A Wetland Restoration Monitoring Protocol for the Northern Montezuma Wetlands Project

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ACKNOWLEDGMENTS

Recognition and thanks are extended to the people and organizations that contributed to the completion of this project. The New York State Department of Environmental Conservation provided the funding and administrative support through the Northern Montezuma Wetlands Project and the Research Foundation at the State University of New York - College of Environmental Science and Forestry. The Montezuma National Wildlife Refuge provided logistical support. Kevin Holcomb, Paul Hess, David Odell and Amy Deller provided valuable advice as well as assistance with field work and document review.
INTRODUCTION

As a component of the Northern Montezuma Wetlands Project (NMWP), wetland restoration is intended to play a significant role in increasing and enhancing wildlife habitat for a diversity of wildlife species. It is well documented that natural emergent and forested wetland ecosystems are essential for a multitude of wildlife populations (Mitsch and Gosselink 1993, Weller 1994) and the goal of most wetland restoration is to regain one or more functions of a natural wetland (Kusler and Kentula 1990). Presently, our knowledge of wetland components and processes is incomplete, and we lack proven methods for early diagnosis of failing functions (Hairston 1992, Hammer 1992). Consequently a long-term monitoring plan is essential to develop a data base for continuous comparisons of the functional status and biological integrity of a system (Hairston 1992, Brown 1995, VanRees-Siewert and Dinsmore 1996). To monitor and evaluate the ecological development of restored areas, vegetation and wildlife communities can be sampled along with environmental variables such as hydrology (Brooks 1995).

The following protocol for long-term monitoring of vegetation and wildlife communities has been developed for agricultural muckland restored to wetland habitat in the Montezuma Marsh complex of central New York. Information used to develop the following methods has been taken from numerous studies involved with wetlands and wetland restoration (Confer and Niering 1992, Hairston 1992, Delphey and Dinsmore 1993, Brown 1995, Chabot and Helferty 1995) and from our field test of selected methods on NMWP sites in 1995 and 1996. This protocol is presented to the New York State Department of Environmental Conservation (NYSDEC). The agency's intention is to employ these methods during subsequent years on NMWP restoration areas. Refer to the NMWP Final Environmental Impact Statement (Wich and Lambertson 1991) for more information regarding the NMWP project activities and goals.

The monitoring protocol is separated into two levels of intensity: (1) Routine Assessment and (2) Comprehensive Assessment (Hairston 1992). The Routine Assessment is less intensive and demands fewer hours in the field than the Comprehensive Assessment. This level should be used in the event that few resources are available to the NMWP for monitoring during a particular year. The Routine Assessment typically requires approximately 10 person-hours per site per year. This assessment is conducted annually during April, May and June. Statistical testing on data collected using the Routine Assessment is possible, however most of the data are qualitative and sufficient only for examining trends over time and making simple comparisons to reference site data and other restoration sites.

The Comprehensive Assessment requires more time in the field over a longer duration during spring and summer months. Approximately 5 person-hours per week per site during April through August are necessary. The Comprehensive Assessment can be thought of as an extended version of the Routine Assessment with additional sampling techniques and increased sample sizes to permit more reliable statistical analyses on quantitative data. All procedures explained in the Routine Assessment are also completed in the Comprehensive Assessment to facilitate yearly comparisons even if different assessment procedures were used.

At present, both levels of assessment were completed on 4 NMWP restoration sites and 4 reference sites in the Montezuma Marsh Complex in 1996. Data collected on these sites are located in various files in the NMWP Monitoring file box as specified throughout the protocol. Refer to the 1996 Monitoring Report located in Folder 7 for further details.

ROUTINE ASSESSMENT

The Routine Assessment should be done annually during the months of April, May, and June (if annual assessments are not possible, alternate years will suffice after the first year following restoration). This is the minimum amount of data collection necessary to comply with monitoring needs as specified by NMWP restoration projects. It is preferable that this assessment be completed by a wildlife technician or biologist, but a volunteer having prior experience and under minimal supervision may suffice. This assessment level is based primarily on the Marsh Monitoring Program designed by the Long Point Bird Observatory in Ontario, Canada (Chabot and Helferty 1995). Some changes were necessary to comply with the goals of the NMWP. The data collected will enable trend analyses in water cover, vegetation cover and type, and the species composition of birds and amphibians. The information gained will provide insight on the habitat condition and wildlife community of each restoration site and possibly alert managers of both desirable and undesirable
ecological changes. The Routine Assessment requires approximately 40 hours per year to complete for 4 restoration sites.

**Goal.** The goal of the Routine Assessment is to survey birds, amphibians, and habitat on restored wetlands in the NMWP area as a method for monitoring and evaluating restored wetland development.

The assessment procedure is designed to provide the following information:

1. Species richness and relative abundance of avian and amphibian species utilizing NMWP wetlands.
2. Habitat characteristics including water cover, vegetation structure and composition.
3. Changes in habitat characteristics.
5. Indicators of the success of NMWP restoration efforts to restore habitat quality and biodiversity.

**Routine Assessment Procedure**

The following section gives detailed descriptions of the methods by which data are collected, stored, and analyzed using the Routine Assessment. Most field and sampling equipment for assessment procedures are stored in the NMWP Equipment Box located in the back of the NMWP office (see Appendix A for the NMWP Equipment Box content list). Locations for other necessary materials including data forms, reference materials, maps and computer disks are either in the Equipment Box as well, or in a specified folder in the NMWP Filing Box which should be kept with the Equipment Box. In addition to a complete list of references at the end of this document, references that specifically apply to each step of the assessment procedures are listed immediately following procedure explanations. After reviewing each section of the Routine Assessment procedure, the following steps should be taken:

**Step 1.** Obtain maps and visit each site to locate sampling points or to determine where to place new sampling points as discussed below. This step should be done in time to conduct call surveys for amphibians between April 15-30. See Appendix B and the folder labeled “Study Areas” in the NMWP File Box.

