UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

DEVELOPMENT AND IMPLEMENTATION OF A WETLANDS VOLUNTEER MONITORING PILOT PROGRAM FOR OKLAHOMA

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

MASTER OF ENVIRONMENTAL SCIENCE

By

Erin Elizabeth Breetzke
Norman, Oklahoma
2000

DEVELOPMENT AND IMPLEMENTATION OF A WETLANDS VOLUNTEER MONITORING PILOT PROGRAM FOR OKLAHOMA

A THESIS APPROVED FOR THE
SCHOOL OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCE

BY [redacted]

ACKNOWLEDGMENTS

Put simply, to thank everyone who helped me through this project, the development of my thesis, and my education at the University of Oklahoma would take forever. I would, however, like to thank my family, my friends back home, and all the friends and acquaintances I have made here in Oklahoma. Without your support and friendship I never would have made it this far.

I thank Dr. Robert Nairn for his guidance throughout this project. I would also like to thank Dr. Canter and Dr. Meo for their supervision and for being on my committee. Thanks is extended to the CEES office staff, the OWRB, OWWG, ESSA and the Izaak Walton League of America for their help and support through the development of this project.

To everyone mentioned here, and to those whom I may have forgotten to mention, your work, guidance and friendship has helped me every step of the way and has been greatly appreciated.

Finally, I dedicate this work to my parents, Gerald and Agnes, my sister, Amanda, and my cousin, Cathy. Though you may never have understood exactly what I've been going to school for, you have continuously been my support and inspiration. Without you I could never have made it this far. Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Due to limited public and private man-power, citizens have become valuable tools for collecting environmental data. Currently over 700 volunteer environmental monitoring programs in the United States are actively collecting data in various ecosystems to be used by governments and university scientists in order to develop legislation or for use in research. Oklahoma currently has three active volunteer environmental monitoring programs, none of which specifically monitors wetland ecosystems. As stated in the Oklahoma Comprehensive Wetlands Conservation Plan, a goal has been set forth to develop and implement a wetland volunteer monitoring program for the state. This research details the development and implementation of the Wetland Health Assessment Monitoring (WHAM) Program. Through the cooperation of Oklahoma state environmental program directors, as well as directors nationwide, parameters, methods, and associated quality assurance protocols were selected for the program's addendum. The implementation of this pilot program produced valuable feedback and information needed to assure the program is meeting its goals. It is expected that the WHAM Program, when implemented statewide, will become beneficial in assessing the condition of Oklahoma's wetland resources.

CHAPTER 1

INTRODUCTION

The success of volunteer environmental monitoring programs nationwide has proven them to be a valuable tool for gathering needed environmental data. The limited availability of professionals and government staff to collect data on every Oklahoma ecosystem, coupled with the unknown health status or condition of Oklahoma's wetlands, makes developing and implementing a wetlands volunteer monitoring program beneficial to Oklahoma. Presenting the development and implementation of this program herein provides a platform for discussing the use of citizens to collect data in the environmental arena.

I. Need for Research

According to a survey conducted by *The Volunteer Monitor* (1998), 21 percent of all volunteer environmental monitoring programs monitor wetlands. These programs monitor for water quality, biological, land use, and other parameters, and have a variety of uses for those entities that utilize the data. The uses of these programs vary from education, to research, and to various types of regulatory enforcement.

Oklahoma's Comprehensive Wetlands Conservation Plan (OCWCP) (OCC 1996) names several objectives which will assist in the compliance of the state's goals regarding wetlands conservation. Specifically related to the development of this monitoring program, one objective (objective seven) states:

> To develop information/education programs on Oklahoma's wetland resources.

In accordance with this, several actions are listed to meet each objective. In objective seven, actions 15 and 16 specifically deal with the development of a monitoring program.

> action 15: develop and implement education materials on the uses and benefits of constructed wetlands.
>
> action 16: develop and implement a volunteer monitoring program for Oklahoma's wetland resources

In order to fulfill this objective and the associated actions, a volunteer wetlands monitoring program was developed in connection with Oklahoma's current lake and reservoir water quality monitoring program, Oklahoma Water Watch (OWW).

Born out of the need for assistance in collecting water quality data on Oklahoma reservoirs, the Oklahoma Water Resources Board (OWRB) established the Oklahoma Water Watch volunteer monitoring program in 1992. This program currently consists of 16 groups with 175 volunteers, and 71 sites including 15 lakes, 4 streams/rivers, and 1 pond (McLaren 1999). Receiving a large part of its funding from USEPA, this program is part of a national volunteer monitoring program.

The program has five main objectives: 1) determining baseline water quality conditions, 2) identifying current or potential water quality problems, 3) determining water quality trends, 4) promoting citizen participation, and 5) educating the public. Volunteer monitors involved in this program range from high school students to retirees involved in established lake associations (as well as some state agency and Army Corps of Engineers personnel) (McLaren 1999). These people enter into a partnership with the OWRB through which they are taught the importance of Oklahoma's water resources and the need to protect them and maintain their quality (McLaren 1999). Volunteers proceed through several steps to become a volunteer monitor: determine personal monitoring objectives (what exactly is it that they hope to gain from the activities), training, certification and data collection. By monitoring an individual lake a minimum of six times per year, their data assist the OWRB Clean Lakes Division in assessing trends or possible problems in the state's reservoirs (OWRB 1997).

II. Scope of Research

The key element of this project is to create an opportunity for wetlands education and awareness through hands-on experience. Eight steps have been identified, and two outcomes are desired. These steps are:

1) establishment of an advisory group
2) designing a volunteer monitoring program
3) development of quality assurance/quality control (QA/QC) protocols
4) development of an addendum for the OWW handbook
5) implementation of monitor training sessions
6) placement of volunteer groups into the field
7) development of an evaluation tool for volunteers' work
8) development of Quality Assurance Project Plan (QAPP)

Through these established steps, two outcomes were achieved. First, a wetland-specific addendum to the OWW volunteer monitoring handbook was completed. Second, a pilot volunteer monitoring group was implemented in the field to collect useful data for state agencies and other scientific entities, and to evaluate the utility of this program. To accomplish these goals, examples of established volunteer monitoring programs were utilized as guiding mechanisms to develop a program for Oklahoma. Input from key personnel in various government agencies, tribal entities and state university scientists was utilized to assist in establishing a pilot program.

With a desire to reach not only students, but the public in general, the key guiding principle of this project was to educate people about wetlands, their functions and importance. By giving citizens the opportunity to learn about wetlands through hands-on monitoring, it was the goal of the investigators that this education will assist the public in developing a sense of stewardship for the state's wetland ecosystems. Additional future benefits of the program include increased public awareness about the need for wetlands and the initiation of a basis for the development of a catalogued inventory of wetlands in Oklahoma.

III. Focus of Research

The focus of this research was to develop and implement a wetlands volunteer monitoring pilot program for Oklahoma. The desired outcomes of this research included:

- development of an addendum to the OWRB's OWW volunteer monitoring handbook
- placement of pilot monitoring groups in the field

To accomplish these goals, several tasks were pursued. Existing water quality monitoring programs throughout the country were analyzed as to their applicability in

Oklahoma. In addition, scheduled meetings with the Oklahoma Wetlands Working Group (OWWG) were held by the Oklahoma Conservation Commission (OCC) to discuss current wetland issues in the state. These meetings were also utilized to gather input regarding establishment of the program, monitoring parameters, data collection methods, monitoring sites and monitoring groups, quality assurance/quality control (QA/QC), and evaluation methods. In addition, the assistance of these professionals was beneficial at all times when complications during the development or implementation occurred.

IV. Research and Thesis Objectives

The goal of this research was to educate the public and augment their awareness about wetlands as well as increase their sense of stewardship for these ecosystems. This goal was met through the hands-on activities involved in the volunteer monitoring program. Describing the program's development, implementation and related results, conclusions and recommendations in this thesis provides a platform for discussing the link between hands-on volunteer environmental monitoring programs, the associated gathered data, and environmental education in a non-classroom setting.

CHAPTER 2

LITERATURE REVIEW

This literature review discusses the two topics inherent in this research: wetlands and volunteer monitoring. A wetlands background is necessary to discuss the numerous aspects of wetlands and their places socially, economically, geographically, environmentally, and otherwise in the United States, both past and present. The idea of volunteer monitoring is presented to discuss its history, applications and practice, usefulness and associated problems.

I. Wetlands Background

A. Introduction and Overview

Since settlement began in America, humans have often chosen to destroy wetlands rather than work toward balanced coexistence. Having developed an image of wetlands as breeding grounds for disease, mosquitoes, and impending danger (Giblett 1996, Prince 1997), it is no wonder wetlands have been given names such as Black Swamp (in Northwest Ohio), or the Great Dismal Swamp (in North Carolina and Virginia) (Giblett 1996). Humans have diminished wetland numbers and areas by draining, channeling, filling or polluting the waters which fed them (Dennison and Berry 1993a, Kent 1994). In addition, indirect actions such as increased withdrawals of groundwater or vegetation alteration due to farming practices (Middleton 1998) have also decreased wetland quality or have eliminated wetlands completely.

Drained or filled, wetlands have disappeared in order to provide fertile land for agriculture (Holloway 1991, Urban Land Institute 1991, Dennison and Berry 1993a) and room for other "progressive" developments (i.e., housing projects, industry, establishment of major cities such as Washington D.C., etc.) (Urban Land Institute 1991, Mitsch et. al. 1998). In the past 15 to 20 years the study of wetlands has escalated to an interdisciplinary science through which humans have begun to better understand these ecosystems and see them as an important part of the biosphere (Leidy et. al. 1992, Dennison and Berry 1993a). Only as these ecosystems have been destroyed, and as humans better understand and appreciate the value of wetland functions, have these ecosystems become protected and received public attention (Clark 1983, USDI 1992, Dennison and Berry 1993b, Mitsch and Gosselink 1993).

B. Wetlands: A Brief History

It has been estimated that before the first European settlers arrived in the U.S., wetland ecosystems occupied approximately 200 million acres of land (Urban Land Institute 1991, Heimlich 1991). Although Native Americans lived harmoniously with the wetlands, settlers saw these areas as something "unclaimed, unfenced, and unimproved," (Prince 1997). This trend continued throughout settlement and into the pioneering of the West. Doyle (1998) reported a classic case of drainage was that of the Black Swamp in the Midwest. Because it was seen as an impediment to travel and settlement, this near-Connecticut-size wetland in Northeast Ohio disappeared between 1859 and 1885. Through four centuries of European settlement, acts such as this one have been conducted in the name of agriculture and urban/industrial development, thus reducing the original 200 million acres by half (Dugan 1993) (Figure 2.1).

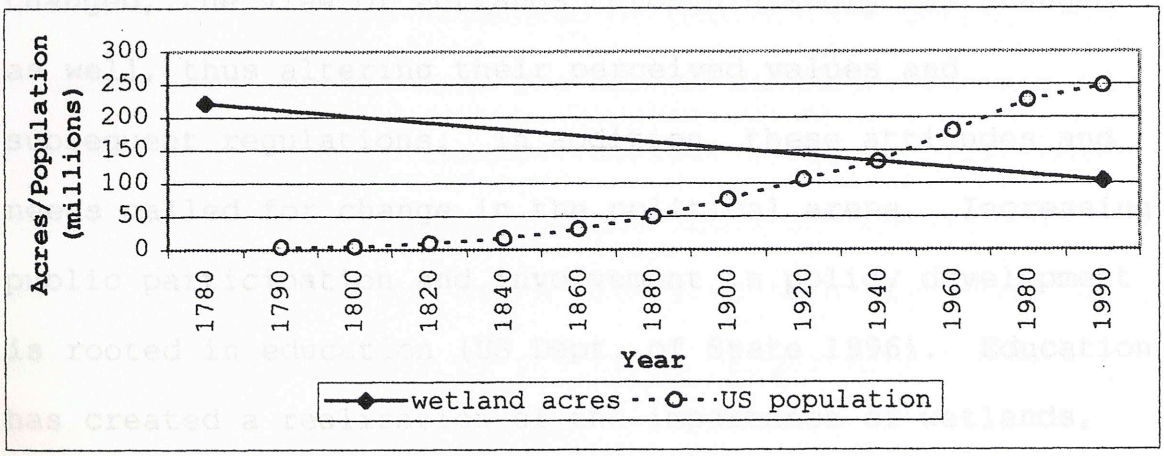


Figure 2.1 Wetland Loss in the United States versus Population Growth from 1780 to 1990 (Mitsch and Gosselink 1993, US Census Bureau 1999).

The "drain them all" wetland ideology persisted into the twentieth century (NWF 1987, Dugan 1993), even though founding father George Washington's attempts to drain the

Great Dismal Swamp of North Carolina and Virginia failed. Until recently, wetland draining initiatives had been greatly promoted by the U.S. government (Heimlich 1991). More recent government policies provide for, or blatantly mandate, the conservation and restoration of remaining wetlands (NWF 1987, Dugan 1993). President Carter's 1977 Executive Order 11990 mandated that all government agencies minimize their actions (and all included effects) on wetlands. This initiative of wetlands preservation culminated into the adoption of a "no net loss" policy during the Bush administration (Heimlich 1991). Today, wetlands policy continues to evolve.

It is apparent that as cultural attitudes and needs changed, the view of wetlands through history has changed as well, thus altering their perceived values and subsequent regulations. In addition, these attitudes and needs called for change in the political arena. Increasing public participation and involvement in policy development is rooted in education (US Dept. of State 1996). Education has created a realization of the importance of wetlands, and has been cause for increased regulation and the birth of wetland science.

C. Attitudes Toward Wetlands

From their first encounters with wetlands, settlers had greatly diverse attitudes toward these ecosystems. The early attitudes of settlers and the general public saw wetlands as an impediment to progress, mainly farming (for which 80 percent of those wetlands destroyed in the United States were sacrificed) (Dugan 1993). Joseph Kennedy, Superintendent of the United States Census in 1860, wrote favorably of wetland drainage: "This important improvement has made great progress in the estimation and practice of our farmers," (Prince 1997). To date, farming is the top reason for wetland drainage, with other practices, such as logging, following closely behind (Middleton 1998). The National Research Council (1995) reports that over half of the original total wetland area in the conterminous United States had been destroyed by the middle 1980s.

Wetland loss was augmented by public fear during European settlement. Fear (or rather misunderstanding) of disease, specifically malaria (Giblett 1996), stirred much enthusiasm for wetland destruction and drainage (Prince 1997). These myths and fears persisted into the local cultures and literature of the time. Edgar Alan Poe wrote of wetlands as dreadful places:

> ...by the swamp
> Where the toad and the newt encamp,-
> By the dismal tarns and pools
> Where dwell the Ghouls,-
> By each spot the most unholy,-
> In each nook most melancholy,-
> There the traveler meets aghast
> Sheeted memories of the Past-
> Shrouded forms that start and sigh...
> (from "Dreaming" in Giblett 1996)

Other authors, however, wrote of the beauty of wetlands. Naturalist poet Henry David Thoreau wrote of wetlands as near heaven on earth:

> When I would recreate myself, I seek the darkest wood, the thickest and most interminable and, to the citizen, most dismal swamp. I enter a swamp as a sacred place, a *sanctum sanctorum*. There is the strength, the marrow, of Nature (Thoreau 1862).

Though only two samples of how wetlands have been seen throughout U.S. history, these quotes are evidence that these ecosystems evoked different emotions in different people at different times. Attitudes and opinions of wetlands changed as times progressed. Destruction changed from a fear of disease to a need for land upon which to farm and live (Prince 1997). Current attitudes toward wetlands have become more favorable than those in the past (Leidy et. al. 1992). With the development of wetland science, and through increased understanding of the importance of wetlands, these ecosystems have found increased protection through federal and state governments.

Since the early 1970s, citizens have been quick to act in favor of environmental protection regulations (US Dept. of State 1996). As the Cuyahoga River in Cleveland, Ohio burst into flames in 1969 due to excessive industrial pollution, public interest groups promptly pushed for the federal government to act upon behalf of a cleaner water initiative. The result was the implementation of the Clean

Water Act (CWA) in 1972 (Adler et. al. 1993). Section 404 of the CWA provides the US Army Corps of Engineers (USACE) with overseeing the dredge and fill program of navigable waters of the U.S. (Heimlich 1991). Because wetlands are transitional zones between land and water, this provision originally regulated the dredging and filling of tidal wetlands and estuaries only. After much debated court cases such as United States v. Riverside Bayview Homes, Inc. in 1985, and Leslie Salt Co. v. U.S. in 1995, wetlands adjacent to other navigable waters of the U.S. or inland wetlands were soon protected (Gallagher 1997). Many people, especially developers, fought against the coverage of inland wetlands with no connection to navigable waters (Adler et. al. 1993). Because of the controversial nature of Section 404, it is continuously debated by various stakeholders (including citizens, land owners, environmentalists and developers).

It is clear that the fate of wetlands has depended on public attitudes and the cultural standards of the time (Prince 1997). One current example exists with wetland stewardship. With a large percentage of wetlands on private land, many landowners have become active in wetland preservation for various reasons (USDI 1992). As outlined in a USDA Bulletin entitled *Working with Wetlands* (USSCS 1994), farmers are becoming aware of the wetlands located on their property. Many look positively on wetlands stewardship as a commitment to the environment. As one Iowa livestock farmer stated, "what value can you put on an eagle in flight, 25 or 30 Canada geese getting off the water, or a deer waiting for a drink on a hot day?" (USSCS 1994).

Stewardship through involvement in water quality monitoring also gives the public a sense of ownership. Being able to aid in policy development, regulation and protection (US Dept. of State 1996) through hands-on activities creates a sense of ownership of the environment (Lyon). Volunteers ultimately become "educated stakeholders" (Mayio 1999). Education is a powerful tool in developing an understanding of how these ecosystems function and how valuable they are through direct and indirect usage.

D. Defining Wetlands

Depending on the objective (e.g., science, management, regulation), definitions of wetlands vary, though all definitions mandate that wetlands include specific soils, hydrologic conditions, and vegetation (Robinson 1995). The Committee on Wetlands Characterization (National Research Council 1995) defined wetlands as:

> A wetland is an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics

of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of recurrent, sustained inundation or saturation.

Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physicochemical, biotic, or anthropogenic factors have removed them or prevented their development.

For regulatory purposes, the accepted wetland definition was developed by the United States Environmental Protection Agency (USEPA) and the United States Army Corps of Engineers (USACE):

> The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas (33 CFR 328.3(b) 1984).

As explained by Salvesen (Urban Land Institute 1991), wetlands are more specifically defined and categorized by their geographic region and those parameters which define a wetland (i.e., depth and flow of water, dominant vegetative species, soil conditions). Based on their geographic location, wetlands vary throughout the U.S. (Table 2.1) (USEPA 1995). The varied nature of these ecosystems has effected how they have been viewed through history, their survival and their understanding.

Table 2.1. Distribution of Wetland Types Through the United States (USEPA 1995).

Wetland Type	Geographic Location
Bogs, Fens	Northeast/Northcentral states, Alaska
Wet Meadows/Prairies	Midwest
Inland Saline/Alkaline Marshes, Riparian Wetlands	(Semi)Arid West
Prairie Potholes	Iowa, Minnesota, Dakotas
Alpine Meadows	Intermountain West
Playa Lakes	Southwest and Great Plains
Bottomland Hardwood Swamps	Southern states
Pocosins, Carolina Bays	Southeast/Coastal states
Tundra Wetlands	Alaska

E. Wetland Functions and Values

United States wetlands loss includes not only loss of wetland ecosystem land acreage, but loss of functions provided, upon which humans place much value (Mitsch and Gosselink 1993).

Wetland functions can be defined as:

> The physical, chemical and biological interactions within wetlands...[that] involve the performance or execution of changes within the wetlands ecosystem...[which] include biological, chemical and physical transformations in the diversity of forms and substances that exist within the wetland (Reimold 1994).

Biological functions include habitat provision for various plants and animals, some of which are utilized for food or pelts (Mitsch and Gosselink 1993, Reimold 1994). Quantified values of this function include $15 billion a year in the fish and shellfish industry, the 1.2 billion pounds ($244 million) of fish and shellfish Louisiana produced in 1991, or the $70 million a year made nationally on muskrat pelts (Finkl 1995). All of the nation's ducks and geese depend on wetlands (USSCS 1993), therefore these habitats provide areas for reproduction, feeding and resting during migration (Euliss et. al. 1992, Reimold 1994). It has been estimated that one-half of fish, one-third of bird, and one-sixth of mammal species on the United States Threatened and Endangered Species List require wetlands for some portion of their life cycle (USDI 1992, McKinnon 1993, Doyle 1998). Wetland habitat is also important because it is adapted to accommodate a number of floral and faunal species (Ely 1998). In addition, these ecosystems support a stock of biodiversity (Semlitsch and Bodie 1998). These living organisms can be utilized as lone indicators of wetland integrity and the importance of a particular site (Keddy et. al. 1993).

Physical and chemical functions include water retention, groundwater recharge, and water quality improvement (NWF 1987, Holloway 1991, Reimold 1994). Absorbing excess floodwater can decrease or eliminate flooding disasters through smaller, more gentle releases of water rather than the immense volumes associated with damaging floods. Wetlands are also known to recharge groundwater supplies humans utilize as primary water sources (NWF 1987). Of great importance to environmental health, wetlands can cleanse water of pollutants and excess nutrients through sedimentation, plant uptake and microbial processes (Johnston 1991). One study (Mitsch et. al. 1995) showed that in areas where nutrient loading through non-point source runoff is a problem, excess nutrients can be significantly retained in wetlands. In regard to wetland volunteer monitoring, most programs focus on water quality functions because of the value of clean water to humans, wildlife, and an overall healthy environment (Lee 1994).

Functions describe the "actions" of a wetland absent of the "worth" humans place on them (NWF 1987). Due to past anti-wetlands actions, wetlands are now generally considered more "worthy" or "valuable" today than at any other time in the past (McKinnon 1993). Defined, wetland values are:

> sociological, subjective term[s], which are particularly malleable,...are based on anthropogenic properties by which wetlands are determined to be useful, or impart public good...[and which] establishes a worth, excellence, utility or importance of a given wetland function (Reimold 1994).

Humans put value on such functions as (OWRB 1998):

-water quality enhancement

-reduction of flood impacts

-biological productivity (e.g., fish and shellfish industry)

-groundwater influences (i.e., cleansing, recharge)

-timber production

-agricultural production (e.g., rice,cranberries)

Natural disasters, usually flooding, are often the result of the degradation and absence of these functions. The worst flooding in U.S. history occurred in the upper Mississippi and Missouri Rivers during 1993, and was contributed to by the overall net loss of wetlands, and thus the additional loss of their function in floodwater retention (Kusler et. al. 1994, Doyle 1998). It has been reported that the 1993 flood inundated approximately 24,291 hectares, caused 523 counties in 9 states in the Upper Mississippi Valley to be declared "flood disaster areas" by President Clinton, and had a preliminary total damage estimate between $12 and $16 billion, half of which was agricultural losses (Hey and Philippi 1995, Prince 1997). On an historical basis, the USEPA (1995) stated that the floodwater retention capacity of the bottomland hardwood wetlands along this river system had been reduced to 20 percent of their original capacity due to draining and filling. One study at the University of Illinois calculated that the floodwater crest in St. Louis could have been reduced by 0.6 meters by returning only one-tenth of one percent of the basin above the city to wetlands (Robinson 1995). It has been suggested that humanity and the environment can mutually benefit by the development of a flood management plan calling for the return of 5.26 million hectares of the Mississippi Basin to wetlands (Hey and Philippi 1995).

From the previous example, the flood attenuation function is clearly evident. The value of more subtle functions may be recognized only over greater time spans. For example, some wetlands perform functions affecting global climate (Kusler et. al. 1994). It has been estimated that northern peatlands contain up to one-third of the world's soil carbon pool (Bridgham et. al. 1998). By storing this carbon rather than releasing it into the atmosphere, they assist in slowing global warming (Kusler et. al. 1994).

Ecosystem health is another subtle function with many ecological links. Leidy et. al. (1992) reported that since wetlands link drier upland and more aquatic lowland habitats, they are important in maintaining the health of both ecosystems. A healthy ecosystem creates a basis for the previously stated functions (i.e., water quality, habitat provision).

The benefit of a healthy ecosystem leads to visual-cultural values of wetlands. This is considered valuable because of the cumulative aesthetic, educational and recreational "functions" provided by wetlands (Smardon 1983). These aesthetic and recreational functions are the basis for a $59.9 billion/year industry (USEPA 1995). As Canter (1996) described, because a landscape has unique features, it may obtain a societal value. One example he provides is that of the Grand Canyon: "If every state had a Grand Canyon, then the unique visual quality represented by the Grand Canyon would be reduced," (Canter 1996). Because of the unique functioning, placement, and diversity of wetlands, the functions as visual-cultural entities and biological, chemical and physical environmental regulators, and the corresponding values placed upon these systems by humans, wetlands have been regulated.

F. Wetland Regulation and Protection

The realization of the ecological importance of the functions of wetlands, and the societal values placed upon them, has led to their regulation and protection by federal and state governments. With an initial push by the federal government, wetlands have received much attention, and the creation of many laws and acts have resulted in stringent standards for wetland protection. In addition, many private agencies and groups have joined the push to increase wetland numbers by aiding in their creation and restoration. However, many developments in wetland science are needed to successfully accomplish this task. Because of a greater need of understanding of the interactive workings of these systems, the question that remains is, can creation and restoration successfully mimic natural wetland ecosystems (USGS 1996, Cole 1998)?

A progressive movement exists to protect wetlands. From the foundation of wetlands protection with Migratory Bird Hunting and Conservation Stamps (1934) and the Federal Aid to Wildlife Restoration Act (1937) (Williams 1990), to the present "no net loss" policy (USDI 1990), and to where the state of Florida is undertaking the largest federally funded wetlands restoration in the Everglades attempted to this day (Cohn 1994, Young 1996, NPS 1998), regulation continues to evolve.

As Mitsch and Gosselink (1993) have documented, wetland regulation in yesteryear actually promoted draining the land in order to provide fertile agricultural acreage. The Swamp Land Acts of 1849, 1850, and 1860, and the Agriculture Conservation Plan allowed the states more individualized control of the land in order to promote various agricultural activities, as well as implement land management practices to manage their own flood regimes. As settlement and technology progressed, wetlands were destroyed in multiple ways: draining, dredging, filling, modification of hydrology, highway construction, mining, mineral extraction and water pollution (Mitsch and Gosselink 1993).

Quantifying total wetland loss has been attempted. It has been estimated that the lower 48 states have lost 53 percent of their wetlands between the 1780's and 1990's (Doyle 1998). When analyzing individual states, it is evident that states relying largely on agriculture (i.e., Illinois) have been key in the loss of inland wetlands, and that states such as Florida have been key in the loss of coastal wetlands. It is estimated that Iowa, Ohio, and California have lost nearly all, or approximately 89-99%, of their natural wetlands (Table 2.2) (Urban Land Institute 1991, Mitsch and Gosselink 1993, Berry 1993). The loss and degradation of these functions through various practices has brought to the forefront the need for regulation and wetland protection.

Regulation of the nation’s waters extends back into the late nineteenth century with the passing of the Rivers and Harbors Acts of 1890 and 1899. The objective of these regulations was to prevent unpermitted obstruction of navigable waters of the U.S., with the USACE as the authorizing agency (USACE 1995). As industry and development progressed, a need to keep the nation’s water free of pollutants, not just obstructive objects and structures, was needed. The Federal Water Pollution Control

Table 2.2. Wetland Loss in the United States from the 1780s Through the Mid 1980s (after Mitsch and Gosselink 1993).

State	Wetland Hectares in 1780 (x1000)	Wetland Hectares in 1980 (x1000)	Percent Change
Alabama	3,063	1,531	-50
Alaska	68,799	68,799	-0.1
Arizona	377	243	-36
Arkansas	3,986	1,119	-72
California	2,024	184	-91
Colorado	809	405	-50
Connecticut	271	70	-74
Delaware	194	90	-54
Florida	8,225	4,467	-46
Georgia	2,769	2,144	-23
Hawaii	24	21	-12
Idaho	355	156	-56
Illinois	3,323	508	-85
Indiana	2,266	304	-87
Iowa	1,620	171	-89
Kansas	340	176	-48
Kentucky	634	121	-81
Louisiana	6,554	3,555	-46
Maine	2,614	2,104	-19
Maryland	668	178	-73
Massachusetts	331	238	-28
Michigan	4,533	2,259	-50
Minnesota	6,100	3,521	-42
Mississippi	3,995	1,646	-59
Missouri	1,960	260	-87
Montana	464	340	-27
Nebraska	1,178	771	-35
Nevada	197	96	-52
New Hampshire	89	81	-9
New Jersey	607	370	-39
New Mexico	291	195	-33
New York	1,037	415	-60
North Carolina	4,488	2,300	-44
North Dakota	1,994	1,008	-49
Ohio	2,024	195	-90
Oklahoma	1,150	384	-67
Oregon	915	564	-38
Pennsylvania	456	202	-56
Rhode Island	42	26	-37
South Carolina	2,596	1,885	-27
South Dakota	1,107	720	-35
Tennessee	784	318	-59
Texas	6,475	3,080	-52
Utah	325	226	-30
Vermont	138	89	-35
Virginia	748	435	-42
Washington	546	380	-31
West Virginia	54	41	-24
Wisconsin	3,966	2,157	-46
Wyoming	809	506	-38
Total Wetlands	158,395	111,060	-30
Total "Lower 48"	89,491	42,240	-53

Act (1956) was amended in 1972 and 1977 with provisions to prevent unauthorized pollution and dredging or filling in the nation's water and was also renamed the Clean Water Act (Adler 1993, USACE 1995).

The key provision protecting wetlands in the Clean Water Act is Section 404. This section regulates "a permit program governing the discharge or placement of dredged or fill material into the nation's waters," (Gallagher 1997). These "nation's waters" (also called Waters of the United States) include wetlands "that are adjacent or tributary to other waters of the United States" (Gallagher 1997). Frequented by waterfowl, tourists and travelers, these waters may not be adjacent to navigable waters, but still are protected as waters of the U.S. (Gallagher 1997).

Controversial changes in this Act included the Corp's phasing out of Nationwide Permit 26 (Cooney 1997). Having been in place since 1977, with reauthorization every five years, the Corps announced its replacement in 1997 (Inhofe 1997). Previously, Nationwide Permit 26 allowed the filling of wetlands up to one acre in size (or 10 acres if an isolated wetland in a headwaters area) without notifying the Corps (Cooney 1997). Revisions included reducing this limit to three acres, and prohibiting the use of Nationwide Permit 26 if cumulative impacts are three acres or more (Davis 1997). Overall, the categories of permitting under Nationwide Permit 26 are for acreage, whereas new permits will be for specific activities (Cooney 1997). This has been met by much disapproval from public officials and developers alike, though some officials see the need for such drastic change (United States Senate 1997). As of 6 March 2000, Nationwide Permit 26 was replaced with five new and six modified Permits as well as three new Nationwide Permit general conditions (USACE 2000). Modifications include a 0.5 acre limit (rather than the proposed 3 acre), and other limitations on development in 100-year floodplains. Published in the 8 March 2000 Federal Register, these new changes become effective as of 6 June 2000 (USACE 2000).

Though they have since changed, policies governing wetlands have become more lax due to details in the boundaries of USACE and USEPA jurisdiction over wetland regulation. One example deals with the Tulloch Rule. In wetlands regulation, the Tulloch Rule states that any discharge into a wetland, including fallback (e.g., any material which accidentally falls back into the wetland from a dredging bucket), is not allowed without a permit (33 CFR s323.2 (d)(1)(iii)). In June 1998, it was decided by the U.S. Court of Appeals in National Mining Association et. al. v. USACE et. al. that the USACE and USEPA overstepped their boundary regarding discharge of fallback from dredging practices (U.S. Court of Appeals 1998). Reasoning for the findings of this decision include 1) the CWA describes no distinction between incidental fallback and regulatory redeposits, 2) fallback is not a discharge, and the Tulloch Rule covers only discharge, and 3) Congress finds no reasoning for fallback to be a discharge due to a net removal of material (U.S. Court of Appeals 1998). The scientific problem behind this ruling is that the suspension of fallback in the water causes similar problems (e.g., suspended particles) to the ecosystem as would discharged material (U.S. Court of Appeals 1998).

Recent wetland protection from the Bush and Clinton administrations include wetland conservation initiatives. Initiated by the Bush administration is the federal "no net loss" policy. This policy was aimed at slowing and stopping the loss of wetlands in the United States (USDI 1990). Convened by the Bush administration, the National Wetlands Policy Forum formed in 1987 with the main objective being an increase in the wetlands resource bank (Mitsch and Gosselink 1993). To meet this goal, the Bush administration formed a three-part plan to assist this policy in 1991 (USDI 1992).

1) strengthen wetlands acquisition programs and other efforts to protect wetlands
2) revise the interagency manual defining

wetlands to ensure that it is workable

3) improve and streamline the current regulatory system

The Clinton administration has recently increased funding for the North American Wetlands Conservation Fund (USCEQ 2000) to the full authorized level of $30 million. This fund will assist "federal, state, local, and tribal governments, the private sector, land trusts, and the public acquire, protect, restore, or enhance wetlands, and restore waterfowl and other wetland-dependent wildlife" (USCEQ 2000).

On a more local level, many states have created their own wetland regulations. Salvesen (Urban Land Institute 1991) described that states have actively taken control of their own wetlands either directly with specific wetland laws, or indirectly through use of previously established federal laws and regulations. As of 2000, 35 states had specific wetlands plans, policies or acts implemented for regulation, conservation or preservation (Wahnee 2000). Of the 15 remaining states, 10 had no wetlands plans at the state level, and the existence of these plans in the other five states is not confirmed (Wahnee 2000). Permitting gives states the ability to assist in regulating their own wetlands, and allows for a more concise plan for specific wetland types and the functions and heritage they lend to each individual state. Whereas Massachusetts defines a wetland as "an area where at least 50 percent of the vegetation is comprised of characteristic wetlands plants," North Dakota defines a wetland as "a natural depression area that is capable of holding shallow, temporary, intermittent, or permanent water" (Urban Land Institute 1991). Though federal wetlands policy is a blanket for a nationwide natural resource, these state-specific definitions allow for a more individual look at the integrity of wetlands in regions throughout the country.

Wetlands are protected under many federal and state acts and policies. Yet despite their protection, wetland destruction is still allowed, provided the loss is mitigated. This requires that the loss of function and acreage is replaced (Brinson and Rheinhardt 1996) through creation or restoration.

G. Wetland Restoration and Creation

Reported by Mitsch et. al. (1998), a proper wetland restoration or creation project can replace many wetland functions lost as a result of development. Because of this, creation and restoration are used extensively, but not solely, in mitigation. Mitigation, the practice of "alleviating some or all of the detrimental impacts arising from a given action," contains a hierarchy to halt the destruction of wetlands (Votteler and Muir 1996).

Specifically defined by the United States Council on Environmental Quality (USCEQ), mitigation includes avoiding impact, minimizing impact, rectifying impact, or compensating for the impact (NWF 1987, Canter 1996). Restoration and creation are used to rectify or compensate for the impact by creating new wetlands, restoring a former wetland, or enhancing/preserving and existing wetland (Votteler and Muir 1996).

1. Restoration

Restoring a wetland to its pre-disturbance functioning and integrity is often practiced (Brinson and Rheinhardt 1996) by improving a former wetland area that has been degraded or altered (Hammer 1997). One key wetlands restoration project currently being undertaken is that of the Florida Everglades (Englehardt 1998, Young 1996). Defined by Cohn (1994), the Everglades (prior to disturbance) are:

> a broad, slow-moving sheet of water flowing south and southwest from Lake Okeechobee to Florida Bay and the Gulf of Mexico, extend[ing] to nearly 50 miles wide and more than 100 miles long. [They] are part of a larger watershed of wet prairies, sawgrass marshes, forest swamps, riverine wetlands, and lakes dominating southern Florida.

Initial reclamation activities, including draining and destruction, in the late 1800s began converting the Everglades from wilderness into more "useful" areas for development (Finkl 1995). Following an extensive history of alteration, the Florida legislature passed the Everglades Forever Act in 1994, initiating the Everglades Program (Englehardt 1996, NPS 1998). Now named the South Florida Ecosystems Restoration and Sustainability Project (SFERSP), three goals have been established: establish the proper hydrologic regime, restore and enhance the natural system, transform the built environment (NPS 1998). Because of extensive sugar cane agriculture in the region, an estimated 200 tons of phosphorus per year flows into the Everglades region (Cohn 1994), thus degrading water quality and creating a lack of diversity in the Everglades flora and fauna (Englehardt 1998). One of the SFERSP's actions is to assist in nutrient removal from the water column by constructing approximately 17,500 hectares of wetlands in seven elemental actions with 55 inclusive projects. These elements (and corresponding projects) include (South Florida Water Management District 2000):

- Everglades Construction Project (18)
- Hydropattern Restoration (7)
- Research and Monitoring (12)
- Regulation (10)
- Exotic Species Control (2)
- Funding (5)
- Annual Progress Report (1)

The Kissimmee River Restoration Project alone includes creating 10,600 hectares of wetlands through such actions as de-channelization of the river (Olson 2000).

An underlying purpose of this project lies not only in the stated goals, but in the fact that the Everglades are a unique feature found nowhere else on earth that need to be preserved (Davis and Ogden 1994, NPS 1998). In March 2000, Florida Governor Jeb Bush asked the state's legislature for $100 million to be budgeted as part of Florida's contribution to the project because of the importance of the Everglades to Florida's future (News 2000).

> While it is important for Florida families to invest for their future, it is also important that state government make a different kind of investment. There is no more valuable legacy we could leave them than a clean and bountiful natural world.

It was previously discussed that visual-cultural functions are important, especially when the features are unique to a specific entity. This holds true in the Everglades (NPS 1998). One National Park Service official was quoted as saying, "we can't return to what we had a hundred years ago. But we can restore the natural functioning of the Everglades," (Cohn 1994). To date, the project is estimated to cost $518 million which will be approximately equally shared by the federal government and the state of Florida (Olson 2000).

Restoration projects are also being undertaken in Oklahoma. Through the USDA, the National Resource

Conservation Service (NRCS) currently has 60 Wetlands Restoration Program (WRP) projects occupying 9717 hectares in Oklahoma, one of the top 10 states in the U.S. with land enrolled in the program (NRCS 1999). One of the largest of these projects, also one of the largest of all projects, is the 2920 hectare Red Slough project. These projects include replacing shallow water conditions, filling drainage ditches, constructing low dikes, installing water control structures, and re-establishing natural vegetation (NRCS 1999). Another project is Hackberry Flat Wildlife Management Area. Hackberry Flat is an important restoration project due to its location along major waterfowl flyways and for providing habitat for endangered whooping cranes (Cameron University (a) 1997). As stated in a press release from the University (Cameron University (a) 1997), "when completed, more than 8,000 acres, including a 400 acre lake, will have been developed as habitat for waterfowl."

2. Creation

Creating a wetland where one did not previously exist is another mitigation practice. Created wetlands are built in areas where wetlands did not previously exist (Hammer 1997). This requires establishing the hydrology, soils and vegetation that define a wetland (Brinson and Rheinhardt 1996). Of these, establishing the hydrology (i.e., water-level flux and pulse) (Middleton 1998) is of utmost importance because wetlands are highly dependent on the amounts of water available to meet their specific requirements (Kusler et. al. 1994). As described by Brinson and Rheinhardt (1996), some wetlands are quite difficult to create due to their hydrologic requirements. For example, without building a river, river floodplains are impossible to create.

Problems with created and restored wetlands lie in the fact that this science is relatively new and success is sometimes limited. Too often failure is due to improper hydrologic conditions (Mitsch et. al. 1998). Even with a successful ecosystem construction (including hydrology), it has been noted that other goals, including the attraction of specific endangered birds, has failed (Young 1996, Mitsch et. al. 1998). In addition, problems exist in measuring the success of creations and restorations. The development of functional standards can assist in quantifying restoration activities (Brinson and Rheinhardt 1996), and creation efforts can be successful if this science can create "wetlands that achieve acceptable levels of function within acceptable time periods," (Scatolini and Zedler 1996).

H. Oklahoma's Wetlands

Like all wetlands, Oklahoma wetlands perform many important environmentally and economically valuable functions (Jones et. al. 1996). The Oklahoma Conservation Commission (OCC) has identified important wetland functions for the state to include (1996):

-sediment/toxic substance retention

-nutrient removal/transformation

-flood peak reduction

-habitat provision for:

aquatic species

semiaquatic species

wetlands wildlife species

vegetation

food chain support

-groundwater recharge

-low flow augmentation

-groundwater discharge buffering

-recreation/education

-timber/agricultural production

Though these ecosystems provide the state with many important functions, Oklahoma has lost an estimated 67 percent of its wetlands over the past 200 years, since the late 1700s (Jones et. al. 1996). One estimate by the United States Fish and Wildlife Service (USFWS) reports that less than 15 percent of the state's original bottomland hardwood forests still stand due to agricultural development (Wilkinson 1987). Present wetlands cover approximately two percent of the state's land (Jones et. al. 1996). Distributed throughout the state, Oklahoma's wetland resources vary from riparian corridor wetlands along the Cimarron, Canadian, Washita and Red Rivers, playa lakes in the Panhandle, to swamps and bottomland hardwood forests in eastern and southeastern parts of the state (Jones et. al. 1996, OWRB 1998).

Despite the important functions they perform, a survey conducted in January 1997 by the Business Research Center at Cameron University in Lawton, Oklahoma indicated that, though 82 percent of those who responded to the survey were aware of wetlands in Oklahoma, over 50 percent had heard little or nothing about these ecosystems (Cameron University (b) 1997). To assist the plight of the wetlands in Oklahoma, the OCC developed the "Oklahoma Comprehensive Wetlands Conservation Plan" (OCWCP) in 1996. This document states:

> ...[The Plan] provides the state with a focused strategy for identifying, understanding, managing, and enjoying one of Oklahoma's most versatile natural resources. The plan offers a comprehensive look at Oklahoma's wetlands and their future conservation needs. The plan identifies issues that are unresolved and the limitation on wetland data and science.

Included in the Plan were the following goals:

- data collection and analysis, as well as long-term monitoring of wetlands trends

-a strong, cooperative partnership between the public and private sectors

With this drive to forge ahead in order to learn and to have a better understanding of these natural resources, the Plan's goals provide an ideal setting for volunteer monitoring. The development of a volunteer monitoring program in Oklahoma will assist with these aforementioned goals through its data collection tied to public participation.

II. Volunteer Monitoring Background

Volunteer monitoring refers to the use of the public sector to collect data on many environmental parameters through training and education. These monitoring activities are growing across the country, and can assist states in increasing the environmental information pool (Mayio 1999). As of 1994, water quality information existed for only 17 percent of the nation's 5.64 million river and stream kilometers, 42 percent of the 16.41 million hectares of lakes, 78 percent of the 88,060 square kilometers of estuaries, and 9 percent of the 57,960 shoreline kilometers, but these numbers continue to grow (Mayio 1999). Everyday citizens are monitoring many parameters in streams, rivers, lakes, reservoirs, estuaries, coastal water, wetlands and wells where they live (USEPA 1998a). Their efforts assist various government agencies with protection and regulation issues (Lyon 1999).

A. Volunteer Monitoring: A Brief History

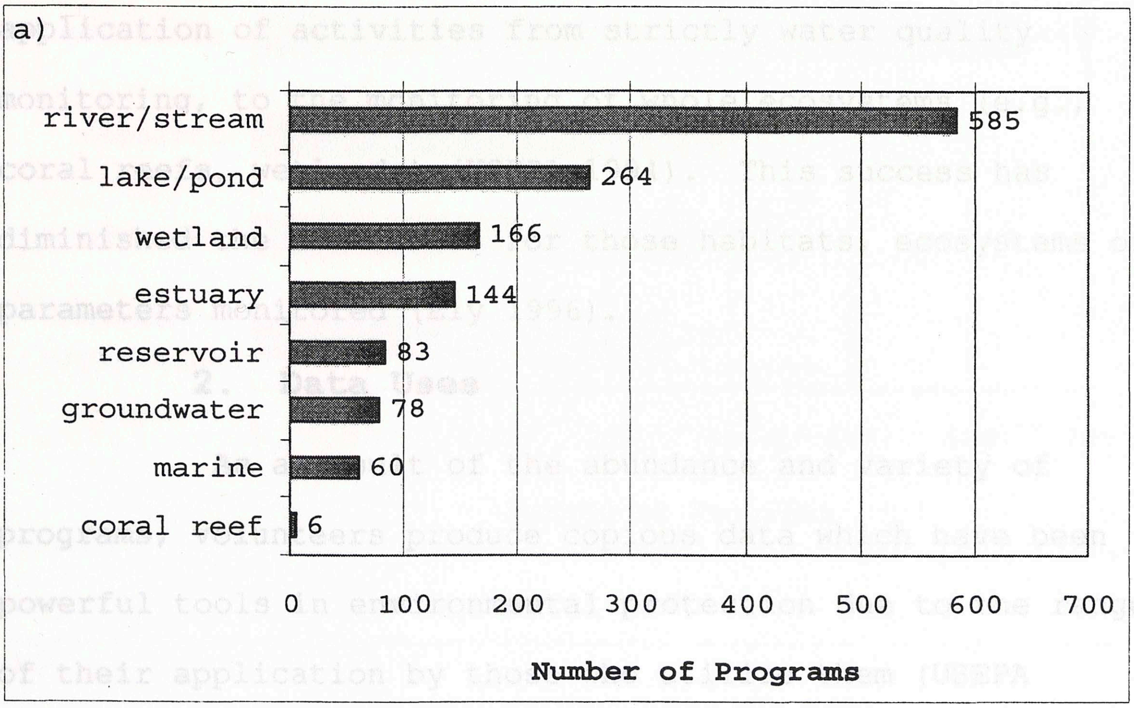
For over 100 years government and private agencies have utilized volunteers to gather pertinent data. The National Weather Service (NWS), U.S. Fish and Wildlife Service (USFWS), Audubon Society, and the National Marine and Fisheries Service (NMFS) have relied upon volunteers to report pertinent local weather data, migratory bird information, and observations on fish populations (Lee 1994). With the dawn of Rachel Carson's *Silent Spring*, citizens came to learn the importance of the environment and have worked with the government to increase its protection (Beattie 1996). The re-birth of the CWA in 1972 included the need for water quality data to be collected by the states (Lee 1994). States soon found a key way to gather data was through volunteer monitoring programs. This also provided a way to collect data in as inexpensive and reliable form (Lyon 1999). Water quality monitoring received formal support in 1988 by the USEPA for two key reasons: 1) to form a basis for stewardship, and 2) to improve what is known about the nation's waters (Mayio 1999). The application of volunteer data collection to many aquatic systems for different uses continues to grow, and has found a stronghold in the stable growth of monitoring connected with state, interstate, local or federal agencies, with environmental organizations or universities (USEPA 1996).

In a survey funded by the McKnight Foundation in Minnesota, it was discovered that many citizens are concerned about the environment in which they live (MacGregor 1997). At the same time, they feel helpless to act in favor of their environment other than by simply visiting a nature center or actively voting against public servants not committed to environmental protection (MacGregor 1997). The development of volunteer monitoring programs has helped to alleviate this feeling of helplessness. The rich history of volunteer monitoring has its roots in citizen-based activities and has more recently allowed many individuals to develop a sense of ownership of the environment and responsibility for the world around them (USEPA 1994, MacGregor 1997).

B. Applications of Monitoring and Data Uses

1. Applications of Monitoring

Before the USEPA published its first edition of the "National Directory of Volunteer Environmental Monitoring Programs" in 1988, 129 volunteer monitoring programs had already been established throughout the United States (USEPA 1994). The latest edition of this directory (1998b) has reported an estimated 768 monitoring programs with the top three environments being rivers/streams, lakes/ponds, and wetlands, respectively (Figure 2.2) (The Volunteer Monitor 1998).



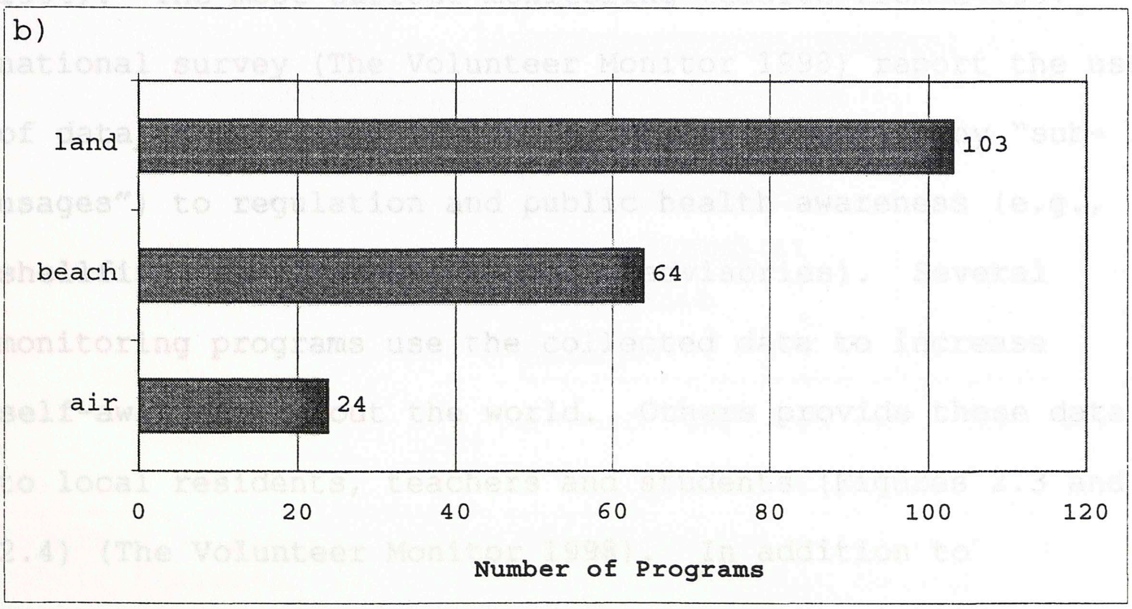


Figure 2.2 Volunteer Environmental Monitoring Programs which Monitor Aquatic (a) and Non-Aquatic (b) Environments (after USEPA 1998b).

This growth has been caused by a need for public involvement due to lack of manpower in government agencies to perform the required monitoring (OWRB 1997). The growth of the volunteer monitoring movement has aided the application of activities from strictly water quality monitoring, to the monitoring of whole ecosystems (e.g., coral reefs, wetlands) (USEPA 1994). This success has diminished the boundaries for those habitats, ecosystems or parameters monitored (Ely 1996).

2. Data Uses

As a result of the abundance and variety of programs, volunteers produce copious data which have been powerful tools in environmental protection due to the range of their application by those who utilize them (USEPA 1994). The most current monitoring results from a 1997 national survey (The Volunteer Monitor 1998) report the use of data to vary from education (which includes many "sub-usages") to regulation and public health awareness (e.g., shellfish bed closures, swimming advisories). Several monitoring programs use the collected data to increase self-awareness about the world. Others provide these data to local residents, teachers and students (Figures 2.3 and 2.4) (The Volunteer Monitor 1998). In addition to themselves, programs reported the data users include primarily all levels of government, advocacy groups and scientists (Figure 2.5) (USEPA 1994).

