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Natural
Resources
Conservation
Service

National Biology Handbook

Aquatic and Terrestrial Habitat Resources

July 2003

DRAFT

Acknowledgments

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Subpart A - General Information

Part 6XX.00 - Introduction

Mission of the NRCS: The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

The focus of this Handbook is biological resources, which include all living things such as fish and wildlife, plants, fungi, and soil microorganisms. The " environment" that NRCS helps people conserve, maintain, and improve is habitat for these biological resources. There is no inch of our environment that is not habitat for some living organism. This maxim is simple to understand. What is not so simple in a complex world of cultures, societies, human needs, and resource economics is how to integrate fish, wildlife, and plant habitat considerations into resource conservation actions. Habitat is everywhere we are asked to go to provide technical assistance in natural resource conservation.

Today, more and more of our environment, and thus habitat, is in poor condition or unsuitable to support diverse fish and wildlife resources. Human land uses tend to simplify, fragment, and degrade habitats and the biological communities that depend on them **(Figure 1)** .

Because we in turn depend on biological resources for food, fiber, and intrinsic values, we are wise to protect, conserve, and improve their conditions.

This Handbook is meant to help conservationists effectively and efficiently integrate the habitat considerations of biological resources into conservation plans for farms, ranches, backyards, city parks, rangelands, streams, rivers, lakes, wetlands, estuaries, and riparian areas. Habitats are components of living landscapes, and their conservation is critical to all living things, including humans. Thus, humans cannot set themselves apart from impacts that result from their conservation decisions.

Habitats are not discrete biological units, nor are farms and ranches. These sites are immersed spatially and temporally into ecosystems and landscapes **(Figure 2)** . Thus, conservation of biological resources requires a holistic approach to planning.

Figure 1: *Poor land management leads to simplification and degredation of habitat at the site and within the broader landscape.*

Figure 2: *Working lands provide habitat at the site and connect habitats to broader landscapes.*

Animals, be they terrestrial or aquatic, move. Their food sources move or are affected by elements in the landscape. Habitats influence and are influenced by the surrounding landscape of which they are a part. Taking landscapes into consideration when planning at a local scale will save the conservationist and the landowner time and money, especially in the long term.

As conservationists providing technical assistance to landowners, we need to play several roles, including natural resource specialist, facilitator, and planning advisor. We need to respect the needs and desires of the landowner, and consider the needs of the biological community within the property and beyond its borders.

We diligently offer technical assistance at a local scale, with the greater landscape in mind. If we think of working lands as habitats, we can better integrate the needs of fish and wildlife with the objectives of landowners **(Figure 3)** . Considering habitat components in an environmental context relevant to humans should be considered when planning at a local scale.

The scope of habitat conservation is large. National Initiatives that focus on biological resources and their habitats include those for Conservation Buffers, Invasive Species, Clean Water and Air, Threatened and Endangered Species, Wetland and Wildlife Habitat Restoration and Conservation, Drought Protection, and Upland Watershed Protection.

The purpose of this Handbook is to provide field office personnel a well-organized and comprehensive compilation of key technical information needed to integrate fish, wildlife, and plant habitat considerations into resource conservation on working lands. Conservation of the biological resources and stewardship of their habitats is everybody's responsibility.

CONSIDER	**Habitat**	**=**	**Environment of Working Land**
	Biotic community		Farm, Ranch, Acreage, Backyard
EVALUATE	Habitat condition, Ecological setting, Food source, Cover	➡	Site uses, Ecosystem, Landscape conditions, Matrix type, Patch size, Connectivity
INTEGRATE	Fish and wildlife needs	**with**	Landowner objectives economics, and capability of the land

Figure 3: *Habitat considerations for fish and wildlife should be linked to environmental conditions of working lands.*

This cannot be carried out without the technical, financial, and regulatory support of our Conservation Partners. For this reason, an entire section (Part 610.2) of this handbook provides information on how to develop partnerships to leverage time and money, and be as effective as possible in delivering fish and wildlife habitat conservation on working lands.

In addition, the Handbook provides a framework to which state-specific technical guidance related to habitat considerations can be incorporated. This Handbook should be used in conjunction with the National Biology Manual, which provides the NRCS policies that guide the management of fish and wildlife resources.

The materials in this Handbook are designed and presented in a format that will provide the conservationist with a consistent and efficient means to determine how to plan and implement habitat-related conservation on the ground, in the environments provided by the working lands of our customers.

Timely transfer of technical resources and guidance to land managers and conservation planners is now easier with the development of online resources. This Handbook will be available online and its contents will be updated periodically to reflect new science and technology associated with managing lands with fish and wildlife in mind.

Part 6XX.01 - Conservation Partnerships

The mission of NRCS is to work on the Nation's non-Federal lands to conserve, improve, and sustain natural resources. The agency emphasizes voluntary, science-based assistance, partnerships, and cooperative problem solving at the community level. In order to carry out its mission, the agency works in partnership with owners and operators of non-Federal lands, providing resource inventories and assessments and conservation planning technical assistance.

One of the four goals identified in the 1996 NRCS publication, *Framework for the Future of Wildlife*, is to use partnerships for delivery and enhancement of quality wildlife planning assistance to NRCS customers.

This document recognized the great potential to use the expertise and resources of numerous fish and wildlife agencies and organizations to enhance the quality of technical assistance that NRCS provides to private landowners and managers. In addition, it recognized the potential for the extensive field network of NRCS conservationists working with farmers and ranchers to advance the goals and objectives of these many fish and wildlife interests.

Development of productive partnerships is the key to maximizing the ability of the NRCS, other fish and wildlife interests, and owners and managers of working lands, to realize fish and wildlife habitat objectives.

NRCS has entered into a wide variety of partnerships at the local, state and national levels that directly or indirectly enhance the agency's ability to foster effective conservation of natural resources on non-Federal lands, including management of fish and wildlife resources. Innumerable additional opportunities exist for new fish and wildlife conservation partnerships to be formed.

A. Why Partnerships?

Partnerships provide an efficient mechanism for an individual or entity to accomplish more than would otherwise be possible if the individual or entity were working alone. Each party brings a unique set of expertise, resources, perspectives, experience, and energy to the partnership, maximizing the effectiveness of achieving common goals.

Successful partnerships are based on mutual understanding, trust, effective communication and collaboration, and shared objectives as shown in Figure 1.

Characteristics of successful partnerships can also be explored by comparing attributes of partnerships that have succeeded with those that have failed or have been ineffective **(Table 1)**.

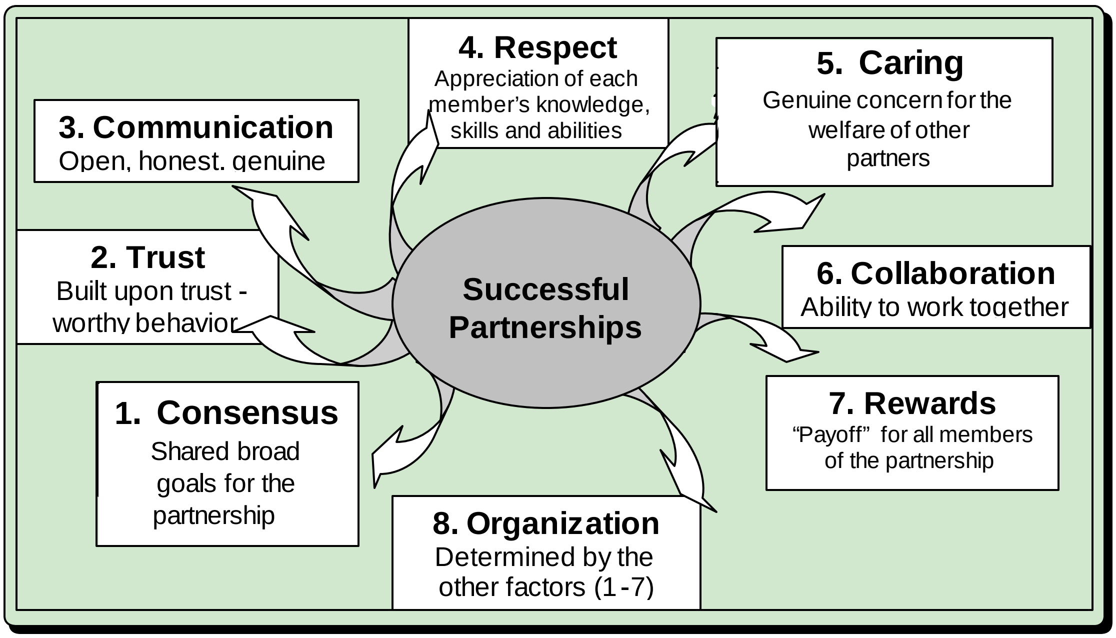


Figure 1: *The foundation for successful partnerships represented by eight primary factors (Adapted from Nebraska Cooperative Extension Publication NF96-262).*

Table 1: *Comparison of attributes of successful and unsuccessful partnerships.*

Successful	Unsuccessful
The development of compatible ways of working, and flexibility	One partner manipulates or dominates
Good communication	Lack of clear purpose
Collaborative decision-making, with a commitment to achieving consensus	Unrealistic goals
Effective organizational management	Differences of philosophy and ways of working
Agreement that a partnership is needed	Lack of communication
Respect and trust among parties	Unequal and unacceptable balance of power and control
Complementary resources	Key interests missing from the partnership
The leadership of a respected individual or individuals	Hidden agendas
Commitment of key interests developed through a clear and open process	Financial and time commitments outweigh the potential benefits
Development of a shared vision for the partnership and what might be achieved	A history of conflict among key interests
Adequate time taken to build the partnership	

There are several primary purposes of NRCS partnerships with other agencies, groups and individuals:

Conservation Planning and Implementation. Providing conservation planning assistance to farmers and ranchers is a primary NRCS field activity. Through partnerships with other entities, planning assistance can be increased and improved by bringing the expertise and resources of partner agencies and organizations into the planning process.

Monitoring Conservation Activities and Projects. Conservation projects are often easily monitored and managed by local partner organizations or individuals. Where partners have a stake in the conservation work accomplished, the quality of follow-up monitoring to ensure conservation goals are met is typically very high.

Project Funding and Implementation. Sharing project costs may be the most recognized partnership purpose. In general, greater conservation accomplishments are possible where several funding sources contribute.

Program Coordination and Delivery. Coordination and delivery of conservation programs presents a significant workload challenge in many areas. Partner agencies and organizations that have a technically sound field presence can greatly assist with this heavy workload while meeting shared conservation objectives.

Technical Assistance. Each partner organization typically possesses a unique area of technical expertise. This expertise can be applied directly or indirectly to NRCS activities through partnerships.

Technology Development. As with technical assistance, the technical expertise of various partner entities can be used to develop technical tools and training programs to improve the quality of technical assistance provided to NRCS clients.

Common Mechanisms used to Forge Partnerships. There are several different types of instruments used to forge conservation partnerships between NRCS and farmers and ranchers, other governmental agencies, private organizations, and other entities. It is important to use the proper instrument in developing partnerships with other entities. **Table 2** provides general guidance on where to use the various types of instruments. Additional guidance should be sought from NRCS contract specialists as appropriate.

B. National Conservation Partnership

A primary mechanism used to deliver technical assistance to non-Federal landowners and operators is the National Conservation Partnership. This partnership is a dynamic relationship between federal,

***Table 2:** Common types of instruments used by NRCS to forge partnerships with other entities to meet fish and wildlife habitat and other conservation objectives.*

Type of Instrument	Use:
Memorandum of Understanding	Provides a plan for joint sharing in the operation of a project or undertaking. Each party carries out its responsibilities by using its own authorities and resources, including funding. No financial or other resources are directly obligated, transferred or exchanged between the parties.
Joint Agreement	Provides structure for parties to share responsibility for planning and carrying out a project or undertaking. Each party is responsible for doing their own part, and each party contributes funds or other tangible resources to the project. Party contribution may not necessarily be equal so long as they carry out their own role. Joint agreements may be with other Federal agencies, state or local governments, and other entities and individuals.
Contribution Agreement	A relationship in which one or more non-federal party contributes funds or other resources to NRCS so NRCS can accelerate an ongoing activity.
Interagency Agreement	Joint or cooperative ventures in which each agency contributes to part of the cost of a project or undertaking, with funding separated and each agency's responsibilities spelled out. Each participating agency must have a program authority for the undertaking.
Grants	Reflect a relationship between NRCS and a State, local government, or other recipient where the purpose is to transfer a thing of value to a recipient in order to gain public support or stimulation authorized by Federal law and substantial Federal involvement **is not** anticipated.
Cooperative Agreements	Reflects an assistance relationship between NRCS and a State, local government, or other recipient where the purpose is to transfer a thing of value to a recipient in order to gain public support or stimulation authorized by Federal law and substantial Federal involvement **is** anticipated.

For additional information on the use of these instruments and other related subjects (e.g., contracts), refer to NRCS General Manual, Title 120 Administrative Services.

state, and nonprofit groups that have pledged to jointly provide national conservation leadership. The Partnership was formalized in January 1993 when three conservation leaders signed a national agreement, pledging to work together for natural resource conservation. A fourth partner was added in 1997. Independently, partnership members have separate responsibilities for sustaining the environment and conserving the nation's natural resources.

As partners in conservation, they speak with a unified voice and act to realize a common vision: a productive nation in harmony with a quality environment (Table 3).

The national conservation partnership involves:

Listening and responding to customers' local resource conservation needs,

Fostering economically viable environmental policies,

Advocating a total natural resources approach to conservation, and

Maintaining and advocating grass roots conservation delivery systems.

C. Other Partnerships

While the National Conservation Partnership strives to address a broad range of natural resource conservation issues on non-Federal lands, the agency is engaged in numerous other partnerships to effectively address the full range of issues necessary to carry out its mission. Along with individual owners and operators of non-Federal lands, NRCS' conservation partners also include:

- Conservation districts
- Local communities
- State and federal agencies
- Native Hawaiians, Alaskans, and Tribes
- Agricultural and environmental groups
- Conservation organizations
- Professional societies
- NRCS Earth Team volunteers
- RC&D councils
- Watershed councils and associations
- Agribusiness
- Schools and universities

Fish and Wildlife Habitat Partnerships

Many partnerships are developed either for the purpose or have the potential of benefiting fish and wildlife resources on private lands. Partnerships have been developed around funding and delivery of specific programs, such as agreements with state agencies to implement Conservation Reserve Enhancement Programs, as well as around more generic technical assistance objectives.

Opportunities for partnerships identified by fish and wildlife interests outside NRCS (adapted from Framework for the Future of Wildlife) include:

- Sharing employees through details

Table 3: *The National Conservation Partnership.*

Conservation Partnership Member	Conservation Partnership Role
NRCS	As the federal agency with the lead in assisting the American people to conserve natural resources on private lands, NRCS brings over 60 years of scientific and technical expertise to the partnership.
National Association of Conservation Districts (NACD)	NACD is the national organization for 3,000 local conservation districts across the country. Conservation districts are local units of government responsible for the soil and water conservation work within their boundaries. The districts' role is to increase voluntary conservation practices among farmers, ranchers and other land users.
National Association of State Conservation Agencies (NASCA)	NASCA is a coalition of state conservation agencies across the country. These agencies provide guidance and funding for conservation districts. They operate numerous state environmental, sediment control, and soil erosion prevention programs.
National Association of Resource Conservation and Development Councils (NARC & DC)	NARC&DC provides a collective voice for more than 300 local Resource Conservation and Development Councils nationwide. The NARC&DC serves as an advocate and assists local councils to identify and take action on issues and opportunities to improve the quality of life and environment in their communities. Local RC&D Councils are grass-roots community leaders working collectively on behalf of conservation and sustainable development.

and interagency personnel agreements (IPAs)

- Recruiting new partners from diverse sectors, including corporations and industry
- Increasing networking through workshops and demonstration projects
- Developing agreements based on funding and donation of time and materials
- Nurturing results-oriented partnerships through embracing the various motives, resources and objectives of parties
- Soliciting partner input of information into the NRCS Technical Guide
- Serving on State Technical Committees to engender field input
- Conducting region-specific technical meetings and retreats

- Inviting partners to assist in training NRCS personnel on fish and wildlife issues.

Examples of broad-based fish and wildlife partnerships follow.

North American Waterfowl Management Plan (NAWMP)

The North American Waterfowl Management Plan (NAWMP) was launched in 1986 with the signing of an agreement between the United States and Canada. Mexico joined the program in 1988. The Plan provides a policy framework for analyzing North American waterfowl issues. It sets out a number of objectives relating to waterfowl habitat and populations, with a focus on conserving and expanding wetland areas.

NAWMP is based on the principle of joint ventures that serve as a framework for the activities of its private and regional member agencies. These partners coordinate their efforts in the pursuit of common objectives for waterfowl protection in each region, province or state. The goals of NAWMP extend beyond waterfowl to include all wetland wildlife resources.

North American Bird Conservation Initiative (NABCI)

The vision of NABCI is to see populations and habitats of North America's birds protected, restored and enhanced through coordinated efforts at international, national, regional, state and local levels, guided by sound science and effective management. NABCI-US seeks to accomplish this vision through:

- Broadening bird conservation partnerships
- Working to increase the financial resources available for bird conservation in the U.S. and wherever these birds may occur throughout their life cycle
- Enhancing the effectiveness of those resources and partnerships by facilitating integrated bird conservation.

The efforts of NABCI are intended to integrate the bird conservation work associated with implementation of the NAWMP, the U.S. Shorebird Conservation Plan, the North American Colonial Waterbird Conservation Plan, and Partners in Flight. Productive and creative conservation partnerships are the fuel that drives all of these efforts.

Partners in Amphibian and Reptile Conservation (PARC)

The mission of PARC is to conserve amphibians, reptiles, and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/ private partnerships. PARC represents the most diverse group of individuals and organizations ever to work together to address problems confronting reptiles and amphibians on a national and global scale.

To maintain this strength, and to enhance it in the future, membership in PARC is open to all persons, businesses, and organizations that share a commitment to herpetofaunal conservation through cooperative means, and who can bring resources to PARC in support of this objective.

North American Bat Conservation Partnership (NABCP)

The North American Bat Conservation Partnership is a program to promote more effective protection of bats and their habitats through the collaboration of bat researchers, private organizations and foundations, corporations, and government agencies in Mexico, Canada, and the United States.

The NABCP seeks to develop, through its partners:

- A continental strategy for bat conservation
- Improved conservation efforts through increased communication
- Efficiently delivered resources and matching funds for bat-related projects in the field.

National MOU's

NRCS has entered into Memoranda of Understanding (MOU) with fish and wildlife organizations at the national level to formalize the productive working partnership it shares with these entities. These MOU's establish the general framework of cooperation between the parties to foster better conservation and fish and wildlife management on private lands. Copies of national MOU's are filed as exhibits in the National Biology Manual.

The following pages contain National fish and wildlife-oriented partner organization names and contact information. As of July 2003, NRCS has national MOU's with entities identified with and asterisk.

Partner Name	Address, Telephone Number, Web Site
American Fisheries Society	5410 Grosvenor Lane, Suite 110 Bethesda, MD 20814-2199 (301) 897-8616 www.fisheries.org
Bat Conservation International *	Post Office Box 162603 Austin, TX 78716 (512) 327-9721 www.batcon.org
The Conservation Fund	1800 N. Kent Street, Suite 1120 Arlington, VA 22209-2156 (703) 525-6300 www.conservationfund.org
Ducks Unlimited *	One Waterfowl Way Memphis, TN 38120 (901) 758-3825 www.ducks.org
International Association of Fish and Wildlife Agencies	444 North Capitol Street, NW, Suite 544 Washington, DC 20001 (202) 624-7890 www.iafwa.org
National Audubon Society **	700 Broadway New York, NY 10003 (212) 979-3000 www.audubon.org
National Association of Conservation Districts *	509 Capitol Court, NE Washington, DC 20002-4946 (202) 547-6223 www.nacdnet.org
National Fish and Wildlife Foundation *	1120 Connecticut Avenue, NW, Suite 900 Washington, DC 20036 (202) 857-0166 www.nfwf.org
National Wild Turkey Federation *	PO Box 530 Edgefield, SC 29824 (803) 637-3106 www.nwtf.org

* National MOU with NRCS
**National MOU with NRCS in development

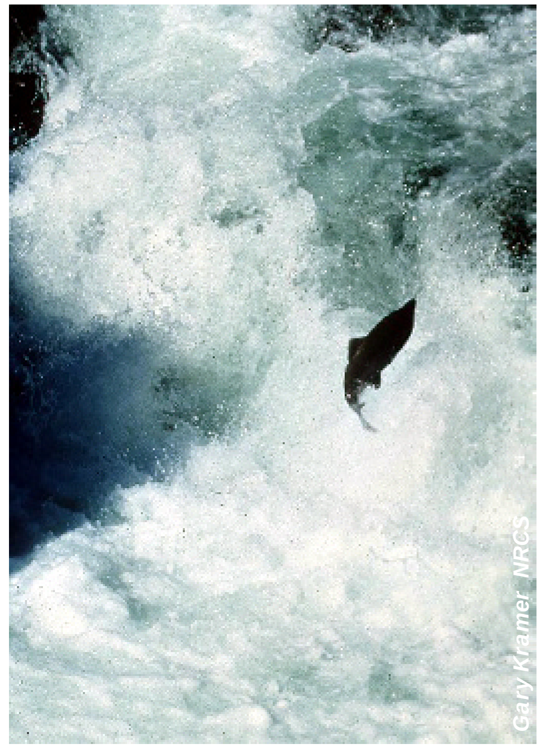
Partner Name	Address, Telephone Number, Web Site
National Wildlife Federation	8925 Leesburg Pike Vienna, VA 22184 800-332-4949 www.nwf.org
Pheasants Forever *	1783 Buerkle Circle St. Paul, MN 55110 (651) 773-2000 www.pheasantsforever.org
Quail Unlimited **	31 Quail Run, P.O. Box 610 Edgefield, SC 29824 (803) 637-5731 www.qu.org
Rocky Mountain Elk Foundation *	2291 W Broadway, P.O. Box 8249 Missoula, MT 59807 (406) 523-4500 www.rmef.org
Society for Range Management	445 Union Blvd., Suite 230 Lakewood, CO 80228 (303) 986-3309 www.srm.org
The Nature Conservancy	4245 North Fairfax Drive, Suite 100 Arlington, VA 22203-1606 (800) 628-6860 www.nature.org
The Wildlife Society*	5410 Grosvenor Lane Bethesda, MD 20814 (301) 897-9770 www.wildlife.org
Trout Unlimited **	1500 Wilson Boulevard, Suite 310 Arlington, VA 22209-2404 (703) 522-0200 www.tu.org
Wildlife Habitat Council *	8737 Colesville Road, Suite 800 Silver Spring, MD 20910 (301) 588-8994 www.wildlifehc.org

* National MOU with NRCS
**National MOU with NRCS in development

Partner Name	Address, Telephone Number, Web Site
Wildlife Management Institute *	1101 14th Street, NW, Suite 801 Washington, DC 20005 (202) 371-1808 www.wildlifemanagementinstitute.org
Examples of Regional Partnerships Include:	
Point Reyes Bird Observatory	4990 Shoreline Highway Stinton Beach, CA 94970 (415) 868-1221 www.prbo.org
Rocky Mountain Bird Observatory	14500 Lark Bunting Lane Brighton, CO 80603-9311 (303) 659-4348
Manomet Center for Conservation Sciences	81 Stage Road, P.O. Box 1770 Manomet, MA 02345 (508) 224-6521 www.nmnh.si.edu/BIRDNET
California Waterfowl Association	4630 Northgate Blvd, Suite 150 Sacramento, CA 95834 (916) 645-1406 www.web-stat.com
Alabama Waterfowl Association	1346 County Road #11 Scottsboro, AL 35768 (256) 259-2509 www.alabamawaterfowl.org
Minnesota Waterfowl Association	3750 Annapolis Lane, Suite 135 Plymouth, MN 55447 (763) 553-2977 www.mnwaterfowlassociation.org

* National MOU with NRCS
**National MOU with NRCS in development

Part 6XX.02 - Training Opportunities



Learning, for most, is a lifetime pursuit. Opportunities to acquire additional knowledge come in a number of ways. Spending time in the field and working with cooperators and fellow resource professionals is often a primary source of continuing education. Often referred to as " on-the-job" training, locating and using local resource professionals, land managers, and agency colleagues, can be a primary source of accessing new information.

At times, individuals may seek more advanced information in a particular area that is not available through local sources. This section is intended to offer direction to those looking to gain additional training in the area of Biological Resources. Most of the training resources mentioned in this section can be accessed on the World Wide Web. Keep in mind that there are myriad local and regional training opportunities provided through local conservation districts, producer groups, environmental organizations, as well as local community colleges, state colleges and universities.

State Government

Many state and territorial fish and game agencies have training for their employees. Those sessions are often accessible to resource professionals who work in that particular location.

Some examples of training opportunities available in most states include training in water resources, forestry, parks and recreation, conservation, and land management.

Individual states and territories can be accessed through the International Association of Fish and Wildlife Agencies' website:

http://www.iafwa.org/documents/state_and_provinces_website_links.htm

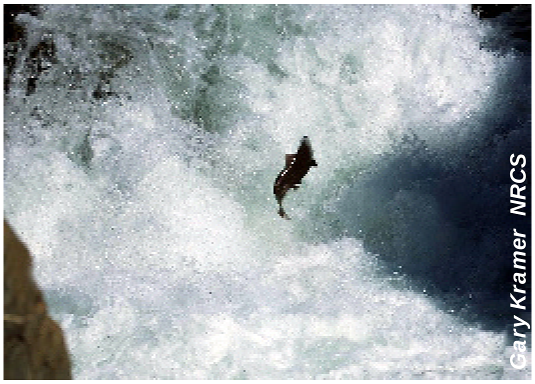
A growing number of Colleges and Universities now offer courses referred to as Distance Education through the Internet. Virtually any institution of higher leaning with natural resources courses is likely to offer training through distance education. Training in Fisheries and Wildlife can be accessed through the National Association of University Fisheries and Wildlife Programs.

Additionally, specific offerings from selected Universities are provided:

- **Oregon State University**

Organization Name	Web Site
Natural Resources Conservation Service	http://www.nrcs.usda.gov/
Bureau of Land Management	http://www.blm.gov/nhp/index.htm
US Fish and Wildlife Service	http://www.fws.gov/
United States Geological Survey	http://www.usgs.gov/
US Army Corp of Engineers	http://www.usace.army.mil/
National Oceanic & Atmospheric Administration	http://www.noaa.gov/
National Marine Fisheries Service	http://www.nmfs.noaa.gov/
National Riparian Service Team	http://www.or.blm.gov/nrst/
Environmental Protection Agency	http://www.epa.gov/enviroed

- **Colorado State University**
- **University of Missouri**
- **Pennsylvania State University**



Excellent sources of training are local, state, regional, and national sections or chapters of Professional Societies or Associations. Examples of those offering certification and training are:

- **American Fisheries Society**
- **The Wildlife Society**
- **Society for Ecological Restoration**
- **Society of Wetland Scientist**
- **Ecological Society of America**
- **Society for Range Management**
- **Society for Conservation Biology**
- **Xerces Society**

Other examples of accessible training can be located through the local state Native Plant Society. Virtually every state has state and local chapters. An example is offered with the South Carolina Native Plant Society.

Private and Non-Profit Organizations

There are training opportunities offered from a wide array of private and not for profit organizations. The Natural Resources Conservation Service has Memoranda of Agreements with a number of the organizations that provide training.

Bat Conservation International

National Audubon Society

Other locations for training opportunities are:

Bird Observatories:
Point Reyes, Alaska, Cape May, Idaho, Great Basin, Whitefish Point.

Natural History Museums:
Arizona-Sonora Desert Museum, High Desert Museum, Illinois State Museum.

Most of the training resources listed are directly related to Aquatic and Terrestrial Biological topics. An expansion of the topic area include associated ecological processes or natural resource disciples would, of necessity, create a much broader are, in which, to search further for training to meet your needs.

Part 6XX.10 - Ecological Principles for Resource Planners

A. Ecosystems and Landscapes

An ***ecosystem*** is a biological community, or assemblage of living things, and its physical and chemical environment. The interactions between the biotic and abiotic components of ecosystems are intricate. When we consider the social, cultural, economic and political realities of our modern world and the complex, multi-dimensional nature of ecosystems, conservation of natural resources can be daunting.

Often fish, wildlife and plants are dependent upon several ecosystems within broader ***landscapes*** For example, migratory birds, butterflies and salmon use different ecosystems that traverse political boundaries (often thousands of miles apart), during phases of their life cycles. Conservation of these migratory species creates land management challenges that can only be adequately addressed at the landscape scale. ***Landscape ecology*** considers principles about the structure, function and changes of interacting ecosystems in natural resource conservation and planning (Forman and Godron 1986).

Dynamic processes occurring over multiple scales of time and space determine the physical and biological characteristics of our landscapes. These include:

1. Geomorphological processessuch as erosion,

2. Natural disturbancessuch as fires, floods, and drought,

3. Human ***perturbations***such as land clearing and urban development, and

4. Changes in the make-up of biological communities, from days to millions of years.

In order to implement effective conservation practices that take into consideration the often extensive migratory paths of species, we need to think broader than the project site and longer than the project time. Even a cursory evaluation of landscape conditions and their ecological and cultural history provides a valuable context when considering fish and wildlife resource concerns. This can lead to a better understanding of how large-scale processes affect individual parcels of land and the habitats they provide, and how actions on small pieces of land can influence ecological processes and biodiversity at broader scales.

" An ecosystem is a tapestry of species and relationships. Chop away at a section, isolate that section, and there arises the problem of unraveling."

David Quammen, *The Song of the Dodo.*

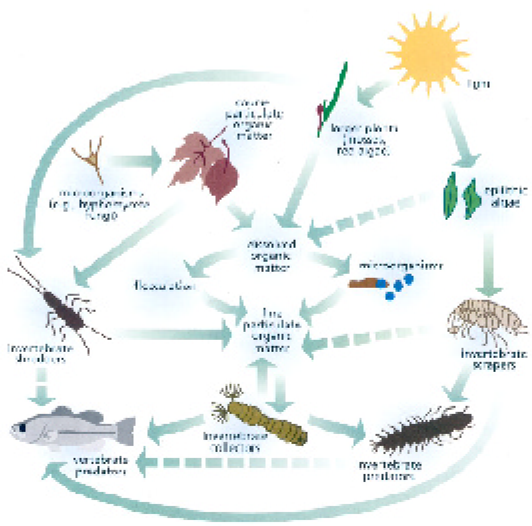


Figure 1. *The Aquatic Food Web. From: Stream Corridor Restoration - Principles, Processes, and Practices.*

B. Ecosystem Processes

1. Energy Flow

Energy flows through and fuels ecosystems and all living things. Virtually all energy originates from the sun. Organisms can be grouped into food chains, or more complex food webs, according to the ***trophic level*** that represents where they obtain energy from their environment as shown in Figures 1 and 2.

Green plants are ***autotrophs***, or primary producers. They use solar energy for photosynthesis, combining atmospheric carbon dioxide and water into high-energy carbohydrates such as sugars, starches, and cellulose (see *Carbon Cycle* on page 6XX.10-5).

Animals are ***heterotrophs***; they derive their energy from the carbohydrates stored within plants. Heterotrophs can be herbivores or carnivores. Herbivores, or ***primary consumers***, obtain their energy by directly consuming plants. Carnivores, or *secondary consumers*, derive their energy by consuming herbivores and other carnivores. Animals that eat both plants **and other animals are referred to as *omnivores***. Food chains or webs end with ***decomposers***, usually bacteria and fungi, that re-cycle nutrients from dead or dying plants and animals of higher trophic levels.

The amount of energy available to organisms at different trophic levels declines as it moves through an ecosystem. Thus, more energy is available to support plants than herbivores and even less to support carnivores. As a rule of thumb, only about 10 percent of the energy that flows into a trophic level is available for use by species in the next higher level.

For example, if green plants are able to convert 10,000 units of energy from the sun, only about 1,000 units are available to support herbivores and only about 100

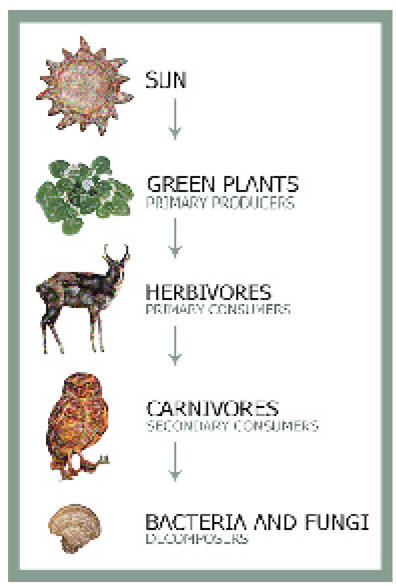


Figure 2. *The Terrestrial Food Chain.*

From a habitat management standpoint, the sources of available energy at each trophic level affect the mix of species in an ecosystem, their populations, and how they interact.

to support carnivores. Energy is lost primarily in the form of heat along the food chain.

2. Water and Nutrient Cycles

Chemicals such as water, carbon, nitrogen, and phosphorus are critical to life. Unlike energy that flows through an ecosystem, these materials are cycled, and reused rivers are said to "spiral" instead of cycle as they do on land.

Nutrient spiraling is a concept that explains the directional transport of nutrients in streams and rivers, rather than closed *nutrient cycles* associated with terrestrial ecosystems. All of these important processes provide elements that are essential to all living things, and all are powered by energy. Thus, human actions that disrupt or alter energy flow in ecosystems also affect water and nutrient dynamics in those systems.

The water, or ***hydrologic cycle*** (Figure 3), has two phases: the uphill phase driven by solar energy, and the downhill phase, which supports ecosystems.

Most rainfall comes from water evaporated from the sea by solar energy (uphill phase). In fact, about one-third of the solar energy reaching the earth's surface is dissipated in driving the hydrologic cycle.

Approximately 80 percent of rainfall recharges surface and groundwater reservoirs and only 20 percent returns to the sea. As water moves through ecosystems

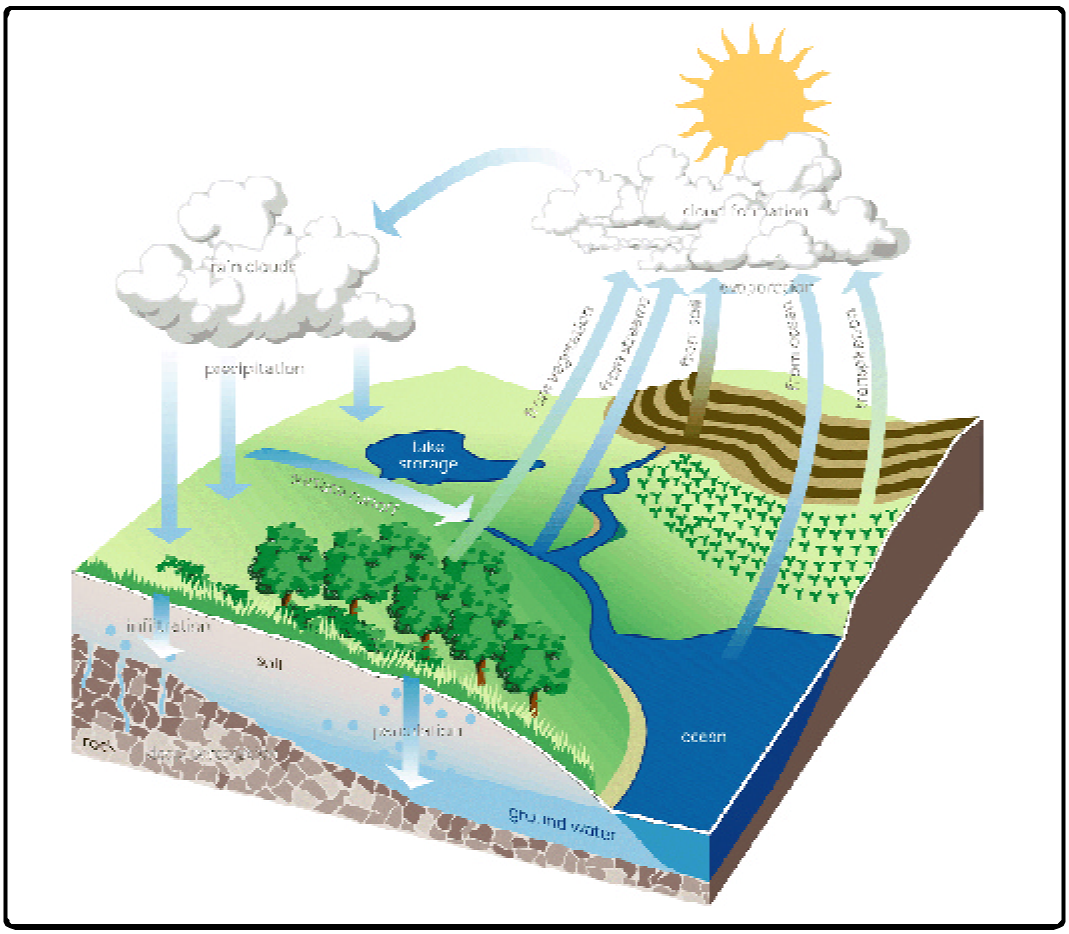


Figure 3. *The Hydrologic Cycle. From: Stream Corridor Restoration - Principles, Processes, and Practices.*

(downhill phase), it shapes the physical structure of the landscape through erosion and deposition. It also affects the distribution and abundance of living things as it regulates availability of nutrients in soil that must be dissolved by water to be utilized by plants. Soil is thus an essential component in the water cycle.

The water cycle links the land to aquatic ecosystems where the flow rate and nu-

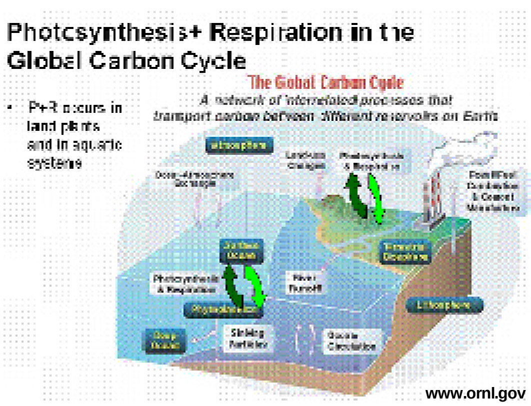


Figure 4. *The Carbon Cycle and its effect on the earth's atmospere.*

trient levels determine the make-up of their biological communities. Carbon dioxide (CO_2) in the Earth's atmosphere, and that which is dissolved in water, serves as the reservoir of inorganic carbon from which most carbon compounds used by living things are derived. During photosynthesis, plants use CO_2 to manufacture carbon compounds such as glucose and lignin, thus beginning the ***carbon cycle***

During plant respiration, some CO_2 is released back into the atmosphere, but much is stored in the plant tissues, or sequestered, until the plants die. Human activities, including the burning of fossil fuels and clearing of forests, have increased the amount of CO_2 in the atmosphere. A "greenhouse effect" results as CO_2 increases the amount of heat absorbed from the Earth and is radiated back again (Fig-

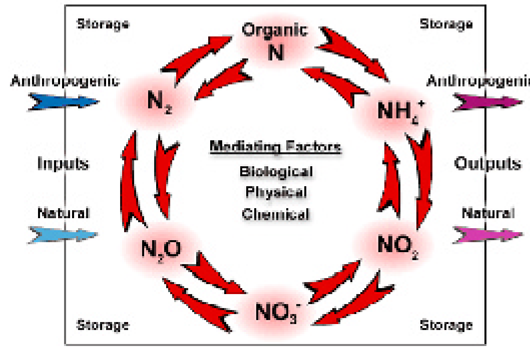


Figure 5. *The Nitrogen Cycle.*

ure 4).

One of the most biologically important elements for living things is nitrogen, which constitutes about 78 percent of Earth's atmosphere as nitrogen gas (N_2). Although important, nitrogen gas is virtually unusable by all but a few living things.

The ***nitrogen cycle***(Figure 5) is dependent on bacteria and algae in soil and

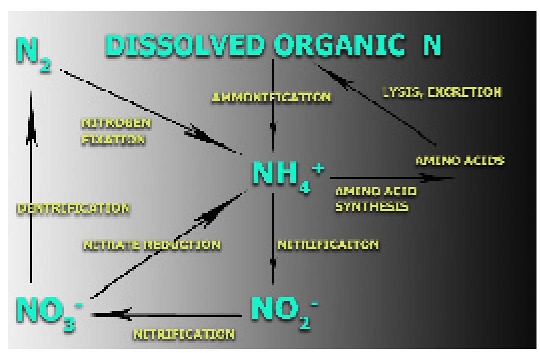


Figure 6. *Nitrogen pathways on working lands.*

water capable of using atmospheric nitrogen to synthesize or fix nitrogen. The resulting nitrogen-containing compounds can then be used by higher plants and animals. Some legumes and other plants fix nitrogen through bacteria that live in specialized nodules on their roots. Nitrogen stored in plants is available to plant-eating heterotrophs. As animals die or are consumed by other organisms, the nitrogen eventually enters the soil where denitrification returns it to the atmosphere (Figure 6).

In the ***phosphorus cycle***, plants and bacteria take up phosphorus from soil. Phosphorus is required for energy transformations within the cells of organisms. Animals obtain it from plants and other animals. Phosphorus returns to an ecosystem's reservoir through excretion and decomposing organic tissue of both plants and animals.

