2010 Annual Report to the Northeast Consortium

for the project:

Examining Fishing Practices of Divers in the Maine Sea Urchin Fishery
2008 Cooperative Research Award 09-019

July 1, 2010

for the period July 1, 2009 – June 30, 2010

Photo by Kerry Lyons, 4/15/09

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PROJECT OBJECTIVES AND SCIENTIFIC HYPOTHESES

Background

The near-shore coast of Maine supports a valuable green sea urchin (*Strongylocentrotus droebachiensis*) fishery, but landings have declined steadily since the mid 1990s. The decline in the fishery has been linked to a decline in stock abundance due to fishing (Harris and Tyrell 2001; Chen and Hunter, 2003; Steneck et al 2004, Grabowski et al. 2005).

About 60% of the catch is made by divers, the rest by draggers. There is a legal minimum size limit of $2^{1}/_{16}$ inches (52.4 mm) and a maximum size limit of 3 inches (78.2 mm). The size limits do not prevent the taking of small and over-sized urchins – harvesters are allowed to take an illegal animal as long as it is "culled on board immediately after harvesting and is liberated alive into the marine waters" (Maine Title 12, Ch. 623, §6749-A). Divers often pick up sub-legal urchins, sending them in bags to the surface where they are culled from the fishing vessel, which may be anchored over deeper, non-productive bottom.

Some divers harvest selectively, and take very little of this under-sized bycatch, while others harvest non-selectively ("straight-raking") and take extensive bycatch, which is later culled overboard.

Studies have shown the importance of maintaining a minimum density of urchins, to ensure their reproductive success (Wahle and Peckham 1999, Harris et al. 2001). Maintaining an adequate density also prevents loss of sea urchin habitat. Sea urchins – important herbivores – play a determining role in controlling community structure in the rocky subtidal zone (reviewed by Scheibling and Hatcher 2007). In Maine, due to fishing, hard bottom that was once carpeted with grazing sea urchins has become open to successional processes (Harris and Tyrell, 2001) and is now dominated by kelp and other macroalgae, including invasive species, which thrive when sea urchins are no longer there to remove them. These algal beds are home for small crabs (*Cancer* sp., *Hyas* sp.) and other urchin predators (McNaught 1999, Steneck et al. 2004). This means that once an urchin bed is gone it is very difficult for urchins to reestablish themselves in an environment that has become inhospitable (Scheibling et al. 1999, reviews in Andrew et al. 2002 and Scheibling and Hatcher 2007). This algal-dominated community becomes an alternate stable state (Scheibling 1986, Steneck et al. 2004). The decline of urchin stocks, the loss of urchin habitat, and increasing algal cover have been documented on the western Maine coast (McNaught 1999; Harris and Tyrell 2001; Vavrinec 2003) and are advancing eastward (Vavrinec 2003; Hunter et al. 2005).

Project Objectives

In this project, working collaboratively with industry divers, we plan to:

1) Evaluate impacts of non-size-selective harvesting by divers, or "straight raking", as compared with size-selective harvesting practices, by simulating harvest methods observed in the current fishery and then comparing long-term effects with control areas.
2) Increase the number of industry divers who have been trained in field assessment techniques.
3) Evaluate the effectiveness of translocating (replanting) culled urchins, using techniques available to any harvester.
4) Inform industry members, managers, and the public of our findings.

The project will add to our understanding of sustainable commercial fishing practices in Maine's sea urchin fishery. We hope to find out whether the decline of Maine's sea urchin stock may have been due in part to destructive fishing practices, and, if so, to explore possible solutions. By addressing the urchin bycatch issue, it may be possible to halt potential stock declines and begin rebuilding this valuable fishery without further reductions in fishing effort.

Scientific Hypotheses

We are conducting a controlled experiment that compares the impact of size-selective harvesting by divers to non-size-selective harvesting (straight raking). Impacts to be measured are reductions in urchin densities, and increases in understory and canopy algal cover, compared with control sites. The scientific hypothesis that we are testing is that there is no significant difference in either sea urchin density (particularly the density of sub-legal-sized urchins) or algal cover between selectively fished sites, non-selectively fished sites, and control (unfished) sites five months (and maybe longer) after harvesting. We are also conducting a translocation (replanting) experiment to learn whether using culled urchins to restock depleted areas can be successful. Success will be measured in terms of the percentage of urchins that survive a translocation for five months.

Companion Project

In addition to evaluating the effects of non-size-selective fishing, it is important to learn the prevalence of this practice, in order to estimate its overall impact. In a related project, we are evaluating the extent of the practice of non-selective harvesting, by estimating the number of culled vs. kept urchins from commercial catches, using our existing port-sampling and harvester interview process (Hunter et al. 2010).

METHODS AND WORK PLAN

We plan to compare the impacts of straight raking with size-selective fishing, and applied each fishing method as a treatment, along with an untouched control treatment, replicated at three study sites in a standard Before-After Control-Impact (BACI) design (Smith, 2002). The non-legal-sized urchins harvested from the study sites were used for a translocation experiment, simulating a commercial harvest-replant strategy.

Design summary:

Three small sites with harvestable populations of sea urchins in Maine's urchin management Zone 2 were selected by a commercial diver, marked, and split roughly into three lanes (plots) each, for a total of nine experimental plots. Each lane was evaluated for urchin density and algal cover. At each site, one of the three lanes was randomly assigned to be harvested size-selectively, one was straight-raked (non-size-selective), and the third serves as a control, untouched plot. Immediately after harvest, the six harvested lanes were re-evaluated for urchin density. A fourth nearby site, chosen for its lack of urchins and its isolation from other urchin populations, was evaluated for urchin density and algal cover. All non-legal-sized (mostly under-sized) urchins from the harvested plots were dropped onto this site from the surface. The replanted site was evaluated for urchin mortality about one week after the transfer. An area at this site just outside the replanted area was selected as a control. All sites were evaluated for urchin density and algal cover after about 2½ months (early July, 2009), and again after another 2 months (early September 2009). During the September sampling, all urchins from four 1-m^2 quadrats in each plot will be collected and measured for test diameter.

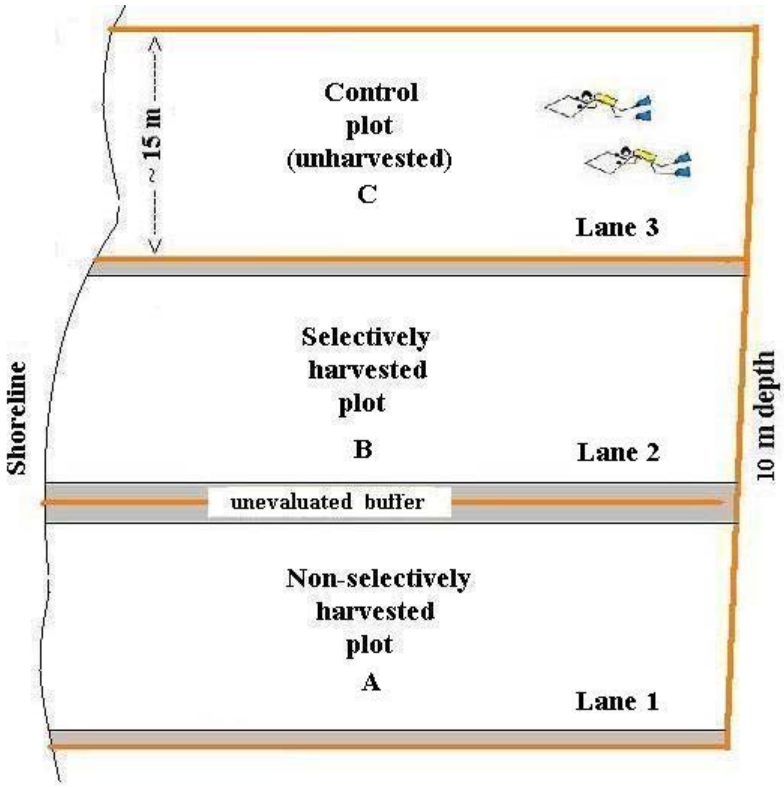

Diagram of one of the three experimental sites, not to scale.

The sea-urchin fishing season was closed throughout the 5-month duration of the experiment (April to early September 2009). Although we evaluated the sites again in June, 2010, we did not close the sites when the urchin season reopened in September 2009. If the sites were disturbed by fishing, it should be evident at the control plots.

