Restoration of Submersed Aquatic Vegetation in Little Bear Creek Reservoir in 2008

A Status Report to the Bear Creek Millennium Project and the Alabama Department of Conservation and Natural Resources

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INTRODUCTION

Little Bear Creek Reservoir (LBCR) is located in Franklin County in Northwest Alabama. It is one of four lakes that are part of the Bear Creek Development Authority (BCDA) Lakes and is within the Pickwick watershed of the Tennessee River system. Little Bear Creek Reservoir was impounded in 1975 as a flood control reservoir and has since become an important driving force for the local economy by providing opportunities for fishing, camping, boating, and other recreational activities. Little Bear Creek Reservoir has a total surface area (at full pool) of about 1600 acres and extends 8 miles upstream from the dam (Figure 1). LBCR has a fluctuating water level of approximately 12 ft (3.6m) each year with full pool occurring from mid-April until late October (TVA 2009).

The remnant flooded timber that once served as habitat for the fishery is in decline and needs to be replaced with a self-renewing habitat for forage fishes and young-of-the-year bass (Cheshier et al. 2008). The best replacement for the flooded timber would be a diverse community of native aquatic plants, such as American pondweed (*Potamogeton nodosus* Poir.) and water celery (*Vallisneria americana* Michx.) (Smart et al. 1996). Aquatic plants mediate physical and biological processes in aquatic systems, forming the basis of the aquatic food chain (Carpenter and Lodge 1986). In addition, native aquatic plants serve as refugia for fish fauna (Dibble et al. 1996). Currently, native vegetation in the reservoir is non-existent which may be problematic when trying to establish a productive fishery (Killgore et al. 1989). After impoundment, LBCR was reported to have contained submersed (e.g. *Potamogeton* spp.) and emergent (e.g. water-willow *Justicia americana* (L.) Vahl) aquatic plant species (Phillip Cooper and Gary Don Fleming, personal communication). However, in recent years, there has been no sign of any submersed aquatic plant species and there are local reports of a reduction in emergent plant communities.

OBJECTIVES

Our objective for 2008 was to successfully cultivate three species of approved submersed aquatic plant species for habitat enhancement in Little Bear Creek Reservoir. This study represents Phase II of the initial restoration plan and the results are included in this report.

METHODS AND MATERIALS

Exclosure Study

Three native submersed aquatic plant species were grown and transplanted in Little Bear Creek Reservoir and their survival was evaluated based on species, depth, and herbivore protection. Methods for this project generally follow recommendations of Smart and others (2005). The plants were first propagated from tubers or fragments in April 2008 and raised in a greenhouse and mesocosm at the R.R. Foil Plant Science Research Center, Mississippi State University, and then transplanted into LBCR. American pondweed was collected from a local source in Russellville, AL. Sago pondweed [*Stuckenia pectinata* (L.) Böerner] and water celery were ordered from Kester's Wild Game Food Nurseries, Inc., Omro, Wisconsin.

Water celery and sago pondweed were planted in 3-in peat pots and allowed to grow at Mississippi State University facilities for approximately 6 weeks. Osmocote fertilizer (19-12-6) was used in each pot to improve plant survival during initial growth periods. Two specimens of a given species were planted in each pot. Plants were transplanted (early July) when sufficient growth had occurred and water levels in Little Bear Creek Reservoir were stable and acceptable. American pondweed (approximately 18in. stem length) was collected and directly transplanted with bare roots at the time of plantings.

There were three sites approved by the Tennessee Valley Authority (TVA) in Little Bear Creek Reservoir to plant the native submersed plants. Two sites are located in Trace Branch and one site in Cooper's Branch (Figure 1). Plants were transplanted inside 1m diameter enclosures made of PVC coated wire mesh and re-bar. Sago pondweed and water celery were left in biodegradable peat pots and placed in a small excavated hole in the sediment. American pondweed was planted by rhizomes into the sediment.

Four pots of the same species were planted inside an exclosure (exclosures only contained one species). Approximately 15 stems of American pondweed were used as an alternative to four pots. Each planting location contained nine exclosures of each species totaling twenty-seven (3 plant species * 9 exclosures per species at each site). The treatments of each species were planted along three contour intervals (0.3 meters, 0.6 meters, and 1.0 m) to assess the survival and growth of each species based on depth (Figure 2). Three additional "patches" of each species at each location were planted without exclosures at a depth of 60 cm. Three exclosures per location in which no pots are planted were used as a control (one exclosure at each depth). Each exclosure was evaluated individually and the data from each site location aggregated based on species, depth, and enclosed/not enclosed.

