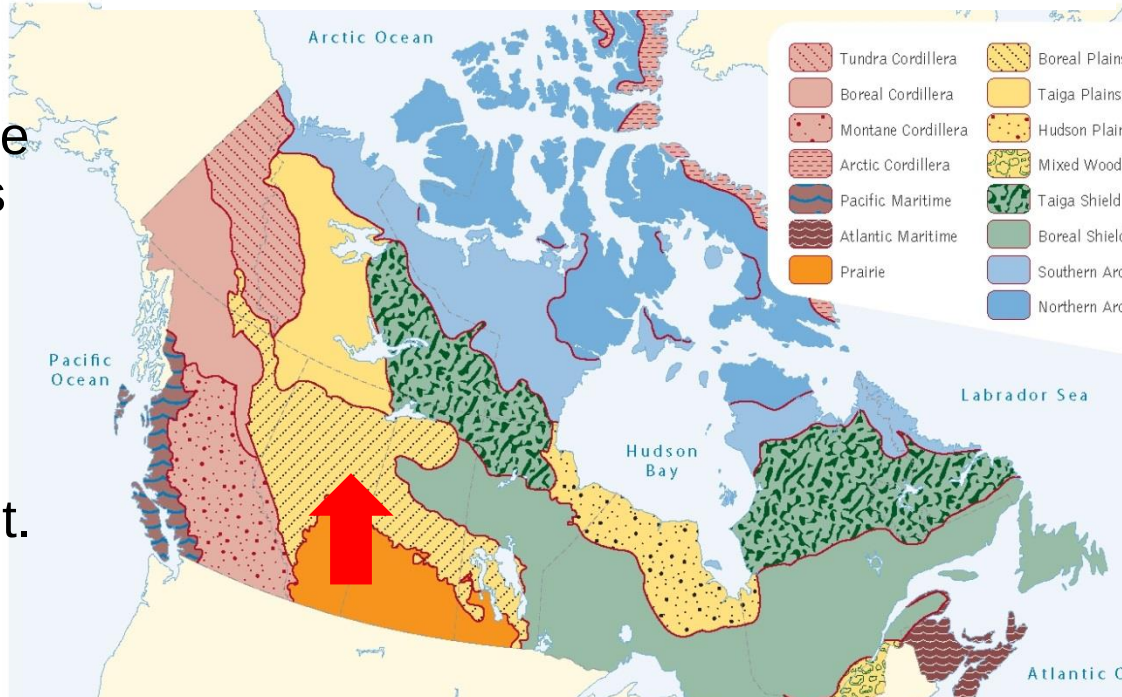
Logs en route to a mill for processing (note small diameter logs versus coastal timber)

Vineyards and orchards supported by soils and climate of BC's Okanagan valley.
http://travelsnapshots.files.wordpress.com/2010/06/okanagan-valley.jpg

Boreal Plains

- SE Yukon, NE BC, northcentral AB, SK and MB
- Generally flat to underlating surface of former glacial plain and outwash area
- Generally cooler and wetter than southern prairies;
- Tree spp: tamarack, jack pine, black and white spruce amongst various deciduous species;
- Dominant industry: agriculture; oil and gas production; forestry
- Communities: Edmonton, Ft. St John, BC; Ft McMurray,

Trembling Aspen (typical of Boreal Plains)
Source: Dearden and Mitchell (2012)



Boreal Plains

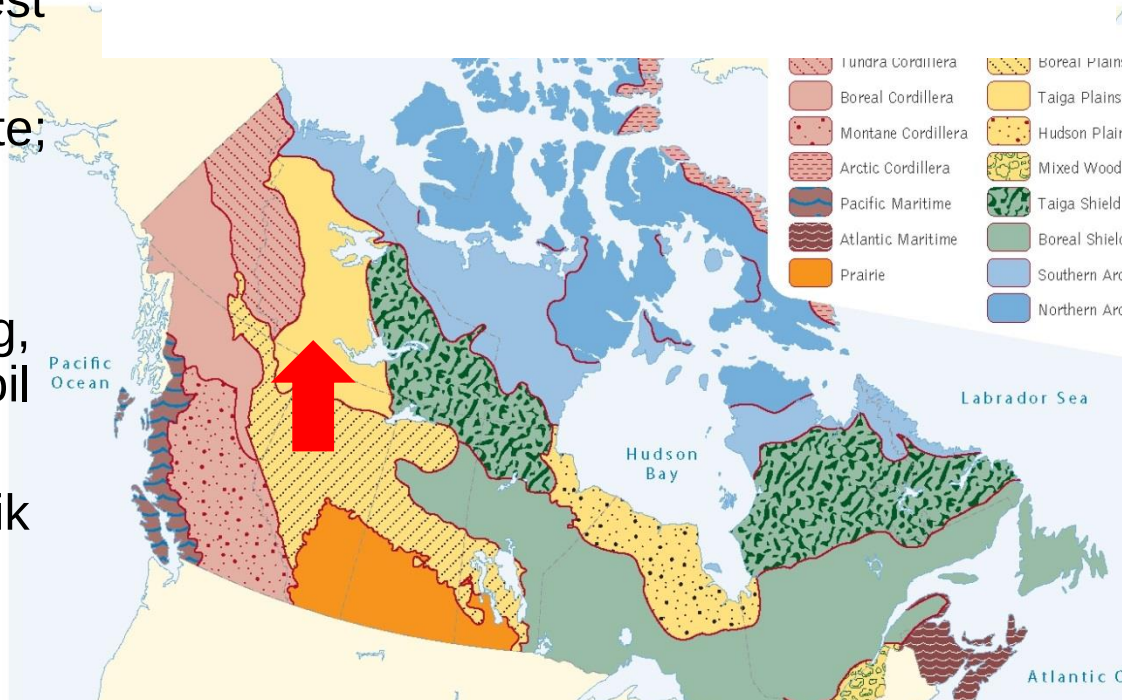
Fort McMurray, AB (source: Royal Lepage)

This image illustrates the breadth of boreal destruction associated with tar sands exploration.
http://www.huffingtonpost.ca/andrew-weaver/eu-law-oil-canada_b_1288264.html

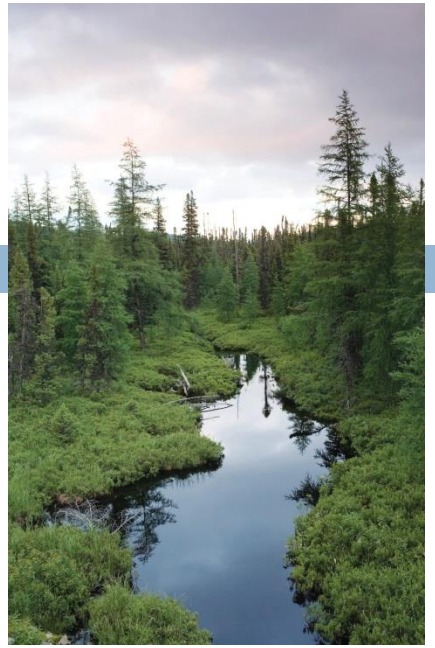
Taiga Plains

- East of the Richardson Mts, including the Mackenzie R. Valley and Great Bear and Great Slave lakes;
- Lies between southern boundary of the tundra and the closed-crown coniferous forest to the south;
- Cold and relatively dry climate;
- Extensive wetland areas;
- Dominant industry: subsistence hunting, trapping, & fishing; some mining and oil extraction;
- Communities: Ft Smith, Inuvik NWT,

