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Point Intercept and Surface Observation GPS (SOG): A Comparison of Survey Methods — Lake Gaston, NC/VA

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INTRODUCTION: Plant biomass data are critical to many aquatic plant assessment efforts, particularly those involving adaptive management of aquatic plant problems, integrated plant management approaches, or ecosystem restoration. Unfortunately, current methods for aquatic plant biomass sampling have depended upon expensive, labor-intensive SCUBA techniques or utilization of large, heavy dredging equipment. While these methods are accepted by the scientific community and resource managers, their high costs preclude their use on many projects. As a result, quantitative data are often lacking or inadequate. Research is currently being conducted to explore and develop new sampling methods that could be employed to provide scientifically acceptable plant community assessment data in a cost-effective manner.

One area where this research is being conducted is Lake Gaston, NC/VA. Monoecious hydrilla (*Hydrilla verticillata* (L.f.) Royle) was first discovered in Lake Gaston, NC by North Carolina State University scientists near Eaton Ferry Bridge in 1985 (North Carolina Division of Water Resources (NCDWR) 1997, Figure 1).

Figure 1. Topped out monoecious hydrilla in Lake Gaston, NC/VA.

In 1987, a 3½-month lake drawdown was initiated to address a Brazilian elodea (*Egeria densa* Planch.) infestation; exposed sediments at the hydrilla bed were chemically treated with dichlobenil at that time in an attempt to kill tubers (NCDWR 1997). Hydrilla expanded the next season to cover an estimated 25 acres, and despite repeated herbicide applications, hydrilla continued to spread (NCDWR 1997). By 1995, hydrilla had expanded to over 3,100 acres, at which time 20,000 grass carp (*Ctenopharyngodon idella* Valenciennes) were introduced and 647 acres were treated with herbicide in an effort to control the plant (NCDWR 1997). In 1996, 680 grass carp were introduced and herbicide applications continued, primarily in areas of high concern. In 1999, an additional 5,000 grass carp were released (NCDWR 1997). Despite grass carp stockings and yearly herbicide treatments, hydrilla reached 3,400 acres in 2002 (Lake Gaston Weed Control Council (LGWCC) 2004) and in 2003, 25,392 more grass carp were introduced (Lake Gaston Stakeholder's Board (LGSB) 2005). Hydrilla coverage declined to about 2,400 acres that year, but then increased to approximately 2,909 acres in 2004 (Aquatic Plant Nuisance Control (APNC) 2004).

Hydrilla remains a serious resource utilization and management problem in Lake Gaston, and because formulation of strategies and adaptive management of ongoing endeavors require up-to-date information on the aquatic plant community, accurate vegetation surveys are critical. The Lake Gaston Stakeholder's Board was created to help provide a holistic focus on the invasive plant problems in Lake Gaston. Because the goal is to replace monospecific hydrilla with diverse aquatic plant communities dominated by native species (LGSB 2005), there was a need to produce baseline mapping of aquatic vegetation and develop a monitoring program to assess development of the plant community. Two scientifically accepted non-biomass survey techniques, point intercept, and visual (Surface Observation GPS - SOG) were conducted in 2005 to facilitate that process. Line transects were not used in this study as they are better suited to study plots, not whole lake surveys (Madsen 1999) and aerial imagery is extremely expensive and still requires ground-truthing for accuracy. Surveys focused on aquatic plant identification, distribution (location on the lake), abundance (total acreage), and frequency (number of species present). Relative values of point intercept and SOG surveys as tools for developing aquatic vegetation management approaches are discussed in this paper.

METHODS: Two vegetation survey methodologies were used concurrently in September 2005 (point intercept and SOG). All plant species observed were mapped, providing community dynamics of all aquatic plants present in Lake Gaston.

Point Intercept Survey — Methodologies: A total of 1,925 points were assessed for aquatic plant presence or absence during the September 2005 survey on Lake Gaston. This survey was conducted using the point intercept method (Madsen 1999). Using MapInfo Professional mapping software (Version 6.5, Troy, NY), coordinates were predetermined for each intersecting point on a 200- by 200-m grid. A Garmin GPS map 76CS GPS unit (Olathe, KS) was used to navigate to each point and a sampling rake was deployed to collect submersed, floating-leaved, or emergent aquatic plants (Figure 2).

Figure 2. Sampling rake deployed on Lake Gaston in order to collect and identify aquatic plants (left): rake, top right and separated plants, bottom right.

Plants were separated to identify species present and depth was measured using either a depth pole constructed from PVC pipe or estimated from a digital contour map (Garmin Map Source Fishing Hot Spots® East v5) loaded onto the Garmin GPS unit. When hydrilla was observed at a point, a percent cover within the sampling area was estimated visually using a rating system of 0-25 percent, 26-50 percent, 51-75 percent, and 76-100 percent; in addition, depth to hydrilla canopy was measured (Madsen 1999). Upon completion of the survey, plant distribution maps were produced using MapInfo Professional (Figures A1, A2, and A3).

SOG Visual Survey — Methodologies: Surface Observation GPS (SOG) was used to document submersed, floating-leaved, and emergent aquatic plant communities in mid-September 2005. Visual observations of aquatic vegetation were recorded by GPS from a boat (Figure 3) using a Recon handheld datalogger and ProXT receiver (Trimble, United States). A depth finder was used to identify potential beds of aquatic plants in water deeper than visible from the surface. In addition, a sampling rake was thrown periodically at depths up to 20 ft to verify surface observations of submersed vegetation, with presence and identification corrections applied accordingly. Geographic Information System (GIS) maps of mixed and monospecific species colonies (see Appendix B) were constructed using ArcView GIS Version 3.2 (ESRI, Redlands, CA).

Figure 3. SOG survey conducted along edge of hydrilla-mixed community of plants, Lake Gaston, NC/VA.

RESULTS AND DISCUSSION:

Point intercept survey. Hydrilla was by far the dominant aquatic plant species. Other exotic submersed plants encountered in the survey included Eurasian watermilfoil (*Myriophyllum spicatum* L.) and Brazilian elodea. Native submersed vegetation was sparse and exhibited low diversity, dominated by coontail (*Ceratophyllum demersum* L.) and muskgrass (*Chara* spp.), but included traces of a naiad (*Najas guadalupensis* (Sprengel) Magnus); additionally, the blue-green alga *Lyngbya* spp. was present at a number of points. Native emergent vegetation was found along the shoreline and in shallow water. Results of point intercept vegetation mapping are given in Table 1.

Table 1. Frequency of aquatic plants in Lake Gaston from a point intercept survey conducted in September 2005. Hydrilla occupied approximately 18% of the whole lake; littoral zone coverage by hydrilla was greater than 50% (littoral zone approximately 5,000 acres, Madsen 2007).

