MONITORING PLAN

PROJECT NO. TE-36 THIN-MAT ENHANCEMENT DEMONSTRATION PROJECT

DATE: March 1, 1999

Project Description

The Thin-Mat Floating Marsh Enhancement Demonstration Project (TE-36) is authorized by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990 (PL 101-646, Title III). The TE-36 project is located in the upper Bayou Penchant Basin in northwestern Terrebonne Parish, approximately 6 mi (9.7 km) south of Amelia, LA (figure 1). The project area is bounded on the north by the GIWW, on the west by Bayou Chene and the Avoca cutoff, on the south by Bayou Penchant, and on the east by Bayou Copasaw. Project sites are to be located within fragile, thin-mat floating marshes (flotants). Components of the project include development of techniques to stimulate the development of thick-mat flotant from thin-mat flotant marsh and monitoring the effects of water movement and sediment on flotant marsh.

Floating marshes historically were widely distributed in coastal Louisiana (O'Neil 1949), and their present distribution is well documented in the Barataria and Terrebonne basins of the Mississippi River Deltaic Plain (Sasser et al. 1994). In these two basins various types of flotant (as defined by Sasser et al. 1996) now cover approximately 75% of the fresh and intermediate marshes (Evers et al. 1996). In many areas the historically expansive thick-mat *Panicum hemitomon* (maidencane) flotant described by O'Neil (1949) has converted to a thin-mat floating marsh dominated by *Eleocharis baldwinii* (Baldwin spikesedge). This thin-mat flotant now covers significant areas of the fresh marsh in upper Barataria and Terrebonne basins (Evers et al. 1996). These thin-mat flotants are relatively fragile and unstable compared to the thick-mat *P. hemitomon* flotants they replaced. A particularly good example of this change occurred in the Bayou Penchant watershed in northwestern Terrebonne basin. Leibowitz (1989) documented the extremely rapid degradation of floating marshes in northwestern Terrebonne basin. Visser et al. (1996) have shown that this degradation has resulted in a change in vegetation type from *P. hemitomon* to *E. baldwinii* marsh. Other factors may have been related to changes in hydrology, hurricane effects, nutrient limitations related to hydrologic changes, and mammal herbivory (Sasser et al. 1995). Grazing effects, particularly by nutria (*Myocastor coypus*), on vegetation in some areas of coastal Louisiana marshes are significant (Chabreck et al. 1983, Fuller et al. 1985, Evers et al. 1992). The impact of herbivory on floating marsh vegetation is unknown, but large concentrations of nutria are often seen on thin-mat marshes.

