Section 10. Lichen Communities

10.1 OVERVIEW

10.1.1 Scope and Application

The purpose of the lichen community indicator is to use lichen species and communities as biomonitors of change in air quality, climate change, and/or change in the structure of the forest community. Lichen communities are excellent indicators of air quality, particularly long-term averages of sulfur dioxide concentrations (Hawksworth and Rose 1976; Smith and other 1993; van Dobben 1993).

Lichen communities provide information relevant to several key assessment questions, including those concerning the contamination of natural resources, biodiversity, and sustainability of timber production (Figure 10-1). Lichens not only indicate the health of our forests, but there is a clearly established linkage to environmental stressors, as described below.
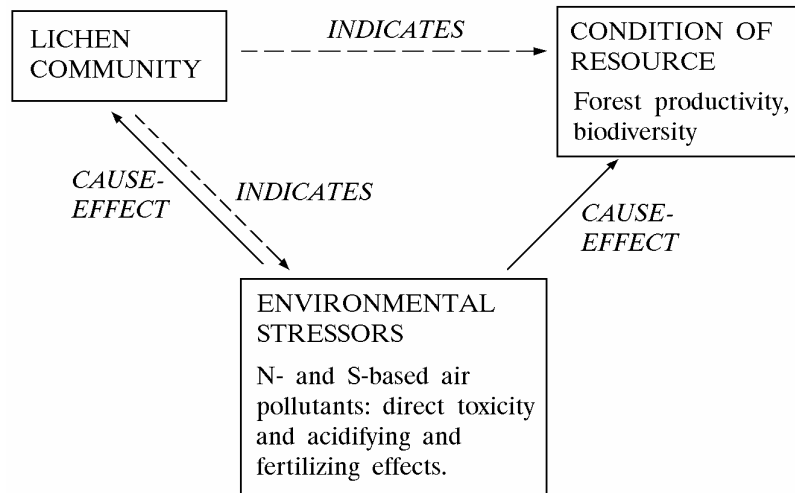
Figure 10-1. Conceptual model of the lichen community indicator.

10.1.2 Summary of Method

The objectives of this task are to determine the presence and ABUNDANCE (section 10.3.9) of macrolichen species on woody plants in each plot and to collect samples to be mailed to lichen specialists. Note that the crew member responsible for this task is not required to accurately assign species names to the lichens (that is done later by a specialist) but must be able to make distinctions among species.

The field method has two parts that are performed at the same time:

1. Collect a specimen of each macrolichen species on the plot for identification by a specialist. The population being sampled consists of all macrolichens occurring on live or standing dead woody plants, excluding the 19.7 inch (0.5 m) basal portions of trees, snags, saplings, and shrubs. Include in your sampling recently fallen branches on which the canopy lichens still look healthy (usually down for no more than a few months). Branches and logs left from recent harvests are

legal substrate. Older down woody debris and any sawed or human-treated wood surfaces are not legal substrates.

2. Estimate the ABUNDANCE (section 10.3.9) of each species. Possible species which you are not sure are different from those already collected should be collected as many times as needed with ABUNDANCE rated separately for each sample.

10.1.3 Equipment and Supplies

10.1.3.1 Consumable Supplies

- Specimen packets folded from 8.5" x 11" paper, averaging 30 per plot. Regions may differ in how packets are provided. It is convenient to type/print your name and State into a master template file, then print your customized template as a master to make copies. This file is available from your regional crew supervisor. Before you print the template, be sure the page margins in your word processing software are set so that the packet label prints on the bottom one-third of a 8.5 x 11- inch piece of paper. You can also type your name and State on a paper template (Figure 10-3) to use as a duplicating master. Take 30-50 #1 or #2 paper bags as backup "packets" on very wet days.
- Permanent ink pen for recording data on packets.
- Mailing forms (Figure 10-5).
- Large rubber bands to keep packets together. Medium size paper bags (#3 - #4) or similar size), one per plot as alternates, or a few for plots with many packets.

10.1.3.2 Equipment and Apparatus

- Backpack or similar bag to keep lichen packets and equipment together.
- Locking-blade or fixed-blade knife with sheath.
- 10X hand lens – Hastings triplet optics preferred to avoid headaches. String hand lens on a neck cord to avoid losing it.
- Hand pruners that are useful for collecting small branch segments.
- Wood chisel at least 0.75-inch wide that is useful for collecting samples from tough-barked hardwoods. Chisel should have a sheath.
- Timepiece.
- Convenient, optional equipment. 8-digit number stamp and date stamp plus ink pad for adding date and P3 HEXID to packets and Plot Data Card.

