Youth and Community Curriculum for

Using Tree Moss as Bio-Indicator for Air Pollution

2022



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Purpose

This material represents only the curriculum to be utilized with youth participants. Separate materials guide training sessions for trainers and staff, as well as overall research design, and program implementation. The materials presented here include not only the lesson plans for each session but also the evaluative tools recommended for assessing learning. This document presents an 11-session curriculum. In the Duwamish Valley where this work was crafted and piloted, both a 9 session and 11 session curricula were implemented.

Additional Resources:

"Using Tree Moss as an Indicator of Air Quality: A Community How-to Guide"

Derrien, M. et al. 2020. "Toward Environmental Justice in Civic Science: Youth Performance and Experience Measuring Air Pollution Using Moss as a Bio-Indicator in Industrial-Adjacent Neighborhoods" *International Journal of Environmental Research and Public Health* 17, no. 19: 7278. https://doi.org/10.3390/ijerph17197278

Duwamish River Cleanup Coalition info page

US Forest Service info page

Recommendations for Use:

Overall Programmatic Themes:

- Be as interactive as possible
- Graphics/visuals are important
- Encourage participation by all
- Check in with youth to see how they are doing/ learn everyone's names
- Watch out for academic jargon
- Step back as a white person as much as possible unless your support is asked for. This is a BIPOC run program. White people are support, not leaders.

Overall Programmatic Goals and Purpose:

- Youth and Community-led exploration into environmental health in their neighborhoods
- Community organizations able to run the program without outside intervention
- Information uncovered is understood by participants
- Information uncovered is shared with the community impacted
- Action is taken to respond to the findings of this work

Lesson Plan 1: Introduction to Moss Program

Time: 2-3 hours

Location: Inside (general classroom) and Outside (in community)

<u>Goal</u>:

Participants have initial understanding of the program, its importance, and enthusiasm to continue.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Describe an overview/purpose of the program
- List 3 group agreements
- Explain what moss is and why we are interested in it
- Explain what a bioindicator is and why we would use them
- Explain what community science is and why it is valuable and necessary
- Discuss sources of air pollution and how this work might identify new ones

Materials:

- Journals for youth
- White board
- Pens/markers
- Posters
- Large post-its
- Moss samples/ examples
- LCD projector
- Laptop/ Computer
- Computer Speakers
- Airbeams or other handheld air quality indicator
- Android phone (depending on ap used)
- Sign-sheet
- Word wall Flipchart (definitions learned over the program)

Background:

• Initial session is designed to introduce youth to core concepts of the program, including the research that will be conducted as well as the reasons why this work is important. The session will overview many concepts and activities, all of which will be covered in

more depth later in the program. Group teams will be established to be used in all sessions moving forward.

Suggested Preparation for the Teacher/Facilitator

- Review moss materials from "Train the Trainer"
- DRCC clean air and moss materials
- DRCC clean air website review
- Video: Why air pollution can be worse across the street
- Expertise of any youth participants that have previously engaged in the program

Word Wall:

- Air pollution Material in the air that can harm human health
- Moss A plant that collects all its nutrients from the air and rain, not roots, and can therefore grow on many different surfaces
- Community Science A process where community members explore answers to their questions through collecting information, and analysis those data to develop conclusions.
- Environmental Justice -

Activity Instructions

- Introductions Everyone (~15 min)
 - o Name
 - Why are you here today?
 - \circ $\;$ Tell us about an experience that you have had with DVYC $\;$
- Handout and review journals (~15 min)
 - Basic intro to the journal
 - Evaluations and pre-survey materials
 - Introductory materials
- Intro to program Video (See Grist video: <u>Why air pollution can be worse across the street</u>) (~15min)
 - Short questions and discussion

• Teams (10-15 min)

Break up into smaller agreed upon groups – these are the groups they will use for the rest of the program.

- Grouping of youth with teachers/facilitators
 - Make team names
 - Announce team name
 - Flipchart paper:
 - Respect each other, help each other, make new friends, get a new experience,
 - Share out with the bigger group

- Ruby will combine small group agreements and type them out. Pass out at every session to remind everyone that these are agreements.
- In Teams (~10 min) Write out and share out with the full group Tell us what you know/have heard about this program?
 - What is air pollution?
 - Where does air pollution come from?
 - What is moss?
 - What is community science?
 - What do we mean by health? What does a healthy community look like to you? An unhealthy community?

------ 10 MIN BREAK ------

OUTSIDE (45-60 min)

- Walk out on the street and look at moss and trees
- Find trees, look at moss:
 - What is moss?
 - Street trees vs Residential trees private property and public property
 - Types of trees where moss is found deciduous
 - How are trees allocated across the neighborhood?
 - How are potential pollutions sources location in the neighborhood?
- Demonstrate an Airbeam or other sensor. Concepts:
 - Realtime information associated with particular locations
 - Variation of air quality across space
- Initial overview of GPS and mapping applications
 - How to find yourself
 - Orient your location within a map
 - Navigate to a point

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INSIDE

• Journals – fill out (10 min) before participants are able to leave

Evaluation/Journal

- Have you, members of your family, or some of your friends experienced environmental and health injustice?
- What is preventing you and/or them from achieving environmental and health justice?

Youth Corps Questionnaire

Na	me:	Age:
Scł	nool:	Grade:
1.	What are your two or three favorite subjects in school?	
2.	What jobs or careers are you most interested in doing after so	chool?

