Citizen's Guide to Monitoring Wetlands in Utah

Foreward

This manual was written for Utah citizens who would like to learn more about wetlands and help protect these important resources by participating in the Utah Division of Wildlife Resources' (UDWR) Wetlands Monitoring Program. The manual contains background information about wetlands as well as specific procedures for monitoring, and is intended to be used in conjunction with volunteer training sessions sponsored by UDWR. The Volunteer Wetlands Monitoring Program is in its third year, and we are encouraged by the commitment of volunteers. We hope you will continue to share our enthusiasm, and be rewarded by knowing that the information you collect will help improve the stewardship of Utah's wetlands. Thank you for your interest in volunteer wetlands monitoring and commitment to wetlands stewardship. We look forward to having you as a member of Wetland Partners Monitoring Program!

What is monitoring?

Monitoring is the process of systematically and repeatedly measuring conditions to track changes over time (Miller et al. 1996). Just as a physician monitors a patient's vital signs as a way of tracking the patient's condition over time, scientists, resource agencies, and concerned citizens have begun monitoring environmental variables as a way of tracking environmental conditions over time. The word "monitor" is derived from a Latin word meaning "to warn." One use of monitoring is as an early warning system of changing environmental conditions. Problems can be detected early, when they are easier to correct. Other uses include assessing progress toward goals such as improving water quality or restoring habitat, or assessing the effectiveness of different habitat management techniques.

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Why monitor wetlands?

Wetlands are scarce and threatened habitats in Utah, comprising only 1.5% of the state's land surface area. Utah has lost approximately 30% of its historic wetlands, and many remaining wetlands have been degraded or are threatened by the state's rapid growth and development. Although rare, wetlands are critically-important habitats in Utah, providing resources needed by a wide variety of plant and animal species. In addition, wetlands can help control flooding, improve water quality, provide open space, generate economic benefits, and serve as sites for recreation, education, and research. Although society increasingly appreciates the importance of wetlands, we need more information about wetland conditions to improve stewardship of these important habitats. Monitoring can help determine whether wetland conditions are improving, deteriorating, or remaining stable, help identify factors that contribute to wetland degradation or restoration, and help evaluate the effectiveness of management activities.

The Utah Division of Wildlife Resources (UDWR) is particularly interested in monitoring three types of wetlands: (1) wetlands which have been identified as providing essential wildlife habitat; (2) mitigation wetlands which have been created, restored, or enhanced to compensate for impacts to other wetlands; and (3) wetlands which have been restored through voluntary stewardship programs such as the Natural Resources Conservation Service's (NRCS) Wetlands Reserve Program.

Wetlands perform many valuable functions including biodiversity, support, water quality enhancement, and flood control.

Wetlands which provide essential wildlife habitat typically are high-quality wetlands that can provide a wealth of information about the structure and functioning of healthy wetlands. Early detection of any adverse impacts to these wetlands is also important if their high quality is to be protected and sustained.

Mitigation wetlands are wetlands which have been created, restored, enhanced, or preserved as compensation for impacts to other wetlands allowed by a Section 404 permit under the federal Clean Water Act. A Section 404 permit is required to deposit dredged or fill material in a wetland, for example during construction of residential or commercial developments or highways. The permitting process requires the applicant to first avoid and minimize wetland impacts to the extent possible, and to provide compensatory mitigation to offset unavoidable impacts. Unfortunately, some compensatory mitigation projects never are carried out, some fail, and still others do not meet their objectives. Monitoring of mitigation wetlands can provide very important information useful for determining whether projects are meeting their objectives, for identifying corrective actions needed to meet objectives, and for improving the planning and design of mitigation projects.

Foreward

Monitoring of wetlands that have been restored or enhanced is needed to assess the extent to which restoration projects are meeting their goals, and can also help identify the types of projects with the highest likelihood of success. Restoration projects have been undertaken on thousands of acres of wetlands nationwide, and have great potential to offset historic and continuing wetlands loss.

Why volunteer monitors?

Although agencies such as the UDWR have initiated programs to collect information on UtahÆs most important wetlands, budget limitations restrict our scope of activities. This is where you, the volunteer monitor, can make a difference! Trained volunteers can collect high-quality data usable by state and federal agencies, and help narrow the gap between information needs and information availability. Several other states have initiated volunteer wetlands monitoring programs, and long-running volunteer water quality monitoring programs have demonstrated what a significant contribution volunteers can make.

Wetlands monitoring is needed to help identify threats to wetlands, evaluate the effectiveness of management activities, and improve approaches to restoration

A volunteer monitoring program is about more than just collecting data, however. Volunteers gain new knowledge and skills, learn more about the natural resources in their community, experience the joys and frustrations of field work, and meet and work with other volunteers and resource agency personnel. We hope that volunteers will share their knowledge and experience with others, including students, family, and other members of their communities, and help create a citizenry that is knowledgeable about and appreciative its wetland resources.

How will the data collected by volunteers be used?

The information collected by volunteers will be compiled and provided to state and federal agencies with responsibilities for wetlands management and regulation, including the UDWR, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. The information will also be made available to local governments and planners, educators, conservation organizations, and anyone else with an interest in wetlands. Agencies will use the information for purposes such as helping to evaluate the success of wetland management programs, helping to identify areas in need of protective measures, and improving conservation programs.

What can I expect as a volunteer monitor?

You can expect to learn a lot about wetlands in general, and to become an authority on the specific wetland or wetlands you monitor. You can expect to meet and work with other people with similar interests. You can also expect to get your feet (or boots) wet, and probably to swat a few mosquitoes. You can expect that UDWR will provide you with training and technical support, and will be responsive to your monitoring-related questions and needs. You can also expect to experience satisfaction from knowing that your work will help enable future generations to enjoy and benefit from Utah's wetlands.

Organization of the Manual

This manual is divided into four major sections. The first section contains background information on wetland science and regulation. This section can be read at your leisure. The second section contains more information on the three types of wetlands (essential habitat, mitigation, and restored) that we will be monitoring. We recommend that you read this section early in the training process. The third section describes monitoring procedures and contains detailed protocols for volunteers to follow when collecting data. The final section contains the references and appendices.

Data collected by citizens will be sued be resource management agencies and others to improve the management and conservation

Introduction to Wetlands

What are Wetlands?

"Wetlands" is a collective term for marshes, swamps, bogs, and similar areas where the presence of water during at least part of the year drives the development of soils and plant communities (U.S. EPA 1995b). Wetlands come in many forms and sizes, occur in every climate from the tropics to the tundra, and are found on every continent except Antarctica (Mitsch and Gosselink 2000). Despite their outward diversity, wetlands have certain fundamental characteristics in common. These common characteristics include (1) standing water or saturated (waterlogged) soils for at least part of the year; (2) special soils known as hydric soils; and (3) plants adapted to life in wet or saturated soils, known as hydrophytic vegetation.

Wetlands share three common characteristics:
1) Hydrology
2) hydric soils
3) hydrophytic

Wetlands develop at sites where shallow standing water or saturated soils occur during at least part of the growing season. Note that water does not have to be present year round, or even in all years. Wetland hydrology encompasses variables such as water source, depth, flow patterns, and the duration and frequency of flooding or saturation, and is the most important determinant of wetland formation and functioning (Mitsch and Gosselink 2000).

Wetland soils may be permanently or temporarily saturated, but are saturated long enough during the growing season to develop anaerobic (little or no oxygen) conditions in their upper layers. When soils are saturated, the air spaces between soil particles fill with water, greatly reducing the ability of oxygen to diffuse through the soil (the rate of diffusion of oxygen in saturated soil is 10,000 times slower than in aerated soil). The soils that develop under these conditions are known as hydric soils.

Hydric soils may be either organic or mineral. Organic hydric soils have a high organic matter content, usually made up of decayed or decaying plant parts, and are known as peats and mucks. Organic hydric soils tend to develop where the soil is frequently or permanently saturated, and low oxygen availability limits the rate of decomposition. Mineral hydric soils have less organic matter and more silt, sand, and clay, indicating that the rate of decomposition is better able to keep pace with the rate of plant production. Mineral soils are more likely to be found where soils are only seasonally saturated. Chemical changes that occur when soils experience alternating periods of saturation and drying produce features helpful in identifying mineral hydric soils. Under anaerobic conditions, iron is reduced from the oxidized state $Fe3+$ to the reduced state $Fe2+$ through gain of an electron, causing a change in coloration so that the soil appears greyish, blueish, or greenish. This process is called gleying. Under aerobic conditions, iron is oxidized from $Fe2+$ to $Fe3+$, creating small orange, yellow, or reddish-brown blobs called mottles.

Wetlands contain plants adapted to life in flooded or saturated soils, known as hydrophytic vegetation. Cattails and rushes are familiar examples of hydrophytic vegetation. Hydrophytes have a variety of physical, physiological, and reproductive adaptations that enable them to tolerate fluctuating water levels and anaerobic soil conditions. Plants without these adaptations will experience stress and eventually die if saturated soil conditions persist, because lack of oxygen in the root zone limits the ability of roots to perform essential functions such as absorbing nutrients. Some of the special adaptations of hydrophytes include shallow roots in or near aerated soil layers; a special tissue called aerenchyma that forms large hollow spaces for conducting oxygen from the aboveground portions of the plant to the roots; adventitious roots which arise from the stem above the soil surface, and provide additional surface area for oxygen to diffuse into the plant; and metabolic adaptations which allow cells to respire anaerobically without accumulating the usual end product, ethanol, which would be toxic if it accumulated in plant tissue.

Wetlands typically occur on the landscape where groundwater discharges or surface water collects.

Wetlands typically occur where ground water discharges or surface water collects (Tiner 1996). Common sites include low-lying areas adjacent to surface water sources, such as the floodplains of streams and rivers and the margins of lake, ponds, and reservoirs; topographic depressions where surface water can collect; and other low-lying areas where the water table intersects the soil surface or springs surface. Many wetlands are underlain by relatively impermeable materials such as clay, which limit the downward loss of water through percolation. Because wetlands are often found at the interface between terrestrial and aquatic systems, they are sometimes referred to as ecotones, are defined as transition zones between different habitat types.

Different definitions of the term "wetlands" have been created to serve different purposes, such as scientific research, inventory, or regulation. Agencies with regulatory responsibilities, such as the U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA) use a narrow definition of wetlands which requires that all three wetland characteristics -hydrology, hydric soil, and hydrophytic vegetation- be present for an area to be defined as a wetland. These agencies have developed procedures for determining the boundaries of wetlands based on the presence of the three indicators, a process known as wetland delineation. In contrast, the U.S. Fish and Wildlife Service's (FWS) definition, developed for research, management, and inventory purposes, requires that only one of the three characteristics be present to identify an area as a wetland.

Utah's Wetlands

The most common wetland types found in Utah include marshes, riparian wetlands, wet meadows, and playas. Marshes are characterized by areas of emergent vegetation such as cattails and bulrushes interspersed with areas of open water where submersed or floating-leaved plants like pondweed or water lilies may be found. Riparian wetlands are located within the floodplains of streams and rivers. Because of the presence of water, riparian wetlands often have more lush vegetation than the surrounding landscape. Typical plants include willows and cottonwoods. Wet meadows are found in a variety of locations around the state, from high alpine locations to low-lying areas around the Great Salt Lake. The soils of wet meadows are normally saturated, although standing water often is not visible on the surface. Wet meadows are dominated by herbaceous vegetation like grasses, rushes, and sedges. Some alpine and sub-alpine wet meadows, such as Albion Basin in Little Cottonwood Canyon, are known for their beautiful wildflower displays in summer.

Wetland types found in Utah include: marshes, wet meadows, playas, riparian wetlands, and

Playas are seasonal wetlands found in locations including near the Great Salt Lake and in the West Desert. Playas are shallow depressions that receive water from precipitation and spring runoff, and dry out during the summer. Minerals contained in the water are deposited on the soil surface when the water evaporates, so that a playa during the dry season resembles a salt flat. The seasonal drying and deposition of salts limit the growth of vegetation, creating conditions ideal for prolific production of insects such as midges which are an important food source for migratory waterbirds. Just because a wetland is wet only seasonally does not mean it is less important ecologically. A rarer type of wetland found in some locations in Utah is known as a fen. Fens are wetlands where peat accumulates, and may appear as mounds that are elevated somewhat above the surrounding area.

Different wetland types occur because of differences in geology, climate, topography, hydrology, water chemistry, and the degree of natural or human-induced disturbance (U.S. EPA 1995a). Several systems have been developed to classify wetlands. The most commonly used classification system is the Cowardin system developed for the U.S. Fish and Wildlife Service for use in wetlands research, management, and inventory. The Cowardin system is hierarchical, similar to the taxonomic classification system used for living organisms. The broadest classification level is the system (wetlands that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors) and includes five types: marine, estuarine, riverine (rivers and streams), lacustrine (lake-like) and palustrine (pond-like, including marshes, wet meadows, playas, and fens). Only the latter three systems are found in Utah. Except for palustrine wetlands, each system is broken down into subsystems, such as lower perennial and upper perennial for the riverine system. Subsystems are broken down into classes which are differentiated based on either the characteristic vegetation or substrate type of the wetland. Subclasses and additional distinctions can be used to further differentiate wetland types. A full description of this system is available in the publication Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

Wetlands make up about 1.5% of Utah's land surface area or about 800,000 acres. There are about 100 million acres of wetlands in the continental U.S. and about 200 million acres of wetland in

Wetlands make up approximately 1.5% of Utah's land surface area. We say "approximately" because it is impossible to get an exact measurement. Wetlands are dynamic systems whose boundaries frequently shrink and swell seasonally or over longer time spans in response to factors such as changes in precipitation. Approximately half of Utah's wetlands are located around the Great Salt Lake.

