Whatever Happened to the Wreckfish Fishery? An Evaluation of the Oldest Finfish ITQ Program in the United States

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ABSTRACT

The wreckfish individual transferable quota (ITQ) program started in 1992 and is the oldest finfish ITQ program in the United States. Initially, the program appeared to be a success, bringing order to the previous years' derbies. Ex-vessel prices rose, harvest stabilized, and there was an orderly shrinking of the fleet to an economically appropriate size. The subsequent history of the fishery is more complex. ITQ sales dwindled in 1995, then ceased for 13 years. Harvest plummeted to barely a tenth of the eligible quota, and in 2010 the fleet's quota was reduced 88%.

Was the wreckfish ITQ program a failure? We provide the first published analysis of the program in two decades. We examine the decisions of former participants to leave the fishery. We also examine the program's current economic, biological, and regulatory performance compared to the program's original stated goals and the goals associated with ITQs in the literature.

Key words: Catch shares, evaluation, individual transferrable quotas, ITQs, *Polyprion americanus*, SES Framework, Social-Ecological Systems Framework, stock assessment, wreckfish.
JEL Codes: D72, D73, D78, N52, Q22, Q28, Q58.

INTRODUCTION

The wreckfish individual transferable quota (ITQ) program is the oldest finfish ITQ program (and second oldest ITQ program) in the United States. Following the discovery of a virgin biomass of wreckfish (*Polyprion americanus*) off the southeast coasts (primarily adjacent to Georgia and South Carolina), the wreckfish fishery grew very quickly. Fearing a biological collapse, the South Atlantic Fishery Management Council ("the Council") implemented the ITQ program in February 1992. As documented by Gauvin, Ward, and Burgess (1994), the ITQ brought order to the previous years' derbies. Many of the initial shareholders decided not to stay in the fishery and sold their shares, creating an active market for quota. The wreck-

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fish ITQ program initially appeared a success, with ex-vessel prices rising, harvest stabilizing, and the fleet predicted to shrink to an economically appropriate size.

However, this active ITQ market and vibrant fishery did not persist. Quota share sales dwindled in 1994 and 1995, then stopped for 13 years. Simultaneously, the harvest of wreckfish and number of harvesters in the fishery plummeted over the decade following the introduction of the ITQ, to the point that by the 2001 season federal rules on confidentiality prevent the public release of fleet harvest statistics. Harvest levels have risen slightly since then, but an 88% reduction in the total quota in 2010 (precipitated by the implementation of the 2006 Magnuson–Stevens Act) threw the program into chaos and prompted a lawsuit.

Has this ITQ program been a failure? This article constitutes the first published analysis of the program in two decades. In this study, we use selected variables from the Social-Ecological Systems (SES) Framework (Ostrom 2007, 2009; Poteete, Janssen, and Ostrom 2010) to assess the strengths and weaknesses of the wreckfish ITQ program from an institutional perspective. This approach allows us to address not only variables important to the economics literature (e.g., efficiency and effectiveness) but also broader issues (equitability, accountability, overharvesting, social and biological sustainably). Our findings show a management approach with a mix of strengths and weaknesses, but one that is still economically profitable, and that was able to weather a regulatory crisis unintentionally provoked by a revision to federal fisheries law. We also emphasize that ITQs are inseparable parts of larger institutional settings and need to be reviewed in that context.

THEORETICAL BACKGROUND

ITQs and similar property rights-based regimes are well established as a tool for managing fishery catch. Simply put, ITQs divide the total allowable catch (TAC) among harvesters, allowing them to buy and sell the catching right so that the end result is most efficient distribution of the catching right among harvesters. Discussion of ITQs emerged in the 1950s (Gordon 1954; Scott 1955), but it was not until the 1980s and 1990s that ITQs emerged as a viable policy, with New Zealand (Dewees 1989; Annala 1996) and Iceland as early adopters (Palsson and Helgason 1995; Eythórsson 2000). The first two ITQ programs in the US were for Atlantic surfclam and ocean quahog (in 1990) and wreckfish (in 1992) (Brinson and Thunberg 2013). Today, ITQs are found in a diverse range of countries and settings (e.g., Andersen, Anderson, and Frost 2010; Holland 2013; Tveteras, Paredes, and Pena-Torres 2011; Yandle, Hajj, and Raciborski 2011; Hannesson 2013; Little et al. 2011; Caballero-Miguez, Varela-Lafuente, and Garza-Gil 2014). In spite of this, the benefits and drawbacks of ITQs remain hotly debated in the literature.[1] In this context, an assessment of wreckfish (as the second-oldest ITQ program in the United States) is appropriate.

THE SOCIAL-ECOLOGICAL SYSTEMS FRAMEWORK

We turn to Ostrom's (2007, 2009) SES framework to provide a structure for assessing the wreckfish fishery. The SES framework itself is grounded in Ostrom's earlier work on design principles for long-lived institutions and the Institutional Analysis and Design (IAD) frame-

1. See Abayomi and Yandle (2012) for a recent summary of the debate and Arnason (2007) and Pinkerton and Edwards (2009) for representative perspectives.

work. Ostrom is perhaps best known for the eight design principles of the multi-layered IAD framework she and her colleagues outlined in the 1990s (e.g., Crawford and Ostrom 1995; Ostrom, Gardner, and Walker 1994). The SES incorporates Ostrom's IAD framework and streamlines it into a comprehensive set of variables researchers can use to explain relationships between human and ecological systems.

In laying the groundwork for the SES framework, Ostrom (2007, 15176) warned of the dangers of panaceas or "recommendations that a single governance-system blueprint . . . should be applied to all environmental problems." Instead of looking for an over-arching solution, she argued that scholars and practitioners should seek to systematically understand and diagnose each problem they are studying. By using a consistent set of criteria (the SES framework) scholars will be able to "diagnose which deeper-tier variables are relevant to a particular class of problem." (Ostrom 2007, 15177). To do this, "one needs to build upon the work of scholars who have undertaken careful, well-documented and theoretically sound" work (Ostrom 2007, 15181). The SES framework offers a structure in which this work can be undertaken.

Table 1 summarizes the variables included in the SES. The SES envisions that within a particular setting, four subsystems (resource systems, resource units, governance systems, and users) interact and produce various outcomes which themselves continue to influence the subsystems in an ongoing cycle (Ostrom 2009). Thus, the SES framework creates a theoretically grounded comprehensive systems model that incorporates not only socio-demographic variables but also key physical and biological characteristics of the natural environment that have been shown to be vital to understanding how people interact with natural resources (e.g., Holling, Berke, and Folke 1998; Agrawal 2001). These characteristics are described as "first tier" variables (settings, related ecosystems, resource systems, governance systems, users, resource units, interactions, outcomes) illustrated in figure 1; "second tier" variables are contained within each first tier.

As described by Ostrom, the SES framework is "a conceptual map that can be used as the starting point for conducting the study of linked SESs . . . Using such a framework also enables one to organize how these attributes may affect and be affected by the larger socioeconomic, political, and ecological settings in which they are embedded, as well as smaller ones" (Ostrom 2007, 15182). Poteete, Janssen, and Ostrom (2010, 236) elaborate: "A list of variables is not a theory. The intention of developing the SES framework is to help scholars, officials, and citizens understand the potential set of variables and their subvariables that can be important in analyzing diverse theoretical questions related to the governance of resources." The SES framework has been applied to fisheries before, usually focusing on small-scale fisheries (Basurto, Gelcich, and Ostrom 2013; Cinner et al. 2013; Ernst et al. 2013), recreational fisheries (Hunt, Sutton, and Arlinghaus 2013), and coastal/marine ecosystems (Hunt, Sutton, and Arlinghaus 2013; Kittinger et al. 2012; Ferrol-Schulte et al. 2013). To our knowledge, this is the first application of the SES framework to assess a fishery managed through ITQs.

