1 A LAKE MANAGEMENT PLAN FOR VAUSE LAKE (AKA AS LAKE FANNY) IN CONJUNCTION WITH LUTHER SPRINGS OUTDOOR MINISTRY

FIRST DRAFT

REPORT WRITTEN BY:

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1.00 TOPICAL OUTLINE FOR A LAKE MANAGEMENT PLAN

1.1 Overview and Agency Informational Sources

This draft report is the result of recommendations made by the Florida LakeWatch Program and various agencies of the Florida Fish and Wildlife Conservation Commission. It provides a first step in understanding the ecological and environmental problems affiliated with aquatic weed problems, water quality issues, and the ecological integrity of Vause Lake.

Segments on the lake ecology originated from the *Natural Resource Management Plan* for Luther Springs, written by Dr. Edward J.P. Hauser, Wetlands Ecologist. This report will become incorporated into the Luther Springs plan.

1.2 Components of a Lake Management Plan

In order to have meaningful dialogue and to make sure that all Vause Lake property owners and agencies within the Florida Fish and Wildlife Conservation Commission, have the same environmental baseline, this lake management plan has been written. Also, it represents a basis for managing Luther Springs, an outdoor ministry and camp, owned and operated by the Lutheran Outdoor Ministry of Florida (LOMF). The “plan” is considered to be a working document that should be updated as needed.

The components of this plan were obtained from the following source:

How to Create a Lake Management Plan
by Jess M. VanDyke, Northwest Florida Region Biologist
Department of Environmental Protection
Bureau of Aquatic Plant Management
3917 Commonwealth Bld.
Tallahassee, FL 32399–3000

In cooperation with Florida LakeWatch
7922 NW 71st Street
The University of Florida
Gainesville, FL 32608

Note: The management plan components and descriptions below have been slightly changed for adoption and use on Vause Lake by Dr. Edward Hauser, Wetlands Ecologist and writer of this document.

1.03 Plan Outline

The following items have been modified from the above cited literature source and incorporated into this document as deemed appropriate by the writer.

1) Location data and applicable descriptions for the subject lake.

2) Define the Problem, i.e., control nuisance submerged aquatic bed species, littoral zone vegetation, alga blooms, etc. Note: species groups need to be identified and wetlands classes need to be determined.

3) Evaluate and list lake use activities. Determine what lake use activities are being negatively impacted by the currently existing problem.

4) Analyze the Potential Primary Causes of the Problem: Fertilizer enrichment (cultural eutrophication of P and N), siltation - sedimentation, septic tank leaching, lowered water table which decreases volume and increases the concentration of nutrients, increased water temperature, elimination of bottom feeding fisheries, i.e., catfish, etc.

5) Determine the solutions which will address the currently existing problem: a) solutions to address the primary cause and b) which ones will treat the existing ecological expressions and/or symptoms.

6) Review the expected results based on existing ecological literature sources or research reports.

7) Check the results for each proposed mitigation activity based on field observations (before and after treatment).

8) Standardize the Improvements. Use appropriate quantitative data established in the literature which is based on the existing lake conditions: volume, size, form, aquatic weed bed density, proposed grass carp per acre, predator fish community, etc. (extremely conservative), 15 grass carp per acre (the norm for most lakes), or 50 grass carp per acre (extreme aquatic weed bed problems. Also, predator fish population needs to be determined.
Large mouth bass will prey upon grass carp that are 8" or less in size.

9) Establish a long range plan.

a) Determine the likely effectiveness of the mitigation activities proposed in the initial lake management plan.

b) What is the longevity or duration of the beneficial results of the plan's actions. For example, how long will sterile carp live?

c) What is the prediction of a positive response to the mitigation activities based on past ecological experiences reported in the literature.

d) Determine the degree or applicability for which the proposed action plan activities will affect the cause of the existing lake problems.

e) Determine the potential negative impacts of the proposed lake management plan mitigation activities.

f) Determine the costs or cost sharing plans needed for implementation of the management plan and operational monitoring maintenance costs of the plan activities.

10) Provide a section on appendices which may include: photo documentation, exhibits, or other germane items related to the lake management plan.

1.04 Luther Springs Camp and Property Description

Luther Springs (hereinafter referred to as LS) is the only outdoor ministry with residence facilities managed by the Lutheran Outdoor Ministries of Florida (LOMF) and the Evangelical Lutheran Church of America (ELCA). A detailed cooperative management agreement was developed in 2014 between LOMF and Novus Way Ministries, Inc. of Arden, NC. Novus Way also manages Camps Lutheridge and Lutherock in North Carolina and Luther Ranch in Georgia. LS is the largest land owner affiliated with Vause Lake in terms of riparian shoreline and lake surface area

LS functions as an outdoor camp, conference center, retreat center, and as an environmental education facility for school groups. LS consists of nearly 360 acres, located in the Coastal Sand Hills Plain of Central Florida. LS is located about 30 miles east of Gainesville, about 25 miles north of Ocala, and 60 miles southwest of Jacksonville.

