![Galveston Bay Foundation logo](GALVESTON BAY FOUNDATION)

June 28, 2018

General Land Office
Coastal Resources Management Program Area
1700 N. Congress Avenue, Room 617
Austin, TX 78701-1495

Attn: Ms. Lucy Flores

Re: Boater Waste Education Campaign
        GLO Contract No. 17-178-000-9815
        Final Report

Dear Ms. Flores:

Enclosed please find the final report for the Boater Waste Education Campaign project for Cycle 21.

Please feel free to call me at (281) 332-3381 ext. 217 with any questions you may have regarding the project. We are currently preparing the final invoice and the appropriate match documentation.

Thank you for your support and encouragement. I look forward to working with you on future projects.

Sincerely,

Sarah Gossett

Sarah Gossett
Water Quality Manager

Enclosure: Final Report

Boater Waste Education Campaign
GLO Contract # 17-178-000-9815

FINAL REPORT

Submitted: June 28, 2018

Prepared by:

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Houston, TX 77058
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Prepared for:

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Project Description

Boat sewage, one of the primary sources of fecal bacteria found in Galveston Bay, can be a public health risk for oyster consumption and contact recreation in areas where localized bacteria levels are heightened from the illegal discharge of boater waste. Despite having 14 stationary pump-outs, five pump-out carts, four mobile pump-out boats, and two portable toilet dump stations throughout Clear Lake and Galveston Bay, many boaters reportedly continue to discharge raw sewage from marine heads directly into bay waters. In large part, illegal boater waste discharge is the result of lack of enforcement and understanding of potential environmental and public health impacts. The Boater Waste Education Campaign (BWEC) works towards direct improvements in water quality by educating boaters, collecting and communicating environmental data to the public, and collaborating with authorities to increase reporting and enforcement of illegal boater waste discharges.

The GBF used CMP Cycle 21 funds to refine the BWEC based on lessons learned from stakeholder feedback, Dockwalker survey data, and previous water quality sample results. The project focus included:

1) carrying out enhanced marketing and outreach efforts to drive boaters to use BEWC's Interactive Pump-Out Map,
2) collecting data on the perceived barriers and benefits to pumping out waste,
3) disseminating data to the boating community and local authorities to raise awareness of illegal dumping,
4) developing the Galveston Bay Action Network (GBAN) into a downloadable, mobile app for increased boater waste and pollution reporting, and
5) facilitating conversation and conducting outreach to raise awareness of the new No Discharge Zone (NDZ) regulations.

Additionally, outreach, surveying, and water quality data collection were be conducted year round with additional sampling during boating season.

This report outlines the work and progress made towards each of these focus areas during the CMP Cycle 21, from October 2016 to June 2018. Sections are separated according to the work plan established for this cycle.

Task 1: Maintain Active Stakeholder Groups and Marketing/Outreach Materials

1.1 Boater Waste Workgroup

During this project, GBF continued to facilitate quarterly stakeholder workgroup meetings. At these meetings local representatives and stakeholders provided recommendations and guidance on key project messages and performance indicators, as well as on water quality survey data collection and analytical strategies. The workgroup members consist of representatives from the Galveston Bay Estuary Program, local marinas and yacht clubs, local municipalities, County Officials, Houston-Galveston Area Council staff, local recreational boaters, Maritime Sanitation Pump Out services (both dockside and stationary), and other local organizations and groups. This diverse group of stakeholders provides different perspectives regarding BWEC efforts. Some provide more technical support while others can better assist with information sharing and program implementation. For example, Galveston Bay Estuary Program and Houston-Galveston Area Council are able to provide environmental insight and expertise, access to data, and aid to the NDZ designation process. Galveston County Health District can help facilitate regulatory partnerships and enforcement. Marina Managers and recreational boaters can speak to the barriers to our

desired behaviors and can help disseminate marketing materials. Maritime Sanitation has provided assistance with and support for pump-out station installation, and has helped spread our message to boaters using their dockside services. The insight provided by the various workgroup members has been instrumental in effective programming, messaging and implementation.

During this project period the following members were added to the Boater Waste workgroup: Marissa Borrego (live-aboard boater), Marie Stewart (marina manager, Marina Del Sol), and Sean and Allie Fitzgerald (Maritime Sanitation owners). Additionally, GBF followed up with all Boater Waste workgroup members to confirm their continued involvement with the workgroup. Table 1 outlines the updated workgroup roster. In total seven Boater Waste workgroup meetings were held between October 2016 and June 2018 (Table 2). Table 3 outlines performance indicator recommendations provided by the workgroup.

Table 1. Updated Boater Waste Workgroup Roster

Workgroup Affiliation	Names	Organization
Boater Waste Workgroup Chair	Helen Paige	Marina Bay Harbor
Boaster Waste	Paul Fannin	Public
Boaster Waste	Lynda Hall	Lakewood Yacht Club
Boaster Waste	Lisa Marshall	Galveston Bay Estuary Program
Boaster Waste	Scott Tuma	City of League City
Boaster Waste	Steven Johnston	H-GAC
Boaster Waste	Linda Broach	TCEQ, Surface WQ Monitoring
Boaster Waste	Jennifer Demers	Maritime Sanitation
Boaster Waste	Jean Wright	Clean Rivers Program
Boaster Waste	Lori FitzSimmons-Evans	Galveston County Health District
Boaster Waste	George Guillen	UHCL - EIH
Boaster Waste	Philip Kropf	Texas Mariners Cruising Association
Boaster Waste	Ron Schultz	Galveston County Health District
Boaster Waste	Mary Carrier	TPWD Boater Safety Education
Boater Waste	Marie Stewart	Marina del Sol
Boater Waste	Marissa Borrego	Liveaboard boater
Boaters Waste	Sean Fitzgerald	Maritime Sanitation

Table 2. Boater Waste Workgroup Meeting Schedule

CMP Cycle	Date	Location	Time	Attendance
20/21	November 7, 2016	GBF Conference Room	1pm	5
20/21	February 6, 2017	GBF Conference Room	1pm	4
21	May 17, 2017	GBF Conference Room	2pm	4
21	August 8, 2017	GBF Conference Room	2pm	10
21/22	November 8, 2017	GBF Conference Room	2pm	5
21/22	February 5, 2018	GBF Conference Room	2pm	10
21/22	May 15, 2018	GBF Conference Room	2pm	9

Table 3. Performance Indicator Recommendations from Boater Waste Workgroup

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

1.2. Marketing and Outreach Materials

During this period marketing materials were maintained, distributed, and updated as needed for all BWEC programs, including Pump Don't Dump, GBAN, the GBF Water Monitoring Team, and the Dockwalkers program. Updates to each program's marketing and outreach materials are elaborated below.

- Pump Don't Dump: GBF continued to distribute the PDD education packets and campaign giveaways that were redesigned and printed during Cycle 19 (Fig. 1). Items included Pump-Out

guides, Pump Don't Dump koozies and floating keychains. The GBAN plastic cards were redesigned into magnets that also promoted the GBAN app (Fig. 2), and were included in the PDD packets instead of the plastic GBAN cards that have previously been distributed. Additionally, outreach materials donated by the Marina Association of Texas (MAT) were also distributed, including the Clean Boater Tip Cards, the Scoop on Poop handouts, the Clean Texas Boater pledge cards and zip ties and dye tabs. In addition to these giveaways, GBF also created new PDD social media campaign for the 2017 boating season (Fig. 3). The goal of the PDD outreach items was to direct people to the Pump Don't Dump webpage and the interactive Pump-Out Map. GBF updated the Pump Out Map webpage to better reflect boater motivations and language, based on workgroup feedback and findings from Dockwalker surveys. GBF also updated the pump out map, making it more interactive and user friendly. Finally, GBF followed up with each marina in the Clear Lake region to ensure that the information provided on the map was up to date and correct.

- GBAN: In addition to the new magnets, GBF designed and printed yard signs promoting the GBAN app to display at community events, trash cleanups, and at other outreach booths (Fig. 2). GBF also created print and digital ads promoting the new GBAN app, which were distributed through various newspapers, blogs, websites, and magazines (Fig. 4). Additionally, GBF created a partner toolkit containing many of these graphics and GBAN messaging to assist in app promotion. This toolkit was shared with 85 partners and stakeholders and posted on the GBAN webpage. GBF created a new webpage for the GBAN app specifically (galvbay.org/gbanapp), with links to the Apple Store and Google Play for app downloads. GBF also created a promotional video about GBAN that has been posted on the GBAN app webpage and on GBF's YouTube page. The video can be viewed at galvbay.org/gbanapp.

- WMT: GBF updated the Water Monitoring Team webpage (galvbay.org/watermonitors) and maintained the Google map with our current and potential monitoring sites in order to make it easier to communicate with volunteers and the public on where we monitor and where we currently need volunteer monitors. GBF also maintained the Citizen Science webpage (galvbay.org/citizenscience). This page houses information about our bacteria sampling, including our bacteria concentrations map and information about past Water Quality Research Internship projects. Additionally, GBF continued to maintain its partnership with the Gulf of Mexico Coastal Ocean Observing System's (GCOOS) Citizen Science Data Portal (gulfcitizenscience.org), which houses GBF's Water Monitoring Team data. To further promote the data and findings of the Water Monitoring Team, GBF created and published year-in-review summaries at the end of both 2016 and 2017. The 2017 summary is included in the appendix. These summaries were shared with property owners and managers at various water monitoring sites, as well as with community members and residents. GBF also designed and printed posters highlighting the team's work and findings, including the impacts of Hurricane Harvey on water quality (Fig. 5). GBF wrote and published several articles about the team and their findings. A list of these various articles can be found in Table 9. Finally, GBF designed, printed and distributed t-shirts for volunteer water monitors to wear while conducting their testing (Fig. 6). These shirts showcased the work of the team and included information on viewing the data online.

- Dockwalkers: GBF updated the Dockwalker survey, as discussed later in the report, and posted the survey on the Pump Don't Dump website to increase the distribution of the survey. The survey was promoted through local partners, such as Texas Mariners Cruising Association and at boating events, as well as through social media posts.

Figure 1. Left: PDD giveaway materials, developed in Cycle 19. Plastic GBAN cards have been replaced with magnets. Right: Giveaway items provided by MAT. Bilge sponges were handed out in limited quantities, due to availability.
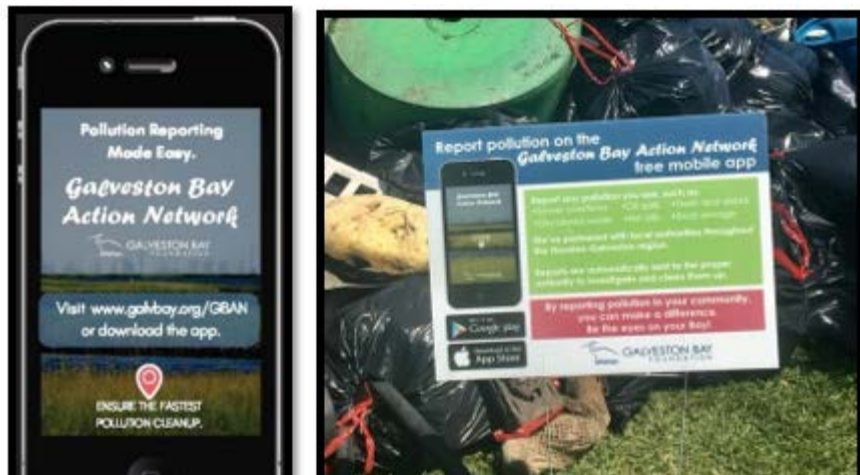
Figure 2. Left: New GBAN magnet promoting the app. Right: yard signs promoting GBAN

Figure 3. Graphics for the Summer 2017 Pump Don't Dump Campaign

Figure 4. GBAN graphics used in social media ads (top), PBS ad (bottom, left), and in Houston Press ads (bottom, right)
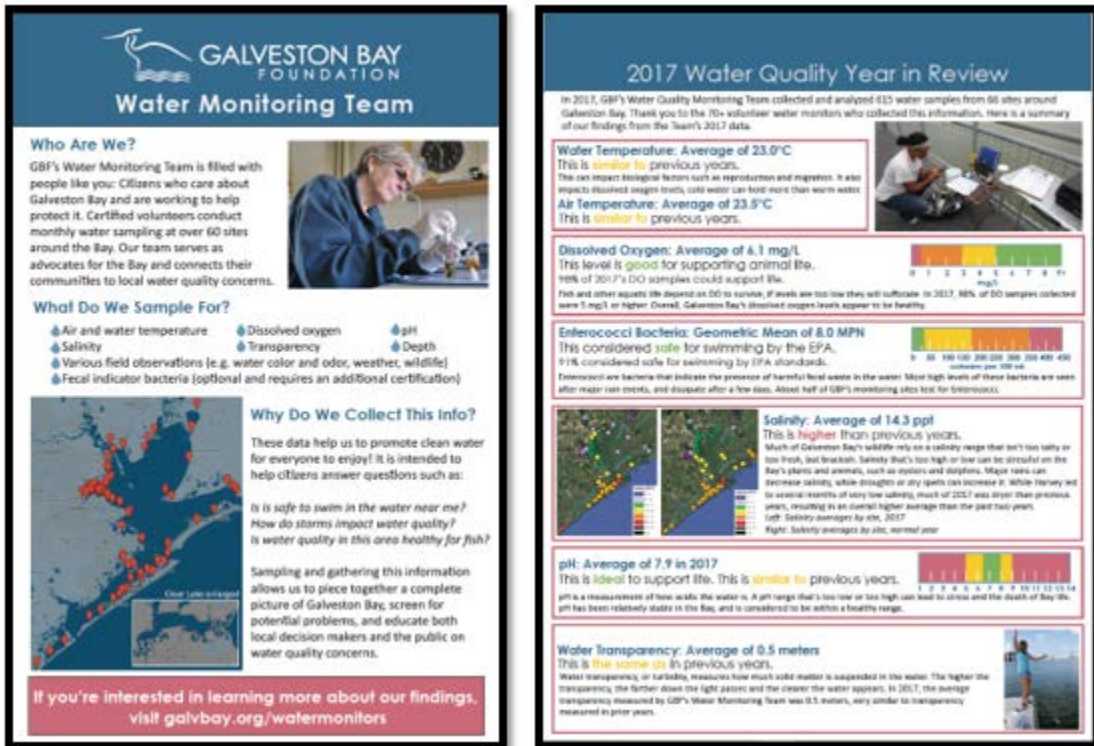
Figure 5. WMT posters brought to outreach and education events, presentations and programs.

Figure 6. Tshirts for the WMT volunteers to wear while sampling

1.3. Interactive Pump-Out Map

During this period, GBF focused on driving boaters to the PDD webpage and Interactive pump-out map (pumpdontdump.org). In past years, boater surveys have shown that most boaters only know of 1-3 pump-out stations within the Galveston Bay region and during this cycle surveys revealed that not knowing of enough available pump-outs was a barrier to pumping out waste. Directing boaters to this map showcased the availability of pumpout services in the Bay while also informing boaters on the location of the closest and most accessible pumpout stations. The analytics of this webpage activity can be viewed below (Fig. 7). During this cycle, the webpage was viewed over 800 times, with peak activity in May and June 2017, and again at the start of the 2018 boating season. The average time spent on the webpage was over four minutes, indicating that boaters were perusing the resources available on the webpage.
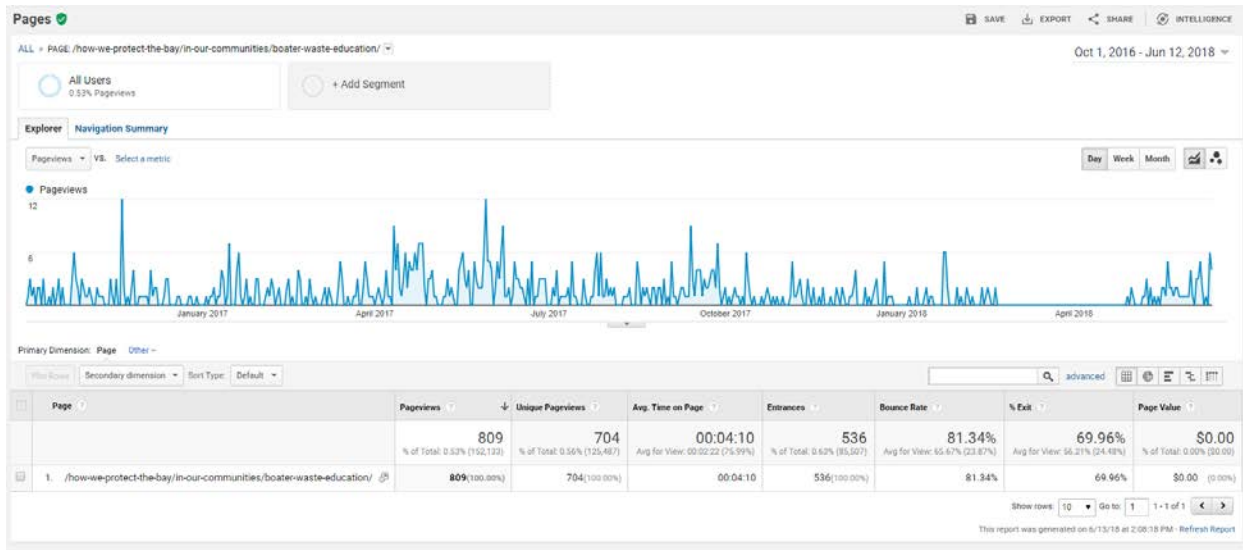
Figure 7. Google Analytics for PDD webpage during the project period.

Task 2: Develop Public Outreach and Distribution Plan

2.1 Print and Digital Media, Outreach and Education Booths and Distribution

During this project period, outreach was implemented through print and digital media, outreach booths, presentations, volunteer programs, and through public events hosted by GBF. Efforts towards BWEC outreach and distribution are outlined below for print media, booths, presentations and events, while details on the reach of BWEC volunteer programs are found under Task 4.