Wetlands of the Canadian Shield

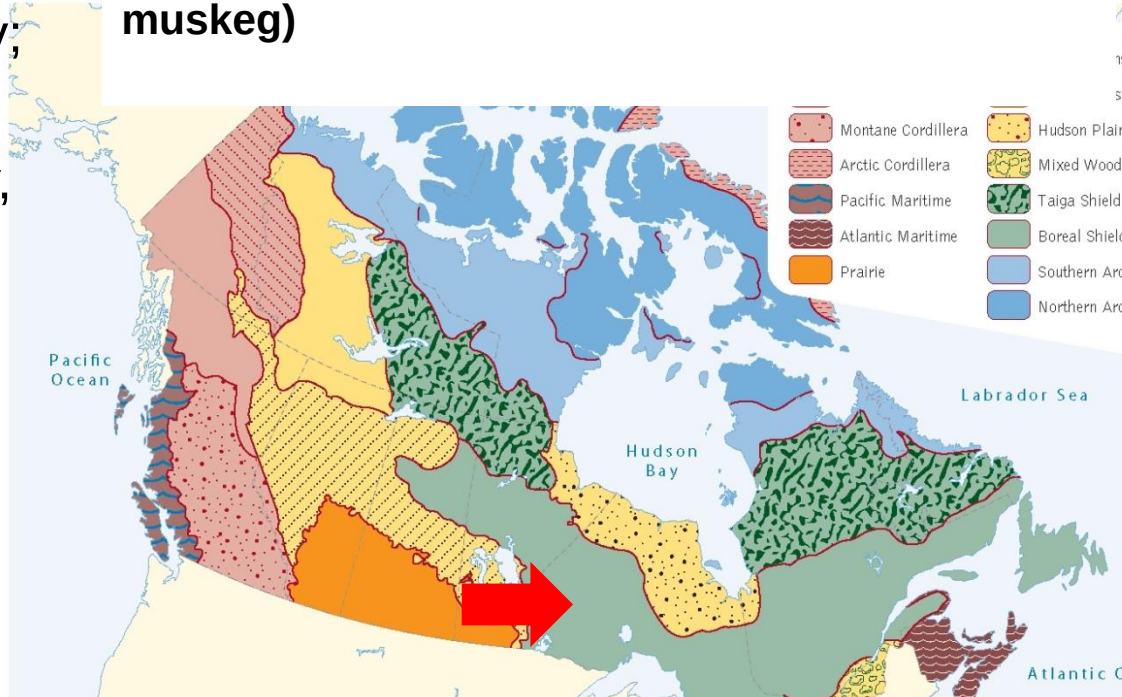


Boreal Shield

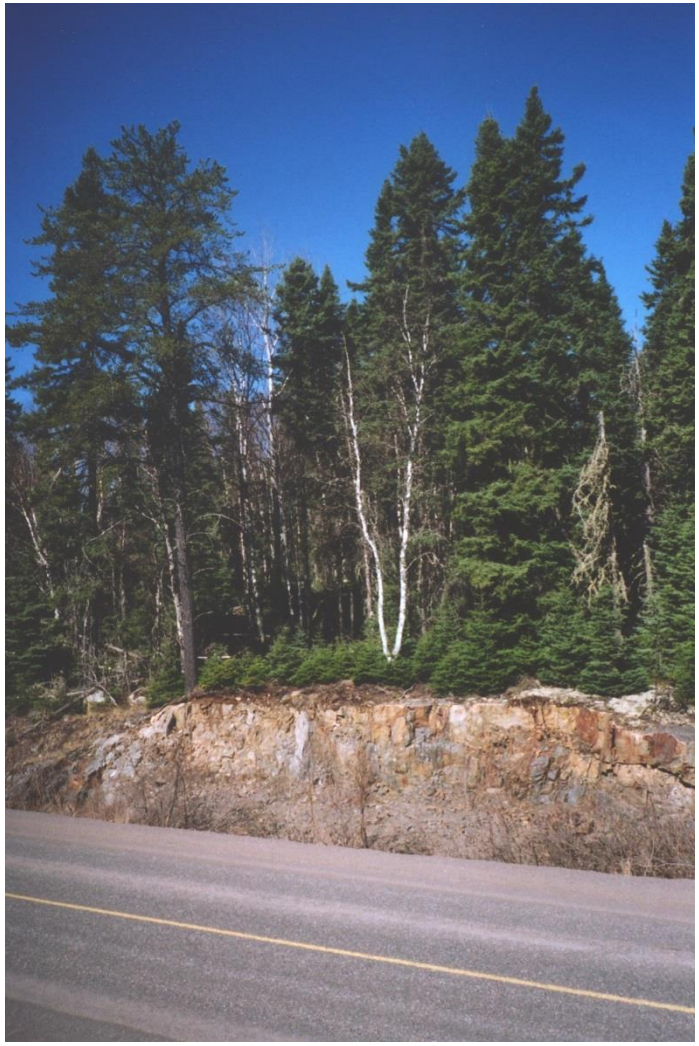


- Largest ecozone (SK to NF);
- Cold winters; summer warm to hot;
- Irregular, rocky glaciated terrain with many lakes;
- Dominant industry: forestry; mining; fishing;
- Communities: Thunder Bay, Kenora, Sudbury, Gaspe Pensinsula, Ottawa,

Boreal Forest (numerous outcrops, lakes and muskeg)



Thin soils and **polished rock surfaces** are typical of Canadian Shield Landscapes



Mixed Wood Plains

- Southern Ontario and Quebec – highly populated;
- Mild or low topographic relief (largely a depositional zone of glacial, marine and fluvial deposits)
- Continental climate (warm, humid summers, cool winters);
- Most diverse tree coverage in Canada (>64 spp); mixed coniferous-deciduous (Red & White Pine, Oak, Maple, …)
- Dominant industry: service industries; manufacturing;
- Communities: those in the Windsor-Quebec City corridor,

Mixed Wood Plains

Source: Dearden and Mitchell (2012)

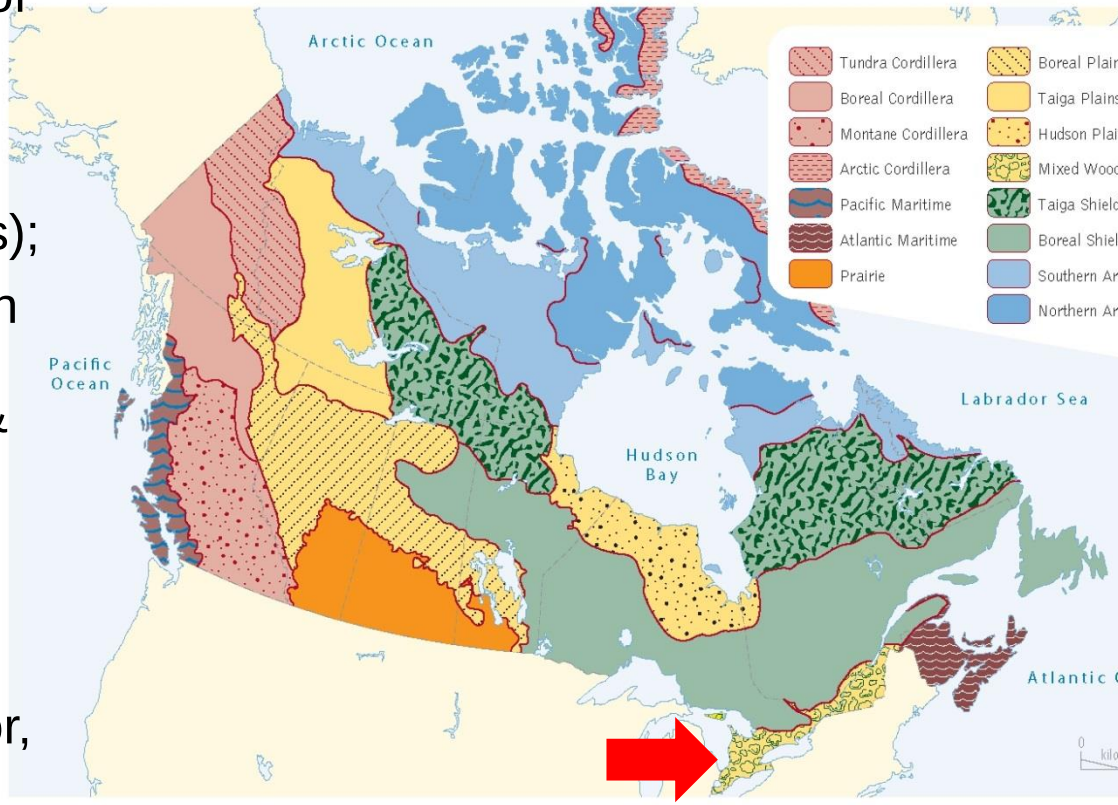


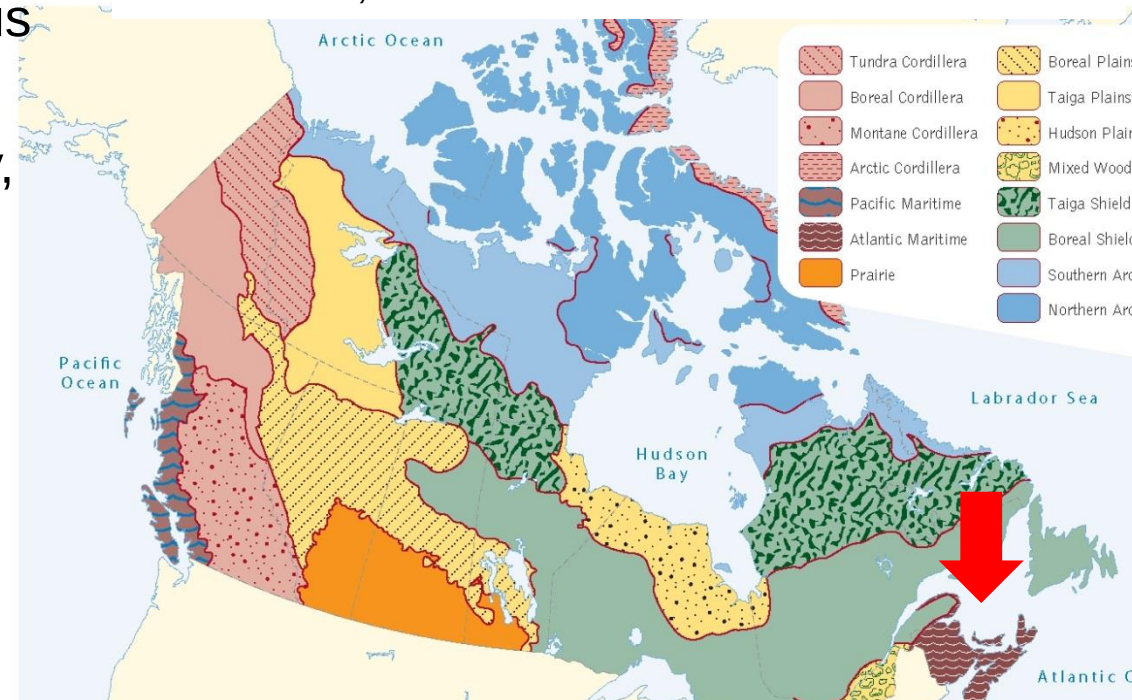
Figure 9.2 | Terrestrial ecozones of Canada. *Source: Wiken (1986).*

Atlantic Maritime

- South of Gulf of St Lawrence, including NB, PEI and NS;
- Strong marine influence on climate (cool, moist) – snowy, stormy winters;
- Mixed coniferous-deciduous stands typically
- Dominant industry: forestry, agriculture (potatoes, fruit), mining;
- Communities: Fredericton, Charlottetown, Halifax, Moncton,

Atlantic Maritime Ecozone

Photo credit; Sara Louie



Forest Ecosystem Services and Products

Forest Ecosystem Services and Products

- As stated earlier, Canada's forest ecosystems provide a variety of beneficial services including, but not limited to:
  - nutrient and water cycling
  - carbon sequestration
  - waste decomposition
- Their vastness means they provide significant contributions at a global scale, examples…
  - It is estimated that 20% of the world's water originates in Canada's forests;
  - The forests are also major carbon sinks (50,000 million tonnes on storage with 72 million tonnes uptake annually)
- Tourism and related recreational opportunities: millions of Canadians travel each year to participate in nature-related recreational activities (estimated to employ 245,000 people and contributes $12 billion to Canada's GDP)

Dearden and Mitchell (2012); NRTEE (2003b cited in D and M, 2012)

Forest Ecosystem Services and Products

- Climate moderating effect of plant communities:
  - Similar to effect of urban street trees
  - contrast clearcut to intact forest areas

Street trees, shading (cooling effect) example from Hell's Kitchen part of Manhattan. *Photo credit: T. Randall (Nov. 2011)*

Dearden and Mitchell (2012)

Forest Ecosystem Services and Products

- Biological communities also protect against extremes of flood and drought and maintain water quality;

Forested Slopes

- Holds soil in place
- Interrupts precipitation, retaining much
- Greater percolation into the water table