C. Ecosystem Structure and its Relation to Ecosystem Function

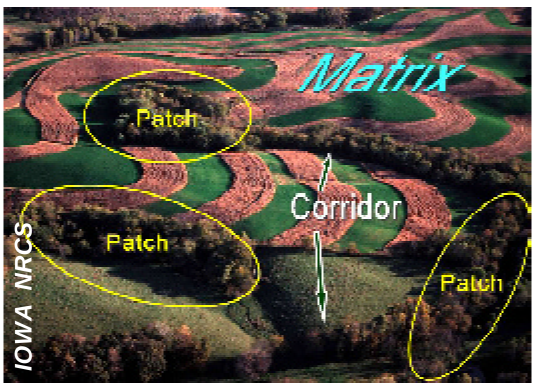


Figure 7. *Landscape elements: patch, matrix and corridor.*

The physical structure of ecosystems varies according to climatic patterns, soil types, soil qualities, disturbance patterns, geologic events, biological interactions, and human perturbations. Individual ecosystems of a landscape can be thought of as patches or corridors within a matrix where flow of energy, materials and species occurs (Figure 7). The components of ecosystems such as animals, plants, biomass, heat energy, water, and mineral nutrients are heterogeneously distributed among patches or corridors that vary in size, shape, number, type, and configuration.

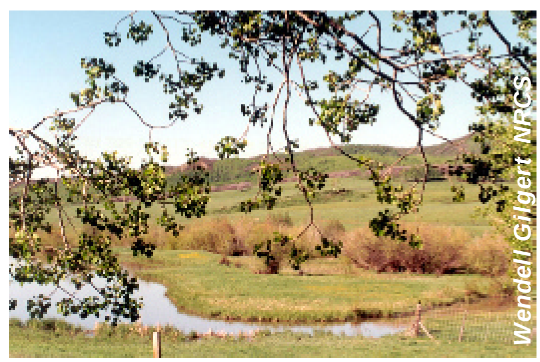
D. Ecosystem Changes and Disturbance

1. Stability in Ecosystems

Many of the ecosystems we are familiar with have changed dramatically over the last 10,000 years. For example, following the last glacial period, North America has become increasingly arid and deserts now occupy areas that were once coniferous forests. Ecosystems and their processes may appear static to us because our familiar frame-of-reference is a short-term human life span.

In reality, ecosystems are in a constant state of flux. The stability and health of ecosystems is a human concern. We

Maintaining natural disturbance patterns to the extent possible, or mimicking their function through management actions, are important considerations for fish and wildlife habitat management.



measure this stability by the resilience to natural disturbances or human perturbations. Natural disturbances are important for maintaining many ecosystem processes and thus biological communities. They can also wreak havoc on infrastructure and human economies. Human perturbations, on the other hand, may disrupt the functions and structure that sustain ecosystem processes and the " goods and services" they provide.

Natural disturbances such as fire, floods, hurricanes, and tornadoes all affect and change ecosystems. They may significantly alter the existing community of plants and animals, making conditions favorable to other species, including alien invasive species. The community progresses through a series of overlapping, successive steps that provide habitat for different species. Over time succession may lead back to an ecosystem similar to the original. However, if there have been climatic changes or new species have moved into the area, the biological community may be significantly different. Fire is one of the most important

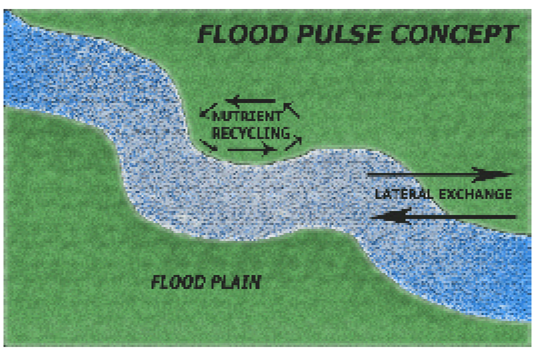


Figure 8. *Flood Pulse Concept.*

natural disturbances because of its high frequency and the extent of area it affects. Where fire is frequent, plants and animals have adapted to it. In fact, the seeds of many plant species lie dormant in the soil waiting for a fire event to release nutrients and provide sunlight that was once blocked by the previous canopy of vegetation. Fire and other natural disturbances create a diversity of habitats within the landscape.

In river and stream ecosystems, recurring floods are critical to sustained production of fisheries, floodplain forests, wetlands and riparian habitat. Rivers and streams derive most of their biomass from within

Figure 9. *Rock and timber revetment on the Willamette River, Oregon.*

the floodplain and their biological communities are dependent on lateral exchanges of water, sediments, and nutrients between the floodplain, the riparian area, and river channel (Figure 8).

Aquatic species move into the floodplain at rising and high-water levels because of feeding and spawning opportunities; terrestrial animals along the rivers then exploit the available food sources that result from receding waters. Dams, dikes, and extensive revetments along rivers have significantly reduced the function of flooding in sustaining ecosystem processes in large rivers (Figure 9).

Ecosystems are dynamic and change is the normal course of events. Change in vegetation structure often creates a more diverse or *heterogeneous* array of habitats for terrestrial wildlife. Many past man-

agement decisions, such as fire suppression and flood prevention, are predicated on the notion that ecosystems are and should remain static over time. From a fish and wildlife standpoint, this has tended to simplify habitats, disconnect the flow of nutrients, and isolate populations. This has led to a loss of habitat for fish and wildlife.

Any land use that severs connections or prevents migration of individuals within a population can affect flow of genes and thus, genetic diversity.

E. Biological Diversity

1. A Hierarchy of Diversity

Biological diversity or ***biodiversity*** is " the variety and variability among living organisms and the ecological complexes in which they occur."

Biodiversity is organized hierarchically, beginning with the genetic diversity of individual organisms and ending with the diversity of ecosystems available in landscapes (Noss, 1990) (Table 1). Biodiversity includes the full range of species, from viruses to plants and animals. It includes the genetic diversity within a species and the diversity of ecosystems in which a community of species exists. Land management goals that include conservation of biodiversity require that we make decisions over spatial scales that are much larger than individual parcels of land.

A ***species*** is a group of individuals that are morphologically, physiologically, or biochemically distinct. In addition, they have the potential to breed among themselves and do not normally breed with individuals of other groups. Species that range over wide geographical areas often are divided into ***subspecies*** if their morphological characteristics vary enough to make them distinctive.

A ***population*** is a group of individuals of the same species that share a common gene pool. This means they are in close enough proximity to each other to potentially interbreed, although they often do not. Populations of many species have wide distributions and to a greater or lesser extent are geographically isolated from each other by physical barriers or distance. A population of frogs in a small pond is isolated from a population of frogs in another pond many miles away. The probability that the two populations will interbreed is low.

A ***metapopulation*** is the collective group of discrete populations of a species across a landscape upon which the species' continued existence depends. For example, a natural disturbance such as fire may cause a local extinction of a population of deer. The existence of other populations in a landscape that allows their dispersal will increase the chances that the species will eventually recolonize the burned area as it recovers.

Genetic diversity among individuals of a population allows for greater flexibility of a species to adapt to changing environmental conditions. For example, genes of one population may offer resistance to a disease that members of another population do not have. If the disease eliminated the other population(s), the resistant group serves as a source for re-establishment of populations in other areas.

Some populations may go extinct on a local scale and new populations may become established on nearby suitable sites. The close proximity of another population of the same species allows colonization of a disturbed site following natural distur-

Table 1. *Indicators of biodiversity at four levels of organization (after Noss, 1990).*

Organizational Level	Compositional Factors	Structural Indicators	Functional Indicators
Landscape	Identity, distribution, richness, and proportions of patch (habitat) types; collective patterns of species distributions (richness, edemism)	Heterogeneity; connectivity; spacial linkage; patchiness; porosity; degree of fragmentation; juxtaposition; perimeter-area ratio; pattern of habitat layer distribution	Disturbance processes; nutrient cycling rates; energy flow rates; patch persistence and turnover rates; rates of erosion and deposition; human land-use trends
Community - Ecosystem	Disturbance processes; nutrient cycling rates; patch persistence and turnover rates; rates of erosion and deposition; human land-use trends	Substrate and soil variables; slope and aspect; vegetation biomass; foliage density and layering; horizontal patchiness; canopy openness and gap proportions; abundance, density, and distribution of key physical features (e.g. cliffs, outcrops, sinks) and structural elements (snags, down logs); water and resource (e.g. mast) availability; snow cover	Biomass and resource productivity, herbivory, parasitism, and predation rates; colonization and local extinction rates; patch dynamics (fine-scale disturbance processes), nutrient cycling rates; human intrusion rates and intensities
Population - Species	Absolute or relative abundance; frequency; importance or cover value; biomass; density	Dispersion; population structure (sex ratio, age ratio); habitat variables (see Community - Ecosystem structure above	Demographic processes (fecundity, recruitment rate, survivorship, mortality); metapopulation dynamics; population genetics (see below); population fluctuations; physiology; life history; growth rate (of individuals); adaptation
Genetic	Allelic diversity; presence of particular rare alleles, deleterious recessives, or karyotypic variants	Effective population size; heterozygosity; chromosomal or phenotypic polymorphism; generation overlap; heritablility	Inbreeding depression; outbreeding rate; rate of genetic drift; gene flow; mutation rate; selection intensity

bance or human perturbation. For example, when converting wetlands to agriculture many species are extirpated from the area. However, when these sites are restored, adjacent populations serve as seed and emigration sources.

A ***biological community*** is an assemblage of populations of many different species. Within the biological community each species uses resources that constitute its ***niche***. For example, a niche for a bird includes where it nests, what it feeds on, how it obtains water, where it migrates, and even its daily time of activity.

When managing for a single species, it is important to understand it's role in the biological community, and how it interacts with the assemblage of other species that are part of its ecosystem. Community composition is often affected by predator-prey interactions and competition among species. Predators can dramatically reduce the numbers of herbivore species. This alters the trophic structure of the entire community. Reduction in one herbivore species will lessen consumption of specific plants within the community and may allow another species to use the resource and increase its population size.

Predators can also increase the biological diversity and individual species numbers of an area. For example, coyotes control mid-size predators such as foxes and cats that prey on songbird populations. A reduction in foxes and cats allows songbird numbers and diversity to increase.

2. Species Interactions

Within biological communities, thousands of species of organisms interact. We may consider some species more "valuable" because their presence is critical to the ability of other species to persist in the community.

Black-tailed Prairie Dog.

Many other wildlife species depend on the unique habitat created by the foraging and burrowing activities of prairie dogs. They also serve as an important food base for many predators, including ferruginous hawks and other raptors at certain times of the year (migration and nesting season). Mammalian predators include badgers, coyotes, bobcats, and foxes. The most endangered mammal in North America, the black-footed ferret, relies exclusively on prairie dogs for food and their burrow systems for cover. The burrowing owl uses abandoned tunnel systems for nesting. Mountain plovers and horned larks prefer the mosaic of bare ground-short grass habitat maintained by prairie dog activities. Rattlesnakes and other reptiles, rabbits, hares, and small mammals are drawn to the food and cover associated with prairie dog towns.

Keystone species are those that have an ecological function that other species and components of the ecosystem depend on. The black-tailed prairie dog is an example of an organism considered by many to be a keystone species of the shortgrass prairie ecosystem.

Indicator species are species whose presence indicates a particular state or condition of an ecosystem. For example, we often assess stream conditions by monitoring the presence of aquatic insects such as mayflies, stoneflies, and caddisflies. In stream ecosystems, these species serve as indicators of water quality and good coldwater habitat.

F. Applying Ecological Principles to Habitat Conservation, Restoration, and Management.

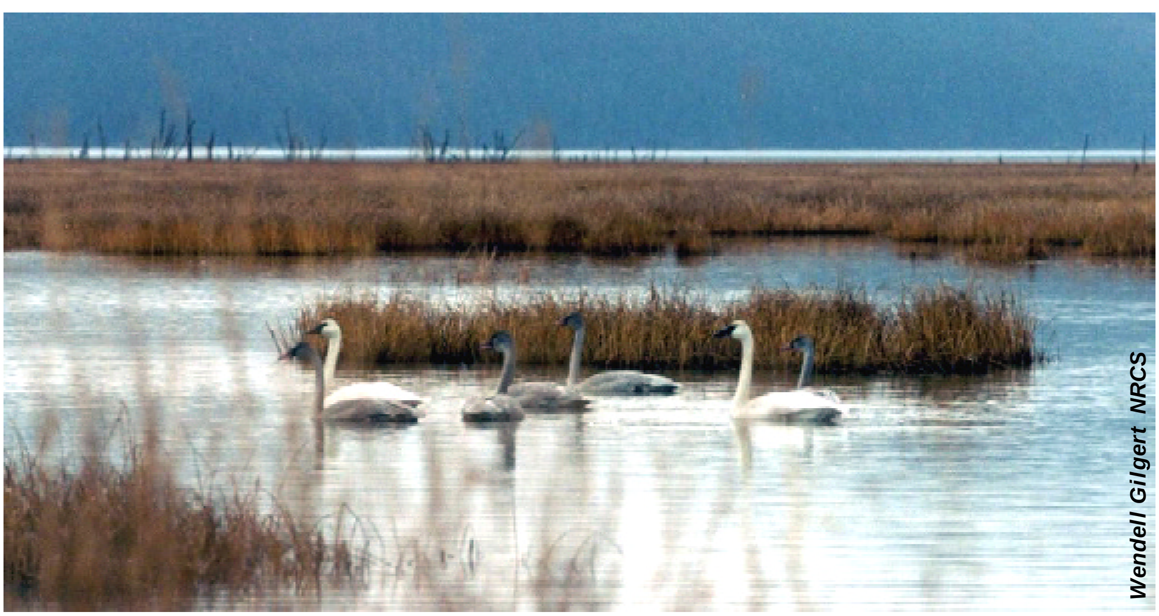
The loss and fragmentation of natural habitats have reduced biological diversity and resulted in considerable loss of fish and wildlife resources important to society. Land use changes are not the only culprit, however. Another factor affecting the loss of biological diversity and decline of species important to ecosystems is the introduction or invasion of alien species.


Roger Hill NRCS

Nearly half of the imperiled species in the Unites States may be threatened either directly or indirectly by alien species (Wilcove et al, 1998). Considering these threats, the following topics are important issues when working with fish and wildlife habitat and should be considered during planning activities.

1. Area of management actions

The number of individuals and species an area can support is related to its size and the life histories and dynamics of the biotic community it supports. In some ecosystems, such as grasslands, areas smaller than 250 acres may be too small to prevent catastrophic rates of habitat disturbance and the loss of many species of vertebrate animals and plants on a time


Wendell Gilgert NRCS

scale of decades (Crooks and Soule 1999).

Small habitat areas cannot support larger species, including some keystone species. Habitat conservation and restoration should ensure the largest tract of habitat possible. In addition, efforts should be made to work with adjacent landowners to build contiguous blocks of habitat and link isolated patches of both terrestrial and aquatic habitats.

2. Edge Effects

The ratio of edge to habitat interior increases geometrically as fragment size decreases. Edge occurs when habitat meets a road, crop field, land use change, or other feature, such as a stream. Wildlife management has historically focused on creating edge habitat for the benefit of specific species. However, increased edge can adversely affect many species. These adverse effects are:

- Higher rates of habitat desiccation and loss of native vegetation,
- Higher frequency and increased severity of fire,
- Higher rates of predation by native and exotic predators (e.g., house cats, foxes, crows, blue jays),
- Higher probability of nest parasitism,
- Greater windfall damage,
- Higher intensities of browsing, grazing, and other forms of disturbance which favor the growth and spread of weedy and alien invasive species, both plants and animals (Wilcove et al. 1986, Noss and Cooperrider 1994).

Roads are the most frequent source of new edge and may facilitate the movement of weeds and pests. They also cause erosion, stream sedimentation, pollution, and increases in mortality rates of wildlife from collisions (Noss 1992). Habitat conservation, restoration and management efforts should reduce edge and minimize roads to the greatest extent possible.

3. Disturbance Effects

Natural disturbances such as fire, storms, floods, and disease outbreaks can increase the mosaic of habitat and increase biological diversity within a large habitat

area. They can also overwhelm small habitat patches. Small areas are more likely to burn completely, resulting in loss of the entire community. This eliminates seed sources for revegetation of the burned area and decreases immigration of animals into habitat created by successional stages following fire since adjacent populations are not present. These factors also require careful management and control of disturbance in smaller habitat patches along the rights of ways.

4. Isolation and Distance Effects

Fragmentation is the alteration of natural patterns of landscapes or ecosystems, creating smaller patches or disrupting the continuity or connectivity of corridors and networks. As habitat patches become isolated and the distance between patches increases, it is harder for many species to disperse and migrate between them. Life cycles of the organisms that make up a biological community are dependent upon the ability of the organism to safely disperse or migrate. Lower dispersal and migration rates increase the likelihood a species will be extirpated from the area, and possibly become threatened or endangered in the long term.

Habitat conservation should focus on maintaining habitat connectivity and linking isolated patches. Maintaining connections on land, and in streams and rivers is critical to the long-term survival of fish, wildlife and all of the ecological components they depend on.

5. Habitat Heterogeneity

Heterogeneity is the complexity or variation in physical structure of habitats. For example, in streams, water depth, velocity, substrate, wood, and pool/riffle complexes add to the heterogeneity of the habitat. Increased heterogeneity creates a variation in habitats for terrestrial and aquatic organisms and supports a greater diversity of species. It also provides more flexibility for species as they seek different types of habitats during different stages of their life cycles.

The complexity of interactions among species in ecosystems often defies our capacity to understand how to effectively manage natural resources.

Actions and practices that maintain habitat and nutrient linkages, allow dispersal and migration, and

Ecological Principles for Land Management Planners

1. **TIME: Ecological processes function at many timescales, and ecosystems change through time.**

2. **SPECIES: Individual species and assemblages of interacting species have key, broad-scale ecosystem effects.**

3. **PLACE: Local conditions (climate, geomorphology, soil quality, altitude) as well as biological interactions affect ecological processes and the abundance and distribution of species.**

4. **DISTURBANCE: The type, intensity and duration of disturbances shape the characteristics of populations, communities and ecosystems.**

5. **LANDSCAPE: The size, shape, and spatial relationships of land cover types influence the dynamics of populations, communities and ecosystems (V.H. Dale et al., 2001).**

sustain the processes that support the biological community as a whole are likely to be more effective at enhancing habitat for targeted species as well.

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Glossary

anthropogenic - caused by humans.

autotrophs - primary producers such as green plants that use solar energy for photosynthesis, combining atmospheric carbon dioxide and water into high-energy carbohydrates such as sugars, starches, and cellulose.

biological diversity (biodiversity) - the variety and variability among living organisms and the communities, ecosystems and landscapes in which they occur.

community - An assemblage of populations of many different species living and interacting in close proximity to each other.

decomposers - organisms such as bacteria and fungi that are found at the bottom of the food chain. They re-cycle nutrients from dead or dying plants and animals of higher trophic levels.

ecosystem - a conceptual unit of living organisms and all the environmental factors that affect them; a biological community, or assemblage of living things, and its physical and chemical environment.

genetic diversity - the array of different genes available in a population's gene pool. Genetic diversity is needed among individuals of a population to allow for greater flexibility of a species to adapt to changing environmental conditions.

heterogeneity - the complexity or variation in physical structure of a habitat.

heterogeneous habitat - diverse or consisting of many different structural components, substrates, types of vegetation, climates, etc.

heterotrophs - animals that derive their energy from the carbohydrates stored within plants. Heteroptrophs can be herbivores or carnivores.

indicator species - those species whose presence indicates a particular state or condition of an ecosystem.

keystone species - species that have an ecological function that other species and components of an ecosystem depend on.

landscape - (1) an area of land consisting of a number of ecosystems; (2) A heterogeneous land area consisting of three fundamental elements: patches, corridors, and a matrix. A *patch* is generally a plant and animal community that is surrounded by areas with different community structure; however, a patch may be devoid of life. A *corridor* is a linear patch that differs from its surroundings. A *matrix* is the background within which patches and corridors exist and which defines the flow of energy, matter, and organisms.

landscape ecology - The study of the spatial and temporal relationships of interacting ecosystems, especially their structure, function and ecological processes.

natural disturbance - any relatively discrete event in nature that disrupts ecosystem, community, or population structure and changes resources, habitat availability, or the physical environment. Natural disturbances include floods, wildfire, earthquakes, volcanic eruptions, tornadoes, hurricanes and tidal waves.

metapopulations - the collective group of discrete populations of a species across a landscape upon which the species' continued existence depends.

niche - all of an organism's interactions with it's environment.

nutrient spiraling - the directional transport of nutrients in streams and rivers, rather than closed nutrient cycles associated with terrestrial ecosystems.

omnivores - animals that eat both plants and other animals.

perturbations - alterations of ecosystem processes as a result of human actions. Examples of perturbations include disruption of natural flow regimes with dam construction, or changes in groundwater hydrology due to poor livestock management or wetland drainage.

population - a group of individuals of the same species that share a common gene pool. They are close enough in proximity to each other to potentially interbreed, although they often do not.

primary consumers - organisms that eat green plants, or herbivores.

secondary consumers - organisms that eat herbivores, or carnivores.

species - a group of individuals that are morphologically, physiologically, or biochemically distinct.

subspecies - the division of species into subcategories that best describe the relationships of their morphological characteristics.

trophic level - an organism's position in a food chain or food web.

Part 6xx.11 - Conservation Planning for Integrating Biological Resources

A. Integrating Fish and Wildlife into Landowner Objectives

The point in time when a conservation planner establishes an effective relationship with a cooperator comes in familiar ways: the cooperator (used interchangeably with landowner, land manager, producer, farmer, or rancher) makes a phone call to a USDA Service Center, or walks into an NRCS field office, or follows a referral from the Farm Services Agency, and RC&D Coordinator, or a Soil and Water Conservation District. Often this contact is made because the cooperator has a concern or a " problem" that requires technical assistance with resource concerns on a piece of working land.

During the introductory stages of the relationship with the cooperator, the planner begins to assess the situation in the area where the resource concern exists. Like anything new, there is a level of excitement as you begin the process of working with the cooperator to develop the conservation plan, assist with the implementation of the plan, then continue to support the assessment and monitoring of the effectiveness of the conservation activities.

Hugh Hammond Bennett, in his text, *Elements of Soil Conservation* stated that "c*onsideration of the land's relationship to the entire farm, ranch or watershed*" is the key principle of conservation planning. While the planner is comfortable with his or her general knowledge of most of the natural resources encountered on the cooperator's land, he or she is not likely to be equally knowledgeable about all of the planning elements — soil, water, air, plants, and animals (SWAPA) — that occur on the land.

The purpose of this handbook is to assist the planner who does not have extensive knowledge or experience with fish and wildlife resources, or *biological resources,* to more effectively integrate considerations of these resources into the development and implementation of the Conservation Plan.

Hugh Hammond Bennett was the first chief of the Soil Conservation Service. His vision of natural resource planning included some key attributes of conservationists who are effective planners.

An Effective Planner*:*

- ***considers the needs and the capability of each acre*** Conservation planning is not an overnight process. It is an accumulation of knowledge, skills and abilities acquired relative to natural resources. It requires an understanding of soil surveys, ability to read maps, ability to understand human history of the area. We need to be able to begin the process of reading the landscape. A lot of our landscapes in North America are in some need of restoration. In other words they have been used hard and there is the ability for them to flourish and to become more sustainable than they are under current land use regimes.

- ***is cognizant of the land user's situation***. An effective planner understands the consequences of proposed actions and helps the landowner clearly understand his or her impact on and off the parcel of land they are concerned about. The land user has economic, social, political and cultural constraints. There are a number of landowner issues that the conservation planner needs to be aware of.

- ***incorporates the land user's aptitude to change***. Change is difficult for some, easy for others. Planners need to help people understand why a change in management may be needed for good conservation on the ground.

- ***considers land surroundings and relationships*** An effective planner recognizes the interconnections between a site and the surrounding landscape. The adjacent property, subwatershed, river basin, watershed, state, and the region of the country should be considered. The planner must understand the land's location and its relationship to surrounding property. If a property is eroding severely, then not only is soil lost from

Other Considerations for an Effective Conservation Planner

1. Recognize the need for resource sustainability. Keep current on new technology by reading scientific literature and attending resource conferences and workshops.

2. Consider short-term, long-term, and cumulative effects of actions. Most of the landscapes we are concerned with did not degrade overnight. What we are doing is for the long term. We want results now, but with conservation, we need to keep clear that it is a process that takes time, and tender loving care to get the land back to some level of sustainability and productivity.

4. Consider economic needs and goals. What will it cost, how much time does a land manager have to invest in the action?

5. Work with client to consider alternative enterprises and their interactions with the site and its surroundings.

6. Respect the owner's rights and responsibilities.

7. Help the cooperator develop and articulate the desired future conditions for the planning area. What would he or she like the property to look like? Encourage new ideas, and provide relevant and timely information and offer sound conservation advice.

8. Collaborate with other natural resource professionals and volunteers when collecting, assembling and evaluating data. Use resources and expertise of others. Interact and work with people who may have a different perspective about the resource concerns you are considering.

Goal of an Effective Resource Planner: *Conserve Natural Resources*. *Planning is not just about DEVELOPING a plan and handing it to a landowner.* Conservationists work with landowners to help them change the way they probably are managing their land. If the land manager did not have doubts about the way they are managing their resources, they would not be asking for technical assistance.

that particular property, but water quality damage can occur in aquatic ecosystems downstream due to the sediment that originated on that piece of property. Water quality can also be used as a starting point for discussions related to integrated pest management (IPM) aimed at reducing pesticide use. Implementation of IPM will have significant wildlife ramifications when related to habitat and water quality enhancement.

B. Fish and Wildlife/Biological Resources: Different Meanings for Different People

When discussing fish and wildlife, or any biological resource with a landowner, it is important to establish a common vocabulary. For many cooperators, the more familiar and visible fish and wildlife (e.g., white-tailed deer, mallards, black bass, raccoons, crows, rainbow trout or prairie dogs) represent the significant biological resources on their lands. It is also a purpose of this handbook to broaden how the planner, and thus the cooperator, thinks of the fish, wildlife, and biological communities that occur or could occur on a piece of working land. While it may not be possible to have conversations with the cooperator about the full range of biological resources on a particular property, a general understanding of those resources by the planner can translate into an increased awareness of their values by the cooperator.

The most favorable time to incorporate biological resources into the plan discussion is during the initial conversations with the cooperator. As the planner probes the cooperator for information about their operation, it is always appropriate to ascertain the level of interest in their biological resources. Does the cooperator consider those resources to be part of the land's production capability where an economic gain is realized? How does the cooperator feel about the presence or absence of those resources on the land? Are they seeing more or less fish and wildlife than they would like to see? Do fish and wildlife contribute to the quality of their experience of working and living on the land? Is the cooperator willing to adjust how they operate their enterprise or manage their land to accommodate biological resources?

While it is preferable to integrate biological resource needs into the early conversations with a cooperator, it is *never too late* to discuss those needs with a landowner seeking technical assistance. An experienced planner, who has not fully discussed the inclusion of the biological resources of a planning area, should make an effort to do so at any time during the planning or implementation process. Remember, all lands and most landscape features provide habitat for biological resources and the quality of that habitat varies.

C. Planning to Meet Life History Needs of Fish and Wildlife

Most planners know that the basic life history requirements for fish and wildlife resources can be broadly grouped into three categories**: water, food, and space (including cover and special habitat areas)**. When planning for an individual species or group of species, the planner must provide the cooperator with more specific information about life history needs. Always consider the specific biological needs for water, food, and space by fish and wildlife.

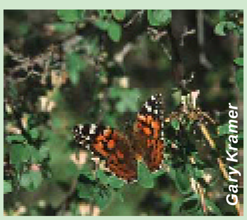
WATER: Some species like snakes, tortoises, desert mammals, and many insects, obtain all of their water requirements from the foods they eat. To support most wildlife, and obviously all fish species, a reliable free water supply is necessary. Virtually every type of uncontaminated surface water source will be used by a variety of fish and wildlife species. A complete inventory of those sources should be a fundamental element to any conservation plan.

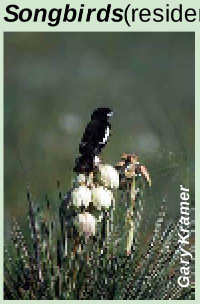
FOOD: Food habits for fish and wildlife are variable throughout the year. Feeding behavior and habits help broadly define groups of animals. Common examples are grazers (elk, prairie dogs, grasshoppers), browsers (deer, beaver), carnivores (snakes, hawks, bobcats), omnivores (black bears, coyotes, crows), parasites (lampreys, many insects, cowbirds), and others.

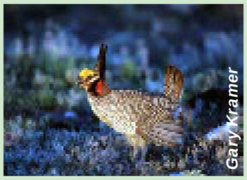
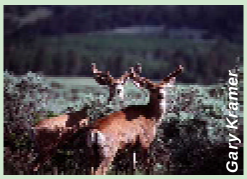
Food requirements vary with time of year. For specific information for any particular species, there can be numerous technical references that will provide food habit information (see Part 6XX.20).

SPACE: The space in which an organism lives provides protection, or cover. Cover types include structural elements in a species' habitat that provide a means of escape from danger (escape cover), provide refuge from temperature changes (thermal cover), protect young (nesting, fawning or brood cover), resting areas (loafing or refugia cover), or hide from predators (hiding cover). A space can also be a large area where a number of animals or biological resources come to-

It is useful to think about fish and wildlife resources in groups or associations and then relate them to the practices that the landowner ultimately chooses to incorporate into the overall conservation plan. The following are ***examples of broad fish and wildlife groupings*** and ***some examples of practices*** that directly or indirectly impact the particular group (See below).

Biological Group Under Consideration	**Relevant Practice Standards**
1. INVERTEBRATES	
a. Aquatic: crayfish, snails, stoneflies, mayflies, riffle beetles 	Stream Habitat Management (395) Riparian Forest Buffer (391A) Wetland Restoration (657)
b. Terrestrial (*Edaphic fauna*): earthworms, nematodes, dung beetles	Conservation Cover (327) Forest Stand Improvement (666) Prescribed Grazing (528A)
c. Pollinators: Integrating all types of flowering plants into vegetation will enhance most areas for pollinators: bees, butterflies, moths, birds 	Alley Cropping (311) Conservation Crop Rotation (327) Tree/Shrub Establishment (612)
d. Integrated Pest Management Species: lady beetles, spiders, wasps	Pest Management (595A) Residue Management (329B) Riparian Herbaceous Cover (390)
2. VERTEBRATES	
a. Fish ***Cold-water Fish***: trout, salmon, grayling, whitefish ***Cool-water Fish***: Pike, pickerel, walleye, suckers ***Warm-water fish*** catfish, black bass, carp, bluegill, minnows 	Nutrient Management (590) Irrigation Water Management (449) Riparian Forest Buffer (391A) Stream Habitat Management (395) Wetland Restoration (657) Fish Passage (396)

Biological Group Under Consideration	Relevant Practice Standards
b. Amphibians: salamanders and newts, toads, frogs	Pond (378) Emergency Field Flooding (649) Stream Habitat Management (395)
c. Reptiles: snakes, turtles, lizards, skinks:  	Wetland Wildlife Habitat Management (644) Wetland Restoration (657) Restoration and Management of Declining Habitats (643)
d. Birds ***Songbirds*** (resident and neotropical migratory):  	Early Successional Habitat Development and Management (647) Hedgerow Planting (422) Prescribed Burning (338)
Waterfowl: ducks, geese, swans:  	Wetland Wildlife Habitat Management (644) Shallow Water for Wildlife (646) Prescribed Grazing (528A)
Shorebirds: sandpipers, plovers, stilts, avocets, dowitchers:  	Irrigation Water Management (449) Restoration and Management of Declining Habitats (643) Wetland Restoration (657)
Raptors: hawks, falcons, eagles, owls:	Field Border (386) Residue Management (329A) Windbreak / Shelterbelt Establishment (380)
Colonial Nesting Birds: egrets, herons:	Wetland Restoration (657) Riparian Forest Buffer (391A) Filter Strip (393A)

Biological Group Under Consideration	Relevant Practice Standards
Game Birds: grouse, quail, turkey, pheasants: 	Forest Harvest Management (511) Field Border (386) Residue Management (329A)
e. Mammals **Large Herbivores:** elk, deer, pronghorn: 	Brush Management (314) Prescribed Grazing (528A) Wildlife Watering Facility (648) Fence (382)
Large Predators: cougar, bear, wolf:	Forest Stand Improvement (666) Riparian Forest Buffer (391A) Tree/Shrub Establishment (612)
Mesopredators: raccoon, bobcat, skunk: 	Conservation Cover (327) Stream Habitat Management (395) Windbreak / Shelterbelt Establishment (380)
Small Mammals: mice, beaver, prairie dogs: 	Early Successional Habitat Development and Management (647) Prescribed Grazing (528A) Structure for Water Control (587)
Bats (Resident and Migratory): 	Mine Shaft & Adit Closing (457) Forest Harvest Management (511) Pond (378)

gether for breeding (lekking, breeding, spawning areas), feeding, loafing, or staging for group migrations.

D. National Conservation Practice Standards Specific to Fish and Wildlife Resources

Currently, there are more than 160 practices listed in the National Handbook of Conservation Practices. Virtually every conservation practice impacts fish and wildlife resources. The following seventeen (17) practices are specifically related to fish and wildlife resources. While it is clear that these 17 practices will, if properly implemented and/or managed, positively affect biological resources, the greater challenge to the planner may be with the integration of those resources into the other 140-plus conservation practices.

1. **Aquaculture Pond*** (397, Acres). A water impoundment constructed and managed for commercial aquaculture production. To provide suitable aquatic environment for producing, growing, and harvesting commercial aquaculture products.

2. **Constructed Wetland** (656, Acres). A wetland constructed for the primary purpose of water quality improvement, i.e., treatment of wastewater, sewage, surface runoff, milk-house wastewater, silage leachate, and mine drainage. Practice treats wastewater by the biological and mechanical activities of the constructed wetland.

3. **Early Successional Habitat Development / Management** (647, Acres). Manage early plant succession to benefit desired wildlife or natural communities. Increase plant community diversity, provide wildlife habitat for early successional species and provide habitat for declining species.

4. **Emergency Field Flooding*** (649, Number and Acres). Ensuring minimal waterfowl habitat on agricultural lands and adjacent wetlands during fall and winter migration during periods of drought to disperse waterfowl concentrations and reduce disease.

5. **Fish Passage*** (396, Number). Features to eliminate or mitigate natural or artificial barriers to fish movement such as dams or cross-channel structures to allow unimpeded movement for fish past stream barriers.

6. **Greentree Reservoir*** (653, Acres). Artificial seasonal flooding of areas dominated by living trees to provide waterfowl habitat.

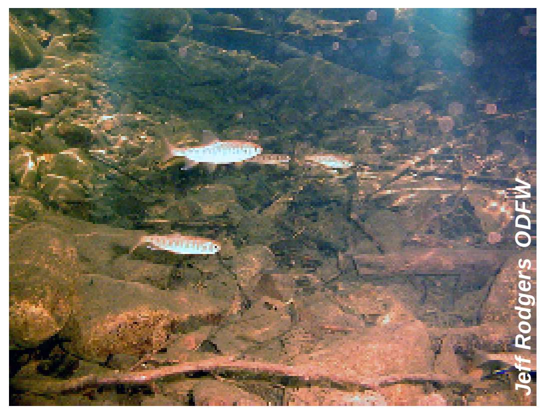
7. **Pond Management*** (399, Acres). Developing or improving impounded water to produce fish for domestic use or recreation. To provide suitable aquatic environment for producing, growing, and harvesting fish or other aquatic organisms for recreational or domestic uses.

8. **Restoration and Management of Declining Habitats** (643, Acres). Restoring and conserving rare or declining native vegetated communities and associated wildlife species to restore and manage habitats degraded by human activity, increase native plant community diversity or manage unique or declining native habitats.

9. **Riparian Herbaceous Cover** (390, Acres). Riparian herbaceous cover consists of grasses, grass like plants, and forbs at the fringe of the water along water courses. The practice provides habitat for aquatic and terrestrial organisms, improves and protects water quality, stabilizes the channel bed and stream banks, establishes corridors to provide landscape linkages between existing habitats, and fosters management of existing riparian herbaceous habitat to improve or maintain desired plant communities.

10. **Shallow Water Management for Wildlife** (646, Acres). Managing shallow water on agricultural lands and moist soil areas for wildlife habitat. Areas provide open water areas to facilitate waterfowl resting and feeding, and habitat for amphibians and reptiles that serve as important prey species for other wildlife.

11. **Stream Habitat Management*** (395, Feet). Create, restore, maintain and enhance physical, chemical, and biological functions of a stream system, to provide desired quality and quantity of water, fish and wildlife habitat, channel morphology and stability, and aesthetics and recreation opportunities.



12. **Upland Wildlife Habitat Management** (645, Acres). Creating, restoring, maintaining, or enhancing areas for food, cover, and water for upland wildlife and species that use upland habitat for a portion of their life cycle.

Provide all of the habitat elements in the proper amounts and distribution and manage the species to achieve a viable wildlife population within the species home range.

13. **Wetland Creation** (658, Acres). A wetland created on a site location which historically was not a wetland or was a wetland but with a different hydrology, vegetation type, or function than naturally occurred on the site. Create wetlands that have wetland hydrology, hydrophytic plant communities, hydric soil conditions and wetland functions and /or values.

14. **Wetland Enhancement**(659, Acres). The modification or rehabilitation of an existing or degraded wetland, where specific function and/or values are improved for the purpose of meeting specific project objectives. For example; managing site hydrology for waterfowl or amphibian use, or managing plant community composition for native wetland hay production.

15. **Wetland Restoration** (657, Acres). A rehabilitation of a degraded wetland where soils, hydrology, vegetative community, and biological habitat are returned to the original condition to the extent practicable. To restore wetland conditions and functions that occurred on the disturbed wetland site prior to modification to the extent practicable.

16. **Wetland Wildlife Habitat Management** (644, Acres). Retaining, developing, or managing habitat for wetland wildlife. To maintain, develop, or improve habitat for waterfowl, furbearers, or other wetland-associated wildlife.

17. **Wildlife Watering Facility** (648, Number). Constructing, improving, or modifying watering facilities or places for wildlife to obtain drinking water.

E. Elements of the Planning Process

Step 1.
Identify Problems and Opportunities

Field office planners are required to consider soil, water, air, plants and animals when developing a conservation plan. In general, concern for fish and wildlife resources is generally not the primary motivation of producers who contact NRCS conservationists for assistance. That fact should not prevent the conservationist from including fish and wildlife resources early in the process of identifying resource problems and opportunities. Explore as many aspects as the cooperator's interest and the conservationist's time allow.

Example: When a rancher contacts the conservationist with questions about grazing management, questions about native grazers should be interspersed into conversations that are intended to obtain information on livestock type, class, and herd size.

- What native grazers (e.g., rabbits, prairie dogs, elk) must rely on the same resources as domestic livestock?
- What are their life history requirements?

- How will those requirements be integrated into the grazing plan?

Subsequent conversations could include changing pasture size or configuration, which would involve discussion of fences, water, and salt or mineral distribution. With every element of the grazing plan, there will be opportunities to raise questions regarding the rancher's attitude toward and aptitude for the integration of fish and wildlife resources on the property. Does wildlife currently move freely on the ranch? If not, would the rancher be open to changing the fence configuration and wire placement to facilitate non-obstructed movement of deer, elk, moose, or pronghorn? Do the livestock stand in the stream, seep, or spring where they water? If so, could it be more efficient and improve herd health if the watering areas were fenced and the water piped into at storage tank for distribution to multiple troughs (with design provisions for wildlife access and egress)?

Step 2.
Determine Goals and Objectives

A producer's motivation to initiate and work through the process of developing and then implementing a conservation plan can come from a concern and/or multiple concerns about the resources on their land or on lands affecting their operation. The step to assist the producer to clearly spell out the desired products of a plan may not be as simple as it sounds. It may take time to establish *trust* between the producer and the conservationist, which can entail many separate visits with the producer, especially if the conservation of the fish and wildlife resources was or is not a primary motivation for the conservation plan.

It may be useful to help the producer to think of and thus break down the conservation goals into three parts *: 1) productivity, 2) quality of life, and 3) the landscape.* Working with the producer to discuss **production goals** on their land is likely the most difficult and delicate topic of the three. A discussion of land, herd, or crop size with a producer is tantamount to a discussion of bank accounts or wills. Yet, unless the planner has a clear understanding of what the land manager needs to produce, an honest conversation about the conservation elements that can be applied to the land will be difficult. Armed with the productivity information, the planner can do a more complete job of formulating alternatives that can more fully integrate biological resources.

Example: A row crop and orchard producer in California was using up to 10 annual pesticide applications on his crops each year. Since there are more than 15 species of insect feeding bats in his region, a suggestion was made that the strategic placement of bat boxes had the po-

tential to increase the local bat population to a level where control of crop insect pests could be positively impacted. Several years and bat boxes later, the producer's pesticide applications were reduced by more than two thirds due to the integrated pest management provided largely by the bats. This is an example of a previously unrecognized resource that led to enhanced habitat quality for the bats and other farm wildlife, improved water and soil quality on and off the farm, and reduction of expensive inputs that allowed the producer more management flexibility.

The other elements of the overall plan goal are the quality of life and the landscape goal. Those goals are critical to understanding what motivates a producer to stay involved in a business that is often marginally productive. What is it that motivates the cooperator to face each day on the land? Is it the smell of newly swathed hay? Is it the sounds of resident or seasonal wildlife, the elk herd passing through on the way to winter or summer range? Is it the sound of the brook trout breaking water chasing a mayfly near the stream edge? Or is it the yearly proliferation of butterflies at the field's edge as they follow the nectar corridor?

