Wetland Restoration Potential At Rice Lake State Park

Jamie M. Schulz [1,2]
[1]*Department of Resource Analysis, Saint Mary's University of Minnesota, 700 Terrace Heights, Winona, Minnesota 55987.* [2] *Department of Natural Resources, Nerstrand Big Woods State Park 9700 170th St. E Nerstrand, MN 55053*

Keywords: wetland, restoration, Rice Lake State Park, Geographic Information Systems, GIS, Steele County, Dodge County, hydric soils, subwatershed basin

Abstract

Historic and current wetlands were used to determine potential wetland areas within Rice Lake State Park. The number of wetlands in the park, outside the park in the subwatershed basin (basin), and in the entire basin was tested to determine if there was a statistical difference in the wetland numbers between 1938 and 1998. It was determined that wetland numbers within the park remained relatively constant between 1938 and 1998 while the wetland numbers outside the park in the basin differed over this time period. It was also determined that there was no correlation between the change of wetland area in the basin and the park. A paired-sample *t* test determined that wetland areas in the entire basin were greater than that in the park.

Once potential wetlands were identified in the park, those areas not currently considered wetlands were prioritized for restoration. The priority was determined by evaluating the current conditions of the site, the estimated difficulty of the restoration, and park management concerns affecting these areas.

Introduction

Rice Lake State Park was established in 1963 as part of the Minnesota State Park System. The park is located in Steele and Dodge Counties of Southern Minnesota, and contains both public and private land within its Statutory Boundary, referred to as the boundary for this study. Leonard Binstock, a long time area resident, remembers that wooded areas had previously been County Park or privately owned, and sometimes grazed by cattle. The open areas had been agricultural fields (Binstock 2000). However, these areas have not been farmed since they became a State Park in 1963. Some native grasses, sedges, and forbs are now found in these areas.

Rice Lake itself is a 303.5 hectare (750 acre) lake with an average depth of 0.9 meters (3 feet). The lake is managed as a waterfowl lake. Low oxygen levels during the winter months, due to the shallow depth, result in frequent fish kills. The lake is the headwater source for the South Branch of the Middle Fork of the Zumbro River, which flows to the east. In the 1870's a dam was built at this outlet of the lake to power a flourmill located east of the lake (Management Plan 1983). The dam allowed the lake water level to be kept artificially high to power the mill during times when river flow decreased. This high water level allowed for recreational uses on the lake until it was returned to natural levels after the area became a State Park.

Because of Rice Lake State Park's relatively flat terrain, it is a good place for concentrating wetland restoration efforts. Flat areas without natural drainage, which is characteristic of Rice Lake State Park, tend to be predominately wetland (Galatowitsch and van der Valk 1998). Water standing after the spring thaw or a heavy rain suggests the potential location of many wetland areas.

The term wetland refers to an area that is inundated with water for a period of time and supports vegetation that normally grows in those wet conditions (Kent 1994). In the nineteenth century, the only good wetland was a drained wetland. By 1985, the amount of drained area in the United States was 44 million hectares (110 million acres). Today, there are more kilometers of drainage ditches and tile lines than highways (Hey and Philippi 1999).

In the late twentieth century, people began to notice the benefits wetlands offered. These benefits included retention of floodwaters, waterfowl production areas, and filtering of groundwater (Kent 1994). Because of this realization, wetland restoration efforts began in areas that had once been drained for agricultural purposes.

With the restoration efforts came many definitions of wetland restoration. The definition used for this study states that restoration is any activity in an area that was once a wetland that restores wetland functions (Kentula and Brooks 1993). By comparison, when you create a wetland in an area where one never existed it is called wetland creation. Restoration is the goal at Rice Lake State Park.

Methods

Data were obtained from the Minnesota Department of Natural Resources (MNDNR) Region V Geographic Information Systems (GIS) Coordinator and Parks Statewide GIS Coordinator. Historic aerial photos were obtained from MNDNR Forestry, Natural Resources Conservation Service (NRCS) Offices, and the Dodge County Highway Department for the years 1938, 1958, 1964, 1971, 1980, 1991, and 1998. The extent of the area in the study was limited to the subwatershed basin that the park is located in. The basin is approximately 10,762 hectares (4,357 acres) in size and includes the majority of the park boundary, approximately 3,932 hectares (1,592 acres) including both public and private land (Figure 1).

