Final Programmatic Report Narrative

Sustainable Restoration and Monitoring of Bayou Grosse Tete through Community Engagement
Primary PI: Tim Carruthers **EasygrantsID:** 52604

1. Summary of Accomplishments

In four to five sentences, provide a brief summary of the project's key accomplishments and outcomes that were observed or measured.

The project achieved primary outcomes through a range of successful activities, engaging students, teachers, professional partners, and community volunteers. This project engaged 96 students and 41 volunteers in removing invasive plants from 16.5 acres, and planting 21.5 acres, of wetlands along Bayou Grosse Tete, adjacent to the Iberville Starship Magnet High School, Louisiana. Teams of students built test hydroponics systems during the spring semester, 2017, identifying the best design for development of a larger hydroponics system in fall semester, 2017. Six stream and wetland monitoring sites were established and regularly monitored by students as part of classroom learning. Students had the opportunity to interact with professional agency partners and research scientists specializing in coastal management and restoration, as well as a diversity of young community professionals from the local area.

2. Project Activities & Outcomes

Activities

- Describe and quantify (using the approved metrics referenced in your grant agreement) the primary activities conducted during this grant.
- Briefly explain discrepancies between the activities conducted during the grant and the activities agreed upon in your grant agreement.

Table 1. *Summary of accomplished activities.*

Metric	Value achieved	Target value
Land wetland restoration (acres)	21.5	26
Removal of invasive plants (acres)	16.5	26
# trees planted	450	180
# grass plugs planted	400	1080
Outreach (# people reached)	96	400
Volunteer participation (# people)	41	100
Monitoring (# sites)	6	6
# GIS data layers developed	6	5
High resolution photographs	10	5

Land, wetland restored - Survey wetland plants and address identified restoration needs

With staff from Water Institute, US Forest Service, and Louisiana Department of Wildlife and Fisheries, students participated in a survey of the wetland areas along Bayou Grosse Tete adjacent to the school, as well as the bald cypress wetland behind the school (Figure 1), to develop baseline data on location and types of native and invasive plant species. Restoration needs for planting native trees, shrubs, and grasses were identified for the river bank vegetation along Bayou Grosse Tete and within the degraded cypress wetland behind the school. In addition, removal of the invasive tree, Chinese tallow, was prioritized for the cypress swamp.

Restoring 21.5 acres was slightly short of the target 26 acres, but was based on the area identified as having the highest need for restoration, the available plants, and the ability of the students, and FORUM35 volunteers, to access sites safely (for example due to water depth in the cypress wetland).

