The Impact of the *USS Spiegel Grove*: Technical Appendix:

"Can Artificial Reefs Reduce or Alter User Pressure on Adjacent Natural Reefs?"
(Leeworthy, Maher & Stone 2005)

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Spiegel Grove: Technical Appendix

This is the technical appendix for a paper entitled "Can Artificial Reefs Reduce or Alter User Pressure on Adjacent Natural Reefs?" This paper assesses the sinking of the Spiegel Grove in the Florida Keys National Marine Sanctuary. It is forthcoming in the *Bulletin of Marine Science*. The purpose of this appendix is to provide the interested reader with the full details of our analysis, allowing for an understanding of our sampling methodology and the calculations involved in our estimation. Using this appendix, the reader can reproduce our estimates of reef use.

This appendix contains a detailed description of the extrapolation process in Section I and complete tables of our on-water sample dates in Section II.

I. Extrapolation Process

This section contains an explanation of the process by which we extrapolated our logbook census numbers to an estimate of total recreational reef use as well as a complete example calculation. The explanation (sub-section A) and the example (sub-section B) refer to the Microsoft Excel Workbooks *pre.xls* and *post.xls*, which are available on our website at http://marineeconomics.noaa.gov. We have also provided the tables contained in these Excel files below in sub-sections D and E. The table numbers referenced in the text have been preserved; however, where specific formulae and cells are given, it may be easiest to download the Excel files. Sub-section C contains an illustration of the extrapolation process in chart form.

A. Calculation Explanation

In order to assess the effects of establishing an artificial reef in the Florida Keys by sinking the *Spiegel Grove*, we need estimates of total reef usage both before and after the sinking of the ship. We had two sources of data for this study: log books from participating dive charter operators and an on-water sample collected at the reef sites on selected days. In order to estimate total usage, we begin with the data from our census of scuba diving charter operation logbooks and inflate these numbers using ratios derived from our on-water sample. We perform these calculations for both the pre-deployment and post-deployment periods, with activity on the *Spiegel Grove* explicitly broken out in the post-deployment period. The details of the calculations are explained below.

Pre-Deployment: (refers to Excel Workbook *pre.xls*)
From our logbook data, we compiled information on how many scuba divers, snorkelers, and others visited both artificial and natural reefs on participating dive charter boats from August 2001 to May 2002 (Table 1). This data was also stratified by season and weekend vs. weekday to provide more information (Summer = June-November, Winter = December-May). The majority of charter scuba diving operations in the Key Largo area provided their logbook data for our study; however, several did not, and we felt that these operators likely accounted for a significant share of reef usage. In order to determine the share of reef usage accounted for by dive charter operators who had elected not to provide their logbook data, we used our on-water sample.

One operator (KLDCO-16) provided logbook data for all months excluding August 2001. Instead of estimating how many users this operator took out in August using our on-water

data (process described below), we calculated the means for the number of users per outing by activity (diving, snorkeling, and other) and the probabilities that the operator went out using data from the months the operator did provide. Means and probabilities were calculated for summer weekends and summer weekdays (only summer because we are concerned only with August). Using these means and probabilities and knowing the number of weekdays and weekend days in August, we derived an estimate of the number of users this operator took out in August (Excel Worksheet 'KLDCO-16'). We added these figures to our initial logbook data to obtain adjusted usage data (Table 2). We then turned our attention to those dive charter operators who had not participated at all.

For those days on which we collected on-water data, we calculated the number of users by activity, season, and weekend taken to both artificial and natural reefs by participating dive charters (Table 3). We also calculated the number of users by activity, season, weekend, and reef type for non-participating dive charters (Table 4). We then derived the ratio of the number users from non-participating dive charters to the number of users from participating dive charters (Table 5).   This is our blow-up factor to move from the total numbers of users for participating charter operations to the total number of users for all dive charter operations (Table 6).

Now that we have estimates of the numbers of users taken out by all dive charter operations, we need to account for those users who access the reefs on non-dive charter boats. Law enforcement and research vessels, glass-bottom boats, and snorkel concession boats are excluded. Once again, we use the on-water data to calculate a blow-up factor. From the on water data we have the numbers of users (by activity, reef type, season, and weekend) for dive charters (Table 8) and other boats (Table 7). Our blow-up factor (Table 9) is the ratio of users from other boats to users from dive charters. Applying this blow-up factor to our estimates of all dive charter users gives us estimates of total users (Table 10).

Notice that when we begin to consider users from boats other than dive charters the category 'Others' becomes 'All Others.' Initially, 'Others' included those people who went out on a dive charter boat but did not snorkel or scuba dive. The new category 'All Others' includes those who went out on a boat but did not participate in any further activity, as well as those who took part in fishing. Consequently, the category 'All Others' accounts for a much larger share of total users than did the category 'Others.'

