

# BIOL 410 Population and Community Ecology

Spatial and temporal distributions of  
organisms

# Model development

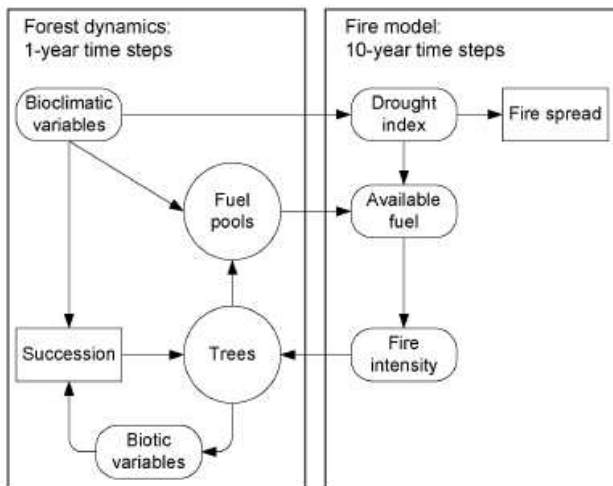
## Trade-offs /resource allocation

### Life history trade-off's



- Growth
- Somatic maintenance
- Reproduction
- Defence

### Modelling trade-off's



- Spatial scale (grain, extent)
- Temporal scale
- Process detail
- Process parameterization
- Computational feasibility

# Model complexity



- **Question / Problem**
- Nature of ecological systems
  - Relevant ecological scale
  - Relevant ecological unit
  - Relevant ecological processes
- Data

Always start from the most basic

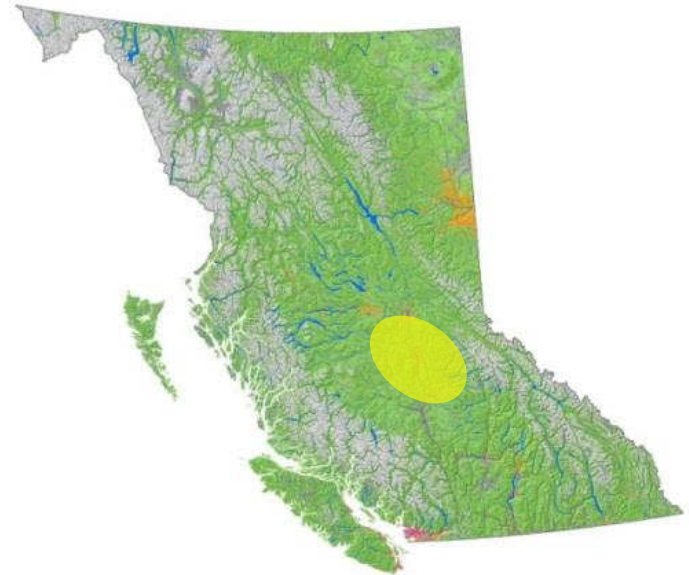
$$N_{t+1} = N_t + B - D$$

What basic assumptions are built into this model structure?

# Basic population model

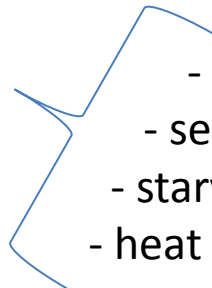
$$N_{t+1} = N_t + B - D + I - E$$

- Open system
- Non-spatial



# What do variables mean?

$$N_{t+1} = N_t + B - D$$

- 
- predation?
  - senescence?
  - starvation?
  - heat stroke?

- Biological underpinning
  - Biology behind all state variables and rate variables
    - What is being represented?
    - Is this accurate?
    - What compromises are being made?

# Simplicity is best

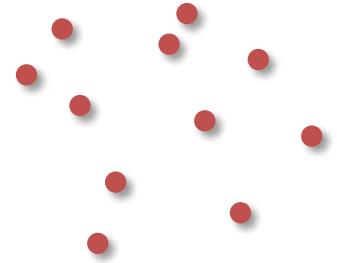
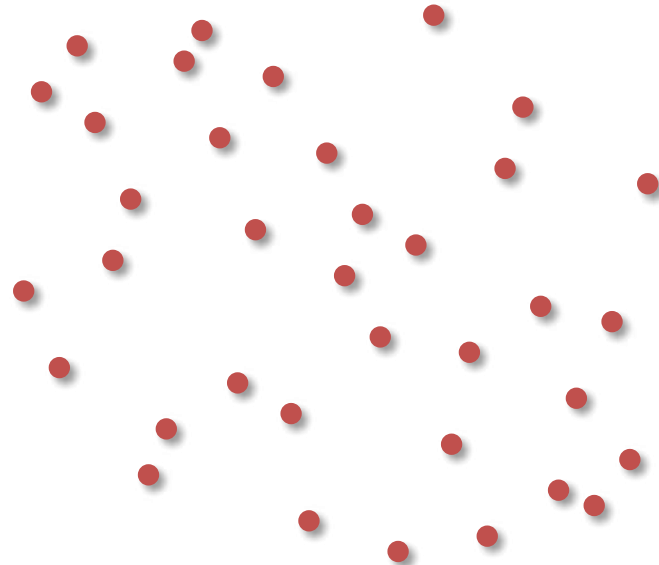
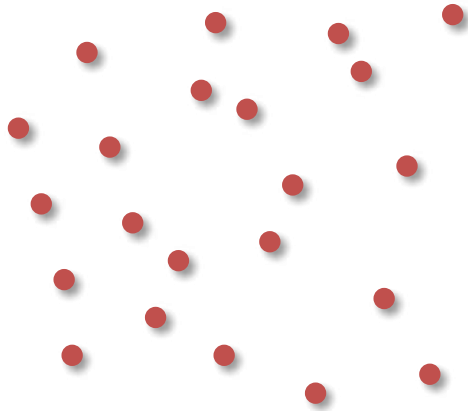
- Occam's razor: the simplest answer is often the correct answer
- The simplest answer is often the most useful answer
- Be as simple as possible, but not simpler

