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Department of Horticultural Science
University of Minnesota, St.Paul, MN

The Swan Lake Restoration Project (Minnesota)

Cyrus Mahmoodi

Introduction

At roughly 10,000 acres (4,000 ha), Swan Lake located in Nicollet County, Minnesota, is considered the largest prairie pothole lake to exist within North America (Figure 1.). Throughout its 11,000-year history the water level of Swan Lake has varied significantly. Today, five county ditches and two intermittent streams drain into the lake and a single ditch on the south end of the lake is the only outlet (Schultz, 1985). The original 10,800 ha (27,000 acres) Swan Lake watershed was subjected to regular severe droughts occurring every 30-35 years as well as sustained periods of above normal water levels (MnDNR, 1987). There is evidence that the lake may have been as much as 3.05 m deeper than it average depth of 1.22 m today (Krohn, 2000).

The annual level of precipitation of the prairie pothole region varies dramatically. Prairie glacial lakes and marshes have adapted to these naturally occurring cyclic fluctuations of precipitation. Sustained high water levels will eventually eliminate emergent vegetation. Squires and van der Valk (1992) found that the growth of several species of mid- and lower level emergent wetland plants (*Carex atherodes, Scolochloa festucacea, Phragmites australis, Typha glauca,* and *Scripus lacustris*) were inhibited when water depths exceeded 70 cm for over two years. Furthermore, increased water level depths inhibit the germination of seeds from existing seed banks subsequently precluding new plant recruitment (van der Valk and Davis, 1978). When low precipitation years return water levels drop, exposing the marsh bottom. The newly exposed seeds quickly germinate promoting the reestablishment of emergent vegetative stands (van der Valk and Davis, 1978). Up until the mid-1950's Swan Lake was still subjected to these natural cyclic weather patterns and still remained in relatively good health even with the changes brought on by more intensive farming practices in the upland areas of the watershed. In the late 1950's the installation of a fixed crest water level structure at the outlet, affected the natural wet/dry cyclic equilibrium of the lake. Many years of sustained high water levels ensued, causing a significant degradation of the emergent vegetation in Swan Lake.