Scientific name	Common name	Exotic/native	Whole lake %	Littoral zone %
Bacopa caroliniana	lemon bacopa	N	0.1	0.2
Ceratophyllum demersum	coontail	N	2.0	6
Chara spp.	muskgrass	N	1.7	5
Egeria densa	Brazilian elodea	E	0.1	0.2
Eleocharis spp.	spikerush	N	0.3	1.0
E. quadrangulata	squarestem spikerush	N	0.3	1.0
Hydrocotyle spp.	pennywort	N	0.3	0.8
Hydrilla verticillata	hydrilla	E	17.8	52
Justicia americana	water willow	N	2.5	7.4
Limnobium spongia	American frog's-bit	N	0.1	0.2
Lyngbya wollei	giant lyngbya	N	0.2	0.6
Myriophyllum spicatum	Eurasian watermilfoil	E	0.3	0.8
Najas guadalupensis	southern naiad	N	0.5	1.5
Nelumbo lutea	American lotus	N	0.7	2.0
Panicum spp.	panic grass	N	0.1	0.2
Peltandra virginica	arrow arum	N	0.1	0.2
Pontederia cordata	pickerelweed	N	0.6	1.8
Sagittaria graminea	bulltongue	N	0.1	0.3
S. latifolia	arrowhead	N	0.5	1.5
Sparganium spp.	burreed	N	0.1	0.2
Typha latifolia	Cattail	N	0.3	1.0
Zizaniopsis miliacea	giant cutgrass	N	0.1	0.3

SOG visual survey. Native emergent plants and hydrilla-dominated submersed stands were the most commonly observed aquatic vegetation in Lake Gaston during the September 2005 survey (Table 2). Water willow (*Justicia americana* (L.) Vahl.) dominated emergent species, occurring along most of the shoreline surveyed, in some cases extending 30 ft offshore in water up to 6 ft deep. Native emergents accounted for approximately 0.47 percent of approximately 19,530 acres of the lake surveyed (Figure 4). Floating-leaved species included watershield (*Brasenia schreberi* J.F.Gmel.), American lotus (*Nelumbo lutea* (Willd.) Pers.), spatterdock (*Nuphar lutea* (L.) Sibth & Sm.), and *Utricularia* spp. Mixed communities occupied approximately 0.006 percent of surveyed lake coverage. Hydrilla was found throughout the lake at depths up to 20 ft, occurring in both monospecific stands (2,710 acres) and as the dominant species in mixed stands with other exotics or native plants (approximately 3,856 mixed hydrilla-acres with 458 of those topped out). Monoecious and dioecious strains of hydrilla were not distinguished in this survey, but all appeared to be monoecious. Only relatively small colonies of hydrilla-free native or other exotic species were observed. Submersed vegetation including native and exotic species accounted for 20.8 percent or 4,063 acres of surveyed lake coverage. Exotics Brazilian elodea (911 acres) and Eurasian watermilfoil (61.1 acres) were observed mixed with hydrilla. Native submersed species coontail (43.0 acres) and muskgrass (349 acres) were observed mixed with hydrilla. Naiads (either southern naiad and/or the exotic brittle naiad, *Najas minor* All.) were also found in mixed communities with hydrilla (0.28 mixed acre).

Table 2. SOG survey of Lake Gaston was conducted in 2005. Total acres include monospecific acreage combined with acreage in which a species was observed occurring in mixed communities.
Note: The sum of these areas does not equal the total acreage occupied by vegetation in the lake.

Scientific name	Common name	Monospecific acres	Total acres
Native emergent			
Echinodorus cordifolius	creeping burhead	0.001	0.001
Eleocharis macrostachya	flatstem spikerush	0.002	0.002
E. quadrangulata	squarestem spikerush	2.66	7.21
Hibiscus spp.	mallow	0.06	0.27
Hydrocotyle spp.	pennywort	0.005	0.005
Juncus spp.	rush	0.32	4.05
Justicia americana	water willow	55.0	74.2
Peltandra virginica	arrow arum	0.11	1.39
Polygonum spp.	smartweed	0.03	0.29
Pontederia cordata	pickerelweed	0.007	0.007
Sagittaria latifolia	arrowhead	0.24	3.79
Schoenoplectus tabernaemontani	softstem bulrush	0.13	16.9
Sparganium spp.	burreed	0.05	0.25
Typha latifolia	cattail	5.87	26.6
Utricularia spp.	bladderwort	0	3.34
Zizaniopsis miliacea	giant cutgrass	0.08	1.17
Native floating-leaved			
Brasenia schreberi	watershield	0.98	0.98
Nelumbo lutea	American lotus	0.14	0.14
Nuphar lutea	spatterdock	0.04	0.04
Native submersed			
Ceratophyllum demersum	coontail	0.15	43.0
Chara spp.	muskgrass	207	349
Najas spp.	naiad	0	0.28
Exotic submersed			
Egeria densa	Brazilian elodea	0	911
Hydrilla verticillata	hydrilla	2710	3856
Myriophyllum spicatum	Eurasian watermilfoil	0	61.1
Algae			
Lyngbya wollei	giant lyngbya	0	1.30

Figure 4. Emergent species were observed along much of the shoreline in Lake Gaston.

CONCLUSIONS: Data acquired from point intercept and SOG surveys were, for the most part, not comparable. The point intercept survey provided quantitative data on aquatic plant populations (species frequency data) suitable for statistical analyses and comparison (Chi-square) (Madsen 1999). Identification and distribution of sampled species were categorized and distribution was mapped, but deriving actual areal coverage from this data may not be reliable because accuracy would be dependent on the resolution (spacing of points) of the survey. Wersal et al. (2007), however, did recently publish estimated total acreage using point intercept data. Since hydrilla was the plant of concern, points were not distributed to access the wetland/shoreline plants. While these plants were not represented in the survey, they were noted as plants that were present in the lake. SOG survey methodology identified more plant species, in large part because every species observed was included; emergent (moist-soil to shallow water) species were more commonly reported in the SOG survey. SOG also reported coverage area in addition to identification and mapped distribution of plant communities.

Overall, point intercept frequency and frequency derived from coverage (SOG, acreage of a species relative to total acreage of vegetation) were similar only for hydrilla: 72 percent for point intercept and 62 percent for SOG. Frequencies of other species, such as Brazilian elodea, were not similar relative to the total plant community surveyed (0.3 percent point intercept and 17 percent SOG). Frequency information gleaned from point intercept surveys is useful for statistical comparison of plant communities over time, rapid collection of large amounts of field data, and less costly collection (Madsen 1999). This can be especially valuable when assessing efficacy of control methodologies in specific areas. Equipment needs are generally economical and readily available. However, actual acreage calculated from SOG data may be more useful in developing and modifying management strategies on the larger scale. Year-to-year, lake-wide plant coverage and distribution can be compared to show plant community responses to management efforts. Drawbacks to both techniques are that they are labor-intensive and require considerable time on the water: 72 person-hours for point intercept versus 80 person-hours for SOG. SOG required increased post-production of data (240 person-hours) relative to point intercept's short post-production time (80 person-hours).

RECOMMENDATIONS: Statistical comparisons are best done with a point intercept method, especially when conducting whole-lake or study plot assessments. The point intercept method is less sensitive to seasonal changes, can be adapted for large areas, and is sensitive to species diversity (Madsen 1999). Site selection for aquatic plant management will not be based upon points, but areas. Herbicide treatments and aquatic plant restoration sites are selected with the knowledge of actual native/invasive plant coverage. In addition, spread of aquatic plants from restoration efforts will be measured as coverage areas in order to compare colony sizes from year to year. SOG survey methodology may be more appropriate as a sampling technique for large-scale, lake-wide aquatic plant coverage. The use of a depth finder in concert with rake tosses likely improved SOG surveys, enabling location and identification of continuous submersed plant colonies not visible from the water's surface. Other improvements to SOG surveys may include predetermined rake tosses similar to the point intercept methods in addition to random tosses at canopy or vegetation change. Visual estimates of percent cover of plant communities should also be incorporated into data collection to monitor changes in native/invasive dominant mixed communities over time.

