2000 SUMMARY REPORT
of
Davis Lake

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
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LAKE IDETIFICATION AND LOCATION

Lake Name: Davis Lake

State: IL

County: Lake

Nearest Municipality: Wauconda

Township/Range: T44N, R10E, Section 29, SE ¼

Basin Name: Fox River Watershed

Subbasin Name: Long Lake

Major Tributaries: Owens Lake and Schreiber Lake

Receiving Water Bodies: Tamarack Lake

Surface Area: 33.1 acres

Shoreline Length: 1.5 miles

Maximum Depth: 18.0 feet

Mean Depth: 9 feet

Storage Capacity: 318.6 acre-feet

Lake Type: Impoundment (flooded wetland - 1940)

Watershed Area: Unknown

LIMNOLOGICAL DATA – WATER QUALITY

Samples were collected at the deep hole location at 3 feet below the surface and 2 feet from the bottom (14-16 feet)(Figure 1). Davis Lake was thermally stratified during the entire course of the study. This means that the lake was divided into warm upper water (epilimnion) and cool lower water (hypolimnion). The strength of stratification dictates whether these layers mix. Thermal stratification is measured in relative thermal resistance to mixing (RTRM). At an RTRM of 20, layers generally do not mix. On Davis Lake, peak RTRM ranged from 74 (July) to 32 (September). This strong thermal stratification prevented any of the high nitrogen (seasonal average 7.6 mg/L of all forms) and phosphorus (seasonal average 0.57 mg/L) concentrations in the hypolimnion from mixing into the epilimnion. Mixing of these nutrients into the epilimnion could cause a variety of water quality problems including extreme nuisance algae blooms and fish kills. During turn over, these nutrients are mixed throughout the lake but are diluted to lower levels. The extent to which these nutrients are diluted is not known. To make these types of calculations a baythmetric map with accompanying morphometric data would be needed. However, based on the water quality data gathered this past summer dilution of the hypolimnion would be minor due to the large volume of the hypolimnion and the shallow nature of the epilimnion.

The region in between the epilimnion and hypolimnion is called the metalimnion and is an area of changing water temperature and dissolved oxygen (D.O.) concentrations. Due to the process of stratification, oxygen is unable to mix into the hypolimnion. Therefore, as oxygen consuming biological processes (such as decomposition of plant material and biological respiration) increase, oxygen is stripped from the water and becomes more anoxic as the summer progresses. Within the metalimnion is the anoxic boundary, which is the point at which D.O. drops below 1.0 mg/L. At this level, no aquatic organisms (except non-photosynthetic bacteria) can live. The oxic volume becomes more shallow as summer progresses (the epilimnion becomes smaller; hypolimnion becomes larger). In Davis Lake the anoxic boundary in May was at 9.9 feet and was at its shallowest in July at 3.6 feet. Furthermore, D.O. concentrations in the epilimnion were dangerously low (below 5.0 mg/L) in July, August and September. In August, D.O. levels were so low that the surface waters, where water is most oxygenated, concentrations were near hypoxia (1.36 mg/L). In these later summer months this leaves an overwhelming majority of the lake uninhabitable by aquatic life. These low D.O. levels cause fish stress. Continual stress can eventually lead to mortality. These oxygen levels are characteristic of natural, boggy lakes such as Davis. These low oxygen levels are not problematic unless sport fishing is a management concern. Many non-game fish species are able to withstand these low oxygen conditions. However, these species are not of a high quality nature. Historically, Davis Lake has experienced fish kills as far back as 1958 and still experiences kills today.

The water quality of the epilimnion is the focus of the discussion below except where noted. The complete data set for Davis Lake is in Table 1. Overall Davis Lake has *above average* water quality in the epilimnion. Several water quality parameters had out

standing results*. Average total suspended solids (TSS), on Davis Lake during the study were 2.08 mg/L. This is over four times lower than the County average. In fact, Davis had one of the lowest single sample TSS concentrations (1.0 mg/L) of any lake sampled in Lake County by the LMU in the last five years (5th out of 358 samples). Nonvolatile suspended solids (NVSS), which is the part of TSS that is related to sediment particles, was also very low (1.38 mg/L). This is an indicator that the concentration of suspended soil particles is low. In general, all of the solids measured were well below average reinforcing above average water quality of Davis Lake in the epilimnion. Due to low TSS (and lack of excessive algal growth), Secchi disk depth was good. The average Secchi disk depth on Davis Lake was 8.14 feet (Lake County average is 5.0 feet). The deepest Secchi readings were in May (12.4 feet). This was the thirteenth best Secchi disk reading the LMU has recorded in the last five years (out of 338 readings). The clarity of the water at Davis Lake is almost entirely due to the massive stands of coontail. This thick plant growth takes up nutrients and stabilizes the sediment, which both greatly aid in good water clarity. However, due to the extremely *poor* water quality of the hypolimnion, water quality at Davis Lake should be considered questionable despite the high quality of the epilimnion.

