

Spiny Lobster Advisory Panel

Spiny Lobster Fishery Performance Report

April 2018

At their May 2018 meeting, the South Atlantic Fishery Management Council's (Council) Spiny Lobster Advisory Panel (AP) reviewed fishery information for spiny lobster and developed this fishery performance report (FPR). The purpose of the FPR is to assemble information from AP members' experience and observations on the water and in the marketplace to complement scientific and landings data. The FPR for spiny lobster will be provided to the Scientific and Statistical Committee (SSC) and the Socio-Economic Panel (SEP) to complement material being used in stock assessments and to inform future management.

Advisory Panel Members:

Bruce Irwin (Chairman; Commercial/FL)	Russell Moore (Commercial/FL)*
Bill Mansfield (Vice-Chairman; Recreational/NC)*	Gary Nichols (Commercial/FL)
Robert Burton (Recreational/FL)	Peter O'Bryan (Conservation/FL)
Richard Diaz (Commercial/FL)*	Mimi Stafford (Commercial/FL)*
Sean Espenship (Recreational/FL)*	Mickey Whittington (Recreational/GA)
Tony Iarocci (Commercial/FL)*	*not in attendance

Fishery Overview:

Summary information on the spiny lobster fishery is presented in a Fishery Information Document (**Appendix A**) intended to provide an overview of several aspects of the fishery including life history of the species, stock status, management overview, and trends in landings and fishery economics for both the commercial and recreational (for-hire and private) sectors. The information was provided as background to elicit the discussion presented in this Fishery Performance Report. The Fishery Information Document presents data from 1999 through 2016.

Observations on Stock Abundance:

Overall, the availability of spiny lobster and associated landings appear to be increasing. Decreases in landings are usually the result of extreme storm years that prevent fishermen from going out while the season is open. For example, Hurricane Irma (2017).

August of the 2017/2018 season was slower in the Florida Keys than normal. This could be the result of August being an extremely hot month or spiny lobsters sensing the impending hurricane. There has been a pattern of bad spiny lobster catch in August followed by an active hurricane season. Recreational fishermen are also seeing a steady abundance of spiny lobster during the special recreational season (the last Wednesday and Thursday of July). In 2017, majority of the participants in the Florida Keys were able to reach their trip limit.

Alternatively, in the St. Lucie/Indian River area of Florida, recreational fishermen have been seeing lower catch during the special recreational season. Spiny lobster have become harder to catch inshore (water <20 feet deep). Offshore, spiny lobster were not seen in 2017 until after

Hurricane Irma.

Observations on Spiny Lobster Size:

The availability of smaller (sub-legal) spiny lobster has increased in recent years. As a result, fishermen are throwing back a lot of spiny lobster, especially near the end of the season. Fishermen are encouraged to release smaller spiny lobster (even if they are legal) so that they can harvest larger lobsters the following season.

In Florida Bay, large spiny lobster have been increasing. These larger spiny lobster can be harder to find because they stay in the seagrass during molting. The number of smaller lobsters in the area fluctuates from year to year, but recently fishermen have seen a large number of sub-legal spiny lobster. It is possible that the increase in small spiny lobster during the 2017/2018 season is due to Hurricane Irma, which would have destroyed lobster habitat flushing the smaller spiny lobster out into the channel and into the reef. This increase in small spiny lobster may be temporary.

In Port St. Lucie and Indian River County there has been a decline in the number of spiny lobster over ten pounds. On the other hand, spiny lobster in the five to six-pound range are still seen in great numbers. The decrease in large spiny lobster may be attributed to increases in fishing pressure.

Observations on Effort Shifts:

Overall, participation in the commercial and recreational spiny lobster fisheries has increased. Catch for both sectors is likely higher than is reported. This increase has created several law enforcement issues.

In particular, participation in the bully net fishery has increased substantially in recent years. This increase in participation has resulted in concerns about the bully net fishery being used as a cover for trap robbing at night. There has also been conflict between bully net fishermen and the general boating public.

Participation in the dive component of the spiny lobster fishery has also increased. This increase in participation has resulted in conflict with trap fishermen resulting from dive boats cutting the line attaching traps to a buoy as well as trap robbing.

There has been an increase in commercial effort around the Chinese New Year (January and February) when the price for spiny lobster increases. The timing of this price increase fluctuates between January and March, so many traps are fished through to the end of the season. Total landings have not changed over the years; rather, the landings have just shifted into later months.

The recreational sector is also seeing an increase in participation, especially during the special recreational season. Participation continues to be high through August and September then slowly decreases as the waters become colder.

Observations on Price and Demand:

Demand from the Chinese markets has increased in recent year. The Chinese markets prefer larger lobster, making smaller lobster harder to market. Demand is so high during the Chinese New Year that spiny lobster can sell for \$12 to 15 dollars a pound.

Along with demand, the price for spiny lobster has increased in recent years. There is some price variation throughout the year, with September prices typically being higher than August prices. The Chinese markets have caused some fluctuation over time, but now are consistent and result in relatively high prices in January and February. Local restaurants will typically not pay more than \$10 dollars for a pound for spiny lobster.

Observations on Community Dependence:

The Florida Keys are very dependent on the spiny lobster fishery. Both the commercial sector and the recreational sector play an important role and are tied to income from tourism. In the last few years there has been a drastic reduction in the number of docks and fish house where fishermen can store their traps. There used to be 10 to 12 fish houses in Marathon, Florida which helped keep the price of spiny lobster high. Unfortunately, the number of fish houses has decreased in recent years and fishermen have had to adapt to the negative effects of development.

Hurricane Irma had a significant impact on the commercial spiny lobster fishery. It has been challenging to get material to rebuild the large number of traps that were damaged during the storm. Additionally, Hurricane Irma has made it challenging to hire crew because low-income housing and space for trailers has become limited. This is an issue for all businesses in the Florida Keys.

In Eastern Florida, communities around inlets tend to have a lot of hotels and dive shops that make a significant amount of money during the spiny lobster special recreational season.

Observations on Management Measures:

The three-inch minimum carapace size limit is appropriate. It reflects what the restaurants prefer, and the Chinese markets purchase larger lobster.

The annual catch limit (ACL) put into place through Spiny Lobster Regulatory Amendment 4 is high enough that is not restricting landings and the safety mechanism that triggers a review if landings drop below a certain threshold in subsequent years ensures any problem would be identified and addressed. Aside from removing the ACL entirely, this is the best situation.

