Monitoring Marine Debris in Virginia's Coastal Zone
Project Report

Virginia Coastal Zone
MANAGEMENT PROGRAM

VIRGINIA
AQUARIUM
& MARINE SCIENCE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

CLEAN
VIRGINIA
WATERWAYS
Of Longwood University

Christina
Trapani
Consulting

2013 VIRGINIA COASTAL ZONE MANAGEMENT PROGRAM GRANT
November 1, 2016
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All photos by Christina Trapani unless otherwise noted.

Visit www.longwood.edu/cleanva/VAdebrismonitoring.htm for more information on this research project.

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The mission of the Virginia Aquarium is to inspire conservation of the marine environment through education, research and sustainable practices. The Aquarium is operated by the City of Virginia Beach in cooperation with the Virginia Aquarium Foundation (VAQF) and the Commonwealth of Virginia. The Virginia Aquarium Research & Conservation section is responsible for directing the organization's efforts in these areas.

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Monitoring Marine Debris in Virginia's Coastal Zone

EXECUTIVE SUMMARY

Volunteers remove clam netting from the accumulation site at FINWR.

With support from the NOAA Office for Coastal Management through the Virginia Coastal Zone Management Program, the Virginia Aquarium & Marine Science Center and Clean Virginia Waterways (Longwood University) conducted 30 months of systematic marine debris monitoring on four coastal beaches in Virginia. The study sites were Back Bay National Wildlife Refuge (BBNWR) in Virginia Beach; Grandview Nature Preserve (GNP) in Hampton, Fisherman Island National Wildlife Refuge (FINWR) in Northampton County, and Chincoteague National Wildlife Refuge (CNWR) in Accomack County.

Efficient use of resources throughout the project allowed for the original timeline of 18 months to be extended for an additional 12 months. The extended project study period of 30 months included three Atlantic hurricane seasons, though no hurricanes made landfall in Virginia during this period. With additional funding from NOAA (Grant # NA16NOS4190171), a new phase of this project was initiated on October 1, 2016, including continued monthly monitoring of the four coastal beach study sites. As a result, this project report will not include a final analysis of survey data, but instead will provide an interim report. A final report will be produced after monitoring is completed under the new grant. During the completed 30 month study period, a total of 125 accumulation surveys and 125 standing stock surveys were conducted: 64 surveys at BBNWR, and 62 each at CNWR, FINWR and GNP. More than 1,400 hours of effort were contributed by volunteer monitors. As of October 28, 2016, 6,777 pieces of debris were documented and entered into the NOAA online database. The vast majority (83%) of debris items recorded at the four monitoring sites were made of plastics, and 51% of the debris was found on one of the four sites: Fisherman Island NWR.

Marine debris at the FINWR site.

BACKGROUND

Growing concern about the impacts of debris in ocean and coastal waters, along with increasing emphasis on stormwater management as it relates to litter and debris, have led to a new urgency to understand and address the sources of marine debris in Virginia. According to the National Oceanic and Atmospheric Administration (NOAA), marine debris has become one of the most widespread pollution problems in the world's oceans and waterways. Systematic monitoring of marine debris is necessary in order to understand sources, locations, amounts, movement, impacts, and accumulation rates. Long-term monitoring also supports evaluation of the effectiveness of educational outreach, pollution prevention strategies, and policies that are put in place to reduce this form of pollution. Monitoring data will also facilitate regional and site-specific comparisons over time, and will provide insights into priority targets for prevention.

A breakout session at the first Virginia Marine Debris Summit.

To strategically address this problem, the Virginia CZM Program undertook a participatory and collaborative planning process from 2012 to 2014. One of the first steps was to organize the first Virginia Marine Debris Summit (February 27-28, 2013 in Virginia Beach) during which participants discussed many gaps in the knowledge about marine debris, including the need for high-value data about the quantity and types of marine debris found on Virginia's beaches. While extensive data exists about the types of litter and trash found on Virginia's beaches and in coastal waters, these data are mostly of the "snapshot" variety, and need to be supplemented with data collected using more rigorous protocols. This grant project used the Marine Debris Shoreline Survey protocols developed by the NOAA Marine Debris Program.

All project partners have a history of engagement in marine debris reduction efforts in Virginia including balloon debris monitoring programs, data collection through the International Coastal Cleanup, cigarette litter prevention campaigns, and social marketing studies.

Project Objectives

The objectives of this project were to initiate a marine debris monitoring program that included: recruit and train volunteer monitors to work with a contracted survey coordinator; collect 30 months of data from April 2014 through September 2016 (including three hurricane seasons, summer/fall 2014-16); analyze the data; and develop a plan to continue monitoring after the initial grant period. In addition, project

coordinators planned to develop and strengthen partnerships with pollution-prevention nonprofits, ocean advocacy organizations, the U.S. Fish and Wildlife Service, and others. The data will serve as a baseline against which Virginia can evaluate the effectiveness of the Virginia Marine Debris Reduction Plan developed with FY11 CZM funds.

Original Grant Timeline

The original grant timeline provided for nine months of marine debris monitoring. As a result of efficient use of resources by the project team and a desire to continue the survey study period to include at least three hurricane seasons, the project was extended to cover 30 months of monitoring thanks to no-cost grant extensions from the Virginia CZM Program.

METHODS

This grant project used the Marine Debris Shoreline Survey protocols and data sheets developed by the NOAA Marine Debris Program (Opfer, Arthur, Lippiatt, 2012 and Lippiatt et al., 2013). These protocols use two survey methods: standing stock and accumulation.

Standing Stock Survey:
"Standing-stock surveys are used to measure the load or concentration of debris at a shoreline site over time. Each survey event is a snapshot of the concentration of debris at the site, and a series of these snapshots over time provides information on changes in the baseline concentration of debris. Knowing the concentration of debris (in units of #items/m2 of shoreline) at various shoreline sites is necessary in evaluating the cumulative impact and conducting impact or risk assessments of debris at a given site and on a regional scale. In standing-stock surveys, the measured debris concentration reflects the long-term balance between inputs (land and sea based) and removal (through export, burial, degradation, etc.). An understanding of how the abundance of debris changes over time facilitates analysis of the drivers of debris deposition (e.g., weather, tides, tourism, prevention efforts)." (Lippiatt et al., 2013)

Volunteers and survey coordinator survey a transect at CNWR. Photo by J. Eliot.

