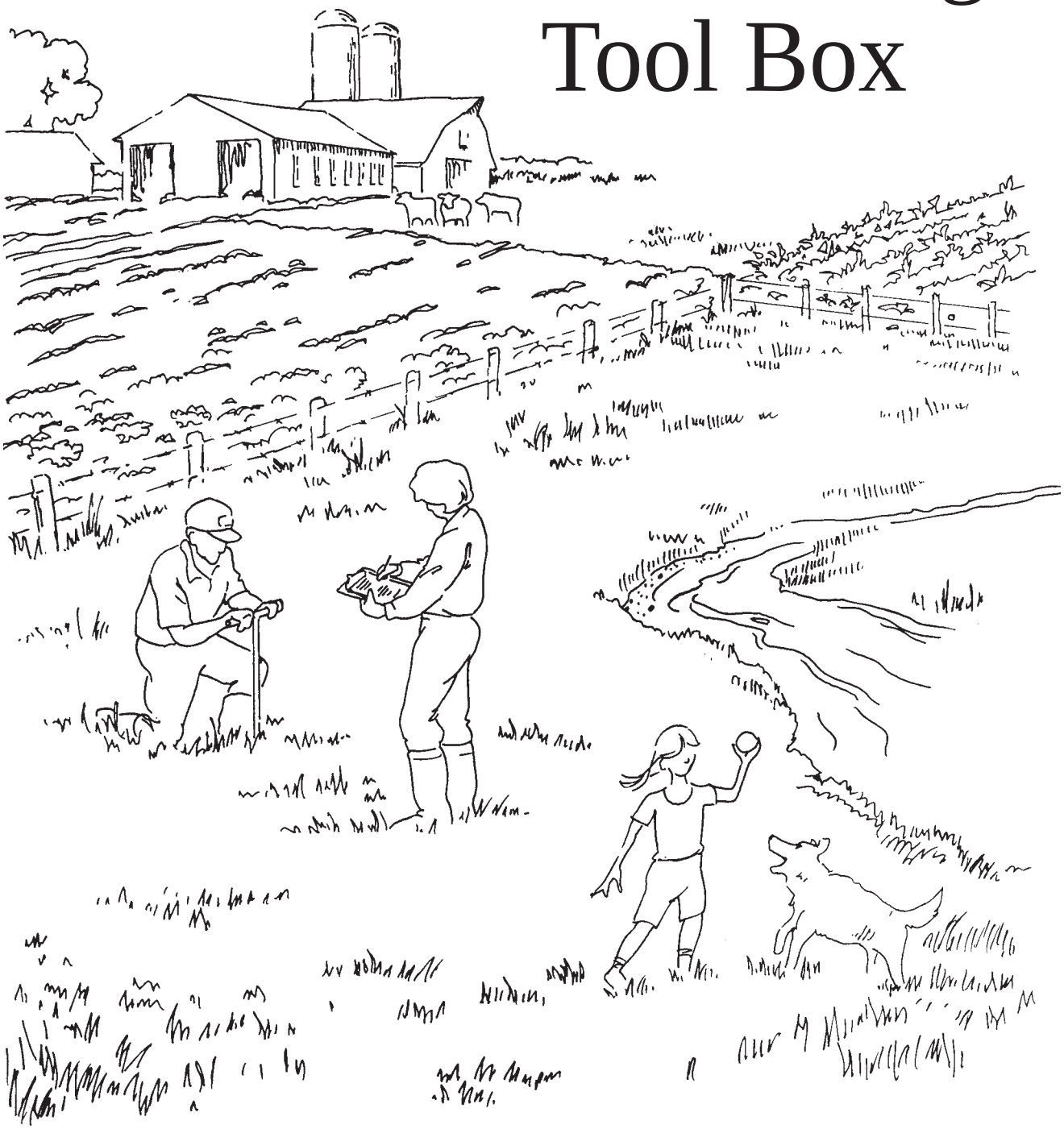
The Monitoring Tool Box



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Making the Most of Your *Tool Box*

Farm families use many ways to measure the success of their farm:

- *Are our crop yields, or pigs per sow, or milk production per cow where we think they should be?*
- *Are we getting the return per acre we want? Is our net income sufficient to support our family's needs and goals?*
- *Is our farm a nice place to live? Do we enjoy our work? Do our kids want to take over the family farm?*
- *Are we being good stewards of the land and water?*
- *Are we good neighbors and good community members?*

Questions like these are at the heart of *The Monitoring Tool Box*. To appreciate what this workbook can do for you, consider the story and work behind its development.

The Story Behind *The Tool Box*

CHAPTER CONTENTS

In the early 1990s, several farmers connected with the Land Stewardship Project began talking with each other about changes they were making on their farms. These changes stemmed from the farmers' use of a more holistic, or whole farm, approach to farm management and centered around management intensive grazing.

A Whole Farm Management Approach

Three key parts of this whole farm approach to management sparked what has eventually become *The Monitoring Tool Box.*

Each farm family first set clear goals for their farm focusing on quality of life values, the profitability of the farm, and the environmental health of their land. Along with making good profits, the farmers identified issues like having fun, reducing soil erosion, improving the quality of their streams, improving animal health, and making sure their farms were welcoming to people and wildlife as important measures of success.

Based on these goals, a management plan for making changes on the farm was drawn up. From there, the farmers planned to monitor the effects of their management decisions to help them judge whether or not particular practices, like management intensive grazing, were leading them to their stated goals. If the evidence from monitoring did not support their goals, then they would figure out what they needed to change to get things moving in their desired direction.

Questions About Monitoring

The farmers' discussions with each other included questions about monitoring, such as:

- How do we measure progress in meeting goals like reducing erosion or making our farms a welcoming place for people and wildlife?
- We think our management changes are having positive effects on the environment. What kinds of things do we check for to make sure they really are beneficial?
- Are there ways to monitor farm profitability that take into account benefits to our rural communities?

Behind these questions was the fact that typical ways of monitoring the success of a farm tended to look only at productivity and profitability. The tools for looking at the whole picture of a farm were not readily available.

The farmers then invited various resource specialists into the discussions to talk about possible whole farm monitoring tools. The initiative called the **Biological, Financial and Social Monitoring Project**—referred to as "the Monitoring Project"—grew out of these joint discussions.

The Monitoring Project

In 1993, a diverse group of people—farmers, nonprofit organization staff, university researchers, government agency personnel, and private consultants—came together to form the Monitoring Project team. As a whole, the team brought together experience in soil science, plant pathology, wildlife ecology, hydrogeology, farm management, water quality, rural sociology, animal production (beef and dairy), crop production, agricultural economics, stream ecology, plant biology, on-farm research, management intensive grazing, and Holistic Management.

The Monitoring Project team's main objective was to develop a process for on-farm monitoring that allowed farm families to assess a variety of physical, chemical, biological, financial, and social measures in their quest to create and sustain a successful farm. Specifically, the team sought to ***document*** the types of observation and monitoring methods the farmers were already using, ***supplement*** these methods with ones developed from the experience of the other team members, and ***share*** all of these methods with as many others as possible.

The idea of a "monitoring tool box" was conceived as a way for the team to share its work with farmers and other professionals and to help these folks more effectively monitor changes on farms of all kinds.

The Monitoring Tool Box was also envisioned as a discussion starter for farmers and their neighbors, agricultural consultants, educators, researchers, and others concerned with the impact of farming on the environment and society. As people shared what they were learning with each other, the hope was that more and better monitoring methods could be identified and shared.

The First Edition

In its attempt to develop a process for on-farm monitoring to measure progress toward holistic goals, the Project's groundbreaking work was necessarily focused.

A Manageable Focus

In order to make the Project manageable, the greatest part of the team's efforts centered on finding tools for monitoring the impact of a specific farming practice (management intensive grazing) on the environmental health of a farm. The specific environmental indicators studied included birds, frogs and toads, soils, and streams.

Finding ways to help farm families set and monitor goals—both for the farm and for their personal goals—also received the team's attention, with particular concern given to quality of life issues. The team's work on finances focused on ways to determine farm sustainability using financial data.

For Farms of All Types and Sizes

Farms of all types and sizes can benefit from the process of monitoring. Lyle Wolle of Truman, Minnesota, figured this out after reviewing a draft copy of the *The Monitoring Tool Box* :

> Monitoring is not a word I commonly use in my life and its application to the whole life of the farm took me off guard. At first I felt *The Monitoring Tool Box* was a little too general for the above average size farms located on the plains of Minnesota. I do not have any creeks or pasture! I had to study and understand what 'monitor' really meant to me.
>
> As I began to understand more of the monitoring concepts, I got more excited. This subject actually hits very close to home. I need to reevaluate my farming enterprise and I was only really using the financial approach. *The Tool Box* started raising my consciousness about my quality of life and how it is affected by all the other subjects monitored. Are we all business or a family too? Aren't we also socially intertwined with the land? I feel we are but that we deny most of those feelings. God always provides opportunities. Is this one of them?

A Powerful Way to Act

The Monitoring Project offered participants from diverse perspectives a context within which to build mutual respect, understanding and a common vision. The following comments by two Project Team members capture the essence of this positive side effect:

Dan French (dairy farmer):

I felt like I could trust Larry because when we talked about improving the stream, he was willing to work in a way that would be profitable. We were both challenged by this. What has occurred amongst this team is a breakdown in barriers between farmers and agencies, as well as an openness to using new management tools.

Larry Gates (Minnesota Department of Natural Resources):

I used to be involved in an awful lot of contentious resource issues filled with polarized arguments—a lot of we-they, you-them. And I was good at it.

But as far as good stuff getting accomplished, that was rare. I knew we had to do something about that in order to address big issues. The people on this team are generous, talking with one another, considering any idea, welcoming anybody to come in and discuss it. It's everybody's issue; it's everybody's problem. You see agreement on describing a kind of future. Speaking for the participating agencies, we embrace the opportunity to work directly with farmers again. This is a powerful way to act."

In addition, the topics of energy use, financial wealth generation, livestock health, pests and pesticide usage, and vegetation and plant diversity were studied; these will be the subject of upcoming materials. (For an overview of the Monitoring Project, see the video *Close to the Ground*, included with your Tool Box.)

A Work In Progress

Consider this first edition of *The Monitoring Tool Box* as "a work in progress." Along with developing more chapters, the plan is to allow *The Tool Box* to evolve and grow as farm families and others use it. And so, not only is your feedback welcome, it is vital to the ongoing development of the cooperative learning process originally envisioned by the Monitoring Project team.

Feel free to contact the Land Stewardship Project with feedback on the successes and challenges spawned from your work with *The Tool Box*, as well as with questions and requests for more information or assistance. Meanwhile, let this first edition introduce you and your family to the general idea and process of monitoring.

Monitoring and Whole Farm Management

As the story behind *The Monitoring Tool Box* clearly indicates, monitoring does not take place within a vacuum. It happens within a context of goals and plans. Most people have goals whether they are aware of them or not—things that are important to them, things they want to do or be—as well as some plan of how to achieve these goals. Likewise, most people keep track of their progress toward their goals in some way, even if just subconsciously.

The Tool Box builds upon this common experience and encourages you to see monitoring as an activity that is best done within the context of clear goals and a well-defined, goal-based management plan. It can also be a useful, everyday tool that enhances your management skills and your enjoyment of life, as

well as a springboard for creative, adaptive management.

Clear Goals and Well-Defined Plans

Monitoring can involve all kinds of activities, from checking for soil compaction to keeping a daily journal of insights and personal experiences. But, monitoring for its own sake is simply busywork. **To be an effective monitor, you will want to be clear about why you are gathering this information.**

In other words, monitoring is more worth your while if you do some prior work. The extent of that work is completely up to you. If curiosity is enough of a motivator for you, start at that level. The prior work of the Monitoring Project farmers involved a fairly comprehensive approach, one that included the following steps:

1. identifying all of the farm's resources including people (family, neighbors, local community), finances, land, and other physical resources;
2. setting clear goals that account for quality of life, profitability, and stewardship of the land;
3. establishing and implementing a plan of action in which management decisions are based on the identified goals and on what the environment can sustain; and
4. monitoring plans and actions to see if they are moving the farm in the desired direction.

This approach to whole farm management appealed to the Monitoring Project farmers because it offered them a way to manage their people, land, and money resources in a way that takes into account the interrelationships among these resources.

If you are unfamiliar with this holistic, goal-driven approach and would like to learn more about it, contact either the Land Stewardship Project or the Center for Holistic Management. The addresses for both are listed in the resources section at the end of this chapter.

Be assured, however, that even if you are unfamiliar with whole farm management, monitoring can still be a worthwhile activity for you. In fact, many of the tools in this workbook that apply to step four can also actually help you get started on the first three steps.

How to Use Your *Tool Box*

After you have read through this chapter, review the following chapter on "General Tools for Monitoring." It outlines some basic tools that can help you develop good observation skills and document your monitoring activities.

Then, leaf through all the specific monitoring chapters to get a feel for what they have to offer, and encourage other members of the family to do so as well. Each chapter includes

- *a number of monitoring tools related to the topic,*
- *suggestions about when to monitor,*
- *a list of materials needed,*
- *a cost estimate,*
- *an estimate of the time required, and*
- *a list of additional resources about the topic.*

At this point, decide how to proceed. At first you might just focus on the topics or activities that most interest you or your family. Or, if a particular topic or activity seems to make the most sense given your farming operation or family situation, start with that one. As your familiarity with the monitoring process grows through experience, you can modify or expand your game plan.

Most of all, approach the process with a sense of fun and openness.

How *The Tool Box* Can Help

Here are some ways *The Monitoring Tool Box* can help get you started on steps one through three of whole farm management:

Resource Inventory and Planning

Most, if not all, of the tools in this workbook can help you size up your farm's existing resources, determine problems and constraints, reveal untapped resources, and stir up innovative possibilities. All this information can then be used to clarify your goals and form a workable plan of action that moves your family closer to its vision.

Such a plan might include specific actions or practices that take into account considerations like the following:

- efficient cycling of nutrients
- water quality and soil health
- healthy crops, healthy livestock, and biological diversity
- improved wildlife habitat
- stability and resilience in the face of variable weather conditions
- pest and pesticide management with an eye toward minimizing adverse environmental impacts and pest problems
- tillage and other field operations that enhance soil and water resources
- processing and marketing options that add value to farm produce
- economic viability and financial independence
- generational transfer of the farming operation
- a happy, loving family life
- the impact of farm management decisions on the community at large

Once considerations like these are worked into a plan of action, they become the "yard sticks" or guidelines for monitoring activities.

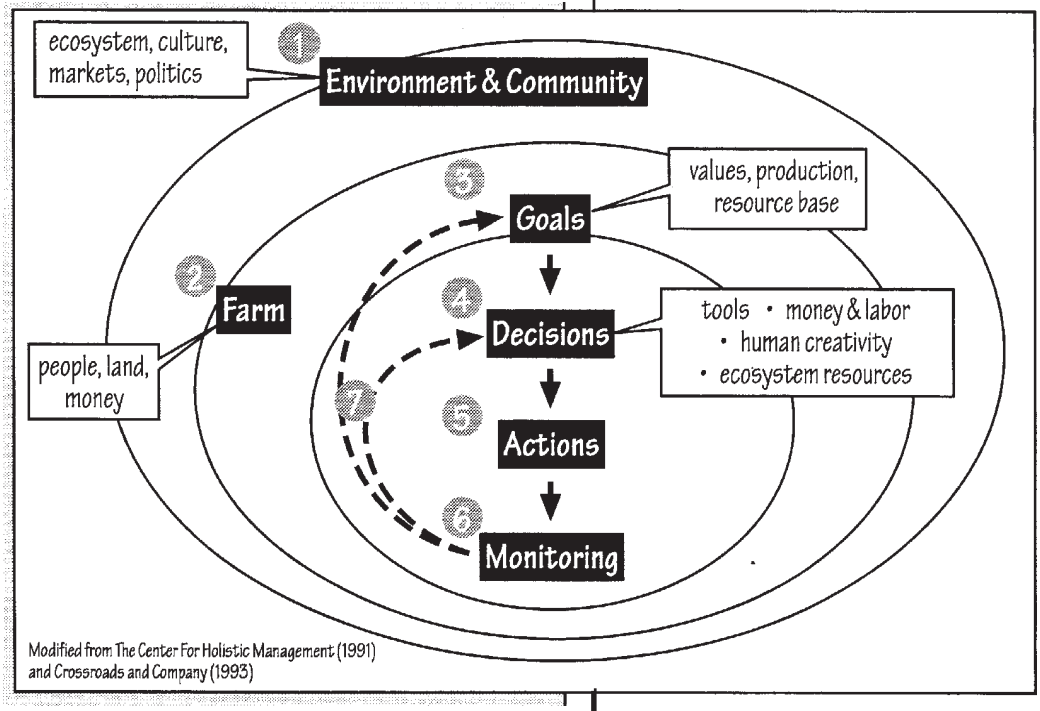
Setting Goals

Ultimately, the purpose of setting goals is to make sure that what you are doing (or where you are heading) with your life and on your farm fits with your core values and meets your needs and desires. If you find this is not the case, take the opportunity to reevaluate your situation. Success and inner peace depend upon this consistency.

The chapter "Monitoring Quality of Life" offers tools that can help you and your family get started thinking about your quality of life values and how they shape your goals for the farm and the way you manage your farm. When all family members join together to create a quality of life vision, they form a powerful base from which to acheive their personal goals and their goals for the farm.

Managing Holistically

1. A farm does not exist within its own isolated world; it is connected to and dependent upon the greater community and the environment for its well-being.
2. A farm is made up of people, land, and financial resources; all these resources depend on and support each other.
3. Holistic goals for the farm take into account the values of all the people directly involved, the need for the farm to be profitable, and the needs of the farm's resource base so it can support profitability and the desired quality of life.



4. Decisions and plans flow directly from the goals set by the farm family. All available options, tools, and resources are considered when creating a plan.
5. Plans are put into action and consist of the mix of options, tools, and resources that seem most likely to achieve the desired goals.
6. Actions are monitored to see how they impact the people, land, and financial resources of the farm. "Is our plan helping us to achieve our goals?"
7. Based on the information from monitoring, *previous decisions* are reevaluated, *new plans* are made and put into action, and then monitored. From time to time, goals may also need to be reviewed and modified based on what is learned from monitoring.

A Vital, Everyday Tool

Within a whole farm, goal-driven management framework, regular monitoring can give you those early warning signals that things are not going according to your plan. This allows you to take steps to make changes before things get too far off course. And, if plans seem to be going in the right direction, monitoring helps you to concretely see this progress.

In essence, monitoring itself is simply a tool, albeit an invaluable one. The farmer members of the Monitoring Project stress this point. They all feel that regular, sometimes even daily, monitoring throughout the year provides them with the highest return on their investment, both in terms of profit and enjoyment.

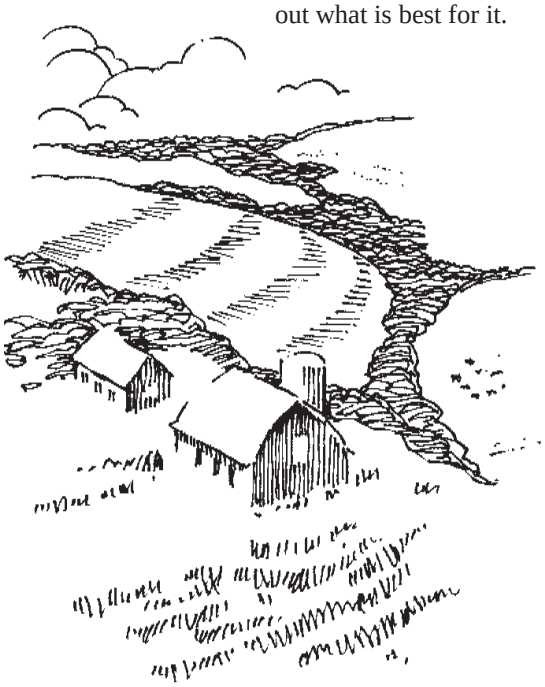
Through the regular practice of monitoring you can also begin to cultivate a general and ever-deepening awareness of yourself, the people you love, and your living environment. Of the various reasons to make monitoring a deliberate, regular activity in your life, this may be the most rewarding.

A Creative Springboard for Management

Ideally, the information gathered from monitoring alerts you to when, where, and how your goals and plans need to change. In this way, monitoring can act as a springboard for finding creative ways to adapt your management.

Addressing the issues and problems identified by monitoring means that you need to understand the meaning of this information within the context of your farm. This may take some additional effort or investigation on your part. For instance, a particular observation, such as the absence of earthworms in your fields, could mean a number of different things. *The Monitoring Tool Box* provides some insights as to the meaning of different observations, but it is by no means comprehensive.

This workbook also purposely avoids laying out prescriptions on how to adapt your farm's management plan in light of the findings a certain monitoring tool might unearth. Again, the specifics of your farm's situation requires that you take a creative, proactive approach to figuring out what is best for it.



Sustaining the Farm

Although each of the farm families participating in the Monitoring Project has their own goals based on the land and people involved, they share some common principles of sustainability. These principles guide them in their goal-setting and decision-making process.

Stewardship. The principle of stewardship means leaving the land in better shape for future generations. It requires assessing current farming practices to determine if they are improving or degrading the environment, both on the farm and off. The Project farmers express this principle in different ways. One family sees it as developing a long-term vision of what their farm landscape should look like. Another family is intent on keeping a viable farm in the family for future generations. A third family wants their farm and family to be a good example of stewardship for others in their community.

Livestock are an important part of a healthy agricultural system. The Monitoring Project farmers insist that, with proper management, livestock can be a useful tool to restore the vitality of the land. They also agree that true wealth comes from the sun (solar wealth). One of their primary goals as farmers is to capture and convert the sun's energy into products that are useful to humans while maintaining or improving their resource base. Management intensive grazing of their livestock allows these farmers to achieve this goal.

A healthy ecosystem is the basis for a sustainable farm. The Project farmers recognize that biodiversity—in both flora and fauna—plays an important role in a healthy ecosystem. They also see interconnections between healthy soil, healthy plants, and healthy people and animals. And so, they are committed to working with natural processes for water and nutrient cycling and for pest control, and to reducing reliance on pesticides and other high-cost, energy-intensive approaches that substitute for natural processes.

Farming can be enjoyable and profitable and still preserve the resource base. For the Project farmers profitability, rather than production, determines their farm's viability. This focus on profitability keeps them mindful of sustaining the needs of their land and animals, as well as their own needs individually and as a family. Purposely focusing on family goals helps provide a more enjoyable quality of life for everyone in the family.

Making the Process Work

So far, this chapter has outlined a full hand of activities connected to monitoring:

- setting whole farm goals
- developing management plans based on these goals
- deciding what to monitor and how
- doing the actual monitoring
- adapting and changing management plans and goals

Addressing these activities is most workable if you start at a place and level with which you feel comfortable. The interconnected nature of these activities means that each of them can—eventually, and with persistence and openness on your part—lead you to the rest.

The analogy of learning to swim fits well here: at some point you need to get into the water. Some people feel comfortable just jumping into the deep end from the start. Others need to sit and dangle their feet in the water for a while before they even feel comfortable slipping into the shallow end. Trying some of the monitoring tools offered in this workbook may be a good way to "get your feet wet!"

Likewise, just as most people would not dream of learning how to swim on their own, learning the skills of monitoring and whole farm management is best done with a little help.

Community Resources

Many resources are available to you within your community—both people and information. Take some time to think of who or what might be available within your local community and make good use of these valuable gifts. Also, review the "Additional Resources" section at the end of each *Tool Box* chapter for suggestions on resources that can enhance your monitoring experience.

Join Up With Others

One powerful way to tap into your community's resources is to join up with other people who are also interested in whole farm monitoring. The farmer members of the Monitoring Project team stress that the likelihood for success in monitoring greatly increases by working with others. Not only does working with others increase your monitoring skills, it can also greatly enhance your creativity and enthusiasm when it comes to identifying and making the management changes needed to meet your goals.

You could join forces with a few family members, friends, or neighboring farmers. Other possibilities include the local ag or science teacher, school groups, youth clubs like 4-H, or environmentally concerned townspeople. An agency staff person from the Department of Natural Resources, the Department of Agriculture, Cooperative Extension Service, the Natural Resources Conserva-

tion Service, or the U.S. Fish and Wildlife Service could also be a valuable addition to your own "monitoring team."

Contact the Land Stewardship Project for help in linking up with others or forming a local monitoring group.

Be Prepared to Learn and Grow

Monitoring can expand your awareness of yourself, your family and community, your farm's resources, and the natural world. It can stimulate creativity and improve problem solving skills. And, it can make life more interesting and fun.

The process can also challenge your assumptions and expose weaknesses in your way of thinking or doing things. Be prepared for both sides of the coin and allow yourself to learn and grow from the experience.

Additional Resources

To further explore goal-driven management, whole farm planning, and general information on monitoring, use the resources listed below.

Publications

Many of the following can be obtained from your local library through the interlibrary loan system, or purchased through your local bookstore.

Holistic Resource Management, by Allan Savory. (Washington, DC: Island Press, 1988.)

One of the most comprehensive texts on holistic goal setting, planning, and decision making. A revised edition is due to be published in the fall of 1998.

Holistic Resource Management Workbook, by Sam Bingham with Allan Savory. (Washington, DC: Island Press, 1990.)

The practical companion to the *Holistic Resource Management* textbook. Contains a wealth of information on financial, biological and land planning and monitoring. Includes a number of useful forms and observation sheets. An excellent resource.

Permaculture: A Practical Guide for a Sustainable Future, by Bill Mollison. (Washington, DC: Island Press. 1990.)

A comprehensive, thought-provoking guide for working with nature to design and maintain permanent, agriculturally productive ecosystems that mirror the diversity, stability, and resilience of natural ecosystems.

The Fifth Discipline: The Art and Practice of the Learning Organization, by Peter M. Senge. (New York: Doubleday, 1990.)

Describes how to build learning organizations—organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together.

The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization, by Peter M Senge, Art Kleiner, Charlotte Roberts, Richard B. Ross and Bryan J. Smith. (New York: Doubleday, 1994.)

A pragmatic guide to building a shared vision, reinventing relationships, team learning, being loyal to the truth, developing personal mastery, designing a dialogue session, and more.

The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change, by Stephen R. Covey. (New York: Fireside/Simon and Schuster, 1990.)

Presents a step-by-step, principle-centered approach for managing one's personal and professional life that gives one the security to adapt to change, and the wisdom and power to take advantage of the opportunities that change creates.

The 10 Natural Laws of Successful Time and Life Management: Proven Strategies for Increased Productivity and Inner Peace, by Hyrum Smith. (New York: Warner Books, 1994.)

Outlines of a view of management—whether of time, life, farm or business—focused on making sure daily activities reflect core values. Smith's "Reality Model" is particularly helpful for seeing the direct connection between beliefs and actions.

Whole Farm Planning: Combining Family, Profit, and Environment. (St. Paul, MN: Minnesota Institute for Sustainable Agriculture and the University of Minnesota Extension Service, 1998.)

A practical guide to doing Whole Farm Planning (WFP). Outlines the four action steps involved, including how to develop a vision for your farm. Describes several WFP tools and provides a visual comparison guide to show the strengths and weaknesses of each suggested tool. Also suggests resources to contact as you plan. (Available from U of MN Extension Service Distribution Center: 1420 Eckles Avenue, St. Paul, MN 55108-6069. Or, call (800) 876-8636 or fax (612) 625-6281. Ask for publication number BU-6985.)

Newsletters

GRAZE is a monthly publication "by graziers, for graziers" with a strong focus on but not limited to the Midwest. All things grazing (mostly cows, some sheep) are approached from practical standpoints and the experiences of real people, covering economics, agronomics, ecology, herd and sward health, and the ever-thoughtful opinions of editor Joel McNair. Contact information: GRAZE, POB 48, Belleville, WI 53508. Phone: 608-455-3311; fax: 608-455-2402; e-mail: graze@ticon.net; website: www.grazeonline.com. Call for subscription rates.

Holistic Management Quarterly. Published by the Center for Holistic Management: 1010 Tijeras NW, Albuquerque, NM 87102. (505) 842-5252. E-mail: chrm@igc.apc.org; web site: www.igc.org/holisticmanagement. $25/year, 4 issues.

The Land Stewardship Letter. Published by the Land Stewardship Project (LSP): 2200 4th Street, White Bear Lake, MN 55110. (651) 653-0618. E-mail: bdevore@landstewardshipproject.org; website: www.landstewardshipproject.org. $35/year, four issues a year.

The Whole Farm Planner. Published by the Minnesota Project: 1885 University Avenue W, #315, St. Paul, MN 55104. (651) 645-6159. Free; also available on the Minnesota Project's website: www.mnproject.org.

Organizations

Center for Holistic Management is nonprofit organization working to restore the vitality of communities and the natural resources on which they depend. The Center offers courses and resources in Holistic Management and helps communities and families practice goal-based planning and decision making. The Center can be contacted at 1010 Tijeras NW, Albuquerque, NM 87102 or by telephone at (505) 842-5252. E-mail: center@holisticmanagement.org; website: www.holisticmanagement.org

Land Stewardship Project (LSP) is a nonprofit, membership organization whose goals include fostering an ethic of stewardship for farmland, promoting sustainable agriculture, and developing sustainable communities.

LSP is committed to building upon the initial work of the Monitoring Project. For more information, contact any one of LSP's three offices:

• Twin Cities office: 2200 4th Street, White Bear Lake, MN 55110. (651) 653-0618.

• Southeast Minnesota office: 180 E. Main St., P. O. Box 130, Lewiston, MN 55952. (507) 523-3366.

• Western Minnesota office: 301 State Road, Suite 2, Montevideo, MN 56265. (320) 269-2105.

The Land Stewardship Project is offering training and support services for communities and institutions that are interested in creating a sustainable future for farming. We offer an introduction to the Farm Beginnings© training model, explain the nuts and bolts of the program and offer tools to gauge the potential for holding a similar program in your community.

Other Minnesota organizations actively involved in whole-farm planning networks include the following:

Minnesota Department of Agriculture's Energy and Sustainable Agriculture Program (ESAP) publishes the annual ***Greenbook***, a compilation of innovative activities of farmers, researchers and educators involved in the Sustainable Agriculture Grant Program. A good resource for possible management ideas. For more information about the *Greenbook*, contact Jeanne Ciborowski, 651-201-6217. Address: 625 Robert Street North, Saint Paul, MN 55155.

Sustainable Farming Association (SFA) has a number of local chapters in Minnesota. The SFA and other grass-roots farmer organizations such as Practical Farmers of Iowa are invaluable sources of information and support. These organizations have field days and workshops where holistic farming approaches are presented and discussed. For the SFA chapter nearest you contact Mary Jo Forbord, Executive Director, 29731 302 Street, Starbuck, MN 56381; phone: 866-760-8732; e-mail: mforbord@sfa-mn.org; website: www.sfa-mn.org.

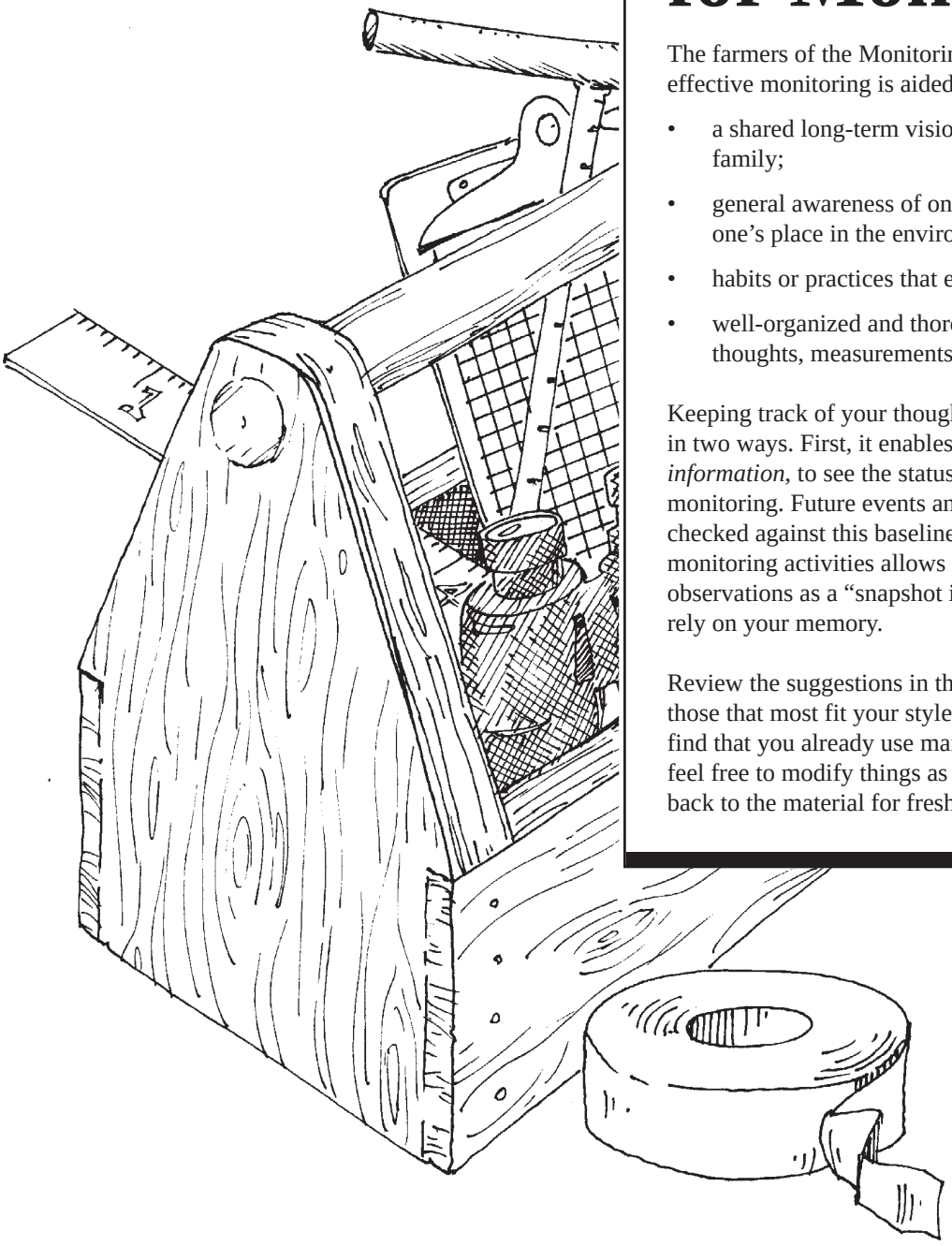
The Minnesota Project addresses a broad range of environmental issues of concern to rural communities. These include sustainable agriculture and water quality, renewable energy development, community sustainability/

small town planning development, river protection and advocacy, and sustainable forestry. The Minnesota Project can be contacted at 1885 University Avenue West, #315, St. Paul, MN 55104. (651) 645-6159; e-mail: mnproject@mnproject.org; website: www.mnproject.org.

Articles

"CASE STUDY: Creating Habitat on Farms—The Land Stewardship Project and Monitoring on Agricultural Land" is an article by Brian DeVore that appeared in the Spring 2003 edition of ***Conservation In Practice*** (Vol. 4, No. 2), a publication of the Society for Conservation Biology. The article describes the work of the Monitoring Team and the development of the *Monitoring Tool Box*. The article can be found at www.landstewardshipproject.org/pr/04/itn_040201.html.

General Tools for Monitoring



The farmers of the Monitoring Project team found that effective monitoring is aided by

- a shared long-term vision or goal for your farm and family;
- general awareness of one's environment as well as one's place in the environment;
- habits or practices that enhance observation skills; and
- well-organized and thorough documentation of thoughts, measurements, and observations.

Keeping track of your thoughts and observations helps you in two ways. First, it enables you to establish a *baseline of information*, to see the status of things at the onset of monitoring. Future events and observations are then checked against this baseline. Second, documenting monitoring activities allows you to capture thoughts or observations as a "snapshot in time" so you do not have to rely on your memory.

Review the suggestions in this chapter carefully, then try those that most fit your style and your farm. You may even find that you already use many of the ideas presented. Also, feel free to modify things as needed and occasionally refer back to the material for fresh ideas and inspiration.

Documenting Tools

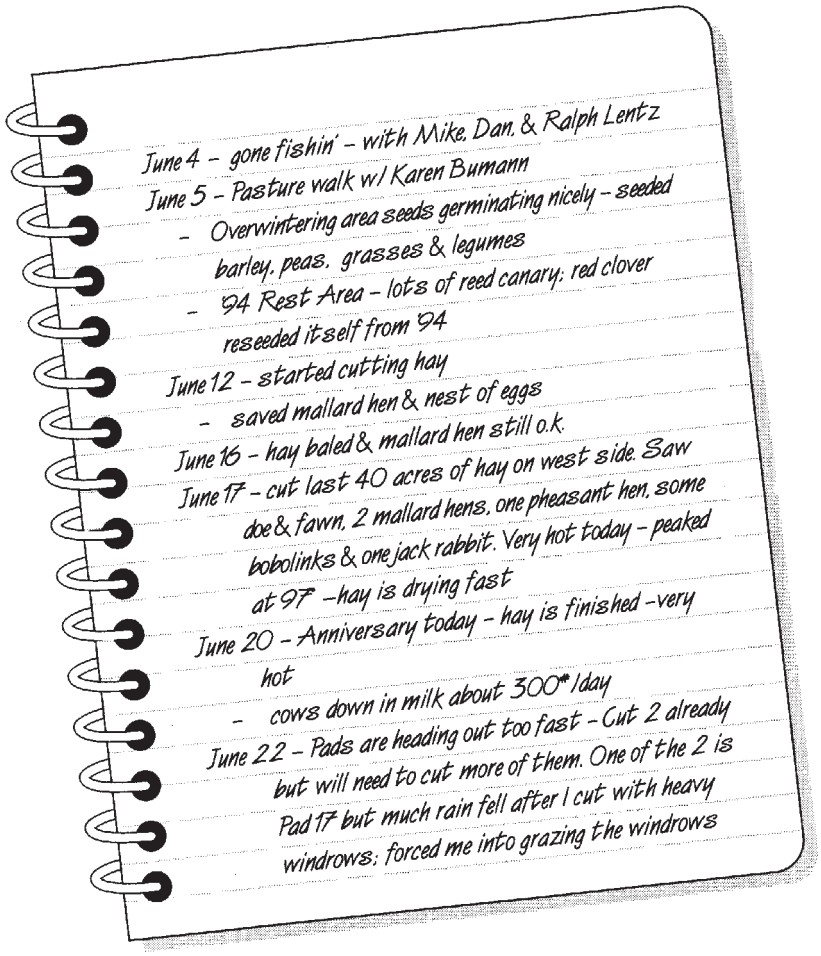
Members of the Monitoring Project Team found the following general tools very helpful for documenting monitoring activities.

CHAPTER CONTENTS

Journals and Field Notebooks

Use a journal to record your thoughts and observations. A spiral bound notebook works well, or you can use a notebook specifically designed for journaling. The latter tends to have a hard cover and smaller pages than a spiral notebook and can be found at bookstores.

Keep your journal where it will remind you to record thoughts regularly, such as on the table next to your favorite chair, on your nightstand, or at your office desk. Jot down a few notes every day or any time something significant occurs.



A field notebook is a journal that can be with you as you do chores or walk around the farm. A size that is easy to carry around, such as a smaller 3-x-5-inch or 6-x-4-inch spiral memo pad, may be the best choice for this use. Stuff a pencil or pen in the spiral and carry it in your jacket pocket, in a ziplock bag on the 4-wheeler, or on the dash of the pickup.

Calendars

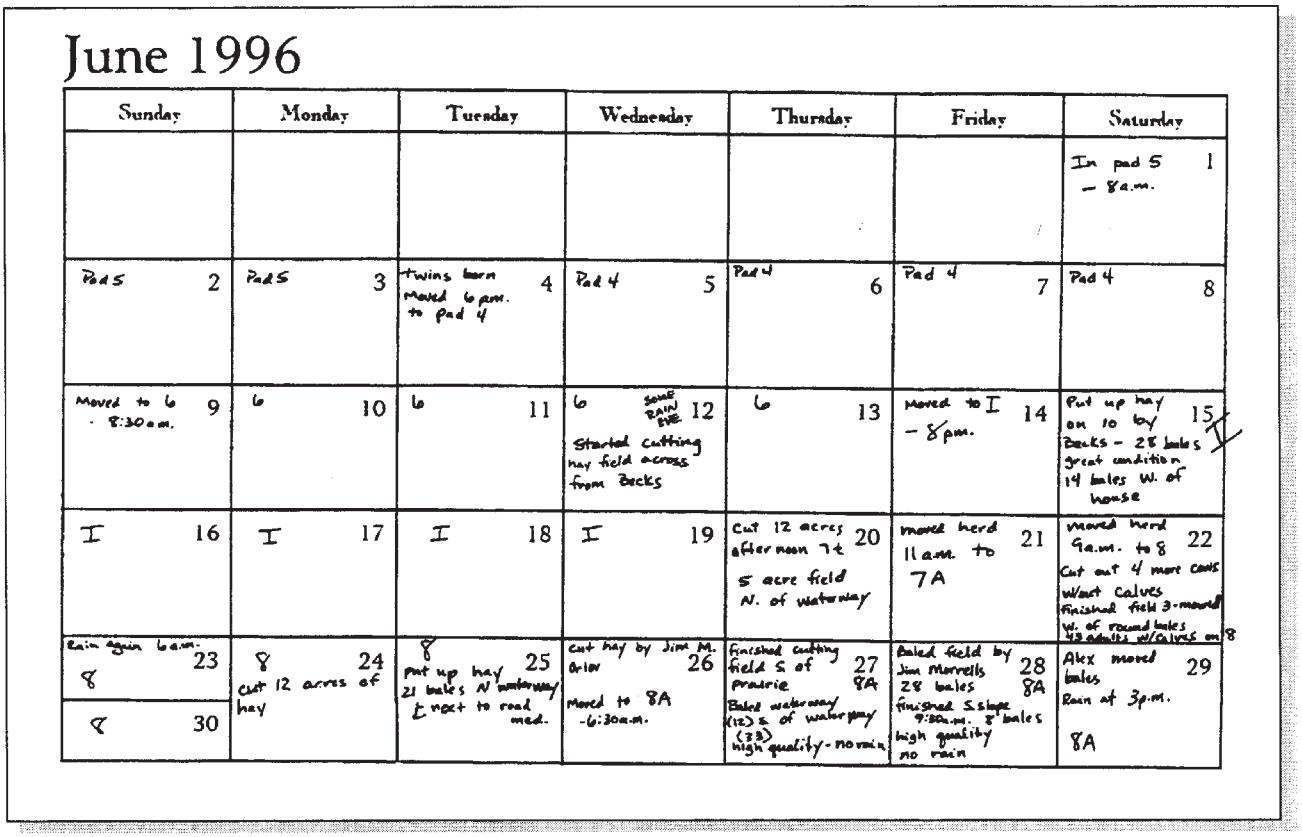
Wall calendars are a practical way of recording daily items such as rainfall or which paddock the grazing herd is in. Some folks record bird sightings directly on the calendar: "May 10 – first barn swallows seen." Kept for a number of years, calendars are a good way to review management decisions, weather records, or seasonal events.

Keep your monitoring calendar posted on the office wall or in the kitchen where you or other family members can note important events and observations. Use your journal to record more detailed descriptions of these events and observations.

Record Sheets

A well-designed record sheet can help capture a lot of information with a minimum of work or writing. Use record sheets in conjunction with a field notebook to capture additional information.

Most chapters of *The Monitoring Tool Box* contain record sheets related to specific monitoring activities. A master copy is included from which you can make copies at the local copy shop or library. Feel free to adapt these sheets to meet your needs or specific situation.



June 1996

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						In pad 5 1 – 8a.m.
Pad 5 2	Pad 5 3	Twins born 4 Moved 6 pm. to pad 4	Pad 4 5	Pad 4 6	Pad 4 7	Pad 4 8
Moved to 6 9 – 8:30 a.m.	6 10	6 11	6 some RAIN FIVE 12 Started cutting hay field across from Becks	6 13	Moved to I 14 – 8 pm.	Put up hay on 10 by 15 Becks – 28 bales great condition 14 bales W. of house
I 16	I 17	I 18	I 19	Cut 12 acres afternoon 7t 20 5 acre field N. of waterway	moved herd 11 a.m. to 21 7A	moved herd 9a.m. to 8 22 Cut out 4 more cows w/out Calves finished field 3-mowed W. of round bales 42 adults w/calves on 8
Rain again 6 a.m. 8 23	8 24 Cut 12 acres of hay	8 put up hay 25 21 bales N waterway & next to road med.	cut hay by Jim M. 6:10 26 Moved to 8A -6:30a.m.	finished cutting field S of 27 8A prairie Baled waterway (12) S of waterway (23) high quality - no rain	Baled field by 28 Jim Morrells 28 bales 8A finished S slope 9:30a.m. 8 bales high quality no rain	Alex moved 29 bales Rain at 3 p.m. 8A
8 30						

Computer Spreadsheets

Spreadsheets are computerized data programs made up of columns and rows that allow you to store information and show relationships between numbers. They make quick and easy work out of repetitive or complicated calculations, and of working up different planning scenarios. Examples include programs for financial planning and recordkeeping, and for enterprise or market analysis. Check with your local County Extension office or computer software store for available programs and their uses.

Charts and Graphs

Charts and graphs, either made by hand or with a spreadsheet, can show when events occur or track trends over time. Sometimes, visual images of observations or monitoring activities can be easier to interpret than numbers in a table. For example, a chart might be used to track non-renewable input costs (machinery, fertilizers, pesticides, energy) over time. Such a chart could point out progress in cost reduction, profitability, and sustainability.

Maps

Maps are a fun and useful tool for planning, recording changes, and documenting observations. A hand-drawn map can be used to identify landscape features, to show distances between objects, to site and find sampling locations, or to practice the non-satellite version of site-specific management. Use county topographical maps or soil survey maps to superimpose additional layers of information on your landscape drawing if helpful.

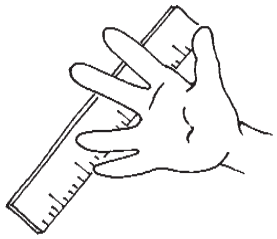
Photographs

Photographs are an invaluable means of tracking changes over time and for capturing things that you might forget or not fully see at the present moment. Think of taking photographs to record intriguing events or unusual observations. Use them to tell a story.Choose a good quality 35 mm camera, either the easy to use “point-and-shoot” kind or the single lens reflex (SLR) type, which allows you to switch lenses. Discount department stores carry many styles and brands of cameras at reasonable prices. If photography really interests you, visit your local camera store for more expert advice.

Buy good quality film, the right speed for the situation (indoor or outdoor), and use good quality processing. Also, work with the same processor and the same brand of film so you can make more accurate comparisons over time. Some film processing washes out colors, making it difficult to pick out features you saw in person. Try several film processors, compare pictures and stick with the one you like. And, different brands of film have different color characteristics; for example, Kodak has brighter reds and Fuji has brighter greens.

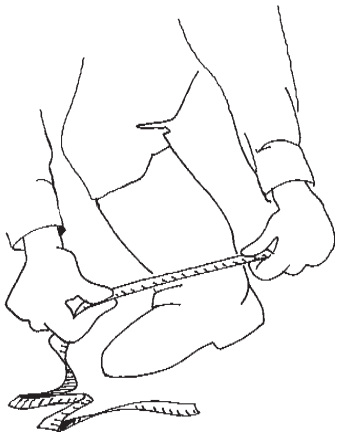
Other Equipment

Equipment such as binoculars and a magnifying glass can also facilitate observation. Binoculars bring you closer to objects that are best observed from a distance, allowing you to better identify characteristic traits. For up-close inspection, a hand-held magnifying glass often shows characteristics that help identify your subject and understand the structure or function of the details.



As you delve into the monitoring process, you may discover a need for other equipment to enhance your work. For example, some people find a flip chart stand handy for family goal-setting or monthly farm management meetings. Just be sure to weigh the cost of the equipment against the benefits it might bring to your monitoring work.

Natural Measuring Tools



Become familiar your natural measuring tools:

- the width of your outstretched hand
- the length of your shoe or boot
- the length of your stride
- the height (from the ground) to the top of your shoe, to your mid-calf, to your knee, and to your waist

These natural measuring tools can be used whenever you need to make note of size, height, and distance, especially when more specific measuring tools are not readily available.

Tips for Better Monitoring

The following tips can significantly enhance the quality and effectiveness of your monitoring activities.

Write Down Your Goals

Monitoring your progress toward achieving your goals is much more effective if your goals are written down. Committing your goals to paper makes them clearer and more real and thus increases your ownership of them. Written goals also give you a tangible reminder of what is really important to you when making day-to-day decisions.

The following quote from *The Holistic Management Workbook* illustrates the importance of clear goals when creating a management plan, but it also hints at why having those goals written down is so helpful:

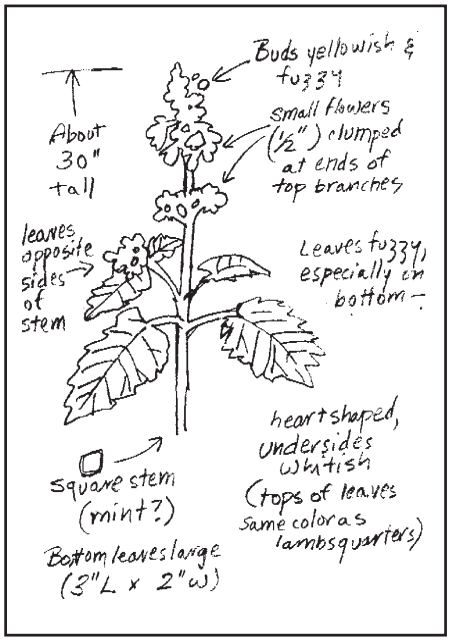
> A close family, creation or preservation of good land, public service, church work, education of your children, loyalty of relatives, and many other desires and duties all put demands on profit. If you do not have these things in mind when you plan your commitment of money and labor, you will make a plan that you will inevitably scrap the minute your higher goals demand it.
>
> On the other hand, clarity of goals will enable you to avoid temptations and opportunities of tremendous promise that nevertheless lead in the wrong direction—for you.
>
> "My neighbor is selling out. I could get a great deal on his hay machinery. Why not get it?"
>
> "The government has a cost-share program. Should I participate?"
>
> "My husband just won a trip for two to Maui. Should we go?"
>
> (Bingham and Savory, p. 4)

Take Good Notes

Good note-taking is a big part of good monitoring. Keep the following suggestions in mind when jotting notes in your journal, field notebook, or on record sheets:

Be mindful of similarities and differences. For example: "Both birds had a red patch on the back of the head and a black and white ladder down the back, but one bird was bigger than the other."

Relate to something you know. For example: "August 1997: Very rainy. Pastures, usually brown and thin by now, are green and lush like during the spring flush in late May or early June."



Note identifying characteristics with sketches or detailed descriptions. This applies to weeds, grasses, other plants, birds, insects, soil texture and so forth. According to Vinson Brown in *The Amateur Naturalist's Handbook*, written observations and sketches build knowledge far better than just trying to keep what you see in your head. Look for these types of characteristics (not all will apply to every situation):

- color
- unusual markings
- size and shape
- feel or texture
- actions, time of activity, food source, growth pattern, reaction to stimuli
- abnormalities, diseases, pests, parasites
- voice, noise, sound
- location, physical and climatic features, soil characteristics
- relationship to other organisms or features
- time of day, time of year
- weather conditions at time of observation
- relationship to a weather event

Tell a Story ✔

If you see something that strikes your interest, try to understand and record it in the form of a story. Ask questions like these:

- What is happening?
- What does it mean?
- Why is it there?
- What other organisms are nearby?
- What are the dominant climatic features (shade, direct sun, cloudy)?

Working with another person can help you get a fuller sense of the story. Also, try thinking backwards to understand why something has occurred. Augment your story with information from books on nature, biology, geology, weather, and so forth.

Explore Your Farm ✔

Take a walk around your farm solely for the purpose of becoming more familiar with it. Explore niches through which you normally do not pass. Become aware of periods of maximum activity so you can catch blossoming wildflowers, nesting seasons, or bird migrations.

Improve your observation skills by inviting others—family members, friends, neighbors, other farmers, or resource people—to join you in your exploration. Also, learn to observe while you go about your daily activities; let this kind of "awareness" monitoring become second nature to you. Who knows what you might witness.

Look for Connections

Learn to look for direct connections between management changes and their effects on the landscape, the environment, and on people, plants, and animals. Hone this skill by experimenting on a small scale. For example, forego mowing your road ditch and watch for changes in the plant community.

Apply this skill to the human or social components of your farm as well. For instance, note the effects of family goal-setting discussions on your children's interest in what goes on around the farm.

Additional Resources

Handbooks and Guides

The following offer general information on field observation and monitoring. These and many others are available at libraries or bookstores:

Holistic Resource Management Workbook, by Sam Bingham with Allen Savory. (Washington, DC: Island Press, 1990.)

The practical companion to the Holistic Resource Management textbook. Contains a wealth of information on financial, biological, and land planning and monitoring. Includes a number of useful forms and observation sheets. An excellent resource.

The Amateur Naturalist, by Gerald Durrell with Lee Durrell. (New York: Alfred A. Knops, 1982.)

An introduction to the naturalist's craft. What to look for and where, and how to interpret what you find. Takes you on walking tours of 17 different environments, from your own backyard to wetlands.

The Amateur Naturalist's Handbook, by Vinson Brown. (Englewood Cliffs, NJ: Prentice-Hall, 1980.)

A classic now revised and expanded to make all the outdoors your classroom. A comprehensive, but easy to understand introduction to the natural life sciences. Written especially for the amateur naturalist.

Through Minnesota's Seasons with Jim Gilbert, by Jim Gilbert. (Minneapolis: Minnesota Landscape Arboretum, 1987.)

A rich and varied book of observations on the changing seasons in Minnesota. Answers questions like "When is the best time to watch for meteor showers?," "Why do mosquito bites itch?," and "Why have bluebird populations declined?"

Journals

Several Monitoring Project members have been inspired by the following books, many of which are also available through your library. Most are the written record of seasonal events occurring on the farms and adjacent land of the author. These journals of observations and essays may also inspire you to become more aware of the seasonal changes around your home.

A Sand County Almanac and Sketches Here and There, by Aldo Leopold. (New York: Oxford University Press, 1949.)

> A classic by the famed naturalist and conservationist. A seasonal journal of Leopold's observations and musings on his farm in Sand County, Wisconsin, plus a number of insightful essays.

Birding from a Tractor Seat, by Charles Flugum. (Published by author and his son, 1973.)

> A compilation of Flugum's monthly columns written for *The Community Magazine* about his observations from the tractor seat on his farm near Albert Lea, Minnesota. (This book is out of print, but should be available through your local library.)

Explorations in the Ordinary: A Backyard Naturalist's View of Minnesota, by David Moffatt. (St. Cloud, MN: North Star Press, 1996.)

> Essays that remind the reader of things seen but too often forgotten.

Great Possessions: An Amish Farmer's Journal, by David Kline. (San Francisco: North Point Press, 1990.)

> A collection of essays, originally written for a column in *Family Life* magazine, showing how much activity occurs around the farm if one just takes the time to observe.

Natural Resource Agencies

Your local natural resource agency offices are also excellent sources of general tools and resources that can complement your monitoring activities. These agencies include the **Department of Natural Resources,** the **Natural Resources Conservation Service,** the **Cooperative Extension Service,** and the **U.S. Fish and Wildlife Service.**

Monitoring

Quality of Life

Farm sustainability not only requires concern for profitability and ecosystem health, but also for the quality of life of the people who live and work on the farm. When a farm family takes the time to talk about their values and to build a shared quality of life vision, they create a powerful base from which to achieve their personal goals and their goals for the farm.

What is It?

Monitoring quality of life begins with creating a vision of the quality of life desired by the whole family. Ideally this vision reflects each person's values and concerns. From there, simple tools are used to monitor the actions or behaviors needed to make this desired quality of life a day-to-day reality. This monitoring allows the family to make adjustments to both the vision and actions as needed.

Who Does It?

The entire family, including children, should be involved. You also may want to include others who regularly contribute labor or other assistance to the farm.

When?

Those tools that help the family create or revise its shared quality of life vision may only need to be used once or twice a year. The actual monitoring tools work well as monthly or weekly activities and can be part of your personal journal-writing time.

Time Required

Plan on three to four hours to complete the structured activities for creating a shared quality of life vision. Some individual preparation time is also required for these activities. How much time you give to making your vision a reality is up to you. Obviously, the more attention you give to it, the greater the likelihood of your success.

Materials and Cost

The main materials needed for the exercises include large sheets of paper and colored markers. You will also need to make photocopies of any worksheets you use. Twenty dollars should amply cover your costs.

Getting Started

CHAPTER CONTENTS

The introductory chapter, "Making the Most of Your *Tool Box*," suggests that monitoring is best done within the context of clear whole farm goals that take into account the interrelationships between a farm's people, financial, and land resources. A good place to start identifying whole farm goals is to take into account quality of life considerations.

Like Beauty to the Beholder

Quality of life considerations boil down to questions like the following:

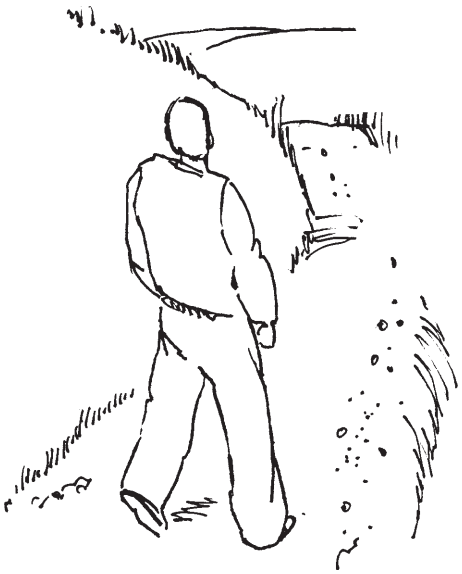
- What are the most important things in life to each member of the family? What are their values, needs, desires, hopes, and dreams?
- What are the core beliefs, attitudes, and assumptions about life held by each member of the family?
- What is the communication, trust, and support climate within the family?

These questions reveal the personal, dynamic, and often challenging nature of quality of life issues. In the words of one of the Monitoring Project team members, "I think quality of life is like beauty to the beholder. It's different for each person and is shaped by the meaning one attaches to his or her everyday experiences." Thus, creating a quality of life vision that the whole family can embrace requires, among other things, a willingness to respect each family member's perspectives and needs.

Tools that give you and your family concrete ways to address these broad quality of life questions can ease this challenge to some degree. This is the goal of this chapter, and the tools offered fall into two categories:

1. tools that provide a framework for creating or revising a dynamic vision of the quality of life desired by the whole family, and
2. tools that provide simple ways to monitor how well your **desired** quality of life matches your **actual** quality of life on a day-to-day, month-to-month basis so that you can make the necessary adjustments along the way.

These tools take you through a process that moves from the broad to the specific, from identifying those values that are most important to you and translating those values into specific actions and behaviors that can be monitored.



Quality of Life and Whole Farm Goals

To link quality of life considerations with whole farm goals, you need to ask: How do all of the above (values, hopes and dreams, core beliefs, assumptions about life, the communication climate within the family, and so forth) influence the "make-up" of the farm and the way it is managed?

Quality of life questions, when answered honestly and without fear, can then be a creative springboard for shaping whole farm goals, helping to

- determine the best profit-producing enterprises and systems for the farm given the people involved;
- create a base of support for including "non-profit" components like flower gardens or wildlife reserve areas in the make-up of the farm; and
- influence the way the farm is managed so that each family member can contribute his or her talents and skills in ways that best serve the individual, the family, and the farm.

Full Family Participation

While full family participation is not required for monitoring soils or frogs and toads, it is of vital importance to formulating and monitoring quality of life.

Every family member's participation is necessary because no one person's values, desires, or beliefs can be assumed to represent those of the entire family. Each member of the family should be assured that their needs and concerns are taken into account. Family members may be more willing to actively participate in the process if they can see how they will directly benefit from it.

Ideally a climate of mutual support and respect permeates this process. Without such a climate, the quality of life concerns of individual family members are in danger of being ignored, frustrated, or undermined. Also, the process will work better if each person takes responsibility for their involvement in it: speaking up for themselves, honestly communicating with other family members, following up on plans or commitments, showing awareness of how their actions and decisions impact others, and so forth.

