National Fish and Wildlife Foundation

Final Programmatic Report

Project Name and Number: Reef Saving Mooring Buoy System Management (FL) #2007-0083-002

Recipient Organization: Broward County Natural Resources Planning and Management Division

Recipient Organization Web Address: www.broward.org

Date Submitted: April 8, 2009

1) Summary of Accomplishments

This project resulted in the addition of twenty-one new buoys to the Broward County mooring buoy system. The new buoys were installed at Suzanne's Ledge, also known as Pompano Drop-Off North, with assistance from the Ocean Watch Foundation and Vone Research, Inc., local non-profit environmental organizations dedicated to protecting South Florida's coral reefs. Volunteers donated 663 hours of their time to assemble, install, and monitor the new mooring buoys. Broward County produced and distributed a new mooring buoy educational brochure. The new brochure provides simple instructions on how to use the buoys properly and shows the locations of the mooring buoys in Broward County. In addition, the grant assisted Broward County in maintaining the mooring buoy system for one year.

2) Project Activities and Results

The project's logic framework is shown in Table 1.

Broward County worked in partnership with the Ocean Watch Foundation, Vone Research, Inc, and with volunteers from local dive clubs and businesses for the majority of the activities associated with this grant. At the beginning of the project in January and February 2008, volunteers assisted in studying boater use patterns of the mooring buoy system (Figure 1). Observations were made regarding the size of vessels using the buoys, the type of activities being undertaken (fishing, diving, or other), and whether the vessels were moored properly. A vessel was considered to be moored properly when an additional line was used from the boat to tie off to the mooring buoy. The results of these surveys indicated high use of the buoys at Barracuda Reef, The Caves, Oakland Ridges, Hall of Fame and Pompano Drop-Off; moderate use of the buoys at Anglin's Ledge, and little to no use of the buoys located at the Hollywood Beach Mitigation Reefs. Approximately 70% of the vessels observed using the buoys were tied off correctly.

