FY-05 104(b)(3)

EPA Grant CA# CD-966017-01, Project 1

FINAL REPORT

Approval Received January 11, 2010

Creation of a Vegetated Wetland Throughout The Littoral Zone of Lake Stanley Draper

Agency: Oklahoma Water Resources Board (OWRB)

Project Location: Lake Stanley Draper, WBID OK520810000130_00, HUC 11090203

Cooperators: Oklahoma City Water & Wastewater Utilities Department [OCWWUD]
Oklahoma City Parks and Recreation Department [OCPRD]
Oklahoma Department of Wildlife Conservation [ODWC]
Corps of Engineers at Lewisville (LAERF)

Acknowledgements

The U.S. Environmental Protection Agency funded 75% of this project, $113,132 making the planting of Lake Stanley Draper a reality. Additional funding, labor and coordination came from the City of Oklahoma City who was supportive at every level to help make this a successful project. Thanks must also go to the Oklahoma Department of Wildlife Conservation for volunteering their labor and expertise in both the nursery and on site plantings, Boy Scout Troop 211 in Midwest City for planting many of the project trees, staff from the Oklahoma State Legislature for assistance planting, and the EPA Region 6 SCUBA team for deep water plantings.

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Abstract

The City of Oklahoma City (OKC) expressed interest in making Lake Stanley Draper a better resource by improving its water quality, fish and waterfowl habitat and overall appearance. OKC started this in the mid-1990's with a watershed management plan that included road improvements, restrictions and closures, as well as timber management. In 2005 OKC was quick to seize the opportunity of focusing federal wetland funds for in-lake wetland treatments as well when approached by the Oklahoma Water Resources Board (OWRB).

From the summer of 2006 through the fall of 2008 OWRB and its partners introduced 26 species of native aquatic macrophytes to Lake Stanley Draper in an attempt to revegetate a shoreline once well populated with Potamogeton and other aquatic plants. The intention of this project phase was to work with Oklahoma City initiating an ecological shift back towards a lacustrine fringe ecosystem. Protected plantings called *"Founder Colonies"* were established throughout the lake to seed and spread over the coming years until permanent unprotected colonies take form. The primary accomplishments of this first phase were to determine the best plant species, their corresponding elevations for planting, the best locations for planting and ideally to establish long-term founder colonies. Project objectives were expanded to control or potentially eradicate invasive species when significant stands of common reed (*Phragmites australis*) were discovered.

Output Threshold I was met, *a survival threshold of 50% or better within the protective cages indicates that the project has successfully established founder colonies*. Cage survival by project end was 72% overall. This substantive success rate gives OWRB confidence that with time and continued effort this lake can have a diverse aquatic macrophyte community.

Output Threshold II, *a survival threshold of 30% of the unprotected plants*, was not met with an average of 4.7% of unprotected plant coverage.

Hence, the founder colonies have in fact been established and the #2 Decision Rule would be the best fit for this project, e.g. "*Output successful but Outcome. Indeterminate*. Given that there is funding from Oklahoma City to continue maintenance on this project, chances for a positive outcome are more likely.

The cage count by project end was 392 and 7 large pens filled with 22 species distributed over 33 sites across the lake. The overall average coverage in the protective cages was 48% for all species. Emergent species that excelled were: *Sagittaria lancifolia, Pontederia cordata, Eleocharis quadrangulata and Schoenoplectus tabernaemontani*. The submersed plants that were most successful were *Potamogeton nodosus* and *Vallisneria americana*. One plant did exceedingly well without any protection at all, *Justicia americana* (Water-willow). By project end founder colonies were healthy and spreading well.

At the time of this writing, summer 2009, Oklahoma City has fully funded continued maintenance of the project. Currently there is substantial growth and significant unprotected stands of *Justicia americana, Potamogeton nodosus* and *Schoenoplectus tabernaemontani* and to a lesser degree smaller stands of *Vallisneria americana*. Furthermore, stands of *Phragmites australis* have been reduced to a fraction of what they were in 2007.

Integration With The Oklahoma Comprehensive Water Plan

Oklahoma's primary water initiative is to direct all of the state's water related project efforts toward its new guidance document now in development, The Oklahoma Comprehensive Water Plan (OCWP). The plan is concerned with both water quantity and water quality. The quality portion of the OCWP will, at some level, search for innovative initiatives that improve water quality and thereby become another option for the citizens of Oklahoma to advance their state.

Consistent with a primary OCWP initiative, this and other OWRB technical studies provide invaluable data crucial to the ongoing management of Oklahoma's water supplies as well as the future use and protection of the state's water resources. Maintained by the OWRB and updated every 10years, the OCWP serves as Oklahoma's official long-term water planning strategy. Recognizing the essential connection between sound science and effective public policy, incorporated in the OCWP are a broad range of water resource development strategies substantiated by data such as that contained in this report.

The endpoint or long-term objectives of this project, upon a fully successful resolution, will provide a viable option for the citizens of Oklahoma to improve the shorelines and water quality of the certain lakes within the state. While revegetation of lakes is not a cure all nor indeed is it viable for many systems, the results of this venture and those ongoing beyond this project's scope give witness to the viability of littoral plantings. Introduced into the OCWP, revegetation would act as one implement within the shoreline management toolbox.

Background

Lake Stanley Draper (Draper) is the largest municipal lake owned by Oklahoma City located in the far southeast portion of the city. It supplies much of the city's potable water. Built in 1962 on Elm Creek, the impoundment is used primarily as terminal storage for water pumped from Atoka and McGee Creek Reservoirs in southeast Oklahoma

Draper Lake's ecological value has been long ignored and underutilized as a recreation resource. The city has made the decision to clean up the lake for recreational purposes as well as reducing treatment plant costs. It invested in a 1998 turbidity study for both Stanley Draper and Atoka lakes that has resulted in, among other things, a series of Best Management Practices (BMP's) in both watersheds. These include paving or disking and seeding some of the dirt roads that surround the lake, restricting access to bordering dirt roads, closing or moving a series of problem ATV trails further from the lake, restricting access points to the lake and contouring and re-vegetating buffer strips near the shoreline. These measures attest that the Oklahoma City Water & Wastewater Utilities Department (OCWWUD) is committed to maintaining the shoreline and protecting the lake from visitor abuse. Unfortunately, little work had been planned at or below the waterline, where essentially all of the problems are realized.

Wetland habitat for wildlife, fishing and aesthetics all suffer due to the turbid waters and often bare littoral zone of Draper Lake. Given the relatively stable water levels, fluctuating less than 3 ft. most years, and low numbers of certain herbivores at Draper, chances are good that a wetland community could be established around much of the shoreline. This would promote healing (reduce nutrient loading, shoreline erosion, resuspension of sediments due to wave action, etc.) of the lake as well as put in place a vibrant healthy ecosystem.

Site Description

Draper is a 2,900-acre lake with 34 miles of shoreline (Figure 1). The lake comprises approximately one-third of the watershed and hence is filled primarily with water pumped by Oklahoma City from Lake Atoka over 100 miles away. Since the lake is filled almost exclusively by pumps and not rain events, it does not fluctuate like most Oklahoma reservoirs. Draper typically fills and drains slowly over several months, generally going up from fall through spring and dropping three to six feet over the summer. This lake acts as storage for the Stanley Draper Water Treatment plant. The lake-wide average for Atoka is 53 NTU as compared to Draper's average of 7 NTU (subsequent to road closures and other basin improvements).

The lake has many well-protected coves with easy access by boat or by truck. The substrate is generally sandy clay. There are intermittent existing colonies or individuals of aquatic macrophytes. Some of these likely come from Lake Atoka, namely *Juncus effuses*, *Cephalanthus occidentalis* and *Eleocharis spp*. Other current resident plant species are listed in the Baseline Assessment in Appendix A. The first summer of the project in 2006 the conditions were correct to promote submersed plant growth. Hence the lake had small littoral populations of various species of *Juncus*, *Eleocharis*, *Schoenoplectus*, and *Potamogeton* (Figure 2 and Figure 3).

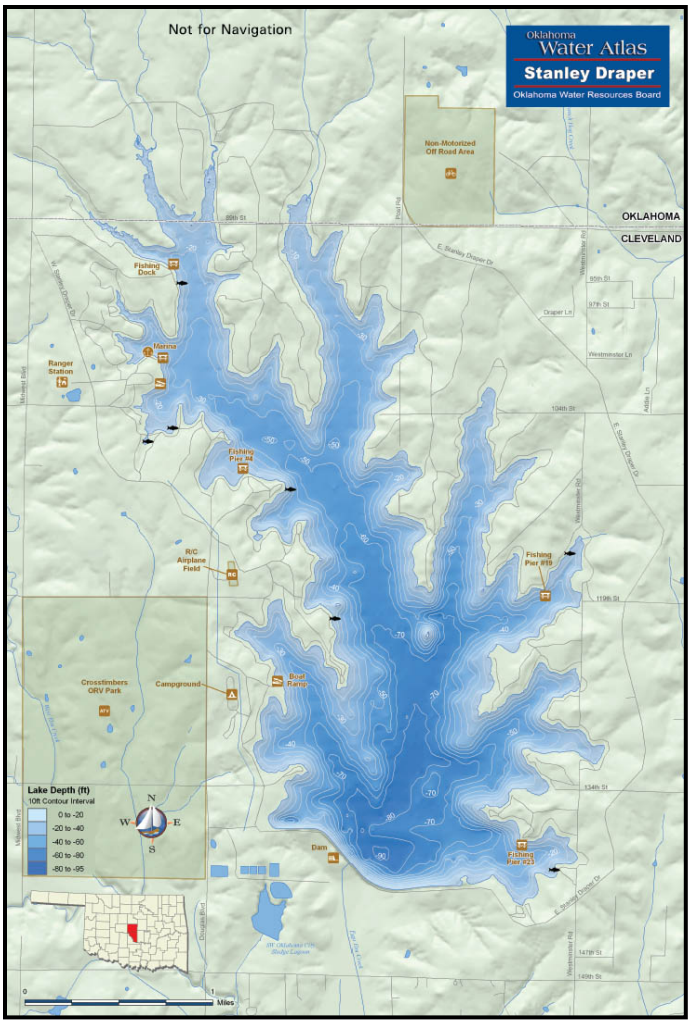


Figure 1: Lake Stanley Draper

Figure 2: Existing stand of *Eleocharis spp*.

Figure 3: Existing colony of *Potamogeton spp*.

Outline of Events

The following outline is not meant to be an exhaustive list of events for the project but does help to give a picture of how the project proceeded.

2006

- March – Consultants from Lewisville Aquatic Ecosystem Research Facility (LAERF) visited Draper to give planting recommendations/strategies.
- April - Nursery work – Plants are taken from Lake Thunderbird and drainage ditch in Oklahoma City and transplanted to pots in the ODWC aquatic plant nursery in Norman, OK. More plants are transplanted to the nursery throughout the summer as time permits.
- May – Outreach – Workshop –First site planted and caged
- June – October
    - Planted sites with assistance from the Oklahoma Department of Wildlife Conservations (ODWC), and Oklahoma City Parks and Recreation Department.
    - Continued nursery work of filling pots and splitting plants with assistance from ODWC.
    - Photo points taken in September.
    - Phragmites was identified as a problem for the lake and the project.
- November –
    - Installed caution signs at each site
    - Addendum to QAPP to strike the Bird Study on the project and replace with monitoring of existing beneficial plant communities and existing invasive plant communities.
    - Workplan revision that greatly reduced breakwater construction and much of the baseline sampling endeavors and replaced them henceforth with eradication efforts of *Phragmites australis*.

2007

- February 24 – April 1 –
    - Outreach - Tree planting with help from Oklahoma City and Boy Scout Troop 211. ~2000 trees at 30 sites.
- May –
    - Repaired existing ODWC nursery ponds,
    - Constructed 6 new ponds at ODWC,
    - Constructed 7 new pens in Draper.
- June - July –
    - Planting cages and pens at Draper,
    - Continued planting and splitting plants at nursery,
    - Spring assessment of plantings.
    - Found some tree sites had been mowed over. Flagged and delineated tree sites better and discussed with OKC how to respond
    - Consolidating cages with mortality to pens or other sites
- August – Initial *Phragmites* eradication with OKC.
- September –
    - More uncaged out-planting plots

    - Deep water plantings of *Vallisneria americana*, and other submersed plants with assistance from EPA Region 6 dive team.
- October –
    - Breakwater construction and planting
    - Last plantings for the season (planting was done late in the year because water levels were very high all summer long
    - Assessment (done later than ideal as plantings were done late in the season.)
- November – Photo point assessment

2008

- March – Tree plantings – mostly in sites that were mowed in 2007. 516 trees
- April – Outreach - Caged trees – Boy Scout Troop 211 made cages with remaining wire and caged to protect more trees and delineate the sites better.
- May –
    - Consultants from LAERF revisited Draper to see our work and make further recommendations.
    - Installed fish release funnels and turtle traps in pens
    - Bisected pens so that high water would at least not overtop the upper portion of pens.
    - Outreach – Presented project to Oklahoma State Department of Tourism (State Parks).
- July –
    - Assessed plantings
    - EPA dive team returns to add to deep water plantings in Cove 11
- August – Phragmites eradication continued. Will need another round in 2009
- September –
    - Last of plantings done, moved some cages to higher elevations due to high water
    - Outreach - State Legislature employees assisted
    - Final Assessment of plantings
- November –
    - Final Tree assessment
    - Outreach – Final Presentation

Meeting Project Objectives

1. Restoration of the shoreline to lacustrine wetlands:

From Project Workplan:

> *By planting founder colonies of wetland species in key protected areas around the lake, natural spread will result in development of wetland habitat around much of the lake. This wetland will result in a healthier lake and more diverse ecosystem. "Founder Colony" plants will be distributed over 40 acres, providing immediate (3 year) wetland habitat in a poorly vegetated environment and is projected to spread over subsequent years to vegetate much of the habitable littoral zone in the lake.*
>
> *In the long term, 10+ years, turbidity will be reduced as the colloidal clays fall out in the plant protected waters. Shoreline erosion will be curtailed by reduction of wave action and compaction of shoreline sediments by root systems. Emergent species such as bulrush, spikerush and duck potato will buffer the lake from upland erosion. Fish nursery habitat will be enhanced as the plants provide cover, macroinvertebrate habitat,*

and improved water quality. Moreover, we are likely to see an increase in lake visitation as fishing and aesthetics improve, bringing in substantial revenue to the city and making it a better place to live.

Outcome: Thirty-three sub-sites (Figure 4) were planted with 2,930 plants and 28 species over three seasons (Maps of each planted site can be found in Appendix C – Site Maps).

The lake currently has 392 cages and 7 pens (50'x 50') and four remaining plots (initially 127 plots) of unprotected plantings improving habitat in almost every major cove in the lake. The lake is well positioned to propagate lake-wide with several successful species. In time, with continued maintenance, the lake should have established diverse unprotected colonies of native wetland plants over a number of coves.

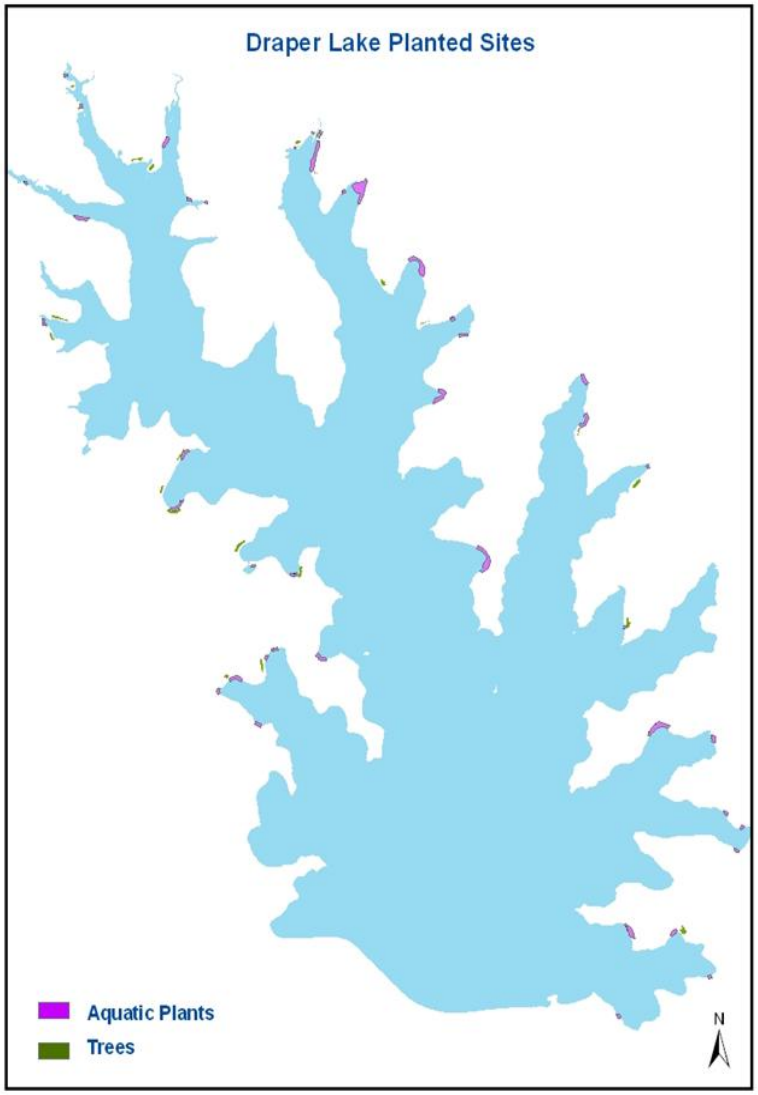


Figure 4: Planted sites of Lake Stanley Draper

On Caged Plantings

As of the 2008 fall assessment the lake had 392 cages of viable plants. Caged plantings are those plants put inside a plastic-coated wire mesh to protect them from herbivores. These cages were usually 4 feet in diameter and ranged from 3 ft. for higher plantings to 5 ft. in height for deeper plantings (Figure 5). Upper elevation plantings used a 2”x4” mesh that is sufficient to control terrestrial grazers. Deeper plantings used a 2”x 2” mesh to filter out small turtles and fish. Tops were constructed for very deep plantings of submersed plants where cages were expected to be overtopped most of the time.

Figure 5: Site 7 *Eleocharis quadrangulata* fills cages; Site 3a: typical caged site.

On Uncaged Plantings

It is much faster and less expensive to propagate sites with unprotected plantings and if successful would be the most viable method.

Over the first season, 2006, 127 uncaged plots (1,160 plants) were set up in a roughly 10’x10’ square plot of 9 to 16 plants (Figure 6). These plots were done with the numerous 2” plugs of sedges and rushes as well as bare root water-willow transplants from Lake Thunderbird. These plots, in general, looked healthy and grew well in the exposed mud.

Figure 6: Typical uncaged plot of Softstem bulrush delineated by the yellow flags

In 2007, the lake came up 3 feet and the plots were subject to aquatic herbivory. New plots were not put in until the water receded in August.

With more plants available than caging material, 231 new uncaged plants were planted in cove's 10, 17, and 23 in September 2007. Plots were planted with help from Oklahoma City and ODWC. Lake levels rose again to cover these uncaged plots. While these plantings were not included in the overall assessment numbers these plots were visited from time to time. Most of these plants were lost; however, one cove had healthy *Pontederia cordata* growing a year later in September 2008 (Figure 7).

Figure 7: Uncaged planting of *Pontederia cordata* after one year

On Pen Plantings

Seven pen plantings were put in place in 2007. These were the most successful and diverse communities in the project (see Results). In a fifty-foot by fifty-foot (50'x 50') pen (Figure 8), plant populations and their seeds, can multiply beyond ring cage plantings by one or two orders of magnitude. The pen methodology was incorporated in the second season after witnessing the vast plant densities observed in the Grand Lake plantings in the 2006 season.

Figure 8: Construction and planting of a new pen in May, 2007

Diverse plant communities can develop as well as habitat for younger age classes of fishes. While not caught on camera, project staff witnessed on multiple occasions young fish darting in and out of the 2"x 4" mesh pens as staff approached. Figure 9 does not show the young fish yet deftly illuminates the outstanding multiple levels of habitat and protection these pens can create.

Figure 9: A canopy of Potamogeton nodosus and wire mesh provide outstanding cover for young age-class fishes

Pens were placed in 7 coves: 4, 7, 10, 11, 16, 17, and 23. These coves were well distributed around the lake to better disperse seeds and to take into account differences in sediment types and water quality. Ring cages were also installed around many of the plantings within each pen to safeguard against breaches that can occur. These additional protection measures assure that if a breach occurred, founder colonies remained to repopulate the pen.

In general, the pens did as expected; creating a mixed community of aquatic macrophytes. The caged and uncaged plants generally spread well, filling both their ring cages and the pen (Figure 10 & Figure 11). These pens also illustrated the magnitude of herbivory pressure in the unprotected waters as these protected plots quickly sprouted with numerous submersed plants, presumably introduced to the lake well prior to this project. These were, by and large, composed of several species of Potamogeton and Naiad (Figure 12). Based on these results, we concluded that Draper has a good seed bank in place for these species and when protection is provided, they germinate and fill cages and pens in many parts of the lake.

Figure 10: Pen - 11; July 18, 2007

Figure 11: Pen 11 - 2 months later; September 21, 2007. Developed community of *P. nodosus, S. tabernaemontani, P. cordata, S. graminea, Chara, N. guadalupensis* and other species.

Figure 12: Dense submersed community of Potamogeton species and Naiad. Pen 10, September 2008.

Not all pens were as densely populated. Pens 4, 16, and 23 had fewer plants, see Figure 13, usually with *N. odorata, P. cordata, and S. graminea* being the dominant plants. The noticeable distinction for these sites was their substrates tended to be sandier and less organic.

Figure 13: Pen at Cove 4, September 16, 2008

Planting Scheme and Lake Elevations during the Project

The initial plantings were done in May through July of 2006 with both caged and uncaged plantings. A representative format is illustrated in Figure 14.

In the first season, the plants experienced a slow drop in pool elevation. This was at first a very positive development for the emergent macrophytes, however by season 2 as the water raised to 1188' mean sea level (msl) the plants suffered from herbivory and inundation. Planting elevations can be seen in Figure 15. Emergent plants were assayed from 1184' msl to 1188' msl. Submersed and floating leaved species were assayed from 1183' msl to 1186' msl. The red line on the graph in Figure 15 shows the lake elevation curve over the project period. Grey boxes at the top of the graph denote the growing season periods of May-September. As can be seen, the water levels came up very high in both seasons 2 and 3. While water level only spiked in season 2, it stayed up for most of the season in year 3. This devastated the uncaged plants and overwhelmed many of the deeper emergent macrophytes. As a result, the project targeted cage planting shallower areas and dropped uncaged plantings altogether. Cages with mortality were moved higher and replanted or consolidated into other sites. Some cages were moved into pens to avoid a total loss of biomass should a breach occur.

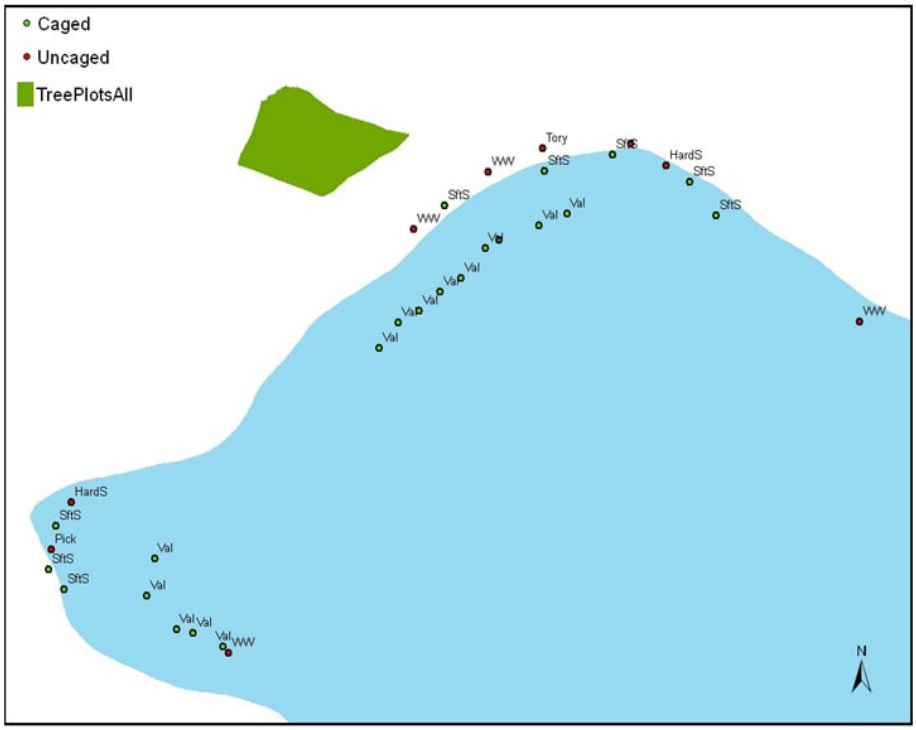


Figure 14: Typical 2006 planting layout with upper caged and uncaged plantings and deeper caged plantings of submersed species.

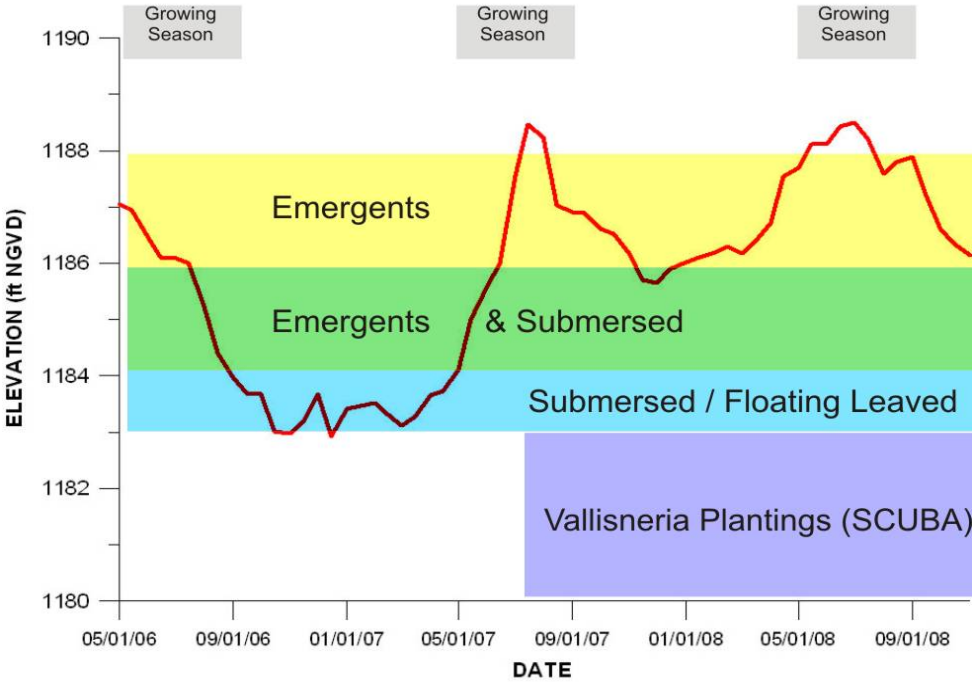


Figure 15: Graph of Planting Regimes as Related to Lake Elevations

By the second season many of the sites were transformed to have fewer deep cages or uncaged sites. This was also the time that pens were added (Figure 16). The expectation was that the plants had a better chance of surviving the upper elevations and eventual drought conditions than lower elevations where they may be inundated for longer periods of time. Deep waters can lead to plants expending their energy on elongation rather than expansive growth. Therefore plantings were moved to higher ground.

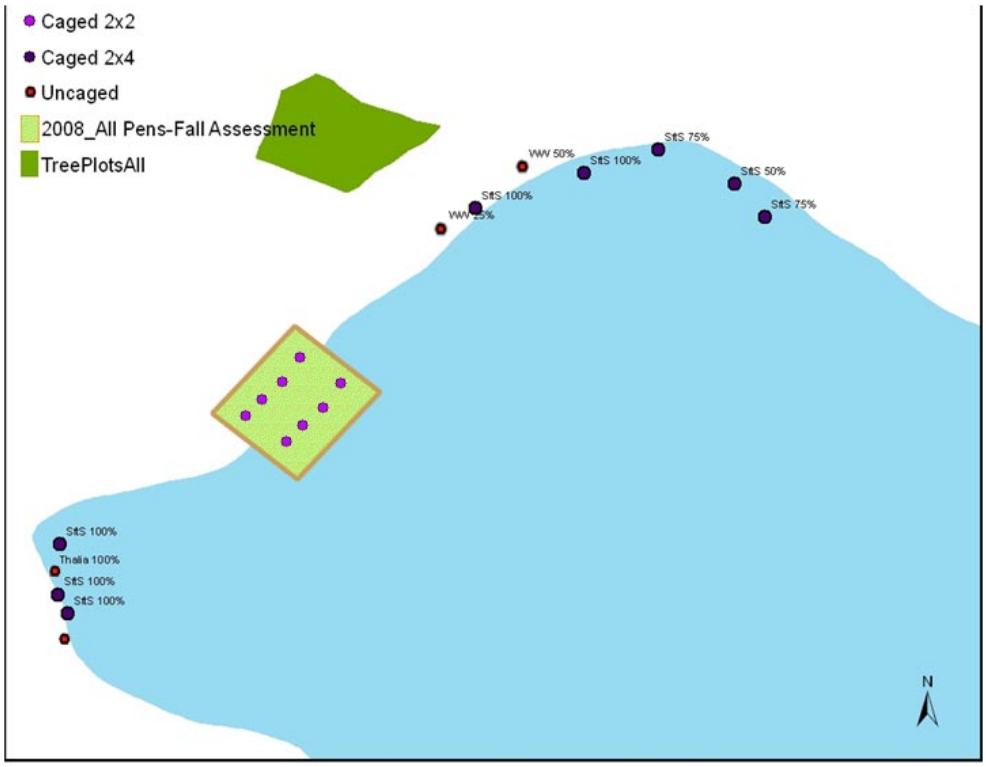


Figure 16: Typical site layout in 2007 with fewer deep cages or uncaged plots. Pens were added in 2007 as well.

2. Enhancement of Watershed Planning:

From Project Workplan:

> *"Plantings will enhance the effectiveness of OCWWUD implemented BMP's by creating another buffer from upland runoff and reducing wave induced erosion and resuspension of sediments. Initial sites will be directed near those sites where wetlands would be of benefit to the lake and watershed."*

Meeting this objective: Oklahoma City Water and Wastewater Utilities Department (OCWWUD) initiated BMPs for the entire lake, by controlling access with a series of gates that they close during wet weather and throughout much of the year to minimize erosion. They also blocked approaches to the lake shoreline with large barriers in virtually every major cove of the lake and moved the motorcycle trail system off-site. Successful plantings, once grown into established colonies, will be another component towards OCWWUD's goal of lowering sediment loads and resuspension in the lake.