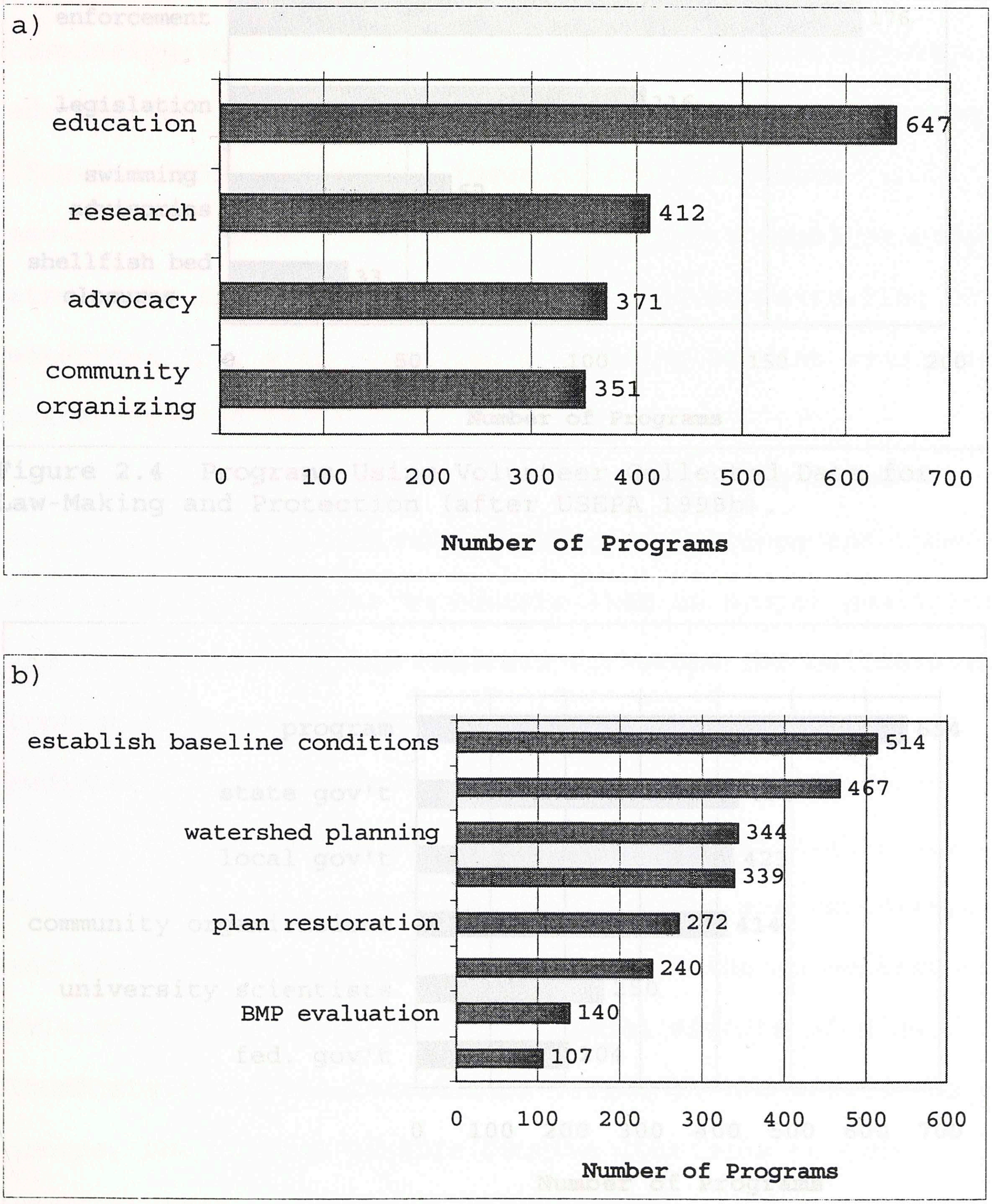


Figure 2.3 Programs Using Volunteer Collected Data for Public Awareness (a) and Planning, Decision Making and Reporting (b) (after USEPA 1998b).

NPS = nonpoint source

BMP = best management practice

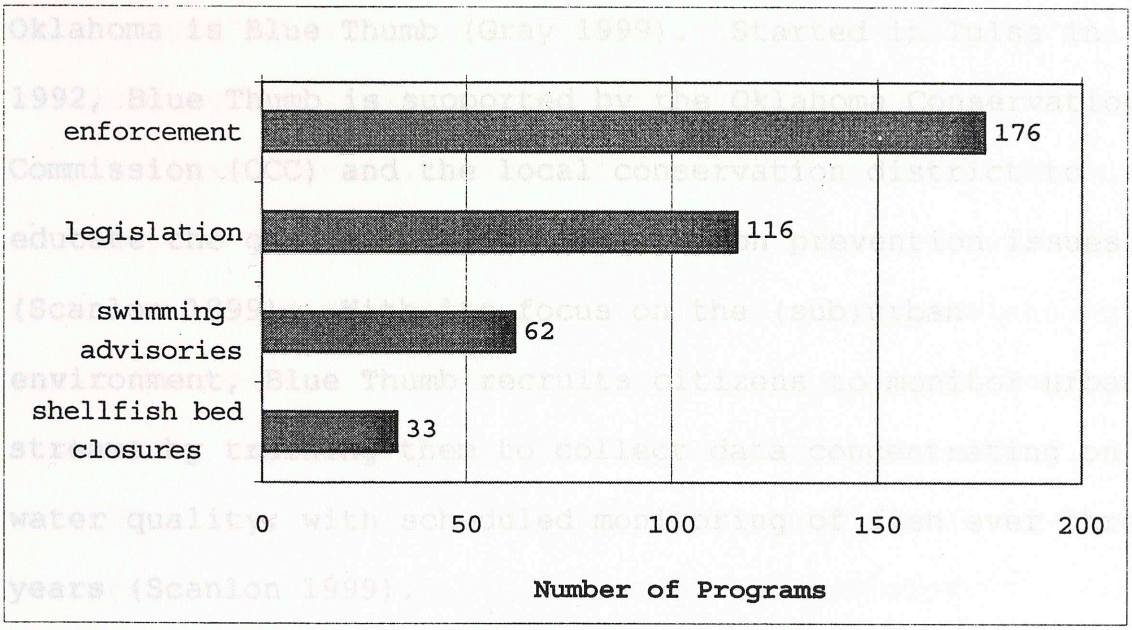


Figure 2.4 Programs Using Volunteer Collected Data for Law-Making and Protection (after USEPA 1998b).

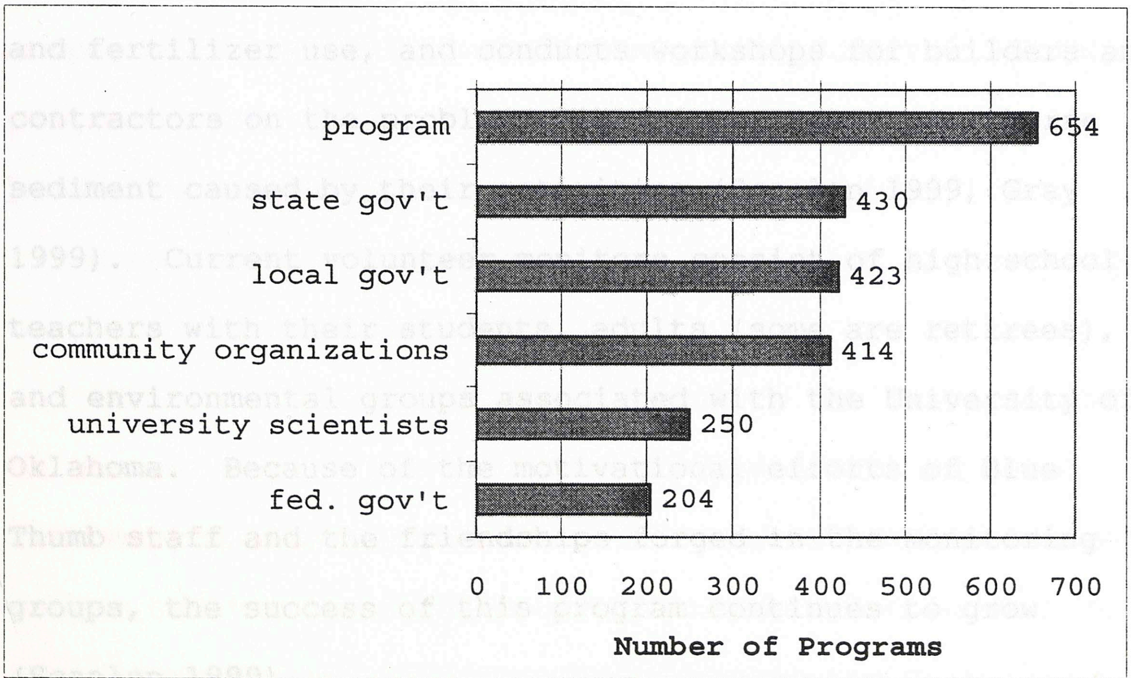


Figure 2.5 Volunteer Environmental Monitoring Program Data Users in the United States (after USEPA 1998b).

One nationwide volunteer monitoring program active in Oklahoma is Blue Thumb (Gray 1999). Started in Tulsa in 1992, Blue Thumb is supported by the Oklahoma Conservation Commission (OCC) and the local conservation district to educate the general public on pollution prevention issues (Scanlon 1999). With its focus on the (sub)urban environment, Blue Thumb recruits citizens to monitor urban streams by training them to collect data concentrating on water quality, with scheduled monitoring of fish ever three years (Scanlon 1999).

In addition to volunteer monitoring, Blue Thumb conducts workshops for homeowners organizations and lawn and garden specialists to educate them on proper pesticide and fertilizer use, and conducts workshops for builders and contractors on the problems with airborne and waterborne sediment caused by their activities (Scanlon 1999, Gray 1999). Current volunteer monitors consist of high school teachers with their students, adults (some are retirees), and environmental groups associated with the University of Oklahoma. Because of the motivational efforts of Blue Thumb staff and the friendships forged in the monitoring groups, the success of this program continues to grow (Scanlon 1999).

C. Problems and Concerns

Though volunteer monitoring is a great supplier of much needed data, problems and concerns arise in data quality and volunteer commitment. The collected data are utilized by all levels of government and scientists for many actions, including regulation and protection. Because of this, it is most important that the collected data are accurate. With this lies the complication of maintaining a pool of committed volunteers to perform the monitoring tasks in a replicable and defensible manner.

When defining objectives for data quality, five factors should be considered: accuracy, precision, comparability, completeness and representativeness (Miller et. al. 1996). The USEPA also requires that any monitoring which is connected to their activities or funding must comply with its quality assurance/quality control (QA/QC) program (OWRB 1997). Because volunteer monitors are not professionals in aquatic sciences or water chemistry, it is often an obstacle to prove to data users that the data are accurate and credible (USEPA 1996).

Maintaining control of data quality can be performed in several ways. *The Volunteer Monitor* (1997) reported that many monitoring programs utilize parallel testing, or rather testing the results of monitored-collected data to that of professionals. It was noted that the main reason for utilizing this technique is to provide government agencies with a guarantee that the monitor-collected data are reliable. When monitors follow the QA/QC protocol and are trained well, it has been shown that their data are credible (Mayio 1999). An additional reason for utilizing parallel testing was for the specific monitoring program's own benefit in identifying the progress, strengths, and weaknesses of the volunteers.

A second area of concern regards maintaining the motivation and commitment of the volunteers themselves. Too often lack of motivation and commitment is the fault of the monitoring program (The Volunteer Monitor 1996). For new, and even established programs, top priority should be to select those volunteers who are committed to the job and whose goals coincide with those of the program for which they intend to work (The Volunteer Monitor 1996). Markowitz (1996) explained that a key element in "volunteer monitoring" and "citizen involvement" is the idea of volunteer leadership. This provides volunteers the ability to set their own goals and brainstorm, thus allowing the sense of community involvement and the "I'm making a difference" notion more of a reality (Markowitz 1996). Additional leaders provide ways of thanking volunteers because "the most effective recognition is to make volunteers feel they're a necessary part of the organization," (Laidlaw 1996).

Overall, the volunteer monitoring movement has grown out of a need for public education and hands-on involvement. Conversely, expanding public education and hands-on involvement results in more citizens volunteering to monitor. Extending into a variety of ecosystems, monitors collect data used by a number of public and private organizations. Though questions have been posed as to data quality, proper education and training results in credible data, and of utmost importance, an educated public.

CHAPTER 3

PROGRAM DEVELOPMENT

Development of this volunteer wetlands monitoring program relied on the integration of information from wetland and public professionals who would be potential data users. Other volunteer monitoring programs nationwide were utilized to select appropriate parameters and methods to be used by the monitors. Compiling these parameters and methods into a monitoring addendum created a tangible product for this program through which the appropriately selected site and group could conduct monitoring activities.

I. Consultation

Wetlands vary throughout the country depending on geographic location. This is especially true in a state as ecologically diverse as Oklahoma (Jones et. al. 1996). Bertolotto (1996) states "a uniform set of monitoring methods cannot be applied rigidly to every wetland, every volunteer group, and every situation." Because of this, establishing an advisory group and receiving consultation from other volunteer environmental monitoring program directors assisted with the volunteer monitoring plan design and was a key task in the development of this project.

As part of a Delphi study (Canter 1996), an initial letter (Appendix A) was sent to all individuals who are members of the Oklahoma Wetlands Working Group (OWWG), an OCC affiliated wetlands interest group. This group consisted of 43 individuals in the technical and public relation fields. These individuals represent various government agencies, Native American entities, universities, and other related state-wide environmental programs. Their responses to several questions were requested per their interest in being involved with the development of the wetlands volunteer monitoring program. Because of their expertise or specific areas of interest in wetlands, their input was useful in establishing those parameters which are most feasible for volunteers to monitor. In addition, their input throughout the project assured reasonable requirements of the volunteers as well as expertise and efficiency in the overall project.

Though only 26.4% of the distributed questionnaires were received (some responses were collections of answers of several individuals at the same agency), all responses indicated that the entities would benefit from monitoring activities, would like to be kept informed as to the progress of the project, and that they would be available for further assistance, schedule permitting. Because the data gathered through volunteer monitoring activities need to be useful and have a relevant purpose to the involved agencies and individuals, responses and comments from these specialists were continuously compiled through questionnaires, comments, and using the regularly scheduled OWWG quarterly meetings. These meetings provided the opportunity to solicit additional information from those individuals present and to discuss the development and implementation of the project in lieu of questionnaires as the program progressed.

II. Selection of Parameters and Methods

A. Parameters

According to the *National Directory of Environmental Monitoring Programs* (1998), 68 parameters, or environmental aspects, are monitored in the nation's wetlands. A majority of wetland monitoring programs monitor a variety of biological and physical/chemical parameters to obtain an overall understanding of the wetlands. However, some programs are only interested in specific parameters rather than whole ecosystem condition (i.e., bird watching programs desire bird-related data, not wetland data unless it is directly impacting the birds, such as surrounding land use or pollution).

The USEPA's *National Directory* (1998b) divides monitoring parameters into two categories, biological and physical/chemical. To compare this program's selected parameters to those nationwide, these two categories were further divided into sub-categories. Biological parameters include aquatic, macrobiological, and task/impact-specific. Physical/chemical parameters include basic water chemistry, toxic water conditions, miscellaneous water contaminants, and existing physical conditions. Parameters are monitored with varied commonality, and each figure represents the number of programs which monitor each parameter (some programs were unable to be quantified due to a lack of information).

Though not commonly monitored by volunteer environmental monitoring programs, four microbiological parameters are monitored in wetlands (Figure 3.1). These parameters provide information about ecosystem productivity because of their status at the bottom of the food chain.

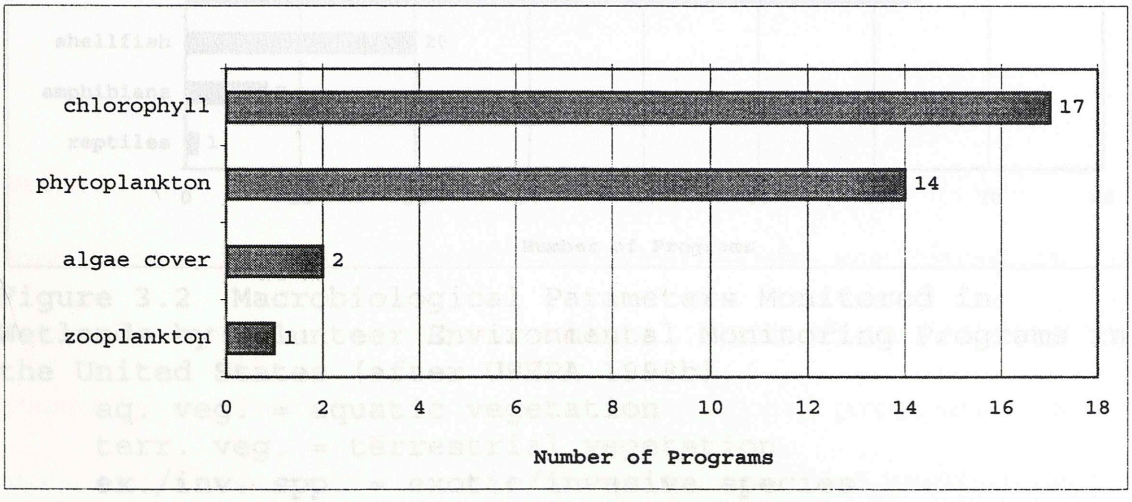


Figure 3.1 Water-derived Biological Parameters Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

Macrobiological parameters are more commonly, or regularly, monitored in wetlands (Figure 3.2). However, some programs monitor only specific parameters (e.g., seasonal bird counts, invasive species).

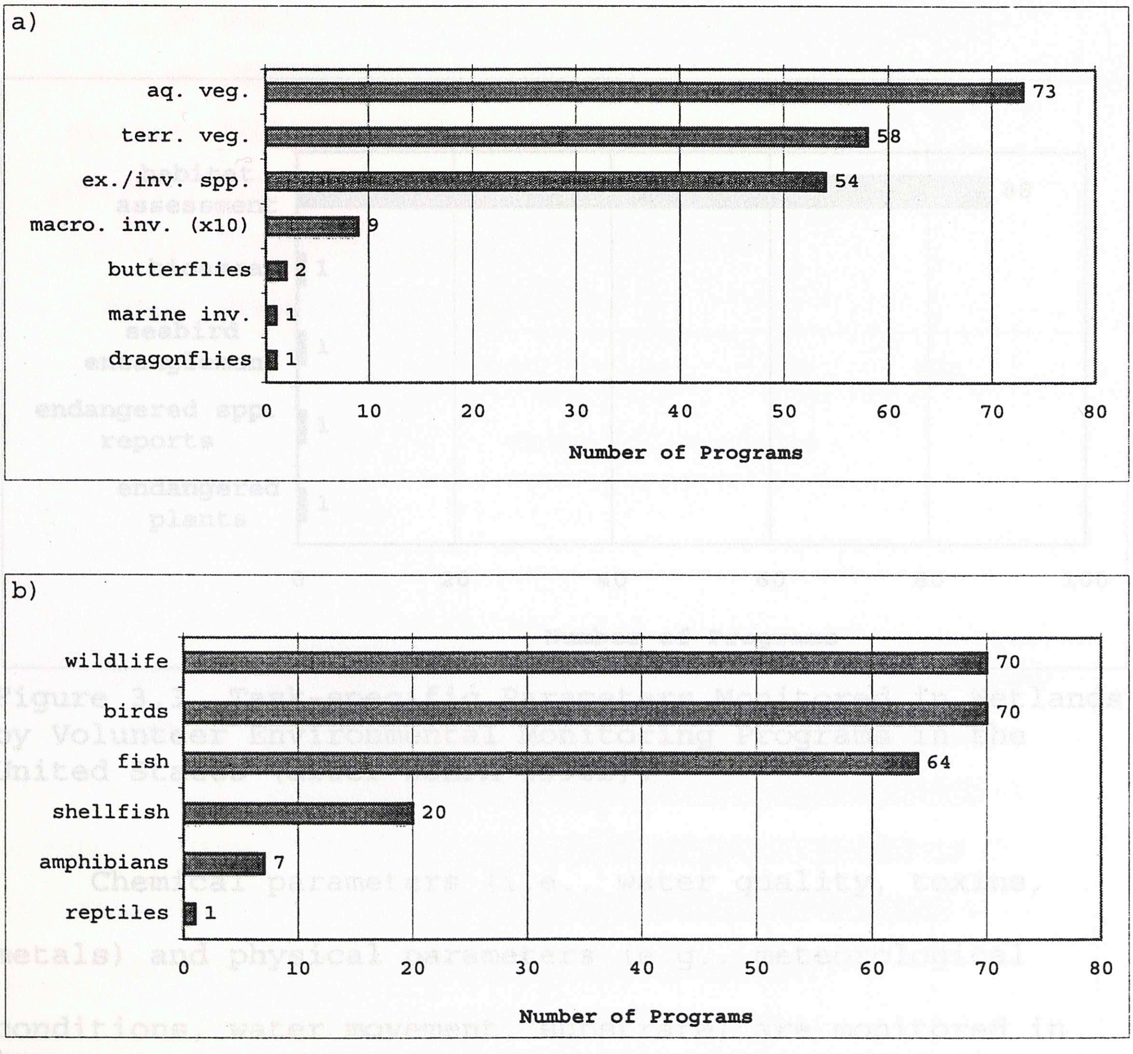


Figure 3.2 Macrobiological Parameters Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

aq. veg. = aquatic vegetation
terr. veg. = terrestrial vegetation
ex./inv. spp. = exotic/invasive species
macro. inv. (x10) = macroinvertebrates (90 programs)
marine inv. = marine invertebrates

The task-specific (Figure 3.3) and macrobiological parameters are often related. For example, those 88 programs which monitor for habitat assessment most often accomplish this by monitoring wildlife, vegetation, or invasive species.

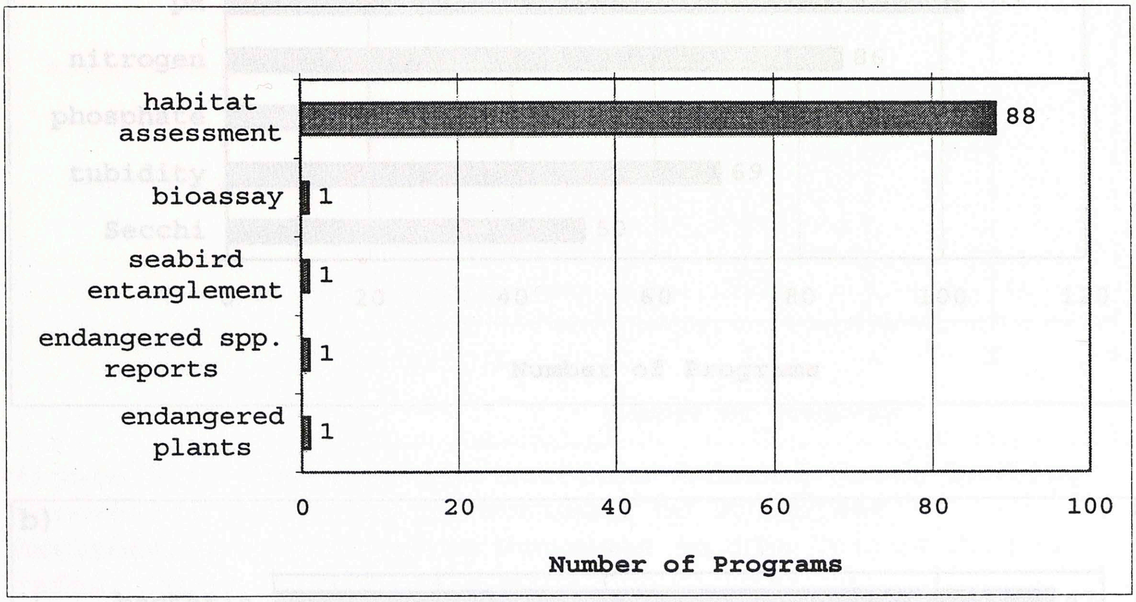


Figure 3.3 Task-specific Parameters Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

Chemical parameters (i.e., water quality, toxins, metals) and physical parameters (e.g., meteorological conditions, water movement, substrate) are monitored in several ways. Basic water quality tests (Figure 3.4) are commonly conducted by volunteer monitoring programs. Not only are these tests relatively easy and inexpensive, but they can provide important information about overall general water quality.

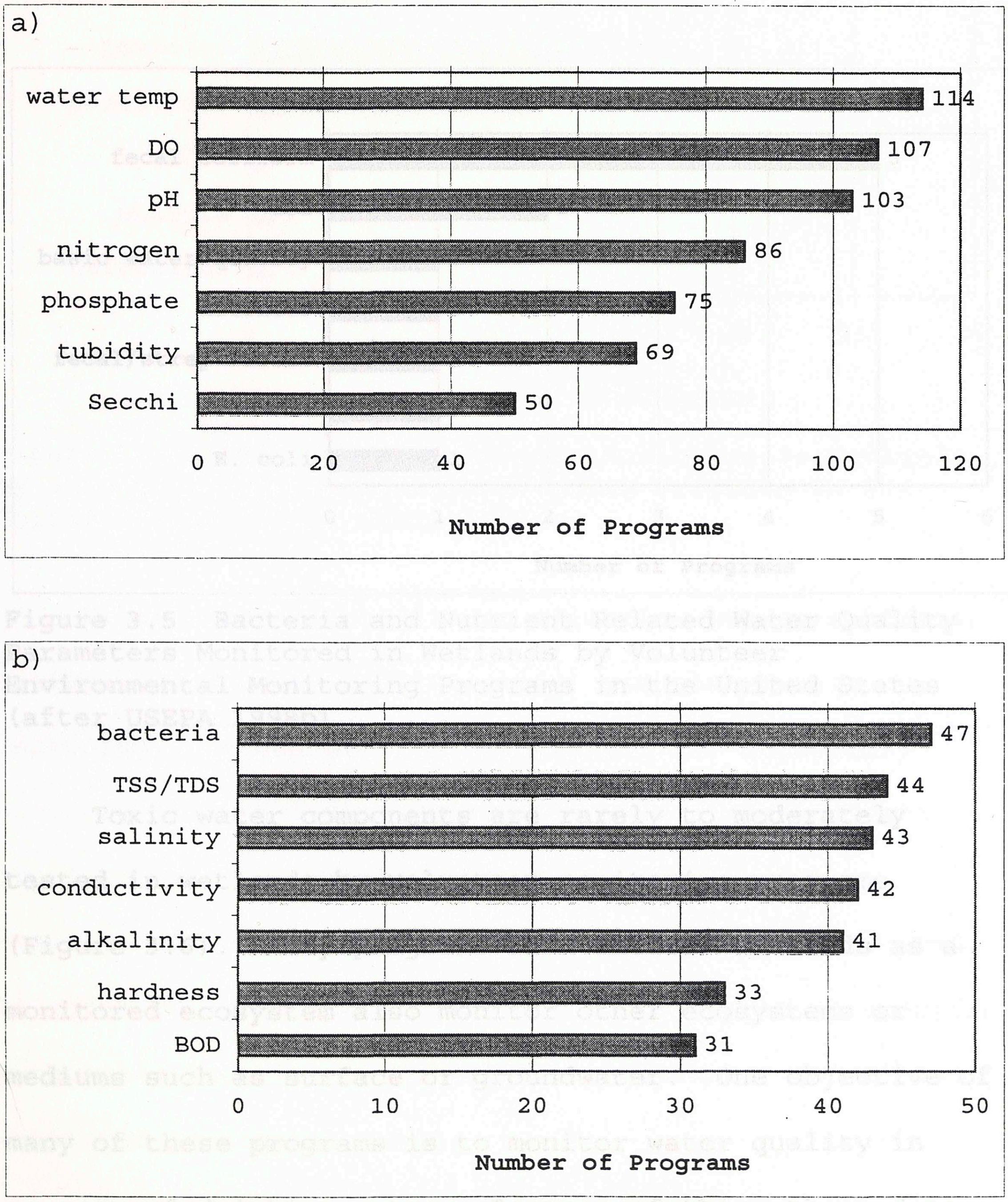


Figure 3.4 Basic Water Quality Parameters Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

TSS/TDS = total suspended solids/total dissolved solid

Because it is usually conducted for a specific purpose rather than general monitoring needs, bacteria and nutrient testing is not common (Figure 3.5).

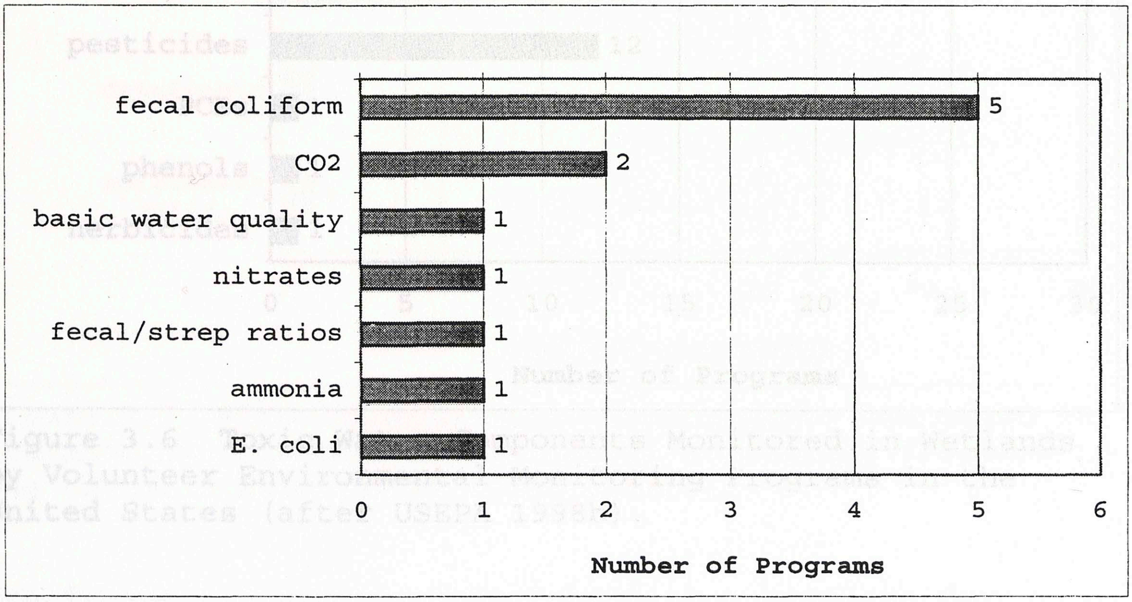


Figure 3.5 Bacteria and Nutrient Related Water Quality Parameters Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

Toxic water components are rarely to moderately tested in wetlands by volunteer monitoring programs (Figure 3.6). Many programs that include wetlands as a monitored ecosystem also monitor other ecosystems or mediums such as surface or groundwater. One objective of many of these programs is to monitor water quality in sources of drinking water. Because of this, these data are often used for regulatory purposes when public health or the welfare of local wildlife may be at risk.

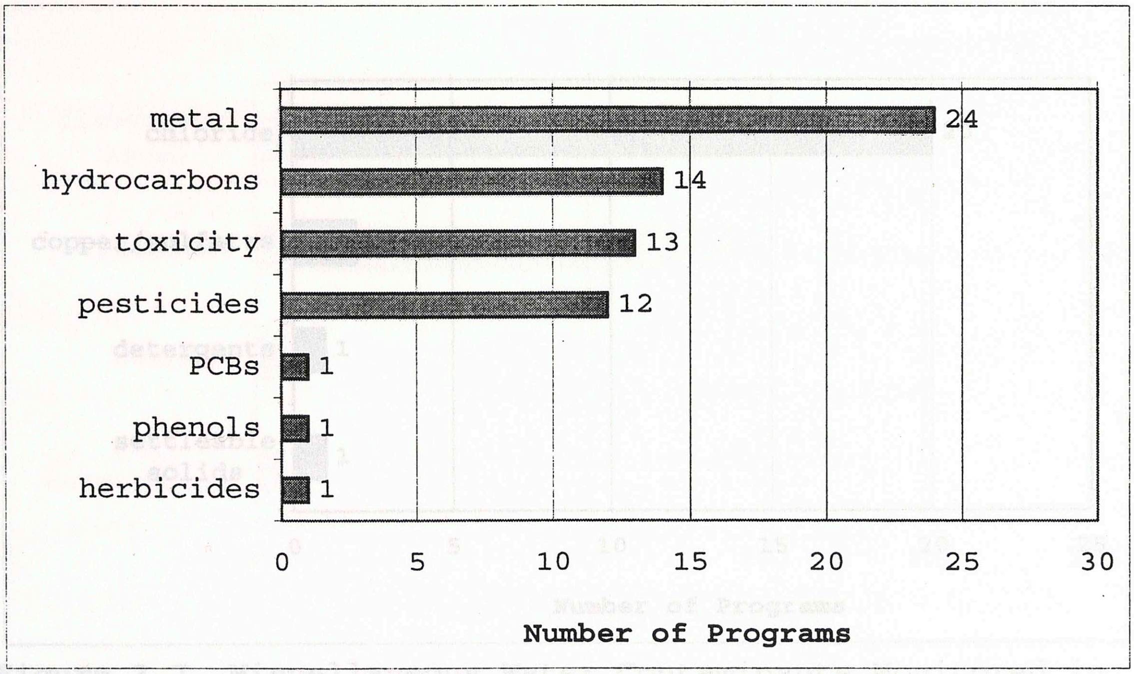


Figure 3.6 Toxic Water Components Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

Other contaminants (i.e., chloride, copper/sulfates, detergents, and settleable solids) are also rarely monitored, but can provide information for regulatory purposes (Figure 3.7). Settleable solids may indicate problems with the water's turbidity, thus having a negative effect on the aquatic ecosystem being monitored. In addition, these parameters may be monitored in specific geographic locations. Chloride, for example, is mainly monitored in coastal areas.

Existing physical conditions affected by meteorological conditions (e.g., rainfall, temperature)

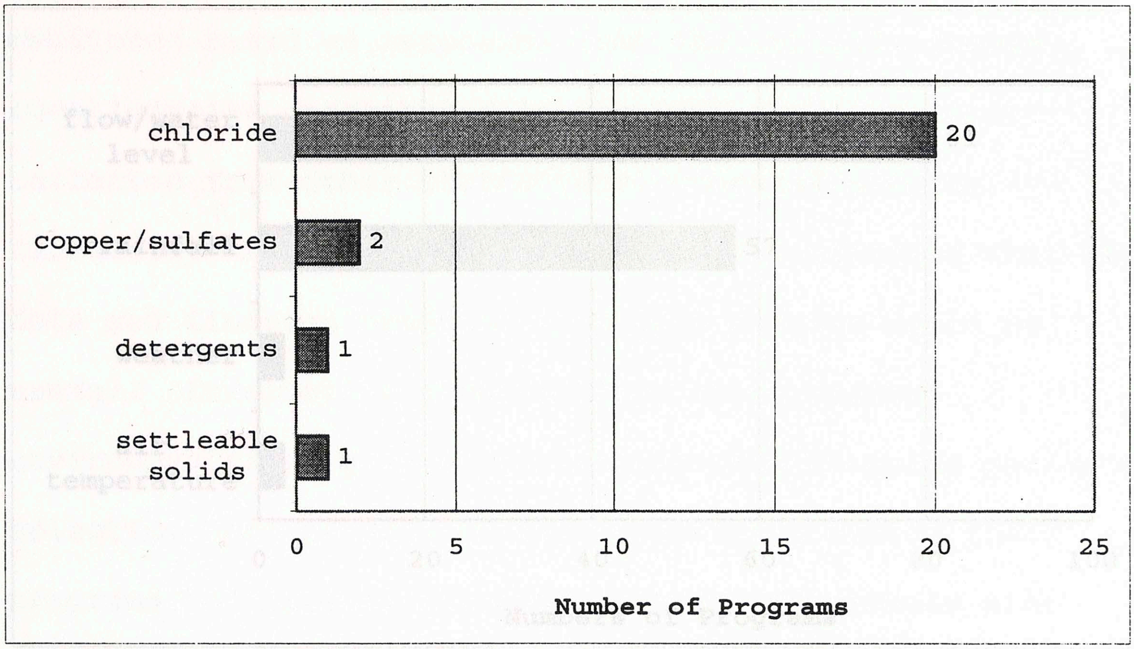


Figure 3.7 Miscellaneous Water Contaminants Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

are frequently monitored to establish a baseline for possible effects on ecosystem processes (Figure 3.8). Because phosphorus can sorb to the surface of particulate matter, for example, excessive rainfall may increase phosphorus levels in the water due to disturbed sediment being suspended in the water column. Dissolved oxygen can be affected by wave action (a result of water flow or surface winds) or photosynthesis (which can be influenced by cloud cover). Other existing physical conditions that are monitored by volunteers are often coupled with programs monitoring streams or land ecosystems (Figure 3.9).

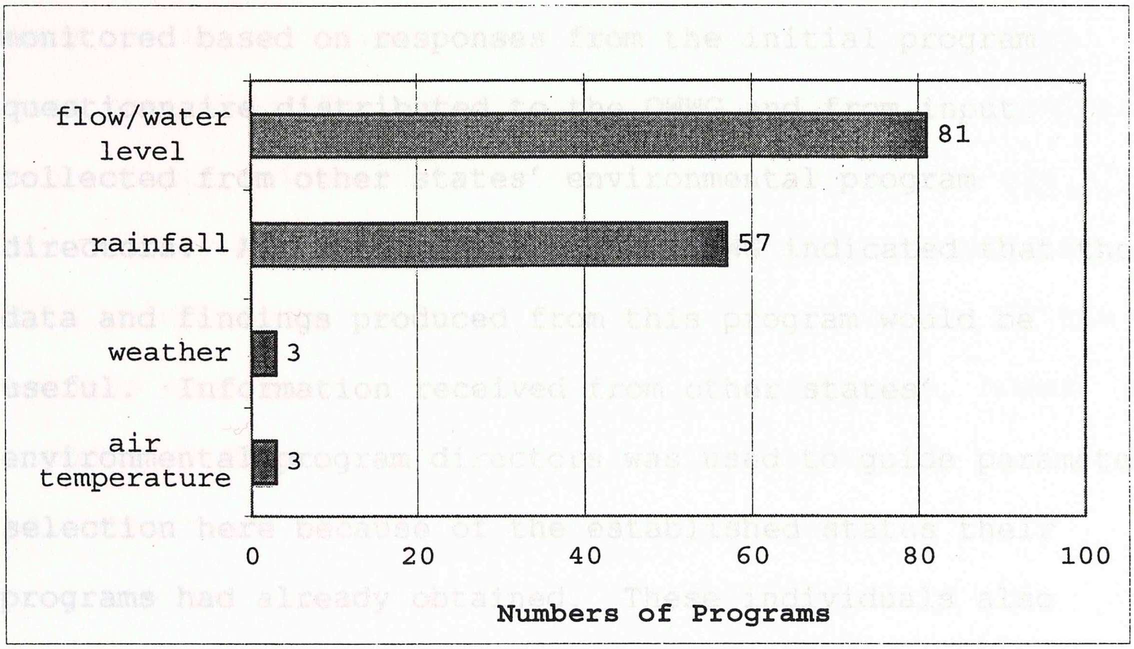


Figure 3.8 Meteorologically Induced Existing Physical Conditions Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

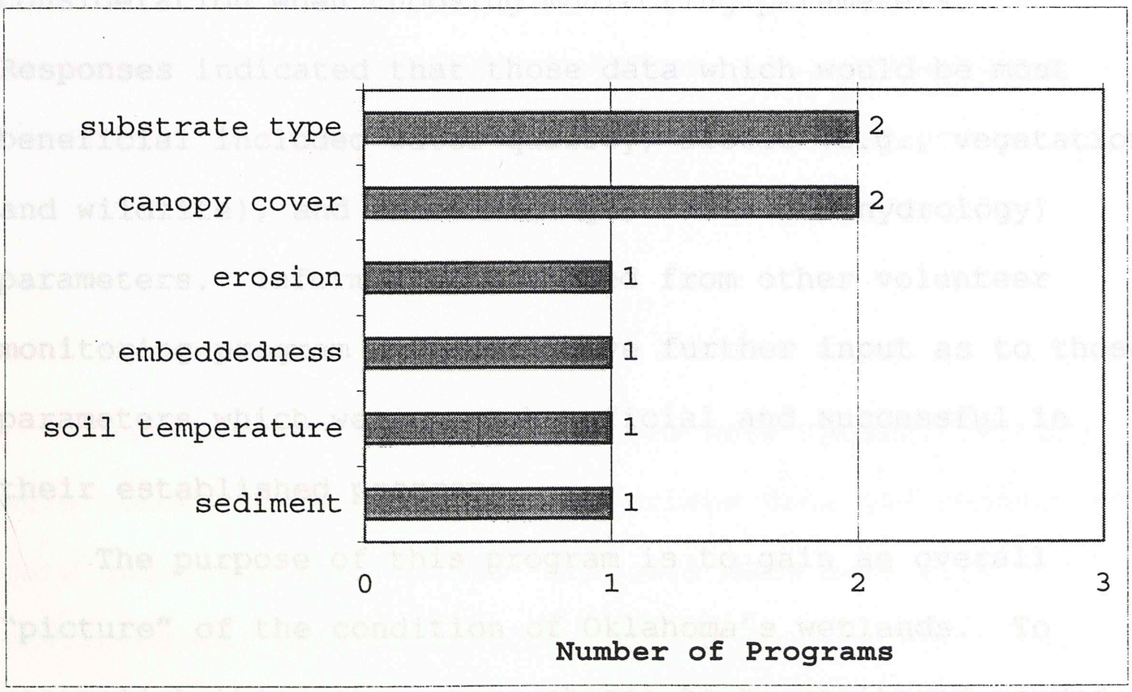


Figure 3.9 Existing Physical Conditions Monitored in Wetlands by Volunteer Environmental Monitoring Programs in the United States (after USEPA 1998b).

Parameters for this program were chosen to be monitored based on responses from the initial program questionnaire distributed to the OWWG and from input collected from other states' environmental program directors. All responses from the OWWG indicated that the data and findings produced from this program would be useful. Information received from other states' environmental program directors was used to guide parameter selection here because of the established status their programs had already obtained. These individuals also expanded the pool of professionals available for use in consultation as work progressed.

All responses from the OWWG were taken into consideration when choosing monitoring parameters. Responses indicated that those data which would be most beneficial included water quality, biotic (e.g., vegetation and wildlife), and abiotic (e.g., soils and hydrology) parameters. Information gathered from other volunteer monitoring program directors gave further input as to those parameters which were most beneficial and successful in their established programs.

The purpose of this program is to gain an overall "picture" of the condition of Oklahoma's wetlands. To accomplish this, parameters chosen to be monitored needed to incorporate data on the physical, biological, and chemical aspects of the wetland ecosystem. Nine parameters were chosen to collect these data: weather, surrounding land use, wildlife, amphibians, water quality, photopoints, vegetation, soils and hydrology. These parameters are among the most commonly monitored nationwide and provide data which can be analyzed to assess the condition of the wetland ecosystem, including baseline conditions, human impacts or degradation. Table 3.1 summarizes the parameters and the data collected from each.

Another essential step in the development of the program was to select a name or title which appropriately conveyed the program's purpose and goals. This program was developed for the purpose of gathering data to assess the health, or condition, of Oklahoma's wetlands. Similar to many other environmental programs, an acronym, WHAM, was developed to convey the name Wetland Health Assessment Monitoring which states the purpose of the program's activities.

B. Methods

Once the monitoring parameters were chosen, methods were needed to collect the appropriate data and conduct the data gathering activities. Contacts were made with environmental monitoring directors nationwide via E-mail and telephone communications. These individuals became the pool for gathering techniques and methods for monitoring

Table 3.1 Parameters and Associated Data Collected in the Pilot Program.

Parameter	Purpose	Data Collected
Weather	gather pre-existing baseline environmental data	-temperature -wind direction -present weather (i.e., sunny, cloudy, etc.)
Surrounding Land Use	reference activities which may impact the wetland	-human impacts -degradation -wetland sketch
Wildlife	provide a general overview of wildlife diversity	-wildlife seen or heard -wildlife evidence
Amphibians	monitor community diversity	-bullfrogs seen/heard -presence/absence of other species
Water Quality	provide baseline water quality data	-temperature, pH, dissolved oxygen, ammonia, nitrate, phosphate, chlorophyll a
Photopoints	document ecosystem change	-establish three sites and take a panoramic photo sequence
Vegetation	sample indicator species and community diversity	-tally counts of 13 plant species
Soils	delineate wetland boundaries and provide data on geochemical processes	-standing water depth -presence/absence of sulfide odor and mottles -relative color -depth to ground water
Hydrology	document the hydrologic regime	-staff/crest height -groundwater depth

activities. Their established methods and monitoring procedures lent experience to the development of methods for this program. Their failures and mistakes were also beneficial in avoiding pitfalls when selecting methods.

Five programs were chosen as templates for developing or borrowing monitoring methods for WHAM because of the similar goals each shared with this program. These programs are:

-Illinois RiverWatch (*Illinois RiverWatch Stream Monitoring Manual*, Illinois DNR 1998)

-Georgia Adopt-a-Wetland (*Georgia Adopt-a-Wetland Manual*, Georgia DNR 1998)

-Washington State's King County Adopt-a-Beach (Miller et. al. 1996)

-USEPA Region 10 Wetland Walk (1996)

-Izaak Walton League of America *Handbook for Wetlands Conservation and Sustainability* (Firehock et. al. 1998)

The successful implementation and establishment in individual states, or in the nation, provided a solid basis which supported the selection of those methods for Oklahoma's program. Most methods were borrowed directly or modified depending on their level of difficulty and the expertise needed in the field for technical assistance. Some WHAM methods were developed independently of any program, but were inspired by the methods used elsewhere.

1. Weather

Using the *Illinois RiverWatch Stream Monitoring Manual* and the USEPA Region 10 *Wetland Walk Manual*, separate weather components were chosen from each in order to monitor the weather conditions present at the time of monitoring. These include air temperature, wind direction, cloud cover (i.e., clear/sunny, partly cloudy/sunny, overcast, showers, rain or storm conditions).

2. Assessing Surrounding Land Use

Surrounding land use can indicate impacts a wetland area may be receiving because of agriculture (i.e., nutrient runoff, livestock grazing) or residential areas (i.e., increased traffic due to all-terrain vehicles, trash, fertilizer lawn runoff). The method used to monitor surrounding land use is simply for the volunteers to walk around the wetland and check off any signs of human impacts or degradation. This parameter is especially important on the initial site visit in order to properly document the initial state of the wetland. Subsequent visits dictate that if there are dramatic changes in land use or if excessive degradation is present (i.e., dumping, pollution), volunteers are to photograph the impact. A complete list of human impacts and signs of degradation was developed using those listed in the EPA Region 10 *Wetland Walk Manual*, *Illinois RiverWatch Stream Monitoring Manual*, *Monitoring Manual*, Georgia Adopt-a-Wetland, and the Izaak Walton League of America *Handbook for Wetlands Conservation and Sustainability*.

3. Describing the Wetland

This method is only performed during the initial visit to the selected monitoring site. As described in the USEPA Region 10 *Wetland Walk Manual* and by the Izaak Walton League of America *Handbook for Wetlands Conservation and Sustainability*, a hand drawn map is created of the wetland area. Several descriptive and spatial features are required in order for non wetland visitors (i.e., those individuals who will not visit the site personally, but will use the data) to understand the site. These features include compass direction and a legend including areas of open water, dominant vegetation, buffers, water flow direction, photopoints, standing water, and transect placement.

4. Wildlife Observations

The purpose of WHAM is to collect information which will assist wetland professionals and other entities in assessing the condition of Oklahoma's wetland resources, including wildlife diversity. It is not expected that the volunteer monitors are biologists, zoologists, ecologists, or have any expertise identifying wildlife species, only that they can identify and quantify the general wildlife seen in their wetland. Wildlife observation methods include listing those animals seen, noting if they are dead (it is thought that even dead animals can indicate wetland wildlife diversity), and checking all boxes which list signs of wildlife evidence such as skins, feathers, tracks, shells, feeding evidence, nests and burrows.

5. Amphibian Observations

The expertise needed to identify amphibian calls or to catch specimens is beyond what is expected of the volunteer monitors for this program, but because amphibians are important indicators of a wetland's health, some amphibian monitoring is needed. Bullfrogs were chosen because of their unmistakable call, their distinguishable appearance, and because their overabundance in a wetland ecosystem can create problems for other amphibian species due to the bullfrog's predatory behavior, thus indicating possible problems in amphibian community diversity.

To monitor bullfrogs, volunteers are asked to record any bullfrogs seen or heard. In addition, volunteers are asked to record any other amphibians seen (these need not be identified, only noted) during a monitoring visit.

6. Water Quality

WHAM is directly affiliated with activities conducted by OWW, thus all water quality monitoring methods from OWW were used for the selected water quality tests used herein and can be found in Appendix B. The water quality tests chosen to be conducted in wetlands include: temperature, pH, dissolved oxygen (DO), nitrate, ammonia, orthophosphate, and chlorophyll *a*.

7. Transect Establishment

Transect establishment is conducted on the initial visit to the wetland site because vegetation observations and soil assessments are dependent on permanent monitoring sites along these transects to collect spatially consistent data throughout the lifetime of the monitoring activities. Traditionally, establishing transects requires placing a baseline parallel to the area to be monitored, then placing transects perpendicular to this baseline at a pre-established interval (Figure 3.10). The Washington Adopt-a-Beach program and the Izaak Walton League of America were chosen as models for the development of a transect method for WHAM.

Because of the expertise available to those programs, wetland professionals are present in the field for the establishment of a baseline and the corresponding transects through the wetland. The purpose of transect establishment for WHAM is to sample vegetation and soils. To gather this information, four transects were placed in the wetland, one in each compass direction (north, south, east and west) (Figure 3.11). These transects (each being a minimum of

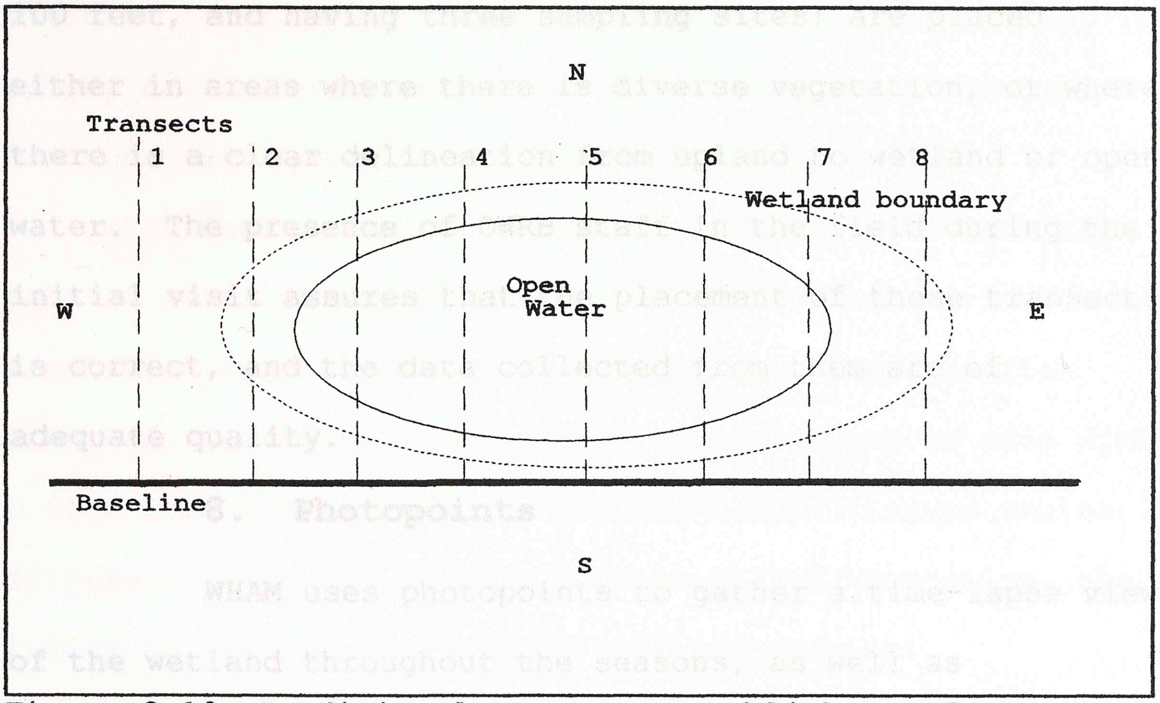


Figure 3.10 Traditional Transect Establishment for Environmental Sampling.