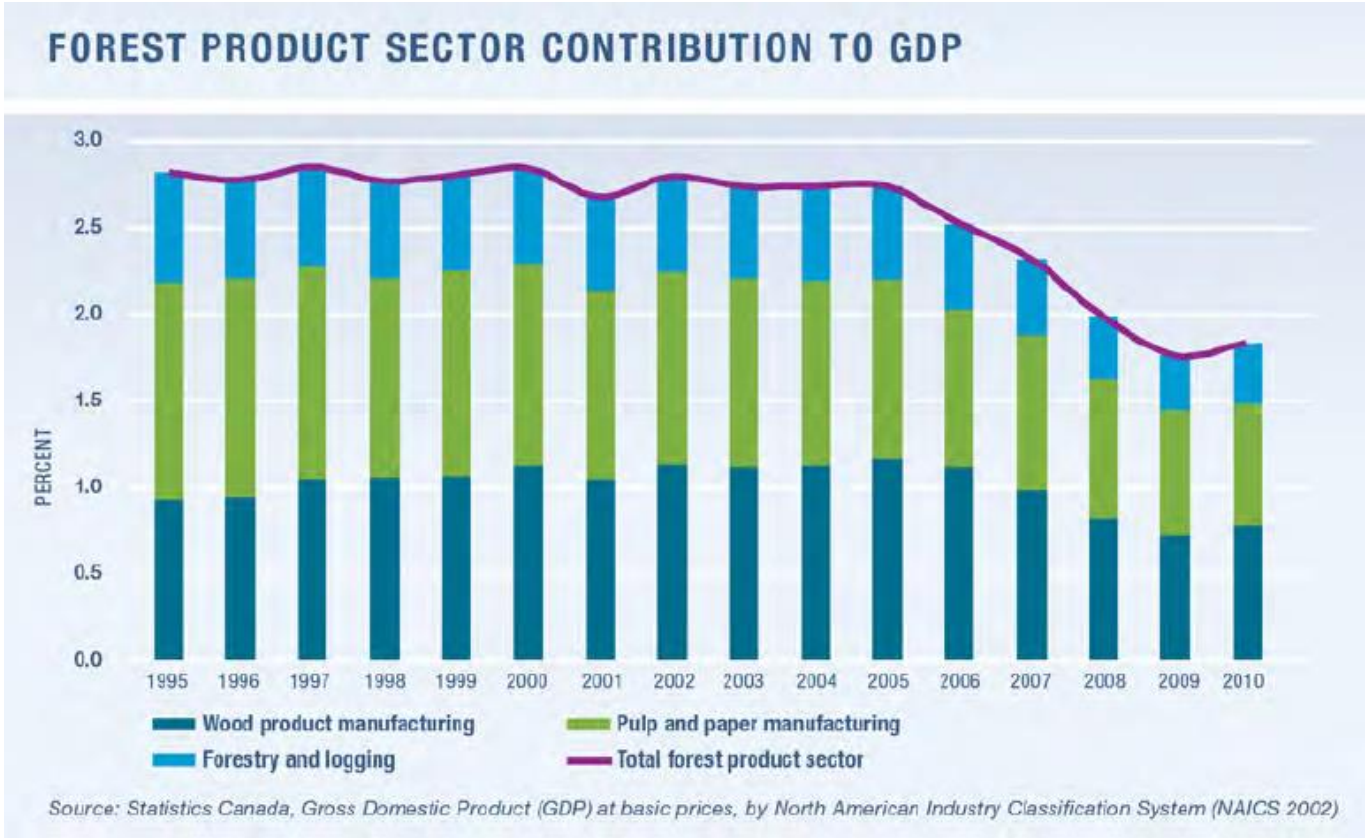
Clear cut Slopes

- Hotter
- No/less interception of precipitation (increased speed of runoff and change in flood behaviour of streams)
- Water table effects

Forest Ecosystem Services and Products

- *Non-timber forest products* (NFTPs) are commodities such as wild rice, mushrooms and berries, maple syrup, edible nuts, furs and hides, medicines, ornamental cuttings, and seeds
  - Contribute $1 billion/yr to the economy;
  - These are renewable (with careful planning)
- *Timber forest products* provide substantial economic benefits;
  - Canada: world's leading forest-product exporter (~15.9% of global trade)
  - For 200+ Canadian communities, forestry is >50% of economic base
- The Canadian forestry industry was(?) also a frequent flashpoint for conflict
  - e.g., Carmanah, Temagami, and Clayquot in the 1990s

Changing forest sector (hints at future lec)

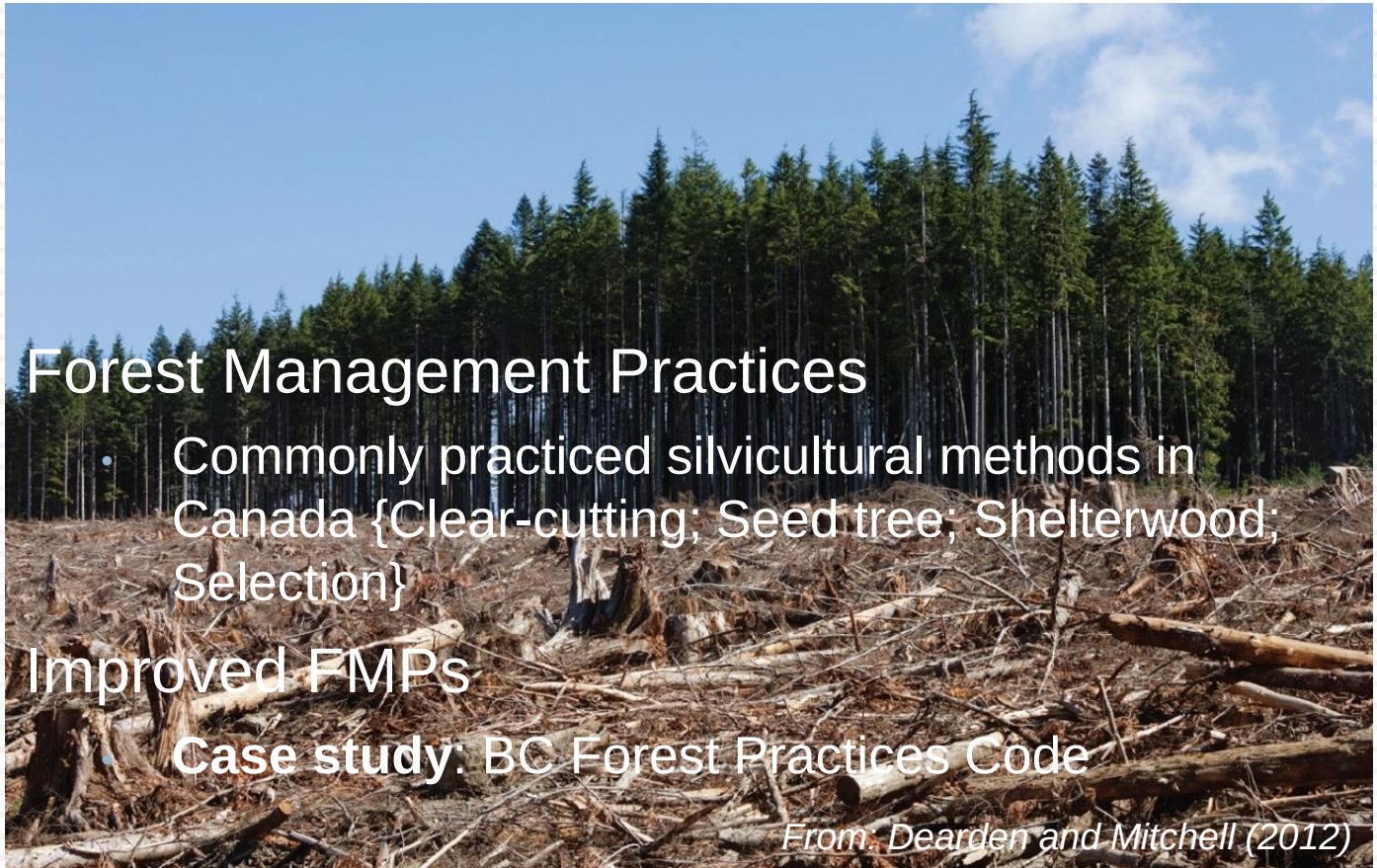


Changing revenue and employment in the forestry sector 1995 to 2010.
Source: NR Canada 2011

References

- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {Chapter 9: 'Forests'}
- Natural Resources Canada (NRCan) 2011. The State of Canada's Forests: Annual Report. Accessed at: http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/32683.pdf

Part 2: Forest Management Practices



Forest Management Practices

- Commonly practiced silvicultural methods in Canada {Clear-cutting; Seed tree; Shelterwood; Selection}

Improved FMPs

- **Case study**: BC Forest Practices Code

From: Dearden and Mitchell (2012)

Forest Management Practices

Rates of Conversion

Annual Allowable Cut

Sustained Yield

Forest Management Plans

Silviculture Systems

Reclamation Plans


Felling – MFR


Yarding – MFR


Loading – MFR

Preamble: FMPs (1)

- Forest management is mainly a provincial responsibility, with governments managing forest resources on behalf of the public through agreements with private logging companies;
- **forest tenures:** refer to the conditions governing forest ownership and use;

Rates of government ownership of forest land relatively high in Canada vs Europe

Jurisdiction	% forest land owned by Gov't	% privately owned	
		(by individuals)	(by corporations)
British Columbia	96%	small	small
Canada	95%	small	small
Finland	31%	62%	6%
Sweden	25%	50%	25%

Table based on Hanna, K in Dearden and Mitchell (p.294)

Preamble FMPs (2)

- **“rate of conversion”** of natural to managed forests … one of the more controversial issues in Canadian forestry
- Each province establishes an **annual allowable cut** (AAC), the amount of timber that is allowed to be cut annually from a specified area
- The AAC should reflect the **long-run sustained yield** (LRSY) of a given unit of land, or what that land should yield in perpetuity; **this varies by forest ecozone** (cf. Pac. Maritime versus Boreal Plain) **and site characteristics within each zone** (valley floor versus valley wall)**;**
- But … there is a difference in monetary returns gained from the ‘first cut’ versus ‘second’ and subsequent cuts … there has been a tendency to ‘convert’ forests at rates higher that can be supported biologically;

Calculation of the AAC

From: Dearden and Mitchell (2012)

- One needs the rotation period for each forest type – called the **culmination age**. (e.g., for Douglas Fir, 90 years on a low-elevation site; 117 yrs on a high-elevation site in coastal BC, Washington state; Curtis [1995]).
- AAC also varies widely due to ratio of old-growth to second-growth timber included in the proposed cutting unit;
- **Old-growth forests** have very high timber volumes, while **second growth** on these sites will have much lower volumes
- This is known as the **falldown effect** and results in AACs up to 30 per cent lower as old-growth forests are eliminated

From: Dearden and Mitchell (2012)

