Analysis of market power under Quota Share and Quota Allocation caps in Gulf of Mexico catch share programs

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Table of Abbreviations

CIE	Center of Independent Experts
DWG	Deep Water Grouper
GG	Gag Grouper
GoM	Gulf of Mexico
Gulf Council	GoM Fishery Management Council
GT	Grouper-Tilefish
IFQ	Individual Fishing Quota
IFQ-Regulated GoM Reef Fish	GoM reef fish regulated under the IFQ programs
NEFMC	New England Fisheries Management Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
Previous Share Limit Analyses	Previous related reports co-written by author of this report
RG	Red Grouper
RGG	Red Grouper and Gag Grouper
RS	Red Snapper
Species Groups	Quota categories within GoM IFQ GT and RS programs
SUR	Seemingly Unrelated Regression (an econometric method)
SWG	Other Shallow Water Grouper
TF	Tilefish

I. INTRODUCTION

A. Principal Scientist

I am Glenn Mitchell. The National Marine Fisheries Service ("NMFS"), within the National Oceanographic and Atmospheric Administration ("NOAA"), has asked me to conduct an analysis of market power under Quota Share and Quota Allocation caps in the Gulf of Mexico ("GoM") grouper-tilefish ("GT") and red snapper ("RS") Individual Fishing Quota ("IFQ") programs.[1]

I hold a Ph.D. and an M.A. in Economics from the University of California at Santa Barbara, and a B.A. in Economics from the University of California at Davis. I have a research background in applied microeconomics, environmental and natural resource economics, econometrics, industrial organization, and finance. Specific research topics include energy and technological development, resource valuation, markets for tradable pollution allowances and empirical research into optimal harvest quotas for U.S. fisheries. I have also taught Economics as an Adjunct Professor at Occidental College and at the University of Southern California, Marshall School of Business.

I co-authored, with Steven Peterson and Robert Willig, the 2011 report "Recommendations for excessive-share limits in the surfclam and ocean quahog fisheries"[2] for the National Marine Fisheries Service and the Mid-Atlantic Fishery Management Council, and I co-authored, with Steven Peterson, the 2014 report "Recommendations for excessive-share limits in the Northeast multispecies fishery."[3] I refer to these previous two reports, collectively, as "Previous Share-Limit Analyses." I have provided consulting services for matters involving allegations of restraint of trade and regulatory review of mergers and joint ventures, including extensive econometric analysis of market power and competitive pricing. My investigations have covered a variety of industries and markets, including computers and related technology, transportation, petroleum refining and marketing, chemicals, consumer products distribution, professional sports, entertainment, journalism, biotechnology and medicine.

B. Statement of Work

The "Statement of Work" attached as Appendix A delineates the Scope, Objectives, Tasks and Deliverables that the NMFS has asked me to provide with this analysis. Similar to the Previous Share-Limit Analyses, the primary objective of this project is to determine what caps on Quota Share or Quota Allocation, if any, would be necessary to restrict the exercise of market power. In this instance, the Statement of Work delineates specific requirements for determining a range of relevant markets and assessments of concentration and market power across all of those

[1] To distinguish between shares of the annual quota for reef fish landings by species group and the common use of the word "share" as a portion of anything, I will use "Quota Share" throughout this report to refer specifically to the ownership of the privilege (subject to regulatory restrictions) to harvest a portion of the Gulf of Mexico Reef Fish annual quota for a species group regulated under the Individual Fishing Quota program. Also, the term "Quota Allocation" refers specifically to the annual privilege to land an amount of Gulf of Mexico Reef Fish regulated under the same program, as opposed to the common use of the word allocation.

[2] Available at http://www.nefsc.noaa.gov/read/socialsci/pdf/SCOQ_ITQ_Exc_Share_Rec_2011-05-03.pdf (as of March 29, 2016).

[3] Available at http://archive.nefmc.org/nemulti/planamen/Amend%2018/compass_lexecon/NEMFC%20Report%2020131216.pdf (as of March 29, 2016).

relevant markets, and explicitly requests consideration of potential cost effects from caps (potentially due to limitations on economies of scale).

In keeping with standard practice in economics, the identification of a 'relevant market' can only be done meaningfully in the context of a specific potentially anti-competitive act (such as collusion or a plan to merge competing firms). For this project, I define relevant markets under the assumption that the potentially anti-competitive act would be an accumulation of Quota Share or Quota Allocation sufficient to harm competition. The determination of relevant markets, requested for this project in more detail than the Previous Share-Limit Analyses, can be informed by an econometric analysis of demand substitution – analysis not undertaken in the Previous Share-Limit Analyses, but similar to the technical work undertaken by Dr. Mitchell in numerous competition-related matters.

Also, precise measurement of economies of scale requires detailed data on cost and/or quantity of inputs and outputs. To the extent that data availability restricts the scope of the analysis, this part of the work has been limited to a broad determination of the approximate range over which economies of scale appear to be present, based at least in part on indirect information, and confirmed by data analysis. The critical consideration has been to determine the extent, if any, by which the range of potential economies of scale might be constricted by caps on Quota Share and Quota Allocation deemed necessary to prevent the exercise of market power.

C. Organization of Report

The first section following this introductory section, Section II, contains a general description of the commercial sector in the GoM Reef Fish fishery (and includes the information required to satisfy task i in the Statement of Work). Following this is Section III, which provides the necessary economic background, and also pertinent critiques raised in reviews of Previous Share-Limit Analyses from NOAA's Center for Independent Experts ("CIE") – along with the information required to satisfy task ii in the Statement of Work. Then Section IV combines the information about the fishery with the economic background to develop the model of the industry that will be used for the remaining analysis – and Appendix B contains a detailed description of the data used in the analysis and the information required to satisfy task iii in the Statement of Work.

Section V presents the analysis of relevant markets and the results and conclusions to satisfy tasks iv, v, and vi in the Statement of Work. Section VI contains the analysis of market power and the results and conclusions to satisfy tasks vii, viii, ix, x and xi in the Statement of Work. Section VII provides the analysis of economies of scale and results for tasks xii, xiii, and xiv in the Statement of Work. Section VIII provides recommendations on Quota Share or Quota Allocation Caps to satisfy tasks xv and xvi in the Statement of Work and concludes the report.

II. DESCRIPTION OF FISHERY

A. General Description

The NMFS, also known as NOAA Fisheries, manages GT and RS harvest activity in United States federal waters of the GoM, in cooperation with GoM Fishery Management Council ("Gulf Council").

There are several species of commercially harvested grouper, tilefish and related species broadly described as "reef fish," many of which the GoM Fishery Management Council regulates under IFQ programs.[4] This report focuses on the reef fish regulated under the IFQ programs (RS and GT, or "IFQ-Regulated GoM Reef Fish"), but the analysis may include other reef fish and seafood products harvested in the region. The most commercially prominent of the IFQ-Regulated GoM Reef Fish are RS and Red Grouper ("RG"), together accounting for approximately 80% of the annual IFQ-Regulated GoM Reef Fish landings (quantity harvested and brought in for landing and sale to dealers).[5] Table 1 shows the landings by groups of species regulated under the IFQ programs, as reported annually by NOAA Fisheries. The ex-vessel value of RS and GT commercial landings in the GoM was, in aggregate, approximately $54 million in 2014 ($23 million and $31 million, respectively).[6]

In addition to reef fish, the Gulf Council also regulates harvests of "coastal migratory pelagics" (mackerel), with combined commercial and recreational harvests approximately similar (in weight) to IFQ-Regulated GoM Reef Fish, as well as shrimp, lobster, red drum, and other species.[7]

Fishing operations for reef fish are conducted with vessels of varying size and age, with varying capabilities with respect to range, using longline and vertical line gear. A captain, who may also be the owner of the vessel or may be hired, determines the operations of each vessel while on a trip. In addition, the captain supervises the hired crew of a vessel. There are a variety of payment methods for hired labor, but it is common for a portion of the payment to captain and crew to come as a share of trip revenue (often after deductions for costs). Other costs of production include fuel and bait, as well as gear and vessel maintenance (and capital costs).

The federal waters of the GoM stretch from the interior coast of the Florida peninsula to the border between Texas and Mexico, along the small coasts of Alabama and Mississippi, and the larger coasts of Louisiana and Texas, excluding ocean territory near the shore that is not federally managed. To get harvested fish to market requires landing and wholesale sales to dealers. Most of the landing transactions and the majority of quantity landed come to shore

[4] NOAA Southeast Regional Office website, accessed on Feb. 9, 2016 (http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_fisheries/reef_fish/index.html); "SPECIES LISTED IN THE FISHERIES MANAGEMENT PLANS OF THE GULF OF MEXICO FISHERY MANAGEMENT COUNCIL (Rev. 7/21/2015), available at http://gulfcouncil.org/Beta/GMFMCWeb/downloads/speciesmanaged.pdf.

[5] Gulf of Mexico 2014 Grouper-Tilefish Individual Fishing Quota Annual Report, NMFS Southeast Regional Office, October 30, 2015 ("GT 2014 Annual Report"), Table 16, p. 20; Gulf of Mexico 2014 Red Snapper Individual Fishing Quota Annual Report ("RS 2014 Annual Report"), Table 13, p. 18.

[6] GT 2014 Annual Report, p. 2, R-S 2014 Annual Report, p. 2. All of these are real values, expressed in 2009 dollars, adjusted using GDP deflator. In 2014, nominal values would have been about 8.7% higher (http://www.bea.gov/national/index.htm#gdp, accessed March 23, 2016). These figures are estimates based on reported ex-vessel prices, including those not considered to be "reasonable." Ex-vessel prices are under-reported for many reasons (GT 2014 annual report, p. 34). As a result, the ex-vessel value estimates in the annual reports are likely under-estimates of the actual values (personal communication with Michael Travis, NOAA Fisheries Service, SE Regional Office, April 19, 2016). I do not present them as precise measures of overall output – just for a general ballpark comparison with other fisheries.

[7] http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_fisheries/index.html, accessed March 29, 2016.

through Florida facilities, but there are landings in every state.[8] Dealers sell the fish along to customers including processing plants, restaurants and distributors.

Climate and other events influence fishing operations in the GoM. The climate in the Gulf includes strong storms and hurricanes that can affect fishing in unpredictable ways, including preventing operations during heavy weather and also shifting fish populations after intense storms. Special events include occasional algae blooms (red tides) that diminish or drive away targeted fish, and also man-made disasters like the Deepwater Horizon oil spill that occurred in April 2010.

Consumers of IFQ-Regulated GoM Reef Fish also consume other reef fish and seafood products from the GoM, and from other fisheries. The South Atlantic fishery, for example, operating on the other side of the Florida peninsula, includes many of the species harvested in the GoM.[9] Reef fish from the GoM may be shipped into other areas of the United States. Furthermore, the United States exports substantial quantities of reef fish from the GoM and other federally managed fisheries into Mexico and other countries, and the US also imports substantial quantities. Approximately 75 percent of the United States snapper supply and approximately 50 percent of the U.S. grouper supply is imported.[10] Total U.S. snapper and grouper import quantity (which includes frozen and processed products) far exceeds the GoM harvest.

The Gulf Council requires commercial harvesters to obtain a permit to land reef fish and other species in the region, and constrains operations that harvest regulated species. These regulations include, for various species and locations, minimum catch sizes, trip limits, seasonal restrictions, gear limitations, prohibitions on activities, etc.).[11] For some of the most popular commercial reef fish, however, the Gulf Council has dropped trip limits and seasonal restrictions in favor of a different regulation method.

The Gulf Council adopted in 2006 a management program for RS based on the use of IFQ, which NMFS implemented in 2007. Under this plan, the Gulf Council determined an initial distribution of "Quota Shares" to permit holders based on historical landing quantities. These Quota Shares can be transferred among private owners, but can also be revoked if the Gulf Council decides to start a different management regime. The Gulf Council sets a quota (in pounds) each year for commercial RS landings from the GoM. The Quota Shares owned determine the Quota Allocation (in pounds) that each Quota Share owner receives for the year, and that Quota Allocation can also be transferred among private owners. Quota Share is a long-term transferrable holding that confers the privilege to a set percentage of the annual quota; Quota Allocation is an annual transferrable holding that confers the privilege to land a set quantity (pounds) of fish within the given calendar year. Quota Share is a fixed percentage of

[8] NOAA Southeast Regional Office website, accessed Feb. 9, 2016 (http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_fisheries/index.html).

[9] http://safmc.net/sites/default/files/Resource%20Library/pdf/SAFMC_ManagedSpecies_091614.pdf (accessed March 29, 2016); http://gulfcouncil.org/Beta/GMFMCWeb/downloads/species%20managed.pdf (accessed March 29, 2016).

[10] Sustainable Fisheries Partnership, "US Gulf of Mexico Reef Fish Fishery Improvement Project," Last update: January 2016, https://www.sustainablefish.org/fisheries-improvement/snapper-grouper/gulf-of-mexico-reef-fish, accessed Feb. 24, 2016.

[11] Gulf Council, "Commercial Fishing Regulations for Gulf of Mexico Federal Waters," January 4, 2016; at http://gulfcouncil.org/fishing_regulations/CommercialRegulations.pdf (access March 29, 2016).

annual quota, but the annual quota itself may vary from year to year based on the scientific evaluation of the state of the fish population in the area.

The Gulf Council instituted a similar management regime in 2010 for grouper and tilefish species. The Gulf Council categorized most of the commercially valuable reef fish species (other than RS) into five categories ("Species Groups"): Red Grouper ("RG"), Gag Grouper ("GG"), Deep Water Grouper ("DWG"), Other Shallow Water Grouper ("SWG") and Tilefish ("TF").[12] As with RS, the Gulf Council determined an initial Quota Share distribution for each category based on historical landings, and sets an annual quota (in pounds) for each category that results in a Quota Allocation of annual pounds by category based on Quota Share. Both Quota Shares and Quota Allocation may be transferred among private owners.

The IFQ programs for RS and for GT include some flexibility provisions. On the last fishing trip of the season (calendar year), permit holders can "borrow" a limited amount against the Quota Allocation due to their Quota Share in the coming year (up to 10 percent). In addition, there are special allowances for using IFQ from one category across other categories – primarily between Red Grouper and Gag Grouper,[13] but also, to a limited extent, between DWG and SWG.[14]

The GoM Reef Fish Fishery has some characteristics in common with many other fisheries. Two fisheries worth noting briefly are the Northeast Multispecies Fishery, also regulated by NOAA (specifically by the New England Fisheries Management Council, "NEFMC"), and the British Columbia Integrated Groundfish program.[15] Both of these fisheries include multiple species frequently harvested in common across a large geographic region, and are substantially regulated through some type of program that establishes an overall quota or quotas (for some of the species), distributes the privileges to the available harvest among participants, and then allows for relatively unregulated transactions among participants (or

[12] The Gulf Council dropped five species from the GT IFQ program in 2012, and the GT categories currently contain 13 species (GT 2014 Annual Report, Table 1, p. 7).

[13] The Gulf Council designates some amount of RG Quota Allocation as "Multi-Use", which means it can be used for either RG or GG, and makes a similar designation for GG Quota Allocation. Given the substantial overlap in production (all producers or GG also produced RG every year, for example), substantial quantities of Multi-Use GG each year (for several of the years, the portion of RG allocated to "Multi-Use" was zero), the limited extent of GG harvesting activities, and the lack, in some cases, of clear distinctions within the data between Multi-Use and regular Quota Allocation use (logbook data, for example, include species type but not which type of quota allocation was used), my analysis of product substitution treats Red and Gag Grouper as one large category ("RGG"). There are persistent price differences between landed RG and GG, there are consistently much higher landings for RG than GG, and for several years there were no Multi-Use RG to convert for GG use – all of which means that it is necessary to allow for the possibility of a small separate relevant market restricted to GG, which I address in the market power analysis.

[14] Certain species typically found in deep waters with the rest of the Deep Water Grouper ("DWG") category may also appear in shallow waters. An operator who has used up all of their DWG Quota Allocation can use SWG Quota Allocation to land those DWG species. Likewise, certain species specifically found in shallow waters with the rest of the Shallow Water Grouper ("SWG") may also appear in deep water. An operator who has used up all of their SWG Quota Allocation can use DWG Quota Allocation to land those SWG species. Given the relatively low incidence of such substitution, this analysis ignores the limited interchange between these categories.

[15] T. Murphy, et. al, "2013 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2013 – April 2014)", US Department of Commerce, National Oceanographic and Atmospheric Association, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts, January 2015 ("NE Multispecies Fishery 2013 Report"); K. Strauss, "Catch Shares in Action: British Columbia Integrated Groundfish Program," Environmental Defense Fund, 2013 ("Catch Shares in Action").

others) for those privileges. The Northeast Multispecies Fishery generated about $86 million in revenue for the 2013 fishing year (ending April 2014), including the "common pool" stock harvested outside of the transferable quota system.[16] The British Columbia Integrated Groundfish program generated about $124 million in 2007.[17] Unlike the GoM Reef Fish fishery, both of these programs include trawl harvesting.

B. Stylized Facts

Much of the information described above and details included below come from the Annual Reports for the GT and RS IFQ programs, and from the NMFS Southeast Regional Office website (all cited above).[18] In addition, I have reviewed several other documents provided by NMFS: draft preliminary findings from ethnographic surveys currently under way in different GoM regions and other Powerpoint summaries,[19] technical memoranda,[20] and a relevant news article.[21] I have also reviewed publicly available relevant news articles, industry articles, and economic literature, as cited throughout this report, including reports on related fisheries.[22] In addition, NMFS has provided data, described in detail in Appendix B, that includes information on IFQ transactions and landings, as well as Logbook data with revenues and costs by trip for GoM and South Atlantic fisheries.[23]

From the above review, I have developed the following list of stylized facts about the fishery:

- The central unit of production is a vessel trip.
- There is considerable uncertainty about the net revenue that will be obtained from each vessel trip.
  - Uncertainty about success at catching fish – external events (like weather or oil spill) can affect location and quality of fish available
  - Uncertainty about ex-vessel prices that the harvest will bring
  - Uncertainty about cost of Quota Allocation necessary to land IFQ-Regulated GoM Reef Fish

[16] NE Multispecies Fishery 2013 Report, p. 9, Table 1.

[17] Catch Shares in Action, p. 3.

[18] This paragraph addresses task i of the Statement of Work.