**Step 2.** Create a time table to ensure all sampling is done during the correct times. As an example, Table 1 is the time table for sampling with the Routine Assessment.

**Step 3.** Review the list of materials necessary for each procedure. Verify the location and availability of all materials before sampling begins. Any questions about missing materials should be directed to the NMWP coordinator.

**Step 4.** Make certain that the methods for each technique are well understood before going into the field. A practice survey of each type is encouraged before actual sampling begins.

**Step 5.** Begin sampling.

**Step 6.** Take time to organize, check, enter, and file sampling data and data forms into the appropriate database files and NMWP folders.

**Step 7.** Analyze and interpret data and compile a monitoring report as directed.
Table 1. Time Table for Routine Assessment illustrating the time periods in which sampling procedures should be completed.

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<tr>
<th>APRIL</th>
<th>MAY</th>
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<td>Monitoring Report</td>
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Site Descriptions and Maps

Obtain and/or create maps and site descriptions to record the location of sampling points and additional information pertinent to field work, presentations and reports. Site descriptions and maps used in 1995 and 1996 are in the “Study Areas” folder. See Appendix B for a sample site description form and map.

When: Descriptions and maps should be located or created (for new restoration areas) prior to field work and before determining sampling points for new sites.

Materials: Maps can be made in a variety of ways, but the inclusion of concise, understandable information is more important than the method used. Existent maps were made using topographic maps for the NMWP project area, which are hanging on the back of the door to the rear of the NMWP office.

How: For each site clearly illustrate and/or record topography, location, size, open water and vegetation types, site boundaries, water control structures, transect lines, and photo points (see Appendix B). Simply knowing the scale of the map being used (i.e., topographic maps have a scale 1"=200') along with a ruler and a compass is enough to locate or place points on the map. Information for open water, vegetation types, site boundaries, and size can be obtained by visiting the site, from aerial photos, and by consulting with NMWP coordinators. Site description cover forms are in the folder labeled “Data Forms”.

Site Photos

Photo points should be established to record annual changes in visual characteristics at each restoration site (Hairston 1992). The number of photo points depend on site size and vantage points. Photo points have been established at four NMWP sites to date. These points are labelled for each site on the maps in the “Study Areas” folder and in the field by green metal posts with orange painted tops and aluminum tags.

When: Photos are to be taken at least once during June and additional photos taken in April and August would be useful. Photos taken on a bright, sunny day provide the best results.

Materials: A camera and slide film should be made available by NMWP coordinators. Information and slide photos from 1995 and 1996 photo points on restoration sites are located in the “Site photos” folder along with additional slide sleeves.

How: Locate existing photo points or determine the placement of new ones for each restoration site of interest. Record the compass direction for each photo and always face the same direction at the same point each time. Carefully record when and where photos were taken to avoid replication or exclusion of points. Data forms are located in the "Data Forms" folder.

Interpretation: The presence of open water, vegetation characteristics, and surrounding land uses can be noted and kept on permanent record with site photos. Site photos can also be used as benchmarks for temporal assessments and presentations on restoration development.
**Birds**

Birds are examined using a 50-m radius point-count method to sample species composition and relative abundance for each restoration site (Ralph et al. 1993). The point-count method facilitates the examination of yearly changes in bird populations at fixed points and abundance patterns of species. Although the point-count method is likely the most efficient and data-rich method of counting birds, it does not provide reliable data on some bird groups including waterfowl, waders, and less conspicuous marsh birds such as rails and bitterns. Therefore, supplemental methods are described following the point count section.

**When:** Bird points should be sampled at least once, preferably twice, during the month of June. The more times sampling can be replicated the more reliable the data. Sampling is to be done between 0530 and 1000 hours with wind speeds no greater than a Code 3 on the Beaufort Wind Scale (Table 2), and not during precipitation or foggy conditions that impair the observer's ability to detect species by sight or sound (Ralph et al. 1993).

**Materials:** Be sure to bring enough Bird data forms ("Data Forms" folder) to have one for each point. Other necessary materials include a clipboard, pens or pencils, copies of site maps, watch/timer, binoculars, insect repellent, bird field guide, and well developed bird identification skills by both sight and sound.

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<th>Table 2. Beaufort Wind Scale. Shading indicates wind strengths unacceptable for bird and amphibian surveys.</th>
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**How:** Points for censusing birds should be placed using a stratified random technique to exclude any other habitat type. One point should be established for every 10 acres of contiguous wetland. For example, for sites 1-10 acres there will be one bird point. For sites 11-20 acres there will be two bird points. Points should be at least 150m apart and at least 50m from the wetland boundary.

Each point should be approached with as little disturbance to the birds as possible. Counts begin immediately when the observer reaches the census point. At each bird point the observer will record any birds seen or heard within a 50m radius from the point for 10 minutes. Observations are recorded separately for the first 3 minutes, the following 2 minutes and the remaining 5 minutes (see sample data form in Appendix C). Details of each point such as the site, point, date, time, and observer are recorded on the top portion of the data form. A four letter code for each bird is used on the data sheets to save time and space. These codes are called alpha species codes for birds as used in the 1988 North American Bird Banding Manual. Alpha codes usually correspond to the first four letters of the common name of the species or, in the case of a two-word name, the first two letters of the first word and the first two letters of the second
word. For example, a killdeer is recorded as KILL and a common yellowthroat would be recorded as COYE. A list of standard codes is located in the "References" folder.

