NOAA Marine Debris Shoreline Survey Field Guide

Sarah Opfer, Courtney Arthur, and Sherry Lippiatt

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Marine Debris Program

January 2012

This shoreline protocol was developed and tested by the NOAA Marine Debris Program. This document is a revised version of the August 2011 field guide, and should be treated as a draft protocol that may be altered in the future. Further testing is currently underway to develop a statistically robust survey design that will recommend the frequency of sampling, number of transects, and sampling unit size at site, location, and regional spatial scales.

NOAA Marine Debris Shoreline Survey Field Guide

Sarah Opfer,[1, 2] Courtney Arthur,[1, 2] and Sherry Lippiatt[1, 2]

[1] I.M. Systems Group, Inc.
3206 Tower Oaks Boulevard
Suite 300
Rockville, MD 20852, USA

[2] National Oceanic and Atmospheric Administration
Office of Response & Restoration
Marine Debris Program
Silver Spring, MD 20910, USA

January 2012

For copies of this document, please contact:
NOAA Marine Debris Program
Email: MD.monitoring@noaa.gov
Website: www.MarineDebris.noaa.gov

Contents

Introduction

Marine debris has become one of the most widespread pollution problems in the world's oceans and waterways today. The NOAA Marine Debris Program (MDP) serves as a centralized marine debris resource within NOAA, coordinating and supporting activities within NOAA and with other federal agencies. The MDP uses partnerships to support projects carried out by state and local agencies, tribes, non-governmental organizations, academia, and industry.

Marine debris monitoring programs are necessary to compare debris sources, amounts, locations, movement, and impacts across the US and internationally. Monitoring data can be used to evaluate the effectiveness of policies to mitigate debris and provide insight into priority targets for prevention. Thus, the NOAA MDP has developed standardized marine debris shoreline survey protocols to facilitate regional and site-specific comparisons. This document provides a standard data sheet and two different methods for shoreline monitoring and assessment.

Types of Shoreline Surveys

The objectives of your study will determine how you monitor for marine debris. There are two main types of shoreline surveys: accumulation and standing-stock surveys.

- Accumulation studies provide information on the rate of deposition (flux) of debris onto the shoreline. These studies are more suited to areas that have beach cleanups, as debris is removed from the entire length of shoreline during each site visit. This type of survey is more labor-intensive and is used to determine the rate of debris deposition (# of items per unit area, per unit time). Accumulation studies can also provide information about debris type and weight. These surveys cannot be used to measure the density of debris on the shoreline because removal of debris biases the amount of debris present during subsequent surveys.
- Standing-stock studies provide information on the amount and types of debris on the shoreline. Debris within discrete transects at the shoreline site is tallied during standing-stock surveys. This is a quick assessment of the total load of debris and is used to determine the density (# of items per unit area) of debris present. Debris density reflects the long-term balance between debris inputs and removal and is important to understanding the overall impact of debris.

Table 1. Salient characteristics of standing-stock and accumulation surveys.

CHARACTERISTIC	STANDING-STOCK	ACCUMULATION
Debris removed during surveys?	No	Yes
Time required per survey	Less	More
Length of shoreline site	100 m	100 m or longer
Is a set survey interval required (e.g., once per week or per month)?	Yes	Yes
Types of data that can be collected	• Debris density (# of items / unit area) • Debris material types	• Debris deposition rate (# of items / unit area / unit time) • Debris material types • Debris weight

We suggest that users give careful consideration to which type of survey best suits their goals and objectives. Table 1 provides important information to take into account when deciding how to monitor. Once a survey type is chosen, meaningful data can be collected through regular monitoring. The following sections describe how to choose survey sites and conduct surveys.

How to Pick Your Site

To select your sampling site(s), follow these steps:

1. The first step is to choose an appropriate shoreline location based on the objectives of your study. For example, if you wish to examine the impact of land use, you should select locations in watersheds with various land use types. Next, categorize the various areas within your location (it may help to use an aerial photo or map, as shown below). For example, your location may cover a span of shoreline 1 km long. Within that 1 km, there may be an area with heavy recreational use and another area where an urban stream mouth is located. Identify any barriers to shoreline access or offshore structures that may affect nearshore circulation (e.g. jetties).

2. Select shoreline sites (where you will sample) according to the characteristics below. If your location includes different use areas (for example, an area with heavy recreational use and a more remote area), it is preferable to select a site within each use category.

