

FINAL REPORT: YEAR 3

record # 18391

Monitoring Spiny Lobsters in Biscayne National Park

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Summary of Work

This was the third and final year of our contract to sample spiny lobsters in Biscayne National Park (BNP). We monitored thirteen sites in BNP, including ocean side reef sites and hard bottom sites in Biscayne Bay. Our goal was to monitor trends in lobster population size and structure. We hoped to determine the effect of the Two-Day Special Sport Lobster Season on lobsters in BNP by sampling before and after the lobster sport season. At each site, teams of divers searched for lobsters for a total of sixty minutes. Abundance was computed as the total number of lobsters seen during the 60-minute search. Data collected from captured lobsters included den depth, sex, size (mm carapace length), molt stage, reproductive status of females, and presence of late stage HLV-PA infection. Lobsters that escaped were not included in abundance estimates; whenever possible, their sex was recorded. Sampling occurred during the end of June (closed fishing season) through the end of August, immediately following the lobster sport season. Data collection was completed in a total of 5 days using two field teams. The last sampling was on August 2, 2003. In 2003, we spent approximately 10% of the budget on this study.

Lobster size and sex were recorded for all lobsters. The size range of lobsters was 10-150 mm. Hardbottom sites in Biscayne Bay had the widest size range of lobsters, from small juveniles to large adults. Juveniles and adults were found on forereef sites. The only site where there was a decrease in lobster abundance following sport season was at Pacific Reef, a site where we have seven years of data.

Introduction

The Florida Fish and Wildlife Conservation Commission's (FWC) spiny lobster research team monitored spiny lobsters, *Panulirus argus*, at 13 marine protected areas (MPAs) and paired reference areas in Florida Keys National Marine Sanctuary (FKNMS) on a semiannual basis from 1997-2001 (Cox et al. 2001). One of our reference sites, Pacific Reef, is in Biscayne National Park (BNP). In 2001, we began a project to obtain baseline data on spiny lobster size, sex, and abundance in BNP, and to monitor lobster population trends in the future. To this end, we extended our sampling to include six additional reefs in BNP and three hardbottom sites in the Biscayne Bay Lobster Sanctuary (Table 1, Fig. 1). In 2002, we added one new forereef site and two patch reefs, bringing the total number of sites in BNP to 13, to achieve better spatial coverage. We also changed the sampling schedule at Pacific Reef to coincide with the other BNP sites. In 2003, all sites were sampled in June (closed season) and in August, immediately following the Two-Day Special Sport Lobster Season.

Sampling Methods

Divers performed 60-minute timed-searches to sample spiny lobsters. Two teams of divers (consisting of one searcher and one catcher) searched for lobsters for 30 minutes each, resulting in the total number of lobsters observed in 60-minutes (abundance). Lobsters observed by the catcher but not by the searcher were neither counted nor captured. Time was kept by the searcher using a stopwatch that was turned off while lobsters were captured or if the team traveled over a large expanse of unsuitable habitat (seagrass or sand).

At the time of capture, each lobster was numbered, and sex and den depth were recorded.

All captured lobsters were brought to the boat where size, molt stage, and reproductive status of females (e.g. presence or absence and condition of spermatophores and eggs, presence/absence of ripe ovaries) were recorded. Additionally, all lobsters brought onboard were inspected visually for signs of late stage herpes-like lobster virus, HLV-PA (Shields and Behringer, in press). Lobsters that eluded capture were always included in abundance estimates, and when possible, their sex and estimated-size were recorded. Lobsters were returned alive to the area of capture. Sampling was conducted in June (closed fishing season) and early August (open fishing season) immediately following the sport season.

Results

2003

All thirteen sites were successfully surveyed during both closed and open fishing seasons in 2003 (Table 2). We counted a total of 247 lobsters during 2003, with estimated total N equaling 248. Search time at BREWPCH was only 57 minutes, so N was extrapolated for a 60-minute search (Table 3). Two of the captured lobsters had obvious signs of the lobster virus, HLV-PA. Both diseased lobsters were found at the Caesar's Creek site in Biscayne Bay. One was a 12 mm CL male captured in June. The other was a 79 mm CL male captured in August.

Overall, we found more lobsters during the closed fishing season than during the open fishing season. Lobster abundance declined following the sport season at seven of the sites, increased at six of the sites and remained the same at one site (Fig. 2). In all cases, sites with increased lobster abundance post-sport season had increased legal-sized lobster abundance, and legal lobster abundance decreased at sites where lobster abundance decreased after sport season

(Fig. 4, Table 4). There was no trend in the change of lobster abundance by site or habitat type between seasons.

