

**Reef Environmental Education Foundation (REEF)
Monitoring of the Artificial Reef *General Hoyt S Vandenberg*
2011 and 2012**

Final Report

**Submitted to Florida Fish and Wildlife Conservation Commission
Artificial Reef Program
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Background

The *General Hoyt S. Vandenberg* is a 523' steel hulled missile tracking ship that was intentionally sunk seven miles off Key West, Florida, on May 27, 2009, to serve as a recreational diving and fishing artificial reef. The ship lies in 140' of water; at its broadest point the deck is 71' wide, creating habitat from a depth of 45' to the sandy bottom. The *Vandenberg* is the largest artificial reef in the Florida Keys National Marine Sanctuary and the second largest in the world. The City of Key West, the Artificial Reefs of the Keys (ARK), Florida Fish and Wildlife Conservation Commission (FWC), US Department of Transportation Maritime Administration (MARAD), 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, Reef Environmental Education Foundation (REEF) was previously contracted by the FWC to conduct a study with pre- and post-deployment monitoring of the fish assemblages associated with the *Vandenberg* and adjacent reef areas (FWC Grant #08266). A Year One report that summarized the cumulative survey effort of five survey events in 2009 and 2010 is available on the REEF website (http://www.REEF.org/reef_files/Vandenberg_1year_finalreport_w_appendicies.pdf). A Year Two report summarizing a monitoring event in July 2011 is also available (http://www.REEF.org/reef_files/Vandenberg2011.pdf). The FWC artificial reef program supported annual monitoring by REEF through 2012. This report summarizes the 2011 and 2012 results.

REEF is an international non-profit marine conservation organization that conducts hands-on grassroots activities designed to educate and engage local communities in conservation-focused activities. REEF is based in Key Largo, Florida, with West Coast offices in California and Washington. The mission of REEF is to conserve marine ecosystems for their recreational, commercial, and intrinsic value by educating, enlisting, and enabling SCUBA divers and other marine enthusiasts to become active stewards and citizen scientists. REEF links the diving community with scientists, resource managers, and conservationists through marine-life data collection and related activities. REEF coordinates the Volunteer Survey Project, which has trained and involved over 14,000 divers and snorkelers in marine life identification and the collection of population and distribution data. This citizen science program has generated one of the largest marine life databases in the world, with over 170,000 surveys conducted to date. REEF's active surveyors achieve one of four ratings of expertise and the most accomplished of these ratings (Levels 4/5) are considered Experts. Active members holding Expert surveyor status make up our Advanced Assessment Team (AAT) and take part in high level assessments for the State of Florida, National Park Service, NOAA, and other international organizations. REEF AAT members who contributed data during the 2012 *Vandenberg* surveys were: Lad Akins (REEF Staff), Joel Barnes, Jim Davis, Jessi Doerpinghaus, Lureen Ferretti, Jana Heubner, Peter Leahy, Jess Levy, Kreg Martin, Rob McCall, Katie Rowe, and Joe Thomas.

Monitoring Objectives

The REEF *Vandenberg* monitoring objectives for this grant project are: To descriptively and comparatively quantify the fish assemblages over time at the *Vandenberg* and nearby artificial and natural reefs as a method to document changes as a result of increased habitat provided by the sinking of the *Vandenberg*. Additionally, efforts to document the occurrence of any non-native



marine fishes (including Lionfish, *Pterois volitans*), orange cup coral (*Tubastraea coccinea*), and titan acorn barnacles (*Megabalanus coccopoma*) were included to facilitate early detection and possible removal efforts with the FKNMS.

Methods and Survey Effort

In 2012, a team of 12 REEF divers conducted fish monitoring surveys between July 30th and August 3rd. Surveys were conducted at each of the 8 project study sites (Table 1).

Table 1. Project study sites.

REEF SITE NAME	REEF CODE	DEPTH	TYPE	COORDINATES
<i>Gen. Hoyt S Vandenberg</i>	34080097	40'-100'	Artificial	24° 27.60' N/ 81° 44.25' W
Joe's Tug	34080010	40'-65'	Artificial / Natural	24° 27.83' N/ 81° 44.24' W
Marker 32 Deep	34080095	50'-75'	Natural	24° 28.25' N/ 81° 44.72' W
Marker 32 Shallow (Topino Buoy)	34080023	15'-30'	Natural	24° 28.34' N/ 81° 44.73' W
Western Sambo Deep*	34080094	50'-75'	Natural	24° 28.66' N/ 81° 42.93' W
Western Sambo Shallow*	34080047	15'-30'	Natural	24° 28.75' N/ 81° 42.98' W
Eastern Dry Rocks Deep	34080096	50'-75'	Natural	24° 27.45' N/ 81° 50.44' W
Eastern Dry Rocks Shallow	34080008	15'-30'	Natural	24° 27.52' N/ 81° 50.67' W

**Sites are located within Western Sambo Ecological Reserve No-Take Zone*

The monitoring project employs two survey methods to quantify fish assemblages; roving diver technique surveys (RDT; Schmitt & Sullivan 1996) and stationery visual counts (SV; Bohnsack and Bannerot, 1986). A team of REEF staff and AAT members conducted RDT surveys at the *Vandenberg* and 7 nearby natural and artificial reefs; SV surveys were conducted at the *Vandenberg* and one nearby artificial reef (Joe's Tug).

