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Environmental and Community Health in South San Diego County: A Behavior Analysis of Recreational Ocean Users Along Imperial Beach, California

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Environmental and Community Health in South San Diego County:

A Behavior Analysis of Recreational Ocean Users Along Imperial Beach, California

by

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Dedication

This research was inspired by a trip to the Southern California coast, where I fell in love with the marriage of mountain, dessert, and shoreline. It is dedicated to all those in the Mexico/United States border region who find a piece of themselves along the Pacific Ocean and to the future generations of beachcombers who do not yet know the joy of the sand between their toes and the sound of waves crashing against the shore. It is dedicated to those who have no voice and to those who do, that they will speak up and play an active role in the preservation of this beautiful coastline.

Acknowledgements

A grand thank you is due to my advisor, Dr. Kamal Alsharif, for sticking with me and for his guidance and support. His patience and encouragement got me back on track when I was overwhelmed and kept me in the running when I was ready to give up. Without his understanding, I might not have completed this important work. I would also like to thank the rest of my advisor committee members, Dr. Connie Mizak and Dr. Jennifer Collins. Their guidance was crucial to ensuring this project was well-rounded and approached from multiple perspectives.

This study was conducted with assistance from Wildcoast, a non-profit that works on health and environmental issues across the borders of the U.S. and Mexico. Wildcoast contributed support in many areas, including supplying internal data from previous studies and surveys, providing contacts in the study site, and promoting the study using their contact lists and website. I would like to thank Paloma Aguirre, U.S.-Mexico Border Director at Wildcoast, for her guidance on identifying gaps in research along the Tijuana/San Diego coastal region and for helping get the online survey publicized. I want to thank Serge Dedina, Executive Director and Founder of Wildcoast/Costa Salvaje, for providing guidance and suggested readings towards this research project. Some unpublished beach closure data was provided by Keith Kezer, Program Coordinator of the Land and Water Quality Division at the San Diego County Department of Environmental Health.

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Abstract

Garbage & sewage runoff into the Pacific Ocean at the shoreline along the U.S./Mexico Border region poses serious health and environmental threats. The purpose of this study was to analyze the current beach users' behavioral factors that may be linked to illness prevalence from Coronado Island to the U.S./Mexico border at Imperial Beach in San Diego County. It is a continuation of a study completed by Wildcoast and Imperial Beach Clinin in 2011. The study tried to answer the following two major questions: How have the number of illnesses reported by users along South San Diego County beaches changed in the last 5 years? What relationships exist between reported illness and beach user behavior, if any? To accomplish this, a 2-page self-reporting survey was administered asking about demographics, beach recreation habits, illness and exposure information, and allowed for comments. Surveys were distributed to beach users along Imperial Beach northward to Coronado Island during May, June, and July of 2014. Quantitative as well as qualitative data were collected. The results show that the majority of respondents did not report suffering from an illness, however, for those who did report an illness, frequency of water entry, seasonality of water entry, entry during beach closures, and primary means of water contact were significantly correlated to illness prevalence.

Chapter 1: Introduction

Garbage and sewage contaminate the Pacific Ocean and beaches along the Mexico/U.S. Borders region, posing serious health and environmental threats. The Tijuana Watershed consistently has the lowest water quality index scores throughout Southern California, scoring a 14 out of 100 for bacteria, ammonia, phosphate, turbidity, and dissolved oxygen levels (Myers, 2016). The contamination stems from three main sources, including the Tijuana River, effluent from the San Antonio de los Buenos wastewater treatment plant, as well as urban runoff/storm water drainage (Gersberg, 2006). The San Antonio de Los Buenos treatment plant discharges up to 25 million gallons per day of secondary treated sewage directly into the Pacific shoreline just 9 kilometers from the international border in Mexico (IBWC, 2010). It has a connection to the South Bay International wastewater treatment plant, located in San Diego County, which secondarily treats peak daily flows to relieve pressure on the Mexican system (IBWC, 2010).

The rapid expansion of "maquilas", or factories, as well as unplanned housing developments that have been illegally and/or poorly constructed, has contributed to the ease which storms move sediment, metals, PCBs, nutrients, pesticides, and trash into the river (EPA, 2016). Contamination from these sources ends up in the Pacific Ocean near the shoreline and, depending on the ocean currents, which tend to shift northward during the summer, can impact beach water quality from Coronado Island in the U.S. down to Playas de Tijuana in Mexico (Wildcoast, 2013). The evidence for health concerns on the U.S. side of the border is overwhelming. Gastrointestinal and respiratory illnesses affect an estimated 1.4 million people in southern California each year from exposure to contaminated beach water (Brinks, 2008). While international pollution issues are a significant problem for the natural ecosystems, it is the recreational behaviors of beach users that make the threat real and imminent to public health because beach users may continue to enter the water when high levels of contaminants are present.

The purpose of this study was to analyze the current beach users' behavioral factors that may be linked to illness prevalence from Coronado Island to the U.S./Mexico border at Imperial Beach in San Diego County. This study is a continuation of research published in 2011 by Wildcoast and the Imperial Beach Clinic (Malvar & Diokno, 2011). The constructs and variables relevant to this study include beach user behavior and illness prevalence data. The independent variables are 1) frequency of water entry, 2) seasonality of water entry, 3) primary means of water contact, and 4) entry behavior during beach closures. Illness prevalence along the Imperial Beach shoreline is the dependent variable.

Overall objectives are:

- Report ocean water-related illnesses experienced by users along South San Diego County beaches.
- Evaluate any relationships between reported illness and beach user recreational behaviors.
- Identify any changes in reported illnesses from the 2011 Imperial Beach Clinic research and make assumptions about those changes, if any, as they may relate to risk communication efforts.

The research topic was chosen in response to research gaps as identified by Wildcoast, a nonprofit organization actively involved in coastal issues along the U.S./Mexico border. The main justification for this research is the high number of beach closures associated with a high frequency of contamination in Imperial Beach, California. This includes fecal contamination, Hepatitis A virus, polio and enteroviruses (IB Clinic, 2008). This area hosts many beach goers on a daily basis, including residents and visitors. Many beach users continue to enter the water during beach closures, which increases their exposure risk. The data collected will be an update to existing data from a similar survey conducted in 2011 by the San Diego County Health Department. This survey was part of the "Networking For Community Health Project 2008-2010", a collaboration between Wildcoast, San Diego State University and the Imperial Beach Health Center. In response to a high number of health reports pertaining to illnesses from contact with contaminated ocean water, the collaborative groups carried out a survey in 2011 aimed at identifying health risks of ocean users. The project examined how ocean water quality affected beach users by identifying health risks as well as attempted to treat associated illness, prevent a

portion of these illnesses through free Hepatitis A vaccines and educated the public about the health risks and safety issues regarding the polluted ocean water. The results established that beachgoers who stay out of the water during beach closures are exposed to a very low risk while those who go in the water throughout the year, including during beach closures, are at a very high chance of contracting an illness (IB Clinic, 2011). This research aims to provide updated information and draw links between the current and previous studies. Refer to Appendix A for detailed descriptions on beach advisories and closures as well as beach water quality standards.

Chapter 2: Study Area

The general study area lies within San Diego County and borders the metropolitan area of Tijuana, both very large coastal communities. San Ysidro serves as the port of entry between these two regions. It is "the busiest land port of entry in the Western hemisphere" and a "critical economic engine" for the region (GSA, 2012, para.3). Nearly 5 million people live in this shared region (KPBS, 2013).

The specific survey areas to be investigated in this study include Imperial Beach, California and the area beaches northward up to Coronado Island in San Diego County. This area encompasses approximately 15 kilometers of shoreline (Figure 1). Imperial Beach is the southernmost municipality in the state of California and the most southwesterly city in the continental United States with a current population just over 28,000. The Pacific Ocean borders the city's west coast with San Diego to the north and San Ysidro to the southeast. Border Field State Park, located within the Tijuana River National Estuarine Research, provides a sand dune and salt marsh barrier between Imperial Beach and the Mexican Border.

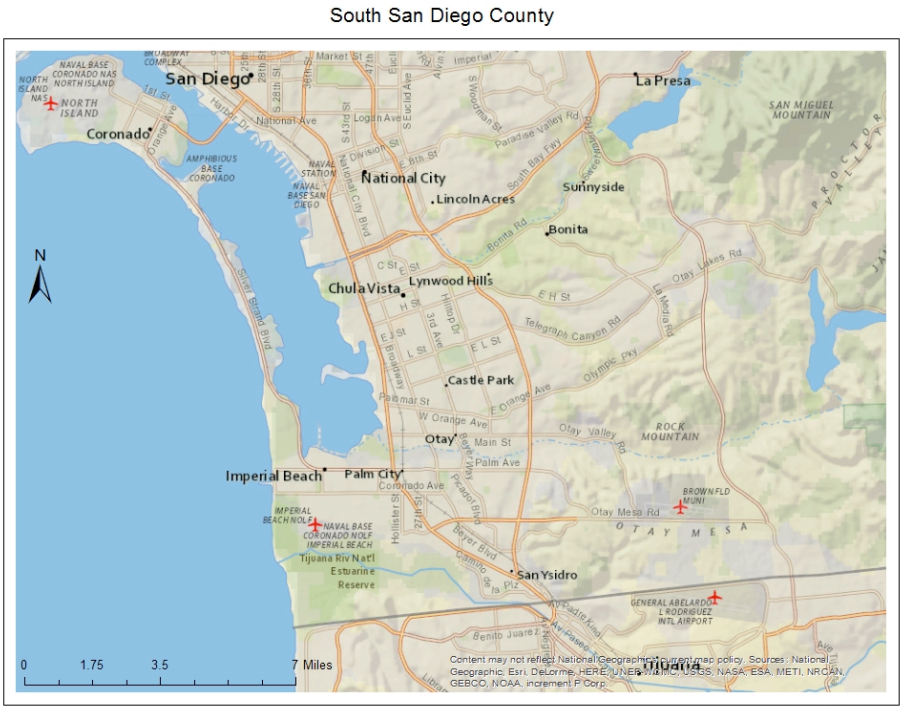

Figure 1: Map of Study Site Coastline

The study area, a 4500 square kilometer binational Tijuana River Watershed, is arid with less than 300 mm of precipitation annually (Das et al, 2010). The Tijuana River begins in Mexico and flows northward through several Mexican cities before it empties into the estuary in San Diego, where only one quarter of the drainage area exists; the remainder of the drainage lies in Mexico (Das et al, 2010). From the Pacific Ocean heading east, the north side of the border is an estuarine preserve with an agricultural community near San Ysidro. The south side of the border is highly urbanized all the way from the ocean to the border entry. The entire region is characterized by a high rate of urban and industrial growth.

The general climate of the area is similar to that of the Mediterranean and is constant nearly year round. High precipitation events occur during the winter months while summer tends to be dry with predictable winds along the Pacific shoreline. Approximately 90% of the precipitation falls from October through April, with the maximum monthly precipitation falling in January (Das et al, 2010). The proximity of the ocean curbs temperature extremes, resulting in mild winters and cool summers. El Niño plays a large role in rainfall variability and results in above normal rainfall during their 2-7 inter-annual events (Cavazos and Rivas, 2004).