For each species, the number of individuals is recorded separately for those within a 50 m radius and for all those outside the circle, out to an unlimited distance. If a bird is flushed from within the plot when the observer arrives at the point, it should be recorded as in the plot. Birds detected flying over the point, rather than detected from within the vegetation, should be recorded separately by circling the record. Do not record female song birds in the surveys. Refer to the sample Bird Data Form (Appendix C) for illustration.

Once established, bird points should be permanently marked using metal stakes with bright paint on top. These stakes will be provided by NMWP coordinators. Bird points for four restoration sites have been permanently marked in the field using metal stakes with fluorescent pink spray painted tops and can be located using the maps in the “Study Areas” folder. Data sheets to record observations are in Folder 3 "Data Forms”. Always make copies of additional sheets before using last form. If it is necessary to print or edit the data sheets, the bird form can be found on the computer disk labeled "Forms" under filename "birdform.wk1" (a Lotus file). All computer disks are in the NMWP equipment box located in the rear of the NMWP office.

Data Summarization and Analysis: Bird data are summarized per plot for each restoration site to facilitate statistical comparisons on means. The total number of unique bird species and total number of individuals for all bird species should be determined for each plot sampled within a site during a sampling year (see Monitoring report for 1995 and 1996 data). All species present should be ranked according to their wetland dependency based on Brooks and Cronquist (1990) located in reference folder. The relative abundance per plot for each species at a site in a sampling year and bird diversity can be calculated to examine trends in bird community composition. Percent similarities can be calculated qualitatively and quantitatively each year to determine if restored areas are increasing in similarity to reference wetlands. Refer to Appendix D, “Formulas and Statistical Testing Procedures” for detailed instructions on calculations and statistical analyses.

Supplemental Bird Survey Methods

Waterfowl Surveys: For waterfowl utilizing each area, counts can be done by walking around the perimeter of the restoration site along the dike and recording the species and number of ducks and geese observed. This survey follows the guidelines set by the Atlantic Flyway Waterfowl Breeding Population Survey conducted by the NYSDEC each year. See Appendix C for explicit details on how the surveys should be conducted and a sample data form.

Data Summarization and Analysis: Species presence/absence data and numbers of individuals can be summarized for each site and compared among sites and between years.

Marsh Bird Surveys: For secretive marsh birds that are inconspicuous and therefore hard to detect, a call back method is recommended as described in Chabot and Helferty (1995). This involves visiting each bird point 1 to 2 times during the end of May or early June and playing a tape of bird calls including those of the Virginia rail, American bittern, and American coot. This will elicit calling of secretive birds that usually do not make a lot of noise. The count is conducted the same as described in the point count method above, with the exception that the first five minute period is surveyed while the tape is playing. Use the same bird points and bird data forms as for the point count method. The bird survey tape is located in the NMWP Equipment Box. This method may be combined with the point count method, however rails and bitterns tend to be more vocal during late May and early June while the recommended initiation of breeding songbird surveys is not until the first week of June.

Data Summarization and Analysis: Data may be summarized and included with the point count survey data and analyzed as described above.

Amphibians

Amphibian audio surveys are conducted to assess species richness and relative abundance for anuran species (frogs and
toads) that call nocturnally during their breeding seasons. An audio point is established at each site and censused 3 times during the spring and early summer. Audio points have been established at four restoration sites as shown on the maps and marked in the field using metal stakes with green painted tops and aluminum tags.

**When:** Audio surveys are to be conducted after 2030 and before 2400 hours. Depending on travel time, multiple sites can be censused in one night. Appropriate air temperature and wind speeds are the most important factors to consider when deciding when to conduct surveys as amphibian body temperatures fluctuate with air and water temperatures (Chabot and Helferty 1995). Frogs and toads usually require an air temperature greater than 46 degrees F to elicit calling activity and some species such as bullfrogs and green frogs do not begin calling until temperatures are at least 70 degrees F. Therefore, night-time temperatures should be between 46-54 degrees F for the first survey, 55-68 degrees F for the second survey, and 70+ degrees F for the third survey to ensure all species can call if present. Although air temperature is more important than date, recommended guidelines for surveys are once between April 15-30, once between May 15-30, and once between June 15-30 (Chabot and Helferty 1995).

Strong wind also deters amphibian activity as well as the observer's ability to hear. Do not conduct surveys when wind speeds are greater than a Code 3 on the Beaufort Wind Scale (Table 2). Nights that are damp, foggy, or have light rain falling are ideal for surveys, but avoid persistent or heavy rainfall.

**Materials:** Be sure to bring enough Amphibian Data Forms to have one for each point. In addition, a small flashlight or headlamp, pens or pencils, watch/timer, clipboard, insect repellant, compass and copies of maps to relocate the points.

**How:** At each point an observer records all frog and toad calls heard within the study site in an unlimited distance, semi-circular sample area (180 degree arc) for three minutes facing a set direction (Figure 1).

![Figure 1. Semi-circular sample plot for surveying calling amphibians. Amphibians are represented by the round dots.](image)

Before going into the field it is important that the calls of different species can be identified and the call level code and abundance count methods are understood. A training tape for learning amphibian calls is located in Folder 5 "Training Tapes". Call level codes are used to categorize the intensity of calling activity for each species. Use the following call
level codes for each species detected during a survey:

1. Assign this number when individuals can be counted easily and calls are not simultaneous. For the abundance count, record the number of individual frogs calling for each species beside the code number (see sample Amphibian Data Form, Appendix C).

