



**State of Louisiana
Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division**

**2004 Operations, Maintenance,
and Monitoring**

for

**Mandalay Bank Protection
Demonstration**

State Project Number TE-41
Priority Project List 9

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Terrebonne Parish

Prepared by:

Elaine J. Lear, Biological Monitoring Section (CRD)
&
Daniel Dearmond, Field Engineering Section (CED)

LDNR/Office of Coastal Restoration and Management
Thibodaux Field Office
1440 Tiger Drive, Suite B
Thibodaux, LA 70301

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2004 Operations, Maintenance, and Monitoring Report
For
Mandalay Bank Protection Demonstration (TE-41)

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I. Introduction

The Mandalay Bank Protection Demonstration (TE-41) project is located along a 3.4 mi (5.5 km) segment of the Gulf Intracoastal Waterway (GIWW) inside the Mandalay National Wildlife Refuge (Figure 1). It is approximately 6 mi (9.7 km) southwest of Houma, Louisiana in the northeast portion of Terrebonne Parish. Vegetative communities in the project area include fresh marsh, scrub/shrub, seasonally flooded bottomland forest, and open-water areas with aquatic vegetation. The two fresh marsh vegetation types fresh bulltongue marsh and fresh maidencane marsh, have relatively high diversity.

From 1944-1983 the north and south shorelines in the project area have experienced an average land loss rate of approximately 13.17 ft y⁻¹. Frequent wave action along the waterway coupled with soft, unstable marsh sediments has resulted in bank erosion and an overall widening of the channel. Adjacent freshwater marshes remain vulnerable to the damaging effects of erosion. The stretch of GIWW within the project area experiences a substantial volume of marine vessel traffic. The traffic is a mixture of recreational vessels, large barges and barge combinations, tug boats, supply vessels, and crew boats. The estimated mid-channel wave height in the GIWW generated by winds and large vessel wakes is approximately 3.0 ft, based upon calculations from preliminary design investigations.

The objective of the Mandalay Bank Protection Demonstration (TE-41) project is to compare both the treatment as well as the cost effectiveness of two off-bank and two blowout treatments' ability to provide protection against shoreline erosion, promote sedimentation, and promote vegetation growth in selected areas along the GIWW (Figure 2).

The Mandalay Bank Protection Demonstration (TE-41) project was constructed in one phase beginning in April 2003 and completed in September 2003. Monitoring will continue for five years post-construction, however structures were designed and built for a 20 year life which began in September 2003.

The principal project features include:

- Construction of approximately 1,196 ft (407 m) of submerged articulated concrete revetment mats.
- Construction of approximately 1,749 ft (601 m) of straight-walled fiberglass sheet pile.
- Construction of approximately 1,241 ft (378.3 m) of 24 inch (0.61 m) high A-Jacks[®] concrete blocks in an interlocking double row with two staggered rows of *Zizaniopsis miliacea* (Michx.) Doell & Aschers. (giant cutgrass) plantings on five foot centers between it and the shoreline.
- Construction of approximately 1,194 ft (355 m) of staggered treated lumber fencing with two staggered rows of *Z. miliacea* plantings on five foot centers between it and the shoreline.



Additional features include:

- Construction of approximately 216 ft (66 m) of concrete revetment armored plugs.



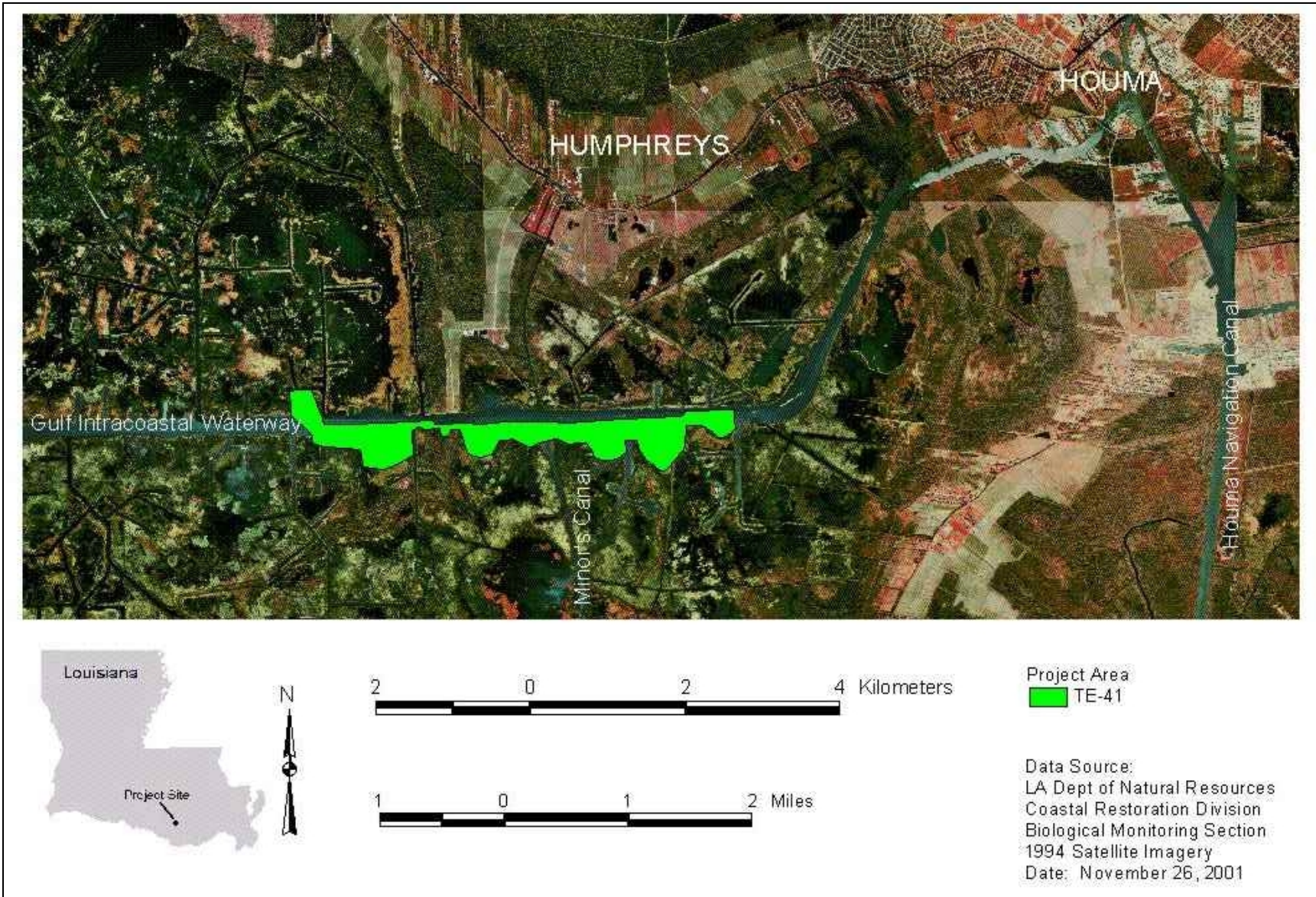


Figure 1. Mandalay Bank Protection (TE-41) Demonstration project location map.

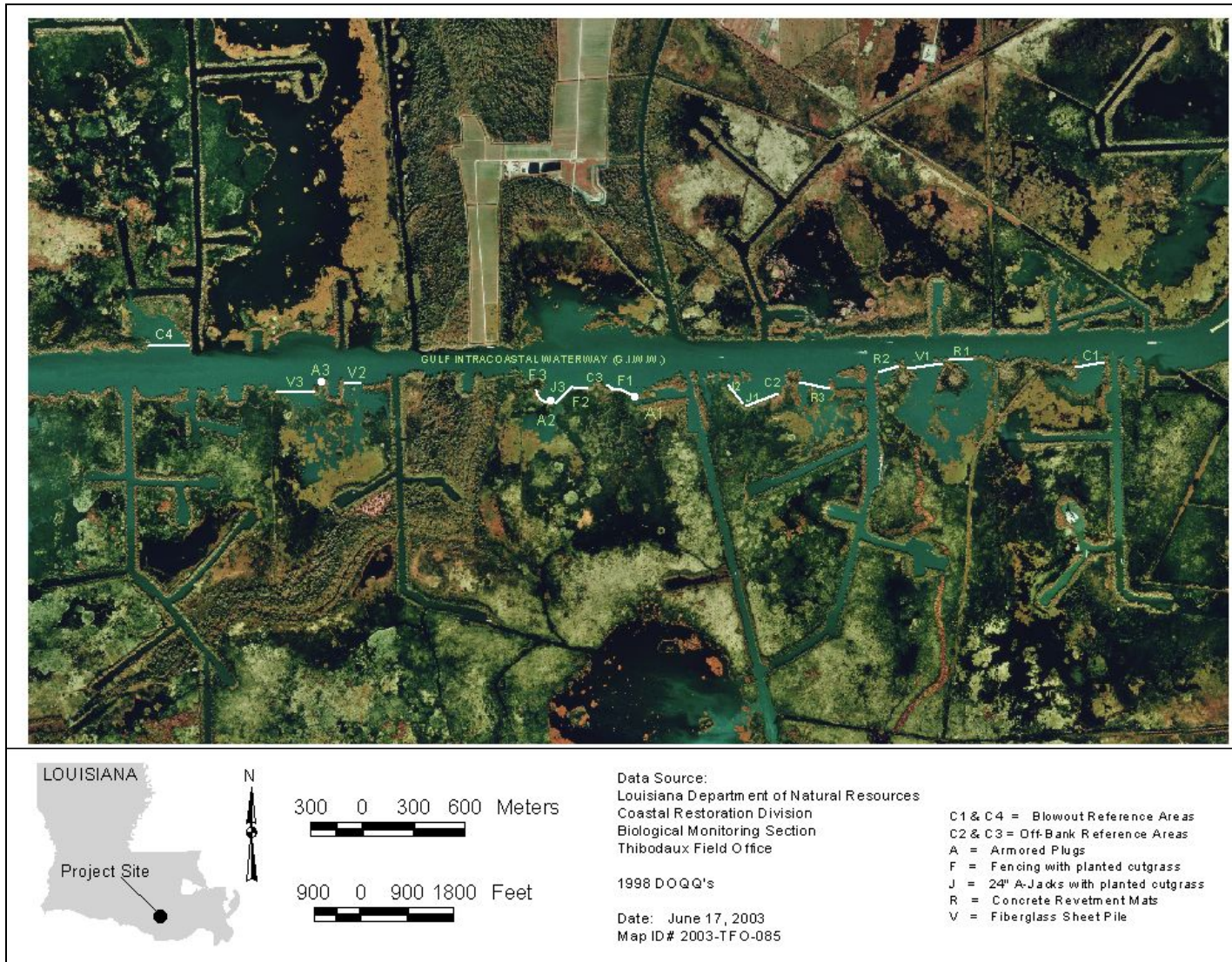


Figure 2. Location of treatments and reference areas for the Mandalay Bank Protection (TE-41) Demonstration project.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The project features will be inspected annually. The first annual inspection will occur during fall 2004.

