

LECTURE 6:  
MAY 13, 2014

# ECOSYSTEMS ARE DYNAMIC

## CHANGING ECOSYSTEMS & MAP LITERACY #1

Text Reference: Dearden and Mitchell (2012), Ch. 3, pp. 92-111

# Outline

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## □ Upcoming:

### □ May 13:

- paper proposal due in class;
- be prepared to briefly discuss your topic and what you hope to learn

## □ Today:

- (lecture) changing ecosystems
- Break (~ noon)
- (logistics: Wed field trip)
- Map Literacy 1 exercise
- (discussion: paper topics and approach)
- (lecture) finish....



**Source: Thunder Bay News Watch**

<http://www.tbnewswatch.com/Pictures/userpics/>



*Source: Dearden and Mitchell (2012)*

# Ecosystem Change

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- 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
- Dynamic Equilibrium in ecosystems.



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.

# Eurasian Milfoil -- invaded lakes in BC's Okanagan in early 1970s

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- Threats to:
  - ▣ Recreation
  - ▣ Lake Ecology
  - ▣ Fisheries
  - ▣ Water Quality
  - ▣ Economic Impacts




## EURASIAN MILFOIL ALERT!

**PLEASE REMOVE ALL AQUATIC PLANTS FROM BOATS AND TRAILERS**


Eurasian water milfoil is an aquatic plant that interferes with boating, swimming, water skiing and fishing on many Wisconsin lakes.

a fragment:



top leaves have a reddish cast

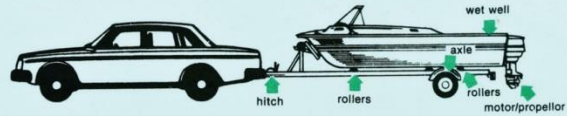
a leaf:



12 or more pairs of leaflets on each leaf

Fragments of Eurasian water milfoil are transported from lake to lake on boats and trailers. New plants grow from these small pieces and, although milfoil has a hard time getting established in lakes with a healthy population of native plants, it can quickly infest disturbed sites.

You can help prevent the spread of Eurasian water milfoil in Wisconsin and neighboring states by removing all aquatic plants from your **trailer, boat, motor/propeller** and **anchor** before launching and after leaving the water. Please take special care to remove aquatic plants from the wet wells of trailered boats, board boxes of sailboats and the interior of car-top boats and canoes.



Places to look for aquatic plants. ▲

Thank you!

**Wisconsin Department of Natural Resources  
Lake Management Program**

Source: Dearden and Mitchell (2012)

<http://saveblacklake.org/invasive-species/eurasian-water-milfoil>

# US Herbicide Plan for Osoyoos Lake Prompts Concern

Aquatic herbicide could end up in Canadian portion of lake where it isn't approved, say water officials

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By Joan Delaney

Epoch Times Staff

Created: July 27, 2011

Last Updated: July 28, 2011



A **milfoil harvester** on a lake in Vernon, B.C. The harvester is used in the Okanagan Valley to trim the top part of Eurasian watermilfoil in summer. A Washington state-based organization has applied to use a chemical herbicide to kill milfoil in the U.S. portion of Osoyoos Lake. (Courtesy of Okanagan Basin Water Board)

<http://www.theepochtimes.com/n2/canada/us-herbicide-plan-for-osoyoos-lake-prompts-concern-59612.html> **2011**

# Eurasian Milfoil

(‘poster child’ of invasive species)

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- Has since spread across other Canadian provinces despite best efforts to contain;
- Conflict between stakeholder groups (local economies dependent on water-based tourism and the chemicals brought in to control)
- This pattern of invasive species has become increasingly common;

# Gaia Hypothesis – re ecosystem equilibrium

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- Postulated by James Lovelock (in 1988)
- Claims that the biosphere is a **self-regulating entity** with the capacity to keep our planet healthy by controlling the interconnections of the chemical and physical environment;
- However, few scientists believe the Earth to be a “super-organism” with all systems working together to create some overall equilibrium
- **Inertia:** ability of an ecosystem to withstand change;
- **Resilience:** ability (of an ecosystem) to recover to the original state following a disturbance



# Invasive Alien Species

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- Organisms found in an area outside their normal range;
  - e.g., Purple Loosestrife and Eurasian Water Milfoil



Source: Alberta: Agriculture and Rural Development  
[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/prm2593](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm2593)



<http://saveblacklake.org/invasive-species/eurasian-water-milfoil>

- they multiply quickly, out-compete native species, and change native habitats;
- are often fast-growing generalists that can alter growth form, reproduce quickly both sexually and asexually, disperse readily, and associate with humans.



# Invasive Species

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- 2<sup>nd</sup> leading cause of biodiversity loss
- (no. 1 is habitat destruction)
- Canada has experienced many 100's of alien species including:
  - ▣ Dutch Elm Disease
  - ▣ Zebra Mussels

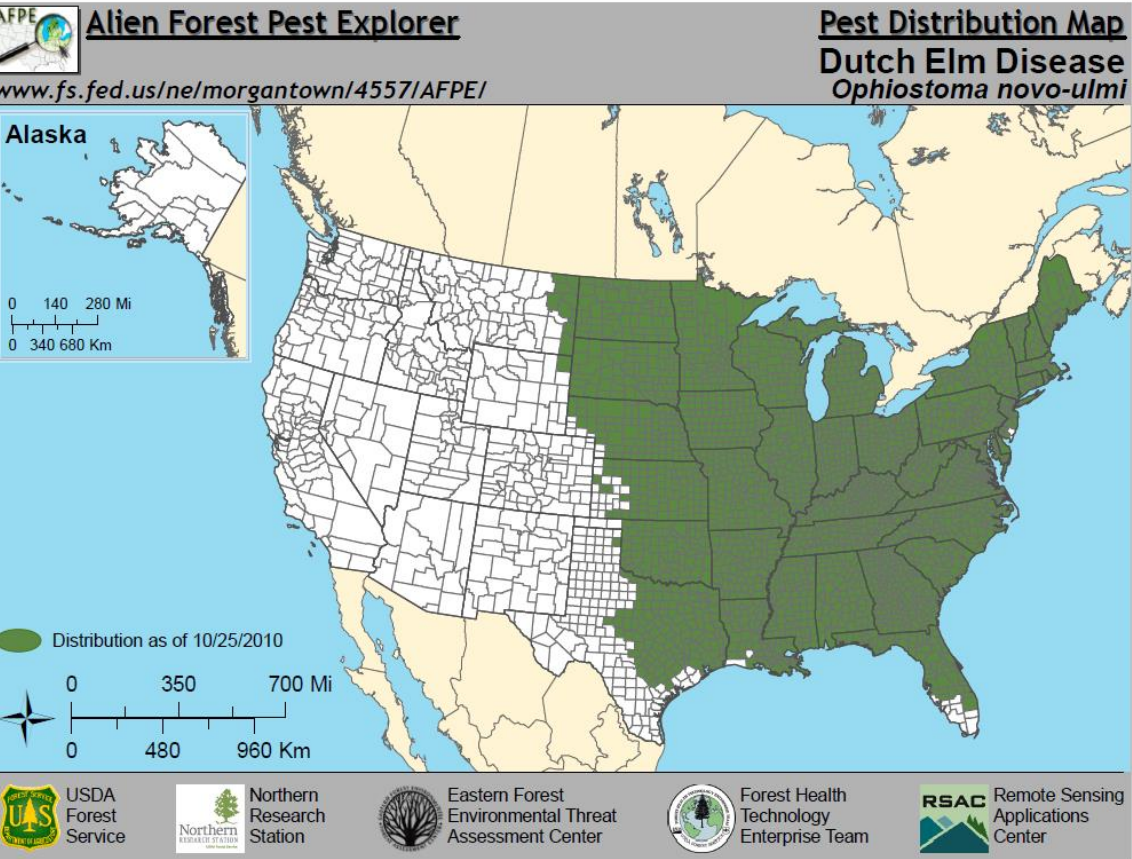


## English Holly

An invasive species now overruns urban forests in Pacific NW (Seattle, Vancouver).  
Was introduced as an “ornamental”.

