Sediment Profile Imagery

Norton Basin, Little Bay, Grass Hassock Channel, and The Raunt

Submitted to:

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Introduction

An important component of the NYSDEC/PANY-NJ Norton Basin/Little Bay Habitat Restoration Study is the assessment of existing benthic habitats within the Norton Basin and Little Bay project areas, and within the reference areas (Grass Hassock Channel and the Raunt). Sediment Profile Imagery (SPI) is a powerful benthic assessment tool which allows researchers to view and photograph estuarine sediments and benthic habitats without removing or disturbing the benthic environment. The SPI camera is designed to penetrate the top layers of sediment on the sea bottom so that a portion of the overlying water, the top layer of sediment, and sub-layers can be viewed and photographed. Benthic ecologists can then perform qualitative and quantitative interpretation of the images to assess the condition of the environment.

SPI surveys were conducted twice during 2001, under the USACE-NYD funded portion of the baseline study (Yozzo et al. 2001). A final SPI survey was completed in 2002, under the present study. The results of the final SPI survey are provided as follows:

Field Collection

A total of 199 SPI images were collected at 100 stations during May, 2002 in the Norton Basin/Little Bay study area and throughout the reference areas (**Fig. 1**). SPI images were taken with a Hulcher Model Minnie sediment profile camera equipped with a UW-Nikkor 35 mm lens (F/3.5, water-corrected) and loaded with Fujichrome 100P slide film. The profile camera was set to take two photographs at each station at 6 and 12 seconds after bottom contact. The weight of the camera was adjusted using detachable iron weights to account for differences in sediment type at various locations throughout the study and reference areas.

Image Analysis

The sediment profile photographs were analyzed visually by projecting the images and recording all features seen into a preformatted, standardized spreadsheet file. The images were then digitized using a Nikon Coolscan 2000 scanner and analyzed using Adobe PhotoShop and NTIS Image programs. Steps in the computer analysis of each image were standardized and followed the basic procedures in Viles and Diaz (1991). Data from each image were sequentially saved to a spreadsheet file for later analysis. Details of these analytical methods can be found in Diaz and Schaffner (1988) and Rhoads and Germano (1986), and in the standardized image analysis procedures of Viles and Diaz (1991).

SPI Parameters

Prism Penetration

This parameter provides a geotechnical estimate of sediment compaction with the profile camera prism acting as a dead weight penetrometer. Camera penetration is positively correlated with soft sediments, high water content for fine sediments, and poorer sorting coefficients for sandy sediments. Penetration is measured as the distance (in cm), which the sediment moved up the 23-cm length of the camera faceplate.

Surface Relief
Surface relief or boundary roughness is measured as the difference between the maximum and minimum distance the prism penetrates, and provides qualitative and quantitative data on habitat characteristics. This parameter estimates small-scale bed roughness on the order of the prism faceplate width (15 cm). The causes of roughness can often be inferred from visual analysis of the film images.

Apparent Color Redox Potential Discontinuity (RPD) Layer
This parameter has been determined to be an important indicator of benthic habitat quality (Rhoads and Germano 1986, Diaz and Schaffner 1988) and provides an estimate of the depth to which sediments appear to be oxidized. The term apparent is used in describing this parameter because no actual measurement is made of the redox potential. An assumption is made that, given the complexities of iron and sulfate reduction-oxidation chemistry, reddish-brown sediment color tones, (or in black and white images whiter or lighter areas of the image) are indications that the sediments are oxidized, or at least are not intensely reducing (Rhoads and Germano 1986, Diaz and Schaffner 1988). This is in accordance with the classical concept of RPD depth, which associates it with sediment color (Fenchel 1969, Vismann 1991). The depth of the apparent color RPD is defined as the area of all the pixels in the image discerned as being oxidized divided by the width of the digitized image. The area of the image with oxidized sediment is obtained by digitally manipulating the image to enhance characteristics associated with oxidized sediment (greenish-brown color tones). The enhanced area is then determined from a density slice of the image.

The apparent color RPD has been very useful in assessing the habitat quality for epifauna and infauna from both physical and biological points of view. Rhoads and Germano (1986), Revelas et al. (1987), Day et al. (1988), Diaz and Schaffner (1988), Valente et al. (1992) and Bonsdorff et al. (1996) all found that the RPD depth from profile images were directly correlated to benthic habitat quality in polyhaline and mesohaline estuarine zones. Controlling for differences in sediment type, habitats with thinner RPD's (mm scale) tend to be associated with some type of environmental stress. Habitats with deeper RPD's (cm scale) usually have healthy epibenthic and infaunal communities.

Sediment Grain Size
Grain size is an important parameter for determining the nature of the physical forces acting on a habitat and is a major factor in determining benthic community structure (Rhoads 1974). The sediment type descriptors used for image analysis follow the Wentworth classification as described in Folk (1974), and represent the major modal class for each image. Grain size is determined by comparison of collected images with a set of standard images for which mean grain size has been determined in the laboratory.

Surface Features
These parameters include a wide variety of features, each of which provides information on the type of habitat and its quality for supporting benthic species. The presence of certain surface features is indicative of the overall nature of a habitat. For example, bedforms are always associated with physically dominated habitats, whereas the presence of worm tubes or feeding pits is indicative of a more biologically accommodating habitat (Rhoads and Germano 1986, Diaz and

Schaffner 1988). Surface features are visually evaluated from each image and compiled by type and frequency of occurrence.

