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A Ten-Year Assessment of Lobster Mini-Season Trends in Biscayne National Park, 2002-2011

Natural Resource Technical Report NPS/BISC/NRTR—2012/560

ON THE COVER
Caribbean Spiny Lobsters harvested during Lobster Mini-Season
Photograph courtesy of Biscayne National Park

A Ten-Year Assessment of Lobster Mini-Season Trends in Biscayne National Park, 2002-2011

Natural Resource Technical Report NPS/BISC/NRTR—2012/560

Vanessa McDonough

National Park Service
Biscayne National Park
9700 SW 328th St
Homestead, FL 33033

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Abstract

This report presents findings based on ten years of lobster harvest data in and around Biscayne National Park during the two-day lobster sport season, familiarly called “Lobster Mini-Season”. Park staff members interviewed park visitors upon their return to one of the local county marinas. Demographic data and data on the quantity, species, and gender of the lobster harvest were collected. A declining trend in catch-per-unit-effort was observed over the study period, suggesting that the local lobster population could possibly be declining. Male lobsters tended to be harvested in higher abundance and had larger average sizes than their female counterparts. Observed size differences among the genders may be explained by male lobsters growing faster and achieving larger maximum sizes than females. Additionally, the harvest of egg-bearing females is illegal and it is likely that egg-bearing females are larger in size than the younger females that are not egg-bearing; this could also contribute to the observed size differences among the genders. The increased occurrence of male lobsters compared to female lobsters may be indicative of a variety of factors, including: true population demographics, gender-specific differences in behavior and/or habitat selection which may make males more susceptible to capture, and/or restrictions on harvesting egg-bearing females. Compliance with lobster harvest regulations was observed to be very high for all ten years analyzed. Such high compliance may be attributed to increased outreach and education during the highly publicized Lobster Mini-Season event, a healthy supply of lobsters which made it possible for most harvesters to find plentiful harvest in compliance with the regulations, and/or the increased presence of law enforcement during this highly-attended event that may have served to deter regulation violations.

Acknowledgments

Although too numerous to name, all of the individuals that contributed to the ramp surveys at Homestead Bayfront and Black Point marinas are thanked for their efforts in collecting data that have contributed to a long-term database that will continue to prove to be useful for assessing recreational fishing trends in Biscayne National Park. Biscayne National Park would like to especially thank all of the park visitors who participated in these surveys throughout the years and who graciously took the time to answer interview questions and allow park staff to count and measure their harvest. A. Atkinson, T. Ziegler, M. Balling, A. DiSilvestro, C. Johnson, K. Wall, and E. Alvear reviewed this document and made meaningful edits that greatly improved the quality of this report.

Introduction

Lobster Mini-Season (also known as Lobster Sport Season) was established in 1987 and is an annual two-day event that occurs on the last consecutive Wednesday and Thursday of July, just prior to the onset of the regular recreational and commercial lobster season, which runs from August 6th through the end of March. The Sport Season is designed to give recreational fishers, who harvest lobsters primarily by hand while free-diving or SCUBA diving, an opportunity to harvest lobsters before commercial fishers, who rely primarily on traps to harvest lobsters, become active (Labisky et al. 1980). Commercial fishers can soak their traps on August 1st, which is five days before the full recreational lobster season begins. The Lobster Mini-Season, as well as the regular lobster season, is managed by the State of Florida's Fish and Wildlife Conservation Commission (FWC). Biscayne National Park (BISC) currently adheres to state fishing regulations, and therefore allows lobstering in the park (except within the designated Biscayne Bay-Card Sound Lobster Sanctuary) during the mini-season and the regular lobster season. Regulations include the following and cover the entire ten-year study period unless otherwise noted below:

- Minimum size limit for Caribbean spiny lobsters is 76 mm (3 inches) carapace length; other lobster species do not have a minimum size limit
- For BISC waters (where harvesting is allowed), the bag limit was 12 lobsters per person per day in 2002, and six lobsters per person per day in 2003 and all later years (this change was made when the FWC, at the request of BISC administration, approved a rule amendment to reduce the daily bag limit within park waters, to mirror the Monroe County 6 lobster limit just south of the park).
- For Miami-Dade County non-BISC waters (where harvesting is allowed), the bag limit is 12 lobsters per person per day from surrounding waters where lobstering is permitted.
- The harvest of any egg-bearing female, regardless of species, is prohibited.
- Lobster harvesters must possess a recreational salt water fishing license and a special lobster stamp

Lobster Mini-Season (hereon abbreviated as LMS) has been a much-anticipated and well-attended annual event throughout the state of Florida since its inception in 1987. In South Florida, as elsewhere, this two-day event is acknowledged to support the local economy through increased tourism as well as increased business to the local boating and diving industries. For example, in neighboring Monroe County, it has been estimated that recreational lobstering activity during LMS accounts for 25% of total annual recreational lobstering effort (Leeworthy 2002). Statewide, recreational lobstering in general (including LMS and the regular season) has been estimated to account for 22% of total annual harvest (Hunt 2000).
.
Since the first LMS in 1987, resource managers in Biscayne National Park have been monitoring LMS harvests within and around the park. Park representatives have maintained a presence at the Herbert Hoover Marina at Homestead Bayfront Park and Black Point Park and Marina, which are county-owned and are the two of the major marinas used by the public to access BISC and surrounding waters.

This report summarizes data collected during the last ten years of LMS, spanning 2002 through 2011. The purpose of this report is to better understand LMS-associated harvest, explore trends

over time, and to assess the health and status of lobster resources in park waters. This report is not intended to be a fisheries stock assessment of the Caribbean spiny lobster; as such, information such as the condition of the stock and estimates of population size cannot and should not be inferred from the information provided.

Methods

Ramp surveys

As described above, BISC maintains park representation at Homestead Bayfront and Black Point marinas each year. Park representation consists of biologists, technicians, interpretive rangers, student interns, and trained volunteers, including some staff members who are fluent in Spanish and able to effectively communicate with Spanish-speaking visitors. Effort has been fairly stable across years, with at least eight people staffing each marina for full-day (eight-hour) shifts. On some occasions, effort may have been less due to poor weather and/or reduced staff availability, but, in general, resource managers and volunteers maintained a presence at both marinas each year, attempting to interview as many returning boats as possible. It is acknowledged that these described survey efforts capture a sub-sample of the total number of people lobstering during the two-day event, as staffing and logistical limitations make it impossible to provide 24-hour staffing at every public and private access point in the area. Still, the rather intensive effort is considered sufficient to provide useful data for assessing long-term trends and describing annual lobstering effort, as well as for providing sufficient demographic data on lobstering activity during LMS.