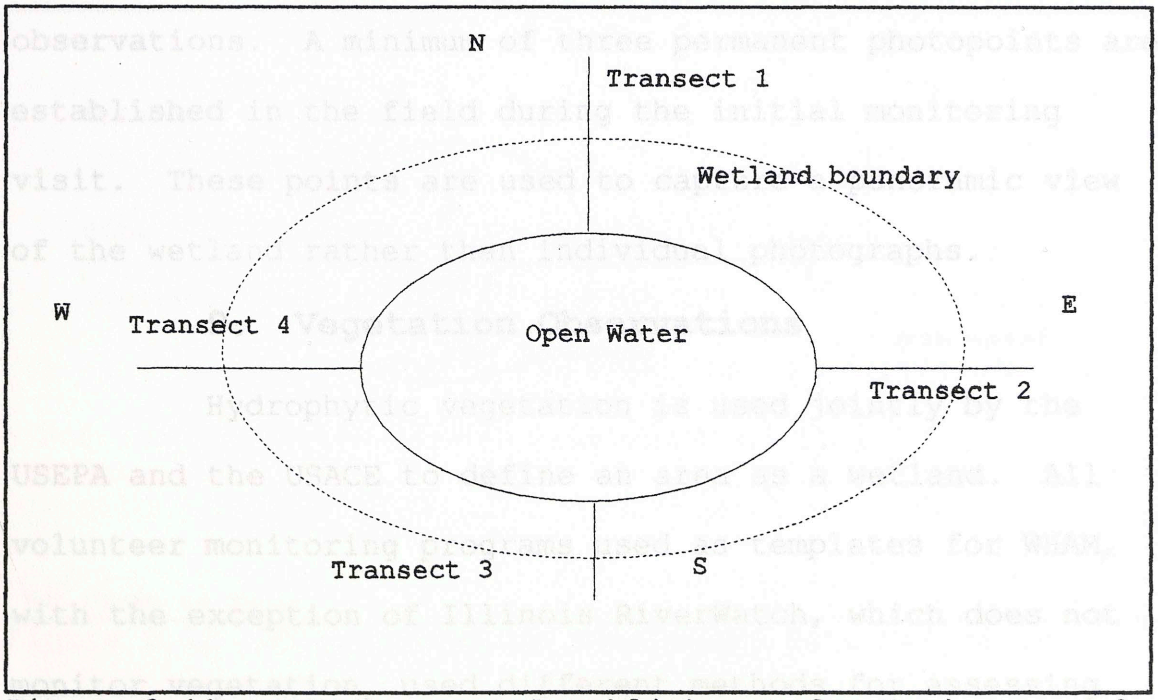


Figure 3.11 WHAM Transect Establishment for Environmental Sampling.

100 feet, and having three sampling sites) are placed either in areas where there is diverse vegetation, or where there is a clear delineation from upland to wetland or open water. The presence of OWRB staff in the field during the initial visit assures that the placement of these transects is correct, and the data collected from them are of adequate quality.

8. Photopoints

WHAM uses photopoints to gather a time-lapse view of the wetland throughout the seasons, as well as throughout the duration of the monitoring program as a whole. In addition, similar to many programs, WHAM uses these photographs as a supplement to volunteers' data and observations. A minimum of three permanent photopoints are established in the field during the initial monitoring visit. These points are used to capture a panoramic view of the wetland rather than individual photographs.

9. Vegetation Observations

Hydrophytic vegetation is used jointly by the USEPA and the USACE to define an area as a wetland. All volunteer monitoring programs used as templates for WHAM, with the exception of Illinois RiverWatch, which does not monitor vegetation, used different methods for assessing wetland vegetation. These programs ranged from utilizing botanists in the field with volunteer monitors during each visit to identify all vegetation in the specified plots, to simply having volunteers check a box describing the most dominant vegetation in the monitored wetland.

WHAM used a combination of these techniques with the help of state personnel to develop an individualized vegetation monitoring method. Using the sampling sites along all transects, volunteer monitors define an area with a five foot radius using the transect site flag as center (Figure 3.12), and identify only specified vegetation, the indicator species, for each of five categories: tree/forest, scrub-shrub, emergent, floating/submergent, and invasive (Table 3.2).

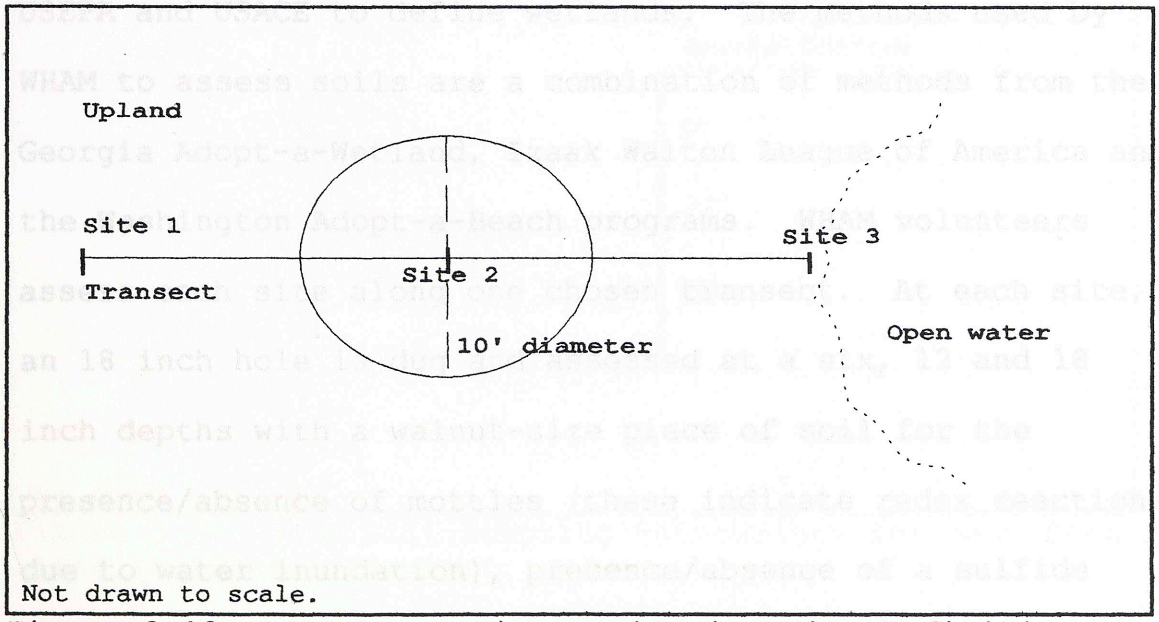


Figure 3.12 WHAM Vegetation Monitoring Site Definition.

Table 3.2 Vegetation Monitored by WHAM Volunteers.

Category	Species		
Tree/Forest	Green Ash (*Fraxinus pennsylvanica*)	Silver Maple (*Acer saccharinum*)	Hackberry (*Celtis laevigata*)
Scrub Shrub	Buttonbush (*Cephalanthus occidentalis*)	False Indigo (*Amorpha fruticosa*)	Black Willow (*Salix nigra*)
Emergent	Cattail (*Typha* spp.)	American Bulrush (*Scirpus americanus*)	Spikerush (*Eleocharis palustris*)
Floating/ Submergent	Duckweed (*Lemna* spp.)	Pondweed (*Potamogeton* spp.)	Coontail (*Ceratophyllum demersum*)
Invasive	Purple Loosestrife (*Lythrum salicaria*)		

10. Soil Assessment

Hydric soils are a second indicator used by the USEPA and USACE to define wetlands. The methods used by WHAM to assess soils are a combination of methods from the Georgia Adopt-a-Wetland, Izaak Walton League of America and the Washington Adopt-a-Beach programs. WHAM volunteers assess each site along one chosen transect. At each site, an 18 inch hole is dug and assessed at a six, 12 and 18 inch depths with a walnut-size piece of soil for the presence/absence of mottles (these indicate redox reactions due to water inundation), presence/absence of a sulfide smell (indicative of microbial activity), and general soil color. The depth of water at the bottom of the hole is also measured (Figure 3.13). In addition, if at any time a site is covered with standing water, the depth of the water is noted, and the next site is assessed.

Because several programs used as templates had professionals in the field each time the volunteers conduct monitoring activities, these general characteristics of soil were chosen on the basis that they are feasible for the volunteers to assess. Input from state wetland professionals at the NRCS in Stillwater, Oklahoma also recommended a simple presence/absence classification and identification system to implement a general soil assessment parameter.

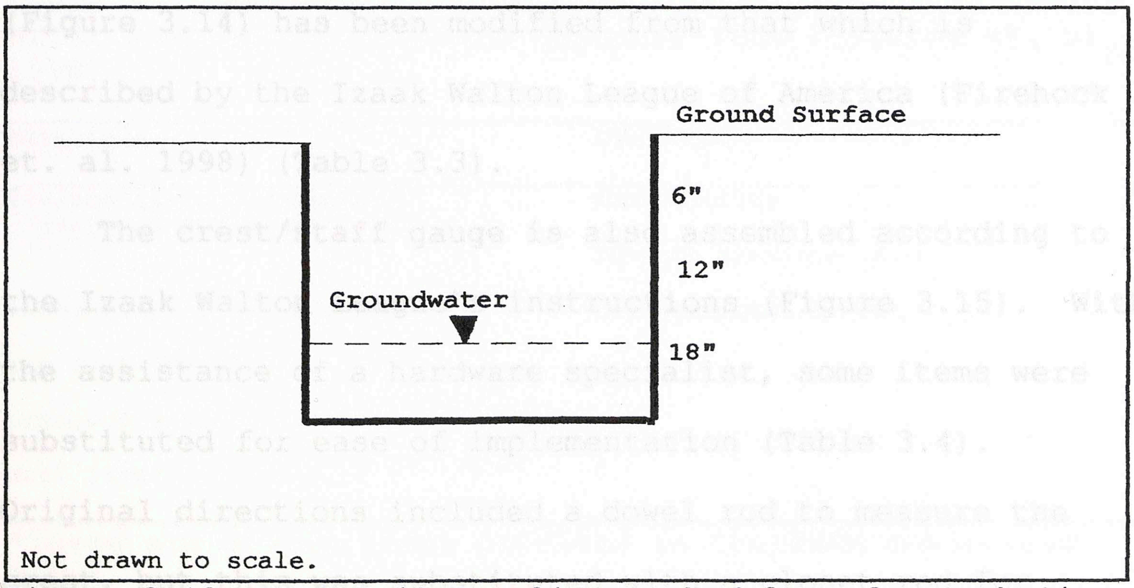


Figure 3.13 WHAM Soil Sampling Methodology for each Site Along the Chosen Transect.

11. Hydrology Assessment

Hydrology, the presence and duration of water, is the third characteristic used by the USEPA and USACE to define wetlands. WHAM volunteers assess hydrology through the installation of a ground water sampler (i.e., shallow well) and a crest/staff gauge in their wetland. These instrument designs were borrowed from the Izaak Walton League of America, though the monitoring methods for the groundwater sampler have been altered for the needs of this program.

It is suggested that a system of groundwater samplers is installed along one or more transects to assess the overall activity of groundwater. WHAM, however, uses only one sampler to assess the general activity of the groundwater. Each groundwater sampler's construction (Figure 3.14) has been modified from that which is described by the Izaak Walton League of America (Firehock et. al. 1998) (Table 3.3).

The crest/staff gauge is also assembled according to the Izaak Walton League's instructions (Figure 3.15). With the assistance of a hardware specialist, some items were substituted for ease of implementation (Table 3.4). Original directions included a dowel rod to measure the crest, but this was substituted with a closet rod for durability and longer lifetime. In addition, the Izaak Walton League suggests that the screen be held in place by duct tape or wire. Because duct tape can deteriorate, and because additional tools would be needed to cut the wire

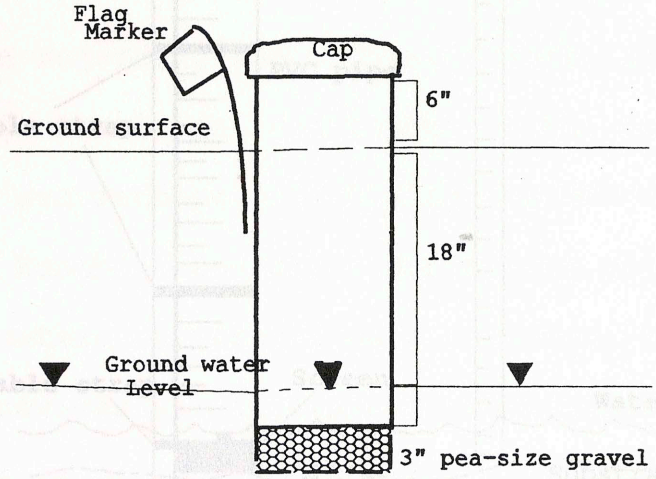


Figure 3.14 Groundwater Sampler Used in the WHAM Program (adapted from Firehock et. al. 1998).

Table 3.3 Materials and Equipment Needed for WHAM Ground Water Sampler Construction (adapted from Firehock et. al. 1998)

Materials	Equipment*
24-inch (4-inch diameter) piece of PVC pipe	sharpshooter
	24-inch aluminum ruler
loose-fitting cap for pipe	red permanent marker
pea size gravel	
orange transect flag*	
duct tape*	

*These are staple items provided in the WHAM monitoring kit.

(which could also possibly rust), heavy duty cable straps were chosen for WHAM because of ease of installation and durability (thus prolonging the lifetime of the equipment).

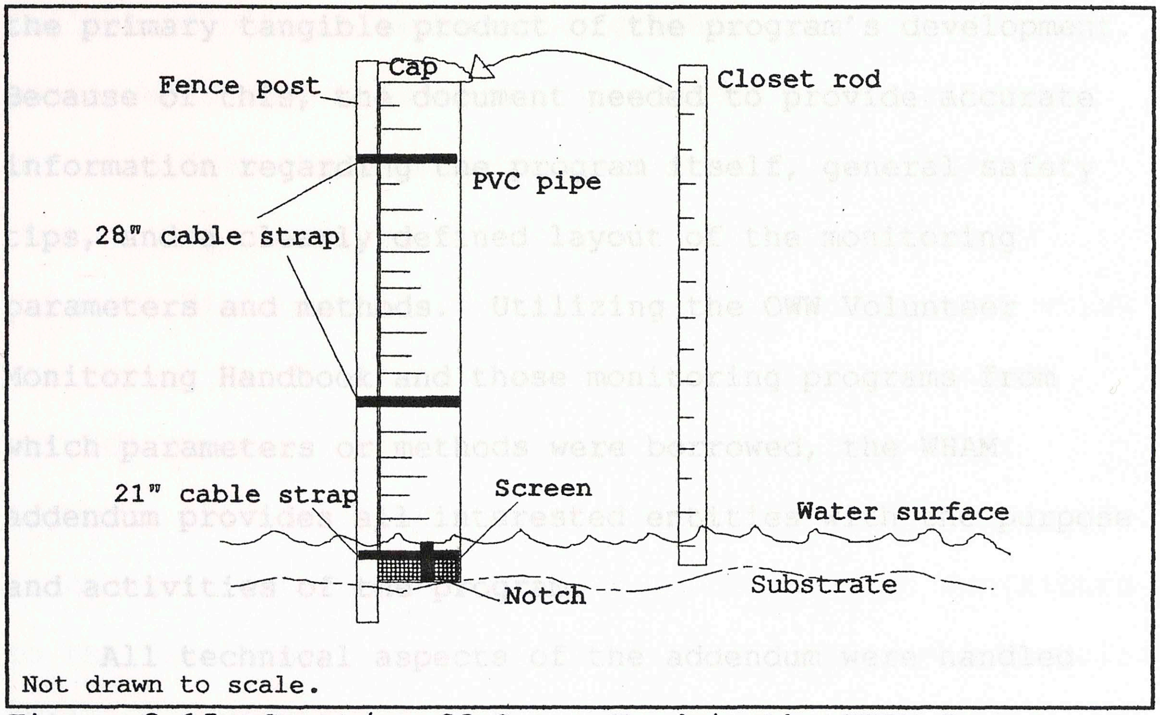


Figure 3.15 Crest/staff Gauge Used in the WHAM Program (adapted from Firehock et. al. 1998).

Table 3.4 Materials and Equipment Needed for Construction of the Crest/Staff Gauge used in the WHAM Program (adapted from Firehock et. al. 1998).

Materials	Equipment*
6-foot heavy duty metal fence post	mallet
	red permanent marker
6-foot (4-inch diameter) PVC pipe	300-foot field tape measure
2-inch closet rod	duct tape
cork (ground with a cheese grater)*	first aid kit
10-inch square piece of fine mesh screen	
2 28-inch cable straps	
1 21-inch cable strap	

*These are staple items provided in the WHAM kit.

III. Wetland Monitoring Addendum

The WHAM Volunteer Monitoring Addendum (Appendix C) is the primary tangible product of the program's development. Because of this, the document needed to provide accurate information regarding the program itself, general safety tips, and a clearly defined layout of the monitoring parameters and methods. Utilizing the OWW Volunteer Monitoring Handbook and those monitoring programs from which parameters or methods were borrowed, the WHAM addendum provides all interested entities with the purpose and activities of the program.

All technical aspects of the addendum were handled using the OWW Volunteer Monitoring Handbook provided by the OWRB. This addendum is an addition to current OWW activities, therefore many references are made to OWW, it's goals, purpose, data uses, and what is expected of its volunteer monitors. Where necessary, WHAM-specific information was written to supplement safety and comfort in the wetland habitat, alterations in data collection, goals and uses of data, and the purpose of WHAM.

Illustrations and graphics were both self-developed as well as borrowed from other programs. Where specific methods were used directly from other programs, permission was gained to use graphics directly, or to model new graphics after the original. Those illustrations and graphics which were developed specifically for WHAM were designed with simplicity, stressing ease of understanding for the volunteers rather than graphic intricacy. Where photographs were used (i.e., vegetation), permission was obtained from the source to use the material. Most photographs, however, were voluntarily contributed by Oklahoma Biological Survey staff or individuals with which the author had familiar contact. In addition to these outside sources, volunteers were notified that their artwork, ability to edit or photograph, would be accepted in order to provide them with an opportunity to contribute to the development and success of this program and to build their credentials.

Finally, all addendum editing and approval was conducted by OWRB personnel and the Izaak Walton League of America. Editing for content, proper use of graphics, and ease of use for volunteers was ongoing throughout the development of the addendum. Each draft was submitted to the OWRB for comments and suggestions, and these were made upon being received by the author. Comments were also accepted by the volunteer monitors regarding errors, unclear directions or confusing graphics. The Izaak Walton League of America requested that it be able to approve the use of any and all methods and graphics borrowed from its *Handbook for Wetlands Conservation and Sustainability*, and this request was granted. In addition, before the final draft was produced, permission was gained from all contributing individuals (i.e., monitoring programs, photographers, and artists).

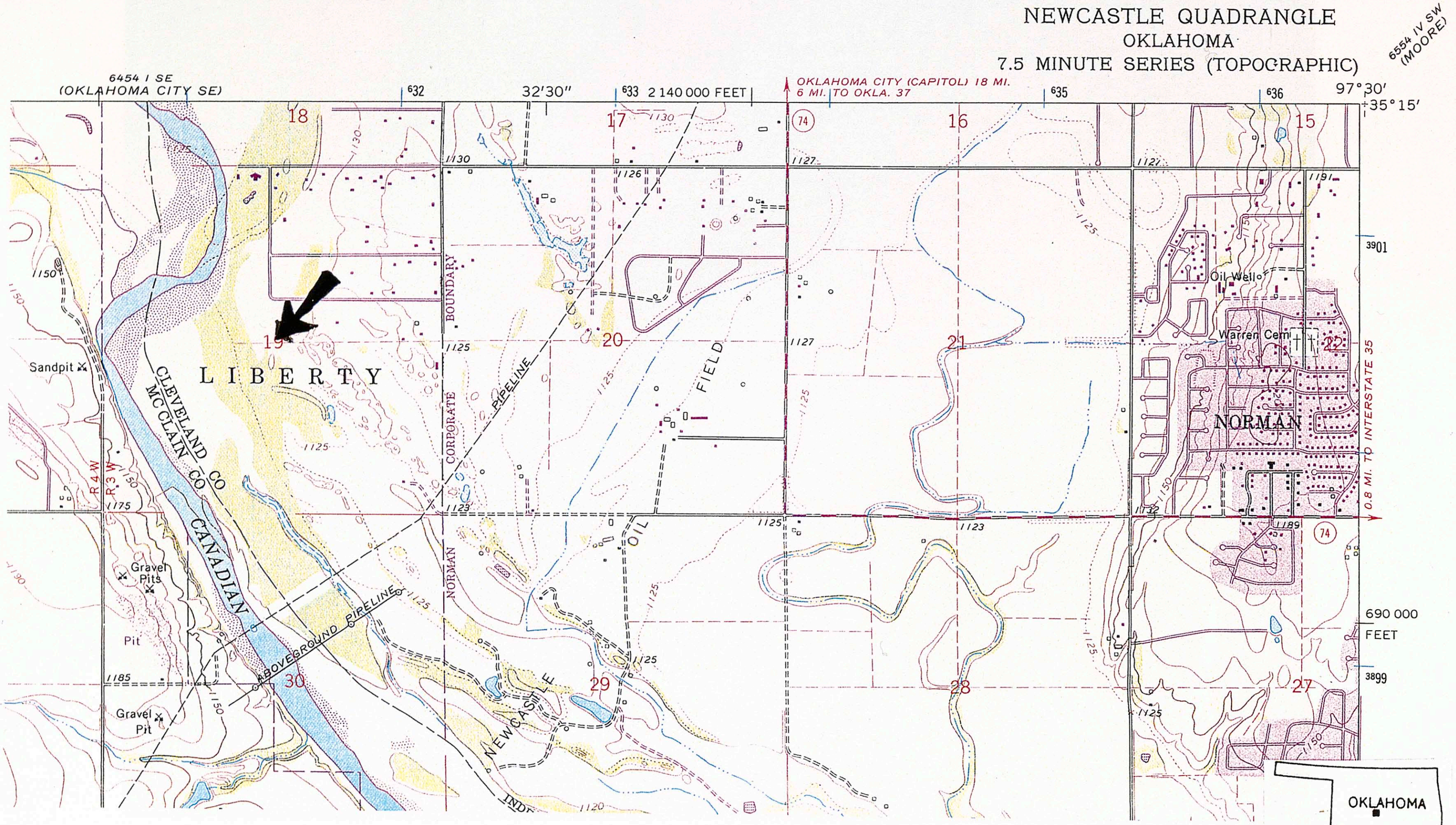
IV. Site and Pilot Group Selection

The selection of a monitoring site and group was a complex part of the program's development. The pilot status of this program offered the opportunity to select several sites and groups of various status and scientific background. The final selection of a monitoring site and group was based on time constraints, location, and the ability of the group to effectively conduct the monitoring and provide pertinent feedback regarding their experience, the feasibility of the parameters and monitoring methods.

A. Site Selection

Oklahoma's wetland resources vary from swamps in the extreme southeast portion of the state to playa lakes in the Panhandle. Because of this, selecting a pilot site took into consideration several aspects related to wetland types, access to the site, and knowledge of the site. The site chosen, Mercer Marsh, provided for ease of access, the ability for all methods to be implemented, and knowledge of the wetland itself.

Named Mercer Marsh after landowner Bill Mercer, the chosen wetland site is located on the west side of Norman, Oklahoma (Figures 3.16 and 3.17) in the floodway of the South Canadian River. This wetland is young, having only



Located approximately 1/2 mile west of the Norman Corporate Boundary near the Cleveland and McClain County Lines, Mercer Marsh (SW 1/4, SW 1/4, NE 1/4, Sec. 19, R3W, T9N) is near the bank of the South Canadian River.

Figure 3.16 USGS Topographic Map Indicating the Location of Mercer Marsh.

Taken on 4 April 2000, only three days following the last sampling trip, this photograph shows the location of Mercer Marsh, including both the open water and sampling areas. (Scale: 4" = 1 mile)

Figure 3.17 Aerial Photograph Indicating the Location of Mercer Marsh.

developed in the past few years during high flow events. It is believed that the wetland is fed by the River through subsurface hydrogeologic connections, though not necessarily groundwater fed. With approximately 4 hectares of open water area, the wetland supports a variety of wildlife and vegetation.

B. Group Selection

Selecting a group of volunteers as the WHAM pilot field group took into consideration the background of the volunteers, the motivation needed to keep them involved, and their location in regard to the site and the primary investigators. The pool of groups from which to choose was quite diverse: a high school environmental science class, a neighborhood advocacy group, and a university-sponsored student environmental association (Table 3.5). Because it met the requirements put forth by the primary investigators, the University of Oklahoma's Environmental Science Student Association (ESSA) was selected as the pilot group for this program. The size of the Association provided a sufficient body of individuals from which volunteers could be recruited. From this group, initially 19 individuals, with an average age of 23 years old, volunteered their time to the program.

Table 3.5 Groups and Accompanying Sites Available for Selection in the Pilot WHAM Program.

Group	Site
High school environmental science class and extra-curricular environmental club	Outdoor classroom on the high school campus which consists of a seasonal stream and a small pond/wetland area
Neighborhood activist association	Local wetland area being impacted by highway construction and traffic
University of Oklahoma Environmental Science Student Association (ESSA)	Privately owned wetland easily accessible to the volunteers and with which the program's developers were familiar with the owner

The scientific background of the individuals provided several benefits to the program.

- Several volunteers had previous monitoring experience (through OWW or Blue Thumb).

- The majority of students had taken general biology and had previous field work experience and lab work experience conducting water quality tests.

- The location of the group made communication easy, and accessibility between the program investigators and the volunteers was maintained on a daily basis.

- Involvement in this program offered the students an opportunity to build their resume as well as learn more about activities in their field of study, therefore motivating the dedicated individuals was not difficult.

- The volunteers' academic and field-related background provided the program's development with knowledge-based comments related to the feasibility of what is expected of lay persons, methods and materials which would or would not work, and improvements which could be made to any aspect of the program.

CHAPTER 4

PROGRAM IMPLEMENTATION

Implementation of WHAM involved several steps including training, development of quality assurance/quality control (QA/QC) protocol, and completing requirements set forth by the USEPA. After the training and quality control tasks were complete, the volunteers were allowed to conduct the specified monitoring parameters in the chosen wetland site. Few problems were encountered during the field implementation, all of which yielded beneficial results and input for the program.

I. Training

The success of this program was judged on the implementation and testing of monitoring activities through the pilot volunteer group. To accomplish this, volunteers needed to be educated about wetlands and the importance of the monitoring activities they were to conduct. This education was achieved through three training phases, during which the WHAM volunteers were introduced to the program, the monitoring parameters, as well as guidelines and overall safety.

A. Phase 1: Getting Acquainted with the Program (Organization and Introduction)

A general overview and welcome to WHAM, the first training session was used to introduce the volunteers to the program. Included in this introduction was an overview of the goals of WHAM, what is expected of the volunteers, and an introduction to wetland ecosystems. Also, to assess the success of this program, a pretest was administered to qualify the previously known wetland knowledge of the volunteers.

To begin the training session, the volunteers were welcomed to the program and were asked to complete the Phase I training pretest (Appendix D1). This pretest asks several questions regarding the goals of WHAM, general knowledge questions about wetland function, value, and the importance of several of the parameters volunteers would be monitoring. This pretest is only short answer, not multiple choice, thus allowing program coordinators to gauge what the volunteers know about wetlands without being prompted with answer choices. In addition, administering the pretest before the general wetlands lecture was given allowed the pretest to be used as both a training and evaluation tool for the WHAM program.

Following the pretest, Dr. Robert Nairn, Assistant Professor of Environmental Science from the University of Oklahoma, presented a brief lecture about wetlands. This lecture was tailored to the volunteer audience in order to provide a background about wetlands and the general knowledge which was asked on the pretest. After the lecture, the volunteers were given a draft copy of the WHAM addendum. An introduction to WHAM, its goals, what is expected of the monitors, and an overview of the purpose of the program was discussed openly with the volunteers. In addition, the monitoring parameters, monitoring schedule and safety were briefly discussed.

It was stressed to the volunteers that they were not committed to any volunteer monitoring with WHAM other than the prescribed field visits needed for this research. Those volunteers who chose to dedicate their time to this program were required to complete the "Pledge to the Program" form (Appendix D2). This form, with the pretest, initiated each volunteer's monitor training record (Appendix D3) and their volunteer file.

Different from the first phase of training, the second and third training sessions were categorized into water quality and ecosystem field observations.

B. Phase 2: Water Quality Testing (Guidelines, Procedures, and Safety)

The first of these two phases of training was concerned only with the water quality parameters, and discussed the methods, procedures, guidelines and safety included therein. To conduct this training, the OWW Volunteer Monitoring Handbook was utilized, though the WHAM addendum was used to discuss wetland-specific issues and procedures. In addition, the OWW Program Coordinator was present to ensure that the information presented was accurate and to supplement the training with any recent changes or other developments in the OWW water quality testing methods.

The training session began by discussing the importance of water quality in general as well as what it can indicate about the aquatic conditions in the wetland being monitored. Each water quality test (i.e., temperature, pH, dissolved oxygen, nitrate, ammonia, phosphate and chlorophyll *a*) was discussed as to its importance, followed by showing the water quality test equipment to the volunteers. Because of the lack of sufficient equipment, all the water quality tests (Appendix B) were performed prior to the training session.

These tests were performed using HACH and Napco water testing kits, and each required the addition of specific powder or liquid reagents to a sample of water. These tests caused color indicative reactions to the sample solution at which time the colors were compared to references to obtain the appropriate reading of the nutrient or pH of the water. These tested samples provided the volunteers with a visual aid regarding water color (i.e., the resulting color for pH or when any of the nutrients were present). Using deionized water, all testing procedures such as rinsing, priming (i.e., rinsing collection bottles with sample water) and properly cleaning the glassware, were performed for the volunteers.

Following the lecture and discussion of the water quality parameters and testing methods, an activity worksheet (Appendix D4) was administered to the volunteers. The worksheet was modeled after the training used by the OWW program. In addition to the worksheet, the volunteers were required to properly use the water testing equipment. To accomplish this, each volunteer was to properly wear the safety equipment (e.g., gloves and goggles), and read the measurements obtained from the sample water (i.e., the water tested prior to the training session which was used as a demonstration of the color indicative reactions). These measurements were recorded on their training sheet, which were later reviewed and scored. This activity allowed the trainer to explain how to use the equipment as well as determine if the volunteers were using it correctly.

C. Phase 3: Ecosystem Field Observations (Guidelines, Procedures, and Safety)

The final phase of training focused on the ecosystem field observations. This training session introduced the volunteers to the activities they would be conducting, the monitoring procedures, guidelines, and safety precautions needed for field work, as well as the monitoring kit they would be using. This training consisted of both a lecture based introduction and several hands-on activities during which a short quiz was administered.

This training session began by explaining the importance of field work to the volunteers. Because the required field work is different from that of OWW, special attention was given to those portions of the WHAM addendum concerned with volunteer safety and comfort in the field (i.e., wildlife and weather hazards, and the expectation to get dirty). It was stressed to volunteers that their personal safety is of utmost importance and that their involvement in the WHAM program does not require that they put themselves in any harmful, or potentially harmful, situation.

Following the general lecture and discussion of the ecosystem field observations, a worksheet (Appendix D5) was given to the volunteers for which they were allowed to utilize their WHAM addendum. This provided the volunteers an opportunity to become familiar with the addendum's layout and wording. In addition to this, each volunteer was given a mock data collection sheet (Appendix D6) and a "Photopoint Identification Sheet" (Appendix D7). These were used for the hands-on activities included in this phase of training. Each parameter on the data sheet was given a station that included all the information (i.e., photos, equipment, site descriptions) needed to complete each task. With a partner, or in a small group, the volunteers were required to complete the activities at the specified stations (Table 4.1). During these activities, the volunteers were evaluated for proper technique, equipment usage, and their understanding of the parameters.

Table 4.1 Parameter Stations and Activities Performed by the Volunteers During Phase III Training.

Parameter Station	Activities
Weather Conditions	Given photographs and a brief written description, a compass and the thermometer, volunteers recorded cloud cover, temperature and wind direction.
Wildlife Observations	Given drawings of common wildlife, volunteers identified each species.
Amphibian Observations	Given a series of three photographs, the volunteers needed to choose the bullfrog.
Transect Establishment	Volunteers calculated the interval spacing for a hypothetical transect.
	In small groups, the volunteers laid out the transect.
Photopoint Identification	Volunteers properly completed a Photopoint Identification Sheet.

D. WHAM Monitoring Kit

As each water quality or ecosystem field parameter was explained, the equipment, its proper usage, care and storage was shown to the volunteers. This information was also reiterated during the end of the training session. This kit (Tables 4.2, 4.3, 4.4 and 4.5) is a combination of items purchased through scientific supply companies, forestry supply companies, as well as through local home improvement stores. The items in the kit are considered property of the WHAM program, and therefore property of the OWRB. These items are provided for the sole purpose of conducting the monitoring activities, and do not include such comfort or safety items (other than a first aid kit) as those listed in the WHAM addendum. In the event of breakage, the volunteers are required to complete the "Equipment Repair Sheet" (Appendix D8) which is used to document any problems with equipment (i.e., equipment styles and performance in the field) and assure that the proper tools are available for monitoring activities.

The basic water quality testing kit (Table 4.2) was supplied by Napco Chemical Company in Spring, Texas. This kit is identical to that used by OWW with the exception that Borger Color System books (used to determine water color) and the Secchi disk (used to measure water turbidity) were omitted. The nutrient water testing kit (Table 4.3) is identical to that used by OWW. All reagents, glassware, cases and measurement instruments were obtained through HACH Suppliers. Chlorophyll *a* equipment was contributed by the OWRB, and additional items such as scissors, goggles, gloves, graduated cylinders and forceps were obtained from local suppliers or borrowed from the University of Oklahoma's Ecosystem Biogeochemistry and Ecology Laboratory (EBEL).

Table 4.2 WHAM Basic Water Quality Testing Kit.

Napco Texas Watch Kit (#NAP9857D3)	
pH	thermometer
dissolved oxygen (DO)	

Table 4.3 WHAM Nutrient and Chlorophyll *a* Water Quality Testing Kit.

HACH and Napco	OWRB and EBEL contributions
Nitraver 6 powder pillows (100 count)	aluminum foil
Nitraver 3 powder pillows (100 count)	4 disposable microfiber filtering funnels
Ammonia Salicylate powder pillows (50 count)	100 mL graduated cylinder
Ammonia Cyanurate powder pillows (50 count)	500 mL sample collection bottles
Phosver 3 powder pillows (100 count)	1L plastic filtering flask
Color disks: phosphate, nitrate, Salicylate ammonia	forceps
long path viewing adaptor	4 chlorophyll *a* hand pumps with regulators
color comparator box	
glass droppers (5 count)	
plastic tubes (8 count)	
square mixing bottles (6 count)	
goggles (8 pair)	
storage case	
latex gloves (50 count), vinyl gloves (100 count)	

The field observation equipment was obtained through a variety of stores. Most of the equipment was purchased at local and catalog-order forestry, scientific, and home improvement suppliers. Items such as binoculars, shop towels, first aid kits and scissors were additional purchases at local discount stores.

Table 4.4 WHAM Field Equipment Monitoring Kit.

Scientific/Forestry Supplier	Home Improvement/Discount Stores
compass	33 gallon tote locker
2 plastic neon clipboards	binoculars (10x magnification)
6 black permanent markers	shop towels (10 count)
2- 24" aluminum rulers	neon twine
1 sharpshooter	whisk broom
2 packages Rite-in-the-Rain copier paper (200 count)	first aid bite kit
	first aid kit
300' fiberglass field tape measure	duct tape
photopoint ID flags (100 count)	scissors
3 lb. Engineer's hammer (mallet)	2 tool storage boxes
wetland delineation flags (100 count)	1 sharpshooter
	½" x 18" wood stakes (50 count)
5 Rite-in-the-Rain wetland delineation field notebooks	
6 indoor/outdoor disposable cameras with flash	
chest waders with belt and suspenders	

The hydrology instrumentation materials were obtained through local home improvement supply stores with the assistance of a specialist familiar with the functioning of hardware materials. Construction and installation procedures for the equipment can be found in the WHAM addendum (Appendix C). Schematics can be seen in Figures 3.14 and 3.15.

Table 4.5 WHAM Hydrology Instrumentation Materials.

Ground Water Sampler	Crest/staff Gauge
50 lb bag pea-size gravel	4 corks
24" x 4" PVC pipe	6' x 4" PVC pipe
1 roll fiberglass fine mesh screen	10' x 2" wooden closet rod
4" diameter loose-fitting cap	1 red permanent marker
	21" cable straps (3 count)
	6' heavy duty metal fence post
	28" cable straps (2 count)
	4" diameter loose-fitting cap

Units on the equipment interchange between metric and English because of the way the equipment is sold (i.e., glassware was sold in metric units, and home improvement stores sold piping and lumber in English units), not because one unit of measurement was favored over another.

II. Quality Assurance/Quality Control (QA/QC)

Through development, implementation and training, volunteers became key to providing a basis from which assessing the health of Oklahoma's wetlands and accelerating their inventory with the help of the Oklahoma Biological Survey (OBS) would be developed. In order to assure the accuracy of collected data, quality assurance/quality control (QA/QC) protocol were developed. Required by the USEPA, all programs directed through its national program offices, regional offices, and laboratories must develop and participate in an established QA/QC program (Simpson 1991). This includes programs like WHAM and other volunteer monitoring programs which receive any USEPA funding (OWRB 1997).

A. Development of QA/QC Protocol

Developing the QA/QC protocol evolved as the methodology of each parameter was written and tested. As in any educational setting, the purpose of the QA/QC protocol was to assess the monitors' knowledge of the methods, their use and purpose, as well as their ability to perform each task to the extent of collecting accurate and precise data. Because of this, quizzes, tests, group-work and hands-on activities were utilized to assess the monitors' data and their data collection techniques. Upon successfully obtaining the required score or reaching the required performance level, the data collected could then be considered of quality and beneficial use to those entities whom desire to utilize them.

Once adopted by the state, all WHAM volunteers being trained for water quality testing would be trained with OWW volunteers because of the program's affiliation and identical tests being performed. For the immediate purposes of this pilot program, WHAM volunteers were trained and assessed independently. The QA protocol used to test OWW volunteers was utilized to test WHAM volunteers because water quality parameters are identical (see Appendix E). These controls, conducted twice a year, include: training sessions, utilizing proper equipment, using quality reagents, properly maintaining equipment, checking and calibrating equipment, and statistical analyses to identify "suspect data" (OWRB 1997).

To pass the water quality QA testing, volunteers were required to correctly complete the data collection sheet and perform all the water quality tests. General activities that were assessed include proper collection of water samples (both for nutrients and for dissolved oxygen), proper cleansing and priming of the sampling equipment, conducting blank tests, and correctly reading the measurements. To assure that the volunteers are obtaining accurate readings, spiked water samples with known concentrations of nutrients are used to compare the volunteers' measurements.

Whereas these water quality QA protocols were already used, all WHAM specific parameters needed QA/QC protocol to be developed and tested. The protocol developed include a short quiz, task performance, and a field visit by OWRB personnel. Protocols are assessed in both the field as well as the lab and they provide for a complete assessment of the monitors' understanding of the monitoring tasks, their ability to perform them, and to assess the field site itself as to impacts and maintenance of the equipment and sampling sites.

The quiz (Appendix D9) focused on field site guidelines and safety. To complete this, volunteers were allowed to utilize the WHAM addendum. It is the intent of the QA assessors that the volunteers not only know the information, but can properly use the addendum and are familiar with its layout in the event that information needs to be referenced. Each parameter has several protocol involved with QA/QC.

Wildlife and amphibians - This assessment is conducted in the laboratory using a series of photographs and audio tools. The volunteers must identify with 70% accuracy the series of wildlife species presented to them. Amphibian (i.e., bullfrog) identification must be met with 100% accuracy for both audio and visual.

Transect establishment - The transects are placed during the initial visit and are assessed for completion (i.e., directional placement and correct spacing of monitoring site intervals) by the OWRB personnel present. Each transect and sampling site on the transect is marked with a stake and wetland delineation flag. Each flag is marked with the compass direction (i.e., N, S, E, W) as well as the site number it represents on the transect. An annual visit to the field by personnel must be conducted to assess the maintenance of the transects and the intervals.

Photopoints - Photopoints are placed in the wetland to collect a panoramic view of the area throughout the seasons. These points are placed in areas where a representative and overall view of the wetland will be created. The photographer's location is marked with a stake and flag indicating the photopoint number (a minimum of three is required). The left and right side of what is seen in the viewfinder is marked with a flag to indicate the range of view for each photograph. These flags (those in the left side of the viewfinder) are marked with the photo number. During the annual field inspection, volunteers are assessed as to the proper photopoint technique and the completion of the "Photopoint Identification Sheet" (Appendix D7). This sheet is used to document the site number, compass heading, date the photograph was taken, and the photographer's name. In addition to these activities, OWRB personnel will assess the maintenance of the photopoint sites.

Vegetation - Vegetation is assessed by collection of field specimens and subsequent identification in the laboratory. Specimens are given to the volunteers and they must identify the complete set of specimens with a passing score of 80%. The invasive species, purple loosestrife, must be identified with 100% accuracy when given a series of other plants. To accomplish this, the volunteers are provided with photographs, line drawings and detailed descriptions in order to identify vegetation to the genus (i.e., *Typha* spp. and *Lemna* spp.) or species (i.e., *Lythrum salicaria*).

Soil Assessment - Volunteers must be able to correctly measure water depth in the hole dug at each site for soil assessment. They must also identify the relative color of the soil, the presence/absence of mottles and a sulfide smell as well as a muck layer on the wetland substrate (refer to Chapter 3 methods for soil assessment). Further assessment may be conducted in the laboratory by providing a series of soils and having the volunteers identify the general color of each. The volunteers are allowed a one shade difference in color identification.

Hydrology - Hydrology is assessed yearly in the field. The correct construction and installation of the equipment is assessed by OWRB personnel. This does not need to occur during the initial visit because several visits may be needed to assess where placement of the instruments will accurately monitor the proper hydrologic regime. During the annual field visit, the maintenance and condition of the equipment will be assessed as well as the volunteers' ability to read the measurements and calculate the groundwater depth.

In addition to these task-specific QA/QC protocol, the volunteers were assessed in general as to how well they completed the data sheet (i.e., including name, date and signatures where needed). Table 4.6 summarizes the QA/QC protocol used for WHAM's field ecosystem observations. The table includes when and where each parameter is assessed, the activities conducted by the volunteers, and the score required to pass the protocol guidelines.

B. Quality Control Assurance (QCA) Sessions

Quality Control Assurance (QCA) sessions were used to implement the QA/QC protocol and test the volunteer monitors' abilities to perform the required monitoring tasks (both water quality and ecosystem field observations), collect the data associated with each test, and to gauge their general knowledge about site safety and the basic tenets of monitoring. Conducting the QCA sessions for WHAM involved dividing the volunteers into two identical sessions. It was thought that this would allow the trainer to give more attention to each volunteer during the testing procedures, thus yielding a more qualified volunteer monitor. Therefore, the volunteers were allowed

Table 4.6 QA/QC Requirements for WHAM Field Parameters with Correlating Activities and Passing Qualifications.

Parameter	Locale*	Time*	Activities Assessed	Passing Score
Transects	F	IV	proper placement and site interval maintenance	complete on initial visit
Photopoints	F	IV	panoramic photo technique	S/U
	L	A	complete Photopoint ID Sheet	100%
Vegetation	F	A	proper specimen ID	80%
	L	A	proper ID of purple loosestrife	100%
Soils	F	A	measure water depth	+/- 0.125"
			ID relative color	w/in 1 shade
			ID presence/absence of mottles and sulfide smell	S/U
Hydrology	F	IV	proper construction and installation	complete on initial visit
	L	A	proper measurement readings	
			staff gauge	+/- 1"
			crest	+/- 1"
			ground water	+/- .0125"
Wildlife	L	A	proper species ID	70%
Amphibians	L	A	ID bullfrog from several photos	100%
			ID bullfrog call from several calls	100%

F = field, L = lab, IV = initial visit, A = annually

to attend one of two identical QCA sessions, but attendance was mandatory at one session in order to be allowed to conduct further monitoring activities.

During the QCA sessions, the "QA/QC Quiz" (Appendix D9) was administered. The volunteers also utilized the QCA data sheet (Appendix D10) to record data from the QCA activities. The volunteers performed the water quality tests, (Figure 4.1), completed a photopoint identification sheet, identified wildlife and the bullfrog (both by sight and call). The field QCA session was not able to be conducted due to extenuating environmental circumstances. In addition, vegetation or soils were not tested during the lab or field QCA sessions. The sessions provided positive results. All volunteers met or exceeded the established protocol (see Table 4.6). The QCA quiz, worth 15 points, resulted in a mean of 13 points(89%) and a median of 14 points (93%).

Figure 4.1 Volunteers work together to perform the phosphate tests during the second QCA session.

C. Quality Assurance Project Plan (QAPP)

A Quality Assurance Project Plan (QAPP) is a document which outlines the QA/QC procedures, as well as any statistical analyses, which are conducted to ensure collected data are of good quality and meet project requirements. In addition, it details the project's methods and procedures (i.e, storage of equipment and reagents, cleaning, recording, analysis) (USEPA 1996), to provide data users proof of the quality of data. Any monitoring program receiving funding from the USEPA must develop an EPA-approved QAPP prior to the initiation of data collection (USEPA 1996). Because WHAM is federally funded, a QAPP was required for the program's completion.

Though WHAM is affiliated with OWW, a separate QAPP was needed to document this program as separate entity due to the additional parameters and methods being implemented. Development of a QAPP usually requires the assemblage of a small team of professionals involved with the program who have expertise in data management, QA development, or those individuals who may utilize the data or perform the monitoring. For WHAM, the program developer was also the QAPP author, however, the OWRB was used as an advisory committee through which recommendations and editing expertise were provided. The completed WHAM QAPP (Appendix E, less the Table of Contents and supplemental appendices) describes the purpose and goals of the program, data uses, training and data collection methodology, as well as QCA techniques. In addition, to expedite the QAPP's development, sections of the OWW QAPP were utilized for the water quality parameters and associated data analyses utilized by WHAM.

III. Site Visits

The final step in the implementation of WHAM was to place the pilot volunteer monitoring group in the field to conduct the monitoring activities. Whereas monitoring would be scheduled to collect data every month, or at least every six weeks, the pilot site visits herein were chosen according to the availability of the monitors to schedule time to conduct a site visit. Because the main purpose of the group was only to test the feasibility of the methods, it was decided that visits did not need to be evenly distributed over several months. The monitoring that was conducted yielded useful input about the feasibility of the parameters and extenuating circumstances which may be encountered during the statewide implementation of this program.

A. Initial Visit

The initial site visit took place on Saturday 19 February 2000. Eleven of the 17 WHAM volunteer monitors performed the initial site visit tasks, including transect and photopoint establishment, completion of the wetland sketch, as well as the regularly scheduled monitoring. To expedite the monitoring activities, the volunteers separated into smaller groups, each of which was responsible for specific monitoring activities. The results of this initial visit yielded results relating to the feasibility of the parameters as well as the equipment used.

1. Tasks

Four volunteers assessed the weather, surrounding land use, and drew a sketch of the wetland. The reconnaissance involved in these tasks required the participation of more volunteers than other monitoring activities. General weather conditions were assessed and recorded utilizing the "Weather and Surrounding Land Use" data collection sheet (Appendix D11). Air temperature was recorded by the water quality assessors at the time water quality samples were collected. As the volunteers investigated the wetland site, human impacts and signs of degradation were recorded throughout the day's activities. As these investigations were conducted, a wetland sketch was compiled to be used as a map of the area (Figure 4.2). This sketch includes locations of the photopoints, transects, areas of open water, wetland buffers, areas of dominant vegetation, the water sampling site, and any other

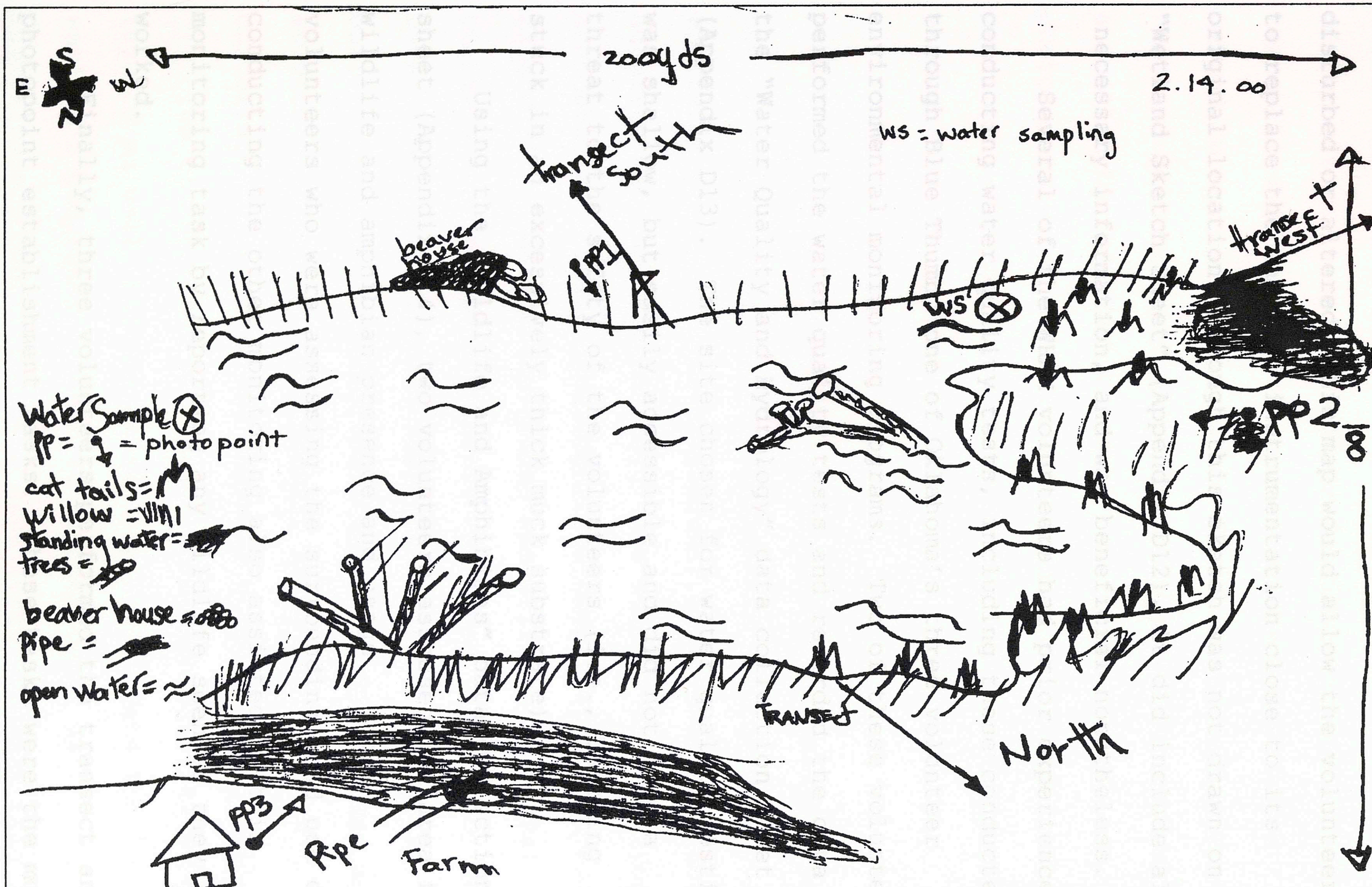


Figure 4.2 Wetland Sketch of Mercer Marsh Created by the Volunteers.

recognizable landmarks. In the event that the site is disturbed or altered, this map would allow the volunteers to replace the sampling instrumentation close to its original location. Though this sketch was not drawn on the "Wetland Sketch Sheet" (Appendix D12), it did include all necessary information, and was beneficial nonetheless.