In this study, we are using a small portion of the variables outlined in SES to assess the outcomes of the ITQ-based wreckfish management system. These variables were selected based on the stated goals of the Council through the regulatory process (SAFMC 1992a,b; SAFMC 2011; SAFMC 2014). This analysis is contained in the primary text of article. We also provide a brief descriptions of additional variables in the SES framework and summarize our assessment of the outcomes in Appendix A (table A1). The SES framework is rather unique because it

Table 1. Variables in Ostrom's SES Framework

Social, Economic, and Political Settings (S)	
S1 Economic Development* S2 Demographic Trends S3 Political Stability*	
S4 Government Resource Policies S5 Market Incentives* S6 Media Organization	
Resource System (RS)	Governance System (GS)
RS1 Sector (e.g., water, forest fish)*	GS1 Government organizations*
RS2 Clarity of system boundaries*	GS2 Nongovernment organizations*
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property rights system*
RS5 Productivity of system*	GS5 Operational-choice rules*
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics	GS7 Constitutional-choice rules
RS8 Storage characteristics	GS8 Monitoring and Sanctioning
RS9 Location*	
Resource Units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of relevant users*
RU2 Growth or replacement rate*	U2 Socioeconomic attributes of users
RU3 Interactions among resource units	U3 History of use*
RU4 Economic value*	U4 Location
RU5 Number of Units*	U5 Leadership/entrepreneurship*
RU6 Distinctive characteristics*	U6 Norms/social capital
RU7 Spatial and temporal distribution*	U7 Knowledge of SES/mental models
	U8 Importance of resource*
	U9 Technologies available*
Interactions (I) → Outcomes (O)	
I1 Harvesting	O1 Social performance measures (e.g., equity, accountability, sustainability)*
I2 Information sharing	O2 Ecological performance measures (e.g., over-harvesting, resilience, biodiversity, sustainability)*
I3 Deliberation process	
I4 Conflicts among users	
I5 Investment activities	
I6 Lobbying activities	O3 Externalities to other SES*
I7 Self-organizing activities	
I8 Networking activities	
Related Ecosystems(ECO)	
ECO1 Climate patterns* ECO2 Pollution patterns ECO 3 Flows into and out of focal SES*	

* Variables documented in this study.
Adapted from Ostrom (2009).

provides a context in which to understand our findings and grounds them in a larger literature accessible to economists, other social scientists, and natural scientists. However, our primary focus is on an assessment of outcomes as presented in the main text, rather than a comprehensive analysis of the entire SES.

METHODS

This study is best characterized as a case study relying on a small number of observation—a "Small N Case Study." A case study is a:

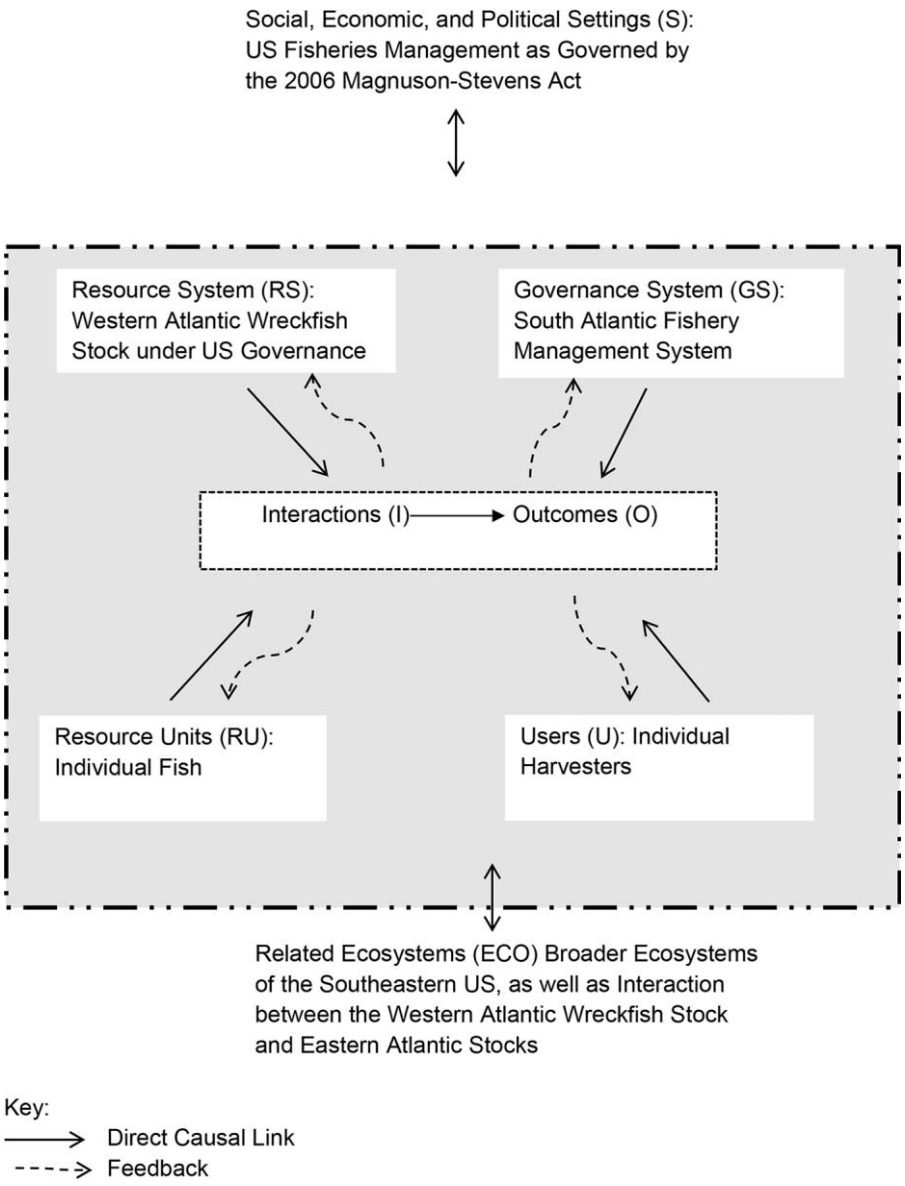

Figure 1. Visualization of First Tier SES Variables as Applied to the Wreckfish Fishery
Source: Ostrom (2007).

. . . research strategy of focusing intensively on individual cases to draw insights about the causal relationships in a broader population of cases. . . . The case study is especially appealing in the effort to make sense of complex processes. It is the only option for empirical field based research in which cross-case data are not readily available. Key disadvantages relate to limited external validity, problems on indeterminacy, and the difficulty of replication (Poteete, Janssen, and Ostrom 2010, 33).

Within natural resource economics, there is a paucity of Small N Case studies, perhaps because so much research focuses on modeling and larger datasets. However, case studies are an important tool, as they provide an opportunity to understand context and details. Case studies can also form the building blocks for later meta-analysis efforts, particularly if they utilize a common set of variables and theoretical underpinning, such as that provided in the SES Framework (see above). In this analysis, we focus on analyzing a selection of the "Outcome" variables in the SES Framework (Social and Biological Sustainability, Effective Rules, Efficiency, Equitability, and Accountability). However, a set of other variables associated with the SES Framework are briefly described in Appendix A. Below, we briefly describe the data sources used in this study.