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.

GBF also promoted BWEC messaging at many different educational exhibits, outreach tables, and presentations to facilitate one-on-one interaction and direct dissemination of BWEC information. Workgroup members and campaign partners assisted with this promotion through inviting GBF to outreach events and presentations, and through distributing campaign materials at their own booths and events. GBF interacted with over 7,000 directly through these events. Table 5 provides a schedule of outreach booths and presentations during this project period.

In addition to in-person outreach, GBF also promoted the BWEC materials through print and digital advertising, including ads and articles on websites and in magazines, social media posts (Tables 6,7,8,9). The BWEC messaging received 113,868 impressions on social media and over 2,198,427 impressions through external advertisements. GBF also wrote and published eight articles about the BWEC programs on the GBF webpage. The Galveston Bay Action Network was also featured in 11 articles or news releases during this project period, though information on the reach of these articles is not available. **Total the BWEC reached over 2,319,632 impressions during this project period, as this number does not include external articles and news stories.**

Table 4. Marinas contacted about BWEC outreach materials

Marina Name and Location			
Blue Dolphin Yachting Center, Inc.	P.O. Box 123	Seabrook	(281) 474-4450
Endeavour Marina	3101 NASA Parkway	Seabrook	(832) 864-4000
Kemah Boardwalk Marina	555 Bradford St.	Kemah	(281) 334-2284
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
Bayland Marina	2651 S. Highway 146	Baytown	(281) 422-8900
Houston Yacht Club	3260 Miramar Drive	Shoreacres	(281) 471-1255

Table 5. Schedule of outreach and education booths and presentations

Presentation or Exhibit?	Presenters	Event / Organization - Topic	Estimated Audience
Presentation	Sarah	Audubon Texas - Bird Nerd lecture series	15
Presentation	Heather S	Pearland Rotary	30
Presentation	Kaitlin	Venture Scout Troop 464 Rain Barrel Workshop	15
Presentation	Sarah G	WMT Happy Hour & Data presentation	20
Presentation	Heather S	Houston Sunrise Kiwanis Club	20
Presentation	Heather S	Lone Star College, Environmental Science Class - Report Card	20
Presentation	Sarah G & Kaitlin	AAZAK Lunch & Learn	20
Presentation	Heather S	Evelyn Meador Branch Library	20
Presentation	Heather S	Baytown Kiwanis	45
Presentation	Heather S	League of Women Voters Bay Area	10
Presentation	Nate J	Celebration Seabrook	30
Exhibit	Heather S	UH Sustainability Fest	75
Exhibit	Heather S	College of the Mainland Science Club	10
Presentation	Sarah G & Heather	TAMUG Texas Academy of Sciences monthly meeting	15
Exhibit	Sarah G & Heather	GBF Membership Meeting	40
Presentation	Heather S	Galveston Alliance of Island Neighborhoods	20
Presentation	Sarah G & Nate	WMT Phase 1 & 2 Training	14
Presentation	Heather S	Cleveland Lions Club	20
Presentation	Heather S	Houston Greenspoint Lions Club	10
Presentation	Sarah G	CTCAC Quarterly General Meeting	70
Presentation	Sarah G	Restore America's Estuaries Summit	30
Presentation	Kaitlin	La Porte Christmas on Main	20
Presentation	Sarah G	Marina Association of Texas Conference	80
Presentation		Restore America's Estuaries Summit	50
Exhibit	Sarah C	Southwestern International Boat Show	25
Presentation	Linda, Emily F, Anja	Cabela's Grand Opening - Report Card, GBF	120
Presentation	Sarah, Michael	Gatorfest	100
Exhibit	Heather	Houston Boat Show	50
Presentation	Heather	Houston CAP	45
Presentation	Heather	Seashore CAP	40
Presentation	Kaitlin	Texas Recreation & Parks Society Conference	30
Exhibit	Kaitlin	Houston Boat Show	10

Presentation	Bob, Heather	Galveston Bay Council	30
Presentation	Sarah G, Nate J	Texas Mariners Cruising Association	70
Presentation	Heather	Winter Texans	45
Presentation	Sarah G	Baytown Kiwanis Club	35
Presentation	Heather	Houston CCA	50
Presentation	Kaitlin	La Porte Bayshore Garden Club	40
Presentation	Sarah G	UH Chemical Society	20
Exhibit	Emily F	Conservation, Ecology, and Environmental Science Career Forum	300
Presentation	Heather	Barbers Hill Lions Club	20
Presentation	Kaitlin	Galveston Rain Barrel Workshop	60
Presentation	Heather	Lonestar College - Environmental Science Class	30
Presentation	Sarah G	West Galveston Island Property Owners Association	40
Presentation	Kaitlin	Keep Friendswood Beauitful CtG Presentation	20
Exhibit	Sarah G & Nate	GOMA Tools Café	15
Presentation	Kaitlin	Houston Zoo Rain Barrel Workshop	70
Exhibit	Nate	REI Outdoor Expo	25
Exhibit	Kaitlin & Genevieve	UTMB Earth Day	50
Presentation	Sarah & Nate	WMT Phase 1 & 2 Training	15
Exhibit	Anna	Exploration Green Earth Day	200
Exhibit	Paula	Spring Outdoor Celebration	400
Exhibit	Emily F	Shell Earth Day and Market	30
Exhibit	Nate	City of Houston Water Week (single day)	500
Presentation	Sarah	BayCERT	20
Exhibit	Gretchen (volunteer)	Bayou Greenway Day	300
Exhibit	Paula & Sarah	Blessing of the Fleet event	20
Presentation	Paula	River Rally presentation	40
Presentation	Kaitlin	River Rally presentation	25
Presentation	Sarah & Nate	River Rally presentation	12
Presentation	Kaitlin	Nassau Bay Rain Barrel Workshop	70
Exhibiy	Kaitlin	Texas Mariners Cruising Association Spring Fling	20
Presentation	Sarah	WMT Phase 1 & 2 Training	10
Presentation	T'Noya	Seabrook Rotary	40
Exhibit	Kaitlin	Artist Boat World Oceans Day	100
Presentation	Kaitlin	Chambers County Rain Barrel Workshop	27

Presentation	Paula	Mott MacDonald/ Securing Freshwater for Galveston Bay	15
Presentation	Kaitlin	WADE	50
Presentation	Kaitlin	Pasadena Rain Barrel Workshop	18
Presentation	T'Noya & Erin (HARC)	2017 Greater Houston Environmental Expo	100
Presentation	T'Noya	2017 GBRC- Preview	70
Exhibit	Paula	Nassau Bay Street Eatz	100
Exhibit	T'Noya & Kaitlin	Back the Bay Day!	100
Presentation	T'Noya	Men's Group	30
Presentation	Kaitlin	Brews & Barrels: Saint Arnold Rain Barrel Workshop	70
Presentation	Emily Innes & Carolyn Hembree	GBF WQ Intern presentations	20
Presentation	Paula	Bay Area Unitarian Universalist Church Presentation "Undersanding Water Conservation Post Harvey"	15
Presentation	Paula	Paddlers Anglers in Canoes and Kayaks (PACK) Presentation "Undrestanding Water Conservation Post Harvey"	15
Presentation	T'Noya & Sarah	Houston Zoo- staff and interns	30
Exhibit	Kaitlin	La Porte Health and Safety Fair	250
Presentation	T'Noya & Sarah	TAMUG students & faculty presentation	5
Presentation	T'Noya & Sarah	Moody Gardens members	30
Presentation	Sarah	River Network Croudsourcing webinar	40
Exhibit	T'Noya & Kaitlin	JSC Safety and Health Fair	100
Presentation	T'Noya	Surfrider Galveston	10
Exhibit	Sarah	Marina Association of Texas Annual Conference, vendor table	90
Presentation	Sarah	Lone Star Groundwater Conservation District - Water Efficiency Network	20
Presentation	Kaitlin	Pearland Rain Barrel Workshop	30
Presentation	Sarah	H-GAC Natural Resources Advisory Committee, post-Harvey updates	40
Presentation	T'Noya	Seabrook Rotary Club	40
Presentation	T'Noya	Dallas Zoo and Trinity River Partners	75
	T'Noya	Ed White STEM Elementary	2
Presentation	T'Noya Thompson	Citizen's Climate Lobby (CCL)	1
Presentation	T'Noya Thompson	Oppe Elementary School	25
Presentation	T'Noya Thompson	PISD- Sam Rayburn HS	15
Presentation	T'Noya Thompson	Bay Oaks Country Club, Seabrook Rotary	50
Presentation	T'Noya Thompson	CCA, Sugarland Chapter	40

Presentation	Paula Paciorek	Houston Rotary Club	140
Presentation	Sarah Gossett	Trash Bash Coordination Committee	15
Presentation	Sarah Gossett	Texas Mariners Cruising Association	50
Both	Sarah Gossett	Post Harvey Community Open House	40
Presentation	T'Noya Thompson	PMHS- Aquatic/Environmental Classes	80
Presentation	Kaitlin Grable	La Porte Rain Barrel Workshop	56
Presentation	T'Noya Thompson	Idylwood Civic Club	41
Presentation	T'Noya Thompson	EIHS- Wildlife Class	35
Exhibit	Sarah & Kaitlin	Clear Lake Racing Association Kickoff Party	50
Exhibit	T'Noya & Kaitlin	REI Membership Event	20
Presentation	T'Noya Thompson	JSC- Employee Brown Bag	25
Presentation	Kaitlin Grable	Dickinson Rain Barrel Workshop	47
Presentation	T'Noya Thompson	Lee College	13
Action Event	GBRC, GBAN, P3	GBF, P3, MG, Port, PCt. 2, Downtown Aqm.	38
Presentation	T'Noya Thompson	Tegler High School	21
Exhibit	Sarah & Paula	Baytown Nature Nurture Festival	100
Prentation	T'Noya Thompson	Bird Nerd Series- Audubon TX	25
Presentation	T'Noya Thompson	REI-Baybrook Store	5
Presentation	T'Noya & Kaitlin	UH Sustainabilty Fest	40
Presentation	Sarah Gossett	Houston Conchology Society	20
Exhibit	Kaitlin & Genevieve	UTMB Earth Day	125
Presentation	T'Noya Thompson	Bay Day	120
Exhibit	Sarah & Paula	Earth Day Houston	400
Exhibit	Anna Deichmann	Exploration Green Grand Opening	200
Exhibit	Paula Paciorek	Nassau Bay Street Eatz	150
Presentation	T'Noya Thompson	Galveston Bay Oasis-UHCL	20
Presentation	Anna Deichmann	Lower Trinity Basin Master Naturalist	14
Exhibit	Sarah Gossett	Waterworks Festival Houston	100
Presentation	Kaitlin Grable	Pearland Rain Barrel Workshop	65
Presentation	Sarah, Kaitlin, Lindsey	Oysters, Water, and Boaters (Bacteria Reduction Plan)	35
Presentation	Sarah Gossett	UH HERE program	75
Presentation	Sarah, Will Merrel (HGAC)	OSSF WOrkshop - Bayou Vista	8
		Total	**7537**

Table 6. Social Media Posts for BWEC programs

Date	Medium	Program	Reach/Impressions
10/24/16	Facebook	WMT	717
11/2/16	Facebook	WMT	1,758
11/5/16	Facebook	GBAN	2,313
11/21/16	Facebook	WMT	791
11/22/16	Facebook	GBAN	934
1/31/17	Facebook	PDD	3,036
2/6/17	Facebook	WMT	7,240
2/6/17	Twitter	WMT	631
2/7/17	Facebook	WMT	3,023
2/7/17	Twitter	WMT	495
2/24/17	Facebook	GBAN	1,271
3/22/17	Facebook	GBAN	1,292
3/23/17	Facebook	WMT	1,194
3/28/17	Facebook	WMT	1,623
3/28/17	Twitter	WMT	536
4/3/17	Twitter	GBAN	407
4/4/17	Facebook	GBAN	1,643
4/7/17	Facebook	GBAN	1,552
4/10/17	Twitter	GBAN	321
4/10/17	Facebook	GBAN	1,286
4/12/17	Twitter	GBAN	322
4/12/17	Facebook	GBAN	1,565
4/14/17	Twitter	GBAN	426
4/14/17	Facebook	GBAN	2,099
4/16/17	Twitter	GBAN	963
4/16/17	Facebook	GBAN	2,225
4/17/17	Twitter	GBAN	480
4/17/17	Facebook	GBAN	1,775
4/21/17	Facebook	WMT	1,418
4/25/17	Twitter	GBAN	1,350
4/25/17	Facebook	GBAN	4,935
4/27/17	Twitter	GBAN	536
4/27/17	Twitter	WMT	536
4/29/17	Facebook	GBAN	1,830
5/1/17	Twitter	GBAN	542
5/1/17	Facebook	GBAN	2,310
5/2/17	Facebook	GBAN	1,301
5/11/17	Twitter	GBAN	690
5/11/17	Facebook	GBAN	575
5/22/17	Twitter	GBAN	600

Date	Platform	Code	Value
5/22/17	Facebook	GBAN	2,556
5/22/17	Twitter	PDD	1,053
5/26/17	Twitter	PDD	1,068
5/27/17	Facebook	PDD	1,760
5/31/17	Facebook	GBAN	2,450
6/1/17	Facebook	GBAN	1,815
6/9/17	Facebook	PDD	1,547
6/9/17	Twitter	PDD	678
6/13/17	Facebook	GBAN	1,526
6/14/17	Facebook	PDD	6,363
6/20/17	Facebook	PDD	2,711
6/20/17	Twitter	PDD	554
6/21/17	Facebook	GBAN	3,173
6/26/17	Facebook	WMT	2,749
6/27/17	Facebook	GBAN	1,700
6/30/17	Twitter	PDD	980
7/1/17	Facebook	PDD	3,450
7/6/17	Facebook	GBAN	1,299
7/7/17	Twitter	PDD	603
7/11/17	Facebook	PDD	1,860
7/11/17	Twitter	PDD	770
7/12/17	Facebook	GBAN	1,641
7/15/17	Facebook	PDD	2,147
7/29/17	Facebook	PDD	792
7/31/17	Facebook	WMT	2,531
8/4/17	Facebook	GBAN	3,654
8/12/17	Facebook	GBAN	2,099
9/13/17	Twitter	GBAN	486
11/30/17	Facebook	GBAN	1,312
Total			**113,868**

Table 7. External advertisements published during reporting period

Publication	Date	Program	Description	Reach
Changing Currents Magazine	Dec-16	GBAN	1/2 page ad	165
Marina Association of Texas	Apr-17	GBAN	1/2 page ad	165
Houston Press	Summer 2017	GBAN	half page add, GBAN	500,000
Marina Association of Texas	Sep-17	GBAN	1/2 page ad	165
Houston Press	5-Oct-17	GBAN	Belly Band	500,000
Houston Public Media - PBS Kids	Jul – Sept 2017	GBAN	tv ad on Splash & Bubbles	900,000
Facebook Ad	Apr-17	GBAN	ads for pertinent facebook users	11039
Google Ad	Apr-17	GBAN	ad for various keyword searches	23,979
Houstonia	1/11/2018	GBAN	banner ad on website	72,000
Houston Public Media	12/25/2017 - 1/15/2018	GBAN	banner ad on website	29,400
Houstonia	1/16/2018	GBAN	link from air pollution article	131,958
Facebook Ad	Apr-18	GBAN	ads for pertinent facebook users	21291
Google Ad	Apr-18	GBAN	ad for various keyword searches	8265
		Total		2,198,427

Table 8. External articles written and published during reporting period

Name of Publication	Date/Issue of Publication	Program	Link to Article (if possible)
Fox 26 News	4/28/2017	GBAN	http://www.fox26houston.com/news/251790468-story
Houston Chronicle	5/1/2017	GBAN	http://www.chron.com/neighborhood/article/If-you-re-doing-these-things-you-re-polluting-11111416.php
Eco Ology	5/9/2017	GBAN	http://eco-ology.org
Houston Public Media	5/22/2017	GBAN	https://www.houstonpublicmedia.org/articles/news/2017/05/22/201861/galveston-bay-area-has-an-app-to-report-pollution/
Gulf Coast Mariner	Jul-17	GBAN	http://www.gulfcoastmariner.com/tag/galveston-bay-action-network/
EPA Press Release	12/8/2016	GBAN	https://www.epa.gov/newsreleases/epa-grant-300000-will-help-galveston-bay-foundations-education-program
Houston Moms Blog	1/17/2018	GBAN	https://houston.citymomsblog.com/preventing-pollution-with-one-easy-step/
Houstonia	1/4/2018	GBAN	https://www.houstoniamag.com/articles/2018/1/4/non-profit-offers-free-easy-to-use-tool-to-keep-houston-galveston-communities-clean

GBRC website	4/30/2018	GBAN	http://www.galvbaygrade.org/cover-stories/2018/04/galveston-bay-foundationplastic-pollution-prevention-partnership-collaboration-coordination-and-cleanup/
Channel 13	2/20/2018	GBAN	http://abc13.com/large-trash-piles-fill-parts-of-houstons-ship-channel-/3115599/
Channel 11	3/7/2018	GBAN	http://www.khou.com/article/news/local/whats-being-done-about-trash-off-galveston-bay/285-526717366

Table 9. WMT Articles & Infographics published by GBF during project period

Media Outlet	Publication Year	Location
Water Monitoring Team webpage	2017	GBF Website
Bacteria Monitoring webpage	2017	GBF Website
2017 data summary	2018	GBF Website
2017 individual site summaries	2018	GBF Website
Harvey Infographic	2017	GBF FB Page
WMT article on Report Card webpage	2018	GBRC website
Bacteria Testing infographic	2017	GBF FB Page
WQ Research Assistant Report	2018	GBF Website

2.2 Marina Partnerships

As a part of the BWEC, GBF aims to develop relationships with marinas through long-term participation in various programs that support BWEC goals. During this project period, GBF continued to contact marinas about participating in the BWEC and joining GBF's Clean Water Partnership. Clean Water Partnership marinas actively participate in at least two BWEC programs including the BW Workgroup, Pump Don't Dump distribution, Water Monitoring Team, Dockwalkers, or Water Quality Internship projects. During this period, GBF contacted marinas not currently part of GBF's Clean Water Partnership to encourage participation, and met with interested marina managers to determine the best activities for their marina. During this period, two new marina Clean Water Partnerships were created and 17 existing partnerships were maintained. Table 8 shows which programs each marina plays an active role in. Additionally, 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. 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.