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Appendix A:
Lake Gaston, NC/VA September 2005 Point Intercept Survey Maps

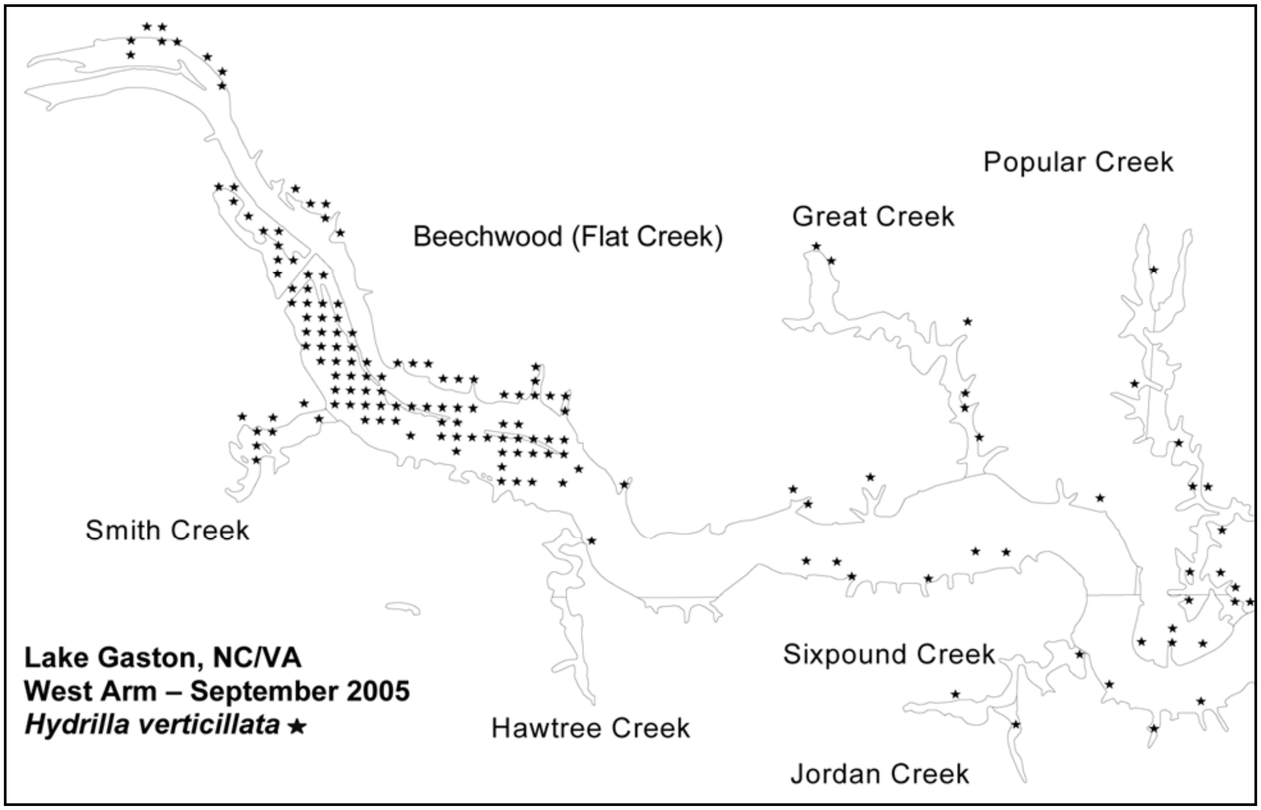

Figure A1. Lake Gaston, NC/VA West Arm, September 2005 Point Intercept Survey Maps.

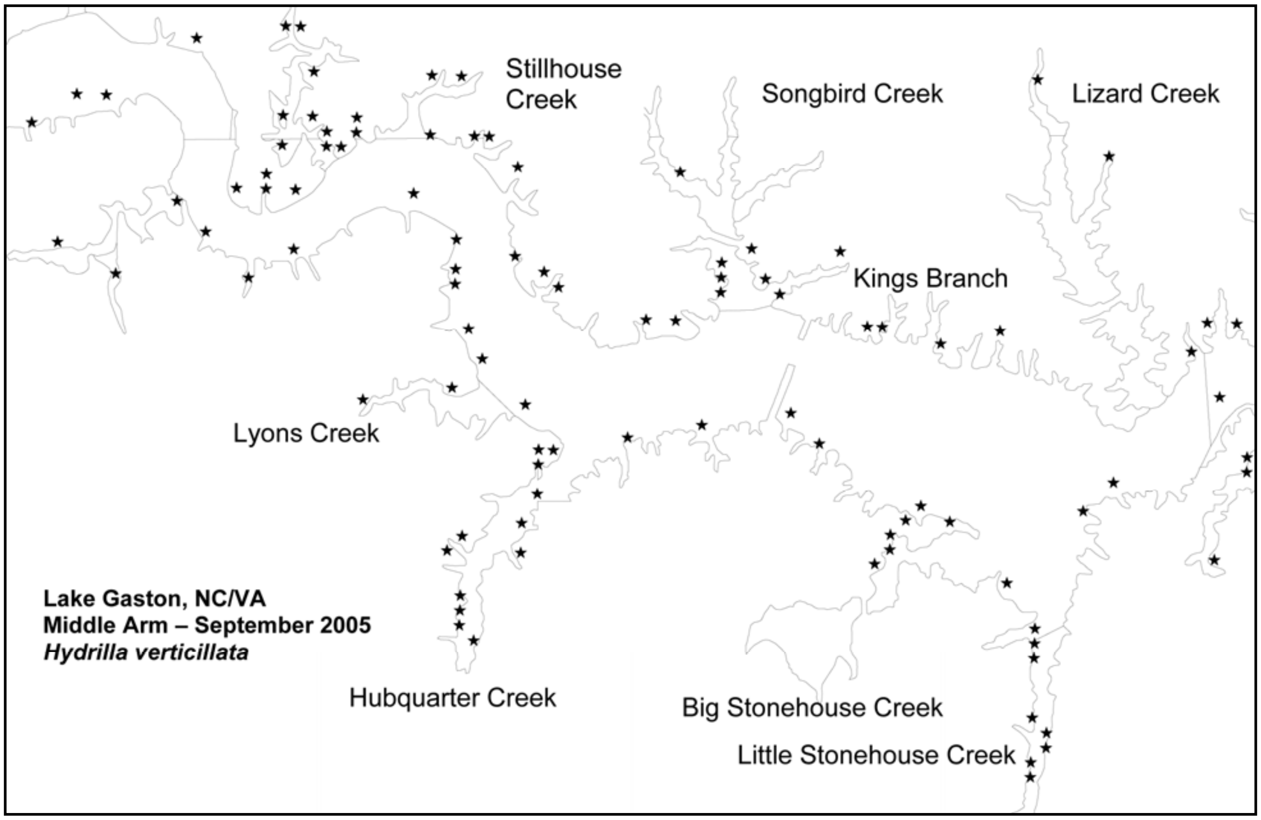

Figure A2. Lake Gaston, NC/VA, Middle Arm, September 2005 Point Intercept Survey Maps.

