Building Vegetative Buffers at Base of Anthropogenic Landforms for Sediment Reduction, Improving Floodplain Connectivity and Freshwater Mussel Habitat, Apalachicola River

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The following includes several figures of the site to be restored including historical and current conditions with arrows demarcating locations of Sand Mountain and Virginia Cut (Figure 1), historical dredging (Figure 2), and field photographs (Figure 3). Also shown are a topographic-hydrographic survey of Sand Mountain made in December 1980 with arrows demarcating the current bankline (Figure 4), and historical photographs of the site showing floodplain spoil deposition, widening and sedimentation at both sites. Lastly is a photo showing site vegetation and the current buffer (Figure 6) and abundance of a listed mussel species upstream (Figure 7). Figures are of high resolution and more detail can be seen by zooming in.

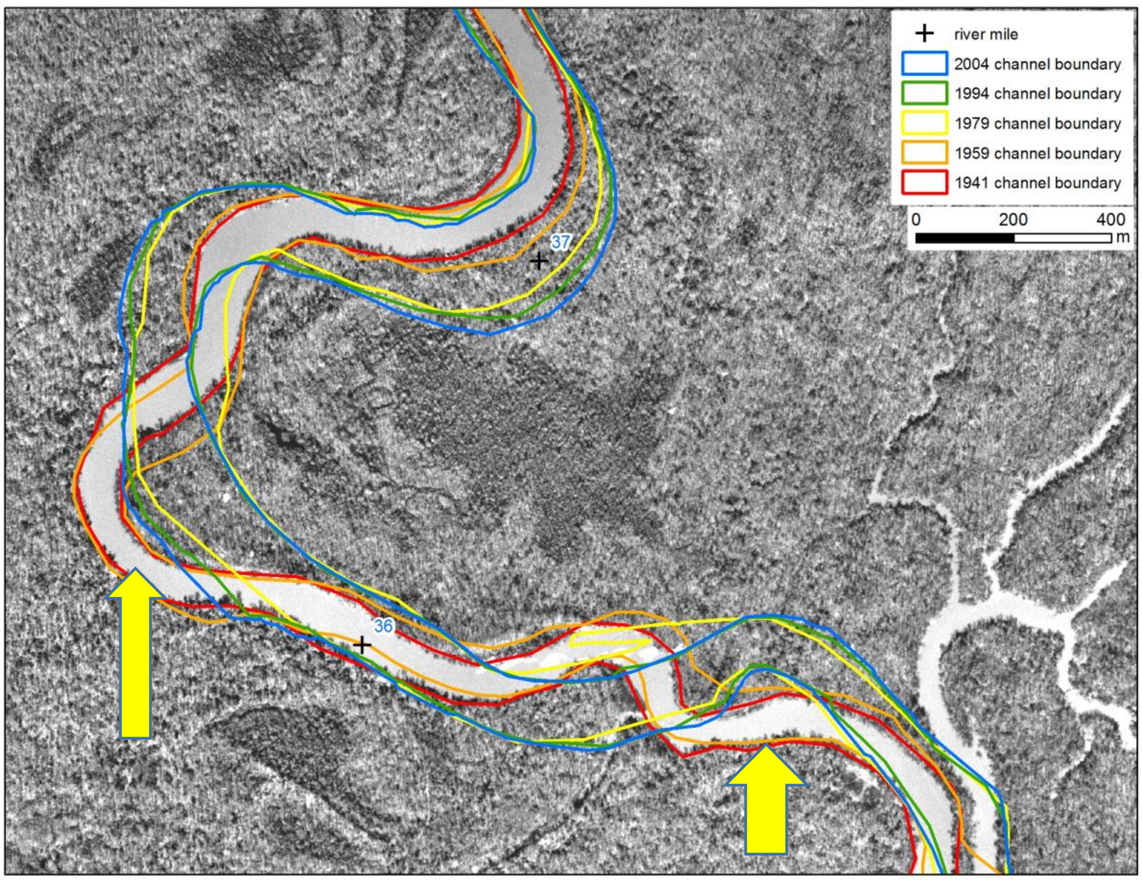

Figure 1. Channel changes near River Mile 35 to 37 on the Apalachicola River happened mostly between 1959 and 1979 photography when artificial cutoffs were made. The channel has a different position and is much wider due to dredging and other engineering alterations. Arrows point to former channels and disposal sites that are largely unvegetated.

