CS-27

Black Bayou Hydrologic Restoration
Summary Data and Graphics

12/08/03

Castellanos, D. 2003. *CS-27 Black Bayou Hydrologic Restoration Summary and Graphics, Louisiana Department of Natural Resources, Coastal Restoration Division, Baton Rouge, Louisiana 37 pp.*

Black Bayou Hydrologic Restoration (CS-27)

Project Overview:

The Black Bayou Hydrologic Restoration Project (CS-27) is located approximately 18 miles (km) west-northwest of Hackberry, Louisiana in northwest Cameron and southwest Calcasieu Parish. The project is bordered to the north by the Gulf Intracoastal Waterway (GIWW), to the south by Black Bayou, to the east by Gum Cove Ridge, and to the west by the Sabine River (figure 1). Total project area is approximately 25,529 acres (10,336 ha) and is comprised of approximately 6,516 acres (2,638 ha) of fresh/intermediate marsh, 7,353 acres (2,977 ha) of brackish marsh, and 11,660 acres (4,721 ha) of open water. Fresh/intermediate marshes are dominated by *Juncus roemerianus* (black needlerush), *Phragmites australis* (common reed), *Schoenoplectus californicus* (california bullwhip), *Schoenoplectus robustus* (leafy three-square), *Spartina patens* (marshhay cordgrass), and *Typha sp.* (cattail). Brackish marshes are dominated by *J. roemerianus*, *P. australis, Schoenoplectus americanus* (three-corner grass), *S. robustus, S. patens,* and *Typha sp*..

Beginning in the late 1800's significant hydrologic changes effecting water level fluctuation and water circulation patterns occurred in the project area. Modifications to Calcasieu Pass such as the removal of the Calcasieu Pass oyster reef in 1876, increased the magnitude and duration of tidal fluctuations in both the lake and the surrounding marshes (LDNR 1993). Construction of the GIWW, North Line Canal, Central Line Canal, and South Line Canal established a hydrological connection between the Calcasieu and Sabine basins, allowing the saline waters of the Calcasieu Basin to encroach on the Sabine Basin. Water level fluctuations are also influenced by wind. A strong north wind can cause drastic de-watering of the marshes, while a strong sustained southerly wind can result in drastic increases in water levels blown in from the gulf. The extensive system of navigation channels, natural drainage, bayous, oil exploration canals, and trenasses, have allowed increased water fluctuations and salinities to reach the interior of the marsh (USDA, 1991).

Black Bayou Hydrologic Restoration (CS-27)

Project Overview: (continued)

Marsh types and the associated vegetation in and around the project area also indicate that salinities have been increasing for the last 45 years. All of the project area was classified as fresh or low salinity (intermediate) marsh in 1949, except for the area adjacent to Sabine Lake and Sabine River just north of Black Bayou where brackish marsh conditions existed (Oneil 1949). Brackish marsh conditions in this area expanded north to the GIWW and eastward along Black Bayou to the Black Bayou Oil Field by 1968 (Chabreck 1968). By 1988, the majority of the project area was identified as brackish marsh with fresh marsh found only in the extreme northeast corner of the project area adjacent to the Gum Cove Ridge.

The Black Bayou Hydrologic Restoration Project includes structural and non-structural measures designed to allow freshwater from the GIWW near its confluence with the Vinton Drainage Canal into the wetlands south of the GIWW between the Sabine River, Gum Cove Ridge, and Black Bayou, and to create a hydrologic head that increases freshwater retention time and reduces salt water intrusion and tidal action in the Black Bayou watershed. Planned structural and non-structural measures and their intended functions are listed below:

1. Breaches in the GIWW spoil bank west of the Gum Cove Ridge were repaired with approximately 22,600 linear ft. (6,889 m) of rock foreshore dikes.

2. A weir with a barge bay made of graded stone was constructed at the GIWW in the Black Bayou Cut Off Canal to limit water exchange in and out of the project area.

3. A weir with a boat bay made of graded stone was constructed in the Burton Canal at its intersection with the Sabine River to limit water exchange in and out of the project area.

Black Bayou Hydrologic Restoration (CS-27)

Project Overview: (continued)

4. A rock weir with a 15 ft. (4.6 m) boat bay at - 3 ft. (-0.9 m) bottom elevation was constructed at the intersection of Block's Creek with Black Bayou to limit water exchange in and out of the project area.

5. A self-regulating tide gate to limit flow into the NO-13 hydrologic unit during high water events was constructed where the hydrologic unit meets an existing canal that leads to Black Bayou Cutoff.

6. Vegetative plantings of approximately 161,496 linear ft. (49,224 m) of bullwhip (*Schoenoplectus californicus)* Approximately 32,000 plants in one gallon trade containers with a minimum of 5 stems per container were installed on 5 ft. (1.5 m) centers.

Black Bayou structural features construction was completed in November 2001.

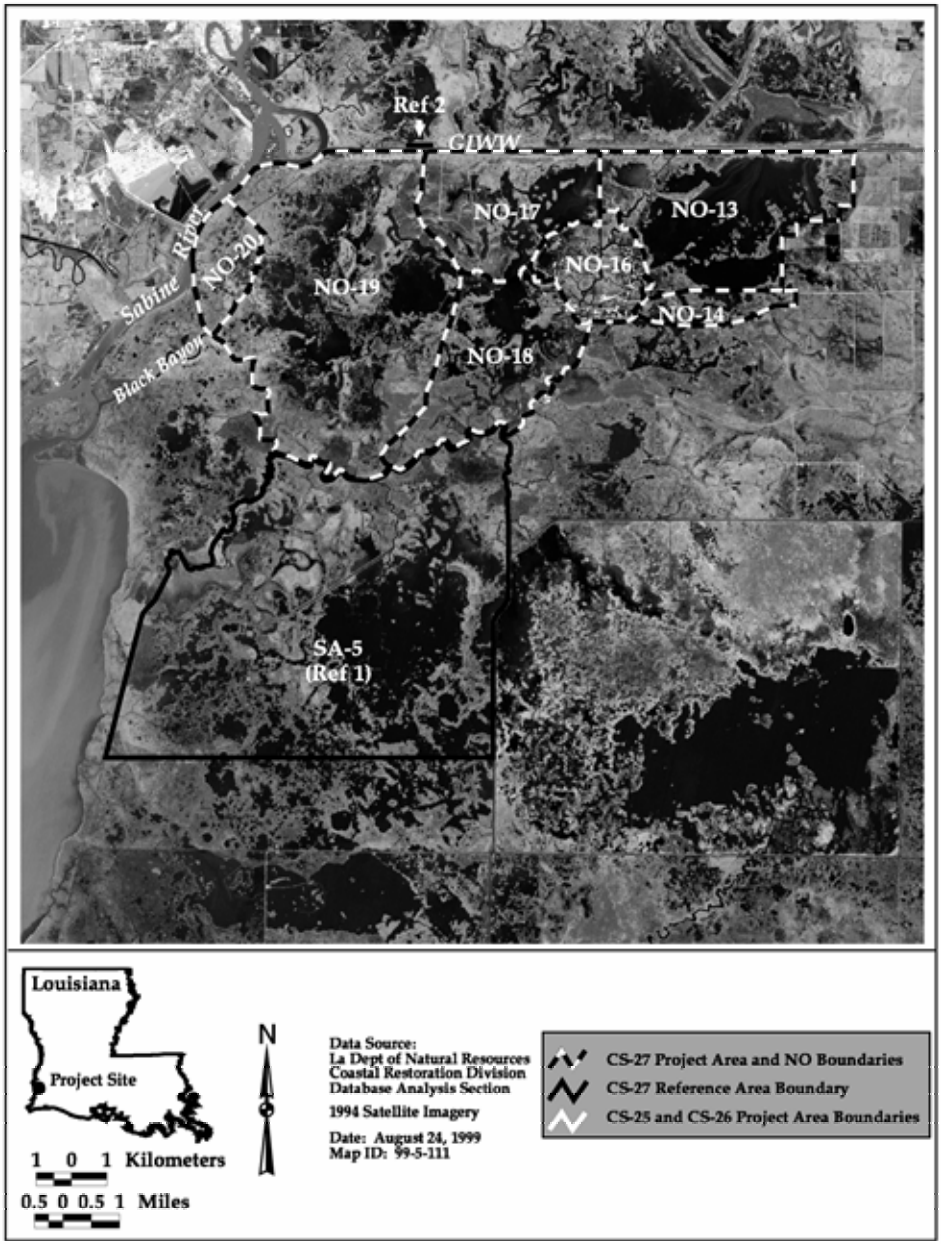


Figure 1. Black Bayou project and reference area boundaries.

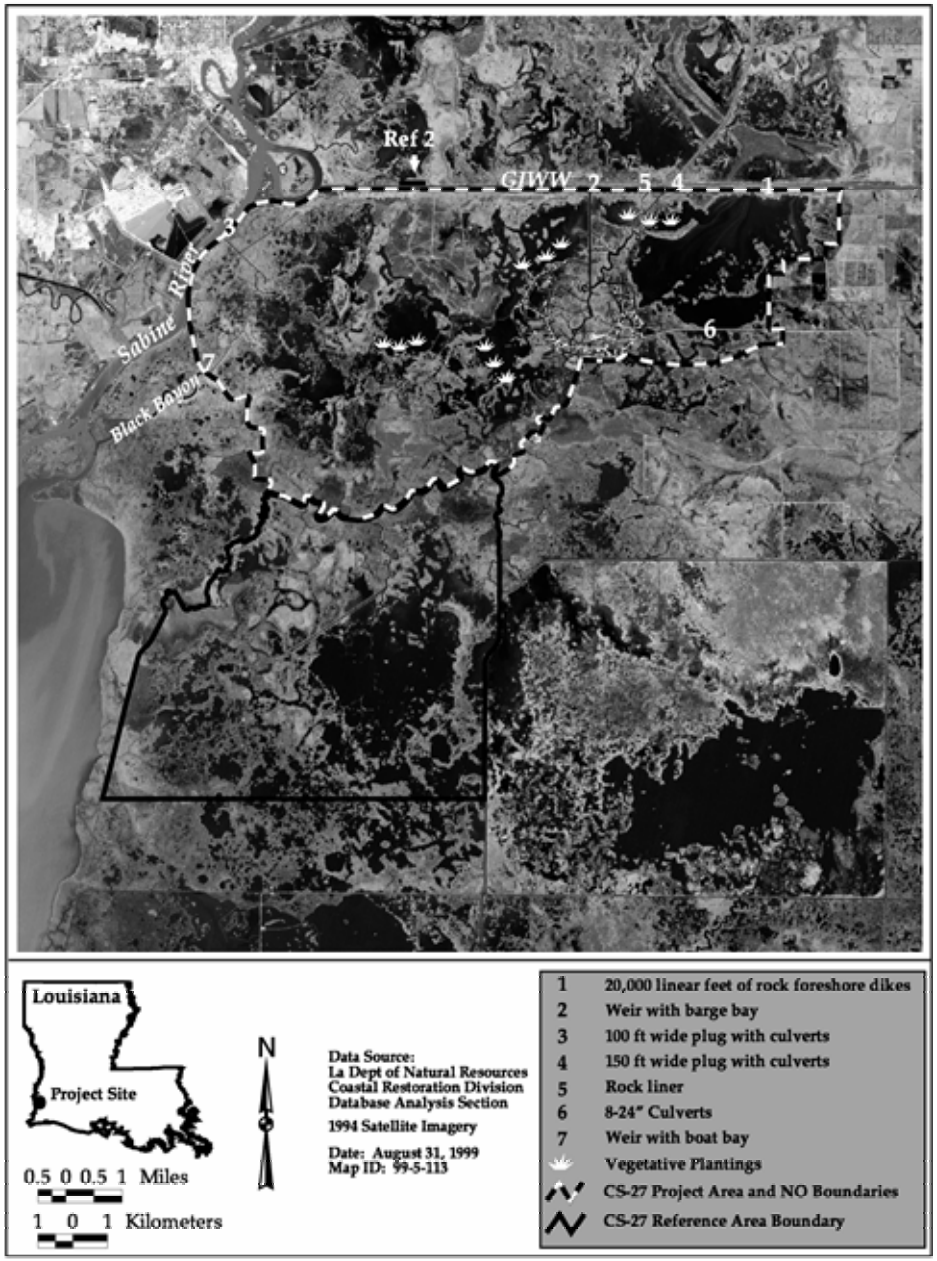


Figure 2. Black Bayou project features.