3. After you are done with school, how much do you think you might be interested in working in each of the following fields (Circle one number for EACH job field)?

Future Job Fields	Your level of interest?				
	1= Not at all			5=Very	
	interested			interested	
Teaching/education	1	2	3 4	5	
Police/fire	1	2	3 4	5	
Forests, parks, nature	1	2	3 4	5	
Health care/medicine	1	2	3 4	5	
City/community planning	1	2	3 4	5	
Music, art, entertainment	1	2	3 4	5	
Air or water pollution	1	2	3 4	5	
Animal care, veterinary	1	2	3 4	5	
Sports, athletics	1	2	3 4	5	
Community organizing or politics	1	2	3 4	5	
Wildlife/fish protection	1	2	3 4	5	
Science/research	1	2	3 4	5	
Crime investigation/forensics	1	2	3 4	5	
Food/beverages services	1	2	3 4	5	
Landscaping or lawn/garden care	1	2	3 4	5	
Mechanical or electrical trades	1	2	3 4	5	
Other?:					
	1	2	3 4	5	
	1	2	3 4	5	

First Training Session Day

- 1. What is moss?
 - □ Skin rash
 - □ Type of hair or fur
 - □ Small plants
 - □ Colorful fungus or stains
 - □ I have no idea
- 2. Where can moss be found?
 - Outdoors on trees, plants and rocks
 - □ On clothes and material
 - □ Inside a dirty house, garage, or basement
 - □ On animals and pets
 - On people's skin
 - □ I have no idea
- 3. Which of the following can moss help us to measure (CHECK ALL THAT APPLY)?
 - □ Indoor air quality
 - Outdoor air quality
 - □ Indoor water purity
 - □ Outdoor water pollution
 - □ Solar energy
 - □ I have no idea

4. Where can 'elemental metals' be found?

- Soil
- Water
- 🗆 Air
- □ All of the above
- I have no idea
- 5. How can trees help improve life in a city (CHECK ALL THAT APPLY)?
 - □ Cool the temperature during hot weather
 - □ Make neighborhood look nice
 - □ Increase house and property values
 - □ Reduce air pollution
 - □ Help clean up water
 - □ I have no idea

Lesson Plan 2: Moss Sample Collection

Time: 2-3 hours

Location: Inside (Classroom) and Outside (Community)

<u>Goal</u>:

Participants learn and practice moss sample collection techniques and understand the purpose of these approaches.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Youth will be able to navigate to a predetermined point and working from that point identify locations of Orthalyyie.
- Youth will practice how to collection the moss correctly from the tree
- Youth will practice reading their precise location using GPS, information about the moss and tree in a recording sheet
- Youth will understand why these techniques are used and how they enable understanding of their community
- They understand why we could collect using a sampling grid.

Materials:

- Team Field Bags (one for each group)
 - Disposable gloves,
 - Kapak bags (pre labeled matching your sample #),
 - o Permanente pens,
 - o Duct tape,
 - Smartphone with app and camera,
 - Moss Identification 'cheat sheet'
- Moss and lichen samples
- Step ladders
- Spray bottle (optional)
- Binder of support materials:
 - Overview of project for interested community
 - SDOT letter of support
 - Seattle Parks Permit
 - Moss identification 'cheat sheet'
 - Sampling and Sample Prep Protocols
 - 1-page Collection Protocols for Youth draft
 - Materials List
 - Covid-19 Safety Protocols

- Air Beam Protocols
- 2021 Staff Contact List
- Smart Phones with ap (multiple for each team)
 - Practice plots pre-loaded for each team
- Van or car for travel outside of walk shed (optional for training sessions)

Background:

• Youth will both learn and practice techniques for identifying site locations, identifying moss at sites, collecting moss, and recording their process.

Suggested Preparation for the Teacher/Facilitator

Resources:

• Methods are originally established here: <u>https://www.fs.usda.gov/treesearch/pubs/50919</u>

Additional Equipment:

- Air Beams and Dylos mobile air monitors have been attempted to be incorporated into these sessions as well. They are not presented here; however, they could be an important addition to provide youth participants immediate data to associate with the different parts of the community they are visiting.
- GPS phone ap prior to each field session tasks for each team should be loaded into the ap and shared with the appropriate teams.

Word Wall:

- **GPS** (Global positioning system) mapping software that uses a latitude and longitude to identify your location.
- Latitudes A set of lines that run straight east-west across the globe used to identify locations
- Longitudes A set of lines that run straight north-south across the globe used to identify locations

Activity Instructions

- Get into groups/ Teams (5 min)
- Pre-evaluation Pass out pre-evaluation as students enter room (10 min)
- Introduction/ refresher (10) min)
 - Team names
 - What are you excited to learn about today
- Review from Session/ Reflection why collecting moss and why particular locations (10 min)
 - Mapping and navigating practice in classroom (15 min)
 - Open and log into ap
 - Access your teams assignment
 - Identify the location
 - Pull up directs to navigate to the location

