The Plastic Breakdown

Nicole Warren
CEL Project 2016
Miami University, Ohio
December 4, 2016

The Plastic Breakdown:

Involving Youth in Mapping Marine Litter

INTRODUCTION

Marine debris and plastic pollution in our ocean is a global phenomenon that can be linked to individual purchases and disposal (Eastman et al., 2014). In fact, many items commonly used on a regular basis including plastic grocery bags and straws are thrown away after only one use (Hopewell, Dvorak, & Kosior, 2009). Even with recycling and reusing, plastics and other litter continues to be an ever-increasing threat to our marine ecosystem. In 2010, it was estimated that 4.8 to 12.7 million metric tons of plastic waste contaminated the ocean (Jambeck et al., 2015). This substantial buildup of marine litter and specifically of plastic debris has caused and continues to raise concern in many countries throughout the world (Eastman et al., 2014).

Marine debris as defined by Jameback & Johnsen (2015) is any solid, persistent material either

Marine debris found along Atlantic Beach, North Carolina

manufactured or processed that is found along coastlines or in waterways and the ocean. Plastic pollution can enter our environment and ocean indirectly or directly through stormwater runoff or inadequate waste management. Once in the ocean, marine debris, particularly plastic pollutants, can act as vectors for contaminants or degrade into smaller pieces called microplastics. These tiny plastic pieces are relatively the same size as planktonic organisms and can be mistaken as prey to a wide range of marine organisms including invertebrates (Hall, Berry, Rintoul, & Hoogenboom, 2015; Koelmans, Besseling, & Foekema 2014; von Moos, Burkhardt-Holm, & Köhler, 2012). Furthermore, these contaminants can potentially reside and accumulate in consumable seafood (Moore, 2008).

Such a large-scale ecological problem requires an urgent need for activism and conservation. Ideally, informed local citizens would have the knowledge and motivation to remove marine pollution before it makes its way from the shore into the ocean to protect and preserve their local environment (Jamback & Johnsen, 2015; Kollmuss & Agyeman, 2002). However, a lack of baseline understanding of marine litter sources and distribution hinders and challenges conservation action projects (Bennett-Martin et al., 2015; Eastman et al., 2014). Additionally, Jamback and Johnsen (2015) found that global scale marine debris and pollution monitoring can be difficult because of local organizational disconnect and typical paper documentation.

Nevertheless, the use of new tools and mechanisms for engaging learners in activities such as participatory mapping can support and encourage positive public participation in science, conservation action, and Earth stewardship (Bennett-Martin et al., 2015). The Ocean Conservancy's Clean Swell marine debris tracker application or other such mobile applications such as the National Oceanic and Atmospheric Administration's (NOAA) Marine Debris Tracker app can act as tools in evaluating relationships between humans and the environment as well as a resource for quantifying and analyzing marine debris quantities, sources, and distribution.

FAST FACTS

54%

Of the **120** marine mammal species on the threatened list have been observed **entangled** in or **ingesting** plastic.

92.5%

Is the percent of dead seabirds (Northern Fulmars) found to have **ingested plastic** in amounts equal to **5%** of their body weight.

FOR MORE INFORMATION

www.oneworldoneocean.com

These applications further allow for data analysis of marine pollution not just locally but globally (Bennett-Martin et al., 2015; Jamback & Johnsen 2015). With more than 400,000 items tracked, the Marine Debris Tracker app can provide a valuable link between global understanding and community action (Jameback & Johnsen, 2015).

In recent decades, there has been a growing interest in collecting cumulative marine debris type data. Historically, citizen science projects such as beach cleanups have concentrated on incorporating college age or adult collaborators (Bennett-Martin et al., 2015). Younger citizens or school age children are utilized less in the collection of scientific data. This is unfortunate as collecting data through collaborative mapping can foster a sense of place and connect individuals, especially children, with their surrounding environment. In turn, this connection can contribute to pro-environmental behavior (Kudryavstev, Stedman, & Krasny, 2012).