[19] Draft presentations of preliminary findings on the Effects of the Grouper-Tilefish IFQ Program on Gulf of Mexico Coastal Fishing Communities, Sept. 21, 2015 – Bayou Lafourche Corridor, Louisiana; Florida Panhandle and Beyond: Pensacola to Steinhatchee; Galveston, Port Bolivar and Freeport/Surfside; Madeira Beach, Cortez and Beyond; Grouper-Tilefish Network Analysis. "Essential IFQ – Data Connectivity Emphasis," NOAA Fisheries Service, not dated.

[20] Lee Anderson and Mark C. Holliday, ed., "The Design and Use of Limited Access Privilege Programs," NOAA Technical Memorandum NMFS-F/SPO-86; Danial Holland, Eric Thunberg, Juan Agar, Scott Crosson, Chad Demarest, Stephen Kasperski, Larry Perruso, Erin Steiner, Jessica Stephen, Andy Strelcheck, and Mike Travis, "U.S. Catch Share Markets: A Review of Characteristics and Data Availability," NOAA Technical Memorandum NMFS-F/SPO-145, September 2014.

[21] Ben Raines, "Kingpins of the Gulf make millions off red snapper harvest without ever going fishing," Jan. 24, 2016, AL.com, http://www.al.com/news/index.ssf/2016/01/kingpins_of_the_gulf_make_mill.html, accessed on Feb. 24, 2016.

[22] Kent Strauss, 2013. Catch Shares in Action: British Columbia Integrated Groundfish Program. Environmental Defense Fund.

[23] See Appendix B for a complete description of data provided.

  - Uncertainty about whether holdings of Quota Allocation will be sufficient for the harvest: captains may have to arrange to obtain Quota Allocation after harvest and before landing
- There is a high level of supply substitution across species
- Avoiding capture of one regulated species while harvesting another can be costly
- Expected catch is likely to have a positive quantity of multiple IFQ species groups (and other species, as well).
- A vessel's characteristics, gear, and captain's experience help determine the level and nature of the expected catch per trip.
- In some areas, a small number of dealers are the primary buyers of landed fish, and those buyers may control substantial Quota Share (either directly or through joint ownership arrangements).

These stylized facts are the basis for my analysis of the industry.

C. Current Quota Share and Quota Allocation Caps

The Gulf Council has placed some restrictions on Quota Share and Quota Allocation ownership and transfer, and imposes fees to cover the "incremental costs" of administration and enforcement. Incremental costs are the additional costs to manage a fishery with a catch share program relative to the management costs under the preceding management structure.

For RS, the current Quota Share limit is 6.0203 percent (based on the largest share at the initial apportionment), as shown on Table 2.[24] The Quota Share limits for each species group in the GT program are also shown on Table 2.[25] For RS, there is no Quota Allocation cap, but GT Quota Allocation is capped at the total of Quota Share caps for all species groups applied to current year quotas (a bit over 500,000 pounds in 2013). As of January 1, 2012, there are no restrictions on parties that can buy or sell Quota Allocation or Quota Shares (other than US citizenship). NMFS currently collects the maximum allowable 3 percent cost-recovery fee on the ex-vessel value of all RS or GT landings.[26]

III. ECONOMIC FRAMEWORK FOR ANALYSIS

A. Multiproduct Production

As noted above, fishing operations for GoM reef fish occur with vessels (operated by captains) – this is the primary unit of production in my model of the industry.[27] Each vessel may have several physical characteristics and gear types that improve the harvesting operations for targeting certain species. In addition, the experience of the captain, an intangible asset, helps guide the fishing operation.

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[24] RS Annual Report, p. 8.
[25] GT Annual Report, Table 2, p. 9.
[26] RS Annual Report, pp. 8-9; GT Annual Report, p. 9.
[27] A business entity can own, whole or in part, several different units of production (several vessels, in this case). That entity may also own, whole or in part, onshore fishing or fishing related business such as seafood dealers and processors. Determining the presence or magnitude of vertical integration in the industry would require ownership data for onshore businesses that is not available to NMFS or the Gulf Council.

For any given configuration of vessel and captain, and for given market prices, I assume that there exists an "optimum" vector of expected production of several species of reef fish, with a corresponding expected revenue. This vector may include positive quantities of several different species, and could also have zero quantities of some species. For example, the captain of a vessel outfitted to harvest RS may expect to avoid areas where TF tend to be caught and so expect that the harvest will include no TF, but also expect that there may be some positive catch of RG or some species of SWG. I assume that a profit-maximizing vessel owner configures each vessel to the expected profit-maximizing harvest vector, as determined by the vessel characteristics and captain as well as the owner's information and beliefs about the availability of fish for harvest, and that the vessel will only go on trips for which the expected revenue exceeds the expected cost of the trip (including the cost of any Quota Allocation required to land IFQ-Regulated GoM Reef Fish). In other words, vessel operators are maximizing short run profits based on available information as well as vessel and captain characteristics.

The actual harvest on any given trip will likely vary from the expected harvest, due to changes in unknown factors affecting fish population locations, interference from weather or other fishing operations, etc. Similarly, the actual revenue from the harvest will likely vary due to fluctuations in market prices, and the cost will vary due to, among other things, fluctuations in prices of Quota Allocation required to sell the landed harvest. Thus, the vessels may lose money on some trips or make large short-run profits on other trips.

The results of each vessel trip, in addition to the accumulated results of the industry, provide information that may serve to modify expectations about future trips. In the long run, the vessel owner may choose to change the configuration of the vessel and the captain in order to direct harvesting toward a different vector of species, or the cease harvesting altogether. The latter would occur if, for example, the vessel owner determined that there was insufficient expected net revenue to justify continuing to employ the vessel asset in production in this industry.

B. ITQ and Efficiency

NMFS regulates harvests of GoM RS and GT because unregulated production would likely result in inefficient overfishing (inefficient here meaning that the same amount of harvest could be achieved at lower cost, or that larger harvests could be achieved without any increase in cost). When each vessel operator maximizes her own short run profit, then no harvester is taking into account the full value of leaving fish unharvested to replenish the fish population. This leads to unrestricted harvesting, a reduction in the fish population, and increased costs for harvesting the same amount of fish – thus, inefficient overfishing. This is a common efficiency problem of resources for which one party's extraction affects the current or future costs of other parties' extractions.[28]

Another efficiency problem that may be encountered in many types of markets is when the market is insufficiently competitive to prevent the substantive exercise of market power. Market power is simply the ability to sell product for more than the competitive price, which also happens to be equal to the marginal economic cost of production. Although there are many markets for which industry participants appear to be making accounting profits on the margin,

[28] See, for example, M. Berman, "Long Term Effects of Limiting Access to Alaska's Sablefish and Halibut Fisheries," Institute of Social and Economic Research, University of Alaska, July 30, 1997.

selling products for more than the marginal accounting cost of production, this is not a correct measure of market power. Economic costs may differ from accounting costs.

Of particular note in resource industries is the economic cost associated with the resource itself, commonly referred to as "resource rent" by economists. There may be substantial fishery revenue flowing to resource rent, and received by the owners of the resource, which is typically not captured by accounting costs.

The exercise of market power is inefficient because it results in restrictions in output, as that is the only way to sustain an increased price when demand slopes downward. Given that fishery regulation seeks to restrict output to improve efficiency by reducing overfishing, it may seem counterintuitive to be concerned also with market power. However, even with regulatory restrictions on output, there may still remain opportunities for exercising market power. In seasons when the competitively driven maximum harvest happens to fall below the regulated output level, for example, then actions to withhold output below the competitively driven maximum harvest would be an inefficient (but potentially profitable) exercise of market power. When the regulated output level falls below the competitively driven maximum harvest level, then there is still opportunity for inefficiency from restricting output further below the regulated level. Also, market power can be used to divert resource rent from one party to a different party, which may give rise to distributional concerns.[29]

My model of the industry assumes that the quota determined by NMFS each year for each species group of IFQ-Regulated GoM Reef Fish is the closest achievable approximation of a management target that, based on biological factors and also, possibly, economic considerations, leads to an outcome desirable for the regulators and the industry participants. It is not necessarily the most economically efficient level output, but it is the maximum level of output that regulators think will satisfy all of the fishery goals.[30] Therefore, I will deem inefficient (from a social welfare perspective) any restrictions from that level of output that are artificially imposed on the industry by market participants with the capability to do so.

C. Market Demand and Relevant Markets

Market demand, from an economic perspective, refers to the relationship between the price of a product (or service) and the quantity purchased. Under any given set of conditions, economists expect that a higher price would result in a lower quantity purchased. A quantitative measure of that relationship is "elasticity" – the percentage change in quantity purchased that would result from a small percentage change in the price.

When there is sufficient competition among different producers in a market, then it is primarily the cost of production that determines the price each producer charges. Attempts to raise the price above the cost of production result in other competitors undercutting the price and securing a higher share of the market. Competition causes the elasticity for a specific competitor to typically be much higher than the market elasticity. When firms produce differentiated but

[29] See, for example, L. Anderson, "A Note on Market Power in ITQ Fisheries," Journal of Environmental Economics and Management, v. 21 (1991), pp. 291-296.

[30] See, for example, NOAA's current National Standard 1 guidelines, pp. 32-3, "§600.310 National Standard 1—Optimum Yield. (a) Standard 1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield (OY) from each fishery for the U.S. fishing industry." Available at http://www.nmfs.noaa.gov/sfa/laws_policies/national_standards/ns1_revisions.html, downloaded April 19, 2016.

related products, products that are imperfect substitutes for each other, the profit maximizing decision for the firm includes shifting production across different products. Given this extra flexibility, the elasticity faced by a multi-product firm for its full differentiated output will be lower than the elasticity it faces for each of its individual products.[31]

Market power occurs when a producer can consistently obtain a price that is above the economic cost of producing the product – possibly due to inelastic market demand coupled with lack of robust competition. Although this extra profit may benefit an individual producer, it would typically result in less of the product being produced and sold than would be most economically efficient. Market power can exist in a variety of industries with many different characteristics, including different levels of competitive interaction among industry participants. Conspiracies to reduce competition (i.e., collusion) are illegal under U.S. anti-trust laws because they can lead to the exercise of market power.

When examining whether an action or regulatory rule change could lead to the exercise of market power, economists usually examine existing markets. In order to focus investigation on the salient product transactions, economists define a relevant market – the set of product transactions relevant to the potential exercise of market power. Generally, this starts with the small set of products included in the activity that is alleged to allow for the exercise of market power, and then expands to include close substitute products, competition from which could help constrain prices and the exercise of market power. A relevant market is reached when the set of products includes all close enough substitutes sufficiently so that a hypothetical monopolist controlling the set of products would be able to raise prices by a small but substantial amount and obtain an increased profit (i.e., there would not be sufficient substitution to other items to constrain the price increase).

The definition of a relevant market flows first from the behavior or situation of concern (because the behavior might reduce competition and increase market power). In the analysis for this report, the focus is on whether accumulations of Quota Share or Quota Allocation can result in increased market power – it is the size of Quota Share or Quota Allocation holdings, relative to the amount available overall, that is the behavior or situation of concern. The subsequent possible increase in market power could occur either within the Quota Share or Quota Allocation markets directly, or within directly related markets (such as the market for landed IFQ species).

D. CIE Reviews of Previous Market Power Analyses

Reviews conducted from the Center for Independent Experts of the Previous Share Limit Analyses raised some specific concerns and possible deficiencies. I address those within this analysis as follows:[32]

- Include a review of economic literature on product markets, especially multiproduct markets.
    - A complete review of this type is not one of the tasks included in the Statement of Work and therefore was not included in the budget for this project. I have, however, attempted to cite some of the relevant literature (in

[31] See, for example, A. ten Kate, Sr. and A ten Kate, Jr., "A Multi-product Lerner Index and Elasticity Aggregation," (October 16, 2013). Available at SSRN: http://ssrn.com/abstract=2341258 or http://dx.doi.org/10.2139/ssrn.2341258 (accessed February 25, 2016).

[32] This list addresses item ii of the Statement of Work.

Section II.C. above and Section IV) for those seeking more background. In the Previous Share-Limit Analyses, the selected references provide more comprehensive lists of relevant economic literature.

- Include an econometric assessment of market power
  - Some empirical research relies on structural models with demand and supply equations for all potentially substitutable products. In the case of joint production, which is common here, it is not always possible to separate costs and some or all of the supply equations may have to be merged into joint supply equations. The more complete and detailed that a structural model becomes, the more parameters there are to be estimated by that model. The statistical results that can be derived from a structural model derive from a large number of independent observations relative to the number of parameters to be estimated. The data in this instance (and for previous reports) are not sufficient for the type of complete structural econometric model (and asymptotically-derived statistical results) employed by some researchers. It is sufficient, however, to allow for substantial econometric analysis to augment the qualitative analysis of the industry, similar to the type of econometric analysis of market power employed in regulatory review of mergers or in antitrust legal actions. I provide details in Sections V, VI and VII, along with related appendices.
- Include a self-contained description of the fishery with complete sources.
  - I provide this in Section II above.
- Address multi-output production and the ability to target specific species
  - I provide an overall explanation in Section III.A. and technical details in Section IV.
- Consider information from related fisheries, such as British Columbia groundfish.
  - I have included this in my description of the fishery in Section II.
- Consider relevant literature on elasticities in multiproduct framework.
  - I discuss this in Sections III.C. and V.B.
- Provide quantitative evidence of presence or lack of scale economies
  - This is one of the tasks included in the Statement of Work and I show the evidence in Section VII (and the relevant appendices).

IV. MODEL OF PRODUCTION

A. Harvesters

In all of the analysis here, I assume that a vessel operator (the owner or group of owners with the authority to direct the activities in which the vessel is employed) equips a vessel with gear and employs a captain (which may also be the owner) and, possibly, a crew (which may also include owners), and other inputs (fuel, bait, ice), to harvest reef fish. The vessel owner may, in some cases, also harvest other types of fish, or use the vessel for other purposes, such as for-hire fishing.

I assume that the objective of the vessel operator is to maximize expected profits from the activities in which the vessel is employed, including harvesting reef fish. Due to the inherent uncertainties in the industry, the profit from vessel operations may exceed expectations or fall short of expectations (and could be negative, on occasion). I assume that vessel operators develop and update their expectations from information that is largely shared by other vessel operators currently harvesting, although individual vessel operators or the captains they employ may have specialized knowledge from experience that serves as an intangible asset. Because of the variation in owner experience and the ability of captains to extract from a vessel operator the value of the captain's experience, expected profits will vary across different vessel operators. Likewise, the optimal gear and other inputs used for harvesting will vary across vessels, as will the expected harvest (the expected quantity of landed fish, by species).

Vessel operators, possibly through the activities of their captains, procure sufficient Quota Allocation to land reef fish harvested while the vessel was at sea, unless the cost of obtaining Quota Allocation (price plus transaction costs) exceeds the expected revenue from the fish, in which case the fish are discarded (at some cost) and the revenue is zero. The vessel operator may hold an inventory of Quota Allocation that has been purchased and/or distributed on the basis of Quota Share owned, or may obtain Quota Allocation just prior to landing the harvest.

B. Expected vs. Actual Production

In an industry with production under uncertainty, the actual output may differ from the expected output. This may be obvious in the case of an individual vessel operator on an individual trip, but it should be less obvious in the aggregate (either across all vessel operators or across all trips for a given vessel operator). Under some circumstances, the variations among individual producers (or production runs) should average out so that the aggregate amount remains reasonably close to the aggregate of the expectations. Under other circumstances, this will not be the case.

The common idea that everything tends to average out in the end has been mathematically formalized into the "law of large numbers." This "law" dictates that the average of several independent but identically distributed random outcomes will come very close to the expected value of each random trial. The individual trials may vary greatly, but the more trials there are, the closer the average will be to the true expected value (the variance of the average decreases linearly with the number of trials).

This "law" only holds true, however, when the individual trials are *independent* and *identically distributed*. In the case of fishery production, both of these conditions may be violated. For example, a vessel operator may experience an unusually large catch on one trip due to there being an unexpectedly large population available. In this case, the random observations are not independent: many of the other operators will experience an unusually large catch, or the vessel operator may continue to obtain large catches all year long. A different example demonstrates what happens when the random observations are not *identically distributed.* Different types of vessels and vessel operators may face different types of uncertainties. If there are some vessel operators that have a high average catch but also a very high variation, and other vessel operators that have a much lower but much less variable average catch, then the average of those types together can vary considerably depending on the mix of the two types.

The final reason for outcomes to vary, in aggregate, from expectations, occurs when the common "knowledge" about the fishery happens to be incorrect. Industry participants may hold common beliefs about the likelihood of environmental disasters depleting the fish population, or the effect of global climate change on ocean temperatures and the resulting changes in the fish population. If an environmental disaster has an impact that exceeds the common beliefs, or if ocean temperature changes outpace expectations, then the harvest for all vessel operators may, on average, fall below expectations. This reflects two costs – the direct cost of the environmental disaster or the climate change, and the indirect cost that occurs because industry participants have not adjusted to the new situation by altering their harvesting inputs and methods to maximize harvests within the environmental reality.

C. Implications of production model

Modelling production in the manner described above, which matches the stylized facts of the commercial GoM Reef Fish industry, implies some general outcomes for the analysis. Two important results matter for the analysis of market power.

First, the inherent uncertainty and lack of complete knowledge about changing environmental and market conditions, combined with the multi-product output targets for many firms, means that there will always be widespread demand for all types of Quota Allocation, even when the actual harvest fails to approach the limit set by the quota. This will lead to positive prices for purchasing Quota Allocation, even when some of it goes unused.

Second, there will be variation in observed costs and profits and this variation need not be randomly spread across vessel operators – some groups or types of vessel operators may occasionally or consistently earn more profits than others. These profits may reflect intangible assets from the type of experience or "know-how" held by some vessel operators, or may simply be the result of environmental conditions that happen to favor populations of specific species over others.

In other industries without the conditions described above, it may be possible to identify market power from the existence of transactions with positive prices under conditions where there is no apparent scarcity, or from the existence of unusual profits for some of the industry participants. Due to the nature of this industry, however, those facts alone cannot be sufficient to determine the existence of market power.

V. ANALYSIS OF RELEVANT MARKETS

A. Relationships between IFQ markets and fish harvest markets

The Quota Share holdings for GoM RS or GT IFQs play no direct part in industry production. It is not necessary to be active in the industry in order to own or trade Quota Share, and it is not necessary to own or trade Quota Share in order to be active in the industry. Because Quota Shares contribute no technical input into production, it is useful to consider them as financial instruments – a specific type of investment with specific characteristics with respect to the average and the variability of the expected financial payoff.

