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Cover Page Footnote

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DATA NOTES

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ABSTRACT

In 2018, over a period of five months, researchers from the United States National Oceanographic and Atmospheric Administration's Southeast Fisheries Science Center conducted a study with fishers and local business owners on the South Florida yellowtail snapper fishery. We asked fishers about changes in their targeting strategies over the last several decades—they perceive changes in their targeting to have altered the health and the biology of the yellowtail snapper species, including improving both the overall abundance of yellowtail and having sped up its the growth and reproductive cycles

BACKGROUND

Positive relationships between humans and natural resources are documented by studies of where traditional ecological knowledge (TEK) and sustainable use practices have been developed by a people over time (Drew 2005; Stoffle et al. 2018). Traditional ecological knowledge has been shown to be an important component of managing natural resources so they can be both sustainable and increase in productivity (Trusler 2002). People continually learn from and adapt to their environment over long periods (Stoffle and Arnold 2003).

Fishing communities rely on shared ecological knowledge which informs their fishing practices, knowledge of species interactions, ecosystem functions, and methods for conserving their fragile coastal environment (Stoffle et al. 1995; Stoffle, Stoffle and Van Vlack 2020). It follows that shared ecological knowledge can increase resilience for the fishing community. Thus, fishing knowledge can be an important source of information for fisheries management (Stoffle and Minnis 2008; Johannes et al. 2008; Silvano and Valbo-Jørgensen 2008).

There are both marine and land-based ecological relationships where human use of the resource have led to better management and improved health of that resource. This phenomenon is commonly seen as leading to successful cooperative management where the resource users cooperate with formal institutions or agencies to ensure the long-term health and sustainability of common pool resources (Ostrom 1990). Two maritime examples of this are the successful co-management efforts of lobster fishers in Maine

(Acheson 2013) and the conservation ethic developed by the fishers of Buen Hombre, a coastal fishing village in the Dominican Republic (Stoffle et al 1995). Co-adaptations by these fishers ensured their continued access to marine resources and contributed to a formal management strategy that involved a shared responsibility between resource users and policy makers (Dyer and McGoodwin 1994). In each of these cases, the health of the resource in part was placed in the hands of the marine resource users who had management strategies based on formal and informal relationships with each other and the resource. Management strategies were guided by traditional ecological knowledge developed over generations.

There are cases where the practice of harvesting itself has impacted the underlying processes that govern the ecological system and resulted in unexpected positive biological outcomes (Ryan et al. 2014). Some studies have demonstrated that a balance between natural resources and people can be achieved through the accumulation of knowledge relative to a local environment (Whittaker 1998). Lobstermen in the Gulf of Maine, for example, found that baiting traps with herring increased the productivity of the fishery. Researchers confirmed that this fishing practice has both led to an increase in lobster growth and an increase in egg and larval viability (Grabowski et al. 2009; Goldstein and Shields 2018). Another example where resource users contributed to the welfare of a species occurred in the Adriatic Sea where *Chloeia pinnata*, a primary fish food source, was shown to increase in population as a result of trawling in the area by exposing new food for the species (Pranovi et al. 2000). The ability of harvesters to affect the biological productivity of a fish stock by changing food availability can have positive impacts and can be taken into account by resource managers when practicing ecosystem-based fisheries management (Ryan et al. 2014). Traditional ecological knowledge and conservation practices can be essential for fishing success, so there is a potential link between enhanced resource production and successful exchange systems (Turner 2016).

Following Hardin's (1968) notion of the tragedy of the commons, many scholars and managers have accepted the idea that interactions between humans and natural resources will ultimately result in a negative impact on the natural resources because humans maximize and intensify their use of the resource until its ultimate demise. Social scientists like McCay and Acheson (1987) in their seminal work, *The Question of the Commons*, provide examples of where a balance has been established between resource users and their environment.

METHODOLOGY

The National Oceanic and Atmospheric Administration yellowtail snapper study utilized various ethnographic research methodologies, including (1) rapid ethnographic appraisal, (2) semi-structured interviews, (3) key-informant interviews, (4) group interviews, (5) focus group interviews, (6) participant observation, and (7) community mapping. Both qualitative and quantitative analysis were utilized.