Black Bayou Hydrologic Restoration (CS-27)

Project Objectives

1. Increase freshwater retention that reduces salt water intrusion in the project area wetlands.
2. Establish emergent wetland vegetation in shallow open water areas.
3. Protect emergent marsh in project area by reducing erosion along GIWW.
4. Increase occurrence of SAV in project area.

Specific Goals

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

1. Reduce mean salinities within the project area.
2. Increase the land to water ratio within the project area.
3. Reduce mean erosion rate of protected shoreline along GIWW.
4. Increase SAV in interior ponds within the project area.

Black Bayou Hydrologic Restoration (CS-27)

Monitoring Elements:

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

Aerial Photography: To document land to open-water ratios and land loss rates, color-infrared aerial photography (1:24,000 scale) were obtained post construction, as an as built in the fall of 2000, and will be obtained during the fall of 2004, 2009, and 2016. The photography will be processed by National Wetlands Research Center (NWRC) personnel using standard operating procedures documented in Steyer et al. (1995) for determining land-to-water ratios and corresponding acreage through GIS analysis.

Salinity: Salinity will be monitored at least monthly at permanent discrete sampling stations within the project and reference areas. The appropriate number of stations will be placed in each hydrologic unit (figure 2) to detect salinity changes. Salinity data will be used to characterize the spatial variation in salinity throughout the project area, and to determine if project area mean salinity is being reduced. Discrete salinities were monitored in 1999 (preconstruction) and will continue through 2017 (post construction). Hourly salinity and water levels will be monitored with two continuous recorders. Adjacent to the continuous recorders, staff gauges were surveyed relative to North American Vertical Datum 1988 (NAVD88) inside and outside of project structures to correlate water levels to a known datum..

Vegetation Plantings: The species composition and relative abundance of all plant species and the percent survival of vegetative plantings will be determined in 3% of the vegetation plantings or in eighty sampling plots. Each sampling plot will consist of 16 plantings, from one or more rows depending on the planting design, with the sampling location determined by a random numbers table and marked with a labeled post. The sampling plots will be divided equally among the hydrologic units containing vegetative plantings. Planting survival will be determined as a percentage of the number of live plants to the number initially planted (percent survival = no. plants/no. planted x 100), after Mendelssohn and Hester (1988) and Mendelssohn et al. (1991).

Black Bayou Hydrologic Restoration (CS-27)

Monitoring Elements (cont.)

Survival was documented after one growing season post construction in 2003 and will be again in 2005 and 2007, or until the individual plantings become indistinguishable. Percent cover estimates will be taken from the entire 16 plant plot to determine species composition and relative abundances for all species, including the plantings, using the Braun-Blanquet methodology (Mueller-Dombois and Ellenberg 1974).

Shoreline Change: To document shoreline movement along the southern shoreline of the GIWW, differential global positioning system (DGPS) surveys of unobstructed sections of the shoreline will be conducted at the vegetative edge. A survey was conducted in 2000 (preconstruction), and in 2002, and will be conducted in 2004. DGPS shoreline positions will be mapped and used to measure shoreline erosion/growth rates. Shoreline rates will be used to calculate the total acres gained/lost.

Submerged Aquatic Vegetation: To document changes in the frequency of occurrence of SAV three transects per hydrologic unit and one transect in the reference area are being monitored using the rake method (Chabreck and Hoffpauir 1962). Transects were established in open water areas in each hydrologic unit and separated by an equal distance. Each transect has a minimum of 25 equally spaced sampling stations. At each station, aquatic vegetation will be sampled by dragging a garden rake on the pond bottom for one second. The presence of vegetation will be recorded to determine the frequency of aquatic plant occurrence (frequency = number of occurrences/25 x 100). When vegetation is present, the species present is recorded in order to determine the frequencies of individual species (Nyman and Chabreck 1996). SAV was monitored in the fall 1999 preceding construction, and in postconstruction year 2003. Monitoring will be conducted in years 2005, 2007, 2010, 2012, 2014, 2017.

Black Bayou Hydrologic Restoration (CS-27)
Aerial Photography

Aerial photography was acquired before construction in November 2000, and the area will be photographed again in 2004.

Figures:

Figure 3. 2000 (preconstruction) photomosaic and land/water analysis of the Black Bayou Hydroloic Restoration (CS-27) project and reference areas.

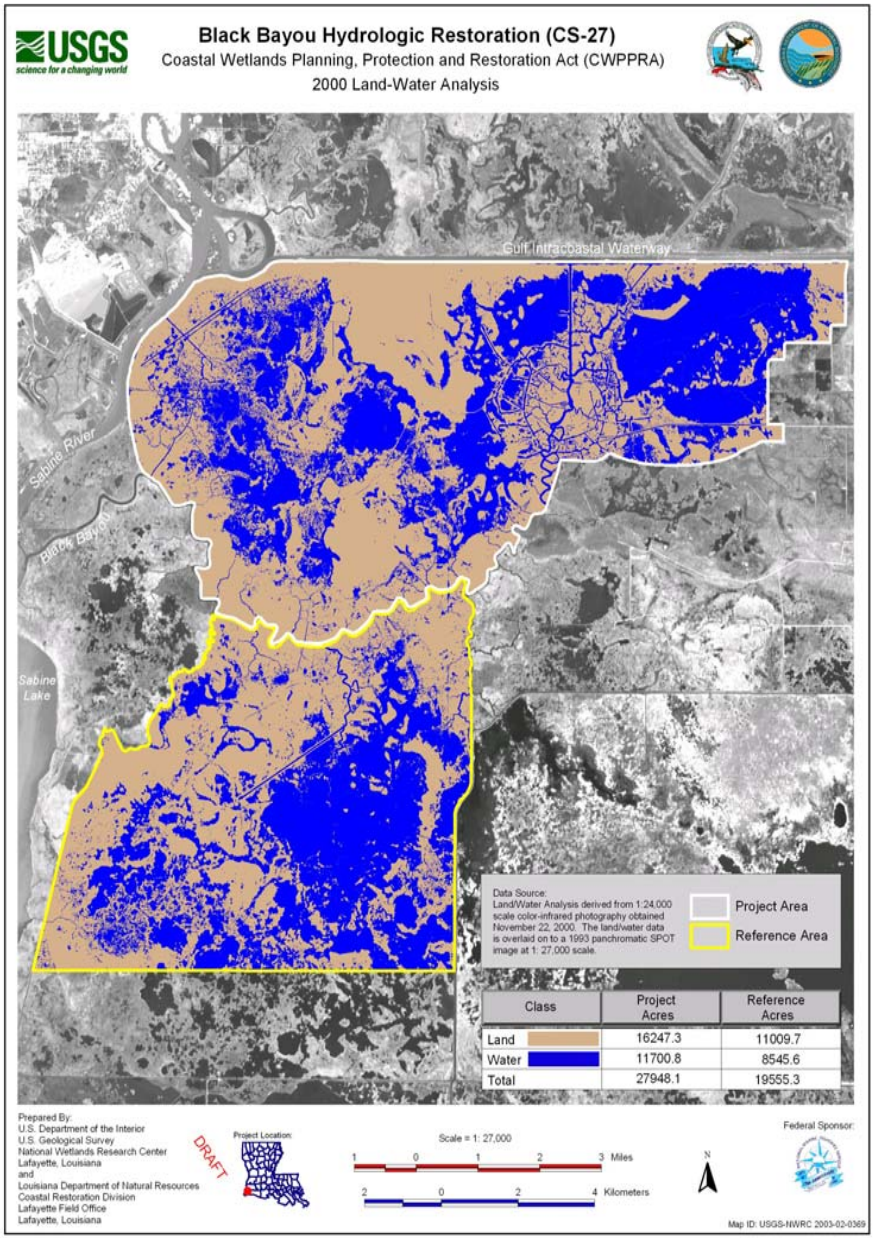


Figure 3. Preconstruction land/water analysis of project and reference areas.

Black Bayou Hydrologic Restoration (CS-27)
Salinity

Hourly water salinity (ppt) and water level (ft, NAVD) have been collected at the CS27-22 and CS27-25 stations from May 2000 to present. Discrete data have been collected from June 1999 to present

Figures:

Black Bayou Hydrologic Restoration (CS-27)
Salinity

Figures: (continued)

Figure 16. Hourly water level (m) and salinity measurements for station CS27-25 year 2002.

Figure 17. Yearly mean salinity from monthly discrete hydrologic data for grouped monitoring stations. The following is a list of legend terms and what stations they include: P perimeter south - project stations 12, 14 15; P hydrologic unit – project stations 2, 6, 10, 24, 25, 26; P interior east – project stations 3, 5, 7, 8, 9, 11, 13, 21, 23, 27,28, 29; P interior west – project stations 17, 18, 30, 31, 32, 33, 34, 35; P perimeter north – project stations 1, 4, 16, 19, 22; R – reference stations 3R, 4R, 5R, 6R, 7R, 8R. Error bars represent 1 standard error. Note: Data for 1999 does not include January through May. Also some stations were not accessible every month in all years.

Figure 18. Yearly mean salinity for stations CS27-22 and CS27-25. Error bars represent 1 standard error. Note: Data for CS27-22 year 2000 includes only May through July