And if it were entirely within the cooperator's ability, what would the land look like? Would there be more trees, more open expanses of land, lush riparian areas, more of all types of songbirds? More water?

Within the context of working with the producer to articulate his or her goals, the planner, through probing and timely questions, finds that the producer has or can have a much broader role for fish and wildlife resources on their land.

Step 3.
Inventory Resources

For the planner, the resource inventory is often one of the more eagerly anticipated steps of the planning process. It is during this process that the planner is fully engaged with the producer to explore the extensive information and gain an understanding of the cooperator's land and those lands that surround it. There are numerous tools that will assist the planner with this inventory. The following should be considered essential tools for a thorough field inventory:

- Series of maps to locate the property in the proper landscape context
  - 71/2 minute quadrangle topographic map
  - Aerial photos
  - Soils maps
  - Habitat maps
  - Various layers of Geographic Information System (GIS) maps
- Camera
- Binoculars
- Notebook
- Field guides, soil survey
- Hand lens
- Safety kit
- Soil knife
- A daypack to keep the materials in one location

Investigating and analyzing the resources that the planner gathers from the land can be as exhaustive as time allows. The planner will want to ensure a quality effort is made to read the landscape, take legible notes, talk to, walk with, or ride with the land manager. A comprehensive resource assessment may therefore require several visits to the property. Look for additional conservation opportunities with every trip on the land. This, too, is an opportunity to locate specific and critical habitat elements for the fish and wildlife using the property. Water features are especially critical not only because of their relationship to biological resources, but because they are often indicators of wetland and cultural resource locations.

During the inventory process, it is critical to think beyond the property boundary both in terms of space and time. Some spatial scales that can be useful include:

1. Hemispheric Scale
Important for wildlife and fish that migrate long distances, such as salmon, waterfowl, neo-tropical migratory birds, jaguars, large ungulates, bats, and various insects. Virtually all lands planned by NRCS con-

servationists are visited by transitory or migratory fish or wildlife one or several times across a year. Whether the animal spends a few days or an entire season on the cooperator's land, it is an important component for that species' overall life history and should be accommodated.

2. Regional Scale
Steelhead, salmon and other migratory fish, as well as many terrestrial species use a smaller but critical subset of a region in which the cooperator's land is located.

3. Watershed or Sub-watershed Scale
Some species of fish and/or wildlife live their entire life cycle in discrete areas where cooperation and coordination among and between land managers is critical to their sustainability. These include endemic species that are only found in a particular watershed or field office area. Also, local species are those that live their entire lives on individual farms or ranches .

4. Field or Tract Level
Important for dispersal-sensitive species, like frogs, chipmunks, native fish or insects that may never move past the boundary of a field or tract within a farm or ranch.

Different time scales, or temporal scales, are also important considerations for fish and wildlife and their habitats. For example, the intervals of time between disturbance events such as floods, fires, or hurricanes affect species and their habitats. Some questions that you may ask:

- *Is it a 2-year, 5-year, or 10-year flood that will likely create the sediment point bar that will allow for a new generation of cottonwood seedlings to germinate in the riparian zone?*

- *Will a prescribed burn in the brush vegetation cause a water release that will benefit the local amphibian population and at the same time favor early successional forbs for the migratory pollinators?*

- *How long will the effects last?*

Step 4.
Analyze Resource Data

The field office technical guide (FOTG) offers a template for organizing resource concerns. There are also effective tools available for use in analyzing data. Many of these tools are available in the NRCS office or from wildlife agencies if you do not have appropriate wildlife habitat evaluation protocols readily available. The conservationist should work with state, federal, or non-governmental fish and wildlife organizations to secure as much information as is available. An example of a Habitat Evaluation from Utah is provided, but every state has Species Habitat Evaluations, or Habitat Evaluations. In addition, the U.S. Fish and Wildlife Service has Habitat Suitability Index (HSI) models for a number of fish and wildlife species. The guides are relatively comprehensive and examine various aspects of habitat for a variety of fish and wildlife. There are different habitat evaluation guides available in each state or territory.


Gary Kramer

Step 5.
Formulate Alternatives

Develop alternatives that include a spectrum of conservation practices to utilize on the producer's land. These practices, when implemented, should accomplish the following:

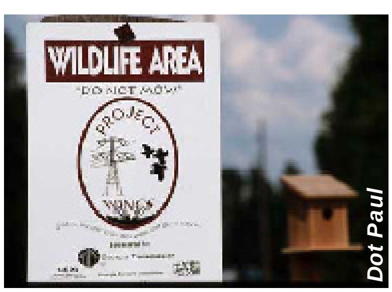
1. *Achieve Landowner Objectives*. Virtually all of the practices that we use are in the FOTG, and there are nearly 160 conservation practices. Of these, only seventeen are strictly "fish and wildlife practices." Of the remaining practices, virtually all have the potential to address the needs of fish, wildlife and other biological resources. The conservationist's creativity, experience, education, and training will provide an opportunity to engage other people's expertise for incorporating fish and wildlife into the planning process. It is the planner's responsibility to ensure that the objectives of the landowner and the objectives of the cooperating fish and wildlife management agency are addressed during the discussion and formulation of conservation alternatives.

2. *Solve Identified Problems* By now the problems that initiated development of the conservation plan in the first place should be very clearly spelled out. During this step, the conservationist can explain how the resource problem

likely began. The landowner will begin to realize the consequences of various management actions on the land and the surrounding landscape. It is during this process of conservation planning and application that the planner can help the producer more fully understand stewardship obligations to the land.

3. *Take Advantage of Opportunities* When it comes to economics, most land users are going to be receptive to and qualify for cost-share programs or related assistance such as grants, building materials, labor, or other resources needed to apply the necessary conservation practices. The planner needs to be very aware of the array of technical and financial resources that are available to the landowner. The producer may indicate a sincere desire to apply a conservation practice, but lack the resources to do so. At that point, the planner can offer cost-share programs, grants, as well as assistance from a number of partner groups that would like to cooperate with the producer. The planner must facilitate development of partnerships (see Part 6XX.01 - Conservation Partnerships) to help the producer take advantage of all available opportunities.

4. *Prevent Additional Problems* There are numerous tools available to assist the planner with motivating the cooperator to think about alternative management or business practices that avoid generation of new natural resource management problems.



Example: A hay operator chooses to explore equipment modifications such as a flush bar that moves nesting ducks, pheasants, or songbirds out of the swather or mover path so they are not destroyed during hay harvest activities. Perhaps harvest actions can be delayed for a couple of weeks to allow the nesting birds time to fledge their young and move out of the field. Think creatively with the producer! Help the producer to think of ways to apply different cultural practices relating to agriculture, and, for example, the habits of migratory shorebirds. During the shorebird migration, the birds may only be on-site for a few days. In some cases the shorebirds may stay and nest. The producer can alter irrigation management practices by providing additional soil moisture, or altering planting dates. The producer can benefit these species by providing soil foraging resources through this process.

Step 6.
Evaluate Alternatives

The planner should provide sufficient information about each alternative or combination of alternatives so that the cooperator can make decisions that will move him or her closer to their stated goals. Potential positive as well as negative outcomes should be discussed with the decision-maker. Each step of conservation planning is critical. In Step 6, it is critical to display the alternatives in a way that is clear and sensible. A Choice Analysis type of spreadsheet can be useful (see Appendix A).

Clear communication and understanding between the planner and the cooperator regarding the range of alternatives and the effects of implementing them must exist.

In turn, this will lead to intelligent choices that will provide long-lasting benefits to biological resources.

Step 7. Make Decisions

Decisions are the prerogative of the landowner. The planner should provide sufficient information that may assist and influence the choices that the cooperator will find acceptable. Conservation planning is dynamic; it is an on-going, and likely lifelong process for the cooperator. On occasion, the producer takes a conservative approach to the plan that can lead to disappointment for the planner.

RESIST the urge to influence the producer to act outside of his or her comfort zone. Remember — is the cooperator's decision!

Example: A producer contacts the NRCS conservationist to request assistance on improving irrigation efficiency. The producer replaces an open ditch with a pipeline and engages in irrigation water management. From a wildlife perspective, there seems to be little benefit. However, the planner has a foot in the door—has planted the conservation seed. Perhaps the next logical step is the inclusion of a tail-water return system. The design of the sump for that system could have multiple wildlife benefits for waterbirds, perhaps fish, and if adjacent cover is provided, small mammals.

Step 8. Implement the Plan

Work with the producer to adopt new ideas and concepts with the goal of finally implementing those ideas or practices on the land. Once the practices are applied to the land, the producer will require the support of the conservationist to ensure proper installation of the conservation practices and the associated proper management of those practices. If cost-share programs are involved, the planner will have to ensure that the practice meets the standards and specifications. All subsequent visits with the cooperator will provide great opportunity to work with the landowner to adjust their thinking relative to the management of the particular practice on the land.

Step 9.
Monitor and Evaluate

Monitoring and evaluation are yet another critical step in conservation planning. However, it is one of the most neglected phases of the process. Monitoring must be integrated so that the producer and the planner know that the desired conditions are occurring on the land. There are many monitoring tools that can be cost and time effective.

One excellent and thorough source is ***Inventory and Monitoring of Wildlife Habitat*** compiled by Allen Cooperrider, Raymond J. Boyd, and Hanson R. Stuart, available through the U.S. Department of Interior, Bureau of Land Management (September 1986). The reference has inventory and monitoring protocols for most major habitat types and for all vertebrate fish and wildlife species.

Example: One straightforward monitoring technique is photo monitoring. Cameras are inexpensive and easy to use. A date-back camera (where the date is printed on the photo image) is preferred. While a photo may not be quantitative data, it can contain a wealth of information. In order to make sure that the responsible person can go back to the same locations, previous photographs must be in the planner's or producer's possession. Use of a 7 ½-minute topographic map or Global Positioning System (GPS) will ensure continuity of photo point location through time. Marking with rebar or flagging can also help ensure your ability to relocate fixed photo points.

Monitoring Allows Re-planning: Like construction of a building from a blueprint, a conservation plan must invariably be modified. As the landowner learns and acquires a more thorough understanding of the consequences of various management activities on the land, the natural progression is that the plan has to be modified. It is a dynamic process. The application of the plan begins with the establishment and management of the array of conservation practices on the land. As the cooperator recognizes what is and is not effective, then modifications of both management and practices are often necessary.

Final Thoughts

The conservation plan enables the planner to engage the landowner, their beliefs, values, and attitudes relative to natural resource conservation. The planner then works with the cooperator to move them toward a conservation ethic. However, the planner cannot be available at every step.

At some point, the cooperator will hopefully embrace a conservation ethic so that when the conservationist moves or retires,

the cooperator will have the conservation ethic embedded as a way of life. Whatever conservation measures are applied to the land will benefit the land. That is the true value of the conservation plan and that is what the planner can expect as the ultimate outcome.

" There are two ways to apply conservation to land. One is to superimpose some particular practice upon the pre-existing system of land-use, without regard to how it fits or what it does to or for other interests involved. The other is to reorganize and gear up the farming, forestry, game cropping, erosion control, scenery, or whatever values may be involved so that they collectively comprise a harmonious balanced system of land-use."
Aldo Leopold, *Coon Valley: An adventure in Cooperative Conservation* (1935).

Part 6XX.12 - Reserved - Fish and Wildlife Habitat in Ecological Site Descriptions (in development)

Subpart C - Technical Resources

Part 6XX.20 - Technical References for Integrating Fish and Wildlife Habitat Considerations into Conservation Planning

Keeping up with all of the technical information pertaining to terrestrial and aquatic resources is a tremendous challenge in the information age. All of us have been stymied by the inability to find and access new or old information. Indeed, nothing is more frustrating than being unable to locate a resource that you know to be buried somewhere in your office.

Assembling and organizing a library containing all of the technical resources needed to achieve fish and wildlife conservation goals simply is not feasible for most of us.

Thanks to the Internet, however, a lot of the information that is needed to plan, implement, and monitor conservation actions is now available online. Sorting through all of potential sources of information available online can be every bit as challenging as trying to find a needed publication in a busy office. Moreover, information resources keep changing, with new sites constantly coming online.

Below is a list of online resources containing information potentially helpful to NRCS field staffs for planning, implementing, and monitoring projects. To improve the usefulness of this " electronic toolbox," links were organized into NRCS' planning framework. The quality and usefulness of information clearly is better for some subjects (e.g., birds) than it is for others (e.g., reptiles and amphibians), but electronic access to needed resources improves daily.


NRCS

Because of the dynamic nature of online resources, the electronic toolbox provided here will need to be frequently updated. For the latest version of the electronic toolbox, go to the Wildlife Habitat Management Institute's website at www.whmi.nrcs.usda.gov.

How does the electronic toolbox work?

Example: The goal is to design a WRP site near Ames, Iowa to benefit migratory birds.

Ames, Iowa, is in the tallgrass prairie physiographic area:

www.natureserve.org/explorer

Bird conservation priorities identified by bird conservation groups for the tallgrass physiographic area are displayed at the Partners-in-Flight website

www.partnersinflight.org/pifbcps.htm.

The relative abundance of these and other birds observed breeding in the vicinity of the project site is available at the Breeding Bird Survey's Clickable Abundance Map

www.mbr-pwrc.usgs.gov/geotech/bbsmaps3.html.

See www.mbr-pwrc.usgs.gov/bbs/ for their breeding and wintering distribution in North America. The occurrences and population trends for birds also can be determined at the Breeding Bird Survey's website:

www.mbr-pwrc.usgs.gov/bbs/.

For detailed information on habitat requirements of priority species, see The Birds of North America – Life Histories for the 21st Century (soon to be available online) or

www.natureserve.org/explorer/.

Additional resources on bird life histories and habitat requirements of individual species of North American birds are identified at:

www.partnersinflight.org/birdacct.htm#Table.

See The Nature Conservancy's

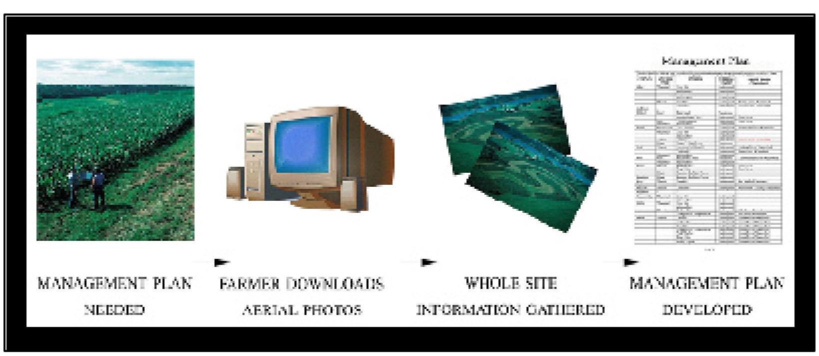
www.natureserve.org/explorer/,

state GAP

www.gap.uidaho.edu/,

or the U.S. Fish and Wildlife Service's

http://endangered.fws.gov/wildlife.html#Species



websites for information on the conservation status of area plants and animals. See

www.mp1-pwrc.usgs.gov/powcase/

for guidance on designing a bird monitoring program for birds on the site.

I. Planning

A. Conservation Priorities Established by Conservation Partners

1. Birds

a. Songbirds – Partners in Flight bird conservation plans identifying species priorities by physiographic (vegetative) region:

www.partnersinflight.org/pifbcps.htm

b. Waterfowl – North American Waterfowl Management Plan:

http://northamerican.fws.gov/NAWMP/nawmphp.htm

c. Shorebirds – North American Shorebird Management Plan:

www.manomet.org/USSCP/index.htm

d. Waterbirds — North American Waterbird Management Plan:

www.nacwcp.org/

2. Threatened or Endangered Species

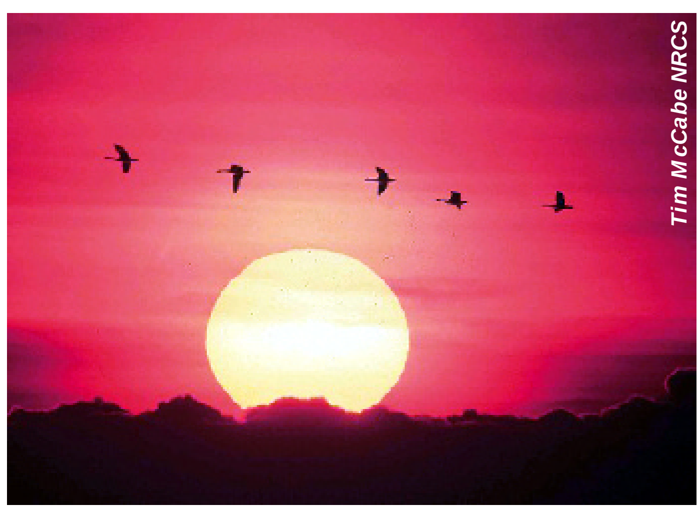
a. Federally listed plants and animals:

http://endangered.fws.gov/ ildlife.html#Species

b. See *Conservation Status of Fish and Wildlife Species* links in section B.4.

c. Specific

1). Aquatic/Wetland species at risk:



www.epa.gov/iwi/1999april/iii8_usmap.html

3. Habitats

a. General

1). The Society for Ecological Restoration's Primer on Ecological Restoration provides general information concerning restoration of habitats by restoring ecological processes:

http://ser.org/Primer.pdf

b. Aquatic

1). General

a). USDA Forest Services Stream System Technology Center provides links for downloading information on hydrology, fluvial geomorphology, and stream habitat improvements, including fish passage:

www.stream.fs.fed.us/

b). EPA's *Surf Your Watershed* website defines boundaries of watershed, identifies political jurisdictions, and provides links to environmental databases:

http://cfpub.epa.gov/surf/locate/index.cfm

c) NatureServe Explorer is source for information on ecological communities in the U.S. and Canada:

www.natureserve.org/explorer/

2). Streams and Stream Corridors

a). Stream Corridor Restoration: Principles, Processes, and Practices contains excellent resources for planning, implementing, and monitoring restoration projects within a watershed context.

www.usda.gov/stream_restoration/

b). EPA's River Corridor and Wetland Restoration website:

www.epa.gov/owow/restore/

c). Know your watershed website:

www.ctic.purdue.edu/KYW/Brochures/GetToKnow.html

c. Terrestrial

1). General

a). NatureServe Explorer is source for information on ecological communities in the US and Canada:

www.natureserve.org/explorer/

b). Gap Analysis Program (GAP) was undertaken to provide regional assessments and to facilitate the application of this information to land management activities. When completed will provide searchable database for landcover, indices of biodiversity, and distribution and conservation status of terrestrial vertebrates. Go to:

www.gap.uidaho.edu/

Check your state for GAP status and access to database.

4. Plants

The NRCS PLANTS Database is a single source of standardized information about plants. This database focuses on vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories. The PLANTS Database includes names, checklists, automated tools, identification information, species abstracts, distributional data, crop information, plant symbols, plant growth data, plant materials information, plant links, references, and other plant information:

http://plants.usda.gov

B. Inventory of Terrestrial and Aquatic Resources

1. Species Distributions and Abundance

a. General (all fish and wildlife species/groups)

1). NatureServe Explorer is source for information on distribution, conservation status, life histories, and habitat requirements for over 50,0000 plants, animals, and ecological communities in the US and Canada:

www.natureserve.org/explorer/

2). Gap Analysis Program (GAP) was undertaken to provide regional assessments of the conservation status of native vertebrate species and natural land cover types and to facilitate the application of this information to land management activities. When completed will provide searchable database for landcover, indices of biodiversity, and distribution and conservation status of terrestrial vertebrates:

www.gap.uidaho.edu/

Check your state for GAP status and access to database.

b. Specific References

1). Birds

a). Breeding Bird Survey Clickable Abundance Map

www.mbr-pwrc.usgs.gov/geotech/bbsmaps3.html

will allow you to determine what species are found in your area and their relative abundance.

b). Christmas Bird Count is an annual survey organized by The Audubon Socety and conducted by volunteers since 1900. Website maintained by Patuxent Wildlife Research Center provides background information on the survey and distribution maps for wintering birds based on CBC data:

www.mp1-pwrc.usgs.gov/birds/cbc.html

2). Mammals

a). Information on systematics, distribution, fossil history, genetics, anatomy, physiology, behavior, ecology, and conservation of 631 species of mammals provided by the American Society of Mammalogists:

www.science.smith.edu/departments/Biology/VHAYSSEN/msi/default.html

b). Lists of mammal species for selected states:

www.mammalsociety.org/statelists/index.html

c). Bats. Photos, distribution, and life history information for selected species:

www.batcon.org/ (Go to *Bat Links,* go to *Detailed Species Information).*

3). Amphibians

a). Searchable database for occurrences of amphibians:

www.mp2-pwrc.usgs.gov/ampCV/ampdb.cfm

b). Northern Prairie Wildlife Research Center website provides information on identification, distribution, and habitat associations for selected amphibian species:

http://npwrc.usgs.gov/narcam/idguide/index.htm

4). Fish

a). National Biological Information System's National Fish Strain Registry website contains information on managed fish strains, populations and broodstocks located throughout the United States:

http://159.189.37.201/

b). North American Native Fishes Association's website contains links to taxonomically structured indices of the freshwater fishes of North America:

www.nanfa.org/resources.htm

c). FishBase is a relational database that is available for purchase. However, considerable species account information is available for downloading from the website:

www.fishbase.org/home.htm

5). Butterflies. Butterflies of North America website contains distribution maps, photos, species accounts (information on size, identifying characteristics, life history, flight, caterpillar hosts, adult food, habitat, species range, conservation status, and management needs), and Species checklists for each county in the U. S., and state in northern Mexico:

www.npwrc.usgs.gov/resource/distr/lepid/bflyusa/bflyusa.htm#maps

2. Plants, Plant Communities

a. Plants – Comprehensive list of online plant and vegetation maps organized by state, region, country, and continent:

www.lib.berkeley.edu/EART/vegmaps3.html#noamer

b. Physiographic regions/vegetative alliances – NatureServe Explorer is source for information on ecological communities in the US and Canada:

www.natureserve.org/explorer/

c. Landcover - Gap Analysis Program (GAP) was undertaken to provide regional assessments of the conservation status of native vertebrate species and natural land cover types and to facilitate the application of this information to land management activities. When completed will provide searchable database for landcover, indices of biodiversity, and distribution and conservation status of terrestrial vertebrates:

www.gap.uidaho.edu/

Check your state for GAP status and access to database.

d. Trees by State. The Dendrology homepage at Virginia Tech provides tree identification fact sheets on over 450 species of trees, as well as lots of other tree information:

www.cnr.vt.edu/dendro/dendrology/map/zonemap.htm

3. Habitats

a. Riparian - Assessing condition of riparian wetland corridors at area-wide level using Proper Functioning Condition methodology:

www.wcc.nrcs.usda.gov/watershed/products.html

b. Corridors or buffers - Workbook for designing conservation buffers for wildlife at the landscape scale:

www.wcc.nrcs.usda.gov/watershed/products.html

c. Streams - NRCS Stream Visual Assessment Protocol:

www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf

4. Conservation Status of Fish and Wildlife Species

a. General References

1). NatureServe Explorer is a source for information on distribution, conservation status, life histories, and habitat requirements for over 50,000 plants, animals, and ecological communities in the US and Canada:

www.natureserve.org/explorer/

2). Gap Analysis Program (GAP) was undertaken to provide regional assessments of the conservation status of native vertebrate species and natural land cover types and to facilitate the application of this information to land management activities. When completed will provide searchable database for land cover, indices of biodiversity, and distribution and conservation status of terrestrial vertebrates:

www.gap.uidaho.edu/

Check your state for GAP status and access to database.

b. Aquatic Species - North American Native Fishes Association’s website contains links to taxonomically structured indices of the freshwater fishes of North America:

http://www.nanfa.org/resources.htm

5. Invasive Species

a. General – USGS website providing links to resources on nonindigenous plants and animals:

http://nas.er.usgs.gov/links.html

b. Specific

1). Aquatic – a central repository for accurate and spatially referenced biogeographic accounts of nonindigenous aquatic species. Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information:

http://nas.er.usgs.gov/ .

C. Fish and Wildlife Habitat Requirements

1. General

a. NatureServe Explorer is source for information on distribution, conservation status life histories, and habitat requirements for over 50,000 plants, animals, and ecological communities in the US and Canada:

www.natureserve.org/explorer/

b. Gap Analysis Program (GAP) was undertaken to provide regional assessments of the conservation status of native vertebrate species and natural land cover types and to facilitate the application of this information to land management activities. When completed will provide searchable database for land cover, indices of biodiversity, and distribution and conservation status of terrestrial vertebrates:

www.gap.uidaho.edu/

Check your state for GAP status and access to database.

c. Northwest Habitat Institute's website provides matrices for fish and wildlife habitat relationships for species found in Oregon and Washington. The site also includes an interactive Biodiversity Information System (IBIS):

www.nwhi.org/nhi/

2. Specific

a. Birds

1). Partners-in-Flight (PIF) provides a table showing availability and providing links to online species accounts for North American birds:

www.partnersinflight.org/birdacct.htm#Table

2). *Birds of North America — Life Histories for the 21st Century* provides detailed life history accounts for all North American birds. See

www.birdsofna.org

for description of information contained in species accounts. Note that BNA accounts currently are available only in printed format.

3). Wildlife Habitat Management Institute and Wildlife Habitat Council's Fish and Wildlife

Habitat Management Leaflets are available for selected species, species groups and habitats at

www.whmi.nrcs.usda.gov/technotes1.htm.

b. Amphibians - Partners of Amphibian and Reptile Conservation fact sheets for selected species:

www.parcplace.org/education/educational_materialsposters.htm

c. Fish - North American Freshwater Fishes Index - Images, distribution maps and life history information:

www.tmm.utexas.edu/tnhc/fish/na/naindex.html

D. Additional Ecological Datasets for Planning:

1. Watershed Boundaries

Hydrologic unit boundaries define the areal extent of surface water drainage to a point. The goal of this initiative is to provide a hydrologically correct, seamless and consistent national Geographic Information System (GIS) database at a scale of 1:24,000, that has been extensively reviewed and matches the USGS topographical 7.5 minute quads. The new levels are called **watershed (5th level, 10-digit)** and **subwatershed (6th level, 12-digit)**.

The watershed level is typically 40,000 to 250,000 acres and subwatershed level is typically 10,000 to 40,000 acres with some as small as 3,000 acres. An estimated 22,000 watersheds and 160,000 subwatersheds will be mapped to the 5th and 6th level. The GIS coverages will be available by the Internet to any person, including federal, state, local government agencies, researchers, private companies, utilities, environmental groups, and concerned citizens. The database will assist in planning and describing water use and related land use activities:

www.ftw.nrcs.usda.gov/huc_data.html

2. Soil Surveys

SOILS is part of the National Cooperative Soil Survey, an effort of Federal and State Agencies, universities, and professional societies to deliver scientifically based soil information. The USDA Natural Resources Conservation Service (NRCS) leads the National Cooperative Soil Survey and hosts this site:

http://soils.usda.gov

3. Spatial Data

http://fgdc.ftw.nrcs.usda.gov/NRCSgateway.html

II. Establishment and Management of Habitats

A. Terrestrial Habitat

1. General References

a. Printed sources

Bookhout, T. A. 1994. Research and management techniques for wildlife and habitats, 5th edition. The Wildlife Management Institute, Washington, D.C. 740 pp. ISBN 0933564-10-4.

Payne, N. F. 1992. Techniques for wildlife management of wetlands. McGraw-Hill, New York. 549 pp. ISBN 0070489564.

Payne, N. F. and F. C. Bryant. 1994. Techniques for wildlife management of uplands. McGraw-Hill, New York. 840 pp. ISBN 0070489637.

2. Specific References

a. Habitats

1). Riparian

a). Riparian Management Systems - A management approach for environmental enhancement of intensively modified agricultural landscapes:

www.buffer.forestry.iastate.edu/

b). Riparian Ecosystem Creation and Restoration: A Literature Summary-Riparian ecosystem information from 92 records (primarily published papers or reports) in the U.S. Fish and Wildlife Service's Wetland Creation/Restoration (WCR) Data Base was used to develop a literature summary of creation and restoration of riparian ecosystems. The summary provides an overview of the status of riparian ecosystems in the U.S., a discussion of several riparian functions, and a review of some techniques used for planning, implementing, monitoring, and measuring project success of riparian ecosystem creation/restoration efforts. Case studies of various riparian ecosystem creation or restoration projects are used to demonstrate these techniques:

www.npwrc.usgs.gov/resource/literatr/ripareco/ripareco.htm

c). National Academy Press. 2002. Riparian Areas: Functions and Strategies for Management. Washington, D.C. 428 pages. ISBN0309082951. Downloadable at

www.nap.edu/books/0309082951/html/

3. Technical Notes and Pamphlets

a. NRCS sources

1). Establishment of warm season grasses pamphlet (IN):

www.in.nrcs.usda.gov/PlanningandTechnology/biology/NATIVEGRASSPAMPHLET98.pdf

2). Establishment and Management of Forbs in Grass Plantings (IL). Go to Technical Notes in Technical Resources section of NRCS-IL website:

www.il.nrcs.usda.gov

3). Illinois' Buffers for wildlife job sheets for filter strip, riparian forest buffers, windbreaks and shelterbelts, grassed waterways, and field borders. Go to *Wildlife* in the *Information On* section of NRCS-IL website:

www.il.nrcs.usda.gov

4). Attracting Iowa wildlife - a guide for providing habitat on private lands (IA):

www.state.ia.us/government/dnr/organiza/fwb/wildlife/pages/plhabitatguide.htm

5). Recommendations for the establishment of vegetation on restored wetlands in the lower Mississippi River Alluvial Valley (LMRAV) based upon recent research and publications:

www.pwrc.usgs.gov/WLI/wrts1.htm

b. Extension Publications

1). Assortment of publications on Iowa's wildlife and natural resources:

www.extension.iastate.edu/pubs/wi.htm

2). Links to all state extension web pages:

www.ext.colostate.edu/links/linkexte.html

B. Aquatic Habitat

1. General references in print

a. Rehabilitation of Rivers for Fish: A study undertaken by the European Inland Fisheries Advisory Commission of FAO. I. G. Cowx and R. L. Welcomme, editors. 1998. ISBN 92-5-104018-4 (FAO). 260 pages.

b. Restoration of Aquatic Ecosystems. Science, Technology, and Public Policy. National Research Council. 1992. National Academy Press. 552 pages.

2. Specific references

a. Amphibians and reptiles

1). Center for Amphibian and Reptilian Management and Conservation site provides habitat management guidelines for amphibians and reptiles of the Midwest:

http://herpcenter.ipfw.edu/Outreach/MWHabitatGuide/

3. Technical Notes and Pamphlets

a. NRCS publications

1). Shallow water management job sheet (IN):

www.in.nrcs.usda.gov/PlanningandTechnology/Biology/646_jobsheet.pdf

2). Using Micro and Macrotopography in Wetland Restoration. Go to Technical Notes in Technical Resources on NRCS-IL website:

www.il.nrcs.usda.gov

3). Trout Management leaflet at:

www.whmi.nrcs.usda.gov/technotes1.htm

b. Extension publications

1). Assortment of publications on Iowa's fish and aquatic resources:

www.extension.iastate.edu/pubs/wi.htm

2). Links to all state extension web pages:

www.ext.colostate.edu/links/linkexte.html

III. Monitoring and Evaluation of Terrestrial and Aquatic Resources

A. Designing a Monitoring Program

1. General

a. Patuxent Wildlife Research Center's website provides basic information regarding the design of a monitoring program:

www.pwrc.usgs.gov/monitoring2/

2. Specific

a. Terrestrial

1). Birds

a). U.S. Forest Service publication entitled, " A land managers guide to point counts of birds in the Southeast," provides techniques for inventorying and monitoring populations of birds in southeastern forest habitats:

www.srs.fs.fed.us/pubs/viewpub.jsp?index=1594)

b). U.S. Forest Service publication entitled, " Monitoring bird populations by point counts," reviews technique for inventorying and monitoring populations of birds:

www.rsl.psw.fs.fed.us/projects/wild/gtr149/gtr_149.html

c). U.S. Forest Service publication entitled, " Handbook of Field Methods for Monitoring Landbirds," provides general summaries of techniques for inventorying and monitoring populations of landbirds

www.psw.fs.fed.us/Tech_Pub/Documents/gtr-144/gtr-144-cover.pdf

www.psw.fs.fed.us/Tech_Pub/Documents/gtr-144/gtr-144-content.pdf

2). Butterflies – Recently established census (since 2000) carried out by members (volunteers) of the North American Butterfly Association to monitor occurrences of North American butterflies:

www.naba.org/4july.html

b. Aquatic

1). Amphibians

EPA publication describing methods for evaluating wetland condition using amphibians:

www.epa.gov/waterscience/criteria/wetlands/amphibians.pdf

2). Fish and fish habitat monitoring protocol developed by the State of Oregon:

www.oregon-plan.org/monitoring/status.html

B. Monitoring Methods

1. Aquatic

a. The Wetlands Division of EPA's Office of Wetlands, Oceans, and Watersheds site providing introduction to why and how people monitor wetlands, handbooks, and manuals that offer detailed information on wetlands monitoring for the layperson.

1). A volunteer's guide for documenting quality assurance methods, project organization, goals and objectives with examples and references:

www.epa.gov/owow/monitoring/volunteer/qappcovr.htm

2). Estuary monitoring methods:

www.epa.gov/owow/estuaries/monitor/

3). Lake monitoring methods:

www.epa.gov/owow/monitoring/lakevm.html

4). Stream monitoring methods:

www.epa.gov/owow/monitoring/volunteer/stream/

5). An introduction and resource guide for wetland monitoring:

www.epa.gov/owow/wetlands/monitor/volmonitor.html

6). Methods, case studies, glossary, and publications for wetlands bioassessment:

www.epa.gov/owow/wetlands/bawwg/

7). Sampling Amphibians in Lentic Habitats. D. H. Olson, W. P. Leonard and R. B. Bury, editors. Northwest Fauna Number 4. Society for Northwestern Vertebrate Biology.1997. 134 pages.

C. Ongoing Monitoring Programs

1. Terrestrial

a. Birds

1). Project FeederWatch:

http://birdsource.cornell.edu/pfw/

2). Raptor Monitoring:

http://srfs.wr.usgs.gov/NARMS.htm

3). Breeding Bird Survey Summary and Analysis:

www.mbr-pwrc.usgs.gov/bbs/bbs.html

4). Bird Banding Laboratory:

www.pwrc.usgs.gov/bbl/

b. Butterflies

1). Recently established census (since 2000) carried out by members (volunteers) of the North American Butterfly Association to monitor occurrences of North American butterflies:

www.naba.org/4july.html

2. Aquatic

a. Amphibians

1). EPA publication describing methods for evaluating wetland condition using amphibians.

www.epa.gov/waterscience/criteria/wetlands/12Amphibians.pdf

b. Fish

1). The Multi-State Aquatic Resources Information Systems database provides long-term data on fish populations. In 2002, data was limited to lake fisheries. Beginning in 2003, stream fish population data will be available on a state-by-state basis:

http://fwie.fw.vt.edu/projects.htm#maris/

IV. Additional Resources

Scientific Journals

1. Links to Environmental Sciences Journals

www.esd.ornl.gov/journals.html

B. Directories

1. State Conservation Agencies

a. Links to state fish and wildlife departments:

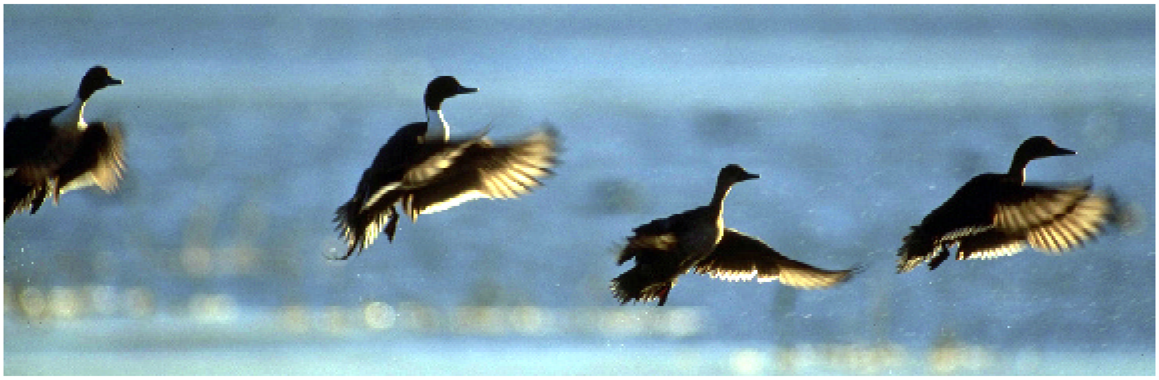
www.lib.washington.edu/fish/fandg/fandglist.html

C. Glossaries

1. Links to Online Dictionaries and Glossaries for Science and Technology

www.nbii.gov/datainfo/onlineref/dictionaries.html

Part 6XX.21 - Technical Guidance Documents



There is good deal of technical guidance information available to field personnel and conservation planners. NRCS state offices manage websites with links to state- and region-specific technical information regarding conservation of aquatic and terrestrial habitats.

Other technical documents that are useful to field office personnel for integrating biodiversity, fisheries and wildlife considerations into the conservation planning process are *technical notes* and *job sheets.* Both of these types of guidance documents are NRCS directives originating at the national, regional, state, and area office level. They are usually prepared entirely or in part by NRCS biologists or other technical specialists. Examples of these types of guidance documents are provided in the Exhibits.

A. Technical Notes

The fundamental purpose of a biology technical note is to provide information related to improving wildlife and fisheries habitat when assisting with conservation planning on private lands. Technical notes have been developed on many subjects found to be important to field office staff. In many instances the technical notes are developed specifically at the request of the field office to address a specific need. Generally, technical notes fall into four categories:

1. Tech Notes that highlight tools designed to restore, create, or enhance habitat.

   Exhibit A - Idaho Plant Materials Technical Note on the Waterjet Stinger.

2. Tech Notes that take national guidance and develop it for use in a particular state.

   Exhibit B - Hawaii Biology Technical Note and Transmittal Letter providing state instructions for implementing national guidance on the Stream Visual Assessment Protocol.

3. Tech Notes that provide technical information, for example, state Heritage Databases, or Threatened and Endangered Species lists to the conservation planner.

Exhibit C - Hawaii Biology Technical Note demonstrating the use of ArcView and Toolkit to access the state Heritage Database.

Exhibit D - Kentucky Biology Technical Note listing T&E species by county.

Exhibit E - Kentucky Biology Technical Note listing FOTG practice effects on T&E species.

4. Tech Notes that highlight techniques designed to restore, create, or enhance habitat.

Exhibit F - Indiana Biology Technical Note on developing macro-topography and micro-topography in wetland restoration.

5. Technical Notes that provide guidance on how to evaluate habitat conditions.

Exhibit G - Fish Assemblages as Indicators of the Biological Condition of Streams and Rivers
www.pwrc.usgs.gov/wli/

Exhibit H - <Reserved> Stream Visual Assessment Protocol
www.wcc.nrcs.usda.gov/water/quality/common/svapfnl.pdf

B. Job Sheets

The purpose of a biology job sheet is to provide the " how to" information necessary to create, restore, or enhance the fish and wildlife habitat when developing a conservation plan for the landowner. Job sheets, in general, are associated with standards and specifications for specific conservation practices in the FOTG and become a part of the landowner's conservation plan.

Although development of biology job sheets is the responsibility of the NRCS biologist, interest in fish and wildlife habitat development on working lands is important to many conservation partners. Involving these partners in the process of developing job sheets can improve the content and enhance the partnership.

The Wildlife Habitat Management Institute undertook a pilot project to evaluate this technique in six states (Illinois, Maryland, North Carolina, South Dakota, Texas, and Utah) in 1998.

Each of the states hosted a facilitated workshop to gather the information and design the job sheets that would work for the NRCS State Office as well as include components important to our conservation partners. The process, although challenging, was supported by all and viewed as a commitment to considering fish and wildlife habitat in conservation planning. Although such extra effort is often viewed as unnecessary to develop the technical document, it is extremely valuable for gaining support.

The following are examples of job sheets for the same practice from different states to illustrate the multitude of options available to accomplish the same task across the varied landscape in the United States.

1. Field Border—Practice Code 386

Exhibit I - Illinois Job Sheet
Exhibit J - North Carolina Job Sheet
Exhibit K - Texas Job Sheet
Exhibit L - Georgia Job Sheet
Exhibit M - Utah Job Sheet
Exhibit N - Maryland Job Sheet

C. Other Technical Guidance References

NRCS state offices, and National Institutes and Centers, develop technical guidance materials for internal and external use by partners and clients. In particular, the following NRCS web sites provide excellent technical information for aquatic and terrestrial habitat considerations:

Wildlife Habitat Management Institute:
www.whmi.nrcs.usda.gov

Watershed Science Institute:
www.wcc.nrcs.usda.gov/watershed/

Soil Quality Institute:
http://soils.usda.gov/sqi/

Wetland Science Institute:
www.pwrc.usgs.gov/WLI/

NRCS Plant Data Center:
http://plants.usda.gov/

NRCS New Hampshire is a good source of information regarding salt marsh/estuarine ecosystems of New England:
www.nh.nrcs.usda.gov

NRCS Minnesota:
www.mn.nrcs.usda.gov/mnres.html/

NRCS Montana: See especially " Creating Native Landscapes"
www.mt.nrcs.usda.gov

Lastly, see Part 6XX.20 for additional sources of technical guidance documents.

