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THE MARINE FISHES OF BROWARD COUNTY, FLORIDA Report of 1999-2000 Survey Results NOAA/NMFS Order # 40GENF900158

Richard E. Spieler

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Submitted by: Richard E. Spieler, Ph.D.
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Signed:_____
Richard E. Spieler Ph.D.

Date: _____

Introduction

The ability to determine change in an environmental resource in response to any anthropogenic, or natural, activity requires an accurate inventory of that resource prior to the activity occurring. The resources of interest to this study are the coral reef fishes of Broward County, Florida.

The coral reef fishes in this area, residents and transients, are subject to multiple environmental insults including: heavy fishing pressure, effluent from Ft. Lauderdale and Port Everglades, and habitat destruction from anchoring and ship groundings (five major groundings have occurred on Broward reefs in the last 5 years). Multiple local management decisions are being implemented, or considered, to alleviate the current situation or to mitigate damage (i.e. small boat mooring buoys, artificial reefs, fish stocking, and marine protected areas). Further, management decisions at the state and federal level can potentially impact the reef fishes of Broward County (e.g. catch limits, redirection of fresh water outflow from Everglades restoration efforts, creation of reserves for reproductive stock in the Florida Keys). Without the knowledge of current stocks the effects of these decisions, or other management approaches to aquatic resources, on local fish stocks will be speculative. In addition, we can continue to anticipate that a variety of unpredicted natural or anthropogenic factors will affect local fishes (e.g. hurricanes, epizootics). Likewise, it will be impossible to evaluate the full extent of damage from these phenomena without baseline data for comparison. Although museum records indicate there has been some sporadic fish collecting in the past (www.flmnh.ufl.edu/fish) there is no record of a comprehensive fish survey for Broward County.

Materials and Methods

During this survey period (14 June 1999 - 14 June 2000) we continued the characterization of the reef fishes offshore Broward County in water from 3 to 30 m. Width of the survey area was determined by the westernmost edge of the first reef (closest to shore) to the easternmost edge of the third; this distance varies but is about one nautical mile. The new transects censused during this contract period were north of the Port Everglades inlet (N 26° 5.50' to N 26° 0.50') in an area of intense recreational fishing and diving. In addition, to gain insight into potential temporal variation in terms of seasonal and annual change, 34 sites previously sampled during the winter months of January through March of 1999 were re-sampled in July and August 1999 and 42 sites initially sampled in August 1998 were re-sampled in August 1999. Five sites, relevant to the survey but counted in July, outside the contract period, are also included in the data files and in the statistical analysis.

The survey consisted of a non-destructive, visual census using the stationary visual census technique of Bohnsack and Bannerot (1986). This method has been statistically verified and is in wide use nationally and internationally on coral reefs. In brief, the technique is a stationary point count of fishes in a 15 m diameter cylinder. A diver, using SCUBA and at a selected point on, or directly above, the substrate, recorded all fishes

within a 7.5 m radius around the point during a 5 min period. After the 5 min species-count was completed, the number of fish per species and the minimum, maximum and mean total length of each species was also recorded along with depth and bottom features The diver carried a 1 m rod with a ruler attached at one end of the rod in a T-configuration to aid in length estimation. In future, more detailed, analyses total length estimates will allow for post-census calculation of biomass using length-weight equations published by Bohnsack and Harper (1988). When a length-weight equation for an identified species is not available, the equation for a congeneric can be used.

The census stations were arranged in a grid pattern: a series of nine stations on an east-west line (determined by DGPS) were done every 0.25 nautical mile of the coastline. Each series of nine stations was divided into three per reef line, one station at the easternmost edge, one at the westernmost edge and one at the crest or centrally located. The sites were selected by motoring west to east on the correct line of latitude and determining the western and eastern edges and crest (or center if no obvious crest) of a reef tract with a paper-recording, depth sounder. The sites were buoyed and immediately cesused. With the exception of the temporal variation studies, each station was censused once. Data were analyzed with non-parametric analysis of variance techniques using Statistical Analysis Systems (SAS) software (PROC GLM of ranked data ≈ Kruskal-Wallis k-sample test, and a Student-Newman-Keuls test between means).

Results

Censusing was accomplished between July 1999 through July 2000. The specific dates of each individual census as well as the DGPS coordinates of each station are included in the attached computer files (this report is accompanied with three computer disks of census data. One each in RVC, Word, and Excel format). As part of the temporal study 76 sites initially counted in 1998 were repeated in this study. In addition, 110 new sites (including 5 in July) were surveyed (Fig. 1, 2). A total of 19,922 fish of 149 species (Table 1) were recorded for the 110 sites.

Seasonal variation: The 34 sites sampled during the summer of this contract period did not differ in fish abundance from the same sites previously sampled during the winter ($p>0.05$). However, there were significantly more species during the summer months ($p<0.001$).

Annual variation: The 42 sites sampled during August of 1999 did not differ in abundance or species richness from counts at the same site the previous August ($p>0.05$). However, there was a large variation amongst counts and these results may represent a Type II statistical error. If time and funds permit, annual variation will be re-examined at a later date.

New sites: There were significantly fewer species ($p<0.05$), but not total fish ($p>0.05$), on the inshore reef tract than on either the middle or offshore tracts, which did not differ ($p>0.05$) (Fig. 3, 4). There was also a differences amongst the positions on a reef with the

three reef tracts combined. The eastern edge had significantly more species as well as total fish ($p<0.001$) than the crest/center and western edges (which did not differ significantly, $p>0.05$)(Fig. 5, 6).