Post-Deployment: (refers to Excel Workbook *post.xls*)
The calculations for the post-deployment period are virtually identical to those from the pre-deployment period. We begin with our logbook data; however, in this case the logbooks were collected from July 2002 to July 2003. Consequently, we limit our sample to the 10-month period from August to May in order to be consistent with our pre-deployment sample. We calculate the numbers of users in our logbooks by activity, type of reef, season, and weekend (Table 1). We did not have any partial non-participants, as was the case with the pre-deployment logbooks, so we move directly to developing blow-up factors from the on-water data. The numbers for the *Spiegel Grove* are a subset of the numbers for artificial reefs in general.

From our on-water sample, we calculate the number of users by activity, reef type, season, and weekend for both non-participating and participating dive charter operations

(Table 2 and Table 3, respectively). From these numbers we calculate our first blow-up factor (Table 4), which we apply to our initial logbook figures in order to derive our estimate of total dive charter usage (Table 5).

Still using the on-water sample, we now calculate the number of users by activity, reef type, season, and weekend who access the reefs via dive charters (Table 7) and the number who access the reefs via other boats (Table 6). These numbers give us our second blow-up factor (Table 8), which, when applied to our estimate of total dive charter usage, gives us our estimate of total reef usage. It should be noted that the second blow-up factor for other users (non-divers or snorkelers) on artificial reefs on winter weekends is quite sensitive to small changes in the number of this type of users observed on dive charters in the on-water sample. While it is important to recognize this sensitivity, this does not have a major effect on our results, as the 'all others' category is not particularly important to dive shops.

B. Example Calculation: (refers to Excel Workbook *pre.xls*, worksheet *Pre*, unless otherwise noted)

This is an example of the calculations employed to derive our estimate of total reef usage from our pre-deployment logbook and on-water data. The calculations are virtually identical for the post-deployment data, as is explained below. Here we provide the formulas for moving from one cell in a table to the same cell in the next table. Specifically, this example is for the number of divers visiting natural reefs on summer weekdays. The calculations would be identical for other activities/user categories, for winter as opposed to summer, and for weekends as opposed to weekdays. Only these individual numbers broken down by activity, reef type, season, and weekend are recalculated as we move from one table to the next. For some tables, the individual entries come directly from our SAS summary reports on the data sets. The row and column totals are calculated for each table by summing the corresponding entries.

1) Looking at scuba divers on natural reefs on summer weekdays, we begin with the number of these users taken the logbook data (worksheet *Pre*, Table 1, cell B5).

2) We have one partially non-participating dive charter operation, KLDCO-16, who did not provide logbook data for August 2001. We estimated the number of users for each activity and reef type for summer weekends and weekdays for this operator using means generated from the months for which the operator did provide logbook data. The calculations described below can be found in Excel Workbook *pre.xls*, worksheet *KLDCO-16*. Entries in the second row apply to weekdays; those in the third row apply to weekends. We begin with the numbers of weekdays and weekend days in August (B2 & B3). Multiplying by the 6 gives us the number of potential dives per day (C2 & C3; $C_x = 6B_x$). Using SAS, we calculate the following means:

    a) The probability that operator KLDCO-16 takes out customers on a given potential dive in the summer (E2 & E3)

    b) The probability that KLDCO-16 goes to a natural reef in the summer, assuming that KLDCO-16 does go out (D2 & D3)

    c) The probability that KLDCO-16 goes to an artificial reef in the summer, assuming that KLDCO-16 does go out (F2 & F3; $F_x = 1 - D_x$)

d) The mean number of divers per potential summer dive taken out by operator KLDCO-16, across all potential summer dives (G2 & G3)

e) The mean number of snorkelers per potential summer dive taken out by operator KLDCO-16, across all potential summer dives (H2 & H3)

f) The mean number of others per potential summer dive taken out by operator KLDCO-16, across all potential summer dives (I2 & I3)