Management measures for spiny lobster were collaboratively designed, considering input from commercial and recreational fishermen as well as scientists and managers. Overall, involving stakeholders in management has been beneficial for fishermen and the fishery.

Environmental Observations:

Large hurricanes can affect spiny lobster in a myriad of different ways. For example, after Hurricane Wilma, Florida Bay was flushed which cleared the water creating the right conditions for seagrasses to grow. These seagrass beds are where spiny lobster are often found early in the season (August and September). Alternatively, during Hurricane Irma the water of

Florida Bay became murky, killing seagrasses and having a negative effect on the spiny lobster fishery.

Water quality can also have an impact on spiny lobster populations and there are concerns that fresh and polluted waters flowing into Florida Bay will have a negative effect on spiny lobster. Algae blooms have also been seen in deeper water (200+ feet) this year. These blooms make it hard to bring in traps and can damage gear.

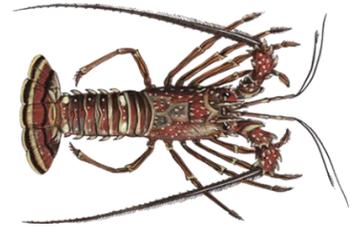
Other Observations:

Overall, the commercial and recreational spiny lobster fisheries are healthy and thriving. The fishery has been well managed thanks to proactive regulations by stakeholders who have worked together and prioritized the resource.

Appendix A: Spiny Lobster Informational Document

Spiny Lobster Advisory Panel

May 2018



General Biology

The Caribbean spiny lobster (*Panulirus argus*) is widely distributed throughout the western Atlantic Ocean as far north as North Carolina to as far south as Brazil including Bermuda, the Bahamas, Caribbean, and Central America (Herrnkind 1980; **Figure 1**). Analyses of DNA indicate a single stock structure for the Caribbean spiny lobster throughout its range (Lipcus and Cobb 1994; Silberman et al. 1994; Hunt et al. 2009). More recent genetic studies have shown almost all recruits in U.S. waters are from elsewhere in the Caribbean. Spiny lobster is known to have the longest larval duration of any oceanic marine animal. However, other studies have shown that the wind effects or the presence of local gyres or loop currents in certain locations could influence the retention of locally spawned larvae in some years more than others (Johnson 1960; Phillips 1989; Yeung and McGowan 1991; Yeung 1996; Yeung et al. 2001). A more recent study has shown retention of local larvae in Florida ranges between 10-40 percent (Kough et al. 2013). While recruitment is considered stable, it is not thought to be linked to production.

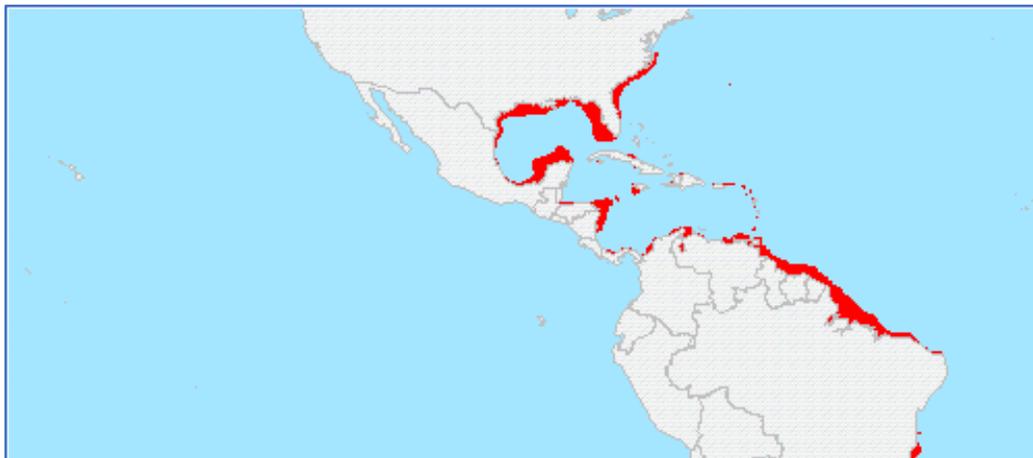


Figure 1. Distribution of Caribbean spiny lobster (in red).

Source: FAO Fisheries Synopsis 1991

This species typically inhabits shallow waters, occasionally as deep as 295 ft (90 m). Spiny lobster can be found among rocks, on reefs, in seagrass beds or in any habitat that provides protection. This species is gregarious and migratory. Maximum total body length recorded is 18 in (45 cm), but the average total body length for this species is 8 in (20 cm; FAO Fisheries Synopsis 1991).

Distribution and dispersal of spiny lobster is determined by the long planktonic larval phase, called the puerulus, during which time the larval lobsters are carried by the currents until they become large enough to settle to the bottom (Acosta et al. 1997; Davis and Dodrill 1989). As the lobsters begin metamorphosis from puerulus to the juvenile form, the ability to swim increases and they move into shallow, nearshore environments to grow and develop.

Young benthic stages of spiny lobster typically inhabit branched clumps of red algae (*Laurencia* sp.), mangrove roots, seagrass banks, or sponges; they feed on invertebrates found within these habitats. In contrast to the social behavior of their older counterparts, juvenile lobsters are solitary and aggressive to ensure they remain solitary. Two to four-year olds are nomadic, emigrating out of the shallows and moving to deeper, offshore reef environments. Adult spiny lobsters tend to aggregate in enclosed shelters including: natural holes in a reef, rocky outcrops, or artificially created environments (Lipcius and Cobb 1994).

Mass migrations of 2-60 spiny lobsters occur annually throughout the geographic range of the species and are dependent on latitude and climactic factors. Observed locations for the migration include Bermuda in October, the Bahamas and Florida in late October and early November, and the Yucatan and Belize in December (Herrnkind 1985). The first autumn storm in the tropics usually drops the water temperature by about 5°C and brings large sea swells. The shallow regions that the lobsters exploit during the summer months become turbid and cold, initiating the diurnal migration of thousands of lobsters to evade these conditions. The spiny lobster is highly susceptible to severe winter cooling and will exhibit reduced feeding and locomotion at temperatures 54-57 °F (12-14 °C); molting individuals usually perish under these conditions. According to Herrnkind (1985), the behavioral changes observed in spiny lobster as well as the known biological information about the species lends credence to the idea that individuals migrate to evade the stresses of the cold and turbidity in the winter. Biologically, the queuing behavior is an important hydrodynamic drag-reduction technique for the migration of individuals over long distances (Bill and Herrnkind 1976). Studies done by tagging individuals found that during the migration, individuals tended to move distances of 19-31 statute miles (30- 50 km; Herrnkind 1985).

