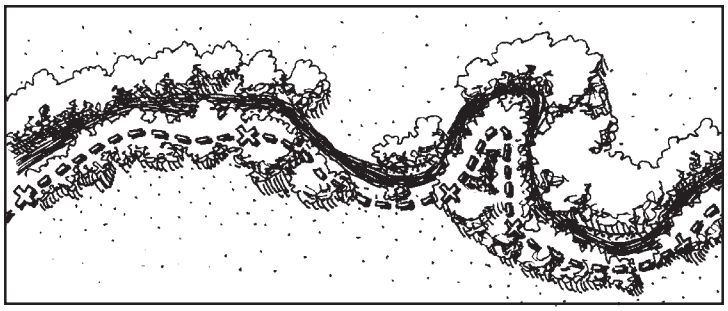
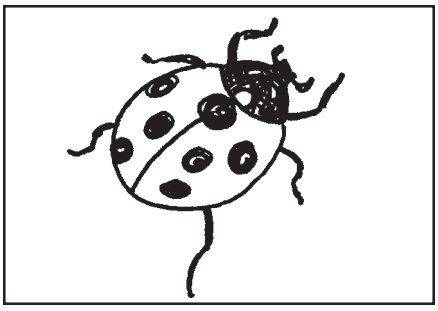
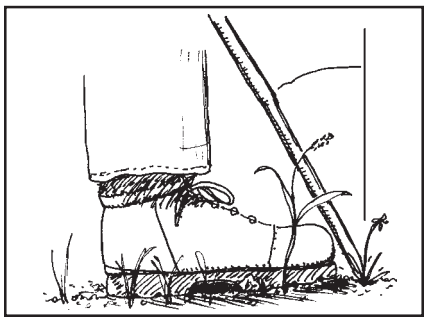
Monitoring on Your Farm

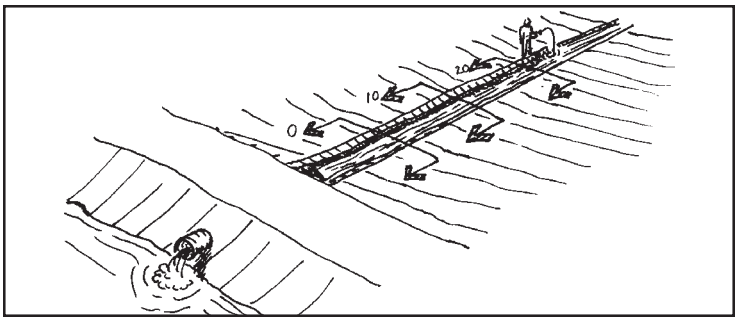
A Guide to Tracking and Understanding the Resources and Wildlife on Your Land

Utilizing Low-Cost, Low-Tech Equipment
and Easy Methods with Minimal Time Input









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Monitoring on Your Farm

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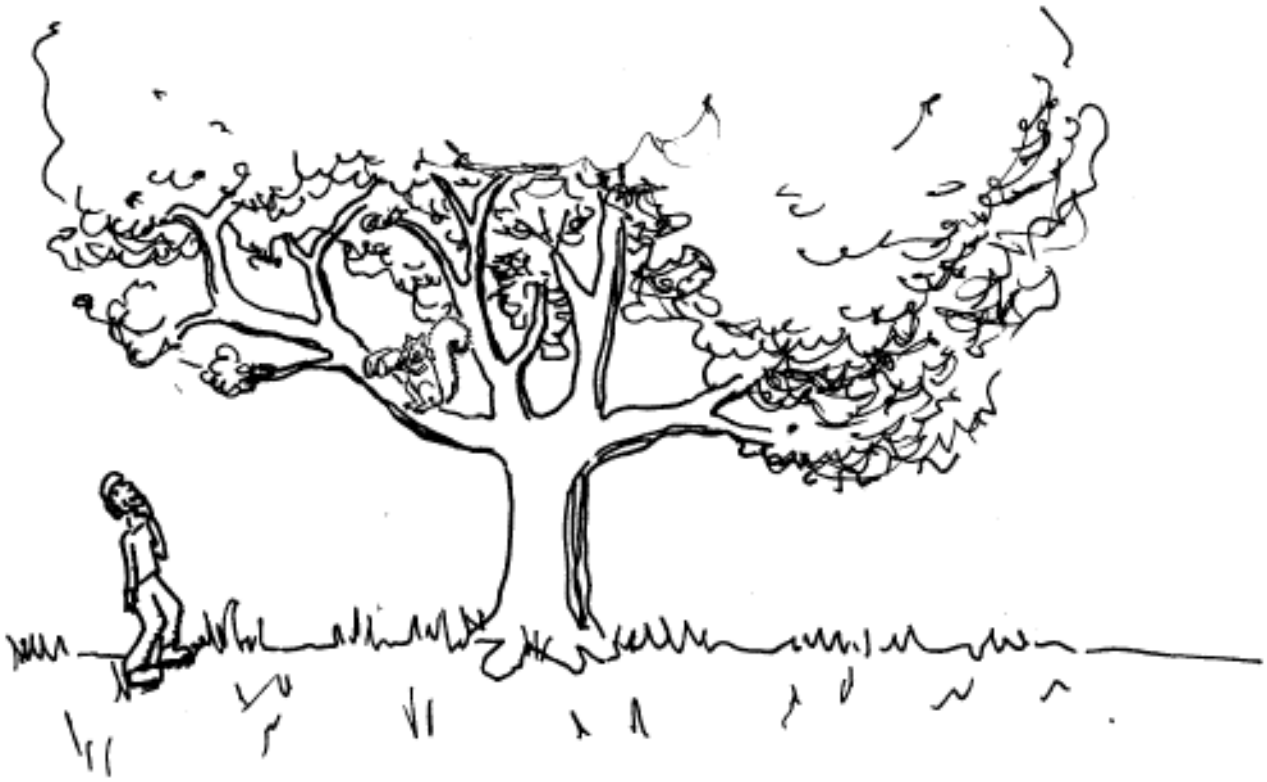
PREFACE

I began this effort in order to share some of what I have learned and developed at the Yolo County Resource Conservation District (RCD) in recent years about the loosely-defined subject of "monitoring." My desire is to pass along the practical aspects of the process, along with a little bit of philosophy – but mostly the practical stuff, since that's where the rubber meets the road. Lots of commentary and theory can be debated, but when it actually comes down to getting the job done . . . we are all looking for *what is it that gets the job done!*

One goal of this guide is to provide you with suggestions and ideas for monitoring equipment that are low cost, low-tech, and easy to come by. Another goal is to suggest methods that are fairly simple and that require a minimum of time input for the information gathered. The equipment and methods presented here do require some money, but mainly time and commitment. Since a third goal of this guide is to be as succinct as possible, certain peripheral details are left out. You may not be reminded to do such things as store your negatives carefully if you are photo-monitoring, or to bring along your notebook or binoculars!

Technical, complex and expensive methods of monitoring abound and many of them do a wonderful job of providing the answers you may want. I have enjoyed using many of these methods myself. However, from my perspective, there is beauty in simplicity. That quality, applied to both the tools and the methods, provides a much greater likelihood that the monitoring will actually get done.

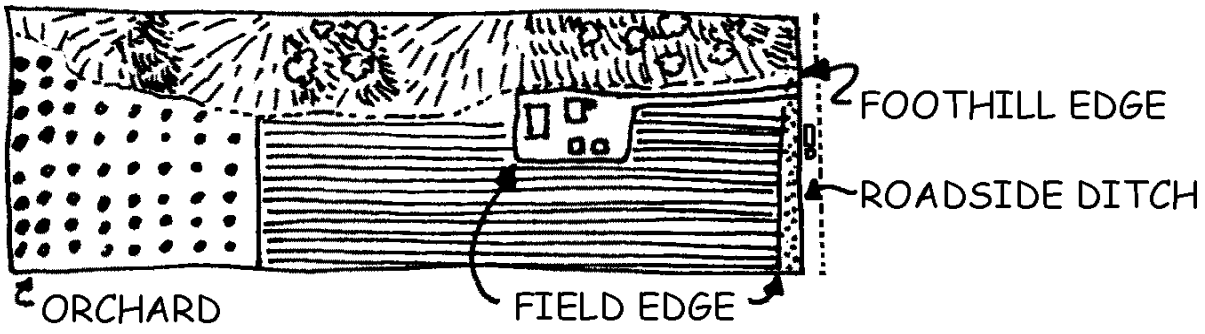
Monitoring on our own property and within our home watershed are likely to become increasingly important. In the process of learning more about our own farms through monitoring, we, as individuals and as a group can show others (be they our neighbors or our legislators) what we have been doing to be good stewards of the land. "Good stewardship" benefits both our farming operations, and our neighbors near and far.



I have come across a number of other written guides to monitoring. Some are highly technical manuals from agencies or special interest organizations. I will refer to some of these guides, since they have been valuable resources to me both in deciding what *to* do and what *not* to do for particular projects. This guide is intended to provide simple methods – based on more complex approaches – for tracking change while providing a basis for adapting management decisions over time. While developed for Yolo County, California in particular, much is transferable to practically any location, with just minor adjustments.

Much of what is in this manual can be closely tied with another RCD publication entitled *Bring Farm Edges Back to Life*. That publication discusses numerous conservation methods and techniques that can be integrated into a normal farming operation or implemented on any private land, to help address resource conservation problems such as weeds, silt deposits, beneficial insect habitat and soil stability. At the same time these practices can provide many additional benefits.

If conservation practices are about to be implemented, there is an excellent opportunity to start a monitoring program, beginning before the changes are made. There is a section at the end of this manual describing the same example farms used in *Bring Farm Edges Back to Life*. These farms will have brief descriptions of some of their pertinent land characteristics. Along with these are descriptions of possible conservation practices. Refer to that publication if you want to learn how to design and install these conservation practices. They may be similar to some of the changes you have considered. If so, there are potential monitoring activities described here that could go along with them.



HOW TO USE THIS GUIDE

This guide is divided into sections to allow you to locate a subject quickly.

The **introductory section** talks about:

- The concept of monitoring
- The thinking process
- Questions to ask regarding living and lifestyle
- Questions to start you thinking about your land and your goals for it
- Questions about the living things that occupy the place
- Deciding what, when and how to monitor

Don't skip those, unless you already feel pretty comfortable with monitoring.

Next will be separate **sections on specific topics** or areas to monitor:

- Photo-Monitoring
- Soil
- Water
- Plants
- Animals
- Birds
- Mammals
- Reptiles and amphibians
- Insects

Each section will contain:

- a short discussion
- equipment needed
- costs, if appropriate
- explanation of procedures
- estimated time to complete the task
- a summary card (somewhat like a recipe), containing:
  - equipment list
  - procedure summary
- a data sheet or other form for recording the information that you collect
- sources, references, guides, handbooks and/or websites

For two reasons it would be best to photocopy the data sheet and bring the copy out into the field with you. First, it will invariably get muddy or ripped or dropped in the water. Second, if you write on the original, you won't have another to use for the next project.

The **resource lists** won't be exhaustive, but should be helpful. The extent to which you explore these is up to you and will, I'm sure, depend on the amount of time and interest you have.

Please keep in mind that this is not a *technical* guide. You will not find endless equations or articles from engineering journals. Expect practical information that you can put into use as soon as you read it.

I. INTRODUCTION TO MONITORING ON YOUR FARM

What is "your farm?"

A discussion about monitoring on your farm should start with what is meant by "your farm." That term could mean an actual farm (a place where some food, fiber or domestic animal product is produced and where a profitable income is expected from those products). But, your farm could also include *any* piece of land – however small or large – that you call your own. Many of the techniques presented in this manual would work well in your own backyard. For the purposes of this manual, monitoring involves gathering basic information about your land and its users (not all of them human) that is useful to you as the landowner.

It is important to recognize that your farm doesn't exist in its own world. It is affected by the other farms around it and by the larger landscape, of which it is only a small part. In the same way, either the farm, or you and your family, are equally connected to and dependent upon a community of people for other needed resources, for support, and for enrichment. Because of these connections, sharing your results may be useful to many other people who are a part of your community, or a larger watershed.

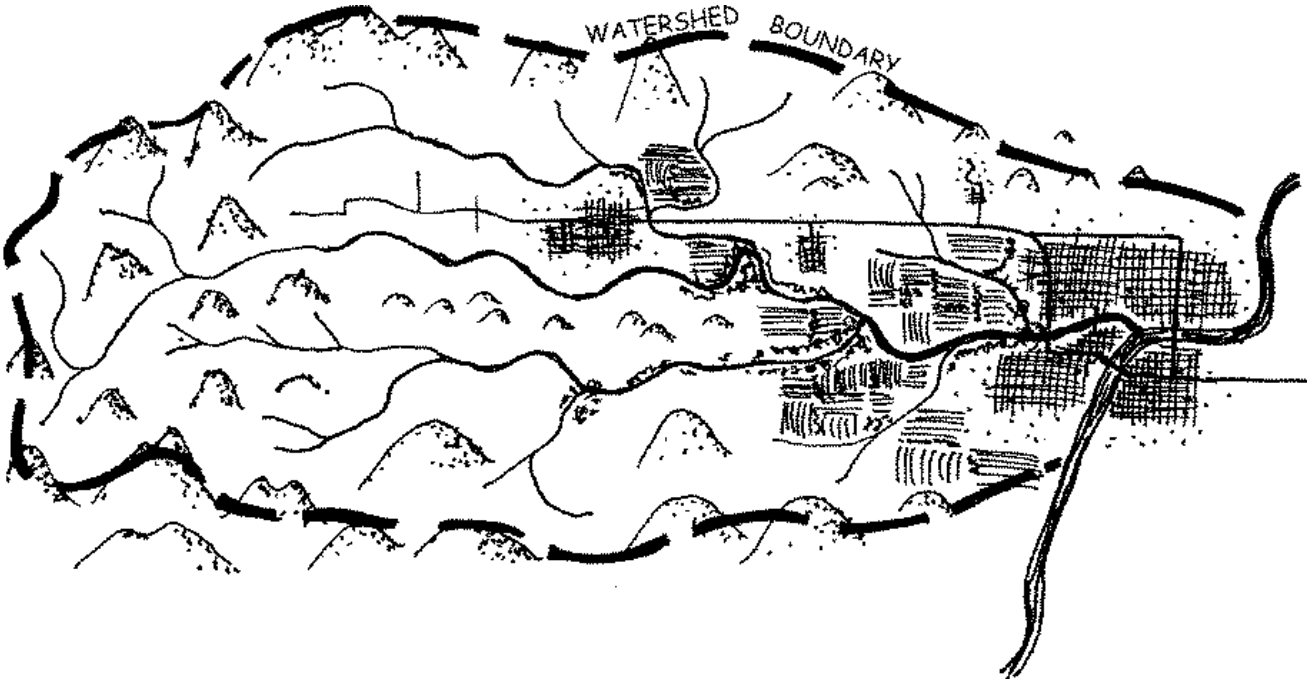
What is monitoring?

Monitoring usually goes hand-in-hand with some form of management change hoped-for. However, monitoring can be very valuable for simple fluctuations in natural conditions.

There may be some differences - either short-term or long-term - in the way the land looks, feels or functions as a result of new ownership, changing uses, or natural conditions. If you would like to *know* if real changes are happening, monitoring can help. Monitoring can also help to check your progress toward your goals and re-focus your efforts.

The changes you are looking for may be as short-term as before to after, season to season, or as long-term as decade to decade. They may be related to anything from plant species differences to economics to how a

Monitoring is a set of activities aimed at measuring change in some informal, yet consistent way.



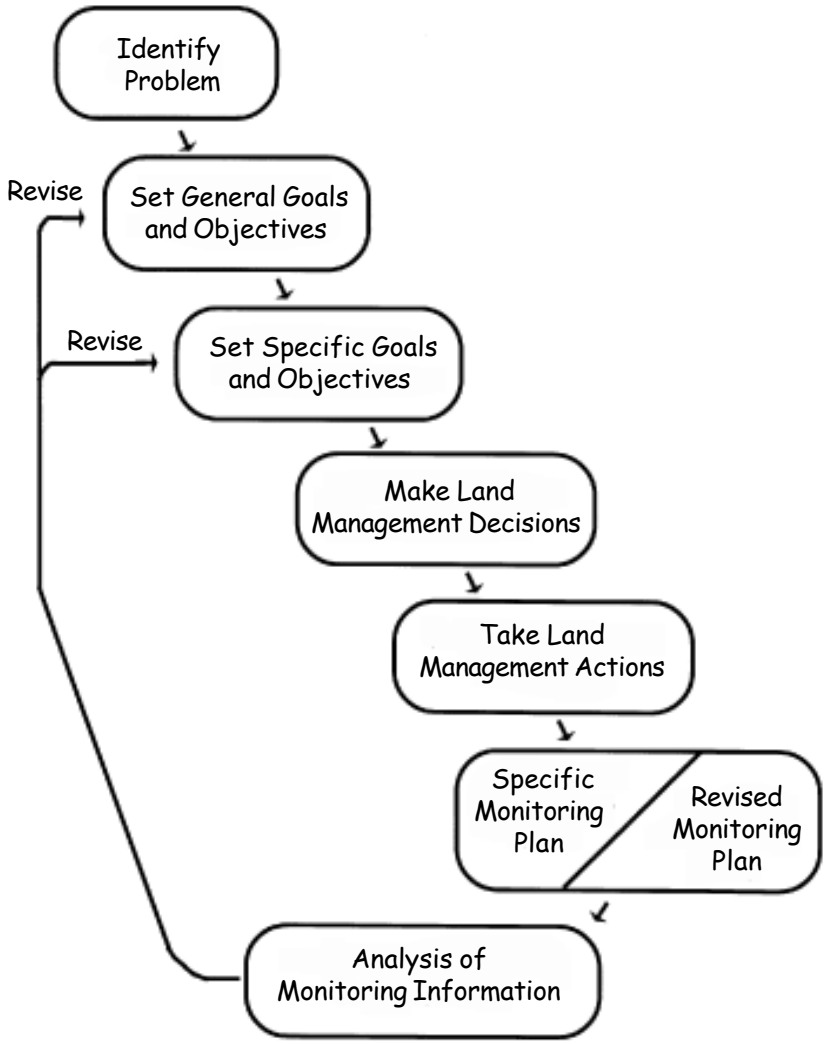
place "feels" to walk through. They may involve only once-a-year efforts, or very intensive time for short periods. You will be the one deciding , based upon what you want to find out. The amount of input is up to you. *The key to having it work is to be committed and consistent!*

Monitoring vs. research

Research is a very intensive way of studying something. It requires very careful planning – sometimes a year or more ahead of time. It also requires carefully phrased questions, placing intentional limits on the answers that can be achieved, and a lot of time in between spent gathering specific information. To be legitimate there must even be several duplicates (replications) at the same location of all variables that are in the test. Anyone can do research, given the know-how, but it's tricky. It helps to have some experience or to work with someone else who does.

Monitoring, on the other hand, is a lot more low-key, but just as legitimate for its intended purpose. It may not provide irrefutable answers with statistical confidence levels attached to them, but if done correctly, can accurately document changes in natural resource conditions, show trends in land use, measure differences between land areas, or measure qualitative changes that don't involve hard numbers.

Adaptive Management Flow Chart



Why monitor?

Your monitoring program may allow you to:

1. Establish some "baselines." These are basically definitions of your existing situation.
2. Follow general trends or normal fluctuations in natural resource conditions
3. Track specific species – how they increase, decrease, stay the same
4. Follow changing use of resources by wildlife
5. Improve the management on your land (determine its effectiveness and modify it accordingly)
6. Help you decide if you are meeting your goals or going in the right direction
7. Measure economic success
8. Involve other members of your family in the farm
9. Help you avoid regulation
10. Help you get to know your farm or ranch better
11. Address personal or community issues

The information you get through monitoring fits into a feedback loop (see "Adaptive Management Flow Chart," above), allowing you to change your management decisions to fit reality. Although you may be convinced from the start that the changes you intend to make will be an improvement, that may or may not actually be true. You may *think* you are seeing a change happening, but are you really *sure*? Monitoring can help you find out if your new way of treating the land is actually a benefit or a detriment. You may be surprised. Try to maintain a "neutral" frame of mind.

From a landscape viewpoint, your small pieces of localized information may make important contributions to a broader understanding of the area you live in, and may give you a sense of how each small area contributes to the intricate functioning of the larger whole. This understanding leads to more effective solutions if problems exist or arise, and shows you how to work *with* the land and not *against* it. There may be local or regional land-use or resource issues that are important to you as well as your neighbors. Monitoring information, especially if gathered by several landowners, can be a powerful tool for addressing these issues, so try getting your neighbors involved. They may be able to share the work.

Time expenditures

Be realistic. Spend as little time doing monitoring as you can to still get the information you will need to make decisions. If you don't have the time, get someone else to help, such as a hired hand or your kids. Monitoring can be a good school science fair, 4-H, or FFA project.

Some monitoring work requires more time than others. Time estimates are given under the topic sections, but first attempts at a given activity may take a little longer.

What to monitor

There are innumerable things that you could choose to monitor. Ask yourself any of the following questions.

Q: What interests me most about my land?

Possible answers

"Just being a landowner!"
"How can I *keep* it?"

Q: What are my 3 biggest concerns about my ranch?

Possible answers:

"The soil seems to be compacting."
"I have a lot of weeds."
"I need to use my water more efficiently."

Q: What would I like to see be different about my farm?

Possible answers:

"I'd like to have about a 5 acre corner of it be a safe place for my kids to play and to explore the outdoors on their own."

Q: Am I happy about how farming affects my life?

Possible answer:

"I like the rural lifestyle, but I feel isolated."

Answers to these questions give you your first clues to what you should monitor.

If you have a serious weed problem in a particular area, you could seek some advice on setting up a 2 to 3 year plan for management or control. Monitor changing plant populations two times each year for at least those three years to see if you are achieving your goal.

When thinking about what to monitor, consider things such as:

1. long-term goals
2. short-term goals
3. time investment
4. how you prefer to spend your time
5. financial return
6. personal satisfaction
7. time spent with family
8. time spent in community
9. quality of life
10. feelings, such as satisfaction, thankfulness, concern, frustration, and hope

Examples of what to monitor

ENERGY USE (not specifically covered in this manual, but can be easily tracked with your existing business records)

Things to monitor in the area of energy use could include:

- personal time and energy
- time spent by book-keepers or other employees
- amount of electricity, diesel fuel and gasoline used to keep things operating

ECONOMICS (work with your accountant)

Economics and profitability are often critical to your ability to continue to *enjoy* the place where you live or farm. Try taking a new look at:

- month-to-month cash flows
- annual balance sheets
- long-term goals

If your answer to the first question was "How can I keep it" then you may want to do some financial monitoring with the assistance of an accountant. You could also set a goal to increase the value of your ranch in the eyes of the larger community. You could monitor your progress toward that goal by measuring the number of people, outside of family members, that have attended one of your "cattle drive" experiences, or who have participated in a bird count along your creek. These people are more likely to want to see your property remain as one large ranch rather than being split up for housing, and could provide support in the future.

NATURAL RESOURCES

Natural resources are often the unspoken treasures of a landowner. They have a value that goes beyond what is measurable in numbers. However, there are many things that we *can* measure that can give an understanding of the condition they are in. Places to examine include intensively-farmed areas, field edges, roads, woodlands, and streams. Consider looking more closely at:

SOIL

- The ability of soil to hold water
- Basic fertility of the soil
- Soil "tilth"
- Soil quality (overall "health," salinity, sand/silt/clay content)
- Soil stability against erosion during storms

- Soil stability along waterways such as creeks, sloughs or ditches
- The ability of the soil to support life (above ground, below ground)

GEOGRAPHIC CHARACTERISTICS

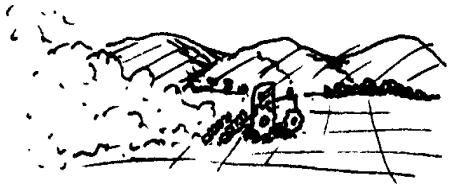
- Land slopes
- Rockiness, soil cover, soil type
- Sun exposure
- Nearby waterways
- Neighbors

WATER

- Water quality (taste, purity, sediments, fertility)
- Water quantity
- Water flow characteristics (field, farm, local, regional)
- Water temperature, Dissolved oxygen, pH

PLANTS

- Plant communities (landscape level examinations, broad transects)
- Surveys for classes of plants (grasses, forbs, shrubs, trees)
- Surveys for species (specific weeds, endangered species)
- Density of plant cover
- Crop characteristics
- Special status (threatened or endangered) species

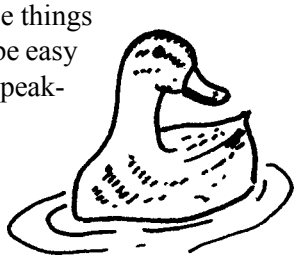


AIR

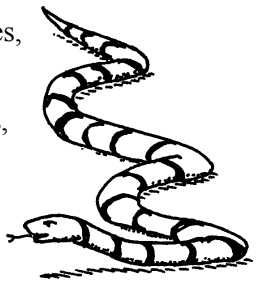
- Haziness
- Smoke
- Dust
- Pesticides moving with air currents
- Temperature
- Precipitation
- Weather patterns

WILDLIFE

The term "wildlife" includes a whole host of living things. Truly, it includes everything from bacteria to elephants, but not all of those things may be of interest to you or be easy to keep track of. Practically speaking, the list might include:

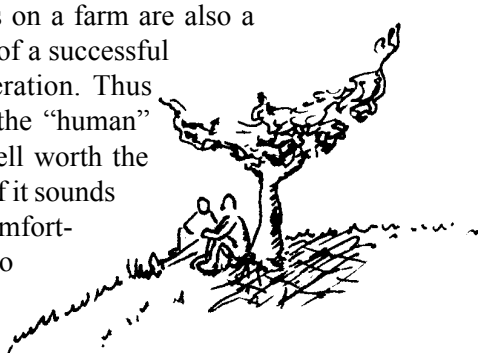


- Insects (crop pests, beneficial insects, pollinators, neutrals)
- Birds (raptors, song birds (residents vs. migrants), shorebirds, game-birds: waterfowl, turkey, quail)
- Mammals (small rodents, predatory cats, game species, livestock)
- Reptiles (lizards, snakes, turtles)
- Amphibians (frogs, toads, salamanders)
- Fish



Quality of Life and Farm Family Factors

The quality of the life you live as it relates to your land can be examined by looking at things such as your goals, expectations, satisfaction, or dreams, and how close you come to fulfilling them or how quickly you are moving toward them. The interactions of the family members on a farm are also a critical part of a successful farming operation. Thus monitoring the "human" factors is well worth the time spent. If it sounds like an uncomfortable thing to do, keep in mind that *you* are the one determining what and how something will be monitored. Your methods can be modified according to your comfort level.



If you have goals for your farm, it is certain that they are tied up with issues of your own happiness, peace of mind, sense of accomplishment, or connection to the land or your community. Just as you may want to know if your soil health is improving, you may want to find a way to measure whether or not you are moving closer to your personal goals as a farmer or landowner.

Do some thinking about whether you would like to re-examine your overall progress once a year, every six months, or if you would like to "check in" on shorter-term issues monthly or weekly.

You should include your entire family in some way. Even small voices can make remarkably good sense. Including them can awaken their interest in the land and they may be interested in helping with the monitoring. Be willing to ask some basic but very important questions and listen closely to your own – and everyone else's – honest answers.

At the end of this introductory section is a worksheet with questions to ask yourself and your family members. These will help you begin to clarify how your life and your family are tied to your land, and how to get more of what you want from the life you have chosen with the land. Rephrase them as you need in order to fit your situation.

Example Farms

In trying to decide what monitoring really means for you and how you can integrate it into the many other daily activities on a farm, it can often be helpful to hear about a farm or piece of land that may be similar to your own in some way. There are three example farms described in the last section of this manual before the Resources Section. These are taken from another RCD publication: *Bring Farm Edges Back to Life*! The farms are described just as they are in that publication, along with some proposed conservation practices.

The changes in farm management that go along with the implementation of conservation practices can be a good opportunity to try some monitoring techniques. Some possible monitoring practices will be listed for each of the example farms.

In the *Farm Edges* publication, conservation methods are discussed that can enhance and improve the natural resource conditions on your land, while decreasing problems such as weeds, siltation, water use efficiency, habitat for beneficial insects and habitat for other wildlife. The methods and techniques discussed in that publication can go hand-in-hand with much of the monitoring methods described in this manual.

Where To Monitor

This is an area where monitoring diverges *greatly* from research. In doing research, data is usually gathered "randomly" or else in a strictly systematic way so as to eliminate personal bias. For monitoring choose a *likely* place to see those things you are interested in tracking! Then stick with it!

If you want to discover if your management practices (i.e. grazing time and duration) are allowing clover to spread without additional seeding:

- Locate your monitoring exactly at some key clover patches and in the fields the cattle typically move to next!

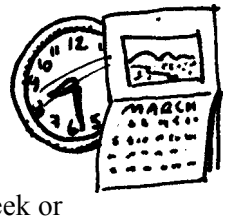
If you want to know if a check dam in the streambed will reduce stream bank erosion either above or below the site:

- Locate your monitoring site exactly at the future check dam location, with stations above and below.

If you want to know if or where any songbirds frequent your place:

- Find a place where birds might find food and shelter and plan to go out *early* in the morning to find them.

When To Monitor



What is it that determines frequency of monitoring?

The time of day, day of the week or month of the year that you should be out doing monitoring activities is all your decision (and partly determined by Mother Nature), although some of the decisions you make may lock you into certain schedules.

The amount of time you have available is probably the most important factor, along with how important certain information is to you. If you are able to enlist the support of students or volunteers, your time may be more freed up.

The condition of the resources that you plan to monitor can sometimes dictate the timing of your monitoring activities.

For "before/after" kinds of monitoring, the timing is determined by the start and end of your project. If you are digging a pond, photos and plant surveys should be done before the pond is dug and during a season of late plant growth and early maturation.

For determining seasonal changes in conditions, plan to go out and complete your activities four times each year, mid-season.

For long-term monitoring, pick a time of year that seems most appropriate to have a good look at the area or subject of interest and put the date on the calendar once a year for the next 10 years! Changes in the landscape happen slowly. It takes long-term thinking, perspective and commitment to being a good land steward.

