Final Report

To

Virginia Coastal Program

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

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Task 10.03 Restoration of seagrasses in Virginia Coastal Bays – Year 5 (Oct. 1, 2006, to Dec. 31, 2007)

By

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INTRODUCTION

The system of barrier islands, coastal bays, and salt marshes along the Atlantic coast of Virginia's portion of the Delmarva Peninsula represent some of the most natural, unspoiled coastal habitat along the U.S. East Coast. Historically, finfish and shellfish resources in this region supported large fisheries. However, during the 1930s, this region underwent a dramatic ecological shift, and seafood harvests declined dramatically.

Seagrasses, primarily eelgrass, Zostera marina, were once very abundant in these coastal bays, covering most of the shallow, sub-tidal sub-aqueous bottom. In the 1930s eelgrass underwent a massive decline attributed to a wasting disease pathogen, Labyrinthula sp. The decline was pandemic, affecting not only populations in the coastal bays but also populations on both sides of the Atlantic. In August 1933, this region was affected by one of the most destructive hurricanes to influence the area in the twentieth century, contributing to the decimation of seagrasses in the bays. Natural recovery of seagrasses had been limited primarily to Chincoteague, Sinepuxent, Isle of Wight and Assawoman bays. No recovery was documented in the Virginia coastal bays during this same period, which was attributed to a limited supply of propagules and short dispersal capabilities.

One of the most notable consequences of the loss of seagrass habitat in the coastal bays was the immediate collapse of a previously productive commercial bay scallop fishery, which is dependent on seagrasses as primary habitat. Almost certainly this loss of seagrass habitat resulted in declines in production of other commercially and ecologically important species, but little documentation of these impacts is available

We initiated a seagrass restoration program in the coastal bays, with efforts in Magothy Bay initiated in 1997, and South Bay in 1998, using test plots of adult transplants. The success of the test plots and the discovery of several natural patches in South Bay led us to conduct seed addition experiments there in 1999 and 2000. The success of the seed experiments and the sustained growth of previous transplants in South Bay led the Virginia Marine Resources Commission (VMRC) to designate a 400 acre area of subtidal habitat in South Bay to be set aside for seagrass restoration. In the fall of 2001, we broadcast 3.8 million seeds into 24-one acre parcels in the 400-acre set aside area. In addition we broadcast 600,000 seeds into 4 one-acre parcels in lower Cobb Island Bay and 600,000 seeds into 6 one-acre plots in Magothy Bay. We continued the large scale restoration of seagrass in South Bay in 2002 by broadcasting 1.8 million seeds into an additional 24 one acre plots at seed densities of 50 and 100K seeds (12 one acre areas at each seed density). In 2003 we broadcast 1.7 million seeds into 35 0.5 acre circular plots at 4 seed densities in both Cobb and Spider Crab bays. In 2004 we distributed approximately 7 million seeds in spring and fall plantings into 39 acres. In 2005, we broadcast 1.5 million seeds into 22 ½ acre plots (11 acres). In 2006 we established 28 plots in Hog Island Bay, each covering either 0.5 or 1.0 acres and receiving either 50,000 or 100,000 seeds per acre. A total of 1.6 million seeds were broadcast by hand across a total area of 21 acres. Plots were spaced across the High Shoal Marsh set-aside in a pattern that spread the various size and density combinations across shallow, medium, and deep sites, allowing future evaluation of optimal density and size for each depth zone.

A notable milestone of the seaside restoration effort in 2005 was the request to, and subsequent approval by the Virginia Marine Resources Commission of a 500 acre set aside near High Shoal Marsh in Hog Island Bay for 5 years (Fig. 1). In 2006 VMRC approved the continuance of our set aside in South Bay along with a request for an additional 366.36 acres, giving us a total of 727.85 acres as set aside in South Bay. This mirrors the 400 acre set aside in South Bay that was approved in 2001, and allows the continuation of successful seagrass restoration efforts without issues relating to clam dredging and aquaculture leases. Much of the area in Hog Island Bay is leased either to aquaculture or to individuals involved in clam dredging, and little area in the public grounds is suitable for eelgrass restoration

This final report details accomplishments in each of the stated objectives for year 5 of the seagrass restoration program.

TASK 1 – MONITOR SUCCESS OF TEST AND ESTABLISHED SEAGRASS AREAS

a.) In 2006, we did not establish additional test plots. Because we had covered all four major bays (South, Cobb, Spider Crab, and Hog Island bays) in previous years with test plots and with the termination of the SHP program in year 6, we felt the four most important bays highlighted above had shown success and that test plots were no longer necessary to show plants could grow and trigger a larger scale effort.

b.) Previously established large scale plots.

Many of the areas planted with seeds in the early years of this restoration effort have survived, spread and become denser. In addition, our in-situ monitoring has recorded numerous patches of eelgrass both adjacent to and distant from many of the established plots, suggesting movement of seeds from flowering shoots produced within these plots. We determined the most optimal way for assessing persistence and spread of eelgrass was from the air. We have attempted to combine high and low level aerial photography for documenting the annual changes occurring in each of the four bays. However, we have found that, in general, plants establishing in the first year are difficult to assess from the air if their densities are very low, thus necessitating on the ground quantitative transects.

Figs. 2, 3, and 4 show established beds that have begun to spread naturally in South, Cobb, and Spider Crab bays. This is most noticeable in South Bay when comparing the spread of eelgrass between 2004 and 2007, (Fig. 2). South Bay was the first bay targeted for large scale restoration and the results have been impressive as the entire 728 acre set aside now has plants, with an approximate 175 acre area occupied by continuous eelgrass. The well-outlined 'B' and 'W' noted in aerial photographs taken between 2001 and 2006 have blended with the expanding eelgrass such that they are not noticeable in the 2007 aerial photographs. Cobb Bay (Fig. 3) which has received fewer seeds than South Bay has been spreading also which is noticeable when comparing the 2004 and 2007 photography.

Initial seedling establishment in plots seeded in Hog Island Bay in fall 2006 were assessed in April 2007 by two divers swimming diagonal transects across each plot (Figure 5). Seedling establishment was generally excellent by comparison with other sites and years; most plots exceeded 15% seedling establishment, where generally, 10% has been considered good success. Prior to the 2006 seed distribution we were aware of a small number of naturally recruiting eelgrass patches in the central region of the set-aside. However, during the spring 2007 assessment it became clear that natural seed spread had occurred across wide regions within and outside the set-aside. Many of the plots we seeded in 2006 featured seedlings derived from our efforts, as well as natural adult patches from the previous year (not detected in aerial photography) and presumably some naturally recruiting seedlings. These natural recruits contributed to the very high seedling densities observed in some plots (e.g. 30% - 50% range in Fig. 5), but in the majority of plots, seedling densities dropped to zero immediately outside the seeded plot, suggesting that natural recruitment had not enhanced densities in these plots.

TASK 2 – COLLECT SEEDS FOR 2007 EFFORTS

In 2007, we discovered that the original South Bay restoration site had expanded and the bed was very dense (Fig 2). Our monitoring of the bed revealed that the area was producing a large number of very productive flowering shoots. While we initially collected some reproductive shoots in a couple of Chesapeake Bay sites, we focused most of our attention on seed harvesting at South Bay. Indeed, the seed collection in South Bay was very successful and we collected all the seeds we required for the large scale plots in Hog Island Bay and in Spider Crab Bay.

TASK 3 – WATER QUALITY MEASUREMENTS USING FIXED STATION CONTINUOUS MONITORS AND SURFACE MAPPING OF WATER QUALITY WITH DATAFLOW

During 2007, continuous underway sampling (DATAFLOW) and fixed station water quality measurements were made in the Virginia Coastal Bays restoration area. The DATAFLOW cruise track conducted in 2007 (Figure 7) traversed transplant restoration areas in South Bay, Cobb Bay, Spider Crab Bay, and Hog Island Bay. Cruises were conducted monthly throughout the seagrass growing season on March 27, April 9, May 21, June 20, July 19, August 20, September 4, October 17 and November 19. A YSI 6600 was deployed at a fixed monitoring station at the Wreck Island restoration site in South Bay at bi-monthly intervals throughout the growing season over the following range of dates; March 29 to April 26, June 13 to July 29, August 13 to September 314 and October 10 to November 8.

The DATAFLOW underway sampler recorded in vivo measurements of surface water quality taken at 2-3 second intervals (0.25 m depth; approximately every 50 m) along each cruise track. Measurements included turbidity (NTU), chlorophyll fluorescence, temperature, salinity, pH, dissolved oxygen, GPS location and depth using a YSI 6600 EDS sensor array (Yellow Springs Instruments, Inc.). In addition to the continuous underway sensor measurements, eight calibration and verification stations were sampled at discrete stations along each cruise track for total suspended solids, light attenuation profiles, secchi disk measurements, extracted pigment chlorophyll and dissolved oxygen via Winkler Titration. Concurrent with every other cruise (bi-monthly), two week deployments of a YSI 6600 EDS sensor array identical to that used in the DATAFLOW sampler were undertaken at the South Bay Wreck Island restoration site. Here, water quality was measured at 15-minute intervals throughout each 2-week deployment. These deployments bracketed, by approximately one week, each DATAFLOW water quality, monitoring cruise.

Figures 9, 11, 13, and 15 present the continuous underway DATAFLOW cruise tracks of water quality measurements for turbidity, chlorophyll, and salinity for the four monthly cruises that were paired with fixed monitoring station deployments during the SAV growing season in 2007. Results of the other cruises showed similar trends. The location of the fixed, continuous monitoring station is highlighted with a circle, and the transplant study areas are highlighted with rectangles on each cruise figure. The restoration study sites identified by boxes in the DATAFLOW figures are those indicated in Figure 7: South Bay-1, Cobb Bay-2, Spider Crab Bay– 3, Hog Island Bay- 4.

Salinities were found to be very consistent over the course of the 2007 SAV growing season and rarely dropped below 30 ppt throughout the Coastal Bays area. This is similar to previous years' results and illustrates the relatively consistent salinity environment of near full strength seawater found here. Full strength seawater (salinity of 35 ppt) has been found to be near optimum for eelgrass growth. Salinities among the various transplants sites were very similar and typically were found to be within 1-2 ppt.

Turbidity levels varied throughout the region with highest levels often observed in the western Coastal Bays region near Oyster, VA, especially during the spring. Turbidity levels were usually lower over the four restoration study areas. The Hog Island Bay site typically had the lowest turbidities. A region of high turbidity was observed between the South Bay and Hog Island Bay sites. This may have been related to inlet dynamics, which was typically a location of high wave and currents. Other regions of high turbidity were also observed through the area sampled by DATAFLOW. Most of these areas were associated with high turbidities within or near marsh creeks. We have determined that turbidity levels of 10 NTU or less in the Virginia Coastal Bays are equivalent to a light attenuation coefficient (K_d) of $\leq 1.5\ m^{-1}$. In the Chesapeake Bay these light attenuation levels have been associated with shallow water areas where SAV have been found growing to depths of 1m at MLW.

Low water column chlorophyll levels were again typical of both the transplant sites and the coastal bay regions throughout 2007, with concentration typically below 5-10 ug/l. In the Chesapeake Bay chlorophyll levels of 15 µg/l or greater have been associated with SAV habitats that are under stress or in decline. As with salinity, chlorophyll levels appear consistent among the sites although the South Bay study area was modestly higher that the other sites, especially in August.

Continuous records of turbidity, chlorophyll, temperature and depth for the four, bi-monthly fixed monitoring station deployments are presented in Figures 8, 10, 12, and 14. Tides ranged from 1 – 2 meters. Periodic high levels of turbidities due to resuspension during storm or wind events were evident a periodically, especially in April as well as October and November. A storm event during the period of April 15-19 period (Figure 8) demonstrated elevated turbidities during incoming tidal periods following low tides for 4-5 days after this event. During November increased turbidities due to storms were evident approximately every 5-10 days (Figure 14).