- Regional guides for lichen identification. Different guides will be needed for different areas:

  Northeast, Mid-Atlantic, and Southeast:
  - Hale, M.E. 1979. How to Know the Lichens. 2nd Ed. Wm. C. Brown, Dubuque, Iowa.
  - Flenniken, D. G. 1999. Macrolichens in West Virginia. 2727 Twp. Rd 421, Sugarcreek, OH: Carlisle Printing

  North Central
  - Hale, M.E. 1979. How to Know the Lichens. 2nd Ed. Wm. C. Brown, Dubuque, Iowa.

  Interior West
  - Bungartz, F.; Rosentreter, R.; Nash, III, T. H. 2002. Field guide to common epiphytic marolichens in Arizona. Arizona State University Lichen Herbarium. 91 p.
  - McCune, B.; Goward, T. 1995. Macrolichens of the Northern Rocky Mountains. Eureka, CA: Mad River Press, 208 pp.

- St. Clair, L. L. A Color Guidebook to Common Rocky Mountain Lichens. Available from M. L. Bean Life Science Museum, 290 MLBM, Brigham Young University, Provo, UT 84602.
- McCune, B.; Geiser, L. 1997. Macrolichens of the Pacific Northwest. Corvallis, OR: Oregon State University Press. 386 p.

  California
- Hale, M. E.; Cole, M. 1988. Lichens of California. Berkeley: University of California Press.
- McCune, B.; Geiser, L. 1997. Macrolichens of the Pacific Northwest. Corvallis, OR: Oregon State University Press. 386 p.

  Pacific Northwest:
- McCune, B.; Geiser, L. 1997. Macrolichens of the Pacific Northwest. Corvallis, OR: Oregon State University Press. 386 p.

10.1.4 Procedure

Note: This indicator is CORE OPTIONAL on all phase 2 plots.

1. The area to be sampled (henceforth the "lichen plot") is a circular area with a 120-foot radius centered on subplot 1, but excluding the four subplots (see Figure 10-2). The area of the lichen plot is 40830 ft^2 ≈ 3793 m^2 ≈ 0.379 ha ≈ 0.937 acres.
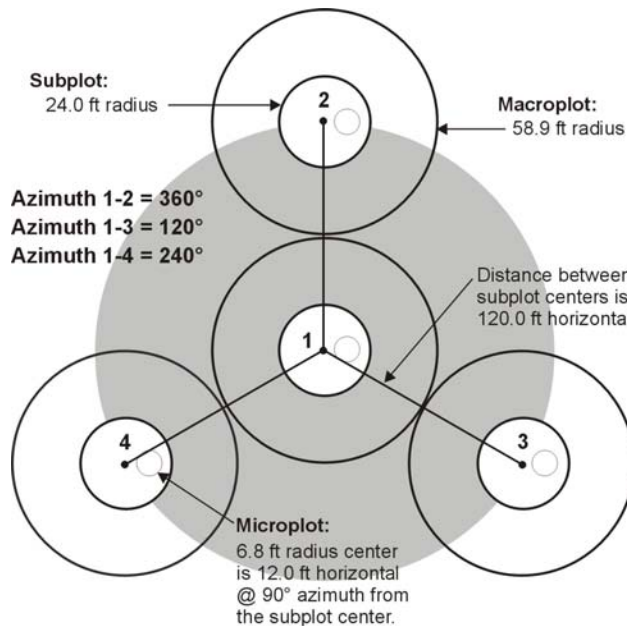
Figure 10-2. Lichen sampling area. The shaded area is the lichen plot.

2. Record TIME LICHEN SAMPLING BEGAN and TIME LICHEN SAMPLING ENDED. Sampling continues for a maximum of two hours or until 10 minutes elapse with no additional species recorded. At least 45 minutes in the Northeast, North Central, South, and West Coast including Alaska, and 30 minutes in the Intermountain West, must be spent searching the plot, even if very few lichens are present.

3. Take a reconnaissance walk through the lichen plot, locating lichen epiphytes on woody plants and collecting lichen samples and assigning ABUNDANCE scores . The following method is suggested. Begin at approximately 100 ft due north from plot center, estimating to the limiting boundary of 120 feet, and continue to the right in a sinuous manner until reaching the perimeter of subplot 3. The same procedure is followed between subplots 3 & 4 and 4 & 2. The idea behind this approach is that the crew can scan the whole area but intensely scrutinize selected areas to best represent the diversity on the plot (see item 4 for more details). If time allows, make additional circuits of the plot, searching for substrates or spots that were not visited on the first pass. Collect on the entire lichen plot regardless of forest vs. nonforest condition. Do not collect from any portion of the lichen plot that is denied access or inaccessible. If only part of the plot is sampled for one of these reasons, note on the PDR under SAMPLING ISSUES OR PROBLEMS (section 10.3.24).

