

# **LICHEN INDICATOR TRAINING PLAN**

**FOREST HEALTH MONITORING PROGRAM  
LICHEN COMMUNITIES INDICATOR**

**Indicator Leads: Peter Neitlich (West), Susan Will-Wolf (East)  
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This training plan presents the lichen indicator's requirements for conducting a successful indicator training, as well as some basic information about training content.

## PARAMETERS FOR PLANNING AND SET UP

### Stand-Alone Trainings

The lichen indicator has conducted both stand-alone and simultaneous lichen trainings. Results of stand alone trainings have been far better in terms of certification scores and crew confidence level. When possible, trainings should be conducted separately from other indicators for the following reasons:

1. Concentration on this difficult subject is vastly improved when crews are allowed to focus exclusively on the lichens for an unbroken time.
2. A stand-alone event allows the indicator to choose a field setting tailored to the specific requirements of the lichen training without working at cross purposes or putting additional burdens on siting of the less site-dependent, larger FHM training.

### Training Site Requirements

1. *Lichen Diversity*: The two primary requirements for a good lichen training site are high lichen diversity and access to diverse forested stands. In practice, this will mean holding the training in a clean air area with good access to as many of the regional sub-climates as possible. The lichen indicator leads need to coordinate with other indicator leads and regional FHM staff to assure that the prospective training site is appropriate. Cases of low local diversity have led to poor training in a region's lichen flora, thus detracting from potential field data quality. *One way to insure appropriate training sites without inconveniencing the rest of the FHM training group is to hold lichen trainings as a stand alone event (see above).*

In the PNW/CA region, Corvallis proved to be an ideal training location. From there, the bulk of the species in the region could be easily accessed, including the eastside species on a day long field trip. Trainers felt that crews left training with a good sense for the entire region's genera and species. The Asheville, NC and Rhineland, WI sites are also excellent.

By contrast, the northeast and Lake states regions reported inadequate diversity in their areas in the 1998 trainings. As a result, these crews are far more likely to have missed some of the diversity in their plots. Examples of poor sites include:

- Morgantown, WV
  - Fox Forest in Hillsborough, NH
  - Wisconsin Dells, WI.
2. *Workspace*: A large, unshared classroom or lab that will be available all day and evening for the entire length of the training (including setup and post-training). The room must have ample electrical outlets for microscope lamps, and water nearby for dealing with laboratory chemicals. Space must be able to accommodate:
    - 5 - 6 large tables and seating (approximately 4 linear feet of table space per trainee) for interactive lichen teaching stations and other microscope work
    - seating for talks and slide presentations
    - enough extra room for a collection of local specimens
  3. *Other Logistical Needs*:
    - Access to photocopier

### Time Requirements

The length of the training will vary according to the lichen diversity of a region and the skill level of the crews. The following guidelines are proposed for beginning crews:

South: 2.5 days\* (see immediately below)

Northeast: 2.5 days\*

Lake States: 2.5 days\*

PNW/CA: 4 days

Intermountain West: 2.5 days\*

\* informal evening practice sessions strongly recommended. Otherwise training time will need to be augmented. Five half-days of training produced adequately trained crew members in 1993, 1994, and 1995, especially when training arrangements were such that crew members had the time and energy to practice discriminating and identifying lichens with the informal help of trainers in the evenings.

Two-day trainings were tried in the east in 1998, but have been judged to be too short to be effective. A third day would make a large difference in skill levels. Trainings can be shortened by 50% or more for veteran crew members who have done good work.

The following assessment has been made for the 1998 field season.

<b>Region</b>	<b>Trainees</b>	<b>Trainers</b>	<b>Time</b>	<b>Trainer Confidence in Crew Abilities</b>	<b>Cert. Score Ranges and approx. mean</b>
PNW/CA	8	2	4 days	High	65-96; mean ~83; mostly high pass and pass
Southeast	12	3	2	Low	60-75; mean~70; mostly low pass
Northeast	7	1.5	2	Low to Moderate	60-80; mean~70; mostly low pass
Lake States	12	2	2	Low	60-75; mean<70; mostly low pass

The 2 days of time allocated to most trainings in 1998 did not allow sufficient time for recertification, which was necessary in several cases. These recertifications had to be done at great inconvenience to both crew members and trainers.

### Number and sequence of time blocks and days for each component of training

In general, it is best to program taxonomic activities for the mornings, as this is the time of maximum concentration and good outdoor light. If the training is held concurrently with other indicators, all attempts should be made to give lichens the morning sessions, and certainly for the first two days of training.

