Price variation in the Caribbean spiny lobster fishery: Incentives for ongrowing wild-caught lobsters in Florida

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Abstract

The Caribbean spiny lobster, *Panulirus argus*, is historically one of Florida's most valuable commercial fisheries. The creation of a live export market in the 2010s increased the value of this fishery despite declines in total landings and potentially provides an economic opportunity to enhance the value of the fishery. However, the market potential may be limited by a misalignment between fishery production and market demand, as both landings and price have high seasonal variation. We explore the economic incentives for aligning fishery landings with market demand by estimating a hedonic price function to examine the effects of seasonality and product characteristics on the ex-vessel price of spiny lobster. Seasonality and product grade were the most important factors explaining variation in ex-vessel price. The monthly price premiums increased as the season progressed, with the largest increases in price in January and February, with 61 and 63% premiums compared to the price in August when most lobsters are harvested. In addition, live grade lobsters received a 34% premium to whole grade lobsters. The results call attention to the significant potential to increase the revenue of the fishery if lobster harvest was shifted from August and September to January and February, or if aquaculture-based live storage or ongrowing of lobsters landed early in the season could be sold live and later in the season.

Keywords: *Panulirus argus*, hedonic model, ongrowing, aquaculture

Highlights

- Seasonality and lobster grade are important factors of price determination.
- Regulatory and cultural impediments weaken fishery adaptation to market demand.
- Ongrowing operations can target higher-value markets regardless of seasonality in catch.

1. Introduction

The timing of fishery harvests throughout the year has important implications for product form, price, and ultimately revenue generated by the fishery (Larkin and Sylvia, 1999: Grafton et al. 2000). While seasonality in landings is an inherent feature of fisheries, it is often amplified by management systems and consumer demand (Homans and Wilen 2005; Birkenbach et al., 2020; Love et al., 2023). Short fishing seasons, aimed at reducing fishing effort, can result in derby fishing, market gluts and weak incentives to develop higher-value fresh markets (Homans and Wilen 2005). Birkenbach et al. (2017) show that the transition of US fisheries to individual fishing quotas (IFQs) extends the fishing season, and Birkenbach et al. (2023) show that the extended fishing season results in higher prices for species with higher paying alternative markets, such as fresh markets, which can then be served. Pincinato et al. (2022) find higher ex-vessel prices for Norwegian whitefish after introduction of IFQs, but that the fishing season was not extended, suggesting that higher prices were the result of higher quality fish.

The Caribbean spiny lobster fishery in Florida has recently shifted from supplying frozen tails in the domestic chain restaurant market to live exports, primarily to China. While this transition to a higher quality product has enhanced the value of the fishery, market potential may be limited by the seasonal landing pattern and unit prices for live and frozen spiny lobsters that show strong seasonal variation. Higher prices are typically observed toward the end of the season when landings are at their lowest (Matthews et al., 2019), providing an example of a misalignment between supply and demand (Love et al., 2023). The market for spiny lobster, similar to many seafood commodities, is globally integrated and with prices determined at the

71 global level.[1] Florida produces only 7% of the Caribbean spiny lobster supply and a much
72 smaller share of the world's spiny lobster supply, and thus domestic production only weakly
73 influences market price.

74 In this paper, we explore a misalignment between fishery production and demand in the
75 Caribbean spiny lobster fishery in Florida. We estimate a hedonic price function to examine the
76 effects of seasonality and product attributes on the ex-vessel price of spiny lobster. The results
77 show that seasonality and product grade were the most important factors explaining price
78 variation. We discuss the results considering two alternatives for better alignment of the landings
79 of lobsters to market demand: delaying harvest or ongrowing aquaculture of wild-caught lobster.
80

81 **2. Description of the Spiny Lobster Fishery in Florida**

82 The Caribbean spiny lobster, *Panulirus argus*, is found in tropical and subtropical waters
83 throughout the Caribbean basin, along the US South Atlantic coast and Gulf of Mexico
84 (Holthius, 1991). Its range extends from North Carolina to Brazil, and it supports economically
85 and culturally valuable fisheries across most of its range (Pereira and Josupeit, 2017). Strong
86 international demand for Caribbean spiny lobster results in high market prices and significant
87 international trade (Matthews et al., 2019). In the United States, commercial harvest of the
88 Caribbean spiny lobster is limited to Florida, and it is one of Florida's most valuable commercial
89 fisheries. Since 1990, the fishery had an average annual commercial harvest of 2040 metric tons
90 (Fig. 1) and an annual dockside value of approximately US$40 million (FWC, 2023). Florida
91 also has a substantial recreational fishery that lands an average of 680 metric tons and

[1] Anderson et al. (2018) show how the market for most species are global with common price determination processes. Asche et al. (2022a) provide a good example in the U.S. by showing how domestic shrimp prices are determined by the price in the global market.

92 contributes significantly to the local economy in south Florida (Leeworthy, 2002; Sharp et al.,
93 2005).