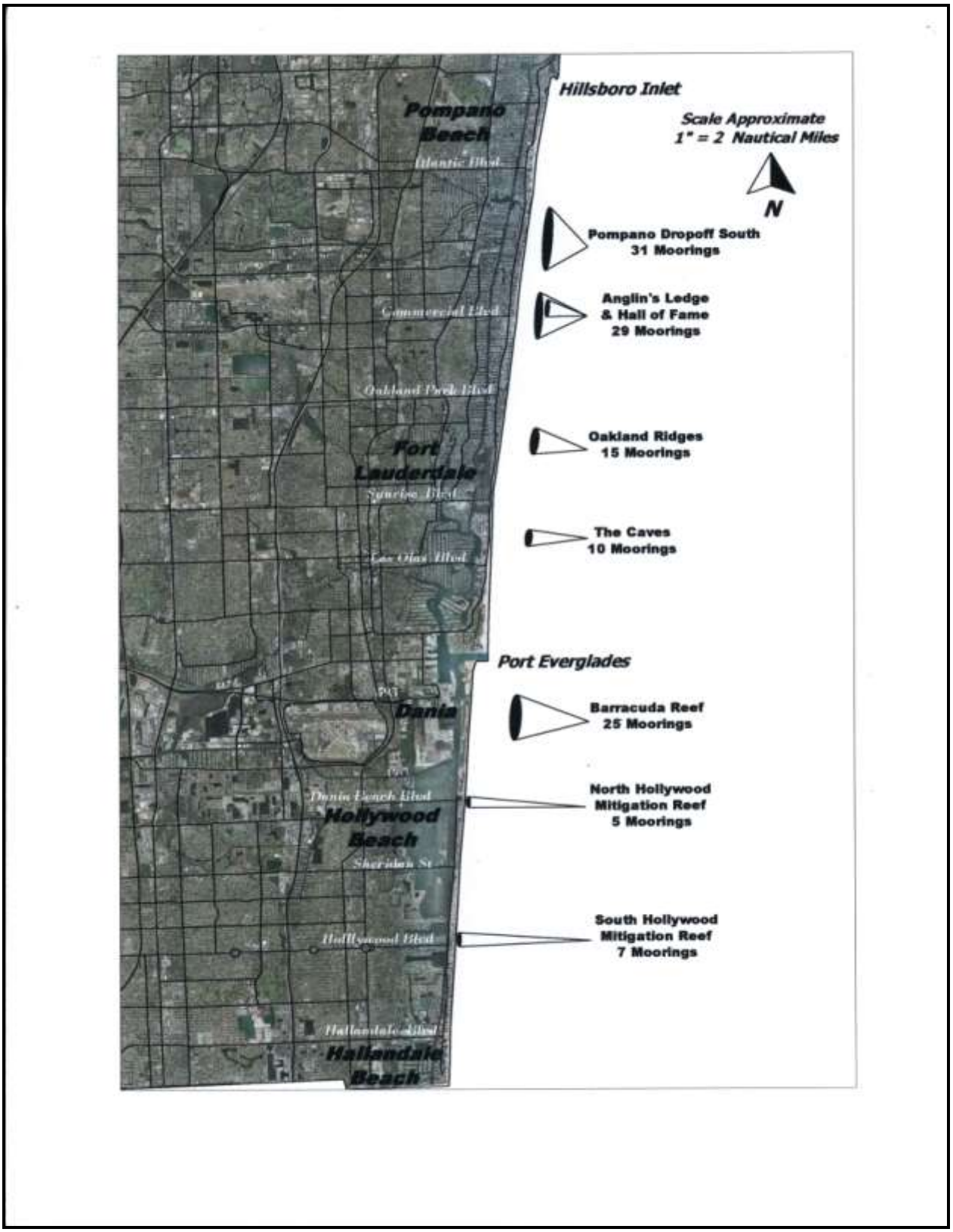

Figure 1: Location of Broward County mooring buoys at the beginning of the project.

Table 1: Approved logic framework.

Table 1: Logic framework **Activities**	**Project Output**	**Post-Project Outcomes**	**Indicator**	**Baseline Value**	**Predicted Value Project Output**	**Predicted Post-Project Outcome**	**Actual Value of Project Output**
Recruit Ocean Watch Foundation volunteers to install 21 new mooring buoys at a popular dive site	Strengthen partnership with local environmental group dedicated to protecting Florida's coral reefs	Increased awareness about coral reef conservation efforts and effort required to manage a mooring buoy maintenance program	Number of participants in marine conservation programs	0 volunteers	12 volunteers	12 volunteers	31 volunteers
			Number of hours/volunteer/month	0	2.45 hours/volunteer/month	2.45 hours/volunteer/month	3.5 hours/volunteer/month
Conduct one field trip to install 21 new mooring buoys	21 new reef protecting mooring buoys installed at a popular dive site	Reduce anchor impacts to coral reef resources	Number of boats using the new buoys	0 boats	Average of 5 boats per day using new buoys	Average of 10 boats per day using the new buoys	6 (more use observed on weekends)
			Number of well maintained mooring buoys in place	122 buoys currently installed	143 mooring buoys in place after installation at Suzanne's Ledge	143	122 (12 buoys removed from Hollywood mitigation reefs; 9 removed from Anglin's Ledge)
Maintain Broward County's mooring buoy system for one year	System of 143 mooring buoys maintained in optimum condition	Reduce anchor impacts to coral reef resource.	% hard coral coverage, and octocoral and sponge density (colonies/m^2) at Suzanne's Ledge[1]	0.97 % (coral cover) 5.4 (octocorals/m^2) 6.3 (sponges/m^2)	0.97 % (coral cover) 5.4 (octocorals/m^2) 6.3 (sponges/m^2)	0.97 % (coral cover) 5.4 (octocorals/m^2) 6.3 (sponges/m^2)	0.97% (coral cover) 4.7 (octocorals/m^2) 4.3 (sponges/m^2)

Table 1: Logic framework **Activities**	**Project Output**	**Post-Project Outcomes**	**Indicator**	**Baseline Value**	**Predicted Value Project Output**	**Predicted Post-Project Outcome**	**Actual Value of Project Output**
			Average # of anchor scars (determined by broken octocorals and/or fractured hard coral) within 25 meter radius of mooring anchor	.014 scars/m^2 (reef damage/m^2)	.007 scars/m^2 (reef damage/m^2)	0 scars/m^2 (reef damage/m^2)	.012 scars/m^2 (reef damage/m^2)
			Number of buoys replaced per month	11	9	7	9
			Number of buoys assessed for damage per unit of time	122/Quarter (1x122)	286/Quarter (2x143)	286/Quarter (2x143)	366/Quarter (3x122)
Redesign and distribute mooring buoy educational brochure	Update buoy location map, buoy use instructions and agency and partnership contact information	Increased awareness of boating public on where to find the buoys and how to use them properly. Less buoy maintenance required.	Number of brochures distributed	0	Distribute 10, 000 in 1 year	Distribute 20,000 in 3 years	Distributed 5,935 (as of 3/31/09)
			Percent of boaters moored properly	70%	80%	90%	TBD In 2009, we will continue distributing the educational brochure and monitor this output.
[1] Baseline reef community transect data at Suzanne's Ledge was obtained in 2006.							

