Lake Gaston Aquatic Plant Management:

Revised Long Term Management Plan

January 24th, 2013

Current Treatment Site Selection Procedure

The overall goal of Aquatic Plant Management on Lake Gaston is to develop and maintain a healthy lake ecosystem based on a diverse plant community dominated by native species. Management recommendations and associated costs are provided to the Lake Gaston Weed Control Council (LGWCC) from the Technical Advisory Group (TAG), the Lake Gaston Stakeholders Board (LGSB) and applicators. The LGWCC identifies priority areas where treatments should be conducted based on applicator input and decides based on four major categories.

Priority 1 – Ecological Integrity

Priority 2 – Public and Residential Access

Priority 3 – Commercial Access

Priority 4 – Aesthetic Aspects

The Lake Gaston Long-Term Action Plan for managing aquatic plants prepared by the LGSB in 2005 was founded upon the main objective to reduce hydrilla and other noxious weed coverage to less than 300 acres by 2012. Since 2005, hydrilla coverage estimates have held at approximately 1500 acres, and in 2012 total hydrilla acreage increased slightly to 1,713 acres. A number of environmental factors could have led to fluctuation in coverage estimations over the years, however the original objective of 300 acres total coverage has not been fully realized. New management techniques and strategies need to be adopted in an attempt to bringing hydrilla to levels that can potentially be managed and maintained while also ensuring that funding produce the maximum benefit on both the short and long term.

The existing management plan has not been shown to reduce hydrilla levels to a "maintenance" level, but rather removes large amounts of hydrilla biomass annually from specified locations year to year. This management strategy would be effective in a whole lake treatment effort, but jumping from area to area on an annual basis provides no real control of the hydrilla tuber bank nor provides any effort to reach manageable levels of hydrilla. Past funding has only supported the treatment of approximately 1,500 acres of hydrilla over the past several years. Consecutive treatment (2+ years) has rarely been achieved as treatment areas have varied annually (Table 1). The sporadic treatment of areas without consecutive control increases the likelihood of tuber bank regeneration in these areas, which poses the largest threat to long term progress. Continual, long term (3+ year) treatment of hydrilla is

thought to be what is needed to bring hydrilla to manageable levels. If treatments are not applied in consecutive years then only hydrilla biomass is being managed and not the long term problem: tubers. The continued fluctuation of hydrilla acreage has led to frustration among funding sources, particularly the counties in North Carolina and Virginia who fund treatment activities annually. The current plan allows for the selection of treatment sites with input from TAG but the applicator and supplier has traditionally played a large role in the final decision.

Site	2008	2009	2010	2011	2012
Beaver Creek				x	
Beechwood Flats			x		x
Big Stonehouse	x		x		x
Coldsprings		x		x	
Dogwood		x		x	
Eagles Cove	x				
Flats	x		x	x	
Great	x				x
Hamlin			x		
Hawtree		x			
Hubquarter	x			x	
Jimmies	x			x	x
Jordon	x				x
Kings Branch	x		x		
Lees		x		x	
Little Stonehouse	x			x	
Lizard		x		x	
Lyons	x	x			
Mill	x				
Mistipines			x		
Pigeons Roost	x				x
Poes		x		x	
Poplar		x	x		x
Pretty		x			x
Six Pound	x				x
Sledge	x		x		x
Smith	x				x
Songbird	x				x
Speckle		x		x	
Stillhouse		x	x		
Timberline Shores			x		x
Triton Point				x	
Woodhaven			x		
Woodland Hurst	x		x		x
Consecutive Treatment =					

Table 1. Treatment areas for the last five years.

Tuber Sampling

Tuber sampling was initiated on Lake Gaston in the spring of 2007 by researchers with the Department of Crop Science at North Carolina State University (NCSU). A total of 10 sites have been sampled a total of 10 times. Three additional sites were added in 2011 located in the Flats region at which samples were taken at each site consisting of 30 sediment cores per sample.

Over the past 6 years of sampling a large amount of data has been generated, documenting hydrilla tuber bank response to management (Table 2 and Figure 1). The findings of this study should play a vital role in selecting treatment sites from year to year. It has been shown that tuber regeneration varies across treatment sites. For example, areas such as Smith Creek have very low regenerative capacity after a successful treatment, whereas sites like Hubquarter and Lyons have shown a 244% and 1,842% increase respectively following 2 or 3 years of consecutive treatment and then a lapse in treatment. These highly regenerative sites should be targeted for multiple year treatments to severely deplete the tuber bank and thus, maintain hydrilla at manageable levels when treatments are shifted elsewhere.