# Objectives

- What is a population
- What is a community
- How are population and community related
  
- Why are spatiotemporal processes important to population and community ecology?
- What are some common, but simplistic patterns of animal and plant distributions?
- What is “scale” and why is it relevant to ecology?
- What are the implications of incorrectly extrapolating across scale?



# What is a population?



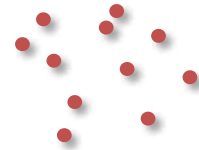
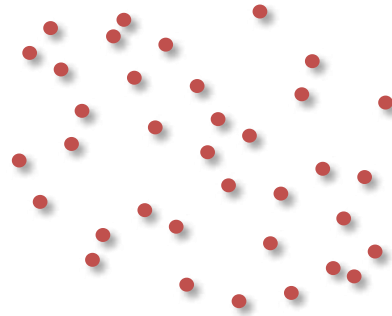
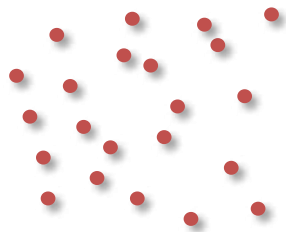
# What is population?

- Different definitions
  - Human demography
    - A set of humans in a given area
    - Area defined: Canada, B.C., Prince George, UBNC
  - Genetics
    - A group of isolated interbreeding individuals
  - Population ecology –
    - A group of individuals of the same species **inhabiting a similar area**
    - A group of **interbreeding** individuals within the same species, occupying the same space at the same time.
    - A group of individual of the same species that have a high probability of **interacting** with each other
    - A population may not correspond with a herd, flock, or other unit of cohesion



# What is a population?

- Area?
  - How are borders defined?
- Interbreeding?
- Interactions?

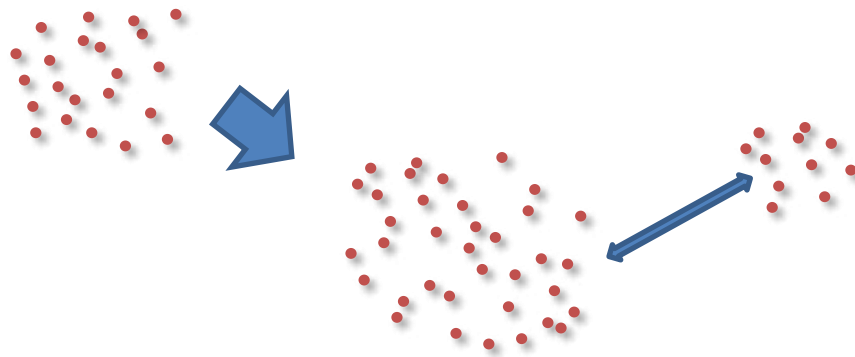


# What is a population?

- Area?
- Interbreeding?
  - Rate and amount of genetic exchange?
  - Ecological distance vs. genetic distance?
- Interactions?

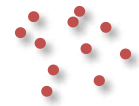
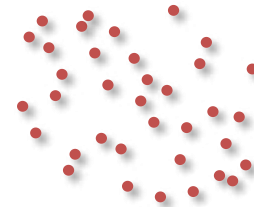
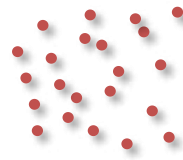


Ross 2006, CJFAS



# What is a population?

- Area?
- Interbreeding?
- Interactions?
  - Reproductive
  - Competitive
  - Mutualistic
  