Wide ranges of landscapes span the region, including seashore, ravines, foothills, mountains, various bodies of freshwater and an extensive tract of desert (Community Trails Program, n.d.). The topography of the region, especially directly near the border, is composed of precipitous, easily abradable terrain and the flow is down gradient from the higher altitude Mexican side to the U.S. side (Seamans, 1998). High precipitation events cause regular flooding and promote urban runoff.

Chapter 3: Literature Review

Environmental and health issues along the beaches of Southern California and Baja, Mexico, have been studied in the past, and the many of the published articles point to poor infrastructure as a main problem (Das et al, 2010; Liverman et al, 1999; Malvar and Diokno, 2011; Meehan, 2013). In the 1980's, the County of San Diego wanted to address the pollution issues along the U.S./Mexico border with a defensive U-Turn pipe that would redirect raw wastewater flowing into the country from Tijuana back to Mexico's wastewater system. Seaman (1998) highlights that the U-turn pipe solution was only exacerbating the problem because if the capacity of Tijuana's facilities were reached, the sewerage overflow would just eventually end up back in the ocean. Due to historical northward shift of ocean currents in the summer, the pollution would travel to the U.S. beaches. By 1999, the South Bay International Wastewater Treatment Plant was constructed just outside of the San Ysidro border crossing to treat sewage stemming from Tijuana and discharges the effluent with a 7 kilometer outfall pipe through the South Bay Ocean Outfall (IBWC, 2010). Mexico and the U.S. share operation and maintenance costs.

While the international treatment plant has been beneficial, poor water quality still plaques the border's coastal beaches. Much of the literature addresses precipitation and storm events as they affect urban runoff patterns and public health related to climate change. A study of Southern California beaches evaluated levels of indicator bacteria in correlation with precipitation events and the results suggest that urban runoff through river discharge is a primary source for coastal water pollution, with bacterial levels peaking with high rainfalls levels (Dwight et al, 2002). Dwight et al. (2002) also suggest that climate change might cause more urban runoff through higher levels of river discharge, posing serious health threats to recreational beach users. Their research was backed up by another similar study conducted by Noble et al., in 2003 along the southern California shoreline. They tested water quality in 254 shoreline sites roughly 36 hours after a storm presented in Southern California and down to Ensenada, Mexico. Similar results appeared in Mexico and the U.S., with 60% of the sample sites failing U.S. water quality standards after the storm. These results were compared to dry weather testing, which

showed only 6% failed water quality standards during this period, and indicate that precipitation events play a major role in poor beach water quality. In addition, they highlight that water quality standards were considered failing at over 90% of sample sites that were directly adjacent to urban runoff outlets. In a follow up study, Dwight et al. (2011) linked precipitation events with water quality and compared the data to urban development in each associated watershed in Southern California. The results indicated that in highly developed watersheds, precipitation produced higher levels of bacterial concentrations in recreational waters as compared to watersheds with less urban development. Dwight et al. (2011) note a very important detail: urban runoff is not a source of pollution, it is merely a transporter of dissolved, suspended and solid contaminants that are already present within storm drains, riverbeds and other conveyance systems, ultimately winding up on beaches. This study pinpointed a serious issue with regards to the highly urbanized and continuously developing Tijuana region. However, compared to the similar 2002 study conducted by Dwight et al. (2002) the authors forecasted a decline in winter precipitation due to changing climate patterns in the area and suggest this could mean less recreational water contamination for the coastline, hopefully decreasing the associated public health risks.

There exists a wealth of literature measuring water quality for bacteriological and viral indicators in beaches, especially in the waters off the coast of Southern California. Two studies are worth mentioning here. In the first, published in 2001, Jiang, Noble & Chu are interested in showing that the use of bacterial indicators to predict virological water quality is insufficient. Samples were taken at 12 sites from Malibu, California to the Mexican border. The most important finding was that the Tijuana River sample had the highest coliphage concentration with a relatively low adenovirus concentration, implying that the present water quality standards for recreational marine waters are not appropriate to reveal viral water quality (Jiang et al, 2011). The second study focuses on a shoreline assessment of bacteriological water quality on the Mexico side from Tijuana to Ensenada. The authors Orozco-Borbòn, Rico-Mora, Weisberg, Noble, Dorsey, Leecaster & McGee collected water samples from 29 shoreline sites that included beaches and outfalls (2006). The results indicate that only 7 of the sites are safe for recreation during both winter and summer. The remaining 22 sites pose significant health risks due to exceeded water quality standards. The authors attribute this to the effluent from the Tijuana and Ensenada wastewater treatment facilities.

Dwight and Fleisher are authorities within the body of knowledge on illnesses associated with recreational marine activities (Dwight, 2004, 2007, 2011; Fleisher, 2006, 1998, 1996). The first published studies within this field of literature appeared in the 1950's but have remained few. Working off the previous 11 major studies, Fleisher, Kay, Salmon, Jones, Wyer and Godfree (1996) established dose-response relationships among beach users recreating in marine water contaminated with sewage in the United Kingdom. The dose-response relationship links exposure of those entering the water to heightened levels of fecal streptococci and an elevated risk of contracting acute febrile respiratory illness. The dose- response relationship also links high levels of fecal coliform with contracted ear ailments. The results reveal that anywhere from 34.4% for gastroenteritis to 65.8% for ear ailments, of reported illnesses are the consequence of swimming in sewage-contaminated marine waters, indicating a large burden of illness within the study group. It is important to note that the marine waters used for the study met the current U.S. EPA water criteria standards, backing up the work of Jiang et al. (2011) and emphasizing a need for new water quality criteria.

Dwight, Baker, Semenza and Olson (2004) studied the health effects associated with recreational coastal water use with specific focus on comparisons between surfers recreating in waters connected to urban and rural watersheds separately. The surveys collected self-reported data from the participants with regards to health symptoms typically associated with waterborne illness from recreational water exposure as experienced over a previous 3-month time frame. The authors support including variables on political outlook and level of concern about water quality as a restraint for reporting biases due to differing perspectives about health effects of environmental contamination and water quality. The results showed the risk increased by 10% for every 2.5 hours of weekly water exposure, and that nearly double the symptoms were reported in the urban watershed group during the 1998 El Niño winter period. These results hold that precipitation events and urban development play a very significant role in urban runoff that contaminates beaches, ultimately posing grave public health risks. This is exemplified during the wet season in San Diego where ocean water at the mouth of the Tijuana River outlet is highly contaminated (IB Clinic, 2011). Another study by Turbow, Kent, and Jiang (2007) analyzed a web-based survey that assessed demographic and self-reported illness information of surfers over a 10-year period. The results indicate a strong direct relationship between poor water quality and illness reports (Turbow, et al, 2007).

Exposure and dose-response relationships vary with various types of recreational activities. Risk of pathogen ingestion is significantly greater in surfers than swimmers, and greater in swimmers than waders (Balarajan, et al, 1991). The World Health Organization cites that the use of wet suits, in activities such as surfing, promote extended immersion in water, thereby increasing exposure (Pond, 2005). Due to the extended length of exposure as well as the nature of full-body exposure, surfers may ingest up to ten times more water than swimmers, greatly increasing their risk of pathogen ingestion (Stone, et al, 2008).

Risk communication theory provides a practical theoretical framework for considering elements that impact risk awareness and of an individual or population. Risk communication theorists hold that chosen risk is a wanted risk because the individual or group believes the expected benefits are greater than the expected risks, and that they can remove themselves from the risk at any point (Schmidt, 2004). In specific regards to risk communication in water recreation, multiple studies argue that risk perception is rooted in personally observable experiences (poor smell, visible trash or unusual water color) instead of actual water quality data (Martin and Pendelton, n.d.; Jensen and McClelland, 2005; Hous, 1996). Additionally, actual and/or perceived illness prevalence may be influenced by media coverage regarding water quality (EPA, 2011).

Since the 2011 IB Clinic survey results were concluded, there have been ongoing efforts to remediate the environmental damage and raise public awareness. Countywide programs led by the IB Clinic and the San Diego Health Department offering free Hepatitis A vaccinations have been highly publicized. Wildcoast, the Imperial Beach Health Department, and the San Diego County Department of Environmental Health, along with other local groups, have implemented several outreach strategies. These include the “Sick from the Surf” initiative and the “No Border Sewage” campaign to heighten public awareness about the risks involved with recreating in contaminated water (Gill, 2009; Wildcoast, 2013). Wildcoast and the Surfrider Foundation have mobilized thousands of volunteers to remove ocean-bound trash from the Tijuana River watershed and have trained over 500 local clean water advocates (Wildcoast, 2016; San Diego Coast Keeper, nd). The initiatives have been aided by media coverage from Fox 5 News, the San Diego Union Tribune, and other news outlets.

Chapter 4: Methodology

4.1 Survey Form

In the fall of 1997, an Ocean Illness Survey was designed by the San Diego County Department of Health and distributed along the San Diego Coast (County of San Diego, 2000). Wildcoast conducted a similar survey in Imperial Beach in 2011. The 2014 Ocean Illness Survey was derived from the previous surveys for consistency and comparison. Based on recommendations reported in the 1997 survey results, this study's survey includes more detailed information on respondent usage patterns. It consists of a 2-page form that gave respondents the opportunity to provide several types of information. Comment fields were included to clarify information provided on the forms. The surveys were available in English and Spanish (see appendices), were self-administered, and took under 10 minutes to complete. An identical online survey was also designed using Qualtrics Survey Software (Utah, 2014). The study was approved by the IRB at USF for both behavioral observations and experimentation as well as surveys and questionnaires/psychometric testing (IRB Protocol #Pro00012014). The application listed respondent comments as an intended source of data. The types of questions asked included demographics (age, gender, race), beach recreation habits, illness description, exposure information, diagnosis and treatment information, and additional comments.

Symptoms specifically associated with waterborne illness were listed with checkboxes as follows:

- Respiratory/Sinus Problems
- Sore Throat/Swollen Glands
- Eye/Ear Infections
- Diarrhea
- Headaches/Fever
- Skin Irritation

4.2 Survey Distribution

Because the research was focused in one specific geographic region, the sample area was small and respondents were identified by their direct presence within the impacted location. Survey forms were distributed to beach users along Imperial Beach northward to Coronado

Island during May, June and July of 2014. Based on a recommendation in the 1997 survey results, this survey was distributed in a manner to focus on a broad cross section of recreational users. Selection of respondents was via a voluntary, convenience sample. Every adult day user or group of users over the age of 18 who were visibly present on the beach or in the water during a two hour survey period were asked to participate using the hardcopy version of the survey. To account for various types of beach users, surveys were collected on various days of the week, as to include surveying at least 3 days per week and to include a minimum of 1 weekday (Monday through Friday) and 1 weekend day (Saturday and Sunday) each week. Surveying was also completed at various times of the day, from early morning until sunset, as different types of users (surfers, fisherman, sunbathers, etc) utilize the water at different times. Links to the online survey were made available on the Wildcoast website and printed on cards that were handed out to beach goers who may have wanted to complete the survey at a later time.

4.3 Analysis of Results

Data analysis was completed using IBM SPSS statistical analysis of existing data sets, creation of new data sets based on survey answers, and visual interpretation of graphs created from survey answer data sets. Survey responses were logged into an Excel spreadsheet and categorized by responses. Informal analysis of relevant documents obtained from trusted Internet sources, news releases and community health reports aided in providing background materials in which to frame the survey results. Quantitative analysis included the creation of cross tabulations to demonstrate bivariate relationships. The Spearman's rho correlation coefficient test, a nonparametric measure of statistical dependence between two variables, was implemented to analyze correlations between the indicator questions and identify significance of relationships.