The goal of this project was to provide an opportunity for youth to take a closer look at the locations in which marine debris washes up along their local beach. Teens enrolled in the North Carolina Aquarium at Pine Knoll Shores Aquarium Teen Ambassador Program were the primary participants. Nevertheless, through collaborative efforts this project engaged not just the Aquarium Teen Ambassadors but also local community members and aquarium staff. After determining the local marine litter "hotspots" along North Carolina's Atlantic Beach teens ranging in age form twelve to sixteen years old were engaged in an open-ended discussion on ways to reduce pollution and help their local community. Strengths and weakness to different approaches were also highlighted and a best solution was established in an effort to raise awareness to our local community leaders and create a positive local environmental change.

METHODS

Study Site: Atlantic Beach North Carolina

Atlantic Beach forms a 4.5-mile long beach on the eastern portion of Bougue Banks, a 21-mile long barrier island off the mainland of North Carolina in Carteret County.

AROUND TOWN

Atlantic Beach, North Carolina

The beach is bordered to the south by the Atlantic Ocean and to the north by a relatively small stretch of land and the Bougue Sound, which separates it from the mainland (Atlantic Beach, n.d.). The town of Atlantic Beach offers curbside recycling for the following items: all plastics, all green, brown, and clear glasses, all beverages and food cans, and all newspapers, inserts, copy paper, computer paper, stationery, and non-window envelopes (WI AB-Newport Insert – FINAL – Atlantic Beach, n.d).

Listening to the Community

The Aquarium Teen Ambassadors' program is a teen initiative started by the North Carolina Aquarium at Pine Knoll Shores, which allows students in grades seven through ten to learn and participate in marine science activities. Before data collection and mapping, several Aquarium Teen Ambassador members were engaged in open-ended discussions about marine debris and the health of our ocean. Parental consent forms were received for participation in the discussion. Seven open-ended questions (see Appendix A) were asked to several teens in an informal setting. Since marine debris is ubiquitous two adult community members were also asked the same seven open-ended questions (Eastman et al., 2014).

Surprisingly, almost all teens felt that people were the largest threat to the ocean and marine ecosystem through direct and indirect actions such as pollution and oil spills. In contrast, the adult community members named overfishing as the largest threat, although one community member did mention trash as a cause of concern. This is consistent with Sheavly and Register's (2007) findings on the management and conservation of living marine resources. Sheavly and Register (2007) found that marine litter is a top concern along with overfishing and other human activities. Both groups took part in personal actions at home such as recycling and not littering to help the ocean but neither group was sure on what else could be done to help. Lastly, both groups thought that marine life would be most impacted by marine debris. Interestingly, one of the community members further commented that marine debris such as shipwrecks could have a positive impact on marine life in the form of artificial reefs.

Listening to the adult community members and the Aquarium Teen Ambassadors validated marine debris, specifically marine litter such as plastic, as a problem of concern for local citizens. Although both the teens and the adult community members were well informed on marine debris issues, discussions did prove the

need for greater knowledge on consumer best practices as neither group mentioned using reusable items.

Collaboration

In an effort to strengthen community and map the full 4.5-mile stretch of beach, the Aquarium Volunteer Service Core, as part of a fellow coworker's Community Engagement Lab project, was also incorporated in collecting and mapping marine litter data. The Volunteer Service Core is a program sponsored by the North Carolina Aquarium at Pine Knoll Shores geared towards families, individuals, and groups. Lastly, fellow aquarium staff members were also involved in data collection.

Participatory Mapping

Data was gathered for the entire 4.5-mile stretch of beach over a two-week period from November 2, 2016 to November 16, 2016. Atlantic Beach was divided into nine half-mile segments. Some segments consisted of purely residential areas while other areas were highly trafficked with public accesses and parking. The Aquarium Teen Ambassadors collected and helped map data specifically on November 6th, 2016 at one of the most highly trafficked sections, the Atlantic Beach Circle.

