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EX-USS KILLEN SITE INVESTIGATION AND BIOLOGICAL CHARACTERIZATION VIEQUES ISLAND NAVAL ACTIVITY PUERTO RICO

6/1/2002

GMI

EX-USS KILLEN SITE INVESTIGATION AND BIOLOGICAL CHARACTERIZATION, VIEQUES ISLAND, NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

FINAL REPORT

JUNE 2002

Prepared for:
Commander Atlantic Division, Naval Facilities Engineering Command
Attn: Mr. David M. James (Code BD31DJ)
1510 Gilbert Street
Norfolk, Virginia 23511-2699

Contract Number: N62470-95-D-1160
Task Order Number: 0050

Prepared by:

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VIEQUES ISLAND 02-6

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TABLE OF CONTENTS

No.		Page
1.0	**INTRODUCTION**	**1**
2.0	**STUDY SITES**	1
3.0	**METHODS**	**2**
	3.1 Logistics	2
	3.2 Locating the Wrecks	2
	3.3 Mapping the Wrecks	2
	3.4 Submerged Aquatic Vegetation (Seagrass) Assessment	7
	3.5 Fish Population Assessment	8
	3.6 Coral Population Assessment	11
4.0	**RESULTS**	**11**
	4.1 Descriptions of the Wrecks	11
	4.2 Submerged Aquatic Vegetation	20
	4.3 Fishes	21
	4.4 Corals	23
5.0	**DISCUSSION**	**27**
	5.1 Drums on the Wrecks	27
	5.2 Submerged Aquatic Vegetation (Seagrass)	28
	5.3 Fishes	28
	5.4 Corals	29
6.0	**REFERENCES**	**30**
7.0	**LIST OF PREPARERS**	**31**

APPENDICES:

A Maps of the Killen and the Barge
B Seagrass, Fish, and Coral Data

LIST OF TABLES

No.		Page
1	Locations and headings of 200-m (656-ft) long transects at the wreck and control sites (K = Killen; B = Barge; C = Control)	8
2	Barge and Killen dimensions, depths, drum count, and sediment apron dimensions	12
3	Number of coral transects, photographs, and area samples at the Killen, Barge, and Control sites	23
4	Study site characteristics: number of coral species, coral density, and total live cover	23
5	Coral species composition and mean coral density (col/m^2) by site	24
6	Percent live cover by site and taxa	24
7	Coral species diversity and evenness of the study sites	26

LIST OF FIGURES

No.		Page
1	General location map of Vieques Island, Puerto Rico and study sites	3
2	Transect locations in (A) area of wrecks, Bahia Salina del Sur and (B) area of control site, Bahía Jalova	5
3	Layout of fish and coral transects on the barge and the Killen	9
4	Sketch and photomosaic of a barge sunk as a target in Bahia Salina del Sur, Vieques Island, Puerto Rico	13
5	(A) Sketch (Department of the Navy 1945), (B) Photomosaic of the Killen sunk as a target in Bahía Salina del Sur, Vieques Island, Puerto Rico, and (C) Aerial view of the Killen wreck location	15
6	Underwater view of the barge bow (Bahia Salina del Sur, Vieques Island, Puerto Rico)	17
7	Corals growing on the barge deck (Bahía Salina del Sur, Vieques Island, Puerto Rico)	17
8	Drums in the barge (Bahia Salina del Sur, Vieques Island, Puerto Rico)	18
9	Sediment aprons surrounding the barge and the Killen (Bahia Salina del Sur, Vieques Island, Puerto Rico)	18
10	Coral growing on the Killen (Bahía Salina del Sur, Vieques Island, Puerto Rico)	19
11	Drums on the Killen (Bahía Salina del Sur, Vieques Island, Puerto Rico)	19
12	Comparison of live cover categories versus percent cover between study sites	25
13	Comparison of coral colony density (col/m^2) between study sites	26

LIST OF ACRONYMS AND ABBREVIATIONS

ac	=	acre
CDR	=	Commander
cm	=	centimeter
col/m^2	=	colonies per square meter
DNER	=	Department of Natural and Environmental Resources
EOD	=	Explosive Ordnance Disposal
Killen	=	Ex-USS Killen
ft	=	feet
in	=	inch(es)
GMI	=	Geo-Marine, Inc.
GPS	=	Global Positioning System
km	=	kilometer(s)
LIA	=	Live Impact Area
m	=	meter
m^2	=	square meters
mi	=	mile(s)
MSO	=	Marine Safety Officer
NSRR	=	Naval Station Roosevelt Roads
OP-1	=	Observation Post-1
PWD	=	Public Works Department
SAV	=	submerged aquatic vegetation
USCG	=	U.S. Coast Guard
USFWS	=	U.S. Fish and Wildlife Service

1.0 INTRODUCTION

During the 1970s, or perhaps as early as the mid-1960s, two U.S. Navy vessels, the Fletcher Class destroyer USS *Killen* (Hull No. DD-593) and a barge (both containing numerous 55-gallon drums), were sunk as targets in Bahía Salina del Sur, located in the Live Impact Area (LIA) of Vieques Island, Puerto Rico. These vessels have remained on the seafloor and function as artificial reefs (Department of the Navy 1983). In an undated letter to Commander (CDR) Joseph Sirvidio (U.S. Coast Guard [USCG] Marine Safety Officer [MSO], San Juan, Puerto Rico), Gilberto Cintron (U S. Fish and Wildlife Service [USFWS]) described the Ex-USS Killen (Killen) as "blasted apart" and "totally ruptured"; there was "no remaining superstructure," and "only some of the internal machinery could be seen." [Cintron's description probably referred to a survey he co-authored in 1978] (Rogers et al. 1978). Representatives of the Puerto Rico Department of Natural and Environmental Resources (DNER) and the U.S. Navy (Navy) conducted a joint inspection of the Killen and found that the wreckage of the Killen was "an important marine habitat and that no action should be taken to remove the remaining hulk because it would be ecologically damaging to attempt to do so" (Department of the Navy 1983). The joint inspection also found that "the hulk is not a hazard to navigation, is being colonized by coral and should be left in place as a marine habitat" (Department of the Navy 1983). In 1989, Hurricane Hugo slammed into the eastern end of Vieques, possibly further demolishing the Killen.

In a year 2000 videographic survey of both wrecks ("Year 2000 video footage"), Navy Region Southeast (Naval Air Station, Jacksonville) documented artificial reefs supporting hard coral and sponge growth, and numerous fishes. The videotape also documented the presence of many 55-gallon drums scattered within the mangled remains of the Killen and below deck on the barge. All of the drums appeared heavily corroded, mangled, and broken open.

The presence of 55-gallon drums on the wrecks prompted the Commander, Navy Region Southeast to undertake this biological characterization of both the wrecks and the surrounding areas. The Navy specifically requested an assessment of the health of the indigenous marine species on and around the wrecks, and an assessment of potential impacts of the wrecks and their contents on the surrounding biota. To that end, the Atlantic Division, Naval Facilities Engineering Command contracted Geo-Marine, Inc. (GMI), Marine Sciences Group, to conduct a research effort in November 2001, including the mapping of the wrecks and the biological characterization of organisms associated with the wrecks, the areas surrounding the wrecks, and a control site.

The null hypothesis underlying the research effort was that the biota on the wrecks, when compared to the surrounding habitat, was no different than what would be seen in a natural environment. The alternative (research) hypothesis was that there would be a difference between the diversity and abundance levels on the wrecks compared to the natural situation

2.0 STUDY SITES

Our research took place on and around the wreck of the Killen and a barge in Bahía Salina del Sur, in the LIA, at the southeastern end of Vieques Island, Puerto Rico (Figure 1). We also investigated a control site located at Bahía Jalova, 3.3 kilometers (km) (2.1 miles [mi]) west of the Killen (Figure 1). The control site was contiguous with the eastern shoreline of Bahía Jalova, a Level 2 Conservation Zone (Naval Station Roosevelt Roads [NSRR] 2001). The coral reef and seagrass environments of Bahía Jalova, as well as the physical conditions of the bay, were comparable to Bahía Salina del Sur.

Aerial photography and hyperspectral imagery of Bahía Salina del Sur showed that the vessels were sunk within a large seagrass area (Department of the Navy 2001) (Figure 2A). The control site contained both a vast seagrass area and a fringing coral reef (Figure 2B).

Both wrecks were roughly rectangular in shape. The areal cover of the Killen and the barge was approximately 1,200 square meters (m^2) (0.3 acre [ac]) and 300 m^2 (0.07 ac), respectively. The wrecks lay in 2.5 to 10 meter (m) (8 to 33 feet [ft]) of water. The control site was 2 to 4 m (7 to 12 ft) deep.

3.0 METHODS

3.1 FIELD LOGISTICS

A team of six marine scientists conducted the field research from November 2 to 9, 2001. Sea conditions prevented underwater survey efforts on November 6. The majority of the work required the use of SCUBA. Given the shallow depth range of the study sites (2 to 10 m; 8 to 33 ft), the team used compressed air. The team was based in Esperanza, on the south side of the Vieques non-military area. The team boarded and disembarked from the GMI research vessel, R/V *GMI-Explorer*, at the Esperanza diving dock. The GMI boat was fueled and kept overnight at the NSRR Pelican Roost Marina. The daily work schedule included one hour of transit and six to seven hours of underwater work, totaling approximately 21 hours on the barge, 21 hours on the Killen, and seven hours at the control site.

Access to the work site was authorized by Security at NSRR and Camp Garcia through Winston Martinez and Sindulfo Castillo (Public Works Department [PWD], Environmental Division Office, NSRR). Explosive Ordnance Disposal (EOD) NSRR briefed all the researchers on ordnance safety before entry to the LIA. Furthermore, EOD NSRR (Master Chief EOD Cliff Ancelet) checked the work sites for unexploded ordnance before we began our work.

The GMI Emergency Medical Response was coordinated with the NSRR Emergency Room, Camp Garcia Range Control (Observation Post-1 [OP-1]), NSRR Dive Chamber (Mobile Diving Salvage Unit 2), Navy Rescue Helicopter, and the NSRR Senior Medical Diving Officer. All GMI participants were current on CPR and First Aid training. The GMI research vessel captain briefed all field participants on boat safety before leaving the Esperanza dock.

The field sampling was done by GMI (prime contractor): Ken Deslarzes, Ron White, Dan Wilkinson; Dial Cordy and Associates, Inc. (sub-contractor): Steve Dial, Jason Croop, Jeff Howe; and David Reynolds (sub-contractor).

3.2 LOCATING THE WRECKS

The positions of the Killen and the barge were clearly visible in aerial photographs of Bahía Salina del Sur (Figure 2A). We found the Killen by criss-crossing the area immediately north of Roca Alcatraz. The shallow depth and high water transparency allowed us to see the wreckage of the Killen from the surface. Once located, a diver attached a line and float to the Killen. A Geographical Positioning System (GPS) waypoint marking the approximate center of the Killen was stored in a Garmin GPS 76 (accuracy of 3 to 5 m). We found the barge to the north of the Killen, marked if with a float, and recorded a GPS waypoint at the center of the wreck.

3.3 MAPPING THE WRECKS

Mapping of the wrecks required basic measurements of length, width, height, and depth. To measure the length and width of each wreck, two divers laid a 50-m (164-ft) or 200-m (656-ft) fiberglass measuring tape (Keson Open Reel Fiberglass Tape) across each wreck. The height was assessed as the depth difference between the deepest and shallowest points using the depth gauge of a dive computer.

A series of down-looking underwater color photographs was taken in order to produce photographic mosaics of the wrecks using geographic information system (GIS), graphic, and photo editor software (Jasc Paint Shop Pro® 7.04, Adobe Photoshop® 6.0, and Environmental Systems Research Institute ArcView 3.2a® and ArcGIS 8.1®). The photographs were digital stills taken with a digital video camera and a digital photographic camera. The digital video camera was a Sony TRV-20 equipped with Mini DV and placed in an Amphibico Dive Buddy housing. The digital photographic camera was a 3.3 megapixel digital camera (Olympus C-3030) set in an underwater housing (Light & Motion TETRA 3030) and equipped with two synchronized strobe lights (Nikonos SB-105). Underwater pencil sketches of the wrecks were also made. The video stills were taken from near the sea surface, while the photographic stills were taken 1 m (3.3 ft) above the wrecks.

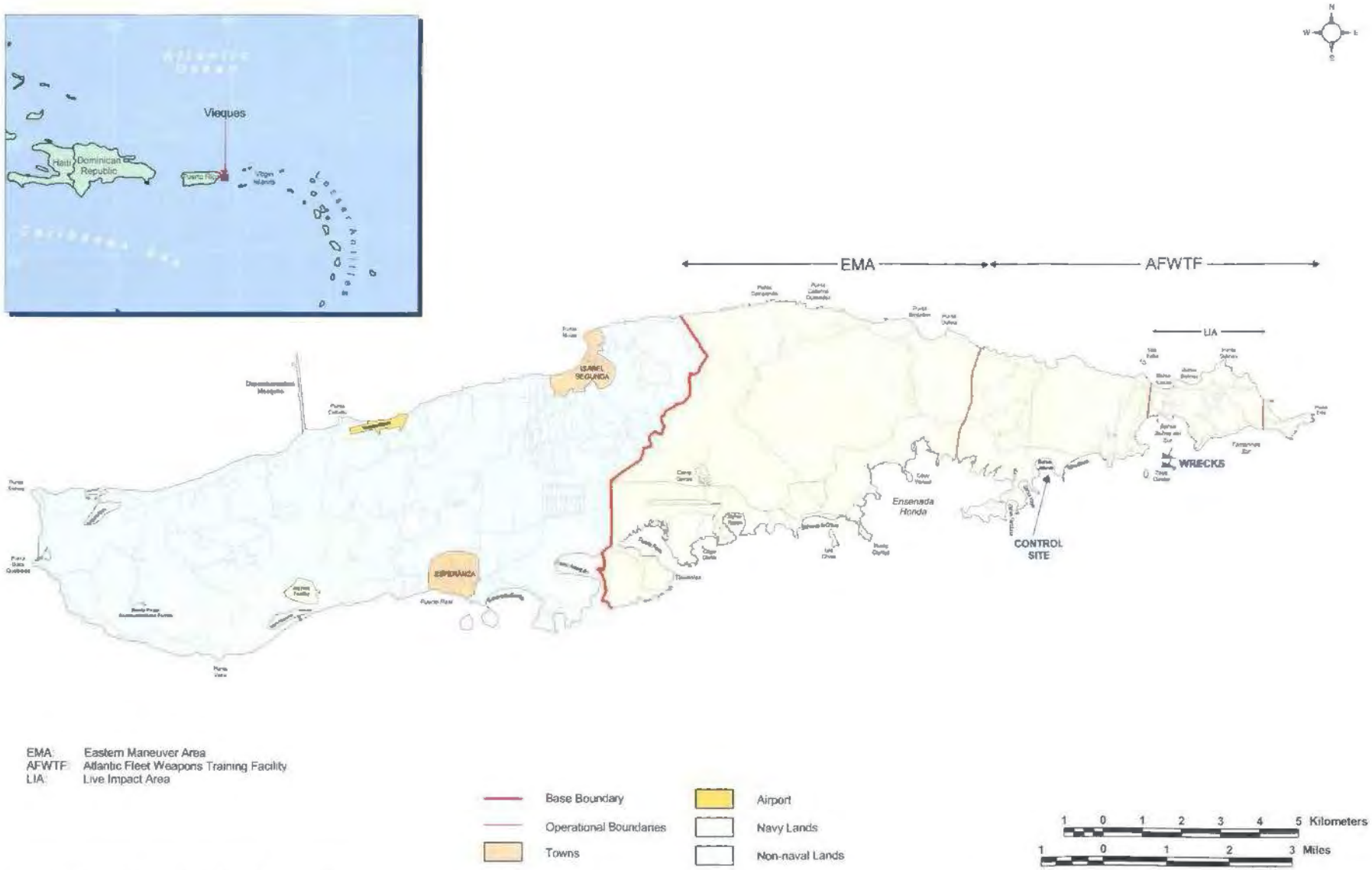

Figure 1 General location map of Vieques Island, Puerto Rico, and study sites

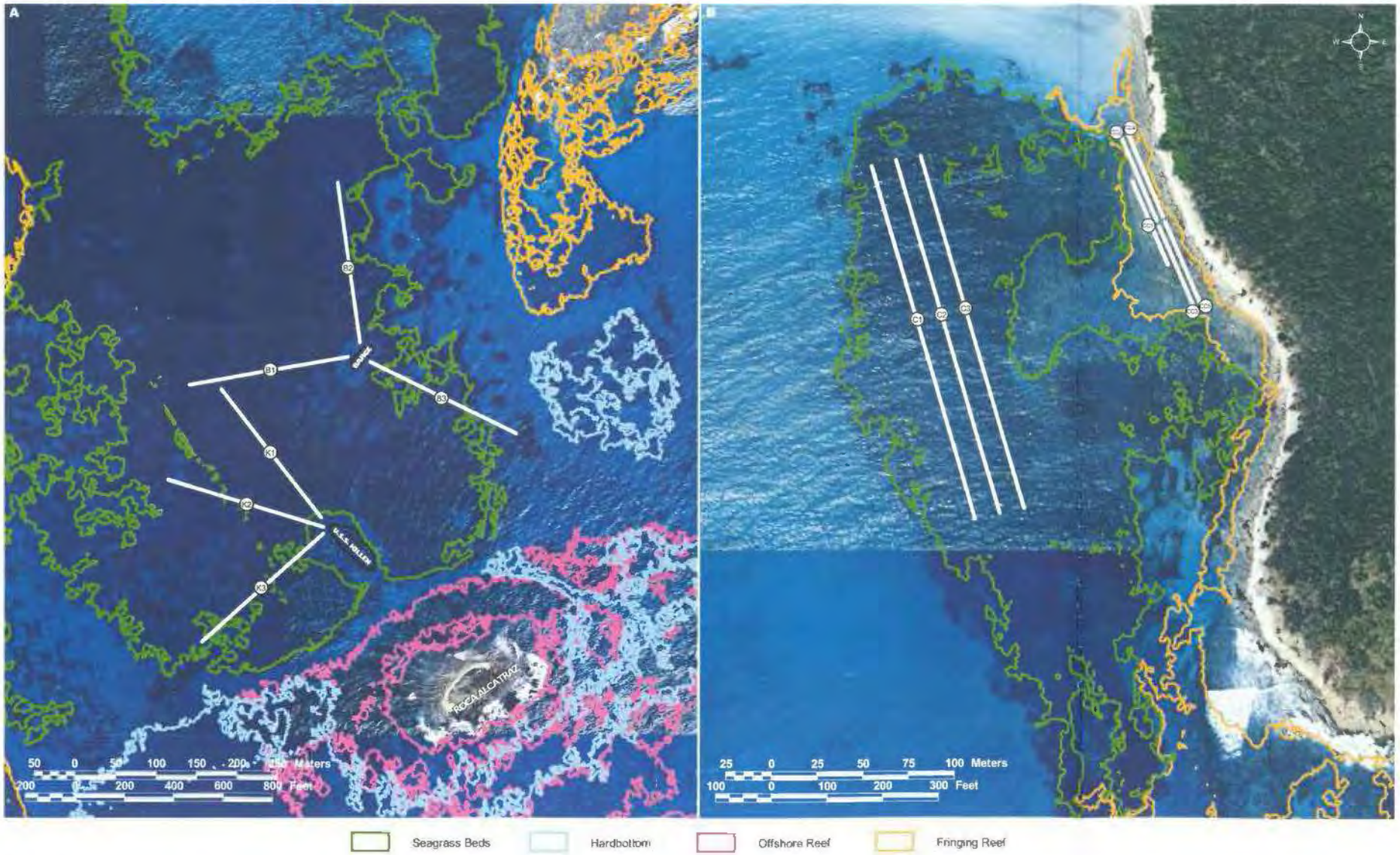

Figure 2. Transect locations in (A) area of wrecks, Bahía Salina del Sur, and (B) area of control site, Bahía Jalova

To geo-reference the photomosaics we included geo-referenced 17x15 in checkerboard-patterned targets (4 cells of a checkerboard) within numerous areas of the wrecks. To geo-reference the targets, we acquired the latitude/longitude coordinates of the center of each target by recording the position of a weighted float set directly above the center of each target.