Chapter 5: Results

Results presented in this section are from a total of 153 surveys collected during the period of May 23rd, 2014 to July 23rd, 2014. Fifty four surveys were completed online and 99 completed in-person. Initially, 160 surveys were collected. The results exclude 2 surveys because an illness was reported outside of the survey area, 3 surveys because a reported illness was not within the time frame of "the past year" (anything reported before May of 2013 was excluded), and 2 surveys were excluded because the respondents were under the age of 18.

5.1 Demographic Characteristics

Demographic data was collected from survey respondents to measure if the data sample was representative of the population distribution in Imperial Beach. Demographic data for Imperial Beach was taken from 2010 U.S. Census Data published by the U.S. Census Bureau. The majority of survey respondents are identified as White/Caucasian (52%) and Hispanic/Latino (31%), (see figure 2). This is a close representation of 2010 U.S. Census Bureau data describing the Imperial Beach population as 62% White/Caucasian and 49% Hispanic/Latino. Respondents were 44% male and 54% female (2% chose not to answer), just slightly off from the 2010 U.S. Census Bureau data describing the population of Imperial Beach as equally 50% male and 50% female. Figure 3 below shows the majority of responses came uniformly from men and women in the 30-35 year range. Respondents were mostly full time residents of the study area (90.8%). However, a few respondents were part-time residents (4.6%) and tourists (2.6%).

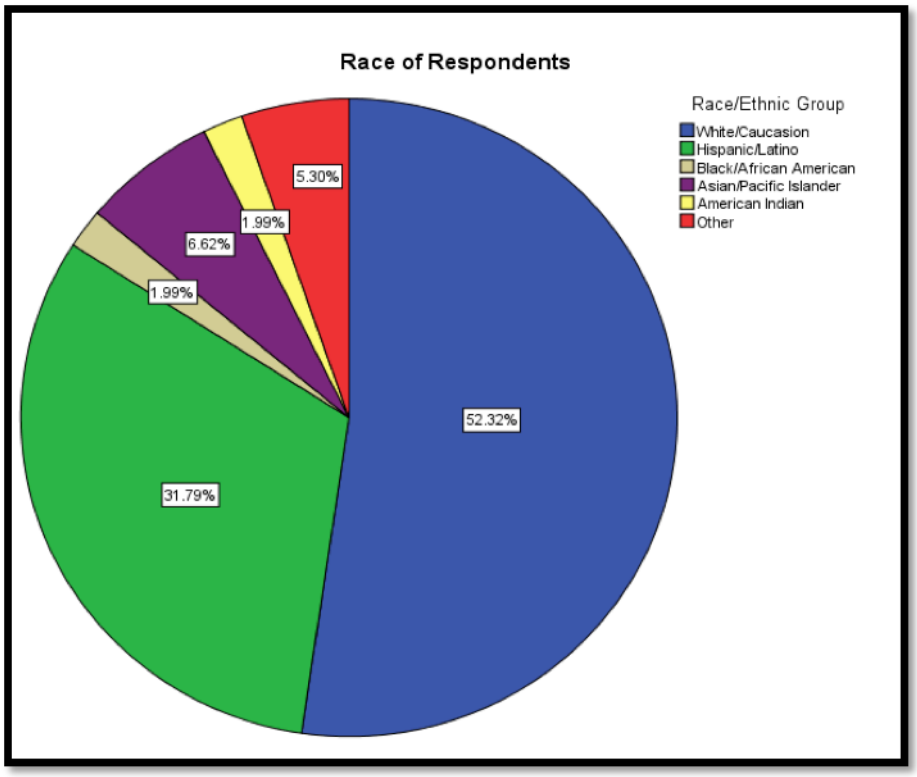

Figure 2: Race of Respondents

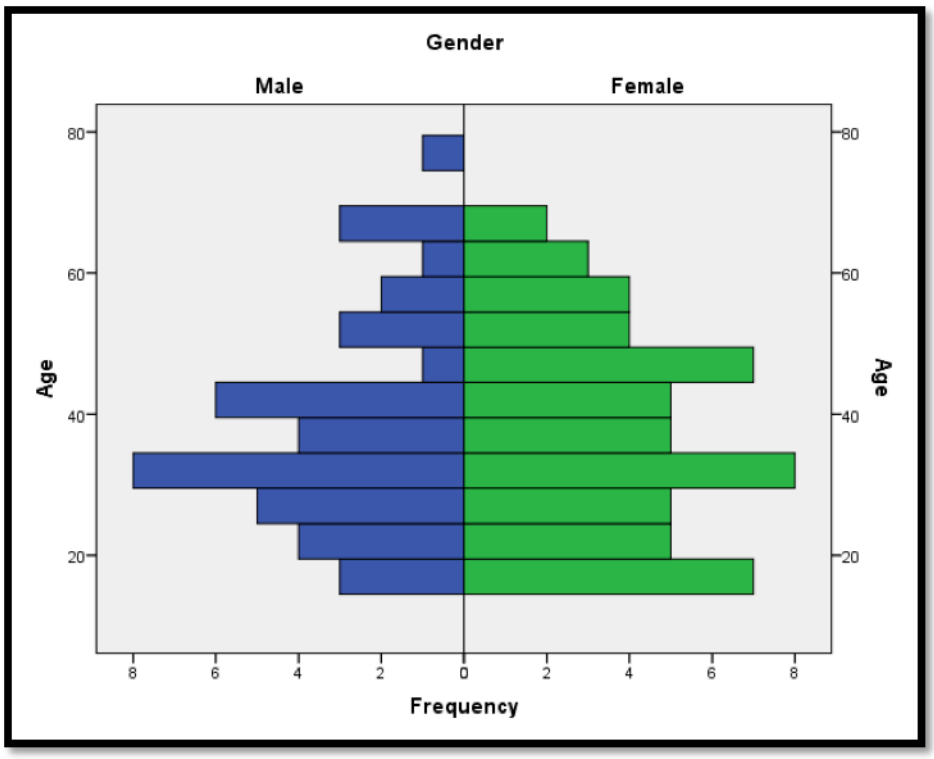

Figure 3: Histogram of Gender and Age

5.2 Contracted Illness Responses

Seventeen respondents, or 11.11%, reported contracting an illness they believed was related to ocean water contact in San Diego County in the past year (Table 1). One hundred and twenty five people, or 81.7%, of respondents reported they did not contract any illness they believed was related to ocean water contact. Five respondents, 3.3%, left the question blank but wrote in that they were unsure and 6 respondents, or 3.9%, did not mark a response. Nine of those reporting an illness also reported not visiting a doctor while 2 reported visiting a doctor. With respect to age, race, or gender, no significant difference was found between demographic data and illness response.

Table 1: Contracted Illness Response

Respondents' reports regarding contracting illness due to ocean water contact in the last year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	11.1	11.1	11.1
	No	125	81.7	81.7	92.8
	Unsure	5	3.3	3.3	96.1
	No Response	6	3.9	3.9	100.0
	Total	153	100.0	100.0	

5.3 Illness Characteristics and Reported Symptoms

From the 17 respondents who reported contracting an illness, the two most reported symptoms were respiratory/sinus problems (47%) and upset stomach (35%) (Table 2). Respondents were able to report more than one symptom.

Table 2: Reported symptoms

Symptom	Number of Respondents Reporting Symptoms	% of Total Respondents
Respiratory/Sinus	8	47
Diarrhea	4	24
Vomiting	1	6
Upset Stomach	6	35
Fever	4	24
Eye Discharge/Pink Eye/Etc	1	6
Fatigue or Excessive Tiredness	5	29
Sore Throat/Swollen Glands	4	24
Headache	3	18
Ear Discharge/Ear Pressure/Etc	3	18
Skin Irritation or Rash	1	6

The following indicator questions from the survey were focused on identifying exposure risks. These questions were cross tabulated with the responses from the question "In the past year, have you contracted any illness that you believe to be related to ocean water contact in San Diego County?"

1) On average, how often do you go into the water?

2) What times of the year are you typically in the water?

3) What is your primary means of water contact?

4) If the beach is closed due to contamination, do you stay out of the water?

5.4 Water Entry Frequency

The scale of water entry frequency was as follows:

- Infrequently: Less than twice per year
- Occasionally: Once every 1-6 months
- Moderately: 1-2 times per month
- Frequently: 2-4 times per month
- Very Frequently: Once per week
- Routinely: More than once per week

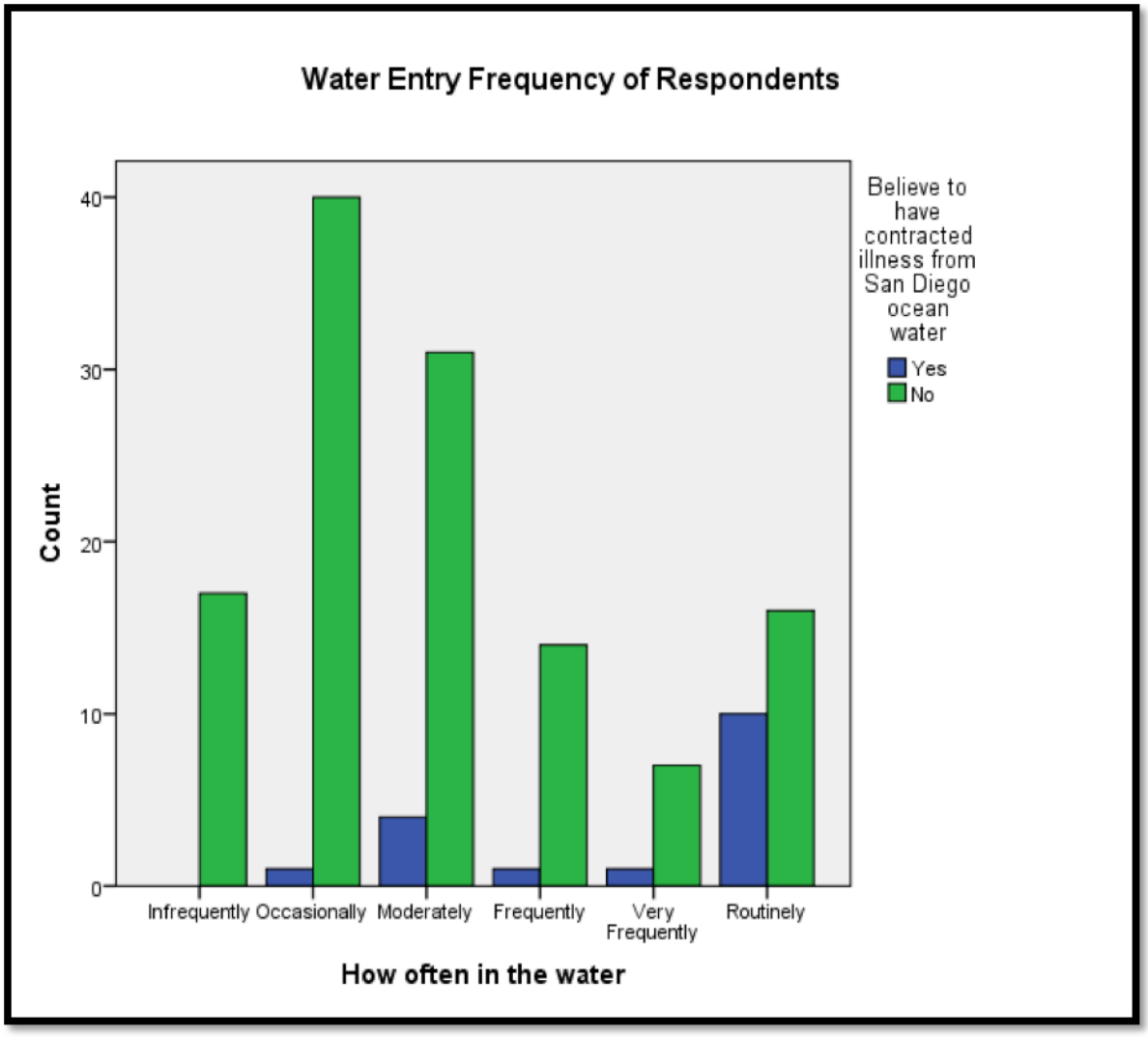

Figure 4: Water Entry Frequency

Over half of the respondents (59.1%) reported going in the water one to two times per month or more (Figure 4). Of the 17 respondents who reported having contracted an illness, ten (58.8%) reported entering the water routinely (more than once per week). Sixteen out of 17 respondents (94%) went into the water moderately or more. The Spearman's rho analysis shows a weak negative relationship (-0.344) between water entry frequency and reported illness that is statistically significant (p=<.01)(see Table 3)

