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Identifying Potential Anglers and Customer Segments of Texas Catfish Anglers to Guide Management Actions

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[A]Abstract

In this paper, we demonstrate how one can combine angler survey data with ESRI® Tapestry™ data to assist in developing a statewide catfish R3 (Recruitment, Retention, and Reactivation) and management plan. In 2010, Mississippi State University surveyed 1,078 Texas freshwater catfish anglers to examine their catch-related attitudes and trip preferences using a stated choice experiment. The study showed that the responding freshwater catfish anglers could be grouped into five clusters based on their catch-related attitudes. We used ESRI®'s Business Analyst® extension to define the primary customer segments (also called Tapestries™) within these five catch-related clusters. We used principal components analysis followed by a similarity profile analysis to help

us identify differences among the customer segmentations for the five catch-related clusters. We found that the Rooted Rural Tapestry™, located outside urban areas, were significantly more likely to be associated with those catfish anglers whose answers suggested they had higher trophy motivation compared to the other angler clusters. We also found that anglers in the urban areas were more likely to have a variety of motivations. The Southwestern Families Tapestry™ was identified as an underserved group that shows high growth potential and should be considered for targeted R3 efforts using insight gathered from that tapestry on media channels where they get information. We plotted areas with high populations and proportions of individual Tapestries™ that were the greatest in discriminating among the catch-related angler clusters. Our ESRI® predictive maps for 2024 showed areas throughout Texas where managers could focus different R3 advertising and catfish management strategies based on the underlying customer segments.

Many natural resource agencies are concerned about declining outdoor participation (ASA and AFWA 2007; Cordell 2012; RM and NSSF 2017). One response to declining participation has been involvement in R3 (Recruit, Reactivate, and Retain) activities (AREA and RBFF 2016). These R3 activities focus on finding ways to recruit new customers to become license buyers, reactivate customers who have purchased a license in previous years, but have not bought one in the current license year, while retaining current license buyers. To be effective, angling R3 activities must both recognize our country's current and future angler demographics (e.g., age, ethnicity, and residency), and recognize how changes in those demographics might affect future participation (RM and NSSF 2017). For R3 to be successful the messages delivered must resonate with each specific angler. Because not all anglers are homogeneous (Burlingame and Guy 1999; Reitz and Travnichek 2004), one strategy of the current R3 approach is to provide a diversity of angling opportunities (AREA and RBFF 2016). The Texas Parks and Wildlife Department (TPWD), Inland Fisheries has approached this need for diversity using the angler specialization continuum (Bryan 1977; Fedler and Ditton 1986) for guidance. Tailoring the right message or managing for the right fishery can be difficult without knowing the preferences and desires of the local anglers.

Surveys can begin to help us to understand this diversity, as well as what barriers anglers may face (Wilde and Ditton 1999; Oh et al. 2005; Hunt and Hutt 2010). Unfortunately, surveys can routinely suffer from low response rates, and every survey approach has its own set of biases (Kish 1965; Graefe et al. 2011). Many angler surveys are mail based, an expensive approach that can suffer from low response rates (Sexton et al. 2011; Lesser et al. 2016; Campbell et al. 2018). To overcome difficulties of low response and bias, practitioners routinely suggest using large, multi-modal surveys (Essig and Holliday 1991; Dillman et al. 2009). The complexity and expense of these survey approaches make it difficult for many state agencies to routinely survey their anglers. As such, it is incumbent to get as much information from each survey as possible.

A previous statewide survey (Wilde and Ditton 1999) suggested some key differences between Texas catfish anglers and other Texas anglers. Thus, in 2010, TPWD worked with Mississippi State University to conduct an angler survey to better understand Texas catfish anglers (Hunt and Hutt 2010). Within the survey, Hunt and Hutt (2010) characterized Texas' catfish angler attitudes and preferences using two methods. First, they used a more traditional approach based on consumptive orientation (Fedler and Ditton 1986; Wilde and Riechers 1994; Anderson et al. 2007). Second, anglers were asked a series of stated choice questions that examined catch aspects as well as trade-offs associated with distance traveled, amenities, and waterbody preferences (Hunt and Hutt 2010; Hunt et al. 2012; Hutt et al. 2013). The results from this survey identified five significantly different segments of catfish anglers (Hutt et al. 2013) based on their catch-related attitudes and fishing preferences. When deciding between catch-related attributes and other aspects, the Texas statewide catfish survey (Hunt et al. 2012; Hutt et al. 2013) found that one primary barrier to continued angling was having a desired fishing experience close to home; a result common among angler surveys (Caulkins et al. 1986; Hunt and Hutt 2010; Hunt et al. 2019).

While the statewide catfish survey was able to discriminate between five distinct angler groups, it could not tell managers how these groups were spatially distributed (Hunt et al. 2012, Hutt et al. 2013). The spatial scale of the survey was too coarse to advise a fisheries manager about how to manage or market a specific waterbody's

catfish fishery to the local anglers. At the other end of the scale, regional management biologists can conduct localized surveys (e.g., Dawson et al. 1991; Driscoll and Myers 2014). However, it can be difficult to understand how to expand results from a single waterbody to other locations. What is needed is a way to match the resolution from the survey with the resolution of management, and hence integrate this information in a manner to facilitate good decisions.

The Environmental Systems Research Institute (ESRI®) has a software extension called Business Analyst® (BA) that can be added to an ESRI ArcGIS license; the extension segregates people into various groups based on customer behavior and location (ESRI® 2011, ESRI® 2018, ESRI® 2020). One such grouping (Urbanization Summaries) has 11 subdivisions based on the level of urbanization and population density. Another grouping (LifeMode™ Summaries) has 12 subdivisions based on lifestyle and life stage or age. The finest scale is called customer segments or Tapestries™ (ESRI® 2020) and groups those with similar customer behavior (i.e., interests, income, spending, media habits, and demographics). It has been previously demonstrated that some of these LifeModes™ are more likely than others to contain anglers (ASA and AFWA 2007). However, even within a LifeMode™, not all Tapestries™ appear to include anglers. Not only do Tapestries™ segregate by behavior, they often segregate spatially as well. We posit that linking Tapestries™ with an understanding of what the anglers within those customer segments want could provide a possible remedy for knowing which angling opportunities to provide and where to provide them.

Using the Tapestries™ from BA it may be possible to use data from one scale (e.g., a statewide survey, a local survey) and apply the results at another scale (e.g., locally, and statewide). For instance, if the different catfish angler clusters from Hutt et al. (2013) were comprised of contrasting customer segments, biologists might be able to evaluate customer segments around a given waterbody and create fisheries or targeted marketing that reflect the preferences of the local anglers. Thus, our objective was to identify relationships between ESRI®'s customer segments and the five catch-related clusters of catfish anglers identified by Hutt et al. (2013). As a proof of concept, we then create maps to see how we could use a combined survey and GIS approach to suggest

where TPWD might develop (through management activities) or highlight (through R3 targeted marketing) catfish-focused fisheries based on those customer segments.

[A]Methods

We took the solutions for the five bias-corrected, catch-related clusters of catfish anglers directly from Hutt et al. (2013); they found that some anglers focused on harvest (Harv; n=81), some on high catch rates (Catch; n=121), some on both high catch and harvest (Num_Size; n=77), others on maximum size (Size=37), whereas many seemed most focused on non-catch related aspects of the fishing experience (Casual=146). These five unique cluster identifiers from Hutt et al. (2013) were matched with the unique identify number (ID) from the initial mailings of the statewide catfish survey (Hunt and Hutt 2010). Using ESRI®'s ArcGIS 10.0 North American Geocode Service (ESRI® 2016), we geocoded each respondent associated with the survey (n=462) to the census block level. The geocoded IDs, along with the information on the cluster associated with each ID, were imported into BA. Using BA from 2016 (the oldest year we had access to through our Tapestry™ license), we estimated the proportion of each of the 66 customer segments (also known as Tapestries™) that made up each of the five catch-related catfish angler clusters. A data table which contained the proportion of each customer segment within each of the five catch-related catfish angler clusters, along with the customer segments associated with adults (age 18+) in Texas (Texas Adults) was imported into Primer-e (Clarke et al. 2014; Clarke and Gorley 2015). Primer-e is a statistical software package developed primarily for analyzing multivariate data on ecological communities (Clarke et al. 2006; Clarke et al. 2014; Growns et al. 2014). Although the tool has been used primarily for multivariate relationships between organisms and their environment, many of the tools within this package can be used to solve a variety of multivariate problems. We used a principal components analysis (PCA: Legendre and Legendre 2003; Hair et al. 2010) option in Primer-e to estimate the similarity in customer segments among the six different groups: the five different catch-related angler clusters and Texas Adults. We then used Similarity Profile (SIMPROF) tests (Clark et al. 2014) in Primer-e to segregate significantly different clusters. Finally, we used the highest loadings (i.e., customer segments with correlations >0.4) from the first two axes of the PCA (Hair et al. 2010) to identify which customer segments best

segregated the angler clusters. The length and direction of the vectors within the plot show how strongly the various Tapestry™ segments influence each axis.

Once we had identified those customer segments with the highest loadings on our PCA axes, we used BA to plot densities (i.e., numbers of people) and relative densities (i.e., percent of population within the spatial designation) of these customer segments throughout Texas for 2019. In addition, we also used ESRI®'s 2019 - 2024 projections to plot the percent change in the number of households for each focal Tapestry™.

[A]Results

A plot of the physical location of respondents (Figure 1) indicates that, because the initial catfish angler survey frame was selected from a random selection of license holders, many of the respondents lived in or near the larger metropolitan areas of Dallas-Fort Worth, Houston, Austin and San Antonio. Of the potential 66 customer segments (or Tapestries™) within ESRI®'s BA, 47 Tapestries™ appeared in at least one of our catch-related catfish angler clusters (Table 1). A SIMPROF test on the catch-related catfish angler clusters and Texas Adults suggested that there were two groups (Figure 2). The "Size" cluster differed ($p=0.047$) from the other four catch-related clusters and Texas Adults. Texas Adults and all other clusters were not significantly different from each other ($p>0.05$). Primarily, as the vector that points in the positive direction along PCA axis 1 shows, the "Size" cluster had higher representation from "Midland Crowd" and "Rooted Rural", and as the vector that points in the negative direction along PCA axis 1 shows, fewer "Up and Coming Families". In addition, the "Size" cluster had no representation in 27 of the 66 Tapestries™ represented in at least one of the other catch-related catfish angler clusters. To test whether these missing Tapestries™ could have been associated with our sample size, we took the average proportion of each Tapestry™ from within the other four clusters and estimated the expected number of respondents given our sample within the "Size" cluster. We estimated that of those 27 Tapestries™, only 6 had expected values of at least one individual (Table 2); suggesting that in all but those 6 Tapestries™ we had too few individuals within the "Size" cluster to know if this Tapestry™ was truly under-represented or was instead, simply missed. Along the second PCA axis, as the vector

that points in the positive direction along PCA axis 2 shows, we noted that all catfish angler clusters have fewer "Southwestern Families" than exist within Texas' adult population (Casual=1.5%; Catch =1.9%; Num_Size=2.7%; Harv=4.2%; Size=5.6%; Texas Adults=10.4%). Combined, PCA axes 1 and 2 described 64% of the variability in the data.

[C]Numbers of People within Focal Tapestries™.— We used the BA extension to plot populations of "Rooted Rural" (RR), "Up and Coming Families" (UCF), and "Southwestern Families" (SWF) for Texas (Figure 3) in 2019. Although the 2016 Tapestry data suggested that the "Midland Crowd" also showed high correlation with our "Size"-focused anglers it is not included in our figures. ESRI® examines its Tapestry™ designations annually and reassigns neighborhoods when significant changes occur (ESRI® 2018). Sometime between 2016 and 2019 ESRI® removed the "Midland Crowd" Tapestry™ cluster. As the "Midland Crowd" were also a primarily rural tapestry, it is possible they were rolled into the RR by 2019. In the Dallas-Fort Worth area, we found that the RR segment (most closely associated with the Size-focused angler cluster) could be found outside of the main city center, and predominantly to the east, near Lake Tawakoni (located southeast of Dallas; Figure 3a), whereas the UCF crowd (Figure 3b) was found in the city center, especially in the western portion of the metro. In the Houston metro, we found that the RR segment was again found outside the city center, and could be found in the northeastern portions, near lakes Sam Rayburn and Livingston (both are found northeast of Houston; Figure 3a), whereas the UCF segment (Figure 3b) was found in the city center. In both Dallas-Fort Worth and in Houston, there is some evidence of the SWF segment, concentrated towards the center of those urban regions (Figure 3c).

[C]Proportions of People within Focal Tapestries™.— Areas with the highest proportions of the population for our focal segments (RR, UCF, and SWF) show a different picture (Figure 4). For the RR segment (Figure 4a), whereas many of the areas with the highest proportions are still found in the eastern part of the state, outside the urban centers, these areas are much more dispersed. Further, areas with high proportions of the RR segment now appear in the far west and in the panhandle. For UCF (Figure 4b), we found less difference in the two metrics (i.e., population compared

to proportion of the population). The areas with the highest proportions remain the urban centers and there are a few areas that are both a high number and a high proportion of this segment. Finally, for the SWF (Figure 4c), areas with the highest percentages are found in the southern and western portions of the state, and neither the Houston nor Dallas urban areas show high proportions of this segment.

[C]Expected Growth of People within Focal Tapestries™.— For both RR (Figure 5a) and UCF (Figure 5b) Tapestries™, the western side of Dallas is expected to be an area of growth from 2019 to 2024, and areas with currently high populations are expected to retain those populations. For the SWF Tapestry™ (Figure 5c), growth is expected in both Dallas and Houston. Further, Texas should expect large increases in the SWF Tapestry™ in the southern regions and around Corpus Christi.

[A]Discussion

In this study, we have shown how integrating angler survey results with customer segmentation can be used to help managers be strategic in their outreach and angler participation goals. Combining the survey results with Tapestry™, and then creating maps of these results can help managers decide where differing management strategies can be applied to meet the preferences of local anglers, and where to invest their limited resources. Differentiating between various angler clusters (e.g., “Size” versus other clusters), can identify areas that may benefit from focused management and targeted marketing. Even when statistical differences between clusters are not found, this mapping technique can be useful. For instance, although we discerned no statistical difference between the remaining four clusters, our maps still indicated that SWF clearly were not represented in current catfish anglers, yet should be considered for future recruitment efforts. We found that among the five catch-related angler clusters, we could effectively segregate these into two customer segments (RR & UCF) and map where these customer segments overlap and diverge. These results are valuable to managers making decisions for they could allow managers to either manage (through regulations or stocking) existing waterbodies within these areas, work to create new waterbodies in areas that have high catfish interest, or market fisheries that match the catch-related motivations of anglers or current non-anglers in these Tapestries™.

