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Non-compliance in marine reserves: measuring the drivers of behavior among recreational fishermen within the Great Barrier Reef Marine Park

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SIT Study Abroad

Non-compliance in marine reserves: measuring the drivers of behavior among recreational fishermen within the Great Barrier Reef Marine Park

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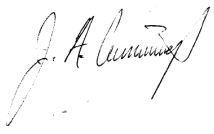

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Abstract:

The Great Barrier Reef Marine Park (GBRMP) provides outstanding ecological, cultural, social, and economic services to the number of communities that use it. Most of the park is regulated via a zoning system designed to protect its biodiversity and ensure the sustainable use of its resources (GBRMPA, 2004). Like any social institution, zoning regulations rely heavily on compliance in order to be effective. Recreational fishing on the GBRMP accounts for most of the noncompliance behavior associated with zoning (Arias and Sutton, 2013). Thus, understanding fishers compliance behavior is central to understanding how to best manage these areas. Using results from a survey conducted on recreational fishermen over a period of four weeks, this study explores the attitudes and beliefs of fishers on the GBRMP. It also uses data on fishers' consumptive orientation and the importance of fishing to their lifestyle to determine if differences among fishers in these categories lead to different perceived social norms. Finally, It assesses the perceived level of the legitimacy of authorities on the GBRMP, and how that perception influences compliance behavior.

I find that the mean perceived norm among fishers on the GBRMP is that about 8.35% of fishers practice noncompliance. Fishers with a higher consumptive orientation tend to estimate higher levels of noncompliance than those with a lower consumptive orientation. Additionally, fishers who say that fishing is their most important activity are more likely to perceive a more compliant norm than those who do not consider fishing to be the most important activity to them. Finally, fishers tend to personally identify with marine parks personnel, and have a strong personal moral obligation to abide by zoning regulations. There seems to be a fairly strong perceived social norm positively affecting fishers' decisions to comply with zoning regulations.

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1. Introduction

1.1: Ecological and social consequences of non-compliance

The Great Barrier Reef (GBR) is the largest and most valuable reef system in the world (Sutton and Arias, 2013). It provides outstanding services to the wide variety of life that depends on it ecologically, financially, culturally, and socially (Sutton and Arias, 2013). Most of the GBR is within the multiple use Great Barrier Reef Marine Park (GBRMP), which is managed via an extensive zoning system meant to limit human activities such as tourism, fishing, and recreation. The zoning plan was reformed in 2004 by the Great Barrier Reef Marine Park Authority (GBRMPA) to expand no-take zones from less than 5% of the park to 33%. These no take-zones, often referred to as green zones, are completely shut off from fishing. The remainder of the park was divided into various other zones, of which most are open to some form of fishing (GBRMPA, 2004). The GBRMPA's aim with the new zoning scheme was to increase the protection of the biodiversity of the GBR (Fernandes et al, 2005).

The effectiveness of the new zoning plan in protecting the biodiversity of the GBRMP is extremely dependent on compliance by fishers (Arias and Sutton, 2013; McCook et al, 2010). Available data suggests that compliance within the GBRMP is incomplete and that recreational fishing accounts for most of the violations related to zoning (McCook et al, 2010). Non-compliance can diminish outcomes as well as reduced biodiversity. It has been shown that even short bursts of non-compliance can negate decades of protection (Lester and Halpern, 2008). In one case, a single boat was able to fish out a third of all the coral trout within a green zone in the GBRMP in less than four weeks (Arias and Sutton, 2013). Non-compliance also leads to social consequences such as free riding, where a violator receives the benefit of fishing in a green zone while pushing the greater costs onto society. A history of non-compliance can

lead to the acceptance of destructive practices within the fishing community and the creation of a social norm that threatens the goals of the current zoning plan (Hatcher et al, 2000). Non-compliance also causes increased costs in enforcement, and can damage livelihoods as important stocks are diminished (Jackson et al, 2012).

1.2: Justification for study

Enforcement over an area as large as the GBRMP is extremely costly and difficult to organize and manage (Cinner et al, 2012). Especially after the expansion of green zones, there is simply too much ground to cover to stop noncompliance solely from the top down. Consequently, there is a strong need to better understand the level of zoning compliance among recreational fishers in the GBRMP and the factors that influence fishers' decisions to comply with zoning regulations. Reliable estimates of compliance can aid in determining the environmental impact of infractions, in understanding how enforcement affects compliance, and in distributing staff in the right numbers, times, and places (Arias and Sutton, 2013; Cowles et al, 1979). A better understanding of compliance levels can also help gauge management effectiveness in the GBRMP and the level of acceptance of the zoning plan by local communities (Ham, 2009). Furthermore, an understanding of the drivers of compliance behavior among fishers would be beneficial to incorporate into management schemes to make them more comprehensive and effective. It has been recognized in the literature that creating policy under the assumption that fishers will only consider the illegality of an action in terms of its expected cost is inefficient is not a good predictor of actual behavior (Jackson et al, 2012). In reality, many fishers do comply with the zoning regulations, regardless of the monetary benefits associated with breaking them (Cinner et al, 2012). It is important to build an understanding of the motivations behind compliance, and what factors lead to compliance

behavior, in order to create an accurate predictive model of compliance from which effective policy could be formulated.

1.3: Review of Previous Research and Aims of This Study

There are multiple factors that play into an individual's behavior in a given situation. Before Icek Ajzen's theory of planned behavior (TPB) in 1991, it had only been concluded in the literature that general attitudes could be shown to influence behavior given an aggregation of situations (Kaiser et al, 2005). Ajzen was able to build the first framework that can be used to predict behavior in a specific context (Armitage and Conner, 2001). The theory has since been expanded upon, but it laid important groundwork for predicting situational behavior. The central factor in the TPB is intention. Intention captures motivation to perform a behavior, and how hard a subject is willing to try. The stronger the intention is, the more likely the behavior. To predict intention, the TPB uses perceived behavioral control, attitude towards the behavior, and the subjective norm (Ajzen, 1991). In simpler terms, these can be defined as the perception of consequences of performing or not performing an action, personal morals and values concerning the behavior in question, and what is socially considered the norm regarding said behavior. The theory has since been expanded to incorporate value-belief-norm theory. This addition evaluates self-ascribed responsibility, one's awareness of the consequences of a behavior, and one's ecological worldview (Kaiser et al, 2005). Moving further, this study also incorporates criminal phycology to determine how perceptions of authority and the legitimacy of authority play into decision-making processes regarding illegal behavior.

