Dallas Floodway Extension
Chain of Wetlands Ecological Management and Monitoring

Status Report to U.S. Army Corps of Engineers
Fort Worth District
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Gary Owen Dick, Lynde L. Dodd, and Aaron Schad
USACE ERDC Lewisville Aquatic Ecosystem Research Facility
Lewisville, Texas
972-436-2215

Background

The Dallas Floodway Extension (DFE) project includes of a chain of wetlands designed to permit unimpeded overflow of floodwaters along the west side of the Trinity River from the Dallas Floodway to Loop 12, while at the same time provide quality wetland habitat during periods of low water flow. The project is fully authorized for flood control by Section 301 of the River and Harbor Act of 1965 (79 Stat. 1091) and modified by Section 351 of the Water Resources Development Act of 1996 (110 Stat. 3724), which authorized inclusion of non-Federal levees. The authorization was further modified to add environmental restoration and recreation as project purposes by Section 356 of the Water Resources Development Act of 1999 (Public Law 106-53). In initial planning, ecosystem restoration following construction would result in 271 acres of habitat improvement, including 123 acres of emergent wetlands, 45 acres of open water, and 102 acres of grasslands.

The USACE Fort Worth District (SWF) requested assistance from the Corps' Engineer Research and Development Center's (ERDC) Lewisville Aquatic Ecosystem Research Facility (LAERF) in planning and implementation of native aquatic plant establishment in the project. ERDC is providing general guidelines for wetland cell construction to maximize vegetation establishment and ecosystem function while maintaining the system's hydraulic capacity. ERDC is also providing aquatic plants, their installation, and long-term monitoring and management during this project. The overall goal of the project is to provide wetland habitat for waterfowl and other wildlife during low flow periods by way of development of significant native vegetation communities.

The original project proposal called for construction of four wetland cells, designated as D, E, F, and G, known collectively as the Lower Chain of Wetlands (LCOW); construction on Cell D was completed in 2004, and plant establishment and ecosystem management was begun thereafter (2005-2010). Construction of Cells E, F, and G was completed in late fall 2008; establishment of native aquatic plants and ecosystem management was initiated soon after the wetland cells were filled to test pumping/filling systems and levee integrities. Three additional wetland areas are included in the project: Rochester Park Lake (planted 2005-2007) and Cells E-West and F-North (construction completed in winter 2008 as part of the LCOW). Additional cells, A, B, and C (Upper Chain of Wetlands, UCOW) are currently under planning stage and will be included in this project as they are completed.

In addition to establishing and monitoring wetlands vegetation, SWF has engaged ERDC to

monitor several other components of wetland function, including sedimentation (filling in of cells), macro-invertebrate community development, fishery development, and use by aquatic and semi-aquatic wildlife, primarily shorebirds and waterfowl. SWF also requested that ERDC conduct efforts to establish vegetation in rip-rap areas, most notably the river channel below Interstate 45 and the outfalls of Cell F and Cell G. SWF has also requested that ERDC monitor results of grassland seeding and planting at higher elevations beginning in spring 2010. Following results of upland monitoring, SWF requested that ERDC include in its FY2011 Scope of Work methodology and implementation of repairing grassland vegetation communities that failed to establish under previous efforts. While this report focuses on work conducted during FY2010, it includes some work performed thus far conducted under the FY2011 SOW.

Vegetation Community Establishment Approaches

ERDC initiated establishment of desirable native aquatic plants and ecosystem management of Cell D in 2005 using techniques developed by ERDC researchers, and will continue there and on other cells during the remainder of the project. Strategies that proved successful in establishing desirable plants in Cell D are currently being applied to other cells, with modifications made as needed to maximize plant establishment and diversity. Results from earlier plantings are being used to identify the most suitable approaches for establishment and expansion of plants in each cell, and include a diversity of species and growth forms (emergent, floating-leaved, and submersed). Because environmental conditions in cells may vary from those occurring in Cell D, this adaptive management approach is being applied as needed to ensure that substantial establishment of native wetland vegetation will occur.

Protective devices proved necessary for establishing submersed and floating-leaved aquatic vegetation in Cell D, where herbivory affected certain plants, particularly submersed species. It was expected that feeding activities of aquatic (common carp, basking turtles, nutria, etc.) or terrestrial animals (deer, rabbits, loose cattle, wild hogs, etc.) will impede establishment of those same species in new cells during 2010 and beyond. Therefore, those species most likely to be impacted by herbivory are being planted with protection. In addition to protection, trapping and removing turtles and variances in water level manipulations in Cell D improved spread of some submersed and floating-leaved species, and will be practiced in other cells if deemed necessary.

In contrast to submersed species, experience in Cell D suggests that most emergent species will establish and spread readily without protection. Emergent species will therefore be planted in new cells without protection unless grazing begins to affect their survival and spread. This proved true in the remainder of the LCOW during 2010 efforts: emergent species have not required protection in those cells. However, submersed and floating-leaved species remained susceptible to herbivory in all cells, and plantings of those have continued to be protected to enable initial establishment. In general, spread from protected areas has occurred in all cells once plants are established, evidently able to overcome herbivore pressures once greater plant biomass is present.

In addition to installing and protecting plants, water levels in Cell D are being manipulated to encourage growth of desirable volunteer wetland species such as smartweeds and sedges, as well as upland grasses and forbs. This strategy has resulted in development of a plant community comprised of a combination of species that provide high habitat value to waterfowl and other aquatic wildlife. In general, water levels are lowered by about one foot during the summer growing period (summer pool), exposing large areas of moist soil, which encourages growth of both upland and wetland plants. At the same time, wetland and submersed species are able to grow in permanently flooded shallows. Following plant community development and seed production, water levels are raised to maximum pool during the fall and winter (winter pool), allowing waterfowl and other aquatic wildlife access for feeding. This same general strategy is being applied to other cells in the LCOW, with variations in timing and level fluctuation range to enable ERDC researches to develop the best water level management approach.

Monitoring has and will include evaluation of plant community development in the wetland cells. Additionally, basic water quality (pH, dissolved oxygen, conductivity, and temperature) and sedimentation in the cells are being monitored at prescribed stations. Moreover, further biological monitoring (fish and invertebrates) was initiated in 2009 that includes not only the wetland chain but also the stretch of the Trinity River just beneath I-45. Monitoring of the adjacent grasslands and planting efforts to establish vegetation in rip-rap areas were initiated in 2010. These efforts will continue in 2011 and will include pilot studies to ascertain the most successful methodologies for establishing grassland vegetation adjacent to the LCOW cells.

Plantings

Plant establishment was initiated in Cell D in October 2005 and continued throughout 2008, with the greatest planting efforts occurring in late spring/early summer. Table 1 provides the twenty-six species of perennial aquatic plants that have been transplanted into Cell D to date. These include nine submersed species, two floating-leaved species, and fifteen emergent species. In all, over 2,500 plants and 120 cages were installed in Cell D during that time. Because initial plantings indicated that only submersed and some floating-leaved plants would require protection from herbivory in Cell D, resources were shifted to install more emergent plant species with fewer cages than projected in the original scope of work, reflecting the adaptive management approach implemented in this project. Despite the additional effort to establish herbivory-prone species, their importance as components of the aquatic ecosystem merited their continued inclusion in active aquatic plant community development. Because greatest establishment success of initial plantings of submersed and floating-leaved species occurred when they were planted in protected clusters, we continued this strategy in subsequent plantings. Additional plantings of submersed species in Cell D were initiated during FY2010 to compensate for losses due to water pump issues occurring the previous summer.

Table 1. Twenty-six species of native aquatic plants representing three growth forms have been installed in Cell D since September 2005.

Scientific name	Common Name	Growth form
Bacopa monnieri	Water hyssop	emergent
Carex cherokeensis	Cherokee sedge	emergent
Ceratophyllum demersum	Coontail	submersed
Chara vulgaris	Muskgrass	submersed
Echinodorus berteroi	Tall burhead	emergent
Echinodorus cordifolius	Creeping burhead	emergent
Eleocharis acicularis	Slender spikerush	emergent
Eleocharis macrostachya	Flatstem spikerush	emergent
Eleocharis quadrangulata	Squarestem spikerush	emergent
Heteranthera dubia	Water stargrass	submersed
Juncus effusus	Soft rush	emergent
Najas guadalupensis	Southern naiad	submersed
Nymphaea mexicana	Yellow water lily	floating-leaved
Nymphaea odorata	American water lily	floating-leaved
Peltandra virginica	Arrow arum	emergent
Polygonum aquaticum	Water smartweed	emergent
Pontederia cordata	Pickerelweed	emergent
Potamogeton illinoensis	Illinois pondweed	submersed
Potamogeton nodosus	American pondweed	submersed
Potamogeton pusillus	Slender pondweed	submersed
Sagittaria graminea	Bulltongue	emergent
Sagittaria latifolia	Arrowhead	emergent
Schoenoplectus americanus	American bulrush	emergent
Schoenoplectus tabernaemontani	Softstem bulrush	emergent
Vallisneria americana	Wild celery	submersed
Zannichellia palustris	Horned pondweed	submersed

Cells E, F, and G were completed in 2008 and introduction of native plants was initiated. Although not part of the SOW, seed-laden fragments of Illinois pondweed (*Potamogeton illinoensis*) and water hyssop (*Bacopa monnieri*) were distributed in Cell E during filling (fall and early winter 2008) to evaluate whether that approach could benefit plant establishment in the LCOW. Additionally, seeds of American pondweed (*P. nodosus*), bulltongue (*Sagittaria graminea*), arrowhead (*S. latifolia*), American bulrush (*Schoenoplectus americanus*), softstem bulrush (*S. tabernaemontani*), pickerelweed (*Pontederia cordata*), arrow arum (*Peltandra virginica*), creeping burhead (*Echinodorus cordifolius*), and tall burhead (*E. berteroi*) were collected from LAERF cultures and hand distributed in Cell F. Pond sediments laden with American pondweed, slender pondweed (*Potamogeton pusillus*), southern naiad (*Najas guadalupensis*), horned pondweed (*Zannichellia palustris*), and muskgrass (*Chara vulgaris*) seeds (or spores) were distributed throughout Cell F and at the northern end of Cell E. Because late-in-the-year planting and subsequent successful establishment in Cell D, we also planted potted individuals of American bulrush, squarestem spikerush (*Eleocharis quadrangulata*), flatstem spikerush (*E. macrostachya*), slender spikerush (*E. acicularis*), and water smartweed (*Polygonum aquaticum*) throughout Cell E and in selected locations in Cell F and Cell G during mid and later winter 2009. During 2009 and 2010, plantings of the full suite of species (Table 1) using containerized plants were made in Cell E-West (full planting), Cell E (supplemental planting), Cell F (supplemental planting), Cell F-North (partial planting), and Cell G (partial planting). ERDC will complete planting of the LCOW in FY2011. Containerized plants were also used in plantings made in rip-rap areas.

Results to date

Moist soil management and plant establishment

Design and construction of Cell D resulted in three general depths at full-pool (392-ft ASL): a shallow shelf (approximately one-foot deep; 391-ft ASL), a deep shelf (approximately three-foot deep; 389-ft ASL), and a flood conveyance channel (approximately seven-ft deep; 385-ft ASL). Our original planting strategy called for a moist soil management plan in which water levels were to be held at two elevations dependent upon time of year: full pool (winter pool, 392-ft asl) would be held between late fall and late winter to provide habitat access to waterfowl and other aquatic wildlife on the shallow shelf; low pool (summer pool; 391-ft asl) was set for between late winter and late fall to encourage establishment, growth, and spread of both emergent aquatic and terrestrial plants on the shallow shelf. Submersed, floating-leaved, and deepwater emergent species would be established from the grade between shallow and deep shelf, and on the deep shelf itself (389-ft asl); no plants would be established in the channel or grade between deep shelf and channel, although some species are ultimately expected to grow as deep as four or five feet along the slopes leading to the channel.

The original planting strategy was not followed in 2005 in order to reduce possible erosion of the newly excavated wetland during overbank events. Water levels were held at winter pool rather than summer pool, with test plantings of emergent species conducted at the winter pool shoreline and floating-leaved and selected submersed plants installed at the drop-off to the three-foot deep shelf. Because plants continued to grow, albeit slowly, throughout the 2005-2006 winter, we continued planting at winter pool through late spring, 2006, although some submersed plants were planted on the deep shelf during that time.

Between 2006 and 2007, we lowered Cell D to summer pool according to our prescribed schedule and planted the majority of emergent plants at the water's edge (391-ft asl) and submersed and floating-leaved plants on the deep shelf (389-ft asl), which was 2-ft deep at the time of plantings). This, combined with volunteer colonization by desirable upland and wetland

vegetation, resulted in full vegetative coverage over the shallow shelf and partial coverage on the deep shelf, meeting the goals of aquatic plant establishment set for Cell D by the end of the 2008 growing season (Figure 1). All species given in Table 1, with the exceptions of wild celery (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), and squarestem spikerush, were well-established by end of 2008 and continued to thrive during the growing seasons of 2009 and 2010. Desirable volunteer wetland species that have become established in Cell D include Cherokee sedge (*Carex cherokeensis*), water primrose (*Ludwigia repens*), annual smartweeds (*Polygonum* sp.), wild millet (*Echinocloa* sp.), flatsedge (*Cyperus acuminatus*), duckweed (*Lemna* sp.), rushes (*Juncus* sp.), buttercup (*Ranunculus* sp.), and rattlebox (*Sesbania* sp.).

Figure 1. Vegetation is widespread along the shoreline and in the shallows of Cell D, meeting the overall goals of aquatic plant establishment in that wetland.

In addition to scheduled water level manipulations, we periodically attempted to temporarily inundate exposed areas (during excessively hot and dry spells, when emergent species showed signs of stress) to ensure that adequate moisture was available to sustain survival and growth of wetland species. Water is supplied to Cell D via a moderately small pump managed by City of Dallas Waste Water Treatment Plant operations, and during the heat of summer, this pump proved inadequate to inundate the shallow shelf (raising elevation from 391-ft asl to 392-ft asl) in a timely manner, taking as long as three weeks when pumping 24-hours per day. Despite this limitation, plants were able to withstand and recover periods of excessive dryness on exposed areas of the shallow shelf. The worst periods of exposure occurred during the summers of 2008 and 2010. In 2008, an unknown culprit lowered the weir gate to lowest managed pool (389-ft ASL, or 3-ft below winter pool) on two occasions, exposing all plants to desiccation. In 2010, an extended period under which the water supply pump was not working resulted in water levels dropping below 389-ft ASL, with all plant colonies exposed to desiccation for a significant portion of the growing season and summer heat, resulting in a major setback to the wetland plant community in Cell D. However, plants showed signs of recovery in late summer/early fall following pump repair and refilling to summer pool.

Although initially viewed as inhibitory to our goals, expansion of some species while water was lower than planned in 2008 and subsequent recovery of other plant species when the cell was refilled showed that timely lower water levels could increase growth and spread of the wetland plant community to lower elevations, resulting in more of the cell occupied by beneficial plants. We used this information to alter the moist soil management schedule we had set by adding a water level change event: following the dry heat of summer (September 2008), we lowered the cell to 390-ft asl (one foot below summer pool), where we left it until the schedule called for winter pool (392-ft asl) in late October/early November. This manipulation resulted in additional growth of emergent species onto lower elevations, increasing colony sizes and overall vegetative coverage in the cell, without causing damage to other more water-obligate species. As this project emphasizes adaptive management, we decided to incorporate a late summer to fall

drawdown below summer pool in an effort to increase habitat value. A revised moist soil management schedule for Cell D is therefore:

- ***Winter pool (full pool; 392-ft asl): late October to late March***
- ***Summer pool (1-ft below full pool; 391-ft asl): April to August***
- ***Fall pool (1.5-ft to 2-ft below full pool; 390 to 390.5-ft asl): September to mid-October***

Deviation from this schedule is considered when environmental conditions are not conducive to intended results of water level manipulations, or when additional benefits might be realized:

1. Winter pool (full pool, 392-ft asl) serves to make food and cover available to migrating waterfowl and other wildlife; winter pool can be periodically (and temporarily) lowered by one or two feet to provide mudflats for migratory shorebirds and some waterfowl, particularly in late winter to early spring. Winter pool is generally set between November and March.

2. Summer pool (391-ft asl) serves to enable maximum plant growth during the bulk of the growing season on the shallow shelf; during excessively hot and dry conditions, summer pool can be periodically raised by one foot (to winter pool) to inundate dry areas and ensure survival of wetland plant species; temporary inundations can also benefit lower elevation grasslands surrounding the cells. Summer pool is generally set between April and August.

3. Fall pool (390-ft ASL to 390.5-ft ASL) enables expansion (and increase in food and cover) onto the deeper shelf. If conditions are such that plants will not grow during the fall pool schedule (e.g., hot and dry), fall pool should be delayed or eliminated. Fall pool is generally set between September and October.

4. Lowest managed pool (389-ft ASL) should only be used for managing algae blooms or facilitating construction repairs. In all cases, duration of this water level should be as short as possible; if extended drawdown is needed, it should be made only during winter months when plants are dormant.

Numerous overbanking events have occurred during the project, with the most severe occurring during summer 2007, when long-term overbanking lasted about six weeks in June and July (during the active growing season). Complete submersion of plants combined with high turbidities damaged both planted and volunteer plant species, but recovery was noted for nearly all species within four weeks of overbanking termination. Species that were most severely impacted due to this event included wild celery and squarestem spikerush. Shorter-term overbanking events, usually lasting only several days to a few weeks, have occurred during all years of the project, but have had only minimal direct impacts on wetland plants. Indirectly, flushing of nutrients that build up when adding effluent has improved water quality and benefited plant establishment and growth in the cells. Overbanking has also served as a natural stocking mechanism for fish and other aquatic wildlife.

While we continue to operate Cell D using the above prescription, we have also been attempting to diversify both plant communities and function of other cells in the wetland chain by varying moist soil management for each of the additional cells. In 2009 and 2010, we manipulated water levels for moist soil management under the following schedule:

- Cell E-West is being managed with a winter (full; 384.5-ft ASL) and summer (1-ft lower; 383.5-ft ASL) pool. Cell E-West was built with steeper slopes than most other cells, and lacks planting shelves, which is resulting in a thinner band of mixed upland/wetland plants

along its perimeter. However, an island located in the western half of the cell should increase overall wetland plant coverage. Plants installed during spring and summer 2009 and 2010 are moderately well established (Figure 2); however, a significant flush of willow seedlings in 2010 required extensive herbicide applications in late summer---additional plantings will be made in areas not supporting vegetation during 2011, including the island area.

- Cell E is being managed to produce a mixed wetland vegetation/mudflat habitat. Winter pool (full pool; 389-ft ASL) is lowered by 1-ft (388-ft ASL) to achieve summer pool, and then periodically lowered another ½-ft to 1-ft (fall pool; 387 to 386.5-ft ASL) to provide habitat for migrating shorebirds and mudflat-loving waterfowl such as shovelers (*Anas clypeata*) and teal (*Anas* spp.). This adds a habitat component (mudflats) that benefits a number of migratory water and shorebirds. Plants installed during 2009 and 2010 have established well and begun to spread to unplanted areas in this cell (Figure 2).

