Long Term Resource Monitoring Program

Program Report

95-P002-3

Long Term Resource Monitoring Program Procedures:

Vegetation Monitoring

July 1995

Long Term Resource Monitoring Program Procedures: Vegetation Monitoring

by

Sara J. Rogers and Thomas W. Owens
National Biological Service
Environmental Management Technical Center
575 Lester Avenue
Onalaska, Wisconsin 54650

July 1995

The Environmental Management Technical Center issues LTRMP Program Reports to provide Long Term Resource Monitoring Program partners with programmatic documentation, procedures manuals, training manuals, and geospatial applications.

Cover graphic by Mi Ae Lipe-Butterbrodt

The National Biological Service . . . gathering, analyzing, and sharing the biological information necessary to support the wise stewardship of the Nation's natural resources.

Printed on recycled paper

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' (Corps) Environmental Management Program. The original authorization for the LTRMP was for 10 years, starting in 1987. Authorization has since been extended for an additional 5 years (to 2002) by Section 405 of the Water Resources Act of 1990 (Public Law 101-640).

The LTRMP is being implemented by the Environmental Management Technical Center, a National Biological Service Science Center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The Corps provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

Goal 2 of the LTRMP Operating Plan (USFWS 1992) is simply stated: *Monitor Resource Change*. Strategies for monitoring resource components are listed under this goal.

This report should be cited as:

Rogers, S. J., and T. W. Owens. 1995. Long Term Resource Monitoring Program Procedures: Vegetation monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-3. 10 pp. + Appendixes A-E

Contents

Page

Preface iii

Contents v

Tables vi

Figures vi

1. Monitoring Submersed and Floating-Leaved Vegetation 1
   General Sampling Approach 1
   1.1 Objectives 1
   1.2 Procedures 1
      1.2.1 Transects 1
      1.2.2 Informal Surveys 4
      1.2.3 Abiotic Measurements 4

2. Aerial Photography Interpretation 5
   2.1 Photo Preparation 5
   2.2 Scaling Photos/Minimum Mapping Unit 5
   2.3 Work Area Preparation 6
      2.3.1 Overlay Preparation 6
      2.3.2 Endlap Preparation 6
      2.3.3 Sidelap Preparation 6
   2.4 Field Verification 8
   2.5 Photointerpretation 9

3. References 10

Appendix A A-1
   Long Term Resource Monitoring Program Vegetation Transect Data Sheet . . A-1

Appendix B B-1
   Vegetation Codes B-1

Appendix C C-1
   Long Term Resource Monitoring Program Vegetation
   Informal Survey Collection Sheet C-1

Appendix D D-1

   Photointerpretation Materials List D-1

Appendix E E-1

   Long Term Resource Monitoring Program Vegetation Classification E-1

Tables

Page
Table 1. Density rating for recovered vegetation 2
Table 2. Reliability of identification codes 3

Figures

Page

Figure 1. Side-matching photos - Case A: The left-hand photo is offset above the right-hand photo. Case B: The left-hand photo is offset below the right-hand photo. 7
Figure 2. Sidelap correction 8

1. Monitoring Submersed and Floating-Leaved Vegetation

The Upper Mississippi River System (UMRS) is physically diverse and biologically productive, providing habitat to hundreds of species of plants and animals. Aquatic and terrestrial plant communities provide structure, food, and shelter to a variety of organisms, influence nutrient dynamics and water quality, and stabilize sediments (Sculthorpe 1967; Wetzel 1983). Although aquatic and terrestrial vegetation have important ecological value, there are few long-term studies directed toward understanding spatial and temporal changes or understanding potential factors influencing this important component.

General Sampling Approach

The Long Term Resource Monitoring Program (LTRMP) monitors aquatic vegetation in four navigation pools of the Upper Mississippi River (Pools 4, 8, 13, and 26), and La Grange Pool of the Illinois River. Specific locations and timing of monitoring are directed by the spatial and temporal patterns of the vegetation. For example, aquatic vegetation monitoring is not conducted in the open river reach since this life form is generally lacking. In the other navigation pools, field surveys are conducted during the growing season to assess the distribution and abundance of aquatic vegetation. Selected areas are surveyed twice during the season to document seasonal patterns. Aerial photography is taken annually in the upper reaches where aquatic vegetation is most extensive and less frequently (5-year intervals) in lower reaches where agriculture and forests dominate the floodplain. Photographs are interpreted based on extensive field verification and are archived at the Environmental Management Technical Center (EMTC).

1.1 Objectives

The objectives of monitoring floating-leaved and submersed aquatic vegetation in the UMRS are as follows:

a. To document the distribution of these life forms in selected reaches of the UMRS as affected by environmental changes.

b. To compare present distribution of these life forms with past distribution.

c. To identify environmental factors potentially responsible for both long- and short-term changes in the distribution of these life forms.