The three habitat types supported different size assemblages of spiny lobsters (Fig. 3). The smallest juveniles were found on hardbottom sites in Biscayne Bay (Table 5). The mean size of lobsters observed at patch reefs was 68 mm CL in the closed season and 71 mm CL in the open season (Table 5), reflecting the preponderance of sub-legal lobsters on patch reefs (Table 6). The largest lobster observed, 103 mm CL, was found on a patch reef after sport season (Table 5). No lobsters smaller than 50 mm CL were found on the forereef (Table 5, Table 6).

2001-2003

Each year, lobster abundance on forereef habitat decreased after sport season, but this decrease was not significant. Abundance at patch reefs varied without trend (Fig. 4). Abundance was log-transformed to reduce variance heterogeneity and transformed data was analyzed using ANOVA. Variance homogeneity was not achieved after transformation, so multiple comparisons were made using Tamhane's T-2 test that does not assume homogeneous variance. Year and season were not significant factors affecting lobster abundance. There was, however, a significant habitat effect (ANOVA: $F = 4.37$; $df = 2, 73$; $P = 0.017$), with lobsters more abundant on forereef than hardbottom (T-2: $P < 0.05$). Log-transformed abundance of legal-sized lobsters was analyzed in a similar fashion. Variance was reduced, but homogeneity was not achieved after transformation, so multiple comparisons were made using Tamhane's T-2 test. Abundance of legal-sized lobsters differed significantly by habitat (ANOVA: $F = 43.54$;

df = 2,51; $P < 0.0005$). Legal-sized lobsters were significantly more abundant on forereef (T-2: $P < 0.05$) than on patch reefs that supported significantly more legal-sized lobsters than hardbottom (T-2: $P < 0.05$).

Abundance of lobsters at Pacific Reef was compared by year and season for using all seven years of data collected at Pacific Reef. There were significantly fewer lobsters during the open fishing season (ANOVA: $F = 10.10$; $df = 1,30$; $P = 0.003$) (Fig. 5). Year was not a significant factor.

Size of all lobsters was compared by year, season, and habitat. Variance heterogeneity was not reduced with transformation, so untransformed values were used in ANOVA, and multiple comparisons were made using Tamhane's T-2 test. Lobster size varied significantly by year, season, and site (Table 7, Fig. 5), but the year x season, year x habitat, and year x season x habitat interactions were significant, precluding conclusions about the main effects. Size of legal-sized lobsters varied without trend among years, seasons, and habitats. Year, season, and habitat were not significant factors affecting size of legal lobsters.

Pacific Reef, 1997-2003

Abundance of lobsters at Pacific Reef was compared by year and season for using all seven years of data collected at Pacific Reef. There were significantly fewer lobsters during the open fishing season (ANOVA: $F = 10.10$; $df = 1,30$; $P = 0.003$) (Fig. 6). Year was not a significant factor.

Discussion

The goal of this three-year study was to establish baseline population information for lobsters in Biscayne National Park and to determine significant factors affecting lobster size and abundance in BNP. To that end, we counted and measured lobsters at selected sites in three different habitats, forereef, patch reef, and hardbottom. We sampled twice yearly, before and immediately following the Two Day Special Sport Lobster Season which may reduce lobster abundance in BNP. We also inspected lobsters for the lethal herpes-like lobster virus, HLV-PA, which may kill infected juveniles before they attain legal size.

Lobsters on forereef sites in BNP were predominately larger than the 76.2 mm CL legal size limit (Fig. 5). If a significant number of legal-sized lobsters were removed from the forereef areas during the sport season, we would expect to see a significant decrease in the size and abundance of forereef lobsters in the open season each year. This however, was not the case (Fig. 4, Table 7).

Very small juvenile lobsters as well as legal-sized adult lobsters were found on patch reef sites in this survey (Table 6, Fig. 5). There was no obvious trend in abundance increase or decrease on patch reefs between years or fishing seasons (Fig. 4). Many factors probably contribute to the actual number of lobsters on a patch reef at any given time. Most patch reefs contain appropriate settlement habitat, and thus may house juvenile lobsters of various sizes. Patch reefs are also located between the large lobster nursery area in Biscayne Bay and the reproductive grounds on the forereef. It is possible that patch reefs provide temporary shelter for lobsters migrating offshore to reproduce. Molting of lobsters from sub-legal to legal size may mask effects of the fishery.