The following are the land tax parcel ID numbers for LS:

Putnam Co. FL: Sections 3 and 10; Township 11 South & Range 23 East

1) Tax Parcel No.: 03-11-23-0000-0040-0010 (310.45 Acres)
   294 Vause Lake Road; Hawthorne, FL 32640-6110
2) Tax Parcel No.: 10-11-23-0000-0100-0011 (47.2 Acres)
   264 Vause Lake Road; Hawthorne, FL 32640-6110
3) Tax Parcel No.: 10-11-23-0000-0110-0000 (1.5 Acres)
   264 Vause Lake Road; Hawthorne, FL 32640-6110

The site supports a beautiful and ecologically significant series of ecosystems, named after the following plant community types:

1) Upland Hammock Hardwoods,
2) Upland Mixed Xeric Yellow Pine Coniferous Forest,
3) Upland Sand Hill Gopher Tortoise Subecosystem
4) Sandhill Wet Prairies, which are extensions of Vause Lake,
5) Isolated Ephemeral Pool - Wet Meadows, isolated from Vause Lake, and

6) Vause Lake (formerly known as Lake Fanny), which supports aquatic beds and emergent marshes around its perimeter as part of a typical fresh water littoral zonation.

The last three ecosystem types are U.S. Army Corps of Engineers (USACE) jurisdictional wetlands and are subject to Sections 401 (Water Quality Certification) and 404 (Waters and Wetlands of the U.S.) of the Federal Clean Water Act (FCWA), administered by that agency.

About 20 listed ecosystem or species elements (rare, threatened, or endangered) are cited in the Florida Natural Areas Inventory Program and are found at LS, including the: Southern Yellow Pine Forest, Florida Sand Hill Crane, Gopher Tortoise, Gopher Mouse, Gopher Toad, and Tricolor Heron. In 2007, LS was designated as a Gopher Tortoise Restoration site by the Florida Game and Fresh Water Fish Commission, headquartered in Gainesville, FL.

Geologically, LS is part of the Atlantic Sand Hill Coastal Plain and the Hawthorne Lakes Region, which is characterized by thousands of sinkhole ponds or lakes. These range in size from under five acres to over 500 acres. The unique lake topography is the product of karst geologic processes involving dissolution of underground limestone bedrock strata. Over time, underground caverns and caves develop in the limestone and the weak upper strata, consisting mainly of sands, collapse, creating sinkholes. Seepage of water from upper water tables then creates such ponds or lakes.

2.00 LOCATION DATA AND APPLICABLE DESCRIPTIONS FOR VAUSE LAKE (FKA LAKE FANNY)

2.01 Vause Lake Descriptors

Vause Lake is located in the Hawthorne Lake Region of the Central Florida Highlands. It is identified on the USGS 1:24K topographic map for the Keuka, FL Quadrangle. Table 1 below provides additional descriptors.

TABLE 1. VAUSE LAKE LOCATION DATA AND DESCRIPTORS.

Feature Type:	Isolated Clear Water Lake
Latitude:	N29.55953° *(NAD83 datum)*
Longitude:	W81.98426°
Elevation:	82 ft MSL
County:	Putnam County, Florida
Acreage:	About 100 acres
Fisheries:	Warm Water (Bass sp.)
USGS 24K MRC:	29081E8

NOTES:

1) Coordinates are based on NAD83 datum.
2) Vause Lake has an average summer temperature of 79 Degrees F. (26 Degrees C.).
3) Vause Lake has a sandy clear bottom with a thin fine silt layer around the perimeter; the basin supports submerged aquatic vegetation. The littoral zone around the perimeter supports emergent aquatic bed and emergent marsh wetland classes.

2.2 Vause Lake Fisheries

Vause Lake supports a warm water fishery and sport fishing is the major recreational activity on the lake. The following is a list of fish species. Fishing from outboard motor boats is now very difficult as the submerged aquatic weed beds become entangled in propeller shafts of motor boats. Thus, there is no current significant fishing pressure on the lake.

This warm water fishery is dependent upon a fish food web source, consisting of primary and secondary consumers (bait fish size). The perimeter of Vause Lake supports submerged, floating and semiemergent aquatic beds for needed fish nesting and shelter. This type of lake averages 79 degrees F at the surface in the summer; it supports a high quality warm water fishery, with largemouth bass being the dominant predator species (top carnivore). The following fish species inhabit the lake:

Crappie
Catfish
Largemouth Bass
Smallmouth Bass
Spotted Bass
Striped Bass

2.03 Vause Lake Wetlands

Vause Lake is a seepage sinkhole lake which is influenced by the surface and subsurface sandy perched water tables. The current lake level is at least ten feet below its former high water level of 2000. It is considered to be a mature lake or, ecologically, it is said to be mesotrophic, with regard to its ecological life cycle. Characteristics for this type of lake include:

a) slightly turbid open waters,

b) a well defined littoral zone of aquatic and marsh vegetation that is found around the entire perimeter of the lake, and
c) peaty, mucky, organic deposits that form a continuous bottom layer.

Some ecologists place the regional lakes into two categories: a) clear water, and b) colored water. The last type of lake has sufficient build up of peaty organics so as to release tannic acids. Such acids discolor the lake waters from brown to red brown, or orange brown. Clear water lakes do not have a build up of tannic acids and remain relatively clear from this point of view. Alligators typically prefer shallow colored lakes and rarely are found in clear water lakes, such as Vause Lake.

Wetlands of freshwater lakes that have their origin in the lake basin are termed Lacustrine (L). Thus, each of their zones may have this descriptor as part of their nomenclature. The littoral zone is the shallow water zone between open water and uplands. Vause Lake has a classic textbook series of zones which occur as part of the hydroseric ecological succession as illustrated in Figure 1 below.