If considering quality of life issues appeals to you, gather your family together and explain to them why this topic interests you and why it is important for the whole family to participate. Share with them the tools offered in this chapter and ask who else would like to join you in a process of forming and monitoring a family quality of life vision. Together, decide which of these tools to use and develop a plan for how to proceed.

Neighbors, Community, and Quality of Life

Consider including the needs and concerns of your neighbors and your community when thinking about quality of life issues and whole farm goals. You might even consider getting together with your neighbors to talk about common concerns for the community. In the process you may discover ways in which you can help enhance each other's quality of life.

Tools for Creating a Quality of Life Vision

The following tools can help you and your family create a quality of life vision that reflects the concerns and interests of all members of the family.

Guided Discussions

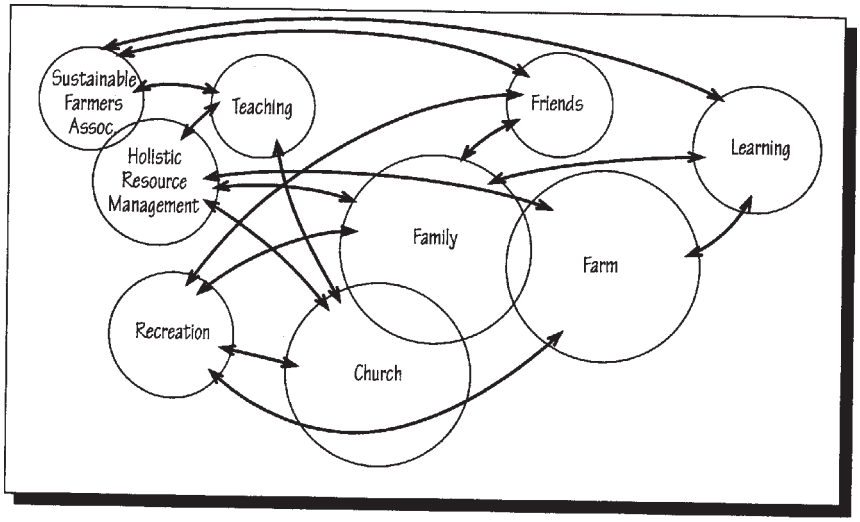
Guided discussions provide the family with a structured way to begin to address quality of life issues.

Use the Guided Discussion Questions worksheet provided with this chapter as a starting point for these family discussions. Make photocopies from the master provided and distribute a copy to each member of the family. In private, they should write down their answers and be prepared to share them with the rest of the family. Set a time when the whole family can come together for several hours and hold the discussion. For each question, allow each person to share their answer while everyone else listens. Then, open discussion on that question before going on to the next one.

You might consider asking someone from outside the immediate family—and with whom everyone in the family is comfortable, such as a local minister—to facilitate the discussion. A facilitator can help keep the discussion on track and create an atmosphere in which each member of the family feels free to contribute.

Values Diagrams

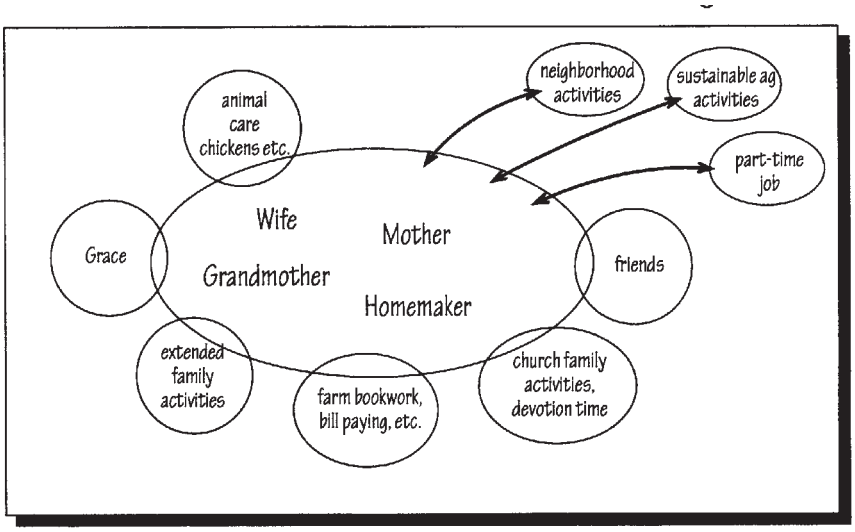
Values diagrams provides a visual complement to the guided discussions. This exercise focuses specifically on those aspects about life that you value most; it also gives you a way to see how you prioritize them and how they relate to each other.



Use the Diagramming Your Values worksheet provided at the end of the chapter for this exercise. Make enough photocopies from the master so that each family member has their own copy to complete privately. Then, come together and share your diagrams with each other. Feel free to ask questions of each other, such as “Why did you put that there?” or “Do you really value this thing more than that?” Let these discussions generate new insights and deepen your understanding of each other.

If you have young children who are too young to fully participate in previous two exercises, they can use a slight variation of the Values Diagram. Instead of using words and circles,

they can draw pictures of what they like about their life. Be sure to let them share their pictures with the rest of the family.



How to Build a Shared Vision

Throughout the process of discussing the guiding questions and sharing of your values diagrams, the family should pay attention to similarities and convergences, as well as differences and conflicts. These are the building materials of your shared quality of life vision.

Draft a Blueprint

Record these similarities and differences on large sheets of paper taped to the wall so that they can be easily seen by everyone. Then, on a separate sheet of paper, begin to draft a shared vision. Your written vision can be as detailed and descriptive as you like, or it could be as simple as an itemized list. Think of this written vision as you would a blueprint of a house. It is not "set in stone," but rather it gives you something to look at and play around with, something to change as needed.

Be Respectful and Creative

When building your shared vision, be especially mindful of finding respectful and creative ways to handle the differences and seeming conflicts in values between family members. Try to share any fears you might have and that could cause you to be defensive or distrustful. Within an atmosphere of mutual trust and support, the legitimate differences in values between family members need not be points of contention or conflict.

Make Periodic Revisions

Visions, like the people who create them, are dynamic, changing realities. Periodically revisiting the above tools gives you a framework from which to adjust your quality of life vision to reflect the inevitable changes that occur within individuals, within family relationships, and in the situations and circumstances of the farm or in the community.

How often you hold guided discussions or diagram your values is up to you and your family. Many of the monitoring tools in the next section offer ways to keep quality of life questions and issues in the forefront of your day-to-day life. It is helpful, however, to take a look at the big picture at least once or twice a year; or when major changes occur, such as when a child heads off to college.

Tools For Monitoring Quality of Life

Monitoring quality of life is ideally something that becomes a regular part of your daily consciousness. If one pays attention, day-to-day life can reveal valuable insights and information, further clarifying what you really want in life and how to best achieve it.

Use the following tools to help you make your quality of life vision a reality and to keep track of your efforts.

Values-in-Action

One effective way to monitor your quality of life is to pay attention to how closely your professed values (what you say is important to you) match your "values-in-action." If, for example, you say that you really would like to see your children take over the farm when you retire, but do not take this into account in how you structure the farm or make provisions for it in your estate planning, your actions contradict your words. This kind of discontinuity can weaken the integrity of your quality of life vision.

A structured way to check for continuity between your stated values and your actions is to first list your values in your journal and then, give two or three concrete examples of ways you currently act on these values. If you are not currently acting upon a particular value, jot down ideas on how you could act upon it or reexamine that value to determine whether or not it is truly important to you. Also, consider if you regularly do things that go against any of your professed values. Describe these actions, the motivating factors behind them, and what you could do to change this situation.

Do this kind of self-examination from time to time to keep tabs on yourself. You might also consider asking for feedback from friends or other family members about the relationship between your professed values and your values-in-action. They may have a clearer perspective on the situation than you.

Beliefs and Assumptions

Core beliefs and assumptions about life play a big role in creating the day-to-day reality of life. In fact, the contradictions between professed values and values-in-action often have their origins in one's underlying beliefs or assumptions.

For example, the reason why you might not do the planning necessary to ensure that your children can take over the farm could stem from the fact that deep-down, you believe there really is no future in farming and that your children would probably have a better life off the farm. And so, while you might really want them to continue the farm, your belief is that it not in their best interest to do so. Your actions reflect your beliefs, not your values.

If you encounter a situation or issue in which your desired outcome does not match reality, examine the beliefs or assumptions that might be

influencing the situation. These may be your own or those of someone else in your family. Ask, Does this belief or assumption really support my (or our) goals or needs? If not, get creative and come up with an alternative belief or assumption that you can fully embrace and that will achieve what you want. A willingness to examine beliefs and assumptions can make a big difference in whether or not you actually achieve the quality of life you desire.

Quality of Life Objectives

Objectives are clear-cut, positive, and measurable actions that transform visions into reality. Setting and meeting specific objectives is another powerful tool for creating your desired quality of life. And, because objectives are measurable, they also serve an important monitoring function. By keeping track of your compliance with these objectives, you give yourself a concrete way of gauging the level of commitment you bring to your quality of life vision.

Some Examples

Quality of life objectives fall into two categories: the objectives of the family as a whole, and the personal objectives of each individual family member. Here are some examples of both:

- spend one whole Sunday a month together as a family
- read to my young children every day
- show our support for our children by attending all school concerts, programs, and home ball games
- talk one-on-one to each parent at least once a week
- devote a half-hour to prayer and reflection every morning
- take my wife out on a date at least once a month
- take a two week family vacation every year
- play with my younger brother at least three times a week
- help my husband with chores every Saturday morning
- straighten up the house everyday after school before Mom comes home from work
- participate in at least two major “career development” activities a year
- meet as a family once a month to address quality of life concerns

On photocopies of the Quality of Life Objectives worksheet provided with this chapter, list your objectives and keep track of your efforts to meet them.

A Supportive Environment

Obviously, the whole family must be committed to those objectives that apply to everyone, like spending one Sunday a month together. But it is also very important for family members to be supportive of each other’s personal objectives.

While the person who sets a personal objective is ultimately responsible for its achievement, other family members should make sure their actions and attitudes do not create a negative environment, or any other obstacles, for that person. This means not judging, dismissing, laughing at, or putting down each other's objectives. And, it means offering willing cooperation when necessary, such as when creating schedules and plans.

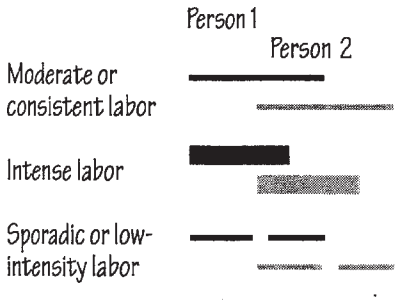
A Family Activities Calendar

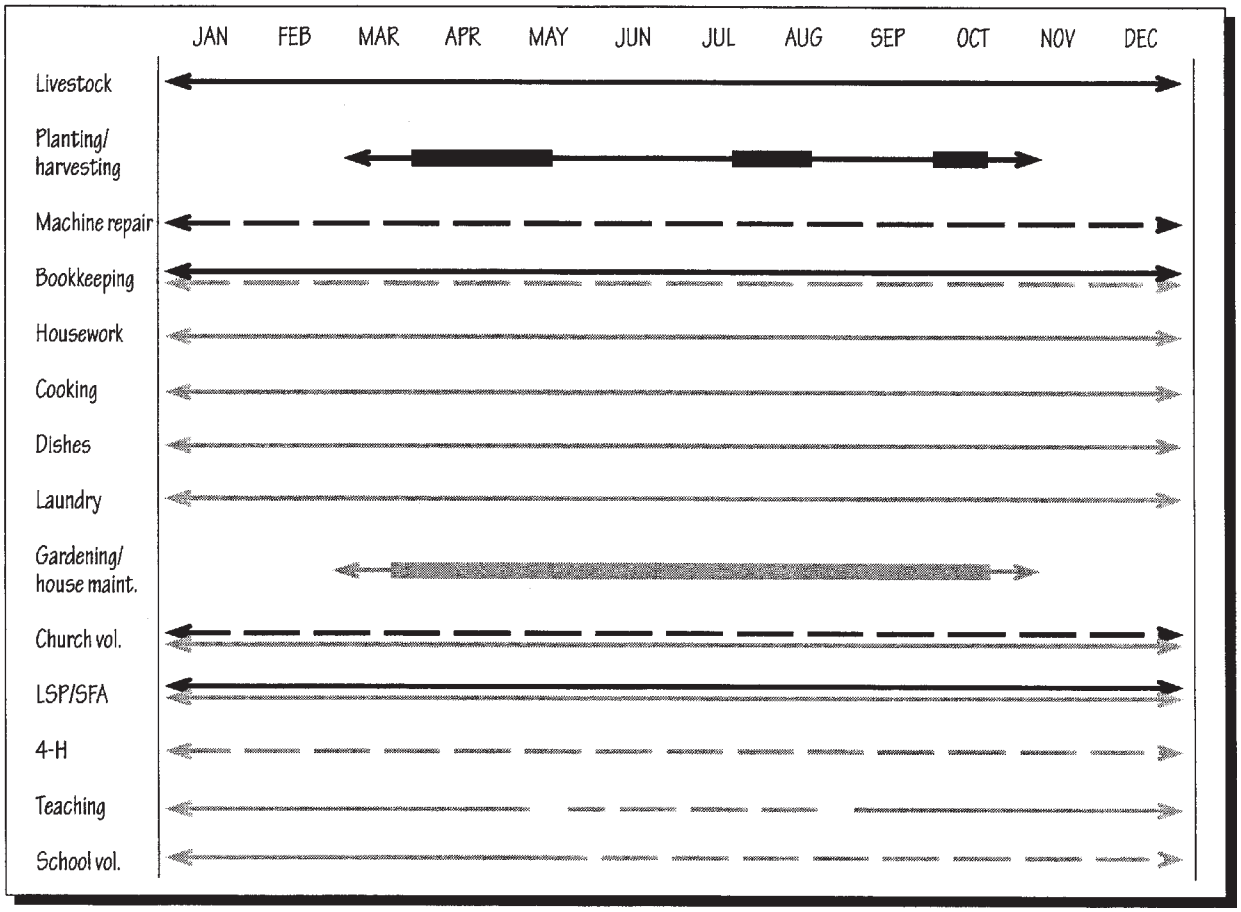
Another useful way for families to get at the question "Do our daily activities reflect our desired quality of life?" is to put together a "family activities calendar" that lays out all the major activities of each family member throughout the year. To do this exercise, see the instructions sheet provided at the end of this chapter.

How It Can Help

An activities calendar can help you make your desired quality of life a day-to-day reality by:

- providing everyone with a clear—and sometimes eye-opening—picture of what each family member does, when, and at what intensity level;
- revealing differences in workloads or activity levels between family members and serving as a springboard for renegotiating who does what and when;





- helping you spot stressful "crunch times" in advance and giving you an opportunity to come up with plans that could help lessen the stressfulness of these times;
- showing you whether or not you are actually allocating time to those things you claim are important to you; and
- helping you to more effectively make adjustments when unexpected occurrences such as accidents, illness, or opportunities come along.

How to Use It

The first time you do this exercise, plan on making two calendars. Your first calendar will show the current way family activities are distributed. More than likely, this will reveal some problem situations. If this happens, get creative and play around with things until you can come up with a calendar everyone feels good about.

Revise your family activities calendar annually, such as at the New Year or at the beginning of each school year. And, hang it in a location that everyone has easy access to it. You may even want to look at it together at the beginning of every month just to refresh your memory of upcoming activities or to make any necessary adjustments.

Additional Resources

Publications

In addition to the following publications, also refer to those listed in the introductory chapter, "Making the Most of Your *Tool Box*." Most of the publications can be obtained through your local library or purchased from your local bookseller.

Rut Buster: A Visual Goal Setting Book, by Wayne and Connie Burleson. (Absarokee, MT: Sloping Acre Publishing Co., 1994.)

Offers a step by step process for identifying your basic values, desires, strengths, and weaknesses; developing a word picture of who you are and where you want to go; and dealing with the roadblocks that get in your way. This book can be obtained directly from the publisher at R.R. 1 Box 2780, Absarokee, MT 59001; 406-328-6808.

Living the Simple Life: A Guide to Scaling Down and Enjoying More, by Elaine St. James. (New York: Hyperion, 1996.)

The author uses short snippets from her life and the lives of others to present a number of strategies for focusing on activities that bring you the most satisfaction and enjoyment.

The Table Where Rich People Sit, by Baylor Byrd. (New York: Scribners, 1994.)

An illustrated book for all ages that tells the story of a young girl's discovery that her family is rich in things that matter most in life.

Your Money or Your Life: Transforming Your Relationship with Money and Achieving Financial Independence, by Joe Domingues and Vicki Robin. (Penguin Books, 1992.

A thought-provoking, practical book that outlines a nine-step program for transforming how one thinks about, earns, and spends money. Addresses questions like, "Does your job reflect your values?" and "Is your life whole? Do all the pieces—your job, your expenditures, your relationships, your values—fit together?"

The Cornerstones Model: Values-based Planning and Management, by Jerry Aaker and Jennifer Shumaker. (Little Rock, AR: Heifer Project International, 1996.)

Based on fifty-three years of livestock development experience in rural communities, this book combines visioning with planning and provides tools for a holistic, participatory approach to change.

Organizations

Quality of life considerations are an important part of Holistic Management, which is discussed in more detail in the introductory chapter, "Making the Most of Your *Tool Box*." To learn more about Holistic Management, see to the references for the **Center for Holistic Management** and the **Land Stewardship Project** listed on page 13 of that chapter.

The **Center for Leadership Development** and **Kennedy Consulting, LLC** provide a broad base of services geared toward helping family businesses ensure long-term sustainability, increased profitability, improved communication and relationships, leadership development, effective long-range business planning, and appropriate financial, estate, and succession planning. For more information, contact Don Green at Kennedy Consulting: 3030 Cortland, P.O. Box 1100, Salina, KS 67402-1100. Phone: 785-825-1561 or 800-303-3241; website: www.kcoe.com/kconsult.

Learning Strategies Corporation of Minneapolis, Minn., provides a variety of self-development tools that can enhance a person's efforts to achieve his or her life goals. For a catalog or more information, write to the Learning Strategies Corporation at 2000 Plymouth Road, Minnetonka, MN 55305-2335; phone: 888-800-2688 or 952-767-9800; e-mail: Info@LearningStrategies.com; website: www.learningstrategies.com/index.asp.

Monitoring Quality of Life

Guided Discussion Questions

In your journal, write down your answers to the following questions and be prepared to share them with your family members. Feel free to skip those that do not apply to you, or simply rephrase them so that they do apply to you.

1. List three things that you really like about your life right now and why.

2. List three things about your life that you would like to change and why. What would need to happen in order for the changes to occur? Are you willing to do what it takes to bring about these changes?

3. Identify three skills or qualities that you have and briefly describe how these contribute to your family, farm, or community.

4. Pick out three skills or qualities you appreciate in your spouse, child, parent, grandparent, closest friend, or hired person. Explain why you value these in this person.

5. Describe what you would like to be doing five to ten years from now. Identify the changes that would be necessary to bring that life to reality.

6. Summarize the biggest change in your life or on your farm in the last three to five years. How did that change affect you? Your spouse? Your children? Your parents? Your siblings? Your friends? Your hired help? Your neighbors?

7. Describe at least one major change you know will occur in your life or on your farm in the near future. How do you feel about this change? What can you do now to help prepare for it?

8. Name the three people with whom you most frequently discuss life decisions or decisions affecting the farm. Briefly tell why you turn to these people.

9. List your favorite school, work, or farm activities and why you like to do them.

10. What do you most like to do away from school, from work, or from the farm? Specify how these activities add to your quality of life.

11. If you could change one thing about your farm, what would it be and why? Do you see this change as actually being possible? What would need to happen to make it so?

12. Answer the questions that apply to you:

    a. How do you feel about passing the farm on to your children or grandchildren? Why?

    b. How do you feel about the possibility of taking over the farm from your parents or grandparents? Why?

    c. If either of the above is something you desire, what needs to happen or change in order for you to achieve this goal? Address specific issues, such as money and estate planning needs; family relationships and communication patterns; the land base, its size, location, and ecological condition; preferred profit-producing enterprises and farming systems; and so forth.

13. Describe your community as you would like it be for yourself as an adult, or for your children or grandchildren. What services, opportunities, and people are needed to make it a good place to live?

14. Address any other quality of life issues of concern to you that are not covered by the above questions.

Monitoring Quality of Life

Diagramming Your Values

Read through the following instructions before proceeding with the exercise. Once you have completed steps one and two, gather with your family members to share and discuss your diagrams.

1. List the things or ideas that are most important to you in your life (for example: leisure time, church activities, nature walks, motherhood, financial security, exploration, a clean house, and so forth):

2. In the space below or on a separate piece of paper, create a diagram using circles or other geometric shapes that visually describes the interrelationships between your values. Follow these guidelines as you create your diagram:

    a. Use different sized shapes to indicate the relative importance of each value; for example, enclose your most important values with the largest shapes.

    b. Arrange the shapes in a way that best shows how you see the interrelationships between all the different things you value. For example, overlapping circles might indicate a close interaction between two or more values; distance between circles might mean that the values have little to do with each other.

    c. Arrows or some similar device can also be used to indicate relationships between your values.

    d. Let go and let your imagination guide you!

Monitoring Quality of Life

Quality of Life Objectives

Name _____ Month/Year _____

Record your quality of life objectives below and keep track of your actual completion of these objectives. When appropriate, note any reasons for differences between what you planned and what you actually did. List your objectives in order of frequency: daily, weekly, monthly, and yearly; or use a different record sheet for each of these categories. Use as many record sheets as you need for all of your objectives.

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Objective: _____

Actual: _____

Difference: _____

Instructions for the Family Activities Calendar

This exercise requires the following materials:
- several large pieces of paper
- a black marker for general information and activities that involve everyone
- a different colored marker for each family member
- masking tape

1. In the upper right-hand corner, make a key indicating which color belongs to which person. Then, write out the twelve months of the year across the top of the paper in black. Be sure to start far enough to the right to leave space along the left hand side of the paper for the activities column.

2. On a separate sheet of paper, brainstorm a list of all the principal activities family members engage in throughout the year. Be specific and include all farm-related activities, recreational and personal activities, household chores, educational commitments, volunteering and community involvement activities, joint family activities, and so forth. Make sure everyone's activities are represented in this list before proceeding.

3. List all of the labor activities vertically on the left-hand side of the calendar with the black marker.

4. For each activity, fill in across the months of the year when the activity is performed using the color marker of the person who does it. If more than one person engages in a particular activity, you will have several lines in different colors for that activity. Or you may have a single line consisting of different colors if a different person does that activity at different times of the year.

   Also, classify the level of intensity for each activity using the following key:
   - thick line = heavy or intense activity level
   - light line = consistent or moderate activity level
   - broken line = low or sporadic activity level

5. Put the completed calendar on the wall or in a spot where everyone can see it. Concentrate on the patterns of the colors and lines. Discuss what you see:

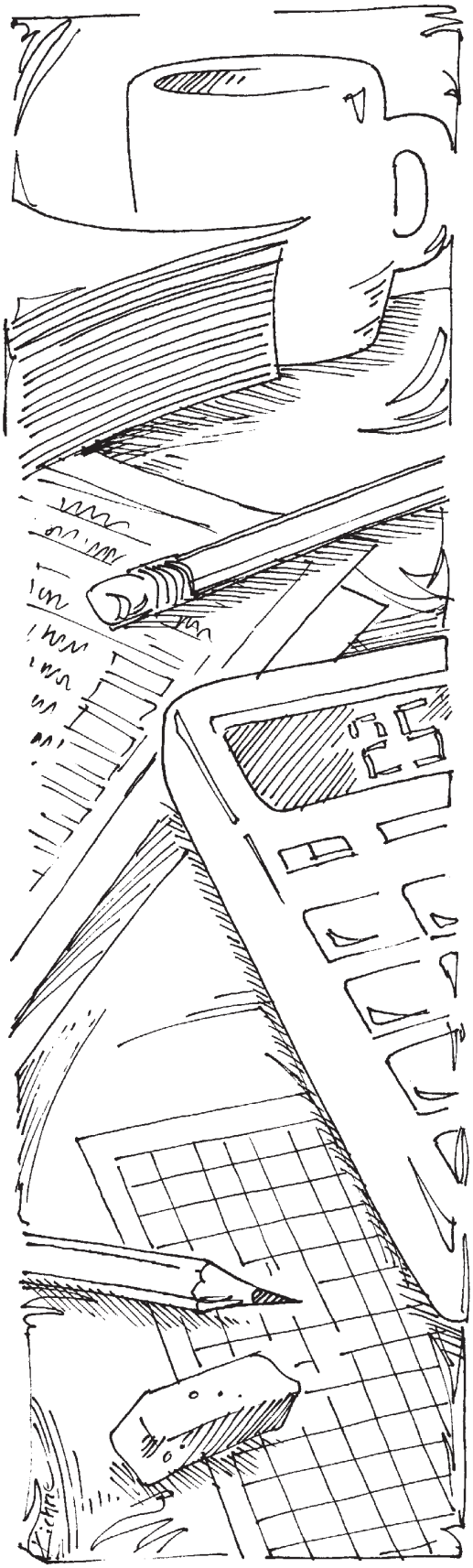
   - What differences does this calendar reveal in the way different family members mentally divide the year? For example, do some members think in terms of the school year while other think in terms of the growing season?

   - Does the calendar reveal any major discrepancies in terms of who does what or when? How do you feel about these discrepancies? What changes could be made to even things out more?

   - Do you spot any other problems, such as too many activities being bunched up at one time or major conflicts between the activities of several people? Again, work with each other to come up with an agreeable solution.

   - How does this big picture of how the family members allocate their time correspond to the shared quality of life vision you have created?

6. If necessary, create a second calendar that seems workable and with which everyone is comfortable.



Monitoring

Farm Sustainability with Financial Data

Determining the sustainability of your farm means looking beyond maximizing profits, the traditional measure used by agricultural economists. If maximizing profits is your only guide, you will miss the larger picture of quality of life, environment, and community. The materials presented in this chapter provide you with a way to see how well your farm supports this larger picture.

What Is It?

Monitoring farm sustainability with financial data involves the use of a simple worksheet and information from common financial statements to measure your farm's progress in four areas: 1.) reliance on government programs; 2.) use of purchased inputs; 3.) creation of local jobs; and 4.) balance between feed use and feed production.

Who Does It?

The worksheets are geared primarily for use by individual farmers or farm families.

When?

The worksheet should be completed once a year, as part of your annual financial planning process or after tax reports and financial statements are completed.

Time Required

Once the usual financial statements and tax reports are complete, filling out the worksheet should easily take less than an hour.

Materials and Cost

A master copy of the worksheet is provided with this chapter; your only cost will be to make photocopies of this master.

Some Background Information

CHAPTER CONTENTS

The following material was first published by the Land Stewardship Project as a report entitled *Monitoring Sustainable Agriculture with Conventional Financial Data* by Dick Levins, a professor and extension agricultural economist from the University of Minnesota and a member of the Monitoring Project team. The impetus for Dick's development of this material came from a discussion he had with the Monitoring Project farmers on what they mean by profit, how they measure profitability, and what planning methods have been most useful to them.

Here is Dick's recollection of this conversation:

> These farmers seemed as interested as any other group of farmers in making sure their operations were profitable. But as we talked, a picture of profit that went beyond dollar signs came into focus.
>
> Return on assets is a common guide to financial performance, but not for these farmers. Each of them agreed that farm income should be enough to cover debt payments and make some progress toward getting out of debt altogether. Bills should be paid, the need for off-farm income should be minimized, and a farmer should not be relying on inventory sales or depreciation to get by. Maximizing income took a back seat, however, to a delicate balancing act that includes quality of life, environment, and long-term goals for land and community. In this balancing act, making enough money was a better guide than making as much as possible.
>
> The farmers agreed that keeping track of certain expenses was an essential part of tracking profit. Accurate, honest figures were essential. Veterinary costs, feed costs, and custom hire costs came up often in our discussions. One of the farmers was using the computer program Quicken to track his expenses and, after one year, found the method not only useful but fun.
>
> The bigger questions of measuring profit were most often addressed in a more general way:
>
> - Was our family able to do what it wanted to do?
> - Was there enough money and time?
> - Did the debt level increase?
> - Were the bills being paid?
> - What about inventories, were they up, or down?
>
> If the answers to these questions were favorable, the farmers were inclined to consider the last year a profitable one. A farmer who was profitable would likely have a gut feeling that things were going in the right direction and that progress was being made. Some of this satisfaction might come from the bottom line of a conventional accounting statement, but some of it might not.

The contents of Dick Levins' report follow.

The New Indicators

I am proposing four indicators that, along with farm profits, can be used to evaluate the sustainability of farming operations. The indicators are:

1. reliance on government programs;
2. use of equipment, chemicals, and non-renewable energy;
3. creation of jobs; and
4. balance between feed use and feed production.

Why these indicators, and not some others? For one thing, these indicators lend themselves to being easily calculated from financial numbers farmers already have on hand. There are many other reasons, too, that are explained in this chapter.

Reliance on Government Programs

President Kennedy's farm advisors faced a huge problem—how could they control the cost for government farm programs? That was a generation ago, and every president since has struggled with the same problem, only on a grander scale. Kennedy's three billion dollar dilemma would have looked very good to Reagan's advisors and the 20 plus billion they were trying to justify each year in the mid-1980's! As this is being written, Clinton and a Republican Congress are squaring off over exactly the same problem.

An entire generation of farmers have come to see government subsidies as an essential part of many types of farming; however, a fully sustainable system of farming should not require this type of continual assistance. The first indicator in the system therefore measures the extent to which a farm is indebted to the taxpayers for its survival. This indicator can also be useful in helping the public see what kind of farming they are choosing to favor with special payments.

Use of Equipment, Chemicals and Non-renewable Energy

A quick look at almost any farm balance sheet will show you that chemicals, fertilizer and machinery are "assets." The chemicals and fertilizer usually show up as "current assets" and machinery is a big chunk of the "intermediate assets." In a recent year, the balance sheet for US agriculture as a whole showed these assets as having a value of slightly more than $85 billion.

The history of US agriculture in the twentieth century has generally been one of people being replaced by assets such as these. It has also, more recently, been one of environmental problems resulting from the use of these assets. So how do things that eliminate farming jobs and harm the environment come to be worth $85 billion?

The answer lies in another question: who are these assets serving? The type of farming that used these assets in 1991 paid $19 billion for petroleum based inputs, $6.9 billion for repair and maintenance, $6.8 billion in non-mortgage interest, and $17.3 billion in wearing out machinery and buildings. Non-farm, largely non-local, corporations have generously agreed to help farmers do their jobs in exchange for $50 billion per year. These may be expenses to farmers, but they are income to those who furnish the assets.

The level of expenses used by such "assets" is one indicator of how willing a farm is to share its income with non-farm corporations. Expenses accounted for by chemicals, commercial fertilizers, and gas guzzling equipment are also a measure of how a farm is interacting with the environment. When measuring sustainable agriculture, the rule here must be "the less, the better."

Creation of Jobs

Everyone has heard stories about how many people can be fed by the work of a single farmer. The down side of this is that economic activity at the farm level employs virtually no one.

Too strong a statement? According to a recent report, the average farmer in southeast Minnesota spent $252,942 during 1993. Of that money, less than $7,000 went for hired labor. A quarter million dollars of economic activity supported the operator's family and less, much less, than one other local family.

The average farmer spent over three times as much for interest than for hired labor. He or she spent over three times as much to lease land and equipment than for hired labor. He or she spent over three times as much on machinery and equipment purchases than for hired labor. He or she spent over three times as much for fuel and repairs than for hired labor. And he or she spent over three times as much for fertilizer and chemicals than for hired labor.

On the national level, the numbers are much bigger, but the story is much the same. Total production expenses for agriculture nation-wide were $141.3 billion in 1991. Hired labor, counting wages, benefits, and contract work, accounted for $12.6 billion, about nine percent of the total expenses. For comparison, interest claimed $13.5 billion. Equipment and machinery replacement cost $15.7 billion. Fertilizer, lime and pesticides expenses were $13.7 billion. Even the $7.9 billion bill for energy in the form of petroleum and electricity wasn't that much smaller than what non-operator labor was paid.

During the process of converting our farms from labor users to equipment and chemical users, millions of operators were "freed up to seek jobs elsewhere," as the economists like to say. There were 5.6 million farms in 1950 and only 2.1 million in 1991. Even with 3.5 million more operators on the land, farms in total spent 15 percent of their expenses on hired labor in 1950. That number is down to nine percent today.

This is no problem for economic theory. People, pesticides and plows are generic "factors of production." Each must submit to the same profitability test: marginal revenue must exceed marginal cost. Each must pay its own way, but only in terms of those things we choose to measure in dollars. Communities and environment, unfortunately, don't make the list.

What are we to make of such an agriculture? Is it one that is a marvel of efficiency in labor use? Or is it one that is a massive engine for generating rural unemployment? Which view you take has a lot to say about which economic indicators you use to measure a farm's performance.

Providing a living for a local family is something good, not something to be avoided. Whether the job is in the farmer's family or in someone else's family is not important as far as this indicator goes. The part of farm income that is directly available to local families is a number that should be maximized, not minimized, to the extent a farmer can remain consistent with his or her other goals.

Balance between feed use and feed production

One of the biggest transformations in American agriculture has been that farmers, as a group, have decided to spend their lives waiting hand and foot on livestock. Farmers routinely grow feed, harvest it, bring it to animals who live indoors with absolutely nothing to do, pick up the manure, and carry it back to the fields so they can grow more feed.

Working like a dog (or more properly, like a cow or pig) is hardly satisfying, so farmers start looking for ways around it. Some buy 100-horsepower tractors to pull manure spreaders while that much horsepower, and more, is in the animals they are keeping on welfare. Others decide to "specialize" and grow only feed or only livestock. Then where to put manure becomes a major problem, and any chance for the animals participating in the production and harvesting of their feed is gone for good.

Pulling plows with mules is not the only way to put farm animals to work. Animals can break ground with their hooves. They can harvest feed by grazing. They can spread manure by walking on the fields where manure is needed to replenish nutrients and build up soil structure. All of this is possible, but only if the animals live where their feed is grown.

There is another problem, too, when feed production and use are out of balance. A farmer buying feed has little or nothing to say about how the land upon which that feed is grown is being treated. Conversely, a farmer selling feed has little or nothing to say about how the animals which consume it are treated.

How to Calculate the Indicators

The worksheet at the end of this chapter can be used in a simple, straightforward way to calculate the indicators I am proposing for evaluating a farm's sustainability.

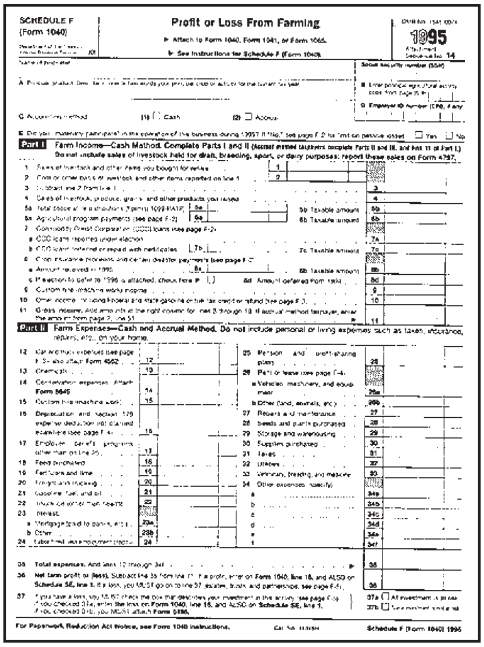
Sources of Numbers

The worksheet has been designed so that a farmer can do all the analysis from income and cost categories normally used on tax forms. This is not to say you should necessarily use the exact numbers on the tax forms, but at least the categories should be familiar.

The reasons you may not want to use the actual numbers on tax forms relate to the various purposes for which you are using the numbers. For example, over the years the government has helped many farmers pay for bigger and fancier equipment. The way it does this is through depreciation bonanzas of one sort or another. The more depreciation the government allows you to claim, the less you will have left to pay taxes on. But the high depreciation does not necessarily indicate how much your equipment and buildings are actually being used up in production during the year.

If you have a good set of farm records, they should certainly be used. Otherwise, work from your tax reports and be careful. To avoid the biggest pitfalls in working from tax records, check the following things before using them.

- Income should be for crops and livestock produced in the tax year. If you sold grain from last year, for example, you should adjust your numbers accordingly.
- Expenses should only be for the crops and livestock produced in the tax year. If you prepaid feed or supplies for next year, this is one of the adjustments you will need to make to get everything to match.



SCHEDULE F (Form 1040)

Profit or Loss From Farming

1995

▶ Attach to Form 1040, Form 1041, or Form 1065.

▶ See Instructions for Schedule F (Form 1040).

Part I Farm Income—Cash Method. Complete Parts I and II (Accrual method taxpayers complete Parts II and III, and line 11 of Part I.)

Do not include sales of livestock held for draft, breeding, sport, or dairy purposes; report these sales on Form 4797.

Part II Farm Expenses—Cash and Accrual Method. Do not include personal or living expenses such as taxes, insurance, repairs, etc., on your home.

For Paperwork Reduction Act Notice, see Form 1040 instructions. Cat. No. 11346H Schedule F (Form 1040) 1995

- Depreciation on machinery and buildings should be an accurate reflection of the degree to which those items were actually used up during the year.
- If you sold breeding livestock during the year, it will be on Form 4797 instead of on Schedule F. It is income, nonetheless, and it should be included in the Gross Income figure you use in the worksheet.
- If you decide to make any changes on your tax numbers, make sure you recalculate net income so it will be consistent with the changes you have made.

These adjustments should be easy enough to make, and then there is only a matter of copying some numbers onto a form, adding them up, and doing a little division here and there.

Worksheet Calculations

The first section of the worksheet determines what part of gross farm income is from government payments. There is only one calculation to make: divide Agricultural Program Payments by Gross Income.

The next group of numbers is a general indication of how your way of farming uses chemicals, machinery, and non-renewable energy. The expense categories listed here are Chemicals; Custom Hire (machine work); Depreciation on Equipment and Buildings; Fertilizers and Lime; Gasoline, Fuel and Oil; Rent or Lease Vehicles, Machinery, and Equipment; Repairs and Maintenance; and Utilities.

Add these numbers up and divide them by Gross Income. This will show the percent of your income that you are choosing to spend on this group of expenses. As a general rule, you would like to see this percentage be lower rather than higher.

The third section of the worksheet asks you to look at the money you spent to directly support families in your community by providing employment. This may be your family or it may be someone else's. There are four numbers in this section: Employee Benefit Programs; Hired Labor; Pension and Profit Sharing Plans; and Net Farm Profit (or loss). Divide the sum of these four numbers by Gross Income.

The final section of the worksheet is devoted to determining the balance between livestock and feed on your farm. The balance for your farm is calculated by first subtracting the dollar value of feed sold from the dollar value of feed purchased. This difference is then divided by Gross Income. A value of zero indicates a perfect balance. A grain farm would have a positive number close to 100 percent, indicating that almost all of the grain it produces is sold for feed used on other farms. A livestock operation that did not grow all its own feed would have a negative number. The closer that number comes to minus 100 percent, the less feed used on the farm would have been produced on the farm.

Remember, the feed-sold and feed-purchased numbers used in estimating the balance should be for a single year. If your numbers include sales or use from inventories, you will have to adjust them accordingly.

Using the Worksheet

So we have four indicators. One shows the degree to which you depend on the government for income, one shows the degree you depend on non-renewable energy and machinery, one shows the degree to which you provide jobs for local families (including your own), and one shows the balance of feed production and use on your farm.

No one of these numbers is intended to be used by itself any more than profitability should be used by itself. Each number is part of a bigger picture, and being "perfect" on any one of them might come at the expense of another looking much worse than you would like to see.

Four Examples of Using the Indicators

Four examples of how the indicators look for different types of farms in Minnesota are shown in this chapter. Each is based on actual farm records and is intended to show how differences in farms show up in the indicators.

Conventional Grain Farm

The first example is a Southwest Minnesota grain farm. The farm is 960 acres and, apart from the acres set aside for government programs, is all planted to a corn-soybean rotation. It is typical of many farms in the area in that about one-third of the land is owned and the other two-thirds are rented.

The gross income for the farm is $255,000. This includes an $18,000 check from commodity programs, so seven percent of this income comes from government programs.

The farm relies heavily on chemicals, fuel and machinery. Chemicals, depreciation, repairs and fertilizer are major contributors to the $99,200 spent on this category. The total spent here accounts for 38.9 percent of gross income.

The high machinery use makes for low labor use. Out of the quarter million dollar gross, only $7,100 goes for hired labor. The operator and family are, however, making a reasonably good living. Still, the total for this category of $44,600 is only 17.5 percent of gross income.

Finally, the farm is as out of balance as you can get. There are no animals on the farm and all of the feed is sold. Only the government payment keeps the balance indicator from being a "perfect" 100.

This example farm is almost a complete failure in terms of the financial indicators of sustainability. Equipment and chemical companies love it, but it generates virtually no jobs in the local economy. The operator may get rich—that depends on how much is paid for rent and interest—but few other local people share in the benefits. There is no chance for animals to work on the farm. And the farm ties up enough land to support at least three farms using different methods.

Monitoring Farm Sustainability with Financial Data

Conventional Grain Farm

Government Payments as Percent of Gross Income

Gross Income	255,000	
Agricultural Program Payments	18,000	
Ag Program Pmts / Gross Income (x 100) ==>		7 %

Energy and Machinery as Percentage of Gross Income

Chemicals	28,500	
Custom Hire (machine work)	5,500	
Depreciation on Equipment and Buildings	25,000	
Fertilizers and Lime	13,500	
Gasoline, Fuel, and Oil	6,000	
Rent or Lease Vehicles, Mach. & Equipment	0	
Repairs and Maintenance	18,000	
Utilities	1,700	
Total	99,200	
Total / Gross Income (x 100) ==>		38.9 %

Support for Local Families as Percentage of Gross Income

Employee Benefit Programs	0	
Labor Hired	7,100	
Pension and Profit Sharing Plans	0	
Net Farm Profit (or loss)	37,500	
Total	44,600	
Total / Gross Income (x 100) ==>		17.5 %

Indicator of Feed Production and Use Balance

Gross Income from Crops Sold for Feed	237,000	
Feed Purchased	0	
Difference	237,000	
Difference / Gross Income (x 100) ==>		92.9 %

Conventional Grain, Finishing Hogs

The second example is also a Minnesota grain farm, but this time there is an older finishing barn on the farm which is usually used to feed out about 1,000 feeder pigs each year.

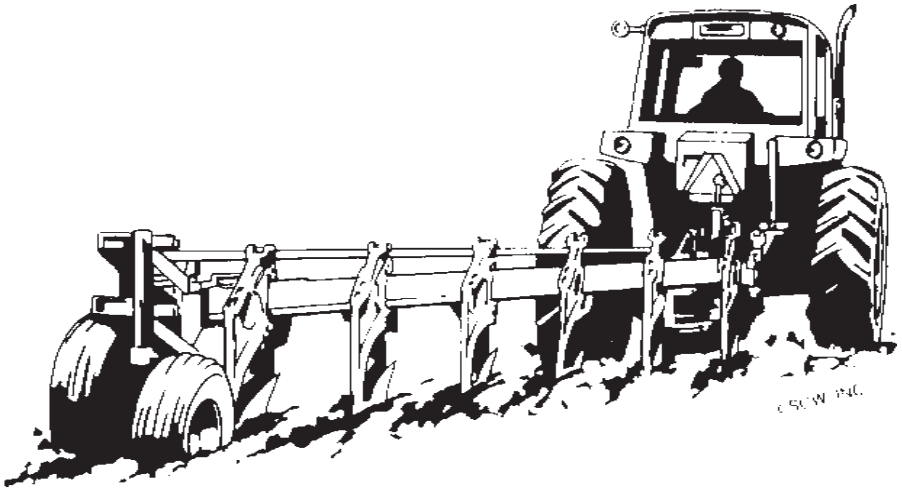
The farm's gross is up to $350,000 because of the added income from selling hogs. There is still lots of corn base, however, and this qualifies for a $15,000 commodity payment. The payment is 4.3 percent of gross income.

This farm is also heavily dependent upon equipment and non-renewable resources, and it has all of the usual expenses that go with grain farming. In addition, the hogs are raised in confinement and have no opportunity to provide useful work. Instead, feed and manure handling equipment add to the $114,355 total for this category. It comes to 32.7 percent of gross.

The operator of this farm is doing very well. Net farm income is $65,000 in a typical year. Almost 22 percent of gross goes to the jobs category, but the income shows the same split as the conventional grain farm—lots to the operator, very little for anyone else. The total bill for hired labor is barely $11,000.

Finally, the farm is substantially out of balance. After the hogs are fed, there is still $217,743 in feed grains to be sold to other farms. A relatively small amount of specialized feeds are also purchased, and the final balance indicator is 59.6 percent.

This farm shows that adding livestock alone does not always improve the financial indicators used here. It takes more equipment, not more people, to care for them in this case, and the problems of conventional grain farming are not addressed at all.



Monitoring Farm Sustainability with Financial Data

Conventional Grain, Finishing Hogs

Government Payments as Percent of Gross Income

Gross Income	350,000	
Agricultural Program Payments	15,000	
Ag Program Pmts / Gross Income (x 100) ==>		4.3 %

Energy and Machinery as Percentage of Gross Income

Chemicals	25,307	
Custom Hire (machine work)	254	
Depreciation on Equipment and Buildings	25,388	
Fertilizers and Lime	33,629	
Gasoline, Fuel, and Oil	7,390	
Rent or Lease Vehicles, Mach. & Equipment	1,240	
Repairs and Maintenance	18,499	
Utilities	2,648	
Total	114,355	
Total / Gross Income (x 100) ==>		32.7 %

Support for Local Families as Percentage of Gross Income

Employee Benefit Programs	0	
Labor Hired	11,291	
Pension and Profit Sharing Plans	0	
Net Farm Profit (or loss)	65,000	
Total	76,291	
Total / Gross Income (x 100) ==>		21.8 %

Indicator of Feed Production and Use Balance

Gross Income from Crops Sold for Feed	217,743	
Feed Purchased	9,194	
Difference	208,549	
Difference / Gross Income (x 100) ==>		59.6 %

A Conventional Dairy

The third example is a conventional Minnesota dairy milking 54 cows. The farm uses 225 acres to grow corn and hay. There are another 45 acres of conventional pasture and seventy or so acres of woodland.

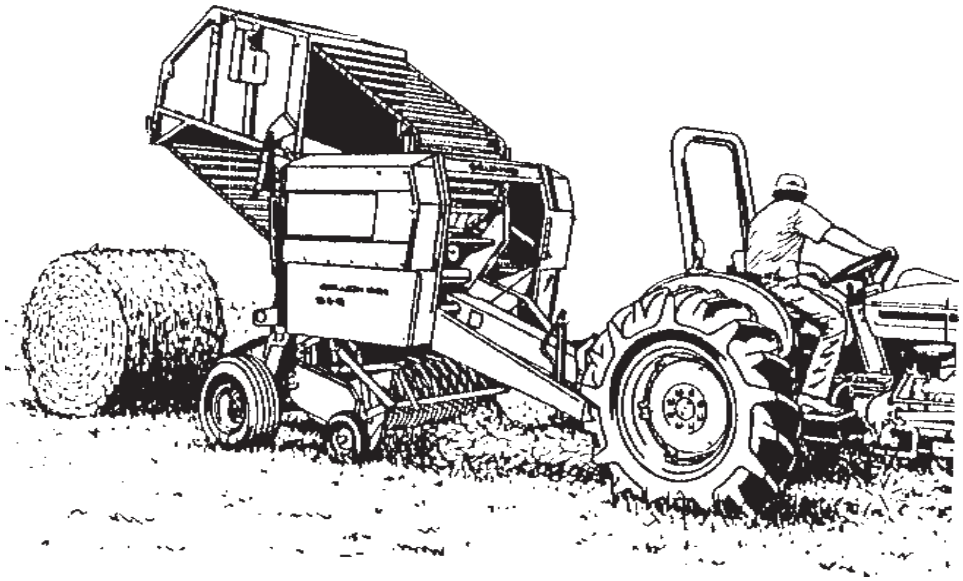
The farm grosses $161,000 and gets a $3,000 check from the government for growing corn. Program payments are less than two percent of gross income.

The farm is not much different from a grain farm in that it is top-heavy with equipment. There is corn equipment, hay equipment, feed handling equipment, manure handling equipment—you name it. It costs a lot to own this much equipment, and just as much to keep it running. When you add in chemicals and fertilizer for the crops, the bill for the second category comes to $47,500, or 29.5 percent of gross.

The farm hires some part time help at harvest time and occasionally gets some relief from milking. The majority of the $59,400 in this category, however, goes to the husband and wife who each work very hard for the $49,500 they are clearing. They wonder if it is really worth both of them working full time just to keep things going.

This farm, too, is out of balance, but not as badly. A small amount of corn and hay gets sold each year, and, in spite of 225 crop acres and another 45 acres in pasture, there is still $17,000 in feed which must be paid for.

Perhaps it is no wonder that Minnesota is losing almost three dairy farms every day. In spite of the gruelling work put in by husband and wife, suppliers of equipment and non-renewable resources still make as much as they do. And while the grain farmer works six to eight weeks a year, these folks are working 52 weeks a year tending crops and waiting hand and foot on milk cows.



Monitoring Farm Sustainability with Financial Data

Conventional Dairy

Government Payments as Percent of Gross Income

Gross Income	161,000	
Agricultural Program Payments	3,000	
Ag Program Pmts / Gross Income (x 100) ==>		1.9 %

Energy and Machinery as Percentage of Gross Income

Chemicals	2,100	
Custom Hire (machine work)	1,400	
Depreciation on Equipment and Buildings	17,000	
Fertilizers and Lime	3,400	
Gasoline, Fuel, and Oil	4,100	
Rent or Lease Vehicles, Mach. & Equipment	0	
Repairs and Maintenance	17,000	
Utilities	2,500	
Total	47,500	
Total / Gross Income (x 100) ==>		29.5 %

Support for Local Families as Percentage of Gross Income

Employee Benefit Programs	0	
Labor Hired	9,900	
Pension and Profit Sharing Plans	0	
Net Farm Profit (or loss)	49,500	
Total	59,400	
Total / Gross Income (x 100) ==>		36.9 %

Indicator of Feed Production and Use Balance

Gross Income from Crops Sold for Feed	2,900	
Feed Purchased	17,000	
Difference	–14,100	
Difference / Gross Income (x 100) ==>		–8.75 %

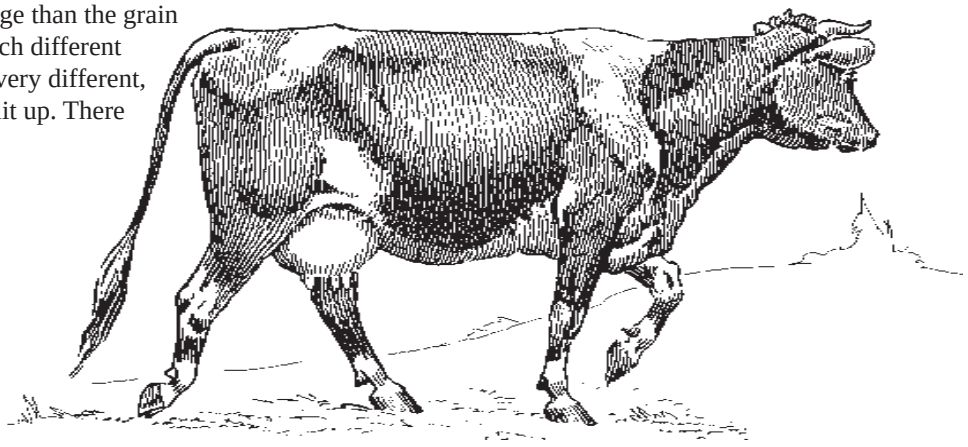
Grazing Dairy Cows

The fourth and final example is also a dairy. It has more cows than the dairy just described, has a lower gross income, and looks a whole lot better when seen with the new indicators. The big difference between this farm and the conventional dairy is that there is no corn grown on the farm. The farm's 250 acres are all in pasture which is carefully grazed for maximum production.

The farm grossed $149,318 in a recent year. Since there was no corn, the government saw no reason to help this operator at all. Perhaps the public will someday rethink its decision to single out the one farm which used no chemicals and no commercial fertilizer for such treatment!

The cows are not inside all day waiting to be fed and cleaned up after. They are out most of the year, spreading manure and harvesting feed. One result is that there is very little equipment on the farm. The total bill in this category, even counting custom hay harvesting and manure handling (you can only ask so much of cows in a Minnesota winter!), is $30,924, or 20.7 percent of gross. This is by far the lowest percentage for this category among the four example farms.

The third, or "jobs" category, shows $58,295, or 39 percent of gross. This is a far higher percentage than the grain operations have shown and is not much different than the conventional dairy. What is very different, however, is the way the income is split up. There is a much better balance between the operator and the hired help, and both get reasonable vacations and time with their families.



Finally, the farm is close to being in perfect balance. Some hay was sold, some feed was purchased, but the overall percent of gross was less than four percent.

This example shows that the answer to dairy financial problems does not necessarily lie in bigness. The problem to begin with is too much equipment, and buying more won't fix it. What works better in this example is creative management guided by thoughtful goals.

And compared to grain farming, there is no contest at all with these indicators. Grain farming, even with conventional livestock feeding, is heavy on equipment, light on jobs. Grazing dairy cows is the mirror image—light on equipment, heavy on jobs.

Monitoring Farm Sustainability with Financial Data

Grazing Dairy Cows

Government Payments as Percent of Gross Income

Gross Income	149,318	
Agricultural Program Payments	0	
Ag Program Pmts / Gross Income (x 100) ==>		0 %

Energy and Machinery as Percentage of Gross Income

Chemicals	0	
Custom Hire (machine work)	93,560	
Depreciation on Equipment and Buildings	8,000	
Fertilizers and Lime	0	
Gasoline, Fuel, and Oil	2,039	
Rent or Lease Vehicles, Mach. & Equipment	1,019	
Repairs and Maintenance	6,424	
Utilities	4,086	
Total	30,924	
Total / Gross Income (x 100) ==>		20.7 %

Support for Local Families as Percentage of Gross Income

Employee Benefit Programs	0	
Labor Hired	26,486	
Pension and Profit Sharing Plans	0	
Net Farm Profit (or loss)	31,809	
Total	58,295	
Total / Gross Income (x 100) ==>		39 %

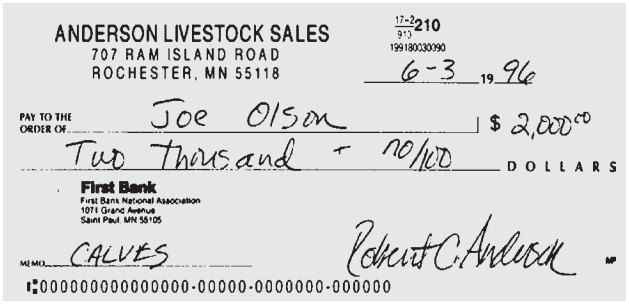
Indicator of Feed Production and Use Balance

Gross Income from Crops Sold for Feed	3,987	
Feed Purchased	9,678	
Difference	–5,691	
Difference / Gross Income (x 100) ==>		–3.8 %

How Do Profits Fit In?

There is general agreement that farms should be profitable, but not nearly as much consensus on just what that means. Economists see things one way, and most everyone else sees things another way.

For most everyone, except economists, the word "profit" means something like "what's left after the bills are paid" or "what's left for the family." Some might even go so far as to include "and something has been set aside to replace equipment and breeding stock," but that is about as far as it goes. Making profits, rather than defining the word, is vastly more important to regular people.


ANDERSON LIVESTOCK SALES
707 RAM ISLAND ROAD
ROCHESTER, MN 55118
17-2/910 210
199180030390
6-3 19 96
PAY TO THE ORDER OF Joe Olson $ 2,000.00
Two Thousand + 00/100 DOLLARS
First Bank
First Bank National Association
1071 Grand Avenue
Saint Paul, MN 55105
MEMO CALVES
Robert C. Anderson
⑆000000000000000-00000-0000000-000000

Economists generally have more time on their hands and consequently have thought a great deal more about exactly what the word profit should mean. The economist's definition is based not on making enough to live on, or even on having enough to buy a Buick, but on seeing that each resource used in production is making more than it could if it were used some other way.

The way profits are defined makes a difference in how they are measured. It also affects how profits fit into an overall system for becoming more sustainable.

The Economist View of Profits

Some of the costs economists use in calculating profits are very real in the sense that a check must be written to pay them. Buying feeder livestock is an example. Other costs, however, are more hypothetical in the sense that they represent income that could be gained in some other use of farm resources. Both types of costs are subtracted from income to determine profits in the sense economists use the term.

Land is a good example of how the economist's definition might seem unusual. What was originally paid for land used in farming is irrelevant. So is the size of the mortgage payment. Instead, economists subtract the full value of whatever could be made by letting someone else use the land at the going rate.

The labor and management provided by a farm family are treated the same way by economists. They are charged against gross income at whatever could be made doing something else off the farm. If a person can make $55,000 working in town, it doesn't matter if that same person can make $50,000 per year farming. It would not be profitable to farm, no matter how good $50,000 might look at first glance. To farm would be to lose $5,000 per year.

The Regular Person's View of Profits

The way land, labor, management, and other farm resources are often treated by economists is not only unusual, it can be downright dangerous. As they say in the TV commercial, "Don't try this at home!" Imagine going into a tax audit with a story like this: "Sure I made $50,000, but actually I didn't make a dime because I could have made more doing something else, so I am not paying any taxes this year." About the best you could hope for would be that your jail time would be spent in a minimum security facility.

This is not to say that the IRS doesn't have the words "Profit and Loss from Farming" in big letters right on top of the Schedule F tax form, because they do. And, furthermore, it doesn't mean that a farmer who drives a nice car and regularly pays his or her bills is not commonly thought of as "profitable."

The general way in which IRS asks that farm profits be calculated works well enough for day-to-day purposes. Common expenses actually paid, along with some estimate of depreciation for equipment and breeding livestock, are subtracted from farm income. The remaining "profit" is what is left to support the farm family.

Enough Versus Maximization

In this regular person's view of profits, whether a farm is profitable depends a bit on individual circumstances that economists don't consider. For example, a farmer could have long ago paid for land that has now become

much more valuable. The farmer might be easily paying his or her bills and living well, so in the regular person's sense, this farm is profitable. For economists, however, the land value makes all the difference in the world. This farmer may well be losing money by not selling out to developers and finding a job in town.

This points out the key difference between the economist and regular person's view of profits. The economist looks at making the maximum dollars possible, and the regular person looks at making "enough" dollars. The idea of "enough" is troubling to economists because it varies from person to person. The idea of "maximum" is troubling to most farmers because they see themselves as farmers, not as investors managing a portfolio of resources.

"Maximum" is a fine guiding principal if all that is being considered is profits. The only goal is making more. But in sustainable agriculture, there is always a balancing act among family, community, and environment that includes, but is not confined to, profits from farming. In this balancing act, the concepts of "enough" and "acceptable to me, if not everyone else" are simply more useful than maximization of profits or any other single goal.

The goal of making "enough" will not only vary from farm to farm, it will vary for the same farm as circumstances change. Farmers usually need off-farm income when they are getting started. Later on, things might turn more their way and what the farm is making becomes enough. And, as age brings wisdom, farmers might decide that having enough money has two sides: making more and needing less.

The important thing for sustainable agriculture is that "enough" at least leaves open the possibility of concentrating on other goals. "Maximization" will always have a reason to look only at profits.

Looking Ahead

The system shown in this report, like all financial analysis systems, is primarily one for looking back and seeing where you have been. It is useful for measuring your own progress and for making comparisons with other farms.

There are also many good tools for looking toward the future and seeing how you are going to move more toward "enough" while staying true to your other farming goals. Land Stewardship Project occasionally offers courses in Holistic Management throughout Minnesota, and many farmers have put HM planning tools to good use. Some conventional planning tools work well for these purposes, too, if only you are careful to keep all your goals, and not just profit, in mind.