The RDT is a visual survey method specifically designed to generate a comprehensive species list and sighting frequency and relative abundance estimates. During RDT surveys, divers swim freely throughout a dive site and record every observed fish species. During each survey, divers assign each recorded species one of four log₁₀ abundance categories [single (1); few (2-10), many (11-100), and abundant (>100)]. The RDT survey methodology is employed by the REEF Volunteer Fish Survey Project, and all survey data are archived in the REEF Marine Life Sightings Database (www.REEF.org). Following each survey dive, the surveyor enters their species data along with survey time, depth (from dive computers), temperature (from dive computers), and other environmental information, including habitat type, current, and visibility (estimated) into the REEF database via on-line data entry. During entry and prior to final uploading, data undergo QC/QA checks including automated and human reviews. Once uploaded into the REEF database, summary data can be accessed by the public on the Internet at REEF's homepage (<http://www.REEF.org>) by geographic location. In addition to a species list, the following metrics can be calculated from survey data for each site:

- 1) Sighting Frequency (%SF)** = number of surveys reporting species of interest / total number of surveys at that site



- 2) **Density Score (DEN)** = $[(nS \times 1) + (nF \times 2) + (nM \times 3) + (nA \times 4)] / (nS + nF + nM + nA)$ Where n is the number of times each abundance category was assigned and s=single, f=few, m=many and a=abundant (the four categories of abundance recorded during RDT surveys).
- 3) **Abundance Score (ABS)** = %SF * DEN By multiplying the sighting frequency with the density score a weighted measure of abundance can be derived.

The RDT method does not include size estimates and documenting changes in size structure is not possible from this dataset. Stationary Visual Count surveys were conducted at the *Vandenberg* and one other artificial/natural site (Joe's Tug) to document estimated sizes of fish over time along with a more precise measure of density for conspicuous, non-cryptic species. During SV surveys the diver is stationary in the middle of an imaginary cylinder with a radius of 7.5m, recording all species present in the cylinder for a period of 5 minutes. Following the 5 minute list compilation, an abundance count and the corresponding minimum, maximum, and mean sizes are recorded for each species present in the cylinder area. Additional information on time of day, depth, current, and visibility are recorded. All SV surveys are conducted on the same day, towards the end of the week-long monitoring effort. Surveyors are given PVC measuring sticks to aid with size estimation. Prior to the SV surveys, REEF surveyors practiced estimating fish length to the nearest centimeter.

A total of 88 RDT surveys and 20 SV surveys were conducted during the 2012 monitoring event. Table 2 summarizes the survey effort and dates for the entire monitoring project (7 events total). In all monitoring events, SV surveys were only conducted on *Vandenberg* and Joe's Tug. However, based on recommendations made in the year 1 report, the number of both SV and RDT surveys were doubled at these sites in 2011 and then increased again in 2012.

Currents were rarely present at any of the reference sites, though visibility varied significantly. Surveys conducted on the reference sites were similar in nature to those conducted on the *Vandenberg*, with deeper sites limited to 30 minutes of survey time and shallower sites standardized to 60 minutes.

Site Descriptions

The *Vandenberg* is an intact steel-hulled ship located upright on a level sand bottom at a depth of approximately 140'. Vertical relief of the ship is as much as 100' in the superstructure, which reaches a depth of approximately 40'. Between 4 and 7 mooring buoys are attached around the ship, depending on maintenance schedules, providing access to both commercial and recreational fishing and diving. Currents and visibility on the site vary widely depending on wind and other environmental factors, though generally, visibility is greater than 30' and currents are less than 1kt. The main deck on the bow of the ship lays at about 100' and most of the complexity in the ship is at depths shallower than this. Open doorways allow marine life to move in and out of the interior spaces, though surveys on the *Vandenberg* during this project were conducted only on the outside of the wreck and at depths shallower than 100'.

During RDT surveys, following descent to the wreck, the divers spread out in buddy teams and surveyed from bow to near the stern, keeping bottom times within no decompression limits and survey time no greater than 30 minutes. During SV surveys, divers conducted each point count in the



same general area of the artificial reef. These areas included portions of the wreck where survey areas would be minimally disrupted by vertical structure and where available open deck space would allow unobstructed views of the 7.5m radius survey area.