FIGURE 1. SCHEMATIC REPRESENTATIVE OUTLINE OF VAUSE LAKE (A LACUSTRINE FRESH WATER BODY) AND THE WETLAND LITTORAL PLANT ZONES.

a) Open Water (LOW) Zone with Submerged Aquatic Beds (LSAB) Zone (which is affiliated with all of the interior sections of the lake and found in water 2' – 15' in depth).

b) Aquatic Bed (LAB) Zone (1' – 3' in depth).

c) Emergent Marsh (LEM1) Zone (up to 1' in depth).

d) Emergent Marsh (LEM2) Zone (saturated soils to surface).

e) Scrub Shrub Swamp (LSSS) Zone (saturated soils within 12” of the surface, established as perimeter wetlands)

Upland Mixed Pine - Oak Forest

During extended periods of drought and normal or high precipitation cycles, the lake levels will be in a state of flux and the ecological communities will adjust to the newly established hydrology regime. For example, under high water precipitation cycles and deeper water levels, Bog Moss will probably not occur in the central deep basin of the lake.

The littoral zone of Vause Lake creates many habitats and niches for wildlife, including fish, amphibians, birds, insects, and invertebrates. It has the largest ecological diversity affiliated with Vause Lake.

It is significant to note that two weedy invasive or nuisance species were discovered in these ecological zones of Vause Lake. In the open water, Bog Moss (Mayaca fluviatillis), a native plant of northern Florida lakes, was found throughout the lake to depths of 10'. It forms dense mats which are not conducive to swimming and boating activities.

The other nonnative, exotic, weedy species is Tornadograss (*Panicum repens*). It was discovered on the shallow shoreline adjoining the boat dock of Luther Springs. In Florida, it is considered to be the most invasive species of shallow aquatic beds and marsh lands, including wet sand hill prairies.

Both species can form a monotypic ecological community and are capable of destroying the existing ecological diversity of the plant community wetlands classes, fisheries, and other wildlife niches and habitats.

3.00 THE LIFE CYCLE OF FRESHWATER LAKES

3.01 Overview

This section provides additional environmental and ecological information on fresh water lakes so as to better understand their management protocols. Some of the information can be used for environmental education at the camp, especially for junior and senior high school classes, college students, and adult learners.

Ecologically, freshwater lakes go through geological and ecological life cycles that are usually not reversible, especially if they are isolated seepage lakes such as Vause Lake (FKA Lake Fanny). In addition, isolated seepage lakes have a long term turnover time and rate because there are no inlet feeder streams and outflow discharge streams. In addition, it is well documented that in the Central Florida Region there are short term low precipitation cycles of fie or more years duration, whereby lake levels may fluctuate by at least 5' to 10' in depth, with lake levels being lowest during periods of drought.

The ecological parameters that drive the speed of a lake's life cycle are buildup of organic sediments on the floor of the lake and buildup of nutrient levels such as nitrogenous and phosphorous compounds. For the growth of aquatic bed plants and most algae, phosphorous is the most limiting factor.

Thus, as in the current situation for Vause Lake, the ordinary high water mark is approximately 10' below where it was in 2000. Under these conditions, with a 33% decrease in lake volume, the concentrations of dissolved phosphorous can only increase. This has stimulated the growth of nuisance submerged aquatic beds, such as Bog Moss, and filamentous green algae which now occur across most of the lake basin. John Corneilson, former Camp Director for

Luther Springs, has indicated that a major alga bloom occurred in August of 2011.

It should be noted that blue green alga or green alga blooms may significantly deplete oxygen supplies at night, which may result in fish kills; also, blue green algae (*Mycrocystis* or *Anabaena* species) may release phytotoxins which can be lethal or cause health problems to mammals, including humans.

Thus, it is important to understand the ecology and life cycle of freshwater lakes. The development is linear, stepwise and usually is nonreversible, unless nutrients and their source(s) can be removed. The three tier classification is as follows:

1) YOUTH (OLIGOTROPHIC)
2) MATURITY (MESOTROPHIC)
3) OLD AGE (EUTROPHIC)

Each of these life cycle stages is discussed below. IT IS IMPORTANT TO NOTE THAT IF VERY SLOW ADDING OF NUTRIENTS AND ORGANIC SEDIMENTS OCCURS, LAKES CAN REMAIN HEALTHY AND SUPPORT MANY HIGH QUALITY FROMS OF PLANT AND ANIMAL LIFE.

HOWEVER, IF ADDING OF NUTRIENTS (ENRICHMENT) OCCURS VERY RAPIDLY, NUISANCE SPECIES OF PLANTS AND ANIMALS WHICH ARE ADPATED TO THESE CONDITIONS WILL INVADE A LAKE. THIS CONDITION IS TYPICALLY CALLED HYPERTROPHIC OR CULTURAL EUTROPHICATION AND SUCH LAKES ARE TERMED HYPERTROPHIC.

3.02 Dissolved Oxygen (D.O.) Interrelationships

Dissolved oxygen (D.O.) is the most limiting factor for aquatic animals. It can range from 0 ppm (anoxic) to 1-3 ppm (hypoxic) to 14 ppm (hyperoxic). At 14 ppm, water becomes saturated with D.O. and forms air bubbles which are liberated into the atmosphere. Thus, there is an upper limit of D.O in a freshwater lake. Typical sources of D.O include wave action, water entering from fast flowing streams,

and green plant photosynthesis. In the case of Vause Lake, the major source of D.O. will be via photosynthesis carried out by green plants. High quality animal life and cold water fisheries usually requires D.O. in the range of 7-10 ppm. A healthy warm water fishery at Vause Lake will require 4 – 7 ppm of D.O.

