Practical Application of ACS Place of Birth Data in an App Created for
American Red Cross International Services

by

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To Red Cross volunteers

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List of Abbreviations

ACS   American Community Survey

DA   Disaster Assessment

ICRC   International Committee of the Red Cross

IFRC   International Federation of Red Cross and Red Crescent Societies

ISO   International Services Outreach

RFL   Restoring Family Links

Abstract

Thousands of people around the world lose contact with family members each year due to armed conflict, disaster, and migration. The International Committee of the Red Cross provides coordination between National Red Cross and Red Crescent Societies around the world to restore contact or provide closure for those with missing loved ones. The American Red Cross plays a part in this effort by collecting information to initiate a trace request on behalf of someone within the US for a loved one missing abroad and by conducting a trace for missing persons within the US on behalf of family members in other countries. This thesis describes the creation of a web app, referred to as the American Red Cross International Services Outreach web app (the "ISO App"), to support this work. Community outreach is vital to educating immigrants about the scope and availability of Red Cross services. The ability to locate specific communities allows workers to target outreach efforts, saving valuable time and volunteer resources; the ISO App helps American Red Cross International Services staff locate specific immigrant communities anywhere in the United States. The ISO App is centered on an interactive map of 145 American Community Survey (ACS) 'place-of-birth for the foreign-born population' fields at tract level. The ISO App does not provide predictions or conclusions about the location of individuals or communities, but provides geospatial clues that may increase chance of a successful trace or outreach effort. To meet American Red Cross technical requirements, the ISO App is built within an out-of-the-box ArcGIS Story Map template, compatible with ArcGIS Enterprise 10.4 Portal installation. This project will serve as a model for additional web apps utilizing ACS data to support other American Red Cross lines of service, as well as other organizations.

Chapter 1 Introduction

Thousands of people around the world lose contact with loved ones each year due to natural disaster, armed conflict, and migration. The International Committee of the Red Cross (ICRC) works with national Red Cross and Red Crescent Societies in 190 countries to reunite people through a program called Restoring Family Links (RFL). When the American Red Cross receives a tracing request from ICRC for someone thought to be in the United States, National Headquarters staff in Washington D.C. forward that request to the regional Red Cross office nearest to the person's last known location. There, RFL caseworkers begin a search by reaching out to the local foreign-born community of the country where the trace originated.

This thesis documents the creation of the American Red Cross International Services Outreach (ISO) web app (the "ISO App"), a series of interactive maps published online via Esri's Story Map platform that utilizes American Community Survey (ACS) data to locate specific immigrant communities at tract level throughout the United States.

1.1. Motivation

People go missing in countless ways. Natural or man-made disaster may separate parents from children or other family. Soldiers become missing in action. The vulnerable may become stranded in an area of conflict or violence, or swept away to camps with no way to contact loved ones. Others may migrate looking for work, then disappear.

According to the ICRC, a missing person may be "dead or alive, held in a secret prison cell, living in a refugee camp or in a foreign country, or lying in a mass grave" (ICRC 2014, 6). As the ICRC states, "Of all the suffering caused by war or natural disasters, perhaps the bitterest anguish stems from not knowing what has happened to a loved one" (2009, 2).

In November of 2016, the RFL Coordinator for the American Red Cross Los Angeles Region approached me with a question: did I know of any maps that would show him where to find specific ethnic or immigrant communities in Los Angeles? Not only would this information facilitate tracing efforts, but outreach as well. Volunteers often go into the field to educate immigrants about other services that Red Cross provides.

I could not locate any maps or online layers showing the level of detail needed to support sending volunteers in the field. However, I was aware of a long list of countries itemized in the American Community Survey (ACS) tract geodatabase under "Place of birth for the foreign-born population." Those fields, if mapped, would show where immigrant populations were located.

Although the request had been made in Los Angeles, I began to think that those ACS fields could be valuable to International Services workers around the country. Every American Red Cross region does RFL work. More than likely, every one of them could use that data.

1.2. The International Red Cross and Red Crescent Movement

Collectively, the International Committee of the Red Cross (ICRC), International Federation of Red Cross and Red Crescent Societies (IFRC), and 190 National Societies are known as the International Red Cross and Red Crescent Movement. The seven fundamental principles of the movement are humanity, impartiality, neutrality, independence, voluntary service, unity, and universality. These principles guide all humanitarian work within the Movement, although the focus of each of the groups is somewhat different (ICRC, Fundamental Principles 2017a).

1.2.1. The International Committee of the Red Cross

The ICRC was created in 1863 in Geneva, Switzerland, to protect and assist those injured by armed conflict (ICRC 2017b). The ICRC continues to play this role today, by providing

humanitarian aid to victims of war and internal violence. ICRC Staff with specialized training often work in war zones to bring help to injured and vulnerable people caught in harm's way.

1.2.2. International Federation of Red Cross and Red Crescent Societies

In 1919, the National Red Cross Societies from Britain, France, United States, Italy, and Japan formed an international federation to better coordinate their efforts. By that time, services had expanded to assisting victims of natural disaster and other humanitarian emergencies, in addition to conflict.

The International Federation of Red Cross and Red Crescent Societies (IFRC) has now grown to 190 member-societies (IFRC 2017a). Whenever a natural or manmade disaster overwhelms the resources of an affected country, that country's National Society may reach out to the IFRC for help. The IFRC then coordinates efforts between other member Societies to provide assistance. The IFRC also assists member Societies with development work, to strengthen community capacity and resilience to disaster.

1.2.3. National Red Cross and Red Crescent Societies

The 190 National Societies in countries around the world are staffed primarily by volunteers who work in their local communities in disaster preparedness, emergency response, first aid, community-based health care, and restoring family contact. (IFRC 2017b)

The National Society in the United States is the American Red Cross. Ninety percent of American Red Cross work is carried out by a volunteer workforce; the terms 'staff' or 'worker' may refer to employees or volunteers. The American Red Cross has five lines of service: Disaster Relief, Service to the Armed Forces, International Services, Health and Safety, and Blood Services. The modern organization is comprised of seven geographical divisions, encompassing 60 operational units referred to as regions (American Red Cross 2017c).

1.2.4. The Restoring Family Links Network

The International Red Cross and Red Crescent Movement's RFL network is made up of the ICRC's Central Tracing Agency, tracing agencies of ICRC delegations, and the tracing services of National Societies (ICRC 2009). To initiate a trace, a special tracing request form is filled out by family members with assistance from ICRC or National Society staff, in the country where the family is located. The person filling out the form is encouraged to include as many details as possible that may assist in a search. The completed form is forwarded to the Central Tracing Agency.

The data collected is checked against other data collected by the ICRC, such as lists of those reported safe, injured, detained, or deceased. It is also checked against other trace requests, media reports, and internet records. The form is then forwarded to the National Society of the country where the sought person is most likely to be found, or the sought person's last known location.

The National Society that receives the trace request evaluates the information given, and then forwards it to local RFL staff who may visit the last known address, contact neighbors or organizations, check camps and shelters, and look for records from hospitals or cemeteries. With consent of the enquirer, information may also be submitted to authorities or published (ICRC, Looking for Family Members 2017c).

1.2.5. The American Red Cross Role

When a tracing request is received at American Red Cross National Headquarters in Washington DC, International Services staff evaluate the information given, and then forward the request to the local region nearest to the last known location of the sought person.