4. Lichen species with the following growth forms will be collected: fruticose and foliose (i.e., macrolichens).

    * Inspect woody plants (trees, saplings, and shrubs > 19.7 inches tall (0.5 m tall)) within the lichen plot for lichen species. This includes dead trees.
    * Be careful to inspect the full range of substrates and microhabitats available:
        * shaded and exposed
        * both live and standing dead trees,
        * conifers and hardwoods
        * branches and twigs on trees
        * recently fallen (judged to be from above 19.6 inches (0.5 m) healthy lichens plus branches and twigs on which the canopy lichens still look healthy (usually down for no more than a few months). Branches and logs left from recent harvests are legal substrates.
        * shrubs
        * trees in particular topographic positions (for example, check in a draw or ravine on an otherwise uniform slope, so long as it occurs within the lichen plot).
        * Older down woody debris, decayed stumps, and any sawed or human-treated wood surfaces are not legal substrates.

5. Collect a large (ideally palm-sized) sample of each possible species and place it in a packet. Label the packet with the STATE, COUNTY, PLOT NUMBER, P3 HEXAGON NUMBER, and CURRENT DATE, packet number (sequentially as collected), and record relative ABUNDANCE code. Revise the ABUNDANCE rating as collection proceeds. Also record any comments on the outside of the packet. For more details about variables, see section 10.2, "DATA COLLECTION 1: SAMPLE PROCUREMENT". After completing the task, check each packet to be sure that each one has a STATE, COUNTY, PLOT NUMBER, P3 HEXAGON NUMBER, CURRENT DATE, and ABUNDANCE code.

6. The field crew may have uncertainties about the classification of an organism. The following rules for the field crew are designed to put the burden of the responsibility for classification on the specialist, not the field crew.

    * When in doubt, assume it is a lichen.
    * When the growth form is in doubt, assume it is a macrolichen.
    * When species distinctions are in doubt, assume that two different forms are different species.

    The purpose of these rules is to encourage the field crew to make as many distinctions in the field as possible. The specialist can later adjust the data by excluding specimens that are not macrolichens and by combining forms that were considered separate by the field crew but are actually the same species.

7. Be sure the electronic documentation and the Plot Data Card are complete and comparable where necessary.

8. Dry packets as needed, store them in a dry place, and mail them to the designated lichen specialist using package tracking.

10.1.5 Safety

Care should be used when removing lichens specimens with a knife or chisel. The knife must have a locking blade or fixed blade. Trees should not be climbed to procure specimens.

10.1.6 Assistance From Persons Not Certified For Lichens

A crew member not certified in lichens may assist by labeling lichen packets for the 'lichen' crew member as the latter collects. Crew members not certified in lichens should not collect specimens, nor should they help assign ABUNDANCE ratings for lichens.

10.2 DATA COLLECTION 1: SAMPLE PROCUREMENT

The set of lichen samples you collect, with the accompanying written information (See 10.3 DATA COLLECTION 2: PDR AND WRITTEN DATA) on the samples, are the primary data for the lichen indicator.

1. Optimally collect a sample of each macrolichen species that has at least 20 lobes or branches and has abundant morphological characters. For larger species this means collect a sample about 3-4 inches in diameter if possible. Macrolichens include all species that are three-dimensional (fruticose) or flat and lobed (foliose). Even minute fruticose and lobate forms should be included. Squamulose species and *Cladonia* squamules lacking fruit bodies or upright stalks should not be included.

2. Place each specimen in a separate packet and fill in the label (Figure 10-3) as follows:

    - Number packets sequentially as collected.
    - Record relative ABUNDANCE on the packet using the codes listed in section 10.3.9. (Revise this rating as collection proceeds.)

Code	Abundance
1	Rare (< 3 individuals in area)
2	Uncommon (4-10 individuals in area)
3	Common (> 10 individuals in area but less than half of the boles and branches have that species present)
4	Abundant (more than half of boles and branches have the subject species present) Note: this code is not frequently assigned, but is valid. Make sure that more than one out of every 2 boles, branches, and twigs host this species.