Subsurface Features

These parameters include a wide variety of features and are used to characterize the physical and biological processes influencing the bottom. For example, the presence of methane gas voids has been found to be an indication of anaerobic metabolism associated with high rates of bacterial activity (Rhoads and Germano 1986). Muddy habitats with large amounts of methane gas are generally associated with areas of oxygen stress or high organic loading. Habitats with burrows, infaunal feeding voids, and/or actual infauna visible are generally considered "healthy" (Rhoads and Germano 1986, Diaz and Schaffner 1988, Valente et al. 1992). Surface features are visually evaluated from each slide and compiled by type and frequency of occurrence.

Results

Sediment Profile Imaging

Detailed station summaries of the May 2002 SPI survey are presented in **Table 1**. The summaries present information on camera (prism) penetration depth, surface/near-surface features, RPD depth, grain size, and observations of benthic fauna. All SPI images have been catalogued on a CD-ROM (attached). Qualitative comparison of the May 2002 SPI images with previous SPI surveys (June and October 2001) indicate that the benthic habitats of the study areas and reference areas are stable, and have not undergone changes in sediment quality, texture, and presence/absence of biotic or abiotic structures. Additional comparison and analysis of SPI data among the three surveys will be performed and presented in the Final Report to PANY-NJ and NYSDEC, due in November, 2002.

Norton Basin

The dominant sediment types present throughout Norton Basin were silt and fine sand. Within the two borrow pits, sediments were highly aqueous organic fines, and the SPI camera often over-penetrated, precluding the collection of satisfactory images at the water/sediment interface. Sandy sediments overlain by shell hash were encountered in the vicinity of the entrance channel to Norton Basin.

A large number of stations throughout Norton basin were covered with dense mats of green algae (*Ulva lactuca*). Snail eggs were observed on the green algae in some of the SPI images

Little Bay

Nearly all of the SPI samples collected in Little Bay over-penetrated. Sediments in the Little Bay borrow pit were soft, black, and highly aqueous. Despite repeated efforts, the SPI camera did not yield satisfactory images of the sediment-water interface.

Grass Hassock Channel

The dominant sediment type present within Grass Hassock Channel was silt. *Ampelisca* mats were apparent in a large number of sample images from this area.

The Raunt

The dominant sediment type throughout the Raunt was silt, with fine sand present at the stations located near the confluence with Runway Channel. This is indicative of higher wave/current energy in the area, relative to conditions in Grass Hassock Channel or Norton Basin/Little Bay.

A majority of the samples from the Raunt included images of dense *Ampelisca* mats. Sample images from the upper, lower-energy reaches of this waterway were characterized by finer, darker, sediments, with fewer occurrences of macrofauna and *Ampelisca* mats.

Literature Cited

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Figure 1. Sediment Profile Imagery (SPI) sample locations in Norton Basin and reference areas, May 2002.