As boaters return to the marina slips, BISC interviewers approach each boat (when possible) and request the captain's participation in the survey. Public participation in this survey is completely voluntary [NOTE: an exception to this is when BISC staff are working in collaboration with law enforcement officials, such as from Florida's Fish and Wildlife Conservation Commission (FWC), in which case the boaters must make their lobsters available for verification of compliance with LMS-associated regulations]. Once the boaters agree to participate, a short series of questions are asked of the captain and crew. These questions are designed to assess lobstering effort as well as obtain general demographic information on people participating in the event. The questions include the following:

- How many people were actively lobstering?
- How many hours were spent lobstering?
- Where did you lobster? (Participants can provide common names for an area and/or indicate their general location on a map provided by the interviewer).
- How many times did you drop anchor while lobstering?
- What method(s) (e.g., free-dive, SCUBA, or hookah) of lobstering did you use ?
- What is the city of residence of the boat captain?
- How many undersized lobsters did you catch and release?
- Did you visit familiar sites (i.e., a site that you have lobstered at before?)
- Did you use a GPS to access your sites?

While this information is being collected by the interviewer, other BISC staff members ask permission to board the boat and begin counting, measuring, and identifying the gender of harvested lobsters. Lobster carapace length is measured to the millimeter using handheld calipers. All staff members participating in this event are trained in the proper use of the calipers prior to beginning the interviews. Gender can be determined by examining the structure of the pleopods (also called swimmerets or swimming legs) on the ventral side of the tail. Pleopods in males consist of one lobe and resemble feathers or paddles; in females, the pleopods have two lobes: one which is the same as described in the males, and a second lobe under the first lobe

which resembles pincers (see Figure 1). Every lobster present on board is counted, although time constraints and/or unwillingness of survey participants sometimes prohibit every harvested lobster from being measured and/or having its gender determined. Illegal activity (e.g., undersized lobsters, too many lobsters, possession of egg-bearing females, and lobsters harvested by spear or other illegal means, etc.) is noted when observed during inspection of harvested lobsters and the surveyors take the opportunity to educate the interviewee about the illegal activity. When undersized or egg-bearing lobsters are discovered and are still alive, they are returned to the water if a law enforcement officer is present; if no law enforcement officer is present, the surveyor recommends to the harvester that he/she release the lobster. Surveyors also educate park visitors who may be free of regulation violations but are admittedly unknowledgeable about the regulations.

Figure 1: Distinguishing between female (top) and male (bottom) spiny lobsters.

Data collection and storage

Surveyors work together in teams of at least two people. One person is the interviewer and records all of the data on the data sheet. All other team members complete the inventory (counting, measuring, and sexing) of harvested lobster.

Datasheets from each day's efforts are compiled and reviewed for completeness and accuracy. All data from the datasheets are entered into a Microsoft Access database. For security reasons (e.g., file back-up and to prevent permanent loss), this database is stored on one of the park's network drives which is backed-up on a daily basis and is not affected by individual computer performance or staff turn-over. Each interview is assigned a unique ID and all data associated with that interview can be traced back to that interview. The hard copies of the data sheets are

filed in BISC's files for several years, and then later moved to the archives at the South Florida Collections Management Center, located at Everglades National Park, for permanent storage.

Data analyses

Data were analyzed using a variety of programs including Microsoft Access, Microsoft Excel, and Systat statistical software. A total of 55,125 lobsters were counted and a subset (33,643) of *Panulirus argus* lobsters were assessed for both size and gender statistics. An additional 566 *P. argus* lobsters had gender data collected but length data was not collected, likely due to time constraints. Analyses were conducted on the 33,643 that had both size and gender data collected. Size and gender data for species other than *P. argus* were often collected but were not included in these specific analyses.

For analyses, Hourly Catch-Per-Unit-Effort (CPUE) was defined as the number of lobsters per person per hour of lobstering effort. Trip CPUE was defined as the number of lobsters per person per trip. Analysis of Variance (ANOVA) was used to test for differences in Hourly and Trip CPUE's among years, with post-hoc Tukey's tests used to determine exactly which years were significantly different.

ANOVA's were also employed to examine the relationships between: i) site familiarity and catch per unit effort and ii) the origin of the harvester and catch per unit effort. Analysis of Covariance (ANCOVA) was used to test for differences in lobster size based on gender (categorical variable) and year (covariate).

For all analyses, data were checked for conformity to assumptions of parametric statistics (e.g., homogeneity of variance, as assessed via Levene's test), and when violations were observed, data were log-transformed in order to meet the assumptions. Transformations were deemed necessary for most analyses. A detailed description of statistical approaches can be obtained by contacting the report author.

Results

Total number of surveys completed and lobsters assessed by year

Over the ten-year study period, the number of interviews completed annually ranged from a low value of 199 (in 2004) to a maximum value of 300 surveys (in 2007) (see Figure 2). Overall, a total of 2,489 surveys were completed in the 10-year period, for an average of 249 surveys per year. Although the refusal rate to participate in the surveys was not specifically tracked, it is estimated that approximately 95% of those approached participated in the survey by answering the questions, and among those who participated, about 90% allowed park staff onto their boats to complete the lobster inventory. Such high participation rates may be at least be partially attributed to the frequent concomitant presence of law enforcement officials, who worked alongside those conducting these surveys.