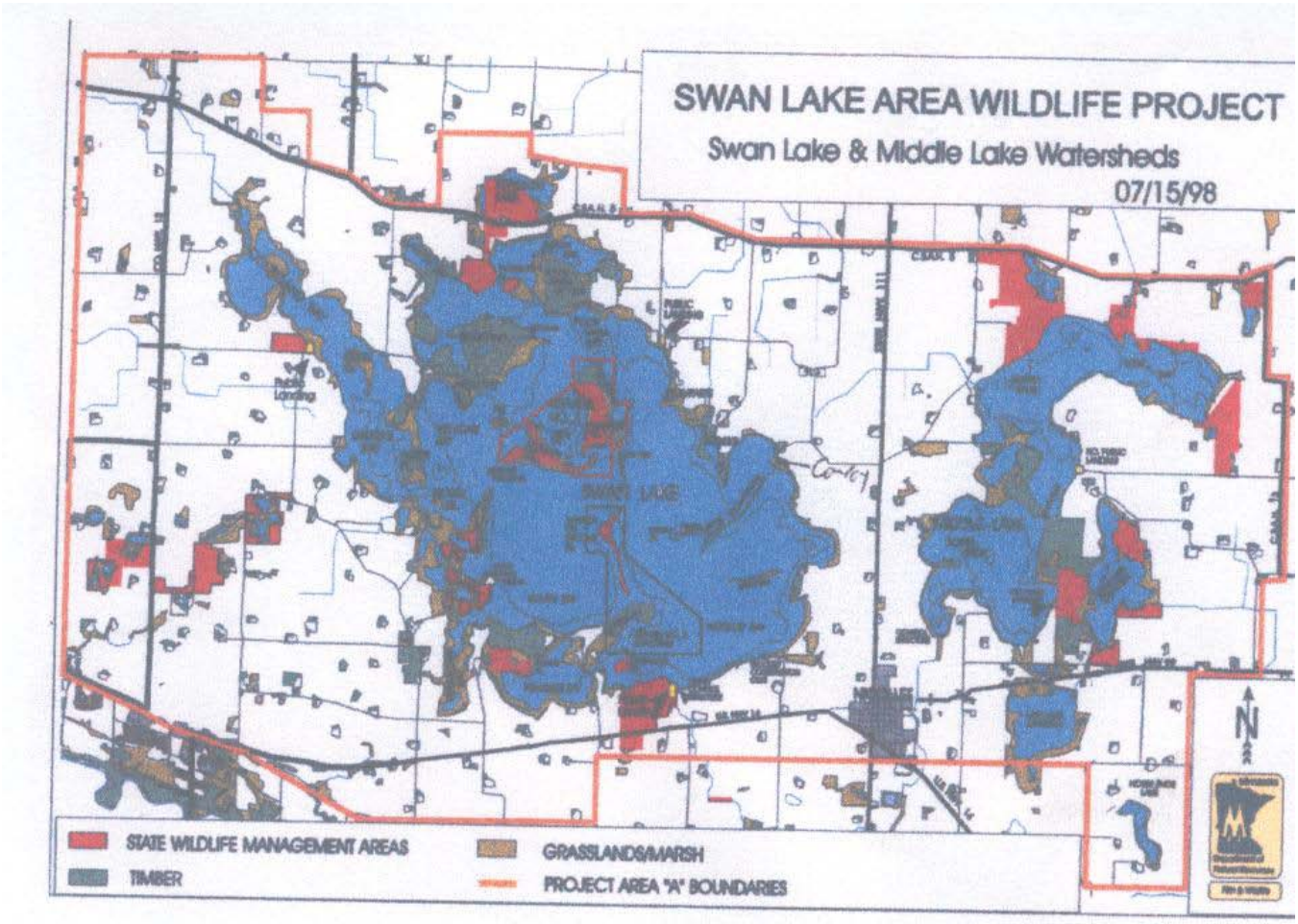

Figure 1. Delineation of Zone A. A total of 2800 ha (7000 acres) are to be acquired with in this zone by the state of Minnesota. Zone B. extends south of zone A. ending at the southern Niccollet County border. To date no land has been acquired by the Swan Lake Area Wildlife Project. Map provided by the Minnesota Department of Natural Resources, Swan Lake Area Wildlife Office, (1998).

Background History

Historically, Swan Lake and associated upland areas have had an abundance of wildlife, attracting many indigenous people to its shores. Archeological sites adjacent to the 11,000-year-old glacially created basin provide evidence that three distinct groups of indigenous people lived on the shores of Swan Lake. The first group, a paleo-Indian culture started using the area as far back as 8000 years ago, with their population peaking some 3000 years ago (Krohn, 2000). It's speculated that this hunting-oriented culture was attracted to the lake by the abundance of wildlife in the area, particularly waterfowl. The second group, the farming-oriented Mississippian culture made its summer home on the shores and islands of Swan Lake, approximately 1000 years ago. The last group, the Dakota/Sisseton Indians made their home on the shores of Swan Lake for nearly three hundred years before first European contact. They subsisted primarily by hunting and farming the area. As more and more settlers began arriving in the mid 1800's conflicts between the settlers and the Dakota Indians arose, eventually leading to the complete banishment of the Dakota by the United States government, in 1862 (Krohn, 2000). The settlers began farming the region more intensely. The land was cleared of trees and ditches were dug to

divert water from farmable areas within the watershed. In the beginning the land was used primarily for dairy production.