There is one other important interdependent and interrelationship with D.O. in all water bodies or streams. All living organisms need oxygen for respiration. We and most other animals breathe or take in air via some type of respiratory system. The oxygen is transferred to the blood circulatory system, whereby it is absorbed by all living cells as part of respiration.

Thus, ecologists recognize that there is a constant biological oxygen demand (B.O.D.) in all waters for all organisms present, including animals, algae, bacteria, and green plants that live in an aquatic ecosystem.

Thus, three interrelationships exist regarding D.O. and B.O.D. as follows:

1) D.O > B.O.D. This is an ecologically healthy parameter that should be maintained in all lake.

2) D.O. = B.O.D. This is not an ecologically healthy situation as these two parameters become closer to each other. The aquatic ecosystem is placed in a precarious position and becomes very sensitive to any other changes, especially increase in water temperature. The reason for this is that as water warms up, it physically holds less D.O.

3) B.O.D. > D.O. This is a catastrophic situation in which no free oxygen is available for aquatic life. Massive die off of aquatic beds and algae occurs. Animals have no free oxygen and die off, the classic example being a fish kill.

Vause Lake is ecologically sensitive to developing scenerios 2 and 3 above. Thus, all prudent environmental measures should be taken to monitor and prevent further lake water quality degradation.

3.03 Youth (Oligotrophic) Lakes

Geologists term those lakes at the beginning of their life cycle as being in a stage called youth. Such youthful lakes have clean original bottoms of sand, gravel, or clayee materials. There may be some build up of organic sediments around the outer littoral zone. Such lakes have the deepest amount of water depth in their basin. Little or no suspended organics occur and so such lake water is very clear and not turbid.

Ecologists term these youthful lakes as being oligotrophic. The prefix *oligo* means very few or low amounts of nutrients are present. The root trophic refers to plant foods such as nitrogen and phosphorous compounds. Such lakes may have P levels as low as .05 ppm. As noted above, P is the most limiting factor for plant growth. Thus, oligotrophic lakes do not have well developed aquatic beds and support simple, unicellular non-nuisance algae. Usually, dissolved oxygen is very high, being around 7-10 ppm. High quality animals that are supported include gill breathing insects such as mayflies and members of the salmon – trout family.

3.04 Mature (Mesotrophic) Lakes

Geologists consider lakes that have a continuous, but shallow organic deposits, as being in a state of maturity. Ecologists term such lakes as being mesotrophic. The prefix of this name means that nutrients such as N and P are at a midpoint or middle levels as far as enrichment of waters are concerned. P may be around .5 ppm. With increased nutrient levels, a littoral zone of submerged, floating, and emergent aquatic beds or zones begins to colonize the shallow waters around the perimeter. There is no colonization of the deep littoral zone (> 10’ in depth). Typically, water clarity decreases in such lakes as waters become more turbid due to increased plankton (microscopic algae and invertebrates) levels and/or suspended solids (SS). Also, D.O. is reduced, ranging from 5 – 7 ppm.

The ecological characteristics of a mesotrophic create new niches and habitats for an array of animals. Invertebrates that can survive under the lowered D.O. conditions include dragonfly and damselfly larvae. The semi-emergent and emergent plant zones niches for feeding and reproductive activities, i.e., laying of egg masses. Warm water pan fish become dominant, including largemouth and smallmouth bass, bluegills, crappies, and bullheads. Significantly, mesotrophic lakes have a very high biodiversity of species. Thus, this is an ideal stage of the lake's life cycle to maintain. Vause Lake is in a mature stage or mesotrophic lake that is becoming enriched.

3.05 Old Age (Eutrophic) Lakes

For geologists, old age lakes are those whose basins have significantly filled in. In the late developmental satges, more than 50% of the original lake basin becomes filled with organic sediments. In addition levels of total nitrogen and phosphorous are now at optimum levels for growth of green plants, including filamentous algae and aquatic bed vascular plants. P levels will be greater than 1 ppm. Ecologists call such lakes as being in a *eutrophic* stage as plant foods (nutrients) are at a high level which will support the optimum growth for alga or green plant biomass. Typically, such lakes have warmer waters, lower D.O. levels, and higher turbidity levels as suspended solids and plankton have increased. Invertebrates that can tolerate lower D.O. include blood worms, air breathing snails, many types of fly larvae, and cladocerans (motile crustaceans). Although eutrophic lakes may still support warm water pan fisheries, rough fish such as carp and bull heads that are organic bottom feeders may become increasingly dominant.

Mesotrophic and eutrophic lakes are very sensitive to any additional nutrient enrichment or cultural eutrophication. Such lakes may become overloaded with plant and animal biomass to the point that during nighttime when no photosynthesis occurs, B.O.D. will exceed D.O. and the lake becomes anoxic (without free oxygen), resulting in massive fish kills. Thus, it essential, as a lake lifecycle reaches a transitional state from mesotrophic to eutrophic that it be prudently managed from an environmental point of view. Under current conditions, Vause Lake is in a transitional stage.

3.06 Florida Lakewatch Program

Florida Lakewatch is is a volunteer based citizen monthly monitoring program whereby individual are trained to conduct water quality sampling. The program is administered by the University of Florida (Gainesville): Department of Fisheries and Aquatic Sciences – Center for Natural Resources. For this program, volunteers participate in a training program, whereby they learn how to make physical and biological observations of a lake such as temperature, water depth, vegetation, and water clarity. In addition, they collect standardized sets of water samples that are shipped to the water quality laboratory where they can be analyzed for total nitrogen and phosphorous, chlorophyll concentration, and turbidity.