Discussion

Temporal Differences: The fact that no significant statistical differences were found between 1998 and 1999 censuses of the same sites supports the idea that a full baseline survey of the county's fish can be accomplished over a multiyear period. There were significant seasonal differences in species richness with lower species abundance during the winter months. It is unlikely, however, seasonal differences skewed the results of 1998-1999 survey study because the inshore reef tract, although statistically lower in species than the middle tract, was not sampled more than the middle reef during the winter months (November-March). Due to seasonal weather conditions, summer counts will no doubt continue to dominate our annual surveys. This will, likely, overestimate the mean annual total abundance and species richness and underestimate the maximum number of fishes and species within a year. However, by including winter months we will obtain some insight into the local distribution of migratory species.

New sites: The sites north of Port Everglades may differ somewhat from the sites South of the inlet. Sites south of the inlet (1998-1999 survey) had significantly fewer total fish ($p<0.001$) and fewer species ($p<0.001$) on the inshore reef tract than either on the middle or offshore tracts, which did not differ. In contrast on the northern sites although there was also significantly fewer species ($p<0.05$) on the inshore reef tract than either on the middle or offshore tracts there was no difference in abundance amongst the three tracts ($p>0.05$). Whereas the eastern edge of the reef tracts had the highest numbers of fish and species north of Port Everglades the western edge was higher in the southern sites. Finally there were more fish and more species at the northern site (19,922 and 149 respectively for 110 sites), than at the southern sites (16,746 and 139 for 186 sites). Although the reason(s) for these differences is unclear it may relate to reef topography. In general, at the northern sites the eastern edges of the reef tracts have the highest amount of relief; at the southern sites the opposite is true. In addition the amount of relief appears greater at the northern sites and there are a large number of artificial reefs in the vicinity of the northern, but not the southern sites.

Future Directions

Funding dependant, we intend to complete the survey of the three reef tracts of Broward County in 2002. In addition we are currently censusing six derelict ships deployed as artificial reefs between the second and third reef tracts. We will therefore be able to make an in-depth comparison of the fish assemblages on these artificial reefs to the adjacent natural reef. In order to gain a better understanding of the correlation between topography and the associated fish assemblages we have added a complexity rating and a rugosity reading to the data recorded at each site. In addition we intend to modify our substrate

evaluation to duplicate the information presently being recorded on NMFS counts. Finally, we have initiated inquires into the potential for funding a census of the deep-water reef fishes (>35m). Deep reef fishes are an important component of the local recreational fisheries and at present there is little information on the distribution, abundance and habitat requirements of these species.

Publications, Abstracts and Articles

Thesis: Ettinger, B.D. 2000. Coral reef fishes of Broward county, Florida: species and abundance. M.S. Thesis. Nova Southeastern University. 135 pp.

Publication: Ettinger, B.D., D. S. Gilliam, L. K.B. Jordan, R. L. Sherman and R. E. Spieler. 1999. The coral reef fishes of Broward County Florida, species and abundance: a work in progress. Proc. Gulf Caribb. Fish. Instit. (submitted).

Abstracts: Jordan, L.K.B., D. S. Gilliam, B.D. Ettinger, P.T. Arena and R.E. Spieler. 2000. Reef fish distribution off Southeast Florida: ongoing research. 80th Annual meeting of American Society of Ichthyologists and Herpetologists. La Paz. Mexico. p212.

Gilliam D.S., B.D. Ettinger, LKB. Jordan, and R.E. Spieler. 2000. Fish assemblages on high latitude coral reefs: a work in progress. Presented at American Fisheries Society Southern Division Annual Meeting. Savanna Ga.

Newspaper: Cocking, S. 2000. Not even fish can escape the census. Miami Herald, April 25.