While some traces can be completed with an internet search, most are significantly more complex. RFL caseworkers often have little information to work with. If the person being sought has no electronic footprint or may be using a different spelling or version of his or her name, a caseworker will attempt to locate a respected community leader, such as a pastor, who may be able to offer more information or help make connections with others in the community who may have information. But where is that local immigrant community located?

A caseworker with local knowledge can point to historic or well-established immigrant communities, such as Koreatown in Los Angeles. But what about the smaller, less established communities? Where would you find the local Sri Lankan, Liberian, or Fijian community? Where are the Eritreans? The Moldovans? Are populations dispersed, or are there pockets in different parts of the city, county, or state?

If caseworkers are unable to locate an individual on the information given, and are unable to divine additional clues from internet searches or the community, the trace request is returned to National Headquarters unfulfilled. From there, it may be forwarded to another region where caseworkers may have better luck. If a sought person is located, caseworkers hand-deliver a written message included with the trace by family members, and assist the sought person in re-establishing contact, if the sought person wishes to reconnect. If a sought person is not located, and all leads are exhausted, the trace is returned to the Central Tracing Agency and family members who initiated the trace are notified that their loved one was not found.

1.3. Application Goal and Objectives

The goal of this project was to create an app that facilitates the work of American Red Cross International Services staff by identifying the possible locations of immigrant communities in the United States. The ISO App is not intended to provide analysis, predictions, or conclusions

about the location of individuals or specific foreign-born communities. Rather, it provides

additional clues or direction to increase the likelihood of a successful search for a community.

1.4. ISO App Overview

Given the needs of the RFL caseworkers in identifying immigrant communities, a web

app that locates specific foreign-born communities can give caseworkers a starting point that

may mean the difference between a successful trace, and one given up because there is just not

enough information. For the person who initiated the trace thousands of miles away, and the

person being sought, this difference may be life-changing.

1.4.1. Intended Users

The ISO App intended users are American Red Cross International Services staff who

need to locate specific immigrant populations for RFL, outreach, and other service delivery. The

intended user, use cases, and user requirements are described in more detail in Chapter 3.

1.4.2. ISO App Software and Data

The ISO app is hosted on the American Red Cross ArcGIS Enterprise portal known as

RCView. The app utilizes a nationwide dataset of 74,001 census tracts. The final version of the

ISO App is built within an out-of-the-box Story Map template, chosen for compatibility with

existing organizational technology. The technical requirements of the ISO App are described in

more detail in Chapter 3.

1.4.3. App in Use

The ISO App was built in two phases. The initial build took place in January and

February 2017. The app was then redesigned and rebuilt in April 2017, to incorporate a request

from National Headquarters and to improve performance. In the final version, each tab of the

Story Map displays a map of the United States with Red Cross division and region boundaries, and a group of place of birth layers corresponding to a specific world region. Users select layers to add as needed. For each layer, the map populates with proportional symbols indicating the number of people per tract from that place of origin.

1.5. A Model for Future Work

The ACS 5-Year Estimates tract geodatabase holds 35,000 attributes in 30 tables. Most of the fields are unavailable as pre-configured layers, thus largely beyond reach for non-developers and less experienced GIS users. Many of these fields hold data that could be used by other Red Cross lines of service, as well as by other organizations and NGOs. For instance, the ability to count populations with specific disabilities in disaster-affected areas would allow Red Cross Disaster Services to better anticipate need for accommodation in shelters. Service to the Armed Forces (SAF) could use a tool identifying different veteran populations for targeting outreach.

The methods and design of this project may act as a model for additional ACS data projects created for use by American Red Cross, as well as for other organizations.

1.6. Thesis Organization

Chapter Two presents background information and related work on immigrant settling patterns, maps and data used to locate communities, and a survey of applications created for Red Cross. User profile, use cases, and requirements for the app are discussed in Chapter Three.

The ISO App began as a local project; Chapter Four traces App development from local to national scale, and then through two versions. Flaws in the initial design created performance issues; when national leadership requested additional functionality, a redesign and rebuild was undertaken to improve performance and support the new request.

The final App was introduced to users via WebEx demonstration with question and answer period. Chapter Five contains screenshots of the newly rebuilt app, and a discussion of feedback received during the WebEx. In Chapter 6, Conclusions, there is a discussion of subsequent work put to use immediately during the 2017 Atlantic hurricane season, and future work with ACS data both within Red Cross and for other organizations.

Chapter 2 Background and Related Work

This chapter provides background on immigrant settling patterns, currently available maps and data used to locate communities, principals of web mapping and humanitarian use of web maps, and applications created for American Red Cross to date.

2.1. Neighborhoods, Communities, and Immigrant Settling Patterns

There are many ways to define a neighborhood. One study of neighborhoods succinctly describes it as "the bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses" (Galster 2001, 2112). Listed among those spatially based attributes are demographic characteristics such as ethnic background. Logan (2011, 354) adds that social scientists begin with "the concept of neighboring—the connections and daily interactions between households living in the same building, or the buildings next door or across the street, or maybe in the next block."

How can these neighborhoods be located? Logan (2011, 354) notes that "the study of ethnic differentiation within cities has depended largely on geographic aggregations of people such as census tracts or wards, which become the lens through which the city is viewed." Logan reviews spatial analysis methods for locating neighborhoods based on characteristics of individuals instead.

A community is similar to a neighborhood in that its members share a connection. However, a community does not have the same spatial requirement, and the connection may run deeper. People who are part of an immigrant community share a connection to the same homeland, and may share similar challenges and struggles.

The term "immigrant enclave" describes the type of neighborhood attractive to recently arrived immigrants who have fewer socioeconomic resources (Edin, Fredriksson and Olof 2003).

Immigrant enclaves offer affordable housing, familiar culture, and more opportunity for unskilled labor. As immigrants become more established and prosperous, they tend to move away from these enclaves to neighborhoods with more amenities. In contrast, the "ethnic community" is an alternative to assimilation (Logan, Zhang and Alba 2002). Ethnic community residents stay in the same neighborhood regardless of resources. A more recent model of "ethnoburbs" describes a pattern in which new immigrants skip the urban enclave and settle directly in suburbs (Zhou, Tseng and Kim 2008).

Heterolocalism is a term used to describe socially cohesive immigrant communities whose members may not have a spatial connection. Instead, these communities may be widely dispersed (Zelinsky and Lee 1998). While Zelinsky and Lee's study was written nearly twenty years ago, its relevance may have increased as society has become more mobile and less reliant on face-to-face interaction.

The immigrant groups included in the ISO App may follow any of these patterns, or none of them. The settlement patterns of any group included in the ISO App, whether observed and described or yet undiscovered, may influence how well the app will work to assist caseworkers and others hoping to locate specific communities.

ACS data may be more successful in identifying ethnic communities over immigrant enclaves, because the ethnic community populations as described by Logan et al. (2002) would be more firmly established in place over time. Residents seek the community, rather than assimilation. In contrast, the immigrant enclave is a more temporary landing place, which may shift more rapidly within a city itself, or even nationally.

ACS data may be particularly suited to uncovering small groups settling in Zhou's ethnoburbs (2008). A community numbering in hundreds may otherwise go undetected across a vast suburban landscape such as Los Angeles. The ISO App will pinpoint these tracts.

Immigrant groups settling heterolocally may not be well identified by ACS data, as these communities are geographically dispersed, despite their cohesiveness. If a population center can be detected, there may still be a benefit to these community ties for RFL caseworkers; a cohesive network may generate more leads.