# Dutch Elm Disease

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[www.cfans.umn.edu](http://www.cfans.umn.edu)

- Originated in Holland
- First noted in the US in ~1930; in Canada in ~1945;
- Significant losses of 'urban forest value' (e.g. boulevard Elm trees in Winnipeg are worth \$307 million, contributing an estimated \$160 in property value)

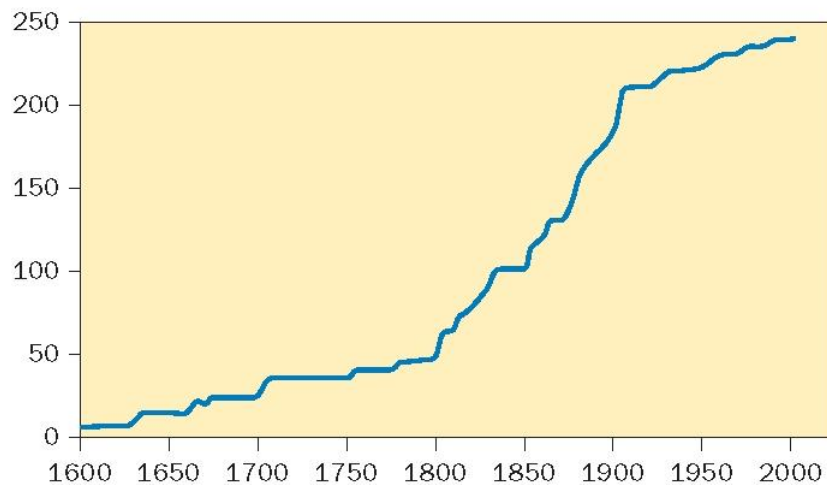
**Source: Eastern Forests Threat Centre**

<http://threatsummary.forestthreats.org/threats/threatSummaryViewer.cfm?threatID=43> as of 2010

# Trends in non-native species

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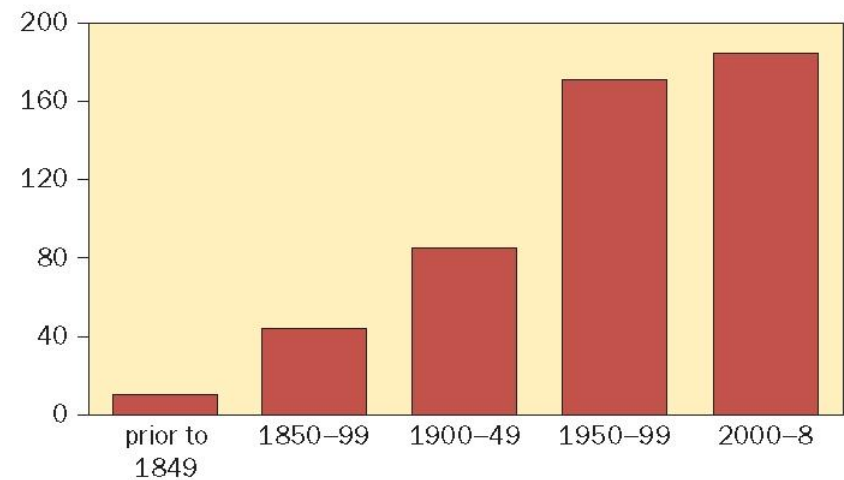
## □ Canada



**Figure 3.6** | Invasive non-native plants in Canada. Source: Federal, Provincial, and Territorial Governments of Canada (2010: 54).

Source: Dearden and Mitchell (2012)

## Great Lakes



**Figure 3.7** | Trends in non-native species in the Great Lakes. Source: Federal, Provincial, and Territorial Governments of Canada (2010: 52).

Source: Dearden and Mitchell (2012)

# Zebra Mussel

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- Native to the Black and Caspian seas (Europe)
- Introduced from the ballast of freighters in the mid-1980s;
- First discovered in Lake St Clair in 1988 (between Lakes Huron and Erie), near Windsor-Detroit
- An aggressive invasive: caused near-extinction of 10 native species in Western Lake Erie
- Photo (right) shows mussels clogging a water intake pipe



*Source: Dearden and Mitchell (2012)*

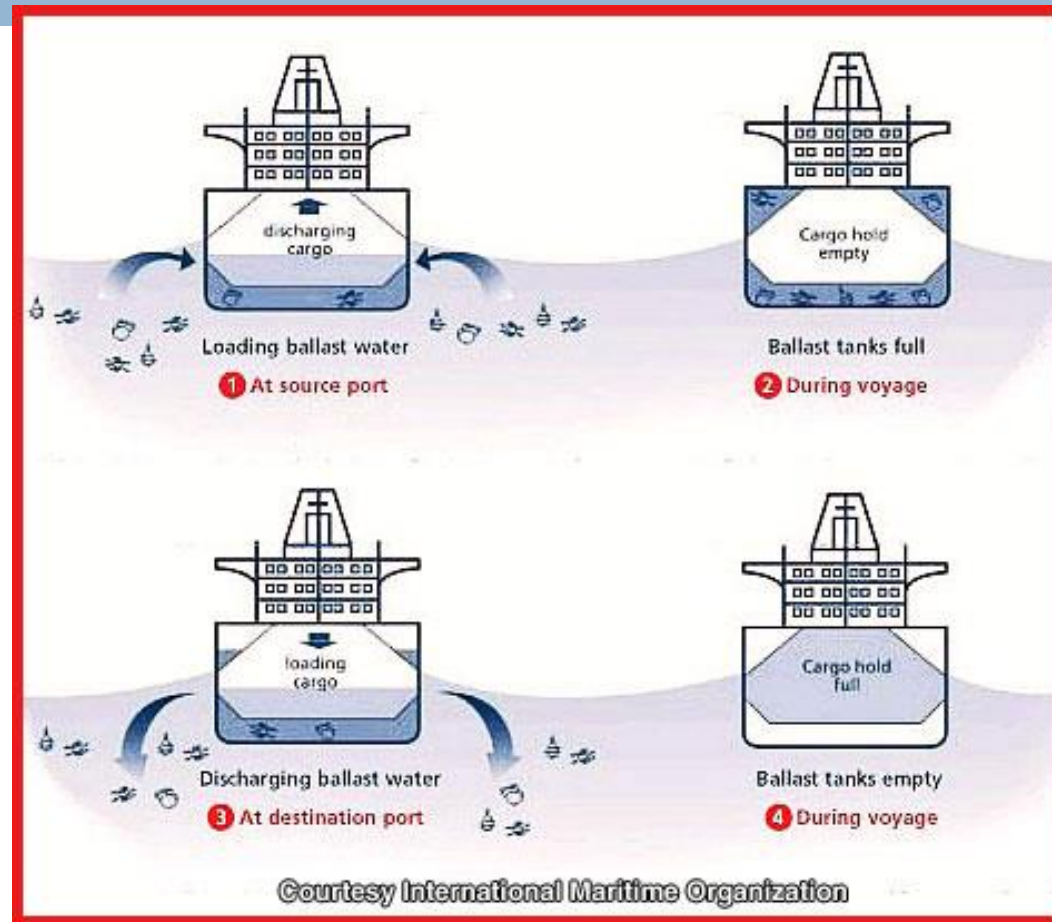
# Control of Zebra Mussels

13

- Water intakes compromised by as much as 50%
- Ontario Power Generation has installed and maintained “chlorine applicators” to rid; (\$20 million) – but this raises concerns over the potential formation of “toxic organochlorides”;
- OPG spent another \$13 million on research to reduce chlorine use
- Estimated damage from the mussels to all Great Lakes utilities is ~\$200 to 500 million;
- Also impacts spawning habitats of other fish (→??? Impact on \$4.5 billion annual fishery and tourism industries??)