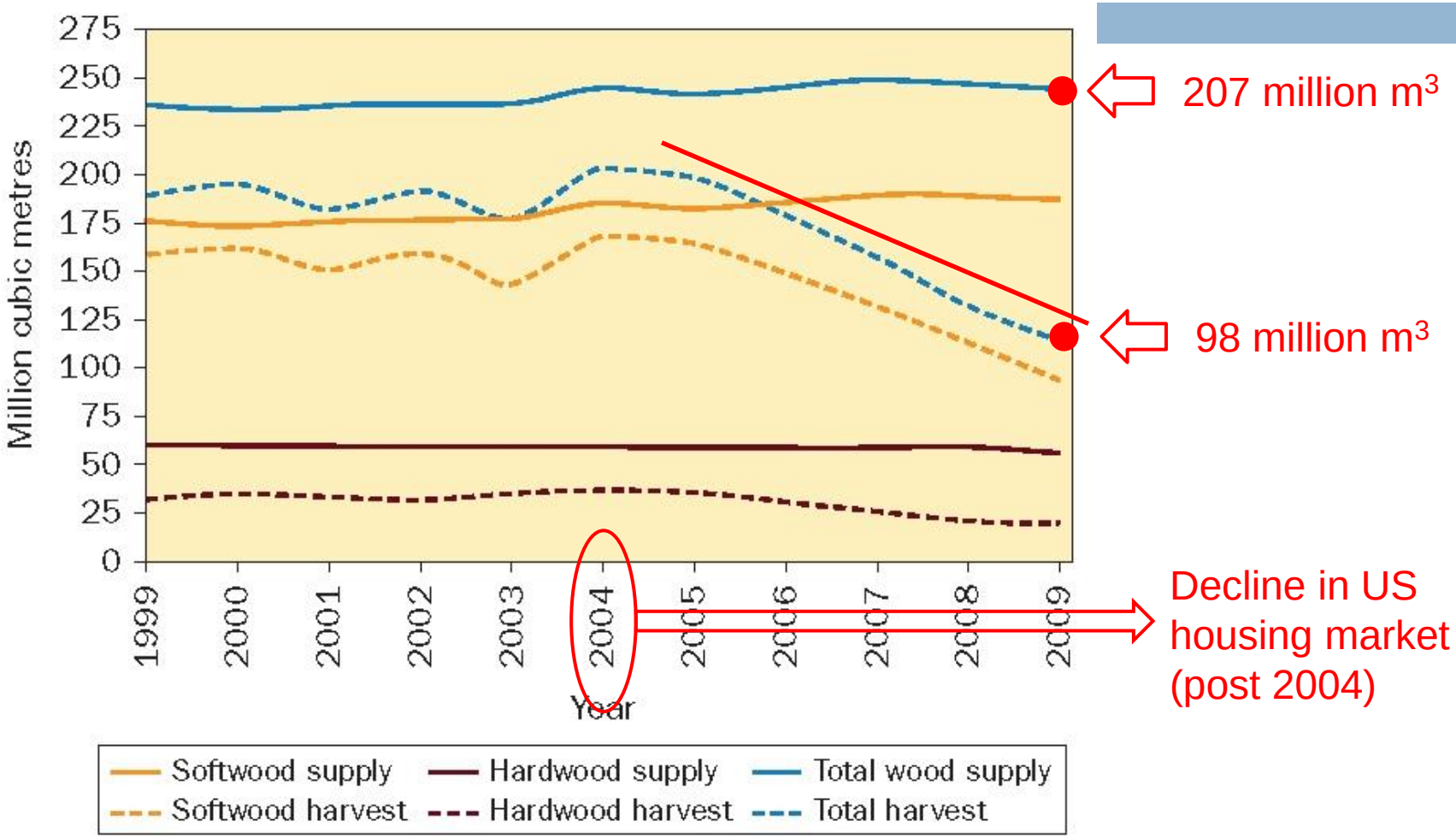
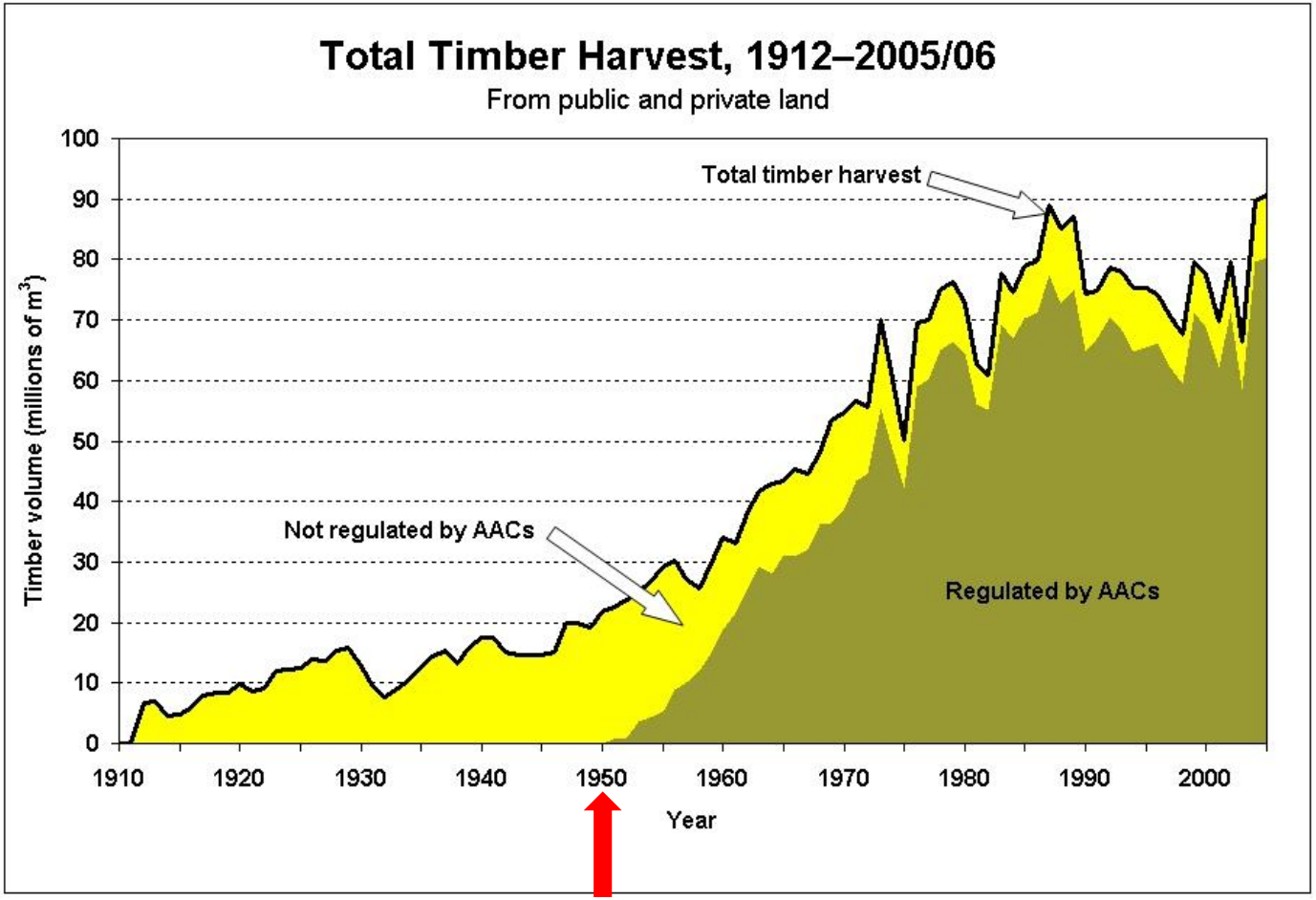


Figure 9.3 | Annual harvest versus supply deemed sustainable for harvest. *Source: Natural Resources Canada, (2011: 33).*

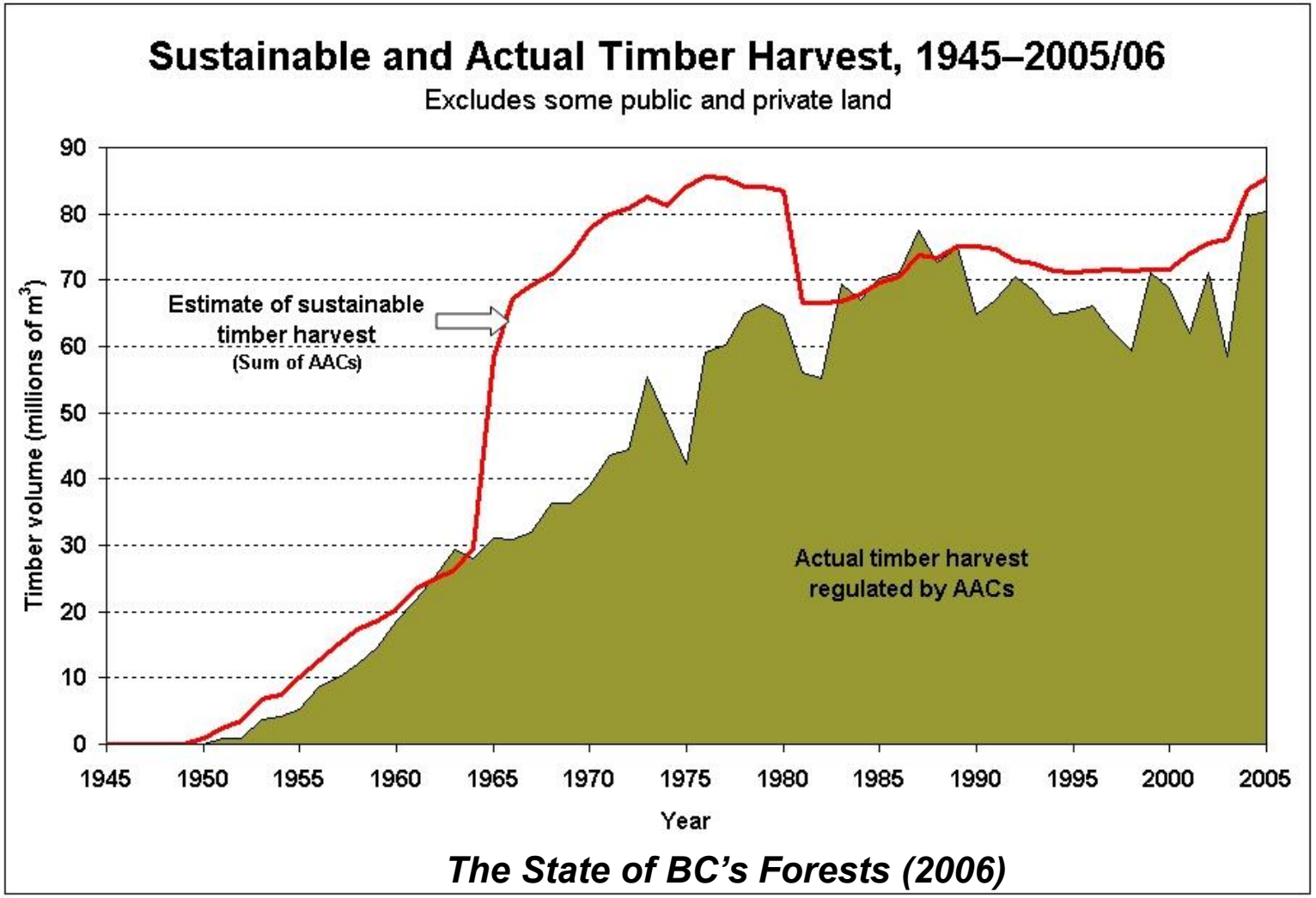
Growth in BC timber harvest (20th Century)