For the standing stock surveys, each 100-meter long site is divided into 20 - 5 meter transects. The survey coordinator and volunteers randomly select four transects using a random number table. Using a tape measure and the measurement chart provided in the Shoreline Field Guide, transects are staked out (using tomato stakes) down the middle of the beach. Volunteers then place stakes at the low tide line and the back of the shoreline to mark each complete transect. GPS coordinates and photos are taken at each end of a transect, and then the transect length is recorded. Generally, two volunteers and a data recorder walk a transect from low tide line to back of shoreline (or vice versa). Volunteers survey specific areas and call out what kind of debris they observe. In the Standing Stock surveys, debris is recorded but left in place. The time from start of survey to completion is also recorded.

Accumulation Surveys:
"During accumulation surveys, marine debris is removed from the shoreline site. Accumulation studies require initial removal of all debris from the site followed by regular surveys to record and remove all debris. Because debris is removed from the

Volunteers remove trash from the accumulation site on FINWR.

site, the data collected over time provides an estimate of the flux of debris onto the shoreline (in units of #items/m2/time), as opposed to the concentration or standing-stock of debris...Accumulation survey data indicate the net flux of debris onto the shoreline, and assume that the rate of debris accumulation is uniform between sample events." (Lippiatt et al., 2013)

Each accumulation survey site is 100 meters in length and the entire site is surveyed. For this survey method, the survey coordinator and volunteers walk parallel to the shoreline. Depending on the amount of debris being observed, both the volunteers and survey coordinator search for debris (always looking right), record what they find and collect the debris for removal from the beach. If the beach seems to be heavily littered, the survey coordinator will only record data. GPS coordinates are recorded at the four corners of the site and a width (low tide to back of the shoreline) is taken at each end of the site. Debris that is observed behind the back of the shoreline (i.e., in the dunes) is also recorded in a separate section of the notes.

In both survey methods, photographs are taken of unusual items and large items are photographed and measured with a measuring tape for more accurate recording (initially, large item measurements were estimated).

Unusual items are always photographed.

Getting Started

During the first few months of the grant, the Virginia Aquarium hired a marine debris research contractor, Christina Trapani, to execute survey site selection, volunteer recruitment and training, and monthly monitoring.

Project supplies were purchased, including a digital camera, gps unit, clipboards, work gloves, grabbers, water and food coolers, Rite-in-Rain paper, wooden site markers and bamboo tomato stakes. CVW provided a measuring wheel and VAQ provided a hanging scale. Surfrider Foundation donated 20 reusable malt bags sourced from a local brewery to be used as the project's collection bags. The survey coordinator began recruiting volunteers and a volunteer application was created. Contacts were made with

Volunteers remove a crab pot from BBNWR during the volunteer training.

the VAQ Stranding Response Team, Surfrider Foundation, Lynnhaven River Now, Tidewater and Eastern Shore Chapters of the Virginia Master Naturalists, Eastern Shore Waste Watchers, Back Bay Restoration Foundation and BBNWR. All partners practiced using the NOAA protocol. A volunteer training was held at BBNWR on April 13, 2014.

The Survey Sites

Katie Register (CVW) and Trapani completed site selection on Fisherman Island on March 27th with the assistance of refuge staff. They chose a site that was least likely to be used by shore birds for nesting. On March 28, 2014, Mark Swingle (VAQ), Register and Trapani travelled to Chincoteague National Wildlife Refuge and met with their biology staff regarding site selection. Shore bird and sea turtle nesting were considered and a northern site that was less likely to have nests was selected.

A site is set up at CNWR with the help of USFWS refuge staff .

In all, four study sites were selected: Back Bay National Wildlife Refuge (BBNWR) in Virginia Beach; Grandview Nature Preserve (GNP) in Hampton, Fisherman Island National Wildlife Refuge (FINWR) in Northampton County, and Chincoteague National Wildlife Refuge (CNWR) in Accomack County (Appendix I). These sites were selected for their relative isolation from the public. Two of the sites (CNWR and BBNWR) were part of a previous marine debris monitoring research project, the *National Marine Debris Monitoring Program* (NMDMP), that was conducted by Ocean Conservancy and funded by EPA between September 2001 and September 2006 (Sheavly, 2010). It is hoped that in the future, data from the NMDMP study can be compared with data collected in this research project.

Each survey beach has adjacent 100-meter survey sites, an accumulation site and a standing stock site, as described in NOAA's *Marine Debris Shoreline Survey* protocol.

The BBNWR sites are located on the “North Mile”, an area of the refuge closed to the public.

The site at BBNWR looking south. The fence in the distance marks the southern border of the “North Mile”

FINWR is closed to the public except for guided tours in October through March and occasional beach cleanup efforts. Refuge staff are aware of the survey sites and instruct birders and cleanup volunteers to not remove trash from the area.

The site at FINWR looking to the south. The Chesapeake Bay Bridge-Tunnel is in the background.

The CNWR site is located seven miles north of the Visitor's Center and can only be accessed by foot from the beach or via a service road that runs through the Refuge. During bird nesting season, walkers may not venture above the high tide line.

The site at CNWR looking to the north.

While the beach at GNP is much more accessible to the public, it is approximately one mile from the nearest parking area and is not frequented by an excessive number of people.

The site at GNP looking north.

Research permits were secured and renewed each year for the three National Wildlife Refuge sites. These permits indicate that if a shore bird or sea turtle should nest in the site, the site will not be accessible until the nest has fully incubated, hatched and/or fledged. With this potential restriction in mind, survey sites were chosen in areas that were least likely to have nesting shore birds. BBNWR and CNWR have occasional loggerhead sea turtle nests that can occur anywhere on their ocean-facing beaches, though this was not an issue in the survey sites during the 30 month study period.

Initially, Naval Amphibious Base Little Creek was chosen as a potential site but was not approved due to access concerns. Grandview Nature Preserve was selected as the alternative beach area and is managed by the City of Hampton. Park officials are aware of the project but no permits are required.

Site Characterizations

As required by the NOAA protocols, Site Characterization sheets were completed annually in March/April for all four sites from 2014 through 2016.

The Survey Period

Under the original grant, nine months of surveys were to be conducted. Efficient use of resources throughout the project allowed for the original timeline to be extended to 30 months. The extended project study period included three Atlantic hurricane seasons, though no hurricanes made landfall in Virginia during the project.