# Ballast management

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[http://www.oil-electric.com/2011\\_09\\_01\\_archive.html](http://www.oil-electric.com/2011_09_01_archive.html)

# Ballast Water Control Measures

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- A convention adopted in 2004, with a view to preventing spread of harmful aquatic organisms;
- All vessels entering Canadian waters must do one of: (1) **exchange** their ballast water; (2) **treat** their ballast water (2) discharge their ballast water; (3) **discharge to a reception facility** ; (4) **retain** their ballast water on board;

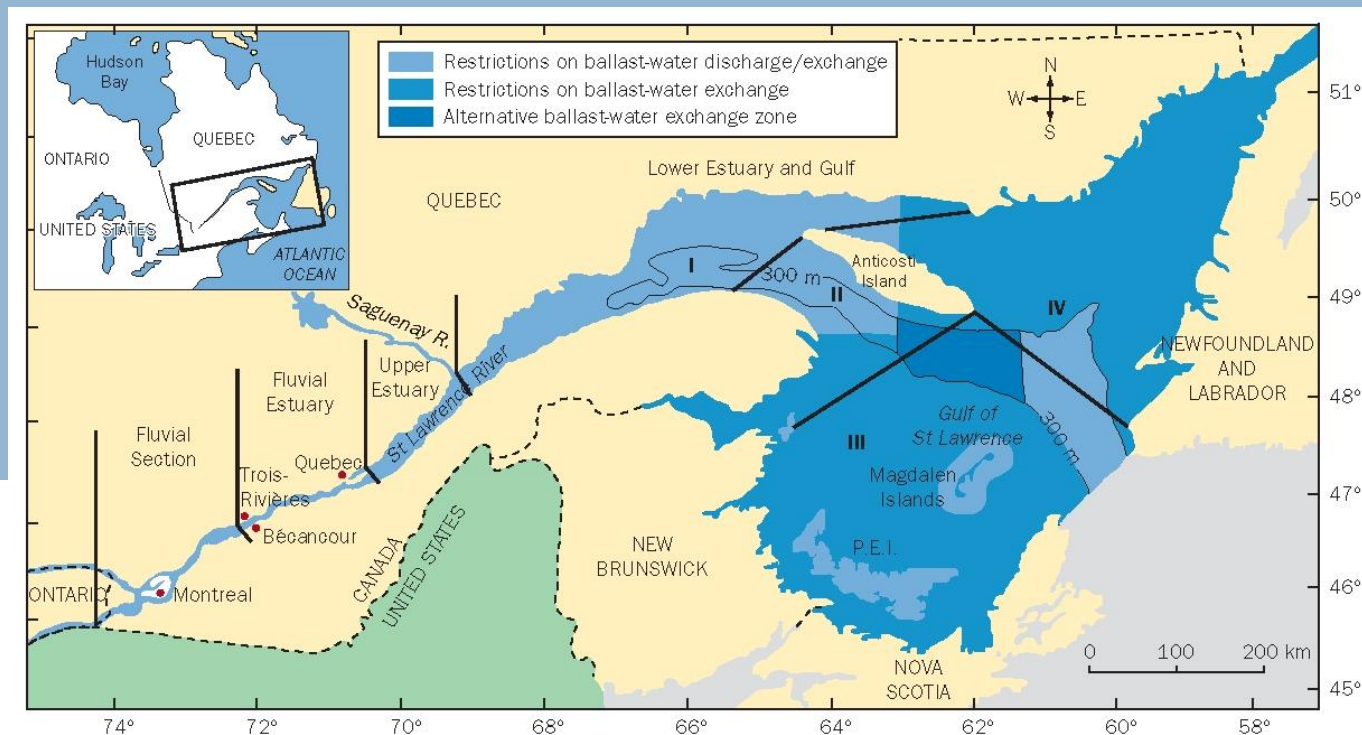


Figure 3.8 | Areas for ballast water control on the east coast.

Source: Dearden and Mitchell (2012)

# Hyperabundance

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- Over-population of native species can also occur
  - ▣ Where natural habitats have been disturbed
  - ▣ When predatory species are removed
- Species culls often used to control these population explosions
- e.g. Ontario Spring Bear Hunt



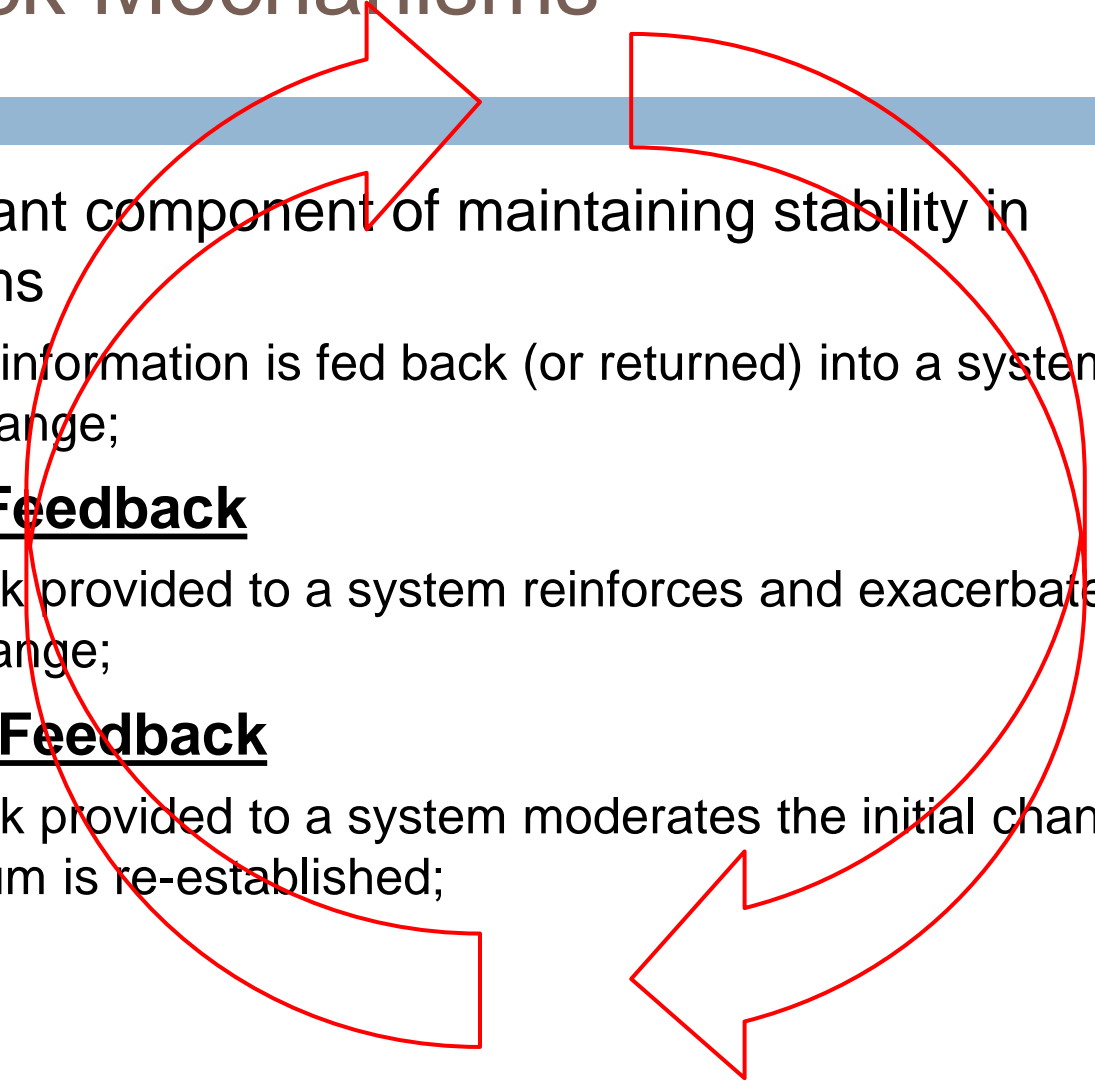
## Show Your Support For Spring Bear Hunting

After 15 years of hard work and determination, the OFAH is pleased that the Ontario government has proposed a two-year pilot project that will bring back the spring bear hunt to a limited number of northern Ontario communities. While this partial reinstatement is a step in the right direction, the OFAH strongly believes that all of bear country requires a spring bear hunt.