Using the means described above, we are able to calculate the estimated number of users taken out by KLDCO-16 by type of user for weekdays and weekend days and for both artificial and natural reefs. These estimates, rounded to the nearest whole person, are provided in cells B6-E9. Since we are concerned in this example only with scuba divers on summer weekdays at natural reefs, we are interested only in entry B6, which happens to round down to zero (B6 = C2 * D2 * E2 * G2). The individual elements of this formula would change if we were interested in weekends, artificial reefs, or non-scuba divers.
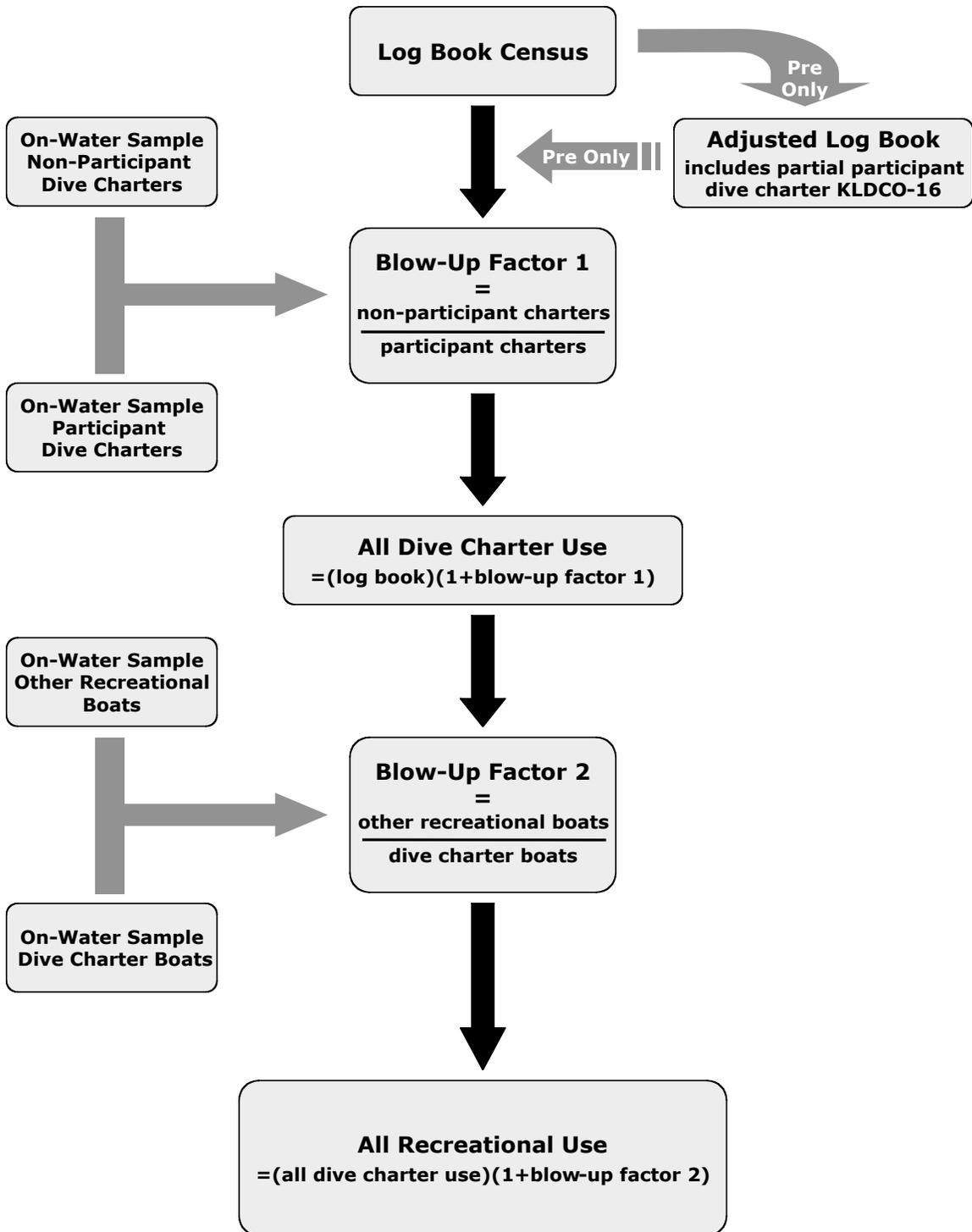
Referring once again to worksheet *Pre*, the entries from cells B6-E9 of worksheet *KLDCO-16* are added to the corresponding entries from Table 1 (only summer entries) in order to give us a new estimate of the logbook data (Table 2), including the missing August data. For scuba divers on summer weekdays at natural reefs, the estimate of KLDCO-16's customers is zero, so H6 = B6 + 0. The only positive estimates of KLDCO-16's customers were for scuba divers and snorkelers on summer weekends at natural reefs.

3) The entries in Tables 3 and 4 come directly from SAS summary reports. The entries we are concerned with (summer weekday scuba divers at natural reefs) are in cell B23 for dive charter operators not providing logbooks and cell H23 for those dive charters providing logbooks.

4) Our first blow-up factors (Table 5; N23 = B23/H23) are the ratios of the numbers of users from non-participating dive charters (Table 3) to the numbers of users from participating dive charters (Table 4). We do not calculate blow up factors for totals.

5) Applying our first blow-up factors (Table 5) to the adjusted logbook numbers (Table 2) gives us estimates of the numbers of users from all dive charter operations (Table 6; T23 = H5 * (1 + N23)).