Consistency

After making the decision to monitor, the single most important thing you can do to get *useful* results is to be *consistent*. That may mean doing something the same day and time on a certain day of the week if you have chosen a weekly schedule. If your monitoring involves seasonal or annual information gathering, make a note ahead of time on a calendar so that you actually remember to get out there at the right time. It will probably be important to use the same equipment, too, and to follow the same routine. More about that later.

How To Monitor

Monitoring is really fairly easy. Following a few basic guidelines is what makes the difference in the value of the information. This discussion assumes that you plan to implement some changes on the land or in the way you manage it or live with it. That may not be the case at all. You may just want to "watch" a wildland area for a period of time to see how it's doing and compare it to other areas. That's fine. The location selection process is still the same and so are the activities. Monitoring intangibles, such as quality of life and other things mentioned earlier, takes a slightly different twist, but the principles are the same.

Planning

The key to success here is to be clear on what your goals are!

Take a walk out onto your property with a copy of the worksheet from the topic section you'd like to work on, and perhaps an extra note pad. Bring a blank copy of a Monitoring Planning Sheet (following page). Fill out the planning sheet as you stand there and look around. These are the questions to ask yourself:

- What do I like *most* about this place? (Start out *positive*!)
- What is my ideal for this place?
- What could bring it closer to my ideal?
- Pick out 2 or 3 specific spots that fall short (no more!).
- Choose 1 (at most 2) things to work on in those spots.
- Spend some time thinking and getting clear on your goals.

If you want to take on several sites, or several topics, repeat the above process, as desired.

With that admittedly broad and loosely defined set of boundaries for monitoring, you are ready to begin.

QUALITY OF LIFE AND FARM FAMILY FACTORS

Ask the following questions of each participant in your farm/family meeting (answers can be drawn as well as written). Consider making copies and allowing each participant to fill them out privately, then discuss them as a group. You could then make a combined worksheet or a diagram on a large piece of paper. Very young family members could have the questions read to them. They could answer by drawing an appropriate picture or someone could write down their answers.

1. What is it that drew/draws me to farm life?

   a.

   b.

   c.

2. What things have made me feel that I am experiencing what I had hoped for?

   a.

   b.

   c.

3. What things do I enjoy most about my life in relation to the farm?

   a.

   b.

   c.

4. What things do I like least about my life in relation to the farm?

   a.

   b.

   c.

5. What could I do to get more of what I like from farm life?

   a.

   b.

   c.

6. What things could I do to reduce the importance of or eliminate the things I like the least ?

   a.

   b.

   c

7. Where would I like the farm to be in 5 years? Ten years? When I retire and pass it along to my children?

   5 years: At retirement:

   10 years: At death:

8. What role does my farm play in my community?
   a.
   b.
9. What role do I play in my community?
   a.
   b.
10. What two things would I change about my farm to have it play a different role in my community?
    a.
    b.
11. What would I like to change about my role in my community?
    a.
    b.
12. What things could I do to accomplish that change?
    a.
    b.
13. What values do I have that I want reflected in my farm?
    a.
    b.
14. Which of my values are reflected in my farm now?
    a.
    b.
15. Which of my values are not yet reflected in my farm?
    a.
    b.
16. What do I need to get where I want to go regarding my values?
    a.
    b.
17. What time frame do I want to work with?
    a.
    b.

Some additional questions might include the following:

- Who in the family can contribute to the farm?
- How much time can I spend with my family?
- How can I get and keep my children interested in keeping the farm?

MONITORING PLANNING SHEET

What do I like *most* about this place?

1. _____
2. _____
3. _____

What is my ideal for this place?

_____

_____

_____

What could bring it closer to my ideal?

- Pick out 2 or 3 specific spots that fall short (no more!).
- Choose 1 (at most 2) things to work on in those spots.

Location 1. _____

a. _____

b. _____

Location 2. _____

a. _____

b. _____

Location 3. _____

a. _____

b. _____

II. PHOTO MONITORING

Discussion

If you were only to do one kind of monitoring on your farm or ranch, it should be photo monitoring. It is the simplest and most striking kind of monitoring you can do for long-term change. It can also provide very dramatic evidence to friends, family, and community of the changes that are being accomplished.

Photo monitoring means taking pictures from exactly the same locations and looking exactly the same direction, over time. You could take pictures once each season, once each year, or once every 3 to 5 years. Photographs can give you a clear, visual image of progress or changes over time.

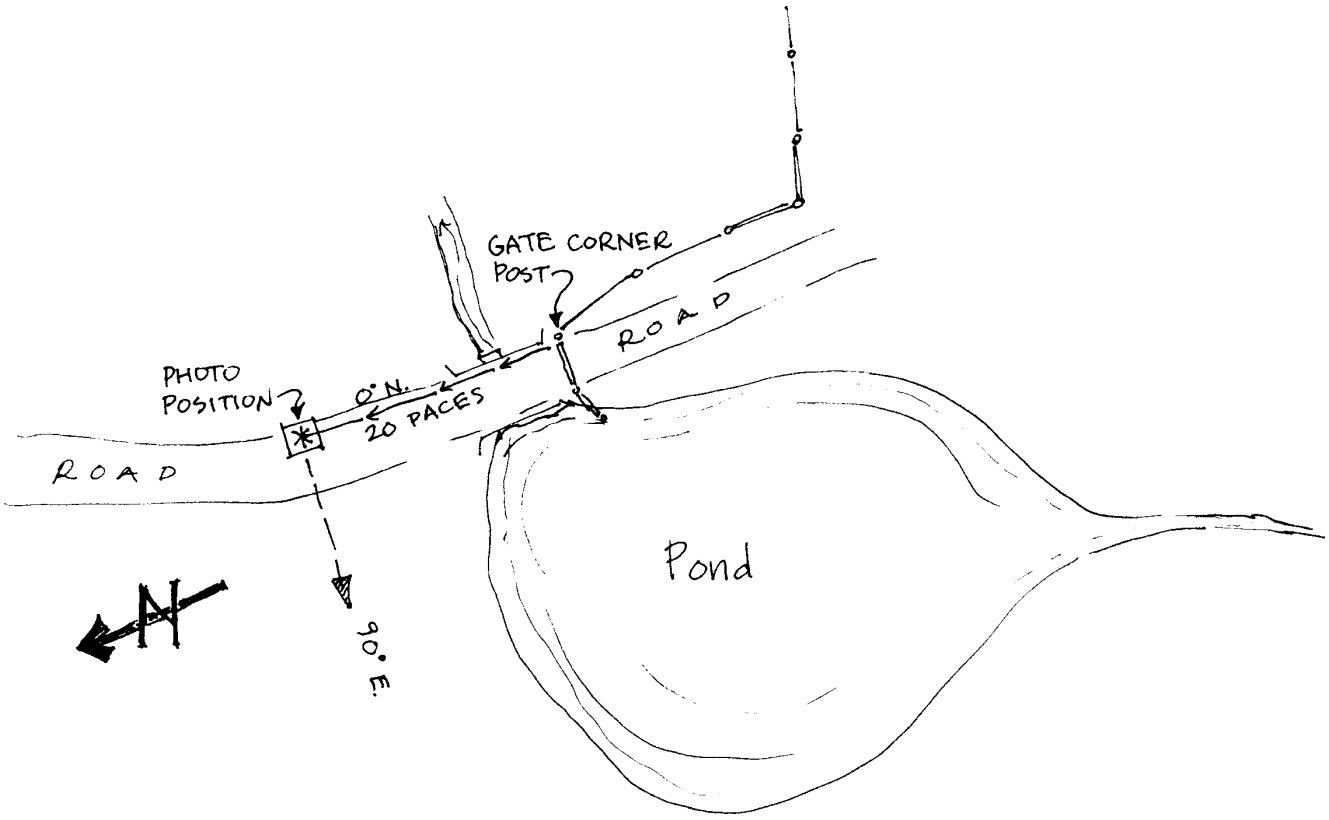
Photo monitoring can be done using a very relaxed approach while still accomplishing your purposes. This section will explain a slightly more formalized method. You can adjust it to fit your time constraints.

Equipment

- Camera – any type, but use the same type each time
- Film – any type, according to preference, but use the same type each time
- Steel fence posts, paint, or other markers (optional)
- Compass
- Notebook
- Pencil
- Photo album

Costs

Your costs could reach the thousands if you purchase a new digital camera. If you buy a disposable camera, an album, and you don't need the fence-posts your costs will be under $20.00.



Procedure

The best way to start your photo monitoring sequence of pictures is to look up historic photographs. If you have inherited your property from a long-time ranching family, they may have photographs taken from a generation ago. If not, there may be historic records elsewhere in the county. These pictures can help you to clarify the historic vegetative cover levels, forest expansion or demise, changes in watercourses, or locate landmarks. The location and perspective of historic photos my help you decide the location for future photo monitoring sites.

Choose several areas where you would like to do photo monitoring, for example a fence-line, a creek bed, and a hill side that slopes down into a valley.

Along the fence line, select one of the posts as the point from which you will take your picture. Mark the post in some permanent way. A bright-colored spray paint may last for several years. Decide in which direction or directions you will be taking pictures. You may want to pivot 180° to take a photo going the other direction along the fence, too. Take notes on your decisions so that when you come back you can get comparable pictures.

Go to the creek bed and decide what areas are most interesting to you and would lend themselves best to photographs. Place a fence-post as a marker, or triangulate off of a landmark. You could also use a large tree as a starting point, walk a certain number of paces from it in a specific direction (use the compass), pivot and take the picture facing the direction of your choice (use the compass). Be sure to take notes or make sketches.

Now go to your hill and valley area. Decide what view might give you the best opportunity to track the kind of changes you are interested in, such as vegetative cover, weed levels, erosion, gully formation, or tree growth. Place your steel post as a marker, but if this location happens to be a cattle grazing paddock, understand that they may use it as a scratching post and knock it over. In this case, it would be wise to also triangulate from an existing, permanent landmark. Use the compass to determine the direction of the photos you wish to take and write the information down.

Use the compass to get an exact directional reading for each of the photo directions so that you can come back the next time and use the compass to get exactly the same direction.

In any of the above locations, you may also want to do close-up photo monitoring. This might give you a sense of specific vegetation composition and changes in them over time. For this, construct a quadrat, as explained in the Plants section. Place the quadrat on the ground in an area you would like a close-up record of. Take the photos from a distance that will illustrate the area, but take notes on what you did.

In your notebook, record the type of camera and film you used, the lens type, and of course the date, time, location and any other helpful information you can think of about the photographs and the site.

When you get the pictures back after developing, record on the backs the same information you recorded in your notebook: date, time, location, camera, lens, film, photo direction and any other comments.

Place the first photos for each location on a separate page, perhaps with several pages in between each "first shot," so that you will have separate sections for each photo point. Subsequent photos can be placed in chronological order following the first shots.

Time estimate

Setting up each photo point will take between 1/2 and 1 hour, not including the travel time in between locations. Subsequent visits to each site will require only the time it takes to snap a few pictures (adding in the time to admire the view).

PHOTO MONITORING
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Sketch of field, photo point locations, compass angles, landmarks:

Equipment:

Camera – any type, but use the same type each time

Film – any type, according to preference, but use the same type each time

Steel fence posts, paint, or other markers (optional)

Compass

Notebook

Pencil

Photo album

Procedure Summary:

Choose the photo monitoring location.

Sketch the area, including compass angles, distance estimates and arrows for camera direction.

Take photos, including close-ups with quadrats, if desired.

Take notes.

Develop film.

Label photographs.

Place in album, with separate sections for each photo point location.

III. SOILS

This section will deal with some basic and functional characteristics of your farm soils that easily lend themselves to monitoring. These include:

Infiltration (related to water-holding capacity)

Soil nutrient status

Earthworm population (related to soil health)

There will also be a brief discussion on assessing soil moisture and soil texture, with additional information sources listed under Resources at the end of this section.

Before starting, provide yourself with a good basic understanding of your own local soils. If you haven't already, look up your farm in the county soil survey, available from your local Field Office of the USDA Natural Resources Conservation Service (NRCS). Locate them in the US Government Section of your telephone book. Some soil survey information for Yolo County is now available on the World Wide Web at http://www.ca.nrcs.usda.gov/mlra/yolo. The soil survey will provide you with lots of information about the soil types you may have and their characteristics, and where soil types change in your fields. That can be invaluable in helping you decide where to sample.

Estimating Soil Moisture

Soil moisture content can change rapidly and is easy to manipulate through irrigation. It doesn't fall into the typical category of things to be monitored over the long-term, but can be very useful in making irrigation decisions. If you do not irrigate your land, it might be telling to check soil moisture several days after a rain to begin to learn about how your soils absorb and hold moisture. There are some simple field-techniques (as contrasted with laboratory techniques) that can be used to estimate it. Practice is the key to improved accuracy in your estimates.

If you are working with a uniform soil type, check a minimum of 4 sites per field, using a shovel to get your samples. Try to check at several depths, down through the rooting zone of your crop. The technique to use involves squeezing a handful of soil together in your palm to form an irregular ball that sticks together somewhat. Squeeze a ribbon of soil off of this ball by pushing the soil between your thumb and the side of your index finger. Next, make some observations about how it looks, including the ability to ribbon, the firmness and roughness of the ball, water on the surface of the ball, loose soil particles, staining on your fingers, and how quickly the ball breaks apart when bounced on your palm.

A silty loam soil at field capacity (holding all of the free moisture that it can, or 100% of available water) will look wet and show free water on the ball surface just after squeezing. It will form a soft ball, and leave a moderate to heavy coating of soil on your fingers and palm.

At 75 – 100% of available moisture, the ball will be wet and hold clear finger marks when squeezed. There will be a light to heavy coating of soil on your palm and fingers and it will ribbon.

At 50 – 75% of available moisture, a ball will form, appear moist, and leave a light coating of soil on your hand. A weak ribbon will form between the thumb and index finger.

	No ball	Ball, no ribbon	1 inch ribbon	1-2 inch ribbon	> 2 inch ribbon
Soil feels:					
gritty	sand				
gritty		loamy sand			
gritty			sandy loam	sandy clay loam	sandy clay
smooth			silty loam	silty clay loam	silty loam
gritty & smooth			loam	clay loam	clay

At 25 – 50% of available moisture, only a weak ball will form, and although it will appear slightly moist, it will have a rough surface and pieces will break away. There will not be any soil staining on your hand.

Soils with varying percentages of sand, silt and clay, will show variations of these characteristics at the different moisture content levels. For example, those with higher clay content will ribbon more easily. Please refer to the free USDA-NRCS brochure listed at the end of this section. It has excellent pictures for reference.

Assessing Soil Texture

Soil texture refers to the relative amounts of sand, silt and clay, as well as small rock pieces and organic matter. Use a form of the "ribbon" method, mentioned above, to estimate your soil texture. Using a handful of soil, spray or drip small amounts of water onto it and knead it in your hand until it forms a ball. Squeeze some soil out between your thumb and the edge of your forefinger so that it forms a ribbon that extends over your forefinger. Keep extending the ribbon until it breaks, and take note of how long a ribbon was formed, and whether it felt smooth or gritty.

INFILTRATION

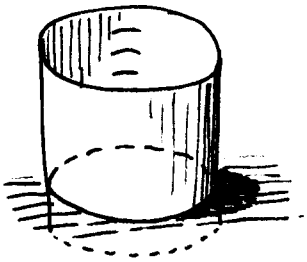
Discussion

If you are changing some cultural practices that might affect the organic matter content of your soil, compaction, or other things that you think may change the penetration or water, infiltration may be a useful parameter for you to monitor.

Water infiltration rates refer to how quickly water is absorbed into and drains through a soil. The rates are affected by soil type, saturation level, organic matter content, soil chemistry, weather conditions, compaction or hardpan, presence of existing (live) plants, plant species present, past and present land uses practices, and many other things. You may be able to control some of those factors; others, such as weather conditions, you have no control over. It is still possible to measure the existing status of water infiltration rates, while making notes on existing weather or soil conditions that might be extenuating. Attention to, and careful notes on existing conditions that may affect infiltration will allow measurements from year to year to be more comparable.

Equipment [infiltrometer]

- 6 inch aluminum irrigation pipe, cut in 8" lengths (mark 1 inch (or 1/2 inch also, if desired) increments on the inside of each 8" cylinder)
- several 1 ft. long (or longer) boards, to assist in pounding the rings into the soil
- 2 lb. Sledge or hammer
- gallon jugs or 5 gallon bucket to carry water
- measuring cup (approx. 4 cup capacity) with English and metric marks
- timer or watch
- notepad
- clippers, optional
- ruler, optional



6" ALUMINUM IRRIGATION PIPE
- 8" TALL
- MARK INSIDE IN 1" INCREMENTS

Alternative Equipment

If you are unable to get 6" aluminum irrigation pipes, then use a large coffee can. Re-calculate the volume of water needed to equal 2" of irrigation or rainfall.

$V = \pi r^2 h$

V = volume of water needed

π = 3.1416 (mathematical constant used with circles, cylinders, and spheres)

r = radius or 1/2 the distance across the widest part of the ring (1/2 x 6in. or 15.24 cm) or coffee can (1/2 x 6.25in. or 15.88cm)

h = the height you wish to reach; in this case 2 inches (5.08cm) of water to be applied inside of the infiltration ring

Examples

Irrigation Pipe

$V = \pi r^2 h$

$= (3.1416)(7.62cm)^2(5.08cm)$

$= 926.67cm^3$

$= 926.67ml$

Coffee Can

$V = \pi r^2 h$

$= (3.1416)(7.94cm)^2(5.08cm)$

$= 1006.13cm^3$

$= 1006.13ml$

Costs

The costs of this apparatus are negligible. All equipment should be generally available. Short irrigation pipe sections can be obtained from irrigation supply yard scrap-piles.

Procedures

Select a location that represents your soils well. If you have two soil types within one field then select infiltration monitoring locations in both soil types. Choose separate locations for each crop, cropping system or field.

Mark the locations well. You *must* be able to go back to the same spot (within a few feet) seasonally or yearly. Wire flags on field edges can be useful – if they won't get disced under. In orchards, colored surveyors flagging tied to a branch can help – as long as they won't get pruned off. Field edge "landmarks" such as telephone poles or large trees can be helpful to triangulate from. Then you could pace the distance to the monitoring site. Draw a sketch, noting the number of paces.

Fill your water bucket(s) with water from or near the site, or with the same water the crop might be irrigated with. Don't use tap or treated water from your office or home. The water chemistry will likely be different. This can change the interactions with the soil and could affect the infiltration rate.

After selecting the location for your infiltration study, clear the vegetation in the area where you will be placing it. Do not pull the plants out; that will disturb the soil surface and change the infiltration rate. Instead, try to nip them off with your fingernails or clip them off at the soil level with clippers.

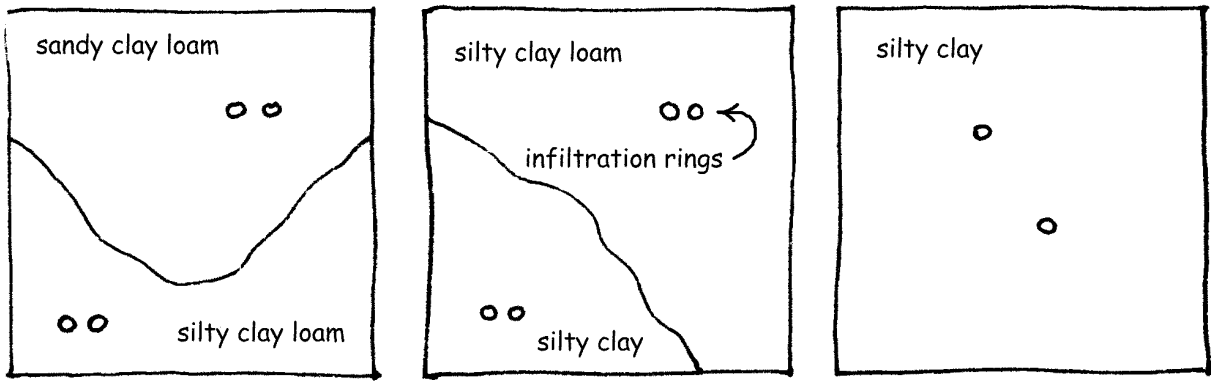
Place the ring on the ground and balance one of the boards across both edges of the ring. Hammer the ring in by hammering on the board. Hammering on the ring will only bend it.

The ring should be pounded 4 inches into the ground and kept level. Use the 1 inch marks on the inside to gauge how deep it is. Absolute minimum is 2 inches, although a depth that shallow can increase the risk of being affected by soil cracks. Some soils are so heavy that you may barely be able to get it in 3 inches. Whatever depth you choose, be *sure* to continue to use the same depth for all of you other locations and for each subsequent test dates.

Once you get the hang of it, you can probably manage two or more infiltration rings at a time, so you could set several up at once.

Once the ring is set, measure out the volume of water you need (i.e. 927ml or 1006ml). Pour the water in gently but not too slowly and begin timing. Some soil – if sandy or cracked – will absorb it all in a matter of seconds or a couple of minutes. Others will take many hours. You will probably have some idea ahead of

Infiltration Fields (oo = pair of infiltration rings)



40 ACRE ALMOND ORCHARD | 40 ACRES of ALFALFA | 40 ACRES of TOMATOES

time. You may want to bring a book to read, or you could choose to come back and check it/them once an hour.

Record on the data sheet (in this section) the total time it takes for the 2 inches of water to penetrate. I consider it to be fully infiltrated when all of the small puddles of free water are gone and there is no more shine or reflection from the water.

If you want to do hourly checks on the water level, rather than sitting and watching it, then each hour, record the time and the inches of water that have infiltrated (Inches infiltrated equals the drop in water level from the moment you first poured the water in. If calculations are correct, the original level should be 2 inches above the soil level – as marked inside the ring. Try to get down to at least quarter-inch increments in your notations)

If you are checking a clay soil that tends to swell a lot when saturated, a ruler may work better to measure the amount of water *left*. Dip the ruler in the water until it barely touches the soil and record the number of inches (or cm). With heavy soils that swell a lot, the ruler method is best. Some soils may swell 1/2 inch or more upwards in the ring and affect your numbers. Subtract that number from the original 2 inches that you poured in, and you will have the amount of water infiltrated.

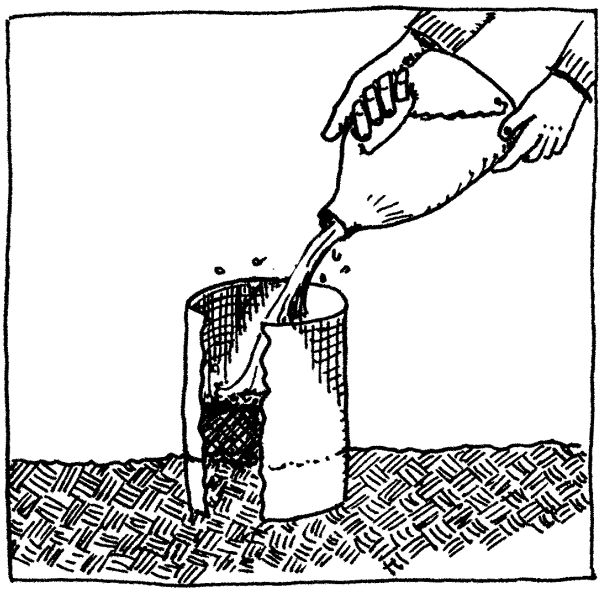
After the first 2 inches has infiltrated, repeat the process at least one or preferably two more times. You will find that infiltration usually slows after the first addition of water.

It is important to finish all of the infiltration sites for a field or block within a few days of each other. Changes in weather conditions, especially rain, can change infiltration.

Infiltration needn't be checked any more frequently than twice a year. Once may be sufficient, but always do it at the same time of year.

Time estimate

Time requirements vary greatly. With sandy soils, each 2 inches can infiltrate in a minute or less. With clay soils, the first 2 inches may infiltrate in 5 to 10 minutes, but the subsequent water may take many hours (overnight). If working with heavy soils, watch the first set of water closely. For subsequent sets, you may want to leave, and come back occasionally to check it.



INFILTRATION
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Sketch of field, sample site locations, and their labels:

Equipment:

6 inch aluminum irrigation pipe, cut in 8" lengths (mark 1 inch (or 1/2 inch also, if desired) increments on the inside of each 8" cylinder)

several 1 ft. long (or longer) boards, to assist in pounding the rings into the soil

2 lb. sledge or hammer

gallon jugs or 5 gallon bucket to carry water

measuring cup (approx. 4 cup capacity) with English and metric marks

timer or watch

notepad

clippers, optional

ruler, optional

Procedure Summary:

Clear vegetation, but do not pull or otherwise disturb the soil surface.

Pound ring 3 – 4 inches into soil.

Pour in 2 inches of water (927 ml if using standard 6 inch irrigation pipe).

Record time for water to completely infiltrate, or record inches of water infiltrated over specified time period.

INFILTRATION DATA SHEET

(site location)	Start time	End time	Time elapsed	Infiltration rate (total inches water ÷ total min. or hrs.)
1st 2 inches water				
2nd 2 inches water				
3rd 2 inches water				

(site location)	Start time	End time	Time elapsed	Infiltration rate (total inches water ÷ total min. or hrs.)
1st 2 inches water				
2nd 2 inches water				
3rd 2 inches water				

(site location)	Start time	End time	Time elapsed	Infiltration rate (total inches water ÷ total min. or hrs.)
1st 2 inches water				
2nd 2 inches water				
3rd 2 inches water				

(site location)	Start time	End time	Time elapsed	Infiltration rate (total inches water ÷ total min. or hrs.)
1st 2 inches water				
2nd 2 inches water				
3rd 2 inches water				

(site location)	Start time	End time	Time elapsed	Infiltration rate (total inches water ÷ total min. or hrs.)
1st 2 inches water				
2nd 2 inches water				
3rd 2 inches water				

INFILTRATION
PLANNING QUESTIONS

What soil condition or situation leads me to want to monitor the infiltration rate?

1.

2.

3.

Where can I realistically do monitoring of each of these conditions?

1.

2.

3.

What question can I ask myself that will clearly define my concerns about soil conditions 1., 2., and 3.?

1.

2.

3.

What activity or activities can I do to answer question 1., 2., and 3. above?

1.

2.

3.

How often should I do each of the activities (daily, weekly, monthly, seasonally, yearly)?

1.

2.

3.

SOIL SAMPLING FOR ANALYSIS

Discussion

Soil sampling can have a great variety of purposes. The same, or very similar, sampling methods are used for most of these. This section presents how to sample soils correctly to get the most representative sample for a field.

The overall concept in soil sampling is that a set of individual samples must be taken from a broad area in a specific way. They are then mixed together to form one sample for analysis. Taking correct samples and mixing them thoroughly is very important. One soil sample, often representing 10 to 20 acres, can weigh a pound or less and only a few grams of soil are used to do the actual test.

You may want to have a soil test done to find out the basic fertility of your soil, or to see if there is a nutrient deficiency. You may want to find out if your soil is acidic or basic or the types and numbers of organisms that it harbors. A soil test can also be used to determine the basic soil category according to the sand, silt and clay content. Results of these kinds of tests can help you make decisions on fertilizer supplements, other soil amendments, or basic soil management decisions.

Soil Fertility

'Soil fertility' refers to the types, the levels, and the balance between certain plant nutrients that are harbored in your soil and may (or may not) be available to plants. It is an extremely complex attribute. It is affected by things such as past and present uses, moisture content, soil type, pH (a measure of acidity), levels of organic matter, numbers and types of soil micro-flora and micro-fauna, climatic conditions and on and on. . .

The myriad of cropping and other land-use systems in place will determine what fertility conditions are most desirable for your land. Local U.C. Cooperative Extension Farm Advisors have information on the best fertility conditions for your land use, whether you are growing peaches or grazing sheep. Look in your local telephone directory under County Government, University of California Cooperative Extension Farm Advisor & 4H, or check the UC website listed in the reference section.

Small home-test kits can be purchased from a variety of companies (see references). They can give you basic information on Nitrogen (N), Phosphorus (P), Potassium (K), and acidity (pH). The kits can cost $35.00 - $40.00 for single nutrients, or $65.00 and up for combination tests.

For really good quality, consistent, reproducible results and thorough reports, try sending a soil sample to an agricultural testing lab. You may also be able to send samples to the UC DANR laboratory for very reasonable prices. See your local yellow pages for agricultural laboratories. UC also publishes a list of commercial laboratories. Check the UC ANR Catalog reference. Samples will generally cost $5.00 or less for a single nutrient, and $25 - $30.00 for "packages" that include multiple analyses. The reports can include information on Organic Matter, Nitrate-nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Sulfate, Zinc, Iron, Copper, Boron, Base Saturation, Cation Exchange Capacity, and Acidity (pH).

Use the sampling method(s) described in this section to collect a soil sample for nutrient analysis.

Equipment

- Shovel (or soil core sampler, available from your local farm supply store)
- Plastic (not metal) bucket (2 to 5 gallon), plus 2 to 3 more, if you wish to sample 2 to 3 separate soil depths
- Plastic bag(s) (zip-close type works well)
- Permanent marker for labeling bags

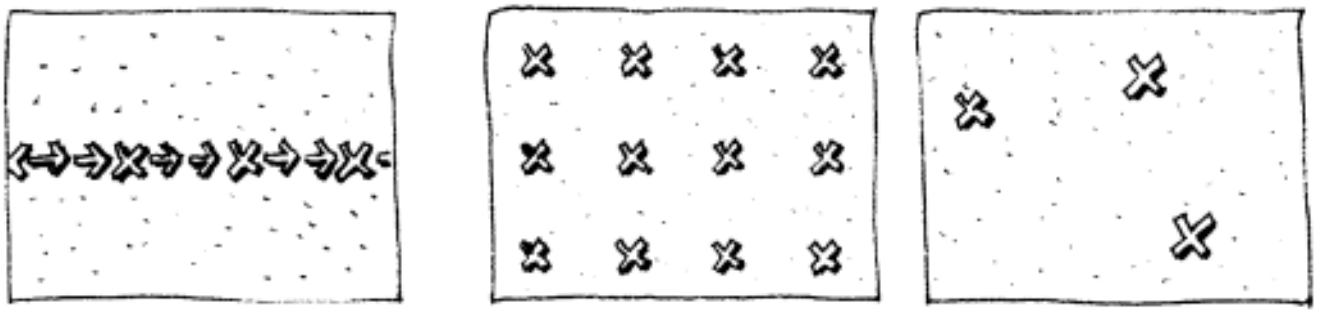
Costs

Under $20.00 if all equipment is purchased. Negligible if pre-owned equipment and supplies are used.