# Feedback Mechanisms

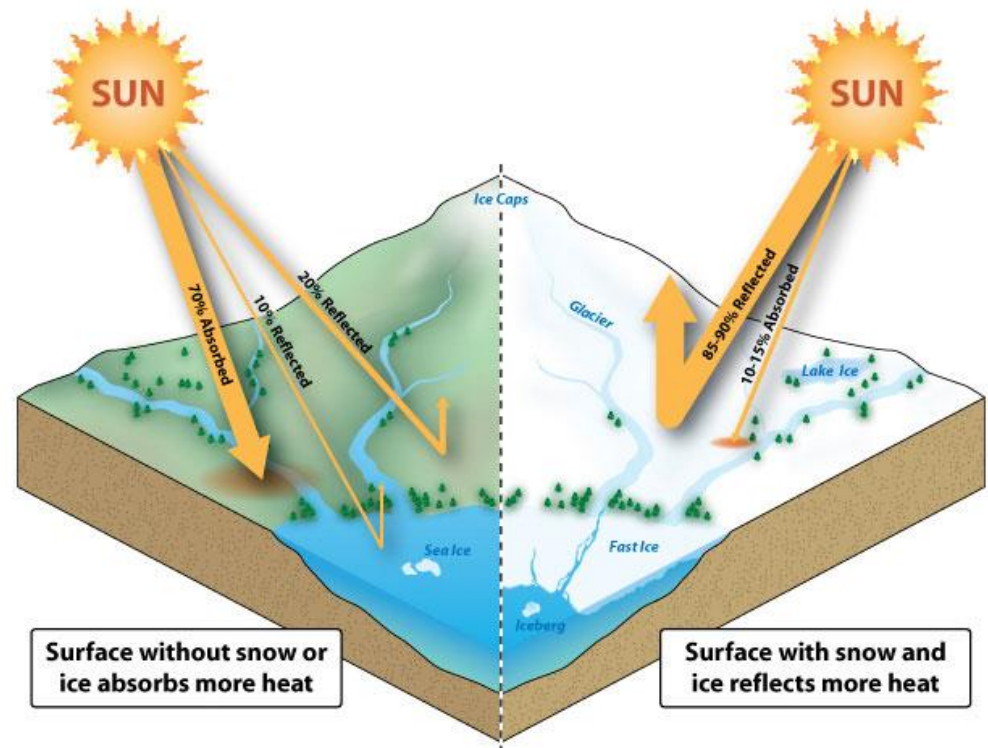
17

- An important component of maintaining stability in ecosystems
    - ▣ in which information is fed back (or returned) into a system due to some change;
  - **Positive Feedback**
    - ▣ Feedback provided to a system reinforces and exacerbates the initial change;
  - **Negative Feedback**
    - ▣ Feedback provided to a system moderates the initial change and equilibrium is re-established;
- 

# Positive Feedback (example)

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- Albedo changes with surface (fresh snow reflects 80%+ of incident solar energy)



the-m-factory.com • 410.420.8032

<http://www.cocorahs-albedo.org/about/>

# Positive Feedback (example)

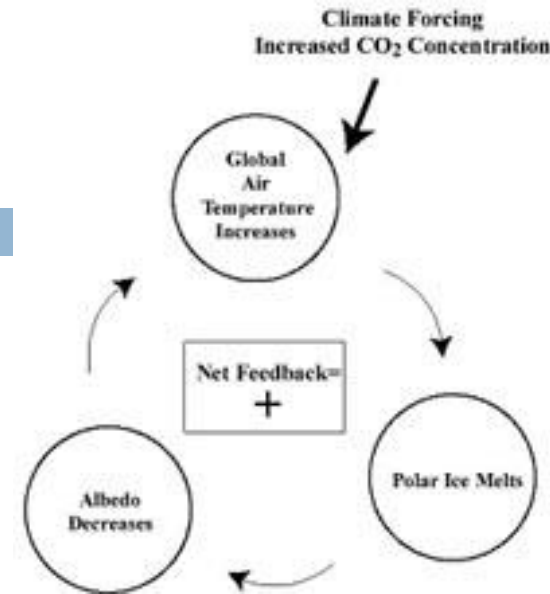
19

Increased Temperature in northern latitudes due to global climate change

Greater **snow free areas** in summer with increased T

Snow free areas have lower albedo, thus **absorb greater incident solar radiation**

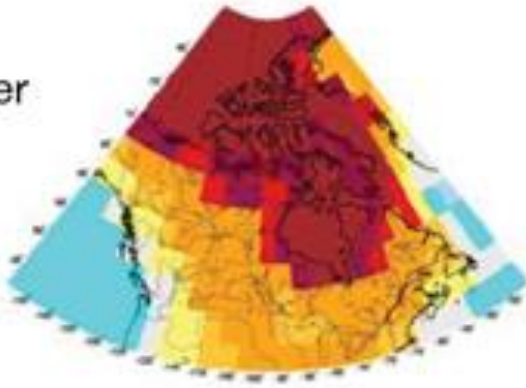
This is an enhancement of the Greenhouse Effect and atmosphere is warmer further



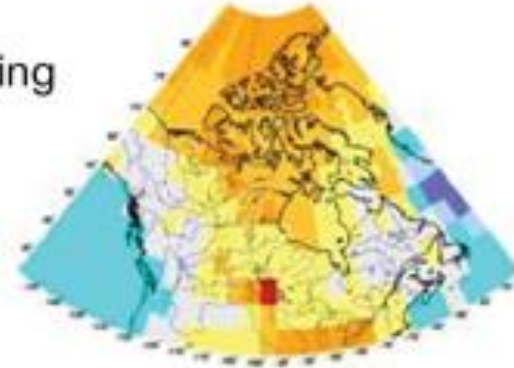
U. California (San Diego)  
[http://earthguide.ucsd.edu/climatechange2/08\\_2.shtml](http://earthguide.ucsd.edu/climatechange2/08_2.shtml)