When lichen training is held concurrently with other indicators:

1. flexibility is possible for scheduling the first three half-day blocks, but
2. there must be 4-8 working hours between the practice plot and the certification plot (usually the third and fourth blocks), and between the certification plot and recertification/and or field trip day in west (usually the fourth and fifth blocks), so trainers can identify and evaluate crew certification plot samples. See lead trainers for trainings involving times other than 2.5 days. Longer trainings have never been done other than as stand-alone events.
3. The minimum duration of each teaching block should be 2.5-3 hours, but preferably 4.

### Preparations Needed Prior to Training

Several items are key here:

1. Determine the number of people to be trained, and budget accordingly. In general, we will budget one trainer per 3-4 crew members for a full training (see above for training requirements), and one trainer per 5-6 veteran crew members. Only one lead trainer is needed ; (s)he will generally be paid at a higher rate than the assistant trainer. All other trainers needed will be assistant trainers, and may be paid at a lower rate. If a worthy, highly skilled veteran crew member (see instructor requirements below) assists with training, budgeting for that person should be discussed with the regional program manager.
2. Determine space needs and other logistical needs based on the total number involved with the training
3. Identify and propose a good training site if the general FHM site is determined to be inadequate or the the training will not occur simultaneously.
4. Procure all necessary supplies (see equipment list below).
5. Prepare the training manuals. Consult with indicator leads for templates.
6. Prepare all supplementary, region-specific materials including species lists, simplified identification keys, reference samples, etc.

### Time Needed for Set-up

If trainers need to collect local materials for teaching stations and reference collections, then 3 days are recommended for set up. If materials are already available, or mostly so, and the training site is already familiar, up to 2 days is recommended. More time may be needed to choose plot and trip locations at new training sites. All trainers should be present for set-up. Activities include:

- Gathering lichens for teaching stations and reference collections (3-4 hours)
- Laying out teaching stations and answer keys (3 hours)
- Compiling reference herbarium, if needed (3 hours)
- Setting up the rooms (1-2 hours)
- Choosing field trip, practice plot and certification plot sites (1 day)
- Conducting practice plot (5 hours), and if possible, certification plot (5 hours) surveys.

### Certification and Practice Plot Requirements

The certification and practice plots should be chosen to represent a fairly high proportion of the potential forest lichen diversity in the region. Plots should be located to reflect, *at a minimum*, the average species richness of the state or region, and should strive in all cases to reflect a richness much higher than this. Attention to this requirement will ensure that crews are exposed to the lichen diversity of their region, and have mastered this diversity by the end of training. Since this is a prime concern in the training, training location must be chosen with this requirement in mind.

### Expectations from Other Training Sessions

The only area which would be helpful for lichen trainees is a good working knowledge of FHM plot layout, and the other sorts of activities which will be conducted on the plots. It would be most helpful for crews to know the basics of plot layout before the practice plot begins, and should certainly be required before the certification plot.

Other indicators should also be aware of two lichen specific needs:

1. The need for high lichen diversity at the training site (see Training Site Requirements above)
2. Other indicators must inform their crews of the lichen indicator's need to collect lichens during times of good light. We are hoping that other indicators will be flexible with schedules in order to accommodate this basic need, and that we can discuss the likelihood of past problems with this situation directly at training.

While only one crew member per plot can collect for the lichen indicator, another crew member can help by labeling and carrying packets. This plus 1. and 2. above should be discussed when plot choreography is taught.

### Instructor Requirements

#### 1. Hiring Guidelines

*Lead Trainers:* Lead trainers need to have specialist-level skills in lichen taxonomy, need to be good teachers, and need to be well-versed in FHM methods and typical crew questions and problems. Lead trainers should have been an assistant regional trainer or auditor, preferably for two or more years, and must have a demonstrated ability to identify most macrolichen species in the region. If possible, that individual should have been an assistant trainer *in that region*. This person would plan to attend a lichen pretraining if there is one, or would be instructed by the indicator lead, as a requirement to be a trainer. In the lichen indicator, specialists perform the identification of field samples, relying on established microscopic and chemical tests. They typically have several peer-reviewed publications on lichens, and have worked with the FHM program or have used the method for related activities. Lead trainers are contracted directly by the indicator lead.

*Assistant Trainers:* Assistant trainers are a critical part of the training program, and tend to be as helpful as the lead trainer in teaching basic lichen discrimination to crews. They may include people in the following categories:

- A good lichen ecologist or lichenologist without FHM-specific experience, but with demonstrated ability to identify the macrolichen species common in the region and has teaching experience.
- An experienced lichen crew veteran (2+ years) who has in addition a demonstrated ability to identify macrolichen species common in the region, and has either had teaching experience or has previously assisted with field training.