Changes from original proposal

- We originally proposed monitoring the harvested and replanted sites for 6 months, but have changed that to 5 months, because the 2009-2010 fishing season opened in the study area almost a month earlier than in past years (September instead of October), leaving a closed period of April 1 - September 8, 2009.
- We were able to add additional site visits and evaluations in June 2010, 14 months after the harvest treatments.
- We had also planned to divide the harvest treatment sites into depth strata of 0-5, 5-10, and 10-15 m, the same depth stratification used in the annual Maine spring sea urchin

- We proposed evaluating algal cover using the same three categories used by the annual Maine spring sea urchin survey – encrusting, understory or turfing, and canopy (Vavrinec 2003; Steneck and Dethier 1994) – but decided to further subdivide the turfing category into green, red filamentous, and red fleshy, in order to provide more detailed information on algal type.

WORK COMPLETED TO DATE

Site Selection and Marking: During late March, 2009, divers explored several near-shore sites in the Winter Harbor (Hancock County, Maine) area, and selected three sites for the experimental harvest treatments and one site for the translocation (replanting) experiment.

Type of Site	Name	Latitude	Longitude
Harvest Treatment	Winter Harbor	44° 23.14″	68° 04.79″
Harvest Treatment	Hancock Point	44° 27.81″	68° 13.93″
Harvest Treatment	Frasier Point	44° 22.2″	68° 04.69″
Translocation	Bean Island Ledge	44° 28.79″	68° 12.0″

The three harvest treatment sites were roughly rectangular areas spanning about 45 m (150 ft) of shoreline and extending out to about 10 m (30 ft) depth, or about 75 m (250 ft) from shore. Each site was selected to have commercially-harvestable densities of legal-sized urchins with a good mix of under-sized urchins, distributed as uniformly as possible. The sites were sloping with no steep drop-offs (which are difficult to evaluate) or other large irregular features. To minimize the chance of disturbance, known urchin, scallop, quahog, mussel, and sea cucumber dragging areas were avoided. Each of the three harvest treatment sites were split roughly into three plots or lanes running perpendicular to shore, each lane with about 15 m along the shore, out to about 10 m depth (see diagram above). The plots were permanently marked by eye-bolts on the corners on shore and submerged anchors and floats on the off-shore corners. The underwater boundaries of the plots were marked by temporary ground lines.

A fourth site was selected to receive the translocated urchins. It was near the harvest sites but with few urchins present and isolated from other urchin populations (by sand bottom) to minimize urchin immigration and emigration. It was a fished-out site previously known to have commercial densities of urchins, lying along a shallow (about 2-6 m) depth contour. It was marked by two buoys (one at each end) with a ground line running between them. An area just beyond (east of) this line will serve as a control and is separated from the treatment site by sand.

Site evaluation

During April 6-11, 2009, shortly after the annual fishing season had closed, all sites were marked and evaluated for urchin abundance and algal cover. Two industry divers were trained in urchin and algal cover evaluation techniques by working side-by-side with a DMR staff diver prior to the experiment. The nine experimental harvest plots were evaluated for sea urchin density and algal cover by the three divers prior to harvesting. Two of the divers, each carrying 1x1 meter square frames made of ¾-inch diameter PVC pipe, began at the deep end of a lane, about 5

meters apart, and swam a compass course toward the shoreline boundary of the plot (swimming two roughly parallel transects, see diagram above). They each counted urchins and evaluated algal cover in 30 haphazard (blind toss) 1x1 meter quadrats, for a total of 60 m^2 quadrats per lane. All urchins 10mm or larger in each quadrat were counted. Percent algal cover for each of five functional groups (encrusting, turfing green, turfing fleshy red, turfing filamentous red, and canopy) in each quadrat were recorded. The protocols for urchin and algal evaluation are the same as those used by the annual Maine sea urchin dive survey (Hunter et al. 2010; Grabowski et al. 2005) except for the addition of algal turfing sub-categories.

The replanting site and its control were also evaluated for urchin density and algal cover using the same methods, with the divers swimming on either side of the ground line, from one marker buoy to the other.

All lanes at all sites were also video-taped under water.

Harvest treatments

Treatments were designated A=straight raking (non-size-selective), B=size-selective fishing, and C=Control (unfished). The lane arrangements ABC, CAB, and BCA (left to right when looking at the lanes from the sea toward shore; see figure above for the ABC arrangement) were randomly assigned to the three experimental sites, which turned out to be Hancock Point, Winter Harbor, and Frasier Point respectively.

The harvest treatments were applied April 15 (Winter Harbor) and April 16 (Hancock Point and Frasier Point), 2009. At the size-selective plots (B), one of the two industry divers (Marcus) began at the deep end of the lane and made his way to shore, harvesting mostly only the legal-sized sea urchins, using the techniques of size-selective divers. At the non-selective plots (A), the other industry diver (Greg) harvested all sea urchins that a straight-raker would take. That is, clumps of urchins that all appeared too small were passed over, but groups that contained at least one urchin that might be legal were entirely harvested. The third plot (C) at each site was untouched. The divers were video-taped to document the two fishing styles. Standard 2¼-inch stretch mesh catch bags were used throughout.

Counting, Measuring, and Replanting

Harvested urchins were picked up by the fishing vessel (a 38-ft lobster-type boat with only 3.5 ft draft). On the vessel, all harvested urchins were separated by treatment and size (sub-legal, legal, over-sized), counted, and put in 80-lb (36 kg) plastic fish totes. The determination of size was made by an experienced commercial sea urchin culler. Test diameters were also measured for forty urchins chosen at random from each tote. The totes were only about two-thirds full to minimize crushing and spine puncture, and periodically hosed with sea water.

When harvesting was finished each day, sub-legal and over-sized urchins were moved to the replanting site at Bean Island Ledge and dropped onto it from the surface, over the ground line between the two marker buoys (see photo, above). The replanted sea urchins had been out of the water about 6-7 hours at most. Legal-sized urchins were returned to the sea at a site well away from any of the experimental sites.

Post-harvest site evaluations in April, 2009

After harvest (later the same day), the harvested plots were re-evaluated for urchin density as above. The replanted site was also re-evaluated for urchin density as above at the end of the second day of replanting (April 16, 2009).

On April 24, a little over a week after translocating, the replanted site (Bean Island Ledge) was evaluated for urchin density, and for urchin mortality by counting healthy-appearing urchins and moribund or broken ones in 60 random quadrats.

Re-evaluations in July, 2009

On July 1, 2009, the two industry divers, with a DMR observer on board, re-evaluated the harvest and control lanes at the Winter Harbor and Frasier Point sites, using the same methods described above for the work done April 6-11, 2009. First, ground lines were laid to mark the three lanes at each site, using buoyed anchors and bolts left behind during the last visit. Then each diver made one dive on each of the three treatment lanes (size-selectively fished, non-size-selectively fished (straight-raked), and control) at each site. During each dive, thirty haphazard (blind toss) 1x1 meter quadrats were evaluated for sea urchin counts and algal cover using the methods described in our previous report. On July 2, they marked and re-evaluated the harvest and control lanes at the Hancock Point site and the replanted and control areas at Bean Island. Then the ground lines were removed from all sites. A total of 11 dives were made by each of the two divers during this period (three at each of the three harvest sites and two at the transplant site), and each diver evaluated 30 quadrats during each dive, for a grand total of 660 quadrats evaluated.

Re-evaluations in September, 2009

On September 1 and 2, 2009, just before the fishing season opened, the four sites were marked and evaluated in the same manner again. In addition, all sea urchins at least 10 mm in diameter were collected from three quadrats by each diver from each lane and measured on the boat. All lanes at all the sites were also videotaped under water. Then the ground lines were removed from all sites.

Re-evaluations in June, 2010

On June 29 and 30, 2010, the four sites were marked and evaluated in the same manner again. Again, all sea urchins at least 10 mm in diameter were collected from three quadrats by each diver from each lane and measured on the boat. All lanes at all the sites were also videotaped under water. Then the ground lines were removed from all sites.

Data entry and analysis

Since our previous annual report, the urchin abundance and algal cover data from the post-harvest evaluation dives in April, July, and September 2009 have been entered in our database and preliminary summaries are presented below.

RESULTS TO DATE

Pre-treatment site evaluation data from April 6-11, 2009, and data from the harvest treatment applications April 15-16, 2009 were reported in our previous annual report (Hunter 2009).

