

Inventory Methods

For Plants and Wildlife on School or Community Grounds



Part I: Background

What Is an Inventory?

While there are many ways to study species that inhabit a school yard or community, a great way to start is by conducting an inventory. When exploring local ecosystems, consider the diversity of plants and animals within the area, the habitats in which they live, and the current and past land use.

An inventory is a list of the plants, animals, soil types, etc., in a given area. It may list the species of birds in a school yard or the different types of trees within a watershed. Such lists provide good information but may not necessarily include the actual number or census of specific plants or animals. The type of information found depends on how the inventory is conducted and the environmental factor (plant or animal) being inventoried. It may be a fairly simple task to count and identify all the trees in a small school yard. In this case, a simple inventory based on observation, identification, and actual count results in an inventory that includes the census or number of trees.

However, it is more difficult to get the exact number of a particular species of bird or butterfly in a school yard. Typically, a bird and butterfly inventory will provide a list of the species found in a certain area. The numbers of each species observed during the inventory may also be recorded. These numbers can then be used as an index to provide an idea of which species may be more common in that area or during a certain time of year.

Inventories can be based on a standardized method and timing, or they may be based on informal sightings. Many parks keep a running inventory of their plants and animals. Visitors jot down their sightings that, if confirmed, are then added to the park's inventory list. Other methods may be more formal, with volunteers doing an inventory in a given area at a given time. Before starting an inventory,

educators and students should determine what it is they want to know. A variety of inventory methods exist to create lists of species, habitats, and land uses that exist in the area. To get an idea of numbers of each species, population density, or habitat use, consider using a more standardized method. (For many species, particular statistical methods and research techniques may need to be used to obtain accurate population estimates and population densities.)

Inventory data typically includes:

- Date
- Name of the observer
- Habitat
- Location
- Species identification
- Number of plants, animals, or signs of animals found

Examples of statewide or nationwide inventory projects are the Audubon Christmas Bird Counts, National Park Service Inventory and Monitoring Program, and Project Budburst, a citizen science program.

Designing a Monitoring Project

Monitoring takes it one step further by studying a population or habitat over a long period of time with multiple inventories. While conducting a one-time inventory of a habitat can be both educational and informative, students may be interested in comparing data from year to year. Studying a site over a long period of time can reveal changes in population, new species introduced to the habitat, or other trends that cannot be studied from a one-time visit. When developing an inventory method set to be used multiple times, it is important to establish a standard, repeatable procedure called a monitoring project.



Monitoring projects have very specific procedures that are repeated. Two examples of inventory methods used in monitoring projects are:

- **Point Count Method.** Often used for birds but also can be used for butterflies and amphibians. In this method, participants are assigned a route. At established points along the route, all birds are identified and counted, both seen and heard, within a given radius. An example of a project using the point count method is the Breeding Bird Census, which used this method to determine the population density of breeding birds over time. It is performed each year along the same routes or in the same study areas.
- **Spot Mapping Method.** Used to determine estimates of population density over a period of time. The spot mapping method involves establishing a study area, visiting the area several times during the breeding season, identifying birds within the area, and plotting their locations on a grid map.

Whether students conduct a one-time inventory or complete a yearlong monitoring project, it is important to respect all wildlife and natural areas. Refer to "Field Ethics" (page 548) for best practices on navigating instruction in outdoor settings.

Species Identification

Before conducting the inventory, it is helpful for older students to be familiar with at least some common species they may encounter. Depending on the specific inventory planned, give students time to research typical birds, mammals, fish, and other species in habitats similar to the study site. Photos or illustrations, as well as information about possible signs (tracks, eggs, lodges, or nests), will help students determine whether a particular species is present at the site.

Have students make and laminate identification cards to take on the inventory. Plan to have appropriate field guides on hand. A great way to record details of an organism while building critical observational skills is to bring a drawing pad and create a sketch. Place this in science notebooks to identify and label back in the classroom.

Younger students need not be too concerned about identifying exact species. General terms like "tadpole," "frog," "fish," or "duck" are developmentally appropriate descriptions of the different types of wildlife found at a particular site. If students show an interest in learning more, use child-friendly field guides to teach them common local species for the next inventory.

