Marine Pollution in Plettenberg Bay. It's sources and possible solutions.

ABSTRACT

Marine debris has become an ever increasing problem along beaches throughout the world. This debris has many negative effects and influences both land and marine based fauna. This report will concentrate on the effect of debris on beaches and will try to determine the source of various types of debris and how to minimize its presence.

Much of the debris collected was from shore and recreational activities which is directly related to human traffic on the beaches. This along with local activities which included unidentified bits of plastic classified as the highest collection of debris.

Both of these are an indication of human influence on the appearance of our pristine beaches. For a town that is heavily influenced by tourism, and if for no other reason than aesthetics, this is an issue that should be addressed. Not only in the process of cleaning the debris, but also with education and methods of prevention.

KEYWORDS

Beach pollution, Plastic, Solid Waste

TABLE OF CONTENTS

INTRODUCTION

Hugo and Viljoen (1992), as sited in Brand (2006) define solid waste as any material which must be disposed of, since it has no further use. This leads to one of the biggest problems that local authorities have to cope with. The rate at which solid waste is produced by far exceeds the rate at which it can be processed.

Depending on the origin of the waste, the Dept of Environmental Affairs (1988, as sited in Brand 2006) classifies solid waste matter as:

1. House hold waste-paper, food scraps, glass and used containers.
2. Garden waste and building rubble-waste from gardens, parks, sidewalks and building activities. This includes branches, leaves, grass, soil and building rubble.
3. Commercial waste-waste from shops, offices, hotels and restaurants. Consists mainly of large quantities of paper and other packaging material.
4. Litter-misplaced waste matter: mainly packaging material, paper, cardboard and food scraps.
5. Industrial waste-the residue originating from production processes
6. Mineral waste- mainly produced in the gold and coal-mining industries
7. Agricultural and forestry waste-of animal or vegetable origin eg. Dung, hay, chaff, branches and sawdust.

Sea birds, turtles, mammals and benthic organisms are often affected by plastic ingestion and/or entanglement primarily in fishing related debris (Derraik, 2002; Laist, 1997 as cited in Santos et al, 2008). Floating plastics may also act as an artificial substratum for faunal dispersal over large distances. In addition, marine debris negatively affects the scenic potential of a tourist beaches, pose a risk to the health of beach users and damage watercrafts (Santos et al 2005). The presence of debris along shorelines can lead to serious economic problems for regions that are dependent on tourism and marine activities (Ofiara and Brown, 1999 as cited by Siag Oigman-Pszczol, et al, J.C. 2007). The absence of litter has been identified as a desirable beach quality in beach users' priorities (Morgan, Jones, and Williams, 1993 as cited by Siag Oigman-Pszczol, et al, J.C. 2007).

One particular form of human impact constitutes a major threat to marine life: the pollution by plastic debris (Derraik,J.G.B. 2002). The literature on marine debris leaves no doubt that plastics make-up most of the marine litter worldwide (Derraik,J.G.B. 2002). Plastic materials

also end up in the marine environment when accidentally lost, carelessly handled (Wilber, 1987 cited by Derraik,J.G.B. 2002) or left behind by beach goers (Pruter, 1987 as cited by Derraik,J.G.B. 2002).

The Ocean Conservancy (extracted from Ocean Conservancy's 25th annual report) is a non-profit organisation that for the past 25 years has been involved with the creation of new policies, partnerships, product innovation and data collection for trash free seas. Their coastal clean-up has become the world's largest volunteer effort for ocean health. Nearly nine million volunteers from 152 countries have cleaned 15 million pounds of trash from the shores of lakes, streams, rivers and the ocean on just one day each year. They record every item on data forms (appendix 1) giving a clear picture of the manufactured items impacting the health of humans, wildlife and economies. The forms provided by The Ocean Conservancy are used for data collection during this survey and data found in their annual report will be compared to the results collected in this survey.

Originally christened Bahia Formosa (beautiful bay) by early Portuguese explorers, Plettenberg Bay Offers visitors miles of sweeping, unspoilt golden beaches. The beaches are much used by fishing and boating enthusiasts from Keurbooms strand to the Robberg Peninsula where there are 15 kilometres of beaches punctuated by the river mouth and an island (www.plettenbergbay.co.za/welcome/, 2011). These beaches are a major draw card with tourist and proudly boasts a blue flag beach. Beach cleanliness is a priority for this tourism based town.