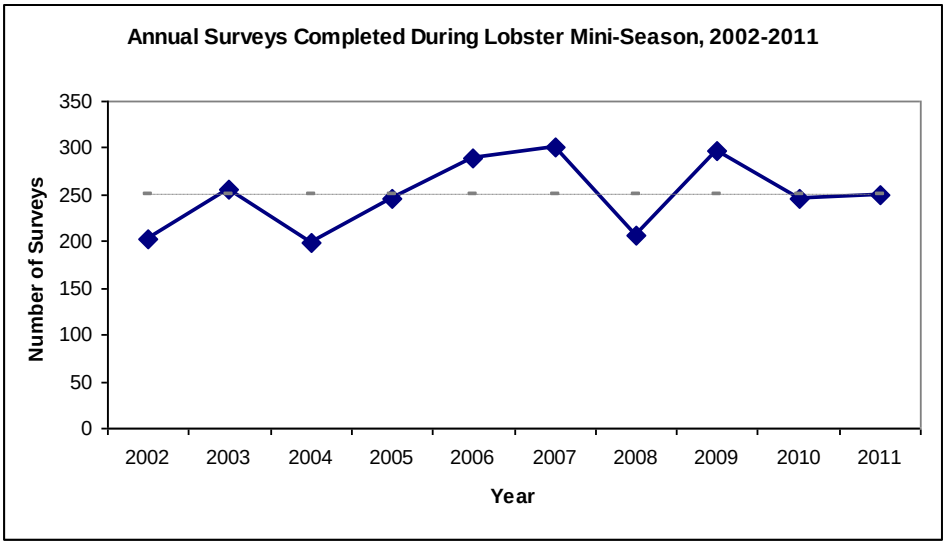

Figure 2: Number of surveys completed during Lobster Mini-Season by year. The grey dashed line indicates the overall ten-year average of 249 surveys completed annually.

Over the ten-year survey period, a total of 55,125 harvested lobsters were counted (for an average of 5,513 lobsters per year). A subset of the 55,125 lobsters encountered was measured due to time constraints and/or willingness of survey participants. Individual annual totals ranged from a minimum of 4,912 lobsters assessed in 2002 to a maximum of 6,112 lobsters assessed in 2006 (see Figure 3).

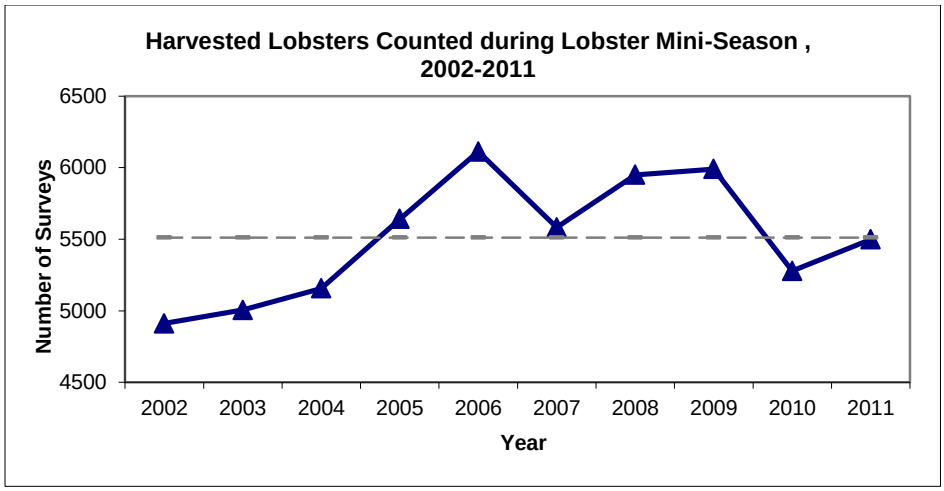

Figure 3: Number of harvested lobsters counted during annual Lobster Mini-Season by year. The grey dashed line indicates the overall ten-year average of 5,513 lobsters counted per year.

Trends in catch per unit effort

Catch per unit effort (or CPUE), defined as the number of lobsters harvested per person per hour, was significantly different across years (ANOVA on log-transformed data, $F = 11.512$, $p < 0.001$), with the results demonstrating an overall declining CPUE over time (see Figure 4). In 2002, the average was 1.72 lobsters per person per hour (which equates to a lobster being harvested for every 34.9 minutes of effort). By 2011, the average hourly CPUE was 1.22 lobsters per person per hour (which equates to a lobster being harvested for every 49.2 minutes of effort). Again, it must be noted that in 2002, the daily bag limit for harvest within BISC waters was 12 lobsters per person, but for 2003 and later years, the daily bag limit was reduced to six lobsters per person.

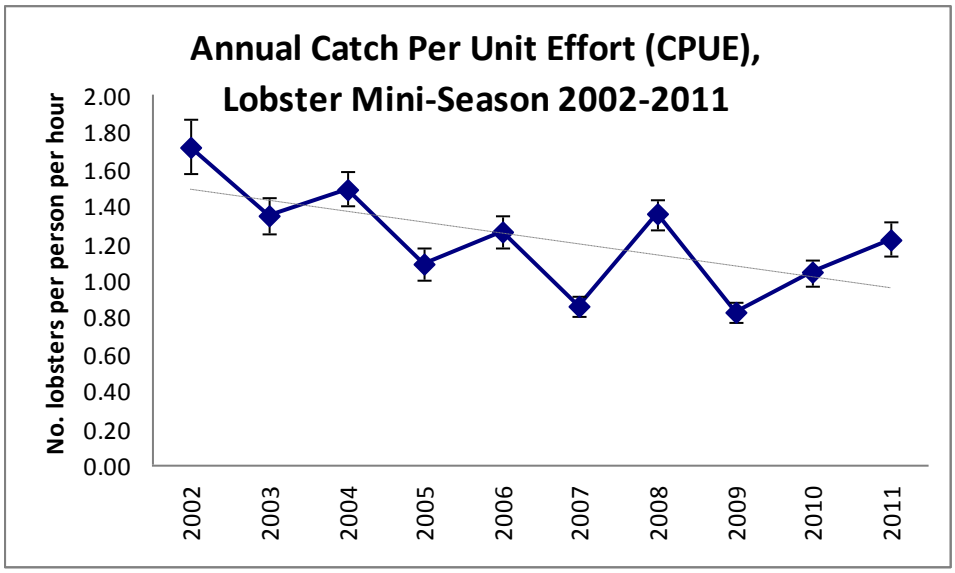

Figure 4: Lobster Mini-Season catch per unit effort (or CPUE, as number of lobsters harvested per person per hour) by year. The dashed gray line shows the declining trend. Error bars represent one standard error.