1.2 Procedures

1.2.1 Transects

a. Locations and spacing. Within trend analysis pools, transects are established in areas currently vegetated with submersed macrophytes. To best document changes in species distribution patterns, transects are systematically arranged (regularly spaced). Sites for selection should include as many vegetated areas within the pool as possible. These areas include various habitat types, such as contiguous and isolated lakes and ponds, channel borders, sloughs, shallow bays, and impoundments.

b. *Number of transects*. The number of transects for each vegetated area is allocated in proportion to plant community heterogeneity and the size of the area. In general, transects are spaced every 50 to 100 m apart. However, in large areas that are fairly uniform in species composition and distribution, transects may be spaced further apart. Before establishing permanent transects, a preliminary reconnaissance of the area to be sampled is necessary.

c. *Arrangement and marking of transects and sites for sampling*. Transects are established perpendicular to shoreline by deploying polypropylene ropes held at each end by an anchored buoy or by marking transect endpoints with stakes along a designated compass bearing. Sampling sites are placed at intervals of about 15 m along the transects, with the first site located 1 m from shore. The length of each transect is determined by the lateral expanse of vegetation. Sampling is terminated at a distance of two sampling sites beyond the last vegetated site (approximately 30 m) or after sampling three sites along presumably nonvegetated transects.

d. *Sampling schedule*. Data on vegetative distribution and abundance are collected by sampling along transects. Sampling is conducted twice during the growing season so that phenological changes can be described. Depending on latitude, the first sampling should be conducted between May 15 and June 15, and the second sampling between July 15 and August 31.

e. *Data collection*. Sites along transects are sampled using a long-handled threshing rake (3 m). At each site along the transect line, a visual approximation of a 2-m circle is used as the sample area. Three grabs with the rake are made within the circle, with each grab sampling within a visualized third section. For each grab, the rake is dropped within a section, twisted 180°, and pulled out of the water. Vegetation is identified to species.

f. *Data reporting*. Transect data are reported on the transect data sheet (Appendix A). Each transect has its own sheet(s). *Location codes* are river miles, to the tenth of a mile. If the *sampling location* does not have a name (e.g., Lawrence Lake), a name that references the geographical location and the habitat type (e.g., west impounded) is used. *Transects* are numbered, beginning with "1" at each location. *Sites* along transects are lettered, beginning with "A" at the first site from shore. For very long transects (with more than 26 sites), sequential lettering is continued with AA, AB, AC, etc. *Veg type* codes, listed at the bottom of the sheet, identify nonvegetated sites and different life forms. See Appendix A for complete instructions for each field.

A density rating for each species is provided in accordance with the criteria in Table 1.

Table 1. Density rating for recovered vegetation

Recovery of species	**Density rating**
Teeth full on all three casts	4 (abundant)
Teeth partly full on all three casts	3 (common)
Taken on two casts	2 (occasional)
Taken on one cast	1 (rare)

g. Vegetation codes and nomenclature. Nomenclature for species identification follows the Fish and Wildlife Service's Annotated National Wetland Plant Species Database (Reed 1988). Species codes in the database are used on the data sheets. For easy reference of the codes while in the field, a list of the codes for the species most likely to be encountered should be created from the database and the sheet laminated and attached to the field clipboard for reference. Submersed and floating-leaved vegetation most likely encountered are listed in Appendix B.

h. Quality assurance codes. When collecting data, the surveyor must identify the species present. However, it is not always possible to identify all plants to the species level if key taxonomic characteristics are lacking because of physical conditions, flowering time, or life-cycle stages. A reliability of identification code is entered on the data sheets to express uncertainty of identification for difficult species. The codes for reliability of identification (Table 2) are numbers that indicate the taxonomic certainty at which the plants have been identified.

Table 2. Reliability of identification codes

Code	Reliability of identification
0	Species identified, variety or subspecies known
1	Species identified, variety or subspecies not distinguished, though may occur
2	Species identification is trivial because of hybridization among several recognized species (e.g., *Rubus* spp.)
3	Genus identified, species identification uncertain
4	Genus identification uncertain, family known
5	Unknown taxon

i. Permanent marking of transects. Approximate locations of transects are marked on base maps. The Global Positioning System is used to record Universal Transverse Mercator (UTM) coordinates for the shoreline edge of each transect. Transects are marked by placing a stake at the shoreline or by placing anchored floats at the transect's shoreline edge so they can be easily relocated. A compass bearing is taken for each transect and is recorded on the data sheet for that transect in the "Comments" section.

j. Collection of voucher specimens. Samples of all species encountered are collected for vouchers. A voucher is collected for each species present in every area with permanent transects. Additional species found in subsequent years are also collected. Plants are placed in plastic bags with water, the bags are cooled on ice, and the specimens are returned to the lab for identification, pressing, and drying. Once dry, specimens are mounted on herbarium paper. They are then labeled and stored at the field station.

1.2.2 Informal Surveys

a. *Survey area and methodology*. In addition to sampling along permanent transects, all other areas within the pool, with the exception of the main channel, are monitored. Observations are made by boating slowly throughout the pool and sampling with the long-handled rake. Areas that traditionally contained wildcelery or other species that do not form a canopy are thoroughly surveyed by sampling with the rake, as the occurrence of these species may not be visually obvious from the surface.

b. *Data reporting*. If vegetation is discovered, the rake is used to gather species for identification and for estimating the relative abundance of each species. Collection of voucher specimens, species nomenclature, and species codes are addressed in 1.2.1, Transects. The size of the aquatic plant bed (width and length in meters) and the percent plant coverage of surface area are estimated. Coverage classes are grouped as following: 1%-20%, 21%-50%, 51%-90%, and ≥91%. UTM coordinates are taken in the center of the bed and are recorded. The predominant substrate is recorded for each location (data sheet, Appendix C).