    - Often there will be more than one species on a given bark sample. If there is any chance of ambiguity about which species in the packet corresponds with the ABUNDANCE rating, write a descriptive clarifying phrase, such as "the white one" or "the sorediate one," on the packet in the REMARKS box.
    - If you are not using a packet template with the CREW MEMBER NAME and STATE printed on it, fill out the CREW MEMBER NAME in the "collector" field and STATE in the label title.
    - Fill in these additional fields on the packet label – P3 FHM HEXID, FIA PLOT NUMBER, COLLECTION NUMBER, ABUNDANCE NUMBER, REMARKS -- with an indelible marker, preferably a medium point rolling ball pen with permanent ink. Alternately, regular ballpoint pen

(dry packets), waterproof alcohol markers (dry or damp packets), and very soft (#2 or softer) pencils (very damp packets) can be used. If you want to try naming the lichen in the "Scientific Name" box, leave enough room for the ID specialist to also write a name. Leave the "ID Notes" box blank for the ID specialist to use.

- Make sure to check packets for missing ABUNDANCE ratings before you leave the plot.

FOREST INVENTORY AND ANALYSIS PROGRAM - P3
LICHENS OF _____ *(STATE)*

P3 FHM Hexid No: FIA Plot No:	Date:	Coll. No:
Scientific Name:	ID Notes:	**Abundance:**
Collector:	Remarks:	

Figure 10-3. Lichen packet label. This label is printed centered at the very bottom of an 8.5 in x 11 inch sheet of paper. The sheet is triple-folded with the label on the outside flap; then the sides are folded in to make a packet with a flap.

3. Avoid multi-species packets. Each species should be placed in a separate packet with its own ABUNDANCE rating. Multi-species packets typically result in missing ABUNDANCE ratings. Genera such as the tufted lichens *Usnea* and *Bryoria* are frequently found on the branch with several species clustered together. Separate these prior to packeting specimens if possible.

4. Label all of the packets from that day with STATE, COUNTY, P3 HEXAGON NUMBER, CURRENT DATE, PACKET NUMBER, and ABUNDANCE.

5. When also using the PDR, fill out only **bold** fields on the Plot Data Card, (Figure 10-4) Fill out this card also for a plot when **you have searched and found no lichens**.

6. Place all of the specimen packets from a given plot with the Plot Data Card. Either bundle with two crossed rubber bands, or place into a single or several paper bags **only if** there are too many samples for rubber bands. For paper bags, record P3 HEXAGON NUMBER, CREW MEMBER NAME, CURRENT DATE, and "Bag#___of___" (total # of bags for that plot). Fold the top of each paper bag closed and secure with a rubber band (no staples, please).

7. If specimens were damp or wet when collected, the individual packets should be spread out and dried as soon as possible. Never store or ship lichen specimens damp, and never in plastic bags. For more details, see 10.4 *SPECIMEN PRESERVATION, STORAGE, AND MAILING*.

8. Successful performance of the sample procurement procedure is the goal of all QA and the subject of all tests. For a successful procedure, a crew member finds at least 65% of the macrolichens found on the same plot by a lichen specialist, and correctly records all data for sample packets, the Lichen Data Card, and the mailing form. Correct selection and recording of data for the PDR are tested by correct recording of data on the Plot Data Card.

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┌──────────────────────────────────────────────────────────────────────────────────────┐
│ Lichen Communities Indicator          PLOT DATA CARD                              FIA   │
│ This will be part of the permanent record for this plot. PLEASE COMPLETE IT FULLY!      │
│ If using the PDR, complete BOLD fields only.  If not using the PDR, complete all fields.│
│ P3 FHM Hexid #: _____    FIA Plot # _____  State: _____   County: _____ │
│ Date: _____     Lichen Project_____    Crew Member's Name: _____  │
│ Crew Type _____  QA Status _____           LICHENS COLLECTED   Y    N              │
│ Time lichen sampling began:_____  Time lichen sampling ended:_____Elevation (ft): _│
│ % Cover (on lichen plot): Conifers _____  Hardwoods _____  Tall Shrubs _____ │
│ Dominant Tree/Shrub Species(w/% cover) _____│
│                                                                                          │
│ _____│
│ _____│
│                                                                                          │
│ Important substrate species not on subplots _____ │
│                                                                                          │
│ _____│
│ % gap _____   Recent( <5 yr)?   Y   N           w/ Tall Shrubs?    Y   N               │
│ Size class(es) of 3 largest trees (in DBH) <10 ____  10-20 ____  21-30 ____ 31-40 ____ >40 ____ │
│ Features important for high/low lichen diversity (if any) _____ │
│                                                                                          │
│ _____│
│ Sampling issues/problems (weather, etc) _____ │
│ Other comments _____ │
│ REMEMBER:                                                                                │
│  •  Record the abundance code on each packet!                                            │
│  •  Remember to look for the common species.                                             │
│  •  Try to put only one species in each packet.                                          │
└──────────────────────────────────────────────────────────────────────────────────────┘
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Figure 10-4. Plot data card for lichen communities. Complete this form and bundle it with the packets for each plot.