Other aspects of the wrecks that were assessed included the halos or sediment aprons around each wreck and the number of 55-gallon drums at the wreck sites. The sediment aprons separated the outer edge of each wreck from the surrounding seagrass. To measure the sediment aprons, we laid a 50-m (164 ft) fiberglass measuring tape outward from the extensions of the length and width axes, and diagonals of the wrecks. This resulted in eight measurements per wreck. While the divers measured the sediment aprons, they also recorded the presence of structures such as 55-gallon drums, found within the sediment apron. Further, the divers estimated the number of whole and broken 55-gallon drums found within the wrecks. Other details about the wrecks were gathered from our analysis of the Year 2000 video footage

3.4 SUBMERGED AQUATIC VEGETATION (SEAGRASS) ASSESSMENT

To examine submerged aquatic vegetation (SAV), three 200-m (656-ft) long transects per site were evaluated: K1 through K3 at the Killen site, B1 through B3 at the barge site, and C1 through C3 at the control site (Figure 2). Seagrass transects at the control site were parallel to each other and approximately 100 m (328 ft) away from the control fringing reef. At the wreck sites, the seagrass transects radiated away from the edges of the wrecks. The radiating transects were designed to not overlap and to be contained within the seagrass area immediately surrounding the vessels.

To obtain data regarding the location, occurrence, abundance, and density of marine seagrass, we performed a SCUBA point intercept survey along each assigned transect. For each transect, the average percent occurrence was estimated in 1 m^2 (10.76 ft^2) quadrats at 10 m (33 ft) intervals along the transect line. The diver estimated the percent occurrence of SAV within 16 sub-quadrats located in a 1-m^2 quadrat that contained at least one seagrass shoot [sub-quadrats measured each 25 x 25 cm (6, 10 x 10 in)] (Braun-Blanquet 1965; Virnstein 1995, Fonseca et al. 1998).

Each 200-m (656-ft) long transect contained twenty-one 1-m^2 quadrats. Specific data recorded for each 1 m^2 quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of the substrate type, and any other observations considered useful. The seagrass cover abundance scale used is shown below. The cover abundance scale values were recorded for each quadrat. The content of each quadrat was visually inspected and a cover abundance scale value assigned to the quadrat.

The seagrass cover abundance scale values were:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5 to 25% cover
3.0 = Any number of shoots but with 25 to 50% cover
4.0 = Any number of shoots but with 50 to 75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, the frequency of occurrence, abundance, and density of seagrass were computed as follows:

Frequency of occurrence = Number of occupied sub-quadrats/total number of sub-quadrats

Abundance = Sum of cover scale values/number of occupied sub-quadrats

Density = Sum of cover scale values/total number of sub-quadrats

Transects radiating away from the wrecks were designed to include potential chemical sampling stations at 5-m, 50-m, and 200-m (16-ft, 164-ft, and 656-ft) distances from the wreck. The biological information collected along these transects would serve as a biological background for the results of the chemical analyses. Therefore, we recorded the latitude/longitude (Garmin GPS 76) of weighted floats set directly above the 5-m, 50-m, and 200-m (16-ft, 164-ft, and 656-ft) distances. We found, however, that the accuracy of these coordinates was consistently insufficient. This placed our control transects, for example, approximately 1 km east of their actual locations. Therefore, the exact locations of the markers of each transect was unknown. Nevertheless, we placed transects on geo-referenced aerial views of the study sites (Figure 2) to approximate the locations of the transects. These approximate locations are listed in Table 1.

Table 1. Locations and headings of 200-m (656-ft) long transects at the wreck and control sites (K = Killen; B = Barge; C = Control)

Transect	Heading	Latitude	Longitude
Killen			
K1-5 m	350°	18.1252	-65.3030
K1-50 m		18.1256	-65.3033
K1-200 m		18.1267	-65.3042
K2-5 m	300°	18.1251	-65.3030
K2-50 m		18.1252	-65.3034
K2-200 m		18.1257	-65.3048
K3-5 m	270°	18.1251	-65.3030
K3-50 m		18.1248	-65.3033
K3-200 m		18.1239	-65.3044
Barge			
B1-5 m	330°	18.1274	-65.3027
B1-50 m		18.1269	-65.3032
B1-200 m		18.1267	-65.3045
B2-5 m	0°	18.1272	-65.3026
B2-50 m		18.1277	-65.3026
B2-200 m		18.1291	-65.3028
B3-5 m	120°	18.1272	-65.3024
B3-50 m		18.1268	-65.3021
B3-200 m		18.1262	-65.3021
Control			
C1-50 m	210°	18.1249	-65.3324
C1-50 m		18.1245	-65.3322
C1-200 m		18.1232	-65.3318
C2-5 m	210°	18.1249	-65.3322
C2-50 m		18.1246	-65.3321
C2-200 m		18.1232	-65.3317
C3-5 m	210°	18.1249	-65.3321
C3-50 m		18.1246	-65.3320
C3-200 m		18.1232	-65.3316

3.5 FISH POPULATION ASSESSMENT

Fish populations were assessed along transects on and around the wrecks and at the control site. Different transect lengths were used at the different sites. One reef fish scientist swam slowly 2 m (6.6 ft) above a given transect line, identifying and counting fishes 1 m (3.3 ft) on either side of the transect line, and 2 m (6.6 ft) in front (2 x 2 x 2 m moving box) of the line. The assessments of fishes were only conducted when there were no other divers present or no nearby human activity. Upon arriving near the beginning of the transect line, the diver waited 15 minutes before beginning an assessment.

On the barge, fishes were assessed along one transect (BF1) running lengthwise along the axis of the deck (36 m/118 ft long). A measuring tape was used as the transect guide. On the Killen, fishes were assessed along 5 parallel transects (KF1-KF5: 27-35 m/89-115 ft long) set at a 45 angle to the axis of the wreck. Transects on the Killen were diagonal versus vertical for the barge simply to maximize coverage of the very large wreck. The Killen was roughly oriented north-south, with its stern at the south end. To evenly distribute the Killen fish transects, we subdivided the rectangular surface of the wreck into three parts, and then quartered each third of the wreck. The extremities of fish transect KF1 were the southeast corner of the wreck and the northwest corner of the first third of the wreck (Figure 3). KF2 also began on the east side of the wreck and joined the southeast corner of the second quarter and the northwest corner of the third quarter on the west side of the wreck, and so on. The transect extremities were marked with numbered racetrack-shaped aluminum tags. KF1 extremities were tags #1 and #2, KF2 extremities were tags #3 and #4, and so on. The barge transect was labeled with tags #11 and #12.

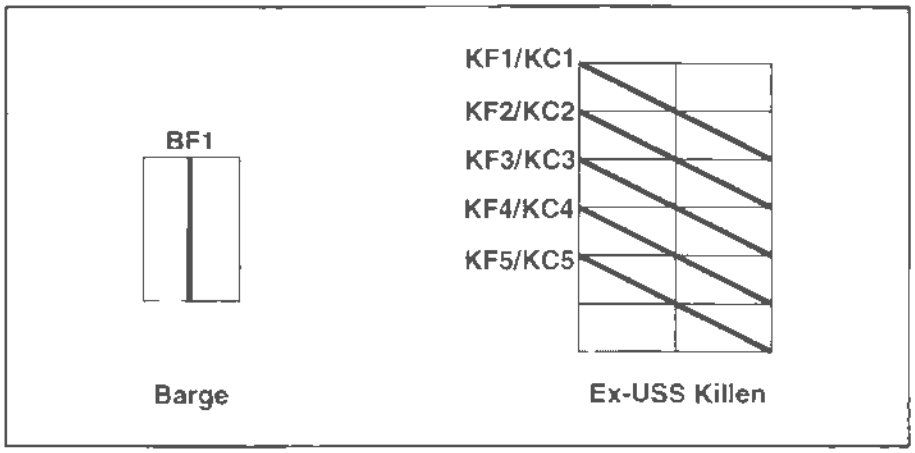

Figure 3. Layout of fish and coral transects on the barge and the Killen

Fishes were also assessed along the 200 m (656 ft) long transects used to assess seagrass: C1 through C3 at the Control site, B1 through B3 at the Barge site, and K1 through K3 at the Killen site (Figure 2). Refer to the methods section "3.4 Seagrass Assessment" for a complete description on the 200 m (656 ft) long transects. On the 200 m (656 ft) long transects, 3 successive surveys of fishes were done: 5 to 55 m (16 to 180 ft), 55 to 105 m (180 to 344 ft), and 150 to 200 m (492 to 656 ft); the sampling effort was separated by a 10 minutes break between transects. At the control site, fishes were counted and identified along five parallel transects CF1 through CF5 set within a fringing coral reef (Figure 2B).

For each of the 38 transects, the number of individuals of each species of fish was recorded. The observations made along replicate transects of a given type were averaged. The "type" of transects were: control seagrass (transects C1-5, C2-5, C3-5, C1-50, C2-50, C3-50, C1-200, C2-200, C3-200), control coral reef (CF1, CF2, CF3, CF4, CF5), barge seagrass (B1-5, B2-5, B3-5, B1-50, B2-50), barge (BF1), Killen seagrass (K1-5, K2-5, K3-5, K1-50, K2-50, K3-50, K1-200, K2-200, K3-200), and Killen (KF1, KF2, KF3, KF4, KF5). The seagrass areas were considered to be habitats of low spatial complexity. The coral reef barge, and Killen sites were considered to be habitats of high spatial complexity

The term "diversity", defined as the number of species present, was used in place of "richness" because diversity is the more intuitive term. The Shannon-Wiener index of diversity was not used for several reasons: our data set was not directly compared to other data sets from other studies, so some sort of statistical index was not necessary; the Shannon-Wiener index is unit-less, making it non-intuitive. The alternative to not using the index (i.e., using the average number of species per transect for a group of transects) is more intelligible in the context of this report. For example, the number of fish species along the nine seagrass transects at the Killen averaged 20.2 species/transect. Also, because each transect

represents a "unit-of-effort," the data can be statistically analyzed such that sites can be compared to each other.

To distinguish the differences in abundance and diversity at three different sites for fish, we tested several hypotheses using the two-tailed t-test. The test statistic is $t = (\bar{X} - \mu)/s_{\bar{x}}$. The null hypothesis is rejected if the absolute value of t is greater than the critical value of $t_{\alpha/2, v}$ (as listed in reference tables of critical values of the t distribution) where α (2) refers to the two-tailed probability of the level of significance (α = 0.05), and v = n-1.

Hypothesis #1

Null: There is no difference in fish diversity in the control study area between the coral reef and the seagrass meadow.

Alternative: There is a difference in fish diversity in the control study area between the coral reef and the seagrass meadow.

Hypothesis #2

Null: There is no difference in fish abundance in the control study area between the coral reef and the seagrass meadow.

Alternative: There is a difference in fish abundance in the control study area between the coral reef and the seagrass meadow.

Hypothesis #3

Null: There is no difference in fish diversity in the Killen study area between the Killen wreck and the seagrass meadow.

Alternative: There is a difference in fish diversity in the Killen study area between the Killen wreck and the seagrass meadow.

Hypothesis #4

Null: There is no difference in fish abundance in the Killen study area between the Killen wreck and the seagrass meadow.

Alternative: There is a difference in fish abundance in the Killen study area between the Killen wreck and the seagrass meadow.

Hypothesis #5

Null: There is no difference in fish diversity in the barge study area between the barge wreck and the seagrass meadow.

Alternative: There is a difference in fish diversity in the barge study area between the barge wreck and the seagrass meadow.

Hypothesis #6

Null: There is no difference in fish abundance in the barge study area between the barge wreck (high-spatial complexity) and the seagrass meadow (low-spatial complexity).

Alternative: There is a difference in fish abundance in the barge study area between the high-spatial-complexity area (i.e., barge wreck) and the low-spatial-complexity area (i.e., seagrass meadow).

3.6 CORAL POPULATION ASSESSMENT

The aim of the coral survey was to quantitatively characterize the sessile biota (hard corals, soft corals, sponges, and algae) on the wrecks and on the control reef. Any corals that might occur in the areas surrounding the wrecks were documented during the seagrass survey [refer to "3.5 Submerged Aquatic Vegetation (Seagrass) Assessment"]. The null hypothesis was that coral population levels (number of colonies and species richness) on the wrecks were no different from those of the control site. The alternative (research) hypothesis was that coral populations on the wrecks were lower than those of the control site because of negative impacts caused by the wrecks.

At the barge site, we recorded benthic cover in 80 photographs of the barge deck. Photographs were taken using a 3.3 megapixel digital camera (Olympus C-3030) set in an underwater housing (Light & Motion TETRA 3030) and equipped with two synchronized strobe lights (Nikonos SB-105). Photographs were taken from above looking down at the wrecks from 1 m above the deck (down-looking) subdivided the barge deck into eight parts and took ten frames in each part.

On the Killen, sessile benthos was photographed along five transects (KC1 to KC5) set 45 across the long axis of the wreckage (refer to "3.5 Fish Population Assessment") (Figure 2A). A 50-m measuring tape was laid along each transect line, and a down-looking, digital still photograph of the wreckage was taken at 1-m intervals. The camera was attached to an aluminum angle "monopod" set at a height above the wreckage so that each photograph covered a 1-m^2 area. A similar method was used at the control site except that transects were set on a fringing reef. The only other differences were that the transect length on the Killen was between 27 to 35 m (89 to 115 ft) while we used a fixed 50 m per transect (CC1-CC5) at the control site (Figure 2B).

In each photograph, we identified hard coral species (including the hydrozoan *Millepora* spp.), counted the number of colonies per hard coral species, and estimated the hard coral cover. The coral species identification and colony counts were done while the transects were photographed and in the laboratory. The photographs were viewed using the graphic and photo editor software (Jasc Paint Shop Pro® Version 7.04). To estimate coral cover, we overlaid 50 random dots on each photograph (Microsoft Excel® 2000 SR-1 Professional; Adobe Photoshop® 5.5) and multiplied the number of dots covering hard coral colonies by two. Using the same method, we also estimated the percent cover of algae in the functional groups: "Turfs," "Macroalgae," and "Crustose Algae" (following Steneck 1988), soft corals, sponges, sediment, and no data. Areas with no data photographs where the object directly below the random dot was unidentifiable (e.g., dark areas, areas out of focus, areas masked by the monopod or the 1 m^2 guide frame).

To characterize the study sites, we measured coral species diversity based on mean coral colony counts by site using the Shannon-Wiener index and species evenness (Zar 1984).

$$H' = -\sum_{i=1}^{k} p_i \log p_i \quad \text{(Shannon-Wiener index)}$$

$$J' = \frac{H'}{H'_{max}} \quad \text{(Pielou's evenness)}$$

$$H'_{max} = \log k \text{, where k is the number of species}$$

4.0 RESULTS

4.1 DESCRIPTIONS OF THE WRECKS

The latitude and longitude coordinates of the barge and Killen were 18°07'37.5"N, 65°18'09.2"W and 18°07'29.7"N, 65°18'09.0"W, respectively. Both wrecks were found on a large seagrass area at the entrance of Bahía Salina del Sur (Figure 2B). The barge had a 50 bow heading and the Killen a 318 bow heading. For discussion purposes, the bow of the barge was the left end of the wreck in Figure 4.

The Year 2000 video footage confirms this orientation. Table 2 presents the dimensions, depths, and drum count of each wreck.

Table 2. Barge and Killen dimensions, depths, drum count, and sediment apron dimensions

	Length	Width	Height	Min. Depth	Max. Depth	Drums	Sediment Apron Width (± SD) (n=8)
Killen	67 m (220 ft)	21.6 m (71 ft)	6.1 m (20 ft)	2.4 m (8 ft)	9.1 m (30 ft)	147	15.2 ± 4.0 m (50 ± 13 ft)
Barge	36.4 m (119 ft)	10.2 m (33 ft)	4.6 m (15 ft)	4.8 m (16 ft)	10 m (33 ft)	25	11.2 ± 6.8 m (37 ± 22 ft)

The targets we used to try to geo-reference the wreck were used for reference and scale. The preferred method to photomosaic the wrecks was video still imagery, mainly because overall views of the wrecks were more helpful than close-ups. The photomosaics presented here (Figures 4 and 5) were generated using video stills exclusively. The black and white pencil sketch of the barge provided a simplified but accurate structural reference (Figures 4). The sketch had the advantage of removing the complex structural clutter and photographic color variations. Furthermore, we used the hull tracings of a Fletcher class destroyer as a structural reference (Figure 5) (Department of the Navy 1945).