The post-hoc Tukey's tests suggest a declining trend in CPUE over time. In all, 17 significant differences were detected among all possible 45 pairwise combinations of years, and the large majority (14) of these 17 significantly different pairs showed a significant decrease in CPUE from the earlier year to the later year being compared. CPUE was significantly higher in 2002 (when the daily bag limit within BISC was 12 lobsters per person) than in 2005, 2007, 2009, 2010, and 2011 (when the daily bag limit within BISC had been reduced to six lobsters per person). There were only three pairwise combinations (2007 with 2008, 2007 with 2011, and 2009 with 2011) in which the CPUE of the later year was significantly greater than that of the earlier year.

Site familiarity had a significant effect on CPUE (with all years pooled together). As shown in Figure 5, interviewees who harvested lobsters from a familiar site (i.e., a site that they had previously visited) had a significantly higher CPUE than participants who harvested lobsters from an unfamiliar site (ANOVA, $F = 42.01$, $p = 0.001$). An average of 78% of those interviewed visited familiar sites. The rate of use of familiar sites did not show any temporal trend (e.g., no increased use of familiar sites over time) and variation among years was minimal (e.g., standard deviation of annual mean was 3.7%). The highest observed rate of use of familiar sites was 84.5% (in 2008) and the lowest observed rate was 72.7% (in 2009).

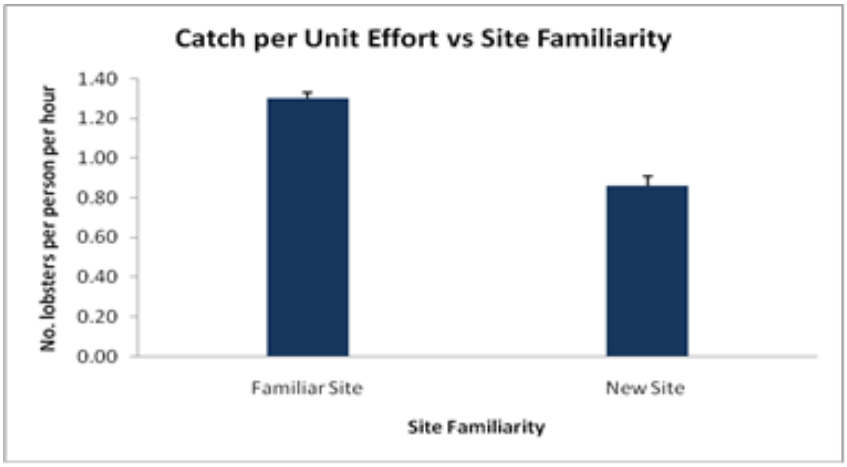

Figure 5: Lobster Mini-Season Trip CPUE as a function of site familiarity. Error bars represent one standard error.

The origin of the harvester (e.g., if the harvester was a local resident or from out of state) did not have a significant effect on CPUE (ANOVA, $F = 0.451$, $p = 0.772$, see Figure 6).

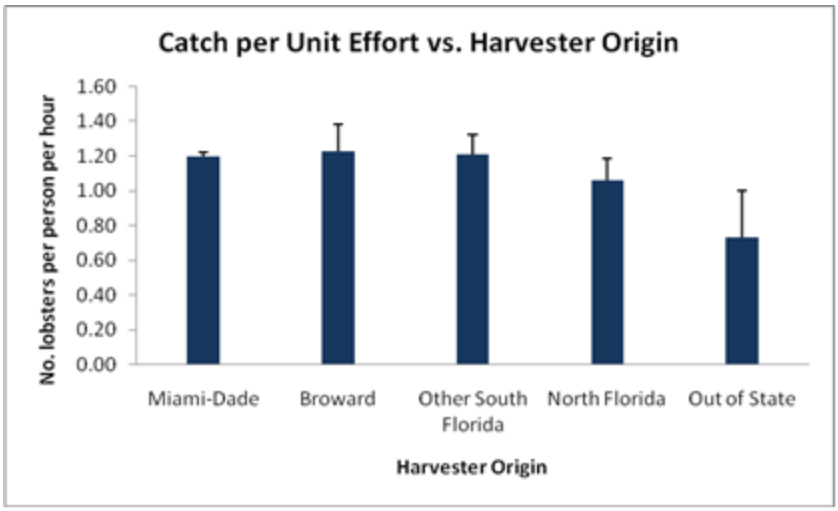

Figure 6: Lobster Mini-Season Trip CPUE as a function of harvester origin. Error bars represent one standard error.

Trip Catch (number of lobsters per-person per-trip, with no consideration of the duration of time spent harvesting lobsters) was also examined. The results are in agreement with the previous CPUE results, showing that trip catch varied by year (ANOVA on log-transformed data, $F = 8.852$ and $p < 0.001$) and that the average number of lobsters a person harvested per trip tended to decline over time (see Figure 7). Note that in 2002, at the beginning of the 10-year period, the average person harvested 5.32 lobsters per trip, but by 2011 this value declined to 3.76 lobsters per person per trip. The 2002 peak in trip catch coincides with the higher daily bag limit (12 lobsters per person) allowed in 2002 versus all other years, in which it was reduced to six lobsters per person per day.

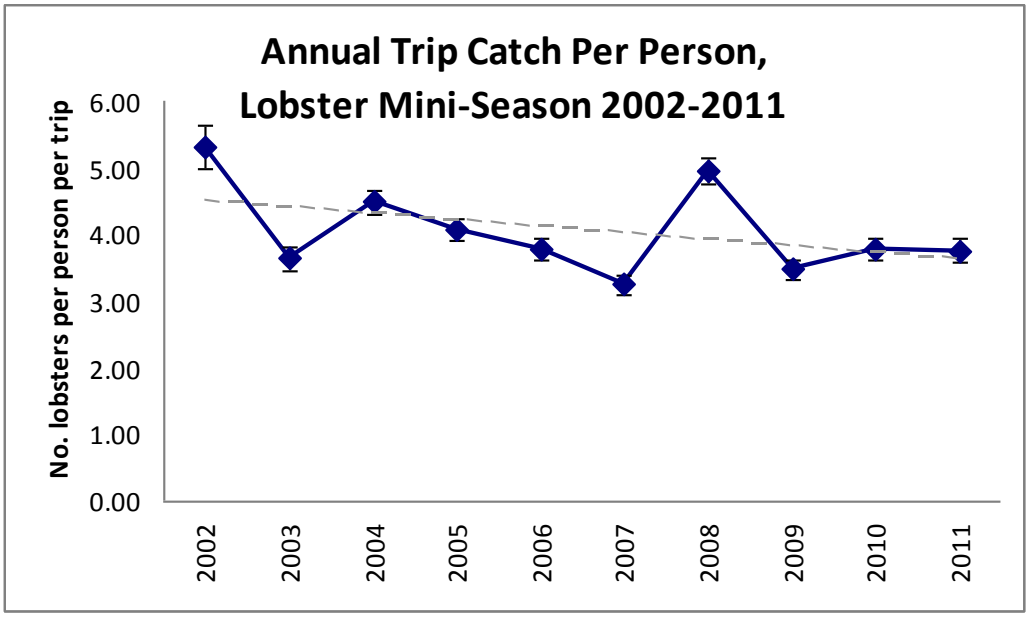

Figure 7: Lobster Mini-Season Trip Catch per person (number of lobsters per person per trip) by year. The dashed gray line shows the declining trend. Error bars represent one standard error.