6) The entries in Tables 7 and 8 come directly from SAS summary reports. The entries we are concerned with (summer weekday scuba divers at natural reefs) are in cell B41 for non-dive charter boats and cell H41 for dive charters.

7) Our second blow-up factors (Table 9; N41 = B41/H41) are the ratios of the numbers of users from non-dive charter boats (Table 7) to the numbers of users from dive charter boats (Table 8). We do not calculate blow-up factors for totals.

8) Applying our second blow-up factors (Table 9) to the estimates of total dive charter usage (Table 6) gives us our estimates of the total numbers of reef users (Table 10; T41 = T23 * (1 + N41).

These calculations are very similar for the post-deployment data (Excel Workbook *post.xls*), the major substantive difference being that Step 2 above is absent from the post-

deployment data, as we had no partial non-participants in our logbook data collection. Consequently, there are 9 tables for the post-deployment calculations, as opposed to 10 for the pre-deployment. Otherwise, the logic of the calculations remains the same.

C. Extrapolation Process Chart

Log Book Census

Pre Only

Adjusted Log Book
includes partial participant
dive charter KLDCO-16

Pre Only

On-Water Sample
Non-Participant
Dive Charters

On-Water Sample
Participant
Dive Charters

Blow-Up Factor 1
=
non-participant charters
——————————————
participant charters

All Dive Charter Use
=(log book)(1+blow-up factor 1)

On-Water Sample
Other Recreational
Boats

On-Water Sample
Dive Charter Boats

Blow-Up Factor 2
=
other recreational boats
——————————————
dive charter boats

All Recreational Use
=(all dive charter use)(1+blow-up factor 2)

D. Pre-Deployment Tables

1: Logbook 10-Month Pre-Deployment Totals

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	101,615	21,262	1,132	124,009
Summer Weekdays	23,083	4,775	185	28,043
Summer Weekends	17,482	3,547	147	21,176
Winter Weekdays	37,975	8,873	528	47,376
Winter Weekends	23,075	4,067	272	27,414
Artificial Reefs	22,176	4,165	310	26,651
Summer Weekdays	5,191	830	48	6,069
Summer Weekends	3,077	392	18	3,487
Winter Weekdays	8,881	2,221	201	11,303
Winter Weekends	5,027	722	43	5,792
Total	123,791	25,427	1,442	150,660

2: Logbook Pre-Deployment w/ KLDCO-16

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	101,618	21,263	1,132	124,013
Summer Weekdays	23,083	4,775	185	28,043
Summer Weekends	17,485	3,548	147	21,180
Winter Weekdays	37,975	8,873	528	47,376
Winter Weekends	23,075	4,067	272	27,414
Artificial Reefs	22,176	4,165	310	26,651
Summer Weekdays	5,191	830	48	6,069
Summer Weekends	3,077	392	18	3,487
Winter Weekdays	8,881	2,221	201	11,303
Winter Weekends	5,027	722	43	5,792
Total	123,794	25,428	1,442	150,664

3: Pre-Deployment On-Water Non-Participants

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	359	26	10	395
Summer Weekdays	24	5	0	29
Summer Weekends	40	6	0	46
Winter Weekdays	94	0	3	97
Winter Weekends	201	15	7	223
Artificial Reefs	113	5	4	122
Summer Weekdays	0	0	0	0
Summer Weekends	19	0	0	19
Winter Weekdays	37	1	2	40
Winter Weekends	57	4	2	63
Total	472	31	14	517

4: Pre-Deployment On-Water Participants

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	1,642	171	56	1,869
Summer Weekdays	326	53	20	399
Summer Weekends	166	10	3	179
Winter Weekdays	316	15	5	336
Winter Weekends	834	93	28	955
Artificial Reefs	679	41	17	737
Summer Weekdays	72	8	2	82
Summer Weekends	107	3	2	112
Winter Weekdays	149	14	6	169
Winter Weekends	351	16	7	374
Total	2,321	212	73	2,606

5: Pre-Deployment Blow-Up Factor #1

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs				
Summer Weekdays	0.074	0.094	0.000	
Summer Weekends	0.241	0.600	0.000	
Winter Weekdays	0.297	0.000	0.600	
Winter Weekends	0.241	0.161	0.250	
Artificial Reefs				
Summer Weekdays	0.000	0.000	0.000	
Summer Weekends	0.178	0.000	0.000	
Winter Weekdays	0.248	0.071	0.333	
Winter Weekends	0.162	0.250	0.286	
Total				