“**polar amplification**” of Temperatures

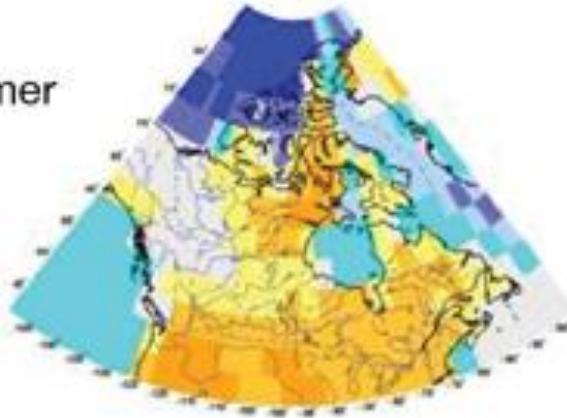
Winter



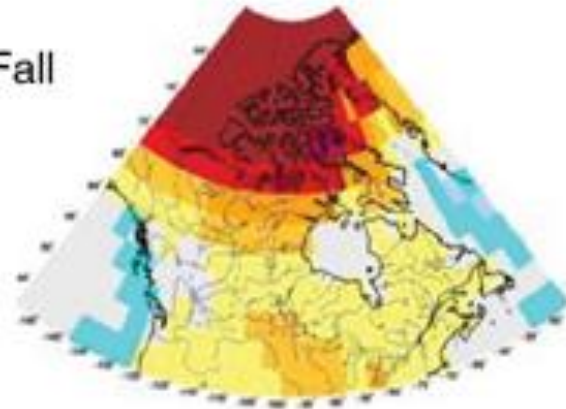
Spring



Summer



Fall



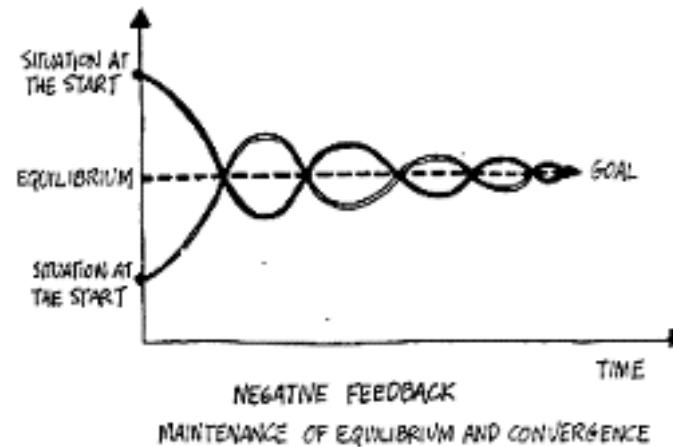
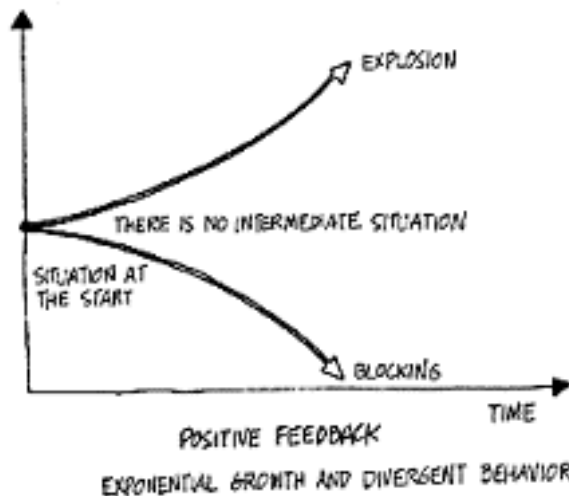
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

Temperature change (°C)

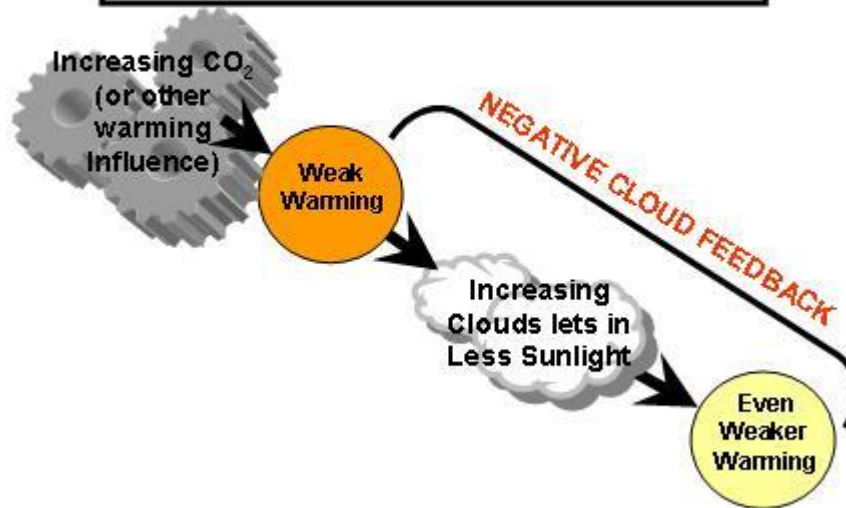
**Modeled Seasonal Change in Temperature across Canada by 2050**  
Source: Natural Resources Canada (2007b)

# Negative Feedback (example)

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## HOW NEGATIVE CLOUD FEEDBACK WORKS



Roy Spencer (former  
NASA climate scientist)  
<http://www.drroyspencer.com/2009/05/>

# Population Growth

- **Population:** the number of individuals in a species
- **Population density:** population calculated for a certain area, e.g., # of individuals per hectare
- **Population dynamics:** changes in population characteristics over time (such as birth rate and death rate)

Source: Dearden and Mitchell (2012)

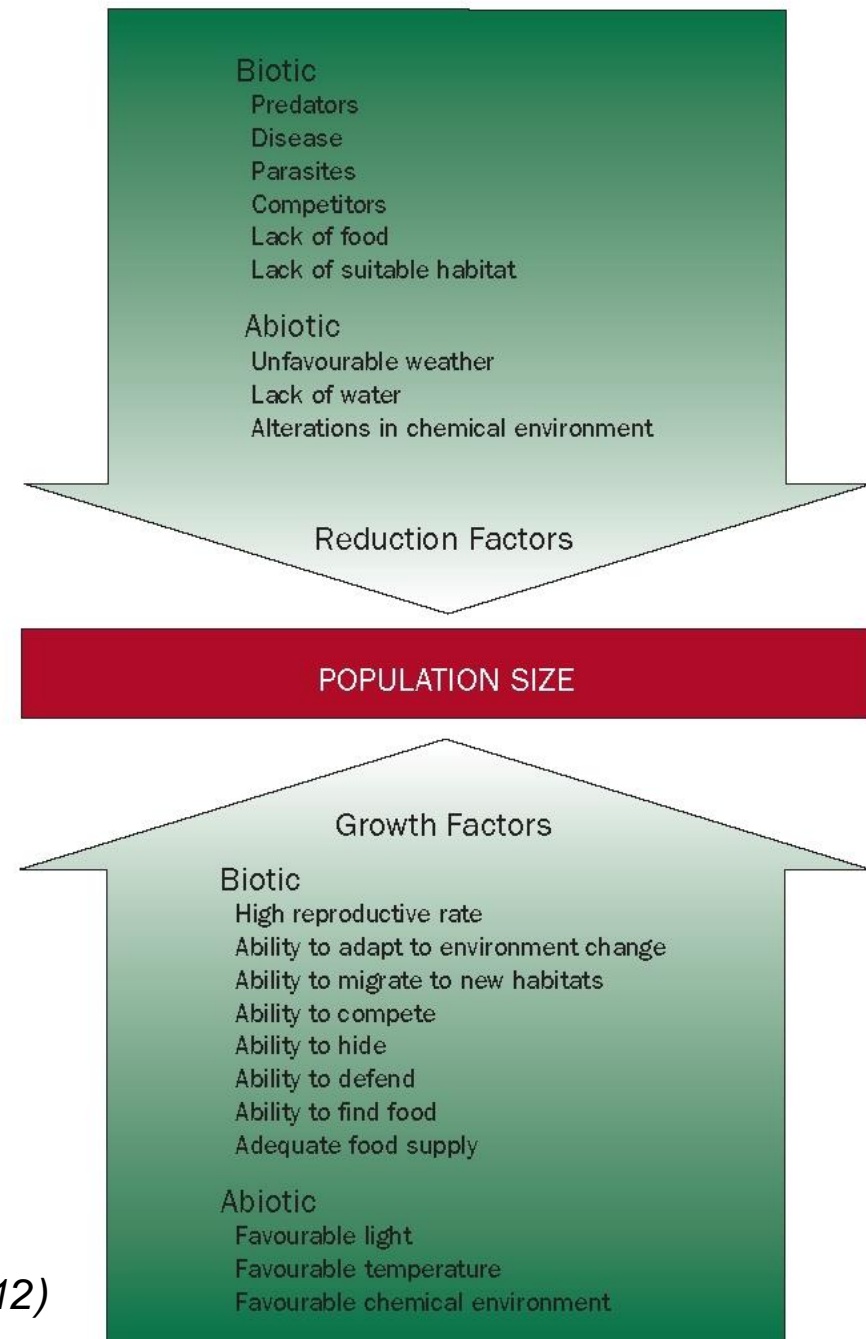
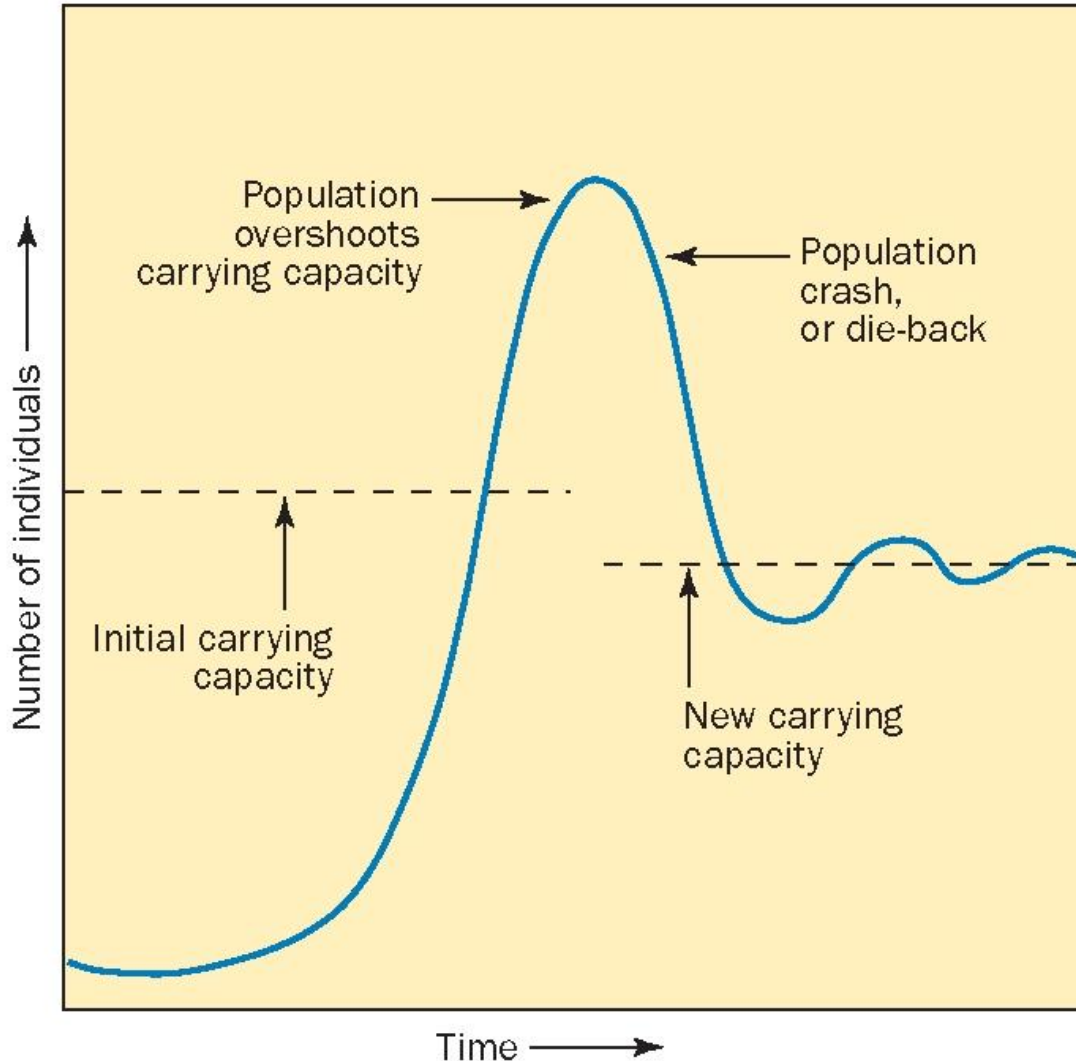