	Spring 07	Fall 07	Fall 08	Fall 09	Fall 10	Fall 11	Fall 12
Cold Springs	151 ± 48*	108 ± 32*	167 ± 49	39 ± 26*	175 ± 121	19 ± 3*	35 ± 21
Cotton	218 ± 30	259 ± 51	589 ± 107	164 ± 52	463 ± 102	687 ± 111	220 ± 58
Flats	-	-	-	-	-	85 ± 51*	119 ± 78
Hamlin	604 ± 168	971 ± 211	418 ± 131	369 ± 202	382 ± 93	604 ± 176	446 ± 88
Hawtree	241 ± 83*	160 ± 37*	198 ± 65	40 ± 33*	113 ± 63	142 ± 114	38 ± 30
Hubquarter	47 ± 16*	153 ± 45*	122 ± 44*	420 ± 130	353 ± 89	108 ± 20*	293 ± 133
Lakeview	410 ± 109	546 ± 150	306 ± 95	101 ± 33	201 ± 95	110 ± 55	124 ± 44
Lyons	160 ± 61*	105 ± 60*	39 ± 25*	7 ± 4*	136 ± 74	219 ± 109	294 ± 175
Poe	693 ± 129	113 ± 19	423 ± 124	102 ± 19*	147 ± 94	118 ± 63*	125 ± 68
Smith	20 ± 8*	167 ± 24*	88 ± 27*	56 ± 12	23 ± 9	83 ± 57	8 ± 6*
Consecutive Treatment							
Baseline Year							

Table 2. Tuber means (number per square meter) and standard errors for all sample sites on Lake Gaston
***Denotes treatment preformed**

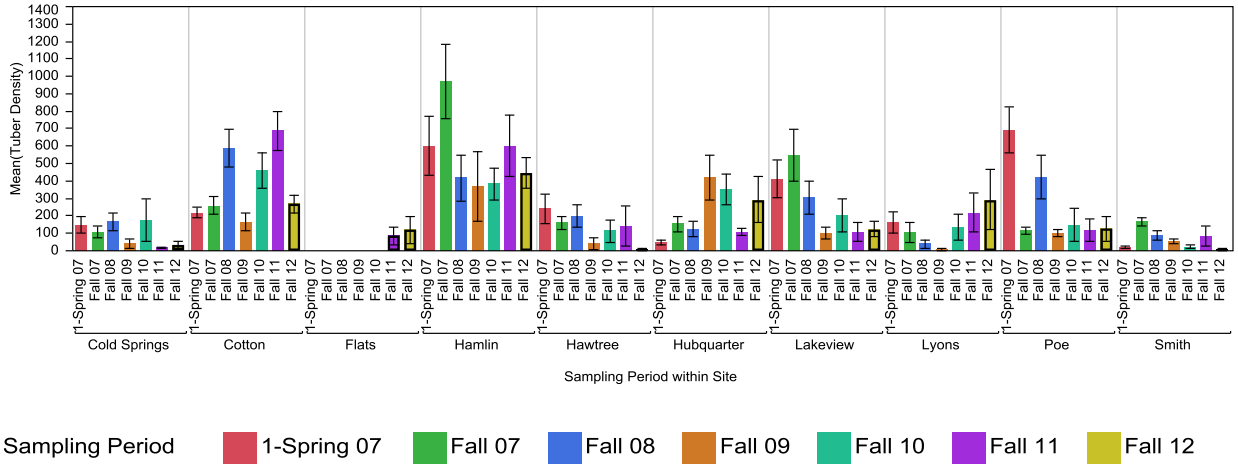

Figure 1. Mean tuber densities for all sites sampled on Lake Gaston

The current model for treatment on Lake Gaston incorporates a number of short-term strategies, particularly the use of herbicides for annual treatment and hydrilla monitoring. There are also a number of long term strategies used to supplement annual treatments including annual grass carp stockings and native plantings. While hydrilla can be successfully treated with herbicides annually, there is a great need to define and demonstrate some long term goals in regards to these methods. When thinking of long term management of hydrilla, most often tuber numbers, specifically density and sprouting rates are involved. As seen above in Table 2, Lyons and Hubquarter creeks saw a very large rebound, even after three years of consecutive treatment. A great amount of funding and resources were absorbed during this time period to reduce these two creeks to low levels of tuber density , however, the lapse of treatment in the following year greatly reduced the impacts from the previous years' treatments and management activities. These lapses in annual treatment translate far beyond tuber numbers alone. An economic study relative to hydrilla in Florida determined that a one year lapse in treatment can more than double the amount spent for long term management while also reducing recreation by more than 20% (Adams and Lee 2007). This same type of impact can be interpolated to Lake Gaston where more than $1 million is spent annually on hydrilla control.