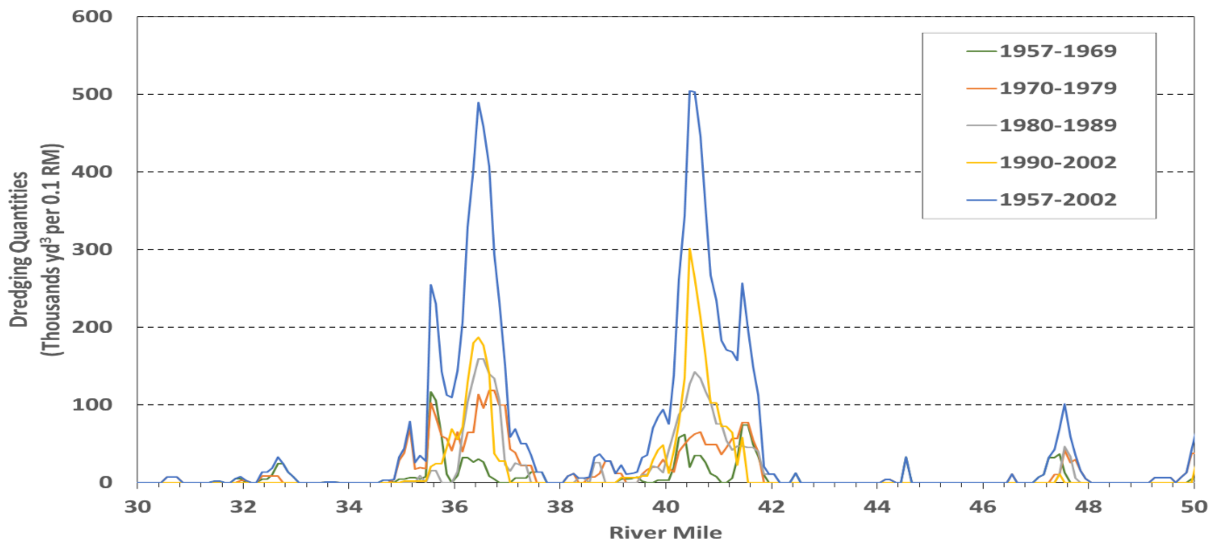

Figure 2. Historical dredging quantities associated with the Navigation project shows that the area near RM 36 had a large amount of sand dredged, much of which was dumped on Sand Mountain (Mobile District, Corps of Engineers, 2002). Approximately 4.5 million yd^3 were dredged in the reach between RM 34.5 and 37.5.

Figure 3. Recent (2015-17) photographs of the eroding face of Disposal area 40 or Sand Mountain. Plantings would be at the very base of these features, where willow stakes and other plantings would be able to access groundwater.