2.2. Locating Immigrant Communities

Few resources are available for locating communities on a practical level. This section surveys maps and articles which may help under limited circumstances, and existing data.

2.2.1. Maps and Other Media

Maps related to migration topics often utilize census data, but tend to cover the location of immigrants on a scale too small for practical use in the field. For instance, the Migration Policy Institute maintains a large collection of maps on migration in the United States. However, few if any explore data compiled for geographical units smaller than county.

The Migration Policy Institute's most comprehensive offering is an interactive web map utilizing the same ACS place of birth fields used in this project, but compiled by Metropolitan Statistical Area (MSA). MSAs contain at least one county with a population center of 50,000 or more, and adjacent counties with significant social and economic ties to that population center (US Census Bureau 2017b). Vast portions of more rural states are excluded. For statistical integrity, the Migration Policy Institute's web map also excludes MSAs with a count less than 2000 for any specific place of birth layer, due to insufficient sample size (Migration Policy Institute 2017).

The 2000-person threshold is difficult to meet for smaller immigrant groups; in the MSA map, the layer for St. Vincent and the Grenadines displays just one large symbol in the NY-NJ-PA metro area. In contrast, tract-level data with no minimum threshold places immigrants from St. Vincent and Grenadines in 618 locations in the United States. While the information provided in the Migration Policy Institute web map does cover every place of birth field, the, the MSA scale is too small to be actionable.

The most useful immigrant community maps found were those aimed toward potential visitors: tourists and urban adventurers looking for exotic food and culture. These provide information largely based on local knowledge and history rather than peer-reviewed research or census data. One mainstream media article provides a survey of ethnic neighborhoods in Los Angeles, presented online with a Google Map (Delsol 2015). However, it lacks the scope and extent needed to be useful for the current purpose. Further, it only identifies one location for each community, failing to note that when place of birth data is viewed by tract, satellite communities appear in other parts of the county. Similar guides appear for other major cities, although the community locations are most often presented in list format rather than mapped. A guide to New York communities features eighteen ethnic neighborhoods (Geier 2015) and another for Chicago details six (O'Donnell 2012).

The most granular display of census data may be "The Racial Dot Map" (Cable 2013). This web map utilizes 2010 block data to generate some 300 million dots across the United States, each of which represents a single person. This extraordinary view of the nation provides insight into racial distribution in the most minute detail. However, data is classified in just five categories: White, Black, Asian, Hispanic, and Other.

2.2.2. Identifying Immigrant Communities with American Community Survey Data

The ACS differs from the decennial census in that the ACS primarily measures changing social and economic characteristics of a population, while the census provides a count of population (US Census Bureau 2008). Each year, approximately three million households, or about 2.5%, are selected to receive ACS surveys. This sample is used to create estimates of social and economic characteristics across the population. The 5-Year Estimates are based on data from the previous 5 years. Since ACS data is based on sampling, there is a greater potential for error than in the decennial census (MacDonald and Peters 2011). Margin of error will be discussed in greater detail in Section 4.2.1.2 Estimates and Margin of Error.

2.2.2.1. Place of Birth or Ancestry?

The ACS includes questions about both place of birth and ancestry. The place of birth question seeks to identify individuals who were born in other countries. The ancestry question identifies "ethnic origin, heritage, descent, or 'roots'" (US Census Bureau 2014). While the ancestry question at first seems promising for identifying ethnic communities, it does not measure the degree of attachment. Someone who identifies as Polish may be a new immigrant, may have a Polish grandmother, or any other connection which instills a sense of identity. Respondents may choose a second ancestry, so that same person may also identify with another heritage.

Place of birth fields are more appropriate for the ISO App, because these fields show where immigrants are living currently. This focus is needed to narrow down the areas for search.

2.2.2.2. Feature Services

Several sources provide census data online for mapping. A selection of attributes from the 2010 Census Demographic Profile are available free from Esri's Living Atlas in four feature

services for Housing, Race, Housing, and Age and Gender. These provide state, county, tract, and block group data for several hundred attributes (Berry 2017). Various additional feature services published by Esri and others provide hundreds more fields.

For a premium, ArcGIS customers can subscribe to Community Analyst or Business Analyst; each service costs $100 per user per year with a minimum of five users. In addition to other analysis features, both advertise access to more than 15,000 data variables (Esri 2017f). That substantial offering covers the data needs of many businesses, agencies, and organizations. However, Esri's *Demographics and Business Data List* (2017) shows that only about 500 of those variables are ACS Estimates. Another 500 are the associated margins of error, and 500 more are proprietary calculations of reliability by Esri Demographics based on the estimate and margin of error figures (Esri 2017a).

None of these represent place of birth. Available feature services cover the most commonly used census and ACS variables, but what is available remains a small fraction of what may be found by querying the source.

2.2.2.3. Census Data API

ACS 5-Year Detailed Tables accessed through the Census Data API contain more than 64,000 variables (US Census Bureau 2017a). When queried in the prescribed format, the API returns a JSON that can be utilized by an application (Breakstone and Anderson 2017). However, an out-of-the-box ArcGIS web map cannot directly consume this as a layer. Developers may use the JSON to build a layer in a custom app, or otherwise transform it to a more compatible format (Tedrick 2014). The Census Data API does not offer lay users a practical solution for mapping hard-to-find fields.

2.2.2.4. ACS Geodatabases

ACS 5-Year Estimates in geodatabase format can be downloaded directly from the US Census. Geodatabases are available for most Census geographical units, such as tract, block group, county subdivision, county, state, urban area, and zip code tabulation area. Tract is the smallest unit for which "Place of Birth for the Foreign-Born Population" is compiled.

The ACS Tract 5-Year Estimates geodatabase includes more than 35,000 fields. Data can be extracted from census geodatabases using desktop software such as ArcMap or ArcGIS Pro, and then published as a feature service. Once created, the feature service can be used to create layers in an ArcGIS web map, and can be shared with others to utilize as well.

This project will utilize data from a geodatabase due to technology limitations, and because the resulting feature service may be used for other purposes afterward.

2.3. Web Maps and Humanitarian Aid

This section provides background on web mapping and ways in which web maps have been utilized for humanitarian aid.

2.3.1. Web Maps

The on-screen format of web maps and interactivity of the online medium create differences in expected map elements and design best practices. Web map users expect the ability to pan and zoom. They may also require a help menu, an interactive legend, a locator map, or other functionality. Elements should only be included if needed to fulfill the purpose of the map and requirements of the map audience; unnecessary elements should be left off the web map (Muehlenhaus 2013, 58).

Web users may be considered to have "relatively short attention spans and high expectations" (Buckley 2012, 50). Because of this, web map functions should respond quickly and the purpose of the map must be clear.

The visual hierarchy for map design, as described by Dent et al., defines the relative importance of each element in print map and portrays this importance graphically (Dent, Torguson and Hodler 2008). Muehlenhaus carries this principal to web mapping, with adjustments unique to the medium. The most important elements to emphasize in a thematic web map, which should be considered 'Level 1', are the title, thematic visualization, and legend; 'Level 2' includes the basemap, info windows, and chart graphics; 'Level 3' consists of basemap labels, and map interactivity (Muehlenhaus 2013, 64). In accordance to visual hierarchy, the most important elements should have the greatest visual contrast in order to stand out.

