BITMAXII Cruise BM0703 Report

Project title: Dynamic stability and particle transformations: tracing pathways of production in Estuarine Turbidity Maxima (NSF-OCE-0453905)

8-14 May 2007

Research Vessel

R/V Hugh R. Sharp (Captain: William Byam)

Scientists

Chief Scientist: Jamie Pierson / Byron Crump Scientific crew: Shih-nan Chen, Raleigh Hood, Edward Houde, Jun Shoji, Krista Hozyash, Ginger Jahn, David Keller, Yong Kim, David Kimmel, Erica Kiss, Dong-Yoon (Daniel) Lee, Kathleen McNamee, Mike Malpezzi, Ed Martino, Larry Sanford, Steve Suttles

Sampling Area

Upper Chesapeake Bay from the southern extent of the Susquehanna River flats (Lat. 39.439) to the Chesapeake Bay Bridge (Lat 38.998).

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I. Activities

Objectives of this cruise were to sample the estuarine turbidity maximum (ETM) region of the Chesapeake Bay with CTD casts, Niskin bottles, MOCNESS zooplankton nets, Tucker Trawl ichthyoplankton/zooplankton nets, and video-equipped bottom withdrawal tubes. The ETM in this system is most prominent in deeper waters of the shipping channel near the freshwater/saltwater interface. Our sampling strategy included 1) axial surveys of the region with CTD casts and Niskin bottles conducted at 11 stations, 2) axial surveys to sample zooplankton and ichthyoplankton with MOCNESS and Tucker Trawl net tows, 3) time course sampling at three anchor stations, 4) time course sampling at two alternating stations with MOCNESS net tows, and 5) channel vs. shoal comparisons of ichthyoplankton and zooplankton abundance with Tucker Trawl net tows.

The ship was loaded at the Sailwinds dock in Cambridge, MD on 7 May, and departed that evening. Operations began at 1034 on 8 May¹ with an axial survey of the study area (campaign "axial-1", Figure 1) consisting of CTD casts at 11 stations (Table 1) to measure conductivity, temperature, dissolved oxygen, fluorescence, optical backscatter, and particle scattering and transmission with a Laser In-Situ Scattering and Transmissometry device (LISST 100C). At each station, water samples were collected at selected depths with a small well pump to directly measure total suspended solids for calibration of optical devices. At five stations (as03, as05, as08, as10, as13c), water samples were collected with 10L Niskin bottles from surface, middle and bottom depths, poured from one end of the Niskins into 6 gallon buckets, stirred with stir bars to homogenize suspended particles, and sampled for multiple biological and chemical analyses (Table 2). At each axial station (and at all stations during daylight hours), a PRR-600 irradiance sensor was deployed after CTD casts to measure subsurface irradiance. In addition, surface PAR was recorded at each daytime station using a Li-Cor LI-1400 DataLogger equipped with a LI-190SA-50 quantum sensor. During this first CTD survey the water column was strongly stratified. We found the ETM centered at station as09 (station 7 in the consecutive station log), and the tip of the salt wedge at station as10 (Figure 2). Two mooring arrays were deployed at approximately 2000 on 8 May at a location between Stations as09 and as10 (vicinity 39° 19.63' N, 76° 12.37'), to the west of the main shipping channel in approximately 11.4 meters water depth. This area was considered the middle of the ETM region. One of the mooring arrays consisted of a string of 5 temperature and salinity recorders on a taut wire mooring, for the purpose of resolving the time series of the density structure at the site. The 2 sensors nearest to bottom were also equipped with an OBS to measure turbidity. The second mooring was a bottom landing 1200 KHz ADCP that was set to sample at a high ping rate for the purpose of calculating the Reynolds stresses in addition to the profiled water velocities. The moorings were recovered on 14 May at approximately 1000 UTC. All data was recovered from these moorings.