Volunteer Recruitment

Volunteer recruitment for this project involved numerous groups, including the VAQ Stranding Response Team, Surfrider Foundation, Lynnhaven River Now, Tidewater and Eastern Shore Chapters of the Virginia Master Naturalists, Eastern Shore Waste Watchers, Back Bay Restoration Foundation, BBNWR and CNWR. A volunteer training was held at BBNWR in April 2014. At the end of the 30 month study period, there were 10 core volunteers and an email list of 18 additional

Volunteer requirements included the ability to lift heavy objects and tolerate extreme weather conditions.

members. Each volunteer was provided with a digital copy of the NOAA protocols and a link to the online monitoring toolbox.

Scheduling

Throughout the 30 month project period, surveys were scheduled every 28 days (+/- 3 days) based on local times for low-tide. At the beginning of each month, a survey schedule was generated and sent to volunteers. On average, two volunteers assisted the survey coordinator during each survey. The survey coordinator often picked-up volunteers at designated areas for car-pooling transportation. This was especially important for the FINWR and CNWR surveys due to the significant tolls and travel distance associated with these survey sites when departing from Virginia Beach. During the project period, only one survey was cancelled due to weather: GNP in February 2015, due to excessive snow and ice cover on the beach throughout the survey window. Another attempted survey at GNP had to be rescheduled due to the discovery of unexploded ordinance on the beach.

RESULTS

Number of Surveys Conducted

A total of 125 accumulation surveys and 125 standing stock surveys were completed during the project period: 64 surveys at BBNWR and 62 each at CNWR, FINWR and GNP. Each standing stock survey required four transects and four data sheets to be completed and entered into the NOAA data base (http://mdmap.orr.noaa.gov/).

Data Collected

What follows is a summary of the data entered as of the date of this report (189 of the 250 completed surveys). See Appendix II for a list of completed surveys and their dates. While not all of the data have been entered, preliminary analyses indicates some trends. In aggregate (standing stock plus accumulation survey data), a total of 6,777 pieces of debris were documented and entered into the NOAA online database. As seen in Figure 1, the vast majority (83%) of debris items recorded at the four monitoring sites were made of plastics. Debris is classified into the following categories on the NOAA Shoreline Debris Survey Data Sheet: plastic, metal, glass, rubber, processed lumber (no natural wood), cloth/fabric and other/unclassifiable. Wood products (including lumber, cardboard, paper and building materials) comprised 7% of debris items, followed by metal at 4%, glass at 3%, cloth at 2% and rubber at 1%. It should be noted that the Ocean Conservancy estimates that 84% of all items collected during the International Coastal Cleanup are made up of plastic (Mallos, 2016), and this project's data indicate a nearly identical percentage.

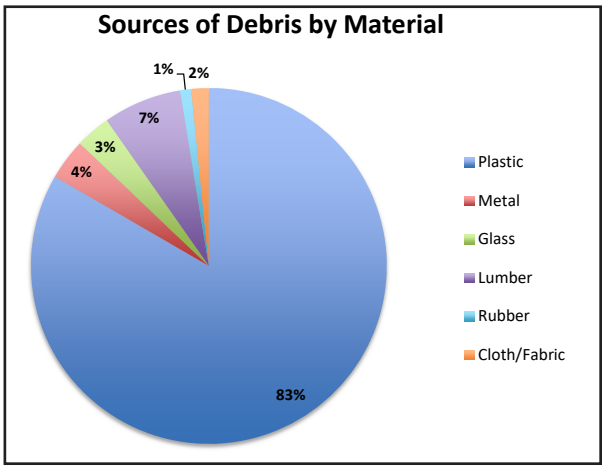

Figure 1. Sources of debris by material

As seen in Table 1, approximately half of the most frequently found items were food- and beverage-related. These included bottle/container caps, food wrappers, plastic beverage bottles, cups, aluminum/tin cans, and straws.

In the field, volunteers conducting surveys recognized a trend that clearly emerged when looking at the data: FINWR had a disproportionate share of marine debris on its beaches relative to the other survey sites.

Trash collected from the FINWR accumulation site.

As seen in Figure 2 and Table 2, the majority (51.0%) of debris recorded during Virginia beach monitoring surveys was found on FINWR. BBNWR followed at 20.5%, then GNP at 17.2%, and CNWR at 11.3%.

Rank	Item	Number of items, Accumulation	Number of items, Standing stock	Aggregate
1	Bottle/Container Caps	351	92	443
2	Balloons Mylar	350	86	436
3	Food Wrappers	263	79	342
4	Lumber/Building Material	229	63	292
5	Plastic Rope/Net	208	73	281
6	Cigarettes	203	53	256
7	Plastic Beverage Bottles	149	104	253
8	Cups	62	64	126
9	Alum/Tin cans	93	33	126
10	Other jugs	85	37	122
11	Plastic Bags	93	22	115
12	Fishing Lures & Line	71	25	96
13	Straws	60	25	85

Table 1. Data by identifiable items.

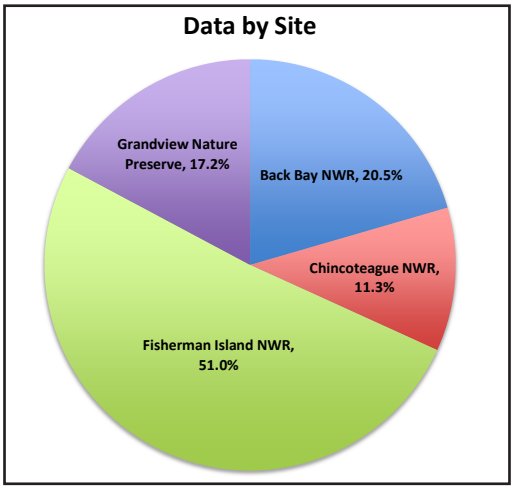

Figure 2. Data by site.

ALL debris by site	Accumulation	Standing Stock	Total	% of total of all debris
Back Bay NWR	1047	339	1386	**20.5%**
Chincoteague NWR	570	195	765	**11.3%**
Fisherman Island NWR	2540	914	3454	**51.0%**
Grandview Nature Preserve	909	263	1172	**17.2%**
Totals	**5066**	**1711**	**6777**	**100.0%**

Table 2. Data by site.