Several of the WHAM volunteers had prior experience conducting water quality tests, including those conducted through Blue Thumb, one of Oklahoma's three volunteer environmental monitoring programs. Two of these volunteers performed the water quality tests and recorded the data on the "Water Quality and Hydrology" data collection sheet (Appendix D13). The site chosen for water quality testing was shallow, but easily accessible and did not pose a threat to the safety of the volunteers (i.e., becoming stuck in an excessively thick muck substrate).

Using the "Wildlife and Amphibians" data collection sheet (Appendix D14), two volunteers assessed the area for wildlife and amphibian presence and usage. Those volunteers who were assessing the surrounding land use or conducting the other monitoring also assisted in this monitoring task by reporting any wildlife seen as they worked.

Finally, three volunteers performed the transect and photopoint establishment tasks. These tasks were the most time consuming and involved both a complete investigation of the site to select locations for the placement of the transects and photopoints as well as the manual labor needed to establish them in the field. The volunteers chose to place transects in areas of varied vegetation, as suggested by the WHAM addendum. The minimum three photopoints were placed as well. These three combined provided a view of the wetland to the south, northwest and east across the open water.

2. Results

The geography of the wetland site itself allowed the wetland sketch team to overlook the area from atop an approximately eight foot embankment, thus creating a more accurate map (see Figure 4.2). The weather provided for an abundance of wildlife and amphibian observations (Appendix F1 and F2). Because the ground was still wet, several tracks and prints were evident. Scat was identified, and several amphibian species were identified as not being bullfrogs. Water quality tests (Appendix F3) yielded an absence of nitrate in the water. Later lab QA tests concurred that nitrate was below detectable limit (BDL).

The transect and photopoint establishment yielded good results as well, but was altered to accommodate the wetland's geography. The area of open water is approximately one-fourth of a mile long. Because this monitoring must be beneficial to the volunteers and not become a chore, the pilot team chose to monitor only the accessible eastern part of the site. The average transect length was approximately 125 feet and each was placed in an area consisting of a varied vegetation. A western transect was not placed due to the length of the open water area. Photopoints were placed with the south transect, east transect, and atop the embankment to overlook the wetland area (Appendix G).

B. Second Visit

The second site visit was conducted on Saturday 25 March 2000. Unlike the previous visit, only five volunteers were available to conduct the monitoring activities during this visit. Upon arriving at the site, extensive flooding prohibited many monitoring tasks. Prolonged rainfall in western Oklahoma had caused high water levels in the South Canadian River, and placed the site under approximately three feet of water (Appendix G).

1. Tasks

The flooding prohibited volunteers from entering the wetland area to conduct monitoring (Figure 4.3), but weather was assessed and this disturbance was noted. Despite the flooding, calm, sunny weather conditions allowed for abundant wildlife observations. Utilizing binoculars, some wildlife was identified by sight, and some bird species were identified by their calls and songs. Photopoint three was also used to photograph the area (Appendix G).

Figure 4.3 To investigate the depth of the flooding at Mercer Marsh, volunteers suited up in chest waders.

2. Results

This site visit provided much beneficial feedback regarding what can be expected of the volunteers, transect and photopoint placement, and the need for observing the wetland before installing hydrology equipment. Though some of the volunteers expressed concerns about wasting a trip to the site, because of the high embankment area, the "flood proof" vantage point allowed weather monitoring

(Appendix F4) and long-distance wildlife observations (Appendix F5). The availability of photopoint three (photopoints one and two were in the submerged wetland area) was quite beneficial to photograph the wetland and compare it to the first visit. This comparison can be seen in Appendix G. The wetland sketch which was conducted on the initial visit became quite important in explaining the placement of photopoints and transects to those volunteers who had not previously been to the site. Overall, this site visit demonstrated the importance of placing the photopoints throughout the wetland and of creating a simple, but accurate map of the wetland site.

C. Third Visit

The third site visit was conducted on Saturday 1 April 2000. Much like the second visit, extenuating circumstances prohibited many monitoring activities. The day before monitoring, program developers visited the site to plan for the following day's activities and field readiness (i.e., the need for waders, boots, etc.).

1. Tasks

With this being the final visit, it was planned that soil assessment, vegetation observations and installation of the hydrology equipment would be conducted. The site was wet due to the previous week's flooding, but initiating these activities was feasible at the time.

Heavy rainfall and the threat of thunderstorms limited the volunteers' time in the field which prohibited these planned activities.

Four volunteers participated in this visit. Activities that were conducted included weather, water quality, wildlife and amphibian observations and photopoints. The water quality assessor collected and fixed water quality samples in the field because of deteriorating weather conditions. The three other volunteers began the photopoints, weather observations and wildlife observations. Again, photopoint three was the only panoramic of the wetland site photographed. Increasingly inclement weather prohibited the volunteers from entering the field in a safe and timely manner to photograph photopoints one and two. In addition to these activities, the transects and photopoints in the wetland site were investigated as to their condition following the prior week's flooding.

2. Results

This visit yielded results as to what can be expected of the volunteers as well as the beneficial use of the wetland sketch and placement of the photopoints. Upon arriving at the site, all volunteers were organized and ready to collect data (Appendix F6 and F7). The weather conditions caused them to prepare to gather field data quickly in order to perform as many monitoring tasks as possible before the weather became too hazardous. The wetland sketch was used to locate transects and the other photopoints. All flags and stakes were intact and easily located in the growing vegetation. The weather prohibited photopoints one and two from being photographed (volunteers could not get to them before the weather became a hazard). Increasing rain halted the progress of the monitoring with the exception of the volunteer collecting the water samples (Figure 4.4). The choice to stop monitoring was left to the discretion of the volunteers to test the limits of weather conditions and the monitoring activities that could be conducted (Figure 4.5).

The limited amount of volunteers and the inclement weather also prohibited the installation of the hydrology equipment, soil assessment and the vegetation observations. Though each parameter's methodology had been developed (see Appendix C for methodology and D13, D15 and D16 for data collection sheets), there was not sufficient time during the final visit to implement the last of these parameters before the weather impeded monitoring activities. Those water quality tests that needed to be performed were conducted in the laboratory, and results were similar to the initial site visit (Appendix F8). It was observed that the environmental conditions (i.e., excessive prolonged

Figure 4.4 A volunteer braved the rain during the third site visit to gather water samples later tested in the lab.

Figure 4.5 Some volunteers chose to discontinue monitoring in the inclement weather.

cloud cover and moderate to heavy rainfall) affected dissolved oxygen and phosphorus levels.

Circumstances beyond the control of WHAM's developers hindered monitoring activities during the second and third site visits, but had weather been conducive to volunteer monitoring activities, all parameters and methods would have been implemented. Following the completion of WHAM's implementation, the only parameters which were not implemented were vegetation, soils and hydrology. These three parameters are used to legally define wetlands jointly by the USEPA and USACE. However, because this program is not used to delineate or define wetland areas, but rather to monitor areas already defined as wetlands, their implementation, or lack thereof, only affected the outcome of the feasibility of volunteer monitoring tasks.

CHAPTER 5

PROGRAM RESULTS, RECOMMENDATIONS, EXPECTATIONS AND CONCLUSIONS

The successful development and implementation of the WHAM program has yielded results and recommendations needed to be considered for the successful implementation of the statewide program. These recommendations include those from the volunteers themselves, as well as state environmental personnel and the program developers. It is expected that this program will be beneficial in the collection of environmental data on Oklahoma's wetland resources as well as increasing their stewardship through hands-on educational activities.

I. Alterations Made to the Program

The purpose of the pilot group and site was to test the feasibility of the methods and tasks being asked of the volunteer monitors. The implementation step of the WHAM program allowed the volunteers to put the monitoring methods into practice in the field. Several program modifications were identified that need to be made to the methods and parameters, equipment used, QA/QC protocol, and expectations of the volunteers.

A. Methods, Parameters and Equipment

Overall, the parameters selected to be monitored were adequate to collect baseline data needed by interested entities. When observing the volunteers and conducting the monitoring activities in the field, all tasks were completed successfully. During the training sessions it was observed that professionals (i.e., botanists and wetland experts) would be beneficial in training the volunteers to look for specific characteristics as well as to lend them hints or clues which may not be provided in a general field identification booklet or soil color chart.

The volunteers also provided feedback as to alterations needed in the program. Equipment was their main concern because its ease of use and availability affected the time needed to perform tasks, the time spent in the field, the feasibility of the parameters, and their motivation to continue the volunteer monitoring. The equipment provided to them was sufficient to perform the tasks at hand, but the addition of several other items was suggested. These suggestions included:

- field guides and additional color photographs of local wildlife
- samplers or nets to collect amphibian species for more accurate identification
- laminated note cards for water quality testing directions

Other alterations needed in equipment were noticed by general observers, trainers and OWRB personnel. Because of the need for a compass to conduct weather observations (i.e., wind direction) and to place all photopoints, additional compasses would expedite data collection. During the final site visit, it was noticed that most of the flags used for transect and photopoint establishment were beginning to rust. Plastic, rather than wire, flags may last longer in the wetland environment. Because of flooding during the second site visit, it is recommended that a photopoint is placed at any high point in the general wetland area. Creating one "flood-proof" photopoint will allow for comparisons between higher and lower water events, as did photopoint three for this pilot program. Also, providing each team with a basic 35mm manually operated camera and film rather than disposable cameras will yield better results due to poor viewfinder quality and photograph organization during development.

Finally, units of measurement on the equipment could be changed to better meet the needs of the data users, and to educate volunteers about scientific measurement. The field equipment materials could only be purchased in English units, and data was collected in these units because other programs used as models collected data in this manner. Increments on such instruments as the groundwater sampler and crest/staff gauge could be made in metric units so the resulting data would be collected in metric units. This would better serve the scientific community, and using metric units would also educate the volunteers about scientific units of measurement.

General observations made during site visits yielded other alterations needed. During the second site visit, the positions of Data Manager and Equipment Manager were implemented because the first visit lacked an organized approach to data sheet submission and yielded disarray in the monitoring kit. These managers were volunteers who displayed exceptional organization technique and legibility on their QCA data sheet. Their responsibilities included performing the final data and equipment check before the monitoring team left the field. The Data Manager was responsible for checking all data sheets for signatures of individual volunteer assessors and the completion and legibility of the data gathered. The Equipment Manager was responsible for post-monitoring equipment cleanup and storage. Neither individual was responsible for the sole collection of data or equipment cleanup, only to oversee that those volunteers who used it followed the guidelines.

B. Feasibility of Tasks

It is expected that those parameters chosen will be feasible for the volunteers to conduct. By dividing the volunteers into separate data-collection teams (provided additional equipment is available) all tasks were performed in a timely fashion and no single volunteer was rushed to complete monitoring activities. Weather conditions hindered volunteer involvement, however. It was stressed to the volunteers that they should not monitor in a dangerous, or potentially dangerous, situation. Under advisement from the OWRB, it is also expected that volunteers will not monitor in extreme cold or excessive rainy conditions. Regarding those environmental conditions encountered during the monitoring visits conducted by the pilot group, a site visit to collect general weather data and one photopoint would be beneficial if the situation did not pose a threat (e.g., lightning, flash flooding).

C. Wetland Diversity and Function

It was intended that WHAM be a program through which the selected parameters would collect basic data needed to assess the overall health of Oklahoma's wetlands. However, the diversity of wetland types needs to be addressed when implementing WHAM statewide. Some wetland types (e.g., playa lakes, cypress swamps) may benefit from parameters being modified, or by having additional parameters implemented per wetland type. For example, in a cypress swamp it would not be as beneficial to monitor cattails as it would to assess the size and abundance of the cypress trees present.

Many constructed and restored wetlands exist in Oklahoma's landscape. Because these ecosystems have been created or restored for a specific purpose, different parameters may be needed if these wetlands are chosen for monitoring activities. For example, the amphibian/wildlife and vegetation parameters can be altered to better assess the desired function of a created wetland if it was created to provide habitat for a specific species of wildlife. These same ideas can be implemented in restored wetlands depending on the desired restoration goal.

II. Alterations to QA/QC

Alterations in QA/QC protocol were based on additional volunteer input. To provide the optimal learning environment, more outdoor training was recommended by the volunteers. In addition, the availability of several monitoring kits would have provided the volunteers a more hands-on learning experience during the lecture sessions. Because of the pilot status of this program and the availability of the volunteers, compromises (i.e., site visits, training make-up sessions) were made in order to meet their needs and provide adequate training. Better scheduling and additional equipment should be planned for the program upon its implementation through the OWRB.

III. Program Evaluation Component

The "Program Evaluation Component" (Appendix D17) given during the QCA sessions provided positive feedback about the WHAM training. Identical to the pretest given during the Phase I training, this evaluation component was used to assess what the volunteers learned through the program compared to what they knew about wetlands when they initiated their training. The mean score of the pretest, worth 22 points, was 10 points (47%), with a median score of 11 points (50%). The mean score of the post-test, also worth 22 points, was 17 points (77%), with a median score of 17 points (77%) (Figure 5.1). Because volunteers departed from the program throughout the training, only the tests of volunteers who took both the pretest and post-test were evaluated.

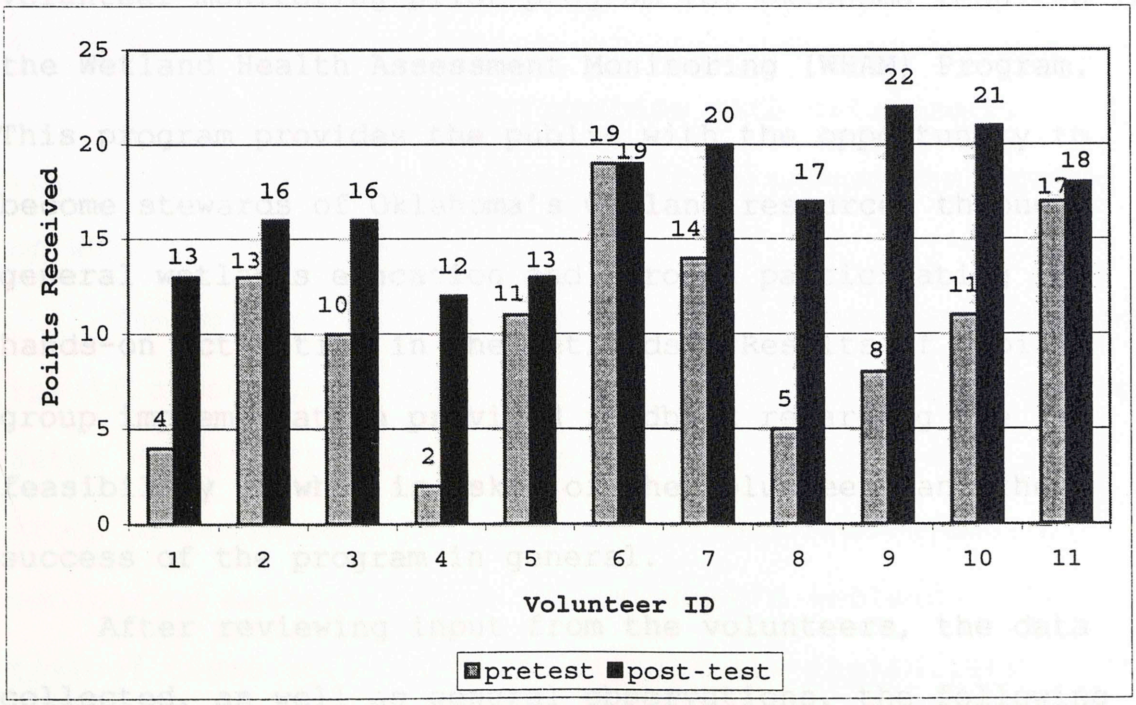


Figure 5.1 WHAM Volunteers' Pretest and Post-test Scores.

Overall, the volunteers improved their general knowledge by increasing their scores an average of seven points (32%). The scientific background of the volunteers provided them with some wetland knowledge prior to their involvement with the WHAM program, but through this training their terminology improved (i.e., water-loving plants were referred to as hydrophytic vegetation on the post-test) as did their awareness of wetlands as being beneficial to humankind. Based on this component alone, the program can be judged as beneficial in meeting its goal of providing a basis for expanding general wetland knowledge of the WHAM participants.

IV. Conclusions

The development and implementation of a wetlands volunteer monitoring pilot program for Oklahoma resulted in the Wetland Health Assessment Monitoring (WHAM) Program. This program provides the public with the opportunity to become stewards of Oklahoma's wetland resources through general wetlands education and through participating in hands-on activities in the wetlands. Results of a pilot group implementation provided feedback regarding the feasibility of what is asked of the volunteers and the success of the program in general.

After reviewing input from the volunteers, the data collected, as well as general observations, the following are expected of the WHAM program:

- The parameters and methods in WHAM provide a basis for future modifications to meet the changing needs of data users, changing educational needs of volunteers, or to assess created and restored wetlands (e.g., addition of more water quality tests for regulatory purposes, observations for wildlife/vegetative species of interest, and wetland type-specific observations).

- Photopoints will become beneficial in documenting change in the wetlands.

- Water quality data collected will augment stream and lake data submitted in Oklahoma's 305(b) report.

- WHAM volunteers need to test the feasibility of the vegetation, soils and hydrology parameters, but their success in other programs lends confidence to this program at this time.

- Continued relationships with data users, volunteers, and program directors will ensure the success of WHAM in the future.

The purpose of this research was to develop a wetland-specific monitoring addendum to supplement current Oklahoma Water Watch activities and to select a wetland site and group of volunteers to implement the parameters and monitoring methods chosen for Oklahoma's wetlands. The task of these volunteers was to test the feasibility of the methods, the equipment, expectations of future WHAM volunteers, and recommend changes which needed to be made to the program or quality assurance related to data collection. Several problems were encountered during the program's development, including site inaccessibility and inclement weather, yet each situation provided valuable feedback needed for the future implementation of the program.

With roots in public involvement, a number of individuals from educators, to students, to private citizens can be involved in wetland volunteer monitoring and stewardship. Educating these people through creation of the WHAM program will not only benefit citizens by teaching them the importance of Oklahoma's wetland resources, but it will benefit wetland ecosystems through an understanding of their importance. Because funding is not available, the WHAM program will not be implemented in the state of Oklahoma at this time. However, the WHAM pilot program has been proven to be beneficial to the collection of environmental data in Oklahoma's wetlands.

LITERATURE CITED

Adler, R.W., Landman, J.C, & Cameron, D.M. (1993). The Clean Water Act 20 Years Later. Washington D.C.: National Resources Defense Council.

Beattie, M.H. (1996). Protecting Our Future. In Working Together for Wetlands: A Celebration of 25 Years of the Ramsar Convention. Washington D.C.: United States Department of State.

Berry, J.F. (1993). Ecological Principles of Wetland Ecosystems. In M.S. Dennison and J.F. Berry (Ed.), Wetlands: Guide to Science, Law and Technology. Park Ridge: Noyes Publications.

Bertolotto, C. (1996 Fall). Monitoring Wetlands: A Flexible Approach. The Volunteer Monitor, pp. 7-8.

Bridgham, S.D., Updegraff, K., & Pastor, J. (1998). Carbon, Nitrogen, and Phosphorus Mineralization in Northern Wetlands. Ecology, 79, pp. 1545-61.

Brinson, M.M., & Rheinhardt, R. (1996). The Role of Reference Wetlands in Functional Assessment and Mitigation. Ecological Applications, 6(1), pp. 69-76.

Cameron University (a). "Keep Oklahoma Beautiful Selects Crawford for Environmental Honor. (Press Release PR#97-086)." 11 June 1997. http://www.cameron.edu/admin/info_services/pr97/86crawford.html (22 July 1999).

Cameron University (b). (1997). State-Wide Opinion Survey on Wetland Conservation. Lawton, OK: Cameron University, Business Research Center.

Canter, L.W. (1996). Environmental Indices and Indicators for Describing the Affected Environment. In Environmental Impact Assessment (2nd. ed.) (pp. 122-144). Boston: Irwin McGraw-Hill.

Clark, J.R. (1983). Foreword. In R.C. Smardon (Ed.), The Future of Wetlands: Assessing Visual-Cultural Values. Totowa: Allanheld, Osmun and Co. Publishers, Inc.

Cohn, J.P. (1994). Restoring the Everglades. BioScience, 44, pp. 579-83.

Cole, S. (1998). The Emergence of Treatment Wetlands. Environmental Science and Technology, 32(9), pp. 219A.

Cooney, C.M. (1997). Army Corps Closes Regulatory Loopholes for Small Wetlands Fills. Environmental Science and Technology, 31(2), pp. 77A.

Davis, M. (1997, June 26). United States Senate: 105 Congress, First Session. Wetlands: Review of Regulatory Changes. Hearing before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety of the Committee on Environmental and Public Works.

Davis, S.M. & Ogden, J.C. (1994). Everglades: The Ecosystem and its Restoration. Delray Beach: St. Lucie Press.

Dennison, M.S. & Berry, J.F. (1993a). Overview. In M.S. Dennison and J.F. Berry (Ed.), Wetlands: Guide to Science, Law and Technology. Park Ridge: Noyes Publications.

Dennison, M.S. & Berry, J.F. (1993b). The Regulatory Framework. In M.S. Dennison and J.F. Berry (Ed.), Wetlands: Guide to Science, Law and Technology. Park Ridge: Noyes Publications.

Doyle, R. (1998). US Wetlands. Scientific American, 278, pp. 24-25.

Dugan, P. (1993). Wetlands in Danger. New York: Oxford University Press.

Ely, E. (1996 Fall). Volunteer Monitoring: No Limit. The Volunteer Monitor, pp. 18-21.

Ely, E. (1998 Spring). What's Thorny about Wetlands? [From the Editor]. The Volunteer Monitor, pp. 2.

Englehardt, J.D. (1998). Ecological and Economic Risk Analysis of Everglades: Phase I Restoration Alternatives. Risk Analysis, 18, pp. 755-72.

Euliss, N.H. Jr., Swanson, G.A., & Mackay, J. (1992). Multiple Tube Sampler for Benthic and Pelagic Invertebrates in Shallow Wetlands. Journal of Wildlife Management, 56, pp. 186-91.

Finkl, C.W. (1995). Water Resource Management in the Florida Everglades: Are "Lessons from Experience" a Prognosis for Conservation in the Future? Journal of Soil and Water Conservation, 50(6), pp. 592-599.

Firehock, K., Graff, L, Middleton, J.V., Starnchak, K.D., and C. Williams (1998 June). Handbook for Wetlands Conservation and Sustainability. (2nd ed.) Gaithersburg: Izaak Walton League of America

Gallagher, L.M. (1997). Clean Water Act. In T.F.P. Sullivan (Ed.), Environmental Law Handbook (14th ed.). Rockville: Government Institutes Inc.

Georgia Department of Natural Resources (1998 September). Georgia Adopt-a-Wetland. Atlanta: Environmental Protection Division.

Giblett, R. (1996). Postmodern Wetlands: Culture, History, Ecology. Edinburgh: Edinburgh University Press.

Gray, S. "Blue Thumb-An Urban Watershed Success Story." http://www.epa.gov/owowwtr1/watershed/Proceed/gray.html (22 July 1999).

Hammer, D.A. (1997). Creating Freshwater Wetlands (2nd. ed.). Boca Raton: Lewis Publishers.

Heimlich, R.E. (ed.) (1991 August). A National Policy of "No Net Loss" of Wetlands: What do Agricultural Economists have to Contribute? (Staff Report #AGES 9149). Washington, D.C.: United States Department of Agriculture, Economic Research Service, Resources and Technology Division.

Hey, D.L. & Philippi, N.S. (1995). Flood Reduction through Wetland Restoration: The Upper Mississippi River Basin as a Case History. Restoration Ecology, 3(1), pp. 4-17.

Holloway, M. (1991). High and Dry. Scientific American, 265, (12), pp. 16+.

Illinois Department of Natural Resources (1998 February). Illinois RiverWatch Stream Monitoring Manual. (3rd. ed.) Springfield: Office of Realty and Environmental Planning.

Inhofe, J.M. (1997, June 26). United States Senate: 105 Congress, First Session. Wetlands: Review of Regulatory Changes. Hearing before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety of the Committee on Environment and Public Works.

Johnston, C.A. (1991). Sediment and Nutrient Retention by Freshwater Wetlands: Effects on Surface Water Quality. Critical Reviews in Environmental Control, 21, pp. 491- 565.

Jones, B.D, Fretwell, J.D., Williams, J.S., & Redman, P.J. (1996). Oklahoma Wetland Resources. National Water Summary on Wetland Resources. United States Geological Survey Water-Supply Paper 2425.

Keddy, P.A., Lee, H.T., & Wisheu, I.C. (1993). Choosing Indicators of Ecosystem Integrity: Wetlands as a Model System. In S. Woodley, J. Kay, & G. Francis (Eds.), Ecological Integrity and the Management of Ecosystems. Ottawa: St. Lucie Press.

Kent, D.M. (1994). Preface. In D.M. Kent (Ed.), Applied Wetlands Science and Technology. Boca Raton: Lewis Publishers.

Kusler, J.A., Mitsch, W.J., & Larson, J.S. (1994). Wetlands. Scientific American, 270, pp. 64B-70.

Laidlaw, T. (1996 Spring). 23 Ways to Say Thank You. The Volunteer Monitor, pp. 1-4.

Lee, V. "Volunteer Monitoring: A Brief History." *The Volunteer Monitor* (1994): Online
http://www.epa.gov/owowwtr1/monitoring/volunteer/spring94/ppresf16.htm
(22 July 1999).

Leidy, R.A., Fiedler, P.L, & Micheli, E.R. (1992). Is Wetter Better?. BioScience, 41, 58-61+.

Lyon, A.E. "Save Money and Increase Community Support: Targeted Volunteer Monitoring." 9 December 1998.
http://www.epa.gov/owowwtr1/watershed/Proceed/lyon.html
(22 July 1999).

MacGregor, M. (1997 Fall). Moving People from Belief to Action. The Volunteer Monitor, pp. 1-3.

Markowitz, A. (1996 Spring). Developing Leadership. The Volunteer Monitor, pp. 12-13+.

Mayio, A. "Citizen Partners in Water Quality Monitoring: The Volunteer Monitoring Movement." http://www.epa.gov/owowwtr1/watershed/Proceed/mayio.html (22 July 1999).

McLaren, C. (1999, August 16). Personal Communication.

McKinnon, C. (1993 April). The Value of Wetlands. Beltsville, MD: National Agriculture Library, Rural Information Center.

Middleton, B. (1998). Wetland Restoration, Flood Pulsing, and Disturbance Dynamics. New York: John Wiley and Sons, Inc.

Miller, T., Bertolotto, C., Martin, J., & Storm, L. (1996). Monitoring Wetlands: A Manual for Training Volunteers. Seattle: Adopt-A-Beach.

Mitsch, W.J. & Gosselink, J.G. (1993). Wetlands (2nd. ed.). New York: Van Nostrand Reinhold.

Mitsch, W.J., Cronk, J.K., Wu, X, & Nairn, R.W. (1995). Phosphorus Retention in Constructed Freshwater Riparian Marshes. Ecological Applications, 5, pp. 830-45.

Mitsch, W.J., Wu, X., Nairn, R.W., Weihe, P.E., Wang, N., Deal, R., & Boucher, C.E. (1998). Creating and Restoring Wetlands: A Whole-Ecosystem Experiment in Self-Design. Bioscience, 48,1019-1030.

National Parks Service. (1998 April). An Integrated Plan for South Florida Ecosystem Restoration and Sustainability: Success in the Making. The Working Group of the South Florida Ecosystem Restoration Task Force.

National Research Council. (1995). Wetlands: Characteristics and Boundaries. Washington, D.C.: National Academy Press.

National Wildlife Federation. (1987). Status Report on Our Nation's Wetlands. Washington D.C.: Feierabend, J.S. & Zelazny, J.M.

Natural Resources Conservation Service. "USDA NRCS WRP: Oklahoma Overview." 30 April 1999. http://www.wl.fb-net.org/ok.htm (22 July 1999).

News. "Governor Jeb Bush State of the State Address Tallahassee, Florida to the Florida Legislature on Everglades on March 7, 2000." 21 March 2000. http://www.evergladesplan.org/news_gov_bush_message1.htm (26 April 2000).

Oklahoma Conservation Commission. (1996). Oklahoma's Comprehensive Wetlands Conservation Plan. Oklahoma City, OK.

Oklahoma Water Resources Board. (1997 March). Volunteer Water Quality Monitoring Handbook: Oklahoma Water Watch (3rd. ed.). Oklahoma City: Bill Cauthron and Julie Cunningham.

Oklahoma Water Resources Board. (1998). Oklahoma Water Quality Assessment Report to Congress. Oklahoma City, OK.

Olson, S. (2000, April 26). Personal Communication.

Prince, H. (1997). Wetlands of the American Midwest: A Historical Geography of Changing Attitudes. Chicago: University of Chicago Press.

Reimold, R.J. (1994). Wetlands Functions and Values. In D.M. Kent (Ed.), Applied Wetlands Science and Technology. Boca Raton: Lewis Publishers.

Robinson, A. (1995). Small and Seasonal Does Not Mean Insignificant: Why it's Worth Standing up for Tiny and Temporary Wetlands. Journal of Soil and Water Conservation, 50(6), pp. 586-590.

Scanlon, K. (1999, August 20). Personal Communication.

Scatolini, S.R. & Zedler, J.B. (1996). Epibenthic Invertebrates of Natural and Constructed Marshes of San Diego Bay. Wetlands, 16(1), 24-37.

Semlitsch, R.D. & Bodie, J.R. (1998). Are Small, Isolated Wetlands Expendable?. Conservation Biology, 12, pp. 1129-33.

Simpson, J.T. (1991 December). Volunteer Lake Monitoring: A Methods Manual, (EPA 440/4-91-002). Washington, D.C.: United States Environmental Protection Agency; Office of Water, Oceans and Wetlands; Assessment and Watershed Protection Division.

Smardon, R.C. (1983). State of the Art in Assessing Visual-Cultural Values. In R.C. Smardon (Ed.), The Future of Wetlands: Assessing Visual-Cultural Values. Totowa: Allanheld, Osmun& Co. Publishers, Inc.

South Florida Water Management District. "Everglades Forever Act - May 4, 1994." http://glacier.sfwmd.gov/org/erd/ecp/egladpro.pdf (26 April 2000).

Thoreau, H.D. (1862). Walking. In C. Bode (Ed.). The Portable Thoreau (1947). New York: Viking Press.

United States Army Corps of Engineers. (1995 July). Section 404 of the Clean Water Act and Wetlands: Special Statistical Report. Fort Belvoir, VA: United States Army Corps of Engineers, Regulatory Branch.

United States Army Corps of Engineers. "PAOs: For Response to Query; Questions and Answers, Nationwide Permits, March 6, 2000." http://www.usace.army.mil/inet/functions/CW/cecwo/reg/press/qanda.pdf (27 April 2000).

United States Census Bureau. "Selected Historical Census Data: Population and Housing Counts." 21 July 1999. http://www.census.gov/population/censusdata/table-16.pdf (28 April 2000).

United States Council on Environmental Quality. "Lands Legacy: Lasting Protection for America's Natural Treasures, February 7, 2000." http://www2.whitehouse.gov/CEQ/landsleg_treasures.html (27 April 2000).

United States Court of Appeals for the D.C. Circuit. (1998, January 9 Argued; 1998, June 19 Decided). *National Mining Association et. al. v. United States Army Corps of Engineers et. al.* consolidated with #97-5112 Appeals from U.S. District Court for D.C. (#93cv01754). http://www.wetlands.com/fed/tulloch4.htm (22 July 1999).

United States Department of the Interior. (1990). Wetlands: Meeting the President's Challenge. Washington, D.C.: U.S. Fish and Wildlife Service

United States Department of the Interior. (1992 April). Wetlands Stewardship. Washington D.C.

United States Department of State. (1996). Working Together for Wetlands: A Celebration of 25 Years of the Ramsar Convention. Washington, D.C.

United States Environmental Protection Agency. (1994). National Directory of Volunteer Environmental Monitoring Programs. (EPA 841-B-94-001). Washington D.C.: Kerr, M., Ely, E., & Desbonnet, A.

United States Environmental Protection Agency. (1995 December). America's Wetlands: Our Vital Link Between Land and Water, (EPA 843-K-95-001). Washington, D.C.: Office of Water, Oceans and Wetlands.

United States Environmental Protection Agency. (1996 September). The Volunteer Monitor's Guide to Quality Assurance Project Plans, (EPA 841-B-96-003). Washington, D.C.: Office of Water, Oceans and Wetlands.

United States Environmental Protection Agency. "Monitoring Water Quality." July 1998(a). http://www.epa.gov/owowwtr1/monitoring/volunteer/startmon.html (22 July 1999).

United States Environmental Protection Agency. (1998b September). National Directory of Volunteer Environmental Monitoring Programs, (5th ed.) (EPA 841-B-98-009). Washington D.C.: Office of Water, Oceans and Wetlands; Ely, E. & Hamingson, E.

United States Environmental Protection Agency Region 10. (1996 October). Wetland Walk Manual: A Guidebook for Citizen Participation. (EPA 910/R-009). Seattle: United States Environmental Protection Agency.

United States Geological Survey. (1996). Do Created Wetlands Replace the Wetlands that are Destroyed? (Fact Sheet #FS-246-96). Reston, VA: United States Department of the Interior; Hunt, R.J.

United States Senate: 105 Congress, First Session. (1997, June 26). Hearing Before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety of the Committee on Environment and Public Works.

United States Soil and Conservation Service. (1993 March). Wetlands: A Heritage to Preserve. East Conservation, MI: United States Department of Agriculture; Soil and Conservation Service Regulatory Branch.

United States Soil and Conservation Service. (1994 March). Working with Wetlands,(Agriculture Information Bulletin 672). Washington, D.C.: United States Department of Agriculture.

Urban Land Institute. (1991). Wetlands: Mitigating and Regulating Development Impacts. Washington, D.C.: Salvesen, D.

The Volunteer Monitor. (1996 Spring). Why Volunteers Leave (And What We Can Do About It), pp. 5.

The Volunteer Monitor. (1997 Spring). Parallel Testing: Volunteers Versus Professionals, pp. 16-18.

The Volunteer Monitor. (1998 Spring). National Survey Results: A Profile of Volunteer Monitoring, pp. 30.

Votteler, T.H. and Muir, T.A. (1996). Wetland Management and Research: Wetland Protection and Legislation. National Water Summary on Wetland Resources. United States Geological Survey Water-Supply Paper 2425.

Wahnee, K. (2000 April). Creation of a State Wetlands Policy Database. Research presented at Undergraduate Research Day at the University of Oklahoma, Norman.

Wilkinson, D.L. (1987 September). Synopsis of Wetland Functions and Values: Bottomland Hardwoods with Special Emphasis on Eastern Texas and Oklahoma, (Biological Report 87(12)). Washington, D.C.: United States Department of the Interior, National Ecology Center, Fish and Wildlife Service.

Williams, M. (1990). Protection and Retrospection. In M. Williams (Ed.), Wetlands: A Threatened Landscape. Oxford: Basil Blackwell Ltd.

Young, P. (1996). The "New Science" of Wetland Restoration. Environmental Science and Technology, 30,pp. 292-296.

APPENDIX A

INITIAL QUESTIONNAIRE DISTRIBUTED TO THE OKLAHOMA WETLANDS WORKING GROUP (OWWG)

Establishment of a Volunteer Wetlands Monitoring Advisory Group Questionnaire

1. The information gathered by the volunteer monitors is to be put to use, not only for the educational benefit, but by scientists and resource managers. Would you have any use for the findings of these volunteer groups? From what type of data would you particularly benefit?

2. Because wetland ecosystems are different than lakes and stream, a greater variety of information will need to be collected by the volunteers. Also, training sessions must be scheduled in order to assure accurate data collection is taking place. What training do you think would be valuable for the volunteers, and how should it be implemented?

3. In order for the information collected by volunteers to be useful, a quality assurance/quality control process must be used. What methods of practices would you implement in order to assure the quality of the volunteers' information?

4. If you would like to be contacted in the future for your input or with updates as to the progress of this program, please let us know below.

APPENDIX B

OKLAHOMA WATER WATCH (OWW) WATER QUALITY TESTING METHODS AND PROCEDURES USED IN THE WHAM PROGRAM

Temperature Test Procedures

NOTE: While taking temperature readings, do not touch the "bulb" end of the thermometer. Your group may choose to tie twine through the "loop" opening at the opposite end of the bulb to make it easier to hold on to and to avoid grabbing the wrong end. Remember to always take the air temperature before the water temperature. Otherwise your result may be biased due to evaporation of residual water on the thermometer.

AIR TEMPERATURE

① Locate some place near your site to test the air temperature. Stand with your back to the sun and form a shadow with your body. Place the thermometer in the shadow of your body.

NOTE: Do not take an air temperature reading in the shade of a tree or other object because the reading will be considerably cooler than the actual air temperature. Do not rest the thermometer against any object as that will bias the reading as well.

② Wait 2-3 minutes (no longer than 5) to allow thermometer to equilibrate and take the reading.

③ Record the value to the nearest 0.5°C on your data sheet.

WATER TEMPERATURE

NOTE: Conduct the water temperature test close to the time the dissolved oxygen sample is being taken.

① After collecting the water sample in the bucket, remove it from direct sunlight and wind.

② Put the thermometer in the bucket for 2-3 minutes and record the value to the nearest 0.5°C. The thermometer bulb should be completely immersed and the reading should be taken while the bulb and lower part of the thermometer are under water. The thermometer should not be resting against the side of the bucket.

Special Instructions: If the liquid filled column has become separated in the LaMotte Armored Thermometer please submit a *Supplies Request Form* and return it to the Oklahoma Water Resources Board for a replacement thermometer.

pH

pH is a measure of how acidic or basic a solution is. In any given solution, some molecules of water break apart to form hydrogen ions (H+) and hydroxyl ions (OH^-). The pH scale is a means of showing which ion has the greater concentration. At a pH 7.0, the concentration of both ions is equal and the solution is said to be neutral. Pure water has a pH of 7.0. When the pH is less than 7.0, there are more hydrogen ions than hydroxyl ions and the water is said to be acidic. When the pH is greater than 7.0, there is more hydroxyl ions than hydrogen ions and the water is said to be basic or alkaline.

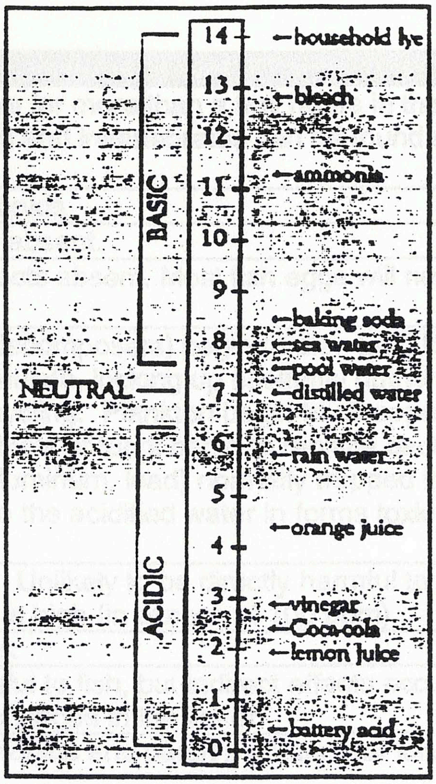
A range of 6.5 to 8.2 is optimal for most organisms. Most organisms have adapted to life in water of a specific pH and may die if it changes even slightly. The toxicity level of ammonia to fish, for example, varies tremendously within a small range of pH values. Acid rain containing nitric and sulferic acids can sharply lower the pH of a stream as the rain runs quickly off streets and roofs. Acidic water can cause heavy metals such as copper and aluminum to be released into the water. Copper from worn automobile brake pads is often present in runoff. Rapid growing algae remove carbon dioxide from water during photosynthesis, which can result in a significant increase in pH levels.

pH is calculated as the negative logarithm of the hydrogen ion concentration. This means that on the pH scale, the concentration of hydrogen ions does not increase or decrease in a linear fashion. A pH of 3 is not just twice as acidic as a pH of 6. Increases are in powers of 10. Every one unit change in pH actually represents a ten-fold change in acidity. In other words, pH 6 is ten times more acidic than pH 7; pH 5 is one hundred times more acidic than 7. Therefore, a change in pH of one whole number is a very significant change and can possibly have a serious impact on the quality of the water you are sampling.

Water's ability to resist changes in pH, termed its buffering capacity, is critical to aquatic life. The ability of water to buffer acidic waters is measured by its ***alkalinity***. Generally, an aquatic organism's ability to complete a life cycle greatly diminishes as pH becomes greater than 9.0 or less than 5.0. There are several phenomenon and natural processes that can severely affect the pH of water. Dissolved mineral substances, aerosols or dust from the air affect the pH of water. Man-generated wastes which are discharged or illegally dumped into a lake or stream can affect the water pH.

Photosynthesis by aquatic plants also influences pH. Photosynthesis is the process used by both vascular aquatic plants and algae for converting sunlight into energy. The photosynthetic process removes carbon dioxide from the water, which increases its alkalinity, thus elevating the pH. In especially low-velocity or still waters with lots of plant life (including planktonic algae), an increase in pH can be expected during the growing season or during warm, sunny afternoons. Moreover, the pH of water may change throughout the day due to changes in biological activity and may differ from the surface to the bottom. The carbon dioxide content of water in rivers and streams is less likely to change due to natural biological activity, but be aware of other events in the watershed that may affect pH. Human activities, such as accidental spills (oil, fertilizers etc.), agricultural runoff (pesticides, fertilizers, animal wastes), sewer overflow and discharge of acidic waters from mining activities may also change pH. Table 2 shows some pH values of common substances.

A variety of equipment can be used to measure pH, ranging from complicated electronic equipment to something as simple as litmus paper. The *OWW* has selected the LaMotte precision wide-range color comparator kit for use in the volunteer monitoring program. The test to determine the pH of a sample essentially involves addition of a reagent to your water sample with a resulting color change. The color of the sample will differ based upon its pH. The color comparator is then used to determine the pH of the sample.



pH values of some common substances

Before Beginning the Chemical Tests...

You will now conduct chemical tests that require adding a reagent. A reagent causes a chemical change to occur, which may form a precipitate or cause a color change. *OWW* testing procedures produce color changes, which give a numerical result, also known as colorimetric tests.

The chemicals used by *OWW* may be in a powder or liquid form. The liquid reagents are in squeeze bottles and/or in plastic bottles and the powder reagents are in pre-measured pillows. When using a reagent in the squeeze drop bottles, always add 8 drops. Many caps are color-coded (i.e. sulfuric acid has a red cap). However, do not rely on color-coded caps when using these chemicals. ALWAYS read the bottle--someone else may have put the wrong cap back on the bottle! The same goes for powder pillows. It is also a good idea to place each chemical back into the kit immediately after it has been used. The kits have been designed so that each test's chemicals are next to each other. Putting them back immediately keeps them in their proper slot and helps avoid accidental spills.

Always wear gloves and goggles to protect your skin and eyes. Put all of the chemical waste in the appropriate waste container—ammonia waste in a container by itself and all other waste in another.

At pH:	Effect on Aquatic Life
3.0 – 3.5	Unlikely that fish can survive for more than a few hours in this range although some plants and invertebrates can be found at pH levels this low.
3.5 – 4.0	Known to be lethal to salmonids.
4.0 – 4.5	All fish, most frogs, insects absent.
4.5 – 5.0	Mayfly and many other insects absent. Most fish eggs will not hatch.
5.0 – 5.5	Bottom-swelling bacteria (decomposers) begin to die. Leaf litter and detritus begin to accumulate, locking up essential nutrients and interrupting chemical cycling. Plankton begin to disappear. Snails and clams absent. Mats of fungi begin to replace bacteria in the substrate. Metals (aluminum, lead) normally trapped in sediments are released into the acidified water in forms toxic to aquatic life.
6.0 – 6.5	Freshwater shrimp absent. Unlikely to be directly harmful to fish unless free carbon dioxide is high (in excess of 100 ppm).
6.5 – 8.2	Optimal for most organisms.
8.2 – 9.0	Unlikely to be directly harmful to fish, but indirect effects occur at this level due to chemical changes in the water.
9.0 – 10.5	Likely to be harmful to salmonids and perch if present for long periods.
10.5 – 11.0	Rapidly lethal to salmonids. Prolonged exposure is lethal to carp, perch.
11.0 – 11.5	Rapidly lethal to all species of fish.

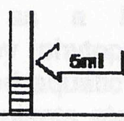
Effects of pH on aquatic life

pH Test Procedures

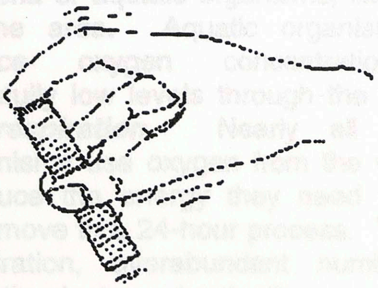
① Rinse the 5 mL test tube (code 0230) *twice* by squeezing DI water into it (just enough to swirl the water throughout the tube). Place a blue plastic cap on the tube and shake.

Be careful not to insert the tip of the DI bottle into the test tube to prevent contamination. Use the blue caps in the test kit and be sure to rinse the caps as well. Discard the waste in the plastic bottle labeled "WASTE CONTAINER."

② Fill the test tube to the 5 mL line with the sample water collected in the plastic sample water bottle or by using a plastic pipette to withdraw it from the bucket. Make sure the **bottom** of the meniscus (sagging water line) is on the dark line.

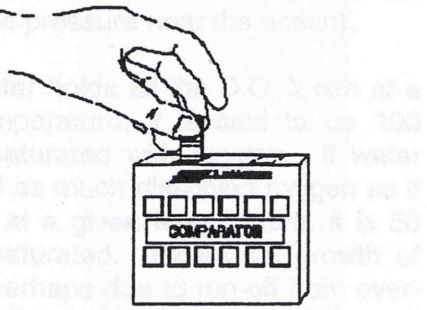


③ Hold the pH precision wide range indicator completely vertical and add 8 drops to the test tube. Cap and mix.



④ Insert the tube into the top of the Color Comparator and match the colors. If you have a visual problem, such as color blindness, either omit this test or have a sampling partner help you.
Hold the Octa-Slide Viewer up to a light source (sunlight or well lit classroom) to read. Make sure there are no other objects behind the comparator to affect the color, such as your hand or a tree if outside.

The pH value is determined by matching the color in the comparator to the sample tube color. Read the results in pH standard units (s.u.). Record the results on your data sheet in the section labeled **pH (standard units).** If the color appears to be between two readings, such as 8.0 and 8.5 your result is 8.25.



DISSOLVED OXYGEN

Dissolved oxygen (DO), one of the most important indicators of water quality for aquatic life, is essential for all plants and animals inhabiting a body of water. When oxygen levels in the water fall to 3 parts per million (ppm), fish and other aquatic organisms may have difficulty successfully reproducing, feeding or surviving. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Oxygen is a particularly sensitive constituent because chemicals present in water, biological processes and temperature all exert a major influence on its availability during the year.

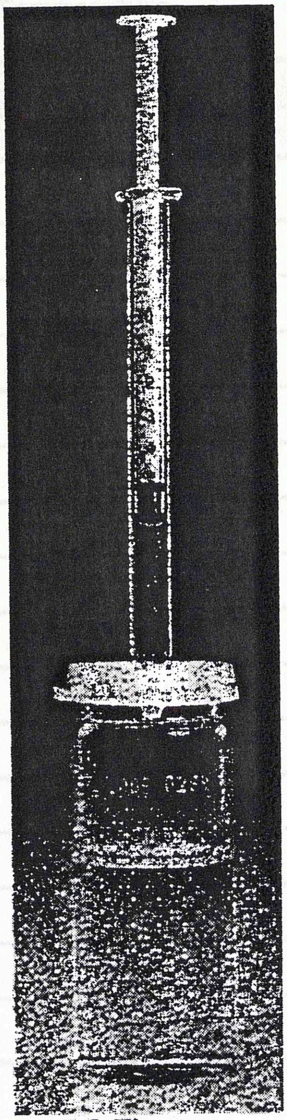
Oxygen is transferred from the atmosphere into the surface waters by the wind and wave action through a process called physical aeration or diffusion. Oxygen can also be added at or near the water surface as a by-product of photosynthesis by phytoplankton or by floating and rooted aquatic plants. Since the existence of plants also depends on the availability of light, the oxygen-producing processes only occur near the surface or in shallow waters where plenty of light is available.

Oxygen levels may be reduced because the water is too warm (e.g., near a power plant) or because there are too many bacteria or aquatic organisms, like algae, in the area. Aquatic organisms can reduce oxygen concentrations to harmfully low levels through the process of ***respiration***. Nearly all aquatic organisms use oxygen from the water to produce the energy they need to grow and move in a 24-hour process. Through respiration, overabundant numbers of aquatic plants and animals can consume most of the dissolved oxygen in the water. This consumption of oxygen can be most damaging at night and on very cloudy days when oxygen-producing photosynthesis does not occur.