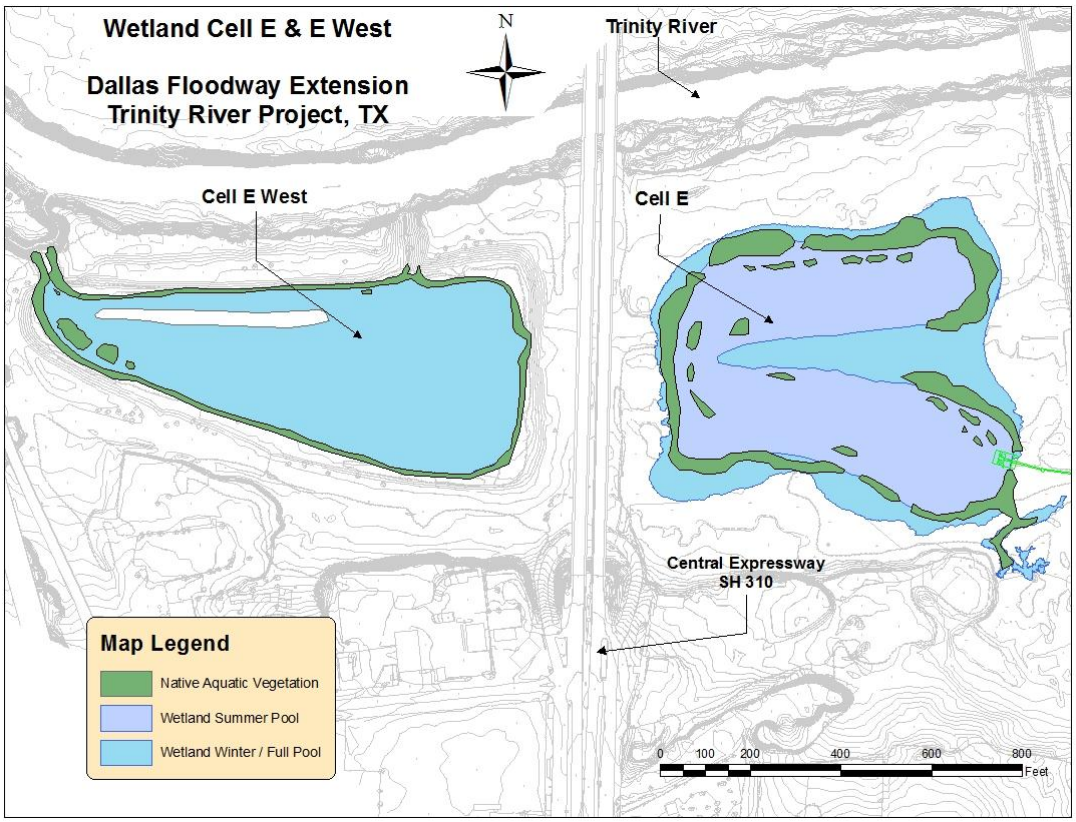

Figure 2. Native aquatic plants were installed around significant portions of Cell E and E-West during 2009 and 2010. Additional plantings will be made in 2011 in conjunction with water level manipulations to increase coverage of wetland and aquatic vegetation.

- Cell F-North is being managed as an ephemeral wetland. Planting species appropriate for those conditions was initiated in 2009, but water levels have not been managed other than to prevent it from dropping below 381.5-ft asl (this should preserve fish and other aquatic wildlife). Included in the Cell F-North management strategy is periodic inundation during periods of drought to ensure survival of desirable wetland species. We have set a full pool elevation (384.5-ft ASL) using the dam board box, and maintained the cell at full pool during the winter 2010/2011 (this is when it will be most easily achieved because its feeder cell (F) will also be full at that time). Plants installed in 2009 and 2010 have responded well to this plan (Figure 3).

- Cell F is being managed with a winter pool (full; 388-ft asl), summer pool (1-ft below winter pool; 387-ft asl), and fall pool (another ½-ft to 1-ft lower; 386.5-ft to 386-ft asl) are being employed to encourage establishment of upland species during summer, which should provide excellent winter habitat for species that use flooded terrestrial areas, such as mallards (*Anas platyrhynchos*). We initiated planting of the westernmost portion of this cell, designated F (West), with wetland plants in 2009 and 2010. Planting in easternmost half, designated Cell F (East), was delayed in order to manage cattail infestation occurring in that cell; planting will be initiated and completed during FY2011. Additional plantings have been initiated in large expanses of winter pool inundated areas associated with this cell in order to hasten plant community establishment in mixed upland/wetland zones (Figure 3).

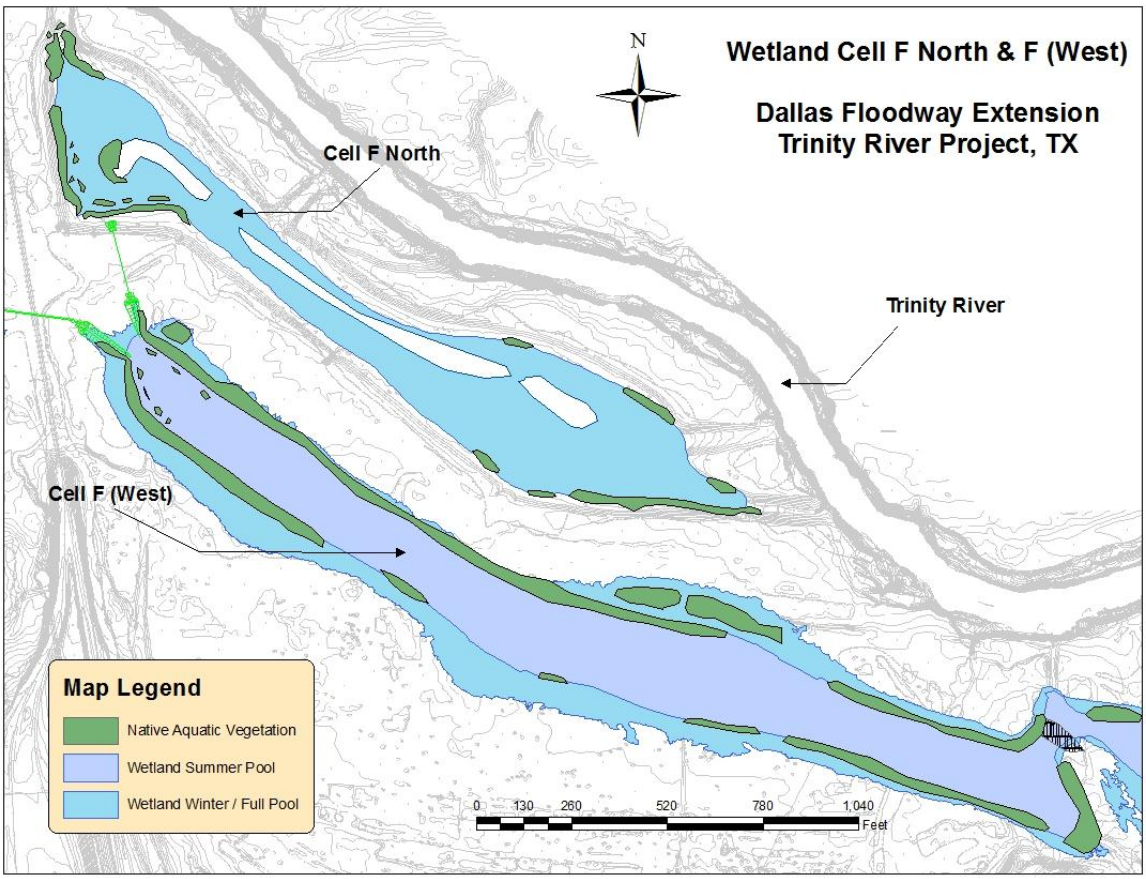

Figure 3. Native aquatic plants were installed around significant portions of Cell F-North and F (West) during 2009 and 2010. Additional plantings will be made in 2011 in these cells and in Cell F (East) in conjunction with water level manipulations to increase coverage of wetland and aquatic vegetation.

- Cell G is being managed with a winter pool at full pool (387-ft ASL) and with summer pool (384.5-ft ASL) set 1 ½-ft below winter pool. This should yield similar results as in other cells, but with more expansive upland species establishment, which when flooded during winter will provide food and cover for dabbling duck species such as mallards, gadwalls (*Anas strepera*), American wigeons (*Anas americana*), northern pintails (*Anas acuta*), and teal (*Anas* spp.). Plants installed during 2009 and 2010 have responding well to this plan (Figure 4). Additional plantings will be made during 2011.

- Planting was initiated in 2009 and continued in 2010 in an approximately 4-acre sump area adjacent to Cell G, herein referred to as the Wood Duck Pond (Figure 4). This pond is connected to Cell G via culvert and water levels fluctuate according to the prescribed management in the cell. The sump area is being planted primarily with floating-leaved species, including American lotus (*Nelumbo luteum*) to produce habitat for wood ducks (*Aix sponsa*). Wood duck nest boxes will be installed in this pond during 2011.

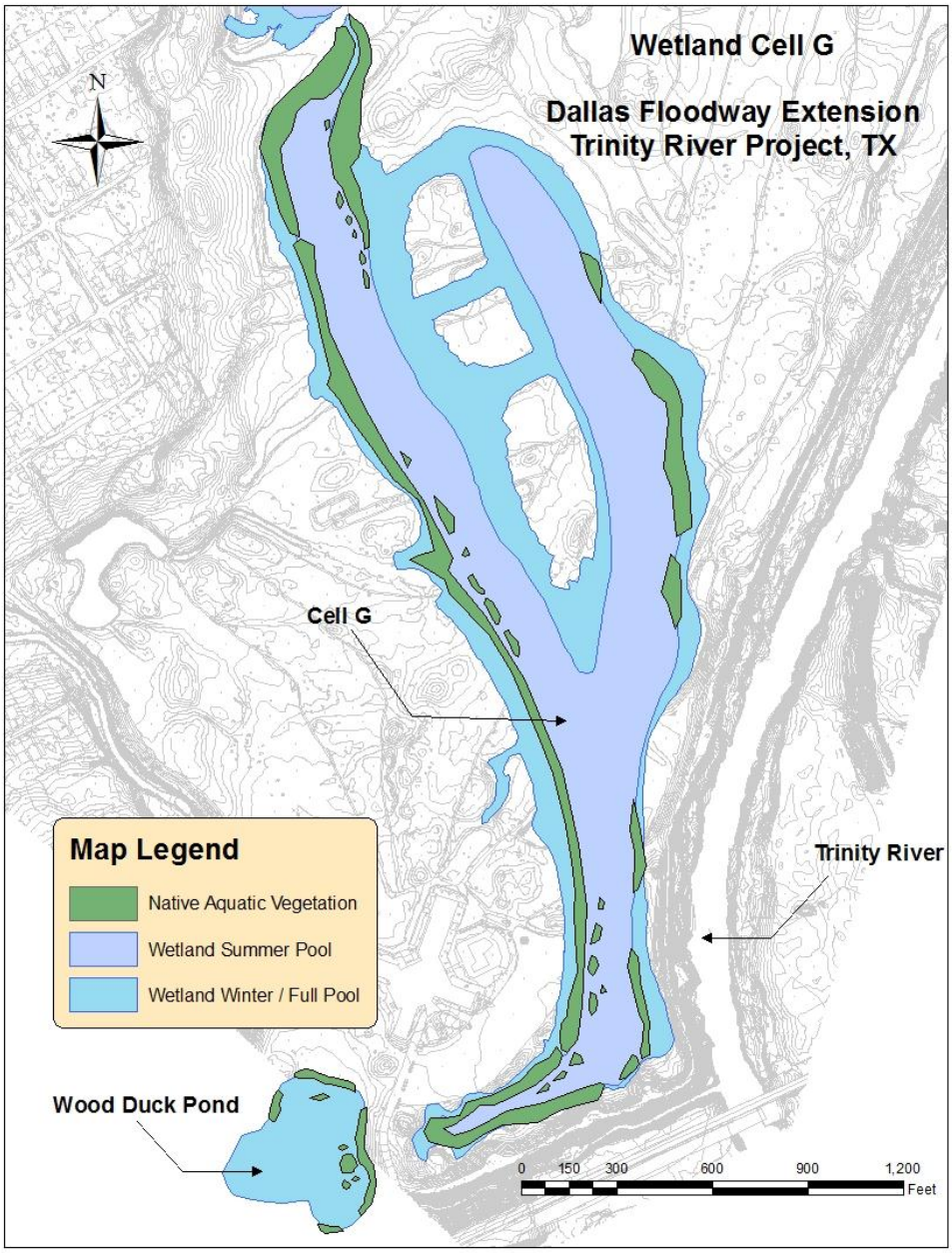

Figure 4. Native aquatic plants were installed around significant portions of Cell G during 2009 and 2010, and planting in the Wood Duck Pond was initiated in 2010. Additional plantings will be made in 2011 in Cell G; nest boxes will also be installed in the Wood Duck Pond and selected wetland cells in 2011.

Herbivory

Plantings have consisted primarily of emergent species, and few, if any, appear to be affected by herbivores, so protection for these plants is no longer used. Reducing costs for protective exclosures has enabled us to reallocate resources to produce and install more plants, following our planned adaptive management approach for establishing vegetation in the wetlands. Floating-leaved species (water lilies) have exhibited some evidence of herbivory, but it appears the level of grazing on those plants is generally not high enough to require protection for all plantings; typically, we plant half with protection and half without, with most plants surviving transplanting, although plants with protection grow more rapidly and are more robust, better able to withstand overbanking and low water events. Survival and growth of submersed species we have planted has been lower than the other two growth forms, which we attribute primarily to turtles. We have therefore continued planting these species in 2009 and 2010 with protection to ensure their establishment, and will use protection in plantings of these species in 2011 (Figure 5). In addition to using ring cages for protection, we have began installing larger pens (approximately 10-ft x 20-ft) for protection of these species in each cell in order to increase overall biomass and seed production, and thereby spread to unprotected areas.

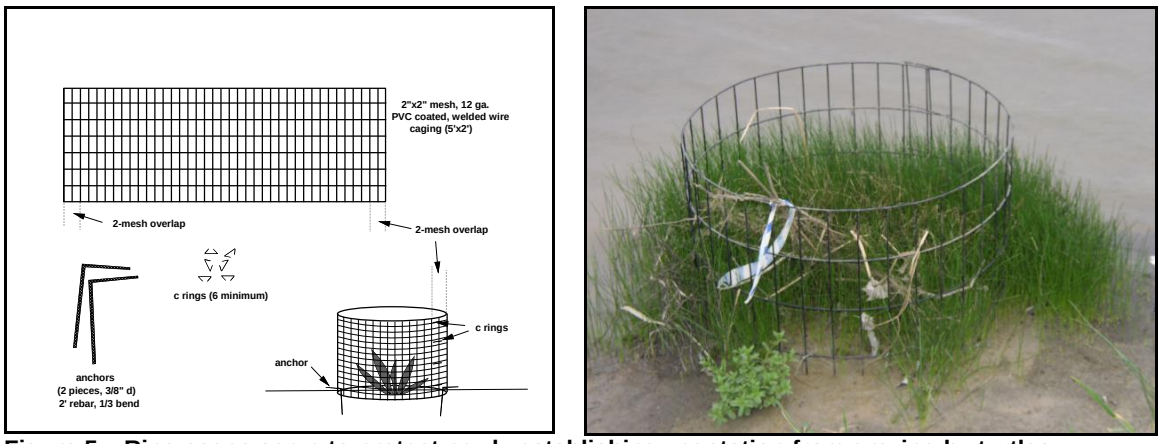

Figure 5. Ring cages serve to protect newly establishing vegetation from grazing by turtles, common carp, and other herbivores.

The principal herbivore encountered in Cell D has been semi-aquatic turtles, mostly red-eared sliders (*Trachemys scripta elegans*), but including river cooters (*Pseudemys* sp.) and map turtles (*Graptemys* sp.). While emergent species have only been moderately affected by turtles, submersed and floating-leaved species have been hard-hit on occasions. Beginning in 2006, we began deploying fall-in traps in Cell D to capture and relocate turtles to the Trinity River or the LAERF (also on the Trinity River). We reasoned that a reduction in turtle population density would in turn reduce grazing pressure on newly establishing vegetation, thereby enabling spread of plants from protective exclosures. Between 2006 and 2010, over 650 turtles were captured and relocated, and following initiation of this practice several species, including American pondweed, water stargrass, American water lily, and yellow water lily exhibited greater spread outside of protected areas. Additionally, the volunteer water primrose has spread significantly throughout the cell. Because red-eared sliders have already been observed in Cells E-West, E, F-North, F, and G, we anticipated that their numbers may increase to the point of becoming problematic for submersed plant establishment efforts. However, we have not encountered significant problems with turtles during 2009 or 2010 following initial planting and protection: once plants are established in those cells, they are able to grow beyond protective exclosures (unlike in Cell D, where turtles herbivory prevented spread from cages). If turtle numbers increase in any of the cells to the point that plants cannot spread beyond exclosures, we will begin trapping and relocating turtles from those cells.

In late 2006, we observed that adult common carp (*Cyprinus carpio*) were present in Cell D and in

subsequent years that common carp were in all cells. While successful reproduction in any cell has not been verified as of this report, we did observe spawning behavior in Cell E in spring 2010. Because common carp can have devastating impacts on aquatic vegetation and aquatic ecosystems in general, we installed eight pens (10-ft x 10-ft x 4-ft tall) designed to trap and contain carp (and turtles) until they can be periodically removed in Cell D. Traps contain exclosures planted with submersed species to act as attractants, and several carp and numerous turtles have been caught using this methodology since their installation. Additionally, overall herbivory damage appears to have lessened in Cell D since turtle and carp traps have been installed. If carp damage is noted in other cells, similar traps will be installed in an effort to control their numbers.

Grazing by other herbivores has periodically caused problems during the project. While evident in all cells since their filling, crayfish did not appear to cause significant problems for plants until spring 2010, when submersed plants in Cell E, Cell G, and the Wood Duck Pond were heavily damaged and required replantings on two occasions. Subsequent to a late spring overbank event, crayfish populations appeared to decline and plants recovered. We will watch the crayfish population more closely in spring 2011 and may manipulate water levels (e.g., lower water temporarily to expose them to predation) to limit their access to plants.

Waterfowl have contributed to some plant loss during winters in all cells, primarily in the form of uprooted bulltongue and rushes, but damage to overall plant populations appears to be minimal. Because plants and overwintering waterfowl have co-evolved, waterfowl feeding typically does not significantly damage plant populations. However, if resident populations of waterfowl (e.g., Canada geese, mallards, etc.) establish in DFE wetlands, their effects on the plant community may become highly problematic. Fortunately, we have seen no evidence as of 2010 that a resident waterfowl population is developing at the LCOW.

Beaver (*Castor canadensis*) have been observed in several cells, with some damage to American and yellow water lily rhizomes in Cell D, but the plants have recovered from this damage during fall 2009. Additional beaver activity and the low water conditions in summer 2010 further damaged these water lily stands, and although some recovery was noted by late fall 2010, it is uncertain if the colonies will adequate recover in spring 2011. If not, supplemental planting will be made in 2011 to ensure those species are present in Cell D. Beaver activity in other cells has not included damage to plants, to date.

Nutria (*Myocastor coypus*) were observed in one cell (E-West) in 2010, but feeding on plants has not yet been seen. Because nutria have the potential to significantly damage belowground portions of bulrushes and other rhizatomous species, and we will continue to monitor their occurrence at DFE and implement control measures if needed.

Feral pig (*Sus scrofa*) tracks have been observed along the shoreline of Cell G. No damage to plants has been noted, but feral pigs can devastate plant colonies. If damage is seen, water levels will be raised to inundate wetland plantings and prevent access to the pigs.

Weed management

Beginning in 2006, several undesirable species began growing as volunteers in Cell D, including cattails (*Typha* sp.), alligatorweed (*Alternathera philoxeroides*), black willows (*Salix nigra*), and cottonwoods (*Populus deltoides*) (Figure 6). Although cattails are native to north Texas and are excellent contributors to wetland function via nutrient abatement, the species is aggressive and tends to crowd out other wetland plants that can provide a much wider range of benefits to wetland-dependent wildlife. Likewise, black willows and cottonwoods are native species that provide certain benefits to wetlands, but because they are woody species that can impede water flow, they are not compatible with the wetland chain function. Alligatorweed is a nuisance species introduced to the U.S. from South America that quickly reaches weedy proportions and

outgrows native plants. We initiated efforts to manage these species in Cell D to ensure minimal impact to overall function of the cell.