Elevated chlorophyll levels as well as slight decreases in water temperature also characterized these stormy periods. The elevated water column chlorophyll was likely due to re-suspended benthic microalgae as their patterns of increase paralleled overall turbidity increases. Rapid declines also suggest re-settlement. A possible bloom event was documented during the June 27-28 period at South Bay (Figure 10) with chlorophyll levels increasing to over100 ug/l. It is possible that these data are erroneous and due to sensor interference from algal fouling as there was little evidence that these high levels of chlorophyll pigment fluorescence were repeated during other time of the year.

Tidal cycles and waves appear to play important roles in affecting both turbidity and the phytoplankton component of the turbidity in the South Bay restoration area again in 2007. There was a distinct tidal periodicity to the chlorophyll and turbidity levels with higher concentrations evident during high tides. On most low tides both turbidity and phytoplankton levels dropped (Figures 8, 10, 12, and 14), suggesting that a rapid settling of particles and clearing of the water was occurring. In addition, as in 2005 and 2006, water temperatures did not exceed 30 C during the sampling periods and decreased 1-2 C with every high tide. This influx of cooler coastal water is in contrast to eelgrass beds in the Chesapeake Bay where water temperatures may exceed 30 C during the summer, resulting in heat stress and other factors that negatively affect eelgrass survival.

Table 1 summarizes the turbidity and chlorophyll constituents of water quality at South Bay during the four bi-monthly sampling periods in 2007 as well as the three, intensive sampling periods for 2005 and 2006. Mean values highlighted in red indicate they are above water quality habitat thresholds of 15 ug/l chlorophyll and 10 NTU. Extremely high, single point spikes that may have been due to sensor optical fouling or blockage were removed for these summaries. Mean values were high in both the March-April and October-November periods due in large part to storm events of 2 to 4 day duration. Turbidity levels were below the 10 NTU threshold in June and August but above for the other sampling periods. The differences in turbidity levels among the study periods for the different years were likely due to the occurrence of wind or storm events. Turbidity levels were generally higher than might be expected given the successful eelgrass growth results. Re-suspended inorganic particles common in the coastal bays, while increasing turbidity and light scatter, typically result in less light absorption of photosynthetically important wavelengths than organic particles found in the Chesapeake Bay. Therefore this increased light quality compensates for the relative higher turbidity. Also, the relatively high tidal ranges found in this region, provide for much shallower conditions at low tidal periods. Light availability at these low tidal periods would be high. In the Chesapeake Bay, period of low tides during the summer are also potential periods for high temperature stress. This does not appear to be a problem currently in the coastal bays. Mean chlorophyll levels were typically low and always met the eelgrass habitat requirements. High maximums in June and October were likely due to sensor interference or re-suspension of benthic microalgae during period of strong winds.

TASK 4 – LARGE SCALE SEAGRASS RESTORATION

In 2006 (year 4 of the SHP) we established 28 large plots in Hog Island Bay, each covering either 0.5 or 1.0 acres and receiving either 50,000 or 100,000 seeds per acre (Fig. 1). A total of 1.6 million seeds were broadcast by hand across a total area of 21 acres. In 2006 (year 5 of the SHP) we established 24 large plots in Hog Island Bay in the set aside interspersed around the 2006 plots, each covering either 0.5 or 1.0 acres and receiving either 50,000 or 100,000 seeds per acre (Fig. 1). A total of 1.35 million seeds were broadcast into 18 acres. In addition, we also broadcast 200,000 seeds into 4 one-half acre plots in Spider Crab Bay at 50,000 seeds per plot (100,000 seeds per acre).

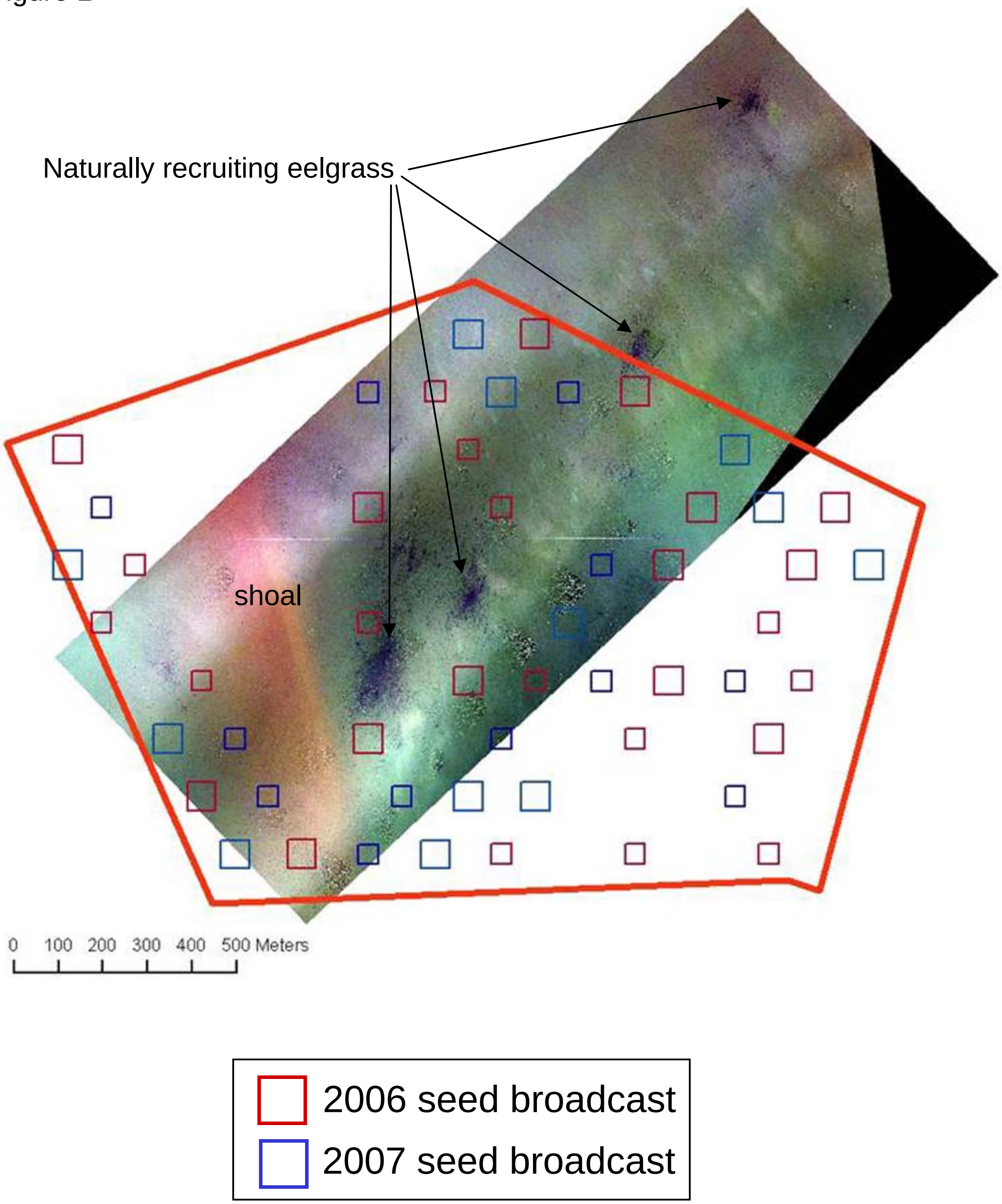
TASK 5 – MAPPING OF SEAGRASS FROM AERIAL PHOTOGRAPHS

High-level black and white aerial photographs were taken in June, 2006. We also obtained low level color photography of a portion of South, Cobb, Spider Crab and Hog Island bays. Both high and low level photographs have revealed the long term success of many of the original large scale plots noted above in Task 1. Acquisition of the photography and mapping of he SAV beds followed the protocols highlighted in the SAV annual surveys conducted by VIMS (http://www.vims.edu/bio/sav/sav06/index.html).

Figure 6 shows the number of acres planted in the coastal bays since 1999, the total number of acres of SAV mapped during this time period in all density classes, and a density weighted coverage which represents the actual amount of bottom covered by seagrass. Almost 200 acres of eelgrass have been seeded in the seaside bays using approx. 23 million seeds. In 2007, the VIMS survey mapped almost 1400 acres of seagrass with the majority being found in South Bay, the bay where much of the original work was established. We believe this is an impressive gain in just less than 10 years of restoration effort. The bed in South Bay has spread to the south end of South Bay primarily from the rafting reproductive shoots carrying viable seeds. Of this total acreage mapped at the four density classes VIMS uses in its annual survey (http://www.vims.edu/bio/sav/sav06/index.html), approximately 1/3, or 400 acres, represents strictly the seagrass canopy area of a patchy seagrass-sand mosaic area.

LIST OF FIGURES

Figure 1



Naturally recruiting eelgrass
shoal
0 100 200 300 400 500 Meters
2006 seed broadcast
2007 seed broadcast

Figure 2

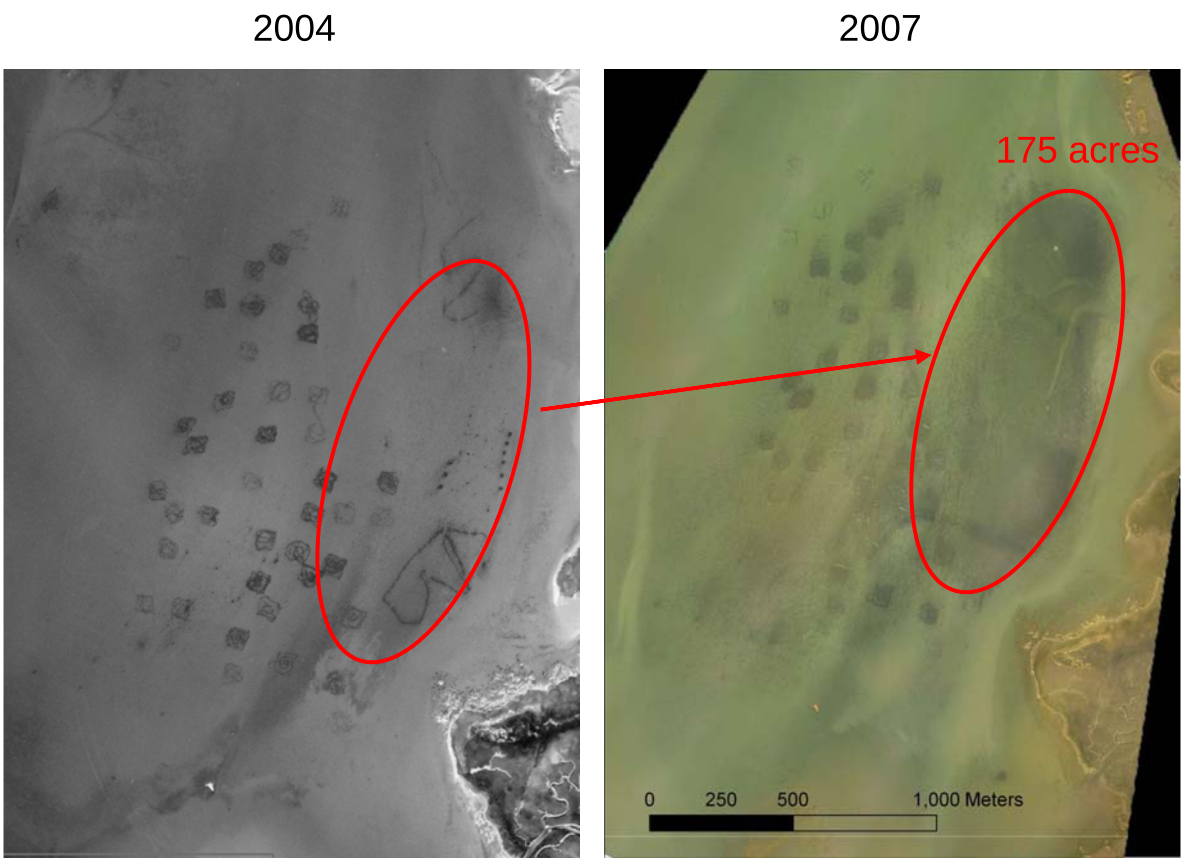
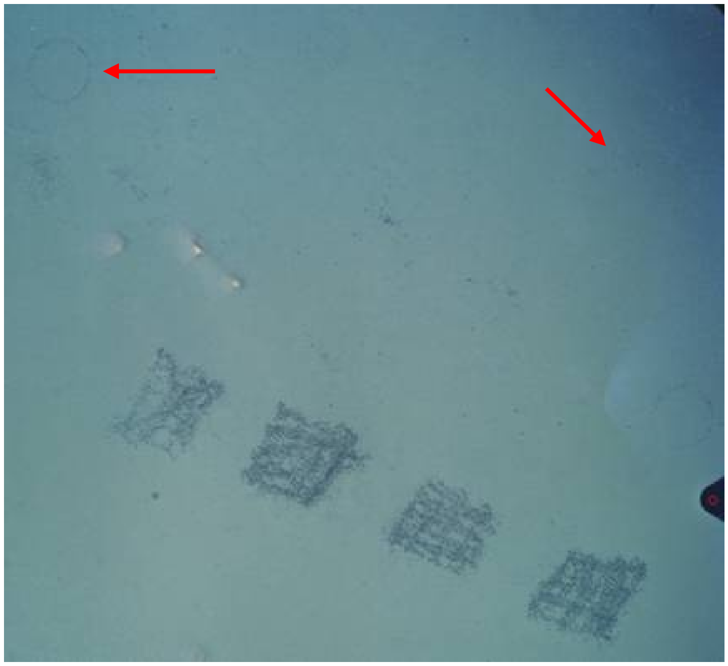