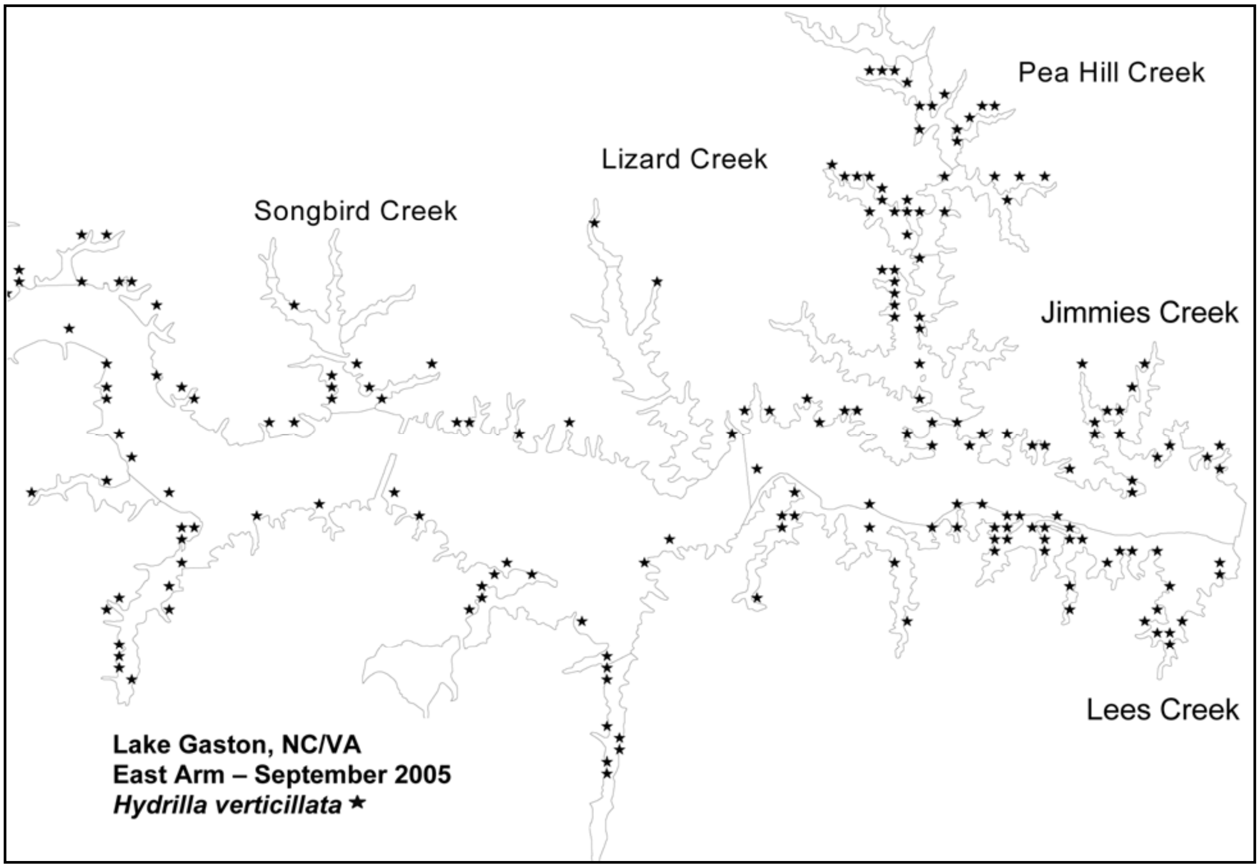

Figure A3. Lake Gaston, NC/VA, East Arm, September 2005 Point Intercept Survey Maps.

Appendix B:
Lake Gaston, NC/VA September 2005 SOG Survey Maps

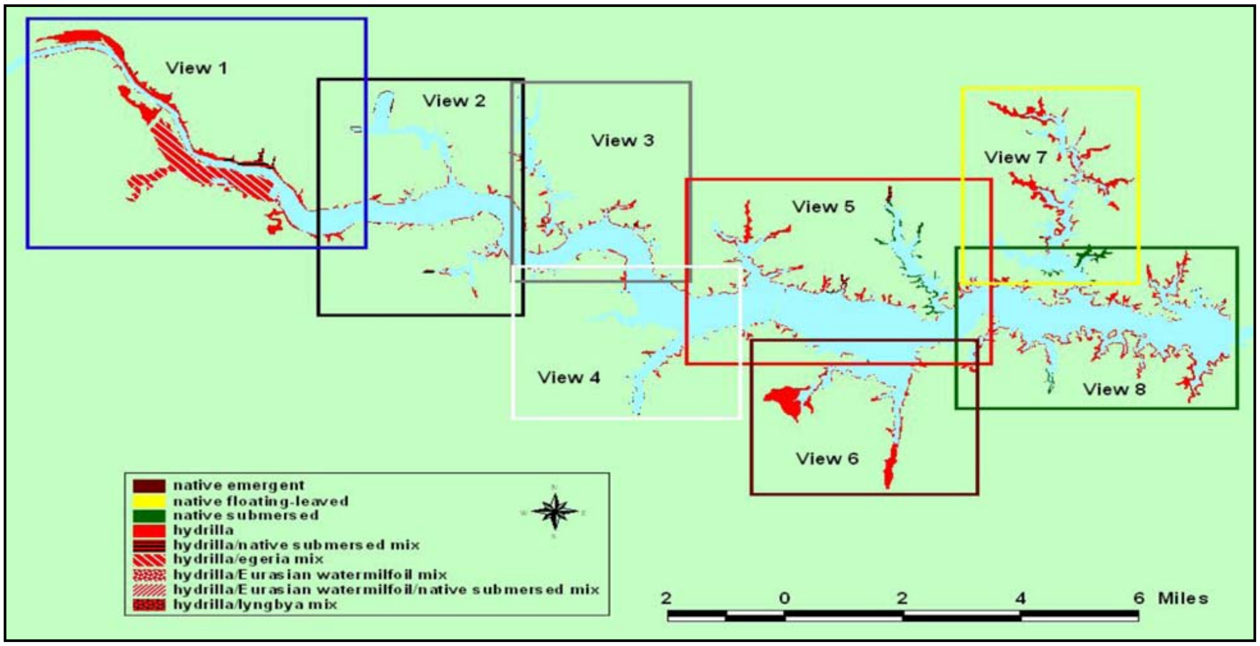

Figure B1. Lake Gaston, NC/VA, Views 1 – 8, September 2005 SOG Survey Maps.

