Boater Waste Education Campaign

GLO Contract # 16-056-000-9100

FINAL REPORT

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Project Description

Approximately 50% of Galveston Bay oyster waters are impaired for bacteria, based on the Texas Commission on Environmental Quality's Six Total Maximum Daily Loads for Bacteria in Waters of the Upper Gulf Coast. The primary sources addressed in the Implementation Plan include insufficient treatment by wastewater treatment facilities and septic systems, sanitary sewer overflows, boat sewage dumping, and stormwater runoff. These impairments result in negative impacts to environmental and public health, as well as the economy.

Water and sediments are often degraded in and around marinas from boat sewage and the introduction of dockside wastes and other non-point sources. The combination of poor circulation and discharge from boaters and boat maintenance operations can create serious localized water quality and potential public health concerns (Jeong et al., 2005). The presence of fecal indicator bacteria in the bay indicates that pathogenic bacteria, which can cause human illnesses (i.e. gastrointestinal, skin, eye, and ear issues), are likely present. Additionally, increased nutrients from fecal waste can lead to algal blooms, depressed dissolved oxygen levels, and subsequent fish kills, particularly in marinas where flushing is often decreased due to the marina design.

The purpose of the Boater Waste Education Campaign (BWEC) is to decrease the incidences of illegal discharge of boater sewage waste in the Galveston Bay Estuary, particularly Clear Lake since it has the third highest concentration of privately owned marinas in the United States. Communication of the potential environmental and public health risks associated with boater waste has improved over the last few years, largely through initiatives like the Boater Waste Education Campaign; however, the Houston-Galveston region lacks the appropriate local data to effectively measure any reduction in illegal discharge of boater waste that may be a result of the BWEC. This, combined with a lack of enforcement of the existing No Discharge Zone in Clear Lake, means that behavior change through outreach alone is difficult and improvements can be difficult to track. GBF has continued to work toward overcoming these barriers to success in CMP Cycle 20.

Throughout the BWEC, GBF communicated the campaign message directly to boaters and marinas. This was achieved by contacting marinas, boating organizations, and boating events to arrange presentations and/or exhibits where boaters were exposed to the campaign message, in addition to distributing education packets to new tenants through our marina partners. The campaign emphasizes 1) the negative environmental and public health impacts caused by vessel sewage, 2) where boaters can properly dispose of their waste and report illegal dumping, 3.) the existing laws and fines associated with illegal boat discharges, 4.) the collection of behavioral data from local recreational boaters regarding vessel discharge, and 5.) the benefits of and the legal process for designating Galveston Bay a federal No Discharge Zone (NDZ). As part of the initiative, boaters and marinas have been encouraged to join the Clean Texas Marina and Clean Boater Programs. Marinas have also been encouraged to seek funding through the Clean Vessel Act Program to construct, renovate, or replace pump-out stations.

Outreach programs have proved to be effective in the past, but there is a need for a strong campaign in the Clear Lake area to reach new boaters and reawaken awareness of the issue. GBF has directed the development and distribution of the message with the input of a workgroup comprised of stakeholders representing 14 different boating and environmental groups, as well as members of the recreational

boating community. Funding from the Texas Coastal Management Program has played a key role in the distribution of the BWEC messages by covering costs associated with marketing, advertisement, outreach, illegal discharge reporting, marina partnerships, and volunteer water monitoring. The BWEC has been well received in the Clear Lake/Galveston Bay community and GBF plans to continue carrying out and enhancing this project indefinitely.

Task I - Maintain Active Stakeholder Groups and Marketing/Outreach Materials

1.1 BWEC Workgroup

A campaign workgroup continued to guide BWEC activities, and consisted of representatives from the Galveston Bay Estuary Program, Clean Marina Program, Clear Lake Marina Association, Texas Parks and Wildlife, and other relevant, bay-area groups. The workgroup was originally formed under a Galveston Bay Estuary Program grant beginning in 2007. The committee members were solicited in the fall of 2007; the original invitation sent to bay area entities predated the beginning of this grant cycle. The workgroup was formed to develop and execute the campaign. The current workgroup consists of several original members, but GBF continually recruits new members in order to keep the BWEC ideas fresh. Participation in the workgroup is open to any interested parties. Table 1 includes a list of the participating individuals during this grant cycle. The meeting schedule is included in Table 2. In addition to the scheduled meetings hosted by GBF, when possible GBF staff attended Clear Lake Marina Association, Gulf Coast Yacht Broker Association, Texas Mariners Cruising Association, Houston Safe Boating Council, and Marina Association of Texas meetings and conferences in order to stay in communication with these and many other local and state representatives in the boating community. These meetings are key to many successes in the BWEC because GBF has built a good reputation in that community.

The workgroup members contributed to the project in different ways. The Clear Lake Marina Association provides the business perspective to BWEC efforts and acts as an effective means to disseminate information and build networks in the local boating community. Unfortunately, the group has been very busy as of late and has not been able to meet as regularly as they previously have, though GBF continues to meet with associated members when possible. The Clean Texas Marina Program offers technical information and a statewide perspective of the boating industry. Both of these organizations are associated with the Marina Association of Texas and aid in getting the BWEC efforts publicized state-wide. Redfish Island Marine and Maritime Sanitation are the two mobile pump-out companies currently in operation in Clear Lake and Galveston Bay. They provide in-kind donations for marina outreach events, as well as technical information on pump-out equipment. Additionally, Maritime Sanitation has been a long-time partner in donating pump-out services for the annual Redfish Raft Up event and assistance to marinas interested in applying for Clean Vessel Act grants to install pump-out facilities. Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and Galveston Bay Estuary Program assist the workgroup with questions relating to environmental regulations, access to data, and aid in the workgroup's efforts to get Galveston Bay designated as a No Discharge Zone. Several members of the workgroup are solely recreational boaters, though others remain heavily involved in the boating industry. Their knowledge and experience in the community is invaluable to the BWEC efforts.

The most valuable result of continuing this workgroup has been the fact that GBF has a group of committed stakeholders from the boating industry that are always available to discuss, criticize, and improve ideas and to give feedback on BWEC efforts. During this funding cycle, organizational representation at the workgroup meetings was about 63%. In addition, 100% of the organizations were

directly involved in assisting with campaign tasks, such as assembling and distributing education packets, connecting GBF to audiences for giving presentations, implementing the campaign at their marina, providing technical assistance for the Water Monitoring Team, etc. The performance indicators used during this funding cycle were approved by the workgroup, and can be viewed in Appendix I. The measured results corresponding to these indicators are addressed throughout this final report in the appropriate sections.

Table 1. Boater Waste Education Campaign Workgroup

Last	First	Organization
Paige	Helen	Marina Bay Harbor
Fannin	Paul	Public
Hollin	Dewayne	Clean Texas Marina Program
Hall	Lynda	Lakewood Yacht Club
Marshall	Lisa	Galveston Bay Estuary Program
Tuma	Scott	City of League City
Johnston	Steven	Houston-Galveston Area Council
Broach	Linda	TCEQ, Surface WQ Monitoring
Demers	Jennifer	Maritime Sanitation
Wright	Jean	Clean Rivers Program
FitzSimmons-Evans	Lori	Galveston County Health District
Derrick	Cassandra	TCEQ - Clean Water Certification Program
Guillen	George	University of Houston Clear Lake – Environmental Institute of Houston
Kropf	Philip	Texas Mariners Cruising Association
Schultz	Ron	Galveston County Health District
Carrier	Mary	TPWD Boater Safety Education

Table 2. Workgroup meeting schedule

CMP Cycle	Date	Location	Time	Attendance
19/20	November 17, 2015	GBF Conference Room	9:30 AM	7
20	May 4, 2016	GBF Conference Room	9:30 AM	13
20	August 16, 2016	GBF Conference Room	1:00 PM	9
20/21	November 7, 2016	GBF Conference Room	1:00 PM	5
20/21	February 23, 2016	Freeman Branch Library	2:30 PM	9

1.2 Technical Advisory Committee

GBF maintained communication with members of the Technical Advisory Committee (TAC) (Table 3) which consists of academic and environmental professionals from local universities, TCEQ and the workgroup chair. The TAC makes recommendations to GBF on strategies for collecting key data to quantify the potential impact of boat sewage on bacteria levels in the bay. They gave advice and comments on the data collected by the Water Monitoring Team, the Dockwalker Team, and the background research being conducted for the No Discharge Zone application. To date, communication amongst workgroup members and GBF has been via phone/email/individual meetings.

Table 3. Technical Advisory Committee membership

Last	First	Organization
Feiveson	Alan	NASA Statistician
Glenn	Stephanie	Houston Advanced Research Center
Hall	Lynda	Lakewood Yacht Club/Clear Lake Marina Association
Henderson	Andrew	University of Texas School of Public Health
Lane	Helen	GBF Board Member/Retired NASA Chemist
Paige	Helen	Marina Bay Harbor/Clear Lake Marina Association

1.3 Marketing/Outreach Materials

Marketing and outreach materials were maintained or newly developed, as needed, for all of the various programs within the BWEC including Pump Don't Dump, GBAN, the GBF Water Monitoring Team, the Water Quality Outreach Internship, and the Dockwalker Program.

GBF continued to distribute the Pump Don't Dump education packets and campaign giveaways that were redesigned during Cycle 19. Items included Pump-Out Guide postcards, GBAN plastic cards, Pump Don't Dump koozies, and floating key chains (Figure 1), in addition to the Clean Texas Boater pledge cards, the Scoop on Poop materials, and Clean Boater Tip Cards donated by the Marina Association of Texas (MAT). GBF also distributed Dockwalker bags to each individual who completed the Dockwalker survey in person. These bags include an absorbent pillow for oily bilge, safety whistle, handy zip-tie, a holding tank dye tablet, and many of the aforementioned outreach materials for Pump Don't Dump.

The overarching goal was to use these items to direct boaters to the campaign website and pump-out map, and to provide boaters with tools that empower them to improve water quality through their actions. These materials act as a conversation starter so we can more easily share the campaign message and help create ambassadors that will help spread the message as well. Campaign messaging was continually analyzed and simplified throughout this grant cycle. Figure 1 shows the campaign handout method that was used most frequently during outreach events.

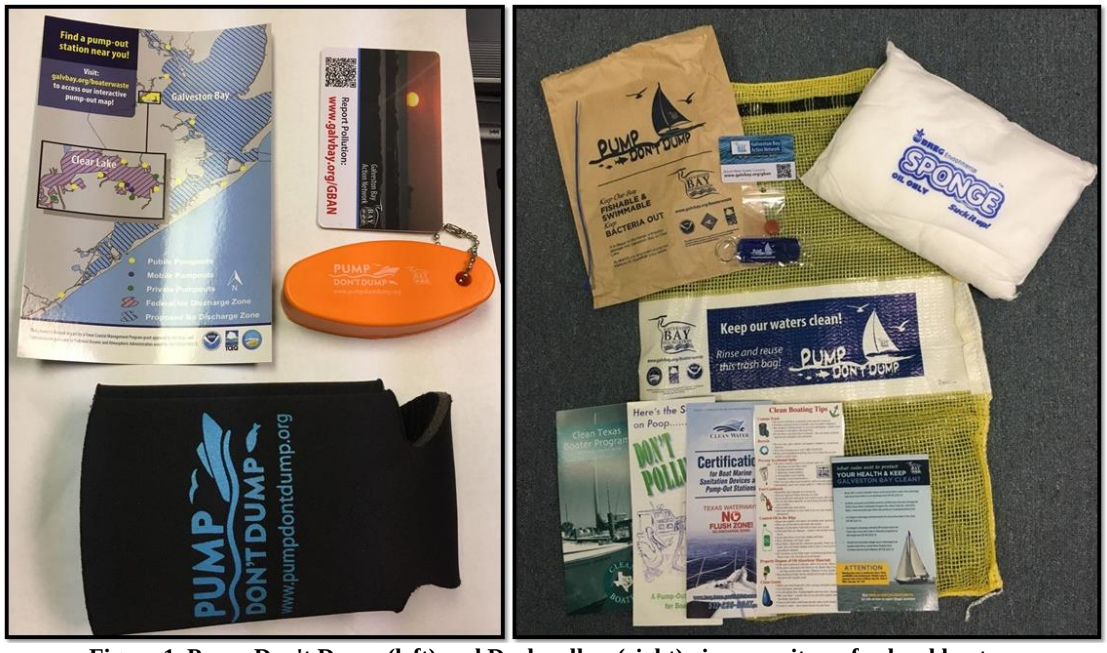

Figure 1. Pump Don't Dump (left) and Dockwalker (right) giveaway items for local boaters

In addition, GBF wrote Facebook posts, newsletter articles, and press releases to advertise BWEC campaign messages, as well as to share our campaign work with GBF followers and supporters through print and digital media. GBF distributed messaging for Pump Don't Dump and GBAN calls-to-action in the Marina Association of Texas' *Changing Currents* magazine (Appendix I) as well as two articles in the Galveston County Daily News. These publications reached our target boating audience with intentional messaging. GBF also distributed an article featuring our Water Monitoring Program in the Gulf of Mexico Alliance's November 2016 newsletter (Appendix I) and in the Gulf Coast Mariner Magazine's June 2016 Issue, which can be seen at http://www.gulfcoastmariner.com/galveston-bay-bacteria-storms/. GBF will continue to look for opportunities to publish similar articles as we develop them. PowerPoint presentations and hands-on activities were developed for various audiences such as the Houston Safe Boating Council's W.A.D.E. summer program, GBF's Bay Day event, the Southwest International Boat Show, and the Texas Mariners Cruising Association. Furthermore, during this grant cycle GBF continued communication with the Marina Association of Texas (MAT) in which the adoption of the Pump Don't Dump Campaign as the state-wide boater waste education program was discussed. MAT is very excited about this possibility moving forward, and the Texas Parks and Wildlife Department is fully supportive of state-wide implementation of Pump Don't Dump. As of the end of Cycle 20, MAT is simply waiting on the necessary funding to formally adopt the Pump Don't Dump Campaign as a state-wide program. Dialogue regarding this recent development will continue into the future, as the regional Pump Don't Dump Campaign's role in the state-wide program is determined. GBF is very optimistic about this progression.

One major enhancement carried out during this cycle was that GBF redesigned the logos for our GBAN, Dockwalkers, and Pump Don't Dump programs to remain consistent with the new GBF logo (Figures 2 – 4). These new logos were rolled out in September 1, 2016, and are meant to be sleeker while retaining the original feel of the earlier logos.

Figure 2. Redesigned GBAN logo

Figure 3. Redesigned Pump Don't Dump logo

Dockwalker Team

GALVESTON BAY FOUNDATION

Figure 4. Redesigned Dockwalker logo

Dockwalker data from Cycle 20 show that 100% of boaters surveyed in our area were unaware of how many pump-out facilities are truly available around the bay, suggesting that a continued focus on the interactive pump-out map is required. By using social and digital media developed by The Hatcher Group in Cycle 18, GBF continued the Pump Don't Dump social media campaign that began back in Cycle 19 (Figure 6). Additionally, GBF posted the Dockwalker survey online to allow for greater participation by boaters who may come across the survey online rather than at a marina or boat show. This additional branch of the campaign has allowed GBF to reach a broader audience by giving boaters the opportunity to take action anytime they are online and empower them to spread the campaign message to their fellow boaters.

GBF continues to use the toolkit developed in Cycle 19 with The Hatcher Group to promote GBAN messaging throughout the duration of Cycle 20, including the hashtag #EyesOnGalvBay. GBF used the toolkit to execute a GBAN social media campaign during the summer of 2016 that focused on teaching citizens how to identify the different types of pollution one can report with GBAN (Figure 7). Graphics created by GBF were also used during this social media campaign as well as for other posts throughout this cycle's duration. GBF also continued to distribute the GBAN Citizen Engagement Toolkit via email through a downloadable folder filled with GBAN graphics, posts and information. This toolkit is intended to help our partners advertise and market GBAN within their own websites and publications. To date, GBF has tracked six partner organizations who have added a GBAN graphic and link to the website or who have featured an article about GBAN in their organization's newsletter (Table 7). Finally, GBF created outreach materials and marketing messaging for the GBAN mobile app release. This compilation of press releases, articles, social media posts, graphics, email blasts, and interview scripts are intended to coincide with the release of the mobile app in April 2017 to increase the tool's awareness within the four-county region (Harris, Galveston, Chambers, and Brazoria).

Figure 5. Image of GBAN cards used as campaign giveaways in Cycle 20

Figure 6. Two separate social media campaign graphics for Pump Don't Dump during Cycle 20

Figure 7. Four separate social media campaign graphics for GBAN during Cycle 20

GBF continued to manage the outreach and training materials for running the GBF Water Monitoring Team and Bacteria Monitoring Lab. GBF updated the Water Monitoring Team webpage on the GBF website and maintained the Google map with our current and potential monitoring sites in order to make it easier to communicate with volunteers when they are trying to choose a site, as well as with the public to let them know where we monitor. GBF also maintained the Citizen Science webpage. This page houses information about our bacteria sampling, including our bacteria concentrations map, as well as information about past Water Quality Research Internship projects. All of this information can be found at www.galvbay.org/watermonitors. GBF also continued to maintain its partnership with the Gulf of Mexico Coastal Ocean Observing System's (GCOOS) Citizen Science Data Portal, which is available to the public at http://www.gulfcitizenscience.org or www.galvbay.org/watermonitors and houses GBF's Water Monitoring Team data. This portal makes citizen science data widely accessible so that it can fill data gaps and enable state, federal and academic programs to allocate their budgets more efficiently and effectively. It is getting national attention from programs across the country that would like to have a similar system, and was even highlighted at the White House Water Summit in honor of World Water Day 2016. We will continue to work with GCOOS to update and improve the data portal, develop marketing and outreach efforts, and ensure that the boating community knows about this valuable

resource for accessing local water quality data. GBF also put together a video overview of our Water Monitoring Team, which can be viewed at https://www.youtube.com/watch?v=HCTPehsnh_U and on GBF's website at http://www.galvbay.org/how-we-protect-the-bay/in-our-communities/water-monitoring-team/.

Task 2. Develop Outreach Schedule and Distribution Plan

During this project period, outreach was carried out through print media, education booths, presentations, and through several BWEC volunteer programs including the Galveston Bay Action Network, Dockwalkers, GBF Water Monitoring Team, and Water Quality Policy and Outreach Internship. Efforts towards BWEC outreach and distribution are outlined below for print media, booths, and presentations, while details on the reach of BWEC volunteer programs are found under Task 3. Total impressions achieved through the BWEC will be discussed under Task 5. However, it should be noted that these impression counts are simply the best estimate available to GBF as of March 31, 2017. These numbers are most likely generally understated, as there are some instances where it is incredibly difficult to track any sort of impression outcome. However, in some instances impression counts from individual campaigns may be overstated. There were a few situations where no direct impression count could be determined, so GBF estimated the campaign's potential reach by multiplying the website's daily page views by the total number of days during which the campaign remained active. Going forward, GBF would like to determine either a better method for tracking digital outreach campaigns or a more effective tracking method for distinguishing between simple impressions and behavior change or actions resulting from an outreach campaign. However, for this report, GBF will largely evaluate the success of an outreach campaign by the number of impressions, or people reached, as a result of the campaign.

2.1 Print Media, Education Booths, and Presentations

GBF contacted marinas and popular boating events to schedule outreach presentations and booth displays, and to offer printed materials for inclusion in tenant packets and event goodie bags. Table 4 shows the list of marinas that were contacted during this grant cycle and Table 5 shows the yacht brokers and other boating-related businesses that were contacted.

Workgroup members and campaign partners frequently help with directly promoting the BWEC through donating banner space at events, inviting us to speak or host education booths, and even distributing campaign materials at their booths. GBF staff and volunteers have hosted many educational exhibits throughout the project area to ensure one-on-one interaction with boaters. In addition, during this grant cycle GBF hosted an exhibit at the Marina Association of Texas' annual conference, the Houston Boat Show, the Restore America's Estuaries conference, and the Southwest International Boat Show to highlight BWEC efforts that have been successful and potential ways that GBF and these organizations can coordinate this effort moving forward. GBF is very pleased that many of our suggestions are being taken into consideration and that MAT is even planning on adopting Pump Don't Dump as the statewide boater education program and supplementing our printing budget for outreach materials with some of their TPWD grant funds, helping us to be able to reach even more boaters around Clear Lake and Galveston Bay.
In addition to these outreach booths, several group presentations were made throughout the BWEC project period. GBF continues to have quality interactions with the boating community through these group presentations, since it facilitates better discussions and the opportunity to disseminate more detailed information than can be done with a passive booth audience. Please see Table 6 for a schedule of both types of education events carried out during this grant cycle. Through these activities, GBF reached over 15,000 people at 53 live events.

In terms of advertising, GBF has promoted the campaign through magazines, websites, social media, and local print and online news sources (an extensive press release list is managed by GBF's Marketing Coordinator). All advertising and article space utilized during this grant cycle was donated because of the publications' support for the BWEC. Numbers of impressions for the various BWEC advertisements, posts, and articles GBF could track are found in Table 7. Through print and digital media, GBF was able to reach over 285,000 people with various BWEC messaging through 29 different media outlets**.**

Table 4. Marinas contacted about the BWEC

Marina Name	Location	City	Phone
Clear Lake			
Bal Harbor Marina	123 Lakeside Lane	Houston	(281) 333-5168
Blue Dolphin Yachting Center, Inc.	P.O. Box 123	Seabrook	(281) 474-4450
Clear Lake Marine Center, Inc.	P.O. Box 716	Seabrook	(281) 326-4426
Constellation Point and Marina	451 Constellation	League City	(281) 334-2527
Endeavour Marina	3101 NASA Parkway	Seabrook	(832) 864-4000
Kemah Boardwalk Marina	555 Bradford St.	Kemah	(281) 334-2284
Lakeside Yachting Center, Inc.	2511- B Nasa Rd. 1, Ste. 101	Seabrook	(281) 326-5547
Lakewood Yacht Club	2425 Nasa Parkway	Seabrook	(281) 474-2511
Legend Point	1300 Marina Bay Drive	Clear Lake Shores	(281) 334-3811
Marina Bay Harbor Yacht Club	P.O. Box 478	Kemah	(281) 535-2222
Marina Del Sol	1203 Twin Oaks Blvd.	Kemah	(281) 334-3909
Nassau Bay Homes and Marina Assoc., Inc.	1120 Nasa Pkwy, Ste. 109	Nassau Bay	(281) 333-2570
Nassau Bay Yacht Club	1120 Nasa Pkwy, Ste. 109	Nassau Bay	(281) 333-2570
Portofino Harbour	One Portofino Plaza	Clear Lake Shores	(281) 334-6007
Seabrook Shipyard & Marina Inc.	1900 Shipyard Dr.	Seabrook	(281) 474-2586
South Shore Harbour	2551 South Shore Blvd., Ste B	League City	(281) 334-0515
Waterford Harbor Marina	800 Mariners Drive	Kemah	(281) 334-4400
Watergate Yachting Center	1500 Marina Bay Drive	Clear Lake Shores	(281) 334-1511
Wharf at Clear Lake	P.O. Box 1208	League City	(281) 334-5976
Galveston Bay			
Bayland Marina	2651 S. Highway 146	Baytown	(281) 422-8900
Eagle Point Fishing Camp, Inc.	Route 1 Box 1718	San Leon	(281) 339-1131
Galveston Yacht Basin	715 North Holiday Dr.	Galveston	(409) 762-9689
Harborwalk Marina	P.O. Box 2328	Hitchcock	(409) 935-3737
Houston Yacht Club	3260 Miramar Drive	Shoreacres	(281) 471-1255
Payco, Inc.	501 Blume Dr.	Galveston	(409) 744-7428
Pelican Rest Marina	7819 Broadway	Galveston	(409) 744-2618
Ray's Marina	6310 Herds Lane	Galveston	(409) 744-2111
San Leon Marina	100 6th St.	Dickinson	(281) 339-1515
Waterman's Harbor, Inc	16426 Clearcrest	Houston	(281) 339-1416

Table 5. Yacht brokers and other boating businesses that received BWEC materials

Yacht Broker	Location	Address	Phone Number
Lauderdale Yacht Sales	League City	2551 South Shore Harbour Blvd Suite B	281-535-0900
Galati Yacht Sales	Seabrook	1902 Seabrook Shipyards	281-474-1470
United Yacht Sales	Kemah	1115 Marina Bay Drive	281-538-6231
Sea Lake Yacht Sales	Kemah	1500 FM 2094 Rd	281-334-1993
Jay Bettis & Co Yacht Sales	Seabrook	2509 Nasa Parkway	281-326-3333
Flagship Yachts	Seabrook	2511 Nasa Parkway #107	281-532-3200
Nautic Yacht Sales	Kemah	585 Bradford St	281-334-2628
J M Yachts	Clear Lake	1500 Marina Bay Dr #1570	281-538-0761
Texas Marine & Brokerage Inc	Seabrook	2700 Nasa Parkway	281-326-9595
HSH Yacht Sales	Kemah	1500 Marina Bay Drive #132b	832-864-2030
Lone Star Yachts Sales	Kemah	1500 Marina Bay Drive #3380	281-334-3500
Texas Sport Fishing Yachts Sales	Seabrook	802 Hardesty Ave	281-474-9600
Discovery Yachts Inc	Seabrook	2101 Todville Road	281-291-9109

Texas Coast Yachts	Kemah	1500 Marina Bay Drive Suite 122-A	281-957-9046
Gibson Weaver Yacht Sales	Seabrook	2511B Nasa Parkway	281-326-1574
Kent Little @ Little Yacht Sales	Kemah	Waterford Harbor, 800 Mariners Drive	713-817-7216
Southern Cross Yacht Sales	Kemah	585 Bradford Ave	281-334-7411
Seawinds International Inc	Kemah	703 Bay Ave	281-334-5296
Marine Max Inc.	Seabrook	3001 Nasa Parkway	281-326-4224
Maritime Sanitation	Clear Lake Shores	1500 Marina Bay Drive	281-334-5978
Redfish Island Marine	Clear Lake Shores	1500 Marina Bay Drive, Suite 112	832-282-8202
Kevin E. Severance Insurance Agency	League City	3027 Marina Bay Drive, Suite 309	281-333-3100
Ron Hoover RV and Marine	La Marque	1903 Gulf Frwy	409-935-7101