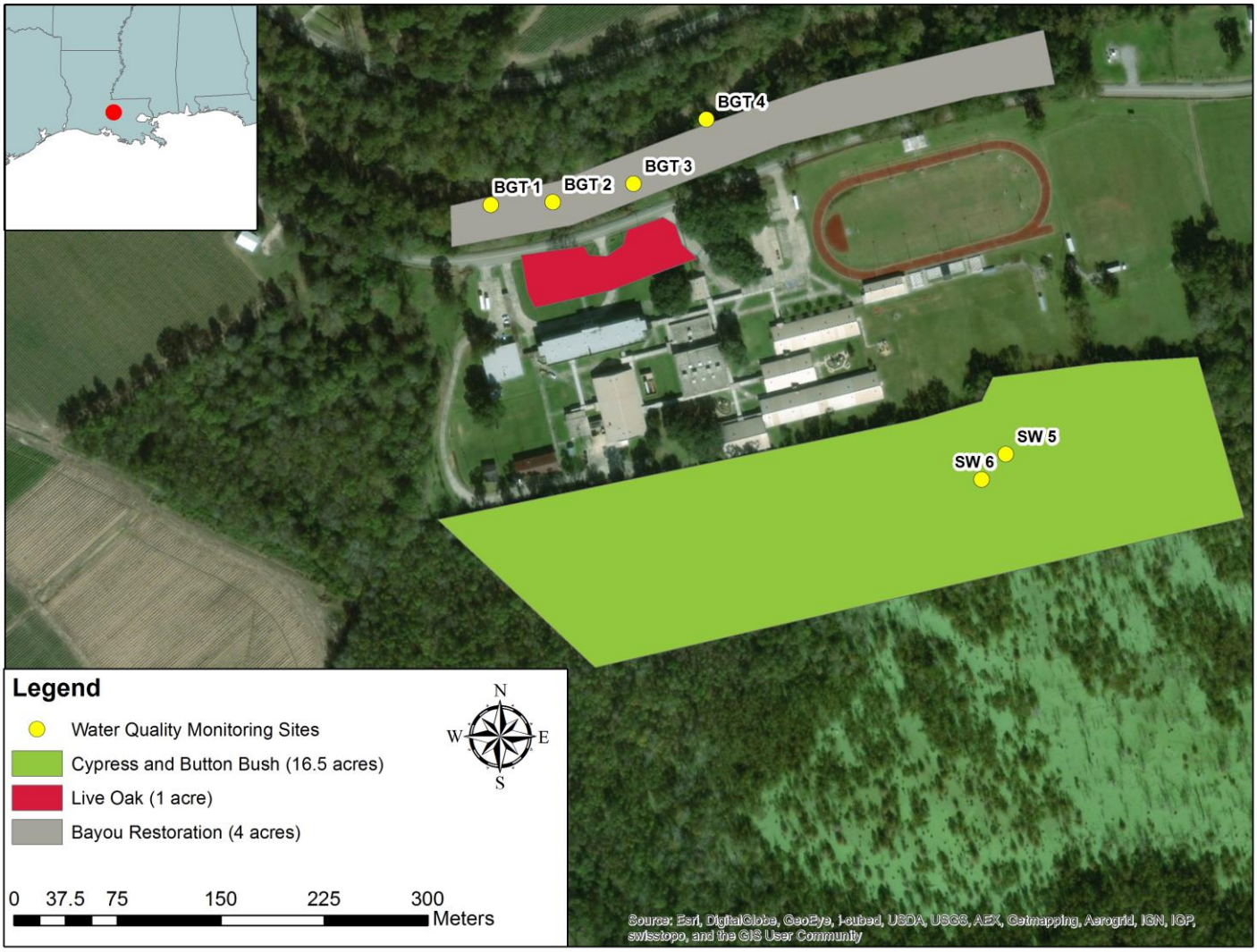

Figure 1: *Map of areas of restoration actions and established water quality monitoring sites along Bayou Grosse Tete adjacent to Starship Academy STEM Magnet High School, Iberville Parish, Louisiana.*

Removal of invasive plants - Identify invasive plant communities and remove invasive plants

With staff from Water Institute, US Forest Service, and Louisiana Department of Wildlife and Fisheries, students participated in a survey of the wetland areas along Bayou Grosse Tete adjacent to the school, as well as the bald cypress wetland behind the school (Figure 1), to develop baseline data on location and types of native and invasive plant species. Restoration needs for removal of invasive trees was prioritized for the cypress swamp.

The primary invasive plant species identified for removal was *Triadica sebifera* (Chinese tallow tree), which was abundant in the wetland area behind the school. Many of these trees were over 20ft tall, so it was determined that the best control method was to kill the trees. Cutting this species can be ineffective as they often re-sprout from the base. Therefore, the bark was removed with a chainsaw in a one-foot wide band around the trunk of each tree and then poison (Garlon) was applied to the bare cut section of tree trunk (Figure 3.2). Using this approach, a total of 517 invasive Chinese tallow trees were killed in the cypress swamp area of wetland (Figure 1), prior to planting native trees on April 18th, 2017. For safety reasons, removal of the Chinese tallow was carried out by FORUM35 volunteers, students were shown the trees after they were killed, and volunteers and project staff explained how removal had been carried out and why removal of these trees was important to allow the planted native bald cypress to regrow.

Although the area cleared of invasive species, 16.5 acres, was less than the target of 26 acres (Table 1), this was directly related to the initial native and invasive vegetation survey identifying the priority invasive plant as the Chinese tallow tree, which was so dense that within 16.5 acres a total of 517 trees were killed. Removal of all

individual trees within a smaller area was determined to provide greater ecosystem benefits than removing the same number of trees from a larger area, as that would have left live Chinese tallow to recolonize.

