SURVEY OF AQUATIC PLANTS

LAKE MURRAY, SC

2018

Prepared for:

South Carolina Electric & Gas Company

Land Management Department

Cayce, SC

prepared by:

Cynthia A. Aulbach

Consulting Ecologist and Botanist

Lexington, SC 29072

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I. Introduction and History of Aquatic Plants in Lake Murray

Lake Murray is a 48,000+ acre reservoir with approximately 650 miles of shoreline in central South Carolina. The Lexington Water Power Company, now South Carolina Electric and Gas, (Lake Murray Country n.d.) created the lake in 1930 to produce hydroelectric power by damming the Saluda River at Dreher Shoals (Lake Murray History 2009). For many decades, the primary use of the lake was hydropower production. Lake Murray now has many uses to include hydroelectric power production, recreation, and it serves as a municipal water supply for Columbia, West Columbia, Lexington, and other areas of Lexington County.

Until the mid-1980s no major aquatic plant problems were known in Lake Murray. The macrophytic algae, *Chara* and *Nitella,* were common; however, no vascular aquatic plants were known to occur until 1985 (personal observations).

Prior to the 1980s, native mussel species were prevalent and Asian clams *(Corbicula fluminea*) were absent (personal observations). The first reports of Asian clams in South Carolina came from the Pee Dee River in the late 1960s or early 1970s and from there, Asian clams spread throughout the state (SCDNR 2015). Asian clams have apparently been a primary cause of the decline and local extinctions of native freshwater mussel species (SCDNR 2015). Sedimentation and shoreline development (Bogan et al. 2008, p. 7) are also likely contributors to the decline of mussels in Lake Murray. Asian clams are found abundantly in Lake Murray and mussels are now rarely found. (personal observations).

The 1980s saw an acceleration of residential development along the shoreline that was accompanied by an increase in aquatic plant growth and diversity. Many nuisance aquatic plants are non-native species introduced from Europe, Asia, and South America. They have the potential to grow out of control outside of their normal range like other well-known introduced plants, such as kudzu. Native aquatic plants are usually a natural component of lakes and rivers and are considered desirable from many viewpoints, especially water quality and fisheries. However, the uncontrolled growth of any plant species can interfere with water quality, aesthetics, recreational and industrial water use, and can impede the growth of, or eliminate, native species of aquatic plants (Aulbach-Smith 1990).

Quantitative and qualitative data have been gathered on the aquatic plants of Lake Murray almost annually from 1989 to 2018, with a few exceptions. The lake was not sampled during years when no significant change was assumed to have occurred in quantity or type of aquatic vegetation.

Brazilian elodea *(Egeria densa)* was first found in 1985 as fragments floating on the surface from an unknown source; by 1990 Brazilian elodea became one of the major species of concern on Lake Murray (Aulbach-Smith 1990). Slender naiad *(Najas minor)* also became problematic and increased in extent until the drawdown in the fall/winter of 1990-1991; populations rebounded after the drawdown. The discovery of dioecious hydrilla *(Hydrilla verticillata)* in 1993 (Aulbach-Smith) resulted in a shift of the survey primarily to the extent and distribution of hydrilla. Because of the emphasis on hydrilla, information on the other species of aquatic plants wasn't consistently gathered from 1994 to 1996. The most comprehensive data set available is from 1997; almost half the records in the database (unpublished) are from that year. At this time, approximately 1,000 sample site locations exist; some of these sites have been sampled each survey year.

Hydrilla may be the most well-known aquatic plant in Lake Murray. It reached a peak of 6,645 acres in 2002 (Figure 1). A drawdown in the fall of 2002 to the 345' elevation controlled nearly 3,000 acres of this infestation. 64,500 grass carp were stocked in the lake in 2003 due to their activity combined with effects of the drawdown essentially eliminated hydrilla from the system. It has not been found since 2004.