Part 6XX.30 - Exhibits

Riparian/Wetland Project Information Series No. 17
January, 2001

Waterjet Stinger:

A tool to plant dormant unrooted cuttings of willows, cottonwoods, dogwoods, and other species

J. Chris Hoag, Wetland Plant Ecologist, **Boyd Simonson**, Biological Technician; **Brent Cornforth**, Biological Technician, and **Loren St. John**, PMC Team Leader. USDA - Natural Resources Conservation Service, Plant Materials Center, Aberdeen, ID 83210

Introduction

Opportunities for riparian revegetation around the nation are numerous. Planting dormant unrooted cuttings often called pole plantings, post plantings, or live stakes is one technique that is often recommended for streambank stabilization and riparian buffer planting. This method is limited to species that can easily sprout from hardwood cuttings, such as: willows, cottonwoods, and dogwoods. There are other species that will sprout from hardwood cuttings, but do not root as readily.

Dormant unrooted cuttings are used because they are easy to harvest, easy to plant, inexpensive, and effective. In the arid and semi-arid West, it is extremely important that any plant that is installed in a riparian zone have its roots in the lowest watertable of the year. This is often difficult when using bareroot or containerized plants especially when the riparian zone has been dewatered to the point that the water table may be several feet below the soil surface. Unrooted cuttings have been planted as deep 12 ft (average depth is about 5-6 ft) by the Riparian/Wetland Plant Development Project at the Aberdeen PMC using a long bar attached to a backhoe (Hoag and Ogle 1994). Most riparian and stream protection projects require planting depths of 3-6 ft. The biggest problem we faced was finding a method and developing equipment that could dig a hole more than 3-4 ft deep quickly and efficiently. The Waterjet Stinger is the result of this equipment development effort.

To plant unrooted cuttings successfully, the bottom of the cutting should be placed about 8-12 in into the lowest watertable of the year. The top of the cutting should extend out of the ground at least 10-12 in or high enough to be out of the shade cast by surrounding vegetation such as grasses or forbs. This allows the bottom of the cutting to act like a straw and pull water up the cutting keeping the roots, stems and leaves hydrated. In some riparian zones, the lowest water table of the year can be several feet deep.

Waterjet Stinger

The Waterjet Stinger was specially designed to use high-pressure water to hydrodrill a hole in the ground to plant unrooted hardwood cuttings into riparian revegetation. This is not new technology, in fact, it has been around for a long time. Oldham (1989) described a water drill that he used to drill holes in the ground to plant stem and pole cuttings 4-5 ft deep. His hydrodriller was a steel pipe that was beveled at the bottom and was hooked up to a "water tank (spray rig) or portable pump." Drake and Langel (1998) reported using a water jet tool to plant willow cuttings. They designed a nozzle that is made out of stainless steel welded to a steel pipe. They used a high-pressure pump and the nozzles to plant cuttings over 2 meters deep. An engineering technician in Manitoba, Canada (Andrews, personal communication) described working with a water jet to drill holes for geotechnical test holes ten years ago. He indicated that they had taken a steel pipe and pounded the end flat to increase the water pressure. These earlier jets did not last very long because the pounding tended to weaken the steel.

The advantages of using the waterjet stinger to drill a hole for planting unrooted willow and cottonwood cuttings are:

1) simple to operate and transport
2) little training necessary to operate
3) hydrodrilling the planting hole is fast
4) plant large number of cuttings in a short period of time
5) allows cutting to be planted directly into a wet environment
6) allows for saturated soil conditions to surround the cutting for a longer period of time
7) liquefied soil will settle around the cutting eliminating air pockets in the rooting zone

Based on a request from Scott Henderson, an Idaho NRCS Field Office employee, and others, Boyd Simonson, PMC Biological Technician, used the paper written by Drake and Langel (1998) and attempted to modify their design to better fit the coarse soils in the Intermountain

West. He started with the actual probe itself. Drake and Langel (1998) provided a detailed drawing of the nozzle (see Appendix A). A local machinist used the detailed drawing to build the nozzle out of stainless steel and welded it to a ½ in steel pipe. Boyd added a T-handle at the top to help with the planting operation and a ball valve at the handle to turn the water on and off.

Waterjet Nozzle

It took quite a bit of research to come up with the right size pump. . Drake and Langel (1998) describe a "cube" pump, but we had difficulty finding anything with that name. We determined that the basic specifications for the pump were:

1) gasoline powered
2) small enough to fit on the back of an ATV
3) output of at least 80 psi or higher
4) 120 gallons/minute output
5) vertical lift of at least 18 ft

Handle with ball valve

There are many different pumps that meet these specifications available on the market.

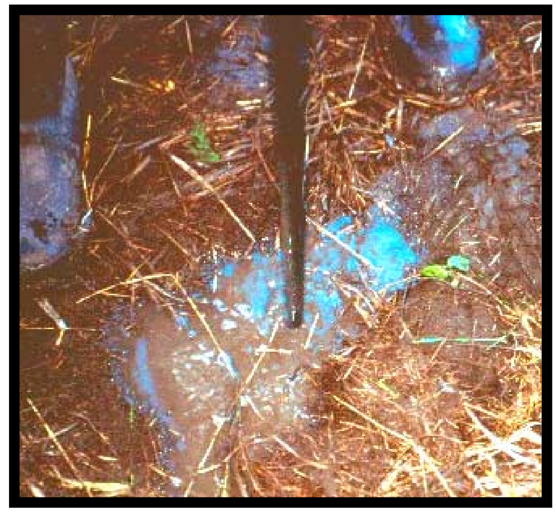
Next, Boyd felt that for safety's sake, a pressure relief valve should be installed so when both waterjets were shut off, the water from the pump would bypass back into the stream or other water source. This would decrease the pressure on the pump and eliminate turning the pump on and off. A manifold was designed to fit on the pump to allow the water to flow from the stream to either the waterjet stingers or to the bypass hose. When a certain internal pressure is reached inside the manifold, the water will divert to the bypass hose and back into the stream automatically.

Garden Hose Quick Coupler Manifold

The garden hose quick coupler manifold allows two waterjets to run simultaneously. It is attached to the main manifold just past the pressure relief valve. Quick couple attachments (available at most lawn and garden stores) are used to keep the connections simple, reduce the possibility of stripping the treads on the hose ends, and to allow the hoses to be hooked up in either direction. Water is delivered through heavy-duty 5/8 in garden hoses with a pressure rating of 100 psi that are 100 ft long. The hoses run from the garden hose quick couple manifold to the waterjets.

At the planting site, the hoses are laid out parallel to the stream channel. The two waterjets can be operated with two separate crews. One crewmember runs each waterjet and the other crewmembers transport the cuttings and push them into the holes after they are hydrodrilled. As the holes are hydrodrilled and planted in the 200 ft length, the ATV with the waterjet stinger pump is driven further down the streambank and the process starts all over again. If the streambank is too high and the lift is too great to get water from the stream to the pump, the pump can be dismounted from the ATV and placed on a flat shelf that is cut right into the streambank. This way the pump is placed closer to the water and the lift is reduced.

Planting Process



Once the pump is set up and pushing water to the waterjets, hydrodrilling holes can begin. Planting sites with vegetation are scalp down to mineral soil to get rid of competing above ground biomass. The waterjet is placed in the center of the scalp and the ball valve is turned on. At this point most beginning users get nervous about being splashed with water. We have found that water rarely splashes up, rather it tends to bubble as it liquefies the soil. Splashing might occur if the hydrodrilling is attempted on soils that are crusted or have a hard layer. However, as soon as the waterjet goes through the surface layer of soil, the splashing is eliminated (except in rocky soils).

After turning on the ball valve and the water starts jetting out of the nozzle, the waterjet will slowly start sinking into the ground. If a hard layer is encountered, the waterjet will stop. If the user leaves the waterjet in place and let the water work on the layer, eventually it will go through it. We have demonstrated this with several demonstration projects from a site with a 6 in hard calcic layer to a site with a 2 ft thick layer of decomposed granite. If medium sized rocks (with lots of fines around them) are encountered, the user must wiggle the jet back and forth until the water can find a way around it. This does make a larger hole below the surface, but the liquefied soil will normally settle back into place after the cutting has been installed.

As the waterjet liquefies the soil, it will continue down until it hits something it cannot cut through, the T-handle hits the ground, or the user stops. We have held the waterjet at a stationary point to have the water cut further into the soil. We have been able to duplicate Drake and Langel's (1998) depth of 6.6 ft (2 m). The depth the waterjet will penetrate depends mainly on the soil texture and the length of the probe.

As the user pulls the waterjet back up out of the hole, the nozzle should be rotated back and forth to increase the size of the hole. The rotation should continue the entire length of the hole from the bottom to the ground surface. The waterjet probe is ½ in diameter and the user should be planting at least ¾ in diameter or larger cuttings (Bentrup and Hoag 1998, Hoag 1993). In order to get larger diameter cuttings in the hole, the soil needs to be liquefied all the way to the soil surface.

Once the hole has been hydrodrilled, the single cutting or a bundle of three to four cuttings can be pushed into the hole. The longer one waits to shove the cutting into the hole, the higher the chance there is to for the suspended sediment to settle to the bottom of the hole. This will limit the depth that the cutting can be pushed to.

An alternative option is to start the hole with the waterjet and then place the cutting or bundle right next to the waterjet pipe and push both the waterjet and the cuttings into the hole at the same time. If done properly, the cutting or bundle will go down as the waterjet liquefies the soil. If the cutting hits a tight spot, the operator will immediately know it and he can spiral the nozzle around a little to loosen the obstruction. A word of caution - make sure that the cutting does not extend past the nozzles or the pressurized water will cut the bark off.

One problem that we have observed is that if there is a coarse soil layer under a layer of fine textured soil, when the waterjet drills into this coarse layer, the water in the hole will drain out into the coarse layer. This will defeat the purpose of planting the cuttings into a slurry to eliminate air pockets. Pulling the waterjet nozzle up to just above the layer will allow sediment to settle back into the bottom of the hole and seal it again.

We have found that a three-person team per waterjet works very well for the planting process. One member of the team runs the waterjet, the other two members haul the cuttings and shove them in the holes. The team members can rotate jobs through the planting day to keep everyone fresh and interested in the planting job. An extra person to transport the cuttings from the soaking location to the planting location with another ATV will speed the process up. The speed of the entire planting process will depend upon the soil, the labor force, and the cutting or bundle sizes.

Once the cutting is shoved into the hole to the depth of the low water table, the sediment will start to settle around the stem. It is important that the operator not allow significant amounts of sediment to bubble up out of the hole while drilling. The more sediment that is allowed to bubble out, the more sediment that will have to be replaced after the water moves out into the surrounding soil. After planting, the planting team needs to return to each of the stems and replace soil that bubbled out and created a depression around stem. The depression is cause by the sediment settling in and compacting around the stem. By replacing soil around the stem, it is possible to provide more opportunity for root development in the upper part of the soil profile. When replacing the soil, use a mud slurry or tamp shoveled soil around the stem to prevent air pockets.

Safety

We would be remiss if we did not mention safety. Before the start of each planting session, safety concerns should be discussed with the planting team members. This ensures that proper safe working conditions are fresh in everyone' s mind before starting to work. Potential safety problems that might occur can be discussed. The proper response to these problems can then be considered. This helps everyone know what to do if problems actually occur.

The water coming out of the waterjet nozzles is concentrated and under extremely high pressure. If the waterjet nozzle were ever pointed at a foot or hand, it could cut through a boot or glove and into the skin. Severe damage could occur if the nozzle were pointed at the face, eyes, or any unprotected part of the body. The waterjet stinger is not a toy and should always be operated by, or at least supervised by, an experienced, mature adult. Caution should always be exercised around the pump. Inspect the hoses regularly to ensure that they are not kinked, cut, or abraded. The quick couple hose attachments should be tested several times during the operation of the waterjet stinger to ensure they are firmly attached. If for some reason the hoses are disconnected from the waterjets, shut the pump down immediately to ensure the metal tipped ends do not whip around and hurt one of the team members. It is much better to anticipate and discuss safety concerns than to heal the wounds caused by a mistake or faulty equipment.

Summary

The waterjet stinger is easy to operate and transport. Very little training is necessary to operate the waterjet stinger. The pump intake should be placed in a fairly sediment free location in the streambed to operate properly. Hydrodrilling a planting hole with the waterjet stinger is fast and relatively splash-free. A large number of cuttings can be planted in a short period of time with very little effort compared to conventional planting methods. Planting into a hole filled with water allows each cutting to be planted directly into a wet microenvironment. The liquefied soil will settle around the cutting eliminating air pockets in the rooting zone that prevent root growth. In addition, the waterjet stinger creates saturated soil conditions around the cutting for a longer period of time. This means the cutting is in the best microenvironment to produce the largest and most desirable root mass possible, which in turn means that the establishment success rate will increase.

Overall, the waterjet stinger is relatively inexpensive when compared to other planting methods. The PMC prototype waterjet stinger cost about $1000 for parts (see Appendix B) and labor to build it was about $500 for a total of about $1500. The design layout was planned to make the entire piece of equipment as simple as possible to build and operate. The most complicated part is putting the manifold together and this only takes about a half-hour. All of the parts can be ordered or purchased locally, except the pump. An experienced machinist can build the waterjet nozzle in a couple of hours with the plans provided in this paper. Once the parts are purchased and delivered, the entire waterjet stinger can be assembled in less than a day.

The waterjet stinger is not new technology, but we have taken it to another level. We have included all the information necessary for a person to build one. After it has been built, it will take some experimentation and experience in your particular soils and conditions to figure out the best way to hydrodrill your planting holes.

More information can be obtained by calling Chris Hoag at 208-397-4133 or Boyd Simonson at 208-397-4501. For those people who have access to the Internet, email messages can be sent to choag@id.usda.gov .

Brent Cornforth demonstrates the Waterjet Stinger at a training session

Acknowledgements

The development of the Waterjet Stinger would not be possible without the support and the generous financial assistance provided by the South Bingham Soil and Water Conservation District, Gem Soil and Water Conservation District, Squaw Creek Soil and Water Conservation District, the Camas Soil and Water Conservation District and Dick Scully (Regional Fisheries Biologist), Southeast Region, Idaho Department of Fish And Game.

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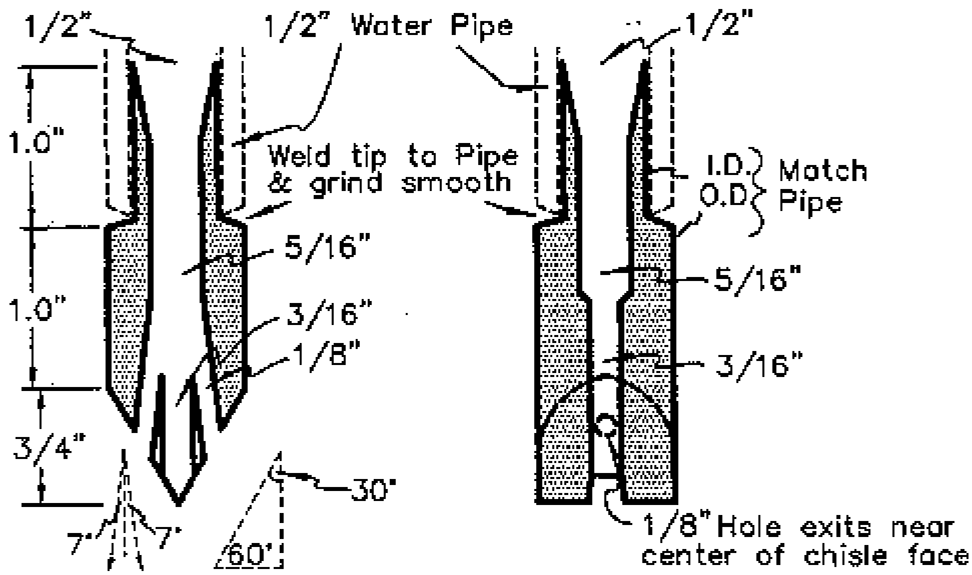
Hoag, JC. 1993. *How to plant willows and cottonwoods for riparian rehabilitation*. USDA Natural Resources Conservation Service, Idaho Plant Materials Technical Note No. 23, Boise, ID. 12 pp.

Oldham, JA. 1989. The hydrodriller: an efficient technique for installing woody stem cuttings. Society of Ecological Restoration and Management annual meeting, Oakland, CA. Jan. 16-20, 1989. 6 pp.

APPENDIX A: DETAILED DRAWING OF THE WATERJET NOZZLE TIP FROM DRAKE AND LANGEL (1998).



Pictures of the stainless steel nozzles that were welded to ½ in steel pipe. The stainless steel is expected to increase the life of the waterjet. A machinist built the pipe, handle, and nozzles as a single unit. The ball valve is added by the end user.

APPENDIX B: LIST OF MATERIALS FOR THE ENTIRE WATERJET STINGER.

Name of item	Number	Cost
Manifold parts		
1 ½ inch pressure relief valve	1	115.00
2 inch galvanized metal Tee	1	$6.99
1 ¼ inch galvanized metal Tee	1	3.89
1 ¼ inch to 1 inch galvanized metal reducer	2	2.79
2 inch to 1 ½ inch galvanized metal reducer	2	3.29
3 inch long 1 ½ inch galvanized metal nipple	1	1.59
3 inch long 1 ¼ inch galvanized metal nipple	1	1.19
2 inch to 1 ¼ inch galvanized metal reducer	1	2.79
1 ¼ inch to 1 inch galvanized metal reducer	1	2.55
Suction and Bypass parts		
2 inch Plastic hose for suction and discharge	40 ft	38.00
2 inch Female pipe to female hose-coupler	2	14.55
2 inch male pipe to male hose king nipple	2	2.95
2 inch female pipe to male hose king nipple	1	5.30
2 inch male hose to female hose coupler	1	14.85
2 inch male to male hose end	1	6.25
2 inch Hose clamps for plastic hose	3	2.70

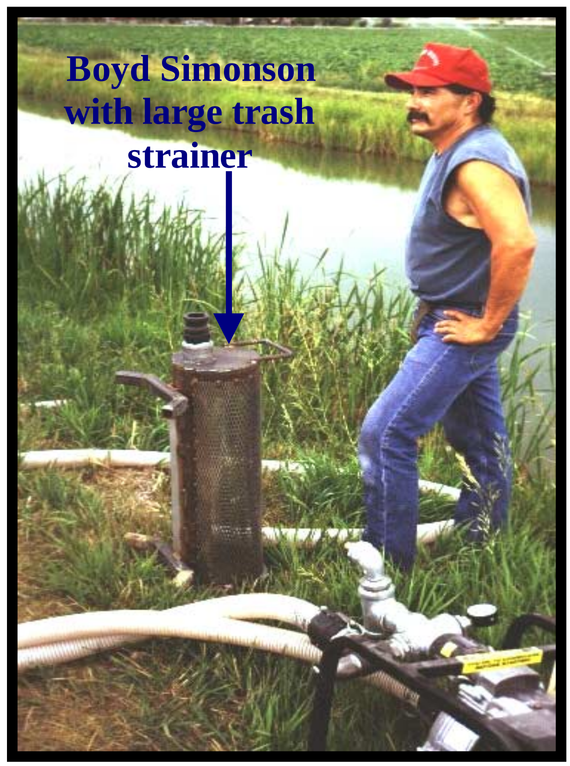
Waterjet Stinger Manifold

Garden hose quick coupler manifold

Name of item	Number	Cost
Waterjet parts		
1 inch Ball valves	2	9.99
Male Garden hose quick couplers	2	5.99
Female Garden hose quick couplers	2	5.99
1 inch Pipe to Hose adapter	2	2.59
Heavy duty 5/8 inch garden hose (100 psi rated)	200 ft	120.00
Waterjets, manufactured by machinist	2	180.00
Waterjet pump		
Pump and Motor (see Appendix C, excludes freight)	1	410.00
Roll cage for pump	1	50.00
Total without labor (costs as of 01/2001**)**		**$1003.60**

APPENDIX C: HIGH PRESSURE GASOLINE POWERED PUMP SPECIFICATIONS

Note: Metal cage around the pump and motor was purchased separately.



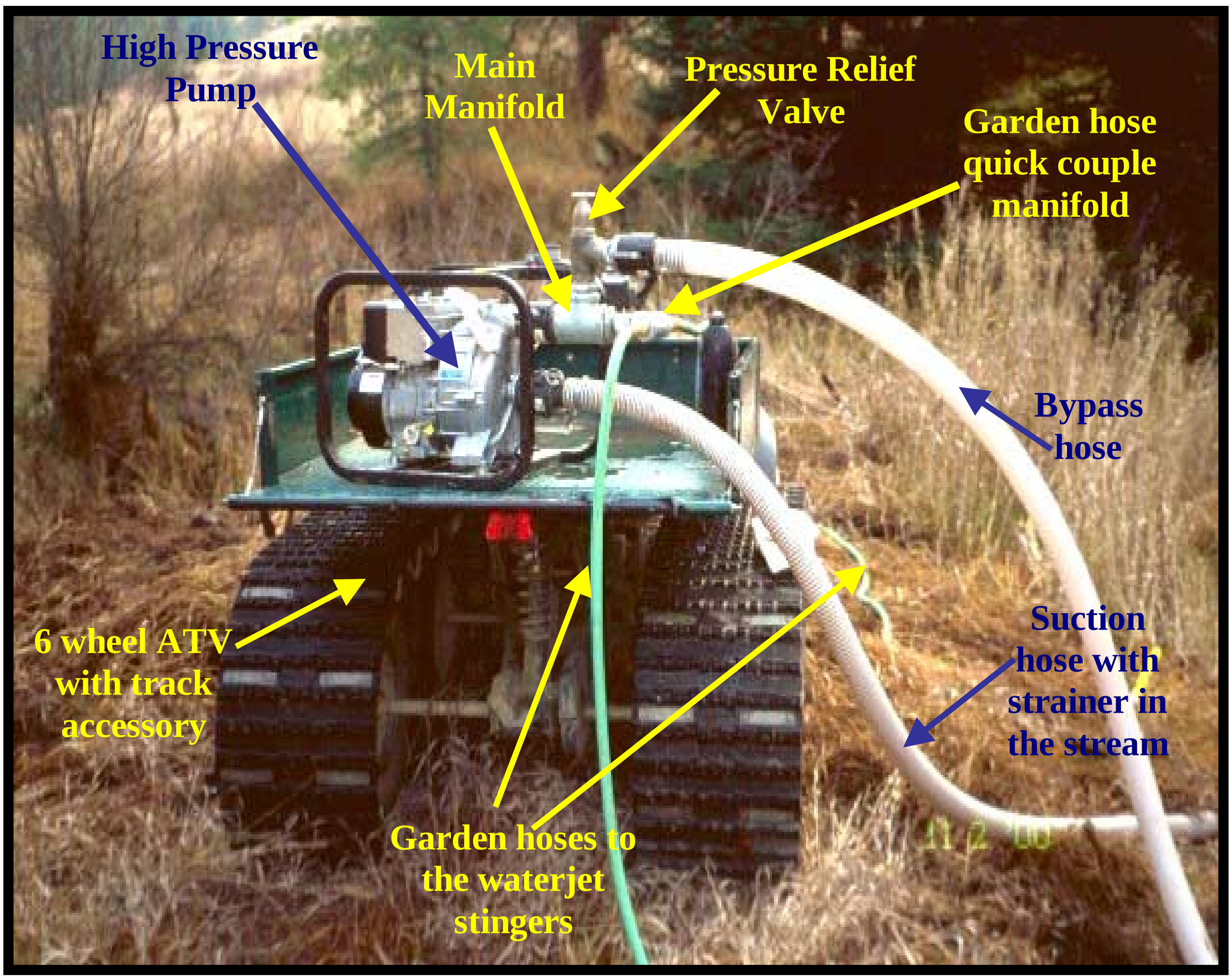
Specifications

- 5 HP Gas powered High pressure pump
- 7200 GPH, 200 foot head, 88 psi max
- Vertical lift 18 ft
- Self priming pump with 2 inch NPT suction and discharge ports
- Aluminum closed impeller
- Cast aluminum housing
- Cast Iron volute
- Built-in check valve
- Water and trash pump strainer 2 in included
- 64 pounds

Note: Trash Strainer shown was built for large stream systems so it could be perched above the stream bottom and was heavy enough not to move with the stream current. The pump was shipped with a small strainer that attaches to the end of the suction hose for use on smaller stream systems (Not shown).

APPENDIX D: AN ILLUSTRATED DIAGRAM OF AN OPERATING WATERJET STINGER

The waterjet stinger is sitting on a large 6-wheel ATV during a workshop in Lapwai, ID on Little Lapwai Creek. The 6-wheel ATV is larger than what is necessary to transport the waterjet stinger. The track option for the ATV is not necessary.



Hawaii Stream Visual Assessment Protocol

USDA
Natural Resources Conservation Service
January 31, 2001

VERSION 1.0

GUIDANCE DOCUMENT

FOR COMPLETING THE FORMS:

EQUIPMENT LIST

Rubber boots, tabis or footwear that can get wet
Measuring tape (100m water resistant one is the best; 30 meter or 100 foot tape will do. Ensure you use same measurement units for all.
Meter or Yard Stick (for depth measurements)
Calculator
Watch with second count
Temperature probe (F or C)
Velocity meter or Guava /ora nge peels (for velocity test)
Flow meter (optional)
Sunscreen
Mosquito Repellant

OVERVIEW DATA SHEET:

Date/Evaluator(s)/Stream Name/ etc. – Fill out the top of the form. The Hydrologic/Watershed unit number and acres can be obtained from the NRCS Arcvi ew database (Currently, Field Office staff should contact State Office GIS staff for this information if you do not have the information on hard copy maps).
Stream Order – This refers to the stream's connection to the ocean. First order streams would d irectly flow into the ocean; second order streams would feed into that stream that flows directly into the ocean; etc. Most streams in Hawaii are 1^{st}, 2^{nd}, or 3^{rd} order streams. Note Yes/No if stream is tributary (connected to the ocean)
Fish Species/Endangered /Flow/Water Quality/Ownership/Major land use – Check the appropriate maps and databases, as applicable or available. There also may be Environmental Assessments or EIS' completed on the stream that would be helpful. Check OEQC or with County Plann ing. Evaluation of other land uses in the watershed is important for later determining restoration activities. Also, the client and other landusers in the area may have knowledge about the history, land uses, aquatic habitat, etc, so always query them.
Other Comments – If there have been other evaluations of the stream conducted, these should be mentioned and attached. Other comments might include landowner's participation in USDA programs, etc.

SCORING DATA SHEET:

CHARACTERIZATION

The following inf ormation will introduce the overall description of the stream reach being evaluated. These data can be used to follow changes over time (e.g. temperature fluctuations or substrate changes). Also, some of the information will be used in the second section , when you evaluate and "score" specific stream elements.

Date/Time/Weather/Stream Name/Surveyors – Fill out the top of the form. For weather, note approximate air temperature, cloud cover, precipitation, and wind.
Reach ID – The Reach ID is a number or letter identifying the reach on a quad map or other map of the stream. For this protocol, the length of the assessment reach is 20 times the active channel width, or a minimum of 100 meters/300 feet; maximum 300 meters/900 feet. The reach (es) to be samp led should be identified after the Overview is done and areas are looked at on aerial photos. Reaches should be representative —that is, there should not be a major change within the same reach (e.g. break into two reaches estuarine part of the stream vs. the upper part).
Stream Type – There are numerous kinds of classification systems. The recommended system for this protocol is one developed by Montgomery and Buffington. It recognizes six classes of alluvial channels – cascade, step-pool; plane -bed; riffle/pool, regime, and braided (based in large part on stream gradient). See the attached stream classification sketches, and pick the one that best fits the situation.
Segment Length – Measure or estimate the channel length (in meters or feet) of each S egment or habitat unit being evaluated (typically 20 meters, which is 100 meters divided by 5, or 60 feet, which is 300 feet divided by 5). Most categories evaluate the entire Segment. The number of Segments depends on the size of the reach (minimum thre e per reach; five is typical; more is better).

Temperature – Use a hand-held thermometer in at least 3 places in the Segment (include shady and open canopy areas if they occur within the segment), get an average, and enter the current stream temperature in Fahrenheit or Celsius. If the time of day for temperature measurement is different than time recorded at top of the form, note the time as well.
Substrate Composition – To estimate this important characteristic, split your segment equally into four plots (e.g. mark off every 5 meters on your 20 meter tape), visually assess substrate within the 5 meter rectangle by estimating cover/composition. Use the following definitions of terms for substrate:

- Silt/Clay – very fine sediment
- Sand – like beach sand
- Gravel – larger than sand; smaller than your thumbnail
- Cobble – larger than your thumbnail, smaller than your fist
- Rock – larger than your fist, smaller than your head
- Boulder – larger than your head or basketball
- Bedrock or concrete bottom – natural solid rock base or human-made concrete/rock bottom (circle which one)

Use the attached Munsell chart as a guide to assess cover. Make tally marks (or a dot count tally) of the top two dominant substrates per plot. If only one substrate dominates the plot, make two marks for that kind of substrate. Then add up tally marks for each kind of substrate and divide that number by 8 to get the overall percentages per substrate type. Also note the composition of the bank materials in "remarks" section.
Embeddedness – Embeddedness measures the degree to which cobble substrate is surrounded by fine sediment (sediment load in streams). It can relate to the suitability of the stream substrate as habitat for macroinvertebrates and fish, or show effects of sedimentation from the upper watershed. It can only be evaluated in riffle and run habitats. One to four representative sites in these types of habitats should be chosen along the Segment. If there are no riffles or runs, write "No RI or RU". If there are, measure the depths to which objects are buried by sediment. This assessment can be accomplished by picking up gravel or cobble with your fingertips and estimating what percent of the stone was buried. At least 50 measurements should be taken, then averaged to produce the overall percentage of embeddedness. Use the back of the scoresheet to document and average your 50 measurements.
Bank Vegetation –Estimate the percentage cover of trees, shrubs/saplings, herbaceous, leaf litter or bare bank viewed upstream along the left and right bank. Look at the area directly adjacent to the stream and use the following definitions of terms:

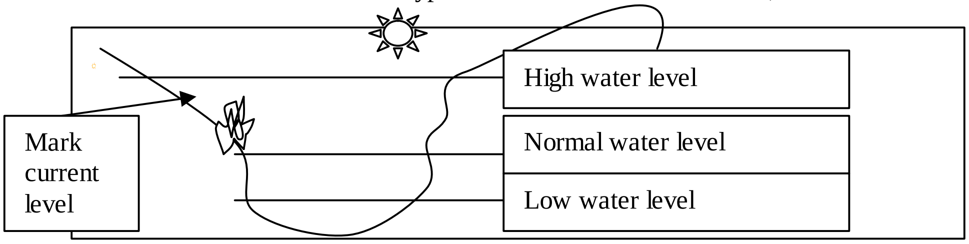
- Tree = a woody plant > 3.0 inches in diameter at breast height.
- Shrub/Sapling = a woody plant < 3.0 inches in diameter at breast height and > 3.2 feet in height.
- Herbaceous = all non-woody plants, regardless of height, and woody plants < 3.2 feet in height.

You should look downstream along the left and right bank of the Segment. In "notes" at the bottom of the page, list the dominant plant species for each segment and any notes about shallow or deep roots. Look at the area directly adjacent to the stream (along the banks). Ground coverage, not canopy, is what you should be estimating.
Average % Canopy/Shade – Record the average percentage of canopy cover over the active stream channel (where the water typically is, not the riparian area). You can either use a densiometer over the active channel, or visually assess the relative amount of shading or concealment of the stream by vegetation. For wide streams/rivers, do not consider the area where no shade is possible. The Munsel Chart guide can be used to visually assess this element.
Average Actual Width -- Cross section widths can be measured by a measuring taped stretched perpendicular to the stream flow across the stream at the normal water level. At least five measurements across the stream should be taken and averaged. Note average on form
Velocity and Depth – To determine velocity, two methods can be used. (1) a guava (or an orange) can be dropped at the top of the segment and timed to the end of the segment to get meters per second, then multiply by a roughness factor of either 0.6 (for rough boundaries) or 0.8 for smooth channels. This multiplier is important, since the guava will find the path of least resistance, and velocity in the channel varies. Do this at least ten times and take an average of the scores. OR (2) use a velocity meter at the same crossing where you measure depth. To determine depth, take at least ten measurements with your yard or meter stick at the same locations where you measured width, and average the scores.
Flow Status- Compare the current water level to the normal water level, and record as high, normal, or low. The normal water line is the line on the bank created by natural level fluctuation as evidenced by destruction of terrestrial vegetation, litter/debris lines, shelving, and changes in soil characteristics. Circle High/Normal/Low.

- High = if upland vegetation or area typically dry is submerged
- Normal = if water level appears to be within normal flow fluctuations
- Low = if water level is significantly lower than normal, as seen by bare areas exposed or wetland vegetation exposed and dead or dying.

Flow – If you have a flow meter, use it in at least your five transect plots used to assess substrate and get an average flow in cubic meters per second. If you do not have a flow meter, take the area of the cross section (your average depth multiplied by your average width) and multiply this number by your velocity number to get cubic meters per second.

Channel Cross-Section – Sketch a typical cross-section of the stream, such as:



THE TEN SCORED ELEMENTS

SCORING

This section involves evaluating different elements of the stream and documenting a score (from 0 to 2.0, low to high rating). Use the "Scoring Sheet for the Elements" for the rating. The total all of the scores recorded will be divided by the number of elements rated for the average score (typically 10, unless for instance embeddedness is not scored because there were no riffles or runs in the Segment). A general stream rating can be obtained from this score. This score can be compared over time, if more than one evaluation is done, or by segment, to determine most degraded or best segments for future restoration. Not only should this overall score be regarded. The evaluation of each scored element should be carefully assessed to determine the degraded elements in the system and to identify potential restoration actions.

1. TURBIDITY

Clarity of the water is an obvious and easy feature to assess. The deeper an object in the water can be seen, the lower the amount of turbidity. Use the depth that objects are visible only if the stream is deep enough to evaluate turbidity using this approach. For example, if the water is clear, but only 20 cms deep, do not rate it as if an object became obscured at a depth of 20 cms. This measure should be taken after a stream has had the opportunity to "settle" following a storm event. This element cannot be measured after recent heavy rains (come back to the site another day). Recognize that organic acids can create tea-colored water; this is not turbidity and should not be counted as turbid. Identify the condition and note the score on the datasheet.

2. PLANT GROWTH

Water that has slight nutrient enrichment may support communities of algae, which provide a greenish color to the water. Streams with heavy loads of nutrients have thick coatings of algae attached to the rocks and other submerged objects. Floating algal mats, surface scum, or microbial sheen (ferri hydrite) are indicators of a eutrophic stream. Note the level of plant/algal growth on the datasheet.

3. CHANNEL CONDITION

Changes in the channel may affect the way a stream naturally does its work, such as the transport of sediment and water, and the development and maintenance of habitat for fish, aquatic insects, and aquatic plants. Some modifications to the stream channels have more impact on stream health than others. And some stream types are more sensitive to management stress than others. For example, riprap along the sides and bottom of the Segment can affect a stream more than channelization. Active downcutting and excessive lateral cutting are serious impairments to stream function. Both conditions are indicative of an unstable stream channel. Usually, this instability must be addressed before committing time and money toward improving other stream problems. Extensive bank-armoring of channels to stop lateral cutting usually leads to more problems (especially downstream). To score this element, pick the condition that best characterizes the Segment and document the score on the data sheet.

4. CHANNEL FLOW ALTERATION

Water withdrawals from the stream affect habitat conditions and change the biological and geomorphological conditions of the stream. Temporary diversions are those that are not meant to last (e.g. small rock diversions for taro that would blow out during a normal storm event). Intermittent withdrawals are those that are occasional or periodic. Any flow alterations outside of the segment should not be counted in this element; instead, note distant diversions/inputs in the "Overview" sheet. If temporary or intermittent, the score should reflect also the amount of water being taken, scoring higher within the range if minimal water is being diverted. Also note if there are inputs, such as stormwater outfalls or culverts in the segment. Record score on the data sheet.

5. PERCENT EMBEDDEDNESS

Review your average number in the Characterization Section on "Percent Embeddedness", Pick the appropriate percentage and note the score on the data sheet. If there were no riffles or pools in the segment, do not score this (and divide total score by 9 instead of the 10 elements)

6. BANK STABILITY

This element is the potential for soil erosion from the upper and lower stream banks into the stream. Some bank erosion is normal in a healthy stream. Excessive bank erosion occurs where riparian zones are degraded or where the stream is unstable because of changes in hydrology, sediment load, or isolation from the flood plain. High and steep banks are more susceptible to erosion or collapse. A healthy riparian corridor with a vegetated flood plain contributes to bank stability. The type of vegetation along the banks is important. For example, most trees, shrubs, sedges, and rushes have the type of root masses capable of withstanding high streamflow events, while pioneer species (such as guinea grass) do not. Mulch can also act as a stabilizer (e.g. ironwood twigs). Hardened banks (e.g riprap) are also stable. Soil type at the surface and below the surface also influences bank stability. Look for signs of erosion, unvegetated stretches, exposed tree roots, or scalloped edges. Evidence of construction, vehicular, or animal paths near banks or grazing area leading directly to the water's edge suggest conditions that may lead to the collapse of banks. Take into account the six key factors that influence stability:

1. Bank Height
2. Bank Angle
3. Bank Composition
4. Root Depth
5. Root Density
6. Surface Protection

Estimate the size or area of the bank that is bare and unstable, relative to the total bank area. Total bank area includes the slope and area immediately adjacent that if unstable would erode into the stream. This element will be difficult to score during high water. Calculate the ratio of eroded -disturbed bank /total area, yielding a percent stable bank value.

7. CANOPY/SHADE

This element is the measurement of shade across the active channel. Shading of the stream is important because it keeps water cool and limits the growth of less preferred types of algae. Cool water has a greater oxygen holding capacity than does warm water. When streamside trees are removed, the stream is exposed to the warming effects of the sun, which can change plant and animal species composition and abundance. For instance, alien fish such as tilapia are more adaptable to high water temperatures than the native Hawaiian gobies. Review your numbers under the Characterization Section on Average % canopy/shade, and determine if the canopy is open, closed, or in-between.

8. RIPARIAN WIDTH/CONDITION

"Riparian area" is the width of the natural vegetation zone from the edge of the active channel (or normal water line) out onto the flood plain. For this element, the word *natural* vegetation means plants native to the site or introduced species that function like them.

In most cases, a riparian zone in good condition

- Reduces the amount of pollutants that reach the stream in surface runoff.
- Helps control surface and bank erosion.
- Provides a shaded microclimate that keeps the water cool for stream biota.
- Provides fish habitat in the form of undercut banks with the "ceiling" held together by roots of woody vegetation.
- Provides organic material for stream biota that, among other functions, is the base of the food chain in higher order streams.
- Provides habitat for terrestrial insects, and habitat and travel corridors for terrestrial animals.
- Dissipates energy during flood events.
- Often provides the only refuge areas for fish during out-of-bank flows (behind trees, stumps, and logs).

In Hawaii's streams, we often find highly incised stream channels with steep-sloped riparian areas in their "natural" condition. This means that the stream is in the evolutionary stage of headcutting. It will typically have a gradient greater than 3%, and should not be scored lower because it is not yet in the stage of having floodplains or terraces. For example, many of the pristine Hawaiian headwater streams are in this stage (e.g. upper reaches of Limahuli Stream on Kauai).

The type, timing, intensity, and extent of activity in riparian zones are critical in determining the impact on the riparian area and adjacent stream. Narrow riparian zones and/or riparian zones that have roads, agricultural activities, residential or commercial structures, or significant areas of bare soils have reduced stream functions. The filtering function of riparian zones can be compromised by concentrated overland flows. Look for evidence of concentrated flows through the riparian zone.

Compare the width of the riparian zone to the active channel width. In this case, observe how much of the flood plain is covered by riparian vegetation. The vegetation must be natural. Take particular note of pioneer, invasive species. These do not provide good cover or stability to the banks and can wash away after storm events. Vegetation should consist of all of the structural component s (aquatic plants, sedges or rushes, grasses, forbs, shrubs, understory trees, and overstory trees) appropriate for the area.

Examine both sides of the stream (looking downstream) and note on the "Channel cross section" diagram which side of the stream has problems. Check for evidence of concentrated flows through the riparian zone that are not adequately buffered before entering the riparian zone. Pick the condition that best characterizes the Segment and document the score on the data sheet.

9. HABITAT AVAILIBLE FOR NATIVE SPECIES

This assessment element measures availability of physical habitat for native Hawaiian stream organisms. The potential for the maintenance of a healthy aquatic plant and animal community and its ability to recover from distu rbance is dependent on the variety and abundance of suitable habitat and flow available.

Observe the number of different habitat and flow types within each Segment and document the score on the datasheet. If there is flow, there will be at least one type of habitat available. Each flow type must be present in appreciable amounts to score. Flow types are described below.

(1) Seeps and Springs (SS) – Areas in the riparian area where there is groundwater input (cooling the water and providing habitat to native aquatic invertebrates).
(2) Pools (PO)– Areas characterized by smooth undisturbed surface, generally slow current, , and typically deep (deep enough to provide protective cover for fish). Included in this habitat would be deep "plunge" pools at the base of a cascade or waterfall.
(3) Runs (RU) – Areas characterized by moving water, but no broken water surface or whitewater.
(4) Riffles (RI) – Areas characterized by broken water surface, rocky or firm substrate, moderate or swift current, and relatively shallow depth (usually less than 18 inches). Generally, flow is fast and shallow.
(5) Cascades (CA) – Waterfalls, or basically steep riffles (greater than 3% gradient).

Chose a high score within the range if there are multiple numbers of each flow type within the reach. Decide on a score in the higher range if there are numerous pools, runs or riffles versus one of each. The range of scores allows best professional judgement to suit each unique situation.

