The site would be inspected within 60 days after the initial planting. If 50 percent survival of transplant material had not been achieved, a second planting effort would be made within the next 30 days. If at least 70 percent canopy coverage were not achieved within one year following planting, an additional planting effort would be made, and those areas not vegetated would be replanted to original specifications. A five-year monitoring study would be conducted following planting, using an adjacent natural marsh as a control site for comparison. Mid-course adjustments might be necessary. The percent vegetative coverage, stem height and density, above- and below-ground biomass, and slope and elevation would be monitored, and subsequent progress reports, including photodocumentation, would be submitted to all resource agencies at years one, two, and three following the initial planting. The monitoring study would note any unusual sedimentation patterns and would include depth of soft-sediment accumulations throughout the site. The geotextile tubes would be removed after the salt marsh was established (when the vegetation coalesced).

Dickinson Bayou

Potential wetland restoration or creation sites were surveyed in Dickinson Bayou from Highway 146 to Interstate 45. Potential sites were also surveyed in Gum Bayou south of Highway 517. Most of the shoreline between Highway 3 and Interstate 45 is bulkheaded with relatively steep, muddy slopes and is not suitable for wetland restoration or creation. Three sites were found to be adequate for marsh restoration or creation projects (figs. 1 and 3). All three are adjacent to upland buffers at least 45 m in width. Sites 4 and 5 are also potential restoration/creation sites (fig. 3); however, no restoration/creation plans were developed for these sites.

Goals

The goals of the wetland restoration/creation projects for Dickinson Bayou are to restore or create salt or brackish marshes that function as fish and wildlife habitat, remove and transform nutrients, and retain sediments and toxicants.

Site descriptions and marsh restoration/creation plans

Site 1

Description. A fairly large site of approximately 10 acres is located on the south side of the bayou about 0.5 km west of the Gum Bayou entrance to Dickinson Bayou (figs. 1 and 3). The area is a cove of open water surrounded by a high marsh of Baccharis halimifolia, Distichlis spicata, Spartina patens, and Eleocharis sp. Aerial photographs from 1952 show that the current open-water areas were once vegetated. At the time of the field

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inspection in March 1994, the high marsh was inundated. Water depths in the open-water area are generally less than 0.3 m. Sediments are primarily muddy sands or sandy muds with high organic content. Salinity is 2.6 ppt.

Marsh restoration. A test plot of _Spartina alterniflora_ would be planted in a 30 m X 30 m area in the cove near the south shoreline. At least two rows of sprigs would be planted parallel to the shoreline at low tide. Planting and monitoring procedures would be similar to those used in Dickinson Bay. If the test plot was successful, at least 5 acres of an area that is currently open water in the cove (66,386 m²) would be planted with _S. alterniflora_ using the planting procedures described above for Dickinson Bay. Approximately 0.15 m of dredged-material fill might be needed in low areas. A sediment conditioning time of two to six months would be needed for dewatering prior to final leveling. Woven geotextile tubes might be used to provide temporary wave protection to the newly transplanted marsh. Except for a comparison with an adjacent natural marsh, the monitoring procedures for Dickinson Bay would also be used at the Cove site. Because there are only a few natural _S. alterniflora_ marshes in the area, and to prevent the spread of the fungus _Rhizoctina solani_, a fungus-resistant variety of _S. alterniflora_ called Vermillion would be obtained from the Plant Materials Center at Kingsville, Texas, and interplanted with local transplants at a ratio of 50:50.

Site 2

Description. Another potential restoration/creation site is at the entrance of Benson Bayou to Dickinson Bayou (figs. 1 and 3). Benson Bayou is a 1.5 km long tributary of Dickinson Bayou that originates in the town of Dickinson and enters Dickinson Bayou on the north side. The entrance to Benson Bayou is approximately 91 m across, is unvegetated, and contains a shallow, muddy spit that covers much of the east side of the entrance. Salinity is 1.5 ppt.

Marsh creation. In the Benson Bayou area, sprigs or clumps of _Scirpus americanus_ would be planted in the intertidal areas of the spit, and sprigs of _Juncus roemerianus_ would be planted along the shallow eastern shoreline of Benson Bayou. Transplants of _J. roemerianus_ would be obtained locally at sites just west of Highway 146. _Scirpus americanus_ would be obtained locally from natural marshes in the Galveston Bay area. Transplanting of _J. roemerianus_ and _S. americanus_ would be conducted between March 15 and May 31. No more than one 15 cm plug of source material per square meter would be obtained from the borrow areas, and incidental damage to the borrow areas would be strictly avoided.