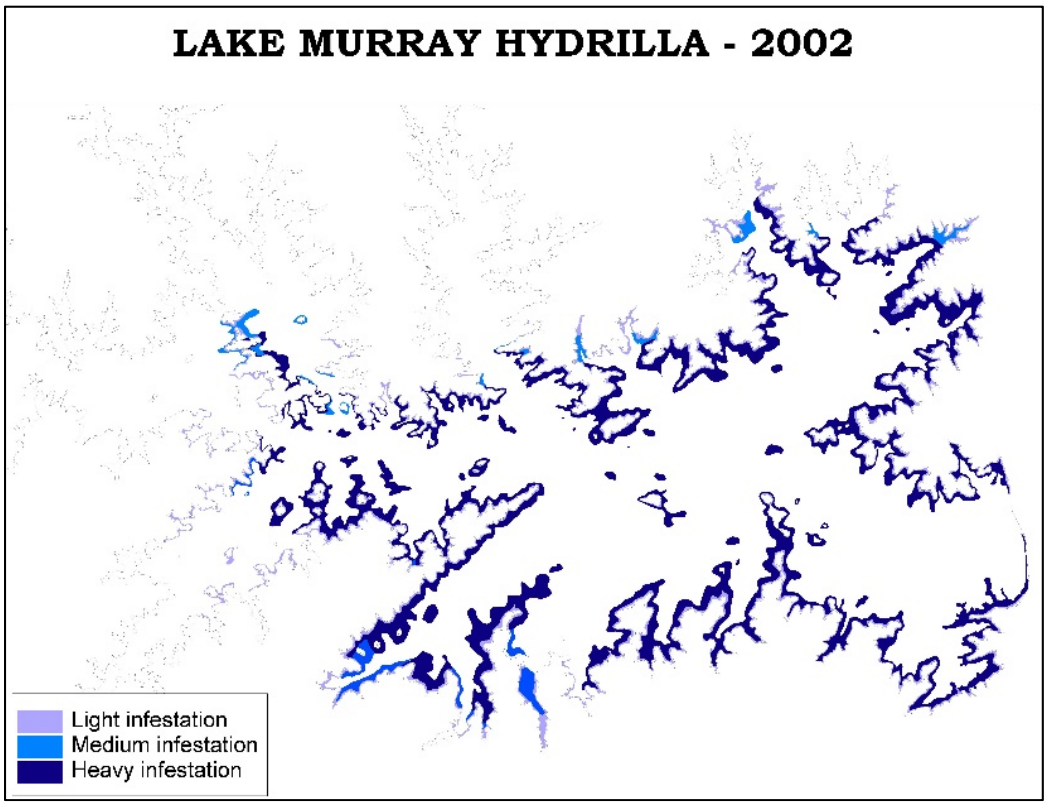

Figure 1. Map of the extent of hydrilla in 2002 (Aulbach 2002)

Over the years, other species that have nuisance potential have been found; these include: Eurasian watermilfoil (*Myriophyllum spicatum),* slender pondweed (*Potamogeton pusillus),* curly-leaf pondweed *(P. crispus)* (1993)*,* and Illinois pondweed (*P. illinoensis)* (1993)*.* Eurasian watermilfoil was confined to one cove of the lake and was eradicated by herbicides. Of the three species of pondweed, curly-leaf pondweed has also apparently been eliminated from the system.

Of further interest was the increase in slender water nymph (*Najas gracillima).* This native species had been found very occasionally in Lake Murray until 1997 when it increased dramatically in amount and distribution. Considered rare in South Carolina, it was known from only two localities in the state before it was documented in Lake Murray. Another native species that increased during the same time frame was coontail (*Ceratophyllum demersum)*. Neither of these species have been found since the drawdown and grass carp stocking in 2003.

In 2011, de Kozlowski reported finding only the macrophytic algae *Chara* and *Nitella* along with a very few fragments of slender naiad and spikerush. By 2012, de Kozlowski reported finding *Chara* and *Nitella* along with a few fragments of southern naiad. By 2016, only southern naiad and *Nitella* were found growing in Lake Murray. However, these species were much more abundant than in previous years and were more widespread and commonly found throughout portions of the lake below the gap. They were particularly prevalent on the north side from Windward Point to the dam (de Kozlowski 2016).

II. Purpose of the 2018 Aquatic Plant Survey

A drawdown to the 350' level (eight feet below normal high levels and 10 feet below full pool) was planned to begin in October of 2018 to reduce the growth of problematic aquatic vegetation, particularly southern naiad and slender pondweed. Desiccation and exposure to freezing temperatures usually kill these submersed species in the drawdown zone. It's anticipated that rainfall during the drawdown period will flush accumulated sediments from coves into deeper water; these sediments are rich in nutrients which results in an increase in aquatic plant growth (SCE&G 2018). In addition, these soft sediments provide a substrate conducive to the establishment and successful growth of submersed aquatic plants.

The purpose of the 2018 survey was to provide baseline data on the extent of invasive and native submersed plant species prior to the drawdown. This will make it possible to assess the drawdown's effectiveness in 2019 in achieving the goals of controlling southern naiad and slender pondweed.

III. Methods

Sample sites were selected by reviewing reports from 1989 to 2016 to assess the trends in aquatic plant abundance and location, and to review the impact of various treatments on the control of nuisance species. These treatments include drawdowns (whether for aquatic plant control or for SCE&G's operational needs), herbicide applications, and grass carp stockings. Especially useful in site selection was de Kozlowski's 2016 Aquatic Plant Assessment; many of the samples were taken at the same location sampled in 2016. Aerial overviews of the lake were conducted to locate areas that may harbor large and/or dense concentrations of vegetation.

Two and one-half days were spent sampling by boat with Curtis Stockman (SCE&G Lake Management) and another half-day was spent sampling by kayak in specific sites found after the boat sampling was completed. Each sample site was viewed visually in shallow water and by using the Lowrance Elite 5 DSI chartplotter/fishfinder in deeper water. When necessary, samples were taken using weighted dethatching rake on a rope to ascertain species present and relative abundance.

IV. Findings

As documented by de Kozlowski (2016), southern naiad (*Najas guadalupensis)* and *Nitella* (Figures 2 and 3) continue to be the most prevalent aquatic plants in Lake Murray. *Chara,* another type of macroscopic algae similar in appearance to *Nitella,* was also found in several areas of the lake but it

tends to grow in primarily in shallow water. On the other hand, *Nitella* is more abundant, extends higher in the water column, and grows to deeper depths than *Chara. Nitella* was found to grow as high as two feet off the bottom and is found as deep as 24 feet below full pool (down to the 336-foot contour interval). The distribution of these three species has expanded greatly in the past two years and they now occupy most of the shoreline of Lake Murray from the "Gap" at Dreher Island east to the dam. Southern naiad is absent from some portions of the lake, particularly on the north side above Dreher Island State Park. Otherwise, the shoreline extent of these two species follows that of hydrilla at its peak in 2002 (Figure 1). Southern naiad is particularly prevalent along the south side of the lake.

Figure 2. Illinois pondweed growing in large patches in shallow water to 5 feet; southern naiad and *Nitella* growing from 5 to 15 feet, appearing as dark water.