Part 2: Preparation

Introducing the Inventory

An inventory study of an organism, population, or habitat can be conducted with many of the same procedures used during a field investigation. An initial inventory of a study site will help students develop greater knowledge of their local environment and is thus a technique fit for conducting descriptive field investigations. That is, data collected in an inventory will help students answer many questions that describe a study site. With this knowledge, students can then go on to develop more involved questions that compare or correlate attributes or phenomena on a site (comparative and correlative investigations).

For more information on field investigations, including a list of field investigation activities in this guide, see "Project WILD Field Investigations" in the introductory pages. Refer to activities such as "Insect Inspection" (on page 2) and "Environmental Barometer" (on page 158) for guidance on helping students develop researchable investigative questions.

When initiating an inventory, explain to students that they will be conducting an inventory to learn about what organisms live in or near a habitat. Point out that scientists conduct field investigations to learn about plants, animals, and other living and nonliving elements of a habitat. Like other scientific investigations, inventories usually start with a question. The question guides the investigation and helps them determine the what, where, when, and how of their study.

Write the following question on the board: What plants and animals use resources or live in the study site? Ask students how this question might guide their inventory of the study site. Does it give



information about what we would be looking for and where?

If a more specific investigation question is needed to guide the inventory, have students propose possible questions to consider. What precisely do they want to find out about the site, or about the wildlife that lives there? Is there anything they are particularly curious about? Do they want to know if a particular animal lives there? Or do they want to get a basic idea of all the plants and wildlife that inhabit the site? Do they want a detailed inventory of a particular group like birds or amphibians to study the population over time?

Taking time to formulate good questions before planning the inventory will encourage student-driven research and provide a solid foundation from which to design the study.

Planning the Inventory

When conducting a survey of plants and wildlife, students should consider several factors:

Size. First, students must decide where to survey. Is the study area large or small? Then decide what to survey. Do they want to get a basic idea of all the plants and wildlife that inhabit the site? Do they want to make a list of all the plants that are in an area? Or, do they want to acquire general knowledge of common plants and wildlife with a more detailed inventory of a particular group like birds, trees, or amphibians?

Time. When should the survey occur? Approximately how long will it take? Will it occur once, or as an ongoing monitoring project? How much preparatory time is needed before students conduct the survey?

Level of Experience. How much survey experience do the students have? Which techniques might be easier and safer for them to use? Select an inventory method appropriate for the grade level.

Sampling Design. A sampling design is a step-by-step method of counting a species. Because an inventory is just a list, the design can be as formal or informal as desired. However, for accuracy and consistency, especially when conducting a long-term monitoring project, students must use a standardized method each time the inventory

An inventory is a data collection technique students can use when conducting descriptive field investigations. That is, data collected in an inventory will help students answer many questions that describe a study site.

occurs. Standard methods or techniques exist for discovering various plants and wildlife that inhabit the site. Specific techniques tend to lend themselves more for inventorying the different groups of plants and animals (insects, mammals, birds, amphibians, or plants). **Plot studies** and **transect lines** are typical survey designs used in conducting inventorying and monitoring projects for a wide variety of plants and wildlife. The actual sampling design can be the same, but the techniques and timing to discover the organism differ.

For example, students may set up a transect line or simply walk a particular trail on site. At set distances, such as every 5 meters (or yards), check for mammals or signs of mammals in a 2-meter diameter from the observation point. Using the same design, they can also check for amphibians or birds. However, students will have to use different techniques to actually find the animal and may need to inventory at different times of the day. To find mammals, look on the ground, in trees and shrubs, etc. Students could also look for tracks, scat, eaten corn, etc. Amphibians can be found under logs or stones; to find birds look for nests and listen for songs or calls. Refer to "Part 3: Inventory Methods" on the following page to learn more on inventorying different species.

Analysis and Reporting. Analyzing and sharing the information gathered through inventorying, monitoring, or research projects is very important.



Some students may benefit from a reporting form, or format that will help them organize different types of data into meaningful analysis and recommendations. Before sharing, prompt students to reflect thoroughly on the inventory and what was learned. Begin with questions such as:

- What did you learn from the inventory or monitoring project?
- What surprised you?
- What questions did the study raise?
- Who else might be interested in what we learned?
- How could we share this information?
- What else could we study next?