III. Operation Activity

a. Operation Plan

None of the project features will require operations.



IV. Monitoring Activity

a. Project Objective and Goals:

The objective of the Mandalay Bank Protection Demonstration (TE-41) project is to compare both the treatment as well as the cost effectiveness of two off-bank and two blowout treatments' ability to provide protection against shoreline erosion, promote sedimentation, and promote vegetation growth in selected areas along the GIWW.

The following goals will contribute to the evaluation of the above objective:

1. Stop shoreline erosion in specified areas along the south shores of the GIWW.
2. Increase elevation in shallow open water behind treatments along the GIWW.
3. Maintain/increase the frequency of occurrence of submerged aquatic vegetation (SAV) within shallow open water blowouts along the GIWW.
4. Increase mean cover of *Z. miliacea* to 50% or greater after five growing seasons in planted areas adjacent to eroding shorelines of the GIWW.
5. Increase mean cover of emergent vegetation within shallow open water blowouts along the GIWW.
6. Evaluate the cost effectiveness of different treatments in selected areas along the GIWW.
7. Evaluate the integrity of the structures associated with treatments in selected areas along the GIWW.

b. Monitoring Elements

Shoreline Survey:

To document the rate of shoreline retreat or progradation in both blowout and off-bank treatments, shoreline position will be surveyed (outward edge of emergent vegetation) in all treatment and reference areas using methods described in Steyer et al. (1995). To determine shoreline position, three transect lines per treatment area will be surveyed by a professional surveyor to a permanent benchmark established in the project area. The survey lines will coincide with vegetation plot transects and sedimentation elevation transects in each area. Shoreline position was documented in fall of 2003 (as-built) funded through construction, and will be documented again in fall 2005 and 2008 (post-construction).

Elevation:

To determine the elevation within shallow open water areas, surveys will be conducted along transects by professional surveyors. Elevation transects will be surveyed to a permanent benchmark established inside the project area. Three transects will be delineated in each treatment area and in each reference area and they will continue into the center of the channel. To document structural movement and integrity, the tops of all structures will be surveyed at the same points, during each elevation transect. Sediment and structure elevations were



documented in the fall of 2003 (as-built) funded through construction, and will be documented again in the fall 2005 and 2008 (post-construction) to document sedimentation and structure settlement.

Vegetation:

To determine changes in % cover of emergent vegetation, plots will be randomly established along three line transects running north to south in each treatment and reference area. For blowout treatments, approximately four plots will be randomly placed along each transect. Three of the plots will be randomly placed within one of three zones based upon plot distance from the proposed structure (if a treatment plot) or channel (if a reference plot). A fourth plot per transect will be established on the marsh surface at a randomly chosen distance from the vegetated shoreline. Zones will be determined by dividing the longest transect in each treatment or reference area into three equidistant areas. For off-bank treatment and reference areas, one plot per transect will be established in the water at a random distance (from the treatment or channel). Two additional plots will be placed along the transects on the marsh surface at a random distance from the vegetated shoreline. Total percent cover as well as individual species cover will be determined within the plots using a 6.6 ft x 6.6 ft (2 m x 2 m) square placed over the southeast corner post. Vegetation data were collected twice pre-construction in the fall of 2001 and 2002, once in the fall of 2003 (as-built), and will be collected post-construction in the fall of 2005 and 2008.

Percent Survival:

To determine the survival of planted *Z. miliacea* behind off-bank treatments, 18 permanent vegetation plots representing approximately 10% of the planted vegetation will be established among the off-bank treatments. Plots will contain 12 plants planted in two staggered rows. The rows will be spaced five feet apart with plants within each row spaced five feet apart. Percent survival was determined in the fall of 2003 (one month post-planting), and will be documented in the fall of 2005 and 2008 (post-construction).

Due to a change in the planting scheme, the plots for percent survival were sampled differently than originally anticipated. When the monitoring crew proceeded with the 2003 as-built survival data collection behind the fencing and the A-Jacks treatments, it was determined that the planting scheme outlined in the project design was not adhered to. There were treatments with one, two, three, or four staggered rows instead of the anticipated design. The following procedure was used to determine percent survival: 1) a plot was established between the shoreline and treatment at each elevation transect (N = 3 transects per treatment replicate), 2) the number of rows established behind each treatment was determined by visual inspection since it did not adhere to the design, 3) standing on the shoreline and facing each treatment, plantings to the left of the observer were selected, 4) three plants per row were counted based upon the assumed five foot staggered spacing of the design and percentages of survival were determined for each treatment.



Submerged Aquatic Vegetation (SAV):

To determine the frequency of occurrence of SAV, open water areas inside blowout treatments and reference sites will be randomly sampled. Each blowout will be sampled at random points along transects using the rake method (Chabreck and Hoffpauir 1962; Nyman and Chabreck 1996). The number of random points and transects will be determined based upon the size and configuration of the blowout. Frequency of SAV occurrence will be determined for each area from the number of points at which SAV occurred and the total number of points sampled. SAV were monitored twice pre-construction in the fall of 2001 and 2002, during the fall of 2003 (as-built), and it will be documented post-construction during the fall of 2005 and 2008.



IV. Monitoring Activity

c. Monitoring Data

Shoreline Survey

An as-built shoreline survey is complete. The survey began in November 2003 and was completed in January 2004. Deliverables for this shoreline survey have not been received. Shoreline survey data collection will not occur again until 2005. Comparative analysis between the two data sets will occur once the 2005 data are available.

Figures:

Figure 3. 1998 DOQQ image indicating survey transect locations within the Mandalay Bank Protection Demonstration (TE-41) project.

Elevation

The as-built transect elevation survey for topography and bathymetry, including structure elevations is complete. The data were collected concurrent with the shoreline position data collection from November 2003 through January 2004. Elevation survey data collection will not occur again until 2005. Comparative analysis between the two data sets will occur once the 2005 data are available.

Figures:

See figure 3 above



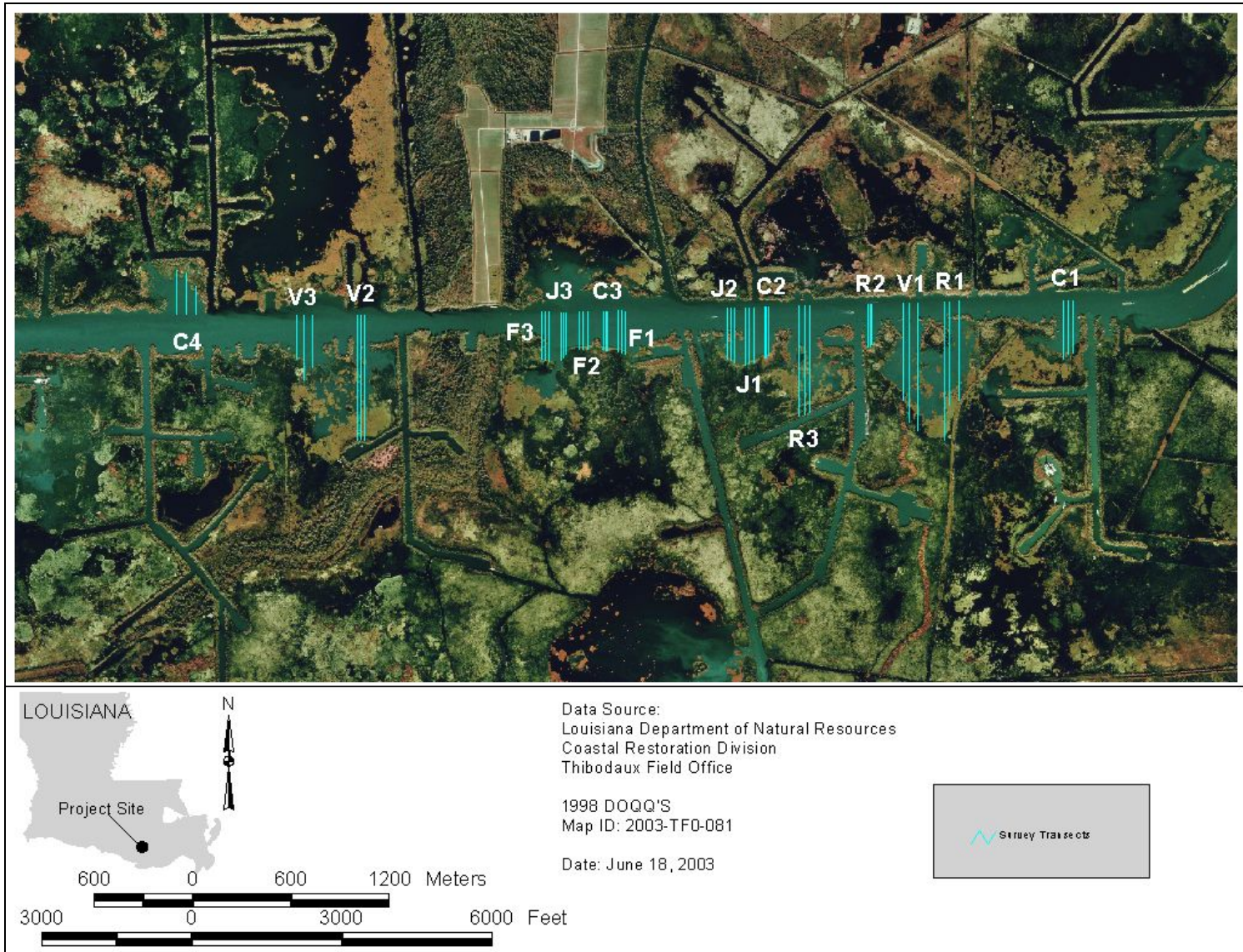


Figure 3. Transect location map for shoreline position, elevation, and vegetation monitoring activities on the Mandalay Bank Protection (TE-41) Demonstration project.