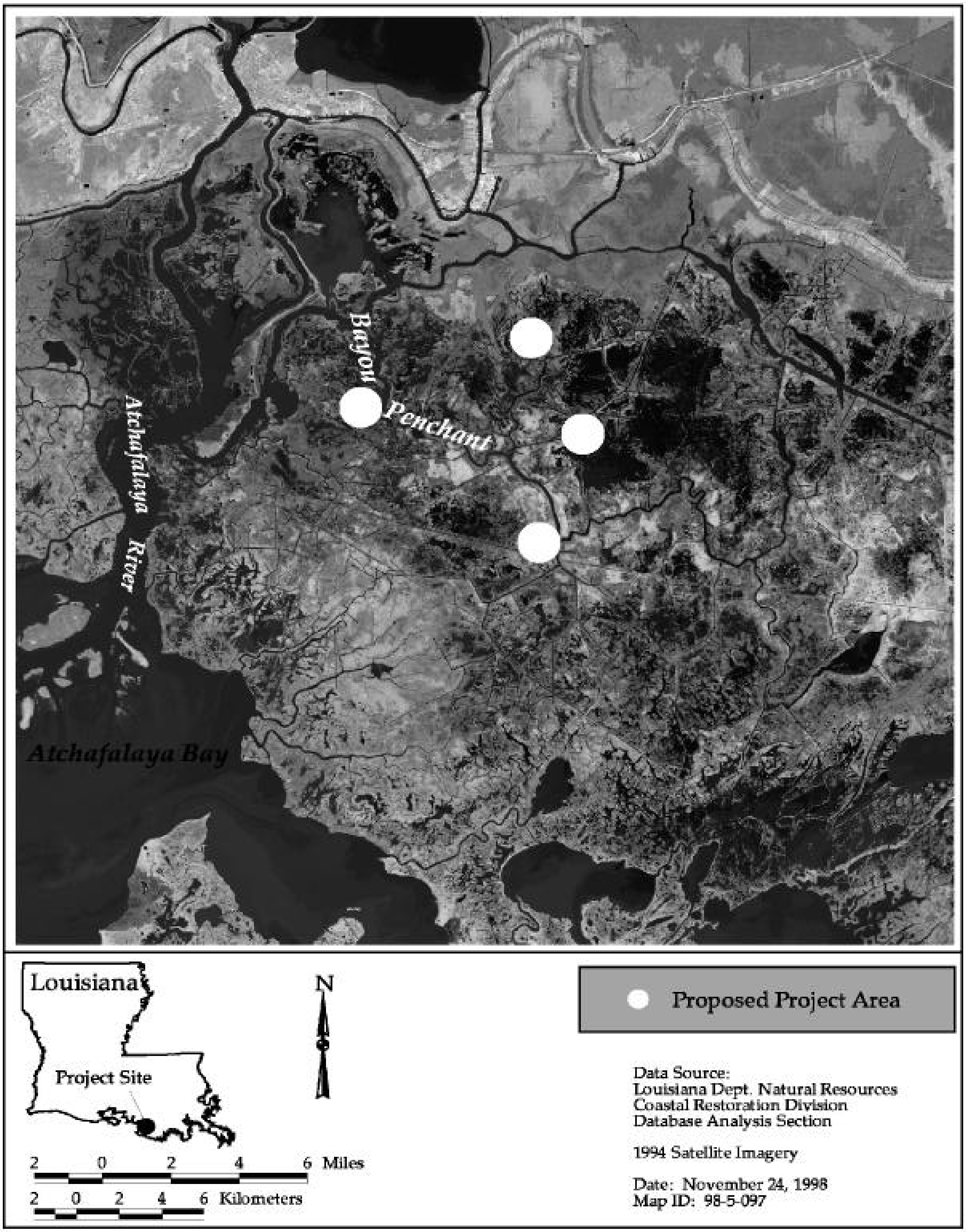

Figure 1. Location of project TE-36

Floating marshes are inundated much less frequently than attached marshes. Hence the mats do not receive the surface subsidies of mineral sediments and nutrients reported for attached marshes (Sasser et al. 1995). Without mineral inputs the mats are almost entirely organic and therefore buoyant. The source of nutrients to sustain productivity on the mat is problematic. Presumably nutrients move with water flows beneath the mat, flowing from adjacent water bodies with rising ambient water and flushing out during falling water, but this has not been demonstrated unequivocally (Sasser et al. 1995). The mechanism for nutrient movement up into the root zone has also not been described.

While the technology for marsh restoration and creation, in the United States, particularly Louisiana, has been widely discussed and is being increasingly applied (Kusler and Kentula 1989; Strickland 1986), there is almost no documentation of restoration or creation of Gulf coast floating marshes. Despite fragmentary evidence that floating marshes are quite different from more familiar attached marshes, we have paid little attention to them and our management practices seldom distinguish between the two types. When they do, management recommendations for floating marshes are based primarily on tradition and superficial observations rather than on sound scientific understanding. In particular, there have been few attempts in Louisiana, and relatively few elsewhere, concerning restoration techniques of floating marsh.

Four sites will be selected in the northwestern Terrebonne basin (figure 1). Heavy sediment loads originate in the Atchafalaya River and penetrate eastward through canals and bayous eventually decreasing in suspended sediment concentrations as the velocity reduces further from the main water flows (Sasser et al. 1995). The sites will be located within the different sediment regimes of low, intermediate and high sediment source loads. At each site, we will construct a boardwalk (figure 2), so that the treatment areas can be easily reached for monitoring and to minimize impacts on the existing vegetation during treatment construction. The total area monitored at each site is1,378 ft^2 (128 m^2) [less than 1 acre (0.4 ha)]. At each site, 4 exclosures will be constructed. These exclosures will be 13 ft x13 ft (4 m x 4 m) and will be constructed using PVC panels with vinyl coated poultry wire (figure 3). A variation on this design has been used in the same area by Louisiana State University Coastal Ecology Institute (LSU/CEI) in cooperation with the Louisiana Department of Wildlife and Fisheries (LDWF) and has been successful in excluding grazers from the area (Sasser, 1998). For the transplanting treatments, 30 plugs from a healthy *P. hemitomon* donor-marsh will be planted at each site in the late spring (April). The fertilization treatments will consist of slow release fertilizer placed within each 13 ft x13 ft (4 m x 4 m) treatment at the beginning of the growing season (April/May 1999) and once during the growing season (July 1999). Each of the four sites will consist of eight plots for all possible three factor combinations (fertilized vs. unfertilized, protected from mammal grazing vs. unprotected, planted vs. unplanted). The eight possible (2^3) treatment combinations will be randomly assigned to cells/plots within the selected sites (figure 4). However, to minimize contamination from leaching effects, the unfertilized plots will be placed at least 114.8 ft (35m) from the fertilized plots (Nyman, 1998).