6: All Dive Charters

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	124,388	24,498	1,517	150,403
Summer Weekdays	24,782	5,225	185	30,193
Summer Weekends	21,698	5,677	147	27,522
Winter Weekdays	49,271	8,873	845	58,989
Winter Weekends	28,636	4,723	340	33,699
Artificial Reefs	25,744	4,504	389	30,638
Summer Weekdays	5,191	830	48	6,069
Summer Weekends	3,623	392	18	4,033
Winter Weekdays	11,086	2,380	268	13,734
Winter Weekends	5,843	903	55	6,801
Total	150,132	29,002	1,906	181,041

7: Pre-Deployment On-Water Other Boats

Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs	277	403	1,198	1,878
Summer Weekdays	53	64	86	203
Summer Weekends	37	153	107	297
Winter Weekdays	29	16	163	208
Winter Weekends	158	170	842	1,170
Artificial Reefs	80	21	385	486
Summer Weekdays	8	0	3	11
Summer Weekends	25	2	117	144
Winter Weekdays	26	18	76	120
Winter Weekends	21	1	189	211
Total	357	424	1,583	2,364

8: Pre-Deployment On-Water Dive Charters

Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs	2,001	197	66	2,264
Summer Weekdays	350	58	20	428
Summer Weekends	206	16	3	225
Winter Weekdays	410	15	8	433
Winter Weekends	1,035	108	35	1,178
Artificial Reefs	792	46	21	859
Summer Weekdays	72	8	2	82
Summer Weekends	126	3	2	131
Winter Weekdays	186	15	8	209
Winter Weekends	408	20	9	437
Total	2,793	243	87	3,123

9: Pre-Deployment Blow-Up Factor #2				
Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs				
Summer Weekdays	0.151	1.103	4.300	
Summer Weekends	0.180	9.563	35.667	
Winter Weekdays	0.071	1.067	20.375	
Winter Weekends	0.153	1.574	24.057	
Artificial Reefs				
Summer Weekdays	0.111	0.000	1.500	
Summer Weekends	0.198	0.667	58.500	
Winter Weekdays	0.140	1.200	9.500	
Winter Weekends	0.051	0.050	21.000	
Total				

10: All Boats				
Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs	139,895	101,448	32,948	274,290
Summer Weekdays	28,535	10,992	981	40,507
Summer Weekends	25,596	59,961	5,390	90,947
Winter Weekdays	52,756	18,338	18,058	89,152
Winter Weekends	33,008	12,157	8,519	53,684
Artificial Reefs	28,890	7,666	5,221	41,778
Summer Weekdays	5,768	830	120	6,718
Summer Weekends	4,342	653	1,071	6,067
Winter Weekdays	12,636	5,235	2,814	20,685
Winter Weekends	6,144	948	1,216	8,308
Total	168,785	109,114	38,169	316,068

E. Post-Deployment Tables

1: Logbook 10-Month Post-Deployment Totals				
Reef Type	**Divers**	**Snorkelers**	**Others**	**Total**
Natural Reefs	93,088	15,794	1,184	110,066
Summer Weekdays	22,286	3,785	316	26,387
Summer Weekends	19,883	2,569	208	22,660
Winter Weekdays	31,019	6,163	436	37,618
Winter Weekends	19,900	3,277	224	23,401
Artificial Reefs	46,149	7,699	583	54,431
Summer Weekdays	11,091	1,867	137	13,095
Summer Weekends	9,677	1,297	60	11,034
Winter Weekdays	15,133	2,948	258	18,339
Winter Weekends	10,248	1,587	128	11,963
Spiegel Grove	18,669	245	138	19,052
Summer Weekdays	4,784	90	51	4,925
Summer Weekends	4,215	61	20	4,296
Winter Weekdays	5,413	50	46	5,509
Winter Weekends	4,257	44	21	4,322
Total	139,237	23,493	1,767	164,497

2: Post-Deployment On-Water Non-Participants				
Reef Type	**Divers**	**Snorkelers**	**Others**	**Total**
Natural Reefs	343	10	3	356
Summer Weekdays	39	0	0	39
Summer Weekends	124	4	3	131
Winter Weekdays	46	6	0	52
Winter Weekends	134	0	0	134
Artificial Reefs	197	2	10	209
Summer Weekdays	18	0	0	18
Summer Weekends	39	0	10	49
Winter Weekdays	51	2	0	53
Winter Weekends	89	0	0	89
Spiegel Grove	84	2	0	86
Summer Weekdays	18	0	0	18
Summer Weekends	13	0	0	13
Winter Weekdays	29	2	0	31
Winter Weekends	24	0	0	24
Total	540	12	13	565