Shoreline sites should have the following characteristics:

- Sandy beach or pebble shoreline
- Clear, direct, year-round access
- No breakwaters or jetties
- At least 100 m in length parallel to the water (note that standing-stock surveys require a 100-m shoreline site)
- No regular cleanup activities

These characteristics should be met where possible, but can be modified.

Before You Begin Your Surveys

Before any data collection begins, the Shoreline Characterization Sheet should be completed for each shoreline site. On this data sheet you will note:

- GPS coordinates in decimal degrees at the beginning and end of your shoreline site, or at the site's four corners if the width of the beach is > 6 m;
- Shoreline characteristics (e.g. tidal range and substrate); and
- Surrounding land-use characteristics that may influence the delivery of land-based debris to the site (e.g., farmland 5 km from a small town or urban parkland 50 m from a river mouth).

The Shoreline Characterization Sheet needs to be completed only once per site per year unless major changes occur to the shoreline.

Shore IDs (on the Shoreline Characterization Sheet) should be created based on the initials of the shoreline name (e.g., Fort Smallwood = FS). This will make it easier to keep track of multiple sampling sites.

The Shoreline Characterization Sheet and Debris Density Data Sheet were adapted from Cheshire et al. (2009)[1].

You will need the following supplies in order to complete your surveys:

- Digital camera
- Hand-held GPS unit
- Extra batteries for GPS and camera (we recommend rechargeable batteries)
- Surveyor's measuring wheel - *for standing-stock surveys only*
- Flag markers or stakes
- ~100′ fiberglass measuring tape
- First aid kit (including sunscreen, bug spray, drinking water)
- Work gloves
- Sturdy 12″ ruler
- Clipboards for data sheets
- Data sheets (on waterproof paper)
- Pencils
- Trash bag or bucket - *for accumulation surveys only*

Safety is a priority. Do not touch or lift potentially hazardous or large, heavy items. Notify your local officials if such items are encountered.

All of the data collection forms you will need are included in Appendix A at the end of this document. The same data collection forms are used for accumulation and standing-stock surveys.

- Shoreline Characterization Sheet (pp. 8–9)
- Debris Density Data Sheet (pp. 10–12)

[1] Cheshire, A. C., E. Adler, et al. (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter, UNEP Regional Seas Intergovernmental Oceanographic Commission: 132 pp.

Accumulation Surveys

If you decide to conduct accumulation surveys, follow this protocol:

1. BEFORE arriving at the site, check local tide tables and plan to arrive at your site during low tide.

2. ONCE ARRIVED, begin filling out the Debris Density Data Sheet's Additional Information section. Mark the beginning and end of your shoreline site, perhaps with flags or stakes. (Remember to pick up these markers at the end of your survey to make sure they do not become marine debris!) The back of the shoreline is where the primary substrate (e.g., sand) changes (e.g., sand becomes gravel) or at the first barrier (e.g., vegetation line).

3. In order to cover the entire site from water's edge to the back of the shoreline, decide whether you will traverse the survey area parallel or perpendicular to the water. See Appendix B for walking pattern schematics. If more than one surveyor is available, the survey area should be divided evenly with clearly specified areas assigned to each individual. Surveyors should traverse the survey area in a pre-determined walking pattern until the entire site is cleared of marine debris.

4. Record on your Debris Density Data Sheet counts of debris items that measure over 2.5 cm, or 1 inch (~bottle cap size), in the **longest** dimension (see Figure 1). If any part of the item is within the survey area, count the item. Record large debris items, anything bigger than 1 foot (~ 0.3 m, typical forearm length from palm to elbow) in the large debris section of the Debris Density Data Sheet.

5. Take photos of your shoreline site and some of the debris items!

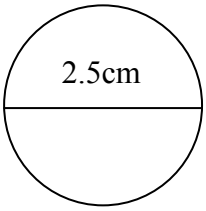


Figure 1. Minimum debris size to be counted. **This size is required to keep surveyors counting the same size items and to help keep the survey results uniform.*

Standing-stock Surveys

If you decide to conduct standing-stock surveys, follow this protocol:

1. Sketch your 100-m shoreline site and divide the 100 m into 5-m segments. There should be 20 of them. Number each section (left to right) from 1 to 20. Each 5-m segment should run from the water's edge to the back of the shoreline (Figure 2). The back of the shoreline is where the primary substrate (e.g., sand) changes (e.g., sand becomes gravel) or at the first barrier (e.g., vegetation line).