10. LITTER/TRASH

The presence of litter, trash and fish or ani mal carcasses are obvious signs of stream degradation. Assess the presence in both the wetted area and riparian zone. Note the condition and score on the datasheet.

EVALUATION

The following ideas are a few examples for improving the various stream eleme nts. It is important to have interdisciplinary input from experts in geomorphology, engineering, plant ecology and fish and wildlife biology.

1. **Turbidity –** Improve water quality by reducing sediment loads into the stream, by revegetating banks, reducing in puts from fields, or other means.
2. **Plant growth –** Improve water quality by reducing nutrient loading in the stream (e.g. nitrates and phosphates). Improve canopy cover to encourage compatible species of algal growth.
3. **Channel Condition –** Evaluate ways to reconnect or enhance the connectivity of the stream channel to its floodplain, where applicable.
4. **Channel Flow Alteration –** Evaluate ways to restore altered sites, producing changes in hydrology (e.g. streambank bioengineering, removing diversions).
5. **Percent Embeddedness –** Reduce fine sediment input from the upper watershed and/or eroding streambanks (e.g., by adding filter strips or riparian buffers).
6. **Bank Stability –** Improve bank stability with a wide riparian buffer, better channel conditions and bioengineer ing methods. Note that if there is major, contiguous erosion occurring around a bend, it may be a system -wide problem that needs to be addressed, compared with small eroding spots that may be treated on site.
7. **Canopy/Shade –** Enhance canopy over the stream to keep water temperature cool with plantings and management.
8. **Riparian Condition –** Improve conditions with plantings and management for a wide riparian buffer.
9. **Habitat Available for Native Species –** Evaluate ways to improve habitat conditions for native fl ora and fauna (e.g. flow, water depth, roughness of the channel).
10. **Litter/trash –** Clean up litter/trash in the stream and stream riparian areas and set up regular trash pickup.

OVERVIEW DATA SHEET

Date______________Evaluator(s)____
Stream Name_____________________________Tributary to:_________________________________
Tributary to:______________________________Tributary to:_________________________________
County________________________USGS Quad name_____________________________________
Location (TMK)___________________Latitude______________Longitude_____________________
Landowner / Access____
____
Hydrologic/Watershed Unit____
Aerial Photos (include scale/flight elev)____
Stream Order____________Connected to ocean at least 1x/year?_______Total length_______miles
Drainage Area___________sq.mi. Stream Length_________ Summer Base Flows____cfs or cms
Elevation range of reach____________feet/meters Headwaters______________feet/meters

Fish and other animal species (known to exist in stream, from HI stream assessment and/or personal contact with experts) ____
____
____
____

Endangered / Threatened / Proposed / Candidate / Sensitive Species (check The Nature Conservancy Heritage Database)____
____
____
____

Stream Flow Data (Check USGS database)(give sta + elevation)________________________________
____

Water Quality Data (Check w/ DOH)____
____

Ownership along Stream (miles) Federal_______State_______Private______ (attach map if possible)
Additional information____
____
____

Major Land uses and other resource issues in the Waters hed (e.g. groundwater withdrawals; buffalo grazing downstream; taro cultivation; urban impacts; roadways crossing stream) (attach map if poss)
____
____
____
____
____

Other Comments____
____
____
____
____
____
____
____

SCORING SHEET FOR THE ELEMENTS

1. TURBIDITY (indicator of present erosion)

Condition	Score
Very clear; objects visible at depth to the bottom.	2.0 - 1.5
Moderately turbid	1. 0 – 0.5
Very turbid	0

2. PLANT GROWTH (indicator of eutrophication)

Condition	Score
Water clear with no significant algal scum or microalgae; rocks may be slimy but algae not obvious	2.0 - 1.5
Large clumps of macroalgae present, or distinctive green/brown scums visible on bottom or sides of stream	1. 0 – 0.5
Water distinctly green or pea green; or channel choked with grasses	0

3. CHANNEL CONDITION

Condition	Score
Natural Channel	2.0 – 1.8
Channelized by humans but natural walls and bottom	1.7 – 1.2
Walls Hardened (e.g. concrete, riprap)	1.1 – 0.6
Walls and Bottom Hardened	0.5 – 0

4. CHANNEL FLOW ALTERATION

Condition	Score
No withdrawals, diversions, or stormwater/ag water discharge entering segment.	2.0 – 1.8
Temporary, Intermittent withdrawals occurring within segment.	1.7 – 1.2
Permanent, Intermittent withdrawals or stormflow inputs (e.g. culverts occurring within segment.	1.1 – 0.6
Temporary, Constant withdrawals occurring within segment.	0.5 – 0.2
Permanent, Constant withdrawals occurring within segment.	0 – 0.2

5. PERCENT EMBEDDEDNESS

Condition	Score
< 10%	2.0
11 – 25 %	1.5 – 1.0
26 – 50 %	0.9 – 0.5
50 – 75 %	0.4 – 0.2
Completely sedimented in (includes hardpan sedimentation)	0

6. BANK STABILITY (total, both sides)

Condition	Score
> 90% Stable (not bare or erodable)	2.0
75 to 89% Stable (not bare or erodable	1.5 – 1.9
50 to 74% Stable (not bare or erodable)	1.4 – 1.0
25 to 50% Stable (not bare or erodable)	0.9 – 0.1
<25% Stable (not bare or erodable)	0

7. CANOPY / SHADE

Condition	Score
Mixed canopy, 20 - 80% cover	2.0 - 1.6
Closed but mixed canopy, >80% cover	1. 5 – 1.0
Closed monotypic canopy >80% cover	0.9 – 0.5
Open canopy, 0- 19% cover	0

8. RIPARIAN CONDITION

Condition	Score
Riparian area same width as floodplain, diverse vegetation, or stream is naturally incised, stable banks. Undisturbed.	2.0 – 1.8
Riparian area width at least two channel widths wide, diverse vegetation, or stream is naturally incised. Minimal Degradation	1.7 – 1.0
Riparian area width at least one channel width wide, or stream is naturally incised, riparian area is somewhat degraded. Regularly grazed, cropped or other disturbance.	0.9 – 0.5
Severely degraded riparian area, less than one channel width wide.	0.4 – 0.2
Little to no riparian vegetation, dirt-lined or fully channelized and lined.	0

9. HABITAT AVAILABLE FOR NATIVE SPECIES

Condition	Score
5 habitat types available	2.0
4 habitat types available	1.9 – 1.8
3 habitat types available	1.7 – 1.0
2 habitat types available	0.5 – 0.2
1 habitat type available	0

Habitat types *(1) seeps/springs (2) pools (3) runs (4) riffles (5) cascades*

10. LITTER/TRASH (indicator of urban/human influence)

Condition	Score
No litter or trash is present.	2.0 - 1.8
Litter or trash is evident but not prominent.	1. 0 – 0.5
Abundant trash, unsanitary wastes, eg. animal carcass or excrement, diapers, or many dead fish.	0

SCORING DATA SHEET

Date		*Time*		*Weather*	
Stream Name		*Reach ID*			
	Segment #1	*Segment #2*	*Segment #3*	*Segment #4*	*Segment #5*
Stream Type					
Segment Length (ft or m)					
Temperature					
Elevation					
Substrate	*1 2 3 4 %*	*1 2 3 4 %*	*1 2 3 4 %*	*1 2 3 4 %*	*1 2 3 4 %*
Silt/clay					
Sand					
Gravel					
Cobble					
Rock					
Boulder					
Bedrock or Concrete					
Embeddedness %					
Bank Vegetation % - looking downstream, left bank / right bank					
Trees					
Shrubs					
Herbaceous					
Leaf Litter					
None (bare)					
Avg % canopy/shade					
Avg Width					
Velocity and Depth					
Flow Status:	*high/normal/low*	*high/normal/low*	*high/normal/low*	*high/normal/low*	*high/normal/low*
Flow (cfs) or (cms)					
Sketch Channel cross-section, include low, normal, and high flow lines and existing water level					
Score Each Element - Use "Scoring Sheet for the Elements" Guidanc					
1. Turbidity					
2. Plant Growth					
3. Channel Condition					
4. Channel Flow Alteration					
5. Percent Embeddedness					
6. Bank Stability					
7. Canopy					
8. Riparian Condition					
9. Habitat Available					
10. Litter/Trash					
Total score					
Total score / # of elements					
Rating of Average					
1.8 - 2.0 Very High					
1.5 - 1.7 High					
1.1 - 1.4 Medium					
0 - 1.0 Low					

***Notes**: ie. wildlife sightings, vegetation species, etc.*

TECHNICAL NOTE

USDA NATURAL RESOURCES CONSERVATION SERVICE HAWAII

Biology Technical Note - No. 10

HAWAII NATURAL HERITAGE DATA QUERY PROCEDURE

I. PURPOSE OF WORKSHEET

This technical note explains how conservation planners can obtain data and maps showing the location and identification of rare, threatened or endangered plants, animals, and natural communities for clients and resource inventories. NRCS obtained a 2001 subscription to The Hawaii Natural Heritage Program database, which contains information about species sightings in both a GIS (ArcView) database and in an Access database. It is currently the most comprehensive native species location database in the state; however, many areas in Hawaii have not been surveyed, and new plants and animals are still being discovered. Therefore, it is important to recognize that it is not all-inclusive. On site observations and plant and animal identification may also be necessary to determine if there are rare, threatened or endangered species in the area.

Questions about this procedure should be directed to the NRCS GIS Coordinator; questions about the data should be directed to the NRCS State Biologist.

II. PROCEDURE

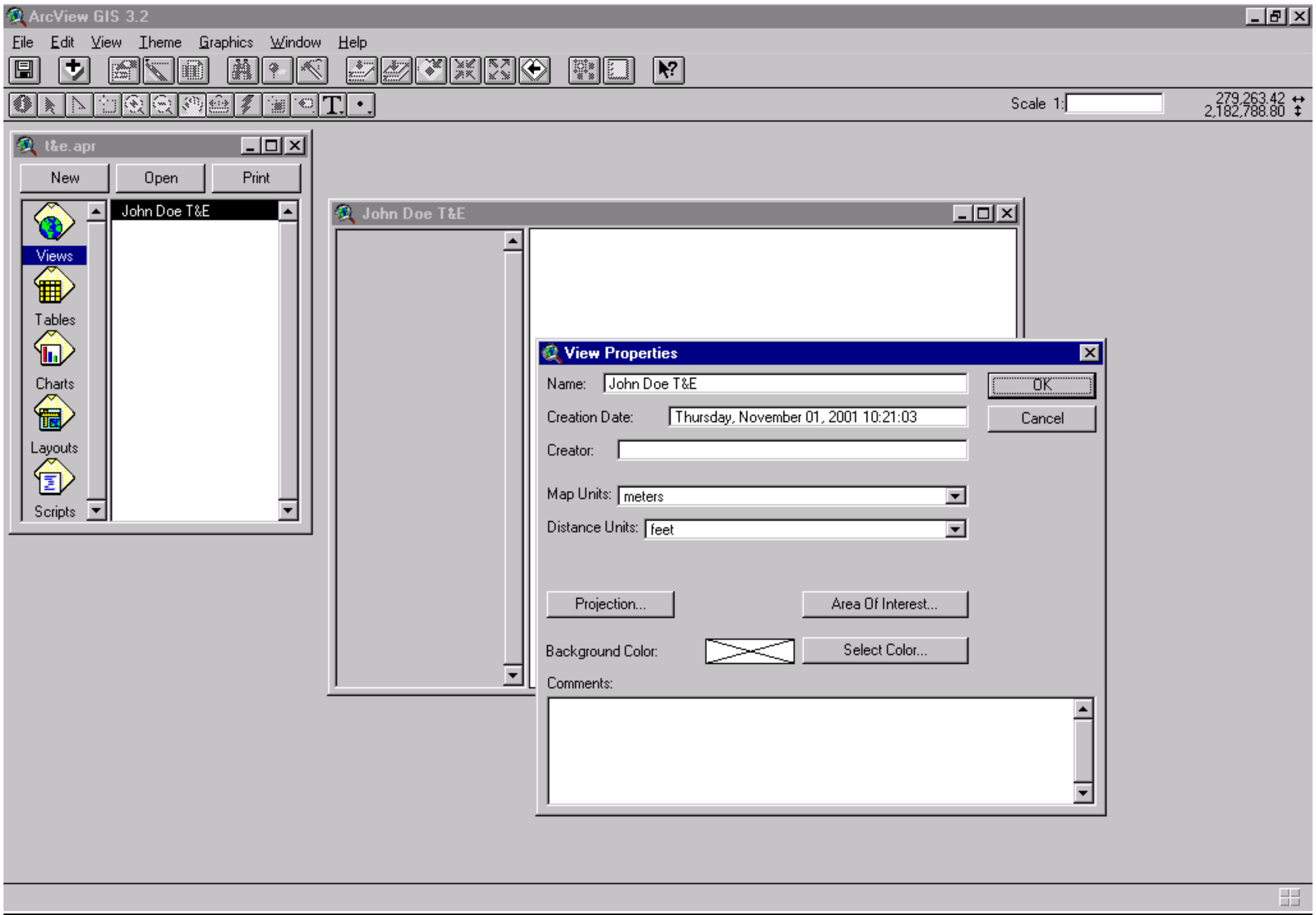
Attached are two documents. The first is a step-by-step instruction on (a) how to query the Heritage Database, using ArcView and Toolkit, (b) how to create maps with species locations, and (c) how to produce reports with the essential information about the data.

The second document includes all of the essential definitions of the GIS data and fields, verbatim from the Hawaii Natural Heritage Program.

This information should be used to develop conservation plans, to fill out ranking criteria for Farm Bill Programs, and/or to ensure compliance with the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). The maps and information should be included in the Conservation Plan Folder.

Hawaii Natural Heritage Data Query Instructions

Open ArcView
Open a New project (on Menu Bar click File /New Project)
Open New view
Set view properties (on Menu Bar click View/Properties



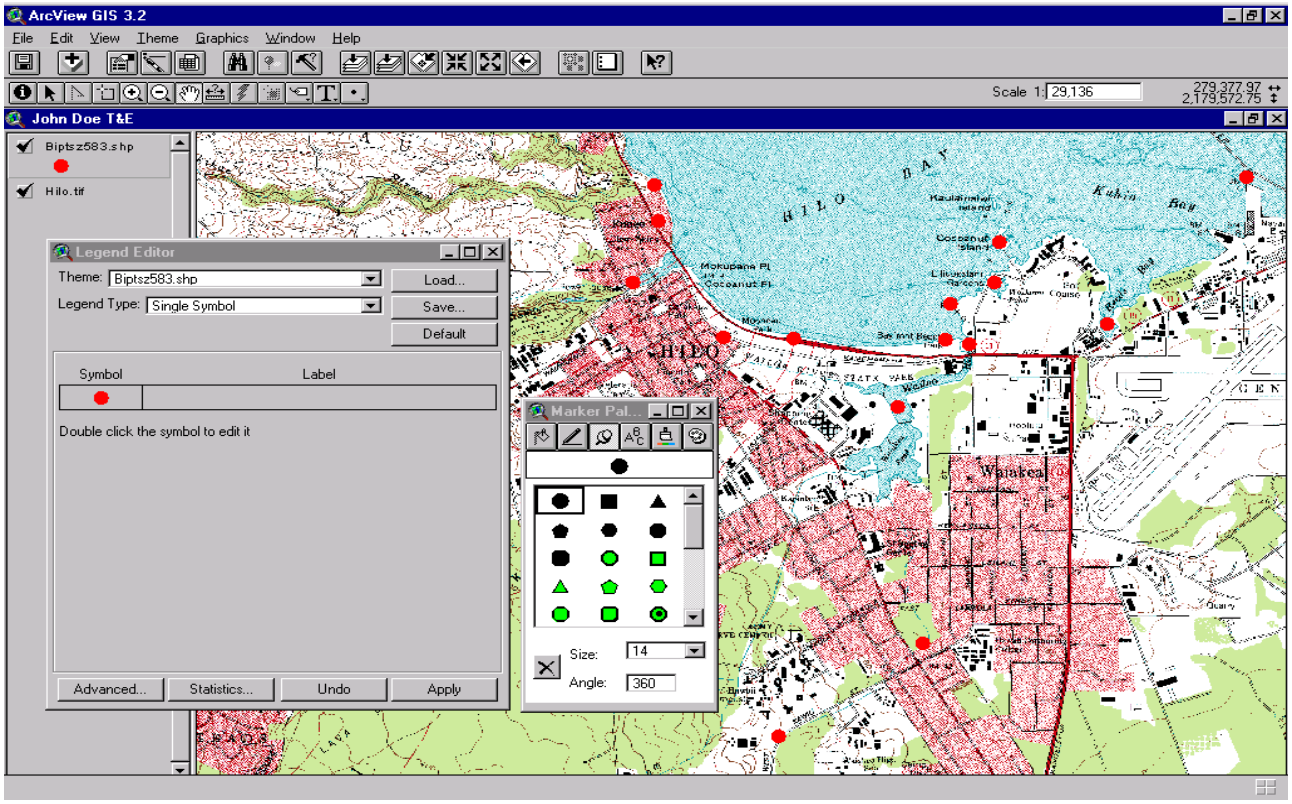
Name: <u>select an appropriate name</u>
Map Units: <u>meters</u>
Distance Units: Distance units are the units in which AV will display measurements while you work with this view. For example, if you use the Measure Tool to measure the distance between two places on the map.

File/Save Project. Choose drive and directory where you save your projects. When typing in project name, be sure to save the **.apr** extension.

Add themes: Add themes to a view by using the View menu/Add theme or use Add Theme button
First add drg(s). Example hilo.tif is the file name for Hilo Quad on Hawaii.
Next add Natural Diversity Data for appropriate island, located at:

C:\ServiceCenterThemes or C:\data\NaturalDiversityDatabase \ArcView\point_data\

Hawaii zone 5 = biptsz583.shp
Kaua' i = kaptsoh.shp
Lana' i = laptsoh.shp
Maui = maptsoh.shp
Moloka' i = molptsoh.shp
O' ahu = oapts.shp



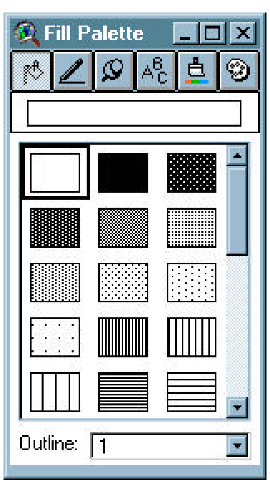
Make Natural Diversity theme active by clicking on it in the Table of Contents. It is active when it appears as a raised gray block around theme name. Click on the check box to draw the theme.

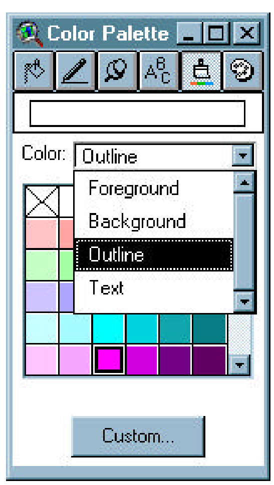
Double Click on the Natural Diversity theme to bring up Legend Editor.

Set symbol to an appropriate shape, size & color. A dot, size 12 or 14, and the color red work well on most maps created for 8 ½ x 11, legal, or 11 x 17 size paper.

To set symbol properties double click on symbol box to bring up Symbol Window. Edit using Marker Palette and Color Palette. Make selections. **Click Apply**. Close Legend Editor. Move or close Symbol Window.

Add TMK data if applicable. Open Legend Editor. In Fill Palette set properties to a polygon with no fill. Set Outline line width to 1.

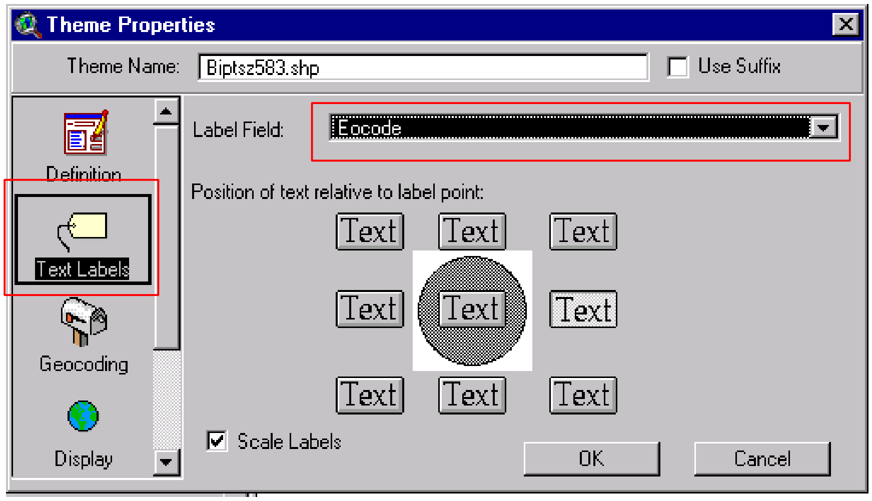




In Color Palette:

Open dropdown menu.
Select Outline.
Select a color.
Click Apply in Legend Editor.
Close Editor.

Save project.

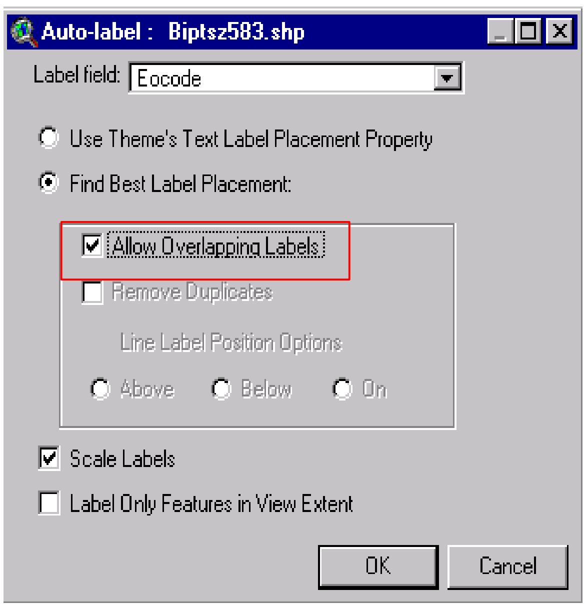


Label Natural Diversity points: Make Natural Diversity theme active. Zoom into area of interest in View Window. Click Theme Properties button or open using Theme menu/Properties.

Theme Properties dialog box opens.

Click on Text Labels (left side of dialog box).

In Label Field: open pulldown menu and select Eocode.



On Menu Bar select Themes/Auto-label. Leave defaults and click on check box Allow Overlapping Labels. Click OK.

On Menu Bar click Edit/Select all graphics. This will select all the labels and put handles (little blocks) around them.

To change font & size open Symbols Window by clicking on Window menu/Show Symbol Window from Menu bar or Ctrl p from the keyboard. Arial font, Bold, in size 10, 11, or 12 is good depending on scale of map and paper size.

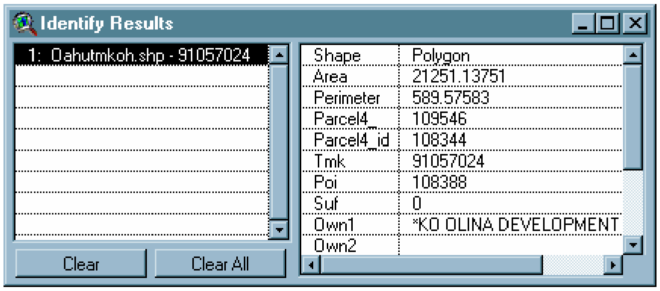
After completing changes, click anywhere in View window to deselect all labels. Move labels as necessary so they are visible and not overlapping by clicking on label with the pointer. This is the time consuming part. Be careful as one point may have many labels. Overlapping labels will appear in green text. Click on one of them and change to same font & size of the other labels if there is room. Otherwise, choose a slightly smaller font size.

Determine which point the label(s) is linked to. Click on the Identify Tool. Click on points to display a list of linked labels. Position labels so they align with point.

Save project.

Digitize parcel if applicable using digitizing tools. Symbolize in black w ith a line width of 2, shows up well.

If area of interest/parcel is a TMK boundary, there are a couple of ways to locate it.



A. Use **Identify Tool Button** (1st on left)

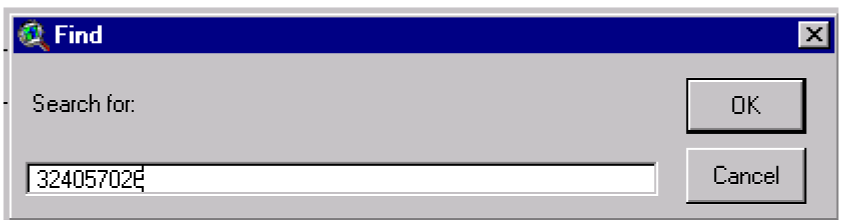
Make TMK theme active. Click on par cel to verify correct owner & TMK number.

Click on Select Feature button (4th on left). Click on the TMK parcel you identified.

Open the theme table. Click on TMK in the Title Bar (it will turn a darker color). See in illustration below.

B. Use **Find Tool** (binoculars).

If you can' t locate the TMK on the map use the Find Tool. Make TMK theme active. Open theme table. Click on Find Tool. Type in <u>EXACT</u> eight or nine digit TMK number (Oahu is 8, all other counties are 9).



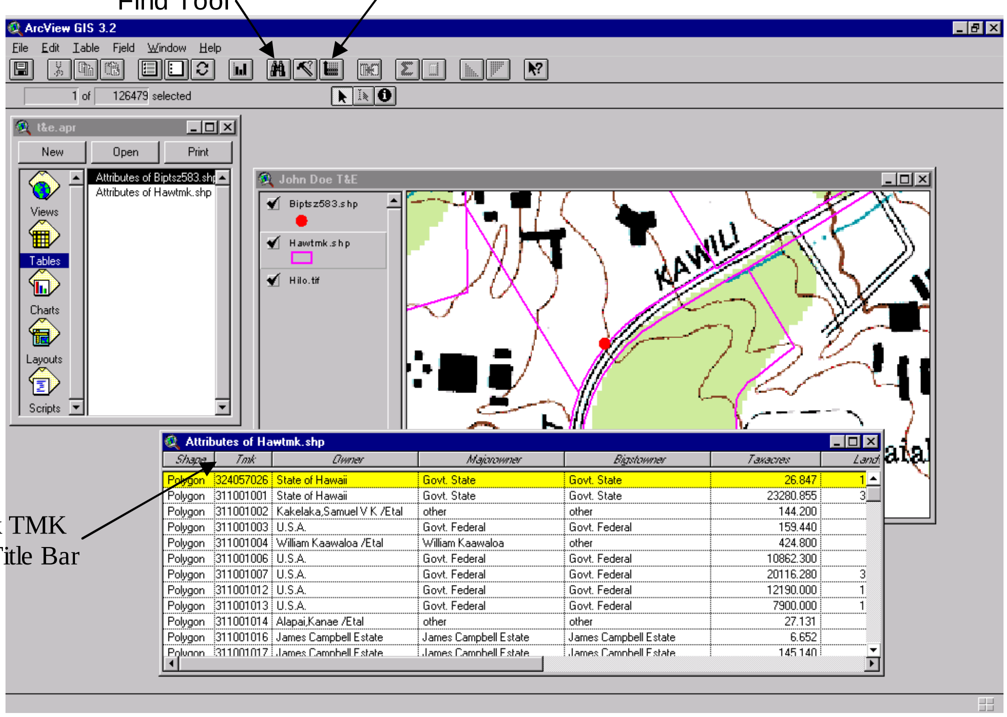
Click OK.

Select Promote button. This brings the selected record to the top of the list in the theme table

See in illustration below.

Promote button

Find Tool



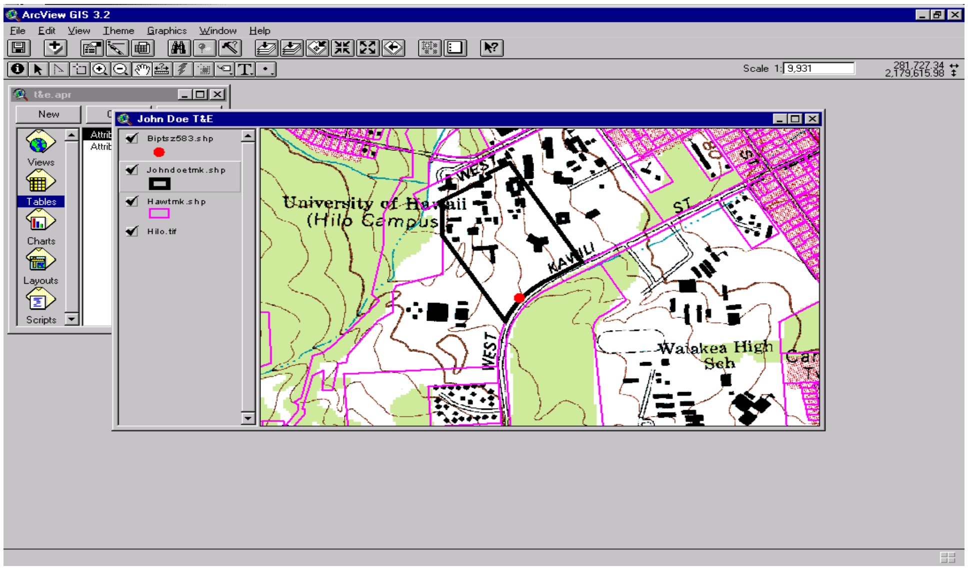
Click TMK On Title Bar

Leaving it selected, make View window active.

From Menu Bar select Theme/ Convert to shapefile.

You will be prompted to save as a file. Choose the appropriate drive & directory first, then name the file. Be careful to keep **.shp** extension.

You will be asked if you w ant to add theme to your view. Answer **Yes**.

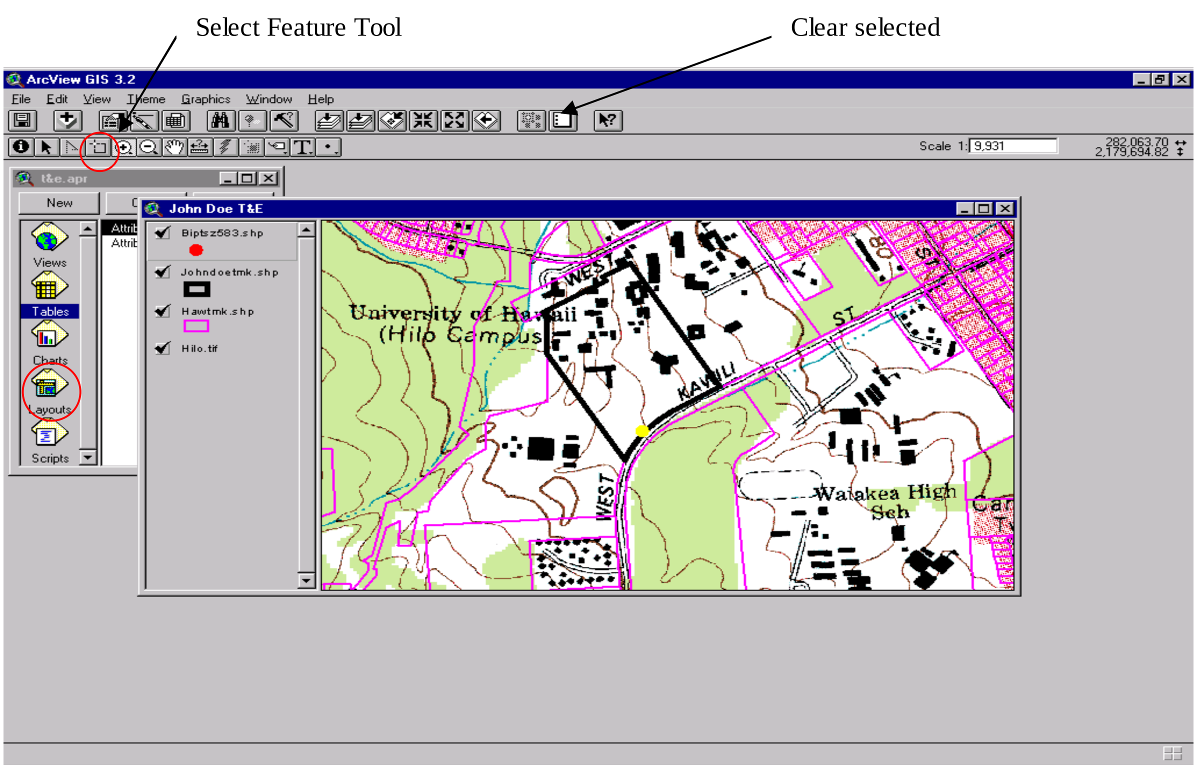


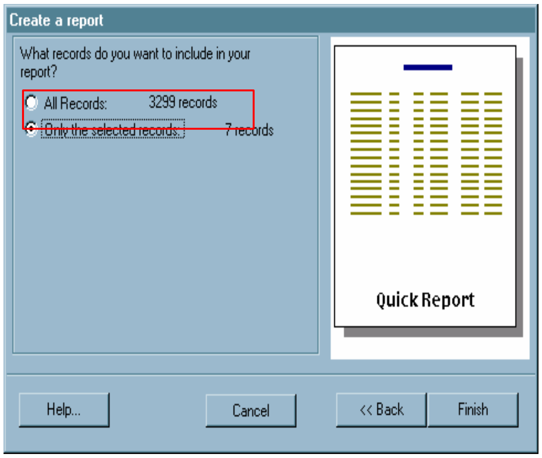
A new theme will appear in your view. Edit properties through Legend Editor to change to a polygon with no fill, outline width of 2, and black in color.

You may now remove the island TMK theme from the view by making it active, click on Edit menu/Delete Themes or simply don' t draw the theme by clicking on the check box to remove the check mark.

Make the T&E theme active. Select the po ints that apply to your area of interest and that will appear on your map. You are doing this for two reasons. First, you will generate a report on the records linked to these points in a later step and second it will help you to determine and align the correct " view" area that will be displayed in the layout (the finished map). Use the Select Features Tool, as shown below. Hold down the shift key as you select multiple points. The points will be highlighted in yellow.

Save project.

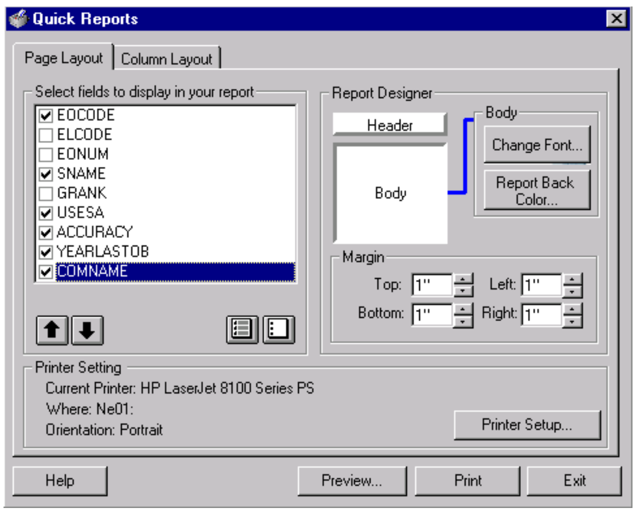




Create a Report.

Under File menu/Extensions, click the check box next to Report Writer. Make the view window active, and the Natural Diversity theme active. From the menu bar select Theme/Create a Report. Dialog box opens. Accept default of Quick Report. Click Next. Click on Only the selected records.

Click Finish.



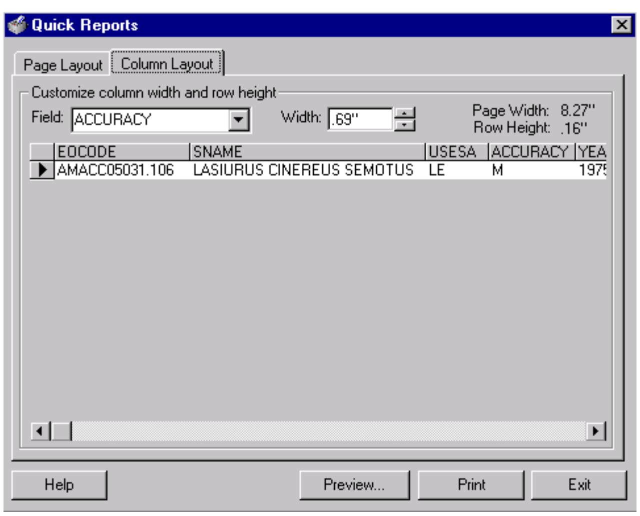
Under the Page Layout tab, check mark the six elements that will be included in your report. They are: EOCODE, SNAME, USESA, ACCURACY, YEARLASTOB, COMNAME. Click Preview.

You can now finish your report using

A. **Quick Report** or
B. Export data into **Excel**.

Quick Report has limited capabilities so you may want to use Excel if you are familiar with it.

A. To continue using **Quick Report:**

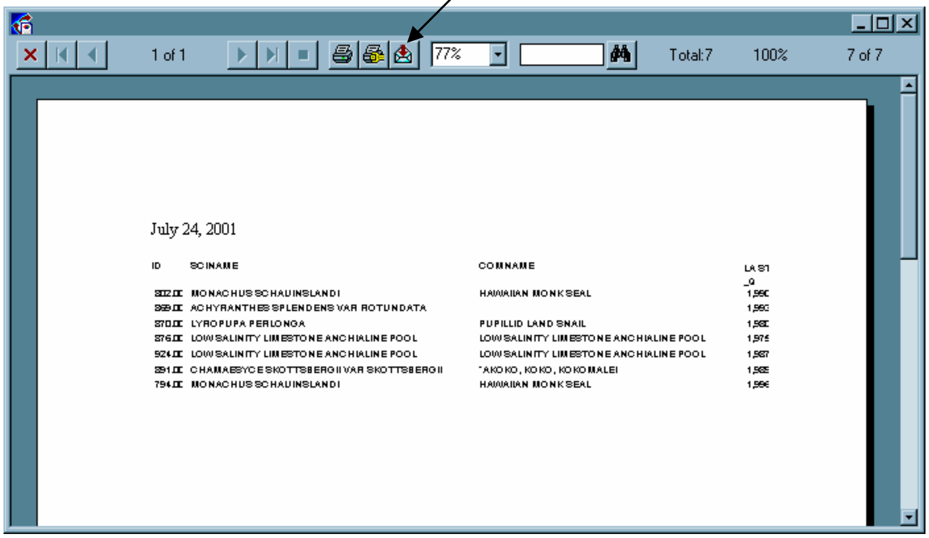


Click Column Layout tab.

Adjust widths of columns to display entire text in SNAME and COMNAME columns and decrease size in remaining four columns.

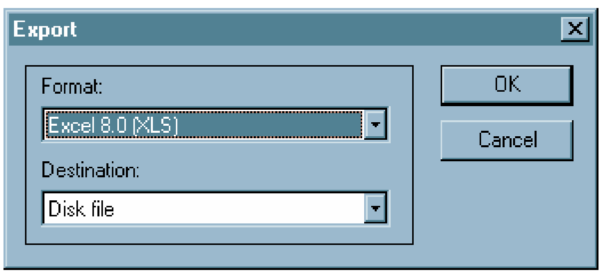
Click Preview, and if OK, then Print.

Export button



B. If you prefer using **Excel**

In Quick Report Preview window, click on Export button.



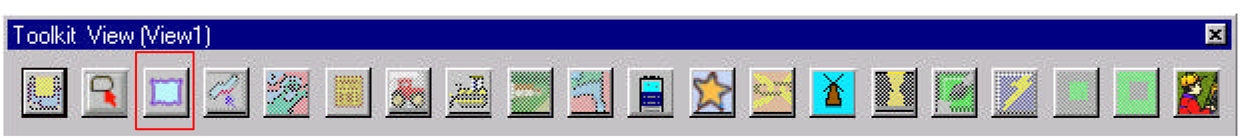
Export dialog box opens, select from the dropdown menu under Format, the Excel version you have.

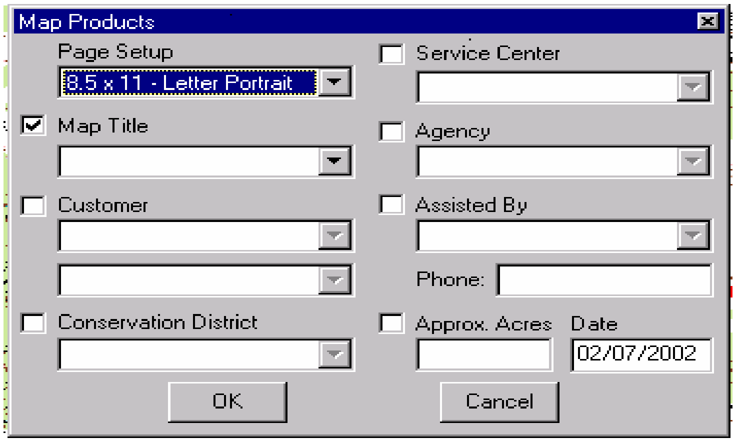
Click OK.

You will be prompted to save as an Excel file. Select drive and directory you want to save it in then type in file name. Be sure to include **.xls** extension. In Excel, make any edits and print.

After report is printed, close any report windows and return to the View window. Make the endangered species theme active, and clear the selected points (see button location on Page 6). They will now turn from yellow to red.

