Spatial Trends of Illegal Crossings from Mexico

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I. Summary of Findings

Urban areas and ports of entry were the most positively correlated variables to illegal crossing apprehensions. It is assumed that illegal crossing apprehensions are an indicator of actual illegal crossings. This would support the notion that: if a crossing is more accessible, then it is more likely to be crossed. There is also evidence to indicate that ports of entry with low legal crossing traffic (perhaps closed) might be preferred by illegal crossers.

This assessment provides some initial insights into illegal crossing locations particularly as it relates to the question, *"How is accessibility related to illegal crossings?"* Additional, more precise data could be collected and these methods could be slightly altered to refine these results. These results are just one step in answering the larger question, "*What areas along the United States' southern border are at the greatest risk for illegal crossings from Mexico?"*

II. Question

A secure nation needs secure borders. Since the 1996 Illegal Immigration Reform and Immigration Responsibility Act (IIRIRA) the United States has increasingly committed significant resources to securing is borders (Ackleson 2003). The vast nature of the U.S.-Mexico border necessitates that these resources be used effectively and efficiently. Thus, United States' southern border should be examined to locate the areas at greatest risk for illegal crossings from Mexico.

This intelligence question could be as analytically vast as the physical border itself. In order to analyze the problem in an organized and efficient fashion, the question must be broken down into more manageable questions. As Clark (2009) states, in order to define a problem in detail, an analysts should: "deconstruct the highest level abstraction of the problem into its lower-level constituent functions.." With this in mind, the primary question of "*What areas along the United States' southern border are at the greatest risk for illegal crossings from Mexico?"* was broken down into several manageable questions as seen in Figure 1.

Another consideration when defining a problem is the deadline. It became apparent for the scope of this assessment that only one hypothesis for the question, *"What geospatial elements are correlated with illegal crossings?"* should be analyzed. This assessment investigates the problem *"How is accessibility related to illegal crossings?"*

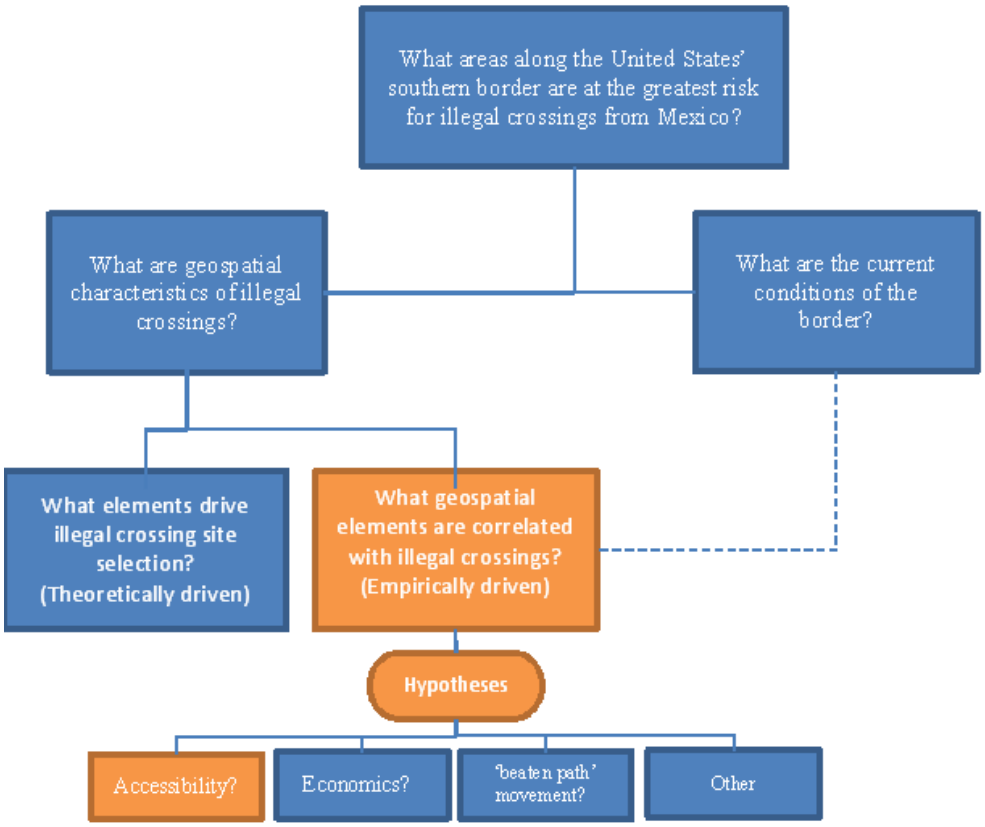

Figure 1. Question Breakdown.

