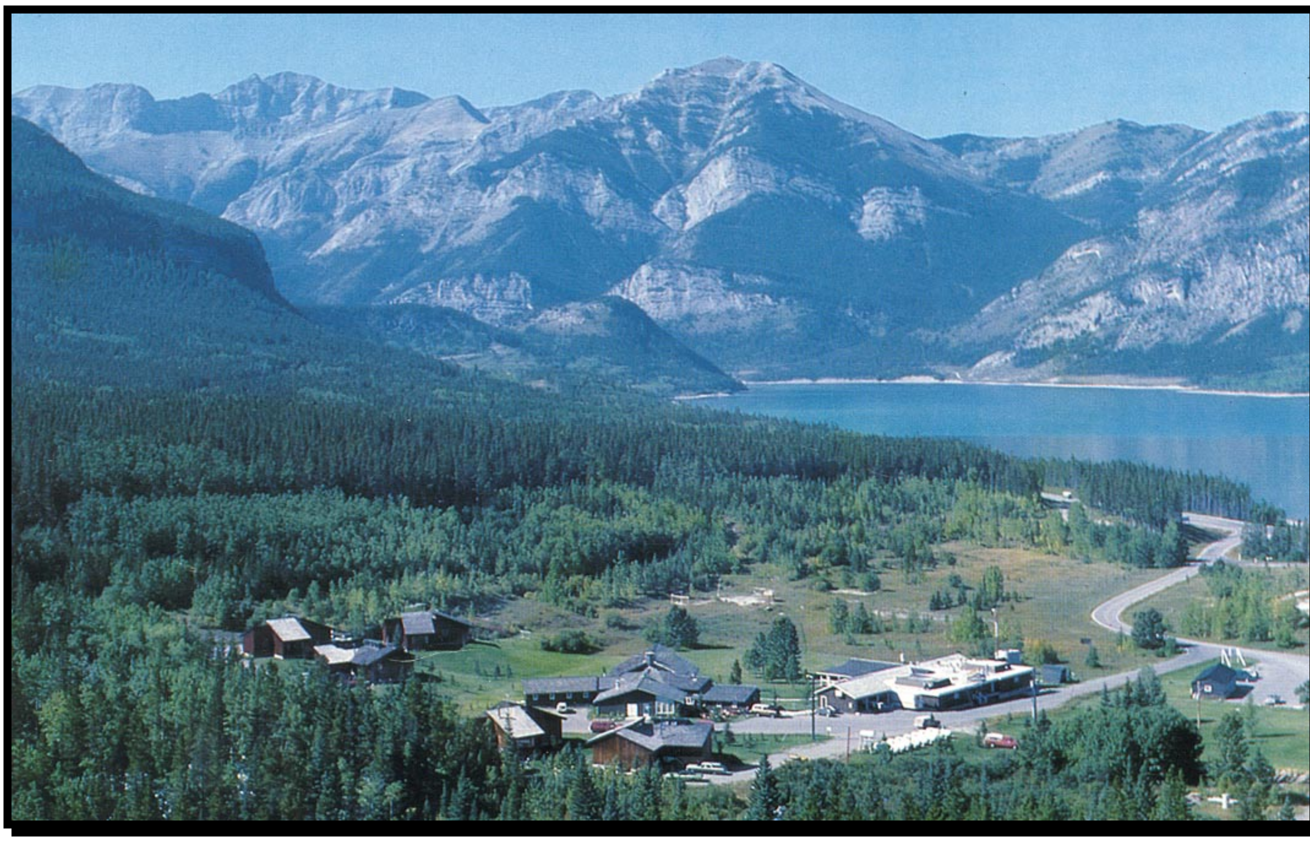
Trees and Forests of the Kananaskis

Barrier Lake Forestry Trails



Developed by:

University of Calgary
Biogeoscience Institute
Barrier Lake Field Station
In Co-operation with
Alberta Land & Forest Division
Alberta Sustainable Resource Development

2007 Update

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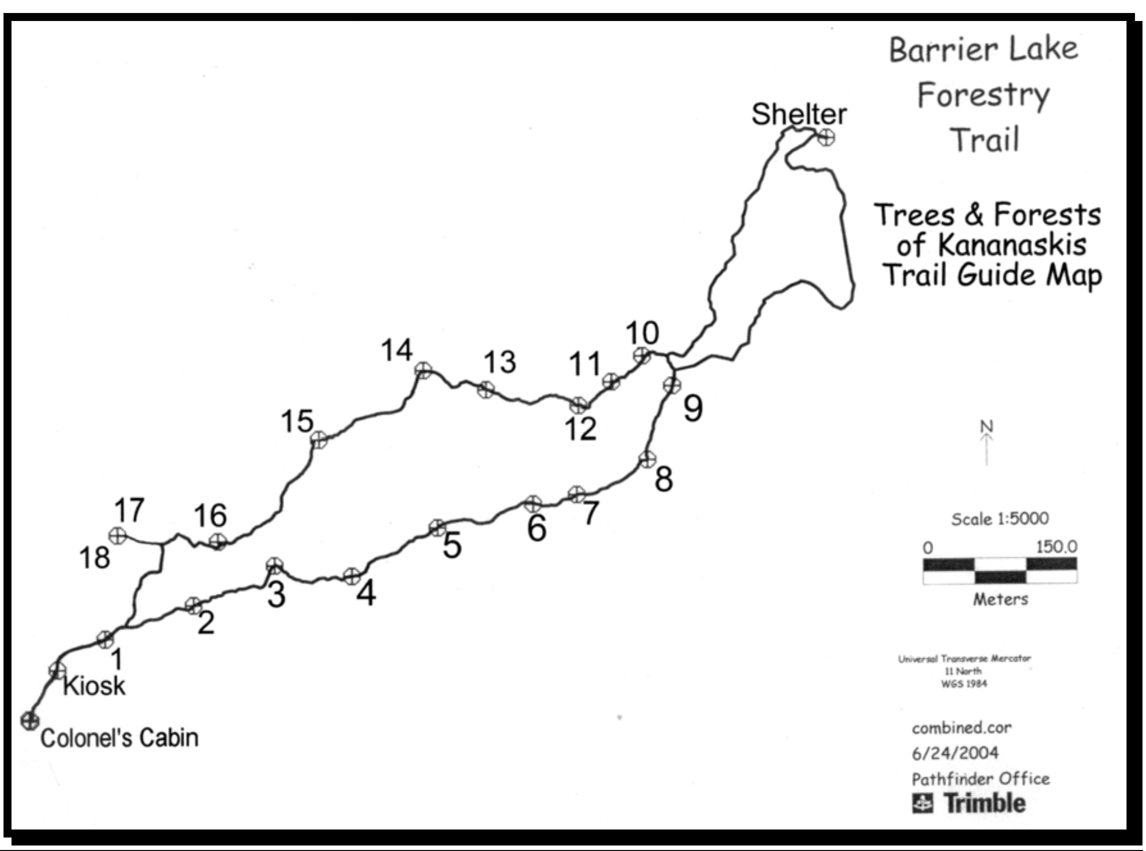


Introduction to the Forest Ecology Trail

This trail guide is for The Forest Ecology Trail, a 2.3 km trail that takes approximately 1 hour to walk. For each of 18 trail signs, the guide provides a brief introduction and diagram for a research topic followed by more detailed summary of the research literature and key references.

To ensure a safe and enjoyable walk of the trail for all visitors please observe the following courtesies and precautions:

- **Refrain from smoking on the trail; it takes only a spark to start a fire.**
- **Ensure that all garbage is deposited in the receptacles provided.**
- **Stay on the trail, especially near signs and exhibits; vegetation is easily destroyed.**
- **Stay away from wildlife; approaching, feeding, or attempting to pet any wildlife species could endanger their life and yours.**

Please return the guide to the kiosk or Colonel's Cabin Historic Site for others to enjoy. Thank you for visiting the trail.

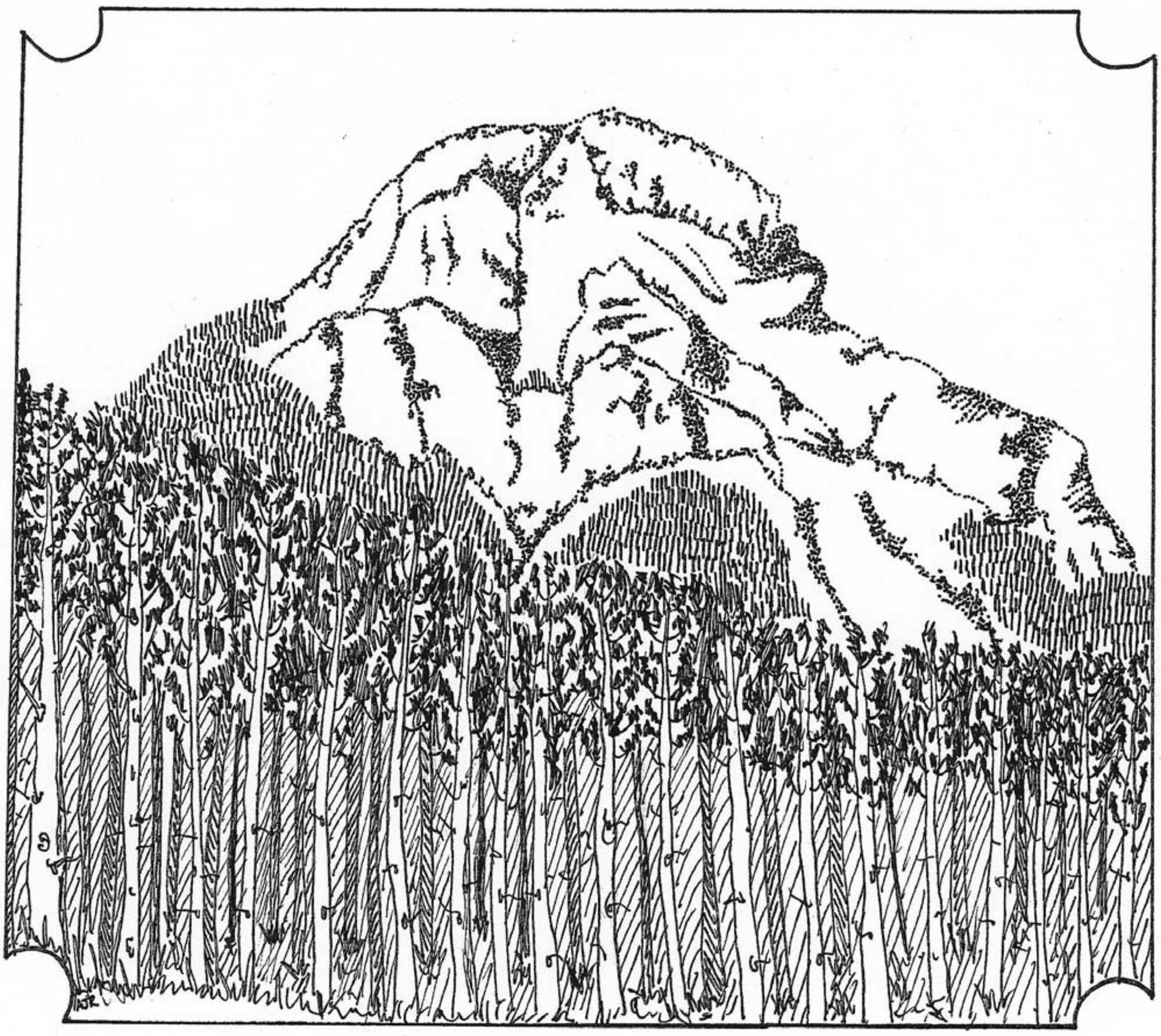
The Biogeoscience Institute (formerly Kananaskis Field Stations) is a Research Institute of the University of Calgary consisting of two field stations: Barrier Lake and R.B. Miller Station. Each year KFS hosts 20 or more scientists whose research is reported in refereed scientific papers.

The information provided in this guide is based on a sample of refereed scientific papers. The references listed at the bottom of each page show where research related to the topic was published.

01

An Introduction to the Trees & Forests of the Kananaskis

- The tree species composition in Kananaskis forests is mainly due to elevation, soil type, and slope aspect, position, and steepness.
- The age of forests is mainly due to large, lightning-caused wildfires.



Research Connection

In the forests of the Kananaskis Valley, tree species composition is determined mainly by elevation, soil type, and slope aspect, position, and steepness. All factors affect the important resources (moisture and energy) plants need to grow and survive.

The age of forests is due mainly to large, lightning-caused wildfires. Avalanches, human-caused fires, and logging have played a relatively minor role.