94 The commercial fishery in Florida primarily uses traps to harvest spiny lobster. The
95 number of traps in the early 1990s was estimated at 750,000 and has since been reduced to about
96 450,000 traps (Florida Fish and Wildlife Conservation Commission, unpubl. data). Reduction of
97 traps was achieved through a Trap Certificate Program which was implemented in 1993 to limit
98 fishing effort (i.e., the number of traps) as well as enable individuals to manage their own fishing
99 effort through the transfer/sale of trap certificates (FL Statute 370.142). The trap fishery exploits
100 Caribbean spiny lobsters' highly social behavior (Childress and Herrnkind, 1996, 1997) and uses
101 traps baited with sublegal-size lobsters to attract and capture other lobsters (Butler et al., 2018).
102 The fishery operates with a minimum legal size of 76.2 mm carapace length equivalent to 375 g
103 total weight (Matthews et al., 2003), and most lobsters are harvested between 1.5 to 2 years after
104 settlement when they are about 400 grams (Maxwell et al., 2009, 2013).

105 There is strong seasonality in the landings of spiny lobster, where catch is highly skewed
106 to the start of the season consistent with a race to fish and an overcapitalized fishery. Currently,
107 half of landings occur in the first two months of the season (i.e., August and September)[2]
108 followed by a sharp decline in landings thereafter (Fig. 2) (FWC, 2023; Ross and Matthews,
109 2023, in review). The decline in landings greatly outpaces the decline in fishing effort as
110 indicated by the declining number of traps used each subsequent month of the fishing season
111 (Matthews, 2001).

112 Historically, the fishery in Florida caught lobsters under 400 g. total weight as early in
113 the fishing season as possible to meet the demand for a low priced, frozen, whole lobster tail in

[2] The commercial season starts August 6 and runs through March 31 each year.

U.S. family-style restaurant chains. However, in recent decades the economic viability of the Florida spiny lobster fishery has become dependent on exports of spiny lobster to China, the main market today (Matthews et al., 2019). Spiny lobsters are exported frozen or live. The live export market began developing in 2010, and by 2022 about 75% of the landings are believed to be exported live[3]. Live lobsters are more valuable, as the ex-vessel price of live grade lobster was occasionally double or triple the price of whole-grade lobsters which are sold frozen.

Data

This study uses ex-vessel data collected from commercial landings reports in Florida's Marine Fisheries Information System ("trip ticket") data (FWC, 2023). Trip tickets are completed at the original sale, which usually occurs when fishers deliver and sell product to wholesale dealers typically referred to as fish houses. A price per pound is given by the fish house. Prices typically vary by live, whole, or unknown grades. Lobsters deemed favorable for the live export market are sold at the higher live price, and lobsters deemed unfavorable for the live export market, such as lobsters that are molting, injured (> 3 missing appendages), or in poor condition, are sold at the lower whole price. Several fish houses do not grade product until after the landings are recorded in the trip ticket system and are thus recorded as unknown grade.

We used trip ticket data from August 2010 to March 2022, which covered 12 fishing seasons. The raw data set contained 289,761 records of commercial lobster fishing trips and included data on ex-vessel price, quantity landed, grade, gear, county landed, and date. Records missing the date, and/or price were removed. This reduced the dataset to 215,156 usable

[3] Commercial trip ticket data indicates 75% of landings are landed as live grade, and most of this is expected to be exported live.

observations (or 178,202 individual trips, as some trips had multiple grades and prices). Descriptive statistics for the dataset can be found in Table 1.

Categorical variables for the model were based on date, gear type, and location. The average quantity landed per trip was 86 kg, although this had high seasonal variation and steadily declined over the season. Traps were the primary gear type and accounted for 94% of landings, with smaller shares captured by the dive and bully net fisheries at 4% and 2%, respectively, but there were a few trips with no gear reported (Ross and Matthews, 2023, in review). Spiny lobsters were landed primarily in the Florida Keys, with 90% of the harvest landed in Monroe County and 8% in Dade County. The shares of gear type and county of landing were consistent across all years examined.

The development of the live export market is relatively recent, beginning in 2010, and thus the shares of lobster grades have changed substantially since then. In the 2010-2011 fishing season, the share of live-grade lobsters was 14% of total landings and landings with an unreported grade were high (i.e., 70% of total landings). In the 2021-2022 fishing season, live-grade was the most important category, and it comprised 75% of lobster landings.

Methods

There is substantial heterogeneity within seafood products that allows producers to benefit from product differentiation, such as product form and size. Hedonic price analysis is a commonly used approach in food market analysis that estimates the marginal value of attributes of differentiated products and can provide insights on consumer preferences and the value of supply-side decisions. Hedonic price functions are commonly estimated for aquatic products at the dockside level using ex-vessel prices (Lee, 2014; Asche et al., 2015; Blomquist et al., 2015;