Listed below are some of the wetlands that are open for public visitation in Utah. The wetlands listed encompass some of the great diversity found in UtahÆs wetlands, from desert oases to Great Salt Lake marshes to subalpine wet meadows. We encourage you to visit these or other wetlands in Utah to experience and learn more about the diversity of wetlands in Utah.

Matheson Wetlands Preserve: The Matheson Wetlands Preserve consists of 875 acres along the Colorado River just west of downtown Moab. The Matheson Preserve protects the largest wetland system along the Colorado River in Utah, and is jointly owned and managed by The Nature Conservancy and the UDWR. The preserve is an oasis in a desert region, a critical stopover for migratory waterfowl, shorebirds, songbirds, and raptors. More than 175 species of birds have been observed at the preserve. The preserve is also home to amphibians, reptiles, and mammals such as mule deer, beavers, muskrats, bats, and river otters. The preserve has almost a mile of trails, interpretive kiosks, and naturalist-led walks every Saturday at 8:00 a.m. from March through October. The preserve is open 7 days a week. For more information you can call The Nature Conservancy's Moab office at (435) 259-4629 or visit their web site at www.netoasis.com/moab/matheson.

Fish Springs National Wildlife Refuge: Fish Springs National Wildlife Refuge is located at the southern end of the Great Salt Lake desert in western Utah. The refuge is owned and managed by the U.S. Fish and Wildlife Service, and features a 10,000 acre marsh system fed by warm saline springs. Like the Matheson Preserve, the refuge is an oasis in a desert, an important migratory stopover for waterfowl, shorebirds, and songbirds. More than 250 species of birds have been observed at the refuge. Resident mammals include mule deer, bobcats, kit foxes, skunks, and muskrats. The best times to see large concentrations of migratory birds are in early spring and late fall. Visitor amenities include an 11-mile self-guided auto tour loop. For more information you can call the refuge at (435) 831-5353.

About half of Utah's wetlands are found around the Great Salt Lake.

Farmington Bay Waterfowl Management Area: The Farmington Bay Waterfowl Management Area (WMA) consists of more than 12,000 acres of marsh, playas, upland, and open water. Farmington Bay WMA was created in 1935 when the dikes that surround the wetlands and ponds were constructed. The entire refuge flooded when the Great Salt Lake rose during the 1980Æs, and extensive restoration was needed after lake levels receded. More than 200 species of birds have been observed at Farmington Bay, with large numbers of migratory and nesting waterfowl, shorebirds, songbirds, and raptors. Spring and fall are the best times to see large numbers of migrants. Most birds have flown south by the end of December, except for bald eagles which winter in the area in large numbers. For more information you can call Farmington Bay WMA at (801) 451-7386.

Albion Basin: Albion Basin is located in upper Little Cottonwood Canyon, on lands owned and managed by the U.S. Forest Service. Many alpine wet meadows are found in Albion Basin, and this area is a prime location for wildflower viewing in July and early August. Visitors can view the wet meadows from any one of a number of trails that start in the vicinity of the Albion Basin Campground.

Wetland Functions and Values

The importance of wetlands was not recognized until relatively recently. Although many Native Americans relied on wetlands as important sources of food and materials, European settlers viewed wetlands as impediments to development, unsuitable for agriculture or settlement. In some parts of the country, wetlands were considered public health hazards since they were breeding grounds for malaria-carrying mosquitoes. During the 1800Æs, federal Swamp Acts encouraged the draining and filling of wetlands so the land could be used for agriculture or other purposes. Support for wetland draining, ditching, dredging, and filling continued until the 1970Æs, when the importance of wetlands became more widely appreciated and policies to encourage wetlands protection were enacted. By that time, more than half of the wetlands that existed in the continental U.S. at the time of European settlement had been destroyed. Utah has lost 30% of its historic wetlands.

The importance of wetlands has not always been appreciated. From European settlement of the U.S. until the early 1970's, wetlands were viewed primarily sd wastelands that could be put to productive use only if drained, dredged,

The remainder of this section describes some of the important functions and values of wetlands, with specific information on Utah wetlands included wherever possible. A given wetland may perform one or more of the functions listed, and different wetlands vary in terms of how well they perform a given function. Wetland size, type, location, and condition are some of the factors that influence which functions a wetland performs, and how well it performs them.

Habitat and Biodiversity Support

Wetlands typically are very productive and diverse ecosystems. Many wetlands have high primary productivity (production of plant matter) which in turn supports an abundant and diverse animal community, including invertebrates, fish, amphibians, reptiles, birds, and mammals. The physical heterogeneity of many wetlands, with areas of open water interspersed with areas of emergent vegetation and upland, creates diverse habitats that are important for supporting biodiversity. Wetland-dependent wildlife includes species that spend most or all of their life cycle in wetlands, such as wood ducks and muskrats, as well as upland species such as deer or foxes that rely on wetlands for food or water. Approximately 80% of all breeding bird populations in the U.S. rely on wetlands at some point in their life cycle.

Wetlands are also important habitats for many threatened and endangered species. The U.S. Fish and Wildlife Service estimates that approximately half of all federally-listed threatened and endangered animal species depend on wetlands. Some wetlands in Utah provide habitat for Utes ladies' tresses (Spiranthes diluvialis), a threatened orchid. Other species of conservation concern that are associated with wetlands in Utah include the least chub (Iotichthys phlegethontis), the spotted frog (Rana pretiosa), the bald eagle (Haliaeetus leucocephalus), the mountain plover (Charadrius montanus), and the snowy plover (Charadrius alexandrinus).

Many wetlands are highly productive, with prolific plant growth supporting a divers and abundant animal community. Some wetlands, such as coastal estuaries, are among the most productive ecosystems in

Wetlands are particularly important as wildlife habitat in an arid state like Utah, and are recognized as biodiversity "hotspots." The Great Salt Lake and its adjoining wetlands are used by more than 250 species of birds, with vast numbers of some species. While some species nest here, others visit the lake mainly to "refuel," gorging on brine shrimp and brine flies to quickly put on the fat needed for migration. Between two and five million birds use the Great Salt Lake and its associated wetlands each year. The impressive numbers include 1,500,000 eared grebes; 1,000,000 pintail ducks; 500,000 Wilson's phalaropes, the largest staging concentration of this species in the world; 280,00 red-necked phalaropes; and 250,000 American avocets. The Great Salt Lake also supports the world's largest breeding populations of California gulls and white-faced ibises. The Great Salt Lake hosts a winter population of 500 bald eagles, one of the top ten winter populations in the continental U.S. The importance of the Great Salt Lake and its adjoining wetlands to wildlife has been recognized by their designation as a Hemispheric Reserve in the Western Hemisphere Shorebird Reserve Network. The Western Hemispheric Shorebird Reserve Network is comprised of a series of reserves located on major flyways stretching from northern Canada to southern South America. To be designated a Hemispheric Reserve, an area must host 500,000 shorebirds or 30% of a flyway population annually. The Great Salt Lake meets these criteria many times over.

Although showy waterfowl and shorebirds may capture most of the interest and attention of visitors to wetlands, less-conspicuous invertebrates play critical roles in wetland ecosystems. Most of the living plant material in wetlands is not consumed directly by herbivores. When this plant material dies, invertebrates play a key role in nutrient cycling by feeding on and breaking down the detritus so it can be further decomposed by organisms such as bacteria and fungi. Invertebrates also are an important food source for many vertebrates, particularly for rapidly-growing young which need a concentrated protein source.

Different wetland types provide different resources for wildlife. Riparian wetlands are an important part of the migratory corridors used by neotropical songbirds such as warblers, flycatchers, and tanagers. Riparian wetlands are also important habitats for many amphibians and reptiles. Playa wetlands, as previously noted, are important sources of food for migratory waterbirds. Marshes provide important feeding areas, nesting sites, and cover for a variety of waterfowl, mammals, reptiles, and amphibians.

The Great Salt Lake and its associated wetlands host as many as 5 million birds each year. Species totals include 1.5 million eared grebes, I million pintail ducks, 500,000

Land use on adjacent uplands affects the habitat function of wetlands since many species depend on both wetlands and adjacent uplands to meet different needs. Uplands are used by wildlife for purposes such as foraging and nesting, and land uses which interfere with these uses may also result in decreased use of adjoining wetlands by wildlife. Some upland land uses, such as agriculture, can be compatible with the habitat function of wetlands. Other uses, such as residential or commercial development, can impair the habitat function of wetlands, especially for species which are sensitive to disturbance or susceptible to predation by dogs and cats.

Flood Attenuation and Erosion Control

Wetlands frequently are compared to sponges, in terms of their ability to temporarily store and slowly release water from runoff and precipitation. This temporary storage and slow release is very important for reducing the volume and velocity of flood waters and for sustaining stream flows during drier times of the year. When water enters a wetland, it slows because of resistence created by vegetation, and also because it generally spreads out over a larger area. Slower flows allow more water to percolate into the soil. Reduction in flood volumes and velocities can also help prevent downstream erosion and related damage, and the root systems of wetland plants help bind substrates in place. Wetlands within and downstream from urban areas are especially valuable since they counteract the increased rate and volume of runoff from impervious surfaces like parking lots and streets (U.S. EPA 1995a).

The U.S. suffers billions of dollars in property damage from flooding each year, in part because wetlands which used to store flood waters have been destroyed. An interagency task force which studied the severe flooding along the upper Mississippi and Missouri Rivers in 1993 concluded that wetland loss in the region had contributed significantly to increased runoff and the severity of the flood (Kolva 1996).

In a few cases wetlands have been protected because their role in flood control was recognized. The U.S. Army Corps of Engineers decided to protect about 8,500 acres of wetlands along the Charles River near Boston after estimating that the loss of the wetlands would result in $17 million of flood damage annually. Preserving the wetlands was far less costly than building flood control facilities.

Wetlands can improve water quality by removing pollutants such as sediments, nutrients, and heavy metals. However, the capacity of a wetland to improve water quality is limited , and can be overwhelmed if the

Water Quality Enhancement

The location of many wetlands between uplands and water bodies allows them to intercept many pollutants contained in surface runoff from streets, parking lots, residential, commercial, and agricultural areas and remove or transform the pollutants before they can reach open water. Important categories of pollutants that can be removed by wetlands include sediments, nutrients such as nitrogen and phosphorus, and toxic substances such as the heavy metals cadmium and zinc. However, not all wetlands are capable of enhancing water quality, pollutants can adversely impact wetlands, and the ability of any wetland to enhance water quality can be overwhelmed if pollutant loads are too high.

Wetlands remove sediments by a physical process. When water flows into a wetland, its velocity usually decreases because of resistance caused by vegetation. Since the ability of water to transport sediment decreases as water velocity decreases, sediment settles out when water velocity drops upon entering a wetland. Sediment is a type of non-point source pollution, and is the largest pollution problem for streams throughout the U.S. (Firehock et al. 1998). Excess sediment can impact aquatic life by reducing the penetration of light needed by plants for photosynthesis, impairing amphibian and fish egg development, and clogging the gills of aquatic animals. Excess sediment can also fill lakes, reservoirs, and stream channels. Because other pollutants such as nutrients, heavy metals, pesticides, and bacteria often are bound to sediment, sediment removal can also reduce the amount of these pollutants as well.

Although wetlands can remove pollutants form water, these pollutants can also degrade wetlands. Sediments can fill wetlands, excess nutrients can alter the makeup of the plant community, and toxic

Excess nutrients such as nitrogen and phosphorus can cause eutrophication of water bodies. Eutrophication involves an increase in plant production and decrease in dissolved oxygen in the water, especially during warm weather, that can lead to the loss of species intolerant of low-oxygen conditions. Wetlands remove nutrients from water by chemical and biological processes. The most important chemical process is the formation of insoluble precipitates between phosphates and certain other compounds, although this process is limited by the supply of chemicals that can combine with phosphates to form precipitates. Biological processes are important for removing nitrogen. These processes include nitrification, which converts ammonium ($NH4+$) to nitrate ($NO3-$) via an aerobic process, and denitrification, which converts nitrate to nitrogen gas ($N2$) via an anaerobic process. The proximity of a narrow aerobic layer at the upper surface of anaerobic wetland sediments facilitates the sequential carrying out of nitrification and denitrification. Different types of bacteria are responsible for these processes, which can go on essentially indefinitely since the end product, nitrogen gas, is released to the atmosphere. Wetlands' role in returning nitrogen to the atmosphere is an important part of the global nitrogen cycle, especially because humans have altered the cycle by removing considerable quantities of nitrogen from the atmosphere to produce fertilizer. Wetland plants can also play a role in removing nutrients from incoming water, but this storage is only temporary since the nutrients are released when the plants die and decompose. Some wetlands may store nutrients for longer time periods if peat accumulates. One way to circumvent this problem in managed wetlands is to harvest the plants, compost them, and return them to a site where nutrients are needed.

Factors which influence a wetland's ability to enhance water quality include the amount and type of pollutant entering the wetland; season (nutrient uptake is greatest during the growing season); density and type of vegetation in the wetland; area of contact between water and wetland substrate (a greater area of contact allows more pollutant-removing processes to take place); and the residence time of the pollutant (the long the pollutant remains in the system, the more time there is for it to be removed, transformed, or sequestered).