3. Outreach:

From Project Workplan:

> *Through the use of a workshop and conferences local interested parties will be given the opportunity to see and work with wetland species. The creation of wetlands around Oklahoma lakes is an unused alternative shoreline treatment. OWRB recognizes all the benefits of colonization of the littoral zone with diverse native plants. OWRB aims to promote the future success of this project to lake managers statewide with the intention of replicating it in lakes across Oklahoma.*
>
> *OWRB will kick off the project by inviting all project cooperators, universities and organizations around Draper Lake to educate them about this project and recruit planting volunteers. This will have a duel role of enhancing project congruity among participants and establishing multiple caretakers of the project.*
>
> *OWRB will make on-site presentations after the third planting season to entities actively managing shorelines such as lake managers, master conservancy districts, municipalities and state parks to teach the multiple advantages of creating wetlands on their lakeshores.*

Two major events were held to achieve this objective.

Event 1

The first was a workshop held on May 15, 2006 to kick off the project implementation. Twenty-four people from ten agencies and organizations attended the workshop. The agenda included a before and after wetlands IQ test; lecture on lacustrine wetland ecology; Draper Lake project overview; lecture on the benefits of aquatic plants on fisheries; outdoor workshop showing caging and planting methods and actual installation of a site by participants.

Figure 17: Opening Workshop: Lecture and site installation; May 15, 2006

The intention of this workshop was to bring awareness, recruit involvement and create understanding of the project to the community and cooperators before the project began. It was very successful in bringing people together and educating 24 concerned people about something they knew little or nothing about. Photos taken during the workshop presentation and installation can be seen in Figure 17.

The key measure in the workplan called for a before and after test with 30% or better overall improvement of participants' score. Ten participants took both tests: 60% had a better score, 20% had a worse score, and 20% did the same.

Event 2

The second event was a presentation of the completed project, held at the Draper Water Plant conference room. This event consisted of a PowerPoint presentation of the project, including project results, followed by a field visit to two sites Figure 18. Fourteen attendees were present from seven agencies.

Figure 18: Project presentation at Draper Lake; Nov. 7, 2008

The intention of this outreach component was to share project results with local interested parties and have a meaningful discussion to follow. Those intentions were fully realized at this meeting, and we were pleased with the interaction and discussion that precipitated from this event.

"After seeing and hearing about this project, what do you honestly think about these methods for lakes in Oklahoma?"
84% indicated very positive responses, meeting our 75% criteria for usefulness of the conference.

"If you were (or are) a lake manager would you implement similar treatments to your lake?
77% indicated in the affirmative, exceeding our 25% criteria. It must be noted here that most of the attendees were lake managers already implementing these treatments or not a "lake manager" at all. Had the audience been composed of more "lake managers", who were not already implementing similar treatments, the results may have been quite different.

Additional Project Endeavors

Plant Nursery Expansion

Many of the project plants came from the aquatic plant nursery at the Oklahoma Department of Wildlife Conservation (ODWC). Using the ODWC design, OWRB staff doubled capacity by adding 6 new ponds to their existing 6 ponds (Figure 19). Staff transferred propagules from local

wetland sites to the nursery for potting and replication. After several weeks the pots could be outplanted to Draper and replicated in the nursery ponds for future plantings.

Figure 19: Aquatic plant nursery expansion construction at ODWC Fisheries Lab in Norman, OK

Habitat Plantings with Trees

Trees were planted with assistance from Oklahoma City, First Step Center, and Boy Scout Troop 211. Bare-root seedlings from the Oklahoma Forest Regeneration Center in Goldsby, Oklahoma were used for this portion of the project (Figure 20). Approximately 10 trees were caged per site with 2x4 welded wire and flagged for visibility (Figure 21). These cages were placed mostly on the perimeter trees to delineate the site boundary for our use and to help those mowing the areas. The caged seedlings were the only ones to be assessed, this was in part because finding the small seedlings once the tall grasses have grown around them is so time consuming even with flagging. The first summer, there were communication gaps between OWRB staff and the lake grounds crew resulting in several of the trees sites getting mowed down. This was rectified through further discussions with the city and replanting those sites the next winter. Cages were flagged better to insure their visibility. Post-project visits in 2009 have shown that grounds crews have continued to avoid the tree plots during their mowing.

Figure 20: Bundle of bare-root seedlings

Figure 21: Caged tree seedling at ~ 6 months

Figure 22: Uncaged tree seedling

Tree plantings were designed, where possible, to compliment the aquatic plantings by providing wildlife habitat species, many of which could be classified as bottomland hardwoods such as Pecan (*Carya illinoensis*) and Sycamore (*Platanus occidentalis*). These tree plots would provide exceptional browse, nesting and cover for multiple species (Figure 22).

Control Burning Plan

There exists a tremendous fuel load throughout the surrounding woodlands of Draper Lake. Wildfire is a very real threat to the tree seedling plots and upper wetland plants, not to mention the parks, facilities and surrounding homes. OWRB recognized that this risk should be reduced if feasible. In the fall of 2007, meetings were held with Oklahoma City, Oklahoma Forestry Services Division (OFS), Oklahoma Department of Wildlife Conservation and local Fire Departments to develop a plan for a rotation of controlled burns over the coming years. To date the fire lines have been made and the OFS awaits suitable weather conditions for a burn.

Additional Outreach Events

- 2 presentations (Spring 2006 and Spring 2007) to OKC Water & Utilities Trust with the Mayor and City Councilmen. These presentations helped make the Atoka project possible. Played on the local City Channel television station.
- Several planting events with "First Step" a drug and alcohol rehabilitation group using crews of about ten persons.
- 1 "Volunteer planting day" summer of 2006. Attended 3 during the spring of 2006 meetings to present the project and round up interested parties to help: Sierra Club Cimarron Chapter, Sustainable OKC, Red Dirt Paddlers Kayaking club meeting.
- 1 On-Site presentation to the Oklahoma City Game and Fish Commission using vans to go to 4 sites. Summer of 2006.
- ODWC and OKC Parks and Recreation Department have come and planted on at least 4 different occasions.
- Presentation of Project to Oklahoma Dept. of Tourism Park Managers throughout the state; May 14, 2008.
- Support personnel from the Oklahoma State Legislature planted one afternoon in September, 2008.
- 2 Tree Planting days with Boy Scout Troop 211 from Midwest City (Figure 23), Oklahoma; 11 Scouts and 3 adult leaders. February, 2007 & March 2008.

Figure 23: Boy Scout Troop 211 planting trees.

Log Breakwaters

The intent of breakwaters was to create wave-protected zones for plants to grow and colonize. This would effectively increase the habitable shoreline. This was a concern during the workplan phase because there exists large wave eroded zones across the lake. However, upon working in the lake through the first season it became evident that there was an abundance of viable planting sites with ample room for colonization. It was therefore deemed not cost-effective to build breakwaters around the lake when time and effort would be better spent tending to the plantings themselves. It was reasoned worthwhile, by EPA, to assay one or two breakwaters to observe the soundness of the method. A workplan revision to deal with this and other issues was submitted to EPA Region 6 in November, 2006.

In 2007 a breakwater was installed in Cove 18 using thirteen logs thirty to forty feet in length. Oklahoma City work crews cut down cottonwoods in an area they desired to clear, so the work was beneficial for both parties. Using a full semi-trailer and a front-end loader, the logs were transported and unloaded into the lake from the raised road above. T-posts were spaced at roughly half-meter intervals in two rows for approximately thirty feet. Logs were slid in-between rows and stacked to a height of four-feet and cabled in place (Figure 24).

There were large waves the day of construction. While it could be seen that the breakwater visibly dampened the wave energy it did not reduce it as much as hoped. This site was planted with 23 plants; four plants were caged. The lake remained very high and thus planting had to be done in one to three feet of water where wave action might still be significant. None of the plants survived behind the breakwater in 2008. Since no evidence of the plants were found at all it is plausible to assume they washed out. Beavers were also another problem for the breakwater. Beavers found and damaged some of the logs on the first night after construction. The damage was primarily on the upper end of the logs that were in the shallows and had no significant effect overall.

Figure 24: Completed breakwater

Volunteer (Preexisting) Plant Colonies

Draper Lake had existing plant colonies before the project began. In November of 2006, prior to the first season of planting, OWRB and EPA determined it would be beneficial to see how volunteer plant colonies spread. Using GPS technology OWRB was to compare changes in overall area of 4 colonies of plants. Originally this was to include submersed species; however the 2007 and 2008 seasons following were wholly absent and could not be mapped. Emergent species were mapped. The chosen species were:

Phragmites australis,
Typha latifolia,
Eleocharis quadrangulata,
Schoenoplectus tabernaemontani
Eleocharis palustris

Results

There were four types of data that were tracked for the project: caged plantings, uncaged plots, pen plantings and tree plantings. Caged plantings were by far the most abundant and will be focused on more heavily, but some important results were found from the other planting types as well.

Total aquatic macrophytes planted lake-wide = 2,930
Total aquatic species introduced = 28

Species planted by number and year are listed in Table 1.

Table 1: Species planted by year

2006

Species	Number
Acorus calamus	37
Bacopa monnieri	102
Carex stricta	39
Carex vulpinoidea	2
Eleocharis macrostachya	39
Eleocharis quadrangulata	152
Hibiscus moscheutos	8
Juncus coriaceus	213
Juncus torreyi	23
Justicia americana	212
Pontederia cordata	207
Sagittaria graminea	12
Sagittaria latifolia	38
Saururus cernuus	34
Schoenoplectus acutus	72
Schoenoplectus americanus	80
Schoenoplectus tabernaemontani	536
Scirpus cyperinus	68
Scirpus robustus	50
Thalia dealbeta	2
Vallisneria americana	160
Total 21 Species	**2086**

2007

Species	Number
Bacopa monnieri	30
Heterantherea dubia	10
Juncus torreyi	35
Justica americana	11
Nuphar lutea	11
Pontederia cordata	100
Sagittaria graminea	91
Sagittaria latifolia	87
Saururus cernuus	41
Schoenoplectus americana	17
Schoenoplectus tabernaemontani	120
Vallisneria americana	126
Total 12 Species	**679**

2008

Species	Number
Echinodorus berteroi	8
Echinodorus cordifolius	12
Heterantherea dubia	11
Justica americana	31
Nuphar luteum	3
Nymphaea odorata	9
Pontederia cordata	4
Potamogeton nodosus	1
Rhynchospora corniculata	14
Sagittaria graminea	26
Sagittaria latifolia	4
Schoenoplectus americanus	2
Schoenoplectus tabernaemontani	21
Scirpus fluvialitis	1
Vallisneria americana	20
Total 15 Species	**167**

On Caged Plantings

The Decision Thresholds set up in the QAPP largely deal with the *survival* of plants by cage or plot, though it is important to report on the *growth* or *coverage* within each plot or cage as set out in the QAPP. Hence, both survival and growth are reported here, see Tables 2 & 3. It is noted on each table or topic which is being presented, Survival or Growth.

Survival of a cage is a simple binary rating: plant/no plant without accounting for size or vigor. *Growth* or *Coverage* refers to the percentage covered, explained below in.

Caged Survival

Cage survival by species is expressed in Table 4. The overall survival was 72% (284 out of 392 cages). Thirteen out of the twenty species survived in more than 50% of their cages. Those species in **bold** are plants that exceeded the 50% survival threshold set in place in the QAPP for the Decision Criteria. Thresholds are thoroughly explained in the Conclusions section below. The results in Table 4 were the current cages in the water at the time of the fall 2008 assessment. Therefore, the percentages and species do not take into account all species and all mortality that occurred over the three seasons, but rather just look at what was in the cages at the time of assessment. There are many species that were attempted that were not in the final assessment cages and consequently are not in the table. Moreover, those cages that were found vacant were actually replanted during assessment but considered a *mortality* for the purposes of this calculation. Plants that were in pens, or in cages inside of pens, are not addressed in Table 4. It is important to note that there are several species that have a very high percent survival ranking, but had very few cages. A small number of data points make results dubious, and these plants should be (and indeed have been) strongly considered for the next phase of the project.

Lake-wide overview statistics for caged plantings are as follows:

Table 2: Lake-wide totals for *Survival* and *Growth* - Inside cages

Total # of cages:	**392**
Total # of *surviving* cages:	**284 cages (72%)**
Good *growth* in cages: (50% or better)	**207 cages (53%)**
Exceptional *growth* in cages: (75% or better)	**155 cages (40%)**

Table 3: Lake-wide totals for *Survival* and *Growth* - Outside cages

Total *survival* outside of cage:	**30 cages (7.6%)**
Good *growth* outside of cages: (50% ranking or better)	**15 cages (3.8%)**
Exceptional *growth* outside of cages: (75% ranking or better)	**5 cages (1.3%)**

Table 4: Cage Planting Survival from Final Assessment

(Species in bold are plants that exceeded the 50% survival threshold from QAPP)

Cage Planting Survival by Species - Fall Assesment 2008				
Species	No. of Cages	Survival	Mortality	Survival %
Acorus calamus	5	1	4	20.0%
Bacopa monnieri	*1*	0	1	0.0%
Carex stricta	*2*	0	2	0.0%
Echinodorus berteroi	9	3	6	33.3%
Eleocharis macrostachya	*3*	1	2	33.3%
Eleocharis quadrangulata	***23***	**17**	**6**	**73.9%**
Heterantherea dubia	***11***	**11**	**0**	**100.0%**
Juncus coriaceus	*5*	2	3	40.0%
Justicia americana	*15*	7	8	46.7%
Nuphar luteum	***3***	**3**	**0**	**100.0%**
Nymphaea odorata	***3***	**3**	**0**	**100.0%**
Pontederia cordata	***53***	**39**	**14**	**73.6%**
Potamogeton nodosus	***7***	**6**	**1**	**85.7%**
Sagittaria graminea	***20***	**14**	**6**	**70.0%**
Sagittaria latifolia	***5***	**3**	**2**	**60.0%**
Saururus cernuus	***2***	**2**	**0**	**100.0%**
Schoenoplectus americanus	***5***	**3**	**2**	**60.0%**
Schoenoplectus tabernaemontani	***176***	**140**	**36**	**79.5%**
Scirpus cyperinus	***2***	**1**	**1**	**50.0%**
Vallisneria americana	***38***	**28**	**10**	**73.7%**
No Species Data for these cages	*4*	0	4	0.0%
Overall	392	284	108	**72.4%**

It is worthwhile to consider the data only looking at species that had a more practical "n" or sample set. Taking only those species with 10 or more cages gives the following results in Table 5:

Table 5: Cage Data of Species where n=10 or more

Cage Planting Data - Species w/ ≥ 10 Samples - Survival by Species - Fall Assesment 2008				
Species	No. of Cages	Survival	Mortality	Survival %
Eleocharis quadrangulata	***23***	**17**	**6**	**73.9%**
Heterantherea dubia	***11***	**11**	**0**	**100.0%**
Pontederia cordata	***53***	**39**	**14**	**73.6%**
Sagittaria graminea	***20***	**14**	**6**	**70.0%**
Justicia americana	*15*	7	8	46.7%
Schoenoplectus tabernaemontani	***176***	**140**	**36**	**79.5%**
Vallisneria americana	***38***	**28**	**10**	**73.7%**
Overall	336	256	80	**76.2%**

When looking at the more tested species (n≥10) the data gives a higher survival percentage than the overall picture at 76.2% and well over the survival threshold.

Caged Coverage

Measurements of cages were taken via visual estimate of a percentage of cage or plot coverage. Since this method would be highly variable in its results it was simplified to build consistency and understanding between sessions as well as between those making the assessments.

Table 6: Percent Coverage Breakdown for Caged Plants

25% Given to initial planted cage with 6" pot

0% Plant(s) of that species not found
10% Loss of initial plant biomass and vigor, unhealthy
25% No appreciable spread
50% New shoots spread across ½ cage area
75% New shoots spread across ¾ cage area.
100% New shoots spread across entire cage area.

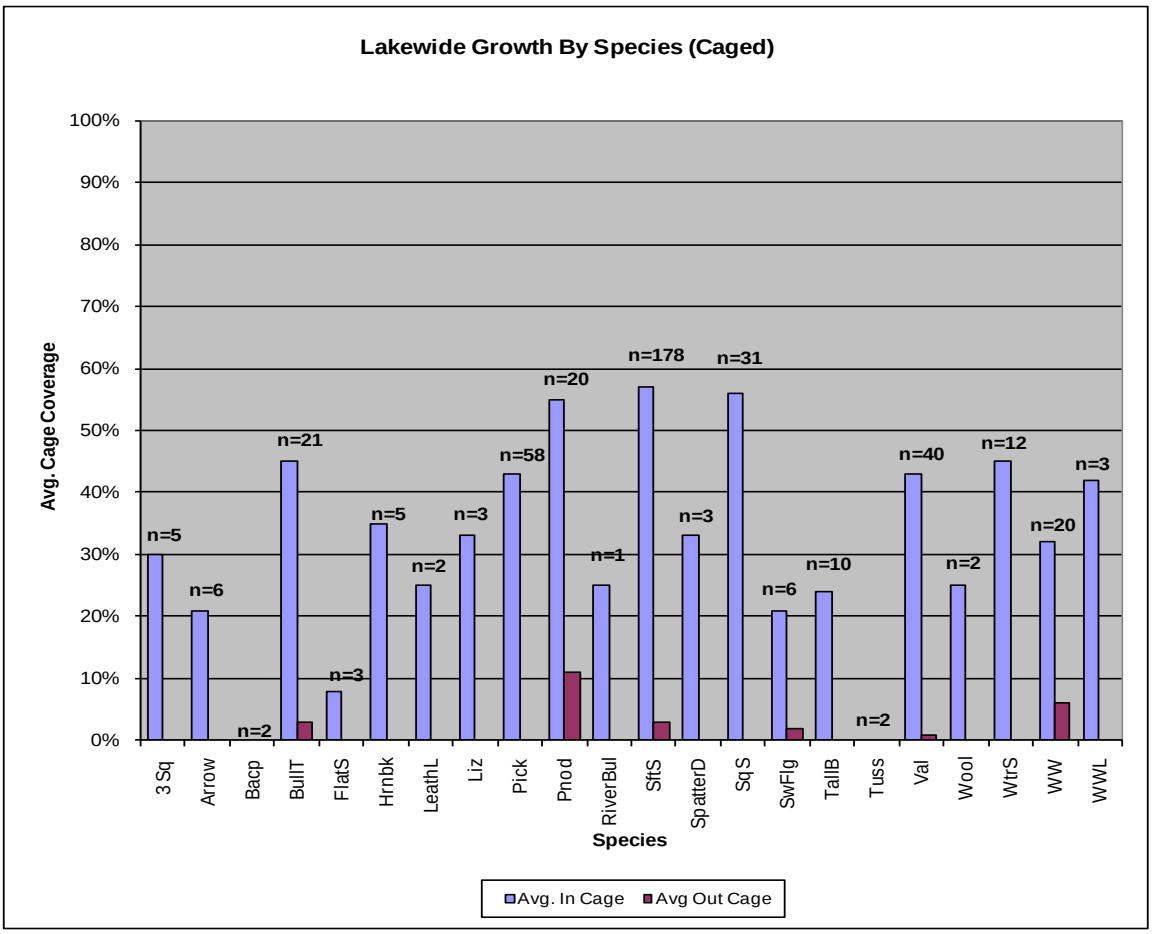
Lake-wide averages are listed in Table 7.

Table 7: Lake-wide Averages of Plant *Coverage* with Protective Cages

	Coverage Inside of Cage	Coverage Outside of Cage
Lake-wide Average of Caged Plants	48%	3%

The maximum average coverage *inside* the cage for a species across the lake was Softstem bulrush (*Schoenoplectus tabernaemontani*) at 57% (Figure 25). Other species that did very well were: Bulltongue (S*agittaria lancifolia*), Pickerelweed (*Pontederia cordata*), American pondweed (*Potamogeton nodosus*), Squarestem spikerush (*Eleocharis quadrangulata*), and Water

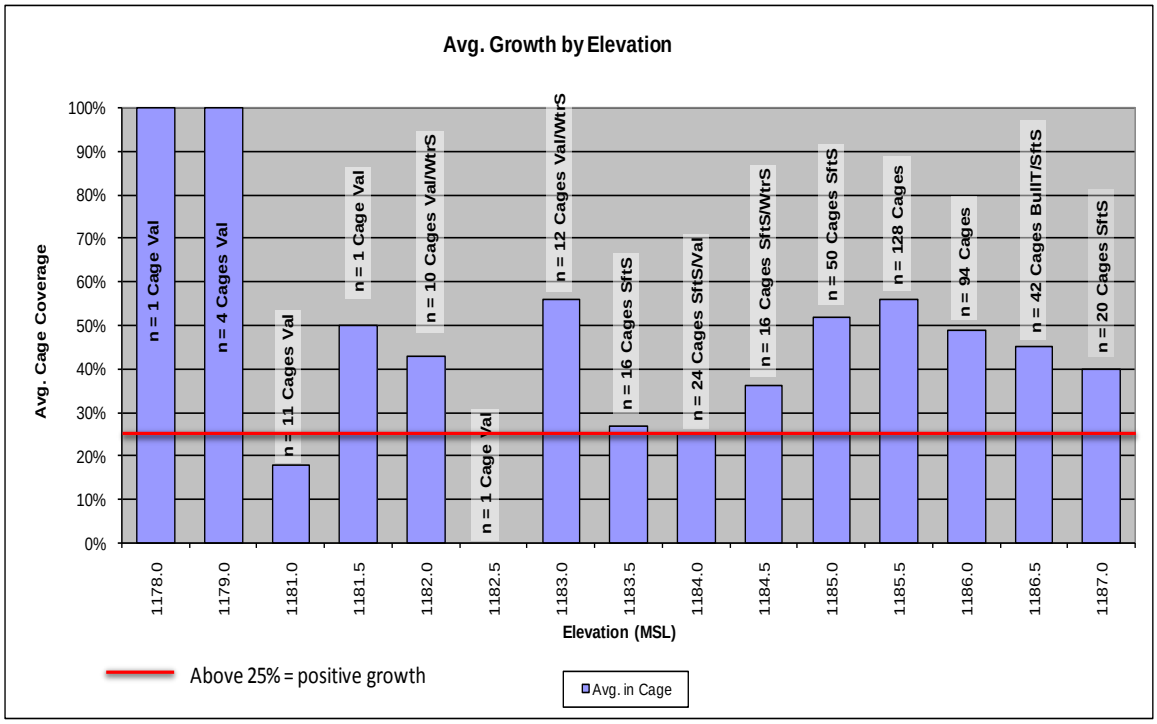
celery (*Vallisneria americana*). Some species did not survive at all, namely Tussock sedge (*Carex stricta*), Bacopa (*Bacopa monnieri*), and woolgrass (*Scirpus cyperinus;* not on graph).



* Numbers above each bar indicates the number of cages in the sample set. Some sample sets may prove too small to be substantive.

Species Key			
SwFlg	*Acorus calamus*	Pick	*Pontederia cordata*
Bacp	*Bacopa monnieri*	Pnod	*Potamogeton nodosus*
Tuss	*Carex stricta*	Hrnbk	*Rhynchospora macrostachya*
TallB	*Echinodorus berteroi*	BullT	*Sagittaria graminea*
FlatS	*Eleocharis macrostachya*	Arrow	*Sagittaria latifolia*
SqS	*Eleocharis quadrangulata*	Liz	*Saururus cernuus*
WtrS	*Heterantherea dubia*	3 Sq	*Schoenoplectus americanus*
LeathL	*Juncus coriaceus*	SftS	*Schoenoplectus tabernaemontani*
WW	*Justicia americana*	Wool	*Scirpus cyperinus*
SpatterD	*Nuphar luteum*	RiverBul	*Scirpus robustus*
WWL	*Nymphaea odorata*	Val	*Vallisneria americana*

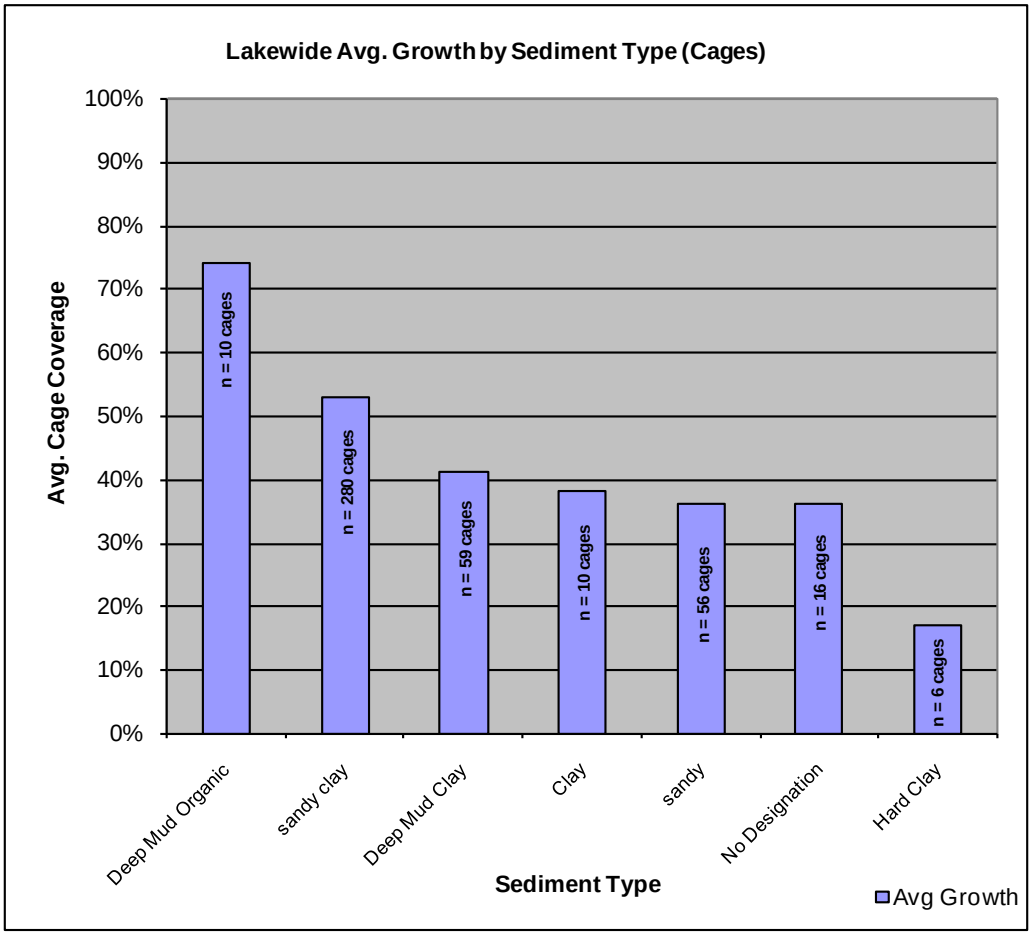
Figure 25: Lake-wide Cage Coverage by Species (Caged)



* Numbers on or above each bar indicates the number of cages in the sample set and the predominant species at that elevation. Some sample sets may prove too small to be substantive.

Figure 26: Average Growth by Elevation

Elevations below 1184' MSL are generally from one site, Cove 11, where deep water submersed plantings were held. A vast majority of the project cages are between 1184' and 1187'. Since the plantings are designated at 25% initially it would seem that elevations with an average growth near or below 25% are displaying only nominal growth. Plantings at elevations ≥1185' showed average coverages ≥40%. The deep water cages seemed to do very well overall with 100% coverage even in the deepest cage. The data suggests that this lake's clarity can support deepwater plantings for submersed plants which circumvent problems from common annual fluctuations. The 11 cages at 1181' did the poorest at < 20%. This result was due to 2 empty cages from the 2007 planting. The remaining cages at this elevation were planted in 2008 and were quite healthy. The mortality may likely be due to some factor(s) other than elevation given there are multiple successes both above and below them. All cages above 1187' died in earlier seasons and does not appear to be a valid planting elevation for this lake. Results further indicate that emergent plants should not be planted below 1185' (Figure 26).



* Numbers on each bar indicates the number of cages in the sample set. Some sample sets may prove too small to be substantive.

Figure 27: Average Growth by Sediment

Sediment type was another factor for consideration. The highest cage coverage percentage with the *Deep Mud Organic* type is 74% (Figure 27). An organic substrate is uncommon however at this lake. *Sandy-Clay* is the by far the most common substrate found. Serendipitously, this is also a very productive substrate with an average coverage of 53%. *Hard clay* had the lowest productivity at 17%. It is an uncommon substrate in Draper Lake.

Mortality in cages was also looked at over the life of the project. Most of the data is a snapshot of the data at the final assessment. Table 8 considers the life of the cage in the lake. If the cage was emptied and replanted it is designated a mortality. This gives a better observation of how species fared when factoring in that a cage may have been replanted (and often moved as a result) several times over the three seasons.

Table 8: Average Cage Coverage by Species Over Three Seasons;

Avg. Coverage for Caged Plantings Factoring Mortality Over 3 Seasons			
Species	Avg. In Cage	Avg Out Cage	Cages (=n)
Acorus calamus	21%	2%	6
Bacopa monnieri	0%	0%	7
Carex stricta	0%	0%	2
Echinodorus berteroi	24%	0%	10
Eleocharis macrostachya	8%	0%	12
Eleocharis quadrangulata	56%	0%	31
Heterantherea dubia	45%	0%	12
Juncus coriaceus	5%	0%	10
Justicia americana	32%	6%	20
Nuphar luteum	33%	0%	3
Nymphaea odorata	42%	0%	3
Pontederia cordata	38%	0%	65
Potamogeton nodosus	55%	11%	20
Sagittaria graminea	41%	3%	23
Sagittaria latifolia	9%	0%	14
Saururus cernuus	33%	0%	3
Schoenoplectus americanus	9%	0%	17
Schoenoplectus tabernaemontani	57%	3%	178
Scirpus cyperinus	25%	0%	2
Scirpus robustus	25%	0%	1
Vallisneria americana	43%	1%	40

<u>On Uncaged Plantings</u>

In year one of the project 129 unprotected plots (Figure 28) were sprigged lake-wide with 1,164 plants. These plots had acceptable results for the first season (Table 9). Most of these plantings were uprooted by herbivores apart from four sites: two sites of *Justicia americana*, one site of *Schoenoplectus tabernaemontani* and one site of *Thalia dealbata*. Photo-monitoring for uncaged plots for the fall were typically bare patches of water. With the poor results of uncaged sites uncaged plantings were discontinued.