Volunteers need boat access to three selected and prescribed sampling locations which are monitored on a monthly basis.

The data presented in the appendices have been collected for Vause Lake as part of the Florida LakeWatch Program.

Contact persons from this organization are:

Mary Lettelier, Florida LakeWatch Assistant
1-800-525-3928
larose@ufl.edu

David Watson, Florida LakeWatch Biologist
dlwatson@ufl.edu

3.07 Turnover Time of Vause Lake

Because Vause Lake is an isolated lake without an inlet or outlet, there is no annual turnover or movement of materials, nutrients, or other chemicals on a short term basis. Normally, lakes the size of Vause Lake, with inlets and outlets have a turnover time of a year or less. For Vause Lake, any movement must be through the perched water table that supports it. Because this water table fluctuates between high > normal > low (droughty) situations that may be decades, the turnover time matches such cycles.

Another important factor that influences the ecology of Vause Lake is that it is a warm water lake that does not reach 39 Degrees F in the winter. At this temperature, water reaches it heaviest density or specific gravity. Thus, in more northern lakes, when upper surface waters reach this temperature, the water will move to the bottom and bottom warmer waters move to the top. This annual fall – winter turnover will move nutrients to the surface whereby they can be translocated outward through an outlet. Because Vause Lake has a long turnover time and no fall – winter turnover, it is very sensitive to nutrient enrichment (eutrophication). This aspect regarding eutrophication is biomagnified when droughty conditions are maintained for several years as lake volume decreases and nutrient concentration therefore increases. Also, warmer waters will contribute to lower D.O. levels; as water warms up, the capacity to hold D.O. is reduced.
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4.00 DEFINITION OF THE PROBLEMS

4.01 Submergent Aquatic Weed Bed Problems

For the Vause Lake basin, the current major existing problem is the extensive growth of a native submerged aquatic bed plant known as Bog Moss (*Mayaca fluviatilis*). The Cooperative Extension Bulletin of the University of Florida – Center for Invasive and Aquatic Plants (2014) indicates that it is commonly found growing in shallow lakes (< 20' in depth) and littoral zone lake margins. It occurs from the northern counties to the central peninsula of Florida. Bog Moss blooms from early spring to late fall. The stems of bog moss are typically several feet long. The stems are whitish-green. The leaves of Bog Moss are soft and mossy, like short pieces of fine threads. The leaves are only 1/4 inch long. They are arranged spirally on the stem, and are densely crowded. Bog Moss flowers are solitary, on stalks that are one to two inches long. The small, 1/2-inch-wide flowers have three petals and are whitish to pink. At Vause Lake this species now colonizes 90% of the lake basin and can be caterized as a nuisance species.

4.02 Emergent Aquatic Weed Bed Problems

The other major problem of the littoral zone of Vause Lake is the invasion of Torpedograss (*Panicum repens*). This aquatic emergent weedy species grows to about 3' in height in shallow waters (< 1')

and transition zones to marsh and wet meadow. Once established, it can form a dense monotypic community and out compete all other aquatic vegetation types due to its thick and vigorous rhizome system. As a result, high quality aquatic bed zones and plants such as cow lily and pickerel weed are eliminated. The change to a monotypic habitat becomes no longer conducive to supporting the niches needed by the fisheries of Vause Lake and other wildlife.

5.00 EVALUATION THE IMPACTS OF THE PROBLEMS ON VAUSE LAKE ACTIVITIS

5.01 Ecological Impacts

The following are projected negative ecological impacts due to the the currently existing submerged and emergent weedy invasive species problems:

1) Loss of habitat and niches for the Vause Lake basin and littoral zones due to development of two aquatic weedy monocultures, i.e., submerged aquatic beds (Bog Moss) and emergent weeds of the littoral zone (Torpedograss).

2) Disruption of existing food chains and food webs as producer and consumer species population levels are reduced, resulting in lowered ecological diversity. NOTE: The marsh-wet meadow ecosystem in which the Florida Sand Hill Crane nests and feeds could be negatively impacted by a monoculture of Tornadograss.

3) Along with increased population density of Bog Moss, there will probably be increases in growth of filamentous green algae and/or blue green algae. The combination of increased plant biomass will reduce D.O. levels at night. If the B.O.D. exceeds the D.O, fish kills will probably occur.

5.02 Recreational Impacts

The following active recreational activities would be or are currently being negatively impacted by existing Bog Moss aquatic weed problems:

1) Boating activities, including use of row boats, canoes, and motor boats will become difficult. Already, motor boats cannot be used due to entanglement of the Bog Moss aquatic weed beds on propeller shafts. Use of oars for row boats would become extremely difficult with increased density of the Bog Moss.

2) Primary skin recreational activities such as swimming and water safety instructional programs could not be conducted due to the

dense colonies of Bog Moss, which will create a safety hazard. These activities are a significant part of the Luther Springs camp activities and programs. Thus, it is essential that high water quality be maintained and that aquatic weed beds b reduced in density.

3) Birding and other wildlife observations activities would be reduced due to loss of habitat and niches, resulting in lowered species diversity.

4) Recreational sport fishing, using traditional casting methods, would become virtually impossible.