Beginning in 1949, the BC government set allowable annual cuts (AACs) to regulate harvest levels on public land and some private land

The State of BC's Forests (2006)
http://www.for.gov.bc.ca/hfp/sof/2006/13.htm

Actual vs Sustainable Harvest (AAC)



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The State of BC's Forests (2006)
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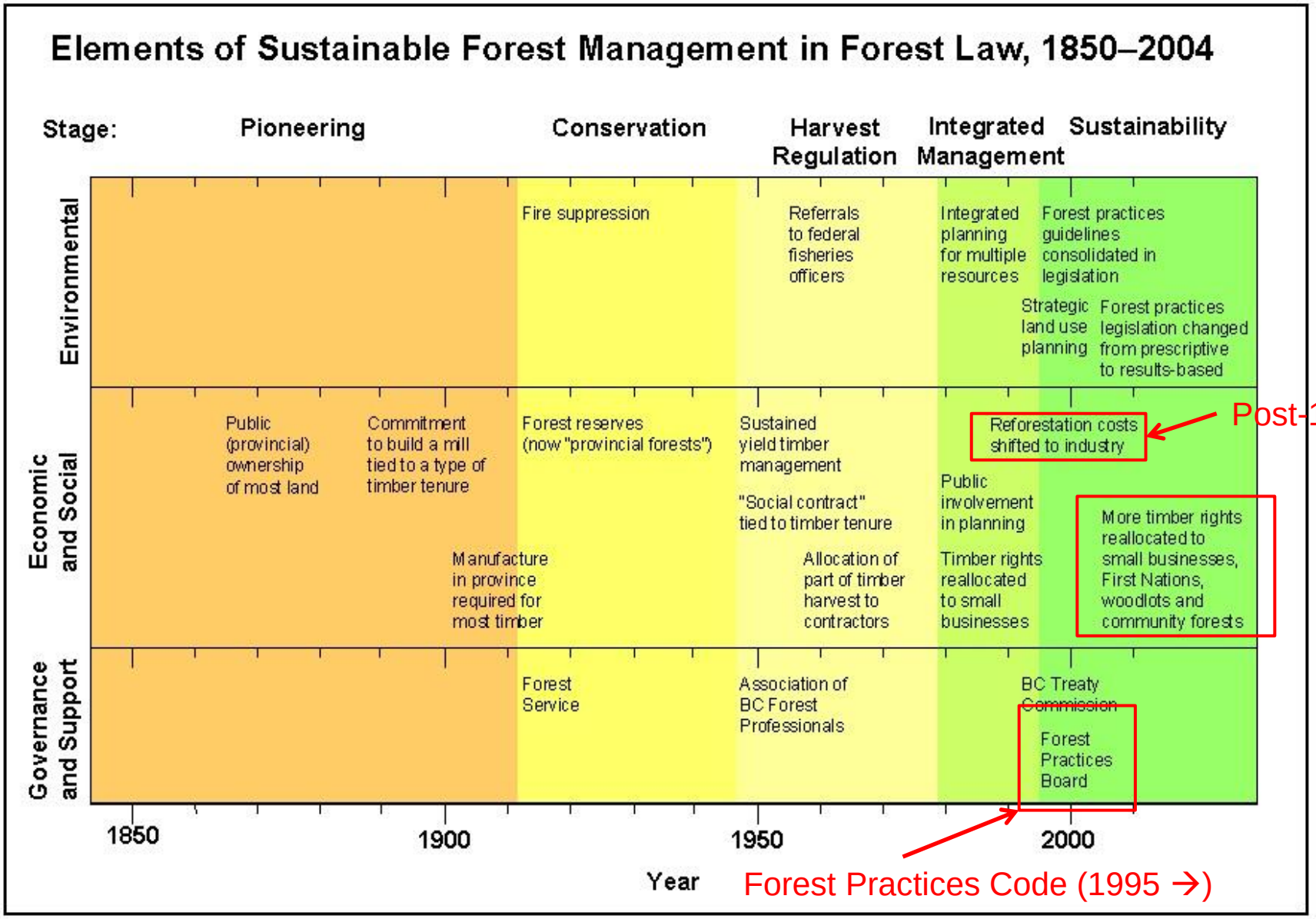
State and Trend

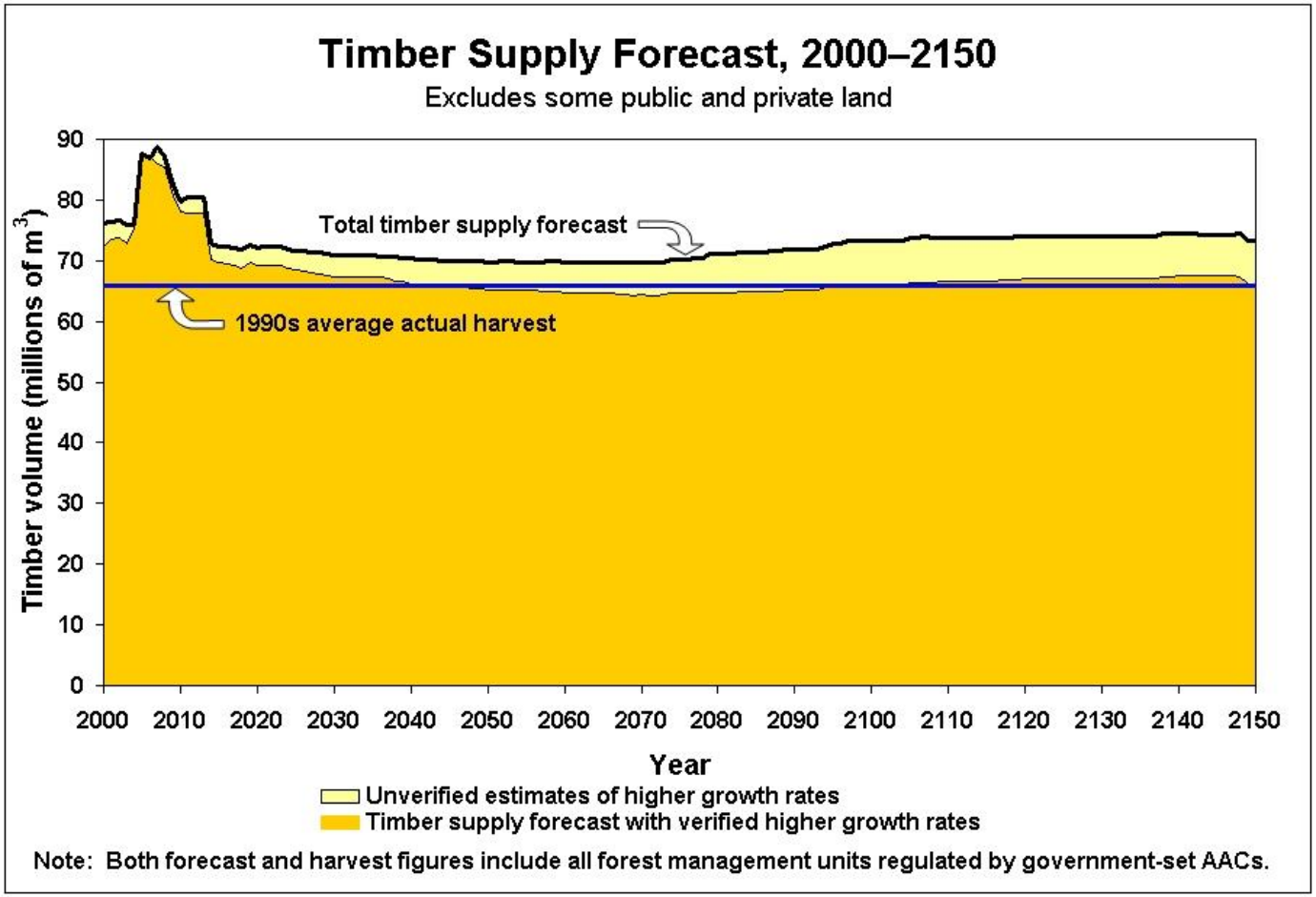
- Each forest management unit's AAC represents a sustainable harvest level that balances environmental, economic and social considerations.
- In the last 10 years, the average harvest regulated by AACs was 68 million m^3 per year, or 10% less than the sustainable level (sum of AACs) of 77 million m^3 per year. Among the causes for this difference are market fluctuations and delays in forest planning.
- AACs are the maximum average level of harvests for a five-year period. Within this period, actual harvests may exceed AACs for a short period, if offset by lower subsequent harvests.
- In the last few years, AACs of some management units have been increased to address the current mountain pine beetle epidemic with pest control measures and salvage programs. Decreases in the AACs of these units are projected for the future.
- AACs have also changed to reflect :
  - new harvesting and milling technologies (increases in the 1960s, 1970s and 1980s);
  - new legislation (the decrease around 1980),
  - and the establishment of new parks and forest practices (the decrease in the early 1990s).



The State of BC's Forests (2006)

http://www.for.gov.bc.ca/hfp/sof/2006/13.htm

What is the provincial timber supply forecast?