Water quality is partially affected by external inputs such as runoff, stream inflow, etc. If these sources are of poor quality, water quality will be negatively effected. Davis Lake receives an appreciable amount of its water from external inputs. These inputs are of high water quality (Schreiber Lake) and questionable water quality (Owens Lake). Fortunately, the negative aspects of Owens' water quality (high phosphorus) do not seem to be impacting Davis due to the small volume of water that is transferred as well as dilution. However, this phosphorus rich water could be one of the contributing factors to the extremely high hypolimnetic phosphorus concentrations found in Davis Lake. Furthermore, there is minimal development in these lakes's watershed (currently), which keeps nonpoint source nutrient influx to a minimum. Additionally, Davis Lake has a smaller watershed and does not receive a large amount of water from this source. Over the course of the study, water levels in Davis Lake decreased by only 5.0 inches. The largest decrease in water level occurred from June to July. This coincides with rainfall amounts, which were low during this period and therefore inflow from the above sources would be minimal. Residents of the lake have stated that historically, Davis Lake has experienced water decreases by as much as 2-3 feet during extreme drought years.

The average epilimnetic pH level on Davis Lake was 7.8, which was slightly below average (Lake County Avg. is 8.65 and neutral pH is 7.0). During the course of the study the pH gradually decreased from 8.36 in June to 7.58 in September. Furthermore, average hypolimnetic pH in Davis Lake was acidic (below neutral of 7.0). In fact, Davis Lake had one of the lowest hypolimnetic pH of any lake sampled by the LMU (1995-2000 data). Hypolimnetic pH are lower than epilimnetic pHs due to biological and chemical processes. These low pH values, in both the epilimnion and the hypolimnion

* In relation to some water quality parameters, such as solids and nutrient concentrations, the lower the concentration the better the water quality (*below* average is good). With some parameters, such as alkalinity and pH, being too low (or too high) is considered problematic. With Secchi disk, the deeper the reading the better the water quality (*above* average is good).

are not unusual for a boggy lake such as Davis. This is due to high levels of organic sediment (from cattails and other vegetation), that are sources of acidic compounds such as tannins.

Another measurement of water quality is nutrient levels. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are generally the limiting factors in algal growth. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. Davis Lake has a TN:TP ratio of 24:1, which means that the lake is phosphorus limited. Average epilimnetic phosphorus levels in Davis Lake were 0.05 mg/L (Lake County average is 0.06 mg/L). Problematic algae growth usually starts to occur at levels of 0.05 mg/L and above. However, Davis Lake experienced less algae growth than would be expected with these nutrient concentrations. This was largely due to the massive amounts of aquatic vegetation, which competes with the algae for available resources. Algal blooms at Davis Lake largely consisted of filamentous growth in the form of isolated surface mats near shore that were of no real concern. However, in spring of 2001 Davis Lake has experienced a massive increase in the amount of filamentous algae growth. The cause of this is unknown but could be due to a variety of factors.

Another way to look at phosphorus concentrations and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus. TSI values are commonly used to classify and compare lakes productivity levels (trophic state). The higher the phosphorus levels the greater amount of algal biomass, which then results in a higher TSI and corresponding trophic state. Based on a TSI phosphorus value of 60, Davis Lake is classified as eutrophic (>50, <70 TSI). A eutrophic lake is defined, as an over productive system that has above average nutrient levels and high algal biomass (growth). However, this definition does not hold completely true for Davis Lake. The eutrophic classification was due to slightly elevated phosphorus levels. These elevated levels did not cause high algal biomass, which phosphorus TSI trophic state is partially based. However, due to the *massive* amount of aquatic vegetation, a hypereutrophic classification is more representative of conditions in Davis Lake. Based on phosphorus TSI, Davis Lake ranks 37 out of 87 lakes studied by the LMU (1988-2000) (Table 2). However, as stated previously, this TSI is based off of epilimnetic concentrations. If the ranking were based off phosphorus from the hypolimnion or epilimnetic samples during the late fall/winter/early spring months the ranking would be much lower.

TSI values along with other water quality parameters can be used to make other analysis of Davis Lake based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most Illinois water quality impairment assessments were listed as *None*. However, widespread aquatic vegetation was the source of impairment based on excessive plant growth ("high" use impairment). Additionally, Davis Lake is listed as having low dissolved oxygen impairment. Based on IEPA indices, Swimming and Recreational Use were listed as *partial* support, and Aquatic Life Use as *nonsupport*.