2022 Moss as Bio-Indicator

Youth Curriculum – 11 Session Lesson Plans

- Walk to a site as a group instructor walks all to known site (10 min)
 - Demonstrate how to navigate to point on phone ap
 - Once at site, do scan for nearest tree
 - Look for moss, if none, move on to next closest tree
 - Discuss what roughly 250 meters would be on this landscape/ how far is too far to go for a collection point
 - Discussion of private vs public property trees
 - Demonstrate identification methods (5 min)
 - Use moss id card/ cheat sheet
 - Use moss and lichen samples as needed so everyone can touch and look at various other types that they might find
 - Spray bottle can be used to wet the moss easier to identify when wet
 - Look at lichens and other mosses as comparisons
 - Demonstrate collection methods (10)
 - Follow collection protocols
 - o Special attention to getting gloves on, and touching only particular items
 - Be sure to collect at at least five locations on the tree
 - Be sure to also have students record information as you go
- Demonstrate recording methods (10 min)
- All return to classroom (5 min)
- Weigh samples and compile materials (15 min)
- Review and Reflection: (10 min)

Evaluation/Journal

Youth Corps Questionnaire (lesson 2)

Name: _____

Questions from introductory training

1. What is moss?

- Skin rash
- □ Type of hair or fur
- □ Small plants
- □ Colorful fungus or stains
- □ I have no idea

2. Where can moss be found?

- Outdoors on trees, plants and rocks
- On clothes and material
- □ Inside a dirty house, garage, or basement
- On animals and pets
- □ On people's skin
- □ I have no idea

- 3. Which of the following can moss help us to measure (CHECK ALL THAT APPLY)?
 - □ Indoor air quality
 - Outdoor air quality
 - □ Indoor water purity
 - Outdoor water pollution
 - □ Solar energy
 - □ I have no idea

4. Where can 'elemental metals' be found?

- Water
- 🗆 Air
- □ All of the above
- □ I have no idea

5. How can trees help improve life in a city (CHECK ALL THAT APPLY)?

- □ Cool the temperature during hot weather
- □ Make neighborhood look nice
- □ Increase house and property values
- □ Reduce air pollution
- □ Help clean up water
- □ I have no idea

Lesson 2: Reflection Continued: Moss sampling for air pollution analysis

- 1. How do you collect moss in the field?
 - □ With a sterilized metal or plastic scraper
 - □ Special vacuum or battery-operated pump
 - □ By hand with gloves on
 - □ With an ice cream scooper
 - □ You don't, you should never disrupt moss
 - □ I have no idea

2. What is the best location or source of moss for us to collect samples?

- Rocks and fences
- □ Hardwood trees and bushes
- □ Buildings and rooftops
- □ Metal structures and poles (like sign posts)
- All of the above
- I have no idea
- 3. Which of the following may contaminate moss samples and ruin its value to understand air pollution?
 - People's hands or breath
 - Dog pee

- Car exhaust
- Road splash
- All of the above
- I have no idea
- 4. How do you store moss after you collect it?
 - Plastic baggie
 - □ Small jar or laboratory petri dish
 - □ Special cloth bag
 - Kapak bag
 - □ I have no idea
- 5. About how much moss is needed from each site to conduct air pollution analysis?
 - □ About the size of a quarter
 - □ 1.5 grams
 - □ 5 grams
 - □ 100 grams
 - □ I have no idea
- 6. When sampling the moss, try to (CHECK ALL THAT APPLY)
 - □ Avoid anything that looks obviously weird
 - Get large fluffy clumps from at least 5 different spots on a tree
 - □ Get clumps from same tree or another tree within about 10 feet of the sample tree
 - □ Pick anything green that might or might not be the right type of moss
 - □ I have no idea

Lesson Plans sessions 3-6: Moss Collection

Time: 2-3 hours

Location: Outside in the community

<u>Goal</u>:

• Participants gain experience of moss sample collection

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Youth will be able to navigate to a predetermined point and working from that point identify locations of Orthalyyie.
- Youth will collect moss samples for analysis
- Youth guide to precise location using GPS, and record information about the moss and tree in a recording sheet
- Youth will understand why these techniques are used and how they enable understanding of their community
- They understand why we could collect using a sampling grid.

Materials:

- Team Field Bags (one for each group)
 - Disposable gloves,
 - Kapak bags (pre labeled matching your sample #),
 - o Permanente pens,
 - o Duct tape,
 - Smartphone with app and camera,
 - Moss Identification 'cheat sheet'
- Step ladder
- Binder of support materials:
 - o Overview of project for interested community
 - SDOT letter of support
 - Seattle Parks Permit
 - Moss identification 'cheat sheet'
 - Sampling and Sample Prep Protocols
 - 1-page Collection Protocols for Youth draft
 - Materials List
 - Covid-19 Safety Protocols
 - Air Beam Protocols (or similar device, if using)
 - 2021 Staff Contact List
- Smart Phones with ap (multiple for each team)

- Plot assignments pre-loaded for each team (3 for the first day, 4-5 subsequent days if travel is minimal)
- Van or car for travel outside of walk shed (driver identified)

Background:

See lesson 2.

Suggested Preparation for the Teacher/Facilitator

• See lesson 2

Word Wall:

No new words

Activity Instructions

Recording info:

- 1. Once at a tree you are going to sample: Use the app to record the exact latitude and longitude of where you are.
- 2. While moss is collected, another person takes 2-4 photos of the sampled tree. Make sure the numbers for each photo in your smart phone are correctly recorded into the field data sheet. Try to get at least one photo that includes all or most of the sampled tree, and a photo of the leaves. It's ok if the people are in the photo.
- 3. Fill out the data sheet fully and legibly. Recorded latitudes and longitudes should be double checked. Also make sure the moss samples are labeled properly.
 - The naming would be: centroid#_Teamname_ yyyymmdd
 - If it's a replicate, the name would be: centroid#-R_Teamname__yyyymmdd

Site selection and documentation:

- 4. If you can't find enough moss on a single tree or shrub, you can sample across multiple trees *if* they are clustered within 5 feet or so. Do not collect moss from multiple trees that are far apart.
- 5. If using multiple adjacent trees, make sure to note the special circumstances (multiple trees) in the 'Notes' column of the data sheet.
- 6. When possible, focus on sampling street trees since they are in the public right-of-way. Make sure not to cut into the tree or otherwise damage it.
- 7. Avoid trees receiving drip from roofs or that are near smoking areas.