10.3 DATA COLLECTION 2: PDR AND WRITTEN DATA

10.3.1 OVERVIEW

Written data are entered for the Lichen Indicator in three locations: (1) the lichen sample Packet, (2) the lichen Plot Data Card, and (3) the lichen PDR screen. All locations for entry are listed for each variable below. If the PDR is working, fill out only **bold** fields on the Plot Data Card. If the PDR is not working, collect all variables by filling out all fields on the Plot Data Card.

Primary data for the Lichen Indicator consist of the set of lichen samples collected from the plots and the data recorded on the lichen packets; these are sent first to a lichen specialist for identification of samples and electronic data entry, then to the Lichen IA for confirmation, proofreading, and merging with other data for the state and region, then to regional and national IM for uploading to the FIA database. Written data on lichen packets link the sample to the proper plot and year during the sample identification process. Required fields on the Plot Data Card accompanying the samples help confirm sample location and provide habitat information about the plot that helps the lichen specialist (who never sees PDR entries) who identifies the samples.

Secondary data for the Lichen Indicator consist of the set of PDR entries on the lichen screen, with optional fields on the Plot Data Card to serve as paper backup when the PDR does not function properly.

Duplicated sample location information on the lichen PDR screen and the lichen sample packets and data card are critical information used to correctly match primary lichen data from samples with both secondary data on the lichen PDR screen and data for P2 and other P3 indicators for the plot, in the FIA database.

10.3.2 P3 HEXAGON NUMBER
Record the unique code assigned to each Phase 3 (former FHM) hexagon on the Packet and the Plot Data card.

When collected: All Phase 3 plots
Field width: 7 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: 7-digit number

10.3.3 FIA PLOT NUMBER
Record the unique code assigned to each FIA plot that, together with the state and county FIPS codes, identifies the location of the P3 plot. Record on the Packet and the Plot Data Card.

When collected: All Phase 3 plots
Field width: 4 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: Up to a 4-digit number

10.3.4 STATE
Record the unique FIPS (Federal Information Processing Standard) code identifying the State where the plot center is located. Record on the Packet and the Plot Data Card, also noting the state letter abbreviation as well.

When collected: All Phase 3 plots
Field width: 2 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1 in the P2 field guide

10.3.5 COUNTY
Record the unique FIPS (Federal Information Processing Standard) code identifying the county, parish, or borough (or unit in AK) where the plot center is located. Record on the Packet and the Plot Data Card, noting the name as well.

When collected: All Phase 3 plots
Field width: 3 digits
Tolerance: No errors
MQO: At least 99% of the time
Values: See Appendix 1 in the P2 field guide

10.3.6 DATE
  Record date on which plot was surveyed, not date of mailing. This is critically important in sorting out coding problems if any occur. Record on the Packet, the Plot Data Card, and the PDR.

  When collected: All plots visited
  Field width: NA
  Tolerance: No errors
  MQO: At least 99% of the time
  Values: Full date in any format

10.3.7 LICHEN PROJECT
  Record the type of lichen project for which these data are collected. Record on Packets, Plot Data Card, and PDR.

  When collected; All Phase 3 plots
  Field width: 1 digit
  Tolerance: No errors
  MQO At least 99% of the time
  Values :

          1   Standard production plot
          2   Special Study
          3   Gradient Study
          4   Evaluation Monitoring

10.3.8 COLLECTION NUMBER
  Record the consecutive COLLECTION NUMBER in the "Collection No." box on lichen Packets **only**.

  When collected: Every lichen packet for every plot sampled for lichens
  Field width: 3 digits
  Tolerance: No errors
  MQO: At least 99% of packets
  Values: 1-999

10.3.9 ABUNDANCE
  Record relative ABUNDANCE score on lichen Packets **only**.

  When collected: Every lichen packet for every plot sampled for lichens
  Field width: 1 digit
  Tolerance: No errors
  MQO: At least 99% of packets
  Values:

Code	Abundance
1	Rare (< 3 individuals in area)
2	Uncommon (4-10 individuals in area)
3	Common (> 10 individuals in area but less than half of the boles and branches have that species present)
4	Abundant (more than half of boles and branches have the subject species present) Note: this code is not frequently assigned, but is valid. Make sure that more than one out of every 2 boles, branches, and twigs host this species.

10.3.10 CREW MEMBER NAME
Record the last name of the crew member who collected lichens on this plot on the Packet and the Plot Data Card.