References:

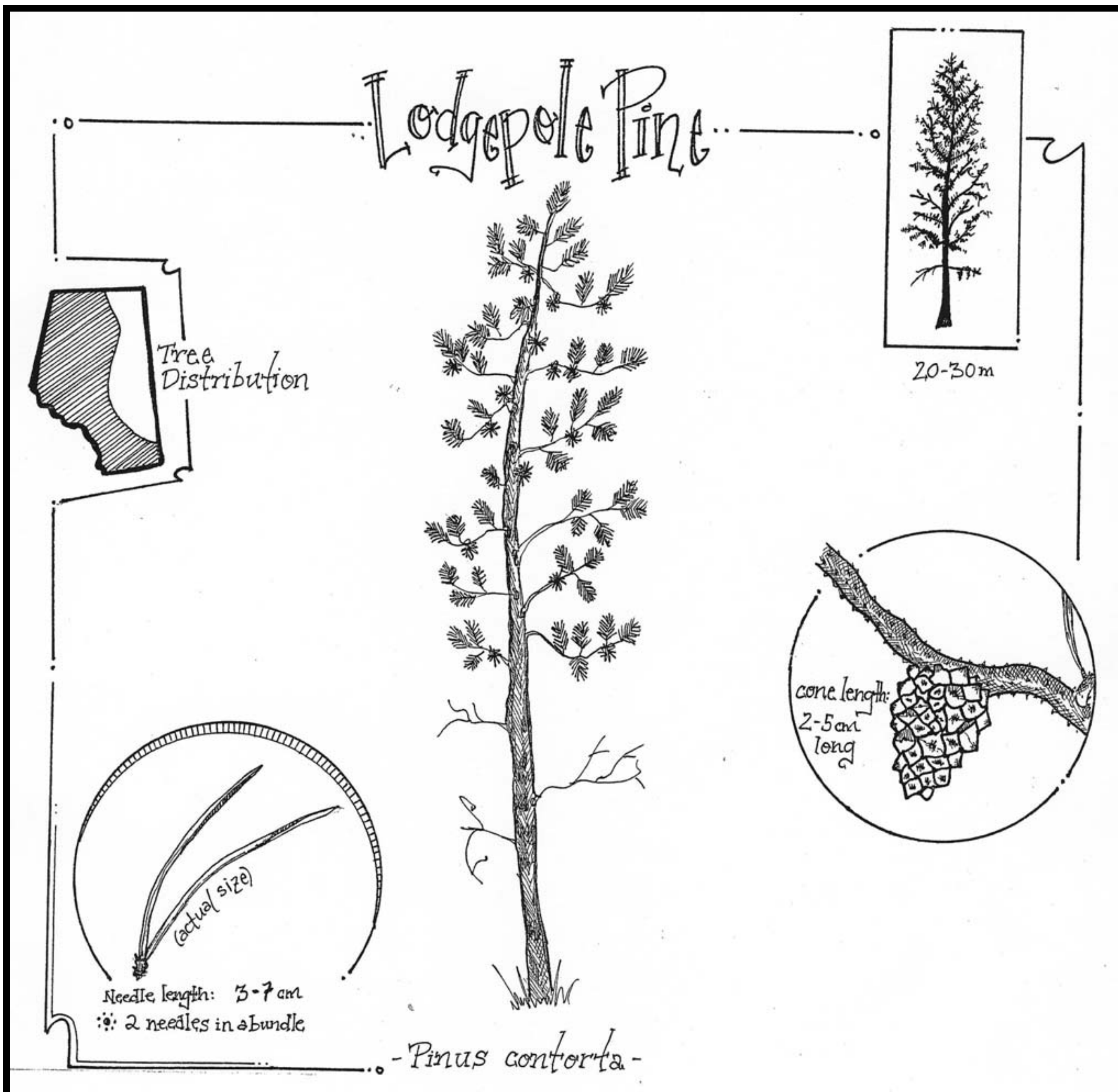
Jarvis, P.G. and J.W. Leverenz. 1983. Productivity of temperature, deciduous and evergreen forests. In: Encyclopedia of Plant Physiology. Volume 12D. Chapter 8: Physiological Plant Ecology. Eds. O.L. Lange, P.S. Nobel, C.B. Osmond, and H. Zeigler. Springer-Verlag, New York.

Johnson, E.A. 1991. Fire and Vegetation Dynamics: Studies from the North American Boreal Forest. Cambridge University Press, U.K. 125 pp.

Stephenson, N.L. 1990. Climatic control of vegetation distribution: the role of the water balance. American Naturalist 135: 649-670.

02 Seeing the Forest through the Trees: Lodgepole Pine *(Pinus contorta)*

- **Lodgepole pine is the most common coniferous tree species in this part of the Kananaskis Valley and is found throughout western North America.**
- **Lodgepole pine seeds are produced within serotinous cones, which remain closed after they mature until opened by wildfire.**



Research Connection

Lodgepole pine (*Pinus contorta*) is the most common coniferous (cone-bearing) tree species found in this part of the Kananaskis Valley. It is found throughout western North America.

Take a close look at some lodgepole pine cones. Lodgepole pine trees produce their seeds in *serotinous cones*, which remain closed after they mature (cones on the ground may open if exposed to warm summer temperatures for long periods). More than ten years worth of cones can be found on a mature tree at any time. Seeds within the cones remain viable for about five years, provided they remain on the tree. The serotinous cones open after being heated in wildfires (see Sign 13 for more detail).

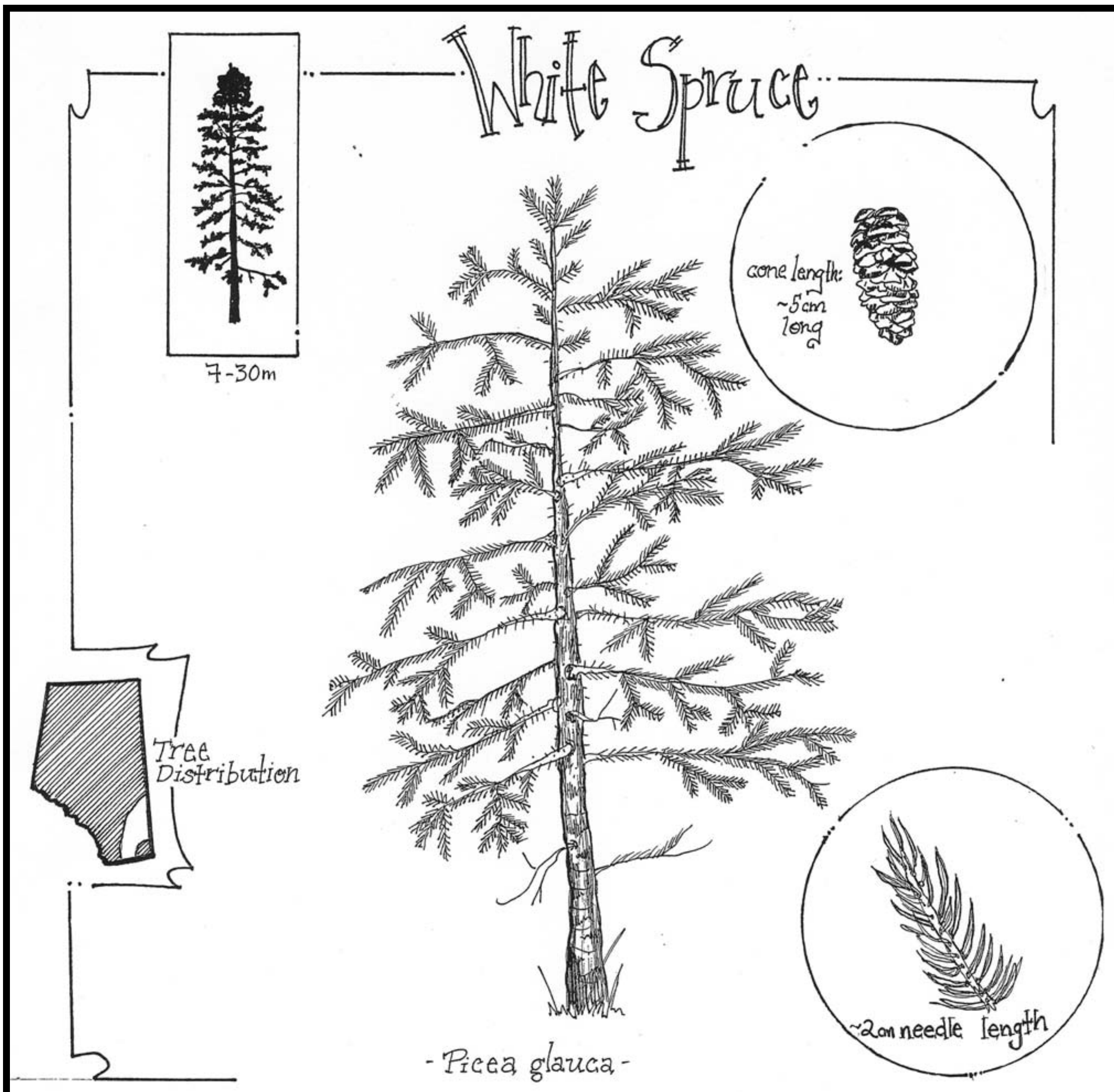
***References*:**

Lotan, J.E. and Critchfield, W.B. 2000. Lodgepole pine. In: Silvics of Forest Trees of the United States. Ed. H.A. Fowells. USDA Forest Service, Washington. 762 pp.

Ritchie, J.C. 1975. Postglacial Vegetation of Canada. Cambridge University Press. Cambridge, U.K. 178 pp.

03 Seeing the Forest through the Trees: White Spruce *(Picea glauca)*

- White spruce is a common coniferous tree species in this part of the Kananaskis Valley and is found throughout the North American boreal forest and Rocky Mountain forest.
- White spruce produce large numbers of cones every seven to ten years (called mast years).



Research Connection

White spruce (*Picea glauca*) is another common coniferous tree species found in this part of the Kananaskis Valley. It is found throughout the North American boreal forest and Rocky Mountain forests, and can also be found in some areas on the Canadian prairies and aspen parklands.

Take a close look at some white spruce cones. Spruce cones can be produced on trees as young as four years, however heavy cone production usually begins after 30 years. The cones mature in the autumn following spring flowering, pollination and fertilization. After cones mature, seeds are shed through the autumn and winter.

The number of cones produced by trees in a region varies from year to year. The interval between mast years (years when very large numbers of cones are produced) is seven to ten years. However, this varies with site conditions and geographic location. Researchers have yet to understand what factors result in mast years, but weather conditions seem to play an important role.

References:

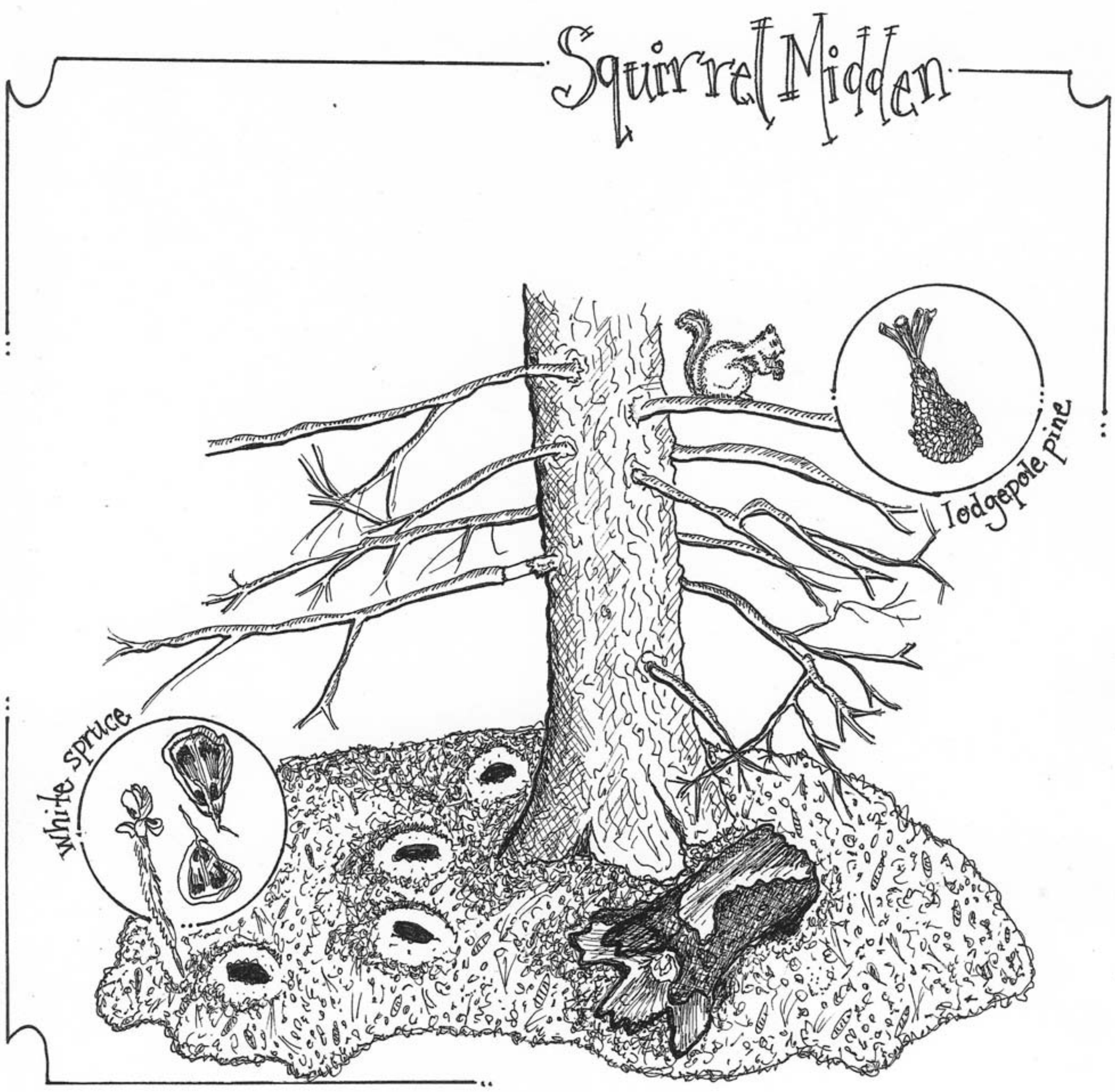
Nienstaedt, H. and Zasada, J.C. 2000. White spruce. In: Silvics of forest trees of the United States. Ed. H.A. Fowells. USDA Forest Service, Washington. 762 pp.