1.2.3 Abiotic Measurements

a. *Water depth*. Water depth is measured at sites along the transects and at beds found during the informal survey. A rigid pole, marked at 1-cm intervals and terminated with a thin, circular plate 20 cm in diameter, is used for measurements (similar sampling pole as used for water quality). Three depth measurements are taken at each site. The mean water depth is recorded in meters to one decimal place (e.g., 1.5 m).

b. *Nutrient analyses*. For plant tissue nutrient determinations, plants (stem and leaves only; no fruits, flowers, or underground parts) are placed in paper bags and are dried at 72 °F for 24 h (plants are rinsed to remove epiphytic materials and excess water is drained off before bagging). The following information is noted on the bags as well as on a separate data sheet: pool, location code, date, transect and site or UTM coordinates, and sample number. A copy of the data sheet accompanies the tissues to the laboratory. Data sheets are provided for each year nutrient sampling is required.

c. *Sediment cores*. Only the top 10 cm of sediment is collected, using the Wildco sediment corer (Wildlife Supply Co., Saginaw, MI). Water collected with the sediment sample is carefully decanted before bagging the sediment. Sediment samples are placed in 1-qt zip-lock freezer bags labeled with the following information: pool, location code, date, transect and site or UTM coordinates, and sample number. The same information is recorded on a separate data sheet. A copy of the data sheet accompanies the sediment cores to the laboratory.

Note: Plant tissues (for nutrient analysis) and sediment cores are collected at 5-year intervals.

2. Aerial Photography Interpretation

2.1 Photo Preparation

Each field station will receive one set of color-infrared contact prints and one set of transparencies in a canister. The prints are used for indexing, field work, and to create work areas. The transparencies are used for photointerpretation.

Immediately upon receipt of the photos, the contact prints are used to find each photo center (the intersection of imaginary lines extended from the fiducial marks), this point is located on the appropriate 7.5-ft topo quad, and a piece of tape labeled with the flight strip number and exposure number is placed at that point.

While indexing is being performed, the photos are carefully checked for proper endlap (60%) and sidelap (30%), color quality, crab (photos that are askew from the flight line due to side winds), cloud cover, and sufficient *coverage*. Major problems (gaps in coverage, insufficient endlap for stereo viewing, excessive cloud coverage, poor exposure) are immediately reported to the Environmental Management Technical Center (EMTC) cartographer.

Each flight strip is organized into a file folder labeled with the strip number and exposure numbers. All topo quads, along with the filed prints, are placed into an accordion folder which is labeled with photo type, scale, pool, and date. Transparencies are cut into individual frames and put into clear plastic sleeves. The transparencies are organized in the same manner as the prints.

A list of materials necessary to complete the tasks described below is in Appendix D.

2.2 Scaling Photos/Minimum Mapping Unit

Aerial photos are taken at a nominal (or planned) scale, but the actual scale is not exactly the same due to a variety of factors (such as changes in topography, changes in flight, or the aircraft's altitude). It is necessary to determine the actual photo scale to make sure that specifications were met and to make a minimum mapping unit guide (instructions follow).

First, a feature (usually a road) that has two points (such as intersections) which are easily identifiable on both the photo and the corresponding 1:24,000 topo quad is located near the photo center.

Using dividers, the photo distance (PD) and the map distance (MD) of the feature are carefully measured, using the same units. These distances are placed into the following formula:

$$SCALE \quad \frac{PD}{MD} \times MAPSCALE \quad \frac{PD}{MD} \times \frac{1}{24{,}000}$$

The calculated scale should be close to the nominal scale (e.g., a nominal scale of 1:15,000 but an actual scale of 1:15,433). This process is repeated in different areas of the pool to determine scale variability.

Next, the minimum mapping unit guide, which is a small piece of clear plastic with the minimum mapping unit (MMU) drafted on it at the photo scale, is created. (For example, at the scale of 1:15,000, if the MMU is 1 acre, the guide could have a 0.17-inch square and a 0.05- x 0.50-inch rectangle.) This guide will serve as a calibration tool for the interpreter's eye so that polygons smaller than the MMU are not delineated, thus eliminating unnecessary detail.

2.3 Work Area Preparation

2.3.1 Overlay Preparation

First, a clear plastic sheet cut to size (8.8 inches on a side) is secured with tape to each print.

Fiducials and photo numbers are neatly marked on the overlay, using a drafting pen (size 0 or 0.35 mm). If the overlay is shifted or removed, it then can be accurately replaced.

2.3.2 Endlap Preparation

Beginning with the first photo in a flight strip, the study area boundary (SAB) is marked on the photo.

On a light table, the end photo is placed over the next photo in the flight line. Features in the overlap area are lined up on both photos, the halfway point of the overlap is determined, and a line (perpendicular to the flight line) is drawn on the overlay to mark this point.

With the stereoscope at 1.0 magnification, the two photos are set into a stereo model and the line just drawn is located. Several points that appear to lie on this line are marked on the matching photo, and the points are connected with a straight edge, completing the process of creating end-match lines for this stereo pair.