2. Assign code 2 when calls are distinguishable and some calls of the same species are simultaneous. In this case an exact abundance count cannot be determined, but a reliable estimate of the number of individuals present based on location and voice can be made.

3. Assign this number when calls of a species are continuous and overlapping, a full chorus. No abundance count can be recorded in this level as there are too many overlapping calls to allow for any reasonable estimate.

Before beginning the survey, fill in the information in the top section of the data form (see sample form, Appendix C). Date and time are written military style. Weather information is recorded using the Beaufort Wind Scale (Table 2), and an air thermometer or reliable local weather report for air temperature. Also record the direction you are facing when conducting surveys at each point for future reference.

Data Summarization and Analysis: Total species richness for amphibians should be calculated as the number of unique species observed during audio surveys at each site. An index of abundance can be determined using the call level codes given for each species during surveys. This information can be used to compare species composition among sites and years.

Habitat
A simple description of habitat is performed usually at a site photo location for each restoration site. The information recorded facilitates interpretation of bird and amphibian data and marks changes from year to year in vegetation and hydrology. Simple distinctions are made between 4 groups of plants: (1) emergents, (2) floating plants, (3) forbes, and (4) shrubs/trees

When: Habitat surveys should be conducted in mid to late June. It is possible to complete the habitat surveys after a bird survey or at the same time as site photos are taken.

Materials: Binoculars, data forms, pens or pencils, compass, vegetation field guide.

How: Habitat features for each site are recorded on habitat data forms located in the “Data Forms” folder (see Appendix C for a sample habitat data form). Only the dominant features of each site need to be recorded, so access to the entire area is not necessary. The survey is begun by standing at a predetermined focal point (photo points work well) and record what can be seen by answering the series of questions on the data form (Appendix C). Questions prompt summary information about the major kinds of habitat cover. Estimate the percentages of the total area that are covered by emergent vegetation (including shrubs and trees), open water (including floating plants), and exposed mud/sand/rock. These three values should add up to 100%. For comparing data between years, surveys must be conducted from permanent points.

Of particular interest is how water contributes to the structure of the habitat. Open water is defined as any patch of water that is at least the size of a standard sheet of plywood (4 x 8 feet). Open water supports little if any emergent vegetation but can have floating plants.

Separately categorize the number of trees and shrubs (living and dead) that are within the sample area. Look again at open water zones and categorize the amount of submerged plants present and floating plant cover. Record habitat types adjacent to the restored wetland.

Dominant emergent vegetation information is recorded by estimating the percent cover of groups of emergent vegetation
types. Scan the site and determine which kinds of emergent plants dominate the area. Sturdy emergents such as cattail are those that can support elevated bird nests; weak emergents cannot. Record the percentages of each emergent plant group and check off or add individual species that are known to be present (see sample form in Appendix C).

Data Summarization and Analysis: Percentages for open water, emergent vegetation cover and exposed mud can be summarized and graphed to show trends over years and make comparisons among sites. The composition of major groups of vegetation can be compared as well.

**Monitoring Reports**
See page 17

**COMPREHENSIVE ASSESSMENT**

The Comprehensive Assessment involves more quantitative measures using transects, quadrats, and sampling replications to increase sample sizes and facilitate reliable statistical analyses. In addition to the Routine assessment sampling techniques described above, the Comprehensive Assessment requires techniques such as amphibian and reptile trapping, quantitative hydrology and vegetation measurements, and increased replication of bird and amphibian call surveys.

**Goal.** The goal of the Comprehensive Assessment is to survey birds, reptiles, amphibians, vegetation and hydrology on restored wetlands in the NMWP area as a method for monitoring and evaluating wetland development. This assessment procedure is designed to provide the following information:

1. Species richness and relative abundance of avian, reptile, amphibian and plant species utilizing NMWP restored wetlands.
2. Habitat characteristics including water cover, vegetation structure and composition.
3. Changes in habitat characteristics.
5. Indicators of the success of NMWP restoration efforts to restore habitat quality and biodiversity.
6. Statistical results to support inferences regarding wildlife and habitat conditions on NMWP restoration sites and to determine significant differences in variables between years and among restoration sites.

**Comprehensive Assessment Procedure**

The following section gives detailed descriptions of the methods by which data are collected, stored, and analyzed using the Comprehensive Assessment. Most field and sampling equipment for assessment procedures are stored in the NMWP Equipment Box located in the back of the NMWP office (see Appendix A for the NMWP Equipment Box content list). Materials including data forms, reference materials and maps are located in specified folders in the NMWP Filing Box which should be next to the Equipment Box. After reviewing each section of the Comprehensive Assessment procedure, the following steps should be taken:

**Step 1.** The first step is to obtain maps and visit each site to locate sampling points or to determine where to place new sampling points as discussed below. This step should be done in time to begin pitfall trapping and call surveys for amphibians. See Appendix B and the “Study Areas” folder for examples.

**Step 2.** The second step is to create a time table to ensure all sampling is done during the correct times. As an example, Table 3 is a time table for sampling with the Comprehensive Assessment.

**Step 3.** Review the list of materials necessary for each procedure. Verify the location and availability of all materials before sampling begins. Any questions about missing materials should be directed to the NMWP coordinator.

**Step 4.** Make certain that the methods for each technique are well understood before going into the field. A practice survey of each type is encouraged before actual sampling begins. Identification abilities for birds, reptiles, amphibians
and vegetation should be well developed.