The post-hoc Tukey's tests suggest a declining trend in trip catch over time. Fourteen significant differences were detected among all possible 45 pairwise combinations of year, and ten of these 14 significantly different pairs showed a decrease in trip CPUE from the earlier year to the later year being compared. There were only two significant decreases (and no significant increases) between year 2002 (when daily recreational bag limit within BISC was 12 lobsters per person) and subsequent years (when the daily recreational bag limit within BISC was reduced to six lobsters per person). There were only four pairwise combinations in which the CPUE of the later year was significantly greater than that of the earlier year.

Trends in size and gender composition of harvested *Panulirus argus* lobsters

An ANCOVA on log-transformed data indicated a significant effect of both year ($F = 4.672$, $p = 0.031$) and gender ($F = 2359.1$, $p < 0.001$) on lobster size (as carapace length). The interaction term between year and gender was not significant ($p = 0.169$).

The smallest average size, 84.29mm, was observed in 2002; the largest average size, 86.18mm, was observed in 2006. Size was variable across years, but there was no clear or consistent trend towards an increasing or decreasing value over time (see Figure 8). It is worth noting that the variation in average size across years was relatively small, with a range spanning less than 2mm.

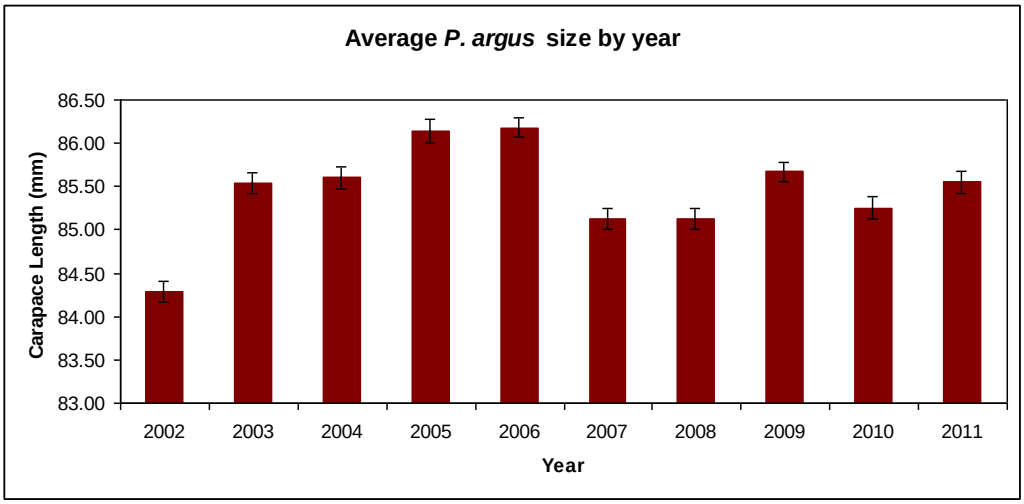

Figure 8: Average size of harvested *Panulirus argus* lobsters measured during Lobster Mini-Season by year. Error bars represent one standard error.

Figure 9 shows that male lobsters were consistently larger than females each year. With all years combined, males averaged 86.86mm in carapace length while females averaged 83.08mm carapace length.

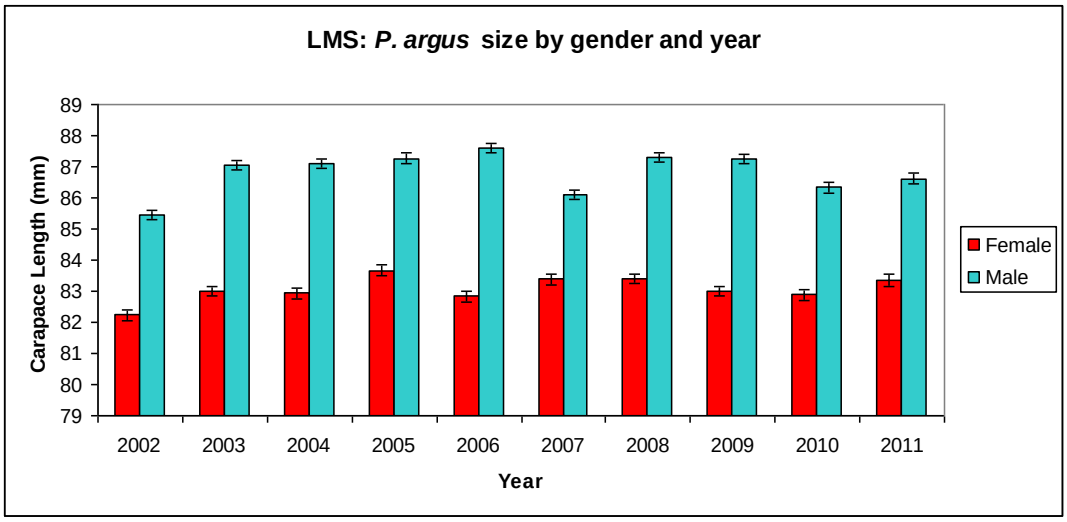

Figure 9: Average size of harvested *Panulirus argus* lobsters during Lobster Mini-Season by year and gender. Error bars represent one standard error.

The entire range of all measured lobsters spanned 95mm. The smallest lobster, which measured 59mm carapace length and was far below the legal minimum of 76mm, was harvested in 2011. The largest lobster observed during the ten-year study period measured 154mm carapace length and was harvested in 2002. In seven of the ten years, the smallest lobster harvested was male. Table 1 provides information on the range of sizes encountered each year.