Numerous studies have attempted to predict fisher's behavior, and many have found specific factors listed above to affect compliance behavior. Overall, previous studies show that normative beliefs, defined as what the perceived norm for compliance is, are the best predictors

of compliance behavior, along with the perceived legitimacy of management (Jackson et al, 2012; Hatcher et al, 2000; Sutton 2007). In the UK, fisher's behavior was inversely related to fines and perceived control, as well as social norms (Hatcher et al, 2000). If a fisher knew someone who did not comply, they were far more likely to do the same. In the US, compliance behavior was observed in those with a higher consumptive orientation and for whom fishing was central to their lifestyle (Sutton, 2007). In Australia, Sutton et al (2013) found that people were mostly motivated by beliefs about penalties and noncompliance, followed by benefits of no take zones. Additionally, consumptive orientation, as well as centrality to lifestyle, was found to be predictive of perceived social norms among fishers in Australia. However, while both of these studies found consumptive orientation to be indicative of perceived social norm, they produced opposite implications for this norm. In the US, fishers were more likely to underestimate the social norm if they had a higher consumptive orientation, whereas fishers in Australia were more likely to overestimate the norm behavior with a higher consumptive orientation. Additionally, results indicate that consumptive orientation and level of interest affect the perception of the norm, and therefore indirectly play an important role in compliance behavior (Sutton, 2003; Sutton et al 2013).

Creating a model to predict behavior is extremely difficult, especially given the cryptic nature of poaching. Nobody wants to admit to an illegal activity, thus the study is vulnerable to response bias. It would be impossible to effectively measure compliance with such a small timeframe and sample size. Therefore, this study attempts to take the first step towards understanding compliance behavior by using survey responses to explore the beliefs and attitudes of fishers in Townsville. Previous research has identified perceived social norm, affected by one's consumptive orientation and centrality of fishing to lifestyle, as well as the

perception of management legitimacy to be the most important drivers of compliance behavior (Hatcher et al 2000; Jackson et al, 2012). Accordingly, this study attempts to answer the following questions: What is the perceived compliance level among fishermen on the GBRMP? Do the perceived levels of compliance change with consumptive orientation or the importance of fishing to one's lifestyle? What are the perceived levels of legitimacy of authorities among fishers on the GBRMP?

1.4: Definition of terms

Consumptive orientation: consumptive orientation is defined as how important it is to fishers that they catch many and high quality fish when they go fishing.

2. Methods

2.1: Study site and data collection

Over the course of four weeks I surveyed recreational fishermen as they came off the water at the Coast Guard Ramp on Ross Creek (see figure 1). This ramp was chosen because it is the most used, and the closest to the GBRMP of all the ramps in the Townsville area. Most data was recorded during the weekends when the weather permitted. I checked the wind forecast each day before surveying, and expected to get my best results on weekends when the wind was below 10 knots. Surveys were conducted between 9am and 4pm. I approached fishers when they were tending to their boats and asked them if I could survey them. The survey itself was recorded on an ipad, and questions were filled in as they were answered. For a full list of questions see Appendix 1.