Each Quota Share confers the right to an annual Quota Allocation of a known portion of the annual quota. The values of the expected future annual Quota Allocation amounts are what determine the value of the Quota Share. However, the payoff to holding Quota Share carries some inherent uncertainty. The size of the annual quota and the per unit value of the resulting

Quota Allocation are both unknown in advance. In addition, the GoM IFQ programs do not specifically guarantee that Quota Shares are granted in perpetuity, which creates some uncertainty about the longevity of receiving annual Quota Allocation that is factored into the values.

Transactions for Quota Shares reveal prices that reflect the traders' expectations of future quotas and future per unit Quota Allocation values, along with the expected likelihood of dissolution of the privilege due to termination or revision of the IFQ programs. Apart from heterogeneous expectations that could arise from different information sets, there is little or no reason for variations in transaction prices for shares (other than transaction costs, which appear to be minimal). If the price of Quota Share were to exceed the expected return dictated by expected annual quota and Quota Allocation prices, then a potential buyer would choose a different investment (a different species of Quota Share, for example, or different type of investment altogether).This means there is very high price elasticity. Consequently, there are inherent strong constraints against the exercise of market power by transactions in Quota Share alone.

Quota Allocation also does not provide any direct technical contribution to production in the commercial reef fish industry in the GoM, but it does have a very direct relationship with industry output. Quota Allocation units must be provided concurrently with landing units (pounds of fish) of GoM IFQ-Regulated Reef Fish, on a one-for-one basis. Unlike many typical production inputs, there are no supply substitutes for Quota Allocation– a vessel operator cannot use fewer Quota Allocation units, for example, by expending more on labor, fuel or bait. Also, Quota Allocation for other species groups cannot serve as a direct substitute for Quota Allocation of a specific species group, with the small exceptions of conversion/multi-use Quota Allocation determined by the program. However, the ability to redirect conventional inputs (vessel, gear, bait, fuel and labor) across different species means that an increase in the price of Quota Allocation for one species group that leads to an increase in demand for a different species group may result in a shift of supply to the relatively higher valued species group. In this way, it is possible that Quota Allocation of one Species Group may serve as an economic substitute for Quota Allocation of a different Species Group, in the sense that price increases for one could affect the demand for the other.

The one-to-one nature of Quota Allocation-to-landings means that the Quota Allocation values have a very direct relationship with harvest activities. While any Quota Allocation holder can extract financial value by selling the Quota Allocation itself, the price of that sale will be determined ultimately by the expected value of using that Quota Allocation to land fish. Thus, the use of Quota Allocation at the time of the landing diverts a portion of ex-vessel revenue to the Quota Allocation holder at that time. Only the ex-vessel revenue net of the value of the Quota Allocation flows to the harvest. The market value of Quota Allocation at any point in time does not depend on whether it is used for landing transactions, sold to another operator for landing transactions, or held for future use, but depends instead on the value of the option of using it for landing harvests now or in the future.

B. Define Relevant Market for Landings

My relevant market determinations begin with the relevant markets for the analysis of whether accumulation of Quota Share or Quota Allocation can create market power in the downstream markets for landed GoM IFQ Reef Fish.[33] The results of my analysis would be consistent with a large relevant market including all landed GoM IFQ Reef Fish and possibly other species in the GoM and elsewhere. The smallest relevant markets for landed fish consistent with the results of my analysis coincide with the categories of species in the program, at a minimum. In other words, I find that the narrowest relevant markets consistent with my analysis are these five (or six) relevant markets for landed fish: RS, RGG (possibly with a separate market for GG), DWG, SWG, TF, and that broader markets including species from one or more categories as well as other species are also consistent with my analysis. In each case, the relevant market spans the entire geographic region of the GoM fishery.

To consider whether the exercise of market power with accumulation of Quota Share or Quota Allocation can occur through the downstream markets for landed fish, it is necessary to examine demand for the downstream products. Consumer preferences ultimately generate the demand for GoM Reef Fish harvests, channeled through retail outlets and restaurants, distributors and exporters, packing houses/dealers, and processors. The varied characteristics of different species of Reef Fish, which can include not only IFQ-Regulated GoM Reef Fish along with other reef fish harvested in the GoM and with reef fish harvested elsewhere, and the wide dispersion of harvest locations create the possibility of distinct markets by species and/or geography. On the other hand, the use of a variety of different reef fish for some processed products and the ability to transport and store frozen and canned product enables substitution that creates the possibility of broad, multi-species markets as big as the entire regulated fishery, or bigger, given the scale of imports and exports.

In addition to demand characteristics, the possibility of supply substitution must also be considered for determining the relevant market. If it is sufficiently inexpensive to take assets previously used in the harvest of one species, or the harvest in one area, and redeploy them into the harvest of another species, or in another area, then there can be effective economic substitution between the markets – an increase in relative price of one species or in one area can cause assets to flow into production until the increased quantity (and decreased quantity elsewhere) evens out the relative prices. The constraints of annual quotas restrict supply substitution when those constraints limit production quantities. In other words, harvesters would only shift activities into an IFQ Species Group if there were sufficient available Quota Allocation to sell the harvest.

With respect to whether accumulation of Quota Allocation or Quota Share creates market power for landed fish, the relevant market would have to be at least as large as the categories established by the IFQ program. Even when there are demand characteristics that distinguished one species in a group from another in the same group, the ability to use Quota Allocation or Quota Share to control output can only be applied at the species group level. Among TF, for example, Species A may account for only 20 percent of the output, but influencing the output of Species A requires influencing not just 20 percent of the TF Quota but all of the TF Quota. There is no way to prevent additional production of Species A by means of Quota Allocation or Quota Share accumulation, other than through the TF category as a whole. There is a similar argument for defining relevant markets that are geographically at least as large as the whole fishery, although the potential existence of geographic technical constraints (applying congruently both

[33] This is task iv of the Statement of Work.

to harvesting and to Quota Allocation or Quota Share transactions) could create more geographically specific markets.

The ability and practice of converting substantial amounts of Quota Allocation between Red Grouper and Gag Grouper creates a unique situation. In the case of Red Grouper, for example, influencing the production of landed fish requires influencing the use of Red Grouper Quota Allocation and also influencing the use of Gag Grouper Quota Allocation that could be converted to Red Grouper Quota Allocation. This is why I combine these two categories into one "species group."[34]

An empirical examination of landed fish transactions helps identify whether there is sufficient substitution between species groups to establish relevant markets beyond the individual group. Table 3 shows the average price by species group every month, based on transaction data recorded for IFQ landings.[35]

Of the many econometric models for measuring demand, one of the simplest is the log-linear form, which simply posits that the log of output is a linear function of the log of the prices of the output and the logs of prices of substitute products. One advantage of this model is that the coefficient on the log of the price of the output is a direct measure of the market elasticity for the product, and the coefficients on the logs of the prices of the other products are direct measures of the cross-price elasticity with other products.

For example, for species group "1", I can econometrically estimate something like the following (possibly incomplete) equation:

$$ln(Q1) = a1 + b11*ln(P1) + b12*ln(P2) + b13*ln(P3) + b14*ln(P4) + b15*ln(P5)$$

In this equation, *Q1* is the quantity of species group 1 landed during a time period, P1 is the average price of that species group during that period, and *P2-P5* are the prices of the other species groups during the same period. The estimated parameter *b11* is the market elasticity for species group 1 – the percentage change in quantity associated with a percentage change in price. The estimated parameter *b12* is the cross-price elasticity – the percentage change in species

[34] As noted earlier, the Gulf Council designates some amount of RG Quota Allocation as "Multi-Use," which means it can be used for either RG or GG, and makes a similar designation for GG Quota Allocation. Given the substantial overlap in production (all producers of GG also produced RG every year, for example), substantial quantities of Multi-Use GG each year (for several of the years, the portion of RG allocated to "Multi-Use" was zero), the limited extent of GG harvesting activities, and the lack, in some cases, of clear distinctions within the data between Multi-Use and regular Quota Allocation use (logbook data, for example, include species type but not which type of quota allocation was used), this analysis of product substitution treats Red and Gag Grouper as one large category ("RGG"). There are persistent price differences between landed RG and GG, there are consistently much higher landings for RG than GG, and for several years there were no Multi-Use RG to convert for GG use – all of which means that it is necessary to allow for the possibility of a small separate relevant market restricted to GG, which I address in my market power analysis.

[35] The prices on Table 3 are "real" prices: I adjust nominal prices from the data for changes in the Producer Price Index. IFQ GoM Reef Fish output generally goes to food producers, rather than directly to consumers, and, as such, are an input into production of final output demanded by consumers. Therefore, the Producer Price Index is the closest measure of changes in general prices levels relevant to the products I am analyzing. In the case of species groups with multiple species, I calculate an index of real prices, based on transactions remaining after filtering out transactions with price or quantities deviating substantially from the norm (see Appendix B, 1.c. for a description of the filtering process). The indices are chained Fisher Price indices normalized to equal real prices during the three month period at the middle of the data analysis time frame. Appendix B describes the data preparation process in detail.

group 1 quantity associated with a percentage change in species group 2 price. A lower estimate of *b11* would tend to mean a relevant market limited to species group 1. Higher estimates of *b12*, *b13*, etc, would tend to mean that the relevant market extends across other species groups.

The equation above can be revised slightly to apply to each of the other species groups. Collectively, these equations create a system of equations that model demand for all of the products regulated by the GoM IFQ program. In addition, I can incorporate prices of potentially substitutable products that are not IFQ-Regulated GoM Reef Fish – such as similar species in the GoM (vermillion snapper as a substitute for RS, for example), the same species groups harvested from the neighboring South Atlantic fishery, or similar species from the South Atlantic. Adding these other species requires relying on logbook data in addition to the IFQ landing data.

Additional econometric techniques can improve the quality of the estimates by taking into account the fact that quantity and price codetermine each other simultaneously – for the most part, this involves incorporating information on input prices and other supply factors. Appendix B describes the econometric analysis and results in detail.

Table 4 summarizes the estimated elasticities across all of the species groups (with RGG combined into one group, as explained above), as well as similar species from the GoM and the same or similar species from the South Atlantic (as applicable).[36] Each column in Table 4 represents an equation from the regression system, and each row shows the estimated elasticity of the Species Group in the column with respect to the price of the product in the row (underneath the estimated elasticity is the standard error, which helps determine whether or not the estimated elasticity is statistically significant at a given confidence level).

Generally, the own-elasticity in a demand system like this would be significant and negative – this is the case only for RS. Also, substitute products would be significant and positive – those do occur occasionally. A low magnitude for estimates for cross-price elasticity means that a price increase for one species group would generally have only a modest effect on quantity for the other groups, but this inference may not be valid when the own-elasticity is also of low magnitude or not statistically significant and negative. Overall, the regression process did not produce significant and consistent results across the several species groups.

These results could mean that the quantity demanded for all or many of the Species Groups categorized here move together because of economic conditions affecting one broad market that includes all of the products, or it could mean that these Species Groups are relatively unrelated in demand. An example of the first possibility would be different colors of Ford Escorts – one would not expect that the price of White Escorts to be related to the quantity of Silver Escorts purchased. An example of the second category would be Ford Escorts and Ford

[36] I define "similar" species for RS as non-IFQ regulated species in the "Snappers – Lutjanidae Family"; for each of the Grouper Species Groups, any non-IFQ-regulated species in the "Grouper – Serranidae Family"; and for TF, any non-IFQ-regulated species in the "Tilefish – Malacanthidae (Branchiostegidae) Family," (according to "SPECIES LISTED IN THE FISHERIES MANAGEMENT PLANS OF THE GULF OF MEXICO FISHERY MANAGEMENT COUNCIL (Rev. 7/21/2015)," available at http://gulfcouncil.org/Beta/GMFMCWeb/downloads/speciesmanaged.pdf.). I applied similar categorization rules to species harvested in the South Atlantic according to "Species Managed by the South Atlantic Fishery Management Council," available at http://www.safmc.net/sites/default/files/SAFMC_ManagedSpecies_12182012.pdf. The results shown on Table 4 are for a Seemingly Unrelated Regression ("SUR") model that does not control for endogeneity and does not rely on asymptotic large-sample properties. The results for two-stage least squares and three-stage least squares were qualitatively similar.

Pickup Trucks – the group of consumers demanding Escorts may be disparate from the group demanding pickup trucks.

If the results had been a combination of significant negative own-elasticities and generally low-magnitude and insignificant cross-elasticities, then this would have strong evidence of several distinct relevant markets differentiated by Species Groups. If the results had been a combination of significant own-elasticities and generally high-magnitude and significant positive cross-elasticities, then this would have been strong evidence of one (or more) broad relevant markets defined across Species Groups and, possibly, beyond IFQ-Regulated GoM Reef Fish. Some of the results show significant positive cross-elasticities with similar but more broadly defined categories harvested in the South Atlantic. In either case, a hypothetical entity controlling the output of the relevant market could improve profits by restricting output. In other words, the benefit from a price increase of, say, 5 percent would be to increase profits per unit sufficiently to outweigh the expected decline in quantity.

The implication of the regression results for relevant market definition is that the regression analysis cannot rule out that a hypothetical entity controlling the output of a single species group could improve profits by restricting output. In other words, the benefit from a price increase of, say, 5 percent would be to increase profits per unit sufficiently to outweigh the expected decline in quantity. This only holds if profits are below a certain very high amount, which analysis in Section VII demonstrates to be the case. Thus, this econometric analysis demonstrates that there is substitution across different species groups, but possibly not sufficient substitution to distinguish different relevant markets indisputably. However, the regression results can also not rule out that the hypothetical entity would need to control the output of several of the Species Groups and other output as well. This is why I conclude that the narrowest relevant markets consistent with my analysis are the Species Groups, while allowing for the possibility that the relevant market(s) could be broader.

I note the geographic market may extend beyond the GoM, because there are significant positive cross-elasticties with products from the South Atlantic and because of the large amount of imports and exports of certain types of products. However, even where the cross-elasticities show that there is significant substitution, the magnitude of substitution is low and likely not sufficient to defeat a profit-increasing price increase by a hypothetical monopolist controlling only output from the GoM. I also examined the geographic market question by estimating a system that distinguished not only the five different species groups but also whether landings occurred in Florida or elsewhere. This introduces more parameters and further diminished the precision of the results, but nevertheless demonstrated substantial substitution across geographic areas within the GoM. These results, combined with the unrestricted supply substitution available within the fishery boundaries, show that it would be incorrect to narrow the relevant market definition geographically to anything less than the entire regulated area of the fishery. The narrowest relevant geographic market consist with the evidence is the GoM.

There is a useful natural experiment pertaining to RS that also addresses whether the relevant market would extend beyond the fishery itself, to include other domestically or internationally produced Reef Fish. Globally, the supply of RS is about 30 million pounds, with the GoM fishery contributing only 6 to 20 percent of global supply. [37] If there is substantial substitution between the GoM fishery and the rest of global supply, then a supply shock locally would not affect prices – a reduction or increase in the GoM could be compensated by increases or reductions elsewhere. In the GoM, there are periodic updates to quota levels every year, plus occasional revisions during the year. The mid-year revisions provide insight into the extent of the market by causing a somewhat unexpected supply shift. Most of the mid-year revisions are modest and have little evident effect on transaction prices, but there was a very substantial mid-year increase in the quota level for RS in 2013.[38] The price for RS dropped substantially in the weeks following this shift, as shown on Figure 1. This shows that RS production outside of the GoM, which globally far exceeds the quantity produced within the GoM, is not sufficiently close of a substitute to constrain the prices of RS production inside the GoM.

The ethnographic surveys of GT harvesting mention substantial effort directed at finding and harvesting desired species at desired sizes. The return on the harvest can be substantially enhanced if the fish obtained can be sold at the premium prices that accompany demand for fresh-caught filets or fresh whole fish for restaurants, which are the products least susceptible to replacement by non-GoM harvests. Based on this qualitative information, and the observed price response for RS, extending the relevant market beyond the regulated GoM area for any of the species would diminish the applicability of the final results.

In summary, I find that, for the analysis of market power from the accumulation of Quota Share or Quota Allocation, the narrowest relevant markets to consider for landed fish are the five species groups – RS, RGG, DWG, SWG, Tile Fish – harvested within the entire geographic region of the GoM fishery.

C. Define Relevant Market for Quota Allocation

My next step in determining relevant markets for the analysis of market power from the accumulation of Quota Share or Quota Allocation is to examine the relevant market or markets for Quota Allocation.[39] I find that there is, at a minimum, a single relevant market for all GoM Quota Allocation for all species groups, and some of the empirical results indicate that there may be smaller markets – one for each species group.

First, I conclude that it would be incorrect to treat Quota Allocation as a purely financial instrument traded in an efficient capital market. My findings about production show that most harvesters will have some demand for most types of Quota Allocation most of the time. This means that ongoing actual production will influence Quota Allocation distinct from capital market considerations. Furthermore, the active participants in the GoM IFQ programs (and participants in ancillary markets, such as dealers) are in a substantially better position to collect and process information about ongoing production that would be relevant to valuing Quota Allocation. This means that outsiders attempting to trade in Quota Allocation would face more risk and would prefer to invest in less costly (risky) financial instruments. This distinction is

[37] Sustainable Fisheries Partnership, "US Gulf of Mexico Reef Fish Fishery Improvement Project," Last update: January 2016, https://www.sustainablefish.org/fisheries-improvement/snapper-grouper/gulf-of-mexico-reef-fish, accessed Feb. 24, 2016.

[38] On September 30, 2012, the quota increased from 1.167 million above the existing level of 3.887 million (3.712 at the beginning of the year, plus an increase of 0.175 million on May 29) – a 30 percent increase (RS 2014 Annual Report, p. 17, Table 12).

[39] This is task v of the Statement of Work.

particularly important for Quota Allocation that expires in a short time period (e.g., at the end of the calendar year).

Given that traders in Quota Allocation represent a small and distinct group of investors, characterized by close affiliation with the GoM reef fish harvest, the relevant market for Quota Allocation cannot extend beyond the GoM fishery. Furthermore, because it is equally costly to transfer quota within one area as it is across the entire fishery, transaction costs related to geography are minimal, and thus there would be no geographic subdivision of this market. The final question is whether the market should be further divided by species group.