158 2020; Sogn-Grundvåg et al., 2020, 2021, 2022; Wolf and Asche, 2022; Kehoe et al., 2023;
159 Anderson and Hammarlund, 2023; Pascoe et al., 2023; Pettersen et al., 2023; Bronnmann et al.,
160 2023) as well as other levels in the supply chain and particularly at the retail level (Ankamah-
161 Yeboah et al., 2016; Bronnmann and Asche, 2016; Hilsenroth et al., 2018; Hukom et al., 2020;
162 Asche et al., 2021; Ray et al., 2022; Botta et al., 2023). We estimated a hedonic price function to
163 examine the marginal price effects of product attributes and seasonality on the ex-vessel price of
164 spiny lobsters landed in Florida. The hedonic price equation is given as follows:
165
166 Equation 1:
167
168 $$lnP_{it} = \alpha + \sum_{j=2}^{3} \beta_j \, (Grade)_{jit} + \sum_{k=2}^{4} \sigma_k \, (Gear)_{kit} + \sum_{l=2}^{8} \gamma_l \, (Month)_{lt} + \sum_{m=2}^{4} \delta_m \, (County)_{mt}$$
169 $$+ \sum_{n=2}^{12} \theta_n \, Year_{nt}$$
170
171 where *P* is the inflation adjusted ex-vessel price per pound of product *i* at time *t*. Grade is the
172 quality grade of the lobster (live, whole, or unknown), gear is the type of gear used to harvest
173 lobster (trap, dive, bully-netting, or other), and county is the county where the lobsters were
174 landed (Monroe, Dade, or other). Month is a set of dummy variables indicating the month the
175 landing occurred (August to March). Year is a set of dummy variables indicating each fishing
176 season from 2010-2011 to 2021-2022. The coefficients represent the contributory characteristics
177 of the product price. This model specification assumes the values of each product attribute is
178 independent of the other product attributes. However, we anticipate that the effect of grade on

price will vary across months and years. This is accounted for by two additional models with all variables in Equation 1 and interaction effects between month and grade, and year and grade, respectively. The percentage price premiums were calculated as 100*[exp(d)-1], where d is the coefficient estimate for the attribute of interest. All analyses were conducted using R software (v3.6.1).

Results

The parameter estimates, standard errors, and percent price premiums are reported in Table 2. The model explained the variation in price relatively well with an R^2 of 0.588. Grade and month had the largest impact on price. Live-grade had a 34% premium relative to whole-grade. The unknown-grade had a price increase of 29% relative to whole-grade, suggesting that a large share of sales with an unknown grade are priced similar to the live-grade price. Seasonality was an important factor explaining the variation in price. The monthly price premiums increased as the season progressed, with the largest increases in price in January and February, with 61 and 63% premiums compared to August when most lobsters were harvested. This is indicative of a very strong seasonal component to price, as the seasonal price variation is much stronger than hedonic studies of other seafood products (e.g., Asche et al., 2022).

The fishing year variables indicated a fluctuating trend in price across years. The highest price was obtained in the 2014-2015 fishing seasons with a price premium of 43% relative to 2010-2011 season and is consistent with anecdotally high prices during this year as a result of new exporters entering the lobster market. The lowest prices were observed from the 2018-2019 to the 2020-2021 seasons with prices 7-14% below the price in the 2010-2011 season. The low prices during this period were initiated by a Chinese tariff on U.S. exports of live lobster

202 followed by the COVID-19 pandemic, both of which reduced demand for lobster in China (Love
203 et al., 2021).
204 The effect of gear and location on price variation was comparatively small. Trap and
205 bully-netting gear received 1.7% and 2.4% premiums compared to lobster caught by the dive
206 fishery. The Other gear category received a 22% increase; however, this gear accounts for a very
207 small share of total landings (<1%), and may include bycatch from other fisheries and erroneous
208 data that furthers the inconsequential nature of these results. Lobsters landed in Monroe and
209 Dade counties received 6.8% and 1.9% price increases, respectively, relative to Other counties in
210 Florida.
211 To examine whether the effect of grade varied by month, an interaction effect was
212 included (Table 3). Live and unknown grades show similar patterns of price development, with
213 the live and unknown grades achieving higher premiums relative to whole-grade lobster (Fig. 4).
214 Live-grade can achieve a 42% price increase relative to whole-grade in the month of January, but
215 the price increase is much smaller at the onset of the season through November, underscoring
216 opportunity to increase revenue if a larger share of lobsters is sold live and in January.
217 Fig. 5 shows the estimated yearly premiums by grade. The price development across
218 years is similar for live and unknown grades with some exceptions. The live-grade achieved the
219 highest prices in the 2014-2015 season, whereas unknown-grade achieved the highest price in
220 2021-2022 season. In several years, the unknown-grade achieved higher prices than the live-
221 grade, and the price for live-grade appears to be more negatively impacted by COVID-19 in the
222 2019-2020 and 2020-2021 seasons. However, it is important to note that in recent fishing seasons
223 the unknown-grade constituted less than l0% of landings.
224

Discussion

This is the first study to explore factors leading to price variation in the Caribbean spiny lobster fishery with a focus on the fishery in Florida. The results show the importance of grade and seasonality in price determination and calls attention to the significant potential to increase revenue if the fishery can meet the demand for live spiny lobster later in the season. These results reflect changes in the market demand for lobsters over the last decade, but the conditions in the fishery appear to create impediments to increasing value and sustainability. Impediments to capitalizing on changes in market demand for spiny lobsters includes limitations imposed by fishing regulations, lobster biology, and the established cultural norms in the fishing industry.