In addition to the *Vandenberg*, seven reference sites were selected in consultation with FWC staff and represent a range of nearby natural and artificial structure (Figure 1 and Table 1).

The closest structure to the *Vandenberg* is a small patch of natural hard coral substrate and remnant sunken vessel rubble (Joe's Tug), located approximately 0.25 miles from the sinking location in a depth of approximately 40-65'. Joe's Tug has deteriorated over time and is considered a mixture of artificial and natural reef. The site is made up of scattered rubble and wreckage in and around a natural reef area. Part of the wreck sits on sandy bottom, while other parts and pieces are up in and around the natural reef.

The closest all natural reef structure to the *Vandenberg* and Joe's Tug is the unmarked reef edge at Marker 32 Deep, approximately 0.80 miles shoreward of the *Vandenberg* sinking site. This reef is comprised of a sloping drop-off starting at approximately 50' and gradually increasing to a depth of approximately 75' where it ends abruptly in a sandy bottom. The sloping portion of the reef features a sediment covered low profile hardbottom (most structure is less than 4' in relief) with sparse coverings of small hard corals, soft corals such as gorgonians, and sponges. At the base of the drop-off, several large coral heads (with profiles larger than 4' in relief) are scattered at varying distances from the reef edge. Shoreward of Marker 32 Deep is the popular dive site noted by the steel I-beam marker #32. This site includes a number of mooring buoys for day-boat use and the buoyed site surveyed during this project is referred to as the Marker 32 Topino Buoy. The surrounding area consists of shallow (20'-30' deep) spur and groove reef featuring high profile coral ridges and massive *Montastrea* coral heads, with up to 10' of relief, separated by narrow sand channels.

Located approximately 1.8 miles east of the sinking site are Western Sambo Deep and Western Sambo Shallow (marked by the buoy called "Haystacks"). These two sites are similar in depth and structure to the Marker 32 deeper and shallower sites, but differ from all other sites in that they are located inside a no-take Ecological Reserve zone of the FKNMS. Taking of any marine life is prohibited inside this zone. Again, the deeper site is unmarked while the shallow site includes a number of mooring buoys for day-boat use.

The furthest study sites from the *Vandenberg* (6.5 miles west) are Eastern Dry Rocks Deep and Eastern Dry Rocks Shallow, again featuring a deeper sloping reef similar in depth, structure, and mooring buoy access to the deeper and shallower sites at Marker 32 and Western Sambo.

All sites are publicly accessible and used regularly by the public. Shallow sites with mooring buoys are commonly used by dive and snorkel tour operators and private day boats, and where fishing is allowed, subject to recreational fishing pressure. The deeper sites are not regularly visited by either commercial or recreational vessels, though some fishing pressure likely occurs at these sites (other than within the Sambo reserve), as fishing line and lost anchors are not uncommon sites on these reefs.

Table 2. RDT (and +SV if relevant) survey effort (number of surveys) during the grant contract period.

	2011	2012
	6/27/11-7/1/11	7/30/12-8/3/12
<i>Gen. Hoyt S Vandenberg</i>	16+ 5 SV	15+ 10SV
Joe's Tug	15 +5 SV	15 +10SV
Marker 32 Deep	8	10
Marker 32 Shallow	8	10
Western Sambo Deep	8	9
Western Sambo Shallow	8	9
Eastern Dry Rocks Deep	7	10
Eastern Dry Rocks Shallow	7	10
TOTAL	77 RDT + 10 SV	88 RDT + 20 SV



Figure 1. Survey site locations.

Data Summary

(Note: this report focuses primarily on the survey effort and data for the 2012 monitoring effort. Additional 2011 results can be found in the 2011 final report, available online at http://www.REEF.org/reef_files/Vandenberg2011.pdf. Additional results from the previous FWC contract, including pre-deployment and first year monitoring can be found online at http://www.REEF.org/reef_files/Vandenberg_1year_finalreport_w_appendicies.pdf).

A total of 77 RDT surveys and 10 SV surveys were conducted during the 2011 monitoring event. These data are summarized in the 2011 annual report (REEF 2012). A total of 88 RDT surveys and 20 SV surveys were conducted during the 2012 monitoring event. During each year, surveys were conducted at 8 sites.

The REEF team reported 76 fish species during the 2012 RDT surveys at the *Vandenberg* (Appendix 1). Three species, Neon Goby, Permit, and Squirrelfish, were new reports for the artificial reef. Fish species richness had been steadily increasing on the *Vandenberg* since it was deployed in May 2009 (Figure 2; Appendix 1; REEF 2011, REEF 2012). Over the last year, it appears that species richness is beginning to level at about 120 cumulative species.