Figure 3

2004



2007

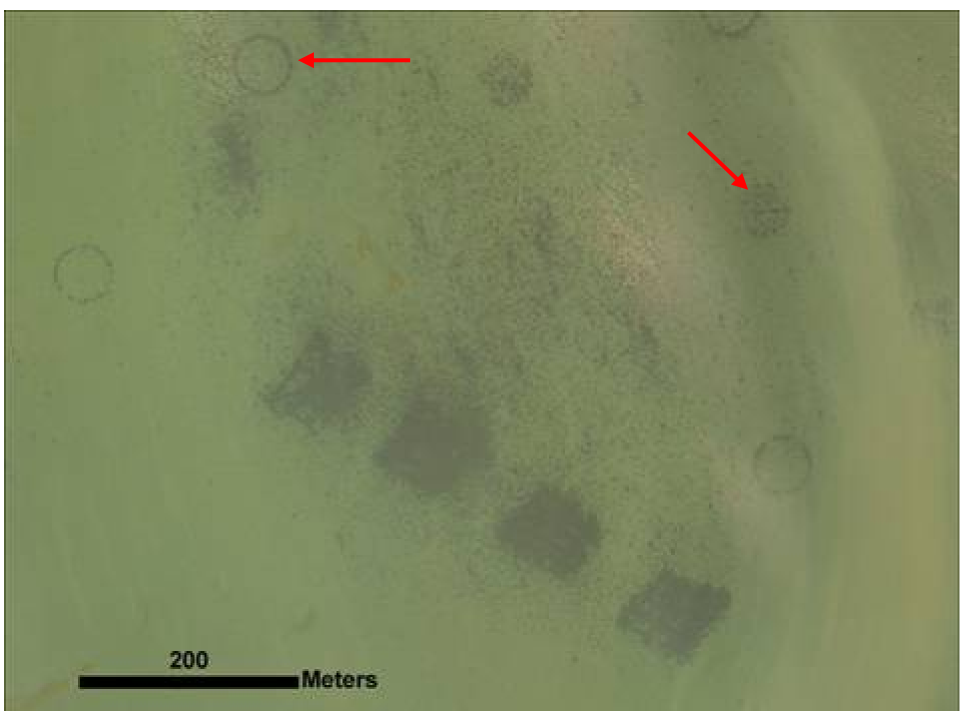
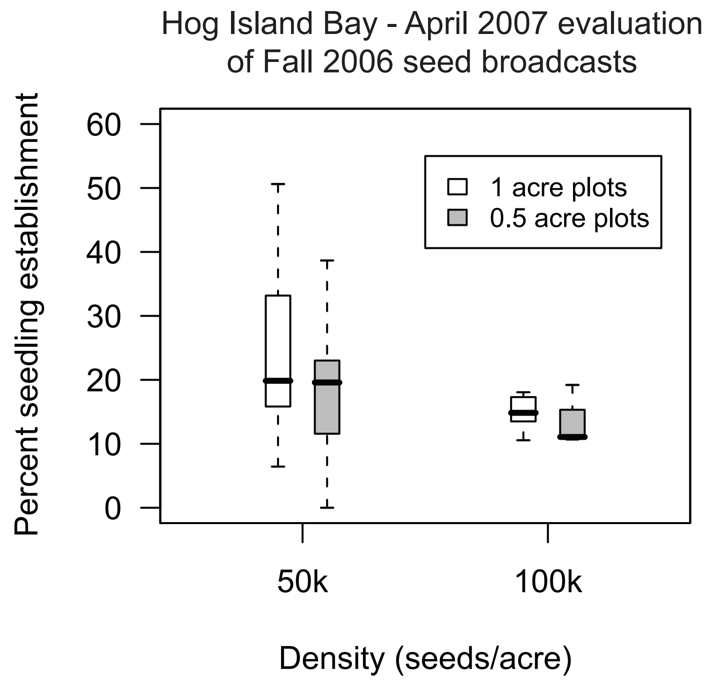


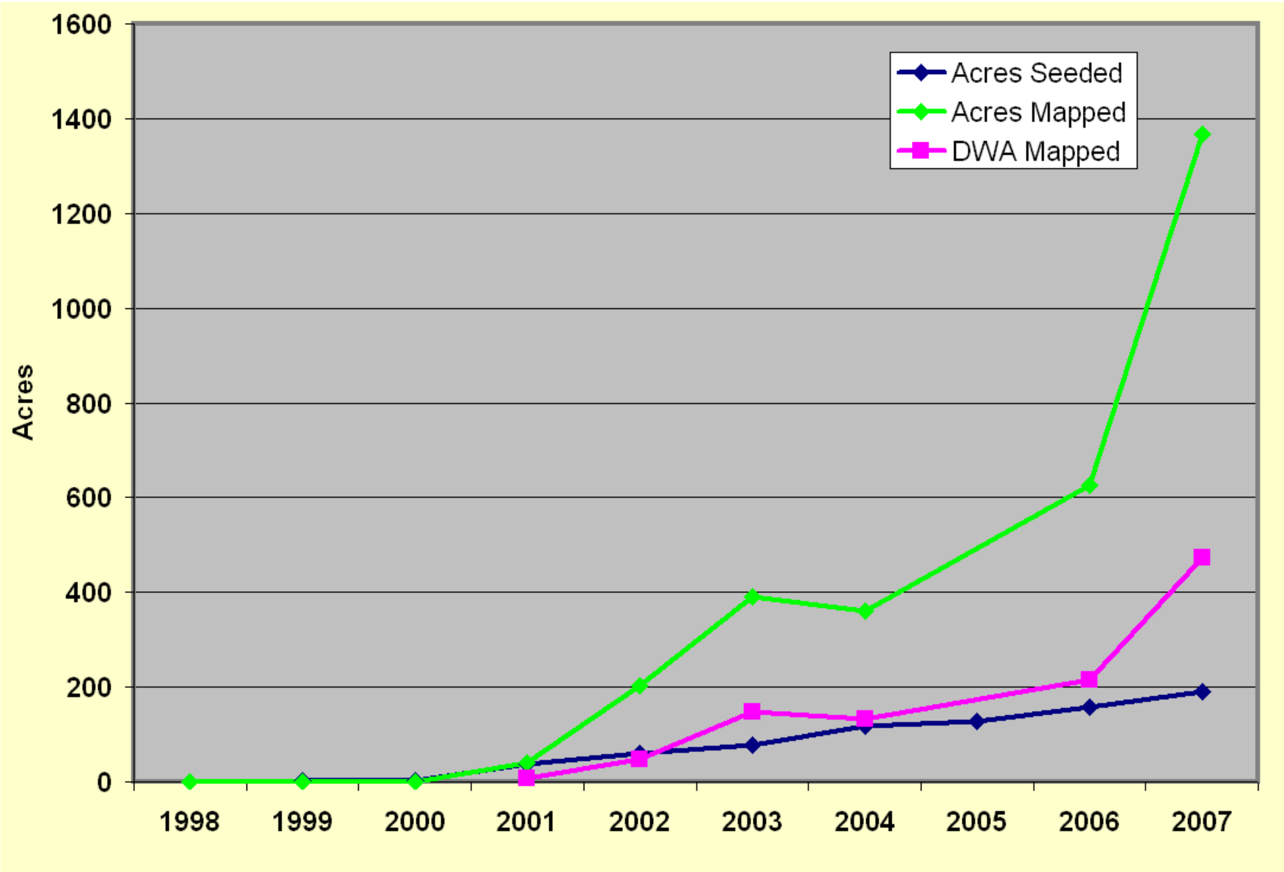
Figure 4

Figure 5



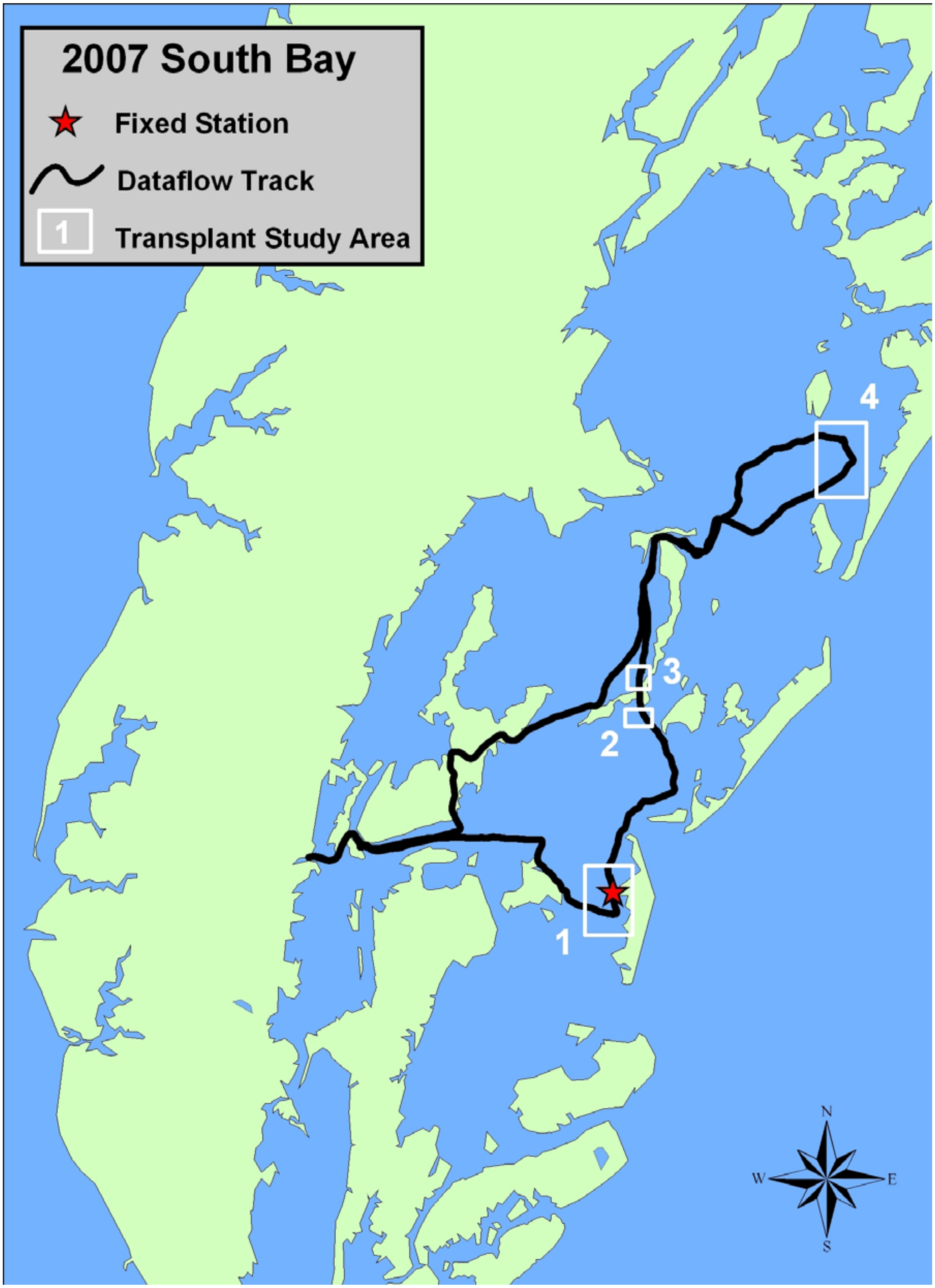
Hog Island Bay - April 2007 evaluation
of Fall 2006 seed broadcasts
1 acre plots
0.5 acre plots
Percent seedling establishment
0
10
20
30
40
50
60
50k
100k
Density (seeds/acre)