- Direct vs. indirect



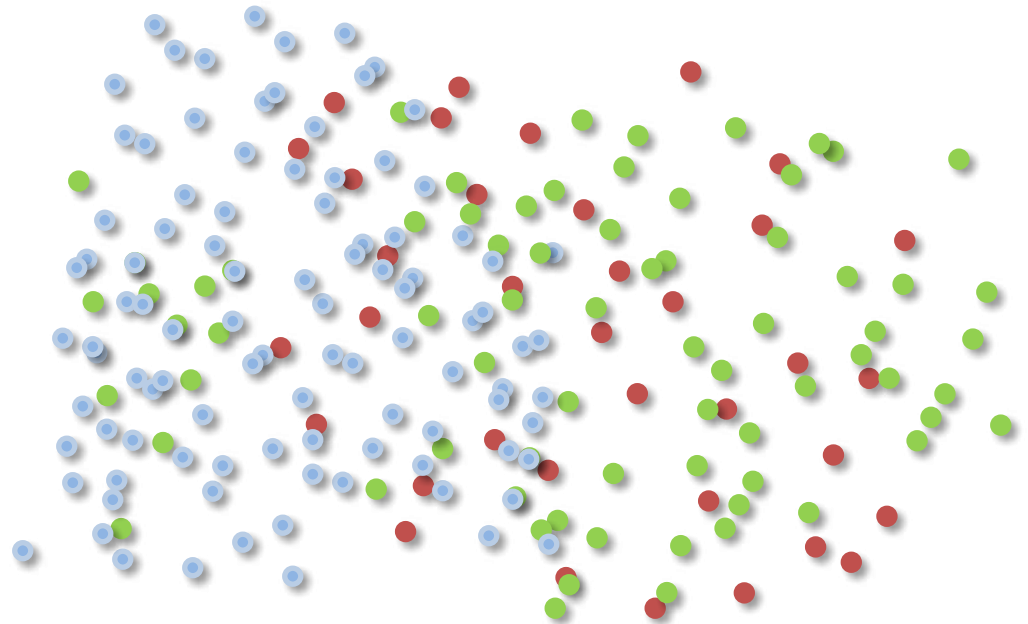
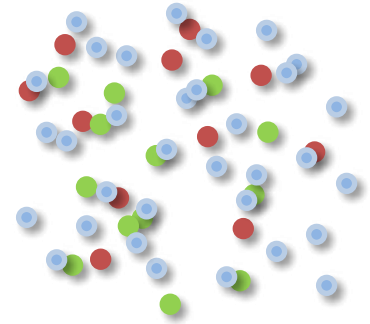
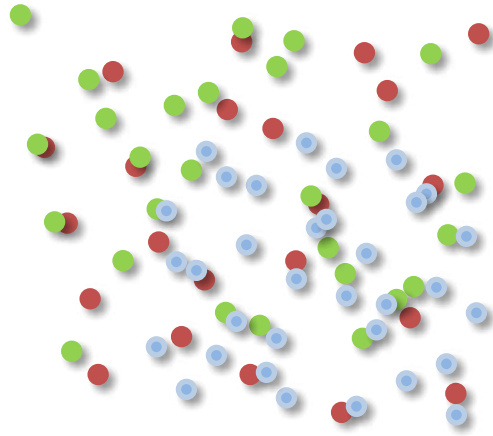
# What is a population?

- Dependent on question:  
e.g. continuity
- Population viability
  - What is the probability that a population will still be around in 30 years?
    - Maintenance of genetic structure?
    - Local extinction followed by recolonization?

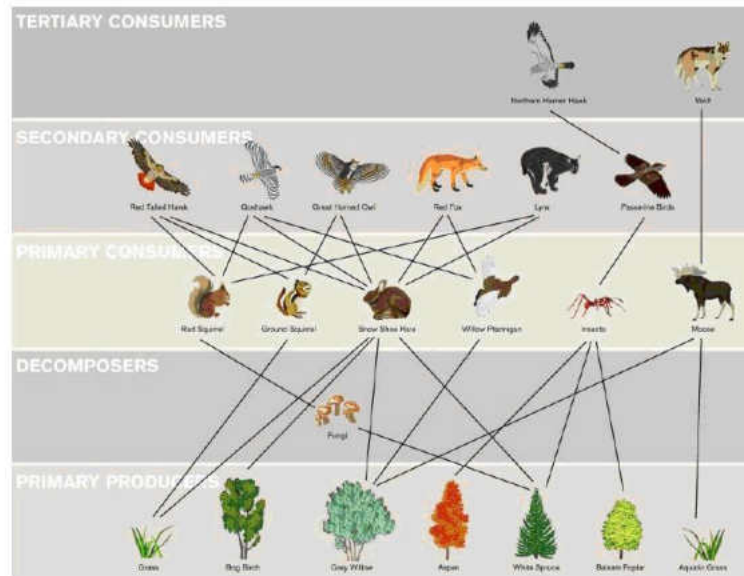




# What is a community?



# What is a community?



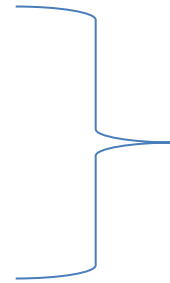
<http://www.ecoplexity.org/>

- A community is an association of interacting species living in a particular area
- An assemblage of overlapping populations of different species, living together in space and time. Direct and indirect interactions between individuals across species affect the population demographics (positively or negatively) of other species.
- Community ecology is the study of interacting populations of coexisting species.
- What is the interface (type of interactions)
  - Predation, herbivory, parasitism, detritivory, mutualism, commensalism, competition.
- Interactions result in a change in distribution, abundance, population composition, life history, or evolutionary trajectory.