Although wetlands can remove pollutants from surface runoff, pollutants can have adverse impacts on wetlands. Sediment can adversely impact wetlands in the same ways that it would lakes or streams, and could ultimately fill up a wetland. Excess nutrients can cause changes in the composition of the vegetative community, in many cases reducing species diversity. Runoff can also carry in the seeds of exotic plants capable of replacing native species. Toxins such as heavy metals and some pesticides can bioaccumulate, increasing in concentration as they work their way up the food chain. Ingestion of heavy metals by young waterfowl can cause neurological effects that interfere with the normal imprinting process so that chicks fail to follow their mother and are more susceptible to predation. Some pesticides persist in the environment long after their release; traces of DDT can still be found in the environment even though use of this pesticide in the U.S. was banned in 1972. Because natural wetlands can be degraded by pollutants, resource management agencies recommend the use of constructed wetlands for water treatment.

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Recreation

More than half of all adults in the U.S. hunt, fish, birdwatch, or photograph wildlife. These activities depend substantially on healthy wetlands (U.S. EPA 1995b). Wetlands at UDWR's Farmington Bay and Ogden Bay Waterfowl Management Areas together host more than 50,000 visitors annually. Some communities are beginning to capitalize on the recreation value of wetlands and their associated wildlife. Since 1999, the Davis County Office of Tourism has sponsored the Great Salt Lake Bird Festival which involved over 2,000 participants each year in activities such as field trips to wetlands around the Great Salt Lake.

Education and Research

Protected wetlands such as those managed by the UDWR, the U.S. Fish and Wildlife Service, The Nature Conservancy, private foundations, and the Audubon Society have been visited by school groups on field trips. Several schools in Utah have developed wetlands on school grounds as outdoor laboratories, including the Treasure Mountain Middle School in Park

City and the Northwest Middle School in Salt Lake City.

Wetlands research is conducted by a variety of organizations, including government agencies, colleges and universities, and non-profit organizations. Major topics of research include wetland processes, wetlands functions, human-induced stresses, wetlands delineation and identification, and wetlands management (Coleman et al. 1996).

Aesthetics

Anyone who has spent time in the marshes around the Great Salt Lake is aware of the beauty of this habitat at the interface between lake and uplands. Blue waters and the brilliant colors of waterbirds are set against the majestic backdrop of the Wasatch mountains, and urban noise is replaced by the sweet music of marsh wrens and blackbirds. Many hikers seek out alpine wet meadows because of the beauty of their summer wildflower displays. The open space, vistas, and serenity provided by wetlands may become increasingly appreciated as other open space is converted for residential and commercial development.

Wetlands around the Great Salt Lake were used extensively by Native Americans who depended on them as sources of food and materials. Humans may have first settled around the Lake more

Heritage Value

The wetlands around the Great Salt Lake were an important source of food and materials for Native Americans, who gathered edible wetland plants and hunted waterfowl and other small game. Evidence exists of human presence near the lake at least 10,000 years ago. Settlements persisted near the lake until about 3,500 years ago, when the climate became cooler and wetter, and rising lake waters flooded the adjacent marshes. The lakeside settlements were abandoned at this time. The area was resettled about 1,500 years ago, when the climate became warmer and drier. The more-recent inhabitants lived in marsh villages, especially in the Bear River and Farmington Bay areas. They used the food resources of the marshes extensively, hunting large waterfowl such as geese, and gathering plants like bulrushes and cattails (Zicus 1995).

Economic Value

Resources harvested from wetlands, expenditures by recreationalists who visit wetlands, and benefits such as flood attenuation and water quality enhancement all contribute to the economic value of wetlands. The easiest economic benefits to estimate are for products harvested from wetlands, such as timber, wild rice, and cranberries, and for commercially harvested fish and shellfish that depend on wetlands for at least part of their life cycles. About 70% of the economic value of the U.S. commercial fishing industry in 1991 (or about $21 billion) was derived from species directly or indirectly dependent on coastal wetlands (U.S. EPA 1995b). Direct expenditures on wetland-related recreation (fishing, hunting, and wildlife observation) totaled about $23 billion in 1991 (National Audubon Society 1994). Expenditures by just one group of wetland users in Utah, waterfowl hunters, are estimated at more than $12 million annually.

Wetland functions such as flood attenuation, water treatment, and nutrient cycling, which do not have a market value, still are essential services that our economy depends on. A few studies have attempted to estimate the economic benefits of these "ecosystem services." One study of a hardwood swamp in South Carolina estimated that a $5 million water treatment plant would be needed to provide water treatment equivalent to what the wetland provided for free (U.S. EPA 1995b). Another study estimated that if half of the U.S.'s remaining wetlands were destroyed, 680 million kilograms of additional nitrogen would contaminate the U.S.'s waters, requiring more than $60 billion annually in sewage treatment plant upgrades (Firehock et al. 1998). Still another study estimated the avoided costs of flood control provided by wetlands in the lower 48 states as $30 billion annually (National Audubon Society 1994).

More than half the wetlands that existed in the continental U.S. at the time of European settlement have been destroyed. Polices and regulations enacted since the early 1970's have helped slow the rate of wetlands loss, but nearly 300,000 acres

Threats to Wetlands

Wetlands covered about 220 million acres of the continental U.S. at the time of European settlement. Today, less than half of that acreage remains. Six states have lost more than 85% of their wetlands, and 22 have lost more than 50% (Dahl and Allord 1996). Threats to wetlands include natural processes, such as drought, erosion, severe storms, and sea level rise, and human activities, such as drainage, dredging, filling, diking, logging, mining, construction, runoff, pollution, grazing, and the invasion of exotic plants. Threats also include public ignorance of the importance of wetlands and the ingrained attitude that wetlands are wastelands. Negative attitudes towards wetlands continue to be reflected in modern language when we use phrases like "bogged down," "swamped," or "in a quagmire" to describe adverse situations.

Conversion of wetlands for agriculture and development has been the biggest factor in wetland loss. Parts of some of the U.S.'s largest cities, including Boston, Washington, D.C., Chicago, Miami, and San Francisco were built on wetlands. Wetland loss has slowed as recognition of the importance of wetlands has grown and as policies to protect wetlands have been put in place. Voluntary stewardship by private landowners and the acquisition of wetlands by government agencies and conservation groups have also helped to slow the rate of wetland loss. However, wetland acreage continues to be lost and remaining wetlands continue to be degraded. From the mid-1970's through the mid-1980's, the estimated loss rate in the continental U.S. was 290,000 acres per year (Dahl and Allord 1996). Most wetlands loss in the 1900's was associated with agriculture, although agriculture's contribution to overall wetlands loss is decreasing because of policies that have been enacted to discourage the conversion of wetlands for agriculture.

Wetland hydrology commonly is altered by draining a wetland or by reducing or diverting its water supply. Once the hydrology changes, hydrophytic vegetation may be replaced by upland

Wetlands may be completely obliterated by some activities, for example by development that paves or builds over a former wetland. Another important category of impacts involves alterations in hydrology, so that standing water or saturated soils no longer occur. Wetland hydrology commonly is altered by draining a wetland or by reducing or diverting its water supply. Once the hydrology changes, hydrophytic vegetation may be replaced by upland vegetation, and wetland animals may be replaced by upland communities. Wetlands can also be threatened by increases in water supply or by pollution of their water supplies.

Habitat fragmentation, defined as the disruption of extensive habitat into small and isolated patches (Meffe and Carroll 1997) poses another important threat to wetlands. Fragmentation subdivides larger habitat patches into smaller patches that may be relatively isolated from each other by barriers such as highways, buildings, and open fields. Because larger habitat patches typically support higher species diversity, habitat fragmentation can result in reduced species diversity in the remaining patches, and even local extinction of certain species. Species which require large areas of habitat (for example, large predators) or that are sensitive to disturbance are especially vulnerable to the effects of habitat fragmentation. Habitat fragmentation can also impede movement between patches, with serious consequences for species which normally move or disperse through the area.

Changes in the landscape adjacent to a wetland can also impact the wetland. For example, a housing development built adjacent to a wetland can destroy upland habitat needed by wetland wildlife; may displace wildlife sensitive to noise or disturbance; may cause increased mortality of wildlife because of predation by cats and dogs; may cause increased runoff of contaminants such as petroleum products, fertilizers, and pesticides into the wetland; and may introduce exotic or weedy species to the wetland.

Exotic plants are non-native species which can pose a considerable threat to wetlands. Unlike native species, which have coevolved with predators, pathogens, or herbivores that help keep their numbers in check, exotic species have no such relationships with the other species in their new community, and often reproduce prolifically at the expense of native species.

Exotic plants (non-native species) can threaten wetlands by displacing native plant species. Most exotic species have far less value to wildlife than the natives they displace; thus the invasion of exotic plants can have far-reaching effects

Two exotic species which pose threats to wetlands in Utah are purple loosestrife and tamarisk. Purple loosestrife is a European species that was brought to the U.S. as an ornamental in the early 1800's. It is an extremely successful invader of wetlands that have been subject to disturbance such as draining or ditching. The species is a prolific seed producer, and its rapidly-growing seedlings crowd out native species. Once established, purple loosestrife is very difficult to eradicate (The Nature Conservancy 1999). Tamarisk is a Eurasian species that was brought to the U.S. for erosion control. It reached Utah sometime in the early 1900Æs and has spread to much of the low-elevation riparian and lacustrine habitat in the state (Welsh et al. 1993). Like purple loosestrife, tamarisk is an aggressive invader of disturbed habitats and produces prolific quantities of seeds. Tamarisk is also called salt cedar because it oozes salt from its leaves. Accumulation of leaf litter with a high salt content beneath tamarisks makes it difficult for other plants to grow nearby (The Nature Conservancy 1999). In addition to displacing native plants, neither purple loosestrife nor tamarisk provides significant wildlife value.

A few species of native plants also can come to dominate wetland plant communities under certain conditions. Suppression of natural cycles of wetting and drying tends to favor the growth of cattail populations, which can outcompete other wetland plants. The common reed Phragmites tends to outcompete other species in disturbed areas. Populations of this species have increased tremendously since the Great Salt Lake marshes were inundated by rising lake levels in the 1980's.

Flooding of the Great Salt Lake marshes in the 1980's is a good example of the impact of natural processes on wetlands. Most of the protected wetlands on the east shore of the Great Salt Lake are freshwater wetlands, separated from the saline waters of the Great Salt Lake by man-made dikes. When rising lake waters breached the dikes in the 1980's, the increased salinity and water depth killed vegetation in the freshwater wetlands. Approximately 300,000 acres of wetlands were inundated, and use of the wetlands by migratory birds decreased by almost 90%. The highest productivity of these wetlands occurred after the high waters receded and wetland vegetation began to reestablish, suggesting that periodic innundation and drying are important for sustaining wetland productivity.

Given that society increasingly appreciates the importance of wetlands, why does wetlands protection remain controversial? Perhaps the biggest obstacle to resolving the continuing controversy over wetlands protection is the fact that the costs of wetlands protection (such as the foregone benefits of development) are borne mainly by private individuals, while the benefits of wetlands protection, such as reduced flooding, improved water quality, and the protection of biological diversity, tend to accrue to society as a whole, without providing a direct monetary benefit to the landowners who choose to protect wetlands. Several federal incentive programs which provide assistance to landowners who undertake voluntary stewardship of their wetlands are helping to close the gap between private costs and public benefits, but for the foreseeable future wetlands protection will require the participation of individuals capable of seeing beyond their property boundaries, and who appreciate the value of wetlands to society as a whole.

Perhaps the biggest obstacle to wetlands protection is that costs are often borne by private individuals while the benefits tend to accrue

Wetlands Protection

There are a number of ways to protect wetlands, including governmental regulation and nonregulatory approaches such as acquisition, land-use planning, technical assistance and stewardship incentive programs, and education. Two major pieces of federal legislation contain provisions which provide the basis for wetlands protection in the U.S. Section 404 of the Clean Water Act regulates the placement of dredged and fill materials in wetlands, and the wetlands conservation provisions of the Food Security Act (known as the “Swampbuster” provisions) deny subsidies to farmers who convert wetlands for agricultural production.

Section 404 of the Clean Water Act establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. The basic premise of the program is that no discharge of dredged or fill material can be permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nationÆs waters would be significantly degraded. The permit applicant must demonstrate that they have taken steps to avoid and minimize wetland impacts, and applicants normally are required to mitigate any unavoidable impacts by restoring, creating, enhancing, or preserving wetlands. The U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency jointly administer the program. The U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and state resource agencies have important advisory roles (EPA 1995b). Some activities that involve the discharge of dredged and fill materials are exempt from Section 404. Examples of exempt activities include normal farming, forestry, and ranching activities, and maintenance of dikes, dams, and levees (Votteler and Muir 1996).

In addition to Section 404 and Swampbuster, the federal government has established broad policy objectives to encourage wetlands protection and restoration. These include the Clean Water Action Plan's goals of a net

The other major piece of federal legislation with provisions for wetland protection is the Food Security Act. The "Swampbuster" provisions of the Food Security Act discourage farmers from altering wetlands by withholding federal subsidies from farmers who drain or convert wetlands (after Dec 23, 1985) for the purpose of planting crops.
In addition to Section 404 and Swampbuster, the federal government has established several broad policy directives to encourage wetlands protection. The "no net loss" policy adopted during the Bush Administration established a goal of no net loss of the nation's wetlands, encouraging the restoration, enhancement, and creation of wetlands to offset wetlands loss. The Clinton Administration's Clean Water Action Plan goes beyond the goal of no net loss to encourage overall wetlands gain, with the goal of a net gain of 100,000 acres of wetlands a year by 2005.

A variety of non-regulatory approaches to wetlands protection exists, including acquisition, land-use planning, technical assistance and voluntary stewardship programs, and education. Acquisition of important wetlands is being actively pursued by a number of groups in Utah. These groups include non-profit conservation organizations such as The Nature Conservancy and the National Audubon Society; governmental entities such as the Utah Reclamation Mitigation and Conservation Commission, which is acquiring wetlands to compensate for impacts from construction of the

Central Utah Project; and partnerships like the Intermountain West Joint Venture, which recently received a $1 million grant from the North American Wetlands Conservation Act grants program to acquire sensitive wetlands along the east shore of the Great Salt Lake.