The Ocean Watch Foundation, Vone Research, Inc., and Sea Scout Troop 307 provided key support for the grant by constructing twenty-one new mooring buoy assemblies. Volunteers were recruited and organized to perform this task after our maintenance contractor was unable to provide buoys as promised. Broward County purchased mooring buoy supplies and volunteers worked several weekends in March and April of 2008 to assemble the new buoys (Figures 2-3).

Figure 2: Members of Sea Scout Troop 307 preparing to construct mooring buoys.

Figure 3: Sea Scouts of Troop 307 learning how to make an eye splice.

The new mooring buoys were installed at Suzanne's Ledge between June 19 and June 21, 2008 (Figure 4). Immediately upon installation, boaters began using the new buoys (Figure 5). Personal communications with a local dive operator and Vone Research, Inc. report heavy use of the buoys, especially on the weekends

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Figure 4: Volunteers from Vone Research, Inc. attaching a new mooring buoy to an anchor.

Figure 5: Six small boats observed using the new moorings on June 21, 2008.

With the addition of 21 new buoys at Suzanne's Ledge, Broward County had proposed to expand the Broward County mooring buoy system to 143 moorings. However, with the information gained during the mooring buoy use surveys, showing a boater preference towards certain mooring buoy locations, it was reasoned that eliminating the buoys at the Hollywood Beach Mitigation Reefs and reducing the number of moorings at Anglin's Ledge would be a cost-effective modification to the mooring buoy program. This change reduced maintenance costs, yet still provided reef-protecting benefits in high use areas where protection was needed most. Broward County continues to manage a mooring buoy system consisting of 122 buoys, which are better located to protect the reefs from anchor damage (Figure 6).

Marine biologists from Coastal Planning and Engineering Inc. volunteered their services and helped perform the radial transect work at Suzanne's Ledge (Figure 7). The radial transects were performed in May 2008 prior to installing the buoys and then repeated in November 2008, approximately 6 months after the new buoys had been in place. Transects were run at four mooring buoy sites: #5, #11, #15 and #21 (Figure 9). At each location, five 25-meter x 2-meter transects were surveyed. The transects extended from each mooring buoy anchor like spokes of a wheel, at a heading interval of 45^0, starting at 180^0 and ending at 0^0. Each transect covered an area 50 m^2 with a total of 250 m^2 evaluated at each buoy site.

Data collection was designed to investigate the following:

a) Hard coral, octocoral, and sponge damage (reef damage observed/m^2), and
b) Debris density (debris observed/m^2).

The density of reef damage and debris at each transect was calculated by dividing the number of damaged organisms and amount of debris counted along each transect by the transect area (Table 2).

Table 2: Comparison of mean density of reef damage and debris observed before and after the new buoys were installed (mean ± 1 SD).

Reef Damage and Debris	Pre-Buoy Installation	Post-Buoy Installation
Reef Damage Observed (n=20)	0.014/m^2 ± .017	0.012/m^2 ± .018
Debris Observed (n=20)	0.002/m^2 ± .009	0.012/m^2 ± .015

During the six months between surveys, it appears that the buoys have had no negative impact on the reef community. However, the data show a greater amount of debris accumulation (trash and fishing line) on the reef, shortly after the buoys were installed.