Table 6. Distribution schedule of education booths and presentations

Audience	Date	Impressions	Description
General public	10/3/2015	400	La Porte Sip and Stroll - exhibit
General public	10/10/2015	500	El Jardin BayFest - exhibit
General Public	10/24/2015	20	GBF Rain Barrel Workshop – La Porte
General Public	11/7/2015	25	GBF Rain Barrel Workshop – Nassau Bay
Environmental Professionals	1/13/2016	25	Galveston Bay Estuary Program State of the Bay Symposium
College Students	3/2/2016	16	Lee College Environmental Science class – presentation
General Public	3/5/2016	22	GBF Rain Barrel Workshop - Baytown
Boaters	3/18-3/19/2016	15	Southwest International Boat Show – presentation
Boaters	3/17-20/2016	10,000	Southwest International Boat Show partner distribution
General Public	3/26/2016	200	Bayou Greenways Day - exhibit
General Public	4/3/2016	20	Water Warriors Brownies Troop – presentation
General Public	4/9/2016	32	GBF Rain Barrel Workshop – Galveston
General Public	4/16/2016	250	Earth Day Houston - exhibit
General Public	4/23-4/24/2016	770	Earth Day Texas - exhibit
General Public	5/21/2016	72	GBF Rain Barrel Workshop – Houston Zoo
General Public	6/8/2016	50	World Oceans Day Festival - exhibit
Boaters	6/8/2016	15	Houston Sail & Power Squadron – presentation
General Public	6/10/2016	75	Cool Nights at the Zoo - exhibit
General Public	6/11/2016	47	GBF Rain Barrel Workshop - Bolivar
General Public	6/25/2016	57	GBF Rain Barrel Workshop - Seabrook
General Public	6/29/2016	50	GBF Open House
Boaters	7/13/2016	40	WADE/Houston Safe Boating Council - exhibit
General Public	7/16/2016	78	GBF Rain Barrel Workshop – Pasadena
General Public	7/16/2016	20	Houston Zoo Beach Clean Up – exhibit
Children	7/22/2016	18	City of La Porte Summer Camp – presentation
General Public	7/22/2016	200	Under the Sea Booth at Houston Zoo Cool Nights
General Public	7/30/2016	50	Houston Zoo Beach Bash – exhibit
General Public	8/6/2016	62	GBF Rain Barrel Workshop - Friendswood
General Public	8/11/2016	15	Galveston Surfrider – presentation

General Public	9/16/2016	20	H-GAC TST training – presentation
General Public	9/17/2016	80	GBF Rain Barrel Workshop – Webster
General Public	9/17-9/18/2016	100	Gatorfest – exhibit
Boaters	9/24/2016	6	South West International Boat Show – presentation
General Public	9/24/2016	500	La Porte Health and Safety Fair - exhibit
Environmental Professionals	10/1/2016	15	Audubon Texas Bird Nerd lecture series – presentation
General Public	10/4/2016	40	H-GAC CWI Lecture – presentation
Students	10/6/2016	15	Venture Scout Troop 464 Rain Barrel Workshop
Environmental Professionals	10/26/2016	20	Greater Houston Assn. of American Zookeepers - presentation
General Public	11/6/2016	30	Celebration Seabrook – exhibit
Boating Professionals	11/7-11/9/2016	80	Marina Association of Texas – exhibit
Students	11/9/2016	15	TAMUG Texas Academy of Sciences Meeting – presentation
General Public	11/15/2016	40	GBF Membership Meeting – presentation
Volunteers	11/18/2016	14	Water Monitoring Team Phase 1 & 2 Training
General Public	12/1/2016	20	La Porte Christmas on Main – exhibit
Environmental Professionals	12/1/2016	70	CTCAC Quarterly General Meeting – presentation
Environmental Professionals	12/11-12/14/2016	1200	Restore America's Estuaries Summit – exhibit & presentations
Boaters	1/6-1/15/2016	50	Houston Boat Show – exhibit
General Public	1/12/2016	30	Texas Recreation & Parks Society Conference – presentation
Boaters	1/20/2017	70	Texas Mariners Cruising Association – presentation
General Public	2/2/2017	35	Baytown Kiwanis Club – presentation
General Public	2/3/2017	50	Kickoff to Rebuild – exhibit
General Public	2/9/2017	40	La Porte Bayshore Garden Club – presentation
Students	2/10/2017	20	UH Chemical Society – presentation
	TOTAL	**15,714**	

Table 7. Media outlets and impressions for outreach distribution

Media Outlet	Distribution Period	Impressions
Dock Line Magazine – Baytown issue (PDD ad)	2015: Oct, Nov, Dec 2016: Jan, Feb, Mar	45,000 (7,500/month)
GBF Pump Don't Dump Webpage	October 2015 – March 2017	619
GBF Dockwalker Webpage	October 2015 – March 2017	188
GBF GBAN Webpage	October 2015 – March 2017	1,618
GBF Water Monitoring Team Webpage	October 2015 – March 2017	4,687
GBAN news article on GBF Webpage	October 2015 – March 2017	183
GBAN Webpage	October 2015 – March 2017	1,618
GBF E-Newsletter (BWEC articles)	2015: Oct (GBAN), Nov (NDZ app), 2016: Feb (WMT)	5,619 (1873/month)
GBF Facebook Page (BWEC posts)	October 2015 – March 2017 (57 posts)	156,096
GBF Twitter Page (BWEC posts)	October 2015 – March 2017 (18 posts)	11,457
GBF Gazette - WMT article and mentions	Winter 2015, Spring 2016	8,000 (4,000/issue)
GBF YouTube Videos (Pump Don't Dump: Maritime Sanitation, Marina Del Sol, South Shore Harbour, How To Pump Out Your Boat, Pump Don't Dump – Message to Boaters)	Oct 2015 – March 2017	Unknown

Marina Association of Texas newsletter – PDD ad	2015: Dec 2016: Mar, Jun, Sep, Dec	1,000 (200/issue)
The Midden – Galveston Bay Area Chapter of TX Master Naturalists newsletter article about marina research	October 2015	Unknown
Double Bayou Watershed Partnership Newsletter – GBAN article	Winter 2015	290 (290/newsletter)
Galveston Bay Estuary Program website – GBAN ad	February 2016 – Present	Unknown
Changing Currents Magazine – GBAN ad	2016: Mar, Jun, Sep, Dec	660 (165/issue)
IM Rivers website – GBAN project highlight		Unknown
Maritime Sanitation website – GBAN ad		Unknown
Highland Bayou WPP website – GBAN ad	February 2016 – Present	1,138
Little Yacht Sales website – GBAN ad	February 2016 – Present	29,500**
H-GAC TST Quarterly Newsletter	May 2016	350
Houston Zoo Blog article about the Bay and GBAN	July 2016	Unknown
Gulf Coast Mariner Magazine article on WMT	July 2016	10,000
H-GAC TST Quarterly Newsletter	August 2016	350
H-GAC TST Quarterly Newsletter	November 2016	350
EPA News Release about EPA grant	December 2016	36,000
* Total Impressions:		**285,223**

* Total impressions are higher than reported due to content views on partner websites that we are unable to track.

**Page views were not recorded in 2016. These values are projected from 2017 page views available at time of report.

2.2 Marina Partnerships

Through the BWEC, GBF aims to develop relationships with marinas through long-term participation in various programs that support the goals of the BWEC. Table 8 shows which programs each marina plays an active role in. The workgroup and GBF collectively encouraged municipalities and marinas to take advantage of Clean Vessel Act funds to install or maintain pump-out facilities wherever feasible, and GBF has had conversations with TCEQ, Maritime Sanitation, and members of the work group to evaluate the possibility of securing additional funds from various sources for pump-out development and maintenance.

Table 8. Cycle 20 marina participation

Clean Water Partner	Partnership Activities
Bal Harbor Marina	GBF Water Monitoring Team
Bayland Marina	Marina Service Learning Program (November 2015)
Blue Dolphin Yachting Center	GBF Water Monitoring Team
Endeavour Marina	GBF Water Monitoring Team
Galveston Yacht Basin	Dockwalkers
Harborwalk Marina	Dockwalkers
Houston Yacht Club	GBF Water Monitoring Team; Marina Service Learning Program (November 2015)
Lakewood Yacht Club	GBF Water Monitoring Team; Boater Waste Workgroup
Marina Bay Harbor Yacht Club	Pump Don't Dump; Boater Waste Workgroup
Marina Del Sol	GBF Water Monitoring Team
Maritime Sanitation	Pump Don't Dump; Boater Waste Workgroup
Nassau Bay Yacht Club	GBF Water Monitoring Team
Portofino Harbour Marina & Yacht Club	GBF Water Monitoring Team
Redfish Island Marine	Pump Don't Dump
Sea Star Base Galveston	GBF Water Monitoring Team
Seabrook Marina	Dockwalkers, Pump Don't Dump
South Shore Harbour Marina	GBF Water Monitoring Team

Star Fleet Yachts	GBF Water Monitoring Team (training site)
Texas Corinthian Yacht Club	GBF Water Monitoring Team
Topwater Grill	GBF Water Monitoring Team
Waterford Harbor Yacht Club & Marina	GBF Water Monitoring Team; Dockwalkers
Watergate Yachting Center	Pump Don't Dump; GBF Water Monitoring Team; Dockwalkers

Task 3. Boat Sewage Discharge Reporting and Enforcement

3.1 Galveston Bay Action Network (GBAN)

GBAN aims to educate citizens on how and where to report boat sewage discharges and other common water pollution incidents. The BWEC workgroup's theory is that more citizens reporting illegal discharges will more effectively open the eyes of marina owners, boaters, and enforcement agencies to the reality of the boater waste issue than would GBF and workgroup members receiving the reports via word of mouth and sending them informally to the enforcement agencies. Having a central location for citizens to submit reports also makes it easier on them and provides regulatory agencies with quicker reporting of pollution events. The site was developed in Cycle 18 (www.galvbay.org/GBAN), allowing citizens to fill out a simple form with critical details of the pollution incident such as location, type of pollution, photos of the pollution, and follow-up contact information. The report is automatically emailed to the appropriate authority based on the type of pollution and municipality reflected in the report. On the back-end, regulatory agencies at the state, county, and city levels are tied into the app to receive reports and have generally been very excited about the technology. Our ultimate goal with GBAN is to keep our water fishable and swimmable through the transparent exchange of information. We hope that this results in safer and more attractive marinas in Galveston Bay and Clear Lake.

The major focus for this task during Cycle 20 included working with the GBAN developer, Vertices, LLC, to develop and launch a mobile app version of GBAN for iPhones and iOS devices. GBF is currently in the beta testing-phase of this process, and the preliminary version of the app is under review from local partners at this time. GBF and Vertices think that by releasing the app to specific partners for a two-three week testing phase prior to the formal launch we will be able to identify and fix any bugs in the software prior to its official release. The formal launch will likely occur in mid April, 2017, ideally coinciding with Earth Day on April 22nd. During Cycle 20, GBF also continued to add partner agencies to GBAN, ensuring quicker and more efficient responses to GBAN reports in certain cities throughout the four-county region. During this cycle, GBF added Chambers County Environmental Health & Permitting and The City of Houston to GBAN to receive relevant pollution complaints. This tool has allowed us to continue bridging relationships with these new partners and previously existing partners.
GBF used the launch of the GBAN online tool, the strength of its partnerships and the improved functionality of the tool to leverage funding for a new grant through the U.S. EPA Gulf of Mexico Program to fund the creation of a GBAN downloadable iOS and Android mobile application. Future CMP funding will continue to help support the annual licensing fees or minor updates to the desktop and mobile-optimized sites, as well as continued outreach to the boating community. Details on GBAN outreach and results are details in Tasks 1, 2, and 5.

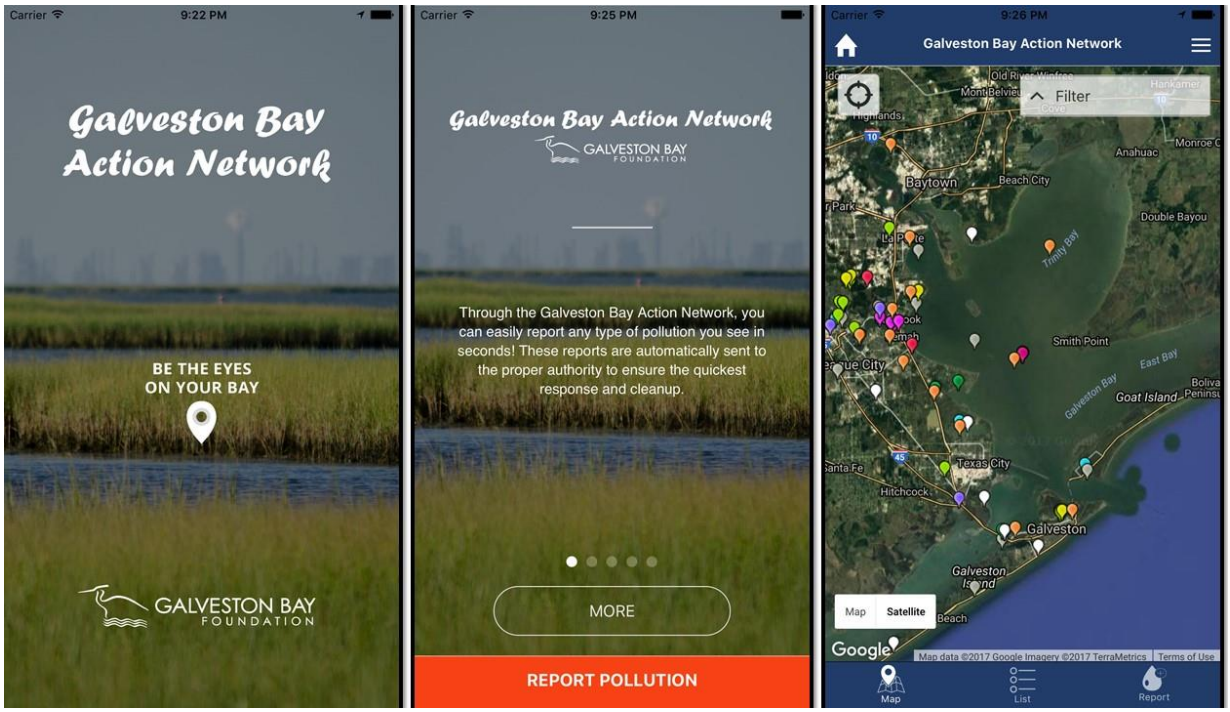

Figure 8. Screenshots of home page (left), main menu (middle), and map of past reports (right) for the GBAN mobile app developed during Cycle 20

3.2 Enforcement-Related Meetings/Presentations

GBF continued to disseminate information related to illegal discharge enforcement in the surrounding community through a variety of speaking engagements and individual meetings with members of the recreational boating community, seafood industry, commercial boating community, enforcement agencies, and community leaders. This information, along with the extensive research carried out with our interns in 2015, now make up some standard content that we included in all presentations for the boating community. The presentations that we delivered during this grant cycle that incorporated enforcement-related information are listed in Table 9. The information in these presentations has opened up great dialogue with the recreational boating community and will continue to provide GBF the opportunity to gain stakeholder support for a federal No Discharge Zone in Galveston Bay. Throughout Cycle 20, it became apparent that in order to realistically pursue an NDZ designation for Galveston Bay, GBF will need to gain additional support from commercial boating groups and the shipping industry throughout the Houston region. Therefore, GBF will focus NDZ efforts in future cycles on strengthening relationships with the commercial boating community and continuing to work with leaders in this industry on a NDZ designation.

Table 9. Enforcement-related meetings and presentations

Audience	Date	Impressions	Description
Environmental Professionals	1/13/2016	25	Galveston Bay Estuary Program State of the Bay Symposium
College Students	3/2/2016	16	Lee College Environmental Science class – presentation
Boaters	3/18-3/19	15	Southwest International Boat Show – seminar presentation
Boaters	6/8/2016	45	Houston Sail & Power Squadron General Meeting – presentation
Surfers & Galveston Island Community	8/11/2016	15	Galveston Surfriders General Meeting – presentation
Natural Science-minded community members	10/1/2016	15	Audubon Texas Bird Nerd Lecture Series – presentation
Yacht Brokers	10/19/2016	1	NDZ discussion with President Gulf Coast Yacht Brokers Association

Houston Zoo Employees	10/26/2017	20	Greater Houst5on Chapter of American Association of Zoo Keepers lunch and learn – presentation
Oil Spill Response Professionals	12/1/2016	70	Central Texas Coastal Area Committee quarterly meeting – presentation
Seafood Professionals	Ongoing	6	NDZ discussion with President of Louisiana Foods, owner of Crazy Alan's Swamp Shack, owner of Tommy's Restaurant and Oyster Bar, Director of Biology at Landry's Restaurants, owner of Captain Benny's Seafood, and owner of Jeri's Seafood
Conservation Professionals	Ongoing	2	NDZ discussion with presidents of Gulf of Mexico Reef Fish Shareholders' Alliance and Coastal Conservation Association of Texas-Galveston
Marina Managers	Ongoing	24	NDZ discussion with Lakewood Yacht Club, Marina Bay Harbor Yacht Club, Seabrook Marina, South Shore Harbor Marina, Nassau Bay Home and Marina Association, Galveston Yacht Basin, and Harborwalk Yacht Club
Commercial Fishers	Ongoing	2	NDZ discussions with owner of Hillman's Oysters and owner of Captain Ron's Shrimp
Industrial Shippers	Ongoing	1	NDZ discussions with Environmental Affairs Director at Port of Houston Authority
	Total	**257**	

3.3 Enforcement Efforts Carried Out

During this grant cycle, GBF focused efforts on collecting data regarding the potential designation of Galveston Bay as a Federal No Discharge Zone. Specifically, we attempted to strengthen the draft application created during Cycle 19 by ensuring our numbers of pump-out facilities, recreational boaters, and estimates of MSDs by type were accurate. However, it became clear that we had little knowledge on how an NDZ designation would impact the enormous commercial industry present in the Bay, and so our focus quickly shifted towards collecting more information on this sector as it relates to waste management and vessel sewage. GBF scheduled and carried out numerous meetings with members of the seafood distribution, restaurant, commercial fishing, enforcement, and tourism industry to discuss the NDZ initiative and to open up a dialogue with these individuals to better address any questions or concerns they may have. A list of these meetings and their outcomes can be found in Table 10. These discussions were generally very positive, with the majority of stakeholders indicating that they would likely support this type of initiative. However, nearly every stakeholder also mentioned that it may be difficult to get all Bay users onboard, and that an NDZ designation will likely take quite some time and may present unintended consequences against low-income members of the commercial boating industry.

Therefore, GBF will continue these discussions with a broader range of stakeholders, and attempt to address any potential concerns as they arise. GBF also drafted a white paper on NDZ implementation throughout the country to answer various questions that city officials, commercial boaters, and recreational vessel owners may have about an NDZ. This document is currently going through a round of revisions and is not meant for mass distribution. During this cycle, GBF also reached out to individuals who worked on NDZ designations in Massachusetts, California, Washington State, Maryland, and Virginia to gather more information on how these states incorporate commercial vessels into their designations and what obstacles they faced throughout the process. GBF is still currently working with commercial groups to determine the best path forward regarding the NDZ, and to collect additional data on boating activity in the Bay that would strengthen any potentially submitted designation application. Throughout this cycle, GBF kept TCEQ and the EPA updated on the status of the NDZ draft application. GBF was able to identify contacts at both agencies who would receive the designation once submitted, though both contacts are generally unfamiliar with the designation process and will most likely be learning as they go.

Throughout this cycle, GBF continued to network with the entities listed in Table 10 that either can directly enforce illegal dumping of boat sewage or that can influence policy in some way. We will continue to keep these lines of communication open as we move forward with advocating for increased enforcement.

Table 10. Entities that can enforce or influence enforcement practices and are in communication with BWEC

Last	First	Organization
Bower	Justin	Houston Galveston Area Council
Brooks	Chris	Food and Drug Administration (Shellfish Specialist) – Dallas Region
Capuzzi	Nicholas	U.S. Coast Guard
Carol	Karen	Brazoria County Environmental Health
Carrier	Mary	Texas Parks and Wildlife – Boater Education
Easley	Gregg	Texas Commission on Environmental Quality
FitzSimmons-Evans	Lori	Galveston County Health Department
Galindo	David	Texas Commission on Environmental Quality
Hall	Lynda	Lakewood Yacht Club/Clear Lake Marina Association/MAT
Hockersmith	Kyle	City of Galveston
Johnston	Steve	Houston Galveston Area Council
Laird	Kim	Texas Commission on Environmental Quality
Mitchell	Steven	Texas Parks and Wildlife Department: Kills and Spills
Morris	Chip	Texas Commission on Environmental Quality
Paige	Helen	Marina Bay Harbor/Marina Association of Texas
Pollock	Greg	General Land Office
Sibley	Nancy	Harris County Pollution Control
Tunze	Rex	Chambers County Environmental Health
Wheeler	Jennifer	Harris County Pollution Control
Wiles	Kirk	Texas Department of State Health Services
Wright	Jean	Houston Galveston Area Council

Task 4. Facilitate Volunteer Programs

Volunteer programs can be a very cost effective way to increase the visibility of a campaign and spread your message further. When the BWEC began in 2007, the only volunteer components were the BWEC Workgroup and occasional volunteers to assist with education booths and assembling outreach materials. There are now five additional volunteer programs: Galveston Bay Action Network, Dockwalkers, GBF Water Monitoring Team (2,442), Volunteer Water Quality Internships (160 hours), and Marina Service Learning Days, three of which were launched just last cycle. BWEC volunteer programs generated a total of over 2,600 volunteer hours during this funding cycle and engaged more than 60 volunteers through four volunteer programs, citizen pollution reporters on GBAN, and the Boater Waste Workgroup. Each of the volunteer programs is described below.

4.1 GBF Dockwalkers

Dockwalkers is a volunteer program for boaters to educate other boaters on environmentally sound practices through positive "pier" pressure, to provide them with physical tools to keep the bay fishable and swimmable, and to collect local statistics to aid in environmental planning. GBF's program is based off a very successful similar program in California, but has been modified to focus on the immediate water quality needs of the Galveston Bay area. GBF trains volunteers, particularly from boating organizations or companies, to take quality controlled surveys. The survey contains questions that helps GBF obtain data to improve the Pump Don't Dump campaign, provide marinas with data on pump-out usage and functionality, and collect statistics to be considered in the process of applying for a Galveston Bay No Discharge Zone.

Dockwalkers ask boaters to take a few minutes to fill out the educational survey (Appendix II) and the boaters receive a Clean Boater Kit (BWEC education materials, Pump Don't Dump zip tie for discharge valve, dye tablet, and bilge oil absorbent pad) (Figure 1) in exchange for their participation. Dockwalkers are also trained to submit water pollution reports through GBAN. Details on the survey sampling design can be reviewed in the Dockwalker Plan found in Appendix II.

Table 11 shows the Dockwalker volunteers and survey plan, while Table 12 shows the Dockwalker training and survey schedule. GBF's Summer 2016 Water Quality Outreach Intern surveyed local boaters and compiled the results and lessons learned. This information was used to tweak and improve the program and we have since determined that the Dockwalker Program is most effectively employed when GBF staff, interns and a small number of highly engaged volunteers are utilized. We will no longer, therefore, try to recruit and maintain a large volunteer team. This also helps GBF ensure that the data collected is high quality. GBF has posted the survey on its website to increase its reach within the boating community, and has also received applications for a summer intern to assist with this program during the summer of 2017. Up-to-date results since the program's establishment are summarized under Task 5.