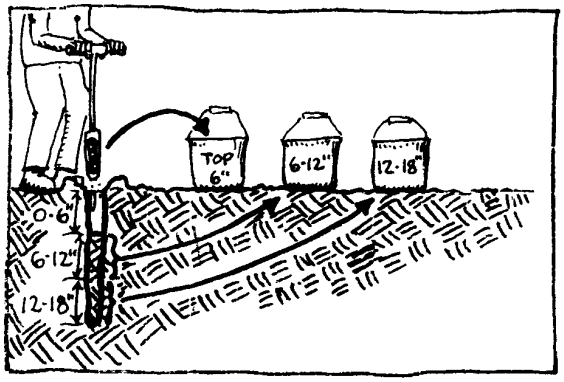
Procedures

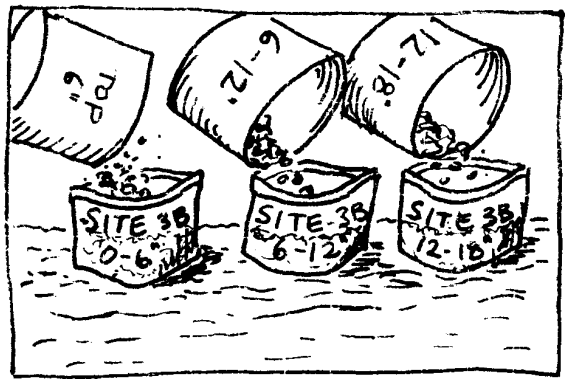
Choose one of the sampling patterns in the diagrams below. Try to avoid field corners, edges, low spots, and other areas that obviously aren't characteristic of the main part of the field or block you are interested. A soil map, available from your local USDA/NRCS (Natural Resources Conservation Service) can be helpful in finding changes in soil types within a block.

At each location, first brush away any surface residue or the loose clods on the top. Use your shovel – or preferably a soil sampler or auger – to take the top 6 to 8 inches, or to the depth you wish to have analyzed. If you want to also check the next depth



separately, you will need a second bucket. Collect all soil samples from the top layer in one bucket, and from the lower soil depth in the second bucket. Mix the samples within each bucket as you go along, and then very thoroughly at the end. Take a sample of about 3 to 4 cups at the most from each bucket and place it in separate zip-close bags. The bag should be thoroughly labeled with your name, the date and the location where the sample was taken. It is then ready to send or drive to the laboratory.





Time estimate

Allow about an hour to collect, mix and label soil samples from a standard, commercial row-crop field. The size (number of acres) of the field has less effect on the time needed than the actual number of samples you take and the walking distance. You may want to allow 2 to 3 hours if you are inexperienced, if the field is long and narrow, rather than square, or if you are taking multiple depths as separate samples.

SOIL SAMPLING FOR ANALYSIS
SUMMARY CARD

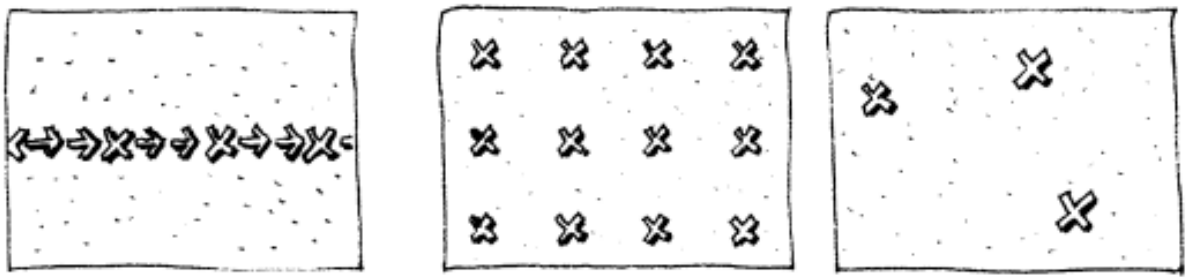
Date: _____ Time: _____ Location (field): _____

Depth: _____ Total Acres represented (field size): _____

Samples taken for analysis of : _____

Equipment:

Shovel or soil probe
Plastic bucket(s)
Plastic bag(s), preferably zipper type
Permanent marker



Procedure summary:

Circle the sampling pattern (above) used for this sample.
Take equal size and equal depth samples from each sample site.
Combine all samples from same depth in separate plastic buckets.
Mix well.
Take 2 to 4 cups from each bucket and place in separate plastic bags.
Label bag(s) with date, name, location, soil depth and any other helpful information.

Bag No.:
Field Location:
Location in Field
Soil Depth:
Parameter Tested:

Bag No.:
Field Location:
Location in Field
Soil Depth:
Parameter Tested:

EARTHWORM SAMPLING

Discussion

The concept of soil 'health' integrates the biological, chemical and physical factors and processes that all work together to support plant and animal life. These include things such as soil strata at different soil depths (gravel or hard-pan layers), slope and aspect, chemical and fertility factors and the micro-biological life supported by the soil. A healthy soil is one that contains a thriving, complex and diverse community of flora and fauna.

This complex community can be analyzed in technical ways, but a simple way of monitoring is to look at one of the soil's most visible inhabitants. Earthworms are good integrators of many of the factors related to soil health from the perspective of a landowner looking at soil utility. Their ability to live and reproduce in a soil can be a useful indicator of how balanced these factors are and how well it can support life. They are relatively easy to sample, which makes them an ideal subject for monitoring.

Two methods of sampling worms will be discussed: shovel sampling and vermifuge.

There are three general categories of earthworms: epigeic, endogeic and anecic. There is a brief, but excellent explanation of these categories of worms in the publication, "BIOS for Almonds" (CAFF, 1995).

Most earthworms are active during the cooler, wetter months so winter and early spring are the time of year to sample. Before you start, decide what type of worm you will be looking for.

Endogeic earthworms (underground, horizontally moving worms) are the workhorses of most California farm soils. They generally live and eat within the deeper soil horizons and are not as disturbed by the loss of surface organic matter or chemical applications as other species. They are commonly found clustered around the root balls of plants, where they feed on the decaying portions of root systems and on the fungi, bacteria, and nematodes that live there.

Epigeic earthworms (red worms, manure worms) live close to the surface, where organic matter is concentrated. These include the red worms that are readily purchased from commercial earthworm dealers. It's not practical to add this kind of earthworm directly to most farm soils and expect a big increase in their population, because they need an abundant and regular supply of surface organic matter to thrive. However, they can be very useful for transforming organic wastes into high-quality fertilizer, a process called vermiculture.

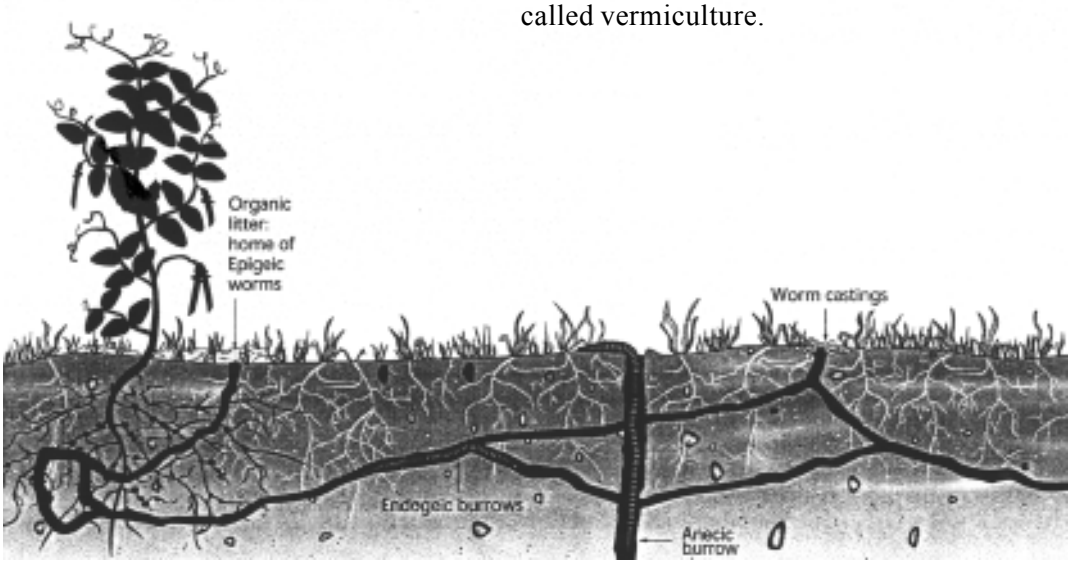


Image reprinted with permission from BIOS for Almonds

The most common worms found in previously disturbed agricultural soils without much litter on top are the epigeic and endogeic worms – those that live on or just below the surface - the top 8 to 12 inches. If the soil has been heavily tilled for years it may be difficult to find any earthworms at all.

There is a third category of earthworms that you should be aware of. These are Anecic worms, more commonly called "nightcrawlers." They are a very substantial worm that is very long-lived – sometimes up to 10 years. They make permanent, vertical burrows that penetrate much deeper into the soil than those of the other two categories of earthworms. Anecic worms typically feed at night (sunlight can be very damaging to them) by coming to the soil surface, grabbing pieces of organic matter such as fallen leaves, and dragging them down their burrows (nutrient cycling in action). Any indigestible parts will be dragged back up to the surface and left in little piles near the burrow. These kinds of worms can do a remarkable job of cycling nutrients from the soil surface to deeper root zones. Unfortunately, with all of the soil disturbance that happens with conventional agriculture, the permanent burrows get destroyed. These long-lived worms are almost never found in cultivated agricultural soils, but CAN be re-introduced.

Equipment - Shovel Sampling

- Shovel
- Tarp

Cost

Materials costs are negligible. If new tarp, $12.00.

Procedure

Earthworms are most active in the cool months of the year. Sampling for them is best done in late winter to early spring. During the summer, they typically retreat from the hot dry soils to cooler places.

Shovel sampling is the simplest and least time-intensive of the two methods discussed. It involves simply taking similar sized shovels full of soil, turning them over and breaking them up sufficiently to count all of the adult and immature worms, and categorize them. Use one of the sampling patterns described in the soil sampling for analysis section above. If you are not able to take as many samples as are suggested in the pattern, then check a MINIMUM of 6 locations per soil type. Dig down a foot, if possible, using about 5 good shovels full per location. Jot down your counts. Take an average per shovel-full. If you intend to count any-and-all worms, use the data sheet directly below, under *Shovel Sampling*. If you will try to distinguish between worm types and mature/immature worms, use the data sheet under *Vermifuge*. Expect to see variability through a field or with changes in soil types or soil conditions, but an average of 5 to 10 is an indication of good soil health.

Time estimate

Allow about 2 hours to complete a field, more if you spend extra time looking at the other organisms you find.

WORM SAMPLING/SHOVEL SAMPLING SUMMARY CARD

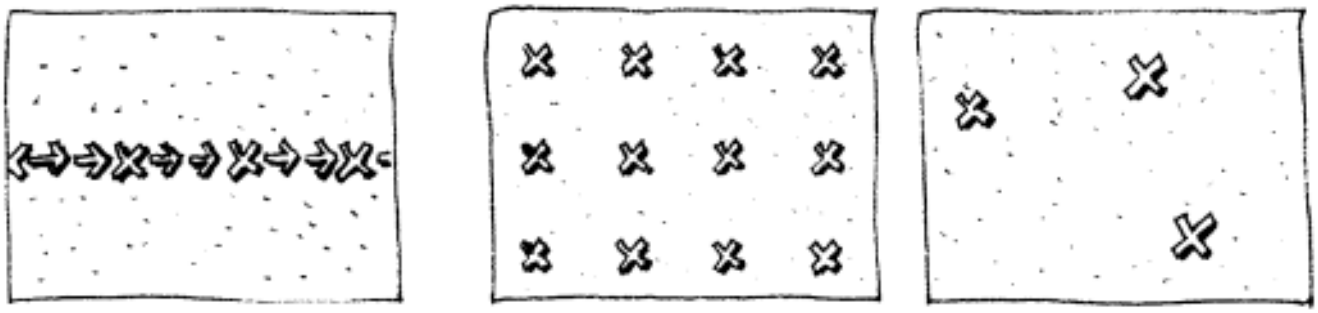
Date: _____ Time: _____ Location (field): _____

Total Acres represented (field size): _____

Equipment:

Shovel
Tarp

Procedure Summary:



Circle the sampling pattern (above) used for this sample.

Choose either the data sheet directly below, or the one under *Vermifuge*.

Take one shovel full of soil up to 1 ft. deep if possible.

Break up the soil sample and count worms.

Take 3 or more shovel samples per site.

Record your counts and take an average per site.

Check a minimum of 6 sites in a field.

Take equal size and equal depth samples from each sample site.

Sample site No.	Worm count/Avg.	Sample site No.	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

Sample site No.	Worm count/Avg.	Sample site No.	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

WORM SAMPLING/SHOVEL SAMPLING SUMMARY CARD - PAGE 2

Date: _____ Time: _____ Location (field): _____

Total Acres represented (field size): _____

Sample site No. ____	Worm count/Avg.	Sample site No. ____	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

Sample site No. ____	Worm count/Avg.	Sample site No. ____	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

Sample site No. ____	Worm count/Avg.	Sample site No. ____	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

Sample site No. ____	Worm count/Avg.	Sample site No. ____	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

Sample site No. ____	Worm count/Avg.	Sample site No. ____	Worm count/Avg.
Shovel 1		Shovel 1	
Shovel 2		Shovel 2	
Shovel 3		Shovel 3	
Average		Average	

EARTHWORM SAMPLING - Vermifuge

Discussion

"Vermifuge" involves imbedding a sample ring in the soil in your selected sample area, pouring a solution of skin irritant in the area and counting what pops out of the ground.

Don't check as many locations if you use this method as you would if doing shovel samples, since the sample area is larger and it takes longer per site. If you have the time to do more samples, though, you'll get more information. If you are doing this annually, be sure to sample at the same time each year and in the same locations.

Equipment

- sampling ring: Cut a 1 foot deep slice from the top of an opened, clean, 50-gallon drum – giving you a ring that is sharp on one edge and finished/rounded on the other.
- A 2' x 4' board, slightly longer than the ring is wide
- 1 gallon jug (milk or juice)
- several cups of dry mustard; (bulk purchase is cheapest) for vermifuge solution (premixed or made on site; see recipe, following page)
- small measuring cup
- large (5 gallon) bucket of water
- copy of field data sheet
- clippers
- hand sledge or hammer
- tweezers (optional)

Cost

Negligible. Most of this equipment is probably already owned. Minimal purchases of perhaps $20.00 may be needed.

Procedure

Select a level site to sample and clip out all of the vegetation at ground level. Do not pull it out; that will disturb the soil below the surface and send all of the worms crawling away. Place the ring, then place the 2 x 4 on top of the ring. Hammer on the board near the edge of the ring until the ring is 3 to 4 inches into the soil.

Shake the vermifuge solution (see next page) well before application to reduce lumps and minimize settling. Pour it evenly over the entire area inside the ring. Allow the solution to soak in and begin removing (with tweezers if you are squeamish) and counting the worms that emerge. Wait about 10 minutes after the solution has soaked in and repeat. Three times should be the most needed to flush everything out. After the last pour has penetrated, stir through the soil surface to find any additional worms. As you are counting, if you are feeling benevolent, you could drop the worms into a jar of fresh water to rinse. They can be returned to the soil afterwards.

Sampling ring: Area conversion

The following information will be useful if you want to convert the number of worms you have counted into a number per unit area (i.e. worms/m^2 or worms/Acre)

$A = \pi r^2$
A = area inside the ring
π = pi = ~3.1416, an algebraic constant used with circles/spheres
r = radius = ½ the diameter of the ring

Example: if the diameter of the ring from the 50 gallon drum is 57.2 cm, then r = 28.6cm or 22.5 inches, r = 11.25in.

Metric	English
$A = \pi r^2$	$A = \pi r^2$
$A = (3.1416)(28.58cm)^2$	$A = (3.1416)(11.25in.)^2$
$A = (3.1416)(816.82)$	$A = (3.1416)(126.56in.)$
$A = 2{,}566.11cm^2$	$A = 397.61\ in^2$
convert to $Meters^2$	Convert to $ft.^2$
$A = 2566.11cm^2(1m^2/10{,}000cm^2)$	$A = (397.61)(1\ ft^2/144in^2)$
$A = 0.25m^2$	$A = 2.76ft.^2$

Converting your counts to per-hectare or per-acre values:

Your counts represent the number of worms per ring, which in this case in .25m^2 (or 2.76ft^2). But there are 1,000m^2 per hectare (and 43,560ft^2 per acre). Multiply your numbers like this if you found 25 worms:

Metric

Worms/ha = (25 worms/0.25m2)(10,000m^2/ha) = 1,000,000/ha

English

Worms/Acre = (25 worms/2.76ft^2)(43,560ft^2/acre) = 394,565 worms/acre = 394,565 worms/acre

Vermifuge solution:

60 cc dry (not packed) mustard in 4.5 Liters of water (or 50 cc/gallon). Shake well. For ease of measuring, if you have an empty plastic 35mm film case, this has a volume just a little over 30cc (= 30ml). Use just under "2 scoops" from one of these canisters if you are working with Liters, 1½ scoops if you are working with gallons.

Time estimate

Set-up and 3 pourings of vermifuge solution will take a full hour or slightly more. If you run 2 vermifuge rings near each other at a time, you can complete four such locations in one full workday.

WORM SAMPLING/VERMIFUGE SUMMARY CARD

Date: _____ Field Location: _____ Ring Station # _____

Equipment:

sampling ring: Cut a 1 foot deep slice from the top of an opened, clean, 50-gallon drum – giving you a ring that is sharp on one edge and finished/rounded on the other

A 2' x 4' board, slightly longer than the ring is wide

1 gallon jug (milk or juice)

several cups of dry mustard; (bulk purchase is cheapest) for vermifuge solution (premixed or made on site; see recipe, previous page)

small measuring cup

large (5 gallon) bucket of water

copy of field data sheet

clippers

hand sledge or hammer

tweezers (optional)

Procedure Summary:

Select site and clip out vegetation (do not pull).

Place the ring with 2 x 4 on top.

Hammer in the ring until it's 3 to 4 inches into the soil.

Shake vermifuge solution.

Pour it evenly over the entire area inside the ring.

Allow solution to soak in.

Begin removing and counting worms that emerge (Place briefly in clear water).

Wait 10 minutes and repeat.

After the last pour, stir soil surface to find any additional worms.

Return rinsed worms to soil.

WORM SAMPLING/VERMIFUGE SUMMARY CARD

Date: _____ Field Location: _____ Ring Station # _____

Pour #1 Count	Category	Notes
	Epigeic - mature	
	- immature	
	Endogeic - mature	
	- immature	
	Anecic - mature	
	- immature	
	Other (larvae, beetles, spiders)	

Pour #2 Count	Category	Notes
	Epigeic - mature	
	- immature	
	Endogeic - mature	
	- immature	
	Anecic - mature	
	- immature	
	Other (larvae, beetles, spiders)	

Pour #3 Count	Category	Notes
	Epigeic - mature	
	- immature	
	Endogeic - mature	
	- immature	
	Anecic - mature	
	- immature	
	Other (larvae, beetles, spiders)	

RESOURCES

Appelhof, Mary. 1977. Worms Eat my Garbage. Flower Press, Kalamazoo, MI. 163pp. $12.95

BIOS for Almonds - A Practical Guide to Biologically Integrated Orchard Systems. Community Alliance with Family Farmers, P.O. Box 363, Davis, CA 95617, (530) 756-8518, or Almond Board of California.

Estimating Soil Moisture by Feel and Appearance. 1998. USDA Natural Resources Conservation Service. Program Aid Number 1619.

Grossman, Shelly and Melissa (Toby) Weitzel. 1977. Recycle with Earthworms: The Red Wiggler Connection. Shields Publications, Eagle River, WI. [Shields Publications, P.O. Box 669, Eagle River, WI, 54521, Vermicoast, 1387 Basswood Ave., Carlsbad, CA 92008-1904.

http://members.aol.com/vermicoast.

LaMotte Company (soil test kits) P.O. Box 329, Chestertown, MD 21620. 800-344-3100, 410-778-3100. http://www.lamotte.com

Matthew Werner, Center for Agroecology and Sustainable Food Systems, University of California, Santa Cruz. (408) 459-4661

Ness, Julia Ahlers, ed. 1998. The Monitoring Tool Box. Land Stewardship Project, 2200 Fourth St., White Bear Lake, MN 55110.

Sava, Roger. June 1994. Guide to Sampling Air, Water, Soil and Vegetation for Chemical Analysis. Environmental Hazards Assessment Program, State of California, Environmental Protection Agency, Department of Pesticide Regulation, Environmental Monitoring and Pest Management Branch, 1020 N St., Sacramento, CA 95814-5604. EH 94-04.

Soil Biology Primer. 2000. USDA NRCS. Good visuals to provide basic information on the biological systems in the soil and their relationship to conservation, pests, nutrients, and soil health. 1-888-LANDCARE, or landcare@swcs.org. www.statlab.iastate.edu/survey/SQI/catalog.

University of California Cooperative Extension Farm Advisors, 70 Cottonwood St., Woodland, CA 95695, 530-666-8143. http://danr.ucop.edu/danrdir/uccequery.cfm

University of California Agriculture & Natural Resources ANR Catalog. University of California ANR Communication Services, 6701 San Pablo Avenue, Oakland, CA 94608-1239, 800-994-8849, 510-642-2431. http://anrcatalog.ucdavis.edu

United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Field Office. There is an NRCS Field Office for each county in the state. These offices have trained soil conservationists, soil surveys and maps and lots of other information on local conservation measures. Look in your telephone directory in the U. S. Government section, under USDA.

Western Fertilizer Handbook, 7th ed. 1985. Soil Improvement Committee, California Fertilizer Assn. The Interstate Printers & Publishers, Inc., Danville, Il 61832-0594. Good basic primer on soil, plant, and nutrient interactions.

IV. WATER SAMPLING

Discussion

There are many issues surrounding water quality, quantity, and distribution. There are ongoing, intense political and philosophical debates about all aspects of water use.

Once you walk away from the debates and discussions and return to your own farm or ranch, you may want to check a few simple things on your own. These could include nutrients, synthetic chemicals, flow rates, and sediment. In a natural waterway, you may be interested in the plant and animal life that it supports.

There are some simple test kits available to do some basic nutrient checks. See the References section at the end. These use pre-measured reagents (i.e. in tablet form), recipe-like procedures, and even provide pre-marked test tubes. The results usually do not have pinpoint accuracy, but can give you a fair idea of where you stand for nutrients such as ammonia or nitrate-N and a few others. A great deal can and should be said about sampling time and frequency in relation to water quality. Your results can be completely swayed one direction or another depending upon when you sample for a particular nutrient or for sediment.

If you will be working with a professional analytical laboratory, check with them for specific instructions on how to sample. Often, a sample bottle must be submerged midstream, opened until it is full, then closed, labeled and sent off to them. A composite sample (meaning a mixture of a number of samples) may be needed. Samples may need to be in glass and not plastic to prevent chemical reactions or attachments to the plastic. They may need to be in amber/brown bottles to prevent photo-degradation. They may need to be chilled immediately. The quality of your results is only as good as the sample that is taken.

This main section will cover sampling methods for flow rate and sediment. Water samples taken for a professional laboratory for chemical or nutrient analysis would generally be taken as described under the section below on Sediment, however, it is always important to check with the laboratory for specific requirements.

Sampling natural waterways, usually small ones like streams, for the insects and other small creatures that live in the water (most of them referred to as macro-invertebrates), is often referred to as "Stream Bio-Assessment." There are many methods for doing this type of monitoring. The simpler versions are useful for giving general indications of stream health and water quality, based on the groups of invertebrates that are most commonly found.

WATER SAMPLING - Flow

This method of measuring water flow can be used in combination with sampling for nutrients or silt.

When you have a professional analysis done for sediment or nutrients, the results are usually in units that indicate the concentration, or the mass in a volume of water. These units might be parts-per-million (ppm), grams-per-liter (g/L), ounces-per-gallon (oz./gal), or the like. These numbers can be interesting, but they can also be useful if you have something to compare them to, such as a reference concentration or numbers from another site. What makes them most useful, is to combine them with a flow rate. If you know the rate of flow of the water coming off the field, that information can be combined with the amount of sediment in a given volume of water. With that you will have a fair idea of the Tons/Acre of sediment moving off a field in a given irrigation.

Equipment

- Yardstick or metal tape measure (or both)
- Graph paper
- 5 - 10 "floats:" pieces of orange peel, or something else disposable and biodegradable that floats

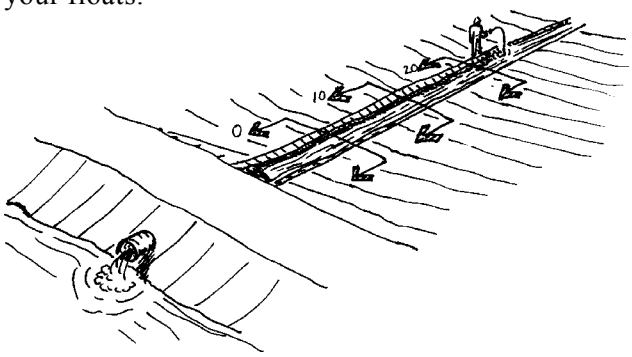
Costs

Approximately $5.00 if you purchase a new pad of graph paper.

Procedure

In order to estimate the flow off a field most accurately, choose a section of your drain ditch that

is nearest the low point or drainage outlet of the field. If the field flows into a slough, choose a section that is close to the exit into the slough, as long as it has a fairly uniform channel and is safe to work around. If you are measuring flow in a slough or creek, choose a section that allows easy access and good visual observation of your floats.



If we assume it is a ditch, choose a fairly straight section of the ditch that is fairly close to the outlet from the field. This could be just before your own field empties into an irrigation district drain or other larger conveyance. Mark a starting point as "0." Place a marker at 10 yards or paces upstream and again at 20 yards or paces. The 0, 10 and 20 yard marks are where you will take cross-sectional areas of the ditch.

Draw yourself a diagram like this and insert your own measurements. Measure the distance from water's edge to waters' edge (a). Then locate the deepest point of the cross-section and measure the height from the ditch bottom up to the water level (b). Be sure not to push the yardstick or tape measure down into the mud. Keep it right at the underwater soil surface. Measurements (c) and (d) should be half-way from the center out to the waters' edge. Repeat this process for the other two locations.

Take one of your floating markers and toss it into the center of the channel a short distance upstream from your upper cross-section. Note the exact time that it passes the uppermost marker (i.e. 20 yds.).

Follow it and mark the exact time it takes to cross the lower marker (i.e. "0" yds.) Record the time. Do this at least 5 times, until there is a clear pattern and your numbers are very close each time. If the float gets stuck on a stick or drifts to the shallow edge of the ditch, start over.

Example: Time for float to travel 20 ft:

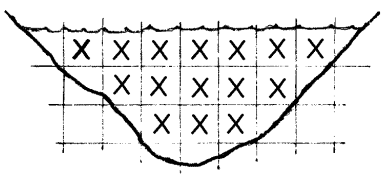
12.0	13.5	12.0
11.0	13.0	11.0
12.0	12.5	12.0
11.5	11.5	12.0

Average of 12 numbers above:
(145.0) ÷ 12 = 12.083 = 12.1 sec.

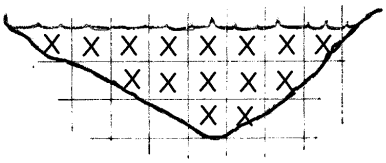
So. . . The water in the ditch is traveling:
20 ft./12.1 sec. = 1.65 ft./sec.

Now find cubic ft. per second:

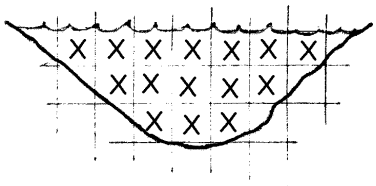
Using your sketch of the 3 cross sections, make a more accurate drawing of them on the graph paper. Use one square, 4 squares, or some other convenient relationship, to represent one foot. Count the number of squares for each of the cross sections, averaging together the partial squares. This will give you the area of each cross-section in ft^2. Be sure that the units you are counting are square feet. This is, in my opinion, much easier to deal with than calculus! Granted, it's less accurate, but acceptable for these purposes. Add these 3 numbers together and divide by 3 to get the



~18 SQUARES
~18 SQUARE FEET



~14 SQUARES
~14 SQUARE FEET



~16 SQUARES
~16 SQUARE FEET

average cross-sectional area of the water flowing in the ditch.

18 $ft.^2$ + 14 $ft.^2$+ 16 $ft.^2$ = 16 $ft.^2$ average

In the prior step, the water was shown to be moving 1.65 ft./sec. Multiply this number by the average cross-sectional area to get cubic feet per second (ft^3/sec).

(16 $ft.^2$) (1.65 ft./sec.) = 26.4 ft^3/sec = 26.4 cfs

If you multiply that times 60 seconds per minute and then 60 minutes per hour, you will know how many cubic feet of water are running off per hour. If you have a 12 hour irrigation, simple multiplication will tell you the total water running off during that irrigation.

(26.4 cfs) (60 sec/min) (60 min/hr) = 95,040 cubic feet

(95,040 $ft.^3$) (12 hrs) = 1,140,480 cubic ft. of water

Knowing that there are 43,560 cubic ft. in an Acre-foot:

(1,140,480 cubic ft) ¸ (43,560) = 26 Acre-feet

That would be the total runoff if that flow rate were consistent for the entire irrigation and if there were no cut-backs (reducing or cutting back the water flow once the water has reached or is near the end of the furrow, or toward the end of an irrigation). Take into account that flow rates change during irrigations. You may want to adjust your figures a little, or take some flow rates at different times during the irrigation.