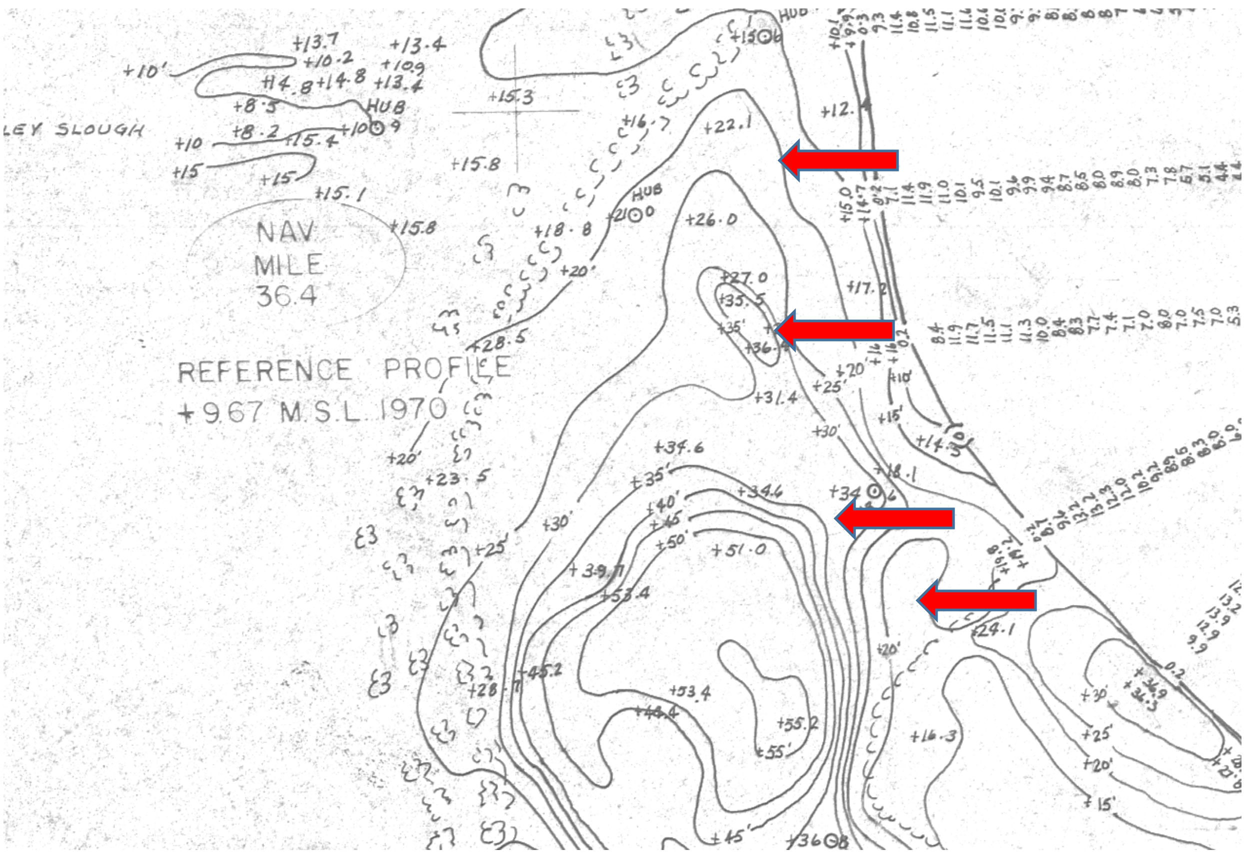

Figure 4. A portion of the topography of Sand Mountain mapped by the U.S. Army Corps of Engineers on December 9-17, 1980. Note that the map says "Reference profile +9.67 MSL 1970, so these are not true elevations). This map was geo-referenced to the 2007 LiDAR data and the red lines show the water surface boundary from 2007 LiDAR. This portion of the river is eroding back toward the crest of the sand mound, indicating that increased sand input is possible if no corrective actions are taken.