In our earlier investigation of the Florida golden crab fishery (Crosson, Yandle, and Stoffle 2013), we confronted issues similar to those in the wreckfish fishery: what is the best methodology for gathering and presenting information about small-scale fisheries? In analyzing these data, we cannot use standard techniques used in large N analysis and modeling, such as calculated measures of confidence. Indeed, we found that analyzing and presenting data on the wreckfish fishery presents somewhat unique challenges in comparison to most commercial fisheries. Because the number of participants is quite low (five participants owning the seven permits at the time of analysis), we needed to be careful to preserve the confidentiality of social and economic data. Furthermore, the small size of the fishery renders even descriptive statistics of economic or demographic data meaningless—common variables, such as median income or education, could not be used for so few individuals. Therefore, we collected data from multiple sources and cross-checked them to verify accuracy (Poteete, Janssen, and Ostrom 2010). These data sources are described below, and methods are summarized in table 2. Broadly, they fall into five categories: primary documents, academic literature, surveys, interviews, and participant observation.[2] Additional details about surveys and their analysis is presented in Appendix B.

In analyzing these data and developing this history, we are guided by Robert Putnam: "No single source of data is flawless, but the more numerous and diverse the sources, the less likely that they could all be influenced by the same flaw" (Putnam 2000, 415). Thus we practice triangulation, in which combinations of multiple source are used to reconstruct and confirm information presented (Yin 2008). Triangulation is particularly important when there is concern that some sources of information should, perhaps, not be taken at face value but instead may be driven more by hidden motivation. By confirming findings across multiple independent sources, we gain confidence in our findings.

HISTORY OF THE SOUTH ATLANTIC WRECKFISH FISHERY

Wreckfish are found throughout much of the world, but the species moves from a pelagic to demersal habitat as it matures, and also appears to migrate around the North Atlantic Ocean in a slow clockwise pattern such that different age groups are not commonly encountered with one another in the same spot (Ball et al. 2000). Wreckfish found off the southeastern US coast are mostly large, mature fish that may have migrated from the mid-Atlantic ridge or

2. We use participant observation as one of many data sources because "more subtle perceptions and behaviors can be observed over time to gain a deeper understanding of their meaning" (Donahue and O'Leary 2012, 399).

Table 2. Summary of Data Sources

Data Source	Description	Application
Primary Documents		
SAFMC Primary Documents	Fishery management plans, meeting minutes, and associated Council documents on wreckfish 1992–2012; minutes from Wreckfish Advisory Panel meetings, 1992–2012.	Documentation on history of fishery and reasons for seeking catch share program, perspectives on the wreckfish ITQ and fishery at different historical points.
Local Newspapers	Newspaper articles from regional newspapers related to wreckfish. All NC, SC, GA, and FL newspapers in the Lexis-Nexis database were searched for the terms "wreckfish" and "*Polyprion americanus*" (January 1985 through January 2014).	Documentation of the public awareness (or lack of awareness) of the policy debates surrounding the fishery as it unfolded.
Academic Literature		
Existing Literature	Review of existing peer-reviewed, technical, and unpublished literature on wreckfish with an emphasis on the American stock and fishery.	Documentation of biology, ecology, history, economics, and politics of fishery; establishing the degree to which the fishery is studied in the literature.
Surveys		
Economic Survey	Economic survey of active harvesters. Survey was as mailed in the summer of 2013. See Appendix B for details.	Current fishery economic performance data.
Exiter Survey	Mail survey of harvesters who were distributed ITQ rights, but have since left the fishery. See Appendix B for details.	Harvester perceptions on reasons for leaving the fishery, information on careers post-wreckfish fishing.
Interviews		
Unsolicited Interviews	While the exiter survey was anonymous, a few exiters returned surveys with unsolicited contact information and offers to discuss the fishery history further. They were contacted for follow-up interviews.	Fisher perspective on origins and history of the fishery and reasons for seeking catch share program.
Participant Observation		
	Coauthor Tracy Yandle has observed regulatory activities in the wreckfish fishery since 2011 as a member of the SAFMC Scientific and Statistical Committee.	Observation and review of wreckfish management program.
	Coauthor Scott Crosson has observed regulatory activities in the wreckfish fishery since 2008 as a member of the SAFMC Scientific and Statistical Committee and a NOAA economist.	Observation and review of wreckfish management program.

areas further east (Sedberry et al. 1996, 1999). As documented by Gauvin, Ward, and Burgess (1994), and confirmed in interviews with fishery exiters, this North American wreckfish stock was discovered accidentally in the mid-1980s by swordfish fishermen seeking lost longline gear off the Charleston Bump, a geographic feature 100 miles off the southeast coast. The fish are caught at depths of 1,500–2,000 feet, mostly on underwater ridge systems (Sedberry et al. 1999). Throughout its history, this fishery has remained relatively shielded from the general public's interest. A search of regional newspaper articles since the 1980s showed that articles were either routine notices of seats available on the SAFMC advisory panel (e.g., *Daily News* 2012), or occasionally mentions of wreckfish in restaurant reviews (e.g., Balmaseda 2011; Winner 2010).

After its initial discovery, the fish flooded into the general reef fish seafood markets, but the harvested wreckfish were considerably larger (~30 lbs.) than local grouper species and trips were correspondingly lucrative. Initial harvesters were a mix of boats that had long histories working deepwater fisheries, and shrimpers who saw an opportunity to diversify their catch by making a relatively inexpensive temporary conversion to deepwater longline equipment (Vaughan et al. 1993; Richardson 1994; exiter interviews).

Harvest exploded from 30,000 lbs. in 1987 to four million pounds in 1990. Fearing a biological collapse, the Council issued a permit system in 1990 and placed a new two million pound TAC limit on the fleet, which subsequently caught it within four months of its implementation (Gauvin, Ward, and Burgess 1994). This was followed by trip and gear restrictions in 1991, the most important of which was banning bottom longlining (which was a key gear for the shrimper conversion vessels) (SAFMC 1992a). At the same time, prices declined for both wreckfish and market-competing groupers (SAFMC 1992b). The combination of these events led to a decline in fishery participation even before the introduction of ITQs (Richardson 1994).

In February 1992, the Council implemented the ITQ program, at which point 49 shareholders qualified for quota share percentages of the existing TAC.[3] Contrary to the Council's expectations, however, the fleet's harvest dropped substantially in the first year of the ITQ program, landing only 1.2M of the 2M lb. TAC. This sudden drop in harvest led to significant concern on the part of the Council and a search for the reasons behind this change in harvest (SAFMC 1994a).

One obvious answer was that the stock had crashed, but Gauvin, Ward, and Burgess (1994) offered several alternative explanations for a declining resource base: fishermen were still adjusting to the ITQ, some found better opportunities in the shrimping fishery, the ITQ market for sales and leases was not yet well established, and fishermen may have raced to other regional fisheries to establish catch histories before those also converted to ITQs (although none subsequently did). Gauvin, Ward, and Burgess (1994) noted that ex-vessel prices had recovered compared to the compressed previous season and that fishermen seemed to be more vested in the fishery, as was intended by the original program goals (SAFMC 1992b).

3. These shareholders demonstrated at least 5,000 lbs. of wreckfish landings in either 1989 or 1990, and received quota shares based equally on landings (50% of the allocation was in proportion to each recipient's shares of landings from 1987–1990) and an equal split of shares (50% of the allocation was equally distributed to all who qualified for the program). No shareholder was allowed to receive more than 10% of the initial allocation (SAFMC 1992b).

