



# BIOLOGY 20: Energy and Matter Exchange in Ecosystems

**Concept 1 - The biosphere is composed of a diversity of biomes each with distinctive biotic and abiotic factors**

## Background

The largest forest biome is the boreal forest which forms an irregular band circling the continents of the northern hemisphere. It is found below the permafrost-dominated tundra biome to the north.

A large portion of Alberta is composed of aspen-dominated boreal mixedwood forest. With harvesting of this forest resource at 60 – 70-year rotations the environmental community became concerned with how harvest might alter and affect the overall forest structure and biodiversity.

In a study conducted and published by the Alberta Environmental Centre (AECV95 – RI) Vegreville, AB and the Canadian Forest Service (Project No. 0001A) Edmonton, AB the mixed boreal forest was analyzed using three basic seral stages; young (20 – 30 years), mature (50 – 65 years) and old (120+ years)\*

Of the three seral stages studied, the mature stands are most simple in structure. They are composed of trees of similar age, height and diameter. The canopy is more complete with a lesser amount of understory type vegetation.

Old stands are the most diverse. They are a combination of trees in all age groups with breaks in the canopy, greater understory when compared to mature growth stands and they show an emergence of a secondary canopy composed of white spruce and birch. There is an accumulation of dead snags and downed woody material in advanced stages of rot. The higher degree of decomposition leads to a rich growth of nonvascular species of plants.

The young stands are the second-most diverse and have some features of old growth forest. They have some residual materials from the previous stand before succession disruption created them. This may include some large canopy trees, occasional snags and coarse downed woody material. Tree densities are greatest in this stage.

Each of the age groups were studied in terms of structure, organic soil depth, microclimate, herbaceous plant diversity and variation and abundance of bird and animal species.

\*Stelfox, J.B. (editor) 1995. Relationships between stand age, stand structure and biodiversity in aspen mixedwood forests in Alberta. Jointly published by Alberta Environmental Centre (AECV95-R1), Vegreville, AB and Canadian Forest Service (Project No. 0001A), Edmonton, AB.

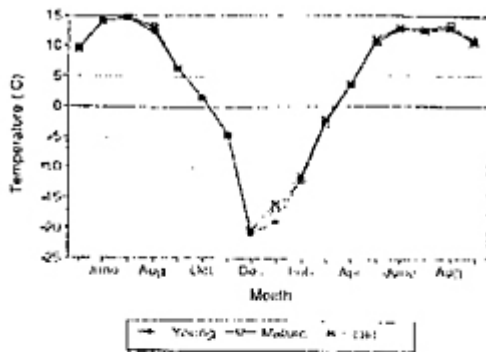
In this set of activities some of the findings of the study are presented for review and analysis. Students will be able to compare abiotic and biotic components in the three seral stages outlined.

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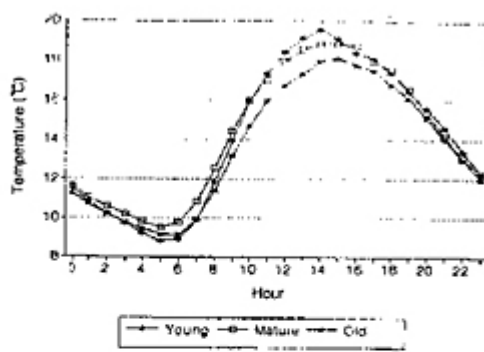
## Activity 1: Relationships Between Microclimate and Stand Age

The graphs below relate to air temperature in young, mature and old aspen mixedwood stages in the study area. All temperatures are taken 25 cm above ground with the soil temperature taken 25 cm below ground.

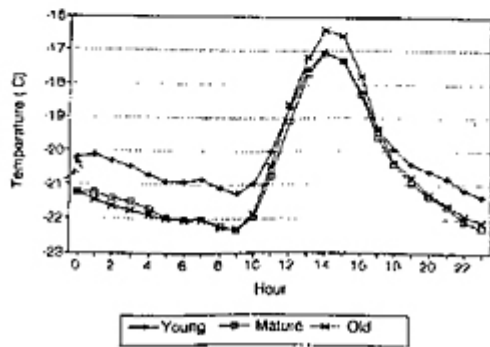
Average 1992-1993 daily temp.