III. Grounding

Background

The U.S.- border is the busiest in the world. Although it is difficult to quantify how many illegal crossings take place each year, estimates put the number between 400,000 and 1 million. A secure border aims to protect against the illegal trafficking of humans, undesirable goods, as well as criminal and terrorist elements. A secure border can also protect a nation's economics. However, at 1,933 miles the U.S.-Mexico border is difficult to secure (CRS 2006).

These illegal crossings, although numerous, are not equally distributed across the border. Physical, cultural, and economic factors all may drive the location of crossings. The general locations of the highest numbers of illegal crossings are not unknown. There are ongoing efforts to secure many of these highly trafficked areas (GlobalSecurity 2011). Should these efforts be successful, will those looking to cross illegally just give up, or will they find the next weakest chink in the armor?

The geographic scope of this asssessment has been reduced to include only the Texas section of the border. There are 15 Texas counties along the border. Two, Culberson and Jeff Davis, do not share a border with Mexico but are within 10 miles (CBP 2011). These counties were grouped into 12 border groups for comparison with their municipios counterparts. Nine of the groups represent only a single county. There are 24 municipios along the border. The groups were numbered from west to east (Table 1). Figure 2 shows all 12 groups.

Number	Name	U.S. Counties	Mexico Municipios
1	El Paso	El Paso	Juarez
2	Hudspeth	Hudspeth, Culberson	Guadalupe, Praxedis G. Guerrero
2	Presidio	Presidio, Jeff Davis	Ojinaga
4	Brewster	Brewster, Terrell	Acuna 1, Ocampo, Manuel Benavides
5	Val Verde	Val Verde	Acuna 2
6	Kinney	Kinney	Jimenez
7	Maverick	Maverick	Guerrero, Nava, Piedras Negras, Villa Union
8	Webb	Webb	Hidalgo, Anahuac, Nuevo Laredo
9	Zapata	Zapata	Guerrero
10	Starr	Starr	Camargo, Gustavo Diaz Ordaz, Mier, Miguel Aleman
11	Hidalgo	Hidalgo	Reynosa, Rio Bravo
12	Cameron	Cameron	Matamoros

Table 1. Border Groupings.

Geospatial aspects

This assessment examines geospatial aspects that relate to border accessibility and border crossings. This includes physical features such as roads, railroads, and streams. It also examines a population's relationship to illegal border crossings. All of these elements are grouped and summarized by general geographic containers (i.e. border groups) so that they can be compared with apprehension data from similar extents.

These elements are examined based on which side of the border they are located. Generally there may be little difference between a road in the U.S. and a road in Mexico. However, for someone looking to cross the border, a road on their side could be a tactical advantage while the same road on the opposite side could be a tactical advantage to their opposition.

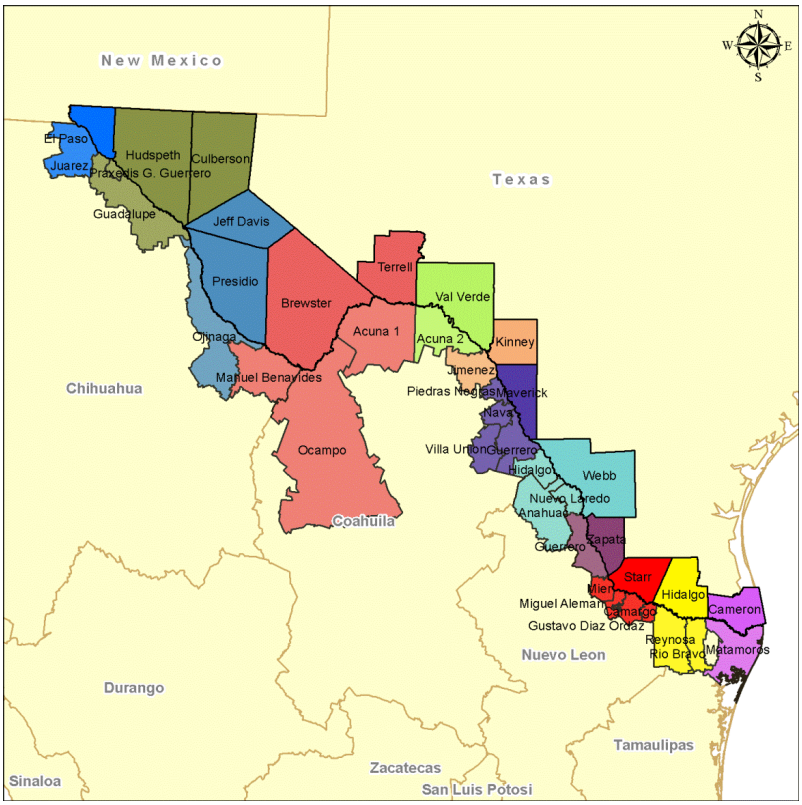

Figure 2. Map of Border Groupings.