Assistant trainers need to attend a lichen pretraining, or would be instructed and certified by the lead regional trainer early in training, as a requirement to be a trainer.

Note: Formal lichen pretraining sessions will be held every third or 4th year. In other years, trainers will be trained and certified by the lead regional trainer just before crew training at that site.

*Veteran Crew Assistants:* Worthy veteran crew members (2+ years) can at the discretion of the lead trainer assist with classroom and field teaching for the indicator.

*Auditors:* Only certified lead and assistant trainers may conduct hot audits, which include recertification of crew members.

## 2. Work Expectations

Lichen training is very intense, both for lead and assistant trainers. Hours tend to be long and grueling. Trainers should be aware that their jobs involve 10 hour days during the setup phase, and 14-16 hour days during the training itself. Much of the additional time required comes in identifying trainee samples in the evenings.

### Prerequisites for Crew Hiring

There are no specific prerequisites for crew lichenology positions. However, it is strongly recommended that the FHM program take steps to:

1. Create incentives to attract experienced crew members to return.
2. Hire people for these positions with good vegetation backgrounds and/or some taxonomic experience, as well as strong interest in the positions.

### Training Requirements for Veteran Crew Members

In general, veteran crew members should need no more than 2 days of training, so long as they have demonstrated good lichen collection skills during the previous field season. Veterans should also be drafted when appropriate to help train novice crew members. The following guidelines are proposed:

Year 1: attend full training session

Year 2: may attend reduced training session, depending on year one QA results (audits and remeasurements) and having completed 15-20 plots. Reduction in training time should not be more than half.

Year 3 and beyond: may attend a reduced training session. With indicator lead approval, this crew may assist with the field teaching portion of training.

### Desired Student/Teacher Ratio

To maintain quality instruction in such a short event, trainings need to keep a student-to-teacher ratio of 4:1 or lower. In calculating this ratio, informal lichen helpers, and highly skilled lichen crew members may be counted as trainers, with two uncertified training helpers counted as the approximate equivalent for teaching of one certified assistant trainer. All of these decisions will rest with the indicator leads as they set up the training program, and will be decided on a case-by-case basis.

### Lichen Pretraining Events

Thus far, the lichen indicator has held one lichen pretraining, a stand-alone "training of lichen trainers and specialists". This is recommended in future years, and should be added to future budgets. This pretraining could potentially overlap with the FHM general pretraining, but should have at least two days of separate, lichen-specific training, as it is designed primarily for the benefit of the lichen indicator. The lichen diversity of the Asheville, NC, is reported to be adequate for lichen training purposes, as was the Estacada, OR site (near Portland) of the previous lichen pretraining.

### Who May Attend Lichen Trainings

Lichen communities training is typically a popular event, and there is usually high interest among FHM and other agencies to send personnel other than FHM crew members. This usually presents a difficult situation

for indicator leads and/or trainers who are forced to turn people away or make accommodations which detract from crew training. Presence of non-crew members presents two major problems for the lichen training:

1. Lowering of the teacher to crew ratio
2. Extra expense and/or effort of identifying samples from the practice and certification plots of non-crew members. In practice, this is typically \$75-100 per person per plot.

Because of this, we recommend the following strict guideline:

**TRAINING SHOULD BE OPEN ONLY TO FHM PERSONNEL DOING LICHEN SAMPLING  
THAT SEASON OR DIRECTLY INVOLVED WITH MANAGING THIS INDICATOR.**

While generally unpopular, this guideline will result in better training for crew members. FHM national pretraining would be a more appropriate place/time to offer lichen indicator training to FHM personnel who wish it.

## TRAINING PLAN

### Lichen Indicator Training/Field Manual

The basic training module is designed to explain and elaborate on the several hundred page lichen training/field manual which contains the following sections:

- Basics (What is a lichen, lichen morphology, illustrated glossaries, where to collect lichens, etc.)
- QA (The latest official version of our QA plan, including crew MQO's, certification requirements and QA methods)
- Mailings (Plot packing slips and specialist mailing forms)
- Rationale for the lichen communities indicator
- Reprints 1: Lichens and Air Pollution
- Reprints 2: Regional Species Lists and Publications
- Lichen 911 and contact information

We are keeping the following session plan skeletal in order to avoid duplicating this effort.