Figure 3.9 | Factors affecting population growth.

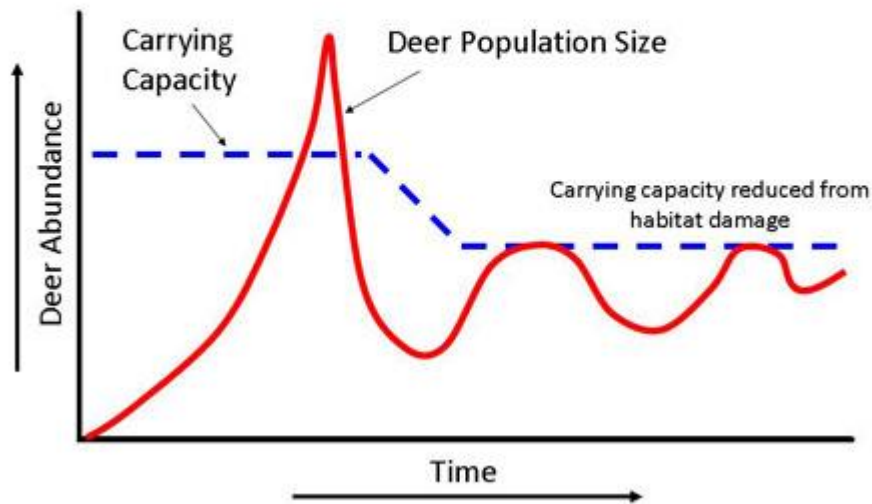
# Carrying Capacity



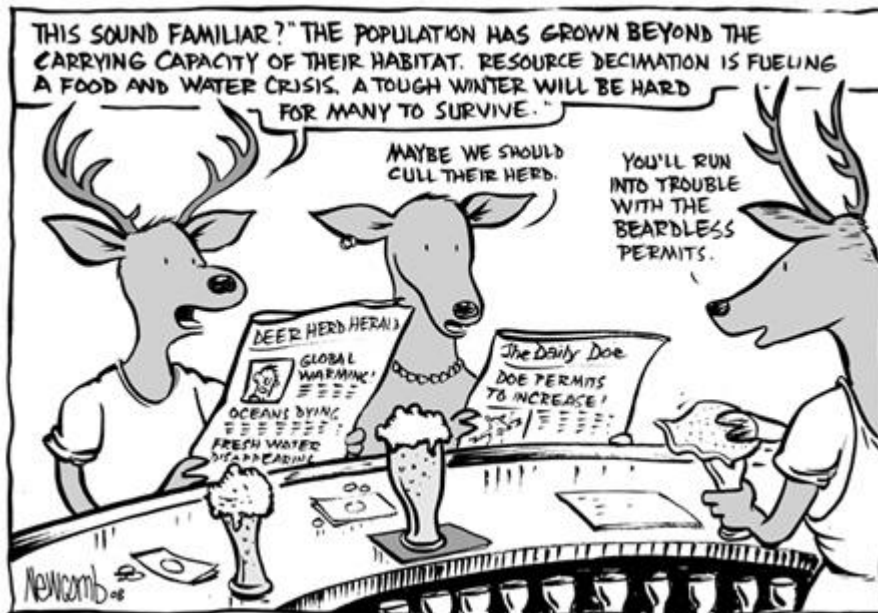
**Figure 3.11** | Carrying capacity and population growth rates.