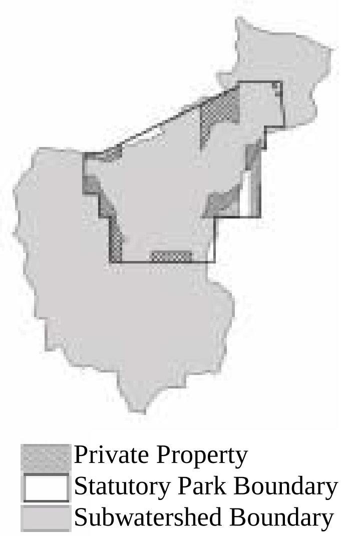

Figure 1. Subwatershed Basin and Park Boundary

The aerial photos used in the study were scanned and rectified. Wetland areas were interpreted from the original aerial photos and a data layer was created for each year to represent the wetlands identified. Coverages were also created from the United States Geological Survey (USGS) topographic map wetlands, National Wetland Inventory (NWI) wetlands, and NRCS wetlands. All of these coverages were combined into one coverage to identify wetlands that existed between 1938 and 1998.

The combined wetlands coverage was used with the soils data, which were classified by vegetation type, to determine where potential wetland areas might occur. Potential wetland areas were deemed those areas where a wetland had occurred between 1938 and 1998, and occupied the same area as a hydric soil. Hydric soils are those soils that generally occur in wet areas, as identified in the soils survey. The areas identified by this method that were not currently wetlands were noted as potential restoration sites. These wetland restoration sites were prioritized according to current site conditions, the ease of restoration, and park management concerns in the identified areas. The sites were visited during the 2000 field season and the above issues noted.

Statistical analysis was used to determine if the findings of the study were significant. The number of wetlands identified each year was determined and tested with the Chi-Square Goodness of Fit test (Zar 1999). This was done for wetlands in the park, the basin outside of the park, and the entire basin. The null hypothesis states that there was no difference in the number of wetlands from year to year.

A correlation coefficient was determined for the data on wetland hectares in the basin and hectares in the park. Finally a paired-sample *t* test was performed on the data to determine if the hectares of wetlands in the basin were consistently greater than hectares of wetland in the park.

Results & Discussion

Statistical Analysis

To determine if the number of wetlands had changed, data from 1938 to 1998 were tested (Table 1, Figure 2) with the Chi-Square Goodness of Fit test. The number of wetlands within the park from 1938 to 1998 has not stayed the same, while the number of wetlands from 1958 to the present has remained relatively constant ($0.75<P<0.90$). There has been a statistically significant change in the number of wetlands outside the park in the basin ($P<0.001$), and in the entire basin ($P<0.05$) from 1938 to 1998.

Table 1. Wetland numbers

Year	Wetlands in the Park	Wetlands in Basin Outside the Park	Wetlands in Basin
1938	15	30	45
1958	5	3	8
1964	6	10	16
1971	3	2	5
1980	3	3	6
1991	6	10	16
1998	5	5	10

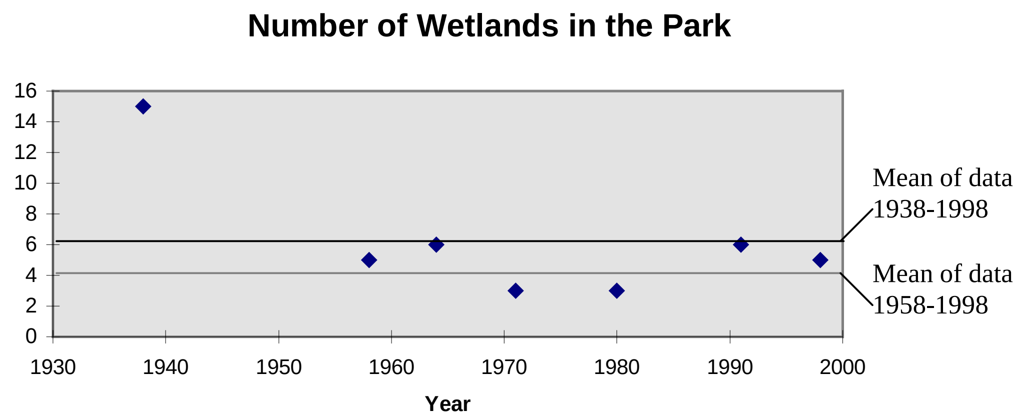

Figure 2. The dark line represents the mean of the data 1938 to 1998. The lighter line represents the mean 1958 to 1998.