Stock Status (SEDAR 8 Update 2010)

With majority of spiny lobster larvae coming from outside sources, reliable estimation of management reference points was not possible during the most recent stock assessment (SEDAR 8 Update 2010). Currently, there is an inability to perform a Caribbean-wide stock assessment because not all countries report landings. The US stock cannot be assessed in isolation and is not the appropriate geographical and biological scale needed to capture population-wide dynamics. It was concluded that the stock status of spiny lobster in the southeast US is essentially unknown. Therefore, the most recent stock assessment was not considered sufficient to inform the Scientific and Statistical Committees (SSC). Due to these uncertainties, there is a lack of confidence in the reliance on recruitment from other populations in the Caribbean. Therefore, the most recent stock assessment was rejected, and other management methods were determined to be needed. A stock assessment of US Caribbean Spiny Lobster (SEDAR 57) will be conducted throughout 2018 and 2019.

Management Overview

The Spiny Lobster FMP largely extended Florida's regulations for the fishery to the EEZ throughout the range of the fishery (North Carolina to Texas). The original Spiny Lobster FMP regulations were effective on July 2, 1982.

Amendment 1 (1987) updated the Spiny Lobster FMP rules to be more compatible with those of Florida and implemented the following management measures: limited live undersized

attractants to 100 per vessel, required live wells, required a commercial vessel permit, provided for a recreational permit, limited recreational possession to six lobsters, modified the special 2-day recreational season before the commercial season, modified the duration of the closed commercial season, provided a 10-day trap retrieval period, prohibited possession of egg-bearing spiny lobster, specified the minimum size limit for tails, established a tail separation permit, and prohibited possession of egg-bearing slipper lobster.

Amendment 2 (1989) modified the issues and objectives of the Spiny Lobster FMP, modified the optimum yield, established a regulatory amendment procedure for instituting future compatible state and federal rules, and added vessel safety and habitat standards to the Spiny Lobster FMP.

Amendment 3 (1990) added a scientifically measurable definition of overfishing, outlined an action plan to prevent overfishing, and added the requirement for collection of fees for the administrative cost of issuing permits.

Regulatory Amendment 1 (1992) extended the Florida spiny lobster trap certificate system for reducing the number of traps in the commercial fishery to the EEZ off Florida, revised the spiny lobster commercial permitting requirements, limited the number of live undersized lobster that could be used as attractants, specified allowable gear for commercial fishing in the EEZ off Florida, specified the possession limit of spiny lobsters by persons diving at night, required that lobsters harvested by divers be measured without removing from the water, and specified uniform trap and buoy numbers for the EEZ off Florida.

Regulatory Amendment 2 (1993) changed the days for the special recreational season in the EEZ off Florida, prohibited night-time harvest off Monroe County, Florida, during that season, specified allowable gear during that season, and created different bag limits during that season off the Florida Keys and the EEZ off other areas of Florida.

Amendment 4 (1995) allowed harvest year-round for any person limited to a daily bag and possession limit of two lobsters per person in the EEZ off North Carolina, South Carolina, and Georgia.

Amendments 5 (1998) identified essential fish habitat (EFH) and habitat areas of particular concern (HAPC) for spiny lobster in the South Atlantic.

Amendment 6 (1998) determined that the overfishing level for spiny lobster was a fishing mortality rate (F) in excess of F at 20% of the spawning potential ratio.

Generic Amendment (1999) identified EFH for spiny lobster in the Gulf.

Generic Amendment Sustainable Fisheries Act (1999) updated the description of the spiny lobster fisheries and provided community assessment information for Monroe County.

Amendment 7 (2002) established the Tortugas Marine Reserves.

Regulatory Amendment 3 (2002) specified that the holder of a valid crawfish license or trap number, lobster trap certificate, and state saltwater products license issued by Florida may

harvest and possess, while in the EEZ off Florida, undersized lobster. However, possession may not exceed 50 in number per boat, and there may be no more than one per trap aboard each boat if used exclusively for luring, decoying, or otherwise attracting non-captive lobster to traps.

Amendment 8 (2008) restricted imports of spiny lobster into the U.S. to minimum conservation standards in an effort to achieve an increase in the spawning biomass of the stock and increase long-term yields from the fishery.

Amendment 9/EIS (2009) provided spatial information for EFH and habitat area of particular concern (HAPC) designations for species in the Spiny Lobster FMP in the South Atlantic (developed by the South Atlantic Council as the generic Comprehensive Ecosystem-Based Amendment 1).

Amendment 10 (2012) established the acceptable biological catch (ABC), annual catch limit (ACL), annual catch target (ACT) and accountability measures (AM) for Caribbean spiny lobster, removed smoothtail spiny lobster, spotted spiny lobster, Spanish slipper lobster and ridged slipper lobster from the fishery management unit, defined maximum sustainable yield (MSY), overfished, and overfishing thresholds, updated the protocol for enhanced cooperative management and the framework procedure, modified the regulations regarding the use of undersized lobster as bait and tailing permit requirements, and addressed the removal of abandoned traps in Florida waters.

Amendment 11 (2012) implemented areas closed to trapping in the Florida Keys to protect threatened and endangered coral species compliant with the 2009 biological opinion on the spiny lobster fishery.

Amendment 12 (2014) consolidated the existing South Atlantic and Gulf federal dealer permits; required permits for dealers and increased the frequency of federal dealer reporting from monthly to weekly; and established requirements to maintain a federal dealer permit.

Regulatory Amendment 4 (not yet implemented) updates the overfishing limit (OFL), ACL, and ACT to incorporate a longer time series of landings. This amendment prohibits the use of traps for recreational harvest of spiny lobster in the EEZ off Georgia, South Carolina, and North Carolina.

Fishery Performance

The following summary of spiny lobster landings was prepared using various data sources, including:

ALS: The Accumulated Landings System (ALS) is the system used by the Southeast Fisheries Science Center (SEFSC) to track commercial landings in the South Atlantic. It includes commercial dealer reports.

