Methods for Monitoring Physical, Chemical, and Biological Characteristics at Selected Wetlands in the Platte River Basin, Nebraska

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Abstract

Methods were developed to collect representative physical, chemical, and biological samples at 31 wetlands in the Platte River Basin from North Platte, downstream to the confluence with the Missouri River near Omaha, Nebraska, during May and August 1994. Transects were referenced with global positioning systems equipment and marked with iron pins. Ten equidistant points along the transect designated locations where samples were collected and composited. Water depth and air and water temperatures were measured and water-column samples were collected at each of these points, whereas bed material was collected at alternate points. A polytetra-fluoroethylene well bailer was used effectively for collecting undisturbed water-column samples as shallow as 2 cm. Wetland water columns consisting of standing water less than 2 cm deep were sampled with a polyethylene syringe and inlet tubing. Water-column samples were analyzed for nutrients, major ions, phytoplankton community composition, chlorophyll-*a*, and triazine herbicides; samples collected in August included analysis for trace elements at sites where tissue samples were collected for trace-element analyses. Dragonfly nymphs (*Genus Anax*) were collected for bioconcentrated trace-element analyses by sieving bed sediment and organic material though a fiberglass screen attached to a wooden frame. Bed-material samples were analyzed for triazine herbicides in May and for trace elements in August. The U.S. Geological Survey BMH-53 bed-material sampler was used to collect nutrient and herbicide samples in the substrate, and a polytetrafluoroethylene pipe was used to collect cores for trace-element analysis. A polytetrafluoroethylene or plastic spoon was used where dense organic matter in the substrate prohibited the use of other samplers. Qualitative macroinvertebrate and algae samples were collected from undisturbed areas near each transect. Vegetation was described at 1m intervals along two parallel plant transects one to two meters on either side of each water and bed-sediment sampling line.

Keywords: Wetlands, methods, sampling, water quality, pesticides, triazine herbicides, trace elements, tissue.

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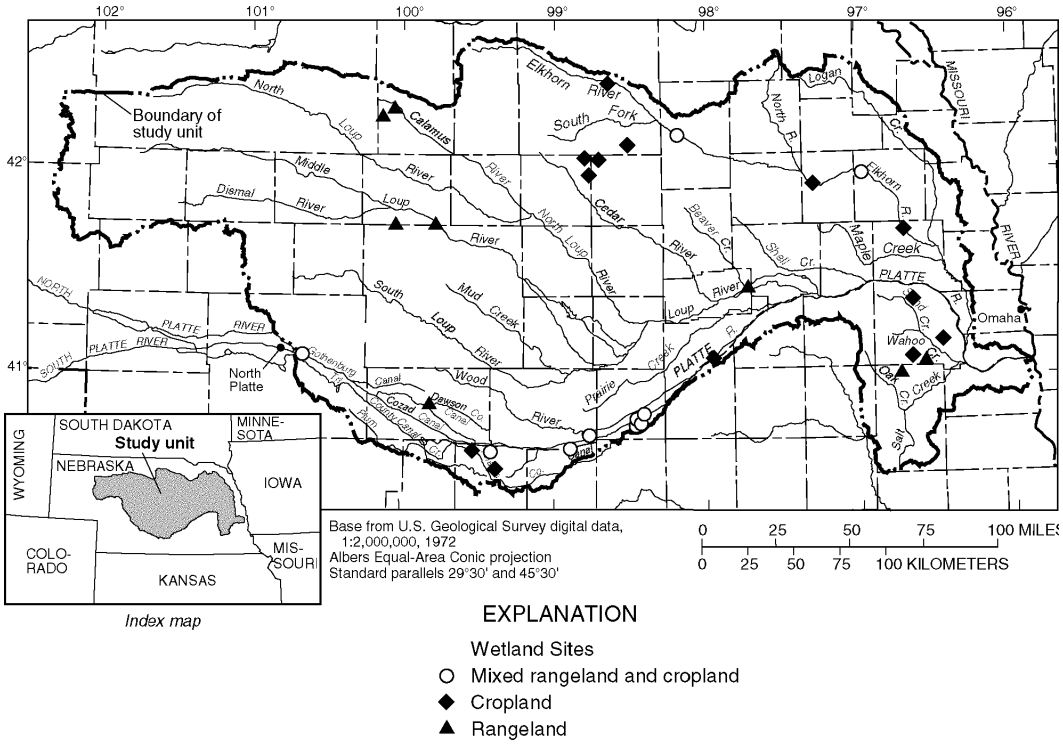