Teens were split into three groups, one positioned along the water's edge, one positioned between the water's edge and dune line, and

FAST FACTS

1315

Total pieces of marine litter collected along the 4.5-mile stretch of Atlantic Beach, North Carolina

43%

The percent of trash collected specifically by the Aquarium Teen Ambassadors

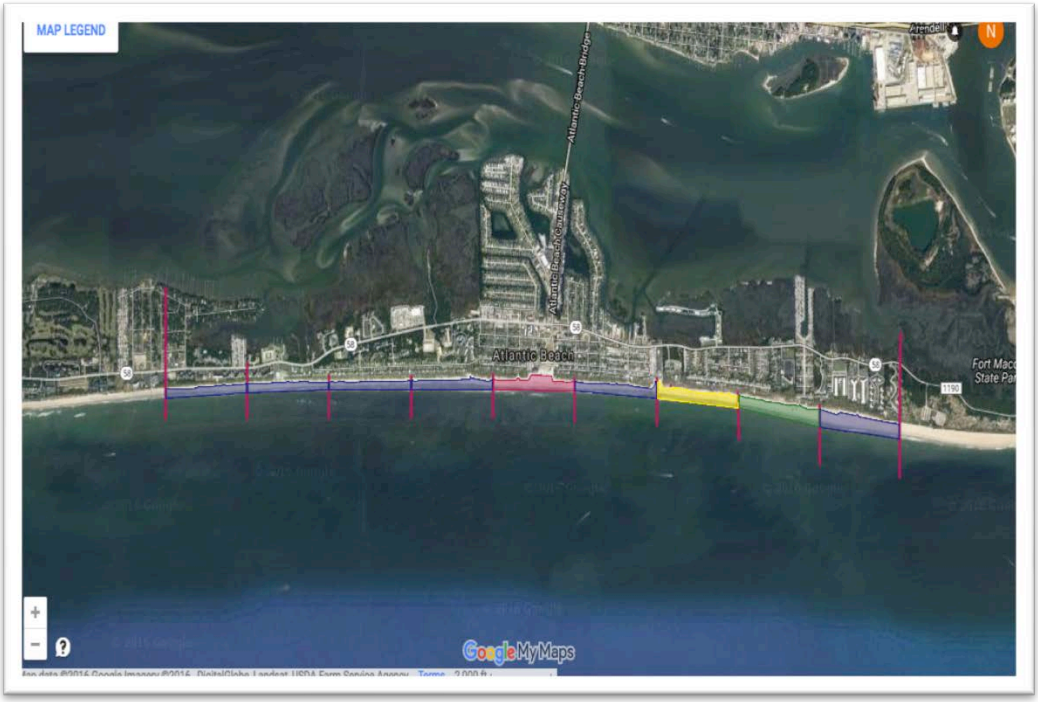

Figure 1. Google Map of Atlantic Beach, North Carolina split into nine half-mile segments with overlaid colors representing different marine debris concentrations. Color legend is listed below. Pink lines indicate beginning and end of half-mile segment. For the full size, interactive map, please visit https://www.google.com/maps/d/viewer?mid=1T_C3_jjVvEnMWLsaMOa-uZvkH84&ll=34.69722858167384%2C-76.74025834999998&z=13.

Color	Total Marine Debris Pieces Collected
Blue	0-100
Green	101-200
Yellow	201-300
Orange	301-400
Pink	401 and up

the other positioned along the dune line. All three groups walked parallel to the ocean collecting all marine debris particles or litter observed using the Ocean Conservatory's volunteer trash collection data form and guidelines (see Appendix B). Teen then recorded and uploaded data into the Ocean Swell app as well as the Marine Debris Tracker app for the half-mile section of Atlantes Beach. After data was collected form all segments, Google earth was utilized to produce the final map showing each half-mile section of beach with overlaid colors.

Colors indicated the following: pink-areas of high marine debris with more than 401 pieces of litter, orange – areas with medium to high marine debris with 301-400 pieces of litter, yellow – areas of medium marine debris with 201-300 pieces of litter, green – areas with little to medium marine debris with 101-200, and blue - areas with little marine debris with less than 100 pieces of litter.