Number of trees planted - Growing and planting native plants

Students designed, built and tested hydroponics systems in the spring semester of 2017, which informed the building of a larger hydroponics facility in the fall semester of 2017. This functional large system is intended for growth of native plants for restoration planting, once students become familiar with the process and needs of growing plants hydroponically.

Planting of native trees and grasses occurred in three different areas. Firstly, 205 Bald cypress (*Taxodium distichum*) trees were planted in the cypress wetland area behind the school (Cypress, Figure 1), 120 live oak (*Quercus virginiana*), 100 button bush (*Cephalanthus occidentalis*), 15 American beautyberry (*Callicarpa americana*) and 10 yaupon holly (*Ilex vomitoria*) were planted in the areas along Bayou Gross Tete and the area between the school and the Bayou (Figure 1). All plantings occurred on Saturday April 8th, 2017, except for button bush which was planted in the fall semester of 2017. Trees and grass plugs were monitored for survival on May 5th 2017, data is included within the supplementary materials.

The number of trees planted, 450, was more than twice the target number (180), although the number of grass plugs planted, 400, was less than the target of 1080 (Table 1). The reason for this was advice from the State Botanist for Louisiana (LDWF partner), who advised that the density of grass plugs would be sufficient to attain complete coverage, and suggested prioritizing the planting additional trees instead.

Number of people reached - Students attending the Starship Program, summer program participants, volunteers, indirectly parents of students

A total of 24 students participated in the restoration planting event on April 8, 2017 planting a range of tree, grass and shrub species. Parents of these students were included in the 14 community members who also participated in the planting during this day (Figure 2). A total of 96 students were reached within all project activities, including water quality sampling (Figure 3.2), tree planting (Figure 3.1, 3.3, 3.4, 3.5, 3.9), and building of hydroponics systems for growing out native plants for restoration (Figure 3.6, 3.8), as well as building of a pollinator garden at the school which was an additional synergistic output from the project. In addition, students were introduced to the use of a GPS (Global Positioning System), learned approaches for data recording and plant identification, and were exposed to ArcGIS software. This engagement included the total number of students at the school during the 2016/2017 school year, and all the additional students who joined the school for the 2017/2018 school year. A pre and post survey of students was carried out, and is summarized as supplementary materials, conclusions were limited due to the project running over two school years with changes in students, teachers, principal, and programs between the two academic years.

Total number of students engaged in the project, 96, was less than the target of 400, however it was the entire student body of the school, so represented the maximum attainable number of students.

Figure 2. *Students, partners, and community volunteers during the restoration planting day April 8, 2017*

Number of volunteers - Engage local community volunteers (young professionals)

A total of 14 community members (including student parents) and 20 volunteers from Forum 35 participated in the restoration planting day on April 8, 2017. Additional Forum 35 volunteers carried out the invasive clearing by killing the 517 invasive Chinese tallow trees within the cypress wetland (3 volunteers on one day and 4 volunteers on an second day). The early career community leaders, represented by FORUM35, were actively engaged with the students, leading groups during planting activities, as well as discussing invasive clearing and planting approaches with students. Engagement with staff from partner agencies and the Water Institute staff, also allowed continued opportunities for students to interact with local professionals and gain exposure to, and understanding of, career opportunities in coastal restoration.

The number of volunteers participating, 41, was less than the target of 100, in part due to the number of students, and therefore the number of participating parents, being lower than anticipated at project inception.

Monitoring sites - Establish water quality and wetland monitoring plan, and plan for monitoring restoration success

Six water quality monitoring sites were established, four along the Bayou Grosse Tete and two within the cypress wetland behind the school (Figure 1). Students and teachers were trained by Team members from the Water Institute of the Gulf in protocols and methodology for water quality sampling, and carried out regular sampling at the six sites (Table 2, 3). Analyses were carried out at LSUAg Center, and data are included in the supplementary materials. While students were being trained in water quality sampling, protocols were developed and provided for future reference when carrying out these monitoring activities, these are included in supplementary materials.