A dissolved oxygen test (using a kit or meter) indicates precisely how much oxygen is dissolved in the water, but it does not show how much dissolved oxygen the water is capable of holding. The temperature, salinity and barometric pressure of the water affects dissolved oxygen levels. The amount of oxygen that water can hold decreases as the temperature and salinity of the water increases. The amount of oxygen that water can hold also decreases as the barometric pressure of the atmosphere decreases. (Barometric pressure generally decreases as the altitude or elevation of the water body increases. For example, the barometric pressure high in the mountains is less than the barometric pressure near the ocean).

When water holds all the D.O. it can at a given temperature, it is said to be 100 percent saturated with oxygen. If water holds half as much dissolved oxygen as it can hold at a given temperature, it is 50 percent saturated. Excessive growth of algae -- perhaps due to run-off from over-fertilized farmland, urban runoff, runoff from golf courses or sewage effluent which contains high levels of the nutrients phosphorous and nitrogen -- may consume oxygen to such an extent that fish-kills can occur. Fish-kills may also occur when oxygen levels in deep, colder waters reach very low levels. Low levels of oxygen in the deeper lake waters can occur when stratification is present. This is because the deeper water is not being brought to the surface for re-oxygenation by wind and wave action, and respiration is depleting oxygen levels. When stratification occurs, no additional oxygen is available to the bottom waters until the stratification "breaks down." The stratification can be "broken down" by either wind and wave action or by changes in water density which cause the lake to turnover during the spring and fall. Table 3 shows the relationship between water solubility and temperature.

To determine dissolved oxygen, a LaMotte D.O. Titration Kit (modified-Winkler titration/azide modification) will be used. You will need to carefully follow the sample collection and analysis procedures you have been taught when you are performing this test.



DO Titrator

Table 3: Relationship Between Water Solubility and Water Temperature.

TEMPERATURE (°C)	SOLUBILITY (mg/L)	TEMPERATURE (°C)	SOLUBILITY (mg/L)
0	14.6	16	10.0
1	14.2	17	9.8
2	13.8	18	9.6
3	13.5	19	9.4
4	13.1	20	9.2
5	12.8	21	9.0
6	12.5	22	8.9
7	12.2	23	8.7
8	11.9	24	8.6
9	11.6	25	8.4
10	11.3	26	8.2
11	11.1	27	8.1
12	10.9	28	7.9
13	10.6	29	7.8
14	10.4	30	7.7
15	10.2	31	7.6

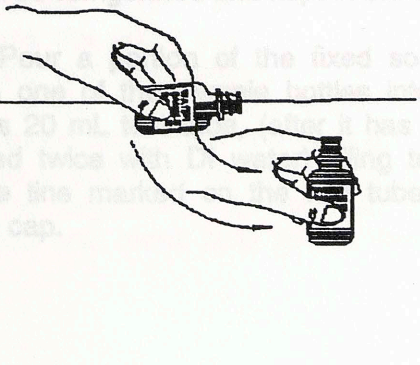
Dissolved Oxygen (DO) Test Procedures

PLEASE PUT SAFETY GOGGLES AND GLOVES ON BEFORE PERFORMING TEST. For greatest accuracy, duplicate tests are run on each water sample.

① Rinse both sampling bottles twice with distilled or deionized water. Discard this rinse water in the waste container. **Do not pour the rinse back into the sample bucket!**

② Place the sample bottle in a horizontal position at the surface of the water and allow the sample water to slowly fill the bottle. Slowly rotate the bottle into a vertical position and submerge it to allow air to escape and be careful not to agitate the water. Lower the cap into the water to fill it and make sure there are no bubbles trapped inside. Cap the bottle while it is completely submerged. If there was no glugging during sample collection, proceed to step 3.

If sampling a stream and the water is not deep enough to rotate the bottle into a vertical position, collect the water sample by holding the sample bottle at the water surface and at a forty-five degree (45°) angle. Keep the bottle slightly submerged, facing upstream, and allow it to slowly fill.



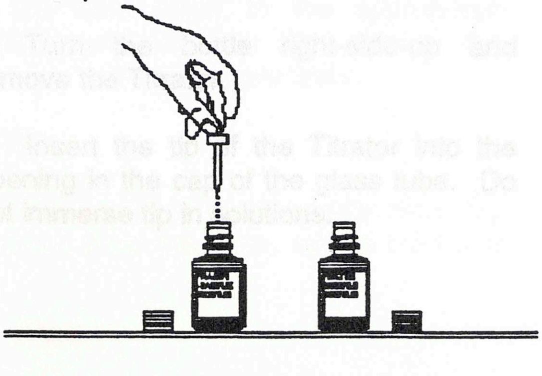
③ Take the bottle out of the water. Turn it upside down and examine it carefully to make sure that no air bubbles are trapped inside. Repeat for the second sample. Once a satisfactory sample has been collected, proceed to steps 4 and 5 to "fix" the sample. **HELPFUL HINT: Collect both water samples at the same time.**

NOTE:

- Be careful not to introduce air into the sample when you are adding the reagents in steps 4 and 5. Drop the reagents into the sample, cap carefully, and gently mix the sample.

- Some of the sample will overflow as chemicals are added during the "fixing" steps, but sufficient amounts of the oxygen-reacting chemicals WILL fall to the bottom of the bottle. *The overflow assures that when the sample bottle is closed again, no air will be trapped inside. An air bubble in the sample bottle may introduce additional oxygen during the mixing step, producing false, high readings.*

④ Add 8 drops of **Manganous Sulfate Solution** (pink) and 8 drops of **Alkaline Potassium Iodide Solution** (clear) to each sample. Hold the reagent bottles perfectly vertical above the sample bottle when dropping the chemical into the water. Cap the bottle.

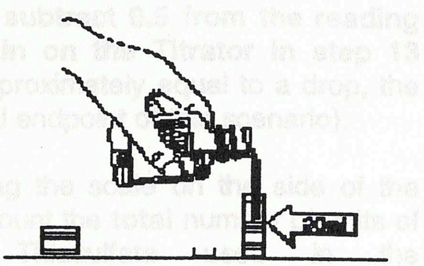


Mix by tightly holding the bottle and inverting it gently approximately ten times. A precipitate or fuzzy "floc" will form. Allow the precipitate to settle below the shoulder of the bottle. Invert the bottle again and allow the precipitate to settle again. In saline waters, you may have to allow up to 2 minutes for each settling step. Mix for the full amount of time specified and allow the "floc" to settle according to the instructions. *Impatience may result in an incomplete reaction and produce false, low readings.*

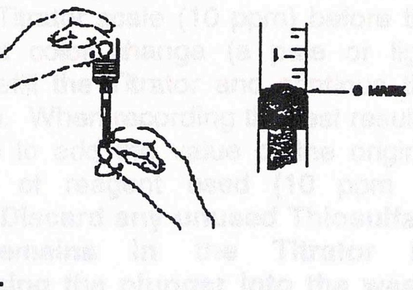
⑤ Add 8 drops of **Sulfuric Acid** (red cap) to each of the sample bottles. Cap each bottle and shake diligently to mix. After the sulfuric acid is added the precipitate begins to look like large pepper flakes. The solution must be shaken until a clear-yellow to brown-orange color develops and all of the "flakes" are gone. The color of the solution will depend on the oxygen content of the sample. A darker color indicates a higher oxygen content.

HELPFUL HINT: Steps 1-5 "fix" the sample. After Step 5, contact between the water sample and the atmosphere will not affect the test result. Therefore, it is not necessary to perform the titration procedure immediately. Several samples can be collected, fixed in the field, and then carried back to a testing station, laboratory, home, etc. for titration (Steps 6-11). Titration should be completed no longer than 8 hours following fixation and must be refrigerated and kept in the dark.

⑥ Pour a portion of the fixed solution from one of the sample bottles into the glass 20 mL test tube, (after it has been rinsed twice with DI water) filling to the white line marked on the test tube and then cap.



⑦ Fill the Titrator (small syringe) to the 0 mark with **Standard Sodium Thiosulfate Solution.** To fill the Titrator, invert the bottle of Thiosulfate Solution and slowly withdraw the plunger until the tip of the plunger is opposite the zero mark on the Titrator. Be sure to expel any air bubbles from the titrator barrel by depressing the plunger to expel air.



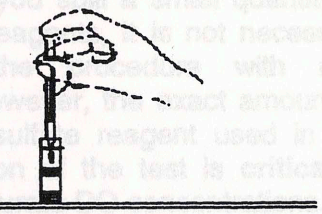
NOTE:

- A small air bubble may appear in the Titrator barrel. Expel the bubble by partially filling the barrel and pumping the titration solution back into the inverted Sodium Thiosulfate container. Repeat this pumping action until the bubble disappears.

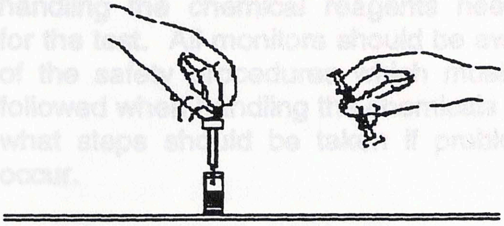
⑧ Turn the bottle right-side-up and remove the Titrator.

⑨ Insert the tip of the Titrator into the opening in the cap of the glass tube. Do not immerse tip in solutions.

⑩ This step is called titration. **Add 1 drop of Sodium Thiosulfate** to the test tube; **swirl the test tube** to mix. Add another drop of the Sodium Thiosulfate and again **swirl the tube.** Continue this titration



process one drop at a time until the yellow-brown solution in the test tube begins to fade to a pale straw color which resembles **BCS #42 in your color**



booklet. Uncap the glass test tube with the Sodium Thiosulfate-filled titrator still intact. Put aside for a moment.

⑪ Add **8 drops of Starch Solution** to the test tube. The solution should turn from light yellow to dark blue. Replace the cap with the titrator intact. Swirl the tube to mix.

⑫ Continue the titration process (described in Step 11) with the remaining SodiumThiosulfate until the test solution turns from dark blue to a light sky blue color **(BCS #134 in your color booklet). Do not add any more Sodium Thiosulfate than is necessary to produce the color change.** Be sure to swirl the test tube thoroughly after each drop. If you "overrun" the endpoint and the solution turns clear you must go back to Step 6 and start the titration process from the beginning. If, however, when you add one more drop to the solution while swirling and it goes from a dark blue to clear, you do not have to start over. You may **subtract 0.5 from the reading you obtain on the Titrator in step 13** (0.5 is approximately equal to a drop, the theoretical endpoint of this scenario).

⑬ Using the scale on the side of the Titrator, count the **total** number of units of Sodium Thiosulfate used in the experiment. Read the test results from where the plunger tip meets the scale. Include both titration amounts in the final test results (from steps 11 and 13). That number equals the number of parts per million (ppm) or milligrams per liter (mg/L) of oxygen in the water. **NOTE: Each minor division of the Titrator scale equals 0.2 ppm (or mg/L).**

⑭ If the plunger reaches the bottom line on the Titrator scale (10 ppm) before the endpoint color change (a pale or light blue), refill the Titrator and continue the Titration. When recording the test results, be sure to add the value of the original amount of reagent used (10 ppm or mg/L). **Discard any unused Thiosulfate that remains in the Titrator by dispensing the plunger into the waste container. DO NOT PUT IT BACK INTO THE THIOSULFATE REAGENT BOTTLE!!**

⑮ Carry out steps 6-15 on the second sample bottle.

⑯ Record the results of the two tests on the data sheet in the appropriate section and calculate and record the Average Value of the two tests.

NOTE:

- If the results of the **two tests differ by more than 0.6 ppm**, take a third test and record the average of the two closest results.

HELPFUL HINT: All of the chemical reagents used in this test, except Sodium Thiosulfate, are in excessive amounts. Therefore, if you spill a small quantity of these other reagents, it is not necessary to repeat the procedure with new reagents. However, the exact amount of Sodium Thiosulfate reagent used in the titration section of the test is critical in achieving accurate DO concentrations.

Contamination of the sample with oxygen from the air is possible and should be avoided. Care should also be taken in handling the chemical reagents needed for the test. All monitors should be aware of the safety procedures which must be followed when handling the chemicals and what steps should be taken if problems occur.

ADVANCED HACH NUTRIENT TESTS

A few notes and reminders before you begin:

BLANKS

A blank must be run on all the nutrient tests using deionized water instead of sample water. All directions for adding reagents to the treated sample should be followed for the DI water. An untreated sample of DI water should be used for comparison. Remember to record your DI blank results on your data sheet to validate your sample data.

If the sample water or DI blank test yields unexpectedly high readings, the glassware may be contaminated. Because of the sensitivity of these tests, the glassware must be kept extremely clean. If contamination is suspected, continue the test procedures, then rinse the tubes with sample water and run the test again. This will allow the test reagents to clean the tubes and eliminate any contamination. Comparing the results of the two analyses should indicate if any interference was present.

POWDER PILLOWS

To open foil powder pillows, first tap the bottom of the foil packets on a counter or other horizontal surface to settle the contents. Then tear the top of the packet open along the tear line using clippers or fingernails. Push the sides of the packet inward to open. Pour the reagent from the powder pillow into sample tubes as directed in the instructions.

COLOR COMPARATORS

The one comparator is used for all three nutrient tests. To change color wheels, simply open the front cover and insert the correct wheel onto the post. Make sure that the wheel is facing the correct direction by seeing if you can read the values through the opening.

Always make sure you are looking at the correct color wheel for the parameter you are testing. Each color wheel has the name of the test on it. **It is very important to be sure to put them into their protective sleeve as soon as you are done with a test.** The colors in the wheel are sensitive to light and can become faded if they are often left out in direct sunlight.

TEST TUBES

Both the ammonia and the nitrate tests use 15 mL **plastic** test tubes. These tubes have been marked with colored dots to prevent cross-contamination. Test tubes with **green dots** on the side are for **ammonia**. Those with **red dots are for nitrate.** You may, however, use either for the untreated sample. This type of test tube does not have marked increments. Instead, please note the frosted area on the tube. The bottom of this area is the 5 mL mark as indicated in the figure below.

The **glass** test tubes are only to be used with the **phosphorus** test.

AMMONIA NITROGEN

Nitrogen occurs in several different "states" or forms in the aquatic environment. One of the various forms of nitrogen present in nature is ammonia nitrogen (NH_2^+). Ammonia nitrogen is nitrogen at its most reduced form. Ammonia is generally produced through the decomposition of organic compounds such as leaf litter, woody debris, etc. Ammonia may come into a lake through various routes. It may enter a lake or stream adsorbed to some type of inorganic particle, such as a colloidal clay particle commonly found in Oklahoma, or it may enter through deposition from the atmosphere. Ammonia is readily available for assimilation by algae and frequently the highest algal growth rates occur through utilization of ammonia.

Ammonia levels in natural, unpolluted waters can range from 0-5 milligrams per liter or can occur at levels greater than 10 mg/L in the hypolymnotic waters of a eutrophic lake which is experiencing anoxic conditions below the thermocline. Ammonia concentrations in a lake are typically low. Ammonia is easily assimilated by algae and broken down in the presence of oxygen, thus ammonia rarely occurs in detectable quantities in unpolluted water. Under very high pH's, ammonia will volatilize. It is generated in the aquatic system through the actions of heterotrophic bacteria as a primary product of the decomposition of organic matter, either directly from proteins or from other nitrogenous compounds. It occurs in water predominantly as NH_4^+, but it can be present as disassociated NH_4OH (ammonia hydroxide) which is extremely toxic to many aquatic organisms, especially fish. As pH increases, the ratio of NH_4^+ to NH_4OH approaches 1 to 1 (a 1 to 1 ratio occurs at a pH of 9.5).

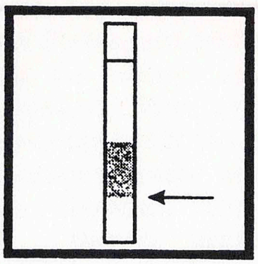
Ammonia is strongly absorbed to clay particulates and this represents the most significant source of ammonia to a waterbody. During stormwater runoff events, the soil particles with the adsorbed ammonia is transported to the lake. In general, the ammonia is "bound-up" in the sediments and is not available for the algae to utilize. However, under strong reducing conditions the ability of the sediments to absorb NH_4 is significantly diminished. This occurs when anoxic conditions are present in the lake hypolymnion and ammonia is released from the lake sediments to the lake water column.

Ammonia nitrogen levels will be determined through use of a Hach ammonia nitrogen test kit.

Ammonia Nitrogen Test Procedures

Caution: This test should be performed in a well-ventilated area. Avoid inhaling any fumes. Discard waste from this test into a SEPARATE container labeled as "Ammonia Waste." Do Not Allow Waste To Come In Contact With Acids!!!

① After rinsing twice with DI water and priming with sample water, fill the **two 15 mL plastic test tubes** marked with green dots to the **5 mL mark** (lowest mark on the tube) with sample water.



NOTE: One of these test tubes will be used for color comparison **only** and **does not** receive any reagents. This is the **untreated sample**. The other test tube will receive all powder pillows and is considered the **prepared sample**.

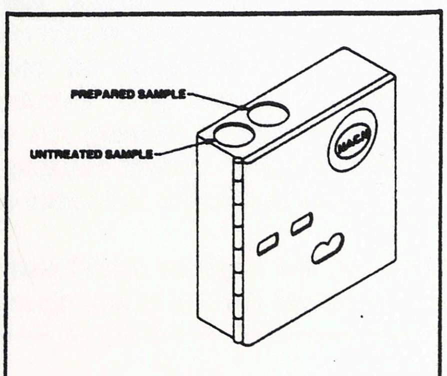


Figure 1.

② Use the clippers to open one **Ammonia Salicylate Reagent Powder Pillow**. Add the contents of the pillow to the sample water in one of the tubes. This is now the **prepared sample**. Cap the tube and shake until all the powder is dissolved. **Wait three (3) minutes.**

③ Add the contents of one **Ammonia Cyanurate Reagent Powder Pillow** to the prepared sample. Recap the tube and shake until all the powder is dissolved. **Allow at least 15 minutes** for the color to develop fully. **The color is stable for several hours if the tube is kept capped.**

④ Clean the outsides of both the prepared and untreated sample tubes with a dry cloth or tissue.

⑤ Insert the prepared, or color-developed, sample into the right-hand opening on the top of the color comparator as shown in *Figure 1.*

⑥ Insert the tube without reagents (untreated sample) into the left-hand opening of the color comparator as shown in *Figure 1.*

⑦ Hold the comparator up to a light source such as the sky, a window, or a lamp and view through the two openings in the front. Rotate the color disc until a color match is obtained.

⑧ Read the concentration of ammonia nitrogen, in mg/L (N), through the scale window. Record this value on the data sheet.

⑨ Dispose of the ammonia waste in the container labeled "AMMONIA WASTE ONLY."

NOTE: In the event that a high reading occurs and is higher than the range of the color wheel, the limits of this test can be increased by diluting the sample. Using the eyedropper, deliver 2.5 mL of sample into the plastic test tube and then add 2.5 mL of DI water. Proceed with test as usual. When reading the comparator, multiply the color wheel number shown by 2 to compensate for the dilution. **Be sure to note on your data sheet that a dilution was performed.**

REMEMBER TO RUN A BLANK WITH DI WATER TO VALIDATE YOUR TEST RESULTS ON EVERY NUTRIENT PARAMETER! YOUR DATA CAN NOT BE USED WITHOUT THEM!

NITRATE NITROGEN

Nitrogen is an essential nutrient for the survival of aquatic micro and macro organisms. Nitrate and nitrite nitrogen are two forms of nitrogen which occur in nature. As nitrate is assimilated by algae it is reduced to ammonia. Nitrate (NO_3^-) can be introduced in the aquatic environment through a number of sources, including sewage or septic waste and through the transport of nitrogen-based fertilizers into a lake during a storm event.

Nitrate may also be introduced through atmospheric deposition. In some parts of the United States, atmospheric deposition constitutes the primary source of nitrate into the system. Both nitrate and nitrite (NO_2^-) generally occur in natural waters at very low concentrations with nitrate being the most abundant form of nitrogen present. Natural concentrations of nitrogen rarely exceed 10 mg/L and are frequently less than 1 mg/L during periods of high algal productivity. Nitrate concentrations in the effluent of biological wastewater treatment plants may be found at levels approaching 30 mg/L.

Nitrates may also be present at high levels in groundwater. If groundwater is a major source of water input into a lake, then nitrate introduction through this route could be substantial. As nitrates are "reduced" they become nitrites. Nitrites are not present at high levels in natural, unpolluted waters. High levels of nitrites are indicative of polluted water.

Nitrate/Nitrite nitrogen will be determined through use of a Hach test kit.

Nitrate Nitrogen Test Procedure

NOTE: There are two different ranges for this test which require slightly different procedures. Always start with the low-range procedure first and then perform the high-range if necessary. If your site consistently requires the high- range procedure (for two or more months) you may start with the high- range procedure and retest with the low- range instructions if a value of 1.0 mg/L or below is obtained.

Low-Range (0-1 mg/L)

① Rinse both of the **15 mL plastic test tubes** marked with **red dots** twice with DI water and prime with sample water. Cap and shake vigorously with each rinse.

② Fill one of the test tubes to the **5 mL mark** with sample water.

③ **Use the clippers to open one NitraVer 6 Nitrate Reagent Powder Pillow.** Add the contents of the pillow to the test tube. **Cap the tube and shake for three minutes. Allow the sample to stand undisturbed for an additional 30 seconds.** Unoxidized particles of cadmium metal may remain in the sample and settle to the bottom of the viewing tube.

④ Pour the prepared sample into the second plastic test tube carefully so that any unoxidized cadmium particles remain in the first tube.

⑤ Use the clippers to open **one NitriVer 3 Nitrite Reagent Powder Pillow.** Add the contents of the pillow to the sample. Cap the tube and shake for **30 seconds.** A red color will develop if nitrate is present. **Allow at least 10 minutes, but not more than 20 minutes, before completing Steps 6 through 8.**

⑥ Insert the prepared sample into the right top opening of the color comparator (see Figure 1 in ammonia instructions).

⑦ Rinse the unoxidized cadmium metal from the plastic tube used in Step 2. Fill to the **5 mL** mark with **untreated sample** water and place in the left top opening of the comparator (see Figure 1 in ammonia instructions).

⑧ Hold the comparator up to a light source such as the sky, a window or lamp and view through the openings in front. Rotate the disc to obtain a color match. Read the mg/L nitrate nitrogen (N) through the scale window and record this on your data sheet.

High-Range (0-10 mg/L)

① Rinse both of the plastic test tubes, marked with a **red dot**, twice with DI water and prime with sample water.

② Rinse the **glass eyedropper** with sample water. Fill to the **0.5 mL** mark with sample water. Add the contents of the dropper to the rinsed plastic test tube.

③ Add **DI water** until the sample is even with the **5 mL** line on the test tube. Swirl to mix.

④ Use the clippers to open **one NitraVer 6 Nitrate Reagent Powder Pillow.** Add the contents of the pillow to the test tube. **Cap the tube and shake for 3 minutes. Allow the sample to stand undisturbed for an additional 30 seconds.** Unoxidized particles of cadmium metal may remain in the sample and settle to the bottom of the viewing tube.

⑤ Pour the prepared sample into the second plastic tube carefully so that any unoxidized cadmium particles remain in the first tube.

⑥ Use the clippers to open **one NitraVer 3 Nitrite Reagent Powder Pillow.** Add the contents of the pillow to the prepared sample. Cap the tube and **shake for 30 seconds.** A red color will develop if nitrate is present. **Allow at least 10 minutes, but not more than 20 minutes, before completing Steps 7 through 9.**

⑦ Insert the tube containing the prepared sample into the right top opening of the color comparator (see Figure 1).

⑧ Rinse the unoxidized cadmium from the plastic tube used in Step 2. Fill to the 5 mL mark with untreated sample water. Place this tube in the left top opening of the comparator (see Figure 1).

⑨ Hold the comparator up to a light source such as the sky, a window or lamp and view through the openings in front. Rotate the disc to obtain a color match. Read the mg/L nitrate nitrogen (N) through the scale window, multiply it by 10, and record it on your data sheet.

The results obtained in the nitrate tests above are actually the sum of both the nitrate and nitrite nitrogen present in the sample.

ORTHOPHOSPHATE PHOSPHORUS

Phosphorus is present in waters in several soluble and particulate forms including organically bound phosphorus, inorganic polyphosphates and inorganic orthophosphates. Phosphorus occurs almost solely in nature as phosphates. Orthophosphates (PO_4), in particular, occur as ions of phosphoric acid. All inorganic phosphates are generally considered as PO_4.

Phosphorus can be introduced into an aquatic system from a myriad of sources. Phosphates are used extensively in laundering and cleaning products and are present in fertilizers which can be transported to a waterbody through stormwater runoff. Organic phosphates are formed predominantly through biological processes, however, domestic sewage can also be a source of these compounds. Because phosphorus is a biologically active element, it cycles through many "states" in the aquatic ecosystem. Phosphorus can be removed from the water column by chemical precipitation to the sediments or by adsorption to colloidal clay particulates which are deposited to the lake sediments.

Phosphorus is essential to the growth of aquatic organisms such as algae, macrophytes, etc. and can be the "limiting" nutrient to primary productivity. Liebig's "Law of the Minimum" states that the element present in the lowest concentration relative to its demand is the element limiting the process at that time. In instances where phosphorus is the limiting nutrient, the discharge of raw or treated wastewater, agricultural runoff or certain industrial wastewaters may serve to stimulate the growth of aquatic plants (both micro and macro). For this reason phosphorus is generally measured in relation to excessive primary productivity and eutrophication problems.

Phosphates are very strongly adsorbed to clay particulates and, in general, they are not biologically available to the algae for uptake. The phosphates are contained in the bottom sediments. Phosphorus is usually the element which is limiting, though nitrogen can be limiting during certain seasons of the year. Total phosphorus concentrations in unpolluted waters are usually less than 0.1 mg/L and ortho-phosphorus is often present at levels less than 0.01 mg/L. Ortho-phosphorus is the amount ready available for assimilation and use.

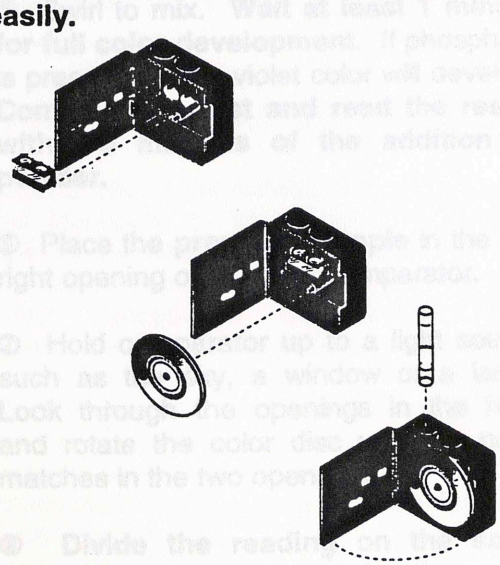
Ortho-phosphate will be determined through use of a Hach phosphate test kit.

Orthophosphate Test Procedures

NOTE: There are three different ranges for this test which require slightly different procedures. Always start with the low-range procedure first and then perform the mid- or high-range if necessary. If your site consistently requires the mid- or high-range procedure (for two or more months) you may start with that range's procedure and retest with a lower range if a value of 5.0 mg/L or below is obtained.

Low-Range Test (0-1 mg/L)

① Insert the Long Path Viewing Adapter into the color comparator (*see the figure below*). **Be extremely careful when handling the viewing adapter because the mirror slides out of its holder very easily.**



② After rinsing twice with DI water and priming with sample water, fill **one 15 mL glass test tube** to the **top line** (which underlines "No. 1730") with sample water. As with the other nutrient tests, this will be the **untreated sample** and will not receive any powder pillows.

③ Place the **untreated sample test tube** in the top left opening of the color comparator.

④ Rinse the **square mixing bottle** twice with DI water and then prime with sample water. Next, fill the bottle to the **20 mL mark** with sample water.

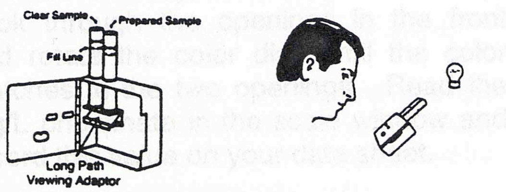
⑤ Add the contents of **one PhosVer 3 Phosphate Reagent Powder Pillow** to the square bottle.

⑥ Swirl to mix. **Wait 8 minutes for full color development.** If phosphate is present, a blue-violet color will develop. **This test is time sensitive, complete the rest of the directions and read the result within 10 minutes.**

⑦ Fill the second **15 mL glass test tube** to the **top line** (which underlines "No. 1730") with the prepared sample from the **square mixing bottle**.

⑧ Place this tube in the top right opening of the color comparator.

⑨ Hold the comparator with the tube tops pointing toward a light source such as the sky, a window or a lamp as shown in the figure below. Make sure the test tubes are uncapped. Look through the opening in the front of the comparator, taking care not to spill the samples.



⑩ Rotate the color disc until the color matches in the two openings. **Divide the reading in the scale window by 50** to obtain the mg/L phosphate. Record this value on your data sheet.

Mid-Range Test (0-5 mg/L)

① If the color comparator has the Long Path Viewing Adapter in place, remove it.

② Fill a glass test tube to the first **5 mL** line with **sample water.** This will be the **untreated sample.** Place this tube in the top left opening of the color comparator.

③ Fill the second glass test tube to the 5 **mL** line with sample water.

④ Add the contents of **one PhosVer 3 Phosphate Reagent Powder Pillow** to this test tube.

⑤ Swirl to mix. **Wait at least 1 minute for full color development.** If phosphate is present, a blue-violet color will develop. **Complete the test and read the result within 5 minutes of the addition of powder.**

⑥ Place the **prepared sample** in the top right opening of the color comparator.

⑦ Hold comparator up to a light source such as the sky, a window or a lamp. Look through the openings in the front and rotate the color disc until the color matches in the two openings.

⑧ **Divide the reading on the scale window by 10** to obtain the mg/L phosphate and record this value on your data sheet.

High-Range Test (0-50mg/L)

① If the color comparator has the Long Path Viewing Adapter in place, remove it.

② Rinse the two **15 mL glass test tubes** with DI water. Fill one glass test tube to the first **5 mL** line with **sample water.** This will be **the untreated sample.** Place this tube in the top left opening of the color comparator.

③ Rinse the **glass eyedropper** several times with the sample water. Fill the dropper to the **0.5 mL mark** with sample water. Dispense this sample water into the second glass test tube. This will be the prepared sample.

④ Add **DI water** until the sample is even with the **5 mL line** on the test tube. Swirl to mix.

⑤ Add the contents of **one PhosVer 3 Phosphate Reagent Powder Pillow** to this test tube. Swirl to mix. **Wait at least 1 minute for full color development.** If phosphate is present, a blue-violet color will develop. **Complete the test and read the result within 5 minutes of the addition of powder.**

⑥ Place the prepared sample in the top right opening of the color comparator.

⑦ Hold comparator up to a light source such as the sky, a window or a lamp. Look through the openings in the front and rotate the color disc until the color matches in the two openings. Read the mg/L phosphate in the scale window and record this value on your data sheet.

QUALITY CONTROL BLANKS AND DUPLICATES

Data collected by **OWW** volunteers serve several valuable functions. In addition to providing the volunteer with information on the water quality of their lake or stream, it provides OWRB personnel with useable data. In order to insure the quality of the data, several quality assurance/quality control procedures should be maintained. First of all, regular quality assurance checks should be scheduled with **OWW** personnel. Second, procedural blank tests should be performed to analyze contamination, precision, and accuracy. Procedural blanks and duplicates should be performed at each site tested by **OWW** volunteers every time they sample. Results of procedural blank and duplicate tests should be recorded in the spaces provided on the data sheet.

PROCEDURAL BLANKS

Procedural blanks are distilled water samples tested identically to your lake or stream sample as indicators of contamination. This contamination can result from dirty glassware, incorrect procedures, or contaminated reagents. Testing a blank adds confidence to the accuracy of test results. A procedural blank (PB), also called a DI blank, should be tested prior to testing your water sample for all nutrient concentrations. A PB tests for contamination due to sample handling during the testing procedure.

If results of the PB test are **negative** (no color change occurs because the nutrient you are testing for is not present in detectable quantities), you can proceed with your sample testing. If the PB test has **positive** results (color change occurs, indicating the nutrient you are testing for is present in detectable quantities), steps should be taken to identify the source of the error.

Procedural Blanks Procedure

① After rinsing twice with DI water, fill the appropriate test tube (depending on whether you are performing the ammonia, nitrate, or phosphorus tests) with DI water to the same mark you would use for sample water.

② Perform test as stated in the handbook for the appropriate test. You should do everything to the DI water that you would normally do to the sample water including adding the appropriate amount of chemicals, shaking or inverting where necessary, and waiting the allotted time before reading test results. **Note: You should perform a blank for the ammonia, nitrate, and phosphorus tests before testing your sample water for these parameters.**

③ After the appropriate amount of time for the test has elapsed you should observe the test tube in its comparator. Any result above the detectable (lowest) limit on the comparator (0.0 for ammonia, 0.0 for nitrate, or 0.25 for phosphorus) should be considered a positive test result. Please follow **trouble shooting** procedures to determine the source of error. If the result is below detectable limits on the comparators, it is considered a negative (zero) result.

④ Record the observed result in the appropriate space on the data sheet no matter if it was positive or negative.

Trouble Shooting

If the PB test is positive, follow these steps:

① **Always** record test results and provide notes describing additional steps. These notes provide valuable information when another person evaluates your data.

② Rinse glassware several times with distilled water. Repeat the PB test and record results (label PB2). If the test is negative, proceed with lake or stream water testing; if the test is positive, go to step 3.

③ Obtain "new" distilled water. Empty and rinse (with "new" distilled water) the distilled water from the water bottle in your kit. Fill with "new" distilled water. Repeat PB test and record results (label PB3). If the test is negative, proceed with lake or stream water testing. The "old" distilled water may have been contaminated. If the test is positive, go to step 4.

④ Inform **OWW** personnel of your results and obtain new reagent powder pillows. Reagents sometimes expire before the printed date or are contaminated from the manufacturer. Repeat the PB test and record results (label PB4). If the test is negative, proceed with lake or stream water testing; if the test is positive, go to step 5.

⑤ Inform **OWW** personnel of your results and obtain new glassware. Your sample tube may have become contaminated; use of a new tube may eliminate positive PB test results. Repeat the PB test and record results (label PB5). If the test is negative, proceed with lake or stream water testing; if the test is positive, inform **OWW** personnel and additional help will be provided.

DUPLICATES

Duplicate samples test precision (how much the measured value varies each time it is tested) and accuracy (how close the measured value is to the actual value). The smaller the degree of precision and accuracy, the less valuable the data becomes. Measured values of duplicate samples (labeled Dup 1 and Dup 2) should be approximately within twenty percent of each other. This can be calculated in the following manner:

$$AL = X * 0.2$$

Where: **AL=** the allowable limit. The difference between the two duplicate values should be less than this number.
X= the higher of the two duplicate values, Dup 1 and Dup 2.

The following is an example of duplicate evaluation:

Dup 1	Dup 2	Difference	AL	Results
15	16	1	1.6	**Acceptable: 1 < 1.6**
150	190	40	19	**Not Acceptable: 40 > 19**
1.5	1.7	0.2	0.34	**Acceptable: 0.2 < 0.34**
0.15	0.19	0.04	0.038	**Not Acceptable: 0.04 > 0.038**

Duplicate samples should be measured, recorded, and evaluated for dissolved oxygen. They can be performed for every parameter if necessary (such as during a QC or after an unusual result is obtained). When possible, the duplicates should be tested by the same individual to reduce potential variation due to individual differences between volunteers.

Trouble Shooting

If duplicate samples do not fall within allowable limits of each other, an error was present during testing. The following steps should help eliminate sources of error in the testing of duplicate samples:

① A negative procedural blank test for nutrient parameters should have greatly reduced the potential for contamination, suggesting an error was made during testing of the lake or stream sample. However, contamination could still have been possible, therefore test and record the results of another PB to eliminate the possibility of contamination. If the test is negative, proceed with step 2 in the duplicate sample trouble shooting. If the PB test is positive, proceed with the PB test trouble shooting.

If the duplicate error occurred in the measurement of some parameter other than a nutrient, proceed to step 2.

② Test a third duplicate sample and record its value (label Dup 3). Compare the third duplicate to the first two. If this value falls within twenty percent of one of the first two, accept those values. (Remember, **do not discard** the value which falls outside the twenty percent range. Include it in the data report as it provides valuable information during data interpretation.) If this value does not fall within twenty percent of one of the first two values, continue to test, record (labeled as previously described), and evaluate additional duplicates until two values fall within twenty percent of one another.

CHLOROPHYLL-A (OPTIONAL)

In addition to performing water quality tests, monitors may collect surface water samples to be analyzed for ***chlorophyll-a***, a green pigment in algae and other plants. Chlorophyll-a is utilized in photosynthesis which is the conversion of carbon dioxide and water aided by sunlight to oxygen and energy in the form of sugar. It is the main energy acquiring pathway of autotrophic organisms.

In a *lake, chlorophyll-a* is measured because the amount present is usually directly proportion to the ***biomass*** of the algae in the lake. Because of this relationship, chlorophyll-a is used by lake managers as an indirect indicator of the algal content present in a water body. Monitoring algal content is important to lake managers for three main reasons: 1) increased algal content decreases the clarity and colors the water body, 2) algal conditions can be easily sampled, and 3)algal conditions form the basis for establishing a lake's trophic state, or age. It should be noted, however, that this cannot be considered a precise measurement of algal content. Different species of algae contain different concentrations of chlorophyll-a in their cells, and the amount of chlorophyll is manipulated by the amount of direct sunlight hitting the surface of the water. Chlorophyll content in cells normally decreases under periods of high sunlight and increases under periods of low light.

The chlorophyll-a concentration will be measured from samples collected by monitors at each sample site and will be used in conjunction with a ***trophic state index*** (TSI) to determine the quality of the water. The higher the chlorophyll-a value, the greater the trophic state index value. Higher TSI numbers reflect poor water quality.

The *Oklahoma Water Watch* groups collect chlorophyll-a samples according to where the groups' sampling sites are located and the feasibility of collection. After sampling sites are approved, samples are taken monthly, quarterly, or biweekly depending on the season of the year, the location of sampling sites, and the feasibility of collection efforts at each approved site on a quarterly basis and biweekly from May through August.

Chlorophyll-a Test Procedures

SAMPLING

① *Collection from **boat dock or boat:*** Collect water sample according to *Oklahoma Water Watch* Standard Operating Procedures (SOPs) for Bucket Grab (pg. 8) approximately one foot or elbow length below the surface of the water.

*Collection from **shore:*** If collecting from shore use the Water Dipper instead of the Bucket Grab method, following SOPs for Water Dipper approximately one foot or elbow length below the surface of the water.

② Fill the one (1) liter plastic sample bottle about one-quarter (1/4) of the way full with sample water by lowering the bottle into the bucket (or pouring from the dipper). Cap and shake bottle to "prime" (coat) the inside surface of the bottle with sample.

Remove the cap and pour out the rinse water.

③ Fill the "primed" sample bottle to the top with sample water and cap.

④ Label sample with Lake Name, Site Number, Date, Monitor's Name (your name).

⑤ Immediately place sample in an ice chest and close the lid tightly. **REMEMBER: SUNLIGHT AND HEAT DEGRADE CHLOROPHYLL.**

⑥ Place samples in refrigerator to keep chilled if not filtering immediately. Unfiltered samples will last for up to 24 hours on ice and OUT OF SUNLIGHT before they start to degrade. **Samples must be filtered within this 24 hour period.**

FILTRATION

① Assemble the bottom half of the chlorophyll-a filtering apparatus. Materials should include: 1 filtration unit with the self-contained filter, 1 rubber stopper, 1 flask, 1 hand-operated vacuum pump with tubing. Attach the rubber stopper firmly to the stem at the base of the filtration unit (this may require you to bore a larger hole in your rubber stopper to accommodate the stem). Then attach the filtration unit to the 1-L flask by firmly pressing stopper into the mouth of the flask. Next attach the hand-operated vacuum pump to the filtration unit by attaching one end of the rubber tubing to the hose connector on the flask and the other end of the rubber tubing to the vacuum inlet of the pump. Make sure all connections on the pump are tight. Finally, dampen the filter paper by squirting the sides of the filtration unit with deionized (DI) water and pump a few times to clear the well.

② Invert the bottle of sample water to mix it thoroughly. Then add a small amount of sample water to the graduated cylinder and turn the cylinder horizontally to "prime" the sides. Discard the rinse water.

③ **Invert to mix** the sample bottle again and then measure a volume of sample water into the graduated cylinder. Start with **200 mL in turbid** (cloudy) water, **300 mL in clearer** water. You may need to tap the bottom of the container to dislodge any settled particles. Record this initial water volume.

④ Pour the measured sample into the filtration unit and begin pumping the water through the filter, carefully **keeping the pressure below 40 psi** (chlorophyll cells will burst at pressures greater than 40 psi). The amount of water filtered is relative to turbidity of the sample: filter as much water as possible (but less than 1000 mL) until the filter clogs. Maintain hand pump pressure less than 40 psi.

IMPORTANT: After initial volume is filtered, add sample water 50 mL at a time. All water that is added to the filtration unit must be filtered through. Water can not be poured out of the filtration device. By adding slowly, it ensures that the process will not have to be repeated.

⑤ Record the total volume of water filtered on chlorophyll sample log sheet.

⑥ Rinse the inside walls of the filtration unit with DI water and pump the hand pump to clear the well.

⑦ Release pressure on the filtration apparatus. This can be done by pressing the spring-loaded valve on the pump. Pressure should slowly bleed off. DO NOT RELEASE PRESSURE BY PULLING OFF THE FILTRATION UNIT OR BY DETACHING THE RUBBER TUBING!!!

PROCESSING & SHIPPING

① Remove the filtration device from the flask by firmly twisting and pulling in one motion to loosen rubber stopper.

② **REMEMBER: DO NOT TOUCH THE FILTER WITH YOUR HANDS AND BE CAREFUL NOT TO SCRAPE THE CHLOROPHYLL SAMPLE OFF THE FILTER WITH THE FORCEPS.**

To remove the filter from the filtration device, first release the bottom of the filtration device from the funnel by breaking the tab. The tab only needs to be broken at one connection. After the tab is broken, gently twist the funnel while holding the bottom portion firmly.

With forceps, fold the filter paper in half (**top side in**), being careful not to touch filtered material, and remove the filter paper from the apparatus. It is important that the chlorophyll stays on the inside of the filter so that it is not scraped off onto the aluminum foil when it is wrapped.

③ Wrap the filter paper in double folded aluminum foil.

④ Label the foil with the lake name, monitor's name, site number, date, and volume filtered using a Sharpie™ permanent marker.

⑤ Place wrapped filter between two ice packs in bottom half of Styrofoam shipping box and place into freezer until frozen solid.

⑥ Place frozen sample and ice packs in Styrofoam shipping box and fill out the FedEx shipping labels. Attach completed shipping label to center of shipping box and tape over the label to secure it.

⑦ Tape the box closed by wrapping tape around the entire box twice in both directions and then ship samples to the Oklahoma Water Resources Board.

Remember: Filtered samples only have a TWO WEEK shelf-life before they must be ground so be certain to mail the package to us as soon as possible!

CLEAN-UP

① Dispose of the filtration device. It is intended for one use only.

② Rinse the flask with deionized water.

③ Dry all equipment and store until next sampling event. If any water backs up into the pump, be sure to dry the tubing and the pump before storing.

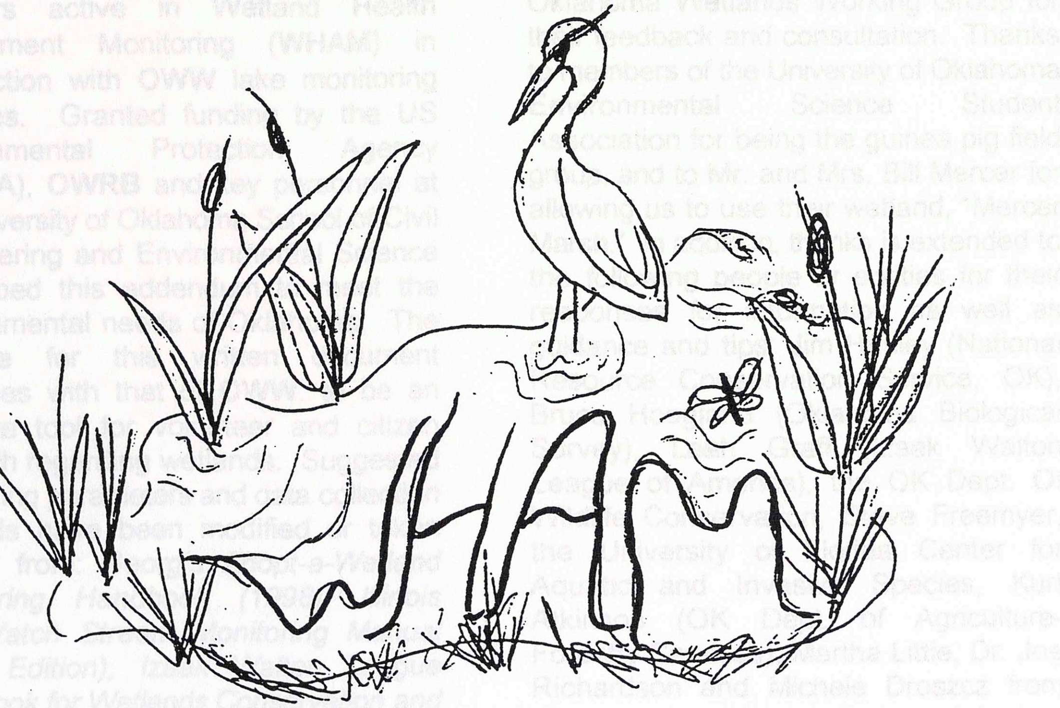
APPENDIX C

OKLAHOMA WETLAND HEALTH ASSESSMENT MONITORING

(WHAM) VOLUNTEER MONITORING ADDENDUM

WHAM

Wetland Health Assessment Monitoring



An Oklahoma Wetland Volunteer Monitoring Pilot Program

An Addendum to the Oklahoma Water Resources Board Oklahoma Water Watch Program

written and illustrated by

Erin Breetzke

edited by

Dr. Robert Nairn, Melanie Foster, Bill Cauthron, and Chuck Potts

March 2000

ADDENDUM INFORMATION

This wetlands addendum was written as part of the *Oklahoma Water Watch Volunteer Water Quality Monitor Handbook* to be used by volunteer monitors active in Wetland Health Assessment Monitoring **(WHAM)** in conjunction with **OWW** lake monitoring activities. Granted funding by the US Environmental Protection Agency (USEPA), **OWRB** and key personnel at the University of Oklahoma School of Civil Engineering and Environmental Science developed this addendum to meet the environmental needs of Oklahoma. The purpose for this written document coincides with that of **OWW**: to be an effective tool for volunteer and citizen outreach regarding wetlands. Suggested monitoring parameters and data collection methods have been modified or taken directly from: *Georgia Adopt-a-Wetland Monitoring Handbook (1998), Illinois RiverWatch Stream Monitoring Manual (Third Edition), Izaak Walton League Handbook for Wetlands Conservation and Sustainability (June 1998), and USEPA Region 10 Wetland Walk Manual: A Guidebook for Citizen Participation (October 1996).* As part of **OWW**, this addendum is published and distributed by the Oklahoma Water Resources Board, 3800 N. Classen, Oklahoma City, OK 73118. The staff is always available if you need information or have any questions. Just pick up the phone and call!

Oklahoma Water Resources Board
(405) 530-8800

OWRB FAX
(405) 530-8900

ACKNOWLEDGMENTS

Completion of this addendum took the efforts of many individuals and agencies nationwide. Thanks goes to Julie Cunningham and members of the Oklahoma Wetlands Working Group for their feedback and consultation. Thanks to members of the University of Oklahoma Environmental Science Student Association for being the guinea pig field group, and to Mr. and Mrs. Bill Mercer for allowing us to use their wetland, "Mercer Marsh." In addition, thanks is extended to the following people or entities for their responses for information as well as guidance and tips: Jim Henley (National Resource Conservation Service, OK), Bruce Hoagland (Oklahoma Biological Survey), Leah Graff (Izaak Walton League of America), the OK Dept. Of Wildlife Conservation, Steve Freemyer, the University of Florida Center for Aquatic and Invasive Species, Kurt Atkinson (OK Dept. of Agriculture-Forestry Services), Martha Little, Dr. Joe Richardson and Michele Droszcz from Georgia Adopt-a-Stream/Adopt-a-Wetland, Ben Barber and Liz Jones (IL Ecowatch), Elissa Ostergaard (King Co. WA, Dept. of Natural Resources), Gary Dailey (ID Dept. of Environmental Quality), Elizabeth Umbanhowar (The Adopt-a-Stream Foundation), Cathy Dingman (Grafton Co., NH Conservation District), Ginger North (DE Nature Society), Krista Rave (USEPA Region 10), Beth Malcolm (NH Dept. of Environmental Services), Peter Dobbins (Friends of Garcia River, CA), Sarah Blanchette (Cosumnes River Preserve, CA), Ann Bove (Milfoil Watchers Program, VT), Jack Leighty and Dave Brownlee (Hunting Creek, MD), Philip Osborne (AR Water Education Team), David Niebuhr (Chesapeake Bay National Estuarine Research Reserve, VA), Mary Bertrand

and Kathleen Pinsch (Chums of Barker Creek, WA), Texas Watch, Amanda Fritz (Friends of Arnold Creek, OR), Jennifer Klang (MN Citizen Lake Monitoring Program), Pennsylvania EASI Senior Environmental Corps, Florence LaRiviere (Citizens Committee to Complete the Refuge, CA), Blaine Hoy (North Fork John Day Watershed Council, OR), Dr. Jill Whitman (Pacific Lutheran University, WA), Daniel Kush (OH Dept. of Natural Resources), Linda Gette (NY Basha Kill Wetland Monitoring), Gordon Russell (Piscataquog Watershed Association, VT), Karen Williams (OR Dept. of Environmental Quality), Ken Cooke (KY WaterWatch), Alan Gregory (Friends of the Nescopeck, PA), Pete Jackson (IL WetlandWatch), David Burdick (Jackson Estuarine Laboratory, NH), Ron James (IWLA-Ropchan Meadowlands, IN), Regina Wilson (Morro Bay National Estuary, CA), and Kathleen Edson (Napa County Resource Conservation District, CA). Your assistance has been most appreciated throughout the development of this program. Thank you.