FWC: Commercial and recreational landings estimates were supplied by the Florida Fish and Wildlife Conservation Commission (FWC). For recreational landings, mail surveys are sent to a portion of recreational license holders to collect data on the number of lobsters caught.

Those numbers are then converted to pounds based on the average size of lobsters caught each August.

Commercial and Recreational Sectors

Total landings of spiny lobster in pounds (whole weight) from 1999 through 2015 are presented in **Table 1**. Total landings are presented graphically in **Figure 1** relative to the stock ACL and ACT.

Landings of spiny lobster since 1999 have ranged from a low of 4,100,135 pounds in 2005 to a high of 10,130,245 pounds in 1999 (**Table 1**). Recreational surveys were not conducted in 2004 due to hurricanes and as a result total landings are unavailable for that year. Majority of spiny lobster are landed in Florida. Landings from North Carolina, South Carolina, and Georgia have increased in recent years, but still account for less than 1% of total spiny lobster harvest. Over the time period examined, landings have generally fluctuated. After peaking in 1999, landings of spiny lobster decreased to a low point in 2005 after which they began steadily increasing again (**Figure 1**). Landings have exceeded the stock ACT (6,590,000 pounds) every year since 2010 and exceeded the stock ACL in 2013 and 2015.

Table 1. Spiny lobster total landings (pounds whole weight) and stock ACL (where applicable), 1999-2015.

Year	Fishing Year	Commercial	Recreational	Total	ACL
1999	1999-2000	7,668,265	2,461,981	10,130,245	-
2000	2000-2001	5,569,306	1,949,062	7,518,368	-
2001	2001-2002	3,079,121	1,251,081	4,330,201	-
2002	2002-2003	4,572,648	1,455,298	6,027,946	-
2003	2003-2004	4,158,698	1,411,509	5,570,206	-
2004	2004-2005	5,451,391	*	*	-
2005	2005-2006	2,969,121	1,131,014	4,100,135	-
2006	2006-2007	4,824,111	1,304,511	6,128,622	-
2007	2007-2008	3,793,068	1,215,068	5,008,136	-
2008	2008-2009	3,284,879	1,263,508	4,548,387	-
2009	2009-2010	4,393,970	1,265,576	5,659,545	-
2010	2010-2011	5,969,950	1,416,466	7,386,416	-
2011	2011-2012	5,854,173	1,230,408	7,084,582	7,320,000
2012	2012-2013	4,064,217	1,558,995	5,623,212	7,320,000
2013	2013-2014	6,373,005	1,602,654	7,975,659	7,320,000
2014	2014-2015	5,436,140	1,621,182	7,057,322	7,320,000
2015	2015-2016	6,060,409	1,491,487	7,551,896	7,320,000

Source: FWC

*Data unavailable, recreational surveys not completed due to hurricanes.

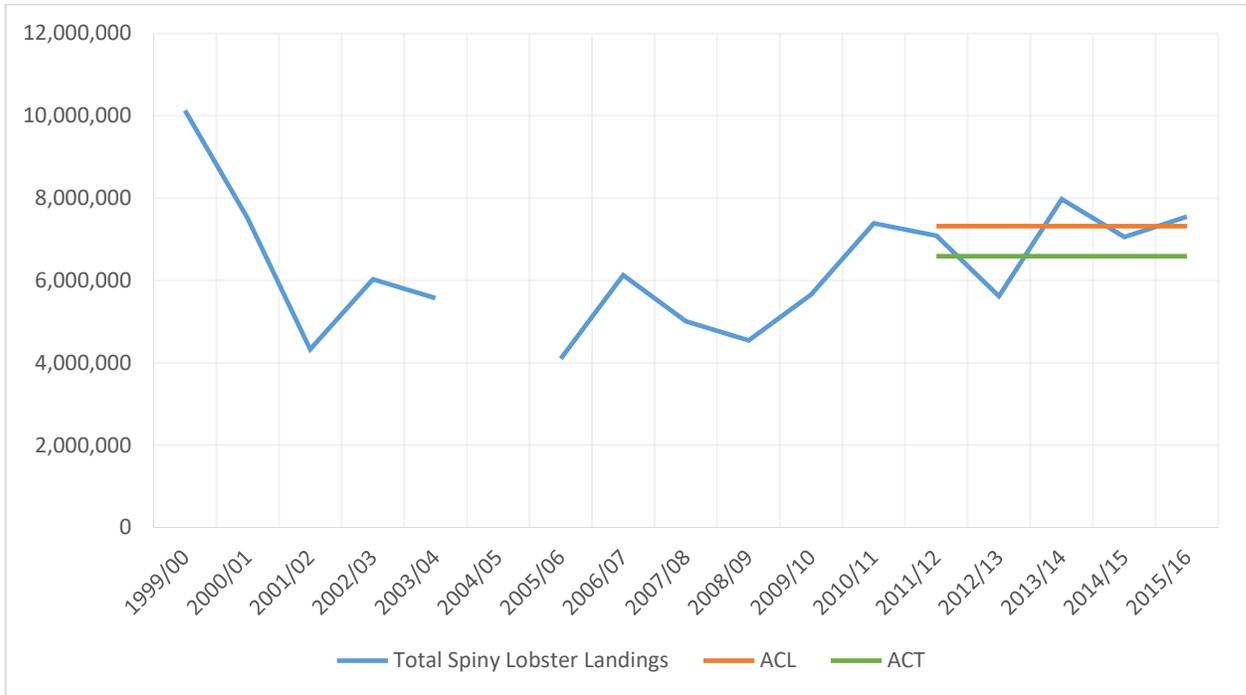


Figure 1. Total landings (pounds whole weight) of spiny lobster, 1999-2015 (blue). Stock ACL (orange line), and Stock ACT (green line) are show since 2012, when first implemented. Source: FWC

Total commercial landings are presented graphically in **Figure 2**. Since 1999, commercial spiny lobster landings have ranged from a low of 2,969,121 pounds in 2005 to a high of 7,668,265 pounds in 1999. Over the time period examined, landings have generally fluctuated, however there has been a slight increasing trend since 2009. **Figure 3** presents commercial landings for the South Atlantic region only (from the Gulf and South Atlantic Council jurisdiction boundary to the NC/VA line). South Atlantic commercial landings of spiny lobster have followed the same trend as total commercial landings, with a low in 2005 and a high in 1999. South Atlantic landings have been increasing since approximately 2009.

