

PBS&J Project No. 461409.00
Document No. 07H037

**CENSUS OF
RECREATIONAL USERS AT
10 URBAN BAYOU SITES**

Prepared for:

Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, Texas 77027

Prepared by:

PBS&J
1250 Wood Branch Park Drive, Suite 300
Houston, Texas 77079

Prepared in cooperation with the Houston-Galveston Area Council, the Texas Commission
on Environmental Quality and the Environmental Protection Agency

August 2007

Contents

	Page
Acronyms and Abbreviations	v
1.0 INTRODUCTION	1-1
1.1 PURPOSE.....	1-1
1.2 BACKGROUND	1-1
1.3 SCOPE AND GOALS	1-3
1.4 ORGANIZATION OF DOCUMENT.....	1-3
2.0 STUDY AREA	2-1
2.1 HOUSTON AREA CLIMATE.....	2-1
2.2 CENSUS LOCATIONS	2-1
2.2.1 Brays Bayou.....	2-1
2.2.2 Buffalo Bayou.....	2-1
2.2.3 Cypress Creek	2-2
2.2.4 Sims Bayou.....	2-2
2.2.5 White Oak Bayou	2-2
3.0 METHODS	3-1
3.1 CONTACT RECREATION INTERVIEWS.....	3-1
3.1.1 Site Selection	3-1
3.1.2 Brays Bayou.....	3-1
3.1.2.1 Arthur Storey Park	3-1
3.1.2.2 Hermann Park.....	3-2
3.1.3 Buffalo Bayou.....	3-2
3.1.3.1 Buffalo Bayou Art Park	3-2
3.1.3.2 Terry Hershey Park.....	3-2
3.1.4 Cypress Creek	3-2
3.1.4.1 Cypresswood Park.....	3-2
3.1.4.2 Mercer Arboretum.....	3-2
3.1.5 Sims Bayou.....	3-3
3.1.5.1 Reveille Park.....	3-3
3.1.5.2 Milby Park	3-3
3.1.6 White Oak Bayou	3-3
3.1.6.1 Stude Park	3-3
3.1.6.2 Watonga Park.....	3-3
3.1.7 Site Observations and Interviews	3-4

	Page
3.1.8 Reporting and Analysis	3-4
4.0 RESULTS	4-1
4.1 RECREATIONAL USE CENSUS.....	4-1
4.1.1 Brays Bayou.....	4-1
4.1.1.1 Arthur Storey Park	4-1
4.1.1.2 Hermann Park.....	4-2
4.1.2 Buffalo Bayou.....	4-3
4.1.2.1 Buffalo Bayou Art Park	4-3
4.1.2.2 Terry Hershey Park.....	4-4
4.1.3 Cypress Creek	4-5
4.1.3.1 Cypresswood Park.....	4-5
4.1.3.2 Mercer Arboretum.....	4-6
4.1.4 Sims Bayou.....	4-8
4.1.4.1 Reveille Park.....	4-8
4.1.4.2 Milby Park	4-9
4.1.5 White Oak Bayou	4-10
4.1.5.1 Watonga Skate Park.....	4-10
4.1.5.2 Stude Park	4-11
4.2 CENSUS RESULTS.....	4-12
4.2.1 Brays Bayou.....	4-14
4.2.2 Buffalo Bayou.....	4-14
4.2.3 Cypress Creek	4-15
4.2.4 Sims Bayou.....	4-15
4.2.5 White Oak Bayou	4-16
5.0 CONCLUSIONS AND RECOMMENDATIONS	5-1
5.1 STUDY SCOPE	5-1
5.2 METHODS TO DOCUMENT RECREATIONAL USES	5-1
5.3 CENSUS	5-2
6.0 SUMMARY	6-1
7.0 REFERENCES	7-1

Tables

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Brays Bayou..... 4-14

Table 4-2 Estimated Number of Recreators Based on Observations During Census on Buffalo Bayou..... 4-14

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Brays Bayou..... 4-15

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Sims Bayou 4-15

Table 4-1 Estimated Number of Recreators Based on Observations During Census on White Oak Bayou 4-16

Figures

Figure 2-1 Study Area Map 2-4

Figure 4-1 Interviewee Reported and Researcher Observed Recreational Activities on Brays Bayou at Arthur Storey Park on Saturday July 28, 2007, from 8:30 a.m. to 4:30 p.m. 4-2

Figure 4-2 Interviewee Reported and Researcher Observed Recreational Activities on Brays Bayou at Hermann Park on Saturday, July 21, and Saturday, July 28, 2007, from 8:30 a.m. to 4:30 p.m. 4-3

Figure 4-3 Interviewee Reported and Researcher Observed Recreational Activities on Buffalo Bayou at Buffalo Bayou Art Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-4

Figure 4-4 Interviewee Reported and Researcher Observed Recreational Activities on Buffalo Bayou at Terry Hershey Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-5

Figure 4-5 Interviewee Reported and Researcher Observed Recreational Activities on Cypress Creek at Cypresswood Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-6

Figure 4-6 Interviewee Reported and Researcher Observed Recreational Activities on Cypress Creek at Mercer Arboretum on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-7

Figure 4-7 Interviewee Reported and Researcher Observed Recreational Activities on Sims Bayou at Reveille Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-9

Figure 4-8 Interviewee Reported and Researcher Observed Recreational Activities on Sims Bayou at Milby Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-10

Figure 4-9 Interviewee Reported and Researcher Observed Recreational Activities on White Oak Bayou at Watonga Skate Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-11

Figure 4-10 Interviewee Reported and Researcher Observed Recreational Activities on White Oak Bayou at Stude Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m. 4-12

Appendices

Appendix A Representative Photographs

Appendix B Vicinity Maps

Appendix C Site Location Maps

Appendix D Contact Recreation Interview Forms (CD)

Acronyms and Abbreviations

CCR	Creative Consumer Research, Inc.
EPA	Environmental Protection Agency
HCFC	Harris County Flood Control District
H-GAC	Houston-Galveston Area Council
MS4	municipal separate storm sewer system
QAPP	Quality Assurance Project Plan
SOW	Scope of Work
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
UAA	use attainability analysis

1.0 INTRODUCTION

1.1 PURPOSE

On May 17, 2007, the Houston-Galveston Area Council ("H-GAC") retained PBS&J to provide environmental consulting services to assist with H-GAC's effort to develop a protocol for contact recreation use attainability analyses (UAA's). The UAA protocol work was conducted on Mill Creek in Austin County and is reported in a separate report (PBS&J, 2007). On June 21, 2007, H-GAC executed a supplemental agreement that retained PBS&J to conduct a census of recreational users at 10 urban bayou sites in the Houston metropolitan area. The purpose of the census was to explore whether an epidemiology study could be conducted to assess the health risks associated with both primary (swimming) and secondary (boating) contact recreational activities on H-GAC area bayous and creeks. On June 27, 2007, H-GAC authorized PBS&J to initiate field and office coordination for the census activities. This document describes the census sites, the methods used to count the number of recreators, the results obtained, and future study recommendations.

1.2 BACKGROUND

The Texas Commission on Environmental Quality ("TCEQ") is responsible for establishing surface water quality standards for all waters in the state, under the authority of Section 303(c) of the Clean Water Act and Section 26.023 of the Texas Water Code. Texas Surface Water Quality Standards are found in Title 30, Chapter 307, of the Texas Administrative Code ("TAC"). The standards establish explicit water quality goals throughout the state. The standards are to maintain the quality of water in the state of Texas consistent with public health and enjoyment, protection of aquatic life, and the operation of existing industries and economic development of the state.

Each standard consists of a designated use, a criteria to protect that use, and an anti-degradation policy. For example, to maintain the contact recreation use in freshwater, 30 TAC 307.7(b)(1)(A)(i) states that "the geometric mean of *E. coli* should not exceed 126 per 100 ml [milliliters]. In addition, single samples of *E. coli* should not exceed 394 per 100 ml."

The Environmental Protection Agency ("EPA") epidemiological studies used to develop the contact recreation criteria may not be applicable to all Texas water bodies. EPA based the 1986 freshwater criteria on studies that measured the incidence of illness in swimmers at two recreational lakes (Keystone Lake, Oklahoma, and Lake Erie, Pennsylvania) along with the concentration of three indicator organisms to determine the organism most correlated with disease incidence. The studies recorded symptoms experienced by almost 30,000 swimmers and over 16,000 non-swimmers during three summers at four separate beaches. During the studies, water column indicator organism densities were measured to

determine possible correlations. The studies were conducted during dry weather on freshwater lake beaches with nearby treated municipal wastewater discharges (EPA, 1986).