Step 5. Begin sampling.

Step 6. Take time to organize, check, enter, and file sampling data and data forms into the appropriate database files and NMWP folders.

Step 7. Analyze and interpret data as suggested. Compile a monitoring report.

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<th>Table 3. Time Table for the Comprehensive Assessment illustrating the time periods in which sampling procedures should be completed.</th>
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<td>Pitfall Traps</td>
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**Site Descriptions and Maps**

Obtain and/or create maps and site descriptions to record the location of sampling points and additional information pertinent to field work, presentations and reports. Site descriptions and maps used in 1995 and 1996 are in the “Study Areas” folder. See Appendix B for a sample site description form and map.

**When:** Descriptions and maps should be located or created prior to field work and before determining sampling points for new sites.

**Materials:** Maps can be made in a variety of ways, but the inclusion of concise, understandable information is more important than the method used. Existent maps were made using topographic maps for the NMWP project area, which are hanging on the back of the door to the rear of the NMWP office.

**How:** For each site clearly illustrate and/or record topography, location, size, open water and vegetation types, site boundaries, water control structures, transect lines, and photo points (see Appendix B). Simply knowing the scale of the map being used (i.e., topographic maps have a scale 1”=200') along with a ruler and a compass is enough to locate or place points on the map. Information for open water, vegetation types, site boundaries, and size can be obtained by visiting the site, from aerial photos, and by consulting with NMWP coordinators. Site description cover forms are in the folder labeled “Data Forms”.

**Site Photos**

Photo points should be established to record annual changes in visual characteristics at each restoration site (Hastbon 1992). The number of photo points depend on site size and vantage points. Photo points have been established at four NMWP sites to date. These points are labeled for each site on the maps in the “Study Areas” folder and in the field by green metal posts with orange painted tops and aluminum tags.

**When:** Photos are to be taken at least once during June and additional photos taken in April and August would be useful. Photos taken on a bright, sunny day provide the best results.

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**Materials:** A camera and slide film should be made available by NMWP coordinators. Information and slide photos from 1995 and 1996 photo points on restoration sites are located in the “Site Photos” folder along with additional slide sleeves.

**How:** Locate existing photo points or determine the placement of new ones for each restoration site of interest. Record the compass direction for each photo and always face the same direction at the same point each time. Carefully record when and where photos were taken to avoid replication or exclusion of points. Data forms are located in the “Data Forms” folder.

**Interpretation:** The presence of open water, vegetation characteristics, and surrounding land uses can be noted and kept on permanent record with site photos. Site photos can also be used as benchmarks for temporal assessments and presentations on restoration development.

**Birds**

Birds are examined using a 50-m radius point-count method to sample species composition and relative abundance for each restoration site (Ralph et al. 1993). The point-count method facilitates the examination of yearly changes in bird populations at fixed points and abundance patterns of species. Although the point-count method is likely the most efficient and data-rich method of counting birds, it does not provide reliable data on some bird groups including waterfowl, waders, and less conspicuous marsh birds such as rails and bitterns. Therefore, supplemental methods are described following the point count section.

**When:** Bird points should be sampled at least once, preferably twice, during the month of June. The more times sampling can be replicated the more reliable the data. Sampling is to be done between 0530 and 1000 hours with wind speeds no greater than a Code 3 on the Beaufort Wind Scale (Table 2), and not during precipitation or foggy conditions that impair the observer's ability to detect species by sight or sound (Ralph et al. 1993).

**Materials:** Be sure to bring enough Bird Data Forms (“Data Forms” folder) to have one for each point. Other necessary materials include a clipboard, pens or pencils, copies of site maps, watch/timer, binoculars, insect repellent, bird field guide, and well-developed bird identification skills by both sight and sound.

**How:** Points for censusing birds should be placed using a stratified random technique to exclude any other habitat type. One point should be established for every 10 acres of contiguous wetland. For example, for sites 1-10 acres there will be one bird point. For sites 11-20 acres there will be two bird points. Points should be at least 150m apart and at least 50m from the wetland boundary.

Each point should be approached with as little disturbance to the birds as possible. Counts begin immediately when the observer reaches the census point. At each bird point the observer will record any birds seen or heard within a 50m radius from the point for 10 minutes. Observations are recorded separately for the first 3 minutes, the following 2 minutes and the remaining 5 minutes (see sample data form in Appendix C). Details of each point such as the site, point, date, time, and observer are recorded on the top portion of the data form. A four letter code for each bird is used on the data sheets to save time and space. These codes are called alpha species codes for birds as used in the 1988 North American Bird Banding Manual. Alpha codes usually correspond to the first four letters of the common name of the species or, in the case of a two-word name, the first two letters of the first word and the first two letters of the second word. For example, a killdeer is recorded as KILL and a common yellowthroat would be recorded as COYE. A list of standard codes is located in the “References” folder.

For each species, the number of individuals is recorded separately for those within a 50 m radius and for all those outside the circle, out to an unlimited distance. If a bird is flushed from within the plot when the observer arrives at the point, it should be recorded as in the plot. Birds detected flying over the point, rather than detected from within the vegetation, should be recorded separately by circling the record. Do not record female song birds in the surveys. Refer to the sample Bird Data Form (Appendix C) for illustration.

Once established, bird points should be permanently marked using metal stakes with bright paint on top. These stakes
will be provided by NMWP coordinators. Bird points for four restoration sites have been permanently marked in the field using metal stakes with fluorescent pink spray painted tops and can be located using the maps in the “Study Areas” folder. Data sheets to record observations are in the “Data Forms” folder. If it is necessary to print or edit the data sheets, the bird form can be found on the computer disk labeled “Forms” under filename “birdform.wk1” (a Lotus file). All computer disks are in the NMWP equipment box located in the rear of the NMWP office.