When the data from within the park were tested, H_o was rejected for the years 1938 to 1998 ($0.01<P<0.025$), suggesting that the numbers of wetlands from 1938 to 1998 has not been stable within the park. When the test was repeated without the data from 1938 included, which had much higher wetland numbers than the data from the years 1958 to 1998, H_o was accepted ($0.75<P<0.90$). Thus, there was no statistically significant difference in the number of wetlands between 1958 and 1998. This may be explained by the fact that the State Park was established in 1963. No additional tiling was done on the public lands after this, and no restoration work had been completed in the park before 1998. Furthermore, the 1938 wetland observations tend to suggest what might likely have been the character of the land during pre-settlement times, and prior to modern drainage efforts. The small variations in wetland numbers within the park (1958-1998) may be due to changes in precipitation amounts, time of year the photos were taken, or changes on private property within the park boundary.

Next, the number of wetlands in the basin outside the park was tested (Table 1, Figure 3) with the Chi-Square Goodness of Fit test. For the years 1938 to 1998 H_o was again rejected ($P<0.001$). The data between 1938 and 1998 did not remain constant. When the test was repeated with the data from 1938 removed because they appeared to vary from the data between 1958 and 1998, H_o was still rejected ($0.025<P<0.05$). Therefore, the number of wetlands from 1938 to 1998 was statistically different. Historical aerial photos support this as well. The variations in wetland numbers observed between 1938 and 1998 on the historical photos could be due to changes in precipitation, seasonal changes, or changes made through artificial drainage.

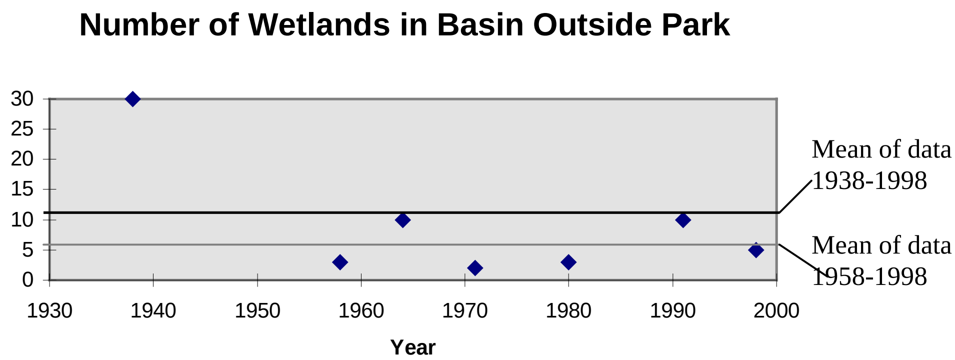

Figure 3. The dark line represents the mean of the data 1938 to 1998. The lighter line represents the mean 1958 to 1998.

Finally, data from the entire watershed basin were tested (Table 1, Figure 4). H_o was rejected for the data between the years 1938 and 1998 ($P<0.001$). When the data from 1938 were removed because they appeared to be outside the data set, H_o was again rejected ($0.025<P<0.05$). It can be concluded that the number of wetlands from 1938 to 1998 was statistically different. This concurs with the results from the basin outside the park. The park accounts for a smaller portion of the total number of wetlands within the basin in most years (Table 1), and therefore, the wetland numbers for the entire basin should follow the pattern established by the data in the basin outside the park, resulting in numbers differing in the entire basin over the period 1938 to 1998.

The data from 1938 in all three instances were much higher than the data from the year 1958 and later. This may be due to the fact that agricultural fields were not commonly tiled before 1938 due to installment methods and costs. Around 1938 tiling was just beginning and clay tiles were laid by hand. As the years progressed, machines were developed to install plastic tile, and the cost of installing tile decreased. Therefore, more drainage tile was installed, reducing the number of wetlands in the basin. As different generations farmed the land, tile was replaced and the tiling system expanded (Dunning and Queen 1997). In the later part of the period studied (1938-1998), wetland benefits became recognized and some restoration may have occurred in those areas that were previously marginal agricultural lands. This would affect the numbers of wetland in the study area outside the park. The years 1964 and 1991 contain more wetlands than the other years studied. One reason for this may be precipitation amounts. There are data (Table 2) that depict 1991 as a year of higher rainfall amounts than other years included in the study. There