Seasonality is a natural feature of wild-capture fisheries shaped by the behavioral and life history patterns of organisms and can often be amplified by management inefficiencies (Birkenbach et al., 2017; 2020). Seasonality in harvest can create misalignment between fishery production and market demand (Love et al., 2023). The strong seasonality in the price of spiny lobster combined with seasonality in landings provides an opportunity to increase revenue of the fishery. Ex-vessel prices of spiny lobster varied up to 63% between months, with the highest price premiums in January and February. However, over 80% of commercial landings were before January. The price variation across months in this study is higher than what most hedonic studies find for other seafood products. Guillen and Maynou (2014) show the ex-vessel price of red shrimp varied up to 40% between months, although many hedonic studies find seasonal price increases less than 25% (e.g., Bronnmann et al., 2020; Asche et al., 2022a). Kehoe et al. (2023) show ex-vessel price of stone crabs, which is also a high-value seafood item in Florida, varied up to 6% between months. Using the model results in Table 2, we estimate the potential additional fishery value to be $11,751,215 ± 2,513,545 per year if lobsters caught within the first four

months of the fishing season (August through November) were sold at the average price between December and March and as the same grade (whole vs. live). While this is a crude estimation, it is indicative of substantial opportunity to improve the value of the fishery.

Higher prices for spiny lobsters late in the season is in part the result of strong demand in the Chinese market associated with the Lunar New Year. There are multiple studies showing price increases of seafood around major holidays that are largely driven by consumer preferences and seafood availability. Guillen and Maynou (2014) show the strongest price increase in red shrimp occurred in December, which results from high demand around the Christmas and New Year holidays. Asche and Guillen (2012) also find a strong price increase in the Spanish hake market in December, and Love et al. (2023) finds higher seafood consumption during December in the U.S. as well as in March for Lent. The high price of spiny lobster in the Chinese market around the Lunar New Year provides opportunity to increase the revenue of the fishery if spiny lobster landings can be better aligned with the demand.

Our analysis shows that seasonality in price may be due in part to seasonal differences in the relative prices of different grades of lobster. Live-grade can achieve a 42% price increase relative to whole-grade in the month of January, but the price increase is much smaller at the onset of the season through November. The primary cause of the low-price differential early in the season is lower market demand, but lobster biology is also a factor. Caribbean spiny lobsters are difficult to ship live when captured at high water temperatures typical of south Florida. The 32°C temperature tolerance of Caribbean spiny lobsters (Field and Butler, 1994) is approached in August, September, and October in Florida, greatly limiting the ability to ship live lobsters (personal communication with Elite Sky seafood).

The weight of lobsters is an important consideration. Nearly all lobsters landed in Florida are small grade (under 460g). This is solely due to intense fishing pressure resulting in over 85% of caught lobsters between 1 and 2 years of age (Matthews, 2001; Matthews et al., 2009). Larger sized lobsters typically garner a higher price in the live lobster market representing an additional consideration for increasing value in the fishery. Our analysis could not consider size as larger grade lobsters are infrequently captured.

The regulatory conditions and fishing culture have impeded the fishery from adapting to the changes in market demand. The spiny lobster fishery is nearly a century old, and the modern fishery and current fishing practices were established in the 1960s and 70s (Robinson and Dimitriou, 1963; Hunt, 1994). The fishing season and size regulations established the conditions that resulted in the derby-like fishery that landed small sized lobsters primarily in August and September that could be frozen for later sale. Transition to individual transferable quota (ITQ) management has benefited other rock lobster fisheries by removing the race to fish and improving product quality and markets served (Gardner et al., 2013; Penn et al., 2015; Linnane et al., 2023). Caputi et al. (2015) show a transition to ITQs in the Australian western rock lobster fishery extended the fishing season from 7.5 to 12 months and increased unit price by about 20%. The increase in price was the result of greater control over the timing and size of the harvest, which ultimately allowed fishers to better target periods and products that receive higher prices. While ITQ management has been adopted extensively in places like Iceland and New Zealand, ITQs have been used to a lesser extent in the U.S. and are highly controversial primarily due their potential impacts on employment and distributional concerns (Abbott et al., 2022). In Florida, the cultural and social significance of the spiny lobster fishery may create challenges for adopting new management regimes. In addition, the derby style fishing has

allowed the fishing fleet to participate in other fisheries, such as stone crab, mackerel, and other fish typical of many tropical fisheries, later in the season and, thus, changes to the lobster fishery may impact other fisheries which increases the difficulty of adaptation in the lobster fishery.

An alternative approach to meet the current market demand without potentially disruptive changes to existing fishery practices is aquaculture, in the form of ongrowing legal-sized wild-caught lobsters. Ongrowing is defined as rearing organisms to a marketable size in aquaculture. Similar practices can be observed for other species like tuna and cod (Shamshak and Anderson, 2009; Pettersen et al., 2023). Ongrowing aquaculture of lobsters could be used to provide a higher-value product to the live export market when demand for lobster is at its highest late in the fishing season or during the closed fishing season. Ongrowing operations could include small, legal-size lobsters harvested early in the season held for sale at peak price, or conversion of whole-grade lobsters to live-grade lobsters through rehabilitation.