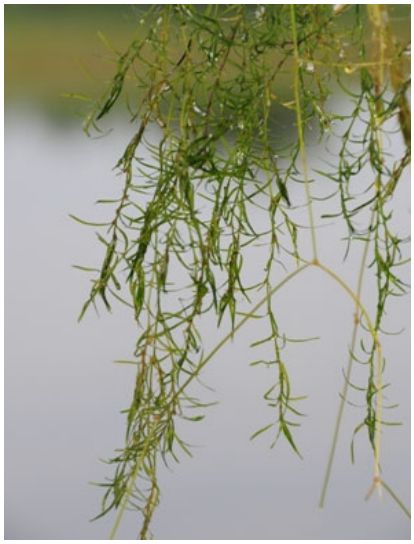

Figure 3. Southern naiad (Keller

In 2016, de Kozlowski documented the presence of tape grass (*Vallisneria americana)* growing around Wessinger Island (Figure 4). Tape grass has continued to expand its presence around Wessinger Island and is now found in abundance on the lake side (see Figure 5) and along portions of the island facing Lake Point. Tape grass was also found in the cove on the south side of Palmetto Point; three large, circular patches occur there in water to five feet deep.

Several species were discovered during this year's survey that haven't been documented since 2001 or have rarely been found in Lake Murray since hydrilla occupied nearly all available habitat in the lower lake in 2002. The species that have recently been found to grow in Lake Murray again include Illinois pondweed *(Potamogeton illinoensis),* slender pondweed *(Potamogeton pusillus),* and slender naiad (*Najas minor).*

Figure 4. Vallisneria-Wessinger Island (de Kozlowski 2016)

Figure 5. Overhead view of Vallisneria between Wessinger and Leeward Islands

Illinois pondweed has become quite prevalent in several areas of the lake. On the north side of the lake, Illinois pondweed is found in shallow water (Figures 2 and 6) from Yacht Cove west to Wessinger Island. In several areas, it grows to at least five feet and is producing seeds as well as floating and submersed leaves (Figures 7 and 8). Some of the more extensive growth is on the north side of Susie Ebert Island. On the south side of the lake, Illinois pondweed is found from the east side Shull Island peninsula to Rocky Well Point and the east side of Lands End. It is very prevalent along both sides of the shoal to Hallmark Key.

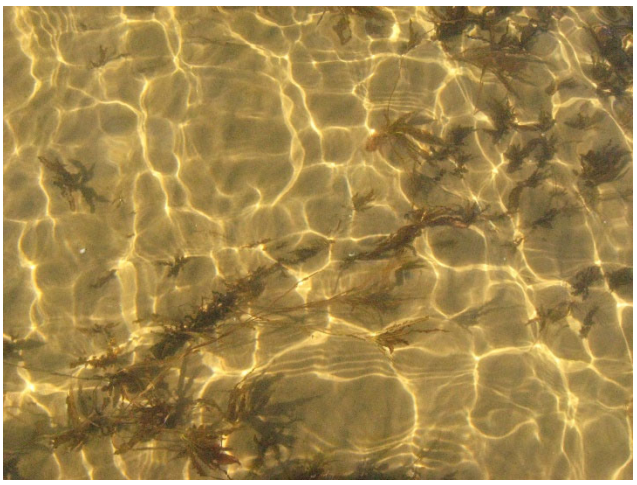

Figure 6. Young Illinois pondweed plants in shallow water

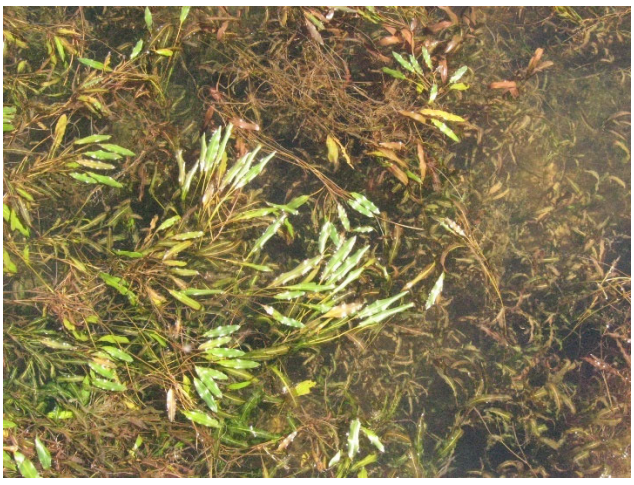

Figure 7. Dense growth of Illinois pondweed at Susie Ebert Island showing both floating and submersed leaves.

Figure 8. Illinois pondweed in patches along both sides of the causeway at Land's End in shallow water, grading into slender pondweed and southern naiad.

Slender pondweed is another species that was found again this year for the first time since before 2003. Floating fragments were found at a few locations; however, a dense, rooted area of slender pondweed is growing in the large cove on the west side of the Land's End causeway (see Figure 8). Like slender naiad and Illinois pondweed, it is probably more prevalent than found in this survey.

Slender naiad was found in two locations this year; it hasn't been found in Lake Murray since before 2003. It was found on the north side of the lake at Billy Dreher Island Marina cove (Figure 9) and on the south side near Woods Point Road Cove. It is likely that slender naiad is more prevalent than found in this survey.

Figure 9. Slender naiad in shallow water at Billy Dreher Island State Park marina.

Large patches of detached southern naiad were discovered floating in the large cove east of Woods Point Road just south of Mallard Bay. Although these large patches of southern naiad could have been uprooted by boat activity, it's possible that this is the result of grass carp activity. Southern

naiad is particularly abundant in this area, especially the Mallard Bay area, and along the entire east side of Shull Island peninsula at least as far as the boat ramp near Larry Koon landing.