Where to collect on the tree:

- 8. For each moss sample, pull out a fresh kapak bag and put on fresh gloves. Be sure not to touch anything with the gloves besides the moss, the tree you are sampling, and the inside of the kapak bag.
- 9. Collect moss from at least 8 spots on the tree if possible. You can collect anywhere above waist height (to avoid road splash). All moss you sample from a single site will go into the same

sample bag. Avoid collecting near nails in trees, barbed wire, other metal things that may be tacked onto it.

Selection of material to harvest:

- 10. Collecting large, fluffy material will save you time in the lab. Try to collect moss from its base. While you won't always succeed, it's easier to trim moss in the lab when the base is intact.
- 11. Try to avoid collecting dead moss. Usually dead moss is a blonde-brown color, less commonly, dead or dying tissue is orange or dark brown. Sometimes the tips will be green and the rest blonde-brown. Skip it.
- 12. Also skip anything that just looks obviously weird moss covered in slug slime, sap, debris.
- **13.** The moss naturally looks browner when it's dry. People new to collecting sometimes assume it's all dead.

Collecting:

- 14. Try to fill at least 1/3 to ½ of the sample bag, when moss is dry. If in doubt, get more than you think is needed.
- 15. When done collecting, press a bit of the air out of the bag so you have room at the top of the bag. Roll the top of the bag 3 times and seal completely with duct tape. Make sure there are no possible openings that would allow air exchange. Label the sample bag using the convention under step L.
- 16. Take a final picture of the sealed bag held up against the tree it was sampled from.
- 17. If this site has a lot of moss (enough for multiple bags worth), once finished with the sample, repeat the process. Remove gloves and start completely over again at step J, above. When you fill out this bag, make sure to label it with an R after the number.

Post Field:

Moss sample storage:

- Keep samples in a fridge (~4C). Do not freeze. It's ok to keep samples un-refrigerated while in the field but make sure to put them in a fridge that evening.
- If samples are very wet, try to prep them and dry them within 2 weeks. For moist samples, aim for 3 weeks. Dry moss samples can persist much longer in the fridge but our rule of thumb is to have all samples prepped and dried by 3 weeks.
- When moss starts to decay it will smell like vinegar and may start to blacken or grow fuzzy red fungi on the stems. Any signs of decay will be recorded in the Sample Preparation datasheet.

Data handling:

- Gathering all the datasheets and scanning them to a shared folder. Keep hardcopies together in a safe place
- Compile all the voucher photos into a single folder per group. Upload to a shared folder.
- Soon after the field days enter date to Excel, with a second person proofreading (checking whether hardcopy matches spreadsheet), and keeping track of any errors that can't be immediately resolved. Upload spreadsheets to shared folder.

Evaluation/ Journal

Using the flip chat teams report back on their day:

- What went well?
- What was difficult?

Lesson Plan 7: Sample Prep Training

Time: 2-3 hours

Location: Inside (preferably a lab setting)

Ample desk space, easy electrical access, ability to sanitize

Goal:

- Youth will learn about what happens next with the moss samples they've collected.
- They will learn why and how it needs to be prepared to be sent to the lab.
- Youth will practice preparing moss samples.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Explain why the moss samples need to be prepared
- Describe the process for the samples from collection through lab analysis
- Practice preparing a raw moss sample, identifying and dividing moss components, and package it for the lab
- Record sample tracking as it moves from a collection sample to a new sample bag
- Set up and clean up a sterile work environment

Materials:

- Kapak bags of Moss from your previous day's collections
- Cooler to put completed moss bags in
- 3 large glass petri dishes, bowls, or watch plates per person
- 70% ethanol, to share
- Deionized water, to share
- Forceps, to share
- Large pair of scissors (titanium or ceramic is ideal), per person
- Colored powder-free nitrile gloves, per person
- Prelabeled Kapak bags, per person
- Duct tape, to share
- Sharpie, to share
- Scale, to share
- Kimwipes or unbleached paper towels, to share
- Headlamps or desk lamps to share
- Sample Prep Tracking Worksheet, to share
- Sample Prep Protocols Instructions, to share

Background:

Sample prep is arguably the most important step in this study and the one with greatest potential for introducing error to the results. This is how we take something we found outside and turn it into a valuable piece of data that lab technicians at the University of Washington will work with.

Our biggest struggle is avoiding contamination by dust or contact with scissors, gloves, that have touched other samples. Take a paranoid view –assume surfaces are contaminated until you've thoroughly wiped them down with ethanol. Change gloves as many times as needed, and wipe everything between samples. This process will work on meticulous, careful precision skills, in contracts to the large-scale neighborhood searches completed previously. These skills are transferable to a range of scientific work in the future.