Overall, we see this technique as another valuable tool to help focus time and budgetary constraints.

Whereas ESRI® defines 66 different Tapestries™, only 47 of those were found in at least one of our catfish angler clusters. Those 47 Tapestries represent 96% of Texans, suggesting that overall our anglers, and our sample of 462 catfish anglers, represent a wide variety of Texans. Of those 47 Tapestries™, each of the five catfish angler clusters were missing representation from a unique subset of Tapestries™. Our "Size" cluster had the highest number of missing Tapestries (i.e., 27), and the highest number of uniquely missing Tapesties (i.e., 9), in part because it was the smallest cluster (n=37). Regardless of the angler cluster, most of the missing Tapestries™ were those with limited representation (less than 2% of the population of Texas). An exception to this was Up and Coming Families. Given the number of anglers in our "Size" cluster, we would have expected to see some representation within the Up and Coming Families Tapestry™; however, we saw none, suggesting that this Tapestry™ would under-represented in the "Size" cluster even if a larger sample were available. In future catfish surveys, we would suggest over-weighting the sample to more rural areas to increase the likelihood of surveying more anglers interested in "Size"-based fisheries. Further, if the focus of the survey is on trophy anglers (or some other group with low overall representation), another option would be to employ a two-phased survey (Shrout and Newman 1989; Brick et al. 2012). In the initial phase one would screen a random sample of anglers for the trait of interest. The second phase could then over-weight the sample for that trait.

Within our PCA, the first axis discriminated between catfish anglers focused on "Size", and all other catfish anglers. Looking at the Tapestries™ that best describe this axis, it appears that the primary discriminator is segregating rural from urban. The RR Tapestry™ is primarily rural. Areas in East Texas, especially areas around lakes Tawakoni, Sam Rayburn and Livingston, have high populations and high proportions of the RR Tapestry™. These locations look to be areas where managers could meet angler needs by focusing on trophy management of catfish in waterbodies that have the potential. As the proportion of anglers who expressed trophy motivations was relatively small (5.6%; n=37) compared to the other groups, managers should consider what level

of effort should be devoted to trophy catfishing. Stewart et al. (2012) found that whereas trophy-oriented anglers were more likely to support trophy-style regulation than were harvest-oriented anglers, both groups did support trophy-style regulations, suggesting that it might be possible to get wide-scale support for regulations and approaches that appear to only benefit a few. As 80% of Texas' population is urban, it seems reasonable that it would be easier to segregate out a rural trophy-focused group than to differentiate between the motivations of the primarily urban groups. In Texas' urban centers managers could better meet angler desires by focusing on non-trophy management of catfish. While we were unable to use the current Tapestry™ data to discriminate between the remaining catch-related angler clusters, it is apparent from Hutt et al. (2013) that these anglers differ in the fishing experience they desire. Our recommendation would be to provide a variety of experiences across the waterbodies in urban areas to provide both the catch, harvest, and amenities that these various groups desire (Hunt and Hutt 2010; Hunt et al. 2012). By providing multiple experiences across the urban landscape most anglers should be able to find a location that meets their desires. Alternatively, focused surveys within these urban areas could try to further identify these anglers, both through specific questions and through further use of Tapestry™. As much of the rest of the state does not contain either the RR or UCF Tapestries™, these could be areas where managers focus on management of other species.

In addition to showing how these customer segments are distributed geographically, the Tapestries™ (ESRI® 2020) inform managers about current leisure activities and how they consume media. The Tapestry™ profile suggests that the majority of the RR segment are non-Hispanic whites, who enjoy the outdoors; they like to hunt and fish, are middle-aged, and are patriotic shoppers who look for American-made products. The RR segment tends to watch the Country Music and the History Channels, and listen to country and gospel music radio. In contrast, the UCF segment is younger and more ethnically diverse. Unlike RR, the UCF goes online for shopping, entertainment and information (ESRI® 2020). Tapestry™ could easily be used as a tool when deciding how to create and distribute R3 materials to specific audiences.

The second axis on the PCA discriminated between all groups of catfish anglers and the current adult population of Texas. That axis suggested that none of our current catfish angler clusters have high representation within the SWF Tapestry™, which is composed predominantly of young families who identify as Hispanic (ESRI® 2020). Statewide, the SWF Tapestry™ is the largest single tapestry, representing 10.4% of adult Texans. Unfortunately, we know of no other Texas angler survey that includes Tapestry™ designations. However, a comparison between the Texas statewide survey (Lee at al. 2014) and the Texas statewide catfish Survey (Hunt and Hutt 2010; Hunt et al. 2012) suggests proportions of catfish anglers who are Hispanic (9%) are comparable to other freshwater anglers (8.7%); both of which are considerably lower than the proportion of Texas saltwater anglers who are Hispanic (12.9%), and all of which are considerably lower than the proportion of Hispanics in Texas in 2010 (38%; Potter and Hoque 2014). Further, this group consists of budget conscious consumers, many of whom live in households that speak Spanish and routinely listen to Hispanic radio and television (ESRI® 2020). Across our catch-related clusters, the “Size” cluster had the highest proportion of SWF (5.6%) but considerably below the proportion of Texas adults (10.4%). Hispanic participation rates in angling vary drastically, depending upon the study. A report from RBFF and TOF (2015) documents rates of freshwater angling between 2008 and 2014 within the U.S. among Hispanics at 9-11% nationwide, in line with what is seen in Texas. Further, about 7% (RBFF and TOF 2015) of those that do not currently angle are interested. Additionally, Harris (2012) showed very low angling participation as well (i.e., 5%), although lower participation may reflect lower recruitment efforts rather than a lack of interest (BBC 2016). The Hispanic community is a growing proportion of Texas’ population. In 2010, Texas’ population had about 38% identify as Hispanic, having grown from 32% in 2000, and projections suggest this group will continue to grow to about 53% in 2050 (Potter and Hoque 2014). An enhanced benefit of the Tapestry™ approach is that even though we might know that this group were under-represented in our angler base, there are at least 9 Tapestries™ that are primarily Hispanic. From a recruitment perspective, it is our opinion that the SWF segment is a group that managers should focus on. While it is unknown if non-fishing Hispanics will be drawn to catfishing, an effort should be made. Some of the primary

reasons Hispanics do not fish are lack of exposure, desire for family inclusion, cost, and confusing regulations (RBFF and TOF 2015; BBC 2016); these may be overcome through focused management efforts to provide desired local catfish fisheries.

[B]Spatial Considerations

Anglers routinely suggest that travel costs (and distance) are a primary consideration in seeking fishing opportunities (Caulkins et al. 1986; Hunt and Hutt 2010; Hunt et al. 2019). Distance travelled was the primary determinate for which trips Texas catfish anglers preferred (Hunt and Hutt 2010). Of the 49 considered scenarios that offered greater utility than the status quo, 32 (65%) involved trips that required the respondent to travel less than 10 miles from home, 14 (29%) involved trips that required the respondent to travel less than 100 miles from home, and only three (6%) involved trips more than 100 miles from home (Hunt and Hutt 2010). By knowing where anglers with specific motivations live, managers can then choose to spatially match anglers and angling opportunity. One finding that lends support to this approach is that some of the areas with the highest “Size”-focused catfish anglers were near Texas’ best catfishing reservoirs for larger fish (e.g., Tawakoni, Livingston, Sam Rayburn). We would recommend that managers look at a variety of suitable waterbodies within the local area, and focus management on those that either maximize the potential customers within a specified drive-time or minimize the average drive-time for the most anglers (Church and ReVelle 1974). Such an approach could allow for the spatial scale of management to match that of the fisheries.

Choosing a new management paradigm is a strategic decision, and one that must be balanced with practicality. Our approach borrows heavily from the location theory and strategic planning examples of public and private businesses (Owen and Daskin 1998) but is qualitative rather than quantitative, recognizing ecological systems have different constraints than the business world. But in a similar manner, locations need to be chosen in such a way that the investment will result in positive returns. When developing a map to help assess potential locations, it is important to consider what metrics to use and what anglers to serve. We illustrated that using the number of people within a given customer segment can produce very different answers than looking at the proportion. However, both can be useful. When a manager is looking at a specific

waterbody, it might make more sense to tailor management based on the proportion of the population that has a specific motivation. In contrast, when looking across a broader landscape, the actual numbers of potential anglers might be of more importance, both those there currently and in the future.

One shortcoming of either applying large-scale surveys to a smaller scale or a small-scale survey to a larger area is that this approach can result in few to no respondents within the area of the management action. We have suggested that combining customer segmentation with the survey is one way of overcoming this problem. Unfortunately, this approach requires spatial extrapolation. Just as with any extrapolation, it is possible that what was found within the sample studied may not extend to new areas. To address this concern, one option would be to use the customer segmentation maps to create new sampling frames. Using these new frames would allow focused sampling of areas before committing substantial resources. For example, very few Hispanic anglers participated in Hunt and Hutt's (2010) catfish survey, and few responses came from the southern border region. However, this region has large proportions of the population designated as SWF Tapestry™, and 5-8% growth is expected over the next five years. A spatially directed survey into these areas, focused on SWF, would be a way to understand the barriers and desires of the local populations before large-scale management began.

[B]Temporal Considerations

It is important to consider how long the current information gained from a survey and the Tapestry™ may be valid. This example provides a short-term perspective of the spatial distribution of customer segments. It is clear that people move and neighborhoods change, especially in our more urban centers. As mentioned earlier, ESRI® examines its Tapestry™ designations annually and reassigns neighborhoods when significant changes occur (ESRI® 2018). Most neighborhoods retain their assignments in the short term, although some high-growth areas will be reassigned more frequently (ESRI® 2018). Similarly, it is unclear what the lifetime of an angler survey should be. The survey this study used as its basis was conducted in 2010, the most recent catfish angler survey for Texas. We then used the 2010 address data to estimate the Tapestries™ based on ESRI®'s 2016 data, then projected our findings

onto ESRI®'s Texas 2019 data. It is our opinion that in most areas the Tapestry™ composition in Texas does not change rapidly, but instead neighborhoods transition gradually over the course of several years. Fisheries can take years to develop and buying patterns may change (ASA and AFWA 2007; Villamagna et al. 2014) based on economics, migration and interest. Longer term temporal patterns of human migration could also be useful in predicting where future management might be directed. In addition, with a better understanding of which customer segments and ages are most impacting license sales (ASA and AFWA 2007), agencies might have the ability to predict future trends in sales (Murdock et al. 1996). Understanding where agencies might expect to see declines in licenses, but increases in potential anglers, could direct future recruitment and retention actions. Rural areas may have high overall interest in angling (Dempson et al. 2012; ASA 2015b; USDI et al. 2016), can be more consistent in their license buying (ASA 2015a), and may experience considerably fewer demographic changes. Although they may hold lower numbers of potential anglers, because of their stability those areas might be suitable for recruitment of new anglers and enhancement of fisheries.

[B]Implications

Customer segmentation can also be useful in the absence of angler surveys. Whereas this current study looked at how one might use catch-related attitudes to focus management for specific motivations, this technique could also be used for broader management questions. As we showed in this paper, comparison of the dominant customer segments of the state's population (SWF) with the segments found in various license types (RR and UCF) can allow agencies to see where investment in recruitment might be fruitful. In a parallel to GAP analysis (Scott et al. 1993; Jennings 1995), the results of these analyses could produce maps used to either select new areas for management or focus current management activities. For example, one possibility would be to map the customer segments of the state's license buyers, then add geographic layers associated with various water resources. Areas with high concentrations of those customer segments found in the angler license database, and good water resources, but with low license sales might be areas to invest in either new R3 or management activities. Finally, we think that combining geo-focused

management changes with longer-term license buying data and targeted angler surveys would allow managers to assess whether management activities were cost-effective.

Throughout, we have assumed that an angler's stated preference would translate directly into actual behavior. However, stated and actual behavior do not always correspond (Sheppard et al. 1988; Berendt et al. 2005; Chandon et al. 2005). Hence, in cases in which management would require a large investment of resources, it would be prudent to conduct a pilot study of the management action and study the response. For example, a large focus of current R3 activities is to provide fishing experiences close to home. A focused experiment to measure explicitly how distance from a waterbody is related to license buying and avidity with a follow-up asking where they actually fish could resolve the relative magnitude of these desires. For example, although anglers claim they prefer fisheries close to home over catch attributes, they may actually drive past closer waterbodies to fish elsewhere. As agencies focus their R3 efforts based on survey responses, we suggest they test their actions before they adopt them programmatically.

Within this analysis, we assumed that the Tapestry™ that had the highest correlation with the angler cluster represents those anglers. To date, we know of no published study that has confirmed that the trophy anglers within these areas belong to the RR Tapestry™. Further, confirmation would be quite difficult given the clustering technique and weights used by ESRI® are proprietary. However, the ESRI® definition of the RR Tapestry™ highlights that members of this segment spend their time outdoors hunting and fishing. Further, RR falls within the Rustic Outposts LifeMode™, which also highlights that members of this mode enjoy fishing. Of ESRI®'s fourteen LifeModes™, only "Rustic Outposts" and "Cozy Country Living" specifically list fishing as a preferred outdoor activity. Finally, before the latest reorganization of LifeModes™, RR used to be part of the "American Quilt" LifeMode™, one of the top two customer segments of license buyers in the U. S. (ASA and AFWA 2007). While none of this specifically shows that anglers are coming from the specific Tapestries™ that our analyses highlighted, they are strong indicators that this is likely the case.

We looked at the population of people within given geographic regions to produce our customer segmentation maps. However, where a database of licensed

anglers exists, managers could also look at current or lapsed anglers with the matching customer segments who might live in those areas. Combining potential recruits, with lapsed and current angler layers could allow managers to explore trade-offs in various locations. We chose to highlight only those customer segments that had the highest influence on the angler cluster differences. An alternative would be to combine and map across several of the discriminating customer segments. We also chose to use the customer segments to highlight areas of greatest difference. However, it should be obvious that managers could also look for areas of greatest overlap as well, then decide whether they wanted to have specialized or generalized fisheries in various areas based on the degree of overlap. Regardless of which approach is used, it is our opinion that combining angler surveys with GIS layers on customer segmentation has the potential to allow managers to identify the best places to develop or create focused fishing opportunities and will aid in the development of targeted marketing for both our loyal and underserved markets. As a result, managers can focus their R3 and management activities to places where they expect the largest benefit, and hence better meet the needs of their angler groups, as well as their R3 goals.

[A]Acknowledgments

Constructive comments provided by Dan Daugherty and four anonymous reviewers greatly improved this manuscript. This study was supported by Federal Aid in Sport Fish Restoration Grants F-30-R, F-231-R2-4 and F-215-C3 to the Texas Parks and Wildlife Department, Inland Fisheries Division.