Figure 1. Location of the Central Nebraska Basins study unit and 31 wetland sites sampled in May and August of 1994.

Introduction

The National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS) is a focused attempt to evaluate water quality on local, regional, and national scales through multiple lines (physical, chemical, and biological) of converging evidence (Hirsch et al., 1988). Investigations began in the Central Nebraska River Basins (Figure 1) study unit in 1991. The study unit comprises nearly 78,000 km^2 in the Platte River Basin from North Platte downstream to the confluence with the Missouri River near Omaha and encompasses a variety of geographic characteristics and land use. The Sandhills, Platte Valley, Loess Hills, and Glacial Till are geographic subunits where land use is primarily agricultural, varying from mostly rangeland in the Sandhills to predominantly cropland in the eastern Glacial Till subunit (Huntzinger and Ellis, 1993).

NAWQA study units have a responsibility, beyond their required research topics, to address locally significant water-quality issues (Leahy et al., 1993). The Central Nebraska Basins study unit lies entirely within the Central Flyway migratory route, and its network of rivers and wetlands provides staging and nesting areas for migratory birds. Thirty-one wetlands were studied to initiate a long-term monitoring network within the study unit. These (Figure 1) sites represent geographically and morphologically diverse palustrine-emergent wetlands.

Hemond and Benoit (1988) stated the importance of wetland structure and comparative long-term water-quality monitoring. They noted the lack of systematic and practical methods of wetland monitoring. Although the USGS has documented methods for sampling the water column, sediments, and biota of streams and rivers by the NAWQA program (Crawford and Luoma, 1992; Cuffney et al., 1993; Porter et al., 1993; Shelton, 1994; Shelton and Capel, 1994), the specialized sampling techniques and equipment to sample wetlands were not developed.

The purpose of this paper is to describe sampling methods and equipment used in the study of wetlands by researchers of the Central Nebraska Basins study unit. The scope of the paper is limited to 31 permanently submerged wetlands in the Platte River Basin during late spring and summer of 1994.

Sampling Strategy

Eighty-four palustrine-emergent wetlands greater than 0.4 hectare in area were selected from the U.S. Fish and Wildlife Service's National Wetlands Inventory Data (U.S. Fish and Wildlife Service, 1981), and from contacts with private organizations and government natural-resource agencies. A field reconnaissance determined accessibility and permanence of each wetland, because the wetlands would be sampled once in May and once in August after summer drying conditions had affected the wetland. The selection process provided some assurance that these wetlands could be sampled in future years and reduced the number of sites to 31. Wetland types selected included bogs, fens, shallow lakes, lotic wetlands, and manmade wetlands with varying degrees of human impact, with the intention of describing morphologic and geographic variability.

Latitudes and longitudes of the sites were determined using global-positioning-system equipment, recorded, and plotted on USGS 1:24,000, 7.5 minute, quadrangle topographic maps. Sampling transects were defined at each site that optimized the number of habitats included,and ranged in length from 30 to 100 m, depending on the size of the wetland (Figure 2). Transects intentionally included open water areas, shaded areas, and areas of emergent aquatic growth. The terminal points of each transect were monumented with iron pins, photo documented, and the transect azimuth referenced to magnetic north.