Overall use impairment was listed as *partial* support. However, these impairments are inconsequential because Davis Lake is not a high use site.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for duration of the study (*Appendix A* for methodology). The extent to which these plants grow is largely dictated by light availability. The plants need at least 1% of surface light levels in order to survive. Based on the depth of 1% light level, where plant growth could occur in Davis Lake varied on a monthly basis. However, due to the good water clarity in Davis Lake, which is itself largely due to the aquatic vegetation, plants were able to grow throughout most of the lake regardless of depth. Light penetration measurements show that aquatic plants could have grown to a depth from < 11 feet (August) to as deep as 15 feet (June). Only one species of plant was found at these depths, coontail, and was the only species found to occur in water deeper than 6 feet. This phenomenon, with coontail occurring all the way to the 1% light penetration depth, occurred in all months of the study. Coontail plants deeper than 9 feet were reduced in structure and had a noticeable dark appearance to them. This is typical of coontail found at deeper depths. This is an adaptation to conserve energy and concentrate resources to the upper parts of the plant. From depths of 1 feet to 6 feet there was low species diversity of aquatic vegetation (Table 3).

The aquatic plant population of Davis Lake was drastically unbalanced. Coontail was the most abundant aquatic plant and was found at 91% of all sites sampled (Table 4). Of sites sampled above the 1 % light level depth, coontail was found at 97% of these sites. Other species that occurred in high numbers included common duckweed (62%), star duckweed (49%), watermeal (58%), and white water lily (58%). Of these four species, white water lily is considered the most problematic. White water lilies are considered problematic because they can be invasive and force out other more desirable plants. Furthermore, upon plant death, lilies contribute a large amount of organic matter to the lake bottom. This eventually leads to filling in of the lakes shallow and perpetuates conditions conducive to lily expansion. Every area of the lake 6 feet or shallower had white water lily growth. In some areas the lilies were so dense that open water could not been seen. The only factor limiting lily growth was depth. Lilies do not tend to grow deeper than 5-6 feet. The biomass from dying water lilies is contributing to the filling in of Davis Lake. This will eventually create more shallow areas for the lilies to inhabit further exacerbating the problem. The free-floating species (duckweeds and watermeal) were not problematic but they do not provide many of the benefits associated with a healthy, well-balanced aquatic plant community. Additionally, the filamentous algae mats that formed on various areas of the lake are not of a large concern if recreational use (boating, swimming, etc) is not a priority. These mats were not wide spread during the 2000 study, however, recent observations (May 2001) show that the mats have become more widespread on Davis Lake. The reason for the expansion is unknown. As with the free-floating vegetation they do not provide any significant source of food or habitat for wildlife. The dense nuisance plant growth, despite the plethora of problems that it

causes, is probably the single biggest factor in the good epilimnetic water clarity/quality at Davis Lake. However, it is one of the biggest contributing factors in the extremely high hypolimnetic nutrient concentrations. On a more positive aquatic plant note, no Eurasian water milfoil (EWM) was found in Davis Lake. Steps should be taken to prevent EWM from entering Davis Lake. Appropriate signs should be posted around the perimeter of the lake educating the public on identification, ecological impacts, and the steps that should be taken to prevent its spread.

Table 3. Aquatic Plants Found in Davis Lake (May – September 2000).

Aquatic Plants	
Coontail	*Ceratophyllum deme*rsum
American Elodea	*Elodea canadensis*
Common Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
White Water Lily	*Nymphaea fuberosa*
Curly Leaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Flatstem Pondweed	*Potamogeton zosterifomis*
Sago Pondweed	*Stuckenia pectinatus*
White Water Crowsfoot	*Ranunculus longirostris*
Giant Duckweed	*Spirodella polyrhiza*
Watermeal	*Wolffia columbiana*
Macroalga	
Chara	*Chara* sp.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

The shoreline of Davis Lake is dominated by cattails. This water-cattail interface does not experience erosion or other problems that plague normal, developed shorelines. A major concern with regard to the "shoreline" of Davis Lake is the continual encroachment by cattails. Davis Lake is at an elevated risk of encroachment due to the expansive, shallow shelf around the perimeter of the lake. The current extent of the cattails should be maintained and expansion should not be allowed. This will help to slow the gradual filling in of the shallow areas of Davis Lake. Another major concern is eliminating/preventing the spread of invasive species, such as purple loosestrife, which were observed at scattered locations around the lake.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling actives. All observations were visual. Several types of waterfowl were observed during the course of the study (Table 5). Included in these was the pied-billed grebe and the black crowned night heron, which are Illinois threatened species. Overall, Davis Lake provides *excellent* habitat for waterfowl and is the lakes single best usage. The healthy populations of cattails provide good habitat for a variety of bird species. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species (such as beaver). Purple Loosestrife (*Lythrum salicaria*) and Buckthorn (*Rhamnus cathartica*) have been noted in several areas around the lake. These plants are seldom used by wildlife for food or shelter. They should be eliminated before they spread and displace other native and more desirable plant species. As stated above, due to the low D.O. concentrations in the lake, the presence of quality game fish is limited. However, Davis Lake may contain important non-game fish species including those that are threatened or endangered. Fishery studies (preferably seining) would need to be conducted in order to determine the condition of the fishery in Davis Lake.

