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Big Data Analysis

Final Paper

Sustainable Management of the Atlantic horseshoe crab (*Limulus polyphemus)*

The Atlantic horseshoe crab (*Limulus polyphemus*) is one of the world’s oldest living arthropods that remains crucial to a suite of human and ecological interests. These animals can inhabit the east and southern coasts of North America from Maine to Mexico with their highest densities occurring between Virginia and New Jersey (Ropes et. al. 1982; Botton and Ropes 1987). Like many oviparous marine animals, female horseshoe crabs lay their eggs (approximately 90,000 annually) on sandy protected beaches to be fertilized by their male counterparts. The spring spawning season can be highly affected by tide, lunar cycle, weather, and other variable environmental conditions (Cohen and Brockmann 1983; Smith et. al. 2002). These factors alone may play a negative role in horseshoe crab reproductivity, but when combined with anthropogenic influences it is clear why this stock has been declining.

Horseshoe crabs are commercially harvested for bait and biomedical purposes, making it a particularly unique fishery. Their use as bait in the eel and whelk pot fishing industry remains the primary disposition of horseshoe crabs caught on the east coast (ASMFC 2019). The biomedical industry will harvest horseshoe crabs for their blood, which is extracted to create Limulus amebocyte lysate; the current gold standard of endotoxin detection in the medical and dental fields (Berkson and Shuster 1999). In response to the high number of crabs being harvested for the American eel and whelk baiting fisheries, the Atlantic States Marine Fisheries Commission (ASMFC) published the first fisheries management plan (FMP) for horseshoe crabs in 1998 (ASMFC 1998). To date, this management plan has grown to incorporate several management tools to preserve the stocks including state-specific quota allocations, sex-based moratoriums, temporal closures, biomedical best management practices, and consideration for migratory shore birds. While these management measures can vary between states, horseshoe crab management units are grouped regionally based on geography and/or further scientific for single stocks (e.g. mixing, genetics).

In order to verify that each state is following the measures established by the FMP, the Atlantic States Marine Fisheries Commission requires an annual compliance report. The bulk of the compliance report can be separated into two main sections: fisheries dependent data and fisheries independent data. The data in Tables 1-4 constitutes the fisheries dependent portion of the report. This data represents how the quota established by ASMFC, which is based on stock assessment, is utilized by the state’s commercial fishing industry. This data is crucial because it captures the temporal scope and mode of harvest, both of which can be used as tools to restrict harvest if the population is underperforming and fishing effort needs to be altered. For the state of Rhode Island, biomedical use is the primary disposition of harvested crabs\*. However, the crabs that are used for biomedical purposes are returned to the water after blood harvest thus not making them a true mortality. Given the taxing conditions of transport to the bleeding facility and the bleeding process, the ASMFC has estimated that mortality associated with biomedical horseshoe crabs is about 15%. This is an incredibly important metric to consider when establishing a sustainable quota for annual harvest. For every other fishery, once an animal is harvested it is never returned to the spawning stock. Biomedical crabs that survive the process and return to the water will presumably continue contributing to the existing population. Although tracking this data does present many challenges, the fact that this resource can be utilized without total mortality is an excellent contribution to sustainability.

The second part of the report, Figures 1-3, display fisheries independent data collected by the state of Rhode Island during annual surveys. As with all biological data, these datasets are important because they are unbiased and represent a long time series. Although it is not presented in the compliance report, the trawl survey first started collecting horseshoe crab data in 1989. For the sake of ASMFC, a ten year time series is considered adequate for use in assessing a stock with a degree of certainty. Although this compliance report may suggest that horseshoe crab data is widely collected and available, it is safe to say this species is one of the most “data poor” in the repository of species that the ASMFC manages. The main reason for this is the lack of directed surveys designed for specifically capturing horseshoe crabs. This is the case in Rhode Island and many other east coast states. As Table 2 shows, 94% of the harvest occurs by hand˚. One of the two surveys used to characterize the population in this report uses an otter trawl which only accounts for 3%˚ of the total harvest. The spawning survey does represent the “by hand” method of harvest; however, this survey is only conducted in two locations due to staff and funding limitations. Increasing Rhode Island’s ability to sustainably manage this stock should start with a more comprehensive understanding of the population in state waters.

This compliance report is an important accountability tool for the states. However, the onus is also on the states to go beyond reporting what is simply available and create meaningful methods to determine whether the data they are seeing accurately depicts the status of the state’s resource. Given the high value of horseshoe crabs in the bait and biomedical markets paired with their dwindling numbers on a coastwide level, I believe it is imperative for states to request and allocate additional resources to reviving this species while it is still within the window of opportunity for successful rehabilitation.

\*This is in reference to the “real” data, not the “mock” data that is in the PDF report

˚This percentage is true for both “real” and “mock” data

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