Ongrowing of lobsters includes both advantages and risks requiring further practical and economic assessment. Lobster grow-out operations have the potential to target high value markets, regardless of timing of the catch. However, the high interannual variation in price associated with external factors in the world market and economy poses some risk for investing in ongrowing operations, and further analysis is needed to examine the economic feasibility of ongrowing culture systems and practices. The development of commercial lobster culture is currently in its infancy and the Caribbean spiny lobster, *Panulirus argus*, has received limited attention (Jeff and Davis, 2003; Matthews et al. 2007; Gnanalingam et al., 2018; Mirzaei et al., 2021). The need for economically viable and nutritionally sufficient feeds is a major impediment to commercial ongrowing of adults (Cox and Davis, 2006; Nankervis and Jones, 2022). There are also several major management concerns associated with a lobster aquaculture industry,

specifically the possession of sublegal-size, out-of-season, and egg-bearing lobsters. Regulation of these new industry practices must be addressed to develop a reasonable and enforceable regulatory framework to ensure the sustainable management of the industry.

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507

508 Table 1. Descriptive statistics of the trip ticket data for the Caribbean spiny lobster fishery in
509 Florida from August 2010 to March 2022.

Variable	Share of landings, August 2010 to March 2022	Average inflation-adjusted price per pound (SD)
Grade		
Live	46.4	10.22 (3.90)
Whole	13.9	9.54 (3.69)
Unknown	39.7	7.21 (1.97)
Fishing season		
2010-2011	12.7	8.59 (2.01)
2011-2012	11.9	8.26 (1.63)
2012-2013	8.8	8.08 (3.77)
2013-2014	11.1	10.60 (4.22)
2014-2015	7.1	13.02 (4.81)
2015-2016	8.8	8.07 (2.17)
2016-2017	8.5	9.05 (2.96)
2017-2018	6.0	8.85 (3.04)
2018-2019	9.2	7.50 (2.58)
2019-2020	5.1	6.94 (1.74)
2020-2021	6.0	8.30 (3.32)
2021-2022	5.0	8.53 (2.33)
Month		
August	31.6	7.04 (1.38)
September	20.8	8.63 (3.33)
October	16.5	8.59 (2.66)
November	11.3	8.22 (2.05)
December	6.5	10.25 (3.35)
January	7.4	12.36 (4.32)
February	3.6	12.71 (4.84)
March	2.2	10.93 (4.18)
Average Price	-	9.02 (3.56)

510

511 Table 2. Results of the hedonic price regression for the Caribbean spiny lobster market in
512 Florida.

	Estimate	Std. error	% Premium
Intercept	1.652 ***	0.003	
Grade			
Live	0.298 ***	0.001	34.7
Unknown	0.255 ***	0.001	29.0
Gear			
Trap	0.017 ***	0.002	1.7
Bully	0.024 ***	0.002	2.4
Other	0.201 ***	0.009	22.3
Month			
September	0.145 ***	0.001	15.6
October	0.148 ***	0.002	16.0
November	0.172 ***	0.002	18.8
December	0.299 ***	0.002	34.9
January	0.480 ***	0.002	61.6
February	0.494 ***	0.002	63.9
March	0.336 ***	0.002	39.9
County			
Dade	0.019 ***	0.003	1.9
Monroe	0.066 ***	0.003	6.8
Fishing season			
2011-2012	-0.007 **	0.002	-0.7
2012-2013	-0.118 ***	0.002	-11.1
2013-2014	0.178 ***	0.002	19.5
2014-2015	0.364 ***	0.002	43.9
2015-2016	0.006 **	0.002	0.6
2016-2017	0.066 ***	0.002	6.8
2017-2018	0.051 ***	0.002	5.2
2018-2019	-0.106 ***	0.002	-10.1
2019-2020	-0.160 ***	0.003	-14.8
2020-2021	-0.073 ***	0.003	-7.0
2021-2022	0.014 ***	0.003	1.4

513 Note: The base category contains the attributes: whole grade, dive gear, August, other counties,
514 and the 2010-2011 fishing season.
515 ** and *** indicate significance at 0.01 and 0.001 levels.
516

517 Table 3. Results of the hedonic price regression with interaction effects for the Caribbean spiny
518 lobster market in Florida.

	Month*Grade		**Year*Grade**	
	Estimate	**Std. error**	**Estimate**	**Std. error**
Intercept	1.739 ***	0.003	1.827 ***	0.004
Grade				
Live	0.147 ***	0.002	0.112 ***	0.005
Unknown	0.172 ***	0.002	0.042 ***	0.004
Gear				
Trap	0.020 ***	0.002	0.018 ***	0.002
Bully	0.023 ***	0.002	0.027 ***	0.002
Other	0.195 ***	0.009	0.196 ***	0.009
Month				
September	0.063 ***	0.002	0.139 ***	0.001
October	0.085 ***	0.003	0.140 ***	0.002
November	0.120 ***	0.003	0.166 ***	0.002
December	0.172 ***	0.003	0.283 ***	0.002
January	0.252 ***	0.00	0.468 ***	0.002
February	0.288 ***	0.004	0.481 ***	0.002
March	0.183 ***	0.004	0.324 ***	0.002
County				
Dade	0.018 ***	0.003	0.013 ***	0.003
Monroe	0.063 ***	0.003	0.069 ***	0.003
Fishing season				
2011-2012	-0.006 **	0.002	-0.075 ***	0.005
2012-2013	-0.121 ***	0.002	-0.297 ***	0.005
2013-2014	0.169 ***	0.002	-0.018 ***	0.004
2014-2015	0.340 ***	0.002	0.075 ***	0.004
2015-2016	-0.001	0.002	-0.146 ***	0.004
2016-2017	0.062 ***	0.002	-0.136 ***	0.005
2017-2018	0.043 ***	0.002	-0.177 ***	0.005
2018-2019	-0.106 ***	0.002	-0.281 ***	0.005
2019-2020	-0.162 ***	0.002	-0.288 ***	0.005
2020-2021	-0.079 ***	0.003	-0.175 ***	0.005
2021-2022	0.014 ***	0.003	-0.202 ***	0.005
$\mathbf{R^2}$	0.610		0.610	