Aknowledgements

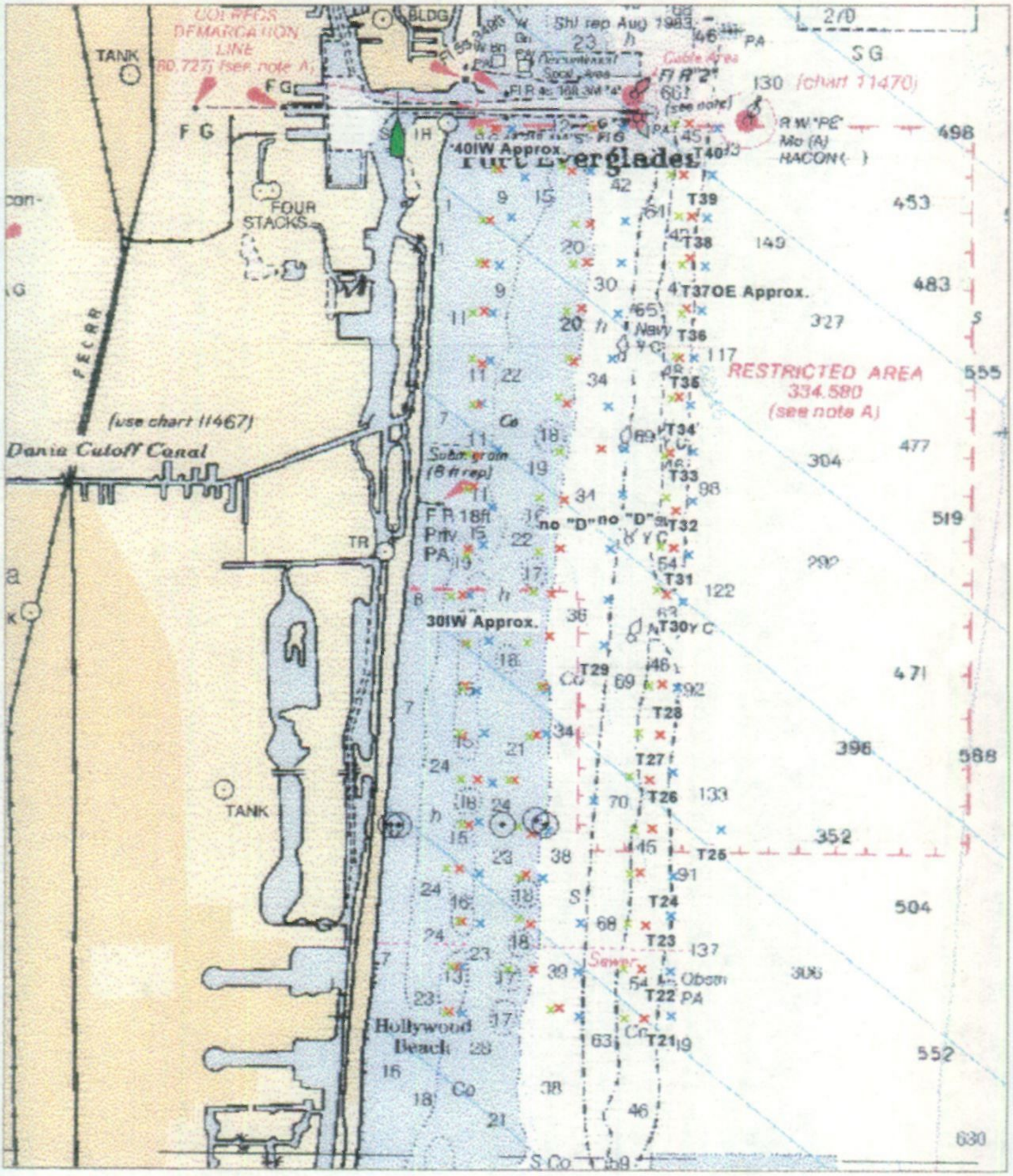
James Bohnsack trained NSU personnel in point-count methodology. Douglas Harper provided essential aid in training NSU personnel in data acquisition and in data transport between differing software programs. Fish censusing was done by Paul Arena, Brian Ettinger, David Gilliam, Lance Jordan, Robin Sherman, Dan Fahy, Brian Walker and Richard Spieler. A number of graduate students from OCN-NSU served as dive-partners. Data from this study, and a portion of the 1998 -1999 study were used as the basis for Brian Ettinger's Masters thesis research.

Literature Cited

Bohnsack, J.A. and S.P. Bannerot. 1986. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. U.S. Dept. of Commerce, NOAA Technical Report NMFS 41:1-15.

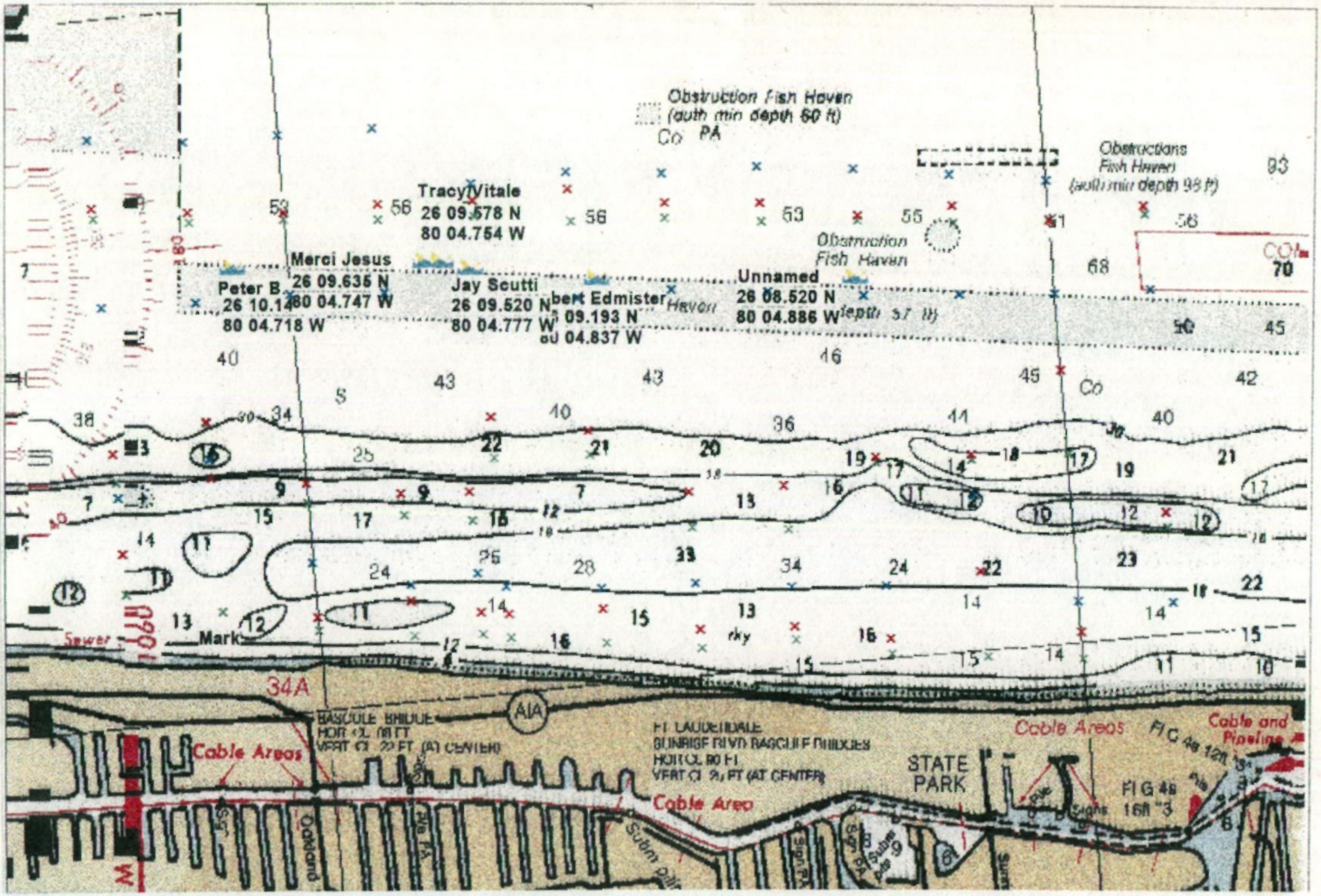
Bohnsack, J.A. and D.E. Harper. 1988. Length-weight relationship of selected marine reef fishes from southeastern United States. NOAA Technical Memorandum NMFS-SEFC. U.S. Dept. of Commerce.