Suggested Preparation for the Teacher/Facilitator

- Sample Prep Protocols are found here: <u>https://drive.google.com/file/d/1Apzj1QVfXXJewRnx5OKFdXjsSyksmWHw/view?usp=sharing</u>
- Youth Specific Protocols here: <u>https://drive.google.com/file/d/1yl8NGi-gtFPhQ2q8YNaIn2Gya5fjLxTs/view?usp=sharing</u>
 Multiple copies should be available for youth participants.
- Image deck for lesson is here: <u>https://drive.google.com/file/d/1zr3iKSu9CaPYiuYmMUO-s03-sQtryXRv/view?usp=sharing</u>

Word Wall:

- **Rhizoid-** a outgrowth or root hair on the underside of the thallus in some lower plants, especially mosses and liverworts, serving both to anchor the plant.
- Forceps- hinged instrument used for grasping and holding objects
- Sterile- free from bacteria or other living microorganisms; totally clean
- **Paranoid** showing suspicion and mistrust
- **Digestion** the process of treating a substance by means of heat, enzymes, or a solvent to promote decomposition or extract essential components.

Activity Instructions

- Participants get into groups, with their tables organized around a training table (5min)
- Set up all supplies each youth should have a set of materials. Use practice moss samples collected during the sample collection training day or other practice samples that may have been collected. (20 min)
- Intro and welcome (5 min)
- Trainer has table set up in full view of each group, and describes each of the tools used for sample prep (5 min)
- Youth gloved up and work through their first sample (staff support answer questions provide motivation, ensure forms are filled out completely and correctly) (5min)

- Trainer begins preparing sample and participants to follow along with their own sample. Not necessary to get it perfect this first practice attempt (15-20 min) (SEE FULL PREP INSTRUCTIONS IN THE BELOW LESSON.)
- Weigh the samples. Staff ensure scale is teared correctly and forms filled out correctly. (10 min) *Stretch and bathroom break* (10min)
- Repeat with a second sample, make sure another group member has an opportunity to practice each step. Someone else preps, someone else records and weighs. (15-20min)
- Group Reflection recap the session, write summary on your flip chart (5 min)
- Clean up (10 min)

Evaluation/ Journal

Collection Recall/Post

1. How do you collect moss in the field?

- □ With a sterilized metal or plastic scraper
- □ Special vacuum or battery-operated pump
- □ By hand with gloves on
- □ With an ice cream scooper
- □ You don't, you should never disrupt moss
- I have no idea
- 2. What is the best location or source of moss for us to collect samples?
 - Rocks and fences
 - □ Hardwood trees and bushes
 - □ Buildings and rooftops
 - □ Metal structures and poles (like sign posts)
 - $\hfill \ensuremath{\mathsf{All}}$ of the above
 - □ I have no idea

3. Which of the following may contaminate moss samples and ruin its value to understand air pollution?

- People's hands or breath
- Dog pee
- Car exhaust
- Road splash
- □ All of the above
- □ I have no idea
- 4. How do you store moss after you collect it?
 - Plastic baggie
 - □ Small jar or laboratory petri dish
 - Special cloth bag
 - Kapak bag
 - □ I have no idea

5. About how much moss is needed from each site to conduct air pollution analysis?

- □ About the size of a quarter
- □ 1.5 grams
- □ 5 grams
- □ 100 grams
- □ I have no idea

6. When sampling the moss, try to (CHECK ALL THAT APPLY)

- □ Avoid anything that looks obviously weird
- Get large fluffy clumps from at least 5 different spots on a tree
- □ Get clumps from same tree or another tree within about 10 feet of the sample tree
- □ Pick anything green that might or might not be the right type of moss
- □ I have no idea

Third Training Day: Moss Sample Prep

- 1. "Prepping the sample" means that you will
 - □ Carefully cut and trim the healthiest (green) part of each field sample for analysis
 - □ Carefully cut and trim the dead and dying (yellow, brown) parts to keep for analysis
 - □ Keep both green and brown parts of the moss for analysis
 - □ Separate all parts of the moss (live, dying, bugs, twigs . . .) for analysis
 - I have no idea
- 2. Prepping the sample for analysis
 - □ Is quick and easy
 - □ Slow and tedious
 - □ The part of process that we DON'T have worry about contaminating the moss
 - □ Takes 3 or 4 months to complete
 - I have no idea
- 3. Potential sources of moss contamination during prepping include:
 - □ Sneezing or coughing on the sample
 - □ Touching the sample without gloves
 - □ Perfume, make up, aftershave . . .
 - $\hfill \ensuremath{\square}$ All of the above
 - □ None of the above, contamination is NOT a problem during sample prep
 - I have no idea
- 4. After prepping, each sample we will put them
 - □ in labelled petri dish on a shelf in the lab
 - \Box an oven to heat and dry them
 - in a refrigerator to cool and preserve them
 - □ back in the original labelled collection bags
 - I have no idea
- 5. After you are finished with prepping all the samples, the chemical analysis will take about

- □ 3-4 days
- □ 3-4 weeks
- □ 3-4 months
- □ 3-4 years
- □ I have no idea

6. If our study finds some air pollution 'hot spots', that means . . . (CHECK ALL THAT APPLY)

- Air quality experts need to investigate to see if there is actually an air pollution problem or not
- □ Air quality experts will try to identify a potential source of the pollution
- □ Air quality experts may bring in highly technical air quality monitors
- □ Your community leaders can use results to encourage help from environmental experts
- □ I have no idea

Lesson Plans sessions 8-9: Sample Prep

Time: 2-3 hours each

Location: Inside (preferably a lab setting)

Ample desk space, easy electrical access, ability to sanitize

<u>Goal</u>:

- Participants will gain experience preparing moss samples for lab analysis.
- Participants will learn why and how it needs to be prepared to be sent to the lab.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Explain why the moss samples need to be prepared
- Describe the process for the samples from collection through lab analysis
- Prepare multiple raw moss samples, identifying and dividing moss components, and package them for the lab
- Record sample tracking as it moves from a collection sample to a new sample bag
- Set up and clean up a sterile work environment

Materials: (* items need to be sanitized before every sample)

- Kapak bags of Moss from your previous day's collections
- Cooler to put completed moss bags in
- *3 large glass petri dishes, bowls, or watch plates per person
- 70% ethanol, to share
- Deionized water, to share
- *Forceps, to share
- *Large pair of scissors (titanium or ceramic is ideal), per person
- Colored powder-free nitrile gloves, per person
- Prelabeled Kapak bags, per person
- Duct tape, to share
- Sharpie, to share
- Scale, to share
- Kimwipes or unbleached paper towels, to share
- Headlamps or desk lamps to share
- Sample Prep Tracking Worksheet, to share
- Sample Prep Protocols Instructions, to share

Background:

Participants should attempt one-two samples each these day. If there are not enough samples one team member could work on filling out forms, providing cleaning support and additional encouragement. Also, could work to have youth swap in halfway through a sample if the process becomes too tedious, no need to complete a whole sample per person.

Suggested Preparation for the Teacher/Facilitator

- Sample Prep Protocols are found here: <u>https://drive.google.com/file/d/1Apzj1QVfXXJewRnx5OKFdXjsSyksmWHw/view?usp=sharing</u>
- Youth Specific Protocols here: <u>https://drive.google.com/file/d/1yl8NGi-gtFPhQ2q8YNaIn2Gya5fjLxTs/view?usp=sharing</u>
 Multiple copies should be available for youth participants.
- Image deck for lesson is here: <u>https://drive.google.com/file/d/1zr3iKSu9CaPYiuYmMUO-s03-sQtryXRv/view?usp=sharing</u>

Word Wall:

- **Rhizoid-** a outgrowth or root hair on the underside of the thallus in some lower plants, especially mosses and liverworts, serving both to anchor the plant.
- Forceps- hinged instrument used for grasping and holding objects
- Sterile- free from bacteria or other living microorganisms; totally clean
- Paranoid showing suspicion and mistrust
- **Digestion** the process of treating a substance by means of heat, enzymes, or a solvent to promote decomposition or extract essential components.

Activity Instructions

This process is very important and it is very difficult. Go slow. It takes time.

The absolute minimum weight we need to send to the lab is 1.5 g of dry moss, and our target is 3g or more. When the moss is wet, you can't rely on what the scale says and will need to guess.

For large, "good" samples with large fluffy clumps, prep usually takes 20 minutes. For more difficult samples, prep may take 30-45 min.

Set Up:

1. Wipe down the table with ethanol. Do this until the wipes don't collect any new dirt.

2. Use ethanol and wipes or paper towels to fully wipe down your forceps, scissors, and your glassware, including the underside of the glassware, before placing on the table.

3. Use a desk lamp or headlamp if needed to see the moss well- Good lighting is important.

4. Write down the label of the bag of moss you are starting with on your Tracking Sheet under "Label on bag moss came from".

5. Make sure the ethanol has evaporated from sterilized surfaces before they touch moss.

6. Adjust your clothes as needed. Put on gloves.

Sample Preparation:

(Re-sanitize everything between your samples)

7. Cut open the bag of moss with your scissors.

8. Pour moss from the bag onto one of the glass bowls or plates (see photo 1). (The other two plates will hold the prepped sample and the discard pile).

(The moss plants go from green to brownish to grubby old brown bases with fuzzy rhizoids and dirt But - you don't want to get rid of all the brown parts)

9. Start with large clumps - Use scissors to cut off the moss base, discolored tissue, foreign debris, insects.

(Trim the moss above one of your plates. If moss is dropped onto the table you can still use it since you sterilized that surface)

(You will be keeping the upper half to 2/3 of the moss stem (photo 2). Some of the live reddish-brown material under the green tips should be included (photos 3-4).)

10. Once you have trimmed the clump, put the remainder on your discard plate (photo 5).

11. If a clump has a lot of dead tissue (usually blonde-brown in color) set it aside and come back to it only if you run out of healthy material.





12. Note any special circumstances, like a lot of dead material, on the sample prep worksheet.

(Once you have gone through the whole bag)

13. Go to your plate of prepped sample. Use your forceps to pick out debris you may have missed and dead moss parts. You can use gloved hands if that's easier.

(You won't be able to get every single speck of dirt out. Use photos 3-4 as reference for what your final sample should look like.)

14. Gently toss all cleaned tissue with glove covered hands (this loosens additional debris) around within the glass bowl or plate it sits in.