Water Institute employees and Starship Academy faculty met on 24 August, 2017, to discuss program accomplishments. Scientists and teachers participated in a brainstorming session to determine how concepts and data collected could be integrated within the school curriculum across grade levels and subject matters. Specifically, activities and prioritized concepts were cross-walked with education standards to ensure that curricula activities developed around the Natural Classroom were supporting student attainment of educational standards.

The target of establishing six water quality monitoring sites was achieved, including the collection of initial background data over a period of nine months, where students and teachers received training and refinement in techniques for continued collection of water quality samples.

Table 2: *Dates of analyzed data from student sampling water quality monitoring locations during 2017. June sampling was conducted by Water Institute researches while students were out of school for summer vacation.*

Day	Month	Sites sampled
15	March	4
16	March	2
29	March	6
12	April	6
26	April	6
9	May	2
13	June	6
27	September	4
1	November	4
16	November	4

Table 3: *Water quality metrics sampled*

Metric
Ammonium (NH4, PPM)
Nitrate (NO3, PPM)
Phosphate (PO4, PPM)
Total Nitrogen (TN, PPM)
Total Phosphorus (TP, PPM)
Total Suspended Sediment
Total Volatile Sediment (TVS, PPM)
Turbidity (NTU)

Generation of maps - Mapping Baseline data as basis to curricula activities

Areas of concern within the wetland were surveyed to develop baseline data. Baseline native and invasive plant species, water quality, and soils data were developed into GIS layers and made available to school students for projects, adding future monitoring data, and learning about spatial data.

A total of 6 map layers (ArcMap and KML versions) were developed, these include the restoration area and site of water quality monitoring locations, land use within the watershed, elevation of the surrounding watershed, locations and growth measurements of live oak and cypress trees planted, location and growth measurements of grasses planted, sampling locations of baseline soil and water quality (with 26 corresponding map images). These data layers and maps were provided to students and teachers for development of further classroom activities associated with the Natural Classroom.

Outreach/ Education/ Technical Assistance - Public outreach and education

- Students will be in the public eye participating in the research.
- Having Students participate in all aspects of the projects will not only educate them but also their families.

On December 5, 2016 a partner presentation to both the teachers and the students at the school provided not only a background and explanation of the project, but explanation of coastal processes and threats in coastal Louisiana, and the role that river and wetland restoration can play as part of a solution. To ensure that technical assistance and educational support was accurate and effective, all project partners met at the school on January 4 and February 1, 2017, to scope out restoration needs and priorities, as well as establishing locations for plantings and invasive clearing prior to the implementation of these actions. On February 16, 2017, Baustian and Jerabek ran a water quality sampling training session with students and teachers, so that teachers and students would be able to accurately and effectively carry out regular sampling for water quality monitoring. A press release (included as supplemental materials) was developed for release on October 5, 2016, and the following media and social media posts were developed during the project:

- 27 Twitter posts (@TheH2OInstitute); see Figure 4
- The Advocate story in December: Starship program taking Iberville Parish students out of the classroom as they try to save an ailing bayou http://www.theadvocate.com/baton_rouge/news/communities/westside/article_b0b661f0-c6d8-11e6-b6ab-fffdab87ad3a.html
- 9 Instagram posts (theh2oinstitute)
- 2 Linkedin (The Water Institute of the Gulf)

Figure 3: *Photos of students, partners, and volunteers carrying out restoration activities. Invasive clearing – 2; Planting – 1,3,4,5,9; volunteer, partner and student planting day – 10; hydroponics systems – 6,8; water quality sampling – 7.*

Outcomes

- Describe and quantify progress towards achieving the project outcomes described in your grant agreement. (Quantify using the approved metrics referenced in your grant agreement or by using more relevant metrics not included in the application.)
- Briefly explain discrepancies between what actually happened compared to what was anticipated to happen.
- Provide any further information (such as unexpected outcomes) important for understanding project activities and outcome results.