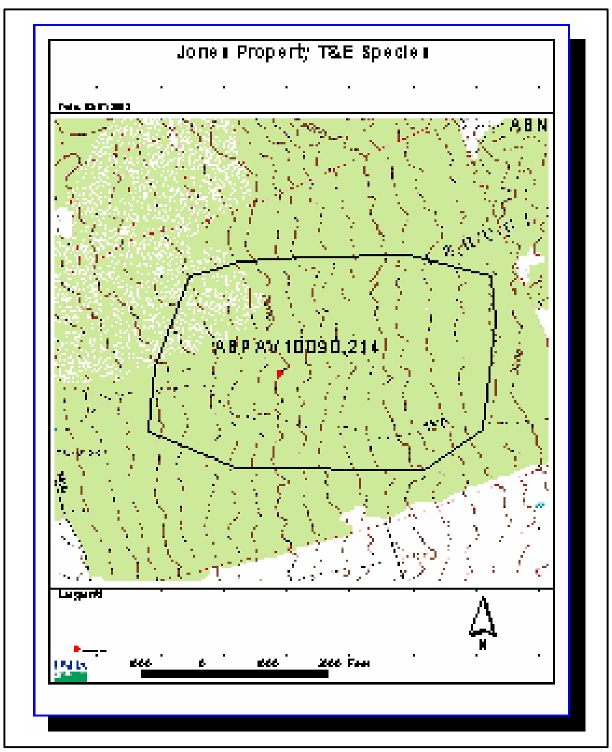
Click on the USDA button to open the Toolkit toolbar. (If you don't have the USDA button, click on File menu and click on Extensions. On the extension list, check the Toolkit Core Extension). On the Toolkit toolbar, click on the map products button.





Fill in the Map Title box and any other information you want included on the map and click OK.

A layout will be created, printed at the scale that was set in the view. If you want to change what is seen in the layout, click back in the view, use the pan and zoom tools, then click the map products button again to make a new layout. The standard Arcview layout tools can be used to edit this map.



For example, use the pointer to click on the legend information. Selection handles (small blocks) will appear around the legend symbols and text. Click on the Graphics menu, and pull down to Simplify. Then each individual object can be edited. Double click on the text next to the red dot, and edit the name of the shapefile. Or use the pointer to drag a box around both the red dot and text, and move them up under the word Legend.

Click on File menu and pull down to Print. Choose a color printer, and click OK.

Click on the File menu and pull down to Save Project. Choose the appropriate folder first, then name the file keeping the .apr extension.

Exit Arcview.

Definitions of GIS Data and Fields

Hawaii Natural Heritage Program, Natural Diversity Database and GIS shape files on this CD is restricted. It is only for the intended use of the individual or organized that requested it. Data on this CD may not be distributed with out the consent of the Hawaii Natural Heritage Program.

The Hawaii Natural Heritage Program (HINHP) collects information on the location and condition of Hawaii's rare animals, plants and natural communities (ecosystems). Information in this datab ase spans from the 1800' s to the present day. Data summarizes species current and historical ranges, decline or increase in the number of individuals, recorded habitat and observed threats.

The individual species, subspecies and natural communities in th e database are referred to as "elements" in the Heritage database. There are four categories of elements: Natural Communities, Special Vertebrates, Special Invertebrates and Special Plants.

In the Heritage database, only data on rare element occurrences are incorporated. A natural community is considered rare and imperiled if it is known from 20 or fewer localities OR if it covers less than 2000 acres in the world. More widespread natural communities that are threatened with destruction throughout thei r range are also considered imperiled.

For plants and animals, the definition of a rare taxon varies depending on professional opinion. The Heritage Program defines a taxon as rare if available records indicate that its current distribution or abundanc e is limited, i.e. it is known from 20 or fewer locations OR fewer than 3000 individuals have been observed in the wild.

An "Element Occurrence" (EO) is a location or area which sustains or otherwise contributes to the survival of a population of a particular element. More simply, an EO is the place an element occurs, not each individual example or observation of the element itself. For example, a report of five `i`iwi at Palikea constitute a single EO, not five. Similarly, 20 reports of the rare fern, Marsilea villosa, at Ihiihilauakea on Koko Head are a single EO, not 20.

Although the specific definition of an element occurrence may differ for each element, the following descriptions typically apply:

> Plants - any verified occurrence of one or more plants. Plants scattered along a cliff face, ridge top, or valley floor are considered a single occurrence if botanists believe the plants may cross-pollinate as a single population.
>
> Animals With Limited Mobility (most invertebrates and most forest birds) - For birds, any reliable audio or visual sighting. For snails, any post -1945 observation of one or more snails, alive or recently dead.
>
> Natural Communities - all contiguous habitat as defined by biological and physical features, where native elements comprise at least 60% of the vegetation cover in any layer.

The "Element Occurrence Record" (EOR) is a summary of the available information for a single element at a single location. Hence, some records reflect many observations spanning centuries, while others are based upon only very recent or very old observations. Each record is updated whenever new information becomes available.

Heritage maps and computer reports summarize data in short, terse narratives, and display information using a variety of codes, condensed phrases, and abbreviations. Given the finite amount of computer storage space, this enables us to maximize the amount of information in each record. Many of the codes and abbreviations are straightforward, and this guide should clari fy most questions you might have.

The following lists the data provided. In each case, explanations for each entry or "data field" are provided. If you have any questions after consulting this material, please contact the Hawaii Natural Heritage Progr am Database Manager at 956 -6894.

Natural Diversity Database ArcView Point and Polygon Shape Files

The Hawaii Natural Heritage Program ArcView point and polygon shape files depicts the locations of rare species and natural communities based upon the Element Occurrence Record Database. ArcView shape files are in UTM Zone 4 NAD 83. The accuracy of each location is dependant upon the source information that the Heritage staff was able to gather. See Accuracy (precision) for more information.

ELEMENT OCCURRENCE RECORD (EOR)

The Element Occurrence Reocord (EOR) is a summary of all the available information for a single element at a single location or occurrence. The record is produced by combining information from museum collections, published and unpublished reports, communications from knowledgeable individuals, and field surveys. Hence, some records reflect many observations spanning centuries while others are based upon only very recent or very old observations. All information sources pertinent to the record are listed in the CITATION field. Each record is updated whenever new information becomes available.

Definition of Data and Fields in the ArcView Point and Polygon files (EOR Database))

EOCODE (Element Occurrence Code)
Unique 14-character identifier code for each EOR location. Combines the ELCODE and EONUM together. See ELCODE and EONUM. Example: PDFAB3M090.001

ELCODE (Element Code)
The Element Code (ELCODE) is the first 10 characters preceding the decimal point of the EOCODE. The ELCODE identifies the species or natural community. It is an international unique species and natural community identifier code determined by the National Natural Heritage office of the Association for Biodiversity Information.

The element code such as the Sesbania (PDFAB3M090) represents several taxonomic descriptions. The 1st character represents the type of element as " Plant" . The second character represents more detailed descriptions about the element such as " Dicot" . The following table summarizes each of the types that the Hawaii Natural Heritage Program tracks:

1st & 2nd character of ELCODE	Element Type	# of elements tracked by Hawaii Heritage
P=Plants		
PD	Dicots	528
PM	Monocots	47
PP	Pteridophytes	32
A=Vertebrates		
AB	Birds	44
AF	Fish	2
AM	Mammals	2
AR	Reptiles	4
C=Natural Community		
CA	Aquatic	16
CS	Sub-terranean	26
CT	Terrestrial	101
I=Invertebrates		
IC	Crustaceans	8
II	Insects	220
IL	Chelicerates	1
IM	Mollusks	311

EONUM (Element Occurrence Number)
The three-digit number following the decimal point (EONUM) identifies the occurrence of this element. For example, PDFAB3M090.001 is the first occurrence of Sesbania tomentosa entered in the Heritage database.

SCINAME

Scientific name of the species or natural community.

GRANK (Global Element Rank)

The Global Rank (Grank) is an international ranking system developed by the Natural Heritage network. It determines the rarity of a species worldwide, and guides agencies to set priorities for protection. The ranking system is based on an element' s number of occurrences and individuals, health, threats, etc. It is independent from the U.S. Fish and Wildlife Federal List of Endangered Species, but the USFWS often cites the Heritage Global Rank to help express how rare and im periled a species is. See Definitions of Global Ranks.

<u>Global Rank Definitions:</u>

G1 (or T1 for subspecific taxa) = Critically imperiled globally. 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
G2 (or T2 for subspecific taxa) = Imperiled globally. 6-20 occurrences and/or 1,000-3,000 individuals remaining; or more abundant but facing serious threats range -wide.
G3 (or T3 for subspecific taxa) = Moderately imperiled globally. 21-100 occurrences and/or 3,000-10,000 individuals remaining; or more abundant but facing moderate threats range -wide; or restricted in range.
G4 (or T4 for subspecific taxa) = Widespread, abundant, and apparently secure, but with cause for long - term concern.
G5 (or T5 for subspecific taxa) = Demonstrably widespread, abundant, and secure.
GH (or TH for subspecific taxa) = Historical. No recent observations, but there remains a chance of rediscovery.
GX (or TX for subspecific taxa) = Extinct. No recent observations, and there does not appear to be a chance of rediscovery.
C = Persisting in cultivation.

USESA (United States Endangered Species Act)

Federal Status of the element. Official U.S. Fish & Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register February 28, 1996.

Listed Endangered (LE)	=	Taxa formally listed as endangered.
Listed Threatened (LT)	=	Taxa formally listed as threatene d.
Proposed Endangered (PE)	=	Taxa proposed to be formally listed as endangered.
Proposed Threatened (PT)	=	Taxa proposed to be formally listed as threatened.
Candidate (C)	=	Taxa for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened.
Species of Concern (SOC)	=	Taxa that available information does meet the criteria for concern and the possibility to recommend as candidate.

ACCURACY (PRECISION)

Precision (accuracy of information) of EO as mapped.

P	=	Precise with exact location reported with GPS reading. Up to 1 meter accuracy.
SC	=	Specific with exact location confirmed by source. Usually location determined with a detailed map provided by the source. Up to 6 meter accuracy.
S	=	Specific - EO reported within a 0.33 mile radius of mapped symbol (or 0.5 km)
M	=	Medium - EO reported within a 1.5 mile radius of mapped symbol (or 2.5 km)
G	=	General - EO reported within approximately 5 mile radius of map ped symbol (or 8km)
U	=	Unmappable - inadequate information to map EO
N	=	Not mapped - primarily cultivated plants & vague locations for which more specific occurrences are already mapped

YEARLASTOBS (Year Last Observed)

Date element was last observed extant at this site; not necessarily date site was last visited.

Notice

The Hawaii Natural Heritage Program database is dependent on the research and observations of many scientists and individuals. In most cases this information is not the result of comprehensive site-specific field surveys, and is not confirmed by the Heritage staff. Many areas in Hawaii have never been thoroughly surveyed, and new plants and animals are still being discovered. Database information should never be regarded as final statements or substituted for on-site surveys required for environmental assessments. Data provided by the Heritage Program do not represent a position taken by The Center for Conservation Research and Training or The Nature Conservancy of Hawaii **. Heritage information is only for the intended use of the individual or organization who requested it. It may not be distributed in any way without the consent of the Hawaii Natural Heritage Program**.

Please cite the Heritage Program and primary sources in all documentation and reports.

Hawaii Natural Heritage Program, University of Hawaii, Center for Conservation Research and Training
3050 Maile Way, Gilmore 406, Honolulu, Hawaii 96822

Exhibit D

Kentucky 2003 Threatened And Endangered Species List By County

This list identifies federal listed threatened and endangered species and species covered by a State Conservation Agreement (SCA) by county. NRCS personnel shall use this list for the NEPA planning process.

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed/Stream Order)	USFWS Species Fact Sheet Available
Adair	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
Allen	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Fanshell	Endangered	Barren River Main Channel	
		*Clubshell	Endangered	Sulfur Creek Main Channel	
Anderson	Plant	Short's Bladderpod	Candidate		
Ballard	Bird	Bald Eagle	Threatened		
		Interior Least Tern	Endangered	Ohio River Main Channel	
	Fish	Pallid Sturgeon	Endangered	Ohio River Main Channel	
	Mammal	Indiana Bat	Endangered		
Barren	Crustacean	Cave Shrimp	Endangered	Mammoth Cave Watershed	
	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Fanshell	Endangered	Barren River Main Channel	
	Plant	Eggert's Sunflower	Threatened		
Bath	Mussel	*Northern Riffleshell	Endangered	Licking River Main Channel	
		*Clubshell	Endangered	Slate Creek Main Channel	
	Mammal	Indiana Bat	Endangered		
Bell	Fish	Blacksided Dace	Threatened	First, Second and Third Order Streams Within the Following Watersheds:	
				Laurel Creek	
				Bennetts Creek	
				Cannon Creek	
				Little Clear Creek	
				Brownies Creek	
				Mill Creek	
				Long Creek	
				Left Fork Straight Creek	
				Straight Creek	
				Four-Mile Creek	
				Sinking Creek	
				Yellow Creek	
				Stony Creek	
	Mammal	Indiana Bat	Endangered		
	Insect	Icebox Cave Beetle	Candidate		
Boone	Mussel	*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
Bourbon	Plant	Running Buffalo Clover	Endangered		Yes
		Short's Bladderpod	Candidate		
Boyd	Mussel	*Fanshell	Endangered	Big Sandy Main Channel	
Boyle	-	-	-	-	
Bracken	Mussel	*Clubshell Fanshell	Endangered Endangered	North Fork and Licking River Main Channel	
Breathitt	-	-	-	-	
Breckinridge	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
Bullitt	Mammal	Gray Bat	Endangered		

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
		Indiana Bat	Endangered		
	Mussel	Clubshell	Endangered	Salt River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Salt River Main Channel	
Butler	Mussel	Purple Catspaw	Endangered	Green River Main Channel	
		*Clubshell	Endangered	Green River Main Channel	
				Russell Creek Main Channel	
		Fanshell	Endangered	Green River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Green River Main Channel	
		Pink Mucket	Endangered	Green River Main Channel	
		*Ring Pink	Endangered	Green River Main Channel	
		Rough Pigtoe	Endangered	Green River Main Channel	
	Reptile	Copperbelly Water Snake	SCA		
Caldwell	Mammal	Gray Bat	Endangered		
	Reptile	Copperbelly Water Snake	SCA		
Calloway	Mammal	Gray Bat	Endangered		
	Plant	Price’ s Potato-Bean	Endangered		
Campbell	Mussel	*Clubshell	Endangered	Ohio River Main Channel	
		Fanshell	Endangered	Licking River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
		*Rough Pigtoe	Endangered	Ohio River Main Channel	
Carlisle	Bird	Bald Eagle	Threatened		
		Interior Least Tern	Endangered		
	Mammal	Indiana Bat	Endangered		
	Mussel	Fat Pocketbook	Endangered	Mississippi Main Channel	
Carroll	Mussel	*Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
Carter	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Fanshell	Endangered	Tygarts Creek Main Channel	
Casey	-	-	-	-	
Christian	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Reptile	Copperbelly Water Snake	SCA		
Clark	Plant	Running Buffalo Clover	Endangered		Yes
		Short’ s Bladderpod	Candidate		
Clay	-	-	-	-	
Clinton	Mammal	Gray Bat	Endangered		
	Mussel	*Cumberland Bean	Endangered	Cumberland River Main Channel & Fourth and Fifth Order Streams Joined to CRMC	
		*Orange-Foot Pimpleback	Endangered	Cumberland River Main Channel	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Clinton (cont)		*Rough Pigtoe	Endangered	Cumberland River Main Channel	
Crittenden	Mussel	Fat Pocketbook	Endangered	Cumberland River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Cumberland River Main Channel	
	Reptile	Copperbelly Water Snake	SCA		
Cumberland	Fish	Palezone Shiner	Endangered	Marrowbone Creek	
	Mussel	*Catspaw	Endangered	Cumberland River Main Channel	
		Cumberland Bean	Endangered	Cumberland River Main Channel & Fourth and Fifth Order Streams Joined to CRMC	
		*Cumberland Combshell	Endangered	Cumberland River Main Channel & Fourth and Fifth Order Streams Joined to CRMC	
		*Fanshell	Endangered	Cumberland River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Cumberland River Main Channel	
		*Oyster Mussel	Endangered	Cumberland River Main Channel	
		*Pink Mucket	Endangered	Cumberland River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
		*Rough Pigtoe	Endangered	Cumberland River Main Channel	
Daviess	Mammal	Indiana Bat	Endangered		
	Reptile	Copperbelly Water Snake	SCA		
Edmonson	Crustacean	Mammoth Cave Shrimp	Endangered	Running Branch Spring Watershed	
	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Clubshell	Endangered	Green River Main Channel	
		Fanshell	Endangered	Green River Main Channel	
		Northern Riffleshell	Endangered	Green River Main Channel	
		Ring Pink	Endangered	Green River Main Channel	
		Rough Pigtoe	Endangered	Green River Main Channel	
	Plant	Eggert's Sunflower	Endangered		
	Insect	Surprising Cave Beetle	Candidate		
Elliot	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
Estill	Mammal	Indiana Bat	Endangered		
		Virginia Big-Eared Bat	Endangered		
Fayette	Insect	American Burying Beetle	Threatened		
	Mammal	Indiana Bat	Endangered		
	Plant	Running Buffalo Clover	Endangered		Yes

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Fleming	Mussel	Fanshell	Endangered	Licking River Main Channel	
				Fish Trap Creek Main Channel	
Floyd	-	-	-	-	
Franklin	Mammal	Gray Bat	Endangered		
	Plant	Short' s Bladderpod	Candidate		
	Mussel	*Northern Riffleshell	Endangered	Elkhorn Creek Watershed	
	Plant	Braun' s Rockcress	Threatened		
Fulton	Bird	Bald Eagle	Threatened		
		Interior Least Tern	Endangered		
Gallatin	Mussel	*Clubshell	Endangered	Eagle Creek Main Channel	
Garrard	Mammal	Gray Bat	Endangered		
Grant	-	-	-	-	
Graves	Fish	Relict Darter	Endangered	Bayou du Chien Watershed	Yes
Grayson	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Clubshell	Endangered	Nolin River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Rough River Main Channel	
		Northern Riffleshell	Endangered	Nolin River Main Channel	
	Plant	Eggert' s Sunflower	Endangered		
Green	Mammal	Gray Bat	Endangered		
	Mussel	Clubshell	Endangered	Green River Main Channel	
				Russell Creek Main Channel	
		*Fanshell	Endangered	Green River Main Channel	
		*Northern Riffleshell	Endangered	Green River Main Channel	
		Rough Pigtoe	Endangered	Green River Main Channel	
Greenup	Mussels	Fanshell	Endangered	Tygarts Creek Main Channel & Lower White Oak Creek Main Channel South of KYHWY 784	
		*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
Hancock	Mussels	*Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
	Reptile	Cooperbelly Water Snake	SCA		
Hardin	Mammals	Indiana Bat	Endangered		
		Gray Bat	Endangered		
	Plant	Eggert' s Sunflower	Threatened		
Harlan	Fish	Blacksided Dace	Threatened	First, Second and Third Order Streams Within the Following Watersheds:	
				Breedens Creek Watershed	
				Clover Fork Watershed	
				Watts Creek Watershed	
				Brownies Creek Watershed	
				Clover Lick Creek Watershed	
				Straight Creek Watershed	
		Johnny Darter	Candidate	Martins Fork (Branch) Cumberland River Watershed	
	Mammal	Indiana Bat	Endangered		

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Harrison	Mussel	*Clubshell	Endangered	Licking River Main Channel	
	Mussel	Fanshell	Endangered	Licking River Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
	Insect	Beaver Cave Beetle	Candidate		
Hart	Crustacean	Mammoth Cave Shrimp	Endangered	McCoy Blue Springs Watershed	
				Suds Basin Watershed	
	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Catspaw	Endangered	Green River Main Channel	
		Clubshell	Endangered	Green River Main Channel	
				Nolin River Main Channel	
		Fanshell	Endangered	Green River Main Channel	
		Northern Riffleshell	Endangered	Green River Main Channel	
				Nolin River Main Channel	
		Pink Mucket	Endangered	Green River Main Channel	
		Ring Pink	Endangered	Green River Main Channel	
		Rough Pigtoe	Endangered	Green River Main Channel	
	Plant	Eggert' s Sunflower	Threatened		
Henderson	Bird	Bald Eagle	Threatened		
	Mussel	*Catspaw	Endangered	Ohio River Main Channel	
		*Fanshell	Endangered	Ohio River Main Channel	
		*Fat Pocketbook	Endangered	Ohio River Main Channel	
		*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
	Reptile	Copperbelly Water Snake	SCA		
Henry	Mussel	*Fanshell	Endangered	Kentucky River Main Channel	
	Plant	Braun' s Rockcress	Threatened		
Hickman	Bird	Bald Eagle	Threatened		
		Interior Least Tern	Endangered		
Hickman	Fish	Pallid Sturgeon	Endangered	Mississippi River	
		Relict Darter	Endangered	Bayou du Chien Watershed	Yes
	Mammal	Indiana Bat	Endangered		
Hopkins	Mammal	Gray Bat	Endangered		
	Reptile	Copperbelly Water Snake	SCA		
Jackson	Mammal	Indiana Bat	Endangered		
		Virginia Big-eared Bat	Endangered		
	Mussel	Cumberland Bean	Endangered	Rockcastle River Main Channel and Forth and Fifth Order Streams within the following watersheds:	
				Horselick Creek	
				Laurel Fork	
		*Cumberland Elktoe	Endangered	Third, Forth and Fifth Order Streams within the Horselick Creek Watershed	
		Little-Wing Pearly Mussel	Endangered	Forth Order Streams within the Horse Creek Watershed	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
	Plant	Running Buffalo Clover	Endangered		Yes
Jefferson	Bird	Peregrine Falcon	De-listed		
	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Clubshell	Endangered	Salt River Main Channel	
		Fanshell	Endangered	Ohio River Main Channel	
		Fat Pocketbook	Endangered	Ohio River Main Channel	
		Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		Pink Mucket	Endangered	Ohio River Main Channel	
Jefferson	Mussel	Ring Pink	Endangered	Ohio River Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
	Insect	Jefferson Cave Beetle	Candidate		
	Crustacean	Louisville Crayfish	**SMC	Goose Creek Watershed	
				Beargrass Creek Watershed	
Jessamine	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Plant	Running Buffalo Clover	Endangered		Yes
Johnson	-	-	-	-	
Kenton	Mussel	*Catspaw	Endangered	Ohio River Main Channel	
		*Clubshell	Endangered	Ohio and Licking River Main Channel	
		Fanshell	Endangered	Ohio and Licking River Main Channel	
		Northern Riffleshell *	Endangered	Ohio River Main Channel	
		Orange-Foot Pimpleback*	Endangered	Ohio River Main Channel	
		Pink Mucket *	Endangered	Ohio River Main Channel	
		Ring Pink *	Endangered	Ohio River Main Channel	
		Rough Pigtoe *	Endangered	Ohio River Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
Knox	Fish	Blackside Dace	Threatened	First, Second and Third Order Streams within the Following Watersheds:	
				Stinking Creek	
				Little Poplar Creek	
				Richard Creek	
LaRue	Mussel	Fanshell	Endangered	Rolling Fork River Main Channel	
	Plant	Eggert' s Sunflower	Threatened		
Laurel	Birds	Bald Eagle	Threatened		
Laurel	Fish	Blackside Dace	Threatened	First, Second and Third Order Streams within the Following Watersheds:	
				Craig Creek	
				Ned Branch	
		Johnny Darter	Candidate	Poor Folk (Branch) Cumberland River	
	Mussel	Cumberland Bean	Endangered	Forth and Fifth Order Streams within the Following Watersheds:	
				Rockcastle River	
				South Fork of Rockcastle River	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
				Sinking Creek	
		*Cumberlanian Combshell	Endangered	Cumberland River Main Channel & Fourth and Fifth Order Streams Joined to CRMC	
		Cumberland Elktoe	Endangered	Third and Higher Order Streams within the Sinking Creek Watershed	
		Little-Wing Pearly Mussel	Endangered	Forth Order Streams within the Horselick Creek Watershed	
		*Oyster Mussel		Cumberland River Main Channel	
	Plant	Virginia Speraea	Threatened	Rockcastle River Banks	
		White Fringeless Orchid	Candidate		
Lawrence	Mussel	Fanshell	Endangered	Big Sandy River Main Channel	
Lee	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
		Virginia Big-Eared Bat	Endangered		
Leslie	Mammal	Indiana Bat	Endangered		
Letcher	Fish	Blackside Dace	Threatened	Poor Fork of the Cumberland River and First, Second and Third Order Streams within the Poor Fork of the Cumberland River Watershed	
	Mammal	Indiana Bat	Endangered		
Lewis	Mussel	*Catspaw	Endangered	Ohio River Main Channel	
		*Fanshell	Endangered	Ohio River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		*Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
		*Rough Pigtoe	Endangered	Ohio River Main Channel	
	Plant	Virginia Spiraea	Threatened		
Lincoln	Mussel	Cumberland Bean	Endangered	Buck Creek and Forth and Fifth Order Streams within the Buck Creek Watershed	
Livingston	Bird	Interior Least Tern	Endangered	Ohio River	
	Mammals	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Clubshell	Endangered	Ohio River Main Channel	
		*Fanshell	Endangered	Ohio River Main Channel	
Livingston	Mussel	Fat Pocketbook	Endangered	Cumberland River Main Channel	
		Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		Pink Mucket	Endangered	Tennessee River Main Channel	
		Ring Pink	Endangered	Tennessee River Main Channel	
	Plant	Price's Potato-Bean	Endangered		

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
	Reptile	Copperbelly Water Snake	SCA		
Logan	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Little-Wing Pearly Mussel	Endangered	Forth Order Streams within the Following Watersheds:	
				Red River	
				Wippoorwillow Creek	
	Reptile	Copperbelly Water Snake	SCA		
Lyon	Bird	Bald Eagle	Threatened		
	Mussel	*Clubshell	Endangered	Cumberland River Main Channel	
		*Fanshell	Endangered	Cumberland River Main Channel	
Lyon	Mussel	*Orange-Foot Pimpleback	Endangered	Cumberland River Main Channel	
		*Pink Mucket	Endangered	Cumberland River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
	Plant	Price' s Potato-Bean	Endangered		
Madison	Plant	Running Buffalo Clover	Endangered		Yes
	Insect	Greater Adams Cave Beetle	Candidate		
	Insect	Lesser Adams Cave Beetle	Candidate		
Magoffin	-	-	-	-	
Marion	Insect	Tatum Cave Beetle	Candidate		
Marshall	Mussel	Orange-Foot Pimpleback	Endangered	Tennessee & Ohio River (s) Main Channel	
		Pink Mucket	Endangered	Tennessee River Main Channel	
		Ring Pink	Endangered	Tennessee River Main Channel	
Martin	-	-	-	-	
Mason	-	-	-	-	
McCracken	Mammal	Indiana Bat	Endangered		
	Mussel	Fat Pocketbook	Endangered	Ohio River Main Channel	
		Orange-Foot Pimpleback	Endangered	Ohio River Main Channel	
		Pink Mucket	Endangered	Ohio River Main Channel	
		*Ring Pink	Endangered	Ohio River Main Channel	
McCreary	Fish	Blackside Dace	Threatened	First, Second and Third Order Streams within the Following Watersheds:	
				Rock Creek	
				Jellico Creek	
				Indian Creek	
				Eagle Creek	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
McCreary (cont)				Mill Creek	
				Fishtrap Creek	
				Beaver Creek	
				Riggs Creek	
				Marsh Creek	
		Duskytail Darter	Endangered	Big South Fork Main Channel	
		Palezone Shiner	Endangered	Little S. F. Cumberland River	
		Johnny Darter	Candidate	Third, Forth and Larger Order Tributaries with the Following Watersheds:	
				Barren Fork	
				Laurel Creek	
				Cal Creek	
				Elisha Creek	
				Jenneys Branch	
				Kilburn Fork	
				Laural Fork	
				Indian Creek	
				Marsh Creek	
				Caddell Branch	
	Mammal	Indiana Bat	Endangered		
	Mussel	Cumberland Bean	Endangered	Forth and Fifth Order Streams within the Big South Fork of the Cumberland River Watershed	
		Cumberland Combshell	Endangered	Big South Fork River and Forth and Fifth Order Streams within the Big South Fork of the Cumberland River Watershed	
		Cumberland Elktoe	Endangered	Third Order and Larger Streams within the Following Watersheds:	
				Big South Fork of Cumberland River	
				Rock Creek	
				Marsh Creek	
		Little-Wing Pearly Mussel	Endangered	Forth Order Streams within the Big South Fork of the Cumberland River Watershed	
				Little S. F. Cumberland Water.	
		Oyster Mussel	Endangered	Big South Fork Main Channel	
	Plants	Cumberland Rosemary	Threatened	Big South Fork Watershed	
		Cumberland Sandwort	Endangered	Big South Fork Watershed	
		Virginia Spiraea	Threatened	Big South Fork Watershed	
		White Fringeless Orchid	Candidate		
McLean	Reptile	Copperbelly Water Snake	SCA		
Meade	Mammal	Indiana Bat	Endangered		

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Menifee	Mammal	Indiana Bat	Endangered		
		Virginia Big-Eared Bat	Endangered		
	Plant	White Haired Goldenrod	Endangered		
Mercer	Mussel	*Clubshell	Endangered	Kentucky River Main Channel	
		*Fanshell	Endangered	Kentucky River Main Channel	
		*Northern Riffleshell	Endangered	Kentucky River Main Channel	
		*Ring Pink	Endangered	Kentucky River Main Channel	
		*Rough Pigtoe	Endangered	Kentucky River Main Channel	
Metcalf	Mammal	Gray Bat	Endangered		
	Plant	Eggert' s Sunflower	Threatened		
Monroe	Mammal	Gray Bat	Endangered		
Monroe	Mussel	*Fanshell	Endangered	Cumberland River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Cumberland River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
Montgomery	Mammal	Indiana Bat	Endangered		
	Plant	Running Buffalo Clover	Endangered		Yes
Morgan	Mammal	Indiana Bat	Endangered		
		Virginia Big-Eared Bat	Endangered		
Muhlenberg	Mammal	Gray Bat	Endangered		
	Mussel	Catspaw	Endangered	Green River Main Channel	
		Fanshell	Endangered	Green River Main Channel	
	Reptile	Copperbelly Water Snake	SCA		
Nelson	Mammal	Gray Bat	Endangered		
	Mussel	*Clubshell	Endangered	Salt River Main Channel	
		*Northern Riffle Shell	Endangered	Salt River Main Channel	
		Fanshell	Endangered	Salt River Main Channel	
				Rolling Fork Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
Nicholas	Mussel	Fanshell	Endangered	Licking River Main Channel	
Ohio	Mussel	*Catspaw	Endangered	Rough River Main Channel	
		Fanshell	Endangered	Rough River Main Channel	
		*Orange-Foot Pimpleback	Endangered	Rough River Main Channel	
Oldham	-	-	-	-	
Owen	Mussel	*Clubshell	Endangered	Kentucky River Main Channel	
		*Fanshell	Endangered	Kentucky River Main Channel	
Owsley	-	-	-	-	
Pendleton	Mussel	*Clubshell	Endangered	Licking River Main Channel	
		Fanshell	Endangered	Licking River Main Channel	
		*Northern Riffleshell	Endangered	Licking River Main Channel	
Pendleton	Mussel	Pink Mucket	Endangered	Licking River Main Channel	
		*Rough Pigtoe	Endangered	Licking River Main Channel	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Perry	-	-	-	-	
Pike	Mammal	Indiana Bat	Endangered		
Powell	Mammal	Indiana Bat	Endangered		
		Virginia Big-eared Bat	Endangered		
	Plant	White-haired Goldenrod	Endangered		
Pulaski	Fish	Blackside Dace	Threatened	First, Second and Third Order Streams in the Big Lick Branch Watershed	
	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
Pulaski	Mussel	*Catspaw	Endangered	Buck Creek Watershed	
		Cumberland Bean	Endangered	Forth and Fifth Order Streams in the Buck Creek Watershed	
				Rockcastle River Main Channel	
		Cumberlandian Combshell	Endangered	Buck Creek and Rockcastle River Main Channel and Forth and Fifth Order Streams in the Buck Creek and R. River Watershed	
		Little-wing Pearly Mussel	Endangered	Buck Creek and Forth Order Streams within the Buck Creek Watershed	
				Pitman Creek	
		*Oyster Mussel	Endangered	Buck Creek Main Channel	
				Rockcastle River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
		*Rough Pigtoe	Endangered	Cumberland River Main Channel	
	Plant	Virginia Spiraea	Threatened		
		White Fringeless Orchid	Candidate		
Robertson	Mussel	*Clubshell	Endangered	Licking River Main Channel	
		Fanshell	Endangered	Licking River Main Channel	
	Plant	Short's Goldenrod	Endangered		
Rockcastle	Mammal	Indiana Bat	Endangered		
		Virginia Big-eared Bat	Endangered		
	Mussel	Cumberlandian Combshell	Endangered	Forth Order Streams within the Following Watersheds:	
				Horselick Creek	
				Roundstone Creek	
				Rockcastle River (main channel)	
		Little-winged Pearly Mussel	Endangered	Forth Order Streams within the Following Watersheds:	
				Horselick Creek	
				Rockcastle River Main Channel	
	Plant	Virginia Spiraea	Threatened		
Rowan	Mammal	Virginia Big-eared Bat	Endangered		

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
	Mussel	*Northern Riffleshell	Endangered	Licking River Main Channel	
		Pink Mucket	Endangered	Licking River Main Channel	
Russell	Mussel	*Cumberlandian Combshell	Endangered	Cumberland River Main Channel	
		*Cumberland Bean	Endangered	Cumberland River Main Channel	
		*Fanshell	Endangered	Cumberland River Main Channel	
		*Orange-foot Pimpleback	Endangered	Cumberland River Main Channel	
		*Oyster Mussel	Endangered	Cumberland River Main Channel	
		*Pink Mucket	Endangered	Cumberland River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
		*Rough Pigtoe	Endangered	Cumberland River Main Channel	
Scott	Mammal	Gray Bat	Endangered		
	Plant	Short's Bladderpod	Candidate		
Shelby	Mammal	Gray Bat	Endangered		
Simpson	Mammal	Gray Bat	Endangered		
Spencer	Mussel	*Clubshell	Endangered	Salt River Main Channel	
		*Fanshell	Endangered	Salt River Main Channel	
		*Northern Riffleshell	Endangered	Salt River Main Channel	
		*Pink Mucket	Endangered	Salt River Main Channel	
Taylor	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Clubshell	Endangered	Green River Main Channel Below GR Lake Dam	
		*Northern Riffleshell	Endangered	Green River Main Channel Below GR Lake Dam	
Todd	Mussel	*Fanshell	Endangered	West Fork Red River Main Channel	
		*Little-wing Pearly Mussel	Endangered	West Fork Red River Main Channel	
		*Ring Pink	Endangered	West Fork Red River Main Channel	
Trigg	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	*Orange-foot Pimpleback	Endangered	Cumberland River Main Channel	
		*Ring Pink	Endangered	Cumberland River Main Channel	
	Plant	Price's Potato-Bean	Endangered		
Trimble	Mammal	Indiana Bat	Endangered		
Union	Mammal	Indiana Bat	Endangered		
	Mussel	Fat Pocketbook	Endangered	Ohio River Main Channel	
	Reptile	Copperbelly Water Snake	SCA		
Warren	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Mussel	Catspaw	Endangered	Green River Main Channel	

Kentucky 2003 Threatened And Endangered Species List By County

COUNTY	SPECIES TYPE	SPECIES	FEDERAL STATUS	Aquatic Species (Watershed)	USFWS Species Fact Sheet Available
Warren (con't)		Fanshell	Endangered	Barren River Main Channel	
				Green River Main Channel	
		*Orange-foot Pimpleback	Endangered	Green River Main Channel	
		*Northern Riffleshell	Endangered	Barren River Main Channel	
				Drakes Creek Main Channel	
		Pink Mucket	Endangered	Barren River Main Channel	
				Green River Main Channel	
		*Ring Pink	Endangered	Green River Main Channel	
		Rough Pigtoe	Endangered	Barren River Main Channel	
		Clubshell	Endangered	Green River Main Channel	
Washington	-	-	-	-	
Wayne	Mammal	Gray Bat	Endangered		
		Indiana Bat	Endangered		
	Fish	Palezone Shiner	Endangered	Little S. F. Cumberland River Main Channel	
	Mussel	Cumberland Bean	Endangered	Forth and Fifth Order Streams within the following Watersheds:	
				Little S. F. Cumberland River	
				Kennedy Creek Watershed	
		*Cumberlandian Combshell	Endangered	Forth Order Streams within the Cumberland River Watershed	
		Fanshell	Endangered	Cumberland River Main Channel	
		Little-wing Pearly Mussel	Endangered	Forth Order Streams within the Following Watersheds:	
				Little S. F. Cumberland River	
				Kennedy Creek Watershed	
		*Orange-foot Pimbleback	Endangered	Little South Fork Cumberland River Main Channel	
		*Oyster Mussel	Endangered	Little South Fork Cumberland River Main Channel	
		*Pink Mucket	Endangered	Little South Fork Cumberland River Main Channel	
		*Ring Pink	Endangered	Little South Fork Cumberland River Main Channel	
		*Rough Pigtoe	Endangered	Little South Fork Cumberland River Main Channel	
Webster	Reptile	Copperbelly Water Snake	SCA		
Whitley	Bird	Red-cockaded Woodpecker	Endangered		
	Fish	Blackside Dace	Threatened	First, Second and Third Order Streams within the Following Watersheds:	
				Jellico Creek	
Whitley (con't)				Young Creek	

				Mud Creek	
				Patterson Creek	
	Fish	Johnny Darter	Candidate	Third, Forth and Larger Tributaries Within the Following Watersheds:	
				Cumberland River	
				Bunches Creek	
				Calf Pen Creek	
				Jellico Creek	
				Little Wolf Creek	
				Brier Creek	
				Youngs Creek	
	Mussel	*Cumberland Bean	Endangered	Cumberland River Watershed	
		Cumberland Elktoe	Endangered	Third Order and Larger Streams within the Following Watersheds:	
				Laurel Fork	
				Lynn Camp Creek	
		*Oyster Mussel	Endangered	Cumberland River Main Channel	
	Plant	Virginia Spiraea	Threatened		
		White Fringeless Orchid	Candidate		
Wolfe	Mammal	Indiana Bat	Endangered		
		Virginia Big-eared Bat	Endangered		
Woodford	Mussel	*Clubshell	Endangered	Kentucky River Main Channel	
		*Fanshell	Endangered	Kentucky River Main Channel	
		*Northern Riffleshell	Endangered	Kentucky River Main Channel	
		*Ring Pink	Endangered	Kentucky River Main Channel	
		*Rough Pigtoe	Endangered	Kentucky River Main Channel	
	Plant	Running Buffalo Clover	Endangered		Yes
	Insect	Clifton Cave Beetle	Candidate		

- *** Denotes older records for species. Species <u>may</u> have been extirpated from watershed. However, survey data can be inconclusive and these species could still be present in very limited numbers.**
- **** USFWS Species of Management Concern and unique to listed watersheds.**

Exhibit E

NRCS Practices Effects on Threatened and Endangered Species (T&E)

Zero (0) - Not likely to adversely affect T&E species
Minus (-) - Practice may adversely affect T&E species if present (May require further consultation.)
Plus (+) - Practice may beneficially affect T&E species if present

This table shall be used to assist in making planning decisions regarding threatened and endangered species. Contact the NRCS State Biologist for assistance. Numbers adjacent to Xs correspond to footnotes at the end of the table. Refer to the "NEPA Guidance Document For Threatened and Endangered Species" for further guidance on use of this table and other tools.