Key assumptions

The fundamental judgments of this analysis rest on the following assumptions:

1. Securing the U.S.-Mexico Border is key to national security.
2. The U.S.-Mexico Border can be secured by physical means (law enforcement, barriers, etc.).
3. Illegal border crossings follow some pattern and are not completely random.
4. Illegal crossing apprehensions are relatively reflective actually illegal crossings both in numbers and location.

This assessment assumes that securing the border is key to national security. Border security is a frequent topic on Capitol Hill. Legislation and initiatives such as IIRIRA, The Secure Fence Act, REAL ID Act, Consolidated Appropriations Act of 2008, Operation Gatekeeper, and the Secure Border Initiative indicate that, at a minimum, border security is a significant concern (CRS 2009).

Many of these policies involve securing the border through physical means. This assessment assumes that the border can be secured through methods such as enforcement and barriers. The most

fortified borders in the world, however, all encounter some amount of penetration so further investigation of this assumption is warranted.

In order detect trends and evaluate risk, it is assumed that these illegal crossings follow some pattern and are not completely random. These patterns could be part of a purposeful strategy or simply the instinctive results of human nature.

The exact number of illegal crossings is unknown. The Border Patrol estimates that 20% are apprehended (GlobalSecurity 2011). This report uses apprehension numbers as an indication of crossings numbers. This assumption must be noted since the quantity and quality of law enforcement could impact this apprehension-to-crossing ratio. It is also assumed that illegal crossers are apprehended in the same geographic area that they crossed. This assumption was driven by data availability. Specific mile marker data was unavailable thus apprehensions were summarized by county.

IV. Alternatives

There are several hypotheses for the problem: *"How is accessibility related to illegal crossings?"* Possibly alternatives for the question examined in this report:

1. If a crossing is more accessible, then it is more likely to be crossed.
2. If a crossing is less accessible, then it is more likely to be crossed.
3. There is no correlation to between accessibility and crossings.

V. Evidence

Rossmo (2008) states that illegal crossings follow typical of criminal behavior in that they are shaped by perceptions, beliefs, knowledge, and personal experiences. Areas of large population on the Mexican side of the border have historically had high numbers of illegal crossings. Rossmo has shown that for his sample area in of several counties in Texas, there was a correlation between illegal crossings and proximities to urban areas in Mexico. This relationship was less for urban areas in the U.S. These Pearson correlation coefficients (r) can be seen in Table 2.

Initiatives such as Operation Gatekeeper and Operation Hold the Line have focused in urban areas. Some of these efforts have shifted illegal traffic to more rural and remote areas of the border. The Border Patrol noticed an increase in foot traffic along trails and dry rivers and arroyos after the

implementation of Operation Gatekeeper in San Diego (Cao 2002). Rossmo also showed medium-to-strong correlations between the proximity of railroads as well as intermittent streams and illegal crossings.

Correlation Based on Distance	
Variable	***r***
Distance to closest U.S. urban area	-0.259
Distance to closest Mexico urban area	-0.637
Distance to closest large flowing river	0.503
Distance to closest medium flowing river	0.213
Distance to closest flowing streams and small rivers	0.417
Distance to closest intermittent stream	-0.394
*Distance vs apprehension numbers thus negative value = positive proximity correlation	
Adapted from Rossmo 2008.	

Table 2. Pearson Correlation Coefficients for Proximity to Illegal Border Crossing Apprehensions.

Roads, streams, railroads, population, ports of entry, border length, legal crossings and Border Patrol apprehensions were all collected and joined to the border groups they fell within (Figure 3). The lengths of spatial dataset (streams, roads and railroads) were summarized by border group. The tabular datasets (population, ports of entry, border length, legal crossings and apprehensions) were joined with the border group spatial features. These variables are compared to the apprehension data for each border group in Figures 4 to Figure 7 in Appendix A. The variables within border groups were plotted to examine any linear relationship between these variable and apprehensions. These figures can be viewed as a border profile since the border groups are plotted geographically from west to east. Pearson correlation coefficients were calculated in Table 3. These coefficients are calculated between each individual variable and the illegal crossing apprehensions of the same border group.