Richardson's (1994) initial evaluations of the ITQ program also suggested a shrinking but economically strong fishery. Not including opportunity costs for the vessel captains and deck hands, he reported a net return of approximately $354,000 on $1.95M in wreckfish sales, or 18%. He noted a 20% increase in the price of quota shares from the first to the second season under ITQ management and a decline in the price of leased quota over the course of the first season, which he attributed to a preference for the purchase of permanent shares as the market for wreckfish quota grew more active. Both Gauvin, Ward, and Burgess (1994) and Richardson (1994) predicted increased stability in the fishery as fishermen adjusted to the then-new program.

These optimistic predictions did not prove to be the case, and catch levels continued to drop. Wreckfish fishermen offered a number of explanations to the Council throughout the remainder of the decade: the stock was no longer virgin and hence harder to catch (SAFMC 1994b, 13); shareholders were waiting for share prices to go back up before selling or leasing (SAFMC 1993, 33; SAFMC 1994a, 14; SAFMC 1994b); other fisheries had become more lucrative (SAFMC 1995, 7); fishermen were trying to develop catch histories in other fisheries in anticipation of more ITQs (SAFMC 1995, 7); and the wreckfish were less prevalent than in the past (SAFMC 1998, 9).

Throughout this time, the Council continued to monitor the fishery and review new analysis on why shareholders were not utilizing their ITQs as predicted. One working paper noted that leasing prices for quota had dropped so low that the fishery was practically returning to open-access status, and that harvest remained depressed far below the TAC. However, the analysis also explained that some wreckfish quota owners were not selling because the quota retained more value as "insurance" against potential closures in other, more lucrative fisheries and that the wreckfish stock was not actually depleted (Brod and Shobe 1996). Two years later, Council staff calculated three alternate measurements of Catch per Unit of Effort (CPUE), which is often an indirect measure of fisheries abundance (e.g., Hilborn and Walters 1992; Walters and Maguire 1996; Richards and Schnute 1986), and found no evidence that the wreckfish fishery was depleted. Instead, they concluded that wreckfish-permitted vessels were choosing to participate in snapper-grouper and pelagic fisheries (Brainerd and Jepson 1998), an argument later supported in an unpublished paper by Gloeckner (2005). Thus, by the late 1990s, the wreckfish fishery was perceived by the Council as a biologically stable fishery that was gradually losing participants to other, more lucrative or less demanding fisheries.

By the turn of the 21st century, the fishery had shrunk still further, although the fleet TAC remained at two million pounds and there were no changes in the ITQ program. Fewer than three permit holders made wreckfish landings between the 2001/2002 and 2008/2009 fishing seasons under the ITQ program. Those years of landings are legally confidential, which contributed to a gap in the social science and biological literature on the fishery over the last decade.

The first significant changes in the wreckfish ITQ program occurred with the passage of Amendment 20A to the Snapper-Grouper Fishery Management Plan (FMP) at the end of 2011. These changes were precipitated by changes in 2006 in US fisheries law requiring fishery management councils to set per-species catch levels that do not exceed the recommendations of their scientific and statistical committees (SSCs) (Crosson 2013; Methot et al. 2014). Noting the lack of a peer-reviewed stock assessment of the wreckfish population, the SAFMC's SSC made a binding recommendation that the fleet quota be lowered from the longstanding two

million pound total catch to a number approximating the fleet's actual catch in recent years (235,000 lbs.). This 88% reduction was distributed equally among the remaining shareholders, meaning that the few active members of the fleet were no longer able to sustain their recent catches without buying up the unused quota shares. Via Amendment 20A, the Council drastically reduced the wreckfish TAC and allocated 5% of it to recreational anglers. To restore function in the ITQ program, the Council also reorganized the ITQ allocations of existing shareholders by reallocating unused quota shares from inactive to active commercial wreckfish shareholders and implementing a new 49% cap on individual ownership of the overall quota. According to the Council, these actions were "necessary to achieve the optimum yield from the commercial wreckfish sector . . . which results in a more efficient use of the species" (SAFMC 2011, 3).

ASSESSMENT OF THE WRECKFISH ITQ PROGRAM USING CRITERIA FROM THE SES FRAMEWORK

The wreckfish fishery has shrunk dramatically since the inception of the ITQ program, and the fleet's total quota is also a fraction of that originally set by the Council. Is this ITQ a failure? We use the "Outcomes" criteria of the SES framework (outlined above) to assess the strengths and weaknesses of this management approach. Specifically, we focus on: Social and Biological Sustainability, Efficiency, Equitability, and Accountability as five important measures of outcomes outlined in the SES framework.

SOCIAL SUSTAINABILITY

In this analysis, we use social sustainability to refer to the degree to which an institutional arrangement (the wreckfish ITQ system) is positioned to survive in the long term. A superficial analysis of the fishery suggests reasons for serious concern about social sustainability. Since the introduction of the ITQ system, the number of fishery participants has dropped precipitously, suggesting an institutional arrangement under severe stress. However, earlier analysis (notably Gauvin, Ward, and Burgess' 1994) suggested that harvesters were shifting out of the wreckfish fishery and back to more profitable alternatives.

To better understand the reasons so many harvesters exited the wreckfish fishery, we conducted a survey of harvesters who received allocation of ITQs, but were no longer participating in the fishery (see Appendix B). Analysis of our survey of wreckfish fishery exiters (table 3) provides support for Gauvin, Ward, and Burgess' (1994) suggestion that some were leaving wreckfish for other species (such as shrimping), particularly after the bottom longline ban went into effect. Our results also highlight factors such as mismatches between ITQ allocation and needs (which could also support Gauvin, Ward, and Burgess hypothesis of ITQ market growing pains) and a suite of issues (such as health, safety, family, and age), which could be described collectively as harvesters "aging out" of a deepwater and relatively dangerous and time-consuming fishery. Subsequent interviews with some wreckfish fishery exiters confirmed that some were indeed shrimpers returning to their original fishery due to a combination of these factors. Finally, the number of harvesters in the fishery has stabilized in the past decade.

Overall, these results do not support the suggestion of a fishery in social decline or crisis, rather one that was in the process of transitioning from a virgin biomass fishery to a mature

Table 3. Top 10 Scoring Responses on Why Harvesters Exited the Wreckfish Fishery (0 = "not a factor" 7= "major factor")

Reason	Mean Reported Score
Better alternative opportunities in fishing	4.40
Health—personal health makes it difficult to fish	3.60
Not enough catching rights to continue fishing after allocation cuts	3.25
Policy uncertainty—concern about future regulation	3.00
Age/retirement—decided to retire from fishing	3.00
Family/lifestyle—wanted more time onshore	2.80
Not allocated enough ITQs to cover catch	2.67
Good selling price for ITQs made it attractive to leave fishery	2.60
Safety—general hazards associated with the fishing industry	2.20
Difficulty obtaining enough ITQs to cover catch	1.40

fishery when the ITQ program was introduced. Results of our analysis support the argument that, while there were some harvesters dissatisfied with their allocation, many of those who left the fishery were returning to other fisheries (notably shrimping) or decided to leave the fishery for personal reasons. In both of these cases, the ITQ system provided a mechanism for them to leave the fishery in a more orderly (and potentially profitable) manner.