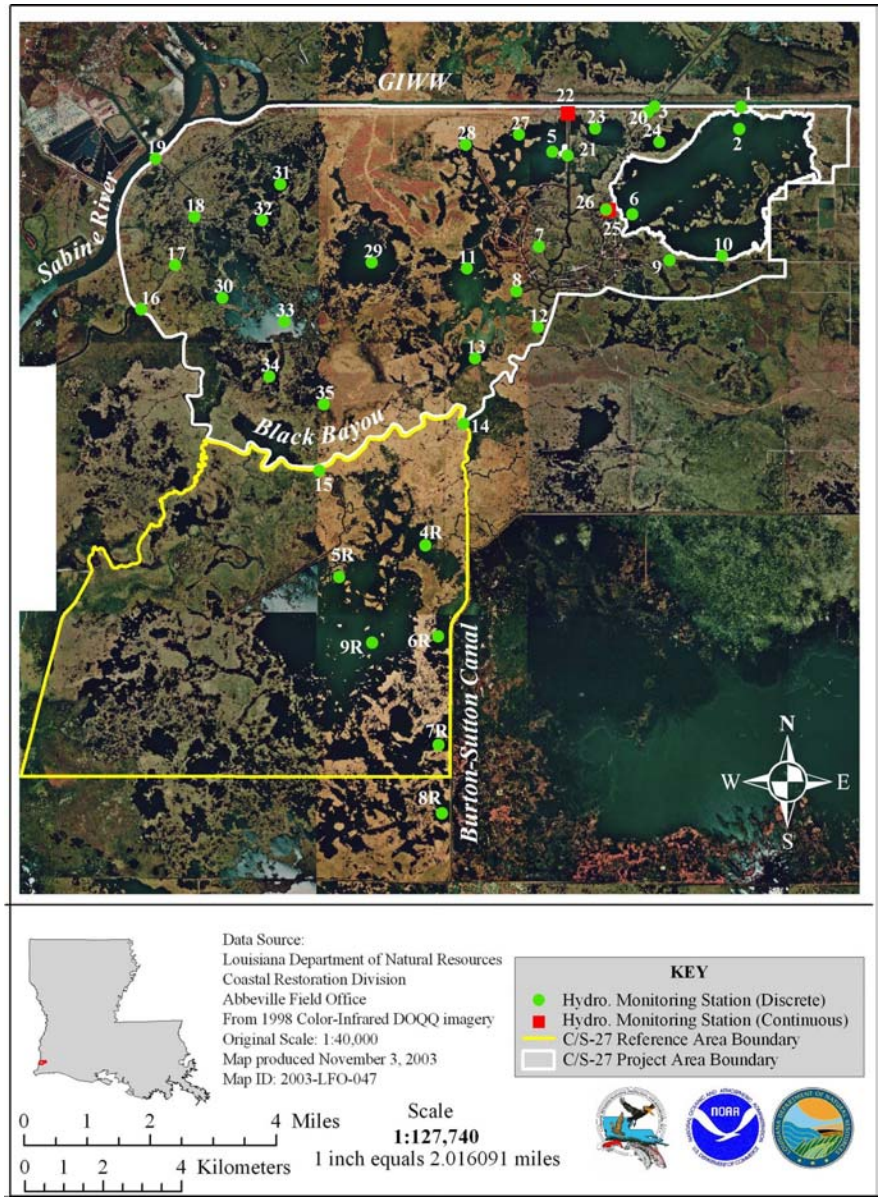
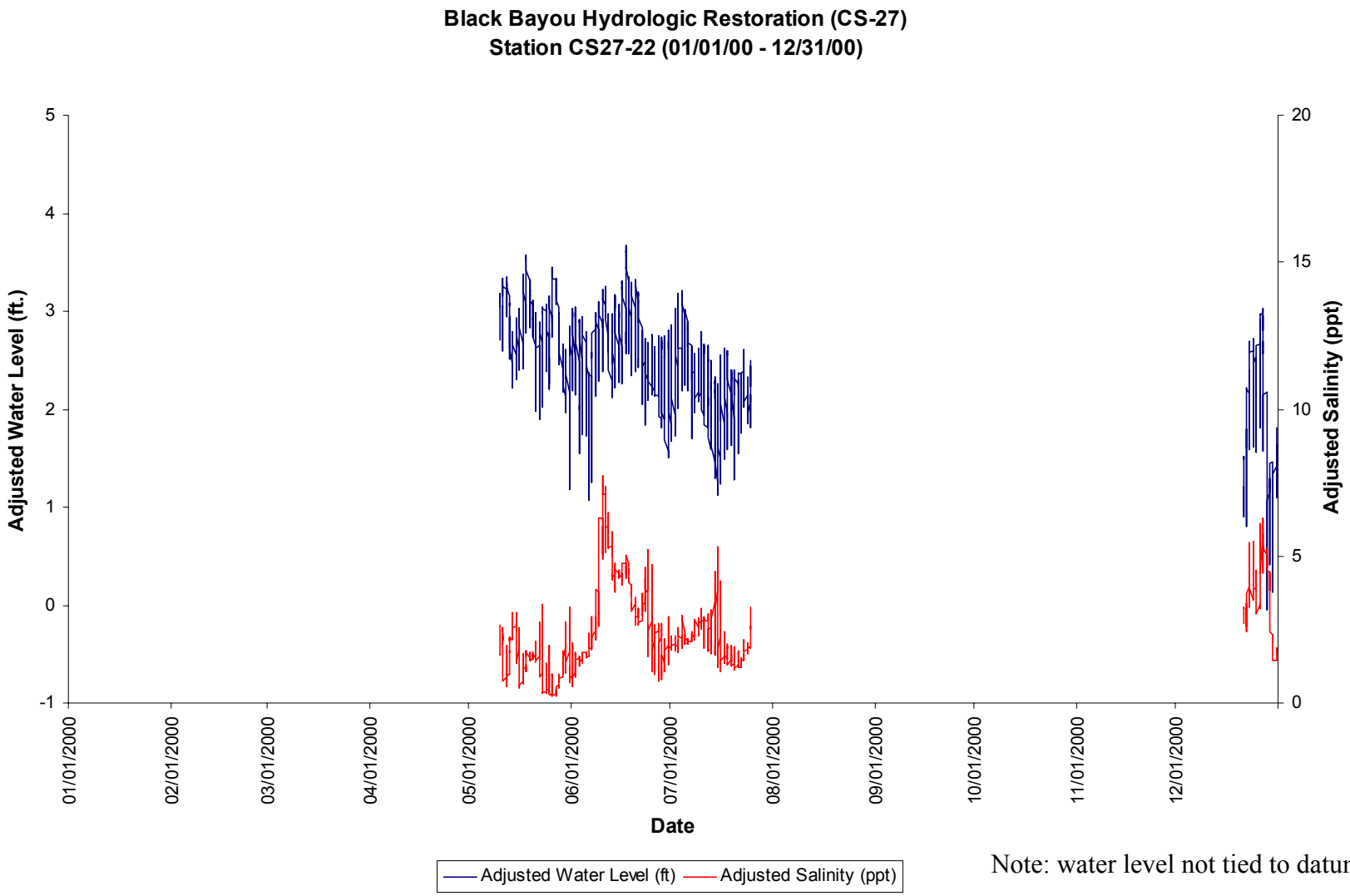
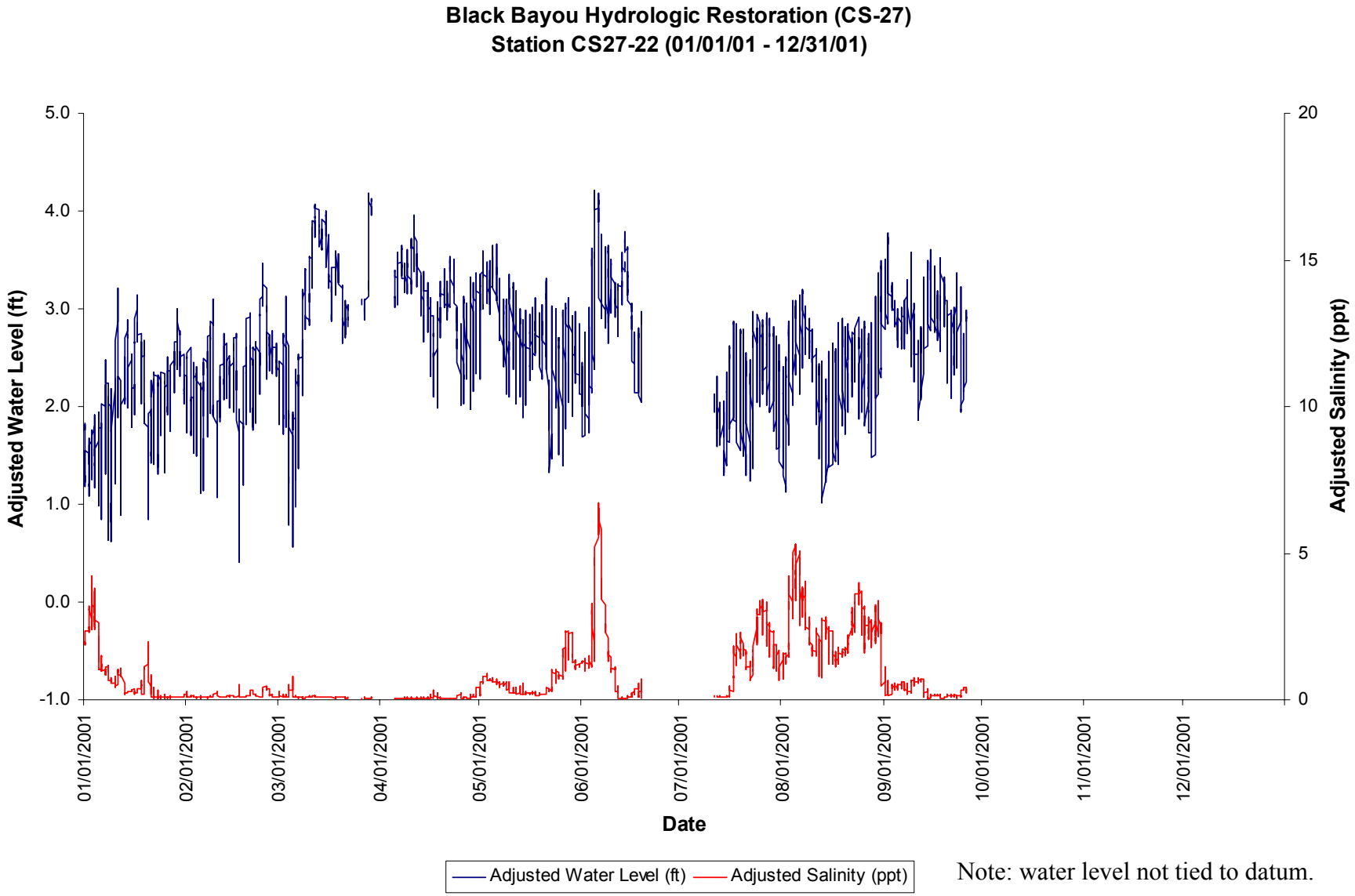


Figure 4. Black Bayou project and reference discrete (green circles) and sonde station locations (red squares).



Note: water level not tied to datum.

Figure 5. Hourly water level (ft) and salinity measurements for station CS27-22 year 2000.



Note: water level not tied to datum.

Figure 6. Hourly water level (ft) and salinity measurements for station CS27-22 year 2001.

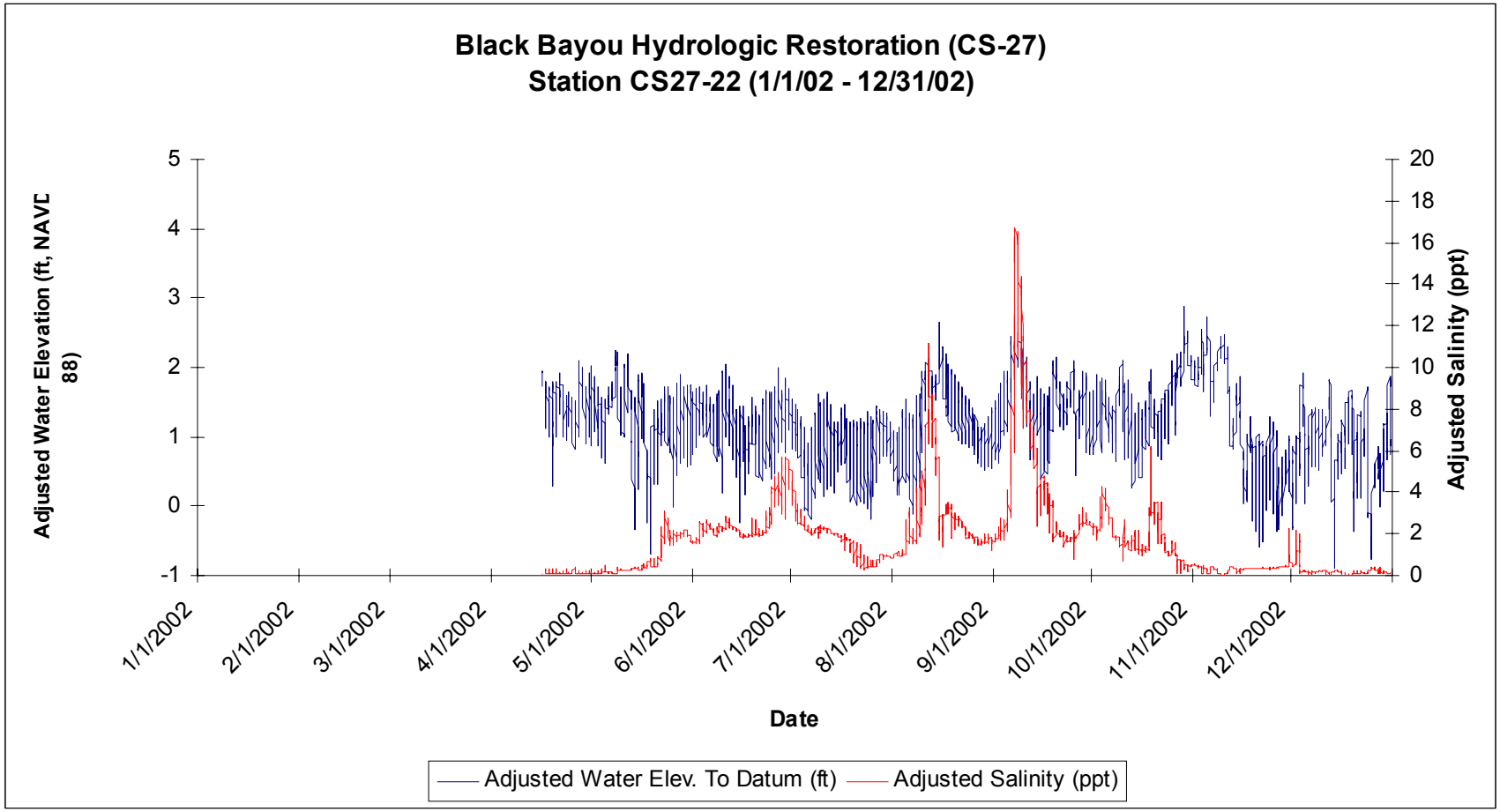


Figure 7. Hourly water level (ft) and salinity measurements for station CS27-22 year 2002.