April 2009 post-harvest site evaluations: See Tables 1-4 for preliminary results of the post-harvest site evaluations for sea urchin density that were conducted shortly after the harvest treatments were applied in April 2009. Note that 9 sea urchins appeared to be dead at the Bean Island Ledge replanting site on April 24, not 5 as reported in our previous annual report. The rest of the 2,969 urchins that were counted appeared to be alive, suggesting that initial mortality was low. As expected, the density of sea urchins at the other locations was consistently lowest in the lanes that had been straight-raked (treatment A).

July 2009 post-harvest site evaluations: See Tables 5-8 for preliminary results of the July 2009 site evaluations for urchin density. Algal cover was also evaluated, but the data have not been summarized yet and will be presented in our final report. At Bean Island Ledge, the density of sea urchins at the replanted lane continued to be high, suggesting very good survival after 2½ months. At the other sites, urchin density continued to be lowest in the lanes that had been straight-raked.

September 2009 post-harvest site evaluations: See Tables 9-16 for preliminary results of the site evaluations for sea urchin density and algal cover. Data on the size of the urchins sampled were entered into a computer but have not been added to the database or evaluated yet. At Bean Island Ledge, the density of sea urchins at the replanted lane continued to be high, suggesting very good survival after 4½ months. At the other sites, urchin density continued to be lowest in the lanes that had been straight-raked. Algal cover data will be discussed in our final report.

June 2010 post-harvest site evaluations:

The data from the June site evaluations have not been entered or analyzed yet, but will be presented and discussed in our final report.

Summary of sea urchin abundance data to date:

Location	Mean sea urchin abundance (count/m^2)				
	Before	**After**			
	April '09	April '09	July '09	Sept. '09	June '10
Bean Island, Control lane	1.77		0.93	1.20	n/a
Bean Island, Replant lane	1.77	43.35 & 49.33	56.93	56.60	n/a
Winter Harbor, Lane 1, Treatment C (control,not harvested)	10.48		17.20	16.03	n/a
Winter Harbor, Lane 3, Treatment B (selectively harvested)	16.58	26.45	24.18	19.80	n/a
Winter Harbor, Lane 2, Treatment A (straight-raked)	12.45	4.12	8.53	4.82	n/a
Frasier Point, Lane 2, Treatment C (control,not harvested)	7.70		23.58	25.87	n/a
Frasier Point, Lane 1, Treatment B (selectively harvested)	14.28	12.82	19.48	23.52	n/a
Frasier Point, Lane 3, Treatment A (straight-raked)	18.83	7.62	13.37	14.75	n/a
Hancock Point, Lane 3, Treatment C (control,not harvested)	7.23		9.42	10.04	n/a
Hancock Point, Lane 2, Treatment B (selectively harvested)	5.63	5.53	5.52	2.78	n/a
Hancock Point, Lane 1, Treatment A (straight-raked)	2.64	1.32	1.30	2.32	n/a

Unexpected difficulties

The divers sometimes forgot to record the depth of each quadrat, and also the depth correction for the dive (to correct observed depths to depth from Mean Low Water). Depth corrections were estimated, by comparing corrected beginning and ending depths from the April 11, 2009 evaluations with uncorrected ones and assuming they should be about the same. Missing or estimated depth data should not cause serious problems.

FUTURE WORK

Data entry for the June 2010 evaluation dives will be completed. Size data collected during the April 2009 harvest, and the September 2009 and June 2010 evaluation dives will be entered. Videos will be reviewed. Further data analysis will be conducted as described in our proposal, in order to evaluate any long term effects of the harvest treatments, and assess the success of the urchin translocation experiment. Data from the companion port sampling project will be evaluated. The final report will be completed.

IMPACTS AND APPLICATIONS

It is too early to know what the impact of the experiments will be, since the follow-up evaluations and statistical analyses for the project have not been completed yet.

RELATED PROJECTS

In a companion project, during our routine port sampling, we asked harvesters to estimate the number of urchins they had culled from their catches at sea. We did this during the 2008-09 and 2009-10 fishing seasons, in order to estimate the prevalence of non-size-selective harvesting. Data collected to date have not been analyzed yet.

PARTNERSHIPS

This project was suggested by the partnering commercial harvester, who also selected the study sites, provided the vessel, and hired the other commercial diver (Greg Brown, incorrectly identified as Greg Smith in our 2009 annual report) and boat crew (tender and cullers). The two commercial divers did most of the site evaluations and all of the harvesting. Other scientists included DMR diver Robert Russell, and Kerry Lyons, a scientist observer on the fishing vessel who also conducted our port sampling during the fishing season. Dr. Larry Harris, University of NH and Maine Sea Urchin Zone Council member, advised us on algal cover evaluation categories.

PRESENTATIONS

No formal presentations have been made yet. A brief verbal description of the project was given to the Maine Sea Urchin Zone council at its June 18, 2009 meeting.

PUBLISHED REPORTS AND PAPERS

No reports (other than those to NEC) or papers have been prepared, yet.

DATA

Data from the project will be submitted to the NEC when our data entry and analyses are complete, about the same time as our final report (September, 2010).

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Table 1. Sea urchin abundance (count/m^2) by quadrat, with depth (ft), for two diver evaluations at **Bean Island Ledge**, April 16, 2009, just after urchin relocation in Lane 1 (replanted), and a few days later, April 24, 2009. Sea urchins appeared to be alive except where noted.

April 16

	Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth
1	7	0	30	20
2	9	28	75	18
3	11	55	70	16
4	12	15	160	18
5	17	22	34	16
6	16	51	125	
7	11	74	250	
8	7	4	105	
9	7	0	110	
10	9	24	51	
11	11	11	26	
12	14	0	110	16
13	17	86	95	
14	16	48	11	8
15	15	104	50	8
16	11	14	5	8
17	9	13	22	9
18	7	0	3	11
19	7	0	1	10
20	9	2	0	9
21	9	8	0	9
22	12	1	9	17
23	15	3	10	18
24	17	426	25	17
25	12	23	1	11
26	9	5	45	9
27	7	0	50	9
28	7	0	14	9
29	9	0	0	6
30	14	88	9	6
Totals		1,105	1,496	
Mean	11.10	36.83	49.87	12.09
Median	11	12	28	10
Variance		6,322.07	3,378.67	
N		30	30	
Both divers				
Total		2,601		
Mean		43.35		
Median		19		
Variance		4,811.35		
N		60		

April 24

	Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth
1	9	26	41	17
2	11	3	7	17
3	14	6	14	17
4	18	25	120	17
5	18	33,+3 dead	150	17
6	17	2,+1 dead	260	15
7	15	90	180	15
8	10	37	80	17
9	9	9	280	15
10	7	0	310	15
11	7	0	110	18
12	5	31	75	18
13	9	0	180	15
14	9	1	2, +4 dead	17
15	15	26	3	17
16	20	257	82	15
17	16	48	90	15
18	15	5	41	9
19	11	18	2	9
20	9	0	0	7
21	7	0	36	2
22	7	0	0	2
23	8	8	10	5
24	9	1	0	7
25	10	9	66,+1 dead	8
26	12	0	20	8
27	14	23	1	10
28	16	12	8	13
29	16	32	59	14
30	17	6	25	15
Total alive		708	2,252	
Mean	12.00	23.60	75.07	12.87
Median	11	9	41	15
Variance		2,327.56	7,849.86	
Total dead		4	5	
N		30	30	
Both divers				
Total alive		2,960		
Mean		49.33		
Median		19		
Variance		5,675.89		
Total dead		9		
N		60		

Abundance Legend	
count/m^2	
	0
	1 - 10
	11 - 20
	21+

Table 2. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in the two harvest treatment lanes, shallow to deep, at **Winter Harbor**, April 15, 2009, immediately after the harvest treatments were applied. Note that depths for each quadrat were not recorded.