Table 2. Precipitation totals for Steele County, MN (DNR Waters)

Year	Precipitation (cm)
1975	71.7
1980	59.7
1991	107.0
1998	80.0

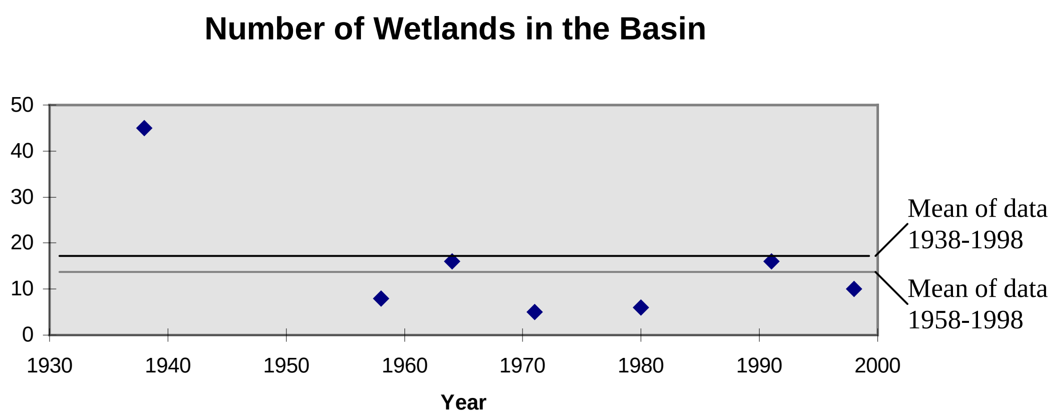

Figure 4. The dark line represents the mean of the data 1938 to 1998. The lighter line represents the mean 1958 to 1998.

was no precipitation data available for Steele County in 1964, but high precipitation amounts may be the cause of the high wetland numbers in this year also. Another explanation may be the fact that the aerial photos for 1964 and 1991 were taken in spring and early summer. Wet areas from spring thaw and spring rainfalls would be easily identified on these photos, and since the vegetation cover in the fields had not grown enough to cover the ground, standing water would be easily identified on the photos. The other photos were taken later in the year (Table 3) when small shallow wetlands have generally dried and/or rainfall amounts tend to be less.

Table 3. Wetland hectares in the study area

Year	Wetland hectares in Basin	Wetland hectares in Park
1938	241.1	176.6
1958	223.8	218.6
1964	236.9	210.0
1971	183.3	182.3
1980	186.2	185.0
1991	221.6	194.4
1998	202.3	183.8

The correlation coefficient (Zar 1999) was determined for the data in the basin and in the park (Figure 1). It was determined that there was no significant correlation in the change of hectares of wetlands between the basin and park ($0.10<P<0.25$). The correlation coefficient, r, was 0.39. This is a positive correlation, but not a strong positive correlation. If the amount of wetland area changes in the basin, a person cannot reliably conclude that the numbers in the park also changed. The park has been managed as a recreation area, which contains grassland and wooded areas. Areas that are not in public ownership have been managed for agricultural crops and tile has been added in areas that would remove some wetlands, while other areas may have had wetlands restored on them. This would account for the lack of change in the park while changes have occurred outside the park.

A paired-sample *t* test (Zar 1999) was applied to the wetland area data from the basin and the park (Table 3). The null hypothesis, stating that the area of wetlands in the basin was the same as in the park, was rejected (0.025<P<0.05). This indicates that the area of wetlands in the basin will generally be greater than the area of wetlands in the park. This is logical since the basin includes the wetlands that are located in the park.

Change in Wetland Numbers

There may be a few reasons why the number of wetlands has changed. First, precipitation amounts change year to year (Table 2). Using aerial photography to obtain data from several years helps to locate wetland areas that may appear differently due to local rainfall changes (Wenzel 1992). The timing of the precipitation relative to the flight date is also important. If an area experiences higher amounts of precipitation than normal, but it is concentrated during a short time, an aerial photo may not capture the short-term effects of the precipitation.