A scientific crew change was conducted at Sandy Point State Park at 2200 on 8 May. The ship then moved to station as03 to begin a nighttime axial survey of zooplankton using a multiple opening closing net sampling system (MOCNESS) equipped with one 333 (drogue) and four 200 micron mesh nets and temperature, salinity, and pressure sensors. Between 0115 and 0810 on 9 May the MOCNESS was fished at six stations (as03, as05, as07, as09, as11, as13c) to within 3 m of the bottom. The 333 micron mesh net was fished first, between the surface and near-bottom, and the three to four 200 micron mesh nets were fished in 3-5 m depth intervals between the surface and bottom, depending on the depth and structure of the water column. The battery case flooded during the second tow, but was fixed and the tow was successfully repeated within one hour. The battery that was in the case was ruined but there was no damage to the MOCNESS because a fuse in the battery case tripped. All samples were preserved in 4% buffered (sodium borate) formaldehyde within thirty minutes of collection. CTD casts preceded each net tow. Copepods, while present, were in much lower abundance than in the previous cruise (BM0702, 9 to 15 April 2007).

The ship then anchored and waited until daylight to begin a daytime axial survey of zooplankton using the MOCNESS as described above with the following modifications. CTD casts were conducted at all eleven stations (rather than just six), and water samples were

¹ All times/dates are in Universal Time Code

collected at five stations (as05, as07, as09, as11, as13c) with 10L Niskin bottles from surface, middle and bottom depths and were processed as during the first axial survey, except that water for chemical and microbiological analyses was pre-screened with a 200 micron pore size Nitex net to remove mesozooplankton. This survey was conducted between 1036 and 1717 on 9 May.

The ship then moved to the ETM region to initiate a 26 hour ETM survey during which zooplankton and ichthyoplankton were collected with the MOCNESS every hour at two alternating stations. The "down" station was between Stations as09 and as10, and the "up" station was between Stations as10 and as11 (Table 1). Water samples were collected at four time points (1031, 1523, 1725, 1926 and 2324 on 10 May) with 10L Niskin bottles from surface, middle and bottom depths and were processed as during the first axial survey, except that water for chemical and microbiological analyses was pre-screened with a 200 micron pore size Nitex net to remove mesozooplankton. This time series ran from 2216 on 10 May to 0043 on 11 May.

Tucker Trawl surveys for ichthyoplankton and zooplankton near the ETM began at 0229 11 May. The $1-m^2$ TT has two nets with 280-µm meshes, a flowmeter in each net, and a time-depth-temperature recorder to document the tow. The gear was deployed and fished obliquely for 2 min in two depth strata (near bottom to pycnocline and pycnocline to surface). CTD casts preceded each TT tow. Samples were preserved in ethanol.

A nighttime axial survey with the Tucker Trawl was conducted at seven stations (as07, as09, as10, as11, as12, as13c, and as 14, see Table 1), and was completed by 0738 on 11 May. Following the axial survey, tows were conducted for a "Channel vs. Shoal" comparisons (TT#01-TT#07) at four stations near the locations of the "down" and "up" MOCNESS 26-hr survey (Table1). Each station was sampled twice during this daytime survey, which was completed by 1443, 11 May. A daytime TT axial survey was then conducted between 1640 and 2213, 11 May at the same stations that were sampled in the nighttime survey.

At 0030 12 May, a CTD cast for water samples and a TT tow were conducted at station as09 to collect samples for stable isotope analysis. Three TT tows (Table 1; designated TT12, TT13 and TT21) were conducted to collect fish larvae (white perch and striped bass) for stable isotope analysis. Individual larvae were picked from samples and frozen for future carbon and nitrogen analysis.

The last TT operations consisted of "Channel vs. Shoal" nighttime comparisons. One tow at each location was taken, with the "Channel" stations being standard stations as10 and as11, and the "Shoal" stations being a location a short distance westward of the standard stations. All TT operations were completed by 0239, 12 May.

A scientific crew change was conducted at Sandy Point State Park at 0530 on 12 May.