	Lane 2 (A)					Lane 3 (B)			
	Greg		Marcus			Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth		Depth	Abundance	Abundance	Depth
30		2	0				322	68	
29		14	10				38	53	
28		10	2				44	45	
27		8	8				34	14	
26		11	6				42	33	
25		26	2				34	22	
24		2	0				41	25	
23		5	4				28	13	
22		14	0				35	27	
21		3	0				31	14	
20		5	0				39	35	
19		17	0				35	15	
18		4	15				29	24	
17		1	12				37	26	
16		6	1				18	32	
15		13	0				14	22	
14		1	1				18	12	
13		1	7				12	20	
12		3	1				26	5	
11		2	7				9	12	
10		4	6				37	3	
9		0	0				2	14	
8		0	3				10	16	
7		0	0				9	21	
6		0	6				28	2	
5		0	4				32	2	
4		0	0				3	0	
3		0	0				0	0	
2		0	0				0	1	
1		0	0				0	4	
Totals		152	95				1,007	580	
Mean		5.07	3.17				33.57	19.33	
Median		2.5	1				28.5	15.5	
Variance		41.10	16.90				3,174.53	261.47	
N		30	30				30	30	
Both divers									
Total		247					1,587		
Mean		4.12					26.45		
Median		2					22		
Variance		29.43					1,740.39		
N		60					60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 3. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in the two harvest treatment lanes, shallow to deep, at **Hancock Point**, April 16, 2009, immediately after the harvest treatments were applied.

	Lane 1 (A)				Lane 2 (B)			
	Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30		2	0	7		2	0	5
29		11	2			11	11	
28		13	2			9	1	
27		5	2			2	10	
26		13	10			10	29	7
25		6	2	9		25	27	
24		1	4			26	42	
23		0	5			39	30	11
22		0	0	14		29	9	
21		0	0			15	1	14
20		0	0	17		1	0	
19		0	0			0	2	16
18		0	0			0	0	
17		0	0			0	0	
16		1	0			0	0	
15		0	0			0	0	
14		0	0			1	0	
13		0	0			0	0	
12		0	0			0	0	
11		0	0			0	0	
10		0	0	23		0	0	22
9		0	0			0	0	
8		0	0			0	0	
7		0	0			0	0	
6		0	0			0	0	
5		0	0			0	0	
4		0	0			0	0	
3		0	0			0	0	
2		0	0			0	0	
1	26	0	0	29	28	0	0	28
Totals		52	27			170	162	
Mean		1.73	0.90			5.67	5.40	
Median		0	0			0	0	
Variance		15.03	4.58			111.61	126.46	
N		30	30			30	30	
Both divers								
Total		79				332		
Mean		1.32				5.53		
Median		0				0		
Variance		9.81				117.03		
N		60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 4. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in the two harvest treatment lanes, shallow to deep, at **Frasier Point**, April 16, 2009, immediately after the harvest treatments were applied.

	Lane 1 (B)				Lane 3 (A)			
	Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	3	2	10	3	2	7	1	2
29		0	9			5	0	2
28		6	5	5		0	2	5
27		25	27			4	0	
26		45	24			26	6	
25		9	17			2	9	
24		12	0			9	1	7
23		23	1			13	10	9
22		0	11	9		18	12	9
21		0	2			13	8	12
20		0	0			0	11	11
19		24	3			1	2	
18		35	5	12		0	0	
17		3	18			0	1	
16		24	34	13		11	2	
15		12	29	15		12	2	
14		4	44	14		22	9	
13		7	4	15		8	8	
12		2	0	15		8	8	
11		22	60	20		2	7	
10		9	7			45	2	
9		2	21			12	11	
8		12	5			7	0	
7		0	17			13	5	
6		1	11			13	12	
5		0	20	23		30	3	
4		16	17	25		16	15	
3		1	18	26		9	0	
2		4	13	28		0	1	
1	29	6	31	28	29	0	3	27
Totals		306	463			306	151	
Mean		10.20	15.43			10.20	5.03	
Median		6	12			8.5	3	
Variance		136.03	198.46			105.75	20.72	
N		30	30			30	30	
Both divers								
Total		769				457		
Mean		12.82				7.62		
Median		9				7		
Variance		171.37				68.95		
N		60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 5. Sea urchin abundance (count/m^2) by quadrat, with depth (ft), for two diver evaluations in each lane, at **Bean Island Ledge**, July 2, 2009.

	Lane 1 (Replanted)					Lane 2 (Control)			
	Greg		Marcus			Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth		Depth	Abundance	Abundance	Depth
1		18	86	10			0	0	17
2		140	37	10			0	0	16
3		63	70	10			0	0	16
4		68	42	15			0	0	16
5		27	35	15			0	0	17
6		5	32	18			0	0	17
7		0	3	16			0	6	17
8		18	0	16			1	0	16
9		23	35	18			0	5	17
10		66	25	18			0	0	16
11		82	21	16			0	0	17
12		118	12	16			0	0	17
13		92	64	17			0	0	17
14		72	1	16			0	0	17
15		156	0	14			0	0	15
16		70	8	13			0	0	13
17		32	28	11			0	1	11
18		13	95	8			0	0	11
19		10	72	7		8	2	0	9
20		0	77	6			0	0	8
21		43	91	6			0	0	8
22		15	103	5			0	0	7
23		171	210	3			0	3	7
24		58	175	3		4	7	0	6
25		3	109	3			1	0	6
26		15	140	2		2	7	0	4
27		10	242	4			0	2	3
28		36	33	6			0	0	2
29		1	10	7			0	0	2
30		33	102	5			8	13	1
Totals		1,458	1,958				26	30	
Mean		48.60	65.27	10.47		4.67	0.87	1.00	11.53
Median		32.5	39.5	10		4	0	0	14
Variance		2,270.52	3,885.03				5.02	7.38	
N		30	30				30	30	
Both divers									
Total		3,416					56		
Mean		56.93					0.93		
Median		36					0		
Variance		3,096.23					6.10		
N		60					60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 6. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Winter Harbor**, July 1, 2009.

	Lane 1 (C)				Lane 2 (A)				Lane 3 (B)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	0	56	33	1	-3	5	2	1	0	18	8	1
29	1	47	18	2	-3	0	5	1	1	86	78	1
28	2	63	49	3	-2	4	1	1	1	55	51	2
27	2	29	38	3	-2	1	2	1	2	27	88	2
26	4	33	31	3	-2	14	8	1	3	9	76	3
25	4	13	56	4	-1	1	8	1	3	38	44	4
24	4	43	36	4	-1	15	5	1	3	44	34	4
23	4	41	18	4	-1	17	11	2	3	35	40	5
22	4	16	10	4	-1	16	24	2	4	29	32	5
21	5	23	8	4	-1	22	9	2	4	23	28	5
20	2	20	15	5	-1	29	4	2	5	14	28	5
19	1	12	30	4	-1	19	27	1	5	22	34	4
18	1	19	20	4	0	21	23	1	4	9	15	5
17	1	27	25	5	0	32	9	2	4	32	16	5
16	1	12	10	5	1	27	4	3	4	11	4	5
15	1	17	21	6	1	4	3	3	4	20	29	5
14	3	1	16	6	1	0	0	4	4	14	11	6
13	4	18	29	6	3	2	3	4	4	3	21	6
12	4	8	10	7	2	8	1	5	4	19	9	6
11	6	3	17	8	2	1	12	5	5	38	3	7
10	8	8	3	9	2	21	0	6	5	25	21	7
9	12	6	14	10	2	53	0	6	5	10	5	8
8	13	0	5	11	4	2	10	6	6	13	0	9
7	14	0	3	12	4	9	6	7	6	21	5	9
6	15	0	2	15	4	7	1	8	6	13	6	9
5	16	0	0	16	4	4	0	9	7	47	2	10
4	16	0	0	17	7	0	0	10	8	14	41	10
3	16	0	0	18	8	0	0	10	9	5	14	11
2	16	0	0	18	11	0	0	11	9	6	4	13
1	16	0	0	18	11	0	0	12	10	3	1	18
Totals		515	517			334	178			703	748	
Mean	6.53	17.17	17.23	7.73	1.60	11.13	5.93	4.27	4.60	23.43	24.93	6.33
Median	4	12.5	15.5	5.5	1	6	3.5	3	4	19.5	18.5	5
Variance		325.94	229.29			160.53	54.48			322.46	568.06	
N		30	30			30	30			30	30	
Both divers												
Total		1032				512				1451		
Mean		17.20				8.53				24.18		
Median		15				4				20		
Variance		272.91				112.56				438.29		
N		60				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 7. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Hancock Point**, July 2, 2009.

