

Mission Report

NOAA/NOS/NCCOS/CCMA/Biogeography Team

July 16 – July 30, 2006

A strategy to inventory, characterize, and monitor the marine region within and around the National Park and Monument boundaries of St. John, USVI

A cooperative investigation between NOAA, National Park Service, US Geological Survey, Virgin Islands Department of Planning and Natural Resources, University of Hawaii, and the Oceanic Institute

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Mission Report: A strategy to inventory, characterize, and monitor the marine region within and around the National Park and Monument boundaries of St. John, USVI

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Mission Purpose:

The intent of this field mission was to continue ongoing efforts: (1) to spatially characterize and monitor the distribution, abundance and size of both reef fishes and conch within and around the waters of the Virgin Islands National Park (VIIS) and newly established Virgin Islands Coral Reef National Monument (VICR), (2) to correlate this information to *in-situ* data collected on associated habitat parameters, (3) to use this information to establish the knowledge base necessary for enacting management decisions in a spatial setting and to establish the efficacy of those management decisions.

Information collected thus far is being extensively utilized by NOAA, NPS, DPNR, University of the Virgin Islands (UVI) and others. Examples include UVI's use of NOAA-produced habitat maps for site selection to evaluate coral bleaching effects on coral communities, NOAA/University of Hawaii's use of habitat maps and fish data for analysis on the "wedge" between VICR boundaries, NOAA's use of data collection methodology for the design of NPS protocols, and NOAA's use of habitat characterizations from sites in the mid-shelf reef (MSR) for ground truthed multi-beam habitat classification.

A highlight of the successes of this mission was the continuation of data collection around the MSR inside and outside the boundaries of VICR. The data collected from these surveys will be analyzed together with data collected from previous years to investigate the possibility of a park boundary shift. NPS is considering a shift of the VICR MSR boundary eastward to include the narrow area that is now excluded. The narrow wedge area currently excluded appears to have a high percentage of live, healthy coral cover, although NOAA/NPS have sampled few sites in this area. This potential shift would create a cohesive, uninterrupted marine protected area that may be more ecologically sound and more enforceable as a no-take zone than the current boundary.

A week prior to the commencement of this field mission, the Biogeography Team, in partnership with NPS in St. John, began work on a new project of acoustically tracking fish movements in the coral reef systems of the VIIS and VICR. This investigation will examine the habitat utilization and movement of fish species among diel time periods, spatial scales, trophic guilds and life histories (Appendix A).

Operational Accomplishments:

- ◆ 167 sites were surveyed (Figure 1), and information on benthic habitat composition (Tables 1 & 2), fish distribution, abundance and size (Tables 3, 4 & 5), and conch abundance and distribution was collected. The project team consisted of 2 NPS, 1 University of Hawaii, 1 Oceanic Institute and 9 NOAA scientific divers. NPS and NOAA dive logs were maintained.
- ◆ Two to three NPS boats were used each day of the mission. The number of boats used depended upon the type of sites surveyed that day. Approximately 3 divers per boat.
- ◆ Divers were able to conduct surveys on all days required.
- ◆ Both air and Nitrox (32 – 34% O₂) tanks were used.

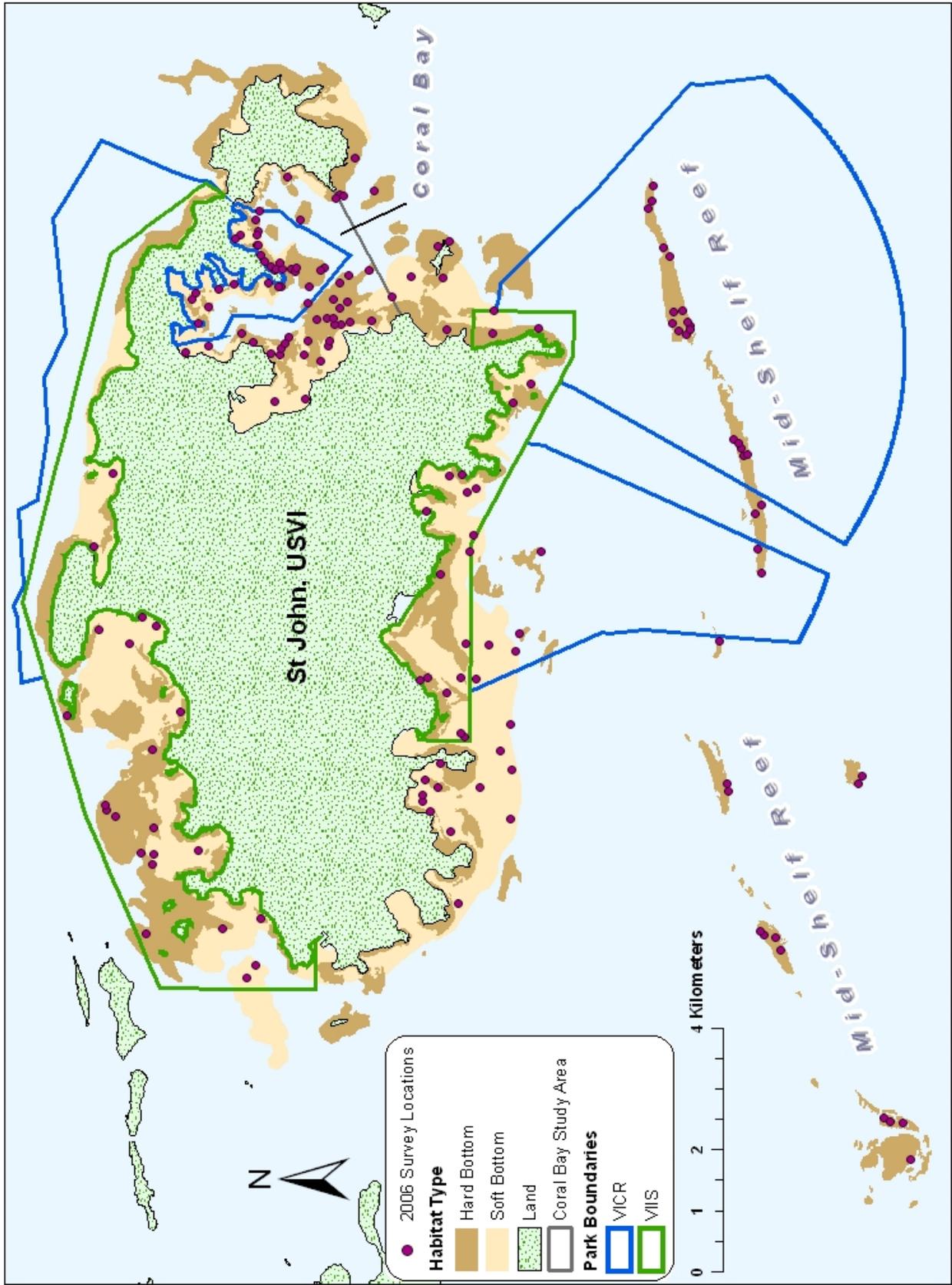


Figure 1. Map of Virgin Islands Coral Reef National Monument and Virgin Islands National Park detailing benthic composition characteristics, park boundaries and selected survey points for the July 2006 mission

Summary of Surveys:

Fish

- ◆ Fish species abundance, size and distribution were characterized using the belt transect survey method (http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html) at 167 sites. The fish data are separated and weighted according to habitat strata and location (Table 1 and 2).

Table 1. Fish abundance, richness, biomass and diversity (all per 100m²) from MSR and Coral Bay around St. John using the belt transect method. Data are from the July 2006 St. John mission.

Habitat Location	Habitat Strata	# of Surveys	# indiv / 100m ²		biomass (g) /100m ²		# species / 100m ²		Diversity*	
			Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Mid Shelf Reef	Inside	20	210.8	25.2	5356.0	1664.4	23.20	1.10	2.38	0.05
	Outside	15	391.1	94.9	4410.5	610.0	27.80	1.58	2.23	0.10
	OVERALL	35	316.3	36.85	4802.6	495.18	25.89	0.73	2.29	0.04
Coral Bay	Inside	27	209.7	25.2	2170.6	317.2	22.63	0.96	2.13	0.10
	Outside	25	407.4	90.1	10041.4	6292.0	22.92	0.99	1.76	0.13
	OVERALL	52	341.3	42.74	7409.4	2822.93	22.82	0.55	1.88	0.07
Both	Inside	47	210.3	12.7	3933.9	573.2	22.9	0.5	2.3	0.0
	Outside	40	399.7	46.3	7406.5	1914.8	25.2	0.6	2.0	0.1
	OVERALL	87	328.8	19.9	6105.9	829.5	24.4	0.3	2.1	0.0

*Shannon Diversity Index

Table 2. Fish abundance, richness, biomass and diversity (all per 100m²) from hard and soft bottom sites around the Virgin Islands National Park using the belt transect method. Data are from the July 2006 St. John mission.

Habitat Location	Habitat Strata	# of Surveys	# indiv / 100m ²		biomass (g) /100m ²		# species / 100m ²		Diversity*	
			Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Other	Hard	29	307.0	42.1	2752.3	441.3	24.34	1.06	1.93	0.10
	Soft	51	52.9	7.2	296.4	158.6	6.67	0.57	1.25	0.09
	OVERALL	80	161.3	10.01	1343.8	132.42	14.21	0.38	1.54	0.05

*Shannon Diversity Index

- ◆ The Bohnsack-Bannerot point-count method (see protocol link above) for characterizing fish species abundance, size and distribution was used to collect data at 87 RHA sites (Table 3). Due to poor visibility, 11 CB point-count surveys were not conducted. **NOTE: Due to a high number of *Coryphopterus personatus* (n=1200) at one CB site and *Decapterus* sp. (n=1000) at another CB site, these values were removed from the abundance and biomass values reported below.**

Table 3. Fish abundance, richness, biomass and diversity (all per 100m²) from MSR and CB sites using the point-count method. Data are from the July 2006 St. John mission.