When collected: All Phase 3 plots
Field width: Alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases, and numbers

10.3.11 CREW TYPE
Record the code to indicate the type of field crew using the following codes. Record on the Plot Data Card.

When collected: All lichen plots visited
Field width: NA
Tolerance: No errors
MQO: At least 99% of the time
Values:

   1   Standard field crew
   2   QA crew (any QA crew member present collecting data)

10.3.12 QA STATUS
Record the code to indicate the type of plot data collected, using the following codes. Record on the Plot Data Card.

When collected: All lichen plots visited
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

   1   Standard field production plot
   2   Cold Check
   3   Reference plot (off grid)
   4   Training/Practice plot (off grid)
   5   Botched Plot file (disregard during data processing)
   6   Blind Check
   7   Hot Check (production plot)

10.3.13 LICHENS COLLECTED
Record on the Plot Data Card and the PDR. When recording on the Plot Data Card, circle Y or N. If N is circled, add the reason to the "Other Comments" field using text from the Values listed below. When recording on the PDR, use the codes listed below.

When collected: All lichen plots visited (include all plots with any part designated as forest)
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

1	Lichens collected
2	Plot searched, no lichens found
3	Not collected – no measurements taken, plot harvested
4	Not collected – no measurements taken – plot dangerous
5	Not collected – ran out of time
6	Not collected – rain/storm
7	Not collected – left plot for emergency
8	Lichens not scheduled for collection on the plot
9	Not collected for other reason

10.3.14 TIME LICHEN SAMPLING BEGAN
Enter TIME LICHEN SAMPLING BEGAN as HHMM, where HH is hour and MM is minutes. Use military time (e.g., 1:45 pm is 1345). Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 4 digits
Tolerance:
MQO:
Values: Military time

10.3.15 TIME LICHEN SAMPLING ENDED
Enter TIME LICHEN SAMPLING ENDED as HHMM, where HH is hour and MM is minutes. Use military time (e.g., 1:45 pm is 1345). Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 4 digits
Tolerance:
MQO:
Values: Military time

10.3.16 % COVER LICHEN PLOT CONIFERS
Percent canopy cover of overstory conifers (not of lichens). Total of % COVER LICHEN PLOT CONIFERS plus % COVER LICHEN PLOT HARDWOODS (10.3.17) plus % COVER LICHEN PLOT TALL SHRUBS (10.3.18) may be >100%. Total of % COVER LICHEN PLOT CONIFERS plus % COVER LICHEN PLOT HARDWOODS (10.3.17) should not be > 100%. Tall shrubs are those > 3.3 ft (1 m) tall. Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time

Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: With the exception of class code 99 for 96% to 100%, class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

10.3.17 % COVER LICHEN PLOT HARDWOODS

Percent canopy cover of overstory hardwoods (not of lichens). Total of % COVER LICHEN PLOT CONIFERS (10.3.16) plus % COVER LICHEN PLOT HARDWOODS plus % COVER LICHEN PLOT TALL SHRUBS (10.3.18) may be >100%. Total of % COVER LICHEN PLOT CONIFERS (10.3.16) plus % COVER LICHEN PLOT HARDWOODS should not be > 100%. Tall shrubs are those > 3.3 ft (1 m) tall. Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time
Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: With the exception of class code 99 for 96% to 100%, class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

10.3.18 % COVER LICHEN PLOT TALL SHRUBS

Percent canopy cover of tall shrubs (not of lichens). Total of % COVER LICHEN PLOT CONIFERS (10.3.16) plus % COVER LICHEN PLOT HARDWOODS (10.3.17) plus % COVER LICHEN PLOT TALL SHRUBS may be >100%. Total of % COVER LICHEN PLOT CONIFERS (10.3.16) plus % COVER LICHEN PLOT HARDWOODS (10.3.17)) should not be > 100%. Tall shrubs are those > 3.3 ft (1 m) tall. Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 2 digits
Tolerance: +/- 10% (2 classes)
MQO: At least 90% of the time

Values:

Code	Definition	Code	Definition	Code	Definition
00	0%	35	31-35%	70	66-70%
05	1-5%	40	36-40%	75	71-75%
10	6-10%	45	41-45%	80	76-80%
15	11-15%	50	46-50%	85	81-85%
20	16-20%	55	51-55%	90	86-90%
25	21-25%	60	56-60%	95	91-95%
30	26-30%	65	61-65%	99	96-100%

Note: With the exception of class code 99 for 96% to 100%, class code is the percentage of the upper limits of the class, i.e., Code 10 is 6% to 10%, etc. Estimates are recorded to the nearest 5 percent to be consistent throughout this guide with other procedures and to allow estimator flexibility.