Plants were evaluated based on two factors: 1) presence/absence of plants planted in each location (exclosure or patch) to assess plant survival, 2) visual estimation of percent cover inside each exclosure to assess growth. Sites were checked daily for one week and then bi-weekly (once every two weeks) after plantings until October 2008. The results provided in this report are the survival of plant species, measured from presence or absence data. In addition, these results are only include presence or absence from the last evaluation of the season in September 2008 and do not include bi-weekly results. By using data collected during the last evaluation survey, we can estimate survival of plants without the confounding effects of intermittent senescent periods that were observed during the summer months.

Data were analyzed using a generalized linear model in SAS. Presence/absence data do not fit assumptions of normality but have a binomial distribution. Therefore the analysis model (Proc Genmod) was set to analyze a binomial distribution using a link (logit) function. Significant differences were determined using a least square means (lsmeans) analysis with alpha equal to 0.05 in SAS.

RESULTS

American Pondweed

Results from trials in 2007 indicated that American pondweed was the only species planted that had significant survival (Cheshier et al. 2008). In 2008, American pondweed had significant survival ($p < 0.05$) and expanded inside most exclosures but did not expand outside. Approximately 93% of the exclosures planted with American pondweed had surviving plants in September 2008 (Figure 4). Specimens planted outside of protective exclosures were absent two days after planting.

Sago Pondweed

Sago pondweed never expanded beyond the initial propagules inside exclosures and was absent in many exclosures after only a few weeks. In September, no living plants could be detected inside any exclosures and resulted in 0% survival which was significantly different from American pondweed and water celery (Figure 4). Specimens planted outside of protective exclosures were absent two days after planting.

Water Celery

Water celery survival in both Trace branch sites was similar to sago pondweed during the warm period of the summer. In Cooper's branch, water celery grew and expanded on the substrate but did not show significant vertical growth toward the surface. In September, with cooling water temperatures, water celery began regrowing in some exclosures. Approximately 63% of the exclosures planted with water celery had surviving plants in September 2008 (Figure 4). This was significantly higher than sago pondweed but lower than American pondweed. Specimens planted outside of protective exclosures were absent two days after planting.

Depths

In 2008, exclosures were planted along a depth gradient in order to assess the relative significance of water depth on propagated plant survival (Figure 2). Water levels did not reach full pool but were relatively stable throughout the study period (Figure 3). Mean survival decreased with increasing depth for pooled species data but there were no significant differences detected among percent survival in any of the three depth treatments (Figure 5).

DISCUSSION

Re-establishment of native aquatic plants is potentially a technique used to restore aquatic habitats in the southeastern US (Smiley and Dibble 2006). Aquatic plant community restoration efforts have been attempted in Lake Guntersville, Alabama as well as in Oklahoma, and Texas (Dick et al. 2004, Doyle and Smart 1993). Establishment of aquatic plant communities can have positive effects on water quality as well as provide habitat and sanctuary for fish fauna (Dibble et al. 1996). Successfully cultivating submersed aquatic vegetation in Little Bear Creek has been problematic thus far with difficulties being attributed to fluctuating water levels and high water temperatures. In 2007, water levels never reached full pool, thus complicating restoration efforts (Cheshier et al. 2008).

Results from 2007 indicated that American pondweed was the best candidate for restoration when compared to other species tested (Cheshier et al. 2008). In 2008 we again planted sago pondweed and water celery along with American pondweed to assess their survival potential for another year in case environmental conditions changed. These species all produce some form of subterranean overwintering structures such as tubers or winter-buds. Tubers provide new plants with the necessary carbohydrates needed to initiate growth in subsequent growing seasons (Hodgson 1966). Tubers may also serve as a mechanism to aid in plant survival during adverse environmental conditions. Given the nature of water level fluctuations in LBCR (Figure 3), focused re-vegetation efforts are only feasible for species adapted to survival when environmental conditions do not meet the necessary requirements for year-round growth.

Similar to 2007, American pondweed was the most successful species in 2008. Water depth may play a key role in the success of submersed macrophytes (Chambers and Kalff 1985). Therefore, we stratified plantings at initially controlled water levels (depths) in order to evaluate this in LBCR. Water temperature in shallow areas can become a significant factor impacting plant growth (Pilon and Santamaria 2002). Our hypothesis was that water depth would facilitate temperature differences and thus cause differential survival and growth of plant species. While increased water temperatures can result in an increase in overall biomass of sago pondweed (Barko et al. 1982, van Dijk and van Vierssen 1991, van Dijk et al. 1992), they can negatively impact photosynthesis (Spencer 1986, Madsen and Adams 1989, Pilon and Santamaria 2002), tuber sprouting (Scheffer 1998) and shoot elongation (Spencer 1986, Madsen and Adams 1988). Our results indicated that water depths of 0.30, 0.60, and 1.0m did not have a significant effect on survival.