Recent research at North Carolina State University suggests that anything less than 3-5 years of consecutive management reduces the likelihood of achieving reduction of hydrilla to manageable levels (Nawrocki 2011). For example, Tar River Reservoir received five years of consecutive treatments, reducing tuber density by 99.8% whereas one year of treatment (the common amount in Lake Gaston) only provided a reduction of 73% mean tuber density (Figure 2). Tubers can produce new plants in a matter of weeks which, in turn, produce their own tubers in the same growing season. Even a 98% reduction of tuber density as seen after two years of treatment can be insufficient to properly reduce hydrilla to low or maintenance levels.

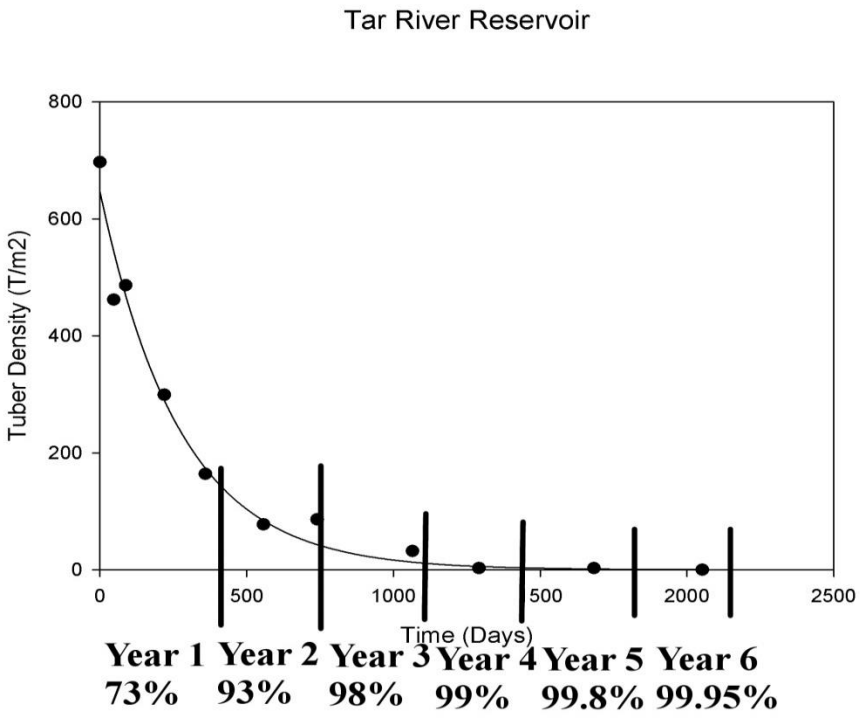

Figure 2. Tuber density (number/m2) reductions after consecutive treatments in Tar River Reservoir.

Introducing a Revised Long Term Management Plan

The purpose of the Lake Gaston Long Term Management Plan (LTMP) is to establish a long term management strategy with the ultimate goal of reducing hydrilla to manageable levels through depletion of the overall lake tuber bank. This plan will take a much more aggressive approach to management of hydrilla in Lake Gaston through the implementation of a Long Term Treatment Area (LTTA) selection. The LTMP would be built around consecutive treatments (3+) years of LTTAs in the Lake totaling 700-800 acres per year. This plan would also designate 700-800 acres of Annual Priority Treatment Areas (APTA) to be treated annually based on the original four priority categories as well as the spatial location of each site and where good results have been achieved in the past. This hybrid approach of combining the existing management plan with new long term strategies and goals would address hydrilla problems annually while also providing a long term vision. The hope would be to deplete the tuber bank of LTTAs over the long term while also allocating enough treatment acreage annually to address additional hydrilla problem areas in the lake. This method of treatment would also address problems inherent in long term plant management plans such as funding shortages, weather patterns, etc.

As treatment of the LTTAs reaches a level at which the tuber bank has been adequately depleted, these areas would be designated as Maintenance and Monitoring Areas (MMA) if appropriate hydrilla and tuber levels have been reached. Intensive monitoring of these sites would be needed to ensure that hydrilla levels remain at manageable levels and would be carried out by NCSU researchers and volunteers. If levels begin to rise again, MMAs would be reclassified as APTAs to address any "flare-ups" in hydrilla growth. Also occurring at the turnover from LTTA to MMA, APTAs from the previous year would be reevaluated to determine appropriateness for selection as LTTAs for the following treatment year. This would reduce the long term management time of those particular LTTAs to fewer years, as candidate LTTAs (the previous year's APTAs) have already received one year minimum of treatment in the prior year. This cycle would continue until the majority of areas have been designated as MMAs, thus achieving the lake-wide long term goal of reducing hydrilla levels to maintenance levels (Figure 3). Extensive tuber monitoring would also be needed in each LTTA to track changes in tuber numbers and density over time. This will aid in decision making as LTTAs are reevaluated annually and reduced to MMAs once tuber numbers have been reduced to a maintenance level (>99.8% reduction). Once a maintenance level has been reached, intensive monitoring will be required to identify any rise in tuber density. Spot treatments using appropriate herbicide applications may be used to address any flare-ups in hydrilla growth within MMAs.