A row of _J. roemerianus_ approximately 100 m in length would be planted at the MHT line and another row at slightly higher

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elevations 2 m inland from the MHT line. Three rows of
S. americanus 50 m in length with 2 m between rows would be
planted in the upper part of the intertidal zone on the spit in
Benson Bayou. A planting unit for each species would consist of
a single, properly pruned sprig with its associated roots.
Planting units would be placed on 0.5 to 0.6 m centers and set to
depths of 15 cm. The total area to be planted is 1,000 m².
Monitoring procedures would be similar to those used for Spartina
alterniflora at the Cove site; however, because J. roemerianus is
a much slower growing species than Spartina (Eleuterius and
Caldwell, 1981), the site would be monitored for at least six
years following planting.

Site 3

Description. Gum Bayou contains a potential site on the east
shoreline approximately 151 m north of the Highway 517 crossing.
Gum Bayou is a 3 km long tributary that originates just east of
the town of Dickinson and enters the north side of Dickinson
Bayou approximately 4 km west of Highway 146. The site is
primarily unvegetated, but the high marsh species Distichlis
spicata, Baccharis halimifolia, and Eleocharis sp. are adjacent
to the site. An elevation transect on a bearing of south 22 east
shows a 0.7 m high erosional scarp between stations 3 and 4 (fig.
13). The total range in elevation along the transect is 1.6 m.
The MHT line occurs at station 6. Water depth at station 7 is
0.15 m. Sediments are primarily sandy muds. Salinity is 2.0 ppt.

Marsh creation. At least one acre of private land surrounding
the Gum Bayou site would be acquired or a long-term conservation
easement obtained prior to beginning the marsh creation project
on Gum Bayou. The site would be fenced to prevent damage by
cattle from adjacent rangelands. Also, some minor adjustments in
intertidal elevations might need to be made prior to the
transplanting of Juncus roemerianus. The elevation of the marsh
creation area would be lowered to approximately -0.3 m MHT line
at the edge of the water and sloped to an elevation of
approximately 0.3 m MHT line at the landward limit of the area.
Any excess sediment would be deposited in an adjacent upland
site. Transplants of J. roemerianus would be obtained locally in
Dickinson Bayou and planted in three rows of approximately 50 m
in length parallel to the Gum Bayou shoreline. One row would be
planted at the MHT line and the other two rows at slightly higher
elevations 2 and 4 m inland from the MHT line. The total area to
be planted is 600 m². Additional planting and monitoring
procedures would be similar to those used at the Benson Bayou
site.

DISCUSSION AND CONCLUSIONS

Wetlands are an integral part of the Dickinson Bayou and
Dickinson Bay ecosystems and perform numerous functions important

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to maintaining the overall chemical, physical, and biological integrity of the bay and bayou. Problems with water and sediment quality in the bay and bayou and relatively low fisheries production for some species when compared to other bays in the Galveston Bay system may be linked to the extensive loss of wetlands in the bay and bayou watershed. Wetland restoration and creation in the bay and bayou watershed will, both locally and regionally: (1) improve water and sediment quality; (2) stabilize eroding shorelines; (3) increase fisheries production; (4) provide additional habitat for birds and mammals; and (5) provide aesthetic, recreational, and educational opportunities. Expanding the scope of the wetland restoration and creation projects to include inland fresh marshes and riparian wetlands would provide additional beneficial wetland functions: increased flood protection, moderation of bayou temperatures, reduction of sediment input, provision of organic matter, and groundwater recharge and discharge.

Wetlands, under favorable conditions, have been shown to remove organic and inorganic nutrients and toxic materials from water and sediments (Mitsch and Gosselink, 1993). Sediments and associated toxic materials are carried by runoff or channel flow into wetlands, where they are removed temporarily or permanently from the water column by sediment deposition (Marble, 1992). Toxic materials can then be removed by burial, chemical breakdown, and/or assimilation into plant tissues.

Analyses of individual wetlands indicate that healthy wetlands and riparian zones reduce eutrophication. Studies generally show that wetlands act as sinks for nitrogen and phosphorus under nutrient-enriched and natural conditions (Marble, 1992). Wetlands function as nutrient traps by intercepting urban or agricultural runoff containing high concentrations of dissolved nitrogen and phosphorus. Wetland vegetation removes nitrogen and phosphorus on a short- and long-term basis by (1) offering frictional resistance to incoming surface water and enhancing nutrient retention through burial, and (2) biological growth processes (Marble, 1992). Forested riparian buffer strips are also effective in reducing sediment and nutrient levels in streamflow and exert major control on NO3-N concentrations in riparian zone groundwaters (Chesapeake Bay Program, 1993).

Wetlands are effective in retaining some nutrients and sediments, but they should not be expected to control all the influx of sediments and nutrients from a watershed (Mitsch, 1993). A wetland's capacity to assimilate pollutants, for example, may be exceeded when the volume and quality of stormwater reaches threshold levels. Also, considerable uncertainty exists concerning the long-term impacts of water and sediment quality changes on wetland biological communities (EPA, 1993).

Figure 13. Gum Bayou Transect

Station 6 = Mean High Tide
Station 7 = Water depth 15.2 cm

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