RESULTS

Of the total 4.5 miles of beach line, only one of the nine half-mile segments of Atlantic Beach had more than 400 pieces of marine litter collected and as such was labeled as a marine debris "hotspot" (Figure 1). With the help of the Aquarium Teen Ambassadors, Aquarium Volunteer Core, Atlantic Beach community members, and aquarium staff a total of 1,315 pieces of marine litter were collected. Out of the total trash pieces collected 43% of the trash was collected and mapped by the Aquarium Teen Ambassadors at the Atlantic Beach Circle segment making it the transect with the most trash. This was followed by the Oceanana Pier segment with a total of 211 trash pieces collected. At the Atlantic Beach Circle half-mile segment cigarette butts were the most collected type of marine debris with a total of 210 cigarettes collected (Figure 2). This was consistent with the entirety of Atlantic Beach with cigarette butts representing 46% of the total marine litter collected followed by foam/metal/plastic pieces at 11% (Figure 3).

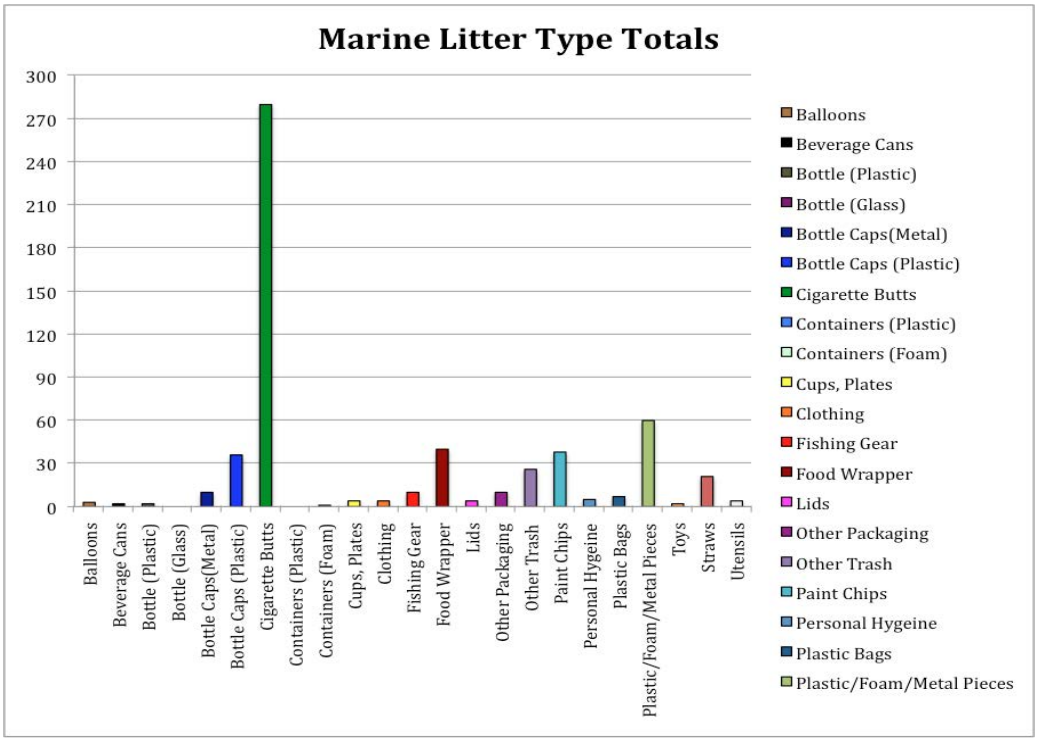

Figure 2. Marine debris type totals collected by the Aquarium Teen Ambassadors from the Atlantic Beach Circle half-mile segment on November 6, 2016.