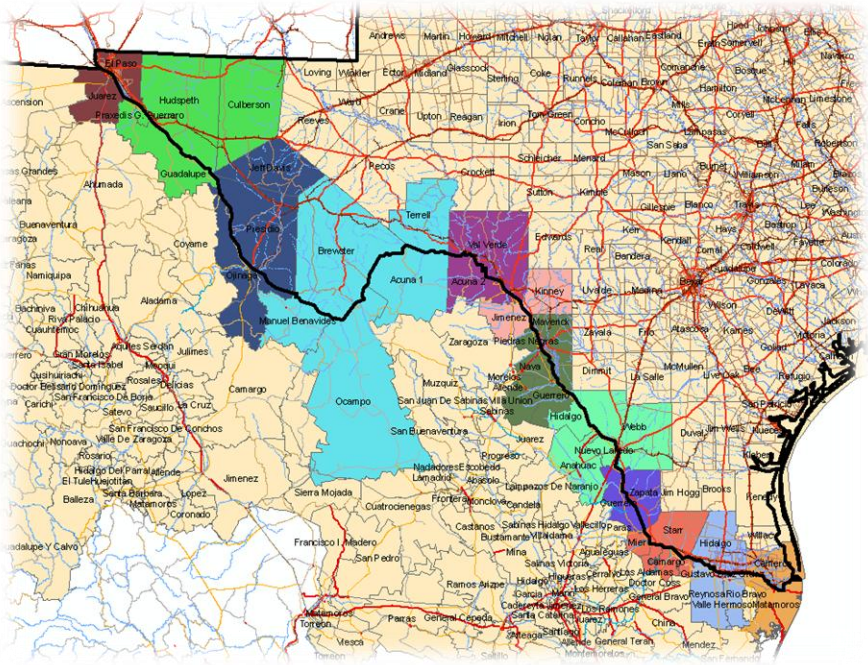

Figure 3. Map of Spatial Data.

Variable	Correlation *(r)*	
	U.S.	Meixco
Roads	0.006	-0.256
Streams	-0.474	-0.243
Rail	-0.268	-0.256
Population	0.410	0.233
Border Length	-0.287	
Ports of Entry	0.510	
Legal Crossings	0.269	

Table 3. Border Group Based
Pearson Correlation Coefficients.

VI. Analysis

The distance proximity (DP) based analysis showed a strong positive correlation between Mexican urban areas and illegal crossing apprehensions (Rossmo 2008). The more general border group (BG) based analysis showed a smaller correlation. There was a small correlation to U.S. urban areas for the DP based and a medium correlation to U.S. populations summarized in the border groups.

The DP based analysis indicated a strong negative proximity correlation to rivers and flowing streams. Intermittent streams indicated a medium positive proximity correlation. BG based analysis showed a strong negative correlation for U.S. streams and a small negative correlation for Mexican

streams. Note that the BG based analysis grouped intermittent streams and rivers so it is difficult to draw a conclusion from the comparison with the DP based analysis.

The lack of correlation with roads using the BG based data, as well as the inconsistencies in the stream correlations, could indicate that the data needs to be evaluated. As with any statistical function, the Pearson correlation coefficients are only as good as the input data. More features should be added and perhaps be classified in more detail. In addition, since the shapes and sizes of both counties and municipios are inconsistent, the data may be better analyzed as a density.

The strongest BG based positive correlation with apprehensions was port of entry. There was not as strong of a correlation found with legal crossings. This is interesting considering that these legal crossings would have crossed at these ports of entry. Aside from intermittent streams, all stream categories for both analyses had the strongest the negative correlations.

VII. Conclusions

The unanimous correlations of urban areas to apprehensions indicate that accessibility positively influences illegal crossings. This is supported by the positive ports of entry correlation. Although legal crossings have a positive correlation, it is smaller than ports of entry. These two correlations indicate that ports of entry with low legal crossing traffic (perhaps closed) might be preferred for illegal crossers. Multiple ports of entry within a border group might be more difficult to secure than a single highly trafficked one. There are also no variables that are positively correlated on the Mexican side, but negatively correlated on the U.S. This is all given the assumption that illegal apprehensions reflect illegal crossings.

This assessment provides some initial insights into illegal crossing locations particularly as it relates to the question, *"How is accessibility related to illegal crossings?"* Additional, more precise data, could be collected and these methods could be slightly altered to refine these results. These results are also just one step in answering the larger question, "*What areas along the United States' southern border are at the greatest risk for illegal crossings from Mexico?"*