From a theoretical perspective, this determination could go either way. On the one hand, most producers, who would tend to be active market participants, are using Quota Allocation for multiple species groups, and have some ability to shift production across species groups. This means that a relatively higher price for Quota Allocation of species group A could cause harvesters to shift to production of species group B, which would reduce the demand for Quota Allocation of species group A and ameliorate the relative price difference. In this manner, the price of Quota Allocation for species group B could constrain the price of Quota Allocation for species group B. However, shifting production from one species group to another can be costly, and the uncertainty and volatility of output and downstream demand could diffuse the price relationship across species groups.

Also, the diffusion of relevant information across the network of Quota Allocation may occur separately for different species groups, especially with regard to very short term variations in availability of different species groups. This may serve to separate the primary buyers and sellers of different species groups from each other, leading to separate relevant markets by species groups. The exception to this argument would be dealers that transact in Quota Allocation, who would be expected to maintain a portfolio of different species groups aligned with the fleet of vessels landing IFQ reef fish with each dealer.

An empirical examination of Quota Allocation transactions could shed some light on the question of further dividing the relevant market by species groups. With a monthly price series of average prices and quantities for Quota Allocation transactions by species group (constructed in much the same manner as the monthly panel of prices and quantities for Landed Reef Fish), it is possible to estimate a system of demand equations for Quota Allocation by species group.[40] Like the results for Landed Reef Fish, these results, shown on Table 5, are indeterminate. Three of the five own-price elasticities for each species group are not statistically significant (slightly better than four of the five, as on Table 4). My interpretation of this result is that the frequency of and variation within the data and the estimation method, given the volatility of prices and quantities

[40] Prior to doing the demand estimation for landed IFQ-regulated GoM Reef Fish, I filtered out data that appeared to be incorrect (as explained in detail in the Data Appendix). For the demand estimation of Quota Allocation presented here, I did not do any filtering, other than leaving out transactions with no price or zero price. Unlike landed fish, here there no obvious "boundaries" beyond which to identify the values as incorrect, especially lower bounds (and there are few, if any, observations with values that might be considered "too high"). This means that the average prices may include some transactions that are internal transfers between accounts controlled by the same entity. I did experiment with filtering out prices more than three standard deviations from the mean and with prices that were under $0.10 - there were no qualitative changes in the results. An alternative methodology, mentioned in the GT 2014 Annual Report (p. 52), would be to filter out observations that were below the "valley" between two peaks of an apparent bimodal distribution. This would appear to filter nearly the same data as the simpler methods mentioned above.

transacted, are not sufficient to estimate demand reliably. It is also possible that demand for Quota Allocation in aggregate is far more prevalent than demand for Quota Allocation of specific species. There are several instances of statistically significant cross-price elasticities, although some of them are negative (which shows complementarity instead of substitution, which may occur from production overlaps with species that tend to occupy the same territory).[41] Statistically significant cross-price elasticities would show substitution across species groups for Quota Allocation transactions, but only if the overall demand estimation were reliable.

The difficulty in reliably estimating demand for Quota Allocation appears to stem from the intermittent nature of the transactions that occur, not the lack of data about those transactions. As more transactions occur over time, and a larger percentage of those transactions have reliable data for price and quantity, a clearer empirical picture of demand for Quota Allocation could emerge.

Without a more precise quantitative assessment of demand, there is insufficient evidence currently to rule out smaller relevant markets for Quota Allocation determined by each species group. For the assessment of market power by accumulation of Quota Allocation (or Quota Share), defining the markets too broadly could result in failure to observe market power within smaller categories. Therefore, I proceed with the determination of relevant market for Quota Allocation at the species group level, and also consider the full combination of all species groups together.

D. Define Relevant Market for Quota Share

My next step in determining relevant markets for the analysis of market power from the accumulation of Quota Share or Quota Allocation is to examine the relevant market or markets for Quota Share.[42] I find that there is a single relevant market for GoM Quota Share for all species groups.

The argument for treating Quota Share as a financial investment, rather than an input into production, is much stronger for Quota Share than for Quota Allocation. Valuations for Quota Share reflect long-term expectations about market prices for Quota Allocation – for example, when the Gulf Council considers a change to the allocation between commercial and recreational sectors (as is currently the case for RS).[43] While short-term market fluctuations can have a large impact on Quota Allocation prices, Quota Share valuations move only when those short-term fluctuations convey changes in long-term expectations. In other words, the prices for Quota Share are less directly linked to supply and demand of landed GoM Reef Fish, and are driven instead by the balance of risk and return relative to other possible investments.

The Quota Share distributions occurred originally to entities previously active in the GoM fishery.[44] Many of those original owners continue to hold their Quota Share. My review of

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[41] In addition to demand effects, complementarity in joint production can cause goods to behave as complements: a price increase for one good incentives increased production of that good, and the quantity of jointly produced goods also increases.

[42] This is task vi of the Statement of Work.

[43] Personal communication with Michael Travis, NOAA Fisheries Service, SE Regional Office, March 15, 2016.

[44] Initial share distributions were based on catch history during periods that varied across different programs. Some previously active during the historical measurement period could have become active by the time of the distribution, and others after the initial distribution.

the names of entities currently holding Quota Share shows that it is still the case that Quota Share resides mostly in the hands of GoM fishery participants (either currently or historical participants). Where Quota Share has accumulated to parties outside the fishery, it has generally been to financial institutions (likely as possessed collateral for defaulted loans) or private individuals apparently related to the original owner (likely as distribution of an estate or through divorce).

This pattern of Quota Share ownership reflects the fact that industry participants (current and former) may have access to information and experience that makes them better able to identify accurate values for Quota Share than non-participants. This separates Quota Share from all other financial investments. This is one of the reasons it would be incorrect to lump Quota Share into a market with other instruments like, for example, stocks or collateralized debt obligations. The distinctions between information for distinct species group that mattered for Quota Allocation transactions fade over the time relevant for valuing Quota Share. This is one of the reasons it would be incorrect to divide Quota Share into multiple relevant markets.

Transactions for Quota Share are very sparse relative to transactions for Quota Allocation. In general, Quota Share only matters on an annual basis (or when mid-year quota increases produce new Quota Allocation distributions), so there are fewer opportunities to examine how changes in supply or demand affect Quota Share transactions. I did not attempt to estimate Quota Share demand elasticity.

Even though most parties engaging in Quota Share transactions are industry participants (current or former), each of those participants choose between buying (or retaining) Quota Share and investing in other financial instruments with different balances of risk and reward. This means that there are a variety of substitute products, which may not rise to the level of being in the same market but which nevertheless assert competitive pressure on the pricing of Quota Share.

Thus, I conclude that, for the analysis of market power from the accumulation of Quota Share, the relevant market for Quota Share is the combined Quota Share for all species groups. I have, however, extended my analysis of market power by preparing measures of concentration for Quota Share by species group, due to the possibility of exerting influence in downstream markets (e.g., dealers and processors) – more on this in the next section.

VI. ANALYSIS OF MARKET POWER

A. Concentration and Current Exercise of Market Power

To examine whether market power exists within the relevant markets, I consider the market concentration. I also rely on assessments of conduct and profit performance, and on price/cost margins estimated in the following section. I concluded there is no evidence that market power exists in the relevant markets.[45]

Market power exists when a supplier can expect to charge prices that are above marginal cost. The simplicity of this definition is deceptive, primarily because "marginal cost" means

[45] Task vii of the Statement of Work is to calculate HHI's, a measure of market concentration that I present below. Task viii is to determine if market power has been or is currently being exercised.

"marginal economic cost," which cannot always be measured accurately. Many firms that earn profits have no market power – their profits may be due to differences between accounting costs and economic costs, failure to account for returns to tangible or intangible assets, unexpected price or cost volatility, or market distortions from taxes or regulation, among other things.

One way to avoid the difficulties of marginal cost measurement is to examine the structure of the industry in question. Industries that are more concentrated, or situations with a large dominant firm, would tend to reduce the elasticity faced by some individual suppliers, which would then create market power. One commonly used measure of concentration is the Herfindahl-Hirschman Index ("HHI").[46] Other measures include C5 and C3 – the share held by the top five or three suppliers – and a sufficiently large share for the largest supplier can also indicate potential market dominance.

Also, market power can be created, generally illegally, by collusive activity between competing suppliers, so identifying conduct that only makes sense as cooperative activity to increase prices would demonstrate the existence of market power. Collusive activity would be unlikely to have much effect unless the market were Moderately or Highly Concentrated (HHI higher than 1500 or 2500, respectively). I could not locate any public news or legal record of complaints about collusive behavior among vessel operators, or even among disparate holders of Quota Allocation and Quota Share.

Another way to address marginal cost measurement is to examine relative profits between the industry in questions and some baseline comparison – another similar industry, the same industry at a different period in time, or the same industry in a different location. Of course, this still requires controlling for differences in factors that affect economic profits between the industry in question and the baseline comparison. In the case of GoM Reef Fish production, the analysis in the next section shows that profits from fishing operations have been approximately equal to the value of Quota Allocation used for those operations. This would not be consistent with market power existing over an extended period of time.

Throughout this analysis of market power, a "supplier" is an entity that holds at least one GoM Reef Fish permit. Some business entities and individuals that own one permit can have ownership interest in entities that control another permit. I rely on the identification of entity groupings supplied by the NOAA Fisheries Service Southeast Regional Office, described in Appendix B.[47]

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[46] The HHI is equal to 10,000 times the sum of the squared market shares of each supplier. A complete monopoly would have an HHI of 10,000. A market with 100 equal sized suppliers would have an HHI of 100. The Horizontal Merger Guidelines from the US Department of Justice identify markets with an HHI below 1,500 to be Unconcentrated (no concern about exercise of market power, including through coordinated conduct, because of the large number of competitors), HHI between 1,500 and 2,500 to be Moderately Concentrated (possible concern about increases in market power given sufficient increase in concentration), and above 2,500 to be Highly Concentrated (this is the only category in which a sufficient increase in concentration leads to a rebuttable presumption of increased market power).

[47] The NOAA Fisheries Service Southeast Regional Office provided a spreadsheet that listed the ID numbers of IFQ program participants, along with business and personal names associated with each ID number (and, when known, the data at which the business and/or personal name first became associated with the ID number). By linking together IFQ IDs that shared common business and or personal names, I created a set of "entities" and matched each IFQ ID to a "Group ID." Each IFQ ID maps to only one Group ID, but each Group ID can contain multiple IFQ IDs. Although I did not conduct myself the research to associate the business and personal

1. *Market for Harvested Fish (Landings)*

The first relevant markets I examine are the markets for harvested fish by species groups. Table 6 shows the concentration measures (based on quantity) and largest firm by market for each year (and also shows the concentration for the aggregate of all GoM Reef Fish, based on revenue).[48]

The market for RS has been Unconcentrated since the start of the IFQ program, with the largest supplier garnering no more than 12 percent of RS quantity in any year, and the largest five suppliers garnering less than one third of RS quantity in any year. Similarly, the market for RGG and the market for SWG are also Unconcentrated and without any dominant suppliers or group of suppliers. I note, however, that the number of entities landing RGG has decreased some after peaking in 2011.[49]

The market for DWG also has been Unconcentrated, but concentration appears to have increased during 2013 and 2014. For TF, concentration decreased from 2010 to 2012, and then also increased during 2013 and 2014, to a level of Moderate Concentration in 2014, along with potentially dominant shares controlled by a small group of suppliers every year, and especially in 2013 and 2014. However, an examination of monthly average prices for all of the species groups (shown previously on Table 3) reveals no relative upward trend for either of those species groups in 2013 and 2014. In fact, TF has a relative price increase between 2010 and 2012, during which concentration was declining (and output was increasing). Absent a strong argument why prices should have been declining in 2013 and 2014, the evident stability in pricing indicates that the increased concentration has not created market power.

As noted earlier, a firm producing multiple substitutable products faces lower aggregate demand elasticity (i.e., has more opportunity to exercise market power) than the individual elasticity for each product. This means that a single entity accounting for large shares of multiple species groups would be more of a concern than if different entities produced the largest shares of each different species group. For example, in 2013 and 2014, the entity that produced the most RS also produced the most DWG and TF. However, as shown on the last panel of Table 6, the concentration across all GoM Reef Fish is quite low.

In all cases, the concentration measured here would understate the actual concentration if it were true that there are additional unknown ownership and control linkages across permits.

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names, I did review the criteria used to determine the association, which I found to be economically sensible, and spot-checked some of the results to assess the reliability of the process. Based on that review, I concluded that, given the available data and assuming that no other unknown ownership or control linkages are present among permit holders, then it would be highly unlikely that any errors in the "entity" associations would substantially change any of the concentration numbers reported here. However, it is possible that additional information could identify broader groups of controlling entities in some cases. For example, a person owning one business might also have a controlling interest in a business that has a controlling entity in another business, but the chain of control may not be evident either because the ownership information is not public, or the controlling interest occurs with a minority ownership share. Also, dealers may own controlling interests in multiple IFQ IDs or in multiple businesses each associated with different IFQ IDs. In other words, <u>there could be higher concentration, but there is no way to measure that without full details of controlling interests in all of the relevant entities</u>.

[48] This analysis relies on information from participation in the IFQ program. As such, there is no data to examine concentration before the IFQ program and assess how concentration changed, if at all, with the implementation of the program.

[49] Table 4 does not show a breakout for GG, but the concentration measures for that small category alone are all lower than the measures for RGG.

However, the added evidence of lack of complaints about collusive activity and lack of aggregate profits (discussed in the next section) support a finding consistent with low market concentration and that there has been no market power in the Landed Reef Fish markets since the start of the IFQ program.

2. Market for Quota Allocation and Quota Share

The next set of relevant markets I examine are the markets for Quota Allocation and Quota Share, by species group and in aggregate. There are two issues to address before looking at concentration measures.

The first issue to address is to identify the appropriate time frame for measuring Quota Allocation concentration. If, for example, one examines Quota Allocation on hand at the beginning of the year, then one is just measuring the same concentration as the market for Quota Share. On the other hand, if one measures Quota Allocation on hand at the end of the year, then any activity to accumulate Quota Allocation and exercise market power during the year would be undetected (as long as the Quota Allocation gets redistributed or used up by the end of the year). Alternatively, measuring Quota Allocation *used* during the year is the same as measuring Landed Reef Fish – and that exercise was already completed above.

The approach that I take here is to measure Quota Allocation held at certain points during the year – specifically January 1 (which is the same as measuring concentration of Quota Share), April 1, July 1, and October 1. Quota Allocation occurs on January 1 according to Quota Share and the amount of quota for each species group. Then each month, the holder of Quota Allocation can transfer, use or acquire Quota Allocation. Occasional mid-year increases in quota also result in new distributions of Quota Allocation. By tracking all of these activities, I calculate each entity's holdings of Quota Allocation at the beginning of each month. To be concise, I report here only the HHI calculations for 4 of the months during the year.

Before presenting the concentration measures, I first consider how the existing caps for accumulation of Quota Share and Quota Allocation might limit concentration. With respect to Quota Share, the figures on Table 6 show that the largest producers in every species group landed volume that was almost always higher than the volume associated with the cap on Quota Share. This means that they were able to obtain sufficient Quota Allocation through market transactions to exceed not only their initial Quota Share but also the overall cap by species group.

Landings can exceed volume related to Quota Share caps because the regulatory constraint on accumulating Quota Allocation during the year is looser than the Quota Share caps. With respect to Quota Allocation, there is no cap on accumulation of RS Quota Allocation. The existing cap on GT Quota Allocation restricts the level of Quota Allocation aggregated across all species to approximately 6 percent of the aggregate total GT Quota Allocation, on an annual basis. For example, the annual allocation cap in 2013 was 529,300 pounds, and the total GT Quota Allocation across all species groups was 8,456,000 pounds, so the annual allocation cap was 6.25 percent of the aggregate quota.[50] An aggregated GT market with 16 firms that have just a bit above 6 percent market share would have an HHI of 625, which would be Unconcentrated. It would be even less concentrated if RS were part of the market.

[50] GT 2013 Annual Report, p. 9, p. 20, Table 15.

However, I conclude that the existing GT Quota Allocation cap does not effectively control concentration in a manner that is meaningful for the relevant markets of GoM Reef Fish and Quota Allocation.

First, it matters how a supplier spreads their production across species groups. If a supplier held the aggregate cap all in one species group, then the supplier could hold about 8 percent of the RGG Quota Allocation market (meaning an HHI of at most 833), almost 50 percent of the DWG Quota Allocation Market, or 92 or 100 percent of the Quota Allocation Markets for TF or Other SWG Quota, respectively. For example, the 2013 total quota was 6,238,000 pounds for RGG, 1,118,000 pounds for DWG, 518,000 pounds for SWG, and 582,000 pounds for TF. So a cap of 529,300 pounds would be 8.5 percent of the quota for RGG, 48 percent for DWG, over 100 percent for SWG, and 92 percent for TF.[51]

Second, the ability for a single entity to (possibly) control multiple permits means that, when the cap is effectively applied only at the permit level, then it is possible for concentration to exceed what the cap allows. For example, based on the ownership data for IFQ permits, there was common overlapping ownership of about two dozen IFQ IDs that together accounted for the largest aggregate supply of RGG in 2013, producing just over 600,000 pounds of RGG (over 10% of RGG landings). That set of IFQ IDs accounted for over 670,000 pounds for all GT, which exceeded the cap in 2013.

Finally, the GT cap does not include RS. It is possible that there is a broad market including both GT and RS (and other species), but there is no indication that a relevant market exists for the specific group delineated by the cap: all GT regulated species excluding RS. Only a cap on all GoM Reef Fish would address the relevant market for all GoM Reef Fish. The largest aggregate supplier of IFQ-Regulated GoM Reef Fish in 2013, also a combination of multiple permit holders, produced over 900,000 pounds across all species groups (about 8 percent of all IFQ-regulated GoM Reef Fish landings that year), including over 500,000 pounds of RS, about 10 percent of all RS landings that year (RS Quota Allocation holdings are not capped).[52]

Table 7 shows the Quota Allocation HHI measures for each of the species groups and for the aggregation of all the species groups. Three of the species groups (RS, RGG, SWG) and the aggregate quantity of all species groups has always been Unconcentrated.[53] Also, Table 7 does not show the largest suppliers, but Table 6 showed that the largest suppliers always had small shares not consistent with market dominance (usually less than 20 percent, and rising above 20 to no more the mid-30s for only a few exceptions in recent years for Species Groups that constitute less than 5 percent of the aggregate IFQ-Regulated GoM Reef Fish output). The two species groups with concentration measures occasionally above Unconcentrated are the same two that have higher concentrations for Landed Fish.