Even as late as the late 1950's Swan Lake was still considered to be a more or less healthy, self-sustaining ecosystem. Drought in the early 1900's and again during the 1930's were both followed by normal to high precipitation periods (MnDNR, 1987). Swan Lake continued to function both as a breeding area for waterfowl such as blue-wing teal (*Anas dicors)* and mallards (*Anas platyhynchos*) and a staging area for migrating waterfowl like lesser scaup (*Aythya affinis)* and canvas back (*Aythya valisineria*). Suitable food and cover were still relatively abundant. Disturbances caused by dairy production in the upland areas of the watershed didn't seem to have a great impact on brood production of upland nesting waterfowl. Periodic water level fluctuations continued to occur, promoting emergent vegetative growth during years of below average precipitation, providing both food and cover for waterfowl. In fact, from the turn of the century until the 1950's, the lake supported a large number of market hunters who would travel in the fall by train to its shores, harvesting waterfowl for restaurants as far away as Chicago. During the late 1950's farming practices within the 10,800 ha (27,000-acre) Swan Lake watershed began to change. Pasture and hay fields associated with dairy production were plowed under in lieu of intensive row cropping practices. As drain tile was installed and a countywide ditch network dug, the hydrology with in the Swan Lake watershed changed. Water diverted via the network of drain tile and county ditches effectively reduced the size of the Swan Lake watershed nearly forty percent to approximately 6600 ha (16,500 acres) today. There was even an attempt led by a local farmers coalition in 1917 to drain Swan Lake; a ruling by the State Supreme Court in 1924 upholding a previous district court ruling prevented it.

In 1957 the Commissioner of Conservation authorized the installation of a sheet pile fixed crest control structure to maintain the water level at the ordinary run out level of 298.9 m Mean Sea Level Datum ([MSLD] MnDNR, 1989). Several years of above normal precipitation followed the installation of the water control structure. The fourteen foot wide spillway was inadequate in size to handle the water outflow. The water level stayed consistently above the 298.9 m MSLD (MnDNR, 1987). In 1970 the Soil Conservation completed a feasibility study to determine how the water control system could be changed and the outflow ditch enlarged to handle additional outflow from Swan Lake to maintain the desired water level. The plan was not implemented due to high costs. After additional years of higher than average precipitation the Minnesota Department of Natural Resources (DNR) requested the lake be classified as a Wildlife Management Lake, in 1972 (MnDNR, 1989). The designation of Swan Lake as a Wildlife Management Lake in 1973, by the Game Lake Designation Program, gave the DNR the authority to manage the lake for wildlife. The DNR immediately authorized a drawdown of Swan Lake. The drawdown was hampered for several years by the inadequate size of the dam and the volume of water the drainage ditch could convey. It wasn't until a natural drought during 1975-1976 that the lake completely dewatered. Once complete the DNR installed a new 20 foot long fixed crest water control structure. The new structure had only two fixed water level points; 297.2 m MSLD and 298.9 m MSLD. Once again several years of high precipitation followed and the emergent vegetation of Swan Lake began degrading. At this time several local conservation organizations concerned about declining waterfowl populations, petitioned the DNR to formulate a long-term restoration plan for Swan Lake (MnDNR, 1987).

The Precursor of the Swan Lake Restoration Plan

In 1984 a comprehensive study sponsored by the Minnesota Waterfowl Association, was initiated to determine the overall degradation to Swan Lake and the surrounding upland habitat and develop management strategies to enhance waterfowl production. The objectives of the study were the following; to estimate the number of successfully breeding waterfowl using Swan Lake; to elucidate the factors limiting the production of waterfowl; to perform a census of food and cover available to waterfowl by

Swan Lake and the surrounding uplands; to evaluate the effects of past and present water levels and its influence on the distribution and abundance of aquatic vegetation; and to monitor the use of the lake by migrating waterfowl (Schultz, 1985). In 1985 the results of the study were used to formulate the Swan Lake Restoration Plan.

Results of Study

In 1947, Swan Lake produced approximately18,000 ducks per year (Smith, 1947), by 1984, Schultz (1985) estimated that less than 100 ducks were produced per year. In fact, they only observed 8 broods of ducks during the summer of 1984. Of the 24 active duck nests that were found that year, thirteen hatched (43%). Eleven of the twelve nests over water hatched successfully (92%) and only one of the remaining twelve nests found on adjacent uplands hatched successfully (8%). Schultz observed mowing had destroyed 48 of 49 duck nests located in alfalfa fields. The nesting success of the ducks in the upland cover (8%) was less than the 15% needed to maintain a static population (Klett et al, 1988). Schultz (1985) postulated that the nests over water were isolated from predators more effectively than the upland nest sites. The upland nests were further exposed by the intensive agricultural farming practices, which limited the nesting area and concentrated the mammalian predators.