The photomosaics (Figures 4 and 5) showed details on the physical nature of the wrecks and on some of the sessile biota. Two quasi-circular holes almost 3 m (10 ft) across were located on the barge midship bow area (Figure 4). The edges of the holes were bent inward, possibly indicating the entry of ordnance. Two circular objects, possibly hatches or covers, with the same diameter as the holes, appeared in the midship and starboard areas of the deck. There were six smaller holes (each approximately 50 cm [20 in] across) in the bow deck. The port side of the stern of the barge seemed to have been torn open, possibly resulting from a combination of ordnance and hurricane impacts (Hurricane Hugo in 1989). From a live cover perspective, the flat and tilted barge deck (Figure 6) was peppered with at least 300 spherical-shaped coral colonies (roughly 1 coral colony/m^2, mainly composed of *Diploria strigosa, Diploria labyrinthiformis, and Siderastrea siderea*) (Figures 4 and 7).

There were at least 25 drums in the barge. Many of the drums were loosely scattered below deck. Other drums below the aft deck still appeared to be clustered in an organized fashion (Figure 8). We found one drum on the sediment apron surrounding the barge 12 m (39 ft) west from the middle of the wreckage. The sediment apron surrounding the barge (11.2 ± 6.8 m; 50 ± 13 ft) was irregular in shape and almost four times as wide on the bow end (19.6 to 22.3 m; 64 to 73 ft) compared to the stern end (2.5 to 5.2 m; 8 to 17 ft) (Figure 9).

As mentioned earlier, the areal cover of the Killen wreckage was four times as large as that of the barge. In contrast with the barge, the Killen wreckage contained virtually no deck (Figure 5). The Killen appeared to have been blown to pieces and reduced to its lower portion, as we saw mainly a fraction of the hull and mostly machinery. The plans of a Fletcher Class destroyer revealed the nature of the various artifacts we found within the wreckage (Department of the Navy 1945). Some of the more obvious artifacts included one of the two drive shafts, two boilers toward midship, and fragments of the bow deck (Figure 5). Much of the remaining keel was probably buried approximately 4.5 m (15 ft) in the underlying sand. The stern appeared to have been separated from the rest of the vessel. The bow appeared to have fallen off or perhaps collapsed upon impact with the seafloor. Compared to the barge, the Killen had much more relief and structural complexity as an artificial reef (Figure 10). As part of the Killen wreckage, we found at least 147 drums, of which 115 drums were mangled. Many of the Killen drums were concentrated toward the bow (Figures 5 and 11).

The width of the sediment apron surrounding the Killen was somewhat more uniform compared to that was measured around the barge. Killen sediment apron widths ranged from 11 to 21.8 m (36 to 71 ft)

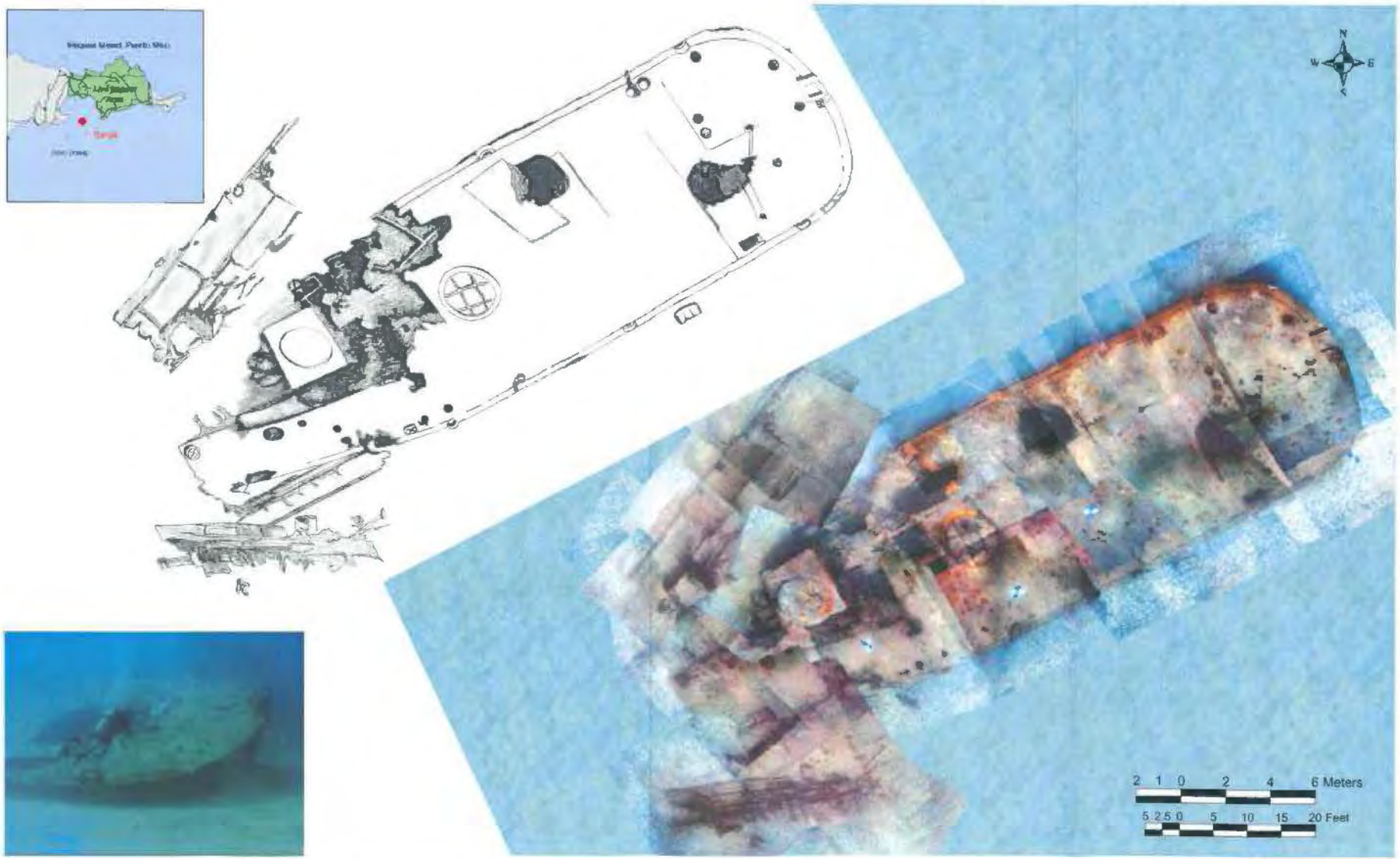

Figure 4. Sketch and photomosaic of a barge sunk as a target in Bahia Salina del Sur, Vieques Island, Puerto Rico

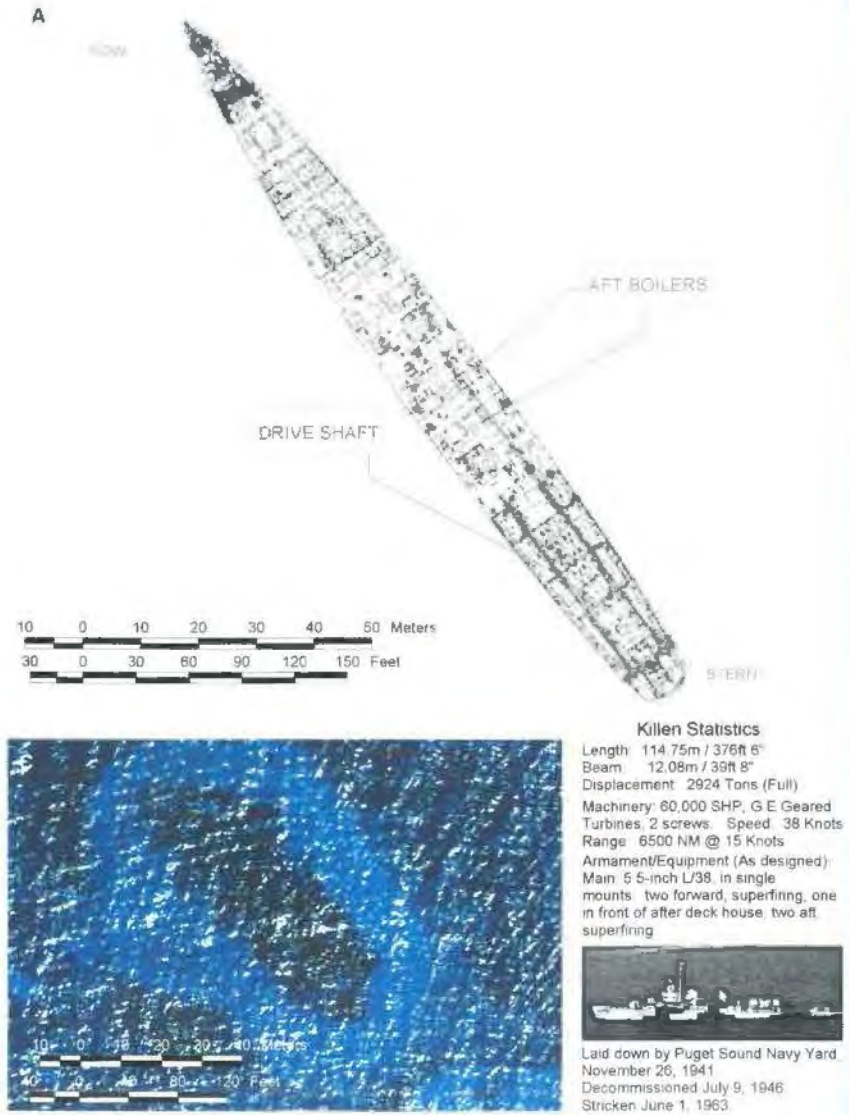

Figure 5. (A) Sketch (Department of the Navy 1945). (B) Photomosaic of the Killen sunk as target in Bahia Salina del Sur, Vieques Island, Puerto Rico, and (C) Aerial view of the Killen wreck location

Figure 6. Underwater view of the barge bow (Bahía Salina del Sur, Vieques Island, Puerto Rico)

Figure 7. Corals growing on the barge deck (Bahía Salina del Sur, Vieques Island, Puerto Rico)

Figure 8. Drums in the barge (Bahía Salina del Sur, Vieques Island, Puerto Rico)

Figure 9. Sediment aprons surrounding the barge and the Killen (Bahía Salina del Sur, Vieques Island, Puerto Rico)

Figure 10. Coral growing on the Killen (Bahía Salina del Sur, Vieques Island, Puerto Rico)

Figure 11. Drums on the Killen (Bahía Salina del Sur, Vieques Island, Puerto Rico)

(Figure 9). The Killen sediment apron bulged portside from midship bow. We found a few artifacts on the surface of the sediment apron: an inert piece of ordnance (MK-80 series) 3 m (10 ft) southeast of the stern, a cage-like structure 20 m (65 ft) south of the stern, and three drums and a hunk of steel portside of midship bow.

The aerial photograph of the Killen site further showed that a 13.4 m wide (44 ft) seagrass area separated the southeastern tip of the sediment apron from a long and wide (approximate width 34 m [111 ft]) sand channel running perpendicularly to the length of the wreck (Figure 9).

The Year 2000 video footage contained visual surveys of the Killen and the barge. On the Killen, the video was taken from stern to bow following the starboard edge of the wreck and then back toward the stern along the portside. The stern footage showed coral growth on mangled steel and cables; schools of fish swimming close to the wreck; sponge and soft corals encrusting the surface of part of the wreck and the drive shaft; drums on the stern with coral growth; and a MK-80 series shell. The midship starboard area included a broken-open drum partially covered with sand. Toward the bow, there were deck plates with coral growth and a concrete mooring and chain. At the midship bow area, the video captured a large cluster of drums, many of which were mangled. The video also showed a drum with probable ordnance entry points. Finally, more cables, pipes, and drums were filmed along the midship portside. The video also showed the barge, including a bow plate and drums filmed through a midship deck opening. The drums appeared heavily corroded and encrusted with live organisms. There were abundant fine sediments in the barge as witnessed by the sediments kicked up by the videographer and the thin layer of sediments covering the drums. There were also abundant coralline algae growing within the same area where the drums were found. The video showed a hatch on the starboard side deck. A drum was filmed under the bow, partially buried in the sand. The video footage concluded with the portside aft and standing drums set side-by-side in an organized fashion under the deck.

In summary, the video footage showed that the Killen was definitely a larger wreck than the barge and contained significantly more mangled debris as well as 55-gallon drums. The seafloor immediately surrounding both wrecks appeared to be mainly composed of coarse carbonate sediments. As an artificial substrate, the Killen had more coral and sponge growth and appeared to support more fish than the barge. Also, the inside of the barge exhibited significant sedimentation.

4.2 SUBMERGED AQUATIC VEGETATION

The vessels were sunk in large areas of SAV (Figure 2A) and caused a halo effect (sediment apron) at each site. SAV did not occur within 5 to 10 m of the wrecks along B1 and B2, and K1 through K3. Other than within the halo area, the density of seagrasses was comparable throughout the length of the transects (i.e., there was no abundance gradient with distance from the wreck) (Appendix B—Seagrass Transect Data). Dominant seagrasses were *Thalassia testudinum* and *Syringodium filiforme*. *Halodule wrightii* was a third seagrass species occurring in a few of the 1-m^2 quadrats (occurred in 1 through 6 quadrats out of 20 total quadrats per 200-m transect line). The macroalgae found with the seagrasses along the 200-m long transects were *Halimeda incrassata*, *Penicillus capitatus*, and *Udotea* sp. Also, the species composition of SAV at the wreck sites was identical to that found at the control site.

Following our research hypothesis, we tested for abundance differences of a dominant seagrass, *Thalassia testudinum*, between the first 40 m distance from the wrecks (near-field) (10, 20, 30, 40 m quadrats) and the last 40 m (far-field) (170, 180, 190, 200 m quadrats) using the Student's t-test (two-tailed; level of significance = 0.05). The abundance of *T. testudinum* was calculated as the ratio between the sum of cover scale values and the number of occupied sub-quadrats.

Hypothesis #1

Null Hypothesis: Abundance of *T. testudinum* within the 10 to 40 m distance from the Killen was identical to that found 170 to 200 m from the wreck.

Alternative Hypothesis: Abundance of *T. testudinum* within the 10 to 40 m distance from the Killen was different than that found 170 to 200 m from the wreck.

$t = -1.62636$; v (degrees of freedom) = 15; $t_{0.05(2),15} = 2.131$. Since $|t|<t_{0.05(2),15}$ we accepted the null hypothesis.

Hypothesis #2

Null Hypothesis: Abundance of *T. testudinum* within the 10 to 40 m distance from the barge was identical to that found 170 to 200 m from the wreck.

Alternative Hypothesis: Abundance of *T. testudinum* within the 10 to 40 m distance from the barge was different than that found 170 to 200 m from the wreck.

$t = 0.3484$; v (degrees of freedom) = 18; $t_{0.05(2),18} = 2.101$. Since $t<t_{0.05(2),15}$ we accepted the null hypothesis.

In both cases, the wrecks did not significantly influence the abundance of *T. testudinum*, one of the two dominant seagrasses at the wreck sites, as a function of distance from the wreck.

4.3 FISHES

The number of individuals of each species of fish seen on each transect is summarized in Appendix B. Overall, 1,425 individual fishes, representing 58 species, were observed (in several cases, the fish was identified only to the genus level). The four most common fishes in terms of number of individuals seen were *Chromis multilineata* (219 individuals), *Thalassoma bifasciatum* (174), *Haemulon sciurus* (109), and *Pseudupeneus maculatus* (101). Thirteen species were represented by only one observation of one individual. The four most common fishes (in terms of the number of transects where they were observed out of a possible 38) were *Halichoeres bivittatus* (20 transects), *Acanthurus bahianus* (15 transects), *Pseudupeneus maculatus* (13 transects), and *Ocyurus chrysurus* (12 transects). Sixteen species were observed on only one transect.

Test #1: Fish Diversity at Control Site

The number of fish species observed on each transect is tabulated below. The average number of fish species along the seagrass transects was 1.6 (S.D.=1.51) while the average number of fish species along the coral reef transects was 13.8 (S.D.=4.21). The number of species (i.e., diversity) on the reef is significantly greater ($P<0.001$) than the diversity in the seagrass area.

Seagrass	C1-5	C2-5	C3-5	C1-50	C2-50	C3-50	C1-200	C2-200	C3-200	AVE	S.D.
	1	0	0	2	3	0	4	3	1	1.56	1.51

Coral Reef	CF1	CF2	CF3	CF4	CF5					AVE	S.D.
	21	10	12	13	13					13.80	4.21

Test #2: Fish Abundance at Control Site

The number of individual fishes observed on each transect is tabulated below. The average number of fishes along the seagrass transects was 1.9 (S.D.=2.09) while the average number of fishes along the coral reef transects was 44.6 (S.D.=20.73). The number of individual fishes (i.e., abundance) on the reef is significantly greater ($P<0.01$) than the abundance in the seagrass area.

Seagrass	C1-5	C2-5	C3-5	C1-50	C2-50	C3-50	C1-200	C2-200	C3-200	AVE	S.D.
	1	0	0	2	3	0	4	6	1	1.89	2.09

Coral Reef	CF1	CF2	CF3	CF4	CF5					AVE	S.D.
	80	26	38	43	36					44.60	20.73

Test #3: Fish Diversity at Killen Site

The number of fish species observed on each transect is tabulated below. The average number of fish species along the seagrass transects was 2.6 (S.D.=1.51) while the average number of fish species along the Killen transects was 20.2 (S.D.=2.5). The number of species (i.e., diversity) on the Killen is significantly greater (P<0.00001) than the diversity in the seagrass area.