DWG has a notable increase in concentration in the second half of 2010. This is mostly due to a large increase in holdings by a particular market participant caused by a small number of low-price transactions (i.e., transactions that were priced considerably below the average price of the other transactions in the data for DWG that year), and failure to use or transfer all of those

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[51] GT 2013 Annual Report, p. 9, p. 20, Table 15.

[52] Eight percent is 900,000 divided by 11,300,000 (from Table 1). Ten percent is 500,000 divided by 4,900,000 (also from Table 1).

[53] Table 7 does not have a breakout for GG, but the concentration measures for quota allocation in that small category alone are all lower than the measures for RGG.

holdings as the season progressed. This conduct could be consistent with an attempt to exercise market power. However, the modest rise in prices for DWG in 2010 is not substantially different from price fluctuations at other times (see Figure 2), nor was there any noticeable impact on Quota Allocation prices (see Figure 3). Absent any effect on prices, it is evident that either this was not an attempt to exercise market power, or, if it was, then there was no market power to exercise.

There is a more consistent pattern of concentration for TF. Notably, the Quota Allocation market for TF starts out Unconcentrated (HHI under 1500) at the beginning of 2010 and stays Unconcentrated for most of 2010 through 2013. In the summer of 2010 and the fall of 2013, and through most of 2014, TF Quota Allocation holdings became Moderately Concentrated. These concentration patterns occur with a mixture of different suppliers in different years and, absent any evident price effect downstream, and fairly regular prices for the Quota Allocation itself (see Figure 3), appear to be more consistent with a small number of harvesters chasing a relatively small population of fish than with any attempt to exercise market power.

B. There are No Markets in Which Market Power Exists

The empirical evidence shows a lack of concentration in the various relevant markets and difficulties inherent in successful collusion across many participating entities. As a result, there are few, if any, opportunities for market power to exist. This may also be due to competition existing more broadly than within the IFQ-Regulated GoM Reef Fish, as discussed in the relevant market analysis. In addition, the next section presents evidence on price/cost margins that would not be consistent with the exercise of market power. Thus, I conclude that there is no pre-existing market power in any of the relevant markets delineated in the previous section.[54]

VII. ANALYSIS OF ECONOMIES OF SCALE

A. Do Economies of Scale Exist for Harvesting?

The final analysis that I undertake is to assess economies of scale in harvesting.[55] Qualitatively, the lack of additional consolidation available even under the accumulation caps may indicate a lack of incentives from underutilized cost reductions that could come from larger individual harvest quantities (more concentrated aggregate output). However, a quantitative empirical analysis shows that current individual harvest quantities do tend to fall well below the minimum efficient level of production – in other words, harvesters could reduce unit costs by increasing individual output. However, I find that the accumulation caps are not what is preventing harvesters from achieving lower costs. In addition, the quantitative analysis provides additional confirmation for my conclusion that no firms are exercising market power in any of the relevant markets.

Economies of scale exist when the cost per unit of production for an individual harvester decreases as production increases. This is synonymous with declining average cost, and with marginal cost below average cost. For price-taking firms, it would be inefficient to produce

[54] Tasks ix, x, and xi of the Statement of Work are to determine the effect of pre-existing market power, the associated deadweight loss, and share caps that would eliminate it. Since I find that there is no pre-existing market power, I proceed no further with these tasks.

[55] This is task xii of the Statement of Work.

output within a range where economies of scale exist – the same amount of output could be produced at lower cost by fewer firms (more consolidated suppliers).

When firms are failing to exhaust economies of scale, there are incentives to consolidate, leading to increased market concentration. The evidence on market concentration presented in the previous section shows that no such consolidation has occurred across the GoM Reef Fish industry. To the extent that there have been some modest increases in concentration, those have been limited to small increases within species groups that constitute a very small portion of the market. Also, in the context of multi-product output, economies of scale can often be achieved by diversifying production among different products (economies of scope). Absent any substantial restrictions on consolidation and the expansion of output across other species groups, the lack of market consolidation may indicate a lack of cost incentives – that there are no economies of scale available from increasing output per harvester. However, there may be other factors limiting consolidation, such as, primarily, extensive sunk costs in vessels and industry-specific intangible assets.

With detailed data on cost and output, it is also possible to test for cost efficiency empirically. Using Logbook data, I estimated a cost function for harvesters operating in a multi-product fishery (primarily, but not limited to, Reef Fish). I provide the technical details in the appendix, but, in summary, the estimation process uses a translog cost function that is flexible enough to allow for a wide variety of production technologies and also can be constrained to meet the theoretical requirements of a production function. This cost function includes variable technical inputs (labor, fuel, etc.), but does not include the cost of Quota Allocation necessary to land IFQ-Regulated GoM Reef Fish.[56]

The results of this estimation, shown in Table 8, provide a fairly precise estimate of aggregate production, and allow me to calculate the minimum efficient scale (the lowest quantity at which a firm minimizes long run costs and therefore has exhausted economies of scale), as well as average and marginal costs, as shown on Table 9. The top panel of Table 9 shows the calculation for "SCE," which is the ratio of marginal to average costs (that would be equal to one at the minimum efficient scale).[57] The second panel identifies that output scale that brings the SCE up to one, *i.e.* the minimum efficient scale, which is approximately 5,000 pounds per trip.[58]

[56] The data here extend beyond IFQ-Regulated GoM Reef Fish, but it would be impossible to compute a common price for Quota Allocation necessary for landing the portion of the data that are IFQ-Regulated GoM Reef Fish (it is possible to compute a price for each harvest, but computing a common price for any harvest is not possible due to the aggregation of all output into a single aggregate of differentiated product). However, Quota Allocation is not a production cost choice in the normal sense of variable costs – the supplier cannot choose how much Quota Allocation to use, because that is strictly determined by the volume of IFQ-Regulated GoM reef fish included in the production output. In graphical terms, the Quota Allocation would serve just to shift the marginal cost curve up or down, without changing its shape, and in econometric terms, Quota Allocation prices would not change the coefficients of the cost regression.

[57] Differentiation of the estimated cost function provides a formula for this ratio, which is just the estimated coefficient on output (labeled Byy on Table 8) summed with the products of the estimated coefficients for each of the output second-order terms (labeled , Byf, Byb, and Byl on Table 8) with the log of the averages for the corresponding data (output, fuel price, bait price, and labor price, respectively).

[58] Taking the equation described above, setting SCE equal to one, then solving for average output, leads to the formula that average output at minimum efficient scale is the exponentiation of one minus the ratio of a sum (the estimated coefficient on output, By, summed with the products of the estimated coefficients for each of the output-cost terms with the log of the averages for the corresponding data) and the estimated second order output coefficient, Byy. The results are in "quality-adjusted" pounds, which are equal to actual pounds only when the average price of

These are "quality-adjusted" pounds that take into account the different valuations of variations among species and fish size (explained in more detail in Appendix C). In contrast, the average trip within the cost data harvested 2,077 pounds (quality-adjusted).

For Reef Fish specifically, the average GT harvest per trip since 2011 has only been about 1,300 to 1,500 pounds (not quality-adjusted pounds), and the average RS harvest per trip each year since 2011 has only been about 900 to 1,300 pounds (not quality adjusted pounds).[59] However, these figures only show the total pounds per trip of the species under consideration, not the total pounds the vessel harvested including other species, as is done in the cost estimation. It is evident that the average harvest of 2,077 (quality-adjusted) pounds can be obtained by combining GT and RS and/or by including other species that are not IFQ-Regulated GoM Reef Fish (and, to a small extent, by the quality-adjustment, when GT and RS prices exceed the average price of all harvests).

In any event, it is evident that the average output across all harvesters is lower than the minimum efficient scale, which means that the industry in its current structure has not exhausted economies of scale. To confirm this, I also ran the same estimation process for a small sample of individual firms with relatively higher output than other firms. As would be expected, the results for a single firm, with far fewer observations, are less precise, but in almost all cases the actual level of output was below the best estimate of minimum efficient scale.

Table 9 also shows, in the final panel, that average cost exceeds marginal cost for the industry, and that relative to output prices, the average cost provides a short-term profit from operations (revenue net of operating costs, per quality-adjusted pound of output) that, on average, would be just sufficient to cover the cost of Quota Allocation for a vessel operator harvesting only IFQ-Regulated GoM Reef Fish. If only a portion of the harvest consists of IFQ-Regulated GoM Reef Fish, which is often the case, then the cost of Quota Allocation spread across the entire harvest is proportionately lower. This result provides additional confirmation of the lack of market power – an industry achieving zero average profit, even with modest marginal profits, would not be consistent with the use of market power by industry participants.[60] Instead, it indicates that the industry still has a surplus of suppliers, and that further consolidation would result in reduced costs.

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the individual vessel's output is equal to the current average price of all vessels' output, and otherwise adjusted up or down according to the relative prices. Thus, for example, the minimum efficient scale of approximately 5,000 pounds could be met by producing 4,000 pounds of product with an average price 25 percent higher than the average overall output, or would require producing 5,500 pounds of product with an average price about 10 percent lower than the average overall output.

[59] RS 2014 Annual Report, p. 20, Table 17; GT 2014 Annual Report, p. 26, Table 22. These are not quality-adjusted pounds, but similar enough for the purposes of this discussion, as the average GT or RS price tends to fall within 10-20 percent of the average overall output price.

[60] I note that vessel operators could still be generating positive cash flow, on average, even if restricting their operations to IFQ-Regulated GoM Reef Fish, but that most of the positive cash flow would flow to the operators' ownership of Quota Share rather than the fishing operations, and that operators who cannot separate their operating costs for producing IFQ-Regulated GoM Reef Fish from other fish are generating positive cash flows, on average, even with the cost of Quota Allocation factored into production cost. Also, I did not attempt to assess relative profitability across different types of vessels or gear types, or for operations in different areas.

B. Existing accumulation caps allow firms to exhaust economies of scale

The evidence shows that GoM Reef Fish harvesters are generally not producing at quantities sufficient to exhaust economies of scale. I find that existing caps on Quota Share and, for the GT program, Quota Allocation, are not preventing firms from exhausting economies of scale and are not imposing any additional cost on the industry.[61]

The minimum volume of landings per trip that would allow for the lowest unit cost is approximately 5,000 pounds. To examine whether accumulation caps restrict vessel operators from achieving this average, I begin by comparing the figure to historical levels and then accounting for the number of trips per year. Five thousand pounds is about 2.5 times the average volume of landings for all of the observations in the logbook data (approximately 2,000 pounds). Even with a narrower harvesting target of only RS, for example, 5,000 pounds would be only 4 times the average RS landings per trip in 2014 (excluding trips with no RS). In both cases, there are many individual vessels that exceed the 5,000 pound level, on average, so there is clear evidence that some configurations of vessel, gear, captain and crew can harvest at the minimum cost level. The next step is to determine whether vessels achieving that level per trip would be restricted in the number of trips due to accumulation caps.

There is a theoretical upper bound on the number of trips that each individual vessel can take per year (approximately 26, given 5 days out and 5 days rest and maintenance, and few or no weather interruptions), but the maximum and average number of trips observed in the IFQ data suggest that typical vessel operations fall well below that upper bound, with most vessels operating 10-15 trips per year. A hypothetical vessel at the upper end of that range, 15, producing at minimum efficient scale per trip would be landing about 75,000 pounds (15 trips * 5,000 pounds per trip). Now it is necessary to assess whether operating this hypothetical vessel at such high, but cost-efficient, utilization would force the operator to exceed existing allocation caps.

This amount of harvest, 75,000 pounds, would constitute a substantial portion of landings for some of the GT species groups: approximately 25-30 percent of SWG, 15-25 percent of TF, or 7-10 percent of DWG. This is above the Quota Share accumulation caps for each of these species, but this would only apply to vessels that limited production to one species group, which is rare (especially for the smaller species groups like these). Among GT in aggregate, 75,000 pounds would only be about 1 percent of output, well below the Quota Allocation accumulation cap for GT in aggregate, and for RS it would be only 1.5 to 2.5 percent of output, which has no Quota Allocation accumulation cap. Given the flexibility to combine species within a trip or across multiple trips and/or reduce the number of trips, vessel operators could achieve this level of output well within the existing Quota Share accumulation caps. Entities controlling vessel operations have historically been quite able to accumulate Quota Allocation in excess of the Quota Share cap: every year there have been scores of entities producing more than 750,000 pounds of IFQ-regulated GoM Reef Fish – ten times the amount of landings generated by the hypothetical highly utilized cost-effective vessel landing 75,000 pounds per year. This means that the Quota Share and Quota Allocation accumulation caps are not restricting entities from

[61] Task xiii and xiv of the Statement of Work are to identify which, if any, caps prevent exhausting economies of scale and, if so, to estimate the cost incurred because of that. Since I find that no caps are preventing firms from exhausting economies of scale, I do not estimate any cost.

achieving the large outputs that would result from operating many vessels in a highly utilized but cost-effective fashion.

VIII. RECOMMENDATIONS AND CONCLUSION

A. Highest Share Caps to Prevent Market Power and Allow Economies of Scale

All of the relevant markets that I define above share this description: market power does not exist and economies of scale are not exhausted. Therefore, my next task is to determine, for every market, the highest Quota Share or Quota Allocation caps that would prevent the exercise of market power and allow economies of scale to be most fully achieved.[62]

I have already determined that the current Quota Share and Quota Allocation caps are not restricting any firms from achieving economies of scale. With respect to the consideration of cost efficiency, there is no need to change any of the existing accumulation caps.

With respect to the consideration of market power, it is possible that higher Quota Share or Quota Allocation caps would continue to prevent the exercise of market power. To analyze this further, I pivot off of the existing empirical evidence on concentration and market power in the fishery. Given that the most concentrated sustained examples currently observed have not resulted in market power, I assume that any accumulation caps allowing no more concentration than those observations would be sufficient to prevent market power. In some cases, I go further based on my findings regarding the market in question.

For the relevant market of Quota Share, the appropriate Quota Share cap would be an aggregate across all species groups, including RS, if possible (the current caps are by species groups, which is appropriate for preventing market power in downstream markets possibly differentiated by these groups). The current caps applied and aggregated across all species groups would result in an aggregate cap of about 7 percent. The highest observed HHI for Quota Share for all Reef Fish has been 139 (in 2014) and the highest for any one species was 775 (TF, in 2014). The theoretical maximum HHI with a 7 percent cap is about 700 (14 firms with about 7 percent each). There is no evidence of market power in the Quota Share market to suggest a need for an aggregate Quota Share cap, but an aggregate cap of 7 percent would likely continue to prevent any market power. In fact, given the likelihood of highly elastic demand for Quota Share as an investment (described above), any cap that prevents concentration below an HHI of 1,500 should be sufficient – this implies an aggregate cap of about 15 percent (this allows for 7 equal sized firms and an HHI of 1,428).

For downstream markets of individual species groups, a cap on Quota Share does not prevent downstream production above that cap, due to the availability of Quota Allocation. However, a cap at 7 percent for any given species group would require that firms accumulate Quota Allocation in order to exceed an HHI of 700. The caps for DWG and TF are already well above that level, and yet the HHIs for Quota Share holdings within those species groups remain well below 800 and there is no evidence that accumulation of Quota Share in those categories has led to market power. Accordingly, there is no evidence that any of the category caps should

[62] This is task xv of the Statement of Work.

be lower than they are now, and there is sufficient evidence to conclude that any of the category caps lower than 7 percent could be raised to that level without harm.

For the relevant market of Quota Allocation, the appropriate Quota Allocation cap would be an aggregate across all species groups (not just GT, which the current cap covers, but also RS). The current caps applied to GT species groups, plus the Quota Share cap applied to RS, would result in an aggregate cap of about 840,000 pounds for 2013, or 7 percent of the aggregate market. The highest observed Quota Allocation HHI for all Reef Fish has been 268 (July 2010) and the highest for any one species was 2,319 (DWG, July 2010), in both cases without any apparent adverse effects. Accordingly, there is no evidence that the current aggregate GT cap should be lower than it is or that a cap inclusive of RS is needed, but there is sufficient evidence to conclude that an aggregate GT/RS cap of 7 percent (or the aggregation across all species groups, including RS, of the Quota Share cap applied to the quota levels) would continue to prevent market power.

Finally, in the relevant market of Landed Fish, it is evident already that the Quota Share and Quota Allocation caps have neither prevented harvesters from producing output in excess of the caps nor prevented harvesters from producing output sufficient for minimum efficient scale. In the RS and RGG categories, it has been common for at least one firm to exceed 10 percent, without any adverse effects with respect to market power. In some cases, the largest producer within a category has exceeded 20 or 30 percent without adverse market power effects (albeit for only one year and only in two of the smaller categories with large Quota Share caps – DWG and TF), but the maximum share within the aggregate has been only 9 percent. Accordingly, there is no evidence that the current accumulation shares need be any lower than they are in order to prevent market power in the downstream landed Reef Fish markets and there is some evidence that the Quota Share caps could be as high as 9-10 percent in the categories with lower caps.

B. Monitoring

Based on my analysis and the discussion above, the minimal changes necessary to align accumulation caps with the relevant economic markets are the following: 1) In order to make the Quota Allocation cap have any meaningful effect on output, monitor the Quota Allocation accumulation during the year, on a quarterly basis; and (conditional on the first recommendation) 2) improve the ability for the Quota Allocation cap to target the relevant set of production activities, change the Quota Allocation cap to include RS (and continue to calculate it as the application of the Quota Share cap to the quota level aggregated across all species groups each year).[63] It is unlikely that either of these changes would have any adverse effects on the markets overall, as they are currently functioning with Quota Allocation levels well below those caps (even though output levels may exceed those caps).

In addition, the determination of common economic control over the use of multiple permits is of paramount importance. None of the caps discussed above apply sensibly to individual permits, only to the economic entities controlling those permits and controlling the use of Quota Share and Quota Allocation. In other words, setting a cap on the quantity of landings associated with a specific permit would not be effective at limiting the overall output of a business entity that controlled multiple permits.

[63] This is task xvi of the Statement of Work.