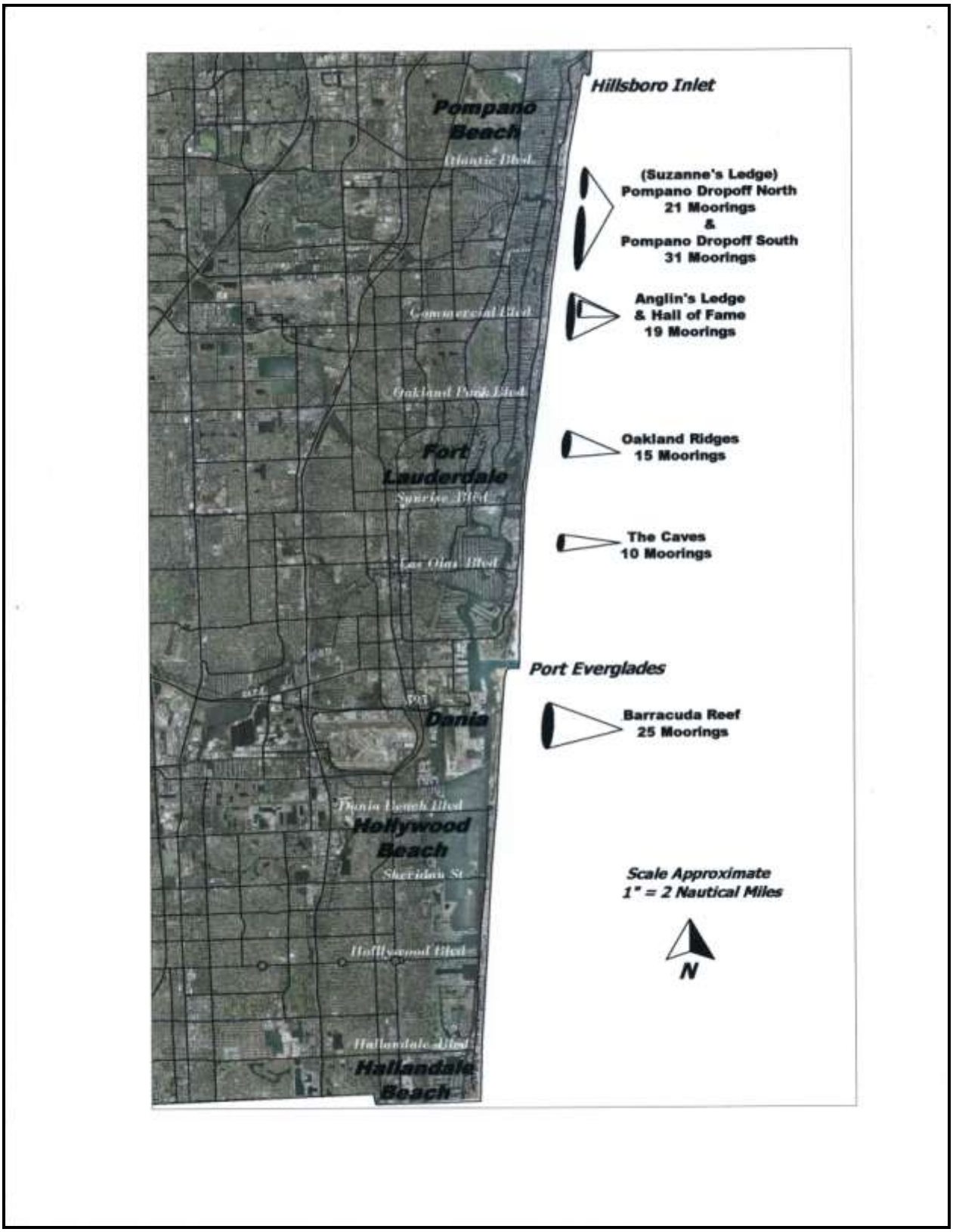


Figure 6: Broward County mooring buoy system reconfigured.

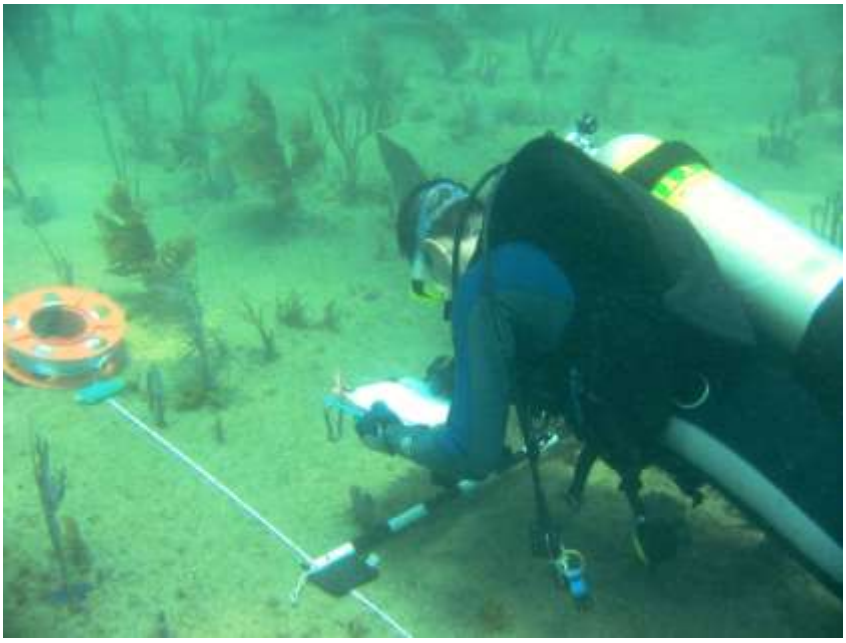


Figure 7: Volunteer diver performing a radial transect.