After meeting with Portofino Harbour Marina, GBF connected Portofino Harbour Marina and Marina Association of Texas to establish conversation about Portofino recertifying as a Texas Clean Marina. At the end of this cycle, discussions are still ongoing.

Table 10. Cycle 21 marina participation

Clean Water Partner	Partnership Activities
Bal Harbor Marina	GBF Water Monitoring Team
Blue Dolphin Yachting Center	GBF Water Monitoring Team; Dockwalkers
Endeavour Marina	GBF Water Monitoring Team
Houston Yacht Club	GBF Water Monitoring Team; Pump Don't Dump
Lakewood Yacht Club	GBF Water Monitoring Team; Boater Waste Workgroup
Marina Bay Harbor Yacht Club	Pump Don't Dump; Boater Waste Workgroup; GBF Water Monitoring Team
Marina Del Sol	GBF Water Monitoring Team; WQRI; Pump Don't Dump; Boater Waste Workgroup; Dockwalkers
Maritime Sanitation	Pump Don't Dump; Boater Waste Workgroup
Nassau Bay Yacht Club	GBF Water Monitoring Team; Pump Don't Dump
Pelican Rest Marina	GBF Water Monitoring Team
Portofino Harbour Marina & Yacht Club*	GBF Water Monitoring Team; Pump Don't Dump; Dockwalkers
Redfish Island Marine	Pump Don't Dump
Seabrook Marina	Pump Don't Dump
South Shore Harbour Marina	GBF Water Monitoring Team
Star Fleet Yachts	GBF Water Monitoring Team (training site)
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
The Wharf Marina*	WQRI, Pump Don't Dump

* denotes new Clean Water Partner

Task 3: Facilitate Boat Sewage Discharge Reporting and Response

GBF created the Galveston Bay Action Network (GBAN) to increase reporting and enforcement of boater waste discharge. GBAN aims to educate citizens on how and where to report boat sewage discharges and other common water pollution incidents.. GBAN serves to rectify this, by providing an easy tool for citizens to report illegal discharges directly to enforcement agencies. A central location for citizens to submit reports also empowers boaters to report waste they see occurring, and provides them an avenue to allow their voice to be heard. The tool was initially launched in Cycle 18 as a mobile-optimized website and aims to make reporting pollution such as boater waste and illegal dumping easier. Reports can be anonymous and are automatically sent to the proper authority based on pollution type and location.

During this project period, GBF launched the GBAN as a downloadable, mobile app (Fig. 8). Launching this tool as a downloadable app makes it much more accessible to those on the water or anywhere without access to a desktop computer, thus making pollution reporting and response even more convenient. GBF contacted new regulatory agencies about becoming GBAN partners and receiving relevant reports. during this period the Plastic Pollution Prevention Partnership was added as a partner agency to receive and respond to trash and debris reports. This partnership serves to leverage community agencies and groups to coordinate trash cleanups around the Galveston Bay shoreline. During this report period GBF contacted the following municipalities about directly receiving GBAN reports: City of League City, City of Webster, City of Baytown, City of Freeport, City of Morgan's Point. None of them responded and GBF is continuing to look into who the proper contacts are in each city in order to add them as regulatory partners. Additionally, GBF worked with existing regulatory partners to ensure that they were promptly receiving and responding to reports, and that reports were being sent to the proper email. GBF followed up with reports that were filed to try to determine resolution. A list of all current regulatory partners (Table 11) can be found below.
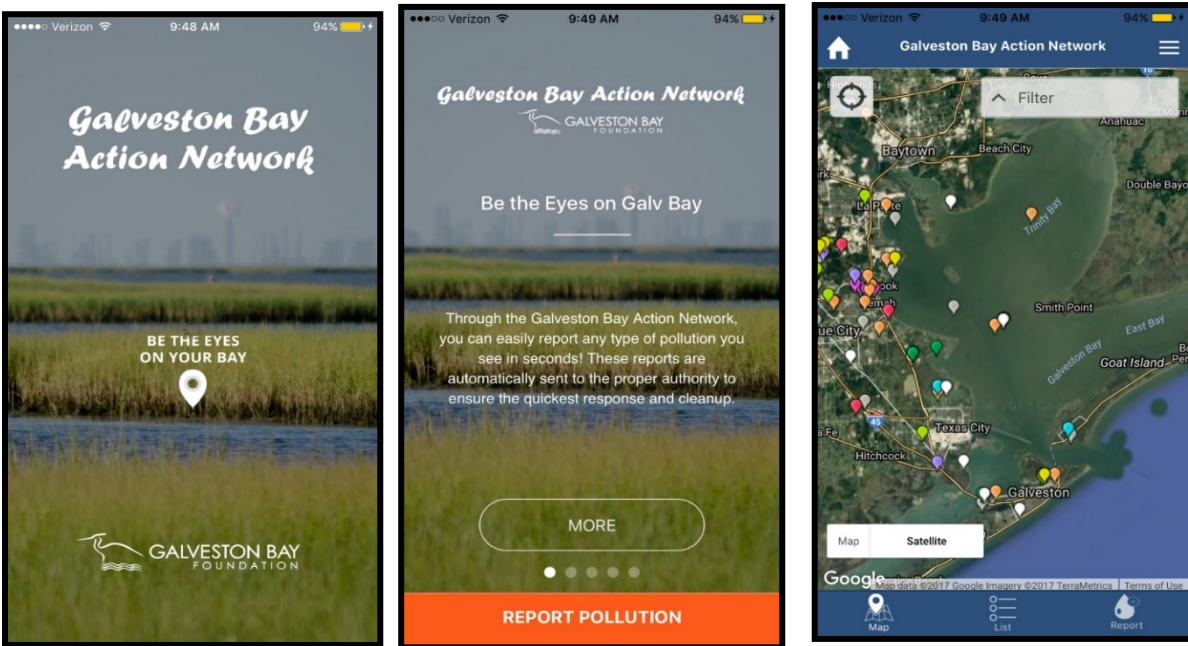
Figure 8. Images of the GBAN app.

Table 11: List of all agencies currently receiving GBAN reports

Partners	Official Email	Contact	Contact Email
TCEQ	cmplaint@tceq.texas.gov	Kim Laird	Kim.Laird@tceq.texas.gov
Brazoria County Environmental Health	karenc@brazoria-county.com	Karen Carol	karenc@brazoria-county.com
City of Passadena	LLocke@ci.pasadena.tx.us	Luz Locke	LLocke@ci.pasadena.tx.us
Galveston County Health Dept	fitzsimmons@gchd.org	Lori FitzSimmons-Evans	fitzsimmons@gchd.org
GLO	landoffice@glo.texas.gov	Greg Pollock	greg.pollock@glo.texas.gov
Harris County Pollution Control	pollution.control@pcs.hctx.net	Jennifer Wheeler	Jennifer.wheeler@pcs.hctx.net
TPWD: Kills & Spills	laporte.le-communications@tpwd.texas.gov	Steven Mitchell	Steven.Mitchell@tpwd.texas.gov
City of Galveston	BoothPau@cityofgalveston.org	Paul Booth	BoothPau@cityofgalveston.org

TPWD: Environmental Crime Unit	laporte.le-communications@tpwd.texas.gov	William Skeen, Robert Waggett	William.Skeen@tpwd.texas.gov
Chambers County Environmental Health & Permitting	rtunze@co.chambers.tx.us ; nvalencia@co.chambers.tx.us	Rex Tunze, Neomi Vale	rtunze@co.chambers.tx.us ; nvalencia@co.chambers.tx.us
City of Houston	311@houstontx.gov	Paulette Pastor	Paulette.Pastor@houstontx.gov
P3 Partnership	stenmead@aol.com	Stenie Mead	sstenmead@aol.com

With the launch of the GBAN app in April 2017, GBF posted a press release, as well as online and print ads and social media posts. As a result, GBF held interviews with FOX26 nightly news (Fig. 9), Houston Public Media, Houston Chronicle, and KPFT radio to promote the launch of the GBAN app in late April and May 2017.

To continue to promote the app throughout the reporting period, GBF also conducted the following outreach and promotional activities:

- GBF published ads in the following webpages: Houstonia Magazine, Houston Public Media, Facebook, Google. Facebook and Google ads targeted certain geographic regions and keyworks. Combined these ads received a total reach of 262,914 people.
- GBAN was featured in a radio ad aired on Houston Public Media (FM 88.7). The 15 second ad aired 10 different times from 12/25/2017 to 12/31/2017 in conjunction with the HPM online ad.
- An article describing the GBAN app was published online on Houstonia Magazine's website on 1/4/2018 (Fig. 10). The article can be viewed by clicking here. Another article about the GBAN app was published on the Houston Moms Blog on 1/17/2018 (Fig. 11). This article can be viewed by clicking here. Both articles were also shared in email blasts to webpage subscribers and via each group's social media pages.
- GBF held interviews with Channel 13 on 2/20/2018 (Fig. 12) and Channel 11 on 3/7/2018. Each interview was featured on the 5pm nightly news, and featured a major trash and debris pileup discovered because of the GBAN app. Both reports highlighted the GBAN app as a way someone can act to clean up local pollution. Because of these reports, the Plastic Pollution Prevention Partnership and GBF hosted and publicized a volunteer trash cleanup of the shoreline. An article about this partnership and cleanup effort can be found on the GBRC website (www.galvbaygrade.org).
- GBF wrote and published an article in the summer 2018 issue of *Changing Currents,* a statewide boating magazine (Fig. 13).

During this reporting period, the GBAN app was downloaded 2700 times, the desktop interface was viewed 1130 times, and the app webpage was viewed 844 times.

During this reporting period, 160 reports were filed on GBAN: 5 from October to December 2016, 64 in 2017, and so far 91 have been filed in 2018. Much of this increase in reporting is likely attributed to the creation of the app, the marketing pushes associated with the launch and app, and with community members seeing success on reports filed and reusing the app for other pollution events. Seven of these reports were of boat sewage. However, GBAN reports have mostly been of Trash and Debris pollution. GBF is working to educate community members and boaters on what the different types of pollution look like, so they can better be reported as well. Images of macerated sewage and boater waste can now be found on the GBAN website and app, as well as in GBAN articles (Fig. 13).

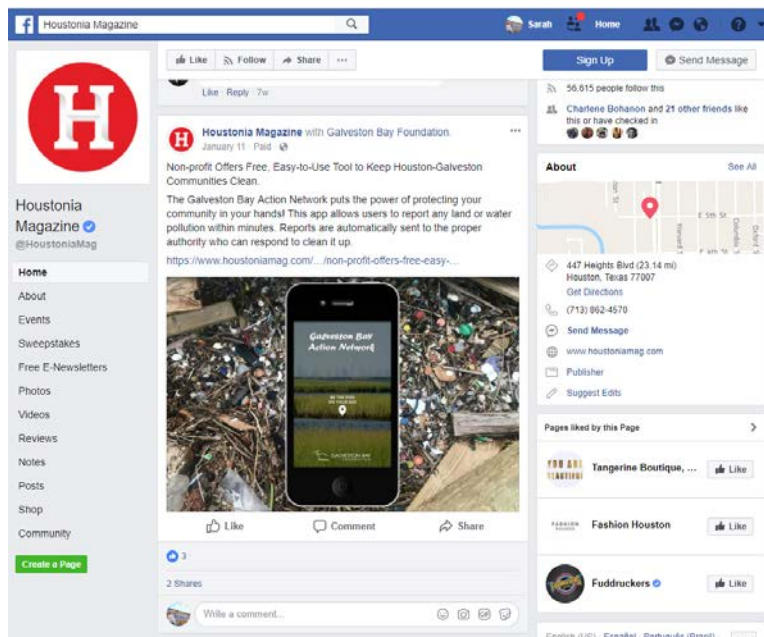*Figure 9. GBF staff on Fox26 news highlighting GBAN app on 4/28/2017*

Figure 10. Article about the GBAN app on the Houstonia website, featured on their Facebook page on 1/11/2018

Figure 11. Article about the GBAN app on the Houston Moms Blog, featured on their Facebook page on 1/20/2018

Figure 12. GBF staff on Channel 13 highlighting a report filed on the GBAN app. 2/20/2018

Figure13. Snipping from an article published in the Changing Currents magazine for their summer 2018 issue.

Task 4: Facilitate Volunteer Programs

4.1 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. 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. 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. This provides established protocol and regional consistency in data collection and recording. However GBF also has its own Volunteer Bacteria Sampling Program to collect Enterococci bacteria data around the nearshore of the Bay on a regular basis. The monitoring team currently has 67 volunteers sampling from 66 locations, 28 of whom have advanced certification to collect bacteria samples (Tables 12, 13). A full map of monitoring locations can be accessed at galvbay.org/watermonitors. The entire monitoring program is conducted under an EPA-approved Quality Assurance Project Plan and Quality Management Plan.

 Due to budget constraints, professional monitoring is conducted at a limited number of sites and generally on a quarterly basis, so GBF's Water Monitoring Team is a cost-effective way to augment this professional data. Additionally, most professional monitoring occurs in the middle of the Bay, while GBF monitoring focuses on the nearshore, where most humans are interacting with the water. Additionally, 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. GBF continues to make improvements to the management and processes within the WMT. Within this cycle GBF focused efforts on expanding the water monitoring team in order to capture areas of the bay where with limited to no historic data, particularly on the east side of the bay. A list of all trainings can be found in Table 14.

During this project period, the team's major priorities were:

- Maintaining consistent, long-term monitoring at existing sites
- Fill in "holes" around the Bay, with focus on adding monitoring sites to the east side of the Bay
- Data analysis to determine trends and relationships, as well as water quality problem locations

Consistent, long-term monitoring is valuable because the identified trends and hotspots can result in targeted outreach, help foster stewardship in those communities, as well as aid in watershed planning activities. Through hosting a training on the eastern part of Galveston Bay, GBF was able to reach out to a community of the bay that we had not reached before. This community now has several residents who not only monitor the water in that area, but also help to educate and inform the public. Due to this recent push for expansion, GBF now has a better overall picture as to what is happening all around the bay and can use the data to inform recreational boaters of ways they are impacted and ways they impact the waters in Galveston Bay. Current water monitoring sites, volunteers, and a training schedule for this project period are all outlined in Table 7-9 below. Analysis of the water quality data can be found in Appendix 1.

Table 12. GBF Water Quality Monitoring Team Sites Monitored

Site ID	Active Site Description	Access	Monitor	Latitude	Longitude	Monitoring Schedule
81181	Christmas Bay @ Drum Bay	Public	Glenn Taylor	29.012245	-95.218408	3rd Sunday @ 1pm
81035	Christmas Bay @ 257S County Boat Ramp	Public	Becky Kowalski	29.048550	-95.165262	3rd weekend @ 10am
81174	Clear Lake @ 18 Waterford Oak Lane	Home	James Dismukes	29.545952	-95.043871	4th Monday @ 830am
80955	Clear Lake @ Bal Harbor Marina	Private	Skai Shadow	29.554958	-95.072739	3rd Friday @ 7am
80956	Clear Lake @ Blue Dolphin Yachting Center	Private	Claire McNulty	29.558397	-95.028258	1st Saturday @ 8am
15105	Clear Lake @ Clear Lake Park Pier	Public	Diane Humes	29.563703	-95.066049	Last Monday @ 815am
80759	Clear Lake @ Clear Lake Shores	Home	Arline Laughter/Helle Brown	29.551061	-95.032680	2nd Tuesday
80953	Clear Lake @ Endeavour Marina	Private	Michael Petitt	29.559879	-95.042235	1st Wednesday @ 10am
80758	Clear Lake @ Jarboe Bayou Park	Public	Helle Brown/Arline Laughter	29.542023	-95.030541	2nd Tuesday
81045	Clear Lake @ Kemah Boardwalk Aquarium	Private	Carolyn Hembree	29.548575	-95.021002	2nd Sunday @ 9am
80467	Clear Lake @ Lakewood Yacht Club	Private	Claire McNulty	29.554589	-95.031020	3rd Tuesday @ 8am
30010	Clear Lake @ Nassau Bay Upper Bay Road	Public	Elizabeth Cornwell	29.544286	-95.085907	20th @ 5pm
81040	Clear Lake @ Nassau Bay Yacht Club	Private	Helen Lane	29.541451	-95.097180	2nd Tuesday @ 9am
81049	Clear Lake @ Portofino Harbor Marina	Private	Lily Bui	29.547255	-95.025551	2nd Tuesday @ 9am
81283	Clear Lake @ Sea Cove Ct	Public	Jane Webb	29.537825	-95.084316	1st Wednesday @ 9am
81037	Clear Lake @ South Shore Harbor	Private	Kate Magee	29.547330	-95.064334	3rd Tuesday @ 1pm
81217	Clear Lake @ Taylor Lake Entrance and Nasa Road	Public	Darling Martinez	29.565483	-95.053867	1st Sunday @ 9am
81173	Clear Lake @ Waterford Harbor Marina	Private	Mary Christian	29.54755	-95.043812	1st Wednesday @ 9am
30014	Clear Lake @ Watergate Yachting Center	Private	Catherine Navarro	29.545433	-95.040012	3rd Thursday @ 4pm
81164	Clear Lake @ Watergate Yachting Center Pier 4	Private	Tyler Dudley	29.545271	-95.036368	3rd Monday @ 9am