5) A significant reduction in scenic beauty and aesthetics would occur.

5.03 Human Health Impacts

It has been reported that alga blooms have recently occurred in Vause Lake. The lake is sensitive to such blooms as indicated by the dense growing masses of Bog Moss. If the alga bloom consists of blue green alga (Cyanobacteria), major health problems can develop. Blue green algae produce phytotoxins which are harmful to most mammals, including humans. Drinking or primary skin contact which results in internal body consumption of contaminated waters can cause intestinal and liver diseases. These may be lethal, as several campers using a Florida lake several years ago died from using waters with blue green alga blooms. *Mycrocystis* is the major blue green alga that can form extensive blooms. The recent (August, 2014) outbreaks and alga blooms in the western basin of Lake Erie is a prime example. As a result of the *Mycrocystis* blue green alga bloom, the City of Toledo, Ohio has to shut down its water supply for 400,000 people for over two weeks.

6.00 POTENTIAL PRIMARY AND SECONDARY CAUSES OF THE AQUATIC WEED PROBLEM

6.01 Nutrient Enrichment

The primary cause of dense growth of the Bog Moss, in part, is attributed to nutrient enrichment. Under normal conditions, phosphorous and nitrogen are the most limiting factors for growth of aquatic plants as noted above in this report. Sources of P and N include:

1) Atmospheric Deposition
2) Ground water contamination from septic tanks or leach fields, especially if a perched water table is the major source of water.
3) Fertilizer surface runoff from lawns or percolation into the perched water table feeding the lake.
4) Input of organic material high in P and N such as leaf litter from fertilized and mowed lawns.
5) Possible agricultural runoff or percolation into the perched water table.
6) Increased concentration of nutrients when water levels decrease due to long term drought, resulting in reduced volume.

In addition to the above causes, warming of water due to climate change, may exacerbate the problem.

It is probable based on environmental studies of small lakes, that items 2,3,4, and/or 6 are the sources of lake enrichment.

7.00 MITIGATION SOLUTIONS TO ADDRESS THE PRIMARY CAUSES

7.01 Community Meeting(s)

A meeting of all property owners should be held to form a consensus of how the aquatic weed problems threaten the ecology and beauty of Vause Lake, as all have a vested interest in lake water quality. This meeting could be held at the Luther Springs Conference Center. Resource people and ecologist should present a short program, followed by a question and answer period. The proposed lake management plan should be summarized.

7.02 Property Owner's Riparian Rights

A signoff by all riparian property owners is required before any remedial or mitigation activities can be initiated, especially if sterile grass carp are to be introduced to Vause Lake. This is a requirement of the Florida Fish and Wildlife Conservation Commission. Thus, a community meeting could be used as an educational event and for signing a riparian zone petition.

7.03 Environmental Inventory of Property Owners Sublots

An environmental inventory of each property owner should be conducted in order to determine possible sources of nutrients that could percolate into Vause Lake. Items to be inventoried include: a) location of septic tanks and leach fields (including distance from the lake shoreline, b) holding capacity, c) age and type of system, and d) "Clean Out" history. A consent form would need to be signed by each property owner.

Based on the findings and LakeWatch data, a Remedial Action Plan (RAP) should be developed as needed, and incorporated as part of this lake management plan.

8.00 PROPOSED USE OF TRIPLOID STERILE GRASS CARP (aka AS WHITE AMUR) TO TREAT CURRENT AQUATIC WEED BED PROBLEMS (SYMPTONS)

8.01 Florida Contact Person for Use of Sterile Grass Carp

The writer has communications via e-mail and phone with the following individual regarding the use of sterile grass carp at Vause Lake:

Mr. Robert Kipker, Biological Admistrator
Florida Fish and Wildlife Conservation Commission
3900 Commonwealth Blvd., MS 705
Tallahassee, FL 32399
850-617-9430
Rob.Kipler@MyFWC.com

Mr. Kipler is the coordinator in charge for issuing the use of sterile grass carp permits. His recommendation is to initiate the use of grass carp on a conservative basis to start with. The reasons are as follows:

1) Bog Moss is a native species and under normal conditions is a beneficial aquatic bed plant.

2) Too many grass carp may cause overgrazing of other aquatic plant life besides the Bog Moss, i.e., plant species of the littoral zones. Mr. Kipler will assign a FFWCC biologist to evaluate on site, the extent of the Bog Moss problem. Currently, it is expected that the introduction of 2-3 carp per acre will be part of an initial phase or project activity.

3) Stocking should be done during the winter season as carp are very inactive with summer warm water conditions. Also, there is die-back of Bog Moss during the winter season. During the following spring, young tender sprouts will emerge which would be a target food of the grass carp.

8.2 Some Literature Sources for Understanding the Role of Grass Carp in Control of Nuisance Aquatic Plant Species

LITERATURE SOURCE 1: George W. Lewis
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The grass carp (*Cteno pharyngodon idella*), also known as the white amur, is used for weedy aquatic plant control using the triploid sterile carp.

The normal diploid grass carp has a chromosome number (2n) of 48, while the triploid grass carp has a chromosome number (3n) of 72. The extra chromosome set result in sterility. Florida laws and regulations require each grass carp be verified and documented as a STERILE triploid.

1) Feeding Habits

Table 3 lists some common aquatic plants and rates them by grass carp feeding preferences. Grass carp will not control all types of aquatic weeds. Because of selective feeding habits, they can eliminate one plant species and make room for the expansion of others.