Figure 6



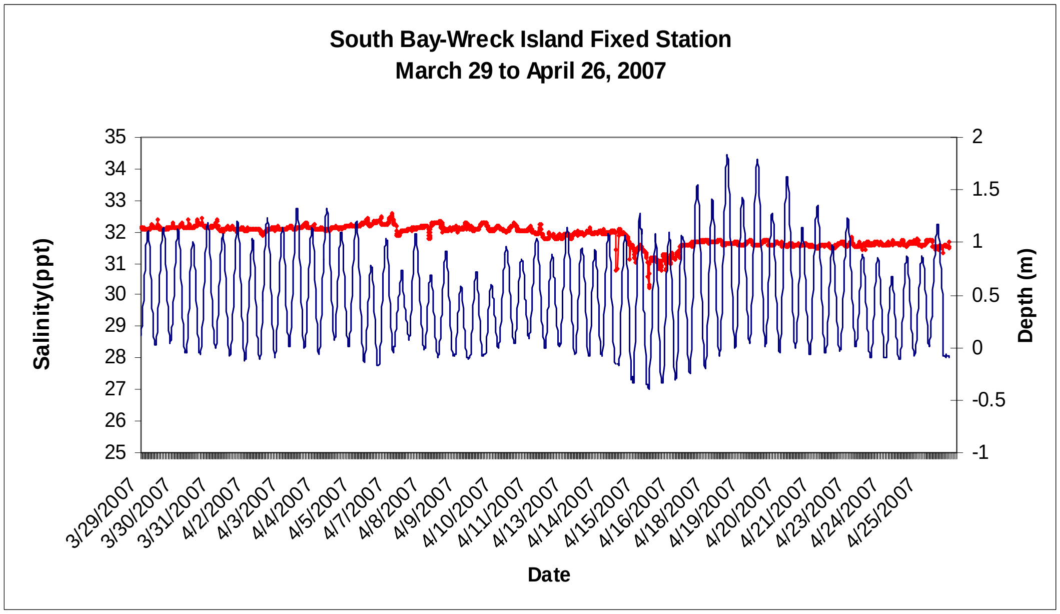
1600
1400
1200
1000
800
600
400
200
0
Acres
Acres Seeded
Acres Mapped
DWA Mapped
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

Figure 7

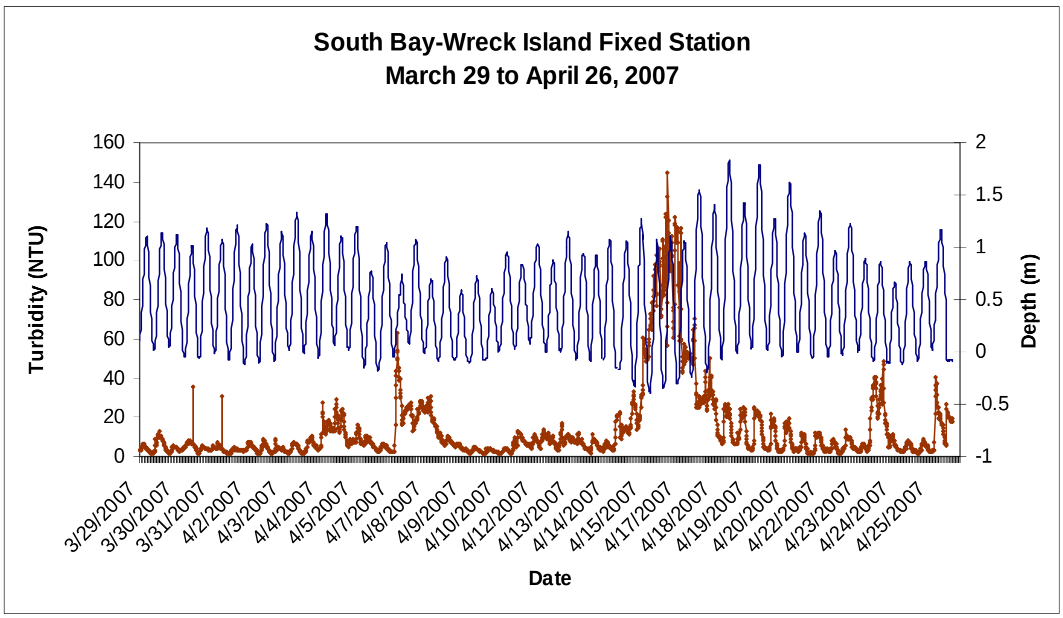


2007 South Bay
Fixed Station
Dataflow Track
1
Transplant Study Area
4
3
2
1
N
W
E
S

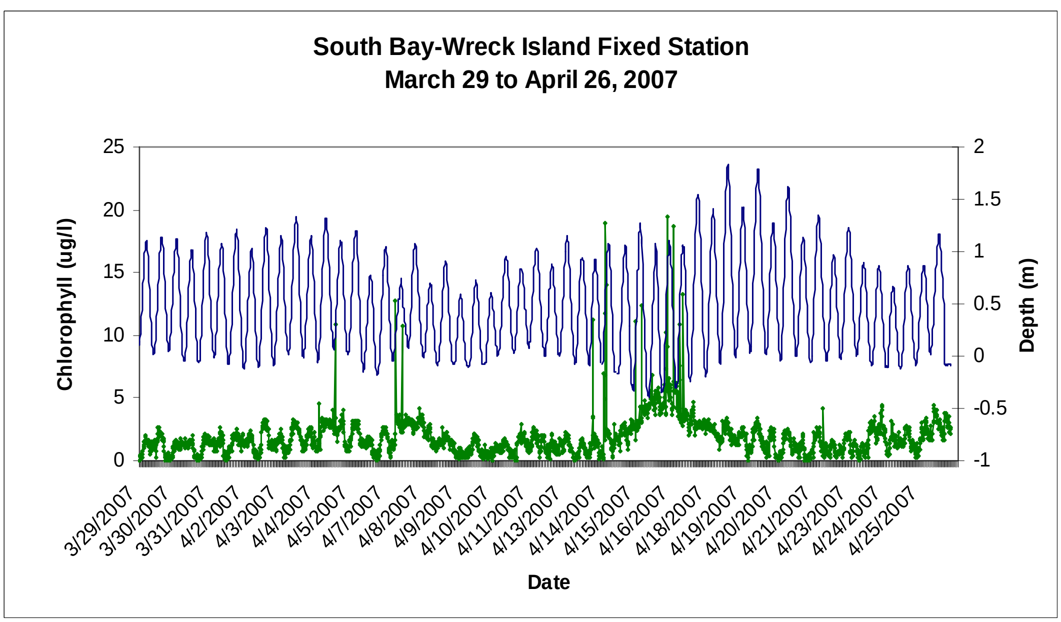
Figure 8



South Bay-Wreck Island Fixed Station
March 29 to April 26, 2007
Salinity(ppt)
Depth (m)
Date

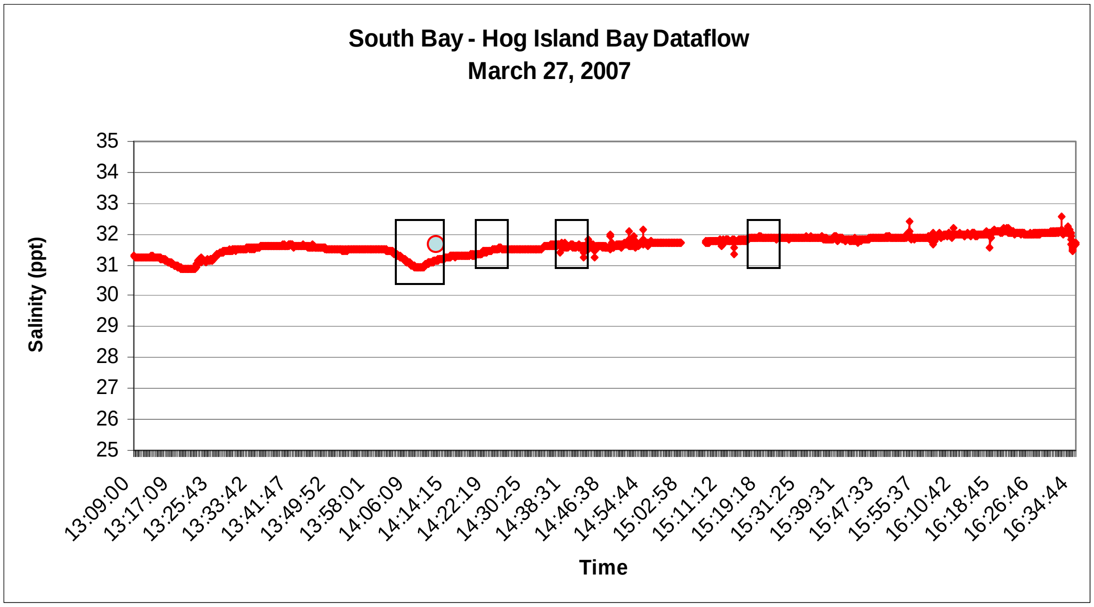


South Bay-Wreck Island Fixed Station
March 29 to April 26, 2007
Turbidity (NTU)
Depth (m)
Date

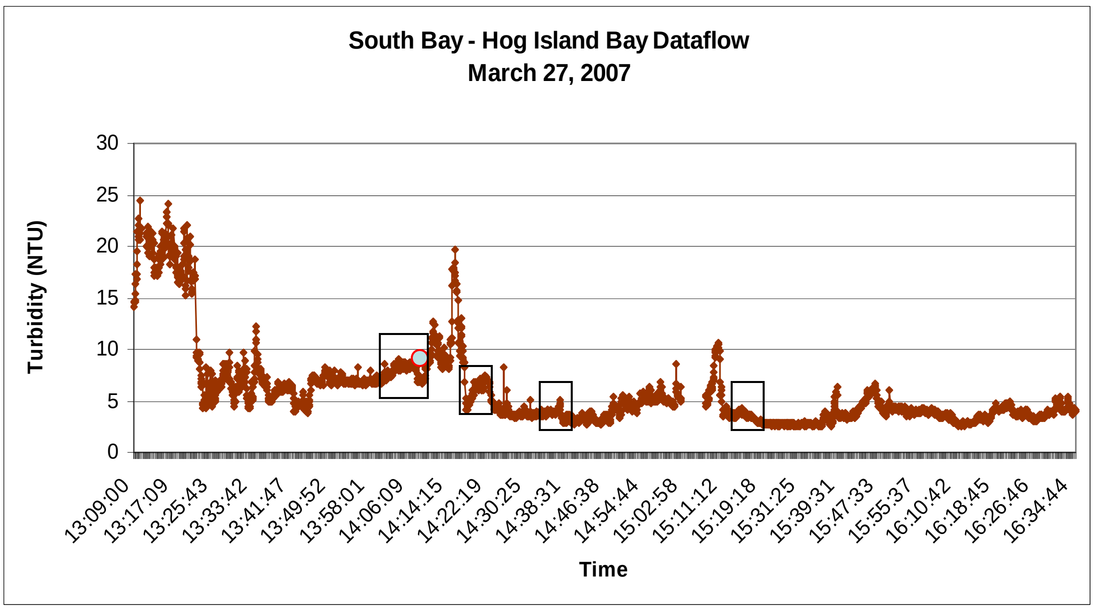


South Bay-Wreck Island Fixed Station
March 29 to April 26, 2007
Chlorophyll (ug/l)
Depth (m)
Date