Erin Breetzke

Dr. Robert Nairn

TABLE OF CONTENTS

Page

INTRODUCTION

Oklahoma has lost about 75% of its wetlands since the middle 1700's (Oklahoma Water Quality Assessment Report to Congress 1998). Though often thought of as breeding grounds for mosquitoes and other undesirable creatures, wetlands (Mitsch and Gosselink 1993) have many **functions** humans world-wide have come to **value**: water quality enhancement, **flood abatement**, biological productivity, **groundwater recharge**, recreation, education, timber production and agricultural production. Though wetlands provide these important functions, they are still misunderstood. With the depletion of wetland ecosystems, damage to human health, the environment, and personal and public property are increasingly becoming manifested. To ensure a healthy environment in which humans can survive, wetland ecosystems are afforded protection under **Section 404 of the Clean Water Act**, though many acts and programs aid in wetland protection and conservation.

Because of the need for conservation, volunteer monitoring programs have been emerging nationwide. According to the USEPA, 21% of all volunteer monitoring programs (like **OWW** and **WHAM**) monitor wetlands (USEPA 1998). These programs continue to grow because wetland studies are a high priority for many scientists and government agencies. Much like other research, the manpower needed to gather information is limited (Oklahoma Water Resources Board 1997). It is the important job of volunteers to assist these scientists and wetland experts by performing field research and collecting the data they need. In addition, the data gathered by volunteer citizens will become a pool of information through which not only the public may become educated about wetlands, but which agencies may draw upon in order to compare and manage their own wetland ecosystems.

OWRB, OWW, WHAM AND YOU

As an addendum to **OWW**, **WHAM** is implemented under the authority of the **OWRB**. Whereas **OWW** volunteers mainly monitor the water quality of Oklahoma's reservoirs, **WHAM** volunteers monitor the overall health of Oklahoma's wetlands. The larger scope of this program provides the state not only with wetland water quality data, but with additional information on ecosystem health. Reporting information such as what human activities are occurring in or around the wetland, the types of wildlife using the wetland, and overall wetland health, provides Oklahoma with an idea as to what is happening "out there." Because **OWRB** staff cannot visit every wetland, **WHAM** includes parameters which may indicate that a visit by professionals is necessary due to possible questionable activities in a wetland or perhaps due to some drastic or significant change in test results.

By being affiliated with **OWW**, **WHAM** will follow many of the same guidelines, have similar goals and training, will require USEPA involvement and will meet the same data quality objectives of **OWRB** staff. Basic guidelines regarding equipment ownership, safety, monitoring frequency, and quality assurance/quality control (QA/QC) activities will also be similar. For these reasons, it is necessary that you become familiar with what is expected of **OWW** volunteers and read the handbook carefully. This addendum is specifically tailored to the monitoring of wetlands and the needs of the volunteers, but useful general information about volunteer monitor goals, expectations, and program background is provided in the ***Oklahoma Water Watch Volunteer Monitoring Handbook***.

WHAT IS WHAM?

WHAM is a publicly funded wetlands volunteer monitoring program based on citizen participation (Oklahoma Water Resources Board 1997). In conjunction with **OWW**, which uses citizen volunteers to monitor lakes, **WHAM** has the responsibility of collecting various data in order to aid professionals in assessing the health of Oklahoma's wetlands. **WHAM** training will familiarize volunteers with wetland water chemistry, soils, plants, **hydrology**, wildlife, and human impacts to these ecosystems. This may ultimately aid Oklahoma in managing these fragile areas. These collected data will be available to various government organizations and numerous researchers, scientists and interested citizens.

WHAM has three main goals:

1) to expand public wetland knowledge including the importance of wetland functions, the value they hold for society and the need for their protection

2) to assess the health of existing Oklahoma wetlands through establishing baselines for water quality and habitat

3) to provide a foundation for establishing an inventory of Oklahoma's wetland ecosystems with the help of the **Oklahoma Biological Survey**

In order to attain these goals, volunteers will progress through three steps in the **WHAM** program that are also associated with **OWW** (Oklahoma Water Resources Board 1997):

1) establishment of monitoring objectives

2) training and certification

3) data collection

More detail about these goals is available in the ***Oklahoma Water Watch Volunteer Monitoring Handbook***.

GOOD DATA ARE IMPORTANT!

This program was designed to be fun and educational for volunteer monitors. More importantly, the program was designed because Oklahoma needed to collect water quality data which would be useful in managing our natural resources. As a monitor, it is your responsibility to collect data 12 times a year (or a minimum of once every 6 weeks). Your training and certification are your tools (along with some monitoring equipment) to gather this information. Your data will be added to **OWW** data for submittal to the USEPA in Oklahoma's **305(b) report** which describes the status of the state's water. It is of utmost importance that you follow monitoring directions at all times. BAD DATA ARE WORSE THAN NO DATA AT ALL, SO CONTACT US IF YOU NEED HELP! We're counting on you! We are always here if you have questions!

BEFORE YOU MONITOR

Before you grab your equipment and data collection sheets and go charging into your wetland, there are several items you need to think about. We want you to have fun, learn about wetlands, and collect good data, but think about the following when planning your monitoring session:

1) **MONITORING SCHEDULE**

Though there are many parameters (i.e., water column, soil, wildlife, etc.) to be monitored in the wetland, not everything is measured during every monitoring visit. Each wetland assessment tool is important, but some are only important at specific times of the year. For example, there is no reason to monitor frogs in January, but it is very important to monitor them in April when they are abundant and are beginning to breed. The ***Monitoring Schedule Calendar*** on page 4 should be utilized when you plan your monitoring trips.

2) **EQUIPMENT CHECKLIST**

You can't perform your experiments without equipment! Remember, not all equipment will be needed every time. Check your ***Monitoring Schedule Calendar*** and your ***Equipment Checklist*** (page 5) so you know what equipment you need. Though your equipment belongs to the OWW program, please treat it as if it were your own. It is understood that there will be normal wear and tear, but abuse of the equipment will not be tolerated. Be sensible!

3) **SAMPLING SEQUENCE**

It is not only important that you monitor your wetland with the proper equipment, but you need to monitor the wetland in the correct order as well. You don't want to be monitoring water quality in an area where you have disturbed and stirred up sediment, and you don't want to start monitoring wildlife after you've scared it due to your water quality monitoring activities. Review the ***Sampling Sequence*** on page 6 before you begin to monitor.

4) **THE DAY BEFORE YOU MONITOR**

Always be prepared when you go into the field. By this point you have your monitoring equipment ready, so now it's time that to prepare for your safety (see ***Safety First*** on page 6) and comfort, and to double check everything else. If you need anything or you can't monitor, be sure to contact OWW staff!

- Gather all of your field equipment and check to see that it is in good condition.
- Look over your OWW handbook and check your water sampling kits and equipment. Make sure everything is stocked and working properly.
- Check the weather report and adjust for extreme forecasts .
- Contact group members to coordinate rides and confirm the appointed monitoring time.

MONITORING SCHEDULE CALENDAR

(after *Miller et. al. (1996) Washington Adopt-a-Beach*)

January
water quality
hydrology
wildlife
photopoints

February
water quality
hydrology
wildlife
soil

March
water quality
hydrology
wildlife

April
water quality
hydrology
wildlife
amphibians
photopoints

May
water quality
hydrology
wildlife
amphibians
vegetation

June
water quality
hydrology
wildlife
amphibians
vegetation

July
water quality
hydrology
wildlife
amphibians
vegetation
photopoints

August
water quality
hydrology
wildlife
vegetation
soil

September
water quality
hydrology
wildlife
vegetation

October
water quality
hydrology
wildlife
photopoints

November
water quality
hydrology
wildlife

December
water quality
hydrology
wildlife

✔ EQUIPMENT CHECKLIST

- ❑ data sheets (for data collection, wetland sketch, and photopoint ID)
- ❑ binoculars
- ❑ clipboard
- ❑ pen/pencil
- ❑ permanent markers (black and red)
- ❑ 300' field tape measure
- ❑ compass
- ❑ water quality kit (nitrate, phosphate, DO, pH, chlorophyll a, 500mL collection bottle, waste containers, deionized or distilled water, thermometer, latex gloves and goggles)
- ❑ mallet
- ❑ neon twine
- ❑ wire flags (pink and orange)
- ❑ wood stakes for transect establishment and photopoint markers (transects/photopoints are only set up during your initial visit, but have extra on hand in case you need to fix up the sites)
- ❑ disposable camera
- ❑ waders
- ❑ sharpshooter
- ❑ ruler
- ❑ wetland notebook
- ❑ first aid kit
- ❑ duct tape
- ❑ whisk broom
- ❑ baggie of ground up cork

SAMPLING SEQUENCE

Much like **OWW**, **WHAM** dictates that you conduct your monitoring activities in a particular order. Generally, you should conduct your activities the way they are laid out in the manual (the same way they are listed under ***Sampling Your Wetland*** in the ***Table of Contents***). It only makes sense that you should fill out the monitoring sheet and walk around your wetland making observations and looking for places to place your transects, take pictures, observe any wildlife (remember, they might hide when everyone starts making noise), and find an access to the standing water in your wetland before you start bringing out all the tools.

Be sure to record your data as you go along and always write down any observations you think need to be mentioned (i.e., excess trash, pollution, large fish kills, etc.). When your monitoring is done, follow the ***Post Monitoring Clean-up and Equipment Storage*** protocol, sign your data collection sheets, and return them to the **OWRB**.

SAFETY FIRST

Safety is an important aspect of any monitoring project. First and foremost, we want this to be a fun, safe experience for everyone involved, so you should NEVER monitor when the situation is dangerous due to weather, sickness, etc. We understand that mother nature is full of surprises, so just be sure to report any changes in your scheduled monitoring time.

Because you will be outside throughout the year in various types of weather for extended periods of time, it is important to dress appropriately. Depending on the weather, altering your field attire will be necessary. Following these few guidelines can help you stay safe:

- NEVER GO INTO THE FIELD ALONE! Always take a buddy, even if they will not be monitoring.
- Use common sense!
- Always be prepared to walk out of the field dirty. Work boots or old tennis shoes are appropriate.
- Pants are a necessity due to tall grasses and possible poison ivy.
- Ticks and other biting insects (mosquitoes) will be abundant during different times of the year. Long sleeves, hats and bug repellant will be VERY handy.
- Watch where you step! Wildlife, such as snakes, may be present.
- During the summer months precautions for heat sickness should be taken. Always have plenty of drinking water available, and be sure to get out of the sun and rest if you begin to feel dizzy or ill.

As a team, you should watch out for each other and know when to stop if the situation becomes too stressful or dangerous due to heat, the presence of ominous weather, or any other situation where your health or safety is threatened. In addition, so the **OWRB** (and the appropriate landowner) knows when you will be monitoring, it is important to keep to your scheduled time. Should any member of the monitoring group be unable to monitor, contact the group leader. Should the group be unable to monitor at its appointed time, monitor the site ASAP.

The following page (**For Your Protection...A Few Things to Keep You Safe**) contains a list of items you might want to take so you and your monitoring team are safe and comfortable in the field.

FOR YOUR PROTECTION...A FEW ITEMS TO KEEP YOU SAFE

- ❑ bug repellent (remember...ticks and mosquitoes!)
- ❑ sun screen (the summer sun is a scorcher!)
- ❑ change of socks and shoes
- ❑ garbage bags (for dirty clothes)
- ❑ garbage bags (clean ones can be used as slip covers to protect your vehicle's upholstery)
- ❑ hat (protect yourself from the sun!)
- ❑ energy snack (field work can be tiresome)
- ❑ watch
- ❑ pocket knife
- ❑ handkerchief
- ❑ sunglasses
- ❑ drinking water (and plenty of it!)
- ❑ extra pairs of hip/chest waders
- ❑ rubber knee boots
- ❑ cell phone
- ❑ gardening/leather gloves

SAMPLING YOUR WETLAND

Now that you have arrived at your wetland it is time to begin monitoring. Be sure to keep the following in mind:

- Follow the **Monitoring Sequence** so your visit goes smoothly and you collect the best data possible.
- Be sure to refer to your ***OWW Volunteer Monitoring Handbook*** for water quality testing procedures.
- Record your data as you go along. DO NOT rely on your memory to store all of your observations and measurements!
- Create specialized monitoring teams in order to make your monitoring visit move along quicker, yet still collect accurate, quality data. For example, if someone in the monitoring group has a hobby, background or expertise in biology or botany, put them in charge of the wildlife or vegetation observations. Someone with an interest in chemistry could be put in charge of the water quality tests.
- Be sure to rotate the teams. Everyone needs to know how to perform each monitoring task in order to meet QA/QC protocol, but these specialized team leaders will help you learn more from your peers, as well as create leaders out of everyone!

FILLING OUT THE DATA SHEET

(adapted from *Illinois RiverWatch Stream Monitoring Manual* and *EPA Region 10 Wetland Walk Manual*)

When arriving at the monitoring site, it is important to complete the top of the data collection sheet by filling in your group number, the names of group members, the date, time, name/number of the wetland, the county in which you are monitoring, the nearest city (or city in which you are monitoring), and the crossroads or street address where your wetland can be located (the latitude and longitude can be used as well).

Note: If your wetland does not have a name, it may possibly be assigned another number or code. Be sure to check with the **WHAM** program director if this is a question.

When noting weather conditions, be sure to include the presence of **precipitation** (e.g., rain, mist), **cloud cover** (e.g., clear, overcast, partly cloudy, etc.), and the temperature.

PRESENT WEATHER

☐ clear/sunny
☐ partly cloudy/partly sunny
☐ overcast
☐ showers (intermittent rain)
☐ rain (steady rainfall)
☐ storm (heavy rainfall)

TEMPERATURE
_____ °C

WIND DIRECTION (where the wind is coming from)

N NE E SE S SW W NW

ASSESSING SURROUNDING LAND USE

(adapted from *EPA Region 10 Wetland Walk Manual, Illinois RiverWatch Stream Monitoring Manual (3rd ed), Georgia Adopt-A-Wetland,* and *Izaak Walton League of America*)

Wetlands have been destroyed by humans since this country was first settled. This destruction has been through draining or filling, but sometimes other activities in the area can slowly destroy the wetland. Excess sediment can choke fish or even increase the natural rate of wetland **eutrophication**. Other activities can alter the habitat for wildlife and prevent beneficial wetland plants from growing. Chemicals from surrounding land can affect the wetland too. Runoff from agricultural fields, golf courses or other urban areas can adversely affect wetlands. Because of this, it is important to look at how the land around the wetland is being used. The land use assessment is included in order to assist in initially determining possible impacts on the wetland and to determine how future changes in land use may impact it.

During subsequent visits, this section will only need to be noted should changes in use occur. **On all visits, if an impact from surrounding land use is new or increasingly evident (i.e., industrial runoff, excessive erosion or litter), photos should be taken with a written description of the disturbance.**

Procedure

① Walk around the upland area of the wetland and observe the surrounding area. Though activities within the watershed as a whole may impact the wetland, only assess the areas within sight.

② Check off any listed impacts you see in the space provided.

③ Note any impacts not listed, or explain any which need to be explained.

HUMAN IMPACTS (LAND USES)

- ☐ undisturbed natural vegetation
- ☐ residential housing
- ☐ construction site
- ☐ agriculture, grazing, crop cultivation
- ☐ commercial development (i.e., offices)
- ☐ industrial development
- ☐ railroads
- ☐ sewage treatment
- ☐ park, recreation area
- ☐ oil, gas drilling
- ☐ open fields

SIGNS OF DEGRADATION

- ☐ dumping (soil, gravel, vegetation)
- ☐ dumping (man-made materials-trash)
- ☐ grading (topsoil removal)
- ☐ draining (water out of the wetland)
- ☐ draining (into the wetland-look for pipes from ditches or parking lots)
- ☐ water channeling (look for trenches or ditches)
- ☐ tracks of All Terrain Vehicles (ATV) or other vehicles
- ☐ livestock usage (look for tracks)
- ☐ silt, sand or gravel deposits
- ☐ stream bank erosion
- ☐ dredging (removal of soil or digging of the channel)

DESCRIBING YOUR WETLAND

(adapted from *EPA Region 10 Wetland Walk Manual* and *Izaak Walton League of America*)

Describing your wetland is important in order to give **OWW** staff a written description of what you see (and as a supplement to your photographs). This sketch will provide information about where dominant vegetation grows in the wetland, where open water has ponded, how the water flows, where your **photopoints** are located, where **transects** are placed, and where your sampling is taking place. This sketch does not require you to be an artist, only for you to be able to draw a representation of what you see. If you can draw a stick man, you can do this.

Procedure

① Your sketch needs to include:

- -areas of open water
- -dominant vegetation (i.e., trees, **emergents**)
- -**buffers**
- -water flow direction
- -**photopoints**
- -standing water
- -compass direction
- -**transects**

② **Estimated wetland size**- An estimation of the size of the wetland is needed. If the wetland is less than one acre, simply check the box indicating so. If it is more, estimate the size to the best of your ability. As a key, the size of a football field is approximately one acre.

ESTIMATED WETLAND SIZE

□ < 1 acre

___ acres

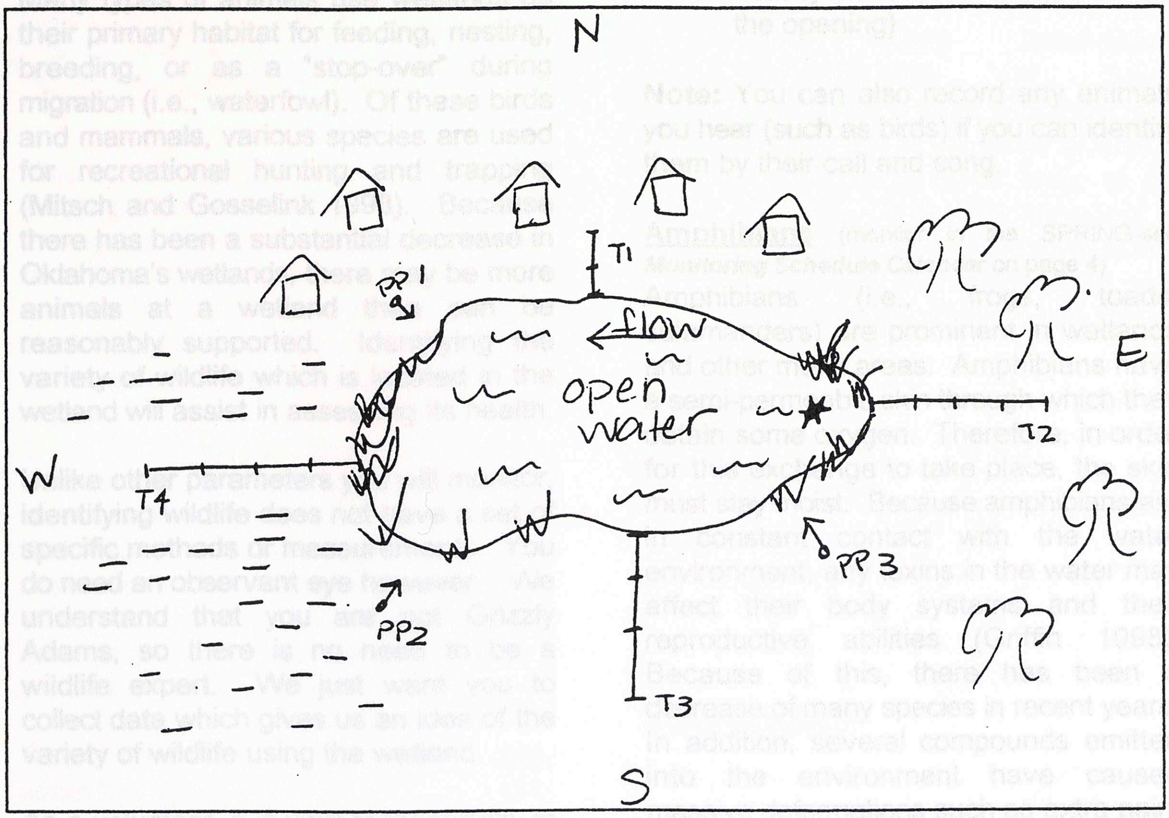
③ **Buffers**- Finally, in order to understand what is happening in the wetland, it is important to know what type of land or activities buffer the wetland, like surrounding land use. Buffers include areas that surround the wetland and offer transition or protection from sometimes harmful activities. Buffers can include forested areas or areas with extensive vegetation. Indicate the buffers on your map. Again, use a legend if it's necessary. To support your drawing, check the proper box for the directional buffer (i.e., north, south, east, west).

Note: Simple structures such as boxes, circles, arrows or stars will be sufficient for identifying these characteristics, but be sure to provide a legend in order for the **OWRB** staff to fully understand the map. Colored pencils would be especially useful if you're feeling ambitious.

Note: Be accurate when drawing your map. If your wetland ever floods, this will be a valuable took to locate photopoints and transects.

SAMPLE WETLAND SKETCH

Group ID: WHAM #1	Wetland ID: OK #1
Artist: Jane Doe	Date: 11-18-99



Legend

⌂ ⇒ housing development
⇒ upland buffer w/trees
W ⇒ emergents
ᴗᴗ ⇒ open water
= ⇒ standing water (really mushy ground)
PP ⇒ photopoints
T1, 2, 3 ⇒ transects
★ = water sampling site

WILDLIFE AND AMPHIBIAN OBSERVATIONS

(adapted from *EPA Region 10 Wetland Walk Manual*)

Wildlife (monitor EVERY time)
Many types of animals use wetlands as their primary habitat for feeding, nesting, breeding, or as a "stop-over" during migration (i.e., waterfowl). Of these birds and mammals, various species are used for recreational hunting and trapping (Mitsch and Gosselink 1993). Because there has been a substantial decrease in Oklahoma's wetlands, there may be more animals at a wetland than can be reasonably supported. Identifying the variety of wildlife which is located in the wetland will assist in assessing its health.

Unlike other parameters you will monitor, identifying wildlife does not have a set of specific methods or measurements. You do need an observant eye however. We understand that you are not Grizzly Adams, so there is no need to be a wildlife expert. We just want you to collect data which gives us an idea of the variety of wildlife using the wetland.

As a volunteer, it is your responsibility to record any birds or animals seen during a monitoring visit (even some spiders are big enough that you can't miss them!). On the ***Wildlife and Amphibian Data Collection Sheet***, be sure to record the correct name of the animal identified (the common name is fine). Also note if the animal is dead or alive (dead animals once used the wetland, so they are important as well). Should a flock of birds be identified, try to record the approximate number. In addition, space is provided to record any miscellaneous evidence of wildlife such as:

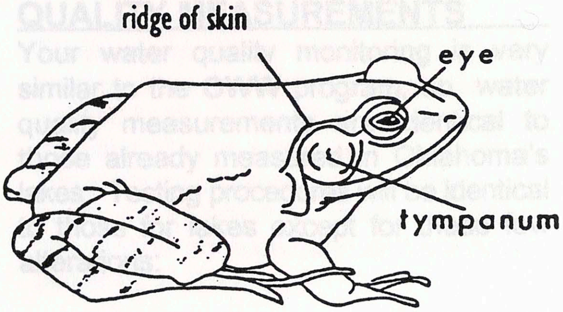
- skins, feathers, tracks, shells, etc.
- dead animals
- evidence of feeding (i.e., feathers, fur, bones strewn about)
- burrows (newly dug burrows will usually have fresh dirt piled near the opening)

Note: You can also record any animals you hear (such as birds) if you can identify them by their call and song.

Amphibians (monitor in the SPRING-see ***Monitoring Schedule Calendar*** on page 4)
Amphibians (i.e., frogs, toads, salamanders) are prominent in wetlands and other moist areas. Amphibians have a semi-permeable skin through which they obtain some oxygen. Therefore, in order for this exchange to take place, the skin must stay moist. Because amphibians are in constant contact with the water environment, any toxins in the water may affect their body systems and their reproductive abilities (Griffin 1998). Because of this, there has been a decrease of many species in recent years. In addition, several compounds emitted into the environment have caused massive deformations such as extra pairs of legs. Survival rates of tadpoles have also been decreased.

Monitoring amphibians requires a knowledge of their calls, the ability to see egg clutches in the water, and to catch and identify what you find. All of this usually requires the expertise of a **herpetologist**. Your monitoring however will be simple. You will be looking and listening for ONE kind of frog, the bullfrog. The call of the bullfrog is a loud, deep, guttural honk (some people think it sounds like a really low note played on a base cello), and its appearance is unmistakable.

-bullfrog
(with permission, *Black and Sievert (1989)*)



This is the largest frog in Oklahoma, ranging from 4-7 inches, and is found throughout the state. To identify it, look for a ridge of skin running behind the eye and around the frog's tympanum (its ear). Look also for brown bands of color on its hind legs (Black and Sievert 1989).

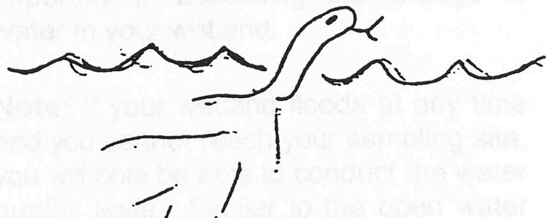
It is important to look for bullfrogs because they are quite aggressive toward other species of amphibians by preying on their eggs and tadpoles. Excessive populations of bullfrogs in a wetland may affect the variety of other amphibian species you will find. Be sure to note if you see or hear bullfrogs.

Note: When monitoring wildlife, think about the following:

- It is always important to maintain the integrity of the wetland without disturbing it, so collecting any wildlife or wildlife related items is not allowed.
- Burrows should not be disturbed and NEVER put your hand where you cannot see.
- Remember, wildlife is WILD, so never disturb, taunt or tease an animal, and NEVER put yourself into a dangerous situation.
- Should you see any snakes, be sure to stay out of their way. Only a few species are poisonous, but it is better to be safe than sorry. Should you see a snake in the water, remember this:

  Water snakes stick their head and neck out of the water and leave their body submerged. Cottonmouths (or "water moccasins") swim with their head sticking out of the water as well as having their whole body at the surface. It is also important to know that Cottonmouths live only in the eastern and southeastern parts of Oklahoma (Sievert and Sievert 1993).

water snake



water moccasin

WATER QUALITY MEASUREMENTS

Your water quality monitoring is very similar to the **OWW** program, so water quality measurements are identical to those already measured in Oklahoma's lakes. Testing procedures will be identical to those for lakes except for these few alterations:

- BE SURE TO REFER TO THE ***OWW Volunteer Monitoring Handbook*** FOR THE FOLLOWING WATER QUALITY TESTING PROCEDURES AND FOLLOW THOSE DIRECTIONS FOR SAMPLING SEQUENCE AND CLEAN-UP.

  -dissolved oxygen (DO)
  -pH
  -ammonia (NH_3)
  -nitrate (NO_3^-)
  -phosphate (PO_4)
  -chlorophyll *a*

- You will have to wade into the open water to obtain your water measurements. NEVER GO INTO WATER THAT IS TOO DEEP OR MOVING SWIFTLY. BE SENSIBLE! Be sure to keep a buddy nearby incase you stuck in the muck.

- To gather water samples, use the plastic collection bottles included in your kit.

- Be sure to gather water samples and measurements in a clear area with no disturbed sediment and no floating algal masses.

- In wetlands with shallow water where it may be difficult not to stir up sediment, try to allow some of the sediment to settle, then reach up-current away from the sediment to collect your samples.

- Sometimes floating algal masses are difficult to avoid, so just do your best. You may try to move them out of the way if possible.

Note: Wetlands are not required to have standing water year-round to be considered a wetland. They do however need to have a significant presence of water or saturated soil. If your wetland does not have standing water throughout the year, you will not have to monitor water quality, HOWEVER monitoring the hydrology (i.e., **staff gauge** and **groundwater sampler**) will be VERY important in assessing the change of water in your wetland.

Note: If your wetland floods at any time and you cannot reach your sampling site, you will note be able to conduct the water quality tests. Similar to the open water drying up, the hydrology measurements become very important.

TRANSECT ESTABLISHMENT

(adapted from *Miller et. al. (1996) Washing Adopt-a-Beach*, and *Georgia Adopt-a-Wetland*)

Transects are "lines" which will be placed leading from an upland area into the wetland itself. These lines can lead up to the edge of open water, but not across it. The purpose of transects is to create key points along which to obtain consistent information on vegetation and soil types (Miller et. al. 1996).

Each monitoring team will establish a minimum of four transects (one at each compass direction leading into the wetland). Each transect should be no less than 100 feet long and have no less than three sampling sites. Beginning and endpoints DO count as sampling sites! This means that if your transect is 100 feet long, you have three sites: beginning, 50 feet (midpoint), and endpoint. Longer transects should have sampling sites spaced evenly throughout the types of varied vegetation.

Transects need to be recorded on your wetland sketch. Recording this is important because it not only helps you if a transect marking is missing, but it helps the users of this data to "see" what is going on (with the help of the photos). In the field, flags and stakes must be used to mark each site in order to assure accurate and reproducible observations for each following visit (Miller et. al. 1996).

Procedure

① Walk around the perimeter of the wetland area to assess areas of varied vegetation, uplands and lowlands.

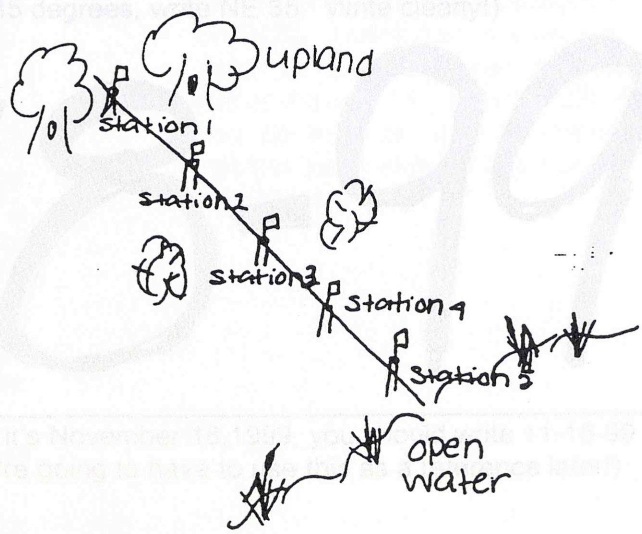
② Using your wire flag and a wood stake, stake out a starting point on the upland side of your wetland. The beginning and endpoint of each transect should be marked with a wire flag.

③ Use twine to run a straight line from your starting point in the upland down to your endpoint in the wetland (KEEP THE TWINE TIGHT!). Be sure to use a compass to get a heading (e.g., east 30 degrees), and mark it on your sketch. Stop the transect when you reach any open water and you are sure you are well into the wetland.

④ Measure the length of your transect.

⑤ You need a minimum of 3 sampling sites if your transect is 100 feet long (i.e., beginning, midpoint and endpoint). Otherwise, guidelines for selecting sampling sites are to either 1) choose areas where there is different vegetation, or 2) space sampling sites evenly along the line (for example: the transect is 100 feet, you want 5 sampling sites, so space them every 25 feet beginning with the starting point). Be sure to stake and flag each site! Mark each flag with the transect direction and site number.

(after *Georgia Adopt-A-Wetland*)



PHOTOPOINT IDENTIFICATION SHEET

Note: Be sure to make your numbers legible! As a suggestion, write your numbers like this:
1 2 3 4 5 6 7 8 9 0.

1

(It's best to stand at least four feet from the camera. Put your site number above in big black numbers so the camera can read it clearly.)

NE 35

(Put the heading of your photo here. For example, when facing directly left, if your compass reads northeast 35 degrees, write NE 35. Write clearly!)

11-18-99

(Put the date above using dashes. If it's November 18,1999, you should write 11-18-99 above. Be sure to write clearly, you're going to have to use this as a reference later!)

VEGETATION OBSERVATIONS

(adapted from *Izaak Walton League of America, EPA Region 10 Wetland Walk Manual, Miller et. al. (1996) Washington Adopt-à-Beach*, and *Georgia Adopt-a-Wetland*)

The condition, composition, and location of a wetland's vegetation are key to understanding the wetland's condition because the plants have adapted to wet (**hydric**) soil conditions and water regimes (**hydrology**). Established in wetlands, these plants can be instrumental in providing erosion and shoreline stability, sediment trapping, nutrient cycling, food chain support and wildlife habitat.

At times, beneficial wetland vegetation can be limited or prevented from growing because **invasive species**, foreign species that take over the area, may choke out the good plants. Wetlands in the U.S. are at risk for growing **purple loosestrife (*Lythrum salicaria*)**. This plant has a pretty purple flower, but it has no use to any wildlife (Mitsch and Gosselink 1993). When monitoring vegetation, if you see **purple loosestrife** anywhere in your wetland, even if it is not in your established transect site, make note of its presence and take a picture.

Procedure

① Beginning at the north transect's upland beginning point, use your tape measure and measure a radius (with your flagged stake at the center) of five feet.

② Using your plant key, identify and record the **indicator species** in the **tree category**. Be sure to indicate the number of species.

③ Repeat step 2 for the **scrub shrub** layer.

④ When complete, repeat steps 1-3 for each sampling site on the transect.

⑤ When you are finished at your north transect, move to your east transect, then south and west.

⑥ Your final vegetation observations will be conducted around the open water of your wetland. At the last site on each transect, record the **emergent** species. To record the **floating/submergent** species, look in and on the water closest to the last site of the transect.

⑦ Before finishing your vegetation observations, observe the area closely and check for **purple loosestrife**. (This can also be done throughout the general vegetation observations.) Make note in the observation section of your data sheet if any is found.

Note: Here are a couple of suggestions to make this monitoring step move quicker:

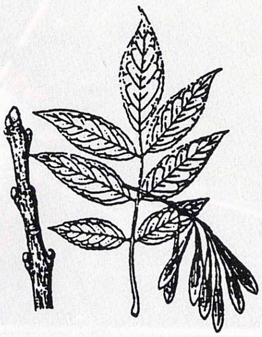
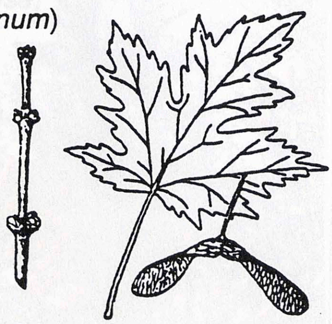
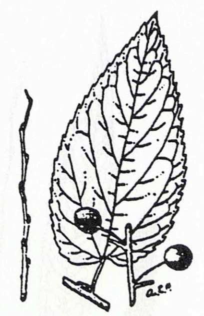
- Split up into smaller groups and have each smaller group monitor a separate transect.
- Designate different team members to look for the different categories of plants. Doing this, you will only need to look for three species rather than all 13. HOWEVER, if you do this, be sure to choose another plant category to monitor next time!

VEGETATION IDENTIFICATION PICTURES

(from *Little 1998*[1], *Knobel 1980*[2], *Fassett 1957*[3], *Hotchkiss 1970*[4], *USGS 1999*[5]; *photos provided by Bruce Hoagland*[1], *Steve Freemyer*[2], *and the University of Florida Center for Aquatic and Invasive Species*[3])

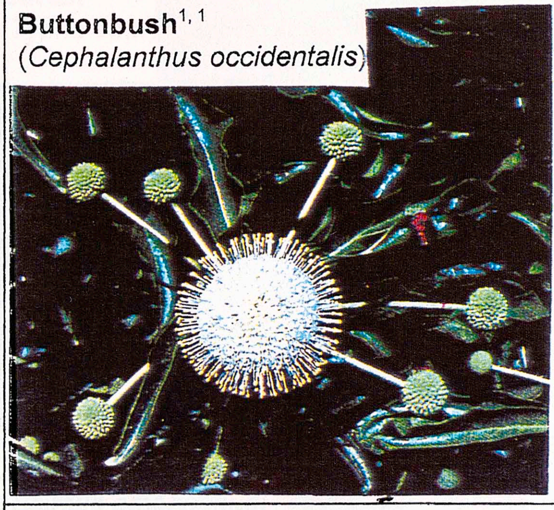
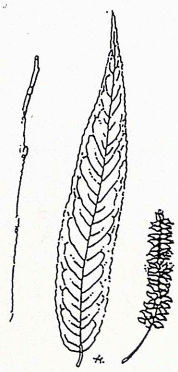
Tree/Forest Species

These species are characterized by their height (over 6 meters). You should pay close attention to the leaves and fruits (e.g., berries or seeds).

Green Ash[1] (*Fraxinus pennsylvanica*) 	**twigs**: stout, gray, hairless or hairy **buds**: rounded, reddish brown, finely hairy, 2-3 pairs of scales **leaves**: paired or opposite, pinnately compound, 6-10" long, shiny green on top, plane underneath, slightly hairy, slightly yellow in autumn **flowers**: tiny and greenish in spring, clustered **fruits**: many hang in clusters, 1 1/4-1 ½ " wide **bark**: gray or brown, scaly ridges with reddish brown inner layer **range**: all of Oklahoma except the western 1/4 of the state and the panhandle
Silver Maple[1] (*Acer saccharinum*) 	**twigs**: long, light green-brown, hairless, emit odor when broken **buds**: small, blunt, reddish with several paired scales **leaves**: paired or opposite, long slender green-reddish leafstalk, deeply 5-lobed, middle is often 3-lobed, 5 main veins, dull green above, silvery white beneath, pale yellow in autumn **flowers**: 1/4" greenish yellow to reddish buds, several crowded in almost stalkless clusters in winter or very early spring before leaves **fruits**: whirligigs, 1½ -2½ " **bark**: gray, smooth, turns to long scaly shaggy ridges **range**: eastern 1/4 - 1/3 of the state
Hackberry[1] (*Celtis laevigata*) 	**twigs**: slender, slightly zigzag, light brown, hairless **buds**: slightly flattened and pressed against twig, pointed, light brown, 4 scales in 2 rows, no end bud **leaves**: 2 rows, ovate, 2-4½" long, 1-2" wide, long, pointed, sharp toothed, 3 main veins, shiny green smooth/sometimes rough above, pale/hairy veins beneath, turn yellow in autumn **flowers**: several clustered on twigs with leaves in early spring, tiny, greenish **fruits**: long-stalked at leaf base, round 1/4" diameter, mostly dark brown, dry and sweet, 1 seed **bark**: gray or light brown, smoothish, warts/ridges **range**: northern ½ of state, except panhandle

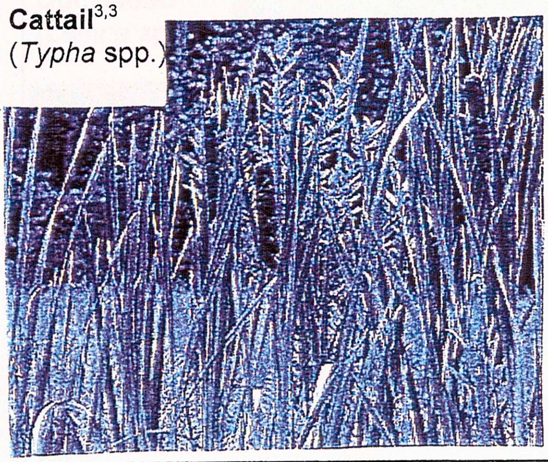
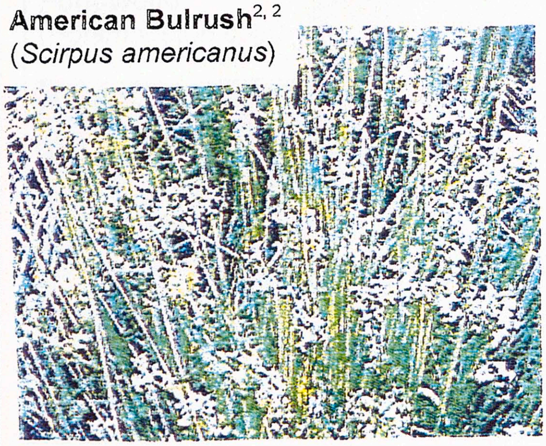
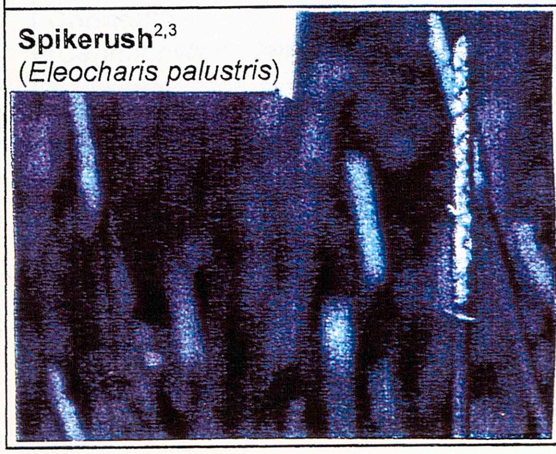
Scrub Shrub Species

These species are characterized by being shorter than 6 meters. Pay close attention to the leaves, flowers and fruits (e.g., berries).

Buttonbush[1, 1] (*Cephalanthus occidentalis*) 	**twigs**: mostly in 3's, slender, sometimes hairy, shiny reddish brown, nodes with rings and 3 rounded raised leaf scars **buds**: tiny, sunken, no end bud **leaves**: in 3's and 2's, ovate or elliptical, 2½-6" long, 1-3" wide, rounded at base, not toothed, shiny green and hairless above, paler and sometimes hairy underneath, nearly evergreen in warmer climates **flowers**: clustered, several round white balls upright on long stalks at end of leafy twig, many fragrant flowers, blooms from late spring through summer **fruits**: multiple compact rough brown balls 3/4-1" diameter, mature in autumn and remain at top of upright twig **bark**: gray or brown, becomes deeply furrowed in rough scaly edges **range**: all of state except extreme east, panhandle and extreme northcentral
False Indigo[5,1] (*Amorpha fruticosa*) 	**twigs**: tan to gray **leaves**: once-pinnate, oblong blade, 6-16 cm; leaflets elliptical and obovate, 1-4 cm long **flowers**: dark purple, irregular; flowers in June **fruits**: oblong, curved upward, 5-7 mm long, 1-2 seeded; fruits in late July-September **range**: wet meadows, stream banks, shores, ditches and floodplains
Black Willow[1] (*Salix nigra*) 	**twigs**: very slender, green, yellow or brown, hairless, easily detached at base **buds**: tiny, brown, covered by one scale, no end bud **leaves**: narrow, lance shaped, 3-5" long, often slightly curved to side, long-pointed, fine saw tooth, (nearly) hairless, shiny green above, paler green beneath, turn yellow in autumn **flowers**: at end of leafy twigs, 1-3" long, many tiny with yellow hairy scales, blooms in early spring with leaves **fruits**: seed capsules, conical, 3/16" long, hairless, many cottony seeds in spring **bark**: dark brown or blackish, deeply furrowed into forking ridges **range**: all of state except panhandle

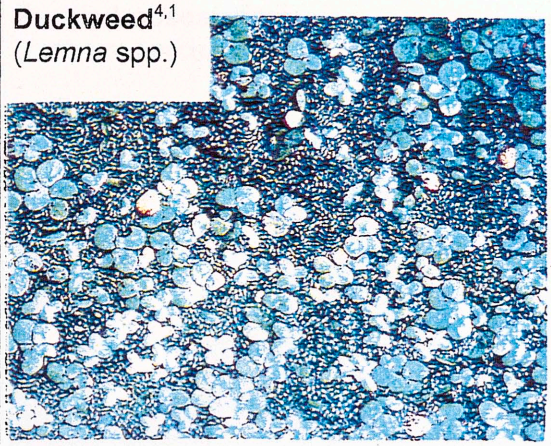
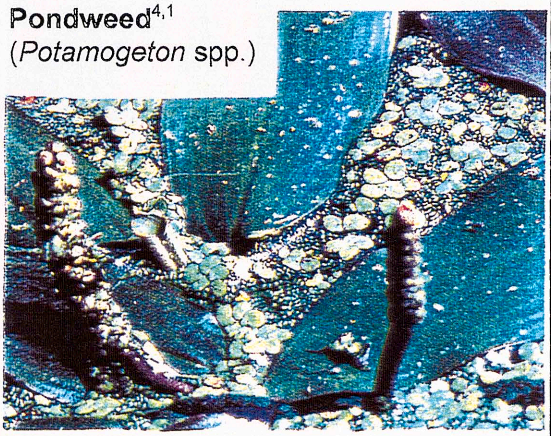
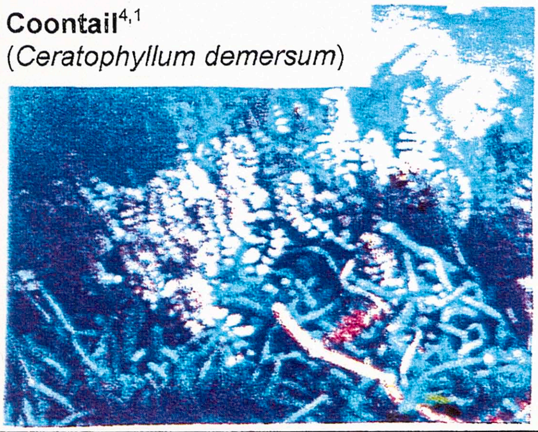
Emergent Species

These species are characterized by being rooted in open water areas and growing above the water surface. Remember: sedges have edges and rushes are round.

Cattail[3,3] (*Typha* spp.) 	**leaves**: long and flat, may be rounded on the back, **stem**: tall, slender and stick-like **flowers/buds/fruits**: brown cylinders at the tops of the stems, release cottony seeds in the fall **range**: extensive throughout most/all wetland areas (if you see these, you know you're in a wetland)
American Bulrush[2, 2] (*Scirpus americanus*) 	**stem**: sharp and triangular, two sides concave, one flat **flowers/buds/fruits**: red/brown scales, abrupt short point **range**: abundant in shallow water, fresh and brackish swamps, often extensive stands
Spikerush[2,3] (*Eleocharis palustris*) 	**stem**: 3 feet high, stout, solitary **flowers/buds/fruits**: somewhat compact spikelet at top of stem

Floating/Submergent Species

These species are characterized by being rooted underwater and floating on the surface, or living completely under the water surface.

Duckweed[4,1] (*Lemna* spp.) 	**general description**: usually looks like a carpet of green on the water surface (NOT like algae), easily moved from surface, not slimy, small roots hang beneath into the water
Pondweed[4,1] (*Potamogeton* spp.) 	**general description**: long stalked seeds found at the top of the stems, ribbon-like leaves, plant stays submerged but may emerge when in bloom, may produce small green or brown flowers in balls in the summer
Coontail[4,1] (*Ceratophyllum demersum*) 	**general description**: stems entirely underwater, usually multi-branched; leaves vary in length, width, forking and firmness; many whorled leaves at each joint

Invasive Species

You only need to look for Purple Loosestrife. It's rather easy to find with its bright purple flowers.

Purple Loosestrife[3,1] (*Lythrum salicaria*) 	**general description**: leaves opposite and almost look heartshaped near the base, many vibrant, showy purple flowers on long spikes

HYDROLOGY ASSESSMENT

(adapted from *Izaak Walton League of America*, *Miller et. al. (1996) Washington Adopt-a-Beach*, and *Georgia Adopt-a-Wetland*)

It has been stated that **hydrology** may be the most important component of a wetland (Mitsch and Gosselink 1993). Water is what makes the wetland "wet," thus its presence or absence is important to the survival of the plants and wildlife living there. Recording differences in surface and ground water level throughout the year will provide information about how the water influences the wetland.

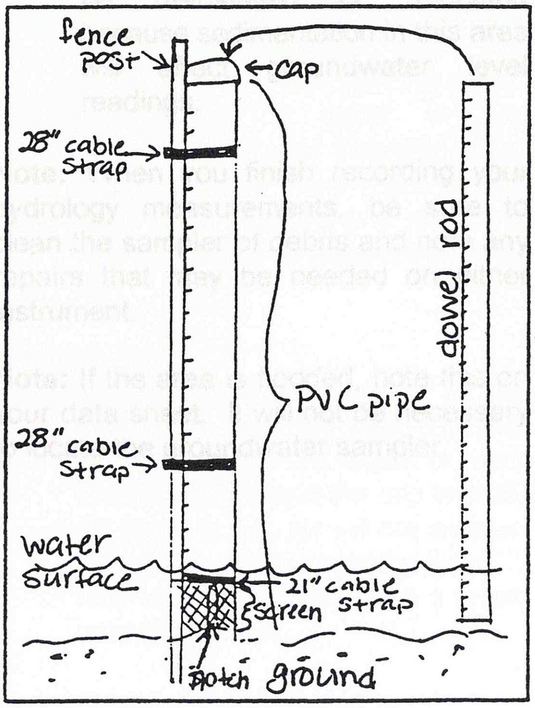
Hydrology will be assessed through the implementation of a **staff gauge** and a **groundwater sampler**, similar to a shallow well. The staff gauge will provide information about fluctuating surface water levels and how water inputs change seasonally. The groundwater sampler will assist in determining the saturation of the soil. Because wetlands are defined by the US Army Corps of Engineers as having soils which are partially or completely inundated or saturated by water throughout the year (Mitsch and Gosselink 1993), levels of "soil water" are important.

Directions for building and placing the staff gauge and shallow well are available in the ***Appendix***. These will not be conducted during your first monitoring session, however. In some instances it is necessary to observe water fluctuation over several months before these instruments can be placed in the wetland where they will effectively provide good data on water fluctuation. In either case, an OWW/OWRB personnel will be in the field to assist in choosing the placement of these instruments, as well as in their proper installation.

Procedure

① To read the staff gauge, record the measurement on the pipe/meter stick that corresponds with the water level.

(adapted from *Izaak Walton League of America*)



② Be sure to rinse the cork from the inside of the gauge, and record any observations which may be affecting hydrology such as changes in inlets, outflows or other modifications (these may be linked to changes in land use).

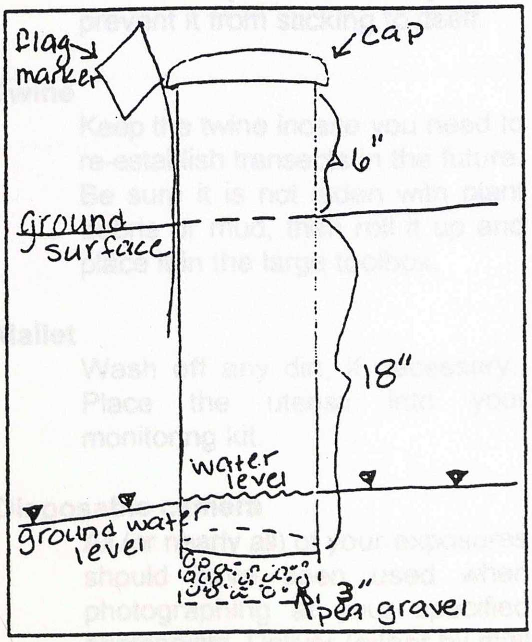
Note: Place the measurements on a side of the staff gauge you will be able to read from a distance (e.g., with the binoculars) incase you cannot get to the gauge because the wetland has flooded.

③ To measure water depth in the groundwater sampler, first be sure that it is still in the same condition as when it was installed. Measure from the top of the well to the ground surface. This should always be six inches. If the measurement is more than two inches less (four inches), reinstall the well.

④To obtain a groundwater measurement, remove the cap and use your ruler to measure the distance from the top of the well to the water surface. Use the following equation to determine the groundwater depth:

well depth (stays the same)
<u>- distance from pipe top to water</u>
groundwater level

(adapted from *Izaak Walton League of America*)



④ Record any observations if changes have occurred in the appearance of the water (e.g., color, smell).

Note: BEFORE you measure the groundwater level, check the following:

- Is the distance from the ground surface to the top of the pipe still 6 inches?