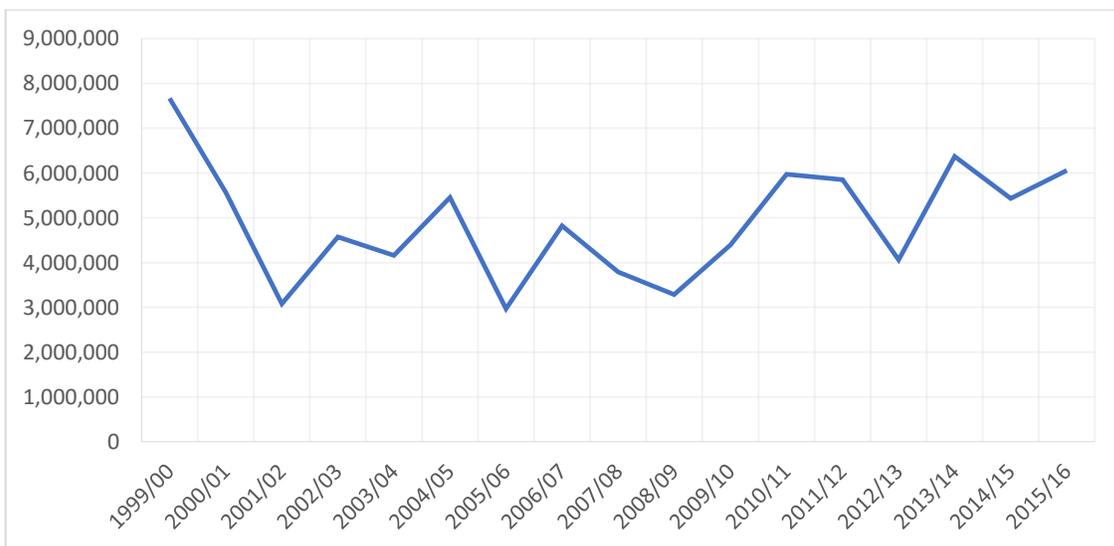


Figure 2. Commercial landings (pounds whole weight) of spiny lobster from 1999 through 2015. Source: FWC

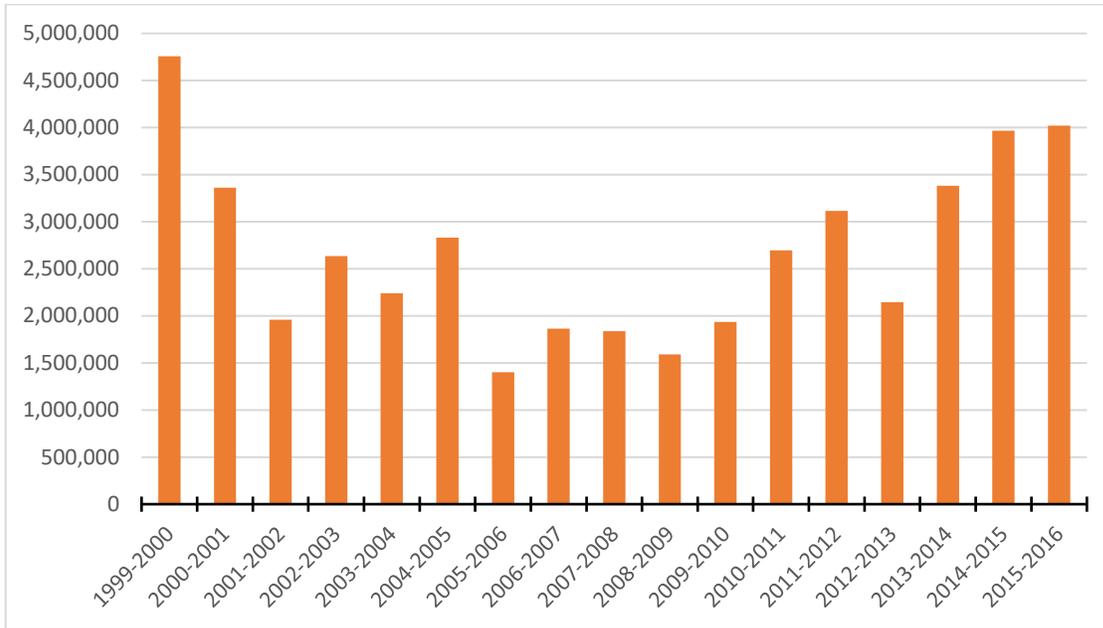


Figure 3. Commercial landings (pounds whole weight) of spiny lobster from 1999 through 2015 for the South Atlantic Region.

Source: ALS

Figure 4 show the seasonality of commercial landings along the Florida East Coast by displaying the average monthly commercial landings of spiny lobster from 1999 through 2015. The commercial fishery for spiny lobster is open from August 6th through March 31st. Landings occur mainly during the fall months with the highest landings being seen in August and September.

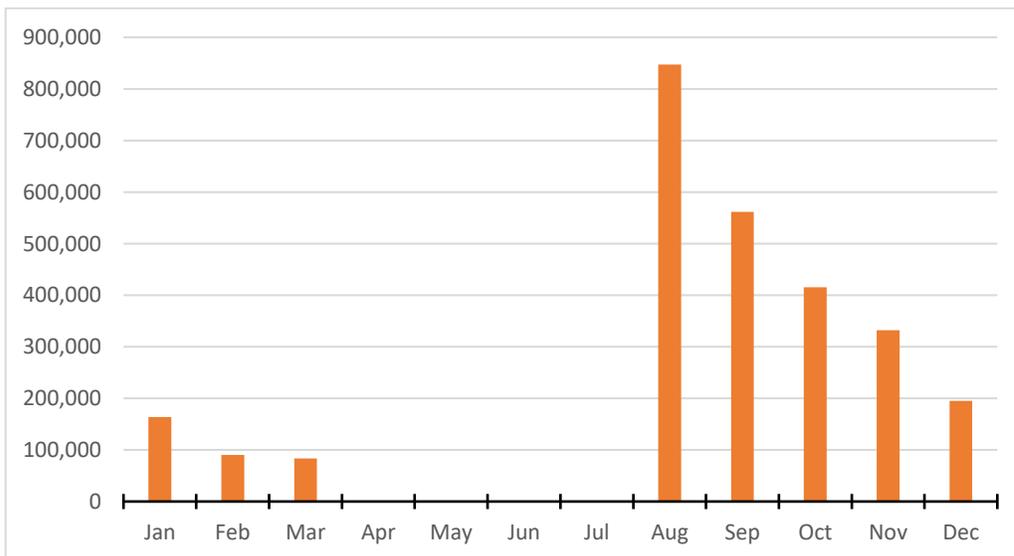


Figure 4. Average monthly commercial landings (pounds whole weight) of spiny lobster in Florida, 1999-2015.