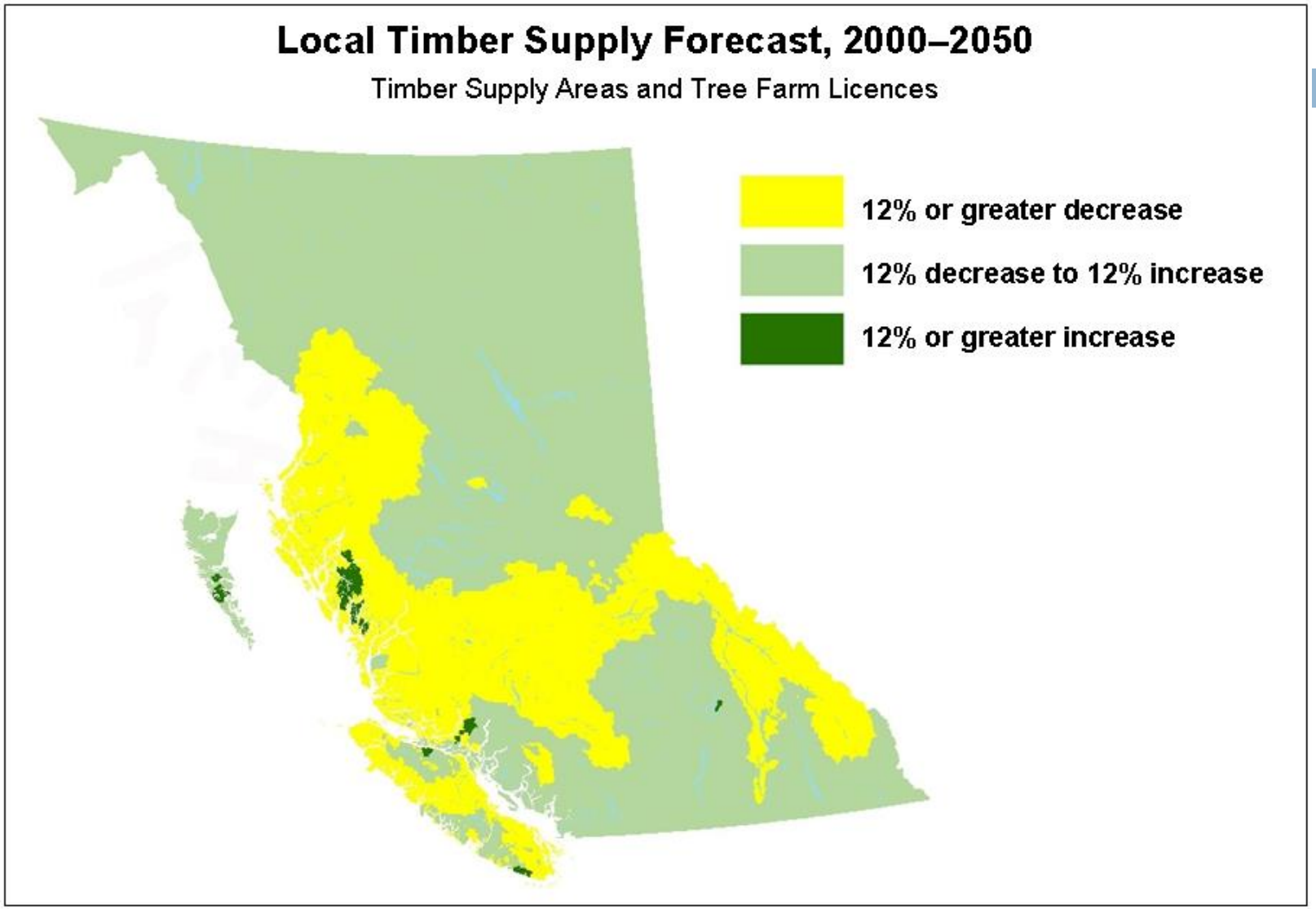
The State of BC's Forests (2006)

http://www.for.gov.bc.ca/hfp/sof/2006/13.htm

State and Trend (2000 to 2150 estimates)

- forecasts are influenced by many factors:
  - past harvest levels; the current mountain pine beetle epidemic; the shift to harvesting more second-growth forests; and estimates of future growth rates.
  - Current harvests are based on accumulated volumes in older forests. Future harvests will rely on the faster growth of second-growth forests.
- Increases in AACs, for pest control measures and salvage programs, the provincial timber supply forecast peaks at 89 million m^3 per year in 2007, or 34% above the average actual harvest of 66 million m^3 per year in the 1990s (before the AAC increases).
- A decrease to 73 million m^3 per year is projected in 2014, followed by further decreases until 2060. The forecast remains between 6% and 13% higher than the average actual harvest in the 1990s.

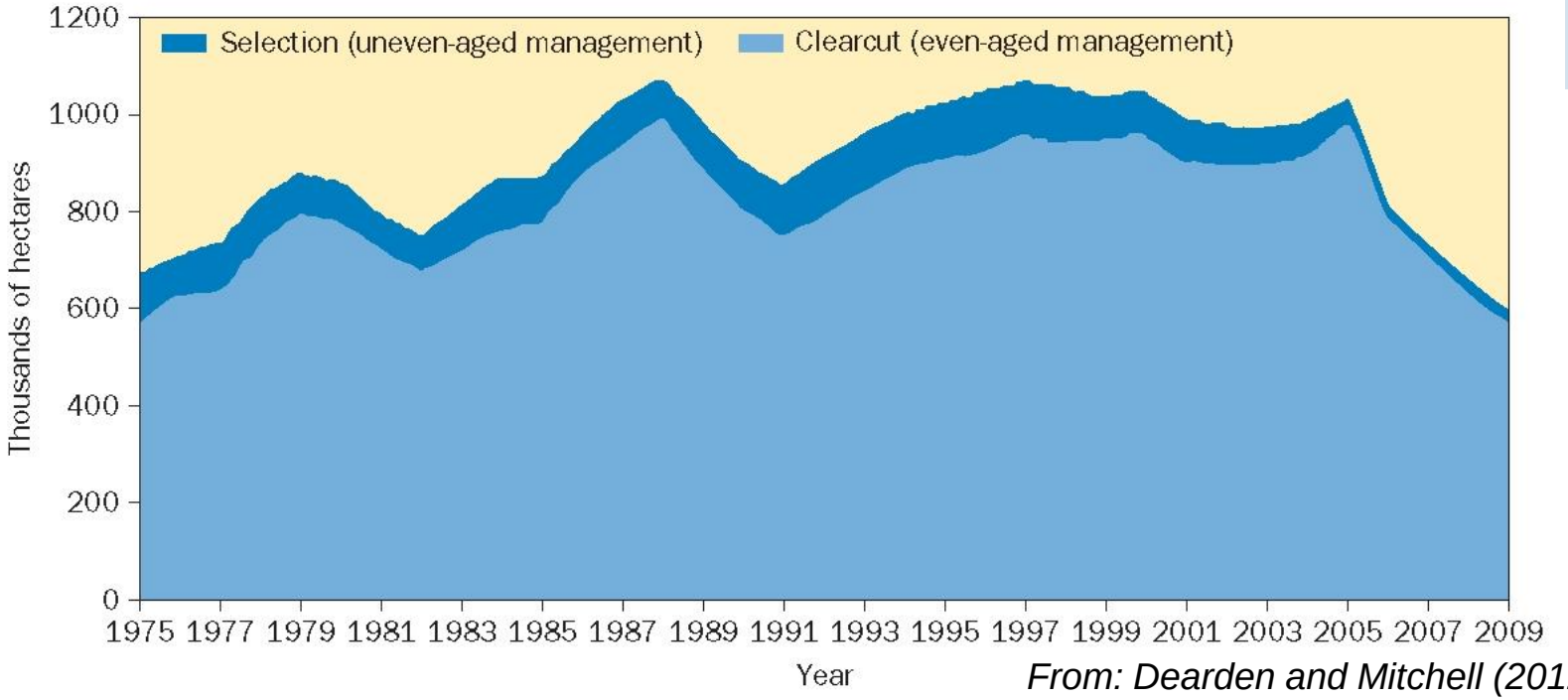
The State of BC's Forests (2006)
http://www.for.gov.bc.ca/hfp/sof/2006/13.htm



The State of BC's Forests (2006)
http://www.for.gov.bc.ca/hfp/sof/2006/13.htm

Silviculture Systems

- Silviculture: directing the establishment, composition, growth and quality of forest stands;
  - Includes: harvesting; reforestation; site preparation
- Harvesting Methods: Clear-cutting; Seed tree; Shelterwood; Selection



From: Dearden and Mitchell (2012)

Figure 9.4 | Silviculture: Area harvested, 1975–2009. *Source: National Forestry Database, Silviculture—National Tables, at: nfdp.ccfm.org/silviculture/national_e.php.*

Clear-Cutting

(*top-left*) **Elaho R. valley** (near Squamish, BC) (~1994, credit: TR); (*top-right*) **Toba Inlet, Coastal BC** – note heli-cutblocks regenerating (~1995, credit: TR); (*right*) **generic clear-cut** credit to Dearden and Mitchell (2012)

Felling – MFR

Yarding – MFR

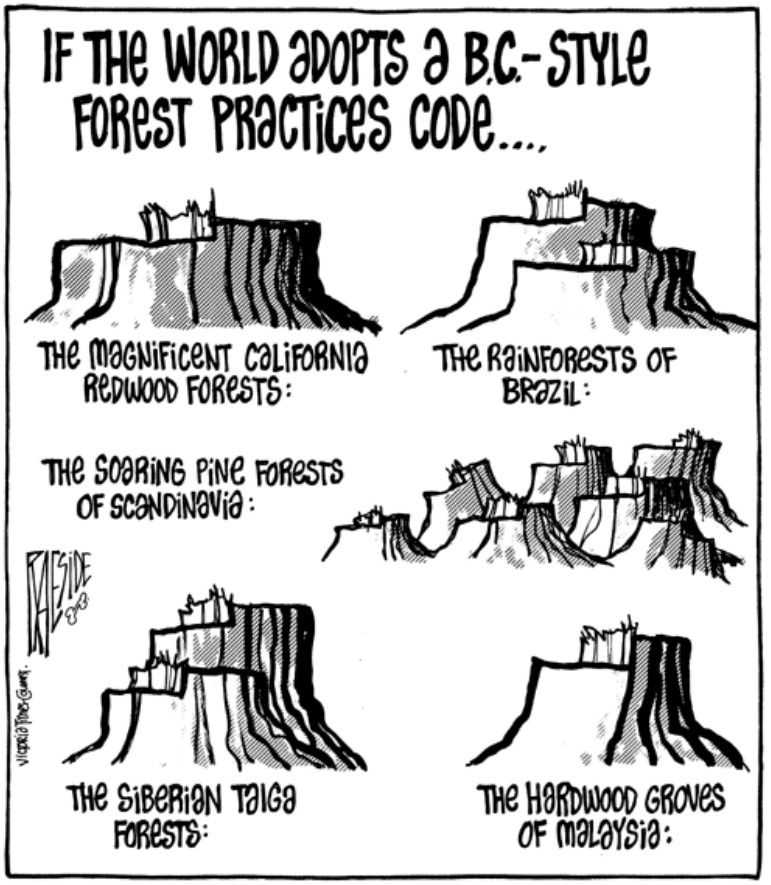
Loading – MFR

The State of BC's Forests (2006)

http://www.for.gov.bc.ca/hfp/sof/2006/13.htm

Clear-Cutting

- Increased use since 1970s vs. Selection
- Has caused a great deal of conflict in Canada (as in other parts of the world);
- Cutblocks are aesthetically unappealing and can have significant environmental impact;
- Pressure from EU resulted in BC reforming forest practices with the introduction of its **Forest Practices Code** in 1995.