- If it is 4 inches or less, the well needs to be re-installed or relocated because sedimentation in this area will affect groundwater level readings.

Note: When you finish recording your hydrology measurements, be sure to clean the sampler of debris and note any repairs that may be needed on either instrument.

Note: If the area is flooded, note this on your data sheet. It will not be necessary to locate the groundwater sampler.

POST MONITORING CLEAN-UP AND EQUIPMENT STORAGE

Note: For all equipment from your **OWW** water quality testing kit that was used to conduct water column tests, you should follow the post monitoring clean-up and storage guidelines found in the back of your ***Oklahoma Water Watch Volunteer Monitoring Handbook***.

Compass

Be sure the face is clean by wiping away any dirt, grit, or moisture. Store the compass the large toolbox.

Field tape measure

Because it is plastic, you can rinse any dirt or mud off with some clean water. There is no need to dry the tape measure, but be sure to shake off any excess water before placing it back in your monitoring kit to prevent it from sticking to itself.

Twine

Keep the twine incase you need to re-establish transects in the future. Be sure it is not laden with plant debris or mud, then roll it up and place it in the large toolbox.

Mallet

Wash off any dirt, if necessary. Place the utensil into your monitoring kit.

Disposable camera

All (or nearly all) of your exposures should have been used when photographing at your specified photopoints. Deliver (either by mail or in person) the camera, along with your data sheets, to the OWRB.

Sharpshooter

To clean the sharpshooter, remove any large pieces of soil, then rinse the instrument with clean water and air dry. Store it with your monitoring kit.

Waders

Any large pieces of dirt or mud should be removed from the waders. These are often the culprit to creating a mess in the monitoring kit, so cleaning them before placing them in the kit will help keep everything a bit more clean. Be sure to hang them up to dry.

Staff gauge

Make sure the instrument is still sturdy. Re-mark any measurement intervals if they are fading or hard to read. Make sure the cap is NOT air tight. If it is, air will not escape and water will not enter the pipe. It may be necessary to poke a small hole in the cap.

Groundwater sampler

Make sure the cap is NOT airtight. If it is, air cannot escape, and water will not enter the pipe. It may be necessary to poke a small hole in the top.

Note: If any of the equipment is in need of repair or does not seem to work properly, notify **OWW** staff and submit the ***Equipment Repair Sheet*** with your monitoring data.

Note: The cleaner you keep the equipment, the longer it will last, the safer it will be, and the better the data you will be able to collect.

IMPORTANT PHONE NUMBERS

Oklahoma Water Resources Board (OWRB)
(405) 530-8800

Oklahoma Water Resources Board (OWRB) FAX
(405) 530-8900

Izaak Walton League of America
Contact: Leah Graff - (301) 548-0150 ext. 219
Technical assistance for Save Our Streams (SOS) Programs - 1-800-BUG-IWLA (284-4952)

Group Members

GLOSSARY

(adapted from *Izaak Walton League of America)*

305(b) report: federal document from a state to the US Environmental Protection Agency that reports the condition of the state's water resources

Buffers: land adjacent to the wetland that minimizes an outside impact

Cloud Cover: the relative amount of sky that is covered by clouds (e.g., clear, cloudy, overcast)

Emergents: wetland plants that are partly in water and partly exposed (e.g., plants which are rooted in water, but whose upper parts are aerial); species include: Cattails (*Typha* spp.), American Bulrush (*Scirpus americanus*), and Spikerush (*Eleocharis palustris*)

Eutrophication: the natural process by which wetlands progress into a nutrient rich state; this is often accelerated by fertilizers and other nutrient rich pollutants which leads to poor water quality

Floating/Submergents: plants that either float on the water surface or live beneath the surface; species include: Duckweed (*Lemna* spp.), Pondweed (*Potamogeton* spp.), and Coontail (*Ceratophyllum demersum*)

Flood Abatement: flood reduction or prevention; the value humans put on wetland function of water storage

Function: any biological, chemical or ecological process that a wetland performs, such as nutrient removal, wildlife habitat support and sediment trapping

Groundwater Recharge: the process by which water percolates through the soil and "refills" groundwater reserves

Groundwater Sampler: small plastic pipe lined pit used to determine soil saturation; similar to a shallow well

Herpetologist: a person who specializes in the study of reptiles (i.e., snakes, lizards, turtles) and amphibians (i.e, frogs, toads, salamanders)

Hydric: characterized by or requiring considerable moisture

Hydrology: the study of the properties, distribution and effects of water on the Earth's surface, in soils and underlying rocks, and in the atmosphere

Indicator Species: species that highlight the ecosystem

Invasive Species: species that tends to spread and take over an area, often in the place of a native specie or species

Mottles: blotches, streaks or spots of black or bright red and orange indicating the presence of a high water table

Muck Layer: this layer of sediment is usually found right below the top layer of submerged sediment in a wetland; its black color indicates that the soil is usually saturated with water

Oklahoma Biological Survey: state-run entity which is responsible for mapping, maintaining records, and being a database for the biological diversity of Oklahoma, of areas of ecological interest and concern, etc.

Photopoints: those chosen spots in the wetland where pictures are taken to show "time lapse" changes of the ecosystem

Precipitation: any form of water which falls to earth (e.g., rain, snow, sleet)

Purple Loosestrife (*Lythrum salicaria*): invasive species with no ecological value that degrades the value of a wetland, it was brought over from Europe to be used in landscaping and is characterized by its bright purple flowers

Scrub Shrub: woody vegetation less than six meters tall; species include: Buttonbush (*Cephalanthus occidentalis*), False Indigo (*Amorpha fruticosa*), and Black Willow (*Salix nigra*)

Section 404 of the Clean Water Act: part of the Clean Water Act which has been used to protect wetlands under the term "waters of the United States"

Sharpshooter: a shoveling instrument with a long, flattened spade-like nose which is used to create steep-walled holes

Soil Color: overall appearance of how deep or bright red, yellow, green, blue or purple the soil appears

Staff Gauge: placed into the standing water of the wetland, this instrument is used to measure how high and low the water level fluctuates

Sulfur Smell: sulfur odor in a wetland indicates high levels of hydrogen sulfide (H_2S), also known as "rotten egg smell"; it indicates bacterial and microbial activity

Transects: permanent "lines" placed in the wetland which are used to gather consistent data on vegetation, soils and hydrology

Tree Category: species that indicate a forested wetland, including: Green Ash (*Fraxinus pennsylvanica*), Hackberry (*Celtis laevigata*), and Silver maple (*Acer saccharinum*)

Value: benefits that specific wetland functions provide to humans, such as timber harvest, flood control and recreation

LEARN MORE ABOUT WETLANDS!

These are only few of MANY sources relating to wetlands, wetland projects in the country and the world. MANY more exist on the Internet and at your local library, so keep looking!

Web Sites

**many of these websites have a search option on their homepage, search "wetlands"*

•US Environmental Protection Agency Office of Wetlands, Oceans and Watersheds
http://www.epa.gov/OWOW

•Ducks Unlimited: http://www.ducks.org

•United States Department of Agriculture, National Resource Conservation Service
http://www.nrcs.usda.gov/

•National Audubon Society, Wetlands for Wildlife: http://www.audubon.org

•Sierra Club: http://www.sierraclub.org/wetlands

•United States Fish and Wildlife Service, National Wetlands Inventory
http://www.nwi.fws.gov/Welcome/html

•United States Geologic Survey: http://www.usgs.gov

•National Parks Service: http://www.nps.gov

•Society of Wetland Scientists: http://www.sws.org/wetlands

•Biological Resources Division: http://www.nbs.gov

•Endangered Species Act Online Resource Guide: http://www.envirolink.org/issues.esa

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

•National Estuarine Research Reserve's Estuary-Net Project:
http://inlet.geol.scarolina.edu/estnet

•Ramsar Convention: http://www.ns.doe.ca/biodiversity/ramsar

•Terrene Institute: http://www.terrene.org

•The University of Florida Center for Aquatic and Invasive Plants:
http://aquat1.ifas.ufl.edu

Books (for kids, adults, and wetland enthusiasts)

☺ denotes childrens' books

**Many more titles recommended by the USEPA Office of Oceans, Wetlands, and Watersheds can be found on their Wetlands Reading List located at:*

http://www.epa.gov/OWOW/wetlands/science/readlist.html

•Handbook for Wetlands Conservation and Sustainability *by Karen Firehock, Leah Graff, Julie Middleton, Kelly D. Starinchak and Christy Williams*
1998-Izaak Walton League of America

•Swampwalker's Journal: A Wetlands Year *by David Carroll, Harry Foster (ed.)*
1999 - Houghton Mifflin Co.

•The Birds of the Wetlands *by James Hancock*
1999 - Academic Press, Inc.

•Wetlands: The Web of Life *by Paul Rezendes, Paulette M. Roy, with Roy Paulet*
1996 - Sierra Club Books

•Discovering the Unknown Landscape: A History of America's Wetlands *by Ann Vileisis*
1999 - Island Press Publishing

•Wetlands: All About Bogs, Bayous, Swamps and a Salt Marsh or Two *by Vicki Leon*
1998 - Silver Burdett Press

•The Everglades: River of Grass *by Marjory Stoneman Douglas*
1997 - Pineapple Press, Inc

•☺ Squish!: A Wetland Walk *by Nancy Luenn*
1994 - Simon and Schuster

•☺ New True Books: Wetlands *by Emilie U. Lepthien and Joan Kalbacken*
1993 - Children's Press

•☺ Squishy, Misty, Damp and Muddy: The In-between World of Wetlands *by Molly Cone*
1996 - Sierra Club Books for Children

Field Guides (books, tapes, and CDS)

- Peterson Field Guide, Animal Tracks
  Houghton Mifflin Co.

- Peterson Field Guides, Freshwater Fishes
  1991-Houghton Mifflin Co.

- Plants in Wetlands: Field Guide to Biological Interactions *by Charles Redington*
  1994-Kendall/Hunt Publishing Co.

- Birding by Ear: A Guide to Songbird Identification (Peterson's Field Guide Series)
  1990-Houghton Mifflin Co.

- Field Guide to Bird Songs (Peterson's Field Guide Series)
  Houghton Mifflin Co.

- Field Guide to Western Bird Songs (Peterson's Field Guide Series)
  Houghton Mifflin Co.

- Marshland Bird Walk
  NorthWord Press, Inc.

- The Calls of Frogs and Toads
  1994-NorthWord Press, Inc.

REFERENCES

Black, J.H. and G. Sievert (1989). A Field Guide to Amphibians of Oklahoma. Oklahoma Department of Wildlife Conservation: Oklahoma City.

Ely, E. and E. Hamingson (1998). National Directory of Volunteer Environmental Monitoring Programs (5th ed.) (EPA 841-B-98-009). US Environmental Protection Agency: Washington D.C.

Fassett, N.C. (1957). A Manual of Aquatic Plants. University of Wisconsin Press: Madison

Firehock, K., L. Graff, J.V. Middleton, K.D. Starnchak, and C. Williams (June 1998). Handbook for Wetlands Conservation and Sustainability. Izaak Walton League of America.

Georgia Adopt-a-Wetland Manual (September 1998). Department of Natural Resources, Environmental Protection Division.

Griffin, J. (1998). Amphibian Decline: Monitors Search for Answers. The Volunteer Monitor, 10,(1), pp. 21-32).

Hotchkiss, N. (1970). Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada. New York: Dover Publications

Illinois RiverWatch Stream Monitoring Manual (February 1998, 3rd. ed.) Illinois Department of Natural Resources.

Knobel, E. (1980). Field Guide to the Grasses, Sedges, and Rushes of the United States. New York: Dover Publications.

Little, E.L. Jr. (1998). Forest Trees of Oklahoma. Oklahoma Forestry Services; State Department of Agriculture: Oklahoma City.

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

Mitsch, W.J. and J.G. Gosselink (1993). Wetlands (2nd. ed.). New York: Van Nostrand Reinhold.

Oklahoma Water Quality Assessment Report to Congress (1998). Chapter Five: Wetlands Assessment. Oklahoma City: Oklahoma Water Resources Board.

Oklahoma Water Resources Board (1997). Volunteer Water Quality Monitoring Handbook: Oklahoma Water Watch (3rd. ed.). Oklahoma City: Oklahoma Water Resources Board.

Sievert, G. and L. Sievert (1993). A Field Guide to Reptiles of Oklahoma. Oklahoma Department of Wildlife Conservation: Oklahoma City.

United States Geological Survey (1999). Aquatic and Wetland Vascular Plants of the Northern Great Plains: *Amorpha* L. Northern Prairie Research Center. http://www.npwrc.usgs.gov/resource/1999/vascplnt/species/amor.htm

University of Florida Center for Aquatic and Invasive Species. http://aquat1.ifas.ufl.edu

Wetland Walk Manual: A Guidebook for Citizen Participation (October 1996). USEPA Region 10, Office of Water (EPA 910/R-009).

DIRECTIONS: BUILDING THE STAFF GAUGE

(adapted from *Izaak Walton League of America*)

Estimate time to build: 1 hour

Equipment List:

- metal fence post (6 feet)
- 4-inch diameter PVC pipe (6 feet)
- plastic cap for pipe
- 2-inch wooden dowel rod (6 feet)
- bottle cork (ground with a cheese grater)
- 10-inch square piece of fine mesh screen
- 2, 28-inch cable straps
- 1, 21-inch cable strap
- mallet (found in your kit)
- red permanent marker (found in your kit)
- 300' field tape measure (found in your kit)
- duct tape (found in your kit)

Before the instrument is placed in the field, the proper site for the staff gauge should have been chosen by observing water flow in the wetland and how it fluctuates over a period of time.

Think about the following when placing the staff gauge:

- look for places of inflow or outflow
- look for places that are constantly or periodically wet

Procedure

① Cut a 4-inch by ½-inch wide notch in the bottom of the plastic pipe. This allows water to enter the pipe even if the bottom is covered by sediment.

② Using the 21-inch cable strap, attach the screen to the bottom of the pipe.

③ Using the red marker and the meter stick, mark the outside of the plastic pipe at regular intervals (every 1 inch is good).

④ Using the red marker, mark the dowel rod every 1 inch.

⑤ Using the mallet, drive the fence post into the ground/sediment and attach the pipe with the two 28-inch cable straps. The pipe should be flush with the ground surface.

⑥ Place the ground cork into the plastic pipe and rinse and dust that clings. Insert the dowel rod and cover the pipe with the cap.

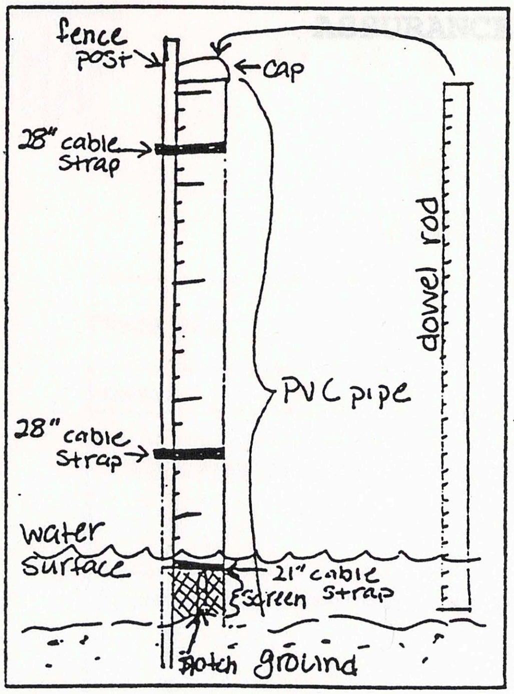
Note: The plastic pipe may be shorter than stated in the equipment list as long as it is always higher than the water level.

Note: The purpose of the notch is to allow water into the pipe even when it sits flush with the ground, so if the gauge is in a high flow or sedimentation area, it would be beneficial to make the notch on the bottom of the pipe taller.

Note: The purpose of the cork is to record the crest of the water (the highest level it has reached). The cork will dry and stick to the dowel rod during the crest. You may need to replace cork as necessary.

Note: When marking the measurements, it is a good idea to label the height every 5 to 10 inches.

-staff gauge
(adapted from *Izaak Walton League of America*)



DIRECTIONS: BUILDING THE GROUNDWATER SAMPLER

(adapted from Izaak Walton League of America, 1998)

Estimate time to build: 30 minutes

Equipment List:

- 24-inch (4-inch diameter) piece of PVC pipe
- plastic cap for pipe
- sharpshooter (found in your kit)
- pea gravel
- meter stick
- red permanent marker (found in your kit)
- orange transect flag (found in your kit)
- duct tape (found in your kit)

Before this instrument is installed, a place at the end of one of your transects should be chosen for its placement. The site where it is installed should be an area that varies in regards to standing water (i.e., the soil can be soggy during parts of the year, but dry during others.

Procedure

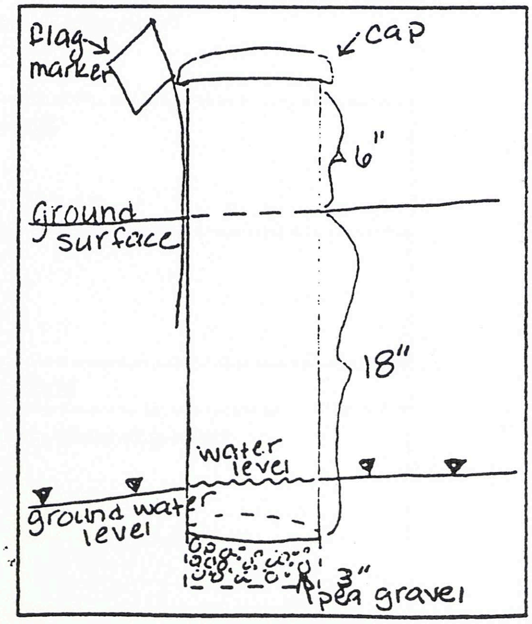
① Dig a 21-inch deep hole (as narrow and vertical as possible). Be sure to save the removed soil.

② Fill the bottom of the hole with 3 inches of pea gravel. Double check this measurement. The distance from the top of the gravel to the ground surface should be 18 inches.

③ Insert the pipe into the hole, making sure it is as vertical as possible. Then fill the area around the hole with the removed soil. Be sure 6 inches of pipe extend above the ground surface.

④ Mark the sampler with a flag and note its position on your wetland sketch.

(adapted from *Izaak Walton League of America*)



APPENDIX D

WHAM TRAINING, DATA COLLECTION AND QUALITY CONTROL ASSURANCE (QCA) SHEETS

D1. Phase I Training Pretest (front)

Oklahoma WHAM

Oklahoma WHAM

Wetland Health Assessment Monitoring

Phase I Training

Please print.

Name:	Date:

1. What three (3) parameters are used to define wetlands?
   a.
   b.
   c.
2. List three(3) reasons why wetlands are important.
   a.
   b.
   c.
3. What is one (1) of the goals of WHAM?
4. How can surrounding land use affect a wetland?
5. Why do you think water column measurements are important?
6. What is an invasive species and why are they bad?
7. What are three (3) functions of wetlands?
   a.
   b.
   c.
8. Soils are used to ____________________ a wetland.
9. What three (3) characteristics do we look for when observing soils?
   a.
   b.
   c.

D1. (Continued) Phase I Training Pretest (back)

10. What two (2) things does measuring wetland water tell us?
    a.
    b.

-circle the best answers-

11. A wetland supports (few / many) of (the same / a variety) of wildlife species.

12. Why have you chosen to become a WHAM volunteer?

13. What do you want to gain from this experience?

Trainee's Signature   Date   Trainer's Signature

D2. WHAM Pledge to the Program and Liability Form (front)

O K L A H O M A

WHAM

WETLAND HEALTH ASSESSMENT MONITORING

Pledge To The Program

IMPORTANT NOTE - LIABILITY

Citizen volunteers participating in this program are not acting on behalf of the Oklahoma Water Resources Board (OWRB) in any official capacity. As such, citizen volunteers are not authorized to be considered agents, employees, or representatives of the OWRB for any purpose, and that citizens are not entitled to the same benefits enjoyed by OWRB employees.

Citizen volunteers must recognize the potential for injury to themselves and their real and personal property which may result from citizen volunteer activities conducted under the Wetland Health Assessment Monitoring Program. Before being accepted into the program, citizen volunteers must expressly assume all risks and liability for any injuries to, or caused by, citizen volunteers under this program.

PROGRAM ACKNOWLEDGMENT AND WAIVER OF LIABILITY

I hereby acknowledge that I am fully informed about the possible risks and potential for injury or loss to myself and to my personal or real property associated with activities and participation in the Wetland Health Assessment Monitoring Program ("the Program") including activities related to the Oklahoma Water Watch Program. Such risks may include, but are not limited to, those associated with boating and water-related activities, equipment usage and handling, adverse weather conditions, other natural conditions and the like. I acknowledge that the Oklahoma Water Resources Board (OWRB) and the State of Oklahoma shall not be responsible for any loss or claims to myself or my property, except to the extent provided by The Governmental Tort Claims Act, and shall in no event be construed to have assumed any duty to me or my property by virtue of my participation in the Program.

I also understand that I am not considered to be an employee, agent or representative of the Oklahoma Water Resources Board (OWRB) or the State of Oklahoma and agree not to hold myself out as such to other persons. I understand and agree that I am not entitled to the same benefits enjoyed by employees of the State of Oklahoma, such as medical insurance, disability, or worker's compensation.

Knowing these facts, and in consideration of your accepting my entry into the citizen volunteer program, I hereby expressly assume all risks and liability for injury or damage caused to myself or to my property, and assume liability for all injuries or damage caused by myself to others or their property. I further, for myself, my heirs and my executors, covenant not to sue and waive, release and discharge the OWRB, the State of Oklahoma, any supporting organizations, and their agents, employees, assigns or anyone lawfully acting on their behalf from any and all claims, damages, losses, demands, and actions of any kind whatsoever, foreseen or unforeseen, which in any manner arise out of or in the course of my participation in the Wetland Health Assessment Monitoring or Oklahoma Water Watch Programs and related activities.

Name: ______________________________ Date: ______________
(print)

______________________________ Age: ______________
(signed)

____
(street address) (city) (zip)

Organization: ____

D2. (Continued) WHAM Pledge to the Program and Liability Form (back)

Pledge To The Program—Page 2

EQUIPMENT LOAN AGREEMENT

I, for myself, my heir(s), and executors do hereby assume responsibility for the safety and care of all equipment, materials and supplies loaned or entrusted to me, and agree to transport, store and use such equipment, materials and/or supplies in a prudent and reasonable manner; to take such action as necessary to reduce the possibility of damage to, of, or from such equipment, materials, and/or supplies. I agree upon verbal or written demand of the Oklahoma Water Resources Board, or their authorized representative, to return said equipment, materials, and/or supplies within five working days of such demand, to the Oklahoma Water Resources Board, 3800 N. Classen, Oklahoma City, Oklahoma, 73118.

I further grant full permission to the OWRB to the use of my name and any videos, photographs, or similar records in which I appear or which may reveal my name or disclose my identity.

NAME: ______________________ Organization: ______________________
(signed)

______________________ DATE: ______________________
(print)

VOLUNTEER COMMITMENT STATEMENT

The following statement of commitment must be read and signed by each volunteer as a condition of participation:

As a volunteer monitor working with Wetland Health Assessment Monitoring, I commit myself to the collection of accurate, objective, environmental information. The data that I collect will be provided to the Oklahoma Water Watch office at the Oklahoma Water Resources Board as soon as possible after I collect it. I commit to monitoring my sample sites, using procedures and timing that is specified in the Wetland Health Assessment Monitoring Handbook and the Field Monitoring Plan. I agree that I will conduct my environmental monitoring in a safe way that will protect me and those people working with or near me from harm. I also agree that I will obey all appropriate state and federal laws and not trespass on private property in order to collect my environmental monitoring data. I agree that I will only monitor at my approved site, on my approved date and time only.

______________________ Organization: ______________________
(signed)

______________________ DATE: ______________________
(print)

Attn: Parent or Guardian
If student is under 18, please complete this section to allow volunteer monitoring.

____
(signed)

______________________ DATE: ______________________
(print)

Revised 01/00

D3. Monitor Training Record

Oklahoma
WHAM

Oklahoma
WHAM

Wetland Health Assessment Monitoring

MONITOR TRAINING RECORD

Please print.

Group ID:	Wetland ID:
Name:	County:
Street Address:	
City:	State: Zip:
Home #: ( )	Work #: ( )
FAX #: ( )	E-mail:

PHASE I TRAINING SESSION
getting acquainted with the program

	✓
WHAM handbook	
OWW handbook	
goals, pledge to the program	
safety	
pretest	
Comments:	score:
Trainer's Signature	Date

PHASE II TRAINING SESSION
water quality testing

	✓
general parameters (temperature, DO, pH)	
nutrients (nitrate, phosphate, ammonia)	
chlorophyll a	
testing procedures	
execution of duties	
data recording	
safety	
post monitoring clean-up, maintenance and storage	
Comments:	score
Trainer's Signature	Date

PHASE III TRAINING SESSION
field observations

	✓
testing procedures	
execution of duties	
data recording	
safety	
post monitoring clean-up, maintenance and storage	
post test	
date and time selected	
group contact list	
Comments:	score:
Trainer's Signature	Date

INITIAL VISIT
refresher and site establishment

	✓
monitoring refresher	
QCA quiz	
transect establishment	
staff gauge	
groundwater sampler	
Comments:	score
Trainer's Signature	Date

D4. Phase II Training: Water Quality Worksheet (front)

Oklahoma WHAM

Phase II Training

Oklahoma WHAM

Wetland Health Assessment Monitoring

Water Quality

Guidelines, Safety and Equipment Care, Measurement Technique

Please print.

Name:	Date:

1. WHAM monitoring should be conducted once every ________ or __________, and should always be done with a _______________.

2. Once a date and time has been established for you monitoring activities, it should not be ______________.

3. After each sampling event, you should immediately ______________ and __________ your monitoring equipment, dispose of ______________ __________ properly and fill out the ___________________________.

4. _________ and ___________ should always be worn when conducting tests as a safety measure to protect against exposure to chemicals.

5. If a chemical reagent is spilled on the skin or gets into the eyes, you should immediately ___________ the area with water and refer to the _____________ for further instructions.

6. Quality Control is an important part of this program because the data is used by government officials and environmental professionals. T or F

7. All of the monitoring equipment should be rinsed ________ times before and after use. When a liquid reagent is used, _________ drops should be added to the chemical test.

8. What should you do if floating algae or suspended sediments are present in your sample collection site?

D4. (Continued) Phase II Training: Water Quality Worksheet (back)

9. If you arrive at your site one month and all the standing water is gone, you cannot collect water quality data. T or F

If false (F), what other parameter becomes critical to monitor at that time? Why?

10. Which should be measured first, air or water temperature? Why?

Basic Parameters

Parameter	Measurement
temperature (°C)	
pH	
dissolved oxygen (mg/L) 1st titration	
2nd titration	
3rd titration (if > 0.6 difference)	
average DO (mg/L)	

Nutrients

Parameter	DI blank	Measurement
Phosphate (ppm)		
Nitrate (ppm)		
Ammonia (ppm)		

* IMPORTANT! Write down the time you added a powder reagent when agitation and mixing times are stated in the procedures. Allowing a sample to sit too long, or not long enough, can lead to bad data. So BE SURE TO WRITE DOWN THE TIME!

Trainee's Signature Date Trainer's Signature

D5. Phase III Training: Field Observations Worksheet (front)

Oklahoma WHAM

Oklahoma WHAM

Phase III Training

Wetland Health Assessment Monitoring

Field Observations
Guidelines, Safety and Equipment Care, Measurement Technique

Please print.

Name:	Date:

1. When is the first time vegetation is scheduled to be monitored?

   ____

2. There is no specific order in which you should monitor. Simply take your monitoring kit into the field and start making observations. T or F

3. Bad data are worse than no data at all, but who is using your data and why (check all that apply)?

   ❑ education ❑ research ❑ government
   ❑ Oklahoma's 305(b) report ❑ other programs

4. During a regularly scheduled monitoring visit, you notice large amounts of trash that were not in the area before. What two (2) things should you do?

   a.

   b.

5. This picture was taken at site 4. How many pictures TOTAL were taken at this site?

   ________ pictures

6. If you observe mottles, what parameter are you monitoring? ______________

7. Complete this statement:

   The ____________ you keep the ______________, the longer it will last, the safer it will be, and the better __________ you will be able to collect.

D5. (Continued) Phase III Training: Field Observations Worksheet (back)

8. It's late May and you've only completed part of the scheduled monitoring when the weather starts to get bad and it looks like it's going to rain any minute. Is it okay to pack up the equipment, complete the data collection sheets to the best of your ability (making note about the sudden weather change), and leaving the site before all of the monitoring is finished?

Y or N

9. As long as the group has finished all of the planned monitoring activities, which of the following ARE ALLOWED (check all that apply)?

- ☐ practice identifying plants with the "vegetation leader"
- ☐ go running through the wetland trying to catch the cool butterfly you saw earlier so you can add it to your collection
- ☐ use your new tape and ID book so you and a couple others can learn all about the frogs and toads that live in the wetland
- ☐ stay behind by yourself to walk through the whole monitoring method again (do a "dry run") for practice

10. Match the equipment with its use:

____ staff gauge

____ waders

____ neon twine

____ sharpshooter

____ 33 gallon tote locker

____ pink flags

____ disposable camera

A. used to create a straight transect

B. creates steep-walled holes for soil observations; assists in groundwater sampler installation

C. holds everything you need to properly monitor your wetland

D. allows you to go into the open water

E. whereas the orange ones are used for photopoint ID, these are used to mark your transects

F. used to take regular pictures of your wetland, or to record unusual/dramatic recent impacts to the wetland

G. measures current open water height and the highest it has been since your last visit

BONUS Choose one of the pieces of equipment and briefly explain how to properly clean and store it.

____

____

____

____

____

____

Trainee's Signature   Date   Trainer's Signature

D6. Phase III Training: Field Observations Mock Data Collection Sheet (front)

Oklahoma

Oklahoma

WHAM

Wetland Health Assessment Monitoring

Phase III Training

Field Observations
Training Field Data Collection Sheet

Please print clearly.

Group ID:	Wetland ID:
Nearest City:	County:
Date:	Time (24-hour clock):
Crossroads/Street Address:	
Group Members:	

WEATHER CONDITIONS

PRESENT WEATHER
*use the given photograph
- ❑ clear/sunny
- ❑ partly cloudy/partly sunny
- ❑ overcast
- ❑ showers (intermittent rain)
- ❑ rain (steady rainfall)
- ❑ storm (heavy rainfall)

TEMPERATURE
*in the classroom

________ °C

WIND DIRECTION (where the wind is coming from)
(circle the direction)
*face the wind-blowing cloud
N NE E SE S SW W NW

D6. (Continued) Phase III Training: Field Observations Mock Data Collection Sheet (back)

WILDLIFE AND AMPHIBIAN OBSERVATIONS

EVIDENCE OF WILDLIFE	AMPHIBIANS
❑ skins ❑ feathers ❑ tracks/prints ❑ shells ❑ dead animals (note these as dead under *ANIMALS SEEN*) ❑ burrows ❑ feeding evidence (fur, bones, feathers strewn about)	*circle the best answer* Which picture is the bullfrog? A B C

Wildlife name	Quantity	Dead/Alive

TRANSECT ESTABLISHMENT

*After assessing the site, you have decided that your transect should be 125' and you want to have 5 sampling sites.

At what interval should these sites be spaced?

Draw a picture of the transect (you can simply sketch a straight line, but indicate the interval and the total distance from 0".

You will do a mock transect set-up in the hall, so grab a partner

PHOTOPOINT IDENTIFICATION

*You have already completed photographing a complete panoramic of site 1 and you are ready to move on to your next site. Properly fill out the PHOTOPOINT IDENTIFICATION SHEET to start photographing the new site.

Trainee's Signature Date Trainer's Signature

D7. Photopoint Identification Sheet (front)

Oklahoma

Oklahoma

WHAM

Wetland Health Assessment Monitoring

PHOTOPOINT IDENTIFICATION SHEET

Note: Be sure to make your numbers legible! As a suggestion, write your numbers like this: 1 2 3 4 5 6 7 8 9 0

(It's best to stand at least four feet from the camera. Put your site number above in big black numbers so the camera can read it clearly.)

(Put the heading of your first photo here. For example, when facing directly left, if your compass reads northeast 35 degrees, write NE 35. Write Clearly!)

(Put the date above using dashes. If it's November 18, 1999, you should write 11-18-99 above. Be sure to write clearly, you're going to have to use this as a reference later!)

D7. (Continued) Photopoint Identification Sheet (back)

Print clearly.

Photographer:	Date:
Wetland ID:	Time (24-hour clock):
Site number:	Site heading:

D8. Equipment Repair Sheet

Oklahoma WHAM

Wetland Health Assessment Monitoring

EQUIPMENT REPAIR SHEET

* This for is to be submitted for OWW and WHAM equipment ONLY! The OWRB is not responsible for any personal equipment you bring into the field as a participant in this monitoring program.

Group ID:	Date:

Name of Equipment:	Date of Breakage:
Request: Repair ☐ Replacement ☐	Reason for Breakage: Normal wear and tear ☐ Broke during usage ☐ Maltreatment of equipment ☐

Please briefly explain how the damage or breakage of the equipment occurred. (This information is requested in the best interest of the WHAM program in case alternative equipment styles or pieces need to be implemented because of poor performance in the field.)

____

____

____

____

____

Please sign and date below.

____

Monitor's signature Date

D9. QA/QC Quiz (front)

Oklahoma WHAM

Oklahoma WHAM

QAQC Quiz

Wetland Health Assessment Monitoring

QUALITY CONTROL ASSESSMENT

General Monitoring Quiz

Name:	Date:

1. Why are bad data worse than no data at all?

2. Should you rely on your memory or write down data and observations as you go along through the monitoring sequence? Why?

3. Which of the following sequences is correct?

- ☐ hydrology, soils, transects, wildlife
- ☐ wildlife, transects, soils, hydrology
- ☐ soils, hydrology, wildlife, transects

4. What can the surrounding land use tell us about the wetland?

5. Which of the following MUST be included when sketching your wetland? (check all that apply)

- ☐ transects
- ☐ photopoints
- ☐ water flow
- ☐ buffers
- ☐ compass direction
- ☐ burrows and nests

D9. (Continued) QA/QC Quiz (back)

6. What is/are the purpose(s) of photographing the wetland?

7. What does the staff gauge measure?

8. What does the groundwater sampler measure?

9. Why is it important to monitor the presence of bullfrogs?

10. When observing wildlife, which of the following should you NOT do? (check all that apply)

- ☐ put your hand in a burrow
- ☐ note any nests or tracks
- ☐ approximate the number of birds in a flock
- ☐ collect butterflies

Certified Monitor's Signature | Chapter Officer's Signature | OWRB Assessor's Signature

D10. Quality Control Assessment (QCA) Data Collection Sheet (front)

Oklahoma WHAM

Oklahoma

WHAM

Wetland Health Assessment Monitoring

QUALITY CONTROL ASSESSMENT

Field Data Sheet

Please print.

Group ID:	Wetland ID:
Nearest City:	County:
Date:	Time (24-hour clock):
Crossroads/Street Address:	
Group Members:	

WATER QUALITY

Technique and Skill Demonstration

Parameter		DI Blank	Measurement
Temperature (°C)			
pH (standard units)			
Dissolved Oxygen (mg/L)	1st titration		
	2nd titration		
If > 0.6 difference	3rd titration		
Ammonia Nitrogen (NH_3) ppm			
Nitrate Nitrogen (NO_3^-)ppm			
Phosphate (PO_4) ppm (be sure to note the wheel measurement and your final calculation)			
Chlorophyll *a* filtered and stored			

Task	Complete
Water Sample Collection (general and DO)	
Temperature Determination (air and water)	
Reagent Drop Methods	
Equipment Cleaning Methods	
Site Safety Methods	

D10. (Continued) QCA Data Collection Sheet (back)

MAINTAINANCE TECHNIQUE

Parameter	Task	Maintained
Transects	Directional placement	
	Monitoring site interval	
	Interval measurements	
Photopoints	Photopoint site placement	
Hydrology	Staff gauge construction	
	Staff gauge installation/field placement	
	Groundwater sampler construction	
	Groundwater sampler installation/field placement	

FIELD OBSERVATIONS

Parameter	Task	Complete	S/U
Photopoints	Panoramic photo technique		
	Photo ID sheet completion		
Vegetation	Specimens identified		
	Purple Loosestrife identified		
Soils	Soil color ID		
	Estimation of mottles		
	Water depth measurement		
Hydrology	Staff gauge measurement		
	Groundwater sampler measurement		
Wildlife/Amphibians	Wildlife photo ID		
	Bullfrog photo ID		
	Bullfrog call ID		

Certified Monitor's Signature　　Chapter Officer's Signature　　OWRB Assessor's Signature

D11. Weather and Land Use Data Collection Sheet (front)

Oklahoma

Oklahoma WHAM

Weather and Land Use

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

Group ID:	Wetland ID:
Nearest City:	County:
Date:	Time (24-hour clock):
Crossroads/Street Address:	
Group Members:	

POST MONITORING CHECKLIST

*Be sure you have all the data sheets collected and signed, and clean up your equipment kit!

Weather and Land use	Wildlife and Amphibians	Water quality/ Hydrology	Vegetation	Soils	Equipment Collected	Equipment Cleaned	Repairs Noted	Data Sheets Signed

MONITORING NOTES

D11. (Continued) Weather and Land Use Data Collection Sheet (back)

WEATHER CONDITIONS

Assessed by:	Date:
	Time (24-hour clock):

PRESENT WEATHER

- ❑ clear/sunny
- ❑ partly cloudy/partly sunny
- ❑ overcast
- ❑ showers (intermittent rain)
- ❑ rain (steady rainfall)
- ❑ storm (heavy rainfall)

TEMPERATURE

_______ °C

WIND DIRECTION (where the wind is coming from)
(circle the direction)
N NE E SE S SW W NW

NOTES

____
____
____
____

ASSESSING SURROUNDING LAND USE

Assessed by:	Date:
	Time (24-hour clock):

HUMAN IMPACTS (LAND USES)

- ❑ undisturbed natural vegetation
- ❑ residential housing
- ❑ construction site
- ❑ agriculture, grazing, crop cultivation
- ❑ commercial development (e.g., offices)
- ❑ industrial development
- ❑ railroads
- ❑ sewage treatment
- ❑ park, recreation area
- ❑ oil, gas drilling
- ❑ open fields

NOTES

____
____
____

SIGNS OF DEGRADATION

- ❑ dumping (soil, gravel, vegetation)
- ❑ dumping (man-made materials/trash)
- ❑ grading (topsoil removal)
- ❑ draining (water out of the wetland)
- ❑ draining (into the wetland – look for pipes from parking lots or industrial-type buildings)
- ❑ water channeling (look for trenches or ditches)
- ❑ All Terrain Vehicle (ATV)/miscellaneous tire tracks)
- ❑ livestock usage (look for prints)
- ❑ silt, sandy or gravel deposits (NOT dumping, but from erosion, runoff, etc.)
- ❑ stream bank erosion
- ❑ dredging (soil removal or channel digging)

NOTES

____

D12. Wetland Sketch Sheet (front)

Oklahoma

Oklahoma

WHAM

Wetland Health Assessment Monitoring

WETLAND SKETCH SHEET

Group ID:	Wetland ID:
Artist:	Date:

Legend

D12. (Continued) Wetland Sketch Sheet (back)

ESTIMATED WETLAND SIZE

☐ < 1 acre

*the size of 1 football field is about 1 acre

_____ acres

Notes

____

____

____

____

____

____

D13. Water Quality and Hydrology Data Collection Sheet

Oklahoma WHAM

Oklahoma
WHAM

Water Quality & Hydrology

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

WATER QUALITY MEASUREMENTS

*Be sure to refer to the *Oklahoma Water Watch Volunteer Monitoring Handbook* for procedures.
*Be sure to note ALL measurements (including math done for dilutions).
*DI blanks are only performed on the NUTRIENTS!

Assessed by:	Date:
	Time (24-hour clock)

Parameter		DI Blank	Measurement
Temperature (°C)			
pH (standard units)			
Dissolved Oxygen (mg/L)	1st titration		
	2nd titration		
If >0.6 diffference	3rd titration		
Ammonia Nitrogen (NH_3) ppm			
Nitrate Nitrogen (NO_3^-)ppm			
Phosphate (PO_4) ppm (be sure to note the wheel measurement and your final calculation)			
Chlorophyll *a* filtered and stored			

*When you're finished, be sure to fill out the equipment review record (this will also assist you to put your water kits back together correctly).

HYDROLOGY ASSESSMENT

Assessed by:	Date:
	Time (24-hour clock):

STAFF GAUGE	GROUNDWATER SAMPLER
	Subtract measurement from well depth.
Staff measurement _______ ft in (circle the correct measurement)	Well depth (stays the same) = 24 in
Crest measurement _______ ft in (circle the correct measurement)	Distance from pipe top to water = _____ in
	Groundwater depth = _____ in

D14. Wildlife and Amphibians Data Collection Sheet (front)

Oklahoma WHAM

Oklahoma WHAM

Wetland Health Assessment Monitoring

Wildlife & Amphibians

FIELD DATA COLLECTION SHEET

Please print clearly.

WILDLIFE AND AMPHIBIAN OBSERVATIONS

Assessed by:	Date:
	Time (24-hour clock):

NOTES	EVIDENCE OF WILDLIFE
	☐ skins ☐ feathers ☐ tracks/prints ☐ shells ☐ dead animals (note these as dead under ***ANIMALS SEEN***) ☐ burrows ☐ feeding evidence (fur, bones, feathers strewn about)

Wildlife name	Quantity	Dead/Alive

D14. (Continued) Wildlife and Amphibians Data Collection Sheet (back)

AMPHIBIANS (only monitor in the spring and summer)	NOTES
Did you see any bullfrogs? Yes ☐ No ☐	______
Did you hear any bullfrogs? Yes ☐ No ☐	______
Did you see or hear any other species of frogs, toads or salamanders? Yes ☐ No ☐	______

D15. Vegetation Data Collection Sheet

Oklahoma WHAM

Vegetation

Oklahoma WHAM

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

VEGETATION OBSERVATIONS

Assessed by:	Date:
	Time (24-hour clock):

Transect (circle): N E S W

Category	species	site # tally	site # site total	site # tally	site # site total	site # tally	site # site total	site # tally	site # site total
Tree Category	Green Ash								
	Silver Maple								
	Hackberry								
Scrub Shrub	Buttonbush								
	False Indigo								
	Black Willow								
Emergent	Cattail								
	American Bulrush								
	Spikerush								
Floating/Submergent	Duckweed								
	Pondweed								
	Coontail								
Invasives	Purple Loosestrife								

D16. Soil Assessment Data Collection Sheet

Oklahoma WHAM

Oklahoma
WHAM

Wetland Health Assessment Monitoring

Soils

FIELD DATA COLLECTION SHEET

Please print clearly.

SOIL ASSESSMENT

Assessed by:	Date:
	Time (24-hour clock):

Transect (circle): N E S W

	site #			site #			site #		
surface/standing water depth									
sample depth	6"	12"	bottom	6"	12"	bottom	6"	12"	bottom
sulfur smell	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
relative color									
mottles	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
water depth at bottom									
depth to saturated soil (groundwater)									
muck	Y N			Y N			Y N		

	site #			site #			site #		
surface/standing water depth									
sample depth	6"	12"	bottom	6"	12"	bottom	6"	12"	bottom
sulfur smell	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
relative color									
mottles	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
water depth at bottom									
depth to saturated soil (groundwater)									
muck	Y N			Y N			Y N		

D17. Program Evaluation Post-test (front)

Oklahoma WHAM

Oklahoma

WHAM

Wetland Health Assessment Monitoring

Program Evaluation

Please print.

Name:	Date:

1. What three (3) parameters are used to define wetlands?
   a.
   b.
   c.
2. List three(3) reasons why wetlands are important.
   a.
   b.
   c.
3. What is one (1) of the goals of WHAM?
4. How can surrounding land use affect a wetland?
5. Why do you think water column measurements are important?
6. What is an invasive species and why are they bad?
7. What are three (3) functions of wetlands?
   a.
   b.
   c.
8. Soils are used to ____________________ a wetland.
9. What three (3) characteristics do we look for when observing soils?
   a.
   b.
   c.

D17. (Continued) Program Evaluation Post-test (back)

10. What two (2) things does measuring wetland water tell us?
    a.
    b.

-circle the best answers-

11. A wetland supports (few / many) of (the same / a variety) of wildlife species.

12. Prior to being trained as a WHAM volunteer monitor, we asked you why you chose to become a monitor, and what you wanted to gain from this experience. Reflecting upon your experience thus far, has the program met your expectations, and have you gained what you hoped through your WHAM training and monitoring?

13. Please provide us with any comments, concerns or ideas about your experience with WHAM. Are there things we should change or improve, or things we can add to make this a better experience?

Trainee's Signature   Date   Trainer's Signature

APPENDIX E

WHAM QUALITY ASSURANCE PROJECT PLAN (QAPP)

Section No. ____
Revision No. ___
Date __________
Page ___ of ____

QUALITY ASSURANCE PROJECT PLAN

OKLAHOMA WETLAND HEALTH ASSESSMENT MONITORING (WHAM)

Citizens Volunteer Environmental Monitoring Program

March 2000

PROJECT MANAGEMENT

A1 Title and Approval Sheet

Project Title: **Wetland Health Assessment Monitoring (WHAM) Volunteer Environmental Monitoring Program**

Organization: Oklahoma Water Watch
Oklahoma Water Resources Board
3800 N Classen
Oklahoma City, OK 73118

Approvals:

______________________________ Date ____________
Melanie Foster
Oklahoma Water Watch Program Coordinator

______________________________ Date ____________
Bill Cauthron
Beneficial Use Monitoring Program Coordinator

______________________________ Date ____________
Derek Smithee
Chief, Water Quality Programs Division

______________________________ Date ____________
Jennifer Myers
Environmental Grant Administrator/QA Officer

______________________________ Date ____________
Tyrone Hoskins
EPA Project Officer

______________________________ Date ____________
Joan Brown
EPA Chief, Assistance Programs Branch

A3 Distribution List

Derek Smithee, Bill Cauthron, Melanie Foster, Crystal McLaren, Chuck Potts
Oklahoma Water Resources Board
3800 N Classen
Oklahoma City, OK 73118

Jennifer Myers
Office of the Secretary of Environment
3800 N Classen
Oklahoma City, OK 73118

Mike Bira, Volunteer Monitoring Program Officer
US EPA, Region VI
Clean Lakes Coordinator
1445 Ross Ave.
Dallas, TX 75202-2733

All ***Wetland Health Assessment Monitoring*** (WHAM) Group Coordinators will receive a copy for their files and are encouraged to distribute to all volunteer monitors.

A4 Project Organization

WHAM funding is provided through the USEPA to the Oklahoma Water Resources Board (OWRB) for establishment of the pilot program. The OWRB coordinates the program, and is responsible for collecting, analyzing, and reporting data results.

Dr. Robert Nairn and Erin Breetzke are initially responsible for establishing the program's monitoring parameters and procedures, as well as the associated QA/QC protocols. Melanie Foster, Program Coordinator, is responsible for overseeing data collection and analysis, reporting of study results, ensuring that quality assurance and quality control (QA/QC) procedures are followed at all times, and implementing QA/QC measures as well as reporting the results of these activities. Melanie Foster shall also delegate specific tasks or actions to other OWRB staff as appropriate. The QA Officer, is responsible for approving and accepting final products and deliverables. Crystal McLaren, WHAM Training Coordinator, is responsible for training volunteers, implementing data collection and conducting quality control assessments (QCAs). Each volunteer monitoring chapter's Group Coordinator will assist the Program and Training Coordinators to ensure that all volunteer monitors are following appropriate QC procedures as defined in this plan.

A5 Problem Background

Oklahoma has lost approximately 70% of its pre-settlement wetlands (Mitsch and Gosselink 1993). These ecosystem losses have also resulted in the loss of such functions as wildlife habitat, water storage, etc. The OWRB does not have the man-power to assess the condition of all the state's wetlands on a regular basis. In order to gather water quality data and data on the overall condition/health of Oklahoma's wetland ecosystems, the OWRB created the Wetland Health Assessment Monitoring program (WHAM) to assist in the acquisition of needed wetland data. Using local citizens to gather monitoring data also meets the program's goals of increasing stewardship for wetland ecosystems and providing general education about wetlands.

The evolution of this program and the changing needs of all involved entities may subsequently change the data collected as well as its use. Data collected in this program will be used in several ways. Through the hands-on data acquisition and analysis by volunteers, the data will become a tool by which citizens and volunteers can observe trends in water quality and ecosystem maturation. Through data management, the OWRB will be responsible for making the data available for those entities interested in Oklahoma's wetland resources. Water quality data will be submitted in the state's 305(b) report. University scientists, the Oklahoma Natural Heritage Inventory (ONHI), Oklahoma Biological Survey (OBS) and the OWRB will also use the habitat data and field observations to assess trends in overall ecosystem health, to determine when site visits by wetland professionals are necessary, and to determine baseline standards for wetlands.

A6 Project Description

Volunteers will collect data monthly, or a minimum of every six (6) weeks. The chosen interval must be pre-approved by the OWRB WHAM staff. The collected data are to be reported to the OWRB within two (2) weeks from the date of collection. The OWRB will enter the data into an electronic database for use in generating reports.

A combination of water quality measurements and ecosystem field observations will be collected by the volunteers.

Water quality measurements are performed in the field using LaMotte and HACH sampling kits. Water samples are collected in-situ with a 500mL plastic bottle provided by the OWRB. Water quality protocol follows the OWW handbook (Appendix 1). The field observations are a combination of techniques from the following programs: Georgia Adopt-a-Wetland (1998), Illinois RiverWatch, EPA Region 10 Wetland Walk, Washington Adopt-a-Beach (Miller et. al. 1996), and the Izaak Walton League of America's Wetland Conservation and Sustainability Program (1998) and are explained in the WHAM Volunteer Monitoring Addendum (Appendix 4).

Evaluation of data will be difficult during the pilot implementation of this program and procedures will only be conducted to assess the feasibility of the parameters. Subsequent state-wide implementation of the WHAM program will utilize data as described in this document. Because wetland ecosystems vary regionally and because they are ecotones and impacted both aquatically and terrestrially, baseline standards for all wetland types statewide are not available at this time. Ecosystem field observations will assist in data analysis due to impacts surrounding land use may have on the wetland area. The involvement of university scientists and other professionals and academicians will assist in the progressive development of baseline water quality standards in wetlands, and the determination between healthy, at risk, and "sick" wetlands in regards to various human and environmental impacts.

A7 Data Quality Objectives for Measurement Data

At this time, this program is not designed to be used as, nor is it intended for, any type of permitting or enforcement purposes. It is intended to motivate citizens to take an active role in managing the state's wetland resources and to supplement state monitoring efforts in collecting baseline data on Oklahoma's wetlands.