Hardbottom sites in Biscayne Bay are primarily habitat for very small juveniles. Lobsters are found in red algae (*Laurencia* spp.) mats, under sponges and octocorals, as well as in solution holes and under small coral heads. Because lobster fishing is not permitted in Biscayne Bay, and because legal-sized lobsters are uncommon at our hardbottom sites (Table 6, Fig. 5) we did not attribute any variation in lobster abundance or size to harvest during the sport season. The observed variation in lobster size and abundance on hardbottom, though not significant, may be attributed to growth and emigration of juvenile lobsters, as well as to the small sample size. There were significantly fewer lobsters observed on hardbottom than on other habitats (Table 5, Fig. 4).

Our results indicate that there is not much effect of lobster harvest during the Two Day Special Sport Lobster Season at most of the offshore reefs we sampled in BNP. Season was not a significant factor affecting lobster size or abundance (Fig. 3, Fig. 4). These findings are consistent with observations made by BNP staff that most of the fishing effort during the sport season is directed nearshore on the Atlantic side of the Keys that border Biscayne Bay, areas that were not areas targeted by this study.

The only site where fishing season was a significant factor affecting lobster abundance was at Pacific Reef (Fig. 6) for which we had seven years of data. Because most of our open season sampling (5 of 7 years) was completed after more than a month of the commercial lobster fishing season, it is difficult to partition this reduction in abundance between the recreational and commercial fisheries. However, the pattern of abundance reduction was similar in the years when sampling immediately followed the sport season (2002-2003) to that observed when sampling followed the commencement of the commercial season (1997-2001).

Yearly variation in legal-sized lobster abundance results from the variation in recruitment

of sub-legal lobsters to legal size. This variation is largely independent of fishing pressure, depending primarily on previous years' post-larval settlement. The yearly variation is often large enough to mask other sources of variation such as fishing season and habitat. Such was the case in the present study.

In 2003, we found two lobsters infected with the lobster virus, bringing the total to six for the three-year study. Visual inspection to detect the virus is very crude; animals were considered diseased only when displaying outward signs of infection such as discolored hemolymph and shell. In the laboratory, electron microscopy is used to document the presence of the virus in fixed histological samples (Behringer et al. 2002, Shields and Behringer in Press). It is possible that animals in early stages of infection, showing no visible signs, were scored as healthy. Infected lobsters in this study were found at two locations: on the forereef at Pacific Reef, and on hardbottom at Caesar's Creek. To date, there has been no systematic or random sampling of apparently healthy individuals to detect early stages of infection of lobsters residing in BNP. Therefore, the prevalence and geographic range of the disease and its effect on the abundance of lobsters in BNP is not known.

Biscayne National Park supports a local spiny lobster population on various habitats ranging from settlement habitat on hardbottom in Biscayne Bay, to adult reproductive habitat on offshore reefs. Mean size of lobsters is generally smallest in the nursery area, intermediate on patch reefs, and largest on the forereef, though legal-sized lobsters can be found occasionally in all habitats. Interannual variation in lobster abundance masks much of the variation that may be attributable to habitat or fishing season. Additional variation in abundance may be attributed to mortality caused by HLV-PA infection, but this factor has not been quantified. There is too much interaction in variation of lobster size by year, season, and habitat to determine the

significance of those factors. However, size of legal-sized lobsters did not vary among years, seasons, or habitats. Future studies to determine the effect of lobster harvest by commercial or recreational fisheries would be enhanced by comparing fished areas to adjacent areas of similar habitat in which harvest is prohibited.

References

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- Shields, J.D. and D C. Behringer. In press. A pathogenic herpes-like virus in the Caribbean spiny lobster, *Panulirus argus*, from the Florida Keys. Diseases of Aquatic Organisms.

Table 1. Lobster sampling sites in Biscayne National Park, 2001-2003.

Site	Site Name Code	Habitat
Ajax Reef*	AJAX	forereef
Brewster Reef	BREW	forereef
Long Reef	LONG	forereef
Pacific Reef	PAC	forereef
Triumph Reef	TRIUM	forereef
Alina's Patch Reef	ALINA	patch reef
Bache Shoal	BACHE	patch reef
Ball Buoy	BBUOY	patch reef
Brewster Patch*	BREWPCH	patch reef
Triumph Patch*	TRIPCH	patch reef
Caesar's Creek Hardbottom	CAESR	hardbottom
North Elliot Hardbottom	NELL	hardbottom
South Elliot Hardbottom	SELL	hardbottom

* added in 2002

Table 2. Sample sites, location, and date sampled during 2003.