Practice Name and Unit	Practice Code	0	-	+
Access Road (Feet)	560		X1	
Agrichemcial Handling Facility	998	X		
Animal Trails and Walkways	575		X1	
Brush Management (Acre)	314		X1,X5	
Clearing and Snagging (Feet)	326		X1,X2, X3, X19	
Closure of Waste Impoundments (No)	360	X		
Commercial Fish Ponds (Catfish)	397A		X1, X4	
Commercial Fish Ponds (Shrimp)	397B		X1, X4	
Composting Facility (No)	317		X1	
Conservation Cover (Acre)	327		X5	
Conservation Cropping Sequence (Acre)	328	X		
Conservation Tillage (Acre)	329	X		
Contour Farming (Acre)	330	X		
Contour Orchard and Other Fruit Area (Acre)	331	X		
Cover and Green Manure (Acre)	340	X		
Critical Area Planting (Acre)	342		X5	
Crop Residue Use (Acre)	344	X		
Dike (Feet)	356		X1	
Diversion (Feet)	362		X1	
Dry Hydrant (Each)	432	X		
Farmstead and Feedlot Windbreak (Acre)	380	X		
Fence (Feet)	382	X		
Field Border (Feet)	386		X5	
Field Wind Break (Feet)	392		X5	
Filter Strip (Acre)	393		X5	X6
Firebreak (Feet)	394		X1, X5	
Fishpond Management (No)	399	X		
Forage Harvest Management	511	X		
Forest Land Erosion Control Systems (Acre)	408	X		
Forest Site Preparation (Acre)	490		X1, X5	
Grade Stabilization Structure (No)	410		X1,	X6
Grassed Waterway (Acre)	412		X1	
Heavy Use Area Protection (Acre)	561		X1	
Hedgerow Planting (Feet)	422		X5	
Irrigation Land Leveling (Acre)	464		X1	
Irrigation Storage Reservoir (No/Acre-Feet)	436		X1	

NRCS Practices Effects on Threatened and Endangered Species (T&E)

Practice Name and Unit	Practice Code	0	-	+
Irrigation System Sprinkler (No/Acre)	442	X		
Irrigation System, Surface and Subsurface	443	X		
Irrigation Water Conveyance, Pipeline (Feet)	430	X		
Irrigation Water Management (Acre)	449	X		
Land Clearing (Acre)	460		X1, X3, X19	
Land Reclamation, Fire Control (No)	451		X1, X19	
Land Reclamation Land Slides Subsidence Treatment (No/Acre) Toxic Discharge Control (No) Highwall Treatment (No/Feet)	 453 454 455 456		X1, X19	
Land Reconstruction Abandoned Mine Land (Acre) New Mining	 543 544A		X1, X19	
Land Smoothing (Acre)	466		X1	
Livestock Exclusion (Acre)	472			X6
Manure Transfer (No)	634	X		
Mulching (Acre)	484	X		
Nutrient Management (Acre)	590	X		
Obstruction Removal (Acre)	500		X1, X2, X3	
Open Channel (Feet)	582		X1, X18	
Pasture and Hayland Planting (Acre)	512		X5	
Pest Management (Acre)	595		X5	
Pipeline (Feet)	516		X1	
Pond (No)	378		X1	
Pond Sealing or Lining Flexible Membrane Lining (No) Soil Dispersant (No) Bentonite Sealant (No) Cationic Emulsion (No) Asphalt Sealed Fabric Liner (No)	 521-A 521-B 521-C 521-D 521-E	X		
Precision Land Forming (Acre)	462		X1	
Prescribed Burning (Acre)	338		X1	
Prescribed Grazing (Acre)	528A	X		
Pumping Plant for Water Control (No)	533		X1	
Recreation Area Improvement (Acre)	562		X1	
Recreation land Grading and Shaping (Acre)	566		X1	
Recreation Trail and Walkway (Feet)	568		X1	
Riparian Forest Buffer (Acre)	391A		X1,X5	X6,X7,X8
Roof Runoff Management (No)	558	X		
Sediment Basin (No)	350		X1	
Shallow Water Management For Wildlife(Ac)	646			X7, X14

NRCS Practices Effects on Threatened and Endangered Species (T&E)

Practice Name and Unit	Practice Code	0	-	+
Sinkhole Protection (Acre)	725		X9	X15
Spoil Spreading (Feet)	572		X1	
Spring Development (No)	574		X1	
Streambank and Shoreline Protection (Feet)	580		X1, X2, X3,X10, X19	X6
Stream Crossing (Interim) (No)	576		X1, X2, X3, X10, X19	
Stripcropping, Contour (Acre)	585	X		
Stripcropping, Field (Acre)	586	X		
Structure For Water Control (No)	587		X1	
Subsurface Drain (Feet)	606		X1, X18	
Surface Drainage Field Ditch (Feet) Main or Lateral (Feet)	 607 608		X1, X18	
Terrace (Feet)	600		X1	
Tree/Shrub Establishment (Acre)	612		X5	X11
Trough or Tank (No)	614		X1	
Underground Outlet (Feet)	620		X18	
Vertical Drain (No)	630	X		
Waste Field Storage (Ea)	749	X		
Waste Storage Facility (No)	313		X1	
Waste Treatment Lagoon (No)	359		X1	
Waste Utilization (Acre)	633		X16	
Water and Sediment Control Basin (No)	638		X1	
Well (No)	642		X1	
Well Decommissioning (No)	351	X		
Wetland Restoration (Acre)	657		X1, X12	X7,X8
Wildlife Upland Habitat Management (Acre)	645		X1, X3, X13	X17
Wildlife Watering Facility (No)	648		X1	X14
Wildlife Wetland Habitat Management (Acre)	644	X		
Woodland Improvement (Acre)	666		X3	
Woodland Pruning (Acre)	660	X		

X1 – Earthmoving or placement of these practices may negatively affect threatened or endangered plant species. Further investigation is required if the practice will be placed in a habitat type where a threatened or endangered plant may reside. Review the habitat type, plant characteristics and appearance in the Kentucky Department of Fish and Wildlife Resources publication entitled Kentucky's Threatened and Endangered Species, 2001. Make a visual observation of the area to determine if the species or habitat for the species exists. Contact the NRCS State Biologist for assistance, when a threatened or endangered plant is identified or thought to exist on the project area.

X2 – Appropriate permits, if required, must be acquired prior to conducting clearing and snagging activities. NRCS shall only provide assistance when the work will be in accordance with the appropriate permits.

X3 – Tree removal or land clearing may adversely affect the Indiana bat if conducted at the wrong time of the year. In counties noted to have the Indiana bat, NRCS must plan tree removal for periods between October 15th and March 31st unless the proposed site is within 5 miles of a cave, mine or other site used for hibernation. Tree removal and land clearing in these areas must be planned between November 15th and March 31st. In counties noted to have the Indiana bat, contact the NRCS State Biologist for assistance when planning tree removal to determine proximity to hibernation areas.

X4 – Currently, Kentucky NRCS is not providing technical or financial assistance for installation or management of commercial fish ponds. If in the future, NRCS provides technical or financial assistance for commercial fish ponds, the NRCS State Biologist must be contacted for assistance during the planning process if the commercial pond will be built in a watershed where threatened or endangered aquatic species are listed.

X5 – Herbicide application or conventional tillage planned as part of these practices may adversely affect listed plant species if present. Further investigation is required if the practice will be placed in a habitat type where a threatened or endangered plant may reside. Review the habitat type, plant characteristics and appearance in the Kentucky Department of Fish and Wildlife Resources publication entitled Kentucky' s Threatened and Endangered Species, 2001. Make a visual observation of the area to determine if the species or habitat for the species exists. Contact the NRCS State Biologist for assistance when a threatened or endangered plant is identified or thought to exist on the project area.

X6 – Practices will have a beneficial effect if the practice is installed on a stream that has aquatic threatened or endangered species. These practices will also provide beneficial effects when planned around sinkholes in counties where the Kentucky Cave Shrimp is listed.

X7 – Practice will have a beneficial effect if the practice is installed in a county noted to contain the Copperbelly Water Snake.

X8 – Practice will have a beneficial effect if the practice is installed in a county that contains the Indiana bat.

X9 – Prior to filling, closing or stabilizing an open throated sinkhole in a county noted to have Indiana, Gray, or Virginia Big Eared Bats, an investigation must be done to determine if any of these species utilize the sinkhole. Contact the NRCS State Biologist to arrange a site visit during planning.

X10 – An adverse effect may occur during practice installation on stream segments that are noted to have aquatic threatened or endangered species. Contact the NRCS State Biologist for assistance when planning these practices on stream segments noted to have threatened or endangered aquatic species.

NRCS Practices Effects on Threatened and Endangered Species (T&E)

X11- Tree and shrub establishment will have beneficial effects when it is planned in any county with the Indiana bat or on flood plain soils in counties noted to contain the Copperbelly Water Snake.

X12 - Wetland Restoration plans shall be reviewed by the USFWS.

X13 – Strip disking or forest openings done under Wildlife Upland Habitat Management (645) may adversely affect threatened or endangered plants. Further investigation is required if strip disking or forest openings will be planned in a habitat type where a threatened or endangered plant may reside. Review the habitat type, plant characteristics and appearance in the Kentucky Department of Fish and Wildlife Resources publication entitled Kentucky's Threatened and Endangered Species, 2001. Make a visual observation of the area to determine if the species or habitat for the species exists. Contact the NRCS State Biologist for assistance when a threatened or endangered plant is identified or thought to exist on the project area.

X14 – Practice will have a beneficial effect when installed in counties noted to contain the Indiana bat, Gray bat, or Virginia Big-eared bat.

X15 – Positive effect in counties where the Kentucky Cave Shrimp is listed if protection of the sinkhole does not include filling.

X16 – The following applies when Waste Utilization is being planned in watersheds where threatened or endangered aquatic species are listed:

1) When applicable, NRCS conservation plans shall include the required waste application set backs established in the Kentucky Division of Water's AFO/CAFO regulations and permit requirements.
2) When the Kentucky Division of Water's AFO/CAFO regulations do not apply, waste applications must be planned at least 40 feet from perennial, seasonal, and ephemeral streams, surface ditches, openings of open throated sinkholes, and other sensitive areas.

X17 – Positive effect when a cave gate is being placed over the entrance of a cave, mine, or other opening where Threatened or Endangered bats reside. The NRCS State Biologist must be contacted when planning to install cave gates.

X18 – All planned drainage must comply with NEPA, the Clean Water Act, and the Swamp Buster Provision of the Food Security Act.

X19 - Tree removal or land clearing around Bald Eagle nests may have an adverse effect on the species. Contact the NRCS State Biologist for assistance when Bald Eagle nests are identified during the planning process.

Exhibit F

Using Micro and Macrotopography in Wetland Restoration

Indiana Biology Technical Note No. 1

This document is intended to be used as a tool to assist in the planning of wetland restorations where the natural topography of the site has been eliminated. The planner is encouraged to be creative when developing the restoration plan. The concepts within can also be used whenever the development of macrotopographic features are desired.

WHAT IS MACROTOPOGRAPHY?

Background Undisturbed wetland systems in Indiana typically consist of complexes that contain a diversity of topographic relief from extremely shallow areas with minor ridges (microtopography) to deeper wetland habitats that include some upland characteristics (macrotopography). When wetlands are drained or altered, they normally lose most of their micro and macro topographic relief through land leveling or other agricultural activities.

Macrotopographic features are wetland "ridge and swale" complexes whose basins are depressional in landscape position and occur on terraces and in floodplains. The basin areas are normally from 0.1 acre to 5 acres in size with depths running from 0-30 inches, depending on the landscape position. These types of wetlands can be found in a multitude of shapes ranging from simple circular basins, to complex amoeba-like outlines, to meandering scours. Ridges (linear) and mounds (circular or elliptical) make up the "upland" component of macrotopographic features that normally do not exceed 30" in height. Together, the ridge and swale features form ephemeral wetlands that hold water from only a few weeks to several months during the year.

Microtopographic features are normally thought of as those shallow depressions with less than 6 inches of depth between the swales and ridges. Examples of microtopography can be seen in flat fields where shallow "sheet" water stands for short durations after a rain. Within the scope of this document, macrotopography will be assumed to include microtopographic features.

WHY IS THE DEVELOPMENT OF MACROTOPOGRAPHY IMPORTANT?

The development of macrotopographic complexity creates a diversity of water regimes (hydroperiods) which can increase water quality, provide flood storage, and enhance the development of a more diverse vegetative community. This results in greater overall wildlife benefits through the development of a variety of habitats. The dispersal, germination, and establishment of plant species, and the life cycles of many amphibians, reptiles, and other wildlife species are dependent on variations in the timing, depth, and duration of flooding.

Pickerel Frog

Food In the spring, shallow, ephemeral wetlands warm up before larger, deeper bodies of water, and provide important seasonal forage for shorebirds, waterfowl, nonmigratory bird species, and other wildlife. These types of wetlands produce significant amounts of protein-rich invertebrates including snails, worms, fairy shrimp, midge larvae, spiders, backswimmers, diving beetles, dragonflies, and damselflies. Organic (woody and herbaceous) debris, roots, leaves, and tubers from aquatic vegetation are additional food sources and provide substrates for macroinvertebrates.

Habitat Wetland restoration plans that include undulating landscape features create a diversity of habitat types. Swales, oxbows, potholes and other macrotopographic basins provide varying hydroperiods from short-term ponding to seasonal and semi-permanent water conditions. A wetland, or wetland complex, with multiple hydroperiods can support a variety of habitat zones. Scrub-shrub, submergent, emergent, and floating-leaf communities (e.g., duckweed) are examples of herbaceous aquatic habitats. A diverse wetland plant community benefits numerous species of wildlife including many fur-bearing mammals, waterfowl, shorebirds, wading birds, amphibians and reptiles. Because native plants provide the best overall habitat, are essentially self-sustaining, and tend to be non-invasive, only native vegetation should be planted. Note that Conservation Practice Standard 657, Wetland Restoration, has an extensive list of native wetland plant species.

Low-level mounds or ridges (maximum 30 inches) are considered to be a component of macrotopography, and can greatly increase the biological diversity of restoration sites when combined with basins. Amphibians, for example, tend to have small home ranges. Thus, having a diversity of wetland types in close proximity to terrestrial habitats within the project area will support the greatest populations.

PLANNING

When developing macrotopographic features, the planner should determine the target species (i.e. species of concern) and review historical aerial photography to determine the appropriate features to include in the restoration project.

Tiger Salamander

Amphibians and Reptiles A primary focus of macrotopography development is the creation of habitat for frogs, toads, salamanders, newts, turtles, and snakes. These amphibians and reptiles are known as herpetofauna or commonly called "herps". Amphibians are an especially diverse group and require wetlands with differing hydroperiods and habitat types. Because macrotopographic basins are often completely dry by summer or early fall, they are normally free of fish. Occasionally pools do retain water year round, but due to warm water conditions that create low oxygen levels, they still do not support fish populations. This is important because fish are primary predators of larval, tadpole, and adult amphibians. In general, sites flooded for longer periods will have more predators of amphibians.

The timing and duration of flooding are important factors that dictate which amphibians will use a particular wetland. Amphibian species are extremely variable in their habitat requirements. Most breeding occurs from May through August, with eggs hatching anywhere from 4 to 20 days later. Complete metamorphosis may take an additional 7 weeks to 3 months. Some species may need as much as a year to develop, with a few species even over-wintering as tadpoles, requiring permanent water. Table 1 (modified from Knutson et. al.) is an example of the diversity in preferred breeding periods and guild associations, for a study in an Iowa and Wisconsin.

Table 1[1]

			Breeding[2]		Nonbreeding[3]			Hibernation[4]		
Common name	Scientific name	Breeding period	Perm. water	Temp. water	Water	Forest/ litter	Open	Water	Forest/ litter	Ground
Wood frog	Rana sylvatica	Mar.-Apr.	N	Y	N	Y	N	N	Y	N
Chorus frog	Pseudacris triseriata	Mar.-May	N	Y	N	Y	Y	N	Y	N
Spring peeper	Pseudacris crucifer	Mar.-Summer	N	Y	N	Y	N	N	Y	N
N. leopard frog	Rana pipiens	Apr.-June	Y	Y	Y	N	Y	Y	N	N
Pickerel frog	Rana palustris	Apr.-mid June	Y	N	Y	Y	Y	Y	N	N
American toad	Bufo americanus	Apr.-June	Y	Y	N	Y	Y	N	Y	N
Eastern gray treefrog	Hyla versicolor	May-Aug.	Y	Y	N	Y	N	N	Y	N
Cope's gray treefrog	Hyla chrysoscelis	May-Aug.	Y	Y	N	Y	Y	N	Y	N
Cricket frog	Acris crepitans	May	Y	N	Y	N	N	N	Y	N
Green frog	Rana clamitans	Mid May-July	Y	N	Y	N	N	Y	N	N
Bullfrog	Rana catesbeiana	May-July	Y	N	Y	N	N	Y	N	N
Fowler's toad	Bufo woodhousii	Mar.-Aug.	N	Y	N	N	Y	N	N	Y

[1] Species that can successfully survive or reproduce in a habitat during the identified life-history phase are identified with a Y; those that do not with an N.
[2] Will breed in permanent water or temporary (ephemeral) ponds.
[3] Active, nonbreeding portion of the year is spent in the water or along the water edges, in trees or forest litter, or in open, nonforested habitats (grasslands).
[4] Hibernation or estivation period is spent in or near water, in forest litter, or underground.

In Indiana, the species that metamorphose their life cycle by early summer are the ones we need to target. Therefore, **macrotopographic basins should be designed to keep water available until at least mid-July.** Note that the process of a wetland drying out is beneficial. It eliminates insect and vertebrate predators, allows seeds to germinate, and exposes detritus to processes of oxidation thereby releasing nutrients.

When planning a site for amphibian and reptile habitat, macrotopographic features should make up approximately 30-50% of the area. The water (swale, meander, etc.) and the upland habitat (mound) acreage are combined to get the percent of macrotopographic features. It can be assumed that for every acre of water created, an additional acre of mound is created. **Table 2** can be used to record the planned macrotopographic features.

Table 2

Field Number	Field Size (acres)	Basin Number	Basin Amount (acres)	Macrotopography Description	Associated Habitat Mounds (height(#))

Where restoration sites have a designed water level, such as those with levees and control structures, approximatey 30% of the area should have macrotopographic features. Consider concentrating macrotopographic features in and near the more shallow water reaches.

Where restoration sites do NOT have a designed water level, such as in floodplains where high stream flows would destroy levees and control structures, approximatey 50% of the area should have macrotopographic features. Note that in these landscapes, the macrotopographic basins may provide the only standing water on the restoration site. Consider concentrating the deeper macrotopographic features in the lower elevations of the site, and shallower features in the higher elevations.

Shorebirds Shallow, ephemeral wetlands provide an abundance of aquatic invertebrates that are a critical food source for shorebirds during migration. Most shorebird species will utilize wetland habitats with water depths from 0-3 inches, and will rarely forage in water depths greater than 6 inches. Maximizing areas which provide conditions from mudflats through 3 inches deep during spring and late summer will provide the greatest benefits for migratory shorebirds.

Waterfowl These same shallow basins provide important invertebrate forage for waterfowl, particularly during spring migration when nutrient needs prior to nesting are high. In addition, several species of dabbling ducks (e.g. mallards and blue-winged teal) will utilize temporary wetlands for pair bonding and mating. Although these temporary ponds may not have water long enough to provide brood habitat in most years, they serve an important function in distributing pairs across the landscape and allowing for courtship rituals. Visually isolating basins, or portions of basins, through irregular shaping will particularly benefit species such as mallards which are more territorial. When combined with semi-permanent basins in close proximity, macrotopographic basins contribute to excellent wetland complexes for water fowl breeding.

Soils It is important for the planner to identify those portions of the restoration site which have hydric soils or soils that will most likely respond to macrotopographic development. Look for soils that have low permeability, a restrictive under-lying layer, or high water tables.

Sites which have soils that are hydric due only to flooding may not be appropriate if the soils are well drained and are not very frequently flooded. In these cases, it may not justify the expense of creating macrotopography and the planner should consider only vegetative restoration measures. If it is unclear whether or not there is sufficient hydrology to maintain the needed water levels within the basin areas, a water budget should be calculated.

Succession and Long-term Management Succession of wetlands is a natural process that can result in significant habitat changes over time. Primary changes include, for example, the development of aquatic macrophytes, invasion of wetlands by trees and shrubs, and canopy closure over wetlands embedded in forested landscapes. Such changes can alter the species composition of wetlands over time by selecting for species that favor or can tolerate later successional stages. Early successional species will consequently be lost, thereby lowering diversity, and can only be restored by periodically reversing succession. Plans to periodically (e.g. every 10-20 years) reverse the effects of succession in some portion of all wetlands (e.g. 5-10% of the total number per year) are important to consider. Natural processes that can reverse succession vary among regions and should mimic local regimes but may include flooding, drying, and burning. Human disturbance regimes such as mowing, timber harvest, draw-downs, or even herbicides may be considered, but only with extreme caution because of possible negative indirect effects.

MACROTOPOGRAHIC BASINS

The macrotopograhic basins are described in abbreviated format as: shape/size/depth.
Where:

1) the shape is described below
2) the size is in acres
3) the depth is in feet

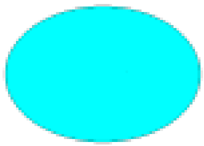
For example, a macrotopograhic basin described as Oxbow/1.5/0.5-1.0-2.0:

1) has shape #2 below,
2) is 1.5 acres in size, and
3) is composed of 3 depths (0.5’, 1.0’ and 2.0’)

BASIN SHAPE DESCRIPTIONS

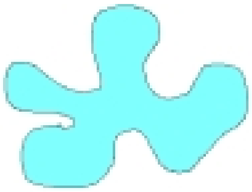
Basins should be irregular in shape. Irregular shapes increase edge and provide additional cover for waterfowl and other wildlife utilizing the site.

1) Shape: **Oval**
Description: Generally circular



2) Shape: **Oxbow**
Description: Kidney shaped with 2 lobes

3) Shape: **Amoeba**
Description: Multiple lobes with random shape, high perimeter to surface area ratio

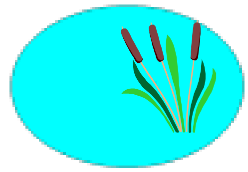


4) Shape: **Meander**
Description: Mimics an abandoned stream channel meander

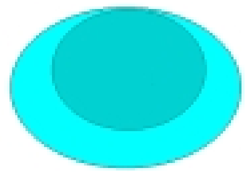
DEPTH DESCRIPTIONS

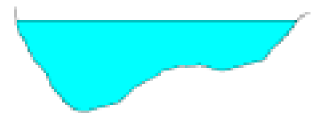
AERIAL VIEW | **CROSS SECTION**

When 1 depth is indicated:
- the basin is primarily 1 depth

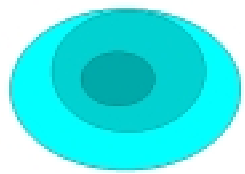


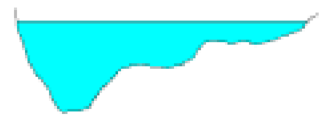
When 2 depths are indicated:
- each depth composes approximately 50% of the area





When 3 depths are indicated:
the depths compose approximately:
- deepest depth = 20% of the area
- middle depth = 30% of the area
- shallowest depth = 50% of the area





HABITAT MOUNDS

Fill excavated from the macro-topograhic basins can be used to create multiple upland habitat conditions based on the height, shape, and location of habitat mounds. Variations in habitat mound design can provide escape areas, denning sites, nesting opportunities, and plant diversity, as well as providing visual breaks within the wetland complex. All side slopes for mounds should have a minimum slope of 6:1, but should be as flat as is feasible. **Note:** In situations where geese are a nuisance, at least 30 feet should exist between the habitat mound and any water surface. This area should then be planted with a vegetative barrier such as warm season grasses, trees or shrubs.

Where restoration sites have a designed water level, habitat mounds should vary in elevation from above to below the expected normal waterline. Approxmately 1/3 of the mounds should be 6 inches to 1.0 foot **below** the normal water elevation, 1/3 should be 6 inches to 1.0 foot **above**, and 1/3 should be **at** the normal water elevation.

Where restoration sites *do not* have a designed water level, habitat mounds primarily provide upland habitat and tend to direct water flow during flood conditions. Approximately 50% of the mounds should be 6 inches to 1.0 foot above average ground level, and 50% should be 1.0 to 2.0 foot above the normal ground elevation. Mounds should mimic the natural landscape as much as possible. For example, if the site is located on the interior of a river oxbow, ridge and swale design may be appropriate (see figures 2 and 3). When possible, place mounds in such a way as to increase meander distance by directing water flow in a path that meanders across the unit.

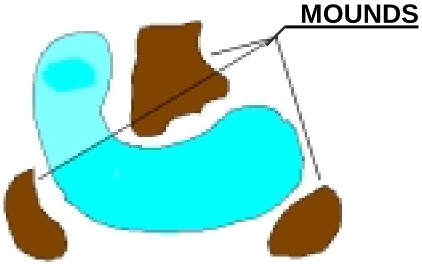


Figure 1

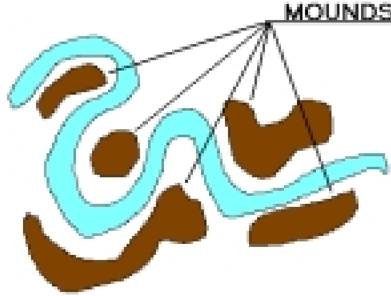


Figure 2

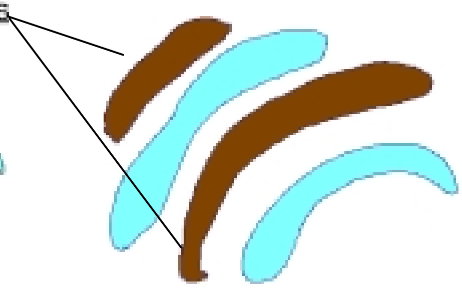


Figure 3

ADDITIONAL MODIFICATIONS

Ditches of varying depths and widths can connect basins to diversify a site. They provide additional cover for waterfowl as well as escape routes away from predators. Connection ditches may have 3:1 (or flatter) side slopes. In some cases, they can also be used for boat access to the site for hunting and recreational viewing, or to limit vehicular traffic of the site. See Figure 4.

Note: In situations where amphibians are the primary species of concern, connecting ditches should be limited because they provide access routes for predatory fish, particularly if connected to deeper, more permanent pools.

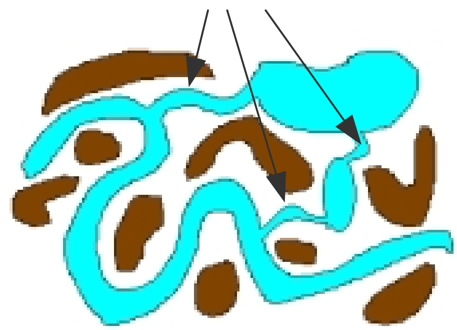


Figure 4

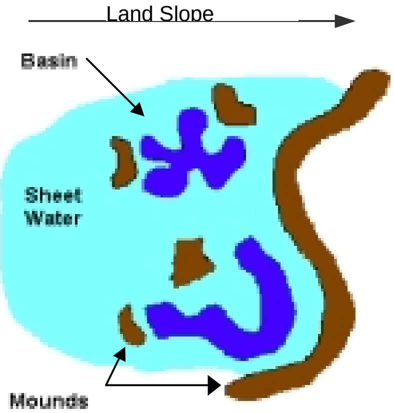


Figure 5

On gently sloping sites, an efficient means of providing shallow, "sheet" water habitat is through the creation of linear habitat mounds. The excavated material from a macrotopographic basin is used to form a low, meandering ridge on the down slope side of the basin(s). Typical heights for the mound range from 1 to 2 feet. By using the spoil in a creative manner, the total shallow water on a project site can be substancially increased. The impounded sheet water provides seasonal or ephemeral water for shallow feeders such as shorebirds, while the excavated basins provide longer hydroperiod wetland habitats. This method can also be utilized where wetland meadow conditions are desired.

CONSTRUCTION

Creative Borrowing Borrow areas for dikes or embankments can be incorporated into the development of macrotopographic features. Potholes, swales, meanders, and other shallow water habitats can serve as borrow areas for needed fill. All side slopes for basins should have a minimum slope of 6:1. Note that, when feasible, slopes should be as flat as possible. Slopes exceeding 20:1 are not considered excessive for habitat purposes. Examples of this include situations where equipment operators randomly fill their scrapers leaving shallow, single-trip borrow sites. Note that the borrow areas will result in the basins being the deepest portions of the wetland complex. In seasonal or ephemeral wetlands these areas provide a diversity of hydroperiods by holding water later into the year than the remainder of the wetland.

Rough-finish Grading The desired macrotopographic features will have rough surfaces on all side slopes and top, an undulating bottom, and a ragged shoreline.

Woody Debris

- Provides sunning and resting areas for herptiles
- Provides loafing sites for waterfowl
- Is a source for organic soil material
- Provides additional vertical and horizontal habitat
- Is an excellent substrate for invertebrates

Depending on water velocities the debris may or may not have to be partially buried. Use as needed.

ASSOCIATED TECHNICAL STANDARDS

This technical note can be used in association with the following technical standards:

- 657 Wetland Restoration
- 658 Wetland creation
- 659 Wetland Enhancement
- 644 Wetland Wildlife Habitat Management

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Exhibit G - <Reserved> - Fish Assemblages as Indicators of the Biological Condition of Streams and Watersheds *(in development)*

Exhibit H - <Reserved> - Stream Visual Assessment Protocol
(in development)

Exhibit I - Field Borders Wildlife Job Sheet Insert - Illinois

Field Borders

Wildlife Job Sheet Insert *386W*

Natural Resources Conservation Service (NRCS)—Illinois ***July 2001***

Field border
Photo courtesy of USDA NRCS

Part I. Planning and Design Considerations

Applicability of Practice

Field borders can be created along field boundaries, ditch or waterway banks, terraces, contour strips, or pipeline areas. Frequent disturbance, such as vehicle traffic, turning farm equipment, mowing, or other farm activities, may limit the value of field borders for wildlife. Nonetheless, in Midwestern agricultural landscapes, field borders can provide a protective buffer between cultivated farmland and sensitive upland or aquatic habitats adjacent to farm fields. Undisturbed or infrequently disturbed field borders potentially provide habitat for feeding, nesting, and resting wildlife. Field borders also may serve as travel corridors that allow animals to move safely between habitats.

Site Considerations

- Landowner objectives (types of wildlife, intended use of the field border)
- Proximity to available water
- Adjacent cropland (irrigated or non-irrigated; type of crop)
- Soil qualities (texture, depth, moisture content)
- Connectivity to other wildlife habitats
- Plant hardiness zones
- Width and length of field border and ability to accommodate desired wildlife species
- Special wildlife needs (e.g., threatened or endangered species)

Design Considerations

Fish and wildlife design considerations in Midwestern agricultural landscapes include (1) frequency, timing, and nature of disturbance; (2) buffer width and length; (3) food value of plants; (4) plant selection to create diverse vertical and horizontal structure; (5) adjacent land uses; and (6) opportunities to link other wildlife habitats. If disturbance is frequent and pervasive, then opportunities to manage field borders for wildlife are greatly limited. Attention, therefore, should focus on those situations where disturbance is infrequent. As is true for all linear or strip habitats (e.g., fencerows, roadsides, or other buffer practices such as filter strips, windbreaks-shelterbelts, riparian forest buffers), wider buffers with mixtures of different plant types (e.g., grass and forb) will attract more species of wildlife than narrow buffers comprised of a single species. If the goal is to provide wildlife with secure travel corridors and year-round cover, then mixes of

Eastern cottontail

native grasses and forbs should be emphasized over introduced or cultivated species such as brome grass and alfalfa. Introduced plants generally do not stand up to adverse weather as well as natives, so their value as winter cover is reduced relative to native plantings. Nonetheless, mixes of wildlife-friendly introduced grasses and forbs may provide excellent nesting and brood-rearing cover for ground-nesting birds if stands are properly maintained. Note that aggressive introduced plants such as reed canarygrass and tall fescue adversely affect wildlife and should always be avoided when planning for wildlife. Refer to the table in Part II for determining plant species suitable to meet the wildlife objectives. Recommended widths of field borders used as travel corridors is 50 ft (20-ft minimum) and nesting or escape cover is 100 ft (40-ft minimum).

Maintenance Considerations

The amount of maintenance required and the method used to maintain field border vegetation depends on how the area is used by the landowner, wildlife or habitat goals, and types of vegetation established in the buffer. For example, maintenance requirements for borders planted in alfalfa hay will be different from plantings of native grasses and forbs. Within the above constraints, management should seek to maintain a non-uniform vegetative structure and minimize disturbance to wildlife especially during the reproductive period. Timing of maintenance is particularly critical if ground-nesting birds are using the field border. Disturbances necessary for maintaining vegetation or buffer function such as light disking, mowing, selective herbicide treatment, or grazing should be delayed until after August 1. Native plantings should be burned approximately every three years; treating one-third of the area each year is preferable to treating the entire area in the same year. Regarding timing of burns, fall burns eliminate winter cover, so burning in spring before the onset of nesting (May 1) is commonly recommended for resident wildlife such as ring-necked pheasant. Fall or winter burning is recommended to maintain the forb component of buffers and enhance their value for pollinators (e.g., butterflies) and young birds. **(Note: Before conducting a prescribed burn, have a qualified professional develop a prescribed burning plan for your area.)** Mowing at night causes high mortality of wildlife (adults and young) and should be avoided at all times. Maintenance schedule of field borders may need to be adjusted to take into consideration activities occurring on adjacent areas. For example, if nests of ground-nesting birds are disturbed in nearby fields (e.g., pastureland or hayland), then displaced birds may attempt to renest in field borders. Delaying treatments beyond conventional dates may be necessary to accommodate these late nesting birds.

Part II. List of Recommended Plants

Native Grasses **Common Name**	**Scientific Name**	**Rooting Habit**	**Site Suitability**[1]
Big bluestem	*Andropogon gerardi*	Bunch	D–WM
Blue joint grass	*Calamagrostis canadensis*	Sod	WM–W
Canada wildrye	*Elymus canadensis*	Bunch	DM–WM
Eastern gamagrass	*Tripsacum dactyloides*	Bunch	DM–WM
Indiangrass	*Sorghastrum nutans*	Bunch	D–WM
Little bluestem	*Schizachyrium scoparium*	Bunch	D–M
Prairie cordgrass	*Spartinia pectinata*	Sod	M–W
Prairie dropseed	*Sporobolus heterolepis*	Bunch	D–W
Sideoats grama	*Bouteloua curtipendula*	Sod	D–DM
Switchgrass	*Panicum virgatum*	Sod	D–WM
Virginia wildrye	*Elymus virginicus*	Bunch	WM–W
Western wheatgrass	*Agropyron smithii*	Sod	DM–WM

—Continued

Part II. List of Recommended Plants (continued)

Native Forbs

Common Name	Scientific Name	Site Suitability[1]
Black-eyed Susan	*Rudbeckia hirta*	D–WM
Butterfly milkweed	*Asclepias tuberosa*	DM–M
Cardinal flower	*Lobelia cardinalis*	WM–W
Common spiderwort	*Tradescantia ohiensis*	D–M
Compass plant	*Silphium laciniatum*	DM–M
Cream wild indigo	*Baptisia bracteata leucophaea*	D–M
Culver's root	*Veronicastrum virginicum*	M–W
False indigo	*Baptisia leucophaea*	DM–M
False sunflower	*Heliopsis helianthoides*	M
Gray-headed coneflower	*Ratibida pinnata*	D–WM
Great blue lobelia	*Lobelia siphilitica*	W
Hoary vervain	*Verbena stricta*	D–DM
Illinois bundleflower	*Desmanthus illinoensis*	DM–M
Illinois tick trefoil	*Desmodium illionoense*	D–M
Lead plant	*Amorpha canescens*	D–M
New England aster	*Aster novae-angliae*	M–WM
Pale beard tongue	*Penstemon pallidus*	D–DM
Pale purple coneflower	*Echinacea pallida*	M
Partridge Pea	*Chamaecrista fasciculata*	DM–M
Prairie blazing star	*Liatris pycnostachya*	DM–WM
Prairie dock	*Silphium terebinthinaceum*	M
Purple prairie clover	*Dalea purpureum*	D–M
Rattlesnake master	*Eryngium yuccifolium*	DM–M
Round-headed bush clover	*Lespedeza capitata*	D–M
Showy tick trefoil	*Desmodium canadense*	M-WM
Spotted Joe-Pye weed	*Eupatorium maculatum*	W
Stiff goldenrod	*Solidago rigida*	D–M
Swamp milkweed	*Asclepias incarnata*	W
Tall tickseed	*Coreopsis tripteris*	M–WM
White wild indigo	*Baptisia alba macrophylla*	DM–WM
White prairie clover	*Dalea candida*	DM–M
Wild bergamont bee balm	*Monarda fistulosa*	D–M
Wild quinine	*Parthenium integrifolium*	DM–WM

—Continued

Part II. List of Recommended Plants (continued)

Non-native Grasses Species Common Name	Rooting Habit	Site Suitability[2]
Smooth bromegrass	Sod	D,WD
Kentucky bluegrass	Sod	WD,PD
Orchardgrass	Bunch	D,WD
Timothy	Bunch	WD,PD
Red top	Sod	WD,PD
Perennial ryegrass	Bunch	WD,PD

Non-native Legume Species Common Name		
Alfalfa		D,WD
Red clover		D,WD
Birdsfoot trefoil		WD,PD
Ladino clover		WD,PD
Alsike clover		WD,PD
Annual lespedeza[3]		D,WD

[1]Site Suitability: D = Dry, DM = Dry Mesic, M = Mesic, WM = Wet Mesic, W = Wet.

[2]Site Suitability: D = Droughty, WD = Well Drained, PD = Poorly Drained.

[3]Annual lespedezas are limited to Illinois NRCS Plant Suitability Zones 2 and 3 only. Common Korean and Summit are recommended varieties of Korean lespedeza. Kobe and Marion are recommended varieties of common (striate) lespedeza.

Part III. Specifications Sheet

Use Specification Sheet provided with general Field Borders Job Sheet. Include wildlife species desired and maintenance specifications relevant to this species or assemblage of species.

Exhibit J

Wildlife Habitat in Field Borders (Supplement to Job Sheet 386)

USDA – NATURAL RESOURCES CONSERVATION SERVICE – NORTH CAROLINA

Photo courtesy of Melissa McGaw, North Carolina Wildlife Resources Commission.

Photo courtesy of USDA Natural Resources Conservation Service.

Field borders can be developed to create valuable cover and food resources for wildlife that inhabit grassy and brushy habitats, such as bobwhite quail, gray fox, indigo buntings, and box turtles. Well-managed field borders may also provide foraging opportunities for typical forest wildlife, such as raccoons, whitetail deer and wild turkey. This job sheet will help you design a field border that provides optimum wildlife habitat.

The importance of properly managed field borders to wildlife include:

- The diversity of plants in a well-managed field border will increase the availability of food resources such as seeds and insect prey (important for many wildlife species, e.g., during the first few weeks of life, the diet of species like quail and turkey chicks is composed almost entirely of insects).
- Field borders provide links between forests and fields around the farm, expanding the amount of useable wildlife habitat.
- Field borders provide critical winter and nesting cover for a variety of grassland wildlife.

Field Border Establishment

- Recommended field border width is <u>at least</u> 20 feet. Where a field border for wildlife will be used as an equipment turn-row, the field border width should be sufficient to allow a minimum of 20 feet of undisturbed habitat.
- For wildlife habitat purposes, the ideal field border will appear unkempt and be composed of a variety of plant species.
- A field border managed for wildlife will attain a height of 3-6 feet. It should be comprised of planted species, for example, switchgrass and shrub lespedeza, as well as volunteer vegetation such as beggarlice, goldenrod, and ragweed (See attached table of Suggested Wildlife Field Border Mixtures).
- Existing cropland can be converted to a field border for wildlife by establishing desired vegetation (See attached table of Suggested Wildlife Field Border Mixtures).
- Field borders can be widened and enhanced for wildlife by cutting woodland edges back to encourage low growing food and cover plant species.

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- The Southeast Quail Study Group recommends the following for replacing tall fescue with wildlife plantings:
  Step 1: Mow, graze, or preferably burn the fescue in late winter for a spring treatment or late summer for a fall treatment.
  Step 2: Allow the fescue to green-up to a height of at least six inches.
  Step 3: Spray the field with one or two quarts per acre of glyphosate (Roundup[Tm]) or 3 WSP (water soluble packets) of Plateau[Tm], 6-7 ounces of surfactant, and ten gallons of water per acre. Always check the product label to insure that the mixture used is adequate for the situation in which this herbicide will be used. In spring treatments wait two weeks after the initial spraying. If there is still green fescue, spot spray the problem areas. For fall treatments, spray during fall green-up then wait until the next spring and spot spray if needed.
  Step 4: After a good kill is achieved, establish wildlife-friendly vegetation.

To get the most wildlife benefits out of a field border, consider the following management practices:
- Periodic disturbance of field borders is necessary to stimulate growth of desirable vegetation and to eliminate encroachment of woody vegetation.
- As a rule of thumb, disturbance should occur within a field border every 3-5 years. However, if visual observation suggests more or less frequent disturbance activity is required, then adapt the schedule accordingly.
- Although disturbance is necessary, not more than 50% of all field border habitat should be disturbed in any one year. In addition, never disturb all of the field border habitat around a single field in the same year.
- Prescribed fire and light disking are preferred management tools.