Figure 6. Black willows (top left), Eastern cottonwoods (top right), cattails (bottom left), and alligatorweed (bottom right) are the primary undesirable species being managed in the wetland chain.

When encountering cattails, alligatorweed, and tree saplings we initially hand-pulled them in order to control their growth and spread. These efforts met with only moderate success, so we began spot-treatment with glyphosate for their control. Treatment in this manner has been highly successful on cattails, black willows, and cottonwoods, with only limited impacts on desirable vegetation. We continued management of cattails and tree saplings as needed in Cell D during 2007, 2008 and 2009, and 2010, and initiated management in other cells during 2009, where all four species had become established from existing seedbanks. At the time of this report, cattails are either absent or uncommon in all cells and tree saplings are only moderately common, with the exception of Cell G, which supports several stands of near-mature black willows (these trees may not be of concern for flow impediment---SWF and the City of Dallas are making decisions on whether or not to retain them). We will continue managing cattails, alligatorweed, and tree saplings in all cells during 2011.

Alligatorweed remains established to some extent in all cells. We began introducing alligatorweed flea beetles (*Agasicles hygrophila*) to control alligatorweed in 2007 and continued introductions in 2008, 2009, and 2010 (Figure 7). Populations of the beetles have not yet established, in large part due to environmental stresses to the alligatorweed population: long-

term overbanking in 2007 and inadvertent drawdowns and desiccation in 2008 resulted in significant decline of the noxious weed. A short-term overbanking event occurred following the 2009 stocking of beetles, and while much alligatorweed exhibited herbivore damage by fall 2009, we unable to document whether or not a beetle population had become established. Additionally, alligatorweed flea beetles may not be able to withstand cold temperatures occurring during some north Texas winters, and we believe that the winter of 2010/2011 was sufficiently cold enough to damage any population that may have been establishing. While we plan to stock beetles again in 2011, we will also initiate herbicide applications in an effort to control alligatorweed. The broad-leaf dicot selective triclopyr will be used to treat alligatorweed with no or minimal damage to most ERDC-planted or naturally occurring wetland species present in the cells. Foliar treatments will be made on windless days to minimize drift and reduce the likelihood of applying herbicide to desirable species that might be susceptible to the herbicide. We will additionally request that the City of Dallas implement alligatorweed management at the source of the infestation: an outflow from the wastewater treatment plant.

Figure 7. Alligatorweed flea beetles acquired from USACE Jacksonville District are being released to help control alligatorweed infestations at DFE.

We will continue to manage nuisance species in the wetland chain during FY11, as well as additional undesirable species located in the LCOW (e.g., a patch of giant cane, *Arundo donax*, which has been documented between the Trinity River and Cell F, was spot-treated with appropriate herbicides during the 2010 growing season).

Water quality

Other than occasional precipitation and overbanking events, wetland cell water levels are maintained by diverting effluent from the Dallas Central Wastewater Treatment Plant. Initially, water levels in Cell D were maintained (to counter evaporation and wicking by upland areas) by pumping effluent 6 hours per day. This resulted in substantial input of nutrients, with total nitrogen sometimes exceeding 8 mg/L and total phosphorus exceeding 5 mg/L. These nutrient loads were responsible for significant algal blooms that occurred during spring 2006, first dominated by filamentous species. We were able to reduce filamentous algal blooms by dropping the water level by six inches below summer pool (to 390.5 ft-asl), completely exposing the shallow shelf where the majority of the algae occurred, eliminating it through desiccation. After bringing water levels back to summer pool, however, a planktonic algae bloom occurred, resulting in water quality problems due to high rates of photosynthesis by the algae. On several occasions, we recorded pH in excess of 10 units (hand-held meter, spot checks), a level that is harmful to fish and possibly to some aquatic vegetation. Because the blooms came on swiftly

and before substantial establishment by macrophytic vegetation occurred, algae were able to tie up nutrients and dissolved carbon, effectively out-competing the small population of native plants present at that time. While an established community of aquatic vegetation can serve to reduce algal blooms, vegetation was not near the point at which that could occur. Therefore, we opted to implement measures in an effort to limit algal growth. First, we reduced pumping to 1 hour per day to lower input of new nutrients. We also raised the water level by six inches above summer pool (to 391.5-ft ASL) to inundate some of the emergent and terrestrial species that had established on the shallow shelf. We reasoned that these plants, which were better established than submersed species, had better potential to compete with algae for nutrients and would help reduce the overall nutrient loading in the water column. Subsequent to these actions, planktonic algae became less and less problematic, and plant growth increased. While pH remained moderately high, it fell to acceptable levels for fish and other aquatic wildlife (9.5 and below). An overbanking event near the end of the 2006 growing season additionally benefited the system by flushing nutrients (and moderate algal bloom) out of the water column. Over the next three years, the system matured further due to plant growth adding organic materials to substrates and binding nutrients, with decomposition contributing to water quality (ecosystem). Algae blooms have not been a problem in Cell D since 2006.

The water source for Cells E-West, E, F-North, F, and G is the same as for Cell D, although treatment plant water is pumped directly into only two of those cells. A second, larger pump supplies water to Cell E-West and Cell E. Valves associated with the water supply lines enable diversion of water to either or both of these cells. The outflow for water in Cell E-West leads directly into the Trinity River, but water pumped into Cell E flows into Cell F, which has two outflows, one that supplies water to F-North and one to Cell G. Cell F-North outflow empties directly into the Trinity River, while Cell G outflow empties into Honey Branch Creek, a small tributary to the river. Weir boxes permit management of water flow through the wetland chain. For instance, water can be set to flow through Cells E, F, and G, bypassing flow to F-North by raising dam boards in the outflow from Cell F. The ability to manage water flow through the wetland chain provides an additional tool for modifying water quality.

As learned from Cell D, monitoring water quality in the wetland chain is critical for optimal adaptive management strategy development needed to establish and manage submersed species. Because water from the treatment plant first enters Cell E (and separately Cell E-West) and then flows into other cells, we planted these cells more densely to hasten plant establishment. This approach should facilitate removal of some nutrients, thereby reducing algal blooms in downstream cells. We have additionally reduced pumping to a minimum (thereby reducing nutrient inputs during the establishment phase) to maintaining water levels, even permitting drops of several inches below target elevations. This combined effort has thus far resulted in only a single partial algal bloom in one cell (northern half of Cell E, where water enters the cell from the treatment plant), which was eliminated by an overbanking event occurring in summer 2009. The bloom has not recurred: as seen in Cell D, once plant communities begin to mature they are able to compete with algae for nutrients.

We periodically take field readings of temperature, pH, dissolved oxygen, and conductivity using a Hydrolab Quanta, (Loveland, Co) in all cells to provide guidance for when algae management or other water quality actions are necessary. Water quality remained in the range conducive to growing aquatic plants and supporting fish and other aquatic wildlife during 2009 and 2010 (Table 2). Occasional periods of high pH (usually in summer or fall) were most pronounced in Cell E-West and E, were water enters the cells directly from the wastewater treatment plant, reflecting increased algal photosynthesis responding to nutrient loading. As water flows through the system, nutrients are being removed by plants, reducing algal photosynthesis (expressed as lower pH). Interestingly, this also occurred in Cell D during its first few years, but as that wetland community matured, algal blooms and high pH have declined, indicating that the wetland is now absorbing nutrients as they enter the system.

Table 2. Water quality (temperature, pH, dissolved oxygen, and conductivity) remained suitable for plants and aquatic wildlife during 2009 and 2010. Summer 2010 data exhibited high evenness between cells because of an overbanking event. Higher conductivity recorded in fall 2010 was indicative of dry conditions the remainder of the year.

Cell & Sample Site	Season	Temp (*C)		pH units		DO mg/L		Conductivity mS/cm	
		2009	2010	2009	2010	2009	2010	2009	2010
D inlet	Spring	28.60	33.29	8.36	8.41	6.64	8.30	0.485	0.485
	Summer	24.16	28.41	8.37	6.67	8.73	7.01	0.379	0.467
	Fall	6.08	12.56	8.25	8.09	11.58	11.52	0.432	0.760
D outlet	Spring	28.55	32.08	8.76	8.12	8.95	6.72	0.520	0.494
	Summer	24.48	28.16	8.78	6.86	10.11	6.15	0.352	0.418
	Fall	6.35	10.52	7.54	8.43	10.66	11.40	0.440	0.759
E-West inlet	Spring	31.03	33.66	8.77	10.07	7.58	12.66	0.375	0.480
	Summer	24.74	28.45	9.21	6.84	12.26	6.42	0.435	0.350
	Fall	7.59	9.96	8.40	8.25	13.02	10.30	0.482	0.610
E-West outlet	Spring	29.98	32.79	8.70	9.92	7.26	13.49	0.387	0.499
	Summer	25.33	28.84	8.97	7.13	11.44	6.35	0.442	0.340
	Fall	8.33	10.68	8.77	8.12	12.76	9.32	0.478	0.815
E inlet	Spring	30.75	31.78	9.81	8.68	15.82	11.99	0.535	0.710
	Summer	25.44	29.27	7.64	7.79	10.75	7.90	0.727	0.541
	Fall	8.04	11.01	9.28	7.76	15.46	10.40	0.457	0.808
E outlet	Spring	31.05	32.67	9.65	8.94	14.20	11.54	0.516	0.706
	Summer	25.18	29.38	7.54	8.28	7.80	6.97	0.724	0.535
	Fall	5.72	11.18	9.53	7.58	16.10	8.00	0.466	0.812
F-North inlet	Spring	32.20	31.74	8.75	8.49	7.11	9.16	0.385	0.349
	Summer	24.97	28.36	8.22	6.97	7.42	6.49	0.378	0.350
	Fall	8.70	10.60	8.85	8.24	13.29	9.63	0.393	0.385
F-North outlet	Spring	31.33	33.81	8.73	8.69	7.47	6.97	0.410	0.340
	Summer	25.58	28.87	8.69	7.49	9.44	7.22	0.353	0.332
	Fall	6.46	9.83	8.72	8.15	10.88	9.55	0.403	0.390
F (West) inlet	Spring	26.60	32.66	9.27	9.37	9.64	8.72	0.350	0.652
	Summer	26.40	28.43	9.07	7.70	10.64	5.95	0.594	0.346
	Fall	7.82	10.48	8.75	7.91	12.82	8.65	0.499	0.769
F (West) outlet	Spring	30.49	32.08	9.61	9.28	13.30	6.86	0.380	0.631
	Summer	27.71	28.27	9.11	7.70	12.22	6.22	0.570	0.357
	Fall	8.99	10.08	8.59	8.30	13.90	12.02	0.528	0.757
F (East) inlet	Spring	26.60	32.70	9.53	9.23	15.50	7.90	0.440	0.575
	Summer	26.87	29.00	9.24	7.71	12.49	6.50	0.496	0.337
	Fall	8.72	9.89	8.21	8.05	12.31	9.71	0.539	0.679
F (East) outlet	Spring	29.76	31.25	9.75	8.50	13.20	8.28	0.322	0.501
	Summer	24.99	28.18	9.05	7.81	13.43	4.89	0.364	0.330
	Fall	6.48	9.93	8.66	8.09	12.31	11.12	0.509	0.645
G inlet	Spring	29.40	31.11	9.57	8.34	9.50	7.61	0.324	0.477
	Summer	25.58	29.18	8.98	7.56	11.85	5.15	0.361	0.386
	Fall	5.91	9.43	8.42	8.42	11.45	10.71	0.488	0.642
G outlet	Spring	28.90	31.23	8.81	7.26	7.60	4.68	0.369	0.495
	Summer	24.44	28.99	8.52	7.55	8.84	3.84	0.361	0.385
	Fall	8.26	9.63	8.82	7.37	14.25	11.06	0.475	0.556

Sedimentation

Trinity River overbanking events occur up to several times a year at the LCOW, with the most notable occurring in June 2007 (lasting for about 6 weeks) and September 2010 (Table 3). During those times, silt may be deposited in the wetland cells and surrounding areas.

In addition to overbanking during Major and Moderate Flood Stage, the Trinity occasionally backflows into Cell D (outlet), Cell F-West (outlet and cut), and Cell F-North (outlet and cut) during Flood Stage crests of about 35-ft. This has resulted in additional occasions for silt build up in some of the LCOW cells.

Table 3. Historical crests for Trinity River, Dallas, TX since 01 January 2007. Overbanking at DFE occurs during Moderate (38-ft) and Major (40-ft) stages. Back flow into Cell D and flows through cuts in Cell E-West and F-North occur during Flood Stage (30-ft) when the river crests at approximately 35-ft.

Date	Historical Crests (ft)	Stage
Jan-07	34.29	Flood
Apr-07	35.71	Flood
Jun-07	31.41	Flood
Jun-07	34.39	Flood
Jun-07	40.25	Major
Jul-07	32.06	Flood
Jul-07	30.80	Flood
Jul-07	31.33	Flood
Sep-07	34.21	Flood
Oct-07	31.63	Flood
Mar-08	37.52	Flood
Apr-08	32.00	Flood
Apr-08	33.02	Flood
Nov-08	31.96	Flood
Mar-09	31.87	Flood
May-09	33.29	Flood
Jun-09	38.19	Moderate
Sep-09	38.55	Moderate
Oct-09	34.63	Flood
Oct-09	37.14	Flood
Oct-09	32.36	Flood
Jan-10	35.92	Flood
Feb-10	32.87	Flood
Feb-10	34.28	Flood
Mar-10	30.09	Flood
Mar-10	30.41	Flood
Sep-10	41.39	Major
Sep-10	31.39	Flood

Beginning in 2008, SWF requested that ERDC begin to periodically measure sedimentation rates in the LCOW cells. ERDC measures water depths along permanent, GPS-marked transects (three to seven, dependent upon cell) that have been established in each cell. Depth measurements are made at three to five points along each transect. Water surface elevation is recorded for each cell, with depths subtracted to calculate cell bottom elevations at each measured point. Depth measurements are made twice-yearly, generally one in summer and one in winter, unless conditions (e.g., overbanking) preclude safe access to the cells (Figure 8).

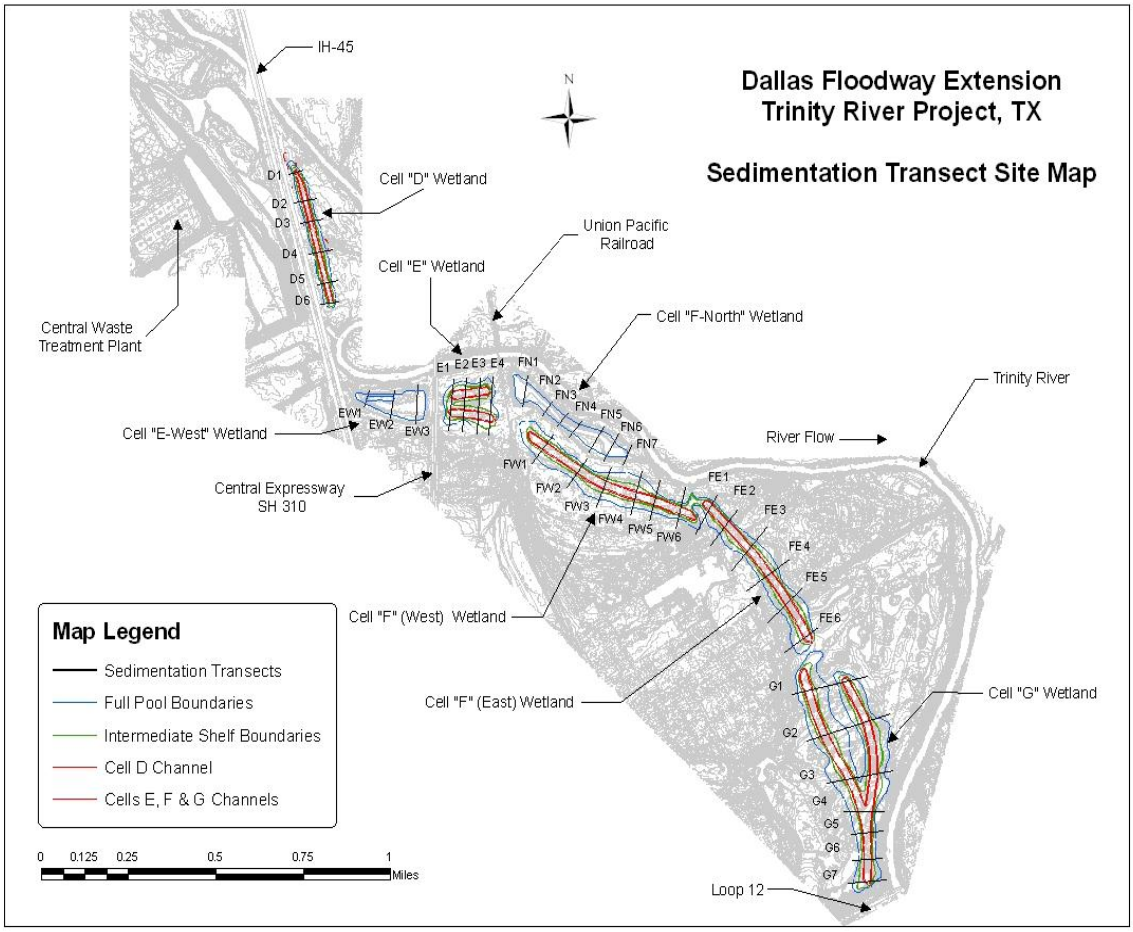

Figure 8. Dallas Floodway Extension Trinity River Project, TX sedimentation transect site map. Transects are symbolized by the wetland cell letter and transect number north-to-south or west-to-east (i.e., the northernmost transect in Cell D is designated as D1).

Depth readings were taken from Cell D in 2008 on two occasions, in 2009 on one occasion, and on two occasions in 2010 (Table 4); Monitoring of sediment buildup began in Cells E-West, E, F-North, F, and G during 2009 and continued through 2010 (Tables 5-10). Because it is divided in half by a rip-rap barrier (culverts permit flow through the barrier), Cell F is being measured as two separate wetland cells, F (West) and F (East). Elevation data provided here represents baseline information for future measurements to help ascertain whether or not the cells are filling in with sediments. For the most part, initial elevation measurements (2008 and 2009) were in line with those targeted during construction, and it does not appear that significant sedimentation has begun to occur in any of the LCOW cells.

Table 4. Elevation (ASL in feet) was calculated from depths taken along six transects in Cell D in 2008, 2009, and 2010.

Transect D1					Transect D2					Transect D3				
Mar-08	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**	**Mar-08**	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**	**Mar-08**	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**
388.05	387.52	388.20	389.41	388.87	387.89	387.33	387.90	389.08	388.70	388.05	387.65	387.90	389.38	388.70
385.36	385.16	385.80	387.31	386.74	384.77	384.37	384.49	386.13	385.72	384.61	384.70	384.19	385.90	385.36
384.77	384.87	385.83	386.98	386.24	384.11	384.04	384.26	385.97	385.36	384.11	383.78	384.03	385.77	385.10
385.59	385.09	385.97	387.11	386.51	384.77	384.11	384.49	385.93	385.46	384.77	384.24	384.29	385.90	385.65
387.79	387.62	388.23	389.31	388.54	387.89	387.39	388.03	389.08	388.38	387.79	387.39	388.10	389.08	388.93
Transect D4					**Transect D5**					**Transect D6**				
Mar-08	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**	**Mar-08**	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**	**Mar-08**	**Oct-08**	**May-09**	**Jun-10**	**Oct-10**
387.89	387.65	387.97	389.08	388.34	388.05	387.33	387.80	388.69	387.69	388.05	387.82	387.93	388.03	388.05
384.61	384.27	384.13	385.80	385.03	384.77	384.50	384.72	385.47	385.03	386.25	385.98	385.38	387.21	387.06
384.11	383.95	384.10	385.67	384.93	384.11	383.91	384.42	385.47	385.00	385.92	385.52	385.15	386.88	386.44
384.77	384.34	384.46	385.57	385.10	384.41	384.24	384.69	385.47	385.06	386.41	386.01	385.11	386.85	386.41
387.79	387.49	388.39	388.95	389.10	387.72	387.49	387.87	388.85	388.61	388.22	387.65	388.00	387.70	388.08

Table 5. Elevation (ASL in feet) was calculated from depths taken along three transects in Cell E-West in 2009 and 2010.

