Forest Health Indicator: Tree and Crown Condition

Name(s):_____

_____

Location:_____

Date:_____

Damage to trees by disease, air pollution, weather, or human activities can affect the health of forests and can also be an indication of overall forest health.

Materials

Paper, pencils, chalk

Method

Count all the trees in the plot, marking the trees with colored chalk to help you keep track. Note trees that have one or more signs of disease or damage (see below). To count it as diseased or damaged, 10 percent or more of the tree should be affected. Calculate the percentage of all trees in the plot that have such signs.

Signs of Disease or Damage	
Sign	**What it may indicate**
Tree has ragged leaves with holes	Insects feeding on the leaves
Black or brown leaves	Stem or leaf disease
Spots or bumps on leaves	Insects and mites
Twisted or malformed leaves	Insects and disease, herbicides
Leaves changing color before fall	Trunk or root damage, drought, pollution
Branch decay	Unhealed wounds
Peeling or broken bark, holes in the bark	Trunk wound, canker disease, or damage caused by humans or animals
Dying branches on one side of crown	Root decay, root injury or internal stem disease, insect attack
Canker (a dead section of a trunk or branch)	Fungal infections
Splits	Broken branches
Hollows	Water entering through old wounds and supporting wood decay by fungi
Fungi or mushrooms growing on tree	Internal decomposition of wood by fungi
Green or brown spots on needles	Air pollution

Results

Total number of trees with signs of disease or damage in plot: _____ (Value A)

Total number of trees in plot: _____ (Value B)

Percentage of trees damaged = Value A ÷ Value B x 100 = _____ percent

Rating

Tree and Crown Condition		
Rating	**Description**	**Points**
Good	Less than 25 percent of trees have damage	3
Fair	25–50 percent of trees have damage	2
Poor	Greater than 50 percent of trees have damage	1
Overall *Tree and Crown Condition* rating for sample plot:		

Forest Health Indicator: Forest Diversity

Name(s):_____
_____
Location:_____
Date:_____

A healthy forest includes a variety of different plants and animals. One way to assess this diversity is to determine whether there is a mix of plant species of different sizes and ages, thus creating forest "layers" that provide habitat for many species.

Materials

Pencil, paper, tape measure, chalk, tree identification guide (optional)

Method

Look at the leaves, bark, seed pods, or flowers of the trees in your forest plot to determine whether they are the same or different species. Use the *Tree Species Diversity* chart below to catalog this information. Tree identification guides are helpful with this step, but not necessary. If a tree identification guide is not available, use your observation skills to describe the differences in tree types and include this information in the *Tree Species Diversity* chart below.

Measure (or estimate) the diameter at breast height (DBH) for all trees in the sample plot. Count (or estimate) the number of trees of different size classes using the corresponding DBH size classifications found in the *Size Diversity* chart below and record your findings. To help you, consider using chalk to mark the trees you have already counted.

Assess the presence or absence of different forest layers, using the descriptions found in the *Forest Layer Diversity* chart and record your findings.

Results

Tree Species Diversity		
	Name or Description	**Number found in sample plot**
Species 1		
Species 2		
Species 3		
Species 4		
Species 5		

Note: Please continue listing to account for all species present in sample plot.

Size Diversity		
Tree Size	**DBH**	**Number found in sample plot**
Saplings or Poles	4–9 inches (10–24 cm)	
Small	10–14 inches (25–37 cm)	
Medium	15–19 inches (38–49 cm)	
Large	20–29 inches (50–75 cm)	
Giant	30 inches or greater (> 75 cm)	

Forest Health Indicator: Forest Diversity (cont.)