**Data Summarization and Analysis:** Bird data are summarized per plot for each restoration site to facilitate statistical comparisons on means. The total number of unique bird species and total number of individuals for all bird species should be determined for each plot sampled within a site during a sampling year (see Monitoring report for 1995 and 1996 data). All species present should be ranked according to their wetland dependency based on Brooks and Cronquist (1990) located in reference folder. The relative abundance per plot for each species at a site in a sampling year and bird diversity can be calculated to examine trends in bird community composition. Percent similarities can be calculated qualitatively and quantitatively each year to determine if restored areas are increasing in similarity to reference wetlands. Refer to Appendix D, “Formulas and Statistical Testing Procedures” for detailed instructions on calculations and statistical analyses.

**Supplemental Bird Survey Methods**

**Waterfowl Surveys:** For waterfowl utilizing each area, counts can be done by walking around the perimeter of the restoration site along the dike and recording the species and number of ducks and geese observed. This survey follows the guidelines set by the Atlantic Flyway Waterfowl Breeding Population Survey conducted by the NYSDEC each year. See Appendix C for explicit details on how the surveys should be conducted and a sample data form.

**Data Summarization and Analysis:** Species presence/absence data and numbers of individuals can be summarized for each site and compared among sites and between years.

**Marsh Bird Surveys:** For secretive marsh birds that are inconspicuous and therefore hard to detect, a call back method is recommended as described in Chabot and Helferty (1995). This involves visiting each bird point 1 to 2 times during the end of May or early June and playing a tape of bird calls including those of the Virginia rail, American bittern, and American coot. This will elicit calling of secretive birds that usually do not make a lot of noise. **The count is conducted the same as described in the point count method above, with the exception that the first five minute period is surveyed while the tape is playing.** Use the same bird points and bird data forms as for the point count method. The bird survey tape is located in the NMWP Equipment Box. This method may be combined with the point count method, however rails and bitterns tend to be more vocal during late May and early June while the recommended initiation of breeding songbird surveys is not until the first week of June.

**Data Summarization and Analysis:** Data may be summarized and included with the point count survey data and analyzed as described above.

**Amphibians**

**Audio Surveys**

Amphibian audio surveys are conducted to assess species richness and relative abundance for anuran species (frogs and toads) that call nocturnally during their breeding seasons. An audio point is established at each site and censused equally for all sites during the spring and early summer. The greater the sample size (number of repeated samples), the more reliable the data. Audio points have been established at four restoration sites as shown on the maps and marked in the field using metal stakes with green painted tops and aluminum tags.

**When:** Audio surveys are to be conducted after 2030 and before 2400 hours. Depending on travel time, multiple sites can be censused in one night. Appropriate air temperature and wind speeds are the most important factors to consider.
when deciding when to conduct surveys as amphibian body temperatures fluctuate with air and water temperatures (Chabot and Helferty 1995). Frogs and toads usually require an air temperature greater than 46 degrees F to elicit calling activity and some species such as bullfrogs and green frogs do not begin calling until temperatures are at least 70 degrees F. Therefore, night-time temperatures should be between 46-54 degrees F for the first survey, 55-68 degrees F for the second survey, and 70+ degrees F for the third survey to ensure all species can call if present. Although air temperature is more important than date, recommended guidelines for surveys are once between April 15-30, once between May 15-30, and once between June 15-30 (Chabot and Helferty 1995).

Strong wind also deters amphibian activity as well as the observer's ability to hear. Do not conduct surveys when wind speeds are greater than a Code 3 on the Beaufort Wind Scale (Table 2). Nights that are damp, foggy, or have light rain falling are ideal for surveys, but avoid persistent or heavy rainfall.

Materials: Be sure to bring enough Amphibian Data Forms to have one for each point. In addition, a small flashlight or headlamp, pens or pencils, watch/timer, clipboard, insect repellent, compass and copies of maps to relocate the points.

How: At each point an observer records all frog and toad calls heard within the study site in an unlimited distance, semi-circular sample area (180 degree arc) for three minutes facing a set direction (Figure 1).

Before going into the field it is important that the calls of different species can be identified and the call level code and abundance count methods are understood. A training tape for learning amphibian calls is located in Folder 5 “Training Tapes”. Call level codes are used to categorize the intensity of calling activity for each species. Use the following call level codes for each species detected during a survey:

1. Assign this number when individuals can be counted easily and calls are not simultaneous. For the abundance count, record the number of individual frogs calling for each species beside the code number (see sample Amphibian Data Form, Appendix C).
2. Assign code 2 when calls are distinguishable and some calls of the same species are simultaneous. In this case an exact abundance count cannot be determined, but a reliable estimate of the number of individuals present based on location and voice can be made.
3. Assign this number when calls of a species are continuous and overlapping, a full chorus. No abundance count can be recorded in this level as there are too many overlapping calls to allow for any reasonable estimate.

Before beginning the survey, fill in the information in the top section of the data form (see sample form, Appendix C). Date and time are written military style. Weather information is recorded using the Beaufort Wind Scale (Table 3), and an air thermometer or reliable local weather report for air temperature. Also record the direction you are facing when conducting surveys at each point for future reference.

Data Summarization and Analysis: Total species richness for amphibians should be calculated as the number of unique species observed during audio surveys at each site. An index of abundance can be determined using the call level codes given for each species during surveys. This information can be used to compare species composition among sites and years.