All information contributes to the general knowledge base and may contribute to management and conservation programs. Contact your state wildlife and resources department (many have local offices) or a conservation organization to see if the inventory results could be valuable as a citizen science contribution. Adapt the results to a catchy report or "news" update on the school social media page or website. Students could also video the inventory and develop a short PSA for the morning announcements. Publishing in a pamphlet, newspaper, journal, or on a website is a great way to practice scientific writing skills.

Part 3: Inventory Methods

Inventorying and Monitoring: Wildlife Populations

A population is the number of a particular species of organisms that occupy a certain area at a certain time as defined by the people interested in the group. A population can be deer in Montgomery County in 1999 or the White Pines in the county park in 1884.

Conducting a census for wildlife has been done for centuries. There are many reasons to determine the population size of a given animal. However, the value of a one-time population estimate is limited. Noting trends in population size is much more valuable. This task is accomplished through repetitive estimates over time. For example, a one-time count gives the number at that time; it does not help assess the overall health or status of a population.

However, population estimates over a period

of years can indicate a decline or area of concern. Reasons for determining population size include the following:

- A species is endangered or threatened.
- The status of a species needs to be determined.
- A "nuisance" species needs to be monitored.
- Harvest size of a species needs to be determined or monitored.
- Habitat management practices require population information.
- Population information is needed to determine the environmental quality index.

Naturally, it would be ideal if all wildlife populations could be counted individual by individual. However, even if it appeared that all were counted, how would biologists be certain? The reality is that most counts are based on some type of sampling methods. Sampling methods inherently have problems; however, over the years, many methods have been shown to give fairly accurate population estimates. The following methods are examples of wildlife population assessment techniques:

Territorial Mapping Method of Bird Populations.

This procedure involves participants observing individual birds during repeated visits and recording the location of the bird at each visit. These locations are mapped on a grid. Clusters on the grids are counted and used for determining breeding population densities in a given area.

Marked Sub-Sample Method. In this approach, a known number of animals are marked individually. A survey is conducted, often aerial, and the marked and unmarked animals are counted. Then, a ratio is used to determine the total population:

$$\text{Total Population Estimate} = \frac{(\text{Number of marked animals}) \times (\text{Total animals observed})}{(\text{Number of marked animals seen in survey})}$$

Change-in-Ratio Methods. These methods remove the animal from the population by means of trapping or hunting. Change-in-ratio methods involve two types of animals (e.g., male and female, with antlers and without antlers, adults and juveniles). For instance, a pre-hunt road count is made of deer with and without antlers. A hunt takes place, and



the road count is conducted again. Then, changes in proportions are determined, resulting in a total population estimate.

Capture-Recapture Methods. These methods entail capturing and marking a known number of animals and then recapturing or observing animals at a subsequent time. Capture-recapture can provide two types of information:

- Data from the recapture of marked animals can be used to help determine survival rates.
- Proportions of the marked and unmarked animals captured at each sampling can be used to estimate population abundance.

An example of this method is the **Lincoln Index**. To use the Lincoln Index, biologists capture a group of animals and mark them. The number of marked animals becomes the sample size. If the biologists captured and marked 100 bears, 100 would be the sample size. At a later date, perhaps a year later, the biologists then recapture 100 bears in the same area and determine how many bears were marked. Then they use the following equation.

$$\text{Total Population Estimate} = \frac{\text{(Sample size)}}{\text{(Percentage of the sample that is marked)}}$$

There are many other techniques to measure populations. For more information, contact a local university or the state wildlife agency.

Inventorying and Monitoring: Plants

The composition of the plant communities in a particular site can be quantified in many different ways. The sampling method used depends on several factors, such as the sort of data the class is interested in obtaining, the type of vegetation, and the amount of time available. The methods described below consist of observing plants along one or more lines, which may be laid out systematically or randomly within a study area.

Point-Transect Line Method

This type of inventory is typically done in a field situation but could be used as part of a plot study in a forest or other location.

1. Decide on the area to be inventoried.
2. Set up transect lines through the area. Students can use posts and string to make the lines.

TRY IT OUT!