V. Discussion

Native and introduced aquatic plants have been a part of the Lake Murray system for over three decades. When submersed aquatic plants have interfered with recreational use of the lake, various control measures have been used to control the extent and growth of these nuisance plants. Drawdowns of the lake have been done several times since 1990 variously for dam and facility maintenance or construction, aquatic plant control, and to improve water quality. The lake was drawn down in 1990 (345' elevation), 1996 (350' elevation), 2002 (345' elevation), 2006 (350' elevation), [figure 10] (350' elevation), and this year, 2018 [figure 10] (350' elevation).

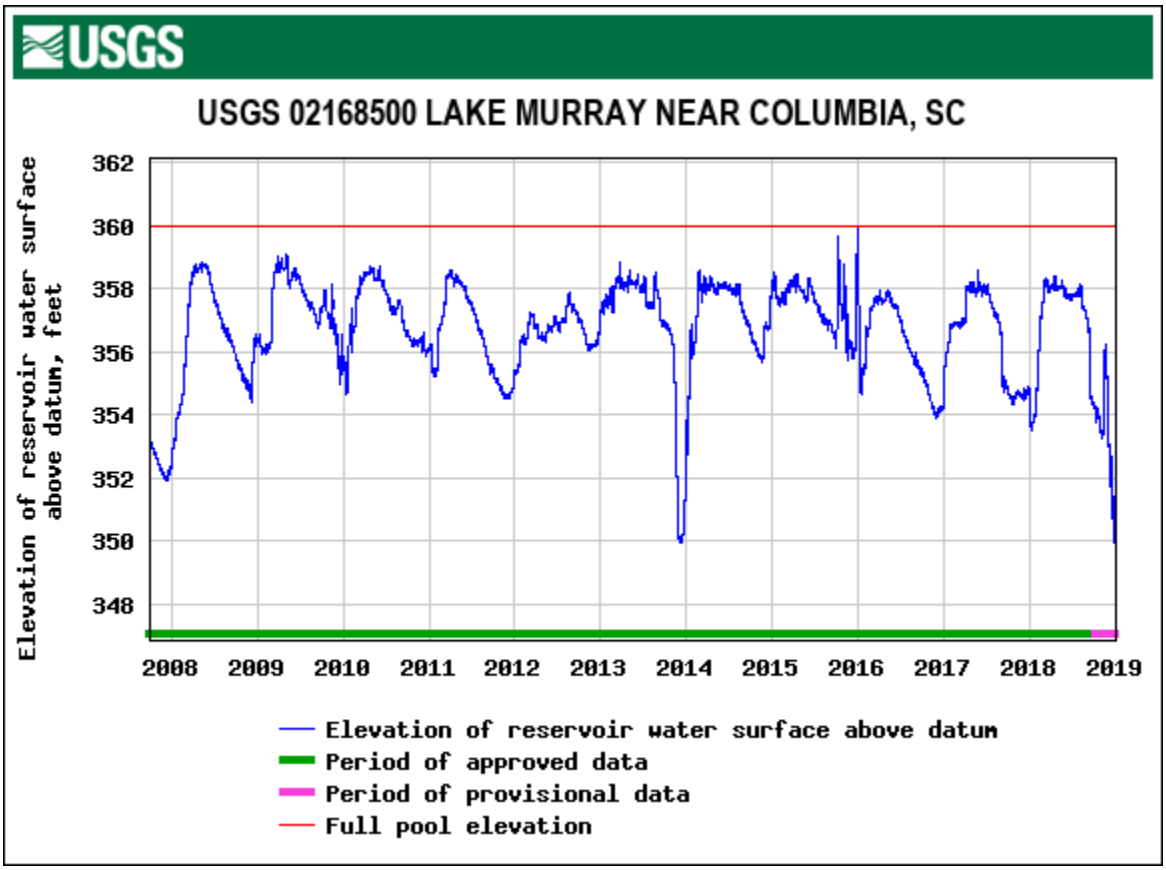

Figure 10. USGS water level data from 2008 to present (USGS 2019)

SC Department of Natural Resources and South Carolina Electric and Gas Company have worked together to restore the population of triploid grass carp to the level required to keep nuisance aquatic plants under control. The initial stocking of 64,000 sterile grass carp in 2003 essentially eliminated hydrilla from Lake Murray within two years. Due to attrition as well as reduced feeding

activity as grass carp mature, an annual maintenance stocking of 1,100 additional grass carp was planned and began in 2014.

The increase in submersed aquatic plant growth is likely attributed to the loss of sterile grass carp during the historic rainfall and flooding in early October of 2015 (Page 2018). Approximately 20 inches of rainfall over a period of just a few days caused the water level of Lake Murray to increase almost to full pool (360' elevation). SCE&G opened a floodgate at the spillway to drop water levels due to the flooding (Breslin 2015). According to Page, it's likely that more than 75% of the triploid grass carp remaining in Lake Murray were lost during this major flood event. Very high numbers of grass carp were found at Saluda Shoals Park along the Lower Saluda River downstream from the Lake Murray dam (Page, personal communication). The spillway was opened again in late December of 2015 due to another major flooding event (Lowe 2015). See figure 10 for historic water level information.