C. Conclusion

The findings of my analysis here lead to the summary conclusion that market power has not been exercised within the GoM Reef Fish IFQ Programs, nor have the accumulation caps been so restrictive as to prevent participants from exploiting economies of scale. In both cases, it may well be the case that the observed outcome has occurred *despite* the accumulation caps rather than because of them. Strong competition between industry participants and from products in adjacent markets (most likely from reef fish species in the GoM not regulated by IFQs and from reef fish produced in the South Atlantic, but also possibly from more distant production) appears to be keeping market power in check even when participants accumulate large and concentrated shares of Quota Allocation or achieve large and concentrated shares for sales of Landed Reef Fish. There has been very little widespread or long-term consolidation of Quota Share holdings, nor have actual harvesting operations consolidated sufficiently to achieve the lowest possible harvesting costs, despite the fact that current accumulation caps allow for considerable consolidation in both dimensions.

Making no changes to the current accumulation caps will cause no harm nor forego any benefit under current market conditions. Some additional leeway from expanding the size of some of the smaller caps would create no additional risk of market power being exercised, and would provide even more flexibility for the type of consolidation that would improve cost efficiency. There appears to be no need to lower the size of any of the caps. But even if there were, it would not appear to affect cost efficiency. Firms are already able to produce well beyond the existing accumulation caps and well into the range of efficient scale – it just happens to be the case that many do not, due to other reasons (these reasons could include “stickiness” in capital allocation, which means that there are transaction costs associated with deploying the capital, mostly vessels, into other uses, and could also include expectations that output will increase and costs decline in the near future when quotas rise and/or industry participants drop out of production).

In the event that market conditions ever change to the point where the accumulation caps become more binding, then moderate changes in the program could improve the effectiveness of those caps. The moderate changes involve aligning the accumulation caps more closely with the way the markets operate, rather than with how the Gulf Council chooses to regulate operations – specifically, to consider an aggregate cap on Quota Share across all species groups, to include RS together with GT in the consideration of aggregate caps for both Quota Share and Quota Allocation, and to monitor Quota Allocation caps more frequently than on an annual basis.

Appendix A

STATEMENT OF WORK / TERMS OF REFERENCE

Statement of Work
Analysis of Market Power Under Quota Share and Allocation Caps in Gulf of Mexico Catch Share Programs

I. Introduction

Section 303A(c)(1)(G) of the Magnuson-Stevens Act (MSA) requires the Regional Fishery Management Councils (Councils) and the Secretary of Commerce (Secretary) to periodically conduct "formal and detailed" reviews of all Limited Access Privilege Programs (LAPPs) established after January 12, 2007. For LAPPs established after January 12, 2007, the initial review must commence no later than 5 years after the program was implemented. The Gulf of Mexico Grouper-Tilefish Individual Fishing Quota (G-T IFQ) program was implemented in 2010 and thus the initial review of the program is currently underway.

In order to properly describe and analyze the program's performance, the review needs to address the program's various structural components, particularly components that are required or must be considered under the MSA, or NOAA's Catch Share Policy says should be evaluated. Section 303A(c)(5)(D) of the MSA requires Councils and the National Marine Fisheries Service (NMFS) to establish appropriate limits or caps to prevent the excessive accumulation of harvesting privileges. The accumulation of excessive shares is thought to potentially create market power in the product market, input markets (e.g., gear, bait, labor, etc.), and/or the markets for quota shares (QS) and annual allocation. Market power creates economic inefficiency, contrary to National Standard 5, and can exist when sellers have the ability to control prices (i.e., monopoly/oligopoly) or buyers have that ability (i.e., monopsony).

Even if market power is not created, excessive shares are also to be avoided for equity/distributional reasons, consistent with National Standard 4, National Standard 8, and section 303A(c)(5)(D)(ii) of the MSA. In addition, a primary concern with caps is their ability to prevent firms from fully utilizing existing economies of scale and producing at the minimum average cost per unit of harvest (i.e., firms are technically inefficient). Because QS caps do not necessarily limit a firm's production in a given year, as QS owners can purchase additional allocation, this concern primarily applies to allocation caps.

Further, the review shall explicitly address whether existing data collection and monitoring programs are sufficient to accurately determine each entity's ownership level and thus whether entities are exceeding the existing caps. The review shall also address whether the caps are being applied at the appropriate levels to ensure they are serving their intended purpose. Since caps typically apply to all "persons" or "entities," the review should determine whether "persons" and "entities" are being identified in the program in a manner consistent with the Council's intent and other agency practices and guidance (e.g., accounting for affiliation, consistent with the Small Business Administration's regulations, where practicable). For example, if the caps are being applied or monitored in a manner that precludes the estimation of an appropriate Herfindahl-Hirschman Index (HHI) or Gini coefficient, that should be noted and addressed in the review. The U.S. Department of Justice (DOJ), the Federal Trade Commission (FTC), and state attorneys general have used the HHI to measure market concentration and thereby the degree of market competition for purposes of antitrust enforcement. Unlike the four-firm concentration ratio, the HHI reflects both the distribution of the market shares of the top four firms and the composition of the market outside the top four firms. It also gives proportionately greater weight to the market shares of the larger firms, in accord with their relative importance in competitive interactions.

According to the DOJ-FTC 2010 Horizontal Merger Guidelines, which can be found at https://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf, these agencies consider a market in which the HHI is below 1500 as "unconcentrated," between 1500 and 2500 as "moderately concentrated," and above 2500 as "highly concentrated." A market in which the HHI is below 1500 can generally be presumed to be competitive, and thus the exercise of market power would not be expected in such a market. Market power could be exercised in a market where the HHI is between 1500 and 2500. Competition is thought to be limited in markets where the HHI is greater than 2500, and thus market power is likely to exist in such markets.

Although the initial 5-year review of the Red Snapper IFQ program (RS IFQ) has already been completed, it found significant interdependencies between the RS and G-T IFQ programs. Further, many entities that participate in the G-T IFQ program harvest other federally managed reef fish species that are not included in either IFQ program. Thus, the review of the G-T IFQ program may need to discuss components or sectors of the reef fish fishery not covered by that specific program.

II. Scope

The primary purpose of the proposed work is to determine if the current QS caps and allocation cap in the G-T IFQ program are allowing for or promoting well-functioning, competitive markets. These caps shall prevent the exercise of market power even if they do not allow economies of scale to be fully achieved. A secondary purpose of the proposed work is to determine if an allocation cap is needed in the Red Snapper IFQ program to promote well-functioning, competitive markets for red snapper products, quota shares, and/or annual allocation.

III. Objectives

The primary objectives of the proposed work are to determine if the current QS caps and allocation cap in the G-T IFQ program: 1) are sufficiently restrictive so as to prevent the exercise of market power in associated product, quota share, and allocation markets, and 2) allow vessels and firms to take full advantage of existing economies of scale. The potential for market power in input markets is not under consideration due to lack of data on these markets. Solely with respect to the product market(s), the proposed work should determine what effect, if any, the QS caps and/or allocation cap have had on market power that may have existed prior to implementation of the G-T IFQ program. For example, did the product market(s) change with respect to whether they were unconcentrated, moderately concentrated, or highly concentrated, per the DOJ-FTC 2010 Horizontal Merger Guidelines?

If the existing caps are not sufficiently restrictive to prevent the exercise of market power, an additional objective of the proposed work is to determine the highest cap(s) that would prevent the exercise of market power in these markets and the economic losses that would result at the individual firm and industry level under these caps as a result of decreased revenue and/or increased costs. Further, if the existing caps are found to prevent vessels or firms from taking full advantage of existing economies of scale, an additional objective of the proposed work is to determine how much higher the costs of harvesting the available commercial quota(s) are as a result. In that instance, if it is also determined the current caps could be increased to allow economies of scale to be more fully achieved while still preventing market power from being exercised, an additional objective is to determine the highest cap(s) that would prevent the exercise of market power and allow economies of scale to be more fully achieved.

IV. Tasks

i. Upon award of the contract, NMFS will provide access to several background documents to the contractor regarding the Gulf IFQ programs and their performance. The contractor shall be required to review these documents prior to conducting any analysis shall provide important context for completing the tasks below.

ii. An analysis of market power in the Mid-Atlantic Surf Clam/Ocean Quahog Individual Transferable Quota (ITQ) program has already been conducted[1] and was the subject of a review by the Center for Independent Experts (CIE).[2] An analysis using the same approach has also been conducted for the Northeast Multispecies Sectors program,[3] which was also reviewed by the CIE.[4] However, the conclusions of the two CIE reviews differ with respect to the appropriateness of the approach and data used to reach the conclusions and recommendations in the respective analyses. Given available data, resources, and time, the contractor shall take into account the concerns and deficiencies noted in the CIE reviews, particularly the review of the Sectors program analysis, when completing the tasks below.

iii. Compile all data necessary to complete tasks below. Unless otherwise approved by NMFS, data compilation and analysis shall be done using Excel, SYSTAT, SPSS, STATA, or SAS. NMFS will provide most of the data necessary to complete the tasks below, for e.g., permit application data (see http://sero.nmfs.noaa.gov/operations_management_information_services/constituency_services_branch/permits/permit_apps/index.html), IFQ data, as largely described in the annual reports for the G-T program (see http://sero.nmfs.noaa.gov/sustainable_fisheries/lapp_dm/documents/pdfs/2013/2013_gt_annualreport.pdf), federal logbook data (see http://www.sefsc.noaa.gov/fisheries/logbook.htm), including the economic cost data, and estimates of ex-vessel prices and revenues for non-IFQ managed species based on logbook and dealer data (additional details to be provided after contract is awarded). This data will be provided at the level(s) needed to conduct the required analyses for the period 2005-2014. NMFS will also provide relevant processor data. Although red snapper and tilefish products are specifically identified in the processor data, grouper species are aggregated into a single product code. Further, it is not possible to directly

1 http://www.nefsc.noaa.gov/read/socialsci/pdf/SCOQ_ITQ_Exc_Share_Rec_2011-05-03.pdf

2 http://www.nefsc.noaa.gov/read/socialsci/pdf/CIE_report_final.pdf

3 http://www.nefmc.org/nemulti/planamen/Amend%2018/compass_lexecon/NEMFC%20Report%20Final.pdf

4 http://s3.amazonaws.com/nefmc.org/6a_CL-peer-review-reports.pdf

discern whether the processed product is domestically produced or imported, though some deductions can likely be made via comparisons with domestic landings and import data. NMFS also possesses trade data, which can be found at: http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/index. Foreign trade data related to IFQ species is aggregated into two species categories, all snapper and all grouper, though each can be separated into fresh and frozen product. Tilefish is not separately identified in this data and thus cannot be taken into account. NMFS does not possess retail level data that will likely be needed to properly analyze product markets. Thus, the contractor shall need to procure this data from other sources.

iv. Define all relevant product markets related to the G-T IFQ program. Markets shall initially be defined based on whether reef fish species are or are not managed via IFQs. With respect to species managed via IFQs, based on preliminary industry input, it may be appropriate to define the markets more specifically in the following manner: red snapper, groupers, and tilefish. However, it is also possible that all reef fish (snapper and groupers) may be part of a single product market. Due to the lack of research on product markets related to the Gulf IFQ programs, the contractor shall need to consult with industry participants, representatives, other industry experts, and NMFS before determining the most appropriate boundaries.

v. Determine the relevant QS markets in the G-T and RS IFQ programs. Market definitions shall initially be based on the market structures established in these IFQ programs, i.e., red snapper, red grouper, gag, other shallow water grouper (SWG), deep-water grouper (DWG), and tilefish. If preliminary analyses show significant interdependencies across these markets, then the markets shall be redefined appropriately after consulting with NMFS.

vi. Determine the relevant allocation markets in the G-T and RS IFQ programs. Market definitions shall initially be based on the market structures established in the G-T and RS IFQ programs, i.e., red snapper, red grouper, gag, other SWG, DWG, and tilefish. If preliminary analyses show significant interdependencies across these markets, then the markets shall be redefined appropriately and after consulting with NMFS. For example, the allocation markets for red grouper and gag are likely interdependent due to multi-use flexibility measures that allow conversion of allocation from one species to the other under certain conditions.

vii. Estimate HHIs in all markets on an annual basis at each of the following three levels: 1) individual, 2) business, and 3) affiliated business/entity level, as feasible given available data. Based on the HHIs, determine whether each market is unconcentrated, moderately concentrated, or highly concentrated, per the DOJ-FTC 2010 Horizontal Merger Guidelines. Determinations of affiliation shall be based on the Small Business Administration's 50% common ownership threshold. Thus, if an entity (individual, business, etc.) is a majority owner in one or more other entities, then those entities are considered affiliated and should be treated as a single affiliated entity. Ownership percentage data began to be collected for corporations that hold QS and allocation in 2009. Though sometimes collected for other business types, such data is not complete even in the 2009-2014 permit and IFQ data. In situations where the ownership percentage data is missing for a particular entity in the 2009-2014 permit and IFQ data, the contractor shall assume the distribution of ownership is equal across owners of the entity (e.g., if an entity has 4 owners and their respective ownership percentages are unknown, then the contractor will assume each owner owns 25% of the entity). For years prior to 2009, the contractor shall need to consult with NMFS on an appropriate method to use for determining affiliation.

viii. Based on market concentration levels and any other relevant factors, determine if market power has been or is presently being exercised in any product, QS, or allocation market associated with the Gulf G-T or RS IFQ programs.

ix. If market power existed in the product market(s) prior to the implementation of the G-T IFQ program, determine what effect if any the QS or allocation caps had on such market power.

x. If market power was found to exist in any market, estimate the resulting deadweight loss (DWL) in that market.

xi. If market power is found to currently exist in any market, determine the maximum QS and/or allocation cap that would eliminate such market power as well as the economic losses that would result at the individual firm and industry level under the cap(s) as a result of decreased revenue and/or increased costs.

xii. Determine if economies of scale exist in the production of IFQ species at the harvesting level.

xiii. If economies of scale are found to exist, determine which if any of the QS or allocation caps are preventing firms from exhausting those economies of scale.

xiv. If any caps are preventing firms from exhausting potential economies of scale, estimate the resulting increase in costs at the firm and industry level.

xv. For any markets where market power does not currently exist and economies of scale are not exhausted, determine the highest QS and/or allocation cap(s) that would prevent the exercise of market power and allow economies of scale to be most fully achieved.

xvi. Based on the results of the market power analysis, determine if the QS and allocation caps are being monitored and enforced at all appropriate levels. If any or all are not, provide recommendations for improving the monitoring and enforcement of these caps.

V. Deliverables

i. The Contractor shall provide an initial draft of the report containing the analyses resulting from completion of the tasks specified in section IV no later than 4 months from the contract's start date and at least 10 days in advance of the presentations noted in V.ii below.

ii. The Contractor shall give two presentations regarding the results in the draft report. The first presentation will be given to NMFS staff at the NMFS Southeast Regional Office, 263 13th Ave S., St. Petersburg, FL. The second presentation shall be made to the Gulf Council's Standing Scientific and Statistical Committee (SSC) and/or its Special Socioeconomic SSC at the Gulf Council's Office, 2203 N Lois Avenue, Suite 1100, Tampa, Florida. NMFS anticipates the two presentations can be made on a single trip, though exact dates will be determined at a later date.

iii. The Contractor shall make revisions to the initial draft report in response to review comments received by NMFS staff, Gulf Council staff, and SSC members and provide a revised draft of the report no later than 6 months from the contract's start date. The Project Manager shall have 30 days to review the revised draft report before determining whether all tasks have been completed satisfactorily and the report is deemed final.

iv. The Contractor shall make any additional revisions to the revised draft report in response to review comments received by the Project Manager and submit a final report by April 14, 2016. The final report shall be accompanied by all datafiles and programs created as a result of or in association with completing the tasks in section IV. All datafiles and programs must be in Excel, SYSTAT, SPSS, STATA, or SAS format.

VI. Government Furnished Property

The Government will not furnish any property under this contract other than the data noted in Section IV.

VII. Security

Because completion of the stated tasks require access to confidential data, the Contractor shall sign and abide by the terms of any and all required non-disclosure agreements, consistent with the provisions of NAO 216-100.

VIII. Place of Performance

Services shall be primarily provided at the Contractor's offices. Certain services, such as presentations of the draft report, shall be provided at the NMFS Southeast Regional Office (263 13th Ave S., St. Petersburg, FL) or at other sites to be later identified by the Government.

IX. Period of Performance

The period of performance is September 14, 2015 through April 14, 2016.

X. Schedule of Payments

The contractor shall be allowed to invoice and thus be paid according to the following schedule: 1) two-thirds of the contract's labor costs upon completion and submission of the draft report, 2) the remaining one-third of the contract's labor costs upon acceptance of the final report by NMFS, and
3) reimbursement of travel costs upon completion of the two presentations noted in V.ii.

All travel shall be performed in accordance with the Federal Travel Regulations. The Contractor shall only be paid for work that is performed and accepted.

Appendix B

2. "Entities Grouping": the Southeast Regional Office provided an Excel file called "EOY Entities" on approximately November 17, 2015, which identified single entities that may control the use of multiple permits.
    a. The file identifies business names and personal names with business ownership, along with calculated percentages among mutual owners (based on assumptions of equal shares) and similar information used to group together entities that controlled multiple permits.
    b. I relied on the groupings in this file to prepare my concentration calculations.

3. "Logbook data": the Southeast Regional Office provided a SAS file called "gulf0515allobs_edits_trip" on approximately January 12, 2016, and an another file with similar information for the South Atlantic, except for cost data, called "satl0714allobs_pims_trip" on approximately October 22, 2015.
    a. This file contains data on landings by vessel by trip, including species outside of the GoM Reef Fish IFQ program.
    b. A small portion of data includes cost information (approximately 15 percent of the available observations).
    c. I relied on this data for my cost regression analysis and for some of the variables used in the demand regression analysis.

The Southeast Regional Office also provided data on processor production quantities (which I did not use in my analysis) and several documents and research publications cited in this report.

I obtained data from the US Bureau of Labor Statistics (producer price index for finished consumer foods, which I used for converting nominal to real prices) and from USDA Economic Research Service (food expenditures by month, which I used in the demand analysis).