Sampling points along the transect were referenced to a measuring tape attached to the terminal pins. The tape was stretched between the terminal pins by giving wide berth to the areas to be sampled and by approaching from the downwind side to avoid drifting disturbed bottom sediments into the sampling area. Sample collection along the transects was completed in the following order to reduce disturbance of the water column during sampling: (1) water-column chemical and phytoplankton samples, (2) bed samples, and (3) plant-community survey.

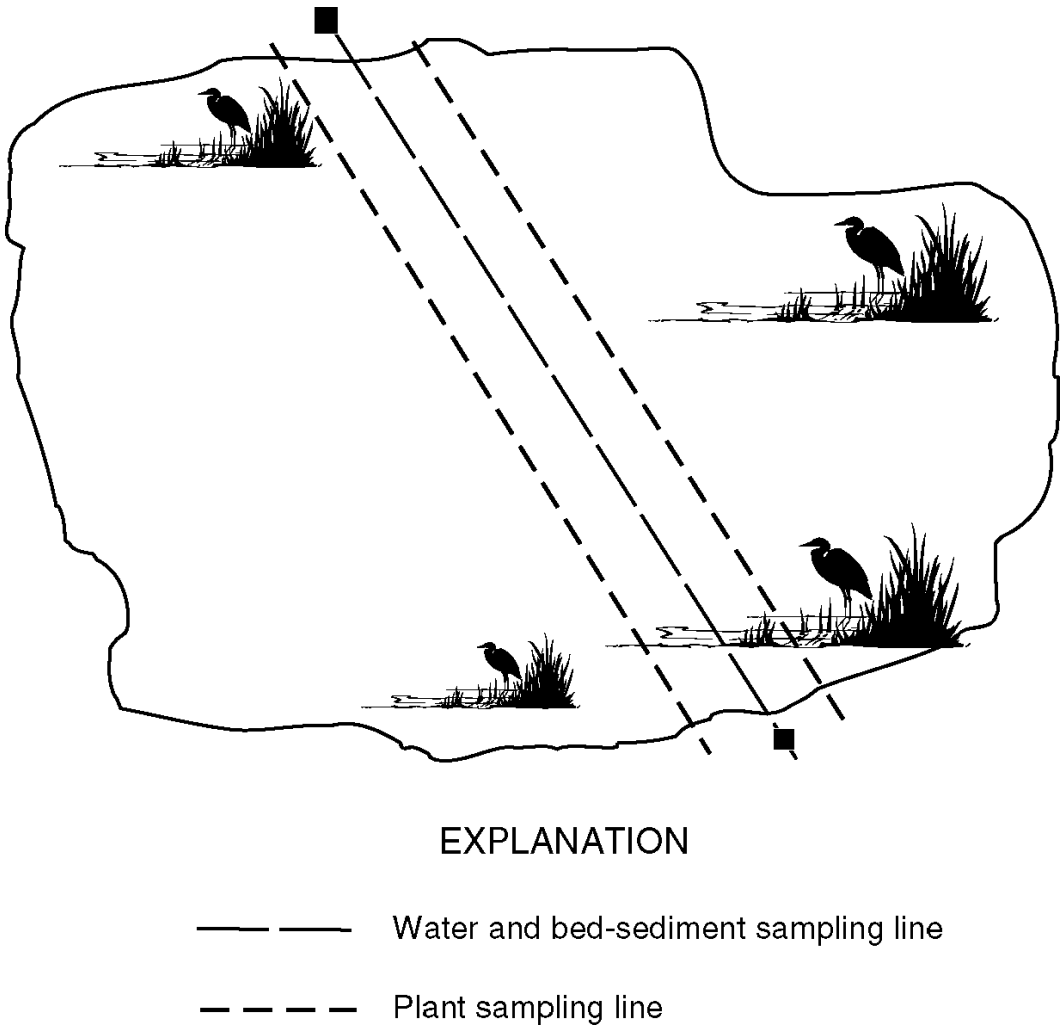

Figure 2. Schematic wetland transect showing water-, bed-sediment, and plant sampling lines.