Debris of special concern

Smoking-related debris

Cigarette butts (n=256), cigar tips (n=47), and disposable lighters (n=31) accounted for 4.9% of the debris items (Table 3). Fisherman Island NWR, which has the most restricted access of all the study sites, had the largest number of cigarette butts with 148, or 57.8% of all the cigarettes recorded.

Cigarette debris by site	Accumulation	Standing Stock	Total	% of total cigarettes
Back Bay NWR	33	9	42	**16.4%**
Chincoteague NWR	6	4	10	**3.9%**
Fisherman Island NWR	117	31	148	**57.8%**
Grandview Nature Preserve	47	9	56	**21.9%**
Totals	**203**	**53**	**256**	**100.0%**

Table 3. Cigarette debris by site.

Balloons and attached ribbons

A total of 436 balloons were entered into the database, representing 6.5% of debris items. The balloon debris, however, was not uniformly distributed. As seen in Table 4, Fisherman Island NWR accounted for 47.5% (n=207) of the balloon debris, while Grandview Nature Preserve (located almost due west across the Chesapeake Bay) registered the fewest number of balloons at 43 (or 9.8% of all balloons). It should be noted that the earlier (2012) version of the NOAA Shoreline Survey Data Sheet included balloons only under the “plastic” section of the sheet. NOAA’s revised Data Sheet now lists balloons under both plastic (for Mylar or foil balloons) and rubber (latex balloons).

Balloon debris by site	Accumulation	Standing Stock	Total	% of total balloons
Back Bay NWR	53	18	71	**16.3%**
Chincoteague NWR	95	20	115	**26.4%**
Fisherman Island NWR	166	41	207	**47.5%**
Grandview Nature Preserve	36	7	43	**9.8%**
Totals	**350**	**86**	**436**	**100.0%**

Table 4. Balloon debris by site.

Derelict fishing gear:

A total of 464 derelict fishing gear items were entered into the database, representing 6.8% of debris items. As seen in Table 5, these items include plastic ropes and nets; buoys and floats; fishing lures and line; and non-nylon rope and net pieces. An additional 68 fishing-related items were added to the data sheet in the “notes” section. These were mostly crab baskets, crab traps, and clam netting.

Item	Accumulation	Standing Stock	Totals
Ropes and nets (plastic)	208	73	**281**
Buoys & Floats	24	14	**38**
Fishing Lures & Line	71	25	**96**
Rope/Net Pieces (non-nylon)	40	9	**49**
Totals	**343**	**121**	**464**

Table 5. Derelict fishing gear items found by category.

As we saw with cigarette and balloon debris, Fisherman Island NWR recorded the highest amounts of derelict fishing gear with 293 pieces, or 63.1% of all derelict fishing gear items (see Table 6).

Site	Total DFG items	% of total DFG items
Back Bay NWR	63	13.60%
Chincoteague NWR	48	10.30%
Fisherman Island NWR	293	63.10%
Grandview Nature Preserve	60	12.90%
Total	**464**	**99.90%**

Table 6. Derelict fishing gear items found by site.

Other debris items

Surveys started to see more of single-use Keurig-style coffee cups. Volunteers also recorded shotgun wads (n= 36) and shotgun shell casings (n=28) at the request of researchers from the Virginia Institute of Marine Science.

Other results

Project staff worked with NOAA Marine Debris Program staff in discussions about the nature of balloon-related litter. NOAA staff were interested in providing clear guidance on how to record balloon litter on the MDMAP forms. With input from this project team, a new item – “Balloons-Latex” – was added to the NOAA data collection form under the Rubber category. The revised form also clarified the Plastic Balloons category with a new designation – “Balloons-Mylar”. In addition, in January 2015, project partner Katie Register (CVW) attended and contributed to a NOAA Marine Debris Program meeting which was focused on marine debris data collected by citizens.

Volunteer Contributions

Volunteers contributed more than 1400 hours to this project. They played an integral role in allowing surveys to be completed in manageable periods of time, especially considering that surveys were designed to be conducted during low tide.

DISCUSSION

As seen in other studies, and data collected by volunteers during the International Coastal Cleanup, the marine debris recorded by this project was primarily composed of plastic items and single-use disposables (Mallos, 2016).

Challenges

Many challenges were experienced during the course of the 30 month project period. The most significant challenges involved the classification of debris and the data collection process (discussed below). Other challenges included:

Volunteers walking to the BBNWR site in very cold weather and windy conditions.

- **Weather:** Winter often brought frigid temperatures which became a potential concern regarding the safety of survey volunteers. Cold weather was also a factor affecting battery depletion and GPS functioning. High winds, while more of an inconvenience, probably caused sand burial of debris as volunteers observed less debris on days of over 20 mph winds.
- **Insects:** Biting flies and mosquitoes often created uncomfortable surveys, especially during the warmer months. Tick checks were also often in order, especially on Fisherman Island. While wind can be an inconvenience, a breeze in the summer is very welcome.
- **Bird watchers & nature lovers removing debris:** Volunteers often observed large piles of collected trash at the waste cans on GNP. It is unknown if the sites were cleaned by well-meaning beach goers. The GNP site was chosen because of its distance from the beach access, hoping that most people would not carry trash that far. GNP biologists and staff at all of the refuge sites were instructed to let people know to avoid all survey site areas.
- **Working around nesting seasons:** The survey sites at the National Wildlife Refuges are particularly susceptible to potential interference due to sea turtle or shore bird nesting. Should a nesting event occur on any of the survey sites, it would require abandonment of the site during the nesting and fledging period. Project staff worked with refuge biologists to choose sites where this was least likely to occur. During the project period, there were no nests in any of the survey sites, though a loggerhead sea turtle nested approximately ¼ mile north of the BBNWR accumulation site in the summer of 2016.
- **Site Markers:** Wooden stakes were intentionally used to mark the survey sites in the event they were washed out to sea during storms. In the case of FINWR and CNWR, all markers eventually disappeared over time as a result of storms. GPS coordinates were used to re-establish site boundaries, and especially at FINWR due to the constant erosion of that beach. CNWR markers were replaced about

once each year using the GPS coordinates from the original site characterization. GNP site markers were consistently found removed, moved and/or thrown on the ground. Eventually, GPS coordinates were utilized establish the survey site boundaries each month.