This process is continued until all photos that cover the study area have end-match lines or SABs. End-match lines do not have to be perfectly perpendicular to the flight line; in fact, where two flight lines meet at a bend in the river, the end-match lines will be angled across the photos.

The project boundary is drawn on photos as the work areas are created.

2.3.3 Sidelap Preparation

When all end-match lines are completed, side-match lines are created. The end photos in two adjacent flight lines are located and the SAB is marked on the appropriate photo.

Photos on adjacent flight lines are normally offset from each other, and each photo must be side-matched with two photos in the next flight line. Two cases can occur, as shown in Figure 1.

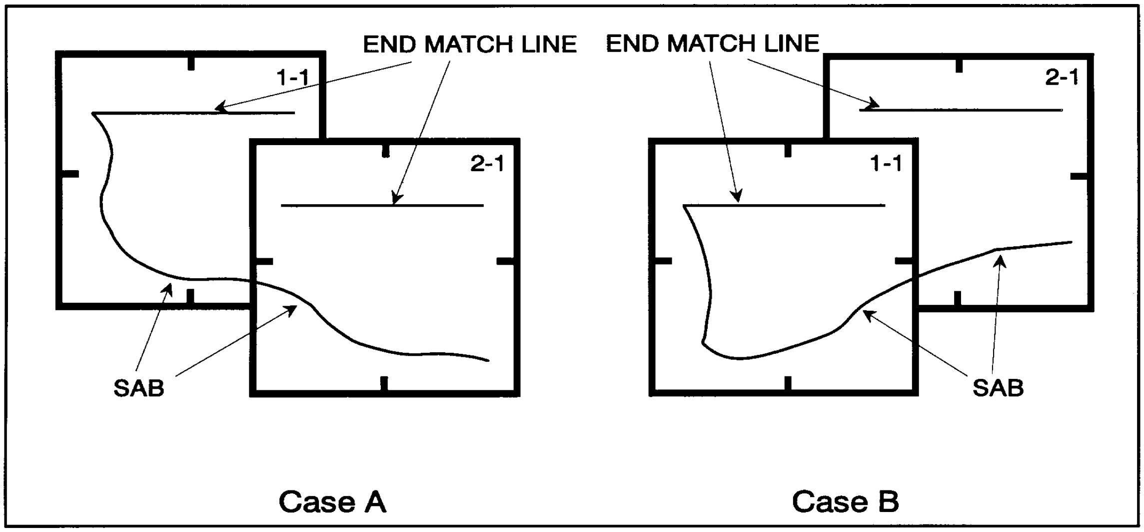

Figure 1. Side-matching photos - Case A: The left-hand photo is offset above the right-hand photo. Case B: The left-hand photo is offset below the right-hand photo.

Creation of the side-match lines will begin differently in each case, but once the process to side-match the flight line is started, the procedure is identical.

On a light table, the photo with the lower SAB is placed over the adjacent photo, and features in the overlap area are lined up on both photos. In Figure 1, case A, the right-hand photo would be on top of the left-hand photo; in case B, the left-hand photo would be on top of the right-hand photo.

Next, the halfway point of the overlap is located, and a line is drawn on the overlay along the side of the photo from where it intersects with the SAB to the intersection with the end-match line.

The two photos are set up into a stereo model and the line just drawn is located. On the matching photo, several points that appear to lie on this line are marked as far as the line appears to go and are then connected with a straight edge. In Figure 1, case A, the right-hand photo will have a closed side and the left-hand photo will have a partially closed side. In case B, the left-hand photo will have a closed side and the right-hand photo will have a partially closed side.

The lower photo is put aside in each case; this photo is completed for the moment. The photo above the photo just set aside is then placed below the remaining photo on the light table (Fig. 2).

After it is determined where the overlap intersects with the upper end-match line on the top photo (the point labeled "half overlap"), a line is drawn from the end of the previously completed side-match line to this point to correct for variation in sidelap up and down the flight lines.

Under the stereoscope, the two photos are set up into a stereo model and the points that appear to lie on the line are marked on the adjacent photo. These points are then connected with a straight edge. The lower photo has a closed edge and is then set aside. The upper photo is completed by repeating the process described.