Table 11. Dockwalker volunteers and survey plan

Name	Organization	Survey Schedule	Target Locations
Sarah Gossett	Galveston Bay Foundation (staff)	As needed	GBF random sampling plan
Nate Johnson	Galveston Bay Foundation (staff)	As needed	GBF random sampling plan
Kaitlin Grable	Galveston Bay Foundation (staff)	As needed	GBF random sampling plan
Raymond Underwood	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
Robert Stevenson	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
Linton Arbaugh	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
James Stanley	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
Mary Carrier	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
Susan Morawski	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
John Morawski	Galveston Bay Sail and Power Squadron	Spring 2016 at the Southwest International Boat Show – volunteer under Candy Day	2016 SWIBS
Kelsey McCraw	Galveston Bay Foundation (intern)	Summer 2016 (inactive)	GBF random sampling plan
Amber Faubion	Individual (former Marina Del Sol marina manager)	inactive	Marina Del Sol
Bill Haddock	Houston Sail and Power Squadron	10/month during boating season	Wherever conducting Vessel Safety Checks
Caitlyn Suttle	Onward/Maritime	inactive	Wherever conducting vessel pump-outs
Chris Machol	Onward/Maritime		Wherever conducting vessel pump-outs

James Carlton	Onward/Maritime		Wherever conducting vessel pump-outs
Jonathan Christopher	Onward/Maritime		Wherever conducting vessel pump-outs
Matthew McLemore	Onward/Maritime		Wherever conducting vessel pump-outs
Sean Fitzgerald	Onward/Maritime		Wherever conducting vessel pump-outs
Sterling Walker	Onward/Maritime		Wherever conducting vessel pump-outs
Candy Capuano Day	Galveston Bay Sail and Power Squadron	Whenever conducting Vessel Safety Checks or at boat shows	Wherever conducting Vessel Safety Checks or at boat shows

Table 12. Dockwalker trainings and survey schedule

Date	Event	Site	Dockwalkers	# Volunteer Interactions	# Surveys
10/3/2015	Surveying	Bal Harbor Marina	Candy Capuano Day – GB Sail and Power Squadron	1	1
3/17 – 3/20/2016	Surveying	Southwest International Boat Show	Candy Capuano Day – GB Sail and Power Squadron	8	52
7/1 – 7/2/2016	Surveying	Galveston Yacht Basin	Kelsey McCraw – Galveston Bay Foundation (intern)	1	25
7/8 – 7/9/2016	Surveying	Harborwalk Yacht Club	Kelsey McCraw – Galveston Bay Foundation (intern)	1	7
7/15 – 16, 7/22/2016	Surveying	Seabrook Marina and Watergate Yachting Center	Kelsey McCraw – Galveston Bay Foundation (intern)	1	14
9/24 – 25/2016	Surveying	Southwest International Boat Show	Candy Capuano Day – GB Sail and Power Squadron	1	17
Sep 2016 – March 2017	Surveying	Online		0	62
			TOTAL	**13**	**178**

4.2 GBF Water Monitoring Team

The GBF Water Monitoring Team (a group within the Texas Stream Team) was launched in February 2012, with the Bacteria Sampling Program launching shortly thereafter in January 2013. There are four main goals for collecting water quality data through these programs for the BWEC:

1.) To engage citizens in a hands-on program that empowers them to be Bay Ambassadors
2.) To create a line of communication between GBF, boaters, and marinas on a regular basis
3.) To establish baseline data trends at marinas and other near-shore recreational sites in Clear Lake and Galveston Bay
4.) To detect potential bacteria impairments in marinas and other near-shore recreational sites in Clear Lake and Galveston Bay

GBF Water Monitoring Team volunteers are certified to sample at sites around the bay and Clear Lake for core parameters (temperature, pH, dissolved oxygen, salinity, transparency, and field observations), as well as enterococci bacteria. Core certification consists of a full day, two-phase group training session and a one-on-one Phase III training at the volunteer's site with a GBF staff member. This training process is based on the Texas Stream Team training protocol. During the Phase I and II session, volunteers learn about water quality in the Bay, the importance and expectations of being on the Water Monitoring Team, and what each of the parameters that they will measure means. Then they practice the sampling techniques as a group with

tap water samples, going through each procedure step-by-step as GBF staff demonstrate the proper techniques and observe their techniques for quality control (Figure 14). Finally, they learn how to properly take a bucket grab sample and record field observations, and then work with a partner to complete the core techniques on a field sample. GBF staff members observe and compare their results to an advanced monitor for quality control. During Phase III each volunteer is encouraged to use their field guide to demonstrate the entire sampling process from beginning to end with the GBF staff member observing and not giving any input (Figure 16). They receive feedback at the end on any improvements needed and GBF staff determines if they meet the quality control checks to become a certified Water Monitoring Team volunteer. They commit to sampling their site(s) on at least a monthly basis. GBF's team is part of the Texas Stream Team because of its partnership with the Houston Galveston Area Council's region. However, GBF also has its own Volunteer Bacteria Sampling Program. The monitoring team currently has 56 volunteers sampling from 58 locations, 23 of whom have advanced certification to collect bacteria samples. A full map of monitoring locations can be accessed at http://www.galvbay.org/watermonitors. The entire monitoring program is conducted under an EPA-approved Quality Assurance Project Plan and Quality Management Plan**.**

The WMT has allowed GBF to develop a strong relationship with the local chapter of Master Naturalists, who are also interested in preserving, protecting, and enhancing Galveston Bay. Implementation of the WMT has allowed GBF to better connect with many marina and waterfront restaurant owners around Galveston Bay to provide sampling sites and promote clean water (Figure 18). GBF continues to make improvements to the management and processes within the WMT, including the creation and maintenance of a Water Monitoring Action Plan, to outline desired measurable results from monitoring (Appendix III). This document is a working document, and will continue to be evaluated and revised in the coming years. GBF plans to continue training new volunteers to fill in some of the gaps around the Galveston Bay coastline and marinas that are not yet monitored, as well as to refill sites if volunteers decide to stop monitoring. Table 13 shows the total number of volunteers trained since GBF began the WMT, the number with advanced certification to sample for bacteria, and calculates the percentage of active volunteers compared to total certified volunteers. In Cycle 20, 95% of GBF's volunteer water monitors were active volunteers. Though this represents a small decrease (5%) from Cycle 19, we believe that this fluctuation is to be expected given the increase in total volunteers over the last twelve months. GBF did, however, train an additional Volunteer Lab Assistant who has helped with bacteria processing and data entry during Cycle 20. A list of certified volunteers and their monitoring schedule is found in Table 14, a list of newly trained monitors that are still finishing their training are listed in Table 15, and a detailed list of WMT training events is listed in Table 16.

Table 13. GBF Water Monitoring Team active monitor data

Reporting Period	# Phase I and II's completed this period	# Phase III's completed this period	Total # Bacteria Samplers	Total # GBF Monitoring Sites	Total # GBF Certified Monitors	Total # Active Monitors**	% Active
Before GBF started team*	0	10	0	9	10	4	40%
11/31/12	36	17	0	23	24	8	33%
5/31/13	16	14	11	27	28	21	75%
1/31/14	21	15	13	39	38	32	84%
12/8/14	26	19	20	49	50	40	80%
3/15/16	37	12	16	36	31	31	100%
3/14/17	34	29	17	58	56	53	95%

*These monitors were previously trained by other Texas Stream Team trainers and adopted onto GBF's team upon formation

**Active monitors are those who submit data on at least a monthly basis with very few missed months

Table 14. Current GBF Water Monitoring Team volunteers, sites and monitoring schedule

Site ID	Site Description	Name	Group	Lat	Long	Monitoring Schedule

81181	Christmas Bay @ Drum Bay	Glenn Taylor	34	29.012245	-95.21841	3rd Sunday @ 1pm
81173	Clear Lake @ 18 Waterford Oak Lane	James Dismukes	34	29.545952	-95.043871	4th Monday @ 8:30am
80956	Clear Lake @ Blue Dolphin Yachting Center	Derek Baldwin	34	29.558397	-95.028258	1st Saturday @ 8am
15105	Clear Lake @ Clear Lake Park Pier	Diane Humes	34	29.563703	-95.066049	Last Monday @ 8:15am
80759	Clear Lake @ Clear Lake Shores	Arline Laughter/Helle Brown	34	29.551061	-95.032680	2nd Tuesday
81216	Clear Lake @ Encore on the Bay	Marie Pope	34	29.564799	-95.05955	1st of the month @ 6pm
80953	Clear Lake @ Endeavour Marina	Lauren & Tony Secino	34	29.559879	-95.04224	1st Sunday @ 10am
80758	Clear Lake @ Jarboe Bayou Park	Helle Brown/Arline Laughter	34	29.542023	-95.03054	2nd Tuesday
81045	Clear Lake @ Kemah Boardwalk Aquarium	LeAnn Kincaid	34	29.548575	-95.021	1st Wednesday @ 9am
80467	Clear Lake @ Lakewood Yacht Club	Claire McNulty	34	29.554589	-95.031020	3rd Tuesday @ 8am
30012	Clear Lake @ Marina Del Sol	Rodney Ray	34	29.552070	-95.052056	1st Thursday @ 8:30am
30010	Clear Lake @ Nassau Bay Upper Bay Road	Michael Chang	34	29.544286	-95.085907	15th @ 6pm
81040	Clear Lake @ Nassau Bay Yacht Club	Helen Lane	34	29.541451	-95.097180	2nd Tuesday @ 9am
81049	Clear Lake @ Portofino Harbour Marina	Betty Henriquez	34	29.547255	-95.025551	2nd Tuesday @ 9am
81283	Clear Lake @ Sea Cove Ct	Sarah Gossett	34	29.537825	-95.08432	1st Wednesday @ 9am
81037	Clear Lake @ South Shore Harbor	Adeola Mosuro	34	29.547330	-95.064334	3rd Tuesday @ 1pm
81217	Clear Lake @ Taylor Lake Entrance & Nasa Rd	Laura MacNeil	34	29.565483	-95.05387	
81173	Clear Lake @ Waterford Harbor Marina	Leydi Serrano	34	29.54755	-95.04381	3rd Friday @ 8am
30014	Clear Lake @ Watergate Yachting Center	Catherine Navarro	34	29.545433	-95.040012	3rd Thursday @ 4pm
81164	Clear Lake @ Watergate Yachting Center Pier 3	Tyler Dudley	34	29.545271	-95.03637	3rd Monday @ 9am
80961	East Bay @ Anahuac National Wildlife Refuge	Brenda Gonzales	34	29.540939	-94.520594	3rd Saturday
81039	East Bay @ Bluewater Bait Camp	Kate Magee	34	29.450572	-94.668544	4th Sunday 3pm
81280	East Bay @ Frenchtown Road	Taylor Cubbage	34	29.371335	-94.7774	3rd Sunday @ 9am
80949	East Bay @ Stingaree Restaurant Bar	Carl Young	34	29.482082	-94.605146	3rd Wednesday @1pm
30008	Galveston Bay @ 1109 6th St. San Leon	Mark Niles	34	29.478655	-94.920231	1st Tuesday @ 6pm
80952	Galveston Bay @ 3903 Bayshore Bacliff	Dianne Forthmann and Joe Cavallaro	34	29.515548	-94.985700	30th of each month
30009	Galveston Bay @ Bayland Park	Lana Berkowitz	34	29.713048	-94.993137	1st Thursday @ 9am
80951	Galveston Bay @ Bayshore Park	Brenda Gonzales	34	29.506474	-94.958050	3rd Saturday
80960	Galveston Bay @ Candy Abshier Wildlife Management Area	Brenda Gonzales	34	29.525213	-94.765333	3rd Saturday
81281	Galveston Bay @ GBF	Jane Webb	34	29.532912	-95.0093	15th @ 1pm
81162	Galveston Bay @ Houston Yacht Club	Teresa Wheeler	34	29.619129	-94.999132	3rd Tuesday @ 17:30

81042	Galveston Bay @ Pier 21	Catherine Navarro	34	29.309929	-94.793224	1st Saturday
80463	Galveston Bay @ Pine Gully Park	Madeleine Barnes	34	29.589580	-94.990566	Middle of month
80418	Galveston Bay @ Seascape Pier	Gary Bell	34	29.584541	-94.996785	2nd Wednesday @ 11am
81052	Galveston Bay @ Seawolf Park	Tera Alexander	34	29.338162	-94.778087	the 31st @ 9am
81044	Galveston Bay @ Shoreacres Pier	Kay and Kendall Pickett	34	29.622030	-95.004664	3rd Sunday @ 1pm
81161	Galveston Bay @ Sunset Cove	Glenn Taylor	34	29.151222	-95.030368	30th of each month
80950	Galveston Bay @ Sylvan Beach Park	Brenda Gonzales	34	29.652914	-95.005539	3rd Saturday
81053	Galveston Bay @ Texas AM University Galveston	Minna Tambourides	34	29.312710	-94.816697	2nd Friday @ 2pm
30013	Galveston Bay @ Texas City Dike	Cindy Liening	34	29.387027	-94.874629	2nd Thursday @ 4pm
81160	Galveston Bay @ Texas Corinthian Yacht Club	Laurence Neuhaus	34	29.529115	-95.00324	4th Tuesday
81218	Galveston Bay @ Todville Rd	Suzanne Milby	34	29.569982	-95.00985	the 28th @ 14:00
81051	Galveston Bay @ Topwater Grill	Mark Niles	34	29.470799	-94.925598	4th Saturday
80957	Jones Bay @ 267 Isles End Tiki Island	John Wright	34	29.299985	-94.927089	2nd Wednesday @ 9am
81159	Jones Bay @ Bayou Vista	Chris Roper	34	29.323449	-94.946625	Every Other Tuesday @ 8:30
80719	Moses Bay @ Texas City Prairie Preserve	Scott Buckel	34	29.428824	-94.950470	Mondays and Fridays
30007	Offatt's Bayou @ Camarone's Coastal Tex Mex	Stan Conley	34	29.278705	-94.834720	3rd Sunday @ noon
81034	Offatt's Bayou @ Sea Star Base Galveston	David Dellapenna	34	29.285622	-94.853502	2nd Tuesday @ 4pm
81041	Swan Lake @ 257J Boat Ramp	Breana Hyche	34	28.979729	-95.268679	3rd Friday @ 10am
81036	Trinity Bay @ Carroll Road	Bob Lanser	34	29.685690	-94.866120	2nd Friday @ 10am
81047	Trinity Bay @ Galveston Bay RV Resort	Genevieve Genest	34	29.698141	-94.945875	3rd Sunday @ 9am
81038	West Bay @ Eckert Bayou	Amber Wisber	34	29.221619	-94.933181	2nd Wednesday @ 8am
81282	West Bay @ Jamaica Beach	Wayne O'Quin	34	29.189151	-94.98031	2nd Tuesday @ 2pm
81048	West Bay @ Oak Bayou	Skyler Carey	34	29.204895	-94.957483	3nd Sunday @ 10am
81158	West Bay @ Pirate's Cove	Sandra Metoyer	34	29.217963	-94.94943	1st Sunday @ 9am
80954	West Bay @ Sportsman Road	Kaitlin Grable	34	29.255152	-94.918154	Every 3rd Thursday
81219	West Bay @ Sweetwater Lake	Arnold Leija	34	29.254835	-94.87969	2nd Saturday @ noon
81046	West Bay @ Sweetwater Preserve	Mary Warwick	34	29.272506	-94.881102	3rd Sunday @9:30

Table 15. New WMT volunteers completing final phase of training

Site ID	Site Description	Name	Group	Lat	Long
81037	Clear Lake @ South Shore Harbor	Adeola Mosuro	34	29.547330	-95.064334
30010	Clear Lake at Nassau Bay Upper Bay Road	Amel Ryman	34	29.544286	-95.085907

81219	West Bay @ Sweetwater Lake	Arnold Leija	34	29.254835	-94.879686
81049	Clear Lake at Portofino Harbor	Betty Henriquez	34	29.547255	-95.025551
81048	Lab Assistant (West Bay @ Oak Bayou)	Cassandra Carey	34	29.204895	-94.957483
81042	Galveston Bay @ Pier 21	Catherine Navarro	34	29.309929	-94.793224
81039	East Bay @ Bluewater	Kate Magee	34	29.450572	-94.668544
30009	Galveston Bay @ Bayland Park	Lana Berkowitz	34	29.713048	-94.993137
80953	Clear Lake at Endeavor Marina	Lauren Secino	34	29.55988	-95.04224
81216	Clear Lake at Encore On the Bay	Marie Pope	34	29.5648	-95.05955
80953	Clear Lake at Endeavor Marina	Michael Secino	34	29.55988	-95.04224
80959	Offat's Bayou at Pelican Rest Marina	Minna Tambourides	34	29.284831	-94.856150
30012	Clear Lake @ Marina del Sol	Rodney Ray	34	29.552070	-95.052056
30007	Offatts Bayou @ Camorone's	Stan Conley	34	29.27871	-94.834720
81218	Galveston Bay @ 2612 Todville Road	Suzanne Milby	34	29.56482	-95.01354
81052	Galveston Bay @ Seawolf Park	Tera Alexander	34	29.338162	-94.778087
81162	Galveston Bay @ Houston Yacht Club	Teresa Wheeler	34	29.619129	-94.999132
81280	East Bay @ Frenchtown Road	Taylor Cubbage	34	29.371335	-94.777401
80956	Clear Lake @ Blue Dolphin Yachting Center	Derek Baldwin	34	29.558397	-95.028258
81173	Clear Lake @ Waterford Marina	Leydi Serrano	34	29.54755	-95.043812
81041	Swan Lake @ 257J County Boat Ramp	Breana Hyche	34	28.979729	-95.268679
81034	Offatts Bayou @ Sea Star Base Galveston	David Dellapenna	34	29.853502	-94.853502
30010	Clear Lake @ Nassau Bay Upper Bay Rd	Michael Chang	34	29.544286	-95.085907
81282	West Bay @ Jamaica Beach	Wayne O'Quin	34	29.189151	-94.980308
80467	Clear Lake @ Lakewood Yacht Club	Claire McNulty	34	29.554589	-95.031020
81281	Galveston Bay @ GBF	Jane Webb	34	29.532912	-95.009303
80949	East Bay @ Stingaree Restaurant	Carl Young	34	29.482082	-94.605146
81217	Clear Lake @ Taylor Lake Entrance	Laura MacNeil	34	29.565483	-95.053867

Table 16. GBF Water Monitoring Team training events

Date	GBF Staff	Event	Location	# Volunteers
10/9/2015	Sarah Gossett	Bacteria Sampler Training	GBF Office	3
11/19/2015	Sarah Gossett	Quality Control Training	Marina del Sol	5
12/12/2015	Sarah Gossett	Quality Control Training	Marina del Sol	7
1/27/2016	Sarah Gossett	Quality Control Training	Marina del Sol	6
2/25/2016	Sarah Gossett, Charlene Bohanon	Texas Stream Team Phase I & II training	Star Fleet Marina	21
3/4/2016	Sarah Gossett	Bacteria Sampler and Volunteer Lab Assistant Training	GBF Office	2
3/30/2016	Sarah Gossett	Texas Stream Team Phase III Training	Todville Rd	1
3/31/2016	Sarah Gossett	Texas Stream Team Phase III Training	Seawolf Park	1
3/31/2016	Sarah Gossett	Texas Stream Team Phase III Training	Bluewater Bait Camp	1

4/7/2016	Sarah Gossett	Texas Stream Team Phase III Training	Nassau Bay Upper Bay Rd	1
4/15/2016	Sarah Gossett	Texas Stream Team Phase III Training	Sweetwater Lake	1
4/14/2016	Sarah Gossett	Texas Stream Team Phase III Training	Portofino Harbor	1
4/4/2016	Sarah Gossett	Texas Stream Team Phase III Training	Pier 21 Galveston	1
4/6/2016	Sarah Gossett	Texas Stream Team Phase III Training	Bayland Park	1
4/20/2016	Sarah Gossett	Texas Stream Team Phase III Training	Endeavour Marina	2
4/29/2016	Sarah Gossett	Texas Stream Team Phase III Training	Encore Apts	1
4/8/2016	Sarah Gossett	Texas Stream Team Phase III Training	TAMUG	1
4/5/2016	Sarah Gossett	Texas Stream Team Phase III Training	Houston Yacht Club	1
4/15/2016	Sarah Gossett	Texas Stream Team Phase III Training	Camerone's Coastal Tex Mex	1
4/5/2016	Sarah Gossett	Texas Stream Team Phase III Training	Marina del Sol	1
5/3/2016	Sarah Gossett	Texas Stream Team Phase III Training	Clear Lake Park	1
7/8/2016	Sarah Gossett	Quality Control Training	Marina del Sol	5
8/21/2016	Sarah Gossett	Quality Control Training	Marina del Sol	4
8/22/2016	Sarah Gossett	Bacteria Training	GBF Office	5
8/19/2016	Sarah Gossett	Texas Stream Team Phase I Training	GBF Office	3
9/8/2016	Sarah Gossett	Texas Stream Team Phase II Training	Nassau Bay Upper Bay Rd	2
9/13/2016	Sarah Gossett	Texas Stream Team Phase I Training	GBF Office	1
9/16/2016	Sarah Gossett	Texas Stream Team Phase II & III Training	Nassau Bay Upper Bay Rd	2
9/23/2016	Sarah Gossett	Texas Stream Team Phase III Training	Bal Harbor Marina	2
11/18/2016	Sarah Gossett & Nate Johnson	Texas Stream Team Phase I & II training	Star Fleet Marina	13
1/24/2017	Sarah Gossett	Quality Control Training	Marina del Sol	9
12/15/2016	Sarah Gossett	Texas Stream Team Phase III Training	GBF Kemah Property	1
12/16/2016	Sarah Gossett	Texas Stream Team Phase III Training	Waterford Marina	1
12/19/2016	Sarah Gossett	Texas Stream Team Phase III Training	Lakewood Yacht Club	1
12/21/2016	Sarah Gossett	Texas Stream Team Phase III Training	Frenchtown Rd, Bolivar	1
12/21/2016	Sarah Gossett	Texas Stream Team Phase III Training	Stingaree Restaruant	1
12/22/2016	Sarah Gossett	Texas Stream Team Phase III Training	Nassau Bay Upper Bay Rd	1

1/4/2017	Sarah Gossett	Texas Stream Team Phase III Training	257J Boat Ramp, Swan Lake	1
1/5/2017	Sarah Gossett	Texas Stream Team Phase III Training	Blue Dolphin Marina	1
1/10/2017	Sarah Gossett	Texas Stream Team Phase III Training	Sea Star Base Galveston	1
1/10/2017	Sarah Gossett	Texas Stream Team Phase III Training	Jamaica Beach	1
1/18/2017	Sarah Gossett	Texas Stream Team Phase III Training	Stingaree Restaruant	1
			Total	**117**

In Cycle 19, GBF participated in a webinar series titled *Monitoring That Guarantees Measurable Results*, hosted by River Network. This five-part series facilitated the creation of a comprehensive monitoring plan that will guide GBF water monitoring efforts to measurable results. The creation of this plan outlines the strengths and limitations of the WMT data through a series of desired outcomes. For each desired outcome, the monitoring plan lays out monitoring questions, targeted decision makers, information needed and further required action to accomplish the outcome. The Action Plan created as a result of this webinar series is included in Appendix III. This has driven the work of the Water Quality Volunteer Coordinator as well as the actions of the Water Monitoring Team throughout Cycle 20. GBF has also decided to host a summer intern in 2017 to examine water quality throughout the Bay, specifically within marinas, to carry out some of the steps outlined in the Action Plan. GBF understands that this Action Plan is a working document that will continue to evolve with the Water Monitoring Team, though GBF has already seen the benefits of this plan in action as staff are better able to communicate the need and purpose of our team to both volunteers and the community as a whole. The Action Plan outlines an estimated timeline for when each component will be completed and these enhancements to the Water Monitoring Team will continue to be carried out during Cycle 21. Finally, GBF submitted an application to the National Academy of Sciences for their Gulf Research Program's Capacity Building Grant Program to engage local stakeholders in water quality issues surrounding Galveston Bay. If funded, this would greatly enhance GBF's ability to maintain and expand our Water Monitoring Team.

4.3 Water Quality Internships

During this grant cycle, GBF hosted one Water Quality Outreach Intern (WQOI) in the summer of 2016. These internships allow students to conduct background research related to social marketing for environmental causes and to conduct Dockwalker surveys and outreach in marinas. These interns have proved to be the most efficient way to collect quality survey data for the Dockwalker program, so this will be GBF's primary focus for future summer WQOI. The results of the 2016 WQOI's work is referenced in Task 5 with the Dockwalker data discussion, and the full report developed by the WQOI can be found in Appendix II. This individual also assisted with social media marketing and outreach initiatives for the Pump Don't Dump, GBAN, and Dockwalker Programs. GBF's Water Quality Research Internship (WQRI) was started in 2013 because there was very little existing water quality data for marinas in the Galveston Bay area. To our knowledge, the only study conducted took place over 20 years ago (Guillen et al., 1993). That study was conducted over a three-month period, looking at various water quality parameters in comparison to flow rates, in order to make recommendations for marina designs.

WQRIs provide university students the opportunity to develop and execute a short-term water quality research project from start to finish, including planning, design, sampling, and data analysis components. This program was started in order to provide the many university students in the Clear Lake/Galveston Bay area an opportunity to participate in a hands-on, professional internship experience. Students are introduced to the Upper Gulf Coast Oyster Water TMDL Implementation Plan and the BWEC, certified to sample under GBF's QAPP, and carry out a project to help answer research questions related to the BWEC. This internship program helps provide the BWEC Workgroup and Clean Vessel Committee with focused data to help guide campaign activities, as well as track potential improvements in marina water

quality over time in a more focused way than is possible with monthly ambient monitoring at just one site per marina. The Boater Waste Impact Studies that were completed as a result of this internship program are referenced under Task 5. After three successful years of conducting marina research through the WQRIs, GBF made the tough decision to cut this part of the BWEC because of how resource intensive it is in both supplies and staff time. However, GBF recently decided to begin this program again in the summer of 2017 during Cycle 21, and is currently accepting applications for the position.

GBF did, however, host a student volunteer/intern during the fall of 2016 from a local high school. This student monitored four different sites that were at the time inactive, and drafted a detailed summary report at the end of her internship for class credit (report can be provded upon request). This internship was very helpful, as it allowed GBF to continue monitoring a few inactive sites while providing valuable training and research experience for an incredibly determined high school student hoping to pursue a career in aquatic science.

Task 5. Track Behavior Change and Resulting Environmental Improvements

GBF is continuously looking for ways to improve our tracking methods in order to better demonstrate behavior change and environmental improvements resulting from the BWEC. Due to the nonpoint source, transient nature of boater waste pollution, it can be difficult to attribute changes in water quality specifically to this one source. This is compounded by the fact that water quality data in marinas are lacking. During this funding cycle, GBF continued to carry out several volunteer programs that began in Cycle 17, which will help increase the amount of water quality data and supporting data that can be collected in marinas. The following sections will detail results for Cycle 20 and will address opportunities for improvement in future cycles.

5.1 Galveston Bay Action Network (GBAN)

GBAN serves as a tool to help the public report all types of pollution they see more easily. In the past, people would often see pollution but have no idea who to call to report this pollution. To help with this, GBF created a table of various contacts to call, based on the type of pollution and location. However, this list was long, complex, and difficult to use leading to pollution often going unreported, and ultimately with no response from authorities. Through GBAN, citizens are now able to easily report any pollution they see, making them more likely to report it in the first place. Additionally, GBAN sends the reports to the proper authority automatically, expediting the response time from the responding agency. In the past, many pollution reports were sent to TCEQ, who would then have to determine who the report needed to be sent to, increasing the amount of time before the proper authority would receive the report.

GBF launched the official GBAN website in December of 2014. During this cycle, the webpage has received 1,618 page views. GBF launched three GBAN social media campaigns this cycle, one in October of 2015, one in June 2016, and one in July 2016. Combined these campaigns received a reach of 88,288 on Facebook and Twitter, with 3,247 Facebook Likes/Comments/Shares and 1,930 post clicks. Previously there had been no direct GBAN presence on GBF's Facebook page. Since October 2015, GBAN has received 46 reports. The most popular types of pollution reports were Oil/Sheen and Trash/Debris. GBF looks forward to continuing its marketing campaign, including the creation of a more focused marketing plan to increase usage of this pollution reporting tool.

In an effort to increase of the use of GBAN by the boater audience, GBAN has created new cards for distribution that specifically target the boating community (Figure 5) and have increased GBAN messaging within the Pump Don't Dump campaign materials. During Cycle 20, GBF focused mainly on distributing GBAN and Pump Don't Dump materials at presentations and boothing exhibits. GBF distributed the GBAN Citizen Engagement Toolkit to partner marinas and other boating groups to increase marketing efforts for GBAN within the boating community specifically. To date, six organizations have used this toolkit to market GBAN on their website: Maritime Sanitation, The Double

Bayou Watershed Protection Partnership, The Galveston Bay Estuary Program, The Texas Coastal Watershed Program, IM Rivers, and Little Yacht Sales (Table 7).