For experimenting with the capture-recapture method, have students use sunflower seeds, beans, or marbles as "organisms," or assign several students to be biologists and the other students to represent the organisms. Place the objects in a container or, if using student "organisms," have students spread out in a gym or outside. Collect a certain number of organisms for a sample and mark them. (Student biologists can use an armband to mark student organisms.) Then, "release" the organisms. Recapture the same number of organisms using the same method. Count the numbers that were marked within the recaptured group and use the equation to calculate the total population. (The calculation given in this text is the basic calculation with no corrections added for bias. To get an accurate count, the larger the sample size and the higher the percentage of marked organisms, the better the estimate will be.)

Developed by T. Alberici, PA Game Commission. Reference: *Research and Management Techniques for Wildlife and Habitat*, edited by Theodore A. Bookhout, The Wildlife Society, Bethesda, Maryland, 1994.

3. Have students walk the transect lines. At set intervals along the line, record the plant closest to that point. The interval depends on how long the transect line is. For example, if the transect line is 25 meters, students may want to record data every 5 meters. Students could be asked to record the height of the plant and whether it produces berries, seeds, or flowers that might be useful to wildlife.
4. Summarize the data. Students will be able to figure out the most common species by looking at the percentage of occurrence (i.e., at how many points did this plant occur).

Variation on the Point-Transect Line Method

This procedure can be used in large field areas or to gain a basic idea of the most common plants in the area.



1. Divide the area into grids by establishing and numbering points along the length and width of the area.

2. Students randomly choose points to start the study by writing the numbers assigned to the points along the length of the site on slips of paper and putting those numbers into a container. Do the same for the numbers assigned to the width, putting those slips into another container. Next, have someone select a number from the width container and a number from the length container. Choose several of these sets of numbers (depending on how many

starting points the class would like). Locate where the points intercept on the site. Then, using a meter (or yard) stick, place the beginning of the stick directly where the numbers intercept. Make sure the meter (or yard) stick always goes the same direction from the starting point. Ask students to record and identify each plant found at a determined point along the stick (e.g., every 10 centimeters).

3. Summarize the data. Have students determine the most common plant on site by looking at the percentage of occurrence at each point. Report all results after the plant inventory is complete.

Sampling with a Daubenmire Frame

A quadrat or Daubenmire frame is one type of frame that may be used to isolate a small area for study, often to determine the type and density of vegetation in a large area by sampling smaller areas (a hula hoop may also be used). When using frames for sampling, make sure all frames are the same size if using more than one in a study. Although biologists may count each stem within a frame, students may find this difficult.

Percentage estimates will work fine.

A grid on or in the frame can make estimating easier. Paint or mark alternating colors on the frame as visual cues to sections within the frame. Or, use string or wire attached at regular intervals to divide the interior of the frame. With a string grid, students can identify species at the intersection of grid lines similar to a point count. If sampling in a shrubby area, open one end of the frame so the frame can be placed around the base of a shrub.

Making a Daubenmire Frame

Supplies

- At least 1.5 meters (5 foot) length of 1/2 inch PVC pipe
- 4 one-half inch PVC right angle elbow connectors
- One Roll Electrical Tape
- Ruler
- Permanent Marker

Assembly:

- Cut two 25 cm (10 in) and two 50 cm (20 in) lengths of PVC.
- On the 50 cm (20 in) lengths of PVC mark 12.5 cm (5 in), 25 cm (10 in), and 37.5 cm (15 in) on the PVC pipe with a marker.
- Connect the PVC lengths together using the right angle elbow connectors to form a rectangle.
- Using the electrical tape, wrap the first and third 12.5 cm (5 in) segment of the 50 cm length of PVC.

This frame, also known as a “six cover class frame” is divided into fourths by painting or taping alternate sections of the frame different colors as illustrated.

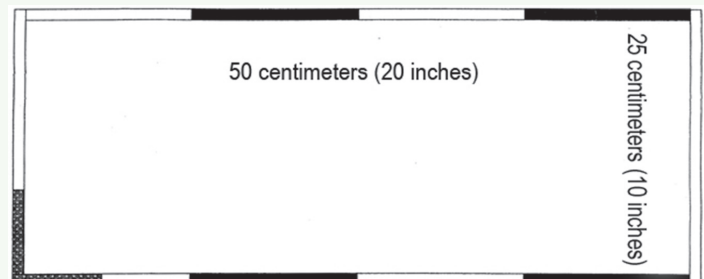
In one corner of the frame, Delineate two ~8 cm (~3 in) sides of an area as illustrated. This represents ~5% of the frame area. The painted/taped design provides visual reference areas equal to 5, 25, 50, 75, 95, and 100% of frame area.