### Outline of Training Plan

The lichen training consists of the following basic components:

1. Introduction to FHM lichen communities indicator--purpose, rationale, methods, examples, basic lichen ecology. This is normally a slide program. Please consult with FHM slide library contents below. (20 min - 1 hour)
2. Lead trainer presents objectives of the training session, schedule and explanation of testing activities including practice, certification and scoring. (10-15 minutes)
3. Introduction to lichen identification--basic lichen morphology, structures and how to use them to discriminate among species (0.5 hours)
4. Learning lichen characters, species discrimination, and lichen genera in the classroom and field through any appropriate combination of the items below (4-8 hours):
  - tutorial workstations (2-4 hours)
  - examining demonstration material in conjunction with regional species lists (1-2 hours)
  - making and examining personal collections (2+ hours)
  - field work (2 hours)
  - genus workstations (1 hour)
  - informal evening activities (e.g., keying, study, etc)
  - and other activities (1+ hours)
5. Lichen indicator methods and detailed explanation of field crew responsibilities (1 hour)
6. Field outings to practice field discrimination of species and lichen indicator methods (2 hours)
7. 1-2 practice plots (4 hours each)
8. Certification plot (4 hours)
9. Retesting if needed (4 hours)
10. West only: Additional field outings to other regional sub-climates (1 day; can be held concurrently with recertification)

Total Time: 20 hours (2.5 days\*) to 33 hours (4 days)

\*NOTE: As stated above (see Time Requirements), 2.5 day trainings are appropriate in some regions provided there is adequate informal time for study in the evenings, and the training is conducive to this arrangement.

### Certification Requirements

As outlined in the QA plan, a crew member is certified if they have found at least 65% of the lichen species that a trainer has found on the certification plot. Failing crews may take the recertification test.

## Testing Materials

*Testing Package:* The only test required is the field-based test detailed in Certification Requirements. The only supplemental materials required are the species identification plot sheets contained in the specialist packet (see indicator lead), and these need to be available only to the lead trainer.

*Preliminary Testing Exercise:* The lichen indicator will attempt to score the results of the practice plots as if it were a certification plot, if time permits. This requires a large effort for the training staff, but is extremely helpful if it can be accommodated.

*Field Test:* Lichen certification (see above) is based completely on a field test which includes performing the lichen survey with higher than 65% species capture compared to the lead trainer, filling in proper abundance coding, and packaging and labeling plot samples for mailing to the specialist, in this case the lead trainer.

*Retesting Materials:* Another certification field test, as above.

## List of Equipment for Training

Each item is followed by the responsible party who will coordinate the arrangements and financial outlays for these items.

- Microscopes - one per person, if possible, but no fewer than one per two people. At an absolute, desperate minimum, at least all trainers must have scopes. (Typically borrow from region--regional staff to coordinate)
- Teaching Stations printouts and corresponding lichens (Indicator Leads)
- FHM Training Manuals (Indicator Leads, but sometimes with reproduction help from region)
- FHM packets (Indicator Leads with help from region in reproducing)
- Several reams of high quality scrap paper for packets, or else new paper (Region)
- Markers (Region)
- Soft Pencils (Region)
- Rubber bands - 1 box per crew member for field season (Region)
- Slide Projector and Slides (Slide projector from region. Slides from Indicator Leads)
- Overhead projector (Region)
- Field Guides - 1 for each crew member and trainer. Examples: *Macrolichens of the Pacific Northwest*, *Lichens of California* for PNW/CA training, Hale's *How To Know the Lichens* for northeast. (Indicator leads to coordinate/recommend purchases by region. Many trainers will have their own copies--check before ordering.)
- Hand lenses (Region)
- Gerber knives (Region)
- Pruners (Region)
- Fanny Packs (Region)
- Watch (Crews)

## Training Objectives

By the end of the training, crew members should be able to:

- A. Collect the majority of lichen species present on a plot and assign proper abundance scores
  - Describe the basic lichen structures and features of a lichen
  - Describe the 3 basic growth forms of lichens and how to discriminate among them
  - Apply basic principles of lichen morphology to discriminate among as many as possible of the epiphytic species in the region
  - Describe the concept of substrate specificity and give several examples using local species

- Recognize many of the most common genera in the region by name (ideally)
- B. Conduct FHM lichen plots according to standard field methods
- Observe protocols on plot time and collection locations and substrates on the plot
  - Describe the range of microhabitats to examine
  - Recite the cardinal FHM lichen rule: "When in doubt, it's a lichen"
  - Collect appropriate specimen sizes
  - Know how to deal with uncertainties relating to species identity and abundances
- C. Describe the steps needed to complete the lichen specimen requirements after the plot
- Drying and storing specimens
  - Packet labelling requirements
  - Plot packing slips
  - Mailing forms and mailing protocols
- D. Understand the basic goals and objectives of the lichen indicator and explain how individual lichen plots will be used in regional and national context
- Explain the basic concept of lichen decline in areas of poor air quality and the indicator in general
  - Discuss the importance of lichens in the ecosystem
- E. Pass the certification
- Achieve a species collection score of 65% or higher of the trainer's score
  - Conduct all FHM plot methods appropriately
- F. Understand the contents of the FHM Lichen Communities Manual
- Read methods section
  - Read basics section
  - Knowledge of how to use forms in the mailings section
  - Knowledge of QA, Publications sections for reference

