Fish Monitoring on the *Spiegel Grove* Artificial Reef
Summary Report – Year 1 (April 2002 – June 2003)

Prepared by the Reef Environmental Education Foundation (REEF)
January 2005

Background

The *Spiegel Grove* is a 510' Navy Landing Ship Dock that was intentionally sunk off Key Largo, Florida, on June 10, 2002, to serve as a recreational diving and fishing artificial reef (Figure 1). The ship lies on its side in 130' of water; at its broadest point the deck is 84' wide, creating a wall-like habitat from 45' to the sandy bottom. At the time of its sinking, the *Spiegel Grove* was the largest vessel intentionally sunk. Monroe County, the Upper Keys Artificial Reef Foundation (UKARF) and the Florida Keys National Marine Sanctuary (FKNMS) worked closely to obtain, clean, scuttle and sink the vessel, as well as raise funds for the effort. Prior to the sinking, the Reef Environmental Education Foundation (REEF) was contracted by Monroe County to conduct pre- and post-deployment monitoring on the fish assemblages of the *Spiegel Grove* and adjacent reef for a period of 5 years. This document summarizes the first year of REEF data, and includes information from 1 pre-deployment effort in April 2002 and 6 post-deployment efforts between July 2002 and June 2003.

The Reef Environmental Education Foundation (REEF) is a 501 (c)(3) non-profit organization that focuses on the collection of fish diversity and relative abundance data by utilizing volunteer divers trained in visual identification of local species. REEF's programs are in place throughout the tropical western Atlantic, all of coastal North and Central America, the Galapagos Islands, and the Hawaiian Islands. REEF's database currently contains over 80,000 individual fish surveys and is the largest database of fish sightings in the world. Summary data reports are available online at www.reef.org. REEF is headquartered in Key Largo, Florida.

It is anticipated that with the sinking of the *Spiegel Grove*, a change in fish community structure on the sinking site and potentially on nearby reefs will take place. REEF has implemented a monitoring plan that will document fish species presence/absence, sighting frequency, and estimated abundance over time at the *Spiegel Grove* site and at 7 nearby natural and artificial reef sites. The primary goal of the monitoring is to document fish recruitment to the Spiegel Grove site as well as detect significant changes within the 7 reference sites. In addition, comparisons between sites will be conducted to potentially detect correlations in patterns between sites.

Method and Sampling Design

Surveys were conducted using the Roving Diver Technique (RDT; Schmitt and Sullivan 1996). The RDT is a non-point visual survey method specifically designed to generate a comprehensive species list along with sighting frequency and relative abundance estimates. During RDT surveys, divers swim freely throughout a dive site and record every observed fish species. At the conclusion of each survey, divers assign each

recorded species one of four $\log_{10}$ abundance categories [single (1); few (2-10), many (11-100), and abundant (>100)]. Following the dive, each surveyor records the species data along with survey time, depth, temperature, and other environmental information on a REEF scansheet. The scansheets are returned to REEF, and the data are loaded into the REEF database.

Once entered into the REEF database, summary data are displayed on the Internet (http://www.reef.org) by geographic location, including a complete species list, sighting frequency of each species, and density score for each species, where

Sighting Frequency (%SF) = number of surveys reporting species / total number of surveys at that site, and

Density Score = $[(n_S x1)+(n_F x2)+(n_M x3)+(n_A x4)] / (n_S + n_F + n_M + n_A)$, where n is the number of times each abundance category was assigned).

The RDT method does not include size estimates and therefore documenting changes in size structure will not be possible from this dataset. It is recommended that this study be conducted as a complement to other monitoring studies.

The survey team is made up of six REEF Advanced Assessment Team (AAT) members. The AAT are REEF surveyors who have achieved a level 4 or 5 experience level (Expert rating) and have considerable experience and expertise in surveying local fish populations. Eight sites are surveyed, including the *Spiegel Grove* sinking site, 6 adjacent natural reefs and 1 artificial reef (Table 1). Surveying was conducted once prior to deployment in April 2002. Post-deployment monitoring will be conducted monthly for the first three months, quarterly for the following three quarters and bi-annually thereafter for 4 years. This scheme represents a total of 7 monitoring efforts in Year 1.

Site Descriptions

The location of the *Spiegel Grove* site is a barren, level sand bottom with a depth of approximately 130'. The 7 comparison sites were selected by FKNMS staff and represent a broad range of nearby natural and artificial structure. The closest structure to this site is a small patch of rocky substrate located approximately $2/10^{th}$ of a mile from the sinking location in a depth of approximately 125' (called Rocks next to *Spiegel Grove*). The nearest substantial reef structures are the natural reef edges at Dixie Ledge and the Red Can Ledges, approximately $4/10^{th}$ of a mile shoreward of the sinking site. These reefs are sloping drop-offs and feature low profile hardbottom with sparse coverings of small corals and sponges. Approximately $7/10^{th}$ of a mile inshore from the sinking site are Dixie Shoals and the Red Can Shallows. These two hardbottom areas are of moderate rugosity with low profile structure and moderate coral cover. Dixie Shoals Shallows and the Red Can Shallows represent the nearest shallow water coral reef communities to the sinking site. More than one mile to the south lies the wreck of the Norwegian freighter, the *Benwood*. This is the closest artificial reef to the *Spiegel Grove* sinking site and harbors a large diversity and abundance of fishes.