Qualitative invertebrate and algal samples were collected from undisturbed areas next to the transect. A listing of physical and chemical field parameters and types of samples collected is presented in Table 1.

Water-Column Methods

All water-quality-sampling equipment was cleaned before sampling using NAWQA guidelines as described by Shelton (1994). Water-quality field parameters, water depth, and air and water temperatures were measured at 10 equidistant points along the transect and noted. Approximately 400 mL of water were collected at each point and composited over the entire transect. Water-column samples were collected with a polytetrafluoroethylene well bailer (Figure 3A). The bailer featured a ball-check valve at the bottom, which allowed the bailer to be carefully inserted into the water column, either vertically or at an angle in shallow water, and withdrawn, capturing the water sample. The samples from individual

Table 1. Measured parameters and types of samples collected at selected wetland sites in the Central Nebraska Basins study unit in May and August 1994.

Measured parameter or type of sample	May 1994	August 1994
Physical characteristics		
Latitude/Longitude (GPS)	X	X
Transect Station, Water Depth, and Turbidity	X	X
Air and Water Temperature	X	X
Water-quality field parameters		
Specific Conductance, pH, and Alkalinity	X	X
Dissolved Oxygen	X	
Water-column chemical analysis		
Nutrients, Major Ions, Chlorophyll-a, and Triazine Herbicides	X	X
Trace Elements		X
Bed sediment chemical analysis		
Nutrients	X	
Triazine Herbicides	X	
Trace Elements		X
Tissue chemical analysis (Odonate nymphs)		
Trace Elements		X
Community composition		
Invertebrates, Algae, Phytoplankton, and Plants	X	X

points then were poured into a glass or polytetrafluoroethylene compositing container. The device efficiently collected an entire column of water in depths ranging from 2 cm to 1.5 m without disturbing sediments and organic debris. Where the depth was less than 2 cm deep, water-column samples were collected through a 0.25 m section of polyethylene tubing and a 60-cm^3 polyethylene syringe.

Water-column samples were analyzed for nutrient species, major ions, chlorophyll-a, and triazine herbicides in May and August at all sites and for trace elements at eight sites in August. Trace-element analyses of tissue were performed at sites

Figure 3A. Special equipment used for sampling water, bed sediment, and tissue at wetlands. Polytetrafluorethylene well bailer.

Figure 3B. Special equipment used for sampling water, bed sediment, and tissue at wetlands. Polytetrafluorethylene bed coring pipe.

where sufficient dragonfly nymphs could be harvested for a tissue sample. All sample processing occurred onsite following NAWQA low-level (parts per billion) constituent protocol. Dissolved constituents were filtered through disposable 0.45 µm capsule filters. Chlorophyll-a was processed by filtering measured volumes of water through a 0.7 µm glass-fiber filter as described by Porter and others (1993). Processing samples for the analysis of triazine herbicides was accomplished by filtering water through a baked (450° C for 1 hour) 0.7 µm glass-fiber filter using a polytetrafluoroethylene pumping system.

An equipment blank for all constituents was collected at the beginning, middle, and end of each of the two sampling trips. Two replicate samples of all constituents and eight reference samples for triazine herbicides, during each sampling trip, provided additional quality assurance of the data set.

Figure 3C. Special equipment used for sampling water, bed sediment, and tissue at wetlands. Odonate nymph harvesting sieve.

Chlorophyll-a samples were analyzed by the staff of the Department of Limnology, University of Nebraska, Lincoln, Nebraska. The USGS laboratory in Lawrence, Kansas, analyzed the triazine herbicide samples. All other water samples were analyzed at the USGS National Water-Quality Laboratory (NWQL) in Arvada, Colorado.