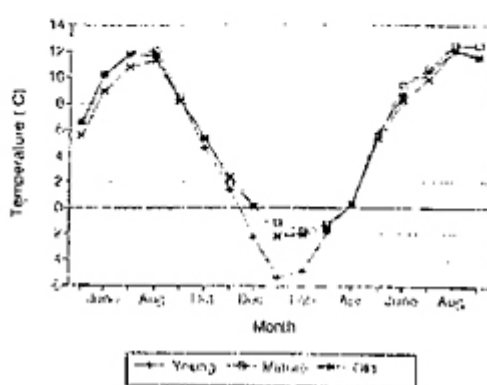
Average hourly temp. - July



Average hourly temp. - Dec.



Average soil temp.



### Questions

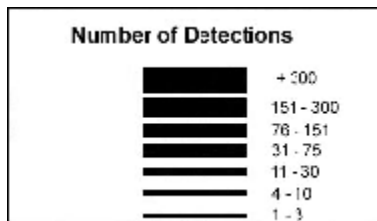
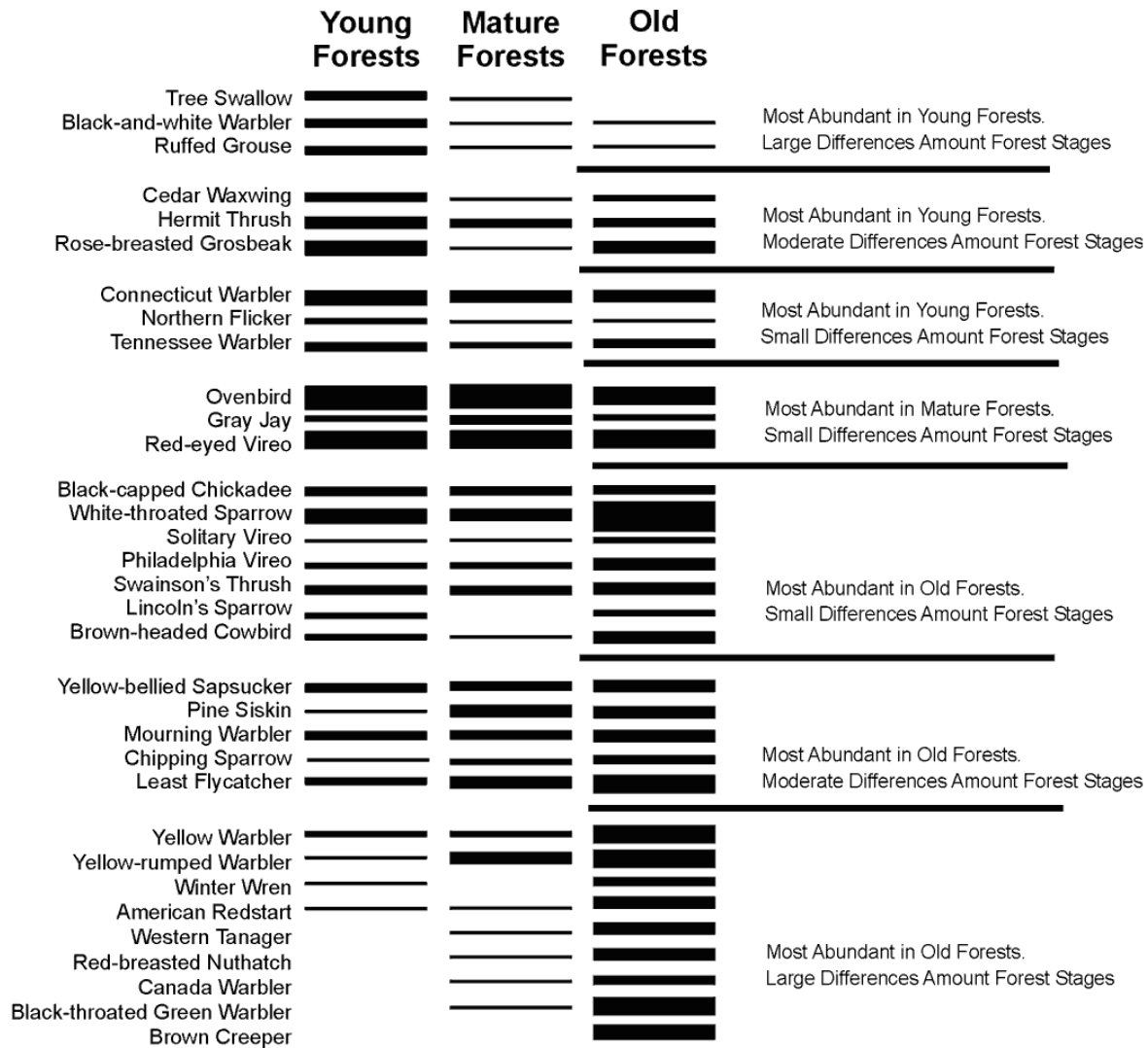
1. Compare the hourly temperature differences between the three age stands in summer and winter. Which age stand deviates the most in each season?
2. At what time of year is there the greatest deviation in daily temperature when the three seral stages are compared. What might account for this?
3. Which stand age has the greatest variation in soil temperature throughout the year? Give reasons for this observation.