- the number of individuals of a given species that can be sustained in a given area indefinitely, given a constancy of resource supply and demand

## Unrestricted deer population growth may diminish the habitat's carrying capacity



Mississippi State University Deer Lab  
<http://www.msudeerlab.com/carryingcapacity.asp>



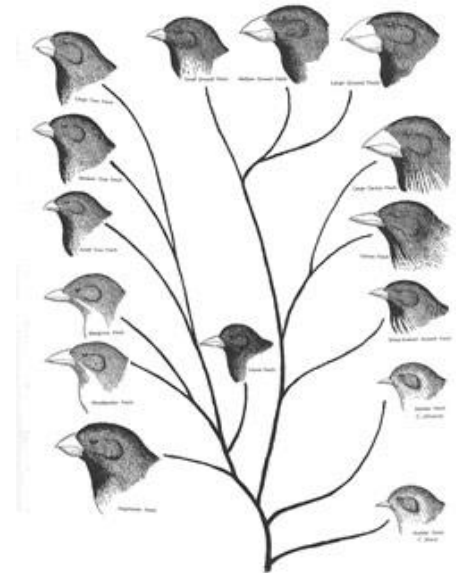
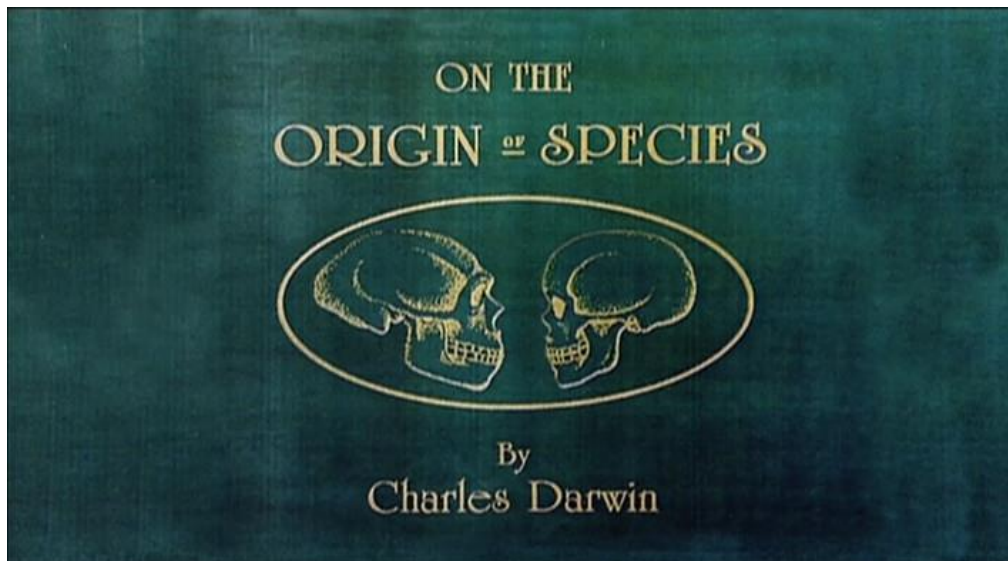


# Population Growth

- **biotic potential:** the maximum rate at which a species may increase its population if there is no environmental resistance
- Various reproductive strategies exist:
- **r-strategists:**
  - ▣ large numbers of young early in life and over a short time period
  - ▣ invest little energy as “parents”
  - ▣ examples: insects, rodents, algae, annual plants, fish
  - ▣ usually small and short-lived; tend to dominate the early seral stages of the successional process
- **k-strategists:**
  - ▣ focus on ‘quality’ not quantity of offspring
  - ▣ time devoted to assist offspring reach maturity
  - ▣ examples: larger mammals....
  - ▣ are larger and usually longer-lived

# Evolution, Speciation, and Extinction

- Populations adapt to changing conditions through **evolution** – a change in the *genetic makeup* of the population with time; often achieved through ‘experimentations’ with genetic mutations;
- **Natural selection**: “survival of the fittest”, those individuals better adapted to new conditions are more successful in terms of survival and reproduction



Darwin's Finches

# Evolution, Speciation, and Extinction

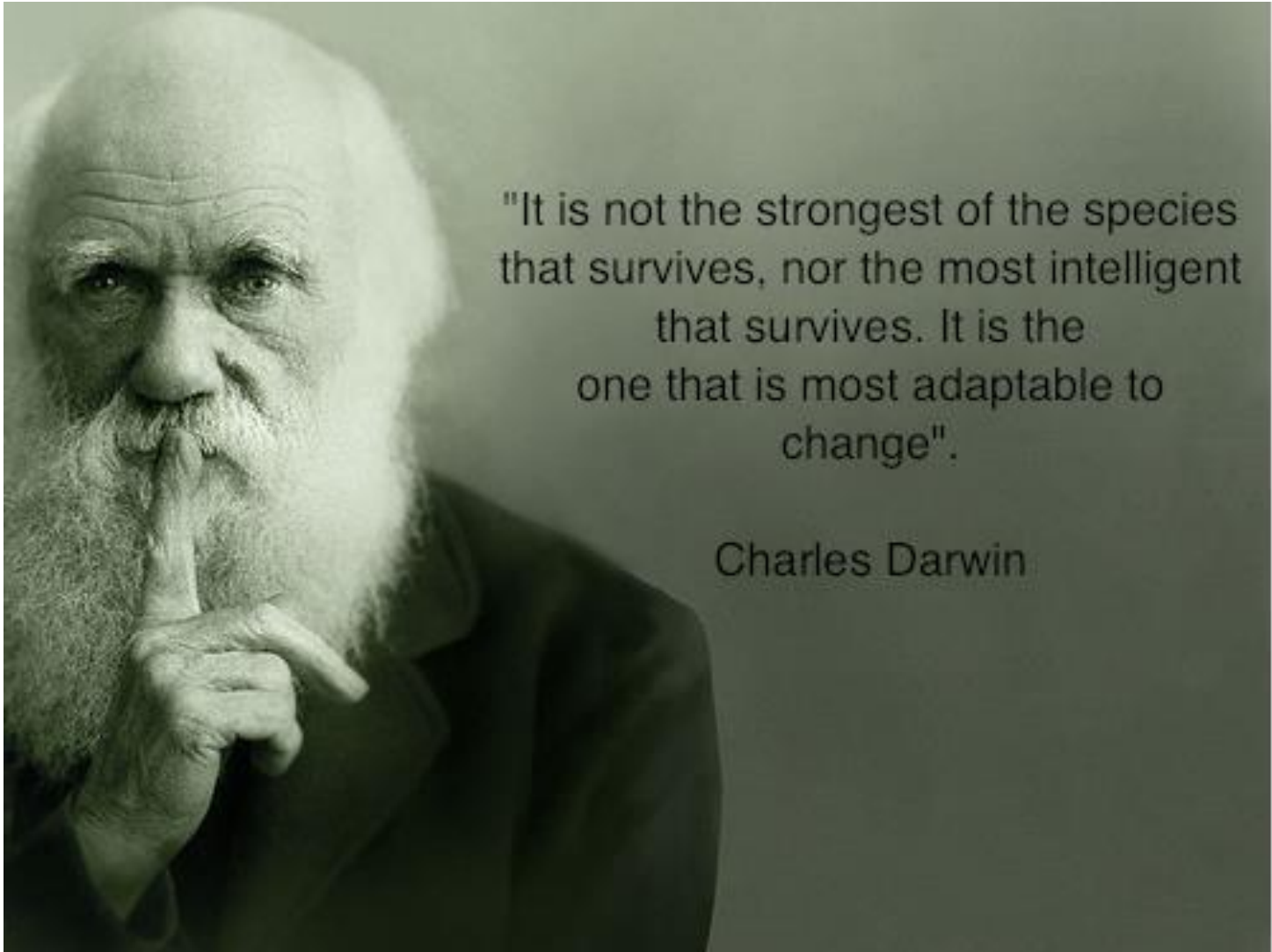
- **Phyletic evolution**: a population has undergone so much change that it is no longer able to interbreed with the original population and a new species is formed
- This is the process of **speciation**
- It can occur due to geographic isolation of populations (e.g., Galapagos Islands), or adaptations of a part of a population, e.g., to a new food source
- Genetic diversity helps to protect a species from environmental change and extinction