Clear-Cutting – environmental challenges (next lecture)

Clear-Cutting – environmental challenges (next lecture)

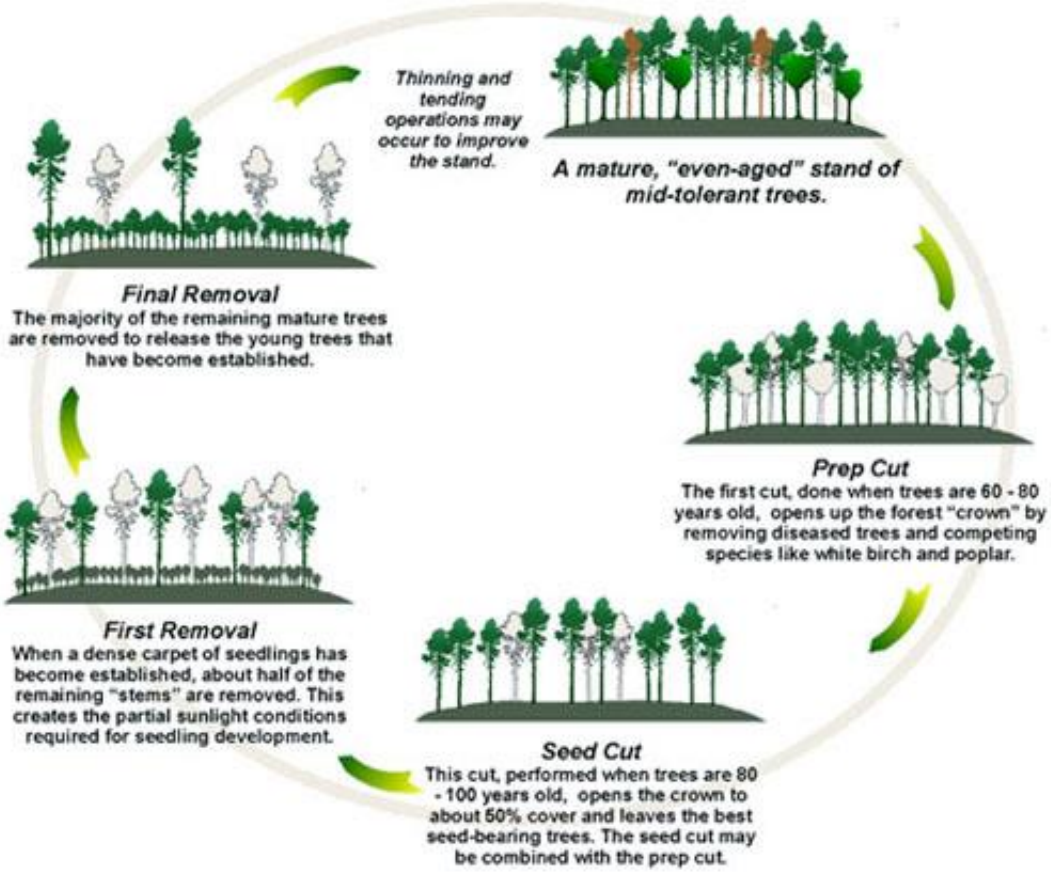
“Second Growth: Environment activists need help to succeed in protecting rivers and forests” Article by: Bill Henderson (Aug. 2011) www.rabble.ca


Vancouver Island - 1860
Productive Old Growth
Low Productivity Old Growth
Non-Forest
Lakes
Nanaimo
Vancouver
Victoria
Sierra Club BC
Map Source: Sierra Club British Columbia

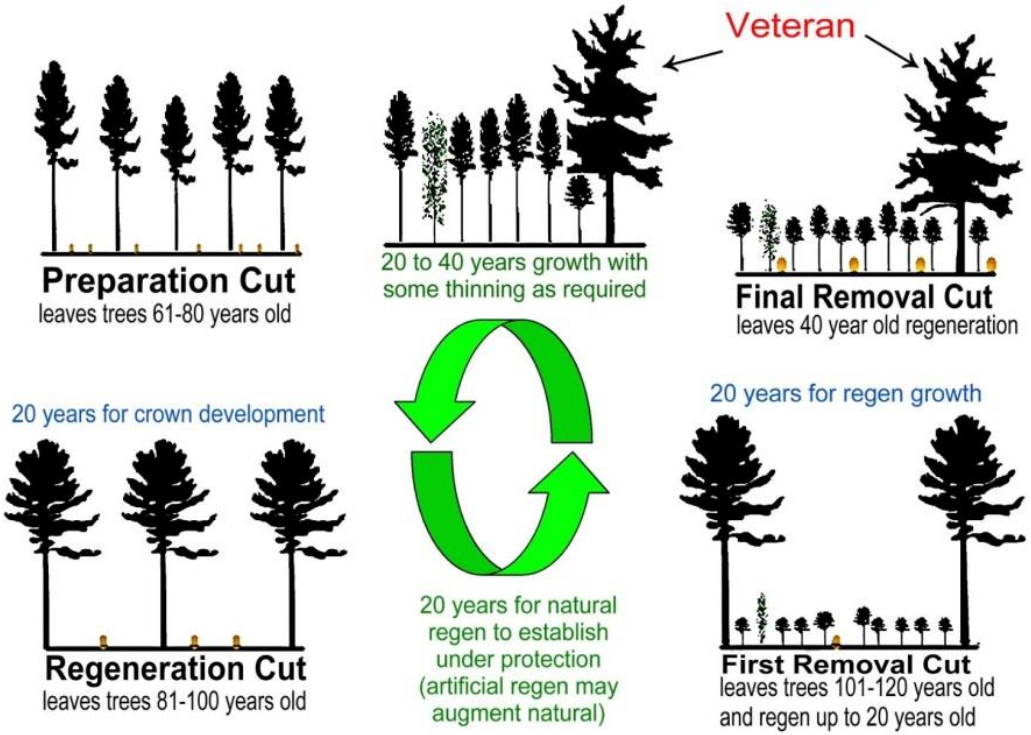

Vancouver Island - 2007
Port Hardy
Campbell River
Productive Old Growth
Low Productivity Old Growth
Logged
Non-Forest
Lakes
Tofino
Nanaimo
Vancouver
Victoria
Sierra Club BC
Map Source: Sierra Club British Columbia

Shelterwood (Partial cuts)

- involves the complete removal of a stand in a series of cuts
- is used with mid-tolerant species, those can tolerate partial shade as saplings, but also require some sunlight in order to thrive (e.g. Oak, White Pine)
- Results in even-aged stands



http://www.sudburyforest.com/silvicsystems.html



Source: OntarioTreeMarkers.ca

Selective Logging

- Periodic harvesting of selected trees of various ages in a stand;
  - Valuable mature trees; or poorly shaped, unhealthy, damaged trees
- Objective is to maintain an **uneven-aged, mixed-species** forest stand;

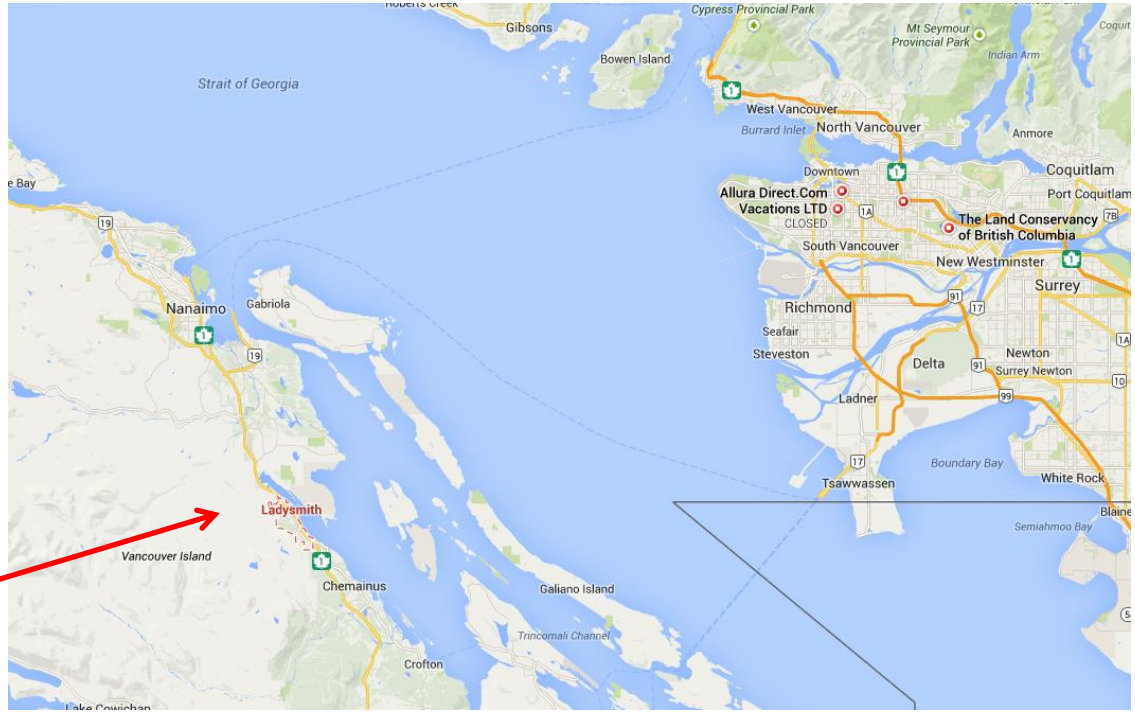
Merv Wilkinson (1913-2011)
Owner/Steward/Eco-forester of Wildwood Forest, Nanaimo, BC (from 1938 to 2003) and promoter of sustainable forestry practices.

Selective Logging

- (++) Maintains recreation, scenic values, minimizing biodiversity losses;
- (--) Applicable to shade-tolerant tree species (e.g., sugar maple, western red cedar, balsam fir), requires skilled-work force; complex and costly system to plan and implement;

Wildwood Forest, Ladysmith, BC

http://www.youtube.com/watch?v=XV5T6tvMkUA



Reforestation Efforts

- Canada's forests, at point one, considered so vast that little thought given to managed reforestation; changed ~1985
- Previously, clear-cuts and slash piles burned on site, with land left to re-generate naturally;
- Deficit (in 2009): (Dearden and Mitchell, 2012)
  - Land area harvested 600,000 ha
  - Land area replanted/reseeded 450,000 ha

  -150,000 ha
  - Land area defoliated by insects 15,200,000 ha
  - Land area burned by fires 3,200,000 ha