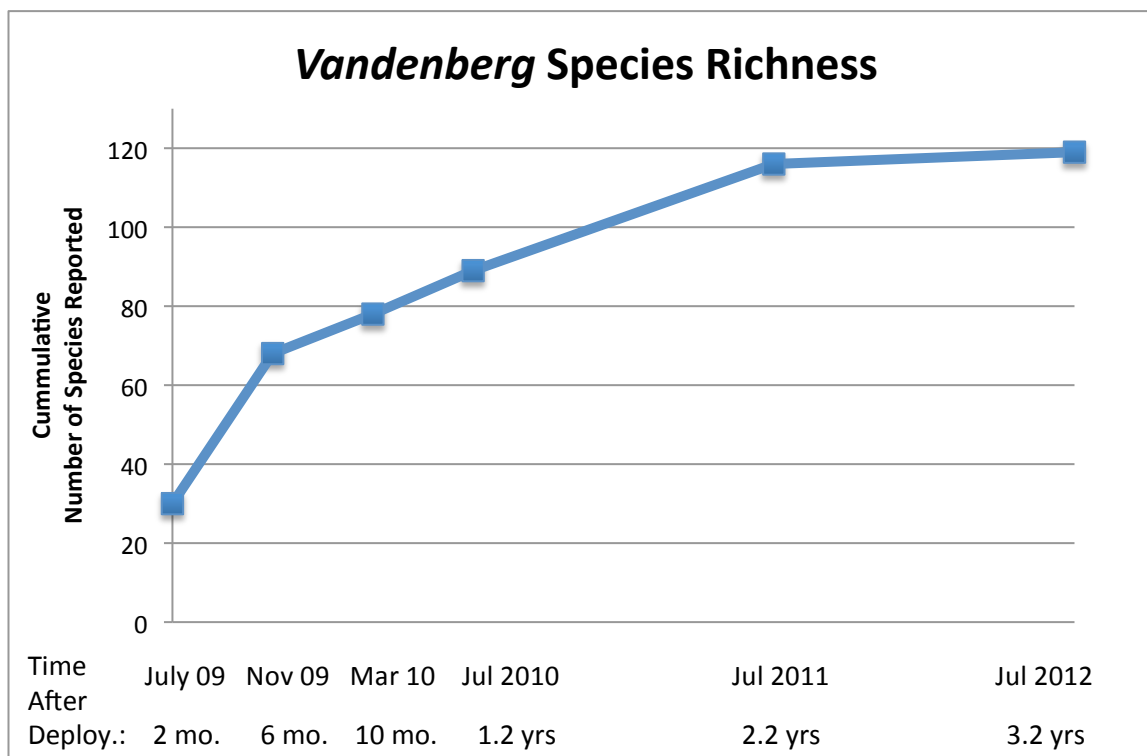


Figure 2. The cumulative number of fish species reported during RDT surveys conducted at the *Vandenberg* artificial reef since deployment.

Species richness values, as recorded during RDT surveys, at the reference sites in 2012 are: Joe's Tug (102), Marker 32 (117), Marker 32 Deep (89), Western Sambo (112), Western Sambo Deep (88), Eastern Dry Rocks (118), and Eastern Dry Rocks Deep (187). The deep reefs all featured lower species



counts than their shallow-reef counterparts. The *Vandenberg* was consistently one of the least species-rich sites throughout the monitoring project. A total of 174 species of fish were documented during RDT surveys in the 2012 monitoring (Appendix 1).

Stationary Visual Surveys

Stationary Visual point count survey data from 2011 and 2012 are given in Appendix 2, showing all species documented during SV surveys at *Vandenberg* and Joe's Tug. For each species, average number of individuals per point count and mean size are shown. A total of 69 species were documented at the two sites. In 2012, 45 species were recorded during SV surveys at the *Vandenberg* and 52 were recorded at Joe's Tug. In 2011, 41 species were recorded at the *Vandenberg* and 44 were recorded at Joe's Tug. The top 15 species, based on density, are noted with asterisks for each year (Appendix 2).

Non-native Species

Lionfish (*Pterois volitans*) was the only non-native fish species observed during the project monitoring events. In the first two years of the project (2009 and 2010), lionfish were only sighted on 2 survey sites (Joe's Tug and Eastern Dry Rocks), both during 2010. In 2011 lionfish were seen on 6 of the 8 sites (all but Joe's Tug and Western Sambo Shallow). In 2012, lionfish were again seen on the majority of the sites (5 of the 8), and cumulatively during the course of the monitoring project, lionfish were seen on all 8 sites. This dramatic increase in sightings from 2010 to 2011 is consistent with the rapid progression of the invasion. All lionfish sightings were reported to the Florida Keys National Marine Sanctuary.