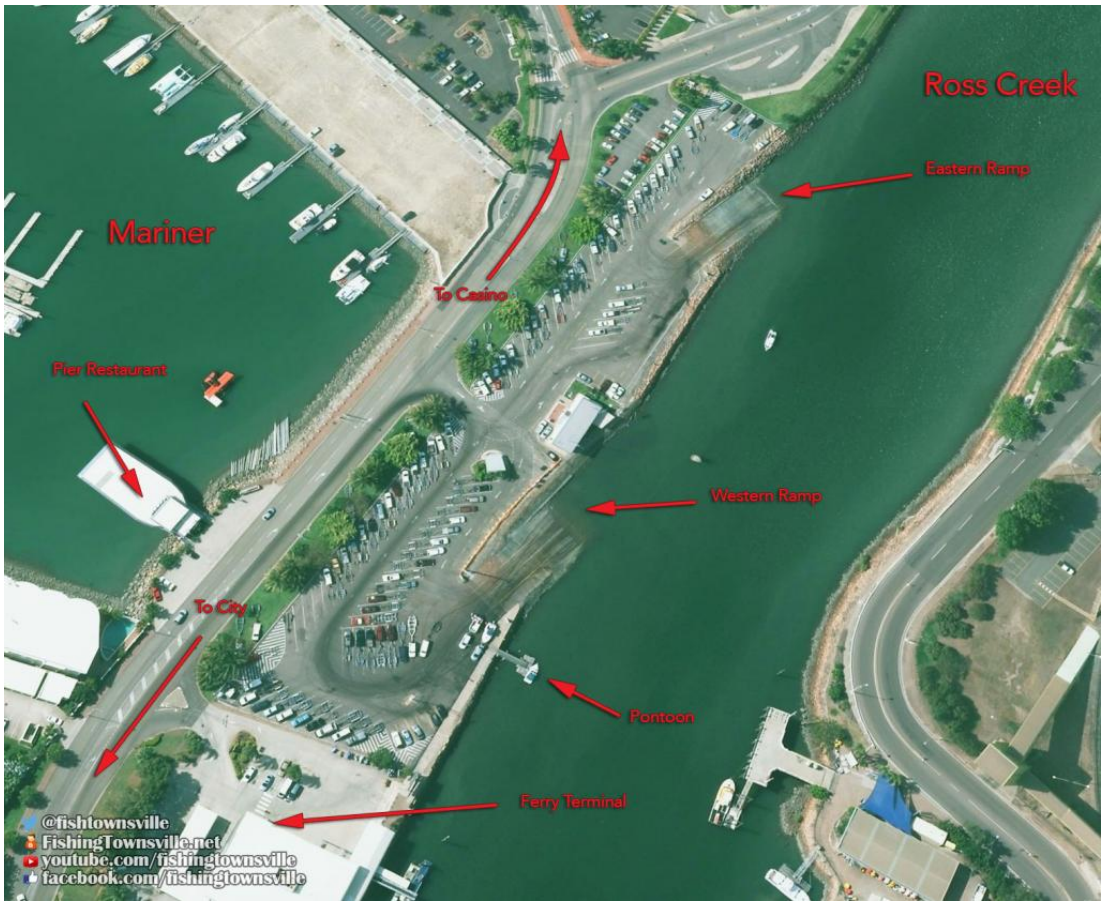

Figure 1: Map of the Coast Guard Ramp near downtown Townsville

2.2: Survey measurements and methods

A complete list of questions and responses on the survey can be found in appendix table 1. However, the only measurements analyzed for this study are consumptive orientation, perceived legitimacy of authorities, importance of fishing, and perceived compliance. Perceived compliance was determined by asking each respondent what percentage of fishers that use the boat ramp, but who they don't necessarily know personally, have fished in a green zone in the last 12 months. Consumptive orientation was broken up into several statements. For each statement, the respondent was asked to rank their level of agreement from 1 (strongly disagree) to 7 (strongly agree). The statements included: The more fish I catch, the happier I

am; A successful fishing trip is one in which many fish are caught; I would prefer to catch 1 or 2 large fish to 10 small fish; It doesn't matter to me how many fish I catch; The bigger fish I catch, the better the fishing trip; I'm not happy unless I catch a lot of fish; I'm the happiest if I catch a challenging sport fish; I like to fish where I know I have a chance of catching a large fish. The responses to these statements were averaged and recorded to get a sense for overall consumptive orientation of fishers. Fishers were then grouped based on their responses to all of the questions. Those who responded 1-2 for the statements pertaining to catching fish and 6-7 for the statement that they don't care how many fish they catch were grouped into low consumptive orientation. Those with opposite results were grouped into high consumptive orientation, and those in the middle were given a medium consumptive orientation. For each group, I then calculated the mean response to what proportion of fishers they think have fished in green zones in the last 12 months as a percentage of total fishers. These results were compared to each other and the overall mean for the same proportion.

Perceived legitimacy of authorities was similarly broken up into a series of statements with which respondents were prompted to agree or disagree. These statements were as follows: Marine parks officers share the same background, morals, values, and goals as I do; this was meant to gauge the level of identification with marine parks officers. I am obliged to obey marine parks zoning regulations; this was a measurement of value-based legitimacy. Marine parks personnel are approachable and respectful to fishers; this measured perceived procedural justice. Marine parks officers use fair processes and make fair decisions when dealing with fishers; this was another measurement of procedural justice. The current zoning plan allows for a fair and equitable use of the resources of the GBRMP; this measured distributive justice. I

trust that marine parks officers will do their job effectively and in the interest of the common good; this was a measurement of motive-based trust.

Importance of fishing was broken up into respondent's answers to the question: how would you rank fishing among other activities you enjoy in the marine park? The possible answers were: my most important activity, my second most important activity, my third most important activity, and one of many important activities. For each category, I calculated the mean response to what proportion of fishers have fished green zones in the past 12 months. These means were then compared to each other and the total mean response to the same question.

2.3: Data analysis

As previously stated, this study was too short to gain a reliable estimate of actual compliance, and thus focuses on the attitudes and perceptions of fishers as they relate to compliance given results from relevant literature. All answers were recorded in excel and organized by category. Descriptive statistics were used to break down the implications of each category of responses. All means were recorded for each category, and were compared across different interest groups (i.e. high vs low consumptive orientation, importance of fishing).

3. Results

3.1: Survey results

When asked for an estimated proportion of other fishers that have fished in a green zone in the last 12 months, respondents gave widely different answers from 0% to 40%. The mean answer overall was 8.35%, with a standard of error of 4.3%. Most respondents guessed 5-10%, with the wide majority of responses guessing 5%. Very few guessed over 15%, and

only 2 guessed as high as 40%. Previous studies by Sutton et al concluded that about 10% of fishers practice noncompliance in the GBRMP. The results from this sample follow relatively closely with this estimate.