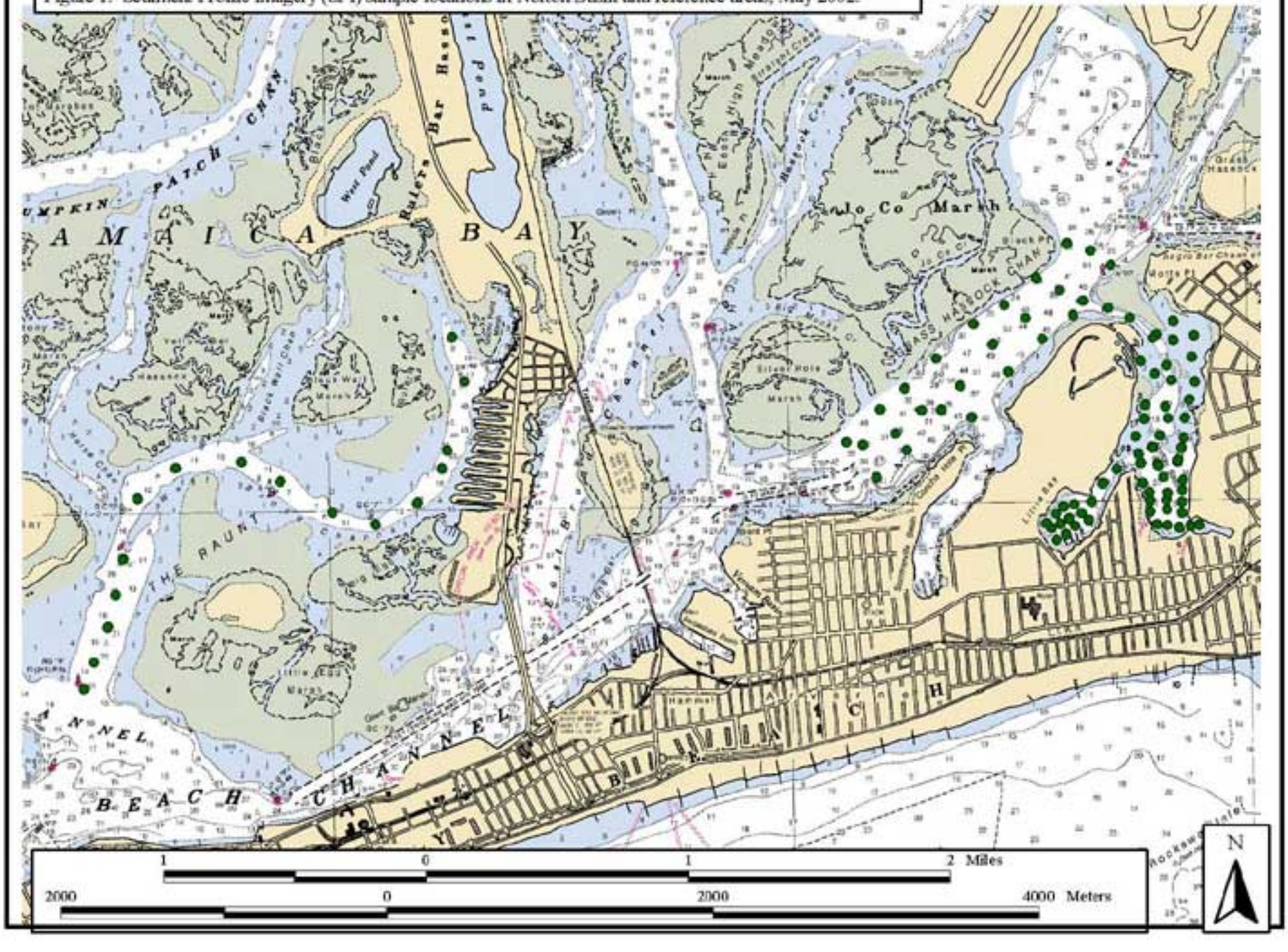

Table 1. Sediment profile imagery (SPI) station summary from Norton Basin, Little Bay, the Raunt, and Grass Hassock Channel, May, 2002.