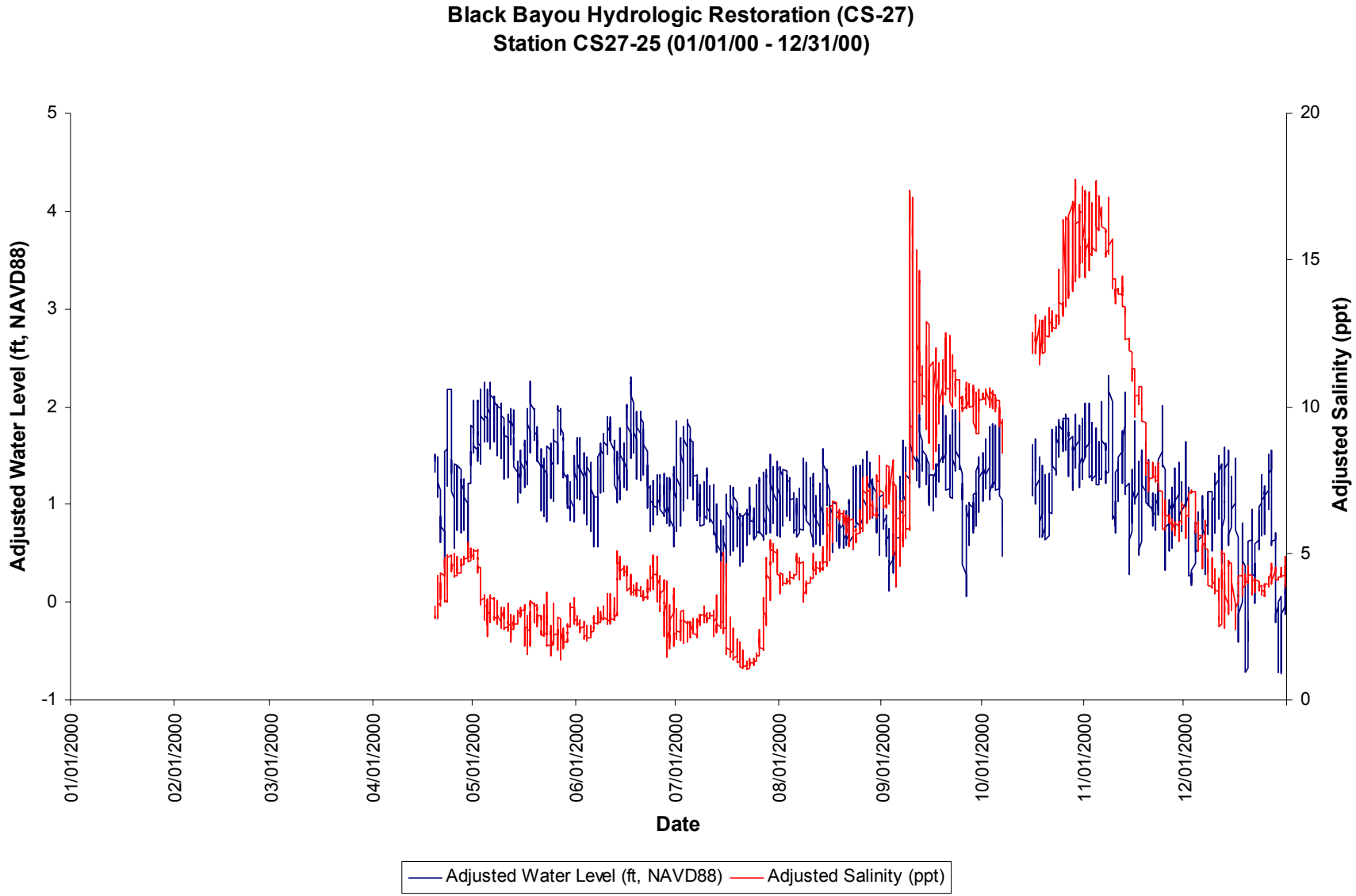


Figure 8. Hourly water level (ft) and salinity measurements for station CS27-25 year 2000.

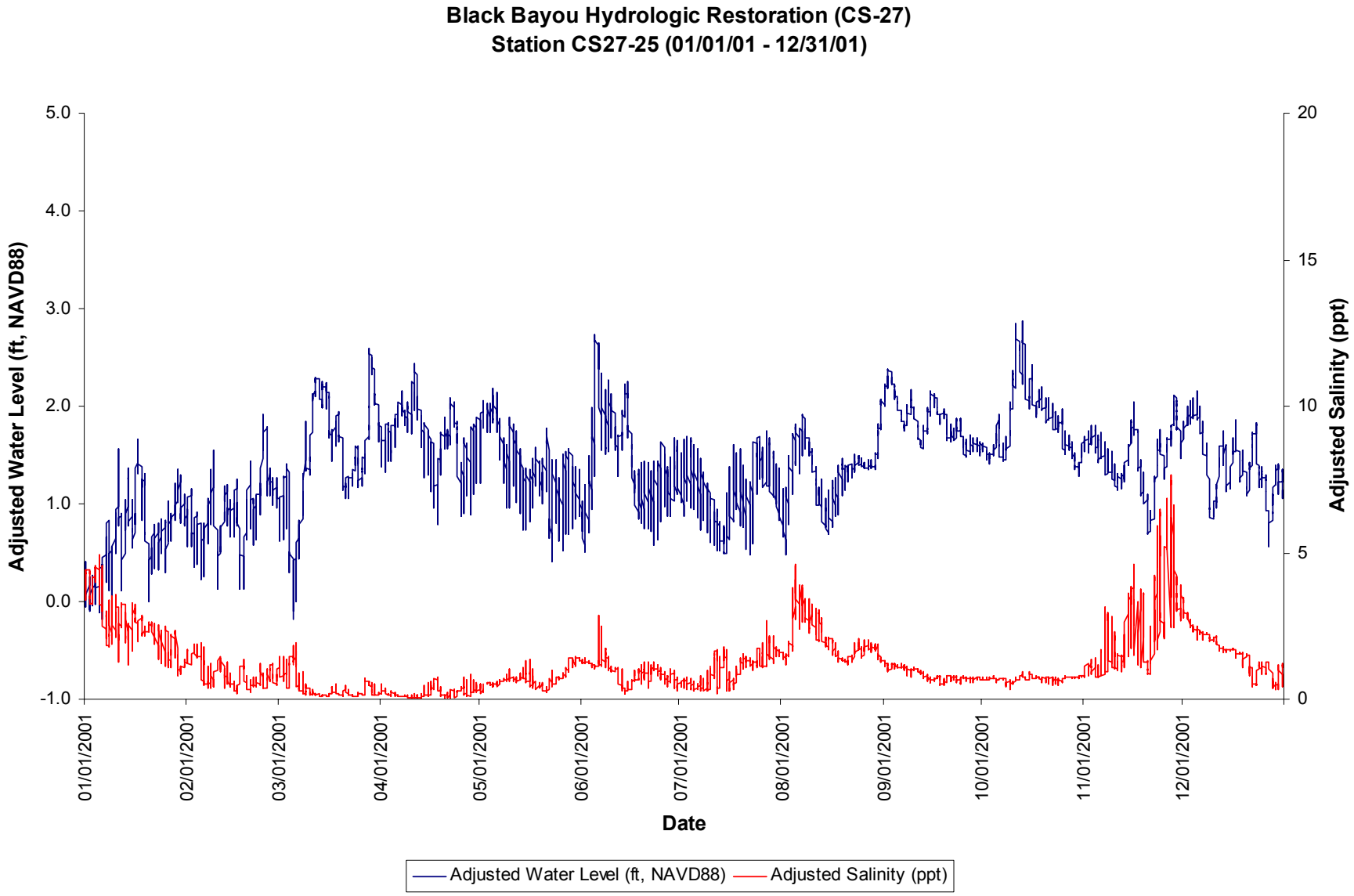


Figure 9. Hourly water level (ft) and salinity measurements for station CS27-25 year 2001.