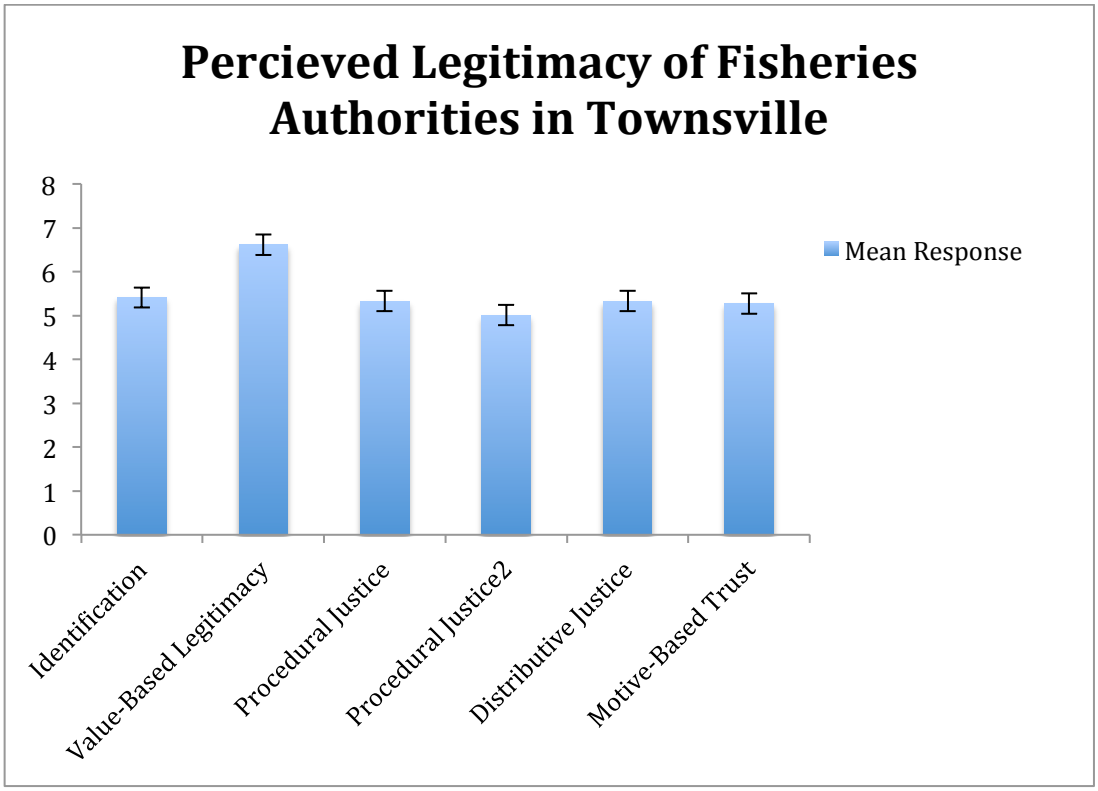

Figure 2: Mean responses to different measurements of perceived legitimacy of authority among fishers

Figure 2 represents the average perceived legitimacy of authorities on the GBRMP. Most respondents agreed that marine parks officers shared similar values, morals, goals, and backgrounds as they do. Fishers also reported almost unanimously that they are obliged to obey marine parks zoning regulations. The lowest result came from asking people if marine parks officers used fair processes and made fair decision when dealing with fishers, although the consensus was still positive. Most agreed that the current zoning plan allows for fair and equitable use of the marine park resources, and that they trusted marine parks officers to do

their job effectively and in the public good. Overall, it seems that fishers identify with marine parks authorities and understand how zoning regulations allow for the continuity of fish stocks.

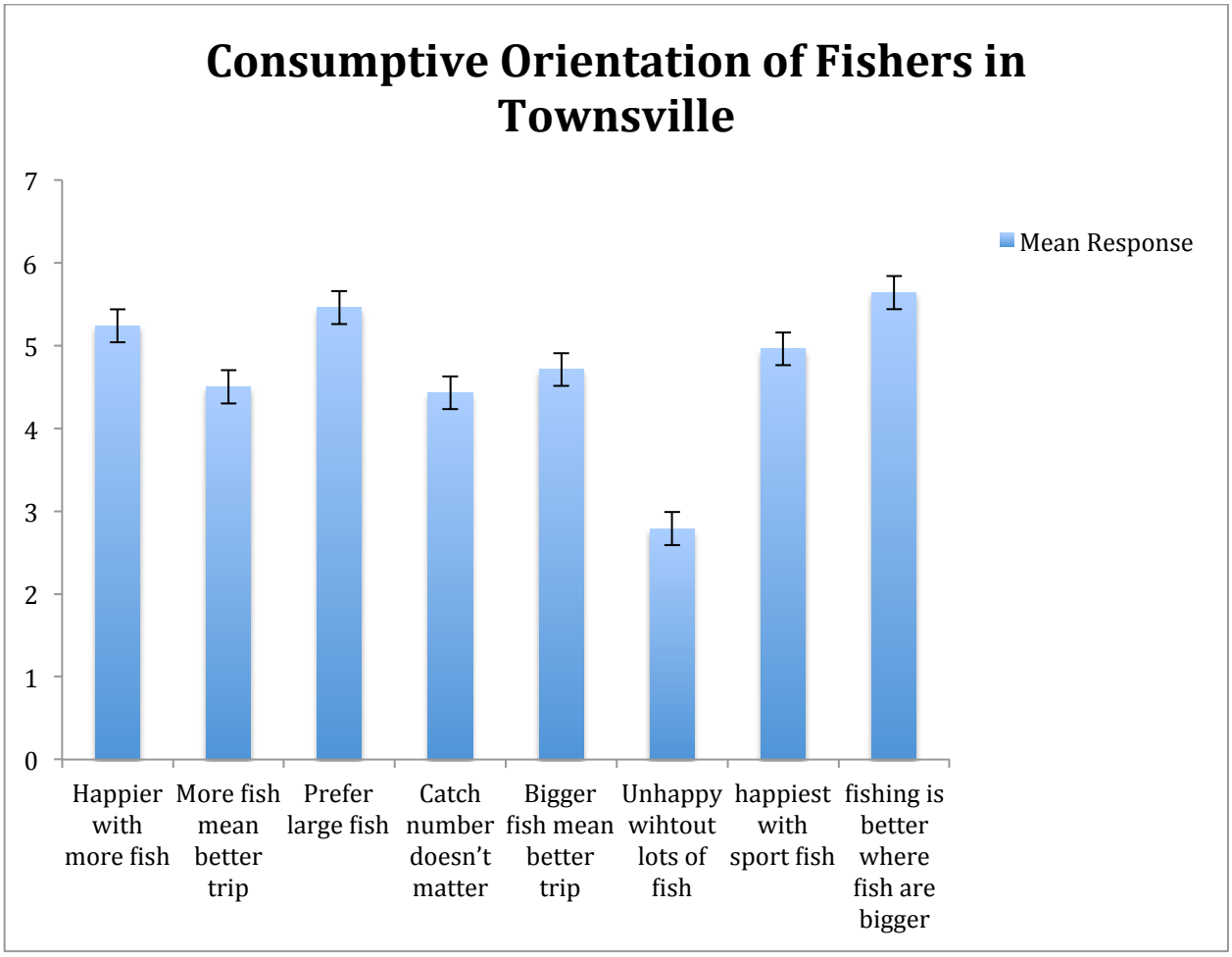

Figure 3: Mean responses to different measurements of consumptive orientation of fishers

Figure 3 represents the average consumptive orientation of fishers surveyed. Most respondents reported that they like to catch many fish when they go fishing, and that they like to fish where they know they have a chance of catching a big fish. It was also generally agreed upon that a successful fishing trip is one in which many fish are caught, yet most people disagreed that they are not happy unless they catch a lot of fish. Generally, larger fish were

preferred to smaller fish, and sport fish were usual targets of fishing trips. However, most fishers are happy going fishing just to be on the water, and don't place an extremely high value on only catching fish.