Table 2. Grass Carp feeding preferences for aquatic plants.

High	Moderate	Low
Musk-grass	Duckweeds	Bog Moss
Naiads	Pondweeds	Eel grass
Hydrilla	Bladderwort	Watermeal
American elodea	Fanwort	Cattail
	Water pennywort	Milfoil
	Coontail	Parrot feather
	Water primrose	Reeds
	Filamentous algae	Sedges
		Water hyacinth
		Alligator weed
		Spatterdock
		Yellow cowlily
		Maidencane
		Torpedo grass
		Watershield Waterlily

2) Recommendations for Stocking

If the grass carp is the preferred weed control option, stocking proper numbers is important. Stocking rates of five to over 200 fish per acre have been used depending on plant species, plant density and distribution, the size and age of the fish, and the pond or lake owner's objectives. There are computer models that determine the appropriate stocking density by considering additional factors such as the amount of human activity around the waterbody, the desired level of control and grass carp feeding preferences. The numbers recommended are designed to provide a 75 to 90 percent reduction in target plant species in three to four years. In most situations complete removal of aquatic vegetation is undesirable because the vegetation provides cover for small fishes and attachment surfaces for fish food organisms.

Grass carp stocking densities are based on the maximum expected weed coverage and the feeding preference rating of the weeds. Stock 10 - 20 fish per acre depending on whether the target weed species

is high, moderate or low on the feeding preference list, respectively. This stocking concept is best illustrated using a few examples:

Example 1: A 10 acre pond is examined in March and found to have five acres of naiads growing in it. However, three of the remaining five acres are shallow and the naiads are expected to spread to this area later in the growing season. Base the stocking rate on the maximum expected weed coverage (eight acres). Because naiads are high on the feeding preference list, stock a total of 80 fish (eight acres times 10 fish per acre).

Example 2: A 10 acre pond is examined in March and found to have five acres covered in watermeal. Because watermeal is a floating plant, pond depth does not matter. The maximum expected weed coverage would be the entire 10 acres. Stock two hundred fish (10 acres times 20 fish per acre).

Example 3: A 10 acre pond is examined in March and found to have a one acre infestation of water primrose. Because water primrose grows only in shallow water (less than two feet deep), base the stocking rate on the area of the pond less than two feet deep. If two acres of the pond are less than two feet deep, stock 30 fish (two acres times 15 fish per acre).

Grass carp could be stocked in weed-free ponds at low rates (five fish per acre) to prevent weeds from becoming established. However, the effectiveness of preventive stocking has not been determined. Generally, no fewer than 10 fish should ever be stocked, regardless of the pond size, because the loss of even a few fish could result in ineffective weed control.

The number of fish and the time required to achieve weed control can be reduced by using grass carp with other aquatic weed control options. For example, herbicides or mechanical removal can be used prior to fish introductions. If the established aquatic vegetation is removed, the tender new growth can be controlled by fewer fish.

Time of stocking affects the initial degree of weed control. Fishes are cold-blooded animals whose feeding rates and metabolism are influenced by water temperature. Grass carp feeding is greatest when the water temperature is between 70 and 80 degrees Fahrenheit and

negligible when it is less than 50 degrees Fahrenheit. Mortality associated with handling stress is less likely when the water temperature is cooler; therefore, fish stocked in late winter or early spring are more likely to survive. They will not begin feeding heavily until late spring or early summer which is when most aquatic weeds begin growing in Georgia.

Because grass carp are attracted to currents, ponds with water flowing over spillways or through drains are not suitable without renovation. Cover horizontal drains with a fence or bars that allow free flow of water but prevent passage of grass carp. If barriers are placed over any drain structures, make sure they do not become clogged or blocked. Water could flow over emergency spillways and possibly wash out the spillway or dam.

Predatory fish, such as largemouth bass, eat grass carp. If used with existing fish populations, grass carp should be large enough to avoid being eaten by the average size predator. A largemouth bass 12 to 14 inches long can swallow a grass carp approximately nine inches long. Even if predation is not a problem, the pond owner should consider using larger carp if they are available because they tend to survive handling and stocking better. Grass carp stocked with existing fish populations should be at least 8-10 inches in length.

Grass carp do not reproduce in ponds and periodic restocking is required. Triploid grass carp will provide effective vegetation control for 8-10 years.

Grass carp grow rapidly in ponds that have preferred plant species. Nine to 11 inch fish stocked in the early spring can reach lengths of 25 inches or more and weights of seven to 10 pounds by the end of the first year. If appropriate numbers of grass carp are stocked, they will eventually reduce the vegetation to the point that new plant growth is eaten as it becomes available. The grass carp will survive and remain healthy but will not increase in size. Once stocked, grass carp are difficult to remove from a pond. They are almost impossible to remove by seining or angling. The only options are draining the pond or using toxicants such as rotenone.

Based on the magnitude of the Bog Moss aquatic weed problem of Vause Lake and low food preference for this species, at least 15 grass carp per acre (of adequate size so they will not be preyed upon) should be an immediate part of the existing problem.