Appendix A: Maps and Graphics

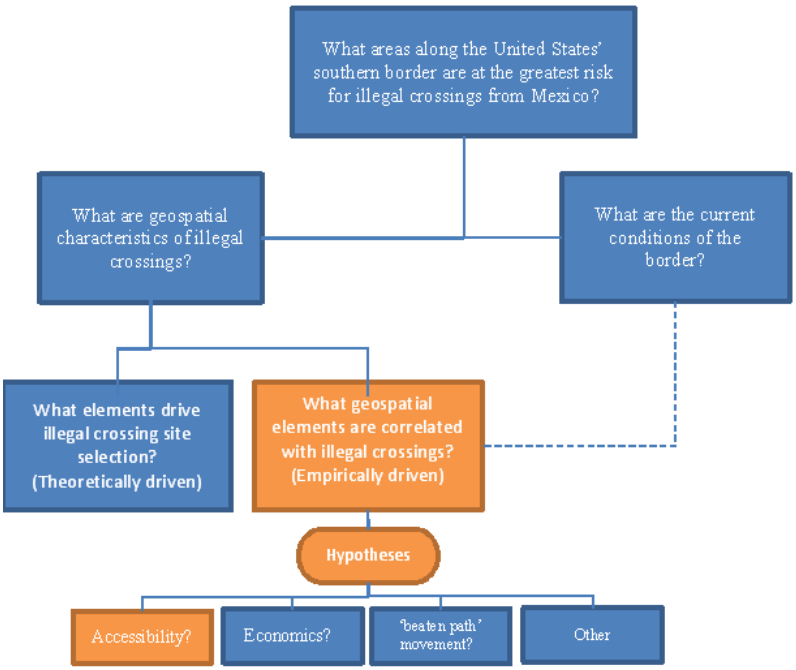

Figure 1. Question Breakdown.

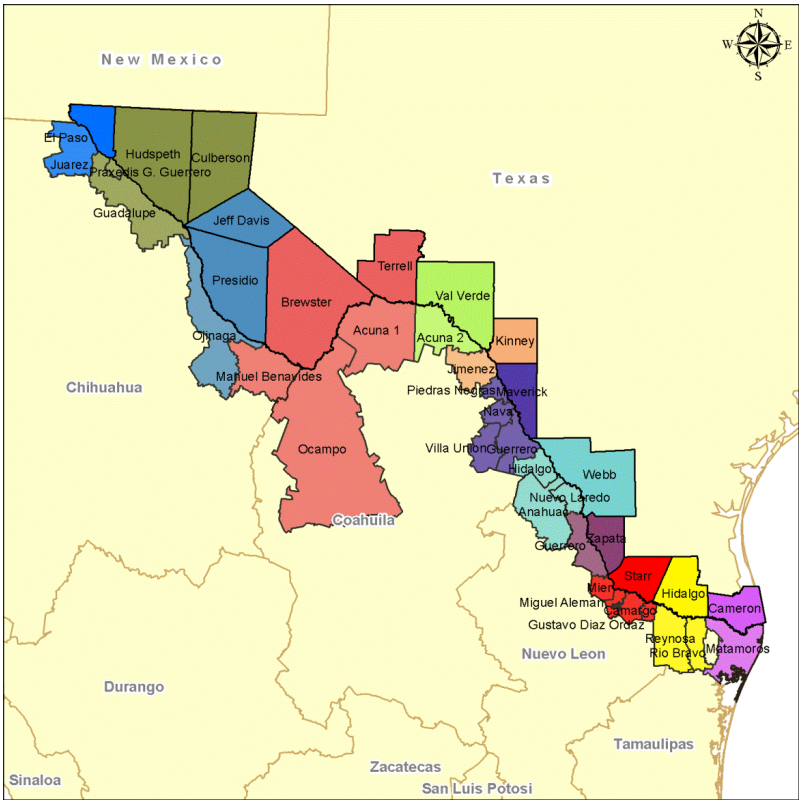

Figure 2. Map of Border Groupings.

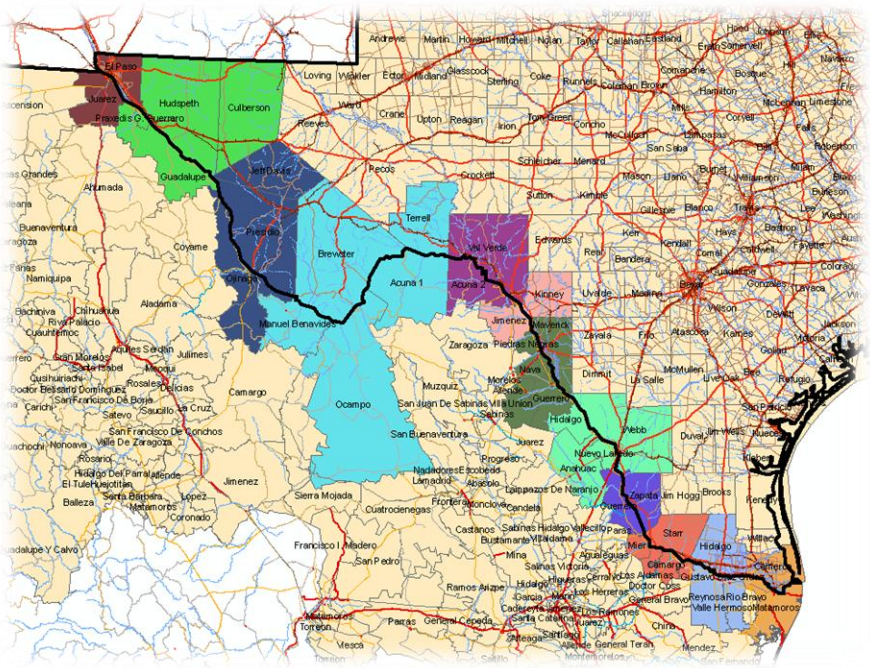

Figure 3. Map of Spatial Data.