Source: ALS

Several different gear types are used in the commercial spiny lobster fishery. **Figure 5** illustrates the proportion of commercial spiny lobster landings by gear type. Over the time period examined, traps accounted for over 85% of commercial spiny lobster landings. The

proportion of commercial landings from diving has decreased in recent years, while bully net gear has increased to account for approximately 3% of commercial landings.

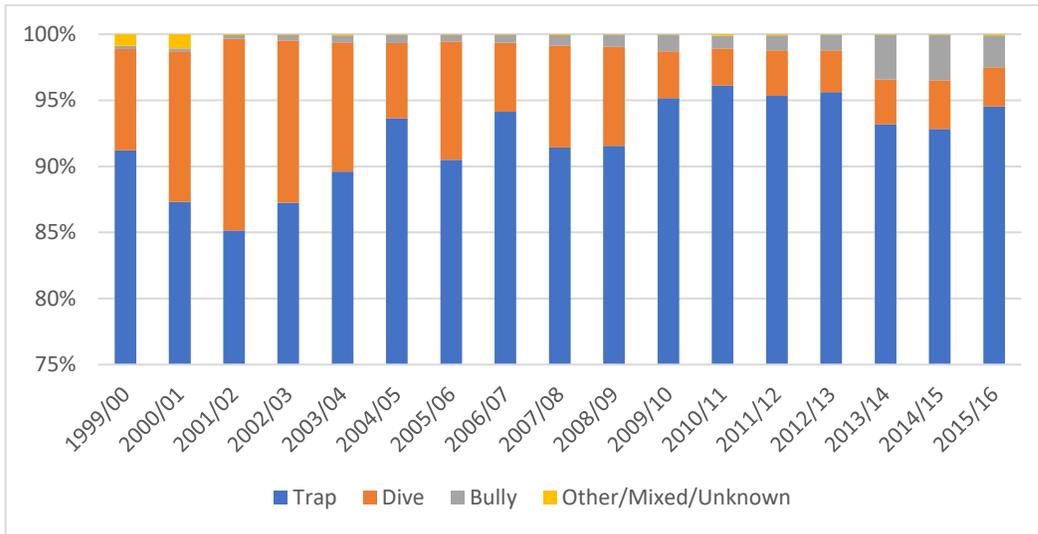


Figure 5. Proportion of commercial spiny lobster landings by gear type, 1999-2015. Source: FWC

Recreational landings of spiny lobster in pounds whole weight from 1999 through 2015 by zone are presented graphically in **Figure 6**. Recreational landings of spiny lobster have ranged from a low of 1,131,014 pounds whole weight in 2005 to a high of 2,461,981 pounds in 1999 (**Table 2**). During the time period examined, recreational spiny lobster landings have remained relatively stable (**Figure 6**). Total landings during the special recreational sport season in Florida (the last Wednesday and Thursday of July) are presented in **Figure 7**. Over the time period examined, landings during the special recreational season have generally fluctuated with a low of 282,816 pounds in 2000 and a high of 567,643 pounds in 1999.

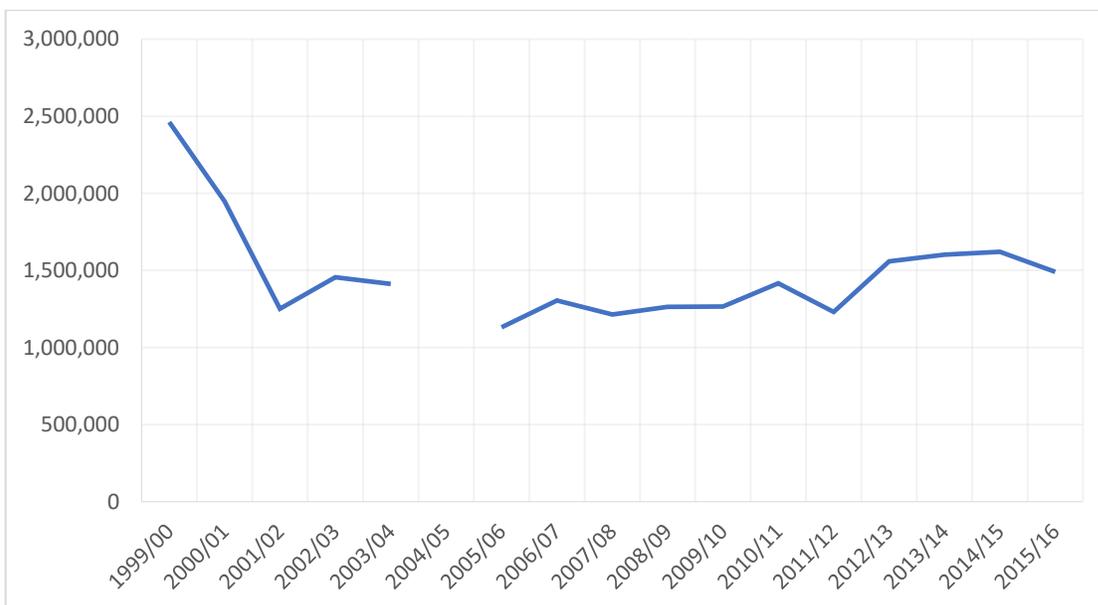


Figure 6. Recreational landings (pounds whole weight) of spiny lobster, 1999-2015. Source: FWC