To get an estimate of Tons/Acre-ft. water:

Once you have this flow and volume information you can use it in combination with any sediment concentration information gathered (see the Sediment section below) to estimate tons/acre of soil lost in that irrigation. This involves simple multiplication, but care must be taken to use the correct mathematical units. If you multiply (2 grams of sediment/quart) x (17 acre-ft. of water) you will get an incorrect answer. All weights must be in the same units (lbs. or g) and all volumes must be in the same units (i.e. gallons).

Researchers may object to this method because it's not *technically* accurate. To have truly correct figures you should be sampling for sediment and getting flow rates each hour through the entire irrigation, making separate calculations for each hour, graphing, integrating or extrapolating under the line and summing all measurements taken over the entire irrigation. That not being practical, the above method gives you a ball-park figure. It may be an under- or over-estimate, depending on when during the irrigation you have taken your samples.

Time estimate

Allow 1 to 2 hours to complete the field portions of this method (taking the channel cross-sections and flows). The time needed for calculations will depend on your affinity for mathematics.

WATER SAMPLING - FLOW
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment:

Yardstick or metal tape measure (or both)

Graph paper

5 - 10 “floats:” pieces of orange peel, or something else disposable and biodegradable that floats

Procedure Summary:

Choose a section of waterway, whether drain ditch or creek.

Mark beginning, middle and end sections approximately 10 yards apart.

Take cross-sectional depth measurements at each mark.

Sketch the cross-sectional contours on graph paper.

(Later, count squares to determine cross-sectional area at all 3 markers. Find the average by adding all 3 totals together and dividing by 3).

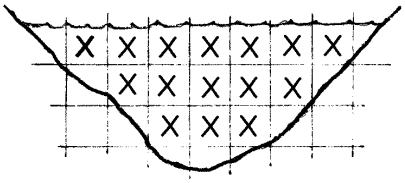
Toss a float into midstream slightly upstream of the upper marker.

Note and record the exact time it crosses the upper marker.

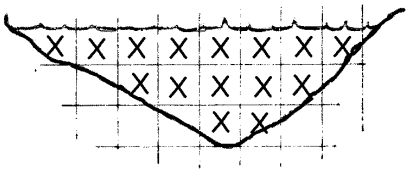
Follow the float and note and record the exact time it crosses the lower marker.

Repeat until you obtain a clear pattern, disregarding any times when the float gets stuck on debris or at the water’s edge.

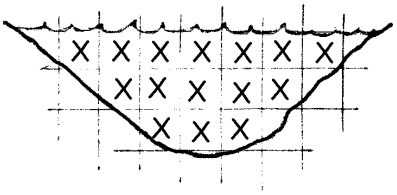
WATER SAMPLING - FLOW
SUMMARY CARD - PAGE 2



~18 SQUARES
~18 SQUARE FEET



~14 SQUARES
~14 SQUARE FEET



~16 SQUARES
~16 SQUARE FEET

Times for float to travel 20 ft.: _____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Average = _____ , _____

Total of timed samples Number of samples

Water flow rate = 20 ft. = _____ft./second

(average flow, from above)

Cubic ft./second = Avg. cross-sectional area in ft.^{2} x flow rate

WATER SAMPLING - Sediment

Discussion

Sediment in waterways refers to the very fine soil particles that get picked up and suspended in the water as a result of the water coming into contact with and/or flowing over bare or unstable soil. This sediment can be heavy enough or the water flow slow enough that it settles out quickly. However, if the particles are tiny and light, or the flow rate is high, they may be carried quite some distance from where they originated before finally being deposited. Accumulated sediment can fill in irrigation ditches, streams, ponds, lakes, rivers and estuaries. The sediment particles can carry excess or unwanted nutrients or pesticides. Knowing the sediment content of the water leaving your property may help you make decisions about how you want to manage your water for the impacts it has on your own place, as well as on those downstream of you.

Most professional laboratories that do nutrient and toxicant analysis will also analyze sediment levels. The goal is to find out, for example, the number of grams of sediment per unit volume of water (i.e. g/L, or oz./gallon). Sometimes you may be able to find out the size and soil class of those particles. Following is a simplified method for collecting and measuring sediment.

Equipment

- Clean, quart-size home-canning jars and lids
- 1 or more plastic 1-cup coffee filter holder (available from grocery store)
- Disposable 1-cup coffee filters (i.e. Melita #2)
- Measuring cup with fine divisions (liter graduated cylinder is great, but many stores now have measuring cups with English and metric measurements. Metrics are easier to work with but if you have fine divisions on an English-System cup that's OK, too)
- Labels or masking tape
- Permanent markers
- Scale, accurate to tenths of grams if possible. Borrow one, or bring your items to be weighed in to your local Cooperative Extension office and use one of theirs.

Costs

You might spend up to $25.00 or $30.00 if you buy new jars, filters and holders, measuring cups, and markers. Scales can cost in the hundreds of dollars.

Procedures

Choose a waterway, such as a field drain, supply or drain ditch, creek, or slough that has some apparent sediment suspended in it (looks cloudy or brownish). If you can't see it, you won't pick anything up with this method. Using a jar, reach into the water to get a midstream sample until the jar is full. Avoid algae, twigs and other debris. If it is possible to open the jar underwater in the center of the channel without endangering yourself, do that. If the center of the waterway is distant, try attaching a plastic cup/jar to a pole to take the sample. Seal the jar and label it either with permanent marker on top or sticky labels or tape on the side. Take several samples (either more at the same site or at several locations along the same watercourse).

Back at home, or in your shop, line up some fresh, clean jars, topped with coffee filter holders. Weigh enough of the paper coffee filter liners for those you have set out and pencil in the weight on each one. These are your "tare" weight. You will subtract it in the end. It may be convenient to pre-weigh all of the filter papers, especially if you are borrowing a scale or using one at someone else's office. Place the coffee filters in the filter holders and then on top of the clean jars.

Slowly pour the water from one of your collected samples into the cone and filter on one of the fresh jars. Patience may be required here. Sometimes the water filters through slowly so you may want to pour a little and walk away. The goal is to collect *all* of the sediment from *one* sample jar on *one* of the filters, and to measure the volume of water that carried that sediment (the total water in the jar). After that is done, carefully lay the filter out in the open - perhaps on a paper towel or newspaper - to dry completely. Measure the amount of water that filtered through. Measure as accurately as you are able. Some small amount of water will have been lost due to evaporation and soaking into the filter paper, but this should be a negligible amount and will probably be uniform across all of the samples.

When the filter papers are dry (usually several days later unless you have access to a drying oven), weigh them all and write down the final weight on each filter (this may save frustration and confusion later). Record the weights on the data sheet. Subtract the tare weight from the final weight and you will have the weight of sediment collected from that volume of water (i.e. 0.5 oz./qt.).

Filtering and weighing the dried sediment from each jar will tell you the weight of sediment per unit volume of water, as in oz./qt. or more often expressed as grams/liter (g/L). If you are interested in calculating total sediment, as for an 8 to 10 hour irrigation, or for a given time period of stream flow, you can calculate an estimate by using your sediment information in combination with water flow rate. See the previous section for how to get an estimate of water flow.

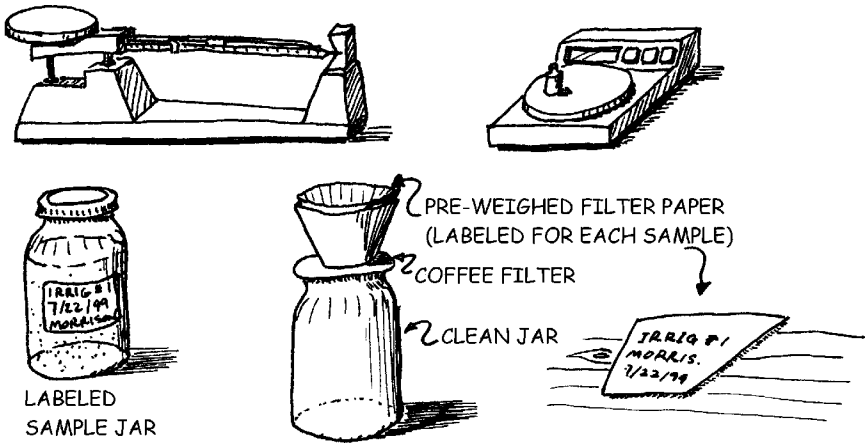
Time estimate

Collecting the samples may take less than ½-hour, unless you have a long drive to the collection site. Filtration can take from several hours to several days, the longer time resulting from lots of sediment and/or clogging of the filters. Fortunately, you can allow filtration to occur while you leave to do other things.

WATER SAMPLING - SEDIMENT SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment:



Clean, quart-size home-canning jars and lids

1 or more plastic 1-cup coffee filter holder (available from grocery store)

Disposable 1-cup coffee filters (i.e. Melita #2)

Measuring cup with fine divisions (liter graduated cylinder is great, but many stores now have measuring cups with English and metric measurements. Metrics are easier to work with but if you have fine divisions on an English-System cup that's OK, too)

Labels or masking tape

Permanent markers

Scale, accurate to tenths of grams if possible, borrowed

Procedure Summary:

Use jar to take water sample from mid-stream, underwater if possible.

Cap and label sample jar.

Pre-weigh filters and record as 'tare' weight.

Set up filter, filter-holder, and jar according to diagram.

Filter water sample through filter.

Measure total volume of water from jar and record.

Dry filter paper containing sediment until completely dry.

Weigh dried filter paper with sediment.

Subtract 'tare' weight and record sediment weight per unit volume of water.

WATER SAMPLING - Stream Bio-Assessment

Discussion

There are a host of creatures for whom water is critical habitat. The waterways that are typically found on privately owned land are streams, sloughs, or ponds. There may be a variety of fish, mammals, birds, and amphibians and insects that all use these waters. Doing a full assessment of all of these creatures, along with water analyses, in order to determine water quality might be time-consuming. There are, however, certain invertebrates (aquatic insects) that indicate water quality factors simply by their ability to live and grow in that water. Taking a standard sample, separating those insects into groups, and counting them, can be a relatively simple way to get a general indication of how your stream, or other natural watercourse is doing. This information may be helpful in making certain management decisions that could affect water quality in the future.

If you are interested in doing one of these simplified assessments, you will need to purchase some specific equipment and you will need a guide to identifying the groups of aquatic organisms according to their indicator categories. For the information you need, refer to the references below on biomonitoring of streams, and aquatic invertebrates. (Herbst, Kellogg, Plafkin, etc.)

Following is a list of possible materials needed for such an assessment, to provide an idea of the technical level and costs, without providing actual numbers (call the supplier).

Materials for Bioassessment of Stream Invertebrates

- Wading Boots (or old tennis shoes)
- Buckets (for sample cleaning)
- Aquarium net (2” to 4” wide)
- Tweezers
- Eyedropper
- Shallow white plastic pan (5” x 8”)
- Marker pen
- D-frame net or seine net (for sample collection)
- Alcohol (to preserve sample)
- Small containers (for insect storage)
- Magnifying lens
- Metric ruler
- Ice cube tray (for sorting samples)
- Large containers (to store full samples)

Equipment Suppliers for Stream Biomonitoring

Forestry Suppliers
(800) 647-5368
P.O. Box 8397
Jackson, MS 39284-8397

BioQuip Products
(310) 324-0620
17803 LaSalle Ave
Gardena, CA 90248-3602

Ward’s Natural Science Establishment
(800) 962-2660
11850 East Florence Ave.
P.O. Box 2567
Santa Fe Springs, CA 90670-0567

Research Nets (206) 821-7345

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California Commercial Laboratories Providing Agricultural Testing. 1991. University of California, ANR Publications #3024. $2.50. Available from University of California, ANR Communication Services, 6701 San Pablo Ave., Oakland, CA 94608. (800) 994-8849, (510) 642-2431.

Calusen, John C. National Handbook of Water Quality Monitoring. USDA/NRCS Part 600.

Environmental Monitoring and Assessment Program, Surface Waters and Region 3 Regional Environmental Monitoring and Assessment Program, 1994 Pilot Field Operations and Methods Manual, For Streams. US EPA, Environmental Monitoring Systems Laboratory, 26 West Martin L. King Dr., Cincinnati, OH 45268. March 1994.

Firehock, Karen. Save Our Streams – Volunteer Trainer's Handbook. April 1994. The Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878-2983. (301) 548-0150.

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy. April 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80526, General Technical Report RM-245.

Herbst, David B. Biomonitoring of Streams: Using Aquatic Invertebrates as Water Quality Indicators. Sierra Nevada Aquatic Research Laboratory, University of California (760) 935-4334.

Humiston, Glenda, Coordinator. January 1995. California Rangeland Water Quality Management Plan. Developed pursuant to Section 319 of the Federal Clean Water Act. Admin. By the Range Management Advisory Committee, in cooperation with the State Water Resources Control Board, The California Association of Resource Conservation Districts and other agencies, landowner and conservation organizations, for adoption into the State Water Resources Control Board's Nonpoint Source Management Plan.

Kellogg, Loren Larkin. 1994. Save Our Streams - Monitor's Guide to Aquatic Macroinvertebrates. Publ. Izaak Walton League of America.

LaMotte Company, P.O. Box 329 Chestertown, MD, 21620, (800) 344-3100, (410) 778-3100. Soil and Water Test Kits

Lehmkuhl, D. M. 1979. How to Know the Aquatic Insects. Wm. Brown Publishers. An introduction with easy to use keys.

Loeb, Stanford L. and Anne Spacie, ed. 1994. Biological Monitoring of Aquatic Systems. Discusses approach, design, interpretation and problems in monitoring.

MacDonald, L.H. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. USEPA region 10 publication EPA/910/9-91-001.

McEwen, P.E., Malcolm. 1977. Field Manual for Phase I of the San Luis Obispo Creek Watershed Monitoring Program. Prepared for the Land Conservancy of San Luis Obispo County, California.

Merritt, R. W. and K.W. Cummins, ed. 1984. An Introduction to the Aquatic Insects of North America, 2nd edition. Kendall/Hall Publishing Co. Complete general taxonomic reference, including keys and natural history information.

Napa River Watershed Owner's Manual, Fall 1994, A Framework for Integrated Resource Management, First Edition. Prepared by Napa County Resource Conservation District. $25, or free for Napa County, CA residents. Napa County RCD, 1303 Jefferson St., Ste. 500B, Napa, CA 94559, 707-252-4188, email: Rcdstaff@napanet.net.

Ness, Julia Ahlers, ed. 1998. The Monitoring Tool Box. Land Stewardship Project, 2200 Fourth St., White Bear Lake, MN 55110.

Plafkin, J. L., et al. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. USEPA. Office of Water (WH-553). Publication EPA/444/4-89-01. The classic description of biomonitoring with methodological detail presented for several levels and types of bioassessment, interpretation and case histories.

Rosenberg, D. M. and V.H. Resh. 1992. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall. Reviews the current status, approaches, and problems for biomonitoring.

Sava, Roger. June 1994. Guide to Sampling Air, Water, Soil and Vegetation for Chemical Analysis. Environmental Hazards Assessment Program, State of California, Environmental Protection Agency, Department of Pesticide Regulation, Environmental Monitoring and Pest Management Branch, 1020 N St., Sacramento, CA 95814-5604. EH 94-04.

Spectrum Technologies, Inc. 23839 W. Andrew Rd., Plainfield, IL 60544. (800) 248-8873. (81) 436-4440, FAX: (815) 436-4460

U.S. EPA, Rapid Bioassessment Protocols for use in Streams and Rivers. Benthic Macroinvertebrates and Fish. US EPA, Office of Water (WH-553), EPA/440/4-89/001, May 1989. By Plafkin, James L., Michael T. Barbour, Kimberly D. Porter, Sharon K. Gross, Robert M. Highes. U.S. EPA, Assessment and Watershed Protection Division, 401 M St., SW, Washington, D.C. 20460.

Save Our Streams, 791 Aquahard Rd., Ste. 100, Glen Burnie, MD, 21061, (410) 766-9443 or (800) 448-5826. www.saveourstreams.org.

Terrell, Charles R., Patricia Bytnar Perfetti. Water Quality Indicators Guide: Surface Waters. USDA-Soil Conservation Service SCS-TP-161.

Water Quality Monitoring Technical Guide Book, The Oregon Plan for Salmon and Watersheds.

Watershed Professionals Network. 1999. Oregon Watershed Assessment Manual. June 1999. Developed for the Governor's Watershed Enhancement Board, Salem, Oregon.

V. PLANT SURVEYS AND SAMPLES

Plant surveying or sampling can come in many different forms. The types or combinations of sampling techniques you might use depend on your goals and the type of information you want in the end. You may first wish to do a general survey to find any and all types of plants on your property. Then you may want to find out what percent of the total each plant type represents. You may want to know the "density," or number of plants per square foot, square yard or square meter. This can tell you plants per acre after a few calculations. That may be helpful for making weed control decisions if you are a farmer. Using a 'Percent Cover Estimator' can help livestock grazers with the decisions on when to move the animals. This could also reveal the amount of bare ground susceptible to weed invasion or erosion.

"Toe Point" or "Point Counts" are surveys used on very large acreage and can tell you percentages of different plant species. Cattle grazers will probably be interested in Residual Dry Matter (RDM) remaining on the ground at the end of the grass growing season to gauge how much feed is left and how much they can still feed their livestock before moving them off or feeding with extra hay. RDM is also an important piece of information for determining the degree of soil protection you have where erosion is a concern. All of these are valuable types of information that can be used in different land management situations. Choose the one that is the most important or useful to you and your farm.

PLANT SURVEY - General Procedures

If you have a good working knowledge of the plants in your local area then a notepad may be all of the equipment you need for your survey. If there are gaps in your knowledge, take along several appropriate field guides. Any of the following would prove valuable (see Reference on page 77 for complete information on these titles):

Weeds of the West

A Field Guide to Pacific States Wildflowers

Growers Weed Identification Handbook

An Illustrated Manual of California Shrubs

Trees and Shrubs of North America

California Range Brushlands and Browse Plants

The Jepson Manual of Higher Plants of California

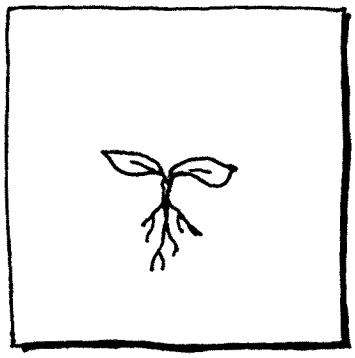
You might also take the cards and contact paper mentioned a few pages later under "Field Press #1." If you discover plants you can't identify, collecting them and pressing them in the field can help you identify them later. You can also bring the pressed plants to an expert for identification. If you just grab a sample and put it on the seat of your car, it will likely be unfit for use by the time you get back.

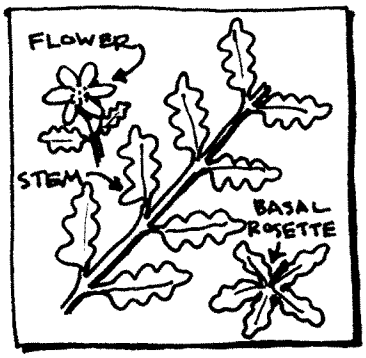
If your survey is being performed with weed control decisions in mind, do it in early spring. Weed control is best done in the seedling (2 - 4 leaf) stage. You may need some professional assistance, since seedling identification can be challenging. However, you may not actually need to have that professional in the field *with* you. Bring good quality plant samples to her/him and you will be appreciated for saving them time.

If you need to see the flowering parts of certain plants, do your survey during its flowering season; in most cases that will be in late spring or summer. In some cases surveys at several times of year may be needed to catch all plant types.

When you encounter a plant you can't identify by sight or by using a field guide, preserving a sample can be invaluable for later scrutiny, recordkeeping, or consultation with an expert. Carefully pull or dig it out of the ground. For seedlings, try to get the root along with the above-ground portions. For larger plants, if it's the right time of year, be sure to get the reproductive parts (flower, seed, fruit) as well as the typical leaf and/or perhaps a leaf from the base of the plant if it has a different form. If the stem is too long to include, perhaps include parts of various sections, or at least make a note as to the total height.

Field pressing a plant has proven to be a very useful tool in the monitoring and learning process. It doesn't provide herbarium-quality results, but for



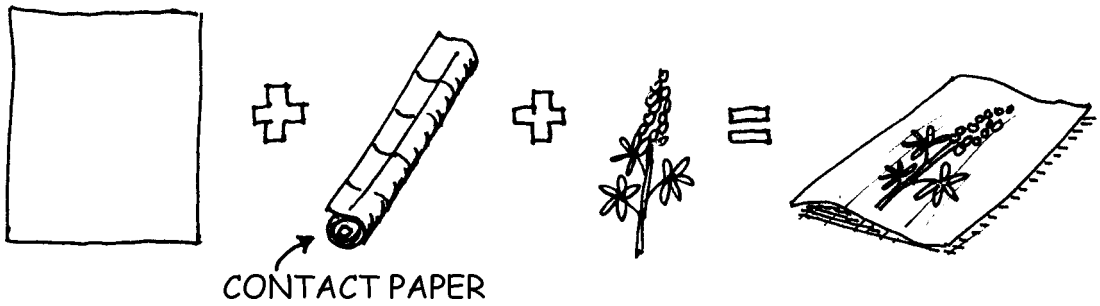


field-level monitoring it can't be beat. The resulting samples are well-preserved in shape and color and are quite durable for transport and teaching aids.

PLANT SURVEY - General Procedures
Saving Plant Samples: Field Press, Method #1

Discussion

This is the quickest, easiest, and most convenient method for pressing plants that is available. It reduces the chance of wilting or distortion of plant parts because the pressing is done immediately. The final product is also VERY rugged and can practically be tossed like a frisbee without damage. A disadvantage is that the contact paper is not absolutely clear. The slight opaqueness can obscure tiny flower or leaf structures, especially if you want to look at it later under magnification. Since microscopes are not usually used for gross identification, this method gets high marks.



Equipment

- 5" x 7" index cards (3" x 5" if plants are small) (11" x 17" cut poster-board if plants are large)
- clear contact paper, cut in 6" x 8 " rectangles (or larger according to card size adding >1" to each dimension)
- clear tape (cellophane-type), optional
- Field guides (see list above or references at end of section)

Costs

$10.00 - $15.00 for all but the field guides. The field guides I recommend under the References section on page 74 may cost from $10.00 to $90.00.

Procedure

Carefully pull the unknown plant out of the ground. Roots can sometimes be helpful, so keep some. Place the plant on a card, laying the leaves and any other identifying structures flat. Use thin strips of tape to keep the plant in position, if needed. Peel the backing off of a piece of the pre-cut contact paper. Carefully center the sticky side of the contact paper down over the card, pressing it against the plant and paper. Smooth it down well. There should be 1/2" overlap on each edge. Fold these over to the back of the card. Don't cover the back of the card. This unsealed area allows a little moisture to escape. Label the back with the date and location, and any other information that might be helpful.

Time Estimate

This method of pressing plants usually takes less than 5 minutes per plant.

PLANT SURVEY - General Procedures
Saving Plant Samples: Field Press, Method #2

Discussion

This method of pressing plants is a little less convenient, in that it takes a little more effort, involves several steps, and takes a little more time. The final product is more delicate, too, but the tiniest plant parts can be observed, unobstructed, under magnification.

Equipment

- plant press or something heavy enough to flatten plants
- zip-close bags (sandwich, quart, or gallon size)
- index cards or cut poster-board, sized to fit inside zip-close bags
  - 4" x 6" for sandwich size bags
  - 5" x 7" for quart size bags
  - 10-1/4" x 10-1/2" for gallon size bags
- clear tape (cellophane)
- newspaper
- 2 or more sheets of corrugated cardboard, according to size needed for bottom and top of stack of plants to be pressed
- Field guides (see list on page 52 or references on page 77)

Costs

$15.00 for the basic equipment, $35.00 or more for a new plant press, or make your own from left-over stakes and lath. Field guides may cost from $10.00 to $90.00.

Procedures

Select an appropriate size card or piece of poster-board. Carefully lay and flatten the plant sample on the cardboard and use thin strips of tape to keep it in place. Place several layers of newspaper above and below the card. Repeat this with as many plant samples as you like and place a stack of these plants between two sheets of corrugated cardboard. Weight the stack with something heavy, such as a large book, a rock, an anvil, or the like. Keep in a warm, dry place out of the sun. Check your samples within a few days to see if they have dried well. When dry, slip the card into the appropriate size zip-close bag and seal it.

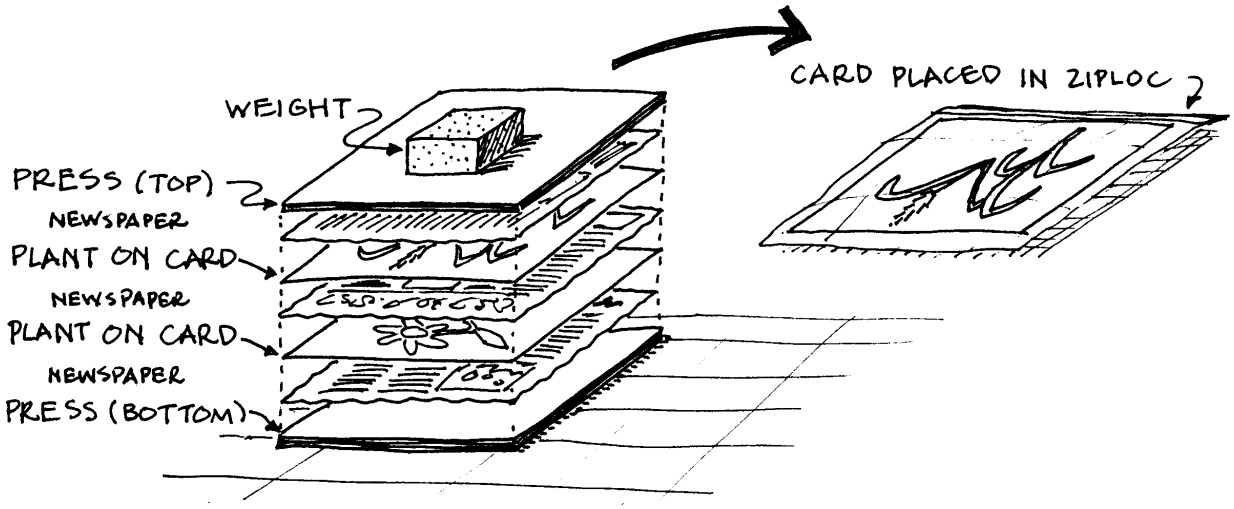
Time estimate

This method may require 15 to 20 minutes to get the plant correctly mounted. It may be several days before the plant is dry enough to slip into the plastic bag.

PLANT SURVEY - General Procedures
Constructing a Sampling Quadrat

Discussion

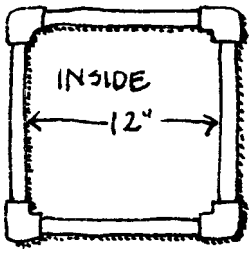
A sampling quadrat is a helpful tool in a variety of situations. It is really just a square of specific dimensions that assists in getting exactly the same sample



size every time. The PVC (Poly-vinyl chloride) pipe version is a favorite because it is easy to make, lightweight and quick, but you can make it from anything convenient and durable, such as steel rod bent to size. Just check the inside measurements to make sure they are accurate.

Equipment

- 5 ft. minimum of PVC pipe, any schedule
- 4 PVC elbows of matching diameter
- PVC glue
- hack-saw or pipe cutter
- Tape measure



Cost

Under $15.00 if you have the saw or can borrow one.

Procedures

Cut the PVC pipe into approximately 1 foot lengths. Fit 2 of the pieces into either side of one of the elbows. Using the tape measure, fit another elbow and straight section on, making marks on exactly the 1 foot mark from the opposite straight section. Fit and measure the final straight section. Glue all parts in place, using marks as guides.

Time Estimate

Less than 1 hour should be needed to measure, cut and glue the quadrat together.

PLANT SURVEY - General Survey

The General Survey, as discussed here, has several forms. The Ambient Survey provides an overall look at what plants are present. Density Counts will involve, not surprisingly, actually counting numbers of plants in a specific area. For this you will need a convenient, portable sampling-area delineator, the quadrat (described above.) A "Search" comes into play when you feel it is important to know if there are *any* plants of a certain species on your property. This might include the Department of Agriculture's "Type A" weeds, or a threatened or endangered species. Transects are often used when you have large areas to cover, but you need a systematic way to sample and get percentages of plant types. Point Counts are used for similar purposes but use a different method. After trying both of those, you may find that you prefer one over the other.

All of these approaches to plant sampling are very useful for different situations, and each have their appropriate applications. Sometimes several may apply. Using even one of them will add to your knowledge and understanding of your land.

PLANT SURVEY - Ambient Survey

Discussion

An Ambient Survey is done to get an overall idea of what plant species are present and a general feel for the percentage of the overall population occupied by each. Check all habitat types and soils that are different from each other.

Equipment

- Notebook
- Pencil
- Field Guides (as listed above under General Procedures)

Costs

Negligible, unless you need to purchase the Field Guides. The field guides I recommend under the References section at the end may cost from $10.00 to $90.00.