- **Site Characterizations.** All survey sites were established to measure 100 meters (326 feet), though subsequent site measurements indicated some level of variability. There may be several factors influencing the variability:
    - The measuring wheel used may slip in soft sand while taking measurements.
    - The beaches themselves have changed over time. CNWR has had a significant slope change over time and BBNWR often has a "hilly" surface.
    - Initial measurements were made at the middle of the beach. The perspective of a straight line from the semi-permanent markers at the back of the shoreline (wooden stakes) may be slightly different each time, changing the location of the start of the site. GPS is often used but also has a +/- error of up to 10 feet.

Images of the sites are taken from many angles during annual site characterization. The image of CNWR above was taken in March, 2014. The image below was taken in March, 2016.

Data Collection Concerns

NOAA Protocols were followed for this project, however, the data collection process vs. the protocols raised many questions. A significant concern involved the recording of items that were over 12" or under 2.5 cm. For example, cigarette butts have their own category on the datasheet, but what was not obvious from the beginning was that cigarette butts under 2.5 cm were not to be recorded. Also, most foil (mylar) balloons are more than 12" which requires them to be recorded as a large item rather than as a balloon.

A few conversations with Sherry Lippiatt resulted in the following determinations for recording data:

- Coal found on Virginia's beaches: while organic, it is not naturally occurring in Virginia and has likely been processed so therefore should be recorded as marine debris.
- Latex balloon nubs with plastic ribbons: if the volume of latex balloon is less than the volume of plastic ribbon, they should be recorded in the "other" category as plastic ribbon. Balloon ribbons without any type of balloon material are also to be recorded in the "other" category.
- Labels from plastic drink bottles are a common item. Project staff were advised to record as food wrappers. This is an item that probably needs further discussion as project staff believe that a bottle label is not actually a food wrapper, but a part (<50%) of another item.
- While "tires" have a category under "rubber", all tires found during this project have been over 12". While initially recorded as tires, they will now be recorded as large items.
- Items such as a rope or balloon ribbon that may be over 12" if unraveled, should be measured as found on the beach. This leads to further questions/concerns such as: if a foil balloon is found in the accumulation site folded or partially buried, it is recorded as a foil balloon. If the foil balloon is still partially inflated or flat on the beach, it will likely be recorded as a large item.
- When several items are found wrapped-up together, the prevalent item is the only item recorded. In one example, a nylon rope with 5 plastic ribbon and latex nubs was to be recorded under large items naming the prevalent nylon rope as the item. Project staff are concerned that, in this example, the collection of data for 5 balloons should also be included in this observation.
- There are several large items in the accumulation sites that cannot be removed. These items are recorded in each survey. How is that information being handled since the items cannot be removed?

Ribbon with a latex nub is counted as "other" rather than balloon.

Many tires washed up on CNWR after a storm.

A tangle of balloon ribbons, latex nubs and nylon rope is recorded as nylon rope under large items.

Email from Sherry Lippiatt regarding balloons: *"The strings or ribbons add another layer of complexity. According to the protocol, an item is recorded based on the most prevalent material type on the surface of the item. So a rubber balloon with a plastic string attached should be recorded as one item, based on whether the string or the balloon takes up the greatest surface area. If a user wanted to collect more detailed data on balloons, eg if they did or did not have strings attached, they could add those as custom item subcategories to the corresponding balloon field. The same goes for weather balloons. I think this is a great example of the many different ways that the monitoring protocols can be built out / expanded depending on your specific question(s)."*

Beyond the written protocol

Throughout the course of the project period, different methods were tried and tested for completing the surveys both effectively and efficiently. Some examples include:

- Green bamboo tomato stakes were utilized to mark transects: these markers are easily inserted into the sand, easily seen from a distance, inexpensive, and lightweight. One of the project volunteers actually sewed a bag to carry the stakes in.
- At one point, a 5-meter piece of string was used to measure the width of the standing stock survey transects at each end, rather than using a measuring tape. However, this procedure usually required two people and the measuring wheel proved to be more convenient.
- Reusable grain bags from a local brewery were used to collect the accumulation debris, rather than relying on single-use plastic trash bags.

Volunteers use a 5-meter string to measure a standing stock transect width.

Reusable bags are used to collect debris from accumulation sites.

Next Steps

Monitoring these four coastal beaches in Virginia will continue thanks to funding from the NOAA Office for Coastal Management through the Virginia Coastal Zone Management Program (FY16 funding) and the continuing dedicated work by the Virginia Aquarium's contractors and volunteers. The project team from the Virginia Aquarium & Marine Science Center and Clean Virginia Waterways of Longwood University are excited to be contributing to the NOAA Marine Debris Monitoring and Assessment Project, and appreciate the ongoing support of NOAA and the Virginia CZM Program.

REFERENCES

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Opfer, S. C.; Arthur, C.; Lippiatt, S. NOAA marine debris shoreline survey field guide, National Oceanic and Atmospheric Administration Office of Response and Restoration Marine Debris Program, NOAA, Silver Spring, MD, USA, 2012; http://www.MarineDebris.noaa.gov.

