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Examining the Tragedy of the Commons Dilemma: Looking at the New Hampshire Fishing Industry

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UNDERGRADUATE HONORS THESIS
UNIVERSITY OF NEW HAMPSHIRE

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Abstract

The Tragedy of the Commons is a widely known problem debated amongst economists for years. Even the topic of the Tragedy of the Commons when applied to fishing has been debated several times. The fishing industry is a major part of the culture and economy here in New Hampshire and the conversation how to properly tax and regulate it to combat this problem is one that has been taking place and will continue to take place for several years. The purpose of this project was to examine this problem at a state level and look at the relationship between State Tax Collections from fishing licenses, the number of Paid Fishing License Holders in New Hampshire and the GDP of the fishing industry. I overall had mixed results with some datasets representing significant statistical relationships, while others had marginal results. More research would need to be done in this area to make any certain conclusions. There are several areas in this topic that I couldn't analyze for a variety of reasons, and this project merely scratches the surface of the amount of research left to be done.

Literature Review

The "Tragedy of the Commons" (originally written by Garrett Hardin) is an economic concept where many people shared a limited common resource such as an ocean, or lake. Each person (in my example a fisherman) puts his own self-interest over that of the common good (a lake). Since the individual fisherman does not own the lake, he can fish as much as he wants and gain all the benefits while spreading the negative effects (such as overfishing) among the larger population, and thus the tragedy (Hardin, 1968). This concept is applied in my work that if the Gross Domestic Product of the fishing industry increases, I would argue both the amount of State Tax collections as well as the number of fishing license holders, as these are the primary

mechanisms in which the State of New Hampshire would combat this problem. “Each man is locked into a system that compels him to increase his herd without limit-in a world that is limited” (Hardin, 1968, p. 1244).

To understand some more background on this dilemma and its current situation it’s important to first understand a little about the fishing situation currently in New Hampshire. New Hampshire as of 2019 has roughly 157,000 paid fishing license holders (US Fish and Wildlife Service, 2019) and maintains roughly 18 miles of ocean shoreline. As far as fishing licenses go in the State of New Hampshire, the most common is a residential freshwater fishing license which costs \$43 which was just increased from \$33 in 2015 as well as residents over the age of 68 paying \$10 for the same license (Tracy, 2015). There are several other licenses both at the recreational and commercial level for a range of different uses and ranging from a variety of prices.

Next some important context around the concept of overfishing and depleting fish stocks provides some necessary information surrounding a fundamental part of my research. According to research, roughly 12-28% of all fishing world-wide is done illegally and unregulated while, “almost 30% of fish stocks commercially fished are over-fished” (“Facts & Figures: The cold hard facts about overfishing”, n.d.). This statistic is important to understand that illegal fishing is a major problem not only in the world but also in our state, as relates to the Tragedy of the Commons as illegal fishermen are able to maximize their gain by fishing public waters, but then spread the cost throughout essentially everyone in New Hampshire as well as the planet. Fishing technology has certainly been a factor in the theme of overfishing, “Advancement in fishing technology, capacity is now estimated to be 2.5X that needed to harvest a sustainable yield from world’s fisheries” (Nellemann, Hain, & Alder, 2008, p. 10). More specifically to understand the

prevalence of the problem in waters close to and surrounding New Hampshire, “In the North East Atlantic and nearby seas, 39% of fish stocks are classified as overfished” (“Facts & Figures: The cold hard facts about overfishing”, n.d.). Another important statistic when examining the Tragedy of the Commons problem at a nationwide level is “Over 95% of the damage and change to seamount ecosystems caused by bottom fishing, most of which are unregulated and unreported” (Nellemann, Hain, & Alder, 2008, p. 10) and as we can see this problem is hurting much of the environment worldwide and needs to be investigated at a state level.

One article by Takaomi Kaneko, Takashi Yamkawa, and Ichiro Aoki (2009) titled, “Fisheries management using a pooling fishery system with a competitive sharing rule as a remedy for the ‘tragedy of the commons’” helps one understand a similar situation and free-riding problem that we have seen all over the world and New Hampshire. It briefly explains that in theory, “all of the fishermen who engage in the fishery pool all of their incomes, and then share the pooled income impartially (i.e., equally) afterwards. In many cases in Japan, this system is used in a small fishing community like a fishery cooperative association. Since they exit from the fishing race, they can prevent fish prices from collapsing due to oversupply and avoid overinvestment in fishing gear. They also gain longterm benefits like stock sustainability or income stability by controlling the total fishing effort in the community” (Kaneko, Tamkawa, & Aoki, 2009, p. 1345). This does address the free-riding problem mentioned earlier because it gives the fishermen incentive by providing more security around income as well as reducing their risk in things such as overinvestment in fishing gear and a sustainable fishing stock. The piece concludes by mentioning, “The standard pooling system and the free competitive fishery resulted in a lower biomass and a smaller income in many cases than the income pooling system with a competitive sharing rule” (Kaneko, Tamkawa, & Aoki, 2009, p. 1356). So even in this one

example it is worth considering if this idea would work and benefit New Hampshire fishermen on a long-run scale as it did in this example.