Transect EW1			Transect EW2			Transect EW3		
May-09	**Jun-10**	**Oct-10**	**May-09**	**Jun-10**	**Oct-10**	**May-09**	**Jun-10**	**Oct-10**
383.75	383.22	383.02	382.43	383.22	383.35	383.35	383.35	383.52
380.96	381.22	381.22	382.83	381.55	380.56	380.43	381.55	378.83
381.22	382.27	382.53	377.15	380.56	376.33	376.30	376.79	376.99
382.14	382.20	381.55	377.94	376.30	376.99	375.71	376.30	376.86
383.35	383.02	383.52	383.35	383.35	383.19	375.81	376.00	376.63
						376.37	376.46	376.46
						379.12	378.76	377.19
						382.17	382.56	383.52

Table 6. Elevation (ASL in feet) was calculated from depths taken along four transects in Cell E in 2009 and 2010.

Transect E1			Transect E2			Transect E3			Transect E4		
May-09	**Jun-10**	**Oct-10**	**May-09**	**Jun-10**	**Oct-10**	**May-09**	**Jun-10**	**Oct-10**	**May-09**	**Jun-10**	**Oct-10**
387.54	386.20	386.36	387.67	387.44	386.46	387.57	387.02	387.05	387.54	386.52	386.69
386.03	386.10	384.06	386.23	385.97	385.97	385.93	383.74	383.74	382.82	382.82	382.46
382.36	382.42	382.00	382.65	383.08	382.42	382.59	382.59	382.46	381.96	382.39	382.39
382.33	382.26	381.74	382.59	382.46	382.46	382.49	382.42	382.36	386.36	386.36	387.02
382.29	382.10	381.70	382.49	382.26	382.59	382.42	382.26	382.33	386.59	386.59	386.43
386.10	386.10	386.10	386.23	386.03	386.03	382.75	382.75	382.59	381.77	382.16	382.16
387.57	385.70	385.87	387.67	385.70	387.02	387.54	386.20	386.69	382.71	382.23	382.78
387.21	387.08	386.03	387.51	386.20	386.36	387.57	387.41	387.28	387.34	386.85	386.95
386.43	386.16	386.10	386.29	386.36	386.03	386.20	386.03	385.87			
382.03	382.36	384.72	382.42	381.90	381.90	382.16	382.26	381.83			
381.44	382.03	381.74	382.26	382.10	381.83	381.77	382.03	381.74			
382.00	381.77	382.10	382.16	382.10	381.60	381.77	381.77	381.60			
382.42	382.42	381.93	382.42	381.70	381.83	382.10	382.10	382.10			
387.67	386.69	386.75	382.03	382.03	381.83	387.54	386.36	386.36			
			387.67	386.20	386.36						

Table 7. Elevation (ASL in feet) was calculated from depths taken along six transects in Cell F (West) in 2009 and 2010.

Transect FW1			Transect FW2			Transect FW3			Transect FW4			Transect FW5			Transect FW6		
May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10
386.34	385.69	385.52	386.67	385.66	385.75	386.41	386.05	385.85	386.31	386.18	385.79	386.51	385.69	385.75	386.61	386.02	386.08
384.97	383.06	384.77	384.90	384.11	384.11	385.52	385.03	385.20	385.23	384.54	384.54	385.36	382.90	384.05	385.43	384.05	384.21
381.10	380.11	380.83	380.28	380.83	380.70	380.67	380.44	380.70	384.70	384.38	384.38	380.51	380.51	380.60	380.47	380.47	380.37
381.03	380.77	380.44	380.60	380.83	380.77	380.87	380.60	380.60	381.33	380.08	380.47	380.77	380.47	380.51	381.36	380.44	380.60
381.03	380.70	380.77	380.93	380.70	380.90	380.83	380.60	380.83	380.64	380.37	380.51	380.93	380.60	380.80	380.87	380.51	380.60
381.85	381.85	381.13	380.55	380.77	380.93	385.36	384.87	384.87	380.64	380.44	380.51	382.57	380.77	380.57	380.90	380.64	380.67
385.56	384.97	384.97	386.08	383.88	385.20	385.20	384.74	385.03	385.10	384.21	384.93	385.03	384.31	384.38	384.74	383.79	384.41
386.70	386.02	385.88	386.51	385.52	385.75	386.34	385.82	386.34	386.57	385.88	386.02	386.51	386.08	386.05	386.57	386.08	386.18

Table 8. Elevation (ASL in feet) was calculated from depths taken along six transects in Cell F (East) in 2009 and 2010.

Transect FE1			Transect FE2			Transect FE3			Transect FE4			Transect FE5			Transect FE6		
May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10
386.02	385.79	386.02	386.21	386.11	386.28	386.02	385.85	386.08	386.51	385.85	385.36	386.05	386.02	386.05	386.34	385.98	385.43
385.26	384.77	384.97	384.74	384.87	384.87	385.26	385.03	385.00	384.70	383.56	383.75	385.16	384.70	384.70	384.77	384.64	385.00
385.29	384.87	384.70	380.47	380.77	380.67	380.50	380.60	380.41	380.93	380.70	380.70	381.36	381.10	380.60	381.10	381.10	381.36
385.13	384.87	384.20	380.93	380.64	380.51	380.77	380.37	380.34	380.18	379.95	380.37	382.74	380.14	380.37	380.34	380.11	380.51
385.13	385.13	384.87	381.10	380.83	380.83	380.77	380.57	380.31	382.67	379.95	380.11	380.77	380.44	380.34	379.46	380.01	380.34
384.44	384.70	384.90	382.74	380.70	380.77	381.10	380.83	380.57	380.22	380.44	379.78	381.10	380.44	380.74	379.50	379.78	379.95
384.97	384.44	384.70	384.02	384.05	382.74	385.52	383.98	384.31	385.10	383.39	384.61	384.97	384.38	384.61	385.03	384.61	384.54
386.34	385.85	386.02	386.21	385.85	386.08	386.31	385.62	385.62	386.18	385.85	386.34	386.51	386.18	386.34	385.26	386.08	385.52

Table 9. Elevation (ASL in feet) was calculated from depths taken along seven transects in Cell F-North in 2009 and 2010.

Transect FN1			Transect FN2			Transect FN3			Transect FN4			Transect FN5			Transect FN6			Transect FN7		
May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10
382.51	383.25	383.52	382.51	382.96	383.16	382.74	383.35	383.52	382.31	383.19	383.25	382.61	383.52	383.22	382.48	383.68	383.35	382.34	383.02	383.06
380.61	380.47	376.96	382.18	382.53	381.94	382.15	382.89	382.34	381.46	382.04	381.84	381.29	382.20	381.88	381.52	382.04	381.19	379.06	380.20	380.53
378.05	377.45	376.96	382.18	382.86	381.91	382.48	383.78	383.52	382.57	383.52	383.35	382.41	383.19	381.58	382.61	383.68	382.76	376.28	378.27	379.15
377.00	377.45	377.55	381.95	382.60	381.58	382.54	383.35	383.02	382.61	383.35	383.52	382.67	383.52	381.74	382.48	382.89	381.84	376.28	376.79	377.94
377.88	377.19	376.96	381.59	381.71	381.25	380.77	381.29	380.73	381.43	382.86	381.32	380.70	380.56	380.60	379.85	379.81	376.56	376.60	377.12	378.53
378.74	377.12	377.22	382.54	383.02	383.25	382.57	383.81	383.52	378.74	381.58	379.09	376.18	376.89	377.25	376.77	377.22	376.69	381.20	380.24	379.48
379.72	377.28	378.89							377.88	379.51	377.28	376.11	376.79	376.53	376.44	376.92	376.76	382.51	383.45	383.16
381.36	379.74	381.45							379.82	378.50	378.50	375.85	376.63	376.14	376.44	376.96	378.43			
382.67	383.25	383.19							381.66	379.22	380.17	378.08	376.76	376.00	379.85	379.91	381.15			
									382.74	381.38	381.94	377.91	377.91	376.27	382.67	382.70	383.68			
									383.29	383.29	383.35	380.61	380.89	379.55						
												383.59	383.52	383.45						

Table 10. Elevation (ASL in feet) was calculated from depths taken along seven transects in Cell G in 2009 and 2010.

Transect G1			Transect G2			Transect G3			Transect G4			Transect G5			Transect G6			Transect G7		
May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10	May-09	Jun-10	Oct-10
382.69	382.35	382.12	382.62	382.25	382.93	382.62	382.35	382.35	382.75	382.35	382.02	382.03	382.48	382.16	382.03	382.19	382.84	383.70	383.25	383.25
380.20	379.92	379.66	380.20	379.92	379.66	380.33	380.12	379.53	380.06	380.09	379.60	380.06	381.83	380.74	379.97	380.51	380.51	379.67	384.45	383.17
380.06	379.60	379.56	380.16	379.92	379.73	380.10	380.09	379.76	380.13	379.92	379.66	378.10	380.12	379.76	379.80	380.09	379.76	379.60	379.76	379.24
382.52	382.53	383.79	382.69	382.35	382.25	382.56	382.22	382.25	379.77	379.76	379.60	379.93	379.86	379.33	380.10	379.76	378.78	377.77	379.10	380.15
382.03	382.35	384.58	382.56	382.35	382.70	382.52	382.52	383.93	382.82	382.55	382.66	382.82	382.17	382.09	382.69	381.24	383.04	379.41	381.17	380.09
381.05	381.89	379.83	380.06	379.89	381.56	380.03	380.74	380.74												
380.42	380.42	379.76	378.88	379.99	379.86	380.25	380.25	379.76												
380.89	381.56	381.56	382.52	382.35	382.53	383.38	384.02	383.19												
381.89	382.19	384.02																		

Despite several overbanking events per year since completion of its construction in 2005, and notably the long-term overbanking that occurred during the summer of 2007 and extensive overbanking in 2010, none of the LCOW cells appear to be filling in with sediments at appreciable rates (Table 11). On the contrary, some cells (E-West, E, F (West), and F (East)) appear to have deepened slightly, likely the result of scouring occurring during the 2010 overbanking event. Cell D, the oldest cell at 6 years since construction was completed, has shown the greatest sediment build up, averaging about 1/10th foot sedimentation per year.

Table 11. Mean changes in elevation between baseline observations and October 2010 observations in the LCOW.

Wetland Cell	Transects							Total Cell
	1	2	3	4	5	6	7	Mean
D	1.07	0.84	0.88	0.67	0.46	0.24		0.69
E- West	0.08	-0.66	0.09					-0.16
E	-0.44	-0.51	-0.46	-0.03				-0.36
F -North	-0.65	0.02	0.56	-0.08	-0.32	0.13	1.08	0.11
F (West)	-0.53	-0.30	-0.22	-0.42	-0.68	-0.48		-0.44
F (East)	-0.28	-0.46	-0.45	-0.68	-0.61	0.10		-0.39
G	0.35	0.19	-0.03	-0.40	0.23	0.07	1.15	0.22

This is not to say that sediments are not shifting within the cells, or being moved between them. While the primary source of sediment deposition in the cells is most likely from overbanking events, movement of soil due during erosion of upland areas may thus far have played a more significant role in areas where sediment deposits have been observed. Washing out of unvegetated shorelines has occurred during windy days, and upland soils are carried into the cells during most heavy rain events and in some areas during overbanking events. In 2005, this was highly evident along portions of Cell D prior to establishment of upland cover crops (winter rye) and wetland vegetation along the shoreline, and was similarly evident in the remaining LCOW in 2009 following their construction. However, once upland plants were established, this type of erosion became less significant, with cover crops holding topsoils in place. Additionally, soil that did wash towards the cell was caught by plants established along the shoreline; at the same time, shoreline plants have minimized shoreline erosion due to wave action. Planting shelves have exhibited some build up of sediments, as have areas where flow bottlenecks, such as the weir gates and levees between cells. The greatest deposition has been observed in five moderately small areas (Cell D weir gate, Cell E-West board gate and cut area, Cell F-North board gate and cut area) that are subject to river backflow when the river is at high elevation but has not overbanked. This situation has been observed not only immediately before and after overbank events, but when large volumes of water are released from upstream reservoirs (e.g., Lewisville Lake) for flood management.

Overall, LCOW cell contours have changed moderately in certain areas, but none to the extent that reshaping is needed. More importantly, the flood conveyance channels remain clear.

Armored areas plantings

Several areas of concern regarding erosion were identified in 2009: the outfall from Cell F to Cell G, and the outfall from Cell G into Honey Branch Creek (Figures 9 and 10); additionally, water flowing into Cells E-West and F-North just prior to and during full overbanking by the Trinity River has caused some erosion problems (Figures 11 and 12). And, finally, areas adjacent to hard-armored slopes of the Trinity River just below the I-45 Bridge were deemed of concern (Figure 13). SWF contracted repairs of hard armored areas at the Cell F to G outfall (2009), the Cell G outfall (2010) and the riverbank (2009). Following repairs, SWF decided to take additional measures by engaging ERDC to plant an array of plants, both terrestrial and wetland, to improve performance of armoring at these sites (Table 12), as well as at cuts associated with Cell E-West and Cell F-North. Plantings at these sites were initiated in 2010 and will continue through 2011.

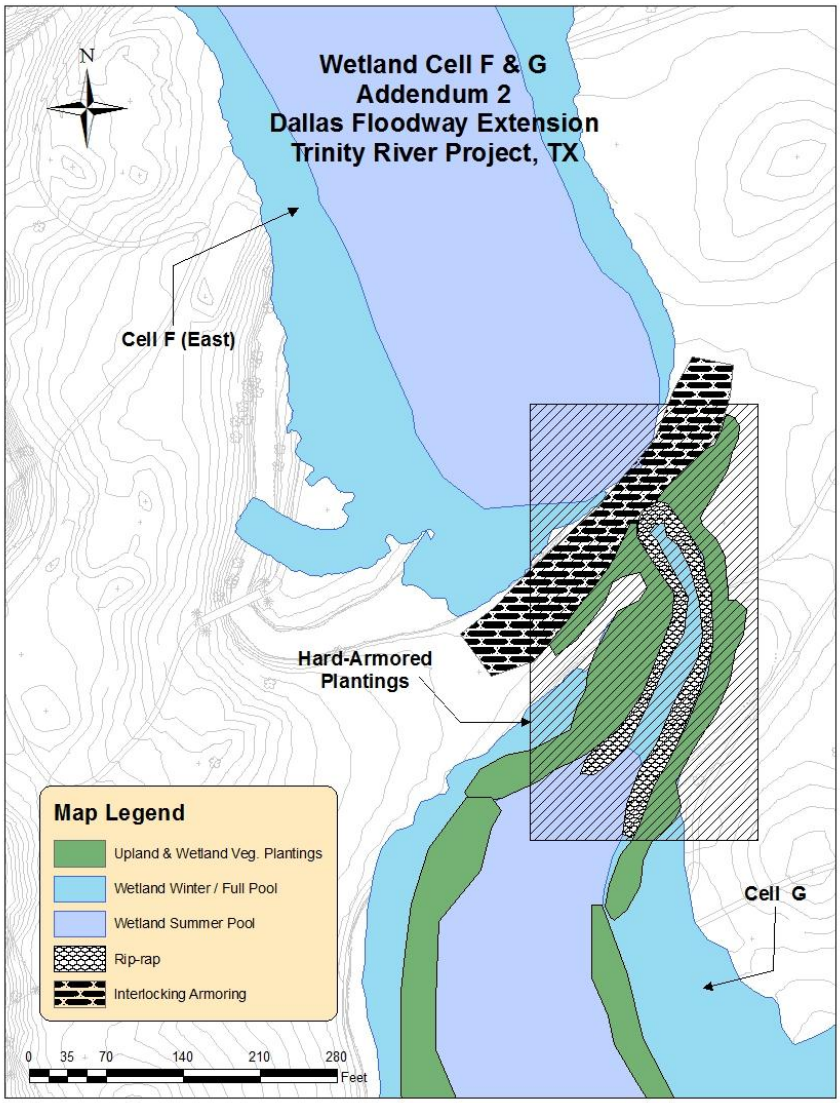

Figure 9. Hard armored areas at the outfall of Cell F into Cell G are being planted to improve performance of armoring. Plantings were initiated in 2010 following completion of repairs and will continue in 2011.

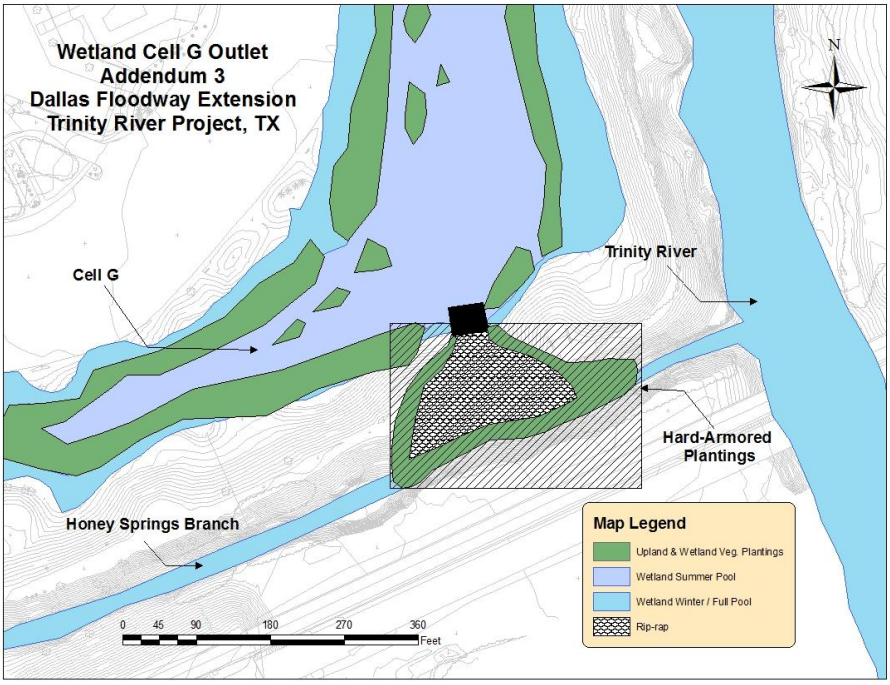

Figure 10. Hard armored areas at the outfall of Cell G are being planted to improve performance of armoring. Plantings were initiated in 2011 following completion of repairs.

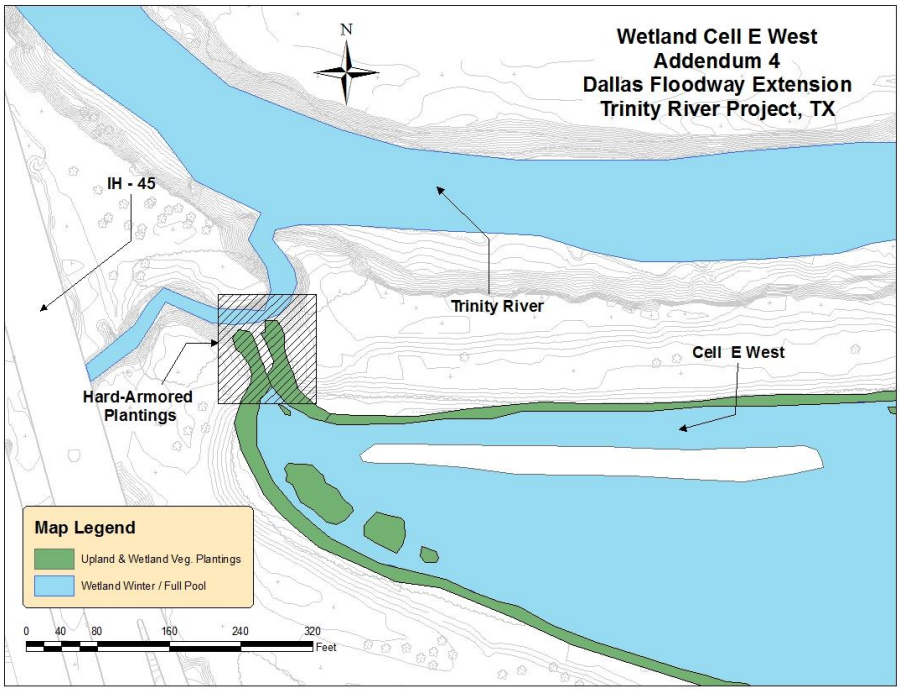

Figure 11. A moderately hard armored cut at the northwest corner of Cell E-West is being planted to improve performance of armoring and reduce overall erosion. Plantings were initiated in 2010 and will continue in 2011.