Appendix C

TECHNICAL DETAILS

1. Demand regression
    a. For the demand regression analysis described in Section V, I relied on a log-linear system of demand equations for each of the five species groups. The dependent variable for each species group was log quantity and the explanatory variables included the log prices for all five species groups, along with food expenditures and the current annual quota for the species group. In addition, I created a price index for categories of possible substitute products that were not IFQ-Regulated GoM Reef Fish. The three possible categories were: 1) similar species harvested in the GoM that are not regulated by IFQ; 2) the same species that are IFQ-Regulated in the GoM, but were harvested in the South Atlantic; and 3) same as category 1, but harvested in the South Atlantic)
    b. To prepare the panel data of prices and quantities, I first filtered out of the IFQ data transactions with apparently erroneous prices or quantities (as described in the Data Appendix). For the remaining data, and for all of the logbook data used for species that were not IFQ-Regulated GoM Reef Fish, I converted prices from nominal to real using the Producer Price Index for finished foods from the US Bureau of Labor Statistics. Then I collapsed multiple species within any given species group into one price index using a chained Fisher Price index, as follows: 1) in any given period, I calculated for any products appearing both in the current and previous periods the percentage price change, 2) I then calculated the weighted average using volumes from the current period as weights and again using volumes from the previous period as weights, 3) I then calculated the geometric mean of those two average price increase with the complete result being a time series of average price changes for the product group for the entire data period, 4) I calculated the nominal average product price in the middle of the data sample period to use as a baseline, 5) I then applied the time series of average price changes to this baseline to develop a complete time series of average prices for the group.
    c. I prepared my panel data at monthly frequency due to the sparseness of data for some of the smaller species groups. Large species groups like RS and RGG could have been evaluated with a weekly frequency. The complete data set contained prices and quantities for all five species groups monthly from 2010 through 2014.[65] The panel contained 60 time periods.
    d. To address the possibility of endogeneity in the regression due to simultaneous determination of both price and quantity, I also included a production equation in translog form: aggregate quantity (summed across all five species groups regressed on input prices (described in cost analysis below). I do not use the results for that equation, but included it so that the input prices could serve as instruments for the demand equations.

[65] RS could have gone back to 2007 within the IFQ data, and the logbook data for all harvests do extend back prior to 2010 (but may not be as accurate).

Appendix C

e. I conducted the regressions using OLS, SUR, 2SLS (two stage least squares) and 3SLS (three stage least squares). Other than OLS, the desirable estimation properties of the other methods rely on asymptotic results most applicable to large samples. The size of this panel, with only 60 periods, may call into question the use of instrumental variables in particular. However, the results for all estimations methods were nearly identical, and none of the methods produced systematically sensible elasticity estimates for all products.

2. Concentration calculations
   a. For the concentration calculations described in Section VI, I first relied on data that the NOAA Fisheries Service Southeast Regional Office provided: a spreadsheet that listed the ID numbers of IFQ program participants, along with business and personal names associated with each ID number (and, when known, the data at which the business and/or personal name first became associated with the ID number). By linking together IFQ IDs that shared common business and or personal names, I created a set of "entities" and matched each IFQ ID to a "Group ID." Each IFQ ID maps to only one Group ID, but each Group ID can contain multiple IFQ IDs.[66]
   b. For landings concentrations, I first aggregated landings in the IFQ data by IFQ ID, and then further aggregated into Group IDs based on my mapping of IFQ IDs to Group IDs. For Quota Allocation, I estimated the Quota Allocation holdings each month by IFQ ID by adjusting the previous month (or beginning of year) Quota Allocation amount for transactions occurring during the month (including buying, selling, and using allocation, and for mid-year disbursements of Quota Allocation occurring with quota increases). I included each year the amount that could be "borrowed" from the next year (and netted out any amount that had been borrowed for the previous year). I then aggregated to Group ID based on my mapping of IFQ ID to Group ID. The Quota Allocation concentration for January each year is the same as the Quota Share concentration at the beginning of each year.

[66] For each year, I assign the first IFQ ID to the first Group ID (denoted by the 4-digit year and then 0001). I assign an IFQ ID to a Group ID whenever a person or business owning more than 50 percent of an IFQ ID are already affiliated with a Group ID, otherwise I assign it to a new Group ID (adding 1 to the most recently created Group ID). I iterate this process each year until reaching a stable number of Group IDs. Although I did not conduct myself the research to associate the business and personal names, I did review the criteria used to determine the association, which I found to be economically sensible, and spot-checked some of the results to assess the reliability of the process. Based on that review, I concluded that, given the available data and assuming that no other unknown ownership or control linkages are present among permit holders, then it would be highly unlikely that any errors in the "entity" associations would substantially change any of the concentration numbers reported here. However, it is possible that additional information could identify broader groups of controlling entities in some cases. For example, a person owning one business might also have a controlling interest in a business that has a controlling entity in another business, but the chain of control may not be evident either because the ownership information is not public, or the controlling interest occurs with a minority ownership share. Also, dealers may own controlling interests in multiple IFQ IDs or in multiple businesses each associated with different IFQ IDs. In other words, <u>there could be higher concentration, but there is no way to measure that without full details of controlling interests in all of the relevant entities</u>.

c. The calculated HHIs are the sum of the squared shares times 10,000 for all entities with 1 percent share or more, plus the remaining market share times 100. This is equivalent to assuming that the portion of the market with shares under 1 percent actually consists of equal sized participants all at 1 percent and will very slightly overstate HHI.
d. I calculate quantity-share HHIs for each species group, but revenue-share HHIs for the aggregate of all species groups together. In any event, there is no difference between quantity-share and revenue-share HHIs substantial enough to change any of my findings.

3. Cost regression:
   a. For the cost regressions described in Section VII, I relied on a translog cost function with ancillary share equations, using the GoM Logbook data on costs per vessel per trip from 2012 through 2014 (which is the period for which the data consistently contain substantial cost data).
   b. The translog cost function regresses the log of cost on a quadratic expansion of the log of output quantity and the logs of input prices. This functional form is dual to a translog production function and has the advantage of being a flexible approximation of a variety of different production functions, while conforming to economic theory with respect to convexity and homogeneity. Also, a cost-minimizing firm would consume input shares in proportion to the some of the same parameters that are used in the cost function, allowing for additional equations ("ancillary cost share equations") using the same data and parameters, which provides for more precision in the parameter estimates.
   c. I calculated a single aggregate output amount across the multiple species included in the logbook data – choosing to treat the different species as different quality levels of the same product rather than using a vector of outputs and a system of cost equations). To do this, I first constructed a chained Fisher price index of all of the products (I describe this process above, in my description of the demand regression) – using real prices (converted from nominal based on the Producer Price Index for finished foods to consumers). I then calculate the ratio of the actual real price to the constructed price index and multiply that by the quantity to get a "quality-adjusted" quantity. Thus, a product with a price 20 percent higher than the average price will get a quality-adjustment of 20 percent to the quantity.
   d. The cost data included input expenditures and, sometimes, prices, but the prices were rarely sensibly recorded. I calculated Fuel prices based on fuel expenditures divided by days at sea for each trip. For Labor, I included all expenditures on crew and captain and divided that by person-days (when the crew amount is zero, I assumed that the captain alone operated the vessel and counted the crew size as one). Finally, I aggregated bait, tackle, ice and "other" into a single category and divided it by output to get price per unit output for "Bait." I exclude fixed costs form this analysis (captured instead by the constant term and by fixed effects for the different vessels). I also exclude the cost of Quota Allocation required to land the reef fish in the Logbook data.

Appendix C

Quota Allocation is not a production cost choice in the normal sense of variable costs – the supplier cannot choose how much Quota Allocation to use, because that is strictly determined by the volume of IFQ-Regulated GoM reef fish included in the production output. In graphical terms, the Quota Allocation would serve just to shift the marginal cost curve up or down, without changing its shape, and in econometric terms, Quota Allocation prices would not change the coefficients of the cost regression.

e. For the translog cost function, the derivative of log costs with respect to log output for the translog cost function results in a ratio of marginal cost to average cost for any given set of input prices and output level, called SCE. From this, I compute the output level that, for the average of input prices (across the full data set) results in marginal cost equal to average cost (SCE equal to one) – this is the minimum level for average cost. This is the mathematical basis for Table 9.

Figure 1

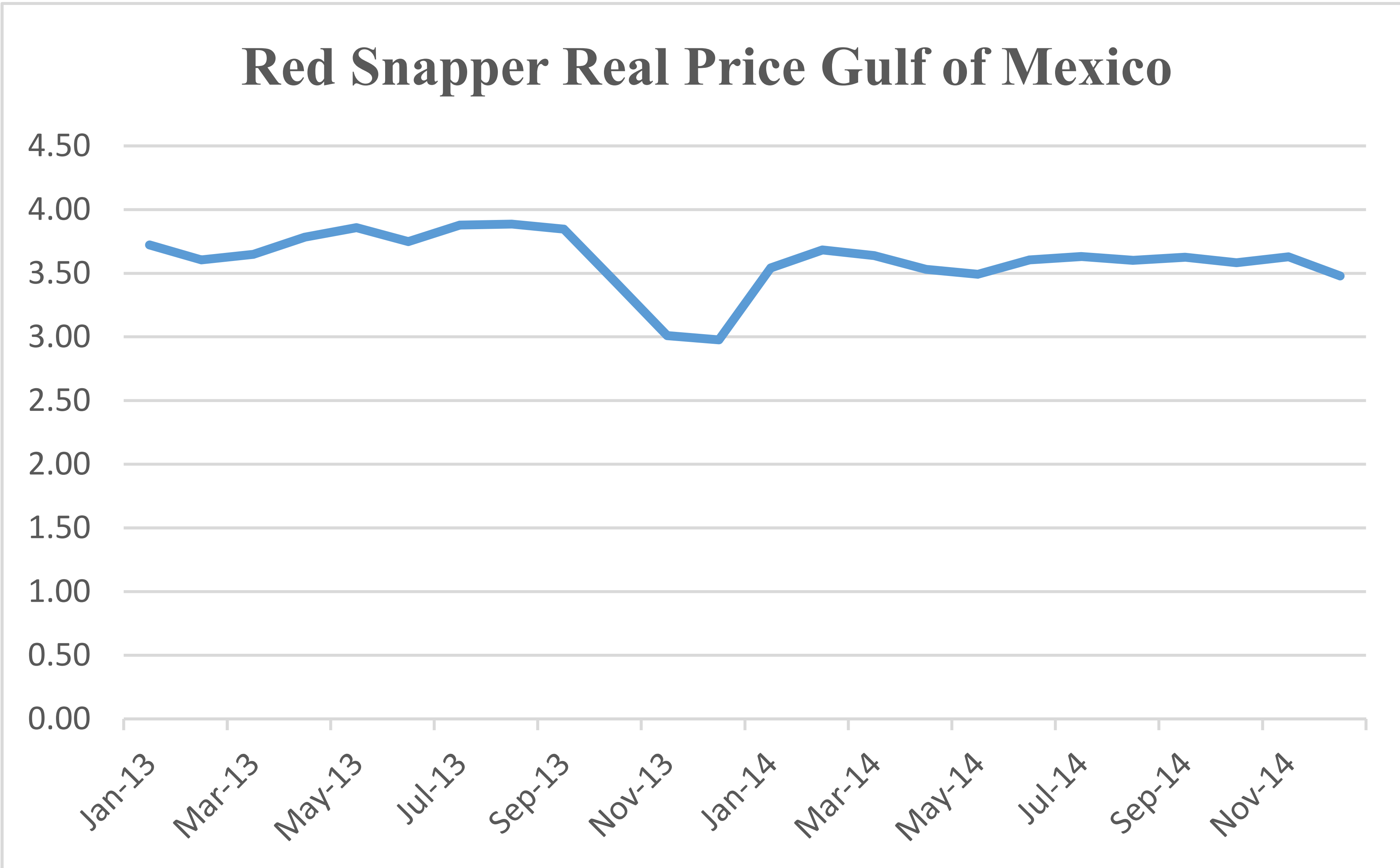

Red Snapper Real Price Gulf of Mexico
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14

Figure 2

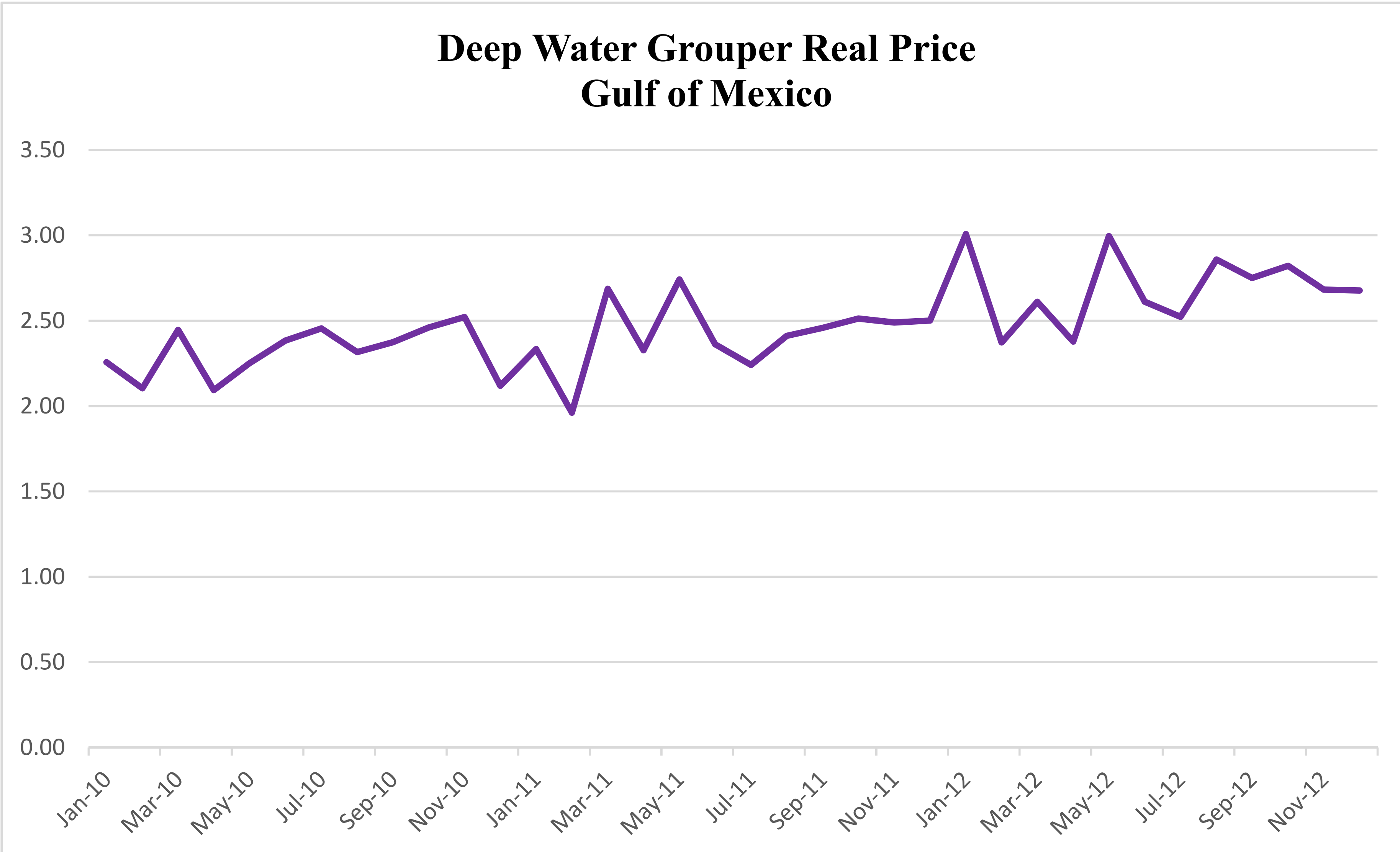
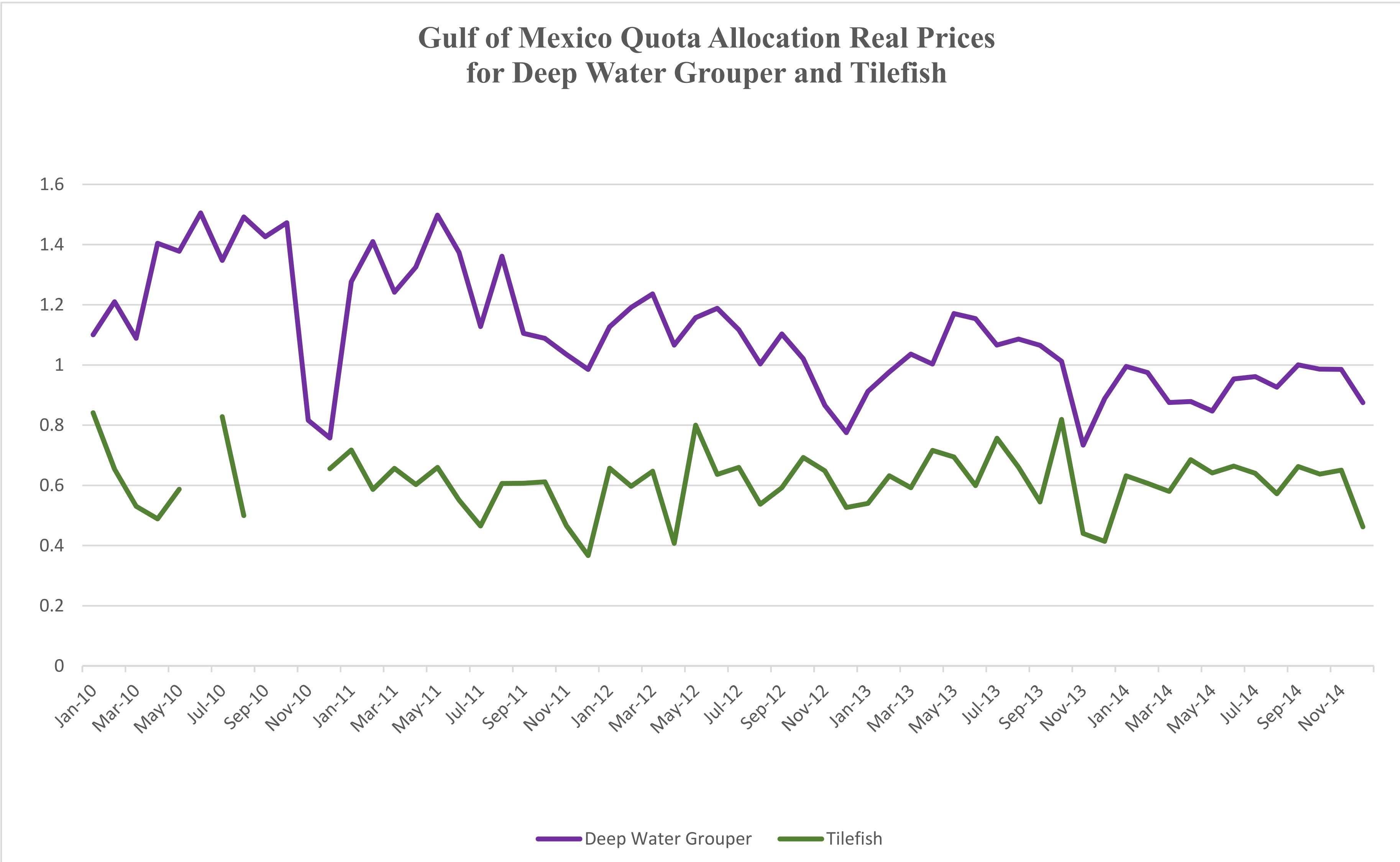