Seagrass	K1-5	K2-5	K3-5	K1-50	K2-50	K3-50	K1-200	K2-200	K3-200	AVE	S.D.
	3	3	2	2	0	1	5	3	4	2.56	1.51

Killen	KF1	KF2	KF3	KF4	KF5	AVE	S.D.
	22	20	16	22	21	20.20	2.49

Test #4: Fish Abundance at Killen Site

The number of individual fishes observed on each transect is tabulated below. The average number of fishes along the seagrass transects was 5.1 (S.D.=4.17) while the average number of fishes along the Killen transects was 140.0 (S.D.=22.51). The number of individual fishes (i.e., abundance) on the Killen is significantly greater (P<0.0001) than the abundance in the seagrass area.

Seagrass	K1-5	K2-5	K3-5	K1-50	K2-50	K3-50	K1-200	K2-200	K3-200	AVE	S.D.
	8	4	3	3	0	1	9	5	13	5.11	4.17

Killen	KF1	KF2	KF3	KF4	KF5	AVE	S.D.
	118	159	126	169	128	140.00	22.51

Test #5: Fish Diversity at Barge Site

The number of fish species observed on each transect is tabulated below. The average number of fish species along the seagrass transects was 4.9 (S.D.=3.22) while the number of fish species along the one barge transect was 21. The lack of replicate transects on the barge precluded the calculation of a standard deviation or other statistical analyses. However, casual inspection of the data strongly suggests that the diversity of fishes on the barge is significantly greater than among the seagrasses.

Seagrass	B1-5	B2-5	B3-5	B1-50	B2-50	B3-50	B1-200	B2-200	B3-200	AVE	S.D.
	5	2	3	1	9	11	4	5	4	4.89	3.22

Barge	BF1									AVE	S.D.
	21									21.00	

Test #6: Fish Abundance at Barge Site

The number of individual fishes observed on each transect is tabulated below. The average number of fishes along the seagrass transects was 5.1 (S.D.=4.17), while the number of fishes along the one barge transect was 140. Standard deviation or other statistical analyses could not be calculated due to the lack of replicate transects on the barge. Review of the data, however, strongly suggests that the abundance of fishes on the barge is significantly greater than among the seagrasses.

Seagrass	B1-5	B2-5	B3-5	B1-50	B2-50	B3-50	B1-200	B2-200	B3-200	AVE	S.D.
	8	60	7	1	77	28	14	13	14	24.67	26.25
Barge	BF1									AVE	S.D.
	217									217.00	

4.4 CORALS

We collected data on corals and other live sessile cover (crustose algae, macroalgae, turfs, soft corals, and sponges) at the Killen, barge, and control sites in a total number of 377 photographic quadrats for a total area of 352 m^2 (Table 3). Appendix B contains the detail of colony counts and percent live cover data extracted from all coral photographic quadrats.

Table 3. Number of coral transects, photographs, and area samples at the Killen, Barge, and Control sites

	Killen	Barge[1]	Control
Sample	5 transects	8 areas	5 transects
Photographs	148	80	149
Area Photographed	148 m^2	56 m^2	149 m^2

[1] Photographic samples of the barge were assembled within eight sub-areas as 10 random quadrats per sub-area

All study sites had a total live cover (hard corals + crustose coralline algae + macroalgae + turfs + soft corals + sponges) greater than 80% (Table 4). Overall, we found a total of 20 reef-building coral species (including *Millepora* spp.) for all sites combined. The Killen site contained 18 hermatypic coral species, the control site 17, and the barge site 9 (Table 5).

Table 4. Study site characteristics: number of coral species, coral density, and total live cover

Site Characteristics	Killen		Barge		Control	
	Mean	SD (n=148)	Mean	SD (n=80)	Mean	SD (n=149)
Coral Density (col/m^2)	6.79	2.96	27.2	11.68	5.3	0.81
Total Live Cover (%)	80.64		98.15		89.72	

The barge site had the greatest density of coral colonies with 27.2 coral colonies/m^2, which was roughly 3.5 times greater than at the Killen site and five times greater than at the control site. Yet, the barge site had the highest variability associated with the mean coral colony count. The barge site quadrats were almost entirely composed of live cover. The 1.85 percent cover not accounted for in the barge quadrats were either unidentifiable (e.g., dark areas) or sediment cover.

Most of the live cover at the Killen and barge sites was made up of algae (>90%) and hard coral (1.5 to 9.0%). Soft coral and sponge cover comprised less than one percent at both sites (Table 6; Figure 12). The barge site had the most live cover and the greatest amount of hard coral cover (9% of the total live cover compared to 2% at the Killen and control sites) despite the fact that it supported the least number of coral species (i.e., least diversity) (Figure 12; Tables 5 and 6). The barge site further stood out as having the largest amount of turfs (approximately 2.5 times more the Killen or control sites) and the least amount of macroalgae (29 times less than the control site; 14 times less than the Killen site) (Table 6; Figure 12).

Table 5. Coral species composition and mean coral density (col/m^2) by site

Species	Killen		Barge		Control	
	Mean	SD (n=148)	Mean	SD (n=80)	Mean	SD (n=149)
Agaricia spp.	0.09	0.07	0.00	0.00	0.62	0.18
Colpophyllia natans	0.06	0.07	0.08	0.13	0.02	0.02
Dichocoenia stokesii	0.33	0.29	0.00	0.00	0.05	0.06
Diploria clivosa	0.00	0.00	0.00	0.05	0.01	0.01
Diploria labyrinthiformis	0.10	0.07	0.27	0.36	0.00	0.00
Diploria strigosa	0.16	0.08	2.80	1.35	0.50	0.17
Eusmilia fastigiata	0.03	0.05	0.00	0.00	0.02	0.02
Favia fragum	0.01	0.01	0.00	0.00	0.21	0.11
Madracis mirabilis	0.00	0.00	0.00	0.00	0.01	0.01
Meandrina meandrites	0.01	0.02	0.00	0.00	0.00	0.00
Millepora spp.	0.12	0.09	0.29	0.45	0.29	0.18
Montastraea annularis	0.03	0.04	0.00	0.00	0.39	0.50
Montastraea cavernosa	0.02	0.03	0.04	0.07	0.11	0.06
Porites astreoides	0.03	0.05	0.00	0.00	0.73	0.18
Porites porites	0.36	0.21	0.02	0.05	1.22	0.54
Siderastrea radians	4.70	2.80	22.98	10.50	1.03	0.18
Siderastrea siderea	0.68	0.08	1.34	1.18	0.09	0.11
Solenastrea bournoni	0.01	0.02	0.00	0.00	0.01	0.03
Stephanocoenia michelini	0.05	0.03	0.00	0.00	0.02	0.03
Tubastrea coccinea	0.01	0.03	0.00	0.00	0.00	0.00

Table 6. Percent live cover by site and taxa

Taxa	Killen		Barge		Control	
	Mean (%)	SD (n=148)	Mean (%)	SD (n=80)	Mean (%)	SD (n=149)
Hard Corals	1.22	0.38	8.85	3.67	1.62	1.48
Crustose Algae	18.26	1.55	2.65	3.68	1.82	1.55
Macroalgae	27.46	8.47	1.90	2.24	54.50	3.73
Turfs	33.52	13.43	83.70	9.97	31.52	4.90
Soft Corals	0.00	0.00	0.03	0.07	0.14	0.21
Sponges	0.18	0.11	1.03	1.93	0.12	0.04

The crustose coralline algae cover differentiated the Killen from the other sites (Table 6; Figure 12). The hard coral cover on the Killen was less than that found at the barge but relatively greater than at the control site (less variability) (Table 6). The cover of the macroalgae and turf at the Killen was less with more variability than those recorded at the control site.

Finally, in terms of live cover, the control site differed from the wreck sites mainly by its relatively high algal cover and low coral cover.

Siderastrea radians (massive starlet coral) was the hard coral species common to all sites and most dominant in terms of colony density (col/m^2) (Table 5; Figure 13). Coral density by species was relatively low (< 1 col/ m^2) but was consistently highly variable. Overall, only four coral species had a density greater than 1 col/m^2: *Siderastrea radians* (all three sites), *Diploria strigosa* (symmetrical brain coral) and

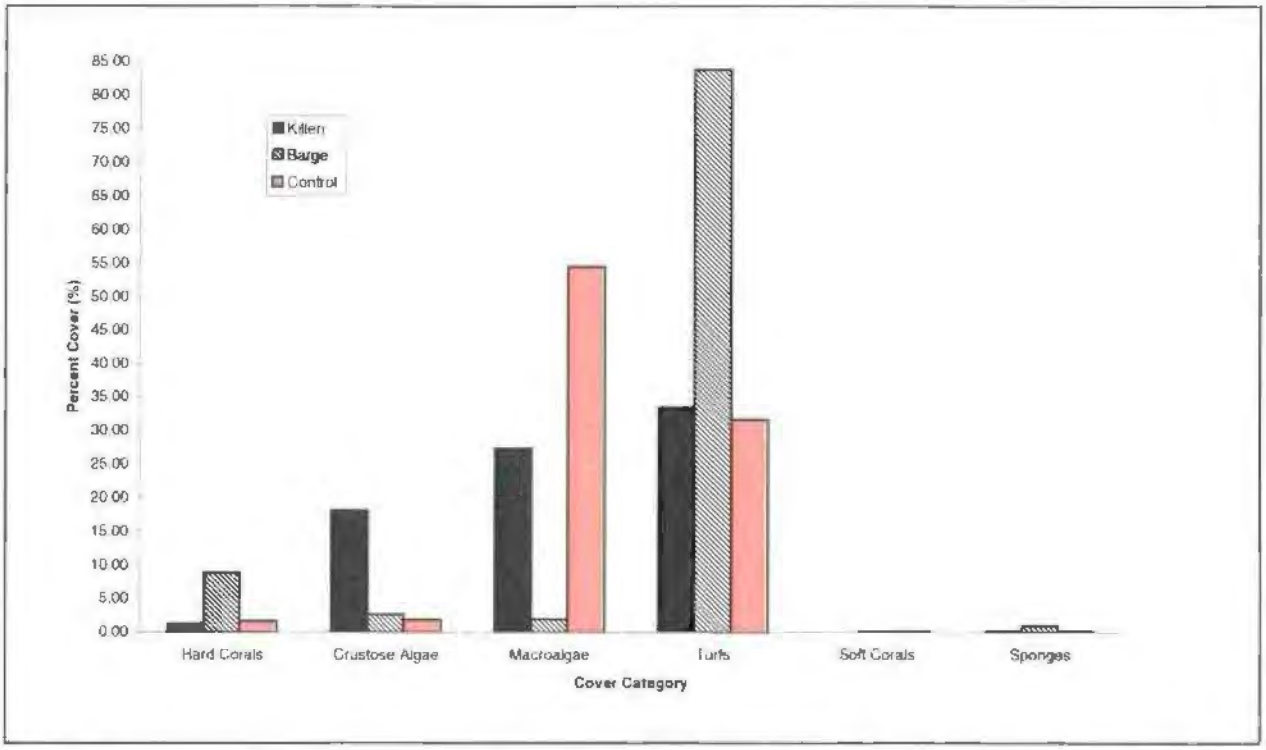

Figure 12. Comparison of live cover categories versus percent cover between study sites

Siderastrea siderea (lesser starlet coral) (barge site), and *Porites porites* (finger coral) (control site) (Table 5; Figure 13). *S. radians* and *S. siderea* favored the wrecks.

Following our research hypothesis that the wrecks had a negative influence on the biota at and around the wrecks, we used the Students t-test (two-tailed, level of significance = 0.05) to test the difference in the coral colony density (col/m^2) between the Killen and control sites as well as between the barge and control sites.

Null Hypothesis: Killen site coral density (col/m^2) was identical to the control site coral density.

Alternative Hypothesis: Killen site coral density was different than the control site coral density.

$t = 0.0456$; v (degrees of freedom) = 33; $t_{0.05(2),33} = 2.035$. Since $t<t_{0.05(2),33}$ we accepted the null hypothesis.

Null Hypothesis: Barge site coral density (col/m^2) was identical to the control site coral density

Alternative Hypothesis: Barge site coral density was different than the control site coral density

$t = 0.7893$; $v = 24$; $t_{0.05(2),24} = 2.064$. Since $t<t_{0.05(2),24}$ we accepted the null hypothesis.

Therefore, we found that the mean coral density did not differ either between the Killen and control sites or between the barge and control sites.

We found that the control site had both the greatest species diversity and evenness (Table 7). Compared to the Killen and barge sites, the control site had a more even distribution of coral species amongst coral colony counts (Figure 13).

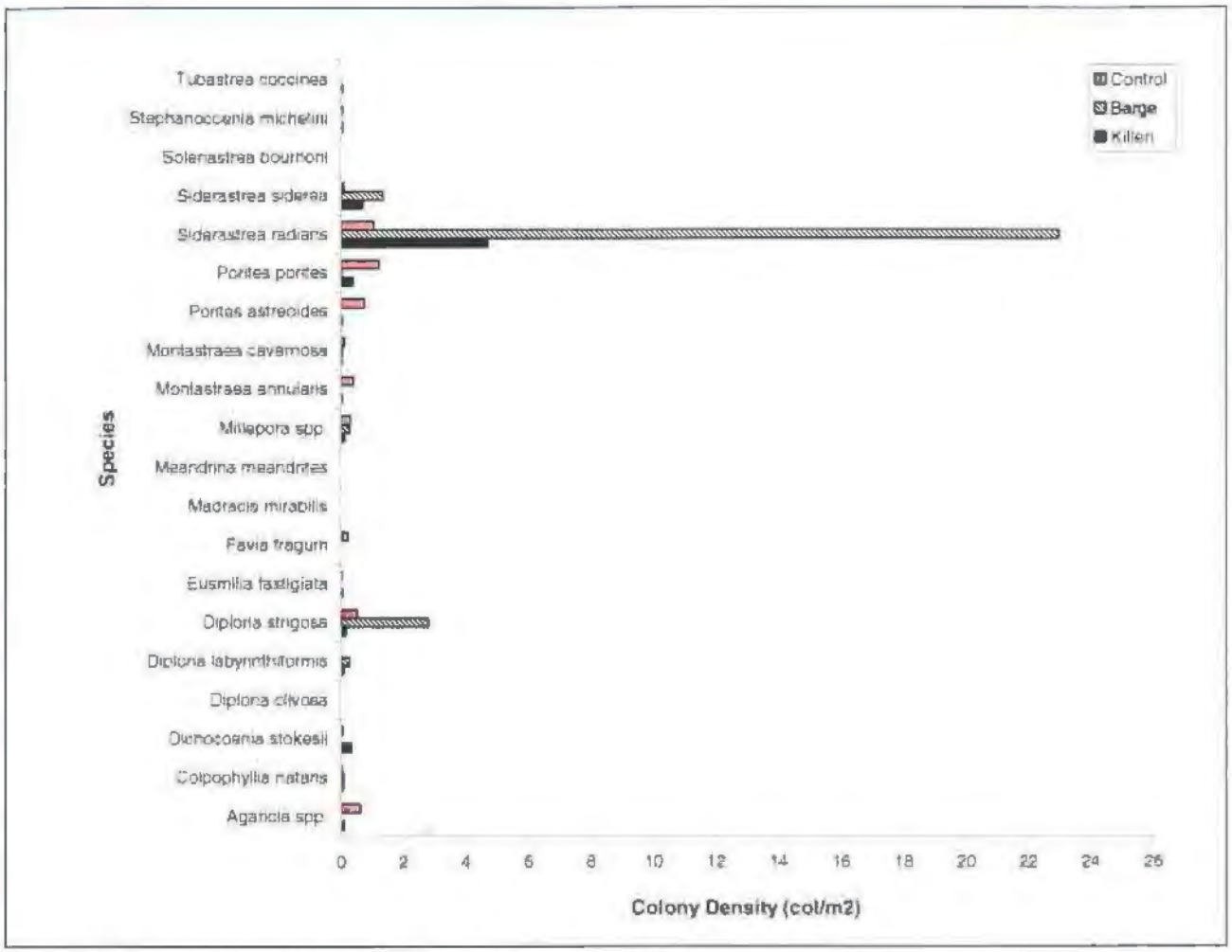

Figure 13. Comparison of coral colony density (col/m^2) between study sites.

Table 7. Coral species diversity and evenness of the study sites

Site	H'	H'$_{max}$	J'
Killen	0.5516	1.2553	0.4394
Barge	0.3802	0.9542	0.3984
Control	0.9387	1.2304	0.7629

To test our research hypothesis that the wrecks had a negative impact on the biota at and surrounding the wrecks, we used the Student's t test (two-tailed, level of significance = 0.05) to examine whether there were significant differences in coral species diversity between the Killen and the control sites or between the barge and the control sites.

Null Hypothesis: Coral diversity at the Killen site was comparable to the coral diversity at the control site

Alternative Hypothesis: Coral diversity at the Killen site was significantly different than the coral diversity at the control site

$t = 0.7912$; v (degrees of freedom) = 8.675; $t_{0.05(2),9} = 2.262$. Since $t<t_{0.05(2),9}$ we accepted H_o.

5.0 DISCUSSION

5.1 DRUMS ON THE WRECKS

A recent broad survey of metals and explosive compounds in fish and shellfish collected at the Killen and barge sites revealed that the 55-gallon drums on the Killen and the barge were and continue to be unlikely sources of contaminants on the surrounding marine biota (ATSDR 2002). No shellfish nor fish collected at the Killen site contained concentrations of metals or explosive compounds that would be a health hazard to humans consuming fish or shellfish captured either at the Killen or the barge site. As discussed below, rather than being used to store hazardous substances, the drums found on the wrecks were most likely used for target stabilization and for reserve buoyancy.

The USS-Killen was one of 175 Fletcher-class destroyers built during World War II. The current condition of the wreckage indicates that the starboard and port sides of the hull have collapsed, falling outward for most of their lengths. The hull has essentially split apart, widening the overall width of the ship. The once vertical portions of the hull have fallen outward and now lie flat on the seafloor. With an original beam of 39.7 ft (12 m), the width of the wreckage is now 71 ft (22 m). The two boilers, which in Fletcher-class destroyers are located below the main deck, are now the highest points on the wreckage above the seafloor. The bow portion of the ship has completely broken up and has collapsed inward. Large parts of the bow have split apart and have fallen or folded over in areas.