Vegetation

Species composition and percent cover data were collected in October 2001 (N=144 plots) and in October 2002 (N=144 plots) during pre-construction. Species composition and percent cover data were collected in September 2003 (N=168 plots) one month post-planting.

Figures:

Figures 4 - 8. Location maps indicating the 168 randomly selected vegetation monitoring plots along transects for the Mandalay Bank Protection Demonstration (TE-41) project.

*Note: Several vegetation stations were inactivated because they could not be relocated during follow-up data collection field trips. New stations were established and activated in their place.

Table 1. Percent stations and mean cover data for all species within 4 m² Braun-Blanquet blowout (fiberglass sheetpile) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Table 2. Percent stations and mean cover data for all species within 4 m² Braun-Blanquet blowout (Revetment Mats) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Table 3. Percent stations and mean cover data for all species within 4 m² Braun-Blanquet blowout (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Table 4. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Fencing and Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Table 5. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (A-Jacks® & Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Table 6. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Figure 9. Mean cover of selected species in blowouts for years 2001, 2002, and 2003 for the (TE-41) Mandalay Bank Protection Demonstration project.

Figure 10. Mean cover of selected species in offbanks for years 2001, 2002, and 2003 for the (TE-41) Mandalay Bank Protection Demonstration project.



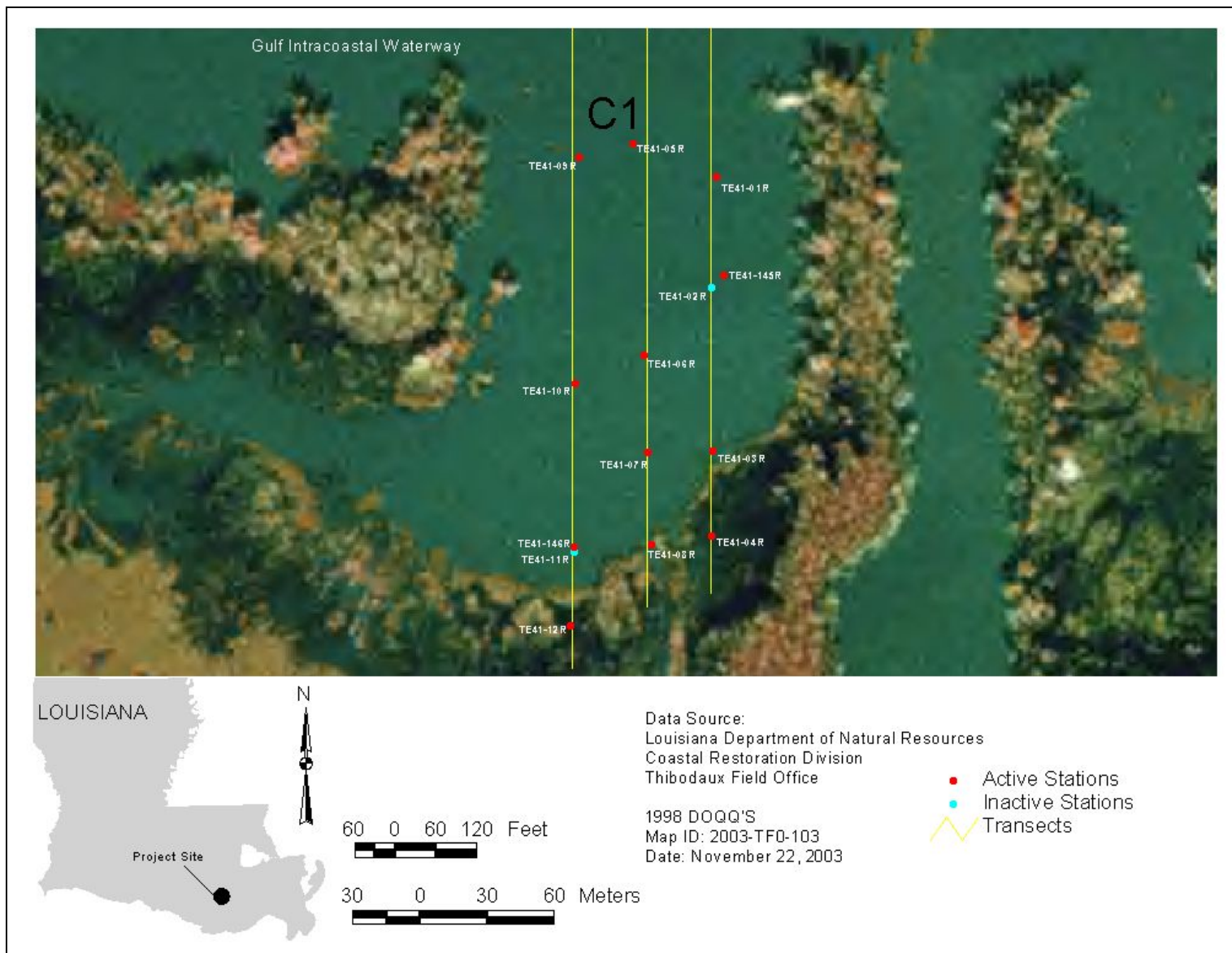


Figure 4. Location map of vegetation plots along transects for the Mandalay Bank Protection (TE-41) Demonstration project.

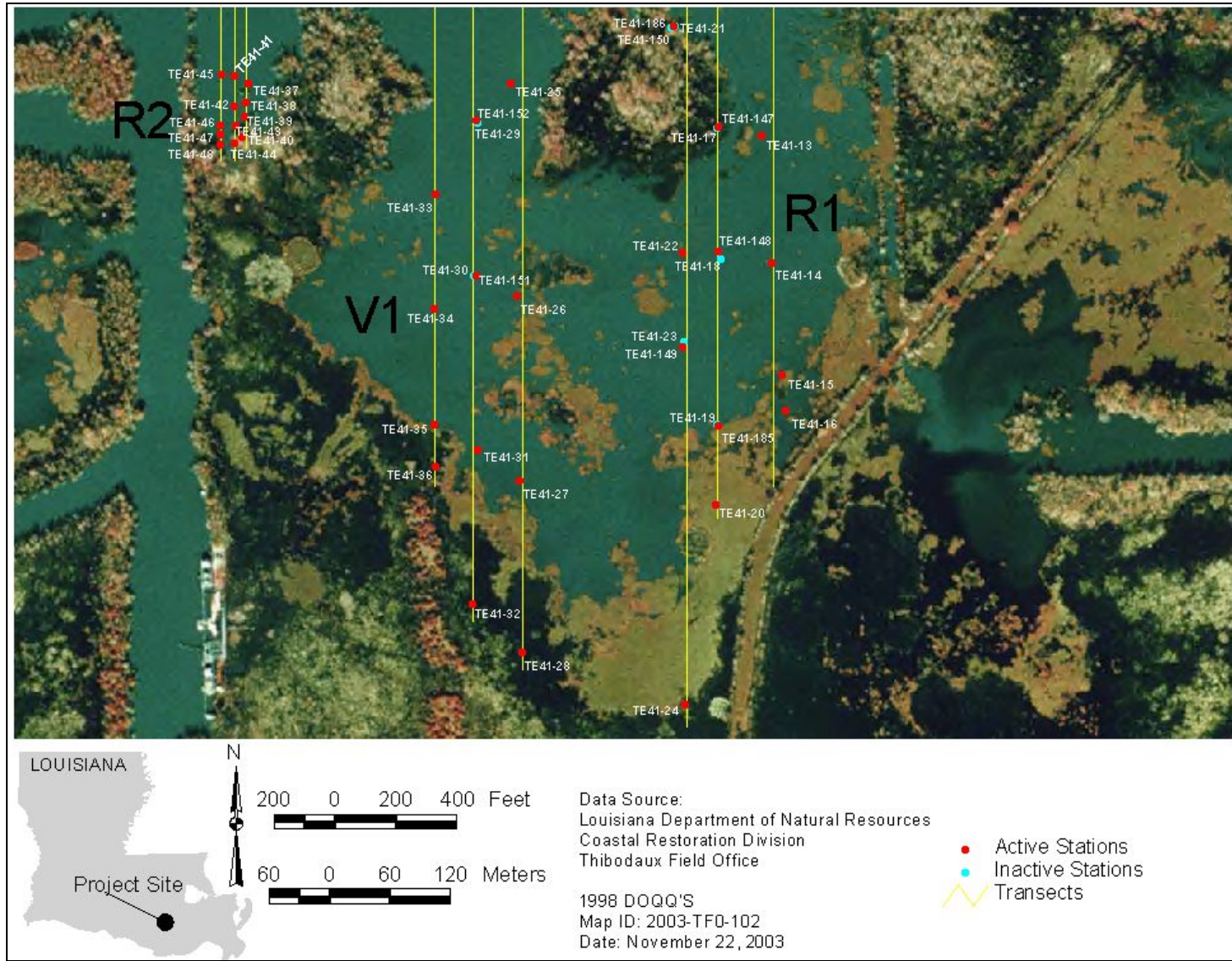


Figure 5. Location map of vegetation plots along transects for the Mandalay Bank Protection (TE-41) Demonstration project.