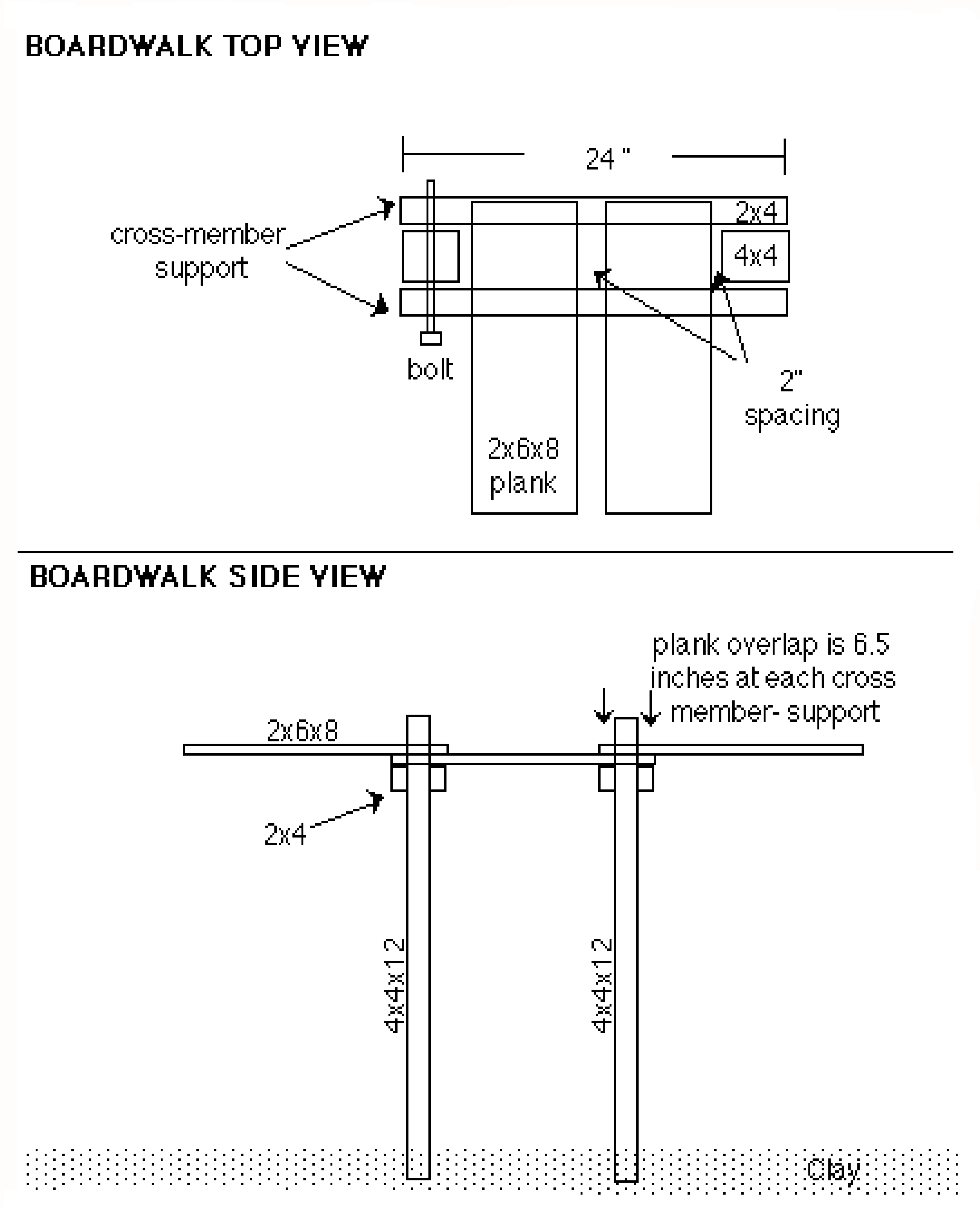

Figure 2. Boardwalk design. Total length of boardwalk and position of boardwalks are indicated in figure 4.