Incorporation of an LTMP would provide the LGWCC and other entities with a plan to address hydrilla not only year to year, but for years to come. Such a plan would also provide lake extension personnel and others with the ability to communicate realistic goals to funding sources and potentially have a real measure of success in the long term.

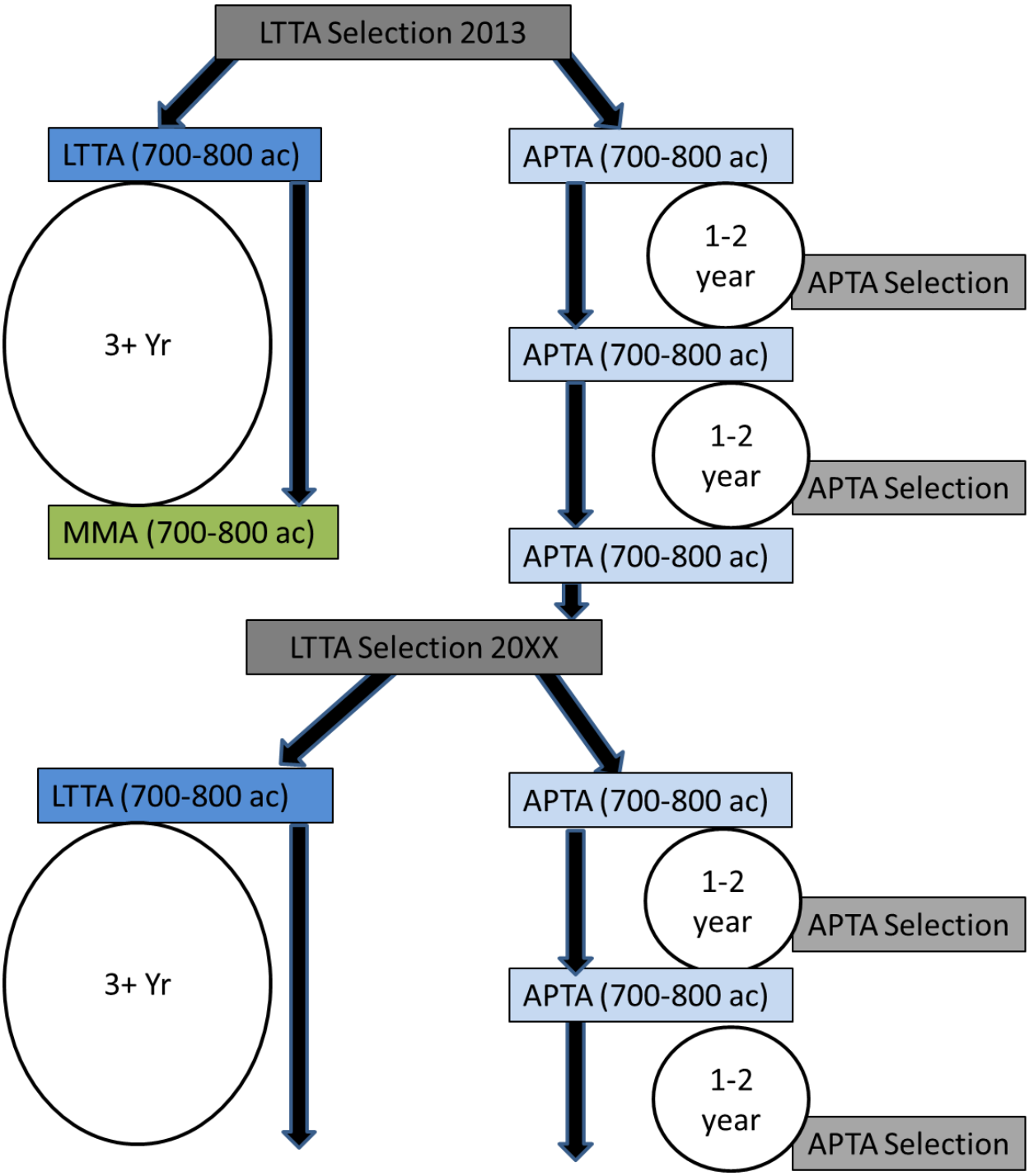

Figure 3. LTMP process diagram. LTTA = Long Term Treatment Area, APTA = Annual Priority Treatment Area, MMA = Maintenance and Monitoring Area.