The configuration of the Killen as it now lays on the seafloor indicates that it had been modified prior to being sunk as a target. The bulk of above decks superstructure appears to have been removed. The wreckage lacks any artifacts resembling weaponry, indicating that all the ship's armament, including all five of the five-inch gun turrets and the two top-mounted torpedo launchers, had been removed. The missing superstructure includes the two smoke stacks, the conning tower and bridge structure, and all other deck housings (i.e., structures located on the main deck).

A good deal of the steel from the main deck flooring also seems to be missing. From examination of the photomosaic image of the Killen wreckage site, it appears that most of the main decking over the engine and boiler rooms was absent at the time the ship was sunk. In the top-down view of the wreckage, the components of the engineering rooms are clearly visible, and no sign of the main deck plates can be seen. Portions of the main decking from the bow area just forward of the first boiler room may have been in place at the time of sinking, but it is difficult to verify just how much was present. Pieces of decking plates can be seen scattered over the rubble at the bow.

Several components of the ship's engineering rooms (boiler and engine rooms) may also have been removed prior to the Killen's use as a target. Fletcher-class destroyers have four completely sealed engineering rooms: two boiler rooms (fire rooms) with two boilers apiece as well as two engine rooms containing the steam turbines (one per room), reduction gear units (one per room), backup diesel engine (one per ship), and other control equipment and machinery (including generators for the ship's electric power). As the photomosaic image (Figure 5)—illustrates, two boilers from the fore boiler room and both the fore and aft turbines, seem to be missing.

Considering the alterations made to the Killen prior to sinking, the presence of the 55-gallon drums could very likely have been used as ballast to redistribute the weight of the modified target ship. With the amount of superstructure, armament, and heavy engineering components that were missing from the Killen when it was sunk, the added ballast weight may have been necessary to stabilize the target vessel during towing to it's the site and during the time it was a target. The ship's fuel and water storage holds may also have been filled with seawater to provide the ballast needed for stabilization, yet additional weight may have been necessary due to the highly reduced tonnage of the modified configuration of the Killen. Removal of various engineering components may have unbalanced the ship causing it to list to one side or the other. If drums were used for ballast, they were most likely filled with sand or seawater.

A large number of the drums may have been empty and sealed to provide added buoyancy to certain compartments of the target ship. A fully intact enemy warship (which the Killen was presumably

simulating) would have had the ability to tightly seal various compartments and rooms of the vessel when under attack. This prevents the ship from sinking if it were hit. Due to the degree of modification the Killen seems to have undergone prior to sinking, she may have lost the ability to securely seal off her fore, mid, and aft compartments to make them independently watertight. The added air spaces located within the sealed drums may have simulated the ability of an enemy vessel to seal off watertight compartments to slow or indefinitely delay its sinking. A slowed sinking would also have extended the Killen's usefulness as a surface target. The empty sealed drums seem to have been placed in areas of the ship where they could not get loose and float away from the sinking vessel (e.g., in the bow). The destruction of the bow and hull during or since the time of the ship's sinking has left many of these drums exposed.

The other portion of the ship that would have contained empty, buoyant drums would have been the stern section, which is currently missing from the main Killen wreck site and its location is unaccounted for at this time. Upon examination of the dimensions and physical characteristics of the Killen and other Fletcher-class destroyers, the strong possibility arose that the barge may very likely be the missing stern section of the Killen. The wreckage of the Killen as measured on the seafloor is 67 m (220 ft) in length. In contrast, the total stem to stern length of Fletcher-class destroyers is 115 m (376.5 ft). Around 48 m (156 ft) of the ship's length is missing from the wreckage at this site. The aft-most region now seen at the Killen wreck (the southeast end; Figure 5) is a portion of the aft engine room, which on Fletcher-class destroyers is around 34 m (111 ft) short of the stern end of the ship. The barge as measured on the seafloor is 37 m (120 ft) in length. The difference in lengths of the "missing section" and the barge is relatively small (3 m, 9 ft) and can be accounted for by the fact that the aft bulkhead of the Killen engine room is missing (i.e., the aft engine room is not complete) and the open end of the barge has a jagged edge, making exact measurements difficult. Many other characteristics of the barge and the stern section of a Fletcher-class destroyer match up as well, such as the measurements of the beam at the stern of the Killen and the width of the barge, the distance from the gunwale to the bottom of the hull at the stern of a Fletcher-class destroyer, as well as other elements such as distances between various deck features. Furthermore, resting along the southern side of the barge wreck is a long and cylindrical structure resembling a drive shaft, which would be unrelated to a barge. The reason for the separation of the stern from the rest of the Killen is unknown and can only be speculated upon.

5.2 SUBMERGED AQUATIC VEGETATION (SEAGRASS)

Sand aprons (halos) surrounded both the Killen and the barge. Halos of non-vegetated areas are typical around significant reef structures, be they natural or anthropogenic. Halos are natural rather than symptomatic of environmental distress. Herbivorous reef fishes typically graze on SAV located closest to the reef (shelter from predation) causing a barren area (halo in the case of this study) along a reef margin (Randall 1965). This was clearly illustrated by two patch reefs and associated halos located approximately 120 m north of the barge site.

The submerged aquatic vegetation (SAV) surrounding the wrecks did not vary in terms of species composition, frequency of occurrence, species abundance, or species density as a function of distance from the wrecks. Using *T. testudinum* (one of the two most abundant seagrasses), we verified that there were no significant differences between near-field (within 40 m of a wreck) and far-field samples (170 to 200 m away from the wreck). Further, the population characteristics (diversity, abundance, and density) of the SAV at the control site were comparable to what we found around the wrecks. Further, the SAV around the wrecks did not exhibit signs of environmental distress.

5.3 FISHES

At all three study sites (i.e., control, Killen, and barge), the results are quite clear: the coral reef, Killen wreck, and barge wreck all support a much greater diversity and abundance of reef fishes than the surrounding seagrass habitat. Coral reefs are well known for their tremendous species diversity and abundance, not only of reef fishes, but other taxa as well (e.g., invertebrates). This faunal profusion is a function of habitat complexity. Simply put, habitats of low spatial complexity (e.g., seagrass meadows) do not offer the opportunities for niche divergence that habitats of high spatial complexity (e.g., coral reefs) do. The potential for trophic and spatial partitioning is higher in habitats of greater spatial complexity.

A coral reef is one of the best examples of a natural habitat with high spatial complexity. Reef environments, however, are patchily distributed, and there are large areas in tropical regions that are not characterized by coral reefs. When an artificial reef is introduced into an area of relatively low spatial complexity, the diversity and abundance of fishes and other reef organisms increase as animals are attracted to the structure (Bohnsack et al. 1994). Artificial reefs may be deliberate (e.g., sunken concrete structures), accidental (e.g., shipwrecks), or incidental (e.g., oil rigs). The positive effect of artificial reefs on the diversity and abundance of fishes was certainly evident at the Killen and barge study sites.

5.4 CORALS

Despite the fact that the vessels were sunk in the middle of a large seagrass area, they were able to function as productive artificial reefs for coral. Hard coral density (col/m^2) and diversity on the wrecks were not statistically different from what was found at the reef control site. Nevertheless, we observed reef building coral colonies to be significantly larger at the wreck sites. The barge deck supported in excess of 300 massive coral colonies, mostly symmetrical brain corals (*D. strigosa*), grooved brain corals (*D. labyrinthiformis*), and massive starlet corals (*S. siderea*). The photomosiac of the barge clearly shows the abundance of these coral heads (Figure 4). What was not visible in the photomosaic were the ever present lesser starlet coral (*S. radians*) colonies. In addition to the mature coral colonies, there were literally thousands of juvenile corals (mostly *S. radians*) disseminated across the barge deck. The Killen wreck also contained numerous juvenile corals and hemispherical coral heads. These growth and colonization characteristics were definitely absent from the reef control site. The higher abundance of corals on the wrecks suggested that the artificial reef was a more suitable environment for successful coral recruitment and growth. Between the two wrecks, we found 18 of the 29 coral species known to occur at the eastern end of Vieques Island (NSRR 2002). We did not witness obvious signs of massive bleaching, abundant coral diseases, or physical destruction at either study site. Further, there was no evidence of any recent impacts on the wrecks and their coral biota that would have been caused by inner range activities (e.g., physical impacts or ordnance).

Sedimentation, algal cover, and type of substrate all influence the success hard corals have in colonizing a substrate (Bagget and Bright 1985; Sorokin 1995). Compared to the control fringing reef site, the wrecks were advantageous in many ways to hard corals. The wrecks allowed hard corals to settle on three-dimensional substrates well removed from sedimentation by coarse or fine sediments of the bay. Furthermore, the complexity of the Killen wreck in particular offered a tremendous number of locations and total hard substrate area for hard corals to colonize. The higher abundance of fishes (many of which were grazers) on the wrecks than the control site explained in part the lower algal cover on the wrecks. The active grazing of algae by fishes adds to the competitive success of hard corals competing for colonization space. Grazers also impact coral recruits and adult coral colonies. Yet, despite the potentially negative impacts of reef fishes on hard corals, the wrecks (particularly the barge) have supported significant coral growth over time (approximately 30 years since the sinking of the wrecks). Interestingly, flat surfaces of the wrecks (the barge deck and remains of the Killen bow deck) and not the more contorted or perhaps protected parts of the wrecks supported the most impressive coral formations. This went against the accepted notion that coral recruits will develop on the underside of recruitment plates (e.g., terra cotta plates or quarry tiles) and in areas protected from predators (Bagget and Bright 1985; Gleason 1999). One other possible advantage of the three-dimensionality of the wrecks was a local increase of oxygenation induced by the wrecks, acting as barriers to water circulation. As we conducted our work on the wrecks we noted perceptible changes in water current speed in areas where large structures obstructed and consequently accelerated water transport at their edges; the accelerated transport possibly oxygenated the water locally.

The wrecks supported coral populations similar to the reef control site. We accept the null hypothesis that the biota on the wrecks, when compared to the surrounding habitat, was no different than what would be seen in a natural environment. Therefore the analyses of the coral data showed that the wrecks and their contents did not have negative impacts on the coral reef ecosystems developing on the wrecks. Rather, the wrecks acted as productive artificial reef habitats

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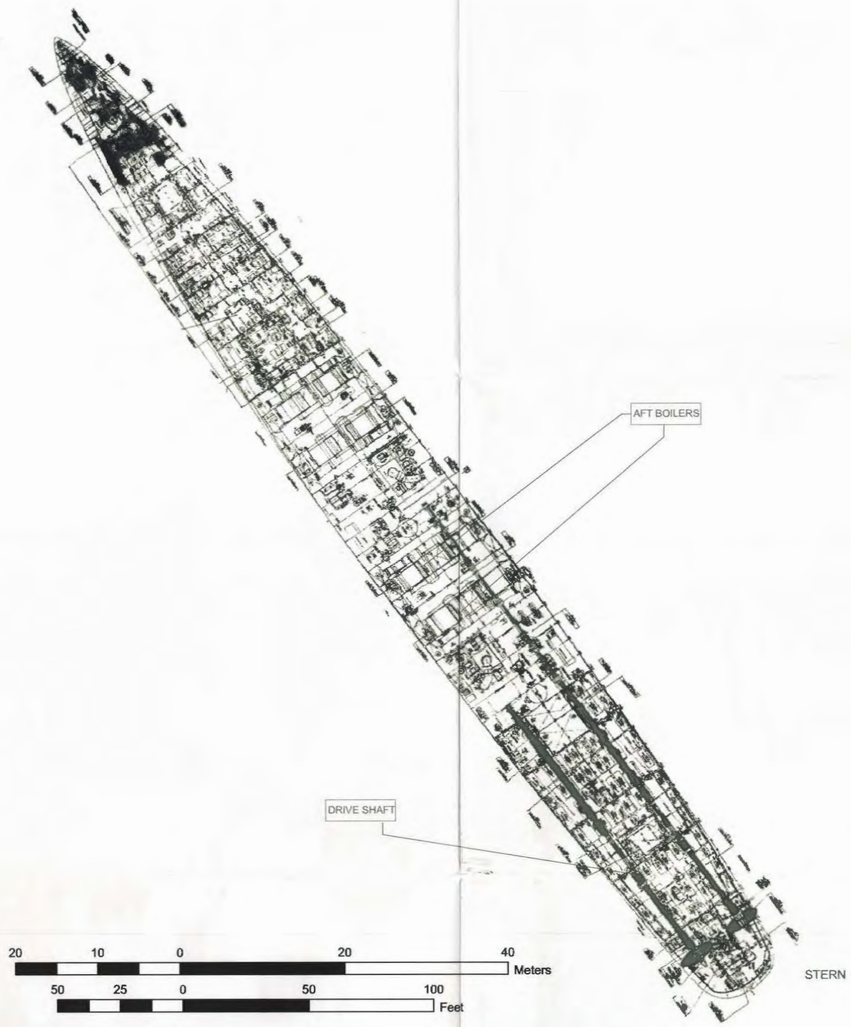
APPENDIX A

MAPS OF THE KILLEN AND BARGE

A



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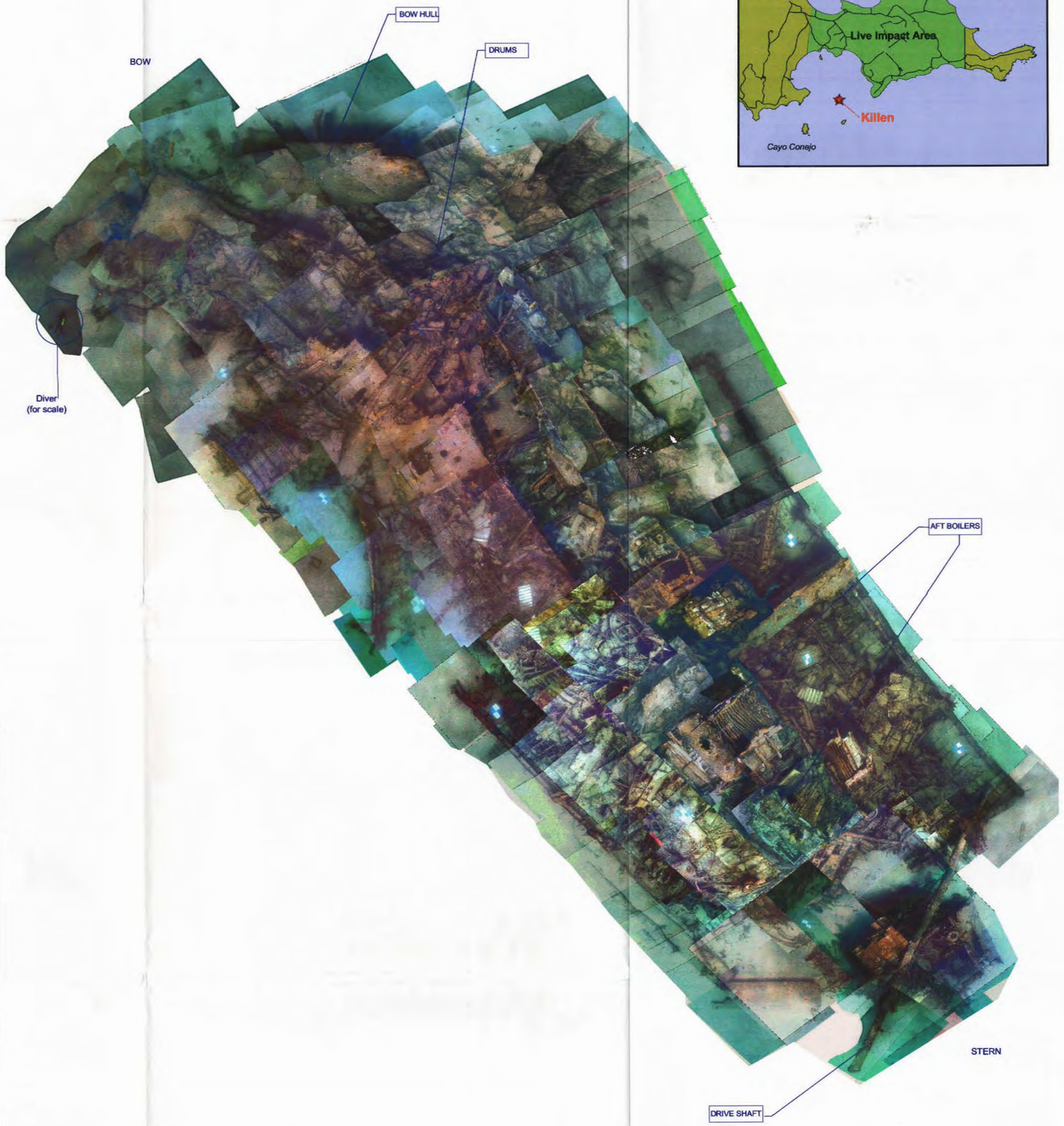