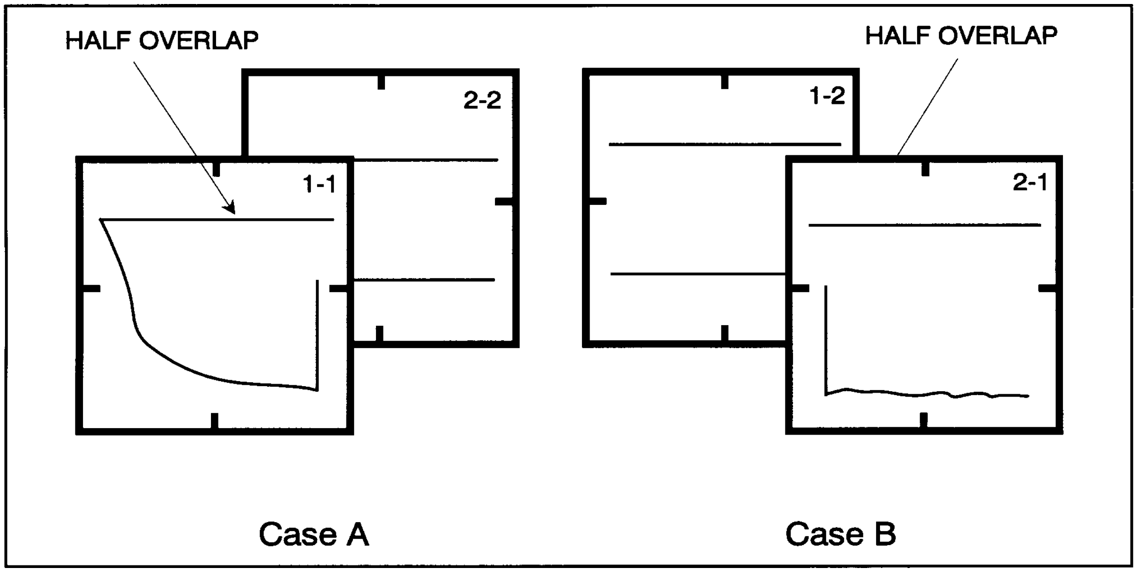

Figure 2. Sidelap correction

During this process, the numbers of adjacent photos are drafted on the margins of all photos so that it will be easy to find these photos when necessary. Progressing up the flight lines, the side-match lines between two adjacent flight lines are determined. When this process is completed, it is repeated for the next two adjacent flight lines. The final products are closed polygons drafted on all overlays that cover the center portion of each photo.

2.4 Field Verification

Field verification is not dependent upon completion of work areas but can be done first. Field work is an ongoing process that will occur before, during, and after photointerpretation and whenever new questions arise.

The photographs are inspected, and questionable areas that are easily accessible by land vehicle, boat, or foot are located. Major signatures (see 2.5) and cover types that are also accessible are noted.

Prints to be field-checked should be placed in clear plastic sleeves for protection and annotation. Sleeves are registered to the prints by marking the fiducials with a fine-tipped permanent marker and writing the photo numbers on the sleeves near the numbers on the photos.

At the field sites, pertinent details about vegetation cover types are noted on the sleeves. These can be brief notes, using abbreviations for different genera. For example, a willow stand could have a lead line drawn to it labeled "SA" for *Salix*. Lead lines are drawn from the stands to the labels (polygons are not drawn around stands). Notes are made only for areas that have been visited or directly observed; extrapolation of signatures should be done in the office under the stereoscope.

Ground photography helps trigger memories when doing photointerpretation. When ground photos are taken, the point from which the picture was taken and the direction are recorded. The frame number is recorded on the sleeve registered to the print.

Field notes are carefully reviewed back in the office to verify that all questions have been answered. Subsequent field work may be necessary as photointerpretation proceeds.

2.5 Photointerpretation

Land cover/use is classified according to the system listed in Appendix E.

Photointerpretation is done using a magnifying stereoscope and a light table. A pair of transparencies is set up as a stereo model under the stereoscope. Interpretation is done on overlays registered to the photo, using a fine-tipped drafting pen (size 0000 or 0.19 mm).

Features are delineated by identifying signatures. The signature is the characteristic appearance of an object on a given type of imagery. Vegetation signatures vary greatly according to time of day, season, type of photography, and scale. Signatures are affected by color/tone, texture, pattern, shape, size, and location. A single factor may not be sufficient to identify an object, but combinations of these factors will lead to proper identification. For example, two vegetation types found in different locations may have the same color and texture; two vegetation types found in the same location may have different colors. It is important to learn the combinations of factors that distinguish one vegetation type from another.

To begin photointerpretation, an area that has been field-checked is selected. The overlay fiducial marks, photo numbers, and work areas are transferred from the print to the transparency. A stereo model is set up under the stereoscope and viewed at 3X magnification.

The entire work area is scanned, and based upon the visual clues of color, shape, size, texture, and pattern, as well as ground information, a determination is made as to how the area will be mapped. Mapping is from the general to the specific. First, large areas that may contain smaller islands of different vegetation are delineated. Then, the smaller areas are delineated, keeping the MMU in mind. Polygons are labeled as soon as they have been delineated.

Delineation and labeling must be done in a neat, legible manner. Lines should be of uniform width and should closely follow the ground features on the photo. Polygons must be closed and labeled.

After each photo is interpreted, all lines and labels are matched with the adjacent photos to ensure that edge ties and labels are accurate and consistent (including side matches).

When interpretation of a photo is completed, a clean sheet of white paper is placed between the overlay and the photo to check for completeness of linework and labeling, as well as for interpretation errors.

A production log is used to track and record completed work. Logs are essential to record completed photos, document problems or concerns, and to track progress.

The following are sent to the EMTC cartographer: (1) completed overlays registered to the transparencies, (2) production logs, and (3) copies of the indexed topo quads to show photo location. The photos are QC'd and if approved, the data are transferred and digitized into a geographic information system (GIS). The GIS data are sent back to field stations when complete.

3. References

Reed, P. B. 1988. National list of plant species that occur in wetlands: North Central (Region 3). U.S. Fish and Wildlife Service, National Ecology Research Center, St. Petersburg, Florida.