Since the publication of the 1986 criteria document, a number of critiques have been published. The most recent publication with a summary of the various criticisms was commissioned by the Metropolitan Water Reclamation District of Greater Chicago in 2006 (Haas, 2006). Some of the criticisms include:

- No attempt was made to evaluate the actual level of exposure (i.e., length of time in the water, extent of contact with the water, or volume of water ingested) of each swimmer at the beaches studied.
- No attempt was made to evaluate the relationship between levels of indicators and actual pathogenic organisms at the study sites.
- Only two of the nine freshwater trials showed a statistical difference in illness rates between the swimmers and the non-swimmers.
- The correlation between swimmer and non-swimmer illness rates was 0.67, suggesting that illness transmission could have occurred via routes other than from water exposure.
- Only swimmers with "highly credible" gastrointestinal illness symptoms were "counted" in the regression, thus likely omitting swimmers with diarrhea without a fever, nausea, respiratory illness, skin infections, nasal infections or eye infections.
- The hypothesis, implicit in the studies, that indicator organism densities are correlated with pathogenic organism densities in recreational waters has not been widely tested.
- The single sample maximum criterion is based upon an assumed log standard deviation which should be replaced by a site-specific log standard deviation, which has rarely occurred.
- The applicability of the derived criteria to bodies of water other than lakes with nearby municipal wastewater discharges is questionable.

Due to the criticisms of the studies leading to the 1986 criteria, concerns about applying the lake criteria to streams and bayous, and questions about what criteria should be used to protect secondary contact recreation (such as boating or bank fishing) H-GAC, TCEQ, and EPA are interested in obtaining a census of urban recreators to assess whether a new epidemiology study could be conducted to enhance the science underlying the current freshwater criteria so that a defensible value can be developed for application to Texas streams and bayous and recreational uses other than just swimming.

1.3 SCOPE AND GOALS

H-GAC, through funding from TCEQ, is conducting a study that seeks to:

- Develop protocols for conducting recreational UAA's
- Explore the feasibility of conducting an epidemiology study of recreational users

To support the development of effective recreational UAA tools and procedures, H-GAC has researched various recreational use questionnaires developed by other states and resource management agencies intended to document recreational activities on or in water. These questionnaires have not been deployed in Texas. This supplemental work assignment is intended to help test and validate the use and design of these types of questionnaires.

To evaluate the feasibility of conducting an epidemiology study of recreational users, stakeholders need to assess the number of recreational users that might be enrolled in a study to evaluate illness rates with statistical rigor. To assess the possible number of study participants, a biased census of recreational users was conducted. A biased census was conducted by observing and interviewing citizens participating in recreational activities on or in the water at sites that are conducive to recreational use. These results were used to estimate a probable number of study enrollees. This aspect of the project was not intended to fully characterize the existing use of the water bodies under study. A fair characterization would include randomized observation sites or sites that are representative of the riparian corridor, rather than those reaches most suitable for recreational use. The work included the following tasks:

- Site selection
- Site observations and interviews
- Reporting

1.4 ORGANIZATION OF DOCUMENT

This document is organized into six sections as follows:

- **Section 1 – Introduction:** Section 1.0 provides the background, purpose of the project, and study area details.
- **Section 2 – Study Area:** Section 2.0 provides information about the general study area and each census location.
- **Section 3 – Methods:** Section 3.0 describes the methods applied for contact recreation census.
- **Section 4 – Results:** Section 4.0 discusses the findings of the contact recreation census.

- **Section 5 – Conclusions:** Section 5.0 discusses recommendations for further consideration with respect to the methods used.
- **Section 6 – References:** Section 6.0 provides a comprehensive list of references cited in this report.

2.0 STUDY AREA

Five bayous in Harris County were selected to conduct a contact recreation survey and census. These bayous were selected to provide a variety of geographic locations, socio-economic status, race, gender and cultures. The sections below describe the climate in the Houston area and detail the bayous chosen for the census.

2.1 HOUSTON AREA CLIMATE

The climate of Houston, Texas, is classified as humid subtropical. The mean annual rainfall in Houston is 51.5 inches. Average rainfall throughout the seasons varies with the most occurring in the spring with 14.7 inches, followed by 13.9 inches in the summer, 13.0 inches in the fall, and 9.9 inches during the winter. Houston experiences relatively warm temperatures throughout the year with a 24-hour average temperature of 56.7°F in the winter, 75.7°F in the spring, 82.2°F in the summer, and 62.9°F in the fall. The average minimum temperature in January, the coldest month, is 42.8°F. The average maximum temperature in July, the hottest month, is 92.3°F (worldclimate.com, accessed August 3, 2007).

2.2 CENSUS LOCATIONS

The below sections provide a description of each bayou. Figure 2-1 shows the location of each watershed in Harris County.

2.2.1 Brays Bayou

The Brays Bayou watershed is located in southwest Harris County and portions of Fort Bend County. The bayou flows eastward from Fort Bend County to its confluence with the Houston Ship Channel, and the drainage area covers approximately 127 square miles. Brays Bayou is made up of three primary streams—Brays Bayou, Keegans Bayou and Willow Waterhole Bayou. There are about 121 miles of open streams within the watershed, including the primary streams and tributary channels. The estimated population within the Brays Bayou watershed (Harris County portion) is just over 722,000 (Harris County Flood Control District ["HCFCD"], accessed July 31, 2007). The two sites selected along Brays Bayou are Arthur Storey Park and Hermann Park. For a detailed description of each site location, see Section 3.1.

2.2.2 Buffalo Bayou

The Buffalo Bayou watershed is located in west-central Harris County and drains an area that is mostly within the City of Houston. The bayou flows eastward from west Harris County and is the sole outlet for the Addicks and Barker Reservoirs. The bayou combines with White Oak Bayou and passes through downtown Houston before flowing into the Houston Ship Channel at the Turning Basin. The Buffalo

Bayou watershed covers approximately 103 square miles and has about 47 miles of open streams within the watershed, including the primary stream and tributary channels. The estimated population within the watershed (Harris County portion) is just over 410,000 (HCFCD, accessed July 31, 2007). The two sites selected along Buffalo Bayou are Buffalo Bayou Art Park and Terry Hershey Park. For a detailed description of each site location, see Section 3.1.

2.2.3 Cypress Creek

The Cypress Creek watershed is located in the northwestern portion of Harris County. This bayou extends into Waller County on the western reach of the watershed and flows into Spring Creek near the Harris County-Liberty County line. The watershed includes the city of Waller and a small portion of the city of Houston. The overall area of the Cypress Creek watershed covers about 373 square miles and includes two primary streams—Cypress Creek and Little Cypress Creek. There are about 303 miles of open streams within the entire Cypress Creek watershed, including the primary streams and over 30 other tributaries, both man-made and natural. The estimated population within the watershed (Harris County portion) is just over 216,000 (HCFCD, accessed July 31, 2007). The two sites selected along Cypress Creek are Cypresswood Park, and Mercer Arboretum. For a detailed description of each site location, see Section 3.1.

2.2.4 Sims Bayou

The Sims Bayou watershed is located in southern Harris County. Most of the watershed is within the city of Houston. The upper reach of the watershed is located in the city of Missouri City, and the lower reach of the watershed drains the cities of South Houston and Pasadena. The Sims Bayou watershed flows eastward and covers about 94 square miles and includes two primary streams—Sims Bayou and Berry Bayou. There are about 121 miles of open streams within the watershed, including the primary streams and tributary channels. The estimated population within the Sims Bayou watershed (Harris County portion) is just over 231,000 (HCFCD, accessed July 31, 2007). The two sites selected along Sims Bayou are Milby Park and Reveille Park. For a detailed description of each site location, see Section 3.1.

2.2.5 White Oak Bayou

The White Oak Bayou watershed is located in central Harris County. The bayou originates northwest of FM 1960 and flows southeast until it joins Buffalo Bayou near downtown Houston. The bayou drains areas in northwest portions of the county as well as the city of Jersey Village and portions of the city of Houston. The watershed covers about 111 square miles and includes three primary streams—White Oak Bayou, Little White Oak Bayou, and Cole Creek. Vogel Creek and Brickhouse Gully are among the major tributaries in the watershed. There are about 151 miles of open streams in the White Oak Bayou

watershed, including the primary and tributary channels. The estimated population within the watershed is just over 416,000 (HCFCD, accessed July 31, 2007). The two sites selected along White Oak Bayou are Watonga Skate Park and Stude Park. For a detailed description of each site location, see Section 3.1.

Figure 2-1
Study Area Map

3.0 METHODS

Prior to commencement of the contact recreation census, H-GAC and PBS&J developed a detailed Quality Assurance Project Plan ("QAPP") for approval by H-GAC and TCEQ. PBS&J submitted the QAPP on May 7, 2007, approximately nine weeks before the scheduled start of field work. The Contact Recreation Use Attainability Analyses: Draft Protocols for Collection of Field Data, May 2007, sited in the QAPP as well as the scope of work ("SOW") attached to the supplemental agreement, were used to conduct the contact recreation census. Below is a detailed description of the field work conducted under the QAPP and SOW. Any significant deviations from the approved QAPP and SOW are noted in this report.