81039	East Bay @ Bluewater Bait Camp	Private	Denise Bell	29.450572	-94.668544	1st week of the month @ 10am
81039	East Bay @ Bluewater Bait Camp	Private	Denise Bell	29.452390	-94.669990	1st week @10am
81305	East Bay @ East Bay Boat Ramp	Public	Cindi Barrett & Joan Ward	29.57498	-94.55566	2nd Tuesday @ 9am
81280	East Bay @ Frenchtown Road	Public	Rachel Martinez	29.371335	-94.777401	2nd Sunday of month @ 1130am
80961	East Bay @ Frozen Point 3 (Anahuac National Wildlife Refuge)	Private	Joan Ward & Cindi	29.540939	-94.520594	2nd Tuesday @ 10am
80949	East Bay @ Stingaree Restaurant Bar	Private	Carl Young	29.482082	-94.605146	3rd Wednesday @1pm
30008	Galveston Bay @ 1109 6th St. San Leon	Home	Mark Niles	29.478655	-94.920231	1st Tuesday @ 6pm
80952	Galveston Bay @ 3903 Bayshore Bacliff	Home	Dianne Forthmann and Joe Cavallaro	29.515548	-94.985700	30th of each month
30009	Galveston Bay @ Bayland Park	Public	Lana Berkowitz	29.713048	-94.993137	1st Thursday @ 9am
80951	Galveston Bay @ Bayshore Park	Public	Penny Bessire	29.506474	-94.958050	4th Tuesday
81281	Galveston Bay @ GBF	Private	Lindsey Nolan	29.532912	-95.009303	15th @ 10pm
81162	Galveston Bay @ Houston Yacht Club	Private	Emily Innes	29.619129	-94.999132	3rd Tuesday @ 530pm
81284	Galveston Bay @ Morgan's Point	Public	Mitchell Amstutz	29.678835	-94.982656	15th @ 9am
81042	Galveston Bay @ Pier 21	Public	Sandra Metoyer	29.310310	-94.793224	Third Thursday
80463	Galveston Bay @ Pine Gully Park	Public	Madeleine Barnes	29.589580	-94.990566	Middle of month
80418	Galveston Bay @ Seascape Pier	Public	Gary Bell	29.584541	-94.996785	2nd Wednesday @ 11am
81052	Galveston Bay @ Seawolf Park	Private	Taylor Cubbage	29.338162	-94.778087	the 31st @ 9am
81044	Galveston Bay @ Shoreacres Pier	Public	Kay and Kendall Pickett	29.622030	-95.004664	3rd Sunday @ 1pm
81304	Galveston Bay @ Smiths Point Boat Ramp	Public	Joan Ward and Cindi Barrett	29.54666	-94.78755	3rd Monday
81161	Galveston Bay @ Sunset Cove	Home	Glenn Taylor	29.151222	-95.030368	30th of each month

80950	Galveston Bay @ Sylvan Beach Park	Public	Sabine Mehay	29.652914	-95.005539	2nd weekend @ 9am
81053	Galveston Bay @ TAMUG	Public	Minna Tambourides	29.312710	-94.816697	2nd Friday @ 2pm
30013	Galveston Bay @ Texas City Dike	Public	Cindy Liening	29.387027	-94.874629	2nd Thursday @ 4pm
81160	Galveston Bay @ Texas Corinthian Yacht Club	Private	Suzanne Milby/Kris Johnson	29.529115	-95.003242	4th Tuesday
81218	Galveston Bay @ Todville Rd	Private	Suzanne Milby/Kris Johnson	29.569982	-95.009848	the 28th @ 2pm
81051	Galveston Bay @ Topwater Grill	Private	Mark Niles	29.470799	-94.925598	4th Saturday
81318	Highland Bayou @ Louis' Bait Camp	Private	Rachel Gamblin	29.33232	-94.945561	2nd Saturday
81159	Jones Bay @ Bayou Vista	Home	Chris Roper	29.323449	-94.946625	Every Other Tuesday @ 830am
80958	Jones Bay @ Tiki Tom's RV Park	Private	Janet Mason	29.304188	-94.906542	3rd Wednesday
81302	Lake Anahuac @ Turtle Bayou	Private	Shelli Ellerbe & Jim Harlow	29.828532	-94.669831	Last Tuesday @ 9am
80719	Moses Lake @ Texas City Prairie Preserve	Public	Scott Buckel	29.428824	-94.950470	Mondays and Fridays
30007	Offatt's Bayou @ Camarone's Coastal Tex Mex	Private	Stan Conley	29.278705	-94.834720	3rd Sunday @ noon
81034	Offatt's Bayou @ Sea Star Base Galveston	Private	Joe Bryan	29.285622	-94.853502	2nd Tuesday @ 4pm
81041	Swan Lake @ 257J Boat Ramp	Public	Breana Hyche	28.979729	-95.268679	3rd Friday @ 10am
81036	Trinity Bay @ Carroll Road	Home?	Bob Lanser	29.685690	-94.866120	2nd Friday @ 10am
81301	Trinity Bay @ Fort Anahuac Park	Public	Laurie Gonzales & Karen Morris	29.75533	-94.69028	1st Sunday @ 9am
81303	Trinity Bay @ McCollum Park	Public	Valerie & Mickey Redus	29.74486	-94.82787	3rd Friday @ 1pm
81050	Trinity Bay @ Oak Island Lodge	Private	Susan Webb	29.654094	-94.699173	2nd Tuesday
81282	West Bay @ Jamaica Beach	Public	Wayne O'Quin	29.189151	-94.980308	2nd Monday @ 10am
81048	West Bay @ Oak Bayou	Public	Skyler Carey	29.204895	-94.957483	3nd Sunday @ 10am
81158	West Bay @ Pirate's Cove	Public	Sandra Metoyer	29.217963	-94.949425	1st Sunday @ 9am

80954	West Bay @ Sportsman Road	Public	Kaitlin Grable	29.255152	-94.918154	Every 3rd Thursday
81219	West Bay @ Sweetwater Lake	Private (GBF)	Mary Warwick	29.254835	-94.879686	2nd Saturday @ noon
81046	West Bay @ Sweetwater Preserve	Public	Mary Warwick	29.272506	-94.881102	3rd Sunday @930am
Currently INACTIVE SITES						
81038	West Bay @ Eckert Bayou	Public		29.221619	-94.933181	
81047	Trinity Bay @ Galveston Bay RV Resort	Private	Jennifer & Arial Pinion	29.698141	-94.945875	3rd Sunday @ 9am
80960	Galveston Bay @ Candy Abshier Wildlife Management Area	Private	Bonnie Campisi & Joan Ward	29.525213	-94.765333	
30012	Clear Lake @ Marina Del Sol	Private	Rodney Ray	29.552070	-95.052056	1st Thursday @ 830am
81306	East Bay @ Frozen Point 1	Private	Cindi Barrett & Joan Ward	29.55925	-94.53404	
81307	East Bay @ Frozen Point 2	Private	Joan Ward & Cindi	29.55331	-94.52593	

Table 13. GBF Water Quality Monitoring Team Members

Monitor ID	Name
8812	Adeola Mosuro
8576	Amber Wisber
9522	Arial Pinion
11416	Arline Laughter
8814	Arnold Leija
8019	Bob Lanser
9439	Bonnie Campisi
9172	Breana Hyche
12224	Brenda Gonzales
9178	Carl Young
9436	Carolyn Hembree
8817	Catherine Navarro
8501	Chris Roper
9444	Cindi Barrett
12173	Cindy Liening
9176	Claire McNulty
9173	David Dellapenna
9952	Denise Bell
9170	Derek Baldwin

8186	Diane Humes
12221	Dianne Forthman
9950	Elizabeth Cornwell
9446	Emily Innes
9294	Gary Bell
8503	Genevieve Genest
8504	Glenn Taylor
8023	Helen Lane
11417	Helle Brown
8506	James Dismukes
9177	Jane Webb
1056	Janet Mason
9441	Jim Harlow
9445	Joan Ward
12228	Joe Cavallaro
12233	John Wright
9180	Kaitlin Grable
9433	Karen Morris
8818	Kate Magee
8027	Kay Pickett
8028	Kendall Pickett
8819	Lana Berkowitz
9179	Laura MacNeil
8820	Lauren Secino
8507	Laurence Neuhaus
9434	Laurie Gonzales
9171	Leydi Serrano
9438	Lily Bui
9182	Lindsey Fuchs
9633	Lindsey Nolan
12052	Madeleine Barnes
12051	Mark Niles
9524	Mary Christian
8614	Mary Warwick
9174	Michael Chang
9946	Michael Petitt
9442	Mickey Redus
8823	Minna Tambourides
9435	Mitchell Amstutz
9634	Rachel Gamblin
8824	Rodney Ray
4117	Sandra Metoyer
8615	Sarah Gossett

11139	Scott Buckel
9440	Shelli Ellerbe
8034	Skyler Carey
8825	Stan Conley
9437	Susan Webb
8826	Suzanne Milby
9169	Taylor Cubbage
8827	Tera Alexander
8828	Teresa Wheeler
8513	Tyler Dudley
9443	Valerie Redus
9175	Wayne O'Quin

Table 14. WMT Training/Meeting Schedule

Date	Presenters	Event/Organization Topic	Location	Estimated Audience
11/18/2016	Sarah Gossett & Nate Johnson	Texas Stream Team Phase I & II training	Star Fleet Marina	13
12/15/2016	Sarah Gossett	Quality Control 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 Restaurant	1
12/22/2016	Sarah Gossett	Texas Stream Team Phase III Training	Nassau Bay Upper Bay Road	1
1/4/2017	Sarah Gossett	Texas Stream Team Phase III Training	257J Boat Ramp, Swam 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 Restaurant	1
1/24/2017	Sarah Gossett	Quality Control Training	Marina del Sol	9

3/23/2017	Sarah Gossett	Bacteria Training	GBF Office	5
4/21/2017	Sarah Gossett & Nate Johnson	Texas Stream Team Phase I & II training	Chenier Plains Visitor Center	14
5/19/2017	Sarah Gossett	Texas Stream Team Phase III Training	Ft Anahuac Park	2
5/23/2017	Sarah Gossett	Texas Stream Team Phase III Training	Tiki Tom's RV Park	1
5/30/2017	Sarah Gossett	Texas Stream Team Phase III Training	Morgan's Point	2
5/30/2017	Sarah Gossett	Texas Stream Team Phase III Training	Oak Island Lodge	1
5/31/2017	Sarah Gossett	Texas Stream Team Phase III Training	Portofino Harbor	1
6/2/2017	Sarah Gossett	Texas Stream Team Phase III Training	Candy Abshier WMA	1
6/2/2017	Sarah Gossett	Texas Stream Team Phase III Training	Turtle Bayou	2
6/6/2017	Sarah Gossett	Texas Stream Team Phase I & II training	Marina del Sol	9
6/7/2017	Sarah Gossett	Quality Control Training	Marina del Sol	7
6/8/2017	Sarah Gossett	Texas Stream Team Phase III Training	McCollum Park	2
6/8/2017	Sarah Gossett	Texas Stream Team Phase III Training	Smith's Point Boat Ramp	2
6/13/2017	Sarah Gossett	Texas Stream Team Phase III Training	Sea Cove Court	1
6/14/2017	Sarah Gossett	Bacteria Training	GBF Office	3
7/13/2017	Sarah Gossett	Texas Stream Team Phase III Training	Galveston Bay RV Resort	2
7/14/2017	Sarah Gossett	Texas Stream Team Phase III Training	Jarboe Bayou Park	1
7/21/2017	Sarah Gossett	Texas Stream Team Phase III Training	Bal Harbor Marina	1
7/25/2017	Sarah Gossett	Texas Stream Team Phase III Training	Louis' Bait Camp	1
7/26/2017	Sarah Gossett	Texas Stream Team Phase III Training	Tri City Beach Road	2
10/30/2017	Sarah Gossett	Texas Stream Team Phase I & II training	GBF Office	2
11/7/2017	Sarah Gossett	Texas Stream Team Phase III Training	Sea Cove Ct.	2
11/10/2017	Sarah Gossett	Bacteria Training	GBF Office	2

12/15/2017	Lindsey Nolan & Sarah Gossett	Bacteria Training	GBF Office	7
1/26/2018	Lindsey Nolan & Sarah Gossett	Quality Control Training	Texas Corinthian Yacht Club	13
1/27/2018	Lindsey Nolan & Sarah Gossett	Quality Control Training	Texas Corinthian Yacht Club	11
2/23/2018	Lindsey Nolan & Sarah Gossett	Texas Stream Team Phase I & II training	Marina del Sol	12
3/7/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Bluewater Bait Camp	1
3/8/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Texas Corinthian Yacht Club	1
3/8/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Pier 19, Galveston	1
3/9/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Nassau Upper Bay Road	1
3/10/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Frenchtown Rd, Bolivar	1
3/11/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Sylvan Beach	1
3/13/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Eckert Bayou	1
3/16/2018	Lindsey Nolan	Texas Stream Team Phase III Training	257S County Boat Ramp	1
3/20/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Endeavour Marina	1
3/21/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Bayshore Park	1
3/28/2018	Lindsey Nolan	Texas Stream Team Phase III Training	Taylor Lake Entrance	1
4/19/2018	Lindsey Nolan	Bacteria Training	Pier 19, Galveston	1

4.2 Dockwalkers

Historically Dockwalkers has been a volunteer program for select volunteers to conduct surveys of boaters in exchange for clean boating kits and outreach materials. These surveys help inform GBF on current boater practices, perceptions and priorities while also promoting the BWEC message. During this project period, the survey was updated to reflect lessons learned from marketing workshops and trainings. The survey focused on better determining the barriers and benefits boaters see to proper waste disposal and pollution reporting. This in turn better informs the BWEC to reduce these identified barriers and speak to the perceived benefits of proper waste management. During this cycle GBF was much more selective on the volunteers who distributed these surveys, as past volunteers had yielded lower quality and often unusable survey results. GBF's summer 2017 Water Quality Outreach Intern redesigned and distributed this survey. Surveys were handed out by specific marina managers to their members and were shared online. During the summer 2017, 96 quality surveys were collected. Results from these surveys are outlined in Task 5.

4.3 Water Quality Internships

GBF hosted two water quality interns during the summer of 2017: a volunteer Water Quality Research Intern (WQRI) and a volunteer Water Quality Outreach Intern (WQOI). These internships provide university students with the opportunity to develop and execute short-term water quality research projects from start to finish including planning, design, sampling, data analysis and creating a final research product. 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. Additionally, these internships were designed to gather information about water quality within marinas and boater perceptions around Clear Lake to better inform BWEC efforts and conduct focused research to track water quality changes and dynamics within marinas at a finer scale than the Water Monitoring Team can provide.

This summer, the WQRI conducted targeted water quality monitoring and analysis at two marinas within Clear Lake: The Wharf Marina and Marina Del Sol. Six samples were collected on a weekly basis for five weeks. While the results did not show statistical significance, the data showed higher bacteria at the monitoring location closest to the pump-out station at Marina Del Sol, and showed a positive relationship between heavy rainfall and bacteria concentrations at the Wharf Marina. Clear Creek drains into the Wharf, whereas no major urban tributary drains into Marina Del Sol. Images from this project can be found below, potentially resulting in this difference in bacteria levels.

The WQOI spearheaded the Dockwalker campaign for this summer by updating and distributing the boater survey and analyzing the results. Over the past several years, we have found that these WQ Interns are the more reliable and efficient way to conduct these surveys. Results from these surveys are outlined in Task 5.

Figure 14. Water Quality Monitoring efforts, events, and views from this reporting period

Figure15. Water Quality Research Intern project poster

Task 5: Quantify Boater Waste Impact and Track Behavior/ Knowledge/Environmental Change

One of the major challenges with behavior change campaigns such as the BWEC is effectively measuring campaign success. Unobtrusively and accurately gauging behavior change on a granular level in a community as large as Galveston Bay's boating community is, at times, infeasible. Additionally, due to the nonpoint source, transient nature of boater waste pollution and the many factors that impact fecal bacteria levels in the Bay, it can be difficult to attribute changes in water quality specifically to this one source. However, over the years GBF has constantly looked for ways to improve measuring program success. Programs such as the Dockwalker Program, the Water Monitoring Team, and GBAN can help measure potential successes and changes over time. During this cycle, Dockwalker data was analyzed to better understand the current issues around boater waste disposal and to better track behavior change over time, and trends and patterns in water quality data were analyzed.

5.1 Water Monitoring Team Data Results

GBF continued to collect ambient water quality data at marina and near-shore sites around Clear Lake and Galveston Bay throughout Cycle 21. A summary of the results from 2016 and 2017 can be seen in Tables 10 and 11 respectively. Additional analysis can be viewed in the appendix.