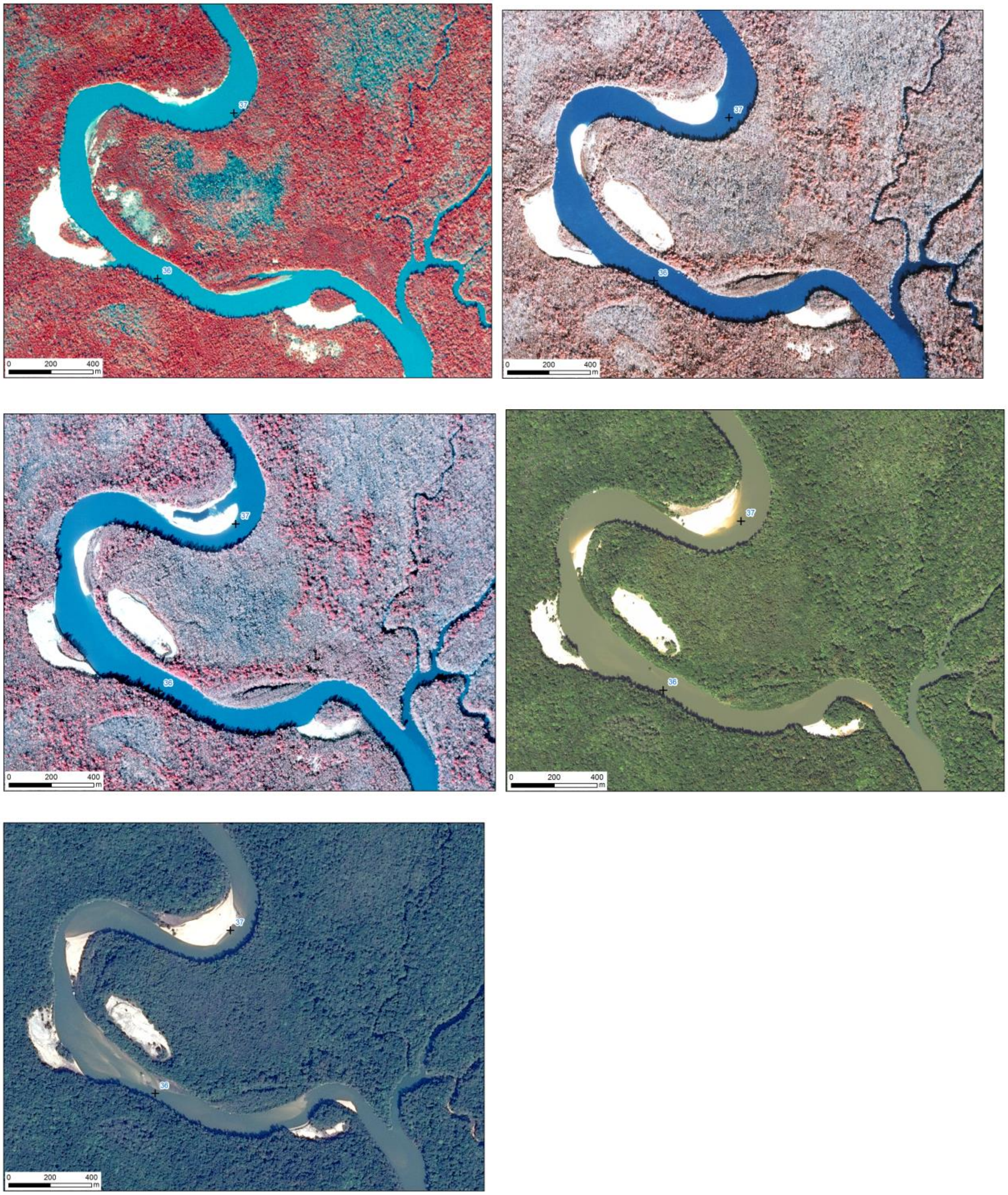

Figure 5. Channel changes near Corley Slough and Virginia Cut, both on the right or west bank of the river, 1979, 1994, 1999, 2004, and 2016. Neither site has stabilized by vegetation naturally. Widening at these locations is visible in all imagery, particularly between 1979 and 1994. Sediment input from both sites is evident especially in the last image from Quickbird satellite.