# Populations and communities

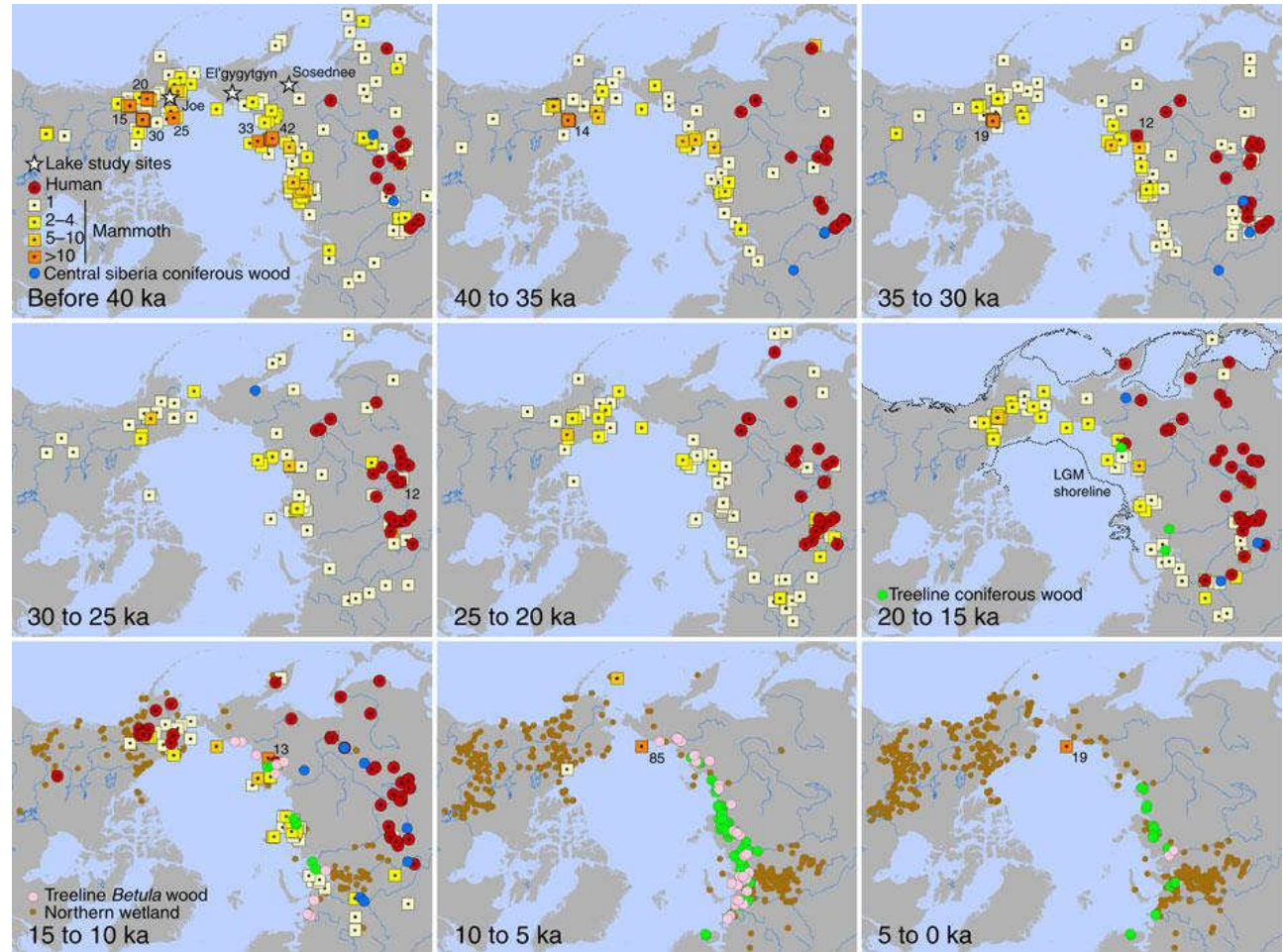
- Spatially
- Temporally



**Pattern**

- Interacting **processes**

# Importance of spatiotemporal patterns in population and community ecology



Pattern of extinction of the woolly mammoth in Beringia

MacDonald et al. 2012

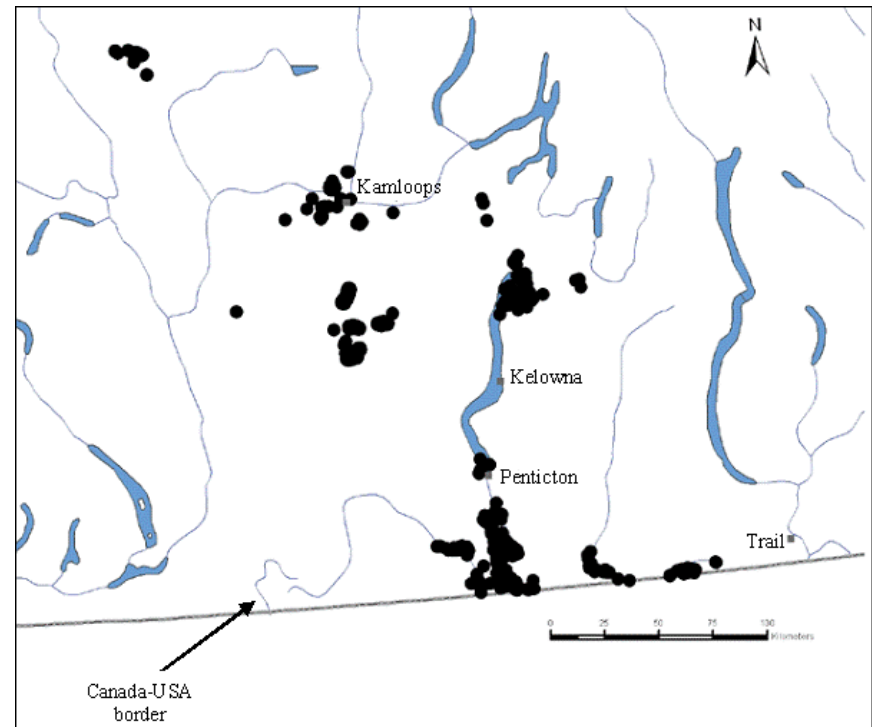
Nature Communications