The study involved primary data collection with 143 individuals including, but not limited to, commercial fishers, recreational/charter fishers, fish dealers, and bait shop owners (Table 1). During the course of our research, we conducted 43 semi-structured interviews with key informants, individuals who participate in the fishery, people who are economically tied to the fishery, and scientists who both study and help manage the fishery. In addition, two group meetings involving a total of 58 fishers were held with members of recreational fishing associations in Miami. And, over the course of a month, six focus group meetings involving a total of 42 fishers were held with commercial and for-hire recreational fishers in Miami, Islamorada, and Key West, Florida.

TABLE 1: Methodology, Location, and Number of Individuals Interviewed

Ethnographic Research Methodology	Number of participants
Six focus groups	42
Focus Group with Commercial Fishers in Islamorada	8
Focus Group with Commercial Fishers in Key West	7
Focus Group with Commercial Fishers in Miami	3
Focus Group with For-hire Fishers is Islamorada	9
Focus Group with For-hire Fishers in Key West	8
Focus Group with For-hire Fishers in Miami	7
Semi-structured interviews commercial, recreational and charter fishers from South Florida	43
Group meetings with recreational fishing associations: The Tropical Anglers and The South Dade Anglers	58
Total	**143**

Stoltz developed her connections with fishers who trusted her to use their videos of yellowtail fishing trips. Through these videos, we were able to observe and ground-truth prior assertions about fishing strategies. This was important because fishers entrusted us with information about what they perceived to be specific successful strategies they developed. While we were familiar with the common fishing methods used to target yellowtail snapper, it was important to actually grasp some of their specific examples of targeting in process—thus documenting their claims regarding the manner in which fish responded to the boat, the fishers, and the power-chumming process.

In addition to primary data collected from local stakeholders, we collected and analyzed secondary source data in the form of maps and fishery-dependent and independent data. From these data, we created maps in a geographic information system that were used as an online database that can be queried by community members and researchers. The data are part of an annual data collection process known as the Southeast Fisheries Science Center Accumulative Landings System. This data records the landings of a species as it is purchased from the fishers by the dealer. From these data, we were able to visually represent the fact that this fishery is very much a South Florida fishery by examining the geographic location and size of the landings. Upon final approval, the data will be placed on the National Oceanic and Atmospheric Administration Social Science Research Group's website for use.

For-hire and commercial fishers were drawn from a stratified random sample. We note that private recreational fishers were a component of the study but not included in the stratified random sample for the focus groups. We hired a local company that specialized in organizing and running focus group research, and they were responsible for drawing the sample and then arranging for the fishers to be present at the meetings. Additionally, they were responsible for the meeting logistics such as providing the locations for the interviews, recording, and transcribing the meetings' comments.

DATA ANALYSIS

For the qualitative data, we used transcriptions from focus groups compared with field notes from semi-structured interviews and group interviews to determine areas where individuals reached consensus and/or differed in perspectives about health and management of the species—specifically focused on issues of allocation between the recreational and commercial sector. We also examined the ways that for-hire fishers made decisions about how they fished or altered targeting strategies during the course of a day trip depending on numerous factors such as weather, clientele, and time of the year. We did the same when examining commercial fishers' decision making of the

appropriate time of the year when targeting yellowtail is most productive in terms of their annual round—remembering that most people who commercially fished for yellowtail also engaged in targeting other species often with other types of gear (multi-species/ multi-gear fishers). The qualitative data were analyzed in MAXQDA, a qualitative coding software, to gather themes and key quotations from the interviews and focus groups using both deductive and inductive coding.

From the focus groups, we also developed basic descriptive statistics that quantified the level of agreement or disagreement about specific subjects. When research participants made declarative statements (i.e., "the yellowtail stock is healthy and not overfished") we asked the group whether they agreed or disagreed with the statement. We were able to record this both during meetings and confirm it with the transcripts from the meeting itself. Research participants who did not voice opposition to statements that were unanimously agreed upon during the meetings and instead contacted us afterwards to indicate their personal dissent were included in these totals.

The informal interviews provide historical and contemporary context as to the relative importance of yellowtail fishing not only from a fisher's perspective but those that are tied to the fishery in other ways such as bait and tackle shops, local hotels and restaurants, boat rental shops, and fuel/gas facilities.