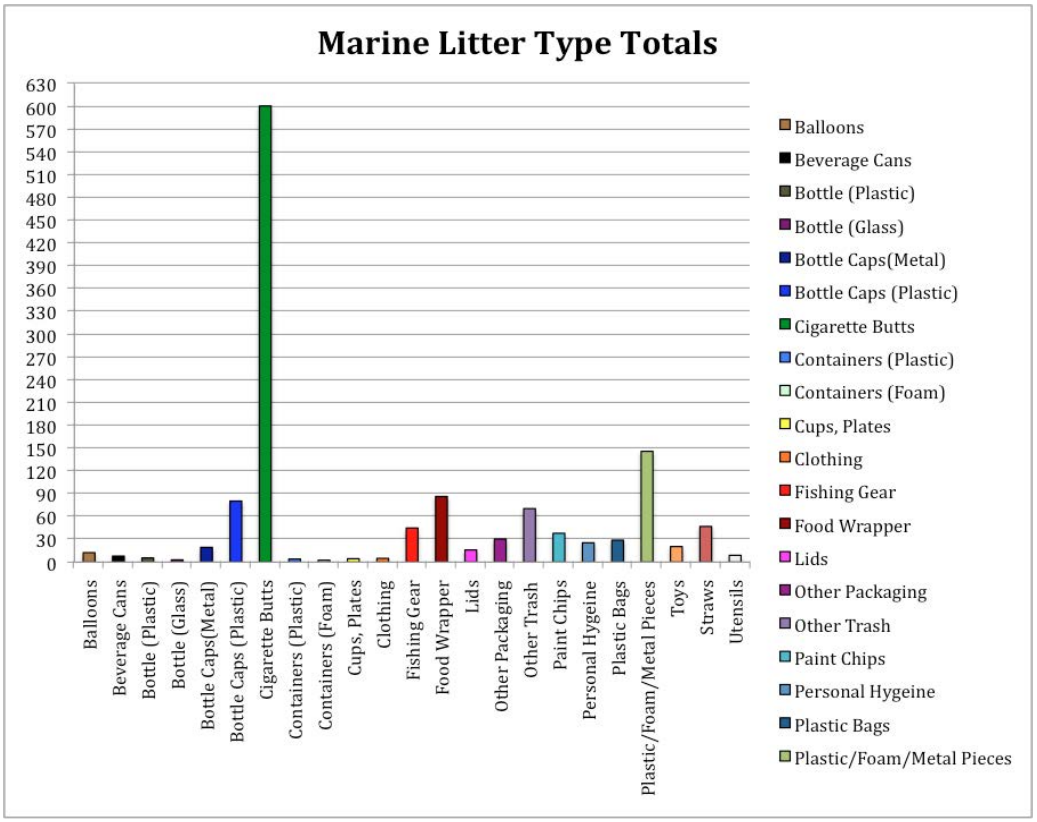

Figure 3. Marine debris type totals collected by the Aquarium Teen Ambassadors, Atlantic Beach community members, Aquarium Volunteer Core, and aquarium staff members for the 4.5 mile stretch of Atlantic Beach, North Carolina during a two-week period, November 2, 2016 through November 16, 2016.

DISSCUSSION

In a compact and easily accessible platform, this collaborative map illustrates the locations of marine debris concern for our local Atlantic Beach community. Marine Debris has historically been released into the ocean through human beahviors such as littering or dumping, which is still accepted by many communities and in many countries throughout the world (Eastman et al., 2014).

Raising public awareness to encourage individuals to choose different alternatives or sustainable best practices may be the best solution for dealing with this detrimental issue long term. As such, community-based initiatives can be the most effective means in addressing environmental issues such as marine debris (Topping, 2007). After the beach cleanup and marine debris sampling, the Aquarium Teen Ambassadors were a little disgusted but also enthusiastic and expressed interest in coming up with long term solutions to help clean up the Atlantic Beach Circle area.

As the map shows, we were unsurprised to find that areas with easy public access and parking such as the Oceanana Fishing Pier and the Atlantic Beach Circle were the sections along Atlantic Beach with the highest concentration of marine debris and litter. The Atlantic Beach Circle area is arguably the easiest beach access to get to as the closest bridge from the mainland deposits traffic directly to a stoplight in front of the Circle's parking. As a result, it is a popular destination for local and visiting tourists. Several restaurants, volleyball courts, and public restrooms are also located right along the beach's edge (Atlantic Beach, n.d.).