Results and Discussion

Between 4 and 6 RDT surveys were conducted at each site during each monitoring period (however, weather prevented effort at two sites throughout the project period) (Table 2). The number of fish species reported at each site during each survey time is shown in Table 3. The *Benwood* wreck had the highest overall species richness during the study period with 179 species and the Rocks by the *Spiegel Grove* was the lowest with 95 species reported.

The fish fauna of the *Spiegel Grove* increased over time (Table 3), with 46 species documented on the wreck less than a month after it was sunk to an average of 62 species on each of the subsequent monitoring events. The pre-deployment survey at the *Spiegel Grove* site (prior to the sinking) was conducted in the general vicinity of the actual location of the wreck, and included a wider area than just the barren sand where the ship eventually landed. The majority of the 26 species documented during that first survey were seen in and around the rocks scattered in the area as well as a few pelagic species.

The persistence in species presence (e.g. which species were seen during each monitoring event), as measured by the Jaccard Coefficient, varied among the sites (Table 4). The highest changeover in species seen from one monitoring event to the next was at the Rocks by the *Spiegel Grove* and the *Spiegel Grove*, with J' values of 0.50 and 0.41, respectively (indicating a mean overlap of 50% and 41% in species present from one time period to the next). The fish residents at the remainder of the natural reefs and the *Benwood* wreck were considerably more persistent over time, ranging in value of 0.59 to 0.70. In order to evaluate the persistence in species composition (species presence and abundance), Spearman Similarity Coefficient values were calculated based on the rank abundance scores of species seen in at least 90% of surveys at each site (Table 5). The similarity in species composition was again lowest for the Rocks by the *Spiegel Grove* and the *Spiegel Grove*. The Spearman Coefficient value for the Benwood Ledge was more in line with those of the other natural sites (as opposed to the site's relatively low Jaccard Coefficient of 0.59), indicating a high persistence in the presence and abundance of the more common species as well as the tendency to see a wide variety of rare species during surveys there.

In order to compare the species composition of the *Spiegel Grove* to the other sites, Spearman Coefficients were calculated for each of the monitoring time pairs between each site and the *Spiegel Grove* using the rank abundance scores of species seen in at least 90% of surveys at each site. Interestingly, the species composition of the *Spiegel Grove* was least similar to that of the *Benwood* Wreck, with a Spearman Similarity Coefficient of 0.19. This is likely due to the fact that this well-established wreck (sunk in 1942) supports a high number of species and is in shallow water surrounded by productive reef and seagrass habitat. The species composition of the *Spiegel Grove* appears to becoming similar to that of the deeper, natural reefs such as Dixie Ledge and Red Can Ledges.

Conclusion

In summary, the Reef Environmental Education Foundation (REEF) has been monitoring the fish assemblages of the *Spiegel Grove* and 7 nearby natural and artificial reefs in Key Largo, Florida, since the ship was intentionally sunk in the Spring of 2002. In the 12 months following deployment, fishes began to take residence on the *Spiegel Grove*. The total number of species present has increased over time, with 46 species documented on the wreck less than a month after it was sunk to an average of 62 species on each of the subsequent monitoring events, and a total of 123 species were documented during the report period (April 2002 and June 2003). The persistence in species presence on the wreck was relatively low between monitoring events, with a mean overlap of 41% in species present from one event to the next. The fish residents at most of the comparison sites were considerably more persistent over time, ranging between 59% and 70% similarity between events. The species composition of the *Spiegel Grove* appears to becoming similar to that of the deeper, natural reefs such as Dixie Ledge and Red Can Ledges, and is least similar to that of the nearby *Benwood* Wreck, a well-established wreck (sunk in 1942) that supports a high number of species and is in shallow water surrounded by productive reef and seagrass habitat. REEF will continue monitoring the *Spiegel Grove* and comparison sites through 2007.

Table 1. Monitoring sites.

Site (surveying depth in feet)	Latitude / Longitude
Benwood Ledge (60-100')	25 03.155 N / 80 19.970 W
Benwood Wreck (30')	25 03.160 N / 80 20.020 W
Dixie Ledge (60-100')	25 04.213 N / 80 18.971 W
Dixie Shoals (20')	25 04.145 N / 80 19.315 W
Red Can Ledge (60-100')	25 04.308 N / 80 18.909 W
Red Can Shallows (25')	25 04.610 N / 80 18.935 W
Rocks next to *Spiegel Grove* (125')	25 04.180' N / 80 18.730 W
Spiegel Grove (130')	25 04.000 N / 80 18.650 W

Table 2. Survey effort.