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Table 1. Customer segments (ESRI® Tapestries™) that were observed in at least one of the five catch-related clusters defined by Hutt et al. (2013) and Texas adults (age 18+). Values indicate the proportion of each Tapestry by cluster (columns sum to ~100 due to rounding). Tapestries™ that did not appear in any of the clusters but do appear in Texas Adults (3.4% of the Texas population in total) are shown at the bottom of the table.

Tapestry Name	Harvest	Num_Size	Num	Casual	Size/Trophy	TX Adults
Aspiring Young Families	2.78	2.74	0.93	0.74	2.78	2.95
Boomburbs	4.17	1.37	3.74	5.15	8.33	5.47
City Commons	0	0	0.93	0	0	0.4
City Dimensions	0	0	0	0.74	0	0.74
College Towns	0	1.37	0	0	2.78	0.85
Connoisseurs	0	0	0.93	0	0	0.45
Cozy and Comfortable	4.17	0	0	0.74	2.78	0.96

Tapestry Name	Harvest	Num_Size	Num	Casual	Size/Trophy	TX Adults
Crossroads	1.39	2.74	2.8	8.09	2.78	2.88
Enterprising Professionals	0	0	0.93	2.21	2.78	2.26
Exurbanites	5.56	4.11	2.8	2.94	0	2.08
Family Foundations	0	1.37	0	0	0	0.83
Great Expectations	0	2.74	0.93	0.74	0	1.03
Green Acres	1.39	2.74	3.74	5.15	0	1.35
Heartland Communities	0	2.74	3.74	5.15	5.56	1.75
Home Town	1.39	1.37	2.8	1.47	2.78	1.94
In Style	0	1.37	0	0.74	0	1.15
Industrious Urban Fringe	1.39	2.74	0.93	1.47	0	6.43
Inner City Tenants	1.39	0	0.93	0.74	0	2.46
Metro Renters	0	0	0.93	0	2.78	1.49
Metropolitans	0	0	2.8	1.47	2.78	0.97
Midland Crowd	15.28	12.33	9.35	8.82	19.44	4.45
Midlife Junction	0	1.37	3.74	0	0	1.33
Milk and Cookies	9.72	6.85	4.67	7.35	5.56	6.77
Modest Income Homes	0	2.74	0	0	0	1.06
NeWest Residents	0	0	0	1.47	0	2.33
Old and Newcomers	1.39	0	0	0.74	0	1.12
Prairie Living	2.78	2.74	1.87	3.68	0	1.31
Prosperous Empty Nesters	2.78	1.37	2.8	0.74	5.56	1.37
Retirement Communities	0	0	0	0	2.78	0.41
Rooted Rural	9.72	5.48	11.21	6.62	13.89	2.91
Rural Bypasses	0	0	1.87	2.21	0	0.86
Rural Resort Dwellers	2.78	0	4.67	6.62	2.78	1.03

Tapestry Name	Harvest	Num_Size	Num	Casual	Size/Trophy	TX Adults
Rustbelt Retirees	5.56	1.37	1.87	0	2.78	1.22
Rustbelt Traditions	1.39	4.11	0.93	4.41	0	2.65
Salt of the Earth	1.39	5.48	2.8	1.47	0	0.82
Senior Sun Seekers	0	1.37	2.8	2.21	2.78	0.74
Silver and Gold	0	2.74	0	0	0	0.4
Simple Living	1.39	0	0.93	0	0	0.65
Sophisticated Squires	2.78	5.48	1.87	2.21	0	1.76
Southern Satellites	4.17	1.37	4.67	3.68	0	1.53
Southwestern Families	4.17	2.74	1.87	1.47	5.56	10.39
Suburban Splendor	1.39	1.37	0	2.94	2.78	1.51
Top Rung	0	0	0.93	0	0	0.62
Trendsetters	0	1.37	0	0	0	0.17
Up and Coming Families	8.33	9.59	8.41	5.88	0	7.42
Urban Villages	0	0	0.93	0	0	0.16
Young and Restless	1.39	2.74	1.87	0	0	3.18

Missing Tapestries: Wealthy Seaboard Suburbs, Laptops and Lattes, Urban Chic, Pleasant-Ville, Pacific Heights, City Lights, Main Street, International Marketplace, Military Proximity, The Elders, Urban Melting Pot, City Strivers, Las Casas, Metro City Edge, Urban Rows, High Rise Renters, Dorms to Diplomas, and Social Security Set.

Table 2. Customer segments (ESRI® Tapestries™) we expected to see represented within the "Size" cluster, but in which we observed no individuals. The "Expected Value" column reflects the number of people that we would have expected to see in the "Size" cluster (value >1.0) had it reflected the average response rate of the other four clusters.

Tapestry Name	Expected Value
Up and Coming Families	2.9
Exurbanites	1.4

Southern Satellites	1.2
Green Acres	1.2
Sophisticated Squires	1.1
Salt of the Earth	1.0

[A] List of Figures

Figure 1. This map shows the locations of randomly selected license holders who responded (open circles) to the statewide catfish survey conducted by Hunt and Hutt (2010), in relation to major cities and urban areas within Texas. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

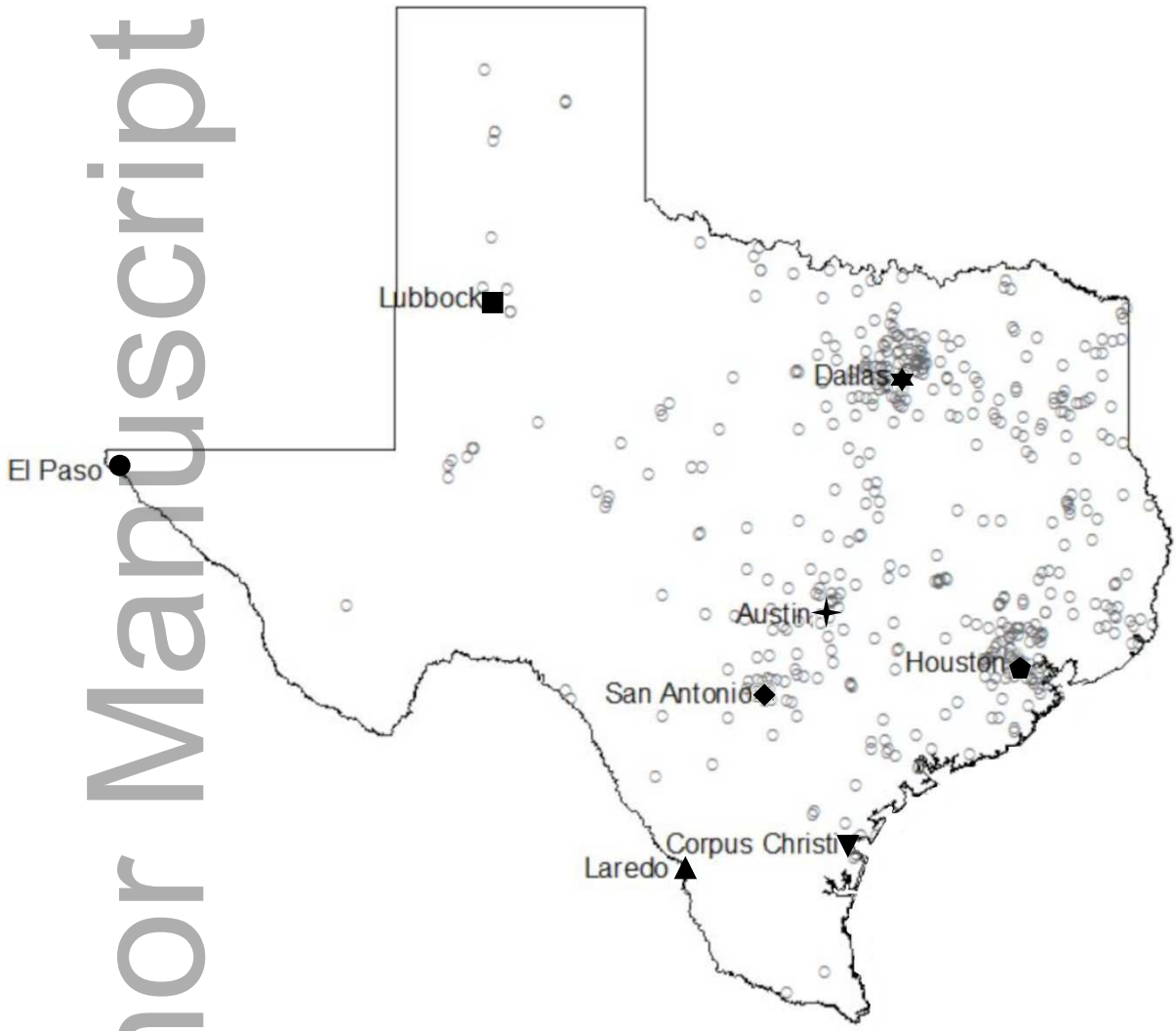
Figure 2. The principal components analysis (PCA) graph showing the ESRI® Tapestries™ distribution of the five catch-related catfish angler clusters defined by Hutt et al. (2013), and the adult population (age 18+) of Texas. The orientation of the triangles (up or down) identifies clusters that are considered similar based on the SIMPROF test in Primer-e. The Tapestries™ with the highest correlations (>0.4) for both axes are included, along with the vectors. The correlation circle is included to give a scale to the vectors and does not share the same dimensions as the points on the PC axes. The center of the circle indicates no correlation along either axis, and the diameter of the circle along a PC axis has a scale of -1 (100% negative correlation) to +1 (100% positive correlation); the relative length and direction of the vectors from the central point indicate the loadings along these axes.

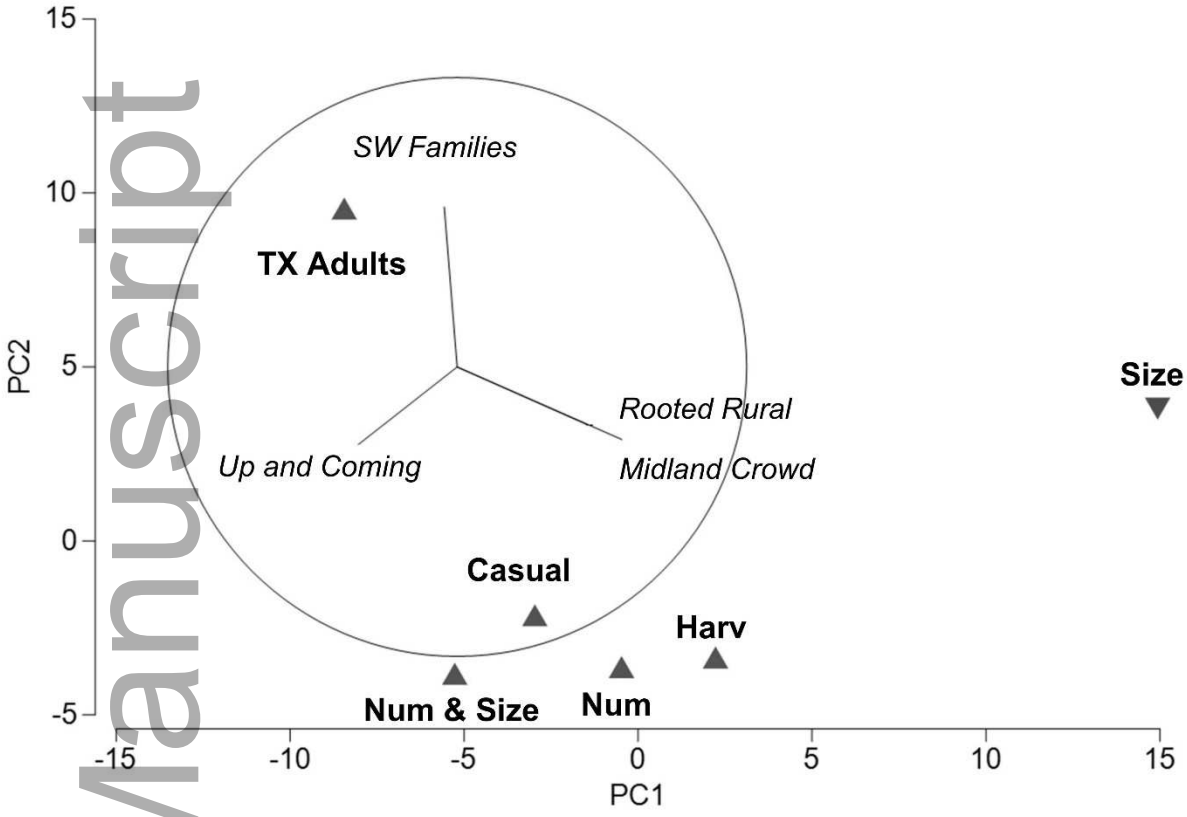
Figure 3. These maps show the adult population (age 18+) within census county subdivisions in 2019 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas (barrier islands have been removed to improve clarity). Census county subdivisions which contained zeroes are not displayed. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (number of individuals age 18+),and therefore the scales differ for each Tapestry. Sections within the map are

census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

Figure 4. These maps show the proportions of the adult population (age 18+) within census county subdivisions in 2019 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas (barrier islands have been removed to improve clarity). Census county subdivisions which contained zeroes are not displayed. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (proportion of adult 18+ population), and therefore the scales differ for each Tapestry. Sections within the map are census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

Figure 5. These maps show the estimated proportional increase in growth in households from 2019 to 2024 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas(barrier islands have been removed to improve clarity). The geographic division used to display the changes are census county subdivisions. Areas without boundaries indicate subdivisions that had no households in the tapestry in 2019. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (proportional growth of households),.and therefore the scales differ for each Tapestry. Sections within the map are census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).