3: Post-Deployment On-Water Participants

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs	2,268	169	30	2,467
Summer Weekdays	351	35	6	392
Summer Weekends	902	63	3	968
Winter Weekdays	392	21	13	426
Winter Weekends	623	50	8	681
Artificial Reefs	1,355	35	17	1,407
Summer Weekdays	310	5	1	316
Summer Weekends	451	16	6	473
Winter Weekdays	216	12	7	235
Winter Weekends	378	2	3	383
Spiegel Grove	698	7	6	711
Summer Weekdays	199	4	1	204
Summer Weekends	214	1	2	217
Winter Weekdays	77	2	0	79
Winter Weekends	208	0	3	211
Total	3,623	204	47	3,874

4: Post-Deployment Blow-Up Factor #1

Reef Type	Divers	Snorkelers	Others	Total
Natural Reefs				
Summer Weekdays	0.111	0.000	0.000	
Summer Weekends	0.137	0.063	1.000	
Winter Weekdays	0.117	0.286	0.000	
Winter Weekends	0.215	0.000	0.000	
Artificial Reefs				
Summer Weekdays	0.058	0.000	0.000	
Summer Weekends	0.086	0.000	1.667	
Winter Weekdays	0.236	0.167	0.000	
Winter Weekends	0.235	0.000	0.000	
Spiegel Grove				
Summer Weekdays	0.090	0.000	0.000	
Summer Weekends	0.061	0.000	0.000	
Winter Weekdays	0.377	1.000	0?	
Winter Weekends	0.115	0?	0.000	
Total				

5: All Dive Charters				
Reef Type	**Divers**	**Snorkelers**	**Others**	**Total**
Natural Reefs	106,218	17,718	1,392	125,328
Summer Weekdays	24,762	3,785	316	28,863
Summer Weekends	22,616	2,732	416	25,764
Winter Weekdays	34,659	7,924	436	43,019
Winter Weekends	24,180	3,277	224	27,681
Artificial Reefs	53,616	8,190	683	62,489
Summer Weekdays	11,735	1,867	137	13,739
Summer Weekends	10,514	1,297	160	11,971
Winter Weekdays	18,706	3,439	258	22,403
Winter Weekends	12,661	1,587	128	14,376
Spiegel Grove	21,888	295	138	22,321
Summer Weekdays	5,217	90	51	5,358
Summer Weekends	4,471	61	20	4,552
Winter Weekdays	7,452	100	46	7,598
Winter Weekends	4,748	44	21	4,813
Total	159,834	25,908	2,075	187,817

6: Post-Deployment On-Water Other Boats				
Reef Type	**Divers**	**Snorkelers**	**Others**	**Total**
Natural Reefs	399	854	985	2,238
Summer Weekdays	93	159	121	373
Summer Weekends	198	454	229	881
Winter Weekdays	45	27	257	329
Winter Weekends	63	214	378	655
Artificial Reefs	288	54	428	770
Summer Weekdays	77	28	27	132
Summer Weekends	105	18	48	171
Winter Weekdays	35	0	93	128
Winter Weekends	71	8	260	339
Spiegel Grove	174	41	67	282
Summer Weekdays	59	28	3	90
Summer Weekends	82	12	12	106
Winter Weekdays	9	0	13	22
Winter Weekends	24	1	39	64
Total	687	908	1,413	3,008

7: Post-Deployment On-Water Dive Charters

Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs	2,611	179	37	2,827
Summer Weekdays	390	35	6	431
Summer Weekends	1,026	67	6	1,099
Winter Weekdays	438	27	13	478
Winter Weekends	757	50	12	819
Artificial Reefs	1,552	37	27	1,616
Summer Weekdays	328	5	1	334
Summer Weekends	490	16	16	522
Winter Weekdays	267	14	7	288
Winter Weekends	467	2	3	472
Spiegel Grove	782	9	6	797
Summer Weekdays	217	4	1	222
Summer Weekends	227	1	2	230
Winter Weekdays	106	4	0	110
Winter Weekends	232	0	3	235
Total	4,163	216	64	4,443

8: Post-Deployment Blow-Up Factor #2

Reef Type	Divers	Snorkelers	All Others	Total
Natural Reefs				
Summer Weekdays	0.238	4.543	20.167	
Summer Weekends	0.193	6.776	38.167	
Winter Weekdays	0.103	1.000	19.769	
Winter Weekends	0.083	4.280	31.500	
Artificial Reefs				
Summer Weekdays	0.235	5.600	27.000	
Summer Weekends	0.214	1.125	3.000	
Winter Weekdays	0.131	0.000	13.286	
Winter Weekends	0.152	4.000	86.667	
Spiegel Grove				
Summer Weekdays	0.272	7.000	3.000	
Summer Weekends	0.361	12.000	6.000	
Winter Weekdays	0.085	0.000	0?	
Winter Weekends	0.103	0?	13.000	
Total				