Habitat Location	Habitat Type	# of Surveys	# indiv / 100m ²		biomass(g) /100m ²		# species / 100m ²		Diversity*	
			Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Mid Shelf Reef	Inside	20	142.1	16.8	6279.2	769.0	19.4	0.7	2.4	0.1
	Outside	15	227.9	41.4	6740.5	984.4	20.5	1.1	2.2	0.1
	OVERALL	35	192.3	17.08	6549.2	469.52	20.1	0.52	2.3	0.03
Coral Bay	Inside	21	197.2	50.4	3435.1	725.8	15.8	0.9	1.8	0.2
	Outside	20	121.8	22.7	3509.2	624.3	16.4	1.0	2.0	0.1
	OVERALL	52	147.0	15.69	3484.4	357.75	16.2	0.55	1.9	0.08
Both	Inside	47	166.7	15.2	5009.5	380.3	17.8	0.8	2.1	0.1
	Outside	40	171.5	15.5	5021.2	392.3	18.3	1.1	2.1	0.1
	OVERALL	87	169.7	8.2	5016.8	206.8	18.1	0.3	2.1	0.0

* Shannon Diversity Index

Habitat

- ◆ Data were collected at 167 sites for benthic composition characterization. Surveys at 87 sites were conducted within and around the waters of Coral Bay (CB) and the Virgin Islands Coral Reef National Monument Mid-Shelf Reef (MSR) locations. Below is a summary of RHA data weighted based on area sampled (Table 4). Methodology of RHA and full-scale collection can be found at http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html.

Table 4. Average percent cover for 87 hard bottom sites in and around MSR and CB for the July 2006 St. John mission.

Habitat Location	Strata Type	# of Surveys	% Coral / 100m ²		% Macroalgae / 100m ²		% Turf-crustose/100m ²		% Gorgonian / 100m ²		% Sponge / 100m ²	
			Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Mid Shelf Reef	Inside	20	2.3	0.3	48.5	4.7	22.4	3.3	16.7	2.8	10.2	1.5
	Outside	15	12.3	2.4	56.5	4.4	18.1	3.3	7.5	0.9	5.5	1.0
	OVERALL	35	8.2	0.86	53.2	2.31	19.9	1.71	11.3	0.80	7.5	0.59
Coral Bay	Inside	27	4.1	1.1	36.6	5.5	43.8	5.7	14.3	3.3	1.1	0.2
	Outside	25	5.3	0.8	35.1	3.8	36.8	4.4	17.3	3.1	5.5	0.8
	OVERALL	52	4.9	0.50	35.6	2.29	39.1	2.60	16.3	1.75	4.0	0.39
Both	Inside	47	3.1	0.3	43.2	2.5	32.0	2.2	15.6	1.5	6.2	0.5
	Outside	40	8.6	0.8	45.1	2.0	28.1	2.0	12.7	1.1	5.5	0.5
	OVERALL	87	6.5	0.3	44.4	1.2	29.5	1.1	13.8	0.6	5.7	0.2

- ◆ Full-scale surveys at 80 sites were conducted on hard and soft bottom sites within and around the waters of the Virgin Islands National Park. The weighted hard and soft bottom data are summarized in Table 5. Methodology on full-scale benthic composition data collection can be found using the methodology link (mentioned above).

Table 5. Average percent cover for habitat types for 80 full-scale sites for the July 2006 St. John mission.

Habitat Location	Strata Type	# of Surveys	% Coral / 100m ²		% Macroalgae / 100m ²		% Turf-crustose/100m ²		% Gorgonian / 100m ²		% Sponge / 100m ²	
			Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Other	Hard	29	4.5	0.8	24.9	5.0	42.2	5.9	3.5	0.7	2.2	0.4
	Soft	51	0.03	0.02	25.1	3.5	9.2	2.7	0.0	0.0	0.4	0.1
	OVERALL	80	2.0	0.16	25.0	2.05	23.3	1.97	1.5	0.12	1.1	0.11

Equations

- ◆ Overall habitat and fish mean values for each stratum (locations and substrate type) and combined strata were calculated using the following equations (Menza et al., 2006):

Mean density for the stratified survey domain is obtained by summing the weighted averages of sample strata means,

$$\bar{y}_{st} = \sum_{h=1}^L W_h \bar{y}_h \quad (4.6)$$

where L is the number of strata, and strata weighting factors (W_h) are given by

$$W_h = \frac{N_h}{\sum_{h=1}^L N_h} = \frac{N_h}{N} \quad (4.7)$$

where N is the total number of possible sample units in all strata. The weighting factor W_h represents the proportion of the overall survey domain (or sampling frame) contained within stratum h .

Two examples of calculations are provided below:

- For one stratum type (e.g. MSR strata),

$$y_{MSRI} = \left(\text{mean \# indiv inside MSR} \times \frac{\text{area inside MSR}}{\text{total MSR area strata}} \right) + \left(\text{mean \# indiv outside MSR} \times \frac{\text{area outside MSR}}{\text{total MSR strata area}} \right)$$

- All strata types combined (e.g. MSR, Coral Bay and Other),

$$\begin{aligned} & \left(\text{Mean \# indiv inside MSR} \times \frac{\text{area inside MSR}}{\text{Total area}} \right) + \left(\text{mean \# indiv outside MSR} \times \frac{\text{area outside MSR}}{\text{total area}} \right) + \left(\text{mean \# indiv inside CB} \times \frac{\text{area inside CB}}{\text{total area}} \right) + \left(\text{mean \# indiv outside CB} \times \frac{\text{area outside CB}}{\text{total area}} \right) \\ & + \left(\text{mean \# indiv OTHER hard} \times \frac{\text{Area OTHER hard}}{\text{total area}} \right) + \left(\text{mean \# indiv OTHER soft} \times \frac{\text{area OTHER soft}}{\text{total area}} \right) \end{aligned}$$

- ◆ The overall and combined standard error values for fish and habitat data were calculated using the estimated variance of the mean (Menza et al., 2006). The variance of \bar{y}_{st} is estimated as

$$\text{var}[\bar{y}_{st}] = \sum_{h=1}^L W_h^2 \text{var}[\bar{y}_h] \quad (4.8)$$

Conch

- ◆ A total of 39 conch, *Strombus gigas*, (11 immature, 28 mature) were observed along transects on soft bottom sites.

Events of Note:

- ◆ There were several fish recorded on transects for the first time in St. John during the July 2006 mission:
 - Chain moray (*Echidna catenata*)
 - Cubera snapper (*Lutjanus cyanopterus*)
 - Greater amberjack (*Seliola dumerili*)
 - Rock hind (*Epinephelus adscensionis*)
 - Spotlight goby (*Elacatinus louisae*)
 - Triplefin species (*Enneanectes* sp.)

- ◆ Increased mean abundance of red hinds (*Epinephelus guttatus*) recorded

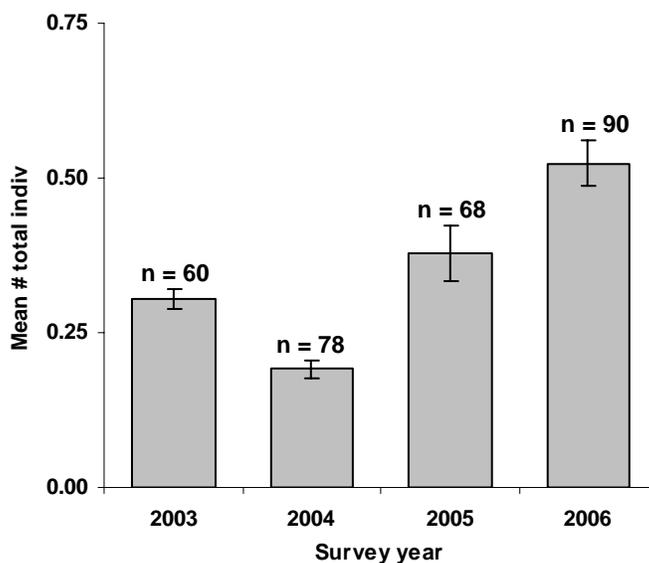


Figure 2. Mean number of red hinds (*Epinephelus guttatus*) across all size classes recorded per year (error bars represent standard error).

- ◆ A gravid queen conch (*Stombus gigas*) was observed with its egg mass exposed.

- ◆ General observations made at the Mid-Shelf Reef suggest an increase number of recently dead corals, most likely a result from secondary infections after the October 2005 bleaching event.



Images of a living and grooved brain coral (*Diploria labyrinthiformis*) at an MSR site. The white section of the coral may be due to snail predation.

Logistics of Note:

- ◆ Point-counts were unable to be conducted at several sites (n=11) in Coral Bay due to poor visibility.
- ◆ St. John dive shops no longer filled nitrox tanks due to cost. Nitrox tanks were filled on St. Thomas resulting in one boat stopping dive operations/data collection early each day.
- ◆ Three divers were taken out of commission for a few days due to illnesses.
- ◆ For one day, two boats worked at the MSR and finished Coral Bay sites.



Four-eye butterflyfish (*Chaetodon capistratus*) and massive starlet coral (*Siderastrea siderea*)



Juvenile Nassau grouper (*Epinephelus striatus*) in a patch of turtle grass (*Thalassia testudinum*)

References

Menza, C., J. Ault, J. Beets, J. Bohnsack, C. Caldow, J. Christensen, A. Friedlander, C. Jeffrey, M. Kendall, J. Luo, M. Monaco, S. Smith and K. Woody. 2006. A Guide to Monitoring Reef Fish in the National Park Service's South Florida / Caribbean Network. NOAA Technical Memorandum NOS NCCOS 39. 166 pp.

Acoustic Tracking of Reef Fishes to Elucidate Habitat Utilization Patterns and Residence Times Inside and Outside Marine Protected Areas in the US Virgin Islands

Preliminary Report
December 1 2006

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Introduction

VIIS Resource Management Division has been working closely with NOAA, USGS, and academic partners to characterize benthic habitats to document resource utilization among habitats in VIIS and VICR. An important complementary component to resource characterization and monitoring is an understanding of the movement (behavior) of organisms among habitats, between VIIS and VICR, and across those boundaries into Territorial and Federal waters. Documentation of movement of reef fish species is extremely important to NPS resource managers, particularly, the knowledge of species movements of fish residents within park boundaries and of those species which frequently move across park boundaries. Understanding habitat utilization patterns, residence time, ontogenetic and diel movement patterns of organisms is critical to defining essential fish habitat (EFH) as well as designing and evaluating marine protected areas (MPAs). Results of this investigation will not only be of importance for Resource Management in VIIS and VICR, but will provide important information on resource characterization and movement throughout NPS. Additionally, results on the effectiveness of management strategies and MPAs will be valuable to several government agencies.