Schultz (1985) found that changes in water level had pronounced effects on the density and distribution of both emergent and submergent vegetation in Swan Lake. Prolonged stabilized water depths have detrimental effects on emergent aquatic vegetation (Harris and Marshall, 1963). Many species of emergent aquatic plants need bare mud flats for successful germination and establishment (Harris and Marshall, 1963). The longer the period of time the water level of Swan Lake remained high, the greater the area of open water (Schultz, 1985). Wind-induced wave action in unprotected open areas causes the suspension of detritus from the lake bottom increasing turbidity (Dieter, 1990). Schultz (1984) found the turbidity was inversely proportional to the percentage emergent vegetative cover in Swan Lake. As the area of open water increased, the turbidity of Swan Lake increased. Turbidity decreases the depth that light can penetrate the water column, thus inhibiting the growth of emergent and submergent vegetation (Chow-Fraser et al. 1998; Chambers and Prepas; 1988, Dieter 1990; Skubinna et al., 1995). The relative abundance and diversity of submergent vegetation decreased as the turbidity increased in Swan Lake (Schultz, 1985).

The Swan Lake Wildlife Project

Based upon the results of the intensive study of Swan Lake by Schultz (1985) a ten-year Swan Lake Area Wildlife Project was proposed by the Minnesota Department of Natural Resources in 1986. The ultimate goal of the project was to restore Swan Lake to the point where the lake would produce 10,000 ducks per year by 1997. The Legislative Commission for Minnesota Resources (LCMR) recommended that Minnesota legislature appropriate 2 million dollars to initially fund the project. Once the money was appropriated, additional monies were matched through grants from the North American Wetlands Conservation Act (NAWCA) and through private conservation organizations such as the Minnesota Waterfowl Association, Ducks Unlimited, the Nature Conservancy, and Nicollet Conservation Club. Once funded, the plan called for two major approaches to accomplish its goal: the development of a water level management plan and the acquisition and restoration of 3200 ha (8000 acres) of upland habitat. In order to implement and manage the long-term restoration plan, a project supervisor and a small staff were hired by the DNR and stationed nearby in the town of Nicollet, Minnesota.

Water Control System Management Plan Implementation and Maintenance

A feasibility study performed by the DNR Bureau of Engineering for upgrading the outlet structure was completed and submitted to Ducks Unlimited for funding (MnDNR, 1989). Ducks Unlimited funded the

project and committed $280,000 for its completion. Ducks Unlimited supervised the project construction until completion in December 1988. A 26.2 m long steel sheet pile weir with earthen embankments replaced the existing 6.1 m fixed crest sheet pile dam (MnDNR, 1989). Eight, 1.42 m stop longs were used to allow the DNR personnel to control the water level of the lake. An additional 3 miles of the downstream outlet ditch were improved to accommodate water drainage through the dam. The goal of the water control structure is to provide optimum growth and species composition of aquatic vegetation by water level regulation thus promoting the waterfowl population goals of the project (MnDNR, 1989). Water levels are managed to promote the regeneration of emergent vegetation through periodic drawdowns of up to 1.52 meters to a level of 297.4 m ft MSLD. A ratio of 50:50 emergent vegetative cover to open water areas will be maintained in the shallower bays through periodic minor water level manipulations of 0.30 meters or less (MnDNR, 1989). The Swan Lake Area Wildlife Project Steering Committee must review any proposed major drawdown, submitted by the DNR Nicollet County Wildlife Office before being approved.

The first draw down preformed using the current water control structure began shortly after installation. The drawdown was accentuated by below normal precipitation during the spring and summer of 1989. Lake water levels recovered by 1991 and the management outlet flow level was set at 298.6 m MSLD. Several years of high precipitation followed 1991 as well as an explosive increase in muskrat population to several hundred thousand animals, causing the near elimination of emergent vegetation by 1997. A second draw down of two feet was initiated during the fall of 1997 and continued until August of 1998, to reestablish the emergent vegetation. No other drawdowns have been performed since.