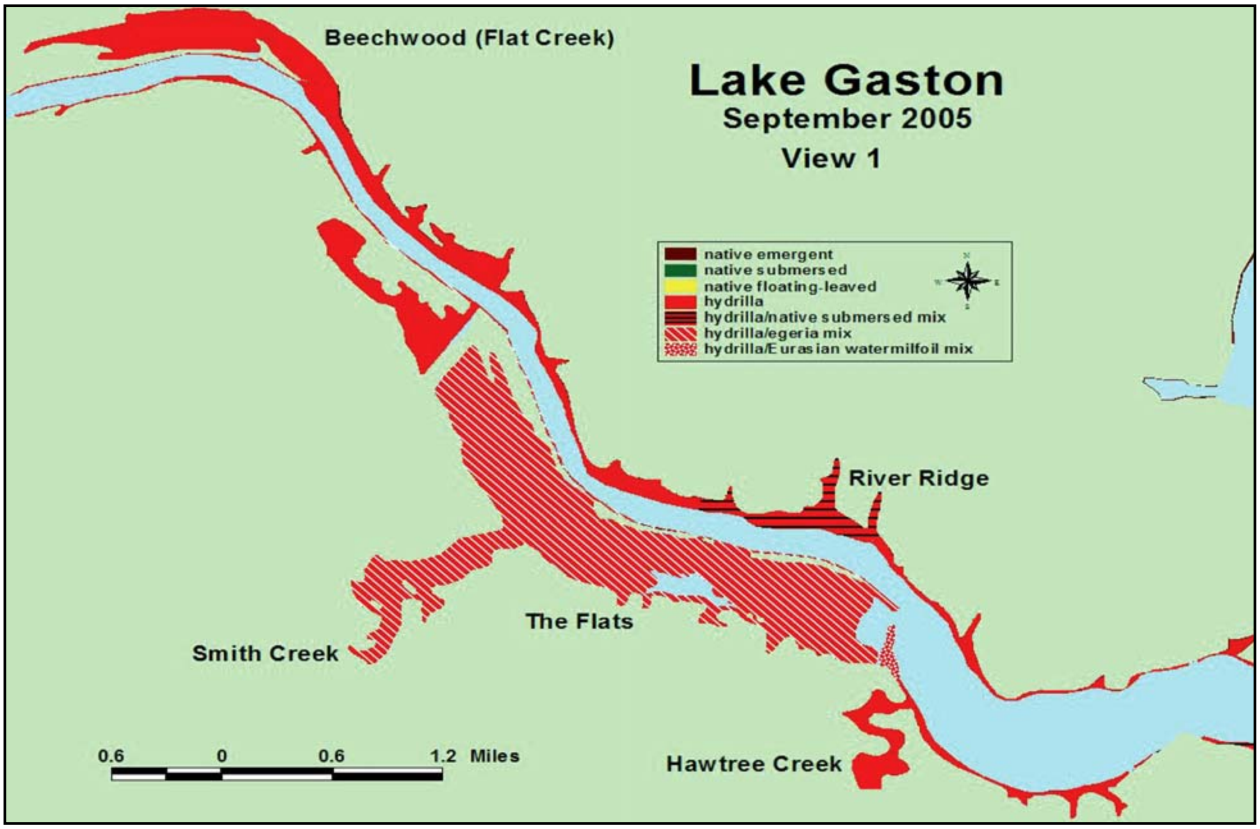

Figure B2. Lake Gaston, NC/VA, View 1, September 2005 SOG Survey Maps.

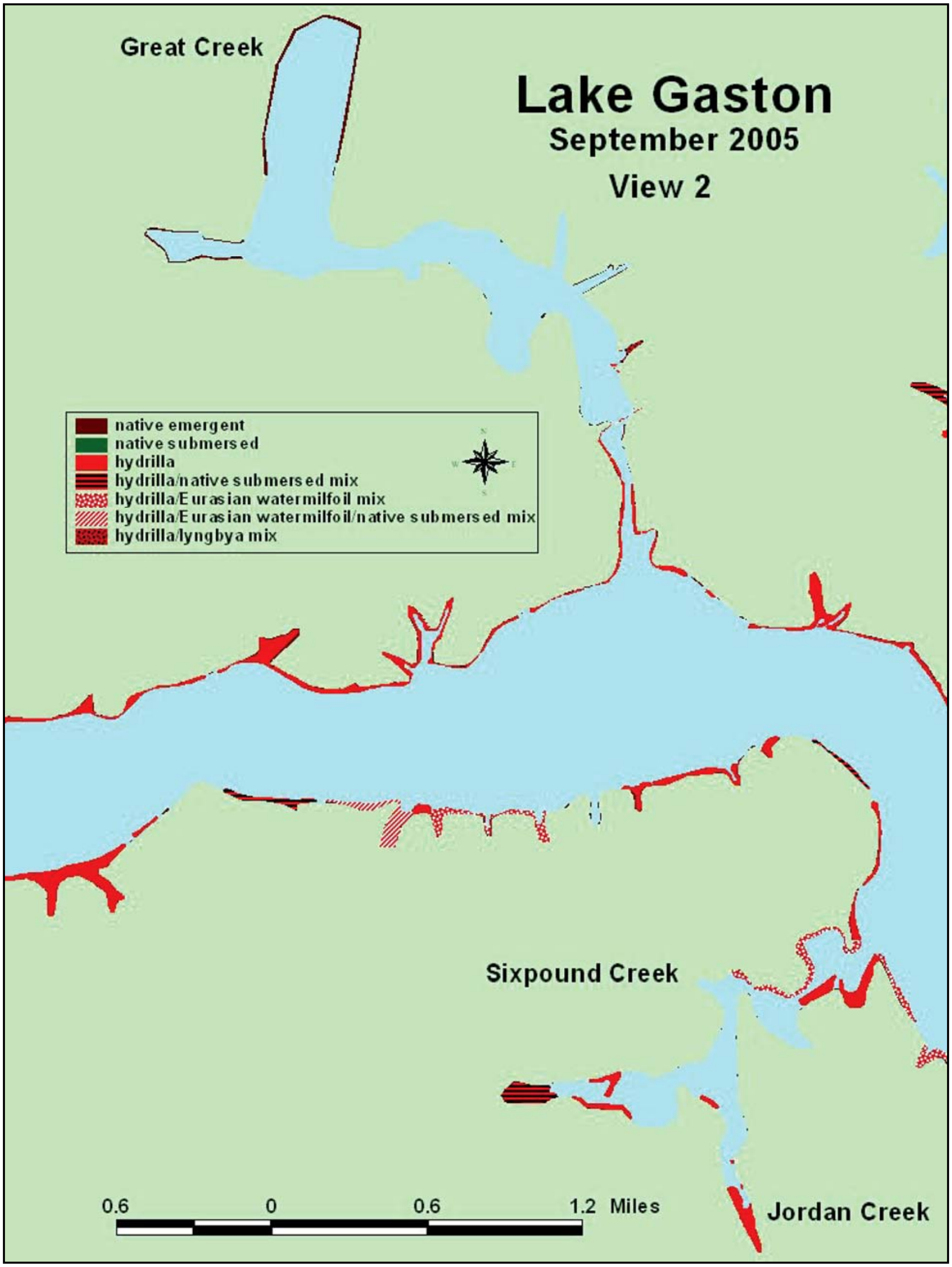

Figure B3. Lake Gaston, NC/VA, View 2, September 2005 SOG Survey Maps.