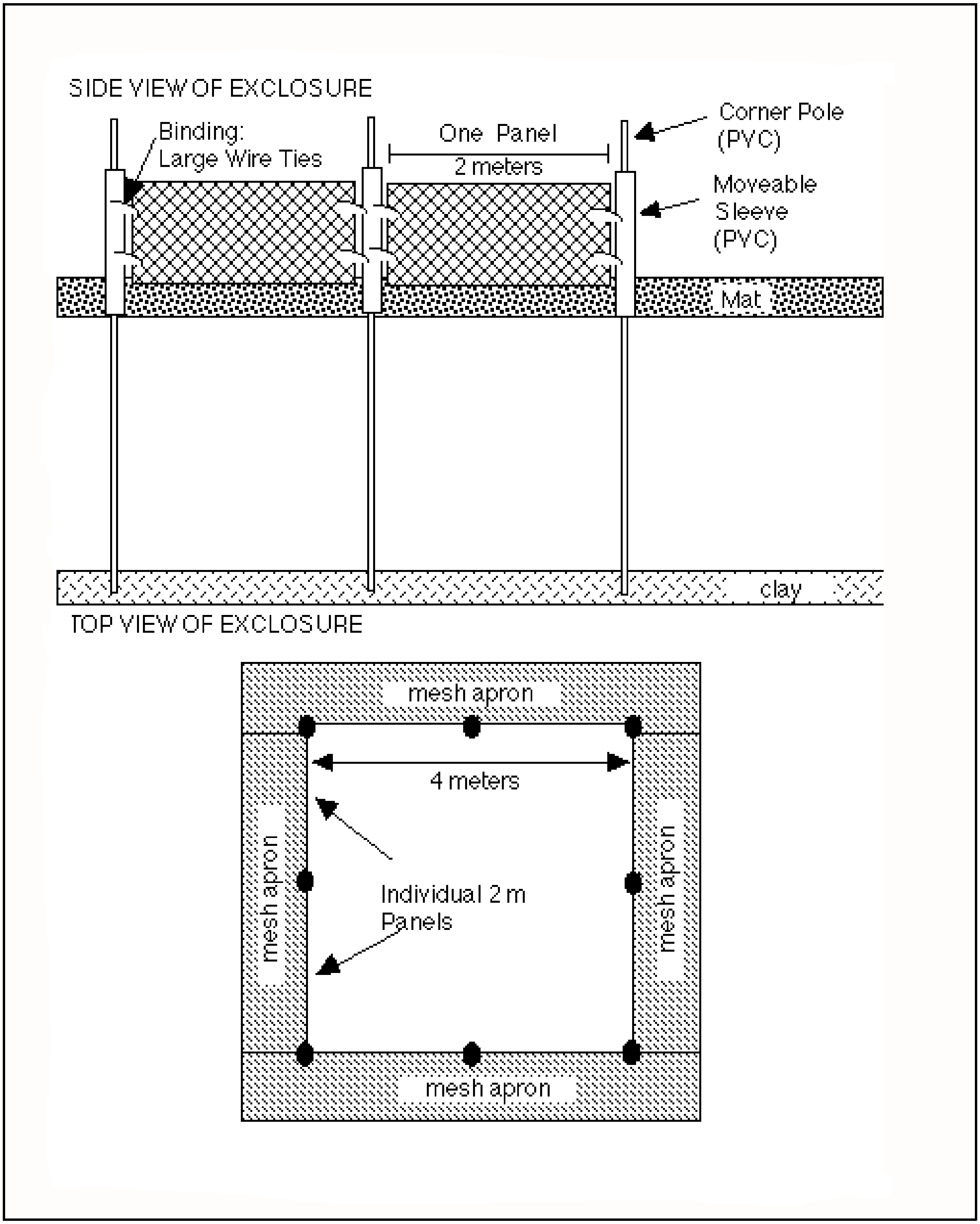

Figure 3. Exclosure design. Panels will be constructed of vinyl coated chicken wire.