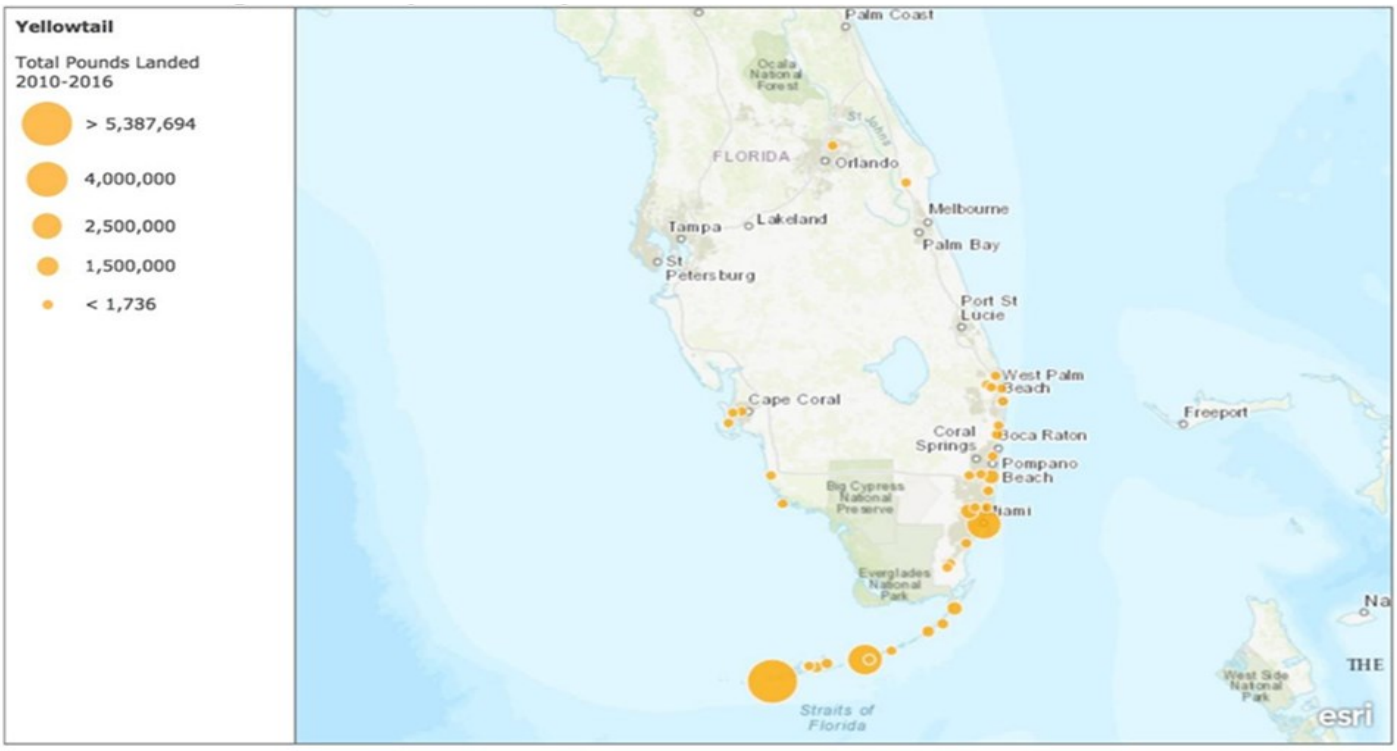
STUDY SITE

For generations, the residents of South Florida and especially the Florida Keys have relied on yellowtail snapper as a means of generating revenue and providing food for local tables (see Figure 1). Today, yellowtail snapper are more important than ever, used as a "fall back species" on for hire fishing trips when weather or fishing can be off, as a "meat" fish for recreational fishers, and also as an important "go to" species targeted at a certain times of year to complete a commercial fisher's annual round. Around the turn of the century (1893), Key West was the largest city in Florida (Epstein 2013). One certainty is that from that time up until today, fishers targeted and consumed a large number of inshore reef species; thus, yellowtail snapper along with the other snapper and grouper species are an important part of South Florida's fishing history (Epstein 2013).

