



# The Bio/Diversity Project

## Data Science Outreach Curriculum Fall 2025

### Lesson 2: How Can We Use Sensors?

**Grade Level:** 8th

**Time:** 50 minutes

#### **AZ Science Standards:**

- **8.U1:** Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.
- **8.U2:** The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.

#### **Student Facing Learning Objectives:**

- I can explain how sensors help us measure invisible environmental factors.
- I can identify four key areas Tucson monitors (air, climate, land, and wildlife)
- I can interpret environmental data to identify changes in the Sonoran Desert.
- I can connect data interpretation to community and conservation decisions.

#### **Guiding Questions:**

- How do we know the desert is changing if we can't see it directly?
- What do sensors measure that our senses might miss?

#### **Vocabulary:**

- Sensor
- AQI (Air Quality Index)
- Air pressure
- Habitat fragmentation
- Monitoring

#### **Materials:**

- [L2 Slides\\_Energy](#)
- Arduino Science Kit R3
- Device with science kit installed (phone/tablet)
- [L2 Station Print-Outs](#) (one copy of this document per class)
- [L2 Station Worksheets](#) (one worksheet per group)



# The Bio/Diversity Project

## Lesson 2: How Can We Use Sensors?

### Background for teachers:

- Environmental monitoring means collecting consistent, measurable data about air, water, climate, and living things so we can understand changes over time. Pima County uses this information to make decisions about land use, air pollution alerts, and habitat conservation.
- In Tucson, our Sonoran Desert ecosystem is especially sensitive to temperature and rainfall changes. Because we live in an arid environment, even small shifts in precipitation or human activity can have huge impacts on plant growth, soil stability, and wildlife.
- Scientists rely on sensors (devices that detect and measure environmental conditions) to collect reliable data to reveal patterns like pollution spikes or habitat loss.

### Local context (for Tucson)

- Air quality is a major concern due to dust storms, vehicle emissions, and wildfire smoke. Tucson's basin geography traps fine particles (PM2.5), worsening respiratory health.
- Climate in the Sonoran Desert is defined by two rainy seasons: winter and the summer monsoon. Drought and heat waves are intensifying, changing the timing of flowering, pollination, and migration.
- Land cover changes quickly near Tucson's edges as desert habitat is converted to housing and roads, fragmenting the landscape.
  - Fragmentation of a landscape means a large, continuous area of habitat is divided into smaller, more isolated patches. This reduces habitat area, isolates habitat patches, disrupts ecosystem processes, and can lead to animal deaths on roads and highways from vehicle collisions.
- Wildlife monitoring helps conservationists see how animals respond to urbanization. Some, like coyotes, javelina, and desert cottontails, adapt well. Others, like pollinators or sensitive desert reptiles, decline as habitat shrinks.



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## Mini-Lesson (5-10 minutes)

### Connection to last class

Example script/flow for teachers!

1. “Last class, we learned that data are pieces of information that tell us what’s happening in the world. Today, we’ll use data to see what’s happening to our desert.”
2. “Sensors help us measure things we can’t see. Like tiny dust particles, rainfall, temperature, or animals that only come out at night.”

**Slideshow hook:** How do we know the desert is changing?

1. **Can we tell how bad this dust storm is just by looking?**
  - a. Kind of, but we could also use sensors that measure particles in the air to track the Air Quality Index (AQI) to accurately assess the severity of the dust storm.
2. **Wildlife camera photo of javelina**
  - a. How could we record animals that we don’t always see in person?
  - b. Motion triggered cameras collect time-stamped data about species presence.
3. **Satellite image of Tucson**
  - a. What does less green space mean?
    - i. Less vegetation means less habitat, more urban development.

**Pima County Monitoring (1 slide each, 30-45s) Goal is to keep track of the health of the Sonoran Desert so people, animals, and plants can thrive.**

### Air Quality

- AQI monitors pollution that we can’t see. Tells us how clean or polluted our air is. Tucson’s main pollutants are dust (PM10) from dry soils and construction, fine particles (PM2.5) from cars and smoke, and ozone (O3) from sunlight reacting with emissions.
- Dust storms and wildfire smoke affect breathing. Data from the Pima County Department of Environmental Quality (PDEQ) informs air quality alerts.

### Climate

- Tucson is warming, and rainfall is becoming more variable. Some years have intense monsoons, others have droughts.
- Longer dry periods lead to vegetation die-off and more dust.
- Warming affects desert plants’ flowering timing and wildlife migrations.



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## Habitat & Land Cover

- Land cover is what's on the land's surface. Plants, water, or built areas. Satellites can keep track of how land cover changes.
- Between 1986 and 2020, Tucson expanded rapidly. More developed areas and less natural habitat means less continuous space for wildlife.
  - Fragmentation: roads and housing cut off animal movement.
  - Heat islands: developed land absorbs more heat, which raises temperatures.
  - Water runoff: paved surfaces prevent water from soaking into the soil.

## Species Monitoring

- Wildlife cameras, microphones, and tracking collars record species presence and activity.
- Tohono Chul and Sky Island Alliance run wildlife camera programs.
- Coyotes, javelina, and rabbits (cottontails) are often seen, meaning they adapt well to urban edges.
- Missing data (no photos) can also tell us when animals leave an area.

**Introduce today's task: Rotate through 4 stations that model the same monitoring Pima county uses. One includes your first Arduino reading.**

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## Work Time (30-35 minutes)

Explain each station's activity as a class before rotation begins. Students rotate through all or most stations, spending around 7 minutes at each, filling out their worksheets in groups. Use the timer on the slides to keep track of time.

### Station 1: Air Quality

- Read classroom air with Arduino AQ sensor. Check Tucson's current AQI on [AirNow.gov](https://airnow.gov)
- Record Arduino reading, AQI comparison, 1 reason values might differ (indoor/outdoor, ventilation, products, dust/smoke)
- Why Tucson?
  - Dust storms, wildfire smoke, traffic -> increase AQI
- Typical classroom air is cleaner (less dust, no smoke).
- Outdoor AQI is often higher due to traffic or dust storms.
- AQI key: 0–50 = Good, 51–100 = Moderate, 101+ = Unhealthy.



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- Encourage reasoning like: “Windows are closed, so less dust inside.”

## Station 2: Climate (Rain & Temperature)

- Read a Tucson rainfall graph and a Tucson temperature graph. Mark one drought year and one wet year.
- Record one pattern from either graph + one likely ecological impact (flowering timing, wildlife movement, water availability)
- Reasoning tips:
  - Drought -> fewer flowers -> less food for pollinators
  - Wet years -> stronger plant growth but more erosion
  - Monsoon timing and water cycles

## Station 3: Habitat & Land Cover

- Red = developed areas; green/tan = desert
- New roads and neighborhoods increase fragmentation
  - Consequence: harder for animals to cross or find food/shelter
- Imagine if your neighborhood suddenly got split by a highway. You would have fewer safe paths to walk around.

## Station 4: Species Monitoring

- Examine a camera trap photo and graph of species occurrences. The top 3 species are the desert cottontail, coyote, and javelina. These species are all commonly found near the city in neighborhoods, washes, yards, parks, gardens, and trash bins.
- Ask: “Why might animals visit the edge of town?”
  - Food sources, shade, water, fewer predators

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## Wrap-Up (5 minutes)

**Reflection:** Have students share about their experiences with the four stations. Ask the class questions like:

- What surprised you?
- What was the most interesting part?
- What was the most challenging part?
- How could you share something you learned today with your friends or family?