Methods

Field work for the initial phase of the acoustic tracking study was conducted in Lameshur Bay, St. John between 8 and 27 July 2006.

Fish capture and handling methods

A total of 46 fishes, representing 11 species and 8 families were acoustically tagged around Lameshur Bay, St. John during July 2006 (Table 1). Fish species were captured using fish traps and handlines and represented a diversity of taxonomic, feedings, and mobility guilds.

Acoustic transmitters were implanted internally into the gut cavity of fishes using standard surgical procedures (Figure 1).

Table 1. Species composition, number, and sizes of fishes acoustically tagged in Lameshur Bay, St. John during July 2006.

Scientific name	Common name	Family	N	Mean total length (cm)	StdDev of TL	Max of TL	Min of TL
<i>Lutjanus synagris</i>	lane snapper	Lutjanidae	18	27.14	4.31	36.0	20.0
<i>Haemulon sciurus</i>	bluestriped grunt	Haemulidae	10	27.75	1.72	30.5	25.0
<i>Ocyurus chrysurus</i>	yellowtail snapper	Lutjanidae	8	30.13	5.87	38.0	22.5
<i>Calamus calamus</i>	saucereye pogy	Sparidae	3	29.33	5.13	35.0	25.0
<i>Balistes vetula</i>	queen triggerfish	Balistidae	1	29.00	-	29.0	29.0
<i>Caranx ruber</i>	bar jack	Carangidae	1	47.00	-	47.0	47.0
<i>Epinephelus guttatus</i>	red hind	Serranidae	1	29.50	-	29.5	29.5
<i>Ginglymostoma cirratum</i>	nurse shark	Rhincodontidae	1	70.00	-	70.0	70.0
<i>Haemulon flavolineatum</i>	french grunt	Haemulidae	1	20.00	-	20.0	20.0
<i>Haemulon plumieri</i>	white grunt	Haemulidae	1	25.00	-	25.0	25.0
<i>Lutjanus analis</i>	mutton snapper	Lutjanidae	1	45.00	-	45.0	45.0
Total			46				



Figure 1. Surgical procedures used for implanting acoustic transmitters in fishes.

A shore-based holding tank (ca. 750 gallons) was constructed at VIERS (Figure 2) and fishes were held in this holding tank to allow for recovery from capture and surgery to ensure that fishes were released in healthy condition. After recovery, fishes were released at a location in close proximity to the capture site.



Figure 2. Shore-based holding tank (750 gallons) at VIERS.

Continuous data loggers

Nine continuous data loggers were deployed in the Lameshur Bay complex using sandscrews, steel cable, and submerged buoys (Figure 3). These receivers record the identification number and time stamp from acoustic transmitters as the animal being studied travels within receiver range.

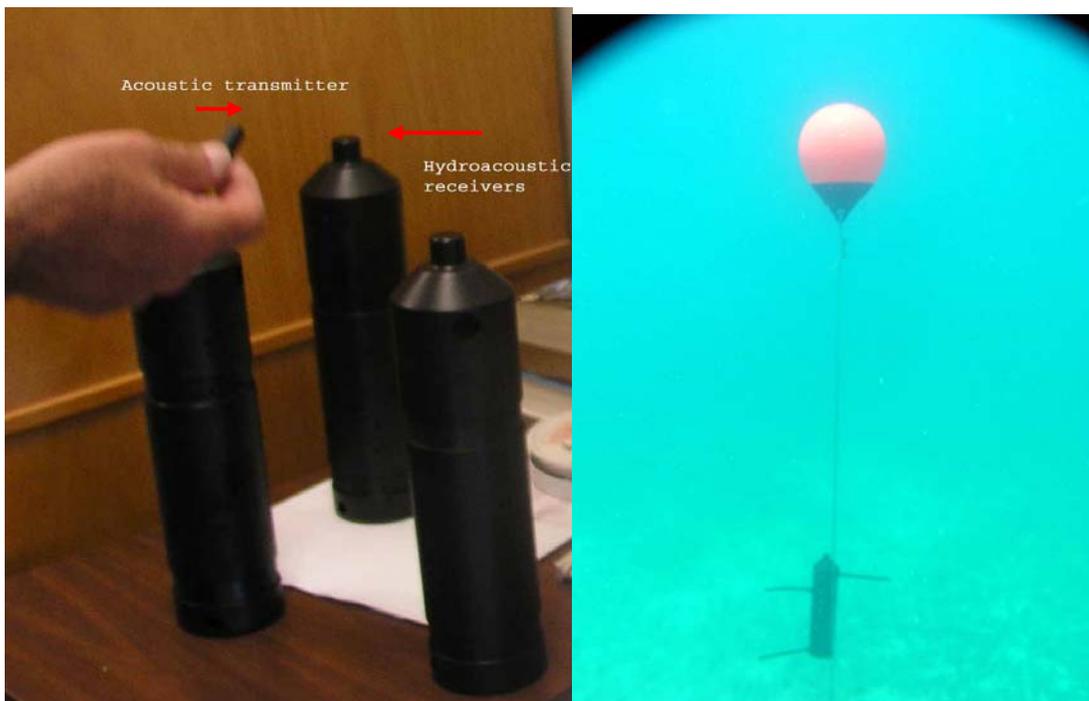


Figure 3. Acoustic transmitters, hydroacoustic receivers, and mooring design.

Range testing and receiver deployment

Range testing was conducted to determine the range of detection of transmitters for individual receivers. Receivers deployed at Yawzi Point, inside Great Lameshur Bay, and off Tektite Reef were able to detect transmitters from between 250 and 350 meters away. Based on these detection distances, we deployed nine receivers in the Lameshur Bay complex as shown in Figure 4. With a minimum effect detection range of 250 meters, the array provided overlap among multiple receivers and allowed for the detection of individual transmitters by multiple receivers (Figure 5). Receiver locations are given in table 2.



Figure 4. Locations of VR2 receivers in Lameshur Bay.

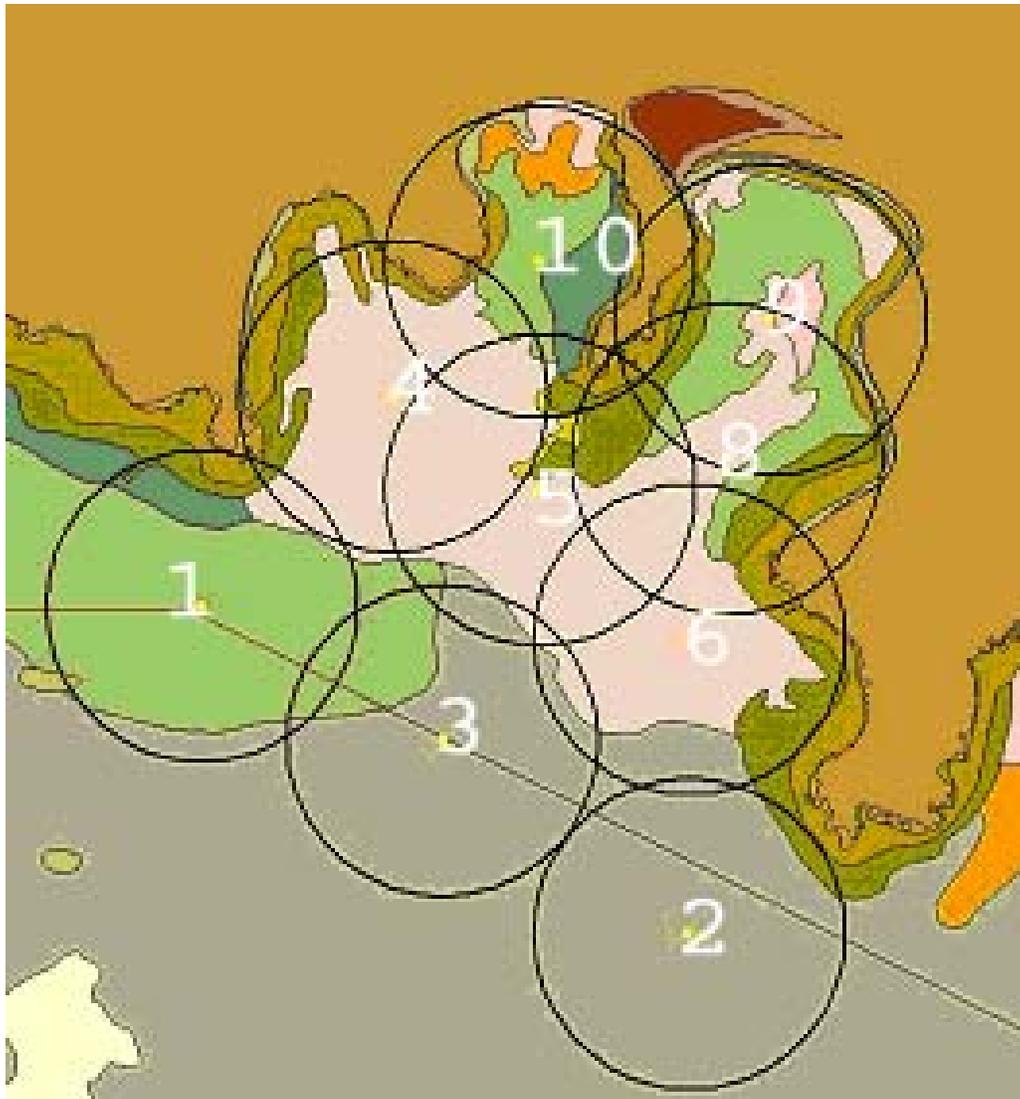


Figure 5. Locations of VR2 receivers in Lameshur Bay. Circles depict a detection range of 250 meters.

Table 2. Locations of VR2 hydroacoustic receivers in Lameshur Bay, St. John.

VR2_station	Location	Latitude	Longitude
1	Eupora	18.31140	64.73278
2	Lameshur_offshore	18.30571	64.72423
3	Lameshur_offshore	18.30900	64.72842
4	Eupora	18.31517	64.72942
5	Yawzi	18.31352	64.72686
6	Tektite	18.31088	64.72433
8	Great_Lameshur	18.31379	64.72356
9	Inner_Lameshur	18.31638	64.72284
10	Little_Lameshur	18.31736	64.72681

Preliminary Results

Date from VR2 acoustic receivers were downloaded on 27 July 2006 to examine initial results.