Tubastrea was also seen by the REEF team for the first time on the *Vandenberg* during the 2012 monitoring events (Figure 7). On July 31, 2012, four small (2-5 cm) colonies were found on the starboard quarter of the bridge bow splash face at a depth of 72'. Anecdotal reports from local dive operators indicate additional colonies had been present on various locations on the wreck but removed in the months preceding the July monitoring event.

The REEF team did not see any Acorn Barnacles (*Megabalanus coccopoma*) during the entire project period. None of the non-native species seen were removed by the REEF team.

Literature Cited

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Appendix 1. Sighting Frequency during RDT surveys conducted during July 2012 REEF Monitoring at the Vandenberg and 7 nearby sites. 174 species were documented during the survey event, including one species of sea turtle.

Species Common Name	Vandenberg	Joe's Tug	Marker 32 Shallow	Marker 32 Deep	Western Sambo Shallow	Western Sambo Deep	Eastern Dry Rocks Shallow	Eastern Dry Rocks Deep
Almaco Jack	40%	7%						
Banded Butterflyfish		20%	90%		56%		70%	10%
Bar Jack	80%	60%	100%	40%	89%	56%	90%	90%
Barred Hamlet	7%			10%	11%			
Beaugregory		20%	60%	30%	44%	44%	70%	50%
Bermuda Chub/Yellow Chub		27%	80%		78%	11%	50%	
Bicolor Damselfish	100%	100%	70%	90%	100%	100%	90%	100%
Black Grouper	7%	7%		50%	78%	11%	50%	40%
Black Hamlet						44%		
Black Margate			30%	30%	44%	22%	50%	30%
Blackbar Soldierfish			70%					
Blackfin Snapper						11%		
Blue Angelfish	20%	20%	40%	30%	11%	33%		60%
Blue Chromis	47%	73%	80%	80%	100%	100%	100%	70%
Blue Dartfish		27%			11%		20%	10%
Blue Hamlet		27%	20%	40%				40%
Blue Parrotfish		7%	30%		56%	11%	100%	
Blue Runner					11%			10%
Blue Tang	80%	80%	100%	60%	89%	67%	90%	70%
Bluehead	93%	87%	100%	90%	100%	100%	90%	90%
Bluelip Parrotfish		7%	10%				30%	
Bluestriped Grunt	80%	100%	100%	90%	100%	100%	90%	80%
Bridled Goby	27%	60%	80%	30%	56%	44%	90%	30%
Brown Chromis	20%	100%	80%	20%	89%		90%	50%
Bucktooth Parrotfish			10%		11%			
Butter Hamlet	7%	67%	20%	100%	44%	100%	100%	100%
Caesar Grunt		7%	80%	20%	78%		80%	10%
Cero	13%	20%	20%	10%	11%			30%
Chalk Bass		60%		10%		22%	10%	30%
Cherubfish	13%							
Clown Wrasse	13%	7%	70%		78%	22%	90%	
Cocoa Damselfish	7%	33%	60%	80%	56%	56%	70%	60%
Colon Goby		7%	40%		22%		50%	

Species Common Name	Vandenberg	Joe's Tug	Marker 32 Shallow	Marker 32 Deep	Western Sambo Shallow	Western Sambo Deep	Eastern Dry Rocks Shallow	Eastern Dry Rocks Deep
Coney								10%
Cottonwick				20%		22%	20%	
Creole Wrasse	47%	93%	10%	80%	89%	78%	50%	90%
Creole-fish	40%					11%		
Crevalle Jack	13%							
Darkheaded Blenny		7%						
Doctorfish	33%	20%	40%	20%	33%	78%	60%	30%
Dog Snapper		7%			11%			
Dusky Damselfish		7%	60%		67%	11%	50%	
Dusky Jawfish							50%	
Dusky Squirrelfish			60%				10%	
Eyed Flounder							10%	
Flamefish					11%		10%	
Foureye Butterflyfish		100%	90%	90%	100%	100%	100%	100%
French Angelfish	53%		20%	10%	56%	11%		70%
French Grunt	7%	100%	100%	70%	100%	78%	70%	90%
Glasseye Snapper			20%					
Glassy Sweeper			80%				40%	
Goldentail Moray			10%					
Goldspot Goby	13%	27%	60%	10%	44%	11%	70%	10%
Goliath Grouper (Jewfish)								10%
Gray Angelfish	20%			90%	44%	56%	20%	
Gray Snapper	93%	40%	100%	50%	67%	33%	60%	80%
Graysby	73%	100%	100%	70%	100%	78%	90%	70%
Great Barracuda	100%	13%	80%		78%		70%	40%
Greater Amberjack	13%							
Greater Soapfish							10%	
Green Moray		7%			33%		30%	10%
Green Razorfish			20%				10%	
Greenblotch Parrotfish		27%	20%		11%		20%	10%
Harlequin Bass	7%	67%	90%	40%	56%	11%	60%	
Hawksbill Sea Turtle								10%
Highhat		80%	60%	70%		22%	20%	20%
Hogfish	33%	60%	60%	70%	100%	67%	90%	80%
Horse-Eye Jack	20%				11%		10%	
Hovering Dartfish		13%	10%	20%				