Sculthorpe, C. D. 1967. The biology of aquatic vascular plants. Arnold, London. 610 pp.

U.S. Fish and Wildlife Service. 1992. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002. 179 pp. (NTIS #PB94-160199)

Wetzel, R. G. 1983. Limnology. W. B. Saunders, Philadelphia, Pennsylvania. 767 pp.

Appendix A

Long Term Resource Monitoring Program
Vegetation Transect Data Sheet

Vegetation Transect Data Sheet

Long Term Resource Monitoring Program
Environmental Management Technical Center
575 Lester Avenue, Onalaska, WI 54650

Bar Code

Page ☐☐ OF ☐☐

Field Station #

Date: mm dd yy

Location Code:

Predominant Substrate
1 = Silt/Clay
2 = Mostly Silt w/ Sand
3 = Mostly Sand w/ Silt Clay

Identification
F = Field
L = Lab

Transect

Distance Between Sites (m)

Recorder Code:

Total Plants

Unidentified Specimen
U = Unidentified Specimen
Blank = No Unidentified Specimens

Locat. Name:

Site	Depth (m)	Veg. Type	Species	Rating	QF Code	Comments
	.		1 2 3			
	.		4 5 6			
	.		7 8 9			
	.		10 11 12			
	.		13 14 15			
	.		16 17 18			
	.		19 20 21			
	.		22 23 24			
	.		25 26 27			
	.		28 29 30			
	.		31 32 33			
	.		34 35 36			

Data recorded on this form were collected in compliance with current LTRMP procedures and are to the best of my knowledge complete and free of errors.
Crew Leader Signature:

Veg. Type Codes:
NV = No Veg.
FL = Floating Leaf
SB = Submergent
SF = Sub/Floating

EMTC 05/14/95

Long Term Resource Monitoring Program
Vegetation Transect Data Sheet Instructions

A data sheet will be filled out for each transect where samples of vegetation are collected. Some transects may require more than one sheet, depending on the number of sites along its length. The following is a list of data fields on the sheet, and an explanation for each one.

<u>Field</u>	<u>Description</u>
Bar Code	Each sheet requires a bar code sticker. The bar code uniquely identifies each sheet.
Page __ of __	Identify page number in sequence.
Field Station #	This number uniquely identifies each field station: **1 = Lake City** **4 = Havana** **2 = Onalaska** **5 = Alton** **3 = Bellevue** **6 = Open River**
Date	The month, day, and year the transect was sampled. A zero is used when necessary so all boxes are filled.
Location Code	The location of the transect or group of transects to the nearest tenth of a river mile. The box to the right of the decimal is filled in; a zero is used if necessary.
Predominant Substrate	A code number based on the predominant substrate type. The categories are used as follows: **1 is used for substrates that are predominantly silt and/or clay** **2 is used for substrates that are mostly silt but have some sand** **3 is used for substrates that are mostly sand but have some silt or clay**
Identification	An "F" in this box designates that all species listed on the form were identified in the field. An "L" entered on the sheet means that samples of species were collected for lab identification.
Transect	A number identifying a transect at a location. Transect numbers remain the same from year to year.
Distance Between Sites (m)	Distance in meters among sites along a transect. A zero is used when necessary so all boxes are filled.
Recorder Code	This number uniquely identifies the person who coded the data sheet.
Total Plants	A total of the number of entries on the data sheet.

Field	Description
Unidentified Specimen	A "U" is entered on the data sheet if an unknown species is discovered. The box is left blank if all species are identified.
Locat. Name:	The name of the backwater or area where the transect is located (e.g., Peterson Lake).
Site	A site along a transect where vegetation is sampled. The code is a single letter or becomes a two-letter code if a transect has over 26 sites along its length. The codes are alphabetical and begin with "a" for each transect.
Depth (m)	Depth is recorded to the nearest tenth of a meter.
Veg. Type	This code has four options as presented at the bottom of the data sheet and is a way of sorting vegetation types for later analysis. In this instance, *Nelumbo* may be classified as a floating-leaf vegetation type.
Species	The four-, five-, or rarely six-digit alpha or alphanumeric code taken from the Wetland Plants database. The code refers to a standard plant name chosen by the database creators as being the most frequently used by a number of authors.
Rating	A number, 1 through 4, that rates the relative abundance of a species sampled at a site.
QF Code	A number, 0 through 5, used to qualify the field identification of the species collected.
Comments	Area designated for recording any unusual conditions at the sampling location or about the species sampled.
Crew Leader Signature	The crew leader signs the data sheet to certify that the data on the form and the samples were collected in compliance with current LTRMP procedures and are to the best of her/his knowledge complete and free of errors. This signature underscores the importance of LTRMP methods and is an LTRMP chain-of-custody procedure.