Using a Daubenmire Frame

- Observe the frame from directly above and estimate the cover class for all attributes you want to characterize.
- When estimating cover, imagine a line drawn around the leaf tips of the plants and projected onto the ground, then use the marks on the 50 cm (20 in) side of the frame to estimate percent cover.
- Estimate the percent cover of the target species, bare ground, litter, or other occurrence to the nearest 5%.
- An estimate of the numbers of individual occurrences of a plant (or other type of unit of study) in each frame
- will then provide an estimate as to whether the aggregate coverage falls in Class 1 or 2, etc.
- The total percent cover in a frame should be 100%.

Daubenmire's 6 Cover Classes

Class No. 1: Range 0-5%, Midpoint 2.5%
Class No. 2: Range 5-25%, Midpoint 15.0%
Class No. 3: Range 25-50%, Midpoint 37.5%
Class No. 4: Range 50-75%, Midpoint 62.5%
Class No. 5: Range 75-95%, Midpoint 85.0%
Class No. 6: Range 95-100%, Midpoint 97.5%



The inside dimensions of the frame are 25 x 50 centimeters (10 x 20 inches).

Source: Based on “How to Make a Daubenmire Frame”, as found on the BugwoodWiki, published online by the Center for Invasive Species and Ecosystem Health at the University of Georgia.



Inventorying and Monitoring: Birds

Many different methods can be used to inventory and monitor bird species within an area. Two methods based on the **point count method** are suggested in this activity. One method is for smaller areas, similar to a small backyard. The other is for larger areas or areas with several types of habitats. Birds are resident and migratory; therefore, the inventorying and monitoring observation days should occur at different times of the year. Most birds are active in the morning and evening, so these times are better to conduct observations. However any time during the school day will also do.

Point Count Method

1. Select the area to be monitored.
2. Establish observation points.
 - Option 1. If the area is small and this is a monitoring project, then establish one or two observation points, observation times, and procedures. For example, observe for 10 minutes between 8 a.m. and 10 a.m. Keep the length of each observation time consistent.
 - Option 2. If the area is large or contains many different habitat types, conduct the more typical point count method. Establish routes through the area. At established points along the route, stop, identify, and count all birds seen or heard within a predetermined radius for a specified amount of time (generally between 5 and 15 minutes).
3. Ask students to count and identify each species observed. At a minimum, data collection should include date, time, weather, observer, species, and number. If students decide to conduct the inventory several times a day (for example, one class does the observations in the morning and another in the afternoon), be careful how they report the numbers of birds in the area. To determine the number for the day, use the largest number of the one species of bird observed at one time. For example, the morning group observed five robins; later that afternoon, the tally for robins was three. The total number reported for the day would be five. (In addition, it might be interesting to compare morning to afternoon numbers over a period of time.)



4. Conduct the inventory at least several times during the year to get an overall picture of what birds inhabit the area. While selecting the observation dates, consider when each bird species migrates.
5. At the end of the each season, have students summarize the data.
6. Using data summaries, students can draw conclusions and report to their class or school.

Winter Feed Count Method

One way to inventory winter birds that come to a feeder is to do feeder counts. Keep in mind that not all birds come to feeders and even birds that will use feeders also use different habitats. A feeder count will not reveal all the birds on the site, but it is a good start. Before a bird feeder program is started, research the types of food preferred by different species. Have students clean the feeders and area under the feeder (remove old seeds and hulled seeds) to prevent the spread of disease. Some people feed birds throughout the year, but keep in mind that other animals, such as squirrels, raccoons, and even bears will use the feeders, which can cause problems. People in areas with bears should not feed birds all year.

1. Research local birds that come to feeders.
2. Learn about the do's and don'ts of bird feeding by bringing in a guest speaker or conducting online research.
3. Select the area for a bird feeder or feeders. Feeders should be easy to refill and be within easy view of a window.



Inventorying and Monitoring: Mammals

Students often enjoy seeing mammals such as squirrels or deer near their school. Direct observation is the most obvious method to observe mammals, but unfortunately mammals are not always cooperative. Before beginning any type of inventory, have students research the habitat at the study site and make a list of mammals that might be found. Next, consider the type of signs those mammals may leave behind. Most often, mammal inventories are based on signs, rather than sightings of the actual animal. Below are two methods for inventorying mammals, but if students are conducting a monitoring project, the **line transect method** (see next page) is more appropriate.