BIOLOGICAL SUSTAINABILITY

Average wreckfish sizes and catches per trip were remarkably consistent in the late 1990s despite falling landings (Sedberry et al. 1996; Weaver and Sedberry 2001; Vaughan, Manooch, and Potts 2001). Thus, it appeared in the late 1990s that the declining catch in the wreckfish fishery was due to a combination of economic conditions, not a decline in the status of the fish stock itself. We compared CPUE statistics from the year preceding ITQs through the lifespan of the program and see no clear trends that indicated the stock has been overharvested since the implementation of quota shares (figure 2). Changes in the annual average weight of a landed wreckfish in this time period have been practically nonexistent, with a mean of 34.6 lbs. and a standard deviation of just 1.2 lbs.

The wreckfish stock managed by the ITQ program is not isolated to US waters, however (Sedberry et al. 1996, 1999). The extent of its intermixing with juvenile wreckfish from the eastern Atlantic or mature mid-Atlantic oceanic ridge-dwelling wreckfish is still unknown, making a formal stock assessment difficult. NOAA scientists have not assessed the stock status to date, a contributing factor to the drastic reduction in the fleet quota (SAFMC 2011). In November 2012, members of the wreckfish fleet hired a non-NOAA stock assessment scientist to apply a statistical catch-at-age methodology to the available data on wreckfish landings in order to produce a scientifically acceptable basis for increasing the wreckfish TAC. The Council and its SSC then developed a process for peer reviewing this "outside assessment" (Butterworth 2014), resulting in an ongoing Council action to raise the TAC to ~400,000 lbs. (SAFMC 2014).

EFFICIENCY

Efficiency is a term that can have different meanings depending upon the audience. In the context of the SES Framework, efficiency is not well-defined, and we focus on economic

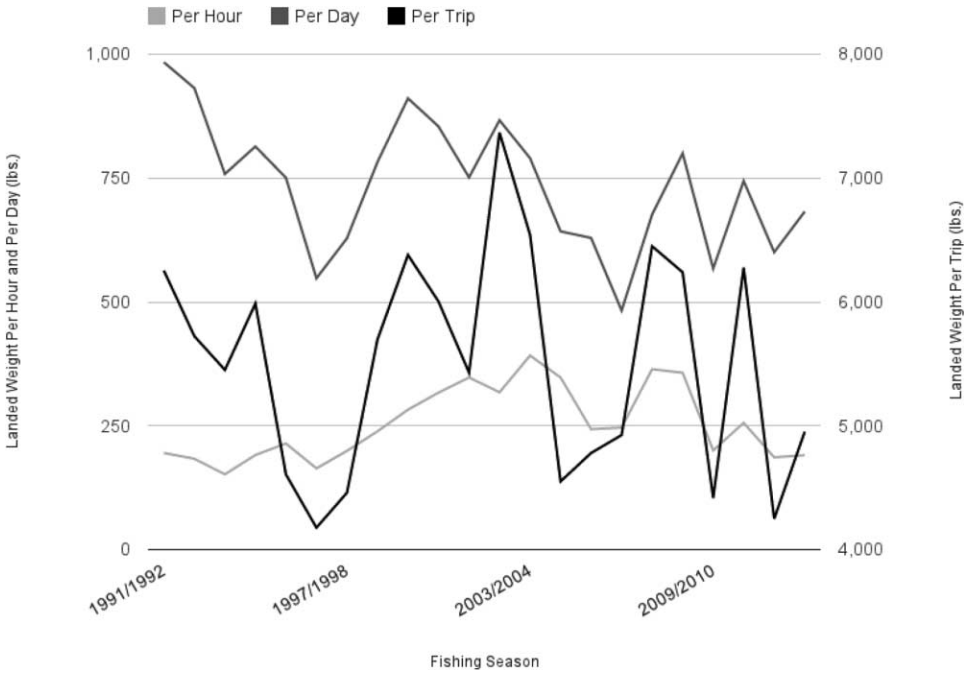

Figure 2. Mean Wreckfish Harvested (lbs.) per hour, per day, and per trip: 1991/1992 to 2012/2013 Seasons

efficiency—the flow of net benefits associated with the resource (Ostrom, Schroeder, and Wynne 1993) and institutional efficiency—how well an institution "gets the job done."

Economic Efficiency

Because of the recent regulatory changes resulting from Amendment 20A and the associated 88% reduction in the fleet quota, the little economic data collected between 1994 and 2011 is of limited use in analyzing current economic conditions (and thus economic efficiency) of the wreckfish fishery. As a result, we undertook an economic survey specifically designed to allow comparability between our results and those of Richardson's (1994) economic survey of the wreckfish fishery. Notably, Richardson's study also focused on a year of regulatory transition for the fishery, the initial year of the ITQ system that now exists. Methodological details of survey development and analysis are available in Appendix B.

Our analysis shows that the current wreckfish ITQ program still maintains an economically healthy fishery (table 4). After updating Richardson's numbers for inflation, the current fishery is smaller (as would be expected), with total landing revenues in the 2012–2013 season less than a quarter (23%) of those in 1992–1993.[4] However, net returns were nearly identical in both years, at 17–18% of landings revenues. The average vessel is more highly valued, but not sufficiently to offset the drop in wreckfish landings, with a return on "hard" assets (vessels and equipment) at 9% in comparison to the earlier 20%. In comparison to other regional

4. Richardson's report was based on the cooperation of 37 vessels, 17 of which provided almost all (99.9%) of the wreckfish landings in the first year of the ITQ.

Table 4. Summary of wreckfish economics for 1992–1993 and 2012–2013 seasons (2012 dollars)

	1992–1993	2012–2013
Active vessels	17	5
Total landing revenue	$3,104,898	$701,005
Total costs	$2,540,966	$581,487
Fleet net revenues (profit)	$563,932	$118,518
Net return	18%	17%
Fleet assets	$2,762,682	$1,375,000
Fleet return on assets	20%	9%
Price/lb.	$2.72	$3.64
Net revenue/lb.	$.49	$.62
Gross value of ITQs	$1,462,800	$236,500
Value of ITQs/lb.	$.81	$1.06
Discount rate	61%	59%

fisheries, this is less than the 21% return of the golden crab fleet (Crosson, Yandle, and Stoffle 2013), but more than the 5% return of the shrimp fleet (Liese 2011), although vessels from those fisheries tend to be more single-purpose than the wreckfish fleet.

After reviewing the price data from quota sales (see below) and multiplying it by the outstanding quota, Richardson estimated the value of outstanding ITQs at $920,000 ($1.5M in 2012 dollars). We found a much lower value, based on the smaller size of the fleet quota and the reduction in sales price of shares in 2012. However, the value of shares per pound has risen 31%. The price of quota should include the present value of future fishery profits (Newell, Sanchirico, and Kerr 2005), so we calculated the discount rates by dividing the mean net revenue per pound with the mean value of permanent shares sold per pound. The rates for both periods are much higher than is typical for an ITQ, particularly a longstanding one, which reflects management uncertainty in both time periods (Asche 2001).

Overall, the fishery is smaller but at a broadly similar level of economic performance compared to its status in 1992. When compared to other fisheries in the region, it provides a reasonably profitable outcome for participants, despite the recent regulatory turmoil. This is even more surprisingly positive considering that in 1992 the fishery was still in the process of transitioning from a virgin biomass stock (typically a highly profitable "gold rush") to a mature fishery (with anticipated returns lower than a relatively new fishery). Thus, from an economic efficiency perspective, the management regime appears to be performing well.