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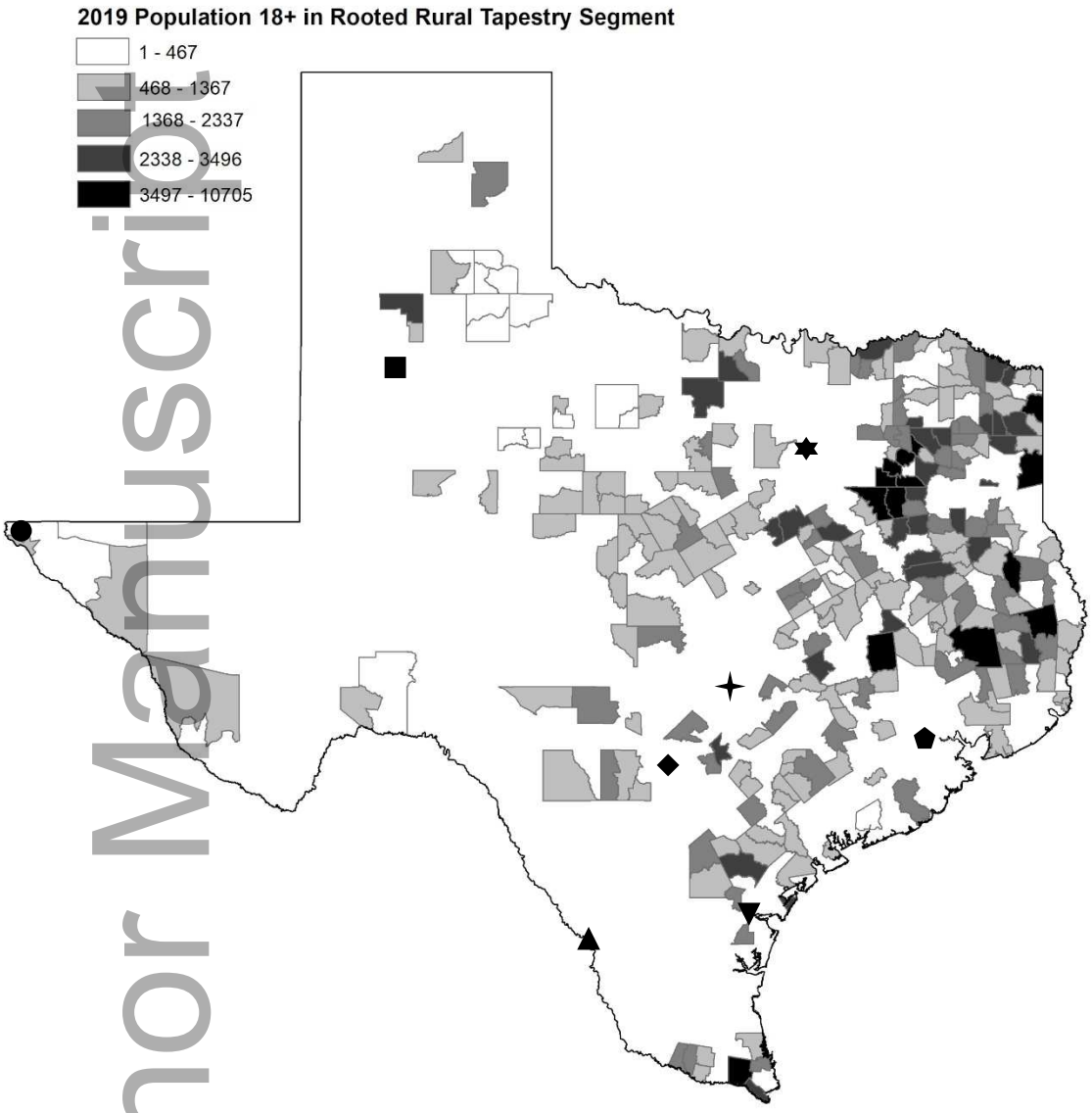

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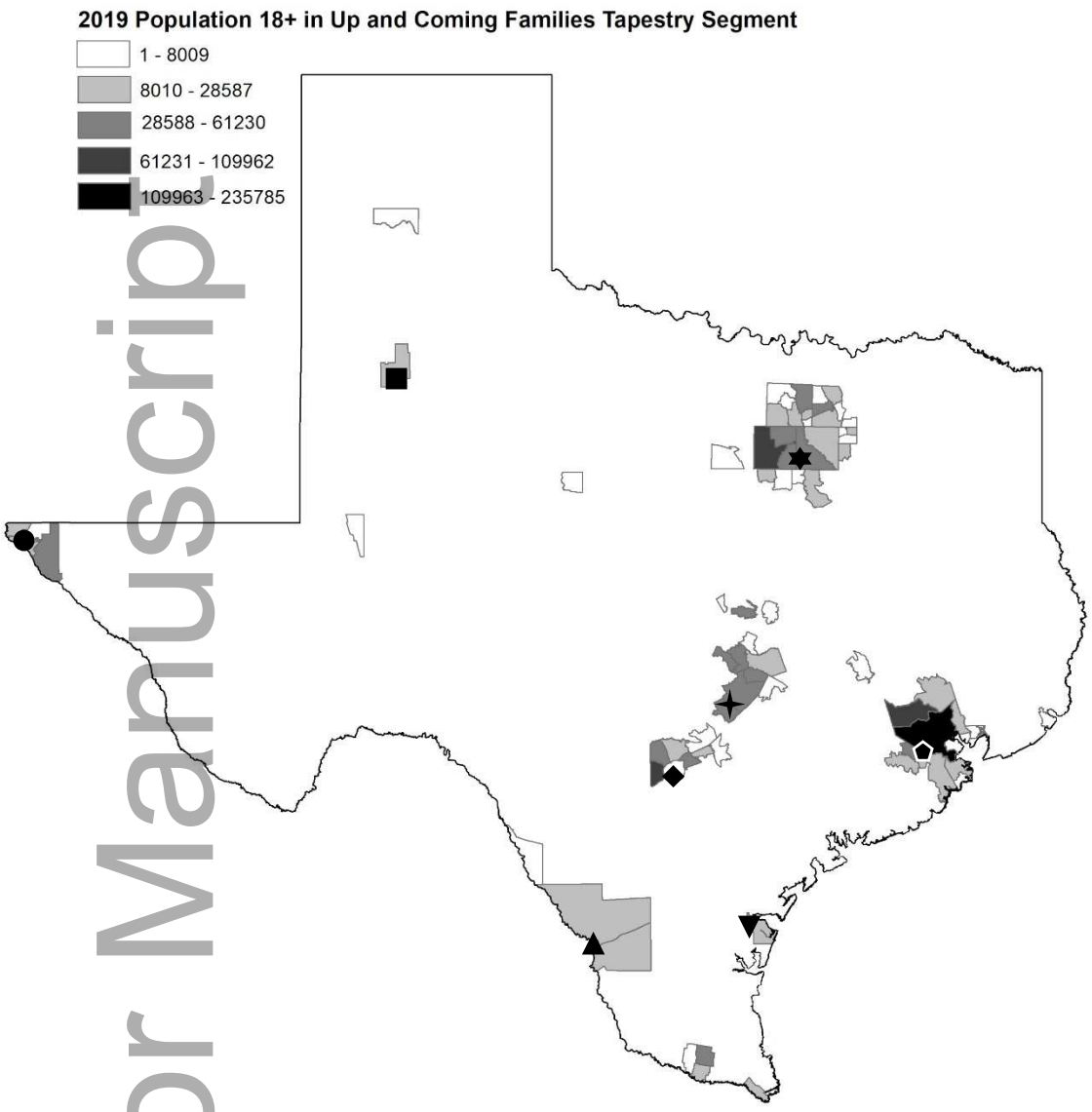

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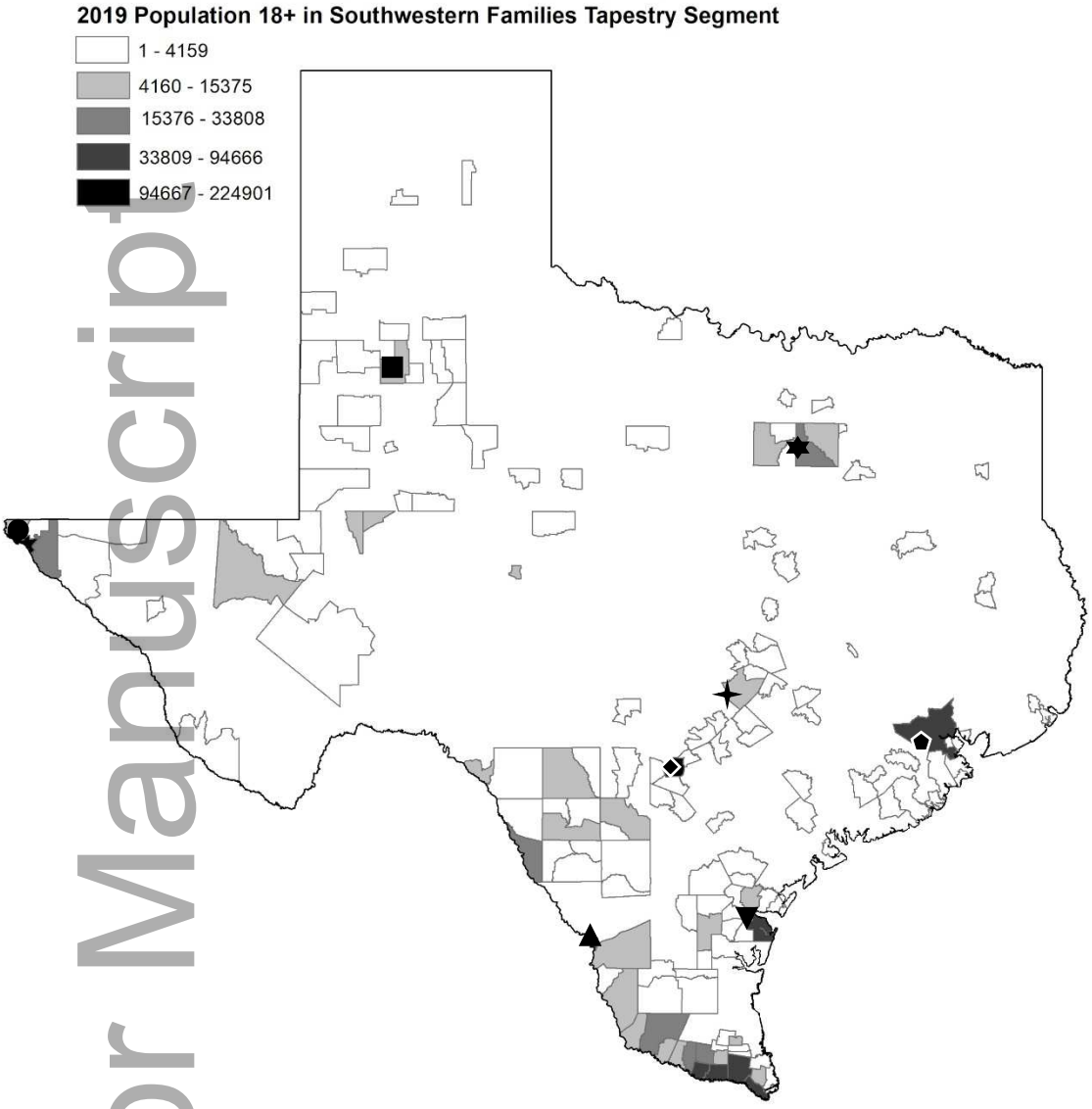

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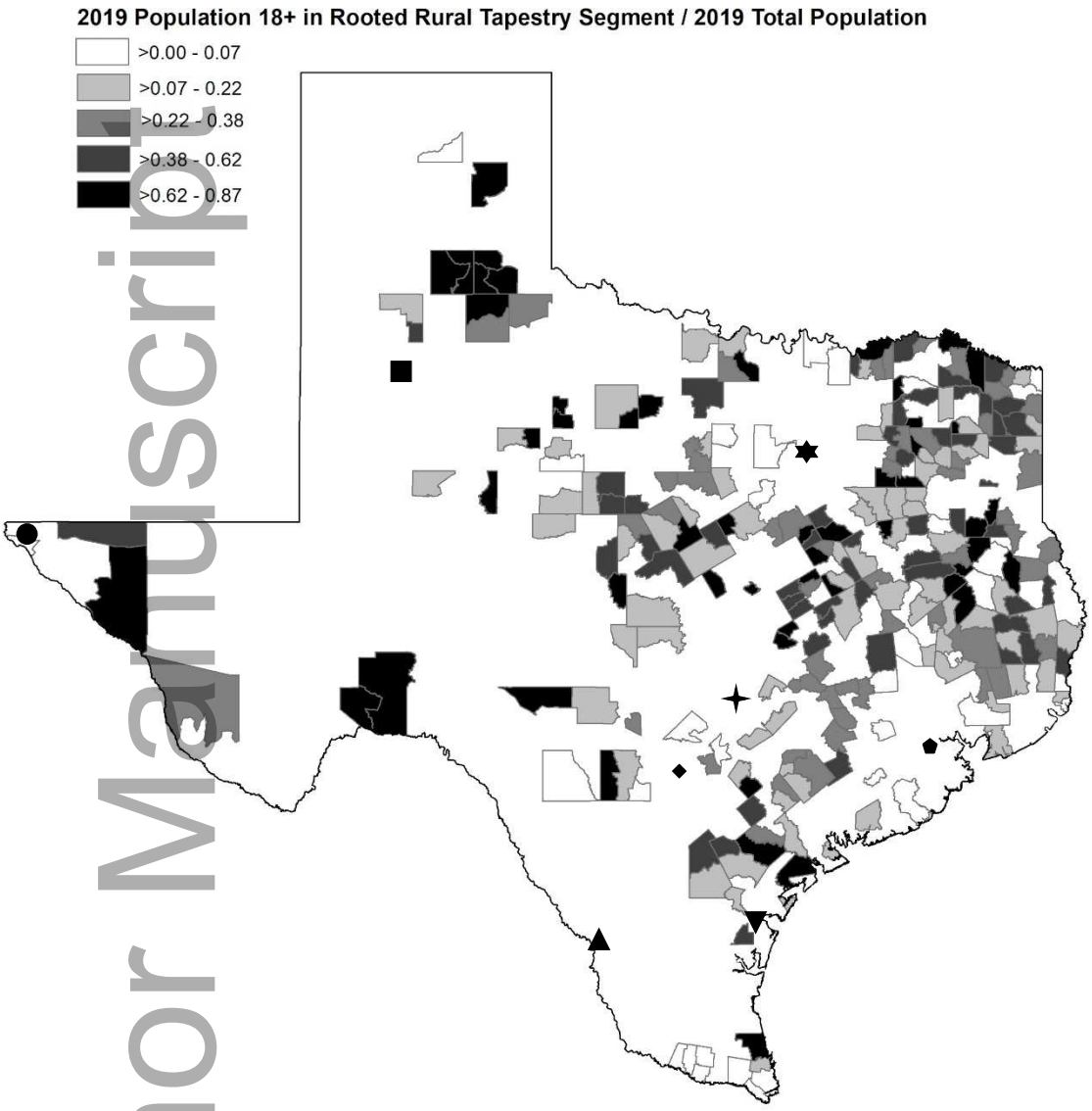