# Importance of spatiotemporal patterns in population and community ecology

- Patterns of distributions (spatial)



Great Basin Spadefoot



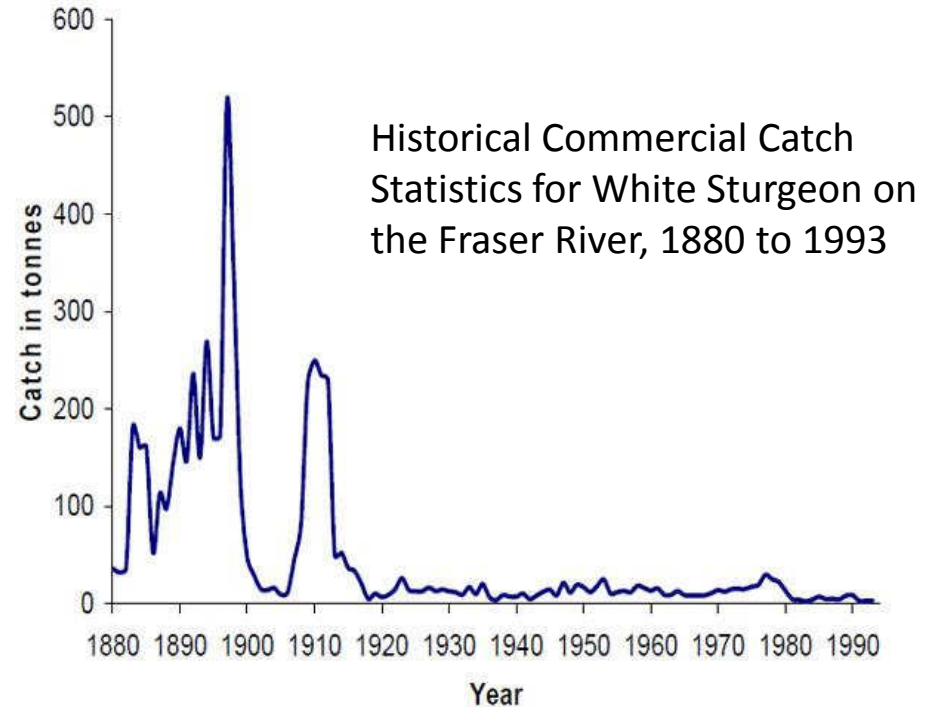
<http://www.cosepac.gc.ca>

# Importance of spatiotemporal patterns in population and community ecology

- Patterns of density (temporal)



White sturgeon



[www.registrelep-sararegistry.gc.ca](http://www.registrelep-sararegistry.gc.ca)