- *Educational Outcomes*:
  The long term educational outcomes for the project were the development and implementation of a 'Natural Classroom' approach to teach middle and high school students in underserved, rural school district STEM science classes through practical engagement in wetland restoration. During the project, 96 students were involved in the design and building of hydroponics systems, initial plant growing to test the systems, planting of native trees and grasses, collection of water quality samples and data handing. In addition, the project provided students with hands on experience of ecosystem restoration, in an engaging way. Through the partnership with local young professional volunteers and agency partners, students had multiple opportunities to discuss the diverse career opportunities open to them, related to ecosystem

restoration. The established 'Natural Classroom' is conveniently located directly adjacent to the Starship Program campus.
A pre and post survey was carried out of both middle and high school students, although the project covered two school years, so that there were many new students. Assessment of the nine middle school students determined to have participated in both surveys, still suggested less engagement at the end of the project than the beginning. This was attributed to the high amount of administrative turnover at the school. At project initiation there was a high level of support and enthusiasm for the project which resulted in strong engagement by the students. For multiple reasons, the engagement by school administration and teachers was not consistent throughout the project (see lessons learned, below).

- *Conservation Outcomes:*
  The 21.5 acres of bald cypress wetland and vegetated banks of the Bayou Grosse Tete have been neglected and provided very high potential for improved habitat provision in a developed agricultural watershed. To maximize conservation outcomes with respect to chances of successful establishment and growth of the 205 planted bald cypress trees (*Taxodium distichum*), 517 invasive Chinese tallow were removed from the same area. In addition, 120 live oak (*Quercus virginiana*), 100 button bush (*Cephalanthus occidentalis*), 15 American beautyberry (*Callicarpa americana*) and 10 yaupon holly (*Ilex vomitoria*) were planted in the areas along Bayou Gross Tete and in a large area between the school and the Bayou Grosse Tete. Monitoring of water quality, invasive plants, and survival of planted native species within curricula activities will allow continued assessment of ecosystem status of the wetland and effectiveness of restoration efforts. Water quality monitoring within the project provided an initial nine months of data from both the Bayou and the cypress wetland.

- *Unexpected Outcomes:*
  One unexpected outcome of the project was the high engagement and support by additional partners. In particular additional trees were donated by the Barataria – Terrabonne National Estuary Program (BTNEP), and they provided equipment and technical expertise to support the student/partner/teacher restoration planting day.

3. Lessons Learned

Describe the key lessons learned from this project, such as the least and most effective conservation practices or notable aspects of the project's methods, monitoring, or results. How could other conservation organizations adapt their projects to build upon some of these key lessons about what worked best and what did not?

The NFWF Five Star and Urban Waters Restoration Grant Program allowed Water Institute scientists to spend time training students and teachers to create a Natural Classroom program at the school, and implement a range of restoration activities.

In addition to funding, institutional buy-in was vital to program success. As school administration changed throughout the year (e.g., four principals in 12 month period), consistency in program activities and student participation was challenging. By the Fall of 2017, an expert curriculum developer and educator was employed as the school principal. This was a crucial change in the program that allowed all partners to work together to achieve Natural Classroom goals and to match them with Louisiana State Student Science and Math Standards (http://www.louisianabelieves.com/resources/library/academic-standards).

Program flexibility was an important aspect of the Natural Classroom program. Developing programs at schools with a flexible schedule (e.g., magnet, private, or charter) is beneficial as school time can be allocated towards program tasks (i.e., water quality sampling, hydroponics construction, pollinator garden building), a Natural Classroom approach could also be effective as part of an afterschool program.

A diversity of partners was also essential to maintain project momentum to meet key objectives. Including students, teachers, volunteers, local government agency partners, and research scientists, allowed flexibility and transfer of responsibility to ensure key targets were met. For example, even though some initial partners were

less involved than planned, additional partners engaged and provided very strong support, and during times that students were less able to participate, due to changing school priorities, volunteers engaged more fully to progress the project. The external research scientists played a vital role, as the consistent player through the entire project, having to retrain new teachers and students, re-engage new school principals in the value of the project, and identify additional partners to assist in filling gaps when some initial partners became unavailable.