While conducting the radial transects, two colonies of *Acropora palmata*, an Endangered Species Act threatened species, were observed. Exact positions of these colonies were recorded and included in an *Acropora* species database that is being developed by coral reef scientists in Southeast Florida (Figure 8).

Figure 8: *Acropora palamta* adjacent to a radial transect.

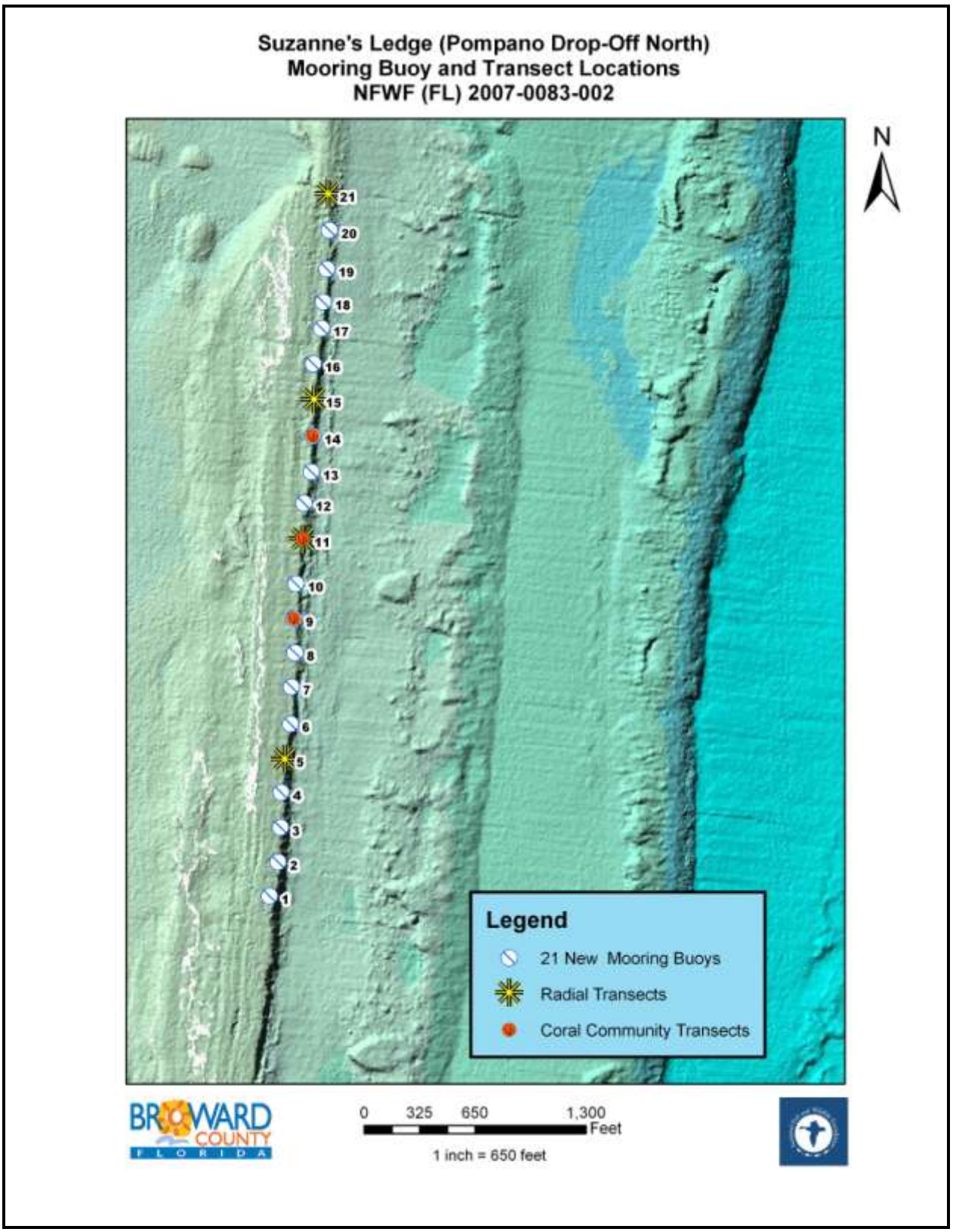


Figure 9: Mooring buoy and transect locations.

Additional time and effort was required to organize a larger group of volunteers than originally planned, but greater community support was developed for the mooring buoy program. In all, 32 volunteers donated 663 hours of time to complete this project, resulting in an average of 3.5 hours/volunteer/month of effort.