	Lane 1 (A)				Lane 2 (B)				Lane 3 (C)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	3	0	1	3		22	33	6	0	24	47	0
29	3	8	0	3		47	40	7		44	42	1
28	4	8	1	4		47	28	7		30	12	4
27	5	4	0	5		22	11	9		41	27	5
26	5	1	5	5		26	2	10		20	32	5
25	7	1	6	7	10	10	18	12		42	31	5
24	11	9	2	11		10	11	13		13	3	6
23	12	8	0	12		1	3	16		8	27	7
22	12	8	0	12		0	0	16		8	23	7
21	13	4	0	13	18	0	0	18		0	24	8
20	15	11	0	15		0	0	18		7	31	9
19	16	0	0	16		0	0	19		3	6	12
18	17	0	0	17		0	0	19		1	14	14
17	18	0	0	18		0	0	20	16	0	1	15
16	19	0	0	19		0	0	20		0	0	16
15	19	0	0	19	22	0	0	22		0	0	17
14	20	0	0	20		0	0	22		0	0	17
13	20	0	0	20		0	0	22		0	0	17
12	21	0	0	21		0	0	23		0	1	18
11	22	0	0	22		0	0	23		0	0	18
10	22	0	0	22		0	0	23		0	0	19
9	23	0	0	23		0	0	24		0	0	19
8	23	0	0	23		0	0	25		0	0	20
7	23	0	0	23		0	0	25		0	1	20
6	24	0	0	24		0	0	26	21	1	0	21
5	24	0	1	24		0	0	27		0	1	22
4	25	0	0	25		0	0	27		0	0	23
3	26	0	0	26		0	0	28		0	0	23
2	26	0	0	26		0	0	28		0	0	23
1	27	0	0	27	28	0	0	29	23	0	0	22
Totals		62	16	25		185	146			242	323	
Mean	16.83	2.07	0.53	16.83	19.50	6.17	4.87	19.47	15.00	8.07	10.77	13.77
Median	19	0	0	19	20	0	0	21	18.5	0	1	16.5
Variance		12.55	2.05			176.63	115.22			195.24	220.46	
N		30	30			30	30			30	30	
Both divers												
Total		78				331				565		
Mean		1.30				5.52				9.42		
Median		0				0				1		
Variance		7.77				143.88				206.18		
N		60				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 8. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Frasier Point**, July 1, 2009.

	Lane 1 (B)				Lane 2 (C)				Lane 3 (A)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	2	3	6	2	4	5	3	1	2	0	0	2
29	2	0	10	4	5	0	4	1	2	0	8	4
28	5	5	19	5	5	5	28	2	4	5	16	6
27	8	15	17	6	5	4	2	4	5	0	0	8
26	8	18	10	5	5	3	1	5	5	0	2	9
25	9	0			7	34	0	5	5	2	2	11
24	9	30			8	21	1	6	7	6	2	11
23	9	4			9	18	7	7	8	7	1	13
22	9	18			9	9	21	8	10	3	1	14
21	9	0	1	9	10	0	13	8	11	0	1	14
20	10	14	28	10	10	9	38	10	12	1	32	14
19	10	35	37	10	11	38	30	11	14	2	7	15
18	12	15	20	10	13	9	23	13	14	2	19	16
17	13	19	77	13	14	45	82	13	14	0	0	16
16	17	22	17	12	14	7	0	13	14	1	92	16
15	18	77	9	14	15	1	21	14	15	19	62	17
14	19	0	31	15	17	13	118	14	15	14	7	18
13	19	1	66	17	17	31	74	14	18	18	15	20
12	20	27	86	18	17	33	68	16	18	2	9	21
11	21	7	34	20	18	29	10	17	19	15	20	22
10	21	45	1	21	20	13	71	20	19	45	0	22
9	22	0	4	22	21	12	17	21	20	83	5	23
8	22	33	3	23	21	22	105	21	21	28	5	23
7	25	5	29	23	23	3	45	24	21	9	43	23
6	25	24	31	24	27	52	2	25	21	34	46	23
5	26	13	35	25	27	14	54	25	22	13	52	24
4	26	12	21	27	27	1	50	28	25	4	20	26
3	26	0	36	27	28	3	2	28	28	5	3	27
2	27	3	10	30	28	9	3	29	29	7	4	27
1	27	7	1	30	29	73	6	29	29	0	3	29
Totals		452	639			516	899			325	477	
Mean	15.87	15.07	24.58	16.23	15.47	17.20	29.97	14.40	14.90	10.83	15.90	17.13
Median	17.5	12.5	19.5	16	14.5	10.5	19	13.5	14.5	4.5	6	16.5
Variance		286.13	511.77			312.72	1122.24			307.45	496.58	
N		30	26			30	30			30	30	
Both divers												
Total		1091				1415				802		
Mean		19.48				23.58				13.37		
Median		15				13				5		
Variance		406.40				746.76				401.73		
N		56				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 9. Sea urchin abundance (count/m^2) by quadrat, with depth (ft), for two diver evaluations in each lane, at **Bean Island Ledge**, September 1, 2009.

	Lane 1 (Replanted)					Lane 2 (Control)			
	Greg		Marcus			Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth		Depth	Abundance	Abundance	Depth
1	5	18	70	9		11	0	0	15
2	6	73	40	10		11	0	0	16
3	7	72	11	12		8	0	0	17
4	7	67	3	14		9	5	0	17
5	8	14	30	15		9	0	0	17
6	12	0	7	16		8	0	0	16
7	13	2	1	17		9	0	0	17
8	15	2	45	18		10	0	0	17
9	8	24	10	18		10	0	0	16
10	4	31	1	18		11	0	0	15
11	4	167	50	18		10	0	0	14
12	4	163	20	17		9	0	0	14
13	5	54	5	16		7	5	0	13
14	5	47	3	16		6	0	2	13
15	1	108	13	10		7	0	1	12
16	2	32	1	10		6	0	0	11
17	6	6	54	8		5	0	0	11
18	9	9	48	8		6	0	0	10
19	13	13	67	8		6	10	0	9
20	15	20	171	7		5	20	2	9
21	11	18	200	7		4	0	4	8
22	9	14	170	5		5	0	1	7
23	5	58	81	5		5	0	2	6
24	4	173	130	4		4	0	15	6
25	4	148	255	4		3	2	0	4
26	5	84	150	5		4	0	0	4
27	10	26	110	5		7	0	0	4
28	11	6	130	6		8	0	0	4
29	15	33	10	7		9	0	2	4
30	14	3	25	9		11	0	1	4
Totals		1,485	1,911				42	30	
Mean	7.90	49.50	63.70	10.73		7.43	1.40	1.00	11.00
Median	7	28.5	42.5	9.5		8	0	0	11.5
Variance		2,796.53	4,815.18				17.08	7.93	
N		30	30				30	30	
Both divers									
Total		3,396					72		
Mean		56.60					1.20		
Median		32					0		
Variance		3,792.62					12.33		
N		60					60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 10. Percent algal cover by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Bean Island Ledge**, September 1, 2009. "Cru" = Encrusting, "Tur" = Turfing, "Can" = Canopy.

	Lane 1 (Replanted)								Lane 2 (Control)							
	Greg				Marcus				Greg				Marcus			
Quadrat	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth
1	5	10	5	0	60	40	20	9	11	50	10	80	30	20	70	15
2	6	10	5	5	70	25	20	10	11	50	15	65	20	30	70	16
3	7	30	5	10	10	0	10	12	8	60	30	60	60	40	50	17
4	7	40	5	15	70	60	30	14	9	60	25	60	70	35	50	17
5	8	60	5	15	70	2	30	15	9	60	15	70	70	35	70	17
6	12	30	10	0	10	2	20	16	8	60	15	70	70	55	70	16
7	13	30	10	5	70	40	50	17	9	60	10	50	20	50	70	17
8	15	30	15	5	20	1	10	18	10	65	15	25	50	51	70	17
9	8	60	15	5	5	1	0	18	10	50	20	50	20	10	50	16
10	4	60	10	5	70	40	40	18	11	50	20	40	10	10	70	15
11	4	60	5	10	40	10	20	18	10	40	5	45	20	10	70	14
12	4	50	0	0	70	30	60	17	9	50	20	15	20	10	70	14
13	5	40	0	0	70	40	30	16	7	40	25	20	1	1	10	13
14	5	50	0	0	70	10	10	16	6	45	15	50	40	10	70	13
15	1	50	5	5	80	20	10	10	7	45	25	40	40	10	30	12
16	2	60	5	10	50	10	40	10	6	50	25	50	20	10	70	11
17	6	50	15	5	70	0	10	8	5	60	20	60	40	10	50	11
18	9	60	5	15	80	10	20	8	6	50	20	35	40	30	50	10
19	13	50	15	5	60	0	10	8	6	60	15	20	60	10	50	9
20	15	15	5	10	60	0	30	7	5	30	25	15	60	20	60	9
21	11	45	10	10	80	0	0	7	4	25	10	30	50	30	40	8
22	9	50	10	20	70	0	0	5	5	30	30	5	50	50	40	7
23	5	60	10	15	60	0	0	5	5	20	20	15	70	40	20	6
24	4	60	0	0	70	0	5	4	4	40	50	15	70	10	20	6
25	4	50	5	15	60	0	5	4	3	55	35	40	30	40	30	4
26	5	60	5	10	70	15	10	5	4	60	25	15	60	20	40	4
27	10	60	10	20	70	0	20	5	7	50	15	40	30	21	30	4
28	11	50	10	25	70	15	30	6	8	50	20	50	30	31	60	4
29	15	50	5	10	30	2	40	7	9	60	25	40	60	20	40	4
30	14	40	5	5	20	0	40	9	11	50	20	30	60	40	40	4
Mean	7.9	46	7	9	57	12	21	10.7	7.4	49	21	40	42	25	51	11.0
Median	7.0	50	5	8	70	2	20	10	8	50	20	40	40	21	50	12
N		30			30					30			30			