The objectives of the WHAM program are:

1. Collection of environmental data, indicating baseline water quality for Oklahoma's water resources
2. Identification of water quality and ecosystem health concerns
3. Determination of water quality trends
4. Promotion of citizen participation in protecting, managing and restoring our wetland resources
5. Education of the public regarding basic ecological concepts related to our wetland resources

These objectives are similar to those of OWW, and represent the overall goal of the program design, which is to provide quality baseline data needed by government agencies and other interested entities, and to create a basis for wetland stewardship. Data Quality Objectives (DQOs) for water quality and field observations are listed as follows (also see Tables 1, 2, 3 and 4):

These data will be made available to any and all public and private entities interested in learning more about Oklahoma's wetland resources, trends in the ecosystems, and their general condition.

I. Data Quality Objectives for Water Quality Data

Precision

Precision is a measurement of "replicability" or reproducibility. Precision analyses are performed using pH, dissolved oxygen, and nutrient spike samples with known concentrations in the same manner and at the same time as accuracy analyses. Precision during Quality Control Assessment (QCA) sessions, monitor precision is calculated by comparing the standard deviation between replicate samples to an acceptable deviation. The smaller the standard deviation of the samples, the more precise the measurements. Precision will be determined for the group and for each individual during the QCA. Performance of the monitor(s) during QCA events will be examined to determine if any problems in data precision are due to testing protocols or human error. In addition, long term precision estimates will be measured from a database established through repetitive QCA sessions.

Accuracy

Accuracy is the amount of correspondence between the value a monitor obtains and the "true" value of a sample. Accuracy measurements for pH, dissolved oxygen, nitrate nitrogen, ammonia nitrogen, and ortho-phosphate are obtained through the use of QCA sessions. For assessing accuracy for these parameters, spike samples with known concentrations are obtained from a certified laboratory before the QCA session. During the QCA session volunteers collect a sample of each spike solution (or it is provided to them) and they run their normal test procedures. Volunteers are asked to run from two (2) to four (4) duplicates on each spike sample. After the volunteer has recorded their test results, WHAM staff compares the obtained result to the "true" value of the spike sample. If a monitor clearly falls outside of accuracy limits, they will be asked to retest the sample to try to ascertain the source of error. If they can subsequently obtain an accurate result (and on any requested duplicates), they will not be considered to have failed the QCA session, although their previously collected data will be questionable.

If a volunteer fails to fall within accuracy limits for any variable during one of the regularly scheduled QCA sessions and cannot find their source of error at that time, then they must meet stated accuracy values at a second QCA session. Failure of a volunteer to meet acceptable accuracy values at a second consecutive QCA session will result in non-acceptance of his/her data and further training of the monitor. If a monitor is still unable to obtain acceptable accuracy values after retraining, then they will be requested to leave the program or to assist data collection efforts in some other way besides reading and/or performing test analyses.

Comparability

All analytical methods to be used are based on the American Public Health Association Standard Methods: 19th Edition (1995), EPA publications (1977, 1979b) and protocols outlined in the OWW Volunteer Monitoring Handbook (Appendix 1). The methods and QA procedures described in this plan will be followed throughout the study period such that information collected will be comparable from one sampling period to the next and with other studies where equivalent analytical methods and QA procedures are utilized.

Table 1. Data Quality Objectives for Water Quality Data

Parameter	Range	Precision	Accuracy
Dissolved Oxygen	0 - 20 mg/L	0.2 mg/L	+/- 1 mg/L
pH	3.0 - 10.5	0.25	+/- 0.50
Temperature (air and water)	-5 - 50 ºC	0.25 ºC	+/- 0.50 ºC
Nitrate	low range 0-1 mg/L	0.04 mg/L	+/- 0.10 mg/L
	high range 0-10 mg/L	0.40 mg/L	1.0 mg/L
Orthophosphate	low range 0-1 mg/L	0.04 mg/L	+/- 0.1 mg/L
	mid range 0-5 mg/L	0.20 mg/L	0.50 mg/L
	high range 0-50 mg/L	2.0 mg/L	5.0 mg/L
Ammonia	0-2.5 mg/L	0.50 mg/L	+/- 0.25 mg/L

II. Data Quality Objectives for Field Observation Data

Precision

Precision is assessed in two ways. First, precision is considered to be the ability of the volunteer monitors to consistently report data from the same site through the data collection technique. This tests the consistency of the methodology, not the data. The establishment of the permanent monitoring sites in the field (i.e., the transects and flagged intervals) allows for spatially collected data in the same site (i.e., precision) even though data will change during each visit. Therefore, changes, even those of an extensive nature, in soil color or vegetation communities is acceptable at the same collection site.

Secondly, precision is assessed separately for each parameter as follows:

describing the wetland - A wetland sketch is created by the volunteers on their initial visit. This sketch aids in all other monitoring parameters because it is used as a map in the event of flooding, altered or damaged photopoints or transects.

wildlife and amphibian observations - Wildlife are identified by using photographs, slides and field guide books. The volunteers must identify 70% of the species presented to them. When given a series of three (3) photographs, the volunteers must identify the bullfrog with 100% precision. When given a series of four (4) frog calls, the volunteers must also identify the bullfrog call with 100%.

transect establishment - The establishment of transects in the wetland creates permanent sampling sites which are used for vegetation identification and soil assessment. These permanent sites allow for reproducible data, though it is expected that vegetation and soils will change throughout the monitoring program due to ecosystem development and changes in the growing season.

vegetation - Vegetation is expected to change during the seasons and throughout ecosystem development. To test the monitors' precision, they will be required to properly identify 80% of the species during each QCA session. Volunteers must 1) identify 80% of the species presented to them, and 2) one transect is chosen in the field for QA/QC during which there must be a 90% correlation between each individual or group assessing the transect. This 90% correlation provides a basis for comparing the precision (i.e., reproducibility) of the data reported by the volunteers.

soils - Soils are expected to change slightly over time. All soils measurements, except color, are related to presence/absence characteristics. To test the precision of identifying the soil's color, monitors must identify a series of soils for their color (soil color books may be used). In addition, one transect must be assessed in the field by each volunteer (or pair of volunteers) with 90% correlation between each data set reported. This correlation, like that of the vegetation, provides a basis for comparing the precision (i.e., reproducibility) of the data reported by the volunteers.

Accuracy

Accuracy for vegetation, wildlife, and amphibian observations will be assessed utilizing photographs, line art and audio aids as identification tools for the pertinent species found in wetland ecosystems.

Identification of vegetation must be met during the annual QCA session with 80% accuracy due to the minimal number of species to be identified and the importance of each species as indicators of the ecosystem's health and boundaries.

During training, slides, photographs, and when possible, specimens are viewed and described to the volunteers utilizing the vegetation identification pages in the WHAM addendum. For each species, the common ID characteristics (i.e., fruits, flowers, leaves) are discussed in detail. During this training, use of Oklahoma Biological Survey (OBS) or state university faculty as plant specialists may be necessary to prepare the volunteers for independent field observations.

Identification of wildlife will be performed by photo identification and must be met with 70% accuracy. This parameter is used only to obtain an overall view of the diversity of species using the wetland, not to look for specific wildlife species, with the exception of amphibian observations.

Photographs obtained from the Oklahoma Department of Wildlife Conservation are used to show volunteers the wildlife in the state, especially those they may encounter in the wetland. These photos are also used during the QCA sessions, and volunteers must identify them with 70% accuracy. The growth of a photo library will allow training staff to introduce the volunteers to additional wildlife species as photos become available. To supplement this portion of the monitoring, field books of common reptiles, amphibians, and other birds or mammals in Oklahoma may be obtained for the volunteers.

The presence of a homogenous amphibian community consisting of only bullfrogs (*Rana catesbeiana*) may indicate areas where other amphibians are declining.

Identification of bullfrogs must be met with 100% accuracy with the use of photographic and audio identification.

Volunteer monitors are shown a series of amphibian photos (e.g., leopard frog, chorus frog, and a bullfrog) all of which are species they will encounter in Oklahoma. Volunteers must be able to identify the bullfrog. To identify the call, a series of four (4) frog calls (e.g., green frog, bullfrog, wood frog and northern leopard frog) are available on a tape for the volunteers to hear. They must then choose either A, B, C, or D (each corresponding to one of the frogs), whichever is the bullfrog call. It is important to note that all the calls used are of frogs found in Oklahoma, most of which are likely to be encountered by the volunteers.

Hydrology measurements (i.e., staff/crest gauge and groundwater sampler) are as follows:

Table 2. Hydrology Data Quality Objectives

Instrument	Range	Precision	Accuracy
staff gauge	0 - 71 in	1 in	2 in
crest height	0 - 72 in	1 in	2 in
groundwater sampler	0 - 24 in	0.125 in	0.25 in

Volunteers must manually mark the measurement increments on each instrument as well as prepare each for field installation (i.e., cut the screen, create a 4" x ½" notch) before the equipment is brought to the field. Once each is prepared for installation, OWRB personnel will be in the field at this time to assure the proper construction and installation of each instrument. During the annual QCA, the monitors must be able to properly read the measurement within accuracy limits. No other training is required at this time.

If a volunteer fails to perform the tasks and meet the accuracy score, they must attend a second QCA session and meet the passing scores at that time. Failure of a volunteer to meet acceptable accuracy values at a second consecutive QCA session will result in non-acceptance of his/her data and further training of the monitor. If a monitor is still unable to meet the acceptable accuracy values after re-training, then they will be requested to leave the program or to assist data collection efforts on a parameter for which they successfully met the accuracy values.

Comparability

The maintenance of equipment and the establishment of permanent monitoring sites will ensure that data can be compared from one monitoring visit to the next. QCA sessions testing precision and accuracy will assure data is collected properly. It is not required that field data remain constant, however, when compared to previously collected data. It is expected that vegetation, soils, and surface/groundwater levels will change throughout the year. It is also expected that changing vegetation will provide information regarding plant community structure and may change drastically due to ecosystem maturation, growing season, or new community establishment. Table 3 outlines the field data DQOs for comparability.

Table 3. Data Quality Objective: Comparability

Parameter	Comparability
wetland description	Photographs used to show detail of hand-drawn sketch. Sketch is further used as a map if transects and sites are destroyed in a flooding event, or disturbed in any way.
photopoints	Permanent flag placement ensures same landscape in the camera's viewfinder for each panoramic photo series.
vegetation	Permanent sites established on all four (4) transects to ensure data collection at the same locale during every visit.
soils	Permanent sites established on one (1) chosen transect to ensure data collection at the same locale during every visit.
wildlife/amphibians	Photographs used to identify actual species seen in the field; audio tape used to identify bullfrog calls. QCA sessions are used to assess the monitors' identification abilities.
hydrology	Instruments checked during each visit for maintenance needs (i.e., re-installment, measurement re-marking). QCA sessions are used to assess the monitors' ability to read measurements.

Completeness

Initially, all field observations will be acceptable. Data will not be considered complete unless monitors have met the requirement of at least nine (9) site visits during the year (meeting the minimum requirement of once every six (6) weeks) Because of the OWRB personnel involvement in transect and photopoint establishment and hydrology equipment construction and establishment, data collected using these tools will be complete until QCA sessions or erratic data show otherwise.

It is important to note that some field observation parameters do not conform to all DQO categories, but rather have more specific DQOs pertaining to the methodology and nature of the data acquired.

A9 Training Requirements/Certification

WHAM volunteer monitors will progress through three phases of training and certification:

Phase I: getting acquainted with the program; organization and introduction

Phase II: water quality testing; guidelines, procedures, safety

Phase III: ecosystem field observations; guidelines, procedures, safety

Phase I training is approximately three (3) hours. Monitors are given a general wetlands knowledge pretest in order for the program managers/trainers to determine the current understanding volunteers have of wetlands. A brief wetlands overview lecture is presented to introduce wetlands (including: history, function, value, legislation) to the monitors. The monitors receive the WHAM Volunteer Monitoring Addendum and review the purpose and need of the program, what is expected of volunteers, the importance of good data, safety guidelines and the monitoring schedule. It is also stressed that attendance is mandatory at all training sessions in order to become a certified monitor, and annual QCA sessions are mandatory in order to maintain certification. Volunteers who choose to commit to the program are instructed to complete the Pledge to the Program sheet (Appendix 2A).

Phase II training is a three (3) hour in-lab session that focuses on water quality testing. Monitors are given a copy of the OWW Volunteer Monitoring Handbook which outlines the water quality testing procedures they will perform. Instruction includes becoming familiar with the different pieces of equipment, their purpose, and proper use. Trainees are given a short quiz to complete (with the aid of the handbook) which consists of safety and general guideline information. Each water quality parameter is demonstrated for the trainees, after which the trainees break up into smaller groups and are trained at individual stations. Monitors must demonstrate their skills by performing each test.

Phase III training is a two (2) hour in-lab session that focuses on wetland field observations. Monitors are instructed as to the contents of each monitoring kit, the proper function and use of each piece of equipment as well as its maintenance. Each parameter is given its own station at which the trainees are to practice using the equipment and to become familiar with the vegetation and wildlife species.

Several parameters are demonstrated in the field. These parameters include transect establishment and construction and placement of the staff gauge and groundwater sampler. These must be placed/installed correctly the first time in order to ensure the subsequent data received from the transect or instrument are of good quality.

Prior to the initial visit to the wetland site, a training refresher is given to the volunteer monitors. This refresher includes a short quiz as well as a question and answer session between the volunteer monitors and trainers.

Within two (2) months after the initial visit, a post-test is administered. This test is nearly identical to the pretest, and is used to allow WHAM personnel to identify if the volunteer monitors have learned from the program and have increased their wetland knowledge.

A10 Documentation and Records

An up-to-date monitor file (Appendix 2) will be established and maintained for each monitor and will contain the following:

- Signed Liability/Commitment & Pledge to the Program Sheet (Appendix 2A)
- Monitor Training Record (Appendix 2B)
- Pretest (Appendix 2C)
- Phase I training sheet (Appendix 2D)
- Phase II training sheets (Appendix 2-E1, E2)
- Phase III training sheets (Appendix 2F1, F2)
- Post-test (Appendix 2G).

Volunteer-collected data are recorded on the appropriate Field Data Collection Sheets (Appendix 3A-G) on-site at the time observations and sampling occur. Monitors are to make copies of the records for their files, then submit the original to the OWRB within two (2) weeks of the visit. Disposable cameras (used for photopoints or to document significant or questionable impacts) are also submitted with the data sheets when applicable.

After data sheets and cameras are submitted to the OWRB, they are reviewed and checked for any errors or missing data. The volunteer group's Data Manager will be contacted if any questionable data are found. Once all data have been reviewed, they are entered into the electronic database, and hard copies are placed in a binder and filed with the associated pictures. Reports are then generated from these data.

MEASUREMENT/DATA ACQUISITION

B1 Sampling Process Design

All WHAM volunteer monitors are required to follow the sampling directions as stated in the OWW and WHAM Volunteer Monitoring Handbooks (Appendices 1 and 4, respectively). This is to ensure a quality sample and reduce sampling error or bias. Though monitoring takes place every month (or at least every 6 weeks), the parameters monitored each month vary slightly due to parameters that do not fluctuate quickly, or may not be feasible at that time of year. Monitors are to refer to their Monitoring Schedule Calendar (Appendix 5) to determine the month's appropriate monitoring activities.

All sampling sites are recorded on a master sketch sheet of the wetland (Appendix 3F) and photographs assist in this documentation. These sites remain the same during all monitoring activities.

It is stressed to monitors that safety is always first. Monitors are to contact their team leader if they are unable to monitor. If a whole team cannot monitor, it is stressed that they monitor as soon as possible and contact the OWW/WHAM personnel about any monitoring problems.

The sampling training and data gathering methodology for each parameter is as follows:

assessing surrounding land use - Conducted on the initial site visit, the volunteer monitors must record any and all human impacts (e.g., land uses) and signs of degradation. On subsequent visits, these conditions are monitored only in the event of a change in the wetland (e.g., new large amounts of trash or chemical spills). Volunteer monitors must consult their data sheet copy from the initial visit as not to duplicate reports of the same land use or degradation if there is a question as to its development (or worsening) since the last wetland visit.

describing the wetland - The wetland area under assessment is to be sketched by the volunteer monitors. This sketch must include:

- -areas of open water
- -dominant vegetation
- -buffers
- -water flow direction (if present)
- -photopoints
- -standing water

-compass direction
-transects

This sketch provides a map of the area in order to locate sampling sites in the event of flooding, vegetation overgrowth (this allows volunteers to locate the flagged photopoints and transects). If transects or photopoints need to be replaced, this map allows the volunteers to place them in the same locale.

wildlife and amphibian observations - Used only as tools to gauge the general variety of wildlife in the wetland, volunteers are shown slides and photographs of various wildlife in Oklahoma that may be encountered in the wetland. These photographs are made available to the volunteers as field guide books. During the QCA sessions, volunteers are asked to identify species from the photos and obtain a passing score of 70%.

Amphibian observations are only conducted for the presence of bullfrogs. Due to their aggressive behavior toward other amphibian species, a homogenous community of bullfrogs may indicate problems in a wetland's food web. Volunteers are shown a series of three (3) photographs and must identify the bullfrog. Volunteers also listen to a series of four (4) frog calls and must identify the proper call. These observations must be met with 100% accuracy during the annual QCA session.

photopoints - The establishment of a minimum of three (3) photopoints in a wetland is used to pictorially document changes in the ecosystem throughout the course of monitoring. During training, monitors are shown how to properly fill out the required photopoint identification sheet, how to use the disposable camera, and how to correctly use the compass. These tasks are also assessed during the annual QCA session. Field placement of the photopoints is conducted on the volunteers' judgement of where a panoramic series of photos will document changes in the wetland best. Flags are placed on the right and left-hand sides of the photographer's viewfinder and are used to guide the panoramic series in order to capture the same range of view for every photographic assessment. A stake is also flagged at the point where the photographer must take the photos.

vegetation observations - Thirteen (13) plant species have been chosen for each of five (5) vegetation categories. These are:

tree/forest: Green Ash (*Fraxinus pennsylvanica*)
Silver Maple (*Acer saccharinum*)
Hackberry (*Celtis laevigata*)

scrub shrub: Buttonbush (*Cephalanthus occidentalis*)
False Indigo (*Amorpha fruticosa*)
Black Willow (*Salix nigra*)

emergents: Cattail (*Typha* spp.)
American Bulrush (*Scirpus americanus*)
Spikerush (*Eleocharis palustris*)

floating/submergent: Duckweed (*Lemna* spp.)
Pondweed (*Potamogeton* spp.)
Coontail (*Ceratophyllum demersum*)

invasive: Purple Loosestrife (*Lythrum salicaria*)

A botanist presents the species and identifying features to the volunteer monitors during training sessions. During the annual QCA session volunteers are presented with samples of each species and need to identify the species with 80% precision. To collect reproducible data, the volunteers utilize each staked and flagged site on all four (4) transects to collect vegetation data. A five (5) foot radius is created using the stake as the center, and the complete area is monitored for the selected data. For floating/submergent species, only those sites located at the edge of the open water are assessed for these species. Purple Loosestrife is monitored not only in the designated sites, but general observations are made through the wetland to identify this invasive.

soils - Volunteers are trained in the field for soil assessment methods. One transect is chosen to assess soils (this is the transect which is placed through an upland to open water area). At any site where there is standing water, its depth is measured, but soils are not assessed. Using the sharpshooter, an 18 inch hole is dug at each assessable site. At six (6) and twelve (12) inch depths, the color, presence/absence of mottles, and the presence of a sulfur smell is assessed. Following this, the next site is assessed. When the complete transect is complete to this point, the first site is then assessed for the depth of any water that has collected in the bottom of the hole as well as the depth from the ground surface to the top of the water, then the hole is to be filled. Conducting this observation after completing the transect allows for any water to accumulate in the bottom of the hole.

hydrology - This parameter is assessed utilizing a crest/staff gauge and a groundwater sampler (similar to a shallow well). These instruments are constructed and installed by the volunteers, with OWRB staff present to assure their proper construction and installation. Measurements on the staff/crest gauge are made utilizing the increments marked on the PVC pipe by the volunteers. To measure the crest, a dowel rod is placed in the pipe with ground up cork. The cork will adhere to the rod at the water's crest. To assess the groundwater level, a 24 inch piece of PVC pipe is placed in a 21 inch deep hole. The bottom three inches are filled with pea-size gravel to allow for filtration, then the four (4) inch diameter pipe is placed vertically in the hole. Soil is replaced and the pipe is loosely capped. To measure the groundwater level, the following equation is used:

sampler depth (stays the same = 24 inches)
- distance from pipe top to water
groundwater depth

Monitors are required to be able to read the measurements on the staff/crest gauge, as well as calculate the groundwater level during the annual QCA session.

B2 Sampling Methods Requirements

Sampling at each site will take place approximately twelve (12) times a year, every month or every six (6) weeks, by each monitoring group. These data are submitted to the OWRB using the data collection sheets and will be entered into a database from which reports will be generated.

The WHAM Volunteer Monitoring Addendum (Appendix 4) and OWW Volunteer Monitoring Handbook (Appendix 1) contain detailed information on all sampling protocols and equipment, including those regarding collecting, analyzing and disposing of chemicals. All analyses will be performed at the time the sample is collected unless the sample is "fixed" in the field, which allows the monitors to conduct water quality tests in the laboratory.

Volunteer monitors will collect pH and nutrient water samples directly in the wetland's open water using a 500mL plastic bottle provided in their kit by the OWRB. Water samples used to analyze dissolved oxygen (DO) are also collected in situ, but utilize the designated glass bottles in the LaMotte kit rather than the plastic container. Monitors are instructed on the proper procedures to collect an uncontaminated sample. It is essential that monitors collect a sample properly so as not to bias the sample analyses (i.e., introducing oxygen, sediment, or algae into the water sample). The site where samples are collected is indicated on the master wetland sketch.

All samples collected for further analysis by a lab will have a Chain of Custody and Sample Analysis Request form submitted with the samples when they are delivered to the appropriate laboratory for analysis. This will only occur in the event of erroneous data or if equipment failed during analysis.

Field observations are documented in the field and recorded on the field data collection sheets (also see section B1 Sampling and Process Design). Photographs (i.e., disposable camera) are submitted with the data sheets within two (2) weeks after a monitoring visit has occurred.

B3 Sample Handling and Custody Requirements

All observations are made in the field which requires monitors to submit only the data sheets. Disposable cameras used for photographic documentation are submitted with data sheets and are to be developed by the OWRB.

Water quality data are gathered by the monitors using the testing protocol outlined in the OWW Volunteer Monitoring Handbook. Because of the pilot status of this program, all water quality data are accepted without further analysis. This may be modified when baseline water quality standards are developed for all of Oklahoma's wetlands.

It is required that all nutrient sample water and DO samples are placed on ice and kept out of the light if it is expected that these tests will not be conducted at the time of collection. Chlorophyll a samples are filtered, packed in ice and shipped or delivered in person to the OWRB within 24 hours. They are then ground within two (2) weeks and sent to a laboratory for further analysis.

B4 Analytical Methods and Requirements

The WHAM Volunteer Monitoring Addendum (Appendix 4) outlines all equipment and analytical methods for field parameters. All water quality equipment and analytical methods can be found in the OWW Volunteer Monitor's Handbook (Appendix 1).

B5 Quality Control Requirements

Each monitoring group will be subjected to annual Quality Control Assessment (QCA) sessions, to determine if Data Quality Objectives (DQOs) are met and to refresh volunteer monitors on proper collection and analysis protocols. Once a volunteer monitor has completed all of the prerequisite training requirements, then the volunteer is certified as an OWW and WHAM volunteer monitor. Monitors must successfully "pass" the annual QCA sessions to retain certification. Data is not accepted from monitors who are not certified at the time of sample collection and analysis.

During the annual QCA, monitors will conduct all associated water quality tests with known spike samples. Data collection requires that nutrient tests are conducted with a blank (i.e., conducting tests with deionized or distilled water) prior to conducting tests with sample water. This measures any background "noise" which may appear in the tests. Dissolved oxygen (DO) tests require duplicate samples be tested. Should these results vary by more than 0.6 mg/L, a third DO titration should be conducted.

All non-water quality parameter QC (e.g., photopoints, soils, hydrology) will be conducted in the field during the annual QCA session unless noted otherwise (see section B1 Sampling Process Design and Table 4).

Attendance at the annual QCA session is mandatory. Those volunteers who do not attend will be considered inactive until they attend the next annual QCA session. Those monitors who do not pass the QA/QC quiz (Appendix 6) with an 80% or the QCA activities with the required scores will not be allowed to collect data until they complete a training refresher session and pass both with the required scores. The quiz asks questions related to the importance of the parameters being monitored, the monitoring sequence, and proper monitoring techniques. In the even that a volunteer passes one of the tasks (i.e., either the quiz or the QCA activities), it will be decided by Training Coordinator to the extent at which the volunteer may be allowed to assist his/her monitoring team in the field until both tasks are completed with the required score.

Data sheets are collected and reviewed for completion by each group's Data Manager. Before they are submitted to the OWRB, data sheets must be signed by the appropriate monitors, the Data Manager and copied for the group's records. Upon submission to the OWRB, data sheets are dated and signed by all personnel involved with data entry (refer to B10 - Data Management). These sheets are reviewed by the Data Manager and OWW/WHAM personnel. At this time, any discrepancies (i.e., missing data, illegible entries) will be investigated.

Table 4. QC Requirements for Field Parameters (with Correlating Activities and Passing Qualifications)

Parameter	Activities Assessed	Passing Qualifications
transects	•proper placement (directional) •monitoring site intervals/measurements	completed on initial visit
photopoints	•panoramic photo technique	S/U
	•completion of a photo ID sheet (Append 3G)	100%
vegetation	•proper ID of specimens when given samples	80%
	•correctly ID purple loosestrife from a series	100%
soils	•measure water depth in hole	+/- 0.125 in
	•ID relative/general soil color using color chart	w/in 1 shade
	•ID presence/absence of mottles in soil	S/U
hydrology	•proper construction/installation of each instrument	completed on initial visit
	•proper measurement reading - staff gauge - crest - groundwater	+/- 1 in +/- 1 in +/- 0.125 in
wildlife/amphibians	•proper ID of wetland wildlife	70%
	•ID bullfrog from a series of photos	100%
	•ID bullfrog from a series of frog/toad calls	100%

B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Proper handling of chemicals, maintenance of equipment, and execution of procedures in the proper sequence will not only produce better quality data, but will ensure smooth operation of the Volunteer Monitoring program. Stockpiling reagents is highly discouraged. Chemicals can deteriorate with time and cause a marked decrease in the quality of data. All reagents must be stored in a room temperature environment at all times. As part of the instrument and equipment maintenance, monitoring equipment, monitoring kits, and reagents will be visually inspected during the QCA session and/or during the retraining of an established group (i.e., a new school group of students at the beginning of a new year). Replacement of reagents will be issued if problems are found or reagents have expired.

An inventory of replacement equipment and supplies, including glassware, color comparators, caps, droppers, reagents, buckets, brushes, and thermometers is maintained by OWW/WHAM staff. When chemicals, reagents, replacement parts, supplies, and/or kits are needed, the chapter's Equipment Manager or Group Coordinator should fill out a Supply Request Form listing the items needed and mail or fax this form to the OWRB and it will be filled in a timely manner.

Field equipment is to be respected and maintained by the monitors. Faulty, broken, and worn equipment is to be reported to the OWRB using the Equipment Repair Sheet (Appendix 8). Equipment should be inspected prior to use each time the monitors go into the field and during the post monitoring maintenance and storage phase of each monitoring visit.

Instruments such as the staff gauge and groundwater sampler are to be maintained in the field and will be inspected for proper installation by OWRB personnel. This equipment will also be checked during the annual field QCA. Monitors should report any defects to OWW/WHAM staff immediately.

B7 Instrument Calibration and Frequency

Instruments such as the staff gauge and groundwater sampler are to be maintained in the field and will be inspected for proper installation by OWRB personnel. This equipment will also be checked during the annual field QCA session.. Measurement markings on the instruments should be checked during each monitoring session to prevent fading or wear. The field tape measure will also be checked annually for scratched or faded readings.

Additional maintenance of the hydrology equipment is recommended by the Izaak Walton League of America's Handbook for Wetlands Conservation and Sustainability Manual (1998), from which this methodology was borrowed. Re-installation may be required if excessive sedimentation or damage to the equipment has occurred. At this time, OWRB personnel must be in the field to ensure the QC portion of the hydrology parameter related to construction and installation of hydrology equipment.

B8 Inspection/Acceptance Requirements for Supplies and Consumables

All monitors are responsible for checking equipment for its proper functioning prior to use. Monitors are required to use the Equipment Repair Sheet (Appendix 8) for all field equipment in need of repair or replacement.

Monitors are instructed to check their monitoring kit for broken glassware and expired reagents prior to a monitoring visit in order to give adequate time to replace supplies. It is also stressed that no data are better than bad data, so when a monitor is doubtful of the reliability of a piece of equipment, they are to report it to the OWRB for replacement.

All equipment is inspected during annual QCA sessions, upon request of a monitoring group, or if problems in equipment usage or life expectancy are a question.

B9 Data Acquisition Requirements (Non-direct Measurements)

At this time, it is not expected that any data will come from outside sources, though supplemental environmental data (i.e., weather and precipitation) may be obtained through local news reports or from the Oklahoma MESONET.

B10 Data Management

Field Data Collection sheets with all sampling data recorded on them are signed by the monitors before leaving the site. After review for completeness and correctness, the Data Manager or Group Coordinator signs each sheet, makes a copy, and submits originals (as well as the disposable camera when pertinent) to the OWRB. Once received by OWW/WHAM staff, data sheets are reviewed for any obvious errors or omissions, and are entered into a computerized spreadsheet/database for each group. Each staff member involved in review or data entry date stamps and initials each sheet. Originals are stored by year and wetland name for at least five (5) years. Quality Control Assessment sheets for individual monitors, along with calibration records are maintained in an electronic format and originals are retained for at least three (3) years. As a final QC check, data in the spreadsheets are randomly reviewed by the Data Manager for overall correctness by comparing the electronic entry to the original data sheet. When generating reports or conducting other types of data manipulation, a second file will be created in order to maintain the integrity of the database.

ASSESSMENT/OVERSIGHT

C1 Assessments and Response Actions

Quality Control Assessments will be conducted annually for each group participating in the WHAM program. All monitors are required to attend. Any monitor who fails to attend the annual QCA session will be classified as inactive and may not submit data until all QC requirements are complete. Impressing the importance of QCA attendance upon monitors is the responsibility of the OWW/WHAM staff, chapter Group Coordinators, and the chapter QA Officers. During QCA sessions, the OWW/WHAM staff member(s) will evaluate sampling collection and testing performance techniques of each monitor. If for any reason QCA data warrants investigation, again, it is the responsibility of the QCA Coordinator and the individual Group Coordinators to identify the cause of the anomaly and correct procedural problems. Monitors having difficulties will be retrained on site during the evaluation.

In addition to this QCA, each monitoring group will receive an annual field inspection. During this inspection, the evaluation of performance of field equipment (i.e., groundwater sampler and staff/crest gauge) will consist of assessing its precision and accuracy as described elsewhere in this document (see Table 2: Hydrology Data DQOs). Also, this inspection will assess the impact being placed on the wetland by regular visits by monitors, and QCA of the monitors in regards to field monitoring observations. In addition, a short quiz is given in the lab to assess the general knowledge of the monitors regarding general safety and guidelines for field visits.

Chapter Data Managers (or Group Coordinator) review the data for correctness and completeness and will consult with the monitor about any reporting or procedural problems (i.e., sampling time frames, sample depth, abnormally high or low values, etc.). If problems cannot be solved within the chapter, OWW/WHAM staff will conduct a retraining event to correct these problems.

In the event that monitors record harmful values for any water quality parameter, the appropriate professionals will be contacted by OWW/WHAM staff.

C2 Reports to Management

All Water Quality Division semi annual progress reports, submitted to Region 6 EPA, will include a progress report from OWW/WHAM to inform regional staff on the status of WHAM. Results of recent performance evaluations/quality control assessments, significant quality assurance problems, and recommended solutions will be reported to EPA, Water Quality Programs Division Chief, OWRB QA Officer, and the appropriate

Project Leader as required. Reports will be in compliance with both OWW, WHAM, EPA and OWRB formats and shall be submitted either electronically or as hard copy.

Reports based on the data collected at Quality Control Assessments will be available three (3) months after the session(s) occurrence. These reports, mostly graphic in nature, will outline the reviewed groups' activities based on their performance.

In the future, individual Chapter Officers will be asked to submit semi-annual progress reports detailing any potential problems and corrective actions taken by the chapter and OWW/WHAM staff.

Annual reports will also be prepared by OWW/WHAM staff to be distributed to the volunteer monitoring groups.

DATA VALIDATION AND USABILITY

D1 Data Review, Validation, and Verification Requirements

All WHAM data is reviewed by each OWW/WHAM Chapter's Data Manager and Group Coordinator and by WHAM staff Training Coordinator and Data Manager. In addition, the OWRB QA Officer and the OWW/WHAM Program Coordinator randomly review volunteer data to determine if the data are correct, complete, and meet the objectives set out in the WHAM QAPP.

Upon completion of entry, the resulting electronic database is double-checked for completeness and to confirm that parameter values are matched with the correct stations, depths, etc. Any sample taken according to the methods described in previous sections resulting in reported value will be assumed to be valid data until proven otherwise. For this reason, extreme values will not be treated as an "outlier" and excluded from data analysis. The Program Coordinator is responsible for supervision of data analysis, validation and reporting. Standard statistical values, including means, ranges, standard deviations and coefficients of variation, will be computed for all data from all stations when appropriate. Additional analysis will be designed and implemented by the Program Coordinator to meet the stated data quality objectives.

Gaps in data are expected due to minor changes in the monitoring schedule (Appendix 5). These gaps do not indicate missing monitoring sessions, only changes in the schedule. These gaps will be indicated with a "n/a" in the appropriate data field. Gaps in water quality data may result if a wetland's open water dries up at any time or if the area is inundated, thus making the water quality sampling site inaccessible. Monitors must note either occurrence on their data sheet and the absence of data will not be considered an incomplete data set. In the event of no open water, it is stressed to the volunteer monitors that hydrology data (i.e., groundwater depth and staff/crest gauge height) become substantially more important in assessing their wetland's water regime. In the event of flooding, a staff/crest gauge reading is important if the instrument is safely accessible, and it is understood that the groundwater sampler may be flooded, thus making it inaccessible for a reading.

D3 Reconciliation with Data Quality Objectives

The purpose of this program is to determine the health status of Oklahoma's wetland ecosystems. Therefore, if data trends indicate problems, or observations indicate detrimental impacts (or illegal activities) in wetland, a visit by wetland scientists may be necessary to assess the health, or the proper authorities may need to be contacted (in the case of illegal activities).

If, after implementation of the program, data does not meet DQOs, the following series of actions should be implemented to investigate the problem(s) and remedy the situation:

1. All equipment should be checked for proper functioning, lack of excessive wear, and cleanliness. In addition, all reagents should be checked for freshness.

2. If there are no noticeable problems with the equipment or reagents, the implementation of a QCA session is necessary. This will allow OWW/WHAM staff to reiterate all the pertinent information, or introduce newly acquired information and tips to the volunteers.

3. A field visit by OWRB personnel during the next scheduled monitoring session should be conducted. Unlike a QCA session, the volunteers will not be tested or assessed as to their technique, only observed, and any problems will not be noted on their training record though it may be noted in an reports generated using prior or subsequent data. It is at this time that the OWRB personnel will correct the monitors on the spot should any obvious problems exist. Because field work often requires improvisation due to non-laboratory conditions, this step is used to allow personnel to observe the volunteers as monitoring tasks are conducted and data is collected so any noticeable problems in data acquisition or faulty equipment can be easily rectified.

4. After any of these steps have been performed, data will be thrown out if it is determined that there have been significant breaches in QA/QC. It is believed that no data is better than bad data because it is not desired that collected data be misleading in any way regarding the status of Oklahoma's wetland resources. Therefore, whenever questionable data are generated, they will either be removed from the data set or properly qualified in reports.

APPENDIX F

COMPLETED DATA COLLECTION SHEETS FROM THE THREE SITE VISITS

F1. Initial Visit: Weather and Land Use Data (front)

Oklahoma WHAM

Oklahoma

WHAM

Wetland Health Assessment Monitoring

Weather and Land Use

FIELD DATA COLLECTION SHEET

Please print clearly.

Group ID: [illegible]	Wetland ID: [illegible]
Nearest City: [illegible]	County: [illegible]
Date: [illegible]	Time (24-hour clock): [illegible]
Crossroads/Street Address:	
Group Members: [illegible], David Horn, Cody Yeatts, Glenda Lopes	

POST MONITORING CHECKLIST

*Be sure you have all the data sheets collected and signed, and clean up your equipment kit!

Weather and Land use	Wildlife and Amphibians	Water quality/ Hydrology	Vegetation	Soils	Equipment Collected	Equipment Cleaned	Repairs Noted	Data Sheets Signed
[illegible]	[illegible]							

MONITORING NOTES

F1. (Continued) Initial Visit: Weather and Land Use Data (back)

WEATHER CONDITIONS

Assessed by: Jennifer Lake, [illegible] Wagner, Jimmy Regaldo	Date: [illegible]
	Time (24-hour clock): 10[illegible]

PRESENT WEATHER

- [ ] clear/sunny
- [x] partly cloudy/partly sunny
- [ ] overcast
- [ ] showers (intermittent rain)
- [ ] rain (steady rainfall)
- [ ] storm (heavy rainfall)

TEMPERATURE

[illegible]5 °C

WIND DIRECTION (where the wind is coming from)
(circle the direction)

N NE E SE S SW W NW (circled: NW)

NOTES

ASSESSING SURROUNDING LAND USE

Assessed by:	Date:
	Time (24-hour clock):

HUMAN IMPACTS (LAND USES)

- [ ] undisturbed natural vegetation
- [ ] residential housing
- [ ] construction site
- [x] agriculture, grazing, crop cultivation
- [ ] commercial development (e.g., offices)
- [ ] industrial development
- [ ] railroads
- [ ] sewage treatment
- [ ] park, recreation area
- [ ] oil, gas drilling
- [x] open fields

NOTES

[illegible] around [illegible] [illegible] the pasture land is across the fence.

SIGNS OF DEGRADATION

- [ ] dumping (soil, gravel, vegetation)
- [x] dumping (man-made materials/trash) — bucket, [illegible], boards, [illegible], carpet
- [ ] grading (topsoil removal)
- [ ] draining (water out of the wetland)
- [x] draining (into the wetland – look for pipes from parking lots or industrial-type buildings)
- [ ] water channeling (look for trenches or ditches)
- [ ] All Terrain Vehicle (ATV)/miscellaneous tire tracks)
- [ ] livestock usage (look for prints)
- [ ] silt, sandy or gravel deposits (NOT dumping, but from erosion, runoff, etc.)
- [x] stream bank erosion
- [ ] dredging (soil removal or channel digging)

NOTES

[illegible] pipes are draining into the wetland

Oklahoma

Oklahoma WHAM

Wildlife and Amphibian

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

WILDLIFE AND AMPHIBIAN OBSERVATIONS

Assessed by:	Date: 2/19/00
Megan Sprouls	Time (24-hour clock): 0900–1000

NOTES

rabbit scat
[illegible] hut
raccoon scat
Muskrat
[illegible] tracks
raccoon tracks
nest
[illegible] skunk
[illegible] little brown running bird
[illegible] pattern in track

EVIDENCE OF WILDLIFE

- ☐ skins
- ☒ feathers
- ☒ tracks/prints
- ☒ shells
- ☒ dead animals (note these as dead under *ANIMALS SEEN*)
- ☒ burrows
- ☒ feeding evidence (fur, bones, feathers strewn about)

Wildlife name	Quantity	Dead/Alive
great blue heron	1	Alive
toad/[illegible] 𝍸	[illegible]	Alive
geese		A
[illegible] hawk	1	D
little brown running bird	1	A
white birds by river	Many	A
minnows/tadpole?	couple	A

F2. (Continued) Wildlife and Amphibian Data (back)

AMPHIBIANS (only monitor in the spring and summer)	NOTES
Did you see any bullfrogs? Yes ☐ No ☐	
Did you hear any bullfrogs? Yes ☐ No ☐	
Did you see or hear any other species of frogs, toads or salamanders? Yes ☒ No ☐	

F3. Initial Visit: Water Quality and Hydrology Data

Oklahoma WHAM

Oklahoma WHAM

Wetland Health Assessment Monitoring

Water Quality & Hydrology

FIELD DATA COLLECTION SHEET

Please print clearly.

WATER QUALITY MEASUREMENTS

*Be sure to refer to the *Oklahoma Water Watch Volunteer Monitoring Handbook* for procedures.
*Be sure to note ALL measurements (including math done for dilutions).

Assessed by: Denae Athay	Date: 2/19/00
	Time (24-hour clock) 1115

Parameter			DI Blank	Measurement
Temperature (°C) 5+5 °C 10°				10°
pH (standard units)			6.5	8.0, 8.0
Dissolved Oxygen (mg/L)		1st titration	—	1.9
	if >0.6 difference	2nd titration	—	2.2
		3rd titration	—	
Ammonia Nitrogen (NH_3) ppm			BDL	BDL
Nitrate Nitrogen (NO_3^-)ppm			~~BDL~~	
Phosphate (PO_4) ppm		9 ÷ 50	BDL	0.18
Chlorophyll a filtered and stored				—

} 2.05 avg

*When you're finished, be sure to fill out the equipment review record (this will also assist you to put your water kits back together correctly.

HYDROLOGY ASSESSMENT

Assessed by:	Date: 02 19. 2000
	Time (24-hour clock): 11 a.m

STAFF GAUGE	GROUNDWATER SAMPLER
Staff measurement _______ M cm (circle the correct measurement)	Subtract measurement from well depth.
	Well depth (stays the same) = 60 cm
Crest measurement _______ M cm (circle the correct measurement)	Distance from pipe top to water = _____ cm
	Groundwater depth = _____ cm

F4. Visit 2: Weather and Land Use Data (front)

Oklahoma WHAM

Oklahoma WHAM

Weather and Land Use

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

Group ID: ESSA	Wetland ID: MERCER
Nearest City: Norman	County: Cleveland County
Date: 03-25-00	Time (24-hour clock): 10:35
Crossroads/Street Address:	
Group Members: Paola Vasquez, Jennifer Lake, Kim Wahnee, Kurt Bey...	

POST MONITORING CHECKLIST

*Be sure you have all the data sheets collected and signed, and clean up your equipment kit!

Weather and Land use	Wildlife and Amphibians	Water quality/ Hydrology	Vegetation	Soils	Equipment Collected	Equipment Cleaned	Repairs Noted	Data Sheets Signed
✓	✓	\	\	\	✓	✓	\	✓

MONITORING NOTES

The water was way up so we could not do hydrology, soils, vegetation, or water quality.

F4. (Continued) Visit 2: Weather and Land Use Data (back)

WEATHER CONDITIONS

Assessed by: [illegible]	Date: [illegible]
	Time (24-hour clock):

PRESENT WEATHER

- [x] clear/sunny
- [ ] partly cloudy/partly sunny
- [ ] overcast
- [ ] showers (intermittent rain)
- [ ] rain (steady rainfall)
- [ ] storm (heavy rainfall)

TEMPERATURE

19 °C

WIND DIRECTION (where the wind is coming from)

(circle the direction)

N NE E SE S SW W (NW)

NOTES

ASSESSING SURROUNDING LAND USE

Assessed by: [illegible]	Date: 3-25-02
	Time (24-hour clock):

HUMAN IMPACTS (LAND USES)

- [ ] undisturbed natural vegetation
- [x] residential housing
- [ ] construction site
- [x] agriculture, grazing, crop cultivation
- [ ] commercial development (e.g., offices)
- [ ] industrial development
- [ ] railroads
- [ ] sewage treatment
- [ ] park, recreation area
- [ ] oil, gas drilling
- [ ] open fields

NOTES

SIGNS OF DEGRADATION

- [ ] dumping (soil, gravel, vegetation)
- [x] dumping (man-made materials/trash)
- [ ] grading (topsoil removal)
- [ ] draining (water out of the wetland)
- [x] draining (into the wetland – look for pipes from parking lots or industrial-type buildings) house pipe
- [ ] water channeling (look for trenches or ditches)
- [ ] All Terrain Vehicle (ATV)/miscellaneous tire tracks)
- [x] livestock usage (look for prints) horse apples
- [ ] silt, sandy or gravel deposits (NOT dumping, but from erosion, runoff, etc.)
- [ ] stream bank erosion
- [ ] dredging (soil removal or channel digging)

NOTES

F5. Visit 2: Wildlife and Amphibian Data (front)

Oklahoma WHAM

Oklahoma WHAM Wildlife & Amphibian

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

WILDLIFE AND AMPHIBIAN OBSERVATIONS

Assessed by: Kim Wallace	Date: 3-24-00 Time (24-hour clock): 10.50

NOTES

Red Wing Blackbirds
Cardinals
Ducks x #2 SE of wetland area

EVIDENCE OF WILDLIFE

- ❑ skins
- ❑ feathers
- ❑ tracks/prints
- ❑ shells
- ❑ dead animals (note these as dead under *ANIMALS SEEN*)
- ❑ burrows
- ❑ feeding evidence (fur, bones, feathers strewn about)

Wildlife name	Quantity	Dead/Alive
Red Wing Blackbirds	many	
Cardinals		
Ducks (SE of wetland area)	many	
Chickadees		
Frogs		
Spiders		

*The wetland was flooded and we could not monitor as we normally would.

F5. (Continued) Visit 2: Wildlife and Amphibian Data (back)

AMPHIBIANS (only monitor in the spring and summer)	NOTES
Did you see any bullfrogs? Yes ☐ No ☒	We saw a frog swimming across the water.
Did you hear any bullfrogs? Yes ☐ No ☒	
Did you see or hear any other species of frogs, toads or salamanders? Yes ☒ No ☐	

F6. Visit 3: Weather and Land Use Data (front)

Oklahoma **Oklahoma** **Weather and Land Use**

WHAM **WHAM**

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

Group ID: ~ESSA	Wetland ID: Mercer Marsh
Nearest City: Norman	County: Cleveland
Date: 4/1/00	Time (24-hour clock): 09 26
Crossroads/Street Address:	
Group Members: David Harn, Cody Yeatts, Italia Gray, Denae Athay	

POST MONITORING CHECKLIST

*Be sure you have all the data sheets collected and signed, and clean up your equipment kit!

Weather and Land use	Wildlife and Amphibians	Water quality/ Hydrology	Vegetation	Soils	Equipment Collected	Equipment Cleaned	Repairs Noted	Data Sheets Signed

MONITORING NOTES

lots of rain

F6. (Continued) Visit 3: Weather and Land Use Data (back)

WEATHER CONDITIONS

Assessed by: David Horn

Date: 4/1/00

Time (24-hour clock): 0926

PRESENT WEATHER

- [ ] clear/sunny
- [ ] partly cloudy/partly sunny
- [ ] overcast
- [ ] showers (intermittent rain)
- [x] rain (steady rainfall)
- [ ] storm (heavy rainfall)

TEMPERATURE

13 °C

WIND DIRECTION (where the wind is coming from)
(circle the direction)

N NE E SE S SW W (NW)

NOTES

lots of rain

ASSESSING SURROUNDING LAND USE

Assessed by: David Horn

Date: 4/1/00

Time (24-hour clock): 0926

HUMAN IMPACTS (LAND USES)

- [x] undisturbed natural vegetation
- [ ] residential housing
- [ ] construction site
- [ ] agriculture, grazing, crop cultivation
- [ ] commercial development (e.g., offices)
- [ ] industrial development
- [ ] railroads
- [ ] sewage treatment
- [ ] park, recreation area
- [ ] oil, gas drilling
- [x] open fields

NOTES

SIGNS OF DEGRADATION

- [ ] dumping (soil, gravel, vegetation)
- [ ] dumping (man-made materials/trash)
- [ ] grading (topsoil removal)
- [ ] draining (water out of the wetland)
- [ ] draining (into the wetland – look for pipes from parking lots or industrial-type buildings)
- [ ] water channeling (look for trenches or ditches)
- [ ] All Terrain Vehicle (ATV)/miscellaneous tire tracks)
- [ ] livestock usage (look for prints)
- [ ] silt, sandy or gravel deposits (NOT dumping, but from erosion, runoff, etc.)
- [ ] stream bank erosion
- [ ] dredging (soil removal or channel digging)

NOTES

F7. Visit 3: Wildlife and Amphibian Data (front)

Oklahoma WHAM

Oklahoma WHAM

Wetland Health Assessment Monitoring

Wildlife & Amphibian

FIELD DATA COLLECTION SHEET

Please print clearly.

WILDLIFE AND AMPHIBIAN OBSERVATIONS

Assessed by: David Horn	Date: 4 [illegible]
	Time (24-hour clock): 0924

NOTES

It was raining alot so the animals were away.

EVIDENCE OF WILDLIFE

- ☐ skins
- ☐ feathers
- ☐ tracks/prints
- ☐ shells
- ☐ dead animals (note these as dead under *ANIMALS SEEN*)
- ☐ burrows
- ☐ feeding evidence (fur, bones, feathers strewn about)

Wildlife name	Quantity	Dead/Alive
Geese (Canada)	2	Alive

F7. (Continued) Visit 3: Wildlife and Amphibian Data (back)

AMPHIBIANS (only monitor in the spring and summer)	NOTES
Did you see any bullfrogs? Yes ☐ No ☑	It was raining and I
Did you hear any bullfrogs? Yes ☐ No ☑	didn't go down there
Did you see or hear any other species of frogs, toads or salamanders? Yes ☐ No ☑	

F8. Visit 3: Water Quality and Hydrology Data

Oklahoma WHAM

Oklahoma WHAM

Water Quality & Hydrology

Wetland Health Assessment Monitoring

FIELD DATA COLLECTION SHEET

Please print clearly.

WATER QUALITY MEASUREMENTS

*Be sure to refer to the ***Oklahoma Water Watch Volunteer Monitoring Handbook*** for procedures.

*Be sure to note ALL measurements (including math done for dilutions).

Assessed by: David Ham	Date: 4/1/00
	Time (24-hour clock) 0930 –

Parameter		DI Blank	Measurement	
Temperature (°C)		X	12.0	0930
pH (standard units)			7.75	1030
Dissolved Oxygen (mg/L)	1st titration		4.4	1030
if >0.6 difference	2nd titration		4.8	1030
	3rd titration			
Ammonia Nitrogen (NH_3) ppm		BDL	BDL	1030
Nitrate Nitrogen (NO_3^-)ppm		BDL	BDL	1030
Phosphate (PO_4) ppm			12.5 – .25	
Chlorophyll *a* filtered and stored			100ml	1030

*When you're finished, be sure to fill out the equipment review record (this will also assist you to put your water kits back together correctly.

HYDROLOGY ASSESSMENT

Assessed by:	Date:
	Time (24-hour clock):

STAFF GAUGE	GROUNDWATER SAMPLER
	Subtract measurement from well depth.
Staff measurement _______ M cm (circle the correct measurement)	Well depth (stays the same) = 60 cm
Crest measurement _______ M cm (circle the correct measurement)	Distance from pipe top to water = _____ cm
	Groundwater depth = _____ cm

APPENDIX G

PHOTOPOINT THREE DOCUMENTING VISUAL CHANGES RESULTING FROM THE FLOODING DISTURBANCE

NAME AND ADDRESS	DATE