Station	Rep	Prism Time	Day	Min Pen	Max Pen	Ave Pen	SR	Qualifyer RPD	Ave RPD	Algae	Mat Bacterial	Snail	Crabs Hermit	Shell	Detritus	Bedforms	GRAIN SIZE	FEATURES SURFACE	TUBES AMPHIPOD	TUBES WORM	INFAUNA	BURROWS	VOIDS OXIC	VOIDS ANAEROBIC	VOIDS GAS	
LB1	2	8:34	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB2	2	8:47	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB3	1	8:52	5/20/2002	IND	IND	>23	IND	IND							x		SI	IND	IND	IND	0	0	0	0	0	
LB3	2	8:55	5/20/2002	IND	IND	>23	IND	IND							x		SI	IND	IND	IND	0	0	0	0	0	Light gray over dark
LB4	1	9:00	5/20/2002	IND	IND	>23	IND	IND			x						SI	IND	IND	IND	0	0	0	0	0	
LB4	2	9:03	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB5	1	9:10	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB5	2	9:13	5/20/2002	18.9	19.4	19.1	0.5		0.0								SI	IND	IND	IND	0	0	0	0	0	Low DO?
LB6	1	9:44	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB6	2	9:47	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB7	1	9:55	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB8	2	11:14	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB9	1	11:18	5/20/2002	19.8	21.8	20.8	2.0		0.0								SI	PHY	NONE	NONE	0	0	0	0	0	Low DO?
LB10	2	10:28	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB11	2	13:55	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	5	
LB12	1	11:00	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	4	
LB12	2	11:06	5/20/2002	IND	IND	>23	IND	IND		X							SI	IND	IND	IND	0	0	0	0	5	
LB13	1	10:34	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB13	1	13:59	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB13	2	14:04	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB14	1	10:42	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
LB14	2	10:48	5/20/2002	9.2	10.3	9.8	1.1		0.4								SI	PHY	FEW	MANY	0	0	0	0	0	
LB15	2	14:11	5/21/2002	8.3	9.5	8.9	1.2		0.0			1		X			SI	PHY/BIO	NONE	MAT	0	0	0	0	0	
LB15	2	10:54	5/20/2002	8.6	10.0	9.3	1.5		0.7					X			SI	PHY/BIO	NONE	MAT	0	0	0	0	0	
NB16	1		5/20/2002	1.2	1.7	1.5	0.5	>	1.5			6				x	MS	PHY	NONE	NONE	0	0	0	0	0	
NB16	2		5/20/2002	4.0	5.2	4.6	1.2		2.0					x			MSSI	PHY/BIO	SOME	MAT	2	0	0	0	0	
NB17	1	11:27	5/20/2002	IND	IND	0.0	IND	IND				15		x			MS?	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB17	2	11:30	5/20/2002	IND	IND	0.0	IND	IND				10		x			MS?	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB18	1	11:37	5/20/2002	6.6	8.7	7.7	2.1		0.2								SI	PHY	NONE	SOME	0	0	0	0	0	
NB18	1	14:14	5/21/2002	8.6	9.1	8.8	0.5	<	0.2	X		1		X			SI	PHY	NONE	FEW	0	0	0	0	0	
NB18	2	14:20	5/21/2002	2.0	8.7	5.4	6.7		1.0	X		1		X			SI	PHY	NONE	MANY	0	0	0	0	0	Snail eggs on algae
NB18	2	11:39	5/20/2002	7.2	8.7	7.9	1.5		1.8					X			SI	PHY/BIO	SOME	MAT	0	0	0	0	0	
NB19	1	16:02	5/20/2002	9.9	11.1	10.5	1.2		3.4			1		X			SI	BIOG	MANY	MAT	0	0	0	0	0	
NB19	2	16:07	5/20/2002	19.9	20.3	20.1	0.4		0.0								SI	PHY	NONE	NONE	0	0	0	0	0	
NB20	1	16:09	5/20/2002	12.6	13.6	13.1	1.0	<	0.2								SI	PHY	NONE	SOME	2	0	0	0	0	Tubes on a thin RPD
NB20	2	16:12	5/20/2002	13.6	15.5	14.6	1.9	<	0.2								SI	PHY	NONE	SOME	3	0	0	0	0	Tubes on a thin RPD
NB21	1	16:14	5/20/2002	11.9	12.9	12.4	1.0	<	0.2			1					SI	PHY	NONE	SOME	1	0	0	0	0	