3.2 Comparative Statistics

Consumptive Orientation	Overall Mean Perceived Compliance (%)	Mean perceived noncompliance level by consumptive orientation (%)	Standard Error (%)
High	8.35	10.06	0.21
Medium	8.35	7.71	0.23
Low	8.35	7.3	0.18

Table 1: Consumptive orientation compared to perceived norm

Table 2 compares fishers with differing levels of consumptive orientation to their respective descriptive norms. Fishers with a higher consumptive orientation tend to think that fish in green zones more than those with a lower consumptive orientation. Additionally, when it comes to fishers that the respondents don't know they perceive the norm to include much higher rates of fishing in green zones. A similar trend along consumptive orientation is observed in perceived norm for personal acquaintances and fishers that respondents don't know, but the norm is perceived differently for fishers respondents don't know personally.

Importance of fishing	Overall mean perceived noncompliance (%)	Mean perceived noncompliance level by importance of fishing (%)	Standard Error (%)
Most important activity	8.35	8.33	0.23

Second most important activity	8.35	8.73	0.19
Third or one of many activities	8.35	9.36	0.21

Table 2: Importance of fishing compared to mean perceived compliance levels

Table 3 compares fishers with varying levels of centrality to lifestyle with perceived compliance levels among fishers in general. Fishers with a higher centrality to lifestyle tend to give lower estimates of what percentage of fishers fish green zones than those with a lower centrality to lifestyle. There is a more compliant perceived norm among fishers for whom fishing is central to their lifestyle. Fishers who place a lower value on fishing tend to estimate lower compliance among the fishing population.

4. Discussion

4.1: Perceived Compliance levels and Legitimacy of Enforcement

The mean perceived compliance among fishers in the Townsville area closely resembles the estimate made by Sutton et al (2013) previously on the GBRMP. Sutton found that about 10% of fishers do not comply with green zones, and that their normative beliefs drive that behavior (Sutton et al, 2013). It has been suggested in the literature that those who participate in a given illegal activity usually overestimate the proportion of other people who also participate, thus they have a higher perceived norm than those who do not participate (Ross et al, 1977; Mullen and Hu, 1988; Sutton et al, 2013). This effect is called the false consensus affect, and is likely to have skewed my results. The average, and thus the perceived norm, of fishers who practice noncompliance would have been much lower without the addition of 5 outliers. Three of these fishers estimated that 20% of fishers practice noncompliance, while 2 of them estimated 40%. Due to the false census affect, it is likely that those who overestimated compliance by at least a factor of 2 are likely to fish in green zones

themselves, even if they don't admit to it on the survey. This bias serves to skew the average perceived compliance levels, meaning that the average fisher probably does not perceive noncompliance to be as prominent as my mean would suggest. This also serves to skew my estimate of the perceived norm. The perceived norm among fishers who participate in noncompliance is therefore more heavily weighed towards noncompliance than the perceived norm for fishers who obey the law.

The results from perceived legitimacy of authorities reveal several insights into the beliefs and attitudes of fishers. Most fishers moderately agreed that they identified with marine parks personnel, saying that they shared the same background, beliefs, and goals. Identification has been underlined in criminology studies as one of the critical factors required for authority to be legitimate (Jackson et al, 2012). By revealing that they identify with marine parks personnel, fishers, on average, recognize their authority and relevance to zoning laws and the ecological and social reasons for those laws. Overall, almost all fishers strongly agreed with the measure of value-based legitimacy. They were in agreement that they are obliged to follow the marine park zoning regulations. Even if the scores for the fairness and justice of the processes used to regulate fishers were lower overall, they all agree on the necessity for the laws. This would suggest that fishers understand the ecological and social significance of zoning laws, and agree with management on a personal, moral level. These two factors, personal identification with marine parks regulators, and recognition of the morality and importance of zoning regulations, strongly suggest that fishers in Townsville are morally driven to obey the zoning regulations, and that they recognize the legitimacy of the authorities trying to uphold those regulations on a personal level. They also understand the importance of management of the commons, suggesting that noncompliance does not stem from a sentiment

that people should have the right to fish where they want. This would also suggest the creation of a norm for the acceptance of management and the legitimacy of that management. While the other scores for legitimacy of authorities were lower than the first two, they were still positive on average. Fishers responded that while they identify with marine parks personnel, they do not agree that these personnel are always fair and respectful to fishers. Some respondents who had bad personal experiences with marine parks officers had become disillusioned with them, yet still recognized the law and its importance. Results are positive overall, however, as legitimacy is critical if social institutions are to operate and grow. The acceptance of legitimacy, therefore, goes hand in hand with the creation of a behavioral norm and voluntary compliance. Based upon the idea that people comply with the law because they believe it is the right thing to do, a normative model of crime control posits that institutions can secure compliance and cooperation by developing policies that generate legitimacy (Jackson et al, 2012). In the case of the GBRMP, this sort of policy seems to be appropriate. Therefore, compliance could be controlled through normative beliefs and morality. Finally, the acceptance of legitimacy in authority can lead to self-regulation, which would cut enforcement costs and help to lower noncompliance (Sutton, 2003). Case studies on the GBRMP have shown that co-management in this sense through those using the resources can help to bolster compliance behavior (Cinner et al, 2012). Townsvillians have taken the first step towards the creation of a norm of compliance with the law from a moral standpoint.