Figure 1. 1998-1999 study area, a 5 nautical mile span along the coast of Broward County extending from the western edge of the inshore reef tract to the eastern edge of the offshore reef tract. The western and central edges and crests of each tract were censused for a total of 181 sites. (Green x=Western Edge, Red x=Crest, Blue x=Eastern Edge). Black circles indicate sites inadvertently censused.



COLREGS DEMARCATION LINE
TANK
FOUR STACKS
Port Everglades
40IW Approx.
RESTRICTED AREA
334.580
(see note A)
(use chart 11467)
Dania Cutoff Canal
T37OE Approx.
30IW Approx.
Hollywood Beach
(chart 11470)

Figure 2. 1999- 2000 study area, a 5 nautical mile span along the coast of Broward County extending from the western edge of the inshore reef tract to the eastern edge of the offshore reef tract. The western and central edges and crests of each tract were censused for a total of 181 sites. (Green x=Western Edge, Red x=Crest, Blue x=Eastern Edge).



Obstruction Fish Haven
(auth min depth 60 ft)
Obstructions
Fish Haven
(auth min depth 98 ft)
Tracy Vitale
26 09.578 N
80 04.754 W
Merci Jesus
26 09.636 N
80 04.747 W
Peter B.
80 04.718 W
Jay Scutti
26 09.520 N
80 04.777 W
Unnamed
26 08.520 N
80 04.886 W
Obstruction
Fish Haven
Cable Areas
Cable Area
Cable and Pipeline
BASCULE BRIDGE
FT LAUDERDALE
SUNRISE BLVD BASCULE BRIDGES
STATE PARK
34A
A1A
Sewer
Mark
Oakland

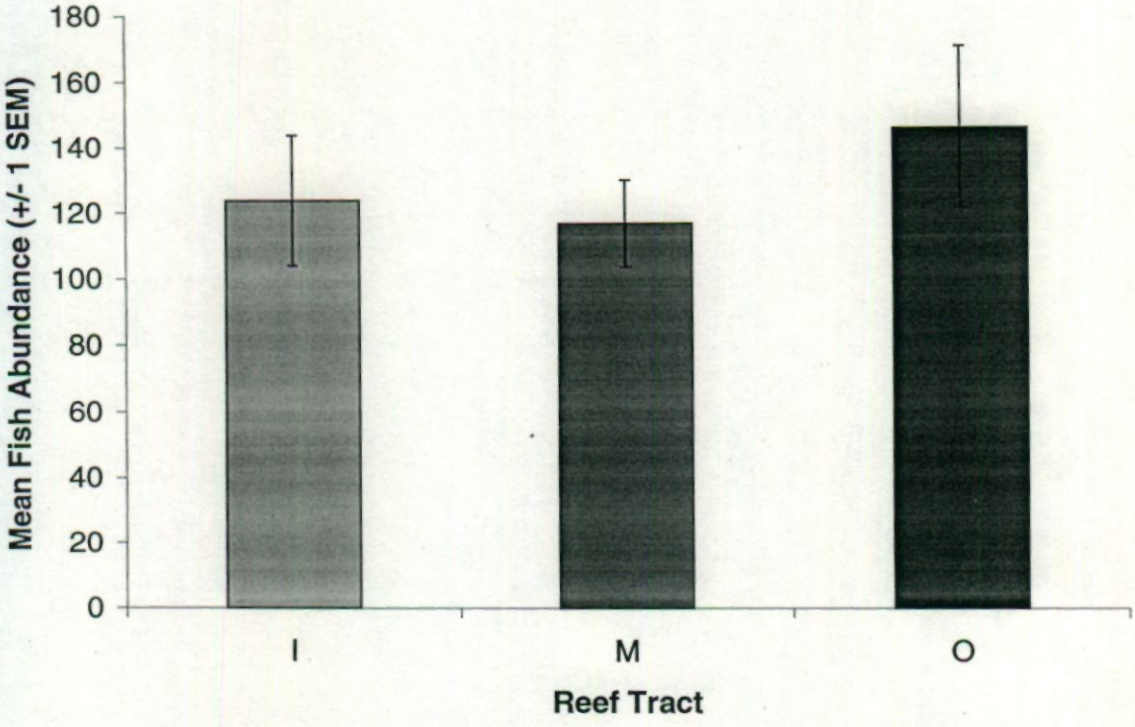


Figure 3. Mean fish abundance on the inshore (I), middle (M), and offshore (O) reef tracts.