Monitoring Farm Sustainability with Financial Data

Indicators Worksheet

Government Payments as Percent of Gross Income

Gross Income _____

Agricultural Program Payments _____

Ag Program Pmts / Gross Income (x 100) ==> _____

Energy and Machinery as Percentage of Gross Income

Chemicals _____

Custom Hire (machine work) _____

Depreciation on Equipment and Buildings _____

Fertilizers and Lime _____

Gasoline, Fuel, and Oil _____

Rent or Lease Vehicles, Mach. & Equipment _____

Repairs and Maintenance _____

Utilities _____

Total _____

Total / Gross Income (x 100) ==> _____

Support for Local Families as Percentage of Gross Income

Employee Benefit Programs _____

Labor Hired _____

Pension and Profit Sharing Plans _____

Net Farm Profit (or loss) _____

Total _____

Total / Gross Income (x 100) ==> _____

Indicator of Feed Production and Use Balance

Gross Income from Crops Sold for Feed _____

Feed Purchased _____

Difference _____

Difference / Gross Income (x 100) ==> _____

Monitoring

Birds

Birds can add color, song, and even joy to your farm. And, because birds respond to both short term and long term changes in habitat, they also serve as good "biodiversity barometers." Management decisions and practices that protect or restore a diversity of habitats not only can bring more birds to your farm, but also contribute to its sustainability. Monitoring bird movements and abundance can help you see the impact of management on biodiversity and ecosystem health.

What Is It?

This chapter describes a modified Point Count Method. The structured consistency of this method works well for tracking changes in bird presence and abundance due to changes in management.

Who Does It?

Any interested member of the farm family can learn to do bird counts. Working in pairs makes the process easier as one person observes and the other takes notes. You might also consider asking the help of someone with experience doing bird counts, perhaps a local bird club member or biologist.

When?

Bird breeding activity peaks between late May and early July. To take full advantage of the opportunity to observe migratory species on their nesting territories, do three counts spaced two weeks apart at each permanent sampling point, during calm weather.

Time Required

Plan on spending a minimum of ten minutes at each sampling point. The total time spent in the field depends on the number of sampling points and how long it takes to hike between them. Summarizing the results of your outing onto the record sheets at home requires a few more minutes.

Materials and Cost

A clipboard, a shoulder bag, pencils, binoculars, and a field guide can be obtained for about a hundred dollars. Higher quality binoculars will increase that figure. To record your observations, master copies of a Point Count Form and a Six-Year Record Sheet are included with the chapter. You will need to make photocopies from these masters.

CHAPTER CONTENTS

Getting Started

To make the most of your bird monitoring activities, spend some time considering why monitoring birds can be a helpful part of your farm management and what you want to learn from the process of monitoring birds.

Why Monitor Birds?

As you know, the sustainability of a farm depends on many factors, including sustaining the ecosystem base that supports the farm. Biodiversity is an important component of a sustainable, productive ecosystem base, and birds serve as good indicators of biodiversity.

Birds are good "biodiversity barometers" because they reflect habitat quality and respond quickly to changes in habitat conditions. Different habitats tend to attract different communities of bird species. Thus, improvements in habitat diversity often translate into increases in the number of different bird species on a farm. If habitat quality and diversity is maintained over time, birds may also experience improved nesting success, which in turn can help long term population levels.

Meadowlark

Conversely, population declines and losses in bird species over time can signal a loss of biodiversity and a weakening ecosystem, which may ultimately threaten the farm's long-term sustainability.

The biodiversity of any farm can be enhanced by implementing a management plan that creates or maintains the variety of habitats needed to support that diversity of life. (See Figure 1.) Options might include

- naturally landscaped areas around buildings;
- woodlands, groves, or brushy areas;
- grasslands, including pastures and hay fields;
- rest or reserve areas; and
- stream corridors, waterways, or wetlands.

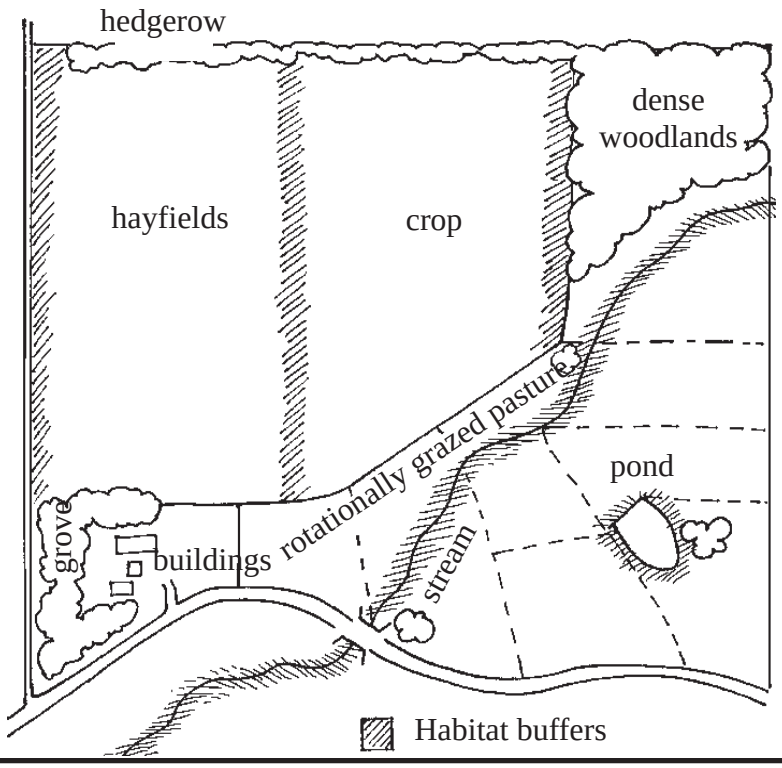


Figure 1: Possibilities for habitat diversity around the farm.

Develop a Monitoring Plan

Before heading out to the field, put together a clear and workable plan for monitoring birds. Use the following suggestions to help you with this process:

- Review the goals you and your family have set for your farm. Do they reflect an understanding of the importance of biodiversity and the need to sustain a healthy ecosystem?
- Summarize the main farming practices you use and rate them in terms of whether or not you think they enhance or discourage biodiversity on your farm.
- Do a quick assessment of the different habitat types already on your farm. Study the types of birds these habitats attract, as well as simple things you can do to start improving bird habitat. (See the "Additional Resources" section of this chapter for guidance.)
- Write down a few clear and workable objectives about what you want to learn from monitoring birds on your farm.

If the process of monitoring is new to you, be assured that you do not need to have everything figured out before hand. In fact, your first year of monitoring may simply be a way to familiarize yourself with birds, bird habitat, and the biodiversity conditions on your farm. Then, from this base of experience, you can begin to see different management possibilities. Most of all, be willing to learn from experience and enjoy yourself in the process.

Grassland Birds

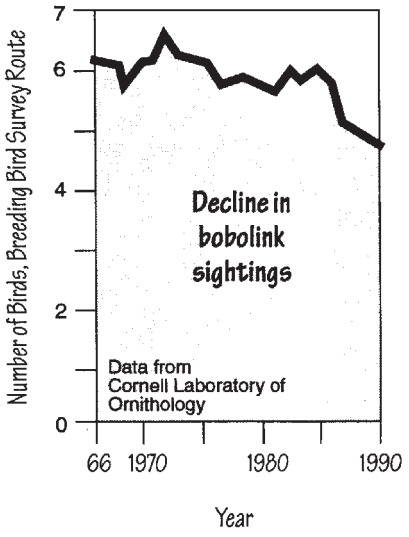
The need to protect or restore a diversity of habitats on farms is especially urgent for grassland nesting birds. Grassland birds have experienced steeper, more consistent, and more geographically widespread declines than any other group of North American migrant land birds. These declines are, in large part, due to the widespread increase during the last thirty to forty years of farming practices that destroy or severely alter grassland ecosystems.

In the Upper Midwest, a number of grassland nesting species have experienced population declines across all or in significant portions of the region:

- **several kinds of sparrows,** namely the grasshopper, the vesper, the savanna, and the field, which migrate to the southern United States or northern Mexico for the winter;
- **eastern and western meadowlarks,** which also winter in the southern United States and norther Mexico; and
- **dickcissels and bobolinks,** which pass all the way through Central America and winter from Venezuela to Brazil.

The grassland birds winter as far away as Venezuela and Brazil.

The bobolink is one of many grassland birds that have experienced declining populations.



Survival Strategies of Grassland Nesting Birds

One survival strategy of many grassland species is polygamy. If conditions are favorable and a male's territory is attractive, more than one female may choose to nest in the area. The male invests the most time and energy assisting with the brood of his first mate, but may also spend time caring for the young of a second, or even a third, mate.

Scattering is another strategy used by grassland birds to increase nesting success. A clutch usually consists of four to six eggs and after about ten to twelve days incubation, the young hatch and are out of the nest in less than two weeks. The young then scatter into cover and signal for the adults to bring food with insect-like chipping. This mobility helps young birds avoid predators, as well as nest disturbance or destruction by wild herbivores or domestic livestock. Also, most females will renest if they lose their eggs or hatchlings to predators.

A Focus of Monitoring Project Farmers

The fact that each of the farms participating in the Monitoring Project had hay fields and rotationally grazed pasture provided the Project farmers with a good opportunity to focus their bird monitoring activities on grassland nesting birds. In general, they wanted to know which farming practices could best help create a habitat that attracted these birds and enable them to nest successfully.

Working with the other Monitoring Project team members, the farmers identified several specific objectives:

- to document the presence (or absence) of grassland nesting birds on their farms,
- to determine whether or not the birds were nesting in their pastures and hayfields,
- to see how the birds responded to rest areas within their grazing system, and
- to determine the presence (or absence) of the birds on several nearby conventionally cropped farms.

After the first three seasons of using the Point Count Method described in this chapter, the farmers' findings were hopeful. The presence of the previously listed grassland species was confirmed on all six farms. Nesting success was verified at several locations, including designated rest areas. The counts conducted on the conventionally cropped farms confirmed the absence of these birds.

Consider Grassland Birds in Your Monitoring

If you have any grassland habitat on or near your farm, consider making grassland birds a focus in your bird monitoring activities. Grassland birds must become the concern of more farmers if their numbers are to improve. And, the open character of their habitat makes them easier to see (compared to woodland birds) and therefore easier to monitor. The relatively smaller number of species associated with grassland habitats also means fewer species to learn to identify.

Managing for Grassland Birds

During the first three years of the Monitoring Project, team farmers identified many of the bird species that respond to improved grassland nesting habitat in their pastures and hay fields.

When clipping a grazing paddock after the nesting season one farmer saw a meadowlark with six young flying up from the grass. His observation suggests that this grass-nesting bird had been able to raise young in a pasture being managed with rotational grazing. This finding is particularly significant because recent Breeding Bird Survey Routes conducted in southeast Minnesota have shown very low numbers of meadowlarks.

Management Intensive Grazing

Management intensive (or rotational) grazing involves dividing a pasture into smaller sections called *paddocks*, and then controlling when the animals enter a paddock to graze and how long they stay there. At the appropriate time, which depends on a variety of factors like grass growth rates and stock density, the animals are removed and rotated to a fresh paddock. Once the animals are removed from the paddock, they are not allowed back into it until the grasses have recovered from being grazed.

Not only does management intensive grazing allow farmers to manage for optimal grass production, it also enables them to create a grazing plan that can accommodate the needs of wildlife that depend on a grassland habitat.

Rest Areas

One strategy favorable to grassland nesting birds that Monitoring Project farmers worked into their grazing plans was to set aside one or more paddocks (or portions of paddocks) and leave these areas ungrazed during the nesting season. No animals were allowed to graze the rest areas from the beginning of the grazing season in mid to late April until at least the end of July. This allowed pasture vegetation to grow taller and more mature than vegetation in neighboring paddocks being grazed.

Based on two years experience and observation, these rest areas appear to help improve bird nesting success because they provide a place for birds to nest undisturbed. And, when birds attempting to nest in nearby paddocks are disturbed by livestock or machines, the rest area gives these birds the opportunity to relocate and renest. Monitoring Project farmers saw concentrations of bobolinks and dickcissels taking advantage of the cover provided by the rest areas. The farmers also saw side benefits in the rested paddocks: increased root growth (which improves soil structure and drought tolerance) and increased seed production (especially of clovers and other legumes.

Other Strategies

In addition to using rest areas, the Monitoring Project farmers looked for ways to avoid nesting disruptions caused by pasture clipping, grazing, and haying, but without dramatically affecting pasture and hay production.

One strategy was to reduce or delay pasture clipping to allow fledglings to achieve some level of mobility before the mower disrupts the nest. Another was to stop the practice of clipping altogether. One of the farmers with a beef herd did not clip any of his paddocks one season, without any noticeably negative affect on pasture or herd productivity. And, he was happy to observe a number of male dickcissels singing from perches on taller plants.

Although active nests were sometimes left intact following grazing by cattle, the results were not always as positive when it came to mechanical grass harvesting. “I cut hay on our other farm and I must have destroyed several bobolink nests,” said one farmer, “the adults were all circling, screaming at me.”

Monitoring Project farmers also experimented with several methods to reduce nesting disruption from hay making, including delaying the first cutting of hay as long as possible.

Flushing bars also help reduce loss of nesting ducks, songbirds, and other wildlife from mower blades. These devices, which flush wildlife before the mower blade gets them, have been around in one form or another for years. Several organizations have information on designs for lighter, more effective front-mounted flushing bars for pull-type mowers:

Ducks Unlimited Canada at P.O. Box 1160, Stonewall, Manitoba, Canada, ROC 2Z0. Phone: 1-800-665-DUCK (3825); e-mail: webfoot@ducks.ca; website: www.ducks.ca/index.html

California Waterfowl Association at 4630 Northgate Blvd., Suite 150, Sacramento, CA 95834. (916) 648-1406; website: www.calwaterfowl.org

The Point Count Method

This chapter teaches how to use a modified Point Count Method to monitor birds. With this method, you establish several fixed points from which you observe and count birds over time. While other less structured methods can be used to monitor birds, the Point Count Method brings a higher level of consistency to your monitoring activities. By avoiding even slight changes in location and by making sure that you are consistent in your timing from year to year, you can lend more validity to your observations.

Bluebird

A Useful Tool in All Habitats

The Point Count Method can be used to monitor birds in different habitats:

- **In grassland habitats:** This method works well for monitoring birds associated with the open spaces of grassland habitat, such as pastures, hay fields, unmowed or rested areas, and even larger grass waterways.

- **In wetland or stream habitats:** This method also works well for monitoring waterfowl, wading birds, and shorebirds associated with water-dominated habitat, including wetlands, streams, and even farm ponds. Counts done during migration and nesting seasons help track changing habitat conditions and the activities of different species throughout the year.

- **In wooded habitats:** The Point Count Method can also be used in wooded habitats, although it becomes slightly more difficult. Woodlands are home to more species of birds, which you will need to learn to identify, and they are harder to observe. This is especially true in larger, more dense woodlands where it is difficult to see except within a short radius. In this situation you will probably hear more birds than you see. This limited visibility reduces the usefulness of the method to the inexperienced birder. If, on the other hand, the main wooded area of your farm is a grove or shelterbelt, the method works fine as described.

- **At the boundaries between habitats:** The boundary between two habitat types, called *edges,* are also excellent places to conduct bird counts. Edge counts are particularly good for monitoring the diversity of birds on the farm because they capture species using both habitats plus those that are specifically attracted to edge conditions.

- **Around the farmyard:** Using a fixed point to count birds works very well around the farmyard, where you may also see a mixture of birds from different habitats.

How to Select Point Locations

The first step in the Point Count Method, then, is to select point locations that are representative of the various different habitat types on your farm. Points can be positioned in the middle of a field or paddock, or they can be located at the edge of a wooded area or a stream corridor. They can

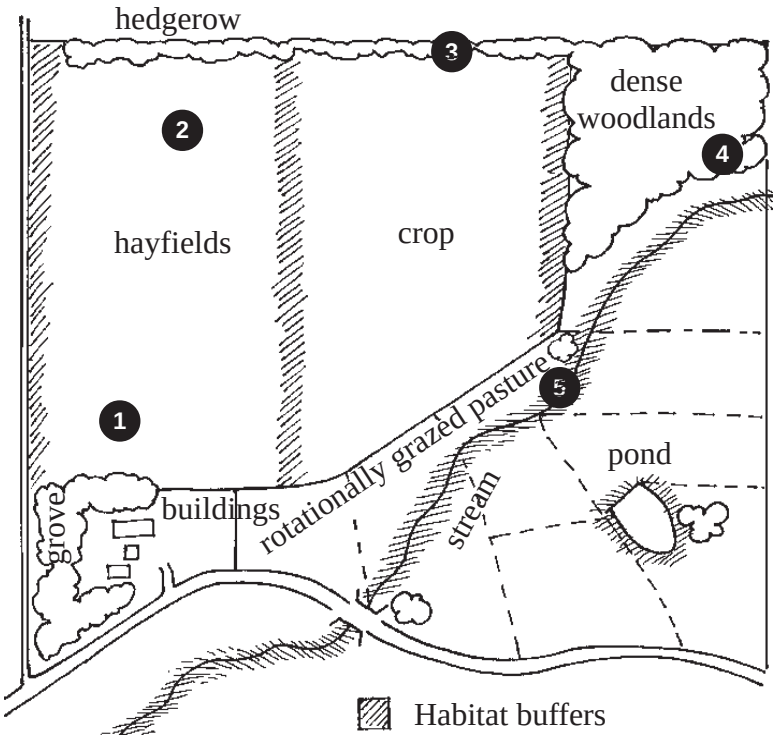


Figure 2: Decide on the best hiking route for your point counts and label your sites accordingly.

also be placed at a corner where different farming practices meet. The main thing to remember with the Point Count Method is this: **always stand at the same place when counting.**

To ensure this, use known distances from fence posts or other reference marks when selecting a point. Use photographs to help you pinpoint a location if fixed markers are not available or desired. If necessary, mark point locations with plastic flags; however, use them sparingly and discretely to avoid disturbing birds on their territories. Place markers a reasonable distance from the sampling point on the N-S or E-W axis, pace off the distance, and write it down.

Mark each point location on a copy of your farm map, then decide on the best hiking route and label your sites accordingly. (See Figure 2.) In a field notebook or journal, write down a detailed description of each point's location and your reasons for choosing it as a monitoring site. This information will be helpful for drawing conclusions from your observations and acts as a backup in case you lose your map.

When to Schedule Counts

Birds tend to be most visible and vocal during the breeding season, generally between late May and early July, making this the best time to conduct counts. By this time the early surge of migrant species has passed through and resident species have settled into their nests. Counts are also completed about the time territorial nesting behavior tapers off.

Plan on doing three counts per year at each point, spaced at roughly two-week intervals. All counts should be done between 6:00 and 9:00 A.M., in calm weather. Also, plan on conducting counts for at least three consecutive years, six if possible. Ideally, systematic observation and record keeping becomes a regular, and life-long part of your farm management.

If you would feel more comfortable doing your first count with someone who has done them before, contact a local bird club member or a natural resource agency biologist for assistance. This is a great way to build confidence in using the procedure and to refine observation skills.

Dates for point counts

Count 1 during:May 25–June 10
Count 2 during:June 11–25
Count 3 during:June 26-July 10

Binoculars: An Essential Tool

Investing in a good pair of binoculars is guaranteed to improve your birding skills and enjoyment.

Binoculars come in a wide variety of lens powers and field widths. Either a 7 x 35 or 7 x 50 (same power lens but wider field of view) model works well. Many birders consider 8 x 40 models to be ideal. Remember that the higher the lens power, the more you will notice shakiness. Compact binoculars can also be jittery.

Solid binoculars with sharp optics generally cost between $150 and $200. Serious birders might spend twice that or more for sharper optics and better durability. Cheaper models ($50-$100) will suffice for light use.

Always protect your binoculars from hard jolts and vibrations as these offset the prisms. Prism damage is hard on the eyes and cannot always be fixed.

And, while one person can conduct accurate bird counts, a team approach can be more effective and enjoyable because it enables one person to make observations while the other person takes notes. If you have trouble hearing high-pitched bird songs, you should team up with a sharp-eared partner.

How to Conduct Counts

On the morning of the count, load the following equipment into a cloth or leather shoulder bag, lined with a plastic bag to keep your things dry:

- enough photocopies of the Point Count Form for each point site, plus a few extra, attached to a clipboard
- sharpened pencils with erasers
- a birding field guide

Be sure to take a watch with you, as well as your binoculars. Also, consider bringing a snapshot camera and using photographs to capture site conditions and characteristics.

A master copy of the Point Count Form (the data sheet with the "bull's-eye and cross hairs") is provided at the end of the chapter, along with a Six-Year Record Sheet. Use these master copies to make photocopies.

At the Point Sites

At each point site, fill out the information at the top of the Point Count Form. Write neatly and in pencil; completely erase any changes or mistakes. The center of the cross hairs on the form represents where you are standing; the inside circle represents a distance of fifty yards out from center and the outside circle a hundred yards. Add reference marks for such things as trees, fences, and buildings.

Then, record all the birds you hear and see during a ten minute period. If working with a partner, keep conversation hushed and to a minimum. Record the bird activity on the form. For instance:

- Show flyovers by name and number with directional arrows.
- Note the location and identity of birds heard singing but not observed.
- Note females feeding young or acting broody.
- Show the relative locations of territorial males.
- Put a question mark (?) after any uncertain identifications.

Refer to the example on the opposite page. Follow the same procedure at each site. Six to eight points can be easily counted in two hours.

At Home

Upon returning home, transfer all of the count results onto the Six-Year Record Sheet. (See the example on the right.) Put this and the day's Point Count Forms into a notebook or file for safekeeping. Any migration

Monitoring Birds

Point Count Form

Date _____ Time _____

Point No. 5 Count No. 1 (2) 3 Year No. (1) 2 3 4 5 6

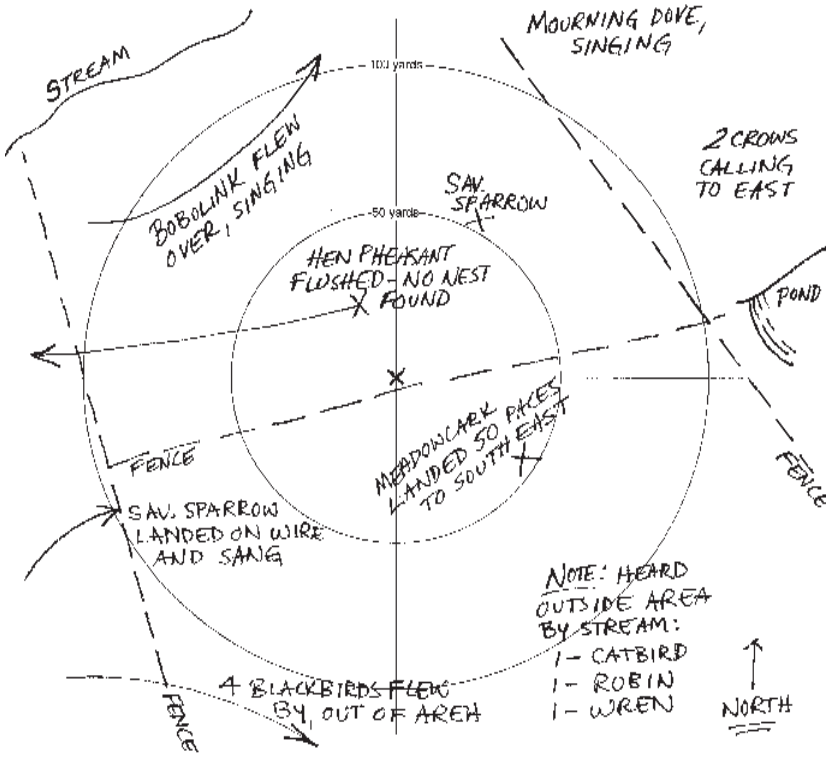
Location NEXT TO FENCE, PASTURE WEST OF POND

Observers J. OLSON, B. SMITH

Weather CLEAR, ABOUT 70°, S WIND 10 MPH

Habitat type REST PADDOCK, UNPASTURED SINCE '96

Vegetation notes MIXED GRASS & CLOVER, 18" TALL



Examples of a filled-out point count form and a six-year record sheet

Monitoring Birds

Six-Year Record Sheet

YEARS	YEAR 1: 1998				YEAR 2:	
COUNT NO.	1	2	3	TOTAL	1	2
MONTH/DAY	5/28	6/15				
Savanna Spar.	1	4				
Grasshop. Spar.	–	–				
Vesper Spar.	–	–				
Field Sparrow	–	–				
E. Meadowlark	2	1				
W. Meadowlark	–	–				
Bobolink	–	–				
Dickcissel	–	–				
Sedge Wren	–	1				
Bluebird	–	–				
Killdeer	2	2				
Blackbird	2	2				
Pheasant	–	1				
Seen or heard outside area:						
song spar.	2	–				
R.T. hawk	–	1				
Catbird	1	1				
Crow	1	2				
Wren	–	1				
Robin	–	1				

observations, unusual sightings, or other natural history notes can be recorded in your field notebook or journal.

Remember, your first season of conducting counts helps you establish a baseline of information. This baseline lets you compare observations made in future years and monitor how birds respond to changes in management. New points can be set up and counted as needed to monitor managed areas. If it makes sense to drop an area, do so. Also, feel free to revise your monitoring objectives as you become more experienced and as you make changes in your management.

Some Monitoring Cautions

The approach suggested in this chapter works well for monitoring birds in a farm setting and within the parameters of the farm family's goals. It is especially useful for defining a baseline of information and then documenting changes through time using a consistent method of observing.

Avoid Comparisons with Other Farms ✔

This monitoring tool is not, however, designed for making comparisons between different farms, as might be done within a scientific research study looking at regional trends. Even though the same count method might be used in a scientific study, the differences in skill, experience, and technique among the people doing the farm monitoring counts introduces too much variability to allow for meaningful comparisons between different farms or regions.

Savannah sparrow

You might also want to take this kind of variability into account when analyzing your results if the counts are not done by the same person or team, or during the same time period, from year to year. Remember too, that some species are more visible and others more secretive. This also may affect results and influence the way your records should be interpreted.

Keep Disturbance to a Minimum ✔

Human disturbance always introduces some bias into monitoring results, whether from farm activity or simply from the act of going out and observing. In fact, intensive searches may cause some females to abandon nests. Predators and nest parasites like cowbirds often are aware of and respond to human activity, making the birds you are investigating more vulnerable. For these reasons, always strive to keep disturbance to a minimum when conducting your bird counts.

Acknowledge the Big Picture ✔

Remember this caution as well when interpreting your results: migratory birds are also vulnerable to habitat loss in their wintering areas. Disappearance or declining numbers of species may reflect hemispheric trends and not necessarily what you are doing on your farm. Local management to improve nesting success may not be enough to overcome wider trends.

Sharing Information

As you become more comfortable with the process of monitoring and start observing connections between farming practices, habitat loss or gains, and bird counts, you may find that it becomes increasingly important to regularly share information with others doing similar activities. Connecting with others can be especially useful when exploring management strategies that promote biodiversity restoration.

Here are some possibilities you might pursue:

- Join the local chapter of a sustainable agriculture organization and attend field days.
- Connect with local schools or nature groups like the local chapter of the Audubon Society.
- Contact your state Department of Natural Resources or other natural resource agencies for ideas on what you can do to make your farm more bird friendly.
- Make use of emerging communication technologies like the Internet to check out the World Wide Web home pages of organizations, universities, and resource agencies.

Also, feel free to contact the Land Stewardship Project with feedback on your monitoring experiences.

Additional Resources

Tap into the vast resources available on birds to enhance your monitoring activities and to learn more about how to create and maintain bird habitat.

Many of the materials described below can be purchased from local bookstores, bird feeding supply stores, or the American Birding Association (see the ABA listing on page 14 of this chapter for address and phone information). Check with your local library as well to see what might be available through interlibrary loan.

Field Guides

A good field guide is a valuable tool for any level of bird monitoring.

Birders Guide to Minnesota, 3rd Edition, by Kim Eckert. (Plymouth, MN: Williams Publishing, Inc., 1994.)

A county-by-county guide to over 800 birding locations throughout the state, including an annotated list of Minnesota birds, selected identification hints and over 200 detailed maps. (If you live outside Minnesota, check with the ABA catalog for a birding guide for your state.)

Guide to Field Identification: Birds of North America, by C. S. Robbins, B. Bruun, and H. S. Zim. (New York: Golden Press, 1983.)

A thoroughly revised update to the first edition published in 1966. Contains full-color illustrations of birds in typical habitats. Text, sonagrams, and range maps appear on pages facing illustrations.

Field Guide to the Birds of North America, National Geographic Society, 2nd edition. (Washington, DC, 1987.)

A comprehensive guide that contains all North American breeding species and many vagrants, accidentals, and exotics. Its 220 color plates provide plumage variations for many species. Color range maps and descriptive information are located on the pages facing the relative plates. The text covers identification, breeding, habitat, and vocalizations.

Field Guide to Birds East of the Rockies, by Roger Tory Peterson. (Boston: Houghton Mifflin Co., 1980.)

Covers North America east of the one hundredth meridian. Includes 136 full-color plates for easy identification and 390 three-color range maps. The Peterson System of pinpointing key fieldmarks on the schematic illustrations is an invaluable aid to beginners.

The Birders Handbook: A Field Guide to the Natural History of North American Birds, by Paul R. Ehrlich, David S. Dobkin, and Darryl Wheye. (New York: Simon & Schuster, 1988.)

A unique handbook designed as a companion for field identification guides. Contains accounts of the natural history of all species known to breed regularly north of Mexico, as well as short essays detailing interesting topics related to each species.

Other useful guide-related items available from the American Birding Association include the ***ABA Checklist and Trip List*** to record your trip or life-long sightings, and the ***ABA Fieldcard,*** which contains all the regularly occurring species in an ABA Checklist Area.

Other Bird Books

The Minnesota Department of Natural Resources offers the following three books by Carrol Henderson; all are available from the DNR Bookstore at (651) 797-3000 or (800) 657-3757.

Landscaping For Wildlife. (St. Paul, MN: State of Minnesota, Dept. of Administration, Communications Media Division, 1987.)

Offers easy-to-follow, affordable landscape plans to enhance wildlife habitat in the Midwest climate.

Wild About Birds: The DNR Bird Feeding Guide. (St. Paul, MN: State of Minnesota, Dep't. of Administration, Communications Media Division, 1995.)

Provides techniques used by the author to double the number of species using his feeders. Includes woodshop basics for construction of 26 different feeders, tips on 44 types of food, plus detailed descriptions and photos of almost all 69 bird species east of the Rocky Mountains.

Woodworking For Wildlife: Homes for Birds and Mammals.
(St. Paul, MN: State of Minnesota, Dep't. of Administration, Communications Media Division, 1992.)

Features numerous diagrams for building shelters for birds and mammals. Includes plans for the Peterson Bluebird house, bat houses, platforms for the great horned owl, wood duck nest boxes, and more. Offers information on 50 species of birds and mammals.

Bird Videos

The following two videos offer general birding instructions for the beginning birder. Other available videos cover more detailed information on specific species. Many birding videos are available through interlibrary loan or can be purchased from the American Birding Association. Or, check with a local birding group to see if they have any videos to borrow or rent.

How to Start Watching Birds, by Diane Porter. 90 minutes. (Fairfield, IA: Ideaform, 1994.)

Covers everything a beginning birder needs to know to start birding. Demonstrates how and why of bird observations and what significant details to look for when identifying a bird. Shows how to use a field guide and tells when and where to find birds. Tells about birding etiquette, binoculars, and various birding resources: organizations, books, magazines, and audio aids.

Techniques of Birding, by Arnold Small. 69 minutes. (South Laguna, CA: Nature Video, 1985.)

Offers instructions on birding techniques aimed at beginning birders. Covers field guides, binoculars and scopes, photography, "pishing," field identification techniques, and sport birding. Features 109 species.

Bird Song Resources

Bird song cassette tapes or compact discs are the best way to learn how to identify birds by their calls. With repeated listening and field experience, songs will stick in your memory. **A note of caution:** Do not play song tapes out in the field. Some species might abandon their nests because of it.

Birding By Ear: Guide to Bird Song Identification, by Richard K. Walton and Robert W. Lawson. 3 cassettes or CDs and 64-page booklet. (Boston: Houghton Mifflin Co., 1989.)

This system teaches various techniques that give you a method for learning the songs of 85 common species occurring in the Eastern and Central United States. These techniques can then be applied to learn the songs of birds not featured.

Field Guide to Bird Songs of Eastern and Central North America, edited by Roger Tory Peterson. 2 cassettes or 1 CD. (Boston: Houghton Mifflin Co., 1983.)

Keyed by page number to the Peterson's *Field Guide to Birds East of the Rockies* and features recorded songs and calls for over 250 species.

Guide to Bird Sounds. 2 cassettes or 1 CD. (Ithica, NY: Cornell Laboratory of Ornithology, 1985.)

Keyed by page number to the National Geographic Society's *Field Guide to the Birds of North America*, both editions. Calls, songs, trills, and other sounds are recorded for 179 species.

Know Your Bird Sounds, Vol. 1, by Lang Elliot. 65 minute cassette. (Minocqua, WI: NorthSound Music Group, 1991.)

Features the songs, calls, screeches, and alarm calls of 35 common species. Becoming familiar with these will help you pick out and identify birds with unfamiliar songs calls.

Bird Song Master, by Gary A. Schumacher. Version 2.2, Mac or PC. (Columbus, OH: Micro Wizard, 1996)

A computer software program that, along with a CD-ROM drive, gives you many ways to manipulate the bird songs contained on the CD versions of the Peterson's *Field Guide to Bird Songs* (Eastern and Western) and the National Geographic Society's *Guide to Bird Sounds*.

Organizations and Programs

American Birding Association (ABA) promotes recreational birding, contributes to the development of bird identification and population study, and fosters public appreciation of birds and their vital role in the environment. It publishes a bi-monthly journal *Birding*, the lively monthly newsletter *Winging It*, and the quarterly newsletter *A Birds-Eye View* for young birders.

Contact the ABA at 4945 N. 30th St., Suite 200, Colorado Springs, CO 80919; e-mail: member@aba.org; phone: (800) 850-2473 or (719) 578-9703. To order books offered by the ABA, contact (800) 634-7736 or www.abasales.com.

National Audubon Society/Minnesota Audubon Council (MAC) has thirteen chapters throughout Minnesota with members skilled at bird identification. To connect with an Audubon birder in your area call or write Audubon Minnesota at 2357 Ventura Drive, Ste. 106, St. Paul, MN 55125; phone: 651-739-9332; website: www.audubon.org/chapter/mn/mn; e-mail: mnaudubon@audubon.org.

Partners in Flight is a cooperative effort of federal government agencies, states and provinces, private corporations, and non-governmental conservation organizations, to maintain populations of forest and grassland neotropical migratory birds in the America's. Website: www.pwrc.usgs.gov/pif.

Articles

"Canary in a farm field" is an article by Jodi Dansingburg and Brian DeVore that appeared in the December 1997 ***Land Stewardship Letter*** (Vol. 50, No. 6), a publication of the Land Stewardship Project. It describes how farmers are using birds as indicators of environmental and agronomic health. The article is at www.landstewardshipproject.org/lsl/lspv15n6.html.

Monitoring Birds

Point Count Form

Date _____ Time _____

Point No. _____ Count No. 1 2 3 Year No. 1 2 3 4 5 6

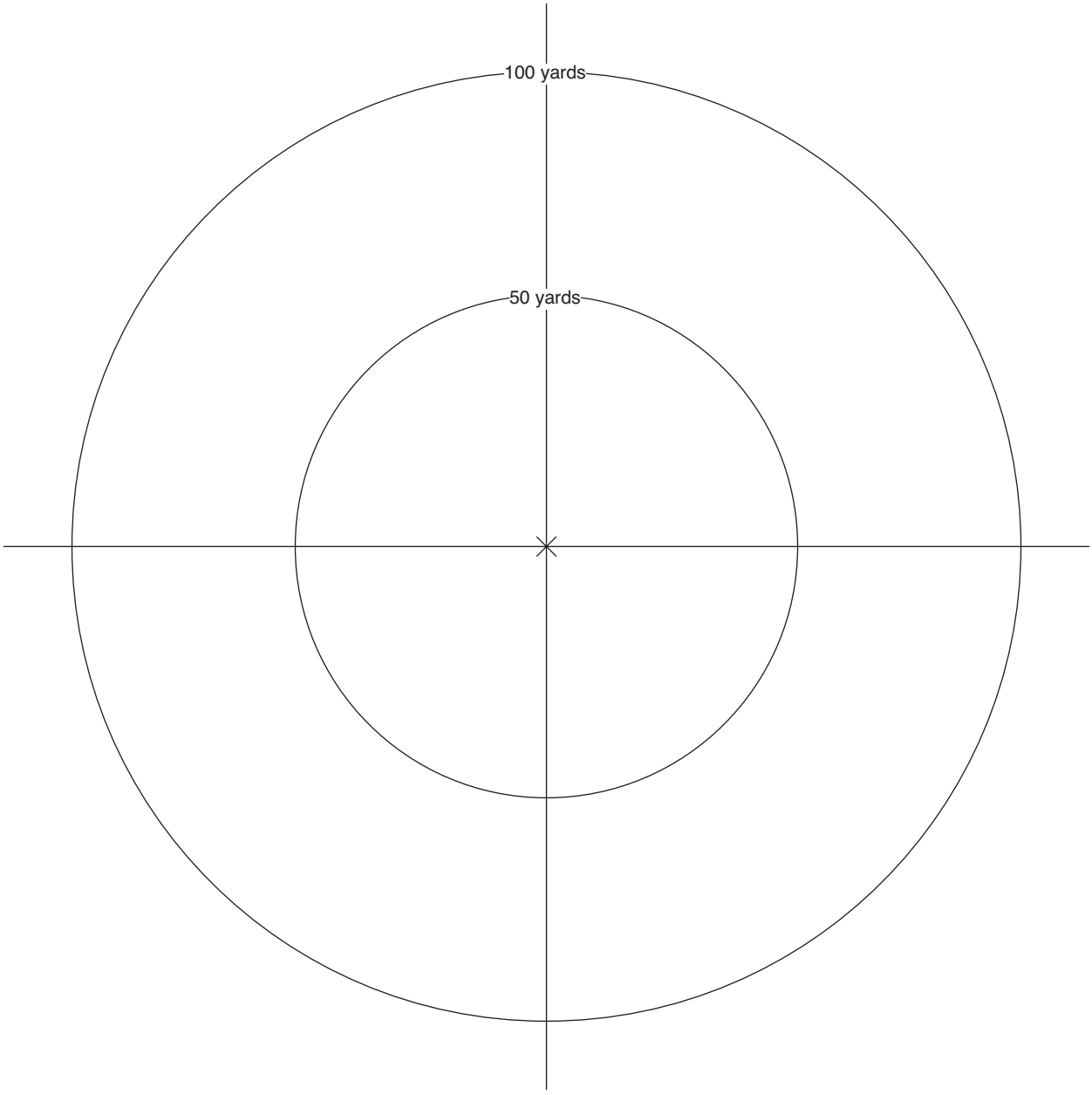
Location _____

Observers _____

Weather _____

Habitat type _____

Vegetation notes _____



Monitoring Birds

Six-Year Record Sheet

Location _____ Point No. _____

YEARS	YEAR 1:				YEAR 2:				YEAR 3:				YEAR 4:				YEAR 5:				YEAR 6:			
COUNT NO.	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL	1	2	3	TOTAL
MONTH/DAY																								

Monitoring

Frogs and Toads

Management practices that enhance the environmental health of your farm are also capable of producing an abundance of frog and toad species. Because of their sensitivity to changes in water quality and land use practices, monitoring frog and toad populations can help you assess the environmental impact of your management practices.

What Is It?

Monitoring frogs and toads involves learning the calls of the different species and then listening for them three times a year at one or more points on your farm. A free audio cassette tape from which to learn the calls is provided.

Who Does It?

Any interested member of the family can learn the frog and toad calls and do the listening counts. Working with others can add to the effectiveness and enjoyment of your monitoring activities.

When?

Listening counts should be done once, at twilight or later, during each of the three count periods: early spring, late spring, and summer.

Time Required

A listening route with three sites might take an hour, depending on the length of the route. The actual time spent listening is five or ten minutes. Preparation time needed to learn the calls will vary from person to person.

Materials

At home, you will need an audio cassette player to learn the calls. On the counts, you will need a pencil and clipboard, a flashlight, the Frog and Toad Identification Guide, and photocopies of the Frog and Toad Record Sheet. The guide and a master copy of the record sheet are provided.

Getting Started

CHAPTER CONTENTS

In recent years, the worldwide decline of amphibians has drawn the attention of citizens and scientists alike. In the midwestern United States, frog and toad populations have dropped dramatically over the last several decades due to extensive loss of wetland habitat and increased degradation of water quality. This sensitivity to changes in land use and water quality makes amphibians good indicators of environmental health. And, while the larger picture may be rather bleak, frogs and toads can quickly respond to changes in local habitat conditions.

Enhancing Environmental Health

Management practices that enhance the overall environmental health of your farm are also capable of producing an abundance of frog and toad species.

Biodiversity plays a vital role in sustaining the environmental health of a farm. Ensuring biodiversity requires management decisions that promote a diversity of habitats on the farm, some of which can provide habitat needed by frogs and toads. These include streams, wetlands, permanent and seasonal ponds, grasslands, and woodlands. Practices that promote good water quality also help increase the abundance of these animals. Even improvements in soil structure help species like the American Toad, which burrows below the frost line to overwinter in upland sites away from water.

Why I Monitor Frogs and Toads

Monitoring Project farmer Ralph Lentz explains why he monitors frogs and toads on his farm near Lake City, Minnesota:

> The frogs get singing on our place a little earlier in the spring than in most other places. This is probably because of the spring-fed pond and relatively warm water temperatures. What I hope to observe as I improve vegetative cover and water quality through rotational grazing that includes areas of extended rest is an increase in the abundance of frogs and toads. I think I am already seeing this, but I will be paying closer attention as time goes on. Paying attention to frogs and toads and other stuff causes me to see things I was not looking for and helps me better define my management in terms of soil health, water quality, diversity, and choices for future generations.

Steps before Monitoring

Before heading out to monitor for frogs and toads on your farm, consider doing the following suggestions:

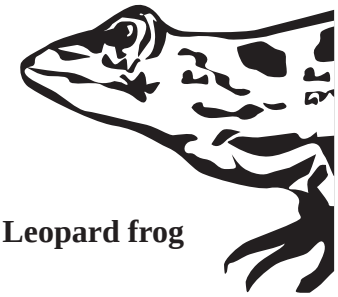
- Review the goals you and your family have set for your farm. Do they reflect an understanding of the importance of biodiversity in sustaining a healthy environment?
- Summarize the main farming practices you use and rate them in terms of whether or not they enhance or harm the environmental health of your farm.
- Write down a few clear and workable objectives about what you want to learn from monitoring frogs and toads on your farm.

Follow up your monitoring activities by investigating ways to improve the health of your farm's natural resources.

Some Monitoring Cautions

While frogs and toads can quickly respond to improvements in local habitat conditions, they do not travel great distances. If your farm currently has no frogs or toads or is missing some species, colonization could take some time. Certain species may not appear if your farm is not within their historic territory.

Conditions such as long-term drought or sources of water quality degradation beyond your direct control can also delay or diminish the response to improved habitat conditions on your farm. In other words, be cautious of how you interpret the information gathered from monitoring frogs and toads on your farm, especially in the short-term.



Leopard frog

Frog and Toad Monitoring Tools

The main tool used to monitor frogs and toads involves conducting listening counts three times a year: early spring, late spring, and summer. This method has proven to be an effective and simple way to monitor frogs and toads for both lay and professional observers.

Prep Work

Prior to doing the listening counts, you will need to do some preparation work.

Learn the Calls

Several weeks before doing your first count, begin listening to the audio cassette tape "Frogs and Toads Found in Minnesota," included with the *Tool Box*, to learn the identifying calls. Also, review the descriptions of the calls given on the Frog and Toad Identification Guide included with this chapter.

Listen and review as often as you need to in order to feel comfortable about your ability to identify the different species this way. Try listening to the tape at times when you might normally listen to the radio, such as driving to town or doing the dishes. Just remember that repeated listenings is a more effective learning strategy than "crash studying."

Select Listening Sites

Do a quick assessment of the different habitat types on your farm and identify those that might provide good frog and toad habitat. From among these, select at least one as a listening site. If you establish several listening sites, make sure they are far enough apart so that the calls from one site are not confused with calls from another site. You could also establish

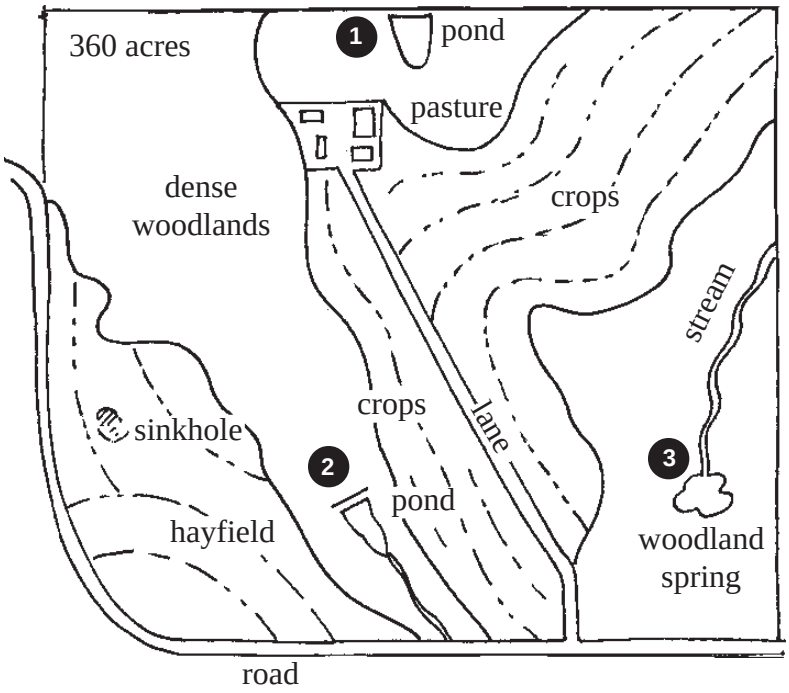


Figure 1: Establish multiple listening sites far enough apart so that calls from one site are not confused with calls from another site.

a monitoring route that includes a couple of off-farm listening points within your neighborhood.

Mark your listening points and monitoring route on a farm map. Also, write down a general decription of each location in your journal as well as your main reasons for choosing the site. (See Figure 1.)

All sites should be relatively free of noises, such as heavy traffic, that might interfere with your ability to hear the animals or cause them to remain silent. Plan on familiarizing yourself with your site(s) and your route during daylight hours so that when you go out at dark you will cause as little disturbance as possible.

Plan Ahead

Refer to the chart at the left and mark your calendar with a reminder to conduct one count during each of three count periods. The best time to do counts is after dusk on a calm night.

Because not every night is good for monitoring frogs and toads, be prepared to seize the opportunity when it comes. Make sure you have a clipboard, pencils, and the Frog and Toad Identification Guide handy; your flashlight has good batteries; and you have enough photocopies of the Frog and Toad Record Sheet on hand. You will need one record sheet per year for each site. Use the master copy only to make photocopies.

Count Period	Range of Dates	Minimum Water Temperature
1. Early spring	April 15–30	50 ℉
2. Late spring	May 20–June 5	60 ℉
3. Summer	June 15–30	70 ℉

Open Your Ears

On the night of the count, gather your monitoring materials and head out to your site(s) after dusk. Be sure to have a watch with you to keep track of time.

Approach each site quietly and sit for a few minutes to let the animals adjust to your presence, then start your timed listening. Listen for five or ten minutes (be consistent from site to site and year to year) and record your observations on the Frog and Toad Record Sheet. (See Figure 2.)

Check the "Present" box if you hear a particular species. Then circle the number (1, 2, or 3) that best describes the level of abundance you are hearing for that species:

1 = individuals of a species can be counted; there is silence between the calls heard

2 = calls of individuals can be distinguished, but there is some overlapping of the species' calls

3 = a full chorus of the species can be heard; calls are constant, continuous, and overlapping

Use the space at the bottom of the record sheet for notes about weather conditions and any other interesting observations made during each count period. Or, record this information in a field notebook or journal.

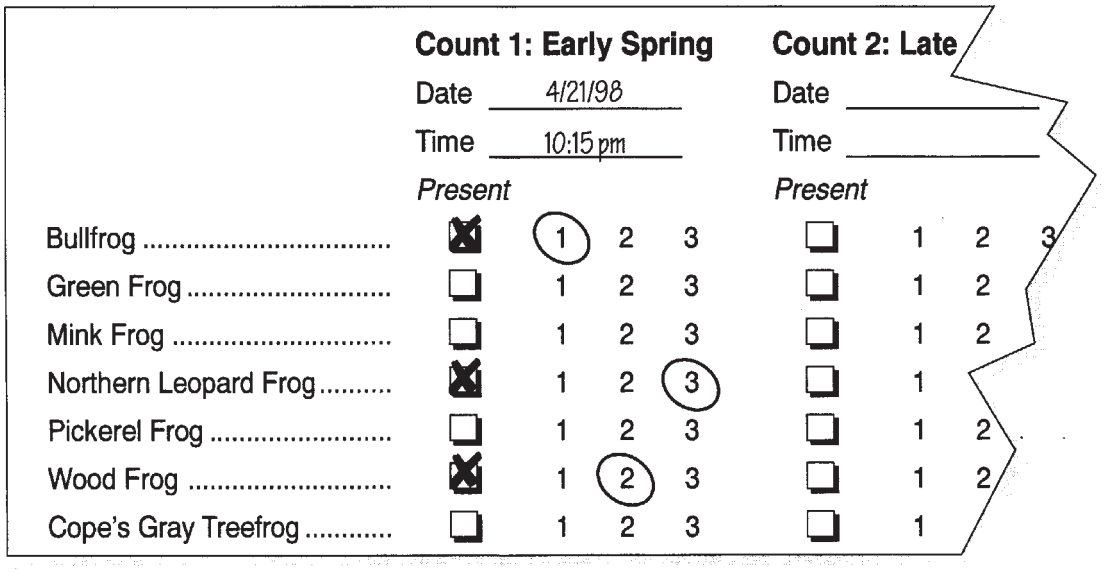


Figure 2: Filling out the Record Sheet

Open Your Eyes

In addition to opening your ears through listening counts, you can also monitor for the presence of frogs and toads on your farm by simply opening your eyes.

When you walk across a pasture or along a stream bank watch the ground to see if any frogs or toads leap away from you. Look for frogs and toads when working around the farmyard and in orchards and garden areas. If you hear tree frogs in your yard, try to get a glimpse of them. Record your sightings on a separate copy of the Frog and Toad Record Sheet labeled "Sightings," or keep track of them in a field notebook.

Monitoring frogs and toads can do more than help you assess the environmental impact of your management decisions. It can also help strengthen—or awaken—your awareness of the world in which you live. And, it can serve as an opportunity to connect with family members in a fun way that adds to the quality of your life.

Additional Resources

Books

The following books can be obtained through your local library or purchased through your local bookseller.

Amphibians and Reptiles Native to Minnesota, by Barney Oldfield and John J. Moriarty. (Minneapolis: University of Minnesota Press. 1994.)

A guide to the forty-eight species of amphibians and reptiles native to Minnesota for the amateur herpetologist, specialist, and curious observer. Describes identifying characteristics and preferred habitat with excellent photos and maps. Outlines techniques for observing, and gives timely discussion of their conservation needs.

Field Herpetology: Methods for the Study of Amphibians and Reptiles in Minnesota, by Daryl R. Karns. (Minneapolis: Bell Museum of Natural History. 1986.)

A practical, "how-to" guide for the field study of amphibians and reptiles in Minnesota. A useful companion to other field guides and highly recommended for weekend naturalists, school teachers, and other amateur herpetologists.

Minnesota's Endangered Flora and Fauna, edited by Barbara Coffin and Lee Pfannmuller. (Minneapolis: University of Minnesota Press. 1988.)

A comprehensive reference covering some three hundred species, ranging from mosses and lichens to jumping spiders and bald eagles. Gives brief descriptions of the natural history, including present and historic range maps, of each species that was listed as endangered, threatened, or special concern at the time of printing. Although the state list was revised in 1996, the book still gives the general audience good background information on many of Minnesota's rare life forms.

Natural History of Amphibians and Reptiles of Wisconsin, by Richard C. Vogt. (Milwaukee: Milwaukee Public Museum. 1981.)

An excellent field guide and a natural history treatise on Wisconsin's herpetofauna, designed to aid both species identification and appreciation. The dichotomous key in the front of the book enables the reader to narrow down choices for further diagnostic identification.

Pond Life: A Guide to Common Plants and Animals of North American Ponds and Lakes, by George K. Reid. (New York: Golden Press. 1987.)

An inexpensive, informative, and well-illustrated guide to the plants and animal that live in or near ponds, lakes, streams, and wetlands. A highly recommended resource.

Organizations and Programs

Minnesota Frog Watch was formed due to concern over the loss and deformities of Minnesota's amphibians. The program is part of the Center for Global Environmental Education at Hamline University in Saint Paul, Minn. A Thousand Friends of Frogs develops educational materials and activities guides, an on-line project, and activities related to the study of toads and frogs. It coordinates volunteer participation in the Minnesota Frog and Toad Survey, which is part of the North American Amphibian Monitoring Program. And, it takes reports on sightings of deformed frogs, toads, and salamanders. For more information, contact Center for Global Environmental Education, Hamline University Graduate School of Education, 1536 Hewitt Avenue, Saint Paul, MN 55104-1284; website: www.hamline.edu/cgee/frogs; e-mail: frogs@gw.hamline.edu.

Information on frogs and toads of Minnesota can also be obtained from the **Nongame Wildlife Program** of the **Minnesota Department of Natural Resources.** Program staff may also be able to offer assistance in conducting listening counts on your farm. Contact the Nongame Wildlife Program, Minnesota Department of Minnesota, Section Wildlife, 500 Lafayette Road, St. Paul, MN 55155-4007. Or, call the Minnesota DNR general information number at (651) 259-5122.

Websites

The following websites offer a wide variety of both local and world-wide information concerning frogs and toads:

Declining Amphibian Population Task Force:
www.open.ac.uk/daptf/index.htm

A Thousand Friends of Frogs:
www.hamline.edu/cgee/frogs

Minnesota Department of Natural Resources:
www.dnr.state.mn.us

Minnesotat Herpetological Society:
www.bellmuseum.org/herpetology/main.html

North American Amphibian Monitoring Program:
www.pwrc.usgs.gov/naamp

Society for the Study of Amphibians and Reptiles:
www.ssarherps.org

Monitoring Frogs and Toads

Frog and Toad Record Sheet

Year _____

Location _____

Check "Present" if you hear a particular species. Then circle the number that best describes the level of abundance you are hearing for that species:

1 = individuals of a species can be counted; there is silence between the calls heard

2 = calls of individuals can be distinguished, but there is some overlapping of the species' calls

3 = a full chorus of the species can be heard; calls are constant, continuous, and overlapping

	Count 1: Early Spring				**Count 2: Late Spring**				**Count 3: Summer**			
	Date _____				Date _____				Date _____			
	Time _____				Time _____				Time _____			
	Present				*Present*				*Present*			
Bullfrog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Green Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Mink Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Northern Leopard Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Pickerel Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Wood Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Cope's Gray Treefrog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Eastern Gray Treefrog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Northern Cricket Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
Spring Peeper	❑	1	2	3	❑	1	2	3	❑	1	2	3
Western Chorus Frog	❑	1	2	3	❑	1	2	3	❑	1	2	3
American Toad	❑	1	2	3	❑	1	2	3	❑	1	2	3
Canadian Toad	❑	1	2	3	❑	1	2	3	❑	1	2	3
Great Plains Toad	❑	1	2	3	❑	1	2	3	❑	1	2	3

Count 1 notes:

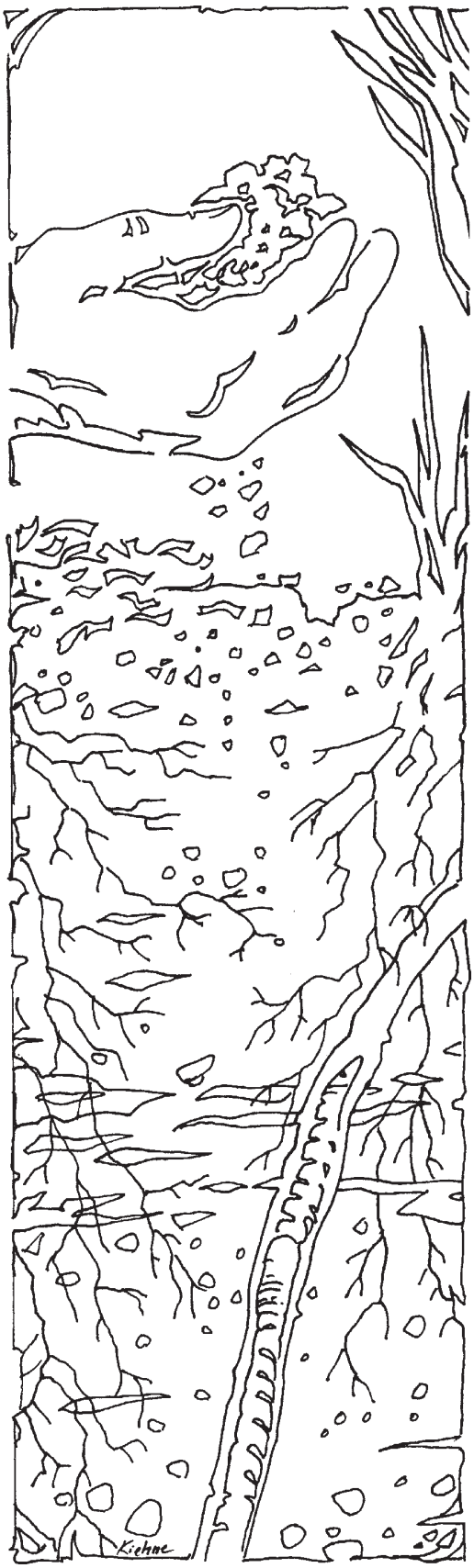
Count 2 notes:

Count 3 notes:

Monitoring Frogs and Toads

Frog and Toad Identification Guide

Species	Calls	Identifying Marks
Bullfrog	Deep bass notes that sound like a foghorn, or the roar of a distant bull but with a more musical quality. They occasionally sing in chorus.	Brown and large; 3 1/2–8 inches.
Green Frog	Vigorous call with considerable carrying power. Resembles the twang of a loose banjo string and is usually given as a single note.	Mottled brown w/ yellowish-green background; 2 3/8–3 1/2 inches.
Mink Frog	Sounds like a creaking porch swing or glider.	Green w/ dark mottling on back. Bright green "smile" on sides of head. 2–2 3/4 inches.
Northern Leopard Frog	A long, deep snore similar to the sound of rubbing your thumb against an inflated balloon. Often interspersed with a chuckling sound.	Two rows of spots on back; 2–3 1/2 inches.
Pickerel Frog	Soft snore that is more regular and has less carrying power than that of the leopard frog. No chuckling.	Two rows of spots on back w/ a yellow edge on the belly; 1 3/4–3 1/4 inches.
Wood Frog	A hoarse, low-pitched croaking. The subtle quacking sound has little carrying power.	Appears to have a mask on the face; 2–2 3/4 inches.
Cope's Gray Treefrog	Similar to the eastern gray treefrog; but shorter, faster, and harsher.	Green or grey. When grey, large dark blotches on back; Inside thighs yellow; 1 1/4–2 inches.
Eastern Gray Treefrog	A loud, resonant trill; somewhat birdlike in sound. Slower, longer, and more melodic than the Cope's gray treefrog. Individual voices may vary.	Gray, w/ dark, black-bordered blotches; 1 1/4–2 inches.
Northern Cricket Frog	Strong resemblance to the chirping of a cricket, or like the sound of two steely marbles striking each other. Begins slowly, continuing more rapidly for 30 to 40 seconds.	Non-climbing treefrog; grey, brown, or tan; dark triangle between the eyes; 5/8–1 1/2 inches.
Spring Peeper	High, ascending peep that can be heard for a 1/4 mile. A trill call similar to the jingling of sleigh bells.	Tan or peach "X" on back; 3/4–1 1/4 inches.
Western Chorus/ Boreal Chorus Frog	Ascending, musical, high-pitched call lasting 1 to 2 seconds; does not carry. Sound similar to running a fingernail across the teeth of a high-quality, fine-toothed comb.	Tan w/ brown stripes; 3/4–1 1/4 inches.
American Toad	Drawn-out, high-pitched musical trill lasting up to 30 seconds. Individual voices carry a slightly different pitch.	Mottled green, brown, or tan; 2–3 1/2 inches.
Canadian Toad	Clear trill similar to the American toad, but deeper, slower, and lasting only about 5 seconds.	Brown w/ variable patterns of white and black; large bump between eyes; 2–3 1/2 inches.
Great Plains Toad	Loud, harsh, metallic rattle often lasting 20 seconds or more.	Large dark patches w/ light back borders; 2–3 1/2 inches.