519 Note: The base category contains the attributes: whole grade, dive gear, August, other counties,
520 and the 2010-2011 fishing season.
521 ** and *** indicate significance at 0.01 and 0.001 levels.

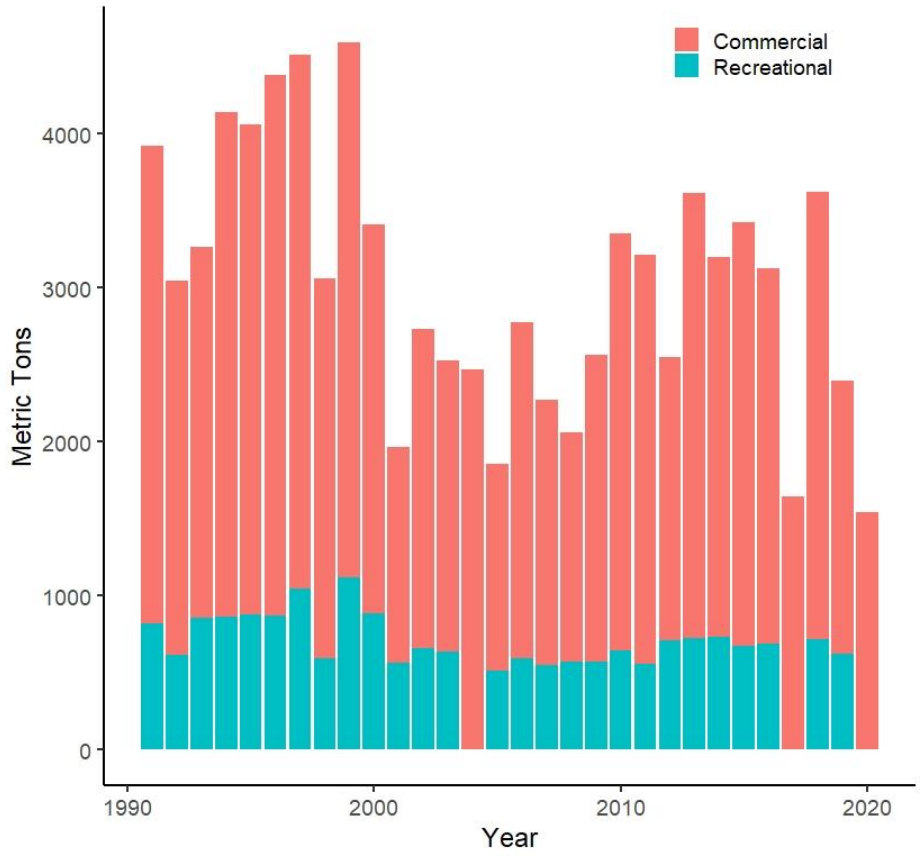