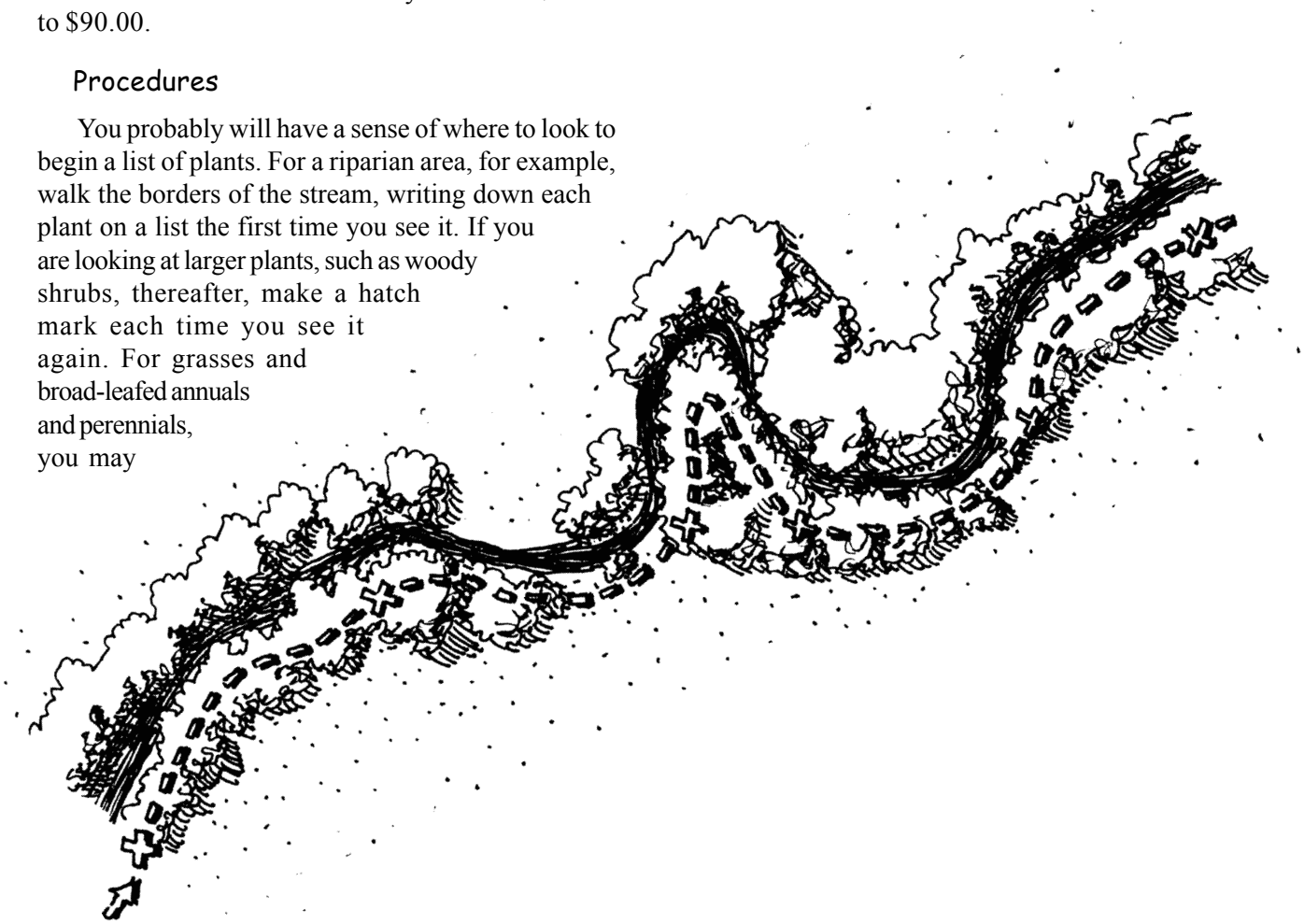
Procedures

You probably will have a sense of where to look to begin a list of plants. For a riparian area, for example, walk the borders of the stream, writing down each plant on a list the first time you see it. If you are looking at larger plants, such as woody shrubs, thereafter, make a hatch mark each time you see it again. For grasses and broad-leafed annuals and perennials, you may want to use the Percent Cover Estimator under 'Density Counts' on page 59. Counts and estimates of percent cover are optional for this method. You may want to have separate categories for trees, shrubs and smaller understory plants like annual or perennial herbaceous flowering plants, or grasses.

If you are checking a pasture, a zigzag pattern walk through it should cover it well, or you could walk a series of parallel lines. Be certain to check the fence-lines.

Time estimate

One to six hours. The time required for this type of survey is very variable. It will depend on the size of the pasture, field or hillside. It will depend on how many different habitat types are present, such as pasture, riparian, or north-facing slope. It will depend on how difficult it is to get to or walk the separate areas.



PLANT SAMPLING - AMBIENT SURVEY SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment:

Notebook

Pencil

Field Guides

Procedure Summary:

Walk the designated area, using a zigzag or parallel line pattern, as appropriate.

Record each new plant species or type upon first sighting.

Record tick-marks for subsequent sightings of plants (optional).

Total up the numbers for each plant (optional).

PLANT SAMPLING - Density Counts

Discussion

Density Counts are taken when well-defined numbers are desired in order to make comparisons between areas that are managed differently, or to more clearly define changes through time. They will require a little more time, but the information you get is easy to compare to other areas, other seasons, or other years.

Equipment

- Notepad or data-sheet
- Pencil
- Quadrat (see above, pages 54-55)

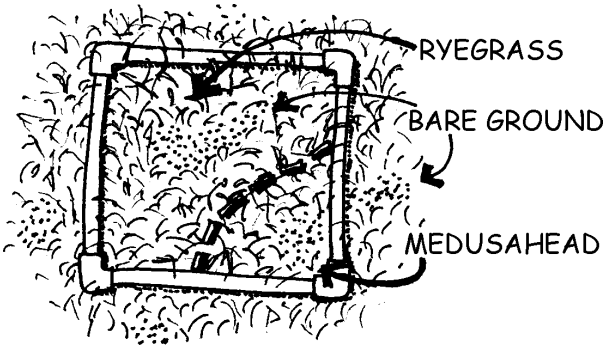
Costs

$15-$20 to construct a quadrat if a large one is needed.

Procedure

Make a quadrat as described on pp. 54-55, using a size that will give you a realistic number of plants to count. If using a m^2 quadrat will give you thousands of seedlings to count, better choose a quarter m^2 or a ft^2.

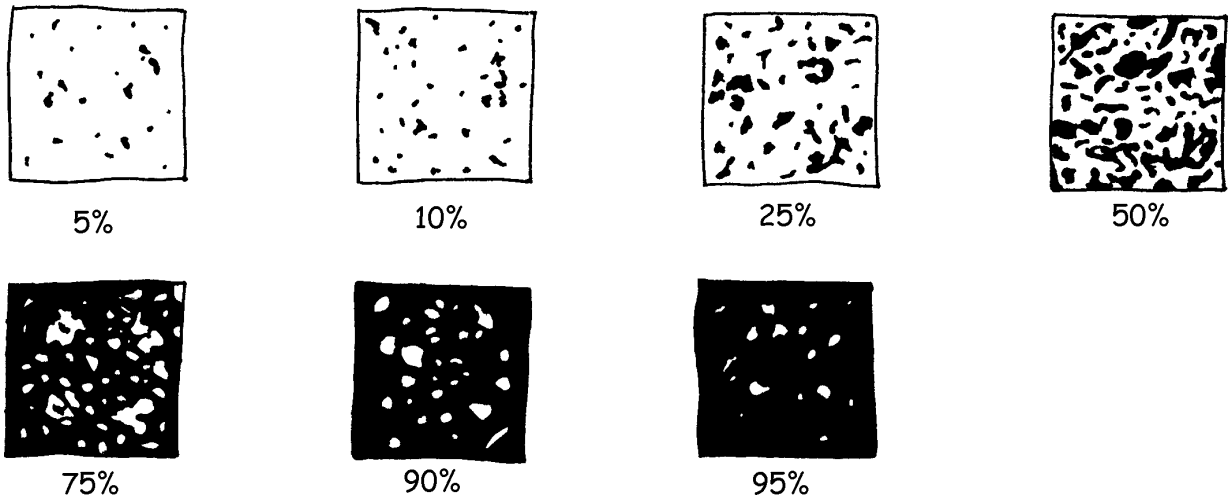
In order to prevent bias in your sampling, you must be either completely random, or strictly systematic. A "random" sample can be accomplished by tossing the quadrat up in the air out in front of you, letting it bounce and roll until it comes to rest, and doing the counts where it comes to rest.This can be done either while walking a long transect, or by wandering "aimlessly" over a large pasture. This should be done in at least 20 locations in the area to be sampled, more if the site is highly variable.



The systematic sample can be accomplished by taking counts at measured intervals: every 10 ft. along a line, every 10 paces, on a 20 ft 2 grid throughout an area or at otherwise pre-specified locations.

Sometimes plants can be so dense that you will have to estimate their numbers or percentages at a given location (see the Percent Cover Estimator on the next page). If you don't *need* to identify them specifically, you may wish to group them according to their usefulness. A grazing manager might group them as "desirable forage grasses," "weedy grasses," "desirable forage broad-leafed plants," or "weedy broad-leafed plants." Under each of these categories, counts could be taken, or percentage values could be estimated in at least 10 (preferably 20) quadrats. Here is an example of counting or doing visual estimation of the vegetation within a quadrat.

PERCENT COVER



PLANT SAMPLING - DENSITY COUNTS SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment

notepad or data-sheet
pencil
quadrat (see above)

Procedure Summary

Decide to use either random or systematic sampling pattern.

Decide to use either Percent Cover estimates, or actual counts.

If counts, decide if within entire quadrat or a quarter quadrat.

Toss or place quadrat , depending on above decisions.

Take counts or make % estimates and record on data sheets.

Calculate averages by totaling each column and dividing by the number of quadrats sampled (i.e. 10 or 20).

If you have some specific plant species that you want to evaluate, like Yellow starthistle and Annual ryegrass, you could set up your data sheet to reflect that, for example:

If you want to positively identify the plants but can't, save samples for later identification using "Field Press #1" or "Field Press #2" described above.

Time Estimate

One field, with 20 samples should take about 2 - 3 hours. Figure on half a day or more if you have several fields to do.

Location	Desirable forage grass (% or count)	Weedy grass (% or count)	Desirable forb (% or count)	Weedy forb (% or count)	Notes
1	35	12	4	1	Mostly soft-chess
2	27	22	7	4	Forbs mostly filaree
3	14	5	10	2	
4	41	10	5	0	
5					
6					
7					
8					
9					
10					
Average					

Sample Data Sheets

Location	Desirable forage grass (% or count)	Weedy grass (% or count)	Desirable broad-leafs (% or count)	Weedy broad-leafs (% or count)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Average					

Location	(% or count)	(% or count)	All Other Cover (% or count)	Bare Ground (% or count)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Average					

PLANT SAMPLING - The Search

Discussion

A search would be used if you want to discover absolutely every type of plant growing on your 200-acre parcel *or* if you need to locate any of one particular species.

Equipment

- Notepad
- Pencil
- Field Guides (as listed at the beginning of the plant section or under References)

Costs

Negligible, unless buying field guides. The field guides I recommend may cost from $10.00 to $90.00.

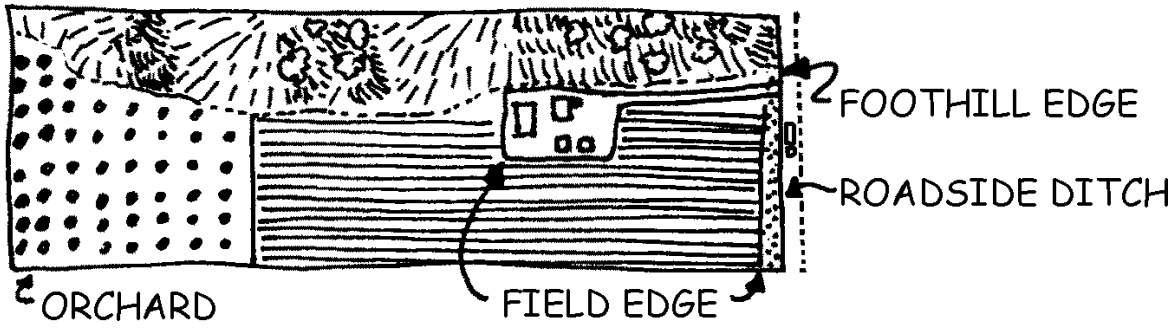
Procedures

Go specifically to each different habitat type on that property (grassy upland, oak woodland, riparian, roadside, field edge, crop field) and look carefully to discover as many plant types as possible. If you are looking for one or two plant-types in particular, go only to the habitat type where they're likely to be found. If you don't know, ask someone like your crop consultant, a UC Farm Advisor, or the RCD staff. Recording the numbers may or may not be an important part of this type of survey.

Make an aerial sketch of the area you are searching. If you are looking for specific species, plan to make marks on your sketch for locations of the plants sighted.

Time Estimate

A search could take from 30 minutes to a full day, depending on how lucky you are and how many areas you must search.



PLANT SAMPLING - THE SEARCH
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment

Notepad

Pencil

Field Guides (as listed at the beginning of the plant section or under References)

Procedure Summary

Aerial sketch of area searched:

Select an area to search.

Look carefully for the plant(s) in question.

Make a list of all plants seen (if that is the purpose of your search), or mark on your sketch the location of the key plant(s).

Plant List

Plant Species	Common Name	Number of Sightings	Total

PLANT SAMPLING - Transects

Discussion

A Transect survey refers to walking a straight line through an area and making notes on plants only along that line. Some sample transect patterns are sketched below. This is useful for large areas where you can realistically take only a small sampling. If you had a large pasture or a foothill paddock that you wanted to do a survey on, you could choose one to several transects that you thought might be representative.

Data sheets from several of the Plant Sampling sections might be useful when doing transects. For example, you could walk a transect, and if you had chosen 50-foot sampling intervals, you could do quadrat counts or percent cover estimates at each 50-foot mark.

Equipment

- Notepad
- Pencil
- Quadrat (optional)
- Data sheet (optional, see other sections, as appropriate)
- Field Guides (optional)

Costs

Under $15.00 if constructing the quadrat. Field guides can range from $10.00 to $90.00

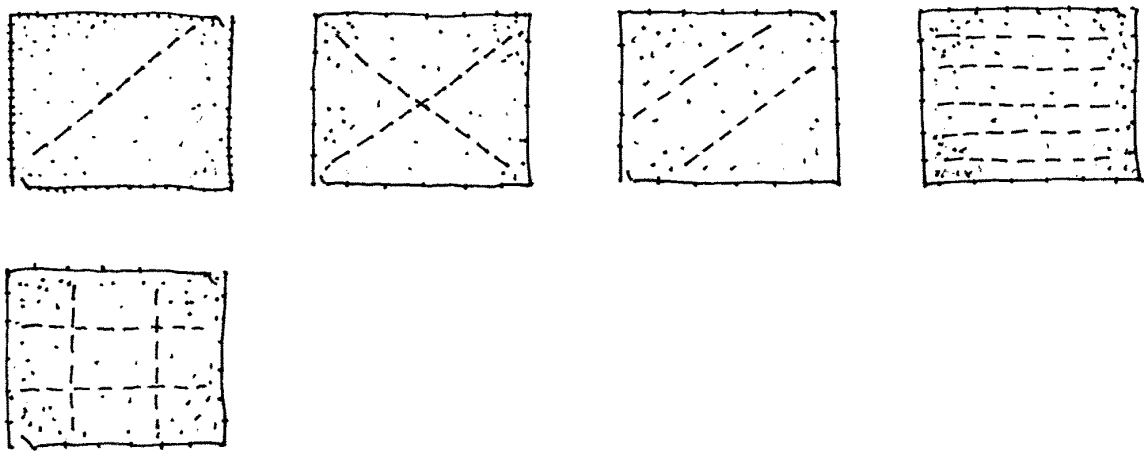
Procedures

Having a partner can be helpful for this monitoring method. You will have someone to help record the information and to discuss questions with.

Select and mark starting and ending points for your transect. This means that you include a plant if one of its leaves would touch a real or imaginary rope strung along that line. If you are surveying a forested area, look up. If the tree canopy crosses the rope line, count it. If it does not, exclude it. Walk a straight line between the two points. If you have chosen to note *all* plants along the transect, record them all on a data sheet the first time you see them, then make tick marks for each subsequent sighting.

If you have chosen to use the transect to help you with systematic sampling, and plan to take data every 100 feet, for example, then again walk a straight line between your starting and ending points. At each interval, take your data and record it on the appropriate data sheet. If you are doing counts using a quadrat, use the data sheet from that section. If you are doing percent surface area/cover estimates, use that data sheet.

Sample Transect Pattern



This process can be repeated until you have a sufficient number of transects to represent the area you are monitoring.

If you are interested in monitoring perennial plants or shrubs, there won't be very many of them, so you could count every one. If you are monitoring grasses, or a weed like Yellow starthistle, they are often too dense for that. In that case, take a sub-sample.

If you want to use a rope, mark it in increments of 1 foot, 1 yard, 1 meter, or 10 meters and note only the plants at those increments. Toe Point Counts, discussed in the next section, would work for taking such a sample without actually marking a rope.

Your transects can all be parallel or they can cross each other. Just don't double-count plants at the intersection points. Decide which pattern will best represent your property. Use the same transects each time you go back.

The transect approach has advantages in allowing you to compare results from time to time. Permanently marking the beginning and ending points will allow you to walk it/them at some time period after management changes to help determine if there has been a species shift.

After you have collected the data, you may already have discovered something of use to you. Otherwise, this may simply be 'baseline' information, and you will want to simply summarize it (take averages, totals, or percents) and store it until the next monitoring date.

Time Estimate

Transects can take from 1 to 4 hours, depending on the frequency of samples and the number of transects.

PLANT SAMPLING - TRANSECTS
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment

Notepad

Pencil

Quadrat (optional)

Data sheet (optional, see other sections, as appropriate)

Field Guides (optional)

Procedure Summary

Sketch of the area being monitored, including transect pattern:

Bring a partner, if desired.

Select starting and ending points for your transects.

Decide on sampling interval (all plants, every 1 ft., every 50 ft., et.).

Take and record data using notepad or data sheet.

Summarize data as desired (i.e. take averages or totals).

Data Sheet (see other sections for additional data sheet designs):

Plant List

PLANT SAMPLING - Toe Point Counts

Discussion

Toe Point Counts are a specific version of the transect method described above. A transect, or straight line, is walked, with notes taken only at the point of the toe of one foot - the same foot - each two steps.

The 'Toe Point' monitoring method, like the other transect methods, allows you to compare results from season to season or year to year.

Equipment

- Notebook
- Pencil
- Dowel, rod, or straight stick, 3 to 4 feet long
- Field guides (optional)

Costs

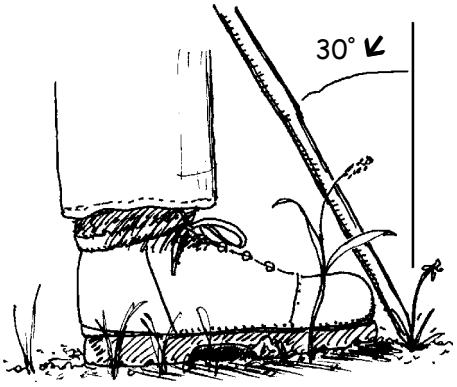
Negligible, unless purchasing field guides. Field guides can range from $10.00 to $90.00.

Procedure

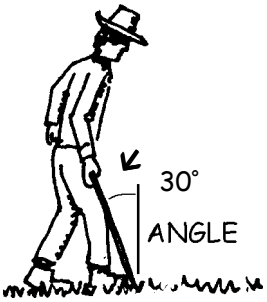
If you bring a partner to help with recording names and numbers, this method will be more enjoyable and you will move more quickly.

Select and mark the starting and ending points for your transect (see sample transect patterns, page 64). You will be walking a straight line between the two markers. Try to use permanent markers, since it is important to return to the same transects in the future.

With Toe-point counts, you could use either of two methods. One method uses a long pointer, one does not. With the pointer method, choose for example your right foot as the one to mark each field note. As you walk the transect line, each time your right foot comes to rest, a long stick, or "pointer" is used to touch the ground off the tip of your boot at the same angle each time. If the pointer tip touches bare soil, then bare soil is noted. If it touches the stem of a filaree, so note (likewise with the base of a grass plant). Do not note leaves of other plants that touch the pointer farther up. If you decide to work without a pointer, then note plants that touch the tip of your boot in exactly the same place. This method is not one to be used with waist-high vegetation, but is more suited to shorter rangeland plants.



Record each plant by name the first time you see it, then use tick-marks to record subsequent sightings. Summarize the data by finding totals, averages, and/or percentages, according to what is useful to you.



You can see that taking care to be consistent about exactly what plant is touched by the boot or the pointer matters most in situations with good plant cover. If vegetation is sparse and the ground is rocky, the decisions about what plant or rock to take note of are easier.

Time Estimates

Toe Point Counts can take from 1 to 4 hours, depending on the frequency of samples and the number of transects

PLANT SAMPLING - TOE POINT COUNTS
SUMMARY CARD

Date: _____ Time: _____ Location (field): _____

Equipment

Notebook
Pencil
Dowel, rod, or straight stick, 3 to 4 feet long
Field guides (optional)

Procedure Summary

Sketch of the area being monitored, including transect pattern:

Bring a partner, if desired.
Select starting and ending points for your transects.
Walk the transect, taking notes every other step.
Record data using notepad or data sheet.
Summarize data as desired (i.e. take averages or totals).

Data Sheet

Plant List

Plant Species	Common Name	Number of Sightings	Total

PLANT SURVEYS AND SAMPLES

SAMPLE DATA SHEET:

Date: _____ Location: _____ Field Name/Number: _____

Survey type: Count/Percent Notes: _____

Category: (circle one) trees shrubs understory: grasses-broad leafs

Location	Desirable Plant (% or count)	Weedy Plant (% or count)	Desirable Plant (% or count)	Weedy Plant (% or count)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Average					

PLANT SURVEYS AND SAMPLES

SAMPLE DATA SHEET:

Date: _____ Location: _____ Field Name/Number: _____

Location	Yellow Starthistle (% or count)	Annual Ryegrass (% or count)	All Other Cover (% or count)	Bare Ground (% or count)	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Average					

PLANT SAMPLING - Residual Dry Matter (RDM) - Calibration

Discussion

Residual Dry Matter (RDM) is usually used to refer to the dry plant material left on the soil at the end of the growing season, or more importantly, before the rainy season. This might help give a measure of how much protection your soil will have from erosive rains, how much feed your grazing animals have taken or left, or how much the soil surface might be shielded from evaporative water loss.

Calibration is a very important step. If neglected, you are highly likely to produce wrong numbers. The result is that you will be making decisions based on wrong information.

If you assume that your eye is still trained from a year ago, or that the density of the cover *appears* the same and therefore *is* the same as last year, you are likely to get errors in your information. It is even important to re-calibrate when changing fields, if there are any differing conditions that have affected plant growth.

Equipment

- Sampling quadrat, 1 square foot
- Clippers
- Paper bags
- Scale capable of weighing ounces or grams
- Notepad
- Pencil

Costs

Under $30.00 if you purchase the clippers, bags and notepad, but not the scale. A spring-type scale might cost $20.00 to $60.00. An electronic scale may cost $100.00 or more, so borrow one if possible.

Procedures

Prior to beginning your RDM samples, do a "calibration" procedure. This is actually a very important step, so don't skip it! It will help develop a closer connection between what your eye sees, the rating you record and the actual amount of dry matter on the ground. To "calibrate" your eye for judging the amount of RDM, and to provide a good source of information for making correct calculations, pairs of samples (two at each RDM level, as described below) should be taken.

Go to the area you intend to monitor, taking along the equipment listed. Find a spot with the lowest amount of dried vegetation on it and drop the quadrat, Rate the area inside your quadrat as to how many Tons per Acre of dry plant material you think would be on it if you had an entire acre that looked exactly the same. Clip all of the dry matter that is rooted inside the quadrat to about 1/4 to 1/2 inch above the ground and bag it in a paper grocery bag.

Select another area to lay your quadrat that seems to have the highest amount of plant material and do the same. Select quadrats with intermediary amounts until you have done 10 or more.

Take all of the bags back home and weigh them (in grams, if possible). If the grass was still a little green, then air dry your samples for at least several days and weigh them again.

If you don't have a scale that will accurately weigh such small amounts, take your samples in to your local UC Extension Farm Advisor's office, or someone else that might have such a scale.

Fit these weights into the worksheet below and use the following calculations to find out Tons/Acre in each quadrat. Don't forget to subtract the weight of the bag. You can either weigh the bag before you go out to sample and record it right on the bag, or you can weigh bag and grass together, discard the grass and weigh the bag separately afterwards.

Actual RDM in Tons/A is calculated by multiplying your bagged sample weight by 0.048 if recorded as grams (g), or 1.36 if recorded as ounces (oz.)

Detailed formulas are as follows:

For grams, in a 1 ft.^{2} area: $\frac{\text{sample weight (g)}}{\text{Ft}^2} \times \frac{43{,}560\ \text{ft}^2}{\text{Acre}} \times \frac{1\ \text{lb}}{453.592\text{g}} \times \frac{1\ \text{ton}}{2000\ \text{lb.}}$

For ounces, in a 1 ft.^{2} area: $\frac{\text{sample weight (oz)}}{\text{Ft}^2} \times \frac{43{,}560\ \text{ft}^2}{\text{Acre}} \times \frac{1\ \text{lb}}{16\text{oz.}} \times \frac{1\ \text{ton}}{2000\ \text{lb.}}$

By doing this exercise, you will find out how close your own ratings are to reality. Adjust your ratings accordingly. Repeat the calibrations until you are satisfied that your visual ratings are coming pretty close to the on-the-ground dry matter.

Time Estimate

Collection of the calibration ratings and samples can take 3 to 4 hours. After the samples are dry, weighing should take less than 30 minutes.

PLANT SAMPLING - RESIDUAL DRY MATTER (RDM) - CALIBRATION SUMMARY CARD

Equipment

Sampling quadrad, 1 square foot
Clippers
Paper bags
Scale capable of weighing ounces or grams
Notepad
Pencil

Procedure Summary

Pre-weigh paper sample bags.
Select area for calibration and monitoring.
Collect 10 or more samples at lowest, highest, and intermediate apparent-RDM levels.
Weigh all samples and record weights on Visual Estimate Calibration data sheet.
If samples not dry, air dry for several days before weighing.
Calculate RDM in Tons/Acre.
Compare visual ratings with calculated values and adjust ratings as needed.

Data Sheet: Visual Estimate Calibration

Quadrat location number	RDM Visual Estimate	Bag weight (g or oz.)	Clipped sample weight, including bag (g or oz.)	Net weight (subtract bag weight)	Actual RDM, Calculated (T/acre)
Example 1	5	28 g	120 g	92 g	
Example 2	7	1.1 oz.	7.1 oz.	6.0 oz.	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Average					

PLANT SAMPLING - Residual Dry Matter (RDM)

Discussion

In determining RDM, calibration is the greater amount of work, but is *very* important. Be sure not to skip that step. Otherwise you risk producing incorrect numbers, which may affect the quality of the management decisions you make.

Try to decide ahead of time how many ratings you would like. Once the calibration is done, RDM ratings can be developed surprisingly quickly. It is not difficult to collect 100 numbers. If you are dealing with a larger number of acres, you might want to collect numbers in blocks of 100.

Equipment

- Notepad or data-sheet
- Pencil

Costs

Negligible.

Procedures

The actual process of taking the RDM numbers uses the Transect sampling method (see above). Mark a starting and ending point for your transect. Walk a straight line between those two points. At designated intervals (every 10 feet, every 50 feet, etc.), drop your quadrat. Use your calibrated eye to give an RDM rating to the plant material within the quadrat only. Walk several transects. Try to get at least 30 visual ratings if your area is fairly uniform. However, if there is much variability due to soils, water conditions, shade, or grazing pressure, try to get at least 100.

Time Estimate

Gathering several hundred numbers shouldn't take more than 1 or 2 hours.

PLANT SAMPLING - RESIDUAL DRY MATTER (RDM) SUMMARY CARD

Equipment

Notepad or data-sheet

Pencil

Procedure Summary

Select and mark transect location.

Walk a straight line between points.

At designated intervals, drop quadrat and rate the area within.

Record your data.

Data Sheet

Transect _____

RDM Ratings	RDM Ratings	RDM Ratings	RDM Ratings	RDM Ratings
Total:	Total:	Total:	Total:	Total:

Average of all ratings: _____

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Brown, Lauren. 1979. Grasses, An Identification Guide. Sponsored by the Roger Tory Peterson Institute. Houghton Mifflin Company. Boston, New York. 240 pp.

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"How to" Monitor Rangeland Resources, Handbook Level-1. December 1994. University of California, Cooperative Extension, Division of Agriculture and Natural Resources, Intermountain Workgroup Publication 2. Order: UCCE Inyo-Mono Counties, 207 W. South St., Bishop, CA 93514, (760) 873-7854

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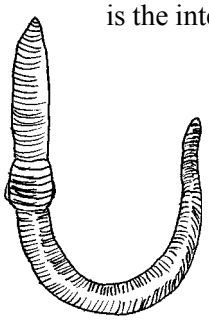
Whitson, Tom D. ed., et. Al. Weeds of the West. Rev. 1992. Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services. To order contact The Western Society of Weed Science at P.O. Box 963, Newark, CA 94560, or University of California, ANR Communication Services, 6701 San Pablo Ave., Oakland, CA 94608-1239. Phone 1-800-994-8849 or 510-642-2431.

VI. ANIMAL MONITORING

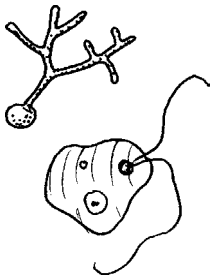
Monitoring animals can be the most challenging, but also the most interesting and rewarding of your monitoring exercises. Animals, which here include birds, mammals, reptiles, amphibians, and insects, tend to be mobile and have changing habitat needs during the course of the seasons. They can be shy or secretive; they can be nocturnal or have other habits that make them quite difficult to monitor.

On the other hand, to do an effective job of monitoring, you must get to know them at least a little. That is the interesting and rewarding part.



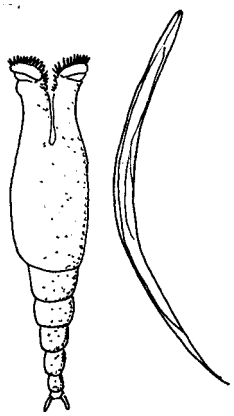
In the following sections you will have the opportunity to learn about some simple techniques to monitor birds, mammals, insects, reptiles and amphibians.

Each category of "animals" requires a different set of techniques. There are some farmland inhabitants for whom I still think there are no easy methods of monitoring. Thus you must rely on either luck, or time and patience to make any sightings. There are innumerable monitoring protocols that have been worked out by state and federal agencies and private conservation organizations for specific species or to fulfill certain goals and purposes. You will find none of those here. The techniques presented are useful for getting a general look, although you certainly can identify specific species by using them, depending on what the species are, your expertise level and the time you are willing to invest to learn.