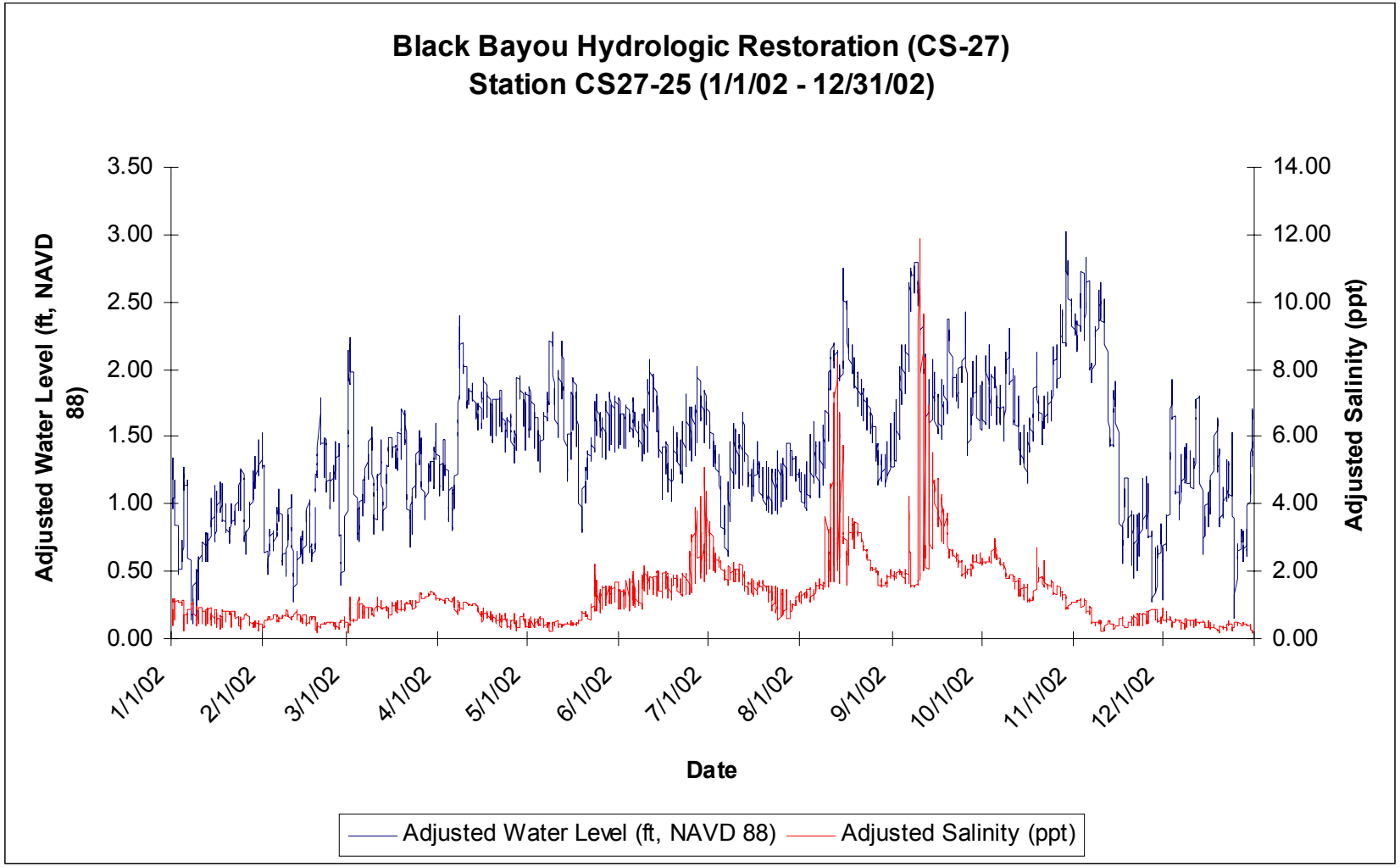
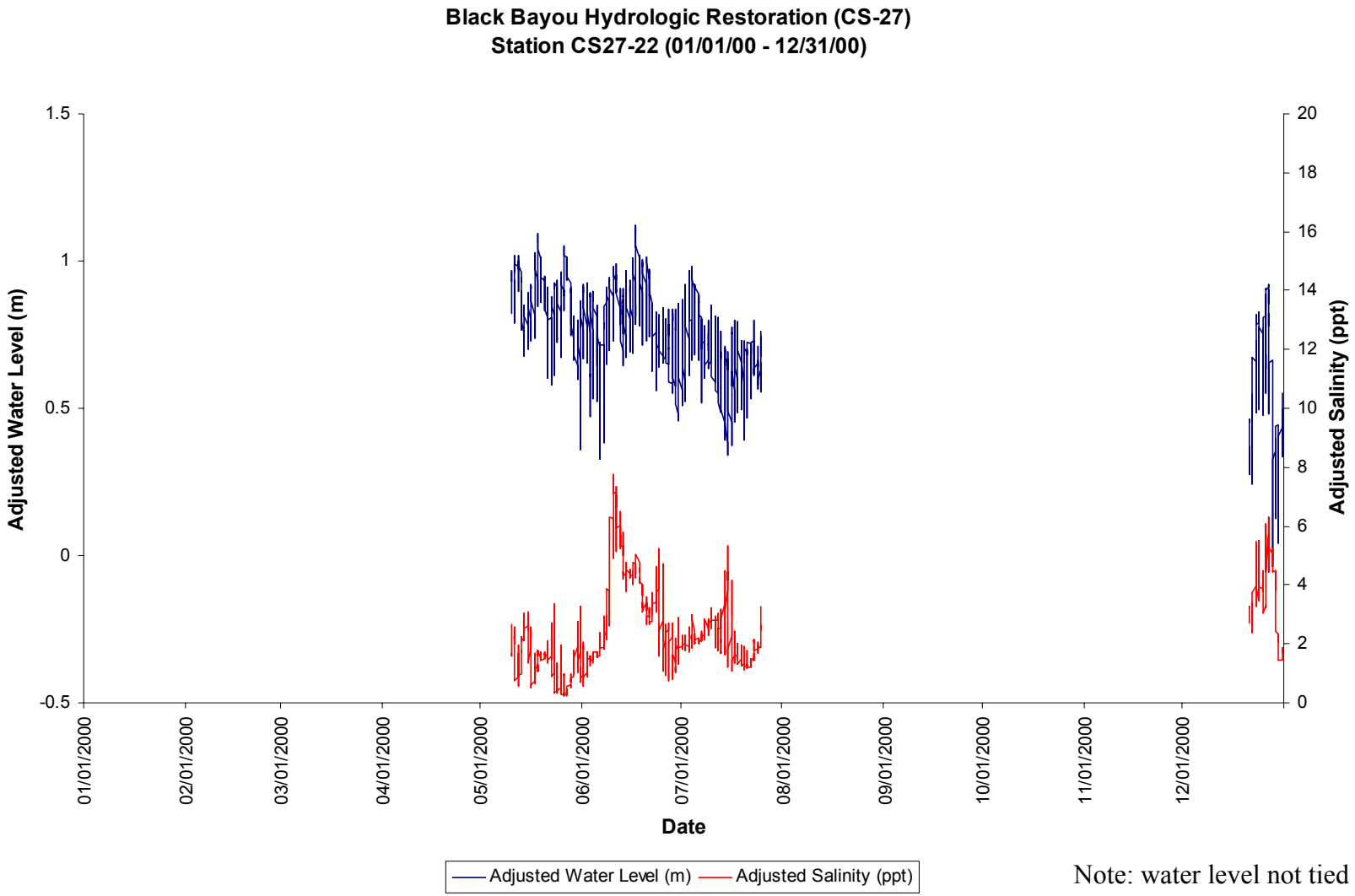
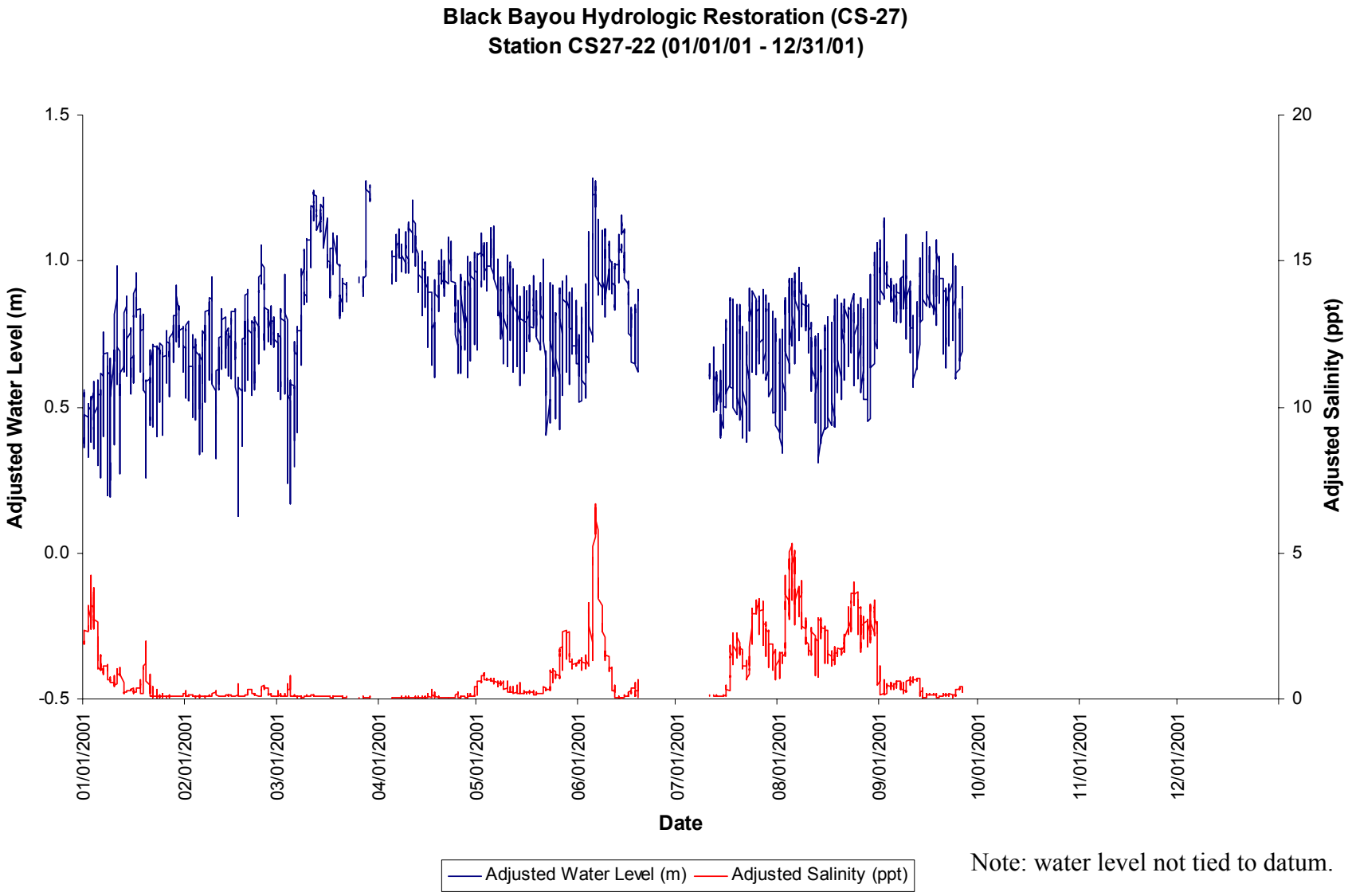


Figure 10. Hourly water level (ft) and salinity measurements for station CS27-25 year 2002.



Note: water level not tied to datum.

Figure 11. Hourly water level (m) and salinity measurements for station CS27-22 year 2000.



Note: water level not tied to datum.

Figure 12. Hourly water level (m) and salinity measurements for station CS27-22 year 2001.

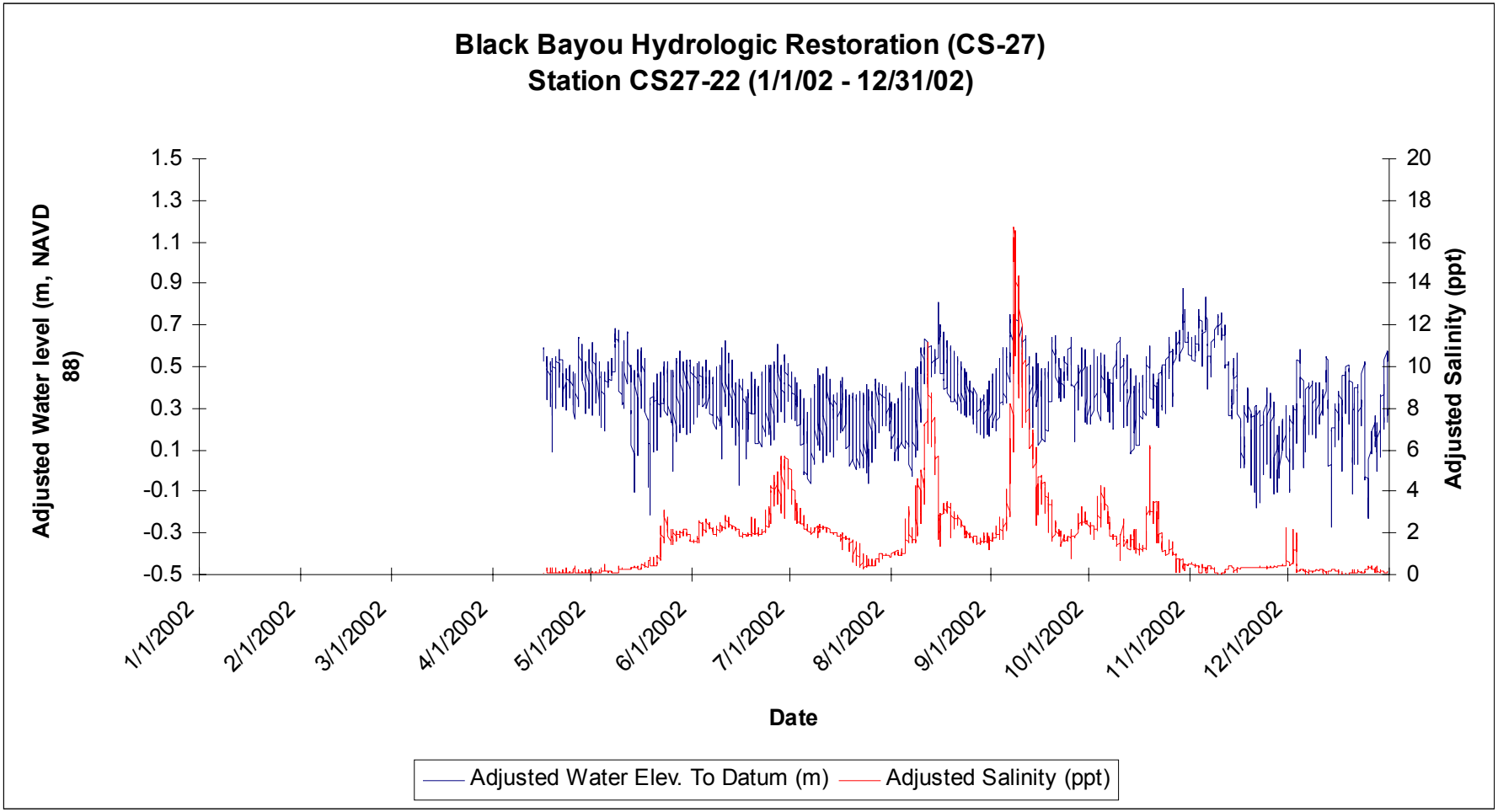


Figure 13. Hourly water level (m) and salinity measurements for station CS27-22 year 2002.