Over the 2008 season, the remaining 2 of 16 uncaged plots of *Justicia americana* did extremely well with a *coverage* inside and outside of the plot of 100% (Figure 29). *T. dealbata* only had one plant and yet also multiplied considerably (Figure 30). In addition, while the *S. tabernaemontani* remained within its original plot it was dense and appeared well established. In Table 10 the results are based on the change from the initial 2006 plantings to their state as of the final assessment in the fall of 2008. From that table, it is obvious that for most species the uncaged method is a dismal failure. However, considering only the successful plantings the average coverage inside the plot is 58.3%. This substantial percentage is worth looking into further. Table 11 looks at the percent survival of only the remaining species. Of these *J. americana* at 12.5% is notable because it is so easy to propagate. *T. dealbata* at 100%, while a considerable percentage, is limited in scope because it had only one sample in the set. Nonetheless, this plant certainly merits further trials.

Table 9: Uncaged planting results after first season

2006 Data	
Total plants	1,164
Total plots	129
Growth average	24%
Good growth % (≥50%)	8%
Poor growth % (≤10%)	10%
Mortality %	5%

Figure 28: Uncaged plot of *Justicia americana*

Figure 29: Similar plot at project end.

Figure 30: Uncaged plot of *Thalia dealbata*

Table 10: Uncaged planting results at project end

2008 Data	
Initial uncaged plants (2006)	1,164
2006 uncaged plots	129
2008 surviving plots	6
Overall survivial %	4.7%
Overall coverage % of plots	2.7%
Coverage % of *remaining* plots	58.3%

Table 11: Results of surviving uncaged plantings

2008 Surviving Plots by Species	
J. americana (4 of 16)	12.5%
S. tabernaemontani (1 of 26)	1.9%
T. dealbata (1 of 1)	100.0%

Another uncaged planting that survived but was not mapped or logged by GPS was a plot of *Pontederia cordata* from a planting done in September of 2007. While not assessed and given a percentage it is worth noting that *P. cordata* is viable for uncaged plantings in the upper pool elevations. Its results can be seen in Figure 31.

Figure 31: Unprotected planting of *Pontederia cordata* after one year

Uncaged results post-project

Maintenance site visits in *2009* (post-project) for OKC have exceeded expectations and warrant mention in this report: Some *J. americana* plots were planted in May, 2006 as seen in Figure 32 only to perform marginally well for the 2007 & 2008 seasons. However, the 2009 season has provided a slowly dropping pool, exposing the sediment and allowing for rapid spread and full establishment of *J. americana* at some sites. Draper had no water-willow in its system prior to this project. As a result of the *J. americana* colony in Figure 29, the final recommendations were to plant more *J. americana* during the subsequent maintenance phase. Multiple plots were planted in July of 2009.

Figure 32: Planting *J. americana*; east, May, 2006 Same site of *J. americana* looking west; June, 2009

S, graminea was also found in July, *2009* growing on its own, independent of cage protection (Figure 33). These plants are extremely interesting because they are likely to be the successful result of sexual reproduction by project plants.

Figure 33*: S. graminea* propagules spreading along shoreline

On Pen Plantings

As with caged plantings and plots, measurements were taken via visual estimate of a percentage of pen coverage maintaining the 0%, 10%, 25%, 50%, 75%, and 100% increments. Since this method would be highly variable in its results it was simplified to build consistency and understanding between sessions as well as between those making the assessments. Pens being much larger than cages will not likely fill to capacity and may yet be healthy and spreading. Hence, giving purely a percent coverage would not accurately reflect the quality of a pen's plant community. For that reason another metric was developed for pens called a Community Rating (CR) that better captured the quality of the pen's health and diversity. Between these two rating systems, a good measure of founder colony establishment is possible.

%Cover (pC) = visual estimation of total area coverage of all plants in the pen.

- Initial condition at time of planting = 25%

Community Rating (CR) = 0 - 4

0 = no aquatic macrophytes
1 = 1 species prominent – monoculture or aquatic macrophytes
2 = 2 species prominent
3 = 3 species prominent
4 = 4 or more species prominent

Prominent = at a minimum, a grouping of healthy macrophytes, i.e. an individual plant in the pen should not be considered prominent.

- Initial condition at time of planting = 4

The results were highly varied, due in large part to any breaches or overtopping that had or had not occurred. Pen placement was intended to cover roughly two or three feet of elevation change from the normal pool level. While this made it possible for the pen to house both emergent and submergent plants it also created the possibility that high waters may overtop the 4 ½ foot tall fence on the deep end and expose the whole community to herbivory. Therefore the pens were bisected by depth to protect shallower plants from aquatic herbivory. This endeavor proved valuable as the results show stark differences between these upper and lower bisections, as can be seen in Figure 34 of Pen 17, where the upper portions approach 100% coverage and the lower portion was virtually empty.

Figure 34: Bisected pen in Cove 17. Lower portion was overtopped weeks before and denuded

It should be noted that all pens have recovered in 2009 as waters receded.

Table 12 lists the results from the final assessment in the fall of 2008.

Table 12: Assessment Results for Pens in fall 2008

Assessment Results of Pens - Fall 2008		
Pen/Cove #	% Coverage	CR
Pen 4	25%	4
Pen 7	50%	3
Pen 10	100%	3
Pen 11	25%	4
Pen 16	25%	4
Pen 17	50%	2
Pen 23	50%	3

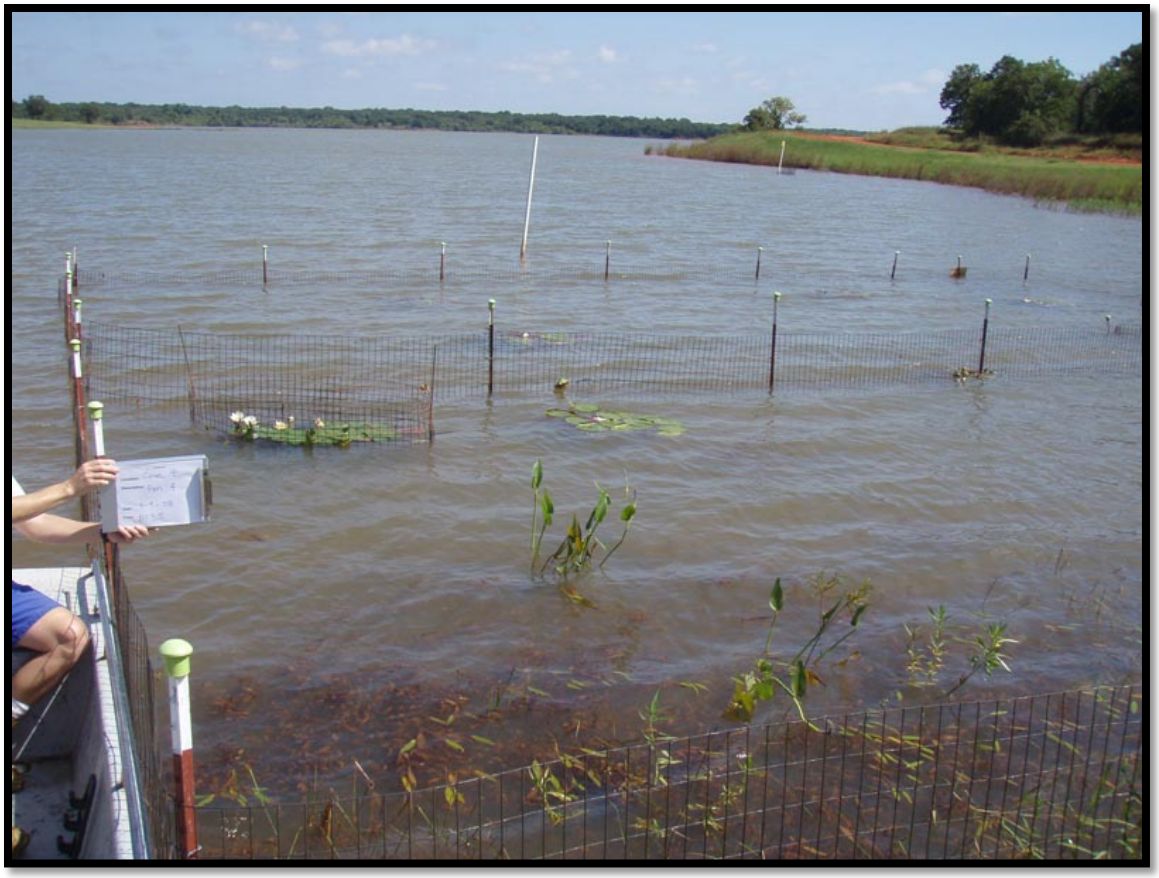


Figure 35: Pen in Cove 4

Pen 4
This pen was less prolific than others. It had a sandy bottom that seemed to do well in the shallows with *S. graminea*, *P. cordata* and an existing colony of *Eleocharis*. The rest of the pen did well with *N. odorata* which fared well given the herbivory pressures from multiple episodes of overtopping (Figure 35).

Figure 36: Pen in Cove 7

Pen 7

While at the time of assessment the pen had been despoiled from herbivory and hence was rated with a 50% coverage, it had previously been the best project pen overall for spread of multiple project species; most notably *S. graminea*, *Pontederia cordata* and *Nymphaea odorata.* Earlier in the season these plants had covered virtually the entire pen. In addition, the existing American pondweed seed bank had filled in between and around the new sprouts of project plants to create a dense community. Incidentally, this pen in 2009 has shown excellent recovery and is again a diverse and well populated site (Figure 36).

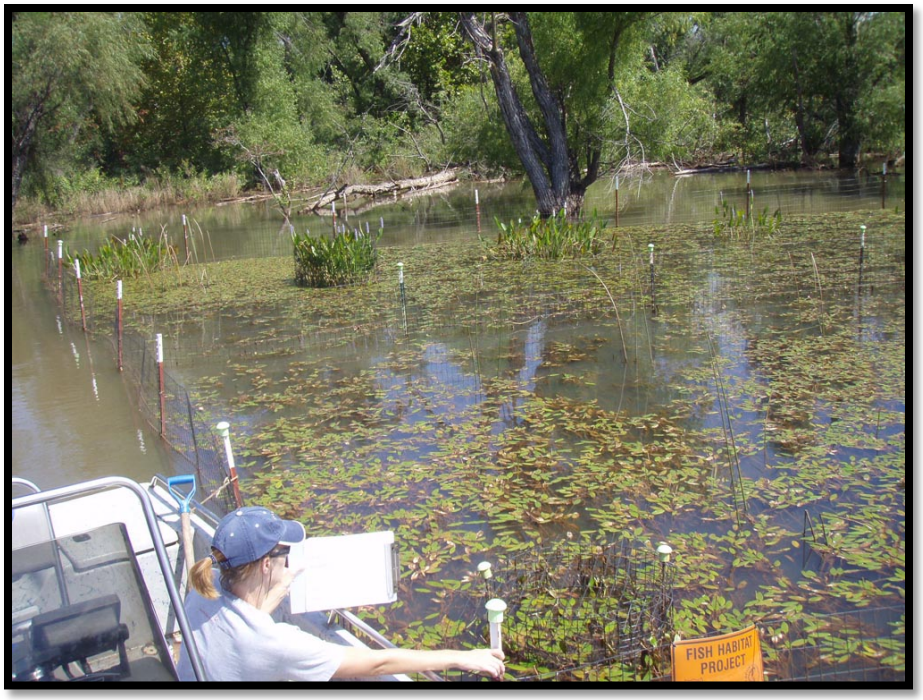


Figure 37: Pen in Cove 10

Pen 10
The 100% coverage rating is due by and large from pondweed and naiad that germinated independent of project plantings (Figure 37). However these were protected and allowed to grow due to project exclosures. *P. nodosus* and *S. tabernaemontani* were prominent species.

Figure 38: Pen in Cove 11

Pen 11
Historically this pen was a very full and diverse pen but was knocked back by the high waters at project end (Figure 38). Most of the remaining macrophytes were further protected within ring cages. *P. cordata, P. nodosus, S. tabernaemontani,* and *S. graminea* were prominent species as well as a volunteer colony of *Typha latifolia*.

Figure 39: Pen in Cove 16 – High water overtops the pen. Arrowhead, pickerel and softstem bulrush visible.

Pen 16
This was another sandy site that had minimal spread from plantings. This site was also exposed to more wave action than other pens and never showed significant expansion. Most survival at the final assessment was found in the upper bisect of the pen or in a ring cage (Figure 39).

Pen 17
This pen was 100% full of American pondweed but only in the upper bisect. The lower bisect of the pen was nearly absent of visible plants as seen at the first of this section in Figure 34.

Figure 40: Pen in Cove 23 - Three *N. odorata* plants (lilies) are visible with *P. cordata* in back.

Pen 23
This was another sandy site that had minimal spread from plantings. A majority of the survival and coverage was in the upper bisect of the pen or in a ring cage. Most of the % coverage came from *P. nodosus*. *N. odorata* and *P. cordata* did best here. While it is difficult to see in Figure 40 due to the very high water overtopping the fence, the macrophyte population is abunddant. The

site scored a 50% coverage and a CR of 3. A turtle trap can be seen floating in the foreground of the pen (Figure 40).

On Volunteer Plant Colonies

Table 13 shows the change in area (square feet) of each colony monitored in the years 2007, 2008 and 2009. OWRB determined that the data would be greatly improved with one additional sampling and was performed on September 18, 2009.

Table 13 : Volunteer Plant Colonies

Volunteer Plant Colonies	2007 (sq. ft.)	2008 (sq. ft.)	**2009 (sq. ft.)
Schoenoplectus tabernaemontani	1,424	1,611 (+13%)	1,978 (22.8%)
Eleocharis quadrangulata	34	95 (+279%)	125 (31.6%)
Eleocharis palustris	6,226	N/A	1,102
**Typha latifolia*	551	394 (-40%)	0 (All Dead)
**Phragmites australis*	14,930	N/A	2,811 (-81.2%)
**Phragmites australis*	1,242	527	566

*Sprayed with Imazapyr to control this plant
**OWRB remapped these sites on 9-18-09 to complete the table.

The 279% increase over one season in *E. quadrangulata* appears disproportionate and may well indicate some error in the GPS survey methods or the limits of a GPS unit to map small plots with sufficient accuracy. Given that the 2009 data more closely agrees with the 2008 data and that the change is more reasonable growth (31.6%) it appears that the original 2007 data of 34 sq.ft. is the data point in question.

Typha latifolia and Phragmites australis were sprayed in 2007 and 2008 with Imazapyr® and is likely to explain the negative spread of the colonies over time. The area of *live Typha* and *Phragmites* is 0 sq.ft. and -81% respectively which authenticates the effectiveness of Imazapyr.

The difficulty with measuring the true area of a colony is that there are few hard boundaries. Some points along the boundary the colony thinned and finding the outliers was difficult and the border subjective. Some areas of the colony had a very distinct boundary and were easy to delineate. Also, while the growth may have taken the boundary out further, the colony itself may be less dense and thus have less overall biomass. It could be said of all colonies that they varied in cover density from 10% to 100% within the stand making again a subjective call as to its overall density.

On Tree Plantings

Trees were initially planted in February through March of 2007 with 122 caged trees logged by GPS for project assessment. Table 14 and Table 15 give the species planted.

Table 16 gives the results. Beyond the mowing issues described earlier there was also a problem with some or even all cages being removed from the more remote sites. To compensate for that

in the data the percentages for growth and survival are calculated using the remaining cages for that year: 104 cages in 2007 and 89 cages in 2008.

Bare-root seedlings were planted

2007: Planted approximately 2000 trees on 30 sites
2008: Re-planted 9 sites with 516 trees to rectify mown trees in summer 2007
Species chosen were classified as "Wildlife" species
~10 trees/site were caged and flagged

Table 14: Species planted in 2007

Am. Plum *Prunus americana*
Hackberry- *Celtis occidentalis*
Sycamore - *Plantanus occidentalis*
Black Walnut - *Juglans nigra*
Red Mulberry - *Morus rubra*
Burr Oak - *Quercus macrocarpa*
Redbud - *Cercis canadensis*
Dogwood - *Cornus drummondii*
Sumac - *Rhus aromatica*

Table 15: Species planted in 2008

Am. Plum *Prunus americana*
Black Walnut - *Juglans nigra*
Burr Oak - *Quercus macrocarpa*
Dogwood - *Cornus drummondii*
Green Ash - *Fraxinus pennsylvanica*
Honey Locust - *Gleditsia triacanthos*
Pecan - *Carya illinoinensis*
Persimmon - *Diospyros virginiana* -
Red Mulberry - *Morus rubra*
Redbud - *Cercis canadensis*

Table 16: Assessment Results for 2007 and 2008

Tree Assessment	2007		2008	
	# Cages	%	# Cages	%
Total Initial Cages	122		122	
Total Cages Assessed	104		89	
Excellent	46	44.2%	29	32.6%
Good	29	27.9%	12	13.5%
Poor	29	27.9%	22	24.7%
Dead	0	0.0%	26	29.2%
Total Survival	104	100.0%	63	70.8%
No Cage	17	-	27	-
No Data Available	1	-	5	-

Most notable results would be the extraordinary 100% survival in year one, 2007; Forty four percent of those rating in the Excellent category. There was a substantial decline in 2008 with a survival of 70.8%. While no designed objective assessment was done on the uncaged trees, where vegetation was less dense, it was possible to distinguish surviving tree seedlings growing throughout the plots. These unmeasured observations gave the impression that most plots will survive more or less intact.

Conclusions

The primary focus of this project was to get "founder colonies" established that would, over time, deposit millions of seeds and fragments to disseminate across the lake and onto the shoreline.

When the conditions are right there will be a "bumper crop" and colonies will be established despite herbivore pressure.

The Key Measure of Success was to establish founder colonies that will initiate a shift from algae dominated productivity, to aquatic macrophyte dominated productivity. Survival and growth of placed founder colonies will quantify this success. The short-term nature of the project does not predict supporting measures outside of the implementation area. Significant shifts far from those areas planted or within the greater lake will not be evident for several years. Any success from this project can be evaluated within the framework of the Oklahoma Comprehensive Water Plan for communities such as OKC that want to see improvements in the shorelines of their lake(s). While this project has shown that at least on some lakes revegetation is feasible it will take long-term commitment from lake managers, owners and/or various government agencies within the state. If the OCWP were to list shoreline management as one of the water quality priorities for

the state and specifically revegetation as an option for Oklahomans to consider it may find funding and support for promising lake candidates through the mechanism of the OCWP.

Reconciliation with Data Quality Objectives

Decision Thresholds:

(from QAPP)

1. ***Outcome Threshold:*** *When plant biomass outside of the protective cages exceeds the biomass within the cages the OWRB is confident this project will result in the predicted outcome; successful vegetation of the littoral zone of Stanley Draper Lake.*

2. ***Output Threshold I****: a survival threshold of 50% or better within the protective cages indicates that the project has successfully established founder colonies at Draper Lake.*

3. ***Output Threshold II****: a survival threshold of 30% of the unprotected planted sprigs will indicate that the project has successfully established founder colonies at Draper Lake.*

Decision Rule

(from QAPP)

"Decisions to be made will be based on first through third year data from the project. Plant establishment may take several additional seasons before significant expansion begins. Environmental conditions for the seeds and the colonies must be on target for exponential growth to occur. The "founder colony" concept works on the idea that the plants are always in place spreading seeds, fragments and propagules waiting for the optimal conditions for explosive growth to occur. Mindful of this concept, if wide expansion has not yet occurred by project end it may be premature to judge the project as failed.

1. *Output and Outcome Failure: No thresholds are met. At the end of year three, total plant loss due to herbivory or other disturbance would indicate output failure and therefore outcome failure.*

2. *Output Successful but Outcome Indeterminate: Only Output Threshold I is met. At the end of year three, if plants are surviving well within their cages but have not been able to grow beyond their cages OWRB will recommend that further monitoring up to year seven after project launch and may request monies for 2 years of additional monitoring to circumvent a False Negative Error.*

3. *Output Successful and Outcome Secure: Output Threshold I is met or Output Threshold II is met. Barring severe drought or unforeseen calamity, OWRB predicts that the habitable littoral zone will be vegetated by year seven after project launch and may request monies for 2 years of additional monitoring.*

4. *Output and Outcome Successful: All thresholds are met. The OWRB expects to initiate the ecosystem shift but not complete this shift within the project period. This scenario is not likely to occur."*

On Thresholds

The lake-wide average *coverage* of protected plantings is 48% (Table 7) within the cages and 3% coverage outside the cages (Table 7) or "unprotected".

The lake-wide average *survival* of protected plantings is 72% within the cages (Table 2) and 7% outside the cages (Table 3) or "unprotected".

The lake-wide average *survival* of unprotected planted sprigs is 4.7% (Table 10)

The Out*come* Threshold "*When plant biomass outside of the protective cages exceeds the biomass within the cages"* **This Outcome Threshold has not been met** with a 48% average coverage. Hence OWRB cannot state with confidence that this project will succeed in its long-term goal of substantial littoral zone wetland colonization. While the 48% average coverage of protected plantings is below the Outcome Threshold the circumstances at the time of final assessment should be considered. Oklahoma City filling the lake to over 1188.5 for much of the summer is highly unusual due to the expense of doing so. This event greatly increased the mortality and decreased the growth by the survivors. This rather uncommon event drastically changed the final outcome of a project that otherwise had been growing and expanding very well. While the long-term results are beyond the scope of this project, recent visits to the lake have indicated that the damage done by the high waters was not ubiquitous. Indeed, many of the caged plantings have recovered well.

The Output Threshold I "*a survival threshold of 50% or better within the protective cages indicates that the project has successfully established founder colonies***"** **This Output Threshold has been met** with a 72% average. This success was definitive at 22% beyond the threshold, especially in the face of highly unusual flooding conditions for this lake. This substantive success rate gives OWRB confidence that with time and continued effort this lake can have a diverse aquatic macrophyte community.

The Output Threshold II *"a survival threshold of 30% of the unprotected planted sprigs will indicate that the project has successfully established founder colonies"* **This Output Threshold has not been met** with a 4.7% average. This rather bleak conclusion however, can be largely offset by the exceptional results of 2 species, *Justicia americana* and *Thalia dealbata*. While the percentage for *J. americana* was only 12.5%, the ease with which it can be propagated makes it possible for extensive plantings with a modicum of effort and cost. These plantings have begun in fact, in 2009, by OKC and OWRB.

It is our opinion that the founder colonies have in fact been established and the #2 Decision Rule would be the best fit for this project, e.g. ***"Output successful but Outcome Indeterminate."*** Since there have been multiple successes and lessons learned from this project combined with the commitment from OKC to continue with maintenance, the future success is greatly amplified. Lake Stanley Draper has an advantage over many lakes because of its water level regime. Since it is filled and drained by pumps instead of rivers or large releases at the dam it slowly fluctuates and in general supplies the plants with a slow dropping pool over the summer months which encourages colony spread. Flood events are rare because of the shear cost of pumping up an entire lake. Given that there is funding from Oklahoma City to continue maintenance on this project a positive outcome is even more likely.

Recommendations:

Project Relevance to The Comprehensive Water Plan

The evidence from this study and with the additional substantiation from post-project results (summer 2009) make viable this methodology to the OCWP. We find that those Oklahoma lakes devoid of extreme and frequent changes in water elevation and in particular, those that currently have some limited community of shoreline plants warrant mention in the OCWP as water quality projects for consideration.

On Caged Sites

Caged sites should be consolidated into fewer more populated sites to increase propagule and seed densities. Large groups of successful vigorous cages should be captured if possible with a surrounding pen to exponentially increase propagule production. Pen sites are perhaps the best solution for long term establishment of aquatic macrophytes in the lake. They provide more propagules, an immediate diversified wetland community (high CR) and excellent micro-habitat.

Plantings should concentrate between 1185' msl to 1186.5' msl, where plants have been most successful. *Vallisneria americana* should not go dry and hence should be planted in deep water 1179' msl to 1183.5' msl with tops on the cages since they will often be fully submersed. Cages may be removed when lake-wide exposed biomass has clearly outgrown biomass within the exclosures and survived a full season. By 2015 cages should be removed from the lake regardless of the state of the plantings. This will ultimately be the decision of Oklahoma City.

The following species were the most successful by far and should be the primary planted species:

Bulltongue (*Sagittaria lancifolia* and *S. graminea*)
Pickerelweed (*Pontederia cordata*)
Squarestem spikerush (*Eleocharis quadrangulata*)
Softstem bulrush (*Schoenoplectus tabernaemontani*)
Vallisneria (*Vallisneria americana*)
Water stargrass (*Heteranthera dubia*)
Water-willow (*Justicia americana*)

Oklahoma City maintenance funding beyond this project scope has made it possible to initiate site consolidation and planting in June of 2009.

With concentrated efforts using what has been learned from this feasibility phase and continued support from Oklahoma City, the chances greatly increase for ultimate success. As stated in the QAPP, if Output Threshold I was met: OWRB recommends further monitoring for the next 2 years to circumvent a False/Negative Error.

On Uncaged Sites

All six of the remaining plots were on somewhat sandy barren sites. It is possible that these are poor habitat for herbivores yet still acceptable sites for *Justicia americana* and *Thalia dealbata*. Both species appear to be resistant to herbivory. Future work should consider planting these species as unprotected sites in large number throughout the lake.

Incidentally, in 2009 *Justicia americana* spread several times in area and density. Tops were harvested in June of this year and sprigged in multiple new plots at several of the project sites with very positive results by season's end.

Literature Cited

1. Beneficial Use Monitoring Report; Oklahoma Water Resources Board; 2007

Appendix A – Baseline Plant Survey

Findings include those listed from Oklahoma Biological Survey and OWRB

Family	Genus Name	Species Name	Common Name
Asteraceae	Achillea	millefolium	yarrow/milfoil
Poaceae	Aegilops	cylindrica	Jointed goat grass
Fabaceae	Albizia	julibrissin	silk tree/mimosa
Liliaceae	Allium	canadense	meadow garlic/wild onion
Amaranthaceae	Amaranthus	retroflexus	pigweed
Asteraceae	Ambrosia	psilostachya	western ragweed
Apiaceae	Ammoselinum	popei	plains sand parsley
Apocynaceae	Apocynum	cannabinum	prairie dogbane
Asclepiadaceae	Asclepias	amplexicaulis	bluntleaf milkweed
Asclepiadaceae	Asclepias	viridiflora	antelope horn milkweed
Asclepiadaceae	Asclepias	viridis	green/spider milkweed
Fabaceae	Baptisia	australis	blue false indigo
Poaceae	Bothriochloa	ischaemum	yellow bluestem
Poaceae	Bouteloua	curtipendula	sideoats grama
Poaceae	Bouteloua	dactyloides	buffalograss
Poaceae	Bromus	arvensis	field brome
Poaceae	Bromus	pubescens	canada brome
Poaceae	Bromus	secalinus	cheatgrass
Poaceae	Bromus	tectorum	downy brome
Moraceae	Broussonetia	papyrifera	paper mulberry
Scrophulariaceae	Buchnera	americana	American blueheart
Malvaceae	Callirhoe	involucrata	purple poppy mallow
Onagraceae	Calylophus	berlandieri	Berlander's sundrops
Onagraceae	Calylophus	serrulatus	yellow sundrops
Bignoniaceae	Campsis	radicans	trumpet vine
Cyperaceae	Carex	blanda	eastern woodland sedge
Cyperaceae	Carex	brevior	short beak sedge
Cyperaceae	Carex	bushii	Bush's sedge
Cyperaceae	Carex	gravida	heavy sedge
Cyperaceae	Carex	vulpinoidea	fox or yellow fruit sedge
Celastraceae	Celastrus	scandens	climbing bittersweet
Ulmaceae	Celtis	laevigata	sugarberry
Fabaceae	Chamaecrista	fasciculata	partridge pea
Euphorbiaceae	Chamaesyce	maculata	spotted sandmat
Euphorbiaceae	Chamaesyce	prostrata	prostrate sandmat
Poaceae	Chasmanthium	latifolium	inland sea oats
Chenopodiaceae	Chenopodium	pratericola	desert goosefoot
Asteraceae	Chrysopsis	pilosa	soft golden aster
Asteraceae	Cirsium	undulatum	thistle
Menispermaceae	Cocculus	carolinus	snailseed/moonseed
Convolvulaceae	Convolvulus	arvensis	bindweed
Asteraceae	Coreopsis	grandiflora	bigflower/tickseed coreopsis

Family	Genus Name	Species Name	Common Name
Asteraceae	Coreopsis	tinctoria	plains coreopsis
Cornaceae	Cornus	drummondii	rough-leaved dogwood
Euphorbiaceae	Croton	glandulosus	croton
Euphorbiaceae	Croton	monanthogynus	prairie tea
Rubiaceae	Cruciata	pedemontana	bedstraw
Cuscutaceae	Cuscuta	gronovii	love vine
Cyperaceae	Cyperus	acuminatus	taperleaf flatsedge
Cyperaceae	Cyperus	echinatus	globe flatsedge
Fabaceae	Dalea	candida	white prairie clover
Fabaceae	Dalea	enneandra	nineanther praire clover
Fabaceae	Dalea	purpurea	purple prairie clover
Ranunculaceae	Delphinium	carolinianum	Carolina larkspur
Fabaceae	Desmanthus	illinoensis	Illinois bundleflower
Fabaceae	Desmodium	sessilifolium	sessileleaf ticktreefoil
Caryophyllaceae	Dianthus	armeria	Deptford pink
Poaceae	Dichanthelium	dichotomum	cyperus panicgrass
Poaceae	Dichanthelium	oligosanthes	small panicgrass
Poaceae	Digitaria	ciliaris	southern crabgrass
Rubiaceae	Diodia	teres	poorjoe
Asteraceae	Echinacea	angustifolia	black Samson
Poaceae	Echinochloa	crus-galli	barnyard grass
Cyperaceae	Eleocharis	montevidensis	sand spikerush
Cyperaceae	Eleocharis	quadrangulata	squarestem spikerush
Poaceae	Elymus	virginicus	Virginia wildrye
Equisetaceae	Equisetum	laevigatum	smooth horsetail
Poaceae	Eragrostis	barrelieri	Mediterranean lovegrass
Poaceae	Eragrostis	curvula	weeping lovegrass
Poaceae	Eragrostis	intermedia	plains lovegrass
Poaceae	Eragrostis	secundiflora	red lovegrass
Asteraceae	Erigeron	strigosus	priairie fleabane
Asteraceae	Eupatorium	serotinum	late boneset
Euphorbiaceae	Euphorbia	corollata	flowering spurge
Euphorbiaceae	Euphorbia	dentata	toothed spurge
Asteraceae	Evax	verna	spring pygmycudweed
Cyperaceae	Fimbristylis	puberula	hairy fimbry
Asteraceae	Gaillardia	aestivalis	prairie gaillardia
Asteraceae	Gaillardia	suavis	rayless gaillardia
Rubiaceae	Galium	circaezans	licorice bedstraw
Asteraceae	Gamochaeta	purpurea	spoonleaf purple everlasting
Onagraceae	Gaura	mollis	velvetweed
Onagraceae	Gaura	sinuata	wavyleaf beeblossom
Rosaceae	Geum	canadense	white avens