## Typical Training Schedules

*PNW/CA*: This schedule was used for the 4-day 1998 training in PNW/CA. It was held as a stand-alone event in Corvallis, OR. This was, from the indicator's perspective, an ideal training event. Crews had 100% certification rate the first time, and scores were generally very high. We had high confidence in the ability of these crews, and recommend this training template as a model.

### **DAY 1**

8:00-9:00 - FHM introductory paperwork for field crew members (1 hour)

9:00-9:10 - Introductions (10 min)

9:10-9:40 - Slide presentation: Lichen morphology, ecology and FHM slide presentation (30 minutes)

9:40-12:00 - Lichen workstations (2.5 hours)

12:00-1:00 - Lunch

1:00-3:00 - Practice plot/training walk in hardwoods outside Suislaw SO to look for genera, look-alike species, and lichen morphological characters (2 hours)

3:00-5:00 - Genus workstations, review lichens using regional epiphyte species lists, examination of look-alikes. Priority genera: *Parmelia*, *Hypogymnia*, *Bryoria*, *Usnea*, *Physcia*, *Physconia*, *Eslingeriana*, *Platismatia*, *Xanthoria*, *Candelaria*, *Leptogium*, *Pseudocyphellaria*, *Sticta*. (2 hours)

5:00 - Lay our weary thalli to rest.

### **DAY 2**

8:00-9:00 - FHM Methods (1 hour)

- Overview of Lichen Community Indicator and how data is used
- Conducting the plot
- What and how much to collect
- Scoring abundance
- Other data needed
- Post plot follow-up (paperwork, drying specimens, mailings)
- Lichen 911

9:00-12:30 - Practice Plot at Mary's Peak : work in groups of 3-4 with at least one experienced crew member in each group. (2.5 hours)

12:30-1:30 - Lunch

1:30-2:00 - Debriefing of practice plot (30 min)

2:00-5:00 - Practice Plot. Work independently. *Practice hard! Everyone must pass tomorrow!* (3 hours)

### **DAY 3**

8:00-11:00 - Continue genus stations, look-alike species. Begin keying using McCune's westside field keys and PNW macrolichen flora. (3 hours)

11:00-12:00 - Collection and data problems in past years (1 hour)

12:00-1:00 - Lunch

1:00 - 5:00 - Certification plots. Location TBA. (4 hours)

### **DAY 4**

7:30 am - 8:00pm Trip to Sisters (East-Side Ponderosa Pine-Juniper Forest)

Morning: Training walk on E-side species

Afternoon: Off-frame plot. Those who didn't certify will have a second chance on this plot. Leave for Corvallis by 4:00 pm.

*Lake States:* This schedule was used for a 2 day training in the Lakes States Region. Like the one below, this schedule is shorter than recommended for good training results. This training was judged after the end of the season to have been inadequate to produce confident trainees.

FHM 1998 - LICHENS - LAKE STATES  
TRAINING AGENDA  
JUNE 6-9

**Session 1. 8-12 am Sat. June 6**

*In classroom:*

- A. Introduction
- B. Why are lichens in FHM? What's a lichen?
- C. Tutorial - lichen stations

*Field:*

- D. How to search for, collect lichens.

*In classroom:*

- E. Learning lichen characters. Make reference collection.

**Session 2. 1-5 pm Sat. June 6**

*In classroom:*

- A. Learn the FHM field collection protocol.

*Field:*

- B. Collect lichens in pairs on miniplots.

*In classroom:*

- C. Continue learning lichen characters. Add to reference collection.

**Session 3. 8-12 am Mon. June 8.**

*In classroom:*

- A. Review FHM field collecting protocol, learn sample labeling, packaging, care, and mailing procedure.

*Field:*

- B. Perform practice plot sample procedure, single, assisted by trainers.

*In classroom:*

- C. Package, label, turn in practice plot sample.

**Session 4. 1-5 pm Tues. June 9.**

*In classroom:*

- A. Review practice plot results, discuss.

*Field:*

- B. Certification test: solo plot sample. Good luck!