Southern naiad and *Nitella,* reported by de Kozlowski in 2016, have spread throughout the main body of the lake and have become quite prevalent. In addition, tape grass has begun to spread from the original location first reported in 2016. Illinois pondweed, a species not seen in Lake Murray since 2007, has become common throughout the main portion of the lake in shallow water. Where Illinois pondweed is well-established, it grows in water below the 2018 drawdown zone and is producing seeds. In those areas, there's a good chance that control will be limited. However, Illinois pondweed is established in very shallow water in many of the sites it was found this year. These shallow water locations may experience good control from the drawdown. Another species that has been virtually absent from the lake since 2001 is slender naiad. Although slender naiad was found to occur in very shallow water in only two sites, it is probably more common than documented. However, it only occupied shallow water and will likely be controlled by the drawdown.

As a result of the flooding in and loss of grass carp in 2015, the grass carp stocking rate was increased from 1,100 fish per year to 1,500 fish per year in 2016.

In 2016, de Kozlowski reported an increase in the abundance and distribution of southern naiad and *Nitella* as compared to what he found in the 2014 survey. Due to his 2016 findings, grass carp stocking was increased again to 2,000 fish in the Spring of 2017.

Due to reports from lake users and other sources, stocking increased again in 2018. In the spring, 1,500 sterile grass carp were stocked and an additional 1,500 fish were added to the lake in late October. The dramatic increase in abundance and extent of submersed aquatic plants found in this year's survey warranted the increased numbers of fish.

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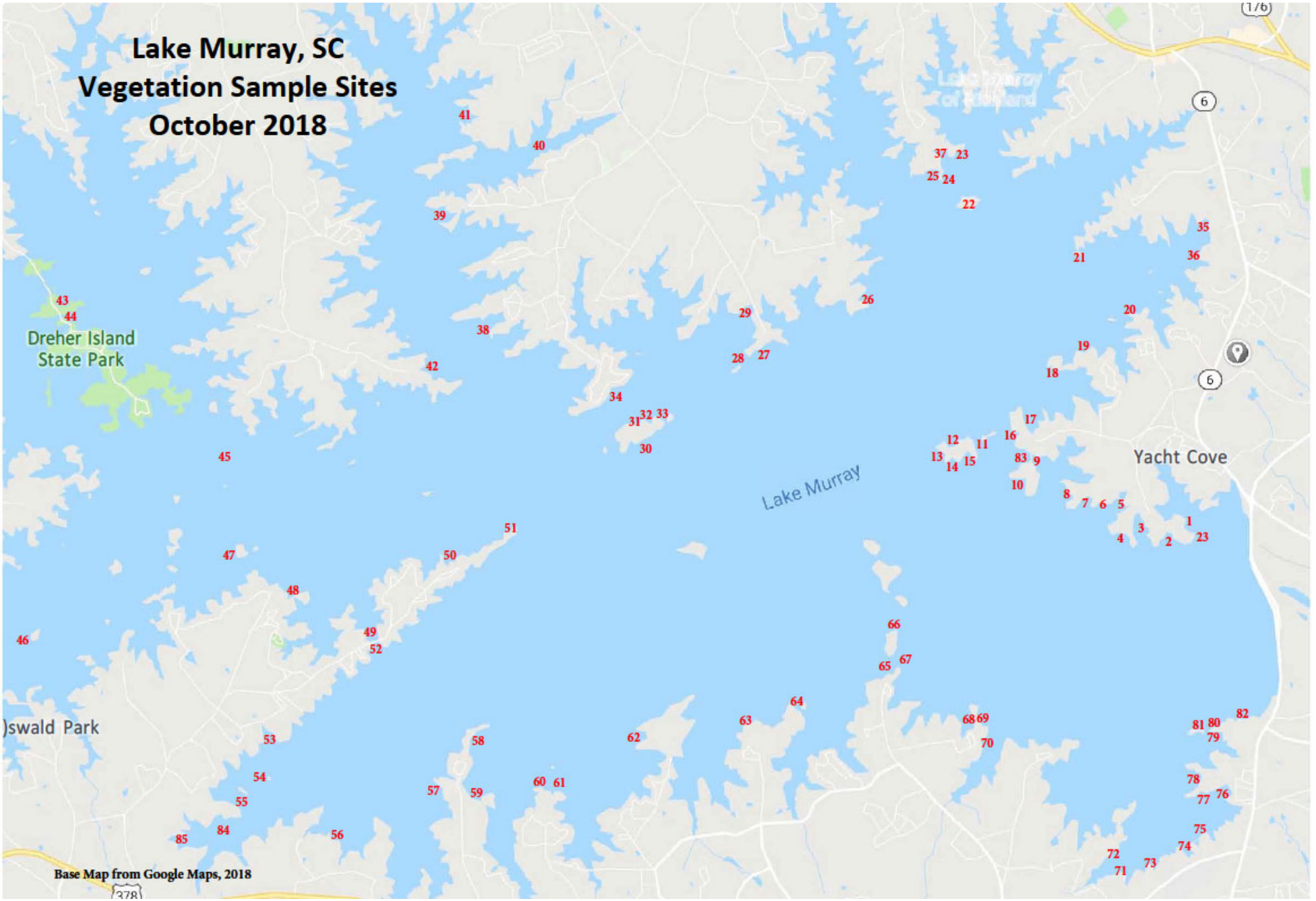
Lake Murray, SC
Vegetation Sample Sites
October 2018
Dreher Island
State Park
Lake Murray
Yacht Cove
)swald Park
Base Map from Google Maps, 2018

Appendix II – Sample Sites

October 22, 2018 – water level ca. 354'