10.3.19 MOST IMPORTANT TREE AND SHRUB SPECIES

Please record on the Plot Data Card only, full scientific names plus % cover for the most common trees and shrubs on the lichen plot. Only 1-3 tree species and 1-3 shrub species are needed here.

When collected: All lichen plots visited
Field width: Alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases, and numbers

10.3.20 IMPORTANT SUBSTRATE SPECIES NOT ON SUBPLOTS

Please record on the Plot Data Card only, the scientific name of any trees or shrubs that were not found on subplots and that hosted a significantly different or more abundant lichen flora from that on tree species also recorded on subplots.

When collected: Only when such a lichen host is found
Field width: Alphanumeric character field
Tolerance: N/A
MQO: N/A
Values: English language words, phrases, and numbers

10.3.21 Gap

The next three variables all relate to presence of gaps on the lichen plot.

10.3.21.1 % GAP

Record % GAP in 5 percent classes on the Plot Data Card and the PDR To be a gap, there must be:
- Markedly different terrestrial vegetation than on forest floor
- Lack of trees on at least 3-5% of plot. 3% of a plot is a circle with a 20-foot radius. 4.4% of a plot is the size of one subplot.
- Canopy opening whose length or width is at least one tree length.

Note: Gaps are caused by disturbance, not just low density of tree establishment.

When collected: All lichen plots visited
Field width: 2 digits
Tolerance: +/- 10%
MQO: At least 90% of the time
Values: 00-99

10.3.21.2 RECENT
Record on the Plot Data Card and the PDR. Did the gap appear to be less than 5 years old (e.g., caused by recent disturbance) or not.

When collected: All lichen plots visited
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:
    0   > 5 yr old
    1   < 5 yr old

10.3.21.3 TALL SHRUBS
Does the gap have > 40% cover of tall shrubs (i.e., > 3.3 ft (1 m) tall)? Broadleaf shrubs in gaps of conifer forest are often especially rich areas for lichen diversity.

When collected: All lichen plots visited
Field width: 1 digit
Tolerance: No errors
MQO: At least 90% of the time
Values:
    0   No tall shrubs
    1   Tall shrubs present

10.3.22 SIZE CLASS OF 3 LARGEST TREES ENCOUNTERED ON THE LICHEN PLOT
Record the size class of the three largest trees on the entire lichen plot. Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 1 digit
Tolerance: No errors
MQO: At least 80% of the time
Values:

Code	Size class (DBH, inches)
1	< 10
2	10-20
3	21-30
4	31-40
5	> 40

10.3.23 FEATURES IMPORTANT FOR HIGH/LOW LICHEN DIVERSITY
Record the important substrate species or conditions that had the most impact on the plot (e.g., recently clearcut, riparian with large hardwoods, old growth). If the diversity is normal, record 00. Record on the Plot Data Card and the PDR.

When collected: All lichen plots visited
Field width: 2 digits
Tolerance: No errors
MQO: At least 90% of the time

Values:

00   No significant features

     High Diversity:
01   Stand appears relatively old for its forest type
02   Old remnant trees in otherwise young stand
03   Riparian
04   Gap in forest
05   Moist areas on plot with open structure and high light
06   Abundance of tall shrubs hosting high lichen diversity
07   Hardwoods within conifer forest had high diversity and/or different species
08   Conifers within hardwood forest had high diversity and/or different species
09   Presence of exceptionally good lichen substrate species (differs by region)
10   Other

     Low Diversity:
11   Very young forest or recently regenerating clearcut
12   Clearcut
13   Recently burned—lichens apparently removed by fire
14   Too dry for good lichen growth
15   Too exposed or open for good lichen growth
16   Some of plot nonforest
17   Most of trees on plot were poor lichen substrates (differs by region)
18   Most of the diversity was on a few trees or less
19   Other

10.3.24 SAMPLING ISSUES OR PROBLEMS

Record on the Plot Data Card and the PDR. Record in the PDR any major problems (up to 4) that negatively impacted the collection effort. If any SAMPLING PROBLEMS = 0, no other values will be retained. Record on the Plot Data Card the reason on the "Sampling issues/problems" line.