During Cycle 20, GBF also began the process of creating a mobile app for GBAN to increase its ease of use and expand its appeal within the Houston-Galveston region. GBF contracted the development work to Vertices LLC, and from August 2016 to March 2017, GBF and Vertices worked on developing the mobile app for Android and iOS devices. GBF began beta testing for the app in March of 2017, and anticipates a formal launch in mid April, 2017. GBF will also internally coordinate a marketing campaign that coincides with the launch of the GBAN app. We believe that creating a downloadable, smartphone-optimized version of GBAN will ultimately make it more appealing to the diverse audience GBF is trying to reach, and make it easier for users to identify and report pollution in their local communities to the proper authorities.

5.2 GBF Dockwalkers

To date, GBF has trained a total of 21 volunteers, and 357 surveys have been conducted since the inception of this program. These data represent approximately 1.5% of the boating population with boats > 25 feet and covers numerous diverse marinas. In order for the data to be statistically significant, GBF calculated that we must reach 370 surveys. This is GBF's goal, though we will continue surveying past this in order to track how boater education and behavior changes over time. Figures 9 – 13 summarize a few key findings from Cycle 20's Dockwalker data. The data in Figures 9 and 10 inform us that we needed to take a new approach to our Pump Don't Dump messaging and distribution since so many people were unaware of how many pump-out stations there really are around the Bay and the consequences for not securing the y-valve/main discharge valve. As a result of these findings, GBF will shift marketing campaigns in the future to focus on educating boaters that there are indeed more than 20 pump-out facilities throughout the Bay. The results in Figure 17 are not surprising considering the ongoing lack of enforcement by state and federal entities. However, GBF will continue to try to drive improvements in enforcement by educating boaters on where to report illegal dumping with the hope that authorities will take notice of this issue. The data in Figure 18, along with other data collected on the survey, will assist GBF in calculating the waste production on the average boat on Galveston Bay and multiply that by the total number of registered boats to get a basic idea of the amount of waste that boaters produce per year. More importantly, it gives the boating community a great visual to show that a large proportion of boaters in our area do, in fact, use their onboard sewage facilities. Though this method of waste calculation may suffice for GBF's purposes, GBF will also continue to work with academic institutions to address questions of relative bacteria contributions by boaters within Galveston Bay compared to bacteria contributions as a whole in the Bay.

Figures 12 and 13 will help us determine how many boats will be impacted by a No Discharge Zone by determining the percentage of boats already in compliance with an NDZ. Figure 12 represents a potentially positive finding from our survey, as it shows that roughly 95.25% of boaters surveyed would already comply with an established NDZ. Only 4.75% of boaters around Galveston Bay, based on our findings, would have to actively make a change onboard their vessel to become compliant with the designation. Ultimately, that means that a very small percentage of the recreational boating population would be required to install a holding tank. However, as mentioned earlier in this report, these data do not account for the commercial boating industry within the Bay. Our Dockwalker data also show that, of boaters surveyed with boats over 25 ft., 100% agree that bacteria from sewage is harmful to the Bay. Based on these and future results, GBF will be able to tailor campaign messaging and strategies to improve knowledge and behavior change, determine priority areas for new pump-out facilities and share valuable market information with mobile pump-out companies. Much of the work accomplished in 2016 for the Dockwalker Program was performed by GBF's Water Quality Outreach Intern from June – August 2016.

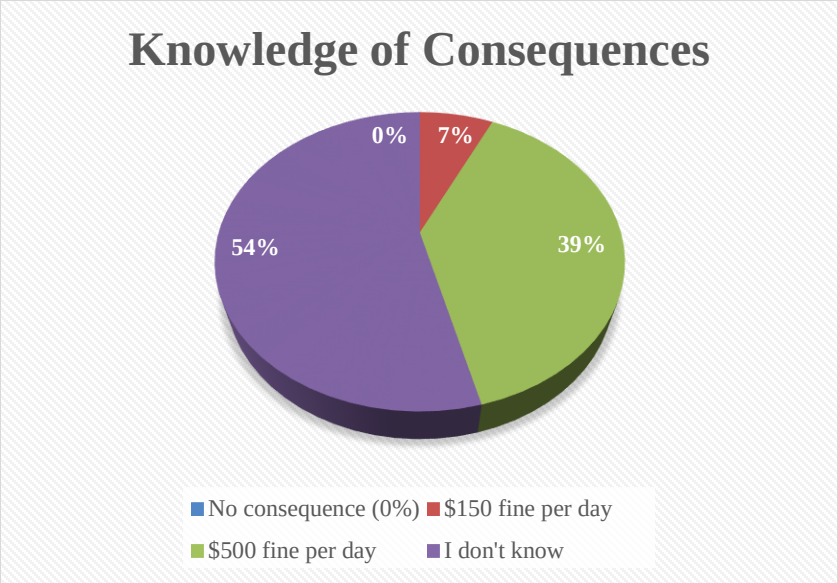

Figure 9. Boater knowledge of consequences for discharging sewage into Galveston Bay

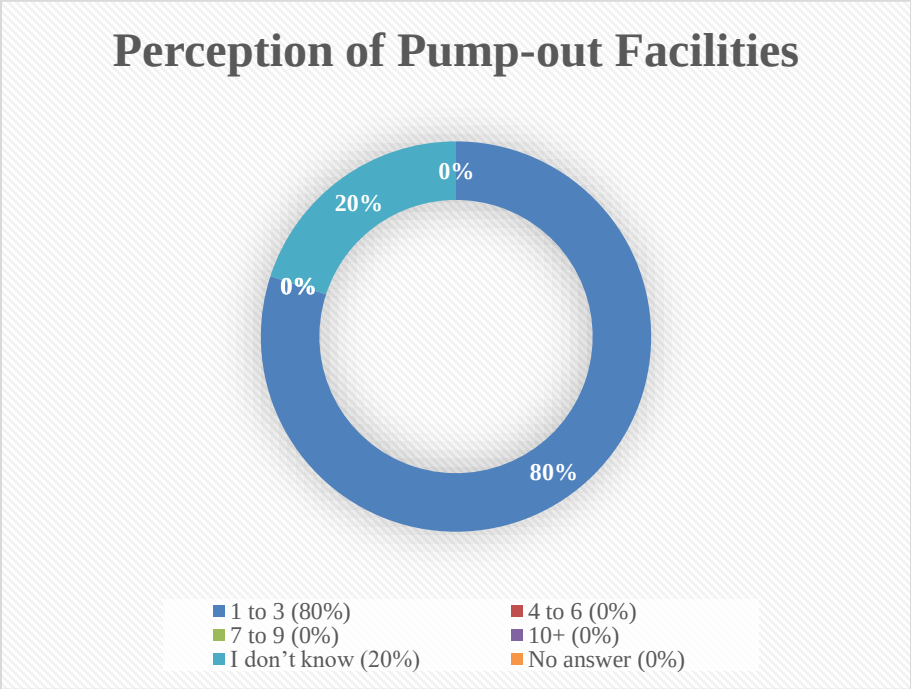

Figure 10. Boater knowledge of pump-out facilities located around Clear Lake and Galveston Bay

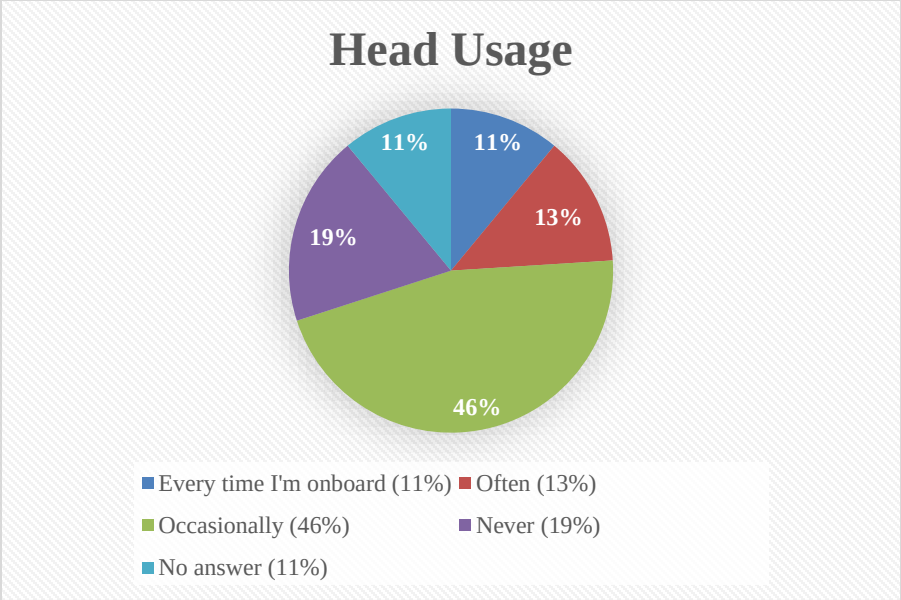

Figure 11. Occurrence of toilet usage while onboard

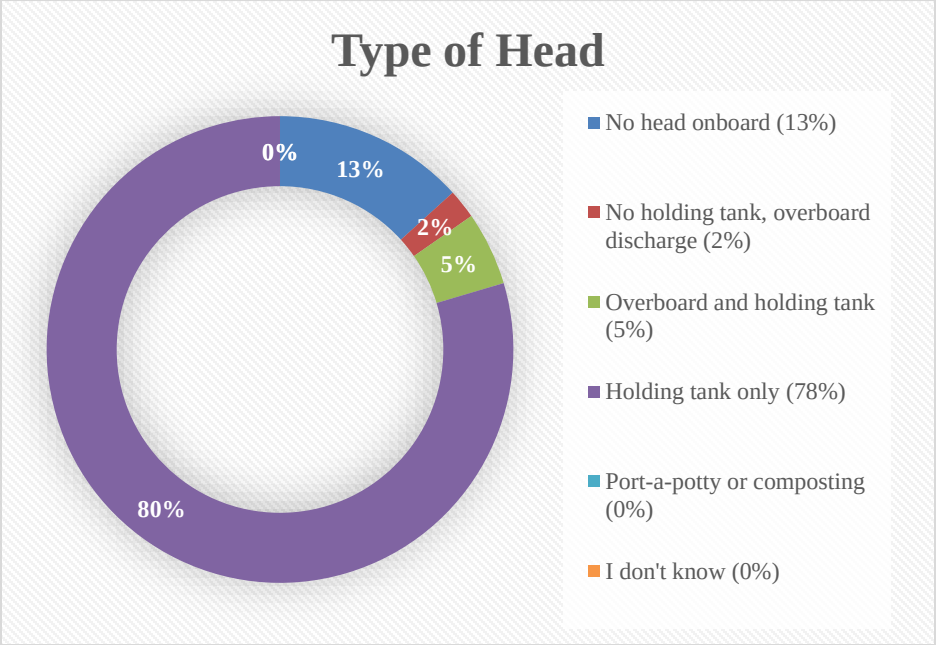

Figure 12. Types of marine toilets found onboard participants' boats

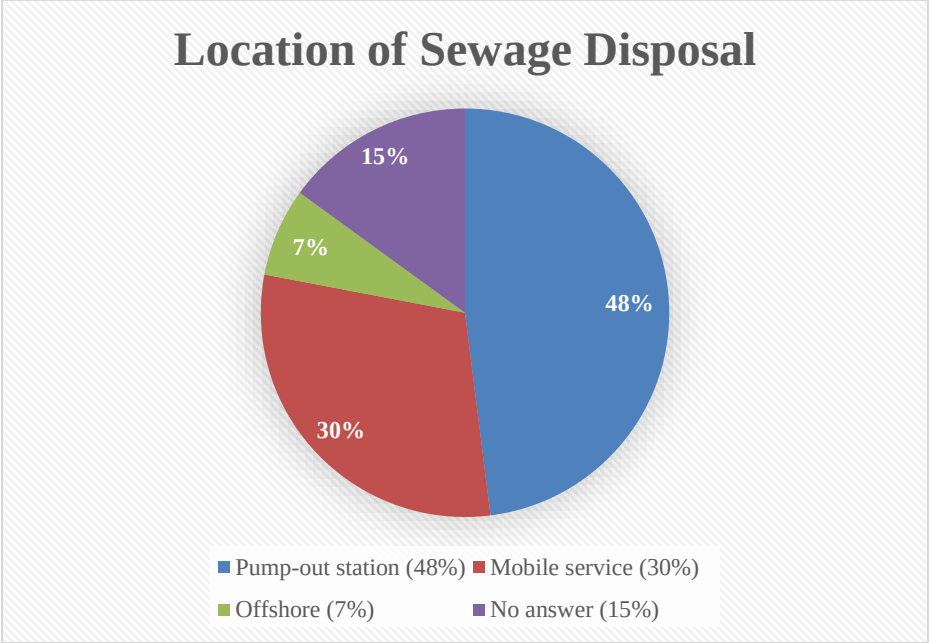

Figure 13. Locations/facilities boaters most often use to discharge their sewage

5.3 GBF Water Monitoring Team (WMT)

GBF continued to collect ambient water quality data at marina and near-shore sites around Clear Lake and Galveston Bay throughout Cycle 20. Please see Appendix III for the 2016 Water Quality Data Analysis.

Figure 14. Photos from GBF's most recent Phase I and II Water Monitoring Training

Figure 15. GBF's Volunteer Lab Assistant receiving a bacteria sample from a volunteer monitor

Figure 16. Photos from the field of GBF's Water Monitoring Team collecting field data

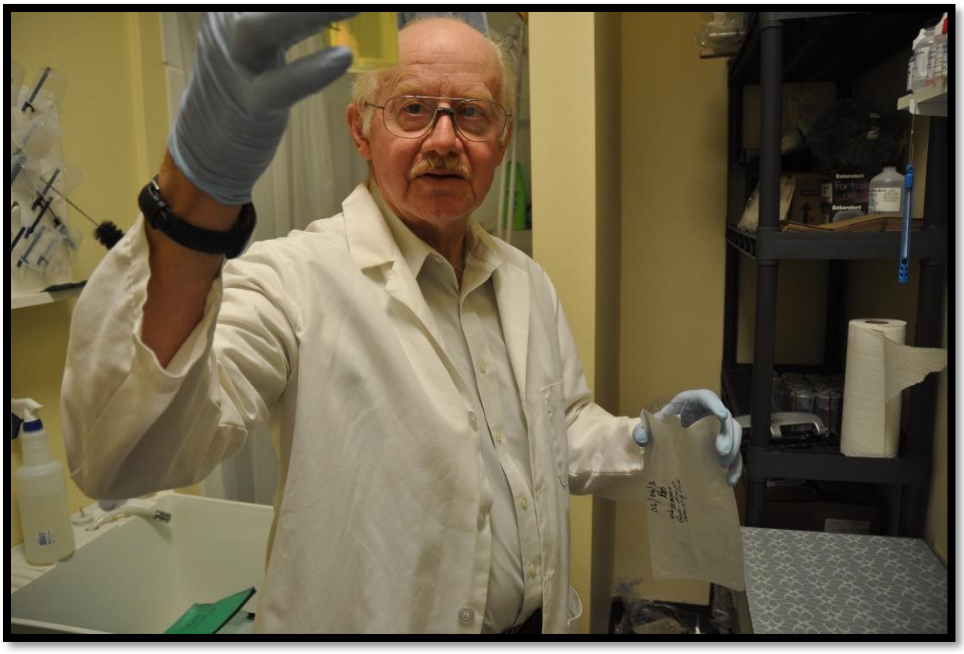

Figure 17. GBF's Volunteer Lab Assistant processing and analyzing a bacteria sample

Figure 18. GBF's first Water Monitoring Team Social Gathering at Topwater Grill in San Leon

5.4 Pump-Out Facilities

Based on GBF's best available data, the number of pump-out stations/carts and mobile pump-out companies decreased this year, although our knowledge about these pump-out facilities has drastically increased. To date, the Galveston Bay region has 24 pump-out facilities, including stations, mobile boats, carts, and dump stations that are available for recreational boaters. In Cycle 19, one of GBF's summer interns compiled a detailed, updated table comprising key information on pump-out facilities around Galveston Bay and Clear Lake as part of the draft No Discharge Zone application. In January of 2017, GBF's Water Programs Manager updated this list (Appendix IV) and learned that the total number of pump outs had decreased for a few reasons. In one instance, a marina that had offered pump-out services was sold and the new company no longer offers this service. In another instance, a marina could not be reached to determine if they still provide pump-out services after numerous phone calls and emails. Finally, a number of marinas could not identify or verify the presence of any dump stations that were previously recorded. Still, the Kemah Boardwalk Marina utilized Clean Vessel Act funds to install a new pump-out station for recreational vessels. This is very encouraging news, as Kemah is a prime location to pump-out as it is the point of entrance to the Clear Lake No Discharge Zone.

The relatively static number of pump-out facilities is likely due to the fact that the Clean Vessel Act funding is not either well-received or is not well known by many local marinas. This may be because marinas aren't as in tune with the latest industry news, or because of the relatively high staff turnover rate in the marina business—those managers who are directly involved with installing a pump-out station at the marina are the most knowledgeable about the source of funding for that pump-out, as well as how reliable the pump-out is. When a new manager is placed at a marina, the prior knowledge about the pump-out is rarely passed

on. This lack of knowledge provides an opportunity for further education of marina managers through GBF partnerships. GBF is currently working with members of state agencies and the Boater Waste Workgroup to better communicate the availability and purpose of these funds, and to potentially secure additional funding for pump-out stations if needed. A former TPWD employee is now working as a consultant for the Marina Association of Texas (MAT), of which GBF's Water Programs Manager is a board member, so we are hopeful to see many enhancements to the use of these grant funds statewide. MAT is currently working with TPWD to offer MAT members the opportunity to recoup annual funds spent on maintaining and operating their pump-out facilities in hopes of encouraging more marinas to install new facilities by lessening their financial burden even further. GBF will continue to advocate for this with MAT and promote the program in the Clear Lake and Galveston Bay area.

Conclusions and Lessons Learned

The Boater Waste Education Campaign saw many rewarding enhancements during this funding cycle. Our continued partnership with the Marina Association of Texas and the work of our summer intern helped give much needed data and support regarding the potential No Discharge Zone application for Galveston Bay. GBF began discussing the NDZ initiative with specific members of the recreational and commercial boating community in order to open up a dialogue on this important issue, and many of these conversations were quite promising. GBF compiled a draft white paper on NDZ implementation and enforcement throughout the country to aid NDZ discussion. Volunteer programs including the Dockwalker Program and GBAN have grown and will continue to grow while providing the campaign with additional data on illicit discharges in the Galveston Bay region. GBF and Vertices were able to develop a GBAN mobile app that is currently undergoing beta testing. And finally, teen and elementary-aged boaters were engaged in the campaign through hands-on activities at the WADE camp with the Houston Safe Boating Council.

To summarize our major findings, 63% of the organizations on the BWEC workgroup attended meetings and 100% directly contributed to campaign activities by distributing Pump Don't Dump campaign materials and helping us build relationships with and gain access to marinas for various volunteer programs. Through education booths, presentations, and workshops, the BWEC reached over 15,000 people at 53 live events. Through print and digital media outlets, GBF was able to reach over 285,000 people with the Boater Waste Education Campaign messaging through 29 media outlets. The GBAN pollution reporting tool was marketed through a social media campaign developed by The Hatcher Group, as well as through outreach booths and presentations, receiving 1,618 page views and 46 pollution reports during this cycle. Additionally, the mobile GBAN app was developed and was launched for beta testing during this cycle. The GBF Water Monitoring Team remained strong at 57 certified volunteer monitors at 58 sites around Clear Lake and Galveston Bay, and 24 of them have their advanced certification to sample for bacteria. However, much of this increase occurred in just a few months. From October 2016 to March 2017, GBF's Water Monitoring Team went from 36 active monitors to 57 active monitors. GBF will be offering an additional training in April for new monitors, and estimates an additional 5-10 volunteers will be added to the Monitoring Team as a result of this training. GBF's two Volunteer Lab Assistants helped us run the lab by analyzing hundreds of bacteria samples (Figures 15 and 17). GBF collected approximately 125 completed dockwalker surveys, compared to 58 in 2014 and 174 in 2015.

Overall, GBF and the workgroup are pleased with the advances that have been made to the campaign. The information collected during this cycle will assist us as we continue to strive for reductions in bacteria contributions from recreational and commercial vessels in Galveston Bay. GBF recognizes that the BWEC is a complex balance of education and advocacy efforts and we look forward to continuing work on this project. Thank you to the Coastal Management Program and NOAA for your ongoing support of this important environmental, economic, and public health issue.

Appendix I: Performance Indicators and Outreach

Table A1. Performance Indicators for Cycle 20

Tasks	Goals	Performance Indicators
Develop Public Outreach and Distribution Plan	Maintain campaign presence in print, radio and TV media outlets	Number of impressions from campaign materials Number of meetings and trainings held educating stakeholders about codes and enforcement
Facilitate Boat Sewage Discharge Reporting and Enforcement	Improve communication between enforcement authorities and other stakeholders	Number of authorities that can address illegal dumping receiving GBAN pollution reports
Facilitate Volunteer Programs	Sustain a core group of active volunteers for the BWEC	Number of GBAN reports Number of active water monitoring sites
Quantify Boater Waste Impact and Track Behavior/Knowledge/ Environmental Change	Increase awareness of boater waste issues and engagement in proper waste disposal	Number of GBAN reports Number of public pump-out stations in project area Volunteer water quality data trends Overall bacteria concentrations in Galveston Bay reported by professional monitors

Pump, Don't Dump to a Brighter Future

From the sailor embracing the fresh, salty breeze, or the fisherman pulling in an amazing catch, or the child discovering a mysterious creature, Galveston Bay is a part of our experiences and memories, an endless treasure and beautiful resource.

Clean water is the foundation of a healthy and beautiful ecosystem. Right now, one of Galveston Bay's most pressing water quality issues is bacteria. Although there are many origins of bacteria, one of them is human waste disposed directly into bay waters by boaters. The Galveston Bay Foundation, an environmental non-profit, provides many ways for you to help keep Galveston Bay fishable and swimmable, including the *Pump, Don't Dump* campaign.

Pump, Don't Dump asks boaters to protect Galveston Bay by properly disposing of boat sewage produced while onboard your vessel. *Pump, Don't Dump* highlights actions individual boaters can take to directly improve our bay, including pumping out marine heads at one of Galveston Bay's 29 pump-out facilities – easily located by using GBF's pump-out map. And, boater waste discharges can be reported to the proper authorities through GBF's pollution-reporting tool, Galveston Bay Action Network (GBAN).

Imagine the impact on the health of the Bay if all 90,000 boaters who call these waters home participated in *Pump, Don't Dump*. Individual actions matter and together we have the power to decide how we will treat the Bay in order to protect and enhance this incredible natural resource for our children and grandchildren. By accessing and actively using tools such as GBF's pump-out map and GBAN, and by encouraging other boaters to *Pump, Don't Dump*, you are doing your part to ensure the health of Galveston Bay. For all of us who love being on the water, our legacy and our responsibility is to help ensure that future boaters will always be able to enjoy seagulls' calls, to eat raw oysters from our waters, or to delight in the sun's warmth on their faces as they sail or motor across Galveston Bay.

Visit *www.galvbay.org/GBAN* and *www.pumpdontdump.org* today.

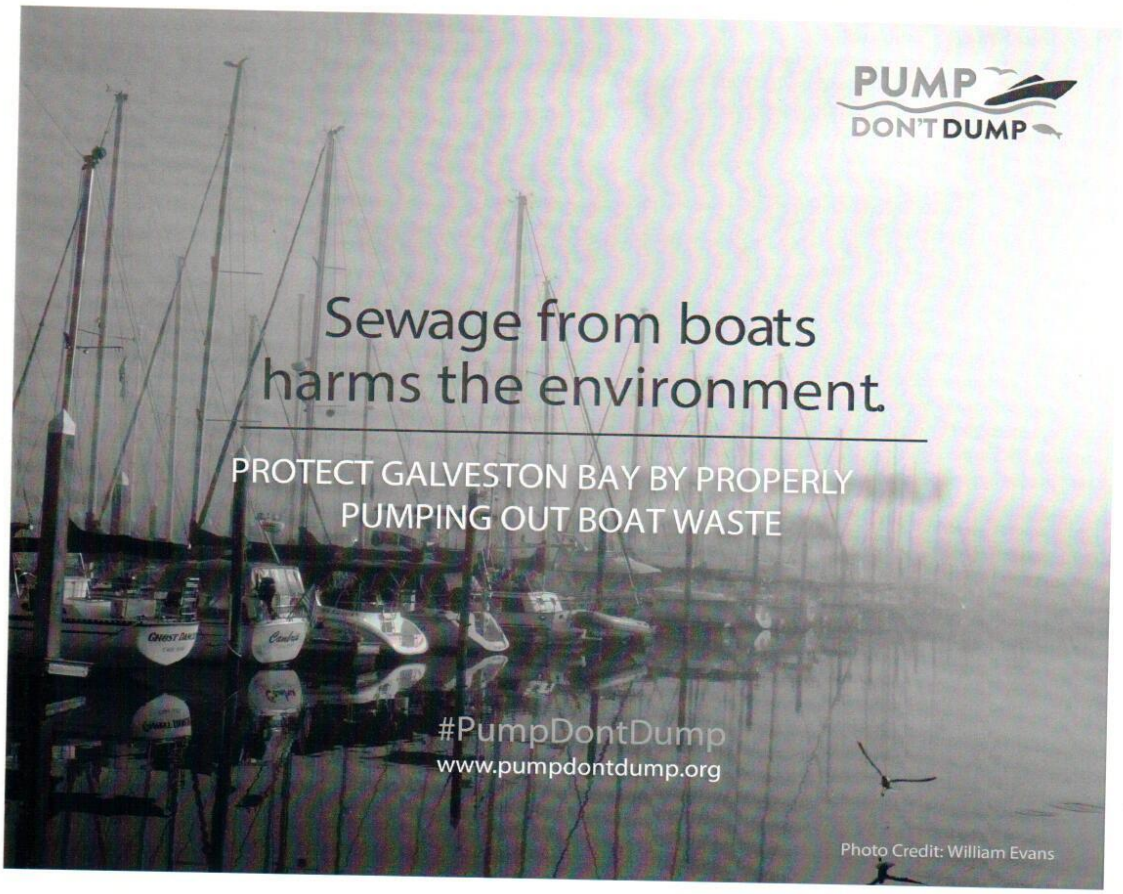

Figure A1. Pump Don't Dump article in *Changing Currents* Magazine

Article published in Gulf of Mexico Alliance's monthly newsletter covering GBF's Water Monitoring Program
Date: November 2016
Authors: Nathan Johnson, Sarah Gossett, & Claire Everett

"On the Water with the Galveston Bay Foundation"

Citizen science programs are growing around the country. They are meaningful ways individuals, communities, and organizations can contribute to local scientific research and environmental management. The Gulf of Mexico Alliance reached out to the Galveston Bay Foundation (GBF) to share their citizen science water quality success story.