Treatment Site Selection Committee

In order to implement this plan, a Treatment Site Selection Committee (TSSC) was developed from the existing entities charged with current treatment site selection. These would consist of members from TAG and the LGSB. The TSSC will take into account a number of factors before determining LTTAs as well as APTAs. LTTAs will be selected based on past consecutive treatments, past treatment success, size, ease of treatment, spatial relation to grass carp stocking locations, county location as well as the original four priority categories. APTAs will be selected based on annual need as designated by the original four priority categories as well as relation to LTTAs. A selection scoring system was developed by the TSSC and will be discussed in the following paragraphs.

Treatment Site Selection Decision Analysis for LTTAs

1.) Past Treatment (Level 1 Selection)

Past treatment successes (and failures) play a large role in the current selection of treatment areas annually. The TSSC believes that incorporating the knowledge of past successes will also be important in choosing LTTAs under the revised LTMP. The past treatment category will include variables representative of past successes and ease of treatment while also taking into account recent and/or consecutive treatments that would aid in quickly transitioning an LTTA into an MMA in a shorter period of time (<5 years). These variables will be used for level 1 selection of sites for LTTAs. This category will determine the level 1 pool of areas for possible LTTA selection based on five variables described below.

A. Recent Consecutive Treatment

Recent consecutive treatment is defined as an area having received treatment for 2 or more treatment years in a row INCLUDING the previous treatment year. An area having been treated for consecutive years in 2 or more of the previous years would also speed up completion of an LTTA. If an area has been consecutively treated for 2 or more previous years, including the previous treatment year, as either an APTA or LTTA, then that area shall receive the highest priority during LTTA site selection.

B. Recent Treatment

Recent treatment is defined as an area having been treated in the past treatment year. Areas treated in the previous treatment year as either an APTA or LTTA will be given priority over areas with previous consecutive treatment but not priority over areas having received a recent consecutive treatment. These areas will be given priority in this manner because they would speed up completion of an LTTA in fewer than 5 years.

C. Previous Consecutive Treatment

Previous consecutive treatment is defined as an area having received treatment for 2 or more treatment years in a row in the past five years, NOT including the previous year. An area having been consecutively treated for 2 or more previous years in the last five years, NOT

including the previous treatment year, as either an APTA or LTTA will be given priority over areas that have had no consecutive treatment in the past 5 years but not priority over areas which have received either recent treatment or recent consecutive treatment., then that area shall receive a score of “1” for this variable. If an area has NOT been consecutively treated for 2 or more previous years, including the previous treatment year, as either an APTA or LTTA, then that area shall receive a score of “0” for this variable.

After a level 2 candidate pool has been created, if all remaining sites total the total desired LTTA acreage, then all remaining sites will be selected for LTTA for that cycle. If all remaining candidates are above the desired LTTA acreage for that cycle, then selection process should proceed to level 2 selection criteria described below. Total acreage of areas being considered for level 2 selection should not exceed double the desired acreage of LTTA site acreage for that cycle. For example, if desired acreage for LTTAs in one cycle is approximately 600 acres, then the total acreage of all candidates after level 1 should not exceed approximately 1200 acres. This is to ensure that the level 1 selection pool be as specific and least robust as possible but still be representative of all counties before proceeding to level 2 selection. Should level 1 selection yield a pool of candidate sites with total acreage below the desired LTTA acreage for that cycle, then additional sites will be added using previously eliminated alternate candidate pool during a separate selection using level 2 selection criteria until total acreage of all level 1 candidate sites reaches the desired LTTA acreage for that cycle. A diagram of the level 1 selection procedure is shown in figure 4.