2.3.2. Web Mapping in Humanitarian Aid

The flexibility and interactivity of web maps creates tremendous opportunity for use in the humanitarian sector. Much work outside of the US has involved data acquisition through crowdsourcing and satellite imagery. The Missing Maps program, founded by the Humanitarian OpenStreetMap Team, Doctors without Borders, American Red Cross, and British Red Cross, utilizes volunteers who digitize previously unmapped communities in areas vulnerable to disaster, around the world (Missing Maps 2017).

Tomnod utilizes volunteer taggers who scan Digital Globe imagery to mark buildings, items, or other phenomena unique to specific humanitarian or research campaigns. A campaign for South Sudan Food Insecurity has enlisted the help of more than 600 volunteers, to scan over 2200 square kilometers of land to mark agricultural fields and dwellings (Tomnod 2017).

Within the United States, data from the census, as well as data collected by companies such as Facebook, offer significant intelligence that could be utilized by humanitarian organizations, if organizations have the ability to access it. As noted in section 2.2.2, this data may be challenging to locate and set up.

2.4. American Red Cross Apps

This section discusses the different types of apps that have been created for American Red Cross to date.

2.4.1. Native Apps

American Red Cross offers several free apps available for both Apple and Android (Figure 1). All but one of these professionally designed and maintained apps are intended for an external audience, and are supported at least in part by corporate sponsors (American Red Cross 2017b). They include individual disaster apps dedicated to flood, tornado, earthquake, hurricane, and general emergency; information and preparedness apps for first aid, pet first aid, blood donation, hero care (for the military community and veterans), water safety, and kids' preparedness; and a special blood app for hospitals and medical professionals. A separate app for volunteers links users to their volunteer profile. This array of topics covers all lines of service except International Services.
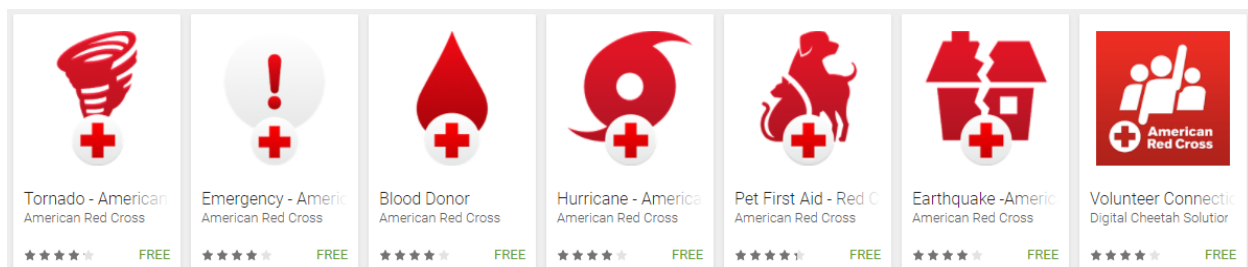
Figure 1. American Red Cross apps available on Google Play (Source: American Red Cross)

2.4.2. RCCollect

When American Red Cross responds to a disaster event, volunteers assigned to Damage Assessment (DA) canvas the affected area to document the extent of the damage. RCCollect is a new system that replaces traditional clipboard and paper with smartphone and Survey123 for ArcGIS. Survey123 is an Esri native app supporting data collection in question-and-answer format (Esri 2017c). The RCCollect survey is accessed through the Survey123 app. Although the app itself is not customized, the extensive RCCollect form with multiple branches and predefined answer lists represents the first major effort by Red Cross to integrate GIS with field operations.

An RCCollect training course was developed to prepare the DA workforce to use the new system. Although Survey123 is considered user-friendly, a training course is needed to ensure uniform adoption across a large volunteer base with varied technical skills.

2.4.3. RCView Apps

Numerous web apps have been created in-house over the last 12 months using Web AppBuilder and configurable templates within the RCView ArcGIS Portal. Many of these were created by newly trained regional users to support local disaster responses, and to help plan preparedness events. Some national situational awareness apps have been set up with layers to monitor weather, fire, flood, and other conditions. Prior to the ISO project, no apps had been created in RCView for use by International Services.

Although RCView users are gaining experience with the ArcGIS Portal system, the extent of training required for successful adoption of RCCollect uniquely highlights the varied technical skills of the national workforce. This must be considered in the design of the ISO App, which will stand alone without benefit of a training initiative.

Chapter 3 Requirements

The ISO App was developed to meet a specific need for information within American Red Cross. For the app to be an effective tool for American Red Cross users across the country, it was important to consider both user needs and technology available within the organization. This chapter contains a profile of intended users and three use case scenarios, as well as a description of specific user requirements, functional requirements, and design requirements.

3.1. Intended Users

American Red Cross is unique among most organizations in the US in that the workforce is almost 94 percent volunteer (American Red Cross 2017a). The unusual mix of paid and unpaid staff accounts for a diverse array of skills and motivation among potential app users.

3.1.1. User Profile

The ISO App's intended users are the organization's paid staff and volunteers who work in International Services. These users may work from National Headquarters, or from region and chapter offices around the country.

3.1.1.1. Paid Staff

Paid staff are reliably proficient in the use of basic workplace technology such as laptops and mobile phones, and with standard software packages such as Microsoft Office. As employees, they attend trainings and adopt new procedures and technology as required by the organization.

3.1.1.2. Volunteer Staff

There are 330,000 American Red Cross volunteers working across all lines of service (American Red Cross 2017a). This group is comprised of people at all career stages, and who may have any level of education. Technology skills in this group are equally variable.

Volunteers perform roles in every part of the organization, and at every level. Their time commitments vary. Some volunteers may staff events, respond to disaster incidents, or assist in other capacities only when called. Others perform regular duties for any number of hours per week. Some have been with the organization for more than forty years; at any given time, many are also new. Attrition occurs as volunteers move away, develop competing priorities, or lose the sense of satisfaction that otherwise makes their investment of time worthwhile (American Red Cross 1988).

3.1.2. Variable Needs of Users

For the app to be useful to a group who have shared goals but such variable background, skill, and time commitment, the app should provide necessary information in a manner that is accessible to users at all levels of technical proficiency. No training should be expected or required for use.

Tools or actions should be intuitive, to the greatest extent possible within the limits of the required ArcGIS platform. Support features such as labels and instructions should be built in when possible. These parameters help to ensure that potential users are not excluded for lack of experience with web maps, apps, or ArcGIS technology.

3.2. Use Cases

The app should aid workers looking for information to address any of the following situations:

- A woman with young children fleeing violence in Myanmar seeks safety in a refugee camp in Bangladesh. Separated from relatives and unsure if her husband is alive, she hopes to somehow reconnect with her husband's brother, who has lived in the United States for several years. She knows that he lives in Oklahoma.

- An elderly widower is injured in an accident near his home in Cameroon. Concerned that the man will not survive, his sister appeals to the Croix-Rouge Camerounaise, the Cameroon Red Cross, for help locating the man's only son, who lives in a place called Greensboro, somewhere in the United States. This search is time-critical.

- A major typhoon makes landfall in Fiji. Many people are displaced from their homes and communications infrastructure is damaged. American Red Cross would like to reach out to Fijian immigrants in the United States, to assist them in reconnecting with family members whose status may be unknown. Where should the 60 Red Cross regions in the country direct local effort?

3.3. User Requirements

To accomplish the goals of the use cases, the following objectives should be met:

- The app should display ACS place of birth fields in a manner that will highlight tracts with specific foreign-born populations throughout the United States;

- The app should utilize technology available within the organization to optimize accessibility and user acceptance;

- App purpose and function should be self-explanatory, without need for user training.