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## Activity 2: Bird Species Richness and Abundance in Relation to Stand Age

The table following outlines the number of times certain bird species were detected during counts in the different series of the aspen mixed wood stands.





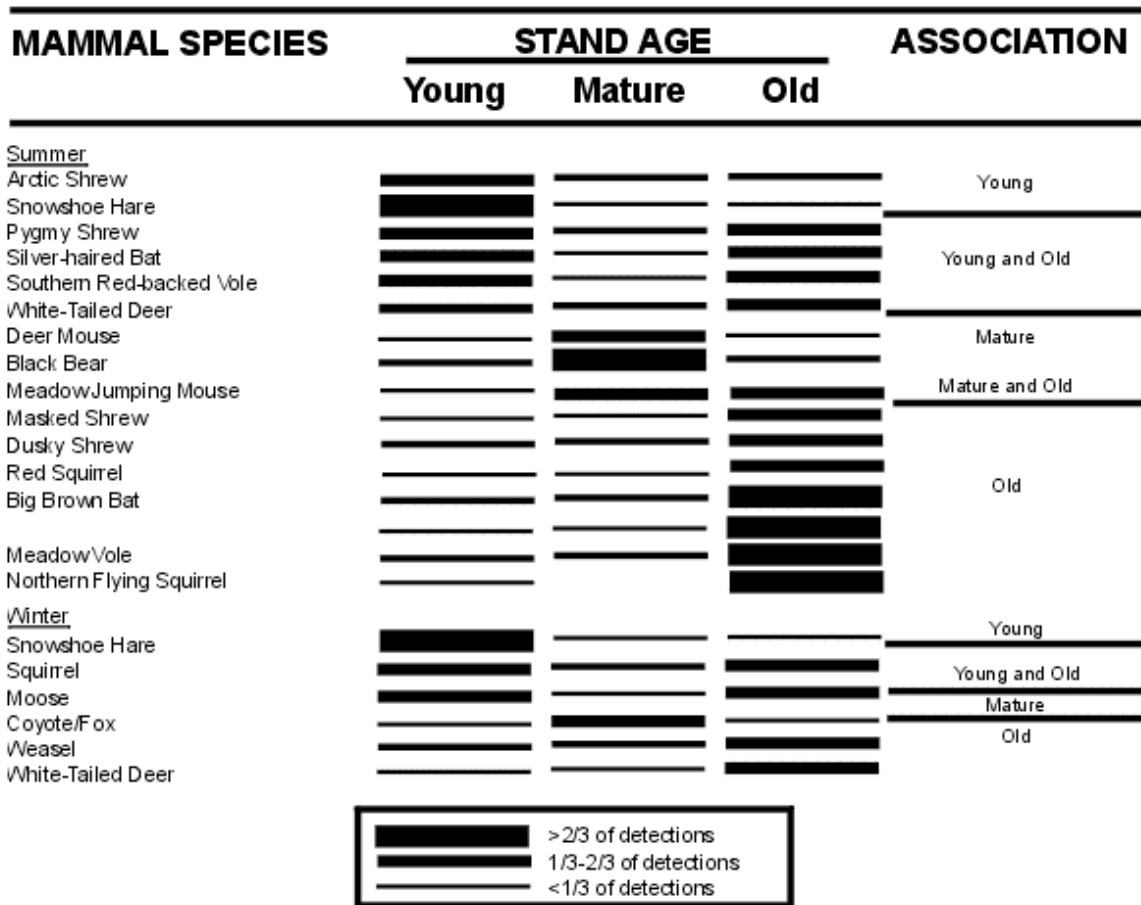
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FIGURE 7.2. Number of times bird species were detected during point counts within the three ages of aspen mixedwood stands in Alberta. Bird species were included only if they were detected on ten or more occasions and were ordered based on the amount their abundance differed among stand ages (see text).