1. Windward Point Shoal – mix of southern naiad and *Nitella* from 2-3 feet down to 15 feet, similar to 2016 results; *Chara* present; on the east side of the shoal - more *Nitella*, no southern naiad.
2. Illinois pondweed in shallow water only*, Nitella* 1-2 feet high off bottom down to 10 feet.
3. *Nitella* 1-2 feet off bottom in very shallow water down to 10 feet.
4. Illinois pondweed –low growing in 1-5 feet, fruiting, rhizomatous; *Nitella* 1-2 feet off bottom from very shallow water down to 7-10 feet.
5. Small amount of Illinois pondweed, moderate amount of southern naiad and *Chara* toward back of cove, southern naiad growing to 15 feet. West side –low growth of *Chara* and southern naiad.
6. Dense growth of *Nitella* with some southern naiad*;* slender pondweed found detached and floating.
7. Scattered low growth of *Nitella* and southern naiad in shallow water; southern naiad common down to 15 feet.
8. Scattered low growth of *Nitella* and southern naiad.
9. Pine Island causeway – east side – scattered low growth of *Nitella* and southern naiad in shallow water; slender pondweed with some southern naiad from 1.5 to 10 feet growing up to 3 feet tall; dense *Nitella* growing from 5 to 15 feet.
10. Pine Island swimming area – scattered Illinois pondweed and with a mix of *Chara* and southern naiad in shallow water down to 10 feet.
11. Goat island East side, Illinois pondweed growing abundantly to 1 foot, then scattered to 5 feet.
12. Goat Island North side – clear.
13. Goat Island West side – clear.
14. Goat Island Southwest cove -- Illinois pondweed growing abundantly to 1 foot, also moderate growth of *Nitella* to 10 feet.
15. Goat Island Southeast cove – Illinois pondweed in shallow water to 1 foot, none in deep water.
16. Illinois pondweed - common in shallow water only. Cannot pull up with rake due to deeply-seated rhizomes; also scattered southern naiad to 5 feet.
17. *Nitella* – scattered in shallow water.
18. *Nitella* – dense in shallow water.
19. Shallow water– spikerush and Illinois pondweed in shallow water*;* southern naiad abundant in deeper water.
20. *Nitella* in dense patches, southern naiad scattered in open shallow water.
21. Salem Church Road – at shoal where suitable substrate is available – southern naiad common down to 10 feet, floating slender pondweed fragments present, *Nitella* absent.
22. Susie Ebert Island
    ESE side – Illinois pondweed – prevalent in shallow water, larger plants occur down to 5 feet; *Nitella* and southern naiad in 1-10 feet of water.
    South side – scattered Illinois pondweed growing down to 4-5 feet; floating slender pondweed present; some *Nitella* and southern naiad to 5+ feet.
    West side – dense patches of Illinois pondweed.
    North side – very dense Illinois pondweed with floating leaves; *Nitella*, southern naiad and *Chara* also present. Plant bed extends as far as shoal marker 142.

23. Sandy substrate west of shoal marker 144, *Chara* and *Nitella;* dense growth of *Nitella* to 17 feet.
24. Coast Guard Island – East side – shallow water, *Chara* and southern naiad.
25. Coast Guard Island - West side – *Chara* dense around docks.
26. Burton's Point – *Chara* 1-10 feet water, not dense.
27. Center of Williams Point, *Chara* present, not dense.
28. At causeway – very little *Chara*.
29. Northeast of shoal marker 153, three large patches of Vallisneria
30. Wessinger Island – ESE side
    1st cove to North – Illinois pondweed in shallow water, large areas of Vallisneria.
    2nd cove –Illinois pondweed in shallow water; Vallisneria in 3-5 feet.
    3rd cove – Illinois pondweed in shallow water; Vallisneria in 3-5 feet.
    4th cove – Illinois pondweed in shallow water; Vallisneria in 3-5 feet.
    5th cove – dense growth of Vallisneria with male and female flowers. Illinois pondweed apparently absent.
31. Wessinger Island, central north side – some Illinois pondweed in shallow water, southern naiad prevalent in deeper water to 10 feet.
32. Next cove to northeast, southern naiad abundant to 10 feet, little Vallisneria, Illinois pondweed in shallow water.
33. Last cove/cut to island –Vallisneria prevalent, Illinois pondweed absent.
34. Lake Point
    1st cove to NE – clear, no aquatic vegetation.
    2nd cove midway, Illinois pondweed in very shallow water, southern naiad scattered.
    3rd cove near Southwest end - little southern naiad, Illinois pondweed absent.
    Southwest cove –Illinois pondweed absent, small amount of southern naiad present.
35. The Village -- *Nitella* dense to 5 feet; *Spirogyra* – dense blooms in shallow water overtopping *Nitella*.

October 29, 2018 – water level 353.6'

36. Columbia water intake – abundant southern naiad and *Nitella*. Growing up to 1 foot high in water greater than 10 feet.
37. Cove across from Susie Ebert Island – 1-10 feet – *Nitella*, small amount of southern naiad, growing up to one foot off bottom – solid and continuous; water primrose and alligator weed stranded on shoreline
38. Putnam's Landing – *Nitella* with *Spirogyra* blooms – *Nitella* 0-10 feet+
    Shoal south of Putnam's landing –*Chara* and southern naiad abundant in 4-10 feet.
39. Near Murray Lodge Estates, south of shoal marker 128
    a. *Nitella* to 6" down to 10 feet, growing 1 foot off bottom in deeper water
    b. Dense *Nitella* at least 1 foot high down to eight feet throughout cove
40. Stinking Creek
    a. *Nitella* – low-growing in shallow water down to 10 feet; all areas have stranded water primrose.
    b. *Chara* – in shallow water farther back in the cove.
41. Northeast of shoal marker 127 – mix of *Chara* and *Nitella* shallow water to 8 feet.
42. Hamilton Point – at area with horses – *Chara* 2+ to 5 feet water.
43. Billy Dreher Island - slender naiad growing from 3" to 7 feet patchy to prevalent.
44. Billy Dreher Marina – southern naiad prevalent close to bottom in 1-8 feet water.
45. Twin Islands – East island – low growth of *Chara*