Table 3: Correlation Illness vs. Water Entry Frequency

			Believe to have contracted illness from San Diego ocean water	How often in the water
Spearman's rho	Believe to have contracted illness from San Diego ocean water	Correlation Coefficient	1.000	-.344**
		Sig. (2-tailed)	.	.000
		N	142	142
	How often in the water	Correlation Coefficient	-.344**	1.000
		Sig. (2-tailed)	.000	.
		N	142	151

****. Correlation is significant at the 0.01 level (2-tailed).**

5.5 Seasonal Water Entry Habits

Of those who responded "no" to having contracted an illness, nearly half go in the water year round (49.6%) and half go in during the summer only (49.6%), while one respondent indicated going in during winter only (Figure 5). Of those who responded "yes" to having contracted an illness, 94.1% go in the water year round, while only 5.9% go in the water during summer only. The Spearman's rho analysis shows a weak positive relationship (0.291) between time of year typically in the water and reported illness that is statistically significant ($p<0.01$) (see Table 4)

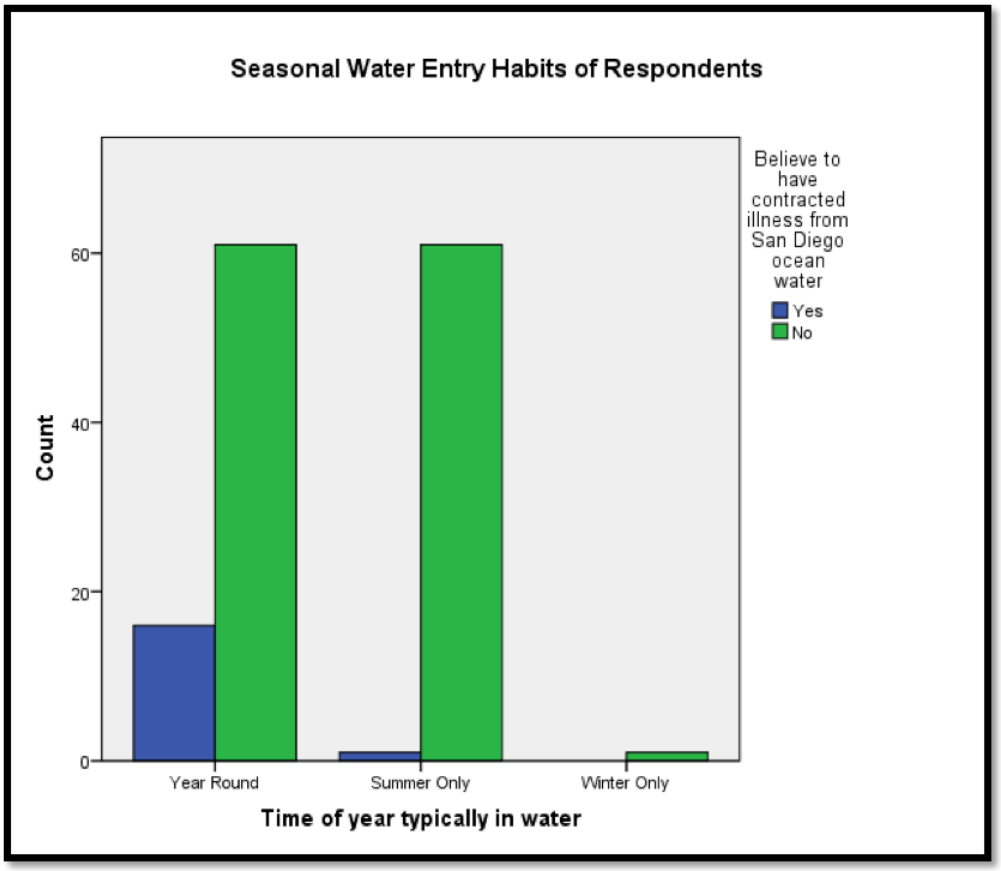

Figure 5: Seasonal Water Entry Habits

Table 4: Correlation Illness vs. Seasonal Water Entry

			Believe to have contracted illness from San Diego ocean water	Time of year typically in water
Spearman's rho	Believe to have contracted illness from San Diego ocean water	Correlation Coefficient	1.000	.291**
		Sig. (2-tailed)	.	.000
		N	142	140
	Time of year typically in water	Correlation Coefficient	.291**	1.000
		Sig. (2-tailed)	.000	.
		N	140	148

**. Correlation is significant at the 0.01 level (2-tailed).

5.6 Primary Means of Water Contact

The primary means of water contact for the majority of the respondents who did not contract an illness was swimming (43.1%) while the primary means of water contact for the majority of respondents who did contract an illness was surfing (70.6%), (Figure 6). Although the group that did not report contracting an illness responded with primary water contact across all recreational types, the group that did contract illness from ocean water only reported swimming, surfing, and mixed uses as a primary water contact. The Spearman's rho analysis shows a weak positive relationship (.289) between primary means of water contact and reported illness that is statistically significant (p=0.01) (see Table 5).

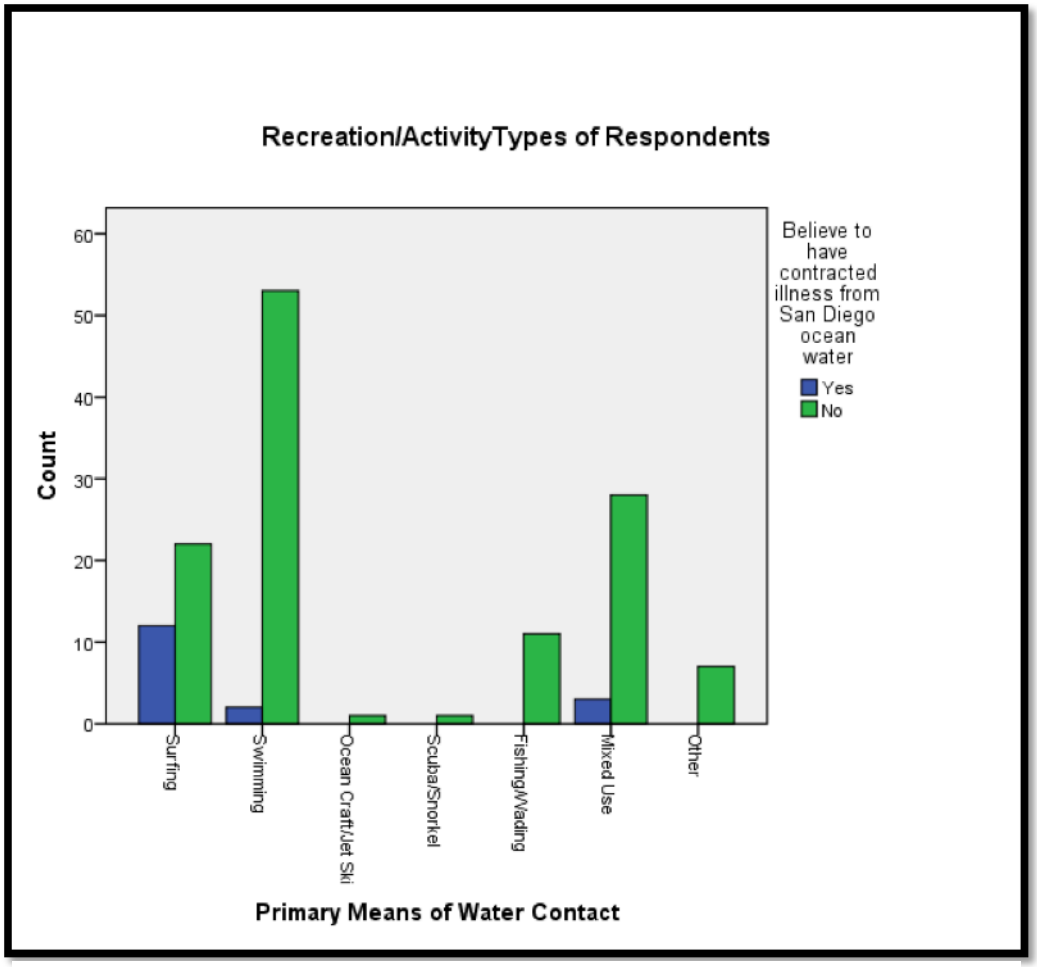

Figure 6: Recreation Types

Table 5: Correlation Illness vs. Primary Means Water Contact

			Believe to have contracted illness from San Diego ocean water	Primary Means of Water Contact
Spearman's rho	Believe to have contracted illness from San Diego ocean water	Correlation Coefficient	1.000	.289**
		Sig. (2-tailed)	.	.001
		N	142	140
	Primary Means of Water Contact	Correlation Coefficient	.289**	1.000
		Sig. (2-tailed)	.001	.
		N	140	149

****. Correlation is significant at the 0.01 level (2-tailed).**

5.7 Water Entry Habits During Beach Closures

The majority of respondents, 80%, reported staying out of the water when the beach is closed due to contamination (Figure 7). 13% of respondents said they ignore beach closure warnings, and 3.9% reported never having seen or heard about beach closures in the areas they visit. Of those that reported contracting an illness, 5 respondents (29%) also reported they ignore beach closure warnings and enter the water during contamination events. Because the crosstab data was not monotonic, a Spearman's rho correlation analysis was not performed. Refer to Table 6 below for descriptive statistics.