Date	Site	Habitat	Latitude	Longitude
23 June 2003	Ajax	forereef	25° 23.827	80° 07.908
23 June 2003	Brewster	forereef	25° 34.024	80° 05.982
24 June 2003	Long	forereef	25° 26.685	80° 07.159
23 June 2003	Pacific	forereef	25° 22.190	80° 08.343
25 June 2002	Triumph	forereef	25° 29.466	80° 06.480
24 June 2003	Alina's	patch reef	23°23.173	80° 09.760
25 June 2003	Bache	patch reef	25° 29.110	80° 08.962
24 June 2003	Ball Buoy	patch reef	25° 18.920	80° 11.239
25 June 2003	Brewster Patch	patch reef	25° 32.559	80° 08.159
24 June 2003	Triumph Patch	patch reef	25° 29.825	80° 08.150
24 June 2003	Caesar's Creek	hard bottom	25° 24.387	80° 14.827
24 June 2003	North Elliot	hard bottom	25° 29.817	80° 11.796
24 June 2003	South Elliot	hard bottom	25° 25.258	80° 13.547
1 August 2003	Ajax	forereef	—	—
1 August 2003	Brewster	forereef	25° 33.985	80° 06.041
2 August 2003	Long	forereef	25° 26.564	80° 07.280
1 August 2003	Pacific	forereef	25° 22.204	80° 08.356
1 August 2003	Triumph	forereef	25° 29.577	80° 06.538
1 August 2003	Alina's	patch reef	25° 23.166	80° 09.750
1 August 2003	Bache	patch reef	25° 29.092	80° 08.948
1 August 2003	Ball Buoy	patch reef	25° 18.935	80° 11.248
2 August 2003	Brewster Patch	patch reef	25° 32.566	80° 08.153
1 August 2003	Triumph Patch	patch reef	25° 29.847	80° 08.115
2 August 2003	Caesar's Creek	hard bottom	25° 24.318	80° 14.839
1 August 2003	North Elliot	hard bottom	25° 29.791	80° 11.908
2 August 2003	South Elliot	hard bottom	25° 25.183	80° 13.917

Table 3. Size and abundance of all spiny lobster observed in Biscayne National Park during 2003 by fishing season. n = total number of lobsters counted. Abundance = (N/search time* 60 minutes).

Site	Closed Season				Open Season			
	n	Abund (N/60 min)	Mean Size (mm CL)	Median Size (mm CL)	n	Abund (N/60 min)	Mean Size (mm CL)	Median Size (mm CL)
AJAX	12	12	79	77	14	14	82	80
ALINA	15	15	75	73	11	11	4	75
BACHE	9	9	60	68	2	2	47	47
BBUOY	1	1	55	55	14	14	71	73
BREW	10	10	79	76	11	11	82	81
BREWPCB	20	21	68	72	17	17	71	74
CAESR	9	9	16	16	10	10	36	27
LONG	8	8	80	80	7	7	79	78
NELL	13	13	54	57	2	2	25	25
PAC	21	21	73	75	13	13	79	82
SELL	5	5	21	21	5	5	41	25
TRIPCH	1	1	38	38	2	2	76	76
TRUIM	11	11	80	79	2	2	88	88
Total	137	138	66	73	110	110	70	75

Table 4. Size of all legal-sized spiny lobster (≥ 76 mm CL) observed in Biscayne National Park during 2003. n = number of lobsters measured.

Site	Closed Season			Open Season		
	n Lobster	Mean Size (mm CL)	Median Size (mm CL)	n Lobster	Mean Size (mm CL)	Median Size (mm CL)
AJAX	9	81	78	12	84	81
ALINA	7	86	83	4	88	87
BACHE	1	83	83	0	--	--
BBUOY	0	--	--	6	89	89
BREW	4	84	82	8	85	82
BREWPCCH	8	81	80	5	85	89
CAESR	0	--	--	1	79	79
LONG	8	80	80	5	82	80
NELL	1	80	80	0	--	--
PAC	10	85	86	9	84	83
SELL	0	--	--	0	--	--
TRIPCH	0	--	--	1	77	77
TRUIM	7	84	85	2	88	88

Table 5. Spiny Lobster Size by Habitat during closed and open fishing seasons in Biscayne National Park, 2003.

		Minimum (mm CL)	Maximum (mm CL)	Mean (mm CL)	N lobsters
forereef	closed season	50	98	77	62
	open season	56	98	81	47
patch reef	closed season	23	96	68	48
	open season	40	103	71	46
hardbottom	closed season	12	80	36	27
	open season	15	79	36	17

Table 6. Spiny lobster size by size-category and habitat in Biscayne National Park during 2003.