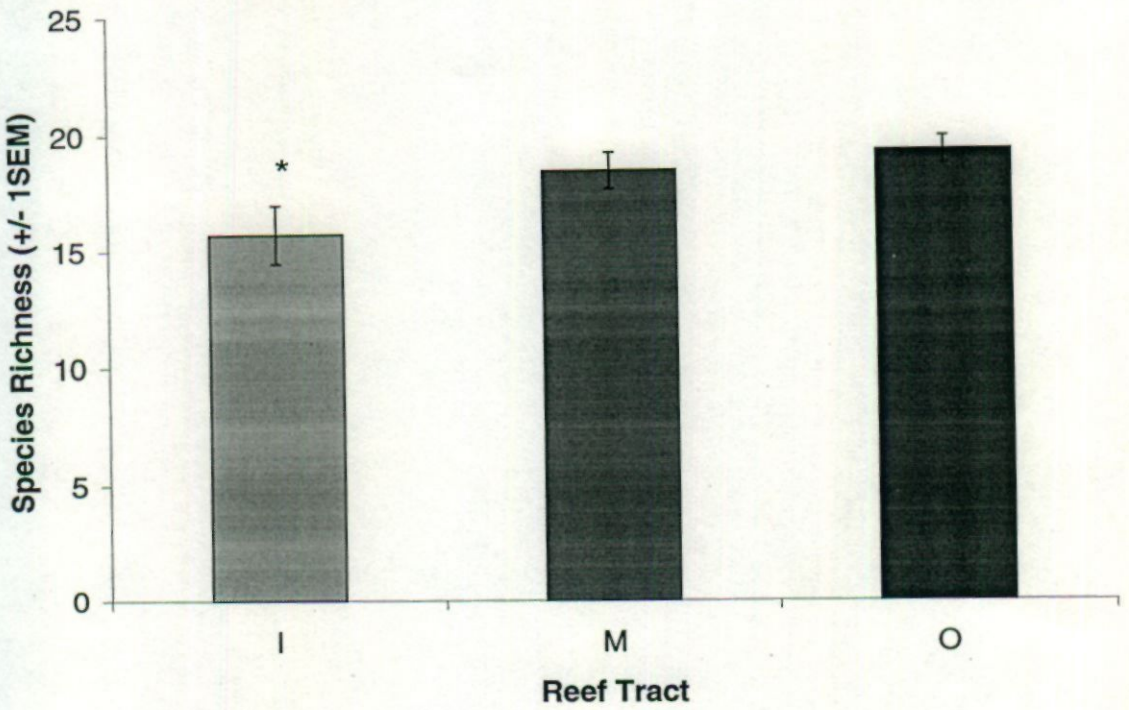


Figure 4. Mean species richness on the inshore (I), middle (M), and offshore (O) reef tracts. Asterisk indicates mean significantly different ($p<0.05$) from non-asterisked groups.

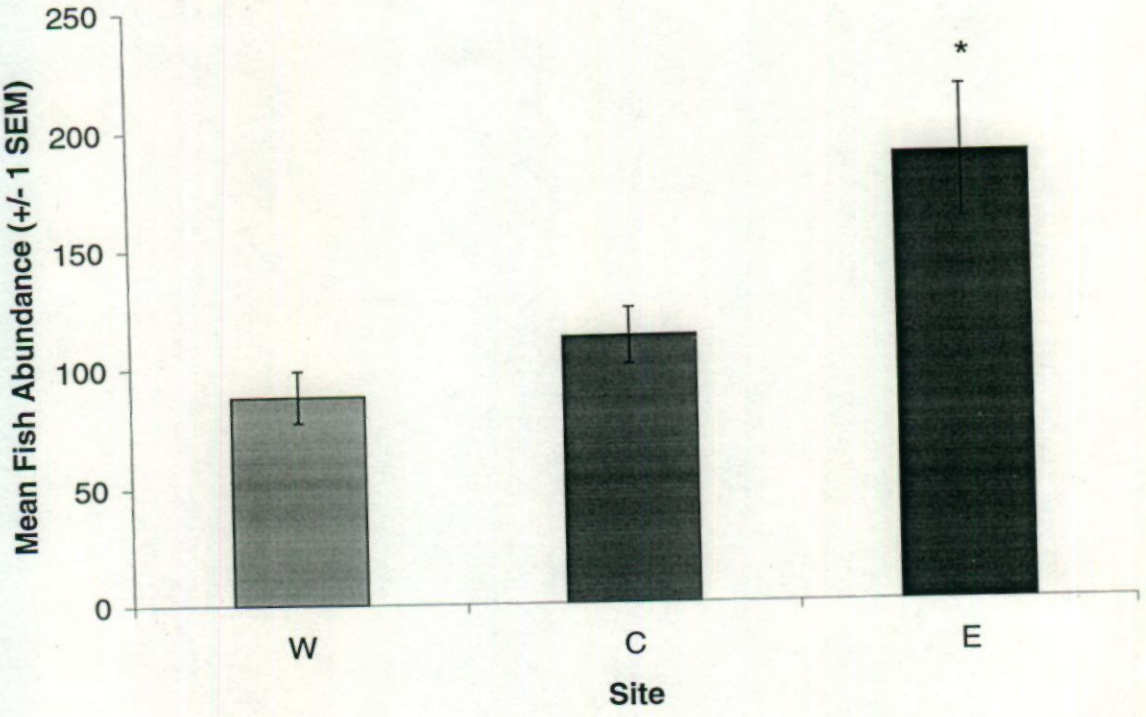


Figure 5. Mean fish abundance on the western (W), crest (C), and eastern (E) reef census sites. Asterisk indicates mean significantly different ($p<0.05$) from non-asterisked groups.