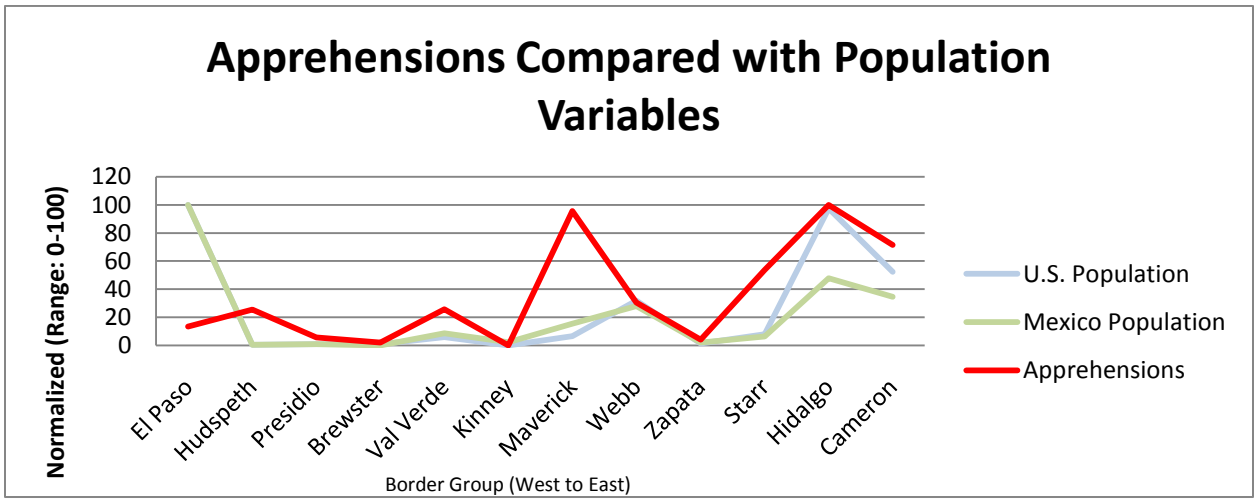

Figure 4. Normalized Population Variables and Apprehensions.

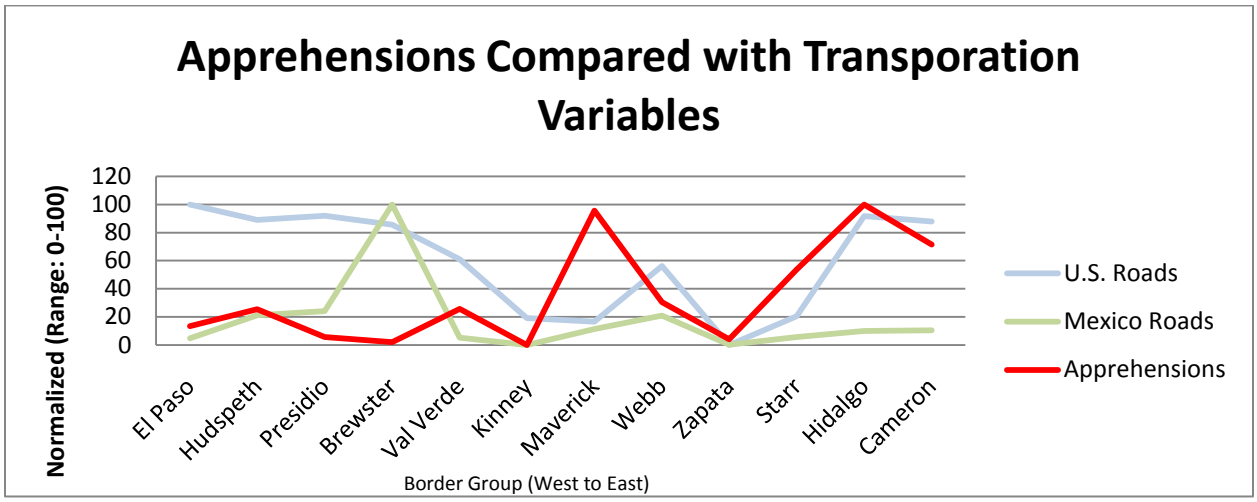

Figure 5. Normalized Transportation Variables and Apprehensions.