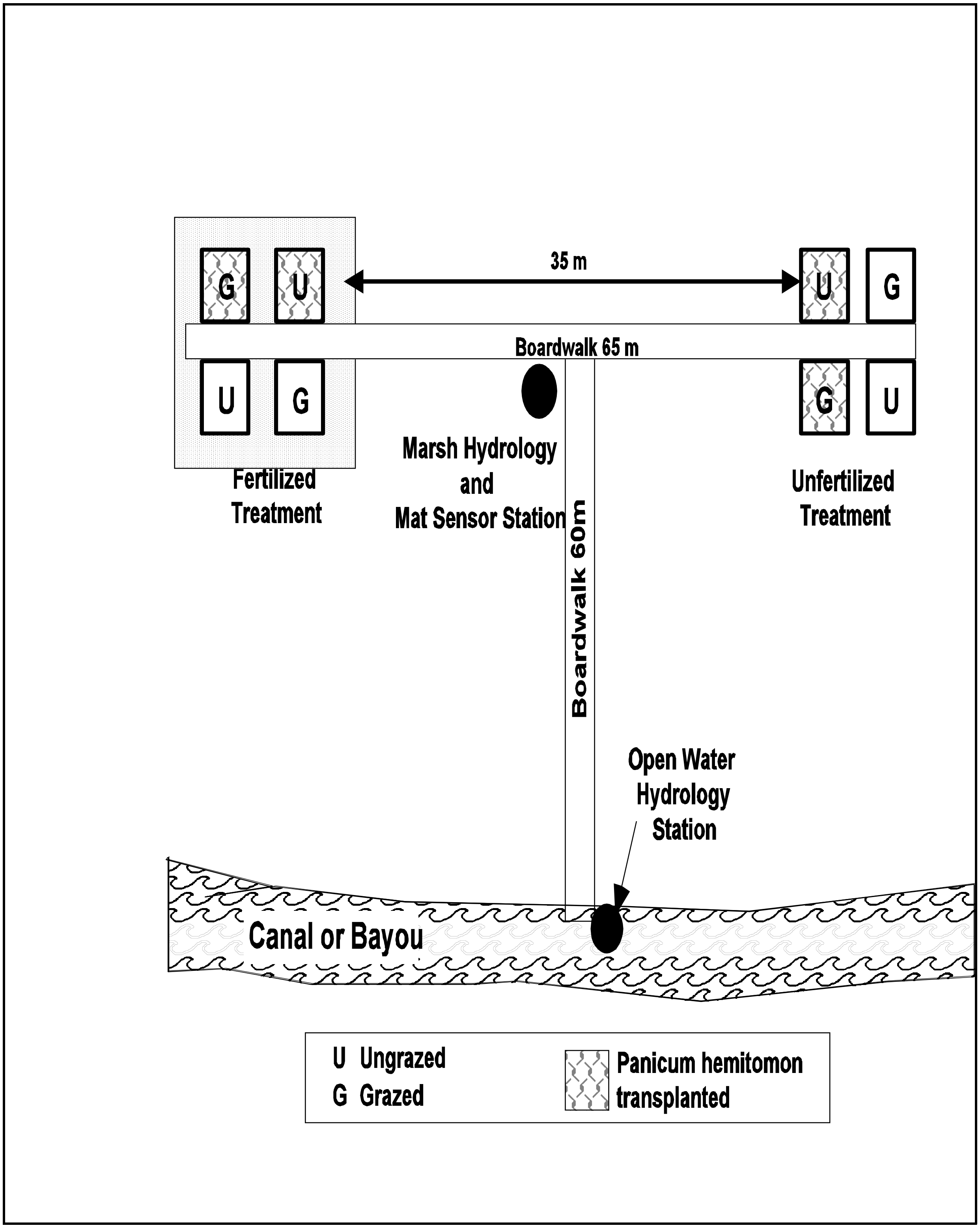

Figure 4. Diagram of project features installed at each site.

Project Objective

The objective of this demonstration is to induce the development of thick, continually floating mats from a thin-mat flotant. In this demonstration we propose to enhance growth of the naturally vegetated mat in three ways: (1) induced growth through fertilization, (2) induced growth through reduction of grazing by mammals, and (3) transplanting plant species of existing thick-mat floating marshes into the thin-mat. In addition, all combinations of these three management techniques will be evaluated.

Specific Goals

The following measurable goals were established to evaluate project effectiveness:

1. Increase percent cover of *P. hemitomon* and other species associated with thick-mat flotants.

2. Increase substrate buoyancy.

3. Increase mat vertical expansion and mat strength.

4. Increase nutrient levels in plant tissue and substrate.

Reference Areas

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons and is therefore the most competent means of assessing project effectiveness. To assist in evaluating project success, the reference areas will be monitored concurrently with the project areas (treatment combinations). There will be one reference plot (grazed, not fertilized and not planted) within each site. Data collected within the treatment and control areas will be used to make statistically valid comparisons of species composition, percent cover, nutrients, buoyancy, mat strength, and mat vertical expansion with and without the treatments of the project. The main criteria for selecting the reference plots are similarities in species composition, percent cover, nutrients, buoyancy, mat strength, and mat vertical thickness located within the same site, but at a far enough distance to not be influenced by the treatments.

Monitoring Limitations

The lack of an estimate of a conversion factor that thin mat will more likely convert to open water than thick mat flotant prevents placing the effectiveness of the project into context with marsh loss rates. It will not be possible to determine if the reversion of thin to thick mat flotant has minuscule, moderate, or enormous impacts on marsh loss.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above. Multiple observations will be made within each treatment plot:

1. Vegetation — Vegetation cover to the nearest 5% and species composition within samples in each 13 ft x13 ft (4 m x 4 m) treatment will be assessed ocularly (Kent and Coker 1992). Cover measurements will be made at the beginning and end of the growing season each year of the project (May/Sept 1999, 2000, 2001). Percent survival of the plantings will also be measured. Additional vegetation assessments will be made if necessary to separate project effects from that of unplanned events such as a major tropical storm or hurricane, flood.

2. Marsh Mat Movement — Substrate buoyancy will be determined using two methods. Continuous recording mat movement gauges (water level gauges adapted to measure mat movement) will record vertical movement of the marsh mat at one location at each study site (figure 5). These gauges will be serviced monthly (Jan 1999-Sept 2001). Additionally, mat movement within each of the treatment plots at each site will be monitored with maximum range indicators installed in each treatment plot (figure 6). These indicators will be checked monthly after the installation of the project (Jan 1999-Sept 2001).

3. Soil Samples — Other substrate characteristics (bulk density, percent organic matter, mat strength, and mat vertical expansion) will be determined at the time of installation (Feb 1999) and at the end of each growing season (Sept 1999, 2000, 2001). Soil samples will be obtained by extracting replicate 2.91 in (7.4 cm) diameter cores from each treatment combination. Mat vertical expansion will be determined by the length of the cores when sampled and calculated using methodology of Sasser et al (1995). The mat strength will be assessed using the Torvane Soil Strength tester (McGinnis, 1997). A profile of vertical samples will be done to compare strength at different depths. In addition, interstitial water samples will be taken in each treatment and water samples will be collected in adjacent open water quarterly for the life of the project (Feb, May, Sept, Nov 1999, 2000; Feb, May, Sept 2001). Suspended sediment concentrations will be determined

