



**UBC**  
**Botanical**  
**Garden**

**Educational**  
**Resource**  
**For Teachers**

# **Applications of Sound: Spectrograms and Identifying Species**

2024

**RESOURCE OVERVIEW****Garden Visit, Lesson/Activities****Grade 11** – Physics

May 31, 2024

**Applications of Sound**  
Spectrograms and Identifying Species**Overview**

Before, throughout, and after a garden visit to the UBC Botanical Garden, or another natural environment, students will look at how the frequency of sound is connected to animal calls and can be used to identify species. The primary focus of this lesson and its activities will be bird identification but can be extended to include other species such as frogs and whales. Students will experience using both generalized sound recording functions in apps and a purpose-built app for bird identification.

**Core Competencies**

Thinking: Critical Thinking and Reflective Thinking

Students will think about wider applications and reflect on the limitations of the method.

Personal and Social: Social Awareness and Responsibility

Students will consider their responsibilities toward the natural environment through developing an understanding of topic related concepts, such as the purposes of species identification and monitoring.

**Curricular Competencies**

Students will be able to:

Physics 11

- Processing and analyzing data and information:
  1. Analyze and interpret graphs (sonographs).
  2. Experience and interpret the local environment.
- Communicating:
  3. Communicate scientific ideas and information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations.

## Big Ideas

**Physics 11:** Mechanical waves transfer energy but not matter.

## Objectives

This lesson aims to apply student understanding of the physics of sound to real applications, particularly species identification.

## Content

Students will understand:

1. The connection between the frequency of sound and vocalizations made by people and animals.
2. That sonographs represent the time-evolution of sound frequencies.
3. The frequencies of vocalizations and their time-evolution can be used to identify species.
4. Sound-based species identification is a tool for monitoring biodiversity in ecosystems.

Throughout the activities, discussions, and learning, this lesson aims to foster an understanding for the need for monitoring biodiversity in nature when considering the impact of humans.

The activities provide students the opportunity to explore the connections between the frequency of sounds, graphical methods for representing these sounds and their time-evolution, and species vocalizations.

## Cross-curricular + Trans-disciplinary Connections and Critical Questions

### 1. Environmental Science 11:

**Big Idea:** Complex roles and relationships contribute to diversity of ecosystems.

**Content:** ecosystem complexity, levels of biotic diversity, restoration practices

- a. How can sound be used to survey the biodiversity of an ecosystem?
- b. What are the advantages and disadvantages of using sound to survey biodiversity? (What are its limitations?)

## Equity and Diversity

The resources listed in this lesson plan are intended to be used in the UBC Botanical Garden or another natural environment. Alternatively, a reasonably similar activity can be conducted within the classroom to give those unable to travel to a natural space the ability to complete the learning objectives.

When implementing this activity in the classroom, the resources provided allow participants to tailor sounds to various regions through audio recordings from around the world.

## First Peoples' Principles of Learning

Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.

Students will look at how sound can help monitor species and so the biodiversity and health of ecosystems.

Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).

Students will experience using applications to directly record calls and songs of birds, ideally in natural environments.

---

**LESSON PLAN****Garden Visit and Lesson Plan****Grade 11** – Physics

May 31, 2024

**Applications of Sound**  
Spectrograms and Identifying Species**Materials and Equipment:**

- Merlin Bird ID app for teacher and students
- speaker
- one of Spectroid, phyphox, or Physics Toolbox Sensor Suite
- post tour reflection handout

**Duration:**

Pre-visit – 30-minute in-class introduction  
Garden-visit – 60-minute tour/activity time at UBC Botanical Garden  
Post-visit – 20-minute in-class post tour debrief

**Resource and Material Links****Main:**Merlin Bird ID - [merlin.allaboutbirds.org/](https://merlin.allaboutbirds.org/)Spectroid - [play.google.com/store/apps/details?id=org.intoorbit.spectrum&pli=1](https://play.google.com/store/apps/details?id=org.intoorbit.spectrum&pli=1)phyphox - [phyphox.org/](https://phyphox.org/)Physics Toolbox Sensor Suite - [www.vieyrasoftware.net/physics-toolbox-sensor-suite](http://www.vieyrasoftware.net/physics-toolbox-sensor-suite)**Additional Resources:**CornellLab Bird Academy - <https://academy.allaboutbirds.org/>Bird Song Hero - <https://academy.allaboutbirds.org/features/bird-song-hero/bird-song-hero-tutorial>Bird Song Hero Video Quiz - <https://academy.allaboutbirds.org/bird-song-hero-video-quiz/>

- Note: completion of the activities leads to a free download of bird songs
- xeno-canto -
- <https://xeno-canto.org/>

## Lesson Preparation

1. Consider making groups or checking students access to smartphones or tablets.
2. Share links to relevant apps with students and have them download and install them in advance. Note: File sizes, especially for Merlin, can be quite large. Packages for birds of different regions can range up to 1 GB in Merlin.
3. Select some example bird calls and songs for use during the lesson.
4. Explore the options (especially for Spectroid) in changing the parameters of the spectrograms.

Note: When arranging your tour, ask for a focus on the best locations to monitor biodiversity and species identification, especially birds.

---

## Introduction + Minds On

**Materials:** Merlin Bird ID app, speaker and one of Spectroid, phyphox, or Physics Toolbox Sensor Suite

1. Open the pre-visit learning with a tie-in to the previous content on sound and frequency.
2. Introduce the concept of a Fourier Transform (FT) graph:
  - a. x-axis is frequency
  - b. y-axis is absolute/relative strength
  - c. Examples checking concept and demos with tuning fork or tone generator
3. Introduce spectrograms:
  - a. FT graph + time dimension
  - b. Display complex changing patterns not otherwise easily recognizable
  - c. Examples checking concept and demos with tuning fork or tone generator and music or other time evolving sounds
4. Student exploration:
  - a. Look at common sounds (clapping, etc.)
  - b. Look at spoken sounds (individual vowels and words work best) for different speakers
5. Tie into sound and species ID:
  - a. Discussion questions:

"What applications could this be used for?"  
"How could this be used for identifying animals?"  
"What would be needed to use this for ... ?"

---

## Lesson

**Materials:** post-tour reflection handout

At the garden:

1. Participate in a garden tour paying attention to the soundscape of the garden and the vocalizations of birds and/or other species
2. After the tour, use Merlin and another app to look at the spectrographs of bird sounds and identify them
3. Reflect on what they learned, noticed, anything that stood out to them.
4. Begin reflecting on the post-visit discussion questions:
  - What problems or limitations does this form of species identification and monitoring present?
  - What other species could this form of identification be used for?

---

## Debrief + Consolidation

Group discussions of the questions for after the tour (at the garden or back in the classroom):

- What problems or limitations does this form of species identification and monitoring present?
- What other species could this form of identification be used for?

---

## Modifications/Alterations

The outdoor activities in this lesson can be replicated in any natural space frequented by birds and with relatively low background noise.

This outdoor activities in this lesson can also be partly replicated within a classroom environment using the repository of recordings included within the Merlin Bird ID app.

---