For many Texans, Galveston Bay is more than home – it's an integral part of their identities. The second largest bay system in the United States, Galveston Bay provides 618 square miles of vital habitat and wildlife for residents to enjoy. It is also a major source of economic growth and supports fishing, shipping and tourism industries alike. In an ever-developing world, Galveston Bay serves as a constant reminder of our inexorable link to the natural world around us.

Galveston Bay Foundation is a nonprofit organization committed to the coastal community and addresses issues concerning the bay. The mission of Galveston Bay Foundation is to preserve and enhance Galveston Bay as a healthy and productive place for generations to come. Galveston Bay Foundation's Water Monitoring Team serves a crucial role in carrying out this mission, and our water monitors test the bay's water quality regularly and accurately.

The program is unique in that it is volunteer-driven and members of the community collect water quality data themselves. After completing three phases of training, volunteers who may have had little to no previous scientific experience are equipped with the tools and knowledge they need to regularly test water quality in their communities.

Each of Galveston Bay Foundation's 45 volunteers collects air and water temperature, dissolved oxygen, salinity, pH, turbidity, and other observational data each month at their respective site. Additionally, about half of the volunteers collect enterococci data from their site as well.

Enterococcus is a genus of bacteria that is used by many health agencies to determine if a body of water is suitable for recreation, fishing, or oyster harvesting. In addition to collecting environmental data, GBF's Water Monitoring Team collects important information regarding public uses of the Bay. The data is displayed through Gulf of Mexico Coastal Ocean Observing System's website, is easily accessible and suitable for all audiences. To view this data, visit http://gulfcitizenscience.org/.

Through the Water Monitoring Team, GBF hopes to foster a sense of stewardship of Galveston Bay within the greater Houston region and get the coastal community involved. It's one thing to see scatter plots and trend lines tracking environmental change over time; it's quite another to see, first-hand, parameters like dissolved oxygen, salinity, and bacteria counts fluctuate in your backyard seasonally or spontaneously. Galveston Bay belongs to all that live there, and the GBF encourages everyone to take steps to ensure that it continues to provide .

-Contributor Nate Johnson is the Water Programs Manager at the Galveston Bay Foundation and a member of the GOMA Education and Engagement Team.

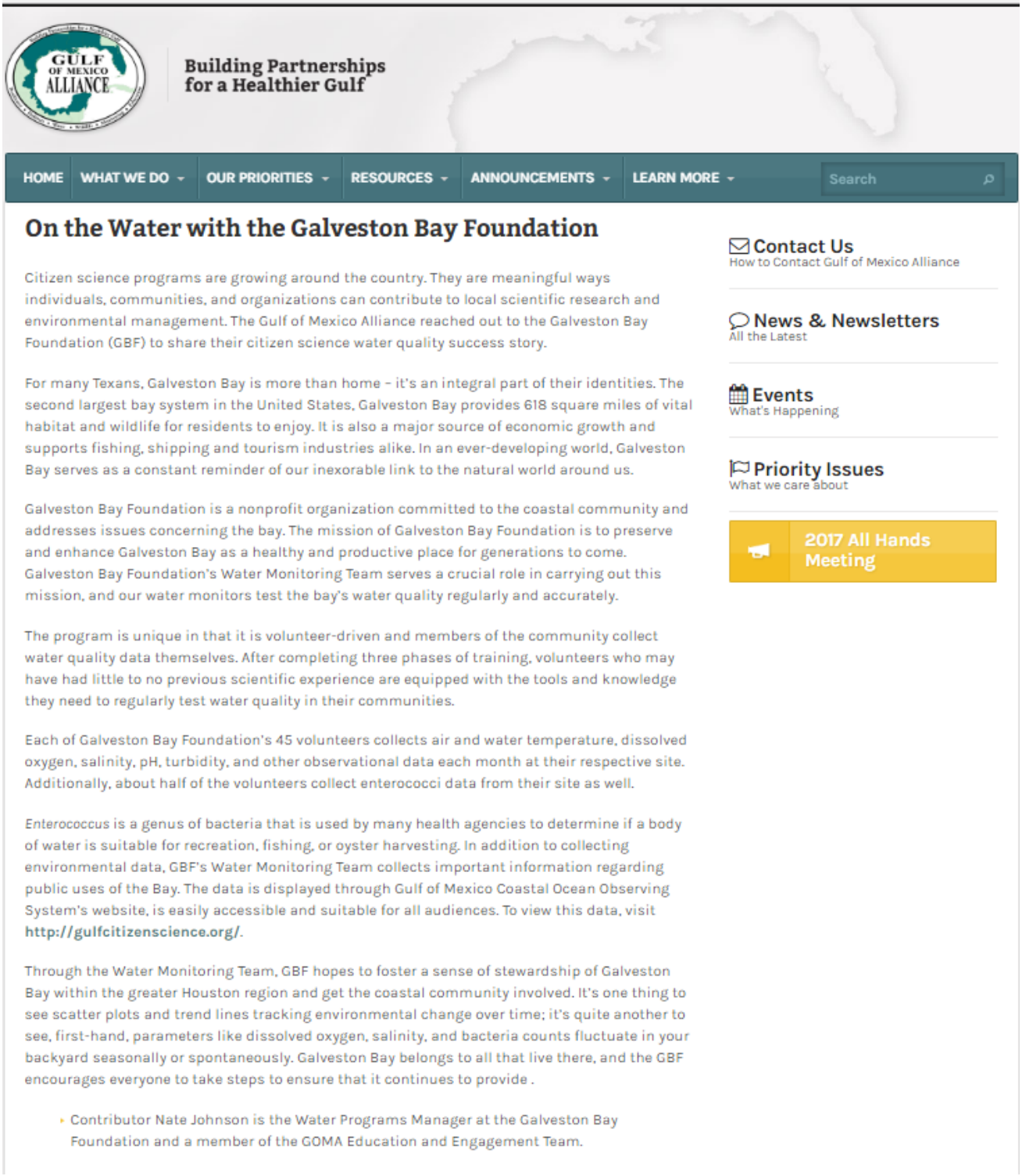

Figure A2. Screenshot of GOMA newsletter article published in Cycle 20

Appendix II: Dockwalker Program

2016 Dockwalker Boater Survey

Date: _____ Location : _____

1. How does Galveston Bay benefit you? (Circle all that apply)
   - **A** Fishing
   - **B** Seafood
   - **C** Recreational tubing and skiing
   - **D** Sailing
   - **E** Swimming
   - **F** Boating/cruising
   - **G** Bird-watching

2. Do you make your living off of the Bay?
   - **A** Yes (occupation): _____
   - **B** No

3. How long have you been boating? _____ year(s)

4. On average, how often are you on your boat per month? _____ day(s)

5. On average, how many people are on board your boat at one time? _____

6. What is your 5-digit home zip code? _____

7. Would you swim in, or eat fish caught from your marina?
   - **A** Yes
   - **B** No

8. Where in Galveston Bay do you fish or boat most often? (See reference map on next page if needed)
   - **A** Trinity Bay
   - **B** Upper Galv. Bay
   - **C** Clear Lake
   - **D** Lower Galv. Bay
   - **E** West Bay (Galv. Island)
   - **F** Off-Shore
   - **G** East Bay (Bolivar)

9. What type of boat(s) do you currently own? (Circle all that apply)
   - **A** Ski boat/run-about
   - **B** House boat
   - **C** Motor yacht
   - **D** Personal watercraft (jet-ski)
   - **E** Off-shore racer (cigarette boat)
   - **F** Other (specify):_____
   - **G** Fishing boat
   - **H** Sailboat

10. What year is your boat? _____

11. What is the size of your boat? _____ feet

12. What is your average cruising speed?
    _____ mph or _____ knots

13. How many pump-out stations/mobile carts do you know of in the Clear Lake or Galveston Bay area?
    - **A** 1-3
    - **B** 10+
    - **C** 4-6
    - **D** I don't know
    - **E** 7-9

14. What is the consequence for boaters in Texas who do not secure their discharge valve or do not have a Clean Water Certification sticker for their marine sanitation device?
    - **A** Nothing, it is discouraged but not against the law
    - **B** Fine up to $150 per day
    - **C** Fine up to $500 per day
    - **D** I don't know

FLIP PAGE

15. Do you conduct maintenance on your boat while in the water?
    a. **A** Yes **B** No

    b. If so, what kind?
    - **A** Washing with cleaning product
    - **B** Waxing (fiberglass)
    - **C** Sanding/staining (wood)
    - **D** Motor maintenance
    - **E** Other (specify): _____

16. Do you know of anyone illegally discharging sewage into Galveston Bay or Clear Lake?
    - **A** Yes, treated sewage
    - **B** Yes, untreated sewage
    - **C** Yes, treated & untreated sewage
    - **D** No

17. Does sewage discharge from boats cause elevated levels of harmful bacteria?
    - **A** Yes
    - **B** No

18. What type of head is onboard your boat?
    - **A** No head onboard
    - **B** No holding tank, discharge overboard
    - **C** Overboard discharge device and holding tank
    - **D** Holding tank only
    - **E** Port-a-potty or composting only
    - **F** I don't know

****If no sanitation device (head) onboard, STOP here****

19. What type of sewage treatment is used onboard your boat? (Circle all that apply)
    - **A** Chemical treatment
    - **B** Biological treatment
    - **C** Physical treatment
    - **D** No treatment
    - **E** I don't know

20. How often is the head onboard your boat used?
    - **A** Every time I go out
    - **B** Often
    - **C** Occasionally
    - **D** Never

21. When using a sewage pump-out/dump station, how often:

	Never	Rarely	Half the time	Most often	Always	N/A
a. Is the pump-out broken?	A	B	C	D	E	F
b. Is the pump-out closed?	A	B	C	D	E	F
c. Do you wait in line?	A	B	C	D	E	F
d. Are you able to find one?	A	B	C	D	E	F
e. Is the station staffed?	A	B	C	D	E	F

22. Which location do you use most often to dispose of sewage?
    - **A** Pump-out station or cart
    - **B** Mobile pump-out service
    - **C** Distance of 3-nautical miles off-shore

COMMENTS:

This project is funded in part by a Texas Coastal Management Program grant approved by the Texas Land Commissioner pursuant to National Oceanic and Atmospheric Administration award No. NA12NOS4190164 and NA13NOS4190113.

Figure A3. Cycle 20 Dockwalker survey

According to 2013 Texas Parks and Wildlife boater registration data, there are 8,771 boats greater than or equal to 25 feet in the four counties touching the bay. Galveston Bay marinas contain 1,345 wet slips and Clear Lake marinas have 5,353, leaving 2,074 non-marina wet slips. Based on the total population (8,771), the Dockwalker Team needs to survey at least 370 boaters in order to reach a representative sampling size with +/- 5% error. This equates to 226 surveys (61.1%) in Clear Lake marinas, 87 surveys in non-marinas (23.6%), and 57 (15.3%) in Galveston Bay marinas (Table 4). GBF will facilitate randomized sampling within each strata and will continue this program over the long-term in order to monitor knowledge and behavior change in the boating community. This survey plan was designed based on the U.S. EPA Guidance on Choosing a Sampling Design for Environmental Data Collection (EPA QA/G-5S) and The Social Indicator Planning & Evaluation System for Nonpoint Source Management.

Table A2. Proportional number of Dockwalker surveys needed and collected per date, per strata

	Registered Slips	**% Representation of Sample Size**	**Surveys Needed**	**Surveys Collected To-Date**
Clear Lake	5,352	61.1%	226	114
Galveston Bay	1,345	15.3%	57	90
Non-Marina	2,074	23.6%	87	97
Total	**8,771**	**100%**	**370**	**357**

Surveying took place on Fridays and Saturdays between 9-11am, 1-3pm, and 4-6pm and was conducted by interns and Dockwalker volunteers. As various boating events came up, Dockwalker volunteers and interns surveyed at these events during the week if needed. If permission was refused at a surveying site, GBF moved to the next marina on the randomized list. Once the Dockwalker program is more established in the community, future attempts will be made to conduct surveys in marinas that originally did not grant permission. Additionally, GBF put the survey online, linked it on the organization's website, and plans to post the survey to social media at regular intervals during boating season in order to collect data.

GBF will continue surveying until the established number of surveys is collected, and then continue surveying in the future in order to track any improvements in knowledge and behavior over time. The surveying schedule and plan in the future will be focused on collecting surveys from marinas and non-marina sites that have not been visited, or have a low number of survey responses. Additionally, GBF will tailor the Dockwalker program to be largely carried out by GBF summer interns and trained volunteers. Lessons learned from surveying will continue to be developed into a standard operating procedures manual for future Dockwalker volunteers.

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Introduction

Galveston Bay Foundation's main objective is to "Preserve, protect and enhance Galveston Bay as a beautiful and productive resource for now and for generations to come." There are countless ways the bay benefits those who live in it and around it whether it is recreational, the fishing industry, transportation, or other environmental factors. There are multiple characteristics of the bay that needs to be protected and enhanced, to not just help the life that surrounds it, but to keep its resources available in order to protect the industry and economy around it.

Water is what makes the bay, a bay. The water is the one of the main sources of life. When the bay is not "healthy" due to pollution or any other source that alters its natural state, there is butterfly effect of problems that can occur and be detrimental to the life in and around the bay. One of the teams at Galveston Bay Foundation is the Water Programs Team. This team runs multiple programs that are all focused on helping improve the water quality of Galveston Bay.

The Dockwalker Program is aimed at stopping illegal discharging of boater waste, which is a main source of pollution in Galveston Bay. Through data collection from surveys taken at local marinas, public outreach and education in the boating community, this program helps GBF have a sense of what problems need to be addressed and if there has been any improvement. Dockwalkers are usually interns or volunteers who survey local boaters about their boating habitats and knowledge, while promoting correct pump-out methods to help protect the bay. The Dockwalker Program has been an on-going project for about two years. Four marinas were visited in summer 2016. The data analyses from the surveys taken are shown in the following pages, along with a comparison to the data from summer 2014.

Dockwalking Process

Before engaging boaters at local marinas, the volunteer or intern checks in with a marina manager at the main office at the marina. Dockwalkers will have a Clean Boater Kit to give to those who participated in taking a survey.

These kits include:

- Reusable trash bag- way to store trash and prevent trash from getting into the bay
- Oil pillow- to collect excess oily bilge from the boat to stop oil and chemicals flowing into the bay
- Dye tab- to see if their boat is discharging sewage into the bay
- Zip tie- to close off their Y-valve to prevent the dumping boater waste
- Whistle and/or floating Pump Don't Dump key chain
- GBF brochures and handouts

The Dockwalker had a clipboard with the 2016 Dockwalker surveys, a tote, pens and the Clean Boater Kits while surveying the local boaters.

Galveston Yacht Basin Preliminary Data Analysis

There were 25 surveys taken at the Galveston Yacht Basin during July 1st at 3-5pm and July 2th 10am-12pm. This marina had the most activity especially with a large amount of individuals that use their boats to make a living.

There was a wide variety of boats and types of boaters at GYB. How the bay benefited the boaters differentiated greatly. 64% stated they used their boat mainly for either recreational or business fishing. 25% of the boaters that claimed that Galveston Bay mostly benefited them by fishing for a living.

The other 36% of the 25 surveyed use their boat for other purposes such as boating/cruising, sailing, and other recreational activities.

The average number of years that individuals have been boating was around 28 years, with the range between 1 to 55 years. 56 % had 30 years of boating experience or more, 16% had 10 years of boating experience or more and 28% had less than 10 years of experience. With the total of 72% that have been boating for more than 10 years shows that many boaters at Galveston Yacht Basin are highly familiar and experienced with boating.

The average amount of days out of the month that people were on their boat was 15 days. This number is high due to several were liveaboards, worked in the fishing industry or made some other profession off their boat. The range of the time spent on their boat was 1 day per month to year around. 72% of the boaters spent 10 days or more a month on their boat. This shows that the boaters have more of an insight of what happens in the marina.

The average number of people on board for each boat was 4. The range was between 1 to 8 people.

There are 6 zip codes in Galveston, 77550, 77551, 77552, 77553, 77554, 77555. 68% of the boaters lived in one of the Galveston zip codes. The other 32% were mostly from either the Houston area or Southeast Texas area.

After a few general questions about the boater, they were asked if they would personally swim in the marina or eat the fish from the marina. The results showed that the preference was almost evenly divided among the boaters with 48% stating they would eat fish they caught in the marina or swim in the marina and 52% stating they would not.

Those who did fish, 88% fished offshore with half of the 88% also fished in West Bay (Galveston Island) or East Bay (Bolivar). The other 12% solely fished near West or East bay.

Out of the 25 that were surveyed, 68% had a fishing boat, 16% had a motor yacht, 12% had a sailboat and 4% had either a house boat or crew boat. The large amount of fishing boats in this marina shows that many fish either for recreation or for a living. The amount of motor yachts and sailboats shows that several boaters are either liveaboards or use their boats for recreational purposes such as boating/cruising or sailing.

Overall there was an even amount of boats that were made in the late 60s to the 2000s. 36% of the boats were made in the 2000s, 20% in the 1990s, 28% in the 1980s and 16% were made between late 1960s to early 70s.

The average size of the boats surveyed was 37 feet.

The average cruising speed was 25 knots. The average speed is high due to the large amount of fishing boats surveyed compared to the amount of slower boats like sailboats.

Boaters were asked about what pump-out stations or mobile pump-out stations they were aware of in the Galveston Bay area. 72% said they knew around 1 to 3 pump-out stations or services and 28% did not know. Also no one knew more than 3 pump-out services in the area.

When asked what the consequences were for boaters in Texas who do not secure their discharge valve, do not have a Clean Water Certification sticker for their marine sanitation device, or dump boater waste in the bay 52% did not know the fine or that it was illegal. 44% guessed that the fine was up to

$500 per day and 4% thought it was up to $150 per day. No one thought that it was legal to dump in the bay or marina.

Many of the boaters did maintenance on their boat themselves such as washing, waxing fiberglass, sanding wood, staining wood and/or motor maintenance. 80% of the boaters did some form of maintenance of their boat and 20% did not. Out of the 80%, all at least washed their boat, 65% besides washing also did the motor maintenance, and 35% of the 80% did all the maintenance on their including waxing, sanding, staining and etc.

Four boaters (16%) claimed that they have seen raw sewage in the bay from other boaters. Three claimed that they believed it was untreated sewage and one thought it was treated sewage. None of the boaters could tell if it was both untreated and treated sewage. The other 21 boaters (or 84%) have not seen sewage being pumped out into the bay or marina.

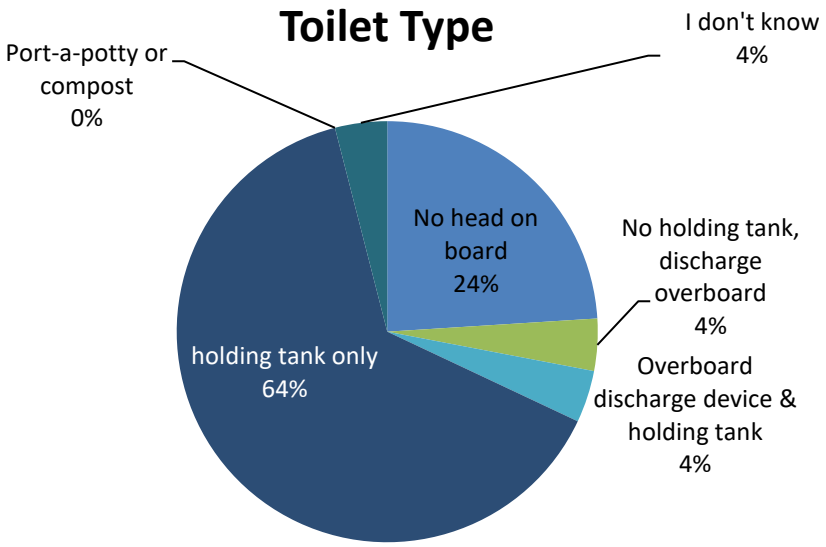
The boaters were asked to identify what kind of head they had on board if they had one and what type of treatment it had. 64% had a holding tank, 4% had no holding tank with a discharge device, 4% had both a discharge device and a holding tank, and another 4% did not know what type of head they had. The boaters who were able to discharge there waste from their boat all either had a chemical treatment, electric treatment, physical treatment, or dumped offshore. None of the boaters that were surveyed claim to dump untreated sewage into the marina or bay but, a few did dump treated sewage into the water.

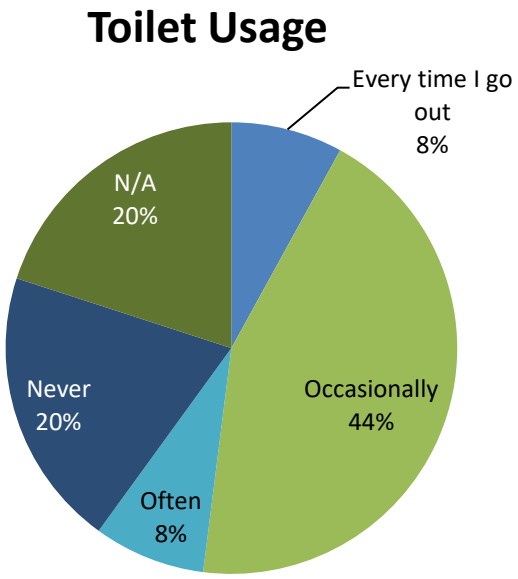
Most did not use their head on their boat that often. Boaters were asked on average how often they used their head, they either chose occasionally, often, never, every time I go out or N/A. 40% was divided between either never used the head or did not have one on their boat, 44% claimed they occasionally used it, 8% said they did often, and another 8% said they used it every time they went out. Judging by the data it seems that the number of people who use their head is roughly close to the amount of people who did not.

The boaters were asked multiple questions about the pump-out station/services. 32% said the pump-out station was never broken, 16% of the boaters claimed that the station was broken rarely or half of the time, and 52% could not answer. Those who could not answer either did not have head onboard or never used the pump-out station at Galveston Yacht Basin. The percentages were almost the same for when the boaters were asked how often the station was closed. Except one less boater said that it was closed half of the time and one more boater said the station was never closed. Besides the 52% that could not answer, 2 boaters said they had to always or often wait in line at the pump out station and 40% of the boater said they never had to wait in line. 60% of the boaters always were able to find a pump-out station and 40% could not answer. 16% claimed the station was always staffed, 8% said the station was staffed rarely or half of the time, 32% said the station was never staffed and 44% could not answer.

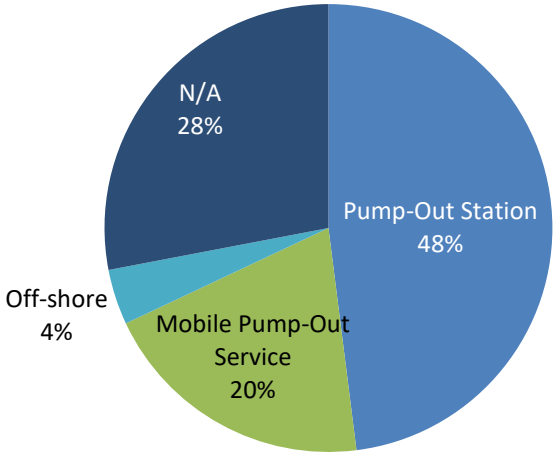
The last question that the boaters were asked was where they disposed their sewage. 48% used a pump-out station, 20% used a mobile pump-out service, one boater disposed of their sewage three nautical miles off-shore, and 28% could not answer.

Compared to the other marinas that were surveyed, Galveston Yacht Basin definitely had the most activity. It was the only marina that had boaters that made a profession off their boat. Also it had the most that claimed that the pump-out station is never staffed. This can become a problem especially if there are new boaters who are not familiar with the pump-out process. It can lead to mistakes and accidental pumping of sewage into the water. Many boaters were suspicious that some were pumping into the marina. The few boaters that had treatment systems on their boat stated they let their boat pump-out into the marina since the sewage is treated.

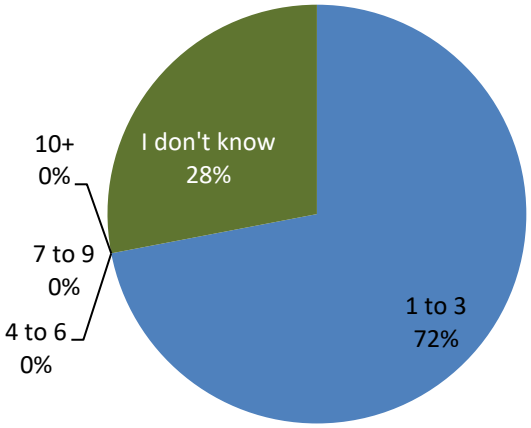

Toilet Type
Port-a-potty or compost 0%
I don't know 4%
No head on board 24%
No holding tank, discharge overboard 4%
Overboard discharge device & holding tank 4%
holding tank only 64%


Toilet Usage
Every time I go out 8%
N/A 20%
Never 20%
Occasionally 44%
Often 8%

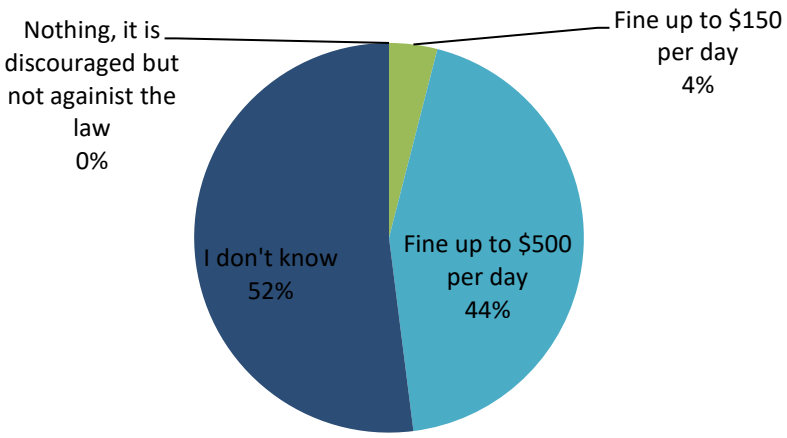
Pump-out Usage



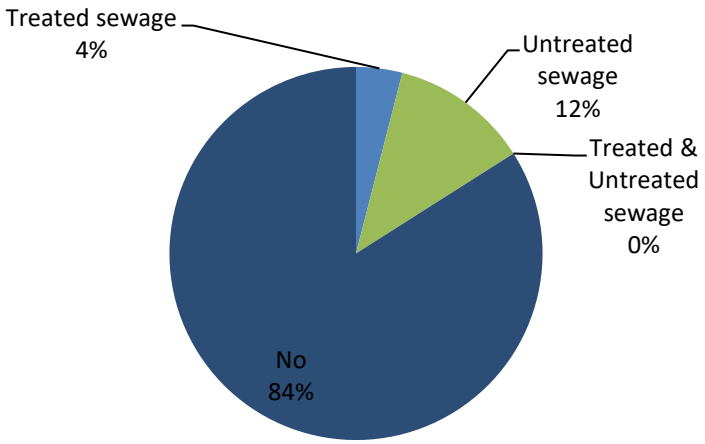
Number of Known Pump-out Facilities



Consequences for Texas Boaters



Discharged Sewage



Harborwalk Yacht Club Preliminary Data Analysis

The second marina that surveys were taken at was at the Harborwalk Yacht Club on July 8th 3-5pm and July 9th 10am-12pm. This marina was much smaller and had little to no activity. Seven surveys were taken.