The mooring site was used for the first anchor station series. CTD casts were conducted hourly for 24 hours starting at 1321 on 12 May with all equipment described above except for the well pump. During this time a Digital Imaging Particle Settling Tube with In-situ Capture (DIPSTIC) was deployed several times with the A-frame to observe particle size and settling speed. Water samples for biological and chemical analyses were collected from three depth at 1321 UTC. The two bottom water samples were sequentially fractionated with a series of screens (63, 20 & 10 micron Nitex mesh, and a 3 micron polycarbonate filter), and sub-sampled for biological and chemical analyses. The surface water sample was also fractionated, and analyzed for primary production and respiration rates, chlorophyll concentration, and pigment composition. Water samples were collected from the DIPSTIC after three deployments for

biological and chemical analysis of particles fractionated by settling velocity (DIPSTIC cast numbers 06, 07, and 09).

Zooplankton were collected using a 50 cm diameter net fitted with 200 micron mesh, which was towed vertically from near the bottom to the surface. Samples collected from these nets were either frozen for subsequent CHN and stable isotope analysis, or were used in incubation experiments to determine the egg production, egg hatching, and development rates of copepods, in particular *Eurytemora affinis*. Briefly, the entire copepod sample was divided among 27 250 ml polycarbonate bottles and incubated in a running seawater bath (at ambient surface temperature) for 48 hours. Triplicate jars were preserved (4% buffered formaldehyde) at 6 hour intervals for analysis in the lab after the cruise.

A second anchor station survey (anchor-2) was conducted at a site up-estuary of the ETM region near station as13c. Water at this station was completely fresh throughout the water column during this survey. CTD casts were conducted hourly from 1527 to 1925 on 13 May. The DIPSTIC was deployed several times as described above. One surface water sample was collected at 1726 for particle fractionation and biological and chemical analyses including primary production and respiration rates, chlorophyll concentration, and pigment composition. Water samples were also collected from the DIPSTIC after two deployments for biological and chemical analyses of particles fractionated by settling velocity (DIPSTIC cast numbers 11 and 19).

A third anchor station survey (anchor-3) was conducted at a site down-estuary of the ETM region between station as04 and as05. CTD casts were conducted hourly from 2302 13 May to 0856 on 14 May. The DIPSTIC was cast several times as described above. One bottom water sample was collected at 2302 for particle fractionation and biological and chemical analyses. Water samples were also collected from the DIPSTIC after two deployments for biological and chemical analyses of particles fractionated by settling velocity (DIPSTIC cast numbers 23 and 24).

Following operations at the anchor station, we conducted a final CTD axial survey (axial-2) identical to the first axial beginning at daylight (1101) on 14 May. Water samples from 10L Niskin bottles for chemical and microbiological analyses were pre-screened with a 200 micron pore size Nitex net to remove copepods.

Following the final axial survey the ship moved to the mooring site and the mooring was deinstalled at 1730 on 15 May. Then the ship returned to the Sailwinds Dock at Cambridge, MD and offloading commenced.

All cruise objectives were met. A total of 132 stations were occupied (Table 3) and all major physical and biological measurements and collections were completed. The crew of the ship was very supportive and helped facilitate a successful cruise.

II. Contact Information

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Field of Work microbiology & chemistry modeling & phytoplankton ichthyoplankton, fish zooplankton particle dynamics

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StationID	Campaign	Latitude	Longitude	Water Depth
as03	Axial	38.998	-76.360	21
as04	Axial	39.059	-76.328	12.4
as05	Axial	39.107	-76.305	5.3
as06	Axial	39.164	-76.304	9
as07	Axial	39.208	-76.256	7.5
as08	Axial	39.260	-76.236	9.1
as09	Axial	39.311	-76.220	9.8
as10	Axial	39.346	-76.173	7.5
as11	Axial	39.374	-76.119	10
as12	Axial	39.399	-76.050	9.1
as13c	Axial	39.440	-76.023	3.4
as14 (Elk River)	TUCKER	39.471	-76.965	13.1
anchor1 (btw as09 & as10)	Anchor	39.328	-76.208	12
anchor2 (as13c)	Anchor	39.440	-76.023	6.5
anchor3 (near as04)	Anchor	39.069	-76.321	13
MOCNESS (up)	MOCNESS	39.363	-76.140	14.6
MOCNESS (down)	MOCNESS	39.325	-76.204	12.8
Tucker Trawl #1	TUCKER	39.333	-76.194	12.0
Tucker Trawl #2	TUCKER	39.339	-76.199	10.5
Tucker Trawl #3	TUCKER	39.365	-76.137	14.2
Tucker Trawl #4	TUCKER	39.367	-76.143	8.1
Tucker Trawl #5	TUCKER	39.367	-76.133	13.7
Tucker Trawl #6	TUCKER	39.368	-76.141	7.8
Tucker Trawl #7	TUCKER	39.327	-76.202	12.3
Tucker Trawl #8	TUCKER	39.332	-76.205	11.9