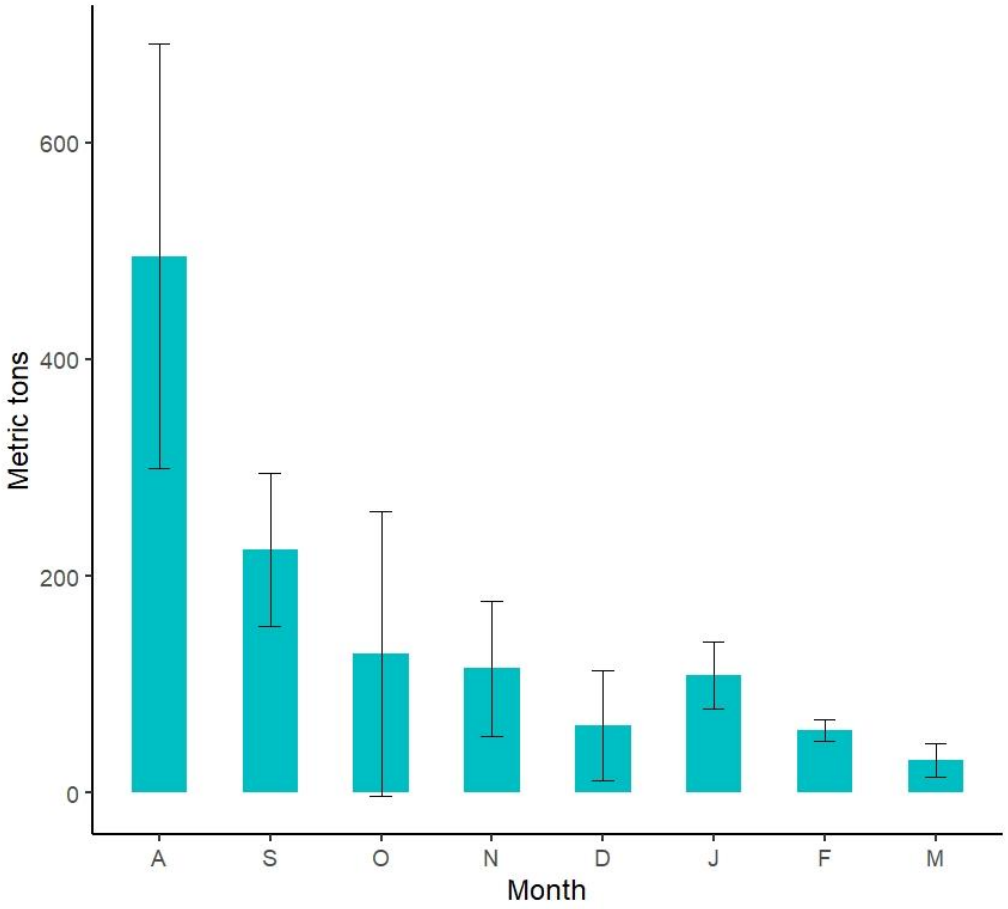
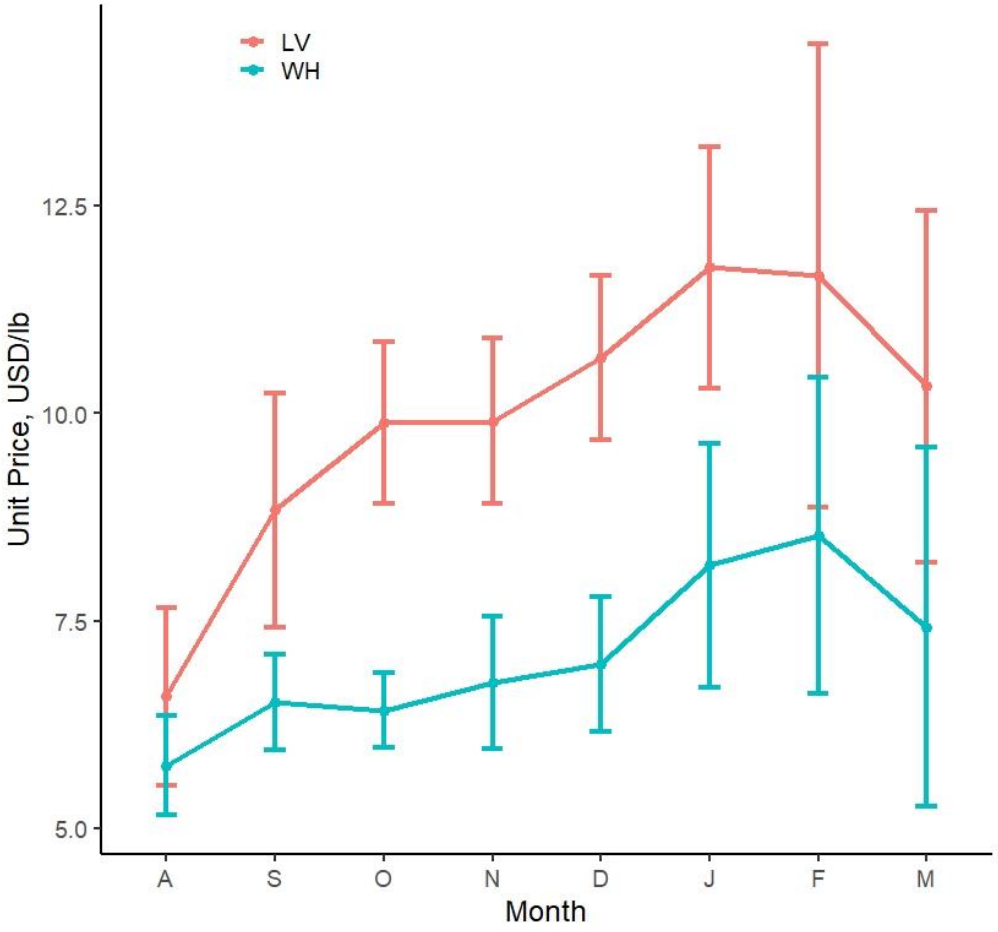


Figure 1. Commercial and recreational landings of spiny lobster. Recreational landings are not available for the 2004-2005, 2017-2018, and 2020-2021 fishing seasons (FWC, 2023).