Station 1. This station was located 0.3 km off Europa. Five tags were detected at this location. None of these tagged fishes were present for long periods of time and fish #3182 appeared on the 17th of July and not again until the 27th.

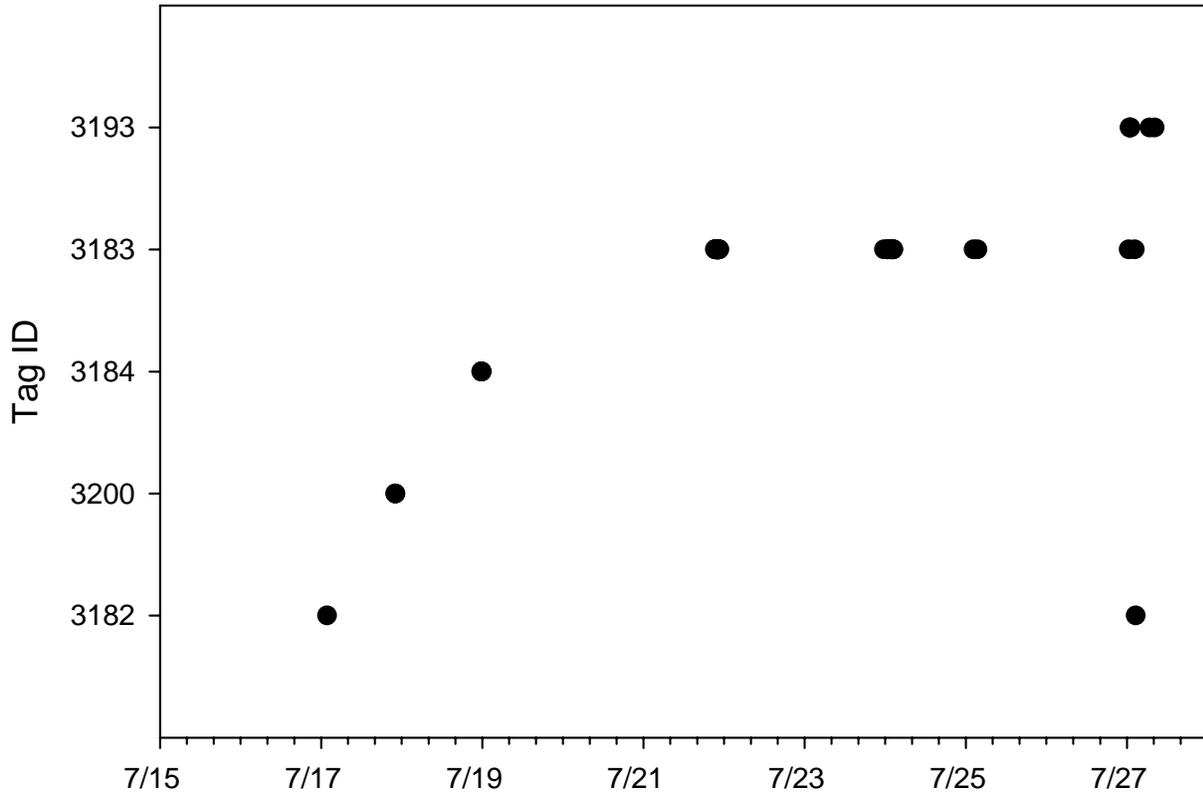


Figure 6. Tag detections at Station 1.

Station 1 tag detections

Tag_ID	July							Total
	17	18	21	23	24	25	27	
3182	1						1	2
3183			19	1	8	2	2	32
3184		4						4
3193							5	5
3200	2							2
Total	3	4	19	1	8	2	8	45

Station 2 was located 0.35 km off Cabrithehorn Point. A total of 15 tagged fishes were detected at this station. Several fish showed continual residence while others were intermittent.

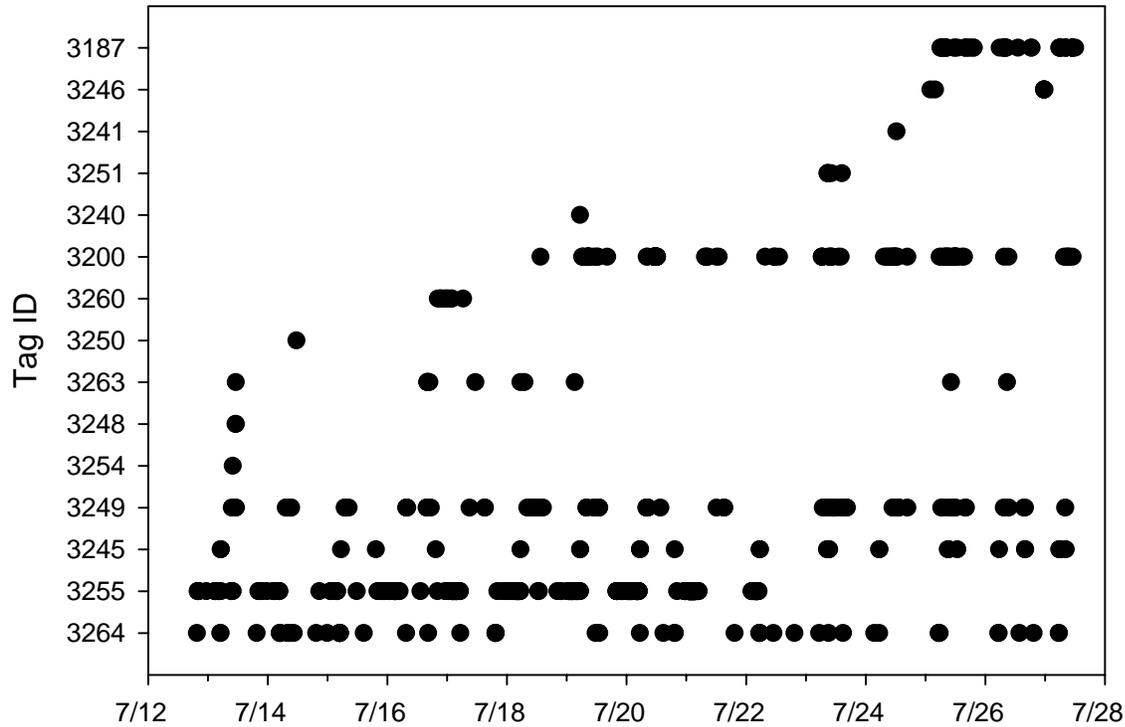


Figure 7. Tag detections at Station 2.

Station 2 tag detections.

Tag_ID	July																Total
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
3187														19	10	14	43
3200							1	18	24	6	5	11	15	21	2	6	109
3240								1									1
3241													1				1
3245		2		2	1		1	2	3		2	4	2	3	3	4	29
3246														2	4		6
3248		2															2
3249		3	10	4	6	3	8	6	6	3		12	7	9	4	1	82
3250			1														1
3251												6					6
3254		1															1
3255	6	19	7	12	18	31	26	44	41	98	33						335
3260					6	5											11
3263		1			5	1	2	1						1	1		12
3264	1	3	8	6	2	5		2	4	1	5	3	2	3	4	2	51
Total	7	31	26	24	38	45	38	74	78	108	45	36	27	58	28	27	690

Station 3 located 0.5 km off Yawzi Point. 22 tagged fishes were detected at this station.

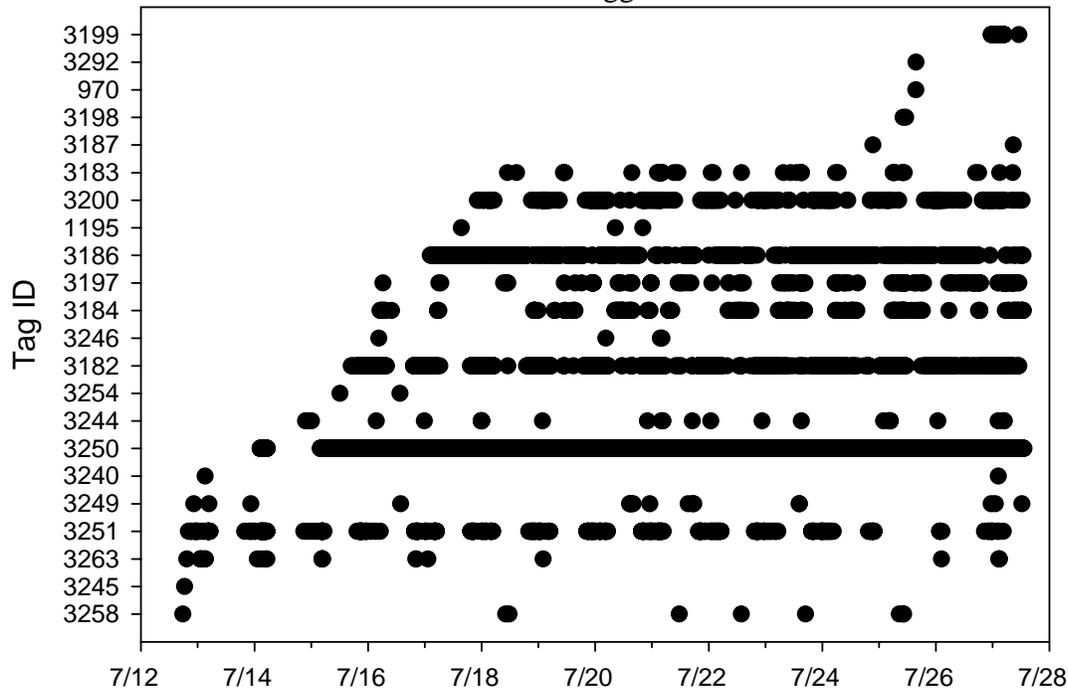


Figure 8. Tag detections at Station 3.

Station 3 tag detections.