Forest Layer Diversity		
Tree Layer	**Description**	**Present in sample plot? (Yes/ No)**
Overstory	Trees whose canopies are fully exposed to the sun	
Understory	Trees growing in the shade of other trees	
Tall shrub	Shrubs (woody plants with several stems arising from the base) greater than 6 feet (1.8 meters) in height	
Short shrub	shrubs less than 6 feet (1.8 meters) in height	
Forb	herbaceous (non-woody) plants such as ferns, wildflowers, and grasses	
Leaf litter	Dead and decaying leaves and other matter on the forest floor	

Rating

Tree Species Diversity		
Rating	**Description**	**Points**
Good	Three or more tree species present	3
Fair	Two tree species present	2
Poor	One tree species present	1
	***Tree Species Diversity* rating for sample plot:**	(Value A)

Size Diversity		
Rating	**Description**	**Points**
Good	Three or more size classes present	3
Fair	Two or size classes present	2
Poor	One size class present	1
	***Size Diversity* rating for sample plot:**	(Value B)

Forest Layer Diversity		
Rating	**Description**	**Points**
Good	Five or six layers present	3
Fair	Three or four layers present	2
Poor	One or two layers present	1
	***Forest Layer Diversity* rating for sample plot:**	(Value C)

Overall Rating

Determine the overall rating by adding up the points shown for the tree species, size, and forest layer diversity ratings; then dividing the total by 3. Round the total to the nearest whole number.

(Value A + Value B + Value C) ÷ 3 = _____ (Average point value)

Overall rating for Forest Diversity:
Good: Average point value of 3 *Fair:* Average point value of 2 *Poor:* Average point value of 1

Overall *Forest Diversity* rating for sample plot: _____

Sources

Greenleaf Forestry and Wood Products Inc. 2010. "Forest Health Checklist." http://www.greenleafforestry.com/greenleafservices_006.htm.

Portland State University. 2010. "Protocol: Measuring Tree Diameter, Class Size, and Average Species Diameter." *Ecoplexity.* http://ecoplexity.org/node/236?page=0,4.

Forest Health Indicator: Lichen Abundance

Name(s):_____
_____
Location:_____
Date:_____

Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Because lichens are very sensitive to air pollution—particularly to sulfur dioxide, fluoride, and ammonia—their presence or absence is an indicator of forest health. The acidity of a tree's bark can also affect lichen abundance.

A lichen is actually two different organisms—either a fungus and an alga, or a fungus and a cyanobacterium—living in a symbiotic relationship. The fungus provides protection and moisture, while the alga or cyanobacterium provides food through photosynthesis.

Trees help support many other living organisms, including these lichens. Far from harming the tree, lichens indicate pollution-free air. Photo by USDA Forest Service - Northeastern Area Archive, USDA Forest Service.

Materials

String, tape measure, compass, chalk, 100-circle grid transparency

Method

Select 10 trees on your study plot to sample. For each tree, measure the diameter at breast height (DBH), and tie a string around the tree trunk at that height. Use a compass to determine north, south, east, and west; then mark the directions with chalk on the tree at the string line.

At each of the 4 directions, place the 100-Circle Grid Transparency against the tree, and count the number of circles in which lichens are showing. That number represents the percentage of lichen coverage. For each tree, find the average lichen coverage by totaling the lichens found within the circles and then dividing the total by 4. Find the total average lichen coverage of the plot.

Results

For each tree and direction, record the number of circles that show lichens. This number represents the percentage of lichen coverage.

Forest Health Indicator: Lichen Abundance (cont.)

Lichen Abundance						
	North	**East**	**South**	**West**	**Total**	**Tree Average (%)**
Tree 1:						
Tree 2:						
Tree 3:						
Tree 4:						
Tree 5:						
Tree 6:						
Tree 7:						
Tree 8:						
Tree 9:						
Tree 10:						
Totals:						
Average:						

Add up the tree averages, which will be recorded in the final column in the chart above. Divide this total by the number of trees sampled to get the average lichen coverage for the entire sample plot.