Species Common Name	Vandenberg	Joe's Tug	Marker 32 Shallow	Marker 32 Deep	Western Sambo Shallow	Western Sambo Deep	Eastern Dry Rocks Shallow	Eastern Dry Rocks Deep
Jolthead Porgy			10%					
Juvenile Grunt		7%	10%	10%		11%	10%	
Knobbed Porgy			10%				10%	
Lancer Dragonet		7%						
Lane Snapper				50%		56%		10%
Lantern Bass		7%	20%		11%		10%	
Leopard Goby					33%			
Longfin Damselfish	7%		40%	30%	56%	11%	40%	10%
Longjaw Squirrelfish			10%					
Longspine Squirrelfish		13%	80%	20%	67%	33%	40%	50%
Mahogany Snapper	27%		100%	40%	100%	33%	50%	60%
Masked Goby/Glass Goby	27%	87%	80%	70%	89%	100%	50%	90%
Midnight Parrotfish		7%	20%		78%	22%	70%	10%
Mutton Snapper		7%		20%	22%			
Neon Goby	7%	40%	60%	60%	89%	56%	90%	60%
Nurse Shark			80%				30%	
Ocean Surgeonfish	33%	67%	80%	90%	89%	89%	90%	70%
Ocean Triggerfish				10%	33%			
Orangespotted Filefish			60%	10%			30%	
Pale Cardinalfish					11%			
Pallid Goby		20%	20%	20%	44%		10%	10%
Permit	7%		10%					
Porcupinefish			20%		22%			
Porkfish	27%	87%	100%	100%	100%	78%	90%	100%
Princess Parrotfish	27%	67%	70%	20%	78%	67%	60%	30%
Puddingwife		13%	90%	10%	56%		90%	
Purple Reeffer	47%	40%	30%	60%	67%	67%		80%
Pygmy Filefish					11%			
Queen Angelfish	40%	33%	50%	40%	11%	22%	60%	60%
Queen Parrotfish	13%	67%	90%	10%	89%	22%	80%	
Rainbow Parrotfish	7%	7%	40%		22%		70%	
Rainbow Runner	7%							
Red Grouper						11%		
Red Hind		13%	10%	10%				20%
Red Lionfish	13%	13%		30%			40%	70%
Redband Parrotfish	60%	73%	100%	80%	78%	100%	100%	90%

Species Common Name	Vandenberg	Joe's Tug	Marker 32 Shallow	Marker 32 Deep	Western Sambo Shallow	Western Sambo Deep	Eastern Dry Rocks Shallow	Eastern Dry Rocks Deep
Redlip Blenny			40%		11%		30%	
Redspotted Hawkfish			30%		11%		10%	
Redtail Parrotfish	33%	27%	40%		56%	11%	50%	
Reef Butterflyfish	93%	47%	10%	90%	11%	100%	20%	90%
Reef Croaker							20%	
Reef Squirrelfish		7%	30%		11%			10%
Rock Beauty	60%	67%	60%	90%	78%	100%	60%	100%
Rock Hind			30%	20%	56%	44%	10%	10%
Rosy Blenny			30%	10%			50%	
Roughhead Blenny		20%	50%	10%	56%	11%	50%	
Round Scad	80%							10%
Saddled Blenny	7%	7%	80%		67%	11%	70%	30%
Sailfin Blenny							40%	
Sailors Choice	7%		50%	30%	33%	44%	40%	
Sand Diver			10%	10%		22%	20%	
Sand Tilefish							10%	10%
Saucereye Porgy		20%	70%	40%	56%	33%	60%	40%
Scamp	13%							
School Bass								60%
Schoolmaster		73%	90%	40%	100%	89%	80%	100%
Scrawled Cowfish		7%	30%		44%		40%	
Scrawled Filefish	33%	40%	40%		11%		70%	
Seaweed Blenny	40%	13%	10%		22%		40%	
Sergeant Major	40%	87%	90%	20%	100%	100%	90%	
Sharksucker		7%			22%		10%	
Sharpnose Puffer	87%	73%	70%	100%	100%	89%	80%	100%
Silversides, Herrings, Anchovies	13%						20%	
Slender Filefish		7%	30%				40%	
Slippery Dick	13%	33%	90%		89%	22%	80%	20%
Smallmouth Grunt	7%	7%	80%		67%		10%	
Smooth Trunkfish		67%	30%		78%	11%	20%	30%
Southern Stingray					11%			
Spanish Grunt			100%	20%	89%	11%	90%	30%
Spanish Hogfish	80%	60%	100%	70%	100%	78%	90%	100%
Spotfin Butterflyfish	53%	47%	90%	90%	100%	67%	90%	60%
Spotfin Hogfish	80%			50%		22%		60%