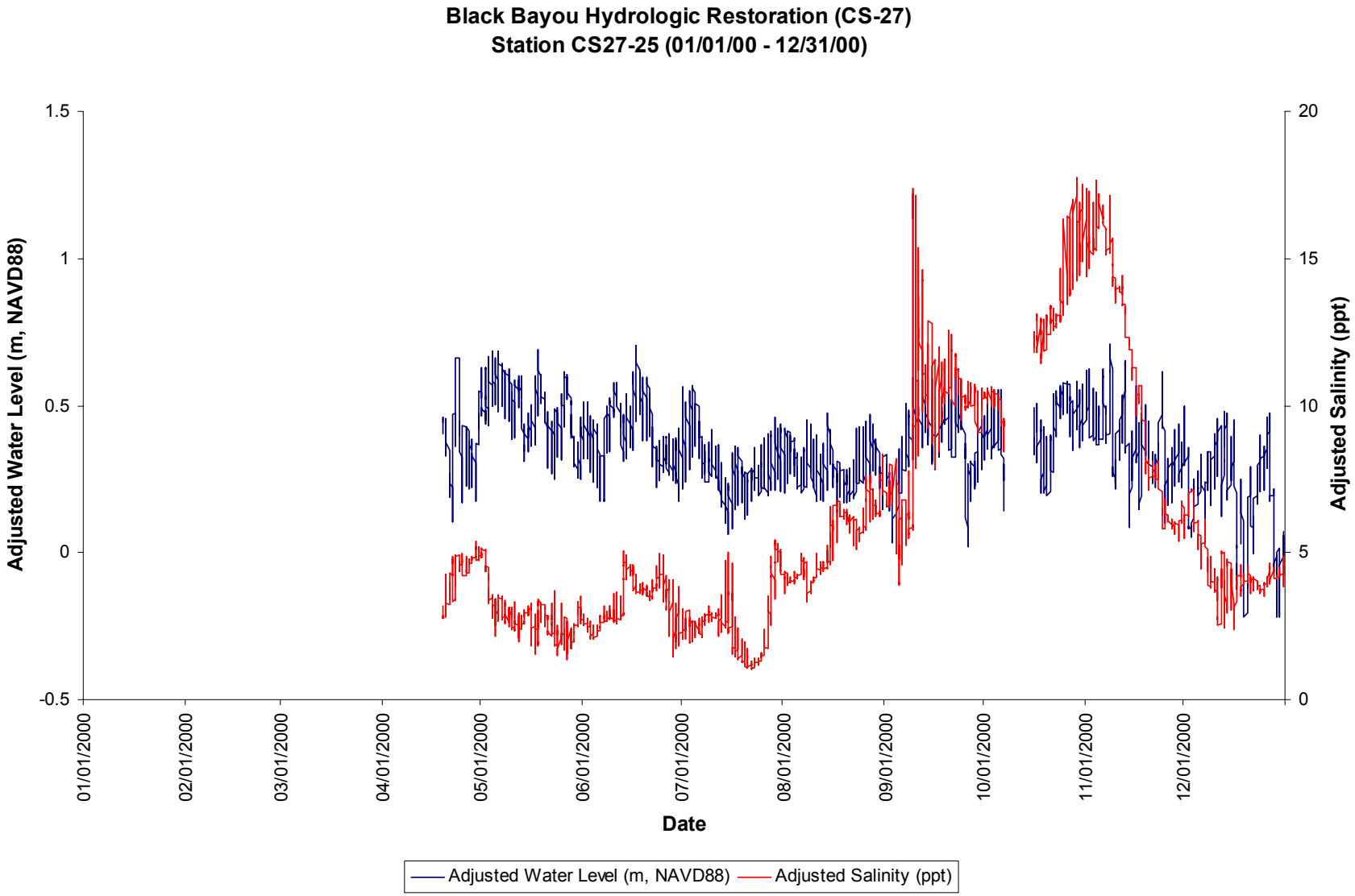


Figure 14. Hourly water level (m) and salinity measurements for station CS27-25 year 2000.

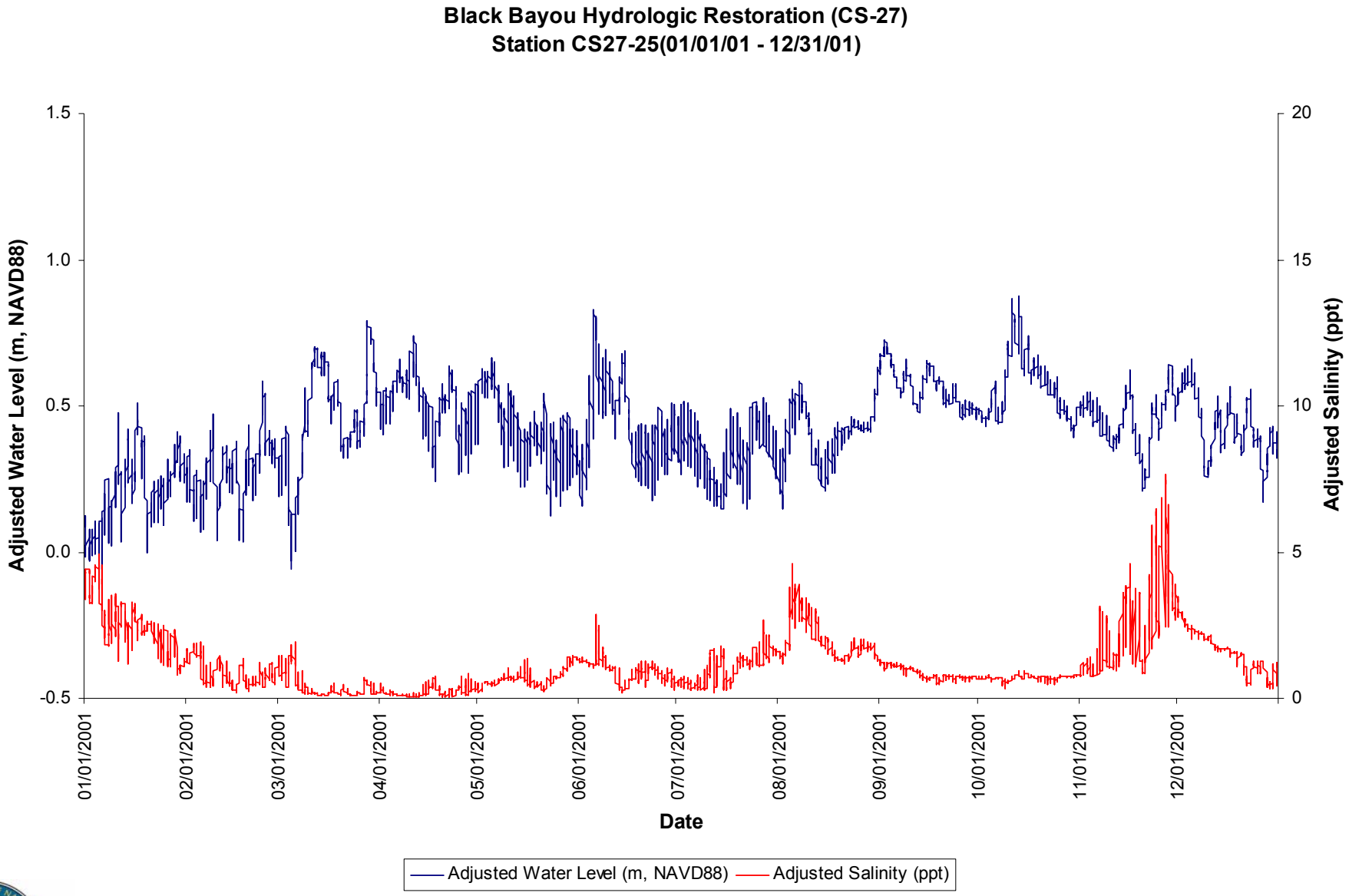


Figure 15. Hourly water level (m) and salinity measurements for station CS27-25 year 2001.