In a piece written by Xavier Basurto (2005) he looks at how to prevent the Tragedy of the Commons in a small Mexican community. While this piece deals with a small-scale example and might be difficult to reproduce in New Hampshire, he does bring up several key points that relate to my example in New Hampshire. After studying the community's access and use controls the author goes on to explain, "Contrary to Hardin's (1968) prediction, the case of the Seri CDH fishery illustrates how communities that face tragedy of the commons dilemmas might still be able to develop access and use controls for their fishing resources and avoid overexploitation" (Basurto, 2005, p. 657). This is a key takeaway when looking at the New Hampshire fishing systems that even though they are government-owned and considered a public good, it still is possible and in the best interest of the public to monitor them and ensure their long-term sustainability as stated in this case. While there is some degree of "access and use controls" in place throughout the state currently such as lake hosts, Marine Patrol units, and others, the purpose of my study is to essentially look at how effective these are.

The last element to reviewing the literature around this tragedy and the fishing systems in New Hampshire, it is important to know what specific laws are currently in place both at a national and state level to prevent this problem. There are 2 key pieces I mention in this piece according to the National Oceanic and Atmospheric Administration's website (2017):

- **Magnuson-Stevens Fishery Conservation and Management Act** "is the primary law governing the management of marine fisheries in U.S. federal waters"

- **Marine Mammal Protection Act** “protects all marine mammals and prohibits the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas”

The Magnuson-Stevens Fishery Conservation and Management Act is most important for my purposes as it speaks directly to the fishing aspect and as its states is the, “primary law” when it comes to addressing the management of fish. This is the basic consequence for someone looking to exploit the Tragedy of the Commons problem and sets the precedence for how we are to treat and manage our waterways. The Marine Mammal Protection Act is important to include here even though it addresses marine mammals rather than fish, but this is an environmental effort to support the health and sustainability of our water ecosystems and protect Marine Mammals. One could argue that their health relates to the health of fish, thus I felt it was an important piece to include. Another Act import to include regarding the overexploitation and protection of fishing is the Lacey Act of 1900. According to the US Fish and Wildlife service website, “it is unlawful to import, export, sell, acquire, or purchase fish, wildlife or plants that are taken, possessed, transported, or sold: 1) in violation of U.S. or Indian law, or 2) in interstate or foreign commerce involving any fish, wildlife, or plants taken possessed or sold in violation of State or foreign law)” (US Fish and Wildlife Service, n.d.). This law gives incentive to catch and sell fish legally in accordance with several laws across the US and is a main deterrent from someone trying to exploit our fishing systems and sell illegal product and maximize their individual benefit.

Research Topic

The main purpose of my thesis was to examine whether there was a statistical significance between the amount of state tax collections from fishing licenses, number of paid fishing license holders in the State of New Hampshire and the Gross Domestic Product of the Private Fishing Industry in New Hampshire. For my purposes I wanted to keep this strictly a state-level study to avoid any overlaps at a national level or share any data with other states. If there is a statistical relationship then my hypothesis would be that as the fishing industry grows we would take more tax collections and that the number of fishing licenses would also increase, as those are our main points to combat the Tragedy of the Commons for my purposes since we can use that money to maintain our fisheries and continue to sustain their growth.

Data and Methodology

The data I collected was all at the state level in a few key areas. As I mentioned before, all my data is yearly collected from 1997 through 2017 which I felt gave a 20-year window which I felt would be complete enough of a data set to look at and examine the numbers against. One mention about this data however is sometimes it is difficult to isolate just fishing statistics and this is one critique I would have of this data. The data I have regarding the state tax collections does include both fishing and hunting licenses and for my Gross Domestic Product (GDP) data it does include the private industries of agriculture, forestry, fishing, and hunting according to the US Census Bureau of Economic Analysis. For the number of paid fishing license holders, I referred to the US Fishing and Wildlife Service, and this data set was my most accurate and precise and was exclusive to fishing. My methodology for this data was to run a regression of the natural logs of all the data because I felt it would be more effective to look at

the percent change across three categories to keep it consistent because both the GDP and state tax data were in dollars while the number of fishing license holder was in the amount of people. I then ran a multiple-linear regression with the natural log of GDP as the dependent variable on the left side of the equation. I then ran the natural log of both the state tax collections from hunting and fishing licenses and the number of paid fishing license holders in the state of New Hampshire as my right-hand side variables.