Species Common Name	Vandenberg	Joe's Tug	Marker 32 Shallow	Marker 32 Deep	Western Sambo Shallow	Western Sambo Deep	Eastern Dry Rocks Shallow	Eastern Dry Rocks Deep
Spottail Pinfish			40%		11%			
Spotted Drum		13%	10%	10%				
Spotted Goatfish		67%	80%	50%	89%	44%	60%	60%
Spotted Moray		7%	30%	30%				
Spotted Scorpionfish	7%	13%						
Spotted Trunkfish			40%		56%		10%	10%
Squirrelfish	7%	7%	90%	20%	44%	22%	60%	10%
Stoplight Parrotfish	33%	67%	100%	60%	100%	56%	90%	70%
Striped Grunt	60%	7%	10%				10%	
Striped Parrotfish	67%	87%	100%	100%	100%	100%	100%	100%
Sunshinefish	73%	67%		70%		89%	10%	90%
Tan Hamlet					11%	11%		
Tarpon							70%	
Threespot Damselfish		7%	30%	50%	78%	44%	30%	50%
Tobaccofish			10%			11%	20%	40%
Tomtate	13%	7%	10%	90%	11%	78%	30%	50%
Townsend Angelfish	7%	7%		20%		11%		10%
Triplefin spp.					11%			
Trumpetfish	13%	13%	90%	50%	22%	33%	30%	30%
White Grunt		87%	70%	90%	100%	78%	100%	70%
White Margate			10%	20%	11%	11%		
Wrasse Blenny				10%		33%	20%	
Yellow Goatfish		7%	100%	60%	67%	22%	30%	50%
Yellow Jack					22%		10%	20%
Yellow Stingray				10%				
Yellowcheek Wrasse					11%			
Yellowhead Jawfish		40%	10%		33%			
Yellowhead Wrasse	33%	93%	100%	70%	100%	100%	90%	30%
Yellowmouth Grouper				20%			20%	
Yellowtail Parrotfish	20%	27%	60%	10%	78%	22%	90%	10%
Yellowtail Damselfish		40%	100%		100%	22%	90%	
Yellowtail Reeffish						11%		
Yellowtail Snapper	93%	87%	90%	100%	100%	100%	90%	90%
TOTAL SPECIES RICHNESS	76	102	117	89	112	88	118	87

Appendix 2. Stationary Visual Count (SV) results from the July 2011 and July 2012 field efforts at *Vandenberg* and Joe's Tug (N=5 in 2011, N=10 in 2012). Average number of individuals per Point Count and mean size are given.

	Vandenberg				Joe's Tug			
	Avg#/SV		Mean Size (cm)		Avg#/SV		Mean Size (cm)	
	2011	2012	2011	2012	2011	2012	2011	2012
Angelfish and Butterflyfish								
Banded Butterflyfish						0.2		15.0
Foureye Butterflyfish					0.4	1.6	14.0	8.6
Reef Butterflyfish	4.2	2.1	10.3	12.3	0.8	0.3	12.5	10.0
Spotfin Butterflyfish	1.0	0.6	11.2	12.3	0.8	0.2	14.0	18.0
Blue Angelfish	1.6		26.0					
French Angelfish	0.2	0.4	43.0	30.5				
Gray Angelfish	0.2	0.2	45.0	40.0	0.2		33.0	
Queen Angelfish	0.8	0.6	35.5	19.3	0.2	0.1	40.0	30.0
Rock Beauty		0.4		10.5	0.2	0.2	18.0	15.5
Grunt and Snapper								
Blackfin Snapper	0.8		33.0					
Gray Snapper	16.4	8.2	37.2	37.2	2.8	0.1	31.1	38.0
Mahogany Snapper	5.4	2.7	29.6	29.6				
Schoolmaster					5.6	1.8	31.1	22.5
Yellowtail Snapper	14.4	31.6	20.3	20.3	4.0	25.3	30.3	21.2
Bluestriped Grunt	0.4	0.5	26.0	24.8	13.2	3.1	26.0	23.4
Boga	9.0	4.5	10.0	10.0				
French Grunt					29.4	21.7	17.3	16.3
Porkfish		0.1		15.0	2.6	0.5	19.8	18.4
Smallmouth Grunt	2.0		19.0					
Striped Grunt		6.2		13.5				
Tomtate		5.6		15.5				
White Grunt					2.6	1.5	27.0	16.3
Damselfish and Surgeonfish								
Bicolor Damselfish	4.8	33.3	6.1	6.1	6.6	29.2	5.2	3.7
Beaugregory	0.2		8.0					
Brown Chromis		0.3		9.0	5.4	17.4	10.4	8.7
Blue Chromis		1.7		3.0	2.4	7.6	9.3	2.2
Cocoa Damselfish	0.2		8.0			0.1		11.0
Dusky Damselfish	0.2		13.0					
Purple Reeffish	0.2	3.1	5.0	3.5		2.7		2.0
Sergeant Major		0.4		11.5	9.0	1.8	11.2	9.7
Sunshinefish	0.2	1.6	3.0	3.0		0.5		10.9
Yellowtail Damselfish		0.1		7.0	0.4	0.1	15.8	12.0
Yellowtail Reeffish	0.4		4.0					
Blue Tang	1.0	2.1	17.6	12.4	2.0	1.1	18.0	15.2
Ocean Surgeonfish	1.4	0.5	20.8	16.4	2.4	0.7	26.1	16.1