Table. 15. 2016 Water Quality Data Summary

	Average	Max	Min	Range	Standard Deviation	Standard Error
Air Temp (°C)	24.0	38.5	1	37.5	6.7	0.32
Water Temp (°C)	23.6	34	7	27	6.4	0.22
Dissolved Oxygen (mg/L)	6.3	12.5	1.5	11	1.9	0.09
pH	7.9	9.1	6.2	2.9	0.5	0.02
Transparency (m)	0.5	1.93	0	1.93	0.3	0.01
Total Depth (m)	1.8	67	0	67	3.3	0.16
Rain Accumulation (in)	0.5	10	0	10	1.2	0.06
Salinity (ppt)	11.9	34.5	0	34.5	7.8	0.37

Table 16. 2017 Water Quality Data Summary

	Average	Max	Min	Range	Standard Deviation	Standard Error
Air Temp (°C)	23.5	38.0	4.0	34.0	6.0	0.2
Water Temp (°C)	23.0	35.0	9.0	26.0	5.5	0.2
Dissolved Oxygen (mg/L)	6.1	12.9	1.6	11.3	1.7	0.1
pH	7.9	9.0	6.2	2.8	0.5	0.0
Transparency (m)	0.5	2.3	0.0	2.2	0.3	0.0
Total Depth (m)	1.4	7.4	0.0	7.4	1.0	0.0
Rain Accumulation (in)	0.4	14.0	0.0	14.0	0.9	0.0
Salinity (ppt)	14.3	34.6	0.0	34.6	8.1	0.3

5.2 Dockwalker Data Results

The graphs below outline the results form the 96 boaters surveyed during summer 2017 (Fig. 16 & 17). About half the boaters did not have a head on board, the vast majority did not report discharging their waste into the Bay, and not enough pump-outs was perceived as the biggest barrier to boaters pumping out their waste. Additionally, 77% of boaters only knew of 1-3 pump-out stations within Galveston Bay. Other reported barriers include the inconvenience of prescheduling a pump-out, taking your boat to a pump-out station, and the limited hours of some pump-out facilities, as well as stations that are difficult to access (shallow waters, malfunctions, etc.). The top perceived benefits to pumping out waste were cleaner recreation waters, cleaner water for wildlife populations and seafood, and an improved image of Galveston Bay. There were multiple comments requesting more pump-outs, easy to access and use pump-outs, and an easier way to find them. Table 17 outlines each of these id'd barriers and benefits, and the strategies and tools to better address them.

An additional note that boaters brought up was the potential for unintentional discharge, du to improper procedure during pump-out or unintentional leaking. One serveyant reported: *"We service on board sanitation systems and regularly find systems set to discharge overboard."*

Based on this research, future campaign focus should target more on increasing the number of easily accessible pump-out stations and better informing boaters of all pump-out stations within the Bay, while playing up the importance this has on clean water to boat and play in, and align future messaging with the way boaters value the Bay.
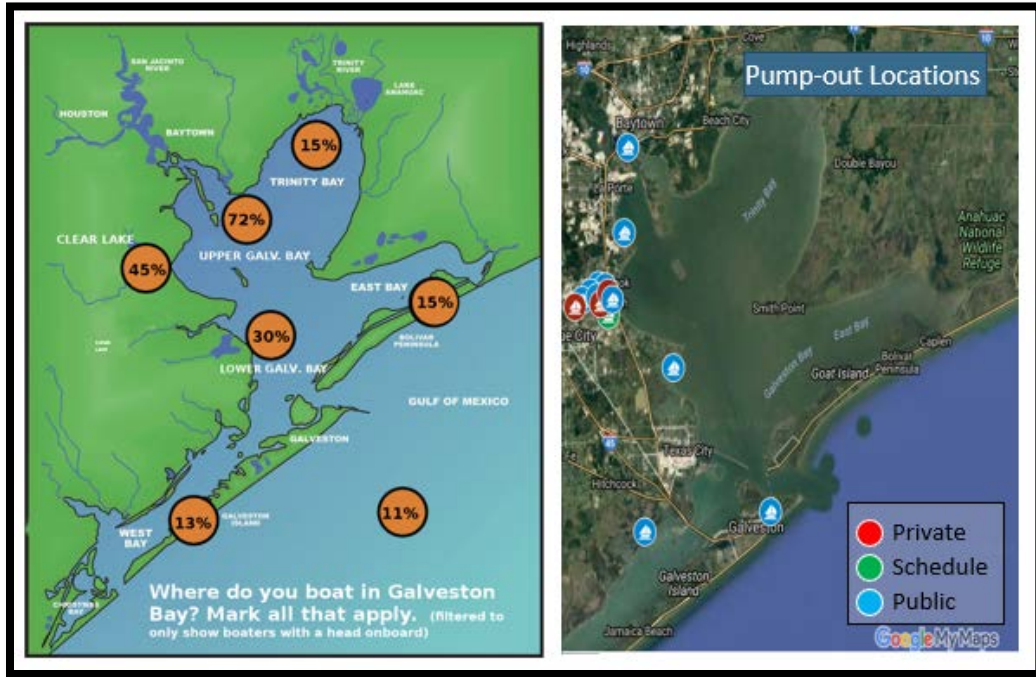
Figure 16. Results from boater surveys, summer 2017. Where do you boat in Galveston Bay?

What type of sanitation device (head) do you have on board?

Answered: 96   Skipped: 0

No head onboard	48.96%
Holding tank ONLY	27.08%
Type 1 or Type 2 MSD	14.58%
Porta potty or composting only	8.33%
I don't know	1.04%

0%   10%   20%   30%   40%   50%

Do your current practices include discharging waste overboard? Answered by all.

☐ Intentional discharge is not a common practice among those surveyed!
☐ Follow-up question: Asked where people discharge overboard. Answered by 6.
- 1/3 discharge at a slip
- 1/3 discharge within 3 miles of Galveston bay
- 1/3 discharge 3 miles off the coast

Yes, treated   Yes, untreated

No

If you have used local pump outs, what benefits do you associate with pumping out boater waste over discharging overboard? Mark all that apply. Answered: 46

Cleaner waters for recreation	
Lower harmful bacteria levels	
Cleaner waters for fish...	
Cleaner waters for oyster...	
Improved image of Galveston...	
Other (please specify)	→ • To be legal • To keep stinky salt water out of the head/toilet
None	

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Which activities in Galveston Bay do you participate in? Mark all that apply.

Boating/cruising	70.83%
Consuming local seafood	68.75% ⭐
Sailing	58.33%
Fishing	56.25%
Swimming	33.33%
Birdwatching	25.00%
Water Sports	21.88%
Other (please specify)	6.25% → •Hunting x 3 •Professional Mariner •Shrimping •Enjoying Scenery

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

What are some barriers you perceive regarding the use of pump-out stations over discharging waste in the bay?

Not enough pump-outs...	52.27%
No barriers over...	29.55%
Having to pre-schedule...	20.45%
Pumps broken frequently	13.64%
Other (please specify)	11.36% → • Pump Out Hours x1 • Inconvenient to use x 2 • Hard to access x 2

0%   10%   20%   30%   40%   50%   60%

How many dockside stations and mobile pump-out services do you know of in the Clear Lake or Galveston Bay area? (filtered by boaters with a head only)

7 to 9
2.08% (1)

4 to 6
12.50% (6)

0
8.33% (4)

1 to 3
77.08% (37)

Figure17.. Results from boater surveys, summer 2017

Table 17. Strategies for Reducing ID'd Barriers and Increasing ID'd Benefits

Barriers vs Benefits

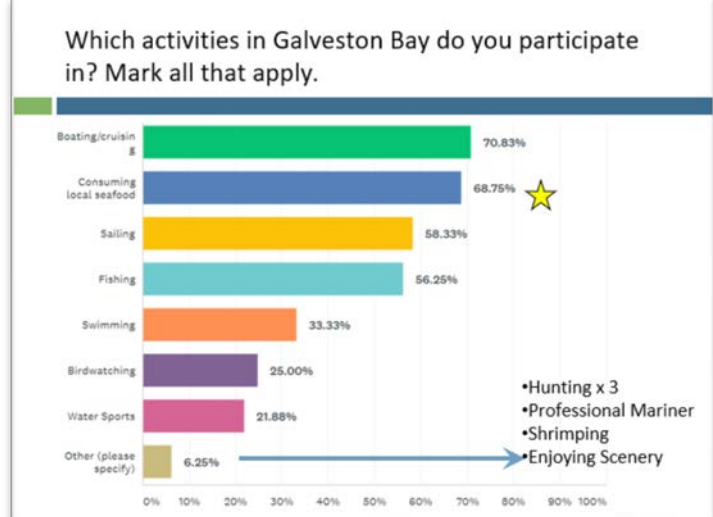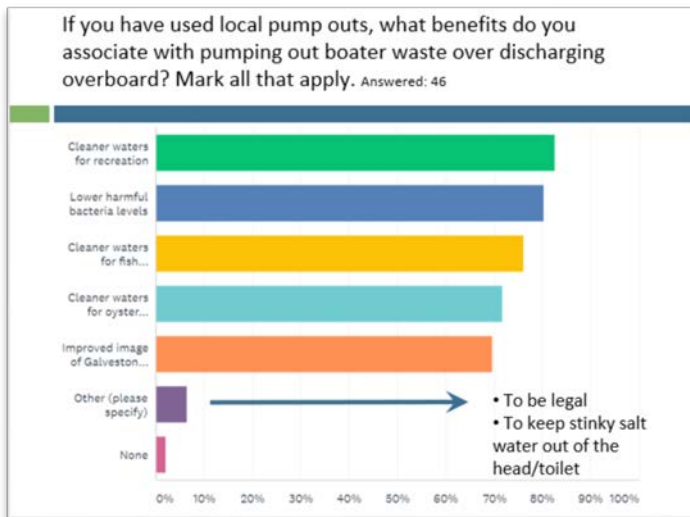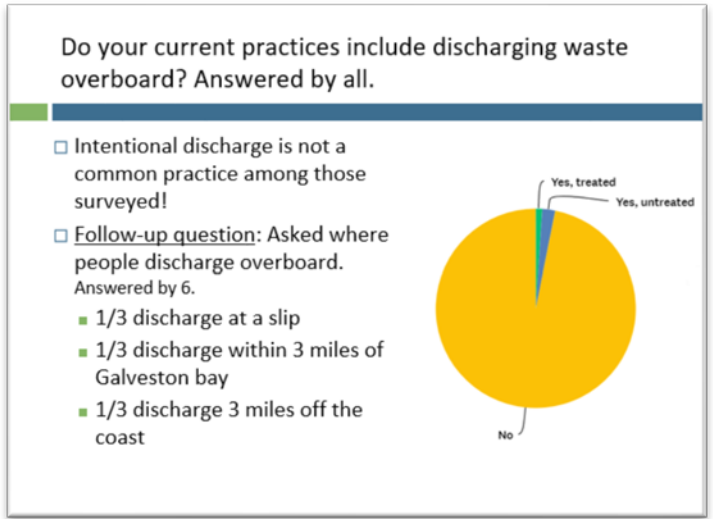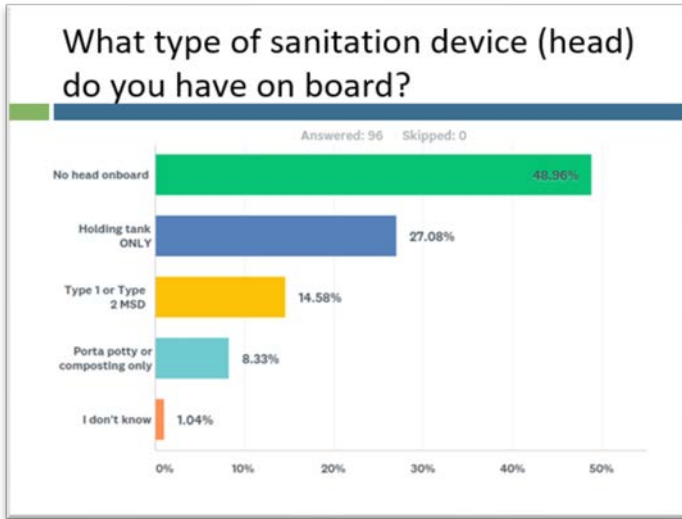| Barrier	Benefits	Strategy	Competing Behavior
lack of access to pumpout stations	cleaner & safer environment	Convenience: increase number of accessible pumpouts	dump waste overboard
do not know pumpout locations	cleaner & safer environment	Communication, Prompts, Diffusion	dump waste overboard
tradition of dumping	cleaner & safer environment	Commitments, Prompts, Social Norms	dump waste overboard

5.3 No Discharge Zone Application

During this project period, GBF continued to meet with stakeholders and garner support for a No Discharge Zone application in Galveston Bay. GBF surveyed recreational boaters to better gauge support for this policy change, and found that 91% of surveyed boaters would support this policy change (Fig. 18). Additionally, GBF continued to meet with stakeholders to foster conversation on how this regulation change would impact them and gauge their support. Table 12 lists the various stakeholders and Industrial groups GBF met with during this reporting period to discuss the NDZ application, and their current stances. While many of these meetings were positive and the majority of the stakeholders showed support for the policy, most also expressed concern on receiving pushback from other stakeholder groups and recognized the challenge that passing a policy change such as this. To help with this, GBF also researched other recent coastal NDZ designations to understand the pushback received there, how it impacted various stakeholder groups, and what was done to reduce these barriers that would lead to pushback. A literature review to this pushback was created, and excerpts can be found in the appendix.
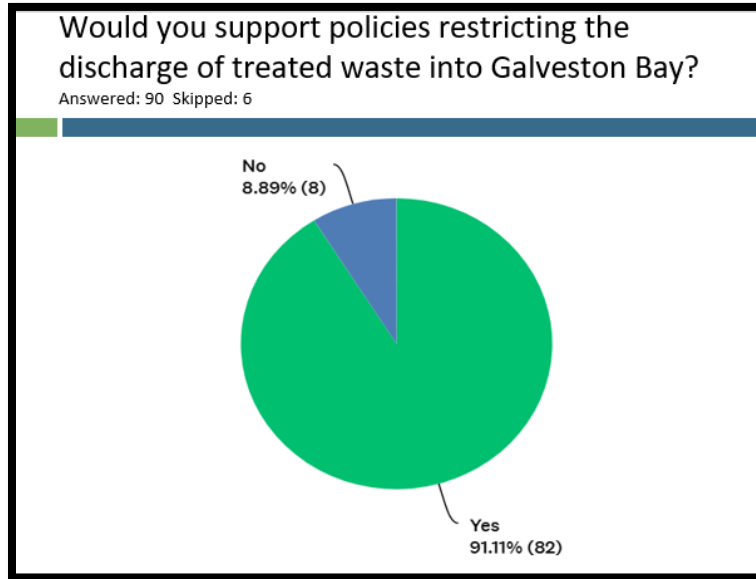
Figure18. Results from surveyed boaters about NDZ support in summer 2017

Table 18. Meetings with Stakeholders about NDZ Support

First Name	Last Name	Organization	Industry	Feelings towards NDZ	Notes
Jim	Gossen	Louisiana Foods	Seafood Distributor	Supportive	Eager to hear what fishers think
David	Hunt	Gulf Coast Yacht Brokers Association	Rec. Boaters	Supportive	Thinks all marinas will support
Ken	Ellis	Coastal Conservation Association Texas - Galveston	Conservation	Supportive	Mentioned that I should talk with politicians sooner rather than later and get their support
Terry	Chapman	Lakewood Yacht Club	Rec. Boaters	Supportive	Big supporter of BWEC, eager to help with NDZ
Lynda	Hall	Lakewood Yacht Club	Rec. Boaters	Supportive	Member of MAT, is eager to help with NDZ
Helen	Paige	Marina Bay Harbor Yacht Club	Rec. Boaters	Supportive	President of Boater Waste Workgroup, very eager to help and very connected to local boaters
Linda	Poulin	Seabrook Marina	Rec. Boaters	Supportive	Would like to get pumpout facility at marina but has difficulty convincing owner
Donna	Rogers	South Shore Harbor Marina	Rec. Boaters	Supportive	Believes that all marinas will be supportive
Cory	Baldwin	Nassau Bay Home and Marina Association	Rec. Boaters	Supportive	Believes it's a good initiative and wants to support however possible

Lance	Parks	Galveston Yacht Basin	Rec. Boaters	Supportive	Does not think most boaters even know that you can discharge any waste into Galveston Bay
Clifford	Hillman	Hillman Oysters	Community Leader	Supportive	Wants to make sure he and other distributors are kept in the loop and are part of the process, wants to know how this will mesh with FDA oyster regulations (5-gallon bucket), and wants to be sure that we listen to everyone's concerns, work with them as best we can, and take it slow
Alan	Franks	Crazy Alan's Swamp Shack	Seafood Distributor	Supportive	Eager to help however possible
Tom	Tollett	Tommy's Restaurant and Oyster Bay	Seafood Distributor	Supportive	Thought I should reach out to Tracy Woody and POHA Board of Commissioners and I should say I spoke with him
Phillip	Kropf	Lonestar Harbor Safety Committee	Rec. Boaters	Supportive	Thought I should present at one of the three subcommittee meetings for LHSC (tricomm meeting December 6), since there are industry reps, commercial boaters, rec boaters, etc all at these meetings
Jim	Prappas	Landry's Restaurants	Seafood Distributor	Supportive	Wanted me to give him all relevant information, and make sure that we let him know if there is anything they can do to support this
Skyler	Jewell	Harborwalk Yacht Club	Rec. Boaters	Supportive	Eager to help however possible, has had some discharge issues with their own residents in the marina
Adam	Baker	Captain Benny's Seafood	Seafood Distributor	Supportive	Eager to help however possible, is willing to distribute information or write letter of support
Ron	Galloway	Captain Ron's Shrimp	Commercial Fisher	Unsure	Didn't really say anything about whether he would support it or not, but did say that for some reason the last few years have not been as productive from a shrimping standpoint as they were back decades ago (when folks were discharging whatever they wanted).

Leah	Oberlin	Port of Houston Authority	Industry	Unsure	Will check on how POHA currently handles discharge, personally is for it but wants to be sure POHA can support it before we agree on anything
Tracy	Woody	Jeri's Seafood	Seafood Distributor	Supportive	Wanted to know how the commercial groups (fishers and industry) would react to this and how it would impact them. Will keep updated and reach out after Kirby meeting, may have some commercial folks we can contact
Eric	Brazer	Gulf of Mexico Reef Fish Shareholders' Alliance	Commercial Fisher	Unsure	Wants to know if this just impacts human sewage discharge or deck wash runoff as well, but will communicate it to his partners and stakeholders

Appendix 1: Water Monitoring Team Data Analysis

Through the BWEC, GBF continues to carry out citizen-based bacteria sampling and increase the number of volunteers and sites being sampled. When setting up this program, GBF selected Enterococci because it is the recommended indicator bacteria for tidal waters and is widely used for measuring contact recreation use-attainment. The downside to using Enterococci is that oyster water use-attainment is assessed using fecal coliform. However, the use-attainment concentrations set by the U.S. EPA for Enterococci and fecal coliform have the same relative ratios for each use, so general discussions can be had regarding GBF's citizen science Enterococci results in relation to oyster waters (see **Table 9**). Our data was not intended to be used for regulatory purposes, so this indicator was a better fit due to it being a straight-forward method for citizen scientists to carry out and relate to.