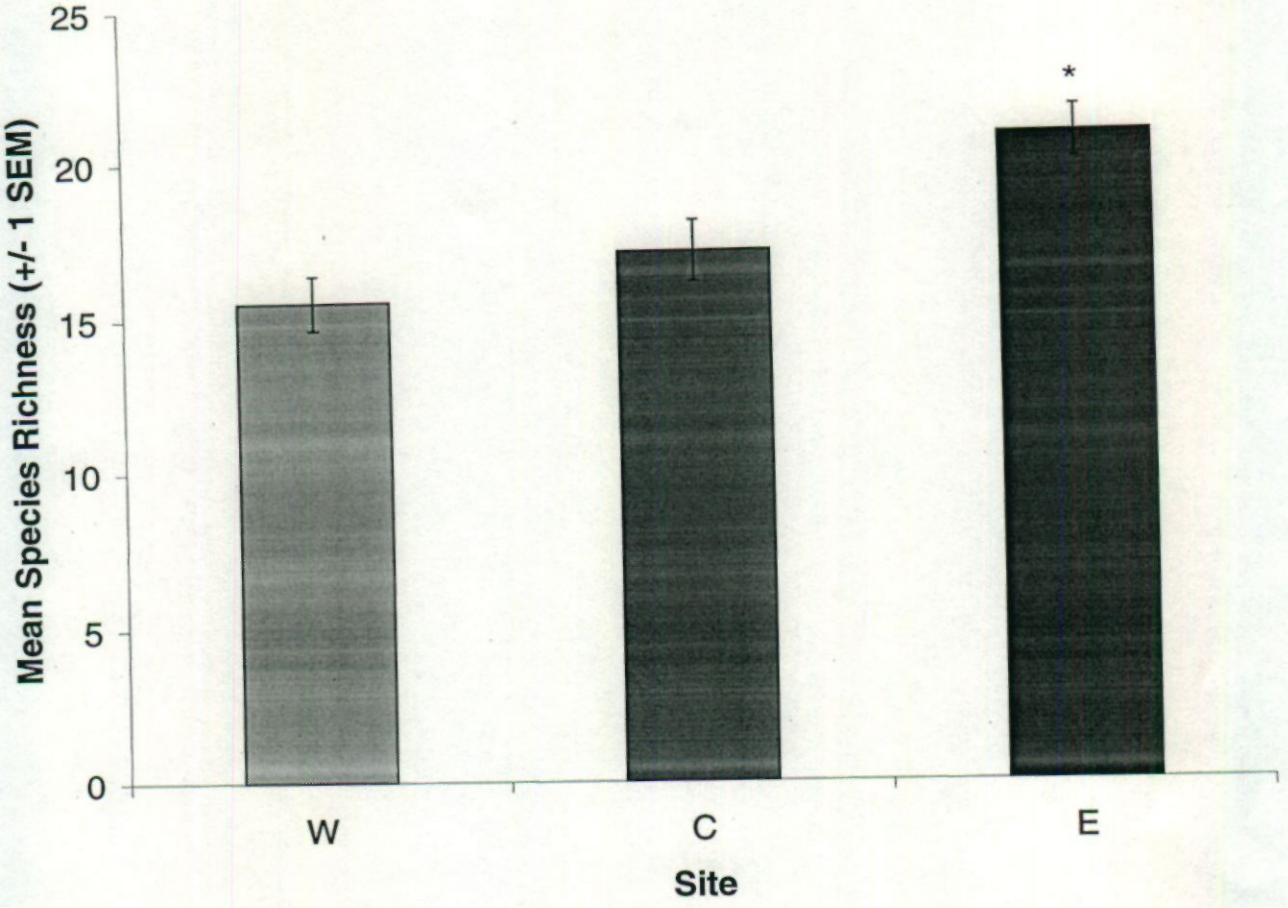


Figure 6. Mean species richness on the western (W), crest (C), and eastern (E) reef census sites. Asterisk indicates mean significantly different ($p<0.05$) from non-asterisked groups.

Table 1. List of fish species identified on at each reef tract from July 1999 through July 2000.

Common Name	Scientific Name	Inshore	Middle	Offshore
STINGRAY	**DASYATIDAE**			
Yellow Stingray	*Urolophus jamaicensis*	X	X	X
Southern stingray	*Dasyatis americana*			X
MORAY EELS	**MURAENIDAE**			
Spotted Moray	*Gymnothorax moringa*		X	X
Green Moray	*Gymnothorax funebris*			X
Purplemouth Moray	*Gymnothorax vicinus*	X		
SEA BASSES	**SERRANIDAE**			
Scamp	*Mycteroperca phenax*		X	
Red Grouper	*Epinephelus morio*	X	X	X
Graysby	*Epinephelus cruentatus*		X	X
Sand Perch	*Diplectrum formosum*	X		X
Hamlet Juvenile	*Hypoplectrus sp.*	X		
Barred Hamlet	*Hypoplectrus puella*	X	X	X
Blue Hamlet	*Hypoplectrus gemma*		X	X
Shy Hamlet	*Hypoplectrus guttavarius*		X	X
Butter Hamlet	*Hypoplectrus unicolor*	X	X	X
Orangeback Bass	*Serranus annularis*		X	
Lantern Bass	*Serranus baldwini*	X	X	X
Tobaccofish	*Serranus tabacarius*		X	X
Harlequin Bass	*Serranus tigrinus*	X	X	X
Chalk Bass	*Serranus tortugarum*		X	X
Tattler Bass	*Serranus phoebe*			X
CARDINALFISHES	**APOGONIDAE**			
Barred Cardinal Fish	*Apogon binotatus*			X
Flamefish	*Apogon maculatus*		X	
TILEFISHES	**MALACANTHIDAE**			
Sand Tilefish	*Malacanthus plumieri*		X	X
BONNETMOUTHS	**INERMIIDAE**			
Boga	*Inermia vittata*			X
JACKS	**CARANGIDAE**			
Bigeye Scad	*Selar crumenophthalmus*	X		
Mackerel Scad	*Decapterus macarellus*		X	
Yellow Jack	*Caranx bartholomaei*	X		
Blue Runner	*Caranx crysos*	X		
Bar Jack	*Caranx ruber*	X	X	X
SNAPPERS	**LUTJANIDAE**			
Gray Snapper	*Lutjanus griseus*	X	X	
Lane Snapper	*Lutjanus synagris*	X		
Mutton Snapper	*Lutjanus analis*	X	X	X
Schoolmaster	*Lutjanus apodus*	X		
Yellowtail Snapper	*Ocyurus chrysurus*	X	X	