3.4. Functional requirements

This section outlines app capabilities which are required to for the app to meet its objectives.

- ACS Place of Birth Data

  The app must identify census tracts with immigrant populations from 145 countries and world regions by utilizing ACS data.

- Layer Access

  Users should have the ability to add and remove place of birth layers. This function is necessary due to the large number of layers provided.

- Change Basemap

  The app should allow users to switch between the Light Gray Canvas basemap and Streets basemap as needed. The Light Gray Canvas basemap best supports initial evaluation of general location; the Streets basemap adds practical information needed to support next steps such as field visits.

3.5. Design Requirements

The app must utilize technology available within the organization. This section outlines these parameters.

3.5.1. RCView Platform

In 2016, American Red Cross introduced a new disaster information management system called RCView. The term RCView stands "Red Cross Visual Interactive Event Wizard." When

fully deployed, the system will be used to manage a range of resources and disaster response activities, utilizing coordinated enterprise software systems.

An integral part of RCView is an installation of ArcGIS Enterprise 10.4 for Portal, which users log into with their Volunteer Connection user ID and password. Volunteer Connection is a volunteer management system used for tracking hours, scheduling, and communicating with the volunteer workforce, implemented across the organization in 2013 (American Red Cross 2013).

3.5.2. ArcGIS Enterprise for Portal 10.4

ArcGIS Enterprise for Portal is a web-based mapping and analytics platform used by organizations to create, utilize, or distribute GIS content. It differs from ArcGIS Online in that Portal system components and infrastructure are managed by the organization, rather than by Esri (Esri 2017d). Users access the portal through a customized website.

To maximize the ISO App's accessibility to organizational users, it must be built within the ArcGIS Portal. Server access is outside the scope of this project. Therefore, app design can only include components, features, and capabilities which are available within the Portal system, configured within standardly available options. No additional customization is possible for this build.

Chapter 4 Application Development

This chapter traces the ISO App development from inception as a local project intended to meet local need, through the creation of a national tool available to assist International Services personnel and others in all parts of the country.

The application development overview is shown in Figure 2. After a decision was made to expand the project from local scale to national scale, data was prepared in ArcGIS Pro and Excel and published as a feature service. The ISO App was then constructed within the RCView Portal, and introduced to potential users. Immediate issues arose with use, and additional function was requested by national RFL leadership. Two months after the initial launch, the app was redesigned and rebuilt to incorporate necessary changes and newly requested capability.

```
┌──────────────────────┐      ┌──────────────────────┐      ┌──────────────────────┐
│ Local need established │ ───▶ │ Project expansion:     │ ───▶ │  Data Preparation      │
│                        │      │ national dataset       │      │                        │
└──────────────────────┘      └──────────────────────┘      └──────────────────────┘
                                        │◀──────────────────────────────────────┘
                                        ▼
┌──────────────────────┐      ┌──────────────────────┐      ┌──────────────────────┐
│ Initial build and soft │ ───▶ │ Issues and requested  │ ───▶ │       Rebuild          │
│ launch                 │      │ changes               │      │                        │
└──────────────────────┘      └──────────────────────┘      └──────────────────────┘
```

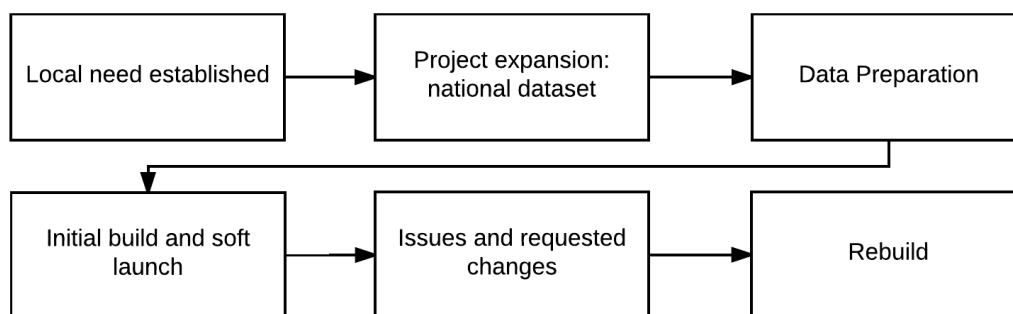Figure 2. Application development overview

4.1. Project Expansion: Scaling Up to a National Dataset

The ISO App began as an effort to meet a local need for immigrant information at the American Red Cross Los Angeles Region. For this purpose, the ACS Tract 5-Year Estimates California geodatabase would be the most appropriate source of data. At 1.07 GB unzipped, it was by far the largest ACS state geodatabase.

I considered clipping the data to Los Angeles County to make it easier to work with, but I was reluctant to exclude data, reasoning that the other five Red Cross regions in the state could also benefit from using the app. In fact, every Red Cross region in the country carried out the same International Services work. Immigrant data would be relevant to all of them.

The labor required to prepare the data and set up the layers would depend upon the number of census fields utilized; the extent of the data would be irrelevant, if computer resources could handle the additional load. Los Angeles County subset of data has 6418 records; California geodatabase holds 23,212; the 9 GB national geodatabase has 74,001. I chose to move forward with the national geodatabase, to create an app that could be used anywhere in the country.

Although certain data preparation processes took more time to complete or were accomplished in stages, as noted in the next section, no significant issues arose from scaling up to use national data during the preparation stage.

4.2. Data Preparation

This section describes the properties of ACS data, and the processes needed to extract and prepare data for publication as a feature service. Figure 3 outlines the general data preparation workflow.
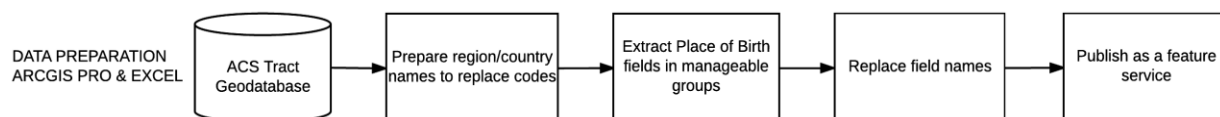
Figure 3. Data preparation workflow overview

4.2.1. About the Data

ACS data can provide tremendous insight into the social and economic profile of an area, but to be used effectively, certain properties of the data should be considered. This section discusses the place of birth field definition, margin of error, and ACS geodatabase architecture.

4.2.1.1. Place of Birth Fields

Place of birth is self-reported by ACS respondents, in a two-part question structured as shown in Figure 4. Respondents are asked if their place of birth is inside or outside the United States. Those who answer inside are asked to list their state of birth. Those who respond outside are asked to provide the name of the country or US territory. Those who do not respond to this question are assigned the place of birth of a family member or similar respondent (US Census Bureau 2014).

Figure 4. ACS place of birth question structure

In 2014, place of birth answers were compiled into 161 categories; 112 of these represent individual countries. Most of the other categories are composite fields, such as "Other Central America" which includes Central American countries not listed individually, or "Central America" which includes all countries in Central America.