4.2: The effects of consumptive orientation and importance of fishing on normative perceptions

My data suggests that fishers with a higher consumptive orientation tend to estimate higher levels of noncompliance. The perceived norm for fishers who place a high value on their catch, therefore, is more conductive to noncompliance that those with a lower

consumptive orientation. This could be an example of the false consensus effect, in that fishers who place a higher value on their catch are more prone to fishing in green zones and therefore assume a more liberal norm than those who do enjoy fishing more for the sport. In support of this, the most common response from fishers as to why other fishers would fish in green zones was that they expected the fishing to be better. It could follow, then, that fishers who care more about the actual catch are more likely to practice noncompliance for this reason. Sutton et al found the same result in 2013, reporting that the perceived norm tended more towards noncompliance among those with a higher consumptive orientation. Previous studies have different results, however, showing that fishers with a higher consumptive orientation in North America were more likely to practice compliance behavior (Sutton, 2003; Sutton, 2007). This was suggested to be due to the fact that those fishers cared about the longevity of fish stocks more than fishers who don't care what they catch, and therefore had a higher personal moral obligation to comply. A reason for this difference could be that fishers who do not comply in the GBRMP care about the longevity of fish sticks, but disagree with the effectiveness of the current zoning plan. Therefore, their moral obligation to ensure continued stocks would not stand in the way of their noncompliance with a system they do not believe furthers those interests. Many fishers with high consumptive orientations had suggestions for revision to the current zoning plan. Namely, many wanted dynamic management, where green zones would change and move around every few years so that one area does not get overfished. Therefore, these fishers do not break the law because they don't care about conservation, but merely because they disagree with the way that conservation is being legally instated. The norm remains one of conservation and longevity of fish stocks, but compliance does not follow

because of disillusionment with the means to achieve conservation. Overall, however, most fishers do agree with the current zoning plan, and do follow a compliant norm.

Previous studies have concluded that fishers who value fishing as an activity more than other activities tend to perceive the norm to be one of more compliance than those who do not value fishing as much (Sutton, 2003). For fishers in America, studies have found this correlation is due to the fact that fishers who place a high value on fishing are more likely to perceive the norm from fishers with the same value. That is to say that the norm for this demographic of fishers is one of compliance because fishers who value fishing tend to value conservation as well. They understand the importance of preserving fish stocks and care more than fishers who do not value fishing as much. Additionally, fishers who place a high value on fishing make up the majority of my data, and also provide the closest estimate of actual compliance. This is to be expected because they are the largest group of fishers on the GBRMP, and therefore have the most accurate perceived norm. In conclusion, the importance of fishing affects one's perceived norm, and therefore one's acceptance of noncompliance. Co-management would be a useful tool in this context because fishers who value fishing could be used to set a norm for all fishers and would work to help enforce that norm.

4.3: limitations to study

Surveying is not easy. It can be extremely difficult to get fishers to answer honestly and thoughtfully, especially to a long survey. My results are therefore limited by response bias, as well as my own bias when surveying. While I tried to be completely objective when presenting the survey, it can be hard to not influence people's answers at all. Additionally, due to the small sample size analyzed in this study, statistical tests were ineffective. I resorted to descriptive statistics about the population in general because there were observable trends, but

I could not find statistical significance. To control for bias, and to enable the use of statistics, many more surveys must be included in future studies to get an accurate read of norms and opinions. This study takes the first step in understanding fisher's perspectives and attitudes, but further analysis would require more time and effort.

5. Conclusions

5.1: Findings and study goals:

This study manages to make a preliminary estimation for perceived compliance among recreational fishers on the GBRMP. Most fishers assume that noncompliance lies somewhere between 5% and 10%, which is fairly accurate of predictions made by previous studies (Sutton et al, 2013). This constitutes the beginning of an understanding of a norm among fishers, which has been reported as a major driving factor in compliance behavior (Ciner et al, 2012). This study also finds a high perceived legitimacy of authority among fishers on the GBRMP, and that most fishers describe themselves as morally obligated to adhere to zoning regulations. This perception suggests a strong atmosphere of compliance behavior driven by normative beliefs of authority and the effectiveness in zoning regulations to protect the common good. Fishers believe in the protection of the resources of the GBRMP, and most voluntarily comply with regulations to ensure this protection. Finally, the perceived norm among fishers plays a critical role in driving their behavior. This study finds that the importance of fishing, as well as consumptive orientation, both have an effect on the creation of norms and the perception of these norms.

5.2: Suggestions for future study and policy formulation

The most important next step is to collect more data in order to build a strong model for compliance and actual compliance on the GBRMP. This study takes the first steps in analyzing the social atmosphere and the perception of normative beliefs among fishers, but it lacks the robustness for statistical significance. With a larger sample size, future study should start to build a model for predicting compliance behavior and the decision-making processes experienced by fishers to obey the law. With such a model, policy could be designed to take advantage of social norms and self-regulation to cut costs on enforcement and make the current zoning scheme for effective in protecting marine resources. The prospect of dynamic management should also be explored, as many fishers wanted a rotating zone system. If there is to be a strong social norm that promotes self-regulation, fishers must agree with the regulations and trust that they protect the common good. While there is a general acceptance of zoning as an institution, revisions to this institution could inspire more action from fishers and a stronger social base to promote voluntary compliance.

References:

Ajzen, Icek. 1991. The theory of planned behavior. *Organizational behavior and human decision processes* 50: 179-211

Arias, A., and S. G. Sutton. 2013. Understanding recreational fishers' compliance with no-take zones in the Great Barrier Reef Marine Park. *Ecology and Society* **18**(4): 18. http://dx.doi.org/10.5751/ ES-05872-180418

Armitage, Christopher J. Conner, Mark. 2001. Efficacy of the theory of planned behavior: a meta-analytic review. *British journal of social psychology* 40: 471-499

Cinner, Joshua E. McClanahan, Tim R. Macneil, Aaron M. Graham, Nicholas. Daw, Tim. Mukminin, Ahmed. Feary, David A. Rabearisoa, Ando. Wamukota, Andrew. Jiddawi, Narriman. Cambel, Stuart J. Baird, Andrew H. Januchowski-Hartley, Fraser A. Hamed, Salum. Lahari, Rachael. Morove, Tau. Kuange, John. 2012. Co-management of coral reef social-ecological systems. *PNAS* 109: 14: 5219-5222
Cowles, C. J., K. H. Beattie, and R. H. Giles. 1979. Limitations of wildlife law compliance estimators.