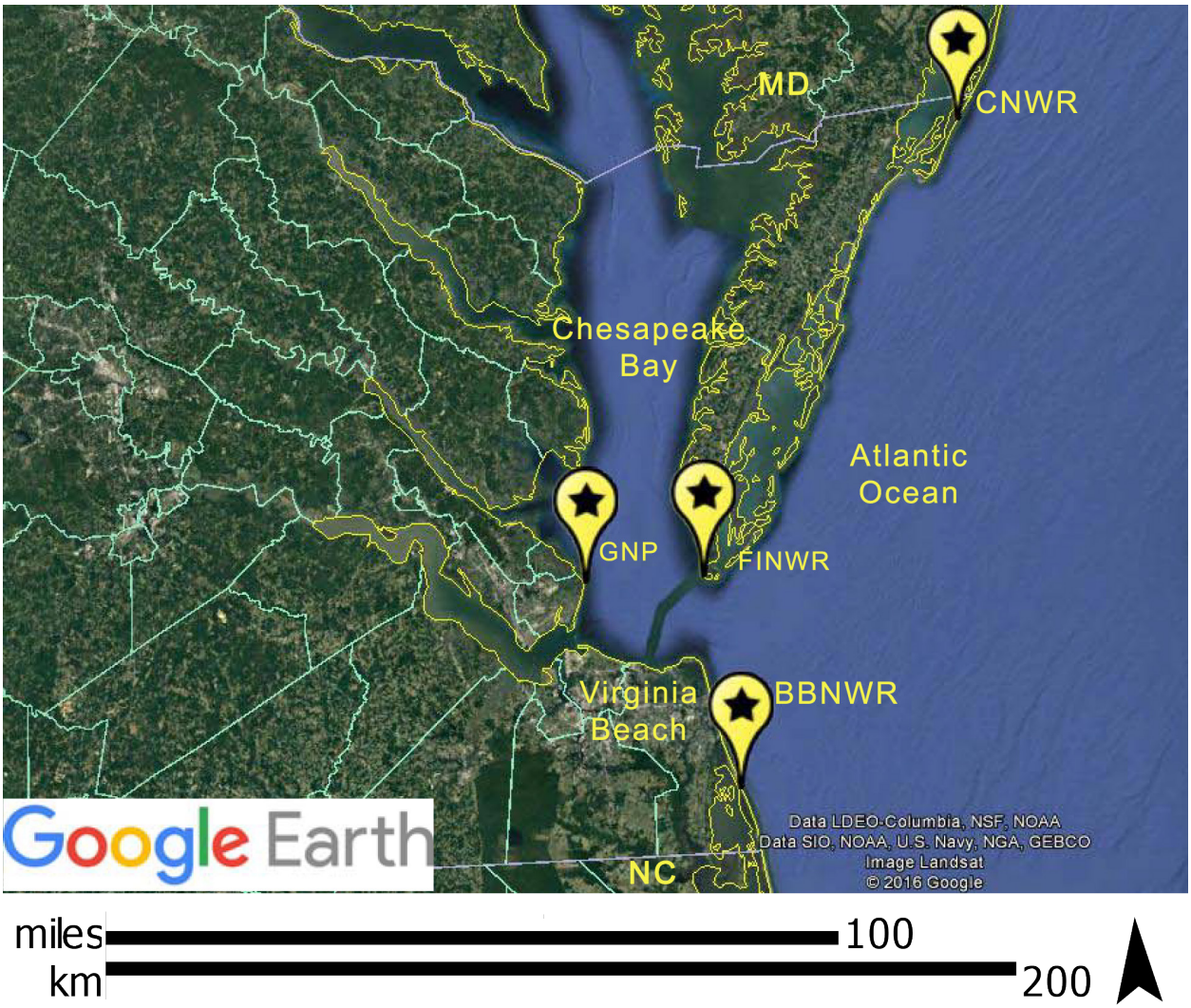
Mallos, N. (May 17, 2016). Marine Debris and Wildlife: Impacts, Sources and Solutions. Written Testimorny of Nicholas J. Mallos, Director, Trash Free Seas, Ocean Conservancy before the US Senate Environment and Public Works Committee.

Sheavly, S. B. (2010). National marine debris monitoring program. *Lessons learned. 26p*.

Visit www.longwood.edu/cleanva/VAdebrismonitoring.htm for more information on this research project.