Monitoring

Soil

Healthy soil, one of earth's most precious resources, is vital to a farm's long-term productivity and profitability; to environmental integrity; and to plant, animal, and human health. Monitoring the effects of management practices on your soil can help you to build and sustain this vital resource.

What is It?

Soil monitoring techniques can be used to assess the current status of soil resources; track changes in soil health due to management practices; and investigate specific soil health problems, such as compaction.

Who Does It?

A farm's soil should be monitored by the person most directly impacting it: the farmer. Working with a partner—such as a spouse, son or daughter, or neighbor—can make your monitoring more thorough and enjoyable. Professionals who can help include an independent soil/crop consultant, or staff from the Natural Resources Conservation Service (NRCS) or Cooperative Extension Service.

When?

Monitor your soil several times during the crop year: for example, a half-day to a day in the spring, a couple of hours in mid-season, and then again following harvest. Also, be consistent from year to year, such as always before field work in the spring or during the first two weeks of July.

Time Required

A few hours, two or three times a season, allows for adequate monitoring of soil health. Investigating specific problems may require additional time.

Materials

Useful materials include a clipboard, a shovel, an aerial photograph of your farm, soil survey maps, a soil probe, and a soil sampling tube. You will also need photocopies of the Soil Assessment Record Sheet and the Soil Test Record Sheet; a master copy of each is provided. Some incidental materials will be needed for specific monitoring tools.

Costs

Many of the above items are readily available—or can be made—on most farms. What is not can be purchased for less than a hundred dollars. Also consider the cost of laboratory soil analysis and consultant fees when planning your soil monitoring strategy.

Getting Started

This chapter of *The Monitoring Tool Box* provides a basic framework from which you can observe, manage, and appreciate your farm's soil resources. It offers some background information on key soil properties and processes, but does not claim to explain all the complex interactions that make soil the wonderful resource it is.

"Monitoring Soil" also describes a number of simple and inexpensive techniques with which to monitor your soil. Feel free to supplement this chapter with ideas, information, and tools of your own.

CHAPTER CONTENTS

The Ideal Soil

As you plan your soil monitoring activities, consider the following description of the ideal soil and how to manage for it from the 1957 Yearbook of Agriculture, *Soil*:

> *[The ideal arable soil has] a deep rooting zone, easily penetrated by air, water, and roots. It holds water between rains, but allows the excess to pass through it. It has a balanced supply of nutrients. It neither washes away during rains nor blows away with high winds. The combination of practices to use depends on what is necessary to develop and maintain a soil as nearly as possible to the ideal on a sustained long-time basis. They vary widely among the many kinds of soil.*
>
> *Successful farmers choose the practices for their fields according to two primary considerations: What practices do I need to come near the ideal? How will the costs and returns fit into my farm budget?*
>
> — Charles E. Kellogg

Ask yourself, "What perspective on soil is most in line with our family's goals for the farm and our management plan? Does it reflect the ideas expressed in this quote, or does it reflect a different view of soil?" In other words, be clear about what you are trying to achieve for the farm as a whole and how healthy soil fits into the mix.

Part of this clarity involves understanding the "playing hand" nature and past farming practices have dealt you. The tools offered in this chapter can help you assess your farm's soil with regard to its

- **general characteristics** (landscape details and history, soil types, soil profile, soil texture);
- **physical fitness** (soil structure, surface conditions, water dynamics);
- **fertility** (nutrient levels, organic matter content, cation exchange capacity, pH);
- **biological activity** (residue decomposition, soil organisms); as well as
- **crop health** (appearance and stress resistance).

The baseline of information gathered from your first year's monitoring can help you learn how best to build upon your soil's strengths and work within its limits. The same tools can then be used to monitor progress toward your long-term goals for your soil and for the farm.

Develop a Monitoring Plan

Thoughtfully review this chapter in light of your goals for your farm and your current management practices. Then ask yourself, "What do I want to learn from monitoring my farm's soil?" From this basis, identify some clear objectives and build a monitoring plan around these objectives, plugging in the tools that seem most likely to help you answer your questions. For example:

Objective: I'd like to know how my tillage practices affect the health of my soil.

Plan: Monitor soil structure and look for signs of compaction and erosion. Also, examine growth patterns of crop roots.

Objective: Does my soil sustain a complex community of beneficial soil organisms?

Plan: Monitor residue decomposition and conduct earthworm counts.

Develop a monitoring plan that is both informative and manageable, and write it down in your journal or field notebook. Keeping things manageable is especially applicable to the first year of soil monitoring while you are still familiarizing yourself with the process. Let your monitoring skills and your plan evolve with experience.

Choose Your Monitoring Sites

To select the specific sites you want to monitor over a period of years, consider variations among fields, differences in management practices and soil types, as well as unique or problem areas. From among your options, select five to ten soil monitoring sites by using the following methods:

Managing for the Ideal Soil

For Mike and Jennifer Rupprecht of Lewiston, Minnesota, leaving their farm's soil resources in better condition than when they started farming is of prime importance. In addition to the social and spiritual value of land stewardship, they fully recognize its direct value to them. They know that how they care for their soil resources greatly affects their ability to meet their other goals for the farm, like paying off the home place and making a good living for the family.

The Rupprechts became involved with the Monitoring Project, in part, seeking specific indicators they could monitor to determine progress toward their goal of managing for the ideal soil. They were also interested in having long-term soils research conducted on their farm so that others could confirm or refute their own observations.

The Rupprechts' farm consists of row crops, hayfields, and rotationally-grazed pasture. To sustain the production and profitability of these components of their farm, the Rupprechts have identified some very clear soil management objectives, including

- increasing organic matter content and cation exchange capacity over time,
- setting target levels for soil nutrients,
- avoiding fertilizers that may be harmful to soil organisms,
- increasing water infiltration and eliminating erosion, and
- minimizing compaction.

Besides providing measurable indicators of progress toward good soil stewardship, these objectives also make that goal more real and more relevant to daily life on the farm. By using the tools offered in this chapter, you too can learn how to measure your progress toward managing for the ideal soil.

A Starting Plan

The following outlines a simple soil monitoring plan that can be used to familiarize yourself with the monitoring process. It can be easily modified and expanded as your comfort, confidence, and interest grows. At one or two monitoring sites, use the following tools:

In the Spring

- ✓ Test the stability of your soil aggregates. (See page 9)
- ✓ Dig for earthworms. (See page 20)

In the Summer

At the end of June or beginning of July

- ✓ Test for compaction using a soil probe. (See page 11)
- ✓ Check the decomposition of last year's crop residue. (See page 19)
- ✓ Do a root inspection. (See page 21)

In the Fall

- ✓ Conduct a perc test. (See page 14)
- ✓ Look for nightcrawler middens. (See page 20)

Every Three to Five Years

- ✓ Have a soil test done to track organic matter, cation exchange capacity, and nutrient levels. (See page 16)

The Specific Site Method

If you identify specific areas you want to monitor, clearly mark these sites on your farm map and label them either with a number or a letter. (See "Sketch a Farm Map" on page 5.) Go out to these locations and write down in your journal any information that will help you to find this location again.

For example, say you select a ten acre area in your north 80 because the crops tend to be poorer there. Make a note such as this:

> *Site A: SW corner north 80, approximately 10 acres. Extends east about 16 wooden fence posts from the SW corner, then north a quarter mile and then back to the west fenceline. Soil obviously lighter in color than surrounding areas.*

You can also note any other facts you know about this site, such as its farming history—both under your stewardship and before.

The Transect Method

Monitoring sites can also be selected along a *transect*, a long continuous strip across a field with monitoring locations spaced at even intervals. (See Figure 1.)

Select a logical starting point and mark it on your map. Next, pick out some feature at the other end of the field, such as a tall tree along a fenceline, and mark it as well. Give this transect a label, such as "Transect 1."

Make your way straight across the field toward the far point. As you go, make notes about every fifty or a hundred paces about soil type, slope, or soil color. For each stop, mark your location on your map and label the site with a number or letter. Record a more detailed description of each site in your journal.

Depending on your farm's layout and size, you may want to mark out several transects. Over the years, keep your eyes open for other areas that might also need to be monitored, such as an area that is not responding well to your management changes, and add these to your list of monitoring locations.

Record Keeping Aids

Along with the various soil monitoring tools, this chapter also includes a **Field Guide** to help you interpret your soil monitoring observations, a **Soil Assessment Record Sheet** on which to keep track of them, and a **Soil Test Record Sheet** on which to summarize the results of laboratory soil analysis. For each year of monitoring, you will need a photocopy of

both record sheets for each monitoring site. The master copies of these record sheets from which to make photocopies are provided. Keeping good records of your soil monitoring activities will help you to see trends and changes over time.

Size Up Your Soil Resources

Before proceeding to the specifics of soil monitoring, take some time to size up the general characteristics of your current soil resources using any or all of the following tools.

Sketch a Farm Map

Put together a map of your farm detailing as much information as possible as it relates to your soil resources. (See Figure 1.)

On a piece of graph paper, trace or sketch out a true-to-scale map of your farm. An aerial photograph of your farm can be a helpful guide; check with your local NRCS office to see if an aerial photograph of your farm is available. On your map, include notable features such as:

- fencelines/boundaries
- treelines/woods
- specific fields
- farmstead location
- field driveways
- lanes
- paddock divisions
- livestock yards
- waterways
- contour lines/strips
- ponds/creeks
- wetlands
- tile lines
- springs/wells
- hills/knolls
- low spots/draws
- sink holes

Walk your farm, if necessary, to check for accuracy and to fill in any missing details. Draw up a map for each of your land parcels if they are not contiguous.

Either on the map itself, or in your journal, note any pertinent information such as farm/field size (in acres), the cropping history of fields, their management history (such as areas that historically have had manure applied), and so forth. Make several photocopies of your map(s) when you finish, keeping the original as a master copy.

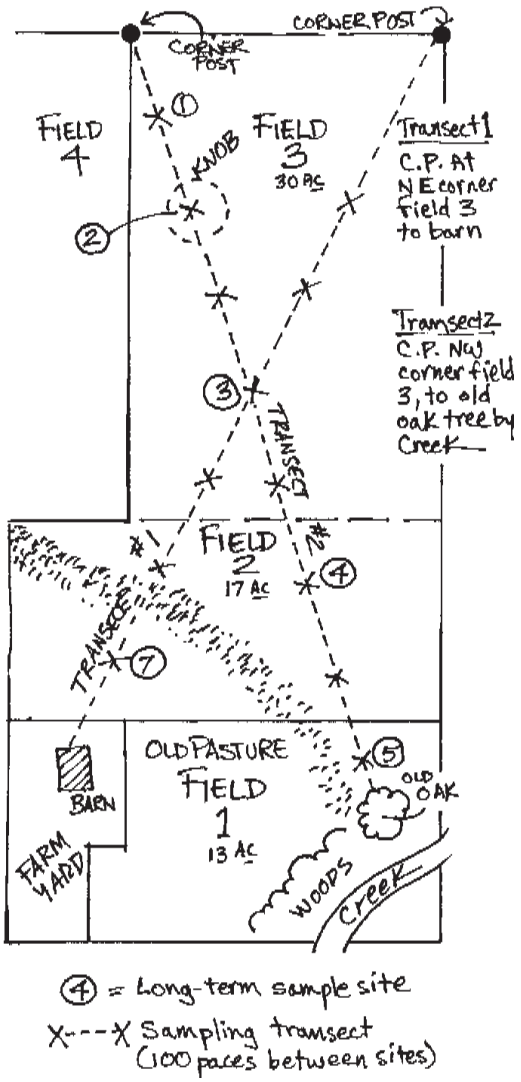


Figure 1: A sketch map is one way to outline a big-picture view of your soil resources.

Get Up Close and Personal

Another way to size up your farm's soil is to get "up close and personal" with it. At each of your monitoring locations, dig into the soil and answer questions like these:

- What color is your soil? How dark or light?
- How easily can you dig into the soil with your hand or shovel?

- What does it feel like in your hand? Sticky? Gritty? Smooth?
- How well does it crumble in your hand?
- How does your soil feel when you walk on it? Hard and packed down? Soft and spongy? Somewhere in between?
- What else do your senses tell you about your soil?

For each location, record this information in your journal. Monitor for this information periodically—such as after a rain, after a long dry period, at different times of the year, or from year to year—and note changes and similarities.

This approach allows you to develop a more subjective "feel" for your soil. Such knowledge, when combined with information gathered from other observation methods, can give you a fuller picture of the well-being of your soil.

Research Your Farm's Soil Types and History

Much information can be gleaned from your county's soil survey, which should be available from your local NRSC office or library. Research this excellent source to find out your farm's main soil types, their locations, and the crop suitability ratings for each soil type. The soil survey also relates general landscape characteristics like slope and aspect, soil forming factors such as whether the area was prairie or forest, the type of bedrock or parent material, climate, and the management history of the soil in your region.

Also, look for other references that might help you understand the history of your soil, as well as its inherent limits and potential. These resources include geological histories such as *Minnesota Underfoot*, and ecological histories like *Minnesota's Natural Heritage: An Ecological Perspective.* Summarize this type of information in your journal or as notes on your map.

Examine the Soil Profile

To complement your soil survey research, actually examine the soil profile at your monitoring sites.

The Soil Profile

A soil's *profile* consists of successive layers of soil and soil-building material running vertically from the surface to the bedrock, or *parent material*. These layers are called *horizons* and are classified according to their color, texture, consistency, structure, pH, boundary characteristics, and continuity. The parent material from which a soil type is formed tends to influence its overall properties:

- **Limestone bedrock:** Soils are typically clays and clay loams with high inherent pH.

- **Sandstone bedrock:** Soils are usually coarse-textured, tend to be more acidic, and have lower nutrient reserves.

- **Shale bedrock:** Soils are typically clays, shallow, and impermeable to water.

- **Glacial till and outwash:** Soils reflect the properties of the parent material carried by the glaciers and the manner in which the material was deposited. They can range from sandy or gravelly to fine, loamy soils.

- **Loess:** Loess soils are wind-blown deposits of fine silt materials and are among the world's most productive soils because of their silty loam texture.

Dig In

If at all possible, find a soil surveyor who will come out and walk your farm with you. In addition to his or her extensive knowledge of soil types and their corresponding profiles, a soil surveyor may also have an extra-long soil sampling tube that allows you to examine the soil profile without having to dig a big hole.

If you do need to use a shovel, dig into the soil as deep as you can. Then examine the walls of the hole and look for different color layers of soil. The top layer, or the *topsoil*, is usually darker than the *subsoil* layer below it.

Measure the depth of the top layer, note the color and record both pieces of information on the Soil Assessment Record Sheet. Do the same for any other distinct layers you can see due to color differences, such as a transition layer between

A Lesson in Soil History

In 1994, just as the Monitoring Project was getting started, Mike Rupprecht invited George Poch, retired Soil Conservation Service (now NRCS) soil surveyor, to his farm. George had conducted soil surveys in southeastern Minnesota for nearly thirty years, and Mike wanted George's help in learning the story of his farm's soil.

On a high spot at the eastern edge of the farmstead, George plunged his personally designed sixty-inch soil sampler into the ground. He pulled out a fifteen-inch core that showed the dark brown topsoil to be about eleven inches deep followed by the light brown subsoil. Taking a pinch of the topsoil between his fingers and rubbing, George identified the soil type as a silt loam.

After removing the first core from the sampler, George probed the hole again and brought up the next fifteen inches of soil, which looked exactly like the bottom four inches of the previous core. George identified the soil in this location as a classic example of Mt. Carroll silt loam, a productive, well-drained soil developed from wind-blown loess.

Walking east about fifty yards, George ran his probe into the ground again and pulled out another fifteen-inch core that was dark brown the entire length. A quick run through with his fingers emptied the probe. Upon sinking the probe again, the dark brown quickly gave way to a light brown in the second core indicating a sixteen-inch layer of topsoil. Although similar in characteristics and management response to the Mt. Carroll soil, this soil would technically be classified as a Port Byron silt loam.

Further probing across the farm revealed predominantly Mt. Carroll silt loam with a few patches of Port Byron mixed in. As they walked, George talked about the geological history of the area—what layers of rock would be found below the soil, how the wind-blown loess was carried in from glaciated areas to the west, and how previous farm management (over the last one hundred or so years) had changed the soil and the landscape.

This last topic piqued Mike's curiosity so they headed into a draw to take a core sample. The probe went down forty-eight inches before they found a change in color. But, instead of finding lighter color subsoil at that depth, the already dark soil became almost black. This black soil was the original soil in that draw when it was first farmed—meaning that all of the soil above it was topsoil eroded off higher ground. For Mike, this was a powerful lesson about the importance of taking good care of his soil resources.

Figure 2: Assessing soil texture with the ribbon method

the topsoil and the subsoil. Use your county soil survey as a reference, especially if you are unable to dig down to the parent material. (For a cross-section of a soil profile, see "The Soil Universe," on page 16a.)

Assess Soil Texture

While examining the soil profile, also check the *soil texture* of each layer. The term soil texture refers specifically to the relative amounts of mineral particles in the soil. But soil is not only made up of sand, silt, clay, and rock fragments, but also organic matter, water, and air. An ideal soil texture is 50 percent solids, 25 percent water, and 25 percent air. Either of the following two methods can be used to assess soil texture.

The Ribbon Method

The ribbon method is a "hands-on" way to determine soil texture. Put a rounded tablespoon of soil in the palm of one hand (about half a handful). Spray a little distilled water onto the soil and knead it. Repeat this process until the soil forms a nice ball in your palm.

Then gently squeeze the soil between your thumb and index finger to form a ribbon that extends over the top of your index finger. Continue to form a ribbon until it breaks. (See Figure 2.) Note how long the ribbon was when it broke and whether it feels gritty or smooth. Compare your findings with the ribbon method chart at left to determine the texture rating. Record this information on the Soil Assessment Record Sheet for each site.

Ribbon Method

No ball: .....sand

Ball but no ribbon: loamy sand

	Feels very gritty	Feels very smooth	Feels both gritty and smooth
1 inch ribbon:	..... sandy loam	..... silty loam	..... loam
1-2 inch ribbon:	..... sandy clay loam	.... silty clay loam	..... clay loam
2 inch or more ribbon:	sandy clay	silty clay	clay

The Quart Jar Method

The quart jar method of assessing soil texture allows you to see the relative amounts of mineral and organic particles within a given soil.

With a permanent marker, make a line approximately one-third of the way from the bottom of a clean, empty quart jar and another line at the two-thirds point. Collect some soil from the top six to eight inches of your soil profile or other depth of interest. Fill the jar with soil to the first line and add distilled water up to the second line. Add a little automatic dishwasher detergent to the water to help disperse the soil particles.

Shake the jar vigorously for about thirty seconds. Let it sit for about five minutes. Again, shake the jar vigorously for about thirty seconds. Place the jar on a hard, level surface and let it sit until the water is mostly clear—at least two hours; overnight is better. The largest particles (sand)

will settle first and form the bottom layer, followed by silt and clay. Organic matter fragments, being much less dense, often float. (See Figure 3.)

When all of the soil has settled out of suspension, look at the soil in the bottom of the jar. With a ruler, estimate the percentage of each constituent, and refer to the quart jar chart below to determine the soil texture. Record this information on the Soil Assessment Record Sheet for each site.

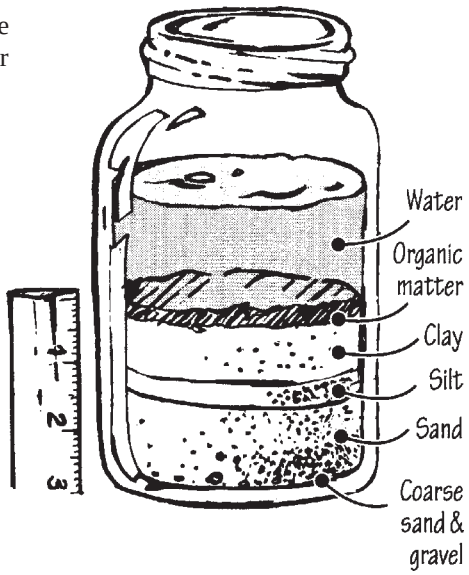


Figure 3: Using the quart jar method to assess soil texture

Quart Jar Method

Particle Distribution	Soil Texture
good mixture (40% sand, 40% silt, 20% clay)	loam
greater than 50% sand	sand or sandy loam
greater than 50% silt	silt or silty loam
greater than 20% clay	clay loam
greater than 40% clay	clay

Physical Fitness

Stresses like drought, heavy rainfall, tillage, and traffic all affect the physical fitness of your soil. To minimize the effects of such stresses, soil needs to be in good physical condition. In soil language, it needs to have good *tilth*. Soil with good tilth is easy to work, makes a good seedbed, is well aerated, and is easily penetrated by roots and water. Soil in poor physical condition is more susceptible to erosion, crusting, compaction, and extremes in soil moisture.

Soil Structure

The proper growing environment for plants depends on good soil structure. *Soil structure* refers to the way individual soil particles group into larger clusters or *aggregates*. In the best soil structure, particle groups are loose and crumbly; a handful of soil easily crumbles into a bunch of small, granular aggregates. Soil with poor structure can be cloddy with big chunks of soil or is dusty and powdery.

Test for Aggregate Stability

A good tool for evaluating the structural condition of your soil involves testing for *aggregate stability*, the ability of soil aggregates to withstand breakdown by water. A soil's aggregate stability is a good indicator of how well it can resist crusting and erosion.

Use a shovel to dig out a six- to eight-inch sample of topsoil and gently mix a handful or two in a bag. Pick out two or three pea-size soil aggregates and place them in the bottom of a small glass jar. Gently add just enough water to cover the soil aggregates halfway and let them soak for

Aggregate Stability Test

Aggregate Response	Stability in water	Interpretation
1 breaks down by wetting	.... none	very susceptible to crusting and erosion
2 breaks down with gentle swirling, water turns cloudy	.....low.....	susceptible to crusting and erosion
3 breaks down with gentle swirling, water stays clear	.....fair	somewhat stable, susceptible to erosion and crusting from bare surface or excess tillage
4 no breakdown with gentle swirling	.....good.....	very stable; sign of good structure-protecting practices

about a minute. Use the aggregate stability chart above to interpret your results. Repeat the test several times at each site and record the results on the Soil Assessment Record Sheet.

Common Symptoms of Poor Soil Structure

Soil Compaction

Soil compaction is the most widespread form of poor soil structure in the Midwest. *Soil compaction* involves compressing the pore spaces between soil particles, resulting in poor aeration, slower water infiltration and drainage, and poor root penetration. The leading cause of compaction is working the soil when it is too wet; heavy axle loads also cause compaction. Soils with poor structure or low organic matter are especially susceptible. (See Figure 4.)

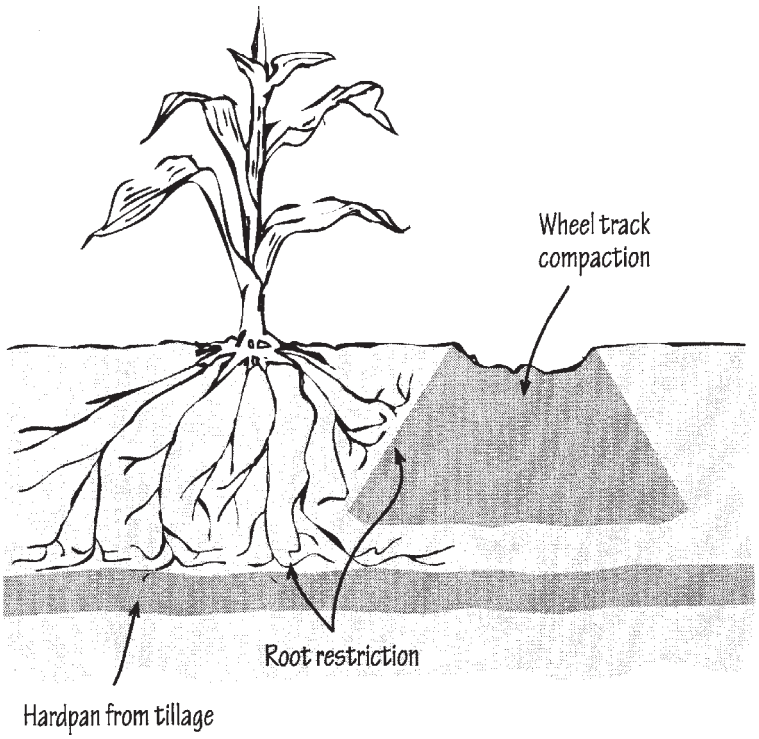


Figure 4: Common examples of soil compaction.

One type of compaction, called the *hardpan*, is usually found at the depth of primary tillage, between six and twelve inches. The breakdown in structure results from repeated use of a tillage tool, such as a plow or disk, at the same depth. Hardpans cause shallow root growth, which makes plants more vulnerable to drought and other stresses.

Check for compaction: Observation of fields and crops is the simplest way to check for compaction. For instance, if you see water standing in the wheel tracks across a field, compaction is likely. If your crops show symptoms of drought even though you have had plenty of rain, a compacted layer or hardpan may be the reason.

A *soil probe*, a solid metal rod with a point at one end and a handle at the other, is also a valuable, easy-to-use tool for checking for compaction. Use this tool several days after a soaking rain when the soil is moist but not muddy. Testing when the soil is too dry could lead to false interpretations because a dry soil is harder to penetrate. Slowly press the probe into the ground until you feel resistance or

compaction. Refer to the measurement marks on your probe to note the depth of the compaction. Use the Field Guide to rate the level of compaction and record this rating on the Soil Assessment Record Sheet. (See "How to Make Your Own Soil Probe" at right.)

If you suspect a compaction problem based on observations and the use of a soil probe, use a shovel to dig a hole twelve to fifteen inches deep. Make note of any dense soil layers or restricted root growth and record this information in your journal or on the record sheet.

Erosion

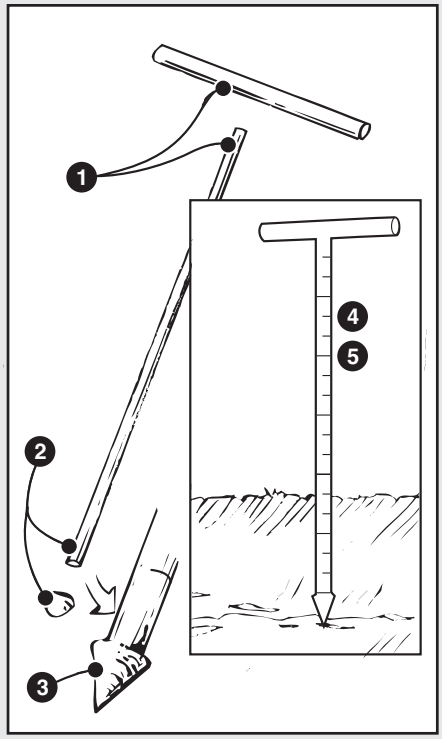
Erosion, from either wind or water, is another common symptom of poor soil management. Erosion directly reduces long-term productivity because it carries away the very topsoil that provides the best growing environment for plants. Whereas compaction or a hardpan can be alleviated through management, erosion requires the formation of new topsoil, which can take hundreds of years.

Check for erosion: The obvious way to track water-caused erosion is to observe your fields during or after a downpour. Check for signs such as the following:

- Is water running in your fields? Is it forming channels?
- Do you see any washouts in field terraces, along fencelines, creeks, waterways or tile outlets?
- Do you find any deposits of soil and debris?
- How muddy or cloudy is the water running in your creek, waterways or ditches?
- How silty is the bottom of your creek after the water level and flow speed return to normal?

Obvious signs of wind erosion include dirty snow, soil drifts in road ditches, and dusty air on windy days. Record the appropriate rating from the Field Guide on the Soil Assessment Record Sheet, as well as any pertinent observations.

How to Make Your Own Soil Probe



When Mike Rupprecht wanted to check for soil compaction in his grazing paddocks where animal impact had been high, he first borrowed a soil penetrometer, a pointed metal stick with a pressure gauge that measures how much force is required to push it through the soil. Not liking the "feel" of the penetrometer, Mike decided to make his own soil probe. It took him thirty minutes to make from two dollars worth of materials. Mike regularly uses his soil probe to "look" below the soil surface.

Follow these steps to make your own soil probe:

1. Weld a nine inch section of three-quarter inch pipe to one end of a thirty-six inch by half-inch diameter steel rod.
2. Add a five-eighth inch ball of weld to the other end of the rod.
3. Grind the ball of weld into a cone-shaped point.
4. Use a hacksaw to make notch marks every two inches along one side of the rod.
5. Every six inches, make a mark all the way around the rod.

Surface Conditions

The surface conditions of your fields also impact the physical fitness of your soil. A soil surface covered by growing plants or crop residues is much less susceptible to breakdown in soil structure and erosion by wind and water. For instance:

- A good plant canopy, such as in a field of solid-seeded soybeans, softens the impact of raindrops on the soil surface and lessens the threat of damaging soil structure.
- Including intensively managed pastures and other sod-based crops in a rotation provides dense surface cover while building soil structure and increasing infiltration.
- Grass waterways and filter strips stabilize soil, slow runoff, and trap sediment in concentrated flow areas and at field edges.
- A "trashy" surface, covered with crop residue, protects against wind erosion while slowing overland water flow, increases infiltration, and reduces water erosion.
- Cover crops between cash crops can effectively protect the soil surface from erosion.

Ideally, the soil surface is protected by some form of surface cover for as much of the year as possible.

Estimate Surface Cover

The following two methods can be used to estimate surface cover:

For residue cover: To estimate residue cover in a row-cropped field, you will need a 100-foot measuring tape. Within the general perimeter of your monitoring site, anchor the beginning of the tape and then stretch out the tape **diagonally across** the crop rows until you come to the end of the tape. Anchor this end as well. (A tape laid perpendicular or parallel to the crop rows will not give an accurate estimate of residue cover.)

Starting with the 1-foot mark, look straight down at the tape and count each foot mark that is **directly over** a piece of residue. (See Figure 5.) Disregard any piece of residue that is smaller than one-quarter of an inch because it is not big enough to dissipate the energy of a rain drop in an intense storm. Used a note pad and pencil to help you keep track as you count. When you have examined the full length of the tape, add up your count marks to determine the percent of residue cover for the site. For example, 32 pieces of residue counted means 32 percent residue cover.

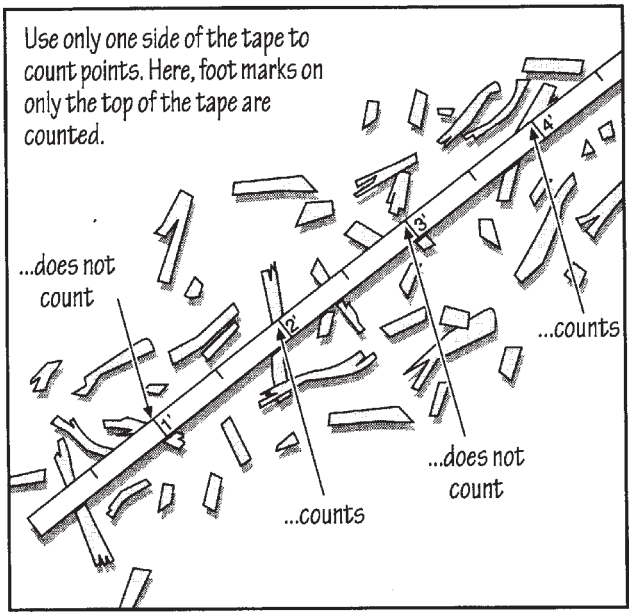


Figure 5: When estimating surface residue, count only the pieces of residue that are directly under a mark.

For a pasture or hayfield: To estimate the percent of the soil surface covered in a pasture or hayfield, you will need a yardstick. At each monitoring site, randomly toss the yardstick. Wherever it lands, lay the yardstick flat on the ground and count each half-inch mark that intersects

with **bare ground.** Divide that number by 72 to get an approximate percent of bare ground. Obtain the percent of surface cover by subtracting the percent of bare ground from 100. Say, for example, you count 29 half-inch marks that intersect with bare ground. The percent of bare ground is approximately 40 (72 ÷ 29), meaning 60 percent of the surface is covered (100 - 40).

For greater accuracy, repeat this procedure two or more times within the monitoring site and average the results. You might even want to take a photograph directly over the yardstick at one or more count locations. Keep track of your notes of the results for each location photographed and write this information on the back of the photograph. This may help to train your eyes to recognize different surface cover percentages.

To interpret the results: To interpret the results from either of the above methods for estimating surface cover, consult the Field Guide. For each monitoring site, record the appropriate rating on the Soil Assessment Record Sheet.

What constitutes good surface cover varies depending on whether or not the field is in a sod-based crop, is row-cropped, or is in a fallow period. For instance, a row-crop field with 30 percent residue cover is considered to be in "conservation mode." In a pasture or hay field, only 30 percent surface cover would be woefully inadequate.

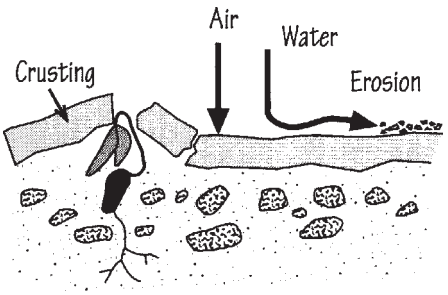
Check for Surface Crusting

One consequence of limited or no surface cover is *surface crusting.* The pounding action of raindrops breaks down the structure of the exposed surface soil, causing a thin crust to form that has little or no structure. Very low levels of organic matter and excessive tillage greatly contribute to crust formation.

A surface crust decreases the amount of water that soaks in, creating more runoff and erosion. Besides contributing to erosion, a surface crust also decreases the amount of air than can reach soil microbes and plant roots. And, severe surface crusting decreases seedling emergence and leads to poor stand density in both row crops and pastures. (See Figure 6.)

To test for a surface crust, take a pencil or pocketknife and stick it into the soil surface at a low angle. Gently lift the end of the pencil or knife blade upward. If you find an obvious crust, note its thickness and how easily it breaks up. Consult the Field Guide and record your rating on the Soil Assessment Record Sheet.

A crusted surface



A rough, well-aggregated surface

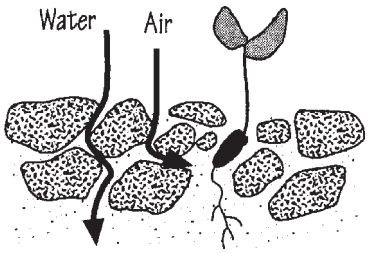


Figure 6: Surface conditions impact seedling emergence and air and water dynamics.

Water Dynamics

The physical fitness of soil also depends on the soil's ability to soak up water, to retain the water needed in the root zone by plants, and to allow excess water to move out of the root zone so that good aeration is maintained.

Infiltration

Water *infiltration* refers to the percolation of water through the soil surface. Infiltration is helped by surface residues, worm holes and root

channels, good soil structure, and a rough soil surface. Surface crusts and compaction slow infiltration and lead to ponding, runoff, and erosion.

One way to check water infiltration is to visit your fields during a heavy rain to see if the water is soaking in or running off. If surface cover is adequate, or the surface is well-aggregated and rough (no crusting), the water should soak in with minimal erosion. (See Figure 6.) A drier way to check the rate of water percolation into the soil is to do a perc test using a coffee can.

Coffee can perc test

The perc test does not give you the exact rate of your soil's rainfall infiltration, but does give you a relative percolation rate in year-to-year comparisons. The best time to do the perc test is in the fall, when the soil has had the longest time to settle after any tillage. To do this test, you will need the following equipment:

- a two pound coffee can
- a small flat plastic lid
- an empty plastic soda bottle (16 or 20 oz. size)
- a ruler and a permanent marker
- a jug with enough water for the number of perc tests being conducted in one outing

Before cutting out the bottom of the coffee can, stick a ruler inside of the can. Measuring up from the bottom, make a visible, permanent line at each of the first three inch marks. Pour enough water into the can to reach the one inch mark, then transfer that water to the plastic bottle. Mark the water line on the bottle to ensure that you always use the equivalent of one "coffee-can" inch of water every time you do the perc test. Cut out the bottom of the coffee can when you finish measuring and marking.

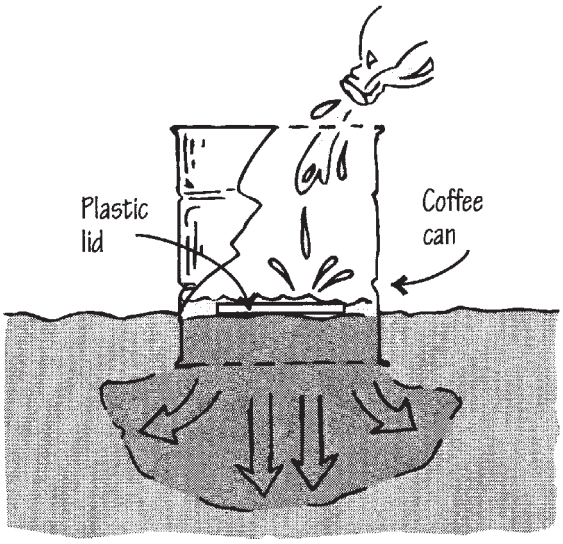


Figure 7: Use the coffee can perc test to check water infiltration.

At your monitoring site, push the can into the soil to a depth of two to three inches, using the lines as a guide. (If the soil is hard, lay a short board across the top of the can and pound it with a hand sledge or hammer to push down the can.) Gently firm the soil around the inside edge of the ring to reduce water flow along the edge and place the plastic lid on top of the soil inside the can.

Fill the soda bottle with water up to the line and pour the water onto the plastic lid to protect the surface structure of the soil. (See Figure 7.) The first inch of water wets the soil and eliminates any variation in soil moisture conditions from site to site and year to year.

Repeat the previous step and note how long it takes the soil to absorb this second inch of water. Compare your results with the assessment criteria given on the Field Guide and record your rating on the Soil Assessment Record Sheet.

When you pull out the coffee can, turn it over and look at the soil core from the bottom. Check for wormholes, root channels, and other *macropores* and rate your findings for these as well. Macropores are large, continuous tunnels through the soil created by worms, roots, or other large soil organisms like beetles. They greatly improve water entry into the soil, as well as root growth.

Water Retention

Soil's ability to retain water in a form available to plants is another important characteristic of its physical fitness. Soils with high organic matter content or some clay hold more water than sandy or silty soils. Loamy soils tend to hold the most plant available water. Soils with poor water retention become obvious during extended dry periods. These soils may benefit from farming practices that increase organic matter, such as using green manure and cover crops. Organic matter builds better soil structure and can hold many times its weight in water, so even small increases in organic matter content tend to increase water retention. Consult the Field Guide to rate your soil's water retention ability and record this information on the Soil Assessment Record Sheet.

Good Drainage

Good *drainage*, the movement of excess water out of the root zone, is also an important soil property for good plant growth. In soil with poor drainage, excess water remains in the root zone and reduces the space for air; this leads to poor root growth and nutrient uptake. Good drainage allows the soil to warm up earlier in spring. More and more soils with good natural drainage are becoming waterlogged or over-saturated because of compaction and poor soil structure. Again, refer to the Field Guide to rate soil drainage and record this information on the Soil Assessment Record Sheet.

Elements of the Soil Universe

Soil profile consists of the successive layers of soil and soil-building material running vertically from the surface to the parent material.

Horizons, the vertical layers of soil from the surface down to the parent material, are classified according to their color, texture, consistency, structure, pH, boundary characteristics, and continuity.

Parent material, the material from which the soil was formed, influences the overall properties of the soil.

Soil structure, the way individual soil particles group into larger clusters, determines the growing environment for plants.

Compaction, the breakdown of soil structure and the compression of pore spaces, results in poor aeration, slower infiltration and drainage, and difficult root penetration.

Hardpan, a type of compaction usually found at the depth of primary tillage, causes shallow root growth and makes plants more vulnerable to drought and other stresses.

Surface cover softens raindrop impact, protects soil structure, and promotes infiltration.

Surface crusts lead to runoff and erosion, limit aeration, and hamper seedling emergence.

Infiltration of water through the soil surface is helped by surface cover, good soil structure, a rough soil surface; and is hindered by surface crusts and compaction.

Water retention refers to the soil's ability to retain water in a form available to plants. Loamy soils tend to have more plant-available water than clay or sandy soils.

Drainage, the movement of excess water out of the root zone, promotes good aeration, root growth, and nutrient uptake.

Organic matter yields key plant nutrients and promotes stable soil structure, good aeration, and water infiltration and retention.

Cation exchange capacity (CEC) is a measure of the soil's ability to store positively-charged nutrients like calcium, potassium, and magnesium. The CEC of any soil can be increased by increasing organic matter content.

Biological activity is concentrated in the top few inches of soil were microorganisms can get food, air, and water. This creates the "fence-post effect."

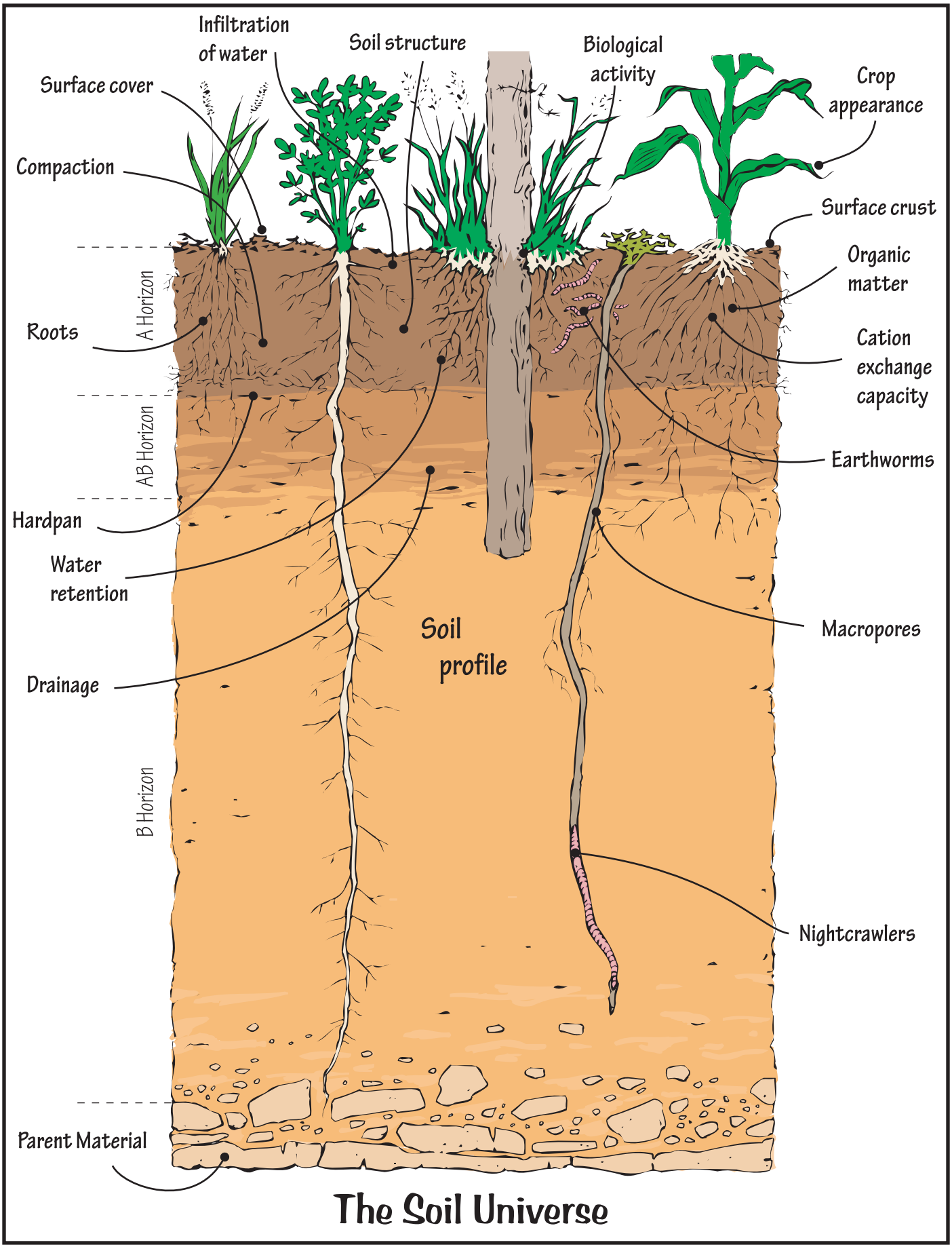
Earthworms convert organic matter into nutrient-rich castings, and create channels for air and water flow and for root growth.

Nightcrawlers are deep-burrowing earthworms that live in single, pencil-sized tunnels. They come to the surface to collect plant material for food, which they store over their burrow hole.

Macropores are large, continuous channels through the soil created by roots, worms, and other large soil organisms like beetles. As conduits for air and water movement, they facilitate aeration, infiltration, and root growth.

Crop appearance, growth characteristics, and resistance to stresses (extreme moisture conditions, pests, and disease) provide a quick appraisal of soil health.

Roots can reveal soil problems such as compaction, poor aeration, toxic conditions, and nutrient imbalances.



The Soil Universe

Soil Fertility

Healthy soil supplies plants with a well-balanced diet of *macronutrients* (nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur) and *micronutrients* (boron, copper, iron, manganese, molybdenum, and zinc). Healthy soil also cycles nutrients more efficiently, meaning it requires fewer inputs and loses fewer nutrients to erosion and leaching. Many people also believe that a well-balanced, fertile soil plays a key role in the nutritional health of livestock and people.

Testing for Soil Nutrients

A laboratory soil test offers the best and most thorough way to monitor your soil's nutrient levels. Contact an independent soil consultant or your County Extension Service to link up with a soil testing laboratory.

Work with a Professional

An independent consultant can help you work out a testing plan, take the samples for you, and help you decipher the management implications of your results. If you choose to take soil samples yourself, ask the laboratory you are working with to send you sampling instructions. You still may want to seek professional assistance for help in interpreting the soil test results. Look for someone with whom you feel comfortable and who is willing to help you reach your soil management and farm goals.

Develop a Testing Plan

Base the frequency of your soil testing program on your goals, crop rotation, soil types, and financial resources. Some farmers like to test every year; those on a two year crop rotation may test every other year. Others prefer to only test for nitrate nitrogen every year and for more stable nutrients (P, K, and most micronutrients) every three to five years. In sandy soils, boron and sulfur may need to be tested annually. Ideally, all monitoring sites should be tested during the first year of monitoring to establish a baseline of information.

Use the Soil Test Record Sheet to summarize the results of your laboratory analysis for each monitoring site. The grid can be used to map out the site location. In the "Notes" section of the record sheet, record any pertinent information, such as your fertility program for that site or your notes on how much credit to take for other sources of nitrogen like hay, cover crops, manure, and organic matter. This section can also be a place to record any plant tissue analysis done to test for nutrient deficiencies in crops.

What Else a Soil Test Can Tell You

Soil test results can tell you more than just your soil's nutrient levels; they can also report your soil's organic matter content, cation exchange capacity, and pH.

Organic Matter Content

In addition to being critical to a soil's structure and water-holding capacity, organic matter also plays an important role in soil fertility. Through the process of decomposition, dead plants and animals are converted into soil organic matter. Organic matter is the source of readily available plant nutrients, particularly nitrogen, phosphorus, and sulfur. Organic matter also increases cation exchange capacity.

Soil organic matter content depends on a number of factors, including climate and soil type. For example, in a cool, temperate region a sandy loam soil type might have 2-4 percent organic matter compared to 4-6 percent in a silt loam soil type. In a warmer climate, these numbers will be lower.

Increasing organic matter content even 0.1 percent per year can benefit soil health significantly. Inversely, even a drop of 0.1 percent per year can signal a decline in soil health—even if the percent of organic matter content is high.

Changes in organic matter content should be tracked over several years to be confident of the trends because laboratory results are not precise enough to reliably detect annual changes as small as 0.1 percent. If you need to increase your soil's organic matter content, research the many different ways to achieve this and decide which makes the most sense for your farm.

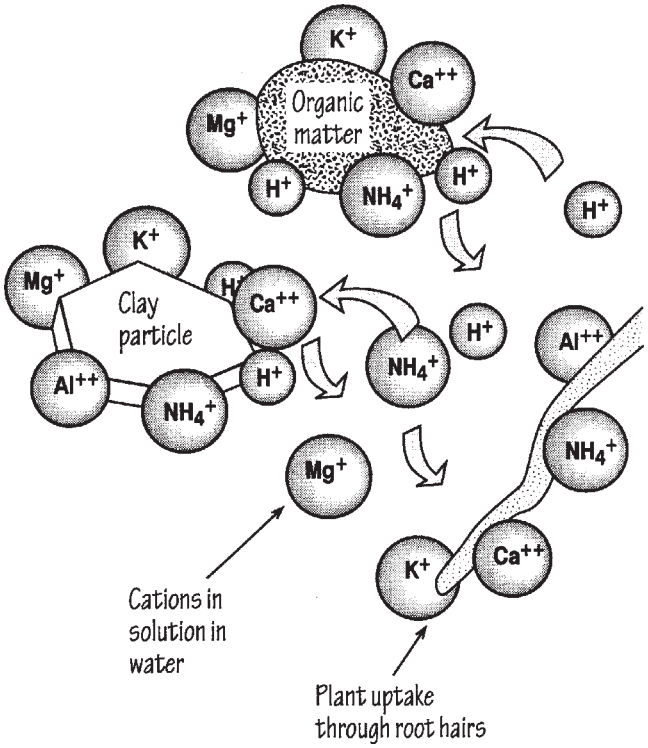


Figure 8: Cation exchange capacity

Cation Exchange Capacity

Cation exchange capacity (CEC) is a measure of how many positively charged nutrient ions (like calcium, potassium, and magnesium) your soil is able to store and supply to plants. For instance, a soil with a CEC of 15 can store many more nutrients than a soil with a CEC of 5. (See Figure 8.)

Cation exchange capacity depends on your soil's clay content, which you cannot change, and the organic matter content, which you can alter. The CEC of sand and silt particles are both low, but clay has a high CEC. *Humus*, the stable form of soil organic matter, also has a high CEC and is very important for storing nutrients in soils with little clay. An increase of about 0.5 percent organic matter will generally increase CEC by about one unit.

Soil pH

The term *pH* expresses the amount of soil acidity or alkalinity on a scale from 0 to 14. Most soils range from 4.5 to 8.5; a pH of 7 is considered neutral. Very few plants will tolerate very acid soils, those testing 4 to 5; nor do many plant thrive in too alkaline soils, anything over 7.8. Information on the optimal pH range for most crops is available from your local agronomist.

Low availability of nutrients usually result from too high or too low of a pH. For example, adding lime to a low pH soil can significantly increase the availability of other soil nutrients. A pH reading should not be used by itself, however, to determine your soil's nutrient needs.

Transfer the results of your laboratory analysis test to the Soil Test Record Sheet and record any other pertinent information. Also, review the criteria in the Field Guide and rate each of these soil fertility categories on the Soil Assessment Record Sheet.

Biological Life in the Soil

In addition to supplying plants with a good balance of available nutrients, a healthy soil also sustains a complex community of *beneficial soil organisms.* The main job of beneficial soil organisms is to convert dead plant and animal remains into soil organic matter, which improves a soil's physical fitness and nutrient supply. Larger organisms like earthworms, also help build good soil structure and aid water infiltration.

The Fence Post Effect

Except for deep-burrowing nightcrawlers, biological activity is concentrated in the top few inches of soil. Here large soil organisms like earthworms, beetles and nematodes, and *microorganisms* like bacteria, fungi, and algae have access to food (in the form of organic matter), air, and water. This high level of biological activity is readily apparent in the *fence post effect:* the first signs of rot on a wooden fence post often appear just below the soil surface. (See Figure 9.)

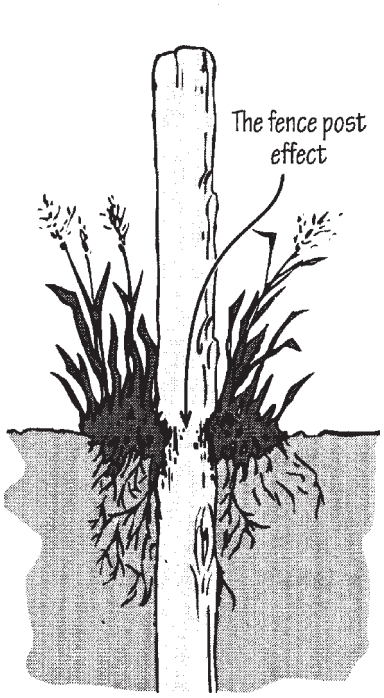


Figure 9: Biological activity is concentrated in the top few inches of soil.

Beneficial soil organisms respond quickly to management and can be a good indicator of soil health. Ensuring a high level of biological activity means avoiding those practices that tend to have a detrimental effect on beneficial soil organisms. These include low levels of plant residue and organic matter; poor aeration and drainage; certain chemical pesticides (especially insecticides); and tillage practices that leave a high percentage of bare soil, excessively break down soil structure, or bury residue too deep. Many farmers claim that anhydrous ammonia inhibits the activity of soil organisms, especially earthworms.

Residue Decomposition

An easy, but informative way to track your soil's biological activity is to look at the previous year's cowpies or buried residue. If there is little evidence of last year's organic additions, you have biologically active soil. If, on the other hand, you find a lot of undecomposed cowpies and buried residues, then your biological barometer is low. If you dig up corn stalks from three years ago, your soil has very little biological activity. Rate biological activity and residue decomposition using the Field Guide and record the ratings on the Soil Assessment Record Sheet.

Earthworms: Super Soil Builders

Earthworms are worth their weight in gold when it comes to soil building. They mix soil; cycle nutrients; provide pathways for air, water, and roots; and their nutrient-rich castings help stabilize soil. The most common types of earthworms are *angle worms,* also called gray worms because of

their grayish color, and *redworms* or red wrigglers. These earthworms reside in the top few inches of soil. Another common type is the *nightcrawler,* a large, deep-burrowing earthworm that comes to the soil surface at night for food.

Earthworms are most active during cool, wet periods in the spring and fall. They typically become inactive during periods of extreme heat, cold, or dryness. You are not likely to find many in July or August unless you check under thick mulch.

Dig for Worms

Take a shovel to the field a few days after a soaking rain in early May. Turn a shovelful of soil onto a garbage bag or sheet of plastic and use your hand to dig around for worms. Many healthy soils will have a worm or two in every handful (more than fifteen in the whole shovelful). If the soil is not a healthy environment for earthworms you may find only a few or none at all. Repeat this exercise three to five times per site. Record the numbers and make notes about what kind of worms you find in the "Notes" section of the Soil Assessment Record Sheet. Mark the appropriate rating for that category based on the criteria in the Field Guide.

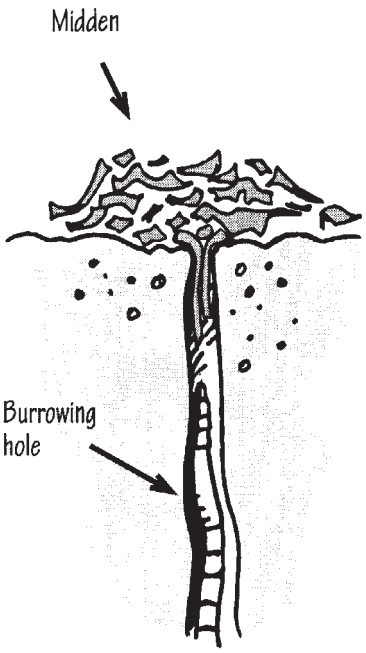


Figure 10: Evidence of nightcrawler presence.

Check for Nightcrawlers

Look for signs of adult nightcrawlers on the soil surface. You should find both burrowing holes and *middens,* or "tents" of plant residue, over the top of their permanent burrow. These tents, which measure about one to three inches across, are the nightcrawler's food supply. If it is a midden, you may even see several leaves or stems pulled down into the hole. (See Figure 10.)

Make a note of how many burrowing holes and middens you find in a two square foot area. Ten or more indicate that your soil management is benefitting from these valuable soil organisms. If you find fewer than five, investigate what management factors might be creating an unfavorable environment. Mark the appropriate rating on the Soil Assessment Record Sheet based on the criteria in the Field Guide.

Monitor Cowpies

Cowpies are a favorite food of worms, so this is an ideal place to look for them as well. Use your boot or a stick to turn over the cowpie. Make note of any evidence of earthworm activity, such as castings or burrow holes. In particular, keep track of how fast cowpies decompose. While microorganisms are contributing to this process, most likely earthworms are at work as well.

Crop Health

Monitoring the health of your crops offers you a very visible way to monitor your soil. In fact, problems with crop health often are your first indication that something is not right with your soil.

Use caution, however, when using crops to monitor soil. Many times the same symptoms expressed by a plant or crop can mean a number of different things, depending on the situation at hand. If your crops show any signs of weakness or stress in the following categories, make use of some of the other tools offered in this chapter and investigate the situation further. An independent crop consultant or the local County Extension personnel can also be a good resource in this regard.

Crop Appearance and Stress Resistance

Periodically walk your fields during the growing season to assess your crop's appearance and stress resistance. The crop health indicators listed below are also summarized on the Field Guide. Rate each category on the Soil Assessment Record Sheet and jot down more detailed information in your journal or in the notes section of the record sheet.

Overall appearance: Scan your field to get an overall impression of the crop's appearance and to spot any problem areas.

Roots: Crop productivity begins with good roots. Dig or pull up a plant and study its roots. Roots in healthy soil should be deep, fully developed with lots of root hairs and fleshy white when scraped. Plants with poorly developed roots are easily pulled out and more susceptible to being blown over by strong winds. Poor root systems tend to bunch or run horizontally instead of vertically down into the soil, and are often discolored or dying. Poorly developed roots can be a sign of a hardpan, poor aeration, toxic conditions, disease or pests, or nutrient imbalance.

Leaves: Healthy plants tend to have lush, full, green leaves. Leaves that are small, narrow, light green or yellow, discolored, or scorched may be showing a nutrient deficiency or imbalance. These same symptoms could also be an indication of poor aeration due to compaction.

Stems: Healthy stems are thick, strong, tall and straight. Short, spindly stems that are easily blown over, or lodged, are a sign that something is out of balance.

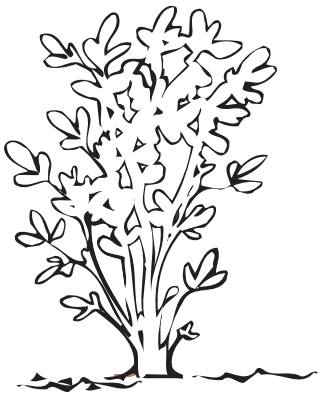
Stand density: Walk your fields several times throughout the season to determine *stand density,* the number of plants in a given area. Pay particular attention to germination rates and seedling emergence, and the percent of bare ground. If weather conditions cannot explain stand density problems caused by poor germination or emergence, then examine your soil conditions. Wet spots and knolls with little or no topsoil are obviously susceptible to poor stand density and indicate weaknesses in your soil resource.

Growth and maturity rates: Barring extreme weather conditions or delays in planting, healthy crops should grow well and mature fully

within their standard "days to maturity" rating. If planting was on time and weather conditions are good, but your crops are lagging behind or mature later than they should, poor soil conditions may be the culprit.

Resistance to pests or disease: Crops grown in healthy soils will show fewer serious pest or disease problems, especially during extreme environmental stress such as drought. If weather conditions are good, but your crops are suffering from disease or are being attacked by pests, the crops may be stressed by poor soil conditions.