This project aims to identify the activities that are involved in the majority of debris collected on the beaches of Plettenberg Bay. Suggestions will also be made as to how to reduce the amount of debris reaching our oceans.

STUDY AREA

Plettenberg Bay is located in the Garden Route area of the Western Cape of South Africa. It is situated between George (approximately 100km to the west) and Storms River (approximately 60km to the east) along the N2 highway. The study areas are well used beaches in the area including the Island Beach on Robberg Peninsula (34 06'23.81" S and 23 23'21.05" E), Robberg Beach which is home to Plettenberg Bay's only Blue Flag Beach (34 04' 47.30" S and 23 22'24.16" E), Central beach, which is the main boat launching beach and

enjoys high use by beach goers (34 03'30.16"S and 23 22'47.67"E) and Keurbooms River Beach (34 02'36.80" S and 23 22'41.20"E).

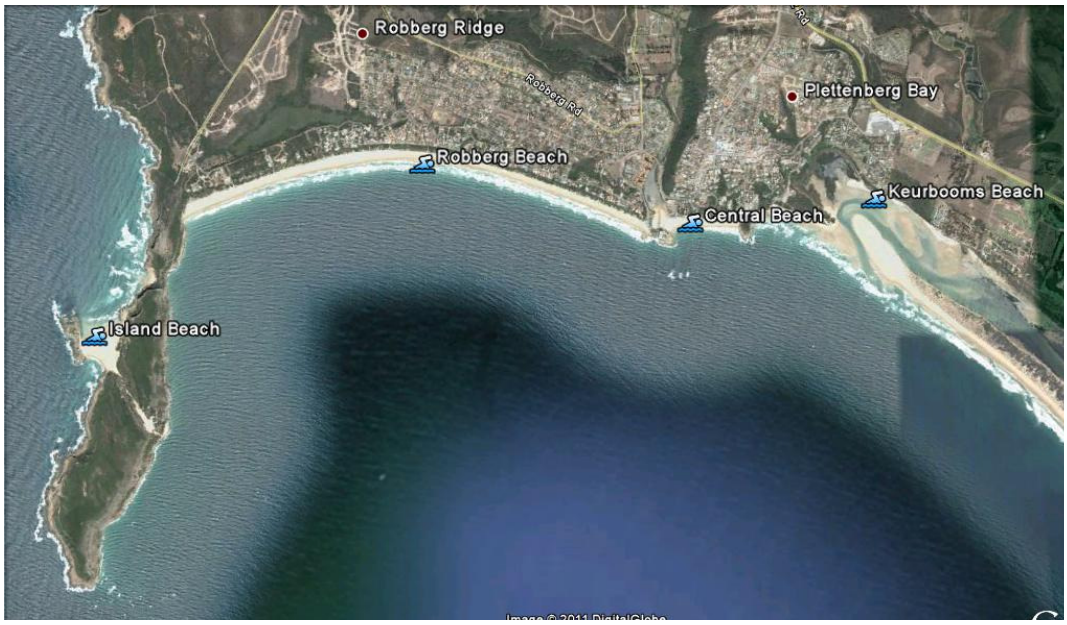

Figure 1 Clean up locations in Plettenberg Bay. www.googleearth.com, 2011

Plettenberg Bay has the oldest rocks in the area of late Precambrian age and is found south of the Outeniqua Mountains to the west of Knysna. They consist mainly of contorted bands of schist, phyllites and feldspathic quartzites of the Kaaimans Formations (Heydorn and Grindly, 1985).

The Knysna-Amatole montane forest runs along the northern border of Plettenberg Bay along the Outeniqua Mountains and is a subtropical moist broadleaf forest eco-region of South Africa. It covers an area of 3100 square kilometres in South Africa's Eastern Cape and Western Cape provinces (Wikipedia 2010). In this region, indigenous forest forms a nearly continuous belt along the Outeniqua and Tsitsikamma Mountains from Mossel Bay to Humansdorp and is widest (18 km) east of Knysna (Koen and Crowe 1987).