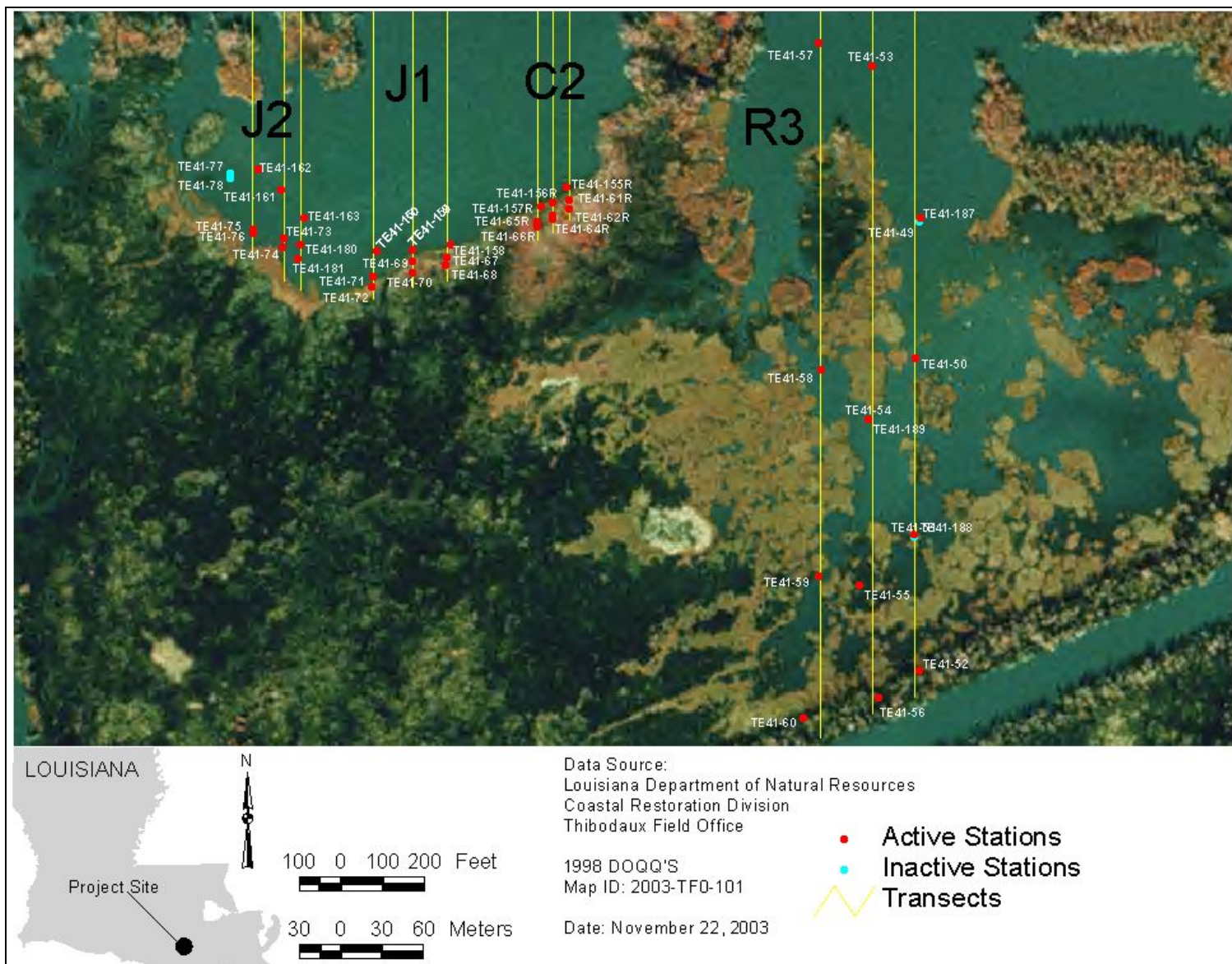


Figure 6. Location map of vegetation plots along transects for Mandalay Bank Protection (TE-41) Demonstration project.

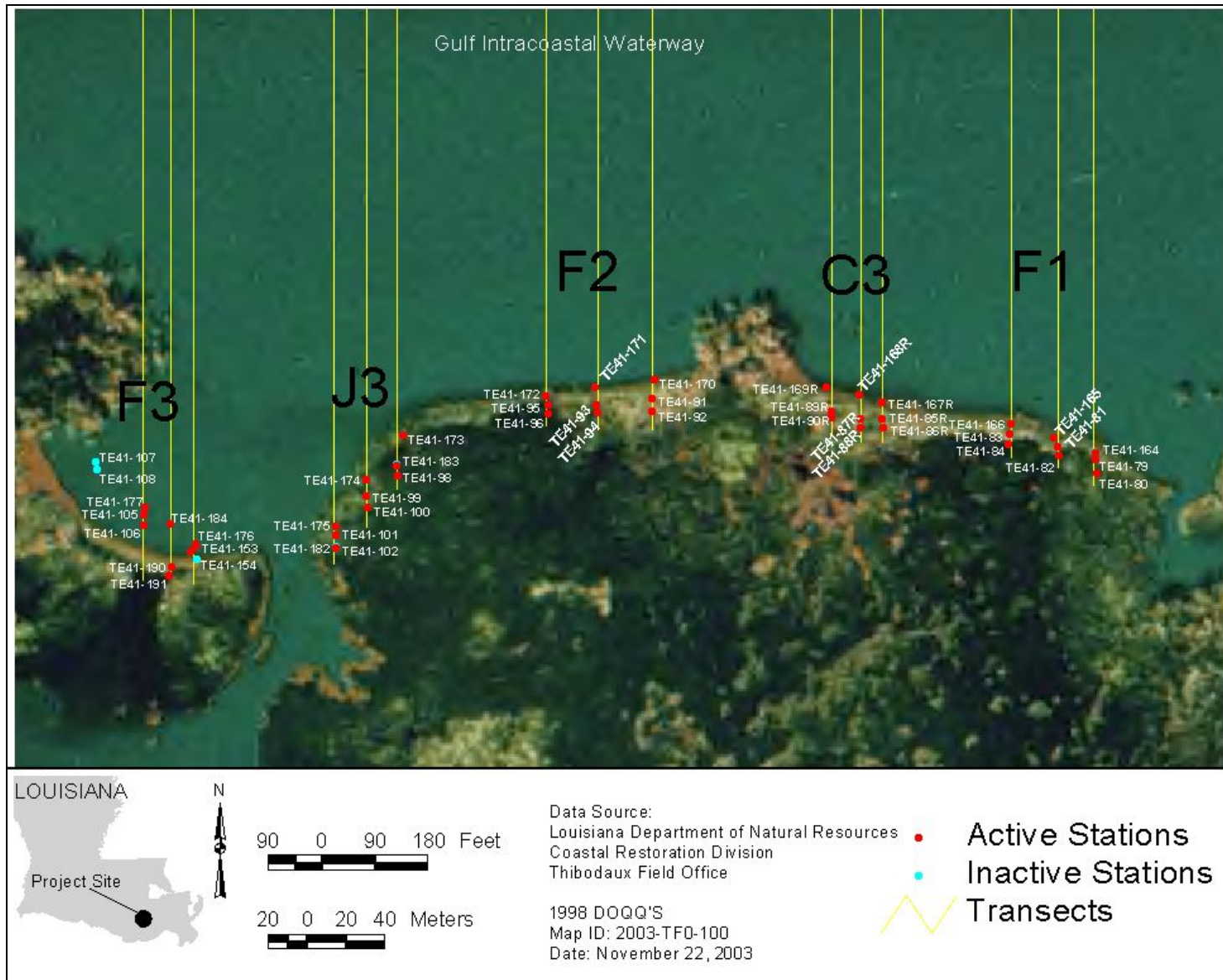


Figure 7. Location map of vegetation plots for the Mandalay Bank Protection (TE-41) Demonstration project.

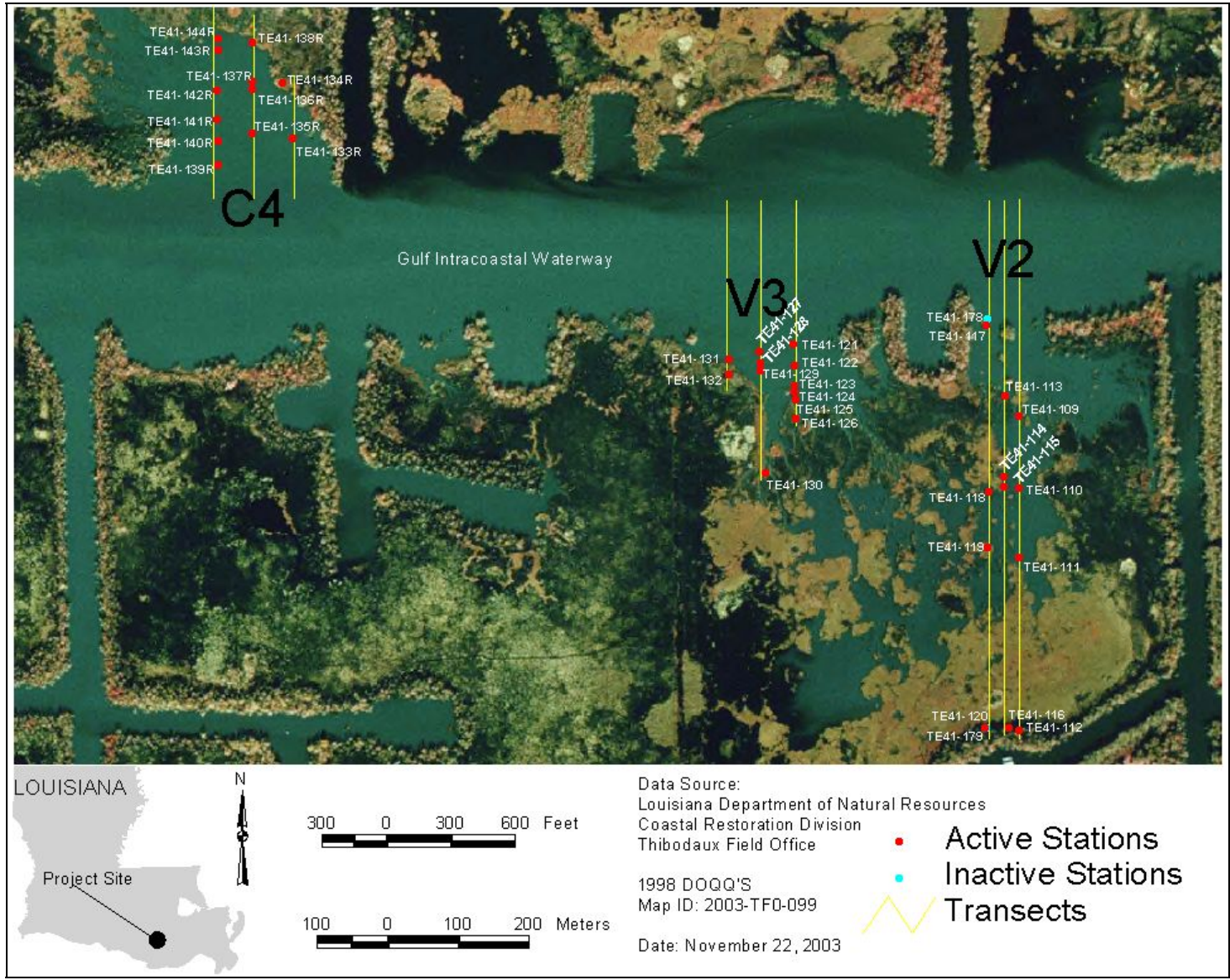


Figure 8. Location map of vegetation plots for the Mandalay Bank Protection (TE-41) Demonstration project.