Response to moisture conditions: The benefits to crops from good, physically fit soil show up dramatically during growing seasons with extreme moisture conditions. Good drainage can lessen the negative impact of too much water during a wet year. In drought conditions, soils with good organic matter levels can hold more moisture in the plant's root zone.



Weeds: The weeds in your fields may be trying to tell you something about how you are managing your soil. Many weeds thrive under specific soil conditions. For example, foxtail, velvetleaf, bindweed and ragweed all compete well in compacted or tight soils. Quackgrass and lambsquarter may mean excessive fertility. Curly dock could be a sign of an acid soil, with low calcium.

Nutrient Deficiency Symptoms

Observing your crops can also be used to monitor soil nutrient deficiencies. The Field Guide summarizes some common symptoms of nutrient deficiencies that show up in plants. Review the summary, then refer to it when you do a crop appearance and health assessment.

Remember, however, that deficiency symptoms that show up in plants do not necessarily mean that the soil is deficient in that particular nutrient. Other factors could be contributing to the situation. Rather than jump to an immediate conclusion, let these symptoms prompt you to investigate all the possible causes. You may also want to have a plant tissue analysis done on a sample from the affected area. Check with an independent crop consultant or your County Extension Service for more information about this test.

From Monitoring to Management

The soil monitoring tools offered in this chapter can help you see the connections between your management practices, the health of your soil, and the long-term viability of your farm. Use this process as a springboard for creativity and generating new ideas so that you can create a soil management plan that brings together "the combination of practices" that "develop and maintain a soil as nearly as possible to the ideal on a sustained long-time basis."

Additional Resources

Publications

Most, if not all, of the following resources can be obtained through inter-library loan. Some can be purchased through your local bookseller.

Best Management Practices: Nutrient Management. (Toronto & Ottawa, Ont.: Ontario Ministry of Agriculture, Food and Rural Affairs, and Agriculture and Agri-Food Canada, 1994.)

A good overview on testing for soil nutrients and interpreting test results. Details the benefits of soil testing and how to collect and handle the samples. Provides brief overviews of soil nitrate-nitrogen testing, manure testing and plant-tissue analysis. Also contains a well-illustrated section on nutrient deficiencies.

Best Management Practices: Soil Management. (See previous citation.)

Seventy pages of bulleted text, well-conceived photos, and stimulating graphics. Provides a comprehensive list of topics on soil and soil health, but the depth of coverage is limited by the bullet format.

Building Soils for Better Crops: Organic Matter Management, by Fred Magdoff. (Lincoln, NE: University of Nebraska Press, 1992.)

Offers an excellent balance of theoretical and practical soil management information. Describes the basic nutrient cycles and their interaction with organic matter dynamics. Reviews the effect of different management alternatives on soil organic matter, biological activity and other soil properties with an eye toward creating healthier soils.

Soil Survey of [Your County and State]

Possibly the single most useful resource in understanding your soils. Each county's soil survey contain maps of the prominent soil types for all land within the county. Simply locate the map(s) for your farm. Your county's soil survey is available through the local Natural Resources Conservation Service (NRCS) office. Your local library may also have a copy.

Methodologies for Screening Soil-Improving Legumes, by Marianne Sarrantonio. (Kutztown, PA: Rodale Institute, 1991.)

A detailed source for soil monitoring in response to management changes. Offers several hands-on tests for characterizing soil and monitoring soil changes over time.

Minnesota Underfoot: A Field Guide to the State's Outstanding Geologic Features, by Constance J. Sansome. (Bloomington, MN: Voyageur Press, 1983.)

Easy to use, easy to understand field guide with detailed maps, directions, and descriptions of fifty-six of Minnesota's most outstanding geological features.

Minnesota's Natural Heritage: An Ecological Perspective, by John R. Tester. (Minneapolis: University of Minnesota Press, 1995.)

Beautifully composed explanation of how ecosystems are structured, how they work and how they respond to natural and human influences. Covers Minnesota's main ecosystems: deciduous forest, northern coniferous forest, tallgrass prairie, wetlands, lakes, and streams and rivers.

Permaculture: A Practical Guide for a Sustainable Future, by Bill Mollison. (Washington, DC: Island Press, 1990.)

A comprehensive, thought-provoking guide for working with nature to design and maintain permanent, agriculturally productive ecosystems that mirror the diversity, stability and resilience of natural ecosystems.

Sustainable Soil Management by Appropriate Technology Transfer for Rural Areas (ATTRA). (Fayetteville, AR, 1996.)

An informative package of materials about alternative methods for understanding, assessing, and managing soil. For a free copy call ATTRA at 800-346-9140.

The Soul of the Soil: A Guide to Ecological Soil Management, by Grace Gershuny and Joseph Smilie. (Davis, CA: Agaccess, 1996.)

Stresses the need for a holistic understanding of soil and soil processes. Emphasizes the biological nature of soil and covers basic principles of soil function as well as management strategies that enhance the life of the soil in search of overall soil quality. Includes a chapter on "Observing and Evaluating Your Soil."

United States Department of Agriculture Yearbook

An annual publication put out by the USDA. Each year focuses on a different topic related to agriculture. Of special interest to soil: ***Soils and Men*** (Yearbook of Agriculture 1938) and ***Soil*** (Yearbook of Agriculture 1957).

Both contain thought-provoking historical perspective, technical information, management suggestions, and policy discussion, as well as several chapters detailing the fundamentals of soil science including soil formation processes, soil chemistry, physical properties of soils, soil biology and soil-water relations. Both are out of print but should be available through interlibrary loan and can sometimes be found at library and yard sales.

Wisconsin Soil Health Scorecard, by The Wisconsin Soil Health Program of the University of Wisconsin Center for Integrated Agricultural Systems. (Madison, WI: University of Wisconsin Press, 1996.)

A short booklet farmers can use to assess and monitor soil health by scoring 43 soil health properties using mostly sensory-based or descriptive indicators.

People

Cooperative Extension Service: Your state's Cooperative Extension Service is set up to share information on soil management specific to your region and/or crops. Many states have regional or state specialists who work in the area of soil management and who welcome farmers' questions. If they cannot answer your questions themselves, they can point you in the right direction to find an answer.

Farmer Organizations: Farmer organizations such as the Minnesota Sustainable Farming Association, the Practical Farmers of Iowa, the Innovative Farmers of Ohio, and the Nebraska Sustainable Agriculture Society allow farmers to network with and learn from each other.

Independent Soil or Crop Consultants: One of the most effective ways to be a good soil manager is to work with an independent soil/crop consultant who you can trust to provide unbiased soil management advice that is sensitive to your goals.

Natural Resources Conservation Service (NRCS): NRCS staff are trained to help identify management practices that will help improve nutrient use efficiency, decrease runoff and soil erosion, and improve soil quality.

Monitoring Soil

Soil Assessment Record Sheet

Date _____

Monitoring location and description _____

Weather conditions _____

Crop/tillage history (current plus previous two years) _____

Soil Profile

Topsoil: Layer 1 Depth from _____ inches to _____ inches Color _____ Texture _____

Subsoil: Layer 2 from _____ inches to _____ inches Color _____ Texture _____

Layer 3 from _____ inches to _____ inches Color _____ Texture _____

Parent Material (depth to and type) _____

Soil Health Assessment

Assess your soil's health by rating the following characteristics:

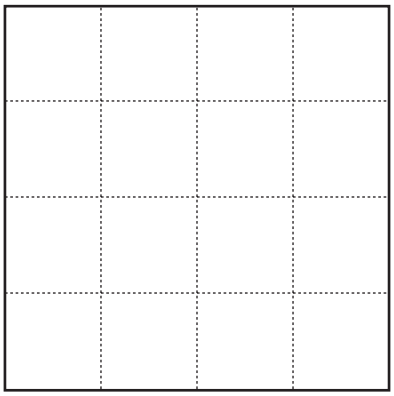
	Good	Fair	Poor	Notes
Physical				
Soil Structure	_____	_____	_____	
Aggregate Stability	_____	_____	_____	
Feel	_____	_____	_____	
Tillage Ease	_____	_____	_____	
Aeration	_____	_____	_____	
Compaction	_____	_____	_____	
Hardpan	_____	_____	_____	
Erosion	_____	_____	_____	
Surface Cover	_____	_____	_____	
Surface Crusting	_____	_____	_____	
Infiltration	_____	_____	_____	
Macropores	_____	_____	_____	
Water Retention	_____	_____	_____	
Drainage	_____	_____	_____	
Fertility				
Nutrient Balance	_____	_____	_____	
Organic Matter	_____	_____	_____	
Cation Exchange Capacity	_____	_____	_____	
pH	_____	_____	_____	
Biological				
Activity/Decomposition	_____	_____	_____	
Earthworms	_____	_____	_____	
Nightcrawlers	_____	_____	_____	
Crop Health				
Overall Appearance	_____	_____	_____	
Roots	_____	_____	_____	
Leaves	_____	_____	_____	
Stems	_____	_____	_____	
Stand Density	_____	_____	_____	
Growth and Maturity	_____	_____	_____	
Resistance to Pests or Disease	_____	_____	_____	
Response to Moisture Conditions Weeds	_____	_____	_____	

Monitoring Soil

Soil Test Record Sheet

Date _____

Monitoring location and description _____



Notes

Macronutrients

Nitrogen _____

Phosphorus _____

(available) _____

Potassium _____

(% base saturation K) _____

Calcium _____

(% base saturation Ca) _____

Magnesium _____

(% base saturation Mg) _____

Sulfur _____

Micronutrients

Iron _____

Boron _____

Manganese _____

Zinc _____

Copper _____

Molybdenum _____

Organic Matter Content _____

Cation Exchange Capacity _____

pH _____

Monitoring Soil

Field Guide

Soil Health Assessment Criteria

Physical

■ Soil Structure

Good—crumbly, granular
Fair—lumpy or blocky
Poor—cloddy with big chunks; or dusty and powdery

■ Aggregate Stability

Good—aggregates do not break down with gentle swirling
Fair—aggregates break down with gentle swirling; water remains clear
Poor—breaks down by wetting or gentle swirling; water becomes cloudy

■ Feel

Good—loose and spongy; springs back after being squeezed
Fair—smooth or grainy; compresses when squeezed
Poor—mucky, greasy, or sticky

■ Tillage Ease

Good—mellow, falls apart, flows off tillage tool; able to till in higher gear
Fair—difficult to work, requires extra passes
Poor—tillage tool rides on surface, scours hard; soil never works down

■ Aeration

Good—open, porous, "breathes"
Fair—dense with few pores
Poor—tight, closed

■ Compaction

Good—no compaction; loose soil resists packing, easy to till
Fair—some compaction and packing, slight hardpan
Poor—high compaction; soil tight, difficult to till; water ponding

■ Hardpan

Good—no hardpan; deep root growth; little resistance to a soil probe
Fair—thin hardpan; some restriction of vertical root growth; requires more pressure to insert probe
Poor—thick hardpan; impenetrable by roots or soil probe

■ Erosion

Good—little or no erosion by wind or water
Fair—some erosion in moderate to heavy rain; some signs of sheet or channel erosion; some blowing of topsoil
Poor—severe erosion by wind or water; gullies or wash-outs form; large amount of topsoil moved or lost

■ Surface Cover

Good—dense plant spacing or plant canopy; no or minimal tillage leaves a "trashy" or heavily mulched surface
Fair—some bare ground visible between plants; moderate canopy; some form of tillage used, leaving a portion of residue cover
Poor—predominantly bare surface or sparse plant spacing; tillage leaves little or no surface residue

■ Surface Crusting

Good—no crust; surface rough, porous, easily dug by hand
Fair—thin crust; surface smooth with few holes
Poor—thick crust, cracks and curls when dry; hard, compacted surface

■ Infiltration

Good—water soaks in immediately; no ponding or runoff even during heavy rain; soil is spongy
Fair—water soaks in slowly; some ponding and runoff during heavy rain
Poor—little or no water soaks in; ponding and runoff even during moderate rain

■ Macropores

Good—five or more within the diameter of the coffee can
Fair—between two and five within the diameter of the coffee can
Poor—two or less within the diameter of the coffee can

■ Water Retention

Good—soil holds moisture well and makes water easily available to plants
Fair—soil drought-prone during dry stretches
Poor—soil drought-prone under normal weather conditions

■ Drainage

Good—excess water moves quickly through the soil and out of the root zone
Fair—excess water drains out out of the root zone slowly, but eventually
Poor—excess water unable to move out of the root zone causing waterlogging or oversaturation

Fertility

■ Nutrient Balance

Good—soil test indicates a balanced supply of both macro and micronutrients; no excesses or deficiencies
Fair—soil test indicates a slight excess or deficiency of one or more plant-essential nutrients
Poor—soil test indicates a severe excess or deficiency of one or more plant-essential nutrients

■ Organic Matter

(depends on soil texture and climate)

Good—content above 4 percent
Fair—content between 3-4 percent
Poor—content at 2 percent or less

■ Cation Exchange Capacity

(depends on soil texture)

Good—CEC over 15
Fair—CEC between 10-15
Poor—CEC under 10

■ pH

Good—between 6.5-7
Fair—slightly below or above the 6.5-7 range
Poor—significantly below or above the 6.5-7 range

Biological

■ Activity/Decomposition

Good—high level of activity; rapid rotting of previous year's plant growth or crop residue; manure quickly consumed
Fair—moderate level of activity; slow or partial rotting of old plant growth, crop residue, or manure
Poor—low level of activity; little or no rotting of old plant growth, crop residue, or manure

■ Earthworms

Good—more than fifteen worms in a shovelful of soil
Fair—between five and fifteen worms per shovelful of soil
Poor—fewer than five per shovelful of soil

■ Nightcrawlers

Good—more than ten in a two square foot area
Fair—between five and ten in a two square foot area
Poor—less than five in a two square foot area

Monitoring

Streams

Streams are an integral part of nature's water cycle and a vital source of fresh water. Streams act as arteries for the movement of materials through the landscape. And so, a stream can reveal not only the condition of fresh water, but also the condition of the environment through which it runs.

What Is It?

By observing the physical, biological, and chemical changes in and along a stream, you can become familiar with the natural processes that keep a stream ecosystem healthy, and recognize how land use practices affect these processes.

Who Does It?

Stream monitoring can easily be done by one person, but it can be a fun activity for families or with neighbors. Plus, working with others gives you a venue for sharing the things you observe. Community partnerships—such as with your local school, agricultural groups, or an agency biologist—can expand your understanding beyond what is happening on the portion of stream that flows through your farm to what is happening at the watershed level.

When?

Physical conditions are most easily monitored during July or August when stream flow is lower. Interesting things can also be learned from examining the stream after a big storm and during each of the four seasons. Different insects emerge at different times throughout the summer and could be sampled several times, such as late May, early July, and mid-August. The main thing is to be consistent from year to year.

Time Required

As little as a few hours a year is sufficient to identify stream organisms and collect information about the stability of streambanks and the condition of the streambed. However, the more time you put into your monitoring program, the more you can learn. Allow yourself the time needed to achieve your objectives and to have fun.

Materials and Cost

Basic supplies such as a plastic tape measure, a yardstick, simple net, and a field notebook might cost less than twenty-five dollars. A pair of inexpensive hip waders will come in handy as well. Reference books and water chemistry equipment needed for a more comprehensive program can be more costly. If intensive monitoring interests you, contact a group already doing stream monitoring to share resources.

Getting Started

CHAPTER CONTENTS

Water is an integral part of the earth's ecosystem and is essential to all life. As an ecosystem building block, water moves in a cycle: from clouds as rain or snow, through soil, over land, through lakes and wetlands, and down streams and rivers to the sea where it evaporates and condenses back to the clouds. (See Figure 1.) Because water cycles continuously over and through the land, all human and natural activity on the land affects water quality.

Why Focus on Streams?

As arteries for the movement of materials through the landscape, streams provide a way of assessing how different land use practices affect water quality. Furthermore, streams reveal key information about the condition of the environment of which they are a part.

This chapter of *The Monitoring Tool Box* also focuses on streams because several of the farmers connected with the Monitoring Project were interested in monitoring the impact of management intensive grazing on their streams. Together with other Monitoring Project team members, the farmers identified the following questions:

- How do different farming practices—row cropping, continuous grazing, management intensive grazing—affect the amount of soil, fertilizers, and pesticides entering adjacent streams?
- How do land use practices impact the shape of streambanks?
- How do land use practices affect the physical habitats of streams, especially the stream bed?
- How do land use practices affect aquatic animals, especially bottom dwelling organisms and fish?

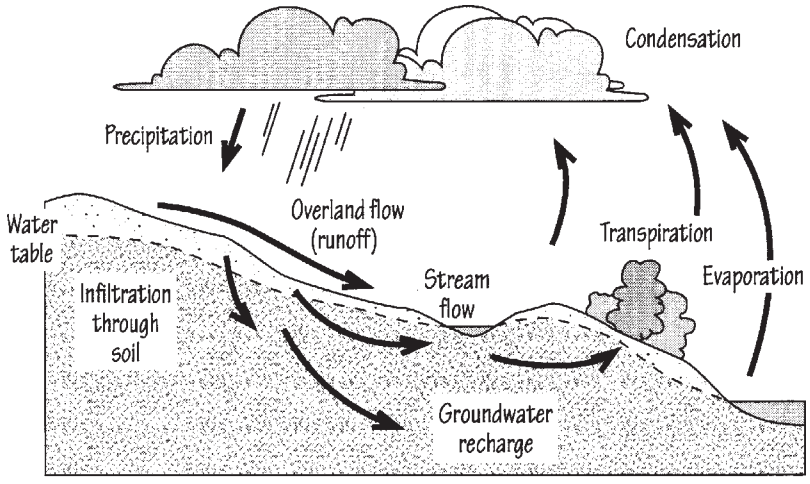


Figure 1: The water cycle

Figure 1: The water cycle.

This chapter grew out of these questions. Along with describing various parts of the stream ecosystem and important processes that connect land to water, the chapter also offers some basic tools for monitoring the physical, biological, and chemical condition of a stream. With consistent monitoring over time, you can begin to evaluate the influence of your management practices on all parts of a stream system.

You Can Make A Difference

To make the best use of the tools offered in "Monitoring Streams," first review your whole farm goals. Remember, holistic farm goals recognize the interconnectedness between people and the environment.

Your farm exists within a local *watershed*, a term for all the land and water within a natural drainage area. This is true whether you have a stream running through your land or not. Local watersheds are part of regional watersheds like the Minnesota River, which are part of continental watersheds like the Mississippi River-Missouri River watershed.

Obviously, your actions have the greatest and most immediate impact on the land and water resources of your farm. But by engaging in land management practices that improve water quality and enhance the surrounding landscape of your stream, you also contribute to the well-being of the whole watershed system. In other words, what you do on your farm makes a difference off your farm as well.

Develop A Monitoring Plan

Once you are clear about goals for your farm, you can put together a meaningful monitoring plan.

Summarize Your Current Farming Practices

First summarize your current farming operation and identify any current practices that might be affecting your stream. For example:

- Is the land adjacent to the stream in row crops, or pasture?
- If in row crops, do you farm on the contour or not; do you use narrow strips or is it one continuous field?
- If in pasture, how do you currently manage it?
- What is the location of livestock facilities in relation to your stream?
- What is your current fertility program? Do you apply manure to your land, and if so when?
- When, where, and how do you use pesticides, if at all?

Identify Clear Objectives

Different tools provide different types of information, so first review the tools offered in this chapter in light of your farming operation. Then ask yourself, "What information do I want to learn from monitoring my stream?" From here, build your plan around a manageable number of clear objectives. For example:

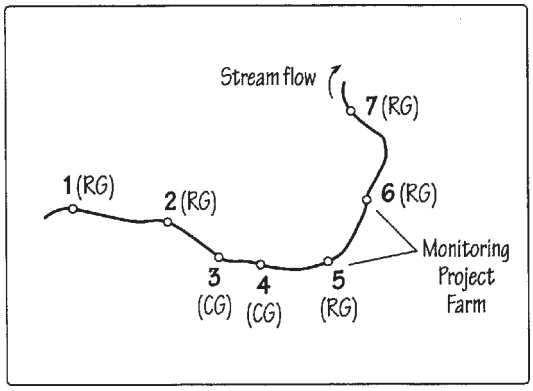
Objective: I'd like to know how much soil is eroding from my fields and entering the stream.

Plan: Monitor water clarity and embeddedness after rainstorms. How clear is the water normally? Does even a small amount of rain cause the water to cloud? Will physical conditions improve in time if I add grass waterways to my fields?

Making a Difference

Given the number of individual farms impacting a stream system, any one of these farmers might rightly ask, "If I change my farming practices, does it really make a difference?" Based on the first three years of the Monitoring Project's work on the stream that flows through one of the Project farms, the answer is yes.

Monitoring Project team members from the Minnesota Cooperative Fish and Wildlife Research Unit set up seven monitoring stations along approximately three miles of the stream: four upstream of the farm, two on the farm, and one downstream (see map). All the stations, except the third and fourth, ran through pasture managed with rotational grazing (RG); stations 3 and 4 ran through continuously grazed pasture (CG).



Even though these seven monitoring stations were located in the middle of the watershed, meaning many upstream management practices could potentially influence the results, two important trends were noted:

1. Fecal coliform (a bacterium associated with cattle manure) consistently peaked at station 4 (the downstream point of the continuously grazed segment) and fell off considerably at station 7.

2. Turbidity levels (reflecting the muddiness or clarity of the water) also peaked at station 4 and fell off at station 7.

The Monitoring Project farmer interprets these results in this way: "I find it very exciting that what I'm doing on my land is improving the quality of my stream. It's telling me that management intensive grazing is helping me to improve the land resource my farm depends on for its success."

With management intensive (or rotational) grazing this farmer still allows his cows access to the stream. But, he limits the amount of time the cows spend in and near the stream, minimizing the threat of pollution. Controlling when the cows have access to the stream and the duration of that access also helps keep the streambank covered with adequate vegetation, reducing the threat of soil eroding into the stream bed.

In most continuously grazed pastures with streams, the banks are constantly exposed to the trampling impact of the animals. This often leads to a high percent of bare soil on the banks, wider and shallower channels, and muddy, polluted water—as was documented with the pasture immediately upstream from the Monitoring Project farm.

How individual farmers manage their land makes a great deal of difference with regard to the conditions of streams and watersheds. The real question is whether the impact is positive or negative; the answer depends on the decisions of individual farmers. As more and more individuals decide to make changes that positively affect their land and their streams, the impacts can begin to add up in truly effective ways.

Check with your county water planner or an area natural resource agency office to learn about the concerns and goals identified for your local watershed. Ask what you can do on your farm to help make a positive difference.

Objective: I'd like to know if runoff from my livestock yards is impacting the water quality of my stream.

Plan: Monitor bottom-dwelling organisms below the runoff entry area twice a summer. Does the stream have high levels of pollution-tolerant organisms? Will creating a wetland in the runoff path help absorb pollutants and allow cleaner water to enter the stream? Will this increase the number of sensitive organisms?

Information derived from the various tools may not always lead to the same conclusions, but when put together they can reveal overall trends.

Choose Your Stream Monitoring Stations

The next step in developing your monitoring plan is to select your *monitoring stations*, the specific areas you will monitor from year to year.

How to Select Sites

The location and number of sites depends on the length of your stream, the habitat/land use areas along it, and your monitoring objectives.

If your stream is fairly uniform, choose station sites that seem typical of the overall stream. If your stream runs through significantly different habitats or land use practices (a tilled field, a pasture, a wooded area, close to a feedlot, and so forth), select at least one station within each of these different areas. At the very least, you might set up two sites: one at the upstream portion of your land to assess the upland watershed effect; and, one at the downstream end of your farm to learn how your practices are influencing water quality and physical conditions. You could also set up stations above and below an area in which you plan to make some management changes.

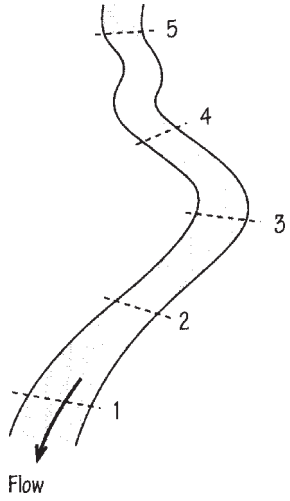


Figure 2: Selecting monitoring sites

Mark and Label Sites

Use a specific reference point, such as a large tree or fence post, to pinpoint the location of each station site so that it is easy to find every time you monitor.

Determine the physical dimensions of your station by stretching a plastic tape measure from the top of one bank to the other. The streambank extends up from the water's edge to where the slope levels out. The station consists of the area extending three feet on both sides of the tape and up both banks. Set surveying flags at the corners if you like. The line of the tape across the water is your *transect*, which is used for a number of the tools that measure the physical condition of your stream. (See Figure 3.)

Label each station and record the identifying information (the reference point) in a field notebook. Also, take a photograph of each station and include the reference point within the picture frame. On the photograph, note the station location and the date. Do this every time you monitor to create a solid record of any changes that might occur along your stream over time.

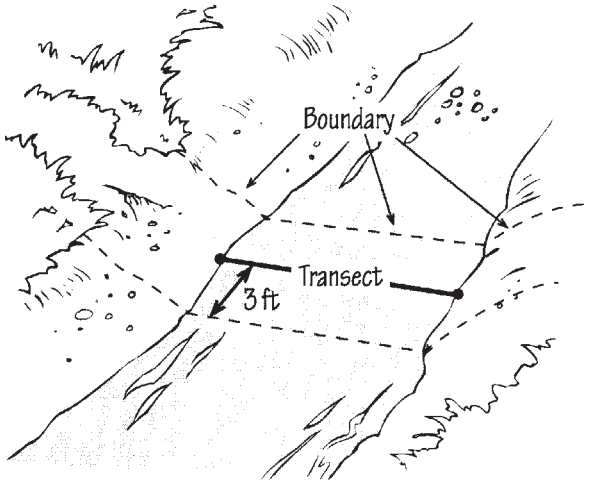


Figure 3. Monitoring station showing boundaries and stream transect

Keep These Points in Mind

Remember that your first year of monitoring provides you with information about the initial condition of your stream. This information gives you a baseline from which to compare information gathered in subsequent years and to track how changes you make in your farming practices affect the stream.

Each time you prepare to go out to your stream to monitor, remember this important point: **The key to good stream monitoring is to closely follow the same procedures every time you use a particular tool.** This applies to selecting stations, to taking measurements, taking samples, analyzing data, and every other procedure involved in stream monitoring. And so, each year before you do your stream monitoring, take some time to review the material in this chapter to refresh your memory.

Also, feel free to supplement your stream monitoring with information and tools besides what is offered in this chapter. Consult the "Additional Resources" section at the end of the chapter for ideas. You may even want to invite an experienced aquatic biologist along the first time you monitor your stream.

Most of all, get in the water and become more acquainted with your stream. You may be amazed at what you discover.

Monitoring Physical Conditions

This section offers a number of tools for monitoring the physical condition of your stream. These include tools for identifying habitat types, examining the condition of streambanks, calculating the width-to-depth ratio of the stream, analyzing the makeup and condition of the stream's bottom material, and monitoring water clarity and aquatic plant growth. (See Figure 4.)

The information you collect using these tools can be recorded on photocopies of the Physical Conditions Record Sheet provided at the end of this chapter. Do not write on this master copy; use it only to make photocopies. Other equipment needs include the following:

- hip waders or tall rubber boots,
- a clipboard and pencil,
- a plastic tape measure,
- a yardstick or other depth measuring device, and
- a bank angle protractor (provided at the end of this chapter).

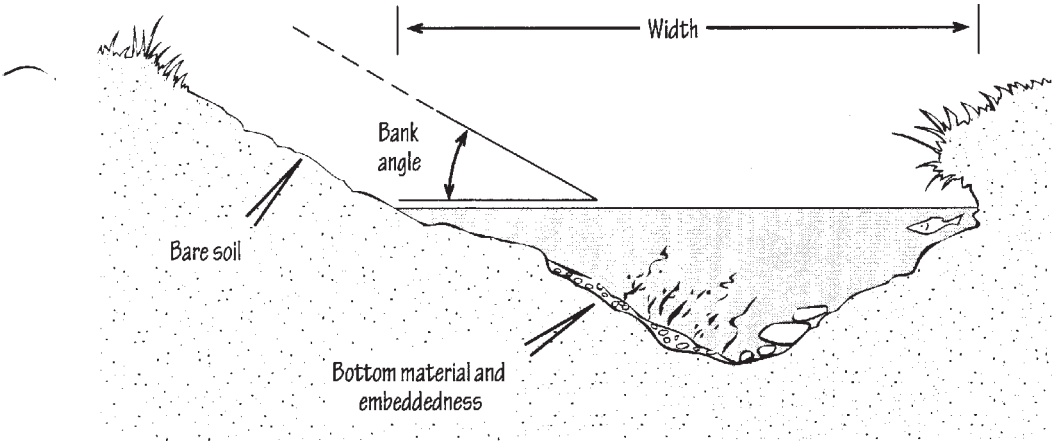


Figure 4: Monitoring physical conditions

Identify Habitat Types

A healthy stream provides many kinds of habitat for fish, amphibians (like frogs and toads) and stream invertebrates (like crayfish or insect larvae). Use the following information about stream habitat types in two ways:

- to identify the habitat characteristics of each of your monitoring stations, and
- to familiarize yourself with the habitat composition of the entire section of stream running through your farm. (See Figure 5.)

For this second option, note which habitats described below are present or missing, the number of each, and the general sequence of habitats from one end of your property to the other.

- ***Riffles*** are the shallow areas along a stream where water moves rapidly over rocks or gravel. The greatest abundance of organisms tends to be found here.
- ***Pools and runs*** are the deeper areas between riffles. The current is slower here, providing places for fish to hide and rest. These areas tend to be silty and are often inhabited by burrowing organisms such as dragonfly nymphs. (See Figure 6.)
- ***Bank overhangs*** are places where streambanks cut under grass and tree roots. The roots extend over the water, shading the stream channel below. Overhangs provide great habitat for fish and insect larvae.
- ***Debris piles*** include tree branches and logs that fall into the water, as well as leaves and crop residues. Debris piles provide habitat and food for insects and hiding places for fish.

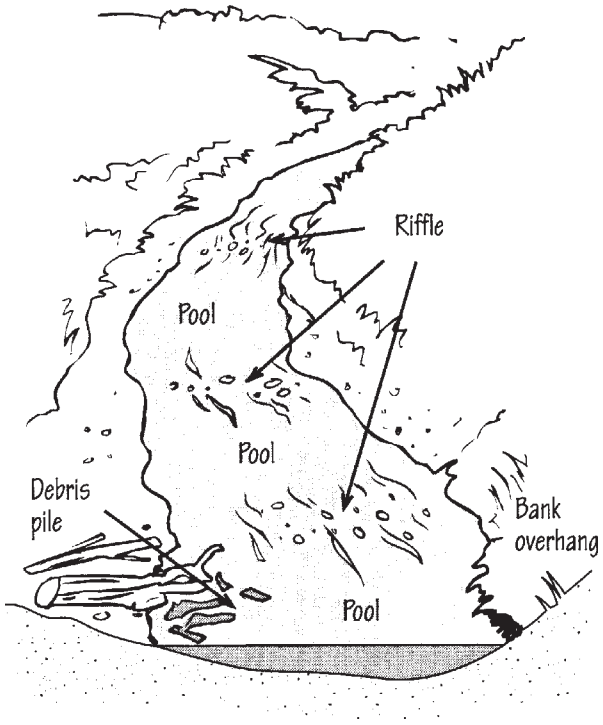


Figure 5: Habitat types

Record your findings in your field notebook and collect this information every two to three years to keep track of changes in your stream's habitat composition.

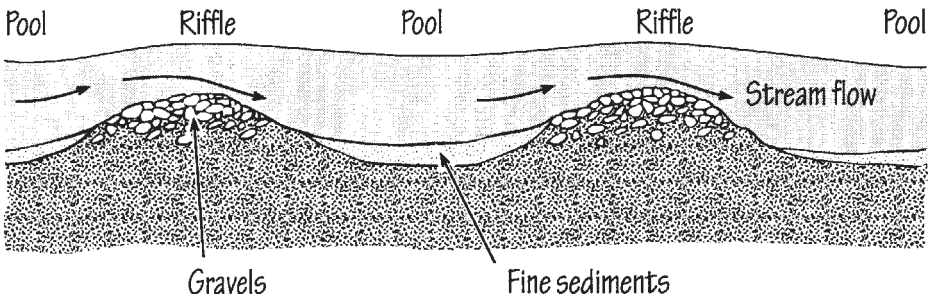


Figure 6: Pool/ riffle sequence.

Monitor Streambanks

The condition of a stream's banks varies depending upon the habitat through which it runs, as well as the land use practices immediately next to the stream and within the local watershed.

Use the following tools to monitor the condition of the streambank at each of your monitoring stations. Record your findings on the Physical Conditions Record Sheet.

Estimate the Percent of Exposed Soil

Stand in the water just behind the lower boundary of the station, facing upstream. Examine the six foot wide area on the right bank and estimate the percent of exposed or bare soil in that area; repeat the procedure for the left bank. You may also want to take a photograph for your records. (See Figure 7.)

Ideally the banks have no bare soil, but levels up to 10 percent bare soil generally indicate good bank stability. Generally, the more vegetation, the greater the stability of the bank.

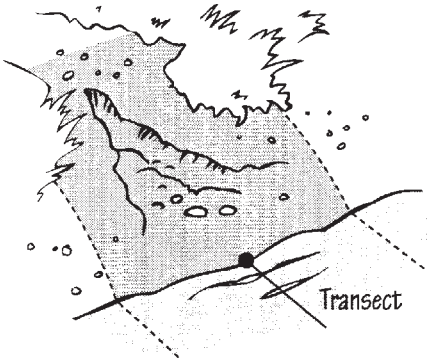


Figure 7: Streambank with 80% exposed soil.

Measure the Bank Angle

Use your bank angle protractor to measure the angle of both banks. Pick a spot within the station area that represents the average slope for that side. Note that the protractor will only give readings for banks that are not undercut.

In situations with simple slope profiles, place a yardstick parallel to the bank slope and place the protractor on the inclined yardstick. The weighted string will hang vertically across the protractor giving you the bank angle. (See Figure 8a) For more complex slopes, two people can stretch a tape or string between them to approximate the angle of the bank. Both ends of the tape should be the same distance from the ground. (See Figure 8b.)

Banks tend to be most stable when the slope is between 25 and 45 degrees. If your bank angles fall outside of this range, consider the causes, such as lack of vegetative cover, erosive run off patterns, the type of soil, the shape of the stream channel. Explore your options for improving bank stability.

Figure 8a: Measuring bank angle with protractor and yardstick.

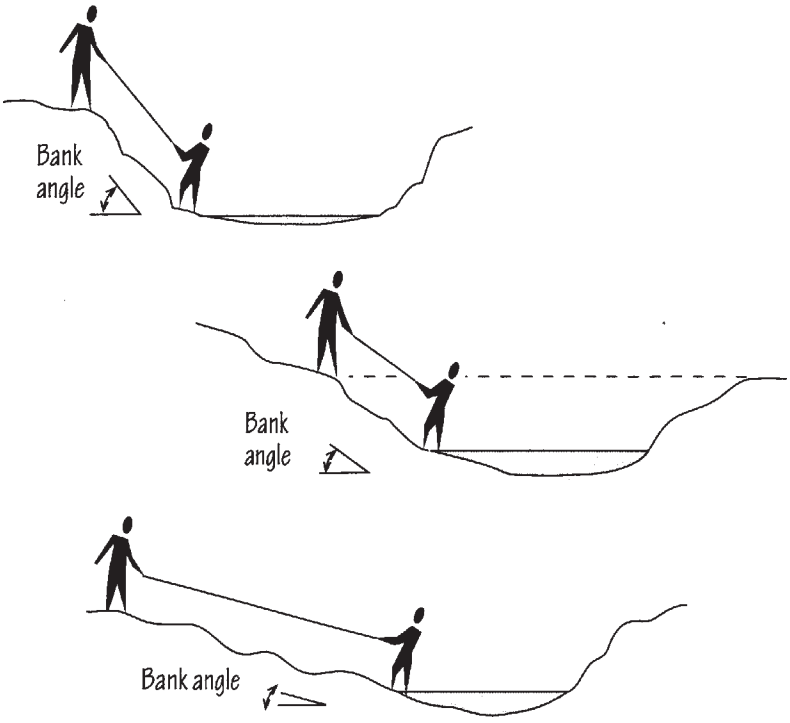


Figure 8b: Two people measuring the angles of more complex streambanks.

Measure the Width to Depth Ratio

To monitor the width to depth ratio of your stream, follow these steps:

1. Measure the width of the stream along the transect.
2. Locate four evenly spaced points on the transect. To do this accurately, divide the total stream width by four to determine the length
   of each quarter section of the transect. (See Figure 9.)
3. Moving from the left bank to the right, locate the first site, then the second, and so forth. At each point, use a yard stick to measure the depth and record the figures in the appropriate column on the Physical Condition Record Sheet.
4. Add the four depth measurements and divide by four to determine the average depth.
6. Determine width:depth ratio by dividing the width by the average depth. Record this number as well.

A good width:depth ratio is generally less than 50:1, indicating a deeper channel and a constricted bank. The wider and shallower the stream, the higher the ratio and the more degraded it is. (See Figure 10.) The

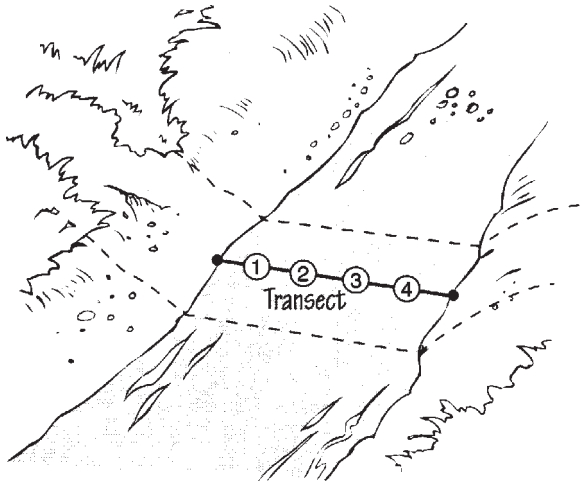


Figure 9: Stream transect showing four equally spaced measuring locations.

Degraded stream

Healthy stream

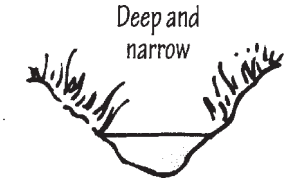


Figure 10: Degraded and healthy streams.

width:depth ratio should decrease over time if the streambanks were initially bare but are then managed to maintain continuous vegetation. This will help the stream narrow and deepen.

Examine the Streambed

Major stream degradation often occurs when soil from poorly covered hillsides and streambanks, as well as off of agricultural fields with poor soil structure and surface conditions, washes into stream channels. This soil covers rocks that provide habitat for insects and fish. Small particles smother developing fish eggs, eliminate space between rocks where insects feed and hide, and block the light needed by underwater plants and algae. By monitoring the material in the streambed, or *substrate*, you can learn whether or not the animal and plant communities of your stream are being threatened by erosion.

The four points along the transect, determined earlier in order to measure stream depth, are also used in the following two tools.

Determine the Substrate Composition

In an area about one square foot around each point along the transect, reach into the substrate with your hands and estimate the percent of

- **fine material** (silt, clay and sand that is under 1/16 inch in diameter),
- **coarse material** (gravel, cobbles or boulders; 1/16 inch or larger in diameter), and
- **organic material** (woody debris, crop residue, aquatic plants or algae).

Record this information on the Physical Condition Record Sheet.

Estimate Embeddedness

At the same time, estimate the stream's *embeddedness*—the degree to which the coarse material is covered by fine material. Use the list below and Figure 11 as guides and record the data on the Physical Condition Record Sheet. If there is no coarse bottom material to be covered, mark this line with a slash.

0% — rocks completely free of fine materials

25% — fine material partially surrounds rocks, but tops are clear

50% — fine material completely surrounds rocks, but tops are clear

75% — fine material completely surrounds rocks; tops are half-covered

100% — rocks are totally buried

Embeddedness greater than 50 percent in a riffle probably indicates that sediment loads are too high. Pools tend to have large areas where embeddedness is greater than 50 percent. However, if embeddedness is

greater than 50 percent at the upstream end of the pool where water velocities are faster, this may also indicate high sediment loads.

Measure Water Clarity

If your stream is susceptible to soil erosion, consider measuring the *clarity*, or cloudiness, of the water after a measurable rainfall. Check the stream several times, such within the first twenty-four hours of the rain, a few days later, and a week later.

One way to measure water clarity is to install a *permanent depth meter*—a pipe or metal fence post with white markings painted at regular intervals, such as every five inches—in the stream at a convenient, easily-viewed location. Use the submerged white markings on the post as a visual reference and note how many you can see. If you do not have a permanent depth meter, the stream bottom or a stick poked into the water can also serve as a visual reference. This information can be recorded on the Physical Conditions Record Sheet.

Pay attention to the trends: Does the stream run muddy only after heavy rainfalls? Or, does even a small amount of rain cause the water to cloud? If need be, investigate further to see if the erosion is taking place on your farm or upstream of it. Also, use the permanent depth meter to keep track of yearly differences in flow levels. Higher flow levels tend to increase turbidity. (See the *Tool Box* chapter, "Monitoring Soil," for information on how to prevent soil erosion.)

Monitor Aquatic Plant Growth

A healthy stream is home to a diversity of life forms, both plant and animal. But when excessive amounts of nutrients enter the stream from farm fields and other sources within the local watershed, aquatic plant growth (especially algae) can explode and take over the stream. As the excess algae break down, the level of *dissolved oxygen*—the amount of available oxygen molecules in the water—declines.

The dissolved oxygen level, in part, determines which fish and invertebrates are able to live there. Measured in parts per million (ppm), the maximum level of dissolved oxygen in water is 15 ppm. Sensitive organisms, such as stonefly and mayfly nymphs, need close to 10 ppm of oxygen to survive. Organisms such as midge larvae can more easily survive at lower oxygen levels.

In agricultural areas, expect to see more aquatic plant growth in a stream in the spring, when rain is more frequent and most fertilizers are applied to fields. Later in summer, stagnant, slow-moving areas will also tend to have higher algae levels. But if high levels of algae are present in non-stagnant areas beyond the spring flush, the stream may be carrying excessive nutrients and negatively impacting oxygen levels.

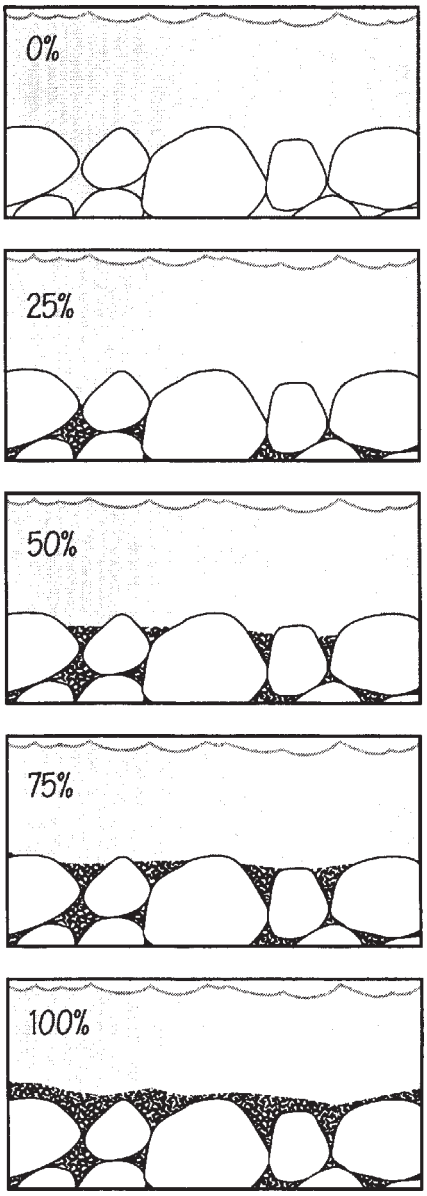
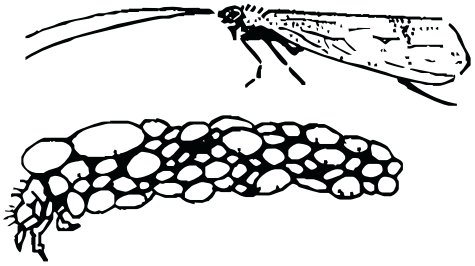


Figure 11: Estimating percent embeddedness

Monitoring Stream Organisms

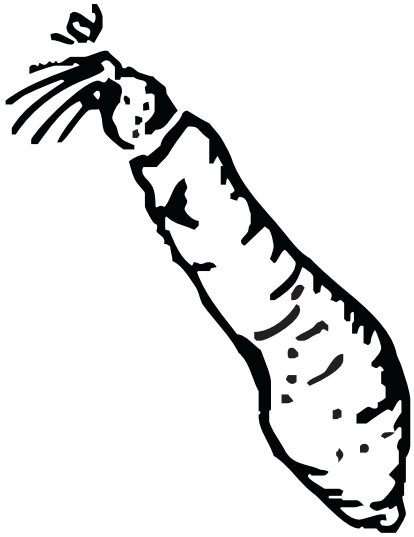
Many fish and other stream organisms cannot survive in degraded conditions. Monitoring the types and population levels of the aquatic organisms in your stream can tell you whether or not there are problems with its physical and chemical conditions, and reveal clues as to what may be negatively affecting the stream.



The focus of the following material is on monitoring *benthic macroinvertebrates*, organisms without a spinal column that live on the bottom (or *benthos*) of a stream or lake and that are visible to the naked eye. (See the identification key, "Stream Insects and Crustaceans," included with this chapter.) This section also includes some information related to monitoring a stream's fish community.

Survey Bottom Dwellers

Doing a yearly survey of a stream's bottom dwelling organisms can be a way to track the health of a stream over a period of years. This tool is useful for detecting changes in water quality because certain macroinvertebrates have a limited tolerance range to chemical and physical changes.



More complex methods for surveying macroinvertebrates are available. However, these require more specialized training to identify organisms and interpret results. If you are interested in these measures, consider contacting an aquatic entomologist from a natural resource agency.

Equipment

To prepare for surveying your stream's benthic community, gather the equipment listed below:

- hip waders or tall rubber boots
- a collection net or sampler
- a clean bucket and spray bottle
- a sorting tray (such as a white dish pan)
- a couple of ice cube trays
- a magnifying glass or box
- forceps or tweezers
- a clipboard and pencil

Your collection data can be recorded on photocopies of the Bottom Dwellers Record Sheet, a master copy of which is provided at the end this chapter. To make your own collection net, see the sidebar on pages 18-19.

Collection

Methods for collecting and identifying aquatic organisms vary depending on the type of stream being sampled. Refer to your field notes on the habitat information for each of your monitoring stations and use the corresponding method as listed below to collect your samples. The main

objective in this collection stage is to net organisms from each of the habitat areas represented on your stream, so make sure you have set up at least one station for each representative area. Complete all four steps of the surveying process—collection, sorting, identification, and analysis—before moving to a different sampling station.

To avoid disturbing the macroinvertebrates, approach the sampling station from the downstream end, walking into the current. To net the organisms, always place your collection net so that the current flows into it. The organisms are transferred from the net to a collection bucket by spritzing the net with a spray bottle filled with clean stream water. This flushes the contents of the net into the bucket. (See Figures 12a-12c.)

At riffles: Choose an area in the riffle about one square yard in size. With your foot or hand, disturb the area in front of a D-frame net or a kick-seine net so that dislodged organisms will float downstream and into the net. You can also pick up larger rocks and brush the organisms into your net or directly into your collection bucket.

At pools or runs: To sample with a D-frame net, jab the net through the sediment in an upstream direction. Make an attempt to dislodge all organisms within one yard of the starting place. If working with another person, the kick-seine net works well: one person stirs up the substrate (bottom materials) in an upstream direction and a partner holds the seine.

At bank overhangs: Using a D-frame net, sweep through the vegetation of an overhang to loosen organisms attached to the vegetation.

At debris piles: Hold the D-frame net or kick-seine downstream of the debris pile and disturb the pile to dislodge the organisms.

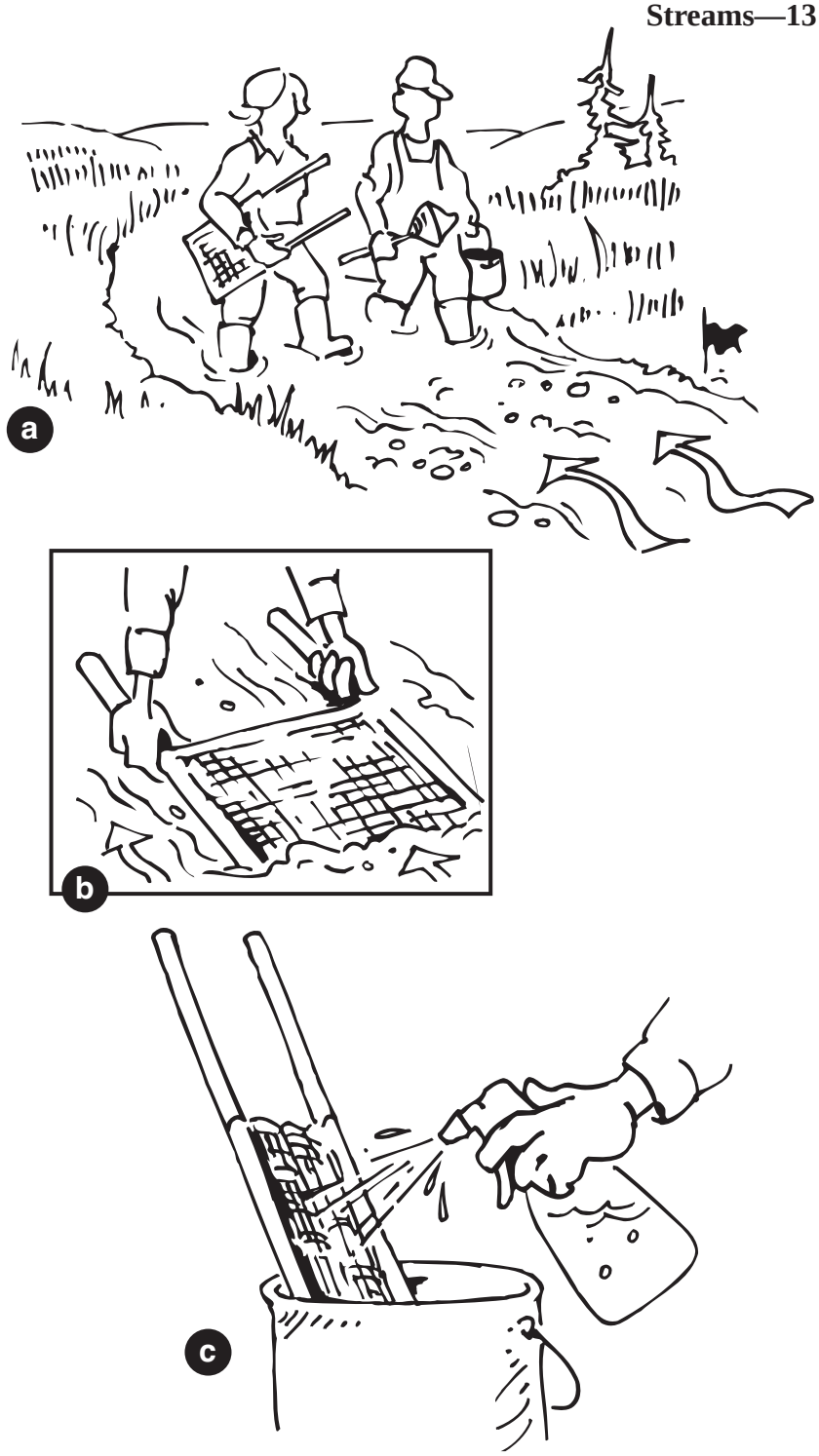


Figure 12: Collecting macroinvertebrate samples

a) Approach sampling station from downstream.

b) Place collection net so that the current carries the dislodged organisms into the net.

c) Flush organisms off the net into a collection bucket.

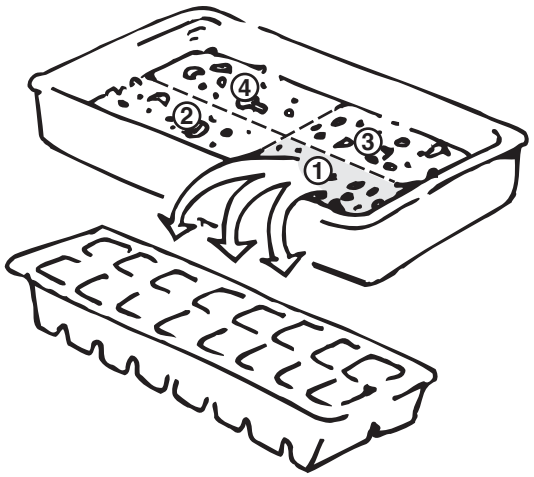


Figure 13: Mentally divide your sorting tray into four quadrants. From one of the quadrants, sort the organisms by type into ice cube trays; then go to the next quadrant and the next, until you have at least 100 organisms.

Sorting

Transfer your sample from the collection bucket to your sorting tray. (If you have a lot of material, divide the sample in half.) In your mind's eye, divide the sorting tray into four equal quadrants. Starting with one of the quadrants, use forceps or tweezers to pick out all of the organisms you can detect there, sorting them by type into the ice cube trays as you go. The quadrant system ensures that you are not just picking out the larger, more colorful, or more active organisms in your sample. (See Figure 13.)

Follow the same procedure for the remaining quadrants until you have at least a hundred organisms. If you reach this quota before you are done with a quadrant, go ahead and finish picking out the organisms in that quadrant and count these as part of your sample. Note that if you are using a D-frame net to collect your sample, you may need to make several attempts within the square yard sampling area to make sure you collect enough organisms.

Identification

Next, use the "Stream Insects and Crustaceans" identification key to sort your sample into the different groups listed on the guide:

- **Group One:** very sensitive to pollution
- **Group Two:** somewhat sensitive to pollution
- **Group Three:** tolerant to pollution

A magnifying glass helps with this process. Be sure to count and record the number of organisms in each group and the total number of organisms collected. When you finish counting and recording, the organisms can be returned to the stream. To preserve and store organisms for further comparisons or identification, put them in a 70-75 percent ethyl alcohol solution in a lidded jar.

If you are unable to identify a particular organism using the key provided, other keys are available. Refer to the "Additional Resources" section at the end of the chapter. One recommendation is *Aquatic Entomology* by W. Patrick McCafferty, written for anglers and ecologists. You might also seek the help of a biologist or aquatic entomologist.

Life Underwater

The majority of organisms that inhabit the bottom of a stream are not adults. In fact, many of the insects you see flying in the air began their life in water.

These insects go through several *larval*, or immature, stages in the water before they become adults. During the last stage before becoming an adult, the insect is called a *pupa*. At this stage it builds a case (like a caterpillar) and undergoes a process called *metamorphosis*. During metamorphosis, the internal larval structures are replaced by those of an adult. Once this process is complete, the adult insect emerges from its case and the water.

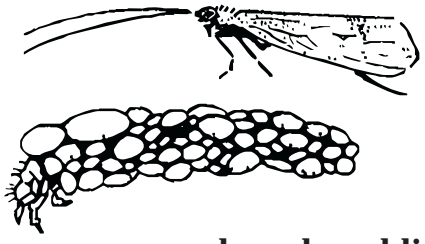
Some of the insects that begin their life in streams and ponds include the caddisfly, the mayfly, and the gnat.

The Caddisfly

The caddisfly (order Trichoptera) is found in a variety of sizes and colors. Like its relative, the butterfly, most caddisfly larvae build cases to protect themselves. Some caddisfly larvae use small pebbles to build their case. Other caddisflies form cases from dead leaves or sticks. Without the case, caddisflies can be identified by their "c" shaped body and the single claw protruding from each leg.

This order of insects is relatively sensitive to pollution. Their presence or absence can serve as a good indicator of water quality conditions.

adult caddisfly



larval caddisfly encased with pebbles

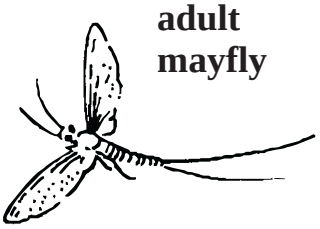
The Mayfly

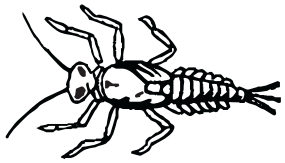
The term "caddis hatch" is often used to describe the sudden appearance of swarms of delicate insects called mayflies. Sometimes the swarms are so dense they can obstruct traffic. But the term "caddis hatch" is actually a misnomer. Mayflies are not a type of caddisfly; they belong to a different insect order, Ephemeroptera.

Adults mayflies are short lived, generally dying within three days of hatching from their larval stage. They only live long enough to mate and lay eggs; most never eat before they die. Swarms of mayflies seen on a summer night often pulse and move, as males attempt to defend their small territory and make contact with as many females as possible.

Ephemeroptera larvae, on the other hand, can live on stream bottoms for up to two years. These larvae are characterized by their two or three-part tails, and usually by plate-like gills coming from their abdomen, the body segment to which the legs attach.

adult mayfly





larval mayfly

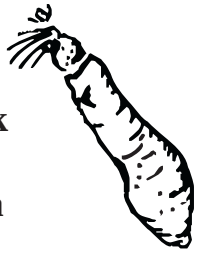
The Gnat

No doubt you have picked a gnat from your eye on occasion. Gnats (or midges) belong to the Chironomid family of insects, and are only one member of a large order of insects called Diptera (true flies).

Along with their cousins the crane fly, the black fly, and the mosquito, midge larvae are fairly tolerant to pollution. Chironomids often live buried in stream sediments and can tolerate lower dissolved oxygen levels than insects like the caddisfly.

midge or chironomid larva

Chironomids are a favorite food for many insect-eating fish. In fact, a common variety called the bloodworm often makes its way into the pet store shelves as freeze-dried fish food. If your stream is home to high percentage of Chironomids, its water quality may be degraded.



black fly larva

Analysis

The main calculations for analyzing your collection data involve finding out the percent of total for each of the three groupings: very sensitive, somewhat sensitive, and tolerant.

The bottom of the Bottom Dwellers Record Sheet provides some space to do your percentage calculations using the general equation given here:

Group Total ÷ **Total Collected** x 100 = Percent of Group

If the number of organisms in Group One is 25 and the total number of organisms collected is 110, to find the Group One percent, your calculation looks like this: 25 ÷ 110 x 100 = 22.7. The percent of total for Group One is approximately 23.

A benthic macroinvertebrate community with organisms from each group indicates good water quality. If, over time, the percent of Group One organisms rises, this signals increasing water quality. If your Group Three organisms constitute more than 50 percent of the total sample, your stream may be experiencing environmental stress or pollution.

Degraded areas also tend to be dominated by one type of organism. If a particular organism seems most prevalent in your sample, calculate the percent of total it represents. Then investigate what the predominance of this organism means for your stream's health—it may or may not mean the stream is degraded. (Some clean, cold water streams are dominated by leeches, a Group Three organism.)

Fish as Stream Condition Indicators

Every stream has its own fish community. How that community changes over time may signal improvement (higher numbers of pollution-sensitive fish) or degradation (overall numbers decrease because habitat has been eliminated by siltation) in stream condition.

Many of the tools used to monitor a stream's physical condition can also help evaluate living conditions for fish. Fish need varied habitat to sustain good numbers and diversity. To reproduce, fish need fast flowing riffle areas with low embeddedness. This ensures that the eggs get plenty of oxygen. Fish also need places to rest and to hide. Log jams, boulders, overhanging grass, and deeper pools give fish refuge from predators. A diversity of habitats also increases the types and numbers of invertebrates, a major food source for many fish.

Because it is difficult to accurately determine the diversity and population levels of a stream's fish community through simple observation, consult a local fisheries biologist. They may be able to aid in collecting and identifying fish.

Common Minnesota Fishes

rainbow darter

The Rainbow Darter

The rainbow darter is one of the more common species of darters found in the small rivers and streams of southeastern Minnesota. As its name implies, it is one of the more colorful fish found in Minnesota's streams.

The rainbow darter only reaches a length of three inches and inhabits clear, rapid waters free of domestic waste. However, it is tolerant of average levels of agricultural enrichment.