525

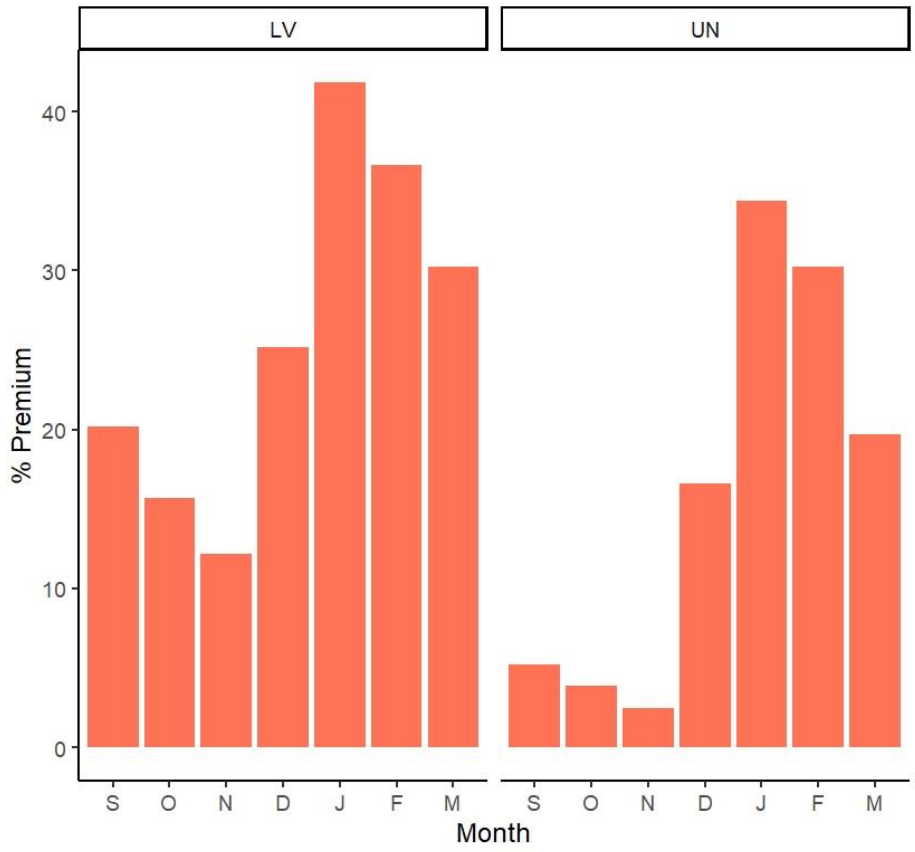
526 Figure 2. Average monthly landings of spiny lobster in Florida, 2017-2021.



527

528 Figure 3. Average monthly unit price ($/lb) of live (LV) and whole (WH) grade spiny lobster in

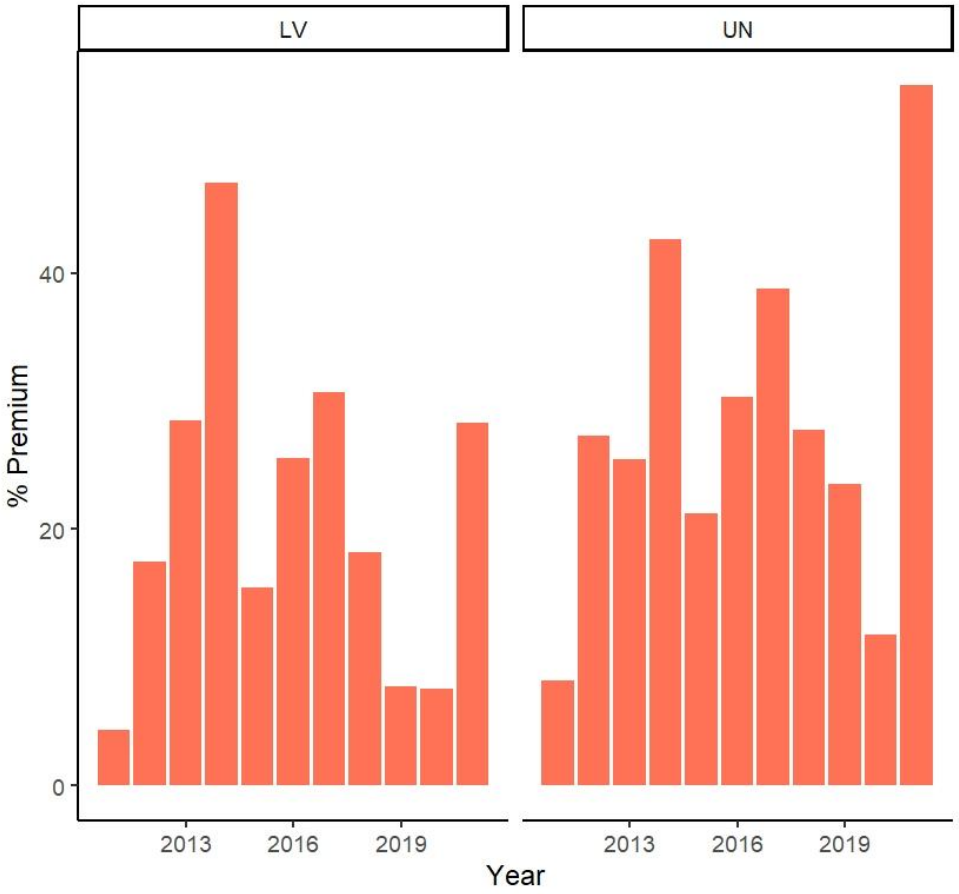
529 Florida from 2017-2022.



530

531 Figure 4. Monthly price premiums by grade for Caribbean spiny lobster in Florida relative to the

532 reference month, August.



533

534 Figure 5. Yearly price premiums by grade for Caribbean spiny lobster in Florida relative to the

535 reference year, 2010.