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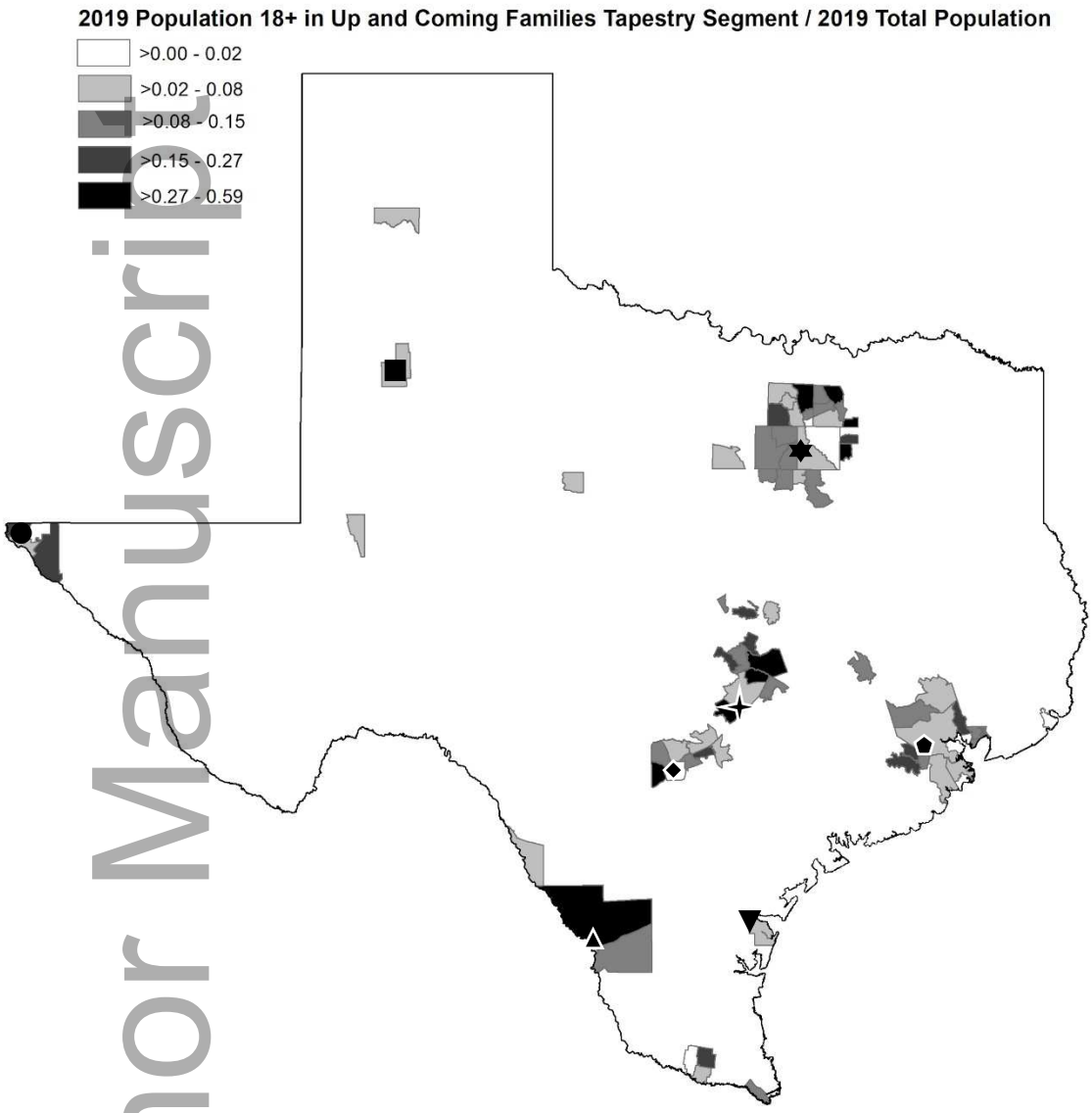

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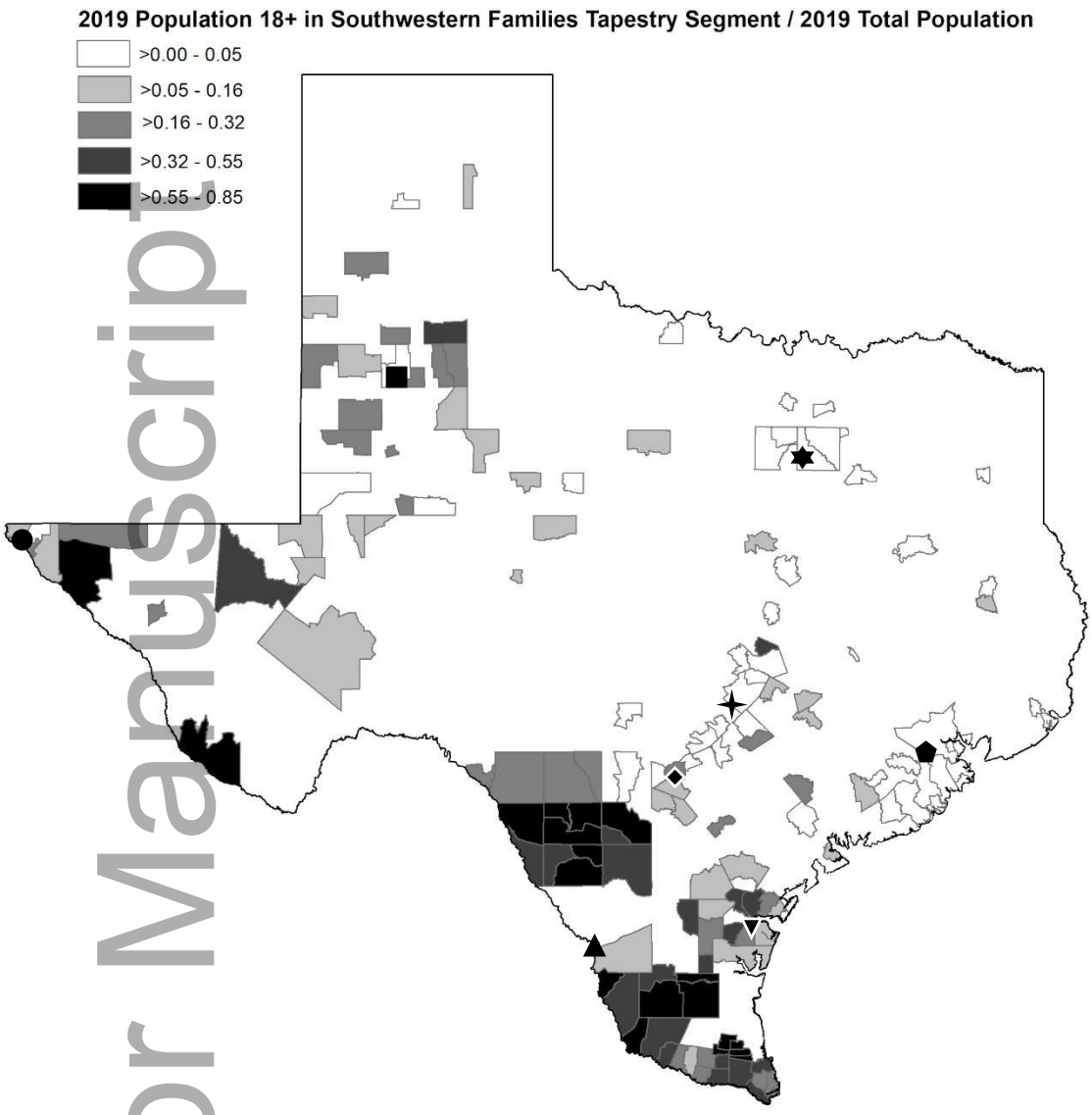

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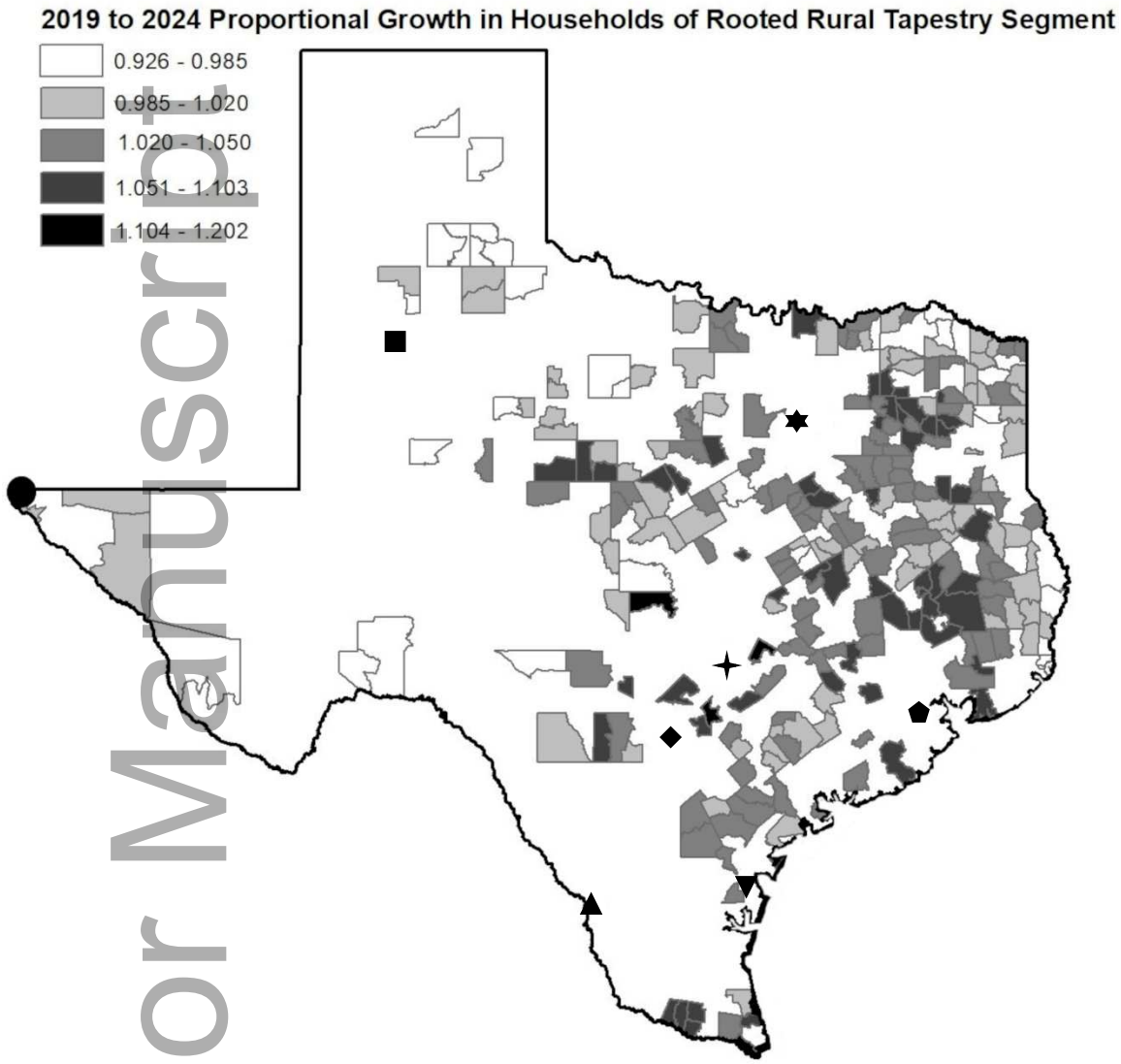

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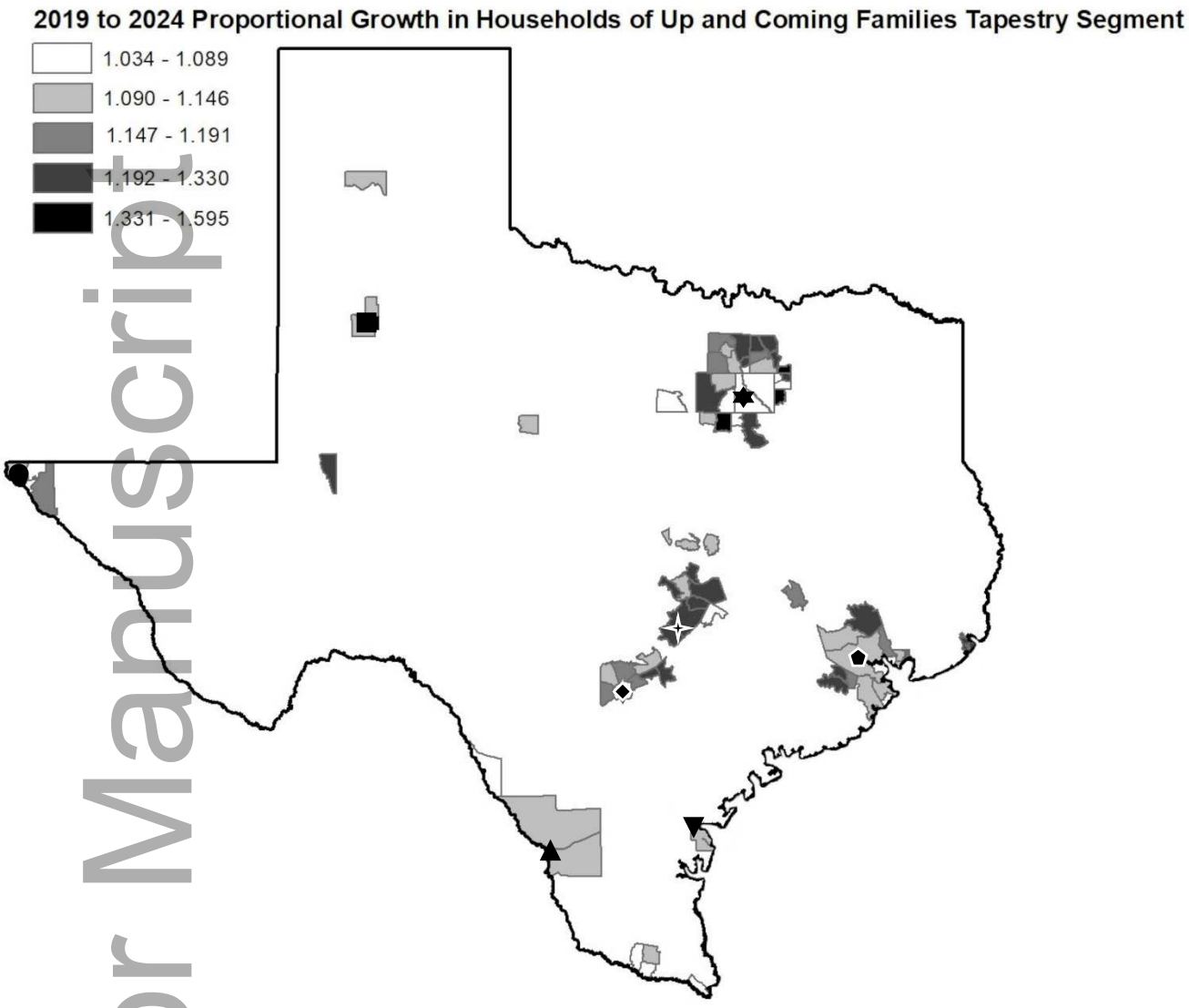