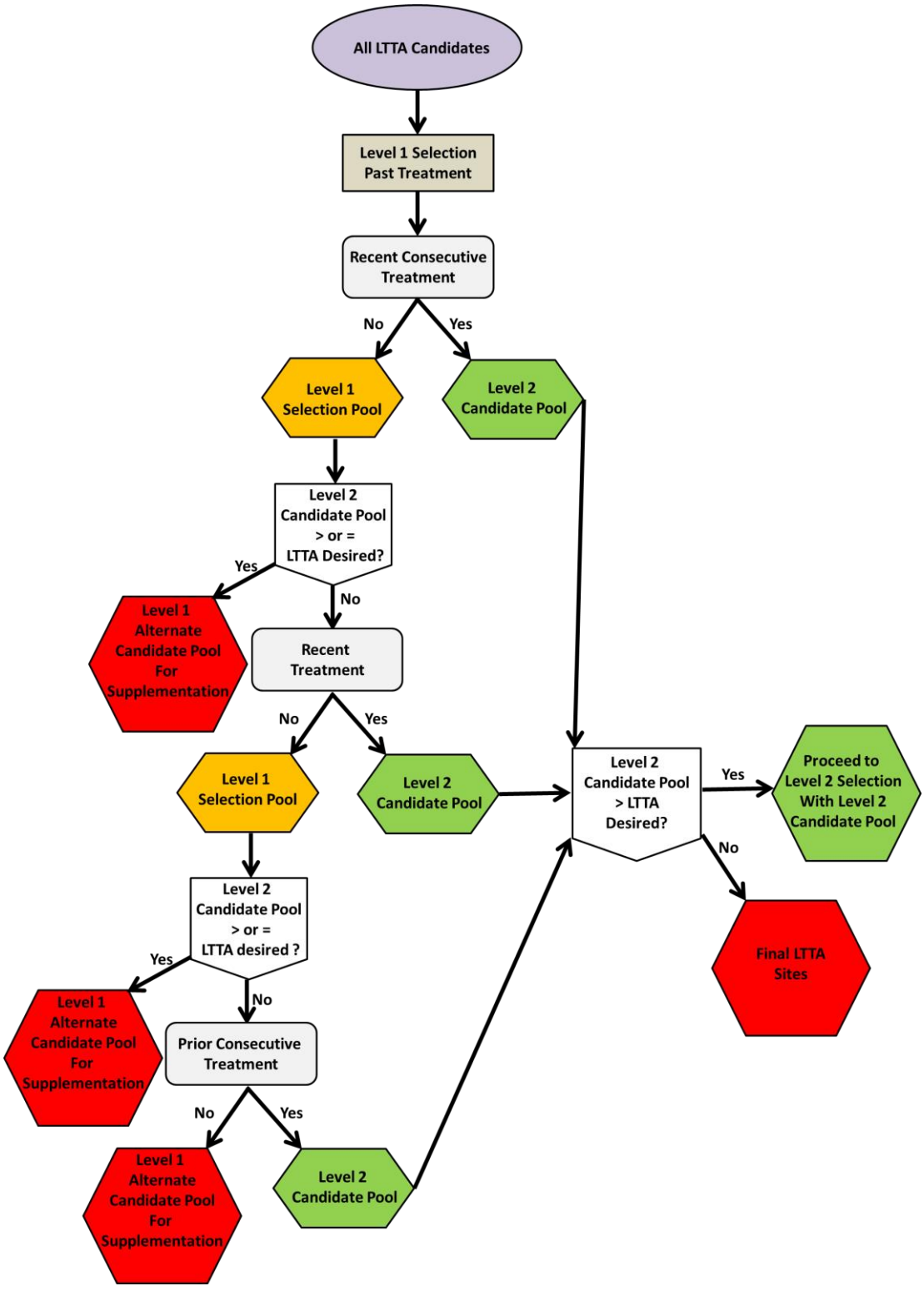

Figure 4. Level 1 selection process for LTTA designation as part of the LTMP.

2.) County Distribution (Level 2 Selection)

LTTAs and APTAs will be selected to equally represent funding contribution from the five counties which encompass Lake Gaston. These include in North Carolina: Halifax, Northampton, and Warren, and in Virginia: Brunswick and Mecklenburg. The total number of treatable acres in Lake Gaston is currently set at 3,037 A. These are divided among the five respective counties as seen in figure 4.

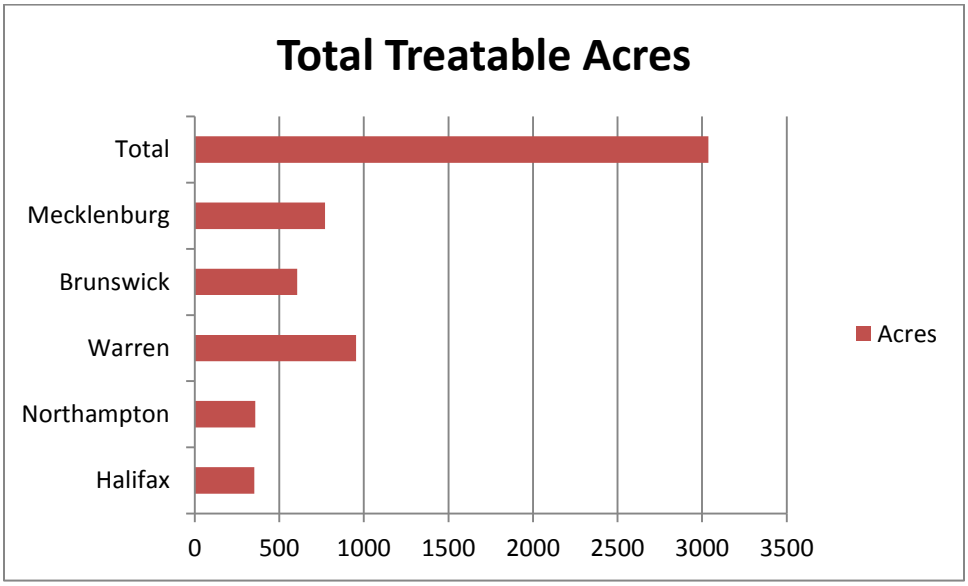

Figure 4. Total treatable acres of Lake Gaston and county contribution to the total.