Ritchie, J.C. 1975. Postglacial vegetation of Canada. Cambridge University Press. Cambridge, U.K. 178 pp.

04

Not in my Territory: Squirrels and their Middens

- **A squirrel midden, made up of discarded cone scales, is a squirrel's food cache and indicates a squirrel's territory.**
- **Squirrels defend their territories by signalling their whereabouts to others; a rattle call signals the occupation of a territory, whereas a screeching call is directed at an invader.**



Research Connection

On the ground in front of you are two large piles of cone scales, each called a *midden*, discarded by red squirrels that have eaten the cones' inner seeds. Red squirrels eat a variety of foods, including plant buds and fungi, but seeds obtained by husking cones are their main source of food. Within each midden is a food cache, with 12,000 to 16,000 unopened lodgepole pine and white spruce cones stored for consumption during the winter. Cones are stored in shallow, underground tunnels within and under middens and can last for many years.

The middens also indicate that you are in a red squirrel's territory. Red squirrels defend non-overlapping territories (1/5 to 1/2 hectares) by scent marking and by aggressively chasing out intruders. Territories are a way of dividing food resources among members of a population and are essential for their over-winter survival. Squirrels defend their territories by signalling their whereabouts to others with a regular vocalization. A rattle call, made as a squirrel moves around its territory, indicates to others that the territory is occupied. If it senses an invasion, it will make a more irregular screeching sound. Is the resident squirrel rattling or screeching at you?

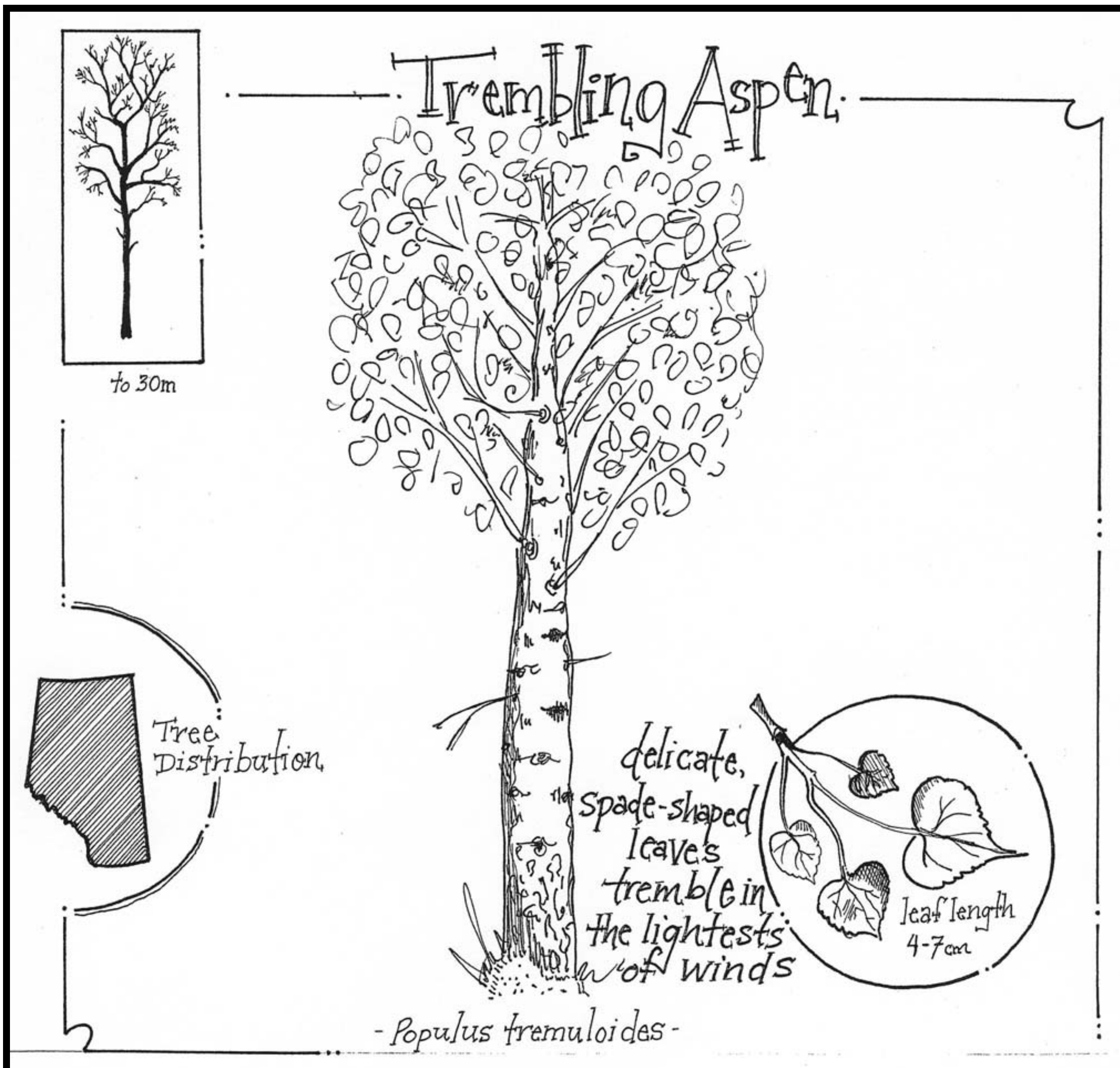
***References*:**

Boonstra, R., Boutin, S., Byrom, A., Karels, T., Hubbs, A., Stuart-Smith, K., Blower, M., and Antpoehler, S. 2001. The Role of Red Squirrels and Arctic Ground Squirrels. In: Ecosystem Dynamics of the Boreal Forest: The Kluane Project. Eds. Krebs, C.J., Boutin, S., and Boonstra, R. Oxford University Press, Inc. New York, New York.

Price, K., Boutin, S., and Ydenberg, R. 1990. Intensity of territorial defence in red squirrels: an experimental test of the asymmetric war of attrition. Behavioural Ecology and Sociobiology 27: 217-222.

05 Seeing the Forest through the Trees: Trembling Aspen *(Populus tremuloides)*

- Trembling aspen is found throughout the North American boreal forest and Rocky Mountain forests.
- Aspen in this area can regenerate either by sprouting from underground stems or from seed.



Research Connection

Trembling aspen (*Populus tremuloides*) is the most common deciduous tree species in this part of the Kananaskis Valley. It is found throughout the North American boreal forest, Rocky Mountain forests, and can also be found in some areas on the Canadian prairies and aspen parklands.

Take a close look at the trembling aspen trees in front of you. Unlike lodgepole pine and white spruce trees that regenerate from seeds, aspen trees often regenerate by sprouting from underground stems. Aspen trees that are connected by a network of underground stems are genetically identical (called clones) and further share nutrients and water. In the autumn you can distinguish clones because all members of the same clone turn colour at the same time.

Aspen trees also regenerate from seeds. Trees produce seeds in capsules surrounded by tufts of long, silky hairs, allowing them to be carried many kilometres by wind. Large quantities of seeds are produced when trees are 10 to 20 years old, however the optimum age for seed production is 50 to 70 years. Good seed crops are produced every four to five years. Few seedlings survive mainly because seeds are viable for only a short period (two to four weeks) and they do not survive moisture and temperature stress well.

References:

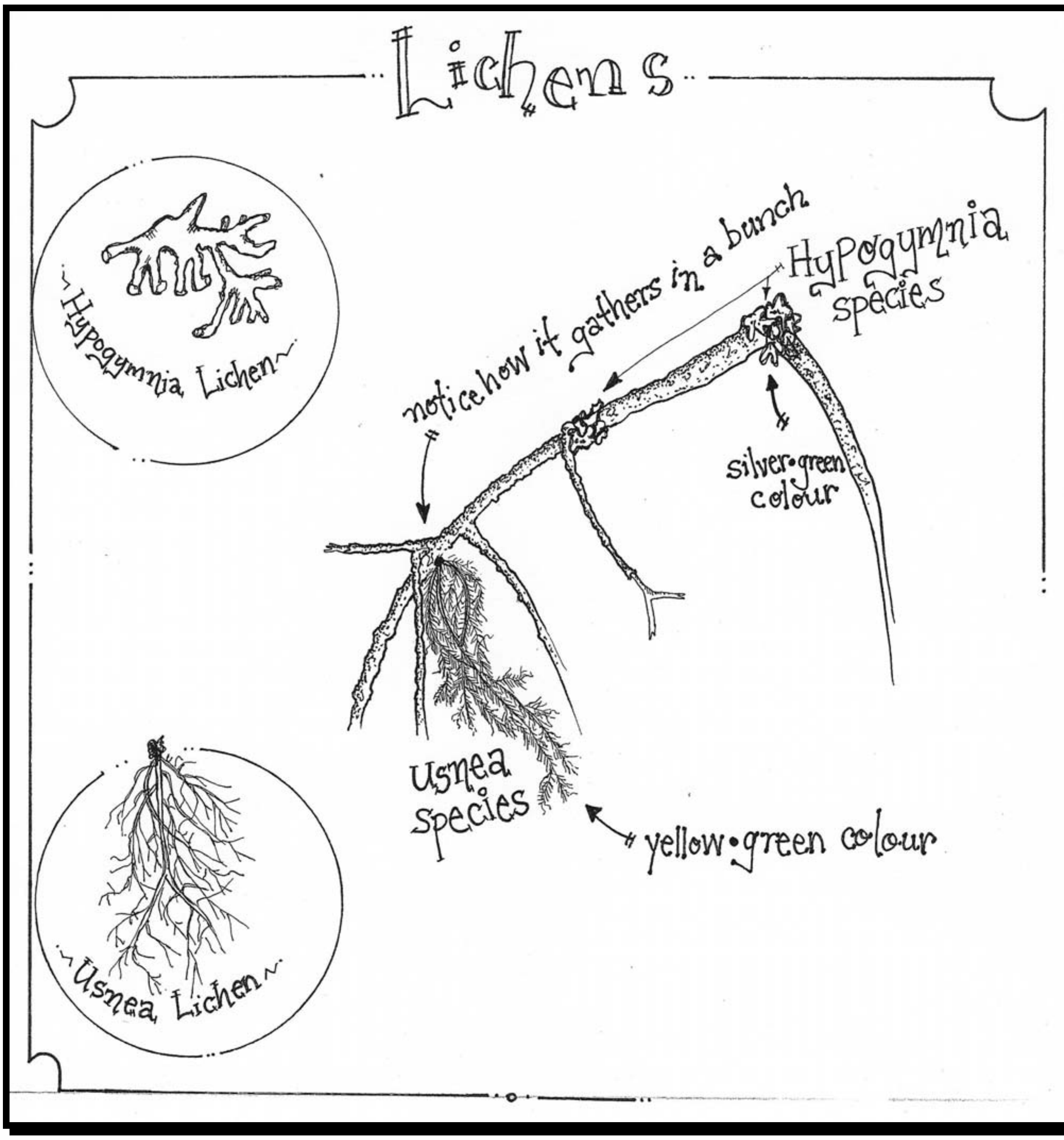
Perala, D. 2000. Quaking Aspen. In: Silvics of forest trees of the United States. Ed. H.A. Fowells. USDA Forest Service, Washington. 762 pp.

Ritchie, J.C. 1975. Postglacial vegetation of Canada. Cambridge University Press. Cambridge, U.K. 178 pp.

06

Nutrient Cycles through Lichens in the Forest Ecosystems

- **Lichen is a fungus with either green algae or cyanobacteria growing inside. Together they form a mutualistic association where both organisms benefit.**
- **Through the uptake, storage, and release of minerals, lichen can affect the overall pattern of mineral cycling in an ecosystem.**



Research Connection

Look up into the trees around you. Some branches have a scruffy tangled mass that looks like an old man's beard hanging from them. This mass, called lichen, is a fungus with either green algae, or cyanobacteria, growing inside. Together they form a mutualistic association where both organisms benefit. The fungus provides a protective environment, water, and minerals for the algae, or bacteria, and the photosynthetic green algae, or cyanobacteria, produce food for both organisms.