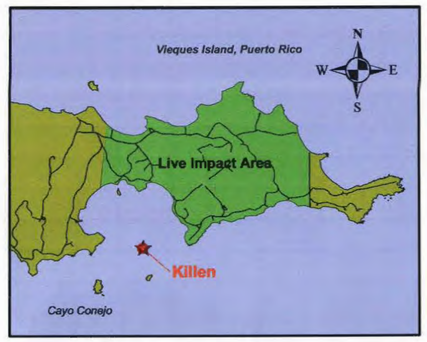

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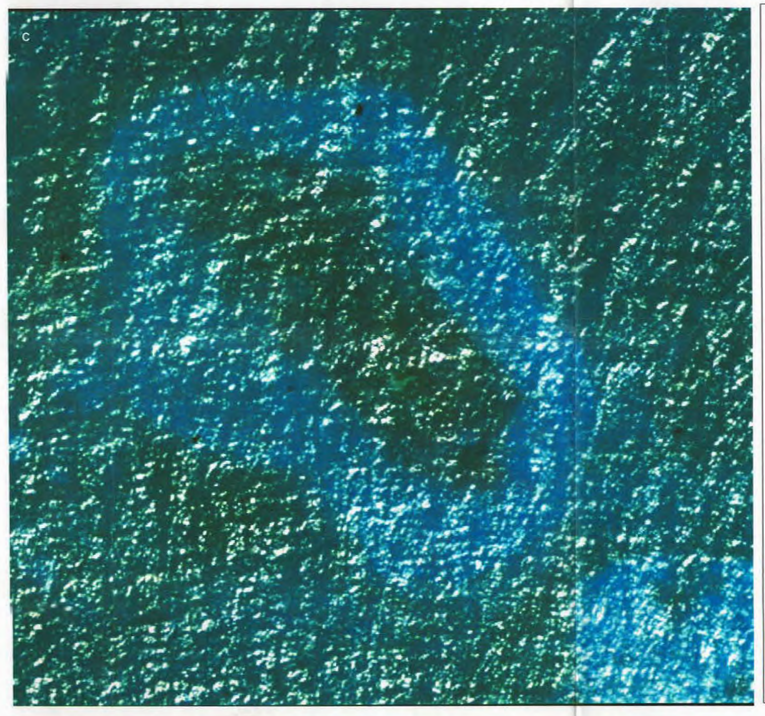


Killen Statistics

Length: 114.75m / 376ft 6

Beam: 12.08m / 39ft 8

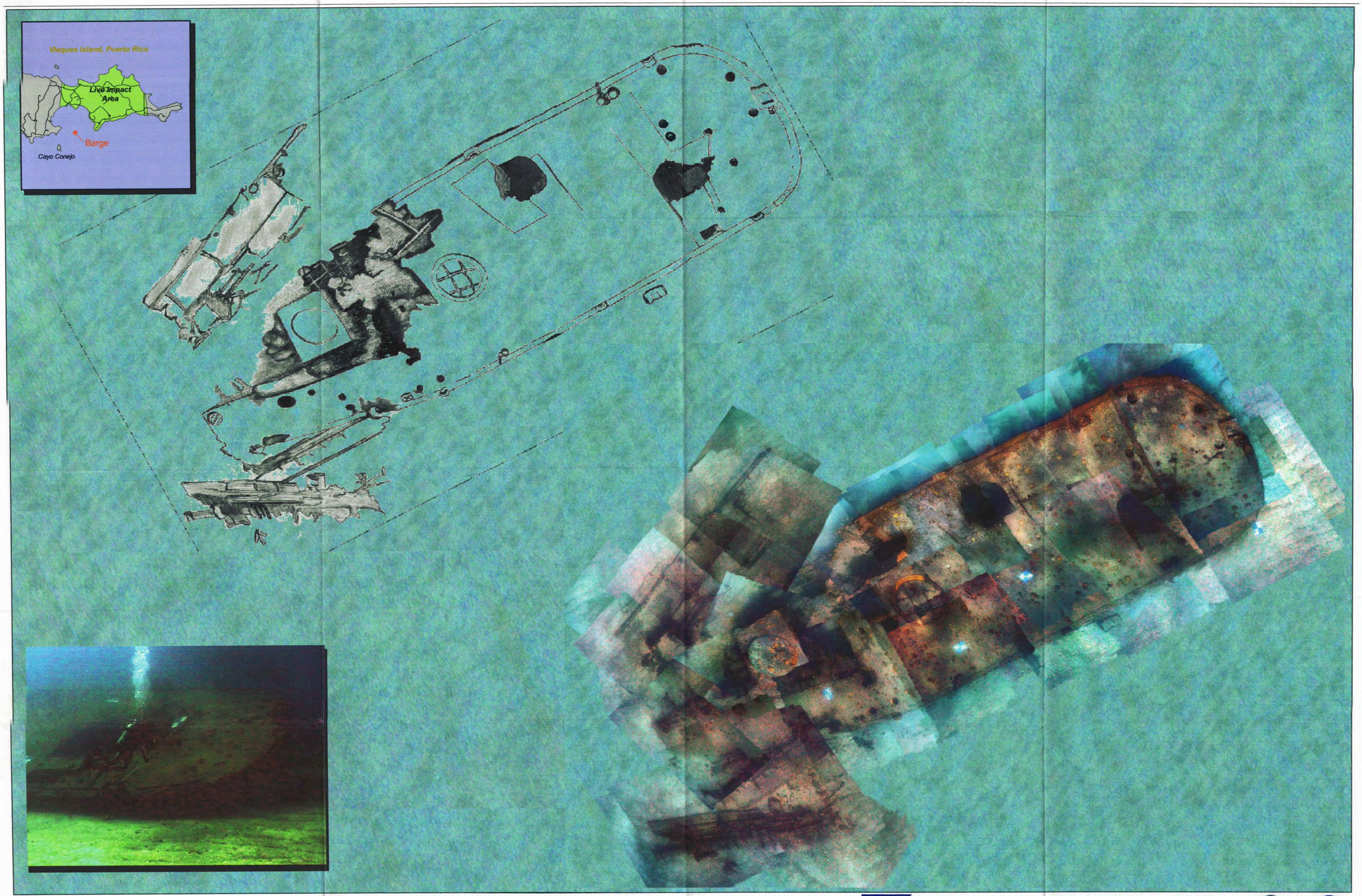
Displacement: 2924 Tons (Full)

Machinery: 60,000 SHP
G E Geared Turbines, 2 screws
Top Speed: 38 Knots
Range: 6500 NM @ 15 Knots

Armament/Equipment (As designed):
Main Guns: 5 5-inch L/38, in single mounts: two forward, superfiring, one in front of after deck house, two aft, superfiring

Laid down by Puget Sound Navy Yard, November 26, 1941.
Decommissioned July 9, 1946.
Stricken June 1, 1963.

(A) Drawing (Department of the Navy 1945), (B) Photomosaic of the Killen sunk as a target in Bahia Salina del Sur, Vieques Island, Puerto Rico, and (C) Aerial view of the Killen wreck location



GMI
GEO-MARINE INCORPORATED

N W E S

1 0.5 0 1 2 3 4 5 6 Meters
3 1.5 0 3 6 9 12 15 18 Feet

Sketch and photomosaic of a barge sunk as target in Bahia Salina del Sur, Vieques Island, Puerto Rico. Data collected in November 2001

APPENDIX B

Seagrass, Fish, and Coral Data

Appendix B. Submerged Aquatic Vegetation: KILLEN TRANSECT K-1

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	Sand				
10 m	HW	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A)
20 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C)
	TT	14/16 = 0.88	3/14 = 0.21	3/16 = 0.19	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
60 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
70 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (C), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
80 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
90 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
110 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
130 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
140 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), U (C)
	TT	2/16 = 0.13	0.5/2 = 0.25	0.5/16 = 0.03	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
180 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
190 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
200 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (R), U (C)
	TT	12/16 = 0.75	4/12 = 0.33	4/16 = 0.25	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: KILLEN TRANSECT K-2

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	Sand				
10 M	SF	11/16 = 0.69	2/11 = 0.18	2/16 = 0.13	
	HW	15/16 = 0.94	3/15 = 0.2	3/16 = 0.19	
20 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	1/16 = 0.06	0.1/1 = 0.1	0.1/16 = 0.01	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P
	TT	16/16 = 1.0	2/16 = 0.13	2/16 = 0.13	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
60 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
70 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
90 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (C), P (C), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
120 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (C), P (C), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
130 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (C), P (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
140 m	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C), U (R)
	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	SF	16/16 = 1.0	3.5/16 = 0.22	3.5/16 = 0.22	
170 m	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	H (C), P (C)
	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
180 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (C), P (C)
	HW	5/16 = 0.31	1/5 = 0.2	1/16 =0.06	
190 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (A)
200 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (A)

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: KILLEN TRANSECT K-3

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	Sand				
10 m	HW	16/16 = 1.0	2/16 = 0.13	2/16 = 0.13	
	SF	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
20 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	TT	16/16 = 1.0	3.5/16 = 0.22	3.5/16 = 0.22	H (R)
30 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
60 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
70 m	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (R), U (R)
	TT	16/16 = 1.0	2/16 = 0.13	2/16 = 0.13	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (C), U (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A), U (C)
	HW	6/16 = 0.38	1/6 = 0.17	1/16 = 0.06	
110 m	TT	14/16 = 0.88	2.5/14 = 0.16	2.5/16 = 0.16	H (A), P (A), U (C)
	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	TT	16/16 = 1.0	2.5/16 = 0.16	2.5/16 = 0.16	
130 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (R), U (R)
	TT	14/16 = 0.88	2/14 = 0.14	2/16 = 0.13	
	HW	4/16 = 0.25	1/4 = 0.25	1/16 = 0.06	
140 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	HW	8/16 = 0.5	2/8 = 0.25	2/16 = 0.13	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (C)
	HW	5/16 = 0.31	0.5/5 = 0.1	0.5/16 = 0.03	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	HW	14/16 = 0.88	1/14 = 0.07	1/16 = 0.06	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (R), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
180 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
190 m	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	HD+, P (T)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	HW	10/16 = 0.63	3/10 = 0.3	3/16 = 0.19	
200 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	HW	4/16 = 0.25	1/4 = 0.25	1/16 = 0.06	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: BARGE TRANSECT B-1

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	SF	12/16 = 0.75	3/12 = 0.25	3/16 = 0.19	
10 m	Sand				
20 m	HW	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
40 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
50 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
60 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	P (C)
70 m	SF	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	H (C)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	P (C)
80 m	SF	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	H (C), P (C), U (R)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
100 m	SF	11/16 = 0.69	3/11 = 0.27	3/16 = 0.19	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
110 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
130 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
140 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	P (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
180 m	SF	14/16 = 0.88	5/14 = 0.36	5/16 = 0.31	H (R), P (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
190 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (R), P (C), U (C)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
200 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (R), P (R), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: BARGE TRANSECT B-2

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	Sand				
10 m	SF	7/16 = 0.44	0.5/7 = 0.07	0.5/16 = 0.03	
20 m	SF	12/16 = 0.75	1/12 = 0.08	1/16 = 0.06	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
60 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
70 m	SF	15/16 = 0.94	3/15 = 0.2	3/16 = 0.19	H (A)
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R)
130 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
140 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (C), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R), P (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
180 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	TT	16/16 = 1.0	3.5/16 = 0.22	3.5/16 = 0.22	H (C), U (C)
190 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
200 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (C), P (A), U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: BARGE TRANSECT B-3

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	SF	15/16 = 0.94	4/15 = 0.27	4/16 = 0.25	
10 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
20 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	P (C)
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
60 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	P (C)
70 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (C)
	TT	14/16 = 0.88	4/14 = 0.29	4/16 = 0.25	
80 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
130 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	U (C)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
140 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	P (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
160 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), U (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
180 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
190 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
200 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: CONTROL TRANSECT C-1

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
10 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
20 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
30 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
60 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
70 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0			H (A), P (A)
	TT	16/16 = 1.0			
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
130 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	HW	8/16 = 0.5	2/8 = 0.25	2/16 = 0.125	
140 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (A)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (R)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
180 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
190 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
200 m	SF	11/16 = 0.69	4/11 = 0.36	4/16 = 0.25	H (A)
	TT	4/16 = 0.25	2/4 = 0.5	2/16 = 0.125	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: CONTROL TRANSECT C-2

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	SF	15/16 = 0.94	3/15 = 0.2	3/16 = 0.19	H (A), P (C)
	TT	8/16 = 0.5	2/8 = 0.25	2/16 = 0.13	
10 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
	HW	2/16 = 0.13	0.5/2 = 0.25	0.5/16 = 0.03	
20 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	HW	2/16 = 0.13	0.5/2 = 0.25	0.5/16 = 0.03	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
50 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
60 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
70 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
90 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
120 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
130 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
140 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
180 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
190 m	SF	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
	HW	6/16 = 0.38	1/6 = 0.17	1/16 = 0.06	
200 m	SF	5/16 = 0.31	1/5 = 0.2	1/16 = 0.06	H (C), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B. Submerged Aquatic Vegetation: CONTROL TRANSECT C-3

SEAGRASS					ALGAE
DISTANCE	SPECIES	FREQUENCY	ABUNDANCE	DENSITY	
5 m	SF	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
10 m	SF	6/16 = 0.38	1/6 = 0 17	1/16 = 0.06	H (C), P (A)
	TT	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
	HW	16/16 = 1.0	3/16 = 0.19	3/16 = 0.19	
20 m	SF	10/16 = 0.63	2/10 = 0.2	2/16 = 0.13	H (C), P (A)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
	HW	15/16 = 0.94	3/15 = 0.2	3/16 = 0.19	
30 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
40 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
50 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
60 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
70 m	SF	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	H (A), P (C)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
80 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	4.5/16 = 0.28	4.5/16 = 0.28	
90 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
100 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
110 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
120 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
130 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A), U (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
140 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (A)
	TT	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	
150 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
160 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C), P (A)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
170 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (A), P (R)
	TT	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	
180 m	SF	16/16 = 1.0	5/16 = 0.31	5/16 = 0.31	H (C)
190 m	SF	16/16 = 1.0	4/16 = 0.25	4/16 = 0.25	H (A), P (A)
	TT	2/16 = 0.13	1/2 = 0.5	1/16 = 0.06	
200 m	SF	14/16 = 0.88	4/14 = 0.29	4/16 = 0.25	H (A), P (R)

SF = *Syringodium filiforme*
TT = *Thallassia testudinum*
HW = *Halodule wrightii*

H = *Halimeda incrassata*
P = *Penicillus capitatus*
U = *Udotea* sp.

A = abundant
C = common
R = rare

Appendix B Fish Transect Data KILLEN TRANSECTS

Killen site	K1-5	K2-5	K3-5	K1-50	K2-50	K3-50	K1-200	K2-200	K3-200	KF1	KF2	KF3	KF4	KF5	Total
Abudefduf saxatilis										4	4	2	8	12	30
Acanthurus bahianus				2			3			2	1	4	1	3	16
Acanthurus coerulus										3	18		18	7	46
Aulostomus maculatus															0
Bodianus rufus										2	10	1	1		14
Canthigaster rostrata											1		1		2
Caranx ruber											1		2	2	5
Chaetodon striatus															0
Chromis cyanea										12				5	17
Chromis multilineata										22	2	22	67	56	169
Clepticus parrae														2	2
Cryptotomus roseus															0
Epinephelus cruentatus														1	1
Epinephelus guttatus															0
Equetus acuminatus															0
Fistularia tabacaria															0
Gerres cinereus														3	3
Gnatholepis thompsoni															0
Gobiosoma evelynae										1					1
Gymnothorax moringa											1				1
Haemulon aurolineatum														2	2
Haemulon chrysargyreum										1	11	1	5	1	19
Haemulon flavolineatum													1		1
Haemulon plumieri										1			7		8
Haemulon sciurus										10		15	15	7	47
Haemulon sp.							1								1
Halichoeres bivittatus	4	2	1	1			1	1	7	2		1			20
Halichoeres garnoti															0
Halichoeres maculipinna															0
Halichoeres radiatus															0
Hemipternotus novacula		1							1						2
Holocentrus adscensionis										1	2	1	1	1	6
Hypoplectrus unicolor													1		1
Kyphosus sp.											50	20			70
Lutjanus apodus										3	3		1		7
Lutjanus griseus										20	2	5	2		29
Lutjanus sp.															0
Malacanthus plumieri						1									1
Malacoctenus triangulatus															0
Microspathodon chrysurus											2		1		3
Mulloidichthys martinicus										10				2	12
Myripristis jacobus															0
Ocyurus chrysurus	1							2						1	4
Ophioblennius atlanticus										1	1	1			3
Priacanthus cruentatus															0
Pseudupeneus maculatus										1			3	11	15
Scarus taeniopterus										1	1		2		4
Scomberomorus regalis															0
Serranus tigrinus															0
Sparisoma atomarium	3						3	2	2						10
Sparisoma aurofrenatum															0
Sparisoma radians		1	2				1		3						7
Sparisoma sp.															0
Sparisoma viride										4	3	2		3	12
Sphyraena barracuda															0
Stegastes diencaeus										3	2		5	1	11
Stegastes fuscus												1			1
Stegastes leucostictus															0
Stegastes partitus										4		3	8	2	17
Stegastes variabilis											1	1	1	1	4
Synodus intermedius															0
Thalassoma bifasciatum										10	43	46	18	5	122
Total	8	4	3	3	0	1	9	5	13	118	159	126	169	128	746

Appendix B Fish Transect Data: BARGE TRANSECTS

Barge site	B1-5	B2-5	B3-5	B1-50	B2-50	B3-50	B1-200	B2-200	B3-200	BF1	Total
Abudefduf saxatilis										6	6
Acanthurus bahianus			3		2	4				5	14
Acanthurus coerulus											0
Aulostomus maculatus					1						1
Bodianus rufus										4	4
Canthigaster rostrata						2		1		5	8
Caranx ruber	1										1
Chaetodon striatus											0
Chromis cyanea											0
Chromis multilineata										50	50
Clepticus parrae											0
Cryptotomus roseus							1				1
Epinephelus cruentatus						1				1	2
Epinephelus guttatus											0
Equetus acuminatus						1					1
Fistularia tabacaria									1		1
Gerres cinereus											0
Gnatholepis thompsoni										10	10
Gobiosoma evelynae											0
Gymnothorax moringa											0
Haemulon aurolineatum										25	25
Haemulon chrysargyreum											0
Haemulon flavolineatum											0
Haemulon plumieri											0
Haemulon sciurus										50	50
Haemulon sp.					12	5					17
Halichoeres bivittatus	2				7	7	4	4	2		26
Halichoeres garnoti			1								1
Halichoeres maculipinna				1						1	2
Halichoeres radiatus										1	1
Hemipteromotus novacula											0
Holocentrus adscensionis					1					2	3
Hypoplectrus unicolor											0
Kyphosus sp.											0
Lutjanus apodus										6	6
Lutjanus griseus										10	10
Lutjanus sp.											0
Malacanthus plumieri						2					2
Malacoctenus triangulatus										1	1
Microspathodon chrysurus											0
Mulloidichthys martinicus											0
Myripristis jacobus						1					1
Ocyurus chrysurus	1				3						4
Ophioblennius atlanticus											0
Priacanthus cruentatus											0
Pseudupeneus maculatus	2	48						3	5	6	64
Scarus taeniopterus											0
Scomberomorus regalis								1			1
Serranus tigrinus						1					1
Sparisoma atomarium		12			45	2	2				61
Sparisoma aurofrenatum											0
Sparisoma radians					5	2	7	4	6		24
Sparisoma sp.	2		3								5
Sparisoma viride					1						1
Sphyraena barracuda										1	1
Stegastes diencaeus											0
Stegastes fuscus											0
Stegastes leucostictus										4	4
Stegastes partitus										3	3
Stegastes variabilis											0
Synodus intermedius										1	1
Thalassoma bifasciatum										25	25
Total	8	60	7	1	77	28	14	13	14	217	439