Family	Genus Name	Species Name	Common Name
Lamiaceae	Hedeoma	hispida	rough false pennyroyal
Asteraceae	Helianthus	annuus	common sunflower
Asteraceae	Helianthus	mollis	ashy sunflower
Asteraceae	Helianthus	pauciflorus	stiff sunflower
Boraginaceae	Heliotropium	tenellum	pasture heliotrop
Asteraceae	Hieracium	longipilum	hairy hawkweed
Poaceae	Hordeum	pusillum	little barley
Asteraceae	Hymenopappus	tenuifolius	slimleaf wooly-white
Clusiaceae	Hypericum	hypericoides	St. Andrews cross
Clusiaceae	Hypericum	punctatum	spotted St. Johnswort
Convolvulaceae	Ipomoea	shumardiana	narrowleaf morning-glory
Juglandaceae	Juglans	nigra	black walnut
Juncaceae	Juncus	effusus	common rush
Juncaceae	Juncus	marginatus	grassleaf rush
Juncaceae	Juncus	torreyi	Torrey's rush
Juncaceae	Juncus	validus	roundhead rush
Krameriaceae	Krameria	lanceolata	trailing krameria
Asteraceae	Lactuca	floridana	woodland lettuce
Asteraceae	Lactuca	ludoviciana	biannial lettuce
Fabaceae	Lathyrus	latifolius	perennial pea
Cistaceae	Lechea	tenuifolia	narrowleaf pinweed
Brassicaceae	Lepidium	densiflorum	peppergrass
Scrophulariaceae	Leucospora	multifida	narrowleaf paleseed
Asteraceae	Liatris	squarrosa	gayfeather/blazing star
Linaceae	Linum	rigidum	stiffstem flax
Linaceae	Linum	sulcatum	grooved flax
Poaceae	Lolium	perenne	perennial ryegrass
Onagraceae	Ludwigia	peploides	floating primrose-willow
Lythraceae	Lythrum	alatum	winged lythrum
Fabaceae	Medicago	minima	little bur-clover
Fabaceae	Medicago	sativa	alfalfa
Fabaceae	Melilotus	officinalis	yellow sweetclover
Fabaceae	Mimosa	nuttallii	Nuttal's sensitive briar
Moraceae	Morus	rubra	red mulberry
Najadaceae	Najas	guadalupensis	southern naiad
Fabaceae	Neptunia	lutea	yellow neptunia/puff
Scrophulariaceae	Nuttallanthus	texanus	Texas toadflax
Onagraceae	Oenothera	laciniata	cutleaf evening primrose
Onagraceae	Oenothera	macrocarpa	Oklahoma evening primrose
Onagraceae	Oenothera	speciosa	pinkladies
Oxalidaceae	Oxalis	corniculata	creeping woodsorrel
Poaceae	Panicum	capillare	witchgrass

Family	Genus Name	Species Name	Common Name
Passifloraceae	Passiflora	incarnata	passion fruit/flower
Scrophulariaceae	Penstemon	cobaea	beardtongue
Scrophulariaceae	Penstemon	laxiflorus	loose flower penstemon
Poacaceae	Phragmites	australis	common reed
Verbenaceae	Phryma	leptostachya	American lopseed
Plantaginaceae	Plantago	lanceolata	buckhorn/English plantain
Plantaginaceae	Plantago	rhodosperma	redseed plantain
Polygalaceae	Polygala	incarnata	pink milkwort
Liliaceae	Polygonatum	biflorum	smooth soloman seal
Polygonaceae	Polygonum	lapathifolium	pale smartweed
Polygonaceae	Polygonum	ramosissimum	bushy knotweed
Potamogetonaceae	Potamogeton	diversifolius	waterthread pondweed
Potamogetonaceae	Potamogeton	nodosus	American pondweed
Potamogetonaceae	Potamogeton	pusillus	small pondweed
Rosaceae	Potentilla	recta	sulphur cinquefoil
Rosaceae	Prunus	angustifolia	chickasaw/sandhill plum
Rosaceae	Prunus	gracilis	Oklahoma/sandhill plum
Fabaceae	Psoralidium	tenuiflorum	slimflower scurfpea
Asteraceae	Pyrrhopappus	grandiflorus	false dandilion
Rosaceae	Pyrus	communis	common pear
Fagaceae	Quercus	macrocarpa	bur oak
Fagaceae	Quercus	muehlenbergii	chinquapin oak
Asteraceae	Ratibida	columnifera	yellow coneflower
Anacardiaceae	Rhus	aromatica	skunkbush
Anacardiaceae	Rhus	copallinum	winged sumac
Anacardiaceae	Rhus	glabra	smooth sumac
Fabaceae	Rhynchosia	latifolia	prairie snoutbean
Rosaceae	Rosa	foliolosa	prairie rose
Rosaceae	Rosa	multiflora	multiflora rose
Rosaceae	Rubus	aboriginum	garden dewberry
Rosaceae	Rubus	bifrons	Himalayan berry
Asteraceae	Rudbeckia	hirta	blackeyed Susan
Acanthaceae	Ruellia	humilis	low/fringed leaf Ruellia
Polygonaceae	Rumex	crispus	curly dock
Polygonaceae	Rumex	hastatulus	heartwing sorrel
Gentianaceae	Sabatia	campestris	Texas star
Poaceae	Saccharum	giganteum	sugar cane plumegrass
Alismataceae	Sagittaria	graminea	bulltongue
Alismataceae	Sagittaria	latifolia	duck potato
Apiaceae	Sanicula	canadensis	snakeroot
Poaceae	Schedonorus	phoenix	tall fescue
Cyperaceae	Schoenoplectus	americanus	American bulrush

Family	Genus Name	Species Name	Common Name
Cyperaceae	Schoenoplectus	tabernaemontani	softstem bulrush
Cyperaceae	Scirpus	pendulus	rufous bulrush
Poaceae	Setaria	pumila	yellow foxtail
Sapotaceae	Sideroxylon	lanuginosum	gum bully
Iridaceae	Sisyrinchium	angustifolium	blue-eyed grass
Smilacaceae	Smilax	rotundifolia	greenbriar
Solanaceae	Solanum	dimidiatum	western horsenettle
Solanaceae	Solanum	rostratum	buffalobur nightshade
Asteraceae	Sonchus	asper	spiny sowthistle
Poaceae	Sorghum	halepense	Johnsongrass
Apiaceae	Spermolepis	echinata	bristly scaleseed
Poaceae	Sphenopholis	obtusata	prairie wedgescale
Rubiaceae	Stenaria	nigricans	diamond-flowers
Onagraceae	Stenosiphon	linifolius	false gaura
Fabaceae	Stylosanthes	biflora	pencilflower
Asteraceae	Tetraneuris	scaposa	four-nerve daisy
Lamiaceae	Teucrium	canadense	American germander
Asteraceae	Thelesperma	filifolium	greenthread
Commelinaceae	Tradescantia	ohiensis	spiderwort
Asteraceae	Tragopogon	dubius	goatsbeard
Poaceae	Tridens	flavus	purpletop
Campanulaceae	Triodanis	biflora	small Venus' looking-glass
Campanulaceae	Triodanis	perfoliata	clasping Venus' looking-glass
Typhaceae	Typha	domingensis	southern cattail
Typhaceae	Typha	latifolia	broadleaf cattail
Valerianaceae	Valerianella	radiata	beaked cornsalad
Verbenaceae	Verbena	stricta	hoary verbena
Asteraceae	Vernonia	baldwinii	western ironweed
Scrophulariaceae	Veronica	arvensis	common/corn speedwell
Caprifoliaceae	Viburnum	rufidulum	rusty blackhaw
Fabaceae	Vicia	sativa	common/spring/narrowleaf vetch
Vitaceae	Vitis	vulpina	winter/fox grape
Poaceae	Vulpia	octoflora	sixweeks fescue
Agavaceae	Yucca	glauca	Yucca
Rutaceae	Zanthoxylum	americanum	American prickley ash

Appendix B – Planting Data

See Excel Spreadsheet File on Enclosed CD

Appendix C – Site Maps

- Plant species key for subsequent maps are as follows:

Species Key	
Acorus calamus	SwFlg
Bacopa monnieri	Bacp
Carex stricta	Tuss
Echinodorus berteroi	TallB
Eleocharis macrostachya	FlatS
Eleocharis quadrangulata	SqS
Heterantherea dubia	WtrS
Juncus coriaceus	LeathL
Justicia americana	WW
Nuphar luteum	SpatterD
Nymphaea odorata	WWL
Pontederia cordata	Pick
Potamogeton nodosus	Pnod
Rhynchospora macrostachya	Hrnbk
Sagittaria graminea	BullT
Sagittaria latifolia	Arrow
Saururus cernuus	Liz
Schoenoplectus americanus	3 Sq
Schoenoplectus tabernaemontani	SftS
Scirpus cyperinus	Wool
Scirpus robustus	RiverBul
Vallisneria americana	Val

- Assessment values for cage/plot coverage are denoted ass follows:

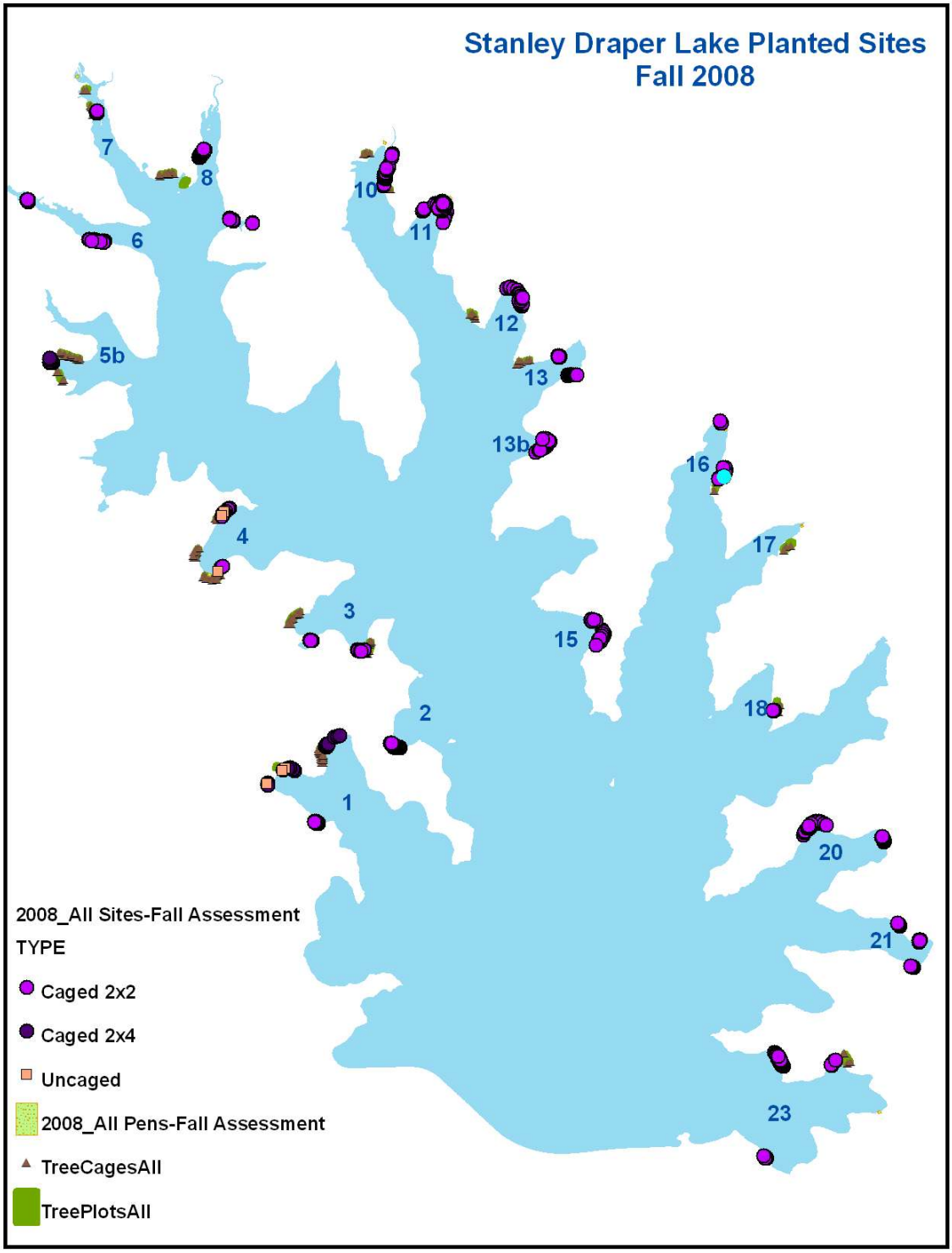
"**SwFlg 50%, 10%**" = (Species name % in cage or plot , % outside cage or plot)

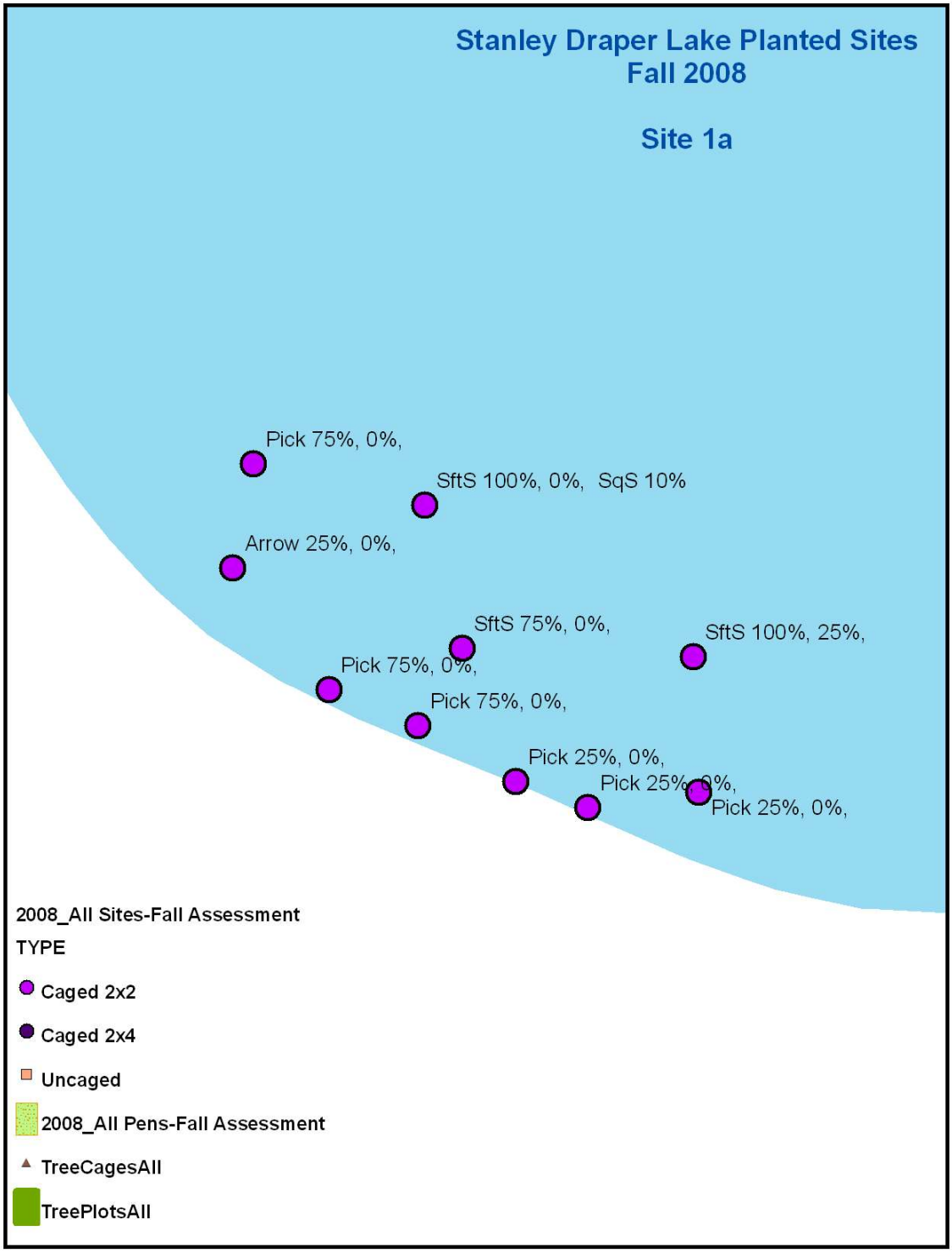
- Assessment values for Pens are denoted:

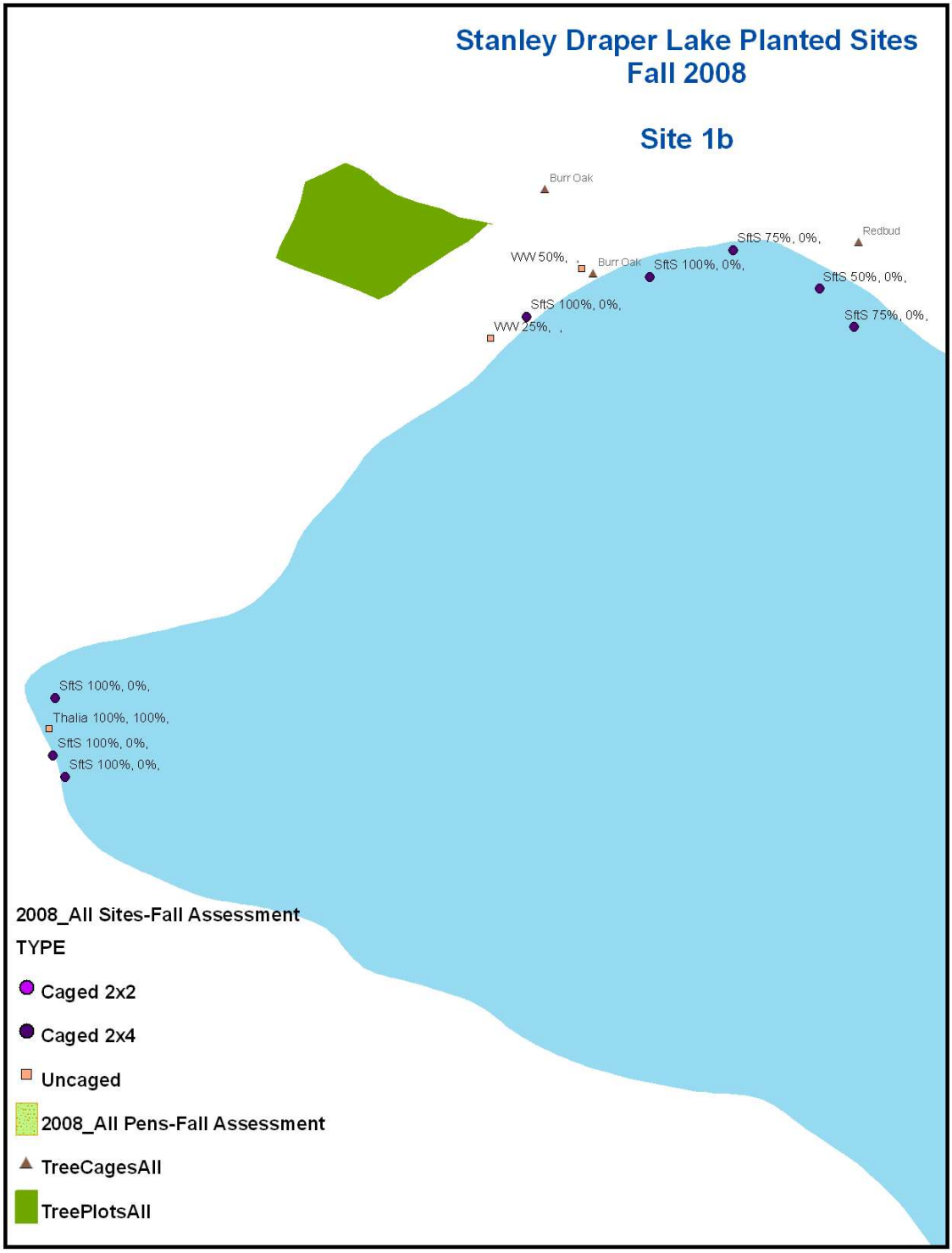
"**25% / CR 4**" = (Overall pen coverage % / Community Rating 1 – 4)

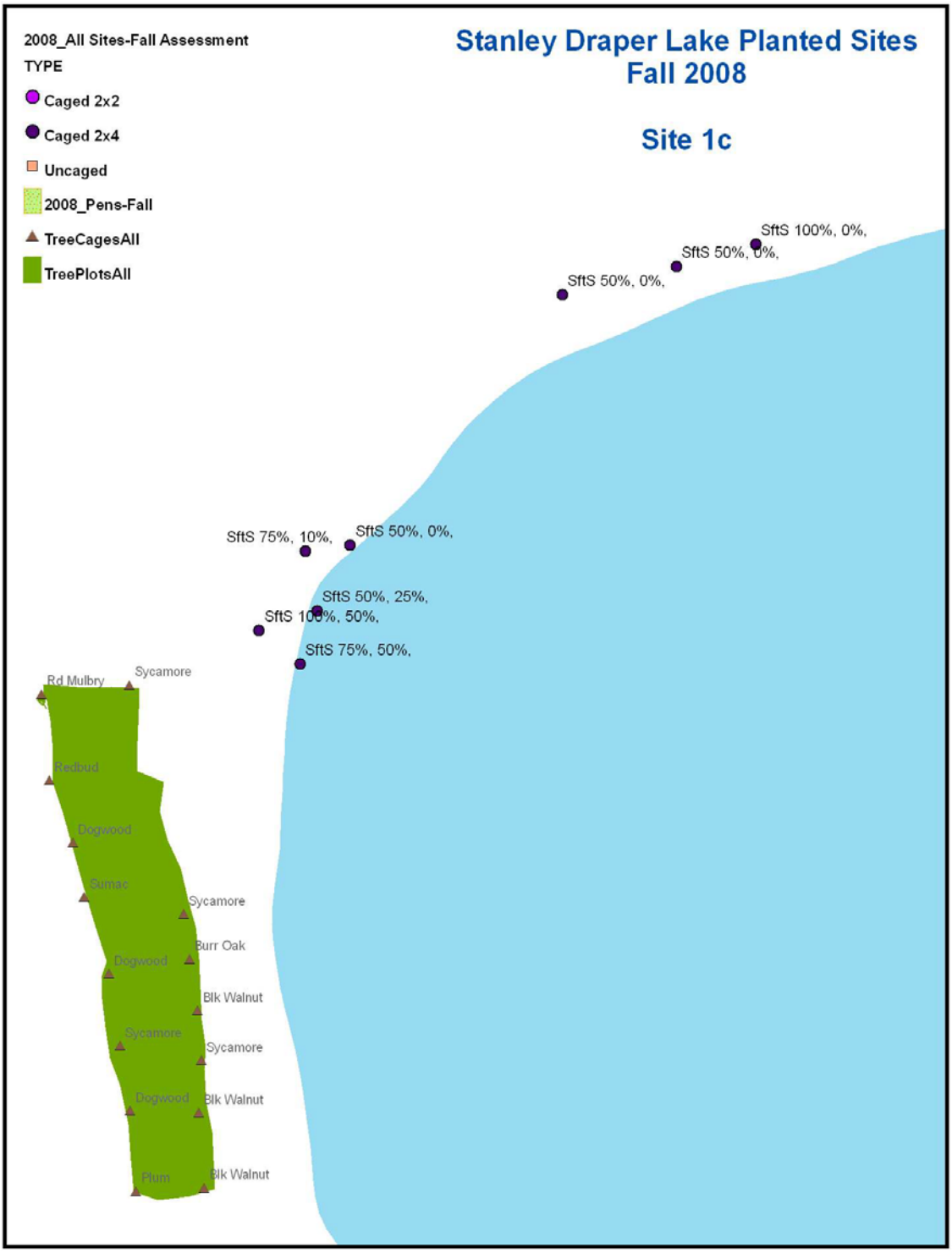
- For Tree plots:

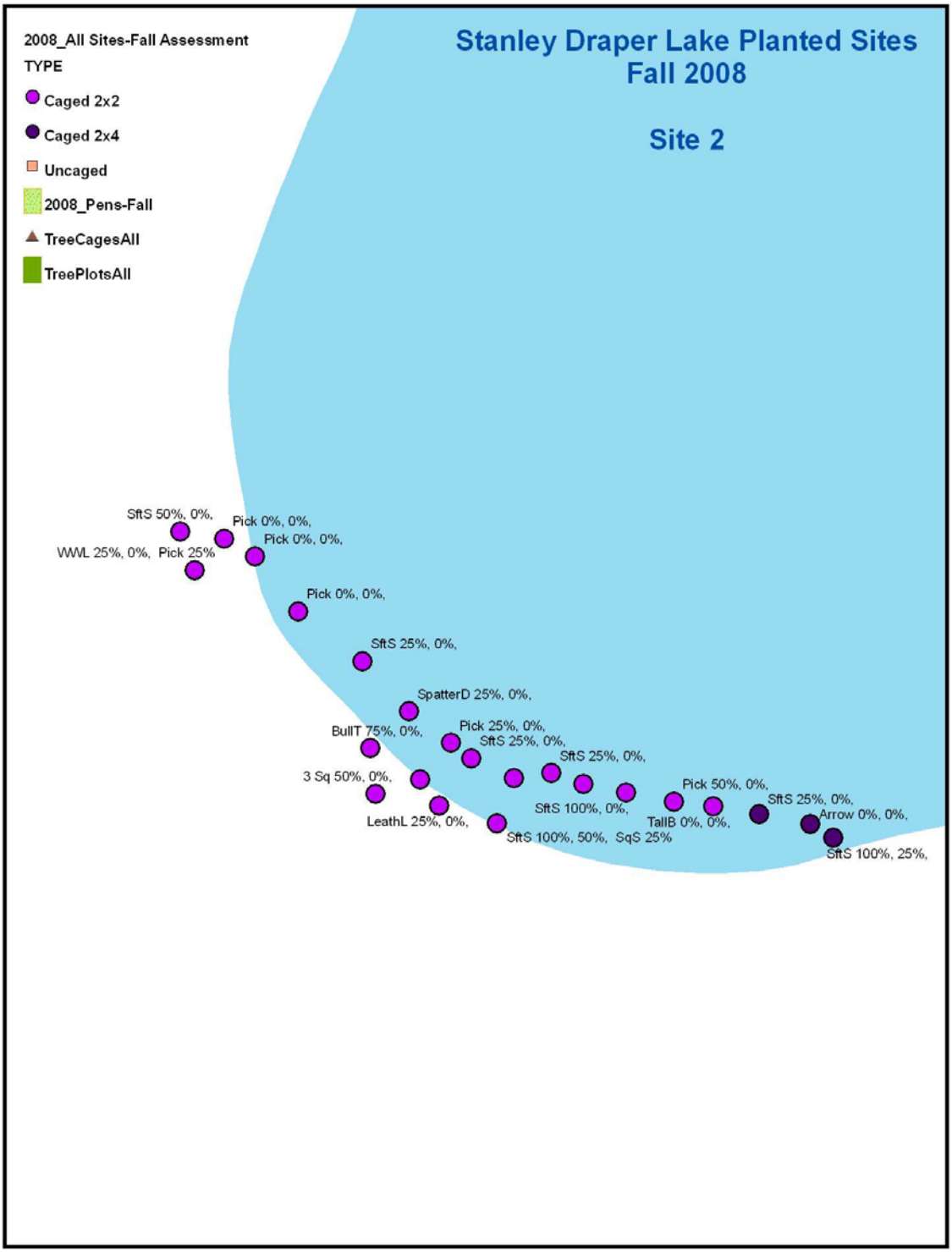
Tree Abreviation Key	
Blk Walnut	*Juglans nigra*
Burr Oak	*Quercus macrocarpa*
Dogwood	*Cornus*
Hackbry	*Celtis occidentalis*
Pecan	*Carya illinoinensis*
Plum	*Prunus americana*
Rd Mulbry	*Morus rubra*
Redbud	*Cercis canadensis*
Sumac	*Rhus aromatica*
Sycamore	*Plantanus occidentalis*

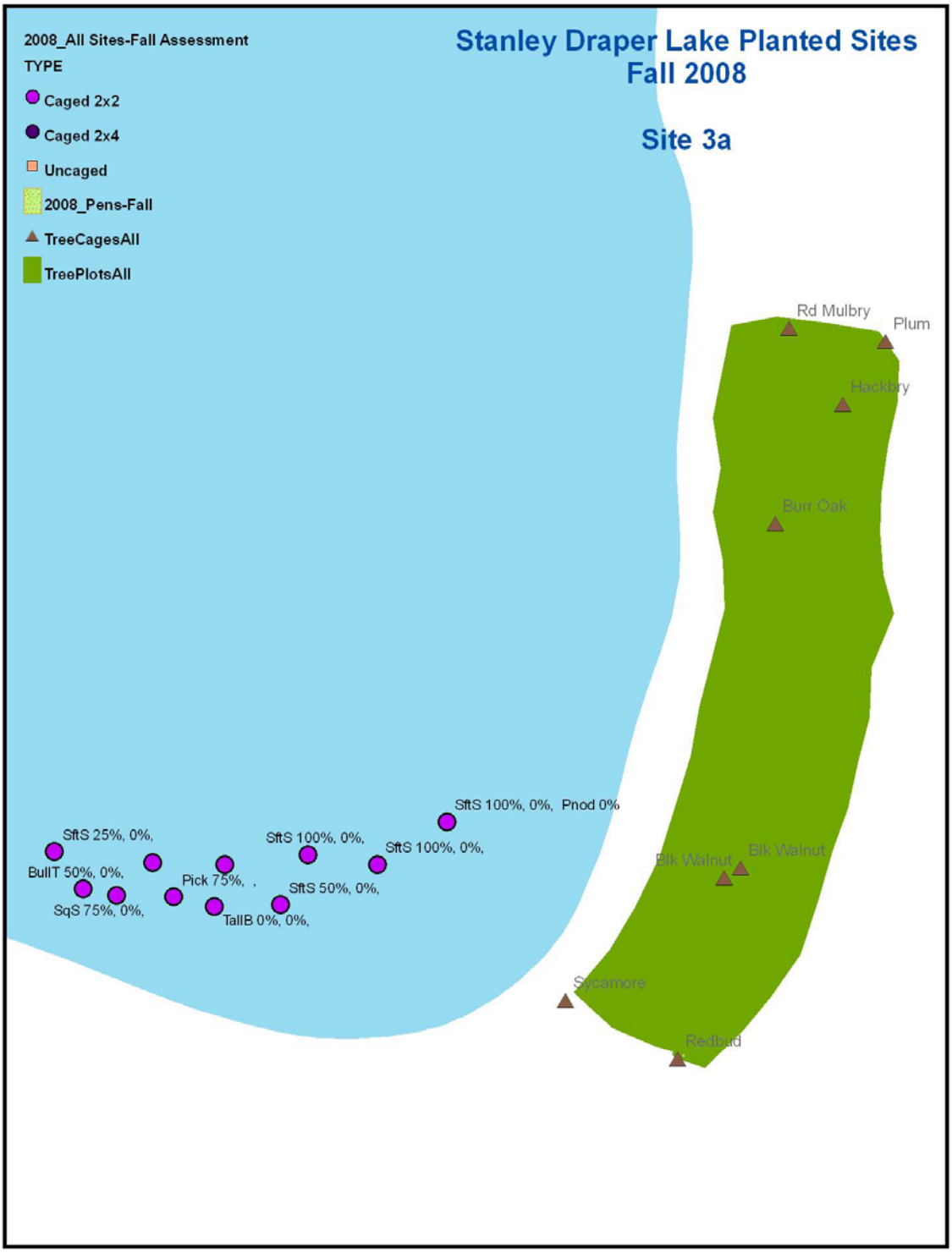

Stanley Draper Lake Planted Sites
Fall 2008
7
8
10
11
6
12
5b
13
13b
16
4
17
3
15
2
18
1
20
21
23
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_All Pens-Fall Assessment
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 1a
Pick 75%, 0%,
SftS 100%, 0%, SqS 10%
Arrow 25%, 0%,
SftS 75%, 0%,
SftS 100%, 25%,
Pick 75%, 0%,
Pick 75%, 0%,
Pick 25%, 0%,
Pick 25%, 0%,
Pick 25%, 0%,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_All Pens-Fall Assessment
TreeCagesAll
TreePlotsAll