Lichens can quickly absorb up to 35 times their own weight in water. The tree and ground lichens absorb and retain moisture within the forest ecosystem. Once water is absorbed, photosynthesis within the lichen occurs at a rapid rate. However, rainy conditions occur infrequently in the Kananaskis Valley. As a result, the growth rate of lichens is only 1/10 mm to 10 mm per year in this region.

Lichens also contain a pool of stored minerals that are absorbed primarily from the atmosphere. Over time, the minerals from lichens are released into the nutrient cycle of forests by two paths. Lichens that fall to the forest floor decompose and minerals are released into the soil. Lichens are also leached by rain, carrying the minerals to the forest floor.

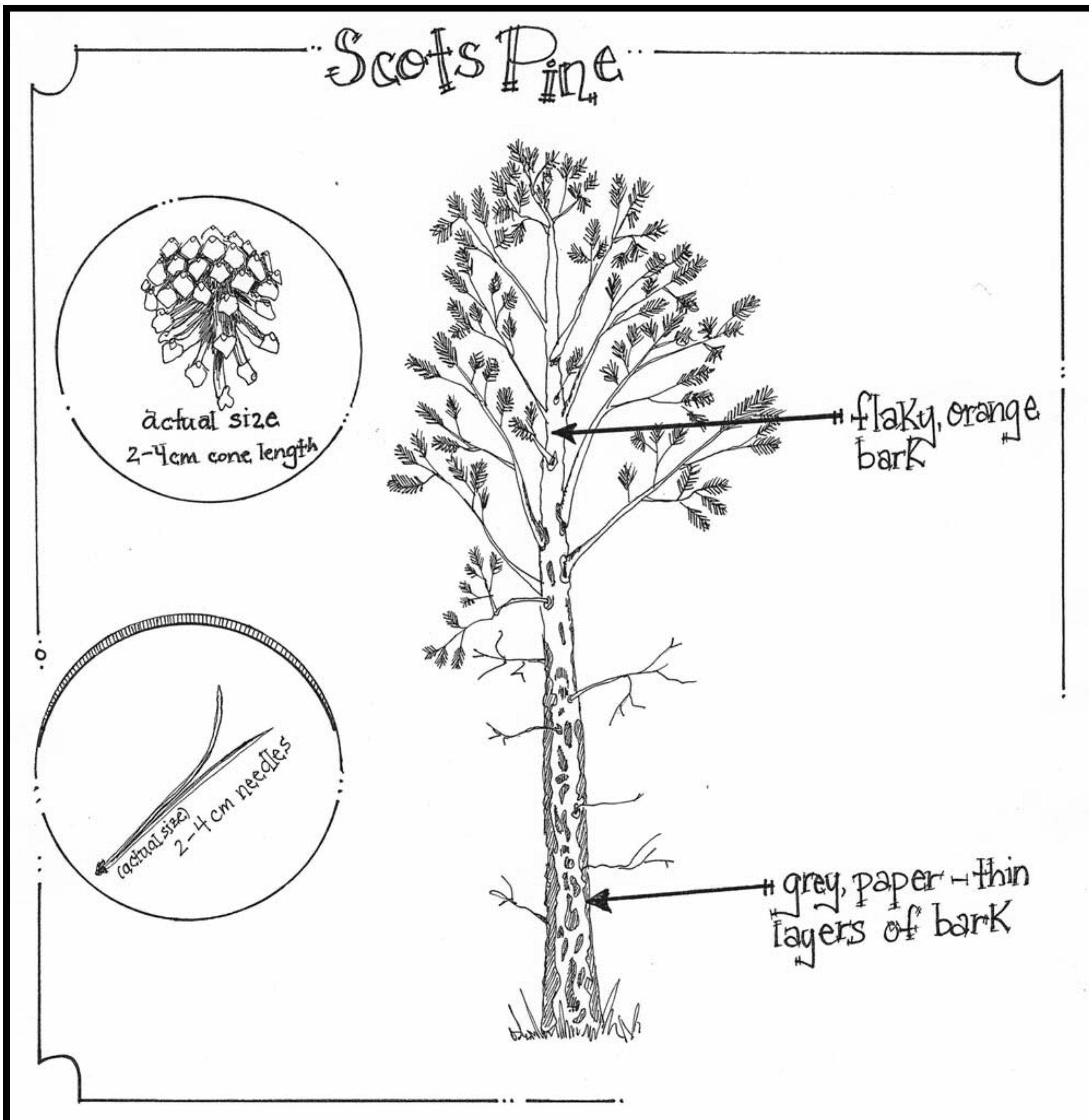
***References*:**

Coxson, D.S., and Nadkarni, N.M. Ecological roles of epiphytes in nutrient cycles of forest ecosystems. In: Forest canopies. Ed. M.D. Lowman and N. Nadkarni. Academic Press, New York. Pp. 495-543.

Pike, L.H. 1978. The importance of epiphytic lichens in mineral cycling. Bryologist 81: 247-257.

07 Seeing the Forest through the Trees: Scots Pine *(Pinus sylvestris)*

- **Planted in the 1940's, Scots pine seedlings from Sweden were able to survive and grow at this site because the resources they require are found here.**



Research Connection

The trees with flaky orange bark that you see here are not native to this area, or this continent. They are Scots (or Scotch) pine trees (*Pinus sylvestris*). This species is found throughout the Eurasian boreal forest, from Scotland to Siberia. How did these trees get here?

In 1944, 1945, and 1947 Scots pine seedlings from Sweden were planted here and left to grow. This plantation was part of the Kananaskis Forest Experimental Station's research to find out if tree species from other countries would grow well in this area. Their continued presence today means that they have indeed survived and grown well, mainly because their resource requirements are very similar to the native species lodgepole pine. However, their seeds have not successfully germinated and grown in the area.

What would have happened if this introduced tree had spread and competed with the native trees in this area?

***References*:**

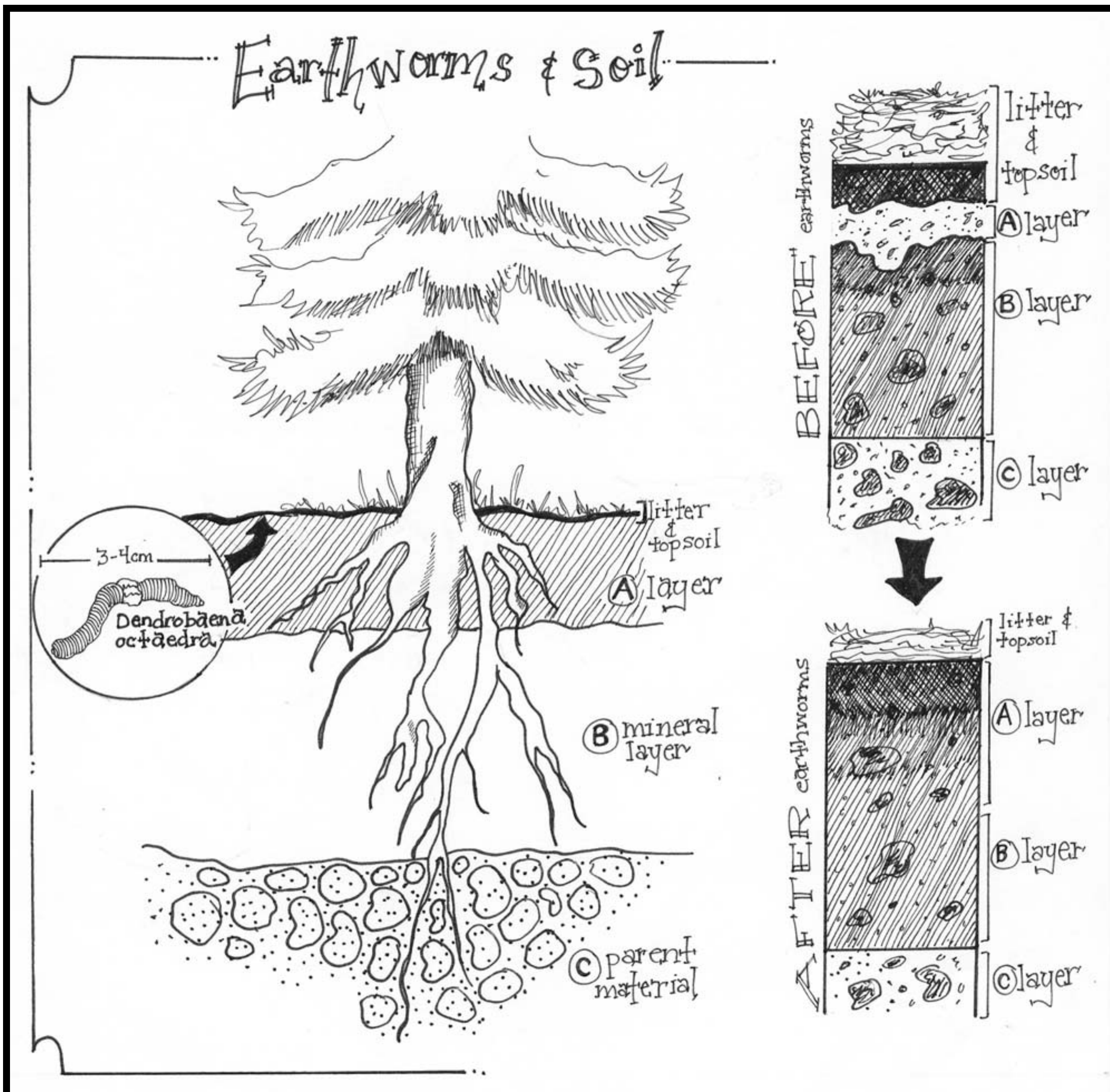
Fordyce, S.L. and J.H. Fochler. 1982. The history and development of Kananaskis Forest Experimental Station research projects. Alberta Forest Service Research Branch. Calgary, Alberta. 70 pp.

Young, J.A. and C.G. Young. 1992. Seeds of Woody Plants in North America. Dioscorides Press. Portland, Oregon. 407 pp.

08

Unintended Consequences: Earthworm Invasion in the Kananaskis

- **The European earthworm *(Dendrobaena octaedra)* has been introduced into Kananaskis forests.**
- **By mixing and aerating soil layers, and by ingesting soil fungi in the organic layer, these earthworms are changing the nature of the soil fungal community.**



Research Connection

With European settlement, the European earthworm species *(Dendrobaena octaedra)* was introduced into North American soils. It continued spreading westward as land was settled and cultivated. Invasion into the Kananaskis Valley began in the late 1970's and 1980's. It is believed that the earthworms were carried here as cocoons primarily by horses, logging equipment and other forestry vehicles and agricultural machinery.

Earthworms are mixing the organic soil layers and mineral soil is being incorporated into the organic layers. This affects the physical and chemical qualities of the soil. By mixing and aerating soil layers, and by ingesting soil fungi in the organic layers, earthworms are changing the nature of the soil fungal community. Further ecological research is needed to determine if this will have an effect on other aspects of the forest's ecology.