Figure 9



South Bay - Hog Island Bay Dataflow
March 27, 2007
Salinity (ppt)
35
34
33
32
31
30
29
28
27
26
25
13:09:00
13:17:09
13:25:43
13:33:42
13:41:47
13:49:52
13:58:01
14:06:09
14:14:15
14:22:19
14:30:25
14:38:31
14:46:38
14:54:44
15:02:58
15:11:12
15:19:18
15:31:25
15:39:31
15:47:33
15:55:37
16:10:42
16:18:45
16:26:46
16:34:44
Time



South Bay - Hog Island Bay Dataflow
March 27, 2007
Turbidity (NTU)
30
25
20
15
10
5
0
13:09:00
13:17:09
13:25:43
13:33:42
13:41:47
13:49:52
13:58:01
14:06:09
14:14:15
14:22:19
14:30:25
14:38:31
14:46:38
14:54:44
15:02:58
15:11:12
15:19:18
15:31:25
15:39:31
15:47:33
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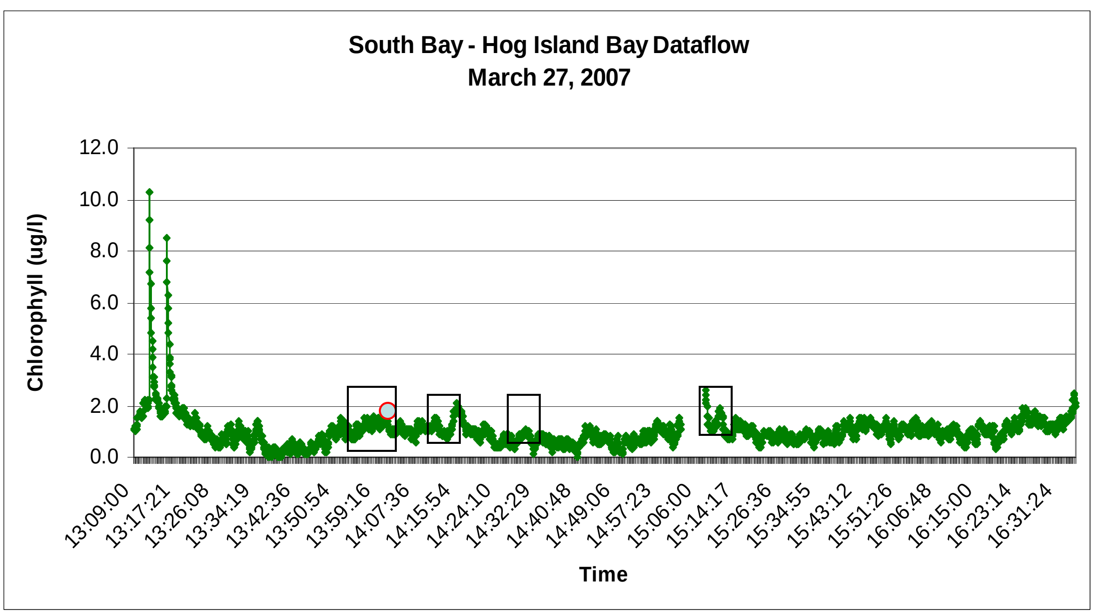
16:26:46
16:34:44
Time



South Bay - Hog Island Bay Dataflow
March 27, 2007
Chlorophyll (ug/l)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
13:09:00
13:17:21
13:26:08
13:34:19
13:42:36
13:50:54
13:59:16
14:07:36
14:15:54
14:24:10
14:32:29
14:40:48
14:49:06
14:57:23
15:06:00
15:14:17
15:26:36
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15:43:12
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16:06:48
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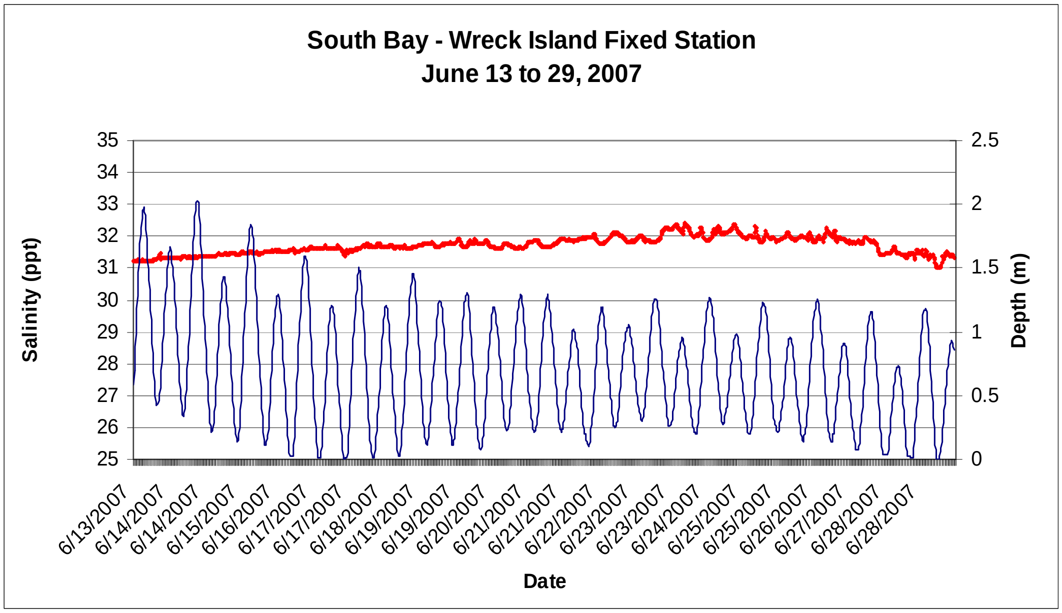
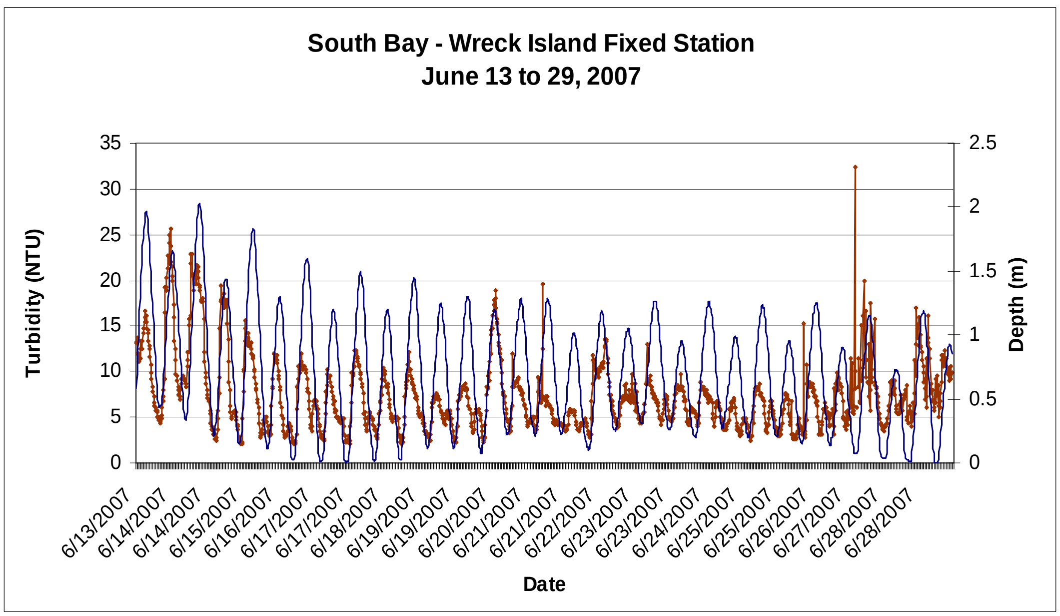
16:23:14
16:31:24
Time

Figure 10


South Bay - Wreck Island Fixed Station
June 13 to 29, 2007
Salinity (ppt)
Depth (m)
Date


South Bay - Wreck Island Fixed Station
June 13 to 29, 2007
Turbidity (NTU)
Depth (m)
Date

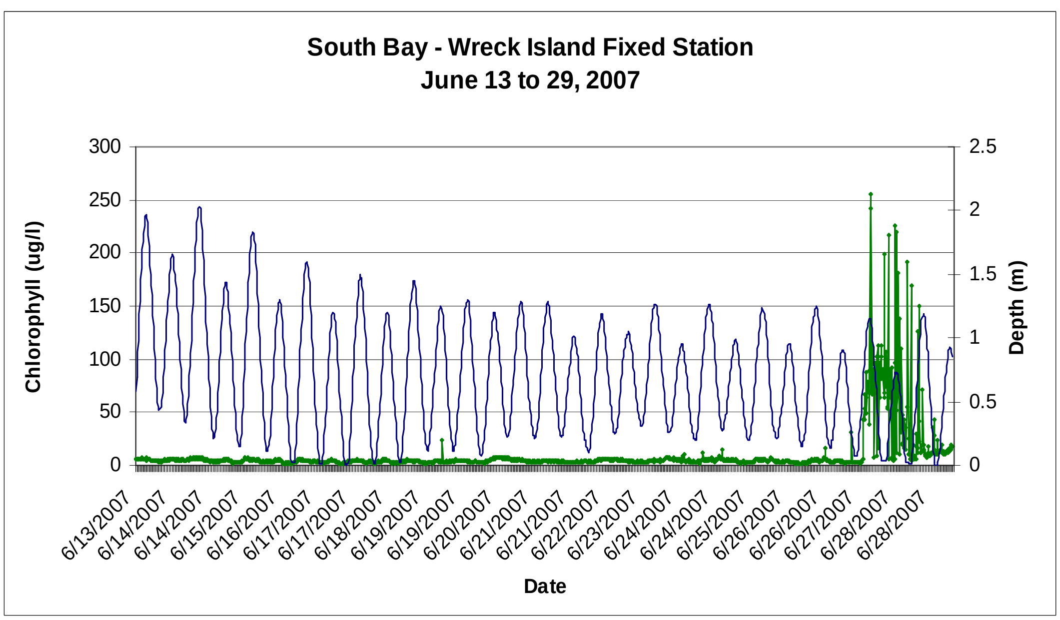
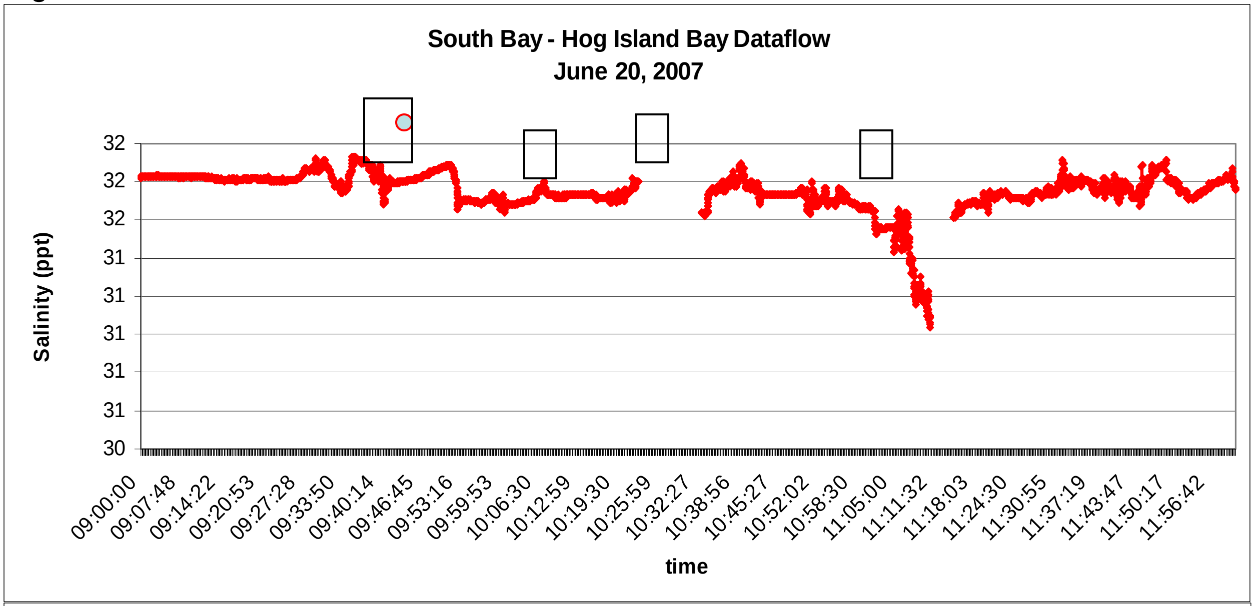