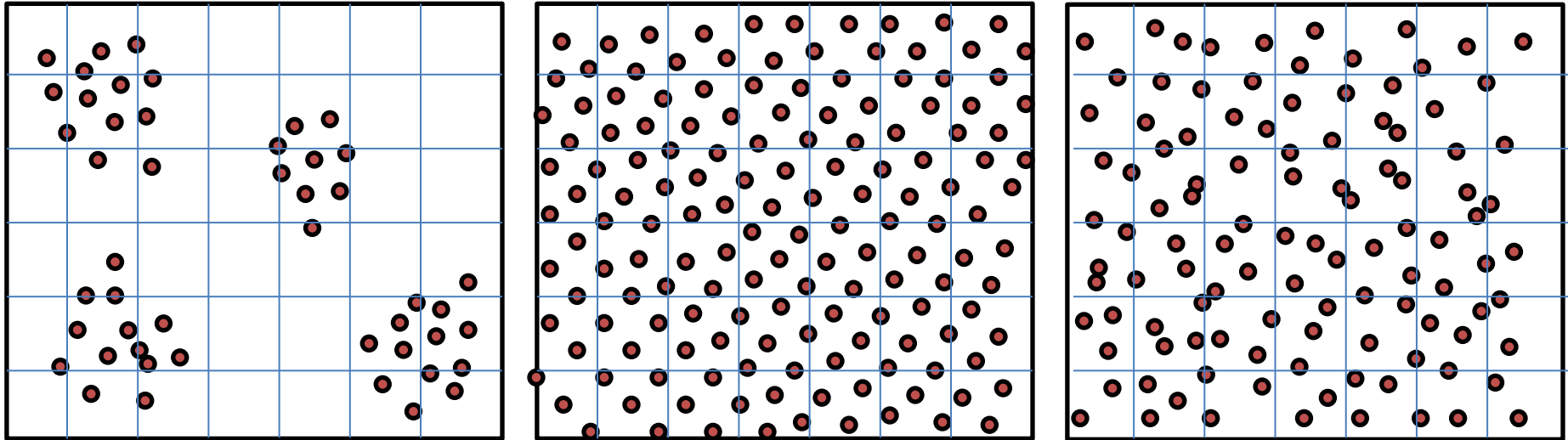
<http://www.cosewic.gc.ca>

# Importance of spatiotemporal patterns in population and community ecology

- Patterns of distributions (spatial)
- Patterns of density (temporal)
  
- Understand what drives the patterns
- Understand the interactions between processes.

What are some common patterns of animal and plant distributions?

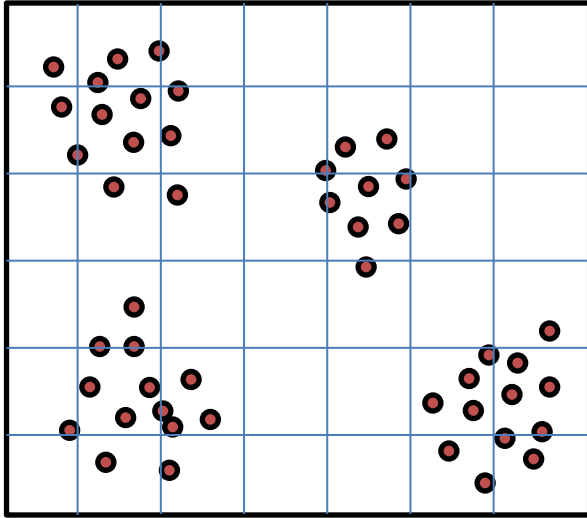
# Simple patterns of plant and animal distributions



- Environmental heterogeneity
- Resource distribution
- Territoriality
- Dispersal ability
- Allelochemistry



# Clumped, aggregated

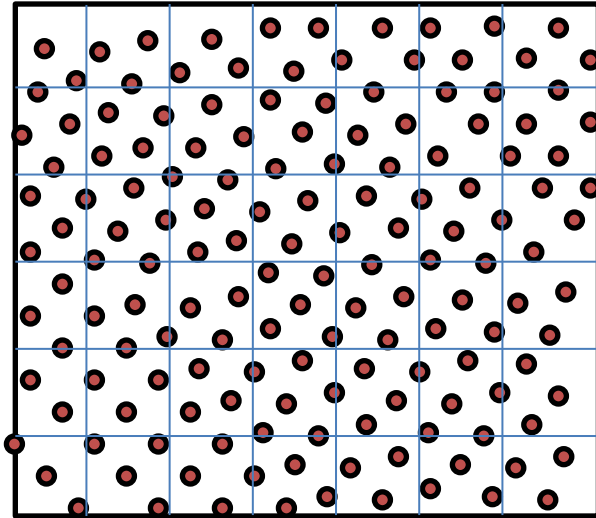


What processes would produce clumped dispersion?





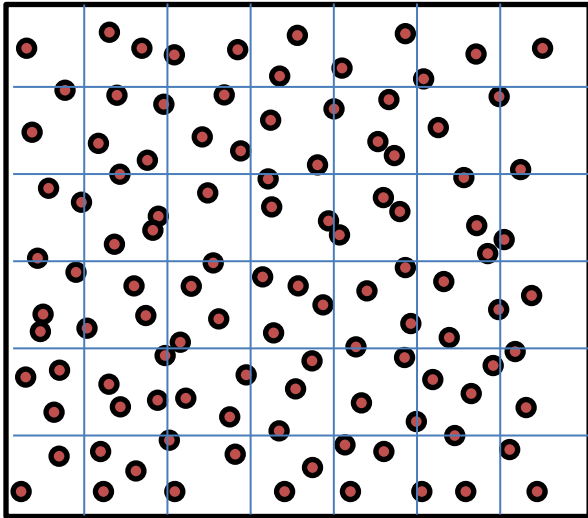
# Uniform, regular



What processes would produce a uniform dispersion?