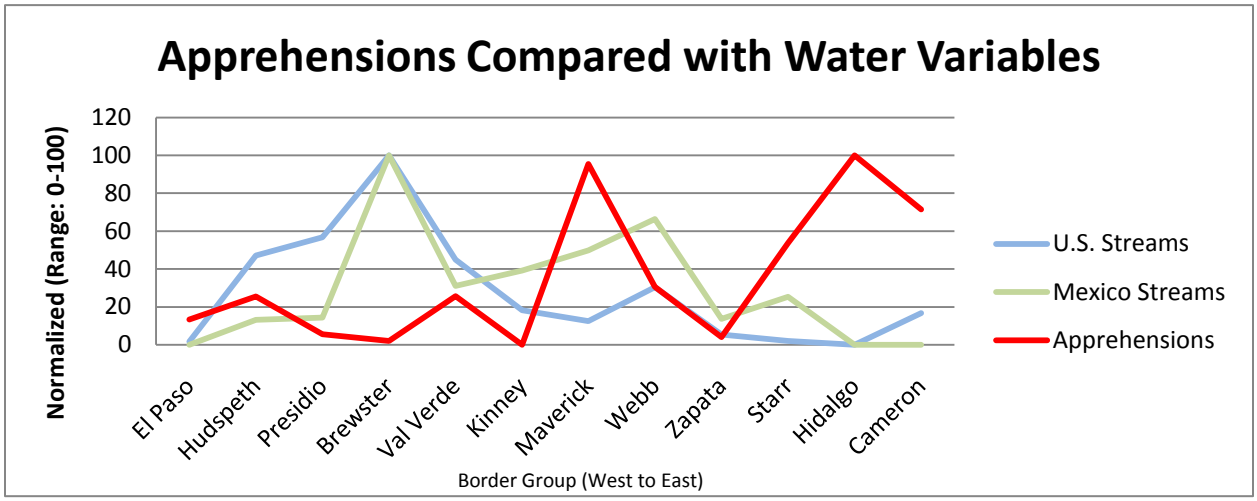

Figure 6. Normalized Water Variables and Apprehensions.

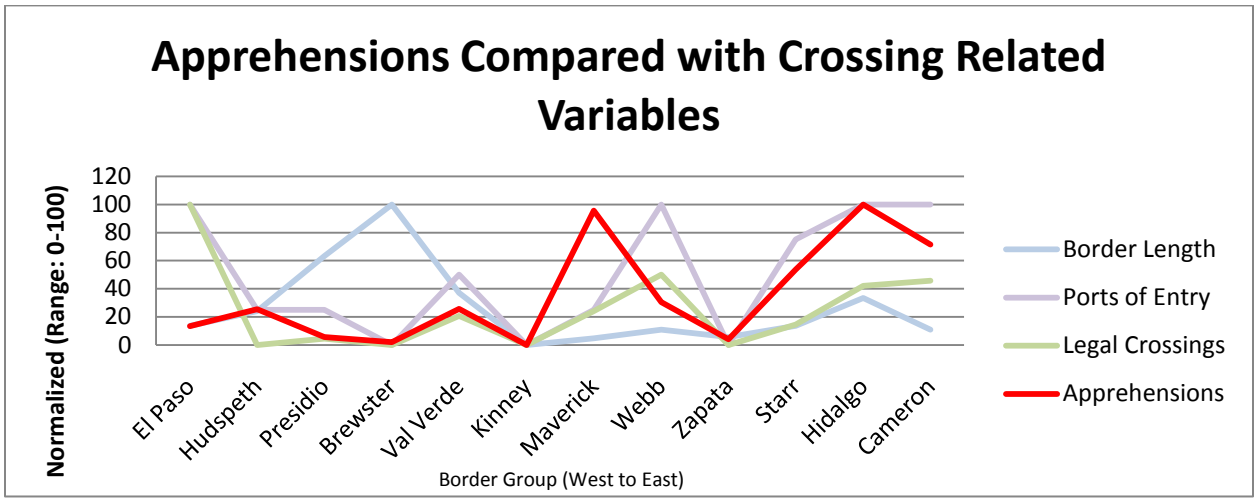

Figure 7. Normalized Crossing Related Variables and Apprehensions.

Appendix B: Annotated Bibliography

Ackleson, J. (2003). Directions in Border Security Research. *The Social Science Journal*. Vol. 40, No. 4.
--This paper gives background on border security policy specifically as impacted by NAFTA and the 9-11 attacks.