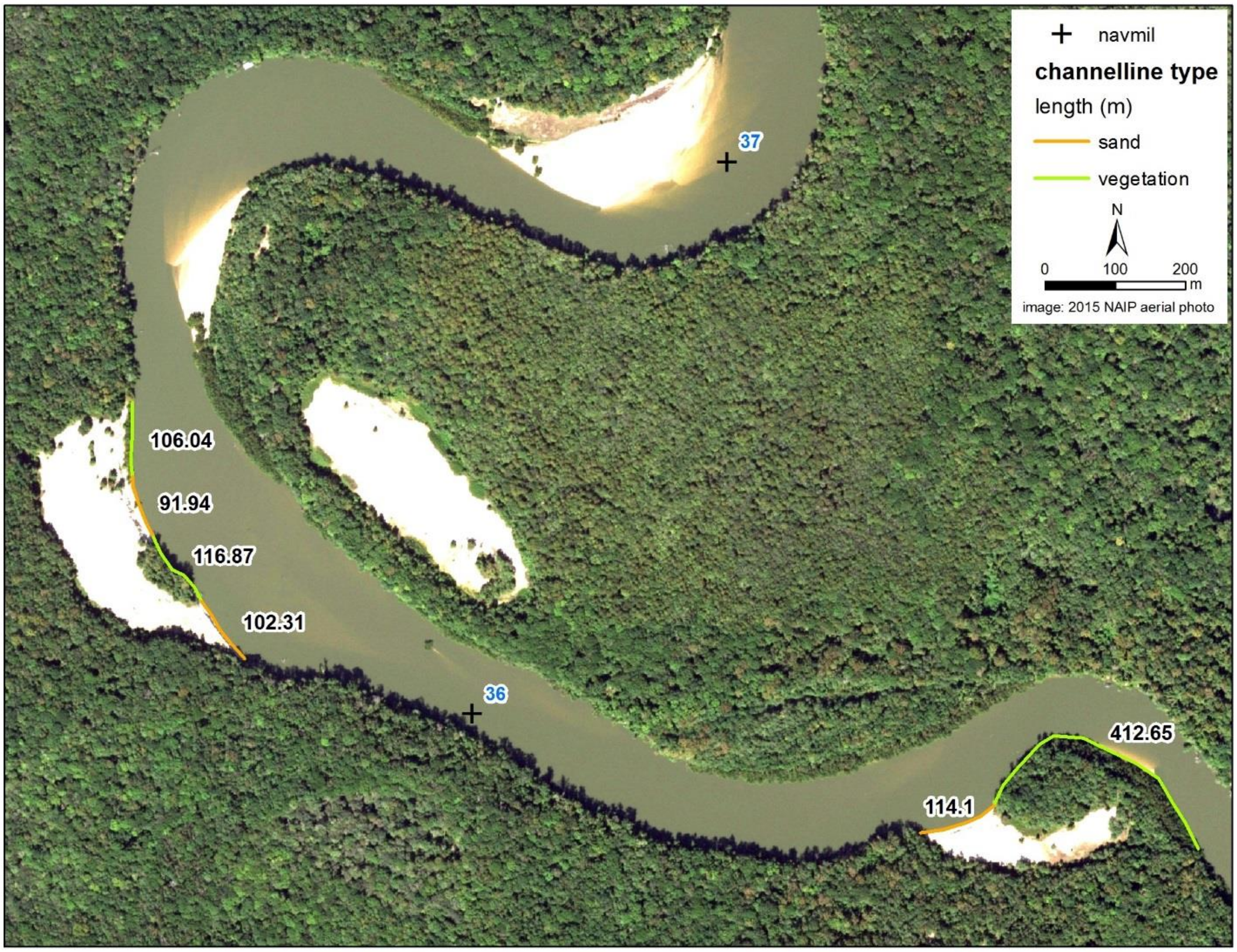

Figure 6. Detailed site map from 2015 NAIP imagery. Green indicates shoreline has some vegetation. At Sand Mountain, these sites will be supplemented with more. Mustard color is non-vegetated area. The entire shoreline of both sites with be planted. Numbers are the estimated length of bankline in meters from GIS.