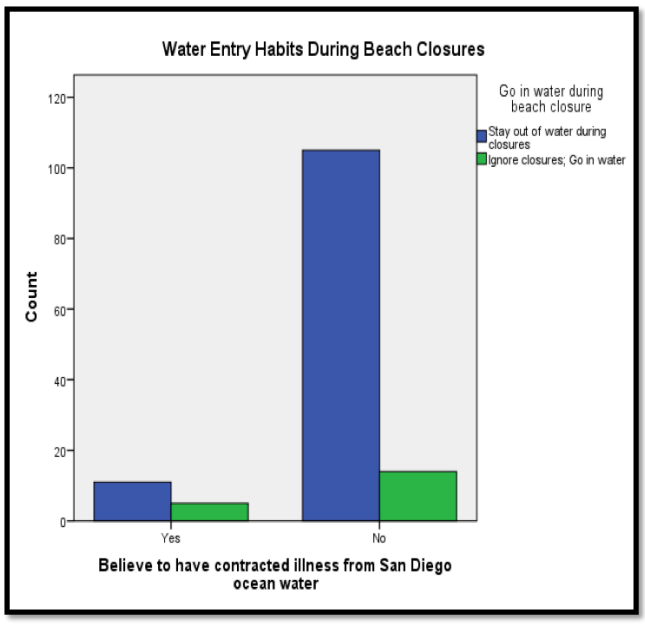

Figure 7: Water Entry Habits During Beach Closures

Table 6: Crosstab Illness vs. Water Entry Habits

Believe to have contracted illness from San Diego ocean water * Go in water during beach closure Crosstabulation

			Go in water during beach closure			
			Stay out of water during closures	Ignore closures; Go in water	Never heard of closures	Total
Believe to have contracted illness from San Diego ocean water	Yes	Count	11	5	0	16
		% within Go in water during beach closure	9.5%	26.3%	0.0%	11.3%
	No	Count	105	14	6	125
		% within Go in water during beach closure	90.5%	73.7%	100.0%	88.7%
Total		Count	116	19	6	141
		% within Go in water during beach closure	100.0%	100.0%	100.0%	100.0%

Chapter 6: Discussion

This research tested the research questions that illness associated with recreational ocean use in the Imperial Beach area is significantly correlated with exposure to ocean water. The question was tested by exploring the relationships between reported illness and the following beach user behaviors: 1) frequency of water entry, 2) seasonality of water entry, 3) primary means of water contact, 4) entry during beach closures. In addition, one of the primary research questions was how the number of illnesses reported by users along South San Diego County beaches and the behaviors of those users changed in the last 5 years. To answer this question, results from this survey were compared to the results from the 2011 survey by the IB Clinic (Table 7).

Table 7: Results of 2011 IB Survey and 2014 Brophy Survey

		2011 IB Survey		2014 Survey	
# Survey Respondents Total		256		153	
# of Respondents Reporting:		Illness	No Illness	Illness	No Illness
		84	166	17	125
% of Respondents Reporting:		35%	65%	11%	82%
Top Symptoms Reported	Respiratory/Sinus	no exact data given		47% of respondents with illness	
	Upset Stomach	no exact data given		35% of respondents with illness	
Frequency of Water Entry		Illness	All Respondents	Illness	All Respondents
	More than once/week	nd	44%	59%	18%
	Once/week	nd	15%	6%	6%
	2-4 times/month	nd	13%	5%	11%
	1-2 times/month	nd	7%	24%	25%
	2-12 times/year	nd	13%	6%	28%
	Less than twice/year	nd	7%	0%	12%
# Reported cases by season of ocean contact		Illness	No Illness	Illness	No Illness
	Year Round	90%	65%	94%	50%
	Summer Only	14%	31%	6%	50%
# Reported cases by type of activity		Illness	All Respondents	Illness	All Respondents
	Surfing	43%	37%	71%	24%
	Mixed Use	42%	33%	18%	22%
	Swimming	11%	22%	12%	39%
% of days that the survey area beaches were closed during the survey period		33%		55%	

Of the 153 surveys included in the analysis of the results, 17 respondents, or 11.11%, reported contracting an illness they believed was related to ocean water contact in San Diego County in the past year. 125, or 81.7%, of respondents reported they did not contract any illness they believed was related to ocean water contact. Although there was not a third option, 6 respondents filling out the in-person survey did not check either "yes" or "no" but instead wrote in that they were "unsure". Nine of the respondents reported not seeing a doctor regarding their illness while 2 respondents did seek medical attention. It is important to note that for the respondents who reported an illness but did not visit a doctor as well as those who said they were unsure about contracting an illness (it is assumed since they are unsure, they did not seek a doctor regarding their illness), are self-diagnosing. In a similar study by Dwight, Baker, Semenza and Olson (2004), the authors included an assessment of political outlook and level of concern about water quality as a restraint for reporting biases due to differing perspectives about health effects of environmental contamination and water quality. The set of respondents who self-diagnosed their illness might be susceptible to bias based off of a heightened awareness of the poor water quality in the study area.

The main symptoms reported were respiratory/sinus problems (47%) and upset stomach (35%). Although no dose-response relationship test was carried out in this study, the symptom results are in alignment with prior research linking gastrointestinal and respiratory illness with contaminated water exposure (Brinks, 2008; Fleisher et al. 1996). Similar symptoms were reported in the 2011 IB Clinic study, with the main symptoms including coughing, diarrhea, and fever (Malvar and Diokno, 2011).

6.1 Water Entry Frequency

The Spearman's rho analysis shows a correlation coefficient of (-0.344) between water entry frequency and reported illness. This weak negative relationship indicates that as the frequency of water entry decreases, the "no illness" response increases. The correlation between water entry frequency and reported illness was found to be statistically significant, $r(142) = -0.344$, $p<0.01$, two-tailed. Additionally, the largest percentage of respondents who reported an illness also reported routine (more than once a week) ocean water entry. These results are in alignment with, and support the findings of the 2011 IB Clinic survey, which found that the

highest proportion of respondents who reported an illness also reported water contact at least weekly (Malavar & Diokno, 2011).

Water entry frequency is an important indicator of exposure because of the frequency of beach closures in the study area. During the survey period, the beaches were closed 55% of the days. Previous studies have documented that risk from contaminated ocean water contact increases by 10% for every 2.5 hours of weekly water exposure (Dwight et al, 2004). So, as frequency of water entry increases, the likelihood that a beach user will be in the water during a contamination event also increases. See section 6.5 for more details on beach closure events.

6.2 Seasonal Water Entry Habits

Of those who responded "no" to having contracted an illness, nearly half go in the water year round (49.6%) and half go in during the summer only (49.6%), while 94.1% of those who responded "yes" to having contracted an illness go in the water year round. The correlation between seasonality of water entry and reported illness was found to be statistically significant, $r(142)= +.291$, $p<0.01$, two-tailed. This weak positive relationship expresses that illness increases with increasing seasonal use. These results are in alignment with, and support the findings of the 2011 IB Clinic survey, which found a "significant relationship between seasonality of ocean use and reported illness" (Malavar & Diokno, 2011, p. 14).

The importance of year-round or winter water entry is based on the fact that the majority of beach closures in the Imperial Beach area occur during winter, due to rainfall-associated runoff (Malavar & Diokno, 2011). High precipitation events occur during the winter months while summer tends to be dry with predictable winds along the Pacific shoreline. Approximately 90% of the precipitation falls from October through April, with the maximum monthly precipitation falling in January (Das et al. 2010). The best surf also occurs in the winter months, with larger, more consistent swells from the west and northwest (Wallis, 2008). The US Ocean Safety group attributes the large swells to the annual storms produced in Siberia that move over the Pacific Ocean eastward to the California coast (2007). The group warns the storms peak in winter months of December, January, and February, and can produce exceptionally strong swells up to 5 meters (US Ocean Safety, 2007). These swells attract surfers to enter the water during the cold winter months. Based on the Oceanic Niño Index, a moderate La Nina event (1.0 to 1.4 SST anomaly) occurred during the 2007-2008 survey period of the 2011 IB Clinic Study. No El Niño

Southern Oscillation event was recorded for the 2013-2014 survey period. (Null, 2016). The results of this survey should not be affected by an ENSO event, as one did not occur.

6.3 Primary Means of Water Contact

The primary means of water contact for the majority of the respondents who did not contract an illness was swimming (43.1%) while the primary means of water contact for the majority of respondents who did contract an illness was surfing (70.6%). Swimming (39.3%), surfing (24.3%), and mixed-use (22.1%) were the primary means of water contact for both groups (illness vs. no illness). The results of this survey are near those of the 2011 IB Clinic survey, which indicated surfing as the primary means of water contact (37%), along with mixed use (33%), and swimming (22%) (Malavar & Diokno, 2011). The two surveys are slightly different, possibly due to: 1) the 2011 IB Clinic survey targeted primarily surfers, and/or 2) this survey collected responses during the summer, when surfers are less likely to be surfing.

The Spearman's rho analysis shows a correlation coefficient of (0.289) between primary means of water contact and reported illness. This weak positive relationship expresses that illness increases with recreation types that increase full-body water exposure. The correlation is statistically significant (p=0.01). These results are in alignment, with and support the findings of the 2011 IB Clinic survey, which found the highest proportions of respondents who reported an illness were those who mainly surfed or had mixed uses of ocean water (Malavar & Diokno, 2011). Surfers are the most at-risk group because they tend to go in the water more often than other beach users (Leeworthy and Wiley, 2001), have full body immersion with every water entry (Dwight, et al, 2007), and ingest more water than any other recreational ocean user group (Stone, et al, 2008).

6.4 Water Entry Habits During Beach Closures

The majority of respondents reported staying out of the water when the beach is closed due to contamination. While the sample size was not large enough to make any significant correlations, a possible relationship may exist between those that ignore beach closures and those that reported an illness. Of those who reported contracting an illness, 5 respondents (29%) also reported that they ignore beach closure warnings and enter the water during contamination

events. From all respondents, 13% said they ignore beach closure warnings and another 3.9% reported never having seen or heard about beach closures in the areas they visit. While this is only a small portion of the sample, it may indicate that there is not enough education, publicity, and awareness about contaminated ocean water and beach closures. The San Diego County Department of Environmental Health posts beach water quality statuses online at sdbeachinfo.com. They share this info with the San Diego Coastkeeper organization, which also posts this data on their website, www.sdcoastkeeper.org. Wildcoast, a local non-profit environmental organization, posts news alerts to their website and social media accounts during beach closure events. Local news channel CBS8 mentions closures during their regular televise news reports. In addition to online notices, warning beach closure signs are posted and maintained by the County until the water quality data reaches safe measurements.

It is important to note that since this could be considered a sensitive or embarrassing question by some respondents, it is possible that misreporting occurred. Tourangeau and Yan (2007) suggest that respondents may avoid answering truthfully to avoid embarrassing themselves. Some research shows that accuracy of sensitive questions may improve as privacy and confidentiality increase (WestEd, 2010). Delivery modes have been shown to play an important role in increasing privacy and confidentiality, with self-administered questionnaires and web-based surveys significantly reducing reporting bias (Langhaug, et al, 2010). Because the two options for this survey were self-administered or web-based, the likelihood of reporting bias is low.

Daily beach closures accounted for a minimum of 30% of days in the year over a seven-year period (Figure 8). The total combined closure days for years 2013 and 2014 were 398, or 55% of the days. Most of the beach closures in the study area are related to sewage flow in the Tijuana River. “The minimum closure extent associated with Tijuana River flow includes the shoreline from the International Border to the south end of Seacoast Drive in Imperial Beach, approximately 2.26 miles.” (County of San Diego, 2015, para. 5). The recall time frame for survey respondents was “one year” and only surveys reporting an illness beginning May of 2013 were included in the analysis. During the survey period, the beaches were closed 55% of the days. The “entry during beach closures” questions was an additional data point that was not

included in the 2011 IB Clinic survey, so there is no opportunity for comparison. However, during the recall period for the 2011 IB Clinic survey, the beaches were closed 36% of the time and there were 84 reports of illness (33% of the sample).