Table 4. Flight dates of aerial photos

Year	Date
1938	April &June
1958	July 7
1964	June 5
1971	July 31
1980	July 23
1991	April
1998	October 13

Second, it is important to note the flight dates. Some photos used for this study were taken in the spring, some in mid-summer, and one in the fall (Table 4). The expected pattern would be to find more wetlands during the spring months and fewer in the summer and fall. If all the photos had been taken at the same time of year the wetland numbers may have been different from what was observed in this study.

Third, it may be the history of draining and then restoring wetlands, as explained previously, that creates the pattern shown by the data (Table 1). The numbers of wetlands should be high in the early part of the period studied, drop in the middle portion of the time period studied, and then start to rise again in the mid to late 1980's. This change is not shown in the data. Reasons for this may be either of the factors listed previously.

Fourth, it may be a combination of the factors (Table 5). Heavier precipitation in the year 1991, coupled with the fact that the photo was taken in the spring, may explain the high number of wetlands that were noted that year. The other two photos taken in the spring or early summer, 1938 and 1964, also show higher numbers of wetlands. The photos that were taken in the mid-summer months have fewer numbers of wetlands identified. The photo from 1998 was the only fall photo and also the only Color Infrared (CIR) photo. Although this photo is from the fall, which tends to be drier, CIR photography is generally used for water detection because water shows up well, which may explain why there were larger numbers of wetlands noted in this year.

Table 5. Data according to season aerial photos were taken

Date	Year	Rainfall (cm)	Wetlands in the Park	Wetlands in Basin Outside the Park	Wetlands in Basin
April	1991	107.0	6	10	16
April & June	1938		15	30	45
June 5	1964		6	10	16
July 7	1958	59.7	5	3	8
July 23	1980		3	3	6
July 31	1971	71.7 (1975)	3	2	5
October 13	1998	80.0	5	5	10

Lastly, it may be that other factors unknown to the author have produced the pattern shown.

Restoration Sites

The fact that there were areas of potential wetland restoration suggests that historically there were more wetlands in the park. These wetland sites, if restored, may provide the wetland benefits that people have come to appreciate, including habitat for wildlife, retention of floodwaters, and filtering of groundwater. These sites have been prioritized by considering the current conditions of the site, the amount of work that needs to be done for restoration, and management concerns of the park. Those areas that exhibit signs of wetland restoration potential, such as having vegetative characteristics of wetland areas, hydrology of wetlands, or hydric soils should be the highest priority for restoration efforts (Figure 5). The site visit was the most important step in the entire process to ensure that the analytical process provided valid results. The site visit allowed verification that the site appeared restorable, which means that topography and hydrology of the areas were such that a wetland could potentially exist in the area.

Area number one is a restored wetland that needs follow-up work to ensure the success of the project. This wetland has a diverse mix of sedges and forbs, but there are a few areas of reed canary grass (*Phalaris arundinacea*), an undesirable exotic, that are slowly expanding into the restoration area. There may also be opportunities to restore additional basins in this area.

Area two contains partially functioning tile lines. There are some blockages in these lines causing erosion problems along the park trail in this area. The tile is still draining the area, as is evident from the blowouts causing the erosion problems. Restoration would include plugging the tile lines, which should restore the natural hydrology of the area. Having wetland hydrology means the soil is saturated within the root zone for a period of time during the year (Kent 1994). The wetland in this area may not hold water for long periods of time because of the lack of terrain. The existing native forbs and sedges