Results of this bacteria sampling are described below. Geometric mean Enterococci concentrations by monitoring site through the years are shown in tables 5 through 8**.** The cells are color coded based on low (no shade = geomean <14.99 CFU/100 mL), medium (yellow = geomean between 15 – 34.99 CFU/100 mL), and high (red = geomean > 35 CFU/100mL) ranges. Tables were sorted out into various locations around the bay (i.e. east side, west side, clear lake) in order to showcase the general trends of specific areas. Locations on the east started being monitored this year (2018), so while the sample sizes are much lower, the area seems to have higher concentrations of bacteria. Many of the sites sampled within the clear lake area have been some of the most consistently monitored sites throughout the years. The geometric means at almost half the sites fall under the medium range. The highest concentration of marinas is within the Clear Lake area, therefore, it has been important for GBF to understand trends in this area so we can educate the local boating community. No other obvious trends are seen throughout the other locations of the bay.

Table A1. Geometric Means in East Bay site locations

Site Description	2013 Geometric Mean	2014 Geometric Mean	2015 Geometric Mean	2016 Geometric Mean	2017 Geometric Mean	Overall Current Geometric Mean
East Bay at Frozen Point 2						59.42
East Bay at Frozen Point 3						58.14
East Bay at Stingaree Restraunt						3.15
Lake Anahuac at Turtle Bayou						85.42

Table A2. Geometric Means in Galveston Bay site locations

Site Description	2013 Geometric Mean	2014 Geometric Mean	2015 Geometric Mean	2016 Geometric Mean	2017 Geometric Mean	Overall Current Geometric Mean
Galveston Bay at 1109 6th St. San Leon	25.17	20.63	7.26	2.87	4.05	5.92
Galveston Bay at Bayland Park						26.79
Galveston Bay at GBF						7.93
Galveston Bay at Houston Yacht Club					8.66	4.44
Galveston Bay at Pier 19					595.54	106.42
Galveston Bay at Pine Gully Park		30.57	7.76	7.7	14.23	4.7
Galveston Bay at Seascape Pier	3.99	2.81	10.26	4.57	2.23	4.4
Galveston Bay at Shoreacres Pier			8.28	3.86	3.23	5.72
Galveston Bay at Starboard Lane	5.57					5.57
Galveston Bay at Sunset Cove			2.11	2.85	2.51	2.75
Galveston Bay at Texas City Dike	1.79	1.52	2.92	4.63	3.59	3.22
Galveston Bay at Todville Road				5.6	11.23	10.61
Galveston Bay at Topwater Grill	2.15	2.58	17.56	7.81	7.15	6.45
Jones Bay at Bayou Vista		29.85	22.18	9.71	15.69	16.5
Jones Bay at Tiki Tom's RV Park	2.51	8.15	124			2.75
Moses Lake at Texas City Prairie Preserve	7.27	5.19	4	11.68	9.02	7.02

Table A3. Geometric Means in West Bay site locations

Site Description	2013 Geometric Mean	2014 Geometric Mean	2015 Geometric Mean	2016 Geometric Mean	2017 Geometric Mean	Overall Current Geometric Mean
Offatt's Bayou at Sea Star Base Galveston		2.51	3.69	4.61	6.99	4.21
West Bay at Eckert Bayou			31	34.91	18.9	16.17
West Bay at Jamaica Beach					29.44	39.98
West Bay at Oak Bayou		4.19	29.28	4.84	3.66	5.01
West Bay at Pirate's Cove					4.54	4.73
West Bay at Sportsman Road				3.16	8.35	6.71
West Bay at Sweetwater Lake					12.74	6.72
West Bay at Sweetwater Preserve		11.37		5.04	5.01	6.49
Christmas Bay at Drum Bay			2.55	5.65	4.3	4.56

Table A4. Geometric Means in Clear Lake site locations

Site Description	2013 Geometric Mean	2014 Geometric Mean	2015 Geometric Mean	2016 Geometric Mean	2017 Geometric Mean	Overall Current Geometric Mean
Clear Lake at 18 Waterford Oak Lane				32.75	13.37	21.86
Clear Lake at Bal Harbor Marina		17.37	49.3			24.99
Clear Lake at Blue Dolphin Yachting Center	9.56	23.44	9.76	14.95	12.19	12.59
Clear Lake at Clear Lake Park Pier	20.47	11.23	39.77	11.02	6.99	18.56
Clear Lake at Clear Lake Shores	14.83	9.48	28.08	6.21	8.37	13.25
Clear Lake at Jarboe Bayou Park	20.67	20.94	85.76	16.52	28.15	29.49
Clear Lake at Lakewood Yacht Club	3.95	12.81	8.54	7.29	17.92	10.45
Clear Lake at Marina Del Sol	6.08	6.89				7.07
Clear Lake at Nassau Bay Upper Bay Road	26.26	14.99	7.91	33.6		14.38
Clear Lake at Nassau Bay Yacht Club		79.96	9.91	23.01	16.58	26.66
Clear Lake at Portofino Harbor Marina			20	17.61		18.37
Clear Lake at Sea Cove Ct					15.59	11.85
Clear Lake at Waterford Harbor Marina				2.53		3.26
Clear Lake at Watergate Yachting Center	3.39	5.25	12.66	2.36	7.7	5.31

Table A5. Summary of water quality standards in the United States.

	Enterococcus (CFU/100mL)	Fecal Coliform (CFU/100mL)	Indicators used to detect fecal waste/pathogens for various uses:
Drinking water	*	0	Drinking
Oyster Waters	* (no standard – equiv. to 7.5 geomean)	43	Oyster harvesting for consumption
Primary Contact Recreation	35 (geometric mean) / 104 (single sample)	200	Swimming, tubing, skiing, jet skiing
Secondary Contact Recreation	175	1000	Canoeing, fishing, power boating
Non-Contact Recreation	350	2000	Birding, hiking, biking

The map below outlines the geometric means for each site, based on all data collected. It must be noted that some sites have many years of data, while others have only been collecting data for a few months, which could skew data.
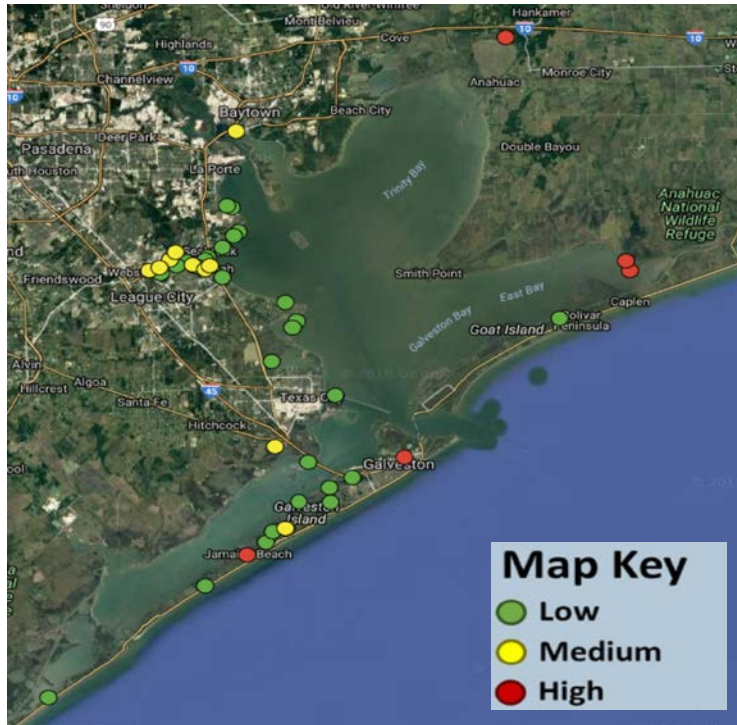

Figure A1. Figure 1. Map illustrating sites geometric means

Geometric Mean Ranges displayed on map for all 45 locations
sampled for bacteria.
- Low: < 15 MPN (29 sites; 64.4%)
- Medium: ≥ 15 and < 35 MPN (11 sites; 24.4%)
- High: ≥ 35 MPN (5 site; 11.1%)

Many monitors were able to begin sampling a week after Hurricane Harvey hit. These sites that were sampled are compiled in Table 10 below. Salinity was the most highly impacted parameter **(Figure 2)**. Bacteria concentrations were surprisingly low. We believe this can be attributed to the high amounts of flow causing the concentration of bacteria to be diluted in the waters. Additionally, enterococci can only live outside it's host for up to 6 hours, so the initial impact of bacteria concentration from the storms runoff could not be captured a week later.

Table A6. Summary of water quality data post Hurricane Harvey.

Site Name	Sample Date	Salinity	Avg Salinity	Air Temp	Water Temp	DO	Transparency	Avg Transparency	Total Depth	Clarity	Bacteria
Clear Lake @ Upper Bay Road	8/31/2017	2	3.3	31	24.5	3.9	1.6	0.8	1.9	cloudy	x
Galveston Bay @ Seascape Pier	9/1/2017	0	9.1	28	28.5	6.25	0.3	0.4	2	cloudy	x
Galveston Bay @ Bayshore Bacliff	9/5/2017	0.6	10.5	28.5	31	7	0.28	0.6	1.29	cloudy	x
Galveston Bay @ Todville Rd	9/4/2017	2.9	7.4	28	27	4.55	0.22	0.7	1.35	cloudy	10
Moses Lake @ Texas City Prairie Preserve	9/5/2017	2.9	10.7	29	27.5	5.9	0.15	0.4	1.2	turbid	10
Clear Lake @ Blue Dolphin Yachting Center	9/5/2017	0.6	6.5	26.5	28	5.6	0.26	**0.1**	1.79	clear	
Clear Lake @ Lakewood Yacht Club	9/5/2017	0.7	6.1	29	28	5.8	0.25	**0.1**	2.31	clear	
West Bay @ Sweetwater Preserve	9/5/2017	14.9	21.3	25	30.5	4.6	0.45	0.6	0.65	clear	<10
West Bay @ Jamaica Beach	9/5/2017	8.9	26.1	30	28	5.6	0.74	0.6	1.3	clear	<10
Clear Lake @ Watergate Marina	9/6/2017	2.7	5.6	28	27	5.2	0.21	1.1	2.46	cloudy	
Clear Lake @ Sea Cove Ct	9/6/2017	0.3	6.12	25	28	6.4	0.6	0.9	2.13	cloudy	
West Bay @ Sportsman Road	9/6/2017	8.3	26.4	24	27	5.5	0.25	0.6	0.8	turbid	
Galveston Bay @ San Leon	9/6/2017	1.5	10.9	23.5	28	5.5	0.21	0.5	1.86	cloudy	
Galveston Bay @ Topwater Grill	9/6/2017	1.5	11.4	23	27.5	5.5	0.2	0.5	1.65	cloudy	
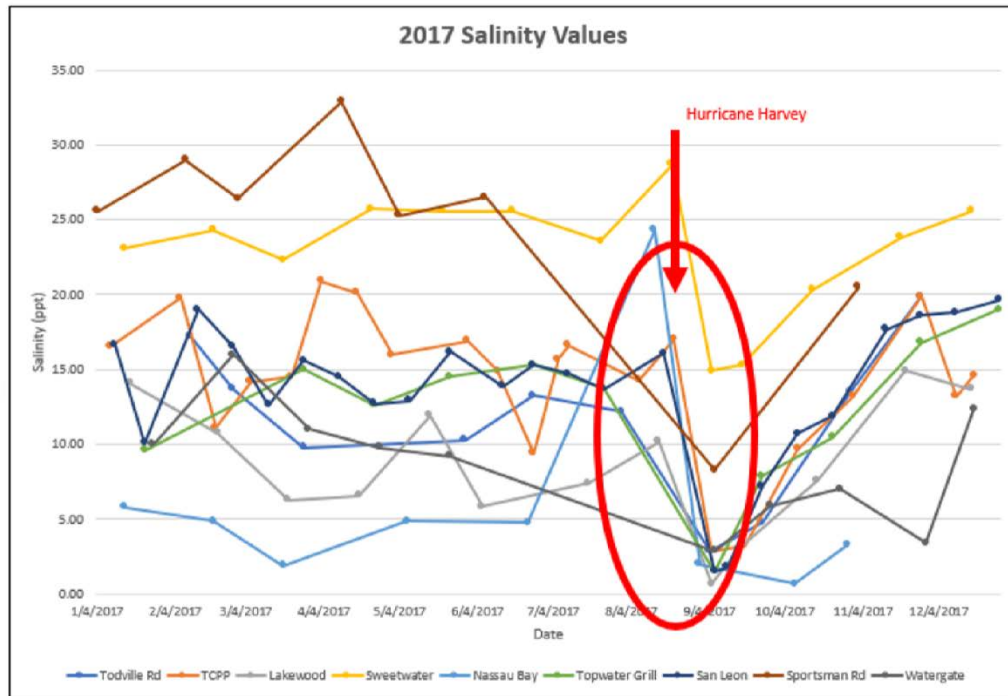
Figure A2.Graph showing salinity values through 2017 highlighting Hurricane Harvey

FigureA3. Graphic about Harvey Impacts on water quality, based on WMT data. Used in outreach materials, articles, and on a poster
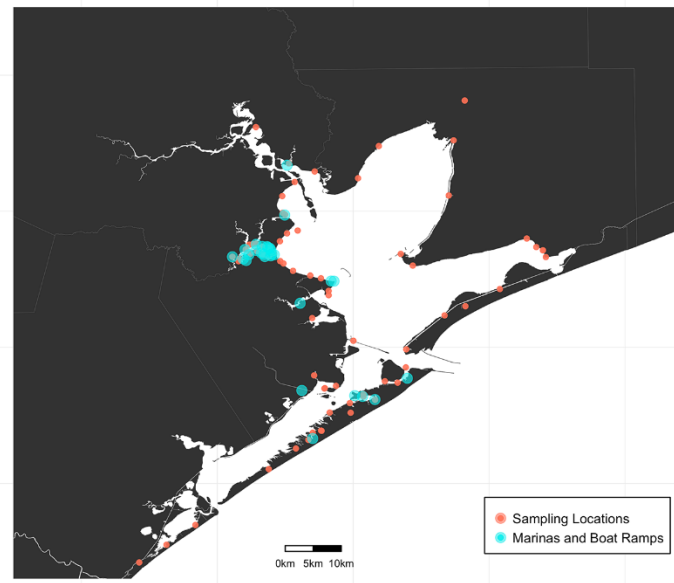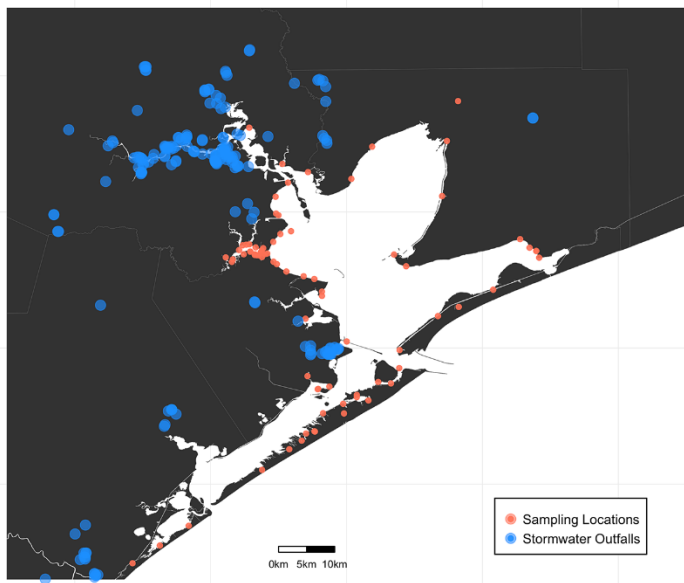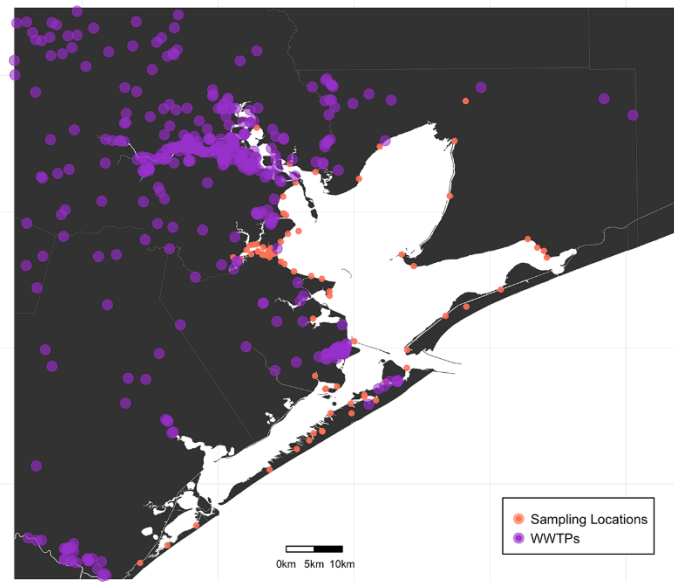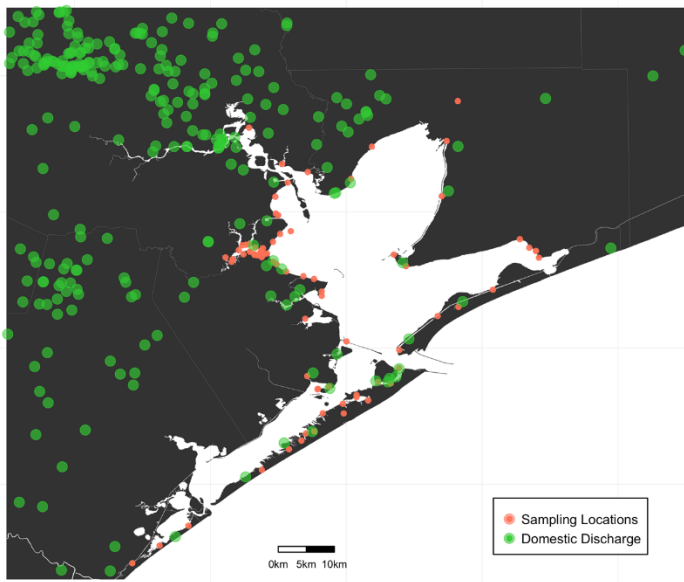
Figure A4. locations of various anthropogenic sources in relation to sampling sites