***References*:**

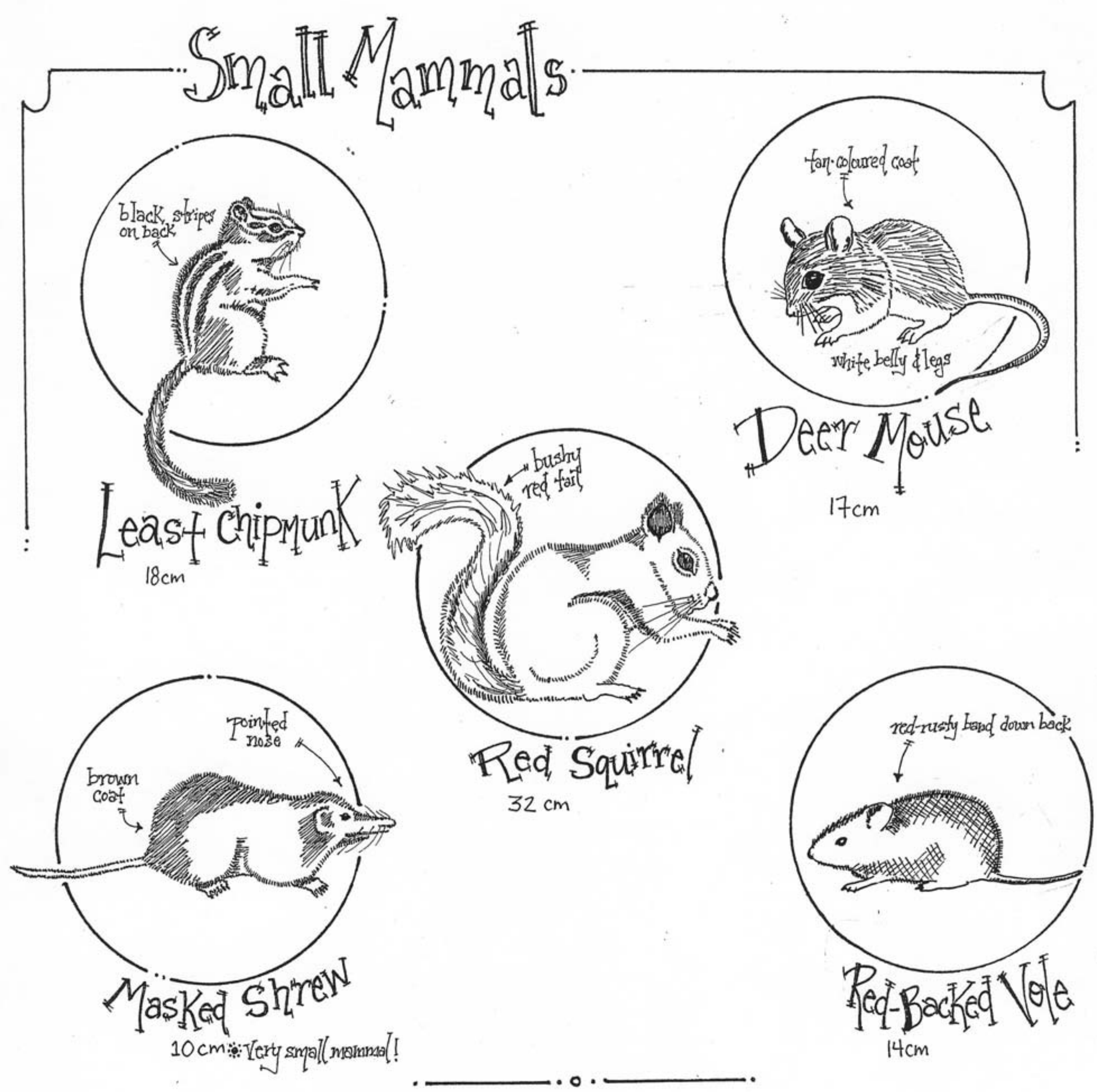
Dymond, P., Scheu, S., and Parkinson, D. 1997. Density and Distribution of Dendrobaena octaedra (Lumbricidae) in aspen and pine forests in the Canadian Rocky Mountains. Soil Biological Biochemistry 29: 265-273.

MacLean, M.A., and Parkinson, D. 1997. Changes in structure, organic matter and microbial activity in pine forest soil following the introduction of Dendrobaena octaedra (Oligochaeta, Lumbricidae). Soil Biological Biochemistry 29: 537-540.

09

Small Mammals: Important Forest Inhabitants

- **Small mammals are an important part of the forest because they eat plants and insects, disperse fungi and seeds, and are prey for larger animals.**
- **In Alberta they are considered when making forest management decisions.**



Research Connection

As you observe the forest here, you may see or hear small mammal species. Squirrels and chipmunks are often seen; mice, shrews and voles are abundant, but less frequently observed. These species are important to the functioning of the forest ecosystem because they eat plants and insects, disperse fungi and cones, and are prey for larger mammals and birds of prey.

The suitability of a forest for small mammals will depend on whether it has a diversity of habitats. The number of small mammals often increases in clear-cut areas because the habitat is made more diverse. In clear-cuts the number of red-backed voles decreases sharply, however they are replaced by an increased number of deer mice and chipmunks, heather voles and long-tailed voles.

In past decades, forest management decisions were primarily based on maximizing the harvest of wood. Ecological research has taught us that other aspects of the forest, such as wildlife, are also valuable. Today, forest managers in Alberta take into consideration mammals, as well as fish, birds, water, and non-economic plants in their management decisions.

***References*:**

Alberta Sustainable Resource Development. 1994. Alberta Timber Harvest Planning and Operating Ground Rules. Publication No. Ref. 71.

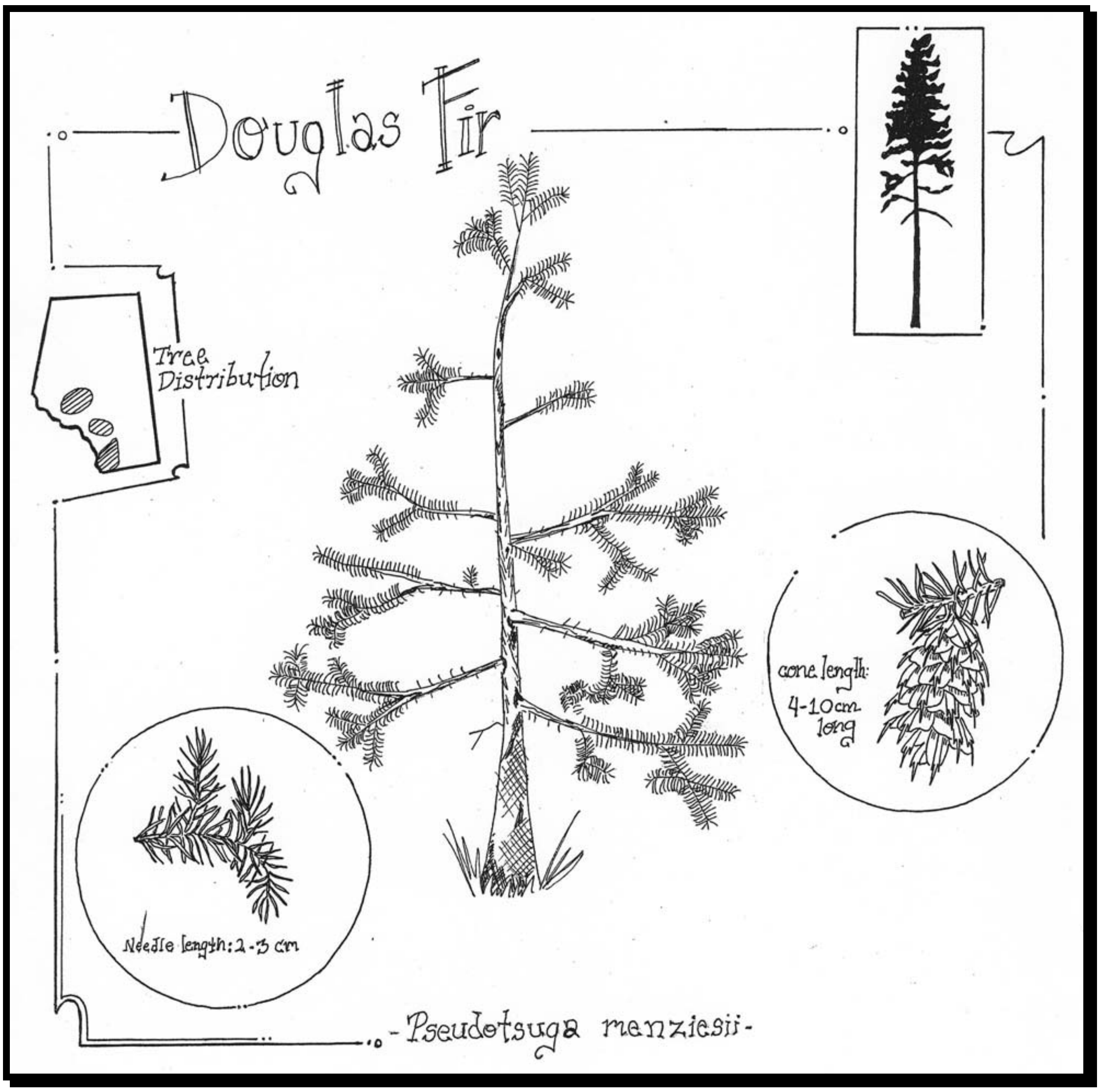
Kirkland, G.L. Jr. 1990. Patterns of initial small mammal community change after clear-cutting of temperate North American forests. Oikos 59: 313-320.

Millar, J.S. and A.G. McAdam. 2001. Life on the edge: the demography of short-season populations of deer mice. Oikos 93: 69-76.

Schulte-Hostedde, A.I. and J.S. Millar. 2002. 'Little chipmunk' syndrome? Male body size and dominance in captive yellow-pine chipmunks (Tamias amoenus). Ethology 108: 127-137.

10 Seeing the Forest through the Trees: Douglas Fir *(Pseudotsuga menziesii)*

- **Douglas fir is a coniferous tree species found in a few areas of the Kananaskis Valley and is found throughout western North America.**
- **Douglas fir cones mature and open in the autumn, with most seeds falling within 100 metres of the parent tree.**



Research Connection

Douglas fir (*Pseudotsuga menziesii*) is a coniferous tree species found in some areas of the Kananaskis Valley. It can be found in large numbers at lower elevations in the Bow Valley and in various canyons throughout the Kananaskis Valley. Douglas fir is found throughout western North America.

Douglas fir can be easily identified by looking at its needles, bark and cones. Unlike the trees species you have encountered so far, Douglas fir needles are flat. The bark of Douglas fir is smooth and gray when trees are young, and becomes brownish and deeply furrowed as trees age.

Douglas fir cones have bracts that stick out between the cone scales. Cones mature and open in the autumn, with two-thirds of the total seed crop dispersing within a couple of months. The remaining seeds disperse in winter and spring. Most seeds fall within 100 metres of the parent tree.

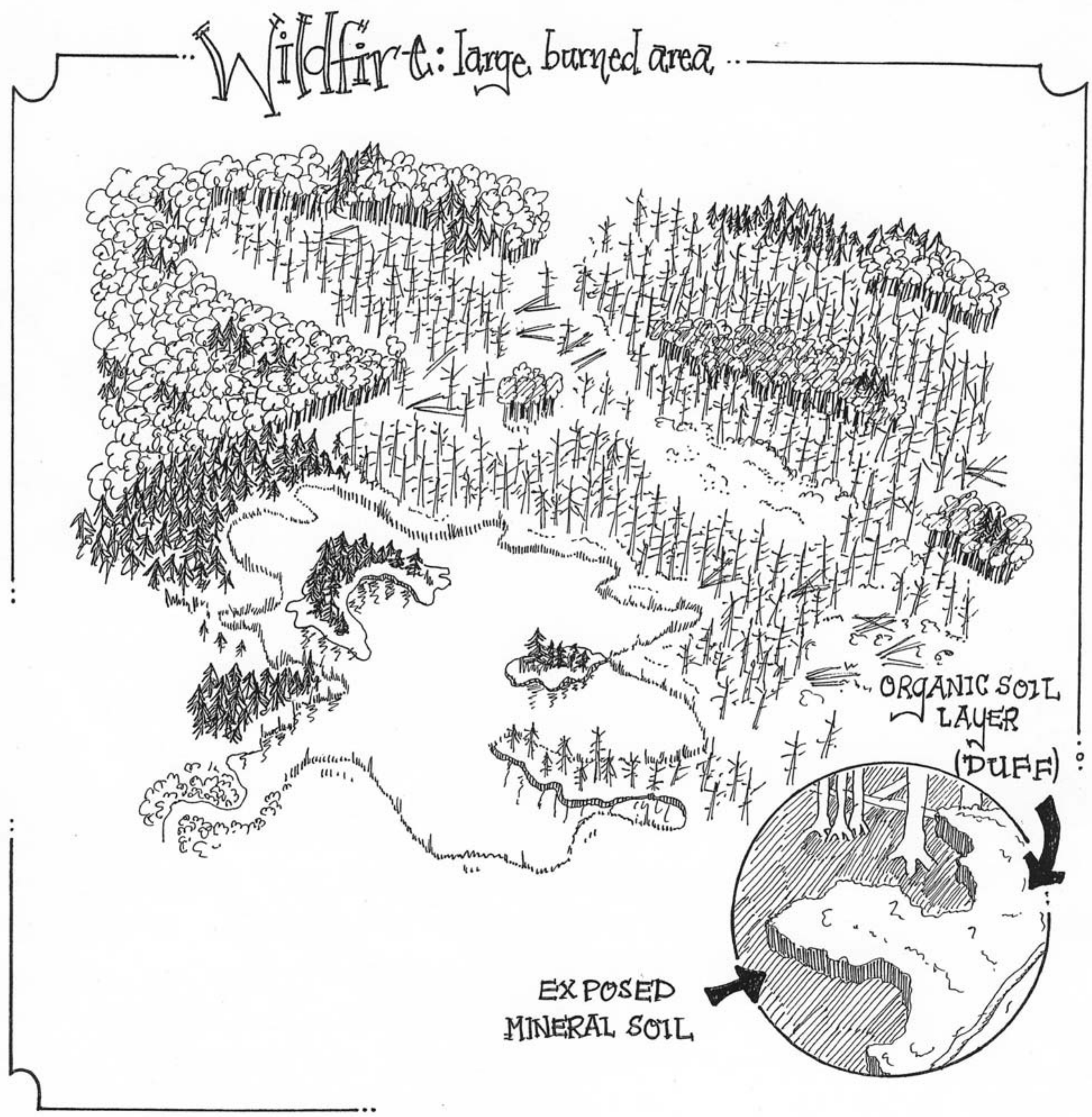
***References*:**

Hermann, R.K., and D.P. Lavender. 1990. Douglas Fir. In: Silvics of North America. USDA Forest Service, Washington DC. 877pp.