The percentage of reported illness in the 2011 IB Clinic Study was 32.8%. During the recall and survey period (2008 and 2009), there were a total 265 beach closure days in the study area. In this study's survey, only 11% of the respondents reported an illness but the beach closures days for the recall and survey period (2013 and 2014) were much higher, reaching a total 398 beach closures. This could indicate that while the beaches were under contamination closures 55% of the time, more beach users stayed out of the water, thereby avoiding ocean water-related illness.

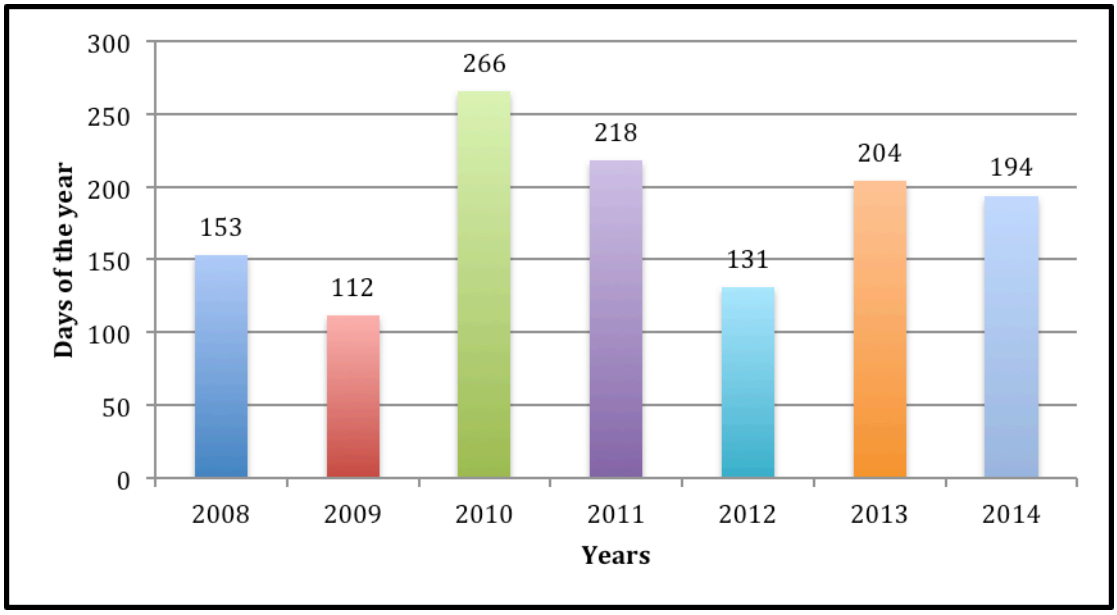

Figure 8: Tijuana River Related Beach Day Closures (Source: County of San Diego, 2015)

6.5 Additional Comments From Survey Respondents

The qualitative data collected from conversations with in-person survey respondents as well as from the "additional comments" section (Table 8) on both survey types suggests that some beach users have a heightened awareness of water pollution issues and take caution in their recreational choices while others exhibit apathy towards the issues and are negligent in obeying health warnings and beach closures. In an epidemiologic study of recreational water associated illnesses, Fleisher and Kay (2006) found that bathers who had predetermined convictions about exposure-related health risks were 10.3 times more likely to report skin ailments, relative to unexposed bathers, than those without any preconceived notions. The results of that study

suggest that risk perception bias can be compelling enough to prompt false relationships in the presence of self-reported symptoms (Fleisher and Kay, 2006).

Table 8: Additional Comments of Survey Respondents

1. Apple Cider Vinegar shots after surfing work well as a preventative measure when one accidentally swallows water. Also, on beach LESS due to the condition of the sand since beach replenishment
2. I have had many similar episodes over the years, primarily, I feel, due to water contact even when the beach was open.
3. I once got a rash from being in the water but it went away after a couple of days
4. We can usually tell when we aren't able to enter the water. It sometimes has an odor or is dark in color. But I also read the paper and read the signs when they are placed.
5. The government should produce a survey like this and actually do something about how contaminated the water is down here! / Thank you for producing this survey. I hope I helped. Please spread the word on how gross this water really is!
6. Got zapped by a stingray a few years ago
7. I have chronic sinus infections when I surf regularly, but they stop when I'm out of the water for any extended period.
8. I wade in the water, not fully submerged
9. I don't go in. Water is dirty and smells. I have friends that have gone in the water and have gotten real sick, Hepatitis and skin infections.
10. Mexico should do their share and help keep our waters clean
11. I hardly ever get into the water here in San Diego because it's too cold!
12. Scared to get in anytime, even without closures
13. Control the Otay Mesa (Tijuana) River where the pollution starts
14. If waves are good, I go surf.
15. I have had sinus issues after swimming at Imperial Beach in past years
16. I go in less now because of stingrays
17. Summer, Fall & Spring
18. The water is not good but I like surfing so I go in anyway
19. We fish here often
20. Got sick 3 years ago when I was surfing more. Now I don't go as much because of work. I've haven't heard of beach closures recently.

6.6 Limitations of the Study

This study is not intended to be a controlled epidemiological study therefore there may be some limitations affecting the overall conclusions that can be gleaned from the survey results.

6.6.1. Survey Distribution May Be Insufficient

To maximize limited time and human resources, surveys were only distributed along the most populated areas of the beaches studied. In addition, as surveys were only distributed to

those directly present on the beach or in the water, it excludes a group of people who might not frequent the beach due to a previous experience of illness or negative perception of water quality, potentially missing out on valuable information.

6.6.2. Accuracy of Self-Reporting

Many factors may influence the accuracy of illnesses reported. The length of time between exposure, illness symptoms, and individual survey responses can vary from days to months and the one-year recall time may be too long to accurately report illness (Hassan, 2005). Telescoping bias is especially important to regard considering the surveys focused on a certain time frame. Because the nature of the survey was self-reporting and not a controlled epidemiological study, the illnesses were generally self-diagnosed. Only 2 of the 11 respondents who reported an illness visited a doctor. One study found that under-reporting of visits to a healthcare provider was more likely than over-reporting over a one year recall time frame (Bhandari and Wagner, 2006). In a study by Bergmann et al. (1998, p. 969), researchers found that "Accuracy of self-reports improved with higher levels of education." The results suggest that self-reports of some diseases can be taken as accurate, but self-reports of other conditions might require medical record verification in epidemiologic follow-up studies." In similar studies, recall accuracy is assessed by comparing data from self-reporting questionnaires with data collected from a source considered to be more accurate, such as a healthcare provider or public health center (Harlow, 1989). For the purposes of this study, no attempt was made to corroborate the reported illnesses with local health data.

6.6.3. Risk Perception

The study area has long been plagued by poor water quality and pollution. Ongoing efforts to remediate the environmental damage and Countywide programs offering free Hepatitis A vaccinations have been highly publicized. Many ocean users have an increased understanding of water quality issues, especially those who are permanent residents of the study area. All of these factors can contribute to differing perceptions about water quality, which could result in risk perception bias.

6.6.4. Sample Size

Observations for those who ignore beach closures (N=20), and those who have contracted an illness (N=17), and those who have contracted an illness AND ignore beach closures (N=5) were too few. With such a small sample size, it is difficult to estimate any significant statistic. Any correlation found should be regarded as weak.

Chapter 7: Conclusions and Recommendations

This study set out to explore current beach user behaviors in the Imperial Beach area of San Diego County. The research questions investigated if there is a relationship between illnesses associated with recreational ocean use increases and increased exposure to ocean water. In addition, the study aimed to provide updated information and draw links between the current and previous studies, including justification for changes seen between those studies. The findings were summarized within the results and discussion chapters. This section will summarize the findings that address the objectives of the study.

7.1 Ocean-water related illnesses experienced by beach users

Majority of respondents did not report suffering from an illness: Only a small portion of the sample reported any illness (11%). Of those reporting an illness, respiratory and gastrointestinal issues were the most commonly reported symptoms. While most of those who suffered an illness did not seek medical attention to verify if the illness was related to the ocean water exposure, the symptoms reported are enough to assume a relationship. This is supported by the findings of previous studies mentioned earlier (Turbow, 2007; Dwight, et al, 2004; Fleisher, et al, 1996), and particularly by the findings of Fleisher, et al (1998), which indicated a definite dose-response relationship linking exposure of those entering the water to heightened levels of fecal streptococci and an elevated risk of contracting acute febrile respiratory illness.

7.2 Relationships between reported illness and beach user behavior

- **Frequency of water entry is correlated to illness:** Fifty-nine percent of all respondents, regardless of illness, reported going in the water once a month or more. Fifty-nine percent % of the sub-set who reported an illness went in the water more than once per week.
- **Seasonality of water entry is correlated to illness:** Ninety four percent of those who reported an illness go in the water year round, while only about half of those who did not report an illness go in the water year round.
- **Primary means of water contact is correlated to illness:** Surfing was the primary means of water contact for those that reported an illness while swimming was the primary

means for those that did not report an illness. Surfing is considered a more consistent exposure to the water than swimming (Dwight, et al, 2004) and therefore those who primarily surf are at a higher risk of contracting an illness from contaminated water.

- **Entry during beach closures may be related to illness:** A possible relationship exists between those that ignore beach closures and those that reported an illness. Twenty nine percent of those that reported an illness said they ignore beach closure warnings and enter the water during contamination events.

7.3. Changes since 2011

- **Reported illnesses decreased:** This survey found 11% of the respondents reporting an illness, a decline from the 2011 IB Clinic survey that found 32.8% of respondents recalling an illness.
- **Tijuana River-related beach day closures increased:** A total of 398 beach closure days occurred during this recall and survey period, a fifty-percent increase from the 265 closure days occurring in the 2008/2009 recall and survey period of the 2011 IB Clinic survey study.

7.4 Theoretical and Political Implications

The results of the study highlights a possible decline of reported illness in conjunction with an increase in beach closure events (Table 7), suggesting that public awareness efforts have been successful. However, there is still a portion of the population that continued to enter the water, whether out of voluntary acceptance of risk or because they were unaware of the contamination event and subsequent beach closures. Risk communication theory suggests that risk communication may work selectively, only reaching those who are already better informed (Langford, et al, 1999). Additionally, media communications that are excessively conveyed with dull data science may prove to be an impediment to the public's ability to comprehend and connect with gravity of the information. It is important to note that the decline in reported illness could have less to do with increased public awareness and more to do with the disconnect between behavior correlation and illness susceptibility. Respiratory and gastrointestinal symptoms stemming from contact with contaminated ocean water could easily be confused with a cold or food poisoning. Comments made by respondents are divided. Some respondents carry a belief that they will not get sick, backed by the reasoning that they have been recreating in the study area and have never experienced an illness or because they feel they are immune. Other

respondents are hyper-aware of the contamination and feel they have been sick because of the water. The theoretical case for risk communication needs to be revisited in future studies to find the most effective means of keeping beach users out of the water during contamination events.

Development processes marked by social and economic inequalities are behind many public health problems stemming from Mexico, affecting the Tijuana River estuary region and specific population groups, and establishing how those people become ill. To better understand these processes and identify interventions, it is necessary to work collaboratively with the fields of knowledge that address the environmental issue from the economic and social development processes. Some challenges can be undertaken by public health agencies to tackle the discussion on health, environment, and sustainable development from the contributions of ecological economics and political ecology. It is important to note the role that community culture and values play in the results. Cross-border culture plays a large role in the context of social stratification. One of the social contexts that stratify beach users in the study area is a lack of open and recreational space in Tijuana, as the study area beaches fill "with families from Tijuana seeking a beach with lifeguards and public facilities and an escape from the stifling inland heat and smog" (Dedina, 2011). Additionally, the surfing culture of the southern California coast may further explain differential exposure and vulnerability that must be addressed.