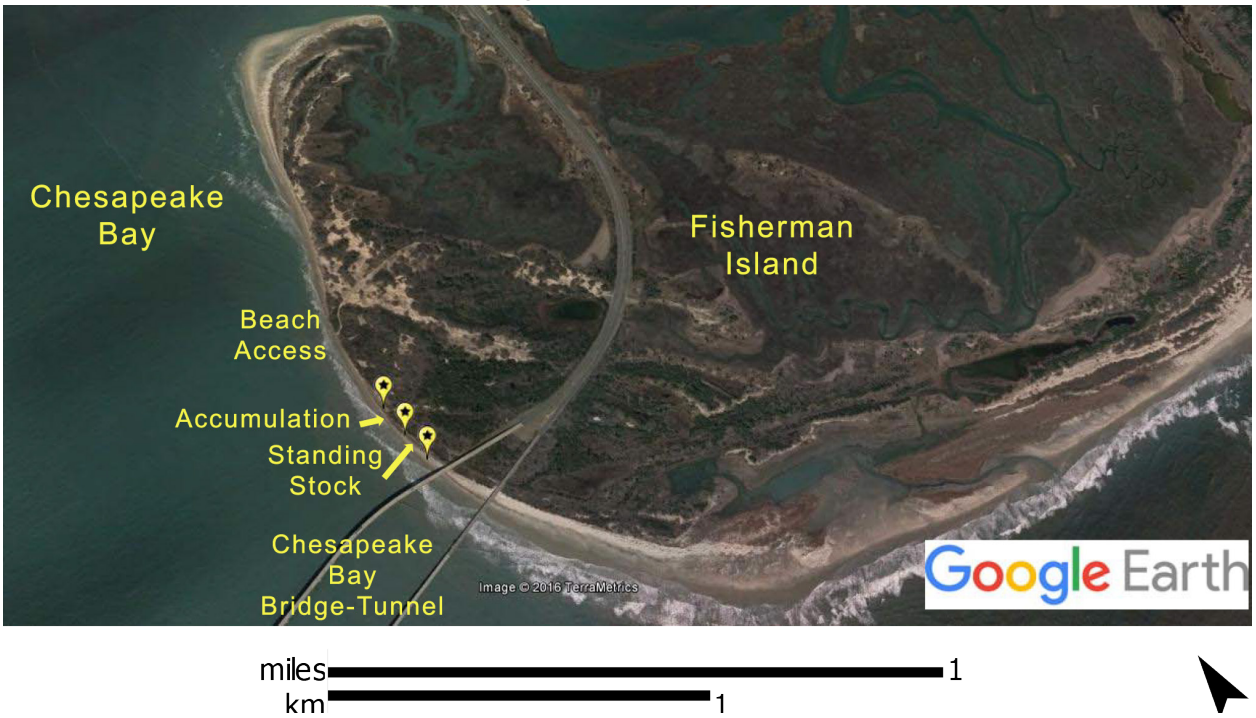
Appendix I
Survey Sites

All Virginia Marine Debris Project sites

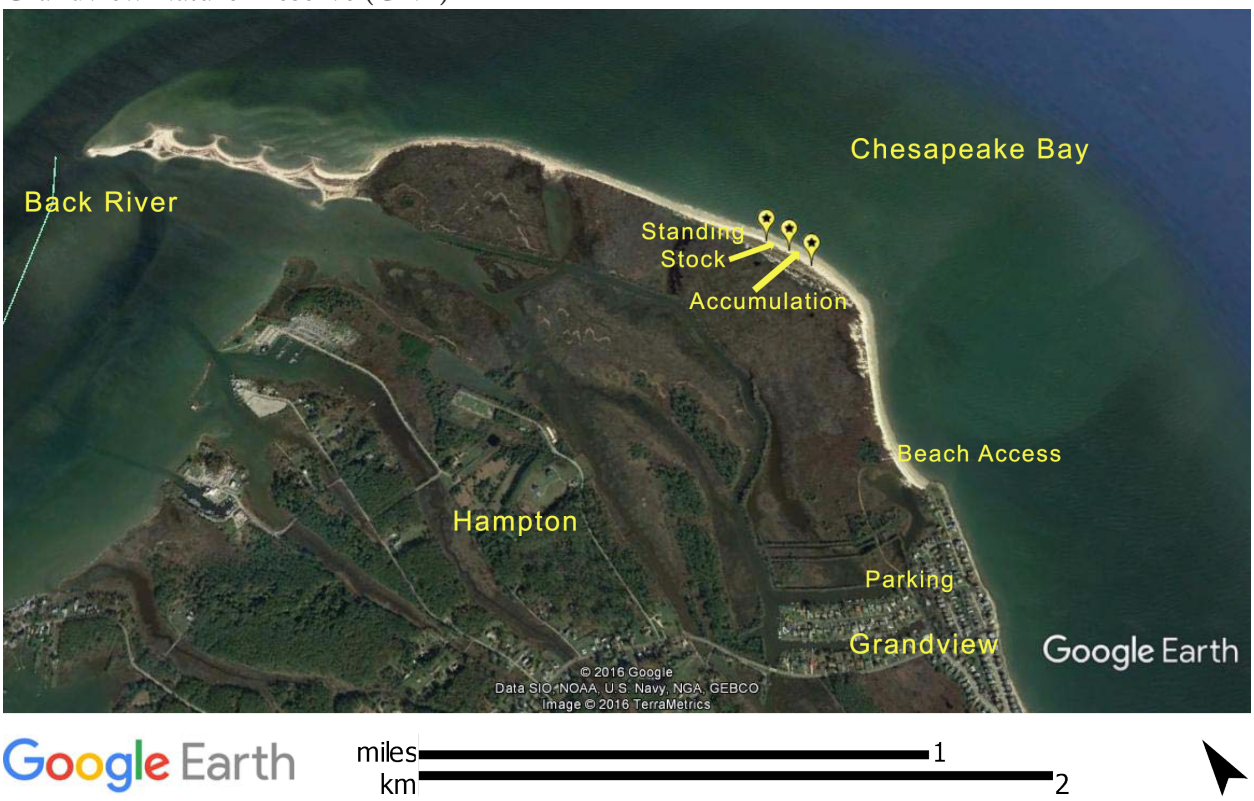


Appendix I
Survey Sites

Fisherman Island National Wildlife Refuge (FINWR)

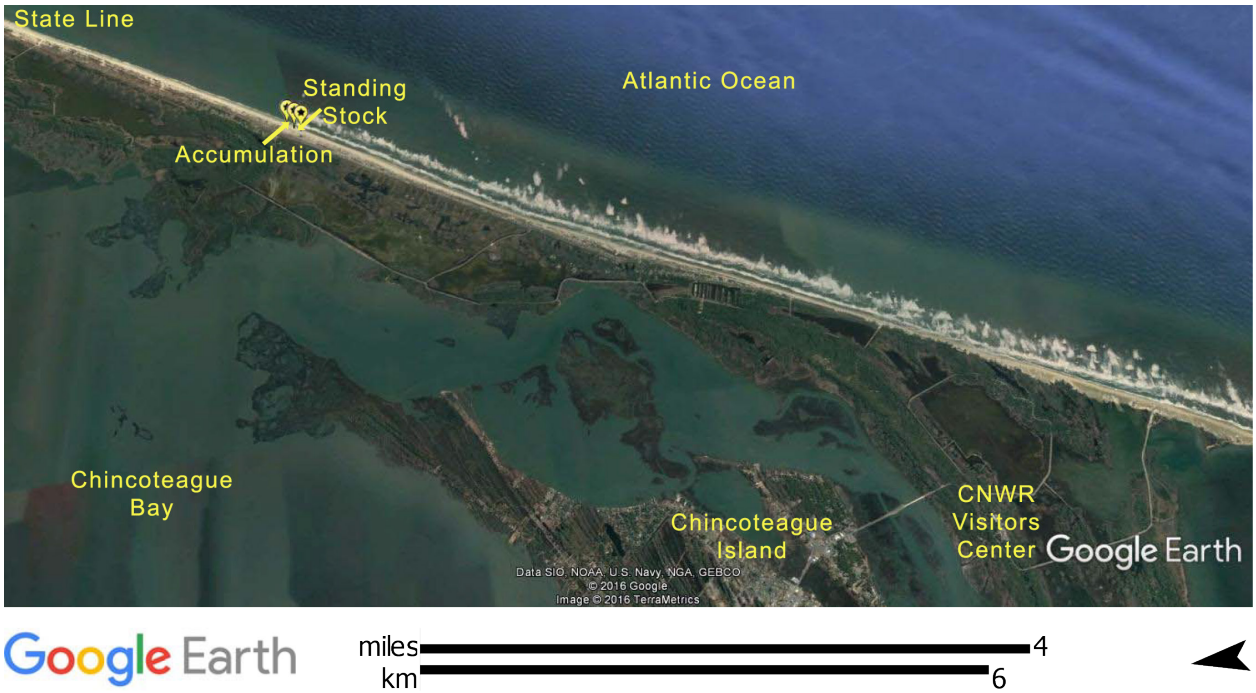


Grandview Nature Preserve (GNP)



Appendix I
Survey Sites

Chincoteague National Wildlife Refuge (CNWR)



Back Bay National Wildlife Refuge (BBNWR)