Table 1. Sampling locations

0	Axial	Particle	DIPSTIC	
Measurements	samples	fractions	fractions	Abbreviation description
NH4	Х			Ammonia
SRP	Х			Inorganic Dissolved P
NO3+NO2, DSi	Х			Nitrate+Nitrite, dissolved silica
DOC	Х			Dissolved Organic Carbon
TDN, TDP	Х			Dissolved Nitrogen, Dissolved Phosphorous
TSS	Х			Total Suspended Sediment
ChlA	Х	Х	Х	Chlorophyll a
POC, PON	Х	Х	Х	Carbon, Hydrogen, Nitrogen
ТРР	Х	Х	Х	Total Particulate Phosphorous
IPP	Х	Х	Х	Inorganic Particulate Phosphorous
TEP	Х	Х	Х	Transparent Extracellular Polysaccharide
HPLC pigments	Х			
BSi	Х			Particulate silica, biogenic silica
Tcarb	Х	Х	Х	Total carbohydrates
DCarb	Х	Х	Х	Dissolved carbohydrates
Tprot	Х	Х	Х	Total protein
Dprot	Х	Х	Х	Dissolved protein
Tlipid	Х	Х	Х	Total lipids
Dlipid	Х	Х	Х	Dissolved lipids
BP	Х	Х	Х	Bacterial production
PP	Х			Primary production
Respiration	Х	Х		Oxygen Respiration rate
OM bioavailability				Organic Matter bioavailability
Preserved bacteria	Х	Х	Х	
Preserved phytoplankton	Х			
Preserved protists				
DNA	Х	Х		

Table 2. Biological and Chemical analyses

Table 3. Consecutive Station Log.

004 005 005 anchor problems, redid CTD as station 020 007 008	009 010 011 012	Searching for ETM Searching for ETM to decide 20- hr MOC stations 13 Begin 26 hr MOC 14 up 15 Big Ship Wert By - High BS! 15 up vp	down up up up up up up up up up up up up up
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141-143 144-146	147-149 150-152 153-155		156-158
016 017 018 019 020 021 021	023 024 025 026 026 028 028 029 030	031 032 033 034 034 036 035 035	038 039 040 041 042 043 044 045 045 046 046 046
13.6 16.2 6.9 6.7 13.1 13.1 11.6	12.9 13.2 13.8 13.8 13.0 12.0 14.2 24.1	13.7 13.2 15.6 9.2 13.0 13.2 13.2	13.8 13.8 13.8 13.8 13.6 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5
76.22' 76.11' 76.02' 76.02' 76.05' 76.12'	76.17' 76.22' 76.25' 76.31' 76.33' 76.33' 76.33'	76.22' 76.17' 76.12' 76.22' 76.22' 76.15' 76.15'	76.22 76.14 76.14 76.14 76.14 76.22 76.14 76.22 76.14 76.22
13.23' 06.75' 01.34' 01.41' 01.42' 02.99' 06.93'	10.42" 13.18" 14.20" 15.28" 18.32" 19.83" 21.65"	13.22' 10.47' 06.92' 13.27' 13.01' 13.01' 08.81'	13.18 13.18 13.18 13.14 13.14 13.14 13.24 13.24 13.24 13.27 13.27 13.27 13.27 13.27 13.27
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18.48' 22.51' 26.50' 26.44' 23.98' 23.98' 22.68'	20.79' 18.56' 15.59' 12.51' 09.77' 03.40' 59.77'	18.54 20.75 20.75 20.75 20.75 20.75 18.56 18.59 21.55 21.55	18.64 18.64 18.64 18.64 18.56 18.56 18.56 18.56 18.56 18.56 18.64 18.64 18.64 18.64 18.67
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06:03 07:05 08:10 10:02 10:36 11:11 11:40	12:27 12:58 13:54 14:32 15:51 15:51 16:40 17:17	19:46 20:15 20:15 20:46 22:16 23:31 23:31 00:31 01:39	03.32 04.33 05.28 06.24 07.28 06.24 07.28 08.25 09.25 09.25 11.32 11.32
5/9/07 5/9/07 5/9/07 5/9/07 5/9/07 5/9/07	5/9/07 5/9/07 5/9/07 5/9/07 5/9/07 5/9/07 5/9/07	5/9/07 5/9/07 5/9/07 5/9/07 5/10/07 5/10/07 5/10/07	5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07 5/10/07
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Axial Axial saturation Name asold saturation Name asold saturation asold asold