SOIL FAUNA

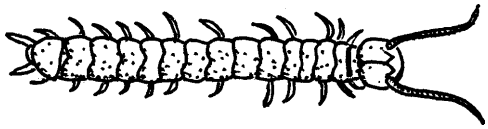
Although soil has been thought of as an inert mass that simply supports the roots of plants, it is actually teeming with life. Healthy soils not only contain the mineral components that are its backbone, but also air, moisture, nutrients and organic matter. These are the most basic components needed to support life in the soil. The kinds of animals (fauna) to be found in the soil range in size from the invisible (to the naked eye) to the large and furry. The smallest ones would include bacteria, fungi, and protozoa, and a microscope is needed in order to see them. The medium sized ones might include nematodes, rotifers, collembola, and mites, most of which also require some level of magnification to be seen. The largest organisms that are not in the mammal category are animals such as centipedes, pseudoscorpions, earthworms, larvae and grubs.



Scientists have developed methods to find and measure the numbers of each of these organisms found in the soil, as well as many of the soil 'microflora,' or microscopic plants. Most of those methods are more technical than this manual is intended to deal with. However, creatures the size of earthworms are fairly easy to work with. When looking for a soil dweller that can integrate a number of soil health factors, including moisture, air, and organic matter, earthworms and their population levels can serve as a good indicator of the balance of these life-supporting factors and the overall health of your soil. Methods of monitoring earthworms are discussed under the section on "Soils" near the beginning of this manual.

BIRD SURVEYS

Bird monitoring can be done using strip censuses, point counts, nest surveys, mist nets, banding, radio-tracking, aerial (airplane) survey estimates, and many other ways. The methods range from the very basic and simple to the complex and technologically extensive. For working on our own land, simplicity is the ticket. Bird surveys, however, require a certain level of skill. Bird identification by sight, by call, by song, or by nest can take many years of practice and experience. Some are most easily identified by their wing shape in flight from high above, some by their flight



pattern, some by certain flashes of color (often quite a brief flash) as they are speeding away from you. Songs and calls (yes, there is a difference) are released under different circumstances, and can vary within the same species, depending on the location (usually significant distances, though). A great deal can be learned from field guides and audio-tapes. There are a number of them listed under the References section on page 91.

BIRD SURVEYS - Strip Census

Discussion

A strip census for birds involves walking an area and recording any and all birds that you see or hear. To get comparable results you should start at the same place, the same relative (i.e. ½ hour after sunrise) time, and walk the same direction each subsequent time you do a census.

Equipment

- Notebook
- Pencil
- Field Guide (see References)

Costs

Under $25.00, including the cost of a basic field guide.

Procedures

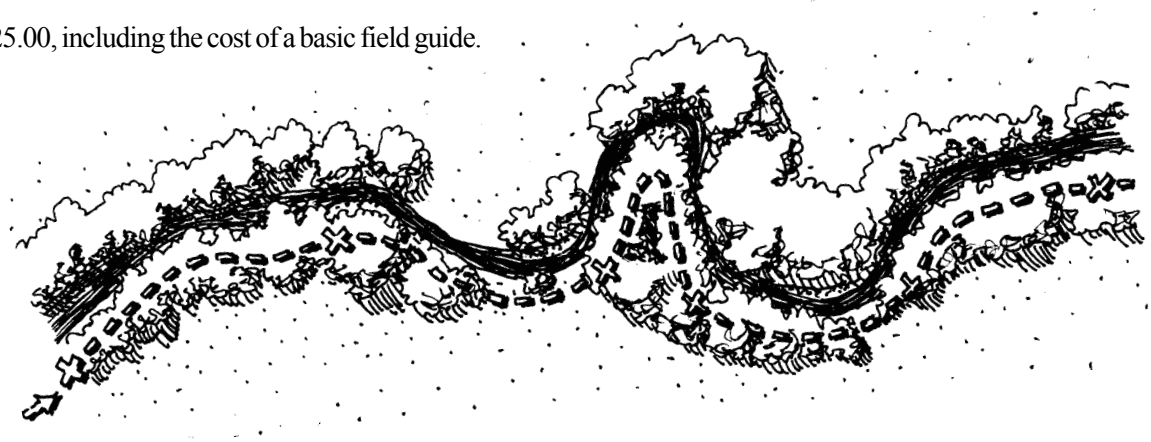
A strip census involves walking an area and recording any and all birds that you see or hear. If you were going to conduct a strip census on a creek running through your property, or through a section of woods, select a quarter to half-mile section, taking note of the beginning and ending points so you can repeat it in the future. Plan to walk both sides of the creek if there is a way to cross, or walk a loop through the wooded area. Start with the sun at your back so that you won't be staring into it for the earliest and most critical part of the survey. Start just a little after sunrise. Most birds are most active in the morning hours, so you are most likely to see or hear them then. Don't count birds that are high overhead and/or flying at a right angle to your survey area – obviously not using it.

As you walk, use the bird list on page 85 (or one appropriate for your county) to keep a tally of birds as you see or hear them. It should cover all of those that you are likely to see in your county. Similar bird lists are available for many areas of the state, so if you are from out of the area, or your farm or ranch is elsewhere, inquire with the local chapter of the Audubon Society for a local list (see References).

If you are not an experienced "birder," never fear. There are usually some very capable birders in your town or a nearby one that would probably jump at the chance to do some birding on private property. Make a few calls to friends, or again, to your local Audubon Society.

Time Estimate

Allow 2 to 4 hours to complete your census.



BIRD SURVEYS - STRIP CENSUS
SUMMARY CARD

Equipment

Notebook

Pencil

Bird List, below

Field Guide (see References)

Procedure Summary

Select a ¼ to ½ mile strip of land for your census (or a loop).

Start at the same time, place and going the same direction each time.

Tally all birds seen (or heard with confidence) on bird list.

Exclude birds high overhead.

Seek assistance from experienced birders, if desired.

Data Sheet: see Bird Census list after Nest Surveys, below.

BIRD SURVEYS - Point Counts

Discussion

The Point Count method of surveying birds provides a more controlled set of boundaries for collecting your information. This is useful when comparisons and analyses are expected to be more rigorous.

Be sure to take along a bird Field Guide. One of my favorite Field Guides is the *National Geographic Field Guide to Birds of North America.* Identifying birds by song or call takes a lot of practice, so if you are able, also take along an experienced birder. At the same time, listening to tapes of bird-songs can begin the process of learning to identify birds by what you hear or can refresh your memory and increase your accuracy. There are some good bird-song tapes listed in the "References" section below.

Equipment

- Notebook
- Pencil
- Bird List, below
- Field Guide (see References)

Costs

Under $25.00, including the cost of a basic field guide.

Procedures

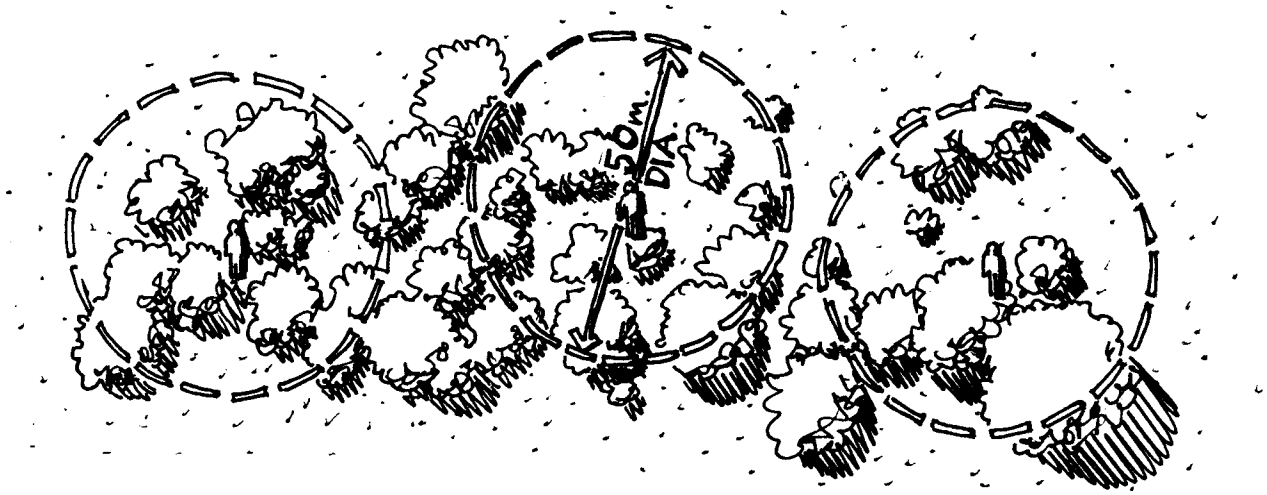
Conduct your Point Counts between sunrise and 11:00am and not on rainy days. The count "Points" should be pre-selected and marked (make sure they are safe locations), with a diameter of 50m (about 55 yards). Decide how many such points your survey area can hold, or how many you can realistically complete. Try a minimum of 3 or 4.

Approach your point count location center-point very quietly, so as not to flush species out. Try to arrive about 15 minutes early, to allow time for any disturbed species to settle down. Begin recording your observations of bird species at a designated time and record them for exactly 10 minutes, no more. You can only count a bird seen leaving your point-count site upon your approach if you are *certain* that it came from within the point area. Even then, it must be recorded as one observed outside of the 10 minute timed observation period.

Repeat this process for as many point count locations as you have set up. Be sure to visit the sites in the same order each time you return.

Time Estimate

Allow 2 to 4 hours to complete your point counts.



BIRD SURVEYS - POINT COUNTS
SUMMARY CARD

Equipment

Notebook

Pencil

Bird List, below

Field Guide (see References)

Procedure summary

Pre-select point-count center locations.

Arrive early and settle in.

Begin recording species seen at a specified time.

Record species for exactly 10 minutes.

Move to next point count site.

Data Sheet: see Bird Census list after Nest Surveys, below.

BIRD SURVEYS - Nest Surveys

Discussion

Depending upon your goals, it may be important to find out not just what birds are using your property while passing through, but those that might be settling in more permanently. Nest-building and the rearing of young is a great indication of that, so nest surveys may be desirable.

Species nest at different times of the year, so your surveys will have to be timed accordingly. Certain species, like the Great Horned Owl, begin nesting in January. Goldfinches nest very late, using the ripened seeds of thistles to feed their young. Although nesting time for any given species of bird can vary according to weather patterns, location, elevation, and other environmental factors, the vast majority of nesting occurs during the months of May and June. Those, then, are the months during which to concentrate your efforts.

If you are interested in finding out if a specific species of bird is using your property, it is best to call your local Audubon chapter to find out the specific nesting habits of that species in your area. Check the References sections for contacting the Yolo Audubon Society.

Equipment

- Notebook
- Pencil
- Bird List, below
- Field Guide (see References)

Costs

Under $25.00, including the cost of a basic field guide.

Procedures

Conduct your nest survey by making once-a-week visits to the area you have selected. This may be a thicket, a grove of trees, a creek reach or the like. Some species, like owls, nest very early (late winter), but most can be caught in nesting activities by continuing to do weekly surveys from mid-March through the end of June. Visual searches may reveal some nests easily. Then it is a matter of sitting patiently until you see and can identify the bird that returns to the nest. If the nest is low and you are able to have a closer look, the *Field Guide to Western Bird Nests* listed below can help with positive identification. In heavier vegetation, nests may never be visible and you will have to rely on observing a bird carrying nesting material for building, or hearing the young calling to be fed. Then it is simply a matter of making notes on what you observe. It can be an exciting event for young families to watch the growth and development of a family of birds.

Time Estimate

Allow up to half a day to complete a nest survey in your strip census area.

BIRD SURVEYS - NEST SURVEYS
SUMMARY CARD

Equipment

Notebook

Pencil

Bird List, below

Field Guide (see References)

Procedure Summary

Select an area for the nest survey.

Decide on the appropriate time of year to begin your survey.

Walk the area slowly and quietly, and observe.

Record any apparent nesting or young-rearing behavior.

Identify nest, if possible.

Data Sheet: Use the Data Sheet below or the Bird List, following.

ANIMAL SURVEYS: Bird Nest Survey

Date: _____ Time: _____ Location: _____

Weather conditions

Temperature: _____ Wind Speed: _____ Wind Direction: _____ Cloud Cover: _____

Notes: _____

Bird Species (common name)	Nest Location	Activity Notes

BIRD SURVEYS - STRIP CENSUS OR POINT COUNT

BIRD LIST

adapted from the Yolo Audubon Society Daily Checklist

Date: _____ Time: _____ Location: _____ Season: _____

Survey type (Strip census, Point count, other):

Weather conditions:

Temperature: _____ Wind Speed: _____ Wind Direction: _____ Cloud Cover: _____

Notes: _____

Bird species (common name)	Number seen	Number heard	Notes
Loons			
Red-throated Loon			
Pacific Loon			
Common Loon			
Grebes			
Pied-billed Grebe			
Horned Grebe			
Eared Grebe			
Red-necked Grebe			
Western Grebe			
Clark's Grebe			
Pelican			
American White Pelican			
Cormorant			
Double-crested Cormorant			
Herons			
American Bittern			
Least Bittern			
Great Blue Heron			
Great Egret			
Snowy Egret			
Cattle Egret			
Green-backed Heron			
Black-crowned Night-Heron			
Ibis			
White-faced Ibis			
Stork			
Wood Stork			
Geese and Ducks			
Fulvous Whistling-duck			
Tundra Swan			
Greater White-fronted Goose			
Snow Goose			
Ross' Goose			
Emperor Goose			
Canada Goose			
Wood Duck			
Green-winged Teal			
Mallard			
Northern Pintail			
Blue-winged Teal			
Cinnamon Teal			
Northern Shoveler			
Gadwall			
Eurasian Wigeon			
American Wigeon			
Canvasback			
Redhead			
Ring-necked Duck			
Greater Scaup			

Bird species (common name)	Number seen	Number heard	Notes
Lesser Scaup			
Surf Scoter			
Common Goldeneye			
Barrow's Goldeneye			
Bufflehead			
Hooded Merganser			
Common Merganser			
Red-breasted Merganser			
Ruddy Duck			
Vulture			
Turkey Vulture			
Kites, Eagles, Hawks			
Osprey			
Black-shouldered Kite			
Bald Eagle			
Northern Harrier			
Sharp-shinned Hawk			
Cooper's Hawk			
Northern Goshawk			
Red-shouldered Hawk			
Swainson's Hawk			
Red-tailed Hawk			
Ferruginous Hawk			
Rough-legged Hawk			
Golden Eagle			
Falcons			
American Kestrel			
Merlin			
Peregrine Falcon			
Gyrfalcon			
Prairie Falcon			
Pheasants			
Ring-necked Pheasant			
California Quail			
Mountain Quail			
Rails			
Virginia Rail			
Sora			
Common Moorhen			
American Coot			
Crane			
Sandhill Crane			
Plovers			
Black-bellied Plover			
Lesser Golden Plover			
Snowy Plover			
Semipalmated Plover			
Kildeer			
Mountain Plover			
Stilt and Avocet			
Black-necked Stilt			
American Avocet			
Sandpipers			
Greater Yellowlegs			
Lesser Yellowlegs			
Solitary Sandpiper			
Willet			
Spotted Sandpiper			
Wimbrel			
Long-billed Curlew			
Marbled Godwit			
Ruddy Turnstone			
Black Turnstone			
Red Know			
Sanderling			

Bird species (common name)	Number seen	Number heard	Notes
Semipalmated Sandpiper			
Western Sandpiper			
Least Sandpiper			
Baird's Sandpiper			
Pectoral Sandpiper			
Sharp-tailed Sandpiper			
Dunlin			
Stilt Sandpiper			
Ruff			
Short-billed Dowitcher			
Long-billed Dowitcher			
Common Snipe			
Wilson's Phalarope			
Red-necked Phalarope			
Red Phalarope			
Gulls and Terns			
Parasitic Jaegar			
Franklin's Gull			
Bonaparte's Gull			
Mew Gull			
Ring-billed Gull			
California Gull			
Herring Gull			
Thayer's Gull			
Western Gull			
Glaucous-winged Gull			
Glaucous Gull			
Sabine's Gull			
Caspian Tern			
Forester's Tern			
Black Tern			
Pigeons and Doves			
Rock Dove			
Band-tailed Pigeon			
Mourning Dove			
Cuckoos			
Yellow-billed Cuckoo			
Greater Roadrunner			
Owls			
Common Barn-Owl			
Flammulated Owl			
Western Screech-Owl			
Great Horned Owl			
Snowy Owl			
Northern Pygmy-Owl			
Burrowing Owl			
Long-eared Owl			
Short-eared Owl			
Northern Saw-whet Owl			
Nightjars			
Lesser Nighthawk			
Common Poorwill			
Swifts			
Black Swift			
Chimney Swift			
Vaux's Swift			
White-throated Swift			
Hummingbirds			
Black-chinned Hummingbird			
Anna's Hummingbird			
Costa's Hummingbird			
Calliope Hummingbird			
Rufous Hummingbird			
Allen's Hummingbird			
Kingfisher			
Belted Kingfisher			

Bird species (common name)	Number seen	Number heard	Notes
Woodpeckers			
Lewis' Woodpecker			
Acorn Woodpecker			
Red-breasted Sapsucker			
Nuttall's Woodpecker			
Downer Woodpecker			
Hairy Woodpecker			
Northern Flicker			
Pileated Woodpecker			
Tyrant Flycatchers			
Olive-sided Flycatcher			
Western Wood-Pewee			
Willow Flycatcher			
Hammond's Flycatcher			
Ducky Flycatcher			
Gray Flycatcher			
Western Flycatcher			
Black Phoebe			
Say's Phoebe			
Ash-throated Flycatcher			
Western Kingbird			
Eastern Kingbird			
Lark			
Horned Lark			
Swallows			
Purple Martin			
Tree Swallow			
Violet-green Swallow			
Northern Rough-winged Swallow			
Bank Swallow			
Cliff Swallow			
Barn Swallow			
Jays, Crows, Magpies			
Steller's Jay			
Scrub Jay			
Yellow-billed Magpie			
American Crow			
Common Raven			
Chickadees and Titmouse			
Mountain Chickadee			
Chestnut-backed Chickadee			
Plain Titmouse			
Bushtit			
Bushtit			
Nuthatches			
Red-breasted Nuthatch			
White-breasted Nuthatch			
Pygmy Nuthatch			
Creeper			
Brown Creeper			
Wrens			
Rock Wren			
Canyon Wren			
Bewick's Wren			
House Wren			
Winter Wren			
Marsh Wren			
Dipper			
American Dipper			
Thrushes			
Golden-crowned Kinglet			
Ruby-crowned Kinglet			
Blue-gray Gnatcatcher			
Western Bluebird			
Mountain Bluebird			
Townsend's Solitaire			

Bird species (common name)	Number seen	Number heard	Notes
Swainson's Thrush			
Hermit Thrush			
American Robin			
Varied Thrush			
Wrentit			
Mimic Thrushes			
Northern Mockingbird			
Sage Thrasher			
California Thrasher			
Pipit			
Water Pipit			
Waxwings			
Bohemian Waxwing			
Cedar Waxwing			
Silky Flycatcher			
Phainopepla			
Shrikes			
Northern Shrike			
Loggerhead Shrike			
Starling			
European Starling			
Vireos			
Bell's Vireo			
Solitary Vireo			
Hutton's Vireo			
Warbling Vireo			
Warblers and Sparrows			
Orange-crowned Warbler			
Nashville Warbler			
Yellow Warbler			
Black-throated Blue Warbler			
Yellow-rumped Warbler			
(Audubon's)			
Yellow-rumped Warbler			
(Myrtle)			
Black-throated Gray Warbler			
Townsend's Warbler			
Hermit Warbler			
Black-throated Green Warbler			
Palm Warbler			
Black-and-white Warbler			
American Redstart			
Northern Waterthrush			
MacGillivray's Warbler			
Common Yellowthroat			
Wilson's Warbler			
Canada Warbler			
Yellow-breasted Chat			
Summer Tanager			
Western Tanager			
Rose-breasted Grosbeak			
Black-headed Grosbeak			
Blue Grosbeak			
Lazuli Bunting			
Indigo Bunting			
Green-tailed Towhee			
Rufous-sided Towhee			
Brown Towhee			
Rufous-crowned Sparrow			
Chipping Sparrow			
Black-chinned Sparrow			
Vesper Sparrow			
Lark Sparrow			
Sage Sparrow			

Bird species (common name)	Number seen	Number heard	Notes
Lark Bunting			
Savannah Sparrow			
Grasshopper Sparrow			
Fox Sparrow			
Song Sparrow			
Lincoln's Sparrow			
Swamp Sparrow			
White-throated Sparrow			
Golden-crowned Sparrow			
White-crowned Sparrow			
Harris'Sparrow			
Dark-eyed Junco (Slate)			
Dark-eyed Junco (Oregon)			
Dark-eyed Junco (Gray-headed)			
Lapland Longspur			
Chestnut-collared Lojngspur			
Snow Bunting			
Red-winged Blackbird			
Tri-colored Blackbird			
Western Meadowlark			
Yellow-headed Blackbird			
Brewer's Blackbird			
Great-tailed Grackle			
Brown-headed Cowbird			
Hooded Oriole			
Northern Oriole			
Finches			
Purple Finch			
Cassin's Finch			
House Finch			
Red Crossbill			
Pine Siskin			
Lesser Goldfinch			
Lawrence's Goldfinch			
American Goldfinch			
Evening Grosbeak			
House Sparrow			
House Sparrow			

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Yolo Audubon Society: (530) 756-9531

MAMMALS

Mammal Surveys can be quite varied, depending on the mammal species, its size, preferred food and habitat, and the season. Live trapping requires a permit and carries some inherent risks if the animal is likely to carry an infectious disease. For those reasons, direct observation and surveying for sign is probably the preferred method. The approaches used can collectively be referred to as 'ambient' surveys. The goal is to get an overall idea of what species are present and where.

There may be several ways that you will want to approach your mammal surveys. These may include looking for tracks or scats (droppings), burrows or dens, or using track stations to draw them in. You may also want to save a record of tracks you find by making plaster casts. These methods are all discussed in the following pages.

Most mammals will never be seen, because of their innate fear of humans, but if you take the time to learn a little about the animals you are likely to see in your county, your eyes can become very attuned to the subtle signs that they leave.

Later in this section you will find a list of most of the mammals you are likely to see in the Yolo County area. The list may apply to much of the rest of the Sacramento Valley and low foothills, but it is always good to check with a local wildlife biologist for any local variations. If you use one of the field guides listed below under References to learn something about where each one lives, you will know what to expect to find when you go out to different areas of your farm or ranch. The reverse approach would be to simply go out and look for signs, assuming you already have well-honed powers of observation for detail, and when you locate something, begin the search through the field guides to determine just what you saw. Either way can be effective and fun. It does help, however, to give yourself at least a little background before you start.

Choose specific locations for your surveys and always go back to that same location. Do the surveys during several seasons, especially spring and summer, and repeat them during the same seasons, close to the same dates, in subsequent years. Use the same methods if you want to be able to compare one year to the next and find out if your management practices are resulting in greater or lesser numbers of a certain animal. Some animals, such as river otter or raccoons, you may be comfortable with seeing increasing or fluctuating numbers of. Others, such as squirrels or gophers, you may be hoping for decreases after installing raptor perches.

MAMMAL SURVEYS - Tracks and Other Sign

Discussion

Near water is an exceptional place to begin a search for sign such as tracks. Most animals need water on a daily basis and will leave tracks in moist banks. If you have a pond on your property, this would be an excellent place to look. Walk the edges of the pond. If you find some tracks, look at them carefully using your "*Field Guide to Animal Tracks*" and see if you can identify them. Take notes on things such as their length and width, the presence or absence of claws, and what side of the pond they are on. Make a guess as to where they were coming from or how old the tracks are (If the mud is dried and cracked, you know they aren't fresh!). A life-size sketch in your notebook would be ideal. If you can identify them with confidence, congratulations. If you aren't certain, make a cast so that you can confirm it later (see "Making Plaster Track Casts," page 101).

Watering areas are not the only places you might find tracks and sign. Many animals will have "runways" or favorite trails they frequent. The dust on the trail may be just right to hold a track. If not, you could use a rake or other hand-tool to disrupt multiple old tracks and to loosen and smooth it. You could then visit it the next day to check for fresh tracks.

Additional places to check for tracks will vary with the animal. From the list of mammals provided at the end of this section, choose a few to look up and learn about. See how that fits with the different habitats on your land and decide where to look. Shrubs lining the edge of a path may hold things like tufts of fur and tree trunks may have been scraped by deer antlers. Depending on the animal, there may be other kinds of signs that you could look for. Check in your field guide for clues.

Equipment

- Notepad
- Pencil
- Field Guide to Animal Sign (Tracks, Scats, Dens)
- Optional: Track casting materials, as listed under Track Casting

Costs

Under $25.00, including the cost of a basic field guide.

Procedures

Select the area where you want to do a track and sign survey.

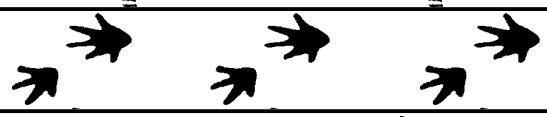
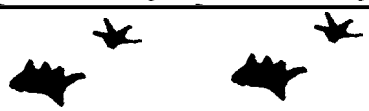
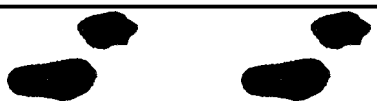
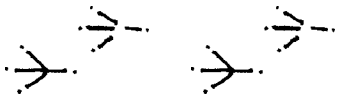
After a little planning, you should define a monitoring "circuit" so that you can walk the same path each time. Where the areas to be monitored are disconnected, just be sure to visit each one every time.

Walk the area, observing carefully for any types of sign and take notes on what you see.

Included here are sketches of basic categories of animal tracks so that you can begin to home in on the type of animal that has made the tracks you find. Use a field guide, such as one of those listed in the References section at the end, to get as close as you can. If your curiosity is aroused by the regular appearance of fresh tracks, you may even be inspired to wait patiently to catch a glimpse to confirm your guess.

Time Estimate

Allow from 1 to 4 hours to do a survey for animal sign, depending on the size of the area.

	Snakes: series of side-to-side trail undulations.
	Lizards: Five toes in front and back prints. Long, slender toes. Claws may or may not be attached. Trail may show dragging tail.
	Turtles
	**Salamanders**: Four toes in front print, five toes in back. Wide trail. Trail often shows a tail drag.
	**Toads**: Four toes in front print, five toes in back. Front print faces to center. Knobs may show on either foot. Webbing in back print between back four toes.
	Frogs: Four toes in front print, five toes in back. Long, slender toes. Front print faces to center. Webbing in back print.
	Raccoons & relatives: Five toes in front and back. Toes often round at ends. Toes may be long and slender.
	Weasels and Relatives: Five toes in front and back (smallest toe, inside, may not show). 1-3-1 grouping of toes. Chevron- shaped pad. Hind foot with heel on ground.
	Bears: Five toes in front and back (smallest toe, inside, may not show). Toes evenly spaced. Hind food with heel on ground.
	Wolves, Dogs, and Relatives: Four toes in front and back. Claws usually show and are detached. One forward lobe on pad.
	Cougars, Cats, and relatives: Four toes in front and back. Claws usually do not show. Double forward lobe on pad.
	**Rabbits and Relatives**: Four toes in front and back. A fifth inner toe may show in front in the best prints. No pads. Foot bottom furry. Back print long.
	Deer and Relatives: Two toes form a hard, cloven hoof. Dew-claws may or may not show.
	**Birds without Webbed Feet**: Three toes facing forward, usually a fourth facing backward. Claws may be detached.
	Birds with Webbed Feet: Three toes facing forward. Often a fourth facing backward. Claws may or may not be detached. Webbing shows between toes.
	Rodents

MAMMAL SURVEYS - TRACKS AND OTHER SIGN SUMMARY CARD

Equipment

Notepad

Pencil

Field Guide to Animal Sign (Tracks, Scats, Dens)

Optional: Track casting materials, as listed under Track Casting

Procedure Summary

Select the survey area.

Walk the survey area.

Observe and record any animal sign for later identification.

Data Sheet.

MAMMAL SURVEYS: Tracks and other sign

Date:_____ Time: _____ Location: _____

Animal species (common name)	Track Location	Sketch/ Notes

MAMMAL SURVEYS - Scat

Discussion

"Scat" is another word for animal droppings. They might not sound like something you would want to look for, but often they will be the *only* indication that an animal has passed through, so it is important to know what to look for. There are field guides devoted solely to that subject, but often books on animal tracks will also include sections on scats because they are so important to actually being able to track and/or identify an animal.

Most of us have seen the "scats" that our pet dogs or cats leave for us to clean up. There are things we can begin to learn about wild animal scats by noticing things about those of our pets. Large dogs leave large droppings, small cats have very small droppings. When you see a scat in the wild, make a guess about the size of the animal based on what you remember about your pets. When our pets eat different things, their scats will change in color and in consistency. Wild creature's diets change throughout the year depending on the season and the availability of food. Their scats will look different depending on what they have been dining on recently.

Equipment

- Notepad
- Pencil
- Field Guide to Animal Sign (Tracks, Scats, Dens)
- Small zip-close bags for possible collection

Costs

Under $25.00, including the cost of a basic field guide.

Procedures

The procedure for doing a scat survey is much the same as that for a track survey.

Select the area where you want to do a scat survey. This may well be the same area where you are doing a track survey, so do them at the same time.

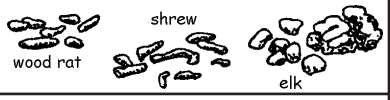
Define your monitoring "circuit" and plan to walk the same path each time. If areas are disconnected, be sure to visit each one every time.

Walk the area, observing carefully for any scat or other sign and take notes on what you see. If you are not sure of the identity of the animal that produced the scat, you could save it to show to someone more experienced. Try turning one of the zip-close bags inside out, put your hand in the inside-out portion and pick up the scat with the bag. Turn the bag right-side out and seal it closed. Save this for comparison with drawings, such as those below, or photos in other field guides.