11

Wildfires: Regeneration of the Forest

- **Wildfires create an environment necessary for the survival and growth of newly germinating tree seedlings; they consume patches of organic soil layers and kill large areas of vegetation.**



Research Connection

Note the fire scarred tree remnants on the ground to the right of the trail. Most of the trees around you regenerated within a few years after a large, lightning-caused wildfire that burned over this area. Wildfires create the conditions that tree species need to germinate and grow.

Wildfires consume the organic soil layers (duff), usually in patches, leaving areas of exposed mineral soil or thin duff. They also kill ground vegetation and canopy trees, reducing the competition for light (energy for photosynthesis) and soil resources (moisture and nutrients).

These conditions last only a few years because seedlings and ground vegetation begin to grow within weeks of a fire. Their rapid growth means that the patches of exposed mineral soil or thin duff created by fire become filled with plants. As you will see at the next few stops, this rapid re-growth explains why tree species in this region regenerate within the first few years after fire.

***References*:**

Charron, I. and Greene, D.F. 2002. Post-wildfire seedbeds and tree establishment in the southern mixedwood boreal forest. Canadian Journal of Forest Research 32: 1607-1615.

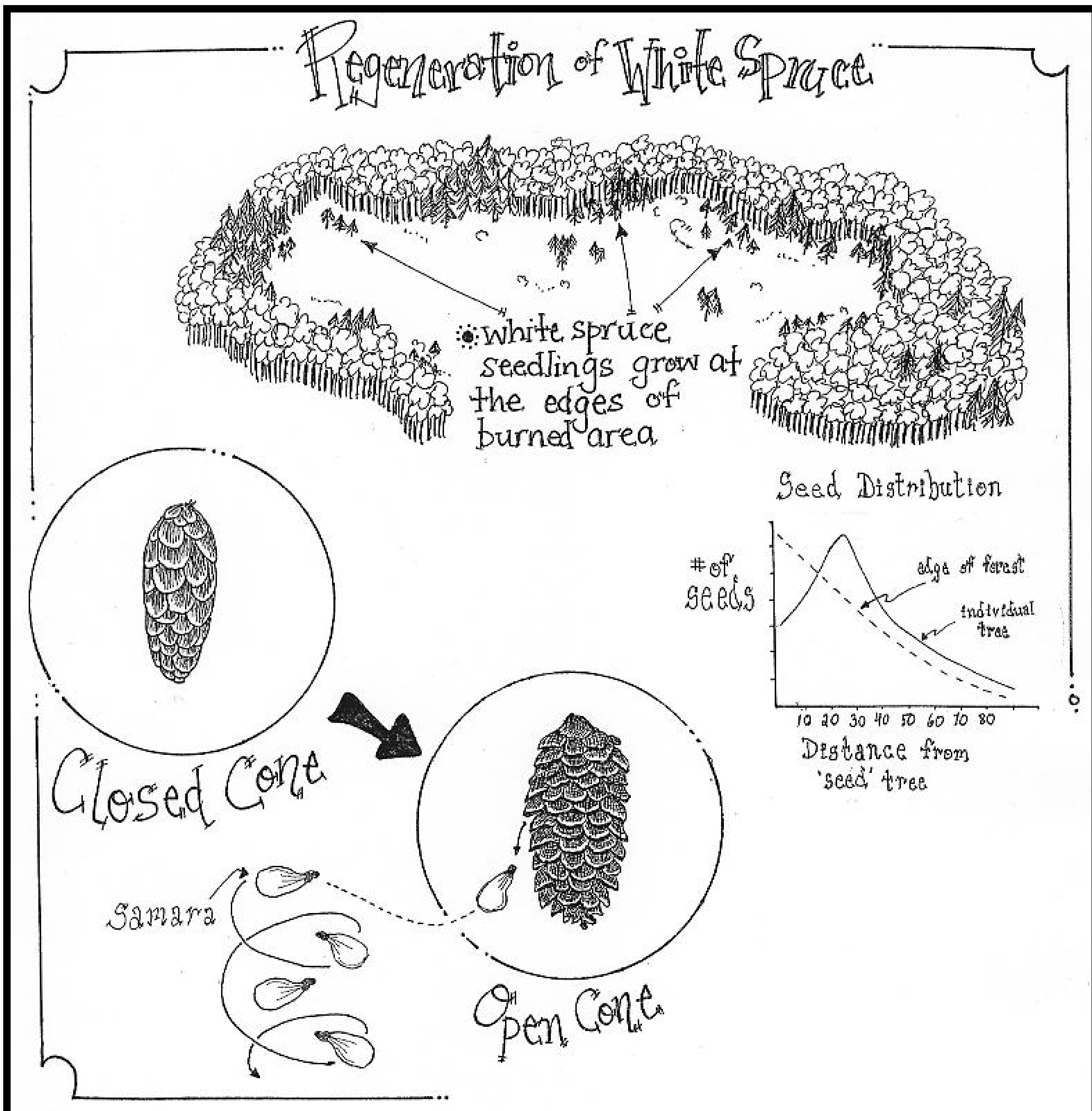
Miyanishi, K. and Johnson, E.A. 2002. Process and patterns of duff consumption in the mixedwood boreal forest. Canadian Journal of Forest Research 32: 1285-1295.

Dickinson, M.B., and E.A. Johnson. 2001. Fire Effects on Trees. In: Forest Fires: Behavior and Ecological Effects. Eds. E.A. Johnson and K. Miyanishi. Academic Press, San Diego California. pp. 477-526.

12

Post-fire Regeneration: White Spruce

- White spruce can disperse their seeds by wind because each seed has a wing called a ***samara***.
- Seeds are dispersed to the burned area from trees that have survived around the edge of the burn, or from unburned patches within the burn.
- Most regeneration of white spruce is not delayed, as is often believed, but occurs within five years after fire.



Research Connection

Look at the white spruce forest on your right. One of the ways tree species can return to a burned area is to disperse their seeds by wind. The cones of white spruce open once they mature and the seeds can be dispersed by wind. Each seed has a wing called a samara, which rotates the seed like a single helicopter blade as it drops to the ground, helping it float on the wind.

Unlike lodgepole pine, white spruce's cones and inner seeds are killed by fire. Thus, in order for white spruce to regenerate after a fire their seeds must be dispersed from trees that have survived either around the edge of the burned area, or in unburned patches within the larger burn. The majority of seeds from live trees travel only 50-100 metres and therefore it is not common to find white spruce seedlings in the centre of large burns.

It is often believed that white spruce regenerates several years after lodgepole pine and trembling aspen, and that white spruce will replace lodgepole pine and trembling aspen in the canopy (a theory called forest succession). In fact, most regeneration of white spruce also occurs within the first five years after fire. After that time the patches of exposed mineral soil or thin duff become filled with plants creating conditions are no longer suitable for seed germination.

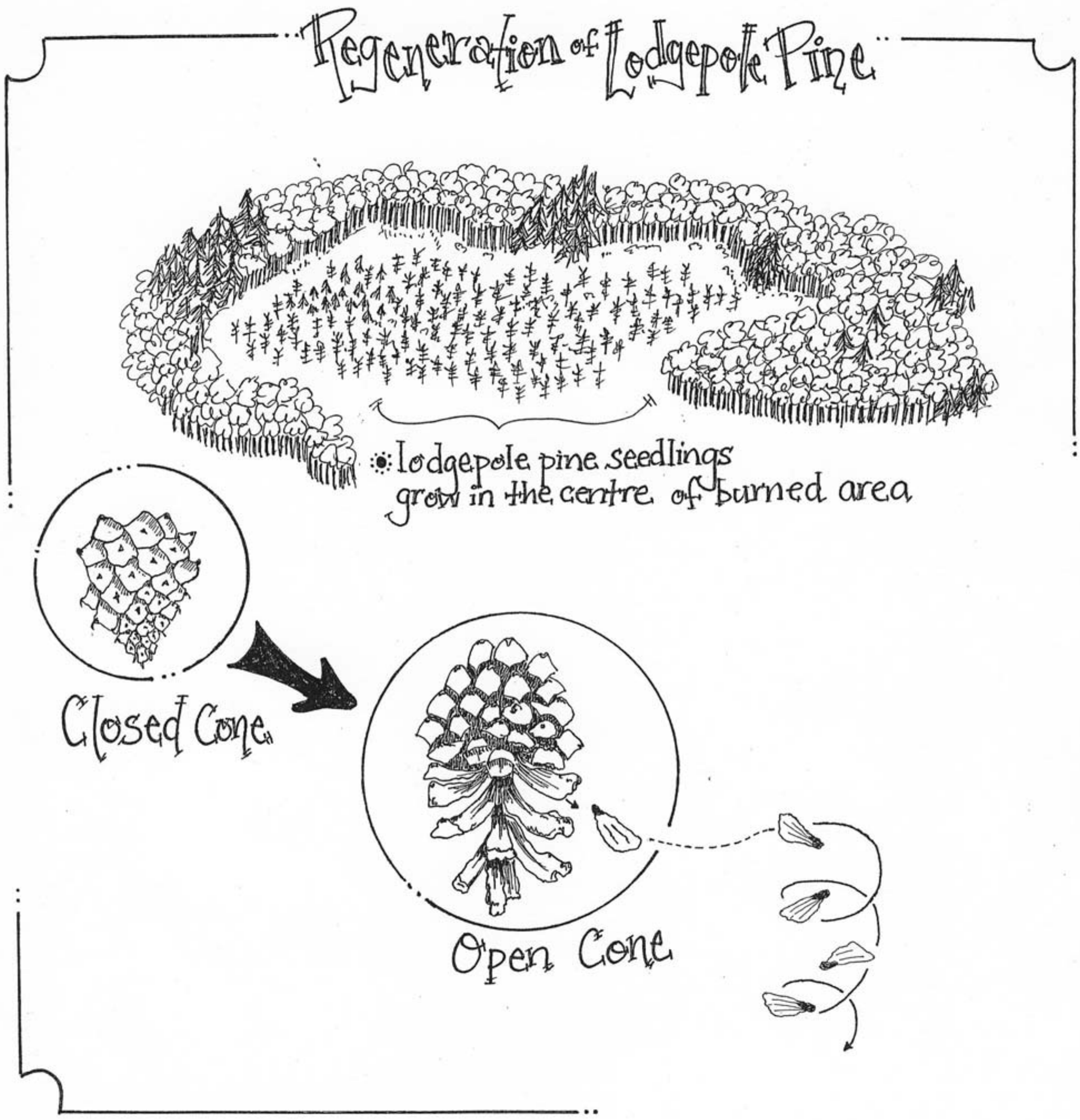
References:

Greene, D.F., and Johnson, E.A. 1996. Wind dispersal of seeds from a forest into a clearing. Ecology 77: 595-609.

13

Post-fire Regeneration: Lodgepole Pine

- The serotinous cones of lodgepole pine open only after heat has softened the resinous bonds of cone scales.
- Cones and seeds are not consumed by wildfire because heating by fire is brief. The cones have insulating properties that resist heating.
- The serotinous cones of lodgepole pine allow this tree to regenerate within five years after a fire.



Research Connection

The forest to your left is dominated by lodgepole pine. As you learned earlier, lodgepole pine produce seeds in serotinous cones. These cones remain closed after the seeds have matured because resin seals their scales together. The cone scales open when the resin is softened by a rapid pulse of intense heat from a wildfire (or if exposed to warm summer temperatures for long periods). Once the resin bond has been broken, scales will open slowly over several days, allowing the wind to dislodge and distribute the inner seeds.

The cones and seeds of lodgepole pine are not usually consumed by wildfire because cones are subjected to high heat from rapidly moving wildfires for only a few seconds or minutes. Also, a cone's internal temperature does not rise instantaneously when heated because its insulating properties resist heating such that heat conducts slowly through the cone's outer surface.

Most regeneration of lodgepole pine occurs within the first five years after a fire. The patches of exposed mineral soil and thin duff are rapidly filled with plants creating conditions unsuitable for seed germination.