Tag_ID	July														Total		
	12	13	14	15	16	17	18	19	20	21	22	23	24	25		26	27
970														1			1
1195						1			2								3
3182				162	342	238	192	251	286	272	290	288	184	349	374	201	3429
3183							2	4	1	37	3	6	2	7	2	2	66
3184					15	5	14	15	49	7	24	44	26	53	6	34	292
3186						173	168	82	64	43	77	125	207	95	123	12	1169
3187													1			1	2
3197					1	2	5	25	13	6	7	23	13	34	28	37	194
3198														2			2
3199															3	34	37
3200						7	49	114	133	66	69	72	61	69	133	64	837
3240		1														1	2
3244			3	1	2	7	1	1	1	5	2	1		10	1	5	40
3245	1																1
3246					1				1	2							4
3249	1	2			1				5	3		2			1	2	17
3250			86	886	996	840	835	909	857	907	798	724	606	796	922	451	10613
3251	38	78	99	124	58	93	104	105	135	134	137	80	80		49	16	1330
3254				1	1												2
3258	1						2			1	1	1		3			9
3263	1	7	4	6	2	1		1							1	3	26
3292														1			1
Total	42	88	192	1180	1419	1367	1372	1507	1547	1483	1408	1366	1180	1420	1643	863	18077

Station 4 located 0.36 km of Yawzi Point between Little Lameshur Bay and Eupora Bay. 23 tagged fishes were detected at this station.

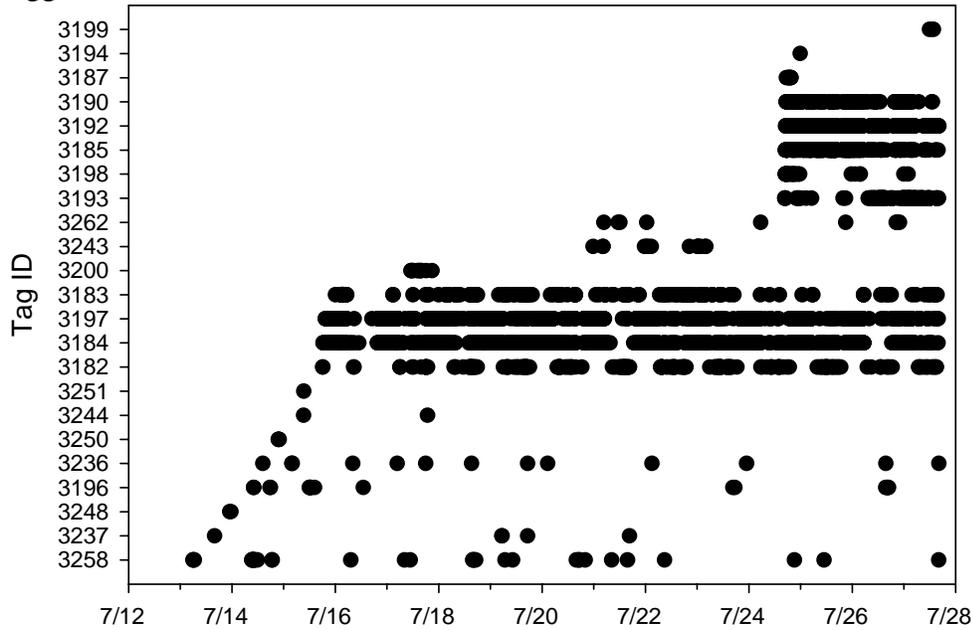


Figure 9. Tag detections at Station 4.

Station 4 tag detections.

Tag ID	July															Total
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
3182			2	2	15	24	32	24	26	28	36	17	25	9	13	253
3183				57	7	23	23	14	18	25	15	3	3	8	9	205
3184			27	124	138	158	100	124	78	58	109	98	63	66	37	1180
3185												62	281	104	28	475
3187												8				8
3190												28	85	109	19	241
3192												59	119	77	61	316
3193												8	5	90	96	199
3194												1				1
3196		4	7	1							2			5		19
3197			48	78	100	99	101	123	113	96	90	81	71	55	51	1106
3198												27	1	4	1	33
3199															2	2
3200					11											11
3236		1	2	1	2	1	1	1		1	1			1	1	13
3237	1						3		1							5
3243								1	3	4	6					14
3244			1		1											2
3248	2															2
3250		4														4
3251			1													1
3258	3	12		1	2	4	2	4	2	1		1	1		1	34
3262									3	1		1	1	3		9
Total	6	21	88	264	276	309	262	291	244	214	259	394	655	531	319	4133

Station 5 tag detections.

Tag ID	July																	Total
	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
101													1					1
154		4	4	8	6	4	1	1	3	3	2	6	2	7	6	1	2	60
162											1							1
169							1											1
187														1	1	3		5
956						1												1
971					1													1
1406								2			1	1			1			5
1407														1				1
1481																	1	1
2201																1		1
3085						1		4	1	1	1		4					12
3182				193	340	390	400	379	363	393	367	377	370	351	276	191	4390	
3183				136	302	362	382	376	369	339	377	355	338	315	302	162	4115	
3184				208	339	416	450	388	424	284	374	350	380	366	268	198	4445	
3185							1	1										2
3187													140	87				227
3192													1					1
3194						1			1									2
3197				229	385	436	420	400	406	387	376	378	379	382	347	226	4751	
3198				1							1		11	172	39	67	291	
3199															82	183	265	
3228													2		1			3
3236				472	591	656	659	697	668	637	593	630	717	687	646	660	306	8619
3237		316	287	228	180	194	108	295	431	407	390	288	231	240	228	126	3949	
3242				6														6
3244				270	236	201	278	299	261	310	254	259	249	281	250	183	142	3473
3247	30																	30
3248				2														2
3250			42	6	8													56
3251					178											124	123	425
3257	65																	65
3258		579	621	713	621	444	508	631	535	484	539	486	414	364	494	375	274	8082
3259										1			1					2
3261							33	36	15	13	67	90	157	143	266	81	120	1021
3273											1							1
3484				1														1
3491																1		1
3498							1					1						2
Total	95	583	983	1759	2642	2854	3279	3431	3323	3442	3269	3358	3295	3334	3578	2971	2121	44317

Station 6 – This station was located off Tektite Reef. 34 tagged fishes were detected at this location.

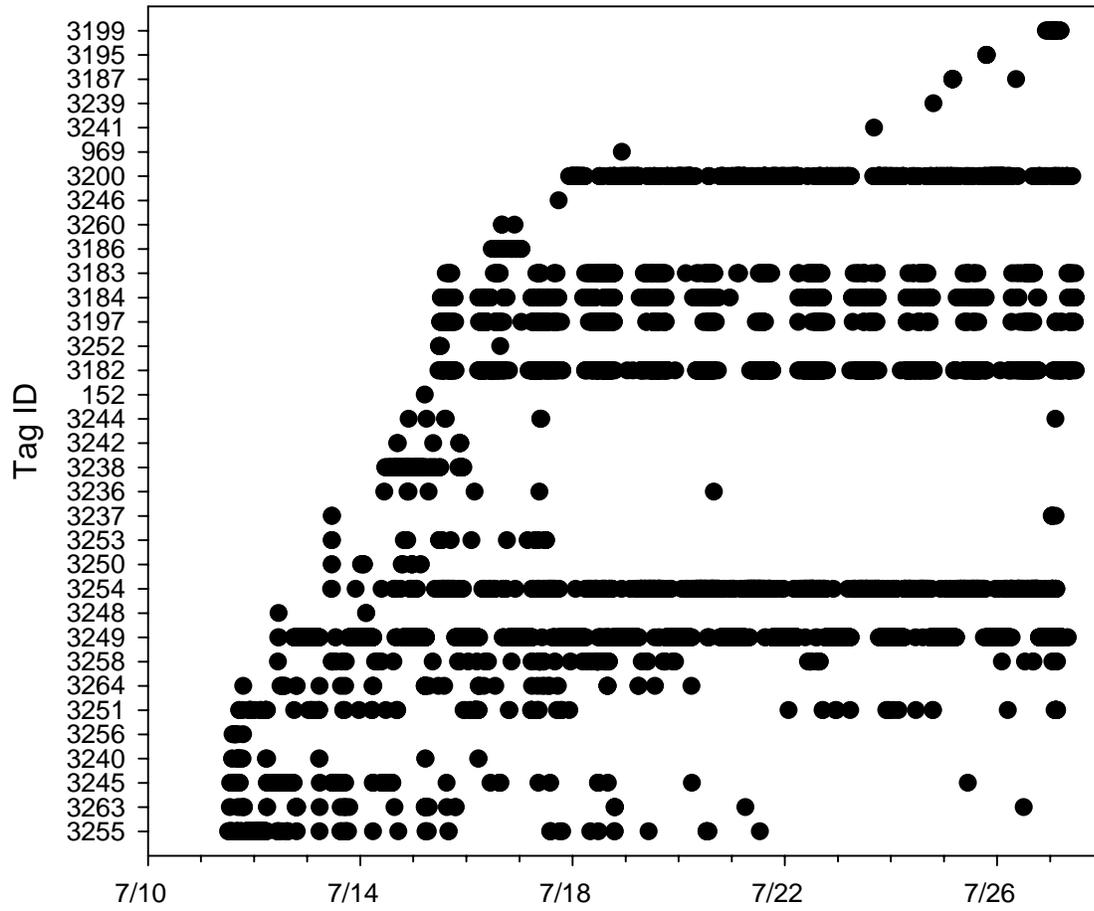


Figure 11. Tag detections at Station 6.

Station 6 tag detections

Tag_ID	July																	Total
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
152					1													1
969								1										1
3182					37	67	85	77	67	103	69	86	84	62	59	47	29	872
3183					8	8	12	53	27	24	29	23	12	11	13	16	6	242
3184					18	57	109	36	53	57		52	50	57	63	7	14	573
3186						30	5											35
3187															9	1		10
3195															4			4
3197					22	30	45	46	18	16	24	24	13	13	10	16	13	290
3199																5	19	24
3200							17	122	92	107	151	94	88	62	118	97	35	983
3236				3	1	1	1			1								7
3237			2															5
3238				60	62													122
3239														1				1
3240	13	3	2		2	2												22
3241													1					1
3242				2	7													9
3244				1	3		3										1	8
3245	23	27	22	18	1	5	2	5		1					1			105
3246							1											1
3248		1		2														3
3249		200	238	211	233	177	214	176	203	214	212	205	218	242	225	207	105	3280
3250			2	12	2													16
3251	11	14	13	7	2	28	19					5	4	5		1	18	127
3252					5	1												6
3253			2	3	4	2	7											18
3254			3	11	42	18	37	54	96	124	119	91	81	75	93	116	25	985
3255	50	81	9	2	5		5	4	1	5	1							163
3256	7																	7
3258		1	8	5	3	5	18	21	9			11				4	2	87
3260						3												3
3263	5	11	5	1	10			3			1					1		37
3264	1	7	3	3	12	5	7	3	3	1								45
Total	110	345	309	341	480	439	587	601	569	653	606	591	551	528	595	518	272	8095

Station 8 – Tektite north, 16 different tagged fishes detected.