Time Estimate

Allow from 1 to 4 hours to do a scat survey, depending on the size of the area.

SHAPES OF SCATS

Spheres	Rabbits and relatives
Elongated spheres 	Rodents, shrews, deer and relatives
Long and thick cords	Raccoons, wolves, bears and relatives
Thick and constricted cords	Mountain Lions and relatives
Folded cords	Weasels and relatives
Long, thin cords with white deposits	Birds and reptiles

MAMMAL SURVEYS - SCAT
SUMMARY CARD

Equipment

Notepad

Pencil

Field Guide to Animal Sign (Tracks, Scats, Dens)

Small zip-close bags for possible collection

Procedure Summary

Select the area for the scat survey.

Walk the area, observing carefully.

Record any sign observed.

Collect any samples desired for later identification.

Data Sheet

MAMMAL SURVEYS: Tracks and other sign

Date:_____ Time: _____ Location: _____

Animal species (common name)	Scat Location	Sketch/ Notes

MAMMAL SURVEYS - Burrows, Dens and Other Shelter

Discussion

Shelter is one of the most basic needs of the animals on our farms or ranches – whether they be wild or domestic animals. Locating their shelters can sometimes be the first or only indication of a wild animal's presence, can help confirm what the animal is, or give indications of how many are there.

Check one of the books on animal tracks or sign for the kind of den to expect. Some mammals have no den at all, but seek other kinds of shelter. In the case of bats, cracks in rock wall faces are ideal. They also like spaces between framing boards in the upper walls and roofs of barns. Some animals merely bed down in a different place each night.

Equipment

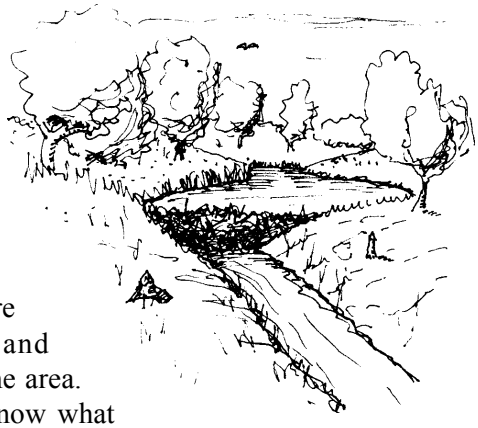
- Notepad
- Pencil
- Field Guide to Animal Sign (Tracks, Scats, Dens)

Costs

Under $25.00, including the cost of a basic field guide.

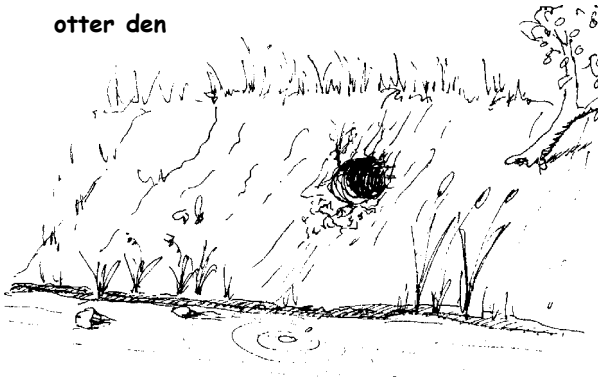
Procedures

beaver dam



Consider the locations on your property where you would be most likely to find a burrow, den, or bed made by the animals you are interested in and plan to walk the area. If you don't know what types of animals to expect, plan to walk a variety of habitats with a keenly observant eye.

otter den



Take notes and make sketches of what you see and compare them with a field guide.

Time Estimate

Allow from 1 to 4 hours to do den or burrow survey, depending on the size of the area. If you do find dens or burrows, you will find that it will add to the time spent, since you will inevitably spend extra time checking it.

mole tunnels

MAMMAL SURVEYS - Baited Track Stations

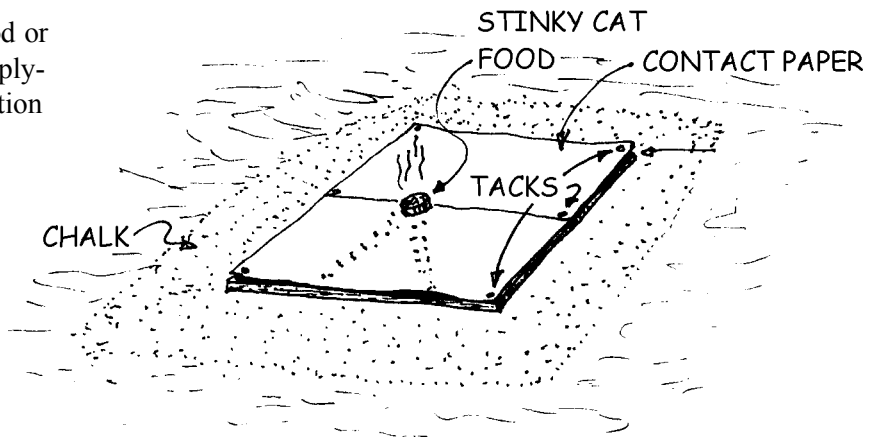
Discussion

A fun way to find out what animals might be frequenting your place, and to get a permanent record of it is to set out a baited track station. The following combination of techniques is fairly simple and works in most circumstances. It requires getting the animal to walk through some colored powder and getting it to leave a print on a smooth, white surface. The food is what draws them in. The method is explained in detail below.

Since most wild mammals are active at night, it is best to set this kind of track station in the evening and check it the next morning. These kinds of track stations don't work in the rain, nor in a heavy dew, because the water makes the chalk and the tracks "runny." It does work remarkably well the rest of the time for preserving a good track for later identification.

Equipment

- 2 ft. x 2 ft. piece of plywood or larger (a 4 ft. x 8 ft. piece of plywood will make 8 track station boards)
- White 'Contact Paper'
- Thumb Tacks
- Small can of cat food – any flavor – or other bait
- Blue carpenter's chalk (as for a chalk-line), available at your local hardware store
- A strainer
- Hand clippers or shears
- Clear Plastic Wrap



Costs

If all equipment is purchased new, you can get set up for 8 separate track stations, with multiple uses possible, for about $50.00. If you already have the wood, the clippers a strainer and thumbtacks, your cost will be $25.00 or less.

Procedures

Cut lengths of the white Contact Paper that will cover the plywood board. Keeping the smooth, finished side *down* and the peel-off side *up*, use thumb tacks to secure the sheets on the board so that they lay flat. Peel back the backing on only the corners before you place the tacks. Select a place to set up your track station: an animal path, near the water, or some other place where you suspect animals are moving. Set the board down so that it rests securely on the ground and doesn't wobble over a rock or stick. Clip all of the vegetation to the ground within at least 2ft, and preferably 3 feet, of the board. If you decide to *pull* the vegetation rather than clipping, smooth and flatten down the soil after you are done.

On the cleared area outside of the board, sprinkle the carpenter's chalk through the strainer and onto the ground until you get a light, even, dusting all around the board. Now, carefully lean over the chalk, and pull off the backing on the white contact paper, leaving a white, sticky surface up.

Next, open and stir your smelliest selection of canned cat food. If you are using some other bait, you *must* be able to secure it to the board. Carefully lean over the chalk again and stick the can to the center of the Contact Paper. You are ready!

The next morning, if there are tracks, pull off the can of cat food and cover the entire sticky surface with clear plastic wrap. You can then remove the contact paper from the board and save it for later examination.

If there are no tracks you could try leaving the station set for another night, but make sure that the bait will be in good shape when the evening begins, or else come back to replace the old can with a fresh one.

Time Estimates

It will probably take about ½ hour to set up one track station, excluding travel time, once you know how. If you plan to set out several, the boards with contact paper can be set up at home ahead of time, making things go more quickly once you are at your selected location.

MAMMAL SURVEYS - BAITED TRACK STATIONS SUMMARY CARD

Equipment

2 ft. x 2 ft. piece of plywood (or larger)

1 4 ft. x 8 ft. piece of plywood will make 8 track station boards

White 'Contact Paper'

Thumb Tacks

Small can of cat food – any flavor or other bait

Blue carpenter's chalk (as for a chalk-line), available at your local hardware store

A strainer

Hand clippers or shears

Clear Plastic Wrap

Procedure Summary

Cut sheet of plywood into 2 ft. x 2 ft. squares.

Cut white contact paper into lengths that will cover the 2 ft. x 2 ft. boards.

Secure the contact paper to the board with thumb tacks, peeling back the contact paper cover just at the corners where the thumb tacks are.

Place the track station board at your selected location *in the evening.*

Clear the surrounding vegetation for 2 to 3 feet.

Sprinkle carpenter's chalk through the strainer in a 2 to 3 ft. area around the board.

Peel back the contact paper cover sheet, exposing the sticky surface.

Open and stir the cat-food or other bait.

Stick the cat food can to the center of the sticky surface of the contact paper.

Leave the track station overnight.

Check the track station for tracks in the morning.

If tracks are present, remove the can of cat food and cover the tracks with plastic wrap.

Remove the sheet of contact paper from the board and store for later identification.

Data Sheet: No data sheet is necessary

MAMMAL SURVEYS - Plaster Track Casts

Discussion

When you come upon a clear track in a muddy place, you may recognize it immediately. If you don't, taking it back with you in some form can make a great difference in an accurate identification. Also, if it happens to be a unique track sighting, it can be exciting and fun to save it to show friends and family.

Equipment

- Powdered plaster-of-paris from your local hardware store
- Water bottle filled with water
- Zip-close bags, sandwich size
- Aluminum foil or paper cups/bowls to make forms
- Marker pen
- Old toothbrush

Costs

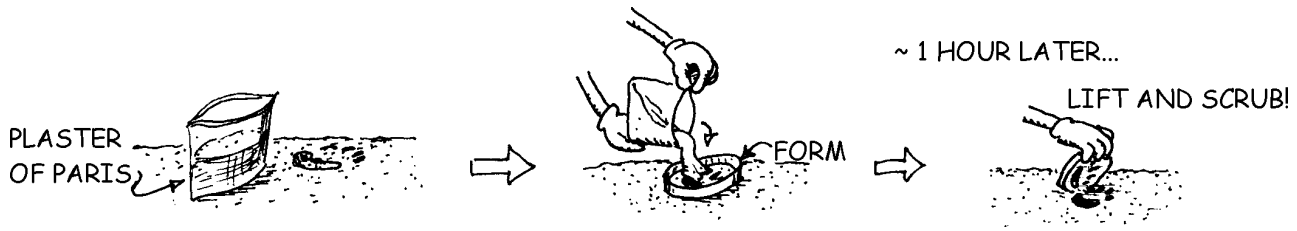
Supplies should cost under $15.00

Procedures

Place 1 to 2 cups of powdered plaster-of-paris in several zip-close bags to carry along on your surveys. When you find a track you would like to cast, pour a little water into the bag, close the bag and knead the water in to mix it. Add water until you get a nice paste, just barely thin enough to pour, but NOT runny (The thinner the mix, the longer it will take to cure and the weaker it will be). If the track is small, cut the top 2 inches off of a paper cup or bowl, place it around the track and pour the plaster over the track. If the track is larger, take several strips of aluminum foil and form them around the track such that they will contain the plaster mix. Pour the plaster over the track and continue your survey while it cures. If your mix is good, it should cure sufficiently to pick it up in about 1 hour, but then will continue to cure for several days. Gently lift the plaster and remove chunks of soil. When you are satisfied that it has cured well, you can scrub it with an old toothbrush, wet or dry. Label the smooth upper side of the cast with the date and location that the track was cast and eventually, the name of the animal.

Time Estimates

It should take no more than 5 to 10 minutes to get a form set around the track and the plaster poured. Allow an hour for it to cure before picking it up.



MAMMAL SURVEYS - PLASTER TRACK CASTS SUMMARY CARD

Equipment

Powdered plaster-of-paris from your local hardware store

Water bottle filled with water

Zip-close bags, sandwich size

Aluminum foil or paper cups/bowls to make forms

Marker pen

Old toothbrush

Procedure Summary

Pre-fill zip-close bags with plaster-of paris powder.

Select track(s) to be cast.

Shape a form around the track.

Mix water with plaster-of- paris powder and mix inside bag.

Pour plaster mix over track.

Allow to cure or set approximately 1 hour.

Pull plaster from soil.

Label smooth side with date, location, and other helpful information.

When plaster is well-cured, scrub clean with toothbrush.

MAMMALS OF THE PUTAH CREEK RESERVE

RODENTIA		
Family Muridae		
Western Harvest Mouse	*Reithrodontomys megalotis*	uncommon
Deer Mouse	*Peromyscus maniculatus*	uncommon
California Vole	*Microtus californicus*	common
Muskrat	*Ondatra zibethica*	common
Norway Rat	*Rattus norvegicus*	common
Roof Rat	*Rattus rattus*	common
House Mouse	*Mus musculus*	common
Dusky-footed Woodrat	*Neotoma fuscipes*	rare valley floor
Family Sciuridae		
California Ground Squirrel	*Spermiphilus beecheyi*	abundant
Western Gray Squirrel	*Sciurus griseus*	uncommon
Family Geomyidae		
Botta's Pocket Gopher	*Thomomys bottae*	abundant
Family Castoridae		
Beaver	*Castor canadensis*	uncommon
CARNIVORA		
Family Canidae		
Coyote	*Canis latrans*	uncommon
Gray Fox	*Urocyon cinereoargenteus*	uncommon resident
Red Fox	*Vulpes fulva*	uncommon resident
Family Procyonidae		
Raccoon	*Procyon lotor*	uncommon
Family Mustelidae		
Spotted Skunk	*Spilogale putorius*	uncommon resident
Striped Skunk	*Mephitis mephitis*	uncommon resident
River Otter	*Lutra canadensis*	uncommon
Long-tailed Weasel	*Mustela frenata*	rare and local
Mink	*Mustela visons*	uncommon resident
Family Felidae		
Bobcat	*Lynx rufus*	rare
Mountain Lion	*Felis concolor*	rare
Family Ursidae		
Black Bear	*Ursus americanus*	rare
ARTIODACTYLA		
Family Cervidae		
Black-tailed Deer	*Odocoileus hemionus*	rare visitor
INSECTIVORA		
Family Soricidae		
Ornate Shrew	*Sorex ornatus*	rare

CHIROPTERA

Family Vespertilionidae

Pallid Bat	*Antrozous pallidus*
Big Brown Bat	*Eptesicus fuscus*
Silvery-haired Bat	Lasionycteris noctivagens
Red Bat	*Lasiurus borealis*
Hoary Bat	*Lasiurus cinereus*
Myotis	*Myotis spp.*
Western Pipistrelle	*Pipistrellus hesperus*
Lump-nosed Bat	*Plecotus townsendii*

Family Molossidae

Brazilian Free-tailed Bat	*Tadarida brasiliensis*

LAGOMORPHA

Family Leporidae

California Jackrabbit	*Lepus californicus*	abundant
Audubon's Cottontail	*sylvilagus audubonii*	common

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Wilson, Don E., F. Russell Cole, James D. Nichols, Rasanayagam Rudran, and Mercedes S. Foster, editors. 1996. Measuring and Monitoring Biological Diversity, Standard Methods for Mammals. Smithsonian Institution Press. Washington (D.C.) and London. 409 pp.

REPTILES and AMPHIBIANS

To this point, there do not seem to be any methods of systematically monitoring for reptiles and amphibians in general that are simple. There are methods available, but they tend to be very labor intensive to run, have some inherent qualities that can complicate and confuse your efforts, and require a lot of upkeep.

Pit traps are one method that is used to detect and monitor reptile species. Usually they are used in conjunction with drift nets. The 'drift net' consists of a length (perhaps 20 ft., more or less) of aluminum flashing or plastic about 1 foot high with a pit trap at each end and sometimes in the center. There are often 3 such drift fences set up together, all meeting in the center like the spokes of a bicycle. The pit trap consist of two, large-sized coffee cans stacked on top of each other, the top can having the bottom removed. The stacked cans are set into the ground such that the upper rim is at ground level. An elevated cover is then put over the top of the pit to keep rain and debris out, but allow room for any animals to walk under. A simple lid can be made from a square piece of wood with a large nail pounded through each corner. The four nails can be pushed into the ground until it is about 2 inches higher than the rim of the pit trap.

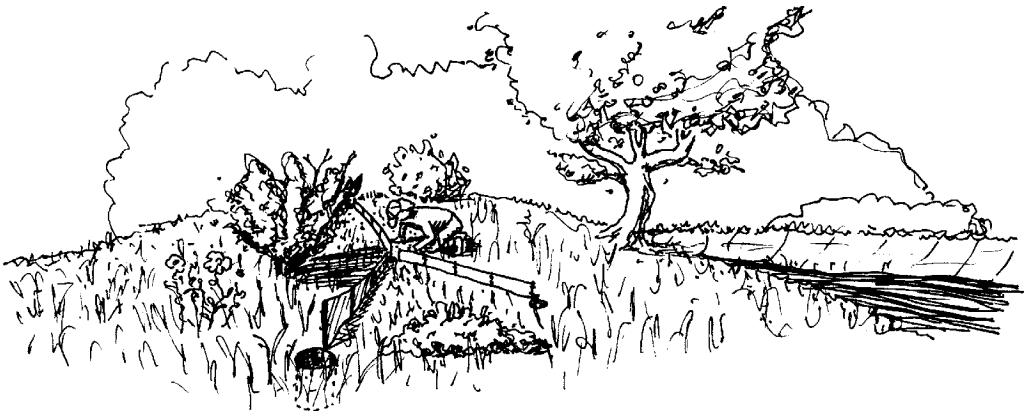
Although they sound rather basic, these traps can be very management-intensive. Checking them twice each day is advised, otherwise rainwater may drown any lizards or mice that fall in, if two animals are trapped they may fight and injure each other or one may be consumed, or ants may overwhelm whatever is trapped.

"Reptile Boards" are another possible method, and one of the simplest methods available. These consist of a 2 ft. x 2 ft. piece of plywood (the same board used for baited track stations, under mammal surveys), laid on the ground in a sunny or semi-sunny location and left undisturbed for long periods of time. After they have been left undisturbed for several weeks, they can be checked periodically (weekly) to see if anything has taken up residence under them. Although the simplicity of this method is very appealing, two full seasons (spring through fall) of field use in five locations proved completely fruitless for one of our projects. This method would probably be more successful if used broad-scale at a site and many boards were laid out in grid-fashion.

Careful field observation during other surveys is probably still the best of the simple methods of reptile monitoring available. Look for "tracks" such as slither marks in dusty areas, or for sign near likely dens such as piles of rock or dry brush that get a lot of sun exposure.

To make the monitoring more comparable from year to year, the best approach would be to wait and watch in designated locations for specified periods of time. For example, select five sites, visit the five sites in the same sequence, and make observations for ½ hour at each site, at approximately the same dates in successive years.

If you are lucky enough to catch a glimpse of a resident snake or other reptile, it is usually a fleeting one, so be prepared to gather as much visual information on identifying marks as you can in a second or two. If you have the time, sitting silently at an observation point near an expected den for specified periods of time can yield clearer looks.



Check the field guide at the end of this section if you need help identifying those things that you see. One the next page is a list of the reptiles and amphibians that you are most likely to see in the Yolo County area.

REPTILES OF THE PUTAH CREEK AREA

Family Colubridae - Colubrid Snakes		
California Kingsnake	*Lampropeltis getulus*	uncommon
Pacific Gopher Snake	*Pituophis melanoleucus*	common
Western Yellowbelly Racer	*Coluber constrictor*	common
Valley Garter Snake	*Thamnophis sirtalis*	common near water
Giant Garter Snake	*Thamnophis couchi*	historically uncommon, now probably extinct on campus but still present in surrounding rural Wetland areas. CA threatened
Sharp-tailed Snake	*Contia tenuis*	rare at this low elevation
Ringneck Snake	*Diadophis punctatus*	
Sharptail Snake	Contia tenuis	
Racer	*Coluber constrictor*	
California Whipsnake	*Masticophis lateralis*	
Gopher Snake	*Pituophis melanoleucus catenifer*	
Kingsnake	*Lampropeltis gentula*	
Common Garter Snake	*Thamnophis sirtalis*	
	Thamnophis atratus	
Night Snake	*Hypsiglena torquata*	
Family Crotalidae - Rattlesnakes		
Northern Pacific Rattlesnake	*Crotalus viridis*	rare
Family Scincidae - Skinks		
Gilbert's Skink	*Eumeces gilberti*	uncommon
Western Skink	*Eumeces skiltonianus*	rare
Family Teiidae – Whiptails		
Western Whiptail	*Cnemidophorus tigris*	
Family Anguidae - Lizards and their allies		
Southern Alligator Lizard	*Gerrhonotus munticarinatus*	common
Family Iguanidae - Iguanid Lizards		
Western Fence Lizard	*Scelophorus occidentalis*	common
Coast Horned Lizard	*Phrynosoma coronatum*	extremely rare
Sagebrush Lizard	*Sceloporus graciosus*	
Family Emydidae - Water and Box Turtles		
Northwestern Pond Turtle	*Clemmys marmorata*	uncommon; California's only native turtle
Red-eared Slider	*Trachemys scripta*	introduced
Mapturtle	*Graptemys spp.*	introduced
Painted Turtles	*Chrysemys spp.*	introduced
Box Turtles	*Terrepene spp.*	introduced
Family Kinosternidae - Mud Turtles		
Mudturtles	*Kinosternon spp.*	introduced
Stinkpot Turtles	*Stenotharus spp.*	introduced
Family Trionicidae - Softshell Turtles		
Spiny Softshell Turtle	Trionyx spineferus	introduced
Family Chelydridae - Snappy Turtles		
Common Snapping Turtle	*Chelydra serpentinae*	introduced (?)
Family Testudinidae - Desert Tortoise		
California Desert Tortois	Gopherus agassizi	introduced locally

AMPHIBIANS OF THE PUTAH CREEK AREA

Family Bufonidae - True Toads		
Western Toad	*Bufo boreas*	common
Family Pelobatidae - Spadefoot Toads		
Western Spadefoot Toad	*Scaphiopus hammondi*	uncommon
Family Hylidae – Tree Frogs		
Pacific Chorus Frog	*Pseudacris regilla*	
Family Ranidae - True Frogs		
Foothill Yellow Legged Frog	*Rana boylii*	
California Red-legged Frog	*Rana aurora*	once common, now prob.; extinct locally; found in surrounding foothills
Bullfrog	*Rana catesbeiana*	common, introduced
Leopard Frog	*Rana pipiens*	very rare, introduced
Family Ambystomidae - Salamanders		
California Tiger Salamander	*Ambystoma tigrinum*	historically common; problem; extinct on campus; occur off campus, including Dixon area
Western newt	*Taricha torosa*	
Arboreal Salamander	*Aneides lugubris*	
Ensatina Salamander	*Ensatina eschscholtzii*	
Slender Salamander	*Batrachoseps attenuatus*	

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INSECTS

The world of insect monitoring is probably more developed than any other area of macro-fauna monitoring. That is probably because there are many insects that use agricultural crops for food, shelter and reproduction, causing crop damage in the process. There seems to be lots of support, both economically and philosophically, for finding out more about those creatures that damage and reduce our food supply.

If there is a specific insect pest, or category of pests, that you need information on for economic reasons, there are many sources of information for agricultural pests. Check the References at the end of this section. There are also many experts affiliated with the University of California and California State Universities programs, UC Cooperative Extension offices in each county, and private crop consultants - who are often excellent field entomologists. It would be wise to use one of these expert sources if an agricultural pest is in question.

Monitoring information on specific pests, such as is done in an agricultural setting for insecticide application decisions, will not be discussed here at all. It would require many volumes to cover all of the insect pests, and new information is being developed continuously for nearly all of them. Refer to the free UC IPM Pest Management Guidelines on the World Wide Web for up-to-date information on specific pests.

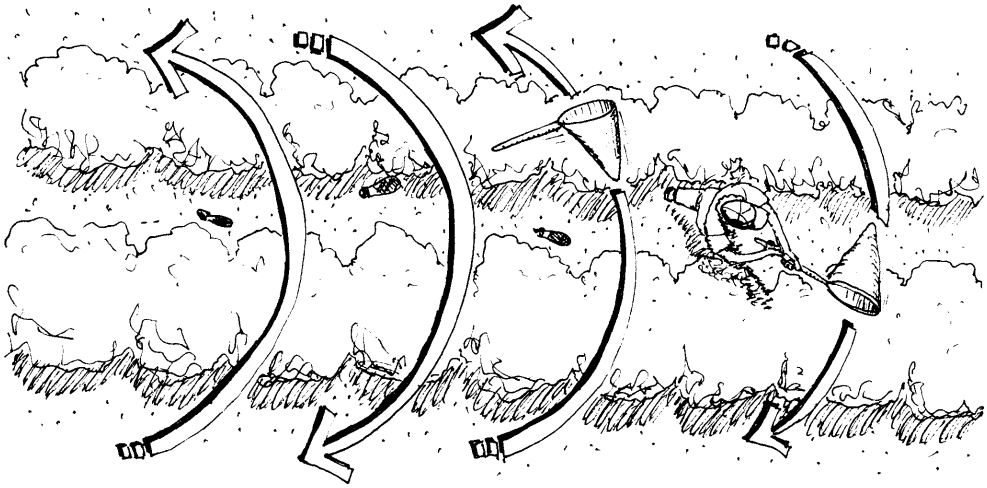
If you are more interested in getting some general information about insects using certain vegetation on your property and want to do general surveys to begin to find out, a couple of useful methods are discussed on the following pages.

INSECT SURVEYS - Sweep Net Samples

Discussion

If you have a cover crop, small pasture, some riparian-edge vegetation or some similar area, sweep-net samples can provide a good overview of the insects present. Plan not only to just sweep, but to collect and save them, since few people have the expertise to identify every member of the broad variety of insect families you might find. You may get anything from large larvae or beetles to wasps that are so tiny that they can barely be seen. If you save them in some form of collecting jar you can show them to someone who does have the expertise. You will then know if what you found are "beneficials," pests, or interesting "neutrals."

This method can be used as a one-time look, or "snapshot," of what is present, or can be used more systematically. To keep track of changing insect species or populations, sweep net samples should be taken at least once a week. Samples can also be compared from like seasons, year to year. Looking at similar dates can tell you how the weather conditions during one year affect the insects differently.



Equipment

Insect Sweep Net (cloth net, 15" diameter) available at most agricultural supply companies

Collecting jars (glass or plastic vials, or any little jar from your kitchen)

14x Hand lens for observation of catches

Labels or masking tape

Marker pen

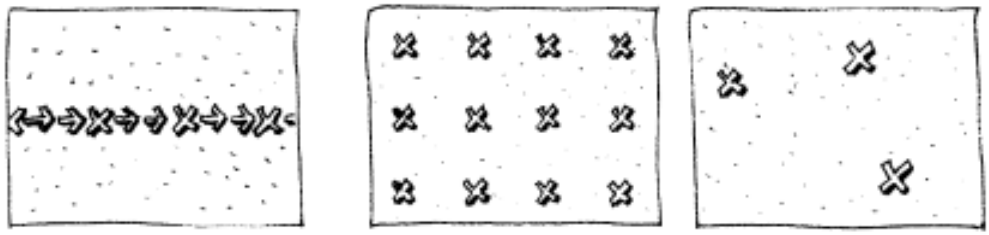
Field guide (optional)

Costs

Approximately $45.00 to $50.00 if the sweep net, hand lens and field guide are new and the other materials are already owned.

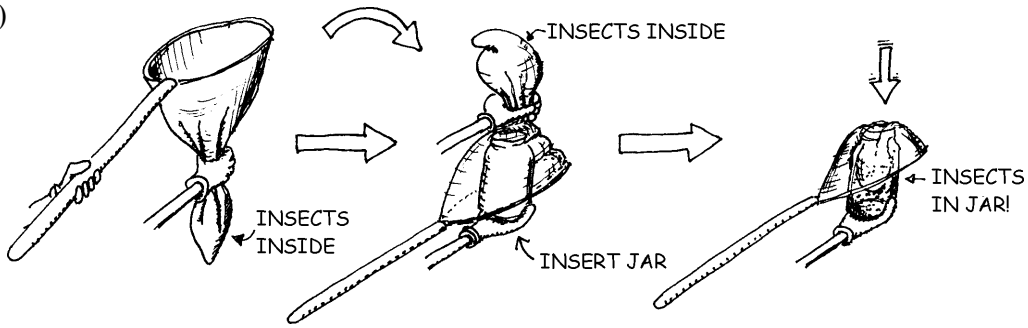
Procedure

Select "quadrants" or sections of the field to be sampled, excluding the very edges and make a sketch as if looking down at it from above, as in the sample drawings. Try to choose areas that are representative of your field, rather than ones that are water deficient, or show some other deviation from the norm (unless, or course, those are the very areas you want to check).



Make sweeps by swinging the net from side to side in complete half-circles, reversing direction each time (see drawing, previous page.) Make one sweeping arc with each step, lifting the net after each arc. Keep the lower side of the net slightly ahead of the upper side to catch any insects that drop. Also keep the net at the same level in the plants during the entire sweep.

Ten sweeps is considered 1 sample. You may need to do several samples in each quadrant. Depending on the size of the field, a minimum of 5 quadrants should be sampled. You will probably want to keep separate collection jars for each of the sampling locations. Getting the insects into the sampling jars can be a little tricky at first, but with practice it gets easier. (see drawing, this page.) The sweeping process should work most of the insects into the bottom, narrowest part



of the net. Using one hand on the *outside* of the net, pinch off a little bubble of the net *above* where the insects are trapped. You can then put the mouth of your jar on the *inside* of the net, tightly up against the pinched off area. Begin turning the "bubble" inside-out inside the jar mouth, releasing the insects into the jar. Be careful not to squash the tiny, delicate insects.

Label the jar with the date, time, location, and any other helpful information.

Try comparing your insects to a field guide and see how close you can come to identifying them.

Time Estimate

Plan to spend from 1 to 3 hours, depending on whether the sampling area is small or large. A significant part of this is walking time between sweep locations.