Twin Islands - West island on east side, low growth of *Chara* – large amounts stranded on shoreline

46. Pleasure Island – 1st Island off Pleasure on S side – southern naiad, common in 1 to 10 feet of water.
47. southern naiad common in 1-10 feet of water.
48. Scattered southern naiad in shallow water.
49. Shoal marker 36 – southern naiad prevalent on shoal 2-10 feet - low growing.
50. Larry Koon Landing– southern naiad in shallow water, low growing but prevalent.
51. Southern naiad growing a few feet off bottom down to 15-20 feet, then at shoreline, southern naiad patchy in shallow water.
52. Tip of Shull Island – southern naiad patchy in shallow water to 5 feet.
53. Southern naiad dense from shallow water continuous down to 8 feet; Variable-leaf pondweed present in shallow water with some *Spirogyra*.
54. Southern naiad prevalent 0-8 feet. From this point to Mallard Bay southern naiad is very prevalent to 10 to 15 feet, growing 3 feet off bottom or more.
55. South side of 1st island N of Mallard Point – southern naiad prevalent in 3-15 feet, then *Nitella* and *Chara* in shallow water.
56. Sandy Point - southern naiad to 10 feet – thick; also patches in shallow water.
57. Southern naiad abundant 3-13 feet, scattered to shallow water
    In this entire area of the lake, southern naiad is prevalent to 13-15 feet from Larry Koon landing, along Shull Island Peninsula south to Mallard Point, Sandy Point and over to Counts Ferry.
58. Illinois pondweed - small plants in very shallow water, then mature plants growing to the surface in 3-5 feet water; scattered to dense throughout the entire whole cove.
59. Southern naiad scattered 0-3 feet, then prevalent to 13 feet.
60. Shoal marker 22 near Hallmark shores – southern naiad scattered in shallow water;
    young Illinois pondweed plants in shallow water then mature Illinois pondweed plants in 2-5 feet of water from the shoal to the island on inside.
61. East side of shoal – Illinois pondweed more prevalent in 2-5 feet water; on mainland side southern naiad continuous in 3 -10 feet.
62. Bundrick Island swimming area – southern naiad scattered in shallow water.
63. Point - scattered southern naiad in shallow water then common to 10 feet.
64. Shoal marker 18, Illinois pondweed dense in 3-5 feet water, southern naiad present.
65. Land's End – Illinois pondweed locally dense to 5 feet of water, slender pondweed abundant from 2-3 feet to 8.5 feet of water, southern naiad abundant to 15 feet.
66. NE side Land's End Point – mature plants of Illinois pondweed in 2-5 feet, southern naiad on bottom to 8 feet. Very rocky in shallow water, no young plants.
67. Illinois pondweed prevalent in 1 – 5 1/2 feet; then southern naiad prevalent with *Lyngbya* to 10+ feet.
68. Harborside at beach, southern naiad patchy in shallow water then common to 8 feet.
69. Beach – rocky in shallow water, southern naiad 1-10 feet low growing.
70. Southern naiad to 10 feet.
71. Water intake – clear.
72. Southern naiad to 10 feet.

73. No plants in shallow water – rocky, southern naiad prevalent in deeper water to 10 feet.
74. Southern naiad prevalent to 12 feet.
75. Southern naiad prevalent from 2-10 feet.
76. Jake's Landing –*Nitella* very abundant in shallow water, southern naiad abundant 3-15 feet.
77. Point near Jake's Landing – small amount of southern naiad in shallow water then prevalent down to 10-15 feet.
78. Cove on north side of Jake's Landing– small plants of Illinois pondweed in shallow water only; otherwise, southern naiad prevalent to 10 feet.
79. McMeekin Cove – *Nitella* abundant 1-4 feet then southern naiad prevalent to 10 feet.
80. Beach near house – clear, no aquatic vegetation found.
81. Illinois pondweed in 1-5 feet.
82. Near swimming area – nothing – white caps and rocky substrate.
83. Illinois pondweed prevalent in 1-3 feet.

November 2, 2018 – by kayak – water level 353.'

84. Large free-floating mats of southern naiad present detached from substrate.
85. Slender naiad prevalent in shallow water with southern naiad and *Nitella*.

October 25, 2018 – Saluda River from Black's Bridge upstream to Higgins Bridge.

1. Saluda Island – upstream side shoal marker 7e; sandy shore, mucky bottom, some Lyngbya.
2. Bush River – North of island, no vegetation – large mud flat.
3. Small amount of *Lyngbya*, sandy mucky clayey substrate – spikerush in drawdown zone.
4. Old willow shoal, mucky bottom with blue-green alga algae – not *Lyngbya.*
5. Kemson's bridge landing – *Lyngbya* and muck.
6. Causeway on northwest side of bridge – sample – muck and blue-green algae.
7. Spit of land in an eddy area – muck and blue-green alga.

8-11. Higgins Bridge/Newberry water/Saluda River resort – clear water flowing from Lake Greenwood, no plants, some *Lyngbya* at SCE&G park #11.