Table A7. Model Summary of Enterococcus vs anthropogenic sources in Clear Lake, 2 km

	Estimate	Std. Error	z value	p-value	
(Intercept)	-3.857×10^{-7}	Inf	-0.007	0.9943	
Marinas and boat ramps	-0.971	1.030	-1.002	0.3165	
WWTP outfalls	1.351	1.142	2.270	0.0232	*
Stormwater outfalls	1.128	1.500	0.297	0.7667	
Domestic sewage outfalls	3.452	1.284	3.839	7.18×10^{-7}	***
Significance codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '

Table A8. Model Summary of Enterococcus vs anthropogenic sources in Clear Lake, 0.5km

	Estimate	Std. Error	z value	p-value	
(Intercept)	3.659	0.267	13.697	$< 2 \times 10^{-16}$	***
Marinas and boat ramps	-0.475	0.170	-2.801	0.0051	**
WWTP outfalls	-0.054	0.277	-0.195	0.8453	
Significance codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '

Table A9. Model summary of DO vs anthropogenic sources, 5 km

	Estimate	Std. Error	t value	p-value	
(Intercept)	5.942	0.090	65.763	0.0000	***
Marinas and boat ramps	0.012	0.005	2.344	0.0192	*
WWTP outfalls	0.079	0.012	6.320	3.83×10^{-10}	***
Stormwater outfalls	-0.114	0.022	-5.066	4.76×10^{-7}	***
Domestic sewage outfalls	0.047	0.031	1.535	0.1250	
Significance codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '

Table A10. Model summary of pH vs anthropogenic sources, 2 km

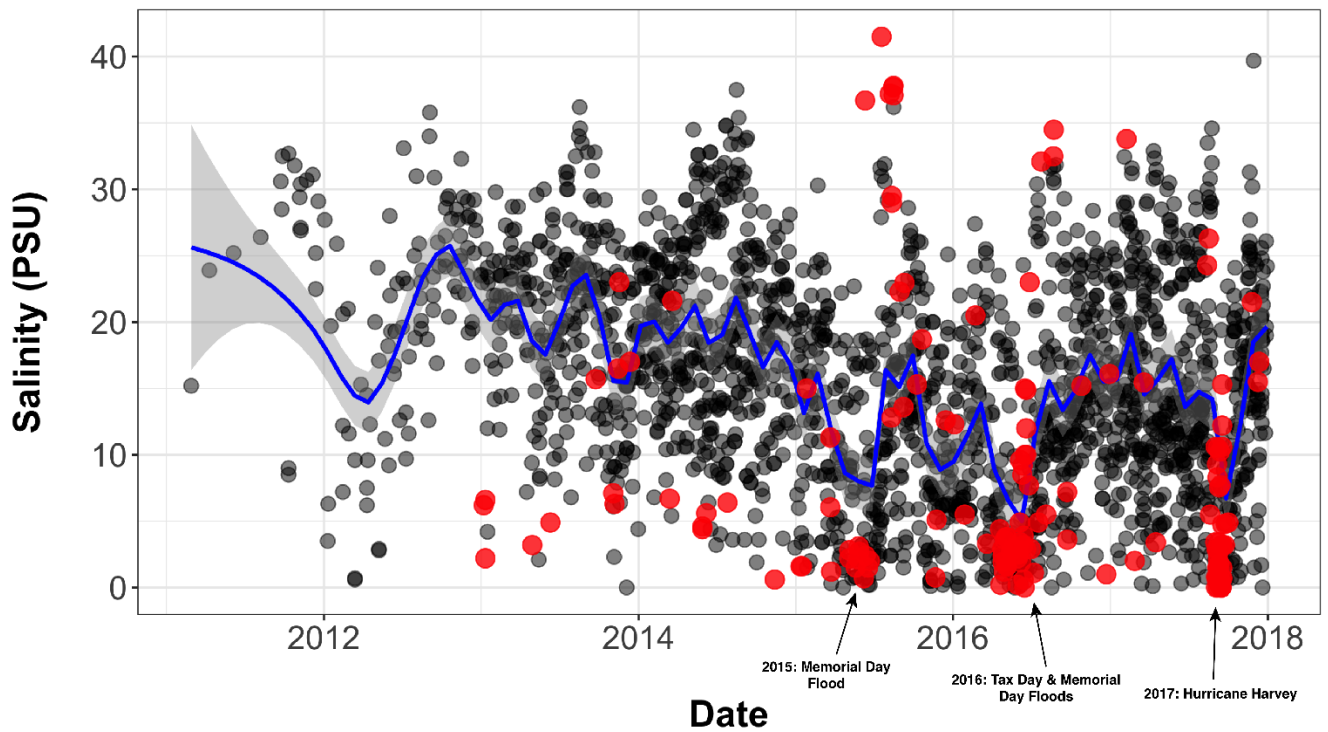|	Estimate	Std. Error	t value	p-value	
(Intercept)	7.871	0.015	534.637	0.0000	***
Marinas and boat ramps	0.024	0.002	10.068	7.59×10^{-23}	***
WWTP outfalls	0.015	0.011	1.328	0.1845	
Stormwater outfalls	0.187	0.038	4.907	1.07×10^{-6}	***
Domestic sewage outfalls	-0.060	0.016	-3.844	0.0001	***
Significance codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '

Figure A5. Major anomalies of low salinity found are shown correlating with various weather events
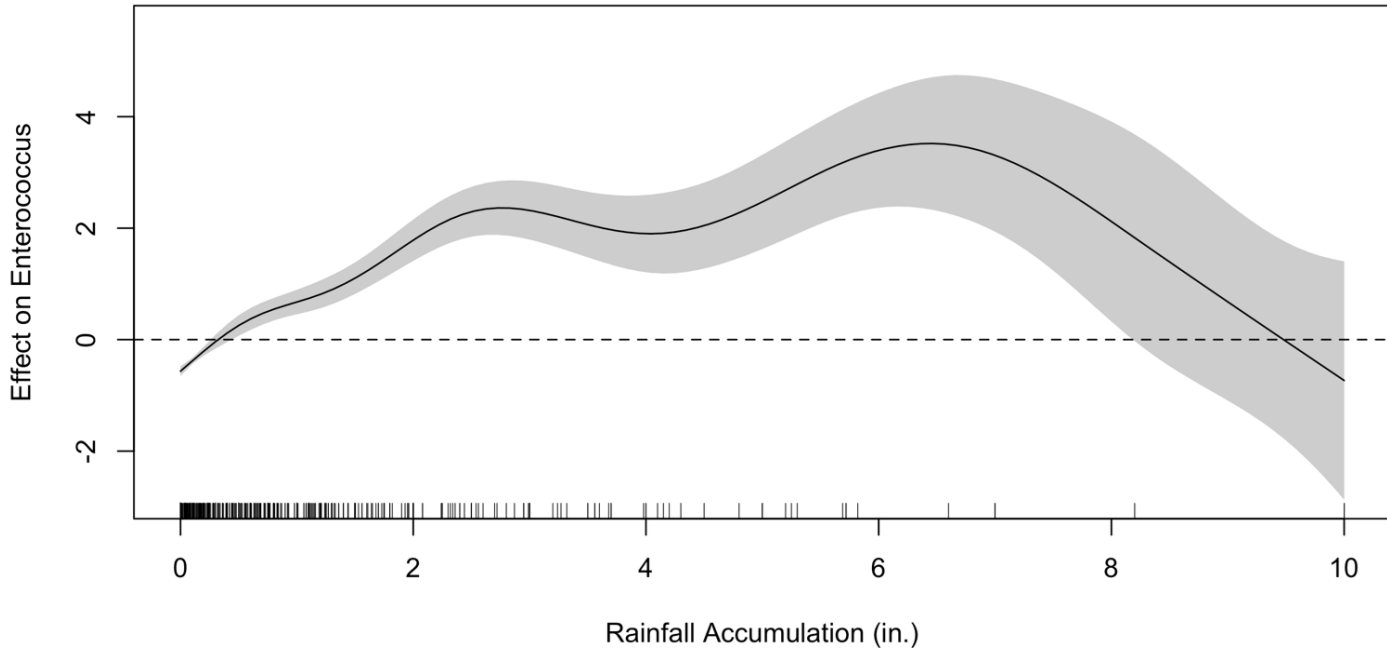
Figure16. Impact rainfall accumulation had on enterococcus with a confidence interval
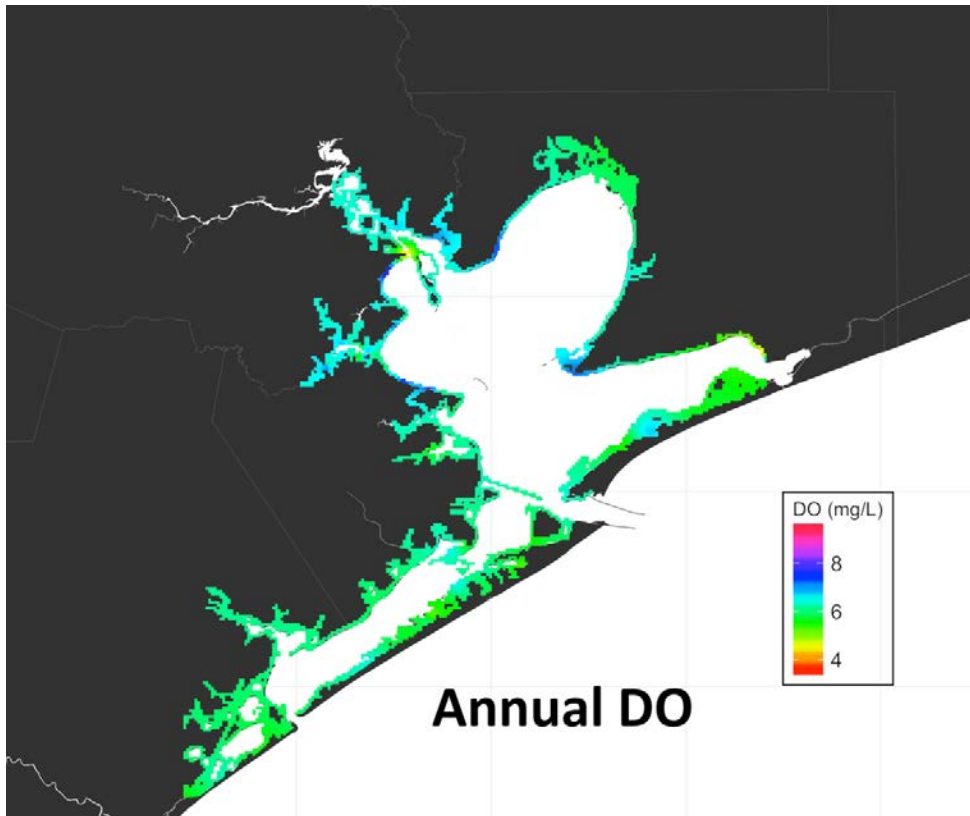

Figure A7. Annual means of DO are shown through an interpolated map of Galveston Bay
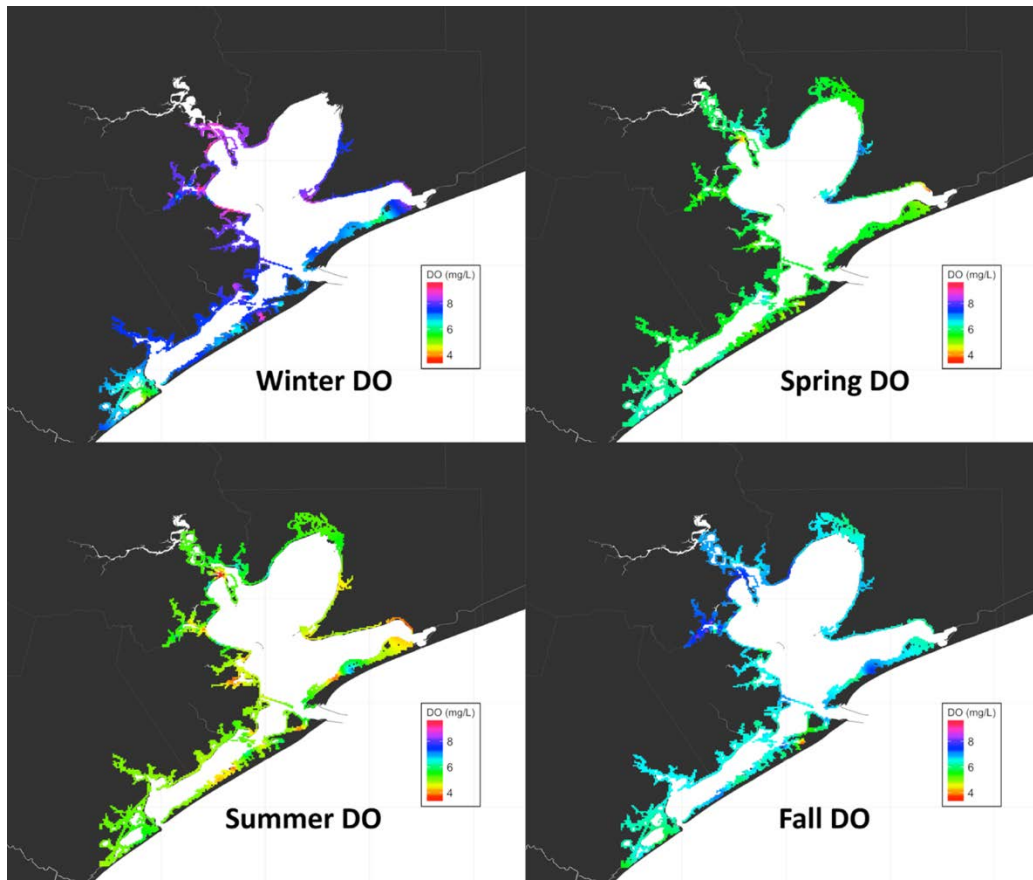
Figure A8. Seasonal means of DO are shown through interpolated maps of Galveston Bay

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How Clean Is My Water?
2017 Water Quality Year-in-Review

• •

In 2017, GBF's Water Quality Monitoring Team collected and analyzed 615 water samples from 66 sites around Galveston Bay. These samples were collected by 70 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 galvbay.org/watermonitors.
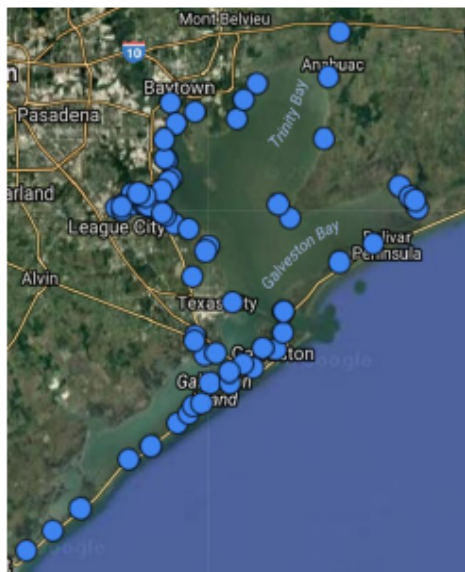

Figure 1. 2017 Water Monitoring Locations

This document summarizes our findings for each parameter based on the Team's 2017 data.

To view 2017 Water Quality summaries for each individual site, please click on each site on our sampling map*, linked here or accessed from our webpage (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 2017 data summary are new as of 2018

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Air Temperature

Average of **23.5° C** in 2017

This is **similar to** previous years.

2016 average: **24.0°C** | 2015 average: **23.1°C** | 2014 average: **22.4°C**

How does air 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 observed a slight increase in the air temperature from 2014 to 2016, with 2017's temperature remaining within a similar range.

• •

Water Temperature

Average of **23.0° C** in 2017

This is **similar to** previous years.

2016 average: **22.8°C** | 2015 average: **22.8°C** | 2014 average: **21.9°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 2017's temperature the highest recorded.
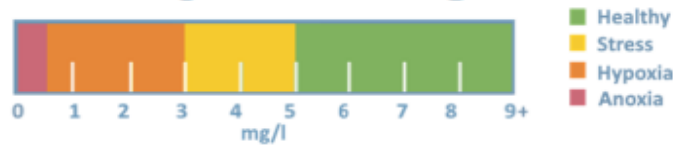
Impacts from Hurricane Harvey:

Harvey did not appear to significantly impact water or air temperature.

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Dissolved Oxygen

Average of **6.1 mg/L** in 2017

■	Healthy
■	Stress
■	Hypoxia
■	Anoxia

0 1 2 3 4 5 6 7 8 9+
mg/l

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

This is **similar to** previous years.

98% of dissolved oxygen samples could support life in 2017.

What is dissolved oxygen?

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

How does dissolved oxygen 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.
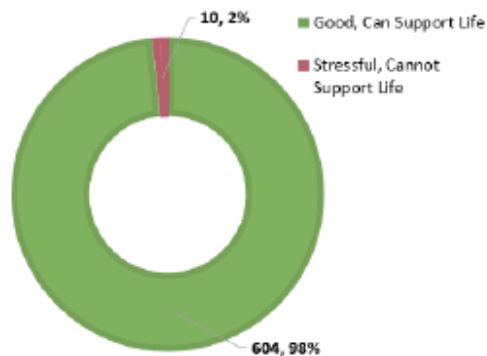
According to the data:

In 2017, 98% 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.