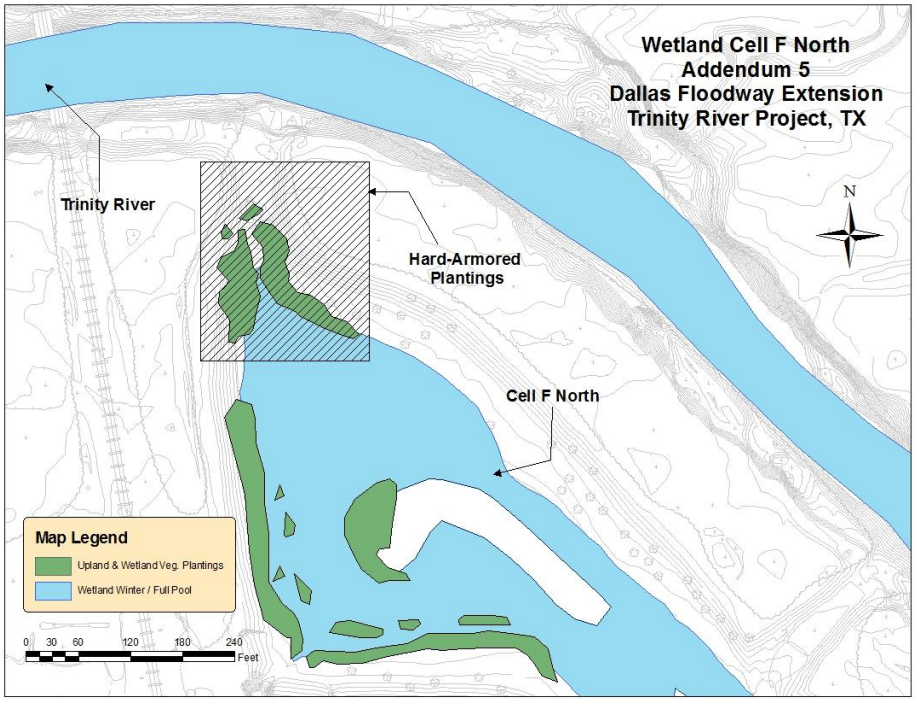

Figure 12. A moderately hard armored cut at the northwest side of Cell F-North is being planted to improve performance of armoring and reduce overall erosion. Plantings were initiated in 2010 and will continue in 2011.

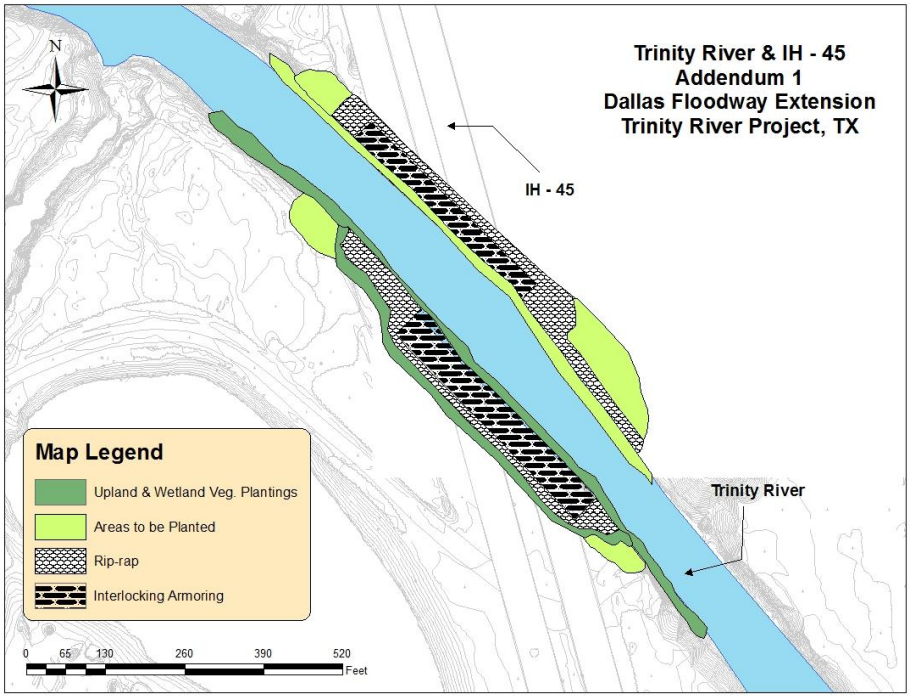

Figure 13. Hard armored areas along the river channel below the I-45 bridge are being planted to improve performance of armoring. Plantings were initiated in 2010 and will continue in 2011.

Table 12. Native plants are being installed around several hard-armored areas at the LCOW to improve performance of erosion control.

Species	Common name	Growth form
Ampelopsis arborea	Peppervine	Woody vine
Ampelopsis cordata	Heart-leaf peppervine	Woody vine
Callirhoe involucrata	Winecup	Perennial herb
Campsis radicans	Trumpet creeper	Woody vine
Eleocharis (2+ spp.)	Spikerushes	Perennial rush
Hibiscus (2+ spp.)	Mallows	Shrub
Justicia americana	Water willow	Perennial herb
Malvaviscus drummondii	Turk's cap	Shrub
Passiflora incarnata	Passion flower	Woody vine
Phyla nodiflora	Frog-fruit	Perennial herb
Schoenoplectus (2+ spp.)	Bulrushes	Perennial rush
*Smilax (*2+ spp.)	Green briar	Woody vine
Vitis spp.	Grape	Woody vine

Results to date: Plant production was begun at LAERF in spring 2010, with test plantings conducted at all sites later than year except for the Cell G outfall, which was under construction during that time. Plantings were made in summer, fall, and winter to evaluate species selection and timing of establishment. Although final evaluations have not been made as of this report, late winter growth indicates that peppervine, winecup, and frogfruit have established well along higher elevation rip-rap areas. Likewise, water willow and spikerushes appear to have established. Other species continue to be evaluated during spring 2011 and full-scale planting will be completed later that year once species suitability is determined.

Biological monitoring

Beginning in 2008, ERDC began monitoring fish and macro-invertebrate populations along the stretch of modified Trinity River just north of Cell D at IH - 45, Cell D, and the other LCOW cells following their filling in 2009. Collection sites were selected and marked (GPS) as permanent monitoring stations for development of a baseline for existing populations. In the river, one station was within an area in which erosion control rip-rap and additional bank armoring has since been installed (under IH – 45), one station is two hundred feet upstream, and one station is two hundred feet downstream of the rip-rap area. Two sampling stations were established in each of the wetland cells, one near the inflow (Site 1) and one near the outflow (Site 2). Cell F was treated as two separate cells for fish and macro-invertebrate sampling: F (West) and F (East). Fish were collected with backpack electrofishing equipment, identified to the species level and counted in the field, and then released. Invertebrates were collected with a sweep net (three samples per site), preserved in the field, and returned to the lab for identification (to family or genera, when possible) and enumeration. After addition of rip-rap to the river, macro-invertebrates were sampled by brushing them off rocks into a downstream collection net. In addition, three rip-rap samples (average of 14 lbs) were taken back to the lab and macro-invertebrates were rinsed off, collected and sorted. Simpson Diversity Indices (SDI) were calculated for macro-invertebrates, where lower numbers tend to indicate fewer species and individuals, and higher numbers indicate greater numbers of species and/or greater equitability between numbers of species present. We initially sampled in fall 2008, with only the river, Cell D, and Cell E sampled---other cells were still under construction at that time and did not contain water. Six additional samplings have been conducted since that time (spring, summer, and fall 2009 and 2010) and results for all but fall 2010 invertebrate samples are given in this report.

Riverine Fish: Five species of fish were collected from the river prior to installation of bank armoring in fall 2008, including mosquitofish (*Gambusia affinis*), bluegills (*Lepomis macrochirus*), brook silversides (*Labidesthes sicculus*), blacktail shiners (*Cyprinella venusta*), and a single tadpole madtom (*Noturus gyrinus*) (Table 13). Mosquitofish were the dominant species collected, representing over 90% of individuals collected from all three sites. The upstream sample site (1)

included riffles from a remnant bridge/culvert and supported the greatest species richness, including blacktail shiners, which represented 24% of the fish collected at that site. Sites under the bridge (2, now armored) and downstream from the bridge (3) had hardpan substrates with little structure and supported fewer fish species and numbers of individuals.

Table 13. Five fish species were collected from the Trinity River near and under the I-45 overpass during fall 2008 sampling, prior to river bottom and bank armoring. Site 1 is upstream from the bridge; Site 2 is the rip-rap area under the bridge; Site 3 is downstream from the bridge.

Sample site	Mosquitofish	Bluegill	Brook silverside	Blacktail shiner	Tadpole madtom	Species richness
1	400	2		125	1	3
2	100					1
3	200		2			2

Subsequent fish sampling in the river was conducted only in spring 2009, with other collections (summer and fall) not made due to high water conditions. While the same areas were sampled, actual sampling technique was altered due to addition of rip-rap at the base of the interlocking armoring along the bank of sampled areas. Instead of wading through shallows adjacent to the shoreline (rip-rap prevented walking), observations of fish were made by walking along the armored shoreline and holding sampler electrodes out into the water. Fish collected using these methods are given in Table 14. The fish assemblage has shifted from one dominated by mosquitofish, which prior to armoring had occupied quieter waters along the shorelines, to blacktail shiners, which occupied turbulent areas generated by flow over and between rip-rap below the bridge. Prior to armoring, highest species richness was observed at the upstream sample site, which was adjacent to riffles and a large, fallen tree. However, following armoring below the bridge, highest species richness shifted to Site 2, indicating that riffles and other habitat (e.g., gaps between rip-rap) created by the armoring benefitted more species in this section of the Trinity River.

Table 14. Four fish species were collected from the Trinity River near and under the I-45 overpass during spring 2009 sampling. Site 1 is upstream from the bridge; Site 2 is the rip-rap area under the bridge; Site 3 is downstream from the bridge.

Sample site	Mosquitofish	Bluegill	Redfin shiner	Blacktail shiner	Species richness
1	0	0	1	23	2
2	2	1	3	53	4
3	1	0	0	57	2

Fish were sampled along the river during fall 2010; spring and summer samplings were not conducted during that year due to high flow conditions and safety concerns (Table 15). No fish were collected upstream (Site 1) or downstream (Site 3) from the bridge along the river's edge. Five species were collected from Site 2 below the bridge. Riffles, interstitial spaces between rip-rap, and overall structure provided by this area appeared to continue supporting fish relative to the bare upstream and downstream channel. While total numbers of fish collected during this sampling period were low, attributable to cool water temperatures (10C) occurring at that time, species richness had increased from the previous year.

Table 15. Five fish species were collected from the Trinity River near and under the I-45 overpass during fall 2010 sampling. Site 1 is upstream from the bridge; Site 2 is the rip-rap area under the bridge; Site 3 is downstream from the bridge.

Sample site	Largemouth bass	Bluegill	Warmouth	Blacktail shiner	Tadpole madtom	Species richness
1	0	0	0	0	0	0
2	1	2	1	2	1	5
3	0	0	0	0	0	0

Riverine Macro-invertebrates: Two families of macro-invertebrates, both insects, were collected from the Trinity River and IH – 45 Dallas, TX in fall 2008, including water striders (Hemiptera: Gerridae) and whirligig beetles (Coleoptera: Gyrinidae). Both families primarily use the water surface for habitat; no benthic macro-invertebrates were collected from any site. Only water striders were collected from all sample sites (Table 16). Macro-invertebrate numbers and diversity were low (richness of R = 2, evenness E = 0.772, and Simpson's diversity or D = 0.353) at all river sample sites, likely due to hard, relatively smooth substrates associated with each site. The upstream sample site that is adjacent to the riffles showed the highest diversity of fish, but that "close by" effect was not noted for macro-invertebrates. Overall, habitats (hard, smooth substrates in varying water flow velocities) in areas sampled were not suitable for colonization by many macro-invertebrates otherwise likely to be found in the river in the fall of 2008.

Six families of macro-invertebrates, all insects, were collected from the river in spring 2009 after the addition of rip-rap below the IH-45 Bridge (R = 6, E = 0.296, D = 0.436). All macro-invertebrates collected were from rip-rap samples taken under the bridge (Site 2) while no macro-invertebrates were collected from upstream and downstream sites (1 and 3). Common netspinner caddisflies (Trichoptera: Hydropsychidae) (71.5%) and common midges (Diptera: Chironomidae) (22.3%) dominated the rip-rap samples, while three mayfly families (Ephemeroptera: Baetidae, Caenidae, Heptageniidae) (5.3%) as well as narrow-winged damselflies (Odonata: Coenagrionidae) (0.8%) were collected. Species collected in fall 2008 were not present at any of the sample sites in spring of 2009 after the rip-rap addition. This was attributed to seasonal changes or a transformation in stream ecology due to addition of rip-rap making a more lotic system with a lack of depositional environments more complimentary to species such as water striders and whirligig beetles. Hard-armoring appears to have improved habitat for a greater number of macro-invertebrates. Both taxa richness and diversity improved from 2008 to 2009, while evenness declined due to the dominance of highly productive taxa such as Chironomidae and Hydropsychidae.

Summer 2010 macro-invertebrate sampling illustrated the continuance of this colonization dynamic due to the hard-armoring and rip-rap additions. Taxa richness, evenness, and particularly diversity increased from 2009 (R = 12, E = 0.384, D = 0.783). New taxa, including riffle beetles (Coleoptera: Elmidae), burrower mayflies, brushlegged mayflies (Ephemeroptera: Ephemeridae, Isonychiidae), dobsonflies (Megaloptera: Corydalidae), and longhorned caddisflies (Tricoptera: Leptoceridae) were all sampled for the first time. Sample site 2 remained similar to that of 2009, although increased in diversity and evenness as well as the riffle beetle population. Interestingly, Site 3, which no individuals were sampled in 2009 had the highest richness (R = 9) in 2010. This could be due to how the additions under IH – 45 have changed the flow regime as well as added habitat structure, which is in turn developing suitable lotic and lentic macro-invertebrate habitat for colonization downstream.

Table 16. Macro-invertebrates were collected periodically from 3 sites under the I-45 Trinity River Bridge in 2008, 2009, and 2010. M = mean; M*f* = frequency.

		Fall 2008					Spring 2009					Summer 2010				
Taxa	**Common name**	**1**	**2**	**3**	**M**	**M*f***	**1**	**2**	**3**	**M**	**M*f***	**1**	**2**	**3**	**M**	**M*f***
Insecta																
Baetidae	Small minnow mayflies							2		0.67	0.008	1	10	4	5	0.043
Caenidae	Small squaregill mayflies							3		1	0.012		6	12	6	0.052
Chironomidae	Common midges							54		18	0.223	22	36	68	42	0.362
Coenagrionidae	Narrow-winged damselflies							2		0.67	0.008					
Corydalidae	Dobsonflies												1		0.33	0.003
Elmidae	Riffle beetles												27	1	9.33	0.080
Ephemeridae	Common burrower mayflies											1		3	1.33	0.011
Gerridae	Water striders	2	5	1	2.67	0.229										0.000
Gyrinidae	Whirligig beetles	4		23	9	0.771										0.000
Heptageniidae	Flatheaded mayflies							8		2.67	0.033		25	1	8.67	0.075
Hydropsychidae	Common netspinners							173		57.7	0.715		35	7	14	0.121
Isonychiidae	Brushlegged mayflies													1	0.33	0.003
Leptoceridae	Longhorned caddisflies													1	0.33	0.003
Mollusca																
Bivalvia	Freshwater bivalves												74	7	27	0.233
Valvatidae	Valve snails													5	1.67	0.014
Totals		*6*	*5*	*24*	*11.7*	*1.000*		*242*		*80.7*	*1.000*	24	214	110	116	*1.000*
Taxa Richness						2					6					12
Evenness						0.772					0.296					0.384
Simpson's Diversity						0.353					0.438					0.783

Wetland Cells Fish: Electrofishing sampling has been conducted seven times in Cell D (2008, 2009, and 2010) and six times in all other wetland cells (2009 and 2010); Cell F is treated as two cells: F (West) and F (East). The first sampling in Cell D occurred several years after fish had been introduced through overbanking events and fishery development had already occurred. Sampling in other cells commenced soon after they filled, enabling us to better rack development of those fisheries from their onset. This is reflected by low numbers collected in spring 2009 but higher numbers collected later that year, when many of the fish in the latter samplings were young-of-the-year. Numbers collected were influenced by environmental conditions: for instance, low numbers and species collected in fall 2009 in most cells, including Cell D, reflect cold temperatures (below 8°C) that occurred during that sample period---fish had moved to deeper waters and were not harvestable using shallow water electrofishing equipment.

Fish collected from Cell D are given in Table 17. Introduction of fish into the cell probably occurred during overbank events or possibly through the inflow pump. Species richness was moderately low during the spring in 2009 and 2010, gradually increasing later in the year, with greatest richness seen in fall during both years and in 2008. These differences are likely attributable to conditions during sampling: during spring sampling, vegetation regrowth was low, but gradually increased in summer and fall, resulting in better shallow water cover for many fish species and their predators. While numbers were dominated by only a few species (mosquitofish and bluegills), both serve as forage for predators found in Cell D, including warmouth (*Lepomis gulosus*), largemouth bass (*Micropterus salmoides*), white crappie (*Poxomis annularis*), and

spotted gar (*Lepisosteus oculatus*). Mixed size classes of many species collected during all three years indicates reproduction of those species is occurring in the cell. Overall, it appears a moderately stable largemouth bass-bluegill fishery had developed in Cell D as of 2009 and persisted in 2010, with low numbers of open-water forage species (minnows) also present.

Table 17. Average number of fish collected from two sites in Cell D from 2008-2010.

Common name	**Scientific name**	Fall 2008	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Warmouth	*Lepomis gulosus*	8	1	6	2			
Bluegill	*Lepomis macrochirus*	75	19	96	64	14	30	14
Redear sunfish	*Lepomis microlophus*		1					
Common carp	*Cyprinus carpio*	1			1		1	1
Blacktail shiner	*Cyprinella venusta*	1				1		
Brook silverside	*Labidesthes sicculus*	1						
Longear sunfish	*Lepomis megalotis*	1					1	1
Largemouth bass	*Micropterus salmoides*	2	6	4	3	1	2	4
Mosquitofish	*Gambusia affinis*	90	54	120	3	10	3	50
Spotted gar	*Lepisosteus oculatus*			1	1			1
Log perch	*Percina caprodes*			1				
White crappie	*Poxomis annularis*							1
	Totals	179	81	221	76	**26**	**37**	**72**
	Richness	8	5	6	7	**4**	**5**	**7**

Fish were not sampled during fall 2008 from Cell E-West: the cell was under construction at that time. Collection data from six samplings conducted in 2009 and 2010 are given in Table 18. Trends in Cell E-West were similar to those seen in Cell D, with lower richness in spring increasing in subsequent samplings each year. However, in 2009, a drop in fall richness followed a large summer spike remains curious: it is possible that low temperatures combined with limited vegetative habitat in shallows during that sampling resulted in fish taking refuge in deeper waters during the sampling period. Overall, species occurring in the cell were similar to those seen in Cell D, not surprising considering the two cells share their source of introduction (Trinity River overbanking). The presence of shad indicates that in addition to the developing centrarchid fishery, a sustained open-water fishery may also be developing in the cell. Common carp spawning behavior observed in spring 2010 may indicate that they have reproduced in the cell, although no young-of-the-year individuals have been collected to date.