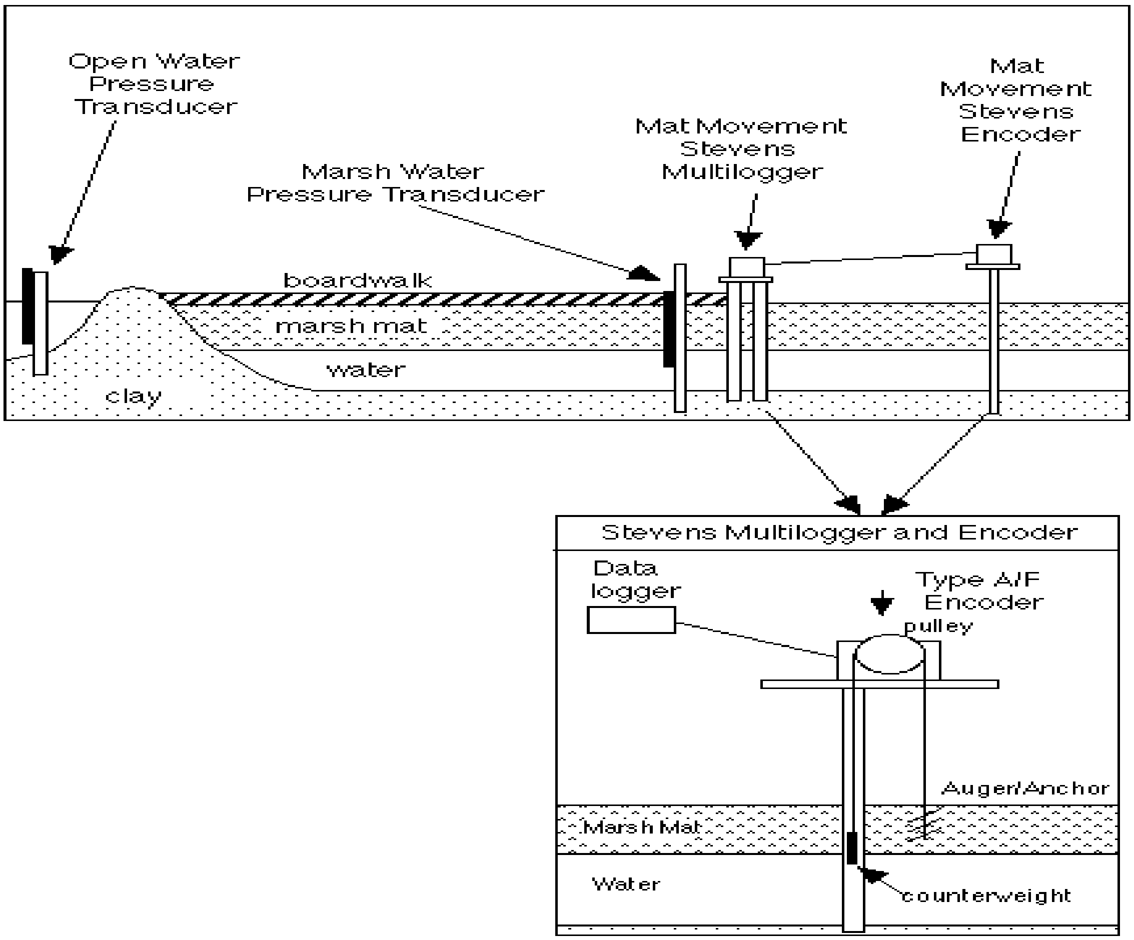

Figure 5. Layout of instrumentation used for water level and marsh mat level measurements.