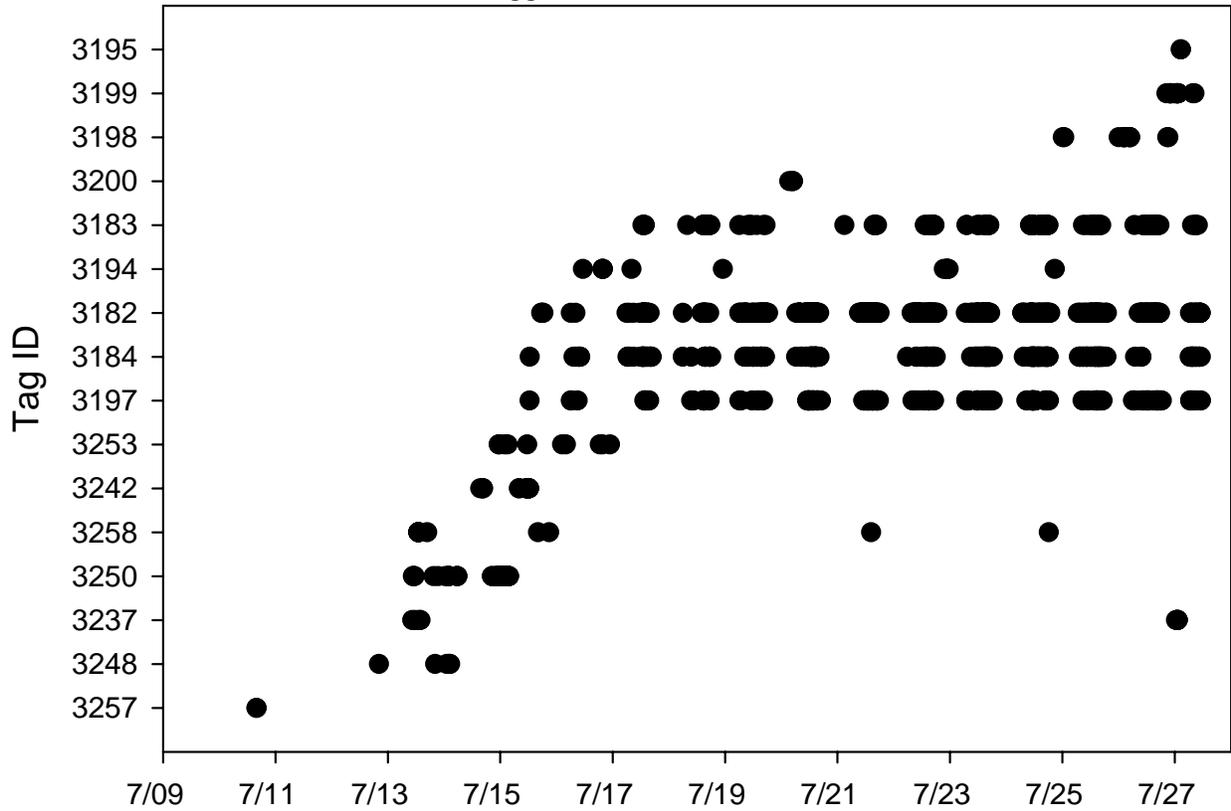


Figure 12. Tag detections at Station 8.

Station 8. Tag ID and number of detections per day

Tag_ID	July																	Total
	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
3182					4	2	31	13	48	76	91	86	58	45	40	48	19	561
3183							5	15	7		6	12	14	27	14	26	5	131
3184				1	9	35	15	23	52			26	46	67	67	3	26	370
3194						4	1	1				6		1				13
3195																	2	2
3197					1	3	7	10	6	26	35	16	17	23	12	26	8	190
3198															2	10		12
3199																11	12	23
3200										3								3
3237			4														5	9
3242				4	12													16
3248		1	1	3														5
3250			6	18	22													46
3253				2	3	5												10
3257	2																	2
3258			6		2					1				1				10
Total	2	1	17	27	45	23	79	54	84	157	133	146	135	164	135	124	77	1403

Station 9 – no receiver was deployed until 28 July 2006

Station 10 – this station was located inside Little Lameshur Bay. 15 tagged fishes were detected at this location.

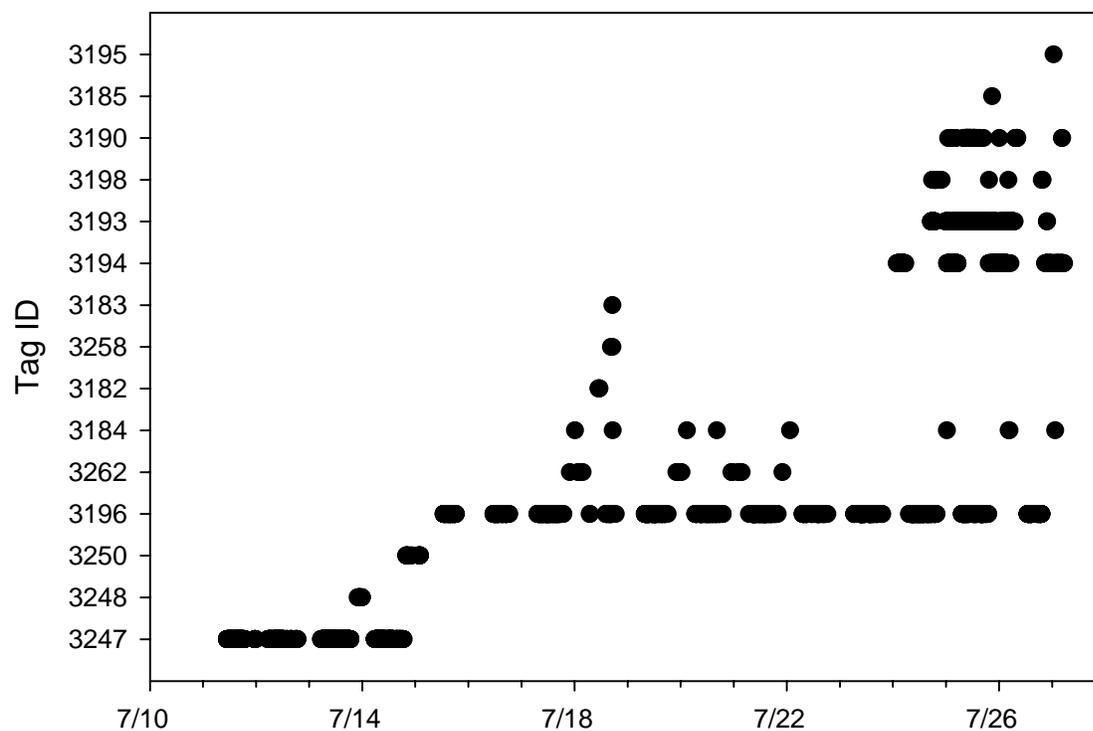


Figure 13. Tag detections at Station 10.

Station 10 tag detections

Tag_ID	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total
3182								4										4
3183								1										1
3184								2		2		1			1	2	1	9
3185															1			1
3190															62	7	2	71
3193															52	631	85	768
3194															119	280	163	604
3195																	1	1
3196					139	145	280	60	250	214	317	150	222	330	232	127		2466
3198														18	1	4		23
3247	371	357	644	480														1852
3248			12															12
3250				9	9													18
3258								2										2
3262							1	3	2	3	5							14
Total	371	357	656	489	148	145	281	72	252	219	322	151	222	519	1208	388	46	5846

Movement Patterns of Individuals Fishes

Lane snapper # 3183

Movement patterns of a 31 cm TL lane snapper (*Lutjanus synagris*) appear in Figure 14. This fish was captured on the 14th of July at Yawzi Point and released at the same location on the 15th at 1100. The fish left the reef off Yawzi Point at dusk on a daily basis and returned at dawn. It was detected off stations 4 and 1 during the night. The fish was not detected on the array for most nights from 2000 until the early morning hours. During the day the fish was detected primarily at station 5 but was also detected at stations 4, 6, and 8, a likely result of movement along various portions of the reef.