3.1 CONTACT RECREATION INTERVIEWS

3.1.1 Site Selection

The purpose of conducting contact recreation interviews is to assess the number of recreational users that might be enrolled in a study to evaluate illness rates with statistical rigor. In order to determine the possible number of study participants, a biased census of recreational users should be taken. A biased census of recreational activities on or in the water at sites that are conducive for recreational use will help estimate a probable number of study enrollees that would be possible. This aspect of the project is not intended to fully characterize the existing use of the waterbodies under study. A fair characterization would include randomized observation sites or sites that are representative of the riparian corridor, rather than those reaches most suitable for recreational use.

PBS&J used ESRI ArcGIS maps displayed with aerial photography, parks, and major roads to determine the number of parks and activity areas along each of the five bayous. PBS&J also did a desktop search to get additional information about access points to the bayou, and to determine which parks contained areas conducive to recreational use. Based on this information PBS&J devised a list of 10 potential sites for the census. PBS&J staff met with H-GAC on July 17, 2007 to make the final site selection and get all sites approved. The below sections provide a detailed description of each site. Census location maps are located in Appendix B. Representative photographs for each site are located in Appendix A.

3.1.2 Brays Bayou

3.1.2.1 Arthur Storey Park

Arthur Storey Park is located west of the Sam Houston Tollway between Beechnut and Bellaire Blvd. This park is a suburban park with over 210 acres, including a series of large detention basins and a small pond located in the park that are easily accessible from the park and an exercise trail along the bayou

(www.projectbrays.com, accessed August 1, 2007). According to the Bayou Preservation Association, a short segment from Arthur Storey Park to Braeburn Glen Park can be canoed (Ruckstuhl, 2007).

3.1.2.2 Hermann Park

Hermann Park is a 445-acre urban park owned by the City of Houston. It is located near the intersection of US 59 and SH 288 on Gold Course Drive. The park houses the Houston Zoo, Natural Science Museum, Bayou Parkland, an exercise trail, and various other centers (Hermann Park Conservancy, accessed July 13, 2007).

3.1.3 Buffalo Bayou

3.1.3.1 Buffalo Bayou Art Park

Buffalo Bayou Art Park is part of a series of urban parks collectively called Buffalo Bayou Park. These parks are adjacent to Buffalo Bayou and start near the intersection of IH 10 near Memorial Drive and end near Allen's Landing in downtown Houston (Buffalo Bayou Conservancy, accessed July 13, 2007). Direct access to the Bayou is facilitated by a canoe and kayak boat launch at the Sabine Street Landing on Buffalo Bayou. This launch is one of seven boat launches near the downtown area.

3.1.3.2 Terry Hershey Park

Terry Hershey Park is located in west Houston. It has a network of walking and biking trails that run along Buffalo Bayou from SH 6 to the Sam Houston Tollway. There are several access points to the trail, including parking lots on Dairy Ashford and Memorial Drive at Mayde Creek. The total length of the trail is 12.5 miles (theanthills.com website, accessed July 2007).

3.1.4 Cypress Creek

3.1.4.1 Cypresswood Park

Cypresswood Park is located in Spring, Texas, near the intersection of Stuebner-Airline Road and Cypresswood Drive. Cypresswood Park is downstream of Kaiser Meyer Park, a known put-in location for canoeists. This park is situated along Segment 1 of three segments in Cypress Creek known for paddling (Ruckstuhl, accessed July 13, 2007). No put-in location is sited for this park but paddlers may be observed from this park.

3.1.4.2 Mercer Arboretum

Mercer Arboretum is located in Spring, Texas, near the intersection of Aldine-Westfield Road and FM 1960. This park is downstream of Kaiser Meyer Park, a known put-in location for canoeists. This park is situated along Segment 3 of three segments in Cypress Creek known for paddling (Ruckstuhl,

accessed July 13, 2007). Mercer Arboretum has a put-in location for canoes. The section begins at Mercer Arboretum and ends at Jesse Jones Park on Spring Creek.

3.1.5 Sims Bayou

3.1.5.1 Reveille Park

Reveille Park is located in southeast Houston just south of Loop 610 off of Telephone Road. The park contains picnic tables, a playground, a paved trail, and a public pool. During Internet search of this park, a canoe launch was mentioned on several websites. No such launch was located during the site visit to the park; however, it would be easy to launch a canoe into the bayou at this location because the banks of the bayou are not paved and bank slope is rather gentle (personal observation). The Sims Bayou Nature Center is located between Reveille Park and Milby Park on Sims Bayou. The nature center was closed during the census; however, interviewers did pick up several fliers about the nature center. All interviews were conducted at the park near the trail and entrance to the pool.

3.1.5.2 Milby Park

Milby Park is located in south Houston just south of Loop 610 between SH 225 and IH 45. The park contains picnic tables, playground and a paved trail. All interviews were conducted at the park. Access to the bayou from this park is not likely to occur since the banks of the bayou are steep; however, this park is adjacent to one of two sections of stream along this bayou that are considered canoe or kayak segments. It is possible that interviewers could see canoeists or kayakers from this park.

3.1.6 White Oak Bayou

3.1.6.1 Stude Park

Stude Park is located north of IH 10 off of the Studemont exit. This park has a large playground, paved trails, and basketball courts. Access to the bayou is possible from this park but is not likely to occur since the banks of the bayou are steep. This park is heavily used and there is a high likelihood that individuals visiting this park have used the other parts of the bayou or have witnessed people using the bayou.

3.1.6.2 Watonga Park

Watonga Skate Park is located at the intersection of Watonga and West T.C. Jester in northwest Houston. This park accommodated mostly juveniles that visit the park for its skate ramps. Access to the bayou from this park is not likely to occur since the banks of the bayou are steep; however, a large trapezoidal-shaped stormwater discharge into White Oak Bayou is easily accessible and contains evidence that kids play in the outfall during dry periods.

3.1.7 Site Observations and Interviews

PBS&J mobilized teams of two to conduct interviews and observations of recreational use at each of the 10 selected sites. Field surveys were conducted during two Saturdays in July. Teams approached individuals at each park over approximately 10 hours from 8 a.m to 6 p.m. Responses were recorded on the use questionnaire following the Draft Protocol for Contact Recreation, May 2007. Additionally, teams recorded census data to determine the number of recreational users at each site. Photos were taken at each site to document conditions, access to the bayou, and contact recreation use. Sites were observed during favorable weather conditions on weekend days to maximize the number of respondents.

The below bulleted section details each category of contact recreation:

- Observed accounts are activities documented by the interviewer that occurred during the 10-hour survey period for each site.
- Personal accounts are activities that were recorded in an interview that the interviewee personally did.
- Witnessed accounts are different from observed in that they document activities the interviewee has observed but that did not occur during the survey period.

Anecdotal accounts are activities that interviewee have heard about but have not personally participated in or witnessed themselves.

3.1.8 Reporting and Analysis

PBS&J performed quality assurance/quality control reviews on all results and then tabulated responses to summarize findings of the interviews and census data. The summary statistics calculated for interview forms include number of individuals interviewed per hour, the number of primary, secondary, and non-contact recreation activities recorded by each interview, and the number of personal, witnessed, and anecdotal accounts recorded for each interview. All of these calculations were performed for each site individually. A list of activities interviewees reported on interview forms were tallied for each site and described in the summary. Data from telephone interviews conducted on behalf of H-GAC by Creative Consumer Research, Inc. ("CCR") under a separate contract (H-GAC, 2007b), the in-person interviews conducted by PBS&J, and a number of other assumed or researched data elements were used to estimate the total number of people recreating at each of the 10 sites over a one-year period.