Marine litter can come in many forms, from cigarette or cigars tossed on the beach to a 200-pound tangle of fishing net or tent. The Aquarium Teen Ambassadors identified three solutions that they

would like to address and discuss with the Atlantic Beach's town council. First and foremost, teens noted that although there were seven trashcans located within the half-mile stretch of the Atlantic Beach Circle none of the trashcans had lids and loose trash pieces could be seen blowing out of the trashcans. Secondly, it was noted that although Atlantic Beach does offer recycling, there were no recycling bins noted along the 4.5-mile stretch of beach. Lastly, during the open-ended discussion with the teens, cigarette butts were mentioned a number of times as a marine debris item of concern. After some research, we discovered Surfrider's Hold On To Your Butt campaign whose goal is to reduce cigarette litter. The campaign has installed more than 200 ashcans at Huntington Beach, California and had kept around 250,000 butts out of the Pacific Ocean (Surfrider Foundation San Francisco Chapter, n.d.). The teens expressed interest in and wanted to pursue this solution of placing ashcans to reduce cigarette litter.

Through this collaborative map creation and open-ended discussion with the Aquarium Teen Ambassadors this participatory map activity has helped establish our teens' link with nature and foster positive environmental action from a bottom-up instead of top-down approach (Kudryavstev et al., 2012). The next step in our project will be to set up a meeting this upcoming January with the Aquarium Teen Ambassadors and the Atlantic Beach town council to discuss the participatory map results and solutions.

REFERENCES

Atlantic Beach. (n.d.). Retrieved October 5, 2016, from http://www.crystalcoast.com/atlantic-beach.html

Bennett-Martin, P., Visaggi, C. C., & Hawthorne, T. L. (2015). Mapping marine debris across coastal communities in Belize: developing a baseline for understanding the distribution of litter on beaches using geographic information systems. *Environmental monitoring and assessment*, *188*(10), 557.

Eastman, L., Hidalgo-Ruz, V., Macaya-Caquilpán, V., Nuñez, P., & Thiel, M. (2014). The potential for young citizen scientist projects: a case study of Chilean schoolchildren collecting data on marine litter. *Journal of Integrated Coastal Zone Management*, *14*, 569-579.

Hall, N. M., Berry, K. L. E., Rintoul, L., & Hoogenboom, M.O. (2015). Microplastic ingestion by scleractinian corals. *Marine Biology, 162(3)*, 725-732.

Hopewell, J., Dvorak, R., & Kosior, E. (2009). Plastics recycling: challenges and opportunities. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *364*(1526), 2115-212.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., ... & Law K.L. (2015). Plastic waste inputs from land into the ocean. *Science 347*(6223), 768-771.

Jambeck, J. R., & Johnsen, K. (2015). Citizen-based litter and marine debris data collection and mapping. *Computing in Science & Engineering*, *17*(4), 20-26.

Koelmans, A. A., Besseling, E., & Foekema, E. M. (2014). Leaching of plastic additives to marine organisms. *Environmental Pollution*, *187*, 49-54.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental education research*, *8*(3), 239-260.

Kudryavstev, A., Stedman, R.C., & Krasny, M.E. (2012). Sense of place in environmental education. Environmental Education Research, 18 (2), 229-250.

Moore, C. J. (2008). Synthetic polymers in the marine environment: a rapidly increasing, long-term threat. *Environmental research*, *108*(2), 131-139.

Sheavly, S. B., & Register, K. M. (2007). Marine debris & plastics: environmental concerns, sources, impacts and solutions. *Journal of Polymers and the Environment*, *15*(4), 301-305.

Surfrider Foundation San Francisco Chapter. (n.d.). Retrieved November 20, 2016, from https://sf.surfrider.org/what-we-do/holdontoyourbutt/

Topping, P. (2000, September). Marine debris: a focus for community engagement. In *Coastal Zone Canada Conference, Saint John, New Brunswick, Canada* (Vol. 17).

von Moos, N., Burkhardt-Holm, P., & Köhler, A. (2012). Uptake and effects of microplastics on cells and tissue of the blue mussel Mytilus edulis L. after an experimental exposure. *Environmental science & technology*, *46*(20), 11327-11335.