Both divers	Cru	Tur	Can
Mean	51	9.7	15
Median	60	5	10
N	60		

Both divers	Cru	Tur	Can
Mean	46	23	46
Median	50	20	50
N	60		

Algal Cover Legend						
Crust % cover		Turf % cover		Canopy % cover	
	0%		0%		0%
	1 - 25%		1 - 25%		1 - 25%
	26 - 50%		26 - 50%		26 - 50%
	51% +		51% +		51% +

Table 11. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Winter Harbor**, September 2, 2009.

	Lane 1 (C)				Lane 2 (A)				Lane 3 (B)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	3	26	20	3	1	7	22	3	3	23	43	2
29	3	33	9	4	2	8	6	3	3	52	76	2
28	3	5	7	5	2	5	13	3	4	39	73	2
27	4	17	10	5	2	1	2	3	3	21	19	2
26	4	26	30	5	2	7	3	3	5	34	77	2
25	5	16	26	6	2	0	34	3	5	18	78	3
24	6	20	4	5	2	2	29	4	4	15	33	6
23	6	21	5	6	3	0	3	4	4	44	31	7
22	5	7	13	6	4	16	2	5	5	12	1	7
21	2	16	34	7	2	4	2	7	5	4	15	8
20	3	16	22	7	2	0	0	8	5	5	4	8
19	3	54	3	7	2	16	0	8	5	13	20	8
18	4	1	11	7	3	10	0	8	5	20	8	8
17	4	36	0	7	3	10	0	8	4	3	1	7
16	5	19	30	7	4	0	2	8	5	21	1	7
15	6	39	63	7	5	0	18	8	5	4	35	7
14	5	30	60	7	6	1	20	9	6	62	7	7
13	5	22	26	8	7	8	10	9	7	31	45	7
12	9	34	15	8	7	0	3	8	7	56	13	7
11	10	29	11	10	6	6	1	8	8	8	11	9
10	11	17	25	12	8	2	0	9	9	13	12	10
9	12	7	23	13	8	10	0	9	10	45	0	15
8	13	8	13	14	8	1	0	13	10	14	0	15
7	15	0	0	16	9	0	0	16	11	4	0	16
6	17	0	0	17	11	0	0	16	11	24	0	16
5	18	3	0	18	13	4	0	17	14	0	0	18
4	18	0	0	19	14	0	0	17	17	0	0	19
3	19	0	0	20	15	1	0	17	18	0	0	19
2	20	0	0	20	16	0	0	18	18	0	0	19
1	20	0	0	20	17	0	0	18	19	0	0	21
Totals		502	460			119	170			585	603	
Mean	8.60	16.73	15.33	9.87	6.20	3.97	5.67	9.00	7.83	19.50	20.10	9.47
Median	5.5	16.5	11	7	4.5	1.5	1.5	8	5	14.5	9.5	7.5
Variance		203.44	274.02			23.14	89.33			332.26	679.27	
N		30	30			30	30			30	30	
Both divers												
Total		962				289				1188		
Mean		16.03				4.82				19.80		
Median		14				2				13		
Variance		235.19				56.02				497.28		
N		60				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 12. Percent algal cover by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Winter Harbor**, September 2, 2009. "Cru" = Encrusting, "Tur" = Turfing, "Can" = Canopy.

	Lane 1 (C)								Lane 2 (A)								Lane 3 (B)							
	Greg				Marcus				Greg				Marcus				Greg				Marcus			
Quadrat	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth
30	3	60	0	10	80	0	10	3	1	60	10	5	90	5	5	3	3	50	5	0	90	10	10	2
29	3	60	10	10	80	0	5	4	2	60	15	5	90	0	0	3	3	65	0	5	90	5	0	2
28	3	60	5	5	80	0	10	5	2	50	10	0	90	0	0	3	4	55	15	5	90	10	0	2
27	4	60	5	5	80	0	5	5	2	50	10	5	90	0	0	3	3	50	15	10	90	5	5	2
26	4	60	5	5	80	5	10	5	2	50	20	10	80	10	20	3	5	50	10	5	80	5	0	2
25	5	50	5	10	70	0	5	6	2	60	10	0	90	0	0	3	5	60	5	5	80	10	5	3
24	6	60	0	0	80	0	0	5	2	60	10	10	90	0	5	4	4	60	15	10	50	20	30	6
23	6	55	10	0	80	0	5	6	3	60	0	0	80	20	0	4	4	50	15	5	40	10	5	7
22	5	50	10	5	50	0	5	6	4	50	0	0	70	35	10	5	5	50	10	15	50	60	40	7
21	2	50	25	10	60	0	10	7	2	60	10	0	70	20	20	7	5	50	15	5	50	20	30	8
20	3	50	10	10	70	10	10	7	2	60	10	0	30	30	50	8	5	45	10	5	50	50	10	8
19	3	60	5	0	60	30	20	7	2	60	10	0	10	10	5	8	5	40	5	10	60	20	10	8
18	4	60	5	5	70	0	10	7	3	60	5	5	40	0	10	8	5	50	15	5	50	10	30	8
17	4	50	0	15	70	5	5	7	3	60	20	10	40	5	10	8	4	50	10	10	70	30	5	7
16	5	40	15	5	80	0	5	7	4	50	15	20	80	5	5	8	5	50	10	5	80	10	5	7
15	6	45	5	15	80	10	10	7	5	40	15	15	80	5	5	8	5	30	15	10	80	0	5	7
14	5	60	10	0	80	2	5	7	6	40	10	15	70	10	30	9	6	40	0	5	70	0	0	7
13	5	50	10	15	80	10	5	8	7	40	10	10	70	20	20	9	7	50	10	5	70	5	5	7
12	9	55	10	15	80	2	10	8	7	50	30	10	70	25	40	8	7	60	10	5	70	20	20	7
11	10	55	5	5	70	25	5	10	6	50	20	15	30	25	90	8	8	50	10	5	70	20	30	9
10	11	60	5	70	60	40	10	12	8	50	20	40	20	10	50	9	9	40	5	10	50	50	30	10
9	12	40	20	25	60	25	10	13	8	50	20	25	40	15	95	9	10	50	10	10	40	50	50	15
8	13	30	25	30	70	30	30	14	8	50	20	50	30	50	60	13	10	60	15	10	40	40	70	15
7	15	20	10	50	20	10	95	16	9	45	15	50	30	80	40	16	11	50	10	10	40	30	90	16
6	17	25	15	50	30	20	95	17	11	30	20	35	30	60	80	16	11	50	10	50	30	60	50	16
5	18	10	10	45	20	10	80	18	13	60	20	25	10	40	80	17	14	45	20	45	30	70	60	18
4	18	10	15	45	30	0	80	19	14	45	20	50	20	50	70	17	17	40	20	50	30	50	60	19
3	19	10	5	15	25	20	80	20	15	40	20	50	20	40	80	17	18	30	20	40	30	30	60	19
2	20	5	5	10	0	0	1	20	16	30	20	50	5	40	70	18	18	40	20	40	30	10	90	19
1	20	0	0	0	0	0	30	20	17	30	20	50	10	25	80	18	19	30	10	60	10	40	90	21
Mean	8.6	43	9	16	60	8	22	9.9	6.2	50	15	19	53	21	34	9.0	7.8	48	11	15	57	25	30	9.5
Median	6	50	8	10	70	2	10	7	5	50	15	10	55	18	20	8	5	50	10	10	50	20	25	7.5
N		30			30					30			30					30			30			
Both divers		Cru	Tur	Can						Cru	Tur	Can						Cru	Tur	Can				
Mean		52	8.6	19						51	18	27						53	18	23				
Median		60	5	10						50	15	15						50	10	10				
N		60								60								60						

Algal Cover Legend					
Crust % cover		Turf % cover		Canopy % cover	
	0%		0%		0%
	1 - 25%		1 - 25%		1 - 25%
	26 - 50%		26 - 50%		26 - 50%
	51% +		51% +		51% +

Table 13. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Hancock Point**, September 1, 2009.