Pitfall Trapping
Pitfalls with drift fence arrays can be used to determine the species diversity of amphibians. Pitfall traps have the ability to detect the presence of many amphibians for a variety of habitat types (Heyer et al. 1994). Reptiles and small mammals are also trapped when this method is employed, however we found that data collected in 1995 and 1996 on reptiles showed little in the way of spatial or temporal trends. Although most anuran species are detected using this trapping method, some species such as the gray treefrog (*Hyla versicolor*) and spring peeper (*Pseudacaris cristata*) are able to escape by climbing up the sides of the pitfall buckets. These species will be detected using the audio surveys.
When: Arrays are to be installed in early April and maintained to trap amphibian species throughout April, May and June. Traps should be run for a minimum of 15 array nights each year to facilitate comparison with data from previous years. Trapping during warm, wet conditions usually provides the best results.

Materials: A drift-fence array consists of 4 five-gallon plastic buckets, 15 m of aluminum flashing, 4 plywood trap covers or plastic bucket covers, wooden or aluminum 0.5m stakes and duct tape. Materials necessary for installation, maintenance and checking of traps include aquatic nets, field guide, water scoop, shovel, pick, gloves, rivets, rivet gun, flashing cutters (wire cutters), data forms, and a meter tape.

How: Installation of drift fences and pitfall traps is simple but labor-intensive. Figure 2 is a diagram illustrating a typical pitfall/drift fence array used previously on NMWP sites. The array is set up in a "T" formation with both arms of aluminum flashing measuring 7.5 m (25 ft). Three 5 gallon buckets (pitfall traps) are placed one at each end of a flashing arm and one at the junction buried in the ground with the opening flush with the ground surface (see Figure 2). Two small holes are placed opposite another 1/3 up the sides of each bucket for water drainage. The edges of each bucket are sliced approximately 3 inches to fit flashing a short distance into the mouth, the middle bucket should be sliced on both sides as flashing passes through the middle bucket, and overlaps the three end buckets to enhance trapping success. Thin plywood boards cut to fit the size of the pitfall openings can be used to cover traps when not in use (Figure 2). Slits should also be cut in the plywood covers to enable flashing to remain in place when traps are closed. Each pitfall with drift fence array should be labeled so that data is collected for each array individually. This should not be an issue if there is only one array per site.

Figure 2. Diagram for a pitfall with drift fence array for trapping amphibians.
Arrays should be placed within the study site on areas with no surface water. It may be necessary to either delay installation until spring high water recedes or move arrays from previously designated locations to more appropriate areas. Traps should be removed at the end of each field season unless trapping is planned for the following spring and summer in which case pitfalls should be securely covered and only flashing removed to prevent damages. The location of traps for 1995 and 1996 sampling are illustrated on site maps in the “Study Areas” folder.

Traps should be checked each day ideally before noon because heat may become a mortality factor. An aquatic net should be used to retrieve animals from the four buckets while recording and then releasing each individual for every species (see Appendix C for sample data form).

Data Summarization and Analysis: Species richness is calculated for amphibians as the number of unique species observed at each study area. Richness and the number of individuals for each species can be determined per trap night and averaged to facilitate statistical comparisons of means. Refer to Appendix D for information on statistical analyses.

Habitat 1
A simple description of habitat is performed usually at a site photo location for each restoration site. The information recorded facilitates interpretation of bird and amphibian data and marks changes from year to year in vegetation and hydrology. Simple distinctions are made between 4 groups of plants: (1) emergents, (2) floating plants, (3) forbes, and (4) shrubs/trees.

When: Habitat surveys should be conducted in mid to late June. It is possible to complete the habitat surveys after a bird survey or at the same time as site photos are taken.

Materials: Binoculars, data forms, pens or pencils, compass, vegetation field guide.

How: Habitat features for each site are recorded on habitat data forms located in the “Data Forms” folder (see Appendix C for a sample habitat data form). Only the dominant features of each site need to be recorded, so access to the entire area is not necessary. The survey is begun by standing at a predetermined focal point (photo points work well) and record what can be seen by answering the series of questions on the data form (Appendix C). Questions prompt summary information about the major kinds of habitat cover. Estimate the percentages of the total area that are covered by emergent vegetation (including shrubs and trees), open water (including floating plants), and exposed mud/sand/rock. These three values should add up to 100%. For comparing data between years, surveys must be conducted from permanent points.

Of particular interest is how water contributes to the structure of the habitat. Open water is defined as any patch of water
that is at least the size of a standard sheet of plywood (4 x 8 feet). Open water supports little if any emergent vegetation but can have floating plants.

Separately categorize the number of trees and shrubs (living and dead) that are within the sample area. Look again at open water zones and categorize the amount of submergent plants present and floating plant cover. Record habitat types adjacent to the restored wetland.

Dominant emergent vegetation information is recorded by estimating the percent cover of groups of emergent vegetation types. Scan the site and determine which kinds of emergent plants dominate the area. Sturdy emergents such as cattail are those that can support elevated bird nests; weak emergents cannot. Record the percentages of each emergent plant group and check off or add individual species that are known to be present (see sample form in Appendix C).

Data Summarization and Analysis: Percentages for open water, emergent vegetation cover and exposed mud can be summarized and graphed to show trends over years and make comparisons among sites. The composition of major groups of vegetation can be compared as well.

**Habitat 2**

Measurements of vegetation and water cover and depth are made to assess vegetation community dynamics and hydrological fluctuations over time and among sites.