Acquisition, Planting and Maintenance of Upland Areas

The Swan Lake Wildlife Plan originally allocated funds for the acquisition of up to 2800 ha (7000 acres) within Zone A (figure 1.), which includes the areas immediately surrounding both Swan Lake, and nearby Rush Lake. The plan also calls for an additional 400 ha (1000 acres) to be acquired within Zone B, which extends into southeastern Nicollet County. To date only 1200 ha (3000 acres) of the 3200 ha (8000 acres) originally slated for acquisition have been purchased, all in Zone A. Recently acquired land is seeded with mixtures containing 5-6 species of native grasses (e.g. *Buoteloua curtipendula, Pancium virgatum, Sorghastrum nutans*) as well as 10-20 native forb species (e.g.*Ratibida columnifera, Dalea purpurea, Monarda fistulosa*). Rotational prescribed burning occurs on a regular basis. Depending upon the quality on the area to be burned it may or may not be interseeded with native species to increase the diversity and quality of particular sites (Anderson, 2001). Older sites dominated by a single or a few species of native grass are left alone due to the difficultly of adding native forb species which get out competed by the grasses (Anderson, 2001). All public rights of way are managed for native plant species as well.

The results of a three-year (1988-1990) survey evaluating the nesting success of *Anas discors* (Blue-wing teal) and *Anas platyrhynchos* (Mallard) indicate poor nesting conditions in the upland areas of the Swan Lake watershed (Moeller, 1990). The survey divided state and privately-owned upland areas into the following five vegetative cover types; *Bromus ciliatus- Medicago sativa* (brome-alfalfa), *Phalaris arundinacea* (Reed canary)-wet meadow, old field-pasture, mixed grass-roadsides, native prairie or native grass plantings, and small grain fields. The survey did not mention the specific vegetative composition of the other cover types. The nesting success on state-owned *Phalarisarundinacea*-wet meadow upland cover had the highest nesting success of 16.7% during the three-year survey. The old field-pasture cover type had the next highest success rate at 14.3%. The native grass cover type had a 6.5% nesting success rate (Moeller, 1990). No nests were found in the small grain fields. Only three nests were found along the roadside ditches during the study, one hatched successfully during the survey period. The overall nest density of the total 1397 acres searched was 0.104 nests per acre.

Predator density counts were preformed in the Swan Lake Project Area from 1987-1993. Counts of red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and raccoon (*Pricyon lotor*) remained somewhat static with in the area during the last three years. Coyotes (*Canis latrans*) began to appear in 1990 (MnDNR, 1993). The Department of Natural Resources is planning to study the effects of an electrified mammalian predator enclosure on the nesting success of ducks beginning in the spring of 2002. Past studies have indicated that electric fences reduce mammalian predation on duck nests (Lokemoen et al., 1982).

Additional land acquisition has been minimal in recent years due to lack of support by the Nicollet Board of County Commissioners. The Board has been reluctant to approve any land sales to the state, which involve what the board regard as high quality farm ground. The tax generated for the county, by privately held farmland is higher than the in lieu taxes paid by the state, for state-owned the land. Another past limitation has been the failure of the state to acquire land in a timely fashion. Funds for acquisition can take as long as a year to appropriate through bureaucratic channels. To overcome this delay, the Nicollet County Conservation Club buys available land on the private market and then resells the land to the state when funds become available.

Additional Studies and Management Techniques

Based upon the initial success of the 28 nest baskets placed on the lake in 1985 and the low duck nesting success (<10% overall) in the upland areas of the Swan Lake Wildlife Project, DNR wildlife personnel started augmenting the number of nesting baskets used, to increase the production of ducklings. By 1992, 250 nest baskets were installed. Placement and maintenance of the nesting baskets is labor intensive. The baskets need to be checked for weather damage each year and nesting material needs to be replaced. Local wildlife managers enlisted the aid of the Nicollet County Conservation Club to help with the endeavor. The Department of Natural Resources conducted two studies to determine the benefit of the nesting baskets. Both studies found that nest basket use increased annually (Emerson, 1991, and Pernu, 1991). In 1987 nest use was 24.9 percent and by 1991 nest use was 55.8 percent (Pernu, 1991). Doty (1974) found that ducks hatched in a nesting structure returned to the same structure to nest the following year, increasing the use of nesting structures every year. Nesting success of mallards using the structures was 71% (Emerson, 1991). Currently the Nicollet Conservation Club oversees the maintenance and installation of nesting structures. The number of nest baskets used each year is dependent upon the water level and the amount of emergent cover (Hamlin, 2001).