Land-use planning represents another opportunity for wetlands protection. Davis and Box Elder counties have developed comprehensive wetlands conservation plans, which try to strike a balance between conservation and development by identifying high-priority wetland for protection and low-priority areas where development will be allowed. The UDWR currently is mapping essential wildlife habitat, including certain wetlands and riparian areas, throughout Utah. This information will be shared with county and regional planners to help them take conservation concerns into account during the planning process.

Technical assistance and voluntary stewardship programs directed towards private landowners are likely to play a pivotal role in wetlands protection since 75% of the U.S.'s remaining wetlands are on private lands. The Natural Resources Conservation Service (NRCS) administers a number of important programs which provide technical and financial assistance to landowners who engage in voluntary wetlands stewardship. The Wetlands Reserve Program provides financial and technical assistance to landowners, and encourages long-term protection of wetlands through conservation easements.

A variety of important non-regulatory approaches to wetlands protection complement regulatory action. These include acquisition, land use planning, technical assistance, voluntary stewardship

Education is a fundamental component of any wetlands protection plan. UDWR is a partner in the work currently underway to develop a comprehensive education plan for the wetlands of the Greater Great Salt Lake Ecosystem. The plan is expected to be finished by November of 2000. More information about this project can be found at the Northern Utah Wetlands Partnership web site at www.utahwetlands.org.

Want to Learn More?

Perhaps the single best reference on wetlands is the text Wetlands by Mitsch and Gosselink (see complete citation in References). Wetlands is comprehensive, clearly written, contains a large reference section, and was just revised in 2000. You may also find the National Wetlands Newsletter published by the Environmental Law Institute and the journal Wetlands published by the Society of Wetland Scientists interesting reading. Websites of conservation agencies and organizations are also good sources of information. The UDWR Wetlands Page provides links to a number of sites, including the Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service (National Wetlands Inventory), and the Natural Resources Conservation Service. The addresses of the UDWR

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Wetlands of Special Interest for Monitoring

UDWR's Essential Wetlands

The UDWR received funding from the U.S. Environmental Protection Agency in 1998 to identify wetlands throughout Utah with a high priority for protection. The goal of this project was to develop information that UDWR and other entities involved in wetlands conservation could use to help prioritize their conservation efforts. The process of identifying priority wetlands included asking regional personnel with extensive knowledge of local areas for their recommendations, and developing a list of criteria that could be used to rate different wetlands. The criteria included factors such as wildlife habitat value, wetland size, proximity to other protected areas, and risk of loss from projected urban development. After this project was begun, UDWR initiated a project to identify essential wildlife habitat of all types statewide. For consistency, priority wetlands have since been referred to as essential wetlands.

UDWR is using the information on essential wetlands to help direct its own conservation efforts, and is also providing maps of its essential wetlands to community and regional planners so that conservation priorities can be considered during the planning process. UDWR is interested in monitoring these essential wetlands because of their wildlife habitat value, because they can help us learn more about how healthy wetlands function, and because an "early warning system" provides time for response if adverse impacts or deteriorating conditions are detected.

The goal of mitigation is to replace the functions and values of the impacted wetlands. Compensatory mitigation normally involves restoration, creation, or enhancement of

Mitigation Wetlands

Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to issue permits which allow the placement of dredged and fill material in wetlands. These permits require that impacts to wetlands first be avoided and minimized to the extent possible, and that mitigation be provided to compensate for unavoidable adverse impacts. The goal of mitigation is to replace the functions and values of the impacted wetlands. Compensatory mitigation normally involves restoration, creation, or enhancement of wetlands. In some exceptional cases preservation of existing wetlands may be allowed.

Restoration involves replacing a wetland on a site where a wetland formerly existed but was lost because of some activity like draining or conversion for agriculture. Wetland restoration generally is believed to have a higher potential for success than wetland creation, since the conditions needed to support a wetland previously existed at the site and relatively simple actions, such as restoring the hydrology, may be all that is needed for a wetland to return. Viable seeds of some wetland plants can persist for years in the soil, and a wetland plant community often can be restored fairly quickly once hydrology is restored.

Creation involves creating a wetland on a site where no wetland existed previously. Creation has been less successful than restoration for a variety of reasons, including poor design of some projects and limited follow-up to correct problems. Creation also has limitations in that some types of wetlands are difficult to create. Marshes are relatively easy to create; fens are almost impossible. This situation has led, in some cases, to the substitution of harder-to-create wetland types by easier-to-create types.

Although the goal of compensatory mitigation is to replace the wetland functions and values lost because of the unavoidable impacts authorized by a Section 404 permit, numerous studies conducted around the country, including in

Enhancement refers to enhancing one or more functions of an existing wetland. For example, the wildlife function of a wetland might be enhanced by planting more of the plants used as food by wildlife. However, tradeoffs often exist, in that enhancement of one particular function might reduce the ability of the wetland to perform a different function.

Although the goal of compensatory mitigation is to replace the wetland functions and values lost because of the unavoidable impacts authorized by a Section 404 permit, numerous studies conducted around the country, including in Utah, have found that this goal often is not achieved. A UDWR study found that enhancement of existing wetlands is a commonly required form of mitigation in Northern Utah. At best, this results in a net loss of wetland acreage. In many cases, it was not even possible to determine whether the required mitigation had been conducted (Starinchak 2000).

Follow-through on mitigation projects is hampered partly the limited resources available to the U.S. Army Corps of Engineers. The Corps simply does not have sufficient staff to ensure that all mitigation projects and subsequent monitoring are conducted as required.

Because properly designed and constructed mitigation projects do have the potential to replace the functions of impacted wetlands, and because considerable resources are devoted to mitigation projects, one important reason for monitoring mitigation wetlands is to make sure that projects are actually carried out, and that the wetlands are developing as intended (or that corrective measures can be recommended if they are not). Another important reason for monitoring mitigation wetlands is to collect information that can help improve guidelines for the design and construction of mitigation projects.

Restored Wetlands

If the U.S. is to meet the Clinton Administration's Clean Water Action Plan goals of achieving a net gain of 100,000 acres of wetlands a year by 2005, programs which support the voluntary restoration of wetlands on private lands will play a major role. Major federal programs which support voluntary wetlands restoration on private lands include the Wetlands Reserve Program, the Conservation Reserve Program, and the Wildlife Habitats Incentive Program. These programs provide technical assistance and financial incentives to help private landowners establish or reestablish wetlands and other wildlife habitat on their property. Thousands of acres have been enrolled nationwide since these programs were established, but few follow-up studies have been conducted to determine how well the restored or improved lands are functioning. Restored wetlands are of special interest for monitoring because follow-up studies can provide information on whether projects are meeting their goals and which restoration practices are most likely to succeed.

Major federal programs which support voluntary wetlands restoration on private lands include the Wetlands Reserve Program, the Conservation Reserve Program, and the Wildlife

Monitoring Procedures and Protocols

Introduction

This section contains detailed protocols for data collection, as well as background information about the variables which volunteers will be monitoring. The monitoring protocols we will be using have been developed and tested by successful volunteer monitoring programs across the country, including the Izaak Walton League (IWL), The Adopt a Beach Program (ABP), National Aquatic Monitoring Center a.k.a. USU Bug Lab, and the Utah Stream Team (UST). The information in this section is intended to be used as a reference in conjunction with information provided during volunteer training sessions, and to be supplemented by the IWL, ABP, USU, and UST manuals. The variables which we will be monitoring during this pilot program include the following:

1) Baseline Data: land use, mapping, global positioning system (GPS) locations, photo points, area history/watershed use, and hydrology;
2) Birds;
3) Macroinvertebrates;
4) Vegetation;
5) Water Quality: temperature, turbidity, pH, dissolved oxygen, nitrate, and phosphorous;
6) Wildlife.

Data forms can be found in Appendix A.

Because the data volunteers collect will be provided to state and federal agencies, local governments, planners and others, it is critical that volunteers be consistent in the methods they use to collect data. Our goal is to collect the highest quality data possible, knowing that the data is intended to help inform conservation and management decisions affecting wetlands. If you have questions about any procedure, or feel that you need more practice with a particular procedure, please let the Volunteer Coordinator or your Team Leader know. Our goal is to provide you with the skills and knowledge needed to collect high-quality data, to feel confident in your abilities, and to have a safe and enjoyable field experience. Appendix B contains information on quality control procedures (excerpted from the Quality Assurance Project Plan prepared for this project) which the wetlands monitoring program must comply with; you may find it useful to review this information. One final component of monitoring found on all the data forms is a space to record "total volunteer time." Please complete this section as it helps us keep track of citizen contribution to the project.

I. Baseline Data

Background: Baseline data are needed to establish a reference point against which future observations and measurements can be compared. It is also important to record the location of transects, photo points, and fixed equipment such as crest/staff gauges so that measurements can be repeated at the same locations in the future (or equipment replaced if for some reason it needs to be removed or is disturbed or vandalized). Because of the importance of documenting these locations, volunteers participating in this protocol should have a good understanding of the overall monitoring process.

Procedure: To obtain general information about each wetland, volunteers will complete a variety of general measurements and activities. The site will be documented using a digital camera as well as with a hand-drawn map. Important data to record include the vegetation transects, monitoring stations, surrounding land use, inlets or outlets in the wetland, structures (e.g., dikes, headgates, etc.), and any other wetland characteristics of interest. Volunteers will use a differential GPS to establish the precise position (UTM) of monitoring points as well as the wetland perimeter. GPS data will be entered into ArcView 3.2 to create a digital map of the wetland site. Volunteers can obtain information on area history and watershed use by interviewing knowledgeable landowners and resource managers or through Internet sites (e.g., EPA's Surf your Watershed). Finally, monitoring hydrology is important since it is one of the defining characteristics used to determine whether an area is a jurisdictional wetland subject to regulation under the Clean Water Act. Hydrology directly and indirectly influences the major physical, chemical, and biological processes that occur in wetlands. For example, periods of standing water or saturated soil cause the development of anaerobic conditions that lead to hydric soil formation, which in turn influences the composition of the plant and animal community as well as processes such as decomposition and nutrient cycling.

Land Use: Researchers have found that land use can have positive and negative effects on wetlands. For example, buffer zones with native vegetation or other ground cover can remove excess nutrients from runoff or provide food and cover for wildlife. Minimum buffer widths range from 100 to several hundred feet. For this program begin by identifying a 200' buffer around the wetland using a tape measure. Using landscape features draw this buffer on an aerial photo of the wetland site. While in the field categorize different types of land uses and delineate and label them on the aerial photo. These include but are not limited to residential, commmercial, industrial, agricultural, roads, and bare ground. Finally using a transparent grid estimate the percent coverage of each land use category in the buffer zone. In addition, list activities or conditions occurring in the wetlands that you observe, e.g. recreation, non-native plants, and dumping.

Mapping: Map the wetland, including the 200' land-use buffer, with as much detail as possible. Be precise (include as many features as possible) and accurate (draw map to scale).

GPS: Take the UTM of the following sites: Water quality and macroinvertebrate station, the three bird monitoring stations, the ends of all the vegetation transects, the vegetation plots, and the crest/staff gauge. Program the GPS unit to take 100 readings at each monitoring point which will be averaged to produce one accurate position.

Photo Points: Photograph the site as a whole, the vegetation transects, each vegetation plot, and any other distinguishing features. Record a compass bearing and description for each photo. If possible, include in each photo a small white board showing the site name, date, and photo description.

Watershed Use and Area History: Obtain information about your wetland through interviews with landowners and reference materials such as, websites, mitigation plans, management plans, and newspaper articles.

Hydrology: To collect basic data on wetland hydrology, volunteers will install and monitor a crest/staff gauge. The crest/staff gauge should be located in an area that will register the lowest annual water level and where it will be observable with binoculars during high water conditions. Read the water level as seen on the outside of the gauge during each visit to the site. Also, read the wooden dowel to see if there has been a change in water level since the last visit. For specific details on installing and using a crest/staff gauge, see the description starting on page 99 in the IWL handbook.

Timing: Land use monitoring should occur at he beginning of each monitoring year and if conditions change. Mapping and GPS work should be done once at the beginning of each monitoring season or after a disturbance at the site. Volunteers should take digital photos seasonally to record changes in vegetation. The crest/staff gauge should be read seasonally and also after periods of precipitation and/or snow melt.

Estimated Time: The estimated time needed to collect and record baseline data depends in part on the number of people involved. Volunteers should allow at least an hour to adequately map the site. GPS location recording will require 30 minutes to 1 hour; photos with the digital camera will require 30 minutes to 1 hour. The time investment for researching area history and watershed use will depend on the extent to which volunteers choose to pursue this information. Initially identifying the proper location for and installing the crest/staff gauge may take about an hour. Reading the gauge on subsequent will take about 10 minutes.

Equipment List: aerial photos, transparent grid paper, compass, measuring tape, GPS unit, digital camera, graph paper, data forms, pencils, clipboard, crest/staff gauge, and extra batteries

II. Birds

Background: Unlike vegetation, hydrology, and soils the presence of certain animal species has not been used as a criterion for wetland delineation because many animals are highly mobile and may be present only during certain times of day or certain seasons. However, information about the use of wetlands by wildlife is important to conservation agencies and organizations which seek to protect essential wildlife habitat. Wetlands are a particularly important habitat for many bird species in Utah, used by both migratory and resident species. The Utah Partners in Flight Program recently identified priority habitats that are important to avian species of conservational concern as well as other avian species. Of these priority habitats, lowland riparian areas and wetlands support the greatest diversity of species. Avian species diversity at a wetland varies seasonally and from year to year; long-term monitoring can help identify patterns and trends in species diversity.