Appendix II
Surveys Completed

Site	Date	Low Tide	# of Volunteers
BBNWR	4/13/2014	1:00 PM	12
BBNWR	5/9/2014	9:30 AM	2
BBNWR	6/8/2014	10:00 AM	3
BBNWR	7/7/2014	9:14 AM	2
BBNWR	8/5/2014	8:40 AM	4
BBNWR	8/31/2014	6:18 AM	2
BBNWR	9/26/2014	3:30 PM	2
BBNWR	10/24/2014	2:38 PM	3
BBNWR	11/20/2014	11:49 AM	1
BBNWR	12/18/2014	10:30 AM	3
BBNWR	1/19/2015	12:32 PM	2
BBNWR	2/22/2015	4:00 PM	2
BBNWR	3/20/2015	2:20 PM	2
BBNWR	4/17/2015	1:05 PM	2
BBNWR	5/15/2015	11:47 AM	3
BBNWR	6/11/2015	9:30 AM	3
BBNWR	7/9/2015	8:10 AM	3
BBNWR	8/9/2015	9:54 AM	3
BBNWR	9/7/2015	9:41 AM	4
BBNWR	10/7/2015	10:26 AM	2
BBNWR	11/6/2015	9:53 AM	2
BBNWR	12/7/2015	10:49 AM	1
BBNWR	1/5/2016	10:07 AM	3
BBNWR	2/3/2016	9:18 AM	2
BBNWR	3/3/2016	8:30 AM	4
BBNWR	3/29/2016	6:10 PM	3
BBNWR	4/27/2016	5:43 PM	1
BBNWR	5/24/2016	3:53 PM	2
BBNWR	6/23/2016	4:19 PM	3
BBNWR	7/22/2016	4:00 PM	3
BBNWR	8/22/2016	5:34 PM	1
BBNWR	9/19/2016	4:24 PM	2

Site	Date	Low Tide	# of Volunteers
CNWR	4/24/2014	9:30 AM	3
CNWR	5/23/2014	10:30 AM	3
CNWR	6/22/2014	11:03 AM	4
CNWR	7/20/2014	9:41 AM	4
CNWR	8/20/2014	11:00 AM	4
CNWR	9/18/2014	10:30 AM	4
CNWR	10/17/2014	10:00 AM	3
CNWR	11/19/2014	10:56 AM	3
CNWR	12/17/2014	10:18 AM	3
CNWR	1/16/2015	10:40 AM	2
CNWR	2/14/2015	10:00 AM	3
CNWR	3/15/2015	10:40 AM	3
CNWR	4/13/2015	10:15 AM	2
CNWR	5/13/2015	10:48 AM	3
CNWR	6/12/2015	11:19 AM	4
CNWR	7/12/2015	11:54 AM	4
CNWR	8/10/2015	11:37 AM	5
CNWR	9/8/2015	10:30 AM	4
CNWR	10/8/2015	11:00 AM	2
CNWR	11/8/2015	11:48 AM	3
CNWR	12/9/2015	12:00 PM	2
CNWR	1/6/2016	10:43 AM	2
CNWR	2/5/2016	11:00 AM	3
CNWR	3/5/2016	10:24 AM	2
CNWR	4/5/2016	10:50 AM	1
CNWR	5/6/2016	1:00 AM	1
CNWR	6/2/2016	11:37 AM	3
CNWR	6/30/2016	10:18 AM	3
CNWR	7/29/2016	9:59 AM	3
CNWR	8/29/2016	11:45 AM	3
CNWR	9/28/2016	12:25 PM	2

Appendix II
Surveys Completed

Site	Date	Low Tide	# of Volunteers
FINWR	4/22/2014	9:00 AM	4
FINWR	5/21/2014	8:30 AM	4
FINWR	6/16/2014	4:51 PM	3
FINWR	7/13/2014	9:35 AM	3
FINWR	8/13/2014	5:20 PM	2
FINWR	9/10/2014	4:00 PM	3
FINWR	10/10/2014	4:43 PM	3
FINWR	11/7/2014	2:36 PM	3
FINWR	12/5/2014	1:35 PM	3
FINWR	1/2/2015	1:34:00PM	4
FINWR	2/1/2015	1:00 PM	3
FINWR	3/2/2015	12:30 PM	3
FINWR	3/31/2015	12:22 PM	2
FINWR	4/27/2015	10:33 AM	3
FINWR	5/26/2015	9:37 AM	2
FINWR	6/26/2015	10:17 AM	3
FINWR	7/24/2015	8:37 AM	2
FINWR	8/24/2015	9:46 AM	4
FINWR	9/22/2015	9:17 AM	3
FINWR	10/21/2015	8:54 AM	4
FINWR	11/20/2015	8:46 AM	4
FINWR	12/20/2015	9:40 AM	3
FINWR	1/18/2016	9:26 AM	4
FINWR	2/17/2016	9:11 AM	4
FINWR	3/16/2016	9:54 AM	4
FINWR	4/13/2016	9:30 AM	3
FINWR	5/12/2016	8:00 AM	2
FINWR	6/12/2016	9:08 AM	3
FINWR	7/12/2016	9:02 AM	3
FINWR	8/11/2016	9:00 AM	2
FINWR	9/9/2016	8:13 AM	4

Site	Date	Low Tide	# of Volunteers
GNP	4/6/2014	9:00 AM	3
GNP	5/5/2014	8:30 AM	2
GNP	6/4/2014	8:30 AM	3
GNP	7/1/2014	8:30 AM	3
GNP	7/30/2014	6:15 PM	4
GNP	8/26/2014	4:30 PM	1
GNP	9/25/2014	4:45 PM	2
GNP	10/23/2014	15:41	2
GNP	11/21/2014	2:15 PM	1
GNP	12/19/2014	1:02 AM	4
GNP	1/20/2015	3:04 PM	3
GNP	3/18/2015	2:20 AM	2
GNP	4/15/2015	1:01 PM	2
GNP	5/14/2015	12:35 PM	3
GNP	6/10/2015	10:16 AM	4
GNP	7/10/2015	10:52 AM	1
GNP	8/6/2015	8:32 AM	2
GNP	9/6/2015	10:13 AM	1
GNP	10/6/2015	10:53 AM	2
GNP	11/5/2015	10:22 AM	2
GNP	12/4/2015	9:40 AM	2
GNP	1/3/2016	9:51 AM	1
GNP	2/2/2016	10:00 AM	2
GNP	3/2/2016	9:12 AM	2
GNP	3/31/2016	9:30 AM	1
GNP	4/29/2016	9:04 AM	2
GNP	5/29/2016	9:30 AM	1
GNP	6/29/2016	11:00 AM	1
GNP	7/26/2016	8:45 AM	1
GNP	8/25/2016	9:24 AM	2
GNP	9/22/2016	8:06 AM	2