# Random



What processes would produce random dispersion?



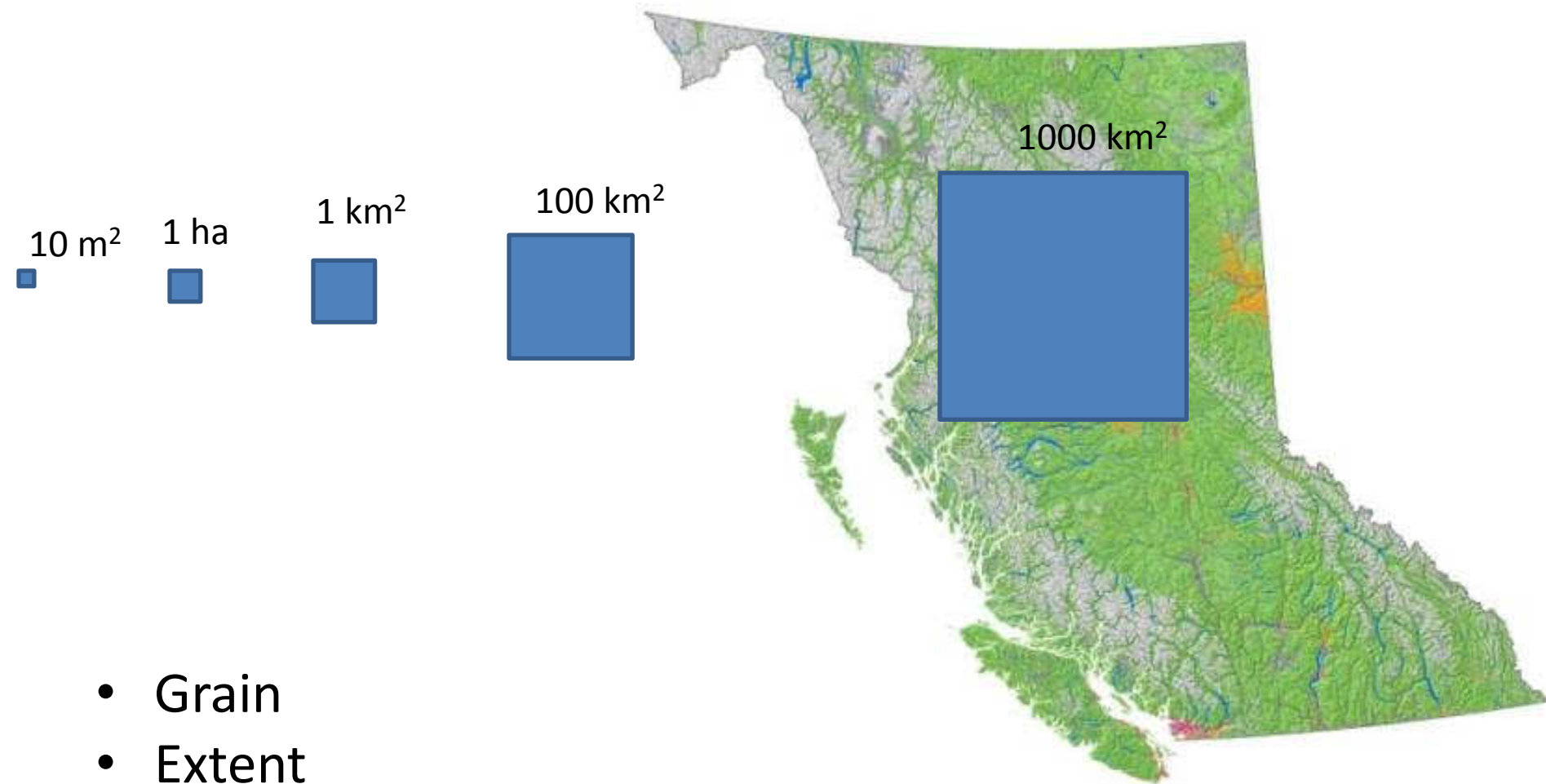
# Populations, communities, and scale

- The definition of a population, community or process is dependent on the scope/scale of observation
- Most patterns and processes will differ with time and space.

To understand population patterns and processes there needs to be a consideration of ecological scale

What is scale?

# Spatial scales



- Grain
- Extent
- Relevant ecological unit
- Relevant ecological processes

# What is scale in a population ecology context?

- Ecological scale
  - Related to:
    - The structures and processes that define the phenomenon under study
    - The sampling method
    - The statistical analysis

# Importance of scale

- What scale should a population be assessed at?
- At what scale do the processes that influence the population operate on?

What factors will influence the extent and grain of the population model?



# Scale of spatial heterogeneity



Homogeneous?

## Grain size

- Small enough to be homogeneous within cell
- Large enough to minimize # of cells.



Heterogeneous?