Appendix B

Vegetation Codes

Code	Scientific name	Common name
ALGA	Algae	Algae
CEDE4	*Ceratophyllum demersum*	Coontail
CHAR	Chara	Chara
ELCA7	*Elodea canadensis*	Water weed
LEMI3	*Lemna minor*	Duckweed
LETR	*L. trisulca*	Star duckweed
MYSP2	*Myriophyllum spicatum*	Eurasian watermilfoil
MYUS	*Myriophyllum* unidentifed species	Watermilfoil
NAFL	*Najas flexilis*	Bushy pondweed
NAGU	*N. guadalupensis*	Southern naiad
NLPW	*Potamogeton* spp.	Narrow-leaved pondweed
NELU	*Nelumbo lutea*	Lotus
NITE	Nitella	Nitella
NULU	*Nuphar variegatum*	Yellow water lily
NYTU	*N. tuberosa*	White water lily
POCR3	*Potamogeton crispus*	Curly-leaf pondweed
PONO2	*P. nodosus*	Long-leaf pondweed
POPE6	*P. pectinatus*	Sago pondweed
PORI2	*P. richardsonii*	Richardson's pondweed
POZO	*P. zosteriformis*	Flat-stemmed pondweed
SPPO	*Spirodella polyrhiza*	Greater duckweed
UTMA	*Utricularia macrorhiza*	Common bladderwort
VAAM3	*Vallisneria americana*	Wildcelery
WOCO	*Wolffia columbiana*	Watermeal
ZAPA	*Zanichellia palustris*	Horned pondweed
ZODU	*Zosterella dubia*	Water star grass

Appendix C

Long Term Resource Monitoring Program
Vegetation Informal Survey Collection Sheet

Vegetation Informal Survey Collection Sheet

Long Term Resource Monitoring Program
Environmental Management Technical Center
575 Lester Avenue, Onalaska, WI 54650

Bar Code

Field Station #

Date mm dd yy

Identification F = Field L = Lab

Unidentified Specimen U = Unidentified Specimen Blank = No Unidentified Specimens

Total Plants

Recorder Code:

% Veg. Codes
1 = 1%-20%
2= 21%-50%
3= 51%-90%
4= 91%-100%

Predominant Substrate Codes
1 = Silt/Clay
2 = Mostly Silt with Sand
3 = Mostly Sand with Silt Clay

Abundance Codes
1 = Abundant
2= Common
3= Rare

Habitat Classes
MCB SC
TDL BWC
MC BWI
IMP

Location Code	UTM Coord.	PDOP	Depth	Bed Size (m)	Habitat Class	Species	Abundance	QF Code	% Veg.	Predom. Substrate	Site Number	Comments
	E N					1 2 3						
	E N					4 5 6						
	E N					7 8 9						
	E N					10 11 12						
	E N					13 14 15						
	E N					16 17 18						
	E N					19 20 21						

Data recorded on this form were collected in compliance with current LTRMP procedures and are to the best of my knowledge complete and free of errors.

Crew Leader Signature:

Comments

EMTC 03/24/95

Long Term Resource Monitoring Program
Informal Survey Collection Sheet Instructions

Data fields not covered under the Vegetation Transect Data Sheet are listed below.

Field	Description
UTM Coordinates	The Universal Transverse Mercator (UTM) given in meters (m) is a coordinate taken with a Magellan. (Informal data sheet only.)
PDOP	PDOP is a measurement of possible error related to the geometry of the satellites. This number value will be recorded from the Magellan reading (informal data sheet only).
Bed Size (m)	An estimate of the width and length of a vegetation bed discovered during the informal survey. Recorded in meters.
Habitat Class	Codes for habitat classes are listed on the data sheet and include: **MCB = Main Channel Border** **TDL = Tributary Delta Lake (Lake Pepin)** **MC = Main Channel** **IMP = Impounded Reach** **SC = Side Channel** **BWC = Backwater Contiguous** **BWI = Backwater Isolated**
Abundance	A subjective determination of the relative abundance of species present in a bed. This code replaces "Percentage of Species."
% Veg. Codes	A subjective determination of the ratio of open water to submersed vegetation expressed as a coverage class as listed on the data sheet.
Site Number	A number to cross-reference the location of a vegetation bed to a base map or copy of an aerial photograph.

Appendix D

Photointerpretation Materials List

Field-Checking Materials

Binoculars
Loupe (hand magnifying glass)
Clear plastic sleeves
Markers (fine-tipped, permanent - "Sharpies")
Clipboard
Waterproof container for photos, maps, etc. (e.g., cooler)

Interpretation/Preparation Materials

Complete set of 9 x 9 color-infrared prints
Complete set of transparencies
Complete set of 1:24,000 topo quads
Magnifying stereoscope
Light table
Map of study area boundary
Masking tape
Scissors
Drafting pens (sizes 0 and 00)
Drafting ink
4-mm clear plastic to cut into 8.8-inch squares
Straight edge/ruler (preferably with inches divided into tenths)
Dividers
Minimum mapping unit guide