Please do not allow students to touch, capture, corner, or chase any wild animal.

General Observation Method

1. Ask students to describe the habitats located at the study site. Examples are grassy, open areas, woods, creeks, gardens, or a deep pond.
2. Create a list of the mammals that may be found on site. Indicate those that definitely inhabit the study site. The latter can be done by confirmed sightings by students or nearby residents.
3. Have students research in teams the type of sign that the mammal or mammals they are counting may leave behind.
4. Divide area into sections. Make sure all habitat types are included.
5. In teams, have students walk the sections and search for signs of mammals and record information on a data sheet based on the sampling design. If possible, bring cameras or science notebooks to sketch the findings.

Mammal signs to search for include the following:

- Direct observation of the mammal
- Sounds and vocalization
- Scat (animal droppings)
- Tracks and trails
- Nests (for example, squirrels' nests among tree branches)
- Scratchings and rubbings (claw marks on trees from bears; rubbing marks from deer or elk)

4. Establish observation times and points.

Observations can be done once or multiple times a day. In this case (for example, one class does the observations in the morning and another in the afternoon), be careful how the numbers of birds are reported in the area. To determine the number for the day, use the largest number of the one species of bird observed at one time. For example, the morning group observed five chickadees; that afternoon the tally for chickadees was three. The total number reported for the day would be five. In addition, it might be interesting to compare morning to afternoon numbers over a period of time.

5. Count and identify each species observed. At a minimum, data collection should include date, time, weather, observer, species, and number.

6. Conduct the inventory at least once a week through the winter months.

7. At the end of the winter, have students summarize their data.

8. Using the data summary, have students draw conclusions and report them to their class or school.

If students would like to get involved with a national bird feeder inventory and monitoring project, contact Cornell University's Project FeederWatch program:

Project FeederWatch

Cornell Laboratory of Ornithology
159 Sapsucker Woods Road
Ithaca, NY 14850

Phone: (800) 843-BIRD (2473)

birds.cornell.edu/PFW



- Gnawings
- Lodges and homes

6. Summarize the data collected.
7. Repeat this inventory several times during the year to include different seasons.
8. Publish an inventory of mammals on the site.

Developed by T. Alberici, Pennsylvania Game Commission. Based on the Project WILD activities “Wildlife is Everywhere!” and “Environmental Barometer.”

Line Transect Method

1. With students, select an area to inventory and monitor.
2. Set up transect lines to cross the area using posts and string. Make sure the lines are far enough apart that observers are not counting the same animal. If the site contains different habitats, have students place transect lines in the different habitats. If this is a monitoring project, then they must develop a standard procedure. Brightly colored yarn, string, rope, or flags can be used to mark the line (e.g., one at every meter) so students can mark where along the transect line a mammal was observed.
3. Walk the transect lines and record the number and identification of all mammals observed. It is recommended to establish a maximum observation distance (e.g., 30 meters or 100 feet from the transect line). Suggested information to record includes observer, weather, length of transect line, habitat, animal, number, behavior of animal at time of observation, and date and time observed. Different animals are active at different times of day and at different times of the year. Prior research and careful planning will increase the chances of observing an animal.

NOTE: To estimate deer populations in an area, see the activity “Dropping in on Deer” on page 475.

4. Summarize the data collected. Keep in mind that if this is a monitoring project, the counts recorded are incomplete. Although they can be used as an “index” to the population, these counts do not provide a real census of the population.
5. Present the conclusions to schools, to the community, or to even broader audiences.

Adapted by T. Alberici from “Line Transects,” *Research and Management Techniques for Wildlife and Habitats*, edited by Theodore A. Bookhout, published by The Wildlife Society, Bethesda, Maryland ©1994, 230–31.

Inventorying and Monitoring: Amphibians and Reptiles

Once a general inventory of the habitats and land use in the study site has been conducted and mapped, consider including reptiles and amphibians. Reptiles and amphibians are useful indicators when studying potential pollution, effects of drought, and insect populations. First, divide the site into quadrants. The boundaries of the blocks should be easily identifiable (street, streams, etc.) or based on a topographical map.