With its Mediterranean climate, the average summer temperature during the day is 22°C and falls to 14°C at night. In the mid-winter months (June, July and August), days are often mild and warm 19°C, but evenings brings crisp and cold temperatures (Pezula, 2010). The mean maximum temperature was 20.1°C and the mean minimum temperature 11.0° C (Koen and Crowe 1987).

Rainfall in the study area tends to be evenly distributed throughout the year (Weather Bureau 1954, 1977), contrasting with the marked seasonal rainfall which predominates throughout

most of southern Africa (Jackson, 1961). The mean annual rainfall ranges from 700mm at the coast to 1161 mm at Buffelsnek station 30/265 (Heydorn and Grindly, 1985).

The trees are of tropical and afro-montane origin, and include Ironwood *(Olea capensis)*, Stinkwood *(Ocotea bullata)*, Outeniqua Yellowwood *(Afrocarpus falcatus)*, Real Yellowwood *(Podocarpus latifolius)*, Cape Holly *(Ilex mitis)*, White Pear *(Apodytes dimidiata)*, Cape beech *(Rapanea melanophloeos),* Bastard Saffron *(Cassine peragua),* Cape Plane *(Ochna arborea),* assegai tree *(Curtisia dentata)*, Kamassi *(Gonioma kamassi)*, White Alder *(Platylophus trifoliatus)*, and Red Alder *(Cunonia capensis) (Wikipedia, 2011).*

The forests are home to African Elephant (*Loxodonta Africana*), African leopard (*Panthera pardus*), Bushbuck (*Tragelaphus scriptus*), Blue duiker (*Cephalophus monticola*), Bushpig (*Potamochoerus larvatus*) and other mammals (Wikipedia, 2011). It has a rich assortment of birds, reptiles, amphibians, and insects (Wikipedia, 2011).

MATERIALS AND METHODS

This study was carried out on four beaches in Plettenberg Bay from the 15th of January 2011 until the 30 of April of the same year. During that time, 13 samplings were completed; two on Central Beach, six on the Island Beach, four on the Keurbooms river beach and one on Robberg Beach (figure 2). The four locations selected are exposed to varying prevailing wind conditions and beach traffic. All sites are influenced by oceanographic events (e.g., cold fronts, currents, etc.) although each one differently. The Island beach has direct influence from prevailing wind conditions; Robberg Beach is nestled in the protection of Robberg Peninsula; Central beach is protected by both Robberg and the Beacon Island and the Keurbooms beach is adjacent to the estuary and is protected by the river mouth and estuary itself.

The sites varied in distance one from the other from 0.75 km to 4.0 km in length and were surveyed at various times of the day. The sampling was done opportunistically such as not to influence the time of day and wind conditions that could influence the amount of beach traffic or debris washing out. The survey was conducted in belt transects of three-metres in width above the high-tide mark, parallel to the coastline. To evaluate the composition and abundance of beach litter, all the visible pieces of man-made debris (number of items) found on each belt transect were collected, identified, categorized and recorded.

According to The Ocean Conservancy (2011), categories were labelled and defined as:

1. Shore and recreational activities - bags, balloons, beverage bottles, cans, bottle caps or lids, clothing, cups, plastic utensils, food containers or wrappers, straws, stirrers, or toys.
2. Ocean activities - bait containers or packaging, bleach/cleanser bottles, buoys/floats, crab/lobster/fish traps, crates, fishing line, fishing lures, light sticks, fishing nets, light bulbs or tubes, oil/lubricant bottles, pallets, plastic sheeting or tarps, rope, strapping bands.
3. Smoking - cigarettes, cigarette filters, lighters, cigar tips, tobacco packaging or wrapping.
4. Dumping - appliances, batteries, building material, cars/car parts, 55-gallon drums, tires
5. Medical - condoms, diapers, syringes, tampons/applicators.
6. Local Items - any three items found in your local of concern which for our location included unidentifiable plastic pieces.

Each category was tallied and entered into a spread sheet such that category subtotals for each beach and a combined total of each category could be calculated.

RESULTS

Debris was found on all locations surveyed and on all transects. The total count of all debris is located in table 1 with a total of 13 samples collected.

Table 1. Combined total of all categories at all locations including a mean number of items collected.