Wildlife Society Bulletin 7:188-191.

Fernandes, L., J. Day, A. Lewis, S. Slegers, B. Kerrigan, D. Breen, D. Cameron, B. Jago, J. Hall, D. Lowe, J. Innes, J. Tanzer, V. Chadwick, L. Thompson, K. Gorman, M. Simmons, B. Barnett, K. Sampson, G. De'Ath, B. Mapstone, H. Marsh, H. Possingham, I. Ball, T. Ward, K. Dobbs, J. Aumend, D. Slater, and K. Stapleton. 2005. Establishing representative no-take areas in the Great Barrier Reef: large- scale implementation of theory on marine protected areas. *Conservation Biology* 19:1733-1744. http://dx.doi.org/10.1111/ j.1523-1739.2005.00302.x

Great Barrier Reef Marine Park Authority (GBRMPA). 2004. *Great Barrier Reef Marine Park zoning plan 2003*. Great Barrier Reef Marine Park Authority, Townsville, Queensland, Australia. [online] URL: http://www.gbrmpa.gov.au/__data/ assets/pdf_file/0015/3390/GBRMPA-zoning-plan-2003.pdf

Ham, S. H. 2009. From interpretation to protection: is there a theoretical basis. *Journal of Interpretation Research* 14:49-57. [online] URL: http://www.thefreelibrary.com/From interpretation to protection: is there a theoretical basis?-a0219824506

Hatcher, Aaron. Jaffry, Shabbar. Thebaud, Olivier. Bennet, Elizabeth. 2000. Normative and Social Influences Affecting Compliance with Fishery Regulations. *Land Economics* 76: 3: 448-461

Jackson, Jonathan. Bradford, Ben. Hough, Mike. Myhill, Andy. Quinton, Paul. Tyler, Tom R. 2012. Why do people comply with the law? Legitimacy and the influence of legal institutions. *British journal of criminology*. 10: 1-21.
Kaiser, Florian G. Hubner, Gundula. Bogner, Franz X. 2005. Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behavior. *Journal of applied social Psychology.* 35: 10: 2150-2170

Lester, S. E. B. S. Halpern. 2008. Biological responses in marine no-take reserves versus partially protected areas. *Marine Ecology Progress Series* 367:49-56. http://dx.doi. org/10.3354/meps07599

McCook, L. J., T. Ayling, M. Cappo, J. H. Choat, R. D. Evans, D. M. De Freitas, M. Heupel, T. P. Hughes, G. P. Jones, B. Mapstone, H. Marsh, M. Mills, F. J. Molloy, C. R. Pitcher, R. L. Pressey, G. R. Russ, S. Sutton, H. Sweatman, R. Tobin, D. R. Wachenfeld, and D. H. Williamson. 2010. Adaptive management of the Great Barrier Reef: a globally significant demonstration of the benefits of networks of marine reserves. *Proceedings of the National Academy of Sciences* 107:18278-18285. http://dx.doi.org/10.1073/pnas.0909335107

Mullen, B., and L. Hu. 1988. Social projection as a function of cognitive mechanisms: two meta-analytic integrations. *British Journal of Social Psychology* 27:333-356. http://dx. doi.org/10.1111/j.2044-8309.1988.tb00836.x

Ross, L., D. Greene, and P. House. 1977. The "false consensus effect": an egocentric bias in social perception and attribution processes. *Journal of Experimental Social Psychology* 13:279-301. http://dx.doi.org/10.1016/0022-1031(77)90049- X

Sutton, Steven. 2003. Personal and situational determinants of catch-and-release choice of freshwater anglers. *Human Dimensions of wildlife: an international journal.* 8:2: 109-126

Sutton, Stephen. 2007. Constraints on recreational fishing participation in Queensland, Australia. *Fisheries* 32:2: 73-83.

6: Appendix

6.1: List of all questions and results

Question	Response
Q1. Since this time last year, how many days did you go spearfishing?	Average of 2.69
Q2. Since this time last year, how many days did you go line fishing?	Average of 28.38
Q3. Since this time last year, how many days did you do any other types of recreational fishing?	Average of 5.38
Q5a) The more fish I catch, the happier I am	Average of 5.24, SE of .21
Q5b) b) A successful fishing trip is one in which many fish are caught	Average of 4.5, SE of .27
Q5c) I would rather catch 1 or 2 big fish than 10 smaller fish	Average of 5.46, SE of .36
Q5d) It doesn't matter to me how many fish I catch	Average of 4.43, SE of .23
Q5e) The bigger the fish I catch, the better the fishing trip	Average of 4.71, SE of .22
Q5f) When I go fishing, I'm not happy unless I catch a lot of fish	Average of 2.79, SE of .22
Q5g) I'm happiest if I catch a challenging sport fish	Average of 4.96, SE of .24
Q5h) I like to fish where I know I have a chance to catch a big fish	Average of 5.64, SE of .23

Q6. Compared to other recreational activities that you do in the Great Barrier Reef Marine Park (such as boating, diving, swimming, etc.) would you say fishing is your most important, second most important, or one of many important activities?	71% Most important, 14% second most important, 15% third most important or one of many
Q7a) Marine Parks officers share the same background, morals, values and goals that I do:	Average of 5.41, SE of .26
Q7b) I am obliged to obey the Marine Parks zoning regulations:	Average of 6.61, SE of .16
Q7c) Marine Parks personnel are approachable and respectful to fishers:	Average of 5.32, SE of .26
Q7d) Marine Parks personnel use fair processes and make fair decisions when dealing with fishers:	Average of 5.01, SE of .26
Q7e) The current zoning plan (fished/blue zones, no-take/green zones) allows everyone a "fair or equal share" of the benefits and resources on the GBR	Average of 5.33, SE of .36
Q7f) I trust that Marine Parks personnel will do their job effectively and in the public good	Average of 5.27, SE of .26
Q8. Have you ever contacted your government representative, made a submission to a government agency (e.g. Fisheries QLD, GBRMPA), or attended a public meeting about a fisheries-related topic?	26% yes, 74% no
Q9a) Fishing in a green zone would result in catching more fish	Average of 5.43, SE of .24