Appendix E

Long Term Resource Monitoring Program Vegetation Classification

Photointerpreter's List - Version 2.06
July 1, 1994

100	Open Wate
101	Lemnaceae
200	Submergents
201	Lemnaceae/submergents
202	Myriophyllum
203	Zosterella
204	Vallisneria/Zosterella
205	Myriophyllum/Zosterella
206	Vallisneria/Potamogeton
207	Myrioph/Potamoget/Vallis
208	Potamoget/Vallis/Zost/Cerat
209	Elodea
250	Vallisneria/Potamoget/Heteran
251	Ceratophyllum
252	Lemnaceae/Ceratophyllum
253	Lemna/Ceratophyll/Potamogeton
254	Potamogeton
255	Vallisneria
300	Submerg-Rooted Floating Aqua
301	Brasenia/submergents
302	Nelumbo/Nymphaea/submerg/Lemn
303	Nelumbo/submergents
304	Nelumbo/submergents/Lemnaceae
305	Nymphaea/Nelumbo/submergents
306	Nymphaea/submergents
307	Nymphaea/submergents/Lemnaceae
308	Nymphaea/Myriophyllum
309	Nelumbo/Myriophyllum
310	Nelumbo/Nymphaea/Myriophyllum
311	Nymph/Ceratoph/Myriophyl/Lemna
312	Nymphaea/Ceratophyllum/Lemna
400	Submerg-Rooted Floating-Emerg
401	Nelum/Nymph/Sag/Sparg/sub/Lemn
402	Nelum/Nymph/Ponted/sub/Lemn
403	Scirpus/Nelumbo/submergents
404	Scirpus/Nymphaea/submergents
405	Zizania/Nymphaea/Nelumbo/sub
406	Pontederia/Nymph/Nelumbo/sub
407	Sagittaria/Ceratophyllum/Lemnaceae
500	Rooted Floating Aquatics
501	Brasenia
502	Jussiaea
503	Nelumbo
504	Nelumbo/Lemnaceae
505	Nelumbo/Nymphaea
506	Nupha
507	Nymphaea
508	Nelumbo/Nymphaea/Lemnaceae
509	Nymphaea/Lemnaceae
600	Rooted Floating Aqua-Emergents
601	Nelumbo/Nymphaea/Sagittaria
602	Nymphaea/Sagittaria
603	Nymphaea/Scirpus
604	Sagittaria/Nelumbo

700	Emergents
701	Acoris
702	Carex
703	Cyperus
704	Decodon
705	Echinodorus
706	Eleocharis
707	Lythrum salicaria
708	Pontederia
709	Sagittaria
710	Sagittaria/Lemnaceae
712	Sagittaria/Scirpus/Sparganium
713	Sagittaria/Sparganium
714	Scirpus
715	Scirpus/Sagittaria
716	Scirpus/Sparganium
717	Sedge meadow
718	Sparganium
719	Typha
720	Typha/Sagittaria
721	Typha/Scirpus
722	Typha/Scirpus/Sparganium
723	Typha/Sparganium
724	Zizania
725	Equisetum
726	Dead Emergents
800	Emergents-Grasses/Forbs
801	Leersia/Carex/Polygonum
802	Leersia/Carex/Sagit/Polygonum
803	Leer/Phalar/Scirp/Lythr/Phrag
804	Leersia/Sagittaria
805	Sagittaria/Phalaris
806	Sagittaria/Polygonum
807	Sag/Sparg/Typ/Scirp/Leer/Phrag
808	Scirpus/Leersia
809	Scirpus/Carex/Leersia/Polygon
810	Scirpus/Phalaris
811	Scirpus/Phragmites
812	Scirpus/Polygonum
813	Scirpus/Typha/Phalaris
814	Sparganium/Leersia
900	Grasses/Forbs
901	Ambrosia
902	Grass
903	Hay meadow
904	Pasture (heavily grazed areas)
905	Leersia
906	Leersia/Polygonum
907	Meadow
908	Mixed forbs and/or grasses
909	Nettles
910	Phalaris
911	Phalaris/Polygonum
912	Phragmites
913	Phragmites/Phalaris
914	Polygonum
915	Polygonum/Nelumbo

916	Rdside-levee/grass/forbs/shrub
917	Sand-prairie
918	Spartina
919	Vines as dense overgrowth
920	Polygonum/Eupatorium
921	Dead Grass
1000	Woody Terrestrial
1001	Acer
1002	Acer/Populus and/or Salix
1003	Amorpha
1004	Betula
1005	Brush
1006	Carya/Nyssa
1007	Cephalanthus
1008	Forest-mesic (moist soil sp.)
1009	Forest-upland (dry soil sp.)
1010	Fraxinus
1011	Plantation
1012	Populus
1013	Quercus
1014	Salix
1015	Salix and/or Populus
1016	Salix and/or Populus - grass
1017	Shrub/grass/forbs
1018	Shrub/Scirpus
1019	Taxodium
1020	Taxodium/Nyssa
1021	Ulmus
1022	Conifers
1023	Juniperus
1100	Agriculture
1200	Urban/Developed
1201	Developed
1202	Developed parks
1203	Industrial pond
1204	Urban
1205	Revetted bank
1300	Sand/Mud
1301	Mud
1303	Sand
1400	No Coverage

Modifiers:

A	10-33% Vegetation Cover
B	34-67% Vegetation Cover
C	68-90% Vegetation Cover
D	>90% Vegetation Cover
1.	0-20 Feet Tall
2.	21-50 Feet Tall
3.	>50 Feet Tall

Genera order has no implications for dominance. If a genus covers at least 10% of the canopy in a polygon it will be included in a mixture. For example, a 5-acre polygon of *Phalaris* contains a clump of *Phragmites* that is about 0.8 acres, which is too small to delineate, but covers 16% of the polygon. The 5-acre polygon will be classed as "*Phragmites*/*Phalaris*" (120).

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the National Biological Service, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.