Average Lichen Coverage for sample plot: _____ percent

Rating

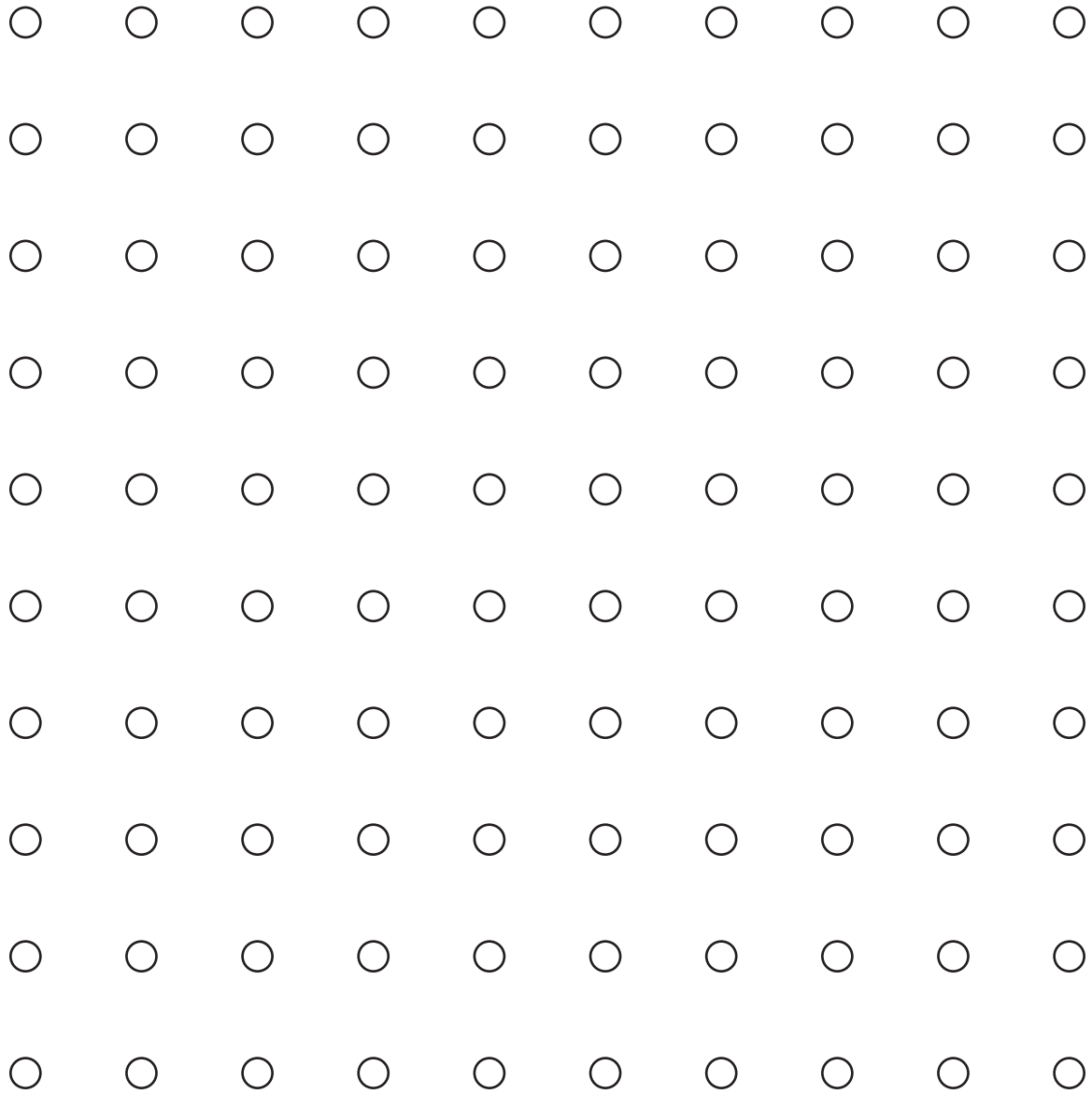
Lichen Abundance		
Rating	**Description**	**Points**
Good	Greater than 5 percent lichen coverage	3
Fair	3–5 percent lichen coverage	2
Poor	0–2 percent lichen coverage	1
	Overall *Lichen Abundance* rating for sample plot:	

Sources

Pathfinder Science. 2006. "Sampling Procedure for Lichen Coverage." http://www.pathfinderscience.net/so2/cproto1.cfm.

Smith, Gregory L., and Thomas R. Baker. 2003. "Lichens as Bioindicators." In *The Middle School Science Classroom*, NSTA ScienceScope, 16–19. http://tbaker.com/tbaker/academics/papers/published/sciscope_lichens/released_byNSTA/Lichens%20as%20Bioindicators.pdf.