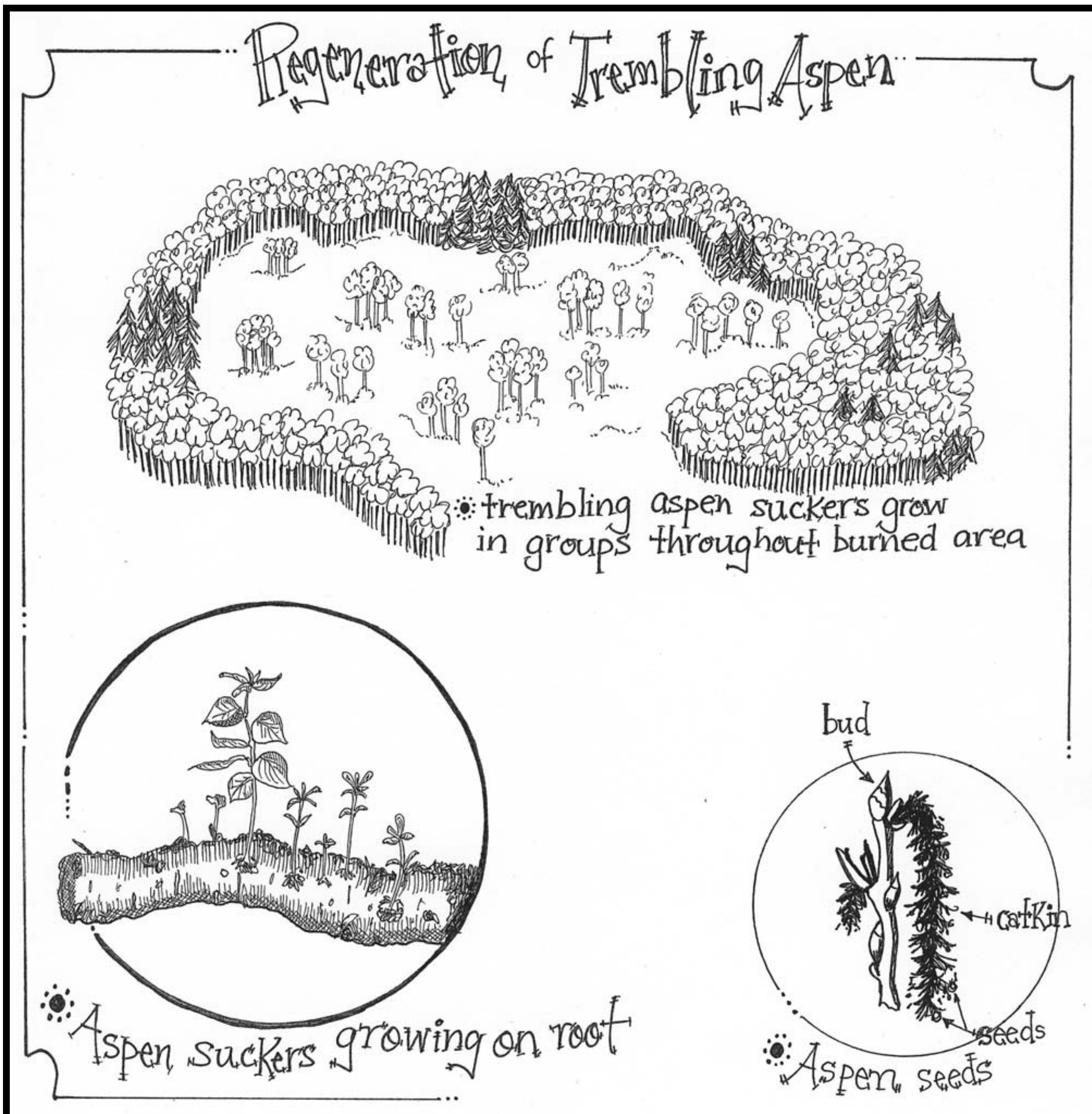
***References*:**

Johnson, E.A., and Gutsell, S.L. 1993. Heat budget and fire behaviour associated with the opening of serotinous cones in two Pinus species. Journal of Vegetation Science 4: 745-750.

14

Post-fire Regeneration: Trembling Aspen

- Trembling aspen may regenerate by seeds, but more often regenerates by sprouting from a network of underground stems.
- Like lodgepole pine and white spruce, aspen regenerate within five years after a fire.



Research Connection

Similar to white spruce, trembling aspen may return to a burned area by dispersing their seeds from live trees around the edge of a burn, or from unburned patches within the burn. However, trembling aspen can also regenerate after a fire by sprouting from a network of underground stems.

If a wildfire kills most of the trembling aspen trees in an area, then large numbers of new individuals may sprout from a network of underground stems. These underground stems allow aspen to regenerate very quickly, often within days after the fire. It also explains why trembling aspen is a very successful species in this fire-dominated ecosystem.

References:

Barnes, B.V. 1966. The clonal growth habit of American aspens. Ecology 47: 439-447.

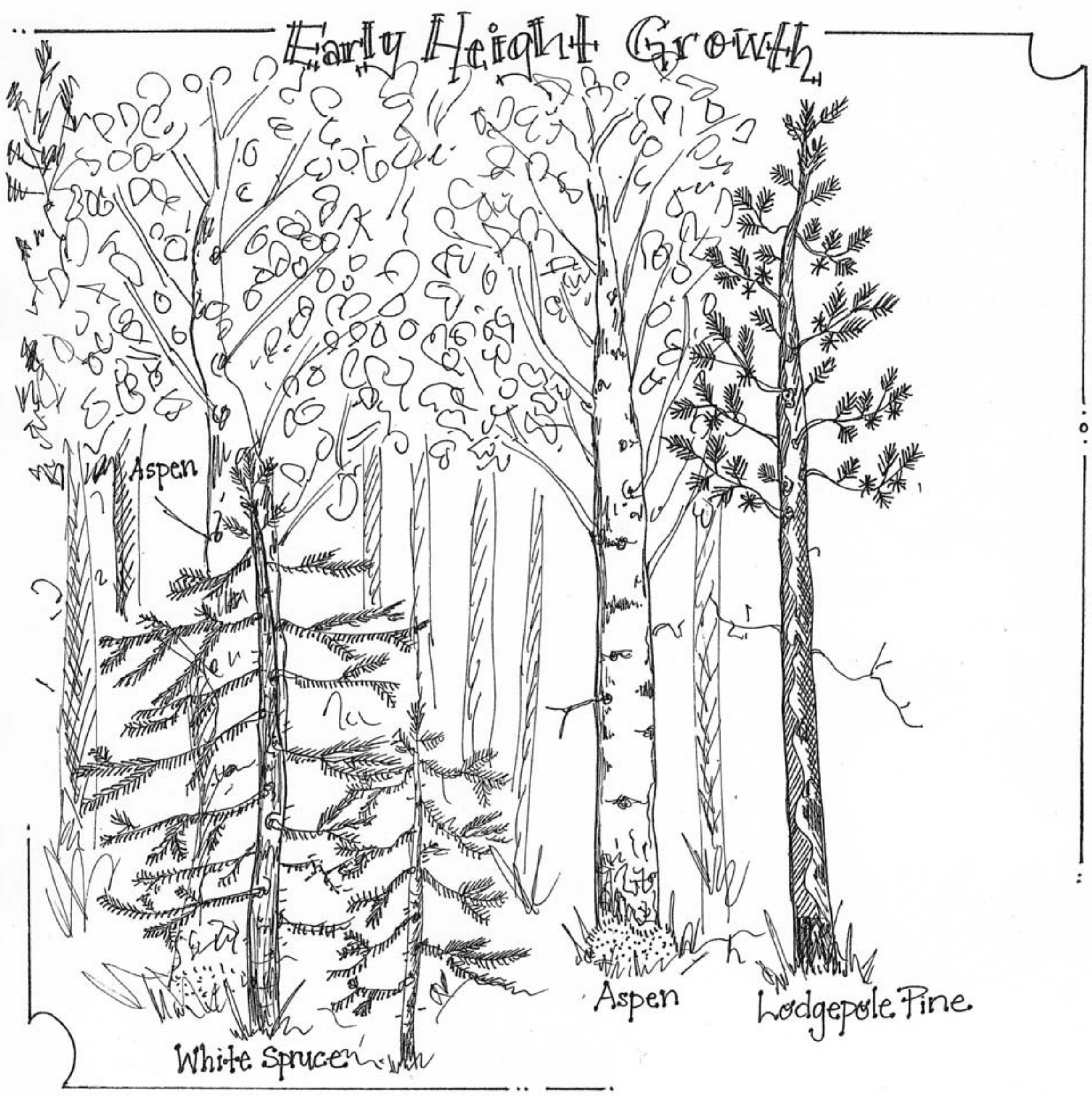
Greene, D.F., Zasada, J.H., Sirois, L., Morin, H., Kneeshaw, D., Charron, I., Simard, M-J. 1999. A review of the recruitment dynamics of boreal forest trees. Canadian Journal of Forest Research 29: 824-839.

Tew, R.K., DeByle, N.V., and Schultz, J.D. 1969. Intraclonal root connections among quaking aspen trees. Ecology 50: 920-922.

15

Post-fire Regeneration: Succession

- **Tree species vary in height not because they differ in age, but because they differ in their early height growth rates (for the first one metre).**
- **Contrary to popular belief, there is no succession of tree species over time in this region.**



Research Connection

Lodgepole pine, white spruce, and trembling aspen are all present at this site. Notice that the three species are different in height, despite the fact that most are about the same age. What accounts for their height differences? Ecologists used to believe that it was because their ages differ. Trembling aspen and lodgepole pine were believed to be older than white spruce. This was believed to result in a succession of species over time, with aspen and pine growing up to form the canopy, eventually dying and being replaced by white spruce.

However, recent research has shown that all species regenerate within five years after a fire. The species differences in height are simply due to differences in early height growth (for the first one metre). Trembling aspen grows most rapidly, followed by lodgepole pine. White spruce has the slowest early height growth rate.

Species differences in early growth rates means that for much of their lifetime trembling aspen and lodgepole pine will be taller than white spruce. If given enough time before the next large wildfire however, white spruce may be able to catch up.

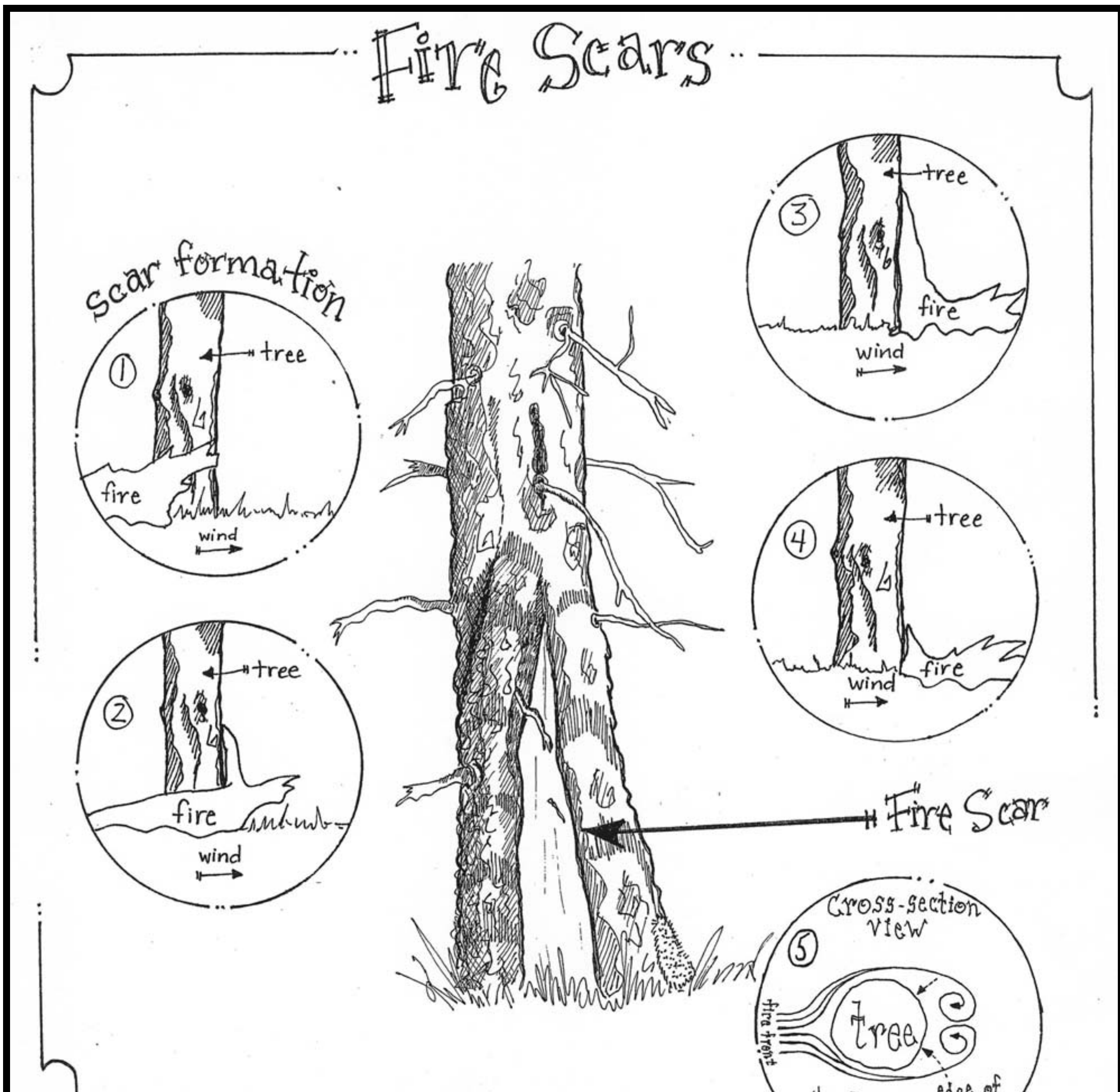
References:

Gutsell, S.L. and Johnson, E.A. 2002. Accurately aging trees and examining their height-growth rates: implications for interpreting forest dynamics. Journal of Ecology 90: 153-166.