In December of 2008 coral community transects were conducted by Broward County staff marine biologists (Figure 10). Data were collected at 3 mooring buoy locations: # 9, # 11, and #14, that were previously surveyed by the Nova Southeastern University Oceanographic Center in 2006 (Klink, 2007) (Figure 9). At each location, divers assessed a single 20-meter x 1.5-meter belt transect. Field data collection was designed to permit the following analyses for each site:

a) Percent live hard coral cover, and
b) Density of octocorals and sponges (colonies/m^2).

Table 3 shows the comparison between the 2006 and 2008 transect data.

Table 3: Comparison of mean percent live coral cover and octocoral, and sponge density at Suzanne's Ledge between 2006 and 2008 (mean ± 1 SD).

Year	% Hard Coral Coverage	Octocoral Density (Colonies/m^2)	Sponge Density (Colonies/m^2)
2006 (n=3)	0.971 ± .607	5.44 ± 4.42	6.27 ± 2.19
2008 (n=3)	0.966 ± .712	4.66 ± 3.65	4.66 ± 2.49

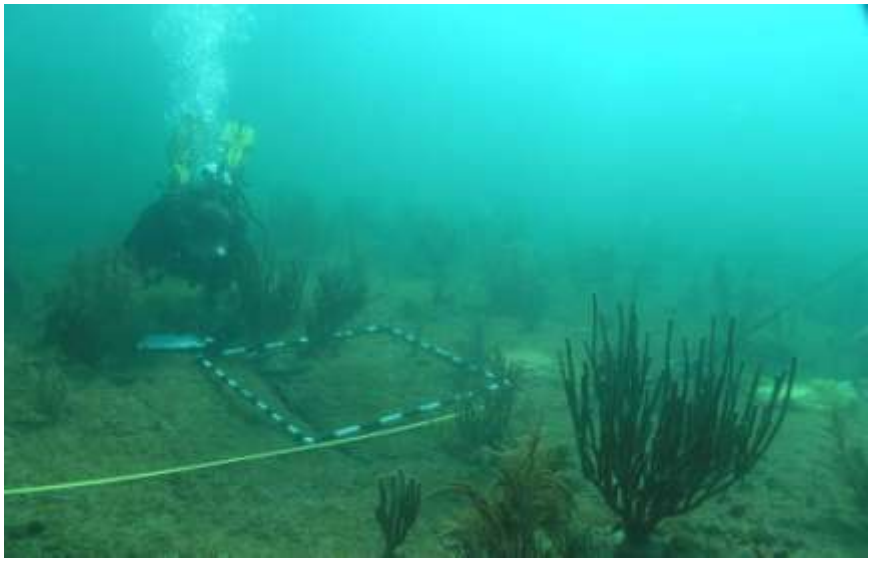


Figure 10: Broward County marine biologist conducting a coral community transect.

Data indicate that mean live hard coral coverage has remained relatively stable between 2006 and 2008. However, the octocoral and sponge densities appear to have declined. The statistical significance of these data has not been evaluated.

The change in the octocoral and sponge density can possibly be ascribed to differences in the divers taking the data. In 2006 the transects were assessed by researchers from the Nova Southeastern University, while in 2008, data collection was performed by Broward County's marine biologists. Transect origins were the mooring buoy anchors and the transects were run at the same azimuths each year. However, without a fixed endpoint, it was difficult to re-establish the transects over the exact same area of the seafloor, and the differences in the data may be attributed to this.

Coral community transect analyses conducted at 23 monitoring stations located along Broward County reef tracts show the overall percent live coral coverage has remained constant between 2000 and 2007; octocoral density has fluctuated, but has not changed significantly, and sponge density has decreased slightly for the same time period (Gilliam, 2008). There were no indications that the changes in organism density at Suzanne's Ledge were due to anchor impacts before the buoys were installed, or to diving and fishing impacts after the buoys were in place. The changes noted may be due to natural population variations.

One surprising aspect about the Broward County mooring buoy program is the high number of buoys that are lost each month. On average, 11 buoys are replaced monthly because they are damaged or missing. The main reasons for losses are from boaters hitting the buoys and from improper use of the buoys, especially by larger vessels placing too much strain on the moorings. In order to reduce buoy loss, Broward County's mooring buoy maintenance contractor now performs a complete underwater and surface inspection of every buoy each month. Maintenance problems that were not apparent when underwater inspections were performed on a quarterly basis are now being remedied before a loss occurs. This effort has been successful. The number of buoys which have been lost during the grant period has dropped from 11 to 9 per month. The level of buoy loss is still high, but Broward County is trying to educate boaters on the proper way to tie up to a mooring buoy in hopes of reducing buoy loss further.