*In classroom:*

- C. Package, label, turn in certification plot sample.

You will hear after you return home whether you have passed certification. Our goal: all pass!

*Northeast:* The following schedule was used for the 2-day 1998 Northeast Training in Hillsborough, NH. This schedule is shorter than recommended, and resulted in a 33% certification rate (later corrected) and generally low scores reflecting bare minimal capabilities as lichen crew members.

**FHM LICHEN INDICATOR TRAINING  
NEW ENGLAND AND NEW JERSEY  
JUNE 9-11, 1998  
FOX STATE FOREST, NEW HAMPSHIRE**

**DAY 1**

8:30 - 9:30 Introductory stations and genus learning (1 hour)

9:30 - 10:00 FHM methods (30 min)

10:00 - 12:00 Field walk: Learn common genera and species; practice collecting solo in limited area (2 hours)

1:30 - 4:00 Assisted practice plot and debriefing (2.5 hours)

4:00 - 5:00 Finish learning stations and work with herbarium and species lists (1 hour)

**DAY 2**

8:30 - 11:00 Solo practice plot (2.5 hours)

11:00 - 12:00 Work on recognition of common species via collections and herbarium (1 hour)

**DAY 3**

1:30 - 2:30 Final work with herbarium specimens and species lists; or assisted field time (1 hour)

2:30 - 5:00 Certification plot. Results will be available by Friday afternoon (2.5 hours)

## Lichen Indicator Slide Show Contents

The introductory slide show generally touches on the following topics:

- The importance of lichen epiphytes in forested ecosystems
- The rationale for the lichen communities indicator
- The FHM lichen communities process, from data gathering to analysis
- Basic macrolichen forms and structures

Talks will need to vary by region, according both to the ecological roles of lichens in the region, the state of the lichen indicator in the region, and the pollution issues of a region.

The following slides have been distributed to trainers for possible inclusion in FHM slide programs.

### Original Slides

1. Text: Rationale for indicator
2. Text: Importance of epiphytes. Input of fixed N important in the N cycle of moist oceanic forests.
3. *Lobaria oregana*
4. Text: Importance of epiphytes. Winter food chain to flying squirrels, voles, owls, and mountain caribou.
5. *Alectoria sarmentosa* (eaten by deer and other ungulates)
6. *Bryoria pseudofuscescens* (eaten by deer, voles, flying squirrels, etc.)
7. flying squirrel
8. Text: Importance of epiphytes. Air quality indicators. Lichens are sensitive to SO<sub>2</sub> and other gasses and are efficient accumulators of heavy metals.
9. low diversity on trunk near coal-fired power plant in Indiana
10. high diversity on trunk in rural Midwest.
11. barb wire on fence -- metal toxicity
12. diagram with rationale for lichen communities as indicator in FHM (see SE demo report for discussion of this diagram.)
13. Importance of epiphytes. Contribute to forest structure and diversity; inherently interesting and enriching in their own right.
14. Text: Summary of field method
15. Text: Community parameters: total lichen abundance, species diversity, and species composition
16. Text: Calibration phase diagram
17. Application phase diagram (Chart)
18. Text: Calibration phase: construct gradient model of lichen communities
19. Diversity results for SE US, 1993 data only (remember: alpha diversity is average no. spp in a plot, beta diversity is the amount of compositional change over the whole sample, calculated as gamma/alpha, and gamma diversity is the total number of species in the whole sample. (Data)
20. Computer map of mean annual precip. in SE US on 10 km grid, output from Chris Daly's model PRISM.
21. July precip, 10 km grid, view of southern Appalachians from SW.
22. Map of transect of urban/industrial supplemental plots in SE
23. Text: Application phase: use gradient model to assign scores to subsequent plots
24. graph of fit vs. gradient score -- This is the method we use to assign scores to new plots, fitting them in with an existing gradient model of lichen communities.
25. Text: QA results
26. Text: Multiple expert study (4 experts, 3 trainees)
27. diagram with scores on two gradients. T=trainee, E=expert
28. Reference plot study design, SE demo, 1993
29. Text: Summary of key results from SE demo Method is repeatable, reliable
30. Method gives similar results for experts and technicians (exception: a lower proportion number of species are detected by technicians) Graph.
31. Text: Clear responses to gradients in climate and air quality.
32. Text: Species-poor young forests are distinguishable from polluted forests.