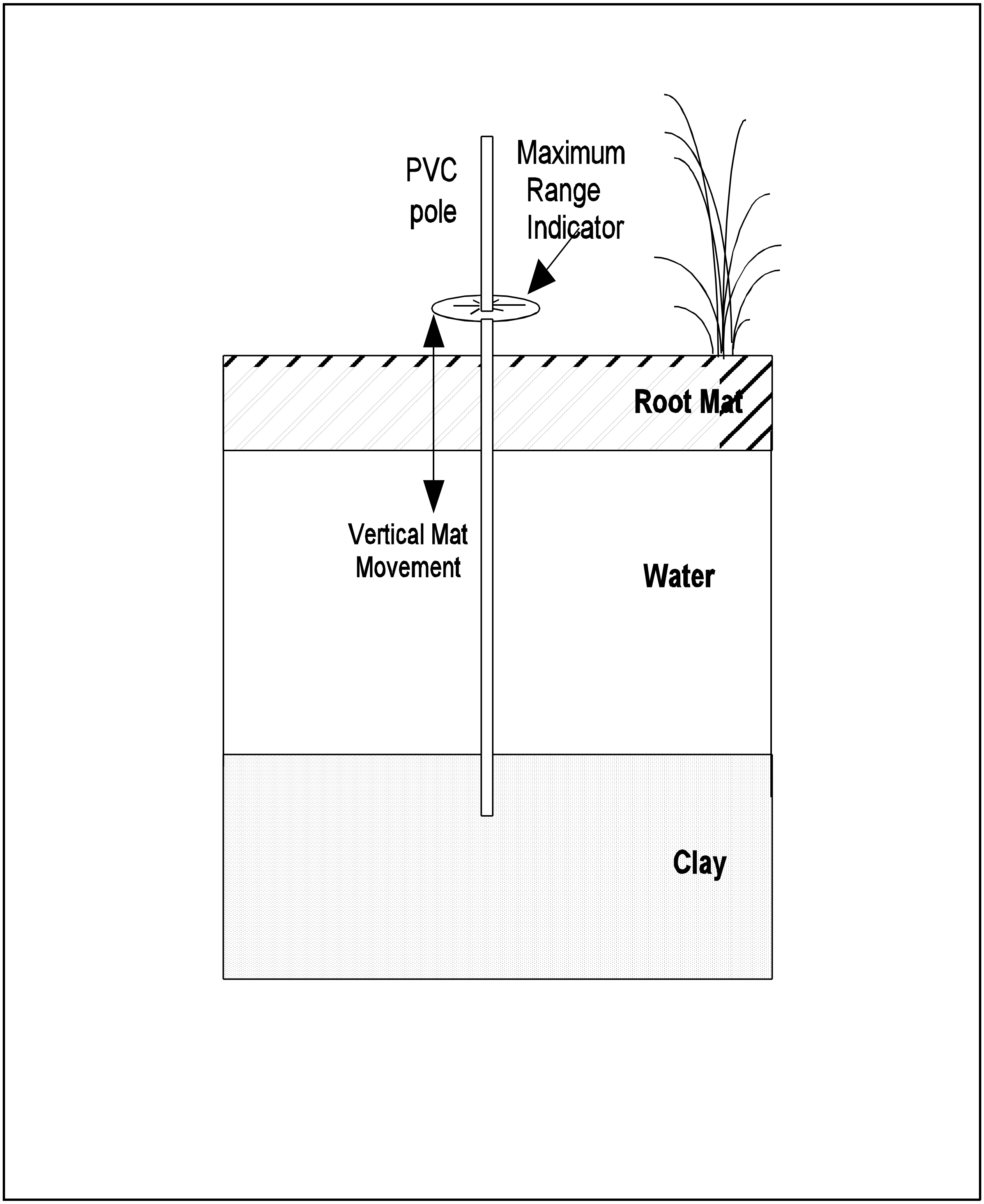

Figure 6 . Diagram of a maximum range indicator installed at each treatment plot.

in adjacent open water sources, and in the study areas. Samples will be collected from water in the adjacent canal or bayou, marsh channels, marsh mat surface where flooded, and the free water below the marsh mat if sampling is feasible, at the same frequency as the water samples.

4. Water Level — To monitor water level variability, four continuous recorder stations will be located in the project area. Water levels in the marsh and in the adjacent open water will be recorded with a continuously recording gauge at each site (figure 5). These gauges will be serviced monthly (Jan 1999-Sept 2001).

5. Nutrients — The fertilization treatment makes it necessary to include monitoring of nutrient levels in the mat substrate. Available nutrients in the mat substrate (live root) will be determined before the start of the fertilization (Feb 1999) and will be monitored semi-annually (May/Sept 1999, 2000, 2001). To assess the effects of nutrient uptake by the plants, tissue samples will be obtained semi-annually (May/Sept 1999, 2000, 2001). Nutrients considered most important to successful plant growth, including carbon, nitrogen, phosphorus, and potassium will be processed using a CHN Analyzer.

<u>Anticipated Statistical Analyses and Hypotheses</u>

Factors to be assessed:

A = fertilized
B = exclosure
C = planted

Treatments:

A	fertlized, grazed, unplanted
B	unfertilized, exclosure, unplanted
C	unfertilized, grazed, planted
AB	fertilized, exclosure, unplanted
AC	fertilized, grazed, planted
BC	unfertilized, exclosure, planted
ABC	fertilized, exclosure, planted
1	unfertilized, grazed, unplanted

The following hypotheses correspond with the monitoring elements and will be used to evaluate the accomplishment of the project goals. Descriptive, and summary statistics will be used to compare the achievement of project goals among the control and treatment plots within the four sites. Sediment11 regime will be used as a co-variate in the analyses. The relative effectiveness of each treatment (fertilization, exclosures, and planting) to reach the goal will also be assessed.

Goal 1: Increase percent cover of *P.hemitomon* and other species associated with thick mat flotants.