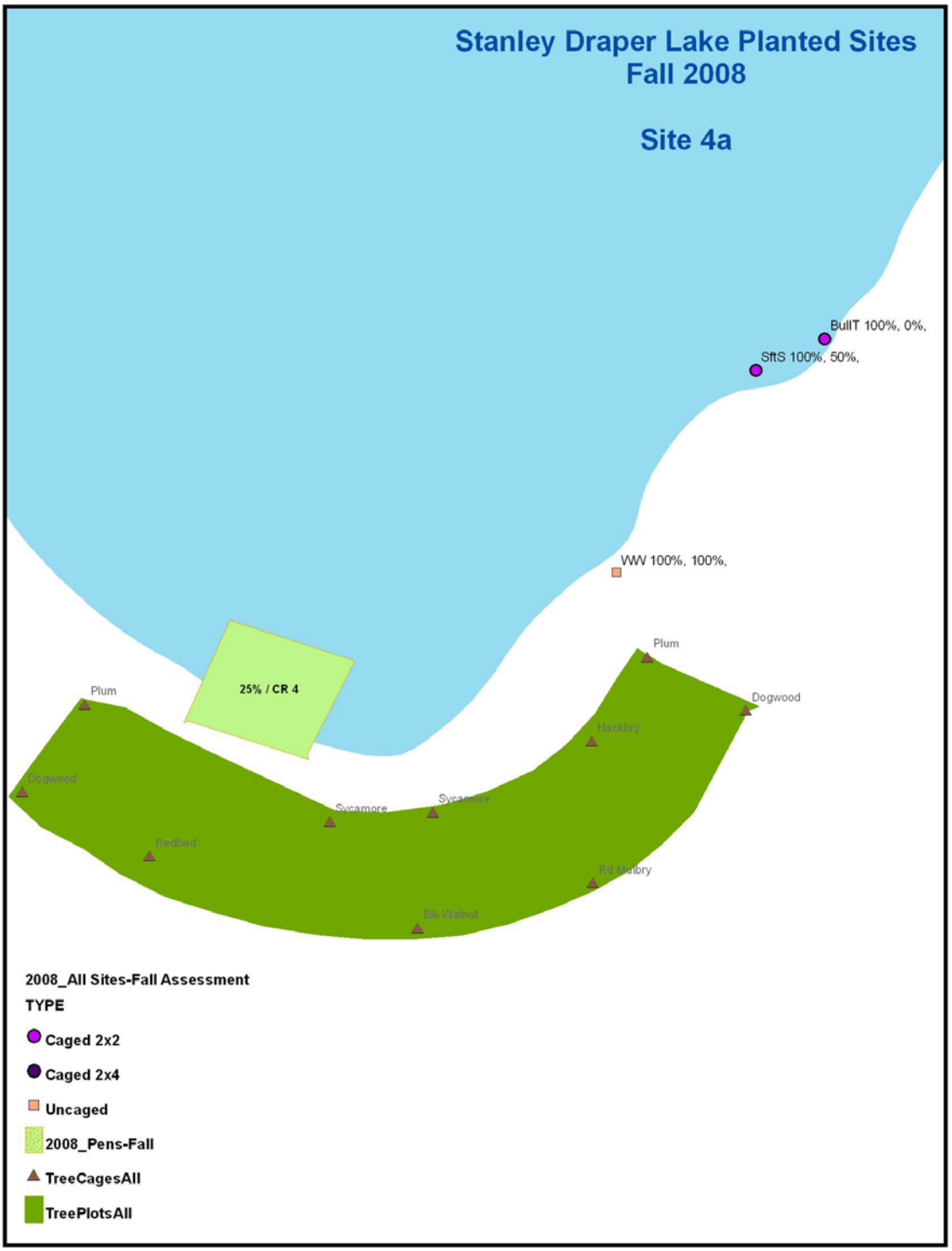

Stanley Draper Lake Planted Sites
Fall 2008
Site 1b
Burr Oak
Redbud
SftS 75%, 0%,
WW 50%,
Burr Oak
SftS 100%, 0%,
SftS 50%, 0%,
SftS 100%, 0%,
SftS 75%, 0%,
WW 25%,
SftS 100%, 0%,
Thalia 100%, 100%,
SftS 100%, 0%,
SftS 100%, 0%,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_All Pens-Fall Assessment
TreeCagesAll
TreePlotsAll

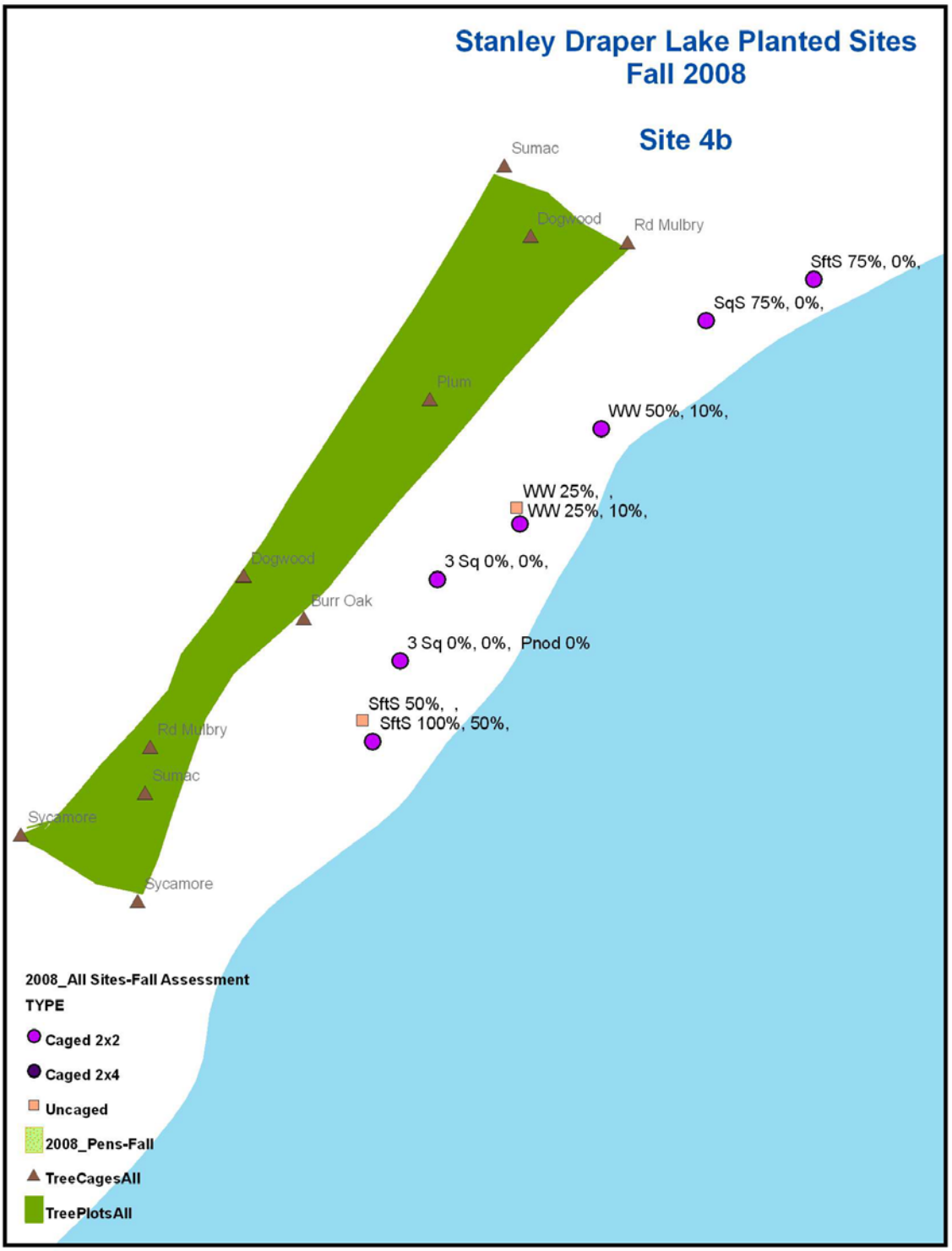

2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll
Stanley Draper Lake Planted Sites
Fall 2008
Site 1c
SftS 100%, 0%,
SftS 50%, 0%,
SftS 50%, 0%,
SftS 75%, 10%,
SftS 50%, 0%,
SftS 50%, 25%,
SftS 100%, 50%,
SftS 75%, 50%,
Rd Mulbry
Sycamore
Redbud
Dogwood
Sumac
Sycamore
Burr Oak
Dogwood
Blk Walnut
Sycamore
Sycamore
Dogwood
Blk Walnut
Plum
Blk Walnut

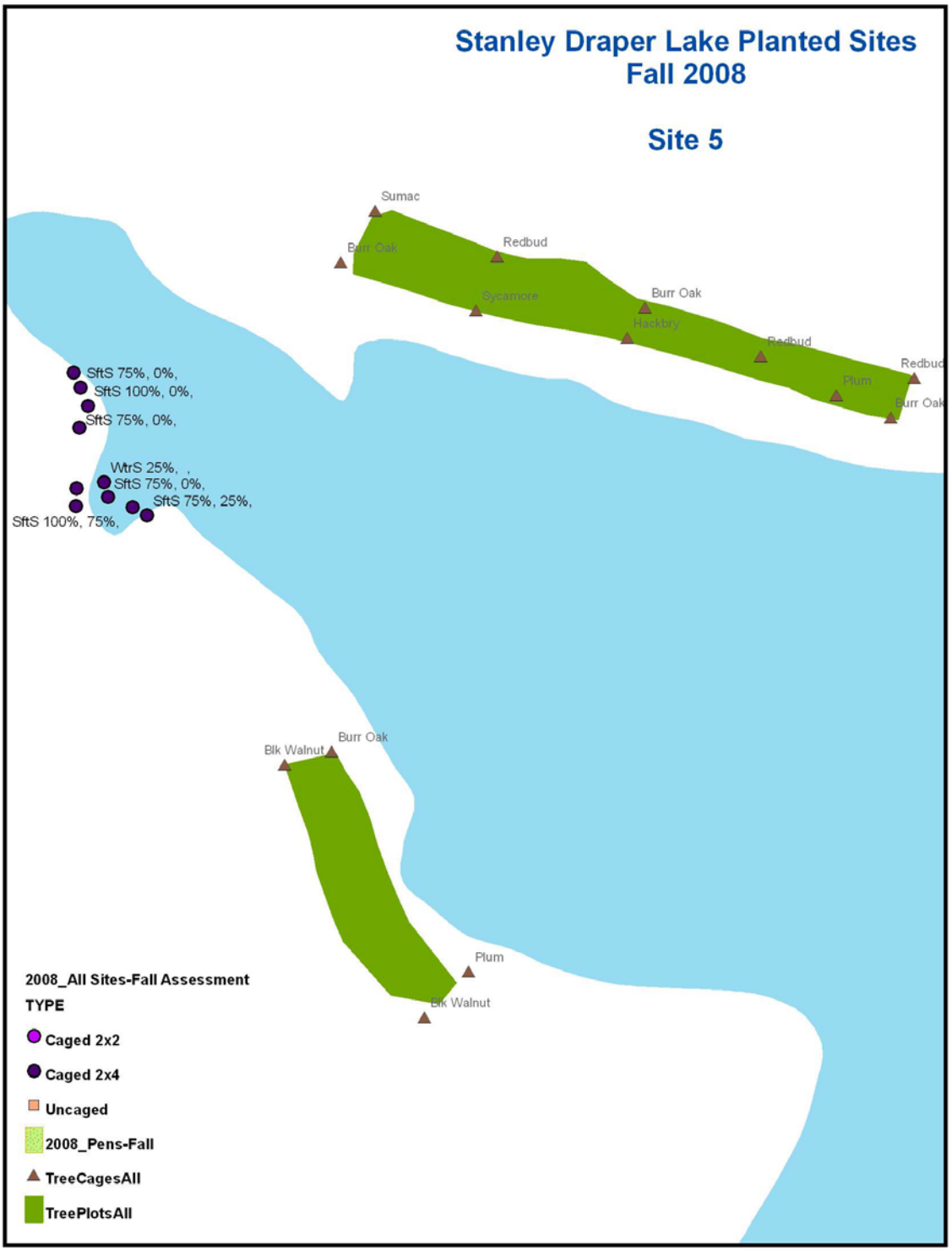

2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll
Stanley Draper Lake Planted Sites
Fall 2008
Site 2
SftS 50%, 0%,
Pick 0%, 0%,
Pick 0%, 0%,
WWL 25%, 0%, Pick 25%
Pick 0%, 0%,
SftS 25%, 0%,
SpatterD 25%, 0%,
BullT 75%, 0%,
Pick 25%, 0%,
SftS 25%, 0%,
SftS 25%, 0%,
3 Sq 50%, 0%,
Pick 50%, 0%,
SftS 25%, 0%,
SftS 100%, 0%,
Arrow 0%, 0%,
LeathL 25%, 0%,
TallB 0%, 0%,
SftS 100%, 50%, SqS 25%
SftS 100%, 25%,

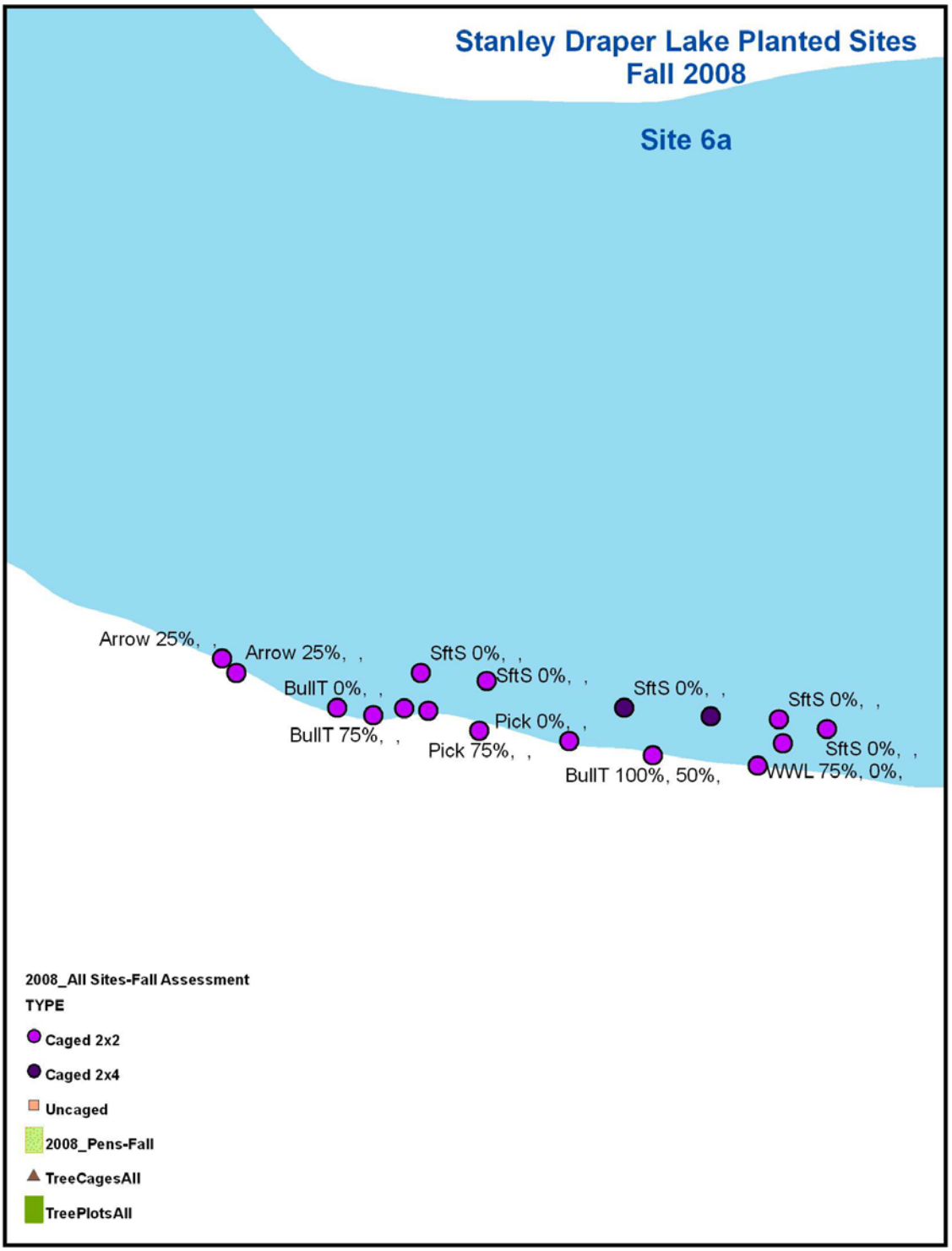

2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll
Stanley Draper Lake Planted Sites
Fall 2008
Site 3a
Rd Mulbry
Plum
Hackbry
Burr Oak
SftS 100%, 0%, Pnod 0%
SftS 25%, 0%,
SftS 100%, 0%,
SftS 100%, 0%,
BullT 50%, 0%,
Pick 75%, ,
SftS 50%, 0%,
SqS 75%, 0%,
TallB 0%, 0%,
Blk Walnut
Blk Walnut
Sycamore
Redbud

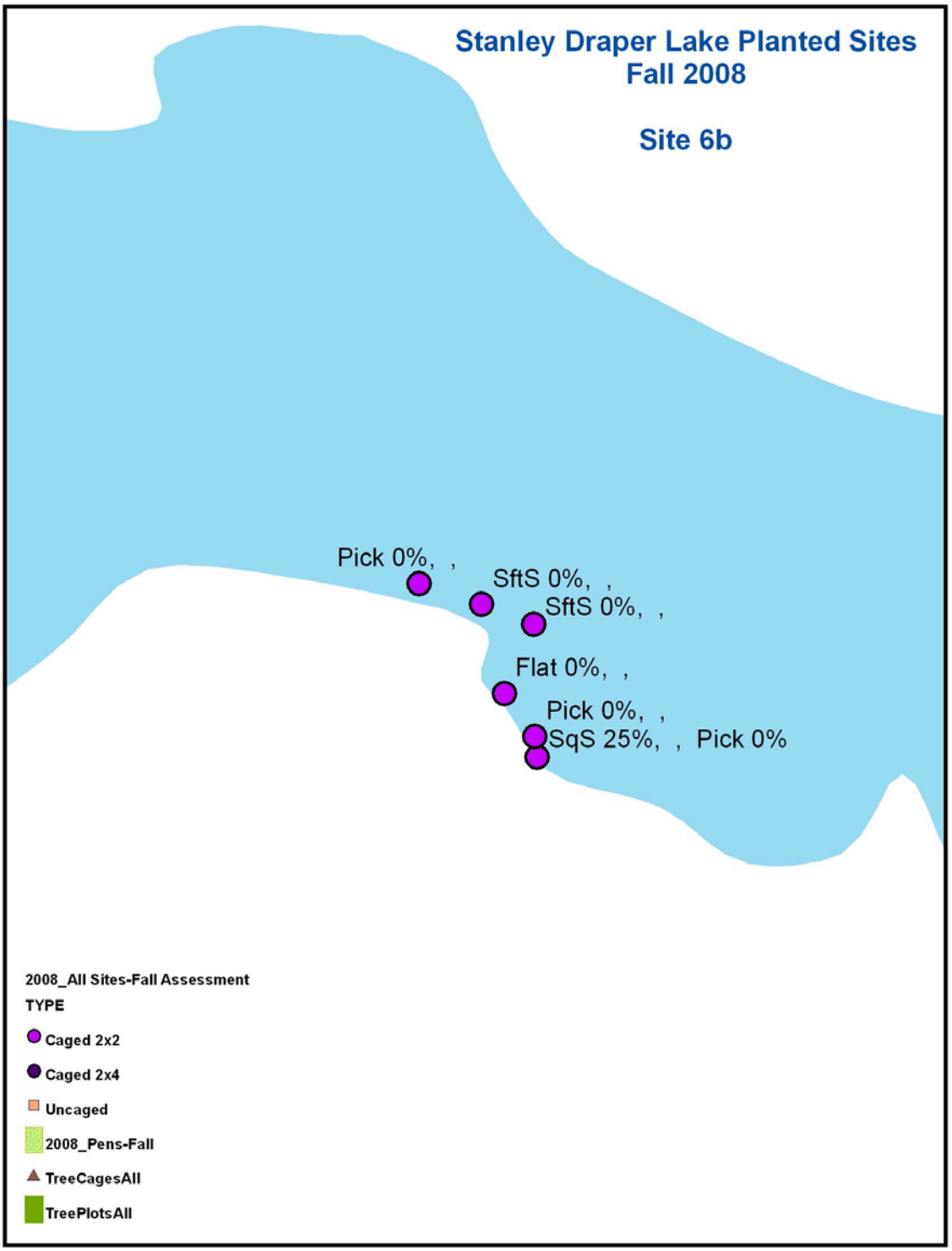

Stanley Draper Lake Planted Sites
Fall 2008
Site 3b
Blk Walnut
Dogwood
Redbud
Blk Walnut
Sycamore
Plum
Redbud
Redbud
Hackbry
Burr Oak
Pick 100%, 0%,
Pick 75%, 0%,
Pick 100%, 0%,
SftS 100%, 0%,
SftS 75%, 0%,
SftS 75%, 25%,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

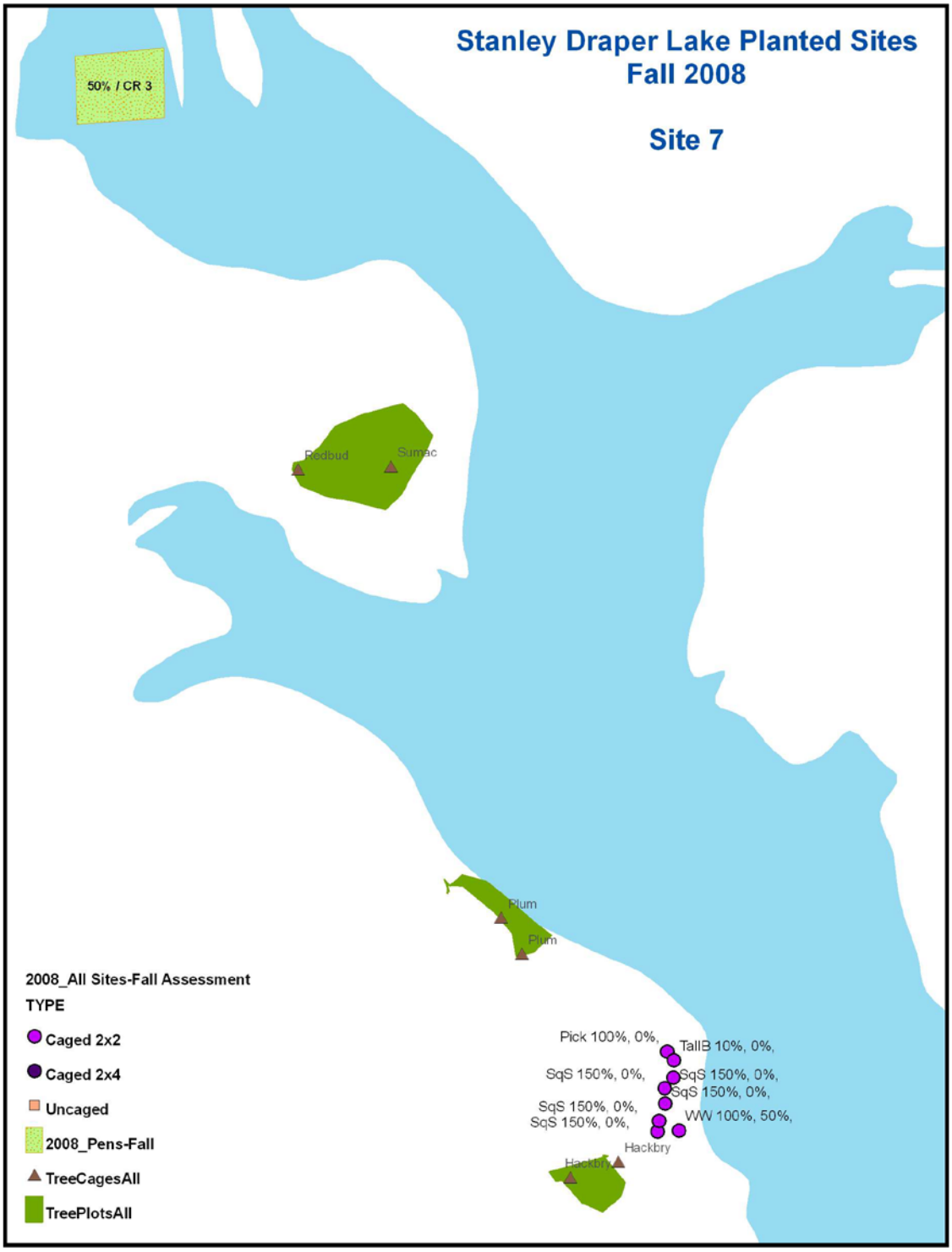

Stanley Draper Lake Planted Sites
Fall 2008
Site 4a
BullT 100%, 0%,
SftS 100%, 50%,
WW 100%, 100%,
25% / CR 4
Plum
Dogwood
Hackbry
Sycamore
Sycamore
Redbud
Rd Mulbry
Blk Walnut
Plum
Dogwood
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

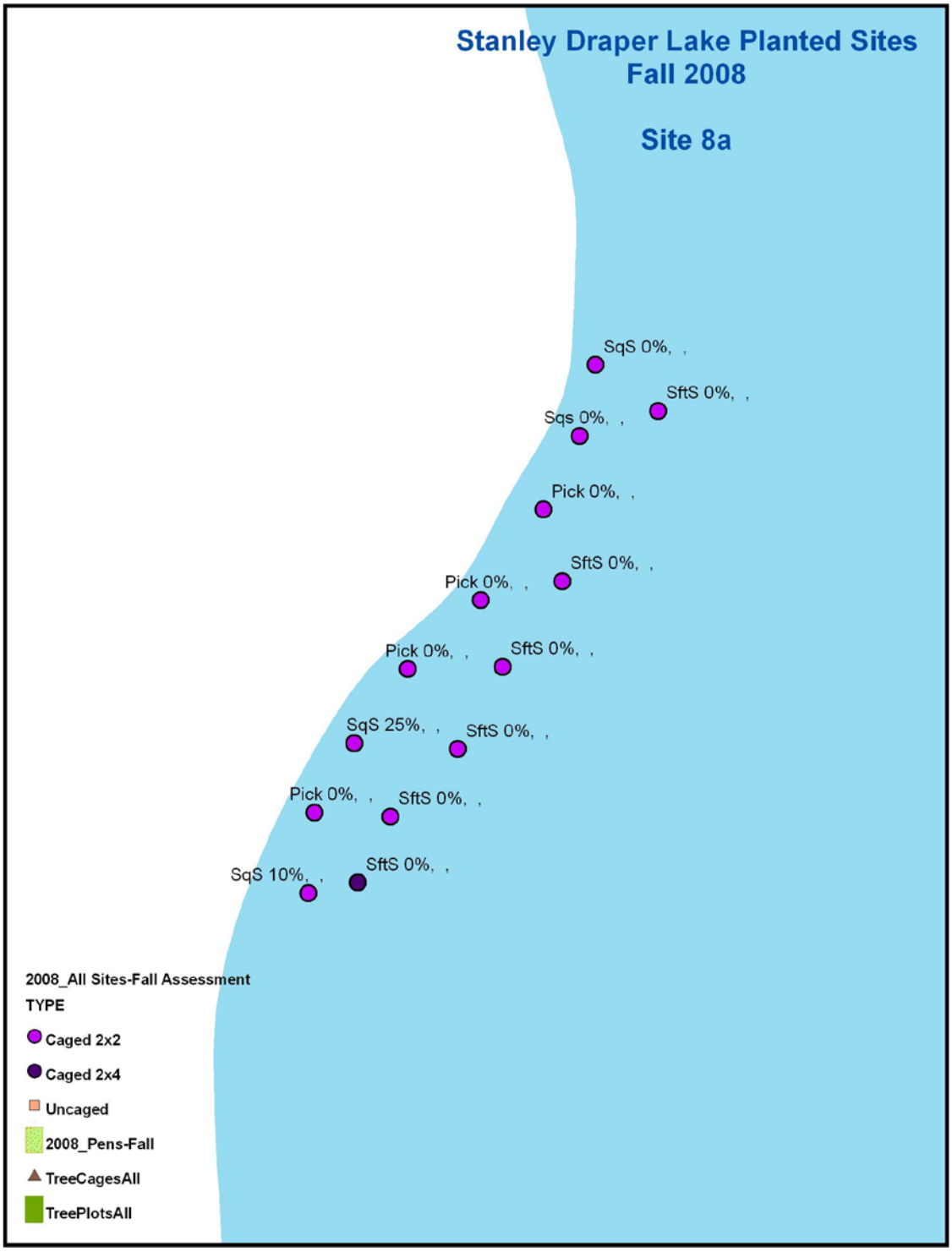

Stanley Draper Lake Planted Sites
Fall 2008
Site 4b
Sumac
Dogwood
Rd Mulbry
SftS 75%, 0%,
SqS 75%, 0%,
Plum
WW 50%, 10%,
WW 25%, ,
WW 25%, 10%,
Dogwood
3 Sq 0%, 0%,
Burr Oak
3 Sq 0%, 0%, Pnod 0%
SftS 50%, ,
SftS 100%, 50%,
Rd Mulbry
Sumac
Sycamore
Sycamore
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