Growth forms

Fruticose

- 33. *Usnea*
- 34. *Ramalina menziesii*
- 35. *Cladonia subsquamosa*
- 36. *Cladina rangiferina*

Foliose

- 37. *Lobaria pulmonaria*
- 38. *Melanelia*
- 39. *Parmelia hygrophila*

Crustose

- 40. *Caloplaca luteominina* ssp. *bolanderi*
- 41. *Ochrolechia subpallescens*
- 42. *Pertusaria*

Lichen structure

- 43. SEM, cortex, medulla, and algal layer
- 44. SEM fungal hypha penetrating algal cell
- 45. apothecia and soredia/isidia (has both, but can just call them soredia) on *Lobaria pulmonaria*
- 46. SEM isidium on *Parmelia pseudosulcata*
- 47. SEM soredia on *Parmelia sulcata*

1998 Additions

- 101. FHM plot layout.
- 102. FHM lichen abundance ratings. Table
- 103. FHM sampling grid, southeast US.
- 104. FHM sampling grid, OR and WA.
- 105. Response of element, cell, organism and community to pollution. Theoretical model.
- 106. National Acid Deposition Program map of wet sulfate deposition, 1992, all US.
- 107. Layers of thallus in fruticose, foliose and crustose lichens
- 108. Layers of stratified foliose thallus.
- 109. Cross section of apothecium showing internal structures and spores
- 110. Cross section of perithecium
- 111. Cross section of thallus showing eruption of soredia
- 112. Magnified view of soredia
- 113. Cross section under magnification of isidium
- 114. Several foliose species on bark in southeast
- 115. *Cladonia* with red apothecia.
- 116. Foliose and fruticose spp on bark.
- 117. *Evernia prunastri*
- 118. *Hypogymnia physodes*
- 119. *Cladonia* with big chlorophaea type cups.
- 120. *Physcia aipolia* on branch.
- 121. *Collema furfuraceum*
- 122. *Parmelia* sp.
- 123. Cluster groupings in ordination space (climate, physiographic province, sp richness) in southeast ordinations.
- 124. Southeast gradient axes on clusters in ordination; pollution and climate axes.
- 125. Pollution tolerant and pollution sensitive species lists in southeast from gradient model.
- 126. Correlations of secondary matrix variables with 2 ordination axes, southeast.
- 127. Thresholds for lichen community parameters and the percentage of plots in the indicated ranges.  
(Table, New England)
- 128. Cumulative response curves.
- 129. Lichen species richness, southeast. GIS map.
- 130. Scores on air quality gradient, southeast. GIS map.
- 131. Scores on climate gradient, southeast. GIS map.
- 132. Regional pollution models, eastern US.

133. Elemental deposition isopleths, eastern US.
134. Number of taxa per plot in southeast, midatlantic and northeast.
135. Species correlations with pollution axis in New England.
136. Alpha, beta, gamma diversity in southeast and northeast.
137. Comparison of southeast and northeast regional gradient models.
138. Ordination overlay of environmental variables, New England gradient model.
139. Species overlays on ordination: *Lobaria pulmonaria* and *Myelochroa aurulenta*.

Others not numbered but in use in PNW/CA talks

- Flying squirrel range map
- Flying squirrel diet graph (lichens and fungi)
- Flying squirrel eating sporocarp
- Text: Northern Flying Squirrels are Fungal Sporocarp and Lichen Specialists
- Text: Trees are mutualistic with fungi, Flying Squirrels and lichens
- Seedlings with and without mycorrhizal inoculation
- Flying squirrel in tree nest with full moonrise
- Boreal Owl, main Flying Squirrel predator
- Text: Small mammals reported to eat lichens: list
- Mule deer eating *Bryoria*
- Graph of lichen associated arthropods in old growth and young forests (which could be analogous to polluted v. pristine forests) - Neitlich MS thesis
- Graph of lichen abundance in forests of four different ages 40 to 510 (Neitlich thesis)
- Personnel: you have to be crazy to work here, but you're overqualified.
- Festoon of *Lobaria oregana* on branch, Oregon.
- Cross section of lichen showing all layers of foliose thallus.
- *Imadophila ericetorum* on soil
- Cross section of *Collema* to show gelatinous lichen structure.
- Soil crust watching, a popular sport (people with heads in ground squirrel holes).