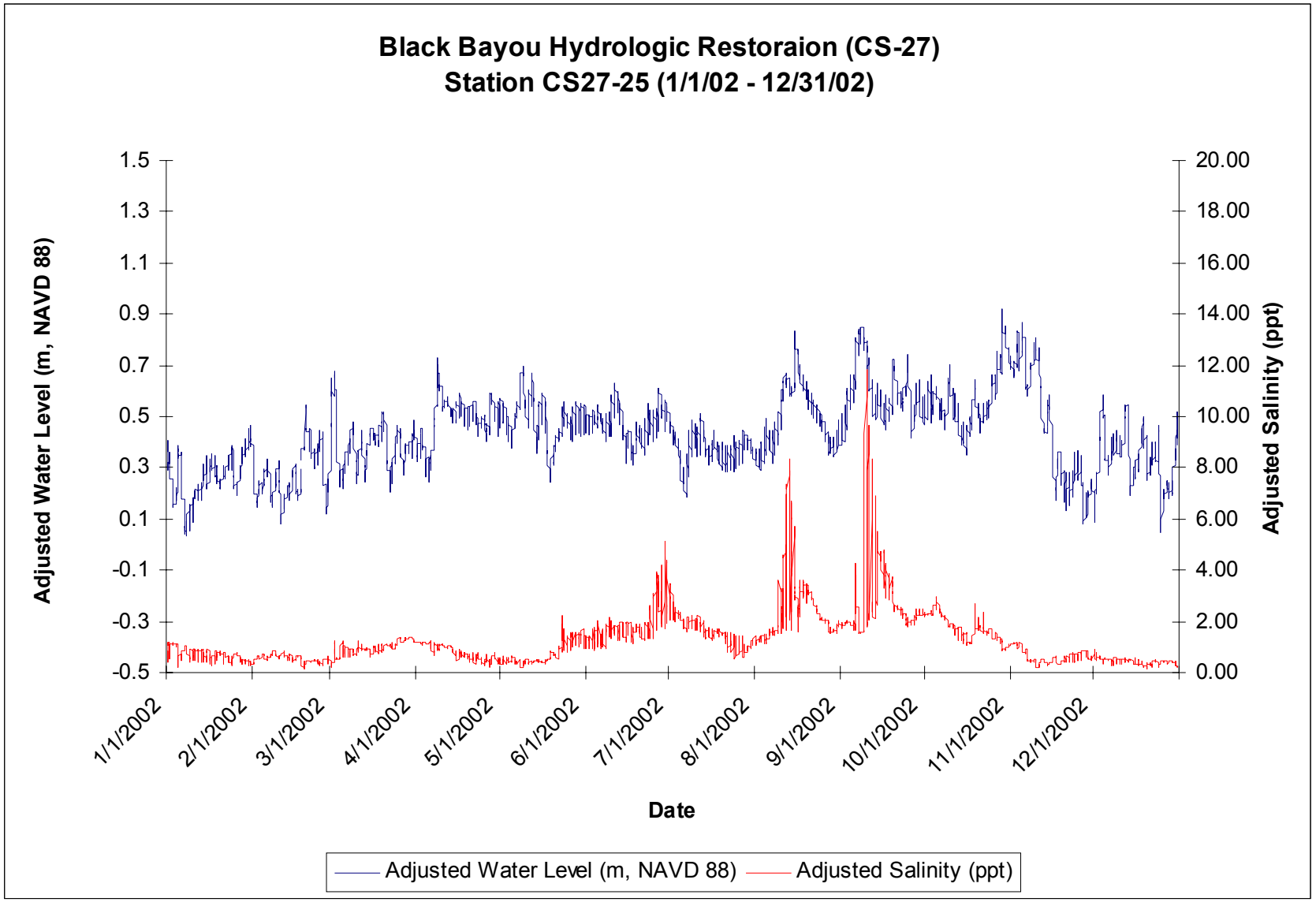
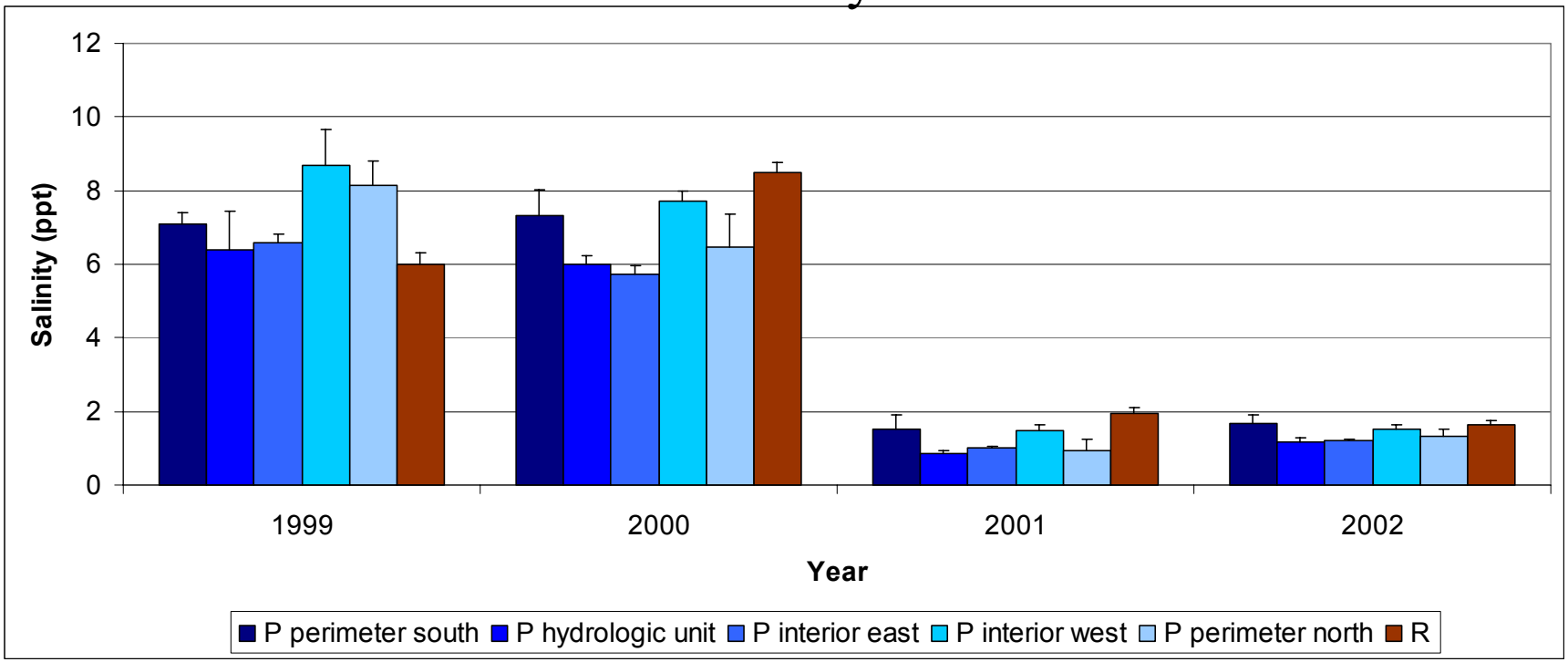


Figure 16. Hourly water level (m) and salinity measurements for station CS27-25 year 2002.

Black Bayou Hydrologic Restoration (CS-27)
Salinity



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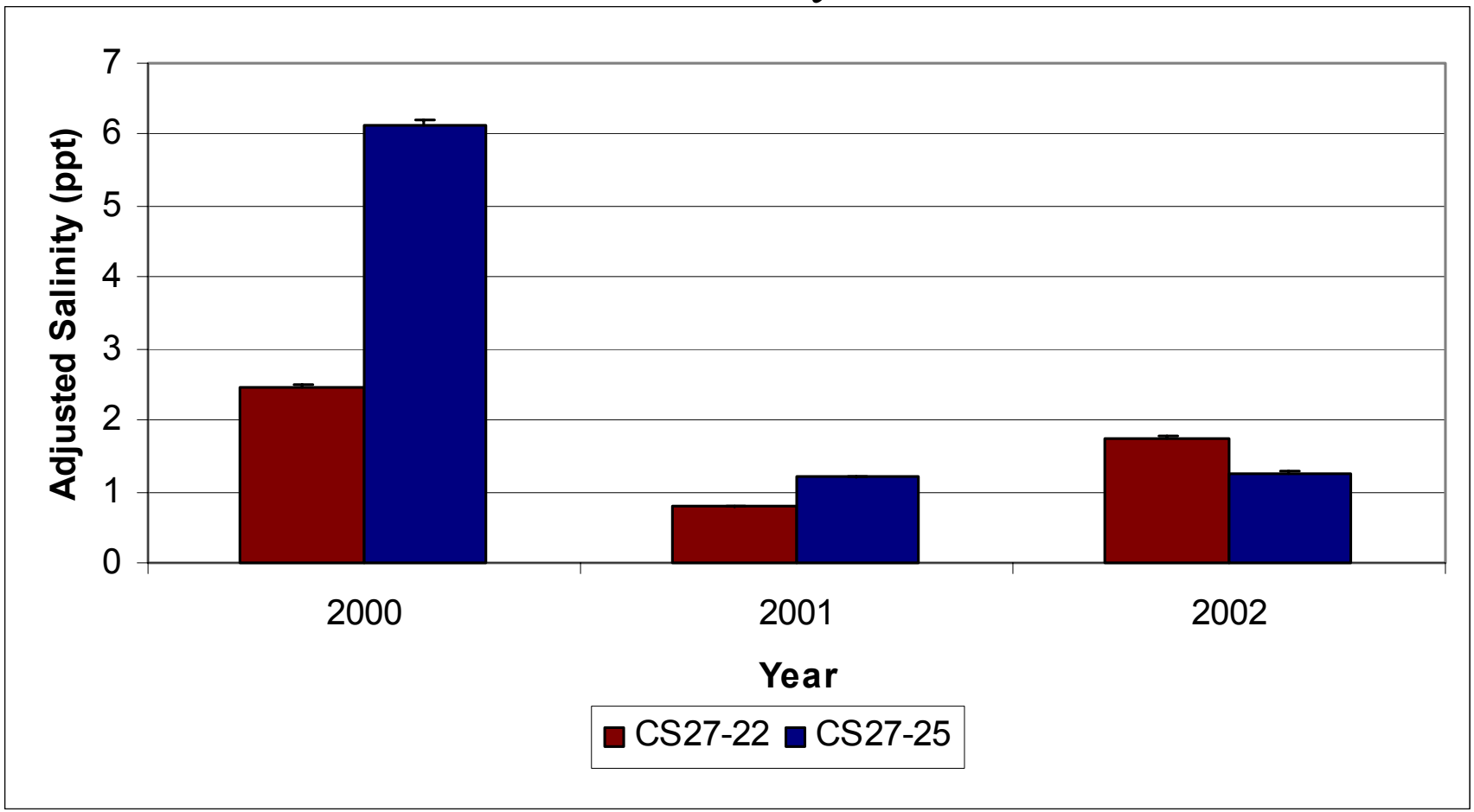
Black Bayou Hydrologic Restoration (CS-27)
Salinity



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Note: Data for CS27-22 year 2000 includes only May through July.

Black Bayou Hydrologic Restoration (CS-27)
Vegetation Plantings

Monitoring of vegetation plantings was conducted in 2003 and is currently being processed and not available for inclusion in this report.

Black Bayou Hydrologic Restoration (CS-27)
Shoreline Change

A DGPS shoreline survey of the south GIWW shoreline was conducted before and after construction of a foreshore rock dike designed to protect the shoreline from wave and wake damage. A reference area was also surveyed in 1999, but it was compromised by a rock dike built in front of the shoreline as part of construction of another shoreline protection project. Therefore, it was not included in the subsequent survey in 2003.

Figures:

Figure 19. GPS survey of GIWW shoreline after rock dike construction.
using a Trimble DGPS.

Figure 20. GPS survey mapping of a portion of the southern shoreline of the GIWW on the north side of the CS-27 project area in 2000 (preconstruction) and in 2003 (post construction)

Figure 19. GPS survey of GIWW shoreline after rock dike construction.