4.0 RESULTS

4.1 RECREATIONAL USE CENSUS

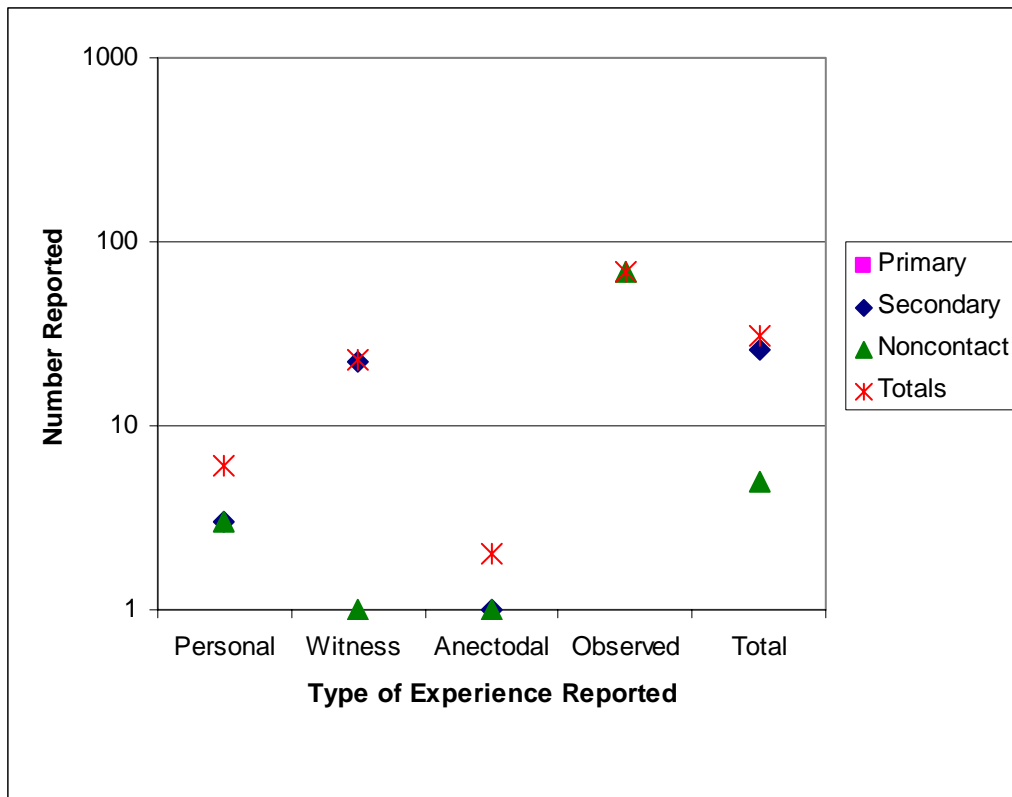
On July 21, 2007, census information was obtained and interviews were conducted at eight sites; seven for ten hours and one for five hours. On July 27, 2007, the remaining sites were visited. Most sites were observed for 10 hours between 8 a.m. and 6 p.m.; however, rainstorms that occurred during the afternoon on July 27, 2007, caused Arthur Storey Park and Milby Park to be observed for approximately eight hours each. The average number of individuals interviewed per hour was 1.5 for all the sites combined. Most recreation activities that were recorded were witnessed accounts of secondary contact recreation. The most frequent activity recorded at all the sites was playing Frisbee with a dog that resulted in dogs wading in the bayou. The below sections detail the findings from the contact recreation census at each site.

4.1.1 Brays Bayou

4.1.1.1 Arthur Storey Park

On July 21 and 28, 2007, Arthur Storey Park, which is currently undergoing construction, was surveyed for recreational use. PBS&J was on-site for approximately eight hours in which 69 people were interviewed. The majority of people utilizing the park arrived before noon and were utilizing the playground and gazebos or taking part in physical activities such as jogging, walking, and practicing martial arts. Among the 69 interviewees, none reported participating in any primary contact with this portion of the bayou, nor had they ever witnessed or heard of anyone utilizing this portion of Brays Bayou for primary contact recreation. Twenty-six people stated that they had personally used, witnessed or heard of people utilizing this portion of the bayou for secondary contact recreation. Five people stated that they had personally used, witnessed or heard of people utilizing this portion of the bayou for non-contact recreation. The majority of persons interviewed stated that they had seen people fishing in this portion of the bayou.

Brays Bayou was fairly accessible; however, the majority of interviewees were surprised at the thought of using it for primary contact recreation, assuming the water was polluted and not safe to use. There were many small children at the park, and some parents stated that they would be interested in using the retention ponds associated with the park for boating and fishing, dependent on whether pollution levels decrease when park construction is complete. A summary of contact recreation interviews for Arthur Storey Park is shown below in Figure 4-1.



*Contact recreation values less than 1 are not shown on graph

Figure 4-1
Interviewee Reported and Researcher Observed Recreational Activities on Brays Bayou at Arthur Storey Park on Saturday July 28, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.1.2 Hermann Park

On July 21 and July 28, 2007, Hermann Park was surveyed for recreational use. PBS&J was on-site for approximately 10 hours in which 18 people were interviewed. The weather was very warm with no wind and the skies were slightly overcast. The majority of people utilizing the park were present from approximately 8:30 a.m. to 10:30 a.m. A diverse demographic of people were observed throughout the day. The majority of people utilizing the parks walking path were jogging, walking, or riding bicycles. No persons were observed near the stream or utilizing this portion of the bayou for primary contact recreation. However, one interviewee stated that they witnessed an individual utilizing the bayou for primary contact recreation. Seven interviewees stated that they had witnessed people utilizing the bayou for secondary contact recreation. Additionally, four interviewees stated that they had either witnessed or heard of people utilizing the bayou for non-contact recreation.

This portion of Brays Bayou consists of a concrete channel with steep, maintained grass above, making access to the water difficult. The majority of interviewees stated that they felt the water was unsanitary. A summary of contact recreation interviews for Hermann Park is shown below in Figure 4-2.

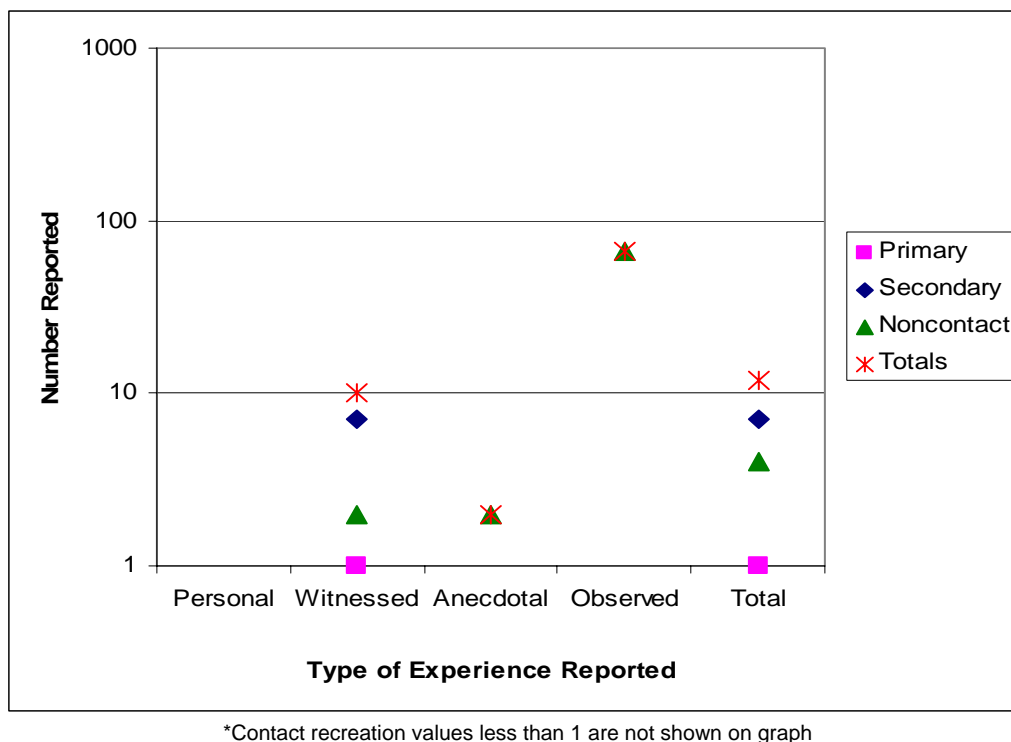


Figure 4-2
Interviewee Reported and Researcher Observed Recreational Activities on Brays Bayou at Hermann Park on Saturday, July 21, and Saturday, July 28, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.2 Buffalo Bayou

4.1.2.1 Buffalo Bayou Art Park

On July 21, 2007, Buffalo Bayou Art Park was surveyed for recreational use. PBS&J was on-site for approximately nine hours in which five people were interviewed. Two kayakers were observed on the bayou; however, their rate of speed did not allow for an interview. One man was seen fishing; however, a language barrier did not allow for an interview. Of the five interviewees, two people had witnessed persons utilizing this portion of the bayou for primary contact recreation. Five people had witnessed or heard of persons utilizing this portion of the creek for secondary contact recreation.

The majority of interviewees stated that high pollution levels deterred them from personally utilizing the creek for recreation. Access to the creek at this location was impeded by steep banks with the exception

of the boat launch. Also, at several bends in the bayou there is considerable erosion to the bank. One walk bridge was thickly covered in fresh sand and silt carried by recent flooding, and it was unsafe to walk across it. One interviewee stated that one of the baskets on the disc golf course had been washed away, along with the dirt it was mounted in, due to erosion. A summary of contact recreation interviews for Buffalo Bayou Art Park is shown below in Figure 4-3.