Procedure: Volunteers will use a modified version of the bird survey protocol outlined in the IWL's Handbook for Wetlands Conservation and Sustainability (see pages 89-90 of the IWL manual) to monitor the presence of bird species at their adopted wetland. Modifications are the result of collaboration with the Utah Partners in Flight Program. Changes to the IWL protocol include monitoring during the duration of the volunteer's time at the site, not just at the established stations. In addition we have included recording the number of individuals of a species on a rough logarithmic scale (see below.) Also, habitat type and sex of the bird (when it can be determined) will be recorded on the data form. Bird species diversity is important because the presence of a particular species may indicate the availability of certain wetland habitats even if the population size is low.

1) At least two people are needed to conduct this type of bird survey. At least one person should be able to identify birds by sight and sound. In addition, one person will be responsible for recording data.
2) Observations should occur before 9 a.m. (if possible), preferably just after sunrise when birds are becoming active.
3) Select enough monitoring stations (usually three) so that at least 75% of the wetland is observable. Add more monitoring stations if necessary. When selecting monitoring stations, include a variety of vegetative communities. These sites should be recorded on the site map as B1, B2, B3, etc. and with a differential GPS unit in UTMs.
4) Fill out general site information, time, weather, etc. on the data form.
5) Record any birds that you have seen or heard so far on the data form.
6) Record the following on the data sheet:

Species Observed: common name and genus/species
Number- 1, 2-9, 10-99, 100+
Method of Observation: sight, song, nest, carcass, feathers, scat, eggs, tracks, other

Behavior: nest building, nest sitting, feeding, fighting, mating, singing, resting, sleeping, grooming, dead, other

Sex (if it can be determined)

Habitat: open water, mud flats, emergent vegetation, grassland, shrub/tree, other

7) Sit quietly and patiently while you observe and listen for birds for 10 minutes at each site.

8) Volunteers will use a tape recorder and/or camera to record birds that they can not identify. Recordings and/or photos can then be taken to an experienced birder.

Notes: Conduct the bird survey before or at a distance from other monitoring activities so that disturbance to the birds is minimized.

Timing: Observation of birds should be conducted at least seasonally and as often as once a month during regional migration periods.

Estimated Time: One hour.

Equipment List: master monitoring map, clipboard, binoculars, bird data forms and protocol, bird guides, pencils, camera, tape recorder.

III. Macroinvertebrates

Background: Some examples of macroinvertebrates found in wetlands include aquatic insect larvae that undergo metamorphosis to become terrestrial adults, crustaceans, and aquatic worms. Macroinvertebrates live in various habitats such as leaf litter, sediment, large woody debris and on vegetation. Invertebrates play a very important role in nutrient cycling in wetland ecosystems. Little direct herbivory on living plants occurs in wetlands. When plants or plant parts die, invertebrates play a major role in consuming the detritus and breaking it into smaller pieces that decomposers such as bacteria can work on. Invertebrates are also an important food resource for many wetland vertebrates, supplying protein needed by migratory birds and juveniles of many species. Because macroinvertebrate species vary in their tolerance of pollution and habitat degradation, identifying which species are present provides valuable insight into water quality and wetland health.

Procedure: The macroinvertebrate monitoring protocol was developed by the Utah State University Bug Lab. Samples collected by volunteers will be used to help develop a biological assessment index for wetlands in Utah. Identification of macroinvertebrates to the species level will be done by the USU Bug Lab. Sampling and sample cleaning will be done by volunteers.

1) After conducting the water quality test, sample for macroinvertebrates while wading in the wetland. There will be one monitoring station at each wetland, at the same place as the water

quality sample site.
2) Using a D-net, sample in and around the water quality station for as long as it takes to collect 500 organisms. Volunteers should make sure to sample as many different habitat types as possible. This includes the substrate, water column, water surface, and emergent vegetation. This will allow for a more diverse sample.
3) Periodically the samples should be dumped in a sieve (3' long cone-shaped bag made from 500 micron material) to remove sediment from the sample. The sieve should be agitated in a bucket of water to remove sediment. Once the fine particulate material is gone the contents should be placed in a pan.
4) At this stage volunteers will continue to remove large particulate material as well as separate the macroinvertebrates from the sample.
5) As Upon collecting 500 organisms, label the sample both internally and externally including the site name, monitor name and contact information, date and number of samples.
6) The sample will than go the USU Bug Lab for species identification and processing.
7) Volunteers will be kept up to date on the development of the Biological Assessment Index through additional training.

Notes:
If volunteers are interested, they can begin to sort macroinvertebrates by order. If this is the case, the USU Bug Lab will review all work done by the volunteers.

Timing: Seasonally

Estimated Time: Sampling- 15 to 30 minutes; Sorting- approximately to 2 hours.

Equipment List: D-net, sieve, 2 large buckets, sorting pans, tweezers, squirt bottles, sample containers, 90% ethanol, waders, labels, pencils

IV. Vegetation

Background: Plants are effective indicators of wetland health and integrity. Because plants usually are restricted to one location for their entire lifetime, they cannot move when their optimum living conditions are degraded. Consequently, species sensitive to disturbance may disappear from the plant community. Finding that the plants in a wetland consist mainly of native hydrophytes is a good sign of the wetland's ecological health. Finding a large proportion of early successional species or other species adapted to disturbed conditions such as Phragmites indicates that disturbance has altered conditions in the wetland or surrounding landscape. Finding that the vegetative community is shifting over time, for example from a community dominated largely by native species to one dominated by exotics such as purple loosestrife, indicates that conditions in the wetland are deteriorating and that management intervention may be needed to restore the native community. Monitoring vegetation is also important because vegetation is one of the characteristics used to assess whether an area is a jurisdictional wetland.

Procedure: Volunteers will identify plant species along transects and in vegetation plots and estimate the percentage each species covers (percent cover). The vegetation monitoring protocol, which uses transects and circular plots in different vegetative communities, was adopted from the IWL's Handbook of Wetlands Conservation and Sustainability. An alternative protocol developed by the U.S. Forest Service for monitoring riparian vegetation uses 1' by 6' rectangular plots spaced 10 to 20' along transects. Five transects will be set up at each wetland, with the endpoints of each transect extending to the boundary of the wetland. The wetland boundary will be delineated by the Wetlands Monitoring Coordinator and volunteers looking at soil, hydrology, vegetation, and landscape characteristics. For more information see U.S. Army Corps of Engineers' 1987 Wetland Delineation Manual or pages 83-87 in the IWL manual.

To establish vegetation monitoring plots:
1) First, establish a baseline (an imaginary line marked at the ends with flagging) that runs roughly along the boundary of the wetland parallel to the flow of water.
2) Perpendicular to this baseline, establish 5 vegetation transects that are equidistant (determine the distance between transects by dividing the length of the baseline by four) and cross the wetland site to the opposite boundary.
3) For the IWL protocol, identify the vegetation communities along the first transect. For example, along the upland edge of the wetland, the vegetation community may be dominated by grasses. As you get closer to standing water there may be combinations of cattails, sedges, rushes, willows, and aquatic plants. Different combinations of plants represent different wetland vegetation communities.
4) Place a marker in each community along the transect.
5) The circumference of the vegetation plots can be marked with rope or flagging at four points.
6) From within the vegetation plot identify all the plant species and enter them on a vegetation monitoring data form.
7) Estimate the percent cover of each species. This can be subjective and may take some practice.
8) Fill out the remainder of the columns on the data form, e.g., native or non-native species, scientific name, layer, indicator status, etc.
9) Continue evaluating vegetation plots along this transect until no new plant species are found. This can be done by creating a species diversity curve. See page 86 of the IWL Handbook.
10) Move to the next transect and repeat the protocol.
11) IN the case of the U.S. Forest Service protocol divide the transect into 9 segments yielding 10 vegetation plot points. Center the 1' by 6' rectangular plot on the transect with the side

perpendicular to the transect. Complete steps 6 through 10 above.
12) Finally, record any unusual or endangered species on the comment line of the data form. It is recommended that volunteers examine the site in general to look for unusual species.

Timing: At least once a year, preferably during the time when the most plants are flowering.

Estimated Time: Two to four hours depending on wetland size, complexity, and number/skill of participants.

Notes: This monitoring protocol can be difficult for two reasons. First, identifying plants to the species level can be challenging for the layperson with no background in botany. Consequently, each site will have a plant species list. Many plants are easiest to identify when they are mature or flowering; once different species have been identified during the growing season, volunteers can learn to recognized them during other seasons. Second, percent cover is a visual estimate. It is therefore subjective and can differ from person to person. For example, what looks like 15% to one person may be 20% to another. Volunteers conducting vegetation monitoring should work together to standardize their estimation of percent cover. Additionally, continuity of volunteers from one monitoring session to another will be strongly encouraged to help standardize data collection.

Equipment List: master monitoring map, site plant species list, flagging or string to indicate plot boundaries, clipboard, data forms, pencil, wetland plant guides, 30 m tape measure

V. Water Quality

Background: Chemicals and nutrients naturally cycle through wetlands. The type of wetland affects the pathways by which these compounds are exchanged and the amount of time they spend in the system. For example, in a riverine wetland, oxygen and nutrients are constantly replenished as water flows through the system. However, a shallow pond that is filled by rain or groundwater may experience periods when nutrient and oxygen levels are very low. Measuring the biogeochemical conditions of wetlands provides us with an indication of water quality. Water quality affects the type of plants and animals found in wetlands. For example, some plants are more tolerant of high salinity while certain fish can only survive in water with a high oxygen content. However, because wetlands are so diverse, water quality parameters vary greatly within and across sites. For example, cold water is more dense than warm water and can hold more oxygen. Water temperature is one parameter that can vary from one site to another or in one site during the course of a day. Therefore consistent sampling (always collect samples from the same station(s)), multiple stations, and long-term monitoring can provide the most accurate picture of water quality and wetland function.

Procedure: Volunteers will use an adaptation of the protocols outlined in the UST manual to monitor water quality using field test kits. Because these test kits have been adapted for use in the field they are relatively simple to use. Follow manufactures instructions on the inside or outside of the kits. To use the turbidity tube, fill it with water and release the water until you can see the small secchi disk at the bottom. Record the height of the water in centimeters and convert to NTUs using the chart provided. For consistency conduct this test with your back to the sun. Other notes: when recording temperature do so in degrees Celsius.

1) Select a monitoring site (same as the macroinvertebrate monitoring site) and mark it so that it can be recorded on the site map and with the differential GPS unit. Try to select a monitoring station that is representative of the wetland as a whole. If there is an input and output to the wetland two stations can be established, one at either end, which will allow any changes in water quality that occurs as water flows through the wetland to be measured. any effects that a specific landscape has on water quality.
2) Fill out informational portion of the data form. Include a site description if you are monitoring at more than one station at the wetland. Record the measurement tool you are using, e.g., HydroLab, field test kits, laboratory analysis.
3) Take water samples before conducting macroinvertebrate sampling.
4) Take water samples at least 6 feet from shore and 6 inches below the surface to offset any localized effects of land use on water quality and to minimize contamination. While wading to collect samples, try to minimize disturbance of the substrate and avoid sampling in areas through which you have walked.
5) Complete chemical testing following the directions provided by the manufacturer. Store all waste in containers to be removed from the site.
6) Record results on the data form.
7) Properly dispose of all chemicals by evaporating the liquid in a shallow pan and discarding the remaining solids.

Notes: When recording results, zero is usually not an appropriate finding. While it is possible that none of the parameter being tested for occurs in the sample it is more likely that it is just outside the detectable limit. To indicate this, record your results as < the lowest value on the test kits. For example the Chemetrics Nitrate test has a detectable limit of 0.1 mg/l. If there is no color change to the sample your result will be <0.1.

Timing: At least once a season and after storm events.

Estimated Time: 1 hour

Equipment List: Chemetrics PO4 test kit, Chemetrics nitrate test kit, Chemetrics DO test kit, Hobo thermometers, pH strips, turbidity tube, HydroLab, sterilized State Laboratory sample containers notebooks, pencils, data forms, protocol outline, waste storage containers, waders.

VI. Wildlife

Background: For the purpose of this monitoring protocol, wildlife refers to organism other than birds and macroinvertebrates. Wildlife use a variety of wetland types. Identifying the wildlife that are present in a wetland may provide insight into the type and quality of habitats available to these organisms. Because many animals are active at dawn or dusk these are good times to view wildlife activity. Monitoring during these times is important as is the ability to identify species by tracks, scat, and marks left on vegetation by foraging animals.

Timing**:** Wildlife monitoring should be conducted at least seasonally.

Procedure: Citizen monitors will use wildlife protocol adapted from the Utah Division of Wildlife Resources.
1) Two people are needed to conduct this type of wildlife survey. At least one person should be able to identify species by sight and sign (e.g. tracks and scat). The second person will be responsible for recording data.
2) Observations should occur in the early morning and/or at dusk when animals are most active.
3) Select a route through the wetland that includes different habitat types. This can be done by circumventing the site and/or by establishing transects through the site.
4) Fill out general site information, time, weather, etc on the data form.
5) Record any wildlife you observe whether by site or sign.
6) Record on the data sheet

Species Observed- Common name and Genus/Species
Method of Observation- Sight, Scat, Tracks, Carcass, Homes, Fur, and Other
Behavior- Feeding, Alert, Running, Hunting, Fighting, Nesting, Mating, Nursing, Grooming, Sunning, Playing, Sleeping, Dead, and Other
Habitat- Open Water, Mud Flats, Emergent Vegetation, Grassland, Shrub/Tree, Other

7) Move quietly and attentively while you attempt to observe and/or flush animals along your route. Stop at areas such as mud flats or bare dirt that might yield tracks or other signs of activity.
9) Work effectively and comprehensively so you do not miss subtle signs of wildlife activity.
8) Volunteers will use a camera and/or plaster casts to record wildlife that they can not identify. Photos and casts can then be taken to a local wildlife expert.