In the early 1980s, fishing for yellowtail snapper involved light chumming for the fish at night (McClellan and Cummings 1998). Yellowtail snapper are a nocturnal fish with good eyesight, and fishers believed that they could not be caught successfully during the day. In the late 1980s, fishers began to realize that by increasing the amount of chum they used, and by mixing it with other food products that would degrade water clarity, they could successfully bring yellowtail up to the boat during the daytime. This practice evolved over time to lead to what the fishers now describe as power-chumming, in which hundreds if not thousands of pounds of chum are used to catch hundreds of pounds of fish. The chum, usually comprised of blocks of frozen ground up menhaden, is released through a perforated bucket, basket, or bag to create a chum slick in the current behind the boat. The release of the chum triggers the yellowtail's feeding behavior causing them to come to the surface of the water in a feeding frenzy. Sand and oats are used along with the chum to muddy the water and disguise the hooks that the fishers cast into the slick.

While it is common for yellowtail fishers to use other recipes for their chum mixture, there are several commonalities. Masonry sand is the preferred type of sand as it is easier to mold into balls for sand-balling—a technique where a ball of bait and sand on a hook is used to catch bottom fish. Yellowtail are somewhat indiscriminate predators and, in the early 90s, fishers used an array of food products to mix with the chum—such as corn, rice, and even gummy bears.

FIGURE 1. Yellowtail Landings in South Florida, 2011-2016 (Southeast Fisheries Science Center Accumulative Landings System Database).



Fishers began to observe that corn was not being readily digested by the fish; an observation supported by aquaculture studies on fish diet (Regost et al. 1999). As a result, word spread throughout the Florida Keys to use oats instead. Fishers now predominantly mix oats with their chum. Oats are also better for making slop; a concoction of oats, seawater, and chum that is thrown overboard while fishing. The inclusion of oats in this fishing practice is well known throughout South Florida and locals confirmed during the study that if you catch a yellowtail snapper its belly normally is full of oats.

RESEARCH FINDINGS

The 143 participants documented a consensus in opinion based on their relationship to the fishery that the yellowtail snapper stock is healthy and that the population has been stable or has grown in the past 30 years. Table 2 identifies areas where consensus was reached among those that participated in the focus groups. No research participants questioned the health of the fishery or mentioned observing a decline. During the focus group interviews, researchers queried each participant after discussing a specific topic to determine if the group agreed or disagreed with the finding. At that time, fishers were able to reach consensus or express a different perspective from the one identified in the group discussion. From this, we were able to identify which topics reached consensus and which topics had differing perspectives.

Focus group participants unanimously agreed that power-chumming has changed fish behavior and has caused the species to aggregate in areas where they are routinely fed by fishers. A commercial fisher who works out of the Lower Keys refers to a location he normally fishes and is well known throughout the fishery as *the farm*. As another fisher explained:

> *He calls his spot 'the farm'... He works that spot and nobody can mess with that. It's his spot. The fish are kind of trained and they see that boat,*

TABLE 2. Statements Agreed Upon by Research Participants

Statement Category (Fishing Sector)	Percent in Agreement
The yellowtail snapper fishery is healthy (Commercial and Charter)	100%
The fishing technique has changed yellowtail snapper behavior (Commercial and Charter)	100%
Yellowtail is a trip-saver for charter captains (Charter)	100%
Recreational catch data is unreliable (Commercial and Charter)	89%
Commercial fishers should not fish on the recreational quota (Commercial)	88%
Support lowering the bag limit from 10 to 5 yellowtail snapper (Charter)	83%
Support closures in the summer with an allowable bycatch trip limit (Commercial)	76%
Growing shark populations are making fishing more difficult (Charter and Commercial)	71%
Commercial fishers should not fish on the recreational quota (Charter)	66%

they hear that motor, they hear his feet up on the deck. I mean they know him. So, he's got that advantage, and that's a wonderful thing. (Commercial Fishers Focus Group in Key West 2018).

According to another fisher, the fish at the farm have been observed aggregating at the back of the boat even before the fishers have a chance to get the chum dispersed. During several interviews, power-chumming was likened to open-water aquaculture. As one commercial fisher explained, "We're using chum 6-7 days a week all year long. We're part of the ecosystem." Dill (1983) suggests that many species of fish are known to become habituated to certain areas based on prey availability and that fish show flexibility in their foraging behavior because of the temporal and spatial variance of the natural environment, altering their behavior to ensure higher feeding rates and broader diets. For example, fish that are acclimatized to clumped food will engage in group foraging behavior (Ryer and Olla 1995). Studies have shown that chumming can contribute to nutrification and cause a decrease in benthic fauna (Babcock 2007; Arlinghaus and Mehner, 2003; Cryer and Edwards, 1987). Other externalities of chumming such as the impacts on water quality and the addition of sand to the environment—especially close to Florida's already fragile coral reefs—warrant further exploration. One lingering question is whether widespread power-chumming in the Florida Keys could potentially alter the ecosystem and impact the food web; but further research must be conducted to understand the magnitude of those impacts, including what happens when the chumming stops.