Impacts from Hurricane Harvey:

Harvey did not appear to significantly impact dissolved oxygen.
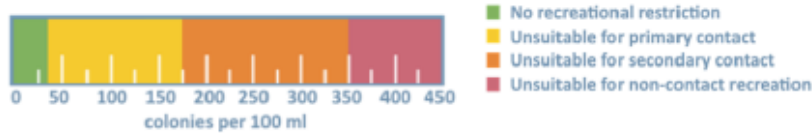
Dissolved oxygen values for 2017:

10, 2%   ■ Good, Can Support Life

■ Stressful, Cannot Support Life

604, 98%

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Enterococci Bacteria

Geometric Mean of **8.0 MPN** in 2017

■ No recreational restriction
■ Unsuitable for primary contact
■ Unsuitable for secondary contact
■ Unsuitable for non-contact recreation

0   50   100   150   200   250   300   350   400   450
colonies per 100 ml

This is considered **safe** for swimming by the EPA.

This is **similar to** previous years.

2016 GM: 6.5 MPN | 2015 GM: 12.8 MPN | 2014 GM: 7.8 MPN

What are Enterococci?

Enterococci are bacteria that indicate the presence of harmful fecal waste in the water.

How do Enterococci impact water quality?

High levels indicate the presence of fecal waste that can make us sick and impact the economy. Sources include polluted storm water, failed wastewater infrastructure, and from pets and wildlife.

According to the data:

About half of GBF's Water Monitoring sites test for Enterococci. Of the 295 samples collected in 2017, 9% of them were considered unsafe for swimming. Most of these occurred soon after major rain events.

Impacts from Hurricane Harvey:

GBF Water Monitors began collecting water quality samples one week after Harvey hit the Texas Coast. By then Enterococci bacteria levels were low enough to be considered safe for swimming.

Enterococci values for 2017:

9%

■ Safe for Swimming
■ Unsafe for Swimming

91%
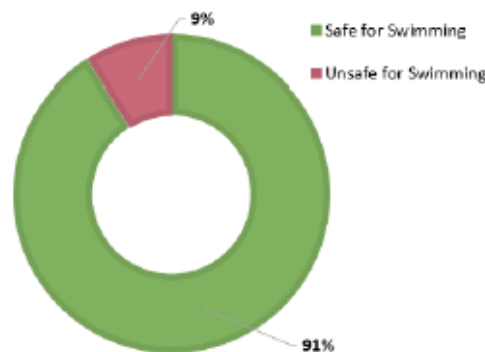
GALVESTON BAY
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Salinity

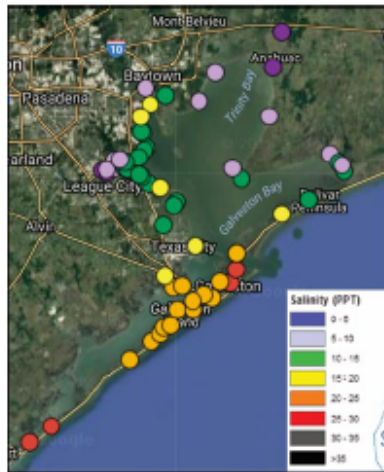## Average of **14.3 ppt** in 2017

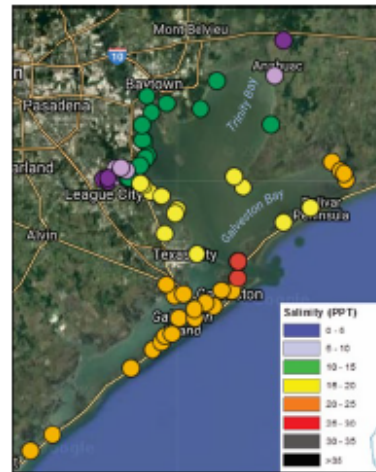*Figure 2. Salinity averages by site, 2017*

Figure 3. Salinity averages by site, normal year

This is **higher** than in previous years.
2016 avg: 11.9 ppt | 2015 avg: 12.45 ppt | 2014 avg: 19.11 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 in 2017, Galveston Bay experienced saltier water overall than in previous years.

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Water Transparency

Average of **0.5 meters** in 2017

This is **the same** as in previous years.

2016 average: **0.5m** | 2015 average: **0.46m** | 2014 average: **0.55m**

What is water transparency?

Water transparency, or turbidity, measures how much solid matter is suspended in 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.

Sediment particles in Galveston Bay are very small. In addition, Galveston Bay is shallow and windy, causing naturally turbid water. However, increased erosion and runoff can increase turbidity.

According to the data:

In 2017, the average transparency measured by GBF's Water Monitoring Team was 0.5 meters, very similar to transparency measured in prior years.

Impacts from Hurricane Harvey:

Harvey caused the water to become much more turbid (or less clear) for a few weeks. This could impact the amount of sunlight that plants and bottom dwelling animals received, and could potentially impact smaller floating animals, such as plankton. Within about a month of the storm turbidity levels were back to "normal."
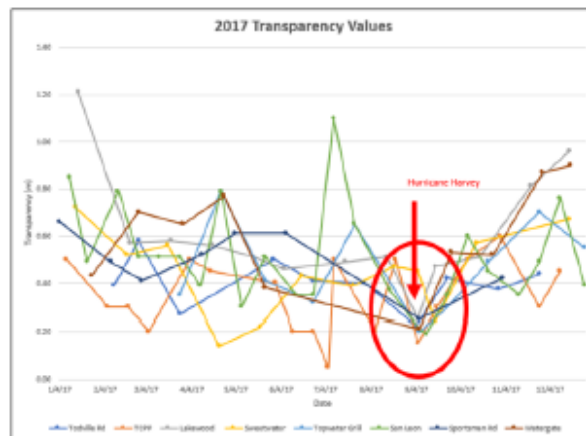
GALVESTON BAY
F O U N D A T I O N

pH

Average of **7.9** in 2017

This is **ideal** to support life.
This is the **similar to** previous years.

2016 average: **7.9** | 2015 average: **7.9** | 2014 average: **8.1**

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.
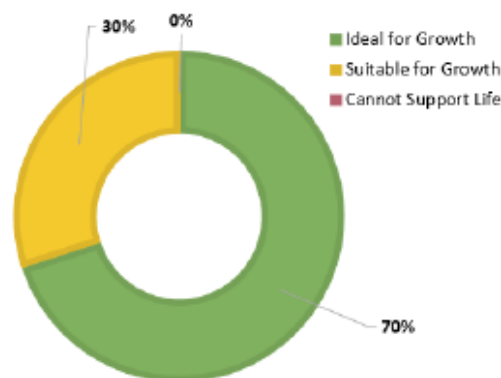
According to the data:

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

Impacts from Hurricane Harvey:

Harvey did not appear to significantly impact pH levels.

pH values from 2017:

- 30%
- 0%
- 70%
- Ideal for Growth
- Suitable for Growth
- Cannot Support Life

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Acknowledgements

Thank you to all 61 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.

Additionally, thank you to Lindsey Fuchs, a student from Clear Horizons High School, for assembling the bar graphs featured in this publication that show ideal ranges for dissolved oxygen, enterococci, and pH. Lindsey also conducted water quality testing on a weekly basis throughout her Fall 2016 semester.

Appendix 2

No Discharge Zone Research: Literature Review into Other NDZ Designations

Massachusetts

Boston Harbor was designated an NDZ back in 2008 under the f(3) justification, with 12 commercial and 22 recreational pump out facilities present in the area at the time. Some of these facilities are free to use, as they were financed by Clean Vessel Act funds. The Harbor itself has a large commercial presence, with containerized cargo, commercial fishing fleets, at least one cruise terminal, petroleum and liquefied natural gas terminals (which supply more than 90% of Massachusetts' heating and fossil fuel needs), ferry operations, and the Port of Boston all located within Boston Harbor. Because of this large commercial presence, the Massachusetts Office of Coastal Zone Management talked with major industry groups (tugs, ferries, marinas, commercial fisherman, etc.) to understand how these businesses operate and what could be done to help them comply with the NDZ (Callaghan, pers. comm.). While some commercial groups were vocally opposed to the designation at first, their concerns were somewhat alleviated by the state's willingness to pursue funds for waste management infrastructure (including Coastal Pollutant Remediation (CPR) grants, Clean Vessel Act funds, EPA Supplemental Environmental Projects, and municipal funds from the City of Boston). Some barges looked at the NDZ designation as a business opportunity—they could use their barges as commercial pump outs for other vessels that needed this service (Callaghan, pers comm.). The Mayor of Boston had sewer line extensions built that could be used by some commercial operators, and a large pumpout boat, operated through an agreement with UMASS-Boston, was given to the City of Boston.

To realistically enforce the Boston Harbor NDZ, the state had to amend its laws to specifically allow harbormasters, local police, and other enforcement personnel to issue tickets to those in violation of the NDZ. Finances from these tickets go towards the state's general fund, which could potentially serve as a revenue stream for additional waste management infrastructure development. State personnel also stressed the importance of developing a long-term plan for pumpout facility maintenance in regions designated as NDZs. Even with multiple agencies enforcing NDZ regulations, enforcement remains difficult due to a number of reasons mentioned earlier in this document. Therefore, educating boaters on the importance of maintaining healthy waterways and providing the boating community with ample alternatives to discharging sewage overboard are incredibly important to ensuring community support for the Boston Harbor NDZ.

Salem Sound was also designated an NDZ in 2008 under the f(3) justification. The region houses eight pumpout facilities and has plans to install another two. According to a 2005 survey of the recreational boater community in Salem Sound, 86% of the boaters surveyed (n = 698) said that they would support an NDZ in the Sound. The survey also indicated, however, that many boaters were either unfamiliar with the pumpout facilities throughout the region, had never used pumpout facilities, or are confused as to whether their vessel's sewage is considered treated or untreated. While the Sound was ultimately designated an NDZ, the authors of the survey stressed the need for continued outreach and education to the boating community concerning the impacts of boater sewage on the Sound, the need for more consistent and available pumpout facilities, and increased communication between all members of the boating community (enforcement agencies, nonprofits, harbormasters, marinas, and boaters).

New York/New Jersey

The Port Jefferson Harbor Complex in New York, which encompasses about 2,000 acres of harbors, bays, and tidal wetlands, was designated an NDZ in 2003 under section 312f(3) of the CWA. The region has an estimated ratio of approximately 300 vessels for each pump out facility. The Port Jefferson Harbor area is a major producer of hard clams, soft clams, and oysters in New York State. It is also used extensively by recreational boaters, and includes seasonal and transient mooring areas, private and public marinas, and boat ramps.

The Hudson River in New York and New Jersey was designated an NDZ in separate parts; two zones were designated NDZs in 1995 based on section 312f(4)(B) of the Clean Water Act, whereas the remainder of the Hudson was designated an NDZ in 2003 under section 312f(3) of the CWA. To ensure compliance with these designations, New York has ensured that:

1. Vessels have access to stationary or mobile pump-out facilities at their home base or any other fuel dock, terminal or facility in New York Harbor both before and after transiting the NDZ;

2. Vessels have access to pump-out facilities, trucks or one of three Hudson River pump-out boats while docked at their cargo off-loading terminals up-River in the NDZ;

3. Vessels can utilize one of the 39 facilities that service portable toilets;

4. If transiting from outside the region, vessels can discharge outside of the no-discharge zone;

5. Vessels can utilize an alternative solution, such as Incinole (an electric waste-incinerating product currently being introduced on new ships by carriers such as Moran, Bouchard, and Exxon/Mobile.)

Any vessel that has a home port in the Hudson River or New York Harbor, or which docks to receiving fuel or unloading cargo in the River or Harbor, has access to a pump-out truck or pumpout boat at its respective home port, fuel dock or cargo terminal. The Hudson River has a total of 38 pumpout facilities for recreational boaters, three of which are mobile pumpout vessels. Some commercial operators have pump-out facilities installed at their docks, while others make arrangements with local waste haulers to service their vessels.

Florida

The waters of Key West, Florida, were designated an NDZ back in 1993 under section 312f(3) of the CWA. The region has a ratio of 126 boats to pump out services, including mobile pump-out services. The region has a significant commercial fishing, diving, and cruise ship presence. In 2002, all state waters within the Florida Keys National Marine Sanctuary were designated an NDZ under sections 312f(4)(A). This area includes state waters within the Florida Keys National Marine Sanctuary (FL) three miles from land on the Atlantic Ocean side of the Florida Keys and nine miles from land on the Gulf of Mexico side of the Florida Keys. About 65% of the sanctuary is State waters. Dry Tortugas National Park is not part of the Sanctuary; however, discharge of all waste is prohibited within the Park. According to the final rule designating the Florida Keys as a Federal No Discharge Zone:

"The City [of Key West] pumps the holding tanks of large vessels by running a hose from docks to a sewage collection line that is directly connected to the City's state-of-the-art sewage treatment and disposal facility. The U.S. Naval Base at Truman Annex in Key West can also accommodate large vessels and is equipped with a pump out station that is directly connected to the collection system of the City's

wastewater treatment facility. This U.S. Naval facility may be transferred to the City of Key West in the future and can now be used by the City in emergency situations for pump out services. The U.S. Coast Guard Base at Trumbo Point does receive fuel shipments via tankers and this facility has a pump out station that is connected to the Key West wastewater management system. In addition, the City of Key West operates a pump out vessel with a capacity of 300 gallons and is scheduled to acquire another pump out vessel with a capacity of 1,000 gallons by summer 2002 [acquired in 2010] …Ocean-going barge traffic navigating through Sanctuary waters should be able to retain the minimum volume of sewage generated while in Sanctuary waters and then discharge that sewage when outside the established NDZ in an environmentally safe manner" (67 FR 35735, 2002).

California

California designated approximately 5,222 square miles of its coastal waters as a NDZ in August 2012 under section 312f(4)(A) of the CWA (40 CFR Part 140, 2012). This designation was the first to specifically target a certain size class of vessels (large passenger vessels of over 300 gross tons or greater). The area has an enormous commercial presence, encompassing the Port of Los Angeles, the Port of Long Beach, and the Port of Oakland. Both the Ports of L.A. and Long Beach have put forth Water Resources Action Plans (WRAPs) which include a control measure to develop a discharge guidance manual for vessel operators whose vessels call at the Ports, including both U.S. and foreign flagged vessels. The California Clean Coast Act of 2005 imposed prohibitions on five types of discharges (sewage, hazardous waste, oily bilge water, graywater, and other waste which includes medical waste and photography and dry cleaning chemicals) from two specific types of vessels, oceangoing ships with sufficient holding tank capacity and large passenger vessels including cruise ships.

Avalon Bay, just off the coast of Catalina Island, represents one of the oldest NDZs in California. Designated an NDZ in 1979 under CWA section 312(f)(3), Avalon Bay Harbor is a popular boater destination approximately 20 nautical miles from Los Angeles. The City of Avalon used Clean Vessel Act funds in the mid-1990s to replace the pumpout facilities surrounding Avalon Harbor and relocate them away from a major ferry ramp to reduce boater congestion (Stephenson 2004). The city also funds the maintenance of a pumpout boat that can service vessels on the water. While the city's large role has certainly been an instrumental component of Avalon Bay's success enforcing the NDZ, local experts are quick to point out that other enforcement strategies are also necessary to protect the health of Avalon Bay. Harbormaster officials instituted a dye-tablet program in the Bay in 1988, which requires all boaters to place a bright green dye tablet in their vessel's holding tank. If discharged, the waste will be easy to spot and track for local enforcement agencies. While there is a monetary fine for discharging in the NDZ, harbormasters claim that the more effective penalty is that violators are prohibited from using the Bay for one year (Stephenson 2004). Newport Bay, another California NDZ, credits the designation with significant economic increases in tourism, recreational and commercial fishing, and property values near the Bay (Stephenson 2004).

Rhode Island

Great Salt Pond, a body of water in Block Island, Rhode Island, was able to reopen some of its shellfish beds in 1996, three years after it was designated an NDZ (Stephenson 2004). These beds had been closed for over ten years due to high fecal indicator bacteria counts. Additionally, state officials attribute the reduction in algal blooms in Great Salt Pond to the NDZ designation as well (Stephenson 2004). Reducing vessel discharge events through an NDZ designation not only reduces bacteria contributions from boaters, but also nitrogen concentrations from boaters.

Maryland

Herring Bay in Maryland was designated an NDZ in 2002 under (f)(3) following a petition for designation by the Maryland Department of Natural Resources (DNR). According to state personnel, the NDZ designation came only after years of collaborative work between the state, the boating community, and passionate individuals to improve water quality in Herring Bay (O'Neill, pers. comm.). As of 2007, the state of Maryland has 452 pumpout facilities operating at 368, more than any other state. Many of these facilities were funded with a combination of CVA funds and Waterway Improvement Funds (WIF) issued by the state of Maryland. According to a 2000 study (The State of Maryland Department of Natural Resources, 2000), approximately 88% of vessels in the state of Maryland that have on-board toilets are able to use a pumpout facility. Staff at the DNR estimate that approximately two million gallons of raw sewage is disposed of at state pumpout facilities each year.

These are just a few the many examples of instances throughout the United States where NDZs have successfully been established and maintained. Many of the individuals instrumental in the development of these zones agree that NDZs should simply be used as one tool for improving water quality, rather than as a single solution to a large and complex issue. It is also important to note that an NDZ designation is not the end, but rather the beginning, of water quality improvement initiatives in a given region. An NDZ that does not house an adequate number of functioning, available pumpout services for its users is not likely to receive support. In areas where the boating community and an NDZ coexist successfully, there is adequate infrastructure in place that can support vessels of all sizes, a clear understanding by the boating and enforcement community of the rules and regulations in place, a desire to educate boaters first and penalize violators second, and strong communication between all community members and waterway users.