			Minimum (mm CL)	Maximum (mm CL)	Mean (mm CL)	N lobsters
sub-legal	forereef	closed season	50	75	67	21
		open season	56	75	72	11
	patch reef	closed season	23	73	60	29
		open season	40	75	62	27
	hardbottom	closed season	12	72	34	25
		open season	15	67	33	16
legal	forereef	closed season	76	98	83	38
		open season	76	98	84	36
	patch reef	closed season	76	96	83	16
		open season	76	103	87	16
	hardbottom	closed season	80	80	80	1
		open season	79	79	79	1

Table 7. Analysis of variance of lobster size by year, fishing season, and habitat in Biscayne National Park, 2001-2003.

Dependent Variable: SIZE

Source of Variation	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	182701.316 ^a	16	11418.832	66.597	.000
Intercept	1613858.832	1	1613858.832	9412.378	.000
YEAR	3769.446	2	1884.723	10.992	.000
SEASON	1383.816	1	1383.816	8.071	.005
HABITAT	134820.897	2	67410.449	393.152	.000
YEAR * SEASON	5233.893	2	2616.947	15.263	.000
YEAR * HABITAT	2964.392	4	741.098	4.322	.002
PERIOD * HABITAT	719.283	2	359.642	2.098	.123
YEAR * SEASON * HABITAT	3754.030	3	1251.343	7.298	.000
Error	131167.918	765	171.461		
Total	3992805.000	782			
Corrected Total	313869.234	781			

a. R Squared = .582 (Adjusted R Squared = .573)

Figure1. Lobster sampling sites in Biscayne National Park, 2003.