Table 1. Cont.

Common Name	Scientific Name	Inshore	Middle	Offshore
GRUNTS	**HAEMULIDAE**			
Black Margate	*Anisotremus surinamensis*	X		X
Porkfish	*Anisotremus virginicus*	X	X	X
Juvenile Grunts	Haemulon sp.	X	X	
Spanish Grunt	*Haemulon macrostomum*	X		
Caesar Grunt	*Haemulon carbonarium*	X		
Smallmouth Grunt	*Haemulon chrysargyreum*	X		
White Grunt	*Haemulon plumieri*	X	X	X
Tomtates	*Haemulon aurolineatum*		X	
French Grunt	*Haemulon flavolineatum*	X	X	
Bluestripe Grunt	*Haemulon sciurus*	X	X	X
Sailors Choice	*Haemulon parrai*	X		
TRUMPETFISH	**AULOSTOMIDAE**			
Trumpetfish	*Aulostomus maculatus*		X	X
SPADEFISHES	**EPHIPPIDAE**			
Spadefish	*Chaetodipterus faber*	X		X
REMORAS	**ECHENEIDIDAE**			
Sharksucker	*Echeneis naucrates*			X
CONGER EELS	**CONGRIDAE**			
Garden Eel	*Heteroconger halis*			X
SQUIRRELFISH	**HOLOCENTRIDAE**			
Squirrelfish	*Holocentrus adscensionis*	X	X	X
JAWFISH	**OPISTOGNATHIDAE**			
Yellowhead Jawfish	*Opistognathus aurifrons*		X	X
Banded Jawfish	*Opistognathus macrognathus*	X		
Dusky Jawfish	*Opistognathus whitehursti*	X		
GUITARFISH	**RHINOBATIDAE**			
Atlantic Guitarfish	*Rhinobatos lentiginosus*			X
BARRACUDAS	**SPHYRAENIDAE**			
Great Barracuda	*Sphyraena barracuda*	X		X
MACKERELS	**SCOMBRIDAE**			
Cero	*Scomberomorous regalis*		X	
SCORPIONFISH	**SCORPAENIDAE**			
Spotted Scorpionfish	*Scorpaena plumieri*	X	X	
BIGEYES	**PRICANTHIDAE**			
Glasseye Snapper	*Priacanthus cruentatus*		X	
SEA CHUBS	**KYPHOSIDAE**			
Bermuda Chub	*Kyphosus sectatrix*	X	X	
FLYINGFISH	**EXOCOETIDAE**			
Ballyhoo	*Hemiramphus brasiliensis*		X	

Table 1. Cont.

COMMON NAME	Scientific Name	Inshore	Middle	Offshore
PORGIES	**SPARIDAE**			
Jolthead Porgy	*Calamus bajonado*			X
Spottail Pinfish	*Diplodus holbrooki*	X	X	
Sheepshead Porgy	*Calamus penna*		X	
Silver Porgy	*Diplodus argenteus*		X	
Knobbed Porgy	*Calamus nodosus*			X
Littlehead Porgy	*Calamus proridens*		X	X
Saucereye Porgy	*Calamus calamus*	X	X	X
DRUMS	**SCIAENIDAE**			
Highhat	*Equetus acuminatus*	X	X	X
GOATFISHES	**MULLIDAE**			
Spotted Goatfish	*Pseudupeneus maculatus*	X	X	X
BUTTERFLYFISHES	**CHAETODONTIDAE**			
Spotfin Butterflyfish	*Chaetodon ocellatus*		X	X
Banded Butterflyfish	*Chaetodon striatus*		X	
Foureye Butterflyfish	*Chaetodon capistratus*	X	X	X
Longsnout Butterflyfish	*Chaetodon aculeatus*			X
Reef Butterflyfish	*Chaetodon sedentarius*	X	X	X
ANGELFISHES	**POMACANTHIDAE**			
Queen Angelfish	*Holocanthus cilaris*	X	X	X
Blue Angelfish	*Holocanthus bermudensis*	X	X	X
Rock Beauty	*Holcanthus tricolor*		X	X
French Angelfish	*Pomacanthus paru*	X	X	X
Gray Angelfish	*Pomacanthus arcuatus*	X	X	X
DAMSELFISHES	**POMACENTRIDAE**			
Beaugregory	*Stegastes leucostictus*	X	X	X
Longfin Damselfish	*Stegastes diencaeus*	X	X	
Dusky Damselfish	*Stegastes fuscus*	X	X	
Threespot Damselfish	*Stegastes planifrons*	X	X	
Bicolor Damselfish	*Stegastes partitus*	X	X	X
Cocoa Damslefish	*Stegastes variabilis*	X	X	X
Yellowtail Damselfish	*Microspathadon chrysurus*	X	X	
Sunshinefish	*Chromis insolatus*		X	X
Yellowtail Reeffish	*Chromis enchrysurus*		X	X
Brown Chromis	*Chromis multilineatus*	X		X
Purple Reeffish	*Chromis scotti*		X	X
Blue Chromis	*Chromis cyanis*		X	X
Sergeant Major	*Abudefduf saxatilis*	X	X	X
WRASSES	**LABRIDAE**			
Hogfish	*Lachnolaimus maximus*	X	X	X
Spotfin Hogfish	*Bodianus pulchellus*			X
Spanish Hogfish	*Bodianus rufus*	X	X	X

Table 1. Cont.