N=13	Weight in Kg	Shore & rec	Ocean Activities	Smoking	Dumping	Medical	Local Items	Total
Total all Locations	57.2	1621	776	317	5	9	3621	6270
Average/ collection	4.4	124.7	59.7	24.4	0.4	0.7	278.5	482
% Total waste		25.85	12.38	5.06	0.08	0.14	57.75	

In total over 57 kilograms (kg) of waste was collected over the 13 sampling periods averaging at 4.4 kg per sampling and a combined total of all categories yielded 6270 items collected and mean collection was 482 items. The dominant categories were, in descending order, local items which tallied 3621 items, shore and recreational activities tallying 1621

items, ocean activities tallying 776 items and smoking debris tallying 317 items collected. The remaining two categories recorded minimal items. Table 1 also indicated that over 57% of all debris collected was unidentifiable bits of plastic and over 25% is directly from shore and recreation activities. Only 12% is dedicated to the fishing activity and the remaining 5% is a collective of the remaining 3 categories.

Table 2. Breakdown of the categories per sampling site.

	Weight	Shore and rec	Ocean activities	Smoking	Dumping	Medical	Local items
Central Beach	14	306	22	224	0	0	104
Island Beach	19.2	933	724	15	3	7	3426
Keurbooms River	21	294	27	28	2	2	81
Robberg Beach	3	88	3	50	0	0	10

Table 2 represents a breakdown of the sample sites and the total amount of each item collected at the survey sites. This indicates that the Island Beach location carries the largest volume of shore and recreation debris (933) and local items (3426) collected.

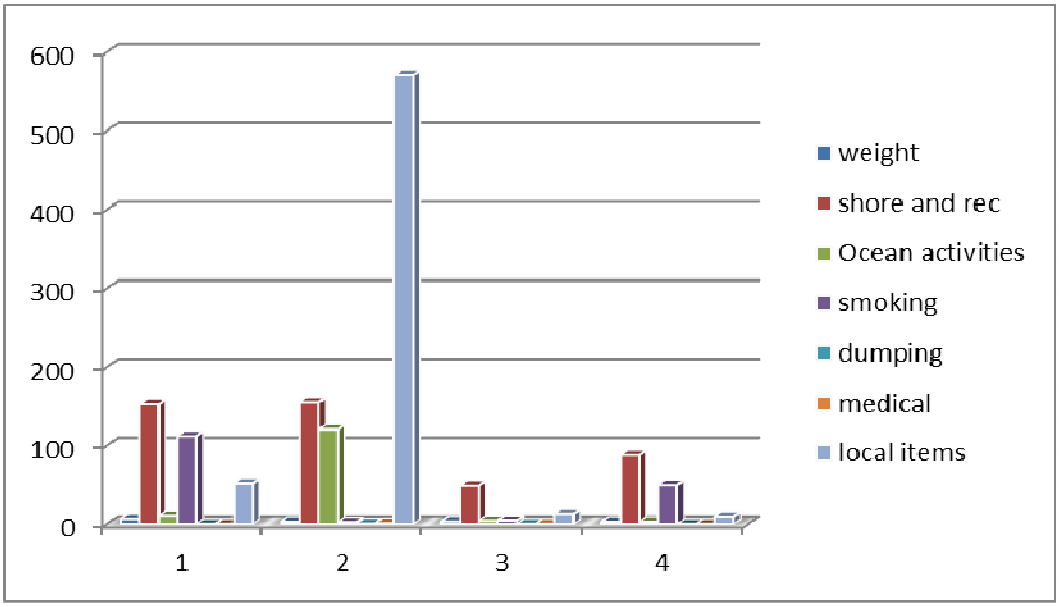

Figure 2. Average amount of debris collected per category at the four specified locations. Location 1-Central Beach, location 2-Island Beach, location 3-keurbooms Beach, location 4-Robberg Beach

Table 3 has further broken the categories down to give a mean number of each category item collected at each survey site. This gives us a clear indication of what activities are related to the debris collected. In general, the median weight collected at each site for each survey was

approx. 3 kg. For the shore and recreational activities, the Island Beach ranked the highest average debris followed closely by Central Beach. For ocean activities, the Island Beach ranked highest, for smoking activities Central Beach ranked highest at 112 followed by Robberg Beach at 50. Local items had the highest average count at Island Beach followed by Central Beach with dumping and medical debris having minimal results for all locations.