Deep Water Grouper Real Price
Gulf of Mexico
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12

Figure 3



Gulf of Mexico Quota Allocation Real Prices
for Deep Water Grouper and Tilefish
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Deep Water Grouper
Tilefish

Table 1

Annual Gulf of MexicoIFQ-Regulated Reef Fish Landings By Species Group (pounds)

	2007	2008	2009	2010	2011	2012	2013	2014
Red Snapper	2,867,326	2,237,480	2,237,446	3,056,044	3,238,335	3,636,395	4,908,598	4,782,465
Gag Grouper				486,081	309,963	490,908	198,807	253,079
Red Grouper				2,894,934	4,782,194	5,217,205	4,594,672	5,048,776
Subtotal Gag and Red Grouper				*3,381,015*	*5,092,157*	*5,708,113*	*4,793,479*	*5,301,855*
Deep Water Grouper				624,762	779,519	963,835	912,923	1,007,049
Other Shallow Water Grouper				158,234	186,235	300,367	307,846	244,903
Tilefish				249,708	386,134	451,121	440,091	499,339
Subtotal Grouper-Tilefish				*4,413,719*	*6,444,045*	*7,423,436*	*6,454,339*	*7,053,146*
Grand Total Reef Fish				7,469,763	9,682,380	11,059,831	11,362,937	11,835,611
						Annual Share		
Red Snapper				40.9%	33.4%	32.9%	43.2%	40.4%
Gag Grouper				6.5%	3.2%	4.4%	1.7%	2.1%
Red Grouper				38.8%	49.4%	47.2%	40.4%	42.7%
Subtotal Gag and Red Grouper				*45.3%*	*52.6%*	*51.6%*	*42.2%*	*44.8%*
Deep Water Grouper				8.4%	8.1%	8.7%	8.0%	8.5%
Other Shallow Water Grouper				2.1%	1.9%	2.7%	2.7%	2.1%
Tilefish				3.3%	4.0%	4.1%	3.9%	4.2%
Subtotal Grouper-Tilefish				*59.1%*	*66.6%*	*67.1%*	*56.8%*	*59.6%*

Source: IFQ Data (see data appendix). Red Snapper IFQ program began in 2007. Grouper Tilefish IFQ program began in 2010.

Table 2

Quota Share Accumulation Limits for Gulf of Mexico IFQ-Regulated Reef Fish

	Quota Share Limit
Red Snapper	6.0203%
Gag Grouper	14.704321%
Red Grouper	2.349938%
Deep Water Grouper	4.331882%
Other Shallow Water Grouper	7.266147%
Tilefish	12.212356%

Source: RS 2014 Annual Report, G-T 2014 Annual Report

Table 3

Average Monthly Real Prices for Gulf of Mexico IFQ-Regulated Reef Fish

Year	Month	Red Snapper	Red & Gag Grouper	Deep Water Grouper	Other Shallow Water Grouper	Tilefish
2010	January	3.66	2.91	2.26	2.97	2.21
	February	3.67	3.02	2.10	3.19	2.55
	March	3.61	3.00	2.45	3.01	1.18
	April	3.79	3.15	2.09	3.26	1.55
	May	3.65	3.14	2.25	3.12	1.66
	June	3.60	2.98	2.38	3.15	2.11
	July	3.80	2.69	2.46	3.03	2.25
	August	3.84	2.80	2.32	2.99	2.15
	September	3.80	3.12	2.37	2.99	2.40
	October	3.61	3.04	2.46	3.15	2.12
	November	3.74	3.21	2.52	3.05	2.48
	December	3.11	2.71	2.12	2.59	2.08
2011	January	3.22	2.88	2.33	3.05	2.04
	February	3.50	2.75	1.96	2.97	1.93
	March	3.34	2.86	2.69	3.21	2.25
	April	3.35	3.43	2.33	3.18	2.24
	May	3.49	3.21	2.74	3.24	1.85
	June	3.31	2.89	2.36	3.18	2.37
	July	3.66	2.84	2.24	3.20	2.06
	August	3.77	2.75	2.41	2.99	2.23
	September	3.53	2.82	2.46	2.77	2.43
	October	3.62	2.82	2.51	3.10	2.18
	November	3.79	3.16	2.49	2.88	2.68
	December	3.38	3.09	2.50	3.17	2.67
2012	January	3.41	3.07	3.01	3.12	2.57
	February	3.43	3.07	2.37	3.18	1.99
	March	3.45	3.19	2.61	3.18	2.47
	April	3.59	3.20	2.38	3.17	1.86
	May	3.72	3.25	3.00	3.25	2.74
	June	3.89	3.21	2.61	3.14	1.91
	July	3.88	3.12	2.52	3.23	2.38
	August	3.89	2.92	2.86	3.17	2.49
	September	3.74	3.12	2.75	3.29	2.31
	October	3.64	3.15	2.82	3.14	2.16
	November	3.49	3.11	2.68	3.10	2.14
	December	3.44	3.13	2.68	3.11	2.09

Table 3

Average Monthly Real Prices for
Gulf of Mexico IFQ-Regulated Reef Fish

Year	Month	Red Snapper	Red & Gag Grouper	Deep Water Grouper	Other Shallow Water Grouper	Tilefish
2013	January	3.72	2.70	2.73	3.13	2.08
	February	3.61	3.14	2.45	3.16	2.02
	March	3.65	3.10	2.81	2.99	2.15
	April	3.78	3.10	3.07	2.97	2.66
	May	3.86	3.07	3.04	3.04	2.30
	June	3.75	3.11	2.90	3.09	2.15
	July	3.88	3.21	3.10	3.16	2.61
	August	3.89	3.21	3.10	3.09	2.39
	September	3.85	3.26	2.65	3.10	2.43
	October	3.43	3.81	2.95	3.20	2.51
	November	3.01	3.18	3.03	3.14	2.36
	December	2.98	3.05	2.99	3.11	2.46
2014	January	3.54	3.09	3.24	3.06	2.58
	February	3.68	3.15	3.22	3.10	2.56
	March	3.64	3.04	3.13	3.01	2.62
	April	3.53	3.16	3.04	3.12	2.34
	May	3.49	3.19	2.44	3.20	1.97
	June	3.60	3.09	2.91	3.07	2.21
	July	3.63	3.08	2.85	3.02	2.40
	August	3.60	3.08	2.95	2.99	2.37
	September	3.63	3.01	3.00	3.08	2.52
	October	3.58	3.18	3.00	3.02	2.47
	November	3.63	3.07	2.90	2.98	2.27
	December	3.48	3.28	2.83	3.07	2.31

Source : IFQ Data
Note: Chained Fisher Price Index of nominal transactions prices deflated by Producer Price Index.

Table 4

Estimated Elasticities for Gulf of Mexico Reef Fish

		Red Snapper	Red & Gag Grouper	Deep Water Grouper	Shallow Water Grouper	Tilefish
Estimated Elasticity with:						
Red Snapper	*estimated elasticity*	-1.208 ***	-1.006	3.513 ***	2.843 ***	-2.967 *
	standard error of estimate	0.575	0.816	1.287	0.863	1.524
Red & Gag Grouper	*estimated elasticity*	1.332 *	1.421	-3.796 *	-1.140	-2.480
	standard error of estimate	0.786	1.313	2.215	1.237	2.135
Deep Water Grouper	*estimated elasticity*	-1.347	-2.996 *	5.168 **	0.790	4.580 *
	standard error of estimate	0.838	1.719	2.363	1.732	2.607
Other Shallow Water Grouper	*estimated elasticity*	5.158 ***	1.741	-0.331	4.281 **	-1.344
	standard error of estimate	1.169	1.932	3.074	1.934	3.321
Tilefish	*estimated elasticity*	0.415	0.184	0.403	-0.171	-0.488
	standard error of estimate	0.381	0.673	0.975	0.655	1.092
Same GoM group not IFQ-regulated	*estimated elasticity*	-0.475	0.083	0.416	-0.465	n.a.
	standard error of estimate	0.786	0.337	0.408	0.345	n.a.
Same species in south Atlantic	*estimated elasticity*	n.a.	-0.550	0.267	n.a.	0.790 ***
	standard error of estimate	n.a.	0.500	0.886	n.a.	0.243
Similar species in south Atlantic	*estimated elasticity*	1.051 ***	0.577 *	-0.760 **	-0.472	n.a.
	standard error of estimate	0.420	0.302	0.370	0.308	n.a.

Source: IFQ Data

Note: Results from log-linear SUR system with additional species-specific annual quota at beginning of year , annual food expenditure, GoM non-IFQ-Regulated similar species (if aplicable), South Atlantic same species group (if applicable) and South Atlantic similar species (if applicable). "n.a." means not applicable. Regression system also includes aggregate supply equation with Quota Allocation prices and production input prices.

* Significant at 90% Confidence Level ** Significant at 95% Confidence Level *** Significant at 99% Confidence Level

Table 5

Estimated Elasticities for Quota Allocation for Gulf of Mexico Reef Fish

	Red Snapper	Red & Gag Grouper	Deep Water Grouper	Shallow Water Grouper	Tilefish
Estimated Elasticity with:					
Red Snapper	0.667	1.916 *	3.572 **	0.393	0.853
	1.332	1.158	1.641	1.227	2.109
Red & Gag Grouper	-0.956	-1.429 **	-1.111	-0.582	-1.657
	0.783	0.682	0.971	0.703	1.152
Deep Water Grouper	0.382	-0.493	0.205	0.003	0.030
	0.859	0.728	1.028	0.774	1.271
Other Shallow Water	0.233	-0.646 **	-0.572	-0.721 **	-0.734
Grouper	0.356	0.293	0.405	0.302	0.500
Tilefish	0.505	0.388	0.003	0.162	0.042
	0.605	0.521	0.734	0.549	0.908

Source: IFQ Data

Note: Results from log-linear SUR system with additional species-specific variable (annual quota at beginning of year) and aggregate supply equation with Quota Allocation prices and production input prices.

* Significant at 90% Confidence Level

** Significant at 95% Confidence Level

*** Significant at 99* Confidence Level

Table 6

Concentration for Gulf of Mexico IFQ-Regulated Reef Fish Landings (pounds)

	2007	2008	2009	2010	2011	2012	2013	2014
Red Snapper								
HHI	224	254	281	239	293	346	361	348
Largest	7.0%	8.2%	7.7%	6.5%	10.4%	10.8%	12.0%	10.4%
C3	16.5%	17.7%	20.2%	16.8%	21.6%	25.4%	25.7%	25.3%
C5	22.4%	24.4%	28.1%	25.2%	28.5%	32.5%	32.6%	32.7%
Red and Gag Grouper								
HHI				301	422	313	285	285
Largest				11.4%	14.1%	13.5%	11.8%	12.0%
C3				21.9%	22.5%	21.1%	19.6%	18.9%
C5				28.7%	29.2%	25.9%	24.3%	23.8%
Deep Water Grouper								
HHI				473	501	405	701	906
Largest				10.1%	11.4%	8.2%	19.3%	21.5%
C3				26.6%	25.2%	22.6%	36.0%	43.1%
C5				38.5%	37.2%	34.1%	47.5%	58.2%
Other Shallow Water Grouper								
HHI				258	278	193	206	227
Largest				7.9%	8.7%	5.0%	5.8%	6.2%
C3				17.6%	20.0%	14.3%	15.6%	16.0%
C5				25.5%	27.1%	20.2%	21.5%	22.4%
Tilefish								
HHI				1,055	933	759	1,287	1,814
Largest				19.7%	14.9%	13.7%	23.0%	33.0%
C3				49.7%	39.4%	34.3%	55.2%	64.2%
C5				64.5%	59.2%	51.3%	71.3%	81.9%
All Reef Fish (Revenue Concentration)								
HHI				179	231	189	270	265
Largest				5.3%	8.4%	6.7%	9.0%	8.9%
C3				11.8%	16.5%	14.1%	21.2%	19.5%
C5				17.5%	22.4%	19.1%	27.5%	26.9%

Source: IFQ Data

Table 7

Concentration for Gulf of Mexico Quota Allocation Holdings

	2010	2011	2012	2013	2014
Red Snapper					
HHI January (Quota Share)	233	247	242	242	269
HHI April	353	447	408	383	440
HHI July	654	417	284	344	407
HHI October	401	442	334	212	432
Red and Gag Grouper					
HHI January (Quota Share)	158	230	249	207	204
HHI April	213	326	296	301	241
HHI July	310	208	256	258	258
HHI October	263	240	280	322	312
Deep Water Grouper					
HHI January (Quota Share)	399	418	446	538	559
HHI April	761	707	473	763	1,350
HHI July	2,319	733	574	700	1,118
HHI October	1,861	808	413	897	864
Other Shallow Water Grouper					
HHI January (Quota Share)	184	216	187	191	162
HHI April	458	607	258	300	314
HHI July	896	548	377	303	373
HHI October	802	780	417	364	349
Tilefish					
HHI January (Quota Share)	519	457	501	613	878
HHI April	1,387	1,270	1,323	1,332	1,914
HHI July	1,679	1,224	1,364	1,134	1,697
HHI October	1,395	1,095	1,429	1,976	2,292
IFQ-Regulated GoM Reef Fish					
HHI January (Quota Share)	123	145	155	145	152
HHI April	174	212	194	203	221
HHI July	268	193	172	195	206
HHI October	222	194	179	190	237

Source: IFQ Data

Table 8

Results of Cost Regression Analysis

Variable	Parameter	Estimated Value	z value
Cost (dependent var.)			
Output	By	0.0015 *	1.90
1/2 * Output - squared	Byy	0.1742 ***	66.11
Fuel Price	Bf	1.1382 ***	576.2
Bait Price	Bb	-0.0563 ***	-46.76
Labor Price	Bl	-0.0819 ***	-60.31
Output * Fuel Price	Byf	-0.0791 ***	-14.42
Output * Bait Price	Byb	0.1201 ***	35.8
Output * Labor Price	Byl	-0.0410 ***	-10.18
1/2 * Fuel Price - squared	Bff	-0.7039 ***	-7.68
1/2 * Bait Price - squared	Bbb	0.0561 ***	8.12
1/2 * Labor Price - squared	Bll	0.1046 ***	16.28
Fuel Price * Bait Price	Bfb	0.0539 ***	3.67
Fuel Price * Labor Price	Bfl	0.0100	0.77
Bait Price * Labor Price	Bbl	-0.0639 ***	-12.62
Constant	A	4.1845 ***	148.07

Ancillary Share Equations not shown.
Fixed effects by vessel not shown.
Sample units are trips.
Cost, output, fuel price, bait price and labor price are logged values.
Output is chain weighted Fisher price index of outputs (quality-adjusted per real price)
Fuel price includes per trip expenditures on fuel.
Bait price includes per trip expenditures on bait and ice.
Labor price includes per trip expenditures on labor.

Table 9

Gulf of Mexico Costs, Scale Economies, and Prices

Value to estimate	**Formula**	**Estimated Parameter**	**Data**	**Result**	
SCE = (MC / AC)	Sum of By and:	0.0015		0.0015	
	Byy * log(average output)	0.1742	2077.3728	1.3306	
	Byf * log(average fuel price)	-0.0791	2.8413	-0.0826	
	Byb * log(average bait price)	0.1201	0.2078	-0.1888	
	Byl * log(average labor price)	-0.0410	192.0896	-0.2157	
				0.8449	"SCE"
When SCE = 1, output is at:	Sum of By and:	0.0015		0.0015	
	Byf*log(average fuel price)	-0.0791	2.8413	-0.0826	
	Byb * log(average bait price)	0.1201	0.2078	-0.1888	
	Byl * log(average labor price)	-0.0410	192.0896	-0.2157	
				-0.4857	("sum")
		Previous Result	**Data**	**Result**	
Minimum efficient scale	exp(1 - "sum" / Byy)	-0.4857	0.1742	**5059.3**	
		Data	**Data**	**Result**	
Average Cost (AC)	Average(cost) / Average(output)	3,235.7	2,077.4	1.5576	
Marginal Cost (MC)	SCE * AC	0.8449	1.5576	1.3161	
Revenue minus Allocation Price	Average revenue - allocation price	3.0733	1.5140	1.5593	

Sources Table 8, Logbook data, IFQ data

Table 9

Notes for Table 9:

SCE is the ratio of marginal to average cost, which would be one at minimum efficient scale. Differentiation of the estimated cost function provides a formula for this ratio, which is just the estimated coefficient on output (labeled Byy on Table 8) summed with the products of the estimated coefficients for each of the output second-order terms (labeled , Byf, Byb, and Byl on Table 8) with the log of the averages for the corresponding data (output, fuel price, bait price, and labor price, respectively)

Taking the equation described above, setting SCE equal to one, then solving for average output, leads to the formula that average output at minimum efficient scale is the exponentiation of one minus the ratio of a sum (the estimated coefficient on output, By, summed with the products of the estimated coefficients for each of the output-cost terms with the log of the averages for the corresponding data) and the estimated second order output coefficient, Byy. The results are in "quality-adjusted" pounds, which are equal to actual pounds only when the average price of the individual vessel's output is equal to the current average price of all vessels' output, and otherwise adjusted up or down according to the relative prices. Thus, for example, the minimum efficient scale of approximately 5,000 pounds could be met by producing 4,000 pounds of product with an average price 25 percent higher than the average overall output, or would require producing 5,500 pounds of product with an average price about 10 percent lower than the average overall output.