100-Circle Grid Transparency



Forest Health Indicator: Soil Quality

Name(s):_____

_____

Location:_____

Date:_____

The quality of the soil in a forest is an important indicator of forest health. How well the soil functions directly influences the health of the trees and other forest organisms. An evaluation of soil quality usually involves measuring the soil's physical, chemical, and biological makeup at different depths.

Materials

Spade or trowel, 3 paper cups or plastic bags, distilled water, eyedropper, 3 Petri dishes or plastic containers, pH paper, white paper

Method

Choose a soil sample site that represents the overall forest plot, and measure 1 square foot (0.09 square meters) of ground, marking the corners with sticks or rocks. Within the plot, first remove the leaf litter layer with a spade or trowel. Next, collect soil samples from depths of approximately 3 inches (7.5 cm), 6 inches (15 cm), and 1 foot (30 cm). Use paper cups or plastic bags to store the samples.

Conduct the following assessments for each sample, recording your results in the "Soil Quality Results and Ratings" chart below.

Results

Soil Type

Most soils are a mixture of sand, silt, and clay. The specific content of a given soil influences how well it holds nutrients and water. To find out your soil type, take a small amount of soil (about the size of a marble), and moisten it with a few drops of water. Squeeze it between your thumb and fingers.

Soil Types

Soil Type	Squeezed Moist Soil	Rating
Sand	Feels gritty and cannot hold ball shape	**Poor**—Has few nutrients, holds little water, and is prone to drought
Sandy Loam	Can be molded into a ball, but ball breaks up easily	**Good**—Has good balance of nutrients and moisture retention
Silt	Can be molded into a ball that is easily deformed; does not feel gritty and has silkiness like flour	**Fair**—Has more nutrients and holds more water than sand, but washes away (erodes) easily
Loam	Can be molded into a ball that can be handled quite freely without breaking	**Good**—Has good balance of nutrients and moisture retention
Clay Loam	Can be formed into a long thin rod or "ribbon" that will break readily, barely sustaining its own weight	**Good**—Has good balance of nutrients and moisture retention
Clay	Sticky and can easily be formed into long thin rod or "ribbon"	**Fair**—Holds water very well, but does not allow movement of air or water, so doesn't drain well

Record your results in the "Soil Quality Results and Ratings" chart.

Forest Health Indicator: Soil Quality (cont.)

Soil pH

Soil pH is a measure of how acidic or alkaline the soil is, and it is an indicator of soil quality. Measure 1 tablespoon of soil from each depth, place this amount onto individual Petri dishes or plastic containers, and label the soil samples. Wet each soil sample with 5 drops of distilled water, and allow it to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. Determine the approximate pH of your soil.

Soil pH		
Rating	**Description**	**Points**
Good	pH of 5.51–7.2, which is optimum for many plant species	3
Fair	pH of 7.2–8.5 (moderately alkaline) or 4.0–5.5 (moderately acid)	2
Poor	pH of 4.0 and less (acid), or greater than 8.5 (alkaline)	1

Record your results in the "Soil Quality Results and Ratings" chart.

Soil Organisms

The presence of living organisms in the soil is an important indicator of productive soils. Soil organisms aid in nutrient cycling, soil creation, and decomposition of organic matter and dead organisms. Pour the remaining soil sample onto a white piece of paper, and look for the presence of the following organisms. For each type, circle whether it is present or not. (Soil fungi are microscopic cells that grow as long threads or strands in the soil.)

Soil Organisms						
Soil Depth	**Ants/ Termites**	**Centipedes/ Millipedes**	**Earthworms**	**Fungi**	**Other**	**Other**
3 in (7.5 cm)	Present None	Present None	Present None	Present None		
6 in (15 cm)	Present None	Present None	Present None	Present None		
12 in (30 cm)	Present None	Present None	Present None	Present None		

Soil Organisms		
Rating	**Description**	**Points**
Good	3 or more types of soil organisms present in soil sample	3
Fair	1 or 2 types of organisms present in soil sample	2
Poor	no soil organisms present in soil sample	1

Record your results in the "Soil Quality Results and Ratings" chart.

Forest Health Indicator: Soil Quality (cont.)