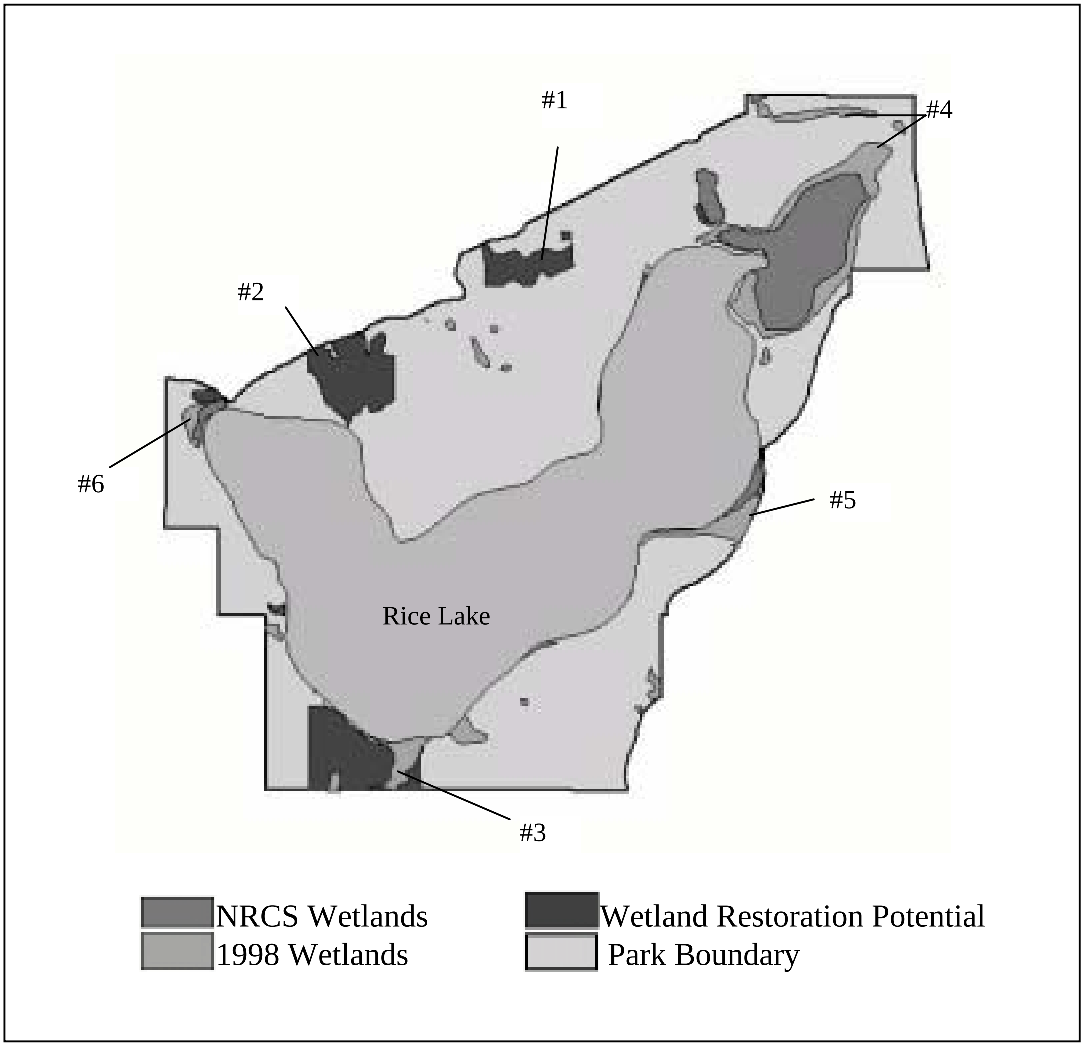

Figure 5. Prioritized wetland restoration sites

would aid the native vegetation establishment efforts that would be part of the restoration project.

Area three would provide important water filtering capabilities and water quality protection for Rice Lake. There is a ditched stream that enters the lake at this site, with grasslands surrounding the ditch that were previously agricultural fields. There is also a remnant prairie in this area. Any restoration work done in this area should not affect the prairie. There may be additional concerns with the cultivated private land adjacent to the park property.

Area four would require management for native species. There is no known artificial drainage in this area, but control of exotics would be a large task.

Area five is past the dam at the lake outlet. Control of reed canary grass (*Phalaris arundinacea)* in this area will be difficult. Reed canary grass seed that is deposited into the lake exits at this point and will provide a seed bank and ongoing maintenance challenge for park personnel.

Area six would be difficult to restore due to lack of access to the site and concerns with adjacent cultivated land. Currently, this area is a grassland area that is not actively managed.

Issues Of Uncertainty

This project used data from a variety of sources. The data and their sources contributed issues of error to the project that had to be carefully considered. These issues included soil data quality, aerial photography, file size, wetland information source, and missing data in the results. These will be discussed in detail.

Soil Data Quality

The soils data for Steele and Dodge Counties were classified differently, which made the data difficult to interpret. To solve this, the original soils coverage (Figure 6, Illustration A) was simplified by using the soils survey to classify the soils data by the vegetation that was growing in the area when the soils were originally forming (Figure 6, Illustration B).