When collected: All lichen plots visited
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:

0   No significant issues
1   Too wet to see lichens well
2   Too dark to see lichen well
3   Sampling compromised by heat
4   Sampling compromised by other extreme weather (e.g., hail, lightning, snow)
5   Very steep slope hindered thorough plot access
6   Access to some or all of plot blocked by natural obstacles (e.g., lingering snowpack, high water, landslide, large blowdowns)
7   Other

10.4 SAMPLE PRESERVATION, STORAGE, AND MAILING

10.4.1 SAMPLE PRESERVATION AND STORAGE

Specimens must be thoroughly air dried to avoid fungal decay. If specimens were damp or wet when collected, the individual packets should be spread out and dried as soon as possible. Extremely wet lichens can be blotted dry between towels, then returned to packets to continue air-drying. Dry in the sun, in an air conditioned room, or in any safe place that is as dry as possible. Lichens are dry enough to store when they have become slightly stiff and have lost their soft, wet appearance and feel. Herbarium dryers may be used, but do not use commercial food dryers, ovens, hair dryers, or other strong heat sources.

Store packets in a dry place until you mail them. Never store or ship lichen specimens damp, and never in plastic bags.

10.4.2 SAMPLE MAILING

Always mail specimens using a mail or parcel service that includes parcel tracking. After the first week of sample collection, mail the specimens to the lichen specialist. The purpose of this is to allow immediate feedback to the field crews concerning specimen quality and quantity. Thereafter, mail the samples each week or every other week to the lichen specialist. You should have the name and address of the lichen specialist. If not, contact your supervisor or:

Susan Will-Wolf (608-262-2754 or swwolf@wisc.edu).

Before mailing the packets, check to see that all fields on packets are filled in. Make sure there is a properly filled in Plot Data Card (Figure 10-4) with each set of samples. Also include a properly filled in Plot Data Card for each plot searched and found to have no lichens.

Bundles of packets should be packed closely, but without excessive crushing, in sturdy cardboard boxes. Bundles of packets from several plots can be mailed in the same box. Enclose in the box a Lichen Specimen Mailing Form (Figure 10-5) listing all plots, including plots with no lichens, for the box's contents. Extra copies of the Mailing Form can be found in the notebook of lichen training materials under "Mailings."

LICHEN SPECIMEN MAILING FORM

Please enclose a copy of this form whenever these specimens are mailed. Keep a copy for your records.

FIELD CREW TO LICHEN SPECIALIST: Date

Sent by: _____   To:_____
Sender's comments: _____
Received: _____
Comments:_____
LICHEN SPECIALIST TO STORAGE: Date
Sent by: _____To:_____
Sender's comments:_____
Received: _____
Comments: _____

CONTENTS

Hex number	State	County	Collector	Notes

Figure 10-5. Form used for mailing lichen community specimens, one form per box.

10.5 REFERENCES

Brodo, I. M. 1991. Lichens of the Ottawa Region. National Museums of Canada.

Dey, J. P. 1978. Fruticose and foliose lichens of the high-mountain areas of the southern Appalachians. Bryologist 81:1-93.

Hale, M.E. 1979. How to Know the Lichens. 2nd Ed. Wm. C. Brown, Dubuque, Iowa.

Hale, M.E. and M. Cole. 1988. Lichens of California. University of California Press, Berkeley. 254 pp.

Hawksworth, D.L.; Rose, F. 1976. Lichens as pollution monitors. London: Edward Arnold.

McCune, B. 1988. Lichen communities along O_3 and SO_2 gradients in Indianapolis. Bryologist 91: 223-228.

McCune, B. 1992. Field Key to the Lichens of the Northwest Forests West of the Cascade Crest. Dept. Botany and Plant Pathology, Oregon State University, Corvallis. 19 pp.

McCune, B. and L. Geiser. 1997. Macrolichens of the Pacific Northwest. Oregon State University Press, Corvallis. 386 pp.

McCune, B. and T. Goward. 1995. Macrolichens of the Northern Rocky Mountains. Eureka, CA: Mad River Press. 208 pp.

McCune B. and J. Peck. 1994. Lichen Communities Training Document. Oregon State University, Department of Botany and Plant Pathology, Corvallis, Oregon.

Pollard, J.E.; Palmer, C.J. 1998. Forest health monitoring plot component quality assurance plan (national 1998). Research Triangle Park, NC: U.S. Department of Agriculture Forest Service, National Forest Health Monitoring Program.

Smith, C., L. Geiser, L. Gough, B. McCune, B. Ryan, and R. Showman. 1993. Species and communities. Chapter 4 in Lichen as Bioindicators of Air Quality. USDA Forest Service Gen. Tech. Rep. RM-224.

van Dobben, H. 1993. Vegetation as a monitor for deposition of nitrogen and acidity. PhD Dissertation, Utrecht University, Netherlands. 214 pp. (privately published)

Vitt, D.H., J.E. Marsh, and R.B. Bovey. 1988. Mosses, Lichens and Ferns of Northwest North America. Lonepine Publishing. 296 pp.

10.6 ACKNOWLEDGEMENTS