Table 5. Observed Wildlife Species on Davis Lake (May – September 2000).

Birds	
Pied-billed Grebe+	*Podilymbus podiceps*
Double Crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Mallard	*Anas platyrhnchos*
Blue-winged Teal	*Anas discors*
Canvasback	*Aythya valisineria*
Bufflehead	*Bucephala albeola*
Red-Breasted Merganser	*Mergus serrator*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Black-crowned Night Heron*	*Nycticorax nycticorax*
Belted King Fisher	*Megaceryle alcyon*
Red-winged Blackbird	*Agelaius phoeniceus*
Unknown Sandpiper	*Calidris* sp.
Mammals	
Beaver	*Castor canadensis*

+ Threatened in Illinois
* Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS AND MANAGEMENT SUGGESTIONS

Davis Lake is best used as a wildlife area and is well suited for aesthetic enjoyment. Little should be done from a management standpoint except to maintain current quality and limit impacts from external sources. However, there are a few management concerns with regard to Davis.

- *Low Dissolved Oxygen*

Due to the shallow morphometry and massive biological oxygen demand during mid-summer months, Davis Lake experiences low dissolved oxygen levels in the epilimnion. D.O. levels in the epilimnion were dangerously low July, August, and September. Low D.O. levels can cause fish stress and if continual, stress can eventually lead to fish mortality. Historically, Davis Lake has experienced fish kills. It is almost certain that Davis Lake still experiences fish kills. This has probably led to a very poor quality sport fishery. If fishing were to become a priority at Davis Lake, besides a stocking program, the low D.O. problems would have to be remedied. This could be accomplished via an aeration system. However, by aerating Davis Lake, complete mixing of the water column would occur. This would cause mixing of nutrient rich water from the hypolimnion into the epilimnion. As a result, Davis Lake may be plagued by wide spread, massive algae blooms. This would eventually cause a stable state shift in Davis Lake from a plant-dominated lake with little algae growth to a algal dominated lake with little aquatic vegetation growth.

- *Excessive Aquatic Vegetation*

A key to a healthy lake is a well-balanced aquatic plant population. Davis Lake has a very unbalanced aquatic plant population. Two species, coontail and white water lily dominate Davis Lake. Coverage by coontail is upwards of 90% of the surface area of the lake. These two species, especially coontail, are the cause of problems such as low D.O., unhealthy fishery, and nutrient enrichment of the hypolimnion.

In order to improve Davis Lake, coontail densities could be reduced. This can best be accomplished by the use of aquatic herbicides. All of the lake would not need to be treated, only enough to bring densities down to 30-40% surface area coverage. This could be accomplished using 2,4-D. This could be applied in either liquid form or slow release pellet form (SRP). To reduce coontail densities to 30% surface coverage (treat 24 acres), approximate cost would be $8,400 – $10,200. For 40% surface coverage (treat 20 acres) cost would be approximately $7,000 – $9,000. Treatment should not be done all at once and should occur in the spring. This can cause severe D.O. depletions. Instead treatment should be

divided up into two parts with the treatments about two to three weeks apart. Application of herbicides will not eliminate the coontail problem. Treatment will have to be made each year possibly multiple times in a year depending on regrowth.

Water lily densities could be reduced using the aquatic herbicide Rodeo™. This product is applied to the folliar part of the plant. Not all lilies would need to be treated. Densities should be reduced to allow for improvement of light penetration and fishery habitat. Typically, Rodeo is applied at a rate of 1 gallon/acre (5-10% spray solution) at approximately $200/gal. Lilies grow from tubers (under ground storage structures), which can continually produce new vegetation throughout the season. After initial treatment, regrowth from the tubers *will* occur. Continual regrowth depletes the tubers. By repeatedly treating regrowth, tubers will eventually be exhausted and eliminated. By retreating selected areas, tubers in that area can be eliminated and extent/densities of lily growth controlled.

- *Create Bathymetric Map with Morphometric Table*

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some lakes in Lake County do have a bathymetric map, but they are frequently old, outdated and do not accurately represent the current features of the lake.

Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size.