7.5 Climate Change Implications

Climate change threatens to alter historical weather patterns in the San Diego/Tijuana region. Annual warming is predicted to increase by at least 1°C and up to 3°C, by the end of the century (Das, et al, 2010). According to a sensitivity analysis in one climate change study conducted by the Sustainability Solutions Institute at the University of California San Diego, runoff will decrease when temperatures increase or when precipitation decreases (Das, et al, 2010). More specifically, a 1°C increase in temperature will lead to a 3% reduction in runoff while a 10% reduction in precipitation will lead to a 20% reduction in runoff in the Tijuana River Watershed (Das, et al, 2010). Decreased runoff will probably mean less beach closures from poor water quality but due to the decrease in precipitation events, runoff from downpours and flooding will likely carry higher amounts of sewage, trash, and bacteria which could pose higher risks for beach users who choose to go in the water during those times. The most recent U.S.

National Climate Assessment warns that coastal storm surges and more intense storm tracks will increase flooding from inland runoff in California (Melillo, Richmond, and Yohe, 2014). Already stressed wastewater management and drainage systems impacting the Tijuana River watershed are at a greater risk of becoming overwhelmed with increased rainfall intensity, increasing the risk of human health impacts (Melillo, Richmond, and Yohe, 2014). The most recent water quality report by San Diego Coastkeeper highlights that low water levels, "caused by the region's fourth consecutive drought, may be worsening countywide inland water quality", and carrying concentrated amounts of pathogens to the ocean, putting beach-goers at risk (San Diego Coastkeeper, 2016).

7.6 Future Research Needs

It is not the particular existence or lack of any one component precipitating poor health outcomes, but more so, the web connection of interlaced components that cause an adverse impact on a population (Krieger, et al, 2008). The scale of this issue is extensive, even at the local level. To generate achievable policy strategies with regards to illness prevalence and risk communication, there is need for more surveying at the local level. Exploring the following as future research strategies can facilitate the attainment of this goal. An attempt should be made to corroborate reported illnesses with local health data to identify how many people are becoming ill from ocean related recreation that may not realize the correlation. An assessment of the effectiveness of advisory and beach closure notification methods is needed. The theoretical case for risk communication needs to be revisited in future studies to find the most effective means of keeping beach users out of the water during contamination events. A formal epidemiological study utilizing a prospective cohort can help eliminate telescoping bias.

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Appendix A: San Diego County Recreational Water Monitoring Guidelines

Land and Water Quality Division Beach and Bay Monitoring Program

For the current status on coastal water quality in San Diego County,

visit **www.sdbeachinfo.com** or call **(619) 338-2073**.

DEFINITIONS:

BEACHES WITH URBAN RUNOFF FLOWS DURING DRY WEATHER: As a precaution, avoid contact with runoff and recreational waters within at least 75 feet from where runoff enters ocean or bay waters during dry weather.

GENERAL (RAIN) ADVISORY FOR ALL COASTAL WATERS:
A General Advisory is issued after 0.2 inch or more rain is received to alert the public of potential ocean and bay water contamination by urban runoff. Bacterial levels can increase significantly during and after rainstorms in ocean and bay waters, especially near storm drain, river, and lagoon outlets. **The Department of Environmental Health advises beach users to avoid contact with ocean and bay waters for at least 3 days (72 hours) after rainfall ends.** While many coastal outlets (storm drains, rivers, and lagoons) within San Diego County are permanently posted with white metal warning signs, additional temporary warning signs are not posted for General Advisories.

CLOSURES:

A water contact Closure is issued anytime a reported sewage spill impacts or may impact ocean or bay recreational waters. Closures are also issued whenever the Tijuana River discharges to the ocean as the Tijuana River is known to be impacted with sewage. Sewage contaminated water may contain human pathogens that can cause illnesses. **The Department of Environmental Health advises beach users to avoid contact with ocean and bay waters in the closure area and where closure signs are posted.**

ADVISORIES / WARNINGS:

A water contact advisory/warning is issued when monitoring reveals ocean or bay water quality does not meet State standards due to high bacterial levels, or during the excavation of a coastal outlet (river or lagoon) when potentially contaminated water is released to the ocean. Beach water quality monitoring uses bacterial indicators to test for the presence of possible pathogens. The bacterial indicators are not specific to humans, and may be from other sources including wildlife, pets, soil, and rotting vegetation such as kelp. However, ocean or bay waters with elevated bacterial levels may contain human pathogens that can cause illnesses. **The Department of Environmental Health advises beach users to avoid contact with ocean and bay waters where advisory/warning signs are posted.** Signs are typically posted 50 yards (150 feet) either side of a sampling location where water quality does not meet State standards.

Recreational Water Monitoring Program

Where is it safe to swim? Southern California beaches are generally clean and safe for recreation as indicated by water quality monitoring. Storm water runoff can make beaches unsuitable for swimming or surfing for at least 72 hours after a rainstorm. Beaches impacted by urban runoff from storm drains, streams and rivers should be avoided. Signs are posted warning not to swim at locations where water does not meet standards or sewage contamination has occurred.

What do we test for? Total Coliform, Fecal Coliform and Enterococcus bacteria. ***What are they?*** Indicators of possible disease producing bacteria/viruses/protozoa (also known as pathogens)

Where do they come from?

Environment-soils, decaying vegetation

Storm water/urban runoff - sources vary

Animal wastes-birds, dogs, cats, seals

Humans-sewage, kids with diapers, shedding from body

What are the standards?

Single Sample Standards	Total Coliforms: 10,000 organisms per 100ml
	Fecal Coliforms: 400 organisms per 100ml
	Enterococci: 104 organisms per 100ml
	Fecal/Total ratio: If total coliforms>1,000 & ratio>0.1
30-day Geomean Standards (5 or more samples in 30 days)	Total Coliforms: 1,000 organisms per 100ml
	Fecal Coliforms: 200 organisms per 100ml
	Enterococci: 35 organisms per 100ml

What pathogens may be found in swimming waters contaminated with sewage and possibly in runoff?

Pathogenic Agent	**Disease**	**Pathogenic Agent**	**Disease**
Bacteria		**Viruses**	
E. Coli	Gastroenteritis	Rotavirus	Gastroenteritis
Salmonella typhi	Typhoid fever	Norwalk virus	Gastroenteritis
Other Salmonella Species	Various enteric fevers (also called paratyphoid), gastroenteritis, septicemia (generalized infections in the bloodstream)	Coxsackie virus (some strains)	Various including sever respiratory disease, fever, rashes, paralysis, meningitis
Shigella dysenteriae and other species	Bacterial dysentery	Adenovirus	Respiratory and gastrointestinal infections
Vibrio cholera	Cholera	Echovirus	Various, similar to coxsackie virus (evidence only in experimental animals)
Protozoa (**Intestinal Parasites**)		Polio Virus	Poliomyelitis
Cryptosporidium	Diarrhea- Crytosporidiosis	Hepatitis A	Infectious hepatitis (liver malfunction), also may affect kidneys and spleen
Giardia lamblia	Diarrhea- Giardiasis		

What happens to bacteria/viruses/protozoa in swimming waters? Die-off due to sun (ultraviolet light), salt water exposure (osmotic forces), age, dilution, predation by other organisms

What is the recent water quality trend at each location based upon the monitoring data? Visit the Heal the Bay web page at www.healthebay.org and select the *Beach Report Card*.

What beaches are currently posted? Visit San Diego County's Mobile Web App (website) at www.sdbeachinfo.com or call the San Diego County Beach and Bay Status Hotline for an update of current water quality status at (619) 338-2073. For more information, go to www.sdbeachinfo.com on your computer, tablet or smart phone.

Appendix B: Written Survey (English)

Title of Research Study: Recreational Ocean User Survey for Imperial/Coronado Beaches, CA

Principal Investigator: Trista Brophy (tbrophy@mail.usf.edu) **Advisor**: Dr. Kamal Alsharif

Institution: University of South Florida, School of Geosciences

INTRODUCTION
You have been asked to participate in a research study being conducted at the University of South Florida. This research study is investigating health outcomes associated with contact of polluted ocean water.

PLAN AND PROCEDURES
If you decide to participate, you will be asked to fill out an online questionnaire in a study collecting ocean water exposure and health information, as well as some basic demographic information. We expect that your participation will take approximately 10 minutes.

ELIGIBILITY REQUIREMENTS
Participants must be at least 18 years of age.

POTENTIAL RISKS AND DISCOMFORTS
We anticipate that this study poses no potential risks. However, in the event that you are uncomfortable answering any question, please feel free to leave the question(s) blank.

POTENTIAL BENEFITS
Participation in the study will provide no benefits.

SUBJECT PRIVACY AND CONFIDENTIALITY OF RECORDS
Researchers will not record your identity and no identifying information will be asked. Any information that is obtained in connection with this study will remain confidential and will be known only to the researchers and their supervisor.

COSTS OF PARTICIPATION
There will not be any costs to you resulting from participation in this study.

VOLUNTARY PARTICIPATION
Participating in this study is voluntary. If you decide to participate, you may stop at any time you choose without penalty. You may choose not to answer any survey question for any reason.

PERSONS TO CONTACT WITH QUESTIONS
The principle investigator will be available to answer any questions concerning this research,

now or in the future. You may contact the principal investigator, Trista Brophy by email at tbophy@mail.usf.edu prior to starting this survey, and after the survey is completed. If you have questions about your rights as a research subject, you may call the University of South Florida Institutional Review Board at phone number 813-974-5570.

Recreational Ocean User Survey

Thank you for completing this survey. Your participation helps researchers understand how people are affected by recreational ocean use. Your answers will help advance knowledge in important public health issues.

What Race/Ethnicity Do You Identify With?

- ☐ White/Caucasian
- ☐ Hispanic/Latino
- ☐ Black/African-American
- ☐ Asian/Pacific Islander
- ☐ American Indian
- ☐ Other: _____

What is your Gender?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer Not To Answer

What is your age? _____

What is your residency status in California?

- ☐ Permanent Resident (I live here more than 6 months out of the year)
- ☐ Part-Time Resident (I live here 6 months or less each year)
- ☐ Visitor/Tourist

On average, how often do you go into the water?

- ☐ Infrequently (Less than twice per year)
- ☐ Occasionally (Once every 1-6 months)
- ☐ Moderately ((1-2 times per month)
- ☐ Frequently (2-4 times per month)
- ☐ Very Frequently (Once per week)
- ☐ Routinely (More than once per week)

What is your PRIMARY means of water contact? (Check ONE that you do most often)

- ☐ Surfing
- ☐ Swimming
- ☐ Ocean Craft/Jet Ski
- ☐ Scuba/Snorkeling
- ☐ Sailboarding
- ☐ Fishing/Wading
- ☐ Mixed (Variety of Uses)
- ☐ Other: _____

Do you wear any of the following while in the water? (Check all that apply)

- ☐ Ear Plugs
- ☐ Nose Plugs
- ☐ Eye Goggles or a Face Mask
- ☐ Wet Suit
- ☐ Other: _____
- ☐ None

If the beach is closed due to contamination, do you stay out of the water?