	Vandenberg				Joe's Tug			
	Avg#/SV		Mean Size (cm)		Avg#/SV		Mean Size (cm)	
	2011	2012	2011	2012	2011	2012	2011	2012
Parrotfish and Wrasse								
Bluehead	3.8	30.3	9.1	9.1	2.8	14.2	9.9	4.8
Creole Wrasse	0.2	0.6	15.0	15.5	10.6	12.9	12.9	10.3
Hogfish	0.2		25.0			0.3		14.0
Slippery Dick		0.3		5.7				
Spanish Hogfish	1.0	1.0	29.2	16.4				
Spotfin Hogfish	0.2	0.6	15.0	10.3				
Yellowcheek Wrasse					0.2		20.0	
Yellowhead Wrasse	0.8	0.3	14.0	10.7	0.6	3.2	5.0	10.8
Greenblotch Parrotfish					0.4	0.5	3.5	5.0
Midnight Parrotfish						0.1		60.0
Princess Parrotfish	0.4	0.3	24.5	20.0	2.8	1.0	22.4	19.3
Queen Parrotfish					0.4	0.5	29.5	17.8
Rainbow Parrotfish	0.2		80.0					
Redband Parrotfish	2.0	1.7	18.3	18.3	1.4	1.8	21.1	16.5
Redtail Parrotfish		0.2		25.0				
Stoplight Parrotfish		1.0		13.2	0.2	1.1	29.0	11.8
Striped Parrotfish	0.2	1.7	20.0	12.9	4.8	2.1	13.3	13.9
Yellowtail Parrotfish						0.1		20.0
Seabass								
Butter Hamlet						0.5		10.8
Chalk Bass						0.5		3.1
Creole-Fish		0.2		6.0				
Graysby	0.6	0.6	22.7	20.5	0.2	0.6	14.0	15.7
Harlequin Bass	0.2	0.1	5.0	7.0		0.2		6.5
Juvenile Hamlet					0.2		5.0	
Lantern Bass					0.2		4.0	
Scamp	0.8	0.1	30.0	25.0				
Jack								
Almaco Jack		0.7		42.3				
Bar Jack	0.6	0.9	21.0	19.7	0.2		20.0	
Blue Runner						0.5		33.0
Round Scad	52.0	123.0	12.0	13.6				
Yellow Jack	1.0		55.0					
Other								
Atlantic Spadefish					6.2		38.6	
Bridled Goby		1.3		3.9	2.0	0.6	3.0	4.7
Common Snook					0.2		77.0	
Goldspot Goby		0.2		2.0	0.6		3.0	
Great Barracuda	1.6	1.6	88.8	56.7				
Highhat					2.4	1.5	15.5	11.0

	Vandenberg				Joe's Tug			
	Avg#/SV		Mean Size (cm)		Avg#/SV		Mean Size (cm)	
	2011	2012	2011	2012	2011	2012	2011	2012
Hovering Goby						0.2		4.0
Masked Goby/Glass Goby					11.0	60.6	1.5	2.2
Neon Goby						0.4		3.5
Roughhead Blenny						0.4		2.3
Scrawled Cowfish						0.1		20.0
Scrawled Filefish						0.2		42.5
Seaweed Blenny	0.2		4.0					
Sharpnose Puffer	5.8	2.9	5.2	5.2		1.1		5.4
Smooth Trunkfish					0.2	0.1	18.0	15.0
Spotted Goatfish					0.2	0.5	18.0	20.2
Spotted Moray					0.2		40.0	
Spotted Scorpionfish						0.1		12.0
Yellowhead Jawfish					1.2	1.6	8.0	7.0

*Actual number indicated for Top 15 varies because of ties for 15th and minimum threshold density of 1.0/SV used.