The range of the rainbow darter extends from southern Minnesota to eastern Ontario and south to Alabama and Arkansas. In Minnesota, the rainbow dart is common in tributaries of the Minnesota River west of Mankato and in the Cannon, Cedar, Root, and Zumbro rivers.

southern redbelly dace

The Southern Redbelly Dace

The southern redbelly dace is another common, colorful fish found in the streams of southern Minnesota. The bright red color appears to help breeding adults recognize each other in spawning areas they share with other small fish.

An adult female may reach four inches in length, while a male only about three inches. The southern redbelly dace lives over many bottom types—sand, gravel and mud—but consistently lives where springs are present. It can be found in abundance in small streams during summer, but then migrates downstream toward large streams and rivers as winter approaches.

The distribution of the southern redbelly dace is centered in the Ozarks and extends into southern Minnesota in the Mississippi River system. This dace is known in Minnesota in tributaries as far north as the Cannon River in Goodhue County.

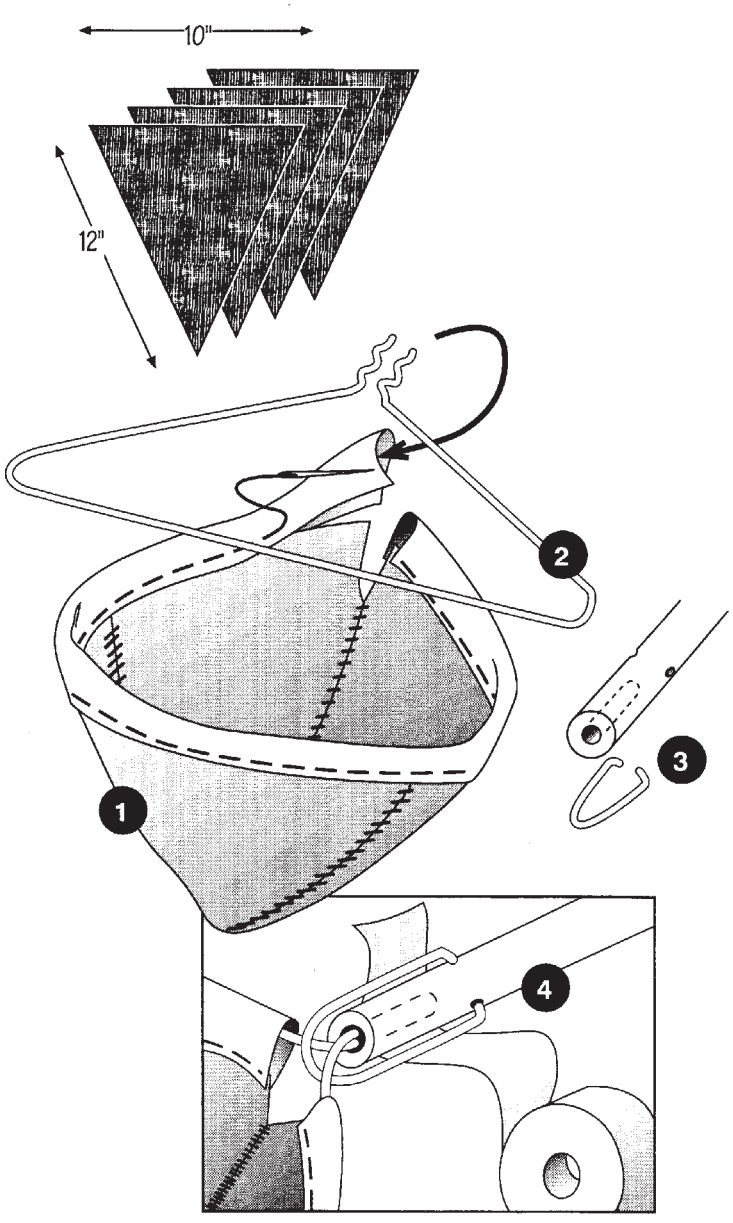
How to Make A Collection Net

Two basic styles of nets are used to collect organisms for a survey of the benthic community of a stream, a “D-frame” net and a “kick-seine” net.

Constructing a D-Frame Net

To make a D-frame net, you will need the following materials:

- enough 1/25-inch mesh nylon netting to yield four, 10-by-12-inch triangles
- 40 inches of 1-inch bias tape
- a wire coat hanger or a somewhat heavier gauge wire you can bend
- a drill with 1/4-inch wood bit
- a 4-foot long wooden dowel or broom handle
- a pair of pliers
- duct tape
- scissors, needle and thread, or sewing machine



Follow these instructions and the accompanying illustrations to assemble your D-frame net:

1. Cut the four triangles from the mesh and sew them together to make a pocket. Sew the bias tape around the opening, leaving the ends open to receive the coat hanger.
2. Cut the hook off the coat hanger with the pliers and untwist the hanger. Slip the coat hanger into the bias-tape casing, and retwist.
3. Drill a hole in the end of the dowel and bend the hanger hook into a U-shape with short right angles on the end.
4. Insert the twisted end of the coat hanger into the hole and slip the U-shaped piece over the end of the dowel to retain the coat hanger frame. Drill holes in the sides of the dowel to receive the right-angle ends. Wrap with duct tape to secure the handle.

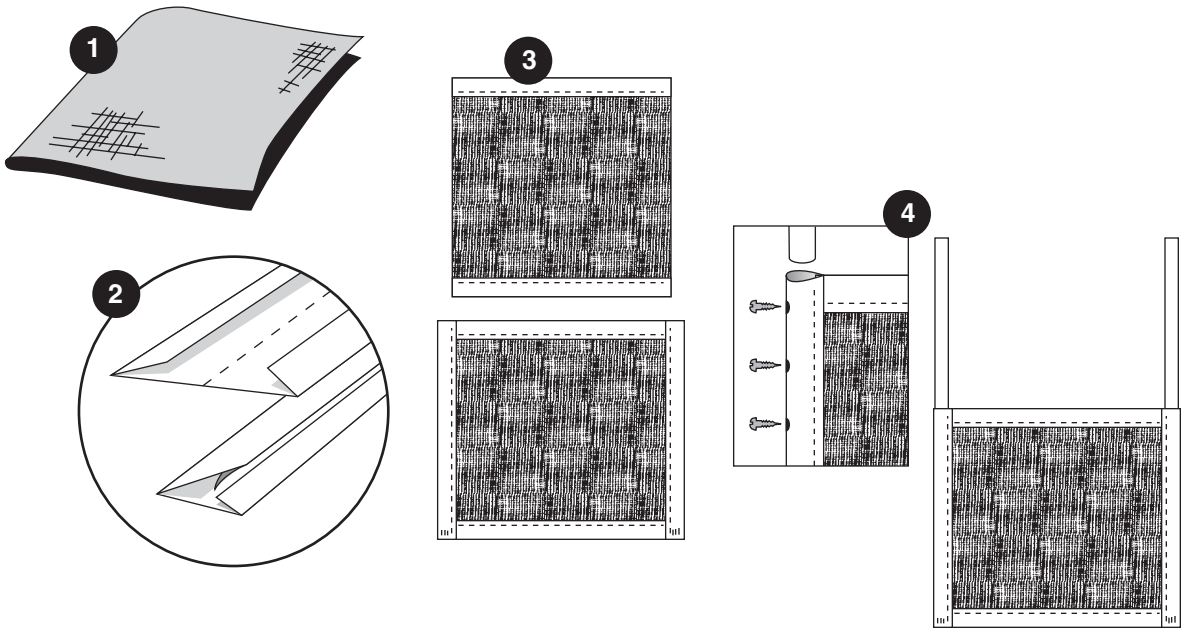
Constructing a Kick-Seine Net

To make a kick-seine net, you will need the following materials:

- 3-foot by 6-foot nylon screening, 1/16-inch mesh
- four 6-by-36-inch strips of heavy canvas
- two 6-foot broom handles or wooden dowels
- iron and ironing board
- scissors, needle and thread, or sewing machine
- wood screws and a screwdriver

Follow these instructions and the accompanying illustrations to assemble your kick-seine net:

1. Fold the nylon screen in half to form a 3-foot square
2. For each of the four canvas strips, make a 1/2-inch fold on each edge of the strip and press with the iron; then fold the strip in half and press again.
3. Sew a canvas strip to both the top and bottom of the mesh square. Then sew the other two strips to the sides to make casings into which you will slip the broom handles. Note that bottom end of the casing is stitched closed and the top end is left open.
4. Once you have inserted the broom handles, secure them to the canvas with wood screws.



Monitoring Water Chemistry

Having your stream's water chemistry tested may be a helpful follow-up to the other tools you use to monitor your stream. For instance, you may want to have water chemistry analysis done if

- your stream catches runoff from a feedlot or from a farmstead in which chemical pesticides are used,
- your stream has an unusually high amount of algae,
- your stream has very few Group One organisms or over 50 percent of Group Three organisms,
- your stream has either low numbers of fish or very little diversity in the fish community, or
- you suspect that a source upstream is adding chemicals to the stream.

Because measuring water chemistry can be complicated, expensive and time consuming, seek the help of an aquatic biologist. (In severe or sudden situations, call the state's Pollution Control Agency or your county's Public Health Department. They may be able to help investigate what is happening.) Some of the complications stem from the fact that water chemistry measures can vary with time of year, climatic events (droughts or floods), intensity of rainfall, and so forth. To account for these variations, a comprehensive sampling plan is needed.

The tools offered in this chapter represent only a small portion of information about stream monitoring. Yet, even if you use just a few of the tools, you can learn a lot about your stream and begin to see the connections between your farming practices, stream conditions, and the long-term sustainability of your farm.

Additional Resources

Publications

Many of the following references can be obtained through the interlibrary loan system, or contact your local bookseller for availability.

Aquatic Entomology: The Fishermen's and Ecologist's Illustrated Guide to Insects and Their Relatives, by W. Patrick McCafferty. (Boston, MA: Jones and Bartlett, 1981.)

Excellent guide to aquatic insects that covers insect biology and identification, ecological information, scientific and common names for insects, and contains great insect illustrations.

Fishes of the Minnesota Region, by Gary L. Phillips, William D. Schmid, and James C. Underhill. (Minneapolis: University of Minnesota Press, 1982.)

General guide to the fishes of Minnesota with photographs of selected species and accounts of individual species biology and natural history. Does not include a key to identification of fishes.

Fishes of Wisconsin, by George C. Becker. (Madison: The University of Wisconsin Press, 1983.)

In depth guide to fishes of Wisconsin that broadly applies to Minnesota. Includes a species-by-species account of the biology and ecology of fishes, distribution maps for individual species, and a key to the identification of fishes.

Guidelines For Evaluating Fish Habitat in Wisconsin Streams, by Timothy D. Simonson, John Lyons, and Paul D. Kanehl. (General Technical Report NC-164, U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station at St. Paul, MN, 1993.)

Methods For Evaluating Stream Riparian and Biotic Conditions, by William S. Platts, Walter F. Megehan, and G. Wayne Minshall. (General Technical Report INT-138, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station at Ogden, UT, 1983.)

This publication and the previous one are technical reports describing specific methods for surveying the physical habitat of streams. Both are detailed accounts with very useful diagrams.

Pond Life: A Guide to Common Plants and Animals of North American Ponds and Lakes, by George K. Reid. (New York: Golden Press, 1987.)

An inexpensive, informative, and well-illustrated guide to the plants and animals that live in or near ponds, lakes, streams, and wetlands. A highly recommended resource.

Sediment in Streams: Sources, Biological Effects and Control, by Thomas F. Waters. (American Fisheries Society Monograph 7, 1995.)

Excellent review of the sources and effects of erosion and sediment in Midwestern streams, and strategies for controlling sediment problems.

Other Resources

Department of Natural Resources (DNR) staff may be able to address specific questions or offer additional assistance. Contact your state DNR and ask for the office nearest you. In Minnesota call the general information number: (651) 259-5122.

Save Our Streams (SOS) is a citizen-oriented, hands-on stream conservation program developed by the **Izaak Walton League of America (IWLA),** founded on the belief that streams are best protected by the people who live near them. Through the free SOS program catalog, you can order publications on a number of topics, including stream restoration, how to organize a volunteer stream monitoring program, wetlands conservation and sustainability, plus a teacher's curriculum. The program conducts hands-on workshops and maintains a technical assistance hotline. For more information about the Save Our Streams program, call 1-800-BUG-IWLA (284-4952) or visit the IWLA web site at www.iwla.org.

The ***Volunteer Monitor*** is a national newsletter of volunteer water quality monitoring. The newsletter facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer environmental monitoring groups across the nation. Different monitoring groups serve as co editor for each issue. It is published twice a year and subscriptions are free. To sign up, contact Eleanor Ely, editor, 50 Benton Street, San Francisco, CA 94112. The *Volunteer Monitor* is also available on EPA's web site at www.epa.gov/OWOW/volunteer/vm_index.html.

Articles

"The Stream Team" is an article by Brian DeVore published in the November-December 1998 issue of the ***Minnesota Conservation Volunteer***, a publication of the Minnesota Department of Natural Resources. It describes how Monitoring Team members Larry Gates and Ralph Lentz worked together on monitoring a farm stream. The article is at www.nativefish.org/articles/grazing.php.

Monitoring Streams

Physical Conditions Record Sheet

Station ID & Description _____

Date_____ Weather _____ Date of last rainfall_____

Habitat type (circle) riffle pool/run bank overhang debris pile

Streambank condition	right bank	left bank
% Bare soil	_____ %	_____ %
Bank angle	_____ °	_____ °

Width:depth ratio

Width _____ feet

Transect	**Point 1**	**Point 2**	**Point 3**	**Point 4**
Distance from edge	_____ feet	_____ feet	_____ feet	_____ feet
Depth	_____ feet	_____ feet	_____ feet	_____ feet

Average depth _____ feet

Width/depth ratio _____ :1

Substrate conditions

Transect		**Point 1**	**Point 2**	**Point 3**	**Point 4**
Material	% fine	_____ %	_____ %	_____ %	_____ %
	% coarse	_____ %	_____ %	_____ %	_____ %
	% organic	_____ %	_____ %	_____ %	_____ %
Embeddedness		% _____	% _____	% _____	%

Water clarity observations

Aquatic plant growth observations

Monitoring Streams

Bottom Dwellers Record Sheet

Station ID & Description _____

Date_____ Weather _____ Date of last rainfall_____

Habitat type (circle) riffle pool/run bank overhang debris pile

Sort the organisms you collect by Group using the "Streams Insect and Crustaceans" identification key.

Group One (sensitive)		**Group Two** (somewhat sensitive)		**Group Three** (tolerant)	
stonefly	_____	crayfish	_____	aquatic worms	_____
caddisfly	_____	sowbug	_____	midge fly larva	_____
water penny	_____	scud	_____	blackfly larva	_____
riffle beetle	_____	alderfly larva	_____	leech	_____
mayfly	_____	fishfly larva	_____	pouch and pond snails	
gilled snail	_____	damselfly	_____	other snails	_____
dobsonfly	_____	watersnipe fly larva	_____		
		crane fly	_____		
		beetle larva	_____		
		dragonfly	_____		
		clam	_____		
Group One total	_____	Group Two total	_____	Group Three total	_____

Total of all organisms (Groups One through Three) _____

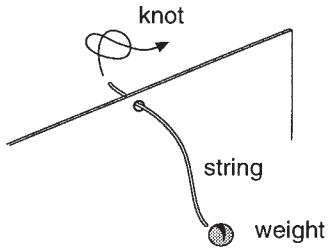
Percent of total sample	_____ %	Percent of total sample	_____ %	Percent of total sample	_____ %

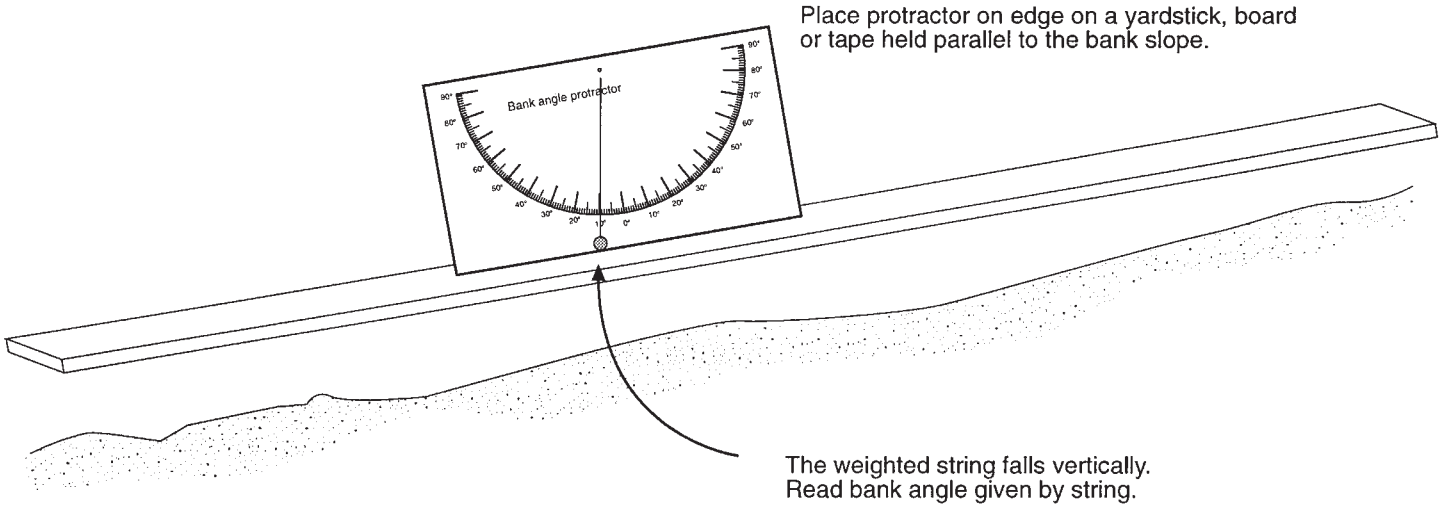
Notes and calculations

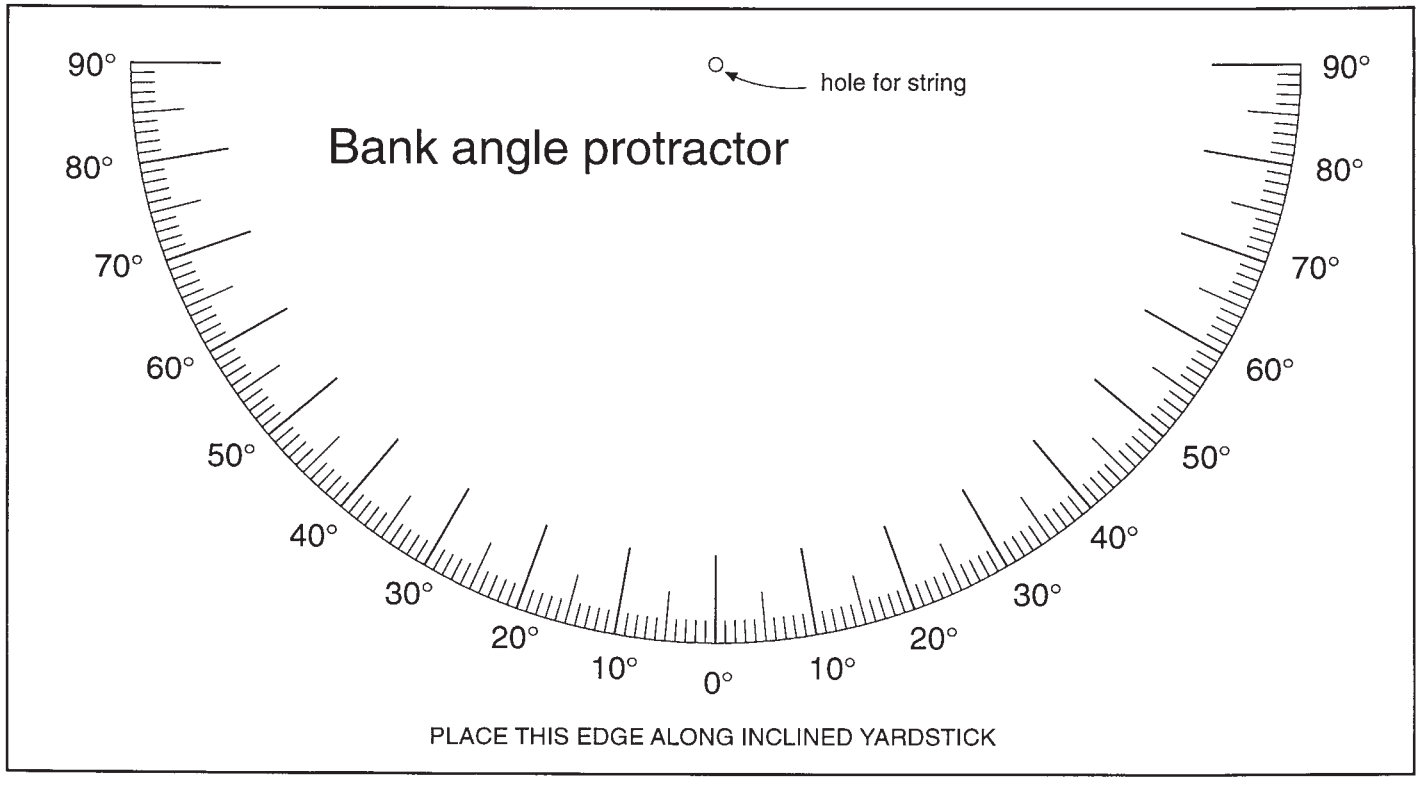
Monitoring Streams

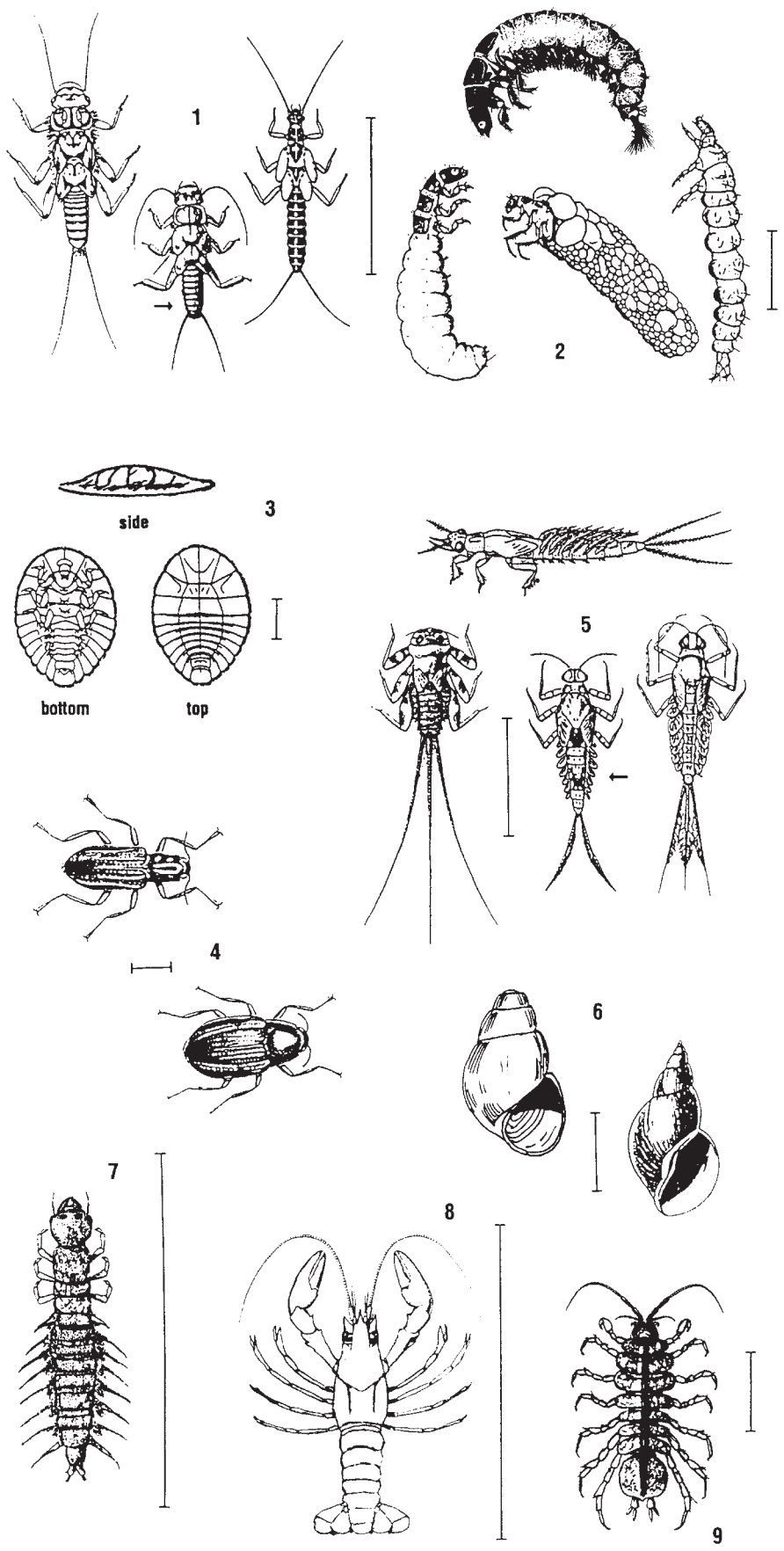
Bank Angle Protractor

Puncture a small hole in the protractor and thread a short piece of string through the hole. Weight the end of the string with a fishing sinker or similar object, at a point just past the angle markings.









Bar lines indicate relative size

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensititve organisms found in good quality water.

1 ***Stonefly: Order Plecoptera.*** 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)

2 ***Caddisfly: Order Trichoptera.*** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on underside.

3 ***Water Penny: Order Coleoptera.*** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.

4 ***Riffle Beetle: Order Coleoptera.*** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 ***Mayfly: Order Ephemeroptera.*** 1/4" - 1". brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6 ***Gilled Snail: Class Gastropoda.*** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.

7 ***Dobsonfly (Hellgrammite): Family Corydalidae.*** 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

GROUP TWO TAXA

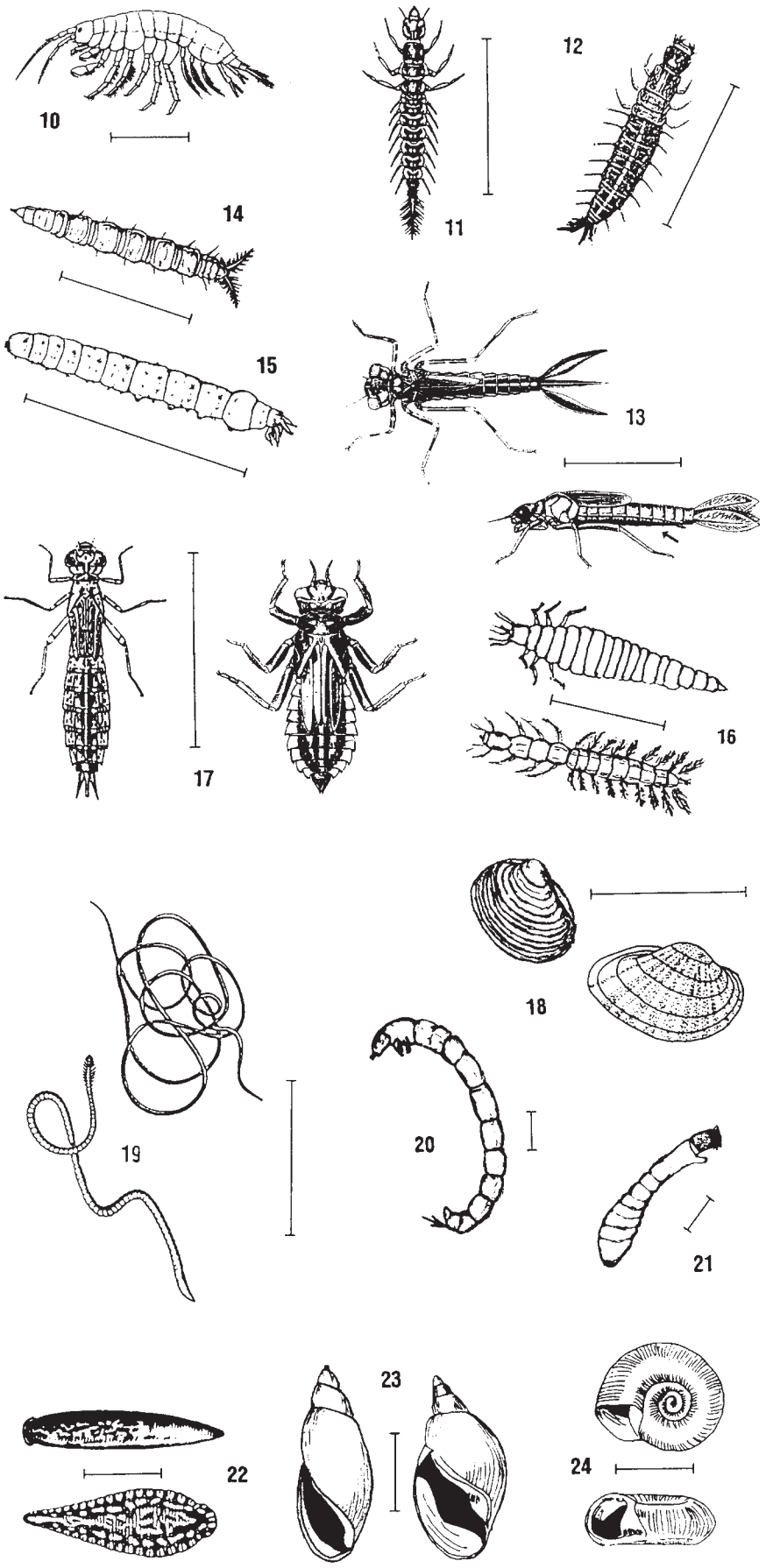
Somewhat pollution tolerant organisms can be in good or fair quality water.

8 ***Crayfish: Order Decapoda.*** Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 ***Sowbug: Order Isopoda.*** 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Save Our Streams

Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983
1(800)BUG-IWLA



Bar lines indicate relative size

GROUP TWO TAXA CONTINUED

10 ***Scud: Order Amphipoda.*** 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 ***Alderfly Larva: Family Sialidae.*** 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 ***Fishfly Larva: Family Corydalidae.*** Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 ***Damselfly: Suborder Zygoptera.*** 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 ***Watersnipe Fly Larva: Family Athericidae (Atherix).*** 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 ***Crane Fly: Suborder Nematocera.*** 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 ***Beetle Larva: Order Coleoptera.*** 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 ***Dragon Fly: Suborder Anisoptera.*** 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 ***Clam: Class Bivalvia.***

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 ***Aquatic Worm: Class Oligochaeta.*** 1/4" - 2", can be very tiny; thin worm-like body.

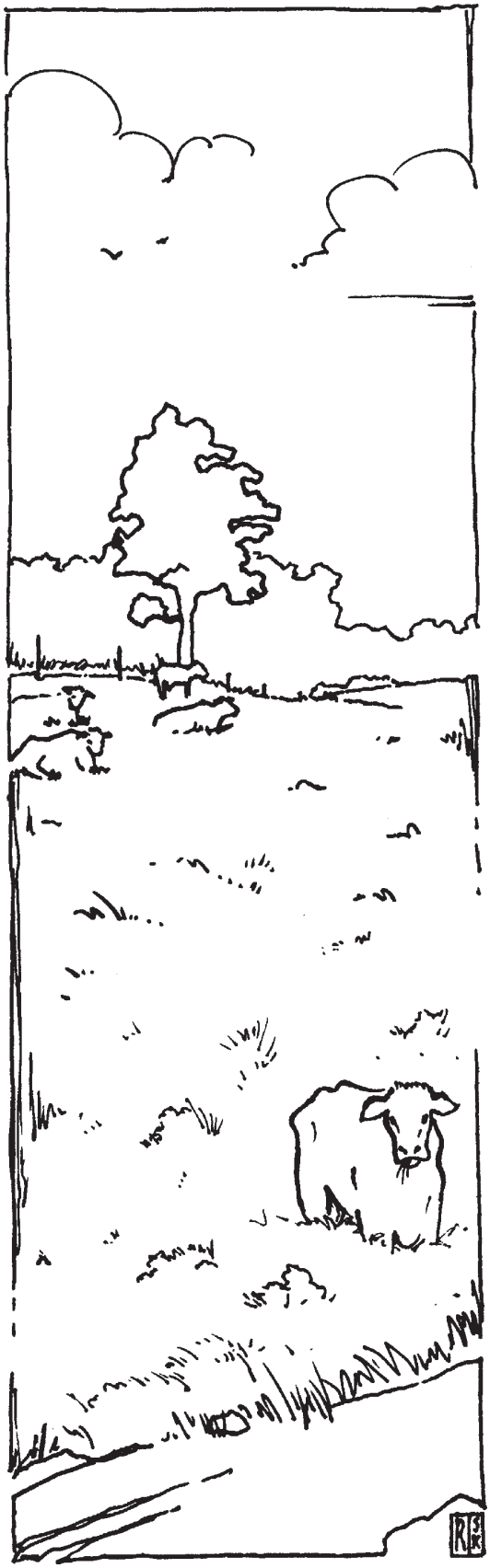
20 ***Midge Fly Larva: Suborder Nematocera.*** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 ***Blackfly Larva: Family Simulidae.*** Up 1/4", one end of body wider. Black head, suction pad on other end.

22 ***Leech: Order Hirudinea.*** 1/4" - 2", brown, slimy body, ends with suction pads.

23 ***Pouch Snail and Pond Snails: Class Gastropoda.*** No operculum. Breathe air. When opening is facing you, shell usually opens on left.

24 ***Other Snails: Class Gastropoda.*** No operculum. Breathe air. Snail shell coils in one plane.



Monitoring

Pasture Vegetation

Pastures played a central role in the Monitoring Project. The six original Monitoring Project farmers were determined to incorporate carefully managed pastures into their farming operations. In doing so they reaped many environmental, financial and social benefits. This chapter shows how you can gain these same benefits from your pasture.

What Is It?

Monitoring pasture vegetation involves paying attention to the impacts of your pasture management decisions—especially your grazing management—on species composition, forage quantity and forage quality.

Who Does It?

The person or persons most involved in the actual management of the pasture, and who have the most at stake in terms of the impacts of that management, should take the lead role in using the tools in this chapter.

When?

The answer to this question varies with the tool being used. Monitoring grazing management can be a daily, weekly, monthly and yearly activity. The Plant Species Survey is typically done twice a year; when depends on your goals and your climate. How often you monitor forage quantity and quality also depends on your goals.

Time Required

This too varies with the tool in use. Be willing to invest the amount of time needed to get the information most useful to you.

Materials and Costs

Some items you will have around the farm or can easily make. Some photocopying costs are involved unless you download the record forms off of www.landstewardshipproject.org. Invest in at least one good plant identification guide. A camera and a computer spreadsheet program are useful but not required. The cost of forage quality analysis depends on the laboratory used and what you have done but typically runs about $10 for a basic analysis. The Alistair George PastureGauge starts at around $500.

Chapter Contents

Webster's Dictionary defines a *pasture* as a plot of land on which plants (such as grasses and legumes) are grown for and harvested by grazing animals. In other words, without animals a field of grass is not a pasture. Monitoring pasture vegetation involves paying attention to how management decisions and practices impact the plants growing in the pasture, and which are being consumed—or ignored—by the animals grazing it. Management, including your **grazing management**, can impact the **species composition** of the vegetation (including physical conditions like ground cover and stand density), the **quantity** of forage available for the animals to eat and the nutritional **quality** of that forage.

This chapter offers you tools for monitoring your pasture management and its impacts. Whether or not you choose to use a particular tool will depend largely on your goals for your farm, and in particular, for your pasture.

Getting Started

As with the other topics in this workbook, your pasture vegetation monitoring will be greatly enhanced if you take some time to set specific objectives before heading out to your pasture. These monitoring objectives should flow, in part, from the whole-farm goals you and your family have developed.

Why Include Pastures

Farmers make pastures a part of their farms for many reasons.

Aesthetic Appeal: Some simply appreciate the beauty of open spaces and of grasslands. In fact, some governments, like the country of Switzerland and the state of Vermont, actually encourage farmers and other rural landowners to maintain pasture land in order to enhance the aesthetic appeal of their countryside.

Environmental Benefits: The environmentally-minded might include pastures in their farming operation to promote biodiversity of both flora and fauna. For instance, pastures can provide critical habitat for numerous species of grassland nesting birds if managed with this goal in mind. Establishing or maintaining a native prairie—by its nature a biologically diverse environment—can often be done more easily with the help of grazing animals. Pastures also can play a significant role in soil stewardship by reducing erosion, building and protecting soil structure, and improving water and mineral cycles.

Economic Advantages: The environmental benefits of pasture played a big role in the decision of each of the Monitoring Project farmers to make the transition to a pasture-based livestock system. But they also based their decision on economic factors.

Pastures provide farmers with an inexpensive, self-renewing source of wealth. Through photosynthesis, plants capture solar energy and transform that energy into food for animals and people. Pastures have the potential to capture solar energy throughout more of the growing season

than do row crops. This reduces the need for stored feeds and enables farmers to lower their overall feed costs without sacrificing quality. And, by using the animals to harvest the pasture's forage and spread the manure through grazing, pastures can reduce a farm's labor and machinery requirements. Monitoring Project farmers have also seen improvements in the health of their animals, resulting in lower veterinary costs.

What Are Your Goals?

Start your pasture vegetation monitoring by addressing these two basic issues: 1) why you have (or want) pasture land as part of your farming operation; and 2) what you are trying to accomplish with it. Your reasons may be quite specific, or you may have multiple reasons:

- Is your primary goal to restore and maintain a track of native prairie?
- Is your main interest in keeping part of your land open for aesthetic reasons thereby creating the need to control the encroachment of woody plants into that area?
- Are the wildlife benefits of pastures of interest to you?
- Do you see pasture as a valuable part of your long-term crop rotation and/or soil conservation plan?
- Is profit from a livestock enterprise your primary goal and you see pasture as the best way to ensure that profit? If so, what species and class of animal (milking, breeding or market) does the enterprise involve?
- Is pasture just one piece of your farming operation or is it the center piece of your farm? Do you consider yourself to be a "grass farmer?"

  Your goals will determine the relevance of the tools offered in this chapter and the information gathered by using them.

Set Your Objectives

Once you are clear about why you have pasture as part of your farm and what you are trying to accomplish with it, create a manageable list of specific objectives of what you want to learn from monitoring. One way to do this is to ask questions and to invite other knowledgeable or interested persons to join in the process. Let curiosity and intuition play a role in this process, along with practical issues.

Then, review the material in the chapter and determine which tools can help you meet your objectives. If necessary, check out additional resources—including tools from other *Tool Box* chapters. Once you have done your first year's worth of monitoring, which sets a baseline of information, monitoring will help you see changes and trends over subsequent years. Also, let your monitoring objectives evolve as your knowledge and experience grows.

Monitoring Pasture Management

All monitoring activity boils down to paying attention to whether or not your management decisions are leading you to your goals. In the case of pasture vegetation, your management has the strongest influence—next to climate and geology—on its species composition and on the quantity and quality of the forage produced.

Nature may set the broad parameters in terms of which pasture vegetation species can grow and survive in your area and the maximum volume potential you can produce. But, within these broad parameters, you determine what actually happens in your pasture.

Management and Monitoring

Some management factors that can influence pasture vegetation include:

- the land you use for pasture
- your grazing management
- your fertility program
- your use or nonuse of pesticides
- your use of tools like clipping, burning or rest
- your soil management
- your reseeding program

Successful pasture management need not require much labor or capital. However, it does require thinking, planning, observation and attention to details. The complexities of working with Mother Nature mean that no set formula will lead you toward your goals and objectives for your pasture. Thus, monitoring can play a critical role in helping you direct your management efforts most effectively.

General Pasture Monitoring Tools

All of the monitoring tools offered in this chapter can help you learn the correlations between management decisions or practices and what is taking place out in your pastures. The base of information gathered from monitoring can then be used for planning purposes, for making day-to-day decisions and for alerting you to issues you need to investigate further. In addition to the specific tools for monitoring grazing management, species composition, and forage quantity and quality, you may want to incorporate some general pasture monitoring tools into your overall farm management program.

Pasture Walks

One of the simplest, yet most informative ways to monitor your pasture management is to walk through it on a regular basis to see what is happening out there. The term *pasture walk* is a common one in grass farming circles, but it can refer to different things.

A regular management practice: Some graziers like to walk their entire pasture once every week or two. They take notice of things like plant growth rates, plant maturity levels, animal grazing patterns, decay rates of animal droppings, soil erosion and presence of wildlife. Some might even use these walks to collect yield estimates in all their paddocks. Much of this information can just be mentally noted; anything needed for future reference can be jotted down in a field notebook or a monitoring record form.

Organized walking tours: A pasture walk can also be an organized group walking tour through a farm's pastures, such as part of a grazing management club meeting. Club members take turns meeting at each other's farms and help the host family assess what is happening in their pasture and why it is occurring based on their own experiences. The visitors are encouraged to point out things about the pasture—both positive and negative—and to question management practices.

A comprehensive assessment: A pasture walk can also be a comprehensive monitoring tool done periodically to evaluate the overall condition of your pasture and to help you find sound solutions to any problems that you may discover. Wayne Burleson, a land management consultant from Montana, has developed a well-thought out assessment that focuses heavily on examining biological processes and movement toward a long-term landscape goal and a holistic production goal.

An especially useful feature of Burleson's Pasture Walk is Wayne's system for classifying the overall condition of the land:

Phase I	The land and plants are stressed because of too many instances and forms of disturbances and inadequate rest.
Phase II	The land and plants are healthy and near or at their productive potential because of balanced disturbance and adequate rest.
Phase III	The land and plants are stressed because of a lack of disturbance and too much rest.

Once you assess the condition of the pasture, you then need to figure out the management causes and consequences. Another feature is the "Land Health Graph" that visually charts out progress toward or away from your goal using a number of biological indicators. (See Figure 1.) Periodic reassessment of these indicators can help you document changes that have occurred in your pasture.

Wayne outlines his Pasture Walk instructions in a useful workbook entitled *Roping Grass: How to Regenerate the Land and the People*. (See the "Additional Resources" section.) This information is also available on his website: www.pasturemanagement.com.

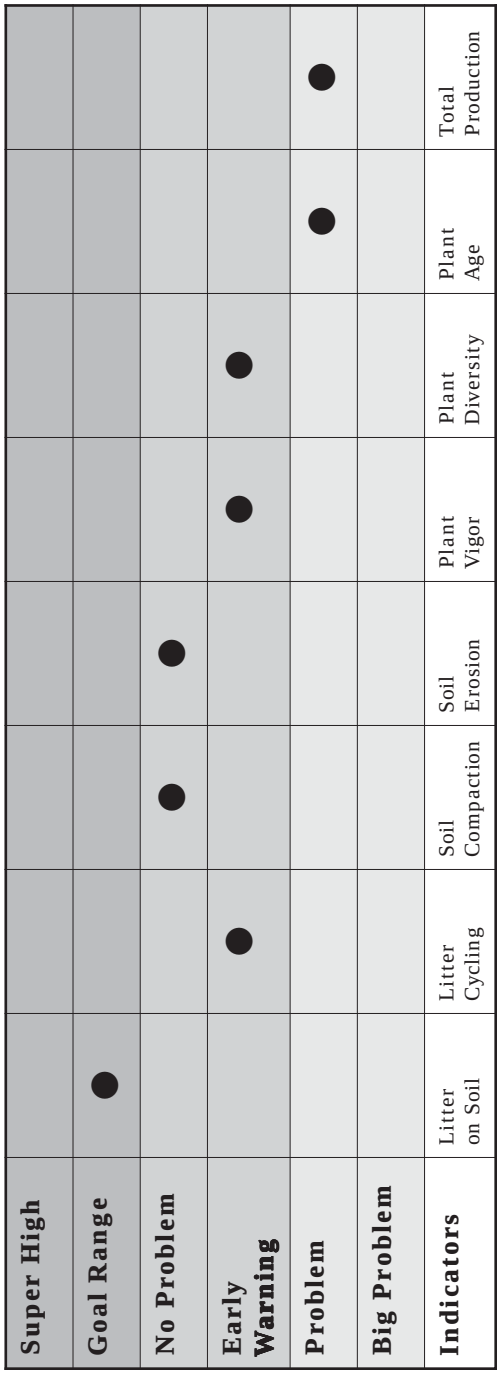


Figure 1: Land Health Graph from the Burleson Pasture Walk

Source: Wayne Burleson. Graph reproduced with permission.

Other *Tool Box* Topics

Review the other *Tool Box* chapters for more tools to help you monitor your pasture management. For instance, use the Points Counts from "Monitoring Birds" to see if you are attracting grassland nesting birds. Or, use the Indicators Worksheet from the "Farm Sustainability" chapter to see if your pasture management is improving your farm's profitability.

Monitoring Journal

Document your general pasture management practices in your monitoring journal or a field notebook. These might include fertilizer applications, seeding, light tillage, mechanical harvest of forage or seeds, use of a paddock as an wintering area for livestock and so forth. For the first year, give a general description of practices used during the past several years up to the present. In subsequent years, describe any changes—even slight ones—in management. Also, use your journal to record any general observations about your pastures and any correlations seen between management and changes and consistencies in your pasture.

Knowledge and Skills

The "Additional Resources" section of this chapter offers only a sampling of the resources available on managing pastures, on grazing management, on pasture plants and more. Let your goals and your natural interests guide you when seeking to increase the knowledge and skills you need to successfully manage and monitor your pasture. And connect with natural resource agency personnel, non-profit organization staff, other farmers and landowners and business professionals who are knowledgeable about pastures and who are willing to help you achieve your goals.

Monitoring Grazing Management

If grazing plays a predominant role in your pasture management, monitoring your grazing management may be one of your most valuable pasture management tools. **Grazing management can override the influence of most other management factors on species composition and forage quantity and quality**, including fertilizing, reseeding and spraying for weeds or problem insects. How you manage the grazing of your pasture can even lessen or increase the influences of weather and land type on your pasture vegetation.

Some Grazing Terminology

The grazing management discussed in this chapter assumes that a pasture is divided into smaller sections called *paddocks*, usually with the use of electric fencing. Paddocks give you a way to control both the *grazing period*, the amount of time the grazing animals are in a designated area and the *recovery period*, the amount of time the plants have to regrow before the animals are returned to that area.

Paddocks are most often associated with a system of grazing called *management intensive grazing*. Sometimes this system is also referred to as *planned* or *controlled grazing*. Another frequently used term is *rotational grazing*. However, this tends to be a more general term and rotational grazing does not necessarily involve as much planning or active management.

Continuous grazing is the typical management system used in pastures with no internal divisions. This includes situations where the farmer has two or more unconnected, large areas of open pasture. The system is called "continuous" because while the animals are in the pasture they have continual access to all the forage of the entire pasture. At any given time, any given plant can be *regrazed* before it has had the chance to recharge its root reserves. When this happens, the plant is said to be *overgrazed*.

If you are unfamiliar with the basics of management intensive grazing, refer to the "Additional Resources" section at the end of the chapter for further study.

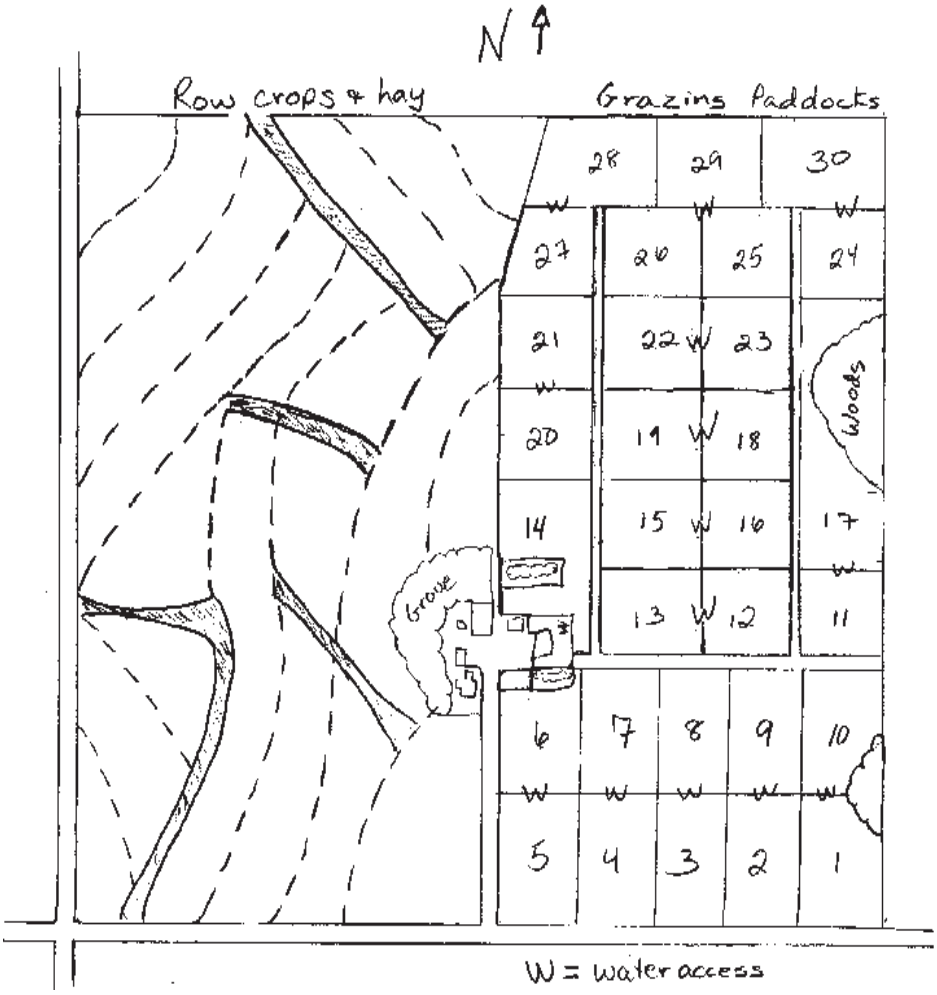


Figure 2: Keep a farm map with your grazing record sheets.

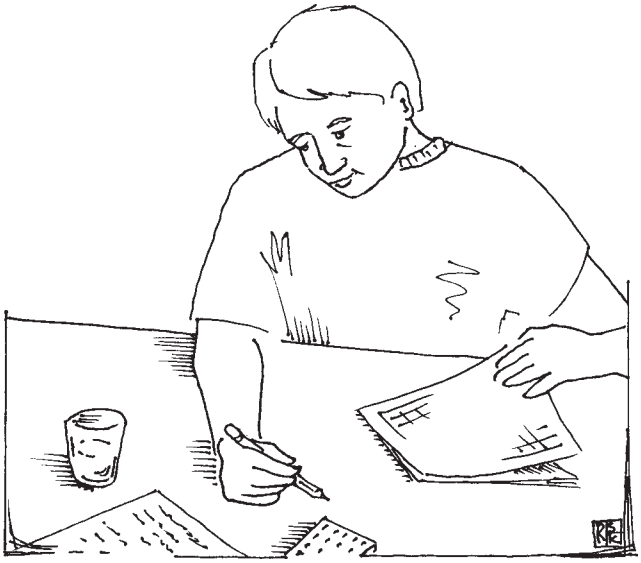
The Main Issues

While obviously closely related, grazing management and the monitoring of your grazing management involve different concerns and activities.

Grazing Management

Grazing management involves making decisions **based on the following factors:**

- land characteristics (soil types and fertility levels, terrain, the presence or absence of water sources and its history of use)
- general climatic conditions (these set the parameters for the length of the grazing season and your total grazing system)
- the predominate vegetation and how and when it was established, the current condition of the stand and its productivity and nutritional quality
- weather conditions like rainfall and cold or hot spells
- plant growth rates and the lengths of the grazing period and the recovery period



- the species and class of animal being grazed and their nutritional needs
- the number and size of pasture divisions and animal stocking rates
- the stage of maturity of the vegetation at the start of the grazing period and the amount of residual leaf material left on the plants at the end of the grazing period
- your management style
- the whole family's quality of life, production and landscape goals

Tools such as the Center for Holistic Management's Grazing Plan and Control Chart (page 11) or the Grazing Wedge (page 37) are available to help guide your grazing management decisions.

Monitoring Grazing Management

Monitoring your grazing management involves **keeping track of your grazing management decisions and paying attention to the impacts of those decisions**. Ultimately you want to know how these decisions affect the farm's larger goals. But, in order to answer the big picture questions, you need to monitor the immediate impacts on things like animal health and productivity, on the quantity and quality of the pasture forage and on the species composition of the pasture. To do this, you will want to keep track of things like the following:

- when you start grazing and where
- the movement of the animals to and from the paddocks
- how long you graze in each paddock
- the length of your recovery periods
- plant growth rates
- any clipping or haying of the paddocks
- weekly and monthly rainfall and other general weather conditions
- the number, class and average weight of the animals being grazed
- the type, amount and cost of any feed supplements

The Grazing Monitoring Record Sheet and the Year-End Summary Sheet included with this chapter provide space to record this kind of information. These tools help you track your grazing management. The monitoring happens when you pay attention to the information these tools give you and combine that information with observations of what is actually happening in your pasture.

The Grazing Monitoring Record Sheet

The Grazing Monitoring Record Sheet is set up to monitor two month's worth of grazing in 30 paddocks (see page 10). Photocopy the master provided with this chapter to make a set of record sheets that accommodates the number of months you graze, included stockpiled areas, and your number of paddocks. If you have pasture at more than one location, make a set of record sheets for each location.

Fill in the general information for all the sheets in a set. This includes the page information, the location and year, the months you will be grazing and the paddock information. If your paddocks vary greatly in size, productivity, and so forth, list them in groups accordingly. Also, use a coding system to indicate special circumstances from either the previous grazing season or for the upcoming one, such as wintering areas, spring sacrifice areas, rest paddocks and stockpiled paddocks. Put the set in a convenient and readily accessible place and get in the habit of using them in your day-to-day management.

A useful companion tool to the Grazing Monitoring Record Sheet is a farm map, such as Figure 2 on page 7, that shows the layout and number label of your paddocks, the locations of water sources, lanes and other useful details. Keep a copy of this map with your set of record sheets.

At the beginning of each month, fill in the number of animals and class of animals to be grazed that month and give an estimate of their average weight. Unless you are absolutely certain that this information will remain the same throughout that year's grazing season, do not fill in this information for any month except the one you are about to enter. You never know what might change for the remaining months. Also, some months you may intentionally graze more than one species or class of animal in the same paddock.

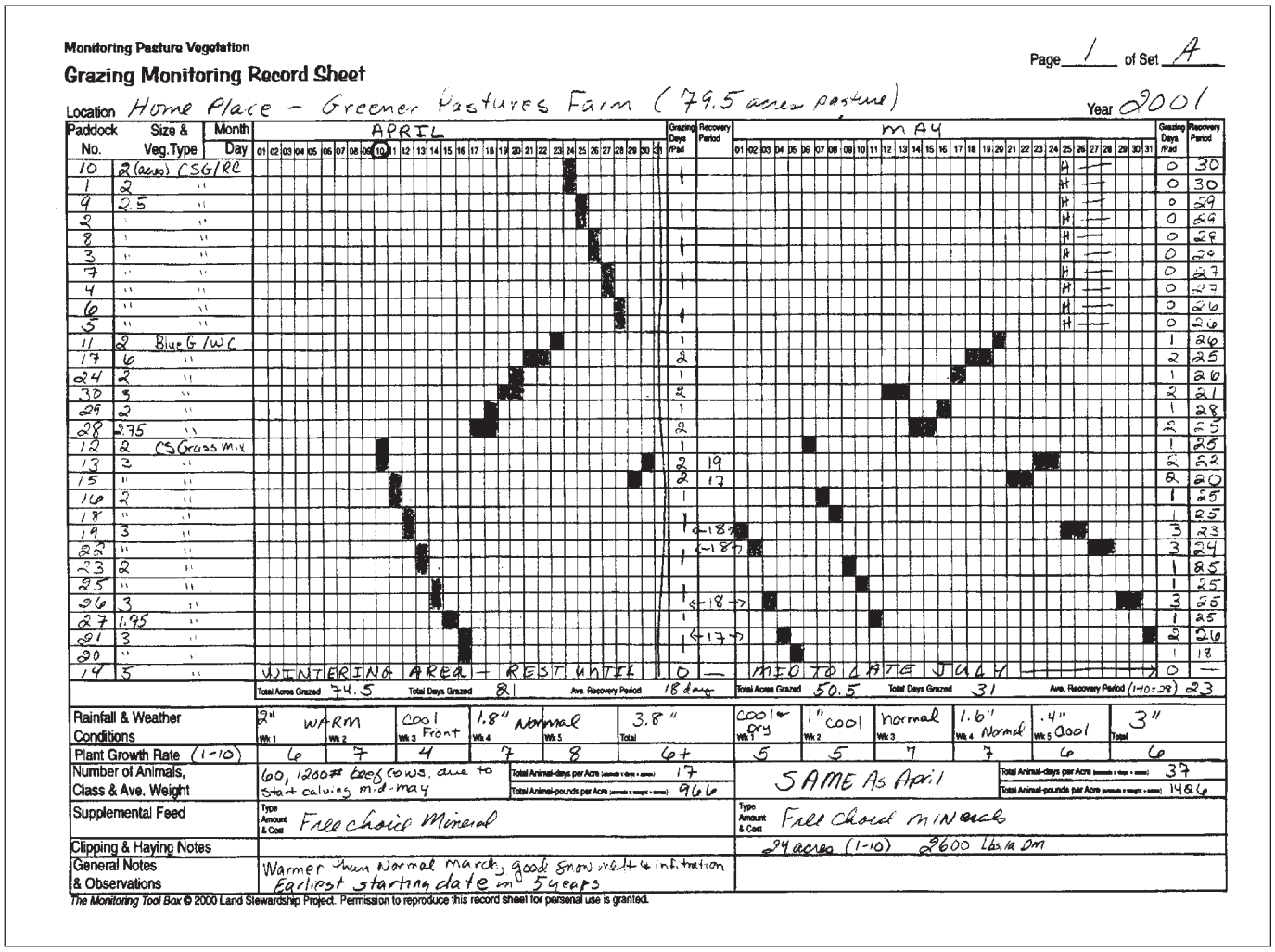
More Grazing Terms

Wintering areas are paddocks in which the animals are kept and fed stored feeds throughout the winter months. These are used as a low cost, low energy alternative to confinement barns or conventional feedlots. Paddock selection can be based on soil and site suitability factors or because of a need for fertility improvement.

Spring sacrifice areas are paddocks where the animals are kept and fed during the wet spring months until the rest of the paddocks are ready to graze. They are called "sacrifice areas" because the sod tends to get broken up heavily under the wet conditions and the prolonged concentration of animals. These may or may not be the same paddocks used as wintering areas.

Rest paddocks are paddocks that are taken out of the regular grazing rotation and in which the plants are allowed to mature. A paddock is rested for a variety of reasons, such as to let it recover from the impacts of being used as a wintering or spring sacrifice area, to provide wildlife habitat, to build up root reserves and the plant seed bank or to improve soil conditions.

Stockpiling refers to the practice of taking a paddock out of the regular grazing rotation, usually in late summer. The accumulated growth is then grazed in late fall and winter, after the grass has stopped growing. Stockpiling is usually done to reduce winter feed costs.