Monitoring Stations: Volunteers should establish circular or straight transects. Points along these transects can be recorded on a GPS unit for documentation

Estimated Time: 1-2 hours

Notes: Conduct the wildlife survey before or at a distance from other monitoring activities so that disturbance to the animals is minimized.

Equipment List: master monitoring map if transect is not apparent, clipboard, binoculars, wildlife data forms, pencils, mammal/track/scat field guides, camera, plaster.

Monitoring Protocol

References

Coleman, R. E., E. T. LaRoe, and R. F. Theriot. 1996. Wetland research by federal agencies. In J. D. Fretwell, J. S. Williams, and P. J. Redman, compilers. National Water Summary on Wetland Resources, pp. 65-72. U.S.G.S. Water-Supply Paper 2425.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service FWS/OBS-79/31.

Dahl, T. E. and G. J. Allord. 1996. History of wetlands in the conterminous United States. In J. D. Fretwell, J. S. Williams, and P. J. Redman, compilers. National Water Summary on Wetland Resources, pp. 19-26. U.S.G.S. Water-Supply Paper 2425.

Firehock, K., L. Graff, J. V. Middleton, K. D. Starinchak, and C. Williams. 1998. Handbook for Wetlands Conservation and Sustainability. Second Edition. Izaak Walton League of America, Gaithersburg, MD.

Kolva, J. R. 1996. Effects of the great midwest flood of 1994 on wetlands. In J. D. Fretwell, J. S. Williams, and P. J. Redman, compilers. National Water Summary on Wetland Resources, pp. 97-98. U.S.G.S. Water-Supply Paper 2425.

Meffe, G. K. and C. R. Carroll. 1997. Principles of Conservation Biology. Sinauer Associates, Inc., Sunderland, MA.

Miller, T., C. Bertolotto, J. Martin and L. Storm 1996. Monitoring Wetlands: A Manual for Training Volunteers. Adopt A Beach, Seattle, WA.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetlands. Third Edition. Van Nostrand Reinhold, New York.

National Audubon Society. 1994. Valuing wetlands: The cost of destroying America's wetlands. National Audubon Society, Washington, D.C.

Starinchak, K. D. 2000. Assessing the ecological integrity of wetlands: Section 404 compensatory mitigation compliance study. Utah Division of Wildlife Resources, Salt Lake City, UT.

References

The Nature Conservancy. 1999. Wildland weeds management and research program. http://tncweeds.ucdavis.edu.

Tiner, R. W. 1996. Wetland definitions and classifications in the United States. In J. D. Fretwell, J. S. Williams, and P. J. Redman, compilers. National Water Summary on Wetland Resources, pp. 27-34. U.S.G.S. Water-Supply Paper 2425.

United States Environmental Protection Agency. 1995a. American's wetlands: Our vital link between land and water. EPA 843-K-95-001.

United States Environmental Protection Agency. 1995b. Wetlands fact sheets. EPA 843-F-95-001.

Votteler, T. H. and T. A. Muir. 1996. Wetland protection legislation. In J. D. Fretwell, J. S. Williams, and P. J. Redman, compilers. National Water Summary on Wetland Resources, pp. 57-64. U.S.G.S. Water-Supply Paper 2425.

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins, eds. 1993. A Utah Flora. Second Edition. Brigham Young University Printing Services, Provo, UT.

Zicus, S., ed. 1995. The Great Salt Lake Story. Utah Museum of Natural History, Salt Lake City, UT.

Appendix A: Data Forms

Appendix A: Data Forms

Wetland Habitat Evaluation Form

Received___________
Reviewed___________
Entered___________
____

Wetland Site: Date:
Watershed:
Field Investigators:

What is the source of information used to make the determination that wetland habitat is present? (E.g., National Wetland Inventory, USGS, or topographic maps, wetland delineation, presence of wetland characteristics, etc.)
____
____
____

What is the approximate area of the wetland? (acre or ft^2)____

Is the area contained in a single area or made up of multiple areas?__________

Is wetland "natural" ☐ constructed ☐ restored ☐ ?

Identify the types of vegetation present in the wetland

- Submergent (i.e., underwater) vegetation
- Emergent (i.e., rooted in water, but rising above it) vegetation
- Floating vegetation
- Shrub/scrub
- Wooded
- Other (please describe):_________________________

Identify the form of the wetland.

- Palustrine (pondlike, but does not necessarily contain standing surface water)
- Lacustrine (associated with a lake, as in shallows or along a shore)
- Riverine (associated with the margin of a stream or river)

What is the vegetation density of the area?

- Dense (greater than 75% total vegetation)
- Moderate (between 25% and 75% of the area has vegetation)
- Sparse (less than 25% vegetation)

Is standing water present? Yes ☐ No ☐ (note date:__________)

If yes, is the water primarily Fresh ☐ Brackish ☐ ?
Indicate approximate area of standing water (acres or ft^2) __________
Indicate the approximate depth of standing water (cm) __________

If known, indicate the source of water in the wetland

- Surface water (lake/stream)
- Groundwater
- Flooding/snowmelt
- Surface runoff (stormwater, irrigation, etc.)

Are there any facilities discharging or potentially discharging into the wetland (i.e., industry, farms, residential, golf courses, etc?) Yes ☐ No ☐

If yes, is discharge
- point source outfall (e.g. permitted outfall
- mon-point source outfall (e.g. storm water outfall, piped runoff from streets, etc.)
- diffuse non-point source (e.g., non-piped runoff from streets, farms, parks, etc.)

Provide any other details:

____

Is there a discharge from the wetland? Yes ☐ No ☐

If yes, indicate the type of feature the wetland discharges into:
- Surface stream, creek, river (Name:_______________________)
- Lake or Pond (Name:_____________________)
- Groundwater
- Can't tell

Does the area show signs of flooding? Yes ☐ No ☐

If yes, indicate which of the following are present (mark all that apply.)
- Standing water
- Water saturated soils
- Water marks
- Buttressing
- Debris lines (hanging or stranded vegetation)
- Mud cracks
- Other (describe):_____________________

Animals observed in the wetland area or suspected to be present based on indirect evidence or other information.
- Birds
- Fishes
- Mammals
- Reptiles
- Amphibians
- Benthic invertebrates (e.g., mussels, crayfish, insect nymphs)

Specify species if known:

____

____

# of Volunteers	X	Hours	=	Total Volunteer Time
_____________	X	_____	=	

LAND USE MONITORING DATA FORM

Received____________
Reviewed____________
Entered____________
____

Wetland Site:______________________________ **Date:**____________ _

City:____________________ **County:**____________________

State:____________________ **Watershed**:__________________

Wetland Owner:____

Phone:____________________

Field Investigator(s):______________________________________ **Phone:**_____________ ______

Project Contact:____ **Phone:**_____________ ______

# of Volunteers X Hours = Total Volunteer Time
______________ X ______ =

Land Use	% Coverage	Land Use	% Coverage
Residential (Single Family)		Roads (Paved)	
Residential (Multi Family)		Roads (Dirt)	
Commercial		Bare Ground	
Industrial		Other	
Agriculture		Other	

Activities that appear to be taking place in the wetland which you observe today:

______dumping soil, gravel and or vegetation
______dumping of man-made materials
______grading (look for heavy equipment tracks and scraped soils)
______draining/channelizing of water (look for pipes or ditches)
______impounding (look for dikes or culverts)
______tracks of recreational vehicles
______livestock access
______pipes or culverts transporting storm water into the wetland
______clearing (fresh or old stumps in an area with few or no trees)
______dredging (look for dirt mounds or evidence of heavy equipment)
______heavy recreational use
______light recreational use
______non-native plants
______Other

Using an aerial photo of the site and a sheet of transparent graph paper, estimate the percentage of each land use. Record these percentages on this form.

MAPPING DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:____________________________ **Date:**___________
_

City:__________________ **County:**__________________

State:__________________ **Watershed**:________________

Wetland Owner:____ **Phone:**____________
______

Field Investigator(s):___________________________________ **Phone:**____________
______

Project Contact:____ **Phone:**__________________

# of Volunteers	X	Hours	=	Total Volunteer Time
_____________	X	______	=	

USE BACK OF DATA FORM

OR

USE GRAPH PAPER AND INCLUDE THE ABOVE INFORMATION

GPS DATA FORM

Received___________
Reviewed___________
Entered___________
____

Wetland Site:___________________________ **Date:**__________ _

City:_________________ **County:**_________________

State:_________________ **Watershed**:_______________

Wetland Owner:____ **Phone:**_____ ___________

Field Investigator(s):_________________________________ **Phone:**___________ _____

Project Contact:____ **Phone:**___________ _____

Elevation:_______________

# of Volunteers X Hours = Total Volunteer Time
____________ X _____ =

Monitoring Station	UTM (Line 1)	UTM (Line 2)	UTM (Line 1)	UTM (Line 2)
Transect #1Endpoints				
Transect #2 Endpoints				
Transect #3 Endpoints				
Transect #4 Endpoints				
Transect #5 Endpoints				
Vegetation Plot # 1				
Vegetation Plot #2				
Vegetation Plot #3				
Vegetation Plot #4				
Vegetation Plot #5				
Vegetation Plot #6				
Vegetation Plot #7				

Monitoring Station	UTM (Line 1)	UTM (Line 2)	UTM (Line 1)	UTM (Line 2)
Vegetation Plot #8				
Vegetation Plot #9				
Vegetation Plot # 10				
Bird Monitoring #1				
Bird Monitoring #2				
Bird Monitoring #3				
Water Quality Station				
Staff/Crest Gauge				
Other				

PHOTO POINTS

Received__________
Reviewed__________
Entered__________
____

Wetland Site:__________________________ **Date:**__________

City:________________ **County:**________________

State:________________ **Watershed:**______________

Wetland Owner:____ **Phone:**______
____

Field Investigator(s):________________________________ **Phone:**__________
______

Project Contact:______________________________________ **Phone:**__________
______

# of Volunteers X Hours = Total Volunteer Time
____________ X _____ =

PHOTO	COMPASS READING	DESCRIPTION	PHOTO	COMPASS READING	DESCRIPTION
Photo #1			Photo #13		
Photo #2			Photo #14		
Photo #3			Photo #15		
Photo #4			Photo #16		
Photo #5			Photo #17		
Photo #6			Photo #18		
Photo #7			Photo #19		
Photo #8			Photo #20		
Photo #9			Photo #21		
Photo #10			Photo #22		
Photo #11			Photo #23		
Photo #12			Photo #24		

WATERSHED USE/AREA HISTORY DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:___________________________ **Date:**___________

City:_________________ **County:**_________________

State:_________________ **Watershed**:_______________

Wetland Owner :____

Phone:_________________

Field Investigator(s):_______________________________
Phone:_________________

Project Contact:_______________________________________

Phone:___________
______

# of Volunteers	X	Hours	=	Total Volunteer Time
____________	X	_____	=	

Place a check mark next to each of the following land use that exists in the wetland watershed at the present time:

_____Oil and Gas Drilling
_____Construction Site
_____Areas of Exposed Soil
_____ Agriculture
_____Sewage Pumping Stations
_____Logging
_____Factories
_____Sanitary Landfill
_____Recreation (Type)________________
_____Mining (Type)________________
_____Developed Land, Residential

_____Developed Land, Commercial or Industrial
_____Trash Dump

HYDROLOGY DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:________________________________
Date:__________

City:________________ **County:**________________

State:________________ **Watershed:** ________________

Wetland Owner:____
Phone:__________
_____

Project Contact:_______________________________________
Phone:________________

Field Investigator(s):________________________________
Phone:________________

Unusual conditions (large storms, construction, etc.)________________________________
____
______

Inches of Rain in last 72 hours:_______

DATE	WATER LEVEL (cm) OUTSIDE	CHANGE FROM PREVIOUS READING	WATER LEVEL (cm) DOWEL

# of Volunteers	X	Hours	=	Total Volunteer Time
______________	X	______	=	

BIRD MONITORING DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:______________________ **Date:**__________

City:__________ **County:**__________ **State:**__________ **Watershed:**__________

Wetland Owner:__________________ **Phone:**__________

Field Investigators:__________________ **Phone:**__________

Project Contact:__________________ **Phone:** __________

\# of Volunteers X Hours = Total Volunteer Time
__________ X _____ =

Weather: Clear/Sunny Partly Cloudy Overcast Rain Showers Snow Fog Other

Wind: Still Low Moderate High **Air Temp:** _____F _____C

Noise Level: Low Med. High **Source of Noise:**__________ **Start Time:**__________ **End Time:**__________

Species Observed	Genus/Species	Number	Method of Observation	Behavior	Habitat

Species Observed	Genus/Species	Number	Method of Observation	Behavior	Habitat

Behavior- Nest Building, Nest Sitting, Feeding, Fighting, Mating, Singing, Resting, Sleeping, Grooming, Dead, Other
Habitat- Open Water, Mud Flats, Emergent Vegetation, Grassland, Shrub/Tree, Other
Number- 1, 2-9, 10-99, 100+

MACROINVERTEBRATE MONITORING DATA FORM

Received___________
Reviewed___________
Entered___________
____

Wetland Site:_______________________________ **Date:**___________________

City:___________________ **County:**___________________

State:___________________ **Watershed:**___________________

Wetland Owner:____ **Phone:**___________________

Project Contact:____ **Phone:**___________________

Field Investigator(s):_____________________________________ **Phone:**___________________