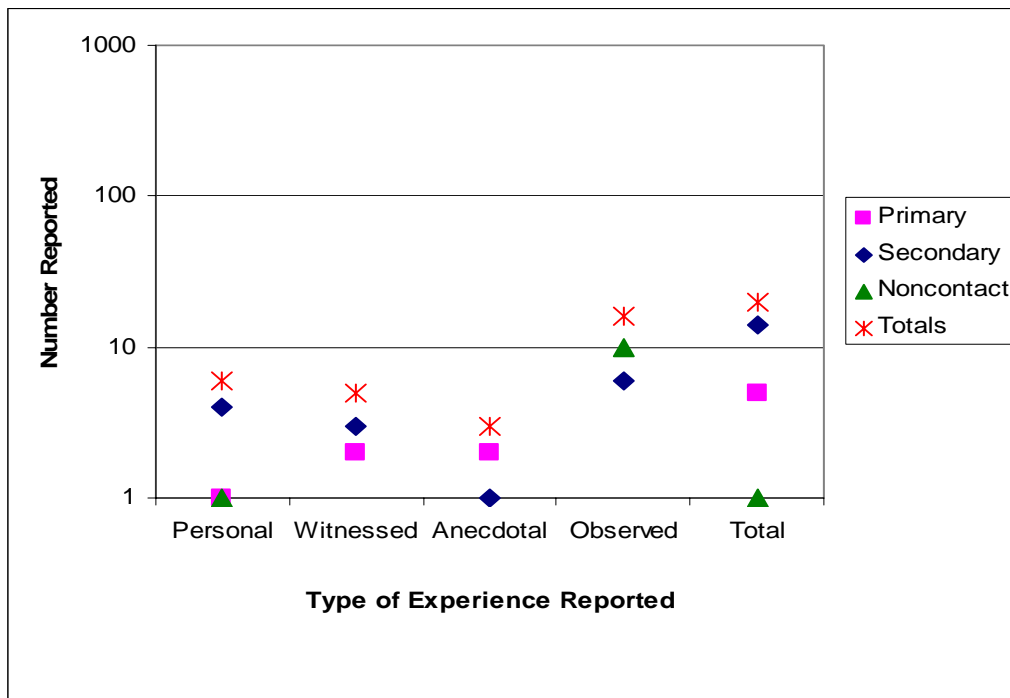
*Contact recreation values less than 1 are not shown on graph

Figure 4-3
Interviewee Reported and Researcher Observed Recreational Activities on Buffalo Bayou at Buffalo Bayou Art Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.2.2 Terry Hershey Park

On July 21, 2007, Terry Hershey Park was surveyed for recreational use for approximately 7.5 hours. Three locations along this park were surveyed, which included the bayou crossing at Dairy Ashford Drive, the crossing at Memorial Drive, and the crossing at SH 6. The park had the highest levels of users between 8:00 am and 11:00 am. All of the pedestrians/people witnessed were joggers or bikers. Among the thirteen interviewees, one person had personally used the bayou for primary contact recreation, two had witnessed persons utilizing the bayou for primary contact recreation, and two had heard of persons utilizing the bayou for primary contact recreation. Eight interviewees stated that they had personally used, witnessed, or heard of people using this portion of the bayou for secondary contact recreation.

During the afternoon, four people were observed fishing. When interviewed, they stated that they regularly fish at the bayou. Access to the bayou at Terry Hershey Park is impeded by steep slopes and fast-moving water. A summary of contact recreation interviews for Terry Hershey Park is shown below in Figure 4-4.



*Contact recreation values less than 1 are not shown on graph

Figure 4-4
Interviewee Reported and Researcher Observed Recreational Activities on Buffalo Bayou at Terry Hershey Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

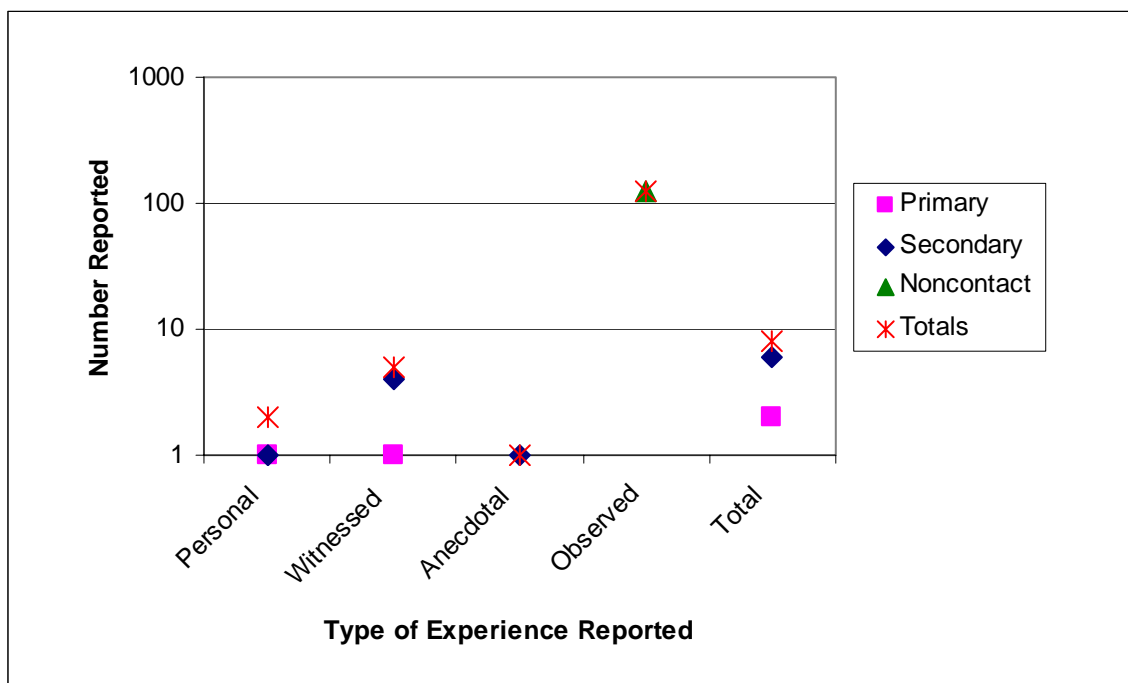
4.1.3 Cypress Creek

4.1.3.1 Cypresswood Park

On July 21, 2007, Cypresswood Park was surveyed for recreational use. PBS&J was on-site for approximately 8.5 hours in which 27 people were interviewed. Upon arrival at the park, there was a group of approximately 20 people taking a Tai-Chi class and were not interested in being interviewed. At approximately 11:00 a.m., additional park users began to arrive at the park for picnics and for kids to utilize the playground. The park was busy until approximately 1:30 p.m. During our observations, no persons came within proximity of the creek or utilized the creek for primary or secondary contact recreation. Of the 27 people interviewed, one person had previously used this portion of Cypress Creek for primary contact recreation and one person had witnessed a person utilizing this portion of the creek

for primary contact recreation. Six interviewees stated that they had witnessed, heard of, or personally used this portion of the creek for secondary contact recreation. None stated that they had personally used, witnessed, or heard of people using this portion of the creek for non-contact recreation.

It was observed that access to the bayou was impeded by saturated or muddy ground in addition to unmaintained grasses and high water levels. The majority of people congregated in other areas of the park, including the playground, picnic tables, basketball court, baseball park, and the skateboarding ramp. Few other park users were observed walking their dogs or walking at the park. It was determined that the majority of park users were unaware of the proximity of Cypress Creek at this location. A summary of contact recreation interviews for Cypresswood Park is shown below in Figure 4-5.



*Contact recreation values less than 1 are not shown on graph

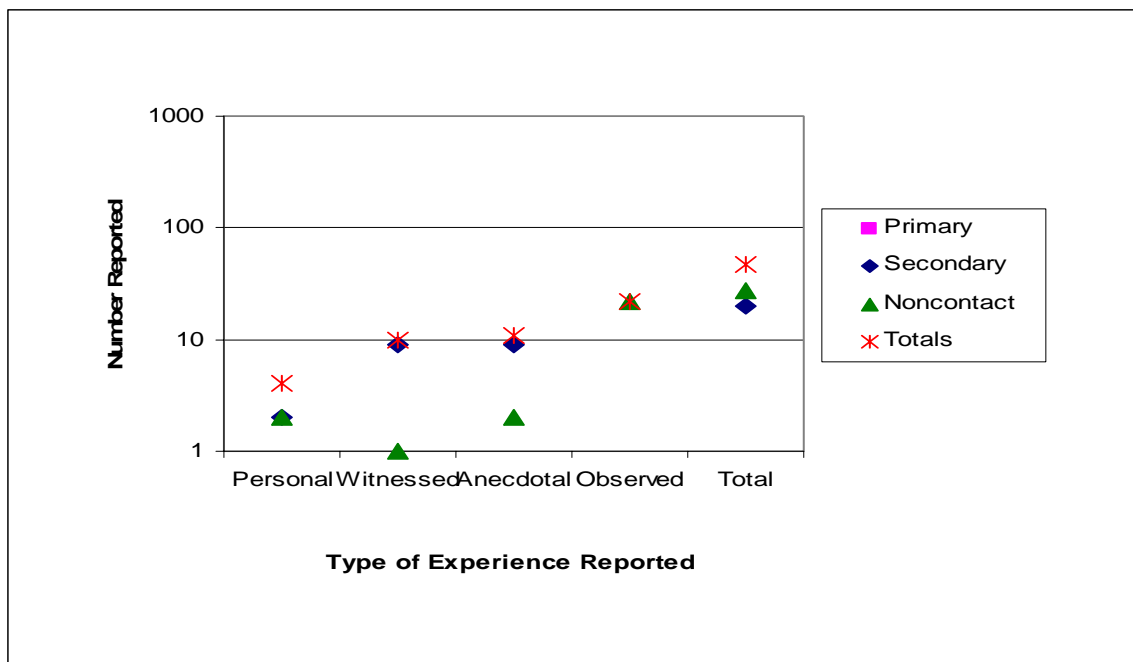
Figure 4-5
Interviewee Reported and Researcher Observed Recreational Activities on Cypress Creek at Cypresswood Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.3.2 Mercer Arboretum