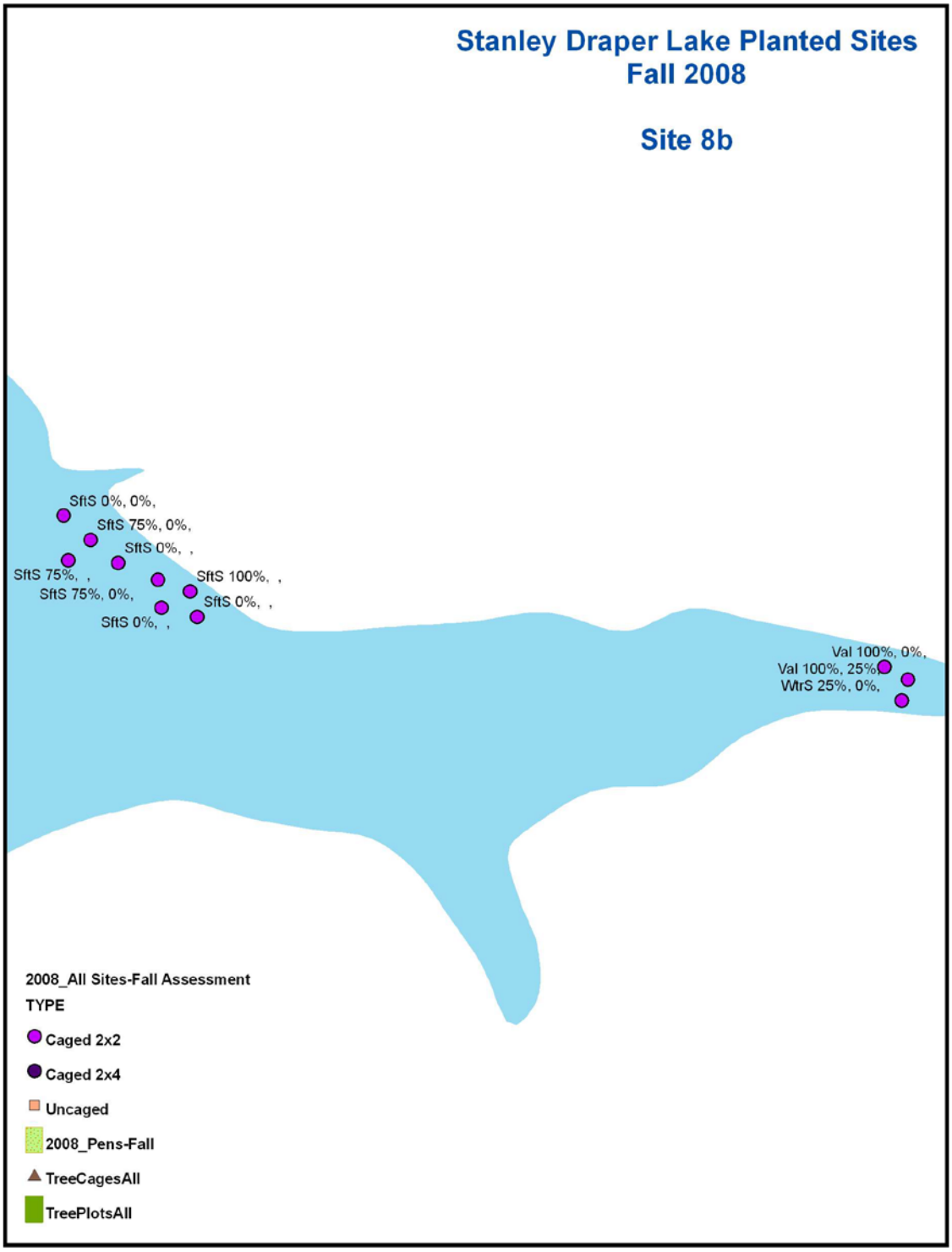

Stanley Draper Lake Planted Sites
Fall 2008
Site 5
Sumac
Burr Oak
Redbud
Sycamore
Burr Oak
Hackbry
Redbud
Plum
Redbud
Burr Oak
SftS 75%, 0%,
SftS 100%, 0%,
SftS 75%, 0%,
WtrS 25%, ,
SftS 75%, 0%,
SftS 75%, 25%,
SftS 100%, 75%,
Burr Oak
Blk Walnut
Plum
Blk Walnut
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

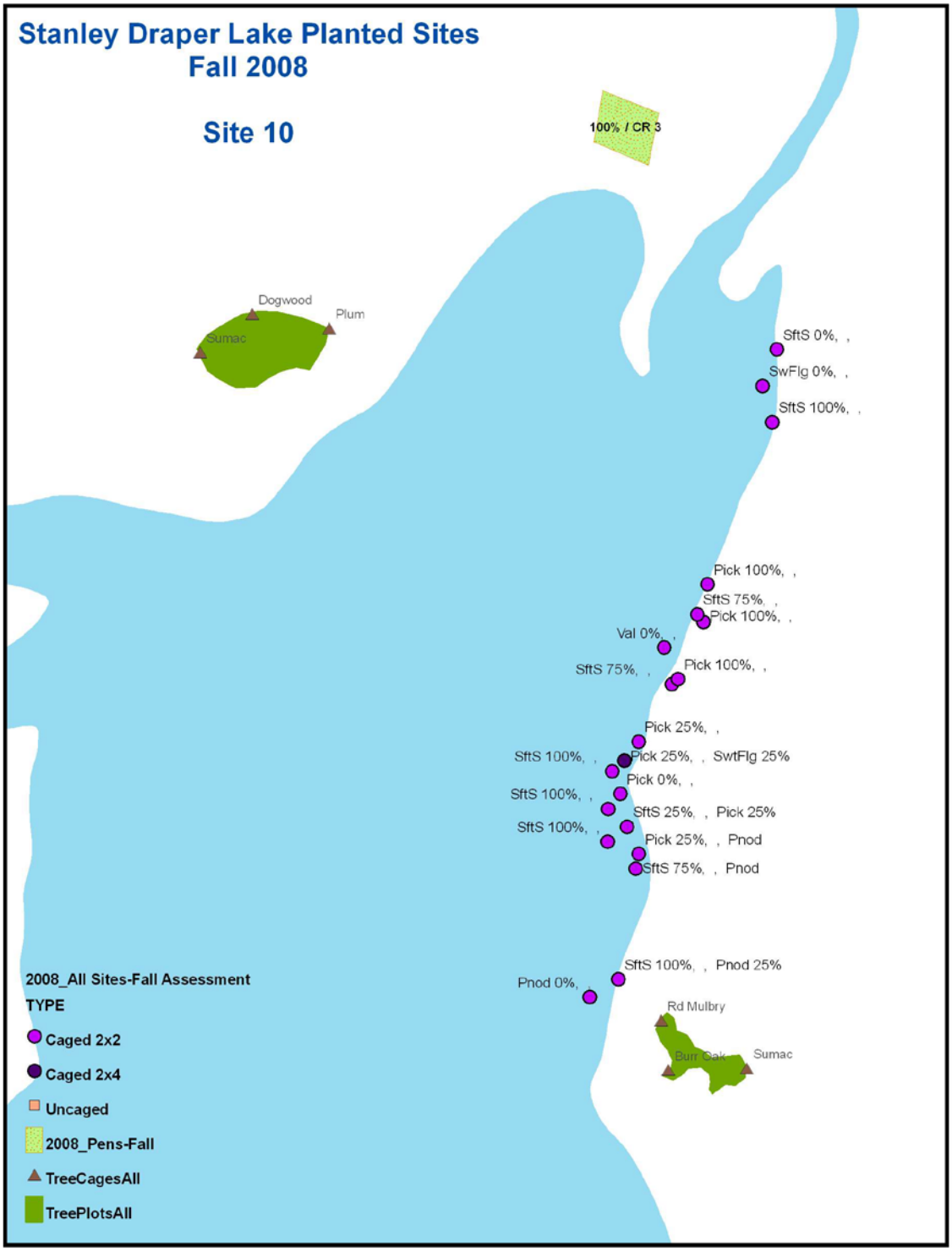

Stanley Draper Lake Planted Sites
Fall 2008
Site 6a
Arrow 25%, ,
Arrow 25%, ,
SftS 0%, ,
SftS 0%, ,
BullT 0%, ,
SftS 0%, ,
SftS 0%, ,
Pick 0%, ,
BullT 75%, ,
Pick 75%, ,
SftS 0%, ,
BullT 100%, 50%,
WWL 75%, 0%,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

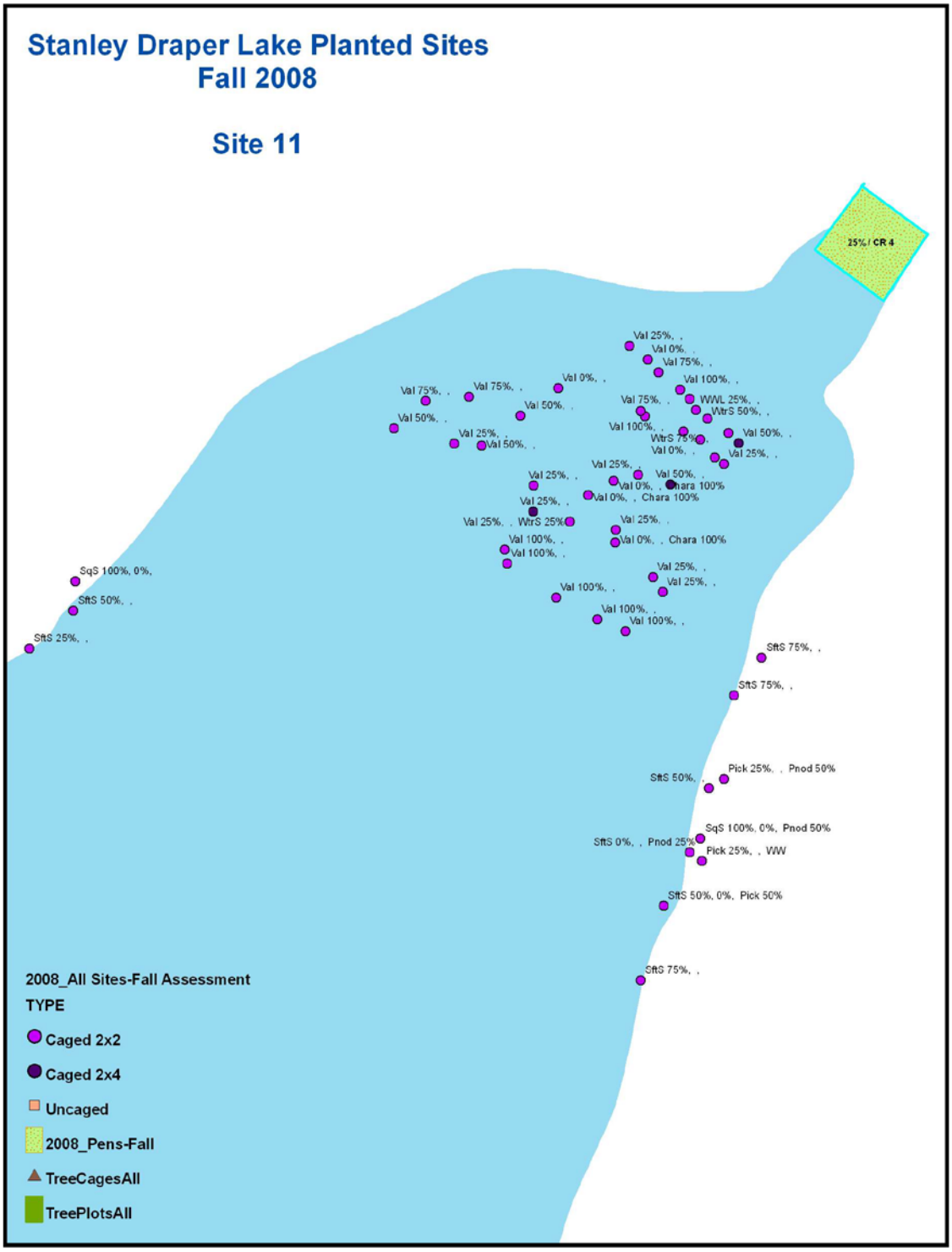

Stanley Draper Lake Planted Sites
Fall 2008
Site 6b
Pick 0%, ,
SftS 0%, ,
SftS 0%, ,
Flat 0%, ,
Pick 0%, ,
SqS 25%, , Pick 0%
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

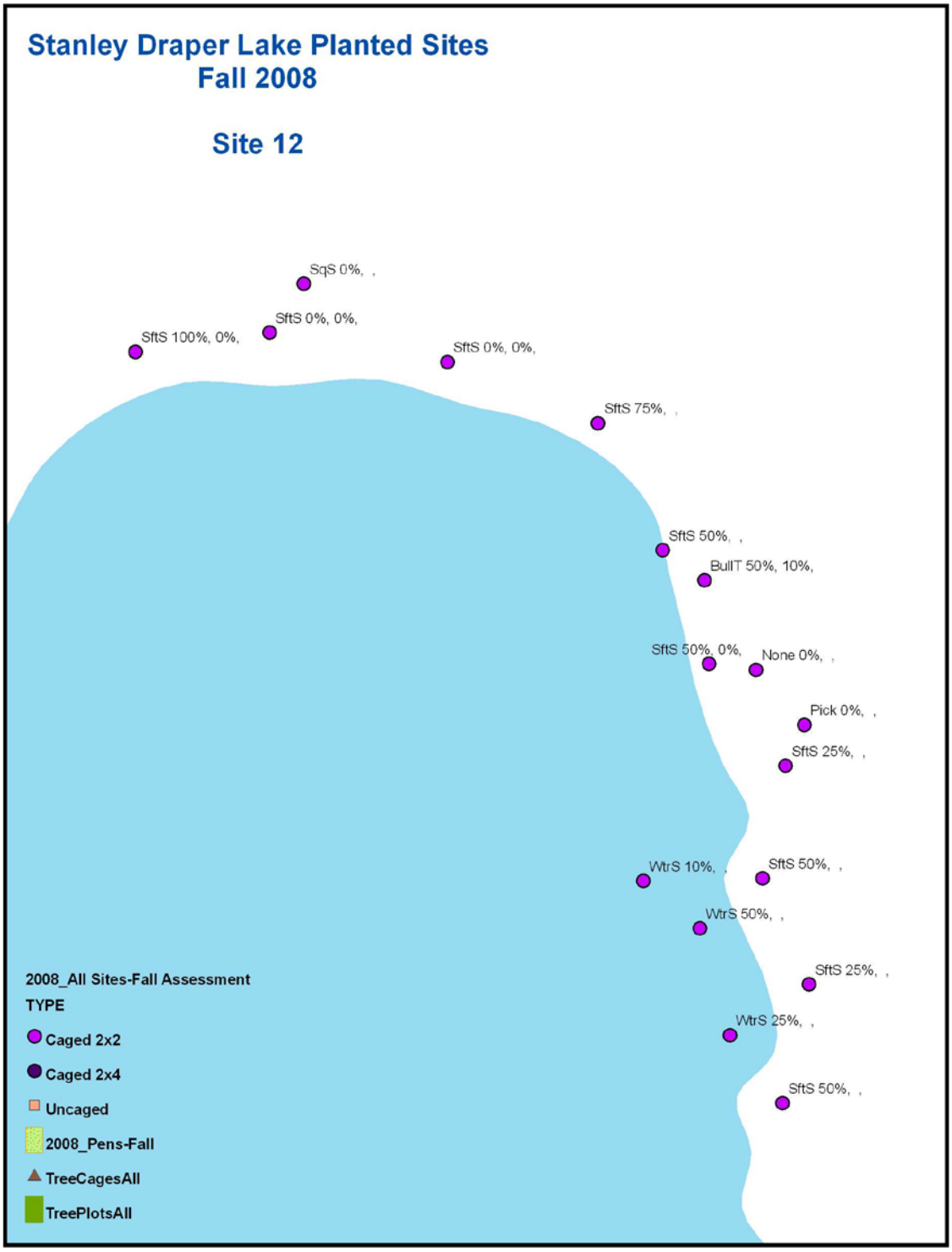

Stanley Draper Lake Planted Sites
Fall 2008
Site 7
50% / CR 3
Redbud
Sumac
Plum
Plum
Pick 100%, 0%,
TallB 10%, 0%,
SqS 150%, 0%,
SqS 150%, 0%,
SqS 150%, 0%,
SqS 150%, 0%,
SqS 150%, 0%,
WW 100%, 50%,
Hackbry
Hackbry
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

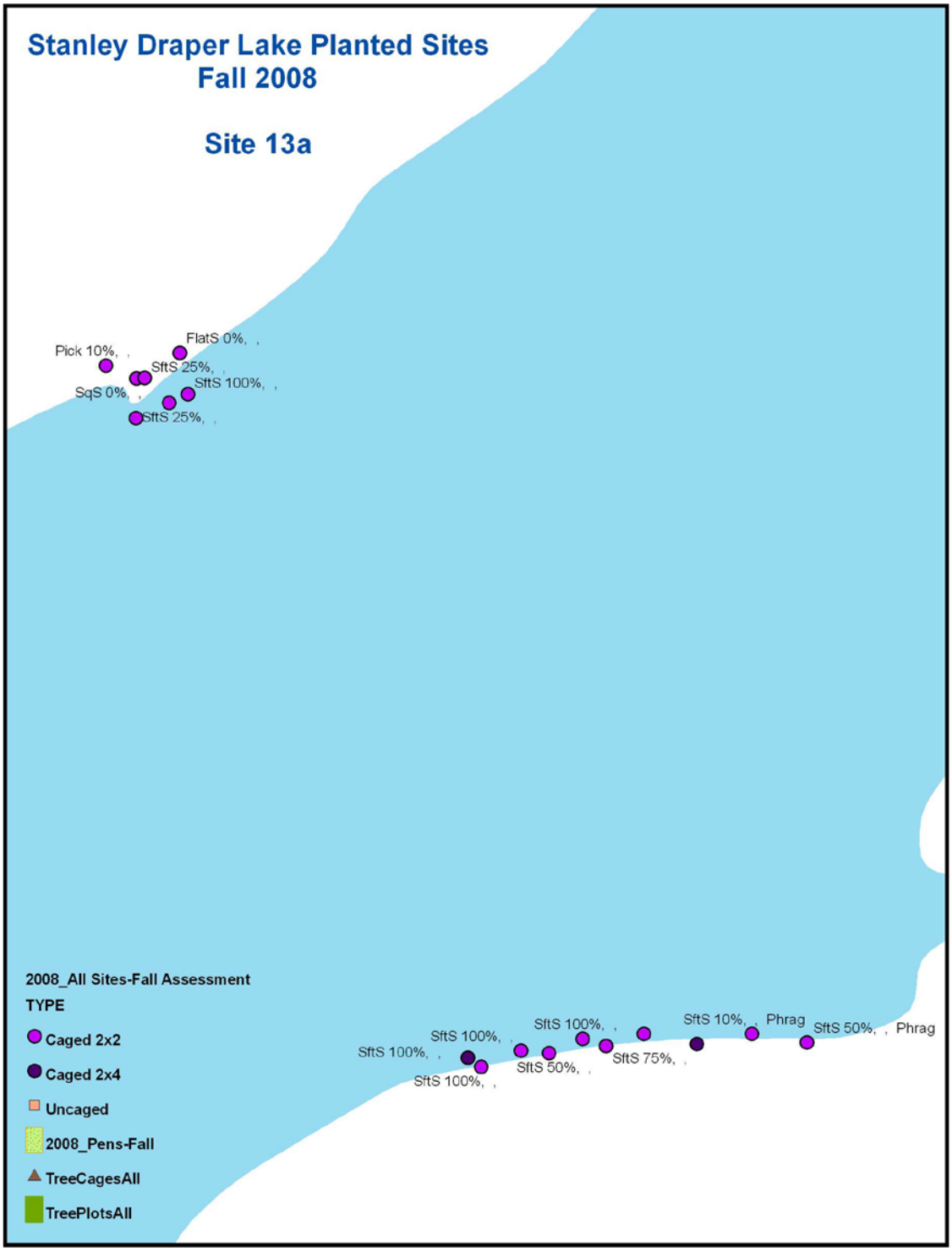

Stanley Draper Lake Planted Sites
Fall 2008
Site 8a
SqS 0%, ,
SftS 0%, ,
Sqs 0%, ,
Pick 0%, ,
SftS 0%, ,
Pick 0%, ,
Pick 0%, ,
SftS 0%, ,
SqS 25%, ,
SftS 0%, ,
Pick 0%, ,
SftS 0%, ,
SqS 10%, ,
SftS 0%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

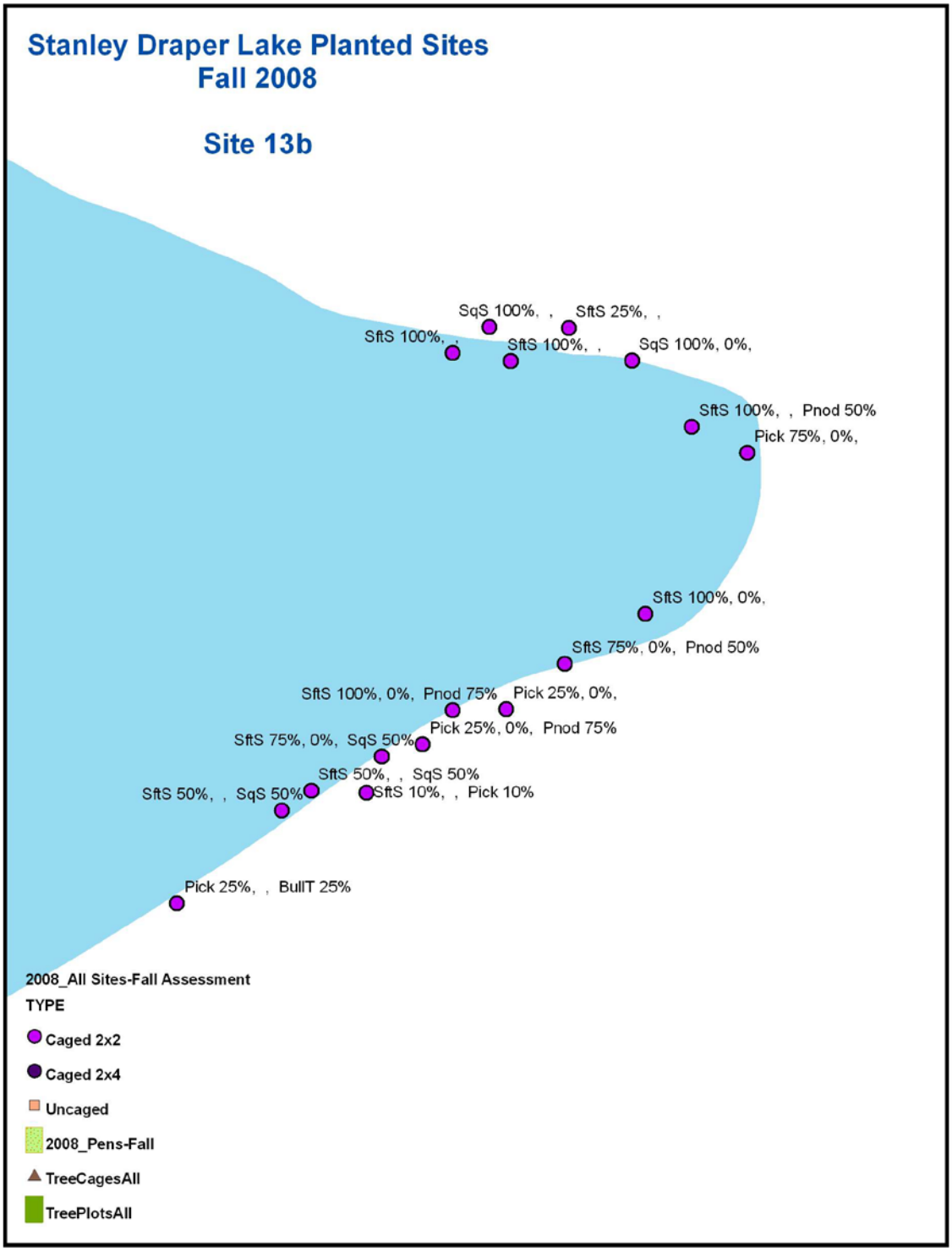

Stanley Draper Lake Planted Sites
Fall 2008
Site 8b
SftS 0%, 0%,
SftS 75%, 0%,
SftS 0%, ,
SftS 75%, ,
SftS 75%, 0%,
SftS 100%, ,
SftS 0%, ,
SftS 0%, ,
Val 100%, 0%,
Val 100%, 25%,
WtrS 25%, 0%,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

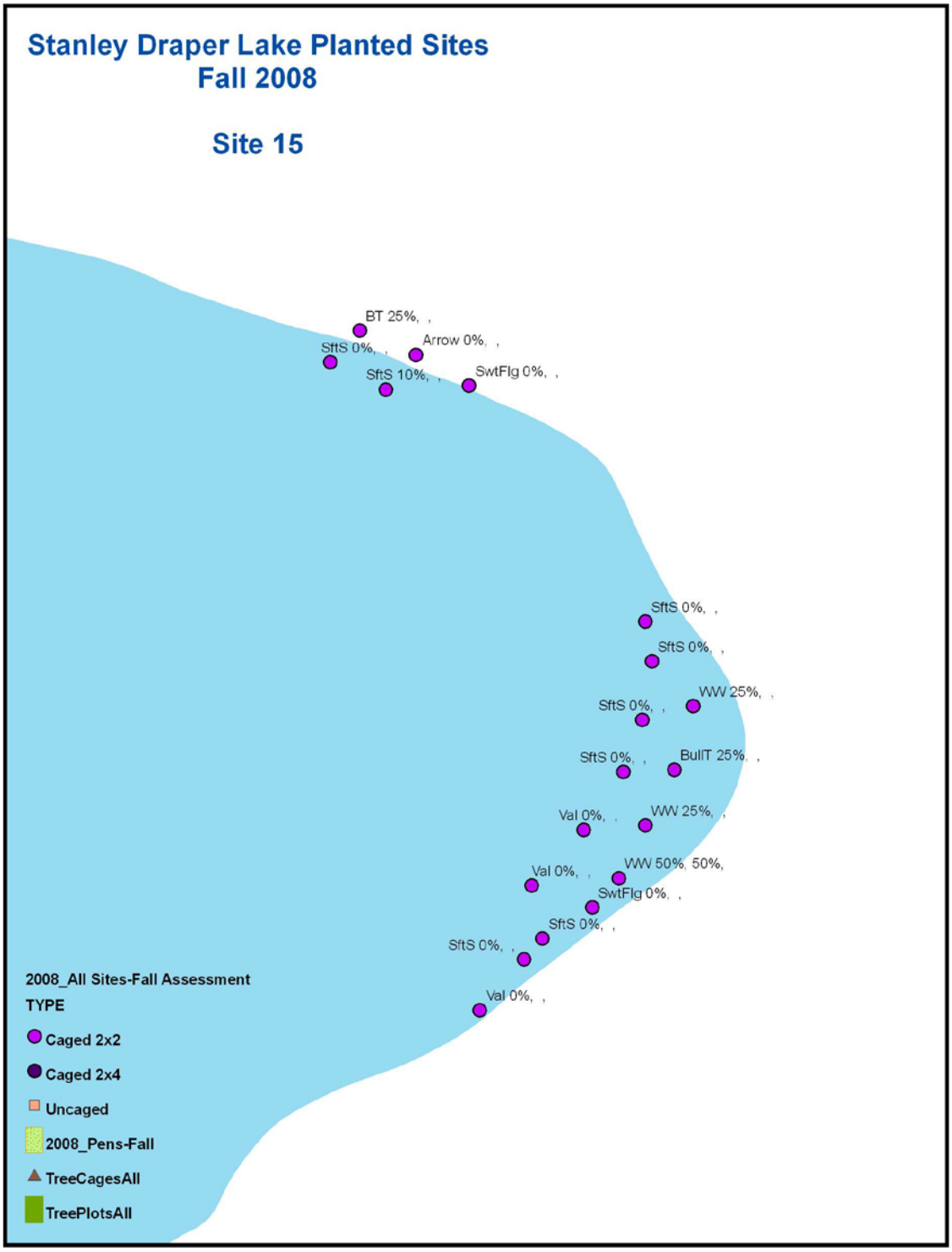

Stanley Draper Lake Planted Sites
Fall 2008
Site 10
100% / CR 3
Dogwood
Plum
Sumac
SftS 0%, ,
SwFlg 0%, ,
SftS 100%, ,
Pick 100%, ,
SftS 75%, ,
Pick 100%, ,
Val 0%, ,
SftS 75%, ,
Pick 100%, ,
Pick 25%, ,
SftS 100%, ,
Pick 25%, , SwtFlg 25%
Pick 0%, ,
SftS 100%, ,
SftS 25%, , Pick 25%
SftS 100%, ,
Pick 25%, , Pnod
SftS 75%, , Pnod
SftS 100%, , Pnod 25%
Pnod 0%, ,
Rd Mulbry
Burr Oak
Sumac
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