Reforestation Efforts

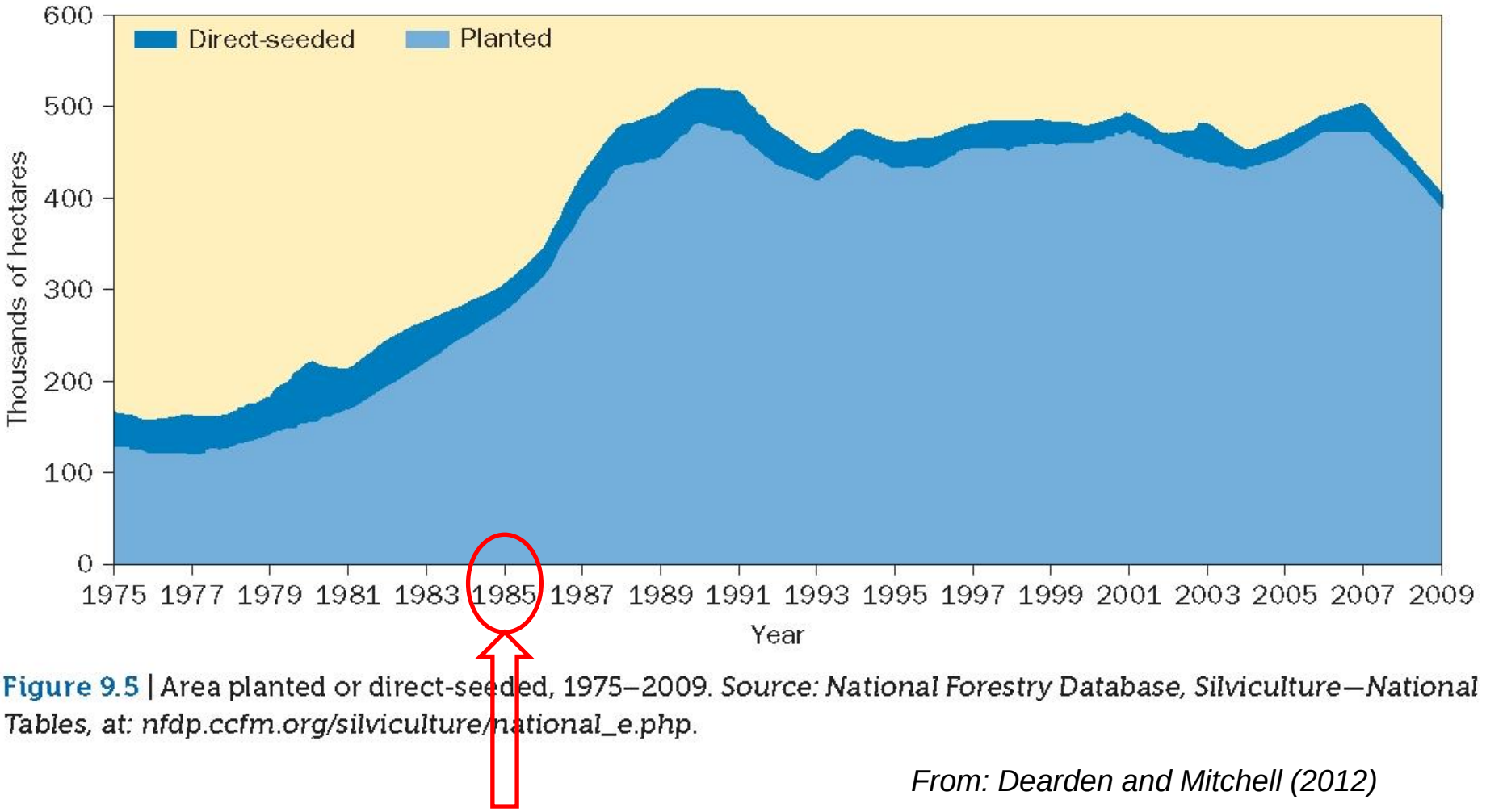


Figure 9.5 | Area planted or direct-seeded, 1975–2009. *Source: National Forestry Database, Silviculture—National Tables, at: nfdp.ccfm.org/silviculture/national_e.php.*

From: Dearden and Mitchell (2012)

Magnitude of Forest Disturbance (natural and other)

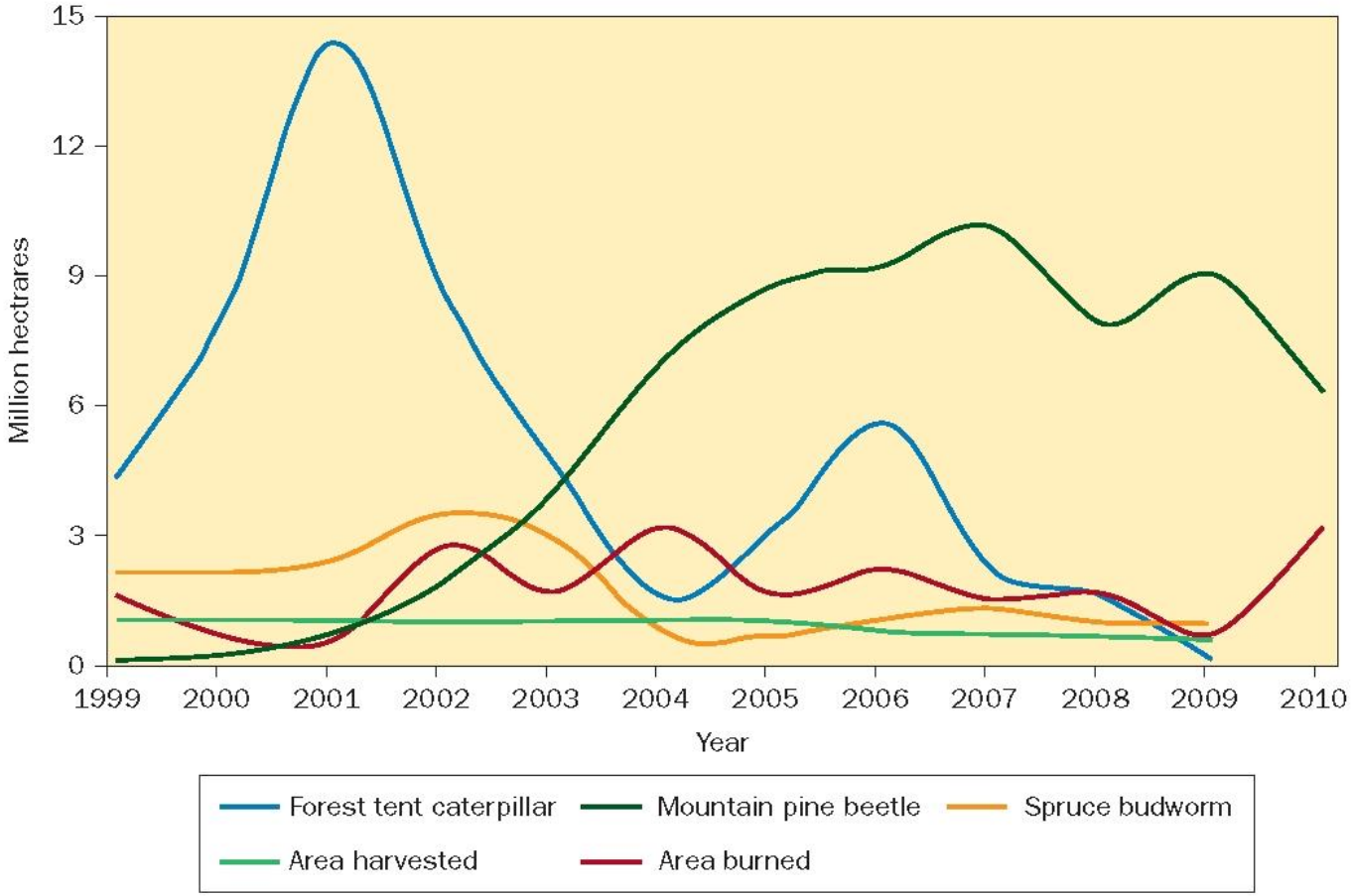


Figure 9.6 | Area of forest disturbed by fire, insects, and harvesting. *Source: Natural Resources Canada (2011: 26).*

From: Dearden and Mitchell (2012)

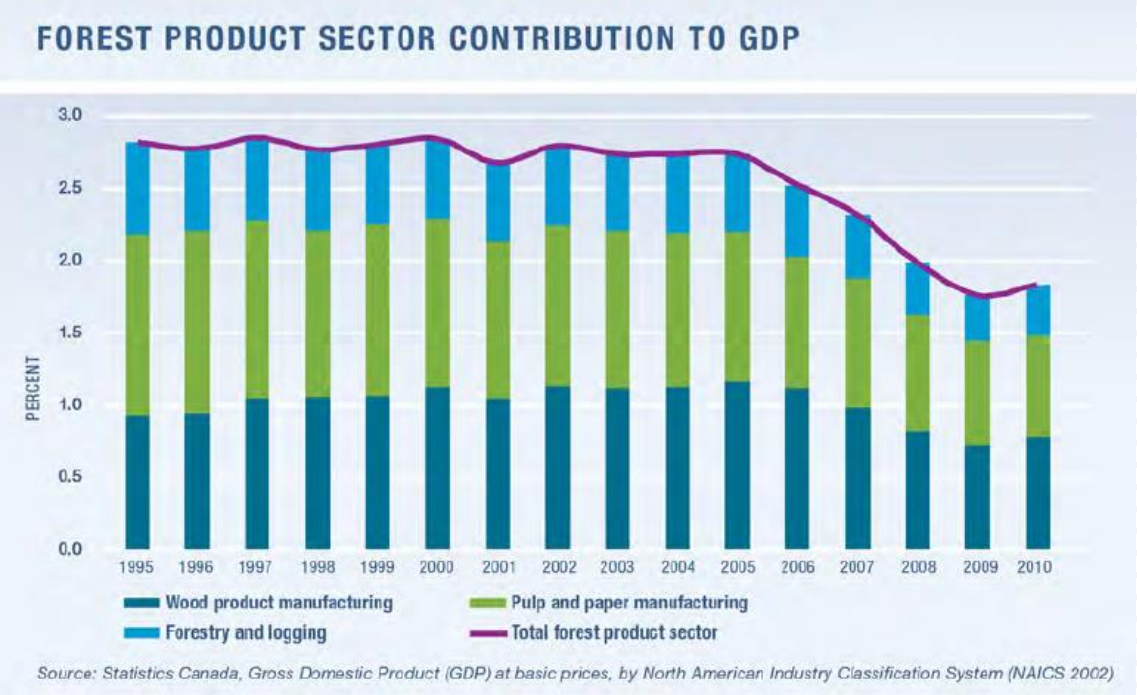
Looking Ahead to the next lecture

Read ahead (pp. 302-320, Chpt. 9, “Forests”)

“*Environmental and Social Impacts of Forest Management Practices*”

Changing revenue and employment in the forestry sector 1995 to 2010.

Source: NR Canada 2011



Looking Ahead to the next lectures

June 2: Forests: Env'l & Social Impacts and ML.3 (Map Literacy 3)

Read ahead (Chpt. 9, pp. 303 →)

June 3: Agriculture: Current Systems and Their Impacts and Related Environmental Challenges

Read ahead (Chpt. 10, pp. 332 →)

June 4 (Wednesday): Field Trip

References

- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {Chapter 9: 'Forests'}
- Curtis, RO, 1995. Extended rotations and culmination age of coast Douglas-fir: old studies speak to current issues. Res. Pap. PNW-RP-485. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 49 p.
- **http://www.sudburyforest.com/silvicsystems.html**, date accessed Jan 29, 2014

The Vermilion Forest Management Company Ltd.

Managing the FSC Certified Sudbury Forest

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