Monitoring Pasture Vegetation

Grazing Monitoring Record Sheet

Page 1 of Set 4

Location Home Place – Greener Pastures Farm (79.5 acres pasture) Year 2001

Paddock No.	Size & Veg. Type	Month / Day	APRIL 01–30	Grazing Days /Pad	Recovery Period	MAY 01–31	Grazing Days /Pad	Recovery Period
10	2 (acres) CSG/RC			1			0	30
1	2 "			1			0	30
9	2.5 "			1			0	29
2	" "			1			0	29
8	" "			1			0	28
3	" "			1			0	28
7	" "			1			0	27
4	" "			1			0	27
6	" "			1			0	26
5	" "			1			0	26
11	2 Blue G/WC			1			1	26
17	6 "			2			2	25
24	2 "			1			1	26
30	5 "			2			2	21
29	2 "			1			1	28
28	2.75 "			2			2	25
12	2 CS Grass mix			1			1	26
13	2 "			2	19		2	22
15	" "			2	17		2	20
16	2 "			1			1	29
18	" "			1			1	25
19	3 "			1	←18→		3	23
22	" "			1	←18→		3	24
23	2 "			1			1	25
25	" "			1			1	25
26	3 "			1	←18→		3	26
27	1.95 "			1			1	25
21	3 "			1	←17→		2	26
20	" "			1			1	18
14	5 "		WINTERING AREA + REST UNTIL	0	—	MID TO LATE JUNE →	0	—
			Total Acres Grazed 74.5 Total Days Grazed 81 Ave. Recovery Period 18 days			Total Acres Grazed 50.5 Total Days Grazed 31 Ave. Recovery Period (1-10=28) 23		

Rainfall & Weather Conditions	2" WARM Wk 1	Wk 2	cool Front Wk 3	1.8" Normal Wk 4	Wk 5	3.8" Total	cool + dry Wk 1	1" cool Wk 2	normal Wk 3	1.6" Normal Wk 4	.4" cool Wk 5	3" Total
Plant Growth Rate (1-10)	6	7	4	7	8	6+	5	5	7	7	6	6
Number of Animals, Class & Ave. Weight	60, 1200# beef cows, due to start calving mid-may			Total Animal-days per Acre 17		Total Animal-pounds per Acre 966	SAME As April			Total Animal-days per Acre 37		Total Animal-pounds per Acre 1486
Supplemental Feed	Type Amount & Cost Free Choice Mineral						Type Amount & Cost Free Choice MINerals					
Clipping & Haying Notes							24 acres (1-10) 2600 Lbs/a DM					
General Notes & Observations	Warmer than Normal march, good snow melt & infiltration. Earliest starting date in 5 years											

Figure 3: The Grazing Monitoring Record Sheet tracks your grazing management.

Fill in when and where you move the animals. This is the step you do most often. Exactly how often depends on the class of animal(s) you are grazing and how long the animals remain in each paddock.

For each day you graze, shade in the box of each paddock that you used on that day. If you graze a paddock for only part of a day, shade in half of the box. As the above example shows, the sequence of moves from one paddock to another most likely will not follow a nice linear pattern. Some paddocks will be more productive or have more acrage than others and you may be able to regraze them sooner. Sometimes you may want to let a paddock recover longer because of special circumstances, such as higher than normal animal impact because the animals were in it during a heavy rain.

Combine this information—when each paddock was grazed last and for how long—along with information gathered from pasture walks and tools like the Grazing Wedge discussed on page 37 to help you plan when to graze each paddock again.

Keep track of weather conditions and plant grow rates. Weather-related factors can directly impact the growth rate of the plants, which in turn dictates how long you need to allow a paddock to recover before grazing it again. In the short-term this information can help you plan

when and where to move the animals and whether supplemental feed is needed. At the end of the grazing season weather information can help explain certain situations and decisions. And, while keeping track of plant growth rates may not be critical from a record-keeping standpoint, its presence on the form serves as a reminder to pay attention to it in your management.

Throughout the month, make note of any supplemental feed fed to the animals, including the type of feed and the amount. Any clipping or haying of paddocks should also be noted. First, mark the appropriate daily slots with a *C* for clipping or an *H* for haying. Then use the space at the bottom of the form to note things like why you clipped or made hay on these paddocks. If you made hay, indicate the yield.

At the end of the month jot down the total number of days each paddock was grazed and the length of the recovery period for each paddock. Count a whole day as 24 hours; if the animals are in a paddock for only part of a day adjust your numbers accordingly.

Also record the total number of acres grazed for the month and the average recovery period for all paddocks for the month. Generally, your average recovery period should lengthen as the season progresses from spring to summer and into fall. If your recovery periods are getting shorter, this usually indicates that you are not paying attention to plant growth rates and sooner or later you will run out of grass. While extreme weather conditions can exacerbate things, management issues should be examined first.

To ensure adequate recovery periods, consider feeding supplemental feed during slow growth periods so that you do not have to move the animals as often. You could also graze annual crops to lengthen the recovery period of your permanent pasture during hot, dry weather or incorporate paddocks of warm season grasses into your rotation.

Calculate the number of *animal-days per acre* (ADA) and *animal-pounds per acre* (APA) your pastures are able to support. Many graziers like to know these figures because they are indicative of a pasture's productivity or *carrying capacity*. This information is especially useful for planning purposes and for monitoring production/profit goals.

An *animal-day* is a measure of the amount of forage it takes to feed one grazing animal for one day. This varies depending on the animal being grazed. For example, one "cow-day" equals about five "sheep-days." To obtain the total number of animal-days per acre per month, first multiply the number of animals grazed by the total number of days grazed in the month. Then divide this figure by the total number of acres grazed in the month. The equation looks like this: animals x days ÷ acres = ADA.

So, if in June you were able to graze a 100 cows for 30 days on 50 acres, your animal-days per acre for June would be 60 ADA. Of course this figure just accounts for the amount of pasture forage being taken in by the animals. It might not reflect any supplemental feed. If, over

Planning Aids

The Grazing Monitoring Record Sheet can also be used to help you create a grazing plan for the year.

A grazing plan is much like a game plan the coaches come up with prior to an atheletic game. They have thought through the strategies they want to use in various situations. As the game unfolds, the game plan may be altered, but without it managing the game would be a much tougher job.

Other planning tools are available from the Allan Savory Center for Holistic Management. The Center offers several guides for doing biological, financial and land planning, including an ***Aide Memoire for Holistic Grazing Planning***. The *Aide Memoire* includes instructions on how to fill out and use the Center's twelve-month "Grazing Plan and Control Chart."

See the "Additional Resources" section of this chapter for contact information.

Project Findings

Here are some key findings from the Monitoring Project on the environmental and socioeconomic benefits of management intensive grazing:

- It can improve soil quality more rapidly than continuous grazing or row cropping because it increases biological activity, structural integrity, water infiltration, organic matter and surface cover.
- It can be a viable tool for the management of riparian corridors. In fact, it can actually improve the physical and water quality characteristics of streams and stream reaches, especially in comparison to conventionally-grazed pastures or rested areas allowed to grow trees in formerly prairie areas.
- It can create nesting habitat for endangered grassland bird species when compared to continuous grazing and row-crop management systems (especially with the use of extended rest periods in selected paddocks).
- It can create the hydrologic system needed to produce habitat for common frogs and toads in Minnesota.
- It can improve herd health and reduce veterinary costs.
- It can improve quality of life because it tends to create a lower-stress life-style on the farm. Manure handling responsibilities, costs and stresses are greatly reduced, as are those associated with crop production.

time, you are able to get the same or more ADA from pasture while reducing supplement feed, this would indicate increased pasture productivity.

The a*nimal-pounds* each acre of pasture can support in a month's time provides similar information about pasture productivity. To calculate APA first multiply the number of animals by their average weight and divide that figure by the number of acres grazed during the month: animals x weight ÷ acres = APA. At an average weight of 1,200 pounds, 100 cows on 50 acres of pasture in June translates into 2,400 APA. By August, it may take 80 to 100 acres to support the same amount of animal-pounds, which would be reflected in lower APA figures (1,500 and 1,200). This can be important planning information.

Keep track of general items and observations. These might include abbreviated notes on any pasture improvement practices such as reseeding and fertilizing, animal death loss, insect or other problems for both the animals and the pasture plants, how fast animal droppings decompose, wildlife sightings and unusual events or circumstances. Use your monitoring journal to record more detail or in place of these notes.

Year-End Summary Sheet

At the end of the grazing season, use the Year-End Summary Sheet to summarize the monthly information. This form gives you both the details and the big picture information you need for your planning and goal-monitoring purposes. It also includes a section for recording the total amount of product produced for every acre of pasture grazed, such as pounds of milk per acre or pounds of lamb per acre. These types of figures can be especially useful measurements of progress toward the farm's production and landscape goals. Keep this summary with its corresponding set of record sheets.

Monitoring Benefits

The management benefits to using the Grazing Monitoring Record Sheet can be quite extensive and immediate. Because it gives you a visible picture of what is taking place out on your pasture as the grazing season unfolds, you can alter your management as conditions warrant. It can also readily show you which paddocks are more productive or which ones need longer recovery periods. This might spark questions about possible differences in species composition, soil fertility levels or other factors.

The information can also be used for planning your stocking rates for different times of the year, for planning where you start each year and for planning or changing the sequence of your moves. It can even reveal benefits or problems related to animal health and productivity. And, as information accumu-

lates over the years, you will be able to see changes in stocking rates and in productivity, as well as differences from year-to-year in the length of the grazing season.

The whole-farm benefits of monitoring your grazing management should be obvious too. These tools can answer direct questions like "Is our grazing management improving the carrying capacity of our pastures and increasing the amount of total product we can produce and sell off of our pasture?" And, they can provide insights to the answers of other goal-based questions like these:

- Are we creating more, or less, work for our family by the way we manage our grazing system?
- Are we improving the soil quality and fertility by the way we manage our pasture?
- Is our farm becoming more sustainable because of our grazing management?

Your answers to questions like these can help you reshape or refine your grazing management so that it does support your goals.

Monitoring Species Composition

Technically speaking, the term *species* is one of two scientific terms, along with *genus*, used to name plants and animals. For example, the scientific name for alfalfa is *Medicago sativa* with *Medicago* being the genus and *sativa* the species. In this chapter, the term *species* is being used in a more common or general way to refer to all the different plants growing in your pasture.

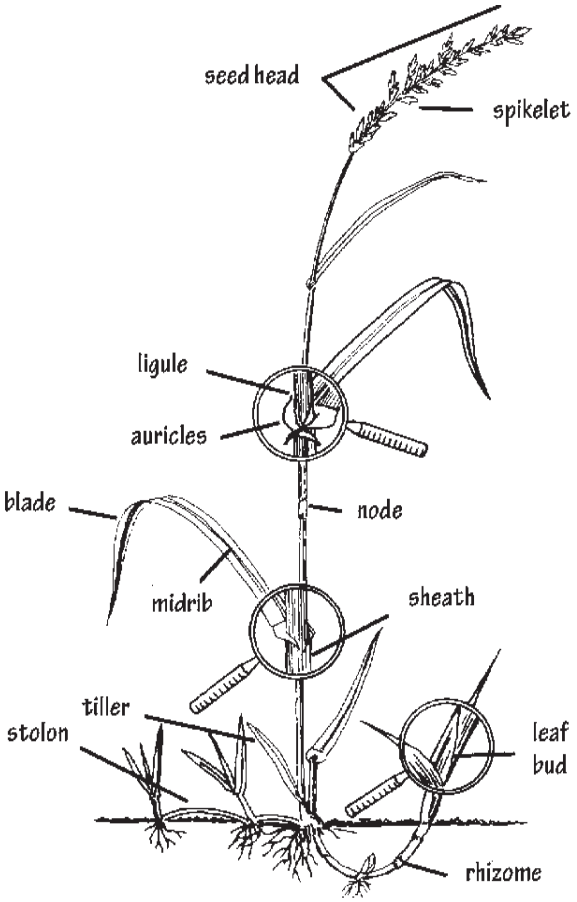
And so, from a big picture perspective, the species composition of your pasture will be determined by these three main factors:

1. Your geo-climatic location and your soil types tend to set the parameters of **adaptability**, or which species can typically grow and survive in your location.

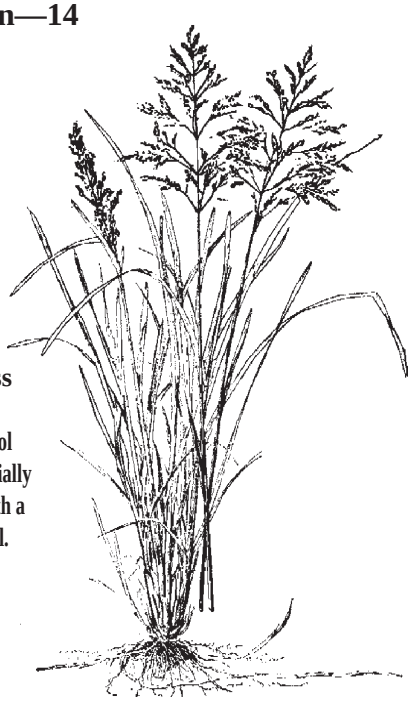
2. The **desirability** of your species composition, or which species or mixture you want in your pasture, will be heavily influenced your farm goals and the purpose of your pasture.

3. The actual **survivability** of the species in your pastures, or their ability to persist over time, is most often determined by the conditions you create or augment through your pasture management.

Figure 4: The anatomy of a grass plant.



Source: ***Conservation Plants Pocket ID Guide,*** **USDA–NRCS**



Kentucky Bluegrass

A common sod-forming, cool season pasture grass, especially productive when grown with a legume like birdsfoot trefoil.

Birdsfoot Trefoil

A non-bloating, high quality legume with bright yellow flowers; the inch-long seed pods look like a bird's foot.

Red Clover

A productive pasture forage and good nitrogen source for pastrue grasses.

Drawings taken from *Pasture Management Guide for Northern Missouri,* USDA–NRCS

Set Your Objectives

Regardless of whether you are converting row cropped land to pasture, renovating an old permanent pasture, managing an established stand or working with rangeland, some general recommendations may be helpful in setting your species composition objectives.

Favor a Diversity of Species

Besides the many biological benefits, a pasture containing a diversity of plant species is more likely to provide a more even seasonal distribution of yield than a pasture dominated by only one or two species. This advice applies to seeded and native pastures as well as to rangeland. A mixture of species also provides yield insurance in the event that one or more of the components is lost, such as due to winterkill.

To find out which pasture plant species are best adapted to your location and soil types, talk to experienced graziers in your area or to your local County Extension personnel. These folks should also be able to supply you with information about the pluses and minuses of different species in terms of their yield, feed quality and persistence tendencies under varying weather and management conditions. From this base of information, you need to decide on the best species mix for you in light of your farm goals, pasture purpose and management program.

If you decide to seed a commercial pasture mix, note that those with a little bit of everything may not necessarily be better those with only a handful or so of species selected to suit your specific needs and conditions. Also, mixing cool season and warm season species within the same pasture area tends not to work well because of their different management needs. If you want to include warm season species in your pasture system, it is usually better to have a separate area in which they are the focus of management.

Balance Yield and Quality Needs

Your forage quality and yield needs will also influence your species composition objectives. For instance, a dairy farmer in Minnesota or Wisconsin will most likely want a mix of species that will provide the highest level of long-term productivity while providing a consistently high level of feed quality. Someone with a cow/calf operation in a drier rangeland situation will likely have significantly different plant species and yield and quality needs. A landowner whose primary goal is to maintain an area of open grassland may be willing to tolerate more plant species less suited to animal consumption.

Balance the Grass to Legume Ratio

A combination of grasses and legumes tends to offer the best potential for consistent productivity and quality in a pasture system. Exactly which species are right for your pasture depends on your goals, purpose and management system. The general rule of thumb is to manage for a ratio of 60/40—either grasses to legumes or legumes to grasses—because grasses and legumes compliment each other in the pasture. Legumes fix nitrogen, which the grasses need, and the grasses help reduce the incidence of legume bloat. Plus, grasses tend to be more tolerant of extremes in environmental conditions than legumes. However, legumes tend to withstand moisture deficits better than grasses. Having both helps to ensure that there is actually something to graze in spite of varying weather conditions.

Consider a Systems Approach

When planning pastures for livestock, keep in mind that it may be difficult to meet all your needs from only one source of pasture, regardless of how well-balanced its species composition may be. Thus, it may be necessary to create a **pasturing system** in which a variety of pasture sources are used.

For instance, given the typical annual weather extremes in the Upper Midwest, a pasture system might look like this:

The main source of pasture for the farm might be dominated by cool season perennial grasses and legumes; these can provide plenty of high quality forage in the spring and fall.

During the summer, when cool season species slow down in hotter, drier conditions, a number of options are available: 1) warm season perennial grasses, 2) legumes like alfalfa, red clover or birdsfoot trefoil or 3) annual crops like millets, brassicas or specific varieties of corn that are suitable for grazing.

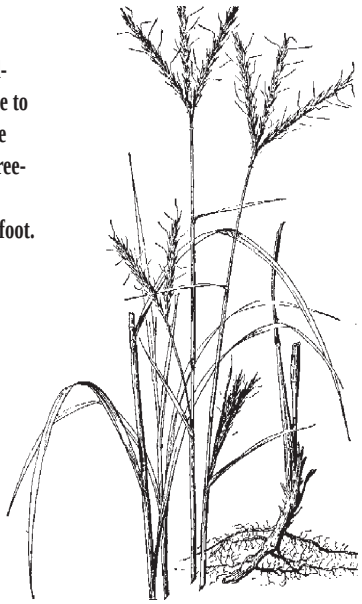
Depending on the animals being grazed, pasturing can continue into late fall and winter by making use of corn stalks or stock piled pastures.

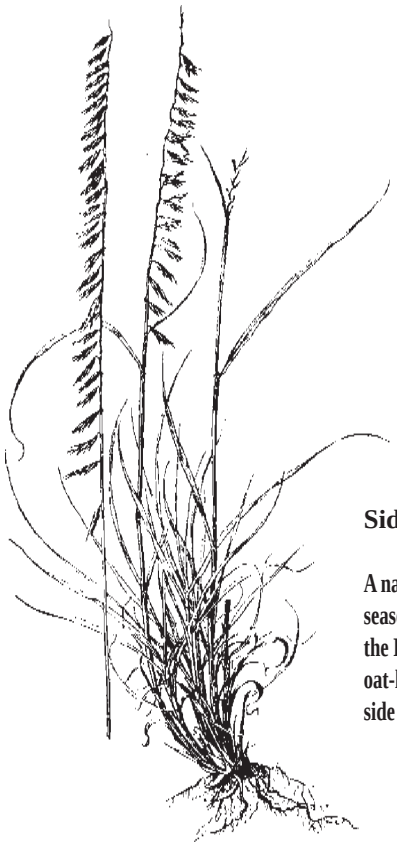
Account for Your Management Goals and Style

Your management goals will heavily influence your species composition objectives. What are you trying to produce off of your pasture? How fast do you want to change the species composition of your pastures? So will your management style. How willing are you to put money into your pasture system? How intensively are you willing to monitor and manage your pasture? What level of risk are you willing to accept in your farming operation? **Your management goals and style may actually be the most determining factors on your species composition.**

Big Bluestem

A warm season, sod-forming grass native to the Midwest and the Great Plains. Its three-part seed head resembles a turkey foot.





Sideoats Grama

A native perennial, warm season grass found east of the Rocky Mountains; the oat-like seeds cling to one side of the stalk.

Keep an Open Mind and Use Common Sense

Keep an open mind when it comes to setting your species composition objectives for your pastures. Strong prejudices for or against certain species might lead to decisions that could jeopardize the success of your pasture or even farm profits. Do not let yourself be blinded by what you or "the experts" think you should or should not have. Careful monitoring and attention to goals will ensure that you are the true expert on your pasture.

Use common sense too. Just because you do not have the latest "hot" grass, legume or mix being discussed in grazing publications does not mean you should immediately convert your entire pasture—especially if what you have seems to be working for you. But, if you think you might benefit from making changes in species composition, experiment on a portion of your pasture. Then use monitoring to determine the benefits of the change as well as its costs and risks.

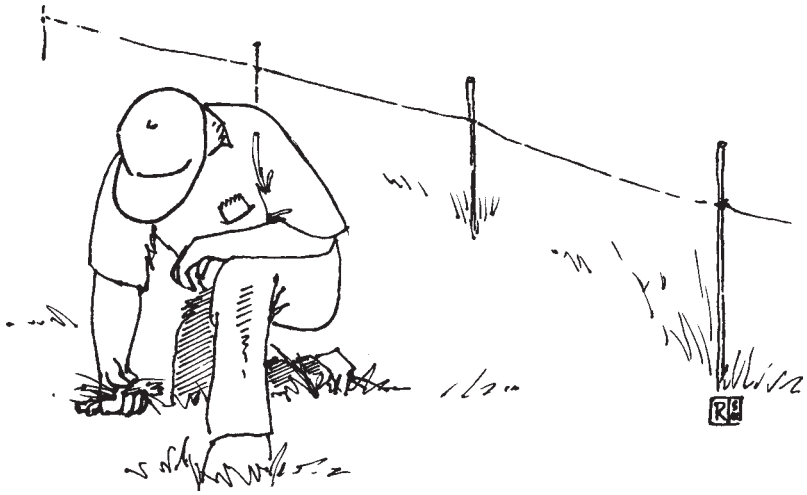
Let Your Goals Guide Your Choice of Monitoring Tools

On-farm monitoring can be as informal or as structured as you want or need it to be. As always, your goals should guide your decisions about which tools to use for monitoring the species composition of your pasture. What kind of information are you looking for? How do you plan to use that information? Are you comfortable with casual observations that you may or may not keep records of? Or do you want to use tools that help you collect and keep track of more "objective" data? This chapter offers several options; feel free to adapt the suggested tools to fit your goals.

Observation as Monitoring

The simplest tool for monitoring your pasture's plant species composition is to walk your paddocks two or three times during the grazing season and observe which plants are growing in them at those times.

If you like, take along a plant identification guide and a field notebook and record what you find. Which species seem to be the dominant ones? Does this vary with different site or soil conditions? You could also make some observations about the physical condition of your paddocks. How much bare soil do you see? Do you see any signs of erosion or crusting of the soil surface? How dense is the pasture's stand? In other words, ask the questions that will help you be a better observer and that will help you make correlations between what you see and how you are managing your pasture.



The Plant Species Survey

A basic Plant Species Survey done twice a year over a period of three to five years by a team of two or three people is a more structured and objective tool with which to monitor the species composition of a pasture. Over time, the survey data can document changes and trends in your pasture's plant community and physical condition and help you make more solid correlations between those changes or trends and your pasture management.

Two Survey Methods

This chapter offers two different methods for conducting the Plant Species Survey: the Frame Method and the Tape Method. The main activities of both survey methods include

- **assessing** the physical conditions of the monitoring site, including the percent of bare soil, ground cover and stand density;
- **identifying** the predominant grasses, legumes, forbs and so forth at the monitoring site; and
- **estimating** the quantity of each species by the percent of living material it represents or **counting** the actual number of plants.

While both methods make use of scientific principles, they have been adapted for on-farm monitoring. As such, they are geared more toward aiding farm or land management decisions than for the purpose of scientific study and analysis. To choose which method to use, read over the instructions for each and see which one makes the most sense for what you want to learn about your pasture's plant species composition and physical condition.

How often and when to do the survey depends on the information you need in order to monitor progress toward your goals and objectives. As a general rule, do one survey count at the height of the growing period for cool season species, which is generally April through June in the Midwest. Then go out again sometime during the warmer summer months, such as late July, August or even early September. The survey should also be done a day or two before animals go into the area to graze.

Survey Prep Work

Determine the survey team. A team approach makes observation and identification easier and often sparks insightful discussions. When deciding the team, give heavy consideration to the need for consistency in procedures when conducting the survey. Having the same people do the survey from year-to-year is one way to ensure that consistency. You could even solicit the help of an experienced botanist.

Set your survey objectives. Walk your pasture with your team members and observe its general layout, terrain and physical condition while pondering your larger farm goals. This will help clarify what you want to learn from using this tool. Jot down your specific monitoring objectives and place then in a folder with your other species monitoring materials.

Determine your monitoring areas. Let your objectives determine where to do your monitoring and how many monitoring sites you need. If your pasture is fairly uniform, three sites scattered across the whole may suffice. If you have distinctly different areas within your pasture, you may want to have one or more sites within each distinct area.

A scientist would probably monitor the exact same spot for each survey count. For on-farm monitoring purposes that is probably not necessary. Instead, simply try to come back to the same general area each time, such as the center of a paddock, or a particular hilltop or sideslope. You can also use easily identifiable landmarks, such as trees, fence posts, buildings or geological features, to help you set the boundaries for each monitoring site. Once you determine your site locations, plot them on a clean copy of your pasture field map, indicate your boundary markers and give each site a label. Also, write down a description of each site's location on the back of the map.

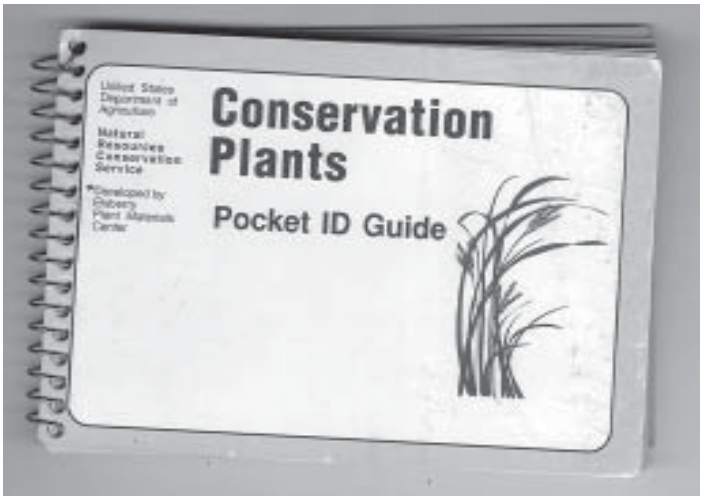


Figure 5: Pocket-sized identification guides are convenient but may not cover all the plant species you find in your pasture.

Get yourself a good plant identification guide and study it. Although you may be familiar with some of the common grasses, legumes and other plants growing in your pasture, a good plant identification guide—or two, or more—is a useful tool to include in your "monitoring tool box." The "Additional Resources" section at the end of this chapter offers some suggestions. Your local Extension Service or Natural Resources Conservation Service (NRCS) should be able to recommend guides that fit your locality. Bookstores (regular and on-line) and libraries are also good sources for ideas.

Plan on taking your guide(s) out with you when you do your plant survey, but also take the time to study them beforehand. Pick them up when you have a few minutes and browse through them. Keep them by your easy chair or as part of your bathroom reading collection so that they are readily available. If you do this often enough, you will start to familiarize yourself with the different species and their defining characteristics. Then, when you come across those species in the field, they will be easier to identify.

The Frame Method

In the Frame Method, a small sampling frame is used to determine the specific area from which data is collected. The most versatile frame is a square, 3-by-3-foot (the inside measurement) frame made out of PVC pipe or lightweight metal. A square-yard frame makes it easy to calculate forage yields on a per acre basis if you plan to monitor forage quantity. If you have no need to do that, something like a Hula Hoop could be used for the species survey instead.

In addition to your sampling frame, plan on taking the following items out to the field:

- your favorite plant identification guide(s)

- a 35 mm or digital camera (note that for on-farm monitoring purposes prints tend to be more convenient than slides)
- a clipboard and photocopies of the Ground Cover Worksheet (square-yard side) and the Frame Method Plant Survey Form
- a copy of your pasture field map that shows your site locations
- several pencils with good erasers
- gallon-sized ziplock storage bags
- a yard stick or measuring tape

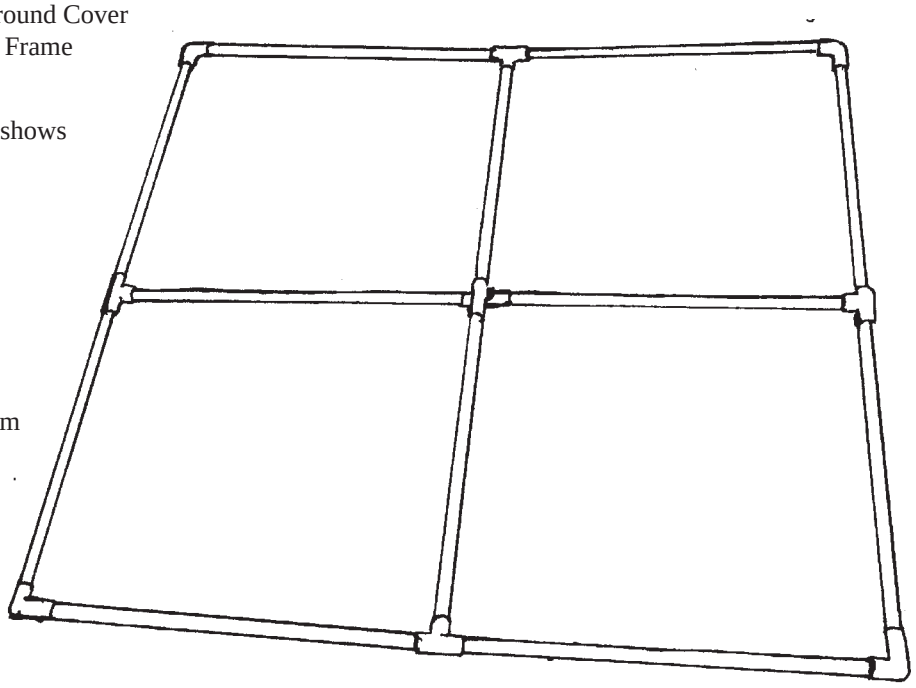


Figure 6: A square-yard frame made of PVC pipe.

Step 1: Prepare your forms. When you arrive at each monitoring site, date the form and indicate the count number. Then jot down the names of the survey team and the site's ID label. If you use a round frame, simply shade out the corners of the square-yard grid of the Ground Cover Worksheet.

Step 2: Toss your frame. The survey process involves tossing the frame out into the general monitoring site area and examining the physical conditions and plants within the frame. Decide on the following procedural issues before you head out to the field:

The number of tosses: Obviously, two or three tosses will yield a more representative account of the plant species in the area than one toss; whether that is critical for your purposes is for you to decide. Just make sure you follow the same procedures at the site every time you survey it. If you do decide to do more than one toss at a particular monitoring site, use a separate copy of the survey form for each toss while out in the field and label them accordingly. The data for the whole site can be combined onto one form later if desired.

Fixed or random tosses: If you want to monitor the exact same spot each time you survey the site, first randomly determine the spot. Then write down instructions on how to find the spot on the back of your map, using nearby landmarks as guides.

If you want your tosses to be random each time you survey the site, here are two ways to accomplish this:

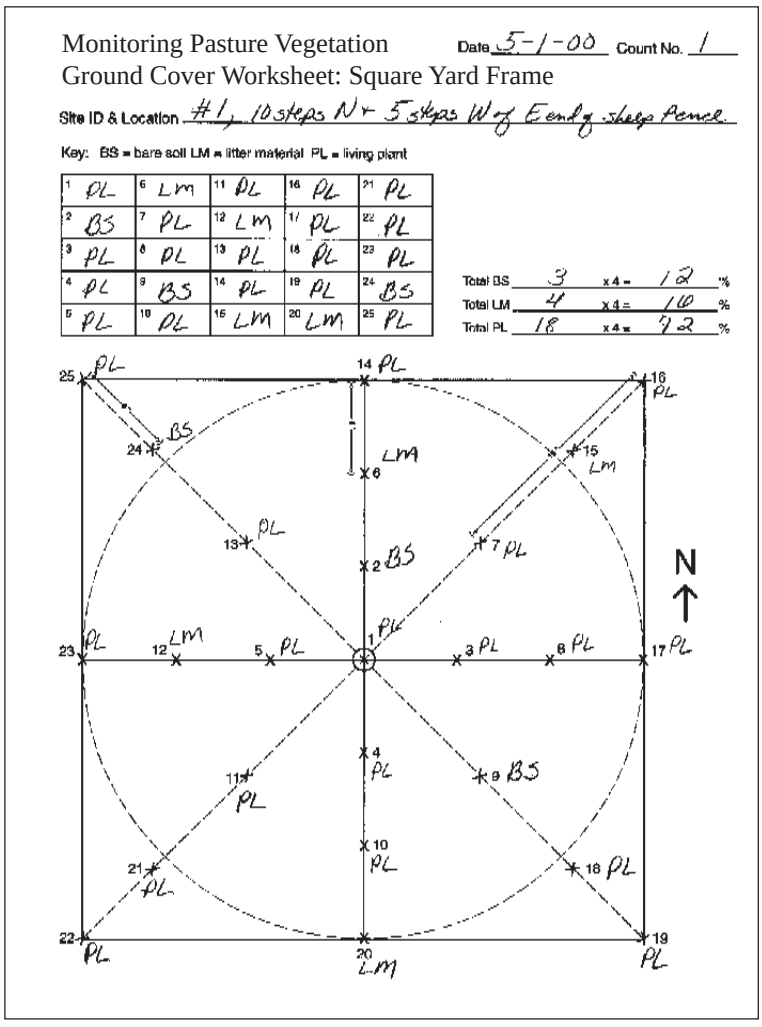
1) Designate a *transect*, or straight line, across the site area and walk along that line, randomly tossing the frame to your right or to your left. For each toss, write down what you do in the "Location" on the survey form so that you can either replicate or vary your pattern from count-to-count and year-to-year.

2) Instead of walking in a straight transect line, determine some other kind of path through the site area and follow the same procedures as with a transect. Just be sure to follow the same general path each time you survey the site.

More tossing tips:

- If the frame lands in a spot that clearly does not represent the rest of the monitoring site, toss it again. This is especially important when determining a fixed monitoring site.
- To ensure truly random tosses, toss the frame over your shoulder or with your eyes closed. This helps curb the natural tendency of the eye and mind to preselect a desired sampling area.
- Give the frame a light toss rather than a good heave, so that it falls relatively close to where you are standing and is easier to find. Your teammates should also pay attention to where the frame lands.
- Tie bright colored surveyor's ribbon to the frame so it is easier to spot in tall grass or if you tend to toss the frame too strongly.

Step 3: Assess the physical conditions. To do this, complete the Ground Cover Worksheet. Use the grid points (*X*) and your yardstick or measuring tape as guides.


Monitoring Pasture Vegetation Date 5-1-00 Count No. 1
Ground Cover Worksheet: Square Yard Frame
Site ID & Location #1, 10 steps N + 5 steps W of End of sheep Fence
Key: BS = bare soil LM = litter material PL = living plant

1 PL	6 LM	11 PL	16 PL	21 PL
2 BS	7 PL	12 LM	17 PL	22 PL
3 PL	8 PL	13 PL	18 PL	23 PL
4 PL	9 BS	14 PL	19 PL	24 BS
5 PL	10 PL	15 LM	20 LM	25 PL

Total BS 3 x 4 = 12 %
Total LM 4 x 4 = 16 %
Total PL 18 x 4 = 72 %

Figure 7: Use the Ground Cover Worksheet to assess the physical conditions of the monitoring site.

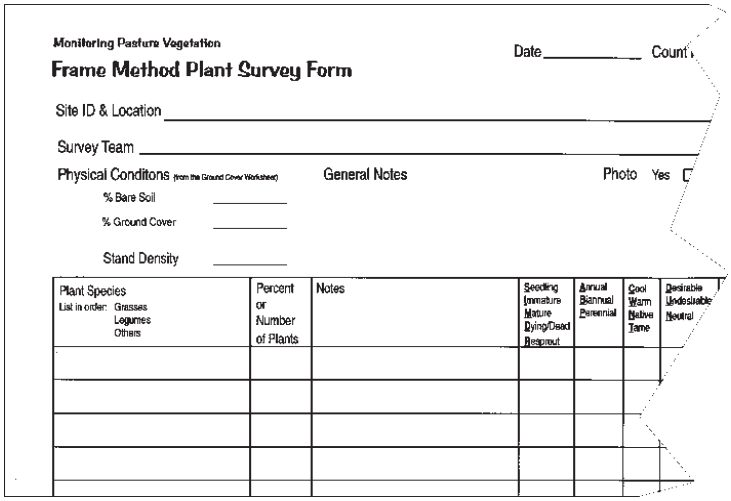
For each of the 25 points, note what you find **at the soil surface**—bare soil, litter material or a living plant—and record your finding in the space provided. Count the number of each and multiply that number by four to get a percentage.

Transfer this information to the Frame Method Survey Form. First record the figure for percent bare soil. Then add the figures for litter material and living plants to get a percent ground cover. The percent of living plants is your stand density. If need be, adjust these figures based on your visual examination of the site.

Step 4: Note any general observations. On the Frame Method Survey Form jot down any other general observations about physical condition of the site. Are there any insects present? Are they causing any damage to the plants? Is there any evidence of earthworms or night crawlers? Note the presence of physical objects like small rocks or cowpies and look for signs of erosion in the site area. These can even be marked on the square-yard frame grid on the Ground Cover Worksheet.

Step 5: Take photos of the site. Take several photos of the site, making sure the entire sampling frame is within the picture frame. If you have a yardstick or measuring tape, stand it up within the frame and use it as a vertical reference mark within the picture. Jot down the photo number(s) for each site so that when they are developed you can label them correctly and paper clip them to the right record form.

Step 6: Identify and tally the plant species. Now spend a few minutes closely examining the plant species within the frame and discussing what you see with your teammates. Focus on the grasses first, starting with the ones you can identify easily. List the grass species on the form as you identify them and estimate how much each grass species contributes to the total plant mass within the frame. Show this figure as a percentage, using the percent symbol (%). Sometimes it may be appropriate to simply list the number of plants of a particular species instead of trying to estimate a percent.



Monitoring Pasture Vegetation

Frame Method Plant Survey Form

Date_____ Count

Site ID & Location _____

Survey Team _____

Physical Conditons (from the Ground Cover Worksheet) General Notes Photo Yes

% Bare Soil _____

% Ground Cover _____

Stand Density _____

Plant Species List in order: Grasses Legumes Others	Percent or Number of Plants	Notes	Seedling Immature Mature Dying/Dead Resprout	Annual Biannual Perennial	Cool Warm Native Tame	Desirable Undesirable Neutral

Figure 8: Record your findings on the Frame Method Plant Survey Form.

Use the "Notes" column to record anything unusual or prominent about the plants of each species, such as insect or disease damage. Some graziers like to give an estimate of how much each species is contributing to the total available forage mass within the frame. This is a bit different from the distribution percentage estimate because it accounts for vertical plant mass and the age of the plants, not just the amount surface area covered by the species.

Step 7: Fill in the optional information. The last five columns on the form provide you with the option of taking note of some more details about the plants you are identifying. First record the plant's stage of maturity. Is it a **seedling** or is it at the **immature** or leafy stage? A **mature** plant is either flowering or setting seed. Perhaps the plant you find is **dying** or **dead**. You might even encounter a **resprout**, seen on brushy plants that put out new growth after being grazed or cut back.

Next, take note of how the species reproduces. Is it an **annual** that must grow from seed each year? Is it a **biannual**, such as a thistle or burdock, that goes to seed during its second year of growth and then dies back? Or is it a **perennial** that grows back each year from its roots?

You may want to note some general habitat information about the species. Does it thrive in the **cool seasons** of spring and fall or does it express itself as a **warm season** plant that grow well in the warmer, drier weather of late spring and summer? Is the species **native** to your area, or is it a **tame** species that was introduced to your area?

Each plant species can also be rated in terms of its desirability for your purpose and goals:

- the **desirables** are those species you want in your pasture;
- the **undesirables** are those species that significantly subtract from your pasture goals;
- the **neutrals** are those species that do fit into neither of the previous two categories.

And finally, you can also note any **indicator species**, those that indicate movement toward a certain level of complexity and stability within the plant community. Whether these indicator species are positive or negative depends on your goals for the pasture.

Is it Really a Weed?

Just because a particular pasture plant is not a perennial grass or legume, does that mean it's a *weed*? Not necessarily. Any plant could be called a weed if it competes with desired plants for resources and reduces the presence or yield of the desired plants. Plants that the animals will not eat or that harm an animal if it does eat them might also be considered weeds.

In pastures, many plants that are weeds in cereal or grain production are readily consumed by livestock. For instance, quackgrass is highly nutritious and cattle love it. And while the yield of plants like pigweed, lambsquarters, foxtails and dandelion may be suspect, they are of high quality if grazed when young. On the other hand, plants such as thistles or leafy spurge are consider undesirable because not only do they compete for resources, they also contain thorns or chemicals that limit animal palatability.

To determine if a particular plant species is a weed in your pasture, ask yourself questions like these:

- Is it nutritious? Does it contribute or detract from the overall quality of your pasture?
- Is it palatable? (This can vary depending on the species of animals being grazed.)
- Is it a dominant species in your pasture? Does it tend to push out other desirable species?
- Does it seem to work well given your soil types and weather conditions?
- Does it fill a useful biological niche in your pasture or benefit wildlife or birds?
- Does it contain constituents, such as thorns or chemicals, that adversely affect the animals or the other plants in the pasture?
- How does it fit in with the balance of cool season and warm season species or with the grass-to-legume ratio?
- Is this species indicating progress toward or away from your desired level of species diversity and stability?

Step 8: Repeat steps 6 and 7 for legumes, and then for any other plants within the frame. If you should encounter a plant that you are unable to identify, either photograph it or pull it out by the roots and put it in a ziplock bag to take home for further examination.

The Tape Method

The Tape Method for surveying plant species is a slightly simpler process than the Frame Method. It involves laying out a measuring tape along either a fixed or a randomly determined transect line and noting what you find at each one-foot interval. It too gives you a general idea of the types, amounts and distribution of your pasture's plant species and yields some information about ground cover and stand density.

To use the Tape Method for your Plant Species Survey, you will need the following items:

- a 50-foot nylon measuring tape
- several tent stakes (or extra helpers)
- a 12-inch long dart topped with a red flag or a florescent orange softball
- your favorite plant identification guide(s)
- a clipboard and copies of the double-sided Tape Method Plant Survey Form/ Plant Survey Tally Sheet
- a copy of your pasture field map labeled with your site locations
- several pencils with good erasers
- a 35 mm or digital camera
- gallon-sized ziplock storage bags

Step 1: Do your prep work. As with the Frame Method, first choose your monitoring sites, label them and plot them out on your field map. Also determine your survey team. Remember to consider whether or not at least one or two of the same people will be available to do the twice-a-year survey from year-to-year.

Step 2: Decide on your basic procedures. The Tape Method Plant Survey Form assumes the use of a 50-foot measuring tape and two different transect lines. These can be modified if you like. Just remember that, as long as you use procedures that give you unbiased, accurate

and comparable results, consistency from survey-to-survey and year-to-year is more critical than which procedures you decide to use.

Tape length: One of the main purposes of the survey is to determine the relative percentage of the different plant species present in your pasture. To most easily and accurately obtain this, the 1-foot counting marks need to add up to 100. This chapter suggests the use of a 50-foot tape measure because it is more manageable than a 100-foot tape.

Transect length and location: The Tape Method Plant Survey Form is set up for readings along two different 50-foot transects at each monitoring site. Two transects lets you monitor more than one part of a site. However, the form can be used without modification with a 100-foot tape or if you choose to continue along the same transect line for your second 50-foot section.

Depending on your goals, you can either do your counts along fixed transect lines each time you do the survey, or you can randomly select different lines each time you monitor. Instructions for both options are given under Step 3.

Optional information: The Tape Method Plant Survey Form and the Plant Survey Tally Sheet each have sections that allow you to note some optional information about the plants you find in your pasture. (See page 21 for more details; this information is also summarized in a reference key on the Tally Sheet.)

Step 3: Complete the Tape Method Survey Form. At the monitoring site, fill in the top portion of the Tape Method Plant Survey Form.

For random transect lines: To collect data from randomly selected transect lines, use the following procedures:

a) Toss the dart or orange softball. Secure the start of the tape at the spot where the dart or ball landed with a tent stake or have a helper hold it in place.

b) Devise some way to randomly determine the direction of the transect. Then, pick up the loose end of the tape measure and head off in that direction. Stretch the tape so it is taut and secure that end as well.

c) At the beginning of the transect line, find the 1-foot mark on the tape and examine what you find at that exact spot. If you find bare soil or some kind of litter material, check the appropriate column. If you find a plant, write down what species it is and note if it is a grass species (*G*), a legume (*L*), or something other than a grass or legume (*O*). If you like, you can also indicate the plant's stage of maturity using the key on the Tally Sheet side of the form. Follow this same process for foot marks 2 through 50.

   If, by chance, you come across a plant you cannot identify, take several photos of it and/or harvest it and put it in a ziplock storage bag to be identified latter.

d) Repeat the above steps 3a through 3c, for Transect B.

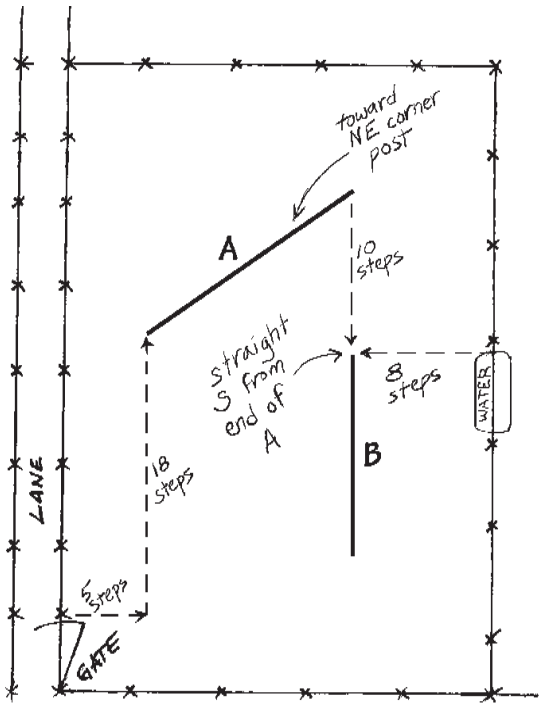


Figure 9: In a field notebook, draw a rough sketch showing the location of your fixed transect lines.

Figure 10: Using the Tape Method for doing a Plant Species Survey.

For fixed transect lines: To use fixed transect lines, determine these ahead of time or when you do your first survey. Simply follow the same basic process outlined in steps 3a and 3b for determining a random transect line. With the tape securely in place, and before you complete the Tape Method Survey Form, step off the transect's location in relation to nearby landmarks and record this information on a sketch map of the site. Also make note of each transect's trajectory. Then, proceed with the instructions outlined in step 3c. Repeat this same process for Transect B.

(Note that a fixed transect line will only bring you back to the same approximate sampling area. Do not expect the tape's counting points to be placed in the same exact spot each time.)

Additional activities: Take a photo or two of each transect and make note of the photo numbers that correspond to each site. Also, use the bottom of the survey form to record any noteworthy observations about the site, the transects, weather conditions and so forth.

Step 4: Complete the Plant Survey Tally Sheet. Upon returning from the field, fill in the Plant Survey Tally Sheet for each monitoring site. (Be sure to photocopy this form onto the back side of the Tape Method Plant Survey Form.)

a) First, count the number of check marks in the "Bare Soil" column of each transect and record those two numbers. Add the totals from Transects A & B and record that sum in the "Percent of Total" column of the tally sheet. This figure gives you an estimate of the percent of bare soil in the site. Do the same for the "Litter" column. Subtracting the sum of these two figures from 100 gives you an estimate of the site's *stand density,* or the amount of soil surface covered by living plants.

b) On a legal pad or piece of scratch paper, sort out the different grasses, legumes and other plants recorded on the survey form. Down the left hand side of the pad write "Grasses," "Legumes," and "Others," allowing about three inches of space under each label. Across the top of the page, to the right of "Grasses," write "Transect A" and "Transect B." (See Figure 11.)

Tip of Your Shoe

Here is another way to gather plant species information: walk criss-cross through the entire paddock and stop every fourth step and note what you find at the tip of your front shoe.

This information can be recorded on the Tape Method Plant Survey Form and gives you a good picture of the species present, their distribution and ground cover conditions throughout the paddock.

(See the sidebar "Monitoring Documents Positive Changes" on page 26.)

c) Refer to your Tape Method Plant Survey Form. For each foot mark, write down the species under the appropriate heading on the scratch pad and make a tally mark under the correct transect. Check off the line of each foot mark on the survey form as you record its listing. (Simply check off those foot mark lines that have bare soil or litter.) Each time you come across a species that is already listed on the pad, simply record it with a tally mark under the correct transect. If you want to sort a single species by age, do that now as well.

d) Transfer the names of all plant species listed on the scratch pad onto the Tally Sheet. Make note of any optional information about the species that you would find helpful. Then, count up the tally marks for each species under the appropriate transect. For each species, add the totals for Transects A and B and record this figure under the "Percent of Total" column.

Analysis Tools

Done over time, the survey is a tool for tracking changes and consistencies in species composition, and for revealing patterns and trends. It lets you see what is happening within the growing season and from year-to-year. It can help you see the effects of management and weather on plants and species composition. And, ultimately it can serve as a way to measure whole-farm goal achievement.

The Five-Year Summary Sheet included with this chapter is one way to collectively keep track of each year's survey results—regardless of which survey method you use—and give you a "picture over time." Or, you could use a computer spreadsheet program to record each year's results. This option allows you create visual summaries, such as bar graphs, that can make it easier to spot patterns and trends.

Complementary Tools

Pasture walks, especially informal ones done on a regular basis, can be especially useful for monitoring problems with weeds, insects or plant diseases. You could also incorporate the Plant Species Survey as part of the Burleson Pasture Walk mentioned on page 5.

Keeping track of your general pasture management practices in a field notebook is another useful companion tool to the Plant Species Survey. These notes might help you better see the correlations between management practices and changes and consistencies in species composition.

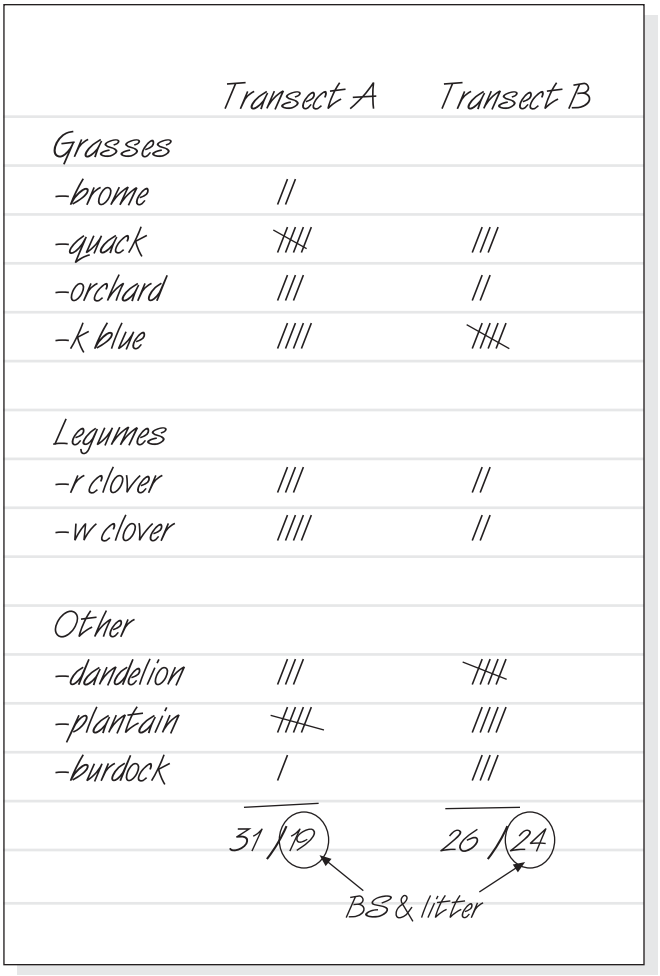


Figure 11: Steps 4b-4c of the Tape Method.

Monitoring Documents Positive Changes

In 1997 the Chippewa River Whole Farm Planning and Monitoring Team[1] began a pasture demonstration project to show how using animal impact in an intensively managed grazing system could be used to establish a healthy, productive pasture, even under challenging physical conditions.

The project is located on a farm long reputed to be one of the poorest in the county. Its gumbo soil (clay over sand) absorbs water very slowly and is unable to hold moisture once it reaches the sand layer. In addition, the farm had been row cropped using heavy chemical inputs for many years and the weed pressure was very high.

In 1996, the pasture was seeded with a mix of clover, alfalfa and grasses. The next year 150 ewes with lambs were grazed through one acre paddocks. During the 1998 and 1999 grazing seasons, 40 beef cows with calves grazed the pasture and about half of the pasture was mechanically harvested in early summer both years. (The 1999 cutting was nearly five times the volume of the 1998 cutting.) This forage was fed to the animals as supplemental feed in mid to late summer and fall.

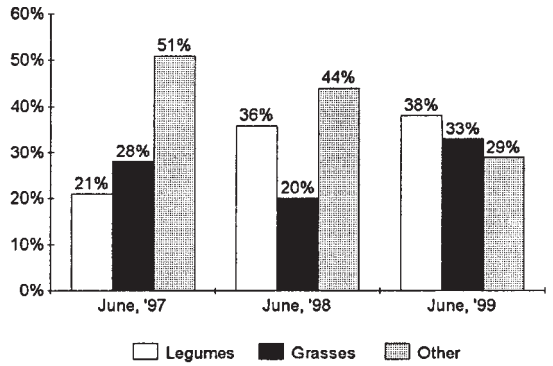
Dan and Don Struxness, who are members of the Chippewa River Team, lease and manage the pasture. They, along with interns hired by the Team, are using three complementary monitoring tools to track whether pasture production is moving toward their goals.

Every 30 days during the growing season, "fixed point" forage monitoring is done at 12 sites throughout the pasture. A Hula Hoop is placed over each point and the monitors take an "on your hands and knees" look at the vegetative growth within the circular sampling frame. A photograph is taken; estimates are recorded of the percentages of bare ground, organic litter and living material; and individual species are identified and assigned a rating that indicates the number (or percentage) of plants of each species.

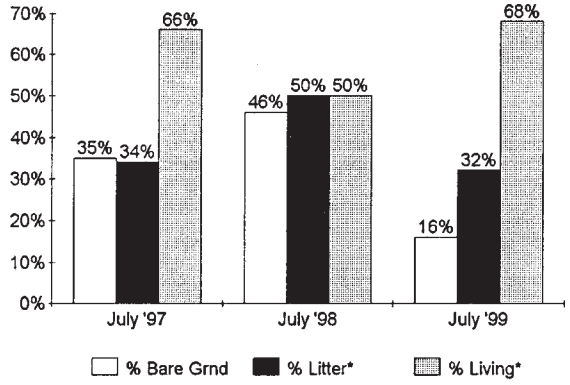
In addition, the monitors walk four imaginary lines, or transects, across the pasture and stop every fourth stride to identify and record the species of the plant to the tip of their shoe. The Struxnesses also use grazing and production records as monitoring tools.

Three years of monitoring reveal significant, positive changes in both the species makeup and in ground cover conditions. The following graphs typify trends the Team is seeing throughout the pasture.

Species Types Present (Paddock 4)



Ground Cover Assessment (Paddock 2)



"The monitoring we're doing, along with the production records, really helps us see what's going on," reports Don Struxness. "It makes it much easier to see the changes and where they're happening instead of just thinking you're going to remember from year to year."

[1] The Chippewa River Whole Farm Planning and Monitoring Team, made up of farmers, agricultural agency representatives and University of Minnesota scientists, promotes cooperation, stewardship and sustainability in the lower Chippewa River basin in Western Minnesota through demonstration projects and collaboration on team member's farms. For more information, contact Terry VanDerPol at (320) 269-2190.

Monitoring Forage Quantity and Quality

Livestock producers who use pastures as a primary feed source typically want to know how much forage they have and how good it is nutritionally because there is a direct link between forage production and animal production. The level of accuracy they need depends largely on what they are trying to get out of the pastures in terms of animal production. The tools for monitoring forage quantity and quality in this section reflect this need for varying levels of accuracy. To place these monitoring tools in their proper context, consider the general management issues related to forage quantity and quality.

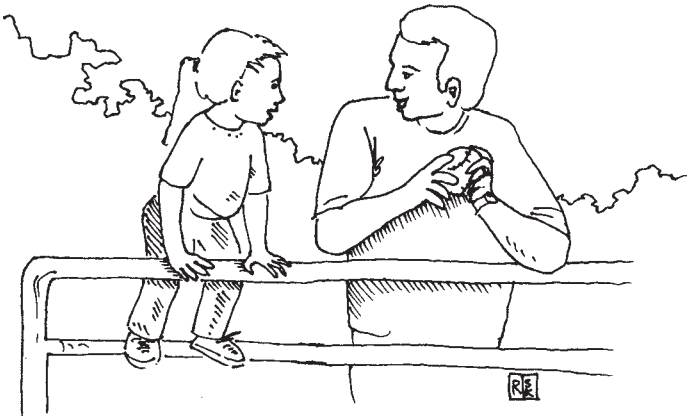
A Balancing Act

Whole Farm Needs

From a whole farm perspective, managing forage quantity and quality means balancing a variety of big picture concerns. First, the farm's need for production and profit must be balanced with the animals' nutritional needs. For example, milking herds are rarely forced to "clean up" a paddock before being moved to fresh pasture because of the detrimental effects this kind of grazing management tends to have on milk production, and therefore farm profits.

The above concerns—farm profits, productivity and animal health—also need to be considered in light of the pasture's needs, especially in terms of plant recovery and reproduction, species diversity and soil fertility. Here you need to think about what you are willing to do to either sustain these needs or compensate for them in other ways. The following example illustrates this point:

> Grass farmer Joe has determined that it is to his greatest advantage to harvest as much high quality forage as possible from his pasture. To do this, he has created a grazing plan in which his objective is to graze each paddock when the plants are between 8 and 10 inches and leave only 3 or 4 inches of residual. In doing so, he fully recognizes that achieving this high level of productivity comes with some predictable costs that he is willing to assume. He knows that only certain species can thrive under this type of management and he is willing to accept a simpler plant community in his pasture. He also understands that periodically he will need to renovate the pasture and may need to apply off-farm fertilizers. Given his goals and the particulars of his farm, all of these "costs" are acceptable because of the other advantages he gains from maximizing forage quantity and quality.
>
> On the other hand, Joe's neighbor, grass farmer Jane, has determined different goals and needs and has instead chosen to create a "self-sustaining," highly diverse pasture in which very little off-farm inputs are needed. She also has "costs" associated with her pasturing system that she is willing to assume because, for her situation and goals, the benefits of her system outweigh those costs.

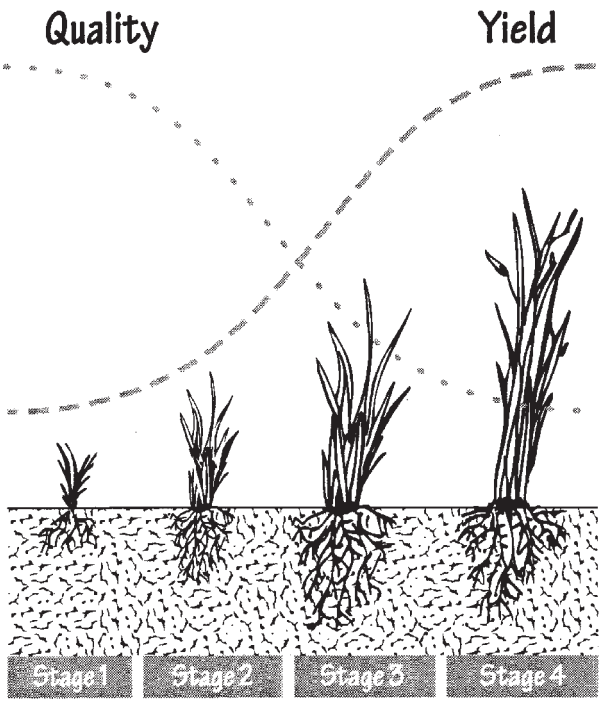


Not to be overlooked in this balancing act is the need to create a management system that fits with your whole family's quality of life goals. For some graziers, a pasture system set up to harvest the greatest amount of high quality forage requires a level of management that goes beyond what they are willing to do. If their farm's production, profit and landscape goals do not require this, then why sacrifice quality of life? The key here is to be aware of what you are trying to achieve and what your needs are—including your quality of life needs—so that you can then create a pasturing system that balances all of these issues.

The Quantity to Quality Relationship

If you are at all familiar with grazing publications, you have probably seen an illustration similar to Figure 12 below, the "Plant Growth Curve." This illustration shows the inverse relationship that exists between the quantity of forage produced by a plant and the quality of that forage. At stage 1, the plant may be of high quality, but volume is low. At stage 4, yield may be at its highest point, but quality has dropped dramatically.

Figure 12: The Plant Growth Curve.



Stage 1:
Freshly grazed
- photosynthesis low
- depletion of energy reserves
- slow growth

Stages 2 and 3:
Lush vegetative growth
- photosynthesis high
- renewal of energy reserves
- rapid growth

Stage 4:
Flowering and seeding
- photosynthesis reduced due to shading
- energy diverted to flower and seed production
- slow growth

The point at which the quality curve and the quantity curve meet is often suggested as best time to graze because this point represents the greatest amount of high quality feed. **However, this fact does not necessary mean that this point is the best time for *you* to graze.** In actuality, the best time to graze can vary a great deal.