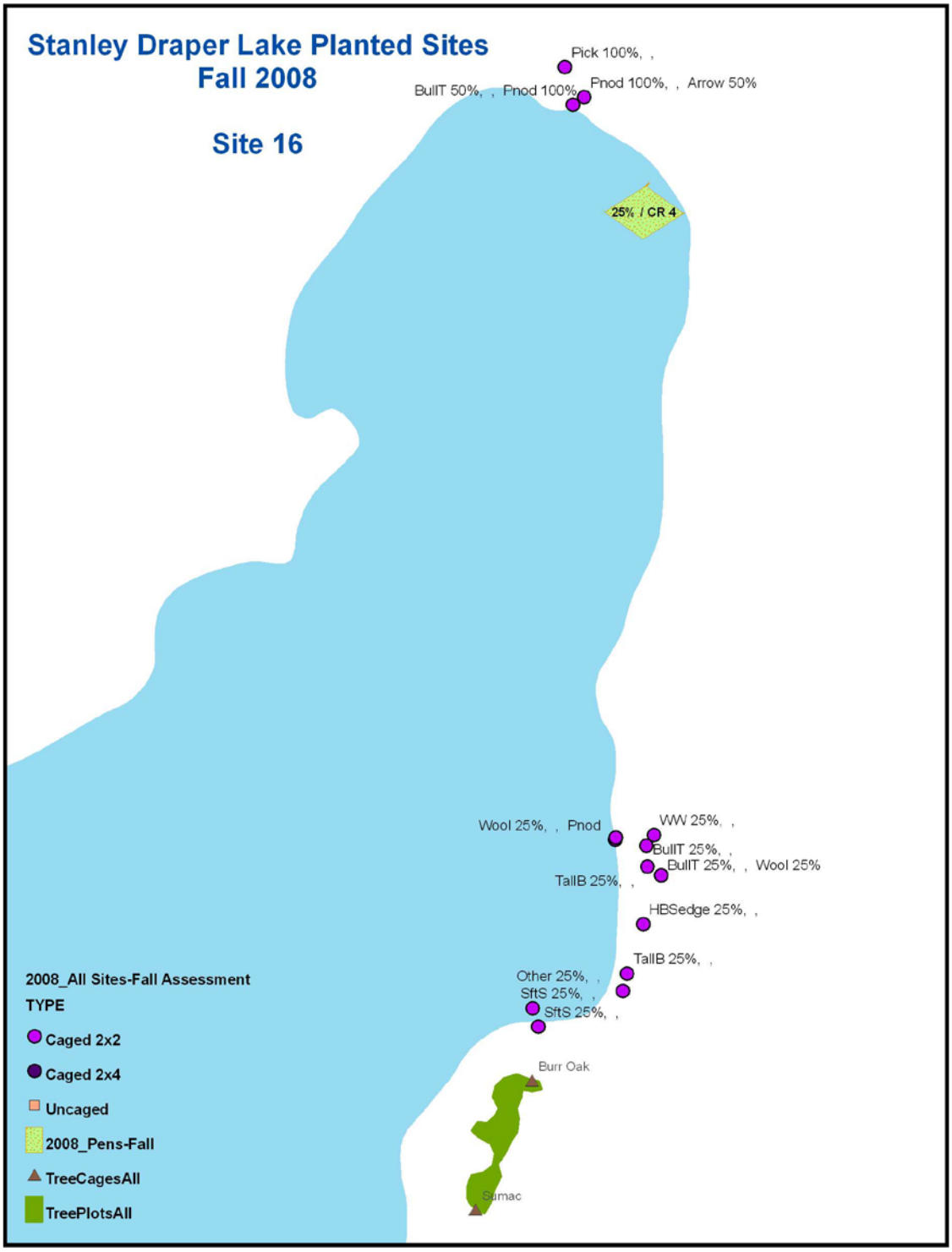

Stanley Draper Lake Planted Sites
Fall 2008
Site 11
25% / CR 4
Val 25%, ,
Val 0%, ,
Val 75%, ,
Val 100%, ,
Val 0%, ,
Val 75%, ,
Val 75%, ,
Val 50%, ,
Val 50%, ,
Val 75%, ,
WWL 25%, ,
WtrS 50%, ,
Val 100%, ,
Val 25%, ,
Val 50%, ,
WtrS 75%, ,
Val 50%, ,
Val 0%, ,
Val 25%, ,
Val 25%, ,
Val 25%, ,
Val 50%, ,
Val 0%, ,
Val 25%, ,
Val 0%, , Chara 100%
Val 25%, ,
Val 25%, , WtrS 25%
Val 25%, ,
Val 100%, ,
Val 0%, , Chara 100%
Val 100%, ,
SqS 100%, 0%,
Val 25%, ,
Val 25%, ,
SftS 50%, ,
Val 100%, ,
Val 100%, ,
Val 100%, ,
SftS 25%, ,
SftS 75%, ,
SftS 75%, ,
SftS 50%, ,
Pick 25%, , Pnod 50%
SqS 100%, 0%, Pnod 50%
SftS 0%, , Pnod 25%
Pick 25%, , WW
SftS 50%, 0%, Pick 50%
SftS 75%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

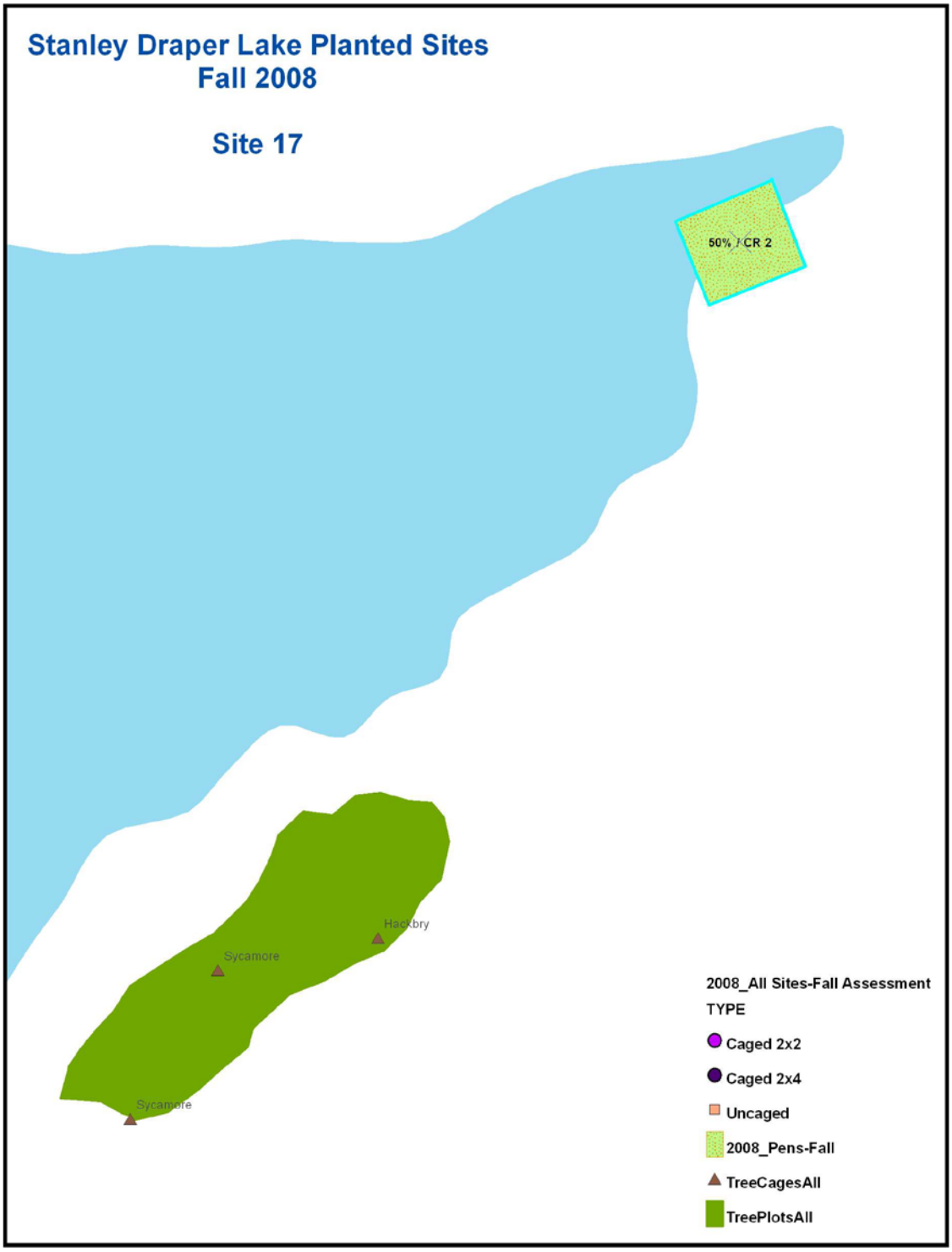

Stanley Draper Lake Planted Sites
Fall 2008
Site 12
SqS 0%, ,
SftS 0%, 0%,
SftS 100%, 0%,
SftS 0%, 0%,
SftS 75%, ,
SftS 50%, ,
BullT 50%, 10%,
SftS 50%, 0%,
None 0%, ,
Pick 0%, ,
SftS 25%, ,
WtrS 10%, ,
SftS 50%, ,
WtrS 50%, ,
SftS 25%, ,
WtrS 25%, ,
SftS 50%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

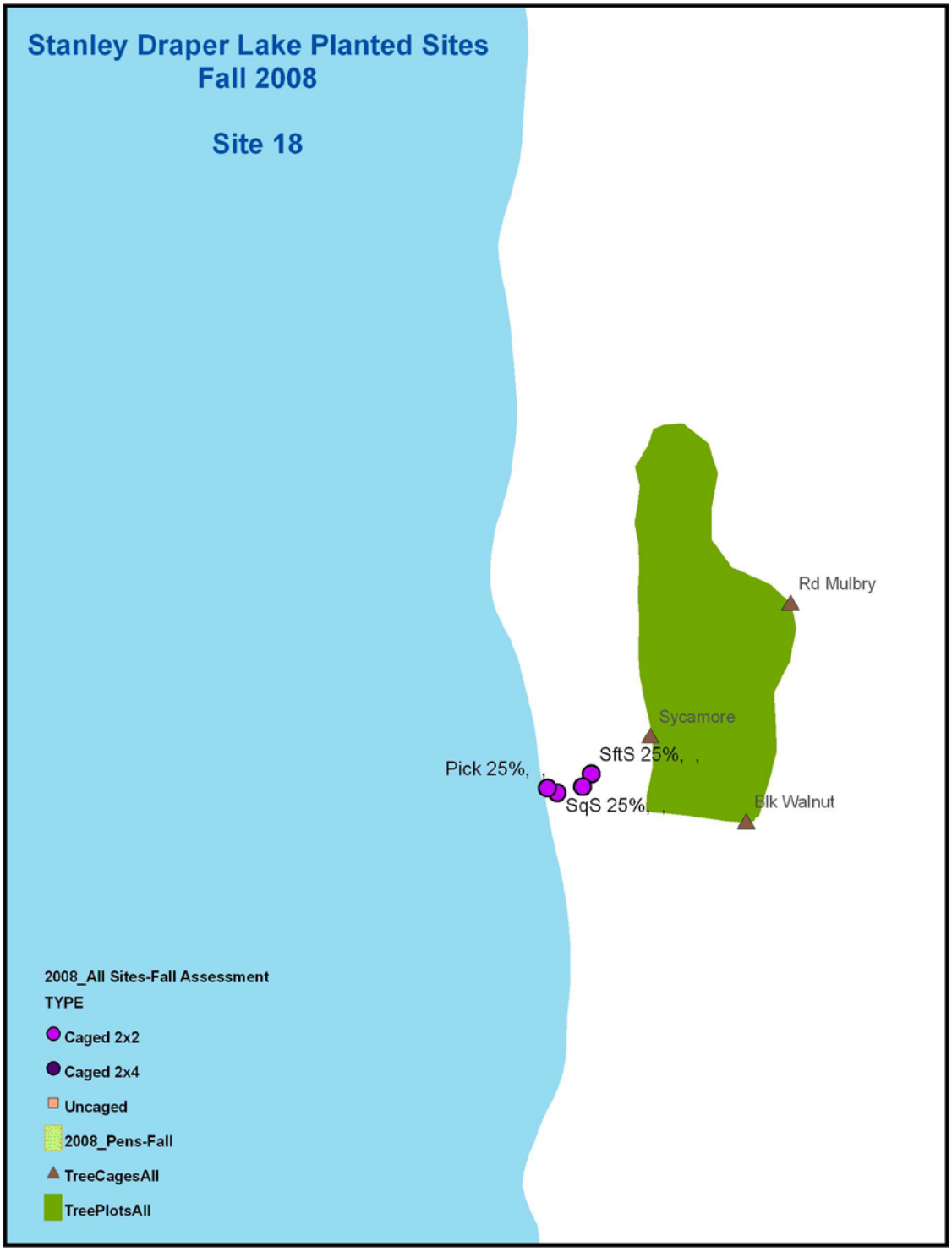

Stanley Draper Lake Planted Sites
Fall 2008
Site 13a
Pick 10%, ,
FlatS 0%, ,
SftS 25%, ,
SftS 100%, ,
SqS 0%, ,
SftS 25%, ,
SftS 100%, ,
SftS 100%, ,
SftS 100%, ,
SftS 50%, ,
SftS 100%, ,
SftS 75%, ,
SftS 10%, ,
Phrag
SftS 50%, ,
Phrag
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

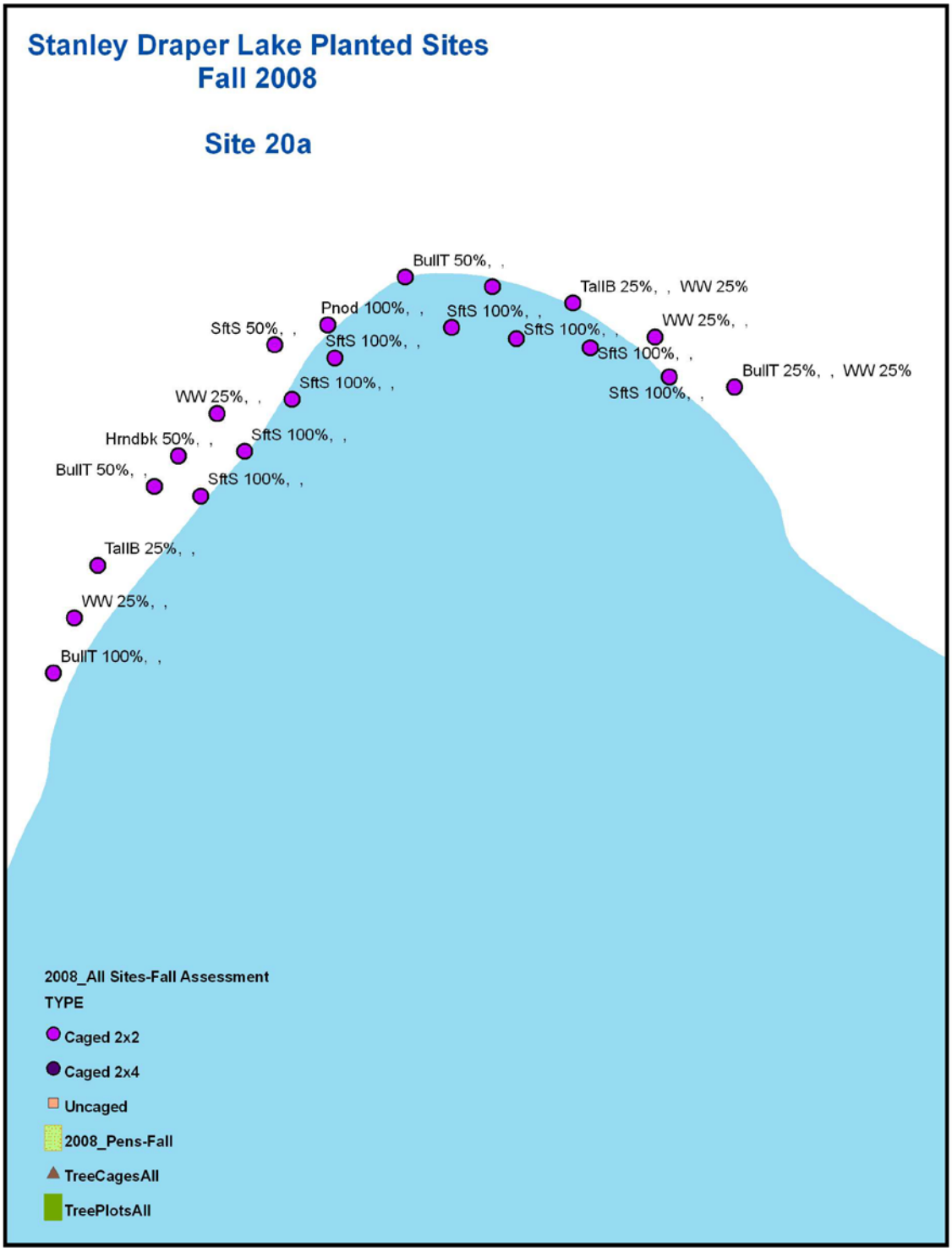

Stanley Draper Lake Planted Sites
Fall 2008
Site 13b
SqS 100%, , SftS 25%, ,
SftS 100%, ,
SftS 100%, , SqS 100%, 0%,
SftS 100%, , Pnod 50%
Pick 75%, 0%,
SftS 100%, 0%,
SftS 75%, 0%, Pnod 50%
SftS 100%, 0%, Pnod 75%
Pick 25%, 0%,
Pick 25%, 0%, Pnod 75%
SftS 75%, 0%, SqS 50%
SftS 50%, , SqS 50%
SftS 50%, , SqS 50%
SftS 10%, , Pick 10%
Pick 25%, , BullT 25%
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 15
BT 25%, ,
SftS 0%, ,
Arrow 0%, ,
SftS 10%, ,
SwtFlg 0%, ,
SftS 0%, ,
SftS 0%, ,
WW 25%, ,
SftS 0%, ,
SftS 0%, ,
BullT 25%, ,
Val 0%, ,
WW 25%, ,
Val 0%, ,
WW 50%, 50%,
SwtFlg 0%, ,
SftS 0%, ,
SftS 0%, ,
Val 0%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

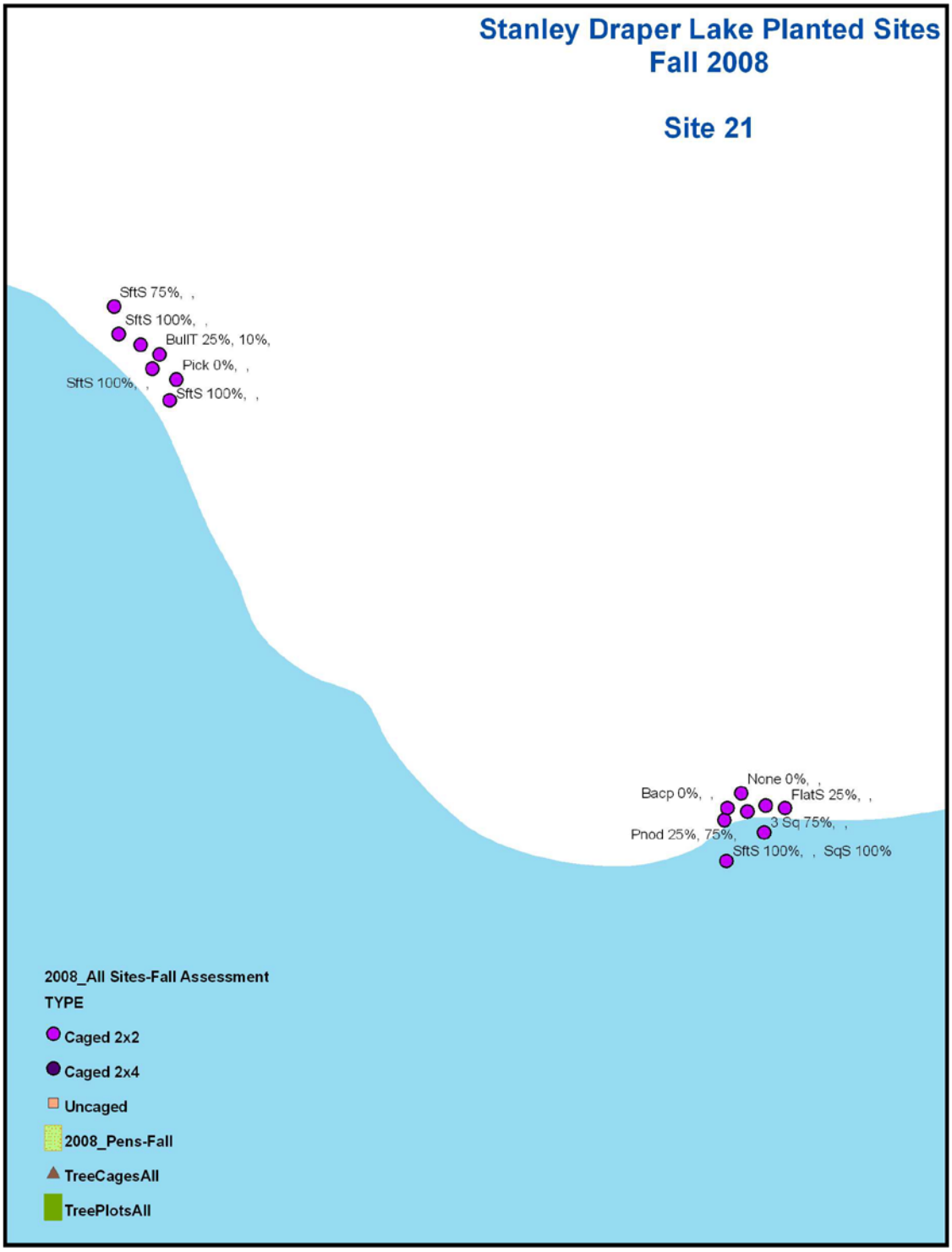

Stanley Draper Lake Planted Sites
Fall 2008
Site 16
Pick 100%, ,
BullT 50%, , Pnod 100%
Pnod 100%, , Arrow 50%
25% / CR 4
Wool 25%, , Pnod
WW 25%, ,
BullT 25%, ,
BullT 25%, , Wool 25%
TallB 25%, ,
HBSedge 25%, ,
TallB 25%, ,
Other 25%, ,
SftS 25%, ,
SftS 25%, ,
Burr Oak
Sumac
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

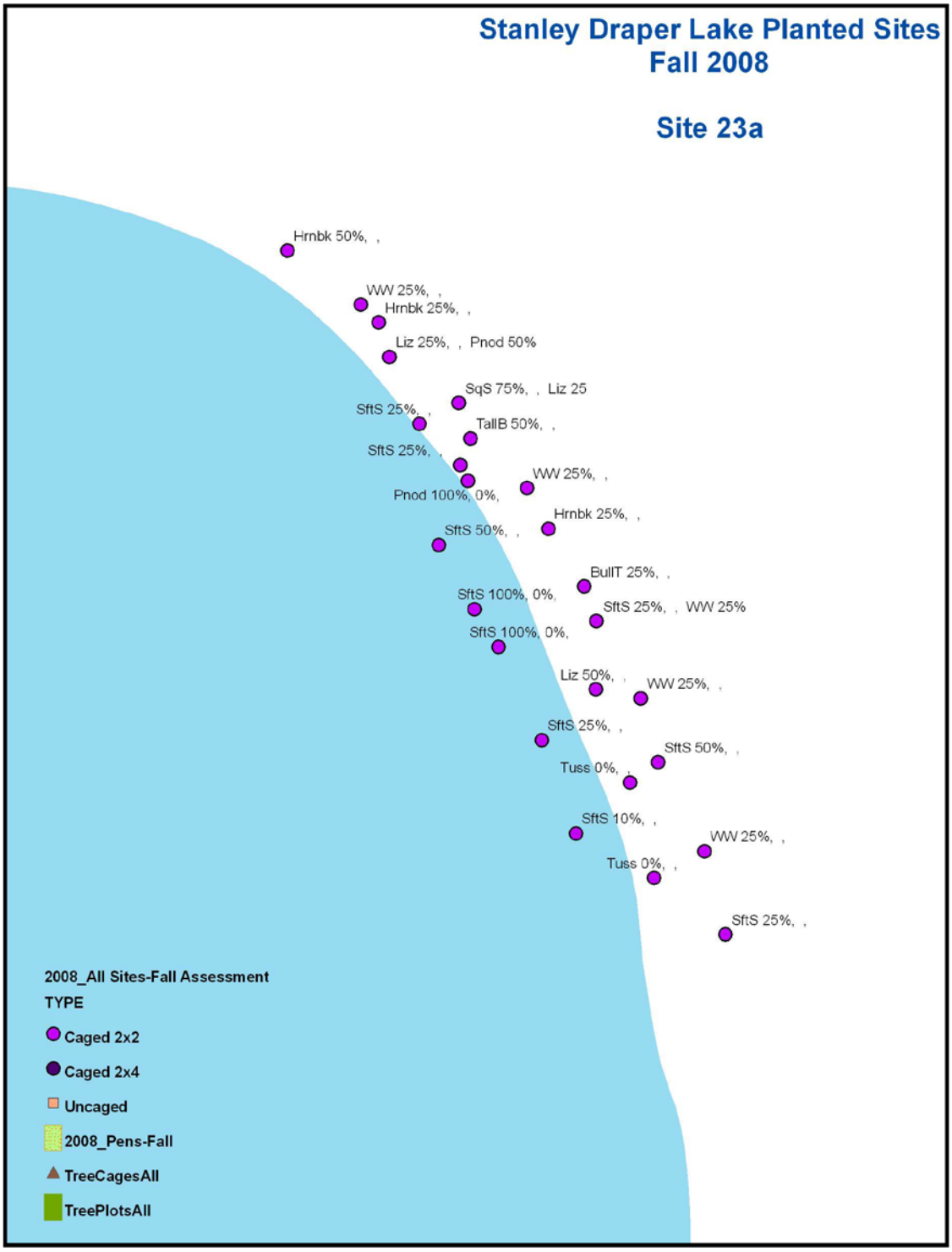

Stanley Draper Lake Planted Sites
Fall 2008
Site 17
50% / CR 2
Hackbry
Sycamore
Sycamore
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

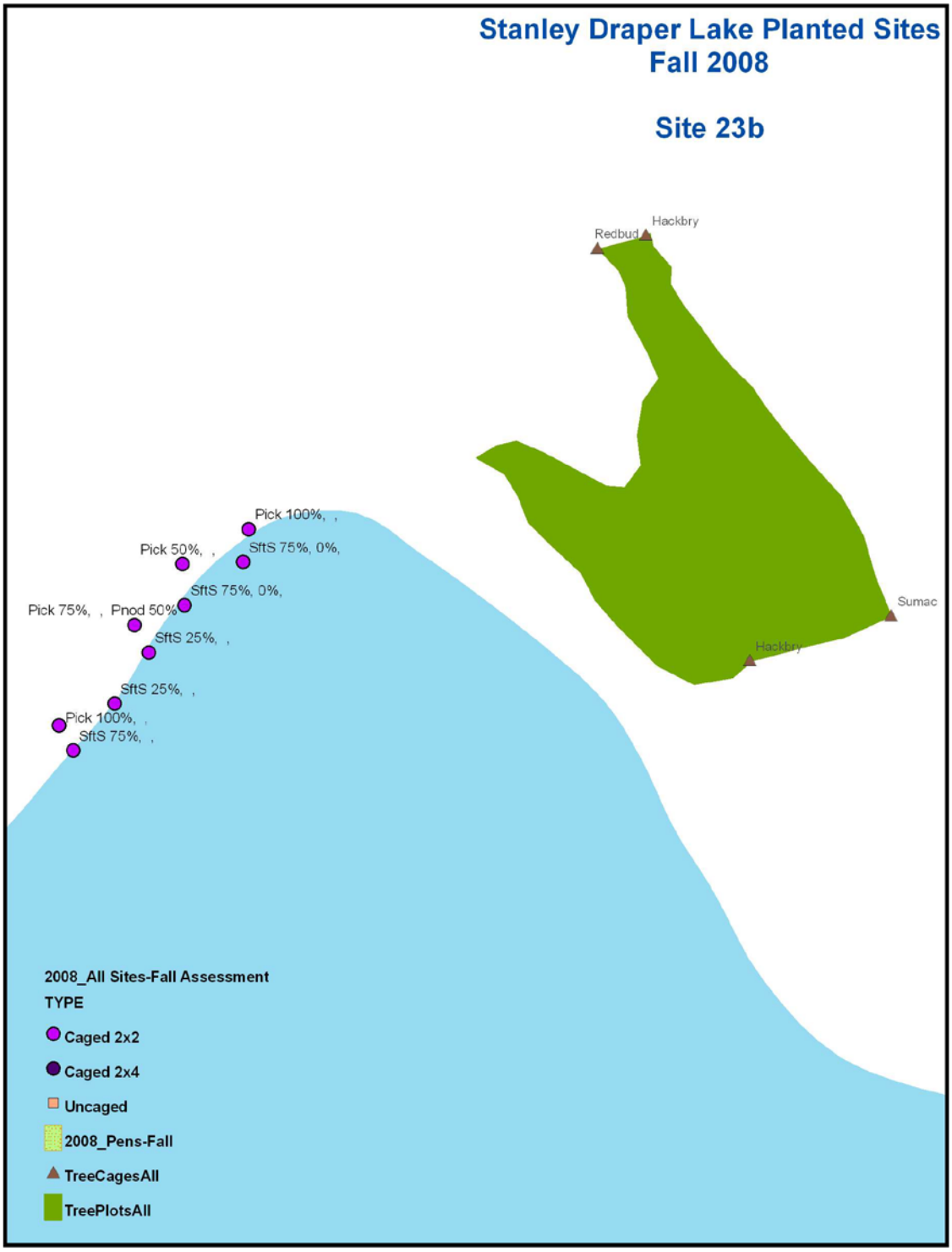

Stanley Draper Lake Planted Sites
Fall 2008
Site 18
Rd Mulbry
Sycamore
SftS 25%, ,
Pick 25%, ,
SqS 25%, ,
Blk Walnut
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