Table 18. Average number of fish collected from two sites in Cell E-West during 2009 and 2010.

Common name	**Scientific name**	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Warmouth	*Lepomis gulosus*		1			1	2
Bluegill	*Lepomis macrochirus*	1	45	11	3	46	23
Green sunfish	*Lepomis cyanellus*		4			1	1
Blacktail shiner	*Cyprinella venusta*	3	23			4	

Redfin shiner	*Lythrurus umbratilis*	1	1				
River redhorse	*Moxostoma carinatum*		1				
Longear sunfish	*Lepomis megalotis*		1				1
Largemouth bass	*Micropterus salmoides*		2			1	3
Gizzard shad	*Dorosoma cepedianum*	2	1	15		3	
Mosquitofish	*Gambusia affinis*	3	174	49	58	21	124
Spotted gar	*Lepisosteus oculatus*		1				
Common carp	*Cyprinus carpio*						6
	Totals	10	254	75	**61**	**77**	**237**
	Richness	5	11	3	**2**	**7**	**7**

Fish were not sampled but were observed during fall 2008 in Cell E, which was constructed but only partly filled at the time of sampling---at that time, large numbers of mosquitofish were observed in shallows near the shoreline. Large numbers of mosquitofish were collected by electrofishing in spring 2009 (Table 19), representing almost 90% of fish collected, but relative numbers declined dramatically by summer and fall, and numbers remained moderately low during 2010. We attribute this, in part, to predator populations, most likely green sunfish (*Lepomis cyanellus*), warmouth, and largemouth bass. Bluegill were one of the most common species collected in summer and fall, 2009, and the most common species in 2010, with the presence of both adult and young-of-the-year indicating reproduction in the cell. Green sunfish and largemouth bass made up significant portions of fish collected on both of those dates. While it appears that the fishery in Cell E is be dominated by centrarchids, large numbers of shad collected during summer 2009 and moderate numbers in 2010 indicate that the cell also supports an open-water fishery: cormorants observed in Cell E during the winters 2009 and 2010 may have been fishing for shad, supporting this possibility.

Table 19. Average number of fish collected from two sites in Cell E during 2009 and 2010.

Common name	**Scientific name**	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Warmouth	*Lepomis gulosus*	1				2	1
Bluegill	*Lepomis macrochirus*	6	23	27	10	35	30
Green sunfish	*Lepomis cyanellus*	1	2	1		5	3
Common carp	*Cyprinus carpio*	1					
Blacktail shiner	*Cyprinella venusta*		7			4	
River redhorse	*Moxostoma carinatum*			6			
Largemouth bass	*Micropterus salmoides*	1	1	2	1	2	1
Gizzard shad	*Dorosoma cepedianum*		76			11	
Mosquitofish	*Gambusia affinis*	89		1	4	16	
Longear sunfish	*Lepomis megalotis*					1	
Channel catfish	*Ictalurus punctatus*					1	
	Totals	99	109	37	**15**	**77**	**35**
	Richness	6	5	5	**3**	**9**	**4**

Fish were not sampled during fall 2008 in Cell F-North: the cell was under construction at that time. Collection data from six samplings conducted in 2009 and 2010 are given in Table 20. Only low numbers of forage species (mosquitofish and shad) were initially collected, reflecting early development of a fishery in the cell. Bluegill dominated sampling during summer and fall, 2009, and fall 2010, with multiple size classes indicating that they are reproducing in the cell. Mosquitofish dominated spring and fall samples in 2010. Predator species have not appeared to be well established in this cell since sampling began: largemouth bass were only collected during summer 2009 and fall 2010, although white crappie and spotted gar were also collected in fall 2010. The absence of mosquitofish in the fall 2010 samples may indicate that predator populations are being to develop in the cell. Although this cell is the shallowest of the LCOW, the presence of shad in 2009 and 2010 may indicate development of an open-water forage species fishery.

Table 20. Average number of fish collected from two sites in Cell F-North during 2009 and 2010.

Common name	**Scientific name**	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Bluegill	*Lepomis macrochirus*		26	8	3	18	15
Blacktail shiner	*Cyprinella venusta*		8			3	5
Brook silverside	*Labidesthes sicculus*		3			1	
Longear sunfish	*Lepomis megalotis*		1				
Largemouth bass	*Micropterus salmoides*		4				1
Gizzard shad	*Dorosoma cepedianum*	2	2			2	
Mosquitofish	*Gambusia affinis*	2	17	1	520	265	
Common carp	*Cyprinus carpio*				1		
White crappie	*Poxomis annularis*						1
Spotted gar	*Lepisosteus oculatus*						1
	Totals	4	61	9	**524**	**289**	**23**
	Richness	2	7	2	**3**	**5**	**5**

Fish were not sampled during fall 2008 in Cell F (West): the cell was constructed but not filled at that time. Collection data from six samplings conducted in 2009 and 2010 are given in Table 21. Mosquitofish, bluegill, and a single largemouth bass were initially collected, reflecting early development of a fishery in the cell. Mosquitofish and bluegill dominated subsequent samplings in both years, and mixed sized classes indicated the species had reproduced in the cell. Fishery (e.g., largemouth bass-bluegill) development appears to be similar to that of other cells, although no open water species (e.g., shad) have been collected.

Table 21. Average number of fish collected from two sites in Cell F (West) during 2009 and 2010.

Common name	**Scientific name**	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Warmouth	*Lepomis gulosus*		3				
Bluegill	*Lepomis macrochirus*	3	48	2	6	15	47
Green sunfish	*Lepomis cyanellus*		3				
Common carp	*Cyprinus carpio*		1				
Blacktail shiner	*Cyprinella venusta*		47			3	2

Largemouth bass	*Micropterus salmoides*	1	1		1	2	2
Mosquitofish	*Gambusia affinis*	59	226	3	80	150	45
Brook silverside	*Labidesthes sicculus*					1	
White crappie	*Poxomis annularis*						1
	Totals	63	326	5	**87**	**171**	**97**
	Richness	3	7	2	**3**	**5**	**5**

Fish were not sampled during fall 2008 in Cell F (East): the cell was constructed but not filled at that time. Collection data from six samplings conducted in 2009 and 2010 are given in Table 22. Low numbers of mosquitofish and bluegill were initially collected, reflecting early development of a fishery in the cell. Bluegill dominated sampling during summer and fall 2009 and 2010, and mixed sized classes indicated the species had reproduced in the cell. Mosquitofish dominated sampling in spring 2010. Overall, the fishery appears similar to that occurring in Cell F (West), to which this cell is joined by culvert, although open water species (shad) have been collected in Cell F (East).

Table 22. Average number of fish collected from two sites in Cell F (east) during 2009 and 2010.

Common name	**Scientific name**	Spring 2009	Summer 2009	Fall 2009	**Spring 2010**	**Summer 2010**	**Fall 2010**
Warmouth	*Lepomis gulosus*		1				
Bluegill	*Lepomis macrochirus*	1	28	31	4	37	18
Green sunfish	*Lepomis cyanellus*		4	3			
Blacktail shiner	*Cyprinella venusta*		11			25	3
Largemouth bass	*Micropterus salmoides*		1			1	1
Gizzard shad	*Dorosoma cepedianum*		2				
Mosquitofish	*Gambusia affinis*	4	30		44	26	13
Redfin shiner	*Lythrurus umbratilis*				3		
Brook silverside	*Labidesthes sicculus*					2	
Longear sunfish	*Lepomis megalotis*					1	
Bullhead	*Ictalurus sp.*						1
White crappie	*Poxomis annularis*						1
Log perch	*Percina caprodes*						1
	Totals	5	77	34	**51**	**92**	**38**
	Richness	2	7	2	**3**	**6**	**7**

Fish were not sampled during fall 2008 in Cell G: the cell was constructed but not filled at that time. Collection data from six samplings conducted in 2009 and 2010 are given in Table 23. Only mosquitofish were initially collected, indicating that fishery development was in its early stages in the cell. Bluegill dominated sampling during summer and fall in 2009 and 2010, and mixed sized classes indicated the species had reproduced in the cell. Mosquitofish dominated sampling in spring 2010. Cormorants and white pelicans observed in the cell in 2009 and 2010 may have been indicative of an open-water fishery (shad, collected both years).

Table 23. Average number of fish collected from two sites in Cell G during 2009 and 2010.

Common name	Scientific name	Spring 2009	Summer 2009	Fall 2009	Spring 2010	Summer 2010	Fall 2010
Bluegill	*Lepomis macrochirus*		28	2	22	41	25
Blacktail shiner	*Cyprinella venusta*		7			8	
Brook silverside	*Labidesthes sicculus*		4		3	20	
Largemouth bass	*Micropterus salmoides*		1			1	3
Gizzard shad	*Dorosoma cepedianum*		12				1
Mosquitofish	*Gambusia affinis*	4	14	4	186	19	20
Flathead catfish	*Pylodictis olivaris*		1				
Common carp	*Cyprinus carpio*					1	
Longear sunfish	*Lepomis megalotis*					2	
Green sunfish	*Lepomis cyanellus*				1	1	3
Warmouth	*Lepomis gulosus*						1
Spotted gar	*Lepisosteus oculatus*						1
	Totals	**4**	**67**	**6**	**212**	**93**	**54**
	Richness	**1**	**7**	**2**	**4**	**8**	**7**

Wetland Cells Macro-invertebrates: Macro-invertebrate sampling has been conducted seven times in Cell D and six times in all other wetland cells. This report includes sampling from fall 2008 to summer 2010, while fall 2010 samples will be included in the FY 2011 report. Similarly to the electrofishing, sampling in Cell D began (fall 2008) several years after its establishment and vegetation management, while sampling in other cells started soon after they were filled, enabling us to track colonization from their onset.

Cell D

In all, thirty-two families of macro-invertebrates have been collected from Cell D from fall 2008 to summer 2010 (Table 24).

Table 24. Population characteristics of macro-invertebrates collected from two sample sites in Cell D from 2008 – 2010.

Cell D	Fall 2008	Spring 2009	Summer 2009	Fall 2009	Spring 2010	Summer 2010
Taxa Richness	18	17	16	8	21	12
Evenness	0.224	0.104	0.180	0.557	0.274	0.149
Simpson's Index of Diversity	0.752	0.435	0.653	0.775	0.826	0.442

18 total taxa were collected from Cell D in the fall of 2008 (R = 18, E = 0.224, D = 0.752) with bladder snails (Physidae) being by far the dominate taxa. With this first sampling occurring several years in to vegetation establishment it is not surprising to see the high taxa richness and diversity.

In subsequent sampling in the spring of 2009, crustaceans comprised the majority (74.3%) of macro-invertebrates collected, due to a population explosion by amphipods (Hyalellidae), with over 750 individuals collected (R = 17, E = 0.104, D = 0.435). Large numbers of amphipods at this time are believed to have been due to seasonal factors, including presence of significant filamentous algae that dominates shallow waters in Cell D prior to aquatic plant dominance in late spring through early fall. Decrease in diversity was due to the decrease in evenness across

sampling because of the large percentage of dominate taxa Hyalellidae. However, new species were sampled including soldier flies, biting midges (Diptera: Strayiomyidae, Ceratopogonidae) and squaregill mayflies (Ephemeroptera: Caenidae).

In summer 2009 taxa richness remained similar and diversity increased due to increased evenness across samples as amphipods evened (R = 16, E = 0.180, D = 0.653). Mollusks represented 53.3% of macro-invertebrates collected, and included four families: bladder snails, bivalves, valve snails, and ram's horn snails.

There was a decline in richness and an increase in evenness and diversity in fall 2009 (R = 8, E = 0.557, D = 0.775). This was most likely due to an overbanking event which basically "resets" the wetland and macro-invertebrate community. This is a continuing force in the floodway extension and illustrates a positive trend in that the more mature Cell D maintained suitable evenness and diversity while taxa richness declined because of the community composition reset.

Spring 2010 was richest most diverse sampling to date in Cell D (R = 21, E = 0.274, D = 0.826). Chironomidae and Hyalellidae (amphipods) were the dominate taxa and provides more evidence in to the seasonal trends in this wetland undergoing vegetation establishment since 2005. Amphipoda individual abundance was not as pronounced as spring 2008, which is positive trend towards community evenness and increased diversity.

Summer 2010 was sampled in close proximity to a major over-banking event. Accordingly taxa richness and diversity decreased (R = 12, E = 0.149, D = 0.442). Chironomidae and Physidae were the dominate taxa collected.

Remaining LCOW: Cells E-West, E, F-North, F (East), F (West), and G)

Five total macro-invertebrate samples have been sorted and counted for the remaining LCOW cells (spring, summer, and fall 2009, and spring and summer 2010). Fall 2010 samplings were conducted but have not yet been processed.

In spring of 2009, water boatmen (Hemiptera: Corixidae) were by far the dominate taxa, representing 84.5% of total species collected. Across all the newly filled wetland cells in spring of 2009 water boatmen ranged from 98.1% to 62.6% of total taxa collected. This low level of evenness among macro-invertebrate community explains the low diversity at the onset of wetland construction and provides evidence for the need of vegetative community establishment to provide habitat for invertebrate colonization (Table 25). Another notable factor at play is that Cell F (East) has not been planted with native aquatic vegetation and has by far the lowest taxa richness and diversity.

Table 25. Population characteristics of macro-invertebrates collected from the LCOW in spring 2009.

Season	Site	E	EW	FN	FW	FE	G	Mean
Spring 2009	**Taxa Richness**	9	7	10	11	5	6	8.000
	Evenness	0.142	0.197	0.220	0.125	0.208	0.361	0.209
	Simpson's Index of Diversity	0.215	0.276	0.546	0.271	0.038	0.539	0.314

Although mean taxa richness remained similar in summer 2009 from spring 2009 both evenness and diversity increased (Table 26). This is due to the fact that in summer 2009 water boatmen ranged from 4.1% to 0% (from 98.1% to 62.6% in spring 2009) total taxa collected with none collected in four of six new cells. Midges were most dominant and ranged from 83.9%-8% in summer 2009 across all newly filled cells, although total abundance may be similar. This is a

common trend (although can vary) when considering the biological monitoring for macro-invertebrates in the newer wetland cells from spring 2009 (right after filling) to summer 2009. This strong dynamic, among others, illustrates the changes in macro-invertebrate colonization and community structure over time and seasonally, sometimes very quickly, in new wetland cell establishment.

Another common trend among the new wetland cells when considering mollusks, which were less abundant in the summer even though new taxa were collected. In addition, total macro-invertebrate individual abundances decreased from spring to summer 2009 due to the drop off in water boatmen and increased evenness among community structure.

Table 26. Population characteristics of macro-invertebrates collected from the LCOW in summer 2009.

Season	Site	E	EW	FN	FW	FE	G	Mean
Summer 2009	**Taxa Richness**	5	5	10	10	7	10	7.833
	Evenness	0.590	0.280	0.466	0.267	0.285	0.435	0.387
	Simpson's Index of Diversity	0.661	0.286	0.785	0.625	0.499	0.770	0.604

Both taxa richness and diversity increased across the new wetland cells in fall 2009 (Table 27). The similarities between wetlands at this point were most likely due to a preceding over-banking event which acts as a “reset” to the macro-invertebrate community. This can be illustrated by the similarities between the lower “developing” wetlands (in terms of vegetation establishment) and the “established” reference wetland Cell D (R = 8, E = 0.557, D = 0.775) for this sample. Chironomidae were the dominant taxa in all wetlands except for Cells D and E-West.

Interestingly, Cell F-North showed the highest taxa richest and high diversity out of all wetland cells and contained taxa not found in any other wetland including springtails (Entognatha: Isotomidae) and phantom midges (Diptera: Chaoboridae). This is most likely due to the over-banking event and Cell F-North’s position in between Cell F’s lentic system habitats and proximity to the Trinity River’s lotic system habitats. Again, the unplanted Cell F (East) was among the lowest cells in terms of taxa richness.

Table 27. Population characteristics of macro-invertebrates collected from the LCOW in fall 2009.

Season	Site	E	EW	FN	FW	FE	G	Mean
Fall 2009	**Taxa Richness**	9	9	13	8	6	6	8.500
	Evenness	0.189	0.460	0.308	0.323	0.459	0.522	0.377
	Simpson's Index of Diversity	0.413	0.759	0.750	0.613	0.637	0.681	0.642

Similarly to Cell D, spring 2010 samples showed the highest taxa richness from any sample to date among the new developing wetlands (Table 28). Water boatmen were again the dominant taxa (as in spring 2009) among all cells, but not to the order of magnitude as in spring 2009 except for in Cell F (East), the unplanted wetland cell. This indicates that macro-invertebrate community structure was much more even in all cells except Cell F (East). This again illustrates the fact that Cell F (East) does not have as developed of a macro-invertebrate community as the other wetland cells undergoing native aquatic vegetation establishment. In turn, Cell F (East) is not as developed of a wetland as a whole and provides insight into the benefits of aquatic ecosystem community establishment. New additions to macro-invertebrate community

composition in the developing wetlands during this sampling included small minnow mayflies (Ephemeroptera: Baetidae), grass shrimp (Crustacea: Palaemonidae), and micro-caddisflies (Tricoptera: Hydroptilidae).

Table 28. Population characteristics of macro-invertebrates collected from the LCOW in spring 2010.

Season	Site	E	EW	FN	FW	FE	G	Mean
Spring 2010	**Taxa Richness**	12	13	10	10	12	14	11.833
	Evenness	0.353	0.270	0.590	0.226	0.101	0.179	0.287
	Simpson's Index of Diversity	0.764	0.715	0.831	0.557	0.177	0.600	0.607

Summer 2010 was sampled in close proximity to a major over-banking event and accordingly taxa richness and diversity decreased, similarly to Cell D (Table 29). Chironomidae were by far the dominant taxa among all developing wetland cells. Although a reset of the macro-invertebrate community occurred because of the over-banking, there were still signs that the community structure was continuing to develop. This includes the presence of multiple mollusks (including Unionidae), grass shrimp, minnow mayflies, and new taxa such as water mites (Arachnida: Hydracarina). The unplanted Cell F (East) showed the lowest taxa richness from any cell at any sampling date.

Table 29. Population characteristics of macro-invertebrates collected from the LCOW in summer 2010.

Season	Site	E	EW	FN	FW	FE	G	Mean
Summer 2010	**Taxa Richness**	10	10	9	6	4	10	8.167
	Evenness	0.119	0.171	0.181	0.315	0.535	0.135	0.243
	Simpson's Index of Diversity	0.162	0.416	0.387	0.471	0.533	0.259	0.371

Raw macro-invertebrate data collected to date for Cell D and the remaining LCOW is given in Tables 30-36.