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Table 3 (cont.). Consecutive Station Log.

	Axial Station Name	as09	as10.5	as14	as13	as12	as11	as10	as09	as07	as10		as11		ae11		as12	as14	as13	as12	as11	as10	as09	as07	as09	as10	as10	as10	as11	as11	as09																	
	Other Activites	down	dn	Tucker Trawl TT01	Tucker Trawl TT02	Tucker Trawl TT03	Tucker Trawl TT04	Tucker Trawl TT05	Tucker Trawl TT06	Tucker Trawl TT07	Tucker Trawl TT08 channel	Tucker Trawl TT09 shoal	Tucker Trawl TT10 channel	Tucker Trawl TT11 shoal	Tucker Trawl TT12 stable isotone test	Tucker Trawl TT13 * stable	isotope test	Tucker Trawl TT14 (axial)	Tucker Trawl TT15 (axial)	Tucker Trawl TT16 (axial)	Tucker Trawl TT17 (axial)	Tucker Trawl TT18 (axial)	Tucker Trawl TT19 (axial)	Tucker Trawl TT20 (axial)	BYRON's ETM Water, CTD redo	Stable Isotope Tows	Tucker Trawl TT22 channel	Tucker Trawl TT23 shoal	Tucker Trawl TT24 channel	Tucker Trawl TT25 shoal	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station	25 hr ETM anchor station								
	MOC / TT / DIPSTIC #	030	031	032	033	034	035	036	037	038	039	TT01	TT02	TT03	TT04	TT05	1T06	TT07	TT08	TT09	TT10	Π11	Π12		1113	TT14	TT15	TT16	TT17	Π18	TT 19	TT20		TT21	TT22	TT23	TT24	TT25		DS01		DS02	DS03	DS04	DS05	DS06,7,8		
	Water Sample #s	159-161		162-164		165-167				168-170																							171-173						174(s),175(m),176(B, size 9)									177(s),178(m),179(B, size 10)
M0703	CTD #	050	051	052	053	054	055	056	057	058	059	090	061	062	063	064	065	990	067	068	690	070	071	010	072	073	074	075	076	077	078	079	080	081	082	083	084	085	086	087	088	089	060	091	092	093	094	960
Cruise # B	Depth (m)	14.0	14.0	13.9	14.2	14.4	14.0	13.5	12.6	13.5	13.5	12.4	5.8	14.0	14.7	13.2	14.6	13.1	13.2	9.7	14.6	8.3	15.4	0.00	13.2	13.1	6.7	14.7	16.4	13.5	14.3	12.5	13.8	13.0	12.9	9.4	14.4	7.6	12.3	12.3	12.2	12.3	12.3	12.0	12.4	12.2	12.2	12.8
	Decimal Longitude	76.22'	76.15'	76.22'	76.14'	76.22'	76.15'	76.22'	76.15'	76.22'	76.15'	75.96'	76.02'	76.05'	76.12'	76.17	76.22'	76.25	76.17	76.17	76.12'	76.12'	76.11'	10.01	/6.05	75.96'	76.02'	76.05'	76.11'	76.17	76.22'	76.26	76.22'	76.17	76.17	76.17	76.11'	76.12'	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21