Table 1. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (fiberglass sheetpile) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Fiberglass Sheetpile					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Acer rubrum L.	8.33	2.75	5.56	15.00	2.78	5.00
Acer saccharinum L.						
Acmella oppositifolia (Lam.) R.K. Jansen var. repens (Walt.) R.K. Jansen						
Aeschynomene indica L.	25.00	11.33	8.33	1.73	11.11	7.03
Alternanthera philoxeroides (Mart.) Griseb.	16.67	3.28	16.67	4.33	16.67	1.25
Amaranthus cannabinus (L.) Sauer						
Amaranthus tuberculatus (Moq.) Sauer						
Baccharis halimifolia L.						
Bare Ground	100.00	81.48	97.22	88.43	88.89	65.16
Bidens laevis (L.) B.S.P.			11.11	4.05	5.56	2.55
Boehmeria cylindrica (L.) Sw.						
Cephalanthus occidentalis L.						
Cicuta maculata L.						
Colocasia esculenta (L.) Schott	8.33	26.00	8.33	45.00	5.56	100.00
Commelina virginica L.	4.17	0.10	2.78	0.10		
Cyperus erythrorhizos Muhl.						
Cyperus esculentus L.			2.78	0.10		
Cyperus strigosus L.						
Cyperus virens Michx.	8.33	0.10				
Echinochloa crus-galli (L.) Beauv.						
Echinodorus cordifolius (L.) Griseb.					2.78	70.00
Eichhornia crassipes (Mart.) Solms	4.17	2.00	0.00		13.89	49.00
Eleocharis cellulosa Torr.			8.33	31.67	8.33	41.67
Eleocharis parvula (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer	4.17	1.00				
Fimbristylis Vahl			2.78	10.00		
Fraxinus pennsylvanica Marsh.						
Hydrocotyle bonariensis Comm. ex Lam.			8.33	8.50		
Hydrocotyle ranunculoides L. f.					5.56	5.25
Hydrocotyle umbellata L.					2.78	10.00
Hydrocotyle verticillata Thunb.	8.33	0.75				
Iris L.						
Iva frutescens L.						
Juncus roemerianus Scheele						
Kosteletzkya virginica (L.) K. Presl ex Gray	4.17	0.10				
Limnobium spongia (Bosc) L.C. Rich. ex Steud.						
Ludwigia L.			2.78	0.10		
Ludwigia leptocarpa (Nutt.) Hara	8.33	7.50	2.78	0.10		
Ludwigia octovalvis (Jacq.) Raven					16.67	17.58



Table 1. (continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (fiberglass sheetpile) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Fiberglass Sheetpile					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.						
Nelumbo lutea Willd.					16.67	59.25
Oxycaryum cubense (Poepp. & Kunth) Lye			5.56	3.00	16.67	17.68
Panicum hemitomon J.A. Schultes	16.67	0.78				
Panicum repens L.						
Panicum virgatum L.			2.78	0.10		
Paspalum fluitans (Ell.) Kunth						
Paspalum vaginatum Sw.						
Phragmites australis (Cav.) Trin. ex Steud.	4.17	3.00				
Phyla lanceolata (Michx.) Greene			8.33	3.53	11.11	1.63
Phyla nodiflora (L.) Greene	8.33	1.25				
Polygonum punctatum Ell.	16.67	41.75	16.67	7.75	19.44	17.16
Rumex L.						
Sacciolepis striata (L.) Nash			16.67	11.00	22.22	18.89
Sagittaria lancifolia L.			8.33	11.67	5.56	35.00
Sagittaria latifolia Willd.	16.67	32.50	5.56	10.05	5.56	2.75
Salix nigra Marsh.	4.17	10.00	8.33	48.33	2.78	15.00
Sambucus nigra L. ssp. canadensis (L.) R. Bolli						
Saururus cernuus L.						
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla						
Sesbania drummondii (Rydb.) Cory			2.78	20.00		
Sesbania herbacea (P. Mill.) McVaugh						
Solidago canadensis L.						
Solidago sempervirens L.						
Spartina patens (Ait.) Muhl.					2.78	0.50
Sphenoclea zeylanica Gaertn.						
Symphyotrichum subulatum (Michx.) Nesom						
Taxodium distichum (L.) L.C. Rich.						
Tillandsia usneoides (L.) L.			2.78	20.00		
Tradescantia L.						
Triadica sebifera (L.) Small						
Typha latifolia L.			2.78	5.00	5.56	9.00
Unknown					2.78	5.00
Vigna luteola (Jacq.) Benth.	4.17	5.00	5.56	0.50		
Zizaniopsis miliacea (Michx.) Doell & Aschers.	4.17	90.00	2.78	100.00	2.78	100.00



Table 2. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (Revetment Mats) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Revetment Mats					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
<i>Acer rubrum</i> L.						
<i>Acer saccharinum</i> L.			2.78	30.00		
<i>Acmella oppositifolia</i> (Lam.) R.K. Jansen var. <i>repens</i> (Walt.) R.K. Jansen						
<i>Aeschynomene indica</i> L.			5.56	10.00	5.56	60.00
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	16.67	1.63	25.00	9.00	30.56	6.50
<i>Amaranthus cannabinus</i> (L.) Sauer					5.56	12.50
<i>Amaranthus tuberculatus</i> (Moq.) Sauer						
<i>Baccharis halimifolia</i> L.	8.33	3.50			5.56	0.10
Bare Ground	100.00	90.46	94.44	90.15	88.89	64.22
<i>Bidens laevis</i> (L.) B.S.P.			8.33	18.33	11.11	15.15
<i>Boehmeria cylindrica</i> (L.) Sw.						
<i>Cephalanthus occidentalis</i> L.						
<i>Cicuta maculata</i> L.					5.56	2.75
<i>Colocasia esculenta</i> (L.) Schott	20.83	15.60	16.67	1.87	16.67	10.77
<i>Commelina virginica</i> L.	4.17	0.10	2.78	0.50		
<i>Cyperus erythrorhizos</i> Muhl.						
<i>Cyperus esculentus</i> L.						
<i>Cyperus strigosus</i> L.	4.17	0.10				
<i>Cyperus virens</i> Michx.						
<i>Echinochloa crus-galli</i> (L.) Beauv.						
<i>Echinodorus cordifolius</i> (L.) Griseb.					5.56	27.50
<i>Eichhornia crassipes</i> (Mart.) Solms	4.17	2.00	5.56	40.00	13.89	26.00
<i>Eleocharis cellulosa</i> Torr.						
<i>Eleocharis parvula</i> (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer						
<i>Fimbristylis</i> Vahl						
<i>Fraxinus pennsylvanica</i> Marsh.						
<i>Hydrocotyle bonariensis</i> Comm. ex Lam.			8.33	15.17	5.56	2.75
<i>Hydrocotyle ranunculoides</i> L. f.						
<i>Hydrocotyle umbellata</i> L.						
<i>Hydrocotyle verticillata</i> Thunb.	4.17	0.50				
<i>Iris</i> L.					5.56	0.30
<i>Iva frutescens</i> L.			2.78	10.00		
<i>Juncus roemerianus</i> Scheele						
<i>Kosteletzkya virginica</i> (L.) K. Presl ex Gray						
<i>Limnobiium spongia</i> (Bosc) L.C. Rich. ex Steud.						
<i>Ludwigia</i> L.						
<i>Ludwigia leptocarpa</i> (Nutt.) Hara			0.00			
<i>Ludwigia octovalvis</i> (Jacq.) Raven					8.33	15.17



Table 2 (Continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (Revetment Mats) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Revetment Mats					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.			2.78	5.00		
Nelumbo lutea Willd.					36.11	45.04
Oxycaryum cubense (Poepp. & Kunth) Lye			11.11	11.25	16.67	39.83
Panicum hemitomom J.A. Schultes	8.33	18.00	2.78	5.00		
Panicum repens L.					5.56	35.00
Panicum virgatum L.					5.56	7.50
Paspalum fluitans (Ell.) Kunth					5.56	40.00
Paspalum vaginatum Sw.			2.78	10.00		
Phragmites australis (Cav.) Trin. ex Steud.						
Phyla lanceolata (Michx.) Greene					2.78	0.50
Phyla nodiflora (L.) Greene	8.33	1.00				
Polygonum punctatum Ell.	12.50	4.17	8.33	8.33	11.11	23.25
Rumex L.						
Sacciolepis striata (L.) Nash			11.11	20.13	13.89	12.00
Sagittaria lancifolia L.	4.17	15.00	2.78	40.00	2.78	30.00
Sagittaria latifolia Willd.			2.78	0.10		
Salix nigra Marsh.	12.50	95.00	16.67	65.00	13.89	45.00
Sambucus nigra L. ssp. canadensis (L.) R. Bolli			2.78	0.50	2.78	3.00
Saururus cernuus L.			2.78	0.10		
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla						
Sesbania drummondii (Rydb.) Cory						
Sesbania herbacea (P. Mill.) McVaugh					2.78	0.10
Solidago canadensis L.						
Solidago sempervirens L.			2.78	0.50	5.56	5.00
Spartina patens (Ait.) Muhl.						
Sphenoclea zeylanica Gaertn.						
Symphyotrichum subulatum (Michx.) Nesom						
Taxodium distichum (L.) L.C. Rich.						
Tillandsia usneoides (L.) L.						
Tradescantia L.					2.78	5.00
Triadica sebifera (L.) Small	8.33	100.00	5.56	50.00	5.56	45.00
Typha latifolia L.	8.33	0.50	8.33	4.00	2.78	10.00
Unknown						
Vigna luteola (Jacq.) Benth.						
Zizaniopsis miliacea (Michx.) Doell & Aschers.			2.78	15.00	2.78	15.00