In 2007 water levels never reached full-pool. In spring 2008, water levels appeared to be rising in concordance with the operating guide for LBCR, however, structural complications with LBCR dam caused TVA to drop the water levels in order to implement repairs. Therefore, in 2008 water levels still did not reach full pool but were relatively stable throughout the study period. The unpredictable nature of water levels from year to year must be considered when planning additional re-vegetation efforts. Providing water levels respond in concordance with the operating guide for LBCR, future projects may be started sooner in the year to allow for a longer growing season.

Phase II of this project was successful in establishing American pondweed. After two years of study, it appears that efforts should focus on this species in order to maximize our ability for re-vegetation. In 2009, we would like to continue our study as an extension of Phase II. American pondweed has shown promising results in the ability to grow and expand within exclosures. However, observations of plant growth outside of the exclosures are rare and have not been sustained. This is likely due to some form of herbivory from fauna that cannot penetrate the exclosures, but can consume or otherwise desiccate plant material that attempts to grow beyond the 1m diameter protection of the exclosure. Future work needs to focus on building larger protected areas in order to allow for greater expansion of plant populations. Furthermore, some exclosures should be removed from well established patches to assess whether patch size has an effect on the ability of the plants to reproduce and continue to expand even in the presence of herbivory.

We will continue to monitor and evaluate plants with similar methods used in Phase I and Phase II. Our initial work in 2009 will be dependent on water levels in LBCR. We will collect American pondweed from local sources and begin planting as soon as water levels are stable and supplies are available.

FUTURE WORK

- Continue planting enclosures of American pondweed in existing planting areas
- Identify new areas for re-vegetation efforts and seek permission for new planting sites.
- Promote the expansion of submersed aquatic plant growth through larger enclosures in more locations throughout Little Bear Creek Reservoir, including deeper water areas.
- Continue to monitor existing, successful enclosures to assess expansion.
- Evaluate potential enhancement of habitat for fish.

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Figure 1. Current restoration areas in Little Bear Creek Reservoir 2008.

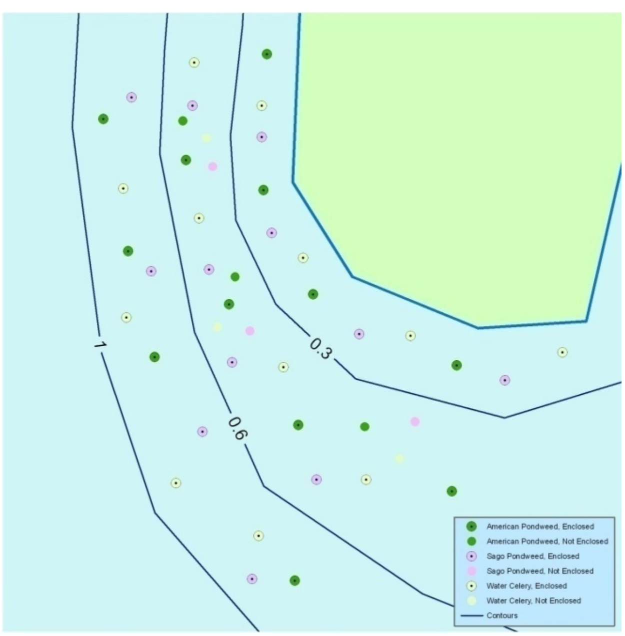

Figure 2. Diagram of planting along depth contours in 2008.