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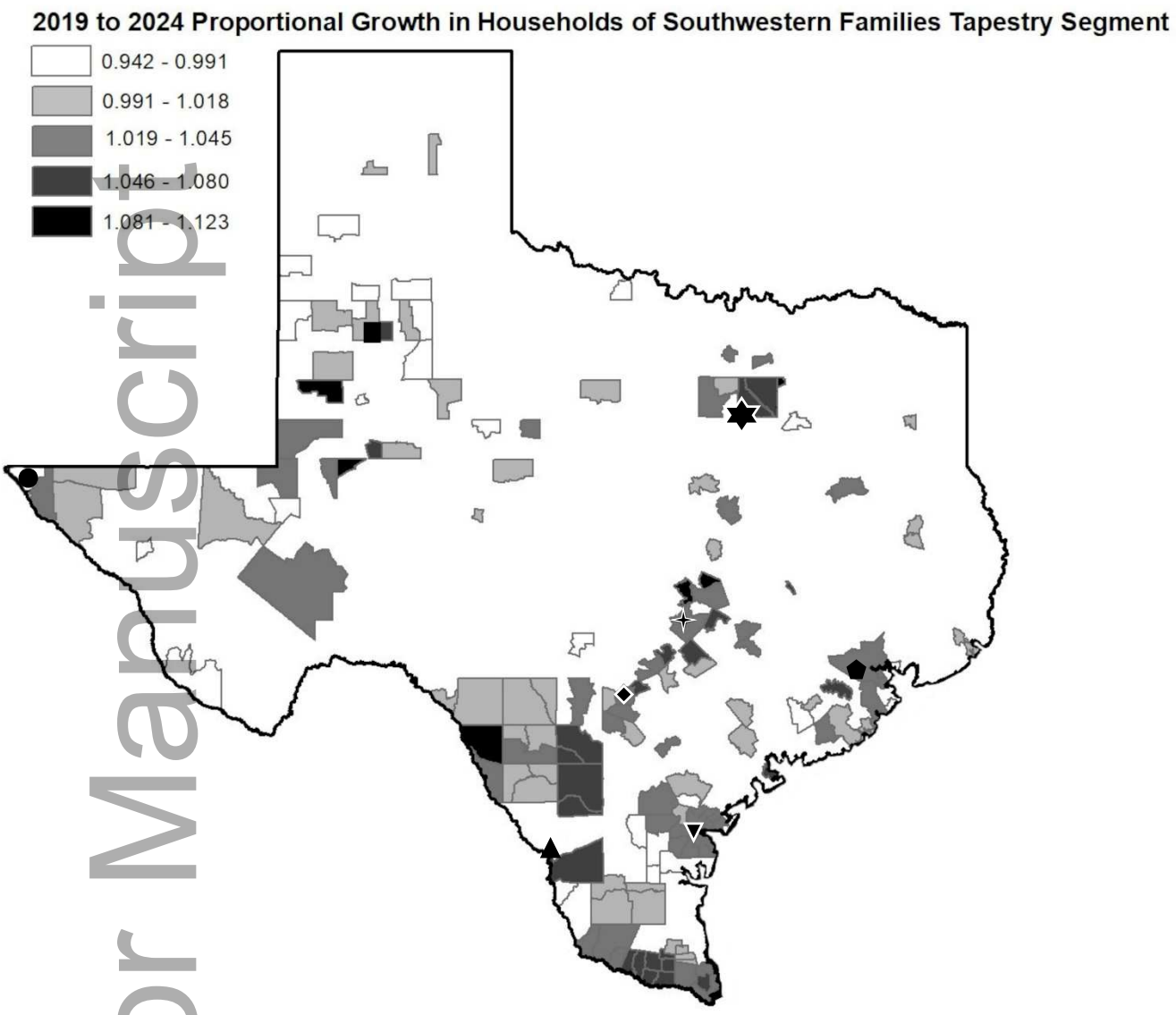

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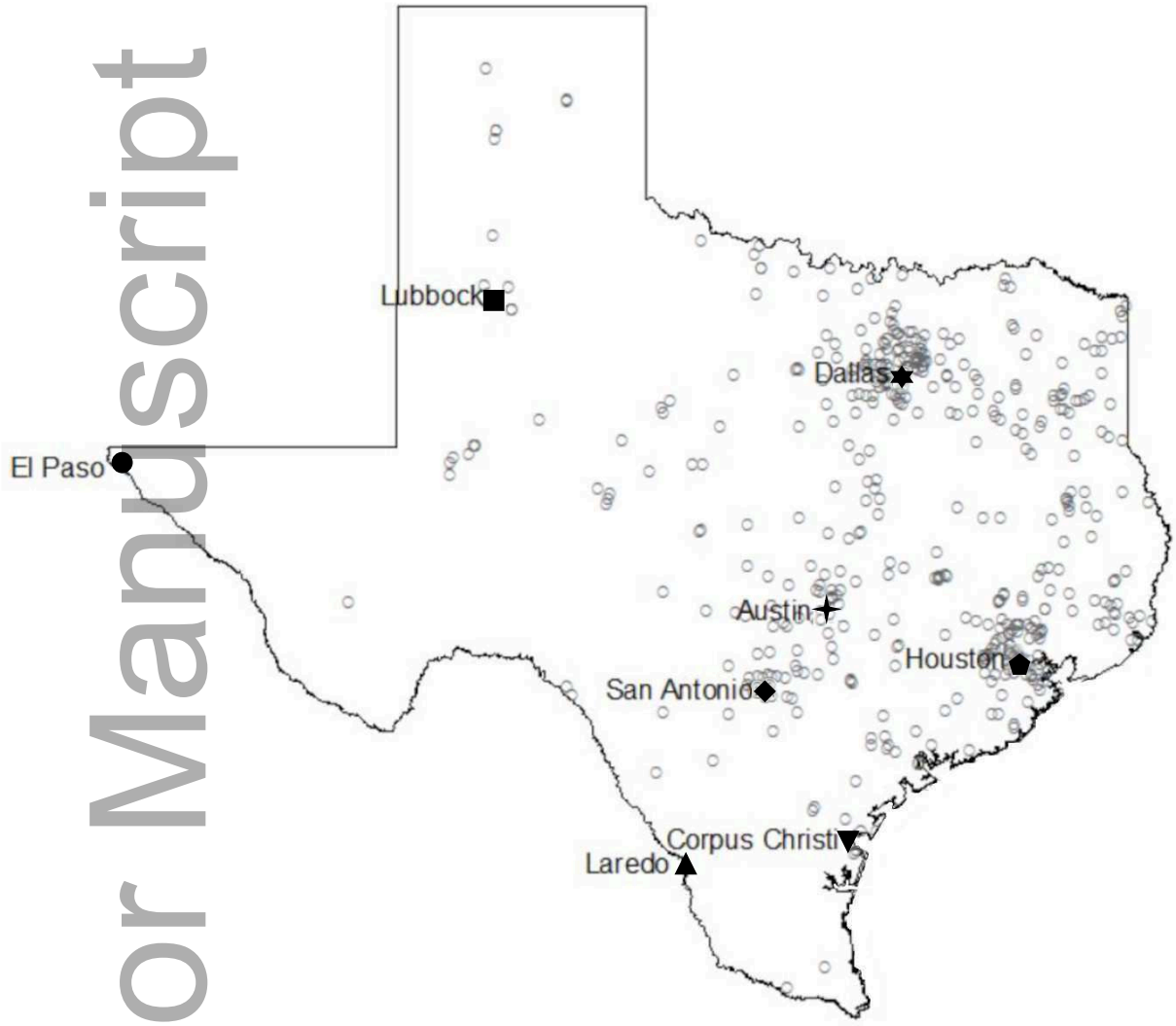

Figure 3

[A] List of Figures

Figure 2. The principal components analysis (PCA) graph showing the ESRI® Tapestries™ distribution of the five catch-related catfish angler clusters defined by Hutt et al. (2013), and the adult population (age 18+) of Texas. The orientation of the triangles (up or down) identifies clusters that are considered similar based on the SIMPROF test in Primer-e. The Tapestries™ with the highest correlations (>0.4) for both axes are included, along with the vectors. The correlation circle is included to give a scale to the vectors and does not share the same dimensions as the points on the PC axes. The center of the circle indicates no correlation along either axis, and the diameter of the circle along a PC axis has a scale of -1 (100% negative correlation) to +1 (100% positive correlation); the relative length and direction of the vectors from the central point indicate the loadings along these axes.

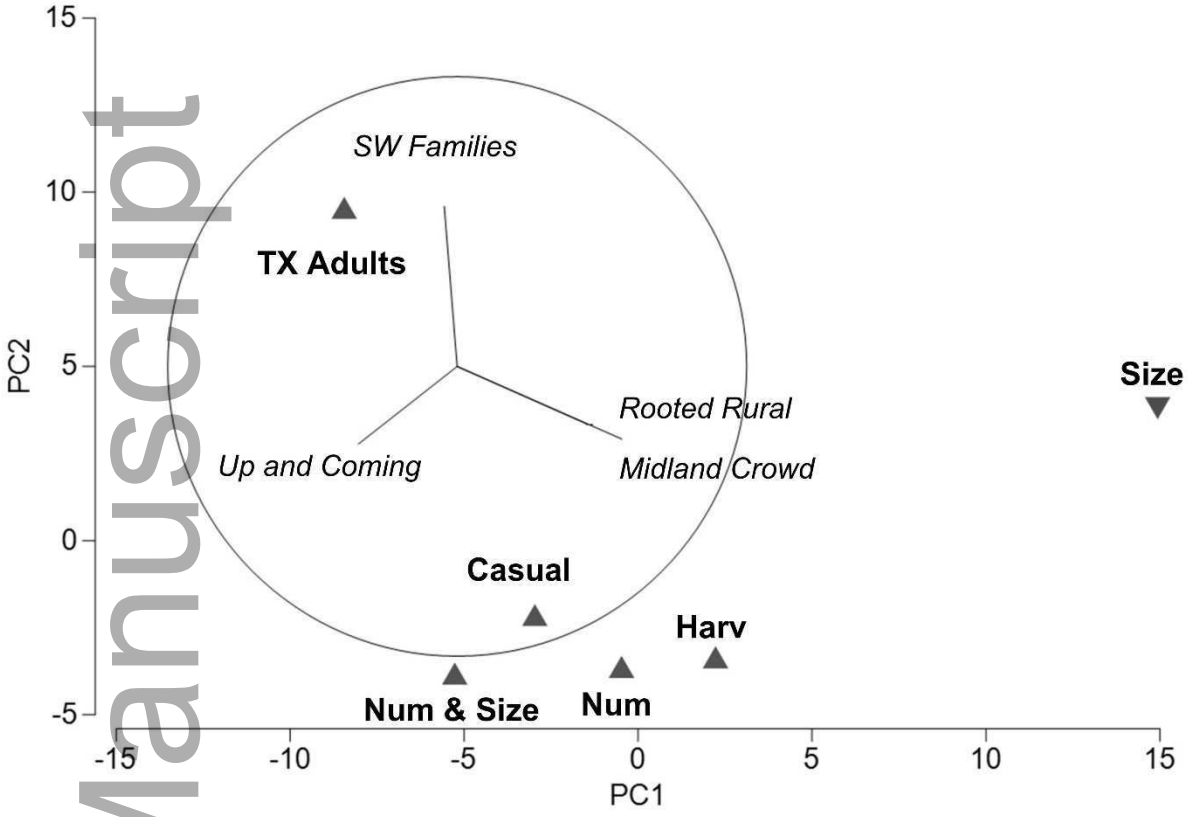

Figure 6

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Figure 3. These maps show the adult population (age 18+) within census county subdivisions in 2019 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas (barrier islands have been removed to improve clarity). Census county subdivisions which contained zeroes are not displayed. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (number of individuals age 18+),and therefore the scales differ for each Tapestry. Sections within the map are census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

A)