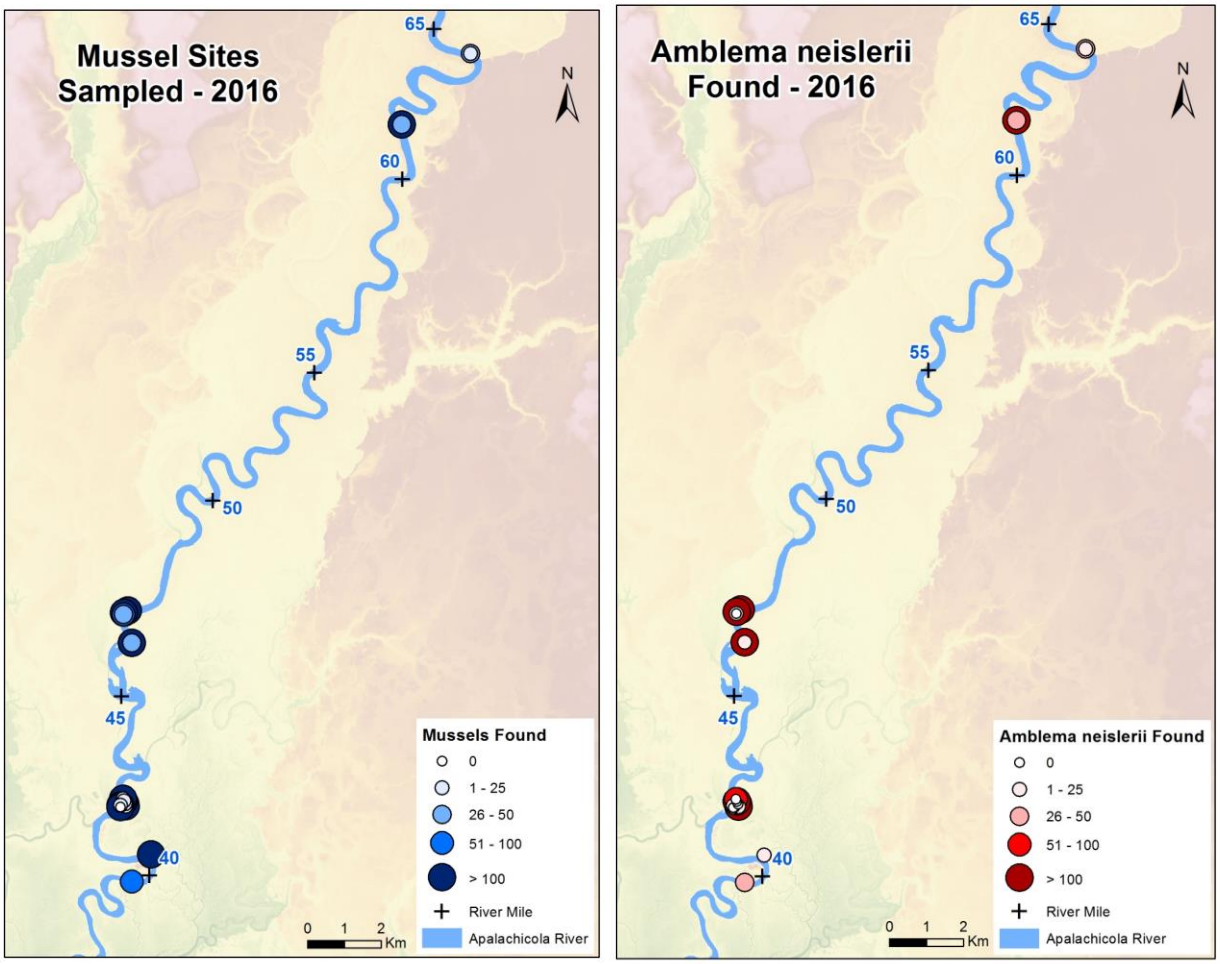

Figure 7. Distribution of sampling sites, overall abundance, and abundance of listed Fat threeridge (*Amblema neislerii*) in the RM40-63 reach of the Apalachicola River in northwestern Florida during 2016. Surveys were conducted by Florida FWC with assistance from Appalachian State University personnel (from Gangloff et al., 2017).

List of Tables

The following includes several tables pertinent to the site including the original Corps information on the cutoffs (Table 1), planting methodology (Table 2), preliminary table for evaluating planting methods (Table 3), success metrics and expectations (Table 4) and project timetable with pre-project baseline, plantings, frequency of measurement of varied success metrics variables, and post-project analysis (Table 5).

Table 1. Artificial cutoffs (modified from U.S. Army Corps of Engineers, Mobile District, 1986)

Location RM	Name	Date	Quantity (cu. yards)	Disposal	Reduction in River Length (Ft)
36.3	Corley Slough/Sand Mtn.	1968-69	159,473	Diked Floodplain	500
35.5	Virginia Cut	1968-69	151,478	Diked Floodplain	500

Table 2. Zonge and others (1997) “Tips for successfully planting willows in riparian areas” advice versus local adaptations. Adaptations relevant to the local setting are in italics.