Table 30. Macro-invertebrates collected from Cell D in 2008, 2009, and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Fall 2008				Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																									
Baetidae	Small minnow mayflies													1		0.5	0.015		1	0.5	0.002				
Belostomatidae	Giant water bugs		1	0.5	0.003																				
Caenidae	Small squaregill mayflies					17	10	14	0.026	2	5	3.5	0.025	12	5	8.5	0.262	10	15	13	0.062	1		0.5	0.002
Ceratopogonidae	Biting midges					10	1	5.5	0.010		2	1	0.007	2		1	0.031	17	19	18	0.089	3	12	7.5	0.028
Chironomidae	Midges	2	32	17	0.103	37	5	21	0.040	35	42	39	0.279					54	68	61	0.302	197	205	201	0.740
Chrysomelidae	Leaf beetles	3	6	4.5	0.027		1	0.5	0.001																
Coenagrionidae	Narrow-winged damselflies		9	4.5	0.027	2	3	2.5	0.005	5	4	4.5	0.033	3		1.5	0.046	8	10	9	0.045	8		4	0.015
Corixidae	Water boatmen		2	1	0.006	18	4	11	0.021	3	4	3.5	0.025	14	5	9.5	0.292	6	5	5.5	0.027	2	1	1.5	0.006
Culicidae	Mosquitoes						1	0.5	0.001																
Curculionidae	Weevils						1	0.5	0.001																
Dytiscidae	Predaceous diving beetles						2	1	0.002										1	0.5	0.002				
Ephydridae	Shore flies		3	1.5	0.009																				
Gomphidae	Clubtail dragonflies										1	0.5	0.004						1	0.5	0.002				
Haliplidae	Crawling water beetles	3	8	5.5	0.033	11	8	9.5	0.018	4	1	2.5	0.018					7	4	5.5	0.027	1	4	2.5	0.009
Hydrophilidae	Water scavenger beetles	3	3	3	0.018	10	3	6.5	0.012		1	0.5	0.004					11	15	13	0.064	1	1	1	0.004
Libelullidae	Skimmers (dragonflies)	1	3	2	0.01													1	3	2	0.010				
Noteridae	Burrowing water beetles	13		6.5	0.039																				
Pleidae	Pygmy backswimmers										1	0.5	0.004						1	0.5	0.002				
Pyralidae	Grass moths	1		0.5	0.003																				
Sciomyzidae	Marsh flies	1		0.5	0.003																				
Siphlonuridae	Primitive minnow mayflies					1		0.5	0.001																
Strayiomyidae	Soldier flies						1	0.5	0.001																
Synclita	Waterlily leafcutter (moths)		6	3	0.018													1		0.5	0.002				
Veliidae	Broad-shouldered water striders	33	36	35	0.209	9	4	6.5	0.012	1		0.5	0.004					2	3	2.5	0.012		1	0.5	0.002
Arachnida																									
Hydracarina	Water mites																	3	5	4	0.020	12	1	6.5	0.023
Crustacea																									
Cambaridae	Freshwater crayfish		1	0.5	0.003																				
Hyalellidae	Amphipods		7	3.5	0.026	372	407	390	0.742		8	4	0.029	1	1	1	0.031	61	36	49	0.240	3		1.5	0.006
Palaemonidae	Grass shrimp		5	2.5	0.015		1	0.5	0.001		5	2.5	0.018					5	1	0.5	0.002				
Mollusca																									
Bivalvia	Bivalves									4	2	3	0.022		5	2.5	0.077	2	1	1.5	0.007				
Physidae	Bladder snails	68	75	72	0.433	36	75	56	0.106	47	95	71	0.514		16	8	0.246	16	10	13	0.064	92	10	51	0.188
Planorbidae	Ram's horn snails										3	1.5	0.011					2		1	0.005	1		0.5	0.002
Valvatidae	Valve snails										1	0.5	0.004					1	2	1.5	0.007				
Totals		*145*	*202*	*165*	*0.99*	*523*	*527*	*525*	*1.000*	*101*	*175*	*138*	*1.000*	*33*	*32*	*33*	*1*	*207*	*201*	*202*	*1.000*	*321*	*235*	*278*	*1.000*

Table 31. Macro-invertebrates collected from Cell E-West in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																					
Baetidae	Small Minnow Mayflies						2	1	0.036						2	1	0.005				
Caenidae	Small squaregill mayflies									11	1	6	0.324	1	23	12	0.062		2	1	0.010
Ceratopogonidae	Biting midges						1	0.5	0.018					15	14	15	0.075				
Chaoboridae	Phantom Midges										1	0.5	0.027								
Chironomidae	Midges	19	7	13	0.052	8	39	24	0.839	7	2	4.5	0.243	20	63	42	0.216	43	106	75	0.734
Coenagrionidae	Narrow-winged damselflies		1	0.5	0.002						1	0.5	0.027	7	8	7.5	0.039	1		0.5	0.005
Corixidae	Water boatmen	193	227	210	0.845					3	7	5	0.270	58	124	91	0.473				0.000
Dytiscidae	Predaceous diving beetles		1	0.5	0.002																0.000
Gomphidae	Clubtail Dragonflies					1		0.5	0.018					1	1	1	0.005				
Haliplidae	Crawling water beetles														2	1	0.005				
Hydrophilidae	Water scavenger beetles	1	5	3	0.012									4	7	5.5	0.029				
Libelullidae	Skimmers (dragonflies)														2	1	0.005		1	0.5	0.005
Limnephilidae	Northern Case Makers													11		5.5	0.029				
Veliidae	Broad-shouldered water striders																	1		0.5	0.005
Arachnida																					
Hydracarina	Water mites									1		0.5	0.019								
Crustacea																					
Hyalellidae	Amphipods		3	1.5	0.006					1		0.5	0.027	4		2	0.010	1	3	2	0.020
Palaemonidae	Grass Shrimp										1	0.5	0.027								
Mollusca																					
Physidae	Bladder snails	19	21	20	0.080	5		2.5	0.089	1		0.5	0.027	12	6	9	0.047	25	18	22	0.212
Valvatidae	Valve snails																	1	1	1	0.010
Totals		*232*	*265*	*249*	*1.000*	*14*	*42*	*28*	*1.000*	24	13	19	*1.000*	*133*	*252*	*193*	*1.000*	*72*	*131*	*102*	*1.000*

Table 32. Macro-invertebrates collected from Cell E in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																					
Baetidae	Small minnow mayflies									3		1.5	0.010		2	1	0.007		1	0.5	0.003
Caenidae	Small squaregill mayflies		4	2	0.001	1	5	3	0.120	2	31	16.5	0.111	10	7	8.5	0.062	1		0.5	0.003
Ceratopogonidae	Biting midges	1	1	1	0.000					2	1	1.5	0.010	5	5	5	0.037	2	4	3	0.018
Chironomidae	Midges	8	9	8.5	0.003	2	17	9.5	0.380	172	52	112	0.754	36	17	26.5	0.194	81	218	150	0.914
Coenagrionidae	Narrow-winged damselflies	3	1	2	0.001						1	0.5	0.003	5	3	4	0.029	1	1	1	0.006
Corixidae	Water boatmen	1858	3529	2694	0.879					1	1	1	0.007	28	85	56.5	0.414				
Hydrophilidae	Water scavenger beetles	6		3	0.001	1		0.5	0.020		1	0.5	0.003	5	6	5.5	0.040				
Libelullidae	Skimming dragonflies	1		0.5	0.000									2		1	0.007				
Arachnida																					
Hydracarina	Water Mites													3				1	2	1.5	0.009
Crustacea																					
Palaemonidae	Grass shrimp													1		0.5	0.004		3	1.5	0.009
Hyalellidae	Amphipods	30	27	28.5	0.009					1	15	8	0.054	9	16	12.5	0.092				
Mollusca																					
Ancylidae	Freshwater limpets																	1		0.5	0.003
Physidae	Bladder snails	492	156	324	0.106	14	7	10.5	0.420		14	7	0.047	20	8	14	0.103	4	6	5	0.031
Unionidae	Freshwater mussels																	1		0.5	0.003
Valvatidae	Valve snails					2	1	1.5	0.060					2	1	1.5	0.011				
Totals		*2399*	*3727*	*3063*	*1*	*20*	*30*	*25*	*1.000*	*181*	*116*	*149*	*1.000*	*126*	*150*	*137*	*1.000*	*92*	*235*	*164*	*1.000*

Table 33. Macro-invertebrates collected from Cell F-North in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Entognatha																					
Isotomidae	Springtails									1		0.5	0.013								
Insecta																					
Baetidae	Small Minnow Mayflies					1		0.5	0.014		1	0.5	0.01			0	0.000	3		1.5	0.010
Caenidae	Small squaregill mayflies	19		9.5	0.008	3	13	8	0.222	6	19	12.5	0.321	3	9	6	0.083		5	2.5	0.017
Ceratopogonidae	Biting midges		26	13	0.011		3	1.5	0.042	1		0.5	0.013		11	5.5	0.076	5		2.5	0.017
Chaoboridae	Phantom Midges									2		1	0.026								
Chironomidae	Midges	1	144	72.5	0.062	4	11	7.5	0.208	23	5	14	0.359	10	32	21	0.292	153	73	113	0.766
Coenagrionidae	Narrow-winged damselflies	3		1.5	0.001	5		2.5	0.069	3	1	2	0.051	7		3.5	0.049	1		0.5	0.003
Corixidae	Water boatmen	362	1123	743	0.638					4	2	3	0.077		28	14	0.194				
Dytiscidae	Predaceous diving beetles		1	0.5	0.000							0	0.000								
Gerridae	Water Striders						3	1.5	0.042												
Hydrophilidae	Water scavenger beetles	2	3	2.5	0.002		3	1.5	0.042			0	0.000	5	16	10.5	0.146	2		1	0.007
Limnephilidae	Northern Case Makers	4		2	0.002	1		0.5	0.014			0	0.000								
Veliidae	Broad-shouldered water striders					1		0.5	0.014										1	0.5	0.003
Crustacea																					
Hyalellidae	Amphipods	30	407	219	0.188					4		2	0.051		7	3.5	0.049				
Palaemonidae	Grass Shrimp													4		2	0.028				
Mollusca																					
Physidae	Bladder snails	146	57	102	0.087	21	3	12	0.333	1	5	3	0.077	6	6	6	0.083	37	10	23.5	0.159
Planorbidae	Ram's horn snails																	5		2.5	0.017
Totals		*567*	*1761*	*1164*	*1.000*	*36*	*36*	*36*	*1.000*	45	33	39	1.000	*35*	*109*	*72*	*1.000*	*206*	*89*	*148*	*1.000*

Table 34. Macro-invertebrates collected from Cell F (West) in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																					
Baetidae	Small minnow mayflies													2		1	0.004				
Caenidae	Small squaregill mayflies	7	25	16	0.019	5	7	6	0.059	7	29	18	0.173	17	21	19	0.073		13	6.5	0.053
Ceratopogonidae	Biting midges	1		0.5	0.001	1		0.5	0.005		5	2.5	0.024	25	11	18	0.069				
Chironomidae	Midges	66	2	34	0.041	50	64	57	0.562	54	66	60	0.577	35	21	28	0.107	114	57	85.5	0.698
Coenagrionidae	Narrow-winged damselflies	1		0.5	0.001					1		0.5	0.005								
Corixidae	Water boatmen	958	455	707	0.850						1	0.5	0.005	218	119	169	0.647	3		1.5	0.012
Dytiscidae	Predaceous diving beetles		1	0.5	0.001																
Elmidae	Riffle beetles						1		0.000												
Hydrophilidae	Water scavenger beetles	1		0.5	0.001	1	1	1	0.010					10	1	5.5	0.021	10		5	0.041
Libellulidae	Skimming dragonflies	1		0.5	0.001																
Limnephilidae	Northern Case Makers	9	1	5	0.006	3	8	5.5	0.054					7		3.5	0.013				
Veliidae	Broad-shouldered water striders					1	42	21.5	0.212												
Crustacea																					
Hyalellidae	Amphipods	11	5	8	0.010		1	0.5	0.005	2	25	13.5	0.130	15	2	8.5	0.033				
Mollusca																					
Physidae	Bladder snails	69	50	59.5	0.072	7	11	9	0.089	2	15	8.5	0.082	12	4	8	0.031	31	16	23.5	0.192
Lymnaeidae	Pond snails									1		0.5	0.005	1		0.5	0.002		1	0.5	0.004
Planorbidae	Ram's horn snails						1	0.5	0.005												
Totals		*1124*	*539*	*832*	*1.000*	*68*	*136*	*102*	*1.000*	*67*	*141*	*104*	*1.000*	*342*	*179*	*261*	*1.000*	*158*	*87*	*123*	*1.000*

Table 35. Macro-invertebrates collected from Cell F (East) in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																					
Baetidae	Small minnow mayflies													3	2	2.5	0.004				
Caenidae	Small squaregill mayflies		2	1	0.001	3	4	3.5	0.072	19	29	24	0.533	10	20	15	0.022	15	7	11	0.431
Ceratapogonidae	Biting Midges													11	7	9	0.013				
Chironomidae	Midges					22	44	33	0.680	47	10			21	10	15.5	0.022	79	27		
Coenagrionidae	Narrow-winged damselflies									1					2	1	0.001				
Corixidae	Water boatmen	537	1804	1171	0.981	1	3	2	0.041	10	11	10.5	0.233	1253	7	630	0.906		1	0.5	0.020
Dytiscidae	Predaceous diving beetles		1	0.5	0.000																
Haliplidae	Crawling water beetles														1	0.5	0.001				
Hydrophilidae	Water scavenger beetles					1		0.5	0.010						8	4	0.006		3		
Limnephilidae	Northern Case Makers										1	0.5	0.011		5	2.5	0.004				
Arachnida																					
Hydracarina	Water mites						1	0.5	0.010						1	0.5	0.001				
Crustacea																					
Hyalellidae	Amphipods	8	1	4.5	0.004					1	6	3.5	0.078	6	15	10.5	0.015				0.000
Palaemonidae	Grass shrimp																	1		0.5	0.020
Mollusca																					
Lymnaeidae	Pond snails					1		0.5	0.010	1		0.5	0.011								
Physidae	Bladder snails	28	6	17	0.014	14	3	8.5	0.175	12		6	0.133	8		4	0.006	24	3	13.5	0.529
Totals		*573*	*1814*	*1194*	*1.000*	*42*	*55*	*48.5*	*1.000*	*91*	*57*	*45*	*1.000*	1312	78	695	1.000	119	38	25.5	1.000

Table 36. Macro-invertebrates collected from Cell G in 2009 and 2010. I = inlet; O = outlet; m = mean; M*f* = frequency.

Cell G		Spring 2009				Summer 2009				Fall 2009				Spring 2010				Summer 2010			
Group (family or genus)	**Common name**	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***	**I**	**O**	**M**	**M*f***
Insecta																					
Baetidae	Small minnow mayflies					2		1	0.027					1		0.5	0.002				
Caenidae	Small squaregill mayflies	6		3	0.004	4	25	14.5	0.387	44	9	26.5	0.209	11	15	13	0.057				
Ceratapogonidae	Biting Midges										15	7.5	0.059	3	9	6	0.026	4	9	6.5	0.027
Chironomidae	Midges	1	2	1.5	0.002	1	5	3	0.080	122	5	63.5	0.500	25	32	28.5	0.124	237	183	210	0.859
Coenagrionidae	Narrow-winged damselflies						7	3.5	0.093	3				2	3	2.5	0.011	2		1	0.004
Corixidae	Water boatmen	455	586	521	0.626		1	0.5	0.013	12	3	7.5	0.059	128	151	140	0.609		2	1	0.004
Gerridae	Water striders						10	5	0.133												
Hydrophilidae	Water scavenger beetles	10	1	5.5	0.007		2	1	0.027					2	3	2.5	0.011	4	6	5	0.020
Hydroptilidae	Micro caddisflies														2	1	0.004	13	3	8	0.033
Libellulidae	Skimming dragonflies						1	0.5	0.013					1	2	1.5	0.007				
Synclita														1	2	1.5	0.007	1	2	1.5	0.006
Arachnida																					
Hydracarina	Water Mites													2		1	0.004	13		6.5	0.027
Crustacea																					
Hyalellidae	Amphipods	372	2	187	0.225					11		5.5	0.043	26	10	18	0.079				
Palaemonidae	Grass shrimp					1		0.5	0.013					2	1	1.5	0.007				
Mollusca																					
Ancylidae	Freshwater Limpets																		4	2	0.008
Physidae	Bladder snails	4	224	114	0.137		16	8	0.213	26	7	16.5	0.130	8	16	12	0.052	1	5	3	0.012
Totals		*848*	*815*	*832*	*1.000*	*8*	*67*	*38*	*1.000*	*218*	*39*	*127*	*1.000*	*212*	*246*	*229*	*1.000*	*275*	*214*	*245*	*1.000*

Macro-invertebrate discussion

From the first six samples from the new developing wetland chain at DFE we can hypothesize certain dynamics about the development of the macro-invertebrate community structure and created wetlands as a whole in a floodway passage. First, macro-invertebrate taxa richness, evenness, and diversity will improve with time and establishment of native aquatic vegetation. Second, macro-invertebrate colonies will be "reset" by over-banking events to some extent. Third, the magnitude by which the macro-invertebrate communities are reset is based, to some extent, on establishment of native aquatic vegetation. For example, wetland cells that have undergone vegetation community establishment showed higher taxa richness, evenness, and diversity after major over-banking events in contrast to the unplanted Cell F (East). As the wetlands continue to mature and more aquatic vegetation becomes established, macro-invertebrate community structure will continue to strengthen and be less affected detrimentally by over-banking events, similarly to the more mature wetland Cell D.

***Casual observations of vertebrates*:** In addition to fish and invertebrates, ERDC has kept informal records of higher vertebrates encountered in the wetland chain, and have observed mammals (8 species), birds (38 species), reptiles (7 species), and amphibians (5 species) to date. We have limited reported observations to only those species observed in direct association with the wetland cells or other nearby water features; additional species (e.g., bald eagles, common crows, rough-winged swallows, etc.) have been observed near the cells and likely benefit from the wetlands, but are not reported in this document.

Identifications have been made visually with and without the aid of binoculars and pertinent field guides. In some cases (mammals), identifications have been made from tracks. Most records have come from Cell D, beginning in fall 2005. However, soon after filling in late 2008, mammals, waterbirds, reptiles, and amphibians began utilizing cells E-West, E, F-North, F, and G, sometimes in large numbers (especially waterfowl and gulls). Table 37 provides a list of species and in which wetland cells they have been observed to date. Species not before recorded at the LCOW are observed every year. For instance, American white ibis (*Eudocimus albus*) were observed for the first time in 2010.

Table 37. Vertebrate species (excluding fish) observed in the wetland chain since September 2005. Those listed in bold font were observed for the first time during 2010.