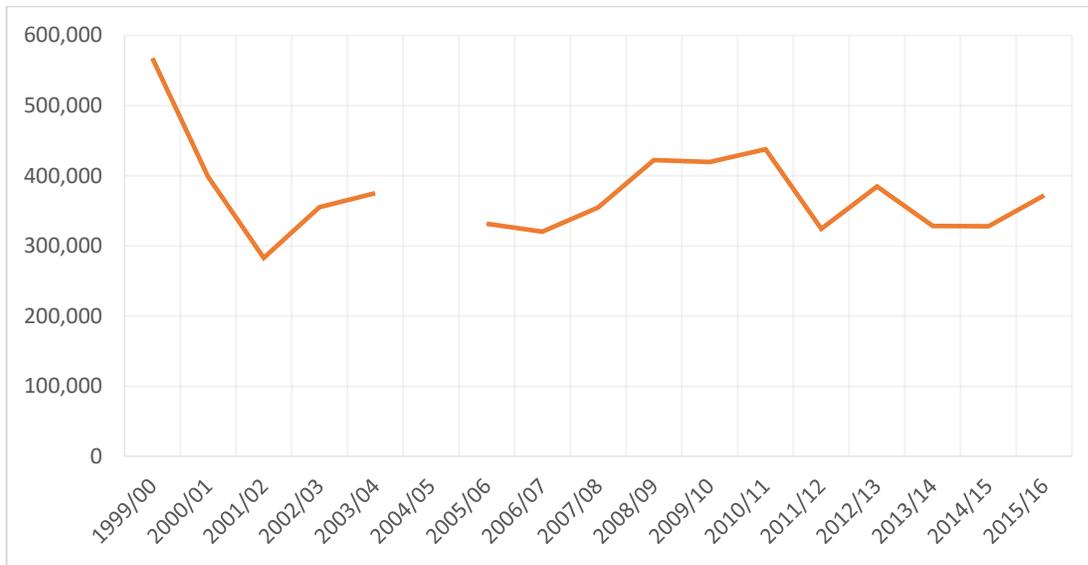


Figure 7. Recreational landings (pounds whole weight) of spiny lobster during the special recreational season, 1999-2015.

Source: FWC

Economic Performance

Metrics that are often readily available to evaluate economic trends for the commercial sector on a species by species basis (such as price per pound or ex-vessel value) are not available for the recreational sector. Nevertheless, trends in harvest are often linked to economic trends in a recreational fishery, with harvest often being associated with economic value. As such, trends in harvest can be used to broadly evaluate likely trends in the economic performance of a recreational fishery. Examining recreational harvest from 1999/00 through 2015/16 (**Figure 6**), the economic performance of the recreational spiny lobster fishery may have seen its highest levels in the mid to late 90's, hitting peak harvest during the 99/00 season before dropping considerably into the mid to late 2000's. Since then, recreational harvest levels have been generally increasing, potentially signaling an improving economic performance of the fishery as well.

Changing focus to the commercial sector, **Figure 8** shows the average nominal (i.e. not adjusted for inflation) and inflation adjusted (in 2016 dollars) price per pound for spiny lobster landed in Florida from 1991 through 2016. The total ex-vessel value for spiny lobster landed in Florida is presented in **Figure 9** in nominal and inflation adjusted (2016 dollars) values as well. Economic data for this report were provided in calendar instead of fishing years and 2017 data are preliminary, therefore the time series only goes through 2016. The ex-vessel price per pound for spiny lobster was variable from year to year, but generally increased through the time series. One notable exception occurred in 2009 when prices dropped dramatically. This was likely due to the instability exhibited in the U.S. and world economies at the time. Prices did recover in subsequent years and in 2014, prices for spiny lobster were the highest in the time series, both on a nominal and inflation adjusted basis (\$10.49/lb nominal and \$10.67/lb inflation adjusted). Since then, ex-vessel prices have slipped but remain at relatively elevated levels, with an average annual ex-vessel price of \$8.20/lb for spiny lobster in 2016.

On a nominal basis, the overall ex-vessel value varied from year to year, with a relatively flat trajectory through 2009. This was followed by a notable upward trend in the ex-vessel value of the spiny lobster fishery, reaching levels not previously observed. When adjusted for inflation, the ex-vessel value of the fishery was relatively robust through the late 1990's. This was followed by a decrease in the ex-vessel value of the fishery through much of the 2000's. In recent years, the inflation adjusted value of the fishery has recovered to levels comparable to the early part of the time series despite comparably lower total landings (by weight) in the fishery. This reflective of the increasing ex-vessel price that has allowed the fishery to increase its ex-vessel value at a lower landings level. The peak total ex-vessel value of the fishery was observed in 2014 at approximately \$59 million. The ex-vessel value of spiny lobster landings in 2016 was approximately \$44 million.

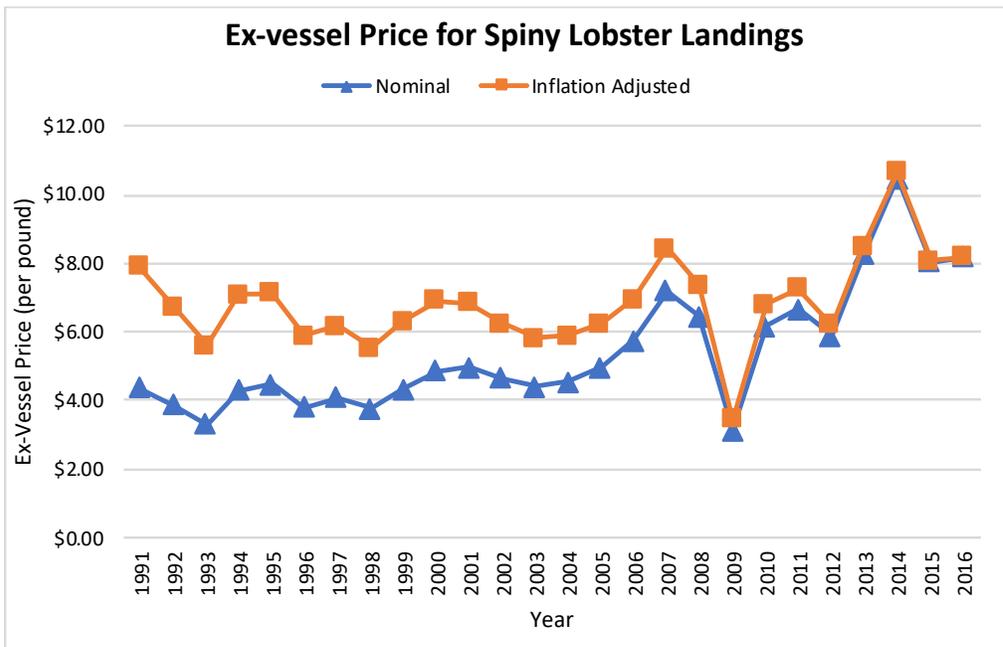


Figure 8. Average annual nominal and inflation adjusted (2016 dollars) ex-vessel price per pound for commercial spiny lobster landings in Florida from 1991-2016. Inflation adjustments use the U.S. CPI. Sources: U.S. Bureau of Labor Statistics and FL FWC, Commercial Fisheries Landings Summaries.