All the boaters used their boat mainly for cruising or sailing. 43% of the boaters claimed that besides boating another way the bay benefited them was fishing. None of the boaters surveyed made a living off their boat.

The average number of years an individual has been boating was around 18 years, with the range of between 2 to 40 years. Four boaters had 15 or more years of experience and the other 3 boaters had less than 10 years of experience. Most of the boaters were very experienced.

The average number of days per month the owners were on their boats was 17 days. Three out of the seven boaters were liveaboards and the remaining boaters were on their boat 16 days or less a month. The range of day was between 3 days a month to living year around on their boat.

After asking for each of the boaters zip codes, it showed that most of them were from different areas of Texas. 29% of the boaters were from Hitchcock which is where the yacht club is located, 42% were from areas outside of Houston and the remaining 29% were either from outside the Dallas-Fort Worth area or San Antonio.

When asked if they would eat the fish caught from the marina or would swim in the marina 29% said no and 71% said they would.

Overall the boaters preferred to fish in different locations, 42% usually fished off shore, 29% fished in Lower Galveston Bay area, 14% or one boater fished in West Bay and another boater did not fish.

57% of the boats that belonged to those who were surveyed were motor yachts, 14% were fishing boats, and 29% were sailboats. Even though there was a smaller amount of sailboat owners that were surveyed compared to the motor yacht owners, at least half of the boats in the marina were sailboats.

The range of the year that the boats were made was between 1987 and 2008. 71% of the boats were made in either the late 1980s or in the 1990s and 29% of the boats were made in the 2000s.

The average size of a boat was around 43 feet.

The average speed of the boats surveyed was 14 knots.

All the boaters that took the survey except for one knew at least 1 to 3 pump-out stations/ services. The one boater who did not claimed that they pumped-out their boat 3-nautical miles off-shore.

When asked what the consequences were for boaters in Texas who do not secure their discharge valve, do not have a Clean Water Certification sticker for their marine sanitation device, or dump boater waste in the bay, 86% said they did not know what the consequences were and 14% answered that the consequence was a fine up to $500 per day.

All the boaters did at least one form of maintenance on their boat. All washed their boat, 28% waxed, another 28% said they did their own motor maintenance and one sailboat owner did sanding/staining for the wood.

When asked if they have ever seen anyone illegally dump sewage into Galveston Bay or Clear Lake all but one boater said that they have not seen anyone illegally dumping. The one boater believed it was treated sewage being dumped into the water. Also a member added that the floating restrooms near the boat slips was leaking sewage into the marina's water for a month before the yacht club realized that there was a problem.

All answered yes when it came to knowing that sewage discharge from boats causes elevated levels of harmful bacteria in the water.

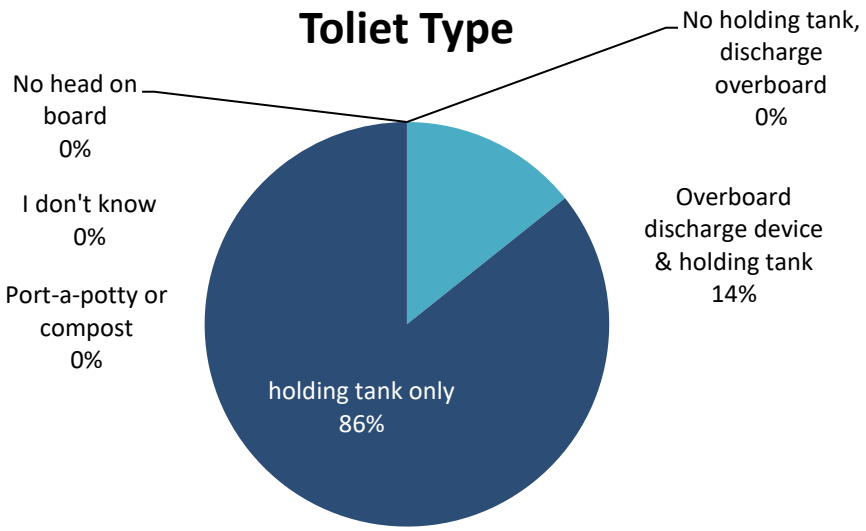
The boaters were asked what type of head they had onboard, 86% had a holding tank only, and 14% had both an overboard discharge device and a holding tank. 57% had a chemical treatment in their sanitation device, 29% had no treatment and 14% had both chemical and physical treatment in their device.

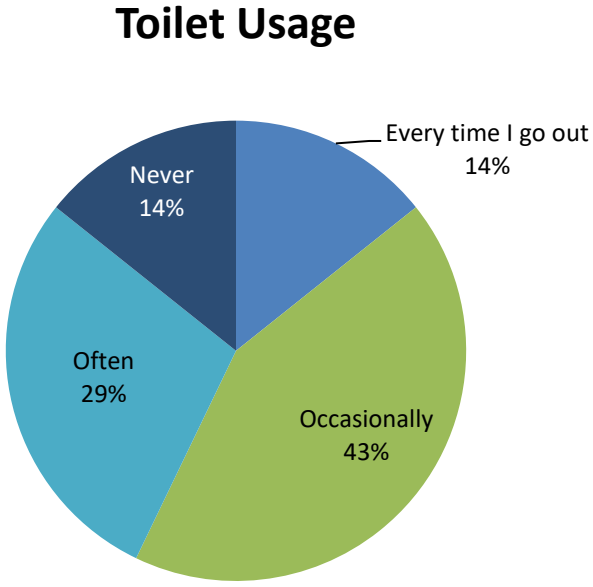
When asked how often they used their head onboard, 14% said every time they went out, 29% said often, 43% said occasionally, and 14% said they never used it.

The boaters were asked multiple questions about the pump-out station/services. All but one said the pump-out station at Harborwalk has never been broken. The other boater had no answer. The results were the same when asked about if the station has ever been closed. 57% said they never had to wait in line, 14% said they rarely had to wait in line, and another 14% said they always had to wait in line. All were able to find a pump-out station and stated that the pump-out station was always staffed. One boater pumped offshore, while the rest mainly used the pump-out station at Harborwalk.

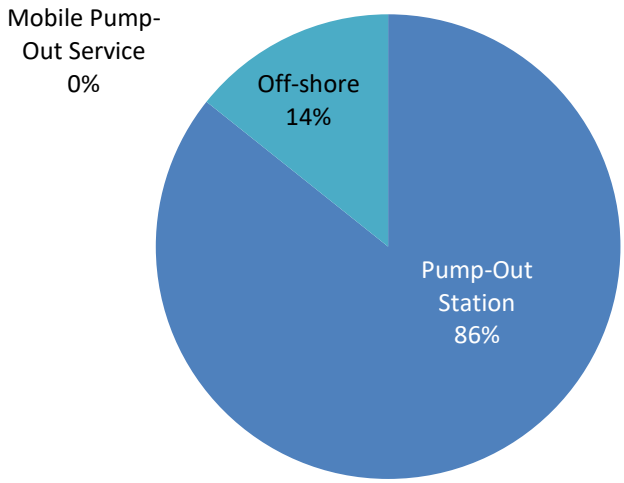
The times that the surveys were taken at Harborwalk there were not many boaters out. Overall the marina seemed to have boaters who pumped-out using a correct method. More research might help reassure this assumption.

Graphics Depicting Data Results

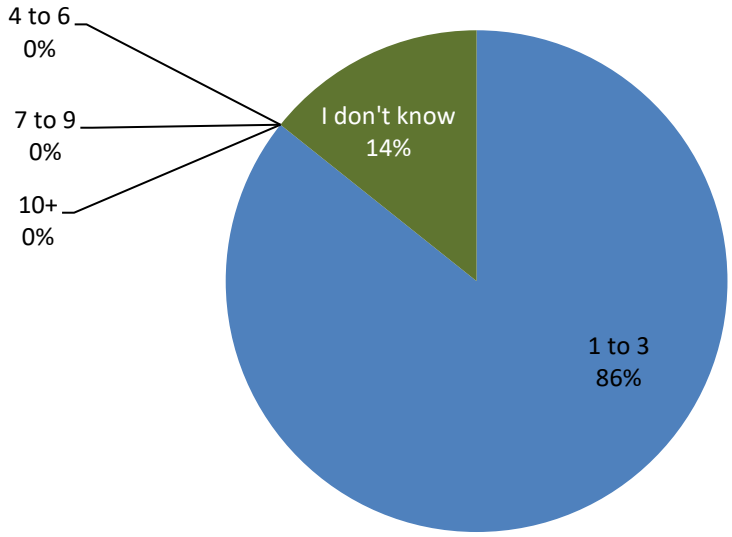

Toliet Type
No holding tank, discharge overboard 0%
No head on board 0%
I don't know 0%
Port-a-potty or compost 0%
Overboard discharge device & holding tank 14%
holding tank only 86%


Toilet Usage
Every time I go out 14%
Never 14%
Often 29%
Occasionally 43%

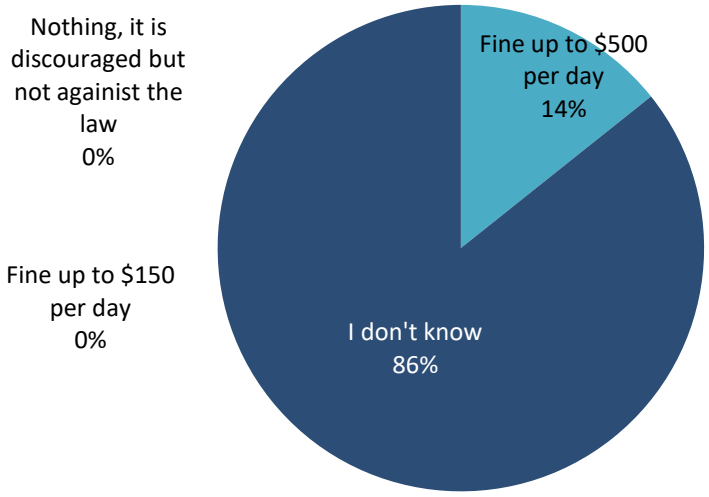
Pump-out Usage



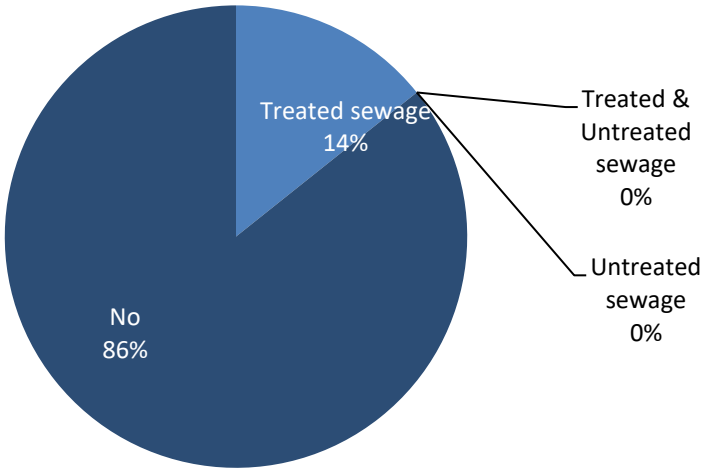
Number of Known Pump-out Facilities



Consequences for Texas Boaters



Discharged Sewage



Watergate Yachting Center & Seabrook Marina Preliminary Data Analysis

Both the Seabrook Marina and Watergate Yachting Center are located on Clear Lake. To have more of larger outlook on the data taken from the surveys, all the surveys from both marinas were combined. There was a total of 14 surveys taken on July 15th 3-5pm, July 16th 1pm-3pm and July 22nd 3pm-5pm.

When the boaters were asked how the bay or Clear Lake benefited them, none said fishing, 50% said sailing and 50% said boating/cruising. There were no boaters who made a living off their boat.

The average number of years of boating experience was around 31 years. The range of number of years was between 7-50 years with 50% having 40 or more years of experience. All but two boaters had at least 15 years of experience or more. This shows that the boaters that were surveyed are a good insight into the boating community and industry since they are very familiar with it.

The average number a boaters were usually on their boat 8 days out of the month. The range of days was 1 day per month to living on their boat year around. There were two boaters who were liveabroads.

Most of the zip codes from the boaters were from the Houston area. 50% lived in the Clear Lake area, 21% lived in the Matagorda, 14% from other parts of Houston, 7% from East Texas, and 7% from Louisiana.

100% of the boaters from the both of the marinas claimed that they prefer not to swim in the marina or eat any fish caught from the marina.

Compared to the boaters from Galveston Yacht Basin and Harborwalk Yacht Club, there were less boater who were fisherman. When asked where they usually fished 64% of the boaters said they did not fish, 14% said offshore, another 14% said they fished near Galveston Island or West Bay and 7% fished Upper Galveston Bay.

There were many sailboats at the marinas on Clear Lake. Many boaters seemed more interested in recreational boating or sailing than fishing. 93% of those who took the survey owned a sailboat and 7% motor yacht.

A boat is usually not considered ‘old’ if it is made in the 1970s or later. A boat is considered ‘new’ when made in the 2000s. 64% of the boats were made in the 80s, 14% were made in the 90s and 21% were made in the 2000s.

Average size of a boat was 35 feet.

Average speed of a boat was 6 knots. The speed is much than the average speed from the other marinas due to large amount of the boaters had sailboats. Sailboats have a lower average speed compared to most boats.

When asked how many pump-out stations or services they were aware of, 93% claimed they at least know 1 to 3 services in the Clear Lake or Galveston Bay Area and 7% did not know.

When asked what the consequences were for boaters in Texas who do not secure their discharge valve, do not have a Clean Water Certification sticker for their marine sanitation device, or dump boater

waste in the bay, 43% answered that it was up to $500 per day, 43% did not know the consequences/fine and 14% thought the fine was up to $150 per day.

93% of the boaters did some form of maintenance on their boat and 7% did not. All of the 93% washed their boat with a cleaning product. 31% those who did their own maintenance waxed their boat, another 31% sanded or stained the wood on their boat, and 23% did motor maintenance.

When asked if they have ever witnessed anyone illegally discharging sewage into either Galveston Bay or Clear Lake, all the boaters stated they have not seen any illegal dumping.

All boaters who participated in taking the survey had a holding tank for their marine sanitation device. 36% put chemical treatment into their system, the other 64% had no form of treatment just a holding tank.

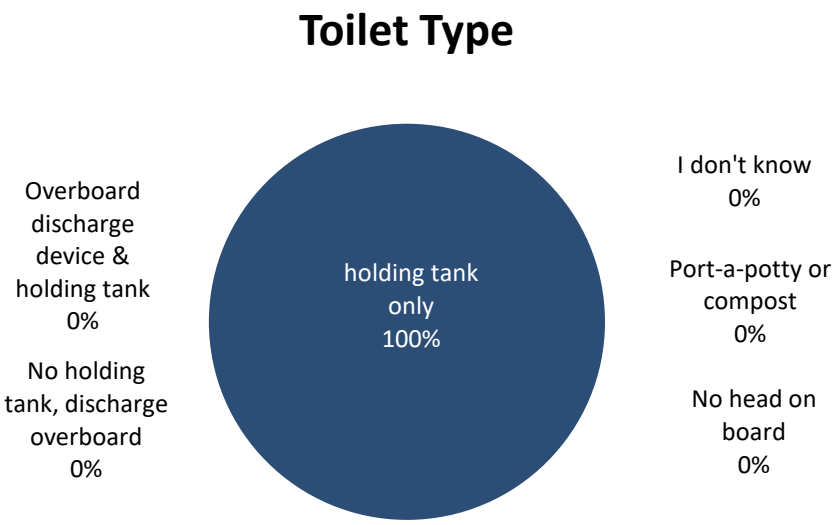
When asked how often their toilet was used onboard, 50% said occasionally, 22% said never. 14% said often and 14% said every time they went out.

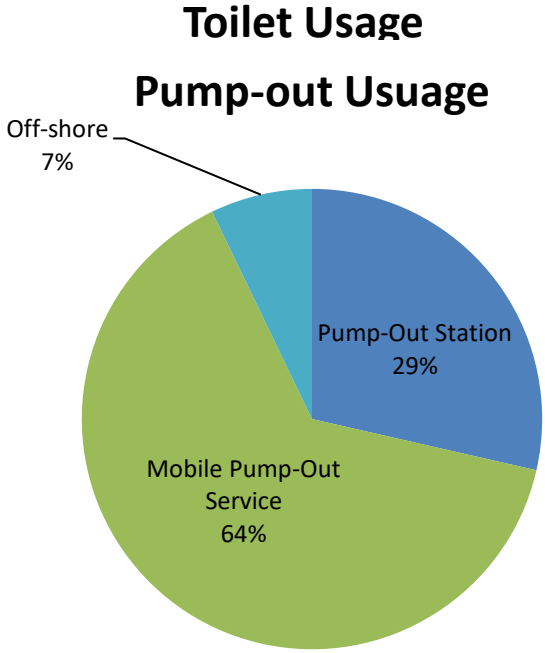
The boaters were asked multiple questions about the pump-out station/services. There was one boater who could not answer any of the questions involving the pump-out station/services. Out of the boaters that were able to, 93% said that the services they used were never broken or closed, and 7% said they were rarely broken or closed. 7% claimed they always had to wait in line for pump-out service and 93% said they never had to wait in line. All were able to find a service or station. 93% stated that the service or station was always staffed and 7% said it was never staffed.

The boaters were asked which location or method did they use the most to dispose sewage. 64% mostly used a mobile service, 29% used a pump-out station and 7% pumped-out 3-nautical miles offshore. A large amount of the boaters used a mobile pump-out service since Watergate does not have a pump-out station.

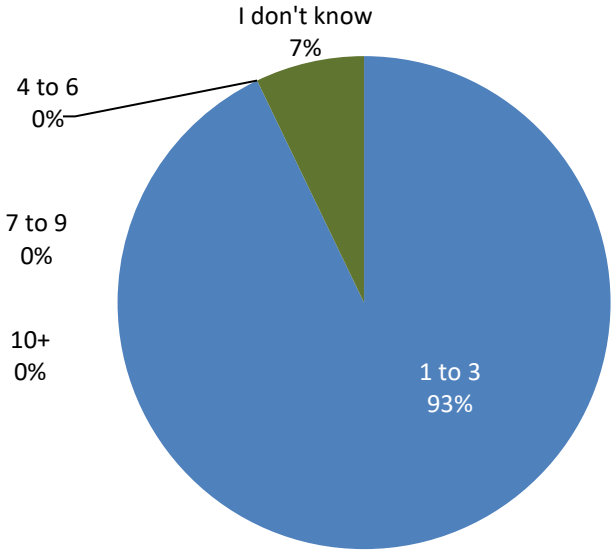
Watergate Yachting Center and Seabrook Marina had positive results when it came to correctly disposing of boater waste. The only difficulty that came up when collecting surveys from these marinas, is that many of the owners were not out with their boats, most of those who were out on the boats were just paid maintenance workers. This made it hard to get wider base of data for these areas.

Graphics Depicting Data Results

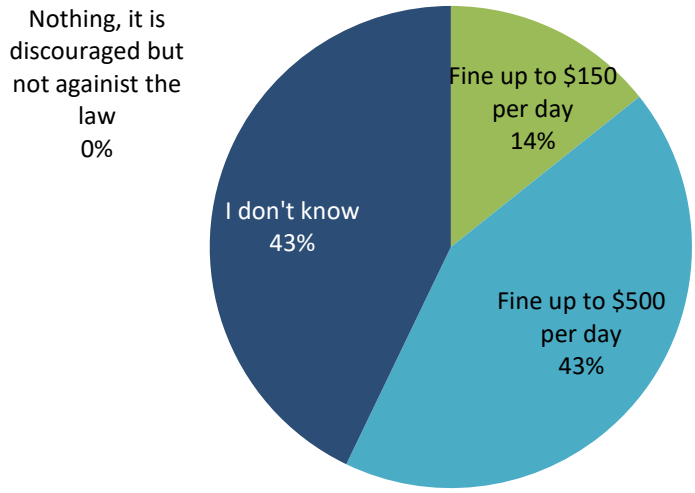


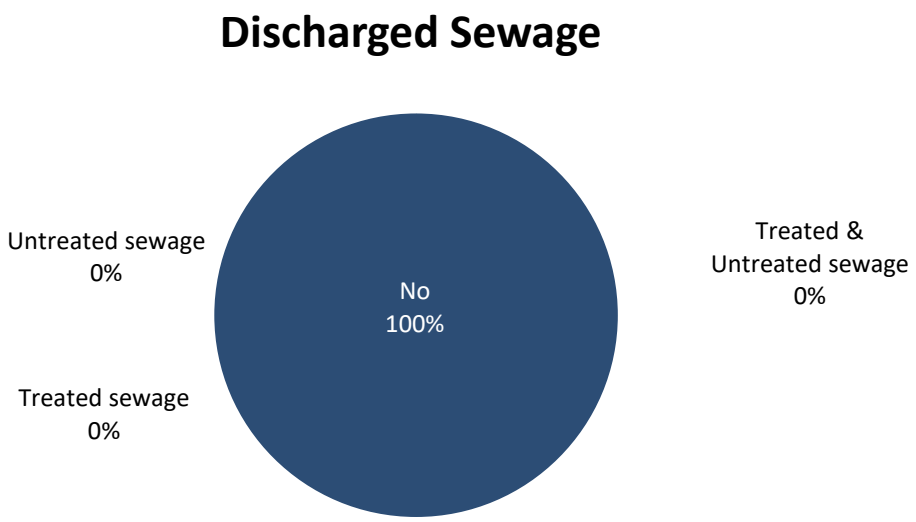


Number of Known Pump-out Facilities



Consequences for Texas Boaters





Overall Preliminary Data Analysis of summer 2016

When visiting the four marinas (Galveston Yacht Basin, Harborwalk Yacht Club, Watergate Yachting Center and Seabrook Marina) between July 1st and July 22nd 46 surveys were taken.

When boaters were asked what kind of marine sanitation device 78% had a holding tank only, 13% had no head on board, 5% had an overboard discharge device and a holding tank, 2% had no holding tank and discharged overboard, and 0% at 'port-o-potty' or compost system.

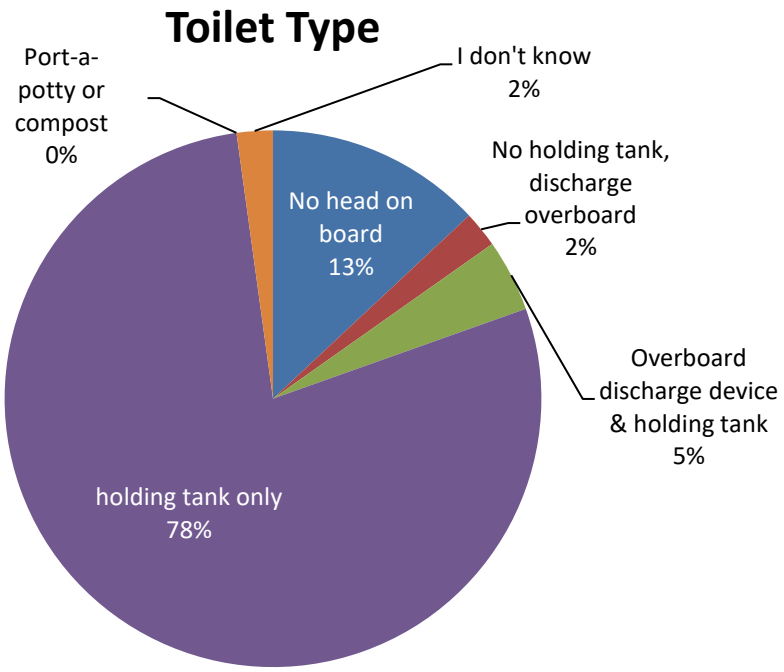
The boaters were asked how often they used their system. 46% of the boaters claimed they occasionally used their head onboard, 19% said never, 13% said often, 11% could not answer, and 11% said every time they went out.

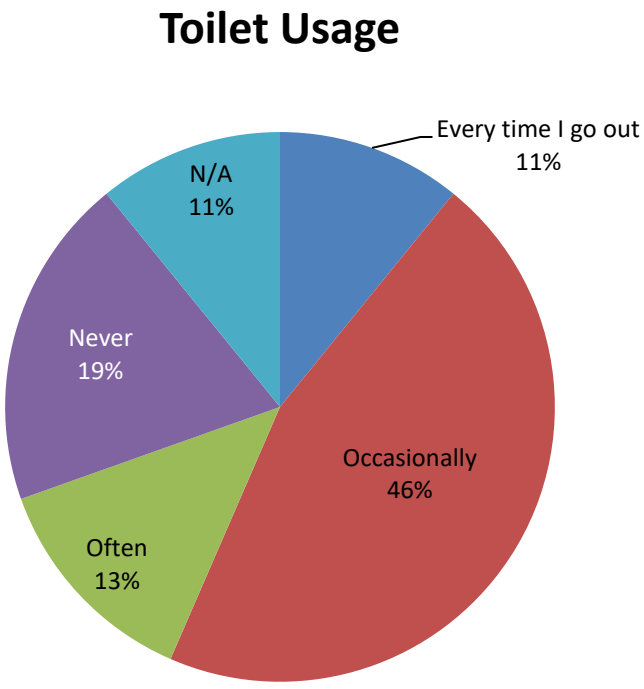
48% of the boaters used a pump-out station, 30% used a mobile pump-out service, 15% could not answer, and 7% discharged their sewage 3-nautical miles of shore.