Q9b) Fishing in a green zone would result in catching larger fish	Average of 5.34, SE of .2
Q9c) Fishing in a green zone would result in catching higher quality/rarer fish	Average of 5.01, SE of .22
Q9d) Fishing in a green zone would result in getting fined	Average of 6.54, SE of .11
Q9e) Fishing in a green zone would result in the confiscation of my boat or fishing equipment	Average of 5.4, SE of .21
Q9f) Fishing in a green zone would result in social shame or disapproval due to being caught	Average of 5.2, SE of .2
Q9g) Fishing in a green zone would result in the removal of important fish from the breeding stock	Average of 5.67, SE of .2
Q9h) Fishing in a green zone would result in other damage to the environment (e.g. damaging corals due to anchors, losing gear, etc.)	Average of 5.22, SE of .19
Q10. Are you a member of any recreational fishing club?	5% line fishing club, 1% mixed club, 94% none
Q11a) Fishing in a green zone will NOT affect the environment:	Average of 2.63, SE of .22
Q11b) My friends, family, and coworkers would approve of me fishing in a green zone:	Average of 1.72, SE of .14
Q11c) When it comes to fishing in a green zone, I really care about	Average of 5.38, SE of .21

what my friends, family and coworkers think:	
Q11d) Fishers that I know would approve of me fishing in a green zone:	Average of 2.02, SE of .17
Q11e) Fishers that I know have fished in a green zone in the last 12 months:	Average of 2.41, SE of .25
Q11f) When it comes to fishing in a green zone, I really care about what fishers that I know think:	Average of 5, SE of .22
Q12. Have you ever been inspected or checked by Marine Parks or Fisheries officers (e.g. rangers, enforcement patrols, etc.)?	32% no, 68% yes
Q13a) Other fishers (that I don't know personally) that use this boat ramp would approve of me fishing in a green zone:	Average of 2.03, SE of .15
Q13b) Other fishers (that I don't know personally) that use this boat ramp have fished in a green zone in the last 12 months:	Average of 4.83, SE of .22
Q13c) When it comes to fishing in a green zone, I really care about what other fishers (that I don't know personally) who use this boat ramp think:	Average of 4.76, SE of .24
Q14d) I know how to get information on green zone boundaries:	Average of 6.6, SE of .11
Q14e) I am educated about, or aware of, the green zone boundaries where I fish:	Average of 6.5, SE of .13

Q15a) It is acceptable to me if I fish in a green zone:	Average of 1.45, SE of .12
Q15b) The risk of getting my boat, fishing equipment, or other property confiscated would prevent me from fishing in a green zone:	Average of 5.27, SE of .27
Q15c) The social shame or disgrace of being caught would prevent me from fishing in a green zone:	Average of 4.66, SE of .25
Q15d) The risk of being fined would prevent me from fishing in a green zone:	Average of 5.87, SE of .21
Q16) Why do you think people fish in green zones?:	
Q16a) Because people expect fishing to be better in a green zone	Average of 6.45, SE of .1
Q16b) Because they don't care about conservation	Average of 5.34, SE of .2
Q16c) Because they don't think they'd get caught	Average of 5.66, SE of .14
Q16d) Because people have the right to fish where they want	Average of 4.41, SE of .2
Q16e) Because they disagree with green zones	Average of 4.8, SE of .2
Q16f) Because it was an accident	Average of 5.4, SE of .18
Q17) Have you ever seen someone fishing in a green zone?	38% yes, 62% no

Q18) In your opinion, what proportion of recreational fishers do you think have fished in a green zone in the last 12 months? (0-100%)	Average of 8.53%, SE of 1%
Q19) Do you personally know anyone that has fished in a green zone in the last 12 months?	8% yes, 92% no
Q20) Have you ever fished in a green zone in the last 12 months?	4% yes, 96% no
Q21) RRT Question	37% yes, 63% no
Q22) UCT treatment	Average of 2.6
Q23) UCT control	Average of 2.4

Table 3: full list of questions and responses with averages where appropriate

6.2: Explanation of randomizing techniques for reporting actual compliance and future uses

The survey contained a series of self-administered questions that were designed to create a reliable estimate of actual compliance among fishers. For the purposes of this study, these questions are not developed with a large enough sample size to be worthwhile, but the continuation of this study will use these questions in order to find a reliable measurement of actual compliance. These include an anonymous answer to the question "have you fished in a green zone in the past 12 months?" as well as two separate techniques to estimate compliance. Each survey contained only one of these questions (i.e. either the UCT treatment, UCT control, or RRT) The first, UCT control and UCT treatment, asked respondents to indicate how many, but not which, of a series of activities they had participated in in the last 12 months. The treatment included: trolling for pelagic species, spearfishing, line fishing, fishing near a green

zone boundary but outside of it, and fishing in a green zone. The control was identical except for the omission of fishing in a green zone. The third survey contained an RRT (random response technique) question to estimate actual compliance. This question involved the use of a randomizing device to answer the question "have you knowingly fished in a green zone in the last 12 months?" the device was a sealed container containing different color beads. 85% of the beads were red or green, and 15% were blue, purple, yellow or orange. Each color corresponded to a response. The red or green beads prompted the question "have you knowingly fished in a green zone in the last 12 months?" The blue and yellow beads corresponded to a "no," without asking a question, and the purple or orange beads corresponded to a "yes." Respondents were asked to pick a bead at random and give an answer without telling the surveyor what color they got. This method serves to protect confidentiality and promote honesty among respondents.