Table 3. a breakdown of the categories per sampling site and the mean items collected for each site.

	Weight	Shore and rec	Ocean activities	Smoking	Dumping	Medical	Local items
Central Beach n=2	7	153	11	112	0	0	52
Island Beach n=6	3.20	156	121	3	1	1	571
Keurbooms River n=4	3.50	49	5	5	0	0	14
Robberg Beach n=1	3	88	3	50	0	0	10

DISCUSSION

Marine debris is an ever increasing problem caused by an ever increasing 'disposable' society. The majority of the debris is produced by careless disregard and disrespect for the environment.

Of the debris collected during the survey, 25% was some form of disposable food or beverage packaging, the majority of which is plastic. Another 57% is attributed to unidentifiable plastic pits and pieces that one can assume at one time belonged to a similar kind of packaging. Our results for Shore and Recreation and Local activities far exceed the results given by the Ocean Conservancy. The remaining results were found to be significantly lower.

Table 4. Total debris collected by volunteers in South African (SA) based clean-ups according to The Ocean Conservancy's 2011 report, accumulated over 25 years.

	Shore & rec	Ocean Activities	Smoking	Dumping	Medical	Total
Total for SA.	30731	6947	3473	905	583	42639
% Total waste	66.48	15.02	7.51	1.96	1.26	

One can assume that depending on the currents, predominant winds and the type of trash created, that beaches in different areas will yield different amounts and categories of trash. This is apparent when comparing the results from the four survey sites. The Island beach does not have a high volume of beach going traffic due to its location on a nature reserve and the 2 km hike to and from the site. One can assume that the debris found on this beach is debris that is washed up from dominant wind and sea conditions. This beach is located on the windward side of the Robberg Peninsula and the dominant summer wind is the south-eastern and the dominant winter wind is the south-western, both of which blow ocean debris directly onto this beach. One factor that could also influence the amount and type of debris found here is the fact that the municipal dump is located approx. 3 km away from this beach and approx. 1km away from the shoreline.

When analysing the results from the Central Beach location one can see that again there is a lot of shore and recreational waste and local activity waste. This beach also showed a high volume of smoking debris. This indicates that there is a high volume of beach traffic and a high number of people spending time on the beach contributing to the high values of smoking related debris. The high shore and recreational waste can be attributed to the fact that there are several concession stands and restaurants located on that beach. This will definitely influence the amount of debris in general.

One sees similar smoking related results on Robberg Beach as it is a place that has a high volume of beach traffic and many people who spend time at this location. The most important variable is that there are no food or concession stands and the people who would frequent this beach would likely bring home packaged food in reusable containers. This would give a significant reduction in the amount of shore and recreation and local activity waste.

The one beach where minimal debris is found is the Keurbooms beach. This could be due to the fact that there is minimal beach traffic influencing this beach and although this beach is adjacent to an estuary that is influenced by boating traffic and beach braais, the debris is still minimal in comparison to the other beaches. This beach would also collect much of the debris that is carried downstream as it lies adjacent to a river.

These results clearly show the varied activities at the different locations and the influence from beach goers. A more intense study should be conducted to determine more specific

information and to give more accurate results. Studies during various times of the year showing the effect of holiday traffic as opposed to summer or winter traffic might also be of great importance.

CONCLUSION and RECOMMENDATIONS

It is quite apparent from the above information that marine debris is manmade and man caused. The debris that has been collected during this survey was found to be mostly from local items (ie unidentified pieces of plastic) and shore and recreational activities. These combined provided over 83% of debris collected. The debris also mostly consists of plastics which can take many years do biodegrade.

There are many ways to deal with ocean trash and in many cases the finger is pointed at everyone else. In fact, we all have a responsibility for clean lands and waterways. Many people say that it is such a big problem, what can they do? Well, every journey begins with the first step and with many people taking these first steps this is easily achieved.