*When:* Sampling should be done during August when many plants are flowering and therefore easily identifiable. Water cover and depth may also be measured at bird points and pitfall trap arrays biweekly throughout the monitoring period.

*Materials:* field guides, field ruler (cm), 50 m tape, data forms, clipboard, pens and pencils, compass, m² plotter, plastic bags, permanent marker, labels, and site maps.

*How:* Five 200-m transects should be placed within the wetland parallel to any significant gradient such as moisture or elevation (Hairston 1992). Hydrology and vegetation are sampled on each transect by starting at a predetermined end of the transect and sampling in 1 m² plots at 20 m intervals. In each plot the percent cover based on the Braun-Blanquet scale (Table 4) is used to estimate the 3 most abundant herbaceous species for each plot (Hays et al. 1981). All other species in the plot should be noted as present. The percent water coverage (Braun-Blanquet scale) is determined for the entire plot, and water depth is measured in the center of each plot in centimeters (See Appendix C for sample Habitat 2 Data Form). The point-centered quarter method as described by Cottam and Curtis (1956) should be used to measure trees and shrubs within 10 m of the center of each herbaceous vegetation plot.

<table>
<thead>
<tr>
<th>Table 4. Braun-Blanquet Cover Scale</th>
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<tbody>
<tr>
<td>r = rare, solitary</td>
</tr>
<tr>
<td>+ = few</td>
</tr>
<tr>
<td>1 = &lt;5%</td>
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<tr>
<td>2 = 5 - 25%</td>
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<tr>
<td>3 = 25 - 49%</td>
</tr>
<tr>
<td>4 = 50 - 74%</td>
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<tr>
<td>5 = &gt;75%</td>
</tr>
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</table>

Plant species are recorded using a four letter code consisting of the first two letters in the Genus name and the first two
letters in the species name. For example, *Lythrum salicaria* (purple loosestrife) is noted as LYSA. It may require some practice to remember the codes, therefore, either bringing along a field guide or the Vegetation Reference sheet located in the “References” folder is recommended.

**Data Summarization and Analysis:** Vegetation data are summarized per plot for each restoration site to facilitate statistical comparisons on means. The total number of unique herbaceous species and woody species, and percent cover should be determined for each plot sampled within a site during a sampling year (see Monitoring report for 1995 and 1996 data). All species present should be ranked according to their wetland dependency based on Reed (1988). The relative importance based on cover per plot for each species along with wetland and diversity indices (Appendix D) can be calculated to examine trends in vegetative community development. Percent similarities can be calculated qualitatively and quantitatively each year to determine if restored areas are increasing in similarity to reference wetlands. Refer to Appendix D for detailed instructions for calculations and statistical testing. Hairston (1992), pages 87-108 discusses additional methods for examining vegetation data on restored wetlands.

Percent water cover and water depth should be averaged over plots for each site for statistical comparisons of mean water cover and depth. Monthly water depths can be used to examine water level fluctuations by graphing the mean monthly water depths per plot taken at each site type (see the 1996 Monitoring Report).

**MONITORING REPORTS**

Monitoring reports are to be completed each year restoration sites are monitored. These reports are intended to summarize data analyses and conclusions as well as provide information for future reference. Refer to the 1996 Monitoring Report for NMWP Restoration Sites in the “Reports” folder.

**NOTES AND RECOMMENDATIONS**

Many research efforts have been and are currently being made toward refining wetland restoration and monitoring. In light of these efforts, future possibilities exist for improving and adding to the monitoring protocol for NMWP restored wetlands. Based on data analysis of two field seasons, literature reviews and professional correspondences, we suggest the following possibilities to be considered for future incorporation and/or thought.

Forested wetland restoration is more complex than emergent restoration and requires a much longer development period. Resources for monitoring restored forested wetlands may be best applied to ensuring the establishment of woody plant species rather than measuring wildlife community development for the first 5 years. Wildlife assessments cannot be realistically compared with natural forested areas until tree and shrub layers have had time to develop. During this time, wildlife community characteristics can be expected to change repeatedly.

Factors critical to forest development include appropriate hydrological conditions, substrate stability, adequate soil rooting volume and fertility, and control of herbivores and competitive herbaceous plants (Clewell and Lea 1990, Barry et al. 1996). Emphasis must be placed on the attainment of an adequate stand of trees; most restored forested wetland functions cannot be compared with reference wetlands until trees are established (Clewell and Lea 1990). Plantings of woody species from natural stock have been met with limited success, but artificially created mounds provide some assurance that high quality plantings will survive flooding (Barry et al. 1996). See Barry et al. (1996) for a detailed descriptions of methods and costs associated with restoration of forested wetlands.

Monitoring trends in amphibian use of restored areas can be challenging. Amphibians are particularly sensitive to environmental conditions, including precipitation levels. Although this sensitivity may seem desirable for monitoring restored areas, it can cause confusion among the effects of restoration, local weather patterns and other environmental variables. Audio surveys appear to be the most efficient and effective means of collecting trend data each year. While trapping methods provide information on a greater number of species, its effectiveness can be unpredictable as seen in 1996, when flooding throughout the spring and summer resulted in sporadic or no trapping at most sites.

Incorporation of productivity measures of wildlife and vegetation communities would provide additional information on restoration success, particularly when restoration goals concern wildlife habitat.
Geographic Information System (GIS) analyses could benefit the NMWP by providing a broader, landscape perspective on changes in the Montezuma Marsh Complex in response to restorations. A GIS would enable overlays of biological and environmental data on topographic maps to facilitate decision making regarding monitoring, restoration techniques and future land acquisition and restorations.

LITERATURE CITED/REFERENCE LIST