Institutional Efficiency

While institutional efficiency can contribute to economic efficiency, the two do not necessarily go hand-in-hand. Broadly, ITQ-based approaches are usually seen as supporting institutional efficiency. This is because ITQs create a market for catching rights (in the form of both leasing and outright ITQ sales) and thus a smooth, effectual transfer of catching rights among harvesters, ultimately resulting in an economically efficient allocation of the resource among harvesters (Newell, Sanchirico, and Kerr 2005; Squires, Kirkley, and Moodie 1995; Anderson 1991).

However, this is not the case with the wreckfish fishery due to two flaws. The first is the failure of a working ITQ market to ever fully develop, as documented in the historical section above. As a result, the expected transfer of catching rights to the most efficient harvesters may

not have taken place. Instead, as prices were so low, fishermen chose to exit the fishery but retain catching rights as a hedge against future problems in other fisheries (such as snapper-grouper). Interestingly, however, the combination of 2011 cuts in the TAC and the threat of forced reallocation of unused quota revived the ITQ market, as shown below in the "Equity" section.

The second cause for concern about institutional efficiency is the mechanism of the ITQ program itself. As an artifact of being one of the earliest ITQ programs, the wreckfish program still relies on a "coupon" system in which fishermen submit coupons for the pounds of fish that they catch (see figure 3). Unfortunately, these coupons are available in limited denominations of 100 and 500 lbs., so when fishermen submit coupons they may be forced to surrender rights for more pounds of fish than they actually caught. (For example, if a fisherman caught 1,375 lbs. of wreckfish, they would have to surrender 1,400 lbs. of catching rights due to the system's inability to "make change.") This also results in some administrative inefficiency, as catch records come to NOAA as both actual pounds landed and total coupon pounds used.

EQUITY

As efficiency can have different meanings, so can equity (or fairness). Fiscal equivalence refers to "the concept . . . that those who benefit from a service should bear the burden of financing that service" (Ostrom, Schroeder, and Wynne 1993, 114). In contrast, procedural equity focuses on each individual or business being treated evenhandedly under the rules.

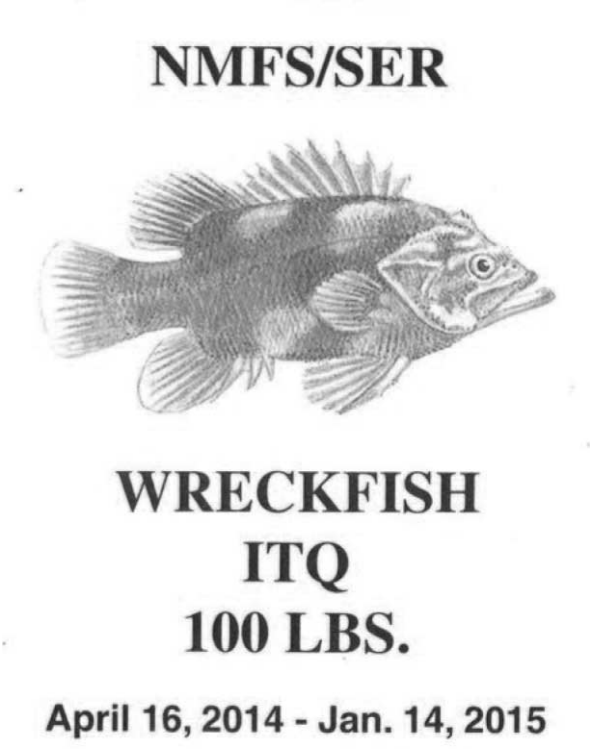

Figure 3. Sample Wreckfish Coupon

"Parties-at-interest must be admitted to the policy process, including both rulemaking and rule adjudication, on the basis of procedures known in advance and applicable to all, and like cases must be treated in a uniform and nondiscriminatory fashion if the concept of procedural equity is to have meaning" (Regens and Rycroft 1986, 423). A third concept is "redistributional equity" which focuses on ensuring that those with the most need receive the most benefit from a public good. Ostrom, Schroeder, and Wynne (1993, 114–115) noted that it can be a particular concern "in developing countries where distributions of wealth are highly skewed" but also can have important implications in ensuring equitable distribution of goods and services. Naturally, there can often be tradeoffs between various forms of equity (e.g., fiscal equivalence versus redistributive equity) and equity versus other evaluation criteria (Ostrom, Schroeder, and Wynne 1993).

Within the literature, the issue of equity in ITQs is hotly debated. ITQs are critiqued on redistributional equity grounds (e.g., McCay et al. 1995; McCay 2004; Pinkerton and Edwards 2009), but receive some praise on procedural equity grounds (e.g., Stewart, Walshe, and Moodie 2006; Dupont and Grafton 2000). Essentially, proponents argue that ITQs provide procedural equity because the approach provides a mechanism for fishermen to exit the fishery with compensation from those who wish to remain and expand their operations. Was this the case in the wreckfish fishery? The answer hangs on both the functionality of the market and the decision in 2011 to reallocate inactive catching rights to active wreckfish fishermen.

Both Gauvin, Ward, and Burgess (1994) and Richardson (1994) noted the presence of a significant number of vessels that normally pursued shrimp in the early, pre-ITQ years of the wreckfish fishery. These vessels found participation economically viable only through the use of bottom longlines and because of the high CPUE provided by the virgin stock. Bottom longlining was banned by the Council in 1991, and at the same time CPUE dropped due to the combination of that ban and the maturation of the fishery (figure 2). Many of these shrimping vessels received shares of the initial quota in the ITQ system, but according to Richardson, two-thirds of the shrimp trawlers who pursued wreckfish in the last year preceding the ITQ made no attempt to catch wreckfish in the first year of the new program, and by the second year only one shrimp trawler was still participating. Many of these shrimpers had caught enough under the allocation rules to quality for some wreckfish quota despite having already left the fishery (SAFMC 1993, 29).

Did ITQs provide a mechanism for these shrimpers to exit the fishery after the bottom longline ban, and was this tool later disabled by the Council's decision to reallocate quota in 2011? What was the impact of this approach from procedural and redistributional equity perspectives? Our review of quota share sales show that in 2012, 58% of the outstanding quota shares were sold or transferred before the Council actions would have reallocated them without reimbursement, and Amendment 20A actually only reallocated a very small remainder (1%). The transfer of quota shares in the fishery occurred in two distinct time periods: from 1992–1998 and again from 2009–2013. Twenty-nine transfers occurred between 1992 and 1998, and nearly all listed plausible prices of between $4,800 and $11,700 per 1% share. Thirty-eight transfers from 2009–2013 were valued between $1,000 and $7,500 per 1% share in anticipation of the SA Council's announced intention to reallocate unused quota as part of Amendment 20A. We surmise that the sharp drop in sales price between the two periods was driven by factors that would have made the latter time period a buyers' market, the

Council's announced intention to revoke and reallocate unused shares, and a drastic reduction in the fleet quota from two million pounds to 235,000 lbs. (plus the first set-aside for a small recreational wreckfish fishery).

This analysis suggests mixed success in procedural equity in the original institutional arrangement. In the early years, there was an active market for ITQs, which suggests that the ITQ market did indeed provide a mechanism for the shrimpers to leave the wreckfish fishery in the wake of the gear rules change (the ban on bottom longlining). However, the subsequent halt in trading of wreckfish catching rights (which only picked up at suppressed prices after the Council's decision to reallocate unused ITQs) suggests that in later years, the ITQ market was not able to perform (from a procedural equity perspective) this vital role of providing a fluid mechanism for fishers to fairly leave, enter, grow, or shrink their role in the fishery. From a redistributional equity perspective, this approach can be considered neutral as initial allocation was based on historical catch, and the market provided a mechanism for fishers to change their role in the fishery as they saw fit.