Water Quality

Water chemistry tests indicate Swan Lake has a relatively good water quality especially in comparison to neighboring watersheds. The results of the most recent water sampling (May 14, 1997) performed at the Nicollet Creek outflow structure show that NO_3 = 2.39 ppm, PO_4 = 0.042 ppm, and total phosphorus = 0.059 ppm (Unknown, 1997). The dissolved nitrate concentration seems to be elevated when compared to past water chemistry sampling. Dissolved nitrate concentrations in Swan Lake were 0.39 ppm in 1962, 0.40 ppm in 1967, and 0.223 ppm in 1974 (Schultz, 1985). The elevated nitrate concentrations in the latest sampling were attributed to the timing of the tests that may have coincided with a spring runoff pulse (Anderson, 2001). For example, the same study shows a nitrate concentration of 15.9 ppm at nearby Hobart's Creek On May 14, 1997 but a nitrate concentration of 2.26 ppm when taken August 12, 1996.

Macroinvertebrate Study

A study with the objective to qualitatively survey the macroinvertebrate abundance, diversity, distribution, and overall biomass with relation to vegetative community occurred during 1992-1993 in

Swan Lake. Macroinvertebrates have been shown to be an important component of nesting and juvenile duck diets (Swanson, 1979). Samples from open water areas had the greatest number of invertebrates, yet had the least diversity and the smallest biomass (Olson, et al., 1993). The study found that *Typha* (Cattail) had the greatest diversity of invertebrates and the highest biomass of the four sampling site types. Based upon the results of the report Olson et al. (1993) suggest that the water level of Swan Lake should be managed in order to optimize the growth of *Typha*. A follow up study is currently being performed with the results to be published shortly.

Success and Future Improvements

The Swan Lake Wildlife Project has nearly accomplished its goal of producing 10,000 ducks per year; estimates suggest that the lake produces between 6000-8000 ducks per year. Large numbers of ducks use the lake as a staging area during their fall migration. Improvements of the water control and drainage systems have allowed the water level of Swan Lake to be managed in a timely fashion. Past drawndowns that used to take years to accomplish, depending upon weather patterns, now take a single season due to the improved water control system. When emergent vegetative stands degenerate from sustained high water levels and high muskrat foraging, managers are able to the regeneration of emergent vegetative the following growing season by lowering the lake level. The presence of emergent vegetation and the subsequent submergent vegetation ensure both food for waterfowl and habitat for macroinvertebrates used by waterfowl.

The Swan Lake Wildlife Project has fallen short in the acquisition and restoration of high quality upland acres; only 1200 ha (3000 acres) of the 3200 ha (8000 acres) originally sought have been acquired. The yearly placement and maintenance of nesting baskets is a labor-intensive activity and will be difficult to rely on as method to augment the local duck production. Nest baskets at Swan Lake are used by a relatively few species of waterfowl. In fact the nest structures may be partially responsible for the burgeoning Canada goose (*Branta canadensis*) that is causing local agricultural crop depredation. Future efforts should focus on the enhancing existing upland areas to create suitable nesting cover for species of waterfowl like northern pintail (*Anas acuta*) and gadwall (*Anasstrepera*). These species need relatively large tracts of suitable upland cover to successfully breed. They tend not to use over water nesting structures like mallards, blue-wing teal, and Canada Geese. The original study by Moeller (1990) examined a relatively small area of native grasses (<64 ha). Moeller (1990) failed to quantitatively describe the age, density, and diversity of the native cover habitat. Without this information it is impossible to determine the significance of the upland native vegetative areas in and around Swan Lake. A re-evaluation of the native upland covers in terms of ground-nesting success rates for both waterfowl and non-game indigenous species is merited.

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