Site selection may be subject to a prorated acreage should a county contribute less than 1/5th of all counties total contribution annually. Sites remaining from level 1 selection should be considered and selected based on acquiring equal acreages across each contributing county when possible. Areas of treatment should be considered by county only during level 2 selection. This category is comprised of multiple variables to narrow down areas by county distribution. These variables should be used to remove candidates from level 1 selection pool, however, they can also be used to add to selection pool when desired representation is not achieved for each of the Lake's five counties. These variables are described below.

Treatment Area Size

Areas of larger size treated over several years as an LTTA will have a greater impact on hydrilla reduction per county than treatment areas of smaller size. Treatment areas of large relative size (>75 acres) will be given priority over areas of small size (<75 acres) by county.

Multiple County Control

There are a number of treatment areas on Lake Gaston which provide hydrilla control across multiple counties. Treatment areas which encompass multiple counties within the areas boundary will be given priority over areas that do not contain multiple counties.

Proximity to Grass Carp Stockings

This category will contain only one variable based on relative proximity of sites to current grass carp stocking sites. Grass carp are needed once an LTTA transitions to an MMA to ensure constant grazing of remaining sprouted tubers. Areas considered closer to grass carp stocking during that year and subsequent years will be given priority over areas farther from grass carp stocking. These sites are currently designated at US 1, Big Stonehouse Creek and Poplar Creek. Sites further than 5 miles from grass carp stocking locations will be given a score of "0" whereas sites closer than 5 miles from carp stocking locations will be given a score of "1". Relative comparisons between candidate sites will also be made. This variables is subject to change as grass carp stocking locations may vary from year to year.

Recreation and Tourism Values

There are a number of publically available areas which provide both economic and cultural opportunities for residents of each county on Lake Gaston. Treatment areas within a county that encompass areas of perceived economic and cultural value, i.e. public boat ramps, marinas, restaurants and other public use areas, will be given priority over areas not encompassing such value.

Once the level 2 pool has been narrowed down to the desired acreage for an individual LTTA cycle using the level 2 variables for selection, the remaining candidates will be selected for that cycle. Should special circumstances arise that additional LTTA candidates be added, the pool of eliminated/ alternative sites shall be revisited and the process described above be repeated until equal county representation is achieved and the total LTTA acreage for that cycle is completed. The total number of LTTA sites will be based upon available funding and subsequent total acreage per year. A diagram for the level 2 selection process is shown in figure 5.