80% of the boaters new at least one to three pump-out stations or services, 20% did not know where a station or service was and 0% knew more than 3 pump-out services.

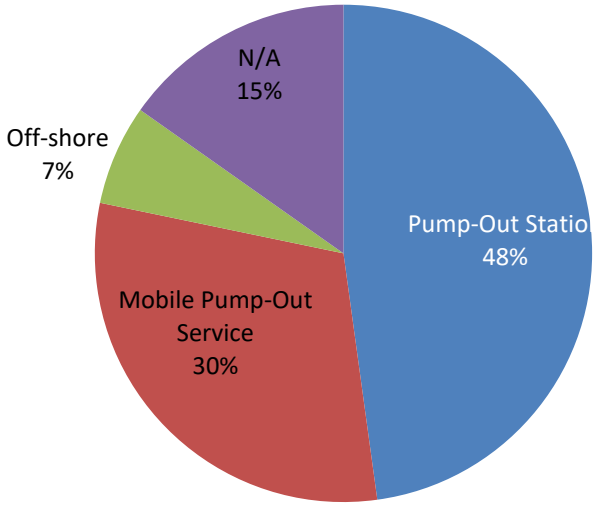
54% did not know the consequences or fines of illegally discharging boater waste, 39% answered that the fine was up to $500 a day and 7% thought the fine was up to $150 a day.

When the boaters were asked if they have ever witnessed anyone illegally dump into a no discharge zone (NDZ) 89% said no, 7% said yes to untreated sewage, and 4% said yes untreated sewage being dumped.

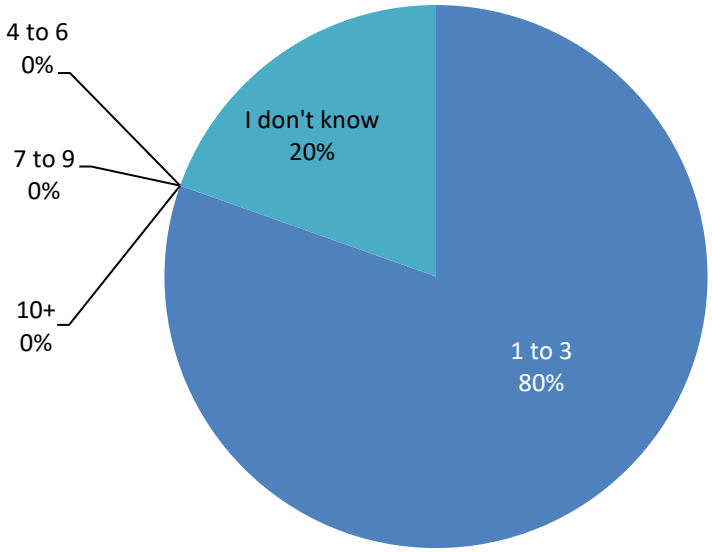

Toilet Type
Port-a-potty or compost 0%
I don't know 2%
No holding tank, discharge overboard 2%
No head on board 13%
Overboard discharge device & holding tank 5%
holding tank only 78%

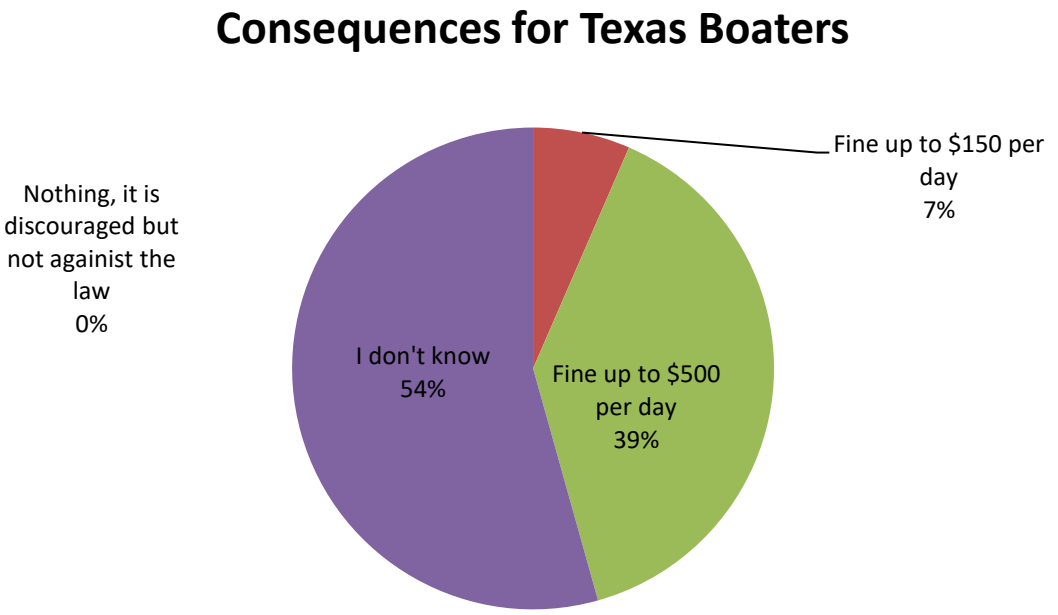

Toilet Usage
Every time I go out 11%
N/A 11%
Never 19%
Occasionally 46%
Often 13%

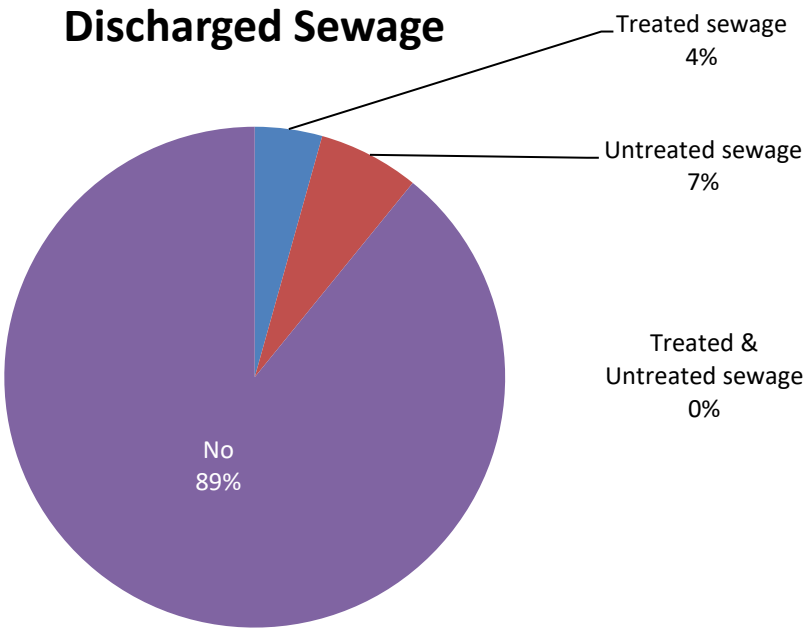
Pump-out Usage



Number of Known Pump-out Facilities







Comparison with Preliminary Data Analysis from summer 2014

To see if there has been any changes in the boating industry, when it comes to boater waste, boater's knowledge, and other concerns about illegal discharging, data from surveys taken in summer 2014 is compared to the recent summer 2016 data.

In order to get a more accurate comparison and representation from the overall data percentages from 2014 and 2016, Harborwalk Yacht Club, Galveston Yacht Basin and Watergate Yachting Center

data taken in 2014 was calculated together and compared to the marinas surveyed in summer 2016. Seabrook Marina was not included in the 2014 data because no surveys were taken at this location.

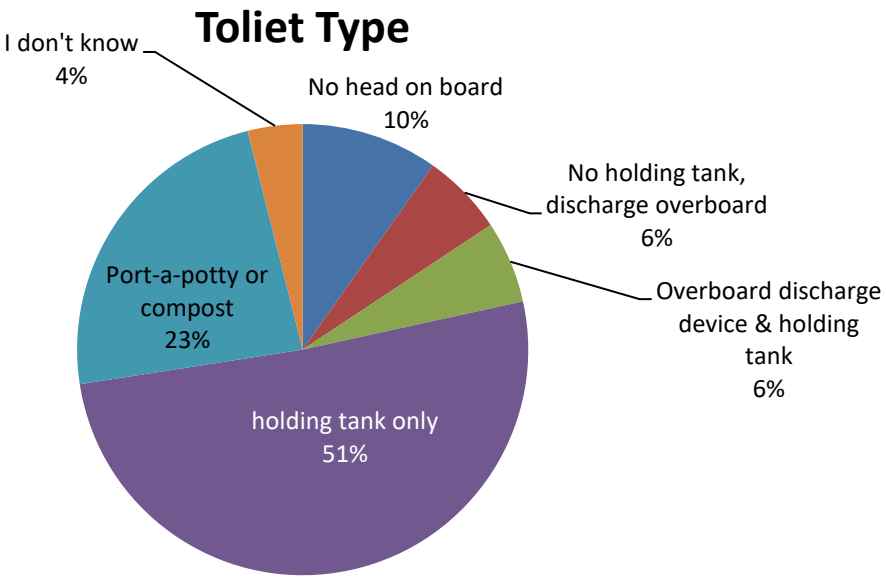
In 2014 51% of the boaters had a holding tank only as their marine sanitation system, 23% had a port-a-potty/compost system, 10% had no head on board, 6% had an overboard discharge with a holding tank, another 6% had an overboard discharge without a holding tank, and 4% did not know what marine sanitation device they had. In 2016 the amount of those who had holding tanks only jumped from 51% to 78%, both discharge overboard systems with or without a holding tank and reduced the same out. There were no boaters who owned boat with a port-a-potty/compost system in 2016. The amount who did not know what system they had abroad also dropped from 4% in 2014 to 2% 2014.

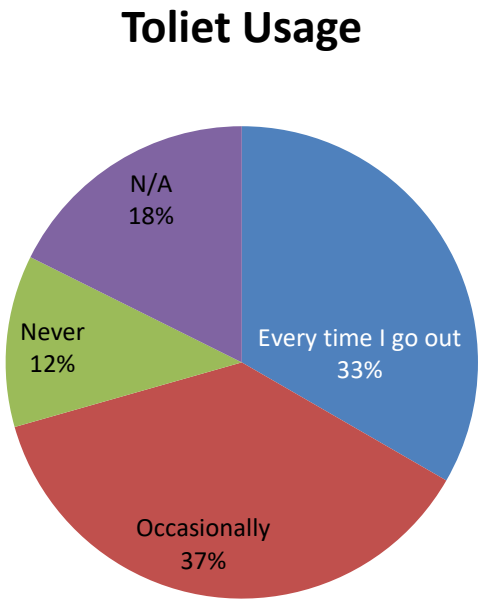
Most of the boaters in 2014 occasionally used their head on their boat (37%). 33% claimed they used it every time they went out, 12% said they never used their head onboard, and 18% could not answer. Those who used it occasionally grew to 46% in 2016, the boaters who used it every time they went out/often decreased by 20% from 2014 to 2016, 19% said they never used it and 11% could not answer.

When it came to how many pump-out stations or services the boaters were aware of in 2014, 55% knew at least one to three services, 35% did not know any, 8% knew four to six, 2% or one boater knew more than 10, and 0% knew seven to nine pump-out facilities or services. In 2016 the amount of boaters who knew at least 1 to three pump-out services grew to 80% and those who did not know of any services reduced by 15%.

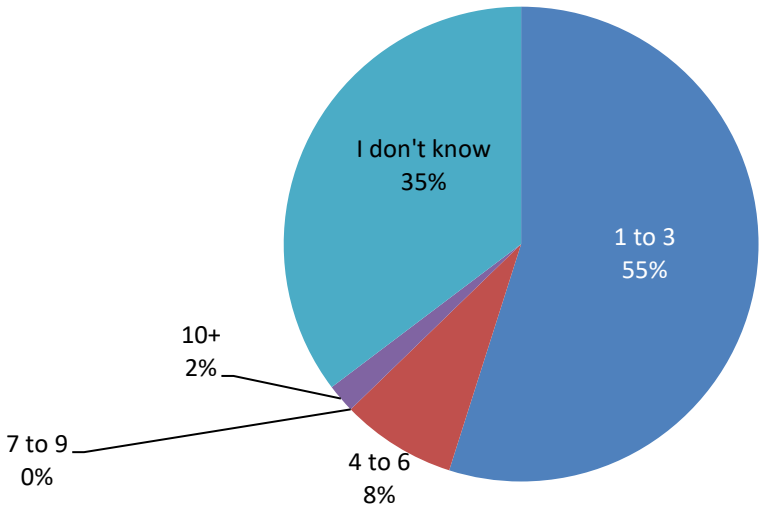
The boaters were asked what the consequences were for not discharging correctly. In 2014 61% did not know, 27% answered that could be fine that is up to $500 a day, 10% believed it was a fine up to $150 a day, and 2% believed there was no consequence just that it was discouraged. There was a positive shift in awareness of consequences from 2014 to 2016. 0% thought that there was no consequence for illegal discharging, the amount of those who did not know reduced from 61% to 54%, the boaters that answered that the fine was up $500 a day grew by 12%, for $150 a day it was reduced by 3%, and 0% believed that there are no consequences or fines.

Finally the boaters were asked if they have ever seen another boater illegally pumping into the Clear lake Area, or the Galveston Bay Area. In 2014 78% said no, 8% said yes to treated sewage being dumped, another 8% said yes to untreated sewage and 6% said yes to both treated and untreated sewage. These percentages improved from 2014 to 2016. 89% said no to witnessing illegal pumping, 7% said yes to seeing untreated sewage, 4% said yes to treated sewage and no boaters reported that they have seen illegal pumping of both treated and untreated sewage.

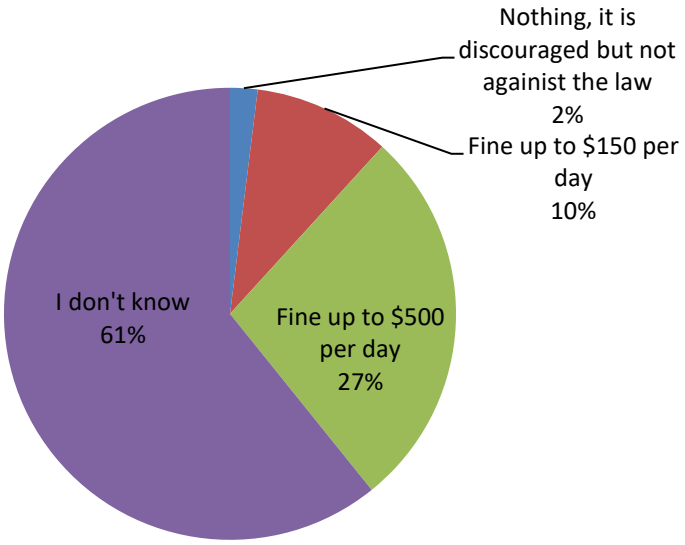

Toliet Type
I don't know
4%
No head on board
10%
No holding tank,
discharge overboard
6%
Overboard discharge
device & holding
tank
6%
Port-a-potty or
compost
23%
holding tank only
51%

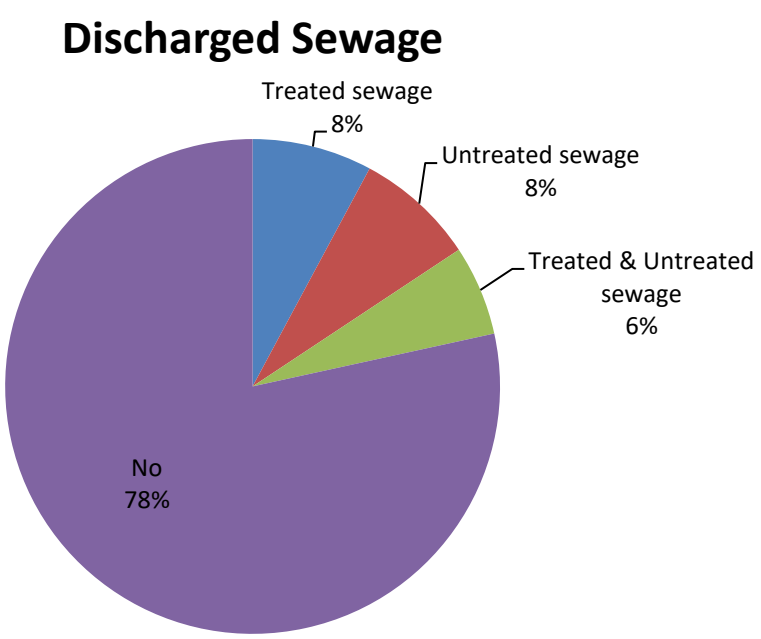

Toliet Usage
N/A
18%
Never
12%
Every time I go out
33%
Occasionally
37%

Number of Known Pump-out Facilities



Consequences for Texas Boaters





Suggestion for Future Dockwalking

1. Collaborate more with local marinas
    - Ask if the marina is informing boaters about proper discharging of boater waste, if so how?
    - Putting up signs in marinas that have the current fine amount when boater waste is illegally discharged
    - Further investigate why large marinas do not have a pump-out station
    - Find new marinas for dockwalking

2. Visit boating shows and events use outreach booth to educate boaters and collect surveys

3. Edit the answer choices for how often a boater uses their toilet, such as changing the "every time I go out" option since some go out on their boat more than others

4. Schedule to visit each marina three or more times to have a larger amount of surveys

5. Continue to collect surveys from a variety of marinas that are in different locations throughout the Galveston Bay and Clear Lake Area

6. Ask boat maintenance workers or any other workers from the marina if they have seen anyone illegally discharge sewage in the bay

7. Continue to compare data between new surveys and past surveys from the same marinas to see if certain boating communities have been improving

Appendix III: Water Monitoring Team

How Clean Is My Water?

2016 Water Quality Year-In-Review, Water Monitoring Team

In 2016, GBF's Water Quality Monitoring Team collected and analyzed 444 water samples from 51 sites around Galveston Bay. These samples were collected by 47 different volunteer monitors who sampled for air and water temperature, dissolved oxygen, pH, salinity, water transparency and depth, as well as general field observations. For more information about this program, visit www.galvbay.org/watermonitors.

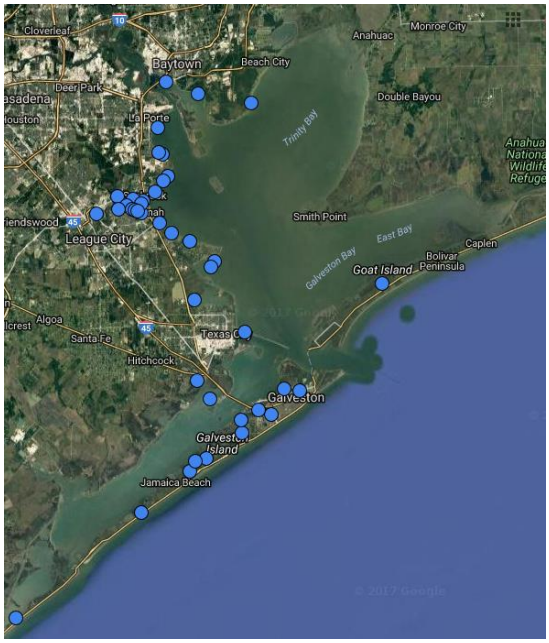


Figure 19. 2016 Water Monitoring Locations. Each blue dot represents a sampling location during 2016.

This document summarizes our findings for each parameter based on the Team's 2016 data.

To view 2016 Water Quality summaries for each individual site, please click on each site on our sampling map*, linked here or accessed from our webpage (www.galvbay.org/watermonitors).

This data can be viewed and downloaded from the Citizen Science Data Portal, accessed through a button on our webpage (listed above).

**Sites on map without 2016 data summary are new as of 2017*

Air Temperature: average of 24.0°C in 2016

This is **HIGHER** than in previous years

2014 average: **22.4°C**, 2015 average: **23.1°C**

How does Water Temperature Impact Water Quality?

Air temperature impacts water quality by influencing weather processes and water temperatures.

According to the Data…

GBF's Water Monitoring Team has observed a slight increase in the air temperature from year to year, with 2016's temperature the highest yet.

Water Temperature: average of 22.8°C in 2016

This is **HIGHER** than in previous years

2014 average: **21.9°C**, 2015 average: **22.8°C**

How does Water Temperature Impact Water Quality?

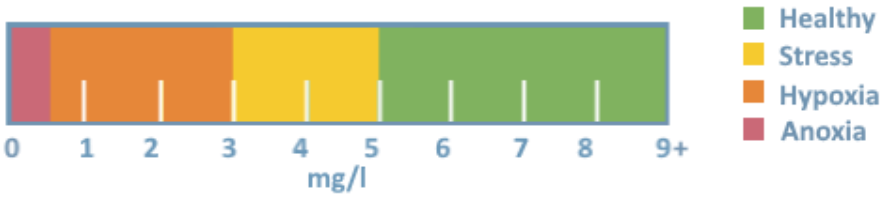
Water temperature can impact biological factors, including hibernation, reproduction, and migration..

Water temperature also impacts water chemistry. It can alter the rate of reactions and how much dissolved oxygen the water can hold; cold water can hold more oxygen than warm water.

According to the Data…

GBF's Water Monitoring Team has observed a slight increase in the average water temperature from year to year, with 2016's temperature the highest recorded.

Dissolved Oxygen: average of 6.3 mg/L in 2016



This level is **GOOD** for supporting animal life.

99 percent of samples had Dissolved Oxygen levels high enough to support life in 2016.

What is Dissolved Oxygen (DO)?

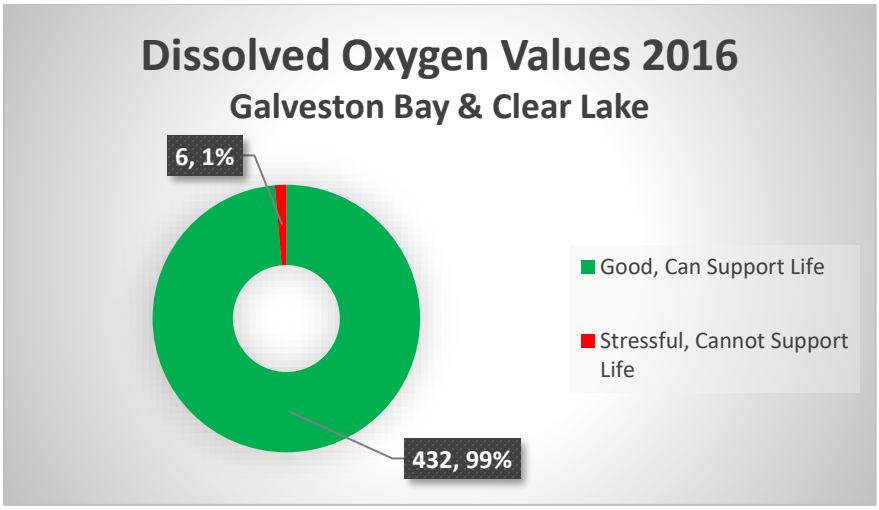
Dissolved Oxygen (DO) concentrations tell us the amount of oxygen freely available in the water.

How Does DO Impact Water Quality?

Fish and other aquatic life depend on dissolved oxygen to survive; if oxygen levels are too low they will suffocate. DO levels of 5 mg/L or higher are required for healthy growth and activity. Levels between 3 and 5 mg/L are stressful to most aquatic animals, and levels below 3 mg/L are considered dangerous (Figure 1).

According to the Data…

In 2016, 99 percent of the DO samples collected by GBF's Water Monitoring Team were 5 mg/L or higher. This indicates that DO levels are suitable for life within Galveston Bay.

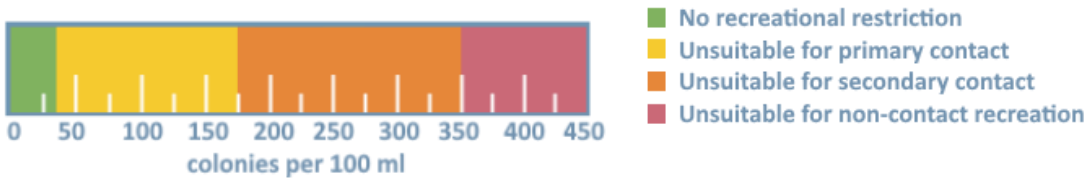


Enterococci Bacteria: Geometric Mean of 6.5 MPN in 2016

This is considered **SAFE** for swimming by the EPA (<35 MPN is safe to swim)

This level is **LOWER** than previous years

2014 geomean: **7.8 MPN**, 2015 geomean: **12.8 MPN**



What are Enterococci?

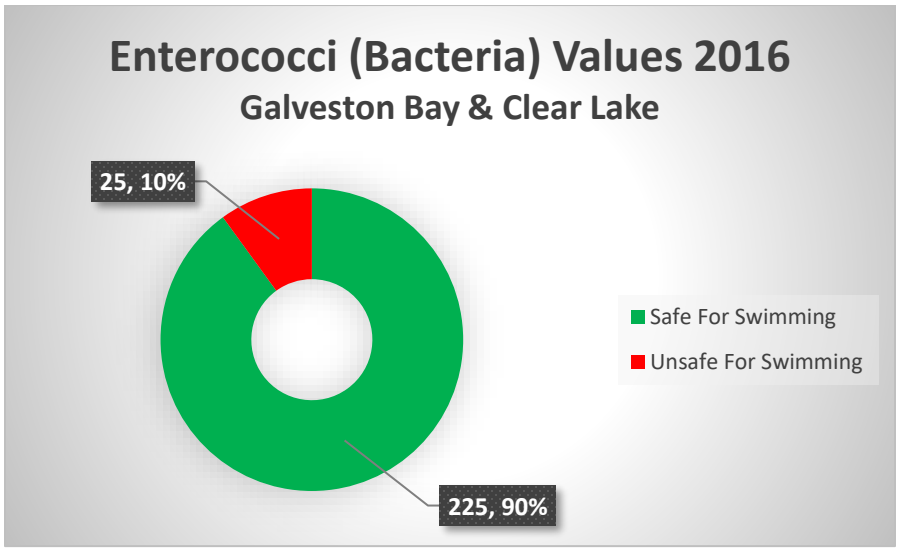
Enterococci are a group of indicator bacteria that indicates the presence or absence of fecal matter in the water and the potentially harmful microorganisms associated with fecal waste.