1. Rather than pointing fingers at the industries that do cause some of the problems, do what you can to prevent ocean trash by reducing what is purchased, recycling where possible and reusing as much as possible.
2. Use trash bins that have closing lids so that trash that has been carefully placed in the bins cannot be blown out by the wind or removed by animals.
3. Be a leader, organise a beach clean-up in your area to encourage community involvement and pride in your beaches.
4. Encourage municipalities or your local rate payers association to provide bins on the beaches and high traffic beach access areas.
5. As a method of recycling and community involvement, provide a bin for recycled bags near one of your beach access areas and encourage people to take a bag and clean the beaches while they are strolling along or walking their dogs.
6. Educate your community about the health hazards and danger to wild life caused by our debris.
7. Write to producers of plastic products to encourage them to make more environmentally friendly products.
8. Write to your local/provincial/national representatives in government encouraging them to strengthen and enforce recycling laws.

If everyone contributes to ocean trash in one way or another, everyone can also contribute to the removal of trash and keeping our valuable beaches clean. This study has only looked at the beaches and the debris collected on them but has not taken into account the effect on human and wildlife health. These are aspect of equal importance and would require separate studies.

ACKNOWLEDGEMENTS

Much of this report would not have been possible if it were not for the assistance of the many people. I wish to express my appreciation to all of them but most specifically: I wish to give my most sincere thanks to Cape Nature in Plettenberg Bay and Henk Nieuwoudt, manager of Cape Nature, for allowing us to conduct the required research on the various areas in the nature reserve; I would like to thank volunteers of the ORCA Foundation for assisting in the collection of data; and I would also like to thank the many people who were involved in the various proof reading sessions. Finally, I wish to thank my parents for giving me the opportunity to study and my husband for his patience during my years of study.

REFERENCES

Derraik, J.G.B. 2002. The pollution of the marine environment by plastic debris: a review Marine Pollution Bulletin 44 (2002) 842–852

Google Earth, 2011. Available on the internet at www.googleearth.com. 2011/02/04

Heydorn, A. E. and Grindly, J. R. 1985. Estuaries of the Cape: Part II Synopses ofavailable information on individual Systems Report 30. CSIR Research Report,Associated Printing and Publishing Co (PTY) Ltd, Cape Town.

Jackson SP. 1961. Climatological atlas of Africa. Government Printer, Pretoria

Koen, J. H. and Crowe, T. M. 1987 Animal-Habitat Relationships in the Knysna Forest, South Africa: Discrimination between Forest Types by Birds and Invertebrates, Oecologia, Vol. 72,No. 3. Pg 414-422.

Pezula. 2010. Knysna's warm, temperate climate makes it the perfect all-year-round destination. Available on the internet at http://www.pezula.co.za/area/climate.html 2010/11/14

Plettenberg Bay and Surrounds Home page [online]. 2011. Available on the internet at http://www.plettenbergbay.co.za/welcome/ 2011/05/21

Santos, I.R., Friedrich, A.C. and Ivar do Sul, J.A. 2008. Marine Debris contamination along undeveloped tropical beaches from Northeast Brazil. Congresso Brasiliero de Oceanografica.

Siag Oigman-Pszczol, Simone and Creed, J.C. 2007. Quantification and Classification of Marine Litter on Beaches along Armação dos Búzios, Riode Janeiro, Brazil. Journal of Coastal Research, Vol. 23, No. 2 (Mar., 2007), pp. 421-428

The Ocean Conservancy 2011 Report. Tracking Trash, 25 Years of action for the ocean.

UNISA. 2006. Conservation ecology III, Study Guide 1. Florida

Weather Bureau. 1954. Climate of South Africa. Part 1. Climatic Statistics. Government Printer, Pretoria: South Africa Weather Bureau. 1977. Climatic Data. File R2250/Inheemse Soorte. Department of Environmental Affairs

Wikipedia [online]. 2011. Available on the internet at http://en.wikipedia.org/wiki/Knysna-Amatole_montane_forests. 2010/11/14

APPENDIX

INTERNATIONAL COASTAL CLEANUP™ DATA CARD

The Ocean Conservancy

Thank you for participating in the International Coastal Cleanup! The effort you are making today is the first step to ensuring there are cleaner oceans and waterways year-round. By taking the time to fill out both sides of this data card, The Ocean Conservancy will be able to compile and analyze data collected by over 300,000 volunteers in over 90 countries, and be able to identify the activities and general sources causing the debris. An annual report will then be created and distributed to help educate the public, business, industry, and government officials about marine debris issues. Your work today truly makes a world of difference.