Since this fishing practice has evolved, catch rates have continued to rise and the most recent stock assessment (SEDAR 64) explicitly accounted for some of this trend by estimating an increase in catchability commensurate with widespread adoption of power-chumming. This reflects the views expressed by fishers in this study regarding the manner in which power-chumming has altered fish behavior and demonstrates how traditional and local ecological knowledge can be used directly in the stock assessment process. This study also elucidated the intriguing hypothesis that power-chumming augments the population. Fishers in this study also believe that the power-chumming practice fosters longer more frequent spawning periods and an increase in overall size and abundance of the species in the last 30 years. Studies have shown that fish diet can affect the number of eggs laid and average egg diameter (Markovich et al. 2007). Alternatively, an increased spawning period could be the result of warmer waters caused by changing climate as seasonal change has a well-documented effect on fish reproduction (Parkhurst and Munday 2011). While this research cannot conclude whether fishers' practices of power-chumming augments the population, it highlights the value of understanding fishing practices in providing a testable hypothesis regarding the fisher-fish relationship that can be used

to better understand the underlying dynamics and more effectively assess and manage fisheries.

Since yellowtail snapper are caught individually with small hooks, fishers are able to work within the current policies of size limits by immediately throwing back fish that do not meet the minimum size requirement of 12 inches. This is another commonality with the Maine lobster fishery where undersized lobsters that consume bait inside traps are thrown back, thus increasing the overall welfare of the species (Grabowski et al. 2009).

Landings data and dealer data suggests that a large percentage of yellowtail snapper is landed in South Florida (Figure 1) and, since the late 1800s, has important ties to both commercial and year-round recreational fishing. In the South Atlantic (as defined by the National Oceanic and Atmospheric Administration), the commercial sector has experienced three approximately one-to-two month-long closures because the sector has been meeting its catch quota. The first closure occurred in 2015 during the winter, which hurt the commercial sector because winter is their most lucrative time of year. The following year, in 2016, commercial fishers successfully lobbied to modify the fishing year from a calendar year to an August-to-July fishing year. The following two closures in 2017 and 2018 occurred during the summer. Overall, fishers who support the summer closures believe that it protects the fish during their peak spawning period by ensuring that they remain unmolested by commercial fishers.

DISCUSSION AND CONCLUSION

Yellowtail snapper is one of the top five species extracted by commercial fishers in Florida, and it has been so for generations. The fishers who took part in this research reported that the yellowtail stock is healthy, which was correlated with the results of a yellowtail snapper benchmark stock assessment conducted by the Florida Fish and Wildlife Research Institute that indicated the species is not overfished (O'Hop et al. 2012). This status has been subsequently maintained in the most recent stock assessment (Allen et al. 2020). Additionally, in 2012, there was an increase of the South Atlantic's commercial Annual Catch Limit to reflect these findings. The 2018 South Atlantic Council's Advisory Panel's Yellowtail Snapper Performance Report also supports the assertion regarding the health of the stock and its relative importance to the local fishers and community (South Atlantic Fish Management Council 2018).

With proper management and monitoring, yellowtail snapper will remain an economically viable species for both the commercial and the for-hire fishing sectors. Yellowtail snapper fishers in South Florida are engaged in the fishery's sustainability while the long-term trends of the coastal population of Florida continues to grow (Creel 2003). With increased population, however, comes more fishers and more boats, providing new conservation challenges.

The South Florida yellowtail snapper has the potential to be another example of the human ecological relationship between resource users and a natural resource where the involvement of harvesting does not necessarily create a tragedy of the commons but instead can prompt collaborative management, potential improvement of fish biomass, economic viability, and cultural continuity and new connections. The South Florida fishers who target yellowtail acknowledge its cultural and economic importance and believe that they are working to ensure its long-term sustainability. Whether yellowtail snapper is dinner for a tourist, a trip-saver for a charter captain, or a money fish for a commercial fisher, it is a highly important resource that many users will continue to protect, manage, and feed for generations.

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