Rating

Circle the ratings that apply for each depth and each assessment. Determine the average score for each depth by adding up the points shown for each rating and dividing the total by 3. Find the average of the three "Average Soil Quality at Each Depth" ratings to get the overall soil quality.

Soil Quality Results and Ratings			
	3 in (7.5 cm) deep	**6 in (15 cm) deep**	**12 in (30 cm) deep**
Soil Type	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point
Soil pH	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point
Soil Organisms	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point	Type:_____ *Good:* 3 points *Fair:* 2 points *Poor:* 1 point
Total Points			
Average Soil Quality at Each Depth (rounded to nearest whole number)			
Overall Soil Quality (rounded to nearest whole number)			

Good: Average point value of 3
Fair: Average point value of 2
Poor: Average point value of 1

Overall *Soil Quality* rating for sample plot: _____

Source

USDA Forest Service. 2007. "Soil Vital Signs: Soil Quality Index (SQI) for Assessing Forest Soil Health." http://www.fs.fed.us/rm/pubs/rmrs_rp065.pdf.

Forest Health Indicator: Regeneration

Name(s):_____
_____
Location:_____
Date:_____

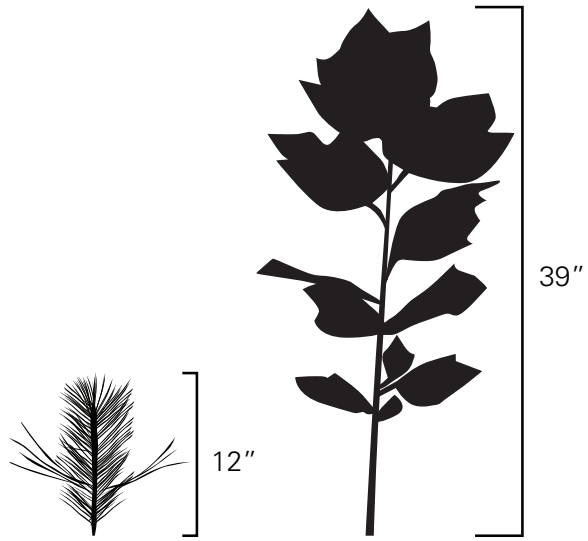
Forest regeneration is a good measure of the health of the forest habitat. When a forest can produce enough young trees to replace the canopy trees when they are cut, blown down, or die, such production is an indication that the forest is vibrant and sustainable. Regeneration is measured by the number of tree seedlings present.

Materials

Tape measure, string or other marker

Method

Using a tape measure and string or other marker, divide the study plot into 9 equal segments (8 equal segments, if it is a circle plot). Survey each segment and determine whether there is a healthy seedling that is at least 12 inches (30 cm) tall if it is a conifer, and at least 39 inches (1 meter) tall if it is a deciduous tree. To be considered healthy, the seedling must not have any apparent damage to its leaves or stems.



Coniferous seedling Deciduous seedling

Results

Number of forest plot segments with at least one healthy seedling: _____ (Value A)
Number of total forest plot segments: _____ (Value B)

Percentage of plots with at least one healthy seedling
Value A ÷ Value B x 100 = _____ percent

Rating

Plot Segments		
Rating	**Description**	**Points**
Good	More than 66 percent of plot segments have at least one healthy seedling.	3
Fair	33 to 66 percent of plot segments have at least one healthy seedling.	2
Poor	Less than 33 percent of plot segments have at least one healthy seedling.	1
Overall *Regeneration* rating for sample plot:		

Source

Forestry Branch, Province of Manitoba. 2010. "Silvaculture Surveys: Regeneration Surveys." http://www.gov.mb.ca/conservation/forestry/renewal/surveys.html.

Forest Health Indicator: Snags and Coarse Woody Debris

Name(s):_____
_____
Location:_____
Date:_____

In natural forest ecosystems, snags (standing dead trees) and coarse woody debris (dead logs and large branches on the ground) are important indicators of forest health. Their presence indicates a forest of diverse ages, and the snags and debris provide animal habitat, energy and nutrient cycling, and stable soils.

Note: In parks or near structures, forest managers may remove snags or coarse woody debris to prevent fire and other safety hazards. If your forest plot is in such an area, the presence of snags or debris will not be a relevant forest health indicator.