WI AB-Newport Insert – FINAL – Atlantic Beach. (n.d.). Retrieved October 5, 2016, from http://atlanticbeach-nc.com/wp-content/uploads/2015/04/Recycling-Information.pdf

APPENDIX A

Open-ended questions for community members and Aquarium Teen Ambassadors *(Before Participatory Mapping Activity)*

1. What do you feel is the largest threat to the ocean and marine ecosystem?
2. Why do you feel [answer above] is the largest threat to the ocean and marine ecosystem?
3. Do you take any personal actions at home to help the ocean and marine ecosystem?
4. What else do you think you could do to help the ocean?
5. Why do you not do [answer above] now?
6. Who or what do you think is impacted most by marine debris?
7. What do you think the relationship is between plastic pollution and marine debris and sea animal casualties?

Aquarium Teen Ambassadors *(After Participatory Mapping Activity)*

1. How do you feel about the amount of marine debris you mapped?
2. Think locally. What can we do to reduce pollution or fix these marine debris hotspots in our community?
3. Now think globally. What can we do to reduce pollution and marine debris across the world?

APPENDIX B

The Ocean Conservancy's Volunteer Ocean Trash Data Collection Form. For the full size, interactive form please visit, http://www.oceanconservancy.org/our-work/international-coastal-cleanup/data-form.pdf

TRASH COLLECTED

Citizen scientist: Pick up all trash and record all items you find below. No matter how small the items, the data you collect are important for Trash Free Seas®

EXAMPLE: Plastic Bags: 𝍸 III = 8 (TOTAL #)

Please DO NOT use words or check marks. Only **numbers** are useful data.

MOST LIKELY TO FIND ITEMS: (TOTAL #)

- Cigarette Butts
- Food Wrappers (candy, chips, etc.):
- Take Out/Away Containers (Plastic):
- Take Out/Away Containers (Foam):
- Bottle Caps (Plastic)
- Bottle Caps (Metal)
- Lids (Plastic)
- Straws/Stirrers:
- Forks, Knives, Spoons:
- Beverage Bottles (Plastic):
- Beverage Bottles (Glass):
- Beverage Cans:
- Grocery Bags (Plastic):
- Other Plastic Bags:
- Paper Bags:
- Cups & Plates (Paper):
- Cups & Plates (Plastic):
- Cups & Plates (Foam):

FISHING GEAR: (TOTAL #)

- Fishing Buoys, Pots & Traps:
- Fishing Net & Pieces:
- Rope (1 yard/meter = 1 piece):
- Fishing Line (1 yard/meter = 1 piece)

PACKAGING MATERIALS: (TOTAL #)

- 6-Pack Holders
- Other Plastic/Foam Packaging:
- Other Plastic Bottles (oil, bleach, etc.):
- Strapping Bands
- Tobacco Packaging/Wrap:

OTHER TRASH: (TOTAL #)

- Appliances (refrigerators, washers, etc.):
- Balloons:
- Cigar Tips:
- Cigarette Lighters:
- Construction Materials:
- Fireworks:
- Tires:

PERSONAL HYGIENE: (TOTAL #)

- Condoms:
- Diapers:
- Syringes
- Tampons/Tampon Applicators:

TINY TRASH LESS THAN 2.5CM: (TOTAL #)

- Foam Pieces
- Glass Pieces
- Plastic Pieces

2.5cm (actual size)

DEAD/INJURED ANIMAL	STATUS	ENTANGLED	TYPE OF ENTANGLEMENT ITEM
	Dead or Injured	Yes or No	

ITEMS OF LOCAL CONCERN:

1. 2. 3.

CLEANUP SUMMARY (circle units)

Number of Trash Bags Filled: Weight of Trash Collected: lbs/kgs Distance Cleaned: miles/km