LITERATURE SOURCE 2: The Ohio State University Cooperative Extension

Facts About The Grass Carp

- Are only distantly related to the undesirable European carp, and share few of its habits.
- Live for at least ten years.
- Will grow rapidly and reach at least ten pounds. They have been known to reach 40 pounds in the southern United States.
- Will not eat fish eggs, young fish or invertebrates, although baby grass carp are omnivorous.
- Feed from the top of the plant down so that mud is not stirred up. However, in ponds and lakes where grass carp have eliminated all submerged vegetation the water becomes turbid. Hungry fish will eat the organic material out of the sediments.
- Have definite taste preferences. Plants like Eurasian milfoil and coontail are not preferred. American waterweed and thin leaved pondweeds are preferred.
- Are dormant during the winter. Intensive feeding starts when water temperatures reach 68°F.
- Are a river fish and have the desire to move from still waters into flowing waters.
- Are difficult to recapture if a waterbody has been overstocked.
- They may not feed in swimming areas, docks, boating areas, or other sites where there is heavy human activity.

Advantages Of The Grass Carp

- Grass carp are inexpensive compared to some other algae control methods and offer long-term control, but fish need to be restocked at intervals.

- Grass carp offer a biological alternative to aquatic plant control.

Disadvantages Of The Grass Carp

- Depending on plant densities and types, it may take several years to achieve plant control using grass carp and in many cases control may not occur or all submerged plants may be eliminated.

- The type of plants grass carp prefer may also be those most important for habitat and for waterfowl food.

- If the waterbody is overstocked, all submersed aquatic plants may be eliminated. Removing excess fish is difficult and expensive.

- If not enough fish are stocked, less-favored plants, such as Eurasian milfoil, may take over the lake.

- Stocking grass carp may lead to algae blooms.

- All inlets and outlets to the lake or pond must be screened to prevent grass carp from escaping into streams, rivers, or other lakes.

LITERATURE SOURCE 3: *Utilizing Triploid Grass Carp For Aquatic Vegetation Control In Ponds*. Forrest Wynne, Area Extension Specialist for Aquaculture, Kentucky State University Cooperative Extension Program , Graves County Cooperative Extension Service Office,
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Grass Carp, or white amur (Ctenopharyngodon idella) were imported from Malaysia to the United States by the U.S. Fish and Wildlife Service in 1963. The fish is native to the river systems of

Northern China and Southern Siberia. Grass carp can be an effective biological control agent for some varieties of submerged aquatic soft-stemmed vascular plants and branched algae. In some instances, aquatic plant control has been obtained for periods of 5 to 10 years. Under the proper conditions, grass carp may provide aquatic plant control in ponds which is longer lasting, more economical, and is less labor intensive than chemical or mechanical control methods.

Grass Carp are members of the minnow and carp family (Cyprinidae). Members of this family have throat (pharyngeal) teeth which are adapted for chewing the food which is obtained by the mouth. Young grass carp, approximately 4 inches in length or less, feed on small invertebrates and plant material which may include filamentous algae. The diet of larger fish consists almost entirely of soft plant material. A short digestive tract requires grass carp to feed almost continuously when water temperature exceeds 68 degrees F (20 degrees C). Under ideal conditions, grass carp may consume 2 to 3 times their body weight in plant material per day and gain 5 to 10 lbs per year. The fish may grow to 4 feet in length and weigh up to 100 lbs in their native waters. However, these fish rarely exceed 30 lbs when harvested from ponds. Large grass carp become very active when trapped in a seine and can be dangerous to handle. Grass carp can survive water temperatures which range from 34 to 95 degrees F (1 to 35 degrees C) and short periods of low dissolved oxygen of 2 to 3 parts per million (mg/l). The fish will not feed when dissolved oxygen is low.

Many states allow the restricted use of grass carp for aquatic weed control. Triploid grass carp are not capable of successful reproduction due to an extra set of chromosomes. These fish are permitted by many states as opposed to the diploid grass carp which have two sets of chromosomes and are physically capable of reproduction. Successful spawning populations of introduced diploid grass carp have been reported in the lower Mississippi River and some rivers in Mexico.

8.2 Closing Summary Statement

To use grass carp is to treat the symptom and not the cause. Dense aquatic weed beds and nuisance algae only develop when there is enrichment of nutrients such as P and N. Because the probable source can be home owners lots, as Vause Lake is an isolated closed lake, an environmental inventory should be conducted as described above. The literature indicates that littoral zone plants and Bog Moss are low preference level food sources for grass carp. Establishment and spread of Torpedograss is a more dangerous source to loss of the existing littoral zone. The only effective means of control for this species is mechanical removal of rhizomes.

The above should be part of a finalized management plan.

8.03 Cost and Size Requirements for Grass Carp

Grass carp recommended for Vause Lake should be at least 10" – 12" long. The cost of a fish may be up to $10.00 each, depending on source and transportation. The property owners are responsible for all costs. Cost responsibility per property owner should be determined on a pro rata basis, as per extent of shore line distance. No monies are available from public sources at this time for this project. FFWCC can provide a list of certified vendors who supply sterile grass carp.

8.3 Other Mitigation Options

Two additional options are available for control of nuisance aquatic weed beds as follows:

1) Use of Herbicides

3) Mechanical Removal

These methods are significantly higher cost alternatives. Depending on the success of controlling Bog Moss using sterile grass carp, These two options should be evaluated as part of an integrated management plan.

E-mail transmittal of this draft report is being sent to the following individuals:

Sarah Anderson, Luther Springs Camp Director

Robert, Kipker, Biological Administrator for the Florida Fish and Wildlife Conservation Service

Keith Johnson, Executive Director for Novus Way Ministries, which manages Luther Springs.

Tom Sims, Vause Lake Property Owner who initiated this project

Please fell free to contact me regarding the above items.

Respectfully submitted,

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