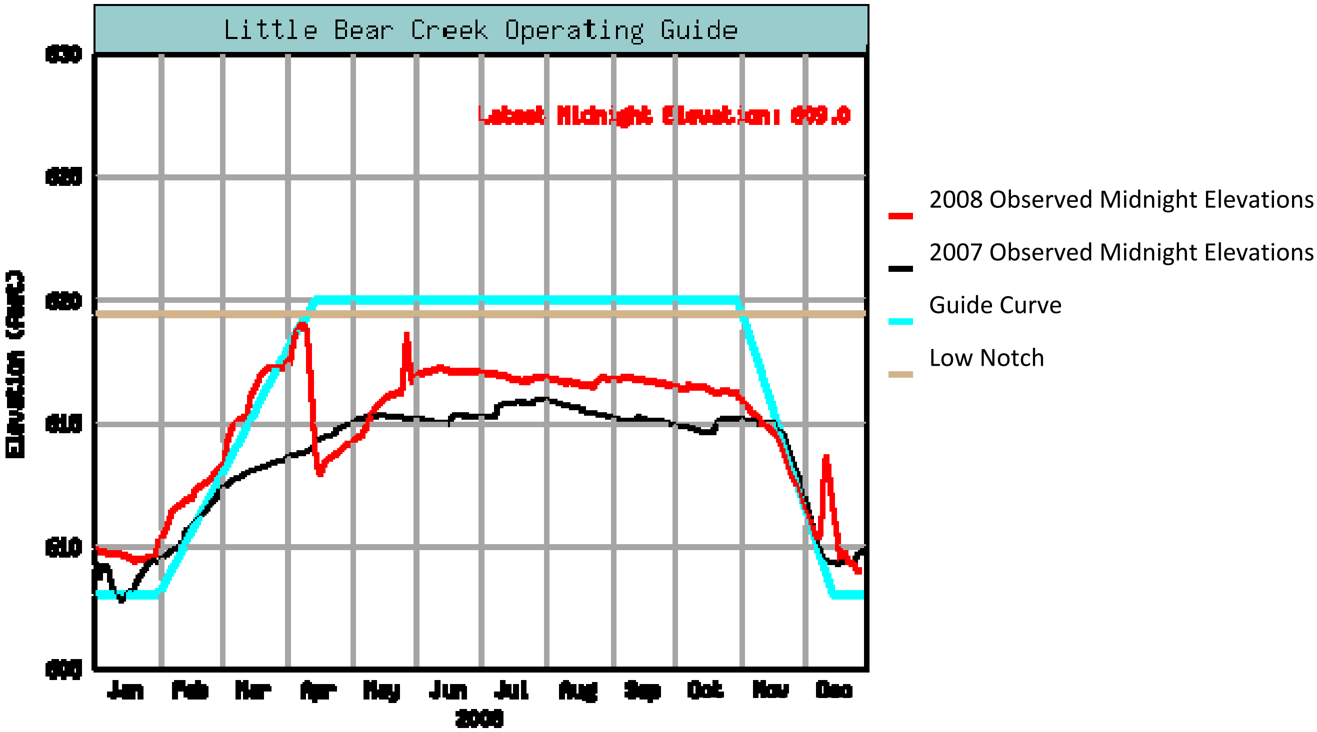

Figure 3. The 2007-2008 Little Bear Creek Reservoir operating guide from TVA (TVA 2009).