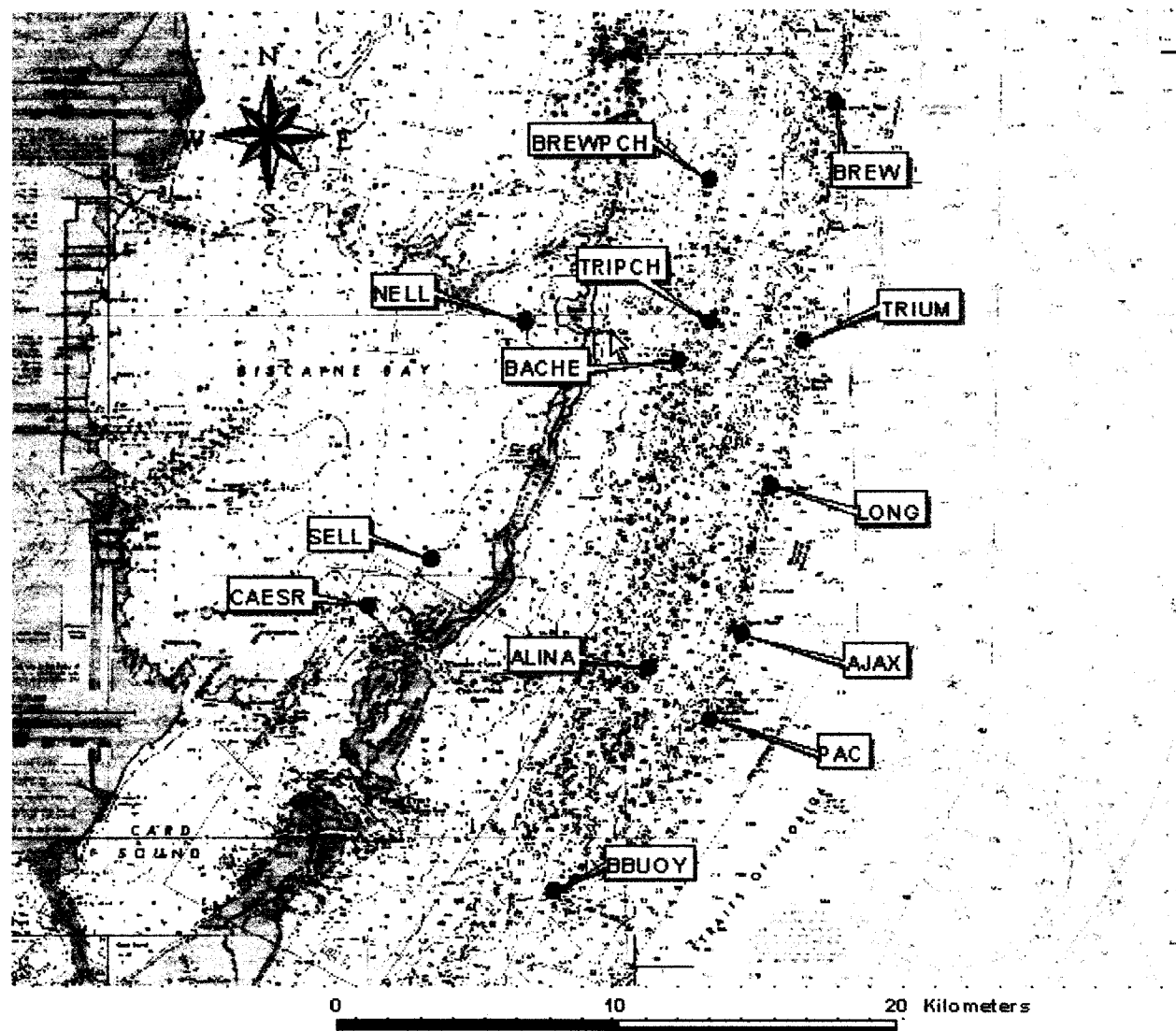


Figure 2. Abundance of spiny lobster at 13 sites in Biscayne National Park before and after lobster sport season during 2003

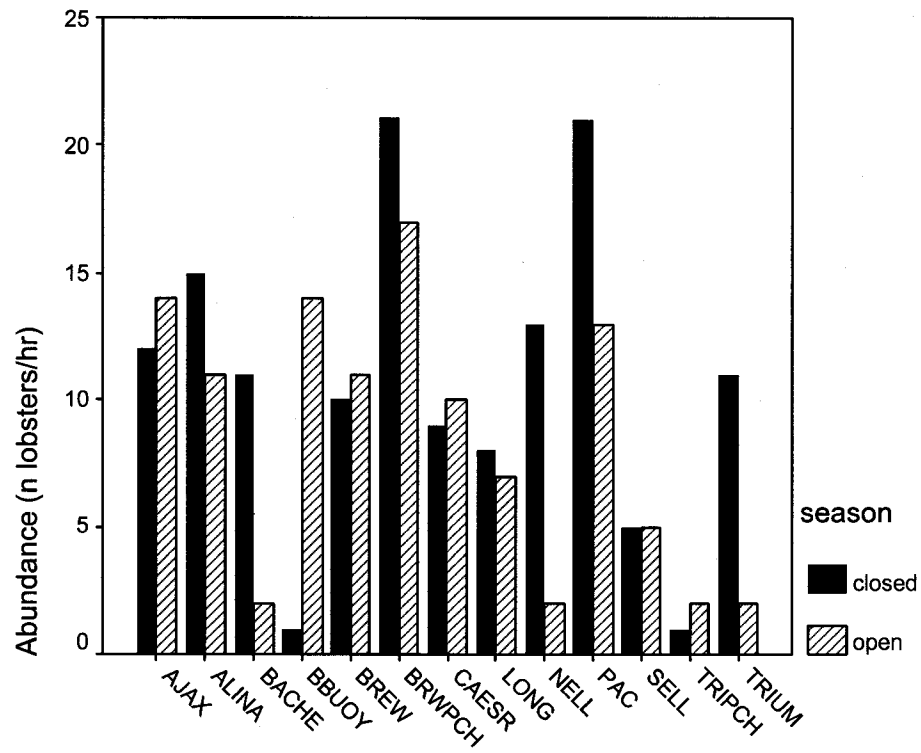


Figure 3. Size of all lobsters measured in Biscayne National Park during 2003. N is the number of lobsters measured.