Before going out into the field to search for amphibians and reptiles, it is important to research which ones could be found in the area and which are venomous. Learn how to identify them. A resource person from a local university or state agency could be helpful during this process. Bring large color pictures of these species or a field guide to reference during the inventory.

Never allow students to approach or handle venomous animals.

The classes Amphibia and Reptilia possess groups with extreme variability, and no single technique will work to locate them. In general, amphibians and reptiles tend to be secretive in nature except during specific times of the year (e.g., mating season) and under specific environmental conditions such as high humidity or rainfall. Techniques for observing and collecting each group of amphibians and reptiles will be discussed separately.

Salamanders

Salamanders, especially terrestrial (land-based) and semiterrestrial species, can usually be found by looking under cover objects, such as rocks, logs, bark, and vegetation. Aquatic forms, such as newts,



can be observed swimming or floating in ponds or along the weedy, shallow margins of lakes. This is also true of spotted salamanders during the breeding season; however, they are seldom found except in fishless ponds in and near woods. Other aquatic salamanders, such as hellbenders and mud puppies, occasionally can be located by lifting submerged objects in streams and other appropriate bodies of water. Remember to replace the cover items where they were found to minimize habitat disturbance.

Generally, salamanders are active on the surface and are nocturnal, so slowly walking about at night in the appropriate habitat with a flashlight or lantern may prove successful. Any area that is likely to yield salamanders during daytime collecting (e.g., spring seeps, stream margins, wooded ravines, etc.) will also be a good area to locate salamanders at night. Rainfall and high humidity tend to stimulate salamander activity, so nighttime collecting for terrestrial and semiaquatic species is most productive under these environmental conditions.



Frogs and Toads

The fact that frogs and toads are highly vocal during the spring and summer breeding seasons makes them most likely to be located at this time. Listening for choruses at night is the most effective method of locating frogs and toads. When they are not calling, frogs can most frequently be encountered by searching the margins of streams, rivers, lakes, and ponds at night with a lantern or flashlight. Browse the Internet to learn frog calls of local species. The cricket frog, for example, can be called by rubbing two stones together in a pattern of increasing frequency. Using tricks to call frogs may help locate them around a body of water.



Lizards

Lizards are often found on exposed rocky areas in forested regions when it is sunny and the air is calm. Search tree trunks, fence posts, and areas with nooks that lizards might use for quick hiding. Most skins are also located in open rocky spots in forested areas, usually in the vicinity of streams.

Snakes

Small to medium-sized species of terrestrial snakes most likely will be found by looking under objects. Water snakes and queen snakes are best found by walking in and along streams and other bodies of water as well as by overturning objects, such as rocks and logs, along the margins of streams and ponds. Large species, such as black rat snakes and black racers, are usually found actively moving about in the open. In general, the best places to look for snakes are along the margins of streams and lakes, around human habitation, in open rocky areas and rocky slopes, and in areas where debris, such as boards and other building material, has been left outdoors. In early spring, open rocky areas with southern exposures may be especially likely to host snakes.



Turtles

Many species of turtles bask either at the surface of the water (e.g., a variety of snapping turtles) or on emergent objects such as rocks, logs, and sandbars (e.g., painted turtles, map turtles, red-bellied turtles, soft-shelled turtles, etc.). Careful and quiet observation of suitable bodies of water through binoculars or spotting scopes will often reveal the presence of turtles. Late spring and early summer is egg-laying season, when individual turtles can occasionally be found moving about on land in search of nesting sites. Sightings are particularly common along the edges of roads in the vicinity of streams and bridges. In addition, heavy summer rains will often initiate terrestrial activity in otherwise aquatic species.



Inventorizing and Monitoring: Invertebrates

Conducting an inventory of invertebrates can often yield large and consistent data sets for a monitoring project. Insects respond quickly to environmental and human influences since they often reproduce in high numbers and live less than one year, which increases the ability to observe population fluctuations during a school year. Invertebrates are found in every habitat, and can be a good option if the class is unable to conduct an inventory offsite. A common way to inventory these organisms is the **capture-recapture method** (see “Inventorizing and Monitoring: Wildlife Populations” on page 532 for procedure).