NB21	2	16:16	5/20/2002	2.1	2.8	2.4	0.8	>	2.4	X				X		X	MS	PHY	NONE	SOME	0	0	0	0	0	
NB22	1	16:18	5/20/2002	4.1	6.5	5.3	2.4		1.6	X				X			SIFS	PHY	NONE	SOME	0	0	0	0	0	
NB22	2	16:20	5/20/2002	0.4	2.4	1.4	1.9	>	1.4	X				X		X	FSMS	PHY	NONE	SOME	0	0	0	0	0	
NB23	1	16:24	5/20/2002	5.0	6.3	5.6	1.3		2.6	X				X		X	FS	PHY	NONE	FEW	0	2	0	0	0	
NB23	2	16:27	5/20/2002	2.3	4.2	3.2	1.9	IND		X							FSSI	PHY	NONE	MANY	0	0	0	0	0	
NB24	1	16:28	5/20/2002	13.0	14.9	14.0	1.9		1.9	X				X			SIFS	PHY	NONE	MANY	0	0	0	0	0	
NB24	2	16:31	5/20/2002	13.7	14.4	14.1	0.7		1.5	X							SIFS	PHY/BIO	SOME	MAT	0	0	0	0	0	
NB25	1	13:21	5/20/2002	13.1	15.0	14.1	1.9	<	0.2								SI	PHY	NONE	SOME	0	0	0	0	0	
NB26	1	13:14	5/20/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
NB27	2	14:48	5/21/2002	14.6	15.6	15.1	1.0		0.0								SI	PHY	NONE	NONE	0	0	0	0	0	Low DO?
NB27	2	12:03	5/20/2002	20.4	22.5	21.5	2.2	<	0.2								SI	PHY	NONE	NONE	0	0	0	0	0	Low DO?
NB28	1	11:52	5/20/2002	19.9	21.1	20.5	1.2		0.4								SI	PHY	NONE	MANY	0	0	0	0	0	
NB28	2	11:55	5/20/2002	15.6	16.6	16.1	1.0		0.8								SI	PHY	NONE	MAT	0	2	0	0	0	
NB29	1	14:26	5/21/2002	13.6	15.6	14.6	2.1		0.0								SI	PHY	NONE	SOME	0	0	0	0	0	Low DO
NB29	2	11:47	5/20/2002	20.5	20.9	20.7	0.4		0.0		X						SI	PHY	NONE	NONE	0	0	0	0	0	Low DO
NB30	1	13:01	5/20/2002	18.8	19.6	19.2	0.7	IND		X							SI	PHY	NONE	NONE	0	0	0	0	0	
NB30	2	13:04	5/20/2002	IND	IND	>23	IND	IND		X							SI	IND	IND	IND	0	0	0	0	0	Small tubes on Ulva
NB31	1	13:07	5/20/2002	0.0	1.2	0.6	1.2	>	0.6					X			FSMS	PHY	NONE	FEW	0	0	0	0	0	
NB31	1	14:30	5/21/2002	13.9	14.7	14.3	0.8		0.0		x						SI	PHY	NONE	NONE	0	0	0	0	0	Low DO
NB31	2	14:35	5/21/2002	2.2	3.6	2.9	1.4	>	2.9					X			FSMS	PHY/BIO	FEW	MAT	0	0	0	0	0	
NB31	3	14:39	5/21/2002	4.6	5.4	5.0	0.9		3.5					X			FSMS	PHY/BIO	SOME	MAT	0	0	0	0	0	
NB32	1	16:56	5/20/2002	4.1	6.5	5.3	2.4		3.0	X				X	X		FSMSSI	PHY	NONE	SOME	0	0	0	0	0	
NB32	2	16:59	5/20/2002	12.3	13.8	13.1	1.5		3.0	X				X			FSMSSI	PHY	NONE	MANY	0	3	0	0	0	
NB33	1	16:52	5/20/2002	3.9	5.2	4.6	1.3		3.5					X		X	MS	PHY	NONE	NONE	0	0	0	0	0	
NB33	2	16:55	5/20/2002	IND	IND	0.0	IND	IND		X				X			IND	PHY	NONE	NONE	IND	IND	IND	IND	IND	Snail eggs on algae
NB34	1	16:47	5/20/2002	12.5	13.8	13.2	1.4		1.8	X							SI	PHY	FEW	MANY	0	3	0	0	0	Stick amphipod, snail eggs
NB34	2	16:50	5/20/2002	0.7	2.3	1.5	1.6	>	1.5					X		X	MS	PHY	NONE	NONE	0	0	0	0	0	
NB35	1	16:39	5/20/2002	10.8	11.9	11.4	1.1		3.0					X			FSSI	PHY/BIO	NONE	MANY	0	4	0	0	0	
NB35	2	16:42	5/20/2002	7.6	8.9	8.3	1.4		4.7	X				X		X	FSMS	PHY	NONE	NONE	1	1	0	0	0	
NB35	3	16:44	5/20/2002	0.6	2.7	1.7	2.2		0.7	X		3	1	X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB36	1	16:33	5/20/2002	4.1	8.1	6.1	4.0		2.6				2	X			SIFS	PHY/BIO	NONE	MAT	1	2	1	0	0	
NB36	2	16:37	5/20/2002	11.7	13.3	12.5	1.6		4.0	X		1		X			SIFS	PHY/BIO	NONE	MANY	0	1	0	0	0	Sail eggs on algae
NB37	1	13:33	5/20/2002	1.1	2.7	1.9	1.6		1.0					X			FSMSSI	PHY	NONE	SOME	0	0	0	0	0	
NB37	1	14:52	5/21/2002	5.2	6.3	5.7	1.1		2.8			1		X			SIFS	PHY	NONE	MANY	0	0	0	0	0	
NB37	2	14:54	5/21/2002	8.5	9.9	9.2	1.4		1.3	X					X		SI	PHY	NONE	FEW	0	0	0	0	0	
NB38	1	13:29	5/20/2002	5.7	6.8	6.2	1.1	IND		X				X			SI	PHY	NONE	NONE	0	0	0	0	0	
NB38	2	13:31	5/20/2002	8.0	8.8	8.4	0.8	IND		X							SI	PHY	NONE	FEW	0	0	0	0	0	