Materials

Tape measure

Method

Count the number of snags and the number of live trees in your forest plot, and calculate the percentage of standing trees that are snags. Then, count the number of dead logs and downed large branches in your plot that are more than 4 inches (10 cm) in diameter and more than 39 inches (1 m) in length, and calculate their abundance.

Results

Snags

Number of snags in plot: _____ (Value A)
Number of live trees in plot: _____ (Value B)

Total number of standing trees in plot:
Value A + Value B = _____ (Value C)

Percentage of snags:
Value A ÷ Value C x 100 = _____ percent (Value D)

Coarse Woody Debris

Number of logs and downed branches greater than 4 inches (10 cm) in diameter and 39 inches (1 m) in length: _____ (Value E)

Abundance of course woody debris:
(Value E ÷ Value B) x 100 = _____ percent (Value F)

(**Note:** For some forest plots, abundance may be more than 100 percent.)

Forest Health Indicator: Snags and Coarse Woody Debris (cont.)

Rating

Snags		
Rating	**Description**	**Points**
Good	More than 10 percent of standing trees are snags.	3
Fair	From 5 to 10 percent of standing trees are snags.	2
Poor	Fewer than 5 percent of standing trees are snags.	1
	***Snags* rating for sample plot**	points (Value G)

Coarse Woody Debris		
Rating	**Description**	**Points**
Good	More than 15 percent abundance of coarse woody debris.	3
Fair	From 5 to 15 percent abundance of coarse woody debris.	2
Poor	Fewer than 5 percent abundance of coarse woody debris.	1
	***Coarse Woody Debris* rating for sample plot**	points (Value H)

Overall Rating

Determine the overall rating by adding up the points shown for the snag and coarse woody debris ratings, and then divide the total by 2. Round to the nearest whole number.

(Value G + Value H) ÷ 2 = _____

Good: Average point value of 3
Fair: Average point value of 2
Poor: Average point value of 1

Overall *Snags and Coarse Woody Debris* rating for sample plot: _____

Source

National Park Service. 2009. "Forest Health: Course Woody Debris and Snags." Resource Brief, Northeast Temperate Network. http://science.nature.nps.gov/im/units/NETN/Education/Resource%20Briefs/NETN_RB_CWDSnags_FINAL.pdf

Forest Health Indicator: Wildlife

Name(s):_____

_____

Location:_____

Date:_____

The presence of a variety of wildlife is an indicator that a forest is vibrant and healthy. Actually seeing the animals may be difficult, but tracks, droppings, burrows, dens, nests, chewed leaves, and other evidence or "signs" reveal their existence. You are more likely to see or hear the animals if you are quiet, respectful, and patient.

Materials

Pencil, paper, binoculars or magnifying glass (optional)

Method

In your forest plot, look on the ground, under shrubs, and in trees for mammals, birds, reptiles, amphibians, spiders, or insects, or for signs of those animals. Record your observations.

Results

Animal Signs and Sightings		
Animal Class	**Signs**	**Sightings**
Mammals		
Birds		
Reptiles		
Amphibians		
Spiders		
Insects		
Other		

Rating

Wildlife		
Rating	**Description**	**Points**
Good	Signs or sightings of 4 or more different classes of animals	3
Fair	Signs or sightings of 2–3 different classes of animals	2
Poor	Signs or sightings of 0–1 different classes of animals	1
	Overall *Wildlife* rating for sample plot:	

Forest Health Summary

Name(s):_____

_____

Location:_____

Date:_____

Use this page to tally the Forest Health Indicator investigations that you have conducted for your forest plot, while noting any key observations. Use the indicators to make an assessment of the forest's overall health.

Forest Health Summary			
Forest Health Indicator	**Overall Point Value (3, 2, or 1)**	**Overall Rating (Good, Fair, or Poor)**	**Key Observations**
Tree and Crown Condition			
Forest Diversity			
Lichen Abundance			
Soil Condition			
Regeneration			
Snags and Coarse Woody Debris			
Wildlife			
Averages / Conclusions			

What is the Overall Health Assessment for your study plot?

_____

_____

Explain your reasoning.

_____

_____

_____

_____