Time:___________________

Site Description:

Make sure to label
sample container properly

# of Volunteers X Hours = Total Volunteer Time
_____________ X _____ =

MAJOR GROUP	TOLERANCE VALUE	# OF INDIVIDUALS	TOTAL
Ephemeroptera (Mayflies)	90 x		
Odonata (Damselflies and Dragonflies)	60 x		
Plecoptera (Stoneflies)	100 x		
Trichoptera (Caddisflies)	80 x		
Chironomidea (Midge and Mosquitoes)	40 x		
Other Diptera (Other Flies)	70 x		
Megaloptera (Fishflies and Dobsonflies)	90 x		
Coleoptera (Beetles)	70 x		
Amphipoda (Shrimp and Scuds)	40 x		
Isopoda (Sow Bugs)	30 x		
Decapoda (Crayfish)	50 x		
Gastropoda (Snails)	40 x		
Pelecypoda (Mussels and Clams)	40 x		
Oligochaeta (Worms)	20 x		
Hirudinea (Leeches)	10 x		
TOTAL		(a)	(b)
b/a= Water Quality Index			

VEGETATION MONITORING DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Address:______________________________ **Date:**____________

City:__________ **County:**__________ **State:**__________ **Watershed:** __________

Wetland Owner :____ **Phone:**______________
Field Investigator:_______________________________________ **Phone:**______________

Transect #_____ **Vegetation Plot #**_____ **(Use one data form per vegetation plot)**

Comments (unusual vegetation or conditions):____

____

____

# of Volunteers	X	Hours	=	Total Volunteer Time
__________	X	_____	=	

Common and Species Names	% Cover	Native/Nonnative	Noxious Weed	Indicator Status	Plant Guide/Page

Common and Species Names	% Cover	Native/Nonnative	Noxious Weed	Indicator Status	Plant Guide/Page

WATER QUALITY MONITORING DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:________________________________
Date:___________

City:________________ **County:**________________

Watershed: ________________ **State:**________________

Wetland Owner:____ **Phone:**________________

Project Contact:_______________________________________
Phone:________________

Field Investigator(s):________________________________
Phone:________________

Unusual conditions (large storms, construction, etc.)________________________________

____

Inches of Rain in last 72 hours:________ **Air Temperature:**________ **Time:**________

Water Quality Test	Result #1	Result #2	Result #3	Result #4
Station Description				
Measurement Tool				
Temperature	<C	<C	<C	<C
pH				
Phosphate (PO_4)	mg/l	mg/l	mg/l	mg/l
Nitrate (NO_3)	mg/l	mg/l	mg/l	mg/l
Dissolved Oxygen	mg/l	mg/l	mg/l	mg/l

Turbidity (Transparency)	cm NTU	cm NTU	cm NTU	cm NTU

# of Volunteers	X	Hours	=	Total Volunteer Time
______________	X	______	=	

WILDLIFE MONITORING DATA FORM

Received__________
Reviewed__________
Entered__________
____

Wetland Site:________________________ **Date:**__________

City:__________ **County:**__________ **State:**__________ **Watershed:**__________

Wetland Owner:____________________ **Phone:**__________

Field Investigators:____________________ **Phone:**__________

Project Contact:____________________ **Phone:** __________

# of Volunteers	X	Hours	=	Total Volunteer Time
__________	X	_____	=	

Weather: Clear/Sunny Partly Cloudy Overcast Rain Showers Snow Fog Other

Wind: Still Low Moderate High **Air Temp:** _____F _____C

Noise Level: Low Med. High **Source of Noise:**______________ **Start Time:**________ **End Time:**________

Species Observed	Genus/Species	Method of Observation	Behavior	Habitat

Species Observed	Genus/Species	Method of Observation	Behavior	Habitat

Method of Observation- Sight, Scat, Tracks, Carcass, Homes, Fur, and Other
Behavior- Feeding, Alert, Running, Hunting, Fighting, Nesting, Mating, Nursing, Grooming, Sunning, Playing, Sleeping, Dead, and Other
Habitat- Open Water, Mud Flats, Emergent Vegetation, Grassland, Shrub/Tree, Other

Appendix B: Quality Assurance/Quality Control

The following information was excerpted from the Quality Assurance Project Plan prepared for this monitoring program.

I. Data Quality Objectives for Measurement Data

Baseline

Baseline monitoring protocol includes land use, mapping, differential GPS locations, photo points, and watershed use/area history hydrology.

Land Use

Working form an aerial photo, volunteers will monitor land use in a 200 ft. buffer around the site. Volunteers will assign cover percentages to categories of observed land uses. Categories include but are not limited to native vegetation, residential, paved roads, dirt roads, and industrial.

Precision: To ensure precision volunteers will use a tape measure to ground truth the 200 ft buffer zone on the aerial photo. In addition, as the aerial photos may be from 1995 or before any changes to the site, e.g., construction, should be noted.

Accuracy: N/A

Measurement Range: N/A

Representativeness: N/A

Comparability: One of the ways volunteers will ensure comparability is to follow the monitoring protocol outlined for the project.

Completeness: There are no legal or compliance uses anticipated for the data. In addition there is no fraction of the planned data that must be collected in order to fulfill a statistical criteria. It is expected that land use monitoring will occur at least once during the yearly monitoring cycle and more frequently if changes occur.

Mapping

Each volunteer group will be responsible for creating a detailed map (hand drawn and to scale) of the wetland site. The purpose of this mapping exercise is to record the location of monitoring stations, transects, crest/staff gauge, land use activities, etc. In effect it complements and is comparable to data recorded using the GPS unit and digital camera as well as the land use data.

GPS

To inventory monitoring stations (e.g., bird monitoring and vegetation plots) volunteers will record positions in UTMs using a Trimble GeoExplorer II differential GPS unit. To obtain as accurate a position as possible, the geographic dilution of precision (GDOP) will be set at 4. However, with the GDOP set at this level it is often more difficult to record a position given the availability of satellites. If this is the case, the GDOP will be increased incrementally (4 to 5 to 6 etc.) until a position can be found. Also, volunteers will record one hundred positions that will be averaged for each monitoring station or location. In addition, GPS data will be used to create a map of the site using ArcView 3.2. Topographic digital base maps are available from the Utah Department of Natural Resources. Using ArcView 3.2, data points gathered by the volunteers will be applied in layers to the base map.

Photo Points

Photo points will be established along the 5 transects and for all vegetation plots, and photos taken with a digital camera. In addition, birds, land use activities, volunteer participation, and other points of interest will be recorded at the discretion of the monitor. To ensure that photo points are comparable over time, they will be marked with flagging in the short term (monitoring session) and with rebar spikes in the long term (duration of the monitoring project) in order to find the exact point in the future. In addition, all points will be recorded using a differential GPS unit. To ensure that photos are recorded accurately, volunteers can include a small dry erase board with the date, site name, and a description in the photo, and write the compass bearing, photo description, and frame number on the photographic record data form.

Watershed Use/Area History

Watershed use and area history are descriptive narratives created from primary sources (e.g., interview with a land owner) and secondary sources (e.g., newspaper articles). In addition, a variety of resources exist to help inform volunteers of activities within their watershed. One example is the EPA website, “Surf Your Watershed.”

Hydrology

Surface water hydrology will be monitored through the installation of a crest/staff gauge. A crest/staff gauge provides a simple way to determine water depth, frequency, duration, and pattern of innundation at the wetland site. The precision of this protocol is 20%, with an accuracy of 0.5 cm and measurement range of 0 to 2 m. Representativeness is ensured by installing the gauge at a location where it will register the lowest annual water level and where it will be observable with binoculars during high water conditions. Volunteers will be trained how to accurately read and record water levels so that data can be compared over time. Finally, it is expected that volunteers will read the gauge seasonally and after large storm events to get an accurate picture of water levels. There are no legal or compliance uses anticipated for the surface water data.

Birds

The bird monitoring protocol has been adapted from the IWL Handbook for Wetlands Conservation and Sustainability. Volunteers will observe, identify, and record birds species from at least three stations within the wetland. Volunteers will spend 10 minutes at each location and must be able to see at least 75% of the wetland site. In the event that three stations do not provide enough coverage, additional locations can be added. All stations will be located to ensure there is adequate coverage of the site and of different wetland habitats. One way in which this protocol differs from the IWLÆs procedure is that volunteers are free to record birds they see at any time during their visit to the wetland, not just at the monitoring stations. Volunteers will record common name, scientific name, method of observation, and behavior as outlined in the IWL handbook. In addition volunteers will record the habitat type where the bird was found and the sex of the individual when possible. Possible habitat types include, but are not limited to, open water, emergent vegetation, and trees and shrubs.

Precision: N/A

Accuracy: To ensure accuracy bird data will be compared to a local area Bird List compiled and maintained by the chapters of the Utah Audubon Society. This form of voucher collection includes common name, scientific name, occurrence (e.g., common, rare, etc.), breeding status, and common habitat. From this information, volunteers will be able to improve the accuracy (i.e. properly identifying bird species based on occurrence, breeding status and common habitat) of their data by comparing historical trends to current visitation by birds in Cache Valley.

Measurement Range: N/A

Representativeness: To ensure representativeness, volunteers will monitor birds from three locations so that at least 75% of the wetland site is observable. Monitoring locations are indicative of habitat types found within the wetland site.

Comparability: This project ensures comparability by following a modification of the protocol outlined in the IWL Handbook for Wetlands Conservation and Sustainability. Also, volunteers will use field guides to identify birds to the species level. This necessitates having volunteers with birding experience. If a group does not have a volunteer with at least two years of birding experience in Utah, the WMC or Wetland Specialist will assist the group with this monitoring activity.

Completeness: There is no fraction of the data that must be collected in order to fulfill statistical criteria. It is expected that samples will be collected seasonally and during migration periods from all sites for a complete catalogue of avian use unless unanticipated weather or dangerous conditions prevent sampling.

Macroinvertebrates

Macroinvertebrates will be monitored using a protocol developed by the USU Bug Lab. Samples from this project will be used by the Bug Lab to help develop a biological assessment tool for wetlands in Utah. The protocol consists of one volunteer sampling representative micro-habitats using a 800 x 900 micron multifilament nylon D-frame dip net. After the sampling period has ended, volunteers will remove sediment using a 500 micron sieve. Volunteers will separate large particulate organic matter from the sample using squirt bottles and tweezers to retain any macroinvertebrates. Finally the participants will preserve the "cleaned" sample in 90% Ethanol in a labeled (both internally and externally with date, site name, monitors' names and number of sample) clean wide mouth bottle.

Precision: N/A

Accuracy: Identification of macroinvertebrates to the species level and construction of the biological assessment tool will be the responsibility of the USU Bug Lab.

Measurement Range: N/A

Representativeness: This program uses sampling techniques developed for wetlands. Volunteers will monitor the substrate, all levels in the water column, and vegetation at one general location so that as many different habitats as possible are sampled. In addition volunteers will collected 500 organisms during each sampling period.

Comparability: Volunteers participating in this project will follow monitoring protocol established by the USU Bug Lab for assessment and analysis.

Completeness: The macroinvertebrate sampling is part of a larger project conducted by the USU Bug Lab which is constructing a biological assessment tool using these organisms. It is expected that samples will be collected seasonally at each site to provide and accurate account of the macroinvertebrates living in the system.

Vegetation

Vegetation monitoring will be conducted using the protocol outlined in the IWL's Handbook for Wetland Conservation and Sustainability or in some instances the U.S. Forest Services' Guide to Riparian Monitoring. Volunteers will monitor a number of vegetation plots representing vegetative communities along transects within the wetland. Volunteers will identify all species inside plot boundaries (circular plots with a radius of five ft. or 1' by 6' rectangular plots) and estimate percent cover of each, i.e., the percentage of total ground space that is overlain by the canopies of individuals or clumps of species.

Precision: Because this type of vegetation monitoring is done by individual observation there is some level of subjectivity involved. At first, what looks like 15% cover of a plant species to one volunteer may appear to be 20% to another. To overcome this, the project will train volunteers using replicate sampling so that individuals can compare their observations and reduce discrepancy. During actual monitoring, 10% of the vegetation plots will be replicated by the WMC. If percent cover differs by more than 5% for any species, it will be re-monitored. If percent cover differs by more than 10% for any species, all the vegetation plots will be re-monitored by the volunteers and WMC together.

Accuracy: To ensure accuracy and facilitate vegetation sampling by volunteers, the project will prepare a plant species list for each site. Development of this list will be done by a botanist trained in wetland vegetation and/or by comparing samples to those kept in the Intermountain Herbarium located at Utah State University.

Measurement Range: N/A

Representativeness: In order that vegetation monitoring represents the "true" environmental condition and identifies as many wetland plant species as possible, volunteers will construct a species diversity curve for each transect. For example, starting at the first plot on the transect, one records all vegetative species. At the second plot, one records the species found there. If the second plot contains species not found in the first plot, volunteers continue to the third plot. When the number of new species equals zero the volunteers have sufficiently sampled along that transect and move to the next. In addition, volunteers will record any unusual, rare or endangered vegetation that they observe anywhere at the wetland site. Trained volunteers will attempt to identify the plant using wetland plant keys and/or field guides. In the case of unknown plants a sketch can be made or photo taken for positive identification by a wetland botanist or at the Intermountain Herbarium.

Comparability: This project will ensure comparability by always following the monitoring protocol outline in the IWL's Handbook for Wetlands Conservation and Sustainability or the U.S. Forest

Services' Guide to Riparian Monitoring. Also, volunteers will use botanical resources as mentioned above and standardized keys to identify wetland plants to the species level.