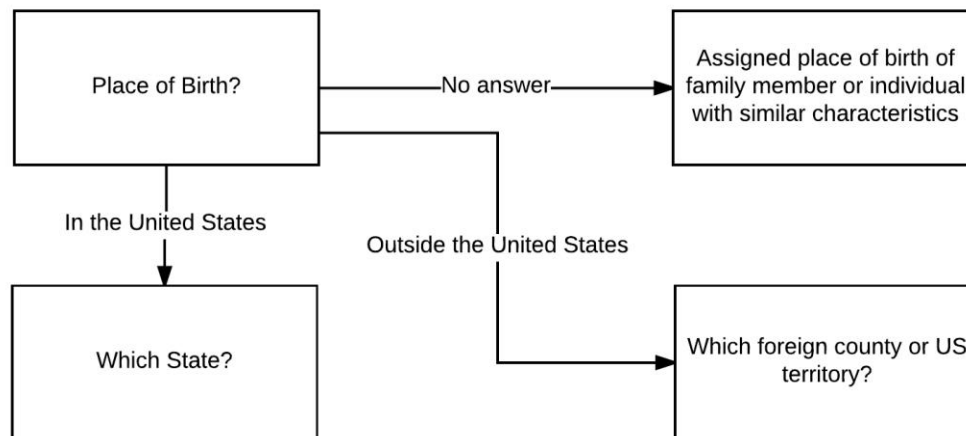Four fields are Europe "n.e.c", Asia "n.e.c", Africa "n.e.c", and Oceania "n.e.c", where "n.e.c." stands for "not elsewhere classified." These fields count instances in which the given answer did not fall into any other category (including "Other ____"), or no more specific answer was given. These fields were not extracted from the geodatabase, because this mixture of vague and/or anomalous data does not offer value for locating specific immigrant communities.

A total of 156 fields were extracted from the geodatabase; of these, 145 would be used as layers in the ISO App. Those not used in layers are either very broad, such as Europe and Asia; are composites which can be broken out separately, such as "China, including Taiwan and Hong Kong"; or are part of North America. Canada was excluded because the population is dispersed and the layer unlikely to be needed by International Services. "Other North America" was excluded because this group, which would include Greenland, Bermuda, and the French territory of Saint Pierre and Miquelon, is so small and so diverse that the layer is unlikely to identify a community.

4.2.1.2. Estimates and Margin of Error

Since the ACS is based on sampling, where only a small portion of the population is surveyed, as discussed in Chapter 2, the data is subject to two types of error. Enumeration error is the result of counting mistakes; the decennial census is also subject to enumeration error. The ACS is further subject to sampling error. Sampling errors occur when the households surveyed are not sufficiently representative of an area. The smaller the sample size, the greater the potential for error (MacDonald and Peters 2011). Tract is the smallest unit for which place of birth data is compiled, due to potential error.

Five-year estimates offer the greatest precision for analyzing small populations, because the figures are averaged over five years; this reduces the effect of sampling error. One-year and

three-year estimates are not released for tracts due to error potential with the smaller datasets (US Census Bureau 2016).

For each category into which place of birth data is compiled, ACS provides both an estimate and a margin of error field. The ACS margin of error calculation only accounts for sampling errors, not enumeration errors (Esri 2014). It measures an estimate's variability within a 90% confidence level. For example, if an estimate of 10 has a margin of error of 2, then we can assume with 90% confidence that the actual figure is 10 plus or minus 2, or somewhere between 8 and 12. Margin of error at tract level may be considerable; for place of birth fields, a margin of error more than 100% of the estimate is not uncommon.

While such high potential error may negate the legitimacy of statistical or spatial analysis, it does not negate the legitimacy of data usage in the ISO App. The app is not intended to provide counts or draw conclusions. Instead, it uses the data as a beacon, which indicates that a given group has been detected in a tract. It is more important for the ISO App to generate possibilities. For this reason, margin of error fields are not included in the ISO App.

4.2.1.3. ACS Geodatabases contents

Each ACS geodatabase includes a feature class of the associated geographical unit, and a selection of tables identified by number and topic. The 2014 tract geodatabase contains 30 tables (see Appendix B for a full list of tract geodatabase contents).

Within each table, attributes are identified by their 'short name,' which is an alphanumeric code of 9-12 characters. The first character of each short name is a letter; the second and third characters correspond to the table number where the attribute is located.

For each short name there is a text definition of the data point called the 'full name.' Short and full names are listed side by side in the Metadata table included with each

geodatabase. ACS full names have as many as seven levels of subcategory and may be more than

300 characters in length. Table 1 shows the typical format for short and full names of place of

birth variables used in this project. The short name codes for estimate and margin of error fields

are identical except for an *e* for estimate, or *m* for margin of error; the full names are identical

except for a text notation in parentheses to distinguish them.

Table 1. Examples of short and full name

Short Name	Full Name
B05006e50	PLACE OF BIRTH FOR THE FOREIGN-BORN POPULATION IN THE UNITED STATES: Asia: Eastern Asia: China: China, excluding Hong Kong and Taiwan: Foreign-born population excluding population born at sea – (Estimate)
B05006m50	PLACE OF BIRTH FOR THE FOREIGN-BORN POPULATION IN THE UNITED STATES: Asia: Eastern Asia: China: China, excluding Hong Kong and Taiwan: Foreign-born population excluding population born at sea – (Margin of Error)

Source: US Census Bureau

4.2.2. Preparing Field Names

Neither the alphanumeric short names nor lengthy full names are suitable field identifiers

for use in the feature service. The short name would be incomprehensible to users, while the full

names include spaces, punctuation, and excessive text. This section describes the process

undertaken to create new descriptive field names for use in the feature service, and explains why
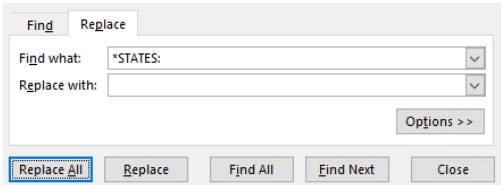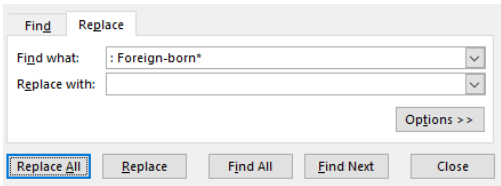
aliases are not used.
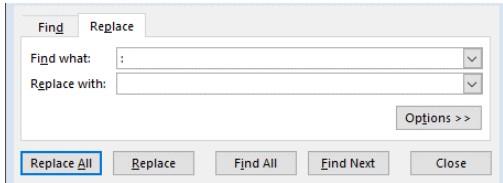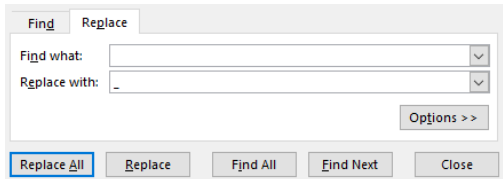
4.2.2.1. Descriptive Names

To ensure that new field names accurately reflected the data, shorter descriptive names were derived directly from the full name of each field. This process was accomplished in several steps. First, the Metadata table was converted to Excel, and the result formatted as a table. A text filter was applied to the short name column for 'begins with: B05006e' to isolate the 161 target fields. The resulting list of short and full names was copied to a new sheet.

To create the new the names, a series of 'find and replace' processes were performed to trim each full name. Using the Azores Islands field as an example, Table 2 shows each process required to distill Europe_Southern_Europe_Portugal_Azores_Islands from

PLACE OF BIRTH FOR THE FOREIGN-BORN POPULATION IN THE UNITED STATES: Europe: Southern Europe: Portugal: Azores Islands: Foreign-born population excluding population born at sea -- (Estimate)

Table 2. Find and Replace sequence to create usable field names from full names.