Model

$\ln(\text{GDP of Private Industry Agriculture, Forestry, Fishing, and Hunting in NH}) =$

$\beta_0 + \beta_1 \ln(\text{Paid Fishing License holders in NH}) + \beta_2 \ln(\text{NH State Tax Collections, Fishing and Hunting Licenses})$

Results

Independent Variables	Coefficients	P-Value
$\ln(\text{Paid Fishing License Holders in NH})$	0.971017	*0.07255
$\ln(\text{NH State Tax Collections, Fishing and Hunting Licenses})$	0.886385	***3.53E-05

It is also important to note that in my regression process I ran regressions with just the GDP against Paid Fishing License Holders as well as ran GDP against NH State Tax Collections and both with the raw data as well with the natural logs of the data, and none of the variables had statistically significant relationships.

Interpretation

While my p-value for the natural log of Paid Fishing License Holders in NH was marginally significant at 0.07255, the p-value for the natural log of NH State Tax Collections was highly significant at 3.53E-05. To interpret the relationship between the GDP and Paid Fishing License Holders in NH we first look at the coefficient of 0.971017. On average for every 1% increase in the Paid Fishing License Holders in NH, GDP increases by 0.97%. Likewise, with NH State Tax Collection's coefficient of 0.886385, on average for every one percent increase in the NH State Tax Collections results in a 0.89% increase in GDP.

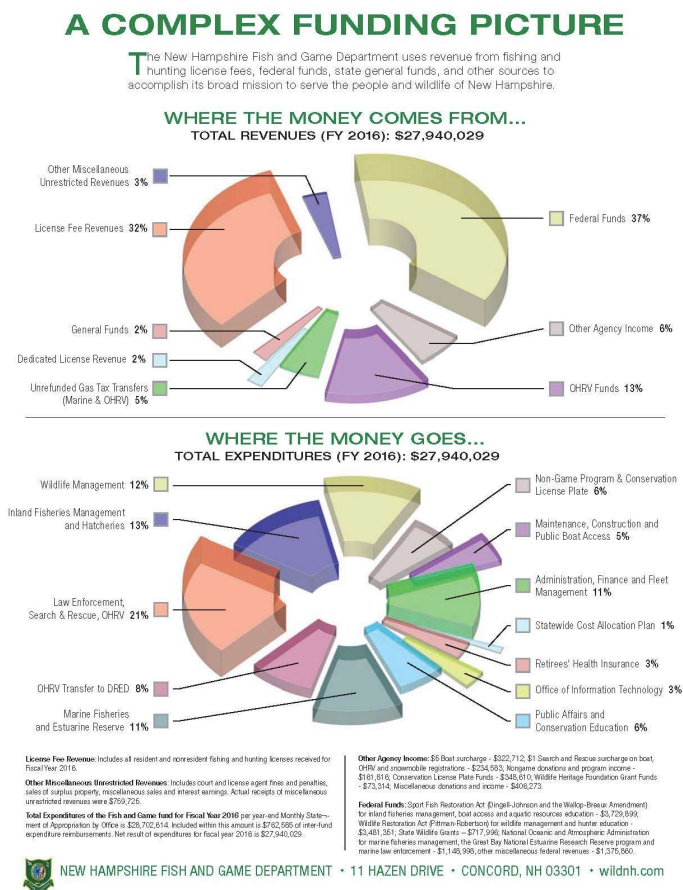
Conclusions

The most important part of my entire research as far as conclusions is to note there is a statistically significant relationship between the Private Industry GDP of Agriculture, Forestry, Fishing, and Hunting in NH, the number of Paid Fishing License Holders in NH, and the NH State Tax Collections from Fishing and Hunting Licenses. The fact that there is a relationship does show that the two primary methods to prevent the Tragedy of the Commons here in New Hampshire in the form of license fees and tax collections are related to the GDP of the very industry. If this had not been the case, one could make the argument that there are not proper measures in place to prevent such a tragedy since the amount the State collects in taxes had no relationship to the actual GDP of the fishing industry. For my purposes and in my intellectual opinion, after gathering data having coefficients of 0.97 and 0.87 for my two factors does show that there are reasonable measures to prevent the Tragedy of the Commons in the State of New Hampshire regarding the fishing industry. It is also very important to note that much more research must be done in this area to make any certain conclusions as my data was limited and

included many other industries especially in my GDP variable as well as the NH State Tax Collections also included revenues from hunting licenses. In further research I would also try to incorporate some form of environmental variable such as mercury levels in the water, boating license information to see if the number of watercrafts in New Hampshire waters has any environmental impact, and potentially trying to measure different data as far as the specific fish species and their population levels over the years. The Tragedy of the Commons will be an ongoing debate for many things such as the environment, fishing systems, and many others in the years to come and this study merely scratched the surface in one small example.

Appendix

Figure 1. NH Fish and Game Revenues and Expenditures for 2016



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