Table 1. Sediment profile imagery (SPI) station summary from Norton Basin, Little Bay, the Raunt, and Grass Hassock Channel, May, 2002.

Station	Rep	Prism Time	Day	Min Pen	Max Pen	Ave Pen	SR	Qualifyer RPD	Ave RPD	Algae	Mat Bacterial	Snail	Crabs Hermit	Shell	Detritus	Bedforms	GRAIN SIZE	FEATURES SURFACE	TUBES AMPHIPOD	TUBES WORM	INFAUNA	BURROWS	VOIDS OXIC	VOIDS ANAEROBIC	VOIDS GAS	
NB39	1	13:01	5/21/2002	18.5	18.9	18.7	0.4	<	0.2								SI	PHY	NONE	SOME	0	0	0	0	0	
NB39	2	13:03	5/21/2002	18.6	19.8	19.2	1.3		1.8					X			SI	PHY/BIO	MAT	MANY	0	2	0	0	0	
NB40	1	17:33	5/20/2002	IND	IND	0.0	IND	IND		X							FS	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB40	2	17:35	5/20/2002	1.1	1.4	1.3	0.3	>	1.3	X		14		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB41	1	17:28	5/20/2002	IND	IND	0.0	IND		0.0	X				BED			SH	PHY	NONE	FEW	IND	IND	IND	IND	IND	Hydroids
NB41	2	17:30	5/20/2002	IND	IND	0.0	IND		0.0	X				BED			SH	PHY	NONE	NONE	IND	IND	IND	IND	IND	Hydroids
NB42	1	17:22	5/20/2002	IND	IND	0.0	IND		0.0	X				BED			SH	PHY	NONE	NONE	IND	IND	IND	IND	IND	Hydroids
NB42	2	17:25	5/20/2002	0.6	1.3	0.9	0.7	>	0.9			1		X		x	MS	PHY	NONE	NONE	0	0	0	0	0	
NB43	1	17:17	5/20/2002	3.6	6.3	4.9	2.7		4.4	X		1		X			FSMS	PHY	NONE	MANY	0	0	0	0	0	Snail eggs on algae
NB43	2	17:19	5/20/2002	IND	IND	0.0	IND	IND						BED			SH	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB44	1	17:12	5/20/2002	11.8	14.0	12.9	2.1		3.6			4		X			SI	BIOG	MAT	SOME	1	3	0	0	0	
NB44	2	17:14	5/20/2002	4.6	5.5	5.0	0.9		0.8			2		X			SI	BIOG	MAT	SOME	0	1	0	0	0	
NB45	1	12:53	5/20/2002	14.4	15.4	14.9	0.9	IND		X							SI	PHY	NONE	FEW	0	0	0	0	0	
NB45	1	15:02	5/21/2002	19.1	19.5	19.3	0.4		0.0	X	X						SI	PHY	NONE	NONE	0	0	0	0	0	
NB45	2	12:55	5/20/2002	9.9	13.6	11.8	3.6	IND		X							SI	PHY	NONE	SOME	0	0	0	0	0	
NB45	2	15:04	5/21/2002	17.1	18.7	17.9	1.6	<	0.2	X	?						SI	PHY	MAT	NONE	0	0	0	0	0	
NB46	1	17:01	5/20/2002	3.2	12.1	7.6	8.9		1.0	X		3		X			FSSI	PHY	NONE	MANY	0	0	0	0	0	Snail eggs on algae
NB46	2	17:05	5/20/2002	7.7	8.3	8.0	0.6		1.6			1		X			FSSI	PHY	NONE	MANY	0	3	0	0	0	
NB46	3	17:08	5/20/2002	6.0	6.4	6.2	0.4		3.0			1		X			FSSI	PHY	NONE	SOME	0	1	2	0	0	
NB47	1	15:49	5/20/2002	0.0	0.5	0.3	0.5	>	0.3			1		X			MS	PHY	NONE	SOME	IND	IND	IND	IND	IND	
NB48	1	15:44	5/20/2002	0.2	0.6	0.4	0.4	>	0.4	X		30		X		X	MSCS	PHY	NONE	SOME	IND	IND	IND	IND	IND	
NB48	2	15:46	5/20/2002	0.9	1.2	1.1	0.3	>	1.1	X		15		X		X	MSCS	PHY	NONE	MANY	0	0	0	0	0	
NB49	1	15:37	5/20/2002	0.1	0.7	0.4	0.6	>	0.4			15		X		X	MSCS	PHY	NONE	SOME	IND	IND	IND	IND	IND	
NB49	2	15:39	5/20/2002	0.7	1.0	0.8	0.4	>	0.8			30		X		X	MSCS	PHY	NONE	SOME	0	0	0	0	0	
NB50	1	15:33	5/20/2002	0.0	0.4	0.2	0.4	>	0.2	X		30		X		X	MSCS	PHY	NONE	FEW	IND	IND	IND	IND	IND	
NB50	2	15:34	5/20/2002	0.0	1.2	0.6	1.2	>	0.6	X		30		X		X	MSCS	PHY	NONE	MANY	0	0	0	0	0	
NB51	3	14:12	5/20/2002	10.4	13.7	12.0	3.3	IND				3					SI	PHY	NONE	FEW	0	0	0	0	0	
NB52	1	14:20	5/20/2002	0.0	0.9	0.5	0.9	>	0.5	X		30		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB52	2	14:23	5/20/2002	1.6	2.8	2.2	1.2		1.4	X		15		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB53	1	15:25	5/20/2002	2.2	3.0	2.6	0.8	IND		X				BED			SHSA	PHY	NONE	NONE	0	0	0	0	0	
NB53	2	15:27	5/20/2002	1.5	5.6	3.6	4.1		1.6	X		1		BED			SHSA	PHY	NONE	SOME	0	0	0	0	0	
NB54	1	15:19	5/20/2002	1.1	1.7	1.4	0.7		1.0			25		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB54	2	15:21	5/20/2002	0.6	1.1	0.8	0.5	>	0.8			30		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB55	1	15:09	5/20/2002	IND	IND	0.0	IND	IND		X		1					ALGAE	PHY	NONE	NONE	IND	IND	IND	IND	IND	All algae