15. Use gloved hands to transfer moss to a fresh **prelabeled** Kapak bag. Don't dump from the plate. Picking up the moss will leave behind any debris that has fallen out. (Don't tear bag - it is pre-opened on one side at the top)

16. Weigh the prepped sample. Record weight on sample tracking sheet **minus the weight of the bag**.

17. Roll top of Kapak bag and seal with duct tape, airtight!

18. Check to make sure the label the sample bag matches the one on your worksheet.

19. Note any abnormalities on the tracking sheet - like confusion on bag labels, or sample weights.

Photo 2 Discarded Portions Photo 3 Where to Cut



Photo 5 Prepared Sample Up Close



20. Put sample back in the cooler. Change gloves and start with a new sample.

Evaluation/ Journal

Evaluations – Sample Prep Post:

Moss Sample Prep Questions

- 1. "Prepping the sample" means that you will
 - □ Carefully cut and trim the healthiest (green) part of each field sample for analysis
 - □ Carefully cut and trim the dead and dying (yellow, brown) parts to keep for analysis
 - □ Keep both green and brown parts of the moss for analysis
 - □ Separate all parts of the moss (live, dying, bugs, twigs . . .) for analysis
 - □ I have no idea
- 2. Prepping the sample for analysis
 - □ Is quick and easy
 - □ Slow and tedious
 - □ The part of process that we DON'T have worry about contaminating the moss
 - □ Takes 3 or 4 months to complete
 - I have no idea
- 3. Potential sources of moss contamination during prepping include:
 - □ Sneezing or coughing on the sample
 - □ Touching the sample without gloves
 - □ Perfume, make up, aftershave . . .
 - □ All of the above
 - □ None of the above, contamination is NOT a problem during sample prep
 - I have no idea
- 4. After prepping, each sample we will put them
 - □ in labelled petri dish on a shelf in the lab
 - \Box an oven to heat and dry them
 - □ in a refrigerator to cool and preserve them
 - □ back in the original labelled collection bags
 - I have no idea
- 5. After you are finished with prepping all the samples, the chemical analysis will take about
 - □ 3-4 days
 - □ 3-4 weeks
 - □ 3-4 months
 - 3-4 years
 - I have no idea
- 6. If our study finds some air pollution 'hot spots', that means . . . (CHECK ALL THAT APPLY)
 - □ Air quality experts need to investigate to see if there is actually an air pollution problem or not

- Air quality experts will try to identify a potential source of the pollution
- Air quality experts may bring in highly technical air quality monitors
- □ Your community leaders can use results to encourage help from environmental experts
- □ I have no idea

Lesson Plan 10: Data Analysis (Thinking like a Geographer)

Time: 2-3 hours

Location: Inside

<u>Goal</u>:

Participants will review the type of information that a pollution concentrations map contains. They will order metal concentrations in ascending order on the sides of the map.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- List at least 3 components of information that one finds on a map
- Explain the purpose of this map interpretation exercise

Materials:

- Maps of Georgetown/South Park
 - o Lead
 - o Chromium
 - o Nickel
 - o Arsenic
 - Cobalt
- Map of Seattle Parks (In future for comparative purposes)
- Pen/pencils
- Colored pins (red, orange, yellow)

Background:

We have spent the last nine weeks learning how to collect moss and prepare moss samples for the lab. But why are we collecting moss? This session will help explain the value of doing this work, and clearly connect it to air quality efforts in the DV. We will utilize the previous seasons metals concentrations data as an immediate result set for the participants to work with.

Suggested Preparation for the Teacher/Facilitator

- Sarah Jovan paper
- <u>Sarah Jovan presentation</u>
- Story of John Snow and the Broad Street pump

- Basic elements of reading a map
- Faith and Leilani presentation

Word Wall:

- Key description of symbols on a map to help understand the information
- Legend the place where a key and other explanations are found on a map or image
- Land use categories of human uses of land used to describe the environment
- Scale the relationship between the distance on a map and the distance in reality
- Outlier a data point that differs significantly from the others

Activity Instructions

- Participants gather in groups (5 min)
- Recap the sample preparation session. Questions or missing understandings? (5-10 min)
- What did we learn? (we will look back at previous seasons data to work with available results).
 - Pass out 4 (or 5) maps with different concentrations of lead, chromium, nickel and arsenic. (In the future sessions, these maps ideally should have no color on them. They will have column on both sides of the map labeled 1-50 where the concentrations from high to low can be written.) (10min)
- Review a large poster map (or smaller group maps) and orient ourselves (15 min)
 - What does the title say?
 - What do we mean by land use? What does mixed parcels mean?
 - Which way is north? Is this standard?
 - What does the scale mean? What is the conversion from km to miles?
 - What is a legend on a map?
 - What is a key on the map?
 - What is an outlier? (not sure if this will be reviewed)
- Working in teams Find the highest 10 concentrations on the map (1-10) (10min)
- Individually review the map and write down the top 10 concentrations on the side of the map and label them red or use a red pen. (10min)
 - There might be some repeats of the same concentration. Example: 1) 3.2; 2) 2.8;
 3) 2.8; 4) 2.5......
- Find the medium concentrations on the map (11-25). (10min)
 - Review the map and write down concentrations from 11-25 on the side of the map and mark them with an orange pen or highlighter.
- Find the lower concentrations on the map (26-lowest). (10min)
 - Review the map and write down the concentrations from 26 to the end on the side of the map and mark them with a yellow highlighter.

• Observations: What have you observed so far as you were creating the list of concentrations? Groups take turns reporting back. (10-15min)

Evaluation/ Journal

- What did I see or learn today?
- How did it make me feel?
- What do I think can be done about it?
- What would my action be?

Lesson Plan 11: What Next? - Taking Action

Time: 2-3 hours

Location: Inside and Outside

<u>Goal</u>:

Interpret the metals maps and develop some ideas about where the metals (sources) are coming from. Discuss next steps about what can be done to reduce pollution – stop sources and mitigate what is there.