2. BEFORE arriving at the site, select four numbers from the Random Number Table (Appendix C) by first choosing a number between 1 and 5, and then a number between 1

and 4. The corresponding number in the table (1–20) is one of the four transects you will survey. Complete this exercise four times to choose four random transects (each transect can be used only once per survey). These numbers correspond to the 5-m segments you drew on your sketch and are called transect ID numbers (see Debris Density Data Sheet). You should fill out one Debris Density Data Sheet per transect. On any sampling day, 20 m of your 100-m shoreline site is analyzed (i.e., 20% coverage of the area). In addition, check local tide tables and plan to arrive at your site during low tide.

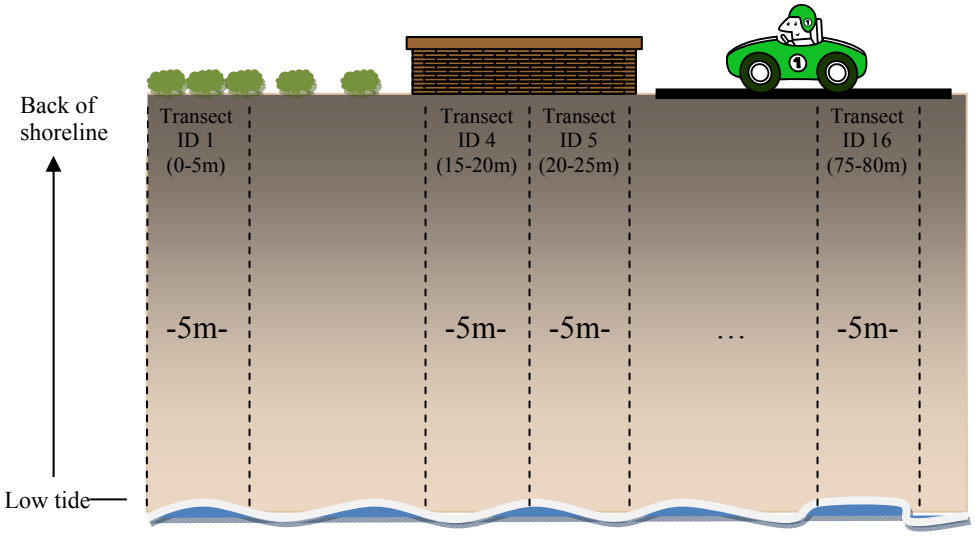


Figure 2. Shoreline section (100 m) displaying perpendicular transects from water's edge at low tide to the first barrier at the back of the shoreline section.

3. ONCE ARRIVED, begin filling out the Debris Density Data Sheet Additional Information section. Using your measuring wheel, begin at the start of your shoreline section and mark the four selected transect boundaries with flags according to the distances provided in the Transect ID table (for example, transect 12 covers 55 to 60 m from the start of your shoreline section).

4. Measure the width of each transect from water's edge to the back of the shoreline. Record GPS coordinates for each transect in decimal degree format. For shoreline segments that are less than 6 m wide from the water's edge to the back of the shoreline, GPS coordinates should be taken at the center (Figure 3). For shoreline segments that are over 6 m wide, take GPS coordinates at two spots—one nearer the back of the shoreline and one nearer the water.

5. Walking each transect from water's edge to the back of the shoreline, record on your Debris Density Data Sheet counts of debris items that measure over 2.5 cm, or 1 inch (~bottle cap size), in the **longest** dimension (see Figure 1). If any part of the item is within the sample transect, count the item. *Remember that for standing-stock surveys, debris is not removed from the shoreline.* Record large debris items, anything bigger than 1 foot (~ 0.3 m, typical forearm length from palm to elbow) in the large debris section of the Debris Density Data Sheet.