9: All Boats				
Reef Type	**Divers**	**Snorkelers**	**All Others**	**Total**
Natural Reefs	122,060	75,375	39,317	236,753
Summer Weekdays	30,667	20,980	6,689	58,335
Summer Weekends	26,981	21,245	16,293	64,519
Winter Weekdays	38,220	15,848	9,055	63,123
Winter Weekends	26,193	17,303	7,280	50,775
Artificial Reefs	63,001	26,453	19,383	108,836
Summer Weekdays	14,490	12,322	3,836	30,648
Summer Weekends	12,767	2,756	640	16,163
Winter Weekdays	21,158	3,439	3,686	28,283
Winter Weekends	14,586	7,935	11,221	33,742
Spiegel Grove	26,045	1,657	684	28,386
Summer Weekdays	6,635	720	204	7,559
Summer Weekends	6,086	793	140	7,019
Winter Weekdays	8,084	100	46	8,230
Winter Weekends	5,239	44	294	5,577
Total	185,061	101,828	58,700	345,589

II. On-Water Sampling Dates and Sample Design

SPIEGEL GROVE PRE-DEPLOYMENT SAMPLE DATES							
DUANE AND BIBB	BENWOOD	ELBOW AND CITY OF WASHINGTON	MOLASSES	FRENCH	CARYSFORT	PICKLES	CONCH
						Grecian Rocks	
Saturday	Thursday	Monday	Tuesday	Wednesday	Sunday	**Sunday**	Saturday
09/01/01	09/27/01	09/03/01	09/04/01	09/26/01	09/16/01	**09/02/01**	09/29/01
Monday	Saturday	Tuesday	Sunday	Tuesday	Monday	Saturday	Sunday
10/22/01	10/20/01	10/16/01	10/21/01	10/23/01	10/15/01	10/13/01	10/14/01
Saturday	Thursday	Sunday	Tuesday	Sunday	Saturday	Friday	Wednesday
11/10/01	11/15/01	11/25/01	11/13/01	11/11/01	11/24/01	11/16/01	11/14/01
Monday	Sunday	Saturday	Saturday	Sunday	Friday	Tuesday	Wednesday
12/10/01	12/09/01	12/08/01	12/29/01	12/30/01	12/07/01	12/11/01	12/12/01
Saturday	Thursday	Wednesday	Monday	Friday	Sunday	Saturday	Sunday
01/05/02	01/10/02	01/09/02	01/14/02	01/11/02	01/06/02	01/12/02	01/13/02
Friday	Saturday	Saturday	Sunday	Tuesday	Tuesday	Thursday	Thursday
02/22/02	02/09/02	02/23/02	02/10/02	02/26/02	02/05/02	02/21/02	02/07/02
Saturday	Friday	Sunday	Sunday	Saturday	Thursday	Sunday	Monday
03/30/02	03/08/02	03/10/02	03/24/02	03/09/02	03/07/02	03/31/02	03/11/02
Tuesday	Sunday	Thursday	Wednesday	Sunday	Saturday	Monday	Saturday
04/16/02	04/14/02	04/18/02	04/17/02	04/07/02	04/20/02	04/15/02	04/13/02
Saturday	Monday	Sunday	Saturday	Used this day to monitor public diving on ship	Thursday	Used this day to monitor public diving on ship	Wednesday
05/04/02	05/06/02	05/05/02	05/11/02		05/09/02		05/08/02
TOTALS	TOTALS	TOTALS	TOTALS	TOTALS	TOTALS	TOTALS	TOTALS
5 Weekends	4 Weekends	5 Weekends	5 Weekends	4 Weekends	4 Weekends	4 Weekends	4 Weekends
4 Weekdays	5 Weekdays	4 Weekdays	4 Weekdays	4 Weekdays	5 Weekdays	4 Weekdays	5 Weekdays