Table 3. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	2001		Reference 2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Acer rubrum L.						
Acer saccharinum L.						
Acmella oppositifolia (Lam.) R.K. Jansen var. repens (Walt.) R.K. Jansen						
Aeschynomene indica L.					4.17	15.00
Alternanthera philoxeroides (Mart.) Griseb.	17.39	0.50	25.00	3.60	25.00	16.33
Amaranthus cannabinus (L.) Sauer					4.17	5.00
Amaranthus tuberculatus (Moq.) Sauer						
Baccharis halimifolia L.						
Bare Ground	95.65	83.41	95.83	90.43	95.83	77.39
Bidens laevis (L.) B.S.P.					4.17	5.00
Boehmeria cylindrica (L.) Sw.					4.17	5.00
Cephalanthus occidentalis L.						
Cicuta maculata L.						
Colocasia esculenta (L.) Schott	26.09	61.67	25.00	50.00	25.00	55.83
Commelina virginica L.	4.35	0.10				
Cyperus erythrorhizos Muhl.						
Cyperus esculentus L.						
Cyperus strigosus L.	4.35	0.10				
Cyperus virens Michx.						
Echinochloa crus-galli (L.) Beauv.						
Echinodorus cordifolius (L.) Griseb.					4.17	10.00
Eichhornia crassipes (Mart.) Solms	4.35	5.00	4.17	90.00	4.17	90.00
Eleocharis cellulosa Torr.						
Eleocharis parvula (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer						
Fimbristylis Vahl						
Fraxinus pennsylvanica Marsh.						
Hydrocotyle bonariensis Comm. ex Lam.						
Hydrocotyle ranunculoides L. f.						
Hydrocotyle umbellata L.						
Hydrocotyle verticillata Thunb.						
Iris L.						
Iva frutescens L.						
Juncus roemerianus Scheele						
Kosteletzkya virginica (L.) K. Presl ex Gray						
Limnobium spongia (Bosc) L.C. Rich. ex Steud.						
Ludwigia L.						
Ludwigia leptocarpa (Nutt.) Hara						
Ludwigia octovalvis (Jacq.) Raven						0.00



Table 3 (Continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet blowout (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	2001		Reference 2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.						
Nelumbo lutea Willd.						
Oxycaryum cubense (Poepp. & Kunth) Lye			4.17	5.00		
Panicum hemitomom J.A. Schultes	4.35	100.00				
Panicum repens L.						
Panicum virgatum L.	4.35	0.50			4.17	30.00
Paspalum fluitans (Ell.) Kunth					4.17	5.00
Paspalum vaginatum Sw.						
Phragmites australis (Cav.) Trin. ex Steud.						
Phyla lanceolata (Michx.) Greene						
Phyla nodiflora (L.) Greene						
Polygonum punctatum Ell.	4.35	40.00	12.50	12.33	16.67	37.63
Rumex L.						
Sacciolepis striata (L.) Nash			12.50	4.00	20.83	5.20
Sagittaria lancifolia L.					4.17	0.50
Sagittaria latifolia Willd.					4.17	20.00
Salix nigra Marsh.						
Sambucus nigra L. ssp. canadensis (L.) R. Bolli						
Saururus cernuus L.						
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla						
Sesbania drummondii (Rydb.) Cory			4.17	10.00	12.50	10.03
Sesbania herbacea (P. Mill.) McVaugh	4.35	5.00			4.17	15.00
Solidago canadensis L.						
Solidago sempervirens L.						
Spartina patens (Ait.) Muhl.						
Sphenoclea zeylanica Gaertn.						
Symphyotrichum subulatum (Michx.) Nesom						
Taxodium distichum (L.) L.C. Rich.						
Tillandsia usneoides (L.) L.						
Tradescantia L.						
Triadica sebifera (L.) Small						
Typha latifolia L.					4.17	15.00
Unknown						
Vigna luteola (Jacq.) Benth.						
Zizaniopsis miliacea (Michx.) Doell & Aschers.						



Table 4. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Fencing and Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Fencing & Cutgrass					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Acer rubrum L.						
Acer saccharinum L.						
Acmella oppositifolia (Lam.) R.K. Jansen var. repens (Walt.) R.K. Jansen						
Aeschynomene indica L.	50.00	24.17			22.22	40.08
Alternanthera philoxeroides (Mart.) Griseb.	61.11	2.68	88.89	12.81	62.96	13.59
Amaranthus cannabinus (L.) Sauer					22.22	23.35
Amaranthus tuberculatus (Moq.) Sauer	5.56	10.00	11.11	3.00		
Baccharis halimifolia L.						
Bare Ground	94.44	38.88	100.00	78.83	70.37	52.84
Bidens laevis (L.) B.S.P.			27.78	0.26	3.70	15.00
Boehmeria cylindrica (L.) Sw.						
Cephalanthus occidentalis L.	5.56	2.00	5.56	20.00	7.41	47.50
Cicuta maculata L.	5.56	2.00			40.74	17.27
Colocasia esculenta (L.) Schott	5.56	1.00	16.67	0.40		
Commelina virginica L.	5.56	0.50			3.70	0.50
Cyperus erythrorhizos Muhl.	11.11	0.50				
Cyperus esculentus L.						
Cyperus strigosus L.	11.11	0.50				
Cyperus virens Michx.						
Echinochloa crus-galli (L.) Beauv.						
Echinodorus cordifolius (L.) Griseb.						
Eichhornia crassipes (Mart.) Solms	33.33	4.08	5.56	5.00	14.81	15.00
Eleocharis cellulosa Torr.						
Eleocharis parvula (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer						
Fimbristylis Vahl						
Fraxinus pennsylvanica Marsh.			5.56	40.00	3.70	30.00
Hydrocotyle bonariensis Comm. ex Lam.			16.67	2.03		
Hydrocotyle ranunculoides L. f.						
Hydrocotyle umbellata L.						
Hydrocotyle verticillata Thunb.						
Iris L.						
Iva frutescens L.						
Juncus roemerianus Scheele			5.56	1.00		
Kosteletzkya virginica (L.) K. Presl ex Gray	16.67	3.70			3.70	10.00
Limnobium spongia (Bosc) L.C. Rich. ex Steud.					3.70	5.00
Ludwigia L.			5.56	0.50		
Ludwigia leptocarpa (Nutt.) Hara	11.11	1.25				



Table 4 (Continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Fencing and Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	Fencing & Cutgrass					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.						
Nelumbo lutea Willd.						
Oxycaryum cubense (Poepp. & Kunth) Lye			5.56	0.50		
Panicum hemitomom J.A. Schultes	50.00	29.56				
Panicum repens L.					7.41	40.00
Panicum virgatum L.	33.33	14.58			18.52	5.02
Paspalum fluitans (Ell.) Kunth					3.70	20.00
Paspalum vaginatum Sw.						
Phragmites australis (Cav.) Trin. ex Steud.	11.11	0.50	16.67	5.17		
Phyla lanceolata (Michx.) Greene						
Phyla nodiflora (L.) Greene	11.11	0.50				
Polygonum punctatum Ell.	88.89	27.81	22.22	26.25	22.22	24.17
Rumex L.						
Sacciolepis striata (L.) Nash			11.11	2.00	44.44	33.75
Sagittaria lancifolia L.	33.33	7.00	38.89	12.17	25.93	50.00
Sagittaria latifolia Willd.						
Salix nigra Marsh.			11.11	12.75		
Sambucus nigra L. ssp. canadensis (L.) R. Bolli						
Saururus cernuus L.						
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla					18.52	12.20
Sesbania drummondii (Rydb.) Cory	11.11	1.25	16.67	8.50	3.70	0.50
Sesbania herbacea (P. Mill.) McVaugh	11.11	6.00			18.52	43.02
Solidago canadensis L.	5.56	0.10				
Solidago sempervirens L.					7.41	2.55
Spartina patens (Ait.) Muhl.						
Sphenoclea zeylanica Gaertn.						
Symphyotrichum subulatum (Michx.) Nesom	5.56	5.00			3.70	0.10
Taxodium distichum (L.) L.C. Rich.	5.56	0.10				
Tillandsia usneoides (L.) L.						
Tradescantia L.						
Triadica sebifera (L.) Small						
Typha latifolia L.	22.22	0.90	11.11	2.55	7.41	5.00
Unknown						
Vigna luteola (Jacq.) Benth.	77.78	9.50	27.78	1.02	22.22	15.00
Zizaniopsis miliacea (Michx.) Doell & Aschers.					14.81	6.38