Learning Objectives:

By the end of this lesson plan, participants will be able to:

- Describe the story of John Snow and the London cholera outbreak
- Discuss where concentrations are high, medium, and low on the map
- Compare park or "background" metals concentrations to South Park and Georgetown metals concentrations
- Discuss possible sources of contamination
- Differentiate between metals in moss as an indicator vs health implications
- Develop a list of next steps for action

Materials:

- Maps of Georgetown/South Park
 - o Lead
 - Chromium
 - o Nickel
 - o Arsenic
 - Cobalt
- Map of Seattle Parks (In future for comparative purposes)
- Pen/pencils
- Colored pens (red, orange, yellow)
- Large poster-board size map of Georgetown/South Park
- Push-pins (red, orange, yellow)
- Plastic take-out lid (3 inches in diameter)

Background:

We have spent the last ten weeks learning how to collect moss and prepare moss samples for the lab. But why are we collecting moss? This session will help explain the value of doing this work, and clearly connect it to air quality efforts in the DV. We will utilize the previous seasons metals concentrations data as an immediate result set for the participants to work with.

Suggested Preparation for the Teacher/Facilitator

- Sarah Jovan paper
- Sarah Jovan presentation
- Story of John Snow and the Broad Street pump
- Basic elements of reading a map
- Faith and Leilani presentation
- Metals sources (make a sheet of what metals sources might be)
- Amanda Bidwell's parks moss paper

Word Wall:

- Cholera
- Hot spot
- Background/baseline
- Indicator
- Distribution
- Source

Activity Instructions

1. Story of John Snow- (10 min)

2. Maps from Part 1 (lesson 10) – Working individually, participants color in the concentrations on the maps. (10 min)

- Use the red, orange and yellow pens to color in the high, medium, and low concentrations
- What are you observing?
- Create a symbol for your metal (ie, arsenic could be a triangle and insert the symbol into your map legend)

3. Large Poster board with blown up GT/SP map. Full class discussion (15-20 min)

• Use red, orange, and yellow push pins and the metal symbol (triangle, circle, square)

2022 Moss as Bio-Indicator

Youth Curriculum – 11 Session Lesson Plans

- What pattern/s are emerging? (Are the metals randomly distributed? Or do they look like they are concentrated or clustered in one area?)
- Use a take-out drink lid to draw circles around the high concentration areas
 - Where are we seeing the highest concentrations of metals (hot spot/s)
 - Are there some metals that are not there?
- How do we know if these concentrations are irregularly high? What would you compare them to? What do we mean by "background"? Amanda's parks maps
- What do you think the source is (Where do you think the problem is coming from?)
 - Industry? The Duwamish River? Dusty roads? Cars? Trucks? Old contaminated sites that haven't been cleaned up?
- Lower concentration areas
 - Where does it look like there are smaller concentrations of metals?
 - What are some reasons why you think the concentrations are lower?
- 4. Full class discussion on sources -Where do metals come from? (10min)
 - o Lead
 - o Chromium
 - o Nickel
 - o Arsenic
 - o Cobalt

(Create a sheet of where each metal comes from naturally and anthropogenically so that connections can be made to the possible sources)

5. Action/Next steps (15min)

- Now that we see these "hot spots", what should we do next?
- What are the moss samples really measuring?
- Do other neighborhoods in Seattle have these same moss concentrations? Why or why not?
- What is the relationship between metals in moss and potential health problems?
- How do we know if these concentrations are causing a health problem?
- If we want to determine if the moss concentrations are causing health issues, what would we do? (PSCAA sampling.....)
 - More sampling? If yes, what kind of sampling would we do?
 - Where would we sample?
 - What kind of monitors?
 - When would we do the sampling? (Seasons)
 - Who would do the sampling?
 - Who would we ask for assistance?
 - o
- 6. Reflection (10min)

- What did I see or learn today?
- How did it make me feel?
- What do I think can be done about it?
- What would my action be?

Evaluation/ Journal

- How did the moss study experience change your beliefs about environmental and health justice?
- What did you learn in this experience that you could not have learned in a traditional science class?
- Based on your experience and the reading on the next pages, who should do more to help the Duwamish River Valley achieve environmental and health justice?

Name: _____

- 1. Compared to other Youth Corps projects, did you like or dislike the moss collection project?
 - Disliked it a lot
 - Disliked it a little
 - □ It was OK
 - Liked it a little
 - Liked it a lot

2a. What did you LIKE about the project? ______

2b. What did you DISLIKE about the project? _____

- 3. What jobs or careers are you most interested in doing after school? ______
- 4. After you are done with school, how much do you think you might be interested in working in each of the following fields (Circle one number for EACH job field)?

Future Job Fields	Your level of interest?					
	1= Not at all			5=Very		
	interested			interested		
Teaching/education	1	2	3 4	5		
Police/fire	1	2	3 4	5		

Forests, parks, nature	1	2	3	4	5
Health care/medicine	1	2	3	4	5
City/community planning	1	2	3	4	5
Music, art, entertainment	1	2	3	4	5
Air or water pollution	1	2	3	4	5
Animal care, veterinary	1	2	3	4	5
Sports, athletics	1	2	3	4	5
Community organizing or politics	1	2	3	4	5
Wildlife/fish protection	1	2	3	4	5
Science/research	1	2	3	4	5
Crime investigation/forensics	1	2	3	4	5
Food/beverages services	1	2	3	4	5
Landscaping or lawn/garden care	1	2	3	4	5
Mechanical or electrical trades	1	2	3	4	5
Other?:					
	1	2	3	4	5

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