Completeness: There is no fraction of the data that must be collected in order to fulfill statistical criteria. It is expected that samples will be collected from all sites unless unanticipated weather or dangerous conditions prevent sampling.

Water Quality

When monitoring water quality volunteers will use protocols adapted from the UST manual and follow testing instructions outlined by the test kit manufacturers (Chemetrics test kits and HydroLab), and Utah Division of Laboratory Services (laboratory analysis).

Precision: Precision will be monitored for 20% of the samples using replicates. Using relative percent difference replicates should not be greater than 5%.

Parameter	Accuracy	Measurement Range
Field Test Kits		
pH	+/- .5	5 to10
Temperature	+/- .1C	-20 C to 70 C
Dissolved Oxygen	+/- .5 ppm (mg/L)	0 to 12 ppm (mg/L)
Phosphorous	+/- .1 ppm (mg/L)	0 to 10 ppm (mg/L)
Nitrate	+/- 1 ppm (mg/L)	0 to 50 ppm (mg/L)
Nitrate	+/- .1 ppm (mg/L)	0 to 5 ppm (mg/L)
Turbidity	+/- .2 cm	6 to >240 NTUs
HydroLab		
pH-	+/- 0.2 units	pH: 2 to 12
Dissolved Oxygen:	0.2 mg/l	0 to 20
temperature:	+/- .2 degree Celsius	-5 to 50 degrees Celsius
conductivity:	+/- 1% of reading +/- 1 count	0 to 100 mS/cm
salinity:	+/- 1% of reading +/- 1 count	0 to 70 pss
turbidity:	+/- 5% of reading +/- 1 count	0 to 1000 NTU
Laboratory Analysis		
TSS (detectable limit):	.001 mg/l	> or = 3 mg/l
Nitrate:	+/- 0.001 mg/l	> or = 0.1 mg/l
Phosphate:	+/- 0.001 mg/l	0.02 mg/l to 1 mg/l

Representativeness: Water quality monitoring will be conducted at one location per site that reflects the quality of the water in the wetland as a whole. Sub-surface samples will be taken at least 6ft from shore and 6 inches below the surface to minimize the effect of inflows and specific land use practices or conditions. However, in the event that volunteers are sampling a wetland with identifiable inlets and outlets, they will monitor these locations to compare the water quality entering and leaving the system.

Comparability: To ensure comparability volunteers will strictly follow the water quality sampling protocol as defined by the manufacturers.

Completeness: There is no legal or compliance uses anticipated for the water quality data. In addition, there is no fraction of the data that must be collected in order to fulfill a statistical criteria. It is expected that water quality data will be gathered from each site at least seasonally unless unanticipated weather conditions prevent sampling.

Wildlife

Depending on conditions specific to each wetland site citizen monitors will establish single or multiple transects in different habitat types when assessing wildlife use. It is important that monitoring is conducted both efficiently and deliberately so as to not miss evidence of animal activity.

Precision: N/A

Accuracy: To ensure accuracy wildlife data will be compared to lists compiled and maintained by the Utah Division of Wildife Resources. This form of voucher collection indicates which species are found in the different regions of Utah.

Measurement Range: N/A

Representativeness: To ensure representativeness, volunteers will monitor wildlife along transects indicative of habitat types found within the wetland site.

Comparability: This project ensures comparability by following a modification of the protocol as developed by the Utah Division of Wildlife Resources. Also, volunteers will use field guides to identify wildlife to the species level. This necessitates having volunteers with scat and track identifying experience. If a group does not have a volunteer with at least two years experience, the WMC or Wetland Specialist will assist the group with this monitoring activity.

Completeness: There is no fraction of the data that must be collected in order to fulfill statistical criteria. It is expected that samples will be collected seasonally from all sites for a complete catalogue of wildlife use unless unanticipated weather or dangerous conditions prevent sampling.

Documentation and Records

To record and store data, standardized data forms are available in this handbook All data sheets will include: site name and address, date, and monitor name(s) and contact information. Hard copies of the original data forms with be stored with the WMC. The data recorded on these forms will be stored on an internet accessible database. Volunteers can view and with the appropriate password access and enter data. The WMC will manage hard copies of the data as well as a back-up disk of the database. Other types of documentation include photos of the site and maps. The photos will be downloaded from the digital camera and stored on a zip disk. Photos will be labeled with site, date, and direction the photo was taken. The map will be scanned and stored on a zip disk with the photos. Only one wetland site will be included on any given disk.

II. Monitoring Design and Protocol

Monitoring Design

To obtain an adequate amount of data, citizen monitors will monitor each site seasonally Volunteer monitoring groups may consist of 4 to 16 (some school groups may be as large as 30 students) people depending on level of experience and availability. Monitoring methods are primarily inventories or characterizations of wetland attributes. This has been successful with volunteers because the protocol is straight forward, it does not require the presence of a trained wetland ecologist, and it is comprehensive, allowing people to become familiar with their wetland and generate useful data. However, it is time intensive, hence the small number of wetlands and large number of volunteers in the project design. Volunteers will also contribute to the creation of a biological assessment index using macroinvertebrates. Many metrics centered around these organisms exist although most are designed for streams, not wetlands. Researchers at Utah State University in collaboration with the State of Utah are sampling wetlands in order to construct such an instrument. Macroinvertebrates sampled by volunteers will be identified to the species level by the USU Bug Lab and included in this effort. Such a contribution will provide volunteers with insight into the health of their adopted wetland and data complimentary to water quality analysis.

Site Selection

To support the volunteer's needs, we feel it is important that s/he is actively involved in selecting monitoring sites. Having sites that are significant to the volunteers helps insure long-term commitment to the project and the wetland as well as motivate the collection of valid and viable data. The latter can be accomplished if the volunteer knows that the quality of his or her measurements affects the utility of the data and one's ability to use the data to manage the wetland. If a volunteer group is interested in participating but does not have a wetland in mind, a site will be provided. At present we are monitoring ten sites with three sites for future groups if needed.

Sample Handling and Custody Requirements

All macroinvertebrate and water quality samples collected as part of this project will be labeled in the field. Labels will be fixed to the outside of the sample container and in the case of macroinvertebrates placed inside as well. The internal label will be on water proof paper and written in pencil. Label information includes site name, names of volunteer monitors, number of samples, and the date. Samples are the responsibility of the monitor until they are returned to the WMC. The WMC will transport them to the USU Bug Lab of Utah Division of laboratory Services and record the date and time of delivery. All samples will be processed by their respective lab at their facility. After processing, the Labs will provide the WMC with a print out

of the results of each sample. This information will be filed as a hard copy, entered into the computer database by the WMC, and shared with volunteers.

Quality Control Requirements

Replicate sampling for vegetation, water quality, and GPS positioning will occur at all sites because each site is monitored by a different group. This will be done twenty percent of the time by the WMC, Wetland Specialist, and/or other persons trained in the specific monitoring protocol in the field while the volunteers are collecting data. If sampler problems are found the specific monitoring activity will be repeated in the presence of the WMC. If necessary, volunteers will review the monitoring protocol. All volunteers will be retrained at least once a year (to review protocol and in the event a protocol is adjusted) by the WMC, VTC and/or professional personnel familiar with the monitoring protocol. Professional personnel may be from the Utah Division of Wildlife Resources, the U.S. Fish and Wildlife Service, the Army Corps of Engineers, USU Extension, or local consulting firm.

Instrument/Equipment Testing, Inspection, and Maintenance Requirements

As part of equipment maintenance, the WMC, wetland specialist, and volunteers will inspect all equipment before monitoring. All water testing kits will be cleaned and checked to see if reagents, bottles, etc. are in good working order. Components that have expiration dates will be replaced according to the manufacturer's recommendations. The D-net used for macroinvertebrate sampling will be checked for rips and holes. All battery operated equipment will be tested and new batteries will brought into the field in case the old ones die. The WMC will maintain a logbook to track maintenance of all equipment. All records and equipment will be stored with the WMC.

Instrumentation Calibration and Frequency

Twice a year all water quality test kits (nitrate, phosphorous, pH, and dissolved oxygen) will be calibrated using samples containing known levels of the substances listed above. Test samples will be purchased from chemical supply stores. D-nets will be cleaned (rinsed of sediment and plant material) so that they are kept in good working order.

Decontamination

As monitors we are capable of transporting pathogens and seeds on boots, dipnets, socks, waders, etc. into and out of wetlands. The effect on fish, reptiles, amphibians, and native plants can be devastating. We only need to look as far as whirling disease in Utah to see what problems could arise. For this reason, Wetland Partners has a decontamination protocol. When working between sites citizen monitors will remove any lingering mud from boots and equipment. Items will than be immersed in a 10% bleach solution (½ cup bleach: 1 gallon water.) The solution can be discarded 40 meters form water or taken to a household drain serviced by a sewage treatment facility.

Inspection and Acceptance Requirements for Supplies

All equipment ordered from chemical and biological supply companies will be inspected upon arrival. Broken and incomplete equipment will be returned to the distributor. The crest/staff gauge will be assembled by volunteers and inspected by the WMC. Components of this monitoring tool will be purchased from a local hardware store by the WMC. Equipment that breaks in the field will be returned if under warranty or fixed provided that it continues to meet all quality control requirements. If this is not the case, a replacement will be ordered and monitoring of that wetland characteristic suspended until arrival of the new equipment.

Data Aquisition Requirements

In addition to data collection on site, this project may acquire and utilize existing data from the following sources:

USFWS National Wetland Inventory maps to determine Cowardin wetland classifications and surrounding wetland sites.

USGS topographical maps to determine latitude and longitude, general land uses and topography of the site.
Aerial photography to help determine acreage and surrounding land uses.
National plant database to determine a plantÆs affinity for wet conditions (obligate wetland to upland).
Mitigation plans (if applicable) to review prior conditions and expected outcomes of the site.
Utah Division of Wildlife ResourcesÆ Wildlife Management Area planning documents.
National Oceanographic and Atmospheric data for information on site weather conditions
USGS Hydrologic unit codes: http://txwww.cr.usgs.gov/hcdn/hydrologic_units.html

Olmernik Ecoregion types

To ensure that these materials are accurate and appropriate only the most recent versions will be used.

Data Management

Data forms will be inspected in the field by the Team Leader and/or WMC to ensure that all information is complete and accurate. If there are errors or omission the sampler will be consulted and corrections made on site. Macroinvertebrate samples will be taken to the WMC and then deposited at the USU Bug Lab. All data will be entered into a computer database. To check for quality control, 10% of the data will be cross-checked by the WMC or wetland specialist with the data forms to make sure that they have been entered properly. If errors are found, all data entered during the same time period will be reviewed for inconsistences.

III. Assessment and Oversight

Assessment and Response Actions

Review of the volunteers in the field is the responsibility of the Team Leader, the WMC and the wetland specialist. Each volunteer group will be accompanied by their Team Leader, the WMC, and/or the wetland specialist at least once a year. If possible, volunteers needing performance improvement will be retrained on site. If this is not possible, retraining will occur prior to the next monitoring session. Volunteers will attend a yearly training workshops to review protocol. Volunteers are welcome to suggest additional training topics at any time. If errors in sampling techniques are consistently identified, retraining may be scheduled more frequently. All field and laboratory activities may be reviewed by the Division of Wildlife Resources and EPA Region 8 quality assurance officers as requested.

Reports

Three external documents will be produced as a result of this project. These include the QAPP, a project evaluation report, and a summary of the data from each site. The evaluation will document the processes used to achieve results as well as a description of all activities completed during the project. The site summaries will include all data gathered for each site monitored as well as general information about site history, photographs, and mapping. All field notes, quality control sample records, training procedures, and data sheets will be kept on file with the WMC for 3 years and not incorporated into any of these reports. All external documents will be available in hard copy or electronic forms.

IV. Data Validation and Usability

Data Review, Validation, and Verification Requirements

All data are reviewed by the Team Leader, WMC and the wetland specialist to determine if they meet QAPP objectives. Decisions to reject or qualify data are made by these individuals. In addition, the Wetland Project Leader at the Utah Division of Wildlife Resources, who is not directly connected with the project, will review the data on a bi-annual basis. Other UDWR staff will also review the data and monitoring protocol annually to make sure they meet the needs of the Division. If needed, the WMC will change monitoring protocols and/or include additional protocols to obtain useable data.

Validation and Verification Methods

As part of this project's monitoring protocol, any sample reading outside the expected range is reported to the Team Leader or WMC. A second sample will be taken by the Team Leader or WMC as soon as possible to verify the condition. Data that has been entered into the database will be reviewed by the WMC. Errors in data will be corrected. Outliers or inconsistences will be flagged for further review, or discarded. Problems or inconsistencies with the data will be discussed and included in the project evaluation report and the data summaries.

Reconciliation with Data Quality Objectives

As soon as possible after each sampling event, calculations and determinations for precision, accuracy, and completeness will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and resampling may occur. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be human error, the volunteers will be retrained. Any limitation on data use will be detailed in the project evaluation report and data summaries. If failure to meet project specification is found to be unrelated to equipment, methods, or sampling error, specifications and protocol may be revised for the next monitoring season. Revisions will be reviewed by the UDWR and submitted to EPA Region 8 for approval.

Citizen's Guide to Monitoring Wetlands in Utah

Acknowledgments: The protocols described in the guide are based on methods developed by organizations including Adopt A Beach, the Izaak Walton League, Utah State University National Aquatic Monitoring Center (a.k.a. The Bug Lab), and the Utah Stream Team. This guide is intended to be used in conduction with materials produced by those programs.

For additional information about the program contact Wetland Partners at (435) 797 8058 or wetlandpartners@utah.gov.