Table 1. Minimum and maximum sized lobsters (carapace length, in mm) by gender and year. Bold values in each row indicate the overall minimum and maximum values for that year.

	Minimum Length		Maximum Length	
Year	**Female**	**Male**	**Female**	**Male**
2002	71	**70**	114	**154**
2003	73	**70**	114	**130**
2004	72	**65**	122	**134**
2005	71	**70**	116	**131**
2006	69	**68**	115	**118**
2007	**70**	**70**	117	**140**
2008	72	**68**	115	**150**
2009	**68**	71	117	**144**
2010	69	**68**	111	**140**
2011	**59**	68	114	**128**
Entire Study	**59**	65	122	**154**

Across all years, males were harvested roughly twice as often as females. Overall, 1.94 males were harvested for every 1 female harvested. While there was some annual variation of this ratio, it was minimal (see Figure 10) and this near 2:1 ratio of males to females was fairly consistent across years.

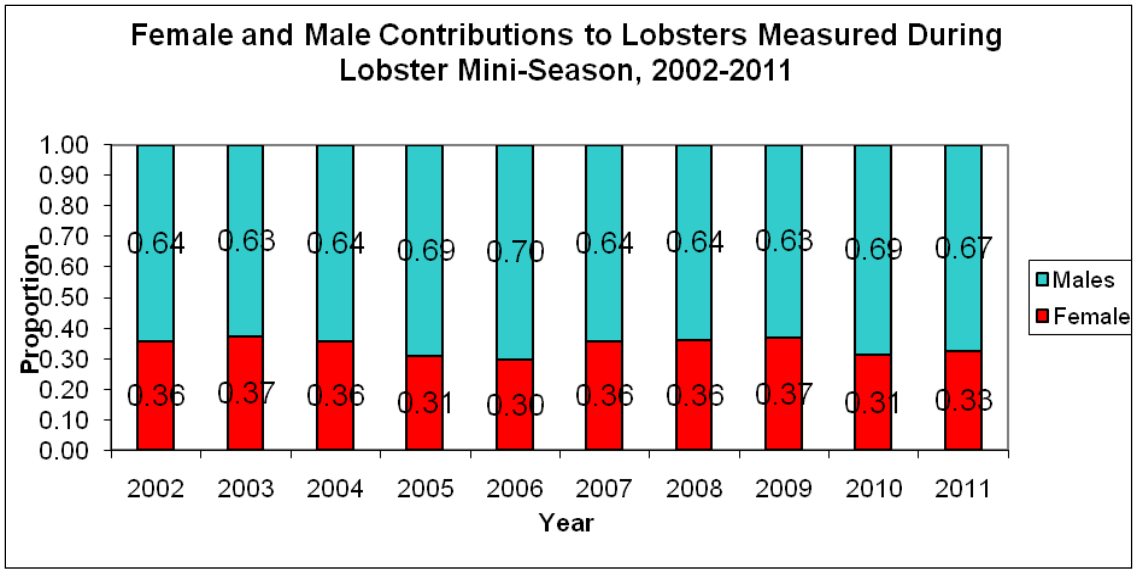

Figure 10: Female and male contributions to all measured *Panulirus argus* by year.

Trends in illegal harvest of undersized *Panulirus argus*

Based on the 33,643 lobsters for which both size and gender data were acquired during the 10-year study period, it appears that compliance with the minimum legal size regulation (76mm, or 3 inches carapace length) was fairly high across all years. Only 1.3% of all lobsters measured during this ten-year time frame were undersized. Individual annual percentages showed that the highest compliance to the size regulation occurred in 2008, in which only 0.5% of measured lobsters were undersized. Non-compliance peaked in 2009, in which 2.3% of all measured lobsters were below the legal minimum size limit. The smallest lobster measured (59mm or 2.3 inches) was illegally harvested in 2011.

Additionally, the proportion of catch that just met the legal minimum (i.e., 76mm exactly) was assessed. Overall, 2.5% of all measured lobsters fit in this category, with 2011 having the highest percentage of just-legal catch (3.1% of that year's measured lobsters) and 2008 having the lowest percentage of just-legal catch (1.2% of that year's measured lobsters). Figure 11 shows annual trends of the proportion of all measured lobsters that were undersized or just met the minimum legal size.

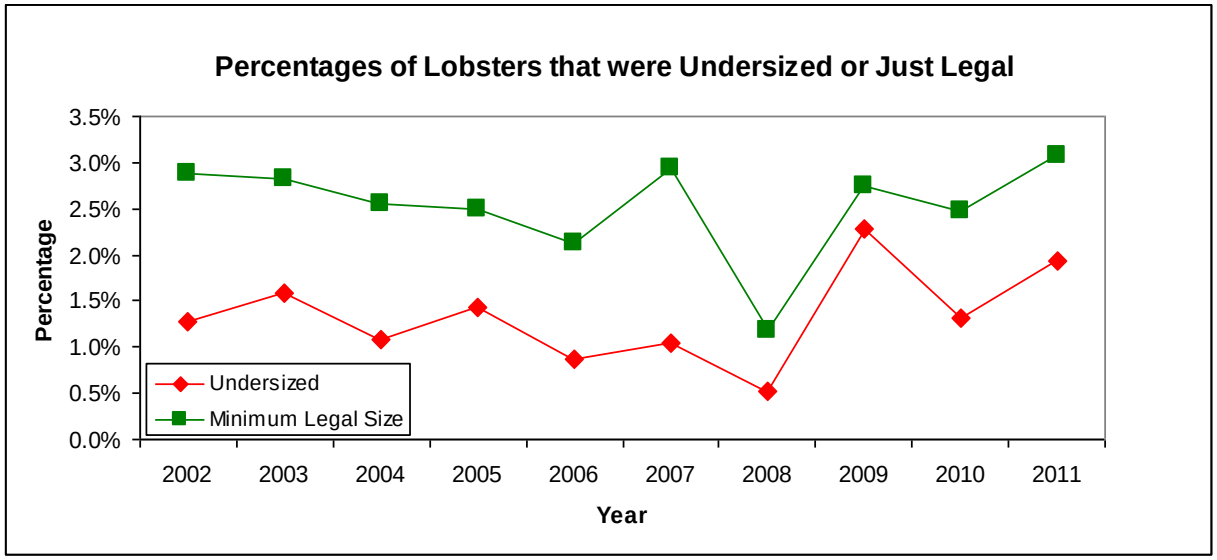

Figure 11: Proportion of all measured lobsters that were undersized (red line) or at the minimum allowable size (green line) by year.