Table 5. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (A-Jacks® & Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	A-Jacks® & Cutgrass					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Acer rubrum L.						
Acer saccharinum L.						
Acmella oppositifolia (Lam.) R.K. Jansen var. repens (Walt.) R.K. Jansen						
Aeschynomene indica L.	33.33	18.35	16.67	1.87	11.11	23.50
Alternanthera philoxeroides (Mart.) Griseb.	38.89	0.87	100.00	38.06	74.07	21.78
Amaranthus cannabinus (L.) Sauer					11.11	26.67
Amaranthus tuberculatus (Moq.) Sauer						
Baccharis halimifolia L.			5.56	10.00		
Bare Ground	94.44	41.18	94.44	45.00	44.44	68.33
Bidens laevis (L.) B.S.P.	11.11	0.50	11.11	1.00	3.70	15.00
Boehmeria cylindrica (L.) Sw.						
Cephalanthus occidentalis L.					3.70	10.00
Cicuta maculata L.					29.63	19.50
Colocasia esculenta (L.) Schott	83.33	30.44	61.11	20.95	48.15	31.69
Commelina virginica L.	5.56	10.00				
Cyperus erythrorhizos Muhl.						
Cyperus esculentus L.					3.70	0.10
Cyperus strigosus L.	33.33	0.98				
Cyperus virens Michx.						
Echinochloa crus-galli (L.) Beauv.						
Echinodorus cordifolius (L.) Griseb.					29.63	36.69
Eichhornia crassipes (Mart.) Solms	5.56	10.00	22.22	5.13	18.52	50.00
Eleocharis cellulosa Torr.						
Eleocharis parvula (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer						
Fimbristylis Vahl						
Fraxinus pennsylvanica Marsh.						
Hydrocotyle bonariensis Comm. ex Lam.			5.56	0.10		
Hydrocotyle ranunculoides L. f.						
Hydrocotyle umbellata L.					3.70	5.00
Hydrocotyle verticillata Thunb.						
Iris L.						
Iva frutescens L.						
Juncus roemerianus Scheele						
Kosteletzkya virginica (L.) K. Presl ex Gray	5.56	0.10				
Limnobiium spongia (Bosc) L.C. Rich. ex Steud.						
Ludwigia L.			5.56	0.50		
Ludwigia leptocarpa (Nutt.) Hara						
Ludwigia octovalvis (Jacq.) Raven					7.41	10.00



Table 5 (Continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (A-Jacks® & Cutgrass) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	A-Jacks® & Cutgrass					
	2001		2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.						
Nelumbo lutea Willd.						
Oxycaryum cubense (Poepp. & Kunth) Lye						
Panicum hemitomom J.A. Schultes	5.56	50.00				
Panicum repens L.					14.81	33.75
Panicum virgatum L.	33.33	12.95	5.56	5.00	11.11	16.67
Paspalum fluitans (Ell.) Kunth						
Paspalum vaginatum Sw.						
Phragmites australis (Cav.) Trin. ex Steud.			16.67	38.33		
Phyla lanceolata (Michx.) Greene					3.70	5.00
Phyla nodiflora (L.) Greene	5.56	0.50				
Polygonum punctatum Ell.	38.89	42.93	77.78	16.50	11.11	13.33
Rumex L.			5.56	5.00		
Sacciolepis striata (L.) Nash			55.56	11.25	37.04	26.60
Sagittaria lancifolia L.	22.22	3.53	5.56	15.00	11.11	15.67
Sagittaria latifolia Willd.			33.33	10.83	3.70	75.00
Salix nigra Marsh.						
Sambucus nigra L. ssp. canadensis (L.) R. Bolli						
Saururus cernuus L.						
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla					7.41	4.00
Sesbania drummondii (Rydb.) Cory	16.67	18.33	55.56	15.00	7.41	20.00
Sesbania herbacea (P. Mill.) McVaugh	11.11	22.50			7.41	25.00
Solidago canadensis L.						
Solidago sempervirens L.						
Spartina patens (Ait.) Muhl.						
Sphenoclea zeylanica Gaertn.	5.56	15.00			3.70	5.00
Symphotrichum subulatum (Michx.) Nesom					11.11	6.67
Taxodium distichum (L.) L.C. Rich.						
Tillandsia usneoides (L.) L.						
Tradescantia L.						
Triadica sebifera (L.) Small						
Typha latifolia L.	22.22	1.43	33.33	9.17		
Unknown						
Vigna luteola (Jacq.) Benth.	38.89	1.50			18.52	17.00
Zizaniopsis miliacea (Michx.) Doell & Aschers.			5.56	30.00	7.41	35.00



Table 6. Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	2001		Reference 2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Acer rubrum L.						
Acer saccharinum L.						
Acmella oppositifolia (Lam.) R.K. Jansen var. repens (Walt.) R.K. Jansen	8.33	5.00				
Aeschynomene indica L.	8.33	10.00	8.33	0.50	16.67	20.00
Alternanthera philoxeroides (Mart.) Griseb.	58.33	5.93	100.00	17.58	55.56	14.00
Amaranthus cannabinus (L.) Sauer					16.67	25.00
Amaranthus tuberculatus (Moq.) Sauer						
Baccharis halimifolia L.						
Bare Ground	91.67	40.45	100.00	47.50	61.11	64.09
Bidens laevis (L.) B.S.P.	8.33	0.50				
Boehmeria cylindrica (L.) Sw.						
Cephalanthus occidentalis L.						
Cicuta maculata L.					16.67	2.83
Colocasia esculenta (L.) Schott	50.00	64.17	58.33	27.87	44.44	48.15
Commelina virginica L.	8.33	5.00				
Cyperus erythrorhizos Muhl.						
Cyperus esculentus L.					5.56	0.10
Cyperus strigosus L.	8.33	0.50				
Cyperus virens Michx.	25.00	1.87				
Echinochloa crus-galli (L.) Beauv.	25.00	3.67				
Echinodorus cordifolius (L.) Griseb.					5.56	0.50
Eichhornia crassipes (Mart.) Solms			8.33	35.00		
Eleocharis cellulosa Torr.						
Eleocharis parvula (Roemer & J.A. Schultes) Link ex Bluff, Nees & Schauer						
Fimbristylis Vahl						
Fraxinus pennsylvanica Marsh.						
Hydrocotyle bonariensis Comm. ex Lam.			8.33	5.00		
Hydrocotyle ranunculoides L. f.						
Hydrocotyle umbellata L.						
Hydrocotyle verticillata Thunb.						
Iris L.					5.56	0.10
Iva frutescens L.						
Juncus roemerianus Scheele			8.33	0.50		
Kosteletzkya virginica (L.) K. Presl ex Gray	8.33	5.00			5.56	0.50
Limnobiium spongia (Bosc) L.C. Rich. ex Steud.						
Ludwigia L.						
Ludwigia leptocarpa (Nutt.) Hara						
Ludwigia octovalvis (Jacq.) Raven					5.56	30.00



Table 6 (Continued). Percent stations and mean cover data for all species within 2x2m Braun-Blanquet offbank (Reference) vegetation plots for (TE-41) Mandalay Bank Protection Demonstration project.

Species	2001		Reference 2002		2003	
	% Stations	Mean Cover	% Stations	Mean Cover	% Stations	Mean Cover
Myriophyllum aquaticum (Vell.) Verdc.			8.33	1.00		
Nelumbo lutea Willd.						
Oxycaryum cubense (Poepp. & Kunth) Lye						
Panicum hemitomom J.A. Schultes	25.00	0.53			5.56	5.00
Panicum repens L.					16.67	15.00
Panicum virgatum L.			8.33	0.10	16.67	3.53
Paspalum fluitans (Ell.) Kunth						
Paspalum vaginatum Sw.	16.67	55.00				
Phragmites australis (Cav.) Trin. ex Steud.			25.00	33.33		
Phyla lanceolata (Michx.) Greene						
Phyla nodiflora (L.) Greene						
Polygonum punctatum Ell.	25.00	18.33	66.67	36.88	11.11	17.50
Rumex L.						
Sacciolepis striata (L.) Nash	8.33	15.00	33.33	5.25	44.44	31.94
Sagittaria lancifolia L.			8.33	0.50		
Sagittaria latifolia Willd.						
Salix nigra Marsh.						
Sambucus nigra L. ssp. canadensis (L.) R. Bolli	8.33	0.10				
Saururus cernuus L.						
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla	16.67	5.25			16.67	68.33
Sesbania drummondii (Rydb.) Cory	16.67	32.50	16.67	7.75		
Sesbania herbacea (P. Mill.) McVaugh	8.33	25.00			11.11	20.00
Solidago canadensis L.						
Solidago sempervirens L.						
Spartina patens (Ait.) Muhl.						
Sphenoclea zeylanica Gaertn.					5.56	0.50
Symphyotrichum subulatum (Michx.) Nesom	16.67	0.10			5.56	0.10
Taxodium distichum (L.) L.C. Rich.						
Tillandsia usneoides (L.) L.						
Tradescantia L.						
Triadica sebifera (L.) Small						
Typha latifolia L.			8.33	0.10		
Unknown					5.56	0.50
Vigna luteola (Jacq.) Benth.	25.00	10.33			27.78	2.30
Zizaniopsis miliacea (Michx.) Doell & Aschers.						