Field Border Management for Wildlife

METHOD	TIMING	NOTES
Prescribed Burning	1 February through 15 April	burn prior to spring green-up; insure firebreaks are properly installed to contain fire
Light disking	1 February through 1 April	use disking to chop woody vegetation and lightly scarify the soil surface; leave a minimum of 30% residue
Weed Sweep[Tm] herbicide appl.	15 April through 15 June	select herbicide to control target species and follow label directions for environmental concerns
Spot spray herbicide	15 April through 15 June	select herbicide to control target species and follow label directions for environmental concerns
Mowing	15 September through 1 April	mowing should be done after August to avoid quail nests, rabbits, turkeys and other ground nesting wildlife; mow to maintain $\geq$12 inches of cover, 18 inches preferred

SUGGESTED FIELD BORDER MIXTURES BENEFICIAL TO WILDLIFE

PLANTING DATE	MIXTURE/RATE
1) 15 September thru 1 November...............	Small grain planting allowed to develop into native vegetation
2) 15 September thru 1 November...............	Small grain/switchgrass mix (40 lbs. wheat or rye, 5 lbs. switchgrass)
3) Fall/Spring...	Small grain planting overseeded with Kobe or Korean lespedeza
4) January thru-April.....................................	10 lbs. Kobe, 5 lbs. partridge pea, 40 lbs. wheat or rye, 4 lbs. little bluestem
5) May thru August..	5 lbs. browntop millet, 5 lbs. Kobe, 3 lbs. 'Atlantic' Coastal panic grass, 3 lbs. switchgrass, 3 lbs. little bluestem
6) September thru December........................	40 lbs. wheat or rye, 5 lbs. switchgrass, 2 lbs. Ladino clover
7) Early Summer...	Switchgrass - 7 lbs. drilled, 9 lbs. broadcast
8) Early Summer..	'Atlantic' Coastal panic grass - 10 lbs. drilled or broadcast
9) Early Summer..	Eastern gamma grass - 8 lbs. drilled only
10) May..	5 lbs. switchgrass, 4 lbs. Atlantic' Coastal panic grass, 3 lbs. Kobe/Korean Lespedeza
11) Late February thru mid-April..................	3 lbs. reseeding soybeans, 5 lbs. Kobe/Korean lespedeza, 5 lbs. red clover, 5 lbs. partridge pea
12) September-thru October.........................	18 lbs. Shilo orchardgrass, 40 lbs. wheat or rye, 3 lbs. Ladino clover, 5 lbs. crimson clover
13) Sept.-Nov...	10 lbs. Kobe lesp., 40 lbs. wheat/rye/oats, 4 lbs. little bluestem, 3 lbs. innnoc. white clover, 3 lbs. unhulled shrub lespedeza, 2 lbs. orchard grass, 5 lbs. switchgrass
14) April-June..	15 lbs. browntop millet, 15 lbs. sudex, 5 lbs. Kobe lesp., 3 lbs. hulled shrub lesp., 3 lbs. 'Atlantic' coastal panic grass, 3 lbs. switchgrass, 3 lbs. Eastern gamma grass, indian grass, or big bluestem

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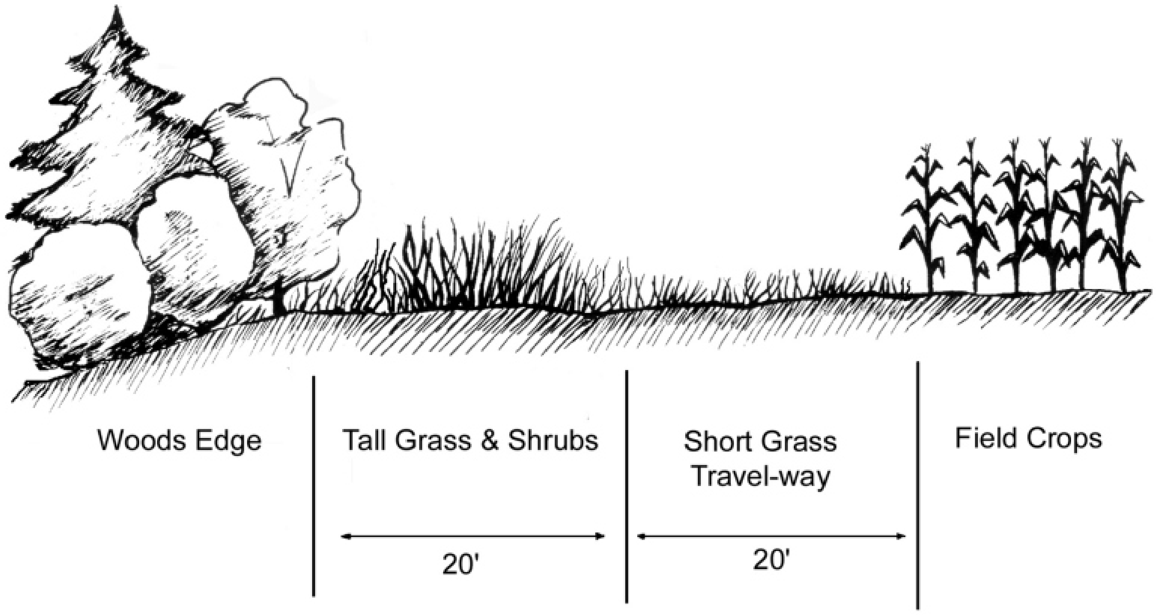
Two Zone Field Border for Wildlife



Additional information is available from your local NRCS office, North Carolina Cooperative Extension Service, North Carolina Wildlife Resources Commission, and various conservation organizations.

This project was a cooperative effort of personnel from the USDA North Carolina Natural Resources Conservation Service, NRCS Watershed Science Institute, the North Carolina Wildlife Resources Commission, and the North Carolina State University Cooperative Extension Service. We gratefully acknowledge Dr. Virgil Kopf, Virginia Department of Game and Inland Fisheries, for facilitating the discussions that took place and eventually resulted in the production of this document.

October, 1999

BUFFERS
COMMON-SENSE
CONSERVATION

Texas Buffers for Wildlife

United States
Department of
Agriculture

Natural Resources
Conservation Service

Temple, Texas

March 2000

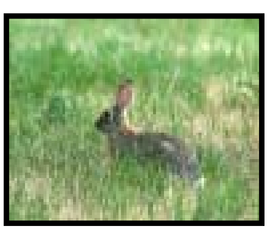
Field Borders

Conservation Buffer Job Sheet 386

DEFINITION
A field border is a band or strip of perennial vegetation established on the edge of a cropland field.

PURPOSE
This supplement to the national job sheet is designed to assist with integrating wildlife habitat prescriptions into planning field borders. A field border provides wildlife habitat; reduces sheet, rill, and gully erosion at the edge of fields; protects water quality by trapping sediment, chemicals and other pollutants; and provides a turning area for farm equipment. Field borders can provide a strip of habitat between two crop fields, or a transition zone between croplands and rangelands, between croplands and forestlands or between croplands and farmsteads or urban development.

The wildlife habitat components that can be provided by a field border include nesting cover, feeding cover, escape cover, travel corridors between habitats, and protection of aquatic habitat. Although species such as bobwhite quail, ring-necked pheasant and blue birds are typically considered users of grassy shrubby field borders, they also provide food and cover for many other species of wildlife native to Texas and migratory wildlife passing through. White-tailed deer, wild turkeys, and great horned owls occasionally use this habitat provided by a common agricultural conservation practice.



SITE CONSIDERATIONS
- Landowner objectives (specific types of wildlife or wildlife habitat integrated into non-wildlife purpose)
- Proximity to available water
- Adjacent landuse (type of crop, irrigated or non-irrigated, range, forest, grazed, etc)
- Soil characteristics (texture, depth, moisture, etc)
- Annual rainfall
- Plant hardiness zones
- Connection to other wildlife habitats

DESIGN CONSIDERATIONS

Alternatives can vary from simple, when creating habitat where wildlife is not the landowner' s primary objective, to complex when managing field borders for specific wildlife such as bobwhite quail or migratory songbirds. The habitat contribution of a field border is determined by the vegetation selected, the width of the border, and the maintenance/management (light disking, prescribed burning, prescribed grazing, etc.) techniques selected. Typically a field border designed and managed with wildlife in mind will have an unkempt appearance with a variety of different plants.

Border Width

Additional width is important to minimize the destruction of nests by predators and to provide habitat that is not disturbed by turning equipment during the primary nesting and brood rearing season.

	Minimum	Optimum
Movement corridor	20 feet	50 feet
Nesting or escape cover	40 feet	100 feet

Vegetation

See the Texas supplement to conservation practice standard 645, Upland Wildlife Management and Plant Materials Fact Sheet for conservation practice standard 386, Field Border to select grasses, forbs, legumes, and shrubs that are beneficial to wildlife.

Simple Option

Plant a native clump grass and legume combination that is suited to the site conditions. On areas subject to erosion, a dead litter cover crop should be sown to protect the soil until the vegetation becomes established.

or

Allow border to grow up in native plants, if suitable species for targeted wildlife are available in the seed bank. When using this option, specific vegetation management will have to be planned in order to comply with the standard. On areas subject to erosion, a dead litter cover crop should be sown to protect the soil until the vegetation becomes established.

Complex Option

Plant a mixture of native clump grasses, forbs, and legumes that are suited to the site conditions. On areas subject to erosion, a dead litter cover crop should be sown to protect the soil until the vegetation becomes established. Depending on the wildlife objective, small group plantings of native shrubs, suited to the site, can add woody cover and/or food to field borders between crop fields or those providing a transition zone between crop fields and rangeland or crop fields and forest land. Leaving several rows of standing crops adjacent to the field border will enhance fall and winter food.

or

Allow border to grow up in native plants, if suitable species for targeted wildlife are available in the seed bank. When using this option, specific vegetation management will have to be planned in order to comply with the standard. On areas subject to erosion, a dead litter cover crop should be sown to protect the soil until the vegetation becomes established. As a supplement to natural establishment, develop plots, within the border, planted to a mixture of native clump grasses, forbs, and legumes. Native shrubs can be established by planting or protecting small groups that become established naturally.

Establishment specifications are as follows:

1. Seedbed preparation and seeding operations for grasses, legumes, and forbs may be accomplished by conventional (plowing, disking, chiseling) and/or no-till methods. Seedbed preparation for shrubs may be accomplished by disking, mowing or herbicide treatment. Planting of shrubs may be accomplished by machine or hand planting. Erosion control during the establishment period must be considered with any seeding operation.
2. Fertilizer and lime will be applied at recommended rates according to soil test results. All materials shall conform to established state specifications for agricultural applications. Nitrogen is usually not recommended during the first year of establishment of native grasses.
3. Field borders established with natural regeneration may be sown to a dead litter cover crop to protect soil as native vegetation becomes established on the fallowed area.
4. Certain (pesticides) herbicides and insecticides may be specified for application as needed to facilitate grass and legume establishment. When these pesticides are applied, the participant is responsible for assuring that all application rates and methods are consistent with label directions and that all required record keeping is maintained.

Maintenance/Management

In order to maximize wildlife benefits over the life of the practice, periodic management practices may need to be implemented. This can include cultural practices such as light disking, prescribed burning, mowing, re-seeding, prescribed grazing, and spot herbicide treatment. Management practices and implementation timing are generally dictated by local conditions, vegetation structure, and habitat conditions desired.

Maintenance/Management specifications are as follows:

1. To avoid interfering with nesting activities, light disking and/or mowing should not be performed between March 15 and July 15. Delaying mowing and/or light disking until after August 15 is recommended to further enhance wildlife habitat.
2. Mowing and/or light disking alone or in combination should be performed on no more than 1/3 of the field border in any year. When the disked areas are rotated, the previously disked strips should have sufficient vegetation to control erosion.
3. Mowing height should be no lower than 8 inches.
4. Disked areas shall have a minimum of 30 percent residue remaining on the soil after disking operations are complete.

5. Prescribed burning is a management option and should be limited to 1/3 of the field border in any year. The participant will be responsible for obtaining a Prescribed Burn Plan and adhering to all local and state laws applicable to open burning.
6. Prescribed grazing is a management option and should be accompanied by grazing management plan that provides the timing, duration and intensity necessary to promote the vegetation composition and structure most beneficial to wildlife and insures the primary purpose of the field border.

SPECIFICATIONS

Field Borders- Specification Sheet

Landowner ____ Field Number ______

Purpose (check all that apply)	
[] Wildlife	[] Trap sediment, nutrients, pesticides, & other contaminants
[] Stabilize field boundaries, turn rows, and headlands	[] Erosion Control
[] Provide protective turn row or equipment travel lane	[] Other (specify)

Field border layout (for exact location see job sketch)	**Field border 1**	**Field border 2**	**Field border 3**
Border width (ft)			
Border length along edge of field (ft)			
Area (ac)			
Slope (%)			
Species #1			
Species #2			
Species #3			
Seeding rate (PLS) (lb/acre)			
Seedling spacing (Shrub Planting)			
Lime (tons/acre)			
N (lb/acre)			
P2 O5 (lb/acre)			
K2O (lb/acre)			

Site preparation
Prepare firm seedbed. Apply lime and fertilizer according to recommendations.
Planting Methods
Drill grass and legume seed _______ inches deep uniformly over area. Establish stand of

vegetation according to recommended seeding rate. If necessary, mulch newly seeded area with _______ tons per acre of mulch material. May seed small grain as a companion crop at the rate of ______ pounds per acre, but clip or harvest before it heads out.
Maintenance
Maintain original width and depth of the grass area. Harvest, mow, reseed, and fertilize to maintain plant density, vigorous plant growth, and to remove plant nutrients. Inspect after major storms, remove trapped sediment, and repair any eroding areas. Shut off pesticide sprayers when turning on a field border.

Field Borders- Job Sketch

If needed, an aerial view of the field border layout can be shown below. Other relevant information, such as complementary practices, and adjacent field or tract conditions, the positioning of multiple or single row sets across a field or tract, and additional specifications may be included.

Scale 1"= _______ ft. (NA indicates sketch not to scale: grid size= 1/2" by 1/2")

Additional Specifications and Notes:

Exhibit L - Field Borders as Wildlife Habitat - Georgia

Job Sheet for

Field Borders as Wildlife Habitat

(386, 645)

Purpose: **A field border** is a strip of *native herbaceous vegetation* established along the edges of crop fields to reduce invasion of woody plant succession, to provide natural wildlife food and cover. Additional benefits may be provided for farm machinery access, erosion control, and water quality.

Requirements:

- Minimum width 25 feet
  - Note: Width may be increased to compensate for field border irregularities and to facilitate row patterns
- Where erosion is a consideration, a temporary cover crop or native perennial species may be planted
  - Suggested temporary cover crops: Spring – browntop and proso millet; Fall – rye, oats, or wheat
    - Reseeding annuals — partridge pea, Kobe or Korean
    - lespedeza
  - Suggested native perennials: native warm -season grasses such as switchgrass, Indiangrass, little bluestem grass, Eastern gammagrass, or Atlantic Coast panicgrass

Maintenance:

- One third of the field borders should be disked each year in late February or early March
    - For example: a field border that is three disks wide would be maintained by disking an area one disk wide each year on a three year rotation
    - Note: supplementary wildlife plantings are not necessary, but would be allowed at the time of disking
- **DO NOT** disk, mow, or burn field borders between **April 1-September 1**

Primary Habitat Consideration:

- Nesting and brood-habitat for quail and various songbirds
- Natural food and cover for quail, rabbits, doves, and turkeys

Site Specific Comments and Recommendations:

USDA-NRCS Georgia
July 1999

Field Borders for Utah Wildlife Job Sheet
(Supplement to Job Sheet 386)

Part I. Planning and Design Considerations

Applicability of practice: Field borders that consider habitat for terrestrial wildlife or protect aquatic habitat can be used to effectively link other habitats or provide a protective buffer in agricultural landscapes. They can be created along field boundaries, ditch or waterway banks, pipeline areas, any area suitable for attracting specific wildlife species.

Site considerations:
- Landowner objectives (types of wildlife, non-wildlife use of the field border that must be accommodated)
- Proximity to available water
- Adjacent landuse (irrigated or non-irrigated, type of crop, grazed, etc.)
- Soil qualities (texture, depth, moisture content)
- Connectivity to other wildlife habitats
- Plant hardiness zones
- Size of field border and ability to accommodate species needs

Design considerations: The type of vegetation, maintenance regime and width of the field border will vary depending on the wildlife species desired, the habitat components it will provide (such as food, cover, travel corridor, or access to water source), and the area required for farm equipment turn-around. Refer to the vegetation matrix for determining plant species suitable to meet wildlife objectives. In general, Utah agricultural landscapes suitable for this practice should strive for the following minimum widths for field borders:

<u>Size of Border:</u>

	Minimum	**Optimal**
Movement corridor	**20 feet**	**50 feet**

Nesting or escape cover **40 feet** **100 feet**

Additional design considerations can be obtained form publications such as "Establishing Food and Cover Plots"(Pheasants Forever 1993); NRCS Technical Notes or contacting the local Division of Wildlife Resources office or the NRCS Wildlife Biologist.

Maintenance considerations**:** The amount of maintenance required, and the method used to maintain the vegetation/habitat of the field border depends on the needs of the landowner (for example, turn-around area for equipment), and the type of wildlife use it is expected to provide. Timing of maintenance is particularly critical if ground-nesting birds are using the field border.

Maintenance: Delay mowing until after ______________
Burn after ___________ or during _____________
Graze after ____________ (develop a grazing management plan)

Part II Vegetation Matrix

(Matrix under development by Utah State Office)

Part III. Evaluation Guidelines

Following can be utilized as a planning/evaluation tool. It calculates an index rating for the potential effect on wildlife habitat to compare proposed alternatives. It can be used for evaluating the success of the practice(s) when used several years after establishment.

EVALUATION MATRIX

	Present	W/Plan	+ years	+ years
Index of Plant Rating (Sum plant ratings/# of plants)				
Diversity index				
Interspersion Index				
Target species (method used:)				
Other				

Instructions:

A. **Index of plant rating** is calculated by taking the sum of the plant rating numbers and dividing by the number of plants. This represents the overall rating of the plant community to benefit wildlife.

B. **The diversity index (DI)** is a numerical representation of the value of an area to wildlife based on the change of plant communities within the area. The numerical value is derived by measuring the linear distance of the edge and dividing it by the number of square feet in the area evaluated. Count only edge changes where the strip of vegetation is >10 ft. wide. The following is the formula used to generate the DI:

$$DI = \frac{E}{2\sqrt{A \times \Pi}} \quad \text{(2 X (sq. root of area X Pi)}$$

Where-

E = Edge (total length in feet) estimated from aerial photos or field observation for the area being evaluated.

A = Area (approx.) expressed in square ft.

$\Pi = 3.14$

C. **Interspersion index:** To measure the amount of interspersion of an area count the number of times the habitat or vegetation types change using the following procedure:

1. Obtain an aerial photograph.
2. Count the number of changes along an imaginary north-south line that it drawn across the widest part of the area.
3. Count the number of changes along an imaginary east-west line that it drawn across the widest part of the area.
4. By counting the number of times the lines intersect different habitat or vegetation types and then summing the numbers, you will get an interspersion index value for the area. This value then can be compared over the life of the project or to other sites to determine which sites might be better for the desired wildlife species. The comparisons must be made using the same size areas and map scales. The higher the value, the better for many resident wildlife species and migratory species that establish seasonal territories.

D. **Target species:** These are species the habitat is designed to benefit. There are several methods (use only one method) to choose from to measure this parameter:

1. Presence or absence of the target species
2. A relative change in abundance (example: A 50 % increase in occurrence)
3. Species-specific model(s) (if available) could be used for evaluation.
   NRCS currently has models for the yellow-headed blackbird, muskrat, ferruginous hawk, mule deer and pheasant. USFWS has many models available.

Part IV. Specifications Sheet

Use specification sheet provided with Field Borders Conservation Practice Job Sheet. Include wildlife species desired, and maintenance specifications relevant to the species or assemblage of species. Specification sheet can be obtained from the local NRCS office or can be accessed on the Internet at: ftp://ftp.ftw.nrcs.usda.gov/pub/nhcp/jobsheet/386js.pdf . Other specification sheets can be used at the planner's discretion.

Appendix: Utah Buffer Job Sheets

1. PLANTS THAT PROVIDE HABITAT FOR UTAH BIRDS

SPECIES	VALUE	NESTING	FOOD	HEIGHT
GRASS - GRASSLIKE plants provide ground cover, food, cover near ground for nesting.				
Bluegrass, Big	Good	Yes	Yes	1-3’
Canarygrass	Fair	----	Yes	1-6’
Fescue, Hard	Fair	Yes	Yes	.5-2’
Fescue, Idaho	Fair	Yes	Yes	1-3’
Fescue, Sheep	Fair	Yes	Yes	.5-2’
Millet, Foxtail	Good	----	Yes	1-2’
Millet, Japanese	Good	----	Yes	1-3’
Orchardgrass	Fair	Yes	Yes	1-4’
Ricegrass, Indian	Good	Yes	Yes	.5-2’
Wheatgrass, Bluebunch	Fair	Yes	----	1-2’
Wheatgrass, Intermediate	Fair	Yes	----	2-4’
Wheatgrass, Tall	Fair	Yes	----	2-8’
Wildrye, Altai	Good	Yes	----	2-5’
Wildrye, Basin	Good	Yes	----	3-6’
Wildrye, Blue	Good	Yes	----	2-5’
Wildrye, Russian	Fair	Yes	----	1-2’
FORBS - FLOWERS provide ground cover and a food supply.				
Aster	Fair	----	Yes	1-3’
Buckwheat	Fair	----	Yes	1-2’
Burnet, Small	Good	Yes	Yes	1-3’
Clover species	Good	----	Yes	.5-3’
Columbine	Fair	----	Yes	1-4’
Coral Bells	Fair	----	Yes	1-2’
Coreopsis	Fair	----	Yes	1-3’
Cornflower	Fair	----	Yes	1-2’
Cosmos	Fair	----	Yes	1-3’
Dahlia	Fair	----	Yes	1-5’
Doveweed	Fair	----	Yes	1-6’
Flax, Blue	Fair	----	Yes	1-2’
Filaree	Fair	----	Yes	.5-2’
Hollyhock	Fair	----	Yes	3-8’
Lupine	Fair	----	Yes	1-3’
Marigold	Fair	----	Yes	1-4’
Petunia	Fair	----	Yes	.5-2’
Phlox	Fair	----	Yes	.5-1’
Pinks	Fair	----	Yes	1-2’
Poker Plant	Fair	----	Yes	2-5’
Primrose	Fair	----	Yes	1-6’
Salvia	Fair	----	Yes	1-2’
Sunflower	Fair	----	Yes	1-8’
Zinnia	Fair	----	Yes	1-2’

SPECIES	VALUE	NESTING	FOOD	HEIGHT
WET AREAS plants.				

Bulrush, Alkali	Good	Yes	Yes	2-5’
Bulrush, Hardstem	Good	Yes	Yes	6-10’
Bulrush Threesquare	Good	Yes	Yes	1-3’
Cattail	Fair	Yes	----	6-10’
Pondlily	Fair	----	Yes	Floating
Pondweed	Fair	----	Yes	1-3’
Rush, Baltic	Fair	----	Yes	1-3’
Sedge, Beaked	Fair	----	Yes	1-4’
Sedge, Nebraska	Fair	----	Yes	1-3’
Sedge, Water	Fair	----	Yes	1-3’
Smartweed	Good	----	Yes	1-5’
Spikerush, Creeping	Good	----	Yes	1-3’
Watercress	Fair	----	Yes	.5-1’
Wildrice	Good	Yes	Yes	3-10’

LOW SHRUBS, and VINES provide nesting sites, food, and cover near ground.

Bearberry	Good	Yes	Yes	1-3’
Huckleberry	Exc.	Yes	Yes	1-6’
Juniper, Horizontal	Fair	----	Yes	1-6’
Orgegon Grape	Fair	----	Yes	1-4’
Sagebrush, Black	Fair	----	Yes	1-3’
Thicket Creeper	Good	Yes	Yes	Vine
Thrumpet Vine	Good	----	Yes	Vine
Virginia Creeper	Good	Yes	Yes	Vine
Winterfat	Fair	----	Yes	1-3’

SHRUBS provide nesting sites, food, and cover near ground.

Blackberry	Good	Yes	Yes	3-10’
Bitterbrush	Good	----	Yes	3-8’
Buffaloberry	Good	Yes	Yes	5-15’
Caragana	Good	Yes	Yes	10-25’
Cherry Mongolian	Good	Yes	Yes	3-6’
Cherry Nanking	Good	Yes	Yes	6-10’
Chockcherry	Exc.	Yes	Yes	10-25’
Cotoneaster	Fair	----	Yes	8-12’
Currant, Golden	Exc.	Yes	Yes	5-10’
Dogwood	Exc.	Yes	Yes	7-15’
Elderberry	Good	----	Yes	8-15’
Honeysuckle	Good	Yes	Yes	6-15’
Lilac	Fair	Yes	----	10-20’
Mockorange	Fair	Yes	----	6-8’
Plum	Good	Yes	----	5-10’
Pyracantha	Good	Yes	Yes	5-15’
Quince	Fair	----	Yes	5-10’
Rose, Woods	Good	Yes	Yes	2-6’

SPECIES	**VALUE**	**NESTING**	**FOOD**	**HEIGHT**
Sagebrush, Basin	Good	Yes	Yes	3-8’
Sagebrush, Wyoming	Good	Yes	Yes	2-5’
Saltbush, Fourwing	Fair	----	Yes	3-8’

Field Border

Sandcherry	Good	Yes	Yes	3-6’
Serviceberry	Good	Yes	Yes	5-15’
Silverberry	Good	Yes	Yes	4-9’
Shrubby Cinquefoil	Fair	Yes	----	3-4’
Snowberry	Exc.	Yes	Yes	2-6’
Spirea	Good	Yes	Yes	4-8’
Sumac, Fragrant	Good	Yes	----	3-9’
Sumac, Skunkbush	Exc.	Yes	Yes	3-9’
Sumac, Smooth	Good	Yes	----	5-15’
Sumac, Staghorn	Good	Yes	----	10-15’
Vibrurnum	Good	----	Yes	6-14’

SMALL TREES provide nesting and foraging sites, food, canopy and habitat structure.

Apple	Good	Yes	Yes	15-30’
Apricot	Fair	Yes	Yes	10-15’
Black Cherry	Exc.	Yes	Yes	15-30’
Chockcherry, Amur	Good	Yes	Yes	15-25’
Crabapple	Exc.	Yes	Yes	10-30’
Hawthorn	Good	Yes	Yes	10-25’
Maple, Amur	Fair	Yes	----	15-25’
Maple, Tatarian	Fair	Yes	----	15-25’
Mountain Ash	Fair	----	Yes	20-30’
Mulberry	Fair	Yes	Yes	15-30’
Pear, Harbin	Fair	----	Yes	15-30’
Russian Olive	Exc.	Yes	Yes	15-30’

MEDIUM TO TALL TREES provide nesting and foraging sites, food, canopy and habitat.

Alder	Good	Yes	Yes	30-60’
Ash, Green	Fair	Yes	Yes	30-60’
Aspen, Quaking	Fair	----	Yes	25-60’
Birch	Fair	----	Yes	30-60’
Boxelder	Fair	----	Yes	30-60’
Cottonwood	Fair	----	Yes	40-120’
Elm	Good	----	Yes	25-65’
Hackberry	Exc.	Yes	Yes	30-60’
Locust, Black	Fair	----	Yes	30-60’
Locust, Honey	Fair	----	Yes	30-50’
Maple	Good	Yes	Yes	30-65’
Oak, Bur	Exc.	Yes	Yes	40-70’
Oak, Mongolian	Exc.	Yes	Yes	30-50’
Poplar species	Fair	----	Yes	40-60’
Walnut, Black	Good	Yes	Yes	30-60’
Willow, Golden	Good	Yes	Yes	30-60’
Willow, Laurel	Good	Yes	Yes	25-40’
Willow, Pacific	Good	Yes	Yes	25-40’

CONIFERS provide excellent winter cover, food and nesting sites.

SPECIES	**VALUE**	**NESTING**	**FOOD**	**HEIGHT**
Arborvitae	Good	Yes	Yes	10-40’
Douglas Fir	Fair	Yes	Yes	25-70’

Eastern Redcedar	Exc.	Yes	Yes	25-50’
Juniper, Rocky Mtn.	Exc.	Yes	Yes	20-40’
Pine, Mugo	Fair	Yes	----	5-20’
Pine, Ponderosa	Exc.	Yes	Yes	30-70’
Pine, Austrian	Good	Yes	Yes	25-50’
Pine, Scotch	Fair	Yes	----	25-50’
Spruce	Good	Yes	----	30-80’

2. REFERENCES AVAILABLE THROUGH UTAH STATE OFFICE

1951. Martin, A. C., Zim, H.S., and Nelson, A.L. American Wildlife and Plants: A Guide to Wildlife Food Habits. A wildlife classic that ranks plants according to their value for groups of wildlife (e.g., water birds, song birds). Plants are listed by common name.

1982. Plant Use Guide for Wildlife. Soil Conservation Service. Somewhat dated information about suppliers, wildlife species utilization of common plants, and site characteristics. May be especially useful for windbreaks and field borders.

1993. Mule Deer Habitat Suitability Model. Soil Conservation Service. Unpublished draft HSM, but has extensive plant list (both scientific and common names) for mule deer.

1996. Krausman, P.R. (editor). Rangeland Wildlife. Relatively up-to-date reference, mostly for upland wildlife.

4. USEFUL WEBSITES

http://www.nr.state.ut.us/dwr/notebook.htm

http://www.utahcdc.usu.edu/ucdc

http://www.ms.nrcs.usda.gov/whmi/technotes.htm

USEFUL WEBSITES (continued)

http://www.wcc.nrcs.usda.gov/watershed/products.html

http://plants.usda.gov/plants/index.html

http://waterhome.brc.tamus.edu/NRCSdata/models/rangecal/

http://Plant-Materials.nrcs.usda.gov/

This project was a cooperative effort of personnel from the USDA Utah Natural Resources Conservation Service (NRCS), NRCS Wildlife Habitat Management Institute, the Utah Division of Wildlife Resources, the US Fish and Wildlife Service, and Utah State University Cooperative Extension Service. We gratefully acknowledge the help of Dr. Alan Clark, Utah DWR, in facilitating the discussions that resulted in the production of this document.

Additional information is available from your local NRCS office, Utah State Cooperative Extension Service, Utah Division of Wildlife Resources, and various conservation organizations.

Exhibit N - Field Border Buffers for Wildlife Job Sheet - Maryland

Conservation Buffers for Wildlife
Maryland Planning and Design Guidelines

C. Rewa

DEFINITION

A strip of permanent vegetation established at the edge or around the perimeter of a field.

PURPOSE

While field borders are frequently used to serve as turn-rows and travel-ways for farm equipment, they also provide a number of conservation functions. Field borders are effective for providing wildlife cover and food, reducing erosion from wind and water, protecting soil and water quality, and managing harmful insect populations. Field borders are particularly useful for maximizing the quality of wildlife habitat in agricultural settings.

The purpose of these planning and design guidelines is to assist conservation planners to integrate wildlife considerations into the establishment and maintenance of field borders. Therefore, these guidelines focus on using field borders to provide wildlife habitat. Many of the concepts presented here can also be applied to other conservation buffer practices as well.

Unlike filter strips and riparian buffers that are typically used on the down-slope side of fields, field borders are generally herbaceous, non-crop buffers that can be used anywhere along the entire field margin to remove low-producing areas from production and provide wildlife habitat. Field borders are a buffer practice that can substantially increase wildlife habitat while minimally affecting farm profitability.

WHERE USED

Edges of agricultural fields and other open areas.

REQUIREMENTS

The minimum field border width to meet the Maryland practice standard is 10 feet. Field borders that are at least 20 feet wide provide room for turn-rows needed for most field equipment. However, wildlife habitat potential can be greatly improved by increasing field border width to meet specific wildlife habitat objectives (see Table 1).

- Select plant species that are native, or are naturalized and non-invasive. Choose species that will maximize wildlife habitat values while providing for erosion control, aesthetics, and other objectives for the site.
- Establish vegetative cover by using appropriate site preparation and planting techniques to ensure survival and growth of the selected species.
- Manage vegetative cover by using appropriate methods and timing to maximize wildlife habitat values.

Table 1. Optimum border widths for wildlife habitat.

Type of Wildlife Desired	Optimum Field Border Width
Butterflies and other beneficial insects	35 feet or more
Small mammals, reptiles and amphibians	50 feet or more
Upland game birds and mammals	100 feet or more
Grassland songbirds	150 feet or more

Specific cost-sharing programs or other funding sources may impose additional establishment and maintenance requirements for field borders. Refer to the applicable program manuals, handbooks, and job sheets for details.

RESOURCE MANAGEMENT SYSTEMS

Field borders are most effective when they are used in combination with other agronomic or structural practices. Whenever possible, field borders should be integrated components of resource management systems that address the soil, water, air, plant, and animal needs and the client's objectives on the planning unit. For example, if gully erosion or other soil erosion problems are identified during the planning process, these problems should be treated by implementing appropriate conservation practices before or in conjunction with establishing field borders. To maintain proper functioning of field borders, excessive erosion must be controlled up-slope of the border, and field border vegetation should be protected from disturbance during the primary nesting season (April 15 to August 15) to the extent possible.

WILDLIFE CONSIDERATIONS

Alternatives can vary from those that are simple, in order to provide habitat when wildlife is not the client's primary objective, to complex, when managing field borders for specific wildlife such as bobwhite quail or migratory songbirds. The habitat contribution of a field border is determined by the vegetation selected, the width of the border, and the maintenance/management techniques that will be used (such as light disking, prescribed burning, prescribed grazing, etc.). Typically, a field border that is designed and managed with wildlife in mind will have an unkempt appearance with a variety of different plant species and growth forms.

Mississippi Cooperative Extension Service

Figure 1. Bobwhite quail.

Consider the following factors when planning field borders for maximum wildlife utility:

1. Composition of vegetation.

Like other conservation buffer practices, field borders support wildlife populations on agricultural landscapes by providing physical habitat structure. This habitat supports the food and cover needs of many species within the field border itself, and also serves as a travel corridor through which individuals disperse and migrate. Maximizing the diversity of native grasses, forbs and legumes increases the availability of wildlife foods in the form of green forage, seeds, fruits, and insects.

The composition of plant species in field borders is a critical element in determining the quality of wildlife habitat provided. In many instances, natural regeneration of field borders provides a diversity of grasses and forbs. Table 2 (see page 6) provides a selected list of common plants that are known to provide wildlife food and cover.

Diversity in both vertical and horizontal structure increases wildlife species diversity. Field borders should be established and maintained to maximize vertical and horizontal structure to the extent possible, as illustrated below in Figure 2.

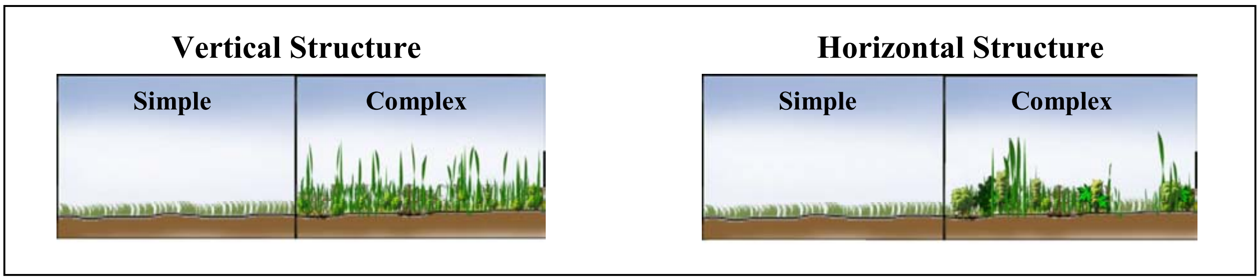


Figure 2. Structural diversity of vegetation.

Vertical structure refers to the "layers" of different plant forms and sizes in the plant community. Vertical structure has a significant influence on the diversity of wildlife species present in the community. Different layers offer food, water, cover, shelter, or breeding sites to different species, resulting in a rich diversity of wildlife utilizing one habitat type. Each species fills a niche or specialized position in the habitat.

Horizontal structure refers to the arrangement of habitat types or plants as seen from above. Field borders can be established and maintained to maximize horizontal structure by encouraging a variety of native vegetation types to become established within certain sections of the field border through planting and disturbance activities. Where feasible, small group plantings of native shrubs (especially fleshy fruit-producing species) can be used to add woody cover and food sources between crop fields. Shrubby field borders can also serve as transition zones between open fields (such as cropland and pasture) and woodlands.

One way to maintain horizontal structure is to provide two zones within the field border (see Figure 3). The zone closest to the field is generally subject to greater disturbance from farm equipment working the crop field, while the outside zone is more protected from frequent disturbance. The outside zone also provides a smooth transition to adjacent wooded habitats.

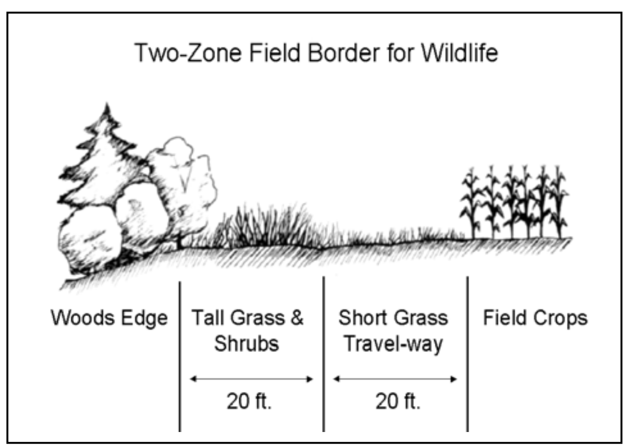


Figure 3. Field border design utilizing principles of vertical and horizontal structure.

2. *Field border width.*

As with many conservation buffer practices, wider field borders provide more and better quality habitat for most wildlife species than narrower buffers. In many situations, field borders should be at least 35 feet wide to provide enough habitat to be used by beneficial insects, small mammals, and other wildlife. Where field borders are used as equipment turn rows, they should be wide enough to leave a strip of undisturbed habitat at least 20 feet wide along the outside edge of the field border.

Figure 4. Field borders that typically have limited wildlife habitat potential are those that are narrow, consist of a monoculture of sod-forming non-native grasses with little vertical or horizontal structure, are mowed every year, and are associated with abrupt edges.

Figure 5. Field borders that provide habitat for a variety of wildlife are those that are substantially wider than 35 feet, consist of a diversity of native grasses and forbs with significant vertical and horizontal structural diversity, are maintained on a 3 to 5-year rotational cycle, and are associated with gradual edges.

Where field borders occur along woodlands, they may be widened by cutting woodland edges back to encourage growth of shrubs and other wildlife food-bearing plants. Leaving cut slash and woody material on the ground along woodland borders can provide additional wildlife cover adjacent to field borders. Leaving several rows of crops standing along field edges can also increase the functional width of field borders, providing increased food and cover for wildlife.

Caution: Take note of applicable regulatory constraints in Maryland concerning removal of existing woody vegetation. Laws pertaining to forest conservation, wetland protection, critical area protection, stream buffers, and erosion and sediment control may be applicable. Permits or approvals from federal, state, or local government agencies may be needed before woody vegetation is cut or removed.

C. Rewa

Figure 6. Leaving several standing rows of crops along field borders improves wildlife food and cover availability.

3. *Field border height.*

Field borders managed for wildlife should attain a height of 3 to 6 feet. They should be comprised of planted species as well as volunteer vegetation that produces wildlife food and cover. Grasses with sturdy stalks (such as the 'Shelter' variety of switchgrass) are especially desirable in regions with heavy snow because they provide residual cover for early nesting species.

4. Disturbance and maintenance.

Periodic disturbance of field borders is usually necessary to stimulate growth of desirable vegetation and to control the growth of woody plants, especially trees. Field borders that are disturbed on a 3 to 5-year rotation typically provide the best habitat over the life of the practice. Periodic disturbance can be accomplished by light disking or burning portions of the field border as needed during late winter to early spring to reduce the amount of rank and woody vegetation and litter build-up. Mowing can also be used as a management technique to control undesirable vegetation, but unlike light disking and prescribed burning, it has the disadvantage of not removing accumulated litter. Where feasible, livestock grazing (especially "flash grazing") may also be an option for managing herbaceous field borders.

Disturbance actions should be tied to local climate conditions. For example, prescribed burning should not be conducted during times of drought. Maintenance activities should be scheduled before or after the nesting and birthing season. Any disturbance action taken to maintain or improve wildlife habitat conditions must also consider how it affects water quality, erosion, and other buffer practice objectives. This is especially important if the field border is enrolled in a cost-sharing or easement program that restricts some management activities.

Disturbance and its effects on succession are the principal agents of change in buffer vegetation. Light disking reduces the density of a grass planting and allows wildlife better movement on the ground. By disturbing the soil surface, disking also encourages germination of seed-producing annuals such as partridge pea, black-eyed susan, ragweed, beggarticks, foxtail and other weedy species that provide food and cover. Maintenance must take into consideration the local climate, soil quality, and moisture conditions. For example, on sites where soils are usually too wet in the spring, maintenance such as light disking or mowing may need to be done in early fall when soils are more likely to be dry.

Although disturbance is necessary, no more than half of the field border around a single field should be disturbed in any one year. In this manner, disturbance can be used as a tool to replenish field border habitat conditions while maximizing horizontal structural diversity.

Frequently, initial nesting attempts by birds in hayfields are destroyed by hay harvesting operations. These birds attempt to re-nest in available habitat elsewhere--typically in nearby buffer areas and other strip cover habitats. Field borders and other buffer areas can provide crucial habitats for these second nesting attempts. Where buffers need to be mowed for maintenance, mowing should be delayed until at least mid-August to allow second nesting attempts to succeed.

Figure 7. Seed-producing annuals such as partridge pea provide wildlife food and cover after light disking or other disturbance measures.

Pesticide drift in field borders should be minimized to support a broad spectrum of butterflies and other native pollinators and beneficial insects.

In conclusion, when well-designed and managed, field borders can provide substantial wildlife food and cover on agricultural lands in Maryland.

Table 2. Commonly used native plants that provide food and cover for various wildlife groups in Maryland.

Plant Species	Plants Provide Food and Cover for:[1/] Upland Game Birds and Mammals	Grassland Songbirds	Butterflies and Pollinators
Native Grasses			
Big Bluestem (*Andropogon gerardii*)	●	●	
Broomsedge (*Andropogon virginicus*)	●	●	
Deertongue (*Dichanthelium clandestinum*)	●	●	
Eastern Gamagrass (*Tripsacum dactyloides*)	●	●	
Indiangrass (*Sorghastrum nutans*)	●	●	
Little Bluestem (*Schizachyrium scoparium*)	●	●	
Switchgrass (*Panicum virgatum*)	●		
Virginia Wild Rye (*Elymus virginicus*)	●	●	
Native Forbs			
American Vetch (*Vicia americana*)	●	●	●
Black-eyed Susan (*Rudbeckia hirta*)	●	●	●
Blazing Star (*Liatris spicata*)			●
Bush Clover (*Lespedeza capitata*)	●		●
Butterflyweed (*Asclepias tuberosa*)			●
Heath Aster (*Aster pilosus*)			●
Lance-leaved Coreopsis (*Coreopsis lanceolata*)	●		●
Partridge Pea (*Chamaecrista fasciculata*)	●	●	
Purple Coneflower (*Echinacea purpurea*)			●
Tickseed (*Coreopsis tinctoria*)	●		●
Wild Blue Indigo (*Baptisia australis*)			●

1/ Note: Depending on the animal's food preferences, wildlife may consume flowers, seeds, nectar, stems, roots, or foliage from these plants.

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