14/2007	Longitude (minutes)	13.17	08.74"	13.25'	08.67"	13.16	08.74"	13.20'	09.15'	13.21	08.86	57.74"	01.31	02.98"	07.05	10.40"	13.13'	15.28'	10.23	10.23	06.94	07.26	06.71		03.14"	57.78	01.29'	03.03"	06.88'	10.29'	13.18'	15.33'	13.16'	10.33'	10.37"	10.31	06.73"	07.23'	12.46'	12.47"	12.47"	12.47"	12.46	12.44"	12.45'	12.43'	12.44"	12.48"
5/8/2007 - 5/1	Longitude (degrees)	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	75°	76°	76°	76°	76°	76°	.92	76°	76°	.92	76°	76°	100	/6°	75°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°
Date:	Decimal Latitude	39.31	39.36'	39.31'	39.36'	39.31	39.36'	39.31'	39.36'	39.31'	39.36'	39.47"	39.44'	39.40'	39.38'	39.35'	39.31'	39.21	39.35'	39.36	39.38'	39.38'	39.38'	0,00	39.40	39.47"	39.44"	39.40'	39.38'	39.35'	39.31'	39.21	39.31'	39.35'	39.35'	39.36'	39.38'	39.38'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'
	Latitude (minutes)	18.64"	21.63'	18.43'	21.66'	18.66'	21.63'	18.49'	21.46'	18.59'	21.57	28.36	26.37'	23.94'	22.50'	20.80'	18.75'	12.48'	20.92'	21.65'	22.58'	22.71	22.60'	000000	23.82	28.29'	26.53'	23.91'	22.54'	20.86'	18.65'	12.38'	18.62'	20.84'	20.84'	21.61	22.65'	22.76'	19.66'	19.63'	19.63'	19.63'	19.63'	19.67	19.68'	19.68'	19.68	19.68'
	Latitude (degrees)	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°		39"	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°
Log	Time (LMT)	11:23	12:18	13:25	14:24	15:26	16:20	17:25	18:35	19:24	20:43	22:29	23:35	00:13	01:00	01:38	02:30	03:38	06:31	07:19	08:20	08:51	09:29		10:43	12:40	13:50	14:40	15:34	16:25	17:11	18:13	19:33	20:30	20:57	21:27	22:11	22:39	09:21	10:30	11:27	12:25	13:28	14:28	15:27	16:25	17:26	18:29
ive Statior	Time (UTC)	15:23	16:18	17:25	18:24	19:26	20:20	21:25	22:35	23:24	00:43	02:29	03:35	04:13	05:00	05:38	06:30	07:38	10:31	11:19	12:20	12:51	13:29		14:43	16:40	17:50	18:40	19:34	20:25	21:11	22:13	23:33	00:30	00:57	01:27	02:11	02:39	13:21	14:30	15:27	16:25	17:28	18:28	19:27	20:25	21:26	22:29
1 Consecut	Date	5/10/07	5/10/07	5/10/07	5/10/07	5/10/07	5/10/07	5/10/07	5/10/07	5/10/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07		5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/11/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07	5/12/07
BITMAX-I	Station	050	051	052	053	054	055	056	057	058	059	090	061	062	063	064	065	990	067	068	690	020	071		072	073	074	075	076	220	078	620	080	081	082	083	084	085	086	087	088	089	060	091	092	093	094	095

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Table 3 (cont.). Consecutive Station Log.