# Galapagos Islands (Ecuador)



# Future lectures will look at the required species responses to forecasted global climate change

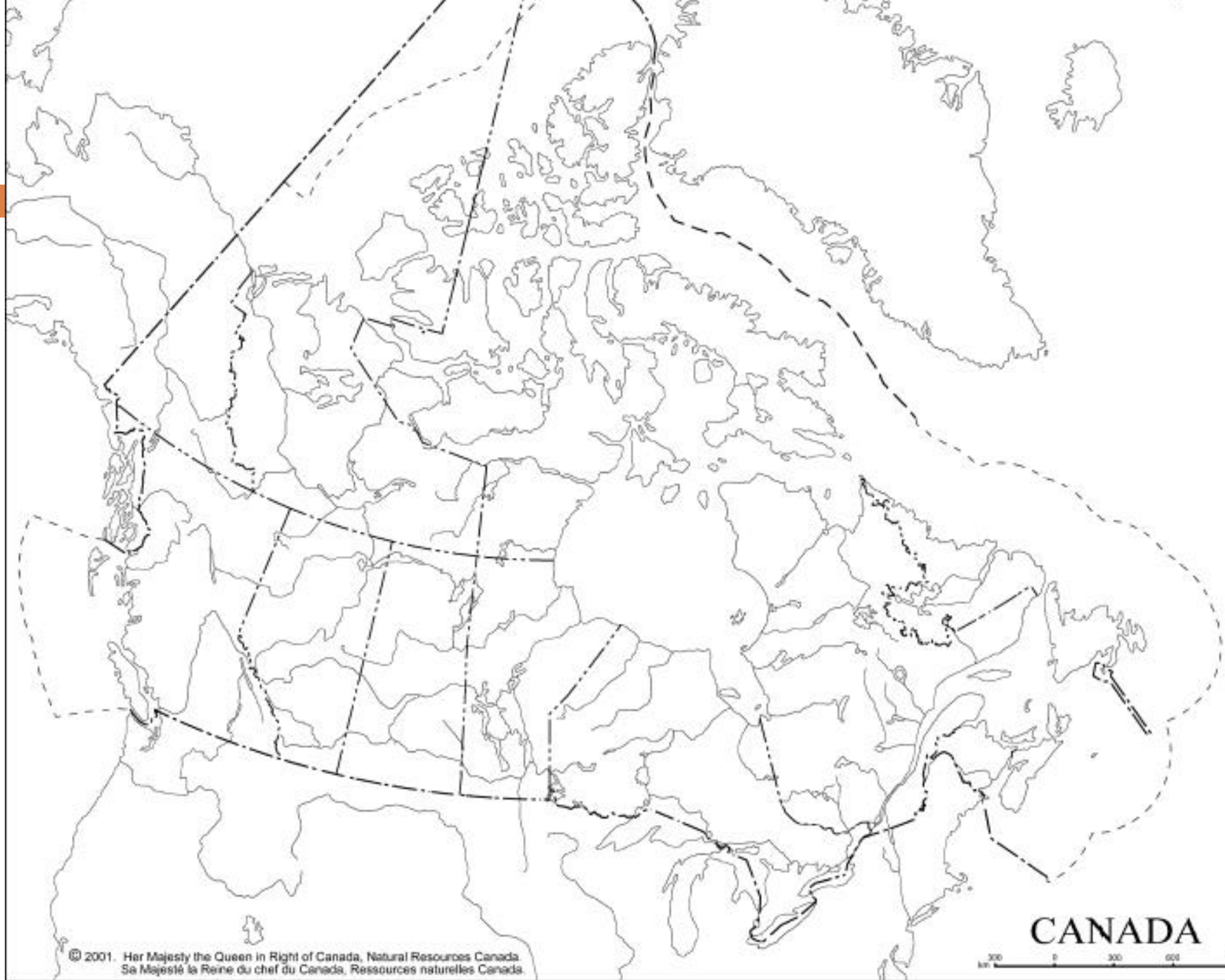
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# Map Literacy 1 (Spring 2014)

Lectures 1 to 6

May 13, 2014



CANADA



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Sa Majesté la Reine du chef du Canada, Ressources naturelles Canada.

# Map Literacy (list 1, May 13, 2014)

## Communities, Parks Jurisdictions

1. Kluane National Park
2. Niagara Region
3. Okanagan Valley
4. Windsor

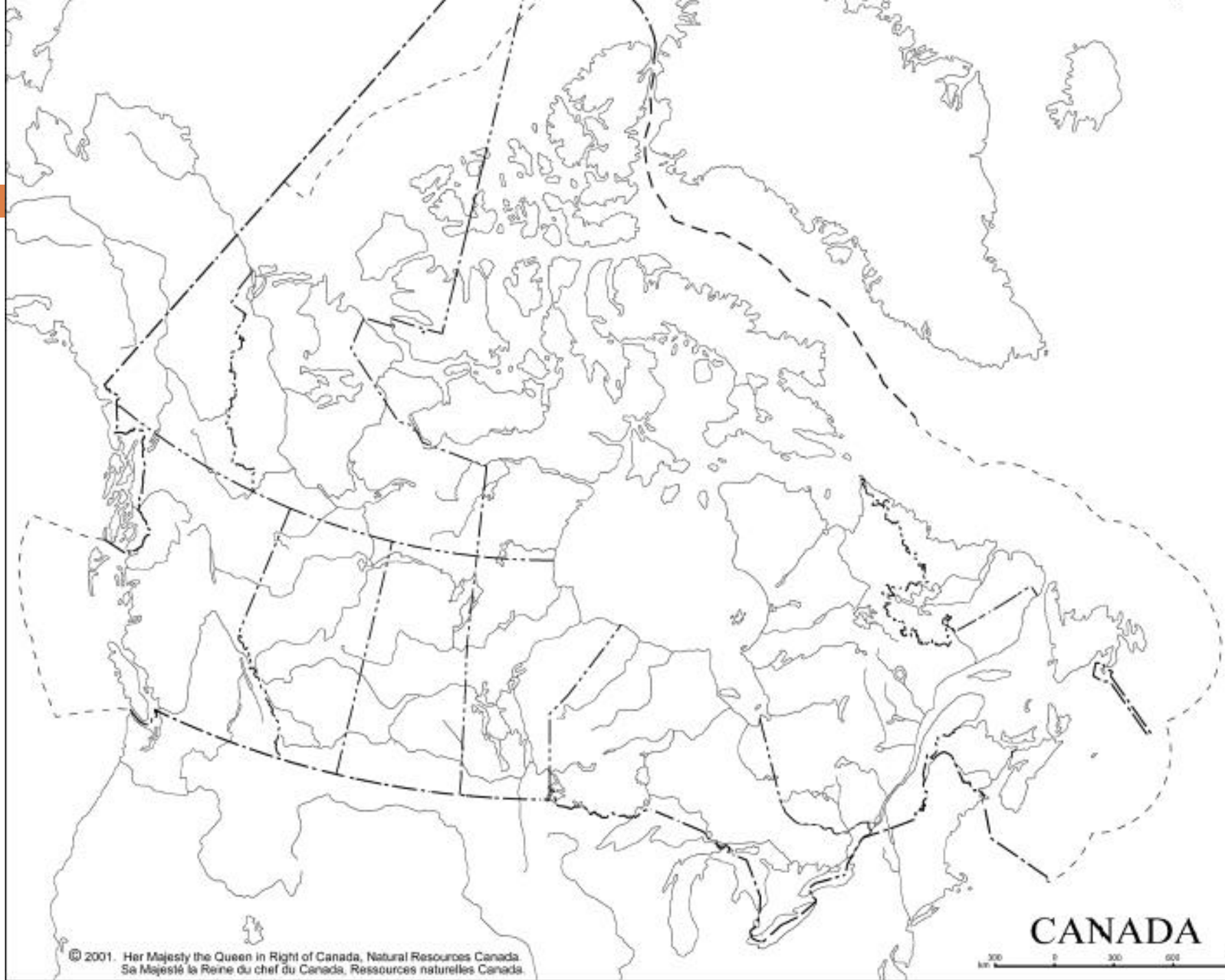
## Basics (0):

1. Pacific Ocean
2. Atlantic Ocean

## Physical Features

1. Cape Breton Island
2. Prairies
3. Rocky Mountains
4. Coast Mountains
5. Appalachian Mountains
6. Vancouver Island
7. Hudson Bay
8. Columbia Icefield
9. Gulf of St Lawrence





# CANADA

0 300 600 900  
km

# Looking Ahead to the next lectures

**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**)

# References

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