The Council's 2011 decision to reallocate catching rights from inactive to active shareholders was a significant change in the institutional arrangement, which requires a separate analysis. From a procedural equity perspective, this decision effectively placed the needs of one group of ITQ owners above the needs of another, fundamentally disenfranchising the inactive fishers and forcing them to sell their ITQs at an artificially reduced price—hurting the integrity of the institution from a procedural equity perspective. Conversely, from a redistributional equity perspective, the reallocation decision is positive—allowing unused resources (the catching right) to be allocated to those currently fishing, most of whom needed the shares to continue because of the reduced fleet quota. Indeed, Council documents assessing options for the redistribution of quota show that considerable effort was spent analyzing the relative impacts of various redistribution options (SAFMC 2011; Appendix B).

While ITQs theoretically provide a mechanism for equity (particularly procedural equity) within a fishery, the wreckfish ITQ program provides mixed results on procedural and redistributional equity. Some of these mixed findings are due to some inherent tension between the goals of these two types of equity. Over time, and with the decisions surrounding reallocation, we see a gain in redistribution equity, but it comes at the cost of procedural equity in the institution decreasing, a potentially serious problem, as one of the key characteristics of an ITQ program is the confidence of the resource users in the long-term security of the ITQs. We believe the very high discount rates for quota shares in 2012 reflect this cost—despite the age of the ITQ and the reasonably high net return rates, a permanent share sold for only 71% more than the expected annual profit from its use.

ACCOUNTABILITY

In the context of a natural resource management institution, accountability refers to the degree to which decision-makers are responsible to resource users and resource users are held responsible for their decisions. Accountability is important in this context because "in the absence of accountability, the provision decisions . . . are likely to be made without much regard for the desires of the final users. Furthermore, without accountability, actors can engage successfully in . . . various strategic behaviors" (Ostrom, Schroeder, and Wynne 1993, 115).

Wreckfish is a species regulated by the South Atlantic Fisheries Management Council, and thus governed by the procedures outlined in the Magnuson-Stevens Act. As such, there are

high levels of accountability for decision-makers built into the regulatory process (Crosson 2013; Dell'Apa, Schiavinato, and Ruilfson 2012). Examples include: open meetings with comment periods, a scientific stock assessment review and TAC setting process that is separate from allocation decisions, and participation by wreckfish shareholders on administratively recognized advisory panels. Conversely, wreckfish fishermen are subject to federal fishing regulations, including licensing and reporting requirements, as well as ITQ ownership requirements to participate in the fishery, and compliance requirements associated with management of the ITQ system (SAFMC 2011).

From the resource users' perspective, Gauvin, Ward, and Burgess (1994) argued that wreckfish shareholders would feel increasingly vested in the fishery and would, to some degree, link their own actions to the welfare of the resource. We found several instances of this in Council documentation, with fishermen explaining to the Council that choosing not to fish ITQ shares was both helping the fishery stocks and adding value to their personal shares over the long run (SAFMC 1994a, 13; SAFMC 1994b,1995, 7).

Similarly, the 2011 decision to reduce the TAC by 88% provides an instructive illustration of what happens when the resource users believe decision-makers are not behaving in an appropriately accountable manner. In this case, active wreckfish fishermen filed suit to challenge the TAC reduction. At the same time, they also addressed the primary concern that led to the TAC reduction (scientific uncertainty over stock status) by hiring an independent stock assessment scientist to provide additional data and analysis to the Council and its SSC. At time of writing, this lawsuit was on hold pending the outcome of Council actions based on the results of the external assessment. However, it is already clear that this suit provided a significant degree of external accountability by pushing the Council and the SSC to develop new ways of incorporating scientific assessments conducted outside of the traditional South East Data Analysis and Review (SEDAR) process. This incident illustrates both internal and external accountability measures available to resource users.

Overall, the federal regulatory structure and Council system in which the wreckfish fishery is nested provides strong accountability mechanisms for both decision-makers and harvesters. Furthermore, wreckfish fishermen actions illustrate a willingness to use the courts as an external accountability measures when they believe that Council decision-makers are not acting in the best interest of the fishery. Taken together, these show an institution with high accountability.

CONCLUSIONS

The South Atlantic wreckfish ITQ program is not a failure. Our systematic analysis of the fishery shows, at worst, a mixed outcome. Furthermore, current economic and social data reveal that the fishery is still profitable despite regulatory turmoil that could have caused crippling dysfunction in other fisheries. We attribute this to both the structure of the original ITQ providing a means of orderly transition as fishermen left or increased their investment in the fishery, as well as the Council's willingness to experiment with adjustments to the program through measures, such as Amendment 20A and working with the fishermen to review a stock assessment by an "outside" stock assessment scientist.

Analysis of social sustainability suggests that this is a fishery that has navigated the transition from virgin biomass to mature fishery. Biological sustainability remains uncertain due to a lack of formal NOAA assessment. However, analysis of landings data shows a steady CPUE—suggesting a biologically stable fishery—and a biological assessment of this fishery paid for by

the fishermen has provided credible evidence for increasing the TAC. The fact that a group of fishermen organized themselves to pay for the analysis is also a sign of social sustainability, as it shows that the fishermen themselves are investing in the future of the fishery and the ITQ program. The Council worked with its SSC to develop a way to review this "outside" assessment while maintaining scientific standards, another positive development.

Turning to more focused outcome variables, this study also assessed efficiency, equity, and accountability. Findings on efficiency show that the fishery is smaller than it was in 1992, but showing similar levels of economic efficiency now, indicating economic health. But the same analysis shows potentially serious concerns over institutional efficiency, with the lack of a fully active market for large periods of the fishery's history and the use of a coupon system for catch reporting, reducing efficiency. Regarding equity, results are mixed. The program performed fairly well on procedural equity, with sale of ITQs providing a means for orderly exit from the fishery, when the market was functioning appropriately. However, there was tension between the goals of procedural equity and redistributive equity as illustrated by Amendment 20A, which provided redistributive equity by ensuring quota was allocated among active fishermen. However, this administrative redistribution hurt procedural equity and reduced fishermen's confidence in ITQs as a long-term property right, as shown by the unusually high discount rate in share sales. Finally, the nested systems of the regionally and federally administered Council system (including the requirement of the Council to follow the SSC's advice on TAC setting), combined with the external accountability of the federal courts provides high levels of accountability.

This analysis leads to both policy and theoretically relevant recommendations. First, at the most practical level, a transition to a modern reporting system without physical coupons would undoubtedly increase the efficiency of the ITQ system. Secondly, ongoing efforts to responsibly incorporate outside scientific assessment of the wreckfish stock opens opportunities to expand and rethink how the production and application of scientific information relates to the management process. More broadly, this case serves as a reminder of the tension between procedural and redistributional equity, and the potential long-term consequences of redistributing what fishermen eventually come to see as their property rights. This is as issue that Councils very reasonably struggle with, and that are at the heart of many Councils' intensive political and policy debates. Application of the SES framework offered practical policy implications by bringing to the forefront the importance of these (often conflicting) equity priorities and the need for Councils to explicitly address these competing objectives when making redistributional decisions.

From a theoretical perspective, these findings are complex. It is tempting to envision ITQs as an intervention independent of the existing political and management context. However, as this case illustrates, it is important to understand that ITQs are embedded in their institutional setting. The application of ITQs as a policy tool cannot be artificially separated from the historical, ongoing political and management context. Decisions such as aggregation limits; lease/sale rules; and limits on ownership, such as the 20A Amendment, have a profound effect on how the ITQ regime functions and are inextricably linked to the institutional context. This case illustrates the importance of using a theoretically grounded set of criteria (such as the SES framework) that evaluate the full range of a program's responsibilities and the social and ecological context in which it is embedded when evaluating the institutional arrangement's success or failure to meet management objectives.