To educate boaters on how to use the buoys properly Broward County is distributing a new mooring buoy educational brochure. The cover of the brochure shows what a typical mooring buoy looks like, both above and below the water; it also shows a vessel correctly tied to the buoy. The brochure provides boaters with easy to follow instructions on how to properly tie off to a mooring buoy and, when unfolded, has a map that shows the locations of the mooring buoy groupings offshore of Broward County. The 21 new buoys installed at Suzanne's Ledge are included in the group of mooring buoys known as the Pompano Drop-Off.

Since printing the new brochure in the beginning of March 2009, 5,935 copies have been distributed to dive shops, fishing tackle shops, boat rental facilities, marinas and other facilities. In an effort to educate boaters on the proper way to use the mooring buoys, Broward County is also updating its website to display this information online.

3) Lessons Learned

In order to have a successful mooring buoy program, careful planning is necessary to identify the best locations for mooring buoy installations, and to determine the number of buoys needed at a particular site to protect the reef from anchor damage. In this case, it was determined that expanding the mooring buoy system was not necessarily the best action to take. Having buoys installed in areas that were seldom visited by boaters and having an overabundance of buoys in other areas, was not a cost effective way to protect Broward County's coral reef resources from anchor damage. By reconfiguring the mooring buoy system, it was possible to maintain an adequate number of mooring buoys to meet boater demand in high use areas, and continue to protect coral reef resources from anchor damage.

While mooring buoys can protect the reef from anchor damage, it was also learned buoys tend to concentrate boaters on particular reef areas and other impacts may occur. One impact observed was the accumulation of trash and debris at some buoy sites. This trend is disturbing and indicates a need for additional boater education directed at keeping Broward County's reefs trash free.

4) Dissemination

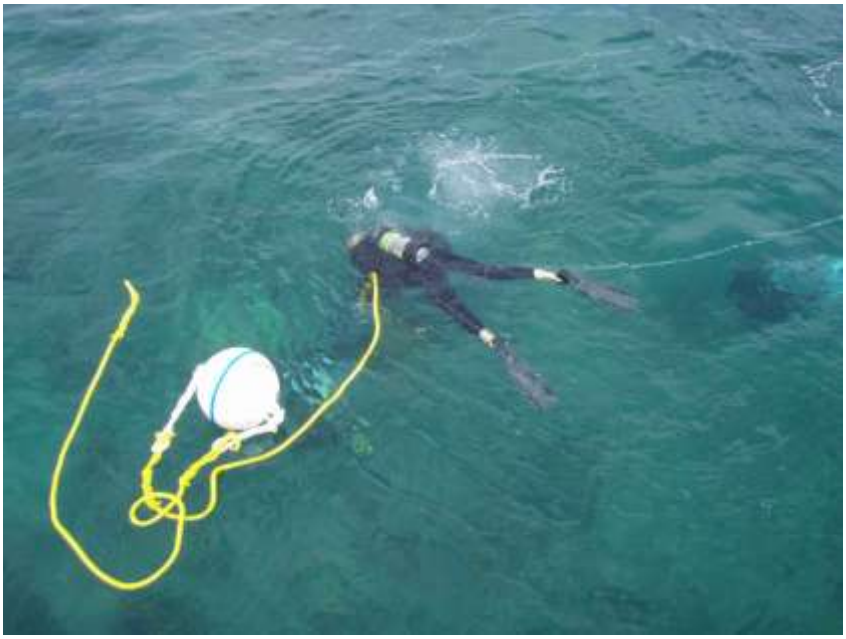
Throughout the grant period, Broward County has been sharing its experience in managing a mooring buoy program with the Florida Fish and Wildlife Conservation Commission (FWC), the Southeast Florida Coral Reef Initiative (SEFCRI), and with Miami-Dade and Palm Beach counties, who are trying to initiate their own mooring buoy projects. The exchange of information about the successes, and more importantly, about the failures, should help these agencies implement good programs. These conversations have forced Broward County to examine its program more closely and look for additional improvements that can be made to manage its mooring buoy system more effectively.