South Bay - Wreck Island Fixed Station
June 13 to 29, 2007
Chlorophyll (ug/l)
Depth (m)
Date

Figure 11


South Bay - Hog Island Bay Dataflow
June 20, 2007
Salinity (ppt)
32
32
32
31
31
31
31
31
30
09:00:00
09:07:48
09:14:22
09:20:53
09:27:28
09:33:50
09:40:14
09:46:45
09:53:16
09:59:53
10:06:30
10:12:59
10:19:30
10:25:59
10:32:27
10:38:56
10:45:27
10:52:02
10:58:30
11:05:00
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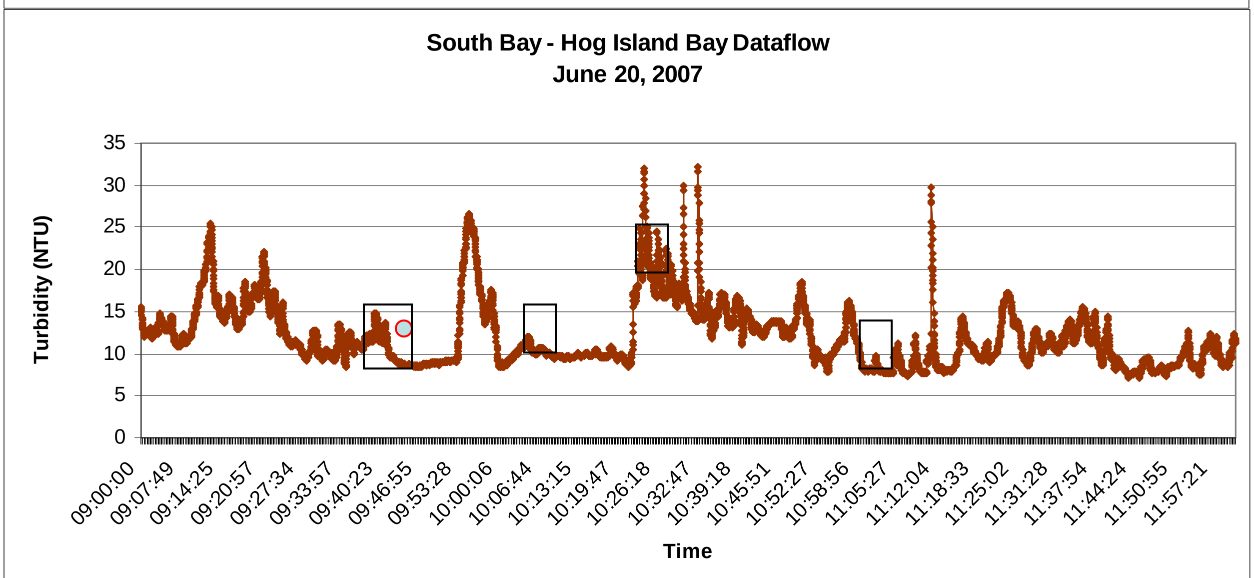
11:50:17
11:56:42
time


South Bay - Hog Island Bay Dataflow
June 20, 2007
Turbidity (NTU)
35
30
25
20
15
10
5
0
09:00:00
09:07:49
09:14:25
09:20:57
09:27:34
09:33:57
09:40:23
09:46:55
09:53:28
10:00:06
10:06:44
10:13:15
10:19:47
10:26:18
10:32:47
10:39:18
10:45:51
10:52:27
10:58:56
11:05:27
11:12:04
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11:50:55
11:57:21
Time

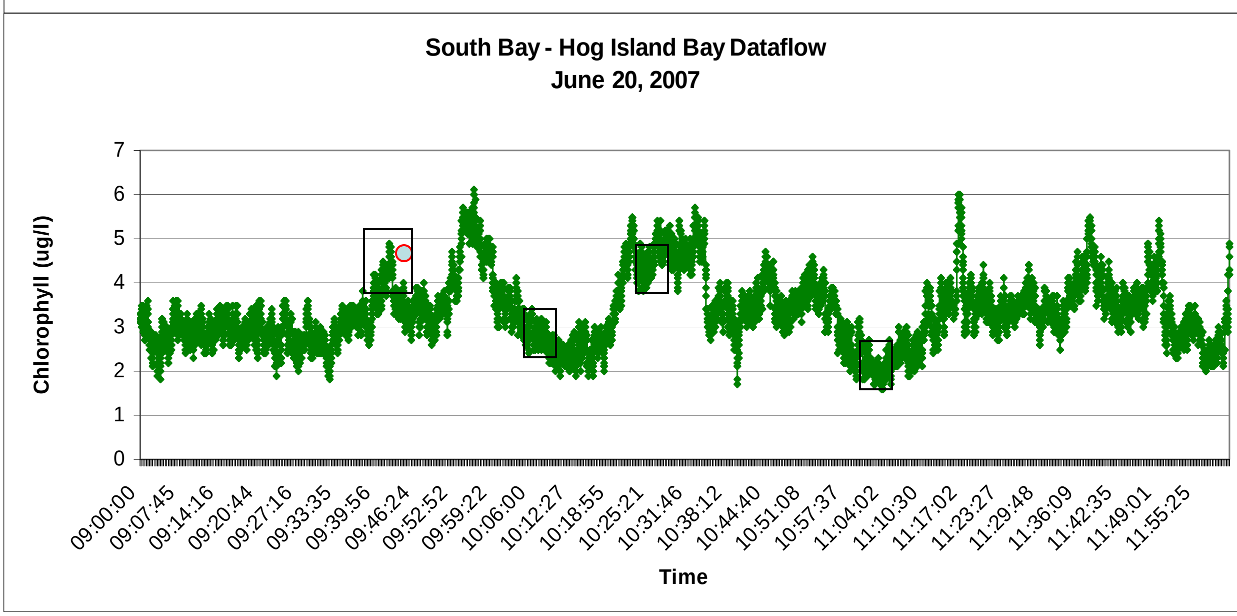

South Bay - Hog Island Bay Dataflow
June 20, 2007
Chlorophyll (ug/l)
7
6
5
4
3
2
1
0
09:00:00
09:07:45
09:14:16
09:20:44
09:27:16
09:33:35
09:39:56
09:46:24
09:52:52
09:59:22
10:06:00
10:12:27
10:18:55
10:25:21
10:31:46
10:38:12
10:44:40
10:51:08
10:57:37
11:04:02
11:10:30
11:17:02
11:23:27
11:29:48
11:36:09
11:42:35
11:49:01
11:55:25
Time

Figure 12

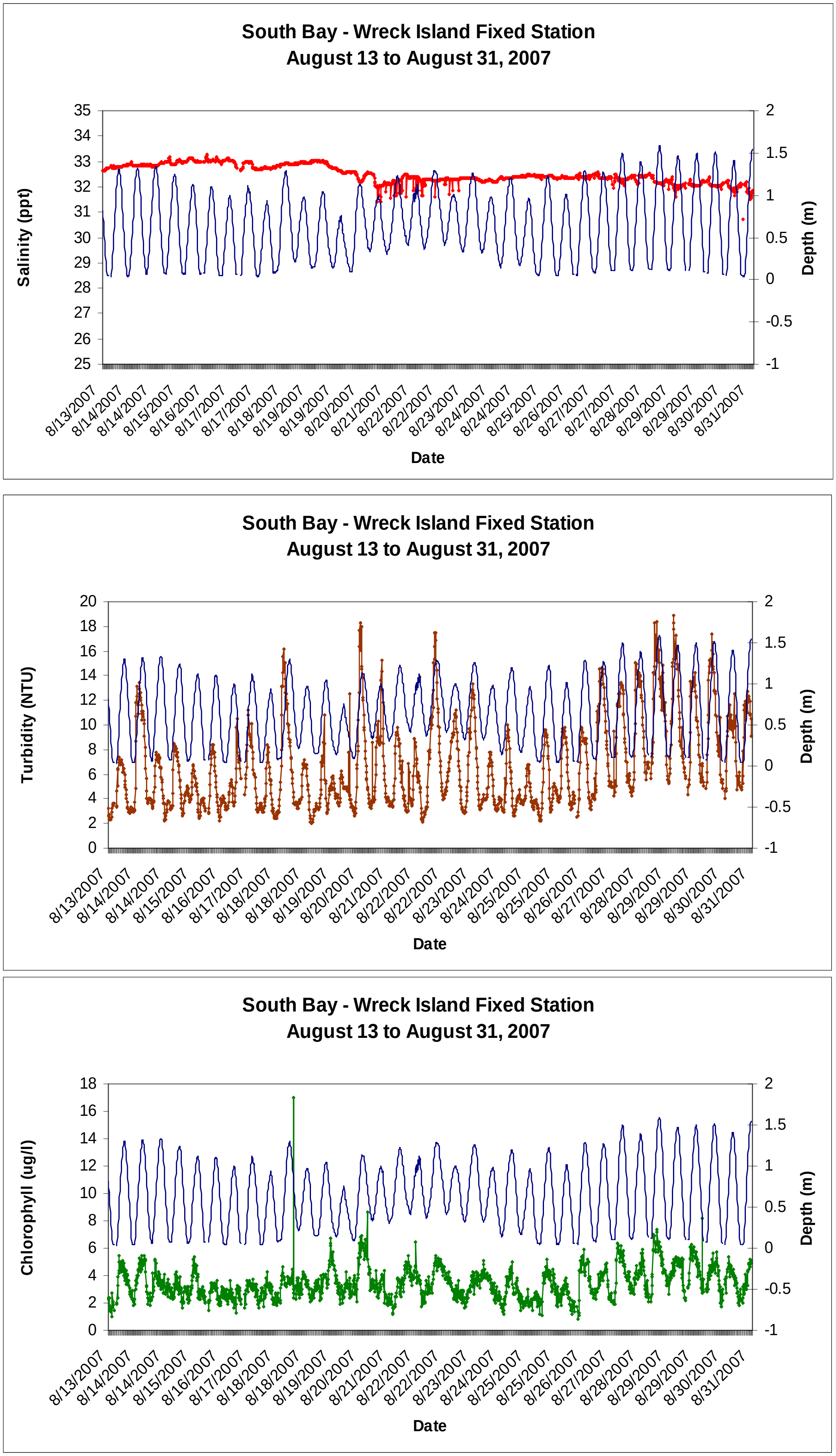
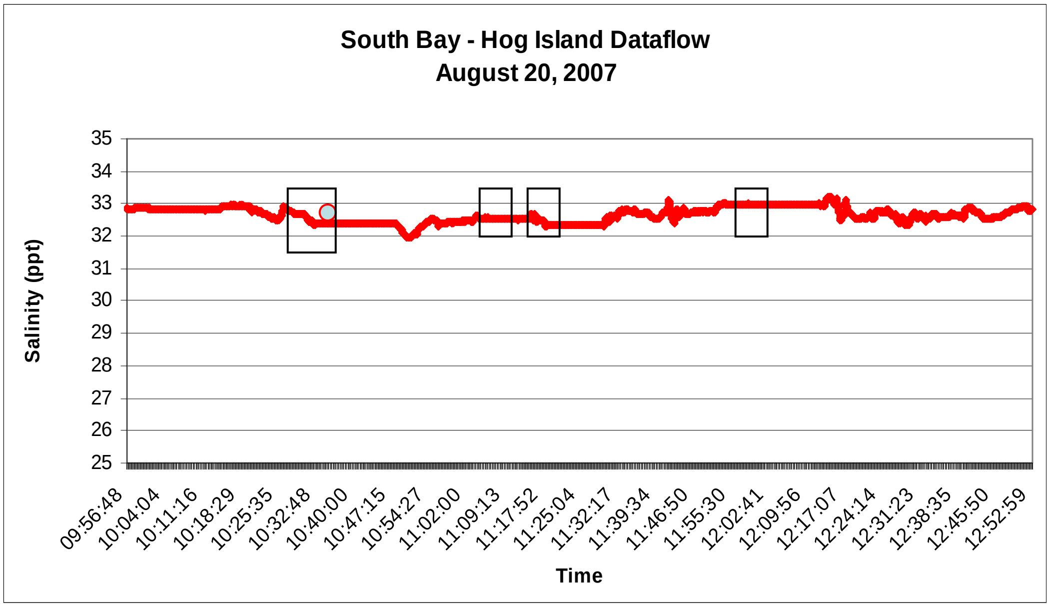
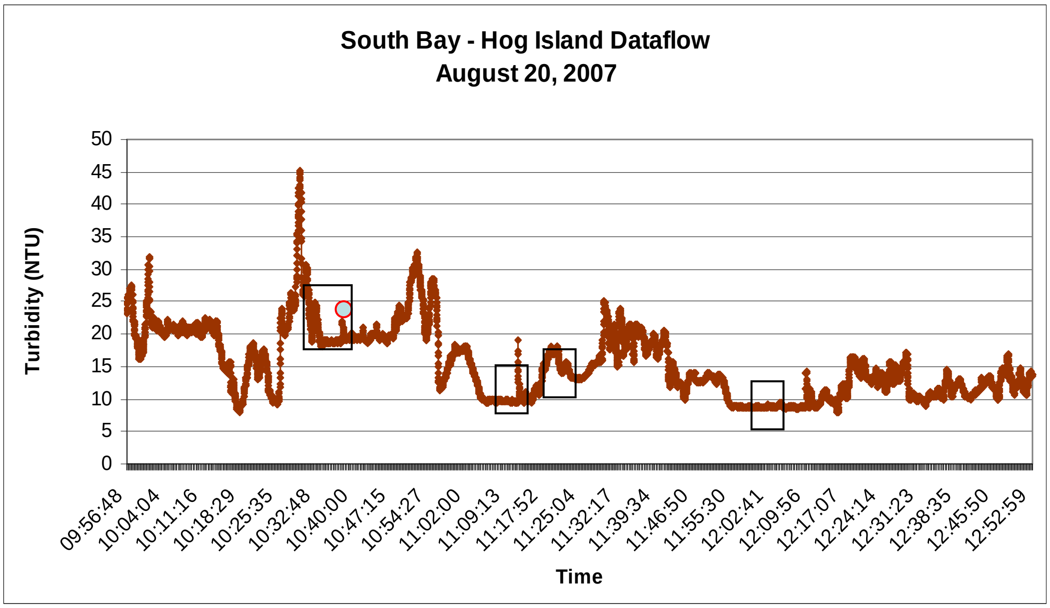