On July 21, 2007, Mercer Park, located between Herschfield Road and Treaschwig Road, was surveyed for recreational use. PBS&J was on-site for approximately 10 hours in which 22 people were interviewed. Mercer Park contains walking trails; however, the park is primarily utilized for the on-site Arboretum and Butterfly Garden. After interviewing 22 people, which included both visitors and the

arboretum staff, it was determined that most people tend to visit the gardens and picnic areas. The office staff stated that although a canoe launch is located on the property, it is rarely used. Visitors are required to register before using the canoe/kayak launch. Office staff stated that approximately one to four people utilize the canoe/kayak launch per month; however, people are often seen utilizing the creek at nearby Jesse Jones Park. Fishing is not allowed on the grounds. Creek access at this site is extremely limited because of dense foliage, with the exception of the boat launch.

Among the 22 interviewees, no persons had ever taken part in primary contact in this portion of the creek, nor had they ever witnessed or heard of anyone utilizing this portion of Cypress Creek for primary contact recreation. Two of the interviewees had previously utilized this portion of the creek for secondary contact, while 18 others had either witnessed or heard of persons utilizing the creek for secondary contact recreation. Five persons stated that they had personally used, witnessed, or heard of persons utilizing this portion of the creek for non-contact recreation. A few persons stated that they would consider using the creek if they were better informed of opportunities or access to the creek and its uses. Several persons stated that Cypress Creek is polluted and they would not consider primary contact recreation unless pollution levels decrease. A summary of contact recreation interviews for Mercer Arboretum is shown below in Figure 4-6.



*Contact recreation values less than 1 are not shown on graph

Figure 4-6
Interviewee Reported and Researcher Observed Recreational Activities on Cypress Creek at Mercer Arboretum on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.4 Sims Bayou

4.1.4.1 Reveille Park

On July 21, 2007, Sims Bayou was surveyed for recreational use. During the eight hours that PBS&J was on-site, eleven people were interviewed. Among the eleven interviewees, none had personally used, witnessed, or heard of anyone utilizing this portion of the bayou for primary contact recreation. Two interviewees stated that they had witnessed people utilizing this portion of the bayou for secondary contact recreation. Additionally, one interviewee personally used this portion of the bayou for non-contact recreation while one interviewee stated that they witnessed people utilizing this portion of the bayou for non-contact recreation. The majority of interviewees stated that they have seen people fishing in the bayou or wading across the bayou to gain access to the park, but all had the impression that the bayou was highly polluted.

This portion of Sims Bayou has very shallow sloped banks with no impediments to enter or exit. While researching Reveille Park on the Bayou Preservation website, it is stated that a storm sewer outlet can be utilized as a launch point for canoes and kayaks, although this area was not seen being utilized during the site visit. Construction was observed on the drainage system between IH 45 and Reveille Road. PBS&J employees also observed a work crew on barges that were located on the bayou between the frontage road and Broadway. A summary of contact recreation interviews for Reveille Park is shown below in Figure 4-7.



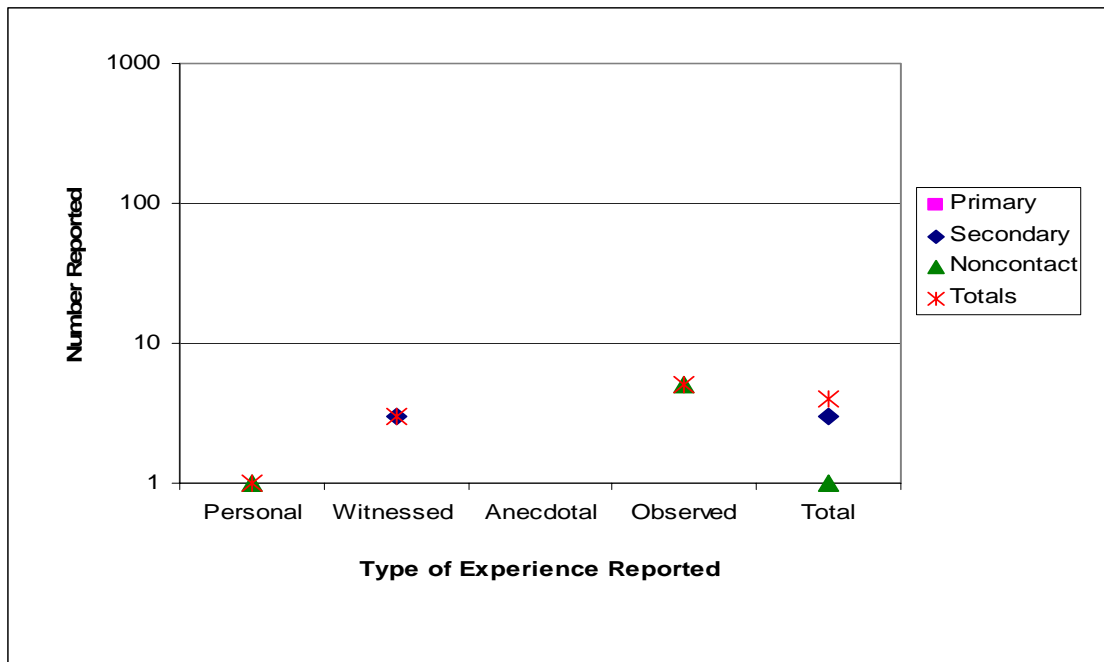
*Contact recreation values less than 1 are not shown on graph

Figure 4-7
Interviewee Reported and Researcher Observed Recreational Activities on Sims Bayou at Reville Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.4.2 Milby Park

On July 28, 2007, Milby Park was surveyed for approximately seven hours. PBS&J concluded interviews at approximately 3:00 p.m. due to rain. Among the five interviewees, none stated that they had personally used, witnessed, or heard of people utilizing this portion of the bayou for primary contact recreation. Three interviewees stated that they had witnessed people utilizing this portion of the bayou for secondary contact recreation. One interviewee stated that they had witnessed people utilizing this portion of the bayou for non-contact recreation. The majority of people stated that they felt pollution levels were high, which contributed to their not using this portion of the bayou.

It was observed that the majority of park users utilized the park to play sports, primarily soccer. No trail within proximity of the bayou, as well as steep banks along the bayou, are also factors contributing to limited stream use. A summary of contact recreation interviews for Milby Park is shown below in Figure 4-8.



*Contact recreation values less than 1 are not shown on graph

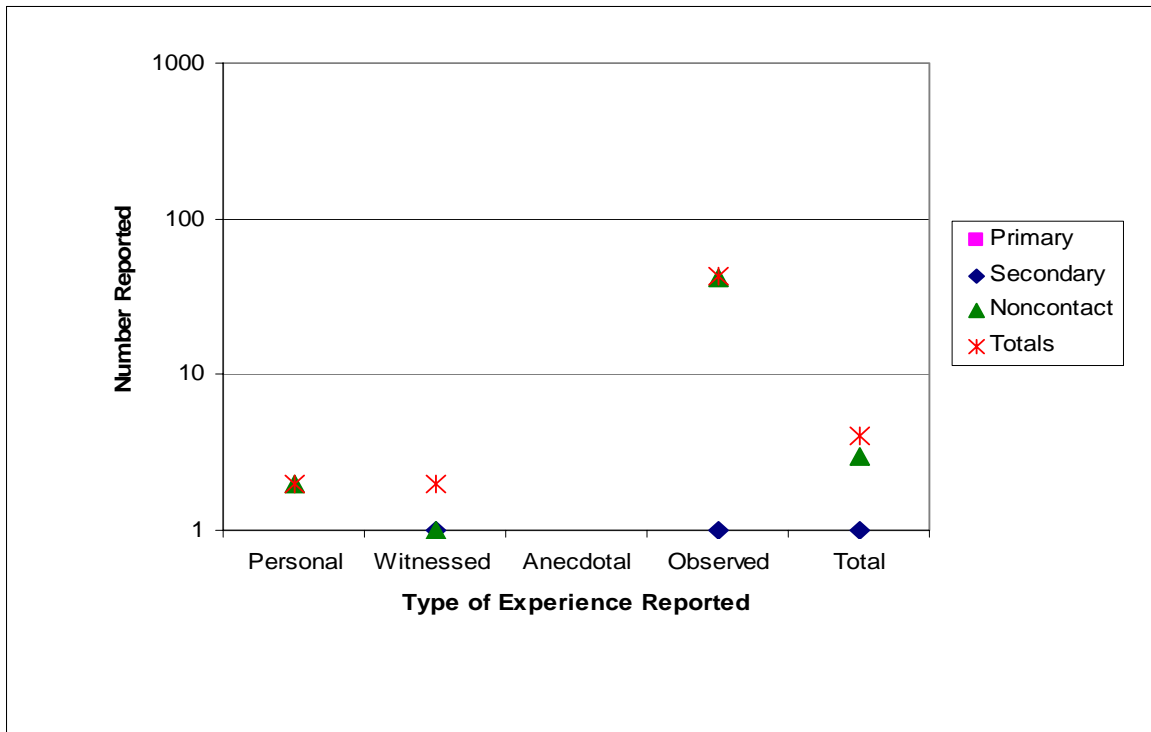
Figure 4-8
Interviewee Reported and Researcher Observed Recreational Activities on Sims Bayou at Milby Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.5 White Oak Bayou