Zonge et al. (1997) advice	Project specific plans and adaptations
Willow cuttings must be collected when they are dormant.	*This advice was developed for Nevada where nighttime temperatures are consistently below freezing. We plan to make cuttings in late winter, a period of slower growth.*
Willow cuttings should be taken from plants growing in riparian areas similar to those where they will be planted.	*We intend to get cuttings from Battle Bend, near RM 28. FWCC would like this artificial cut-off to be more connected with the mainstem Apalachicola. Willows on the bars have partly blocked the lower or southern entrance, and removal of willows in the Battle Bend oxbow would have a double benefit in keeping this waterway more open for recreational fishing.*
The cuttings should be about as big around as a thumb, two feet long, and taken from the base of the stems.	*No adaptation needed*
To avoid planting the cuttings upside down, cut the bottoms at a steep angle and the tops flat.	*No adaptation needed*
The cuttings should be stored in bundles placed in plastic bags, moist peat moss or sand.	*No storage is needed due to differences in climate. We will transplant half the same day and allow half to grow roots in water. Further plantings will depend on comparative successes and failures of both methods.*
To ensure adequate soil moisture, cuttings will be planted with their bases at or near the level of the normal water table.	*We will plant cuttings close to the normal edge of the stream, which will depend on the water levels of that day. Given the steep bank, we hope to do additional plantings as the water level drops in different years. .*
Plant willow cuttings at the edge of the water at the base of the stream bank.	*For about half the first plantings, we will add a weed barrier to part of the steep sand mound to assess if it temporarily minimize erosions and increases the success of the planting effort.*
Willow cuttings should be soaked in water for 7 to 10 days before planting. The water should cover the bottom half of the cuttings and be changed every two days. Roots need oxygen to develop and grow best in cool water ~60º F.	*One half of the first planting will be stored in water. For stakes stored in r buckets, we will change the water every two days, we will examine root length and make appropriate decisions. With the warmer temperatures of Florida, most likely the roots will grow faster, so cuttings will be monitored frequently to examine root length.*
Cuttings should be buried to at least one-half their length or deeper when possible.	*No adaptation needed*
Planting in groups is better than spacing individual cuttings several feet apart.	*No adaptation needed except where constrained by geomorphology.*
Nothing adaptive suggested	*Flexible and adaptive approaches will be taken to maximize project success. For instance, if we observe one technique is performing poorly, we will adjust cutting, weed barrier, soaking, and planting methods to increase the chances of project success.*

Table 3. A sample data collection table for assessing willow planting success and survival early on in the project. Results will inform continued planting efforts. We expect planting small stakes should go more quickly, but we are unsure if survival will be optimal. If the water-jetting technique is successful and efficient, we expect that it will have the least labor.

Type of planting	Number of plants or stakes	Time required to plant	% Survival after a week	% Survival after 2 weeks	% Survival after one month
Stake, small					
Stake, medium					
Stake, large					
Rooted, small					
Rooted, medium					
Rooted, large					

Table 4. Tentative success metrics of vegetative restoration at base of anthropogenic features, Apalachicola River, RM 35 to 37.

Metric of success	Expectation	Methods	Frequency of measurement
Area vegetated (m^2 or ha)	Increase	RTK, Aerial photographs	Annual
Height/maturity of vegetation	Increase	Survey rods, GPS, etc.	Annual
Organic material/sub-canopy grasses (categorical: minimal, low, medium, high)	Increase	Quadrats, GPS	Annual
Erosion rates of features as compared with historical erosion rates	Decrease	RTK, LiDAR, Aerial photographs, historical surveys	Once (comparing Y1 and Y5)
Sedimentation quantities/rates at base of willows	Increase	Mm or weight of sediment on netting and small rods	Annual (note, we will distinguish spoil sediments that are eroding from river sediments if possible)
Average Width-depth ratio of channel	Decrease	Sonar/LiDAR Aerial photographs	Annual (recovery likely will take several years)
FW Mussels Abundance	Increase	Field surveys/SCUBA	Annual (recovery likely will take several years)
FW Mussels Diversity	Increase	Field surveys/SCUBA	Annual (recovery likely will take several years)
FW Mussels listed species (Various)	Increase	Field surveys/SCUBA	Annual (recovery likely will take several years)