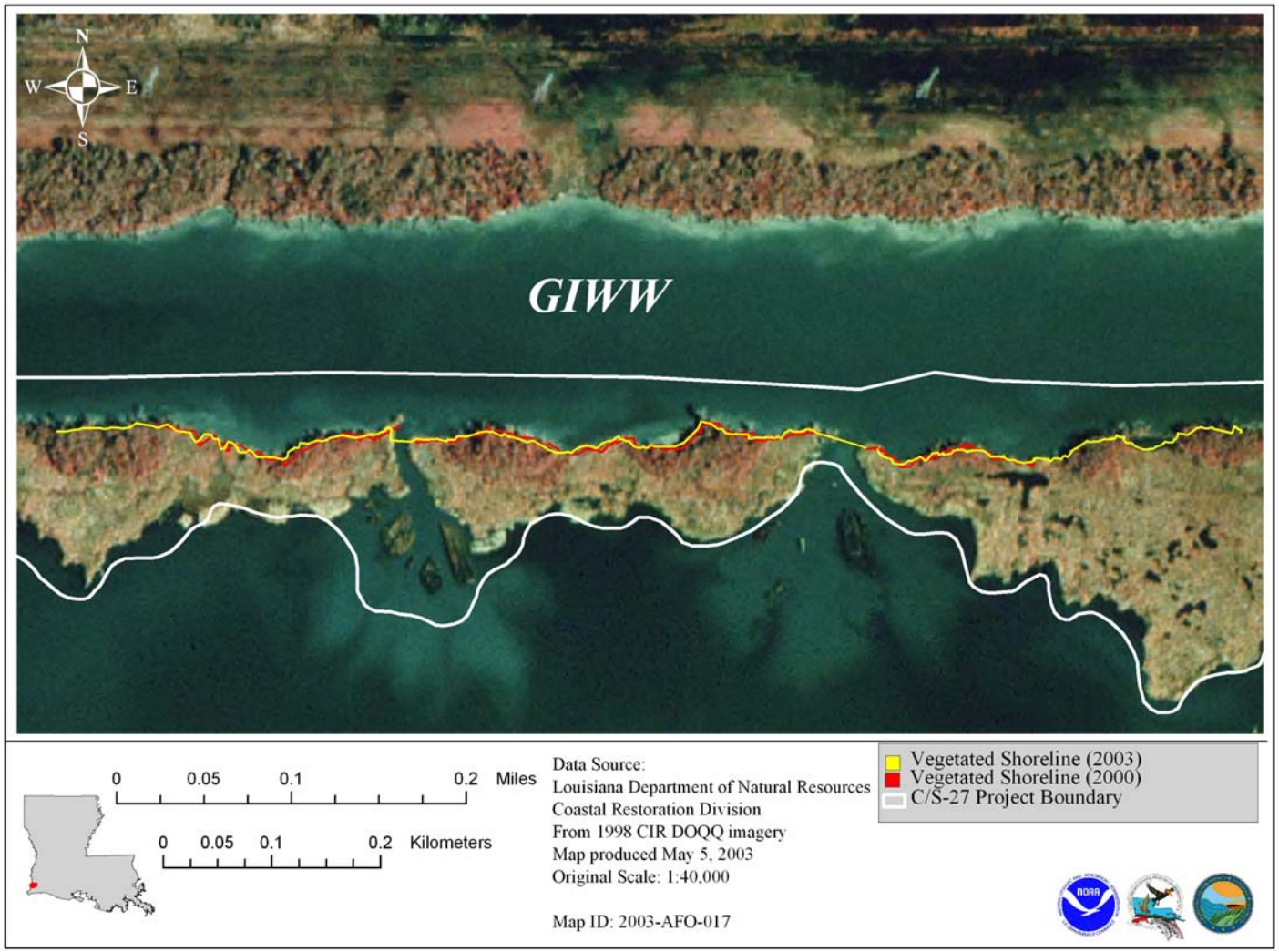


Figure 20. GPS survey mapping of a portion of the southern shoreline of the GIWW on the north side of the CS-27 project area in 2000 (preconstruction) and in 2003 (post construction).

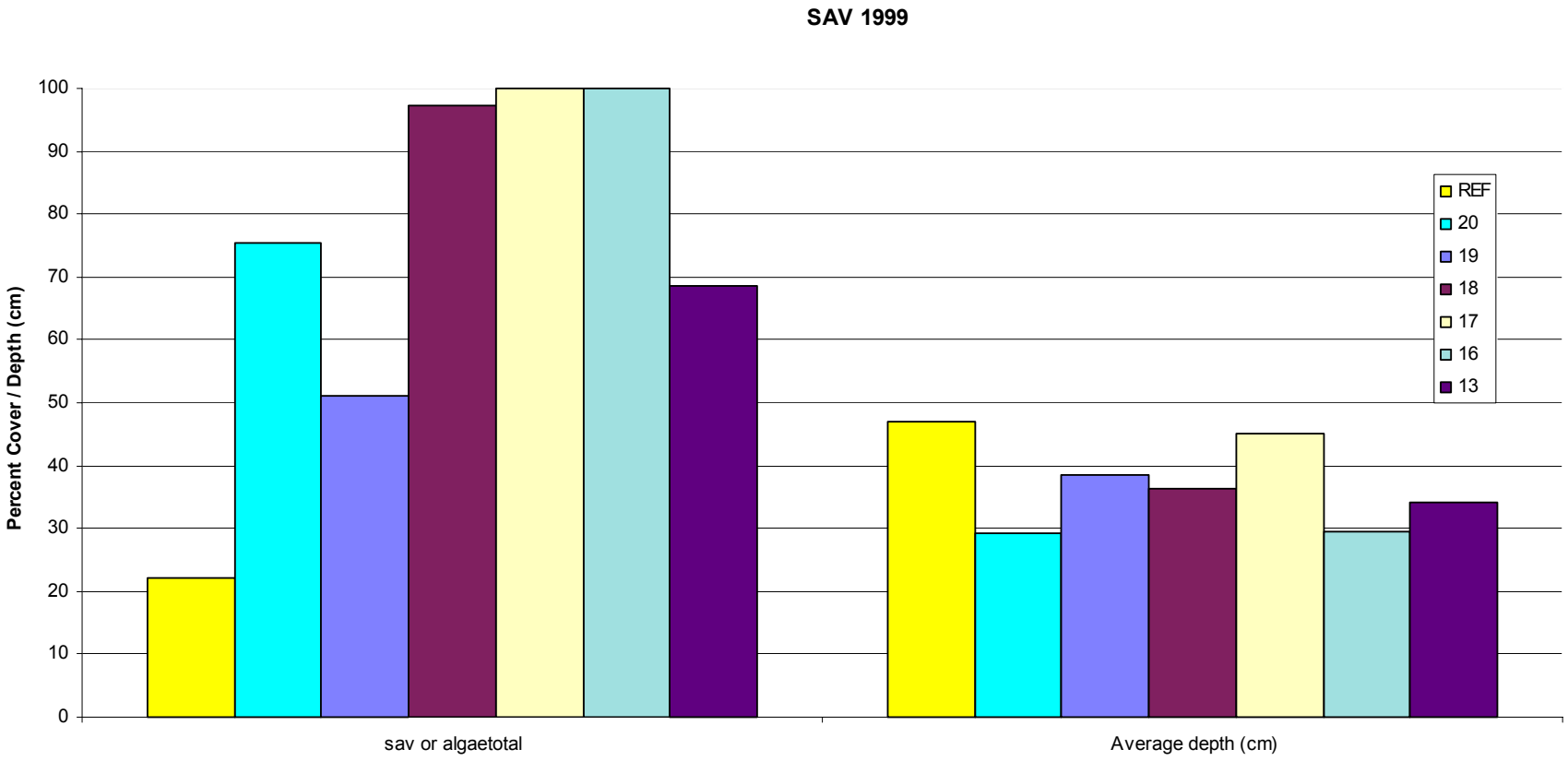
Black Bayou Hydrologic Restoration (CS-27)
SAV

Ponds in the CS-27 project and reference areas were sampled to document the SAV coverage in 1999 and 2003. The 1999 data is presented in the figures below. The data from 2003 has not yet been evaluated.

Figures:

Figure 21. 1999 total SAV cover and water depth in reference area and six subunits of the project area.

Figure 22. 1999 SAV cover by species and area sampled.



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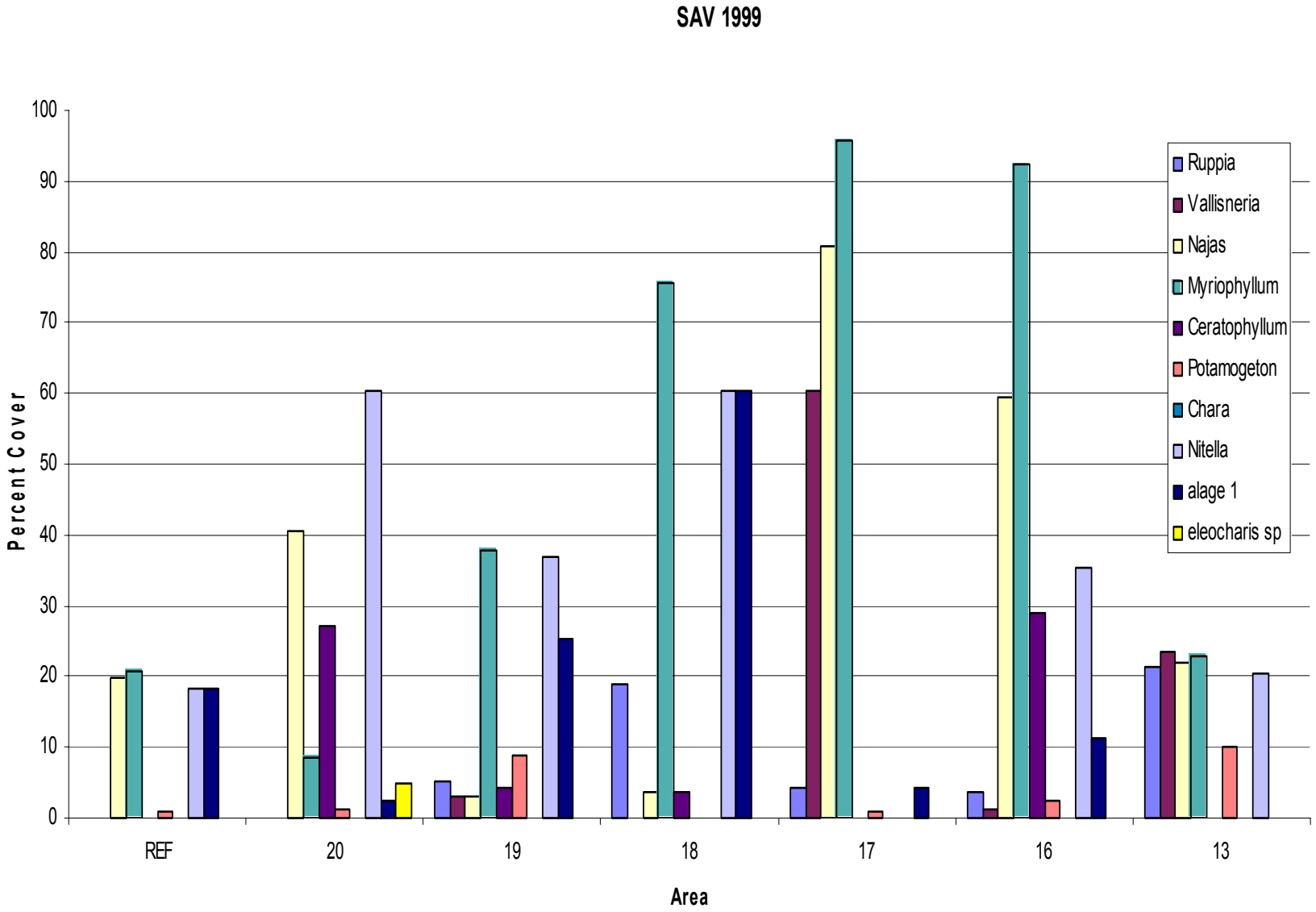

Figure 22. 1999 SAV cover by species and area sampled.

Black Bayou Hydrologic Restoration (CS-27)

Preliminary Findings

Aerial Photography: The available photography and land water analysis is only a preconstruction baseline. Later photography, beginning in 2004 will be compared to the 2000 data to determine land loss or gain.

Salinity: No detailed statistical analyses have been conducted at this time, but mean salinity calculated from continuous recorders and discrete data do not show any large differences between project and reference areas or between preconstruction and postconstruction. The most interesting information is the reduction in salinity across the project and reference area from the 1999 and 2000 period to the 2001 and 2002 period. Climate data indicates that 1999 and 2000 were drought years and years 2001 and 2002 had above normal rainfall in the western coastal part of Louisiana where the project is located. Freshwater drainage into the area and dilution from precipitation in the area likely contributed to the salinity decreases. Differences between groups were not ecologically important considering that all the means were approximately between 1ppt and 2ppt.

Vegetation plantings: *Schoenoplectus californicus* (bullwhip) plantings were installed in 2002. Monitoring was conducted at 1 year after planting (2003) and found apparent varying success in survival, but a full analyses will be available for subsequent reports.

Black Bayou Hydrologic Restoration (CS-27)

Preliminary findings: (continued)

Shoreline change: A DGPS survey of a portion of the GIWW shoreline within the project boundary was conducted preconstruction (2000) and after the rock dike feature was constructed (2003). No significant change in the shoreline location over three years is evident from the current data.

SAV: SAV coverage is very high in most of the ponds sampled in 1999 and has remained high every year afterwards. In 2003, when the latest monitoring was conducted, the cover appears to still be very high, but analyses have not yet been conducted on the new data set. Dominant species found in at both sampling times include: *Myriophyllum spicatum, Najas guadalupensis*, and the algae *Nitella* sp.