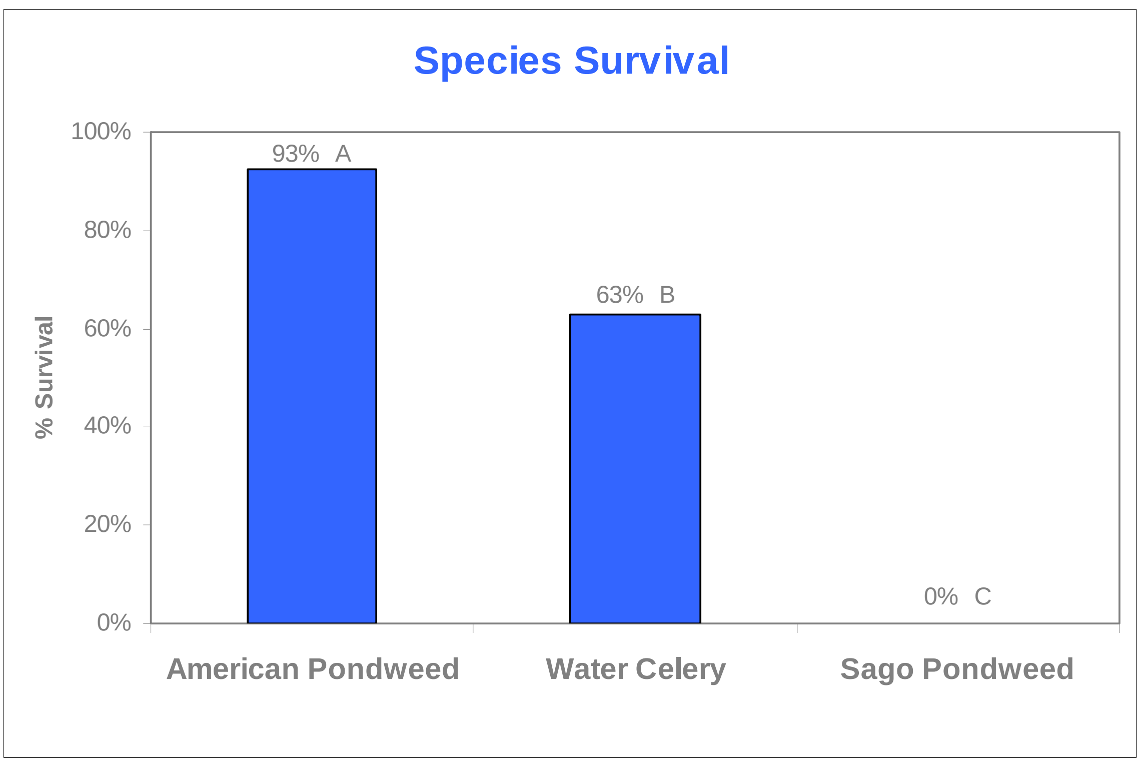

Figure 4. Percent survival of the three submersed aquatic macrophytes planted in exclosures in 2008. Mean survival is significantly different at the $p<0.05$ level if means have different letters, therefore each species had significantly different survival.

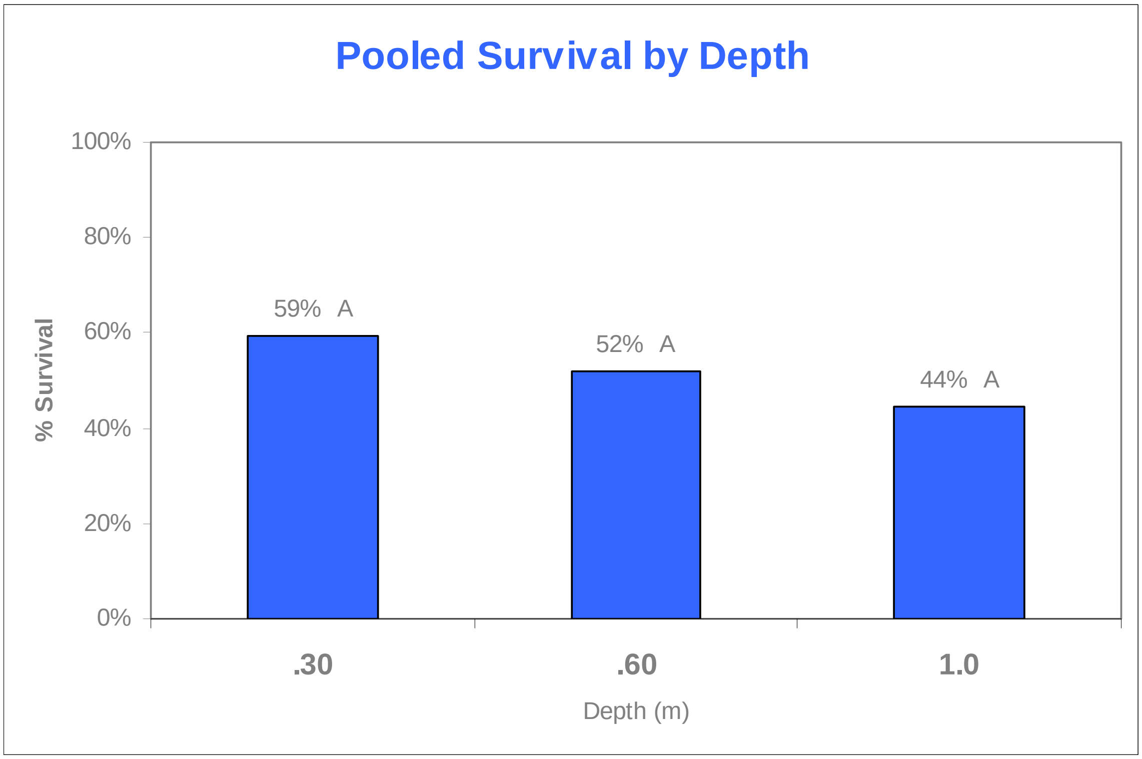

Figure 5. Percent survival of the all three species aggregated based on depth of exclosures in 2008. Mean survival is significantly different by at the $p<0.05$ level if means have different letters, therefore there was no significant difference in pooled survival rate among the three depths.