4.1.5.1 Watonga Skate Park

On July 21, 2007, Watonga Park was surveyed for recreational use from the hours of 7:30 a.m. to 5:30 p.m. This park contains a skate park as well as a drainage outfall that is also utilized by skateboarders. Among the six interviewees, none stated that they have personally used, witnessed, or heard of anyone utilizing this portion of the bayou for primary contact recreation. One interviewee had previously witnessed one person utilizing the bayou for secondary contact recreation while three interviewees stated that they had personally used or witnessed this portion being utilized for non-contact recreation. One woman with her dogs was observed at the bayou edge. She stated that she regularly allows her dogs to play in the water.

The majority of park users stated that they felt the water was highly polluted and not suitable for use. Another interviewee stated that she has observed alligators in the bayou further upstream from Watonga Park. Access to the bayou at this location is limited do to steep, grassy banks. A summary of contact recreation interviews for Watonga Skate Park is shown below in Figure 4-9.

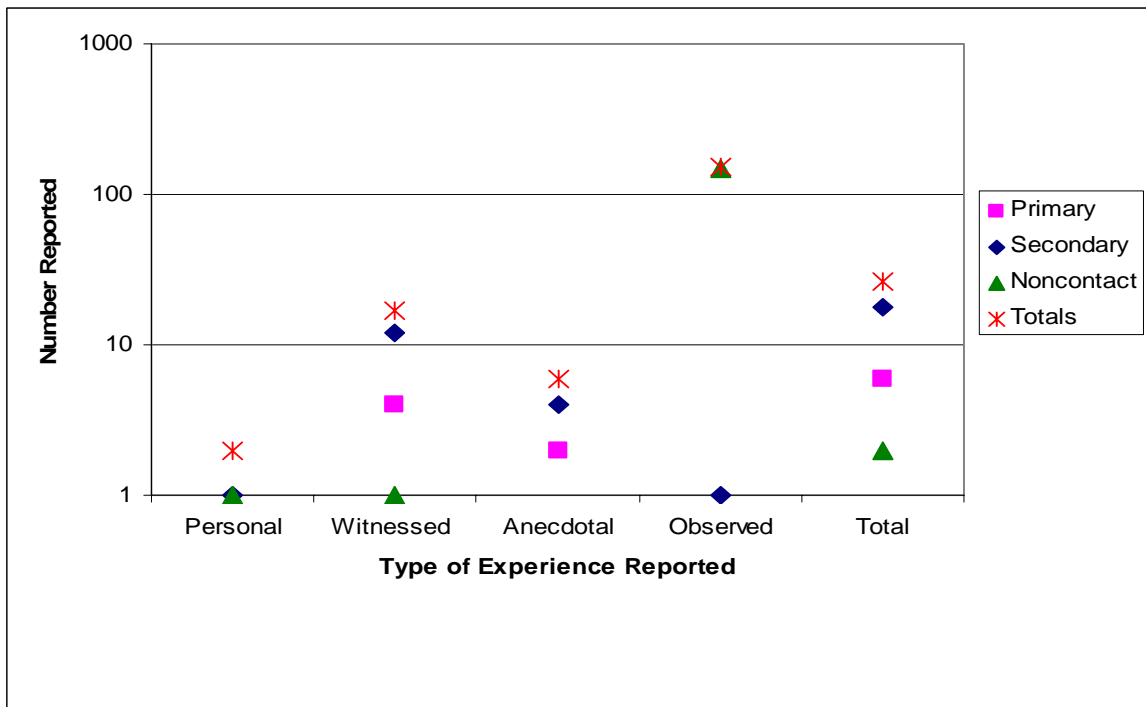


*Contact recreation values less than 1 are not shown on graph

Figure 4-9
Interviewee Reported and Researcher Observed Recreational Activities on White Oak Bayou at Watonga Skate Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.1.5.2 Stude Park

On July 21, 2007, Stude Park was surveyed for recreational use during the hours of 8:00 a.m. to 5:30 p.m. PBS&J employees interviewed 15 people that were utilizing the playground, barbecue/picnic facilities, as well as the Stude Park 0.83-mile trail that connects to a trail that continues along White Oak Bayou to Houston Avenue. One person was observed participating in indirect recreation with the bayou. He stated that he regularly allows his dogs to play in the water, but his family does not enter the water because of high pollution levels. Among the 15 interviewees, all but one stated that they did not utilize this portion of the bayou for primary or secondary contact recreation as they were concerned with levels of household, large waste, or mineral pollution in the water. Six people stated that they have witnessed or heard of people utilizing this portion of the creek for primary contact recreation. Seventeen people stated that they had personally utilized, witnessed, or heard of people utilizing this portion of the creek for secondary contact recreation, while two people stated that they had either personally used or witnessed people using this portion of the bayou for non-contact recreation. Access to this portion of the bayou was limited due to steep banks. A summary of contact recreation interviews for Stude Park is shown below in Figure 4-10.



*Contact recreation values less than 1 are not shown on graph

Figure 4-10
Interviewee Reported and Researcher Observed Recreational Activities on White Oak Bayou at Stude Park on Saturday, July 21, 2007, from 8:30 a.m. to 4:30 p.m.

4.2 CENSUS RESULTS

The number of researcher-observed recreators was used to estimate the number of estimated recreators at each site for the entire summer season. This number was computed to determine if an epidemiology study is feasible based on recreation activities observed during the census. To arrive at the estimated number of recreators for each contact recreation activity, PBS&J used Table 9 and Table 18 from the telephone interviews conducted by Creative Consumer Research (H-GAC, 2007b) to account for seasonality and rain. PBSJ also acquired historical rain data to determine the average number of rainy days during the summer (Climateworld.com, accessed July 30, 2007.). The steps detailed below show the equations used to calculate the estimated number of recreators for each contact recreation activity at each site.

- Used the number of observed recreators in each contact recreation activity category for each site.
- Took a total number of days during the summer season (N=92).

- Calculated the number weekdays (X) and weekend (Y) days during the summer. Using the equations below:
 - $N = 92$ (number of days during the summer)
 - $X = 5/7 (N)$
 - $Y = 2/7 (N)$
- Calculated the number of sunny (S), rainy (R), weekdays (X), and weekend (Y) days during the summer season by inputting the X and Y in the equations below; where RRS is the ration of rainy days during the summer based on historical data (noaa.gov), and RSS is the ration of sunny days during the summer based on historical data (noaa.gov).
 - $S(X) = (1 - RRS)X$
 - $S(Y) = (1 - RRS)Y$
 - $R(X) = X * RSS$
 - $R(Y) = Y * RSS$
- Seasonality (s) was accounted for by using the percentages reported from the telephone interview conducted by CCR for each individual bayou (H-GAC, 2007b). Rain (r) was accounted for by using the percentage of people that reported they used the bayou during rainy vs. sunny days from the telephone interview for any bayou (H-GAC, 2007b). These data were used to calculate the estimated number of recreators for primary, secondary, and non-contact recreation activities based on the observed numbers during the census.
 - $= s [obs * S(X) + obs * r * R(X) + obs * S(Y) + obs * r * R(Y)]$

4.2.1 Brays Bayou

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Brays Bayou		
Name of Site	Type of Contact Recreation	Estimated Number of Recreators in Summer
Arthur Storey Park	Primary	0
	Secondary	0
	Non-Contact	1,136
Hermann Park	Primary	0
	Secondary	0
	Non-Contact	1,057

No observations of primary or secondary contact recreation were made during the census for Arthur Storey Park or Hermann Park. It was estimated that during the summer season for a one-year period 1,136 persons would use Arthur Storey Park for non-contact recreation purposes and 1,057 persons would use Hermann Park for non-contact recreation. The number of estimated persons was calculated from the formula described above.