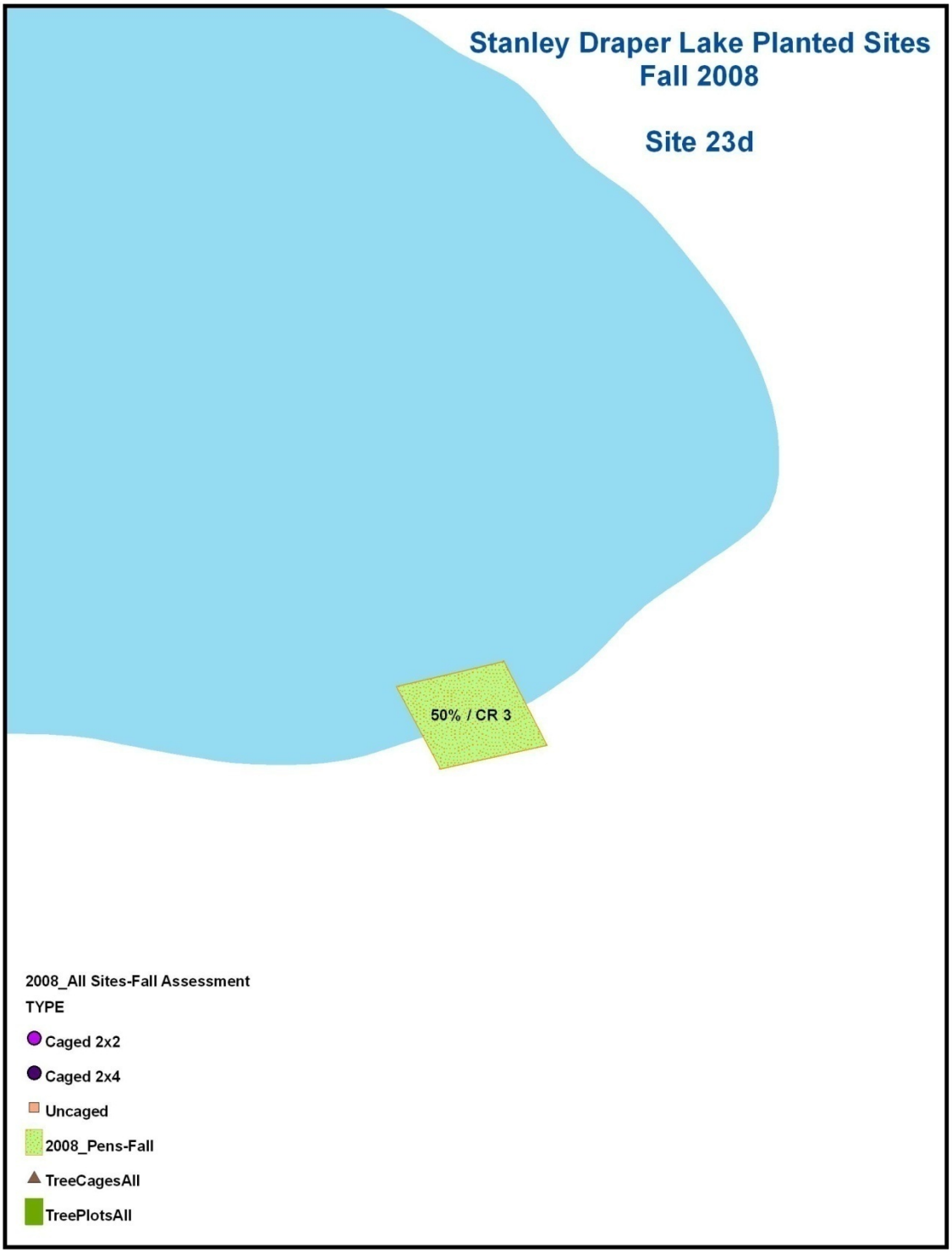

Stanley Draper Lake Planted Sites
Fall 2008
Site 20a
BullT 50%, ,
TallB 25%, , WW 25%
Pnod 100%, ,
SftS 100%, ,
SftS 100%, ,
WW 25%, ,
SftS 50%, ,
SftS 100%, ,
SftS 100%, ,
BullT 25%, , WW 25%
SftS 100%, ,
SftS 100%, ,
WW 25%, ,
SftS 100%, ,
Hrndbk 50%, ,
BullT 50%, ,
SftS 100%, ,
TallB 25%, ,
WW 25%, ,
BullT 100%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

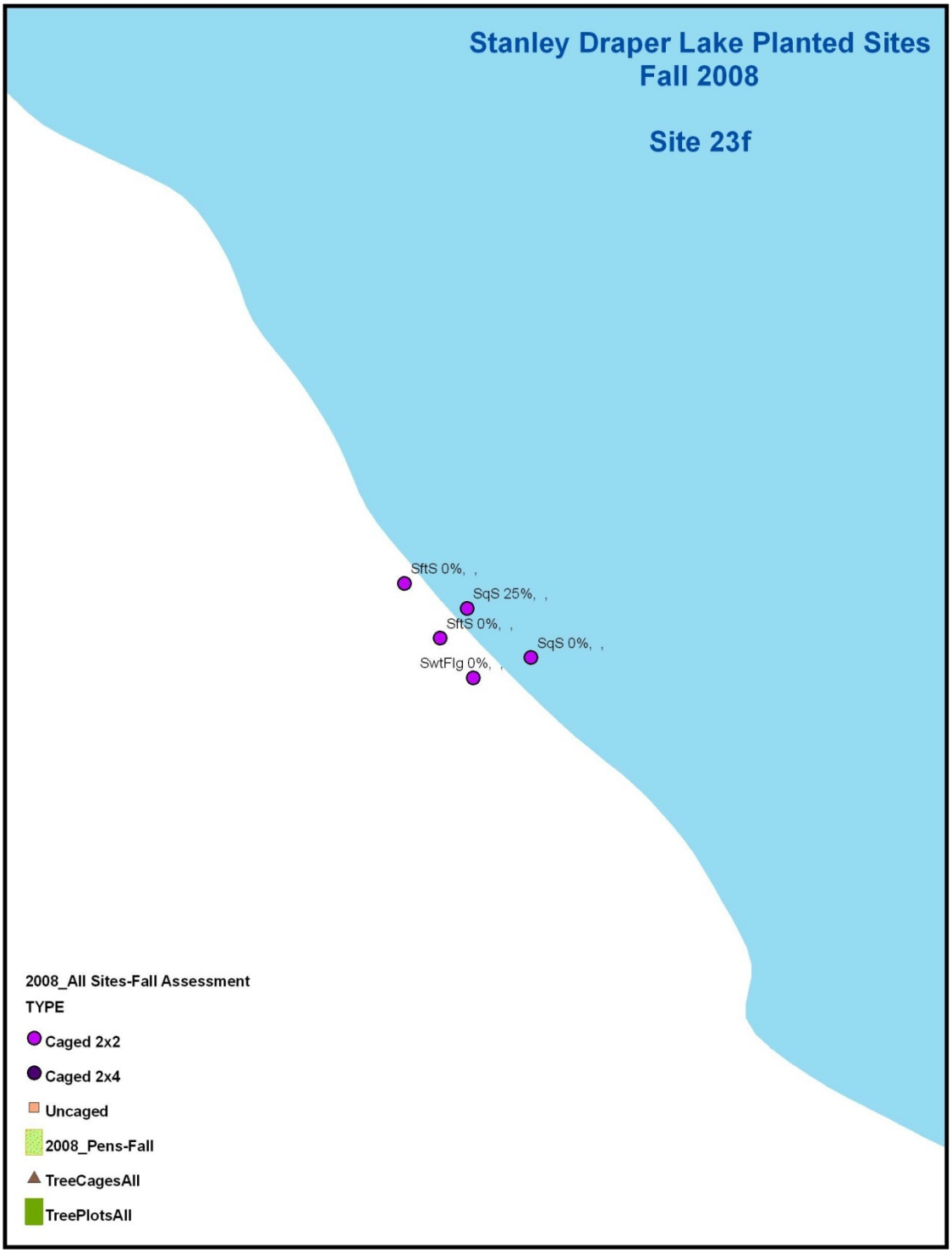

Stanley Draper Lake Planted Sites
Fall 2008
Site 20b
SftS 75%, ,
SftS 25%, ,
SftS 25%, ,
SftS 100%, ,
BullT 25%, ,
LeathL 25%, ,
SftS 100%, ,
SftS 25%, ,
Pick 50%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 21
SftS 75%, ,
SftS 100%, ,
BullT 25%, 10%,
Pick 0%, ,
SftS 100%, ,
SftS 100%, ,
None 0%, ,
Bacp 0%, ,
FlatS 25%, ,
3 Sq 75%, ,
Pnod 25%, 75%,
SftS 100%, , SqS 100%
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 23a
Hrnbk 50%, ,
WW 25%, ,
Hrnbk 25%, ,
Liz 25%, , Pnod 50%
SqS 75%, , Liz 25
SftS 25%, ,
TallB 50%, ,
SftS 25%, ,
WW 25%, ,
Pnod 100%, 0%,
Hrnbk 25%, ,
SftS 50%, ,
BullT 25%, ,
SftS 100%, 0%,
SftS 25%, , WW 25%
SftS 100%, 0%,
Liz 50%, ,
WW 25%, ,
SftS 25%, ,
SftS 50%, ,
Tuss 0%, ,
SftS 10%, ,
WW 25%, ,
Tuss 0%, ,
SftS 25%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 23b
Redbud
Hackbry
Sumac
Hackbry
Pick 100%, ,
SftS 75%, 0%,
Pick 50%, ,
SftS 75%, 0%,
Pick 75%, , Pnod 50%
SftS 25%, ,
SftS 25%, ,
Pick 100%, ,
SftS 75%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 23d
50% / CR 3
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll


Stanley Draper Lake Planted Sites
Fall 2008
Site 23f
SftS 0%, ,
SqS 25%, ,
SftS 0%, ,
SqS 0%, ,
SwtFlg 0%, ,
2008_All Sites-Fall Assessment
TYPE
Caged 2x2
Caged 2x4
Uncaged
2008_Pens-Fall
TreeCagesAll
TreePlotsAll

Appendix C – Photo Monitoring

Photo-monitoring results did not go as expected. There were several unanticipated events that made this monitoring less than successful.

It was determined early in the project that since cage planting results were simple to quantify that the only important plots to photo-monitor were the uncaged plots, this, in retrospect was incorrect. Caged plots should have also been photo-monitored as they had a far greater chance of survival and photo-monitoring may have still been a valuable tool on those plots.

In essence, photo plots were flagged at each *corner* and at the *center* where the camera was to be targeted, the Photo-point. Furthermore, the Camera-point, where the photographer was to stand, was flagged. Lastly, the Photo-points and the Camera-points were logged by GPS.

While this methodology seemed very good at the time, it became evident by the end of the second season that there were problems with the method. The lake came up several feet and remained up. This had several consequences on photo-monitoring.

- Water was too high and completely covered plots that had previously been wholly visible;
- Terrestrials grown amongst the plots confounded any assessment early in the season.
- Later in the season after terrestrials died back from innundation, the aquatic plants were also gone;
- Inexplicably, flagging was no longer in place at many of the plots;
- Photo and Camera points were dependent on GPS which could be several feet off from actual and did not sufficiently help to find the exact flagged point;
- Late plantings due to high water (see below) pushed back assessment.

From the Summer 2007 Quarterly Report:

> *Water levels continue to be too high to assess survival of uncaged plots of plants. While the points can be found by GPS there are many persistent perennial plants that confound any under water assessment. If and when water levels recede an assessment of those plots will be taken. The higher water levels have made herbivory of those uncaged plantings an issue and substantial loss is suspected.*
>
> *Due to high water levels uncaged shoreline plantings were delayed until late September and will continue through October. High water makes uncaged plantings less likely to succeed because of increased opportunity for aquatic herbivory.*

From the Fall 2007 Quarterly Report:

> *High water levels throughout the summer pushed plantings back to the fall. This, in turn, pushed back the fall assessment until November. Many of the plants had senesced by November. This made some guesswork as to the relative health of the plant being assessed or survival of the uncaged plots. The assessment next spring should answer any questions of survival and growth.*

No Picture Available

2006

2007

2008

2006

2007

No Picture Available

2008

2006

2007

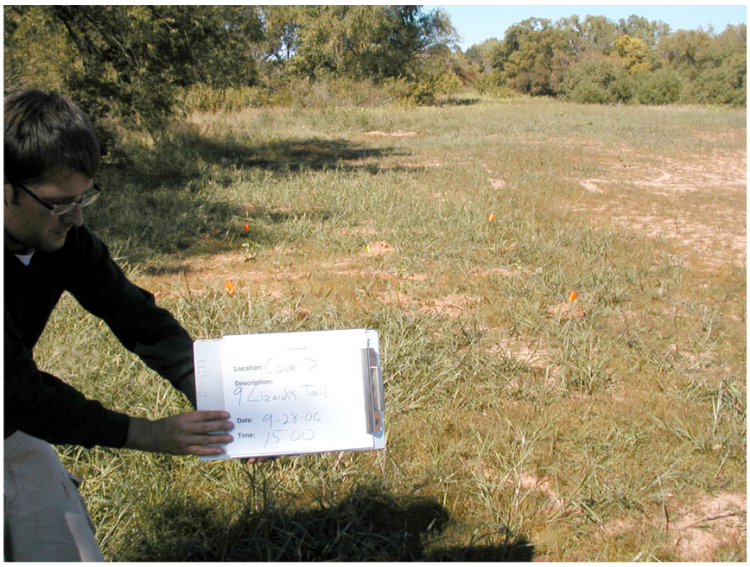
2008

No Picture Available

2006

2007

2008



2006

2007

No Picture Available

2008

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No Picture Available

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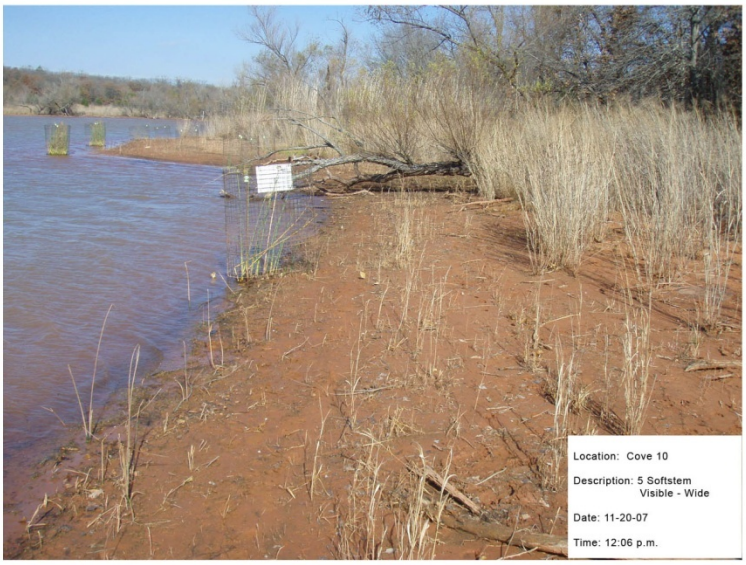
2006

2007

No Picture Available

2008

2006



2007

No Picture Available

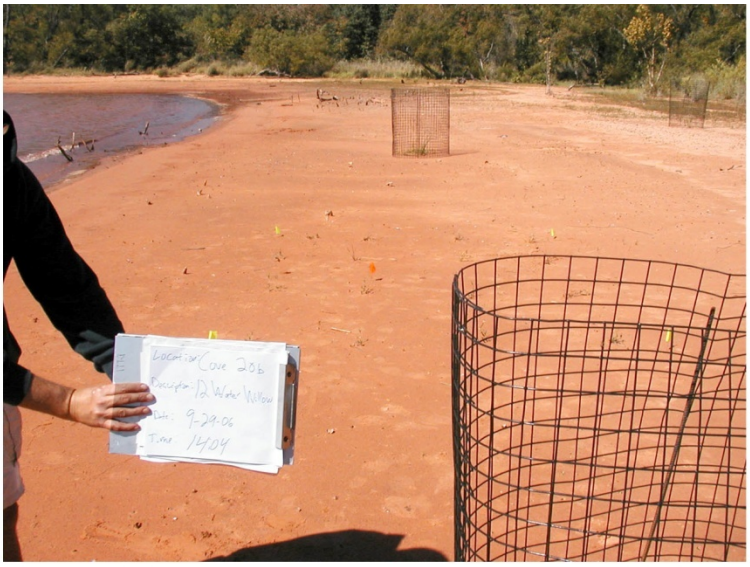
2008

2006

2007

No Picture Available

2008



2006

No Picture Available

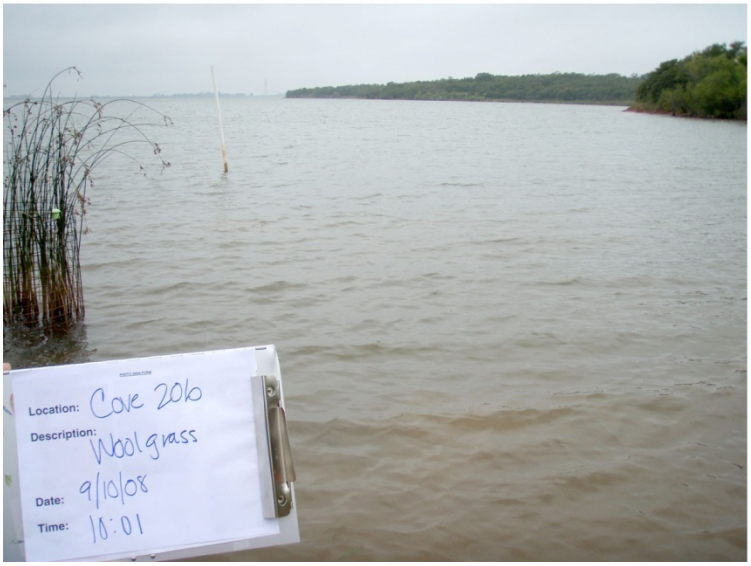
2007

2008

2006

No Picture Available

2007



2008

Appendix E – Water Quality Data

See Enclosed CD

Appendix F – Fish Data

Data presented herein is from sampling performed by fisheries biologists with the Oklahoma Department of Wildlife Conservation (ODWC) and the Oklahoma City Department of Tourism and Recreation. The data was compiled, presented and sent in electronic format to OWRB by the ODWC Fisheries Laboratory in Norman, Oklahoma.

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2006

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS.

LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)
LARGEMOUTH BASS	18	25.111	3.030	18.717	31.505	0.12	4	17
SPOTTED BASS	18	22.889	3.642	15.205	30.573	0.16	7	29

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS
BY SPECIFIC LENGTH CATEGORIES.

YEAR=2006 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)	MEAN REL WEIGHT
LMB < 200 MM	18	6.444	1.258	3.790	9.099	0.20	11	44	89
LMB 200 - 299 MM	18	9.778	1.864	5.845	13.711	0.19	10	42	87
LMB 204 - 330 MM (8 - 13 IN)	18	11.556	1.768	7.825	15.286	0.15	7	27	86
LMB >= 300 MM	18	9.778	1.973	5.615	13.941	0.20	12	47	83
LMB >= 356 MM (14 IN)	18	4.222	1.352	1.370	7.074	0.32	30	118	84
LMB 331 - 406 MM (13 - 16 IN)	18	5.333	1.446	2.282	8.385	0.27	21	85	81
LMB >= 407 MM (16 IN)	18	1.556	0.658	0.167	2.944	0.42	52	206	89
LMB >=534 MM (21 IN)	18	0.222	0.222	-0.247	0.691	1.00	288	1152	80
SPB < 200 MM	18	8.667	2.315	3.782	13.551	0.27	21	82	90
SPB 200 - 299 MM	18	11.556	1.910	7.525	15.586	0.17	8	31	90
SPB 204 - 330 MM (8 - 13 IN)	18	13.556	2.099	9.126	17.985	0.15	7	28	88
SPB >= 300 MM	18	2.667	1.023	0.509	4.824	0.38	42	169	79
SPB >= 356 MM (14 IN)	18	0.222	0.222	-0.247	0.691	1.00	288	1152	80
SPB 331 - 406 MM (13 - 16 IN)	18	0.667	0.485	-0.357	1.690	0.73	152	610	78

2006

LENGTH FREQUENCIES, PERCENT OF CATCH, AND MEAN RELATIVE WEIGHTS
BY 20 MM LENGTH CATEGORIES.

YEAR=2006 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
121-140	5	4.42	.
141-160	6	5.31	78
161-180	6	5.31	78
181-200	12	10.62	96
201-220	9	7.96	90
221-240	3	2.65	105
241-260	6	5.31	88
261-280	10	8.85	86
281-300	12	10.62	81
301-320	9	7.96	84
321-340	8	7.08	81
341-360	12	10.62	79
361-380	4	3.54	80
381-400	4	3.54	86
401-420	2	1.77	95
421-440	2	1.77	88
461-480	1	0.88	92
481-500	1	0.88	88
541-560	1	0.88	80

YEAR=2006 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
61-80	1	0.97	.
101-120	7	6.80	93
121-140	7	6.80	85
141-160	8	7.77	89
161-180	9	8.74	88
181-200	7	6.80	96
201-220	5	4.85	91
221-240	10	9.71	93
241-260	14	13.59	93
261-280	17	16.50	89
281-300	6	5.83	82
301-320	9	8.74	79
341-360	2	1.94	77
361-380	1	0.97	80

BASIC DESCRIPTIVE STATISTICS BASED ON BODY LENGTH (MM) AND WEIGHT(G).

YEAR=2006 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
LARGEMOUTH BASS	113	554	113	2270

YEAR=2006 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
SPOTTED BASS	103	361	103	540

2007

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)
LARGEMOUTH BASS	18	6.222	1.748	2.534	9.911	0.28	23	91
SPOTTED BASS	18	11.111	2.183	6.506	15.717	0.20	11	44
WALLEYE	18	0.222	0.222	-0.247	0.691	1.00	288	1152

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)
WALLEYE	18	0.222	0.222	-0.247	0.691	1.00	288	1152
BLUEGILL	18	21.111	13.047	-6.418	48.641	0.62	110	440
REDEAR	18	8.889	1.501	5.721	12.057	0.17	8	33
GREEN SUNFISH	18	0.222	0.222	-0.247	0.691	1.00	288	1152

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS
BY SPECIFIC LENGTH CATEGORIES.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)	MEAN REL WEIGHT
LMB < 200 MM	18	0.444	0.305	-0.199	1.088	0.69	136	542	76
LMB 200 - 299 MM	18	1.778	0.664	0.376	3.180	0.37	40	161	86
LMB 204 - 330 MM (8 - 13 IN)	18	3.111	1.234	0.508	5.714	0.40	45	181	83
LMB >= 300 MM	18	4.000	1.372	1.105	6.895	0.34	34	136	84
LMB >= 356 MM (14 IN)	18	2.000	0.808	0.294	3.706	0.40	47	188	88
LMB 331 - 406 MM (13 - 16 IN)	18	2.222	0.982	0.150	4.294	0.44	56	225	83
LMB >= 407 MM (16 IN)	18	0.444	0.305	-0.199	1.088	0.69	136	542	103
SPB < 200 MM	18	0.889	0.517	-0.202	1.980	0.58	97	390	82
SPB 200 - 299 MM	18	6.667	1.680	3.121	10.212	0.25	18	73	90
SPB 204 - 330 MM (8 - 13 IN)	18	8.444	2.068	4.081	12.808	0.24	17	69	87
SPB >= 300 MM	18	3.556	1.161	1.106	6.005	0.33	31	123	75
SPB >= 356 MM (14 IN)	18	0.667	0.485	-0.357	1.690	0.73	152	610	79
SPB 331 - 406 MM (13 - 16 IN)	18	1.778	0.580	0.553	3.003	0.33	31	123	76
WALLEYE 300 - 399 MM	18	0.222	0.222	-0.247	0.691	1.00	288	1152	101
WALLEYE 300 - 457 MM	18	0.222	0.222	-0.247	0.691	1.00	288	1152	101

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)	MEAN REL WEIGHT
BLUEGILL < 75 MM	18	2.889	2.663	-2.730	8.508	0.92	245	979	.
BLUEGILL 75 - 149 MM	18	16.667	12.737	-10.208	43.541	0.76	168	673	.
BLUEGILL >= 150 MM	18	1.556	1.127	-0.822	3.933	0.72	151	604	.
REDEAR 75 - 149 MM	18	0.444	0.305	-0.199	1.088	0.69	136	542	.
REDEAR >= 150 MM	18	8.444	1.547	5.180	11.709	0.18	10	39	.
REDEAR >= 200 MM (8 IN)	18	4.222	1.272	1.538	6.906	0.30	26	105	.
GREEN SF >= 150 MM	18	0.222	0.222	-0.247	0.691	1.00	288	1152	.

2007

LENGTH FREQUENCIES, PERCENT OF CATCH, AND MEAN RELATIVE WEIGHTS
BY 20 MM LENGTH CATEGORIES.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
181-200	2	7.14	76
201-220	1	3.57	83
221-240	2	7.14	75
241-260	1	3.57	112
261-280	2	7.14	89
281-300	2	7.14	81
301-320	3	10.71	78
321-340	4	14.29	82
341-360	4	14.29	80
361-380	4	14.29	83
381-400	1	3.57	91
421-440	1	3.57	80
441-460	1	3.57	126

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
101-120	2	4.08	.
141-160	1	2.04	.
181-200	1	2.04	82
201-220	4	8.16	116
221-240	4	8.16	163
241-260	3	6.12	81
261-280	8	16.33	82
281-300	11	22.45	77
301-320	6	12.24	76
321-340	6	12.24	72
341-360	1	2.04	74
361-380	2	4.08	81
381-400	1	2.04	76

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=WALLEYE

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
321-340	1	100	101

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=BLUEGILL

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
0-20	11	30.56	.
61-80	53	147.22	.
81-100	5	13.89	.
101-120	11	30.56	.
121-140	6	16.67	.
141-160	3	8.33	.
161-180	6	16.67	.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=REDEAR

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
121-140	1	2.5	.
141-160	5	12.5	.
161-180	8	20.0	.
181-200	9	22.5	.
201-220	15	37.5	.
221-240	1	2.5	.
241-260	1	2.5	.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=GREEN SUNFISH

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
161-180	1	100	.

2007

BASIC DESCRIPTIVE STATISTICS BASED ON BODY LENGTH (MM) AND WEIGHT(G).

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
LARGEMOUTH BASS	28	450	28	1800

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
SPOTTED BASS	50	390	44	660

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=WALLEYE

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
WALLEYE	1	333	1	373

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=BLUEGILL

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
BLUEGILL	95	180	0	.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=REDEAR

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
REDEAR	40	250	0	.

YEAR=2007 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=GREEN SUNFISH

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
GREEN SUNFISH	1	162	0	.

2008

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS.

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)
LARGEMOUTH BASS	18	15.333	3.021	8.960	21.707	0.20	11	45
SPOTTED BASS	18	15.111	2.389	10.071	20.151	0.16	7	29

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)
BLUEGILL	18	58.444	5.432	46.983	69.906	0.09	2	10
REDEAR	18	18.667	4.241	9.718	27.615	0.23	15	59

SUMMARY OF ELECTROFISHING SAMPLING STATISTICS
BY SPECIFIC LENGTH CATEGORIES.

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)	MEAN REL WEIGHT
LMB < 200 MM	18	3.111	0.828	1.364	4.858	0.27	20	82	91
LMB 200 - 299 MM	18	6.000	1.381	3.085	8.915	0.23	15	61	95
LMB 204 - 330 MM (8 - 13 IN)	18	9.333	1.913	5.297	13.370	0.20	12	48	92
LMB >= 300 MM	18	6.222	1.592	2.864	9.580	0.26	19	75	90
LMB >= 356 MM (14 IN)	18	1.778	0.982	-0.294	3.850	0.55	88	352	97
LMB 331 - 406 MM (13 - 16 IN)	18	1.333	0.723	-0.192	2.859	0.54	85	339	91
LMB >= 407 MM (16 IN)	18	1.556	0.801	-0.135	3.246	0.52	76	306	95
SPB < 200 MM	18	6.667	1.120	4.303	9.030	0.17	8	33	99
SPB 200 - 299 MM	18	4.667	1.381	1.752	7.582	0.30	25	101	87
SPB 204 - 330 MM (8 - 13 IN)	18	7.333	1.688	3.771	10.895	0.23	15	61	84
SPB >= 300 MM	18	3.778	0.884	1.913	5.643	0.23	16	63	78
SPB >= 356 MM (14 IN)	18	0.444	0.305	-0.199	1.088	0.69	136	542	83
SPB 331 - 406 MM (13 - 16 IN)	18	0.889	0.517	-0.202	1.980	0.58	97	390	74
SPB >= 407 MM (16 IN)	18	0.222	0.222	-0.247	0.691	1.00	288	1152	89

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH)

SPECIES	EFFORT (# SAMPLES)	MEAN CATCH	STANDARD ERROR	LOWER 95% C.L.	UPPER 95% C.L.	C.V. OF THE MEAN	# SAMPLES (C.V.=.25)	# SAMPLES (C.V.=.125)	MEAN REL WEIGHT
BLUEGILL < 75 MM	18	3.333	1.836	-0.542	7.208	0.55	87	350	.
BLUEGILL 75 - 149 MM	18	50.000	6.574	36.129	63.871	0.13	5	20	103
BLUEGILL >= 150 MM	18	5.556	1.589	2.203	8.908	0.29	24	94	104
REDEAR < 75 MM	18	0.222	0.222	-0.247	0.691	1.00	288	1152	.
REDEAR 75 - 149 MM	18	7.111	2.059	2.766	11.456	0.29	24	97	100
REDEAR >= 150 MM	18	11.333	2.879	5.259	17.408	0.25	19	74	86
REDEAR >= 200 MM (8 IN)	18	2.000	0.667	0.593	3.407	0.33	32	128	75

2008

LENGTH FREQUENCIES, PERCENT OF CATCH, AND MEAN RELATIVE WEIGHTS
BY 20 MM LENGTH CATEGORIES.

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
121-140	2	2.90	.
141-160	5	7.25	100
161-180	1	1.45	63
181-200	6	8.70	87
221-240	3	4.35	140
241-260	5	7.25	95
261-280	11	15.94	90
281-300	9	13.04	86
301-320	11	15.94	86
321-340	6	8.70	86
341-360	2	2.90	89
361-380	1	1.45	111
421-440	1	1.45	99
441-460	2	2.90	92
461-480	3	4.35	92
481-500	1	1.45	105

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
101-120	5	7.35	96
121-140	11	16.18	110
141-160	7	10.29	99
161-180	5	7.35	79
181-200	2	2.94	95
201-220	1	1.47	101
221-240	1	1.47	97
241-260	3	4.41	90
261-280	9	13.24	86
281-300	8	11.76	83
301-320	7	10.29	79
321-340	7	10.29	74
361-380	1	1.47	78
441-460	1	1.47	89

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=BLUEGILL

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
41-60	3	2.68	.
61-80	32	28.57	174
81-100	85	75.89	96
101-120	66	58.93	104
121-140	50	44.64	105
141-160	10	8.93	96
161-180	7	6.25	106
181-200	10	8.93	.

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=REDEAR

LENGTH	NUMBER OF INDIVIDUALS	PERCENT OF CATCH	MEAN RELATIVE WEIGHT
61-80	1	1.72	.
81-100	5	8.62	107
101-120	8	13.79	105
121-140	14	24.14	92
141-160	15	25.86	113
161-180	21	36.21	87
181-200	12	20.69	81
201-220	6	10.34	75
221-240	2	3.45	.

2008

BASIC DESCRIPTIVE STATISTICS BASED ON BODY LENGTH (MM) AND WEIGHT(G).

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=LARGEMOUTH BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
LARGEMOUTH BASS	69	487	69	1945

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL BASS) SPECIES=SPOTTED BASS

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
SPOTTED BASS	68	449	68	1210

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=BLUEGILL

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
BLUEGILL	263	199	123	110

YEAR=2008 LAKE=STANLEY DRAPER GEAR=SPRING DAY ELECTRO. (TOTAL SUNFISH) SPECIES=REDEAR

SPECIES	N (LENGTH)	MAXIMUM LENGTH	N (WEIGHT)	MAXIMUM WEIGHT
REDEAR	84	222	44	140