NB55	2	15:13	5/20/2002	IND	IND	0.0	IND	IND		X							ALGAE	PHY	NONE	FEW	IND	IND	IND	IND	IND	All algae
NB56	1	15:02	5/20/2002	3.9	4.5	4.2	0.6		2.0			30		X		x	FS	PHY	NONE	NONE	0	2	0	0	0	
NB56	2	15:06	5/20/2002	0.0	6.6	3.3	6.6		2.6	X		10		X		X	FS	PHY	NONE	NONE	0	0	0	0	0	
NB57	1	14:56	5/20/2002	0.5	0.8	0.7	0.3	>	0.7	X		25		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB57	2	15:00	5/20/2002	4.1	4.8	4.5	0.7		3.3			2		X		X	FSMS	PHY	NONE	NONE	0	0	0	0	0	
NB58	1	14:44	5/20/2002	0.7	1.2	0.9	0.4	>	0.9	X		30+		X		X	FS	PHY	NONE	NONE	0	0	0	0	0	
NB58	2	14:47	5/20/2002	1.3	3.2	2.3	1.8	IND		X		7		X			ALGAE	PHY	NONE	NONE	0	0	0	0	0	All algae
NB59	1	14:50	5/20/2002	IND	IND	0.0	IND	IND		X		20		X			ALGAE	PHY	NONE	NONE	IND	IND	IND	IND	IND	All algae
NB59	2	14:54	5/20/2002	IND	IND	0.0	IND		0.0	X		30+		X		X	FS	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB60	1	14:34	5/20/2002	IND	IND	0.0	IND	IND		X		30+		X			FS	PHY	NONE	NONE	IND	IND	IND	IND	IND	
NB60	2	14:39	5/20/2002	0.4	0.9	0.6	0.5	>	0.6	X		30+		X			FS	PHY	NONE	NONE	0	0	0	0	0	
NB61	1	14:27	5/20/2002	IND	IND	0.0	IND	IND		X		4					ALGAE	PHY	NONE	SOME	IND	IND	IND	IND	IND	All algae
NB61	2	14:32	5/20/2002	IND	IND	0.0	IND	IND		X		30+		X			FS	PHY	NON	NON	IND	IND	IND	IND	IND	
R62	1	8:12	5/21/2002	13.0	14.4	13.7	1.4		3.2					X			FSSI	PHY	NONE	SOME	0	3	0	0	0	
R62	2	8:15	5/21/2002	9.8	10.6	10.2	0.8		3.3								FSSI	PHY/BIO	MAT	MANY	0	3	0	0	0	
R63	1	8:18	5/21/2002	16.1	17.7	16.9	1.5		1.0								SI	PHY	MAT	MANY	0	0	0	0	0	
R63	2	8:20	5/21/2002	3.7	5.1	4.4	1.3	IND									SI	PHY	MAT	MANY	0	0	0	0	0	Disturbed surface
R64	1	8:23	5/21/2002	15.1	15.6	15.3	0.5		3.4	X		1					SIFS	BIOG	MAT	SOME	1	2	1	0	0	
R64	2	8:25	5/21/2002	10.4	11.3	10.8	0.9		3.9	X		1					SIFS	BIOG	MAT	SOME	2	5	1	0	0	Snail eggs on algae
R65	1	8:28	5/21/2002	8.3	9.7	9.0	1.4	IND		X				X			SI	PHY	NONE	SOME	0	0	0	0	0	
R65	2	8:30	5/21/2002	11.3	12.9	12.1	1.6	IND		X		4		X			SI	PHY	NONE	SOME	0	0	0	0	0	
R66	1	8:34	5/21/2002	11.7	13.4	12.6	1.7		1.6								SI	PHY/BIO	MAT	MANY	0	3	0	0	0	
R66	2	8:36	5/21/2002	12.3	12.9	12.6	0.7		3.3								SI	PHY/BIO	MAT	MANY	0	5	1	0	0	
R67	1	8:41	5/21/2002	14.2	14.9	14.6	0.7	IND						X			SI	PHY	MANY	SOME	0	0	0	0	0	Disturbed surface
R67	2	8:43	5/21/2002	14.0	16.3	15.2	2.3		2.2								SI	BIOG	MAT	MANY	0	3	0	0	0	
R68	1	8:47	5/21/2002	12.0	14.5	13.3	2.5		5.1	X		2		X			SI	BIOG	MAT	MANY	0	9	0	0	0	
R68	2	8:49	5/21/2002	9.7	20.1	14.9	10.4	IND		X		1		X			SI	PHY	NONE	FEW	0	0	0	0	0	Disturbed surface
R69	1	8:51	5/21/2002	10.4	11.1	10.7	0.6		2.1								SI	BIOG	MANY	MANY	1	4	0	0	0	
R69	2	8:58	5/21/2002	8.2	9.5	8.8	1.3		2.5								SI	BIOG	MAT	MANY	1	5	0	0	0	
R70	1	9:02	5/21/2002	14.2	17.6	15.9	3.4	IND									SIFS	PHY	SOME	SOME	0	0	0	0	0	Disturbed surface
R70	2	9:06	5/21/2002	4.7	7.4	6.0	2.7		4.0	X							SIFS	PHY/BIO	MANY	SOME	0	1	0	0	0	
R71	1	9:11	5/21/2002	16.1	17.4	16.8	1.3		6.0			1					SI	BIOG	MAT	NONE	0	3	0	0	0	
R71	2	9:14	5/21/2002	4.2	11.3	7.8	7.2		3.6	X		1					SI	BIOG	MAT	SOME	0	0	0	0	0	
R72	1	9:18	5/21/2002	14.5	16.8	15.7	2.3		6.3			1					SI	BIOG	MAT	NONE	0	3	0	0	0	
R72	2	9:21	5/21/2002	9.6	10.8	10.2	1.2		3.4								SI	BIOG	MAT	SOME	0	2	0	0	0	
R73	1	9:24	5/21/2002	2.9	3.2	3.0	0.3		2.5			20		X		X	FS	PHY	NONE	NONE	0	0	0	0	0	
R73	2	9:27	5/21/2002	1.9	3.3	2.6	1.3		1.9			15		X		X	FS	PHY	NONE	NONE	0	0	0	0	0	
R74	1	9:29	5/21/2002	1.0	1.5	1.3	0.5	>	1.3					X			FSMS	PHY	NONE	NONE	0	0	0	0	0	
R74	2	9:31	5/21/2002	1.8	3.4	2.6	1.5		1.6	X				X			FSMS	PHY	NONE	NONE	0	0	0	0	0	
R75	1	9:40	5/21/2002	15.3	16.7	16.0	1.4		5.0	X		1					SI	BIOG	MAT	SOME	1	4	0	0	0	