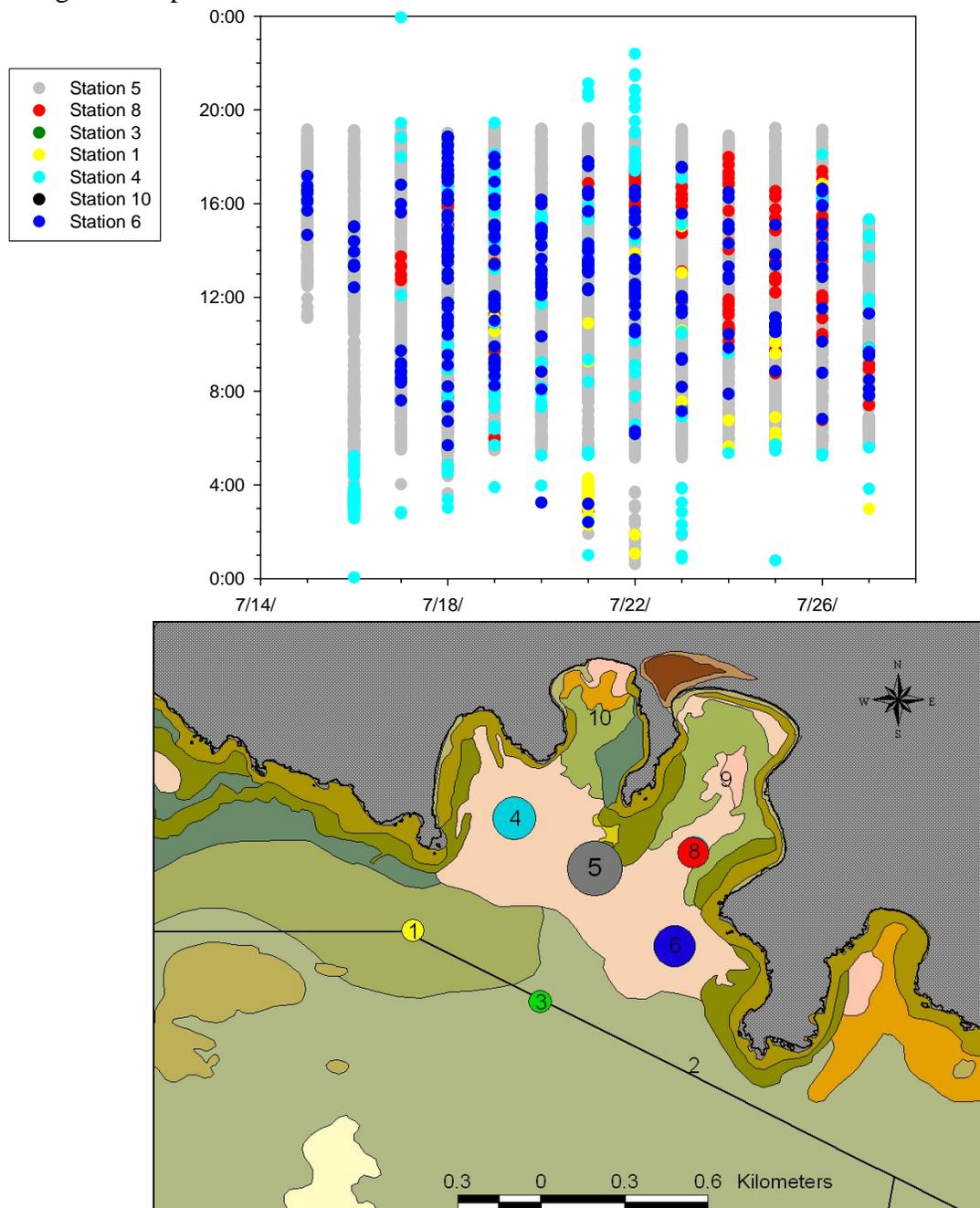


Figure 14. Lane snapper #3183 – 31 cm TL.

Lane snapper # 3200

Movement patterns of this 27 cm TL lane snapper (*Lutjanus synagris*) appear in Figure 15. The fish was captured off Tektite Reef on the 16th of July and released at 1000 on the 17th off Europa Bay. At ca. 2200 it moved offshore and was detected at Station 1. It was detected at Station 3 during the night and was likely out in the seagrass. It was absent from the array at 600 the next day until just after 1200 where it was detected at Station 6 near Tektite reef. For most of the remaining days, it was detected at Stations 6 and 2 and likely moving along the reef edge at Tektite. During the nighttime hours it moved away from the reef and was detected by the receiver at Station 3 and returned to the reef consistently near 600 each day.

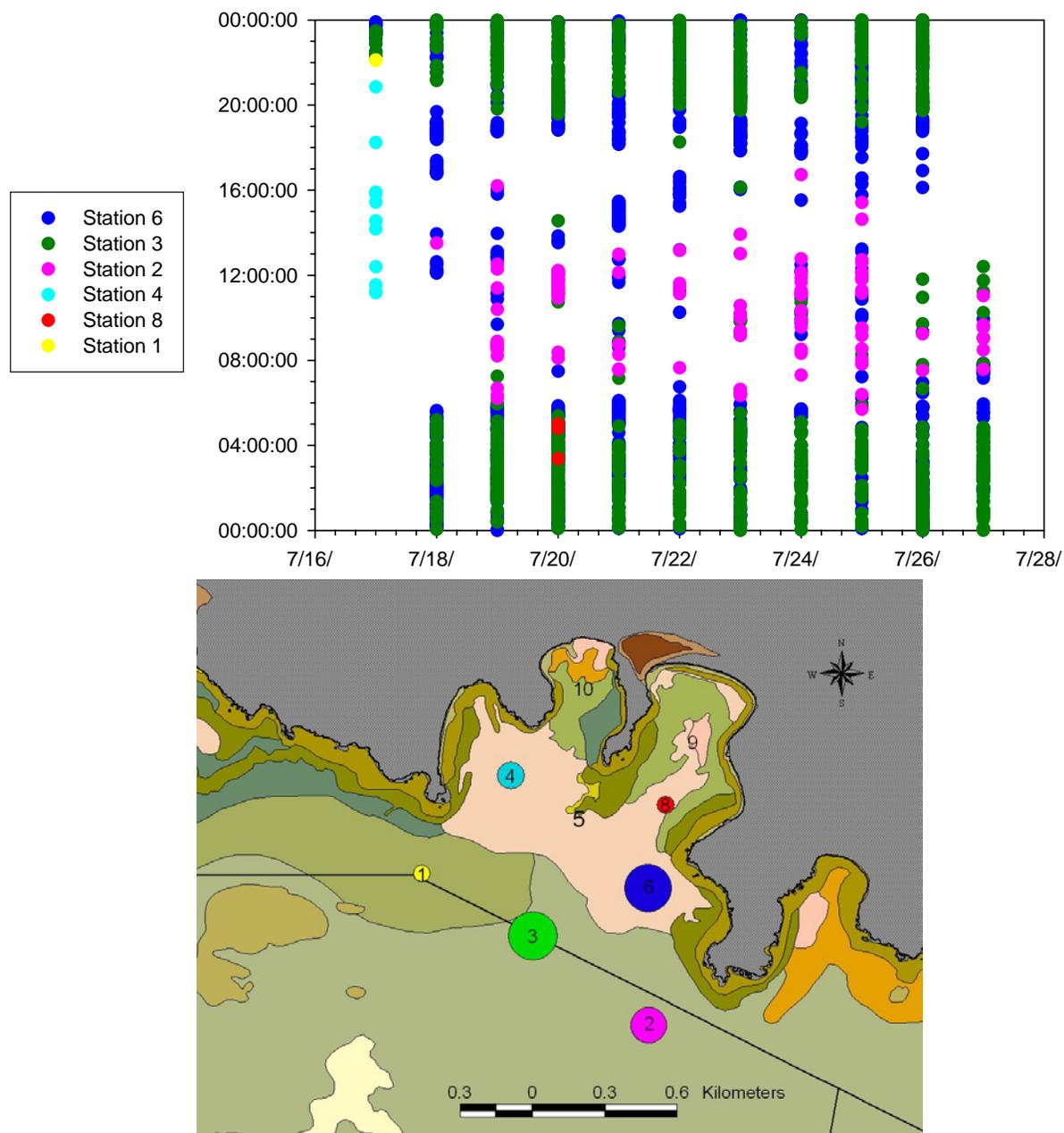


Figure 15. Lane snapper #3200 – 27 cm TL.

Bluestripe grunt # 3198

Movement patterns of this 28 cm TL bluestripe grunt (*Haemulon sciurus*) # 3198 appears in Figure 16. The fish was caught and released at Europa Bay near receiver 4 at ca. 1700 on the 24th of July. It was detected at receiver 4 and 10 (inside Little Lameshur Bay) on the 24th and then moved to Yawzi Point (station 5) where it remained for most of the 25th. During the early hours of the 26th, it was detected on both the east (station 8) and west (station 4) sides of Yawzi reef but was not detected on any receivers during much of the morning of the 26th from 500 to 1100. It was absent from the array from midnight on the 26th until ca. 330 at station 4 on the 27th.

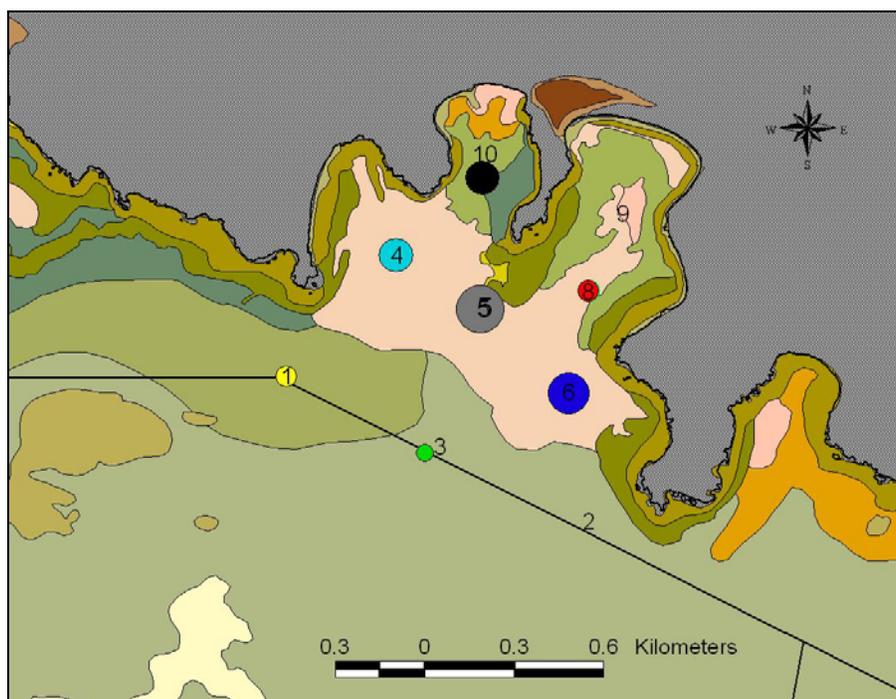
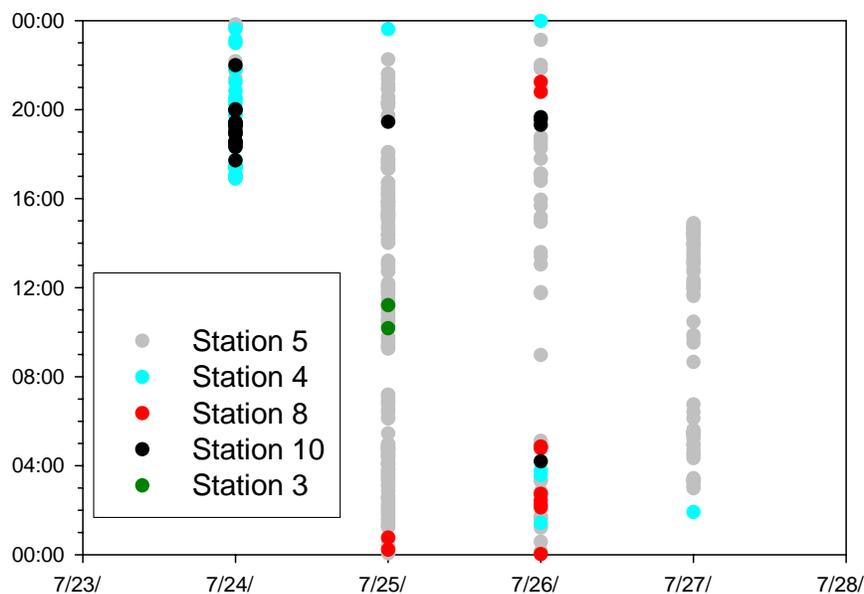


Figure 16. Bluestripe grunt #3198 – 28 cm TL.