4.2.2 Buffalo Bayou

Table 4-2 Estimated Number of Recreators Based on Observations During Census on Buffalo Bayou		
Name of Site	Type of Contact Recreation	Estimated Number of Recreators in Summer
Buffalo Bayou Art Park	Primary	0
	Secondary	78
	Non-Contact	130
Terry Hershey Park	Primary	0
	Secondary	143
	Non-Contact	238

No observations of primary contact recreation were made during the census for Buffalo Bayou Art Park or Terry Hershey Park. There were, however, 78 observations of secondary contact recreation at Buffalo Bayou Park and 143 observations of secondary contact recreation at Terry Hershey Park. It was estimated that during the summer season for a one-year period 130 persons would use Buffalo Bayou Art Park for non-contact recreation purposes and 238 persons would use Terry Hershey Park for non-contact recreation. The number of estimated persons was calculated from the formula described above.

4.2.3 Cypress Creek

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Brays Bayou		
Name of Site	Type of Contact Recreation	Estimated Number of Recreators in Summer
Cypresswood Park	Primary	0
	Secondary	0
	Non-Contact	2,965
Mercer Arboretum	Primary	0
	Secondary	0
	Non-Contact	512

No observations of primary or secondary contact recreation were made during the census for Cypresswood Park or Mercer Arboretum. It was estimated that during the summer season for a one-year period 2,965 persons would use Cypresswood Park for non-contact recreation purposes and 512 persons would use Mercer Arboretum for non-contact recreation. The number of estimated persons was calculated from the formula described above.

4.2.4 Sims Bayou

Table 4-1 Estimated Number of Recreators Based on Observations During Census on Sims Bayou		
Name of Site	Type of Contact Recreation	Estimated Number of Recreators in Summer
Reveille Park	Primary	0
	Secondary	0
	Non-Contact	1,369
Milby Park	Primary	0
	Secondary	0
	Non-Contact	112

No observations of primary or secondary contact recreation were made during the census for Reveille Park or Milby Park. It was estimated that during the summer season for a one-year period 1,369 persons would use Reveille Park for non-contact recreation purposes and 112 persons would use Milby Park for non-contact recreation. The number of estimated persons was calculated from the formula described above.

4.2.5

White Oak Bayou

Table 4-1		
Estimated Number of Recreators Based on Observations During Census on White Oak Bayou		
Name of Site	Type of Contact Recreation	Estimated Number of Recreators in Summer
Watonga Skate Park	Primary	0
	Secondary	13
	Non-Contact	564
Stude Park	Primary	0
	Secondary	13
	Non-Contact	1,890

No observations of primary contact recreation were made during the census for Watonga Skate Park or Stude Park. There were, however, 13 observations of secondary contact recreation at both parks. Furthermore it was estimated that during the summer season for a one-year period 564 persons would use Watonga Skate Park for non-contact recreation purposes and 1,890 persons would use Stude Park for non-contact recreation. The number of estimated persons was calculated from the formula described above.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 STUDY SCOPE

The following section discusses the findings of the study.

PBS&J is assisting H-GAC, through funding from the TCEQ and EPA, in conducting a study that seeks to develop effective recreational UAA tools and procedures for the Houston area. PBS&J was tasked by H-GAC to:

- Document uses at 10 sites selected by H-GAC
- Test and evaluate questionnaires
- Estimate the total number of users for a future epidemiological study

5.2 METHODS TO DOCUMENT RECREATIONAL USES

During this study, questionnaires were used to guide face-to-face interviews to document recreational uses or were provided to subjects to fill out by themselves. Face-to-face interviews during the contact recreational census were generally successful; however, there was a language barrier at the sites on Sims Bayou and at Arthur Storey Park on Buffalo Bayou. More interviews would have been attainable if a bilingual person were available to conduct interviews at these sites. Specifically, a Spanish-speaking person was needed at Milby and Reveille Parks and a Chinese and/or Vietnamese-speaking person was needed at Arthur Storey Park. Few people gave their personal information; therefore, follow-up interviews could be not conducted.

Stationing interviewers at a park has positive points because the interviewer can visually assess the site and determine whether individual accounts of contact recreation are actually possible, whereas the telephone interviews require field visits to each site to verify that activities mentioned in the interview are possible. Additionally, it would have been beneficial to use the data from telephone interviews to select sites where contact recreation is most likely.

A more robust method of documenting recreational uses has been employed in the Santa Ana River Watershed in San Bernardino, Riverside, and Orange Counties in California (Moore, 2007). In this watershed, stakeholders deployed Internet-enabled video surveillance cameras that took a still photograph every 15 minutes during daylight hours for one year. This generated 63,332 pictures of one water body during a year-long study. The frequency allowed stakeholders to assess not only the type of recreational use, but the duration and frequency of the uses. This method of use documentation should be strongly considered for certain Texas water bodies if stakeholder interest is high and adequate funding is available.

All methods used in this study, as well as the use of automated cameras, have positive and negative aspects. Overall, a combined approach of telephone interviews followed by automated photography and field verification is the preferred approach for documenting future contact recreation in future studies.

5.3 CENSUS

The data indicated that no primary recreational use occurred. The maximum number of secondary recreational use by an individual during the summer per site is 143, and the maximum number of non-contact recreation use by an individual during the summer per site is 2,965. This accounts for the total number of days in a season where days of poor weather have been subtracted. The maximum number of secondary recreators occurred at Terry Hershey Park on Buffalo Bayou, and the maximum number of non-contact recreation occurred at Cypresswood Park on Cypress Creek.

6.0 SUMMARY

A biased census was conducted by observing and interviewing citizens participating in recreational activities on or in the water at sites that are conducive to recreational use. These results were used to estimate a probable number of study enrollees. This aspect of the project was not intended to fully characterize the existing use of the waterbodies under study. A fair characterization would include randomized observation sites or sites that are representative of the riparian corridor, rather than those reaches most suitable for recreational use.

A total number of 563 recreators were observed at the 10 sites over a total number of 105 weekend hours. No recreators were observed conducting primary contact recreational activities. However, 11 were conducting secondary contact recreational activities, and 552 were conducting non-contact recreational activities. Based on the calculations described previously, between 0 and 6 secondary contact recreators, and between 5 and 150 non-contact recreators would be present at least one time at typical parks near bayous during the summer months.

This research should assist the TCEQ, H-GAC, EPA, and other stakeholders with assessing the feasibility of conducting an epidemiology study to support the development of revised recreational use criteria for urban streams and bayous.

7.0 REFERENCES

- Bloom, M., et al, 2007. "Bacteria Water Quality Standards: A Primer for Stormwater Dischargers." Proceedings of the Sixth Annual Surface Water Quality Conference and Exhibition. Forester Communications. Held August 21-24.
- Buffalo Bayou Conservancy, accessed July 13, 2007. www.buffalobayou.org/guidetobb.html.
- Dorevitch, Samuel, 2007. Personal communication February 2007. Research Assistant Professor, Environmental & Occupational Health Sciences Research Assistant Professor, Epidemiology, University of Illinois at Chicago, School of Public Health.
- DuFour, A. P. 1984. *Health Effects for Criteria for Fresh Recreational Waters*, EPA-600/1-84-004, United States Environmental Protection Agency, Cincinnati, Ohio.
- EPA, 1986. *Ambient Water Quality Criteria for Bacteria—1986*. EPA-440/5-84-002. Washington DC.
- Haas, C., et al, 2006. *Expert Review Report Regarding United States Environmental Protection Agency's Water Quality Criteria for Bacteria – 1986: Application to Secondary Contact Recreation*. (Report No. 2006-38) Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL, July.
- Harris County Flood Control District (HCFCD). 2007. www.hcfcd.org/ (accessed July 31, 2007).
- Hermann Park Conservancy. 2007. www.hermannpark.org/index.html (accessed July 13, 2007).
- Houston-Galveston Area Council. 2007a. Contact Recreation Use Attainability Analyses: Draft Protocols for Collection of Field Data. May 2007.
- _____. 2007b. Contact Recreation Usage, Attitude and Awareness Survey.
- Moore, Timothy, et al. 2007. "A Picture is Worth a Thousand Words: Using Wireless Video Cameras to Subcategorize Recreational Use Designations." Proceedings of WEF Specialty Conference: TMDL, 2007. Water Environment Federation, Alexandria, VA, pp. 155-165.
- Ruckstuhl, E. Bayou Preservation Association. 2007. www.bayoupreservation.org/pages/paddletrailareas.php?channel=Cypress%20Creek. Accessed July 13, 2007.
- www.projectbrays.org/highlights.html (accessed August 1, 2007).
- www.srh.noaa.gov/productview.php?pil=HGXCF6HOU&version=1&maz=61.
- www.theanthills.com/info/history.htm (accessed July 31, 2007).
- www.worldclimate.com/cgi-bin/grid.pl?gr=N29W095 (accessed August 3, 2007).

Appendix A

Representative Photos

Appendix B

Vicinity Maps

Appendix C

Site Location Maps

Appendix D

Contact Recreation Interview Forms