16

Evidence of Past Wildfires: Fire Scars

- **A fire scar is one sign that wildfire has occurred in an area; it occurs when a tree's cambium is killed.**
- **Fire scars can be used to determine the year of a fire and an area's fire frequency**



Research Connection

One sign that fire has occurred in an area is a *fire scar*. A fire scar is a triangular-shaped area of exposed wood that extends to the base of a tree. A fire scar occurs when the tissue that allows a tree's trunk and branches to grow (called cambium), located between the outer bark and inner wood, is killed by fire. This occurs when the cambium is heated by a fire burning along the ground.

As the flames of a fire spread along the ground they become trapped in wind eddies (see diagram) that form on the leeward side of a tree. These eddies draw a flame upward and hold it in place for a long period, conducting heat through the bark and killing the cambium.

Fire scars can be used to determine the years when wildfires occurred. By counting a tree's annual growth rings back in time, from the outermost ring (produced most recently) to the ring where the cambium was killed, forest ecologists can determine the year a fire occurred. Using fire scars and other evidence a map of the time since the last fire can be made. This map can then be used to determine the fire frequency of an area for the last 300 years or so.

References:

Gutsell, S.L. and Johnson, E.A. 1996. How fire scars are formed: coupling a disturbance process to its ecological effect. Canadian Journal of Forest Research 26: 166-174.

Johnson, E.A., and Larsen, C.P.S. 1991. Climatically induced change in fire frequency in the southern Canadian Rockies. Ecology 72: 194-201.

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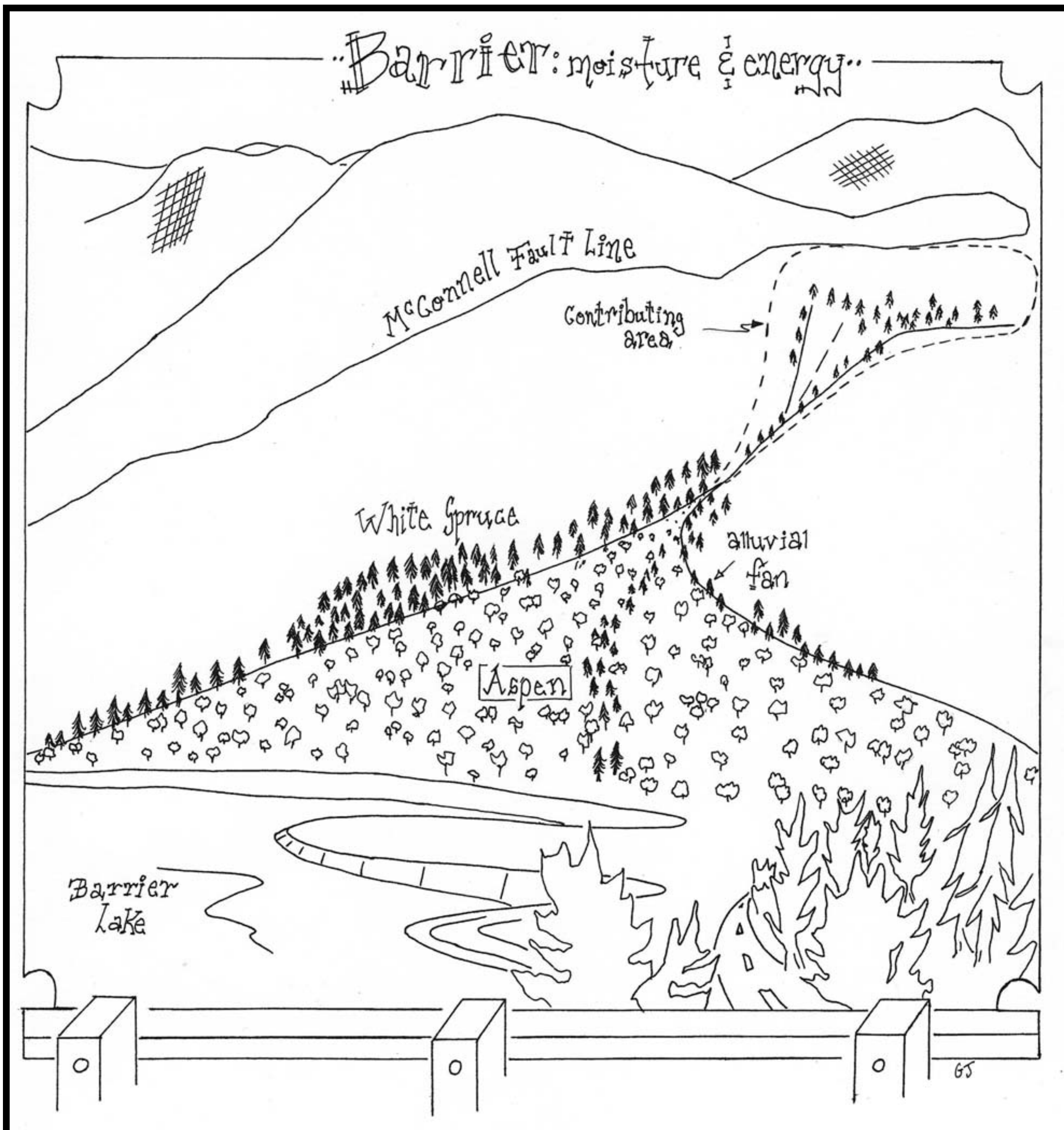
Patterns in the Forest: Tree Species Composition

- **Lodgepole pine, white spruce, and trembling aspen are dominant on different parts of the mountain slope, reflecting site differences in available moisture and energy (two important plant resources).**



Research Connection

Look out across Barrier Lake and observe the pattern of tree species composition; lodgepole pine, white spruce, and trembling aspen are abundant in different locations. This is due to site differences in available moisture and energy, the two resources most important to plant growth and survival.

The moisture available to plants is determined by precipitation, slope steepness, contributing area, and soil type. Contributing area is the area upslope within which drainage occurs (see diagram). Precipitation determines the amount of moisture added to the forest; while slope steepness and contributing area determine how much water will flow to a particular location. Soil type determines how well water is absorbed and retained; clay and silt retain more water than sand. Thus, for any slope the moisture available to plants is usually greater at the bottom.

The energy available to plants for photosynthesis is determined by sunlight and temperature. At higher elevations sunlight increases but temperature decreases. The energy available to plants for photosynthesis is lower at the top because lower temperatures outweigh the effect of increased sunlight.

Lodgepole pine and white spruce are dominant mainly at mid elevations on steep slopes that are energy-poor (high sunlight but low temperatures) with relatively dry sandy soils. Trembling aspen is dominant mainly at lower elevations on gentler slopes that are energy-rich (low sunlight but high temperatures) with relatively wet, clay and silt soils.

***References*:**

Waring, R.H. and Running S.W. 1998. Forest Ecosystems. Academic Press, USA. 370pp.

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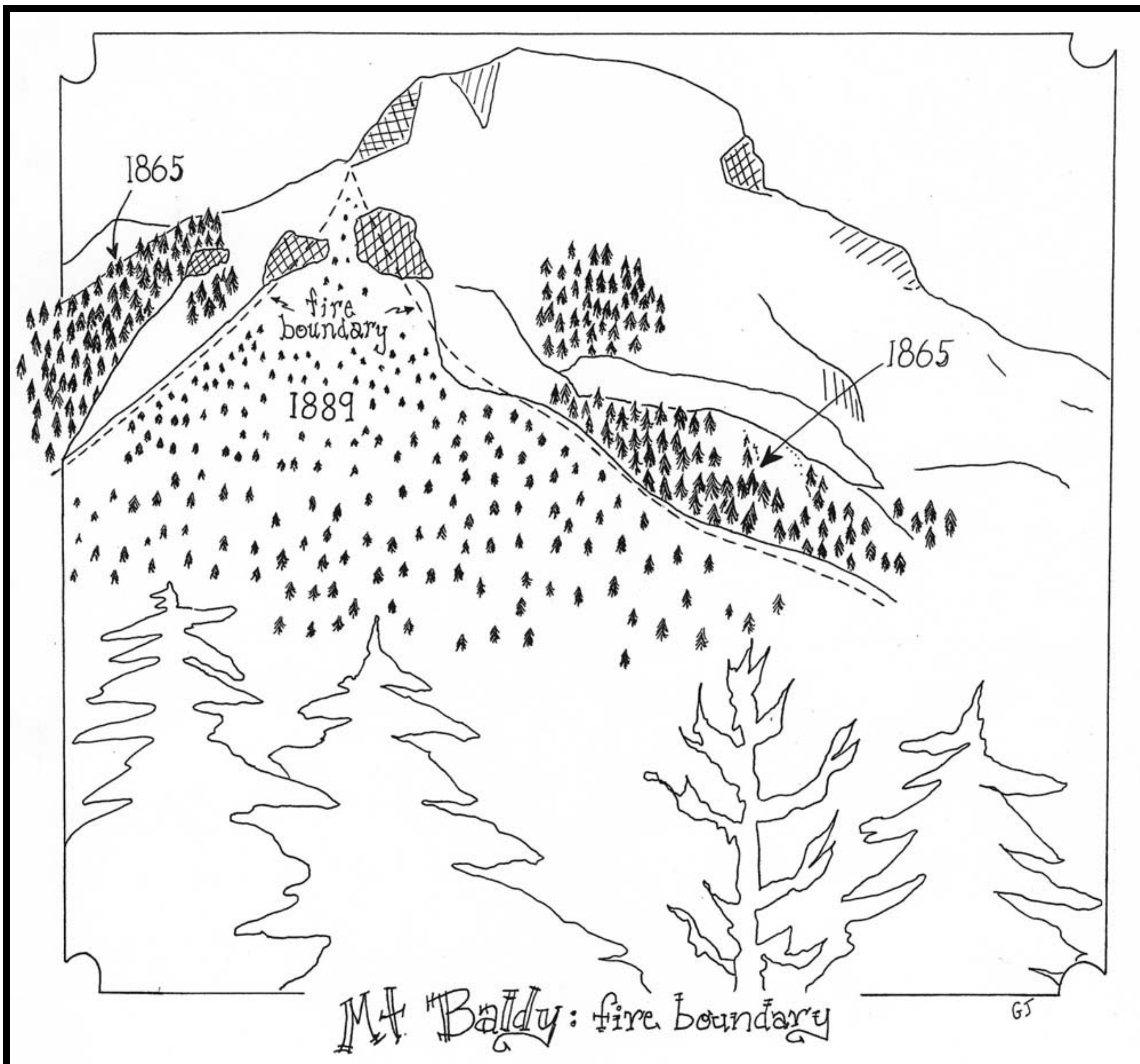
Patterns in the Forest: Tree Age

- To the left of Mount Baldy is a distinct fire boundary that separates an area burned by fire in 1889 (below the boundary) from an area that burned in 1865 (above the boundary).
- The fires that create these burned areas kill nearly all of the canopy trees and ground vegetation in their path and occur after long periods of hot, dry weather.
- These fires burn large areas, have high rates of spread and high heat output, and are very difficult, if not impossible, to control.



Research Connection

Look toward Mount Baldy and observe another forest pattern. There is a distinct *fire boundary* separating a younger forest (below the fire boundary) from an older one (above the fire boundary). Nearly all the forest you see below the fire boundary and across to Barrier Lake regenerated after a fire in 1889. Above the fire boundary is an area of forest that regenerated after a fire in 1865.

The Kananaskis Valley is a mosaic of such large patches of forest, each patch regenerating after a different wildfire. The wildfires that create this pattern kill nearly all of the canopy trees and ground vegetation in their path. They occur after long periods (≥10 days) of hot, dry weather. They burn large areas, have high rates of spread, high heat output, and are very difficult, if not impossible, to control. The last large fire in the valley, the Galatea Creek fire, occurred in August 1936 and burned more than 8400 hectares.

References:

Johnson, E.A., and Miyanishi, K. 1991. Fire and population dynamics of lodgepole pine and Engelmann spruce forests in the Canadian Rockies. In: The Ecology of Pine and Spruce Forests. Eds. N. Nakagoshi and F.B. Golley. SPB Academic Press. pp. 77-91.

Johnson, E.A. and Miyanishi, K. and Weir, J.M.H. 1998. Wildfires in the western Canadian boreal forest: Landscape patterns and ecosystem management. Journal of Vegetation Science 9: 603-610.

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