Appendix B. Fish Transect Data: CONTROL TRANSECTS

Control site	C1-5	C2-5	C3-5	C1-50	C2-50	C3-50	C1-200	C2-200	C3-200	CF1	CF2	CF3	CF4	CF5	Total
Abudefduf saxatilis															0
Acanthurus bahianus										2	2	2	3		9
Acanthurus coerulus										3	1			3	7
Aulostomus maculatus															0
Bodianus rufus															0
Canthigaster rostrata													1		1
Caranx ruber															0
Chaetodon striatus													1		1
Chromis cyanea															0
Chromis multilineata															0
Clepticus parrae															0
Cryptotomus roseus											3	1	1	1	6
Epinephelus cruentatus															0
Epinephelus guttatus											1				1
Equetus acuminatus															0
Fistularia tabacaria															0
Gerres cinereus															0
Gnatholepis thompsoni															0
Gobiosoma evelynae												1			1
Gymnothorax moringa															0
Haemulon aurolineatum															0
Haemulon chrysargyreum										2					2
Haemulon flavolineatum										3					3
Haemulon plumieri															0
Haemulon sciurus										12					12
Haemulon sp.															0
Halichoeres bivittatus							1			2	2		10	1	16
Halichoeres garnoti															0
Halichoeres maculipinna										1	1		6	1	9
Halichoeres radiatus															0
Hemipternotus novacula															0
Holocentrus adscensionis										2			2	1	5
Hypoplectrus unicolor															0
Kyphosus sp.															0
Lutjanus apodus												1			1
Lutjanus griseus															0
Lutjanus sp.					1										1
Malacanthus plumieri															0
Malacoctenus triangulatus										1					1
Microspathodon chrysurus															0
Mulloidichthys martinicus										9					9
Myripristis jacobus										1				1	2
Ocyurus chrysurus	1			1	1		1	3	1	10					18
Ophioblennius atlanticus															0
Priacanthus cruentatus										4		2		1	7
Pseudupeneus maculatus								2		1		15	1	3	22
Scarus taeniopterus										3		2			5
Scomberomorus regalis															0
Serranus tigrinus															0
Sparisoma atomarium					1			1							2
Sparisoma aurofrenatum							1								1
Sparisoma radians				1						3					4
Sparisoma sp.										1					1
Sparisoma viride														1	1
Sphyraena barracuda							1								1
Stegastes diencaeus												2			2
Stegastes fuscus										6	8	3	6	13	36
Stegastes leucostictus										2	4	3	1	3	13
Stegastes partitus										1		1	1		3
Stegastes variabilis											2		5	3	10
Synodus intermedius															0
Thalassoma bifasciatum										11	2	5	5	4	27
Total	1	0	0	2	3	0	4	6	1	80	26	38	43	36	240

Killen-Coral KC1	Colony Count																												
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total	col/m^2
Agaricia spp.			1				2																				1	4	0.15
Colpophyllia natans																												0	0.00
Dichocoenia stokesii		1	2				1																					4	0.15
Diploria clivosa																												0	0.00
Diploria labyrinthiformis	1				1		1	1																1				5	0.19
Diploria strigosa																					1						3	4	0.15
Eusmilia fastigiata																												0	0.00
Favia fragum																												0	0.00
Madracis mirabilis																												0	0.00
Millepora spp.																								1			2	3	0.11
Montastraea annularis																												0	0.00
Montastraea cavernosa																												0	0.00
Porites astreoides																											3	3	0.11
Porites porites								1										2	1									4	0.15
Siderastrea radians			8	4	16	10	9	18		1									4	43	50		1	2		4		170	6.30
Siderastrea siderea			5	2	1		1	1	1										1	4							1	17	0.63
Solenastrea bournoni																												0	0.00
Stephanocoenia michelini																					2							2	0.07
Tubastrea coccinea																1	1											2	0.07
Diadema antillarum																												0	0.00
Soft Corals																												0	0.00

Category	Cover																											Mean Cover	StDev
Crustose Algae	6	6	3	0	3	5	4	10	11	4	8	11	20	28	10	3	17	17	19	4	12	0	12	12	10	1	18	18.8	14.0
Diadema antillarum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	1	0	2	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	4	1.2	2.3
Macroalgae	19	13	17	11	7	13	20	14	16	8	14	13	5	5	9	2	3	3	6	2	3	20	15	16	25	16	5	22.2	13.0
No Data	15	19	15	16	17	17	15	8	3	27	16	21	16	10	11	26	27	19	14	8	13	11	11	7	7	11	10	28.9	12.2
Sediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.6
Turfs	8	11	13	22	23	15	10	15	20	11	12	5	9	7	20	19	3	11	11	32	21	19	12	15	8	22	13	28.7	13.1
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Killen-Coral KC2	Colony Count																													
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total	col/m^2
Agaricia spp.																					1	2							3	0.11
Colpophyllia natans																													0	0.00
Dichocoenia stokesii																								1	2				3	0.11
Diploria clivosa																													0	0.00
Diploria labyrinthiformis																													0	0.00
Diploria strigosa				1																									1	0.04
Eusmilia fastigiata																					2								2	0.07
Favia fragum																													0	0.00
Madracis mirabilis																													0	0.00
Millepora spp.			1				1						1								4								7	0.26
Montastraea annularis																													0	0.00
Montastraea cavernosa															1														1	0.04
Porites astreoides																													0	0.00
Porites porites										1		1		1						1			1				1		6	0.22
Siderastrea radians		2					7	8				4		3	1	3	2	2			1	2		8	11	21	1		76	2.81
Siderastrea siderea			2	1			2	1	1		1	2				1	1	2				2		3	2	1			22	0.81
Solenastrea bournoni																													0	0.00
Stephanocoenia michelini																					2								2	0.07
Tubastrea coccinea																													0	0.00
Diadema antillarum																													0	0.00
Soft Corals																													0	0.00

Category	Cover																												Mean Cover	StDev
Crustose Algae		8	11	18	7	6	5	5	8	5	2	17	13	25	21	10	11	9	23	5	9	12	4	10	5	2	2	6	19.2	12.7
Diadema antillarum		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals		0	3	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	2	0	0	0	0	0	1	0	0.8	1.6
Macroalgae		25	13	10	15	16	32	21	9	31	30	16	23	16	18	19	23	6	6	33	25	20	29	16	18	22	22	10	38.8	15.4
No Data		12	3	5	18	6	3	8	15	5	8	7	9	3	6	0	7	6	10	8	13	15	6	7	23	12	12	8	17.4	10.1
Sediment		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges		0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.3	0.9
Turfs		5	18	16	10	22	10	16	17	9	8	10	5	6	5	21	9	28	11	3	1	3	11	17	4	14	12	26	23.5	14.3
Total		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: KILLEN KC3

Killen-Coral KC3	Colony Count																														
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Total	col/m^2
Agaricia spp.													1										3							4	0.15
Colpophyllia natans					1	1							1																	3	0.11
Dichocoenia stokesii			1				1				1																	1	1	5	0.19
Diploria clivosa																														0	0.00
Diploria labyrinthiformis																												2		2	0.07
Diploria strigosa			2																				1	1					1	5	0.19
Eusmilia fastigiata																														0	0.00
Favia fragum																														0	0.00
Madracis mirabilis																														0	0.00
Meandrina meandrites									1																					1	0.04
Millepora spp.																								1						1	0.04
Montastraea annularis																													1	1	0.04
Montastraea cavernosa																														0	0.00
Porites astreoides			1																											1	0.04
Porites porites						1	2			1		3					1	1				1	2	1						13	0.48
Siderastrea radians				1						1			2	3			1	1			1	3		1		4		2		20	0.74
Siderastrea siderea			1		3					2			2	2	1		1				1	2	2		1				1	19	0.70
Solenastrea bournoni																														0	0.00
Stephanocoenia michelini																							1		1					2	0.07
Tubastrea coccinea																														0	0.00
Diadema antillarum																														0	0.00
Soft Corals																														0	0.00

Category	Cover																													Mean Cover	StDev
Crustose Algae				9	4	9	15	5	3	11	28	21	13	17	17	4	10	25	19	5	2	8	15	9	3	2	0	1	5	20.0	15.3
Diadema antillarum				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals				1	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	4	1	1.0	2.2
Macroalgae				26	25	22	8	22	37	22	12	15	27	23	22	20	23	14	12	12	24	23	18	4	15	5	0	4	11	34.3	17.4
No Data				5	2	9	15	15	4	7	9	13	8	5	4	5	0	2	19	10	0	8	12	30	24	26	45	36	11	24.9	22.7
Sediment				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs				9	19	10	12	8	5	10	1	1	2	5	7	21	14	9	0	23	24	8	5	7	8	17	5	5	22	19.8	14.2
Total				50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Killen-Coral KC4	Colony Count																																			
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Total	col/m²
Agaricia spp.																	1																			1	0.03
Colpophyllia natans																									1											1	0.03
Dichocoenia stokesii									1		1									1					3	2	1		2			1				12	0.36
Diploria clivosa																																				0	0.00
Diploria labyrinthiformis			1																		1				1									1		4	0.12
Diploria strigosa			2																1					3	1	1										8	0.24
Eusmilia fastigiata			1		1																											1				3	0.09
Favia fragum																																				0	0.00
Madracis mirabilis																																				0	0.00
Millepora spp.											1											2											2			5	0.15
Montastraea annularis			1	1																									1							3	0.09
Montastraea cavernosa					1																			1												2	0.06
Porites astreoides																																				0	0.00
Porites porites			1		2			1	2	2	1	1	1	1		2						1				1		1		3		2				22	0.67
Siderastrea radians			1		12	2	2	17			4	7	3							1	1	2			3	3	24	50	10	9	15	8	10	12	48	244	7.39
Siderastrea siderea			1					4			1	2				1							1				3	3	2	1				1		20	0.61
Solenastrea hyades										1																										1	0.03
Stephanocoenia michelini																																				0	0.00
Tubastrea coccinea																																				0	0.00
Diadema antillarum																																				0	0.00
Soft Corals																																				0	0.00
Category	Cover																																			Mean Cover	StDev
Crustose Algae	0	0	5	0	8	9	18	10	17	15	3	6	8	4	4	31	24	13	5	0	16	10	21	5	2	6	10	5	8	7	1	1	0	2	12	16.3	14.9
Diadema antillarum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	0	1	2	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1	2	2	0	1	1	2	0	0	1	1	0	0	1.3	1.4
Macroalgae	3	10	10	12	17	23	7	17	22	18	10	7	17	27	21	10	13	7	3	5	4	5	0	1	3	7	1	9	13	19	7	4	16	10	4	20.7	14.1
No Data	27	20	14	15	8	4	6	10	6	6	5	4	8	2	11	5	7	3	1	5	7	2	3	21	4	8	4	5	8	3	5	4	5	9	1	14.6	11.6
Sediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0.2	1.1
Turfs	20	19	19	22	17	13	19	13	4	11	31	33	17	16	14	4	6	27	41	39	22	32	25	21	39	29	34	30	19	20	34	40	28	29	33	46.9	20.3
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Killen-Coral KC5	Colony Count																																		
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**Total**	**col/m²**
***Agaricia* spp.**																																		0	0.00
Colpophyllia natans				1		1	1									1		1																5	0.15
Dichocoenia stokesii																			2		6	6	1	1	1	4	1	4		1				27	0.82
Diploria clivosa																																		0	0.00
Diploria labyrinthiformis	1		1	1																													1	4	0.12
Diploria strigosa						1				1					1														1	1			1	6	0.18
Eusmilia fastigiata																																		0	0.00
Favia fragum																		1																1	0.03
Madracis mirabilis																																		0	0.00
***Millepora* spp.**														1																				1	0.03
Montastraea annularis																																		0	0.00
Montastraea cavernosa																																		0	0.00
Porites astreoides																																		0	0.00
Porites porites	1					1	1	1					2	1		1	1			1														10	0.30
Siderastrea radians	10	3	4	6	18	9	17	8	7					1	1		1	2	16	14		1	1	2		7	7	9	24	4	19	7	8	206	6.24
Siderastrea siderea			1	1				1	2	4	2	2	4												2	2				1				22	0.67
Solenastrea bournoni																													1					1	0.03
Stephanocoenia michelini					1																													1	0.03
Tubastrea coccinea																																		0	0.00
Diadema antillarum																																		0	0.00
Soft Corals																																		0	0.00

Category	Cover																																	Mean Cover	StDev
Crustose Algae	3	0	7	16	8	7	15	17	14	13	7	16	6	10	24	11	16	9	11	1	7	1	1	0	5	10	11	6	12	5	0	2	10	17.0	11.8
Diadema antillarum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	1	0	1	1	1	1	3	1	0	1	2	3	2	0	1	4	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	2	1	1.8	2.1
Macroalgae	14	8	6	4	16	9	7	5	3	6	13	7	9	16	15	18	13	12	9	15	16	18	11	19	13	16	9	9	12	11	6	1	6	21.3	9.5
No Data	6	0	6	5	1	5	0	0	3	0	0	2	0	4	3	7	4	2	5	2	4	0	2	1	0	0	13	11	4	14	16	34	28	11.0	15.7
Sediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0.2	0.6
Turfs	26	42	30	24	24	28	25	27	30	30	28	22	33	20	7	10	17	25	24	32	23	31	36	30	31	24	17	24	22	19	27	11	4	48.7	16.2
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: BARGE BC1

Barge-Coral BC1	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m^2**
Colpophyllia natans									1	1	2	0.29
Diploria clivosa											0	0.00
Diploria labyrinthiformis											0	0.00
Diploria strigosa	3			1				1	1		6	0.86
***Millepora* spp.**											0	0.00
Montastraea annularis											0	0.00
Montastraea cavernosa											0	0.00
Porites porites											0	0.00
***S. radians* (bleached)**					1	3	4	1	0	16	25	3.57
Siderastrea radians	5	2	5	3	4	6	23	7	36	25	116	16.57
Siderastrea siderea	4	1	2	2	3	4	1	2	1	3	23	3.29
Soft Coral											0	0.00
Category	**Cover**										**Mean Cover**	**StDev**
Crustose Algae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	13	1	1	6	2	3	0	6	7	6	9.0	7.8
Macroalgae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
No Data	0	0	0	0	0	0	1	0	0	0	0.2	0.6
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	37	49	49	44	48	47	49	44	43	44	90.8	7.6
Total	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: BARGE BC2

Barge-Coral BC2	Colony Count											
Coral Species	1	2	3	4	5	6	7	8	9	10	Total	col/m^2
Colpophyllia natans			1			1					2	0.29
Diploria clivosa											0	0.00
Diploria labyrinthiformis											0	0.00
Diploria strigosa	3	2	4	1	3	5	2	2	3	3	28	4.00
Millepora spp.											0	0.00
Montastraea annularis											0	0.00
Montastraea cavernosa											0	0.00
Porites porites	1										1	0.14
S. radians (bleached)	16	15	6	9	11	5	12	5	8		87	12.43
Siderastrea radians	56	41	16	31	23	24	50	30	27	9	307	43.86
Siderastrea siderea	1	4	5	2	1	2	3		1	4	23	3.29
Soft Coral											0	0.00
	Cover											
Category											Mean Cover	StDev
Crustose Algae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	9	11	6	9	7	13	4	2	7	8	15.2	6.4
Macroalgae	7	0	0	0	3	0	0	1	1	0	2.4	4.5
No Data	0	0	0	5	3	0	0	0	0	0	1.6	3.5
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	34	39	44	36	37	37	46	47	42	42	80.8	8.9
Total	50	50	50	50	50	50	50	50	50	50	100	

Barge-Coral BC3	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m²**
Colpophyllia natans											0	0.00
Diploria clivosa											0	0.00
Diploria labyrinthiformis	1									1	2	0.29
Diploria strigosa	1		1	2	5	3	1	1	2	3	19	2.71
***Millepora* spp.**											0	0.00
Montastraea annularis											0	0.00
Montastraea cavernosa											0	0.00
Porites porites											0	0.00
***S. radians* (bleached)**	2	11	3	3	1		9	4	5	1	39	5.57
Siderastrea radians	20	47	24	14	5	9	18	19	30	16	202	28.86
Siderastrea siderea							1	2	1	4	8	1.14
Soft Coral											0	0.00
Category	**Cover**										**Mean Cover**	**StDev**
Crustose Algae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	4	4	3	7	3	2	5	0	2	7	7.4	4.4
Macroalgae	0	0	0	0	0	1	0	0	0	0	0.2	0.6
No Data	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	46	46	47	43	47	47	45	50	48	43	92.4	4.3
Total	50	50	50	50	50	50	50	50	50	50	100	

Barge-Coral BC4	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m^2**
Colpophyllia natans											0	0.00
Diploria clivosa											0	0.00
Diploria labyrinthiformis		1				1		3		1	6	0.86
Diploria strigosa	1	2	7	2	5	3	4	4	3	5	36	5.14
***Millepora* spp.**											0	0.00
Montastraea annularis											0	0.00
Montastraea cavernosa									1		1	0.14
Porites porites											0	0.00
***S. radians* (bleached)**	1	4	3	12	1	2	3	2		3	31	4.43
Siderastrea radians	2	22	7	18	6	16	9	20	1	13	114	16.29
Siderastrea siderea							1			4	5	0.71
Soft Coral											0	0.00
Category	**Cover**										**Mean Cover**	**StDev**
Crustose Algae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Hard Corals	6	4	3	2	11	4	5	5	2	3	9.0	5.3
Macroalgae	6	0	0	0	0	0	0	0	0	0	1.2	3.8
No Data	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	38	46	47	48	39	46	45	45	48	47	89.8	7.1
Total	50	50	50	50	50	50	50	50	50	50	100	