COMMON NAME	Scientific Name	Inshore	Middle	Offshore
WRASSES Cont.	**LABRIDAE**			
Creole Wrasse	*Clepticus parrai*			X
Clown Wrasse	*Halichores maculipinna*	X	X	X
Slippery Dick	*Halichores bivittatus*	X	X	X
Puddingwife	*Halichores radiatus*	X	X	X
Yellowcheek Wrasse	*Halichoeres cyanocephalus*		X	
Rainbow Wrasse	*Halichoeres pictus*		X	
Yellowhead Wrasse	*Halichores garnoti*	X	X	X
Blackear Wrasse	*Halichoeres poeyi*	X	X	
Green Razorfish	*Hemipteronotus splendens*	X	X	
Bluehead Wrasse	*Thalassoma bifasciatum*	X	X	X
PARROTFISHES	**SCARIDAE**			
Parrotfish	Scaridae spp.		X	
Striped Parrot	*Scarus croicensis*	X	X	X
Queen Parrot	*Scarus vetula*	X	X	
Princess Parrot	*Scarus taeniopterus*	X	X	X
Midnight Parrot	*Scarus coelestinus*	X		
Blue Parrot	*Scarus coeruleus*		X	
Rainbow Parrot	*Scarus guacamaia*	X	X	X
Bucktooth Parrot	*Sparisoma radians*	X		
Redtail Parrot	*Sparisoma chrysopterum*	X	X	X
Redfin Parrot	*Sparisoma rubripinne*	X	X	X
Redband Parrot	*Sparisoma aurofrenatum*	X	X	X
Stoplight Parrot	*Sparisoma virride*	X	X	X
Greenblotch Parrot	*Sparisoma atomarium*	X	X	X
Bluelip Parrot	*Cryptotomus roseus*	X		X
MOJARRAS	**GERREIDAE**			
Yellowfin Mojarra	*Gerres cinereus*	X		
NURSE SHARKS	**ORECTOLOBIDAE**			
Nurse Shark	*Ginglymostoma cirratum*	X		
SWEEPERS	**PEMPHERIDAE**			
Glassy Sweeper	*Pempheris schomburgki*	X		
CLINIDS	**CLINIDAE**			
Rosy Blenny	*Malacoctenus macropus*	X	X	
Saddled Blenny	*Malacoctenus triangulatus*		X	
Sailfin Blenny	*Emblemaria pandionis*	X	X	X
Roughhead Blenny	*Acanthemblemaria aspera*		X	
COMBTOOTH BLENNIES	**BLENNIDAE**			
Barred Blenny	*Hypleurochilus bermudensis*		X	
Seaweed Blenny	*Parablennius marmoreus*	X		
GOBIES	**GOBIIDAE**			
Seminole Goby	*Microgobius carri*	X		
Dash Goby	*Gobiosoma saepepallens*		X	X

Table 1. Cont.

COMMON NAME	Scientific Name	Inshore	Middle	Offshore
GOBIES	**GOBIIDAE**			
Neon Goby	*Gobiosoma oceanops*	X	X	X
Bridled Goby	*Coryphopterus glaucofraenum*	X	X	X
Masked/Glass Goby	*Coryphopterus hyalinus/personatus*	X	X	X
Blue Goby	*Ioglossus calliurus*	X	X	X
Hovering Goby	*Ioglossus helenae*			X
Goldspot Goby	*Gnatholepis thompsoni*	X	X	X
SURGEONFISHES	**ACANTHURIDAE**			
Ocean Surgeon	*Acanthurus bahianus*	X	X	X
Doctorfish	*Acanthurus chirurgus*	X	X	X
Blue tang	*Acanthurus coeruleus*	X	X	X
LEATHERJACKETS	**BALISTIDAE**			
Scrawled Filefish	*Aluterus scriptus*		X	X
Orangespotted Filefish	*Cantherhines pullus*	X	X	X
Planehead Filefish	*Monocanthus hispidus*		X	X
Queen Trigger	*Balistes vetula*			X
Gray Trigger	*Balistes capriscus*	X	X	X
BOXFISHES	**OSTRACIIDAE**			
Scrawled cowfish	*Lactophrys quadricornis*			X
Honeycomb cowfish	*Lactophrys polygonia*			X
Smooth trunkfish	*Lacrophrys triqueter*	X	X	X
PUFFERS	**TETRAODONTIDAE**			
Sharpnose Puffer	*Canthigaster rostrata*	X	X	X
Bandtail Puffer	*Sphoeroides spengleri*		X	X
SPINY PUFFERS	**DIODONTIDAE**			
PorcupineFish	*Diodon hystrix*	X		
Balloonfish	*Diodon holocanthus*	X	X	X
Striped Burrfish	*Chilomycterus schoepfi*			X
	Species per site	**96**	**108**	**101**
	Reef Exclusive Species	**20**	**17**	**18**
	Total species			**149**