	Axial Station Name																as13					tear as03										1	asus	asu4	0000	as07	as08	as09	as10	as11	as12	as13
	Other Activites	25 hr ETM anchor station	Delayed 30 minutes because of lightning	25 hr ETM anchor station	up estuary anchor station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Down Estuary Anchor Station	Last CTD of 3rd Anchor	axial survey	axial survey avial survey		axial survey	axial survey	axial survey	acial survey	axial survey	axial survey	axial survey																
	MOC / TT / DIPSTIC #	DS09		DS10	DS11	DS12	DS13	DS14,15	DS16	DS17	DS18	DS19		DS20,21	DS22	DS23		DS24	DS25	DS26			DS27		DS28	DS29	DS30	DS31	DS32	DS33	DS34	DS35										
	Water Sample #s																		180(s, size 11)			181(s),182(m),183(B, size 12)											184-186		107 100	201-101		190-192		193-195		196-198
M0703	CTD #	960	260	860	660	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	121	120	130	131	132	133	134	135	136	137
Cruise # BI	Depth (m)	12.9	12.7	12.6	12.4	12.4	12.8	12.4	12.9	13.1	13.0	12.5	12.7	12.5	12.6	12.4	6.6	6.5	6.3	6.4	6.5	13.1	13.8	13.8	13.8	13.9	14.1	14.1	14.1	14.3	14.2	14.3	22.4	13.1	13.4	13.1	13.9	13.6	13.0	15.6	13.8	6.8
	Decimal Longitude	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.21	76.02'	76.02'	76.02'	76.02'	76.02'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32'	76.32	70.36	76 201	76.30	76.25	76.24	76.22'	76.17	76.12'	76.05	76.02'
14/2007	Longitude (minutes)	12.48'	12.52'	12.52"	12.51	12.52"	12.53'	12.50'	12.50'	12.50'	12.50'	12.47"	12.51'	12.50'	12.51	12.52"	01.42"	01.42"	01.42'	01.41	01.42"	19.23'	19.23'	19.23	19.22"	19.20'	19.21	19.22'	19.20'	19.21	19.23	19.23	21./0	19.95	18 02'	15.24	14.21	13.21	10.45'	06.90'	02.93	01.40"
5/8/2007 - 5/	Longitude (degrees)	76°	°97	76°	°97	-9 <i>2</i>	.92	76°	°97	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	°97	-76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	76°	-9/	-9/ 28°	76°	26°	-2e°	76°	76°	76°	76°	76°
Date:	Decimal Latitude	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.33'	39.44	39.44	39.44"	39.44"	39.44"	39.07"	39.07	39.07	39.07	39.07"	39.07"	39.07	39.07	39.07	39.07	39.07	39.00	39.00	30.17	39.21	39.26	39.31'	39.35'	39.38'	39.40'	39.44"
	Latitude (minutes)	19.64'	19.59'	19.58'	19.58'	19.58	19.59'	19.58'	19.63'	19.63'	19.63'	19.61	19.58'	19.58'	19.58	19.58'	26.43'	26.41	26.40'	26.40'	26.39'	04.04'	04.04'	04.04	04.03	04.04'	04.04'	04.04'	04.08'	04.05	04.07	04.05	28.85	05.49'	10.00	12.53	15.66'	18.63'	20.75	22.54'	24.00	26.41
	Latitude (degrees)	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	39°	38-	30°	200	36	39°	39°	39°	39°	39°	39°
i Log	Time (LMT)	19:34	21:00	21:29	22:30	23:27	00:30	01:30	02:32	03:31	04:28	05:31	06:28	07:26	08:27	09:26	11:27	12:30	13:26	14:22	15:25	18:02	18:58	21:02	21:57	23:03	00:04	00:58	02:03	02:58	03:57	04:56	10:70	08-00	08-44	09:11	09:39	10:09	10:41	11:11	11:50	12:19
tive Station	Time (UTC)	23:34	01:00	01:29	02:30	03:27	04:30	05:30	06:32	07:31	08:28	09:31	10:28	11:26	12:27	13:26	15:27	16:30	17:26	18:22	19:25	23:02	23:58	01:02	01:57	03:03	04:04	04:58	06:03	06:58	07:57	08:56	10:11	17:37	12-44	13:11	13:39	14:09	14:41	15:11	15:50	16:19
I Consecu	Date	5/12/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/13/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/0/	2014/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07	5/14/07
BITMAX-I	Station	960	260	860	660	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	121	120	130	131	132	133	134	135	136	137

Notes: * - large ship passed, increasing turbidity during CTD cast



Figure 1. Axial stations occupied during BM0701 in upper Chesapeake Bay.



Figure 2. Turbidity (NTU, upper panel) and temperature (°C, lower panel) with salinity (isohalines on both panels) from CTD casts during first axial survey, 8 May 2007.