Sweep Net Method (Terrestrial Invertebrates)

1. Similar to reptiles and amphibians, many invertebrates can be discovered by overturning leaves, rocks, logs, and disturbing leaf litter. If the study site possesses a grassy area, a sweep net is a easy and fast way to sample hidden invertebrates.

2. Place students in teams and create transect lines for each team to walk. Another option is to divide the area into sections or quadrants that each team inventories.

3. Have students use the sweep net to gently but swiftly swipe the grasses back and forth as they walk the line or quadrant. Once they have completed the sweep, quickly flip the net over on itself to prevent invertebrates from escaping. Use jars to remove and observe any caught specimens.

Kick Seine and Dip Net Method (Aquatic Invertebrates)

Aquatic macroinvertebrates are excellent bio-indicators of freshwater health. Many terrestrial insects such as dragonflies, mayflies, deerflies, and mosquitoes begin and spend most of their lives under the water. Have students survey all bodies of water at the study site for signs of macroinvertebrates by observing mosquitoes, dragonflies, or other insects hovering above or around the water. There are many web resources that provide detailed lists of macroinvertebrates to use for their inventory sheet. To familiarize students with identifying aquatic insects, practice using an ID book or drawing sample insects in class to count appendages, study body shapes, and learn the sizes of common species. See the Aquatic WILD activity “Water Canaries” to provide a good foundation for the inventory as well. During the aquatic collection it may help to laminate the inventory sheets before arriving on site.

1. Select a collection site. Students could collect from a creek, pond, stream, or a river.

2. Gather the proper equipment. Any sturdy net will suffice, but a dip net provides a long handle to reach out into the water from the bank. Waders are knee or waist high boots that students can place over their clothes to carefully stand in the water and collect. Kick seines are made from two handles and a screen in the middle. Place one group member further up from the kick seine and have them churn up the water with their feet or a log. As the muddy water flows downstream, any invertebrates living in the bottom will be caught in the net.

3. Separate the class into teams and spread them evenly along the waterbody. Make sure to record locations on the inventory sheet. Macroinvertebrates can live in many different areas of a waterbody.

Some move freely through the water such as caddisflies or mosquitoes. Many live along the bank to hide from predators. Have students assess the area to collect from all parts of the aquatic habitat.

4. Begin collection. Bring all nets and kick seines to the bank and place the macroinvertebrates in a shallow pan. White pans work best to help the organisms stand out against the sediment and debris.

5. Determine as a class if the invertebrates will be released back into the water or if several specimens will be taken back to the classroom for further observation or sketches. Refer to “Field Ethics” (page 548) to make an informed decision about removing organisms from their habitat.

6. Summarize the data and report results. Make inferences about the health of the waterbody based on the species collected.

Inventorying and Monitoring: For Younger Students

Do not be concerned about identifying exact species. For this age group, general terms like “tadpole,” “frog,” “fish,” or “duck” are adequate. Encourage students to create their own names for organisms they observe and discuss how scientists might select common names based on color, habitat, or mannerisms.

Look On, Look Under, and Look Above

Take students to a study area outside. Students will focus on three parts of the habitat for about five minutes each, while the educator records their observations. First, have them focus on the ground looking for insects, holes or mounds, droppings, or other wildlife signs. Then, look under

cover objects such as rocks, logs, leaves, and vegetation searching for any snakes, salamanders, or invertebrates. Finally, have them focus above the ground, looking for birds, insects, or other wildlife on buildings, up in overhanging branches, or well into the sky. Back in the classroom, make a list of the types of wildlife that use this habitat.

Hula Hoop Transect

Lay out hula hoops (or sections of rope—all of the same length—formed into circles) in an outdoor study area. Have pairs or small groups of students work together to investigate each circle transect. They can use their science notebooks to draw pictures of each different plant, insect, caterpillar, or other wildlife—or sign of wildlife—within the circle. Have them count (or estimate) the numbers of each and write the totals next to their drawings.

Promoting Stewardship through Inventorying and Monitoring

Using inventory and monitoring methods provides a framework for constructive observation and exploration of the natural environment. Conducting multiple inventories of a site close to the school connects students to wildlife that may not otherwise be noticed and can build a stewardship ethic among students. After teaching the ethics and procedures of an inventory with the class, encourage students to conduct an inventory in their backyards or at a nearby park with their family.