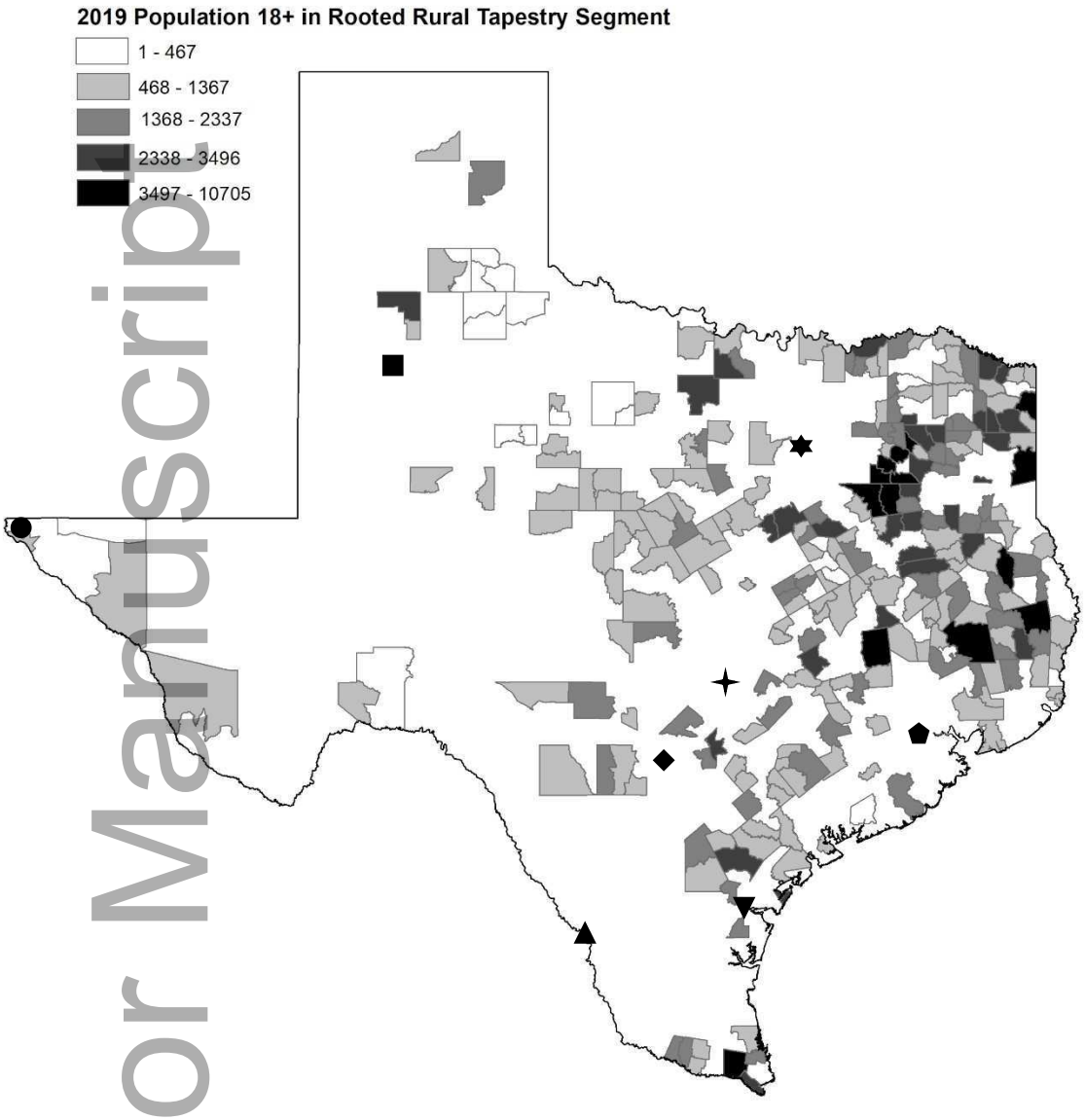
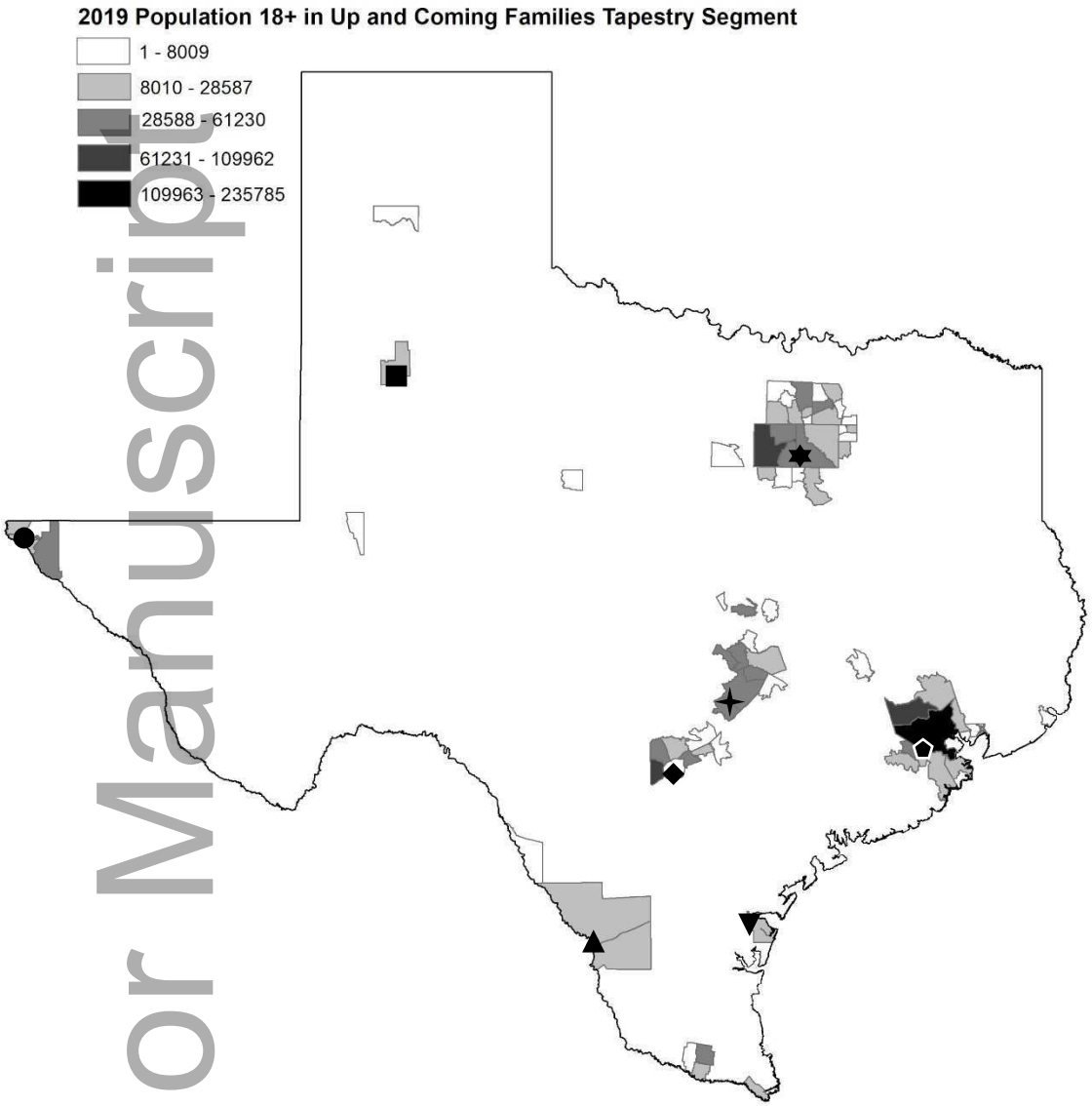


Figure 3

B)



C)

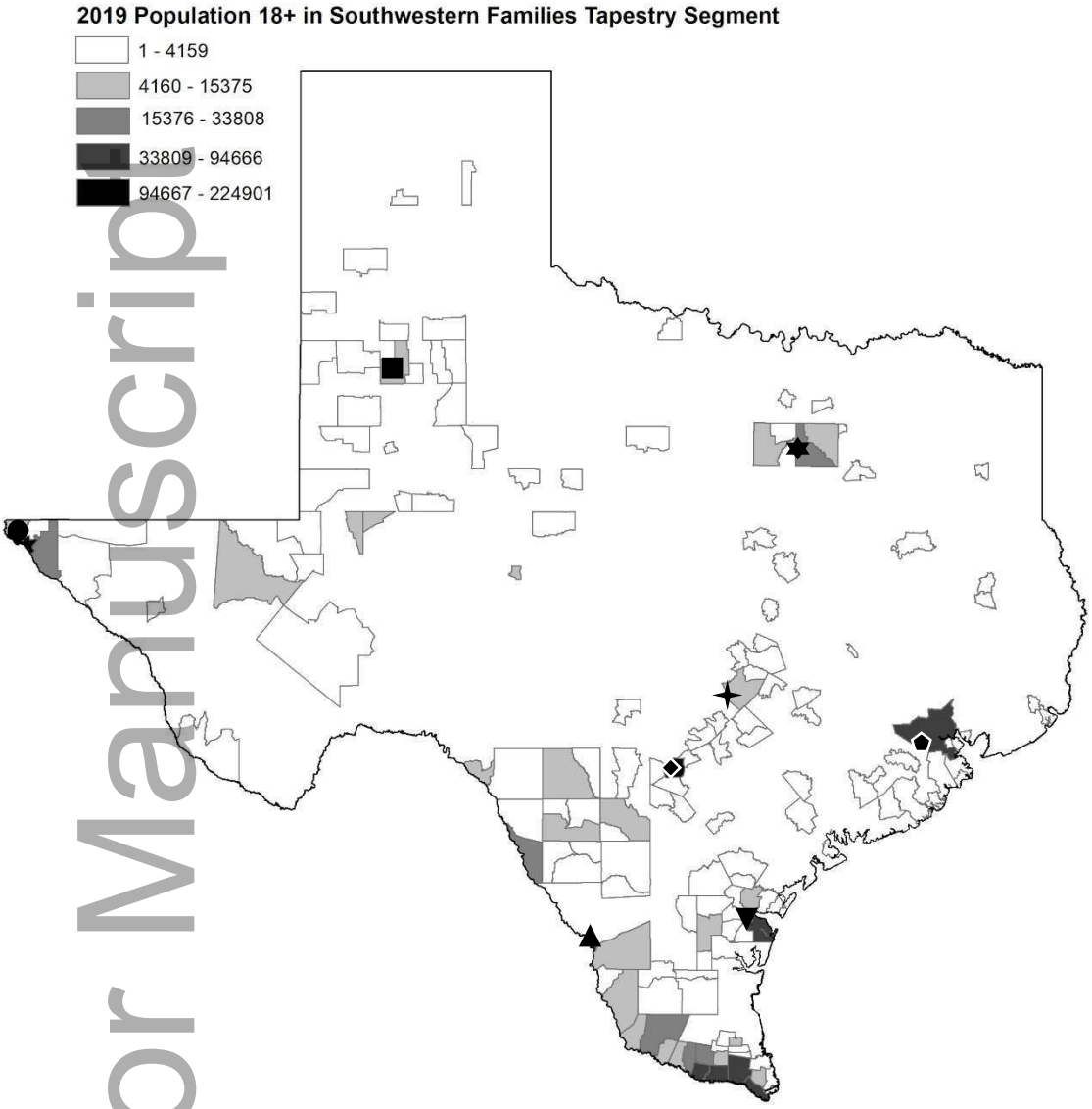
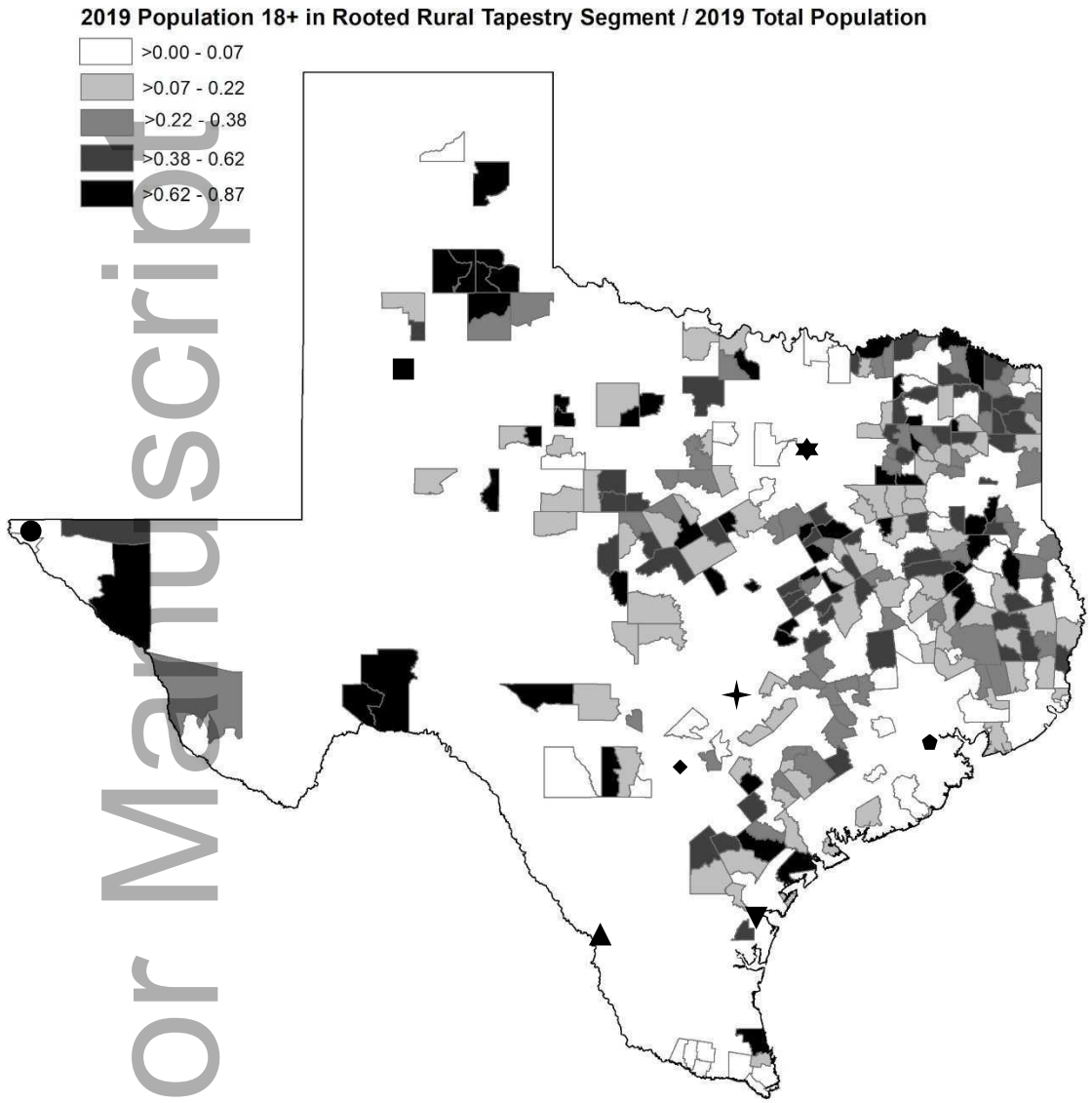


Figure 3

[A] List of Figures

Figure 4. These maps show the proportions of the adult population (age 18+) within census county subdivisions in 2019 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas (barrier islands have been removed to improve clarity). Census county subdivisions which contained zeroes are not displayed. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (proportion of adult 18+ population), and therefore the scales differ for each Tapestry. Sections within the map are census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

A)