## Abiotic

- Elevation
- Aspect
- Slope
- Soil depth

## Biotic

- Organism
- Scale of interactions

# Spatial scale

Relevant ecological unit?



Cell

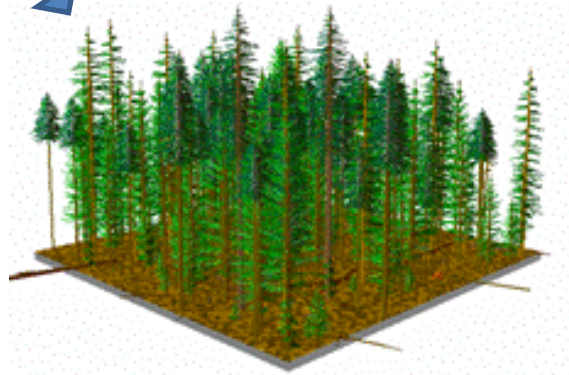


Branch

(organism component)



Tree



Stand

(population / community)



Region

# Spatial scale

- Relevant processes?
  - Competition?
  - Predation?
  - Dispersal?

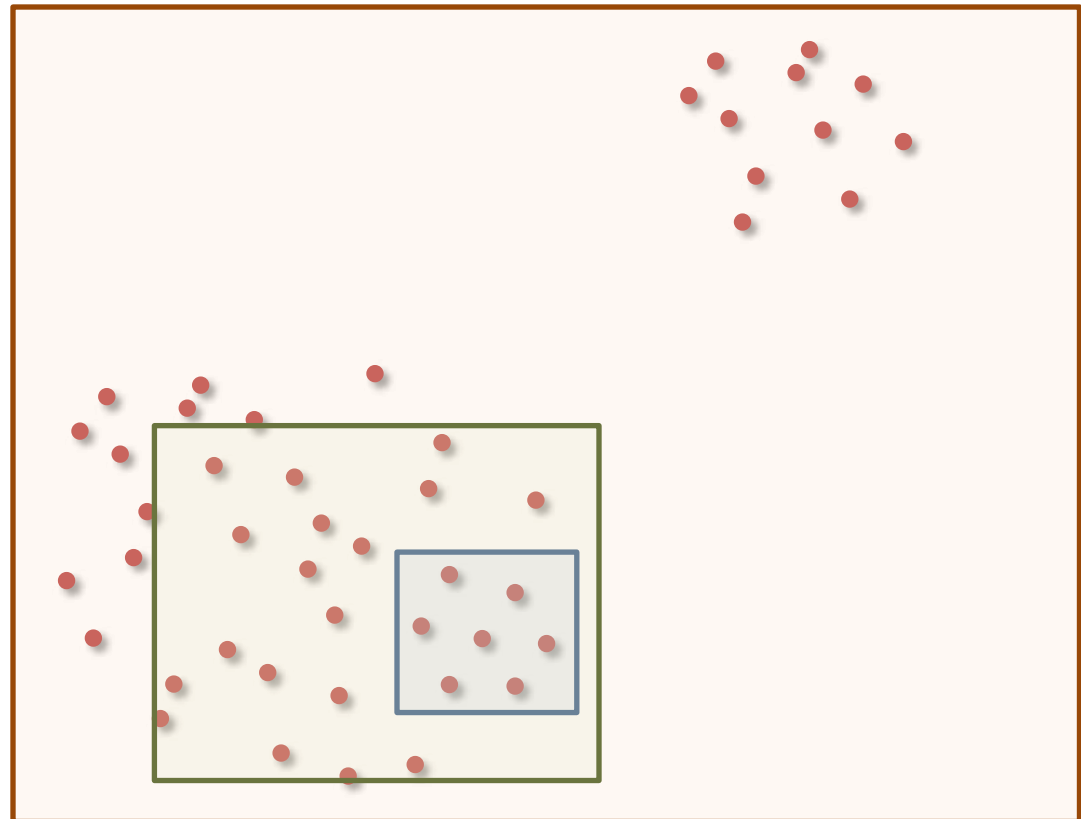
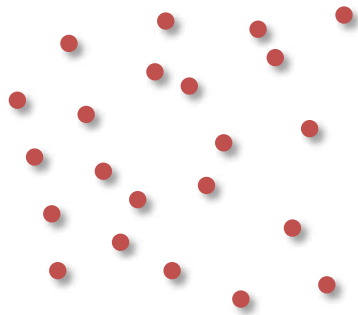


# Scale and ecology

- Key points when considering scaling issues:
  1. Description of phenomenon can be conditional on the scale of observation and resulting analysis
  2. Relating patterns to processes is dependent on the appropriate choice of scale
  3. Scale might be a continuous process without discrete borders or breaks
  4. Identifying variability between units or process can be used to identify appropriate scales
    - Domain: sharp transition from dominance of one set of factors to dominance by other sets

# Scale of observation can influence your ecological conclusions

- Pattern
- Process





# Scale of study in population and community ecology

- Individual?
- Population?
- Geographic range?
- Species range?



Question, objective dependent