FIND AND REPLACE PROCESS	ACTION	RESULT
1 Find what "*STATES:" Replace with *<blank>* Find Replace Find what: *STATES: Replace with: Options >> Replace All Replace Find All Find Next Close	Removes everything up to and including the first semicolon.	*Europe: Southern Europe: Portugal: Azores Islands: Foreign-born population excluding population born at sea -- (Estimate)*
2 Find what ":Foreign-born*" Replace with *<blank>* Find Replace Find what: : Foreign-born* Replace with: Options >> Replace All Replace Find All Find Next Close	Removes everything after the last semicolon	*Europe: Southern Europe: Portugal: Azores Islands* (Results from Step 2 are copied to a new sheet for later use as layer names)

FIND AND REPLACE PROCESS	ACTION	RESULT
3 Find what ":" Replace with *\<blank\>* *[Find and Replace dialog showing Find what ":" and Replace with blank]*	Removes remaining colons	*Europe Southern Europe Portugal Azores Islands*
4 Find what *\<type one space in field \>* Replace with "_" *[Find and Replace dialog showing Replace with "_"]*	Replaces the space between each word with an underscore	*Europe_Southern_Europe_Portugal_ Azores_Islands* Final name with manual edits: *Europe_SouthernEurope_Portugal_ AzoresIslands*

Steps one and two remove unneeded text from the beginning and end of the full name, by replacing wildcards on either end with a blank. This text is the same in each full name. This method preserves the geographical components nested within the full name text, regardless of the number of subcategories in any given record. Before moving on, intermediate results were copied and pasted to a new sheet for later use as layer names in the app. Step three replaces residual colons with blanks. Step four replaces spaces with underscores.

The resulting list of 161 descriptive names, with some additional edits for length or clarity, is used to replace the codes during data extraction, discussed in section 4.2.3. A full list of fields used in the project, and their derived names appears in Appendix A.

4.2.2.2. The Case Against Using Aliases

Standard ArcGIS map components and most widgets and templates consistently display field aliases, when aliases are given. However, some widgets and templates are not designed to use aliases, and instead only show field names. For example, the Incident Analysis widget, which

is useful for providing sums in disaster areas, displays field names in the configuration panel. This inconsistency is problematic when field names are coded, as short names are.

Although this inconsistency would not affect use of the feature service in the ISO App itself, a decision was made to remove the short names, using only the descriptive names, to preserve the ability for others to use the feature service for different purposes in the future.

4.2.3. Data Extraction

The place of birth estimates are contained in table X05 in the ACS tract geodatabase. Table X05 holds nearly 1700 fields and 74,001 records related to nativity and citizenship. Table X05 and the tract feature class which is included in the ACS geodatabase were added to an empty map in ArcGIS Pro, and joined. To reduce the strain on computer resources, 156 place of birth estimates were extracted in groups of approximately 15 at a time. Figure 5 shows the extraction workflow.
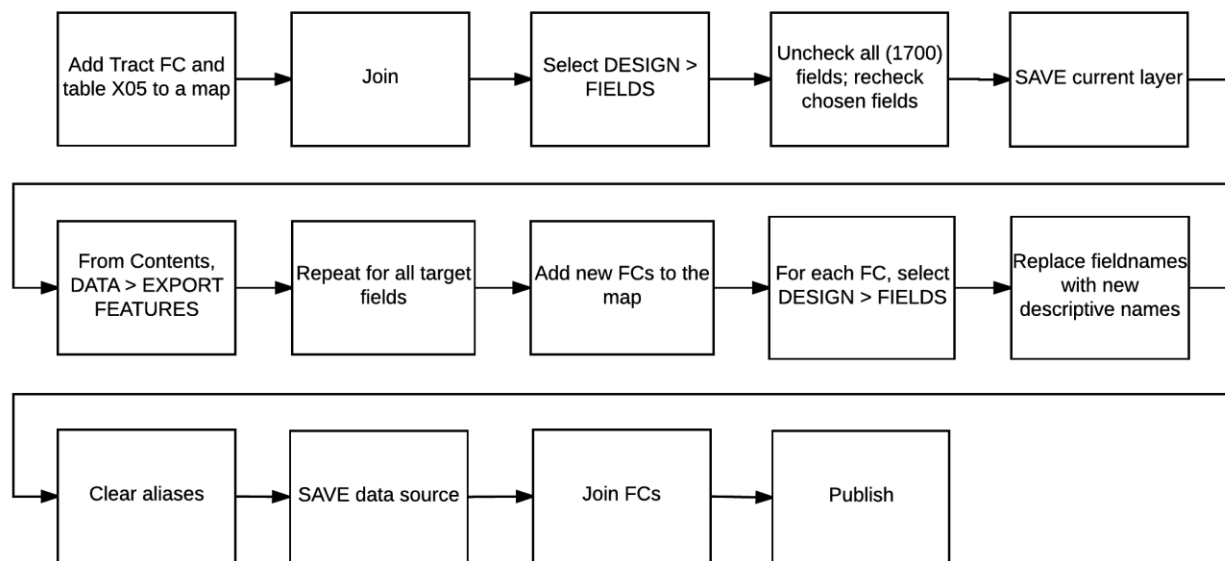

Figure 5. Data extraction workflow carried out in ArcGIS Pro

From the ArcGIS Pro Field view (**Data > Design > Fields**), visibility was unchecked for all fields, and then selectively restored for the target fields in successive groups. The unique tract identifier field GEOID_Data was included with each group so that it could be used as a join field in a later step.

In ArcGIS Pro, changes made within the Field view may be saved to the layer or to the data source by selecting either option from a dropdown menu in the Field panel and clicking save changes. As each group was selected, changes were saved to the layer only. After the layer view was created, that data was exported to a new feature class.

The new feature classes were then added to the map. The Field view for each one was opened in turn, and new descriptive names created earlier were pasted in place of the short name codes; short name aliases appearing in the column beside the field names were deleted. For each feature class, these changes were made permanent by saving to the data source.

Finally, the feature classes were joined using the Join Field tool, and unnecessary ID fields were deleted. The result was published to the organization as a hosted feature service called RFL_Place_of_Birth_by_Tract.