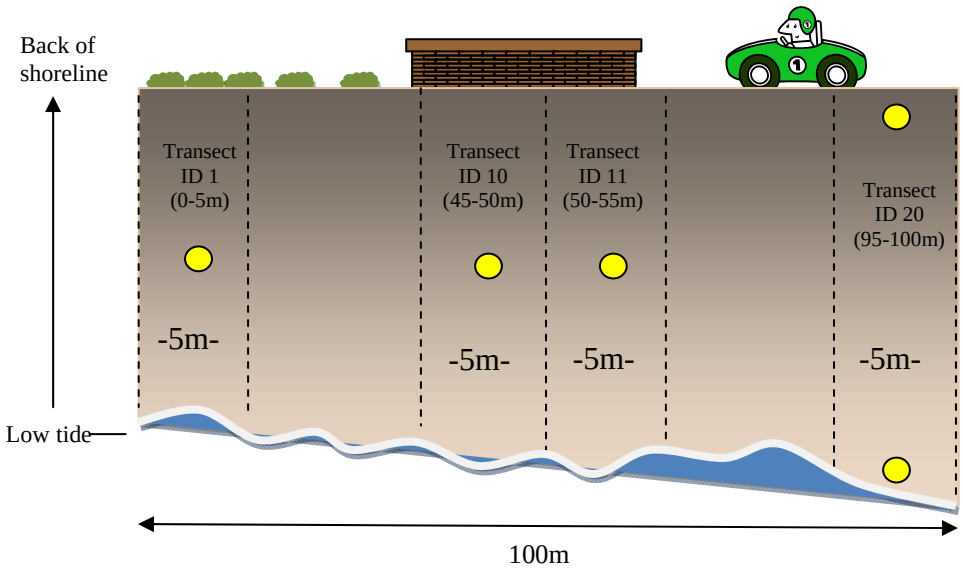


Figure 3. Example of a shoreline section (100m) with yellow circles indicating marked GPS coordinates. Width determines location of GPS coordinates.

6. Take photos of each transect and some of the debris items!

Submitting Your Shoreline Debris Data to NOAA

Marine debris monitoring groups should plan to compile and analyze their own survey results. The NOAA MDP will have periodic calls for data from monitoring groups. If you would like more information on data analysis or to be included in data calls, please send an email to MD.monitoring@noaa.gov.

Appendix A: Data Forms

SHORELINE DEBRIS Shoreline Characterization Sheet	Organization		Name of organization responsible for collecting the data
	Surveyor name		Name of person responsible for filling in this sheet
	Phone number		Phone contact for surveyor
Complete this form **ONCE** for each site location	Date		Date of this survey

SAMPLING AREA

Shore ID			Unique code for the shoreline
Shoreline name			Name by which the section of shoreline is known (e.g., beach name, park)
State/County			State and county where your site is located
Coordinates at start of shoreline section	Latitude	Longitude	Recorded as XXX.XXXX (decimal degrees) at start of shoreline section (in both corners if width > 6 meters)
Coordinates at end of shoreline section	Latitude	Longitude	Recorded as XXX.XXXX (decimal degrees) at end of shoreline section (in both corners if width > 6 meters)
Photo number/ID			The digital identification number(s) of photos taken of shoreline section

SHORELINE CHARACTERISTICS – from beginning of shoreline site

Length of sample area (should be 100 m if standing-stock survey)		Length measured along the midpoint of the shoreline (in meters)
Substratum type		For example, a sandy or gravel beach
Substrate uniformity		Percent coverage of the main substrate type (%)
Tidal range		Maximum & minimum vertical tidal range. Use tide chart (usually in feet).
Tidal distance		Horizontal distance (in meters) from low- to high-tide line. Measure on beach at low and high tides or estimate based on wrack lines.
Back of shoreline		Describe landward limit (e.g., vegetation, rock wall, cliff, dunes, parking lot)
Aspect		Direction you are facing when you look out at the water (e.g., northeast)

LAND-USE CHARACTERISTICS – within shoreline location

Location & major usage	Urban		Select one and indicate major usage (e.g., recreation, boat access, remote)
	Suburban		
	Rural		
Access			Vehicular (you can drive to your site), pedestrian (must walk), isolated (need a boat or plane)
Nearest town			Name of nearest town
Nearest town distance			Distance to nearest town (miles)
Nearest town direction			Direction to nearest town (cardinal direction)
Nearest river name			If applicable, name of nearest river or stream. If blank, assumed to mean no inputs nearby
Nearest river distance			Distance to nearest river/stream (km)
Nearest river direction			Direction to nearest river/stream (cardinal direction from site)
River/creek input to beach	YES	NO	Whether nearest river/stream has an outlet within this shoreline section
Pipe or drain input	YES	NO	If there is a storm drain or channelized outlet within shoreline section
Notes (including description, landmarks, fishing activity, etc.):			

SHORELINE DEBRIS **Debris Density Data Sheet**	Organization		Name of organization responsible for data collection
	Surveyor name		Name of person responsible for filling in this sheet
	Phone number		Phone contact for surveyor
Complete this form during **EACH** survey or transect (if standing-stock) per site visit	Email address		Email contact for surveyor
	Date		Date of this survey