Hypothesis: H_o: Factors A, B, and C do not have any main or interaction effects on percent cover
H_a: Factors A, B, and C have significant main and/or interaction effects on percent cover

< If H_o is accepted, this indicates that none of the techniques are effective
< If H_a is chosen, then we will test which individual or combination of factors has a significant effect

a. H_o: Factor A (fertilization) has no effect
H_a: Factor A (fertilization) has a significant effect
b. H_o: Factor B (exclosure) has no effect
H_a: Factor B (exclosure) has a significant effect
c. H_o: Factor C (planted) has no effect
H_a: Factor C (planted) has a significant effect
d. H_o: Interaction of factors AB (fertilized, exclosure) has no effect
H_a: Interaction of factors AB (fertilized, exclosure) has a significant effect
e. H_o: Interaction of factors AC (fertilized, planted) has no effect
H_a: Interaction of factors AC (fertilized, planted) has a significant effect
f. H_o: Interaction of factors BC (exclosure, planted) has no effect
H_a: Interaction of factors BC (exclosure, planted) has a significant effect
g. H_o: Interaction of factors ABC (fertilized, exclosure, planted) has no effect
H_a: Interaction of factors ABC (fertilized, exclosure, planted) has a significant effect

Goal 2: Increase substrate buoyancy

Hypothesis: H_o: Factors A, B, and C do not have any main or interaction effects on substrate buoyancy
H_a: Factors A, B, and C have significant main and/or interaction effects on substrate buoyancy

< If H_o is accepted, this indicates that none of the techniques are effective
< If H_a is chosen, then we will test which individual or combination of factors has a significant effect

a. H_o: Factor A (fertilization) has no effect
H_a: Factor A (fertilization) has a significant effect
b. H_o: Factor B (exclosure) has no effect
H_a: Factor B (exclosure) has a significant effect
c. H_o: Factor C (planted) has no effect

H_a: Factor C (planted) has a significant effect

d. H_o: Interaction of factors AB (fertilized, exclosure) has no effect

H_a: Interaction of factors AB (fertilized, exclosure) has a significant effect

e. H_o: Interaction of factors AC (fertilized, planted) has no effect

H_a: Interaction of factors AC (fertilized, planted) has a significant effect

f. H_o: Interaction of factors BC (exclosure, planted) has no effect

H_a: Interaction of factors BC (exclosure, planted) has a significant effect

g. H_o: Interaction of factors ABC (fertilized, exclosure, planted) has no effect

H_a: Interaction of factors ABC (fertilized, exclosure, planted) has a significant effect

Goal 3: Increase mat thickness and strength

Hypothesis: H_o: Factors A, B, and C do not have any main or interaction effects on mat thickness and strength

H_a: Factors A, B, and C have significant main and/or interaction effects on mat thickness and strength

- If H_o is accepted, this indicates that none of the techniques are effective
- If H_a is chosen, then we will test which individual or combination of factors has a significant effect

a. H_o: Factor A (fertilization) has no effect

H_a: Factor A (fertilization) has a significant effect

b. H_o: Factor B (exclosure) has no effect

H_a: Factor B (exclosure) has a significant effect

c. H_o: Factor C (planted) has no effect

H_a: Factor C (planted) has a significant effect

d. H_o: Interaction of factors AB (fertilized, exclosure) has no effect

H_a: Interaction of factors AB (fertilized, exclosure) has a significant effect

e. H_o: Interaction of factors AC (fertilized, planted) has no effect

H_a: Interaction of factors AC (fertilized, planted) has a significant effect

f. H_o: Interaction of factors BC (exclosure, planted) has no effect

H_a: Interaction of factors BC (exclosure, planted) has a significant effect

g. H_o: Interaction of factors ABC (fertilized, exclosure, planted) has no effect

H_a: Interaction of factors ABC (fertilized, exclosure, planted) has a significant effect

Goal 4: Increase nutrient levels in plant tissue and substrate

Hypothesis: H_o: Factors A, B, and C do not have any main or interaction effects on percent cover

H_a: Factors A, B, and C have significant main and/or interaction effects on percent cover

- < If H_o is accepted, this indicates that none of the techniques are effective
- < If H_a is chosen, then we will test which individual or combination of factors has a significant effect

a. H_o: Factor A (fertilization) has no effect
   H_a: Factor A (fertilization) has a significant effect
b. H_o: Factor B (exclosure) has no effect
   H_a: Factor B (exclosure) has a significant effect
c. H_o: Factor C (planted) has no effect
   H_a: Factor C (planted) has a significant effect
d. H_o: Interaction of factors AB (fertilized, exclosure) has no effect
   H_a: Interaction of factors AB (fertilized, exclosure) has a significant effect
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   H_a: Interaction of factors BC (exclosure, planted) has a significant effect
g. H_o: Interaction of factors ABC (fertilized, exclosure, planted) has no effect
   H_a: Interaction of factors ABC (fertilized, exclosure, planted) has a significant effect

Notes

1.	Implementation:	Start Construction	February 1999
		End Construction	April 1999
2.	NRCS Point of Contact:	Cindy Steyer	(225)389-0334
3.	DNR Project Manager:	Cheryl Baker Brodnax	(225)342-6690
	DNR Monitoring Manager:	Jennifer Young	(504)447-0993
	DNR DAS Assistant:	Chuck Armbruster	(225)342-0277

4. The three year monitoring plan development and implementation budget for this project is $471,925. A progress report will be available in April 2000, and a comprehensive report will be available in April 2002. These reports will describe the status and effectiveness of the project.

5. Note: The LDNR/CRD references for naming plant species are:

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