5) Project Documents

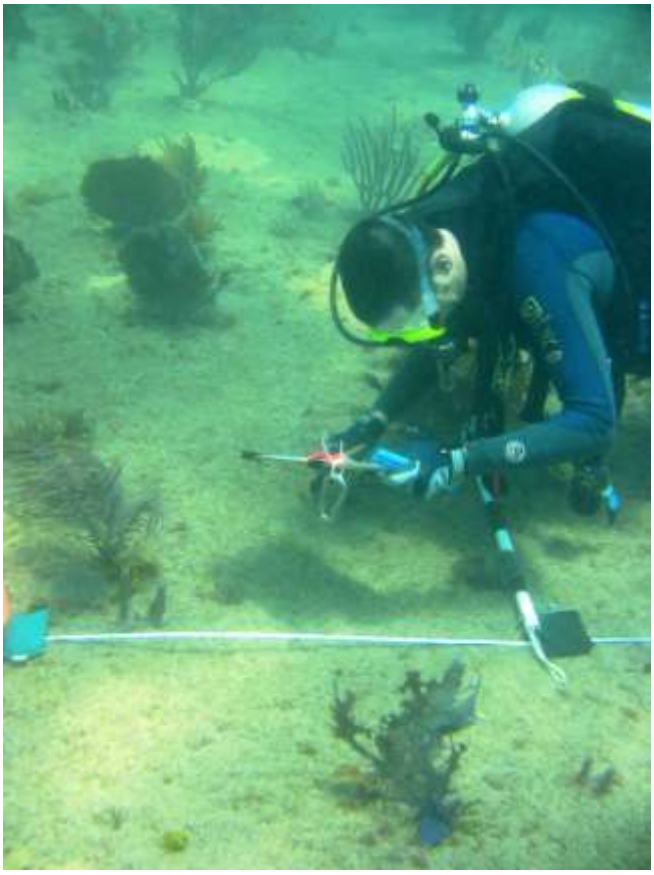
Additional project photographs:

Julie Ciucevich (Ocean Watch) speaking to students at Water Matters Day, March 2008, about Broward County's Mooring Buoy Program.

Kirsten Voss (Vone Research) and Sea Scouts splicing mooring buoy lines.

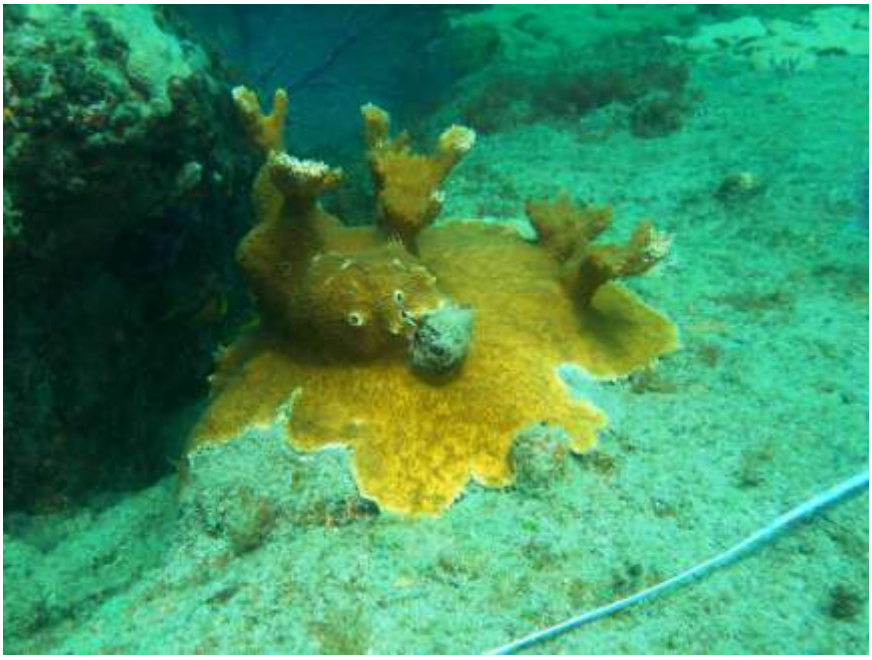


Volunteer divers installing new mooring buoys at Suzanne's Ledge.



Volunteer marine biologist performing a radial transect.

Colony of *Acropora palmata* adjacent to a radial transect at buoy Suzanne's Ledge buoy # 5.



Small *Acropora palmata* colony adjacent to radial transect at buoy # 15.

Video documentation of coral community transect.

Vessel moored properly.

Vessel moored properly.

Diver and a mooring buoy
(Photo courtesy of Ocean Watch Foundation).

Works Cited

Gilliam, D. S., Dodge, R. E., Spieler, R. E., Jordan, L. K., & Walczak, J. C. (2008). *Marine Biological Monitoring In Broward County, Florida: Year 7 Annual Report.Technical Report EPD 07-02.* Prepared for the Broward County Board of County Commisiioners, Broward County Natural Resources Planning and Management Division.

Klink, L. (2007). *Review of international coral reef mooring programs and the effect of mooring buoy use on coral reefs offshore Broward County, Florida, USA.* Masters thesis, Nova Southeastern University.