## Questions

1. Which age stand contains the greatest density and variety of birds? Give reasons for this observation.
2. Some bird species are found in greater abundance in one age stand than in the other two. Give an example explaining why this occurs.

## Activity 3: Relationship Between Mammal Biodiversity and Stand Age





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Figure 8.4. Summer and winter associations of mammal species with young, mature, and old aspen mixedwood stands in Alberta (1992 and 1993 data combined). Detections of  $<1/3$ ,  $1/3$ - $2/3$ ,  $>2/3$  indicate weak, moderate, and strong associations, respectively.

### Questions

1. The lowest concentration of different mammal species is found in which of the three age categories? Give a reason for this observation.
2. Which mammal species are least affected by the age of the forest stand?
3. Why does the snowshoe hare show a stronger association to young rather than old forest?

### Activity 4: Further Research and Analysis

#### Questions

1. With the use of reference material and information from the presented activities outline the characteristics of the boreal forest biome. Include the abiotic components of the temperature range, precipitation and radiant energy as well as biotic components such as types of dominant vegetation and associated animals.
2. A common practice used in harvest of the boreal forest resource was clear cutting, a method that cut down all the woody material and salvaged the salable portions. What long term effects does this type of harvest have on the structure and hence the biodiversity of the mixed boreal forest?
3. A harvesting practice used by Alberta-Pacific Forest Industries Inc. (Al-Pac) is based on an ecosystem management approach. This method attempts to make logging approximate natural disturbances like fires. Harvested areas must have a minimum of 5% merchantable deciduous trees in addition to non-merchantable understory vegetation left standing with support vegetation for 1% merchantable conifers in clumps to prevent blow down. How does this method compare to clear cutting in terms of maintaining the integrity of the ecosystem?

### Answers

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#### Activity 1

1. The young stands have the lowest night temperatures and the highest day temperatures in summer (July). The winter (Dec) temperatures show young stands having the highest night temperatures and old stands having the highest day temperatures. In summer the greatest summer temperature range is found in young stands and in winter the old stands show the greatest deviation.
2. Comparing daily temperatures throughout the year shows the greatest deviation occurring during the months of December to February where young stands show the lowest temperatures and old stands have the highest temperature. This may be because the amount of thermo-cover is lowest in young stands.



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3. Young stands show the greatest deviation in soil temperature during the winter months. They do not have the amount of insulating duff (dead organic material) that mature and old stands do.

## Activity 2

1. The greatest density and variety of birds are found in old growth stands. These stands have the greatest diversity and offer the greatest variety of habitats for bird occupation.
2. The ruffed grouse is found in greater density in young forest. These birds are seed eaters and their food source from herbaceous plants is greatest in young stands.

## Activity 3

1. The mature stands have the lowest concentrations of different mammal species. This is because the mature forest is the simplest, with the least variation, limiting the types of habitats available.
2. The weasel, the masked shrew. The weasel is a carnivore and a generalist type feeder. The masked shrew is an insectivore and preys on a vast variety of insect types.
3. Young growth offers the hare more of the food supply needed. It contains more grasses and young tree bark and twigs preferred.

## Activity 4

1. Average annual temperature range is between  $-10$  to  $5$  degrees Celsius, precipitation is  $80 +$  cm, growing season is relatively short with cold winters. The majority of precipitation is during winter months. The dominant tree types are limited to about nine varieties – six coniferous and three deciduous species. Birds can be viewed in two groups, seasonal and permanent. Permanent birds include ruffed grouse, gray jay and grosbeaks. Summer birds are the warblers, flycatchers, vireos and ducks and geese. Common animals are squirrels, white-tailed deer, moose, black bear, wolf, beaver and varieties of voles and shrews. Topography is generally level, with areas that are dominated by deciduous and areas that are dominated by coniferous stands. Swamp and bogs with black spruce and large are a feature of boreal forests.
2. As succession proceeds the vegetation will be of one specific age. This limits the variety of habitat and thus the types of animals that can inhabit the area.
3. Regrowth of the cut areas will have a mix of age class variation. This will provide a greater variety of habitat and accommodate a greater variety of organisms. It more closely simulates disturbance caused by fire.