SPIEGEL GROVE POST-DEPLOYMENT SAMPLE DATES

DUANE AND BIBB	BENWOOD	ELBOW AND CITY OF WASHINGTON	MOLASSES	FRENCH	SPIEGEL GROVE	PICKLES	CONCH
Monday	Thursday	Wednesday	Sunday	Saturday	Saturday	Sunday	Friday
08/12/02	08/15/02	08/14/02	08/11/02	08/17/02	08/10/02	08/18/02	08/09/02
Sunday	Saturday	Sunday	Monday	Wednesday	Monday	Thursday	Saturday
09/08/02	09/07/02	09/01/02	09/09/02	09/04/02	09/02/02	09/05/02	08/31/02
Monday	Thursday	Wednesday	Sunday	Saturday	Saturday	Sunday	Friday
10/07/02	10/10/02	10/09/02	10/06/02	10/05/02	10/12/02	10/13/02	10/11/02
Sunday	Sunday	Saturday	Wednesday	Tuesday	Friday	Monday	Saturday
12/01/02	11/10/02	11/30/02	11/27/02	11/26/02	11/08/02	11/11/02	11/09/02
Sunday	Friday	Saturday	Thursday	Sunday	Saturday	Friday	Wednesday
12/29/02	12/20/02	12/21/02	12/19/02	12/22/02	12/28/02	12/27/02	12/18/02
Monday	Saturday	Wednesday	Saturday	Thursday	Friday	Sunday	Sunday
01/20/03	01/11/03	01/22/03	01/18/03	01/23/03	01/17/03	01/12/03	01/19/03
Sunday	Saturday	Monday	Thursday	Friday	Sunday	Tuesday	Saturday
02/23/03	02/08/03	02/10/03	02/13/03	02/14/03	02/09/03	02/11/03	02/22/03
Thursday	Friday	Sunday	Sunday	Saturday	Monday	Saturday	Tuesday
03/13/03	03/14/03	03/16/03	03/09/03	03/08/03	03/10/03	03/15/03	03/11/03
Saturday	Wednesday	Tuesday	Sunday	Saturday	Sunday	Tuesday	Monday
04/12/03	04/09/03	04/15/03	04/06/03	04/05/03	04/13/03	04/08/03	04/14/03
Wednesday	Sunday	Friday	Sunday	Saturday	Thursday	Saturday	Tuesday
06/25/03	06/15/03	06/13/03	06/22/03	06/14/03	06/26/03	06/21/03	06/24/03
Tuesday	Friday	Sunday	Friday	Friday	Sunday	Saturday	Sunday
07/15/03	07/04/03	07/27/03	07/18/03	07/11/03	07/20/03	07/12/03	07/13/03
12 MONTH TOTALS	**12 MONTH TOTALS**	**12 MONTH TOTALS**	**12 MONTH TOTALS**	**12 MONTH TOTALS**	**12 MONTH TOTALS**	**12 MONTH TOTALS**	**12 MONTH TOTALS**
5 Weekends	**5 Weekends**	**5 Weekends**	**6 Weekends**	**6 Weekends**	**6 Weekends**	**6 Weekends**	**5 Weekends**
6 Weekdays	**6 Weekdays**	**6 Weekdays**	**5 Weekdays**	**5 Weekdays**	**5 Weekdays**	**5 Weekdays**	**6 Weekdays**
10 MONTH TOTALS	**10 MONTH TOTALS**	**10 MONTH TOTALS**	**10 MONTH TOTALS**	**10 MONTH TOTALS**	**10 MONTH TOTALS**	**10 MONTH TOTALS**	**10 MONTH TOTALS**
5 Weekends	**4 Weekends**	**4 Weekends**	**5 Weekends**	**5 Weekends**	**5 Weekends**	**4 Weekends**	**4 Weekends**
4 Weekdays	**5 Weekdays**	**5 Weekdays**	**4 Weekdays**	**4 Weekdays**	**4 Weekdays**	**5 Weekdays**	**5 Weekdays**

Spiegel Grove Pre-Deployment On-Water Sampling Design			
10-Month Period	**Natural**	**Artificial**	**Total***
Summer Weekdays	9	5	14
Summer Weekends	9	4	13
Winter Weekdays	17	8	25
Winter Weekends	17	10	27
10-Month Totals	**52**	**27**	**79**

* There is double counting across reef types due to simultaneous sampling on artificial and natural reefs, so our totals are too high. We actually sampled 70 days in the 10-month period.

Spiegel Grove Post-Deployment On-Water Sampling Design			
10-Month Period	**Natural**	**Artificial**	**Total***
Summer Weekdays	10	8	18
Summer Weekends	10	7	17
Winter Weekdays	13	10	23
Winter Weekends	12	11	23
10-Month Totals	**45**	**36**	**81**
June/July			
Summer Weekdays	4	5	9
Summer Weekends	6	3	9
12-Month Totals	**55**	**44**	**99**

* There is double counting across reef types due to simultaneous sampling on artificial and natural reefs, so our totals are too high. We actually sampled 72 days in the 10-month period and 88 days in the 12-month period.

Spiegel Grove Pre-Deployment On-Water Sampling Rates			
10-Month Period	**Sampled**	**Total**	**% Sampled**
Summer Weekdays	12	88	13.64%
Summer Weekends	12	34	35.29%
Winter Weekdays	23	130	17.69%
Winter Weekends	23	52	44.23%
10-Month Totals	**70**	**304**	**23.03%**

Spiegel Grove Post-Deployment On-Water Sampling Rates			
10-Month Period	**Sampled**	**Total**	**% Sampled**
Summer Weekdays	16	87	18.39%
Summer Weekends	15	35	42.86%
Winter Weekdays	20	130	15.38%
Winter Weekends	21	52	40.38%
10-Month Totals	**72**	**304**	**23.68%**

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