South Bay - Wreck Island Fixed Station
August 13 to August 31, 2007
Salinity (ppt)
Depth (m)
Date
South Bay - Wreck Island Fixed Station
August 13 to August 31, 2007
Turbidity (NTU)
Depth (m)
Date
South Bay - Wreck Island Fixed Station
August 13 to August 31, 2007
Chlorophyll (ug/l)
Depth (m)
Date

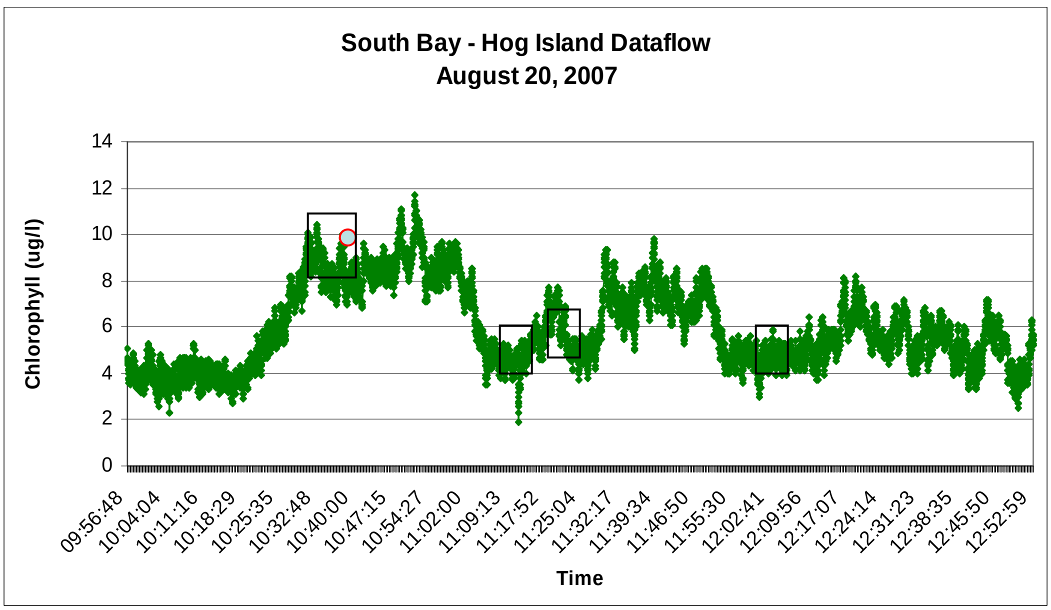
Figure 13



South Bay - Hog Island Dataflow
August 20, 2007
Salinity (ppt)
35
34
33
32
31
30
29
28
27
26
25
09:56:48
10:04:04
10:11:16
10:18:29
10:25:35
10:32:48
10:40:00
10:47:15
10:54:27
11:02:00
11:09:13
11:17:52
11:25:04
11:32:17
11:39:34
11:46:50
11:55:30
12:02:41
12:09:56
12:17:07
12:24:14
12:31:23
12:38:35
12:45:50
12:52:59
Time

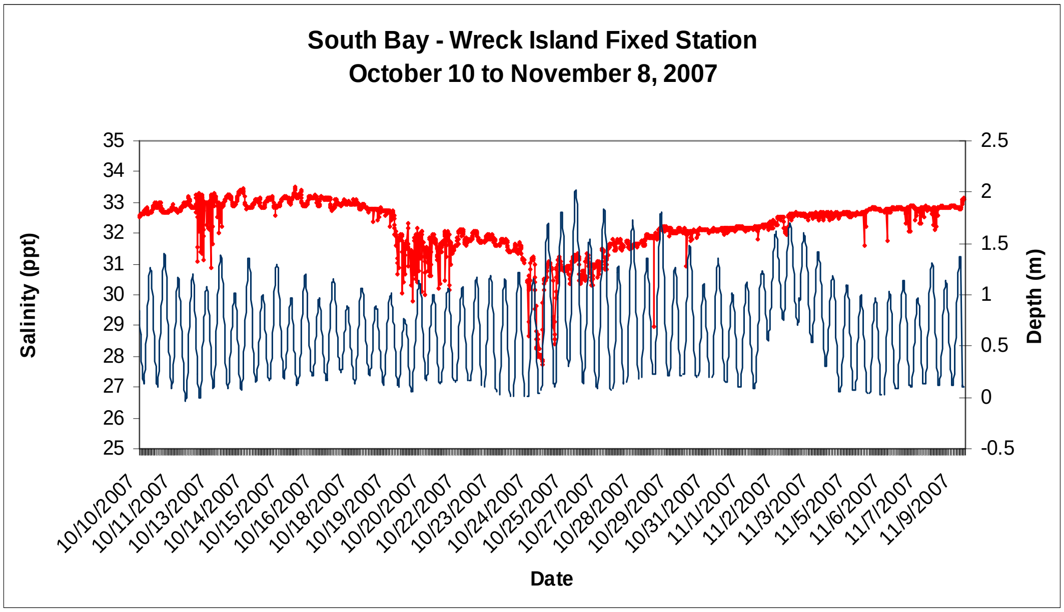


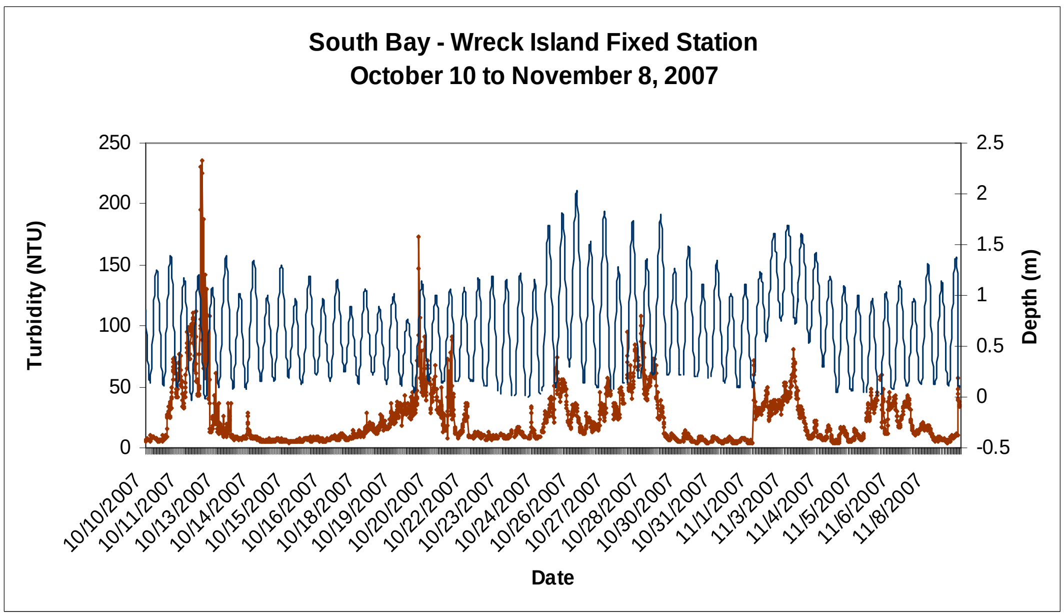
South Bay - Hog Island Dataflow
August 20, 2007
Turbidity (NTU)
50
45
40
35
30
25
20
15
10
5
0
09:56:48
10:04:04
10:11:16
10:18:29
10:25:35
10:32:48
10:40:00
10:47:15
10:54:27
11:02:00
11:09:13
11:17:52
11:25:04
11:32:17
11:39:34
11:46:50
11:55:30
12:02:41
12:09:56
12:17:07
12:24:14
12:31:23
12:38:35
12:45:50
12:52:59
Time



South Bay - Hog Island Dataflow
August 20, 2007
Chlorophyll (ug/l)
14
12
10
8
6
4
2
0
09:56:48
10:04:04
10:11:16
10:18:29
10:25:35
10:32:48
10:40:00
10:47:15
10:54:27
11:02:00
11:09:13
11:17:52
11:25:04
11:32:17
11:39:34
11:46:50
11:55:30
12:02:41
12:09:56
12:17:07
12:24:14
12:31:23
12:38:35
12:45:50
12:52:59
Time