Communication in the school between administrators, teachers, and grounds staff is essential to clarify expectations, roles and responsibilities, as well as ensuring that activities are consistent with goals and needs of all these groups within the school as well as ensuring that completed actions are supported and maintained. This is challenging with frequent turnover of senior school administrators, a briefing to all staff at project inception would be beneficial in maximizing continuity of school engagement in a Natural Classroom program.

The last key element of success for a Natural Classroom program is a champion at the school. Identifying a main point of contact and developing a consistent working relationship is essential for planning and coordinating events such as wetland restoration. Educators have invaluable institutional knowledge regarding individual schools and school district regulations and processes that are necessary for planning events with students both in, and outside of, the classroom. Engaging a specific dedicated individual is crucial to institutional buy-in and achieving program goals.

The Natural Classroom provides an example of how integrating outdoor, hands-on, applied science into the classroom can be challenging, but has potential for engaging future generations in needs and benefits of coastal restoration. To increase success of future programs, maximizing opportunities for open discussions can facilitate understanding of the overall project goals and the required steps needed to meet program goals. Creating technical support documents (i.e., protocols and procedures) for all teachers and partners can help ensure continuity in activities regardless of changes in partners, teachers, and especially program champions. These types of documents assist in institutional buy-in and curriculum integration. Additionally, maximizing opportunities for curriculum development meetings between scientists and teachers can be helpful in assessing program success and student learning.

Finally, time spent working on the program was at times misconstrued by students as an opportunity to get out of class. Testing student knowledge of protocols and concepts prior to sampling could be an effective way to determine if students are understanding activities.

Overall, to maximize benefits of a Natural Classroom approach, it is important to acknowledge the challenges associated with integrating additional field activities and programs into classroom curricula and to minimize additional burdens on classroom teachers.

4. Dissemination

Briefly identify any dissemination of lessons learned or other project results to external audiences, such as the public or other conservation organizations.

See 'Outreach/ Education/ Technical Assistance' above, Figure 4, and the press release in supplemental materials

Figure 4: *Tweets from key activities during the project.*

5. Project Documents
Include in your final programmatic report, via the Uploads section of this task, the following:

- 2-10 representative photos from the project. Photos need to have a minimum resolution of 300 dpi and must be accompanied with a legend or caption describing the file name and content of the photos;
- report publications, GIS data, brochures, videos, outreach tools, press releases, media coverage;
- any project deliverables per the terms of your grant agreement.

- **Ten high resolution photographs of project activities are included;**
  photo 1- photo 10,
  photo_meta_data
- **Six GIS data layers are provided;**
  Starship_elevation_map,
  Starship_Landtype_map,
  Starship_native_grass_planting_map,
  Starship_restoration_monitoring_map,
  Starship_soil_and_water_sampling,
  Starship_tree_planting_map
- **Press release and,**
  flier for engagement of volunteers
- **Five spreadsheets of water quality and monitoring data;**
  Bald_cypress_Live_oak_measurements_May_2017,
  Long_term_Starship_academy_waterquality_dataset,
  Soil_water_bayou_swamp_averaged_nutrient_sampling_June_2017,
  Soil_water_bayou_swamp_raw_data_nutrient_sampling_June_2017,
  Switch_Grass_measurements_May_2017
- **The following sampling protocols and data handling processes were developed for the students:**
  Iberville STEM COC Example,
  Protocol_key_words,
  Water_Quality_data_sheet030717,
  Water_Quality_protocol030717
- **Summary of results from student pre and post questionnaire;**
  Student_questionnare_summary
- **Draft manuscript describing the project for submission to a peer reviewed journal**

POSTING OF FINAL REPORT: *This report and attached project documents may be shared by the Foundation and any Funding Source for the Project via their respective websites. In the event that the Recipient intends to claim that its final report or project documents contains material that does not have to be posted on such websites because it is protected from disclosure by statutory or regulatory provisions, the Recipient shall clearly mark all such potentially protected materials as "PROTECTED" and provide an explanation and complete citation to the statutory or regulatory source for such protection.*