- ☐ Yes, I stay out of the water.
- ☐ No, I ignore beach closure warnings
- ☐ I've never seen or heard about beach closures in the areas I visit.

What times of the year are you typically in the water?

- ☐ Year-Round
- ☐ Summer Only
- ☐ Winter Only

In the past year, have you contracted any illness that you believe to be related to ocean water contact in San Diego County?

- ☐ Yes
- ☐ No

Illness & Exposure Report

Your accurate report of ocean water related illness helps us understand where, how and when ocean water quality affects public health.

Location of Water Contact (beach, break, etc)

- ☐ Imperial Beach
- ☐ Coronado Beach
- ☐ Border Field State Park
- ☐ San Diego Bay
- ☐ Other: _____

Date of Water Contact: month/day/year
(Include dates up to 2 weeks prior to illness)

_____

_____

Did you swallow any water?

- ☐ Yes
- ☐ No
- ☐ Unsure

What symptoms did you experience? (Check all that apply)

- ☐ Respiratory/Sinus (congestion/coughing,etc)
- ☐ Diarrhea
- ☐ Vomiting
- ☐ Upset Stomach
- ☐ Fever
- ☐ Eye discharge/Pink Eye/etc
- ☐ Fatigue or Excessive Tiredness
- ☐ Sore Throat/Swollen Glands
- ☐ Headache
- ☐ Ear Discharge/Ear Pressure/etc
- ☐ Skin Irritation or Rash
- ☐ Other: _____

When did these symptoms appear after water contact?

- ☐ Immediately
- ☐ 0-6 hours
- ☐ 6-12 hours
- ☐ 12-24 hours
- ☐ 24-48 hours
- ☐ Other: _____

Did you see a doctor regarding this illness?

- ☐ No
- ☐ Yes (what was the diagnosis):

_____

_____

Do you have another illness to report?

- ☐ No
- ☐ Yes (Please use an additional form to fill out other illnesses you wish to report)

Additional Comments: _____

Thank you for your participation. Please return this form to the surveyor or the location you picked it up. You can also turn it in to Wildcoast Office at 925 Seacoast Drive, Imperial Beach, CA, 91932 or complete it online at www.borderwater.org

Appendix C: Written Survey (Spanish)

Titulo de Investigación: Encuesta A Los Usuarios Recreativos de Océano por Las Playas de Imperial y Coronado, del Sur de California. IRB Protocol # Pro00012014

Investigadora Principal: Trista Brophy Consejero: Dr. Kamal Alsharif

Institución: University of South Florida, Department of Geosciences

INTRODUCCION
Le han pedido participar en un estudio de investigación conducido en la Universidad de Florida del Sur (University of South Florida). Este estudio de investigación investiga los resultados de la salud asociados con el contacto del agua contaminada del océano.

PLANES Y PROCEDIMIENTOS
Si decide participar, se le pedirá llenar un cuestionario de un estudio que recoge información de salud y exposición al agua de mar, también algunas informaciones demográficas básica. Esperamos que su participación dure aproximadamente 10 minutos.

REQUISITOS DE ELEGIBILIDAD
Los requisitos del elegibilidad para este estudio requieren que los participantes sean por lo mínimo 18 años de edad.

LOS RIESGOS POTENCIALES E INCOMODIDADES
Esperamos que este estudio no planteé ningún tipo riesgo potencial. Sin embargo, en caso de que usted esta incomodo(a) de responder a cualquier pregunta, puede dejar la pregunta en blanco.

BENEFICIOS POTENCIALES
Participación de este estudio no proporcionara ningún beneficio.

PRIVACIDAD Y CONFIDENCIALIDAD DE LOS REGISTROS
Los investigadores no registrarán su identidad y no se le pedirá ninguna tipo de identificación. Cualquier información que se obtenga en relación con este estudio se mantendrá confidencial y será visible sólo por los investigadores y su supervisor.

COSTOS DE PARTICIPACIÓN
No habrá ningún costo como resultado de la participación en este estudio.

PARTICIPACIÓN VOLUNTARIA
Participar en este estudio es voluntario(a). Si usted decide participar, usted podría parar a cualquier momento. Puede parar o detener del responder cualquier pregunta de este cuestionario por cualquier razón.

PERSONAS PARA CONTACTAR PREGUNTAS

La investigadora principal estará disponible para contestar cualquier tipo de preguntas relacionadas con esta investigación, al momento en el futuro. Puede comunicarse con la investigadora principal, Trista Brophy por correo electrónico a tbrophy@mail.usf.edu antes de completarla, y después de completa la encuesta. Si usted tiene algunas preguntas acerca de sus derechos como tema de estés investigaciones, puede llamar a la Junta de revisión institucional de la University of South Florida en el teléfono número 813-974-5570. Puedes obtener mas información de este investigación en www.borderwater.org

Encuesta de Usuarios del Océano Recreativa

a.

Gracias por completar esta encuesta. Su participación ayuda a los investigadores a comprender cómo personas son afectadas por el uso recreativo del océano. Sus respuestas ayudarán a conocimientos avanzados en temas de salud pública importante.

¿De que raza o grupo étnico se identifica como?

- ☐ Blanco/Caucásico
- ☐ Hispano/Latino
- ☐ Negro/Afroamericano
- ☐ Asiático/Isleños del Pacifico
- ☐ Indio Americano
- ☐ Otro: _____

¿Cual es su sexo?

- ☐ Masculino
- ☐ Femenino
- ☐ Otro
- ☐ Prefiero No Responder

¿Cual es su edad? _____

¿Cual es su status de residencia en California?

- ☐ Residente Permanente (Yo vivo aquí mas de 6 meses al año)
- ☐ Residente a Tiempo Parcial (Yo vivo aquí seis meses o menos cada año)
- ☐ Visitante/Turista

¿En promedio, con que frecuencia usted entre en el agua?

- ☐ Infrecuentemente (menor que 2 veces al año)
- ☐ Ocasionalmente (una vez cada 1-6 meses)
- ☐ Moderadamente (1-2 veces al mes)
- ☐ Con Frecuencia ((2-4 veces por mes)
- ☐ Muy Frecuentemente (una vez a la semana)
- ☐ Rutinariamente (mas de 1 vez por semana)

¿Cual es su principal medio de contacto con el agua? (Marque uno que haces mas a menudo)

- ☐ **Surf**
- ☐ **Natación**
- ☐ **Barco/Jet Ski**
- ☐ **Buceo o Esnórquel**
- ☐ **Windsurf**
- ☐ **Pescar/Vadear**
- ☐ **Variado (Variedad de uso)**
- ☐ **Otro:** _____

¿Usas cualquiera de estas opciones en el agua? (Marque todas las que correspondan)

- ☐ **Tapones para los oídos**
- ☐ **Tapones para el nariz**
- ☐ **Gafas o una mascara facial**
- ☐ **Traje de buceo**
- ☐ **Otro:** _____
- ☐ **Ninguno**

¿Si la playa esta cerrada debido a la contaminación, te quedas fuera del agua?

- ☐ **Si, me quedo fuera del agua**
- ☐ **No, ignorar las advertencias de cierre de playa**
- ☐ **Nunca he visto o he oído sobre cierres de la playa en las áreas que visito**

c.

¿Cuáles son las épocas del año que usted típicamente use el agua?

- ☐ **Durante todo el año**
- ☐ **Verano solo**
- ☐ **Invierno solo**

¿En el año pasado, ha sido victima de alguna enfermedad que crea estar relacionado con el contacto con el agua al mar en el Condado de San Diego?

- ☐ **Si**
- ☐ **No**

Utilice el otro lado de este encuesta para describir cualquier tipo de enfermedad que este relacionada con el agua del océano.

Informe de Exposición y Enfermedad

Su informe precisa de enfermedades relacionadas con agua de mar nos ayuda a comprender de donde, como y cuando calidad del agua del agua océano afecta a la salud publica.

Ubicación del contacta con el agua

- ☐ Imperial Beach
- ☐ Coronado Beach
- ☐ Border Field State Park
- ☐ San Diego Bay
- ☐ Otro: _____

Fecha de contacta con el agua: mes/día/año (incluye fechas hasta 2 semanas antes de la enfermedad)

d. _____

e. _____

¿Tragó agua?

- ☐ Si
- ☐ No
- ☐ No estoy seguro

¿Que síntomas experimentó? (Marque todas las que apliquen)?

- ☐ Respiratoria/ Sinusitis (congestión,tos,etc)
- ☐ Diarrea
- ☐ Vómitos
- ☐ Malestar Estomacal
- ☐ Fiebre
- ☐ Ojo Descarga/Ojo Rosado
- ☐ Fatiga o Cansancio Excesivo
- ☐ Dolor de Garganta/Ganglios Linfáticos Inflamados
- ☐ Dolor de Cabeza
- ☐ Secreciones del Oído/Oreja de Presión
- ☐ Irritación de la Piel o Sarpullido
- ☐ Otro: _____

¿Cuando estos síntomas aparecen después de contacto con el agua?

- ☐ Inmediatamente
- ☐ 0-6 horas
- ☐ 6-12 horas
- ☐ 12-24 horas
- ☐ 24-48 horas
- ☐ Otro: _____

¿Has visto un medico con respecto a esta enfermedad?

- ☐ No
- ☐ Si (?Lo que era el diagnóstico?):
  _____
  _____

¿Tienes otra enfermedad para divulgar?

- ☐ No
- ☐ Si (Use una forma adicional para completar otras enfermedades te desea informe)

Comentarios Adicionales:

Gracias por su participación. Por favor devuelva este formulario al la investigadora o la ubicación recogió. También puede entregarlo a la oficina de Wildcoast a 925 Seacoast Drive, Imperial Beach, CA, 91932 o completa en línea en www.borderwater.org

Appendix D: USF IRB Approval Letter

USF
UNIVERSITY OF
SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

April 29, 2014

Trista Brophy-Duron
School of Geosciences
Sarasota, FL 34231

RE: **Exempt Certification**
IRB#: Pro00012014
Title: Impacts of Polluted Water on Ocean Users Along the U.S./Mexico Border

Study Approval Period: 4/29/2014 to 4/29/2019

Dear Ms. Brophy-Duron:

On 4/29/2014, the Institutional Review Board (IRB) determined that your research meets USF requirements and Federal Exemption criteria as outlined in the federal regulations at 45CFR46.101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Approved Documents:

Study Proposal

Informed Consent for In-Person Survey in English

Informed Consent for In-Person Survey in Spanish

Informed Consent for Online Survey in English

Informed Consent for Online Survey in Spanish

As the principal investigator for this study, it is your responsibility to ensure that this research is conducted as outlined in your application and consistent with the ethical principles outlined in the Belmont Report and with USF IRB policies and procedures. Please note that changes to this protocol may disqualify it from exempt status. Please note that you are responsible for notifying the IRB prior to implementing any changes to the currently approved protocol.

The Institutional Review Board will maintain your exemption application for a period of five years from the date of this letter or for three years after a Final Progress Report is received, whichever is longer. If you wish to continue this protocol beyond five years, you will need to submit a new application at least 60 days prior to the end of your exemption approval period. Should you complete this study prior to the end of the five-year period, you must submit a request to close the study.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, Ph.D., Chairperson
USF Institutional Review Board