Others in slide library but not currently in use

- Saw whet owl
- Boreal owl
- Beetle with camouflaging lichen growing on back
- Examples of some chemical tests
- Looking at crusts
- Tree climbing to examine contents of flying squirrel boxes
- *Ramalina* and *Alectoria*
- Sporocarp hats
- Text: Value of aggregated retention trees
- Schematic of dispersed v. clustered retention
- Display of 5 *Hypogymnia* species
- Lichen litterfall
- Graph of clustered v. dispersed retention
- Text: Role of lichens and mosses
- Relict snags act as lichen seed trees
- Text: Indicator Value
- Ken Stolte in Poland
- Clinton clearcut--happy face pattern
- Most important factors influencing community development: list
- Flying squirrel in flight
- Schematic: fungal dispersal by flying squirrels

- Mycorrhizal relationships: squirrels, trees, fungi
- Factors influencing epiphytic lichens (text table)
- America, love it or log it.
- FHM sampling in Latvia
- Roger Rosentreter and Andrea Pipp picking up litter
- Roger Rosentreter and Andrea Pipp picking up litter, #2
- Flying squirrel nest
- Checking nest box
- Bruce McCune, pensive
- Roger Rosentreter in 1997 Wyoming Class
- Text: Leaning Trees
- Text: Microclimate
- Picture of FEMAT report
- Truffles and rodents which eat them
- List: Why eat lichens?
- List: Retention Trees

Outline of Lichen Methods Talk

**PROCEDURES**

During this talk, refer to the methods "cheat cards" distributed to each crew member.

- **Sampling area.** The area to be sampled is a circular plot with 120' radius minus sub-plots (=114 ft radius)
- **Sampling time.** Sampling continues for a maximum of two hours or until 10 minutes elapse with no additional species recorded and all sectors of the plot have been covered. At least 45 minutes must be spent searching the plot OR/WA, even if very few lichens are present. At least 30 min must be spent in CA.
- A **reconnaissance walk** through the entire lichen plot should be taken to locate lichen epiphytes on woody plants, collect voucher samples and assign abundances.
- **Lichens to collect.** Collect epiphytic fruticose and foliose lichens.
- **Substrates to collect from.** Woody plants (must be >0.5 m tall west of the Cascade crest to avoid ground lichens creeping up over moss on bases of trees and shrubs) within the lichen plot will be inspected for lichens species. Fallen and reachable branches will also be inspected. Rotten logs, stumps, and branches overgrown with ground mosses on the forest floor should not be sampled.
- **Where to look.** Care should be taken to inspect the full range of substrates and microhabitats available: shaded and exposed, conifers and hardwoods, fallen upper branches and lower branches, large shrubs and trees in particular topographic positions (e.g. checking in draws or ravines of an otherwise uniform slope).
- **Abundance ratings.** Relative abundance within the lichen plot will be recorded on each packet. Estimate as follows:

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Code	Abundance
1	Rare (<3 individuals on the plot)
2	Uncommon (4-10 individuals on the plot)
3	Common (>10 individuals observed but covering less than half the available substrate)
4	Abundant (covers more than half the available substrate)

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- **Collect sample of each putative species,** place in bag, record abundance. Revise abundance as needed throughout plot.
- **Bagging and Labelling.** Each specimen will be placed in a separate bag (or folded and labeled paper packet.) Often there will be more than one species on a bark sample. If there is any chance of ambiguity about which species in the packet corresponds with which abundance rating, a clarifying phrase, such as "the white one" or the "sorediate one" should be written on the packet
- **Specimen size.** Optimally, a palm-size sample of fruticose and foliose growth forms is collected. Even minute fruticose and lobate forms should be included. Cladonia sp. squamules lacking upright stalks should not be included. Collecting large samples improves the likelihood of picking up inconspicuous species that may not have been noticed in the field. These additional species can be recorded in the office.
- **PUT PLENTY OF MATERIAL IN LICHEN SURVEY PACKETS!!!**

- **How to handle uncertainties.** Field observers will frequently have uncertainties about the classification of an organism. The following rules are designed to put the onus of the responsibility for classification on the specialist, not the field crew:
  1. When in doubt, assume it is a lichen.
  2. When the growth form is in doubt, assume it is a macrolichen
  3. When the species distinction is in doubt, assume two different forms are two different species.
- **Wrap Up** - Complete plot packing slip. Time ended, comments on plot, lichens, veg, weather, mood. Important to know about extenuating circumstances (good or bad).
- **WRITE NEATLY!!!!**

## **POST PLOT**

- **Packaging samples, preservation and storage.** Packets should be stored in a dry place until delivery to the program coordinator. Specimens should be thoroughly air-dried to avoid decay. Place bags from single plot in larger bag with plot packing slip. Never put lichens in plastic bags.
- Send 1st 2 plots ASAP; then every week or every other week.
- **Quality control.** Only those who have successfully completed lichen training should collect the lichen community data. Only those who successfully pass audit certification should continue to collect the lichen community data.
- **Mailing packets.** Send packets to the designated person - the regional lichen specialist or the program coordinator with an accompanying mailing form listing plot #s.