Red Hind #3258

A red hind (*Epinephelus guttatus*) 29.5 cm TL was captured and released at Yawzi Point. After release on the 12th, this fish was detected at Yawzi Reef (station 5) for nearly the entire sampling period. Gaps in detections may be attributed to low detection range when the fish was hidden inside the recesses of the reef. Detections by nearby receivers may reflect movement to different locations on Yawzi reef since the fish was also detected by the Yawzi receiver (station 5) at the same time that it was detected by other receivers.

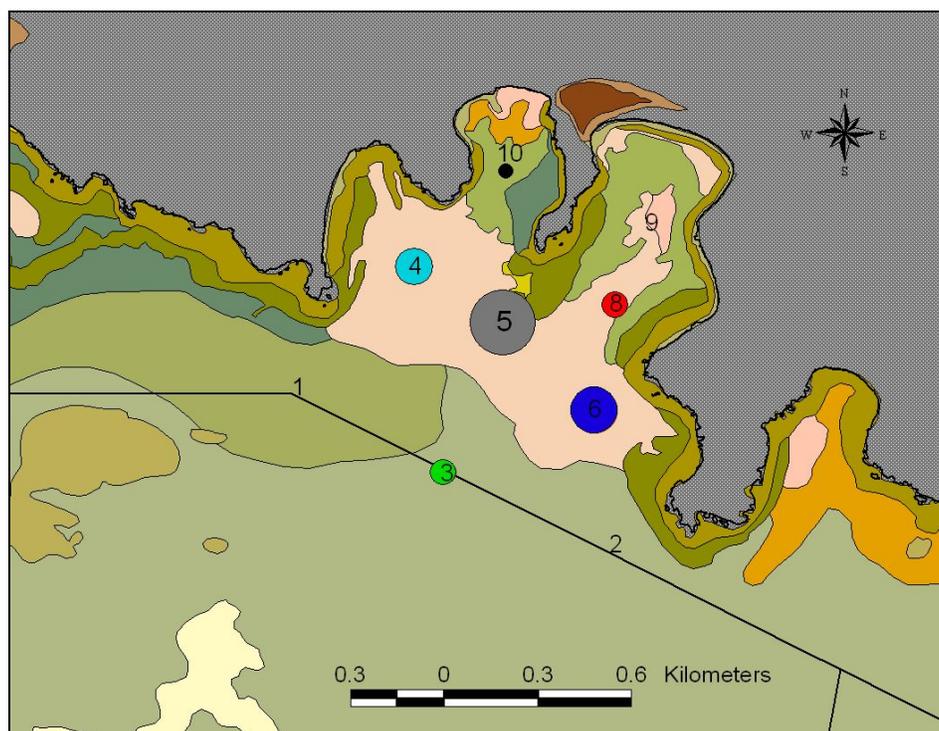
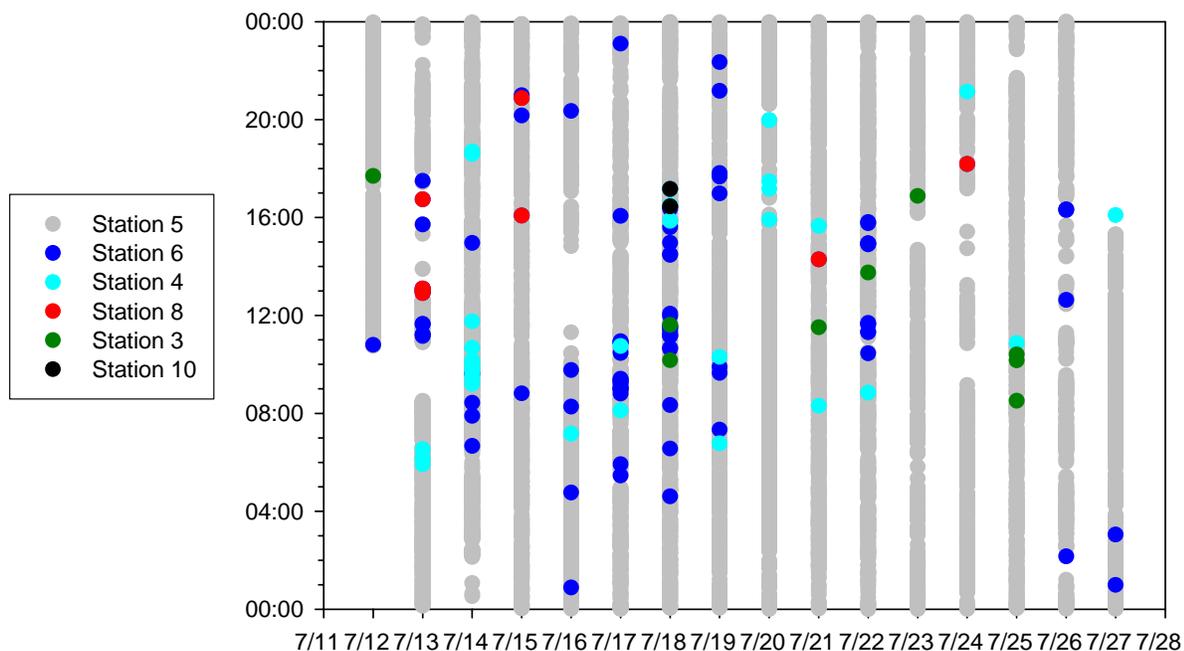


Figure 17. Red Hind #3258, 29.5 cm TL.

Next Steps

The next field deployment is scheduled for April 2007. The plan for this mission is to deploy 15 receivers and tag at least 60 fish.

Analysis of Lameshur Bay data

We will examine telemetry data from the July 2006 Lameshur Bay data on an individual species and tag basis to determine movement patterns and habitat utilization over this short time duration.

Continuation of fine-scale movement patterns

We will continue tagging and tracking of fishes in Lameshur Bay over the next phase of the study.

Shelf-scale movement patterns

In order to examine movement patterns across the shelf, receivers will be deployed in a configuration to maximize spatial coverage and take advantage of know corridors of movement learned from decades of work in the area. Know spawning aggregation points and reefs that serve as navigational aids for migration will also be incorporated into the array design. A proposed receiver array for the next phase of the study appears in figure 3.

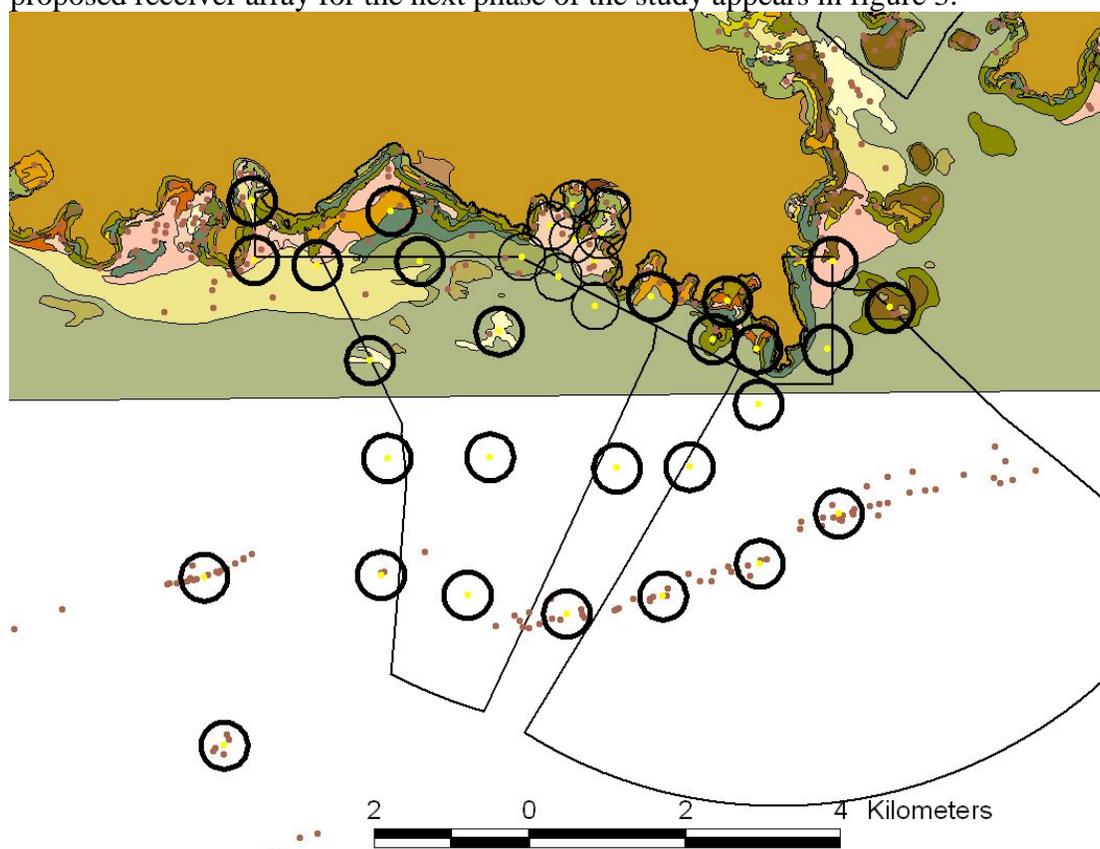


Figure 18. Potential VR2 array design to examine large-scale movement patterns of fishes inside and outside VI National Park, VI Coral Reef National Monument and outside areas (N = 36). 250 m detection radius as an example.