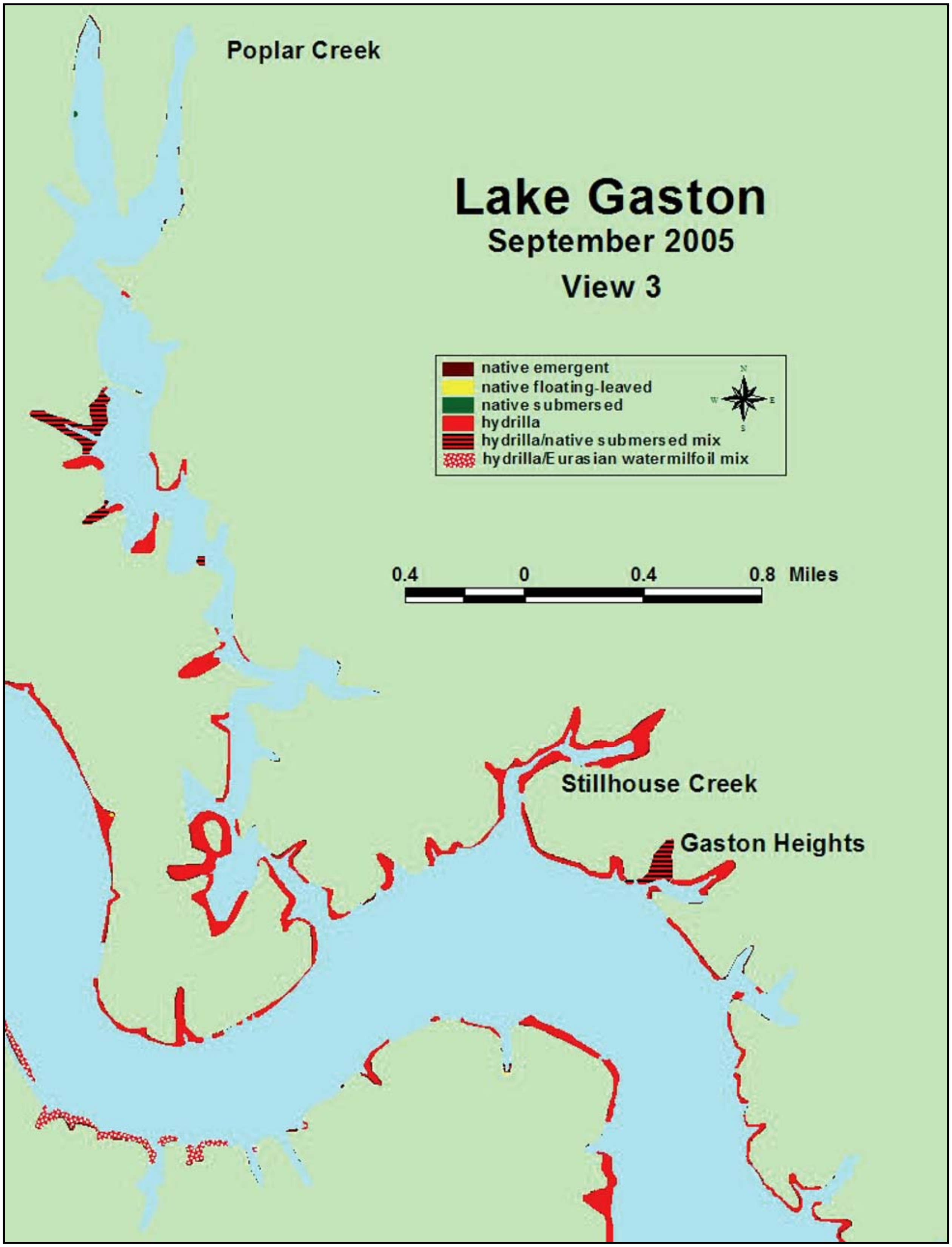

Figure B4. Lake Gaston, NC/VA, View 3, September 2005 SOG Survey Maps.

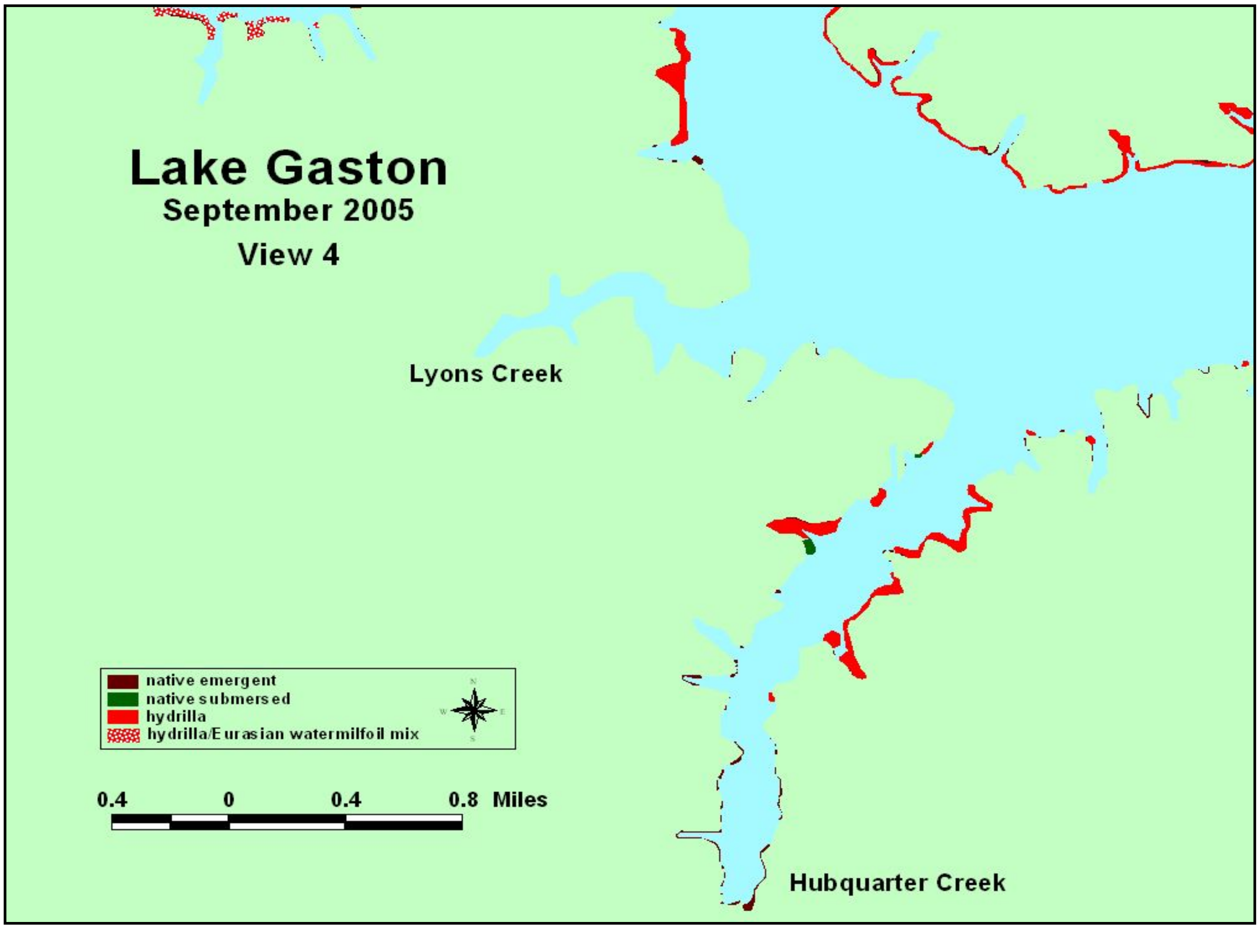

Figure B5. Lake Gaston, NC/VA, View 4, September 2005 SOG Survey Maps.