Figure 14


South Bay - Wreck Island Fixed Station
October 10 to November 8, 2007
Salinity (ppt)
Depth (m)
Date


South Bay - Wreck Island Fixed Station
October 10 to November 8, 2007
Turbidity (NTU)
Depth (m)
Date

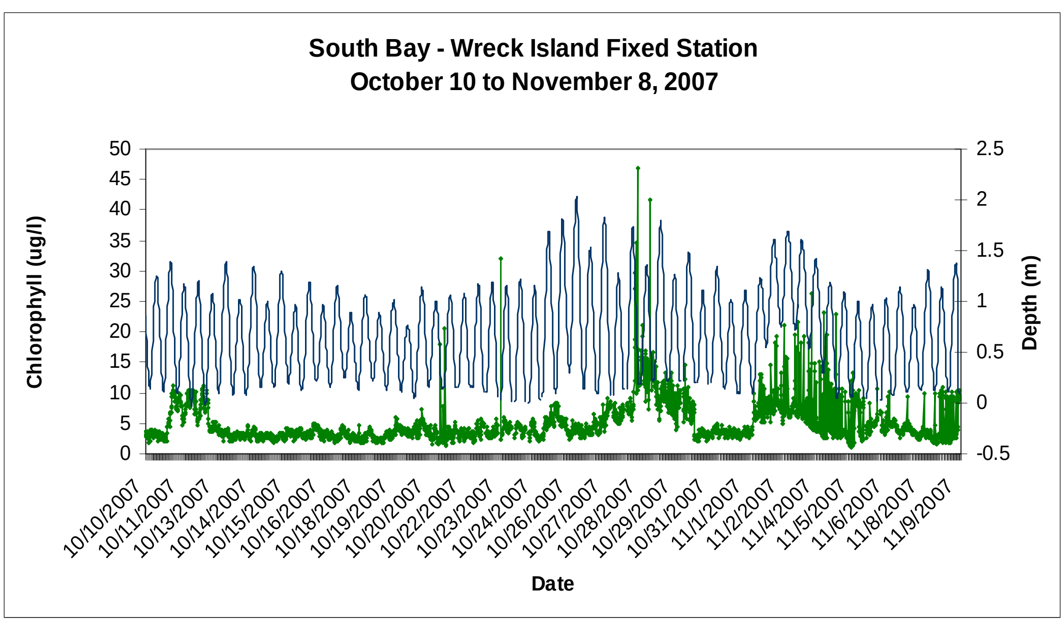
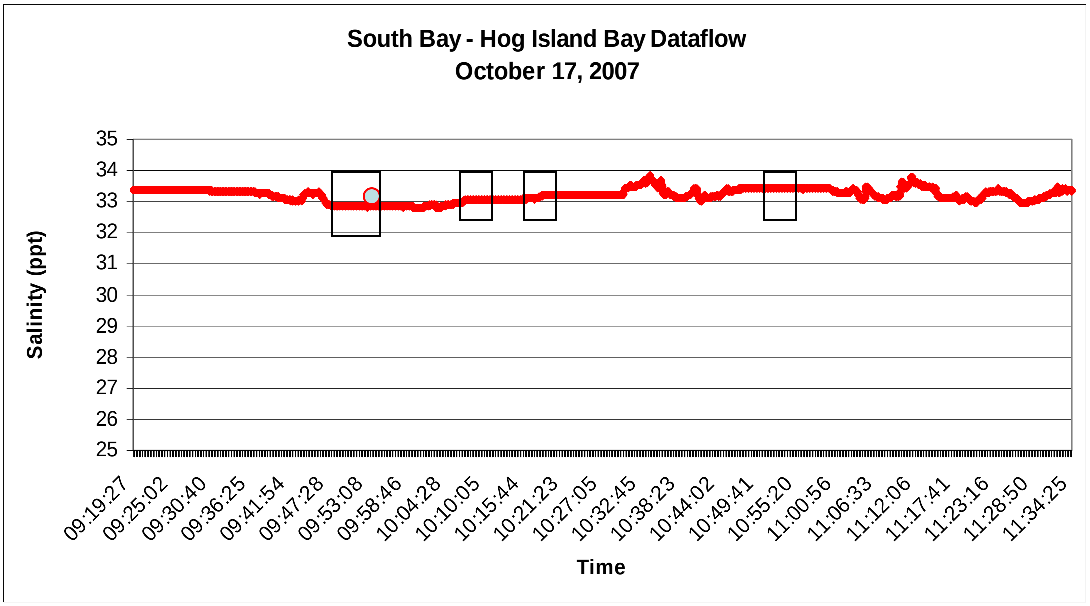
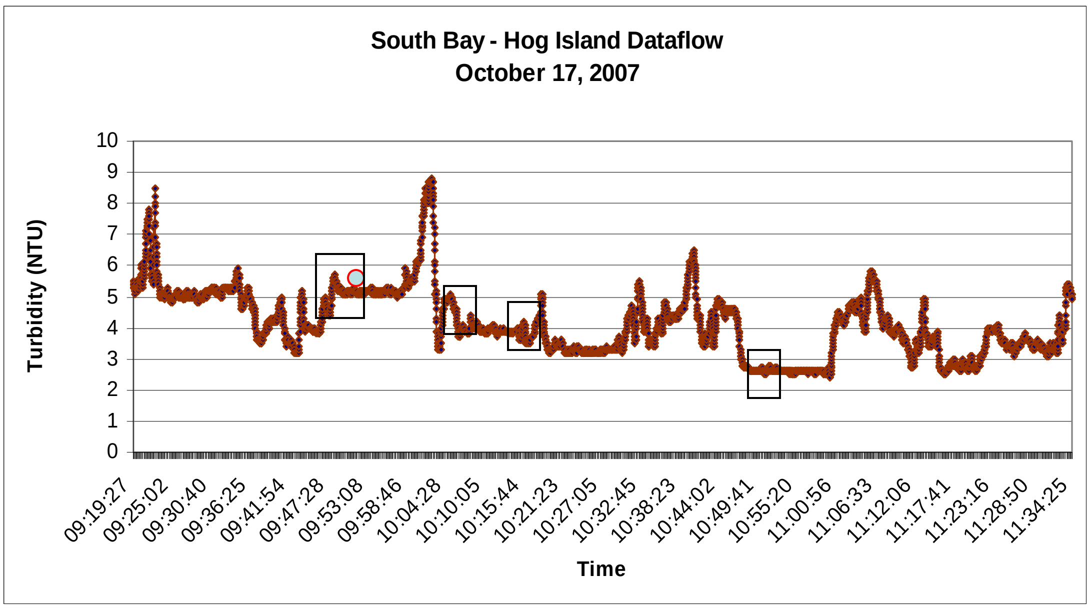

South Bay - Wreck Island Fixed Station
October 10 to November 8, 2007
Chlorophyll (ug/l)
Depth (m)
Date

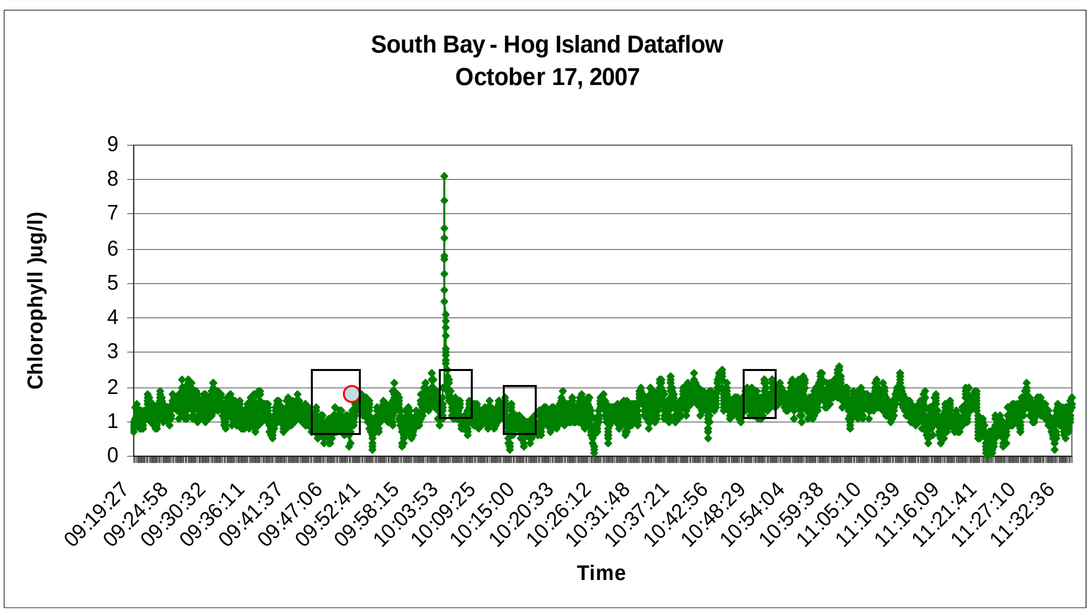
Figure 15



South Bay - Hog Island Bay Dataflow
October 17, 2007
Salinity (ppt)
35
34
33
32
31
30
29
28
27
26
25
09:19:27
09:25:02
09:30:40
09:36:25
09:41:54
09:47:28
09:53:08
09:58:46
10:04:28
10:10:05
10:15:44
10:21:23
10:27:05
10:32:45
10:38:23
10:44:02
10:49:41
10:55:20
11:00:56
11:06:33
11:12:06
11:17:41
11:23:16
11:28:50
11:34:25
Time



South Bay - Hog Island Dataflow
October 17, 2007
Turbidity (NTU)
10
9
8
7
6
5
4
3
2
1
0
09:19:27
09:25:02
09:30:40
09:36:25
09:41:54
09:47:28
09:53:08
09:58:46
10:04:28
10:10:05
10:15:44
10:21:23
10:27:05
10:32:45
10:38:23
10:44:02
10:49:41
10:55:20
11:00:56
11:06:33
11:12:06
11:17:41
11:23:16
11:28:50
11:34:25
Time



South Bay - Hog Island Dataflow
October 17, 2007
Chlorophyll)ug/l)
9
8
7
6
5
4
3
2
1
0
09:19:27
09:24:58
09:30:32
09:36:11
09:41:37
09:47:06
09:52:41
09:58:15
10:03:53
10:09:25
10:15:00
10:20:33
10:26:12
10:31:48
10:37:21
10:42:56
10:48:29
10:54:04
10:59:38
11:05:10
11:10:39
11:16:09
11:21:41
11:27:10
11:32:36
Time

Table 1. Mean, minimum and maximum YSI 6600 turbidity and chlorophyll levels for the South Bay restoration study site. Red indicates that the mean levels were above Chesapeake Bay derived eelgrass habitat requirements.

Deployment Dates	Turbidity			Chlorophyll		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
May 19-June4, 2005	13.3	4.0	75.1	3.5	0.3	23.8
July 20-Aug 4, 2005	16.3	4.2	104.6	4.5	0.9	61.0
September 19-28, 2005	18.1	5.1	147.4	2.9	0.9	9.9
April 10-April 25, 2006	7.0	1.8	28.3	1.2	0.0	8.3
June 16-July 10, 2006	12.2	2.1	286.3	6.0	0.9	124.2
Aug 19-Sept 24, 2006	26.8	3.5	193.1	3.4	1.1	24.5
Oct 10-Nov 3, 2006	22.7	3.6	219.7	3.7	0.9	9.5
March 29-April 26, 2007	13.84	1.4	144.3	1.9	0.0	19.5
June 13-June 29, 2007	7.30	2.0	32.4	9.1	1.3	255.8
Aug 13-Aug 31, 2007	6.67	2.0	18.9	3.5	0.8	17.0
Oct 10-Nov 8, 2007	22.99	3.4	235.9	5.1	1.1	46.8