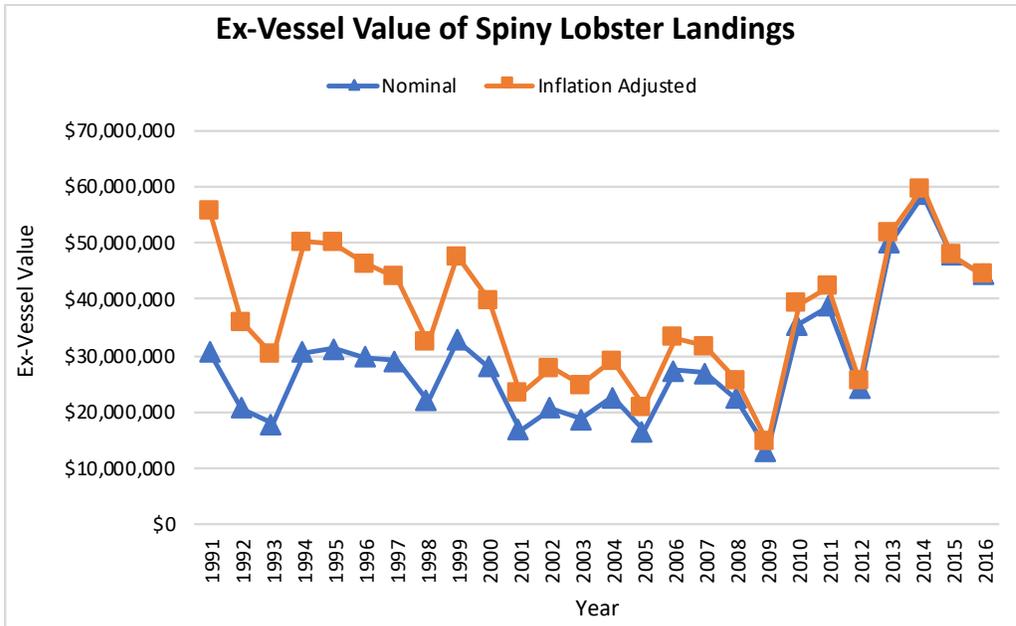


Figure 9. Average annual nominal and inflation adjusted (2016 dollars) ex-vessel value for commercial spiny lobster landings in Florida from 1991-2016. Inflation adjustments use the U.S. CPI. Sources: U.S. Bureau of Labor Statistics and FL FWC, Commercial Fisheries Landings Summaries.

References

Acosta, C., T., Matthews, and M. Butler IV. 1997. Temporal patterns and transport processes in recruitment of spiny lobster (*Panulirus argus*) postlarvae to south Florida. *Marine Biology* 129:79--85.

Bill, R., and W. Herrnkind. 1976. Drag reduction by formation movement in spiny lobster. *Science* 193:1146-1148.

Davis, G.E. and J.W. Dodrill. 1989. Recreational fishery and population dynamics of spiny lobsters, *Panulirus argus*, in Florida Bay, Everglades National Park, 1977-1980. *Bulletin of Marine Science* 44(1):78--88.

FAO Fisheries Synopsis. 1991. Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. Rome: FAO Species Catalogue No. 125 Vol 13.

Herrnkind, W. F. 1980. Spiny lobsters: patterns of movement. Pages 349-407 in J.S. Cob and B .F. Phillips, editors. *The biology and management of lobsters*. Vol. 1, J., Academic Press, New York.

Herrnkind, W. F. 1985. Evolution and mechanisms of mass single-file migration in spiny lobster: Synopsis. *Contributions in Marine Science*. 1985.

Hunt, J. H., W. Sharp, M.D. Tringali, R. D. Bertelsen, and S. Schmitt. 2009. Using microsatellite DNA analysis to identify sources of recruitment for Florida's spiny lobster (*Panulirus argus*) stock. Final Report to the NOAA Fisheries Service Marine Fisheries Initiative (MARFIN) Program, Grant No. NA05NMF4331076 from the Florida Fish &

Wildlife Conservation Commission, Fish and Wildlife Research Institute, FWC/FWRI
File Code: F2539-05-08-F.

Johnson, M. W. 1960. The offshore drift of larvae of the California spiny lobster, *Panulirus interruptus*. California Cooperative Oceanic Fisheries Investigations Report 7:147-161.
Lipcius, R.N., and J.S. Cobb. 1994. Introduction: Ecology and fishery biology of spiny lobsters. Pages 1-30 in B.F. Phillips, J.S. Cobb, and J.K. Kittaka, editors. Spiny lobster management. Blackwell Scientific Publications, Oxford.

Phillips, B. F. 1989. Phyllosoma larvae and the ocean currents off the Hawaiian Islands. Pacific Science 43:352-361.

Silberman, J. D., S. K. Sarver, and P. J. Walsh. 1994. Mitochondrial DNA variation and population structure in the spiny lobster *Panulirus argus*. Marine Biology 120:601--608.

SEDAR 8 Update. 2010. Update stock assessment report of SEDAR 8 Southeast U.S. Spiny Lobster. Southeast Data, Assessment, and Review. Key West, Florida.

<http://sedarweb.org/2010-update-sedar-08-southeast-us-spiny-lobster>.

Yeung, C. 1996. Transport and Retention of Lobster Phyllosoma Larvae in the Florida Keys. PhD dissertation, Coral Gables, FL, USA: University of Miami, pp. 217.

Yeung, C. and M. F. McGowan. 1991. Differences in inshore-offshore and vertical distribution of Phyllosoma larvae of *Panulirus*, *scyllarus* and *scyllarides* in the Florida Keys in May-June, 1989. Bulletin of Marine Science 49(3):699-714.

Yeung, C., Jones, D. L., Criales, M. M., Jackson, T. L., and W. J. Richards. 2001. Influence of coastal eddies and counter-currents on the influx of spiny lobster, *Panulirus argus*, postlarvae into Florida Bay. Marine and Freshwater Research 52:1217-1232.