Cao, L., Raine, J. (2002). "Mapping Illegal Immigrant and Smuggler Trails at U.S.-Mexico Border Using ADAR 5500 Imagery." Proceedings from ESRI UC '02: *22nd Annual ESRI International User Conference. San Diego, CA.*
--This paper demonstrates the use of image analysis to locate smugger trails. It also provides some information about preferred types of crossing locations.

Clark, Robert M. (2009). *Intelligence Analysis: A Target-Centric Approach*. CQ Press: Washington D.C.
--Chapter 6 was used to help define the intelligence problem.

Congressional Research Service (CRS). (2006, November 9). *U.S. International Borders: Brief Facts.* Library of Congress. Washington, DC.
--This report provides the lengths of the U.S. border.

Congressional Research Service (CRS). (2009, March 16). *Border Security: Barriers Along the U.S.International Border.* Library of Congress. Washington, DC.
--This report details border policies and provides the impacts of these border initiatives.

Esri Street Maps: Mexico and United States. (2007). Esri. [Spatial Data Files].

--This source provided all of the spatial data used for this project. U.S. population numbers were 2007 estimates.

GlobalSecurity.org. "US-Mexico Border Fence / Great Wall of Mexico".*GlobalSecurity.org.* Accessed July 10, 2011.
--News article with discussion on the Secure Border Initiative. It also gives some good overview information.

Instituto Nacional de Estadística y Geografía (INEGI). (2011). Mexico. [Data Files].
--This source provided the population estimates. Mexico population numbers are 2005 estimates.

Passel, Jeffrey S. (2006, November 9). *The Size and Characteristics of the Unauthorized Migrant Population in the U.S.* Pew Hispanic Center. Washington, DC.
--This detailed report breaks down the migrants crossing the border. Who they are, where they are coming from, and why are they coming.

Pick, J. B., Viswanathan, N. and Hettrick, J. (2001). The U.S. – Mexican Borderlands Region: A Binational Spatial Analysis. *The Social Science Journal*. Vol. 38, No. 4.
--This paper is a detailed analysis that compares the economic and demographic situations of both sides of the border. It has lots for the Mexican side of the border unfortunately most of this data is only present as in map form.

Rossmo, D. Kim. (2008, February). "Geographic Patterns and Profiling of Illegal Crossings of the Southern U.S. Border." *Security Journal.* Vol. 21, No. 1-2.
-This paper is a great resource in that it is very similar to my question. It looks at areas of high illegal traffic and aims to find what characteristics these locations have in common.

Soden, Dennis L. (2006). "At the Cross Roads: US / Mexico Border Counties in Transition". Institute for Policy and Economic Development. El Paso, TX.
--This report provides a wealth of information (250+ pages). It breaks down each border county. It looks at employment, crime, funding, etc. This was the source of the county apprehension data. This data represents the 2006 apprehensions.

Soto-berelov, M. (2011, June 10). "Continuity and Distinction in Land Cover Across a Rural Stretch of the U.S.-Mexico Border." *Human Ecology: an interdisciplinary journal.* 39(4).
--This paper analyses imagery on both sides of the border looking for similarities/differences in land cover. It does not address immigration, but does provide insight to image processing methods and data sources for border analysis.

Texas Water Development Board. (2011). Texas Natural Resources Information System. [Spatial Data Files]. Retrieved from http://www.tnris.state.tx.us/.
--This site is a clearing house for Texas GIS data. It is a good source for othoimagery, transportation, and other vector datasets. Vector data was collected for Texas but was not used.

U.S./Mexico Joint Working Committee on Transportation Planning. (2011). *Mexico GIS Coverages. .* [Spatial Data Files]. Retrieved from http://www.borderplanning.fhwa.dot.gov/data_gis.asp.
--This site contains various vector data layers. It is valuable because it contains data for Mexico. This data was used to provide quality control for the other Mexico datasets

"U.S. Border Patrol Enters New Era of Mapping Intelligence." (2008). ERDAS Inc. Unpublished document. Retrieved from http://www.erdas.com/Libraries/CaseStudies/U_S_Border_Patrol_Enters_New_Era_of_Mapping_Intelligence.sflb.ashx.
--This pamphlet briefly describes some GIS methods used by the Border Patrol.

"U.S. Border Patrol Maximizes Enforcement with GIS." (2001). ArcNews Online. Retrieved from http://www.esri.com/news/arcnews/fall01articles/usborderpatrol.html.
--This article again briefly describes GIS methods used by the Border Patrol.

U.S. Customs and Border. http://www.cbp.gov/. Accessed August 1, 2011.
--This site proved background information on border patrol sectors.

U.S. Department of Homeland Security. (2010). *Yearbook of Immigration Statistics*. Government Printing Office. Washington, DC. Retrieved from http://www.dhs.gov/files/statistics/publications/yearbook.shtm.
--This site gives access to official tables of legal and illegal immigrants.