Differences in species mix, stand density, climate and weather conditions, plant growth rates, soil conditions as well as your management goals and the class of animals being grazed can all affect when you will want to graze any given paddock. Besides, most real life circumstances do not allow you to always graze at the ideal point, no matter how you have determined it. Use the plant growth curve as a guide but aim to graze within an ideal "range" rather than at a specific point along the curve.

Furthermore, recognize that pastures are not hayfields and animals are not machines. In most situations, the animals will not uniformly harvest the forage in a paddock. Some plants will be regrazed before they have built up root reserves and some plants will be ignored and go to seed. Sometimes, especially early in the grazing season, it may be desirable to clip or hay a paddock in order to keep plant growth more uniform.

Above all, remember that plants have basic survival needs too. Most plants do not fare well when "grubbed into the ground." The different species need varying levels of residual leaf material in order to build up their root reserves and regrow new leaf material. Higher amounts of leaf material allows for more photosynthesis. This, in turn, spurs more vegetative growth and builds a good root system for greater access to water and minerals. (See Figure 13.) All of this helps to protect plant health. Sometimes letting the plants reach full maturity is desired, such as to build up a pasture's "seed bank."

In short, managing the quantity to quality relationship is also a balancing act that requires being clear about the big picture view of your farm.

Monitoring and Planning

On-farm monitoring is essentially a management activity. Good management involves a) knowing where you are at in the present, b) knowing where you want to go, and c) having a workable plan for getting from a to b. Monitoring forage quantity and quality will help keep you appraised of where your are at in the present and help you plan what you need tomorrow, next week, three months from now, a year from now, and so on. And, over time, monitoring will help you to see whether or not you are heading in your desired direction.

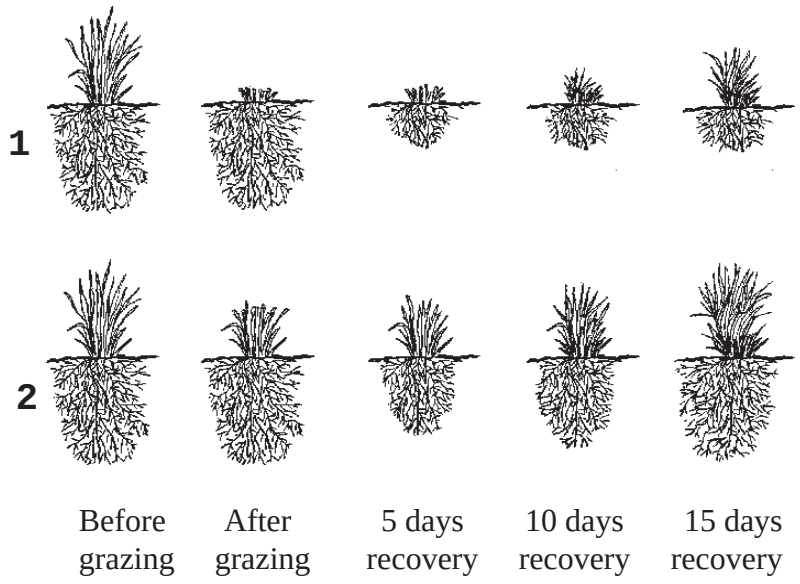


Figure 13: Plant regrowth rates depend on the amount of leaf removed at a grazing. Plant 2 regrows more quickly because it can fix more energy through photosynthesis than Plant 1, which must draw on its root reserves for energy to regrow.

Tools for Monitoring Forage Quantity

Forage quantity is usually measured as *pounds of dry matter per acre* (Lbs./a. DM) because animal feed requirements are usually given as so many pounds of dry matter per day. When monitoring forage quantity in a pasture, your are determining the amount of forage available for animal consumption. Knowing the available Lbs./a. DM allows you to plan your grazing management and to determine whether or not you will need to provide supplemental feed. The tool(s) you choose to measure forage quantity depends on the level of accuracy you need and how frequently you want that information for your planning and management purposes.

Pasture Clippings

One accurate way to determine pounds of dry matter per acre is to use a very simple but time consuming process referred to as a *pasture clipping* in this chapter. (The technical name is *quadrat clipping;* a *quadrat* is any rectangular plot used for ecological or population studies.)

The pasture clipping process is worth learning because it enables you to *calibrate* some of the other forage quantity monitoring tools discussed in this chapter, such as the pasture plate and the swardstick. To calibrate something is to make adjustments for deviations from the norm when taking a measurement. Most measuring devices are used within a specific sets of parameters. Unless your situation matches those parameters, the measuring device may not give you accurate readings. (For example, you would need to readjust a hanging feed scale if you switch to a different size pail than you normally use.) Knowing how to calibrate a pasture plate or swardstick allows you to obtain accurate readings from these tools.

The steps for doing a pasture clipping are divided between fieldwork (gathering the samples) and homework (doing the weighing, drying and calculations).

Fieldwork: For your work in the field, you will need the following items:

- a square-yard frame made of lightweight metal or PVC pipe
- a grass clipper (cordless electric ones work well)
- white kitchen-style garbage bags and twist ties
- a permanent marker
- a large cooler and several ice packs (optional)
- 35 mm or digital camera (optional)
- a yardstick (optional)

Figure 14: Taking a pasture clipping goes quicker when done by two people.

Step 1: Determine where you want to take your pasture clippings. At each site, be sure to randomly toss your frame. This guards against the natural tendency to unconsciously select the best spot to take your sample. Also, plan on taking your clippings a day or two before the animals will be put into the area.

Step 2: At the site, mark the site label on the plastic bag into which you plan to put the clippings. Then get a stand density estimate using the Ground Cover Worksheet as a guide. (See the instructions on page 20.) Record this figure on the bag. You could also take a photograph of the sight, using a yardstick to create perspective. Photos can help train your eyes to visually estimate forage quantity.

Step 3: Clip the forage within the frame to the average height the plants will be after the

animals graze the area. Gather the clipped forage into the bag, force as much air out of the bag as possible and tie the bag shut. Place the bag in the cooler or in a shaded area.

Because forage clippings start to lose moisture as soon as they are cut, you want to work quickly when gathering your samples, such as within an hour's time. Putting the samples in white plastic bags and in a cool place will help to slow moisture loss.

The other option is to bring your scale with you to the field and do steps 1 and 2 of the homework phase of the process right away. Then you would not need to worry about keeping the samples cool. Plus, you would have smaller samples, which could be put in large ziplock storage bags, to bring back to the house.

Homework: At home, you will need the following items:

- an accurate scale
- access to a regular oven or microwave oven
- one or two sheet cake pans (if using a regular oven)
- a plastic, microwave-safe food container
- pencils and a calculator
- photocopies of the Pasture Clippings Worksheet (a double-sided form)

Step 1: Record the sample's site label and stand density reading on the Pasture Clippings Worksheet. If you are calibrating a pasture plate or swardstick, circle the appropriate tool and write down the height measurement. Next, get the wet weight of the square-yard sample and record that weight on line A of the Worksheet. If you have a sensitive electronic scale, you can also weigh an empty bag and subtract that amount from the sample's weight.

For nonelectronic scales that weigh in pounds and ounces, use the conversion table on the Worksheet to record all the weights in decimals. For example: 1 Lb. 12 oz. converts to 1.75 Lbs.; 14 oz. converts to .88 Lb. This conversion is especially important for the whole sample weight (line A) because you will need the decimal format for the final calculation (line E).

Step 2: Place the plastic food container on your scale and adjust to zero. To get the subsample that you will dry down, fill the container with 6-10 ounces of wet clippings and record the wet weight on line B of the Worksheet.

Step 3: A safe, but somewhat slow way to dry down your subsample is to use a regular oven.

a) Preheat the oven to its lowest setting (170° F). Spread the subsample out on one or two sheet cake pans and place in the oven; leave the oven door open slightly. The time needed to dry the sample will vary with the amount of material and its initial moisture content.

Some Notes on Scales

For on-farm monitoring purposes, any scale capable of measuring ounces and pounds will work, such as a good kitchen or postal scale. Electronic scales that give digital readings (1.35 Lbs. or 2.6 ounces, for example) are nice but not necessary. The biggest advantage of an electronic scale is that it allows you to accurately weigh small samples.

An office products supplier should carry both regular and electronic postal scales. Department stores and specialty cooking stores will have kitchen scales. Grocery stores or butcher shops may have used, non-digital scales that they would sell at a reasonable price.

Anyone interested in direct marketing their farm products may want to invest in a scale that is also legally certified for that purpose by their state's Department of Weights and Measures.

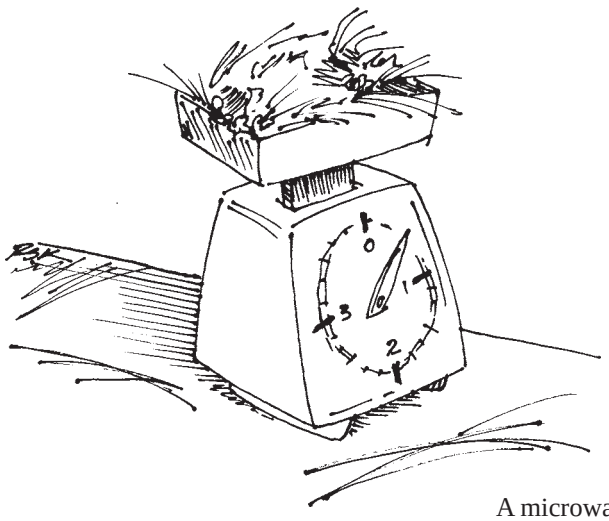


Figure 15: Weigh the subsample.

b) After about an hour, check the sample and gently mix it. If it is still wet, let it dry for another hour or so or until you start to notice a significant difference in the moisture content of the sample.

c) Remove the pans from the oven and carefully transfer the sample to the weighing container resting on the scale. Record the result in the "Test weight" portion of the Worksheet. Then return the samples to the baking pans and put them into the oven. Check the sample again in another 30 minutes.

d) Repeat step 3c until no more weight loss is detected. Record the final dry weight of the subsample on line C of the Worksheet.

A microwave oven can also be used to dry the subsamples. This method is faster, but there is a greater danger of fire when using a microwave. **To reduce the risk of fire, keep a pint jar of water in the microwave during the entire drying process.**

e) Make sure the jar of water is in the microwave. Place the weighing container in the microwave for 3 minutes on high.

f) At the end of the 3 minutes, weigh the subsample and jot down that figure in the space provided for test weights on the Worksheet.

g) Dry the subsample for another minute on high. Weigh it and jot down the figure. Repeat this process until no more weight loss is detected. Record the final dry weight of the subsample on line C of the Worksheet.

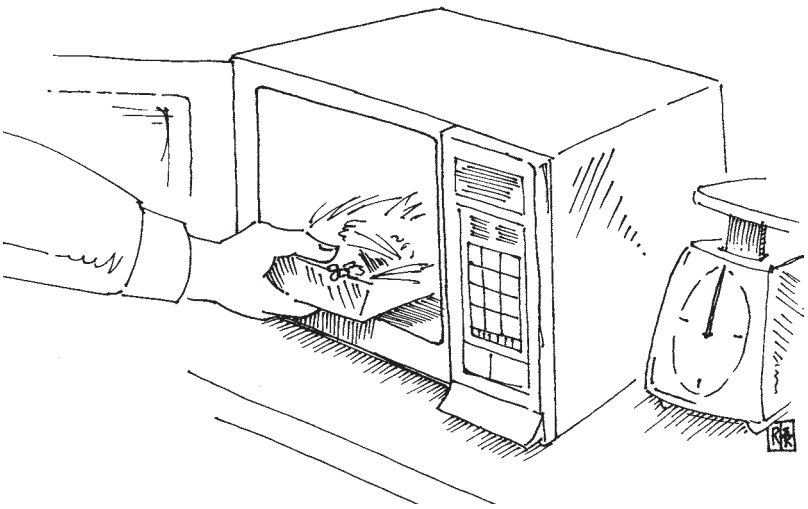


Figure 16: Drying the subsample in a microwave is fast but should be done with caution.

Step 4: Divide the dry weight of the subsample (line C) by its wet weight (line B). This gives you the percent of dry matter (% of DM) you need to calculate the total pounds of dry matter/acre based on your original square-yard sample. Record the % of DM on line D of the Worksheet.

For line E, first multiply line A by line D. Then, multiply that sum by 4,840, which is the total number of square yards in an acre. The equations looks like this: A x D x 4,840 = Lbs./a. DM.

Pasture Plate

A homemade pasture plate can also be used to measure pounds of dry matter per acre. Once the plate is calibrated, it is easy to use as frequently as you want. The sidebar below tells you how to make your own pasture plate. The following is a general description of what the device consists of and how it works:

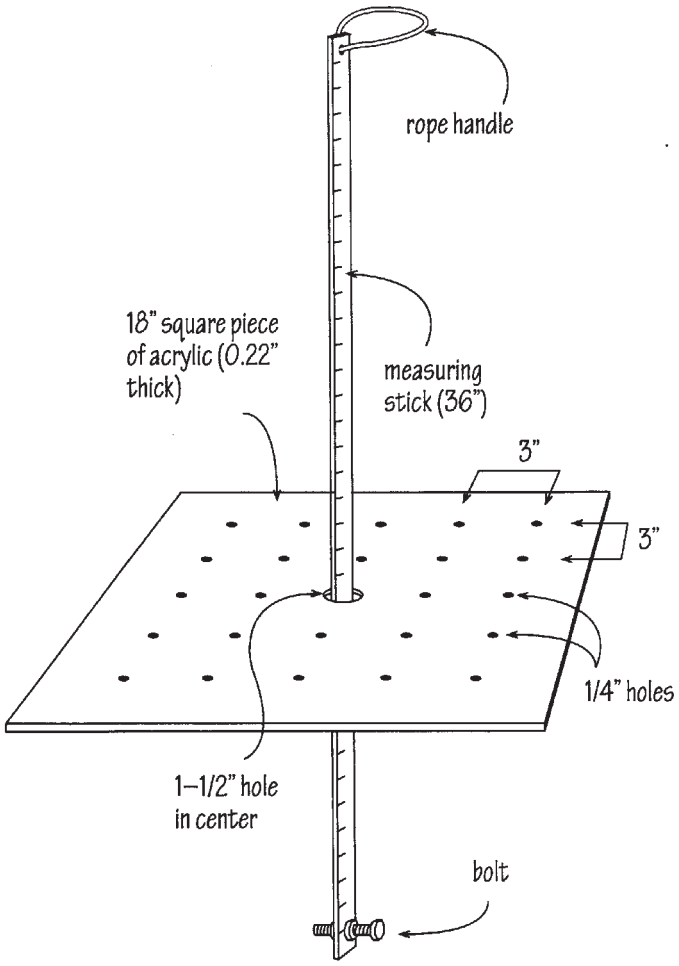
The two main components of a pasture plate are a yardstick and an 18-by-18-inch square of 0.22-inch thick acrylic plastic in which a center hole has been drilled. The center hole allows the plate to slide up and down the yardstick. A bolt or some other stop at the bottom of the yardstick keeps the plate from sliding off the stick.

While the unit is being carried, the plate rests on the stop at the bottom of the yardstick; as the stick is gently lowered to the ground, the plate rises. When the plate comes to a resting stop on top of the forage canopy, simply record the height of the top of the plate using the yardstick. Once the plate is calibrated, **each inch corresponds to a set amount of pounds of dry matter per acre** (Lbs. DM/inch).

The design described below also includes a series of small, uniform holes drilled into the plate. These holes are used to calculate the stand density of the forage you are measuring. This figure can help you to make correlations between stand density, forage height and the amount of forage available in your paddocks.

How to Make a Pasture Plate

1. Have your local hardware store cut you an 18-inch square from .22-inch acrylic plastic (plexiglass). Sand to smooth the edges if necessary.
2. Using a wet-erase marker, make a mark every three inches on each side of the square. Follow the marks and use a straightedge to plot out a grid like the one shown here. Then do the following:
   a) Drill a 1 1/2-inch hole at the center mark. Drill slowly to prevent the plastic from melting.
   b) At each of the remaining 24 grid intersection points, drill a 1/4-inch hole.
3. Select a measuring stick marked to 36 inches (such as a wood, plastic or metal yardstick, a four-sided swardstick or a metal rod notched to resemble a yardstick). The measuring stick should slide easily through the center hole of the plate.
4. Put a bolt through a hole drilled about an inch from the bottom of your measuring stick and secure with a washer and nut.
5. Drill a small hole at the top of the measuring stick and tie on a short rope handle.



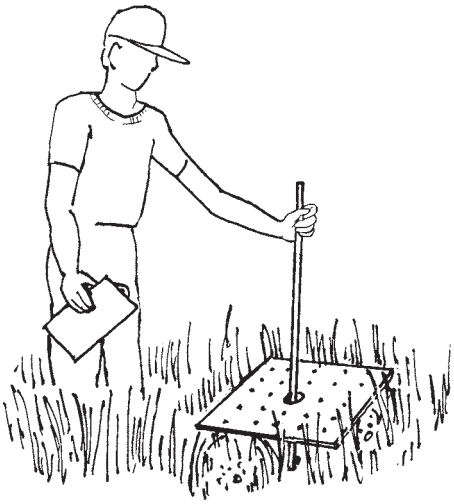


Figure 17: Taking forage quantity reading with a pasture plate.

How to calibrate your pasture plate: Ed Rayburn of the West Virginia University Extension Service tested the pasture plate extensively over a ten-year period (1986-1995) on pastures managed with "intensive rotational grazing." The species composition of these test pastures included a mix of cool season grasses and legumes: orchard grass, timothy, quackgrass, bluegrass, ryegrass, white clover and red clover. Under these conditions, Rayburn found that each inch of forage measured with a pasture plate typically corresponded to 432 Lbs./a DM.

The formula for determining total pounds of dry matter per acre (Lbs./a. DM) when using a pasture plate is to multiple the number of inches by the Lbs. DM/inch figure. For example: 5 inches x 432 = 2,160 Lbs./a. DM. If your pastures are similar to those Rayburn tested, the 432 Lbs. DM/inch figure may work for you. Partially this depends on the margin of error you are willing to accept. Forage quantity readings will vary not only with different species mixtures, but also with different weather and seasonal conditions. To determine the Lbs. DM/inch figure for your particular species mixes and for different climates, weather conditions or seasons, follow these five steps:

Step 1: Lay down your square-yard frame and, inside the frame, take a height measurement with the pasture plate. Record this figure on the Pasture Clippings Worksheet.

Step 2: Use the small holes in the pasture plate to calculate the stand density of the sample area and record this figure as well. (Use the numbered Pasture Plate grid on the Ground Cover Worksheet and follow the instructions on page 20.)

Step 3: Remove the pasture plate and clip the forage within the frame to the height to which the animals would typically graze. Follow the pasture clipping steps outlined on pages 30-32 to get an accurate dry matter reading.

Step 4: Repeat the above three steps at different spots within the same paddock for a total of at least five samples. If the readings from your first five samples vary considerably, then take another five to ten samples to get a more representative measurement.

Step 5: Calculate the average forage height, stand density and pounds of dry matter per acre of your samples. Then divide the average Lbs./a. DM by the average forage height reading. For example: An average of 1,980 Lbs./a. DM divided by an average of 6.5 inches yields a Lbs. DM/inch figure of 305.

Be sure to record these calibration figures in a field notebook so that you can readily find them when you want to use your pasture plate.

How to use a calibrated pasture plate: The process of calibrating a forage quantity measuring device like a pasture plate may seem like a lot of work. But considering how easy it is to overestimate the amount of forage in a pasture paddock, the effort might be worthwhile if that information is a critical part of your management decisions. Plus, once the plate is calibrated for your pastures, the process of using this tool becomes much simpler.

To use your calibrated pasture plate, walk around the paddock and randomly take between 20 and 30 forage height readings. This range of readings will give you the most accurate results. Jot down the height measurement for each reading on a note pad. Use a different pad sheet for each paddock you check and be sure to label each sheet with the correct paddock label. You can check the stand density of a handful of the readings as well.

Average the height readings and multiply that number by your predetermined Lbs. DM/inch figure. The result gives you a good idea of the amount of forage available in that paddock at that time.

Swardstick

Another simple tool for measuring forage quantity is the "swardstick," a four-sided, yard-long wooden stick that is packed with information on how to estimate forage yield in different types of pasture stands. The term *sward* simply refers to the grassy cover of a piece of land.

Generally, most swardsticks are self-explanatory; however, they do come in different versions depending on the agency or organization that is distributing them. These include the NRCS, Soil & Water Conservation Service, University Extension, and your state chapter of the Grazing Lands Conservation Initiative (GLCI). The Minnesota Forage and Grassland Council also puts out a swardstick.

The typical swardstick has inch markings up to at least 12 inches, some are marked to a full yard. It will also have a table showing the pounds of dry matter per acre for a few different vegetation mixes and stand densities. Some swardsticks also give a way to estimate stand density. The main thing to remember with swardsticks is that the information given may or may not fit exactly with your pasture mix. **As with the pasture plate, you will probably need to calibrate the swardstick to fit your conditions**.

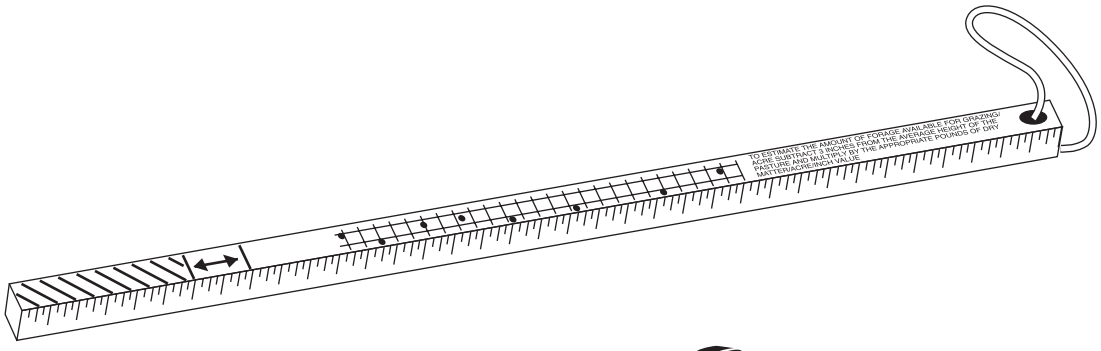


Figure 18: Most swardsticks are packed with helpful information, but be sure to make adjustments to fit your pasture situation and goals.

Electronic PastureGauge

The easiest, but most expensive, forage quantity measuring tool is the Alistair George PastureGauge from New Zealand. This electronic device, which comes in two models, gives you a digital readout of dry matter as you dip the end of the probe into the grass while walking through the paddock. The Junior model measures 1 paddock at a time. The Senior model can measure and keep track of up to 99 paddocks at a time. Optional computer software allows you to download the measurements and chart out the results.

The PastureGauge is easy to use and technological improvements in recent years have increased its reliability in varying weather conditions. In the right management situation, it might be worth the purchase price.

Before purchasing a PastureGauge, consider borrowing one. Use it and compare it with a pasture plate or swardstick. It might even be fun to check its accuracy against some pasture clippings.

Also, talk to other graziers who regularly monitor forage quantity to find out what they use. Then, ask yourself these two questions: 1) How often do I plan to do the monitoring? and 2) Which tool will make it easier for me to actually get the job done? If you find it easy to use a pasture plate or a swardstick, then save yourself the expense of a PastureGauge. On the other hand, if you know that you are much more likely to actually use the electronic device, then it might be the best choice for you. Many graziers who do use the PastureGauge call it the most profitable tool they have ever owned.

Figure 19: The easy-to-use PastureGauge—a profitable monitoring and management tool for many graziers.

Eye Assessment

Regardless of which of the above tools you use to measure forage quantity, time and experience will train your eye and increase your ability to estimate forage quantity just by looking at a pasture's stand. In these kinds of situations, however, human nature tends to be overly optimistic. And so, when management decisions are at stake, eye assessments should always be accompanied by some other, more objective measuring device.

The Forage Monitoring Record Sheet

Regardless of whether you monitor forage quantity with a pasture plate, swardstick or electronic probe, you will probably want to record that information so that you can refer to it when making management decisions. The Forage Monitoring Record Sheet included with this chapter offers you one option for doing this. This form lets you keep track of both forage quantity and quality measurements as well as make note of the species mix and stand density of the samples.

If you prefer, a computer spreadsheet program could be used for the same purpose. The latter is especially useful if you want to create bar graphs and other charts. These graphics make the information stand out more so that it is easier to see patterns and trends.

Tools for Monitoring Forage Quality

A plant's forage quality is assessed according to the amount of energy, fiber, crude protein and minerals it can supply to the animal that consumes it. Again, the level of accuracy you need to know about your pasture's forage quality depends on your goals, particularly in terms of animal production. Based on the level of information you need, choose from the following forage quality monitoring tools.

Laboratory Analysis

A laboratory analysis of your pasture forage will give you the most accurate measurement of its quality. Well-managed pastures can provide excellent forage and this quality needs to be accounted for when balancing the animals' ration or diet.

The Grazing Wedge

For Ohio grazier F.W. Owen, monitoring forage quantity is an integral part of his grazing management. Owen takes forage quantity readings in each of his paddocks at least once a week and uses this information to help him plan the grazing of his dairy herd. To do this planning, Owen maintains what he calls a "Grazing Wedge."

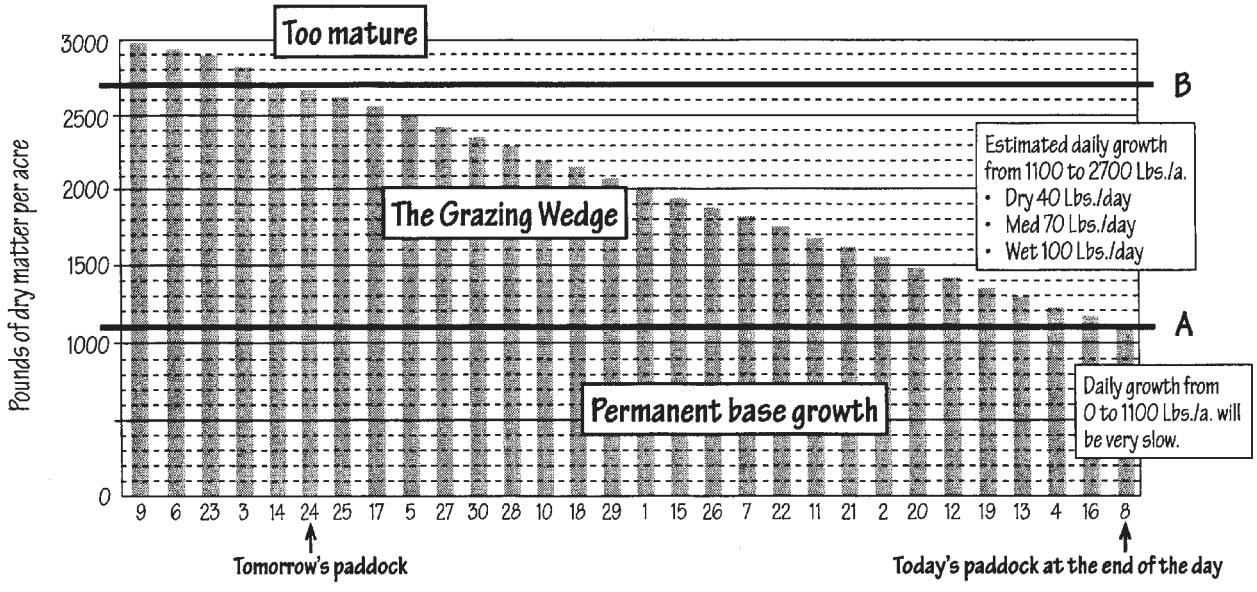
As the graphics clearly show, a Grazing Wedge gives Owen a snapshot of the amount of forage available in all of his paddocks on the day he takes his forage quantity readings. (Owen uses a pasture plate, but a swardstick or a electronic pasture probe could be used instead.) The raw data gets plugged into a computer spreadsheet and the paddocks are listed in order from those with the most available forage to those with the least. When the information is charted out in bar graph form, a wedge-shaped graphic emerges.

From each Grazing Wedge he creates, Owen is able plan which paddocks will be used over the next 5 to 7 days. He also knows which paddocks are too immature to graze in the coming week and which ones he needs to clip or hay. Depending on plant regrowth rates, the grazing order of the paddocks may shift from week–to-week. These shifts will show up on the next Grazing Wedge and Owen will adjust his grazing plan accordingly.

Over the years Owen has learned that for his pastures, which are primarily a bluegrass (or perennial ryegrass)/white clover mix, he needs to leave at least 1,100 Lbs./a. DM in residual plant material to get adequate and timely regrowth (line A). He has also learned that his paddocks are starting to get too mature for his dairy herd when he sees yields over 2,700 Lbs./a. DM (line B).

The Lbs./a. DM figure(s) that indicate when your paddocks are too mature likely will differ from the figure Owen uses. The same is true for the amount of forage you need to leave as a base for good regrowth. With experience, however, you will become familiar with the specifics of your pasture.

For more information on the Grazing Wedge, refer to Owen's Web page, Owenlea Holsteins, at www.bright.net/~fwo/Wedge.html. This information can also be accessed through the Sustainable Farming Connection Web page (metalab.unc.edu/farming-connection/index.html) under the "Links" feature.



If possible, seek out an animal nutritionist in your area who has experience working with pasture forage. They can help you decide what to test for and connect you with a laboratory. Other area graziers, your Ag Extension Educator or NRCS staff may also provide helpful information.

Ask the laboratory to pass on their preferred procedures for collecting and handling the forage samples. Quality factors begin to deteriorate almost immediately upon collection of the sample so careful handling is essential to preserving as much of the quality as possible. Taking care not to contaminate the sample is also important. For example, be sure to wear clean, manure-free boots when collecting the samples.

Most forage quality samples are a collection of 10 to 15 "grabs" of forage within a paddock. Be sure that your collective sample **represents what the animals are actually consuming**. You can use a dart like the one suggested on page 22 to ensure random grabs, but if the dart lands by a plant that the animals will not eat, such as a mature thistle, then toss the dart again to get a more representative sample.

For more in-depth monitoring of your pasture's forage quality, you might want to keep track of the species mix of the samples you collect.

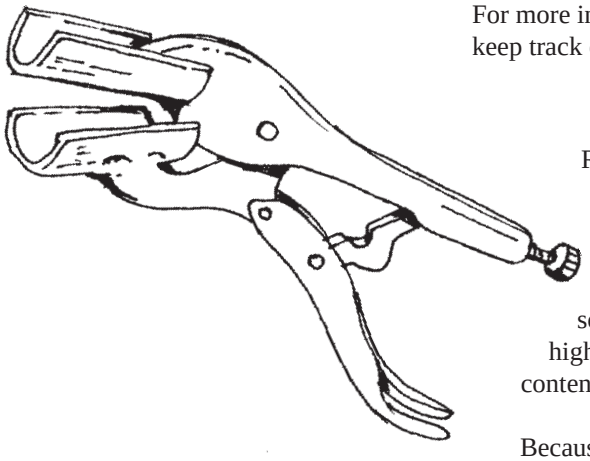
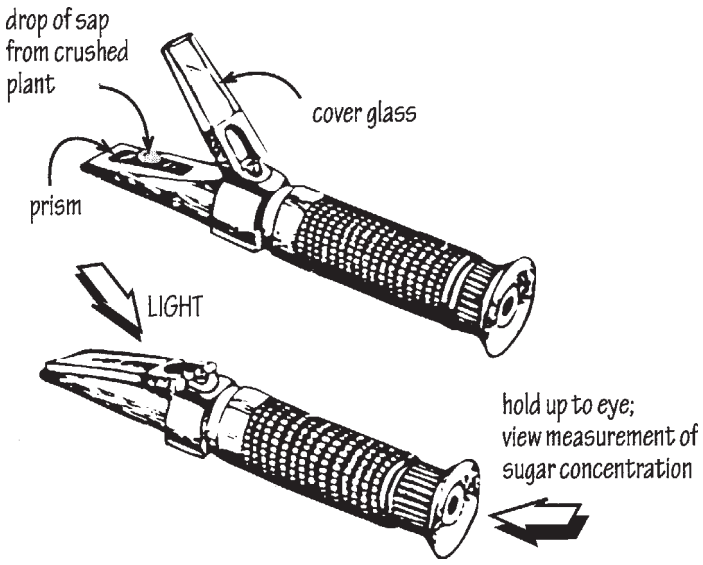


Figure 20: A refractometer reads the sugar content of the juice extracted from the part(s) of a plant to be eaten. A simple tool to crush the plant sample can be purchased, or constructed.

Refractometers

Refractometers have been used for years to help determine the proper harvest time for fruits and other garden produce; in fact, vineyards rely heavily on them. A refractometer gives a *Brix* reading, or a measure of the sugar content of the juice extracted from the part of the plant to be consumed. In the case of pastures, that would be the leaves (and some stems) of grasses and legumes. For any given species of plant, a higher sugar content tends to correlate with higher mineral and protein content and therefore higher quality and palatability.

Because they are easy to use and relatively inexpensive, they may be an appropriate tool to use for monitoring the forage quality of pasture. See the "Additional Resources" section at the end of this chapter for source information.



Selective Grazing

You can also monitor forage quality in pastures by paying attention to the grazing patterns of the animals: which plants are they eating and which ones they are not eating, which plants they tend to eat first, which plants always seem to be the last to be eaten in a paddock, and so forth. Or, perhaps you have a paddock that the animals never like to clean up very well. Let this information prompt you to investigate why the animals find that forage unpalatable. Notes like these can be kept as part of your general observations on the Grazing Monitoring Record Sheet or in a field notebook.

Eye Assessment

Observation of the plants themselves and the pasture stand as a whole can also be useful indicators of forage quality. Keep in mind the correlation between the maturity of a plant and its overall nutritional quality (pages 28-29). Likewise, a pasture's species composition can also affect the quality of its forage. As with forage quantity testing, time and experience using the other monitoring tools listed will train your eyes and you will be able to estimate a paddock's forage quality just by looking at it. Even so, periodic analysis of the forage may still be desired.

Be sure to keep track of your forage quality monitoring results, such as on the Forage Monitoring Record Sheet, the Grazing Monitoring Record Sheet, in a computer spreadsheet or in a field notebook.

The Reality of Pastures

The reality of making a pasture a productive and sustainable part of your farm is that it requires a "custom" management program that fits your farm, your goals and your landscape. While much valuable information exists on managing pastures, no set "formula" exists to tell you exactly what to do and when.

At times, sources of grazing and pasture management information might give you the impression otherwise. For example, the swardstick from the Wisconsin chapter of GLCI gives this advice: "To maintain high forage quality and reduce trampling losses, graze pastures at 6 to 8 inch forage height. Plan to mechanically harvest pastures that exceed 12 inch pre-grazed height or graze and then clip." While this may be helpful advice for some graziers, it is by no means as universally applicable as it reads. In other words, always question what you read or hear and judge it against your goals—your quality of life goals, your production/profit goals and your landscape goals.

The inevitable need to develop a "custom" management plan for your pasture lies at the heart of why monitoring your pasture management is so important. In farming, as in most of life, no two situations are ever the same. With pastures this is doubly true. Not only will your pasture vary from your neighbor's, it will also change and fluctuate within any given grazing season and from year-to-year. Using the tools presented in this chapter will help you adjust for these changes and fluctuations so that you can manage for the accomplishment your whole-farm goals.

Additional Resources

The following listings are only a sample of the growing number of resources available on pastures and grazing.

Books

On Management Intensive Grazing

Grass Productivity, by André Voisin. (New York: Philosophical Library, Inc. 1959; Island Press Edition with Introduction by Allan Savory, 1988.)

> The classic text that started the worldwide revolution in grassland management. From his research, much of it on his own 60-acre farm in France, Voisin discovered that it was the amount of time animals spent feeding in an area, not the number of animals, that lead to overgrazing. Allan Nation of the *Stockman Grass Farmer* calls it "an absolute must read for any grassland farmer and rancher."

Greener Pastures on Your Side of the Fence: Better Farming with Voisin Management-Intensive Grazing, by Bill Murphy. (4th Edition. Colchester, VT: Arriba Publishing, May 1999.)

> The best introduction to management intensive grazing for the beginner. Explains in detail the whys and hows of using management intensive grazing as first outlined by André Voisin. Murphy uses lots of examples to illustrate the fine points of management intensive grazing, including for producing milk, beef and lamb on pasture alone, nutrient cycling, recovery periods, grazing equipment, economics and more.

Holistic Management: A New Framework for Decision-Making, by Allan Savory with Jodi Butterfield. (Washington, DC: Island Press, 1999.)

> The revised and updated version of *Holistic Resource Management* (1988) that reflects the input and experiences of those who have worked to put Savory's ideas on land management, ecology, economics and community into practice.

Intensive Grazing Management: Forage, Animals, Men, Profits, by Burt Smith, Pingsum Leung, and George Love. (Kamuels, HI: The Graziers Hui. 1986.)

A detailed and practical source of basic information on getting started in management intensive grazing. May be especially helpful for those making the transition from conventional grazing management.

Identification Guides

Conservation Plants Pocket ID Guide. Developed by the Elsberry Plant Materials Center, which is operated by the USDA Natural Resources Conservation Service. (Elsberry, MO. 1995.)

> A handy, pocket-sized guide that includes many of the most common grasses and legumes found in pastures of the Upper Midwest, including both native and tame species. Distributed by the National Association of Conservation Districts, (800) 825-5547.

Identifying Pasture Grasses, by Dan Undersander, et. al. (Madison, WI: University of Wisconsin Extension. 1996.)

> Identifies the 15 most common annual and perennial grasses in Midwestern pastures. Pocket-sized and informative. Available from Cooperative Extension Publications, 630 W. Mifflin St., Rm. 170, Madison, Wisconsin 53703; (608) 262-3346. Ask for publication A3637. Also available on-line at www.uwex.edu/ces/pubs/foragecat.html.

Selected North Dakota and Minnesota Range Plants by Kevin K. Sedivec and William T. Barker. (Fargo, ND: NDSU Extension Service, 1998.)

> A selection of 123 plant species commonly encountered in the rangeland of North Dakota and Minnesota. The information for each species includes the scientific and common name, an excellent color photograph, detailed line drawings, a statement of origin and information on growing season, habitat, distribution, forage value and wildlife value. Includes an extensive listing of other references.

Tallgrass Prairie Wildflowers: A Falcon Guide: A Nature Conservancy Book, by Douglas Ladd and Frank Oberle. (Helena, MT: Falcon Publishing Company. 2nd Edition, 2000.)

> An attractive, well-organized guide for accurately identifying 295 tallgrass prairie plants. Includes more than 320 color photographs, habitat and range information, historical and cultural notes and a directory of tallgrass prairies in 13 states.

Weeds of Nebraska and the Great Plains. (Lincoln, NE: University of Nebraska and the Nebraska Department of Agriculture, 1994.)

> A comprehensive identification resource for nearly 400 common plants and weeds in the Great Plains and the western states of the Midwest, including Wisconsin, Iowa, Minnesota, Nebraska and the Dakotas. Geared to serve the needs of botanists, farmers, ranchers and home owners. Replaces the 1979 book *Nebraska Weeds.*

Planning Guides and Workbooks

The following planning guides replace and update the information in the *Holistic Resource Management Workbook*, which is listed as a resource in the "General Tools for Monitoring" chapter of *The Monitoring Tool Box*. All are available from the Allan Savory Center for Holistic Management. (See contact information on page 43.)

Aide Memoire for Holistic Grazing Planning
Early Warning Biological Monitoring: Rangeland and Grasslands
Early Warning Monitoring on Croplands
Holistic Financial Planning Guide
Holistic Land Planning Guide

Pastures for Profit: A Guide to Rotational Grazing, Dan Undersander, et al. (Madison, WI: Cooperative Extension Publications, 1997.)

> Contains productivity information on common pasture grasses and legumes. Available from Wisconsin and Minnesota county extension offices or from Cooperative Extension Publications, Rm. 245, 30 N. Murry St., Madison, WI 53715; (608) 262-3346. Ask for publication number A3529. Also available off of the University of Wisconsin Extension website: www.uw-ex.edu.

Pasture Management Guide for Northern Missouri, produced by the Natural Resource Conservation Service. (Columibia, MO. Spring 1998.)

> A good example of a regionally-oriented publication geared toward helping livestock producers establish and manage grasslands. Includes information and sketches of grasses and legumes common not only to the pastures of Northern Missouri but to many parts of the Midwest, Northeast and eastern reaches of the Great Plains. To obtain a copy of this guide, contact Maurice R. Davis, State Range Conservationist, RR 3, Box 135, Moberly, MO 65270. Phone: (660) 263-5702, fax: (660) 263-3725, e-mail: maurice.davis@mo.usda.gov.

Roping Grass: How to Regenerate the Land and the People, by Wayne Burleson. (Absarokee, MT: Sloping Acre Publishing Co., 1997.)

> Reflects the author's common sense approach to helping people make beneficial changes in their lives through better decision making. Offers people practical tools for making holistic observations of both themselves and their land, including how to do a Pasture Walk. This and other work-books by the author are available from Range Management Services, 332 N. Stillwater Rd., Absarokee, MT 59001. Phone: (406) 328-6808; e-mail: rutbuster1@mcn.net; website: www.pasturemanagement.com.

Periodicals

Acres U.S.A. is a monthly publication packed with practical, hands-on, cutting edge information on commercial-scale, soil-friendly farming technologies, techniques, news, analysis and trends. The publishers of *Acres* also offer an 80-page catalog of "the most impressive selection of eco-books on the planet," including many of the books listed in this resources section. Subscription information: *Acres U.S.A.*, P.O. Box 91299, Austin, TX 78709. Phone: (800) 355-5313; fax: (512) 892-4448; e-mail: info@acresusa.com; website: www.acresusa.com.

GLCI News is a bimonthly newsletter of the Grazing Lands Conservation Initiative, which is a voluntary partnership between federal, state and local agencies, conservation groups and the owners of private grazing lands. The newsletter highlights GLCI efforts across the country. Contact information: National GLCI Coordinator, USDA NRCS, 501 W. Felix Street, Bldg. 23, Ft. Worth, TX 76115; phone: (817) 509-3318.

Holistic Management IN PRACTICE is the bimonthly journal published by the Allan Savory Center for Holistic Management that keeps its readers up-to-date on the latest developments in Holistic Management. Each issue includes timely feature articles, practical tips and insights, book reviews, nuts-and-bolts features for land managers, a lively question and answer column and a readers forum. Subscriptions (US): $27/year, $50/two years, $70/three years. Contact information: The Allan Savory Center for Holistic Management, 1010 Tijeras NW, Albuquerque, NM 87102. Phone: (505) 842-5252; fax: (505) 843-7900; e-mail: savorycenter@holisticmanagement.org; website: www.holisticmanagement.org.

GRAZE is a monthly publication "by graziers, for graziers" with a strong focus on but not limited to the Midwest. All things grazing (mostly cows, some sheep) are approached from practical standpoints and the experiences of real people, covering economics, agronomics, ecology, herd and sward health, and the ever-throughtful opinions of editor Joel McNair. Contact information: GRAZE, POB 48, Belleville, WI 53508; phone: (608) 455-3311; fax: (608) 455-2402; e-mail: graze@ticon.net; website: www.grazeonline.com. Call for subscription rates.

The Stockman Grass Farmer is a monthly publication devoted entirely to the art and science of turning grass into cash flow. It serves as an information network for grassland farmers sharing the latest in intensive grazing technology and pasture management. The publisher also offers informative books and special reports on grass farming and audio tapes from past SGF-sponsored Grazing Conferences and other sources. Contact information: P.O. Box 2300, Ridgeland, MS 39158-9911. Phone: (800) 748-9808; fax: (601) 853-8087; e-mail: SGF@StockmanGrassFarmer.com; website: www.stockmangrassfarmer.com.

Online Resources

Both of the following websites serve as clearing houses of information on grass-based farming systems, grazing and pasture management:

- ***The New Farm***—farmer-to-farmer know-how from the Rodale Institute (www.newfarm.org)
- ***Sustainable Farming Connection*** (www.ibiblio.org/farming-connection).

People

In many states, the Department of Agriculture, University Extension, University Ag Research Department and the Natural Resources Conservation Service offer publications on grazing and pasture management, some of which are available on-line from the source's Web site.

Agency personnel and university researchers may even be available to work with you in some of your pasture vegetation monitoring. These folks should also be aware of any private grazing groups or organizations working with grass farmers in your region or state.

In Minnesota, these include:

- ***Land Stewardship Project*** (www.landstewardshipproject.org)
- ***Minnesota Institute for Sustainable Agriculture*** (www.misa.umn.edu)
- ***Minnesota Department of Agriculture, Energy and Sustainable Agriculture Program*** (www.mda.state.mn.us)
- ***Sustainable Farming Association*** (www.sfa-mn.org)

Additional contact information for these Minnesota organizations is given in the chapter, "Making the Most of Your Tool Box," of *The Monitoring Tool Box.*

Tool Sources

Refractometers

Graziers Supply & Management
Douglas Gunnink
25303 461 Ave.
Gaylord, MN 55334
Phone: (507) 237-5162
Fax: (507) 237-2343
E-mail: dgunnink@prairie.lakes.com

Peaceful Valley Farm Supply
P.O. Box 2209
Grass Valley, CA 95945
Toll-Free Order Line: (888) 784-1722
Website: www.groworganic.com

Alistair George PastureGauge

Graziers Supply & Management
(see above)

Pasture Resources™ by Alpha Ag, Inc.
Don Trott
8295 Bomke Road
Pleasant Plains, IL 62677 USA
Phone: (217) 546-2724
E-mail: alphaag@earthlink.net

Grazing Monitoring Record Sheet

Page ________ of Set ________

Location   Year

Paddock No.	Size & Veg.Type	Month / Day	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Grazing Days /Pad	Recovery Period	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Grazing Days /Pad	Recovery Period

Total Acres Grazed	Total Days Grazed	Ave. Recovery Period	Total Acres Grazed	Total Days Grazed	Ave. Recovery Period

Rainfall & Weather Conditions	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Total	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Total
Plant Growth Rate												

Number of Animals, Class & Ave. Weight		Total Animal-days per Acre (animals x days ÷ acres) Total Animal-pounds per Acre (animals x weight ÷ acres)		Total Animal-days per Acre (animals x days ÷ acres) Total Animal-pounds per Acre (animals x weight ÷ acres)
Supplemental Feed	Type Amount & Cost		Type Amount & Cost	
Clipping & Haying Notes				
General Notes & Observations				

Monitoring Pasture Vegetation

Year-End Summary Sheet

Year _____ Set _____

Location _____ First Day _____ Last Day _____ Total Days Grazing _____

	January	February	March	April	May	June
Ave. Recovery Period						
Rainfall						
Acres Grazed Cool Season Warm Season Other						
Acres Clipped						
Acres Hayed Tons/Acre						
Animals Grazed Number Class Weight						
Supplemental Feed Type Amount Cost						
Animal Days/Acre						
Animal Pounds/Acre						
General Notes						

Monitoring Pasture Vegetation
Year-End Summary Sheet, continued

July	August	September	October	November	December	For the Year

Monitoring Pasture Vegetation

Date _____ Count No. _____

Ground Cover Worksheet: Square Yard Frame

Site ID & Location _____

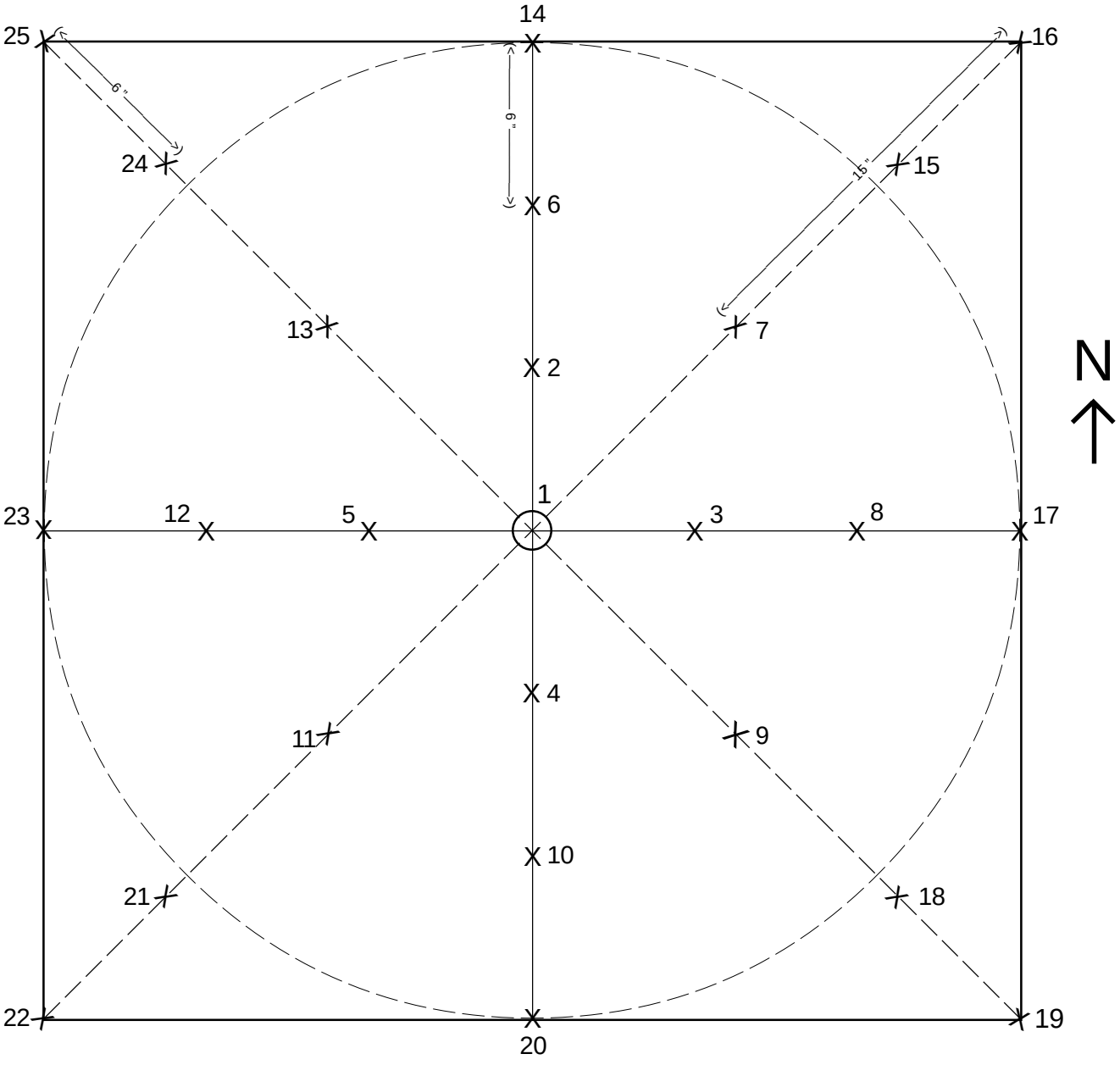
Key: BS = bare soil LM = litter material PL = living plant

1	6	11	16	21
2	7	12	17	22
3	8	13	18	23
4	9	14	19	24
5	10	15	20	25

Total BS _____ x 4 = _____ %

Total LM _____ x 4 = _____ %

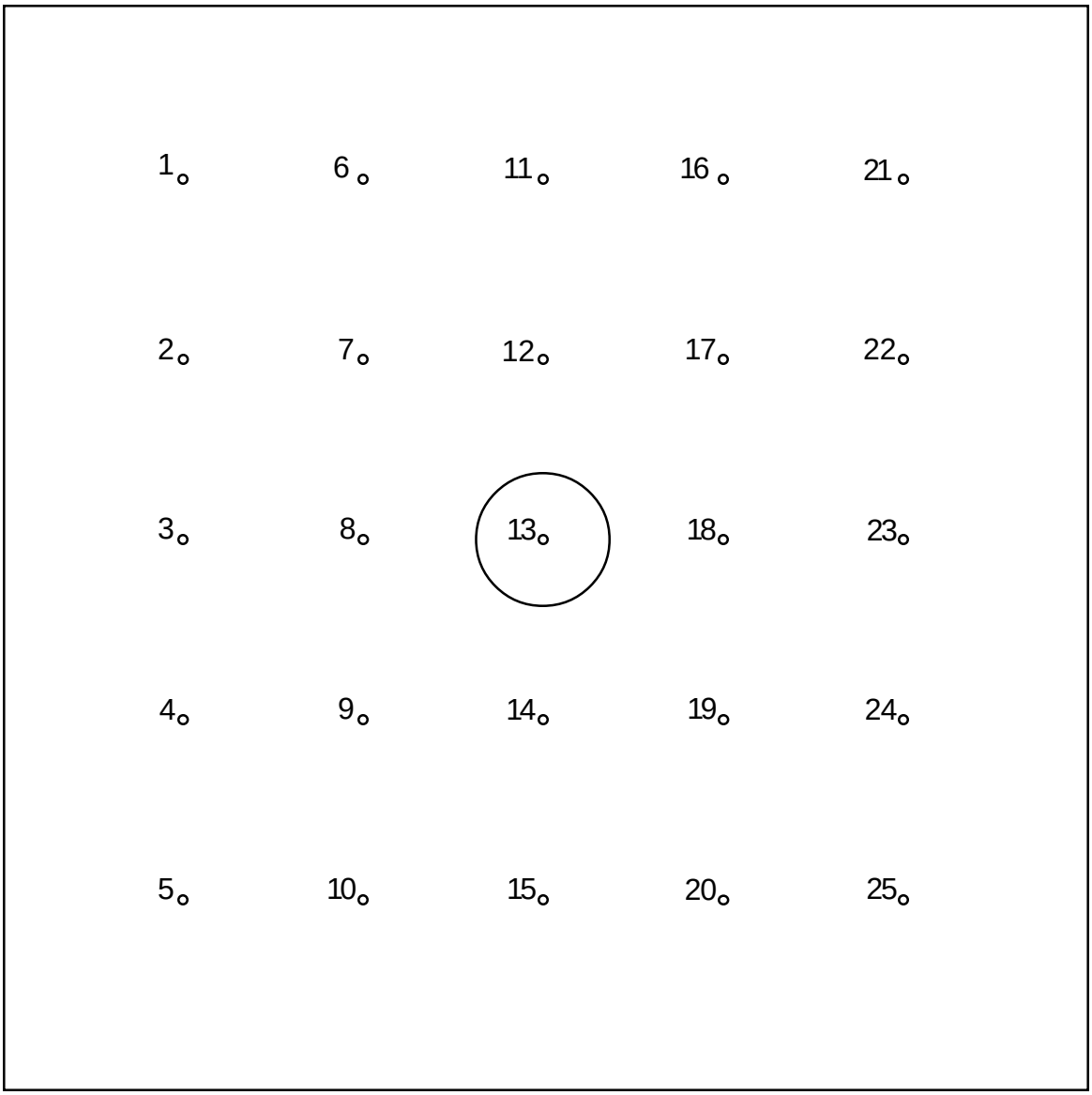
Total PL _____ x 4 = _____ %



Date _____ Count No. _____

Ground Cover Worksheet: Pasture Plate

Site ID & Location _____



Key: BS = bare soil LM = litter material PL = living plant

1	6	11	16	21
2	7	12	17	22
3	8	13	18	23
4	9	14	19	24
5	10	15	20	25

Total BS _____ x 4 = _____ %

Total LM _____ x 4 = _____ %

Total PL _____ x 4 = _____ %

Monitoring Pasture Vegetation

Frame Method Plant Survey Form

Date _____ Count No. _____

Site ID & Location _____

Survey Team _____

Physical Conditons (from the Ground Cover Worksheet)

% Bare Soil _____

% Ground Cover _____

Stand Density _____

General Notes

Photo Yes ☐ No ☐

Plant Species List in order: Grasses Legumes Others	Percent or Number of Plants	Notes	**S**eedling **I**mmature **M**ature **D**ying/Dead **R**esprout	**A**nnual **B**iannual **P**erennial	**C**ool **W**arm **N**ative **T**ame	**D**esirable **U**ndesirable **N**eutral	Indicator species + or —

Monitoring Pasture Vegetation

Tape Method Plant Survey Form

Date _____ Count No. _____

Site ID _____ Survey Team _____

Transect A Photo Yes ☐ No ☐

Foot Mark	Bare Soil	Litter	Plant Species (Grass, Legume, Other)	Stage of Maturity*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
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43				
44				
45				
46				
47				
48				
49				
50				

Transect B Photo Yes ☐ No ☐

Foot Mark	Bare Soil	Litter	Plant Species (Grass, Legume, Other)	Stage of Maturity*
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
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96				
97				
98				
99				
100				

General Notes

**Optional. See the key on the other side of this form.*

Plant Survey Tally Sheet

		Total from Transect A	Total from Transect B	Percent of Total (A + B = %)
Bare Soil				
Litter				
	Stand Density (100 – [% bare soil + % litter])			
Plants (List in order: grasses, legumes, others)	Classification Notes*			

General Notes

*Optional Classification Key

Maturity stage:	**S**eedling, **I**mmature, **M**ature, **D**ying/Dead, **R**esprout
Reproduction:	**A**nnual, **B**iannual, **P**erennial
Season:	**C**ool, **W**arm
Origin:	**N**ative, **T**ame
Desirability:	**D**esirable, **U**ndesirable, **N**eutral
Indicator:	IN**+** or **IN-**

Monitoring Pasture Vegetation

Five-Year Summary Sheet

Count No. _____

Site ID and Location _____

Year 1 ( )	Year 2 ( )	Year 3 ( )	Year 4 ( )	Year 5 ( )
Month/Day	Month/Day	Month/Day	Month/Day	Month/Day
Survey Team	Survey Team	Survey Team	Survey Team	Survey Team
Physical Conditions	Physical Conditions	Physical Conditions	Physical Conditions	Physical Conditions
Bare Soil _____%	Bare Soil _____%	Bare Soil _____%	Bare Soil _____%	Bare Soil _____%
Ground Cover _____%	Ground Cover _____%	Ground Cover _____%	Ground Cover _____%	Ground Cover _____%
Stand Density _____%	Stand Density _____%	Stand Density _____%	Stand Density _____%	Stand Density _____%
Plant Species % of Total	Plant Species % of Total	Plant Species % of Total	Plant Species % of Total	Plant Species % of Total
Notes	Notes	Notes	Notes	Notes
Photo Yes ☐ No ☐	Photo Yes ☐ No ☐	Photo Yes ☐ No ☐	Photo Yes ☐ No ☐	Photo Yes ☐ No ☐

Pasture Clippings Worksheet

Conversion Table*
(decimal equvalants for ounces, rounded to the nearest .00 lb.)

1 oz. = .06	5 oz. = .31	9 oz. = .56	13 oz. = .81
2 oz. = .13	6 oz. = .38	10 oz. = .63	14 oz. = .88
3 oz. = .19	7 oz. = .44	11 oz. = .69	15 oz. = .94
4 oz. = .25	8 oz. = .50	12 oz. = .75	16 oz. = 1.00

Sample ________________ Date ____________

Stand Density ________________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ________________

Wet weight (subsample) B ________________

Test weights

Final dry weight C ________________

% of DM (C divided by B) D ________________

Lbs./a. DM (A x D x 4840) E ________________

Sample ________________ Date ____________

Stand Density ________________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ________________

Wet weight (subsample) B ________________

Test weights

Final dry weight C ________________

% of DM (C divided by B) D ________________

Lbs./a. DM (A x D x 4840) E ________________

Sample ________________ Date ____________

Stand Density ________________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ________________

Wet weight (subsample) B ________________

Test weights

Final dry weight C ________________

% of DM (C divided by B) D ________________

Lbs./a. DM (A x D x 4840) E ________________

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Stand Density ________________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ________________

Wet weight (subsample) B ________________

Test weights

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Lbs./a. DM (A x D x 4840) E ________________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Sample ______________ Date ____________

Stand Density ____________

Forage Height Pasture Plate/Swardstick ____________

Wet weight (1sq. yd.)* A ____________

Wet weight (subsample) B ____________

Test weights

Final dry weight C ____________

% of DM (C divided by B) D ____________

Lbs./a. DM (A x D x 4840) E ____________

Monitoring Pasture Vegetation

Forage Monitoring Record Sheet

Date _____

Location _____

Paddock No. (Size)	Date Last Grazed	Species Mix	Stand Density	Lbs./a. DM	Quality Readings	Comments