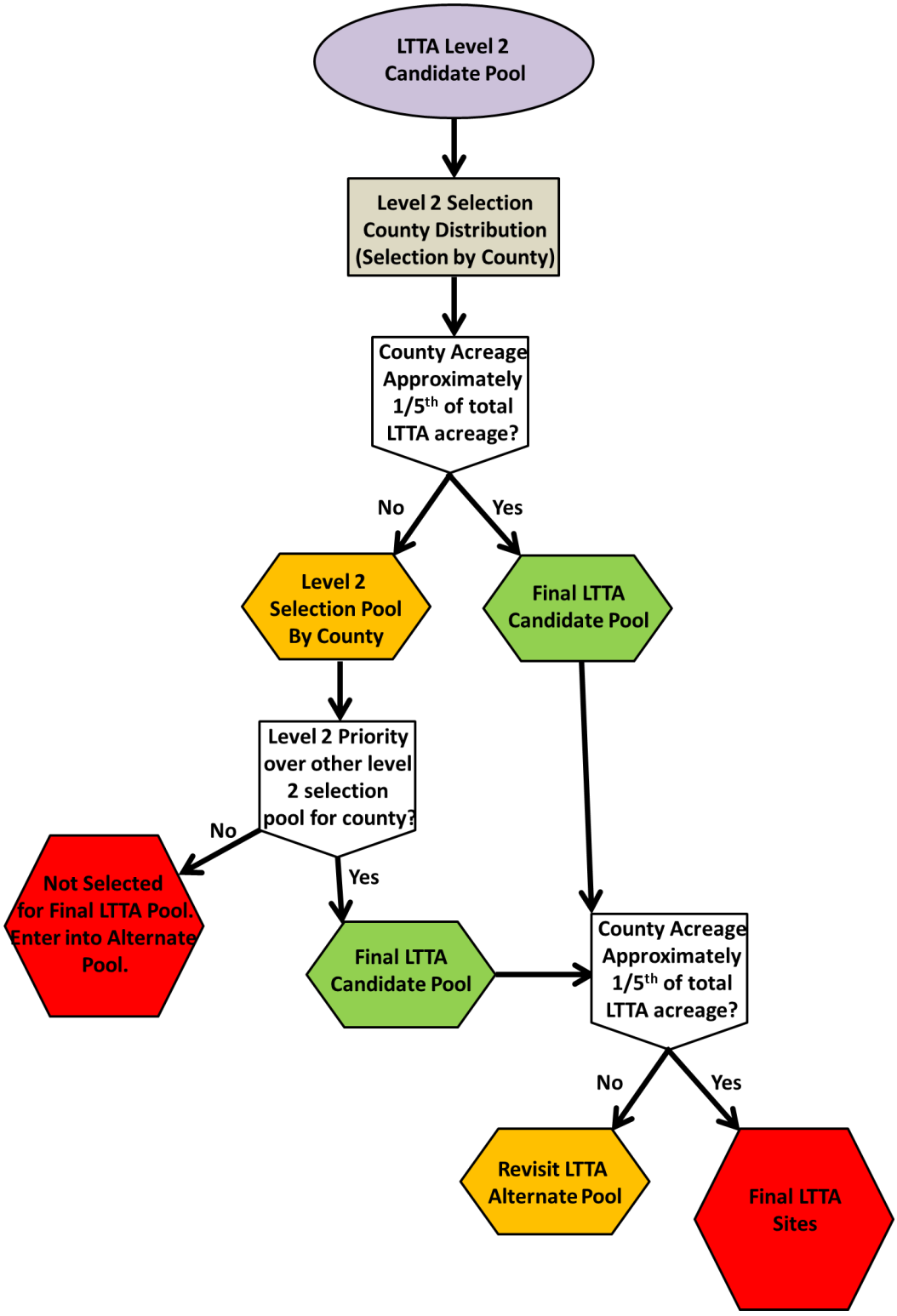

Figure 5. Level 2 selection process for LTTA designation as part of the LTMP.

Fluctuations in Annual Funding

In a changing economic climate, funding for management of aquatic invasive plants in Lake Gaston may change from year to year. Should funding fall **BELOW** the current amount, the LTMP committee will meet to address shortages. The current treatment acreage split for LTTAs and APTAs is set at 50/50. LTTAs will take priority over APTAs annually; however a 70/30 split between LTTAs and APTAs should never be increased despite funding limitations.

If funding should rise **ABOVE** the current amount, the excess will be dedicated to more APTAs without adding additional LTTAs in the middle of a current LTTA cycle. This will ensure that funding fluctuation in following years will not affect the current cycle of LTTAs being treated.

LTMP Monitoring

All progress in LTTA sites will be tracked biannually to ensure program success. Tuber sampling will be completed at multiple sites throughout each LTTA at equal interval, spatially representative points throughout the treatment area. Number of points designated for sampling within each LTTA site will be proportional to the overall size of the LTTA. For example, a site of 150 acres shall have three times the sampling locations than a site containing 50 acres.

All tuber sampling points will be sampled biannually in the spring and fall. Tuber density and tuber sprouting rate will be assessed at each point and measured per square meter of sampling area in the spring sampling to determine the relative density of tubers present and the sprouting rate prior to that years treatment. Fall sampling will only measure tuber density to determine the density of tubers present following that year's treatment. Mapping of tuber density and sprouting rate will be presented annually and discussed among the LTMP committee as needed.

Tuber monitoring will ultimately determine when an LTTA will be transitioned to an MMA based on the existing tuber bank and trend of decline. This number is likely to vary from site to site as each area can show very different regenerative potential. For example, some sites may only require 3 to 4 years of consecutive treatment before management levels are achieved, however other sites may take much longer.

Future Work

The proposed LTMP is an adaptive management plan. An adaptive management plan is a structured, iterative process which takes into account uncertainty inherent in resource management through ever evolving strategies. Adaptive management presents a number of challenges including finding the correct balance between gaining knowledge to improve future management as well as achieving the best short-term outcome (Stankey et al. 2005). These strategies will be based on the system monitoring described above and potentially changed as new information becomes available. Adaptive management is not only used to change a system, but also to learn more about the system and make informed decisions (Holling 1978). As new information becomes available and is reviewed by the LTMP committee, it may or may not be incorporated into the existing plan. For example, private

treatment areas are not currently incorporated into the decision making process of the current LTMP, however, recent improvements in applicator reporting of private treatments should provide valuable knowledge to inform both short and long term goals of aquatic plant management on Lake Gaston. If you have questions, comments or concerns regarding the current LTMP, please contact Brett M. Hartis, Aquatics Extension Associate at (919)-515-5648 or email to bmhartis@ncsu.edu.

**This document was drafted by the Lake Gaston Treatment Site Selection Committee (TSSC)*

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