Table 5. Project timetable for data collection, plantings and other monitoring-related field visits

Year	Site Characterization	Planting	Pre and post-planting field visits
1	Field surveys at low water using RTK surveying equipment, drone and aerial photography, satellite imagery, field photography, and sonar; mussel habitat assessment	2 phases at different water levels, spaced within 10 days to assess different methods	Monitoring of plant mortality, data collection on successes (Tables 3 and 4)
2	RTK survey of vegetative boundary, satellite imagery, aerial photography, field photography, and sonar; mussel habitat assessment	2 phases at different water levels, with monitoring between	Monitoring of plant mortality, data collection on successes (Tables 3 and 4)
3	RTK survey of vegetative boundary, satellite imagery, aerial photography, field photography, and sonar; mussel habitat assessment	2 phases at different water levels, with monitoring between	Monitoring of plant mortality, data collection on successes (Tables 3 and 4)
4	RTK survey of vegetative boundary, satellite imagery, aerial photography, field photography, and sonar; mussel habitat assessment	2 phases at different water levels, with monitoring between	Monitoring of plant mortality, data collection on successes (Tables 3 and 4)
5	Drone and RTK survey of entire site and vegetative boundary, satellite imagery, aerial photography, field photography, and sonar; mussel habitat assessment	None	Data collection on successes (Table 4)

Table 6. Budget combining University of Florida budget with Riverkeeper subcontract.

Current All-Period Totals	Period 1	Period 2	Period 3	Period 4	Period 5	Cumulative
Personnel:	**$79,686**	**$82,077**	**$84,541**	**$87,075**	**$89,687**	**$423,066**
Salaries:	$71,260	$73,399	$75,602	$77,868	$80,205	$378,334
Fringe:	$8,426	$8,678	$8,939	$9,207	$9,482	$44,732
General:	**$40,307**	**$33,413**	**$33,413**	**$33,413**	**$32,613**	**$173,157**
Equipment	$0	$0	$0	$0	$0	$0
Travel - Domestic	$31,913	$31,913	$31,913	$31,913	$31,913	$159,563
Travel - Foreign	$0	$0	$0	$0	$0	$0
Participant Support	$0	$0	$0	$0	$0	$0
Material and Supplies	$5,894	$0	$0	$0	$0	$5,894
Publication Costs	$0	$0	$0	$0	$0	$0
Consultant Services	$0	$0	$0	$0	$0	$0
Computer Services	$0	$0	$0	$0	$0	$0
Rental/User Fees - Equipment or Facility	$0	$0	$0	$0	$0	$0
Alterations and Renovations	$0	$0	$0	$0	$0	$0
Other						
Tuition	$0	$0	$0	$0	$0	$0
Animal	$0	$0	$0	$0	$0	$0
Patient Care	$0	$0	$0	$0	$0	$0
Human Subject Payment	$0	$0	$0	$0	$0	$0
Scholarships and Fellowships	$0	$0	$0	$0	$0	$0
Other	$2,500	$1,500	$1,500	$1,500	$700	$7,700
Trainee:	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Subaward:	**$47,475**	**$43,550**	**$43,550**	**$43,550**	**$49,755**	**$227,880**
Subaward Direct:	$47,475	$43,550	$43,550	$43,550	$49,755	$227,880
Subaward Indirect:	$0	$0	$0	$0	$0	$0
Total Direct less Subaward Indirect:	**$167,468**	**$159,040**	**$161,504**	**$164,038**	**$172,055**	**$824,105**
Total Direct:	**$167,468**	**$159,040**	**$161,504**	**$164,038**	**$172,055**	**$824,105**
Total Indirect:	**$16,747**	**$15,904**	**$16,150**	**$16,404**	**$17,205**	**$82,410**
Project Total:	**$184,215**	**$174,944**	**$177,654**	**$180,442**	**$189,260**	**$906,515**