Assessing the Adaptation Responses of Fishing Communities to Climate Change in the Northwest Atlantic

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Introduction

The gradual warming of oceanic temperatures due to anthropogenic climate change (Figure 1) is becoming an increasingly crucial concern with regards to fishing communities that rely on harvesting a food source that is vital for feeding much of the global population, as well as providing a means of livelihood.

![Change in Sea Surface Temperature, 1901 - 2015](source: http://www.epa.gov)

This radical change is of particular concern to fleet fishing communities, given that a number of commercially-fished species are showing signs of shifting northward as a result of warming waters.

To examine shifts in the patterns of community fleets over time, using techniques of spatial data analysis, would be advantageous in illustrating how fisheries are responding to climate-induced species migrations and other ecological conditions.

The aim of this research is to show whether various degrees of loyalty regarding the port of origin can be linked to specific range shifts of fishing activity.

Materials & Methods

I utilized Communities at Sea (CAS), a database containing secondary fisheries data also integrating VTR data (property of & in accordance with NMFS standards) consisting of fishing trips from commercially-licensed vessels in the Northeast U.S. from 1996 to 2015. The CAS data was processed and manipulated using the R programming language in addition to ArcMap. The CAS database contains spatially explicit information of the geargroup, crew size, trip length, port of origin, and port of landing.

The level of analysis was performed on a community level (combination of geargroup e.g. dredge and port of landing).

The port of Beaufort, NC was selected as the subject for spatial analysis, given the location’s history of range shifts, as well its significance regarding catch quantity and number of vessels.

Using CAS data for Beaufort, three groupings of fishing loyalty were developed:

- Geargroup Trips that landed in Beaufort, but were registered elsewhere (w/87 vessels)
- Geargroup Trips that both registered and landed in Beaufort (w/53 vessels)
- Geargroup Trips that registered in Beaufort, but landed elsewhere (w/54 vessels)

To compare the progression of fishing locations over time, two time periods were used: 1996-1999 & 2011-2015. Weighted centroids for all Beaufort communities, based on fisherdays (= crew * trip length) were developed. Kernel density estimations were developed for the trawler communities.

Results

The weighted centroids of the fishing activity (fisherdays) of different geargroups are shown in Figure 3 show fishing vessels larger/smaller than 65 ft using trawl gear fishing much further northward than most of the other geargroups, on average from 1996 – 2015.

Furthermore, the kernel density estimation of the Loyal vessels larger than 65 ft using trawl gear (Figure 4) shows the fishing hotspots shifting northward during the latter time period.

Observing the core areas of fishing activity of the three groupings of the 65 Plus geargroup, (Figures 5, 6, and 8), the ranges exhibit a shift northward in the latter time period (2011-2015). Additionally, observing the core area activity of the loyal 65 minus geargroup (Figure 7) shows the core areas disappearing in the latter time period. Clearly, the vessel activity of this geargroup has severely waned over time.

Conclusions

These results help in clarifying the types of communities that are being affected by climate change-related shifts in marine species distribution. The large-scale trawlers (larger than 65 ft) fishing activity appears to adapt to the northward shift in fish by shifting further north.

Nonetheless, the fishing activity of the small-scale trawlers disappeared over time. This can additionally be corroborated by the gradual decline in recent years of the annual number of active vessels originating from Beaufort (Figure 9). The issue of whether this decline is climate-related requires further investigation, but it emphasizes the relationship between adaptation mobility and vessel size.

Examining the shifts in the core area ranges amongst the three groupings also shows that the core area of Fisherdays for trips that landed in Beaufort, but were registered elsewhere, are significantly increasing. This “outsider” grouping currently lands more trips in Beaufort than trips that are registered in Beaufort, and has a greater number of vessels.

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Reference