Another factor was the quality of the data that were available. There were no Soil Survey Geographic (SSURGO) soils data for either county the basin lies within. SSURGO data provides detailed information designed for uses including natural resource planning and management. The soils data used were a less detailed data set which did not offer the consistency that SSURGO data offers, county to county. The Soil Conservation Service (now the NRCS)

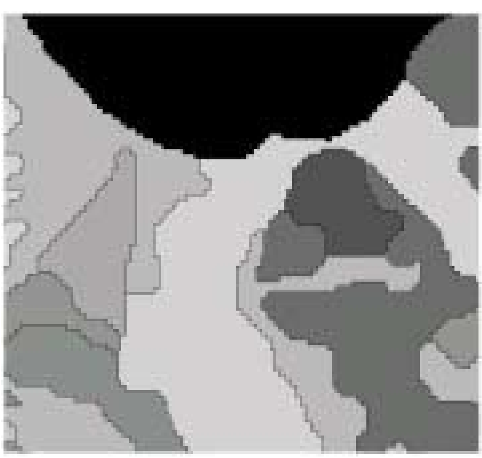

Illustration A

Illustration B

Figure 6. Soils as classified in the soils data in Illustration A. Soils classified according to vegetation, as listed in soils survey, in Illustration B.

and the Minnesota Agricultural Experiment Station originally collected the existing soils data in the field between 1946 and 1962. The soils information was collected to identify what soils existed in Steele County (Soil Survey 1973).

Aerial Photography

The aerial photos that were used for this study also created concerns. These included aerial photography errors, varying flight dates, and types of photography used. These are discussed in further detail.

Errors

Errors are always associated with aerial photography. These range from atmospheric conditions to lens distortion. Every time aerial photographs are used, these errors need to be considered.

Flight Dates

Flight dates are important factors when trying to compare data interpreted from aerial photos. The flight dates from the photos used for the study ranged from April to October (Table 3). One issue was the amount of vegetation cover of the agricultural crops. The more vegetation that covers the ground, the less that can be seen from aerial photography. Another issue was seasonal changes such as temperature and rainfall amounts, which affect the occurrence and size of wetland areas.

Photography

Two types of photography were used for this study, black and white photography and CIR photography. Black and white is the most common because it is the least expensive, most versatile, and most stable type of photography. The DNR Division of Forestry had the CIR photography taken because they used the photos for forest cover type identification. This photography is very good for interpretation of vegetation and water detection, but is not as stable as black and white. When the two types of photography are used together, it must be noted that CIR photography will make water identification easier, and therefore, introduce yet another variable to the study.

File Size

The extension EPPL7, which is used with Environmental Systems Research Institute's ArcView software, was used to rectify the scanned aerial photos. These files were saved as 256 color TIF files because they were much smaller than other types of color image files. This allowed for rectification and manipulation in ArcView. This is an issue because of the poor quality of the 256 color files, which did not allow interpretation of the images, the original photos were used for interpretation. The wet areas were located on the original photo and then digitized on screen by looking for the area on the image, which generally was shown as one or two pixels that were darker in color. The images could have been saved as six million color images, which would have provided a high quality image, but the software used for the study would not handle files of this size for analysis.

Wetland Information Sources

Using only one source of information to identify wetland sites is undesirable because many sources only represent what was present at one specific point in time. Therefore, it is important to collect wetland information from as many sources as possible.

Topographic maps note wetland symbols in areas that were considered wetlands at the time of mapping. There is no delineation information associated with these maps. Using topographic maps to create wetland polygons is very subjective since the interpreter has to choose how big the wetland polygon should be. Another issue with topographic maps is that there are no dates identifying when the map was made. The dates on the map represent the dates of field checks and printing dates. Wetland maps from the Natural Resources Conservation Service show non-cropland that is considered to be on hydric soils. Any wetlands that may currently be under tillage are not considered, and Dodge county NRCS aerial maps did not identify these non-cropland wetland areas.

National Wetland Inventory maps were created from a joint United States Fish and Wildlife Service and State of Minnesota project that created a database of wetlands. This data came from interpretation of National Aerial Photography Program (NAPP) imagery from between 1979 and 1988, USGS topographic maps, and soils surveys. Even though the NWI data were created from the same sources used in this project, the wetlands mapped from the NWI data were very different from those mapped from other sources (Figure 7). The differences may come from the fact that the NWI wetlands were originally located in different years, from different flight dates, interpreted from different types of photography, or had different interpreters identifying wetlands.