	Lane 1 (A)				Lane 2 (B)				Lane 3 (C)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	2	1	8	2	2	1	12	4	3	14	26	3
29	2	11	4	3	3	0	3	5	4	8	31	5
28	2	5	0	4	3	5	16	6	5	32	14	5
27	2	5	4	5	3	11	16	6	6	24	6	7
26	3	21	5	6	6	12	11	6	7	12	35	9
25	5	9	10	7	6	8	12	9	8	14	5	9
24	6	6	14	9	8	2	28	9	9	7	4	11
23	7	11	9	11	9	0	11	10	11	1	3	12
22	10	15	0	15	10	2	13	13	13	0	4	14
21	11	0	0	15	10	0	0	14	14	0	7	14
20	11	0	0	16	11	0	0	14	15	0	14	14
19	12	0	0	17	12	0	0	14	15	0	0	15
18	12	0	0	18	13	0	0	15	16	0	0	17
17	16	0	1	18	14	0	0	16	16	0	0	18
16	18	0	0	18	14	0	1	17	17	0	0	18
15	19	0	0	18	15	0	0	17	17	0	0	18
14	20	0	0	19	16	0	0	18	19	0	1	18
13	21	0	0	20	16	0	0	19	19	0	0	19
12	21	0	0	20	17	0	3	20	20	0	0	20
11	22	0	0	20	17	0	0	20	21	0	0	21
10	22	0	0	21	18	0	0	21	21	0	0	22
9	22	0	0	22	18	0	0	22	22	0	0	22
8	23	0	0	23	18	0	0	22	22	0	0	23
7	23	0	0	23	18	0	0	23	22	0	0	24
6	23	0	0	23	20	0	0	23	22	0	0	25
5	24	0	0	24	20	0	0	24	23	0	0	25
4	24	0	0	24	21	0	0	24	23	0	0	25
3	25	0	0	24	22	0	0	24	24	0	0	25
2	25	0	0	25	22	0	0	25	25	0	0	26
1	25	0	0	25	24	0	0	25	25	0	0	26
Totals		84	55			41	126			112	150	
Mean	15.27	2.80	1.83	16.50	13.53	1.37	4.20	16.17	16.13	3.73	5.00	17.00
Median	18.5	0	0	18	14.5	0	0	17	17	0	0	18
Variance		28.99	13.73			10.59	51.20			63.17	91.59	
N		30	30			30	30			30	30	
Both divers												
Total		139				167				262		
Mean		2.32				2.78				4.37		
Median		0				0				0		
Variance		21.24				32.41				76.47		
N		60				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 14. Percent algal cover by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Hancock Point**, September 1, 2009. "Cru" = Encrusting, "Tur" = Turfing, "Can" = Canopy.

	Lane 1 (A)								Lane 2 (B)								Lane 3 (C)							
	Greg				Marcus				Greg				Marcus				Greg				Marcus			
Quadrat	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth
30	2	10	10	5	10	50	5	2	2	30	10	5	25	10	0	4	3	30	10	5	60	15	0	3
29	2	15	10	5	5	30	5	3	3	20	5	5	25	10	0	5	4	30	5	5	50	21	10	5
28	2	20	10	15	10	5	10	4	3	25	5	5	50	15	5	6	5	40	5	0	50	2	0	5
27	2	15	5	5	40	10	0	5	3	40	5	5	60	10	0	6	6	60	15	0	70	11	0	7
26	3	25	0	5	60	10	5	6	6	40	10	10	80	10	15	6	7	50	20	0	80	20	10	9
25	5	40	10	5	70	10	10	7	6	55	10	10	80	20	10	9	8	30	5	10	80	20	10	9
24	6	50	5	5	80	20	20	9	8	25	15	10	80	20	5	9	9	25	5	10	80	60	20	11
23	7	60	10	10	25	30	30	11	9	25	5	10	60	20	10	10	11	25	5	20	40	50	10	12
22	10	50	5	10	5	5	0	15	10	30	5	15	70	30	10	13	13	20	10	10	60	40	50	14
21	11	40	5	10	5	10	0	15	10	25	5	20	5	0	0	14	14	10	5	5	50	20	50	14
20	11	5	0	0	5	10	0	16	11	15	5	10	5	0	0	14	15	5	0	5	80	20	50	14
19	12	5	0	0	5	5	0	17	12	0	0	0	5	10	0	14	15	0	0	0	40	20	30	15
18	12	5	0	0	10	0	0	18	13	0	0	0	5	10	0	15	16	0	0	0	5	2	0	17
17	16	5	0	0	10	0	0	18	14	5	0	0	5	2	0	16	16	0	0	0	10	2	10	18
16	18	5	0	0	1	10	0	18	14	0	0	0	5	2	0	17	17	5	0	5	5	2	0	18
15	19	0	0	0	1	10	0	18	15	0	0	0	5	5	0	17	17	5	0	0	10	15	0	18
14	20	5	0	0	1	1	0	19	16	0	0	0	5	0	0	18	19	5	0	0	10	6	0	18
13	21	5	0	5	1	2	0	20	16	5	0	0	5	1	0	19	19	0	0	0	5	2	5	19
12	21	5	0	0	1	2	0	20	17	0	0	0	5	0	0	20	20	0	0	0	5	2	1	20
11	22	0	0	0	1	1	0	20	17	0	0	0	5	2	0	20	21	0	0	0	5	2	0	21
10	22	5	0	0	0	2	0	21	18	5	0	0	5	2	0	21	21	0	0	0	0	0	0	22
9	22	0	0	0	1	2	0	22	18	0	0	0	1	2	0	22	22	0	0	0	1	2	0	22
8	23	0	0	0	1	2	0	23	18	0	0	0	1	0	0	22	22	0	0	0	10	2	0	23
7	23	0	0	0	1	20	0	23	18	0	0	0	1	2	0	23	22	0	0	0	0	0	0	24
6	23	5	0	5	0	1	0	23	20	0	0	0	1	2	0	23	22	5	0	5	5	1	5	25
5	24	0	0	0	0	0	0	24	20	5	0	0	1	1	0	24	23	0	0	0	0	0	0	25
4	24	0	0	0	1	1	0	24	21	0	0	0	1	1	0	24	23	0	0	0	0	0	0	25
3	25	5	0	0	1	0	0	24	22	0	0	0	1	0	0	24	24	5	0	0	0	0	0	25
2	25	0	0	0	0	0	0	25	22	5	0	0	1	0	0	25	25	0	0	0	0	0	0	26
1	25	5	0	0	5	0	0	25	24	0	0	0	0	0	0	25	25	0	0	0	0	0	0	26
Mean	15.3	13	2	3	12	8	3	16.5	13.5	12	3	4	20	6	2	16.2	16.1	12	3	3	27	11	9	17.0
Median	19	5	0	0	3	4	0	18	15	5	0	0	5	2	0	17	17	5	0	0	10	2	0	18
N		30			30					30			30					30			30			
Both divers		Cru	Tur	Can						Cru	Tur	Can						Cru	Tur	Can				
Mean		12	5.3	2.8						16	4.5	2.7						19	7	5.7				
Median		5	1	0						5	2	0						5	2	0				
N		60								60								60						
Shallow band		less than 13 ft.								less than 14 ft.								less than 17 ft.						
Both divers		Cru	Tur	Can						Cru	Tur	Can						Cru	Tur	Can				
Mean		30	11	7.6						39	10	7.3						41	15	12				
Median		25	10	5						30	10	8						40	11	8				
N		21								22								26						

Algal Cover Legend						
Crust % cover		Turf % cover		Canopy % cover	
	0%		0%		0%
	1 - 25%		1 - 25%		1 - 25%
	26 - 50%		26 - 50%		26 - 50%
	51% +		51% +		51% +

Table 15. Sea urchin abundance (count/m^2) by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Frasier Point**, September 2, 2009.