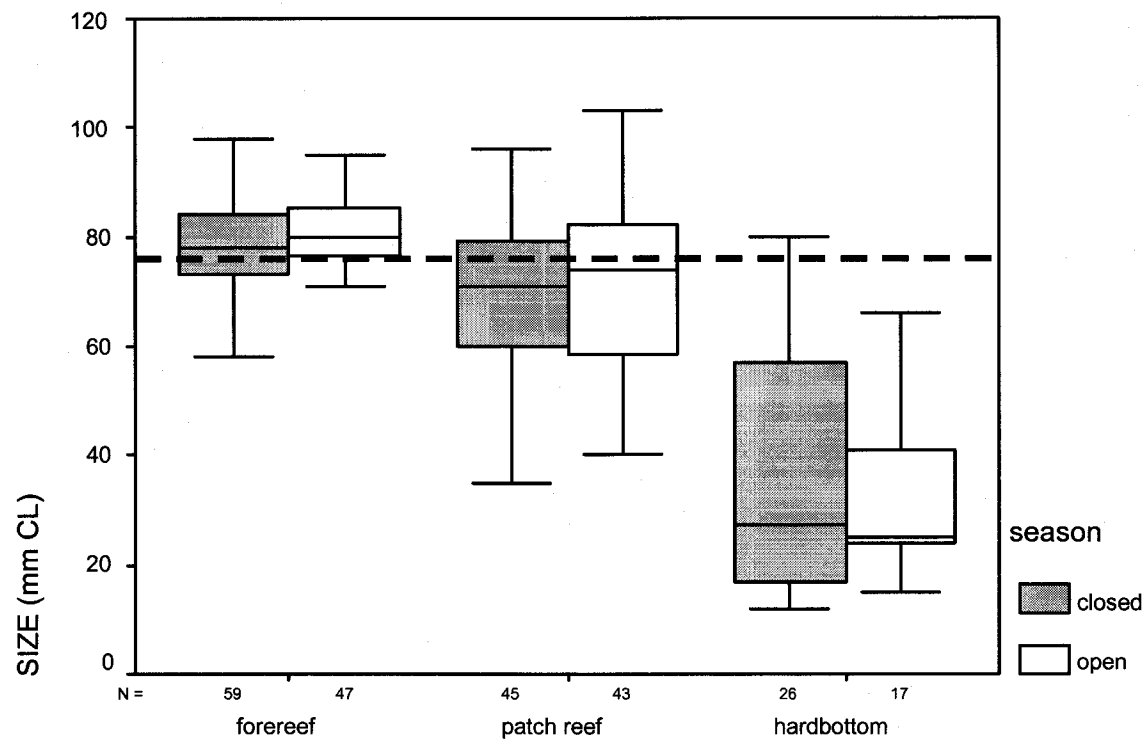


Figure 4. Abundance of spiny lobsters in Biscayne National Park by habitat and season, 2001-2003.

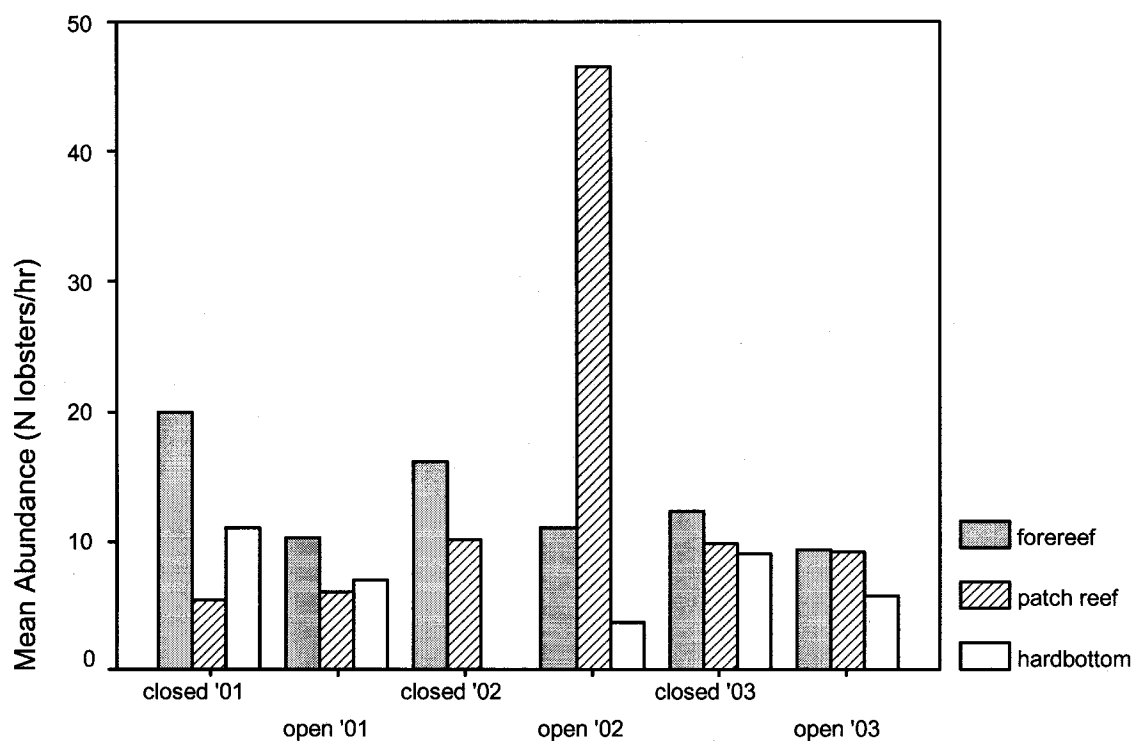


Figure 5. Size of all lobsters measured by habitat, site, and season in Biscayne National Park, 2001-2003. Dotted line denotes minimum legal harvest size (76 mm CL).