APPENDIX A. SUMMARY OF RELEVANT SES VARIABLES

Table A1. Summary of Relevant SES Variables

Variable	Description
Social, Economic, and Political Setting (S)	
S1 Economic Development	Highly developed.
S3 Political Stability	Highly stable.
S5 Market Incentives	Strongly responsive to market incentives.
Resource System (RS)	
RS1 Sector	Fish.
RS2 Clarity of System Boundaries	Administrative boundaries very clear, but do not correspond to broader species range.
RS3 Size of Resource System	Very large.
RS5 Productivity of System	Deepwater long-lived species, with low productivity.
RS9 Location	Species ranges across Atlantic Ocean, regulated area is US federal waters.
Resource Unit (RU)	
RU1 Resource Unit Mobility	Highly mobile, stock is believed to range from mid-Atlantic Ridge (or further east) to Charleston Bump.
RU2 Growth or Replacement Rate	Slow-growing, long-lived species.
RU4 Economic Value	Total landed revenue 2012–2013 season: $701,005.
RU5 Size	Up to 7 ft. and 100 lbs. (2.1m, 45 kg) (Robins, Ray, and Douglass 1986).
RU6 Distinctive Markings	Adults uniformly dark brown, dorsal fin notched, rough head with ridge and protruding lower jaw (Robins, Ray, and Douglas 1986).
RU7 Spatial & Temporal Distribution	Stock is believed to range from mid-Atlantic Ridge (or further east) to Charleston Bump.
Governance System (GS)	
GS1 Government Organizations	South Atlantic Fisheries Management Council (SAFMC) and National Marine Fisheries Service (NMFS).
GS2 Non-Governmental Organizations	No formal organization, but a group of shareholders organized to both sue SAFMC and underwrite cost of new stock assessment.
GS4 Property Rights System	Catch shares.
GS5 Operational Rules	Catch shares, variety of gear, and season limits.
GS6 Collective Choice Rules	Wreckfish Advisory Panel (now integrated with the Snapper Grouper Advisory Panel).
Users (U)	
U1 Number of Users	6 shareholders, 5 active vessels.
U3 History of Use	First commercially fished in 1980s, transitioned from virgin biomass to mature fishery.
U5 Leadership/Entrepreneurship	Shareholders highly entrepreneurial, no single identified leader.
U8 Dependency on Resource	Varies by shareholder.
U9 Technology Used	Hook and line.
Interactions (I)	
I5 Investment Activities	Willingness to invest as illustrated by SAFMC lawsuit and investment in stock assessment.
Outcomes (O)	
O1 Social Performance	Mixed/high.
O2 Ecological Performance	Not formally assessed, believed to be strong.
O3 Externalities to other SESs	None known.
Related Ecosystems (ECO)	
ECO1 Climate Patterns	It is unknown how climate change has or will influence this species.
ECO3 Flows in and out of Focal SES	It is believed but not proven that fish in this this focal area mix with juvenile wreckfish from the eastern Atlantic or mature mid-Atlantic oceanic ridge-dwelling wreckfish.

APPENDIX B. STUDY METHODS

SURVEY OF WRECKFISH EXITERS

A list of all wreckfish permit holders who were issued catch shares at time of initial allocation but were not permit holders (from this point "exiters") in 2013 was obtained from the National Marine Fisheries Service (NMFS). This list contained 49 exiter names and addresses. However, since this list dated to 1992, at the time of this analysis the address list was 21 years old. Thus, considerable effort was needed to create a current working address list for the survey. A comparison of this raw list of exiters against 2013 permit holders removed two exiters from the survey pool, as they were still active in the fishery. Next, we used PeopleSmart—a person tracing service to verify addresses and determine whether people on the exiters' lists were deceased. PeopleSmart works by aggregating personal data from public records and social networks (PeopleSmart 2014). Because PeopleSmart is a proprietary web service, they do not disclose exactly what public and social media sources of information they use. PeopleSmart also offers an opt-out policy for individuals who submit a request. However, since PeopleSmart is an obscure service, it is reasonable to believe that not enough people opted out of PeopleSmart searches to affect our results. We submitted each name and address as provided by NMFS to PeopleSmart and were able to either verify that the address was still correct, or trace forward from that original address to a current address. PeopleSmart also provided information from death records to accurately identify who was deceased.

From PeopleSmart searches, we determined that 13 potential respondents were documented deceased, giving the survey pool a rate of 26.53% verified deceased.[5] We then used PeopleSmart to obtain the most recent mailing address for the remaining exiters. This left us with 33 exiters with PeopleSmart verified addresses.

Mail surveys were sent to these exiters. Five were returned by the US Postal Service (USPS) for incorrect or insufficient addresses, giving us 28 good addresses (PeopleSmart verified USPS returned addresses). Ten surveys were returned; however, one self-identified as a current wreckfish permit holder, giving us nine usable responses. This is an extremely low number of responses; however, it is an effective response rate of 34.62%. This relatively high response rate, coupled with a low number of actual responses, led us to interpret survey results very cautiously. They are presented in this study formally only in table 3 and its analysis, and otherwise results were only used for triangulation.

The survey itself asked three broad types of questions: identification (type of involvement in wreckfish fishery, status now they have left fishery, fishing history); status of catching right ownership (including amounts sold and dates); reasons for leaving wreckfish fishery (modeled on Stewart, Walshe, and Moodie 2006). A copy of the survey is available upon request.

5. Another two names were marked by PeopleSmart as deceased but not with perfectly traceable address matches, so are not included in this total. These are marked "probable deceased" in table B1, and if added would give a deceased rate of nearly 30%.

Table B1. Summary Information for Fishery Exiters' Survey

Raw Data for Determining Response Rate	
# initial addresses	49
# determined current permit holder post survey	2
# documented deceased	13
# probable deceased	2
# PeopleSmart verified addresses	33
# surveys sent out	33
# surveys bad addresses	5
# good addresses (USPS verified–bad addresses)	28
# surveys received back	10
# usable surveys	9
Deceased Rate	
% verified deceased	26.53%
% probable deceased	4.08%
Response Rate	
Response rate—raw	18.37%
Response rate—People Smart verified	27.27%
Response rate—good addresses	32.14%
Response rate—good addresses, usable surveys (current permit holder removed from both good addresses and usable surveys)	34.62%

ECONOMIC SURVEY OF WRECKFISH FISHERMEN

When designing the economic survey instrument, we sought to ensure comparability to the questions asked by Richardson (1994), the only existing estimates of fleet production that included the cost information necessary to estimate fleet profitability. Data was requested for 2012 and collected via a four-page survey form in the summer of 2013 and mailed to the owners of the five active vessels. Three completed the form. Of the two non-responses, one completed a similar form in 2010 for the same vessel's activity in the snapper-grouper fishery, so that data was substituted. Data for the other missing vessel was imputed, using data from a similar wreckfish boat working from the same area. Wreckfish-related fixed costs for each vessel are multiplied by the percentage of boat revenues accounted for by wreckfish. Because the fleet is so small, largely summary information is provided. Landings information is from the logbook data set. Price data was derived from the wreckfish dealer reports and broken down by vessel and area to give a more accurate base for evaluating each boat's profits. Quota share sale prices are from the Southeast Regional Office.

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