I. CLEANUP SITE INFORMATION

Type of Cleanup: ❑ Shoreline/Beach ❑ Underwater ❑ River/Stream/Tributary ❑ Lake

Location of Cleanup: State_____ Country_____

Province_____ Zone or County Cleaned:_____

Cleanup Site Name (beach, park, etc.):_____

Today's Date: Month_____ Day_____ Year_____ Name of Coordinator:_____

Number of People Working on This Card:_____ Distance Cleaned:_____miles or_____km

Number of Trash Bags Filled:_____ Total Estimated Weight Collected:_____lbs. or_____kgs.

Estimated Time Spent on Cleanup:_____

II. CONTACT INFORMATION (EACH INDIVIDUAL TEAM MEMBER)

1. Name:_____
   Email Address:_____
2. Name:_____
   Email Address:_____
3. Name:_____
   Email Address:_____
4. Name:_____
   Email Address:_____

III. ENTANGLED ANIMALS: (❑ Dead or ❑ Alive). List all the entangled animals found during the Cleanup. Tell us what they were entangled in (fishing line, rope, net, etc.) _____

WHAT WAS THE MOST PECULIAR ITEM YOU COLLECTED?_____

The following national and international organizations endorse and/or support the International Coastal Cleanup:

- NOAA–Marine Debris Program
- U.S. Environmental Protection Agency
- IUCN–The World Conservation Union
- Intergovernmental Oceanographic Commission (IOC) of the United Nations' Educational, Scientific, and Cultural Organization (UNESCO)

Please return this card to your area coordinator or mail it to:

The Ocean Conservancy
2029 K Street, NW
Washington, DC 20006
Phone: 202-429-5609
Fax: 202-872-0619
www.oceanconservancy.org

International Coastal Cleanup
The Ocean Conservancy

Figure 3. Coastal Clean-up Data Collection Sheet (Coastal Cleanup, 2011)

ITEMS COLLECTED

Please pick up all debris that you find. Only record information for the items listed below.

Keep a count of your items using tick marks and enter the item total in the box.

Example: [8] **Beverage Cans** 𝍸 III

SHORELINE AND RECREATIONAL ACTIVITIES

(Debris from fast food, beach-goers, sports/games, festivals, litter from streets/storm drains, etc.)

- [ ] Bags (paper or plastic)
- [ ] Balloons
- [ ] Beverage Bottles (plastic) 2 liters or less
- [ ] Beverage Bottles (glass)
- [ ] Beverage Cans
- [ ] Caps, Lids
- [ ] Clothing, Shoes
- [ ] Cups, Plates, Forks, Knives, Spoons
- [ ] Food Wrappers/Containers
- [ ] Pull Tabs
- [ ] 6-Pack Holders
- [ ] Shotgun Shells/Wadding
- [ ] Straws, Stirrers
- [ ] Toys

OCEAN/WATERWAY ACTIVITIES

(Debris from recreational/commercial fishing and boat/vessel operations)

- [ ] Bait Containers/Packaging
- [ ] Bleach/Cleaner Bottles
- [ ] Buoys/Floats
- [ ] Crab/Lobster/Fish Traps
- [ ] Crates
- [ ] Fishing Line
- [ ] Fishing Lures/Light Sticks
- [ ] Fishing Nets
- [ ] Light Bulbs/Tubes
- [ ] Oil/Lube Bottles
- [ ] Pallets
- [ ] Plastic Sheeting/Tarps
- [ ] Rope
- [ ] Strapping Bands

SMOKING-RELATED ACTIVITIES

- [ ] Cigarettes/Cigarette Filters
- [ ] Cigarette Lighters
- [ ] Cigar Tips
- [ ] Tobacco Packaging/Wrappers

DUMPING ACTIVITIES

- [ ] Appliances (refrigerators, washers, etc.)
- [ ] Batteries
- [ ] Building Materials
- [ ] Cars/Car Parts
- [ ] 55-Gal. Drums
- [ ] Tires

MEDICAL/PERSONAL HYGIENE

- [ ] Condoms
- [ ] Diapers
- [ ] Syringes
- [ ] Tampons/Tampon Applicators

DEBRIS ITEMS OF LOCAL CONCERN

(Identify and count 3 other items found that concern you)

- [ ]
- [ ]
- [ ]

Figure 4. Coastal Clean-up Data Collection Sheet (Coastal Cleanup, 2011)