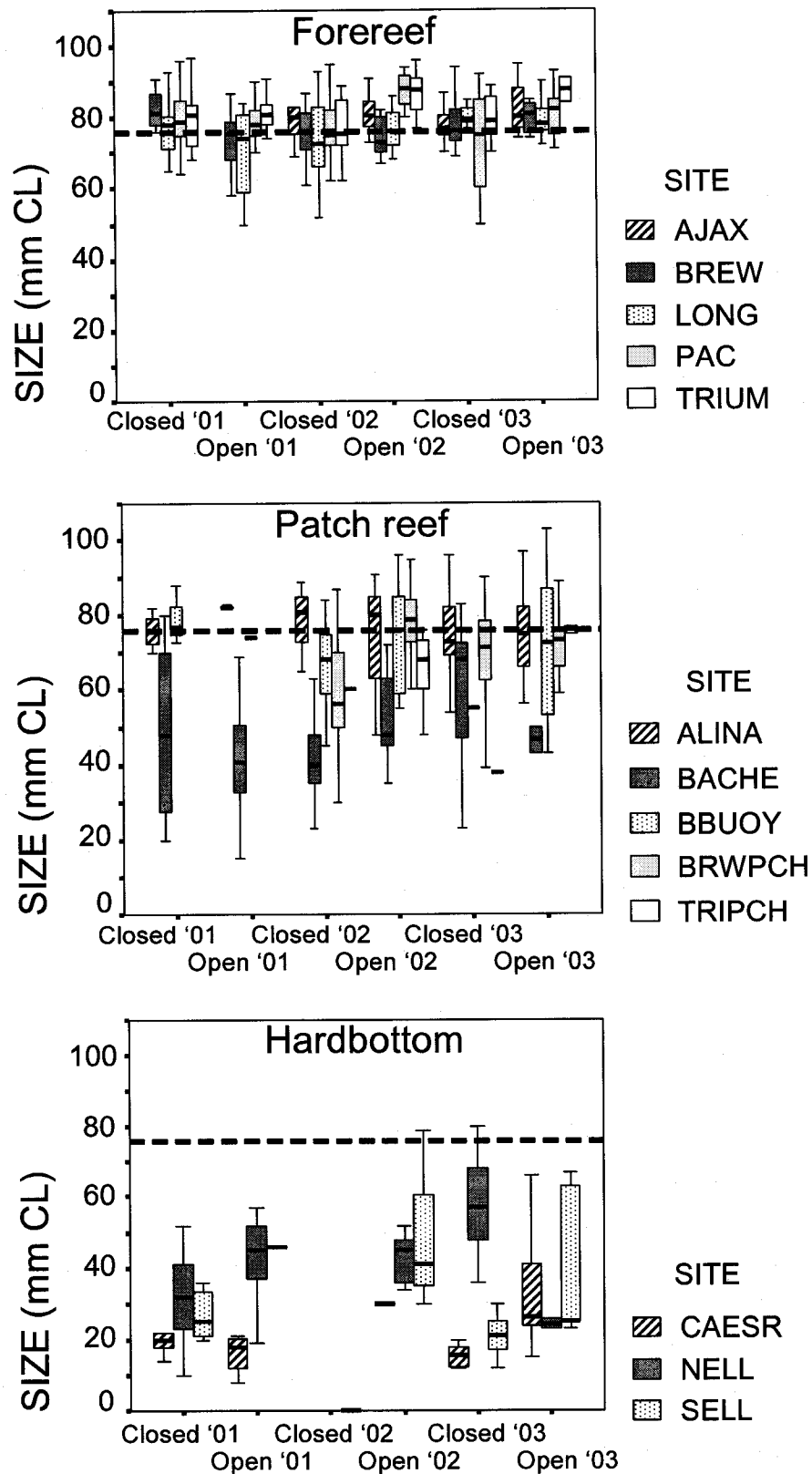


Figure 6. Abundance of spiny lobsters at Pacific Reef, 1997-2003. Bars for 1997 are means of two replicates; bars for 1998-2001 are means of three replicates; bars for 2002-2003 represent one sample each.