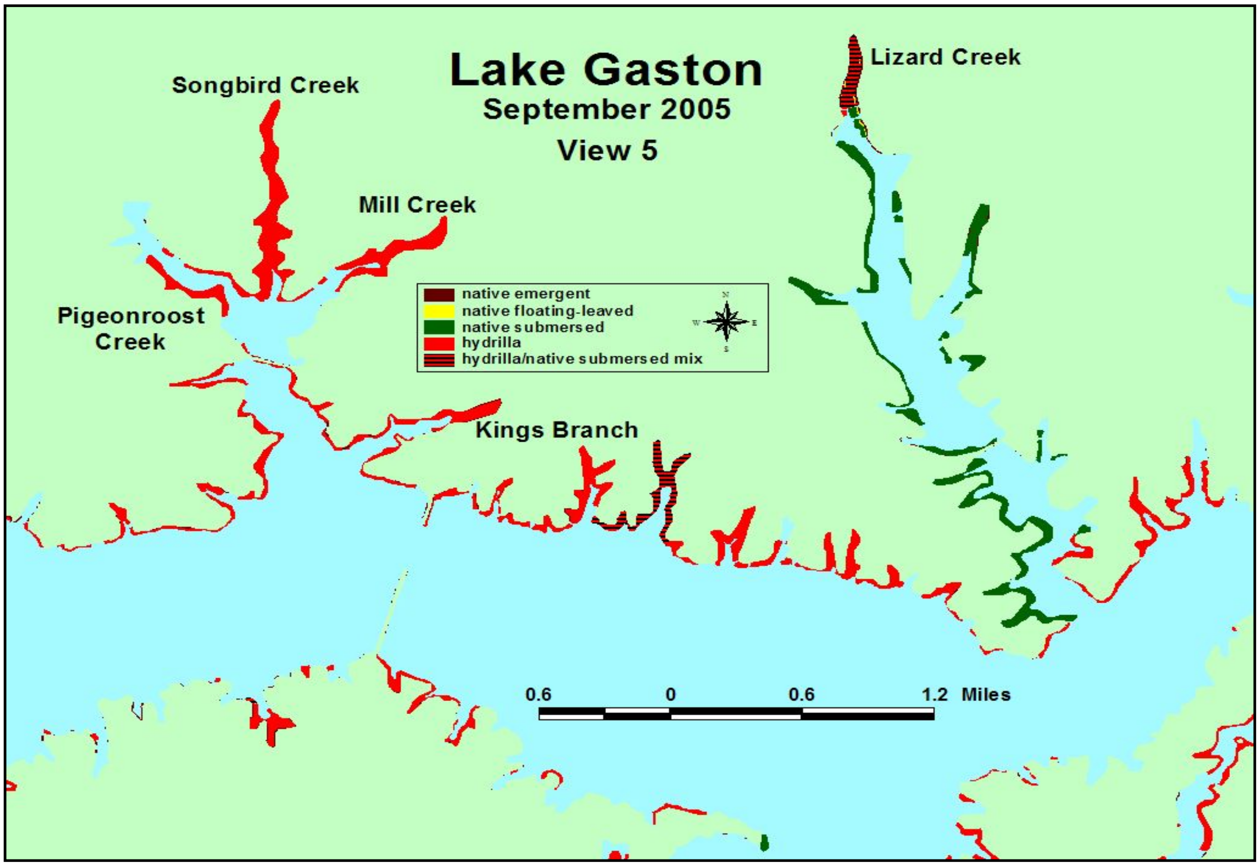

Figure B6. Lake Gaston, NC/VA, View 5, September 2005 SOG Survey Maps.

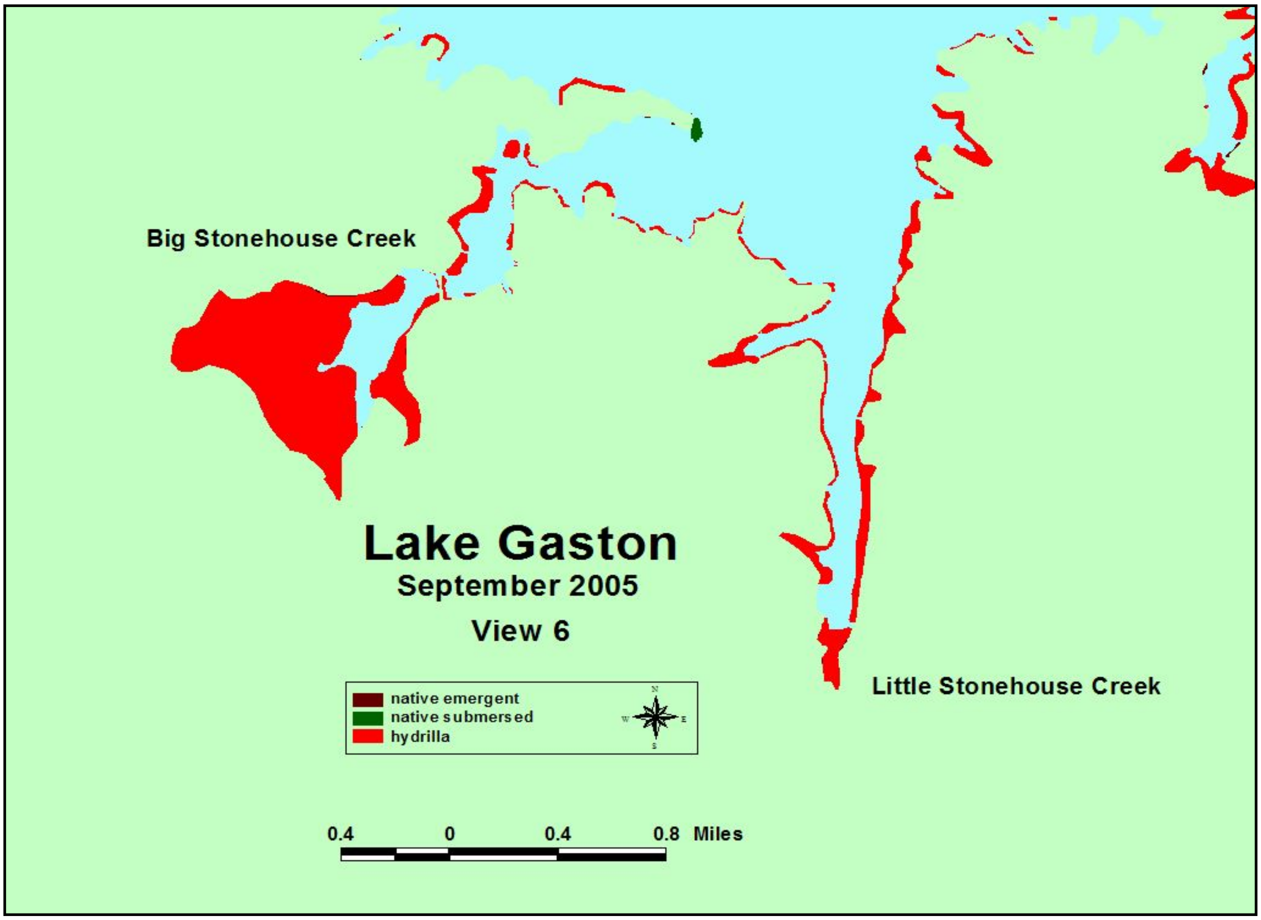

Figure B7. Lake Gaston, NC/VA, View 6, September 2005 SOG Survey Maps.