ADDITIONAL INFORMATION

Shoreline name			Name for section of shoreline (e.g., beach name, park)
Survey Type	Accumulation ☐	Standing-stock ☐	Type of shoreline survey conducted (check box)
Transect ID # (N/A if accumulation survey)			Transect ID (include shoreline ID, date, and transect #)
Coordinates of start of shoreline site	Latitude	Longitude	Recorded as XXX.XXXX (decimal degrees). Record in both corners if width > 6 m. If transect, record at water's edge.
Coordinates of end of shoreline site	Latitude	Longitude	Recorded as XXX.XXXX (decimal degrees). Record in both corners if width > 6 m. If transect, record at back of shoreline.
Width of beach			Width of beach at time of survey from water's edge to back of shoreline (meters)
Time start/end	Start	End	Time at the beginning and end of the survey
Season			Spring, summer, fall, winter, tropical wet, etc.
Date of last survey			Date on which the last survey was conducted
Storm activity			Describe significant storm activity within the previous week (date(s), high winds, etc.)
Current weather			Describe weather on sampling day, including wind speed and % cloud coverage
Number of persons			Number of persons conducting the survey
Large items	YES	NO	Did you note large items in the large debris section?
Photo ID #s			The digital identification number(s) of debris photos taken during this survey.

Notes: Evidence of cleanup, sampling issues, etc.

DEBRIS DATA: (continued on back)

ITEM	TALLY (e.g., ~~IIII~~)			TOTAL
PLASTIC				
Plastic fragments	Hard	Foamed	Film	
Food wrappers				
Beverage bottles				
Other jugs or containers				
Bottle or container caps				
Cigar tips				
Cigarettes				
Disposable cigarette lighters				
6-pack rings				
Bags				
Plastic rope/small net pieces				
Buoys & floats				
Fishing lures & line				
Cups (including polystyrene/foamed plastic)				
Plastic utensils				
Straws				
Balloons				
Personal care products				
Other:				
METAL				
Aluminum/tin cans				
Aerosol cans				
Metal fragments				
Other:				
GLASS				
Beverage bottles				
Jars				
Glass fragments				
Other:				

ITEM	TALLY (e.g., ~~IIII~~)	TOTAL
RUBBER		
Flip-flops		
Gloves		
Tires		
Rubber fragments		
Other:		
PROCESSED LUMBER		
Cardboard cartons		
Paper and cardboard		
Paper bags		
Lumber/building material		
Other:		
CLOTH/FABRIC		
Clothing & shoes		
Gloves (non-rubber)		
Towels/rags		
Rope/net pieces (non-nylon)		
Fabric pieces		
Other:		
OTHER/UNCLASSIFIABLE		

***LARGE DEBRIS ITEMS* (> 1 foot or ~ 0.3 m)**

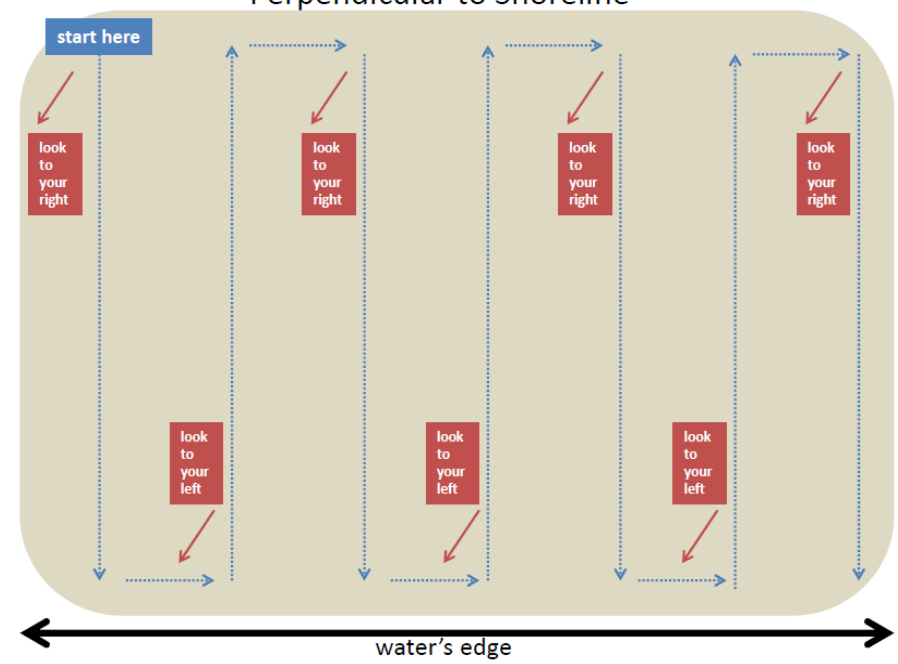
Item type (vessel, net, etc.)	Status (sunken, stranded, buried)	Approximate width (m)	Approximate length (m)	Description / photo ID #