Missing Data

The potential wetland site information, derived from the historic and current wetland information and hydric soils information, was missing areas that were of importance because tile lines were known to occur in these areas. When the NRCS wetland data were added to the potential wetland sites, the potential wetland areas that were missing were

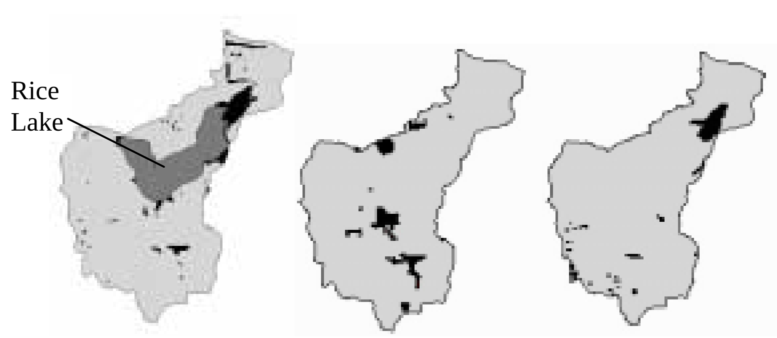

Figure 7. NWI wetlands, NRCS wetlands, topographic map wetlands, left to right

identified. However, in the historic photos, no wetland ever appeared in these areas.

General Comments

The issues described above lead to using information that is suspect to determine where current wetlands might be expected to occur in the park. However, by combining data from all of the information sources, an educated estimate about potential restoration areas can be made. Areas that are already wet probably do not need restoration of wetland functions. Areas that occur in sand or some other well-drained soil types are not considered as candidates for restoration.

Conclusions

Statistical analysis confirmed that the numbers of wetlands within the basin have changed between the years 1938 and 1998. Six separate areas were identified as potential restoration sites within Rice Lake State Park. These sites have been prioritized and could be considered for restoration as opportunities arise.

The methods followed for this study produced valid results and this same process could be used in other areas to determine wetland restoration potential. This wetland restoration site identification tool is useful to identify valid wetland restoration sites to protect the wetland values that people have come to appreciate and will benefit people and wildlife both.

Acknowledgments

I would like to acknowledge Mr. William Marken and Mr. Ron Danielson of the Minnesota Department of Natural Resources for providing data and advice during the project, and Mr. Marken for allowing me to use his equipment. I would like to thank the Minnesota State University - Mankato Geology Department for the soils data used for the study. I would like to thank the Parks and Recreation Division for providing partial funding for this project. I would also like to thank my project advisors Dr. David McConville, Mr. Dean Mierau, and Mr. William Marken for their support, encouragement and advice.

References

"Annual Reports of Monthly Precipitation Totals" http://climate.umn.edu/annual_summary Department of Natural Resources Division of Waters.

Binstock, Leonard. 2000. Personal communication. Wasioja, MN.

Dunning, Kara M. and Queen, Lloyd P. 1997. A Digital Method to Inventory Converted Wetlands [dissertation]. St. Paul(MN): University of Minnesota. 24p. Available from: University of MN Magrath Government Publication Library, St. Paul, MN; MN-DOC no. 97-0510.

Galatowitsch, Susan M. and van der Valk, Arnold G. 1998. Restoring Prairie Wetlands: An Ecological Approach. Ames: Iowa State University Press. 236 p.

Hey, Donald L. and Philippi, Nancy S. 1999. A Case for Wetland Restoration. New York: John Wiley & Sons, Inc. 215 p.

Kent, Donald M. editor. 1994. Applied Wetlands Science and Technology. Boca Raton: Lewis Publishers; 436 p.

Kentula, Mary E. and Brooks, Robert P. 1993. An Approach to Improving Decision Making in Wetland Restoration and Creation. Boca Raton: C.K. Smoley, Inc. 151 p.

Minnesota Department of Natural Resources Office of Planning. 1983. A Management Plan for Rice Lake State Park. St. Paul (MN). Document #3771E: Department of Natural Resources. 33 p.

United State Department of Agriculture. 1973. Soil Survey Steele County Minnesota. Soils and Water Conservation District Office, Steele County, MN. 102 p.

Wenzel, Thomas A., P.E. December 1992. Minnesota Wetland Restoration Guide. Minnesota Board of Water and Soil Resources: Duluth, MN.