Barge-Coral BC5	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m^2**
Colpophyllia natans											0	0.00
Diploria clivosa											0	0.00
Diploria labyrinthiformis											0	0.00
Diploria strigosa	5	1	2	3				2			13	1.86
***Millepora* spp.**		3	5	1							9	1.29
Montastraea annularis											0	0.00
Montastraea cavernosa											0	0.00
Porites porites											0	0.00
***S. radians* (bleached)**	6				1				2	1	10	1.43
Siderastrea radians	12	9	6	5	2	3	8	14	10	12	81	11.57
Siderastrea siderea				1					1	1	3	0.43
Soft Coral											0	0.00
Category	**Cover**										**Mean Cover**	**StDev**
Crustose Algae	0	0	0	0	0	4	3	5	0	0	2.4	4.0
Hard Corals	6	1	0	5	0	0	0	4	0	1	3.4	4.7
Macroalgae	0	0	0	3	22	0	1	1	0	0	5.4	13.7
No Data	0	0	0	0	9	0	0	1	0	0	2.0	5.7
Sediment	0	0	0	0	0	0	6	0	0	0	1.2	3.8
Soft Corals	1	0	0	0	0	0	0	0	0	0	0.2	0.6
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	43	49	50	42	19	46	40	39	50	49	85.4	18.6
Total	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Trasnect Data: BARGE BC6

Barge-Coral BC6	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m^2**
Colpophyllia natans											0	0.00
Diploria clivosa											0	0.00
Diploria labyrinthiformis	2	1						2			5	0.71
Diploria strigosa	4	1	2	1	3	3	2	3	2	1	22	3.14
***Millepora* spp.**									1	1	2	0.29
Montastraea annularis											0	0.00
Montastraea cavernosa						1					1	0.14
Porites porites											0	0.00
***S. radians* (bleached)**	10	1	5	2	8	3	7		3	2	41	5.86
Siderastrea radians	22	18	22	10	25	17	31	13	7	23	188	26.86
Siderastrea siderea	2	1	1					2	5		11	1.57
Soft Coral											0	0.00
	Cover											
Category											**Mean Cover**	**StDev**
Crustose Algae	0	0	0	0	0	0	0	0	10	3	2.6	6.4
Hard Corals	9	6	0	2	0	11	1	7	4	3	8.6	7.7
Macroalgae	0	0	0	0	0	0	0	0	0	0	0.0	0.0
No Data	0	0	0	0	0	0	0	0	1	1	0.4	0.8
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Turfs	41	44	50	48	50	39	49	43	35	43	88.4	10.1
Total	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: BARGE BC7

Barge-Coral BC7	Colony Count											
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**col/m^2**
Colpophyllia natans											0	0.00
Diploria clivosa											0	0.00
Diploria labyrinthiformis											0	0.00
Diploria strigosa	3	1	1	1	1		1		1	4	13	1.86
***Millepora* spp.**				1	2						3	0.43
Montastraea annularis											0	0.00
Montastraea cavernosa											0	0.00
Porites porites											0	0.00
***S. radians* (bleached)**	1	1	1	1	1	2			3	1	11	1.57
Siderastrea radians	1	14	14	12	19	25	6	4	10	13	118	16.86
Siderastrea siderea		1	1								2	0.29
Soft Coral											0	0.00
	Cover											
Category											**Mean Cover**	**StDev**
Crustose Algae	5	2	0	2	0	0	0	13	9	0	6.2	9.1
Hard Corals	5	2	4	0	4	1	4	0	2	7	5.8	4.6
Macroalgae	4	0	0	0	0	0	0	0	0	0	0.8	2.5
No Data	2	7	2	0	0	1	0	5	0	0	3.4	4.9
Sediment	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	2	7	1	0	2	0	5	0	3.4	4.9
Turfs	34	39	42	41	45	48	44	32	34	43	80.4	10.7
Total	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: BARGE BC8

Barge-Coral BC8	Colony Count											
Coral Species	1	2	3	4	5	6	7	8	9	10	Total	col/m^2
Colpophyllia natans											0	0.00
Diploria clivosa							1				1	0.14
Diploria labyrinthiformis											0	0.00
Diploria strigosa	4		1	2	3	2	1	1		3	17	2.43
Millepora spp.											0	0.00
Montastraea annularis											0	0.00
Montastraea cavernosa	1										1	0.14
Porites porites											0	0.00
S. radians (bleached)			4	3	9	2				2	20	2.86
Siderastrea radians	7	6	17	20	36	15	1	3	4	9	118	16.86
Siderastrea siderea	1			2	3	2	1			2	11	1.57
Soft Coral											0	0.00
	Cover											
Category											Mean Cover	StDev
Crustose Algae	0	0	5	15	1	9	8	7	2	3	10.0	9.6
Hard Corals	4	1	1	21	15	8	6	0	0	6	12.4	13.9
Macroalgae	0	0	0	0	0	2	6	5	13	0	5.2	8.6
No Data	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sediment	0	0	0	0	0	0	4	9	4	13	6.0	9.2
Soft Corals	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	3	0	6	2	0	3	2	5	3	4.8	4.1
Turfs	46	46	44	8	32	31	23	27	26	25	61.6	23.9
Total	50	50	50	50	50	50	50	50	50	50	100	

Control-Coral CC1	Colony Count																															
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**Total**	**col/m²**
***Agaricia* spp.**		2	3					1		1	1		1		2	1		3									1		3		19	0.63
Colpophyllia natans																															0	0.00
Dichocoenia stokesii																															0	0.00
Diploria clivosa												1																			1	0.03
Diploria strigosa				1	1	1	1		2	3				1		3	2	3						1	1						20	0.67
Eusmilia fastigiata																											1				1	0.03
Favia fragum							1				1																				2	0.07
Madracis mirabilis					1																										1	0.03
***Millepora* spp.**											1	1	3														1		1		7	0.23
Montastraea annularis	1	2	2				1								1						2	6	7			1	2	3	5	3	36	1.20
Montastraea cavernosa				1										1								1		1							4	0.13
Porites astreoides	1		1		1					1	1		1	1	2		1			2	1		2	3	1			3	3	1	26	0.87
Porites porites		1		1			1			3	1		3	1		1	2	1	1	1				2	1	2					22	0.73
Siderastrea radians									1		1					3	6	1	2				1	2	2		1	2			22	0.73
Siderastrea siderea																										1	1	1			3	0.10
Solenastrea bournoni																												1	1		2	0.07
Stephanocoenia michelini	1			1																											2	0.07
Diadema antillarum				1	1		2	2	2		1			1		2		1													13	0.43
Soft Corals		1																													1	0.03

Category	Cover																														Mean Cover	StDev
Crustose Algae	0	5	7	5	8	2	1	3	7	2	3	3	0	0	1	4	0	0	1	0	0	0	0	0	1	0	0	0	0	3	3.7	4.9
Diadema antillarum	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.6
Hard Corals	0	0	3	0	2	0	3	0	0	1	0	1	1	0	1	2	1	0	0	0	3	9	4	3	0	0	2	6	6	13	4.1	6.1
Macroalgae	34	35	38	35	28	31	24	32	23	22	26	24	22	29	27	8	19	27	17	32	31	20	28	24	22	26	23	20	22	16	51.0	13.0
No Data	6	1	1	4	6	4	5	2	0	6	8	1	3	8	4	3	2	3	8	2	0	2	6	5	5	8	0	2	5	5	7.7	5.0
Sediment	10	9	1	3	3	7	4	0	0	0	0	0	2	0	0	1	0	3	2	2	5	1	1	5	5	0	4	5	2	2	5.1	5.5
Soft Corals	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0.5	1.8
Sponges	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Turfs	0	0	0	0	2	6	12	13	19	19	13	20	22	13	17	32	28	17	22	14	11	18	11	13	17	16	21	13	15	11	27.7	16.0
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: CONTROL CC2

Control-Coral CC2	Colony Count																															
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**Total**	**col/m²**
***Agaricia* spp.**			1					1					1	2	1		1				2		1							5	15	0.50
Colpophyllia natans																										1					1	0.03
Dichocoenia stokesii															2							1									3	0.10
Diploria clivosa																															0	0.00
Diploria strigosa						1		1									1		2	1	2	2	1	1		1	1	1		1	16	0.53
Eusmilia fastigiata																			1												1	0.03
Favia fragum			1								1				1		2		1	1	1				1				1	1	11	0.37
Madracis mirabilis																															0	0.00
***Millepora* spp.**		2	1	1	1	1	1		1		1	1		2	1		1				1				1		1			1	18	0.60
Montastraea annularis																															0	0.00
Montastraea cavernosa															1				1												2	0.07
Porites astreoides				2			1				1	1			2	1		1			2	1	1	1				5		3	22	0.73
Porites porites				2	2	1	1	1	2	1				4		3	3	1	7	1	2	5	3	8			1	1	5	5	59	1.97
Siderastrea radians						2	2						1	1			4	2	2	1	1	3	2	1	4	1	2	3	1		33	1.10
Siderastrea siderea																										1					1	0.03
Solenastrea bournoni																															0	0.00
Stephanocoenia michelini																															0	0.00
Diadema antillarum	4	1			1			1			1		1								1								3	3	16	0.53
Soft Corals			1	1												1						1	1		1					1	7	0.23

Category	Cover																														Mean Cover	StDev
Crustose Algae	7	11	3	5	0	6	3	1	4	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.1	5.5
Diadema antillarum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0.4
Hard Corals	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	3	0	0	0	0	0	0	0.5	1.3
Macroalgae	34	22	29	6	17	35	35	31	32	25	38	31	28	32	22	14	30	37	29	25	26	25	30	22	17	25	28	27	9	8	51.3	16.8
No Data	3	2	4	2	5	3	4	4	3	3	2	2	7	5	4	7	4	3	3	1	2	7	3	5	4	1	5	5	1	3	7.1	3.4
Sediment	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2	2	0	0	0	0	1	1	5	2	1.3	2.3
Soft Corals	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0.5
Sponges	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Turfs	6	13	11	37	28	6	8	14	10	21	5	15	15	13	23	29	14	10	17	21	20	15	16	20	29	24	16	17	35	35	36.2	17.5
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	48	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: CONTROL CC3

Control-Coral CC3	Colony Count																															
Coral Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**Total**	**col/m^2**
***Agaricia* spp.**		1	3	3	1		2	3	1	1		1				2	3		1	1				1		1	1	1			27	0.90
Colpophyllia natans												1																			1	0.03
Dichocoenia stokesii			1																												1	0.03
Diploria clivosa																															0	0.00
Diploria strigosa	2	1	1			3	1			1	1	4	2		2				1					1							20	0.67
Eusmilia fastigiata																				1											1	0.03
Favia fragum							1			3		1									1										6	0.20
Madracis mirabilis																															0	0.00
***Millepora* spp.**				1	1	2			1	1									1												7	0.23
Montastraea annularis	2	2		2	1	1												1			1		1	1	2	1		1			16	0.53
Montastraea cavernosa								1	1				1	1										1	1						6	0.20
Porites astreoides							1		2	1	1		2	2	2				2	2	1		1	1	1		2	1	1	1	24	0.80
Porites porites					4	2	1	4		2	2			1		1			2	1	1	1			3	2	1		2	3	33	1.10
Siderastrea radians	3	1	1	2	2		1	2		1	3			1	2			1		1	1		1		2	1		1	3	1	31	1.03
Siderastrea siderea		1	6																								1				8	0.27
Solenastrea bournoni																															0	0.00
Stephanocoenia michelini																															0	0.00
Diadema antillarum	3	3	2																												8	0.27
Soft Corals	1	2					2	1	1															1							8	0.27
Category	**Cover**																														**Mean Cover**	**StDev**
Crustose Algae	0	0	0	1	0	3	0	1	1	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	1.4
Diadema antillarum	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	1.8
Hard Corals	0	0	2	2	1	2	1	0	0	0	0	0	0	1	3	0	0	0	0	1	1	0	0	6	1	1	0	0	3	2	1.8	2.7
Macroalgae	21	19	25	21	30	23	30	34	25	16	34	32	31	33	32	32	36	41	37	34	36	32	36	32	40	39	37	22	15	8	58.9	16.3
No Data	4	2	0	6	6	7	3	2	4	6	0	4	4	3	4	3	6	3	7	4	5	2	4	2	5	0	0	3	3	5	7.1	4.0
Sediment	2	0	0	0	3	1	2	4	1	4	0	1	0	2	0	0	1	1	0	0	0	0	1	0	1	0	4	9	20	20	5.1	10.2
Soft Corals	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Sponges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0.2	1.1
Turfs	18	27	23	20	10	14	14	9	19	24	16	12	15	11	9	15	7	5	6	8	8	16	9	10	3	10	9	16	9	15	25.8	11.6
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Control-Coral CC4	Colony Count																														
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Total	col/m^2
Agaricia spp.								2	1	5	1			1					1							1	1			13	0.45
Colpophyllia natans									1																					1	0.03
Dichocoenia stokesii																														0	0.00
Diploria clivosa																														0	0.00
Diploria strigosa						1			1								2		1	2		1			1					9	0.31
Eusmilia fastigiata																														0	0.00
Favia fragum							3			1					1															5	0.17
Madracis mirabilis																														0	0.00
Millepora spp.				4																	1							1		6	0.21
Montastraea annularis									1	1							2							1						5	0.17
Montastraea cavernosa																1														1	0.03
Porites astreoides	1	1							2			1	1					1			1	1						1	2	12	0.41
Porites porites	1	1	1		5	1	5	1		4	1	1	1		2	1	4	1	1	3	1	1	1	1	1	1	3	1	1	45	1.55
Siderastrea radians						1				1		2	2	1		1	2	8	1	1	1	1	1	3	5	2				33	1.14
Siderastrea siderea									1																					1	0.03
Solenastrea bournoni																														0	0.00
Stephanocoenia michelini																														0	0.00
Diadema antillarum					1	1	2		1	2																				7	0.24
Soft Corals																					1				1					2	0.07

Category	Cover																													Mean Cover	StDev
Crustose Algae	0	0	0	3	3	0	1	5	2	6	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1.6	3.1
Diadema antillarum	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	1.9
Hard Corals	0	1	0	1	0	1	0	1	0	2	1	0	0	0	0	0	0	2	2	2	0	0	0	0	1	0	2	0	0	1.1	1.6
Macroalgae	21	33	38	28	29	25	18	23	24	31	22	20	43	23	31	23	26	30	29	37	33	32	32	28	32	35	27	32	36	58.0	11.8
No Data	7	3	2	6	3	4	3	5	4	2	5	3	3	4	3	4	3	3	3	1	3	2	5	8	2	3	4	2	3	7.1	3.1
Sediment	1	1	0	0	0	0	0	0	0	0	0	4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	1.6
Soft Corals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.5
Turfs	21	11	10	12	14	20	23	16	20	9	22	23	4	22	14	22	21	15	16	10	14	16	13	14	15	11	17	16	11	31.2	9.8
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Appendix B. Coral Transect Data: CONTROL CC5

Control-Coral CC5	Colony Count																															
Coral Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total	col/m^2
Agaricia spp.	1	1	1	1			1	5	3	1			1	2			1										1				19	0.63
Colpophyllia natans																															0	0.00
Dichocoenia stokesii									1									2												1	4	0.13
Diploria clivosa																															0	0.00
Diploria strigosa	2			1	1		1	1	1		1							1	1												10	0.33
Eusmilia fastigiata																															0	0.00
Favia fragum					1		1	1	1		1									1									1		7	0.23
Madracis mirabilis																															0	0.00
Millepora spp.						1		1					1	1														1			5	0.17
Montastraea annularis					1																										1	0.03
Montastraea cavernosa				1	1			1																							3	0.10
Porites astreoides		2			2		2	1	2	1	1	1					1	2							1		2	4	2	1	25	0.83
Porites porites	1	3	5	2		3			1	1	1	1		1	1					1							1				22	0.73
Siderastrea radians	1	2			2	1		2			2	2		1	1	5	1		3	2			1	3	1	2	1	1	1		35	1.17
Siderastrea siderea																															0	0.00
Solenastrea bournoni																															0	0.00
Stephanocoenia michelini									1																						1	0.03
Diadema antillarum							2	3			1	1																			7	0.23
Soft Corals			1							1	2										1	1									6	0.20

Category	Cover																														Mean Cover	StDev
Crustose Algae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Diadema antillarum	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Hard Corals	0	0	0	1	0	1	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0.6	1.1
Macroalgae	35	38	35	32	39	30	24	14	20	26	22	34	23	19	24	32	27	23	32	33	20	29	26	19	19	6	15	34	30	39	53.3	16.1
No Data	7	1	5	4	4	1	7	6	10	4	4	1	5	5	5	3	5	4	4	1	4	5	0	3	2	4	4	3	4	2	7.8	4.2
Sediment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	4	1	0	0	0	2	4	1	0	0	0	0	1.3	3.0
Soft Corals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
Sponges	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0.1	0.5
Turfs	8	11	10	12	7	18	16	28	20	20	23	15	22	25	21	15	12	21	9	15	26	16	24	26	25	39	28	13	16	9	36.7	14.8
Total	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	100	

Supporting the participation of the United States in the International Coral Reef Initiative and as a member of the U. S. Coral Reef Task Force, The Department of Defense is advancing coral reef conservation by developing management policies for coral reef ecosystems held in trust by the Military Services throughout the world.

The Department of Defense continues to demonstrate its commitment to coral reef ecosystem protection and overall environmental stewardship by funding projects and programs that could reduce impacts on coral reefs in the future. The study "Ex-USS Killen Site Investigation and Biological Characterization, Vieques Island, Naval Station Roosevelt Roads, Puerto Rico," is an example of a research initiative that the Military Services have completed.