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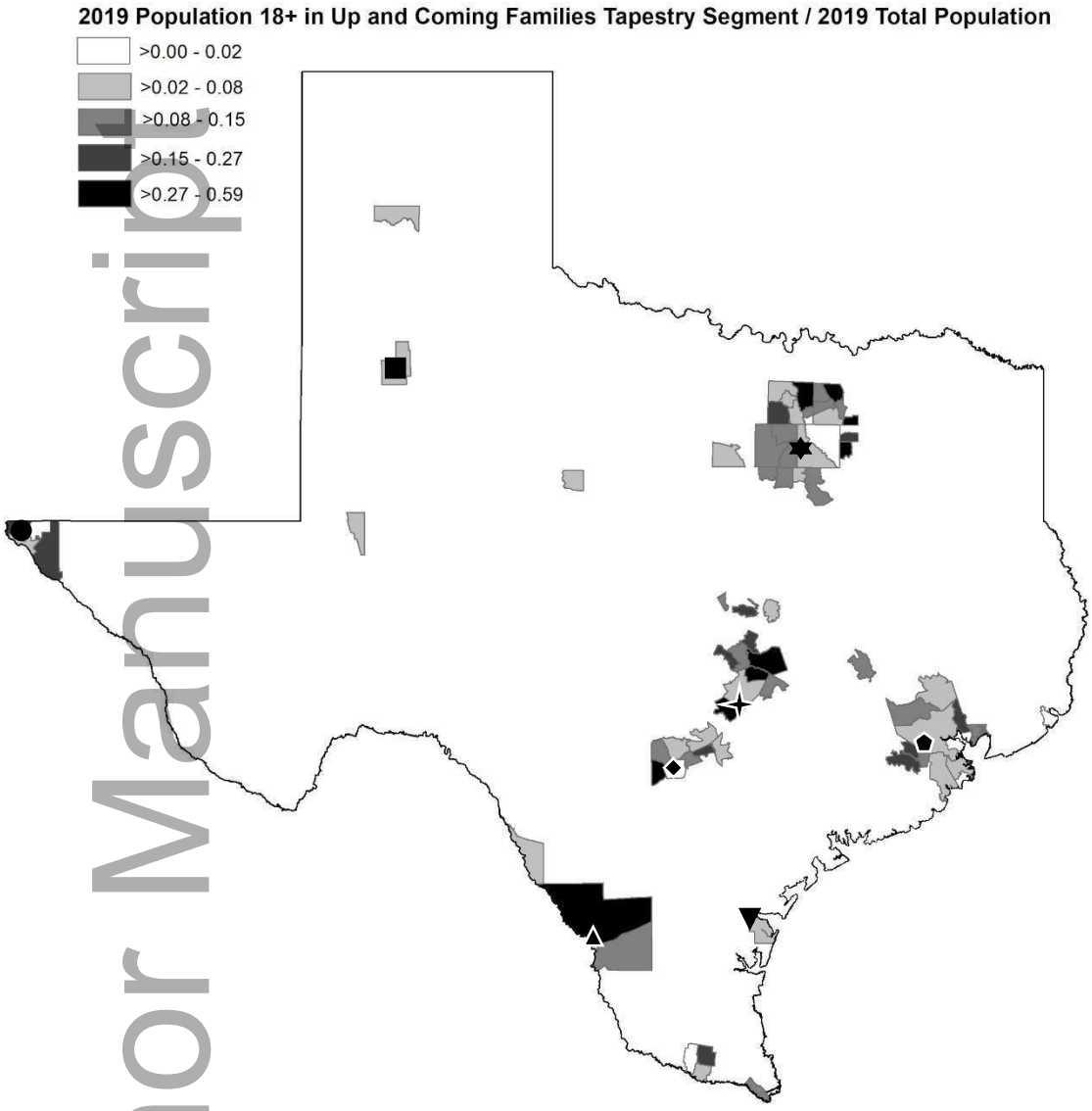

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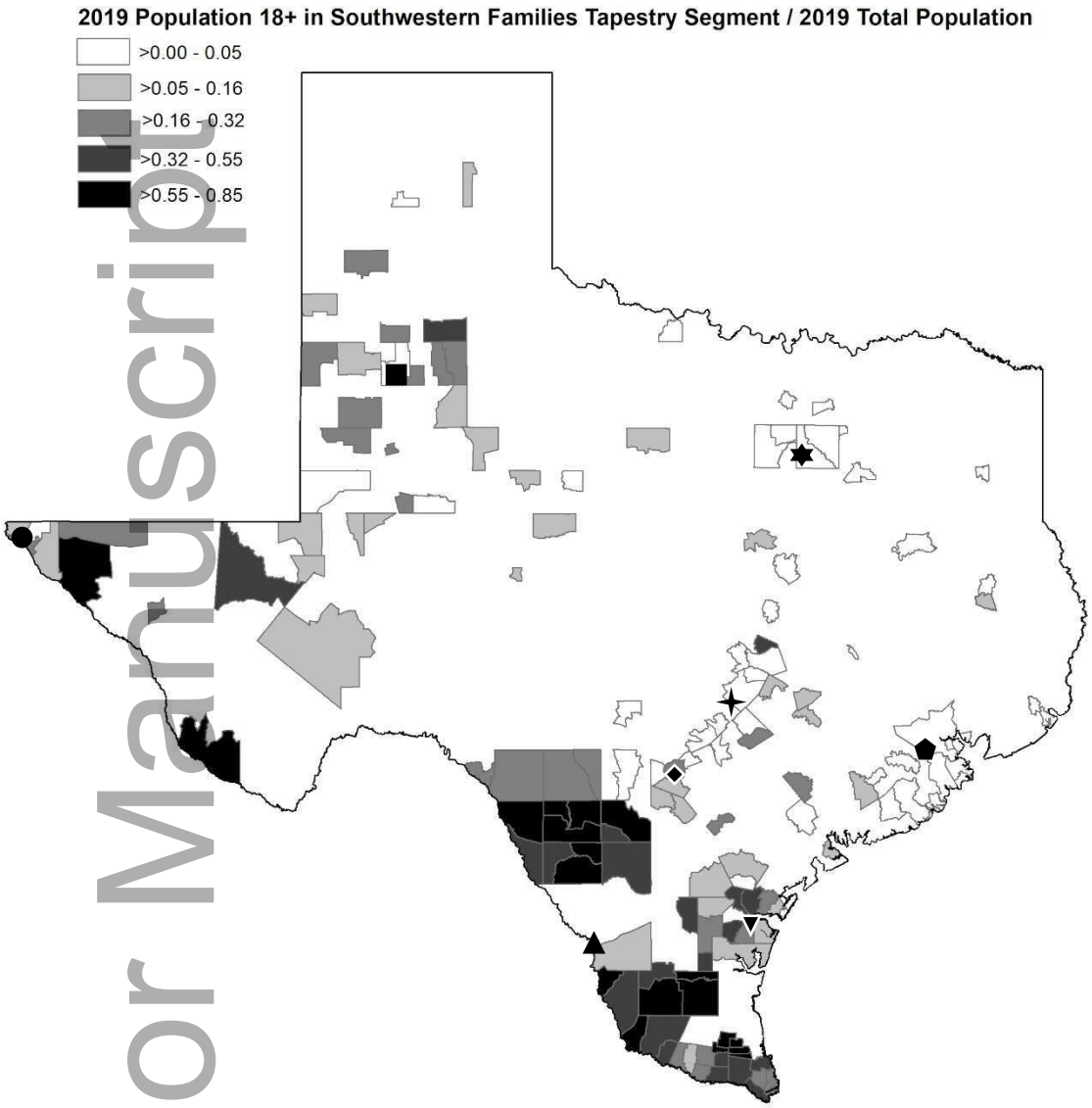

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Figure 5. These maps show the estimated proportional increase in growth in households from 2019 to 2024 for the a) Rooted Rural, b) Up and Coming Families, and c) Southwestern Families tapestries as defined by ESRI®'s Business Analyst® within mainland Texas(barrier islands have been removed to improve clarity). The geographic division used to display the changes are census county subdivisions. Areas without boundaries indicate subdivisions that had no households in the tapestry in 2019. We used the Jenks Natural Breaks (de Smith et al. 2018) approach to create a white-to-black color ramp, where the darkest regions indicate the highest level of our metrics (proportional growth of households),.and therefore the scales differ for each Tapestry. Sections within the map are census county subdivisions. Large cities are designated with symbols: El Paso (filled circle), Lubbock (filled square), Laredo (filled triangle), San Antonio (filled diamond), Austin (filled four-point star), Dallas (filled six-point star), Corpus Christi (filled inverted triangle), and Houston (filled pentagon).

A)

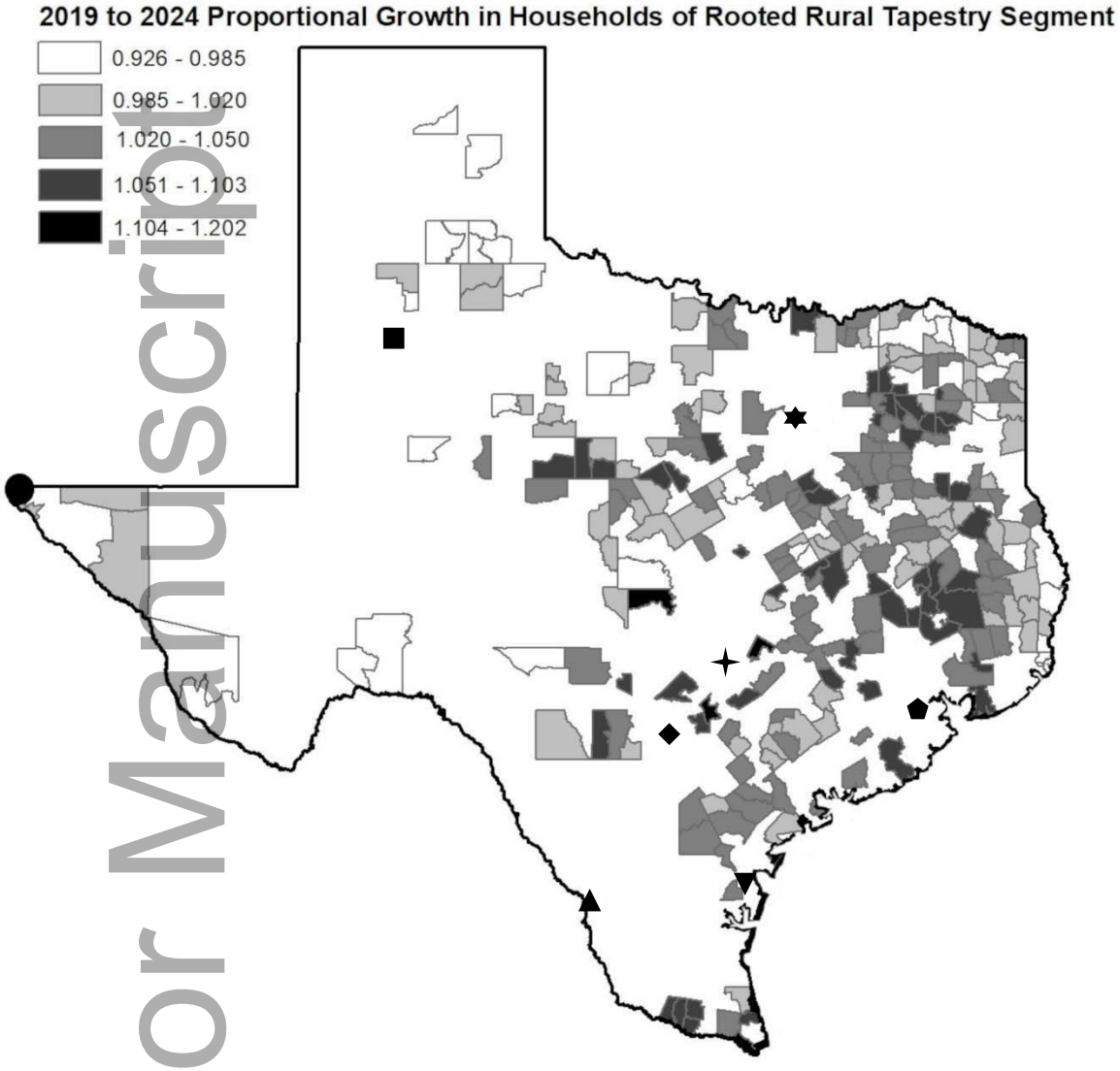
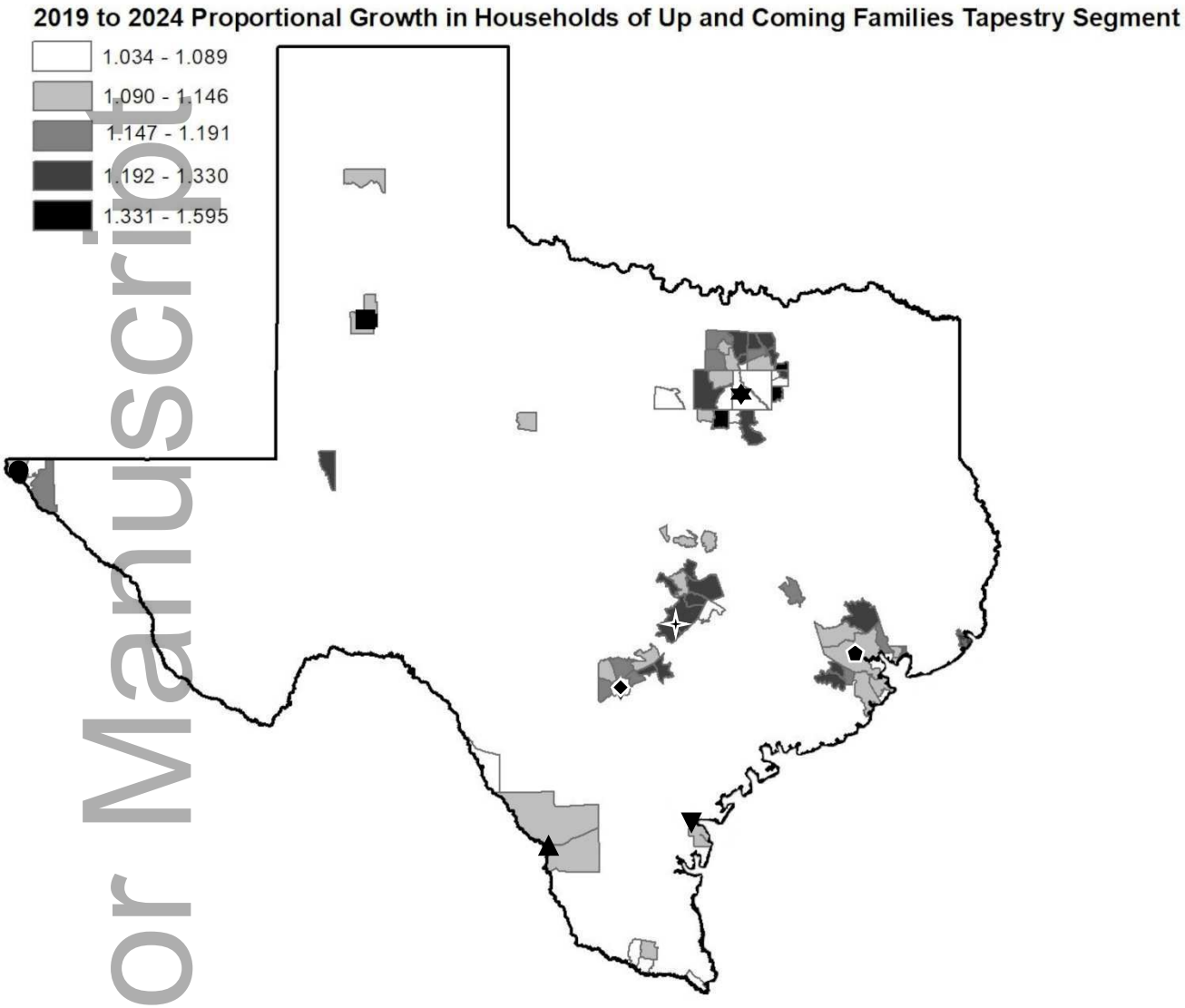


Figure 3

B)



C)