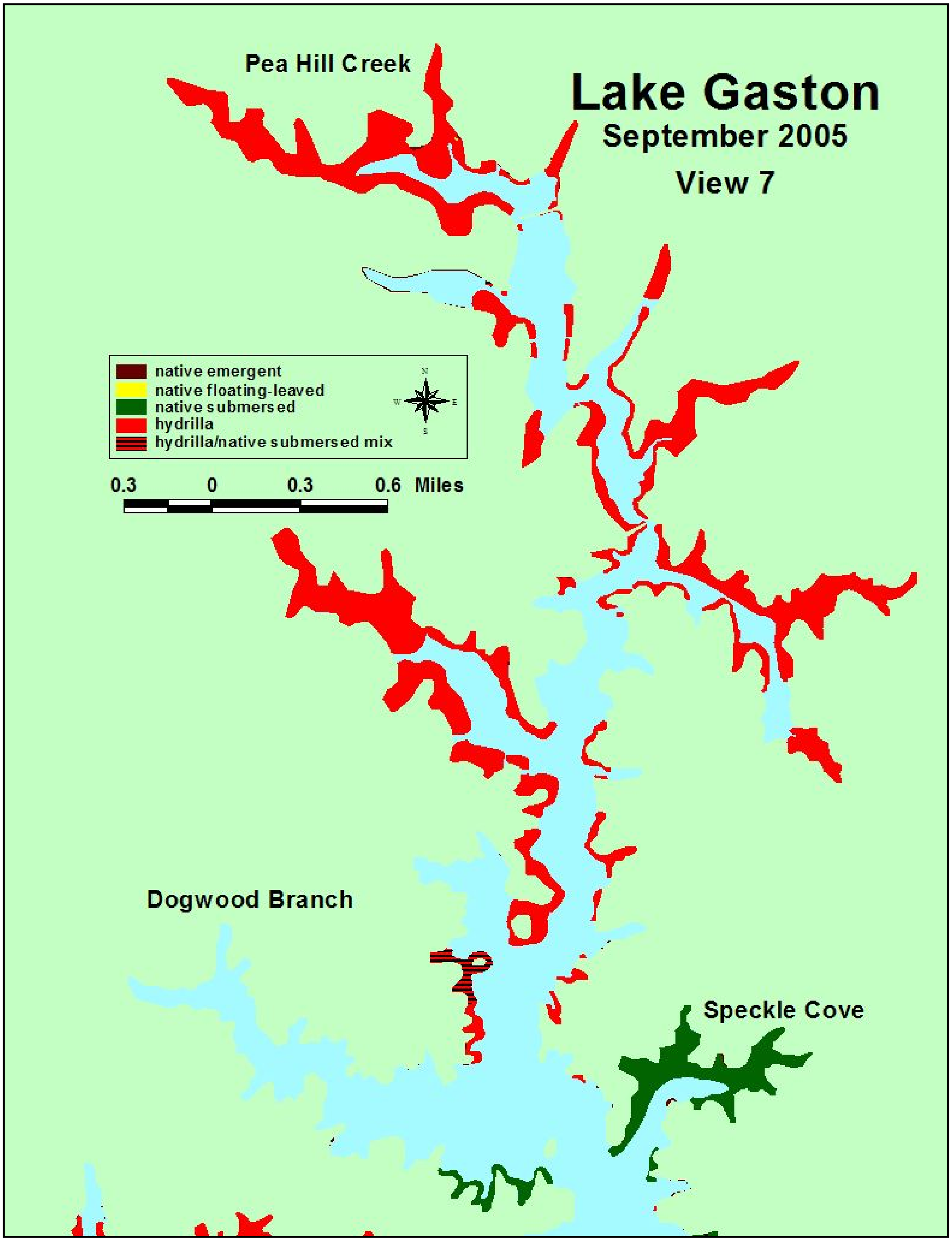

Figure B8. Lake Gaston, NC/VA, View 7, September 2005 SOG Survey Maps.

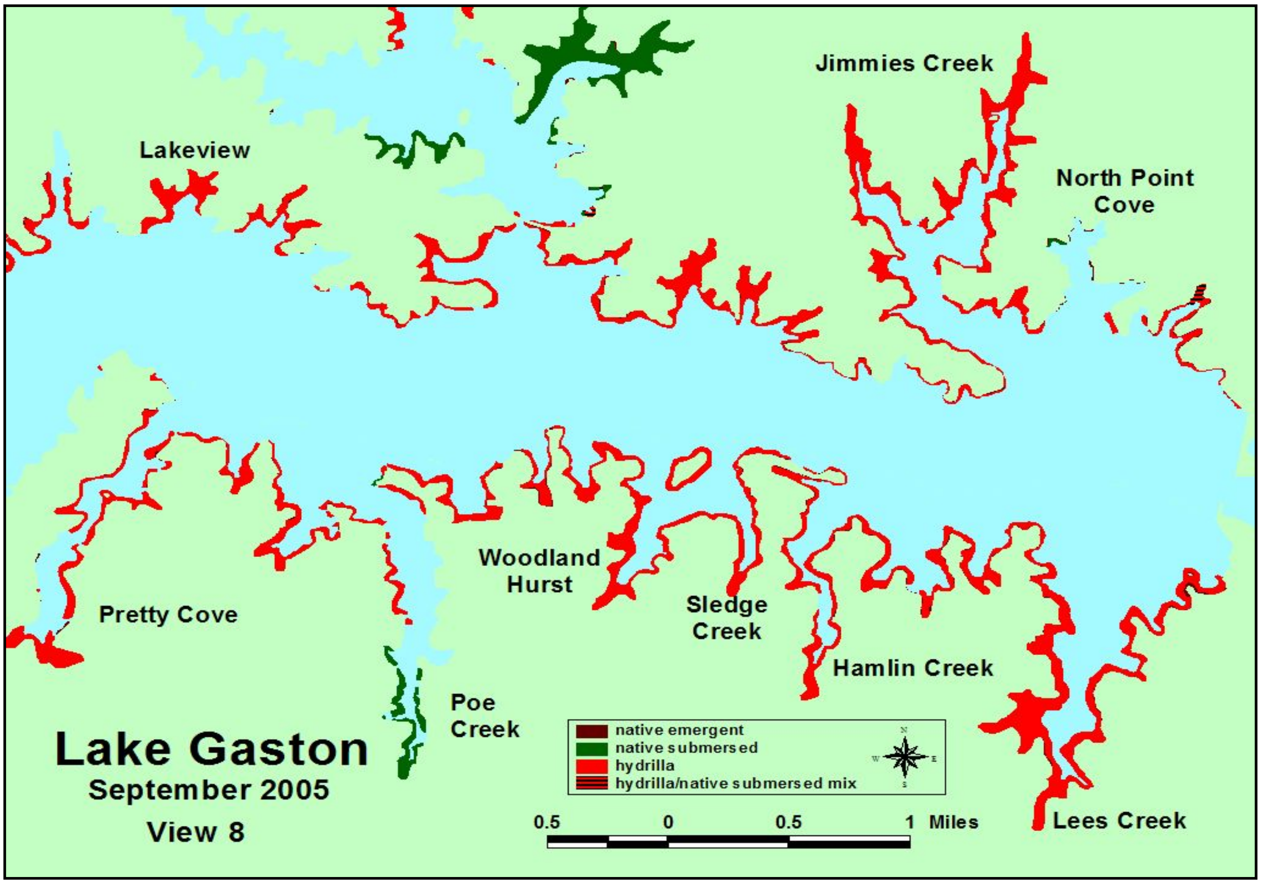

Figure B9. Lake Gaston, NC/VA, View 8, September 2005 SOG Survey Maps.