Undersized males and females are taken with roughly similar frequency. In all, 48% of all undersized lobsters were female and 52% of all undersized lobsters were male. Figure 12 shows the near 50-50 ratio of male to female contributions to undersized harvests by year.

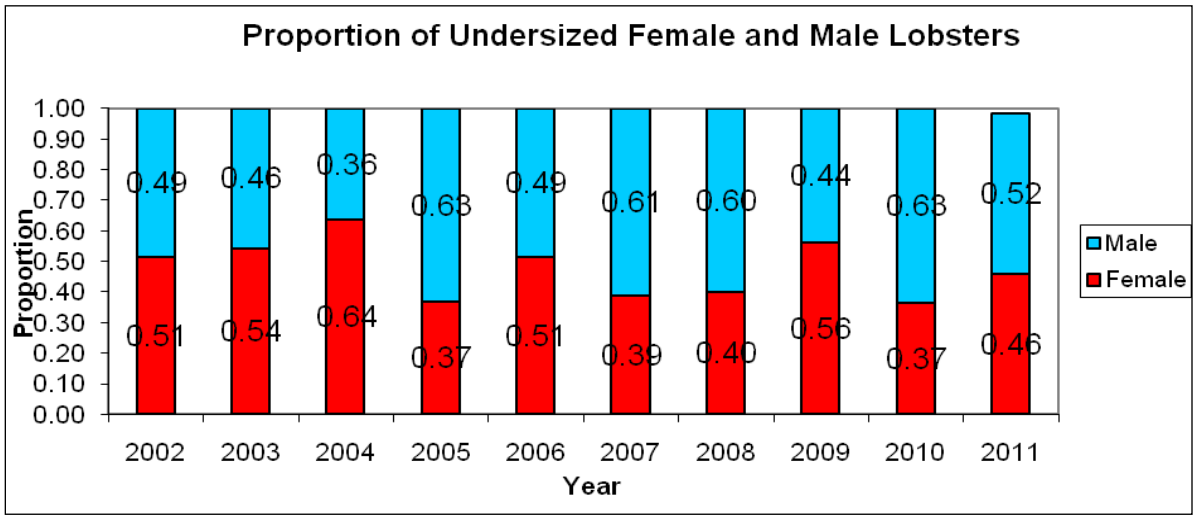

Figure 12: Female and male contributions to observations of undersized *Panulirus argus* by year.

Trends in species diversity of catch

The Caribbean spiny lobster (*Panulirus argus*) is, by far, the most common lobster species in the region. However, other species, particularly the spotted spiny lobster (*P. guttatus*) and slipper, or Spanish, lobsters (Family Scyllaridae) do occur. As shown in Table 2, the very large majority of all assessed lobsters were *P. argus*, which is indicative of the increased regional frequency of occurrence of *P. argus* compared to other species, as well as of the fact that these other less common species are nocturnal in their feeding behavior and tend to hide undetected in crevices during the day when most people are searching for lobsters. While lobsters other than the

Caribbean spiny lobster were altogether infrequent, spotted spiny lobster were slightly more common than slipper lobsters, relatively speaking. The spotted spiny lobster's maximum annual percent contribution to total catch was 0.29% in 2006. The slipper lobster's maximum annual percent contribution to total catch was 0.16% in 2007.

Table 2. Percent contributions of different lobster taxa to composition of assessed lobsters by year.

Year	Caribbean spiny lobster	Spotted spiny lobster	Slipper lobster
2002	99.69%	0.18%	0.12%
2003	99.94%	0.06%	0.00%
2004	99.81%	0.10%	0.10%
2005	99.75%	0.11%	0.14%
2006	99.62%	0.29%	0.08%
2007	99.68%	0.16%	0.16%
2008	99.87%	0.13%	0.00%
2009	99.88%	0.08%	0.03%
2010	99.91%	0.06%	0.04%
2011	99.91%	0.02%	0.07%
Entire Study	99.80%	0.12%	0.07%

Discussion and Conclusions

This report is not intended to be a fisheries stock assessment of the Caribbean Spiny Lobster; as such, information such as the condition of the stock and estimates of population size cannot and should not be inferred from the information provided herein. However, the information provided in this report does provide useful information on trends of lobster harvest over ten years of harvesting lobsters during the two-day Lobster mini-season in and around the waters of Biscayne National Park.

It is not clear if the observed variation in completed survey number is indicative of truly varying effort of lobster harvesters, or if it is better explained by other factors, such as the timing of when people returned to the marinas (which would affect if they were interviewed) or the degree of willingness to be surveyed. Also, the reduction in legal daily bag limit within BISC from 12 lobsters per person to six lobsters per person which took effect in 2003 can at least partially explain why CPUE and trip catch both peaked in 2002. However, it must also be noted that mean trip catch was far less than 12 lobsters per person in 2002 (i.e., bag limit regulations appear to not be the limiting factor determining catch). Furthermore, the bag limit remained at six lobsters per person per day for the remainder of the study period, yet the declining trend continued. Therefore, the change in bag limit is, on its own, insufficient to explain the observed declining trends in CPUE and trip catch. Instead, the trends towards declining hourly CPUE and trip catch over time might suggest declines in the local population, perhaps resulting from reduced reproduction, increased numbers of people fishing, overfishing, and/or poor recruitment of parental sources upstream.

It is worth noting that, as shown in Figure 13, year-to-year fluctuations (i.e., increases or decreases from the previous year) in recreational CPUE during the two-day sport season seem to mirror those of the annual commercial harvest from within Biscayne National Park, although the commercial harvest does, overall, appear to be fairly stable (this analysis is restricted to 2002-2008, the years in which both types of data were available). CPUE data during the two-day sport season could be considered a decent indicator of the local population condition, however mini-season CPUE and commercial harvest show only a moderate (and non-significant) degree of correlation (Pearson's Correlation Coefficient = 0.481, $p = 0.27$). Furthermore, the declining trends observed during LMS could be completely unrelated to the condition of the lobster stock and instead reflective of environmental conditions during the two-day sport season (e.g., rougher seas and/or poor visibility may make it harder to locate and catch lobsters).