	Lane 1 (B)				Lane 2 (C)				Lane 3 (A)			
	Greg		Marcus		Greg		Marcus		Greg		Marcus	
Quadrat	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth	Depth	Abundance	Abundance	Depth
30	5	2	1	5	5	0	2	8	3	4	0	6
29	5	4	1	6	6	16	4	10	7	0	0	10
28	7	43	5	7	9	25	5	12	8	2	0	11
27	8	10	8	8	11	37	26	13	9	0	0	11
26	11	21	5	8	13	17	0	15	10	0	0	12
25	10	8	4	8	11	0	10	15	11	1	0	13
24	11	0	1	12	12	21	51	14	12	0	30	13
23	11	1	20	13	13	66	31	14	13	0	1	14
22	10	16	21	13	14	12	87	15	16	0	64	15
21	10	13	63	14	15	47	29	17	15	25	29	15
20	11	10	5	15	16	43	12	18	15	29	70	16
19	12	24	19	16	16	9	115	18	18	93	74	17
18	14	9	10	18	16	65	67	19	19	22	1	17
17	16	79	35	18	17	5	42	19	19	0	15	19
16	16	0	3	17	18	27	5	20	20	8	19	20
15	17	68	34	17	19	36	14	22	20	0	0	21
14	18	31	17	17	20	87	31	23	21	0	1	21
13	19	13	60	21	21	18	10	24	21	14	1	21
12	19	15	44	21	22	29	2	24	22	1	30	21
11	20	37	50	22	23	24	70	25	23	1	69	22
10	21	8	15	23	23	33	10	26	24	14	75	23
9	22	14	27	25	23	29	5	28	26	0	48	24
8	24	0	52	25	25	18	3	28	24	6	29	24
7	28	4	23	25	26	17	48	28	26	2	2	25
6	28	0	70	24	26	27	46	28	27	7	8	25
5	28	6	30	25	27	65	0	31	28	21	20	28
4	27	8	72	26	28	2	0	31	31	0	25	29
3	27	118	48	26	29	6	4	31	31	4	2	31
2	28	1	13	28	31	27	1	32	32	17	1	31
1	29	40	52	28	31	6	8	32	33	0	0	31
Totals		603	808			814	738			271	614	
Mean	17.07	20.10	26.93	17.70	18.87	27.13	24.60	21.33	19.47	9.03	20.47	19.53
Median	16.5	10	20.5	17.5	18.5	24.5	10	21	20	1.5	5	20.5
Variance		725.06	507.93			462.74	864.87			326.38	681.57	
N		30	30			30	30			30	30	
Both divers												
Total		1411				1552				885		
Mean		23.52				25.87				14.75		
Median		15				18				2		
Variance		617.91				654.19				528.67		
N		60				60				60		

Abundance Legend
count/m^2
0
1 - 10
11 - 20
21+

Table 16. Percent algal cover by quadrat, for two diver evaluations in each lane, by depth (ft), shallow to deep, at **Frasier Point**, September 2, 2009. "Cru" = Encrusting, "Tur" = Turfing, "Can" = Canopy.

	Lane 1 (B)								Lane 2 (C)								Lane 3 (A)							
	Greg				Marcus				Greg				Marcus				Greg				Marcus			
Quadrat	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth	Depth	Cru	Tur	Can	Cru	Tur	Can	Depth
30	5	50	20	10	40	80	30	5	5	30	35	30	10	80	10	8	3	50	45	25	20	55	40	6
29	5	45	35	30	30	90	20	6	6	40	20	25	60	50	50	10	7	35	45	30	30	75	80	10
28	7	60	30	30	30	70	50	7	9	50	15	25	60	50	30	12	8	40	45	50	40	40	40	11
27	8	50	25	20	60	60	40	8	11	45	5	15	70	30	30	13	9	50	25	30	30	65	70	11
26	11	45	15	30	70	50	30	8	13	40	20	30	5	0	10	15	10	40	20	25	50	60	30	12
25	10	40	20	20	70	40	70	8	11	40	25	25	40	10	10	15	11	30	5	15	60	45	5	13
24	11	50	25	20	70	60	70	12	12	40	15	20	80	10	20	14	12	15	15	5	70	40	5	13
23	11	60	30	40	80	50	40	13	13	45	0	15	80	20	10	14	13	5	0	0	80	15	5	14
22	10	50	40	30	80	10	60	13	14	55	5	15	80	0	5	15	16	5	0	0	70	0	0	15
21	10	60	30	40	90	0	30	14	15	45	0	10	80	10	10	17	15	60	0	5	80	0	0	15
20	11	50	30	50	90	20	5	15	16	50	0	10	40	15	5	18	15	60	10	5	90	30	10	16
19	12	60	20	40	90	10	20	16	16	60	5	10	80	10	5	18	18	60	10	5	90	15	20	17
18	14	60	20	30	70	15	30	18	16	60	0	5	70	0	5	19	19	60	10	5	90	15	20	17
17	16	60	10	20	80	10	20	18	17	70	5	5	80	20	10	19	19	40	0	5	80	20	10	19
16	16	60	10	15	70	80	20	17	18	50	5	5	80	30	5	20	20	40	10	15	80	10	20	20
15	17	70	5	5	80	50	30	17	19	50	10	20	70	10	30	22	20	35	5	5	90	0	10	21
14	18	70	5	5	80	40	30	17	20	60	5	5	60	25	30	23	21	25	5	0	30	0	0	21
13	19	70	5	0	80	10	30	21	21	50	5	10	80	10	30	24	21	20	10	0	30	10	0	21
12	19	65	5	10	80	0	20	21	22	30	5	5	60	70	0	24	22	20	0	0	90	0	0	21
11	20	50	10	40	80	10	10	22	23	50	5	10	70	10	10	25	23	45	15	0	90	10	30	22
10	21	60	10	20	80	10	30	23	23	45	5	5	60	10	30	26	24	20	5	15	90	0	5	23
9	22	50	10	20	70	10	30	25	23	35	10	10	60	25	30	28	26	10	0	5	90	0	5	24
8	24	60	20	5	60	0	20	25	25	30	5	5	30	10	30	28	24	10	0	5	80	10	20	24
7	28	25	20	20	80	0	10	25	26	30	10	5	90	0	5	28	26	5	0	5	80	30	20	25
6	28	5	5	10	90	1	10	24	26	30	5	5	90	0	10	28	27	20	0	0	80	10	20	25
5	28	20	5	10	80	0	20	25	27	50	10	15	40	10	30	31	28	10	0	15	80	11	30	28
4	27	20	5	15	80	2	5	26	28	40	5	10	50	10	20	31	31	5	0	0	70	10	30	29
3	27	40	5	10	90	0	10	26	29	50	5	0	70	0	20	31	31	15	0	5	90	1	10	31
2	28	30	5	5	80	10	10	28	31	40	5	5	60	0	40	32	32	10	0	5	90	0	0	31
1	29	25	5	0	80	15	0	28	31	40	5	5	70	0	30	32	33	5	0	0	90	2	5	31
Mean	17.1	49	16	20	74	27	27	17.7	18.9	45	8	12	63	18	19	21.3	19.5	28	9	9	71	19	18	19.5
Median	17	50	13	20	80	10	25	17.5	19	45	5	10	70	10	15	21	20	23	5	5	80	10	10	20.5
N		30			30					30			30					30			30			
Both divers		Cru	Tur	Can						Cru	Tur	Can						Cru	Tur	Can				
Mean		61	21	23						54	13	15						50	14	14				
Median		60	10	20						50	10	10						48	10	5				
N		60								60								60						

Algal Cover Legend					
Crust % cover		Turf % cover		Canopy % cover	
	0%		0%		0%
	1 - 25%		1 - 25%		1 - 25%
	26 - 50%		26 - 50%		26 - 50%
	51% +		51% +		51% +