	Pre-Deploy, April 2002	July 2002	August 2002	September 2002	December 2002	March 2003	June 2003
Benwood Ledge	4	6	6	6	5	0	6
Benwood Wreck	5	6	6	6	6	5	6
Dixie Ledge	6	6	6	6	6	6	6
Dixie Shoals	4	6	6	6	6	6	6
Red Can Ledge	6	6	6	6	4	6	6
Red Can Shallows	5	6	6	6	4	6	6
Rocks by *Spiegel Grove*	5	6	6	6	0	6	6
Spiegel Grove	5	6	6	6	5	6	6

Table 3. Fish species richness.

	Pre-Deploy, April 2002	July 2002	August 2002	September 2002	December 2002	March 2003	June 2003	Total
Benwood Ledge	54	82	85	78	66		91	**136**
Benwood Wreck	111	111	116	115	118	107	124	**179**
Dixie Ledge	86	88	88	81	71	74	78	**142**
Dixie Shoals	77	105	107	109	108	106	104	**157**
Red Can Ledges	84	78	89	90	66	81	97	**150**
Red Can Shallows	79	113	102	105	74	93	109	**166**
Rocks by *Spiegel Grove*	49	42	21	47		51	53	**95**
Spiegel Grove	26	46	64	61	58	62	63	**123**

Table 4. Similarity in species present among monitoring events, measured by percent overlap in species present. Values given are mean Jaccard Coefficient values for monitoring times 1-6 (pre-deployment monitoring not included).

Site	J'
Benwood Ledge	0.59
Benwood Wreck	0.70
Dixie Ledge	0.61
Dixie Shoals	0.68
Red Can Ledges	0.61
Red Can Shallows	0.59
Rocks by *Spiegel Grove*	0.41
Spiegel Grove	0.50

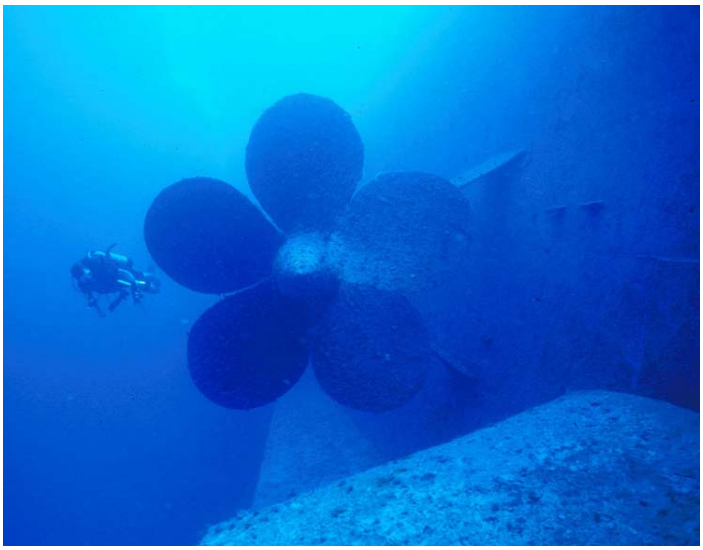
Table 5. Similarity in species composition among monitoring events, measured by Spearman correlation. Values given are mean Spearman Coefficient values for monitoring times 1-6 (pre-deployment monitoring not included), based on rank abundance scores. Species seen in at least 90% of surveys at each site were included in the analysis.

Site	Mean Spearman Coefficient
Benwood Ledge	0.73
Benwood Wreck	0.82
Dixie Ledge	0.77
Dixie Shoals	0.69
Red Can Ledges	0.72
Red Can Shallows	0.63
Rocks by *Spiegel Grove*	0.52
Spiegel Grove	0.56

Table 6. Similarity in species composition between the *Spiegel Grove* and the reference sites. Values are mean Spearman similarity coefficients for monitoring times 1-6 (pre-deployment monitoring not included), based on rank abundance scores. Species seen in at least 90% of surveys at each site were included in the analysis.

Site	Mean Spearman Coefficient
Benwood Ledge	0.62
Benwood Wreck	0.19
Dixie Ledge	0.73
Dixie Shoals	0.64
Red Can Ledges	0.71
Red Can Shallows	0.40
Rocks by *Spiegel Grove*	0.40

Figure 1a. The *Spiegel* Grove during its service years. Photo courtesy of the US Naval Institute, photo #90125.



Figures 1b and 1c. Divers exploring the *Spiegel Grove*. July 2002