12. Clear.
13. Rocky and clear.

Appendix III

2018 Lake Murray Aquatic Plant Management Plan (excerpt from 2018-2019 Annual South Carolina Aquatic Plant Management Plan, SCDNR 2018)

Lake Murray – Lexington, Newberry, Richland and Saluda Counties

Problem plant species

Hydrilla, Water Primrose

Management objectives

Minimize hydrilla growth throughout the lake to prevent its spread within the lake, help prevent its spread to adjacent public waters, and avoid adverse impacts to drinking water withdrawals and public use and access.

Monitor water primrose growth and consider control options if impacts are greater than anticipated.

Maintain diverse aquatic plant community through selective application of control methods and introduction of desirable native plant species.

Selected control method

Triploid grass carp – stock 3000 triploid grass carp to rebalance the population after significant losses due to opening of the Flood Gates in 2015

Aquatic herbicides - selected areas of water primrose infestation to provide public access.

Problem Species	Control Agents
Hydrilla	Chelated copper (Nautique)
Water primrose	Renovate 3, Habitat, Clearcast

Area to which control is to be applied

Release approximately one-half of the triploid grass carp on the north side of the lake and one-half on the south side.

Use aquatic herbicides to provide control at high priority public access points, such as boat ramps and park sites.

Rate of control agent to be applied

Triploid Grass Carp: Stock 3000 sterile grass carp, 1500 in the spring and 1500 in the fall, to rebalance the population. (Continue maintenance stocking in future years with 1710 sterile grass carp per year to maintain a density of 1 grass carp per 6 surface acres (8333 fish). Continue maintenance stocking in 2018 based on conditions. Stock to maintain 1 to 6 surface acres density when population dictates and to add different age class fish. 3000 sterile grass carp to maintain a density of 1 grass carp per 6 surface acres (8333 fish). The Aquatic Plant Management Council is committed to maintenance stocking of triploid grass carp in Lake Murray to provide long-term control of hydrilla. The Aquatic Plant Management Council, with recommendations from DNR and Lake Murray staff, agrees that the adaptive stocking plan should be continued, based on current observations of collected data, Herbicide treatments may be utilized to provide temporary control of hydrilla when necessary. Changes to the strategy will be implemented if survey results, regrowth, or habitat loss warrant.

Water primrose treatment:

Renovate 3 - 0.500 to 0.750 gallons per acre.
Habitat - 2 to 4 pints per acre.
Clearcast - 1 to 4 pints per acre.

Method of application of control agent

Triploid grass carp - See section 3 above.

All agents to be applied when plants are actively growing.

Timing and sequence of control application

Additional grass carp should be stocked in the spring/fall following Council approval. Apply herbicides to aquatic vegetation as it becomes problematic.

Other control application specifications

If needed, all sterile grass carp will be a minimum of 12 inches in length. All sterile grass carp shipments for Lake Murray will be examined by the SCDNR for sterility, size, and condition at the Campbell Fish Hatchery in Columbia prior to stocking in the lake.

Control by Residential/Commercial Interests:

This plan is designed to provide relief from noxious aquatic vegetation for the public at large. Private entities such as lake-front residents and commercial interests may have site specific concerns not addressed immediately using grass carp or mechanical harvesters at public access areas. Residential and commercial interests may remove nuisance aquatic vegetation manually or by use of mechanical harvesting devices. Of the three-major control methods the following conditions apply.

1) Mechanical harvesters – Commercial aquatic plant harvesting services may be hired to remove hydrilla and Illinois pondweed from areas adjacent to residential and commercial property after notification of SCE&G. Harvesting precautions as stated in item above must be adhered to.

2) Aquatic herbicides – SCE&G opposes regular or general application of herbicides in Lake Murray, therefore, aquatic herbicides may not be applied in the lake by lake front property owners. Label rate of herbicide will be stringently adhered to.

3) Sterile grass carp - A sufficient number of grass carp have been stocked by SCDNR tocontrol nuisance aquatic vegetation. Stocking additional grass carp in Lake Murray without written consent by the SCDNR is prohibited.

Entity to apply control agent

Triploid grass carp - Commercial supplier with supervision by the SCDNR. Aquatic herbicides - Commercial applicator under supervision by the SCDNR.

Estimated cost of control operations

Triploid grass carp - $28,000 Aquatic herbicides - $0

Potential sources of funding

Triploid grass carp.

S.C. Electric and Gas Company, Lexington and Richland Counties 50%

S.C. Department of Natural Resources 50% (up to $30,000 cost share per waterbody)

Mechanical harvester, S.C. Electric and Gas Company, Commercial marina operators, and residential property owners.

Aquatic herbicides.

S.C. Electric and Gas Company, Lexington and Richland Counties 50%

S.C. Department of Natural Resources 50% (up to $30,000 cost share per waterbody) (Percentage of match subject to change based on availability of Federal and State funding.)

Long term management strategy

a) Manage the distribution and abundance of nuisance aquatic plant populations at levels that minimize adverse impacts to water use activities and the environment through the use of federal and state

approved control methods.

b) Maintain or enhance native aquatic plant populations at levels beneficial to water use, water quality, and fish and wildlife populations through selective control of nuisance plant populations where feasible, introduction of native plant species where appropriate, and public education of the benefits of aquatic vegetation in general.

c) Seek to prevent further introduction and distribution of problem species through public education, posting signs at boat ramps, regular surveys of the water body, and enforcement of existing laws and regulations.

d) Improve public awareness and understanding of aquatic plant management activities through the maintenance of the Lake Murray Aquatic Plant Management web site. The web site includes up-to-date information on annual management plans, dates and locations of current and historical control operations, locations of habitat enhancement activities, and other pertinent information.

e) Periodically revise the management strategy and specific control sites as new environmental data and control agents and techniques become available and public use patterns change.