How do Enterococci Impact Water Quality?

Enterococci in the water indicate the presence of microbes from fecal matter that can make us sick and impact Galveston Bay's oyster and tourism economy. Fecal matter enters our waterways through polluted storm water, failed wastewater infrastructure, and from pets and wildlife, to name a few.

According to the Data…

About half of GBF's Water Monitoring sites test for Enterococci. Of the 250 samples collected in 2016, 10 percent of them were considered unsafe for swimming by the EPA. Most of these exceedances occurred soon after major rain events.



Salinity: average of 11.9 ppt in 2016

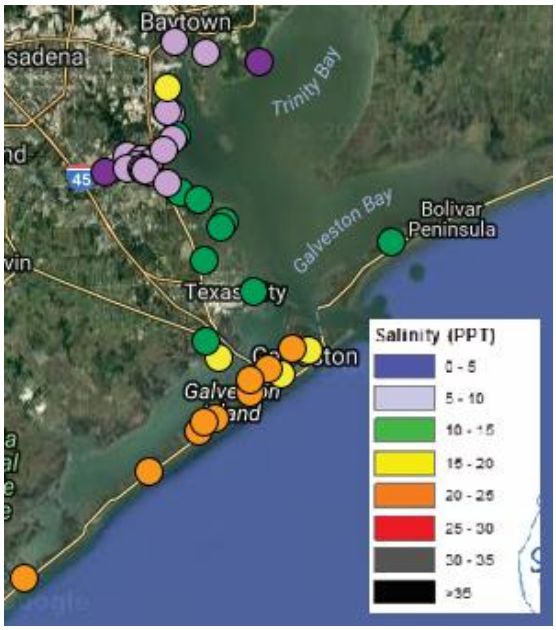


Figure 20.. Salinity averages by site, 2016.

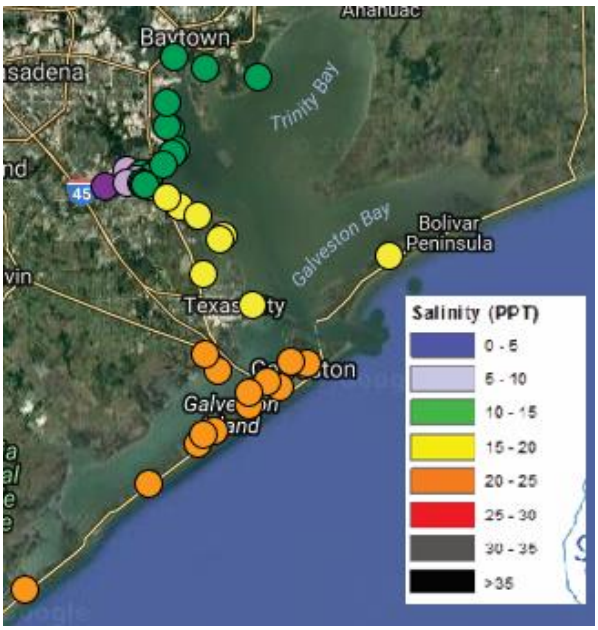


Figure 21. Salinity averages by site, normal year

This is **LOWER** than previous years

2014 average: **19.11 ppt**, 2015 average: **12.45 ppt**

What is Salinity?

Salinity is the total amount of salts dissolved in the water. Fresh water usually has a salinity of 0 ppt, while salty ocean water usually has a salinity around 35 ppt.

How Does Salinity Impact Water Quality?

Galveston Bay's water comes from freshwater rivers and bayous as well as from inflows from the open ocean. Because of this, Galveston Bay should have brackish water, between salty and fresh.

Salinity within Galveston Bay generally ranges over space and time. Impacts on salinity include proximity to freshwater inflows and seawater exchange, rainfall, and tidal patterns.

Plant and animal life within Galveston Bay rely on a specific range of salinity; water that is too salty or too fresh makes it difficult for life to thrive in Galveston Bay.

According to the Data…

GBF's Water Monitoring Team found that Galveston Bay experience fresher water overall in 2016 than what is considered normal. Many sites reported the lowest salinities ever recorded at their site. This is likely due to the rain and flooding experienced over the spring and summer.

Water Transparency: average of 0.5 meters in 2016

This is **THE SAME** as in previous years

2014 average: **0.55m**, 2015 average: **0.46m**

What is Water Transparency?

Water transparency, or turbidity, measures how much solid matter is suspended in the water. It directly measures how these suspended solids decrease light passing through the water. The higher the transparency, the farther down the light passes and the clearer the water appears.

How Does Water Transparency Impact Water Quality?

Turbid waters can prevent plants from getting enough sunlight to grow, and settling sediment can bury or suffocate plants and animals living on the bottom of the Bay.

Galveston Bay's turbid waters are due to:

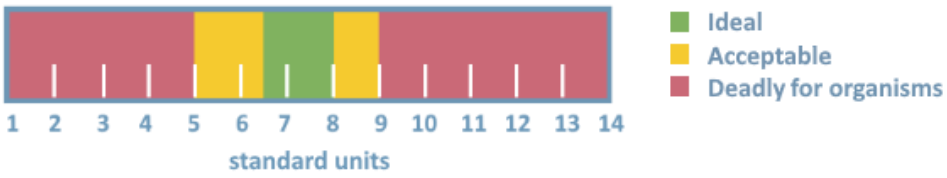
- *sediments from the Bay Bottom mixing in the water column*
- *erosion of the surrounding land*
- *vegetation (ie. plankton, algae) growing in the water column.*

Galveston Bay and the surrounding land has very small sediment particles, so sediment often floats in the water for a long time before settling to the bottom. This, coupled with a shallow and windy bay system, naturally leads to relatively turbid water in Galveston Bay. However, increased erosion due to development and storm water runoff can increase the amount of particles in the water column, causing the water to be more turbid (or less clear).

According to the Data…

In 2016, the average transparency measured by GBF's Water Monitoring Team was 0.5 meters, very similar to transparency measured in prior years.

pH: average of 7.9 in 2016



This is **IDEAL** to support life

This is **THE SAME** as in previous years

2014 average: **8.1**, 2015 average: **7.9**

What is pH?

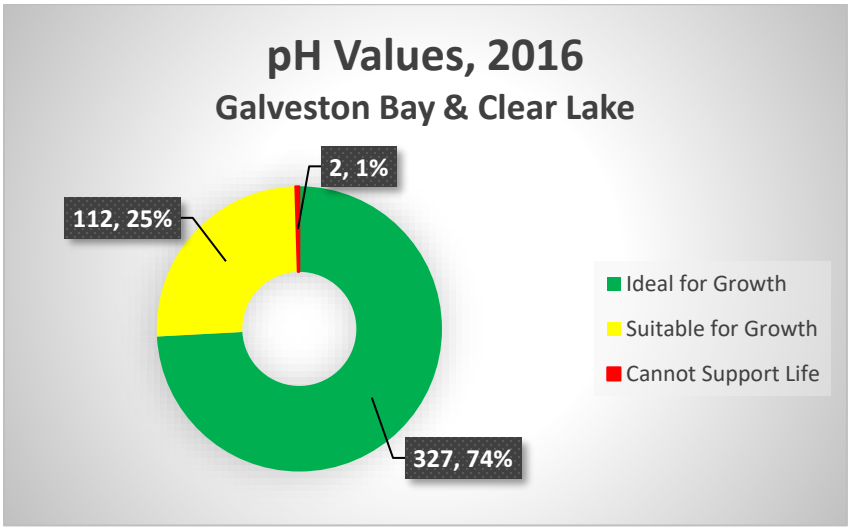
pH is a measurement of how acidic the water is. A pH with a measurement of 7 is considered neutral. Anything less than 7 is acidic, anything greater than 7 is basic. The scale is logarithmic, so every one-unit change equals a ten-fold increase or decrease in acidity.

How Does pH Impact Water Quality?

pH impacts the life and growth rates of aquatic life, how chemicals and pollutants dissolve or react in water, and whether or not these pollutants can be absorbed by animals in the water. A range of 6.5 to 8 is considered ideal for most life. A pH less than 5 or greater than 9 is considered dangerous or deadly.

According to the Data…

pH has been relatively stable in Galveston Bay over the years, and is considered within a healthy and normal range.



Acknowledgements

Thank you to all 44 volunteer water quality monitors for dedicating their time and effort to collecting this data. A special 'thank you' to GBF's two volunteer lab assistants, Dave and

Casandra, for spending countless hours in our lab processing and analyzing enterococci samples.

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Table A3: Water Monitoring Action Plan Blueprint

Assessment Type: BI	**Outcome:** Citizens and stakeholders choose to reduce polluted runoff entering Galveston Bay	**Reason:** B. To exemplify and communicate the impact of human threats on water quality in order to design strategies and encourage public to reduce those threats	**User:** I. Landowners, households, recreational water users

Monitoring question: 1 of 2: How do human events and activities impact Galveston Bay?

Will be answered by: incorporation of data into GBF presentations that outlines how water quality varies with: nearby runoff and development, boater waste and activity. Answering A2: how does monitoring data improve Water Programs? (add question to RBW survey, Cease the Grease?)

Id #	Decision Maker	Decision Made (outcomes):	Info Needed	Information Product	Action Plan Steps
A1	GBF Water Quality Outreach Coordinator and other Social Marketing campaign organizers	Decision makers use data to exemplify whether or not humans are impacting the Bay and will decide to present and report results so that the public better understands how their actions impact their surrounding environment.	-Monitoring locations along a gradient of human use/impact. -Water quality data, including: turbidity, DO, salinity, water color and odor, fecal indicator bacteria, bird count and guano coverage -Method to quantify development/human use -Comparison of water data between various levels of human use -Data collected at regular intervals around the bay, at equal(ish) number of sites for each use level, for at least 1 year. - WMT volunteers provide validity and analysis of data	GBF water team uses information to create relevant presentations for different audiences.	Find development data or method for quantifying human activity - Define role of WMT Site Analysis Volunteer
A2	Residents and users of lower Galveston Bay watershed	Residents and users of the Bay make more informed, everyday decisions to decrease amount of polluted runoff entering the Bay and improve quality of life. Decisions include conserving water, reducing runoff, cleaning up after pets, properly disposing of FOG and decreasing use of pollutants on yards.	- Water quality data, including: turbidity, DO, salinity, water color and odor, fecal indicator bacteria -Method to quantify development/human use -Analyzed data on how human activity impacts Galveston Bay's water quality are available/presented -Information on actions they can take to decrease their impact on Galveston Bay - WMT volunteers provide validity and analysis of data	Use WMT data when creating campaigns and deliverables through messaging of data. (GBF data used to show improve in WQ from campaign actions). How to incorporate language into campaigns.	Identify communities to focus on. Within ID'd communities, determine contacts and how they want to see/receive presentation of data/interpretations - Define role of WMT Site Analysis Volunteer
A3	Galveston Bay Foundation Report Card Coordinator and HARC	Include GBF WMT data in GB Report Card to share data and interpretations with broader audience than GBF water team	- WMT data in usable form, similar to other data used in Report Card	incorporates Water Monitoring data in Report Card	Contact HARC about using data, determine data needs and format

		could reach alone.			
A4	GBF Education Team	GBF Education Team use GBF water monitoring data during relevant Marsh Mania presentations and other education programs.	- Are there sites near Marsh Grass planning they might be able to use the data from?	WMT data is presented and considered during education team programs	Meet with education team, determine relevant monitoring sites, determine what format decision maker would need data
Monitoring question: 2 of 2: What are the current water quality problems in Galveston Bay, if any (within limitations of what we are measuring)?					
Will be answered by: analysis of data that compares water quality data at each location to threshold values.					
A4	GBF Water Programs team, WQ Outreach Coordinator	Locations with unhealthy or problem parameter values, if any, are identified. Locations that need protection are also identified, based on limitations of what we are measuring. These id'd locations would cause monitoring design to shift to AII-b.	-Data on basic water quality parameters (temperature, salinity, turbidity, DO, pH) - Information on ideal/healthy water quality ranges for each parameter - WMT volunteers provide validity and analysis of data	Information is used to focus/adapt existing campaigns and create new campaigns as needed. Information gathered is added to existing campaign materials and deliverables. Short term vs long term goal	Data is interpreted and conclusions are reached about the health of various water quality parameters around Galveston Bay. (what format do we need this data in in order to make the decision and create info product?) - Define role of WMT Site Analysis Volunteer

Assessment Type: AII-b	**Outcome:** Influence Best Management Practices in cities and marinas	**Reason:** A. To characterize water quality in order to identify areas of impact.	**User:** II. Local decision makers and policy makers for decision makers
Monitoring question: 1 of 1: What are the current water quality problems in Galveston Bay and Clear Lake?			
Will be answered by: Water quality has been analyzed at various marinas and cities, communicated to marina managers, city officials and/or HOAs.			

Id #	Decision Maker	Decision Made:	Info Needed	Information Product	Action Plan Steps
B1	Marina managers and owners	Marinas decide to implement management practices that increase DO and decrease bacteria inputs/concentrations in the marina, making marinas healthier and more appealing for both human and animal use. BMPs include adding a pump-out station or encouraging use of existing station, encouraging marina users to report pollution or illegal dumping,	-General water quality parameters measured at regular intervals - Info delivered to decision makers in the format they need - WMT volunteers provide validity and analysis of data	Community marketing campaign (pump-don't-dump, GBAN). Add info to Pump-don't-Dump	- Identify marinas and contact information to share water quality data with. - Identify what info decision makers need: format of data, frequency received - Conduct analysis and interpretation on data, as needed to deliver data - Define role of WMT Site

					Analysis Volunteer
B2	City officials, homeowner associations	Cities implement outreach to residents about decreasing pollutants. Infrastructure assessment when necessary by cities. Decreased pollution will increase appeal of city/neighborhood to potential residents, increase quality of life, protect the people who live there.	- Water quality parameters are measured at cities around Clear Lake/Galveston Bay.	Community marketing campaign: potential new campaigns based on new info, info added to existing campaigns (CtG, GBAN, Scoop the Poop, etc.)	Identify cities and communities for all areas where monitoring is occurring. ID groups and contact information for each city/community. -Conduct analysis and interpretation on data, as needed to deliver data

Assessment Type: AII-a	**Outcome:** Reduce bacteria levels in high-concentration locations along the nearshore	**Reason:** A. To characterize bacteria concentrations for the purpose of identifying areas of impact.	**User:** II. Local decision and policy makers

Monitoring question: 1 of 1: What are the geometric mean concentrations of fecal indicator bacteria around Galveston Bay's shorelines?

Will be answered by: Locations with high bacteria concentrations are identified; ID'd contacts are aware and are working to take steps to remediate

Id #	Decision Maker	Decision Made	Info Needed	Information Product	Action Plan Steps:
C1	GBF staff	Locations with high bacteria concentrations will be identified so that action can be taken to reduce bacteria.	- locations around the Bay need to be monitored at regular intervals for Enterococci concentrations -Enterococci samples need to be analyzed in lab - Definition of "high" bacteria concentrations are outlined and compared to collected data	This information will be passed on to city and marina officials based on action limits and how they want the data presented.	Create action limits for various threshold limits of bacteria (aka talk to officials)
C2	Marina managers, city officials, HOAs	Decisions may include checking for infrastructure failure, outreach to residents, and improve management practices to reduce bacteria, protect people and increase use and improve perception of marina.	- Contact information to share report of high bacteria concentrations are identified - How do we communicate with marinas that data isn't representative of entire marina if there's only one site? What would they then be able to do with our data?	Proper contacts will then be notified to handle bacteria problems.	For each monitoring site, ID a contact to reach out to if bacteria levels become high. - Identify what info decision makers need: format of data, frequency received - Conduct analysis and interpretation on data, as needed to deliver data
C3	Texas Beach Watch, County Dept. of Health	Dept. of Health and Texas Beach Watch will respond when GBF WMT bacteria values consistently exceed threshold values to help them implement their goal of protecting the public	- Each agency's reporting methods and threshold values for high recorded bacteria concentrations.	Information is used to influence information published on Texas Beach Watch website.	- Identify contacts at TX Beach Watch and determine when TX Beach Watch should be notified.

		from harmful pathogens in water.			

Assessment Type: DI	Outcome: Recreaters are aware of potential contact hazards from bacteria	Reason: D. To assess and communicate the safety of Galveston Bay nearshore waters for primary recreation.	User: I. Recreational water users

Monitoring question: 1 of 2: Are there any locations around the nearshore that are impaired for recreation standards for bacteria?

Will be answered by: Locations with impaired averages for recreation are identified and continuously monitored. This information is available and advertised to the public.

Id #	Decision Maker	Decision Made (outcome):	Info Needed	Information Product (output)	Action Plan Steps:
D1	GBF Staff and volunteers	Locations that are impaired are ID'd and recreaters, HOAs, marinas, and/or cities are informed based on action limits.	- Enterococci samples are collected at high use areas around the Bay at regular, frequent intervals - GBF staff monitor single grab and geometric mean levels	GBF staff gather, analyze and record bacteria data.	Identify action limits. - Conduct analysis and interpretation on data
D2	Residents and recreaters along Clear Lake/ Galveston Bay	Recreaters of the bay's nearshore are aware of bacteria threshold and levels and make informed decisions about where/when to swim in various locations around the Bay to remain healthy.	- Bacteria levels are interpreted based on recreation safety standards and are visually disseminated to the public to show where values were "safe"	Bacteria concentrations and interpretations are communicated to the public visually. Public is directed to this deliverable. Could Beach Watch cross-link to our bacteria map at all? - Cross link to bacteria map & TX Beach Watch from Pump Don't Dump page and rain barrel workshop presentations - Social media push during recreation season	Consistent social media presence and partner advertising during recreation season (May – September).

Monitoring questions 2 of 2: Where are the safest locations to swim in Galveston Bay after a rain event, based on bacteria concentrations? *(If unanswerable, can explain why it's unanswerable, which is a measurable result)*

Will be answered by: Bacteria concentrations after major rain events have been analyzed and those with safe/low concentrations are ID'd. Information is communicated to the public.

D2	GBF staff and volunteers	Locations with regularly high bacteria levels after rain events are identified and communicated to recreaters, HOAs, marinas and/or cities so that public remains healthy.	- Rain data (amount of rain in 3 days, time since last rainfall) at each location, bacteria concentrations at locations around the Bay during many different rain/dry events, criteria of "high" bacteria levels - WMT volunteers provide validity and analysis of data - Responsible parties are notified.	GBF staff interpret data to determine "high concentration" locations, if determinable, and publish/market results to recreaters and communities.	Identify criteria for "high" bacteria levels and methods of communication to public. Determine data format required, best avenues to share data. Conduct analysis and interpretation on data. - Define role of WMT Site Analysis Volunteer
D3	Swimmers on Clear Lake/ Galveston Bay	Swimmers and other recreaters avoid areas of likely contamination after large rain events so that they do not become sick.	- Rain data (amount of rain in 3 days, time since last rainfall) at each location, bacteria concentrations at locations around the Bay during many different rain/dry events, criteria of "high" bacteria levels - WMT volunteers provide validity and analysis of data	Swimming recommendations are issued in various communities when necessary. (??)	Determine methods of communicating data. Determine data format required.

			- Responsible parties are notified.		Conduct analysis and interpretation of data - Define role of WMT Site Analysis Volunteer

Assessment Type: CII	**Outcome:** Increase conservation, restoration efforts to improve water quality and reduce pollution	**Reason:** C. To evaluate the effectiveness of GBF conservation and restoration efforts	**User:** II. GBF staff

Monitoring question: 1 of 4: How do water quality parameters compare at conserved vs developed locations?

Will be answered by: Collected water quality data is analyzed for significance of land use on water quality. Results are used to help GBF conservation and restoration efforts.

Id #	Decision Maker	Decision Made:	Info Needed	Information Product	Action Plan Steps
E1	GBF conservation team	Impacts of conservation are generalized and impacts of specific restoration projects are measured in order to guide and promote GBF conservation and restoration efforts and keep Galveston Bay fishable and swimmable	- water quality data collected at natural locations and developed locations. - data collected at regular interval for long period of time - determination of level of development/natural space - sample design to remove "background noise" - WMT volunteers provide validity and analysis of data	Results of analysis are turned into images and deliverables for community based marketing campaigns, presentations and proposals.	- Meet with Haille, Anna, Lee Anne to determine data needs and uses - Determine how to measure development (Cha ris) - Analyze sampling design for feasibility - Determine data format required. - Define role of WMT Site Analysis Volunteer

Monitoring question: 2 of 4: How do water quality parameters change as a location is restored?

Will be answered by: data is collected and analyzed before, during and after a restoration project.

E2	GBF Living Shorelines Program Manager, Land Stewardship Coordinator	GBF Living Shorelines and Conservation staff create monitoring plan to assess conservation/restoration success based on recommendations from WMT to better monitor success of their projects	- identification of type of data that needs to be collected, frequency of data, methods for collecting data.	Results of analysis are turned into images and deliverables for community based marketing campaigns, presentations and proposals.	- Meet with GBF conservation staff to guide/initiate creation of monitoring plan and determine if this decision can be made.

Monitoring question: 3 of 4: What locations and seasons are best for oyster recruitment?

Will be answered by: analysis of water quality and oyster recruitment data at sites where oyster restoration and water quality monitoring are occurring.

E3	GBF Habitat Restoration Coordinator	Location is/is not ideal for oyster recruitment. How oyster recruitment relates to water quality parameters each year. Will help in future oyster restoration decisions	- water quality data (salinity, temperature, DO, turbidity, algae) is measured at locations of constructed oyster beds and compared to recruitment data by GBF restoration staff or intern.	Results from analysis are turned into images and deliverables for community based marketing campaigns, presentations, proposals.	Determine data format needs for GBF Habitat Restoration Coordinator.

Monitoring question: 4 of 4: How do bird abundances compare with water quality data?

Will be answered by: side by side analysis of TERN citizen science data and GBF water quality data					
E4	Audubon TERN program staff	In partnership with Audubon, relationship between bird characterization and water quality at specific sites is determined to help protect bird habitats, especially those that are prime habitat for migratory birds.	- water quality data collected at regular interval at same time and location of TERN data	Results from analysis are turned into images and deliverables for community based marketing campaigns, presentations, proposals.	Set training date with TERN program, train WQMs in TERN monitoring, train TERN volunteers in WQM. Determine data format required.

Appendix IV: Pump-out Stations

Table A4: List of pump-out services provided for recreational vessels in the Galveston Bay and Clear Lake areas during Cycle 20

Marina	Address	Phone Number	Lat/Long Coordinates	Total # Pump-Outs	Stationary	Carts	Dump Stations	Mobile Boat	Hours of Operation	CVA Funding
Bayland Marina	2651 Texas 146, Baytown, TX 77521	281-422-8900	29°42'32.58" N 94°59'47.24" W	2	1	1	0	0	Tues-Sun, 7am-5pm	No
Bridge Harbor Yacht Club	411 Sailfish Ave, Freeport, TX 77541	979-233-2101	28°57'42.59" N 95°17'32.74" W	1	1	0	0	0	Mon-Fri, 8am-5pm; Sat+Sun, 7am-8pm	No
Endeavor Marina	3101 NASA Road 1, Seabrook, TX 77586	832-864-4000	29°33'38.23" N 95° 2'32.30"W	1	1	0	0	0	Mon-Fri, 8:30am-6pm; Sat+Sun, 8:30am-8pm	No
Galveston Yacht Basin	715 North Holiday Drive, Galveston, TX 77550	800-866-2869	29°19'1.84"N 94°46'37.49" W	1	1	0	0	0	Sun-Sat, 8am-5pm	No
Harborwalk Marina	1445 Harborwalk Boulevard, Hitchcock, TX 77563	409-935-3737	29°17'43.36" N 94°58'3.62"W	1	1	0	0	0	Mon-Thurs, 7am-6pm; Fri + Sat, 6am-7pm; Sun, 6am-6pm	No
Houston Yacht Club	3620 Miramar Drive, Shoreacres, TX 77571	281-471-1255	29°37'3.24"N 95° 0'5.64"W	1	1	0	0	0	Wed-Sun, 8am-5pm	Yes
Kemah Boardwalk	8 Kemah Boardwalk Ste. G, Kemah, TX 77565	(281) 538-9600		1	1	0	0	0		

Lakewood Yacht Club	2425 Nasa Parkway, Seabrook, TX 77586	281-474-2511	29°33'32.38"N 95° 1'51.73"W	1	1	0	0	0	Wed-Sun, 8am-7pm (Summer) 8am-4pm (Off-season)	Yes
Legend Point Marina	1300 Marina Bay Drive, Clear Lake Shores, TX 77565	281-334-3811	29°32'28.00"N 95° 2'16.04"W	2	1	1	0	0	24/7	No*
Marina del Sol	1203 Twin Oaks Boulevard, Kemah, TX 77565	281-334-3909	29°33'9.47"N 95° 3'14.76"W	2	1	1	0	0	24/7	Yes
Maritime Sanitation	2506 Anders Lane	(281) 334-5978		2		0	0	2	Mon-Sun 8am-5pm	No
Portofino Harbor Marina & Yacht Club	1 Portofino Plaza, Clear Lake Shores, TX 77565	281-334-6007	29°32'46.77"N 95° 1'28.26"W	1		1	0	0		No
Redfish Island Marine	Watergate Marina #112, Kemah, TX 77565	(832) 340-1600		2		0	0	2	Mon - Sat, 9am - 5pm Sun, 10am-4pm (Summer)	No
Seabrook Marina	Shipyard Dr, Seabrook, TX 77586	281-474-2586	29°33'10.72"N 95° 1'32.96"W	1		1	0	0	24/7	No
South Shore Harbor Marina	2551 South Shore Boulevard, League City, TX 77573	281-334-0515	29°32'40.11"N 95° 4'3.40"W	2	2	0	0	0	Sun-Sat, 8am-6pm	No

Topwater Grill	815 Avenue O, San Leon, TX 77539	281-339-1232	29°28'18.47" N 94°55'32.96" W	2	2	0	0	0	Sun-Sat, 7am-11pm	Yes
Waterford Harbor Yacht Club & Marina	800 Mariners Drive, Kemah, TX 77565	281-334-4400	29°32'51.73" N 95° 2'35.80"W	1	1	0	0	0	24/7	No
TOTAL				**24**	**15**	**5**	**0**	**4**		

*Legend Point is currently in the middle of a project to replace their current pump-out, funded by Clean Veesel Act funds.