Bed-Sediment Methods

Shelton and Capel (1994) provided protocol guidance for cleaning bed sampling equipment before sampling and processing bed-sediment samples. Bed samplers other than those recommended by Shelton and Capel (1994) were selected to facilitate coring into the dense organic matter found in the bed. A USGS BMH-53 bed-material sampler was used to collect cores for the analysis of nutrients and triazine herbicides in bed sediments during the May sampling trip. A 1-m-long by

7.62-cm (inside-diameter) polytetrafluoroethylene pipe provided bed cores for trace element analysis, during the August sampling trip (Figure 3B). The pipe had a machined bevel on one end for penetration into the bed and a stopper on the opposite end. The pipe was lowered to the bed, beveled end down, and the stopper securely in place, thereby preventing almost all the water from entering the pipe. The stopper was released after the pipe was seated into the sediment. The pipe was pushed to a depth of about 4 cm, stopper replaced, and the core removed from the bed. A polytetrafluoroethylene or plastic spoon was used where dense organic matter in the substrate prohibited the use of other samplers.

Cores were collected at alternating points (5 points) along the transect with the top 2 cm of each core retained, composited into a glass bowl, and thoroughly mixed. Nutrient and triazine-herbicide bed samples were processed through a 2-mm stainless-steel sieve, and trace-element bed samples were processed through a 63-μm nylon mesh. Triazine-herbicide bed samples were analyzed by the USGS laboratory in Lawrence, Kansas, and the nutrient and trace-element bed samples were analyzed at the USGS NWQL. Two replicate samples were collected during each trip for quality assurance.

Biological Sampling Methods

Qualitative multihabitat algal and invertebrate samples were collected at each site using standard NAWQA methods and maintaining equal work effort between sites (Cuffney et al., 1993; Porter et al., 1993). Algal samples were collected from all available habitats with forceps, hand picking, bulb syringe, scraping, and squeezing. Cheal et al. (1993) showed that invertebrate samples collected by sweeping with a D-frame kick net equipped with a 210-μm mesh net maximized species richness when compared with other collection methods. All invertebrate samples were collected with the D-frame kick net, supplemented by hand picking, and processed and preserved onsite. Algal samples were preserved with 3 to 5 % buffered formalin and shipped to the Academy of Natural Sciences of Philadelphia for identification. Invertebrate samples were preserved with 10 % buffered formalin and shipped to the USGS NWQL for identification.

Tissue samples were collected during the August sampling trip if preliminary results of the qualitative invertebrate sampling effort demonstrated the existence of dragonfly nymphs (Genus Anax) in sufficient numbers to harvest a tissue sample. Dragonfies were selected because of their relatively long-term association with or near bed sediments, predatory nature, and large mass (Martin et al., 1990). Fiberglass window screening was stretched over a 0.5 by 0.75-m wooden frame to form a sieve capable of removing large amounts of sediment and fine organic material from the sample (Figure 3C). Typically, D-frame kick-net sweeps of bottom and near-bottom material would be deposited in the frame and wet sieved by gentle agitation in native water. Trace-element-tissue samples analyzed by the

USGS NWQL require a minimum of 10 g material, dry weight. The collected nymphs were chilled in native water for a 24-hour depuration period, rinsed in deionized water, weighed, and frozen on dry ice before shipment to the laboratory.

A semiquantitative measure of aquatic plant community composition and density was collected through the point-intercept (or point-quadrat) method documented by Mueller-Dombois and Ellenberg (1974). Plants were identified at 1-meter intervals along sampling lines laid out 1 to 2 meters on either side of the water and bed-sediment sampling line (Figure 2). Plant specimens were pressed and dried onsite for further investigation if onsite identification was not possible.

Summary

Methods were developed for multidisciplinary sampling of physical, chemical, and biological characteristics of 31 wetlands in central Nebraska. Equipment and techniques for sampling water, bed sediments, tissues, and biological community composition are described for long-term monitoring of wetland quality. The U.S. Geological Survey National Water-Quality Assessment Program has established standard methods and techniques for the monitoring of rivers and streams under the Program. Similar standardization of sampling methods for wetland surveys to be comparable on a regional and national scale is needed.

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