Common Name	Scientific name	Wetland Cell
	Mammals	
Beaver	*Castor canadensis*	D, E, F, G
Mink (tracks)	*Neovison vison*	D
Feral pig (tracks)	***Sus scrofa***	**G**
Nine-banded armadillo	*Dasypus novemcinctus*	D
Nutria	***Myocastor coypus***	**E-West**
Raccoon	*Procyon lotor*	All cells
River otter	***Lontra canadensis***	**G**
Virginia opossum	*Didelphis virginiana*	D
	Birds	
American coot	*Fulica americana*	D, E, F, G
American white pelican	*Pelecanus erythrorhynchos*	G
American white ibis	***Eudocimus albus***	**G**
American wigeon	*Mareca americana*	All cells
Belted kingfisher	*Megaceryle alcyon*	D
Black-necked stilt	*Himantopus mexicanus*	E, F
Blue-winged teal	*Anas discors*	All cells
Bonaparte's gull	*Larus philadelphia*	F, G
Bufflehead	*Bucephala albeola*	All cells
Canada goose	*Branta canadensis*	F
Cattle egret	*Bubulcus ibis*	D
Common egret	*Casmerodius albus*	All cells
Common snipe	*Capella gallinago*	D, E

Double-crested cormorant	*Phalacrocorax auritus*	All cells
Franklin's gull	*Larus pipixcan*	F, G
Gadwall	*Anas strepera*	All cells
Great blue heron	*Ardia herodius*	All cells
Green heron	*Butorides virescens*	D
Green-winged teal	*Anas carolinensis*	All cells
Hooded merganser	*Lophodytes cucullatus*	E, F, G
Killdeer	*Charadrius vociferus*	All cells
Least sandpiper	*Erolia minutilla*	All cells
Lesser scaup	*Aythya affinis*	D, E, F, G
Lesser yellowlegs	*Totanus flavipes*	D, F, E, G
Little blue heron	*Florida caerulea*	All cells
Mallard	*Anas platyrhynchos*	All cells
Northern pintail	*Anas acuta*	All cells
Northern shoveler	*Spatula clypeata*	All cells
Pied-billed grebe	*Podilymbus podiceps*	All cells
Red-winged blackbird	*Agelaius phoeniceus*	All cells
Ring-billed gull	*Larus delawarensis*	F, G
Ring-necked duck	*Aythya collaris*	D, E, F, G
Snowy egret	*Leucophoyx thula*	All cells
Sora	*Porzana carolina*	D
Spotted sandpiper	*Actitis macularia*	D, E
Tricolored heron	*Egretta tricolor*	E, F
Water pipet	*Anthus spinoletta*	All cells
Wood duck	*Aix sponsa*	D
Reptiles		
Blotched water snake	*Nerodia erythrogaster*	D, F-North, G
Common snapping turtle	*Chelydra serpentina*	D, E-w, E
Diamondback water snake	*Nerodia rhombifer*	D
Mississippi map turtle	*Graptemys kohnii*	D
Red-eared slider	*Trachemys scripta*	All cells
River cooter	*Pseudemys concinna*	D
Western ribbon snake	*Thamnophis proximus*	D
Amphibians		
American bullfrog	*Rana catesbeiana*	D
Blanchard's cricket frog	*Acris crepitans*	D, F-North, F
Gulf coast toad	*Bufo valliceps*	D
Southern leopard frog	*Rana utricularia*	D, E, G
Upland chorus frog	*Pseudacris triseriata*	D

Use by waterbirds, especially migratory ducks, was high during winter 2008/2009, with hundreds and sometimes thousands of birds observed on each cell during each site visit between November and February. Counts were lower during the 2009/2010 winter (usually around 50 or so birds per cell), which corresponded with lower counts on research ponds at the LAERF, north of Dallas. Most likely unusually cold temperatures that winter may have pushed waterfowl further south to find wintering grounds.

Grassland surveys: Vegetation surveys (informal and formal) were conducted in 2010 to identify, categorize and enumerate the plant communities in seeded upland areas surrounding the LCOW. These areas had been drill-seeded over a period of time between 2007 (Cell D) and 2009 (remaining LCOW). Plugging of several grass species was also conducted at Cell D in 2009. Informal surveys focused on locating species that had been seeded at the site, and suggested that most of the seeds and some of the species did not germinate or that germinated seedlings did not survive; instead, the grasslands appeared to be dominated by nuisance species such as giant ragweed (*Ambrosia trifida*). Of 44 species identified, 12 are introduced and considered undesirable (e.g., johnsongrass, *Sorghum halepense*). Of the 32 native species identified, seven are considered undesirable in grasslands, and included aggressive forbs (e.g., giant ragweed and marsh-elder, *Iva annua*) and woody species (e.g., cedar elm, *Ulmus crassifolia*). Fourteen of the native species observed were included in drill-seeding, but none of these appeared to occur in significant numbers. A list of plant species observed during informal surveys is given in Table 38.

Table 38. Plant species observed during informal surveys. Status: N = native; NS = native, seeded; I = introduced. Category: U = undesirable grassland plant; D = desirable grassland plant.

Scientific Name	Common name	Status	Category
Ambrosia trifida	Giant ragweed	N	U
Andropogon gerardii	Big bluestem	NS	D
Arundo donax	Arundo	I	U
Baccharis halimifolia	Eastern baccharis	N	U
Bothriochloa ischaemum	King Ranch bluestem	I	U
Centaurea americana	American basketflower	NS	D
Chamaecrista fasciculata	Partridge pea	NS	D
Convolvulus equitans	Bindweed	N	D
Coreopsis basilis	Golden-wave	NS	D
Coreopsis lanceolata	Lanceleaf coreopsis	NS	D
Cucurbita foetidissima	Wild gourd	N	D
Cuscuta sp.	Dodder	N	D
Cynodon dactylon	Bermuda grass	I	U
Dalea purpurea	Purple prairie clover	NS	D
Erodium cicutarium	Redstem stork's bill	I	U
Eustoma exaltatum	Texas bluebells	N	D
Fraxinus pennsylvanica	Green ash	N	U
Helianthus maximiliani	Maximilian sunflower	NS	D
Heliotropium indicum	Indian heliotrope	I	U
Iva annua	Marsh-elder	N	U
Lamium amplexicaule	Henbit	I	U
Ludwigia alternifolia	Seedbox	N	D
Melia azederach	Chinaberry	I	U
Oenothera speciosa	Pink evening rose	NS	D
Phalaris sp.	Canary grass	I	U
Phlox drummondii	Drummond phlox	NS	D
Pyrrhopappus pauciflorus	Texas dandelion	N	D
Ranunculus macounii	Buttercup	N	D
Ritibida columnifera	Mexican hat	NS	D
Salvia azurea	Pitcher sage	NS	D
Salvia coccinea	Scarlet sage	NS	D
Secale cereale	Rye	I	U
Sesbania drummondii	Rattlebox	N	U
Setaria macrostachya	Large-spike bristlegrass	I	U
Sida ciliaris	Bracted fanpetals	N	D
Solanum rostratum	Buffalobur	N	U
Sorgastrum nutans	Indiangrass	NS	D
Sorghum halepense	Johnsongrass	I	U
Sporobolus sp.	Dropseed	N	D
Stellaria media	Common chickweed	I	U
Tridens albescens	White tridens	N	D
Tripsacum dactyloides	Eastern gamagrass	NS	D
Ulmus crassifolia	Cedar elm	N	U
Vernonia sp.	Ironweed	N	D

A formal survey was conducted to confirm casual observations and evaluate the need for further efforts to establish desirable vegetation in areas designated as DFE grasslands. ERDC was also tasked with developing a Scope of Work for establishing native grasses and forbs in these areas in the face of frequent overbanking events and drought-like summer conditions.

Seventeen transects were placed around the LCOW for evaluating the plant communities within drill-seeded areas (Figure 14). A 1-m x 1-m sampling plot was placed every 25 m along each transect, with plant species presence and estimates of percent cover recorded. Voucher specimens were collected and returned to the lab for final identification.

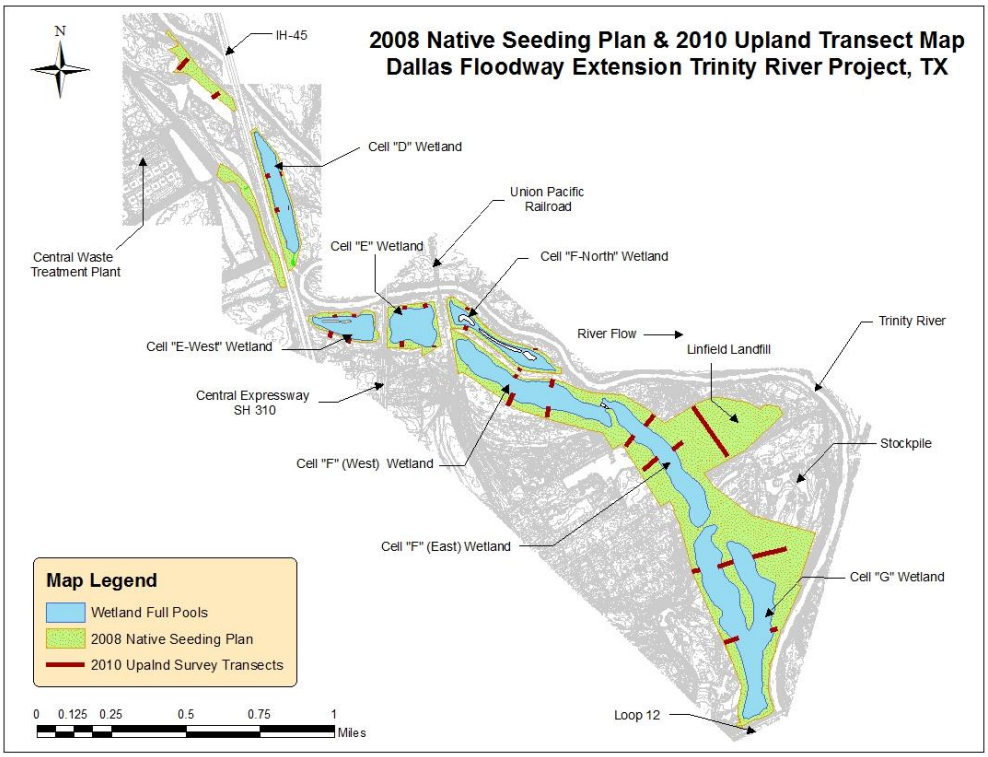

Figure 14. Seventeen transects were placed around the LCOW for evaluating the plant communities within drill-seeded areas.

In all, 71 plant species were identified in the LCOW grassland areas transect surveys, with 45 (63%) of those considered desirable; the remaining 26 (37%) species are considered undesirable and are either introduced or aggressive (Table 39). Only eleven drill-seeded or plugged species were identified in the transect survey, representing 15% of the total species identified and 24% of the desirable native species.

The most common plant occurring in the LCOW grasslands was giant ragweed (26%), a native but undesirable grassland species due to its aggressive nature and limited habitat value. The second most common species observed was rye, *Secale cereale,* representing 8% of the observations. Rye is an introduced species originally seeded as a cover crop; it has remained in the system several years after seeding but appears to be declining. It is not a desirable species for the LCOW grasslands. Other undesirable species observed included Bermuda grass, (*Cynodon dactylon*) approximately 5%; johnsongrass (*Sorghum halepense*) and hedge parsley (*Torilis arvensis*), approximately 2% and 3%, respectively. Areas considered to be bare (no vegetation) comprised over 16%. Overall, 76% of the upland area did not support desirable vegetation.

Desirable species only covered 24% of the upland areas. The majority of cover was from volunteer growth (18% of the total). Drill-seeded and plugged species represented only 5% of total upland cover and most notably included clasping coneflower (*Dracopis amplexicaulis*) 2.8%, Illinois bundle flower (*Desmanthus illinoensis*) 0.8% and Plains coreopsis (*Coreopsis tinctoria*) 0.6%.

This information supported informal surveys and further implied that the upland vegetation community was not meeting project goals as diverse native grassland, but was instead dominated by undesirable ruderal species. At the request of SWF, ERDC developed a SOW addressing this issue and began implementation in late 2010.

Table 39. Frequencies of upland plants identified at the LCOW in 2010. Status: N = native, NS = native seeded; I=Introduced; D = Desirable; U = Undesirable.

Scientific Name	Common name	Status	Upland W I-45		Cell D		Cell E-West		Cell E		Cell F-North		Cell F (West)		Cell F (East)		Cell G		Linfield Landfill	
			D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U
Agalinis sp.	Foxglove	N			1.3		0.83						0.49				0.11			
Allium drummondii	Drummond's onion	N					0.83													
Alternathera philoxeroides	Alligatorweed	I				0.31												0.15		
Amaranthus sp.	Amaranth	N			0.83							0.54	5.2				0.14			
Ambrosia trifida	Giant ragweed	N		4.4		5.7		32		44		53		30		7.0		24		30
Bare	Bare	-		17		3.1		27		9.9		12		13		46		11		6.8
Bouteloua curtipendula	**Sideoats grama**	**NS**													**0.86**					
Cardiospermum halicacabum	Balloonvine	I				0.31		1.1		0.56		0.63		0.73						
Carex cherokeensis	Cherokee sedge	N			4.7															
Carex festucacea	Fescue sedge	N							0.13				0.06							
Celtis laevigata	Sugarberry	N				0.31								0.42		0.09				
Chamaecrista fasciculata	**Partridge pea**	**NS**	**0.36**												**0.19**					
Cirsium texanum	Texas thistle	N															0.08		0.12	
Conyza canadensis	Canadian horseweed	N													4.3				7.4	
Coreopsis tinctoria	**Plains coreopsis**	**NS**			**1.9**		**0.08**		**0.31**				**2.9**		**0.18**					
Croton texensis	Texas croton	N											1.5						0.24	
Cynodon dactylon	Bermuda grass	I		27		0.31		0.83				0.63		0.63		0.99		11		3.0
Cyperus sp.	Cyperus	N					2.1		2.9		1.5		3.3		1.1		0.14		0.12	
Desmanthus illinoensis	**Illinois bundle flower**	**NS**	**0.79**				**2.0**		**0.63**		**0.31**		**2.5**		**0.46**		**0.70**			
Digitaria ischaemum	Smooth crabgrass	I														5.3				
Dracopis amplexicaulis	**Clasping coneflower**	**NS**	**1.3**		**15**		**0.80**		**1.3**		**1.3**		**0.98**		**0.82**		**2.9**		**0.36**	
Echinochloa colona	Junglerice	I		2.6				4.0		2.8		8.5		2.8		1.1				
Echinochloa crus-galli	Barnyardgrass	I		0.14								1.3						0.07		2.3
Eleocharis acicularis	Needle spikerush	N			0.63									0.63						
Eleocharis palustris	Flatstem spikerush	N			0.63															
Elymus canadensis	**Canada wild rye**	**NS**							**2.8**						**0.42**					
Elymus virginicus	Virginia wild rye	N	1.3		5.0		1.1				0.69		2.5		0.30		1.2		1.2	
Euphorbia sp.	Spurge	N													0.37					
Gaillardia pulchella	**Firewheel**	**NS**													**0.09**					
Glandularia bipinnatifida	Dakota vervain	N													0.14					
Grindelia papposa	Wax goldenweed	N	0.01														0.08		1.3	
Helianthus annuus	Common sunflower	N													0.06					
Ipomoea purpurea	Common morning glory	I														0.13				
Iva annua	Marsh-elder	N		0.05										6.1				1.9		
Juncus sp.	Rush	N			0.13		0.50										0.54			
Lactuca serriola	Prickly lettuce	I								0.31						5.2		0.60		2.7
Lepidium austrinum	Pepperwort	N																		
Lippia nodiflora	Frogfruit	N			0.42				9.4		0.25						3.1			
*Lolium perenne**	Ryegrass	I								2.1		6.3		13		1.8		1.5		7.0
Ludwigia peploides	Creeping water primrose	N							0.50											
Medicago orbicularis	Button medic	I														1.3		0.04		
Melilotus officinalis	Yellow sweetclover	I		14				3.3		0.31						0.30				0.24
Monarda citriodora	**Lemon beebalm**	**NS**							**0.31**										**0.12**	
Morus sp.	Mulberry	N								0.31										
Panicum coloratum	Klein Grass	I						0.88		0.63										
Panicum virgatum	**Switchgrass**	**NS**					**0.47**													

Table 39 cont. Frequencies of upland plants identified at the LCOW in 2010. Status: N = native, NS = native seeded; I=Introduced; D = Desirable; U = Undesirable.

Scientific Name	Common name	Status	Upland W I-45		Cell D		Cell E-West		Cell E		Cell F-North		Cell F (West)		Cell F (East)		Cell G		Linfield Landfill	
			D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U
Parthenocissus quinquefolia	Virginia creeper	N							0.31											
Paspalum distichum	Knotgrass	N			5.4				0.50		0.63		2.3		1.8				0.71	
Phyllanthus polygonoides	Knotweed leaf-flower	N	2.1				1.7		0.10		0.44		2.8		0.97		0.21			
Physostegia intermedia	**Obedient plant**	**NS**													**0.56**					
Polygonum hydropiperoides	Swamp smartweed	N													0.94					
Polygonum lapathifolium	Willow smartweed	N	0.09		1.3		3.3		0.25								0.63			
Polygonum pennsylvanica	Pink smartweed	N					0.83				3.3		0.96		0.33		1.3			
Polygonum sp.	Smartweed	N			1.7										0.14					
Populus deltoides	Cottonwood	N						0.83			0.73									
Rudbeckia hirta	**Black-eyed Susan**	**NS**													**0.14**					
Rumex crispus	Curly dock	I		0.05		0.25		0.98		3.8		0.38		1.1		0.43		0.99		
Salix nigra	Black willow	N						0.83				1.6								2.5
Secale cereale	Rye	I		10		47		7.0		5.9		2.1		1.2		1.4		0.28		
Sesbania herbacea	Coffee-bean sesbania	N							1.1											
Setaria parviflora	Knotroot bristlegrass	N	0.09		0.42		0.72		0.25		0.29		0.38					0.22		
Setaria viridis	Green bristle grass	I		0.23		1.3				0.13										
Smilax sp.	Green briar	N							1.3											
Solanum sp.	Nightshade	N														0.18				
Sorghum halepense	Johnsongrass	I		5.5				2.5		2.2		0.81		0.05		5.5				4.2
Symphyotrichum subulatum	Slim aster	N	7.9		1.9												31		0.83	
Tetragonotheca ludoviciana	Sawtooth	N														0.74		0.02		
Torilis arvensis	Hedge parsley	I								0.31				0.88		5.9		1.6		19
Toxicodendron radicans	Poison Ivy	N												0.41		0.08		0.01		
Tridens texanus	Texas tridens	N	0.27										0.05			1.9		1.0		6.1
Unknown	Unknown			0.40		1.3		3.6		4.2		0.31				0.81		1.0		2.2
Viola missouriensis	Missouri violet	N																		
Xanthium strumarium	Cocklebur	N		1.8																
Total (Seeded)			**14 (2.5)**	**84**	**41 (17)**	**60**	**15 (3.4)**	**85**	**22 (5.4)**	**79**	**9 (0.4)**	**89**	**26 (6.4)**	**71**	**14 (3.7)**	**87**	**42 (3.6)**	**56**	**12 (0.5)**	**86**

Grassland test plantings: Although not included in the FY2010 SOW, the 2011 SOW added a three-year effort to establish upland plant communities in the grasslands surrounding the LCOW. First year efforts included conducting test plantings to evaluate differences between seeding and containerized plants for initial establishment. It also includes evaluation of longer-term management strategies (mowing, herbicide wicking, etc.) to ensure establishment of desirable plants while controlling nuisance plants. Plots were planted and will be evaluated during 2011, and full-scale implementation will begin in 2012.

Operations and Maintenance Manual: An O&M manual is critical to ensure that the City of Dallas is capable of engaging interactive management of the cells to provide sustainable aquatic and migratory bird species diversity and stability once the Corps completes its project obligations. ERDC developed a draft O&M manual for Cell D during FY09; after SWF reviewed the document, it was returned to ERDC for modifications in early FY11. Modifications, including preliminary information regarding management of the entire LCOW and upland areas, were made and the second O&M manual draft was submitted to SWF. Additional modifications will continue to be made as more information regarding management of the LCOW becomes available.

Summary

Wetland vegetation is becoming well-established in the LCOW and currently covers most of the perimeters of all cells and significant portions shallow planting shelves found in some cells. A dynamic planting schedule, water level manipulation, herbivore trapping and relocation, and management of nuisance plant species have continued to facilitate development of a desirable native plant community that includes obligate and facultative wetland species, rather than stands of willows and cattails typical in disturbed wet areas in north Texas. Concurrently, fish and macro-invertebrate communities have developed and matured in the cells, leading to usage by a variety of waterbirds, including ducks, sandpipers, egrets, and herons. Planting should be completed in the LCOW cells during FY2011, and plantings of adjacent grasslands have been initiated and will continue through 2013.

We will continue monitoring, planting, and managing LCOW wetland cells and grasslands as needed to ensure long-term sustainability of the plant communities that continue to develop. Modifications to existing strategies will be made when deemed appropriate to address conditions unique to each cell and adjacent grassland.

For more information, please contact:

Dr. Gary Owen Dick
garydick@laerf.org

Lynde L. Dodd
lyndedodd@laerf.org

Lewisville Aquatic Ecosystem Research Facility
Lewisville, Texas

972-436-2215