Table 1. Sediment profile imagery (SPI) station summary from Norton Basin, Little Bay, the Raunt, and Grass Hassock Channel, May, 2002.

Station	Rep	Prism Time	Day	Min Pen	Max Pen	Ave Pen	SR	Qualifyer RPD	Ave RPD	Algae	Mat Bacterial	Snail	Crabs Hermit	Shell	Detritus	Bedforms	GRAIN SIZE	FEATURES SURFACE	TUBES AMPHIPOD	TUBES WORM	INFAUNA	BURROWS	VOIDS OXIC	VOIDS ANAEROBIC	VOIDS GAS	
R75	2	9:42	5/21/2002	2.5	4.0	3.3	1.4	>	3.3	X		3			X		SI	PHY	FEW	MANY	0	0	0	0	0	
R76	1	9:47	5/21/2002	15.3	16.1	15.7	0.8		4.9	X		20					SI	BIOG	MAT	FEW	0	0	0	0	0	
R76	2	9:50	5/21/2002	11.6	14.5	13.1	2.9	IND				4					SI	BIOG	MAT	FEW	0	2	0	0	0	Disturbed surface
R77	2	9:57	5/21/2002	0.9	1.7	1.3	0.8	>	1.3			10	4		X	X	FS	PHY	NONE	NONE	0	0	0	0	0	
GH78	2	10:42	5/21/2002	18.2	19.4	18.8	1.2		3.9								SI	BIOG	MAT	SOME	0	3	0	0	0	
GH79	1	10:56	5/21/2002	18.8	19.6	19.2	0.8		1.1								SI	BIOG	MAT	NONE	0	1	0	0	0	
GH79	2	10:58	5/21/2002	12.1	13.3	12.7	1.2	IND									SI	BIOG	MAT	SOME	0	0	0	0	0	Disturbed surface
GH80	1	11:33	5/21/2002	13.4	14.5	13.9	1.1		2.2								SI	BIOG	MAT	SOME	0	2	0	0	0	
GH80	2	11:35	5/21/2002	12.4	13.5	13.0	1.1	IND									SI	BIOG	MAT	NONE	0	2	0	0	0	Disturbed surface
GH81	1	11:51	5/21/2002	15.8	16.5	16.2	0.7		3.8								SI	BIOG	MAT	SOME	0	2	0	0	0	
GH81	2	11:53	5/21/2002	7.7	9.6	8.6	1.9		2.5			1					SI	BIOG	MAT	SOME	0	5	0	0	0	
GH82	1	12:09	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
GH82	2	12:12	5/21/2002	14.0	14.4	14.2	0.4		0.8								SI	BIOG	MAT	SOME	0	0	0	0	0	
GH82	21	12:14	5/21/2002	2.4	19.8	11.1	17.3	IND									SI	BIOG	MAT	NONE	0	0	0	0	0	Disturbed surface
GH83	1	12:31	5/21/2002	16.9	18.0	17.5	1.1	IND									SI	BIOG	MAT	NONE	0	0	0	0	0	Disturbed surface
GH83	2	12:34	5/21/2002	4.8	7.8	6.3	3.0		3.1								SI	BIOG	MAT	SOME	0	0	0	0	0	
GH84	1	12:50	5/21/2002	8.6	11.7	10.2	3.1	IND									SI	PHY/BIO	MANY	MANY	0	0	0	0	0	Disturbed surface
GH84	2	12:52	5/21/2002	17.6	18.7	18.1	1.1		2.0								SI	BIOG	MAT	MANY	0	0	0	0	0	Disturbed surface
GH85	1	13:14	5/21/2002	0.5	1.2	0.9	0.7	>	0.9	X		2					CSGRPB	PHY	NONE	SOME	0	0	0	0	0	Calcarious serpulid tubes
GH85	2	13:18	5/21/2002	19.0	20.6	19.8	1.6		1.7								SI	BIOG	MAT	SOME	1	2	0	0	0	Disturbed surface
GH86	1	13:22	5/21/2002	16.7	17.7	17.2	1.0		1.2								SI	BIOG	MAT	MANY	0	0	0	0	0	
GH86	2	13:26	5/21/2002	6.0	6.9	6.5	1.0	IND									SI	BIOG	MAT	SOME	0	0	0	0	0	Disturbed surface
GH87	1	12:44	5/21/2002	18.8	19.8	19.3	1.0		1.6								SI	BIOG	MAT	MANY	0	0	0	0	0	
GH87	2	12:47	5/21/2002	18.8	21.4	20.1	2.6	IND									SI	BIOG	MAT	MANY	0	0	0	0	0	Disturbed surface
GH88	1	12:40	5/21/2002	13.4	14.6	14.0	1.3		5.0								SI	BIOG	MAT	MANY	0	3	0	0	0	
GH88	2	12:42	5/21/2002	19.5	21.3	20.4	1.7		3.1								SI	BIOG	MAT	MANY	0	2	0	0	0	
GH89	1	12:04	5/21/2002	5.5	8.0	6.8	2.5		2.0								SI	BIOG	MAT	SOME	0	3	0	0	0	
GH89	2	12:05	5/21/2002	15.8	16.5	16.2	0.7		1.0			1					SI	BIOG	MAT	SOME	0	3	0	0	0	
GH90	1	11:57	5/21/2002	4.4	11.8	8.1	7.4		3.2			2					SI	BIOG	MAT	SOME	0	2	0	0	0	
GH90	2	11:59	5/21/2002	1.2	4.6	2.9	3.5		2.3			2		X	x		SI	BIOG	MAT	SOME	0	0	0	0	0	
GH91	1	11:28	5/21/2002	14.8	16.9	15.8	2.1		3.4								SI	BIOG	MAT	SOME	0	0	0	0	0	
GH91	2	11:30	5/21/2002	8.6	11.3	9.9	2.7		1.5								SI	BIOG	MAT	MANY	0	0	0	0	0	Disturbed surface
GH92	1	11:02	5/21/2002	8.5	10.8	9.6	2.3		3.1			1		X			SI	BIOG	MAT	SOME	0	4	0	0	0	
GH92	2	11:06	5/21/2002	6.8	8.3	7.5	1.5		3.6					x			SI	BIOG	MAT	MAT	0	1	0	0	0	
GH93	1	10:03	5/21/2002	2.6	3.6	3.1	1.0	>	3.1	X		1		X		x	FSMS	PHY	NONE	NONE	0	0	0	0	0	
GH94	1	10:44	5/21/2002	13.4	16.3	14.8	2.9		2.5								SI	BIOG	MAT	MANY	1	3	0	0	0	
GH94	2	10:47	5/21/2002	17.9	19.3	18.6	1.4		2.9								SI	BIOG	MAT	MANY	0	1	0	0	0	
GH95	1	10:48	5/21/2002	14.3	14.7	14.5	0.4	IND									SI	PHY	NONE	NONE	0	0	0	0	0	
GH96	1	11:39	5/21/2002	13.1	15.3	14.2	2.3		1.6			1					SI	BIOG	MAT	SOME	0	1	0	0	0	
GH96	2	11:40	5/21/2002	6.7	9.3	8.0	2.5		1.8			4					SI	BIOG	MAT	MANY	0	0	0	0	0	
GH97	1	11:44	5/21/2002	12.8	14.0	13.4	1.2		1.6			4					SI	BIOG	MAT	MANY	0	1	0	0	0	
GH97	2	11:48	5/21/2002	5.7	7.3	6.5	1.7		2.7			2					SI	BIOG	MAT	MANY	0	0	0	0	0	
GH98	1	12:20	5/21/2002	12.5	15.9	14.2	3.3		2.7								SI	BIOG	MAT	SOME	1	2	0	0	0	
GH98	2	12:22	5/21/2002	6.7	9.3	8.0	2.6		3.2								SI	BIOG	MAT	SOME	0	2	0	0	0	
GH99	1	12:25	5/21/2002	17.8	18.5	18.2	0.7		1.5								SI	BIOG	MAT	NONE	0	0	0	0	0	Disturbed surface
GH100	1	12:55	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
GH100	2	12:57	5/21/2002	IND	IND	>23	IND	IND									SI	IND	IND	IND	0	0	0	0	0	
GH101	1	13:05	5/21/2002	14.3	15.8	15.1	1.5	IND									SI	PHY	NONE	SOME	0	0	0	0	0	
GH101	2	13:10	5/21/2002	IND	IND	0.0	IND	IND				1		X			GRPB	PHY	NONE	NONE	IND	IND	IND	IND	IND	