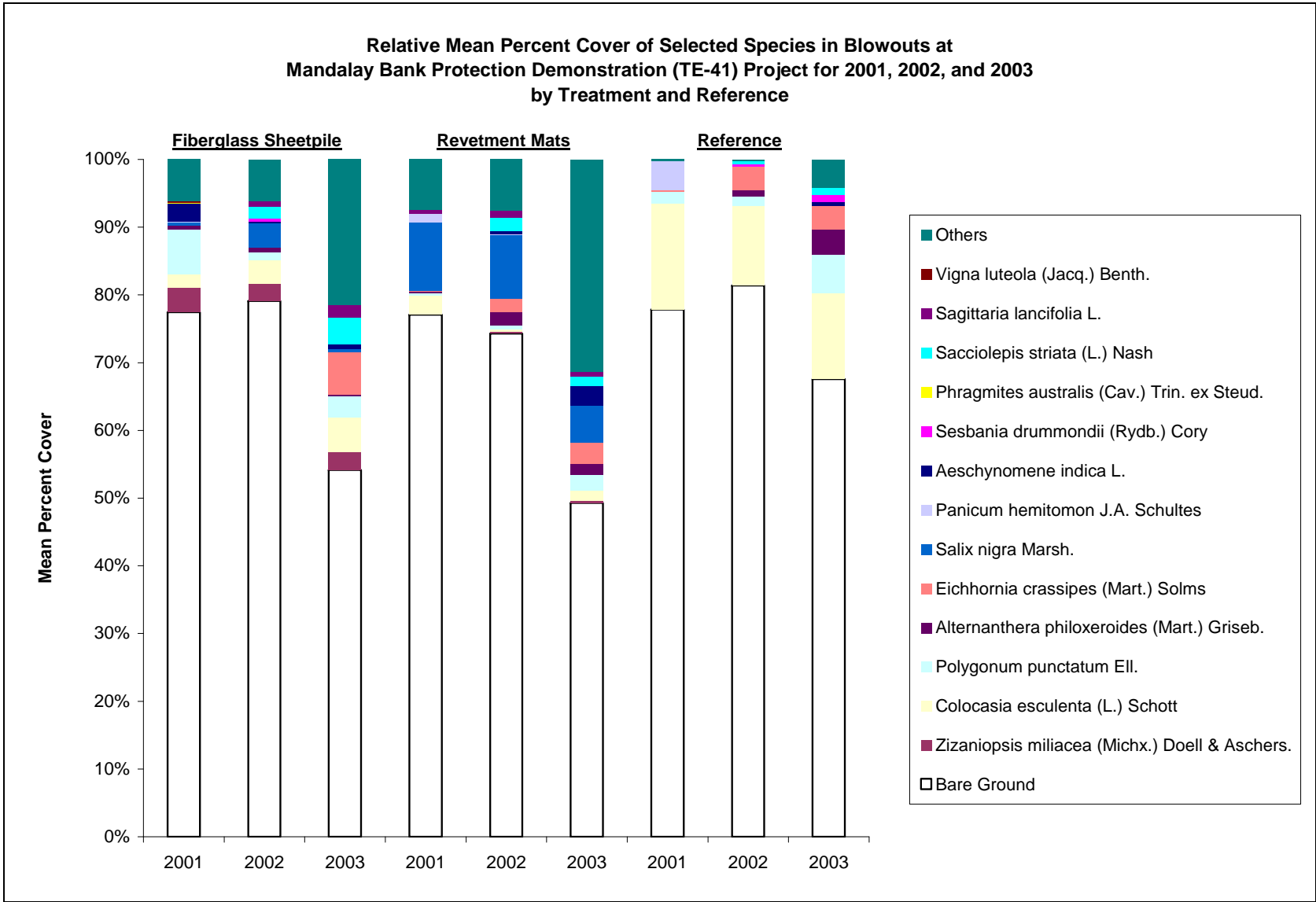


Figure 9. Relative Mean percent cover of selected species inside the 2mx2m Braun-Blanquet vegetation plots in blowouts for the Mandalay Bank Protection Demonstration (TE-41) project.

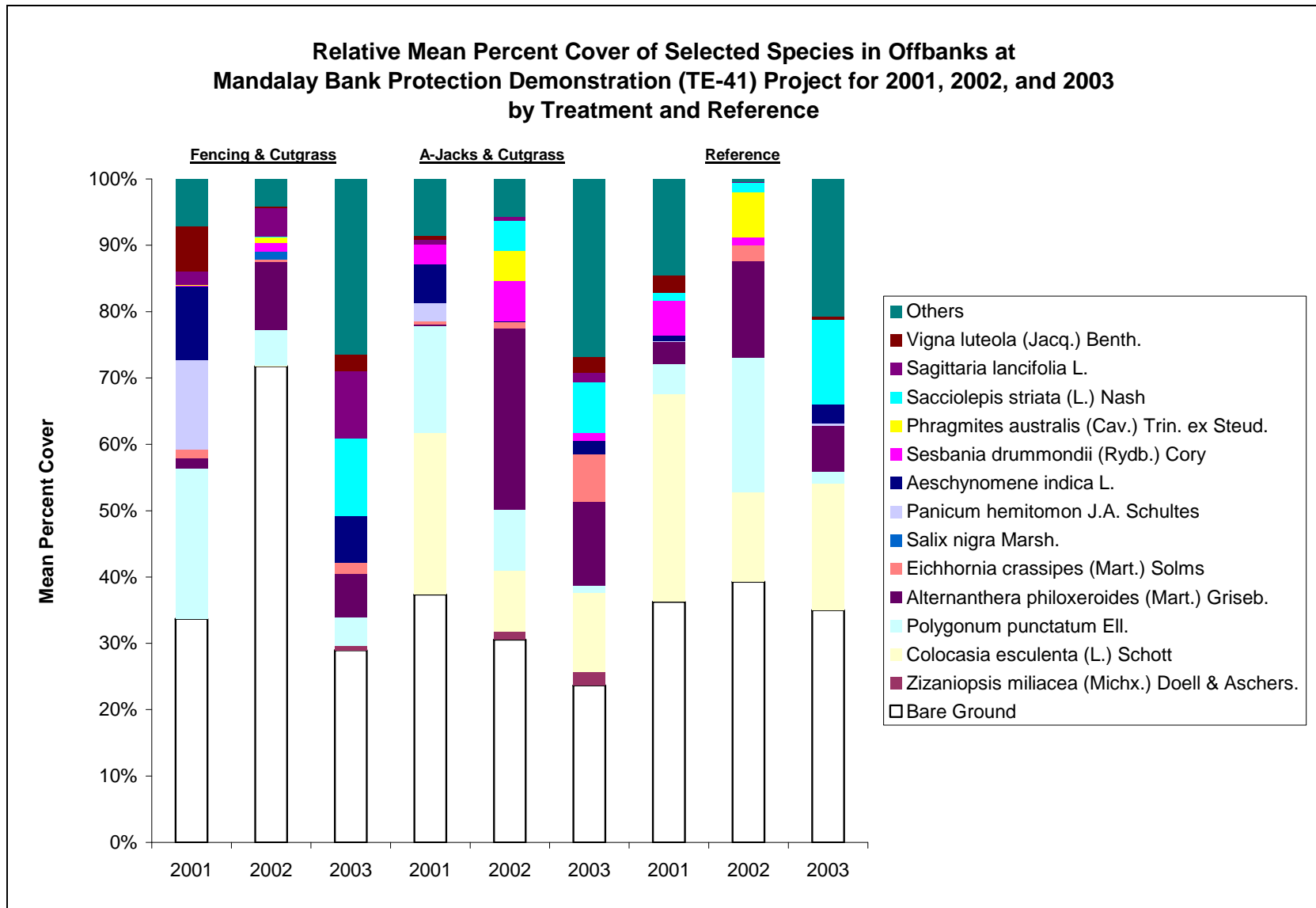


Figure 10. Relative mean percent cover of selected species inside the 2m x 2m Braun-Blanquet vegetation plots for offbank areas for the Mandalay Bank Protection Demonstration (TE-41) project.



Percent Survival

As-built percent survival data was collected during the first week of September 2003 (N = 18 plots) one month post-planting. Only those treatments with planted *Z. miliacea* required this type of data collection (F1, F2, F3, J1, J2, and J3). Survival data collection will occur again in fall 2008. Comparative analysis between the data sets will occur again when the 2008 data are available.

Figures:

Figures 4 - 8. See figures 4-8 above.

*Note: Stations where percent survival data were collected in addition to percent cover and species composition data:

Treatments	Stations
F1	TE41-164, TE41-165, TE41-166
F2	TE41-170, TE41-171, TE41-172
F3	TE41-176, TE41-177, TE41-184
J1	TE41-158, TE41-159, TE41-160
J2	TE41-161, TE41-162, TE41-163
J3	TE41-173, TE41-174, TE41-175

Stations TE41-77 and TE41-78 in treatment J2 and stations TE41-107 and TE41-108 in treatment F3 are inactive because they fell along transects which had to be re-established. The original transects they were located on fell outside of the treatments once construction was complete.

Tables:

Table 7. Percent survival of giant cutgrass plantings at the fencing and A-Jacks treatments for the 2003 post-planting vegetation monitoring at the Mandalay Bank Protection Demonstration (TE-41) project.

Table 7. Percent survival of planted giant cutgrass inside of fencing and A-Jacks treatments for fall 2003 vegetation monitoring one month post-planting.							
Fencing with Giant Cutgrass				A-Jacks with Giant Cutgrass			
Treatment	Planted	Alive	Percent Survival	Treatment	Planted	Alive	Percent Survival
F1	24	9	37.5	J1	18	12	66.7
F2	24	9	37.5	J2	24	11	45.8
F3	27	12	44.4	J3	18	3	16.7
Total	75	30	40	Total	60	26	43.3



IV. Monitoring Activity (continued)

d. Preliminary Monitoring Results

Shoreline Mapping

Conclusions based upon comparative analysis between the 2003 and 2005 shoreline data will be made after the 2008 data is complete.

Elevation

Conclusions based upon comparative analysis between the 2003 and 2005 elevation survey data will be made after the 2008 data is complete.

Percent Survival

The 2003 preliminary results indicate that the fencing with cutgrass treatments (F1, F2, and F3) had 40.0% survival one month post-planting. The A-Jacks with cutgrass treatments (J1, J2, and J3) had 43.3% survival one month post-planting (Table 1).

Vegetation

The data collected thus far represents only pre-construction and as-built vegetation monitoring. Comparisons to post-construction data sets will occur once the 2005 vegetation data collection occurs. However, one overall characterization of the project for the period from fall 2001 (two years pre-construction) through fall 2003 (as-built) is possible. All of the treatment and reference areas have experienced an increase in vegetation cover and a decrease in bare ground (figures 9 & 10). More than one factor may have contributed to this increase, including an end to a period of drought in 2001, and the possible impact of a successful nutria hunt on the Mandalay National Wildlife Refuge (personal communication from Paul Yakupzack, Refuge Manager).



V. Conclusions

- a. Project Effectiveness
It is too early to determine any project effects.
- b. Recommended Improvements
There are no recommended improvements at this early stage in the project.
- c. Lessons Learned
During post-construction vegetation monitoring it was noted that the planted rows of giant cutgrass did not always adhere to the design plans. As-built drawings and associated GPS files for the plantings are necessary to determine the location and spacing of the planted rows in order to meet the monitoring design requirement. This information would have been helpful in locating plant rows to ascertain plant counts during post-planting percent survival data collection.