Notes on debris items, description of "Other/unclassifiable" items, etc:

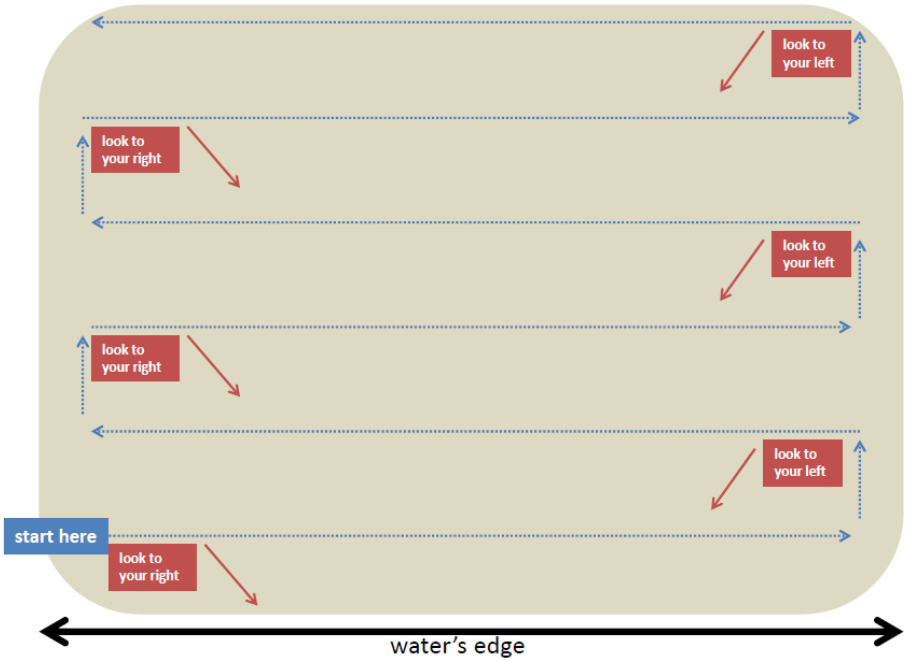
Appendix B: Shoreline Walking Patterns

The schematics below are potential survey walking patterns to ensure that the entire shoreline site or transect is covered. Suggested distance between walking lines is approximately one meter.

Walking Pattern #1:
Perpendicular to Shoreline



Walking Pattern #2
Parallel to Shoreline



APPENDIX C: RANDOM TRANSECT SELECTION

If you are conducting a standing-stock survey, use these tables to select transects. BEFORE arriving at the site, select four numbers from the Random Number Table, by first choosing a number between 1 and 5, and then a number between 1 and 4. The corresponding number in the table (1–20) is one of the four transects you will survey. Complete this exercise four times to choose four random transects (each transect can be used only once per survey).

Random Number Table					
	1	2	3	4	5
1	4	8	17	9	1
2	7	19	2	12	20
3	18	14	6	16	11
4	3	5	15	10	13

Transect ID and distance along shore from start of 100-m shoreline section (see Figure 2 above)

Transect ID	Meters	Feet and inches
1	0–5 m	0–16' 4"
2	5–10 m	16'4"–32'9"
3	10–15 m	32'9"–49'2"
4	15–20 m	49'2"–65'7"
5	20–25 m	65'7"–82'
6	25–30 m	82'–98'5"
7	30–35 m	98'5"–114'9"
8	35–40 m	114'9"–131'2"
9	40–45 m	131'2"–147'7"
10	45–50 m	147'7"–164'
11	50–55 m	164'–180'5"
12	55–60 m	180'5"–196'10"
13	60–65 m	196'10"–213'3"
14	65–70 m	213'3"–229'7"
15	70–75 m	229'7"–246'
16	75–80 m	246'–262'5"
17	80–85 m	262'5"–278'10"
18	85–90 m	278'5"–295'3"
19	90–95 m	295'3"–311'8"
20	95–100 m	311'8" - 328'1"

United States Department of Commerce

John Bryson
Secretary

National Oceanic and Atmospheric Administration

Jane Lubchenco, Ph.D.
Undersecretary of Commerce for Oceans and Atmosphere
Administrator, National Oceanic and Atmospheric Administration

National Ocean Service

David Kennedy
Assistant Administrator for Ocean Services and
Coastal Zone Management