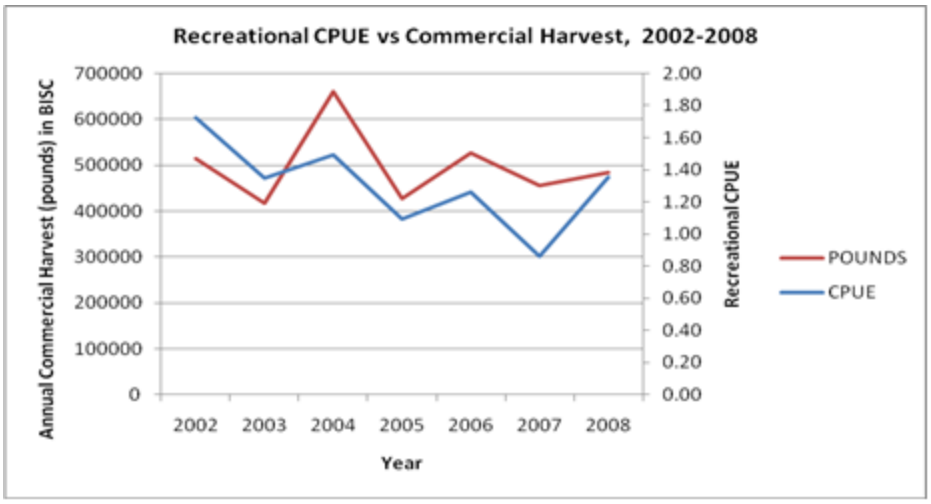

Figure 13: Comparison of recreational sport season CPUE and annual commercial harvest

The finding that CPUE was higher at familiar sites than unfamiliar sites is interesting, yet not surprising. As with many organisms, lobsters do demonstrate habitat preferences (Eggleston et al. 2003), and with GPS technology, harvesters are often able to "scope out" and save the coordinates for sites with high lobster abundances and/or good lobster habitat before the onset of the lobster season. Similarly, if a lobstering site proved fruitful in one year, its location could be stored on a GPS unit for subsequent years. People who visited familiar sites would most likely choose to revisit only those sites that proved to be worthwhile in the past (e.g, those sites with habitat features that continue to attract larger numbers of lobsters), thereby allowing them a higher CPUE. Those who visit unfamiliar (and perhaps random) sites are likely to encounter both high-density and low-density lobster sites, depending on the habitat type, habitat quality, location, and other factors. Therefore, CPUE at unfamiliar sites can be expected to be lower than CPUE at "vetted" familiar sites.

Lobster sizes were fairly consistent across years. Differences in size did not reveal any temporal trend, suggesting that average lobster size is affected more by random processes (such as harvester skill, specific locations fished, etc.) than by any true population patterns.

Observed gender differences are consistent with previously known information and published data that indicate that males grow faster and are typically larger than females (Hunt and Lyons 1986, FWRI 2010, Leocadio and Cruz 2008 and references therein). Observed gender differences can also be explained by the fact that due to restrictions on harvest of egg-bearing females, which are older (and therefore larger) than reproductively inactive females, a portion of the female population is not assessed during these surveys and thus average female size may appear smaller than what occurs in the entire population. Given that male lobsters tend to grow faster and achieve larger maximum sizes than females (FWRI 2010, Hunt and Lyons 1986) and that larger (and likely more reproductively active) females could have been egg-bearing and thus not available for harvest, it is not surprising that the largest lobster encountered each year was always male. The increased occurrence of male lobsters compared to female lobsters may be indicative of a variety of factors, including: true population demographics, gender-specific differences in behavior and/or habitat selection which may make males more susceptible to

capture (such as females moving offshore to spawn), and/or restrictions on harvesting egg-bearing females.

Data analyses indicate that undersized males and females are taken with roughly similar frequency. If gender of undersize harvest was truly random (e.g., a function of population demographics), one would expect that the proportion of males (or females) that were harvested undersized in any given year would mirror the proportion of total males (or females) harvested in that year. Regression analysis shows that the proportion of undersized harvested males in any given year is *not* significantly related to the proportion of total males harvested in that year ($F = 1.959$, $p = 0.199$). In other words, gender composition of the total harvest is not a good predictor of gender composition of the undersized harvest. Therefore, that females comprise, on average, only 34% of the total catch but nearly 50% of the undersized harvest might be a result of the regulation prohibiting egg-bearing females being obeyed to a high degree (and to a higher degree than adherence to the minimum size regulation). The egg-bearing (and typically larger) females would be considered unharvestable, thereby skewing the total harvest to 66% male and 34% female; however when looking only at the smaller (undersized) lobsters, very few, if any, of these would be expected to be egg-bearing, and so the near 1:1 harvest of illegally sized males and females is likely more representative of the population's actual sex ratio, which could be expected to approximate 1:1 (see Davis 1977).

Compliance with lobster harvest regulations appears to be very high, particularly when compared to violation rates for recreational fishing in general. For example, while only 1.3% of lobsters measured during this study period were below the minimum legal size, nearly 40% of red grouper, 28.4 % of hogfish, and 24.1% of mutton snapper harvested in BISC in 2008 were undersized (McDonough 2009). There may be several explanations for this, which are likely not mutually exclusive. First, lobster mini-season is a well-publicized event, with coverage on television, online, on the radio, and in print; the high levels of outreach may be sufficient to educate most harvesters about lobster regulations. Second, it appears that the lobster population is healthy enough that most LMS participants can, with a little effort, successfully locate and harvest sufficient legal catch with fairly high ease, so there is no need to resort to illegal harvest. A third possible explanation may be that participants of LMS are aware that law enforcement presence is generally greater during LMS than on other days, and as such, they may be particularly vigilant about adhering to the regulations to avoid receiving costly citations. Lastly, it is possible that those individuals violating the regulations have avoided detection because of refusing to participate in the survey, using marinas that are unstaffed by survey personnel, and/or returning to marinas at hours when survey personnel are not present. Regardless of the mechanism(s) explaining the high adherence to the regulations, it is reassuring to see such high compliance.

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1201 Oakridge Drive, Suite 150
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