INSECT SURVEYS - SWEEP NET SAMPLES
SUMMARY CARD

Equipment

Insect Sweep Net (cloth net, 15" diameter) available at most agricultural supply companies

Collecting jars (glass or plastic vials, or any little jar from your kitchen)

14x Hand lens for observation of catches

Labels or masking tape

Marker pen

Field guide (optional)

Procedure Summary

Select an area or field to be sampled and divide it into quadrants.

Make an aerial sketch of the area, quadrants and sample sites.

Take samples using 10 full sweeps as a sample.

Observe the insects collected.

Save the insects in a sample jar if desired.

Label the jar.

Compare samples with a field guide.

INSECT SURVEYS: SWEEP NET SAMPLES

Date: _____ Time: _____ Field/location: _____

Weather Conditions: Temperature: _____ Wind Speed: _____

Wind Direction: _____ Cloud Cover: _____

Notes: _____

Sample Location: _____ Number of sweeps per location: _____

Insect Species Name	Number of Individuals

Sample Location: _____ Number of sweeps per location: _____

Insect Species Name	Number of Individuals

Sample Location: _____ Number of sweeps per location: _____

Insect Species Name	Number of Individuals

INSECT SURVEYS - Sticky Traps

Discussion

A less intensive way to get a general idea of insects present is to use Sticky Traps. A Sticky Trap can come in various forms. Many are made to include pheromones (insect hormones) as attractants and are manufactured for monitoring specific pest species in agricultural settings or for other specialized purposes. The most basic kind of sticky trap, however, consists of a thin, sticky coating on one or both sides of a bright yellow-colored card that's anywhere from 4" x 6" to 8" x 10." Many insects are attracted to the bright yellow color, so this can provide you with general indications of insects present or moving through your property. However, some are not attracted to the yellow color, others are active only at night when the bright yellow is not an effective attractant. In this instance, you may want to add a light of some kind to your yellow sticky trap set-up. It is important to understand that no single trap type will attract all insects.

Equipment

- 5 to 10 sticky cards per sampling cycle
- Wire flags or twist-ties for anchoring the cards
- Brightly colored surveyors flagging tape (available at many agricultural supply houses) or other location marker
- Clear plastic wrap or large zip-close bags
- Marker pen to label card
- Hand lotion

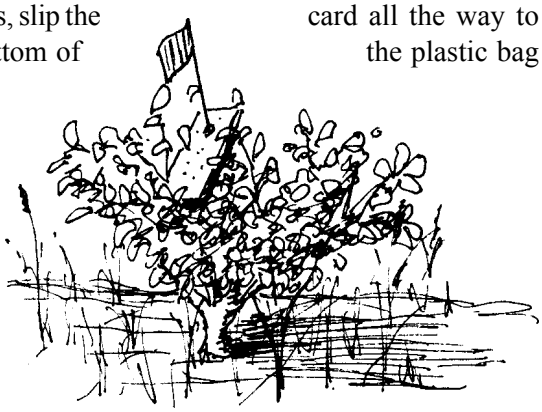
Costs

Approximately $20.00.

Procedures

Decide if you want to attract insects from a fairly long distance or just within a certain shrub. If you want to pull them in from a larger area, place the card out in the open, tied to a stake, or hanging from a tree branch. If you want to draw from a very localized area of shrubs, hide the card well within the foliage, but not stuck to it. A wire flag can sometimes be helpful for securing a sticky card within a low shrub. It is almost impossible to handle the cards without getting your hands sticky. A generous dose of hand lotion along with a rag will usually remove most of it.

Leave the card in place for about a week before picking it up. Bring along clear plastic wrap or clear, flat plastic bags. Detach the card from the wire flag or twist-tie and cover the sticky portion, insects and all, with plastic wrap or a plastic bag. If you use plastic bags, slip the card all the way to the bottom of the plastic bag



without touching the sides of the bag. Once the card is all of the way in the bag, smooth the plastic over the card from the bottom up. Plastic wrap can sometimes be simpler, in that a sheet can simply be torn off and smoothed over the sticky surface. *Do not* allow the card to sit in the sun. Everything will melt together and the insects will begin to liquefy. Instead, bring along an ice-chest and refrigerate it immediately for storage until you can look more closely at it or can bring it to an entomologist. You may want to have a quick look at it yourself, using a hand-lens before you cover it. A 14x hand lens is a small magnifier for observing insects or other tiny objects. They are much easier to use on insects that are immobilized on a sticky card. Label the plastic wrap or bag with the date and location and any other helpful information.

Depending on your goals for monitoring you might choose to put out one sticky card, or one set of sticky cards, per season. Once or twice a month from early winter through the end of harvest could be another goal.

Time Estimate

It may require 5 to 10 minutes per card each time you set them out or pick them up, excluding travel time. Analyzing them afterward (looking at them closely and deciding what species have been trapped) could take anywhere from a few minutes to several hours per card, depending on how carefully you wish to study each card.

INSECT SURVEYS - STICKY TRAPS
SUMMARY CARD

Equipment

5 to 10 sticky cards per sampling cycle

Wire flags

Brightly colored surveyors flagging tape (available at many agricultural supply houses) or other location marker

Clear plastic wrap

Marker pen to label card

Hand lotion

Procedure Summary

Select location(s) for sticky card location.

Sketch area, marking card locations.

Flag card location with brightly colored surveyors tape.

Place cards, securing with wire flag or twist-tie.

Leave in place for approximately 1 week, or other desired time period.

Remove sticky card from sample location.

Cover sticky sides with plastic wrap, or place in clear plastic bag.

Label the plastic cover with the date, location, and other helpful information.

Store in a cool place for later observation.

Compare insects on card with a field guide to insects.

INSECT SURVEYS - STICKY CARDS

Date Range: _____ to: _____

Location: _____

Notes: _____

Sketch of sticky card locations:

Sampling location: _____ Sample Number: _____

Insect Species Name	Number of Individuals

Sampling location: _____ Sample Number: _____

Insect Species Name	Number of Individuals

Sampling location: _____ Sample Number: _____

Insect Species Name	Number of Individuals

INSECT SURVEYS - Pitfall traps

Discussion

Insect pitfall traps can be used as a way of finding out what ground-dwelling insects might be occupying certain areas of your property. Many of these are decomposers, some are spiders, others of grubs of various kinds.

This simple process involves imbedding a cup at ground level, pouring a little liquid inside that will trap, kill and preserve the insect, and placing a cover over the top to keep out rain, leaves, and other debris.

Equipment

- Two sizes of plastic drinking cups
- Antifreeze
- Rubbing alcohol
- 4 to 6 inch squares of plywood or fiber-board
- Long nails
- Storage jars (optional)
- Trowel

Cost

Uunder $25.00.

Procedures

Purchase plastic cups of two sizes, such that the smaller one will sit inside the larger one, with the rims approximately level. The smaller, inside cup will be the removable part of the pitfall trap, while the larger one will stay in place, keeping the site intact.

Make 4 to 6 inch squares of plywood, or some other firm material, to serve as coverings over the pitfall trap. Pound one long nail into each corner of each square, leaving the points protruding below the board.

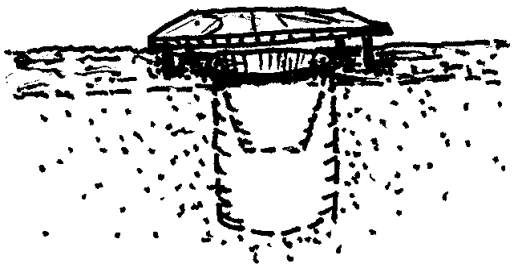
Select a location for the pitfall trap and use the trowel to dig a small hole, just big enough to place one of the larger cups in. Set the cup in the ground, exactly level with the ground, smoothing the surface of the soil to the edges of the cup. Place one of the smaller cups inside the cup in the ground.

Mix the rubbing alcohol with the antifreeze at a 1:1 ratio (1 cup with 1 cup). Pour ½ to ¾ inch of this mixture into the bottom of the smaller cup.

Take one of the squares of wood and place it over the pitfall trap. Push the nails into the ground just enough to leave about an inch of space between it and the ground. Wait between one day and one week and check to see what you have collected.

Time Estimate

Setting up one pitfall trap should take about 20 minutes. The wood squares can be cut ahead of time and done all at once for multiple traps.



INSECT SURVEYS - PITFALL TRAPS
SUMMARY CARD

Equipment

Two sizes of plastic drinking cups

Antifreeze

Rubbing alcohol

4 to 6 inch squares of plywood or fiber-board

Long nails

Storage jars (optional)

Trowel

Procedure Summary

Purchase 2 sizes of plastic cups that will "nest."

Make 4 to 6 inch wood squares to serves as pitfall trap covers.

Pound long nails into each corner, leaving pointed tips protruding underneath.

Dig a hole at your location to fit the larger of the two cup sizes.

Embed the cup at soil level, smoothing soil edges to cup edge.

Place the smaller cup inside the larger one.

Place cover over trap, pushing nails in the ground enough to leave approximately a 1 inch space.

Leave trap for 1 to 7 days, then collect and examine insects.

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http://www.ipm.ucdavis.edu/PMG/crops-acriculture.html Free Online UC IPM Pest Management Guidelines

http://www.anrcatalog.ucdavis.edu online catalog of UC publications or 1-800-994-8849

VII. EXAMPLE FARMS

When trying to decide what monitoring really means for you and how you can integrate it into the many other daily activities on a farm, it can often be helpful to hear about a farm or piece of land that may be similar to your own in some way. The following three example farms are taken from another RCD publication *Bring Farm Edges Back to Life!*

In that publication, conservation methods are discussed that can enhance and improve the natural resource conditions on your land, while decreasing problems such as weeds, and siltation, and increasing water use efficiency, habitat for beneficial insects and habitat for other wildlife. The methods and techniques discussed in that publication can go hand-in-hand with much of the monitoring methods described in this manual.

Each farm will be described as in that publication, listing some proposed conservation practices. The changes in farm management that go along with the implementation of conservation practices can be a good opportunity to try some monitoring techniques. Perhaps some of those described will also work for you.

Joe Flat Farms

160 acres of leveled row crop ground sloping east and south with irrigation canal on north border, county road on south border, and access road and head ditch on west border:

Potential projects on Joe's farm include:

- ½ mile of canal bank stabilization with permanent vegetation
- ½ mile of insectary hedgerow
- 1 acre-foot Tailwater pond with return system
- ½ mile of permanent roadside vegetation

Joe Flat can receive cost share support on all of the above projects if he enlists help from NRCS programs.

Potential monitoring activities on Joe's farm:

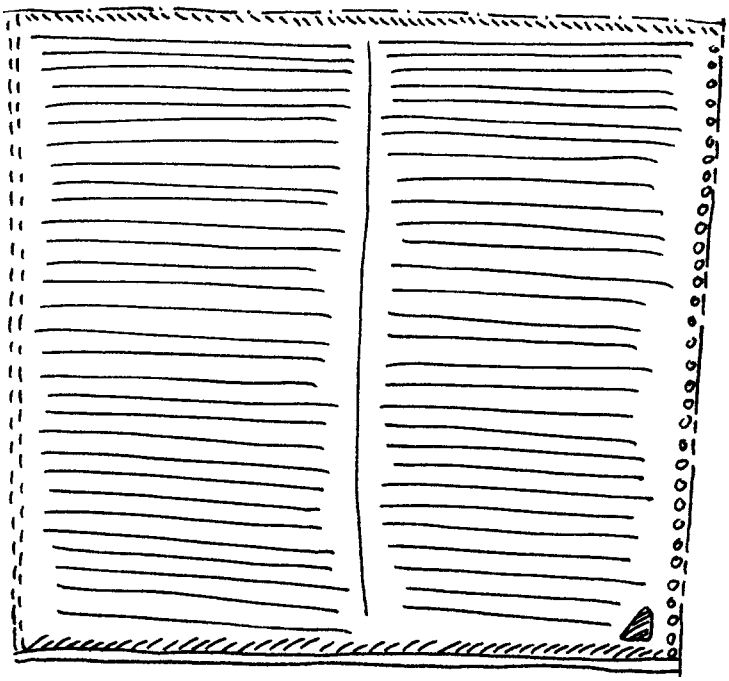
Canal bank stabilization with permanent vegetation:

1. During the growing season before the permanent vegetation is installed, measure the channel contours (Section: Water Sampling: Flow) in 3 places. At the end of the growing season, measure the contours again to get an idea of how much silt has accumulated during the growing season or how stable the bank sides are. Repeat the same process (2 times each year) for the next 3 to 4 years to see if the canal vegetation is holding the soil in place better. Compare this with a non-vegetated canal bank.

2. Every week or 2 weeks, starting in February or March and ending in late June, walk the canal bank at a discreet distance to observe for waterfowl nesting behavior (Section: Birds). At the same time, record any direct sighting of mammals, reptiles or amphibians, and observe for any other animal sign, such as scat, or tracks (Section: Mammals, or Section: Reptiles and Amphibians)

Insectary Hedgerow:

1. Before hedgerow installation, every 2 weeks during the growing season, take sweep net samples



(Section: Insects) in the weedy or other vegetation in the area to be planted. OR:

2. Place yellow sticky cards once a month hidden in the vegetation, collecting them after 7 -10 days.

Repeat this process during the 3 to 4 years following installation of the hedgerow.

One Acre-foot Tailwater Pond (may be recirculating or non-recirculating):

1. Consult your water district office on water delivery amounts per irrigation or per season, OR consult your records on bills paid for water deliveries, to determine if and how much water was saved by recirculating (Economics not discussed in this manual)

2. Once each month, walk around the pond to look for any animal sign: tracks, scat, feathers, dens, etc. (Section: Mammals, Birds, Amphibians and Reptiles)

3. Take water samples during an irrigation at the top of the field, the bottom of the field before the water enters the pond, and at the outlet of the pond, and have them analyzed by a professional laboratory for any components you think apply (Section: Water)

One-half mile of permanent roadside vegetation:

1. Two times during the growing season before the roadside vegetation is installed, use quadrats to count numbers of grassy weeds and/or broadleaf weeds per square foot (Section: Plants). Repeat this process during the 3 to 4 years after the vegetation is installed.

Beeswax Farms

160 acres, 20 of which is taken up by a creek bisecting the property. The rest of the acreage is leveled for row and field crops. The property is bordered on the north by a county road.

Potential projects on their farm include:

- ½ mile of permanent roadside vegetation
- ½ mile of creek channel improvement and riparian buffer strip
- 1-acre-foot Tailwater ponds (possibly installed with return system
- 2 ½-mile strips of insectary hedgerow

The owners of Beeswax Farms expect to substantially reduce their costs with help from NRCS programs.

Potential monitoring activities on Beeswax farms:

½ mile of permanent roadside vegetation:

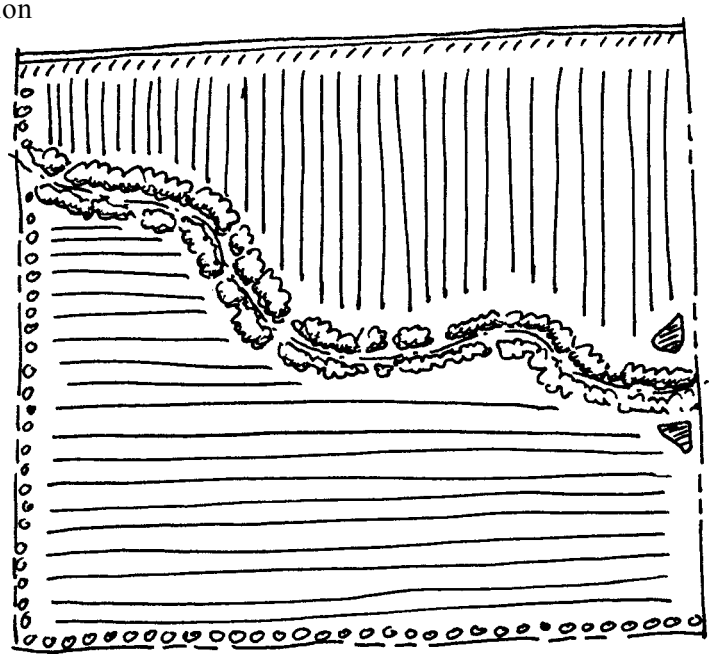
1. Two times during the growing season before the roadside vegetation is installed, use quadrats to count numbers of grassy weeds and/or broadleaf weeds per square foot (Section: Plants). Repeat this process during the 3 to 4 years after the vegetation is installed.

2. Before vegetation installation, every 2 weeks during the growing season, take sweep net samples (Section: Insects) in the weedy or other vegetation in the area to be planted.

½ mile of creek channel improvement and riparian buffer strip:

1. Before the creek channel improvements are made, measure the channel contours (Section: Water Sampling: Flow) in 3 places. After the work is completed, measure the contours again. Repeat this process annually to see if the new contours result in a more stable channel and/or reduce siltation.

2. Before creek channel changes are made or buffer is planted, take water samples, if safe, during storm runoff or irrigation and analyze for silt levels



(Section: Water). Repeat this process in subsequent years during storms or irrigations to check for improvement in levels of silt entering the waterway.

3. Before riparian buffer strip installation, and two times per year afterwards, (preferrably spring and fall), complete a walking mammal survey for tracks, scat or other sign, or set up track stations (Section: Mammal Surveys).

4. Do a spring next survey (Section: Bird Surveys)

Two 1-acre-foot Tailwater ponds (possibly installed with return system):

1. Consult your water district office on water delivery amounts per irrigation or per season, OR consult your records on bills paid for water deliveries, to determine if and how much water was saved by recirculating (Economics not discussed in this manual)

2. Once each month, walk around the pond to look for any animal sign: tracks, scat, feathers, dens, etc. (Section: Mammals, Birds, Amphibians and Reptiles)

3. Take water samples during an irrigation at the bottom of a field before the water enters the pond and at the outlet of the pond, and have them analyzed by a professional laboratory for any components you think apply, such as Nitrogen or silt (Section: Water).

Two ½-mile strips of insectary hedgerow:

1. Before hedgerow installation, every 2 weeks during the growing season, take sweep net samples (Section: Insects) in the weedy or other vegetation in the area to be planted. OR:

2. Place yellow sticky cards once a month hidden in the vegetation, collecting them after 7 to 10 days. Repeat this process during the 3 to 4 years following installation of the hedgerow.

3. Do a spring nest survey.

Hobby Farms

40 acres, a portion of which is leased out for agriculture, 10 acres of which is in pasture, house and barn, and fallow. The property faces a county road on its north side.

Potential projects on Hobby Farms include:

· ¼ mile of permanent roadside vegetation

· Wildlife pond

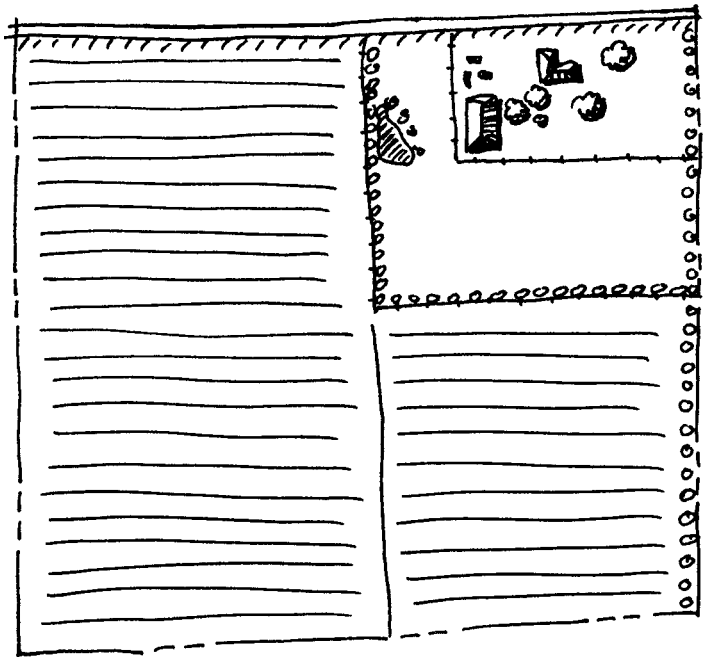
· 2¼ mile strips of insectary hedgerow

The Hobby family will spend much less on these projects if they get cost-share support from NRCS programs.

Potential monitoring activities on the Hobby's property:

1/4 mile of permanent roadside vegetation:

1. Two times during the growing season before the roadside vegetation is installed, use quadrats to count numbers of grassy weeds and/or broadleaf weeds per square foot (Section: Plants). Repeat this process during the 3 to 4 years after the vegetation is installed.



2. Before vegetation installation, every 2 weeks during the growing season, take sweep net samples (Section: Insects) in the weedy or other vegetation in the area to be planted.

3. Before planting of the roadside, place yellow sticky cards in the existing vegetation once each month, collecting them after 7 to 10 days. Repeat this process during the 3 to 4 years following installation of the hedgerow.

4. Do a walking survey for snakes and other reptiles.

Wildlife pond:

1. Before pond installation, walk the area to check for any residual animal sign, then once each month after installation, walk around the pond to look for any new animal sign: tracks, scat, feathers, dens, etc. (Section: Mammals, Birds, Amphibians and Reptiles)

2¼ mile strips of insectary hedgerow:

1. Before hedgerow installation, at least twice during the growing season, take sweep net samples (Section: Insects) in the weedy or other vegetation in the area to be planted. OR:

2. Hide yellow sticky cards in the vegetation once a month, collecting them after 7 to 10 days. Repeat this process during the 3 to 4 years following installation of the hedgerow.

3. Complete a spring next survey (Section: Bird Surveys).

CHART OF CONVERSIONS

LENGTH

1 inch = 2.54 cm
1 foot = 0.305 m
1 yard = 0.914 m
1 mile = 5,280 ft.
1 mile = 1.609 km
1 micron = 0.0000394 in
1 mm = 0.039 in.
1 cm = 0.394 in.
1 m = 39.37 in.
1 km = 0.621 mi.

AREA AND VOLUME

1 acre = 43,560 $ft.^2$
1 acre-foot = 325,829 gal
1 acre-foot = 43,560 ft^3
1 in2 = 6.452 cm^2
1 ft.2 = 0.093 m2
1 $mile^2$ = 640 acres
1 $mile^2$ = 2.589 km^2
1 ha = 2.471 acres
1 ha = 10,000 m^2
1 cm^2 = 0.155 in^2
1 cm^3 = 0.061 in^3
1 m^2 = 10.761 ft^2
1 km^2 = 0.386 mi^2
1 ft^3 (water) = 62.202 lbs @ 20°C = 7.4805 gal.
1 yd^3 = 27 ft^3

FLOW

1,000 gal/min (gpm) = 2.23 ft^3/sec (cfs)

LIQUID

1 oz. (liquid) = 29.573 ml

REFERENCES AND WEBSITES

Following is a list of references used for general supporting material for this manual.

REFERENCES

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7. Reid, Leslie M., Michael J. Furness. On the Use of Regional Channel-based Indicators for Monitoring. USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Laboratory, 1700 Bay View Dr., Arcata, CA 95521 and USDA Forest Service Six Rivers National Forest, 1330 Bayshore Way, Eureka, CA 93501

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WEB SITES

Agriculture Network Information Center (http://www.agnic.org). The Center, part of USDA's National Agricultural Library, includes directories of agriculture-related Internet information resources and agricultural experts as well as an on-line reference service.

Aquatic Insect Library http://osfl.gmu.edu/~avia/intro.htm The Aquatic Insect Library website will provide assistance in identifying benthic macro-invertebrates and/or information on bio-monitoring. Color illustrations, habitat, and general ecology of common specimens are available.

California Rivers Assessment (CARA), a computer-based data management system designed to give

resource managers, policy-makers, landowners, scientists and interested citizens rapid access to essential information and tools with which to make sound decisions about the conservation and use of California's rivers. Information available includes graphic and tabular data on selected California rivers, statewide and other river basin maps, resource documents and contacts. http://ice.ucdavis.edu/California_Rivers_Assessment.

The California Ecological Restoration Projects Inventory (CERPI) http://ice.ucdavis.edu/CERPI/. CERPI is a database of restoration projects in California. Its purpose is both to assist agencies involved in permitting restoration projects and to further the practice and science of restoration. CERPI focuses on implemented restoration projects that involve some aspect of an indigenous ecosystem. Project sponsors include the California Chapter for the Society for Ecological Restoration, U.S. Environmental Protection Agency, California Department of Conservation, and the University of California, Davis.

California Environmental Resources Evaluation System (CERES) http://ceres.ca.gov/ CERES is an information system developed by the California Resources Agency to coordinate electronic information about California's natural resources and to facilitate its access for the public over the Internet. Information available through CERES includes satellite imagery and photography; census, land ownership, vegetation and wildlife databases; and environmental impact reports.

The California Watershed Projects Inventory (CWPI) http://ice.ucdavis.edu/california_watershed_projects_inventory/ CWPI is a geographic information system database and Internet system providing access to a statewide inventory of cooperative restoration and conservation projects. It provides information on more than 300 watershed management, cooperative resource management program (CRMP), habitat conservation planning (HCP) and other regional conservation projects. Each project description includes information on location, participants, resources issues and data holdings. This project is funded jointly by the University of California, Davis and a variety of state and federal agencies

Centers for Water & Wildland Resources: Supports research and extension efforts in water and wildland-related issues throughout California. http://cwwr.ucdavis.edu/

Directory of Watershed-Related Projects and Programs in the Sacramento River Basin: Describes all of the current watershed related projects and programs in the Sacramento River Watershed. Also identifies Resource Conservation Districts (RCD) in the watershed. All of the projects in the Watershed Directory can be found on the Natural Resources Project Inventory (NRPI) web site, http://endeavor.des.ucdavis.edu/nrpi/, which was created and is maintained by the Information Center for the Environment. 300pp. Cost: $18.00. Contact: ICE, 530-752-0532 or info@ice.ucdavis.edu

Earth Natural Resources and Environmental Monitoring. About the Council, research information, symposiums. http://www.stacresearch.org/stac/meet_proto/mee…iscipline4.html

Farm-A-Syst and Home-A-Syst (http://www.wisc.edu/farmasyst). These national programs, housed at the University of Wisconsin, help farmers and homeowners conduct self-assessments of potential hazards to well water and other environmental risks on their property. State contacts are provided.

Forest Health Monitoring: Fact Sheet Series: Soil indicators. http://willow.ncfes.umn.edu/fnm_fact/soils.htm

Forest Products Laboratory. Dedicated to effective and environmentally sound wood utilization practices and the improved performance of forest products, for the benefit of all users of forest products and the people of California. http://www.ucfpl.ucop.edu/

Integrated Hardwood Range Management Program: http://danr.ucop.edu/ihrmp/

Internet Guide to Watershed-related Websites: A compilation of watershed-related websites, intended to aid those interested in utilizing he existing resources available on the internet and to reduce their time spent "surfing." All sites have been categorized into six different types. The Internet Guide is also available as an electronic file of bookmarks

(Netscape Navigator, version 3.01). 24 pp. Cost: no charge. Contacts: Michelle McGraw, 916-255-3100 or mcgrawm@rb5s. swrcb.ca.gov: Val Connor 916-255-3111 or connorv@rb5s.swrcb.ca.gov

Kerr Center for Sustainable Agriculture (http://www.kerrcenter.com). This organization focuses on ecologically and economically sound farming strategies. Select "Newsletter" to browse current and back issues of the Center's newsletter and "Publications" to see a publications catalog.

Mapping and Monitoring of European Grassland and Non-Forest Natural Vegetation. http://www.emap.sai.jrc.it/firs/theme6.html

Monitoring and Natural Resource Management. Application of long-term monitoring to natural resource management. http://www.umt.edu/biology/flbs/research/monitoring/default.htm

The National Watershed Network State/Regional Watershed Contacts Directory http://www.ctic.purdue.edu/KYW/KYW..html, includes: regional EPA NPS/NRCS liaisons, state contacts for Water Quality, Soil/Water Conservation, State Forester, USDA NRCS, UCCE, USDA FSA, USGS, USFWS. Contact CITC @ 765-494-9555, ctic@ctic.purdue.edu, or orders: http://www.ctic.purdue.edu/Catalog/Catalog.html.

Natural Resources Conservation Service http://www.nrcs.usda.gov

NPS Inventory and Monitoring Program – Natural Resource Inventories 1. Natural resource inventories. Baseline natural resource data from the national parks. http://www.aqd.nps.gov/nrid/im/binv1.htm

Natural Resource Monitoring Network Home Page. About the network, monitoring information, discussion page and links. http://www.sheppstc.org.au/environment/nrmn_web/nrmn_und.html

Small Farm Resource Center (http://www.farminfo.org). This organization disseminates information useful to people with small farms or rural property. Much of the information comes from small farmers.

UC IPM. http://www.ipm.ucdavis.edu. UC IPM pest management guidelines and pest notes: color photos and diagrams

UC Davis. http://www.ucdavis.edu. Main website provides access to many departments.

California EPA. http://www.calepa.cahwnet.gov. The website for the California Environmental Protection Agency, with regulatory information and links to the Air Resources Board, the Dept. of Pesticide Regulation, the State Water Resources Control Board, and others.

USDA National Commission on Small Farms (http://www.reeusda.gov/agsys/smallfarm/ncosf.htm). Access this website for general information on the Commission as well as 'A time to Act: A Report of the USDA National Commission on Small Farms (January 1998). The Commission's report, which includes 8 policy goals and 146 recommendations, can be downloaded and printed.

Volunteer Water Monitoring website. http://www.epa.gov/reg3wapd/3wp13/volmon/pl.htm. This website helps volunteers with their role in water protections. Topics cover: Volunteering, water quality and quantity, biological quality, watershed/habitat, EPA resources, water monitoring, government programs, methods, locating your watershed, water snapshots, conferences, beyond monitoring and assessment, pollution prevention, restoration. Hotlinks to National Oceanic Atmospheric Administration, national postings of methods manuals, national directory, national newsletter, etc.

Washington State University's College of Agriculture and Home Economics Information Department (http://www.caheinfo.wsu.edu). Select "Publications" to search for a bulletin or video title or for a subject by keyword. An on-line catalog of publications includes listings under agriculture, animals, community, family and home, forestry, plants and other topics.

The Watershed Information Technical System (WITS) http://ceres.ca.gov/watershed/.is a new information site developed by the California Resources Agency as a focused application of the CERES network. WITS provides a single-point access to a wide variety of data for watershed planning, management, restoration and monitoring.