4.3. Initial App Construction

This section describes the creation of the first version of ISO App. To accommodate the need for an unusually large number of layers, a separate map was created for each of eight world regions, and layers were divided among these maps. The eight maps were then displayed within eight identical apps. A gallery app was created from a template to hold the eight apps. The final product was referred to as the International Services Outreach Gallery. The architecture of the Gallery App is shown in Figure 6.
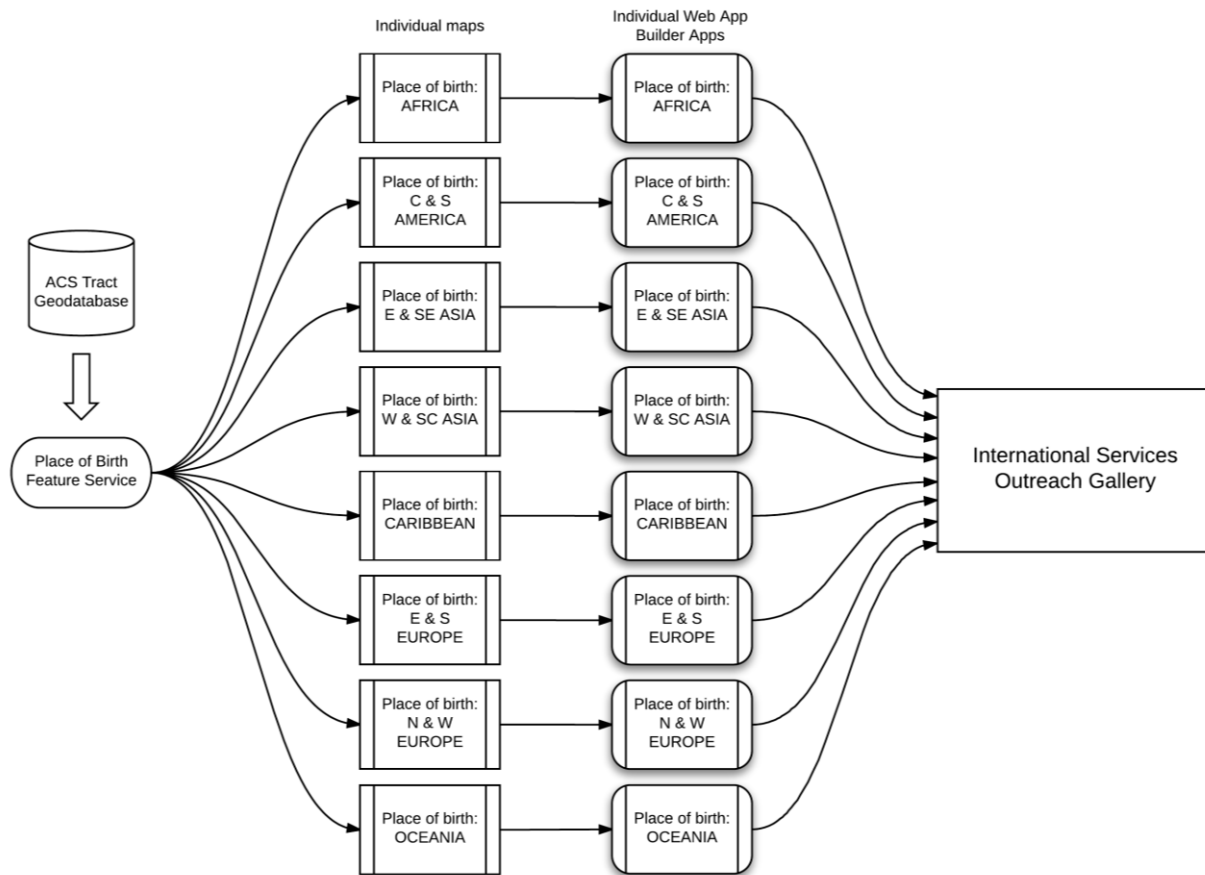
Figure 6. ISO Gallery architecture

4.3.1. Maps and Layers

Eight maps were created with the Light Gray Canvas basemap. Each one was then set up with a different collection of place of birth layers, and identical support layers and popups. This section describes each of these elements.

4.3.1.1. Map Projection and Extent

All the maps utilize the Web Mercator coordinate system which is standard to the ArcGIS Online platform. Although it is possible to change the coordinate system by utilizing a custom basemap, all other organizational content uses the default Web Mercator, and RCView users are most accustomed to seeing to seeing web maps in this projection. Utilizing this projection eliminates the potential distraction of unfamiliar geographic appearance.

The map extents are set to the continental United States. This minimizes the visual impact of size distortion resulting from use of Web Mercator, which would otherwise show Alaska significantly larger, and Hawaii somewhat smaller, than their actual size as compared to the coterminous states. This extent also focuses attention on the most common area of significance for most users.

4.3.1.2. Place of Birth Layers

In the map for each world region, a separate copy of the RFL feature service was added for each of the 145 place of birth layers (selected from the 156 fields published). Each layer was renamed by pasting in one of the descriptive names generated in the second step of the find and replace process (shown in Table 2 on page 30). Layers in each map were arranged in alphabetical order.

Use of a national dataset created some data visualization challenges. Population of some groups is heavily focused in a relatively small number of tracts in one part of the country (for example, the Cuban community in South Florida). These groups are difficult to represent in outlying areas, because locally significant populations elsewhere appear insignificant when data is classified on a national scale.

Choropleth visualization was chosen with data classified at natural breaks in six classifications. This method seemed to work most effectively in drawing the eye to areas of local significance, even if all nearby tracts fell into the lowest classification groups. In contrast, the size difference between symbols at the smaller end of the scale in the proportional symbol method seemed more difficult to distinguish.

The data was not normalized, because the intention was to identify locally significant numbers of people, not the density per unit of land or other resident population.

In the ArcGIS Online platform, choropleth is called "Counts and Amounts (Color)." Each of the 145 country and region layers was configured and set to 25% transparency. The color ramp was randomly selected for each layer from the available options. Since only one choropleth layer can be viewed at a time, all country and region layers were left unchecked by default.

As it would be revealed later, the choropleth decision had unintended consequences affecting the ISO App's usability and performance.

4.3.1.3. Supporting Layers

In addition to place of birth layers, each map also contains layers for American Red Cross organizational boundaries at division, region, and chapter level. Boundaries are provided by a feature service published and maintained by Red Cross. Division boundaries are visible at all extents. Region and chapter boundaries are set to be visible at increasing zoom levels. Labels were enabled for each layer.

4.3.1.4. Popups

The ISO App was intended to provide leads, not counts. Popups were not a priority for place of birth layers, because legends provided a general idea of population size, which was close enough considering potential margin of error. Nonetheless, default popups were enabled for these layers to ensure that users would have access to the underlying data if they wanted to see it. Popups were disabled for the supporting layers, which were labeled on the map.

4.3.2. Intermediate Apps

A series of eight intermediate apps were created to provide functionality in a user-friendly format, using Web AppBuilder. This section covers the construction of these intermediate apps.

4.3.2.1. Web AppBuilder for ArcGIS Overview

Web AppBuilder is a WYSIWYG application available within the ArcGIS platform that allows users to construct functional apps either from desktop software, or through an online interface (Esri 2017e). Apps built with desktop software offer more opportunity for customization than those created in the web interface. However, these must be hosted by an external server. RCView server access was not possible for this project, and so the eight intermediate apps were created online.

The Web AppBuilder online interface offers a choice of eight design themes, most of which offer additional layout options. Title, subtitle, logo, and links may be added to apps depending upon the theme and layout selected. Each theme allows users to choose one accent color to customize the look of menu bars, panels, and icons.

A variety of tools and features known as widgets may be added to apps. Widgets provide functionality in the app; these can be configured to varying degrees, and are represented by icons.

Web AppBuilder apps built through the online interface are hosted in a user's account. Once created, they can be edited by reopening the app in Web AppBuilder, making changes, and then saving. They can also be easily copied by saving with a new file name.

4.3.2.2. Intermediate App Design

To be successful, these apps needed provide three features: layer access, instructions where needed, and basemap access. These functionalities are accomplished with the layer list widget, info widget, and basemap widget.

The Launchpad theme was chosen because it allows more than one widget to be open at once. Most of the other themes allow only one widget to be open at a time; when a second

widget icon is clicked, the first widget closes and the second takes its place in a static panel. In the Launchpad theme, the second widget opens in a new floating window. In the ISO App, this feature would allow users to access the instructions and layer list at the same time.

To keep the design simple and clean, black was set as accent color. Figure 7 shows the basic app design with layer list open. The layer list widget was configured to include the legend along with each layer. This eliminated the need for a separate legend widget and additional floating window. Layer transparency control was enabled. All unnecessary capabilities, such as changing the layer order, were disabled.
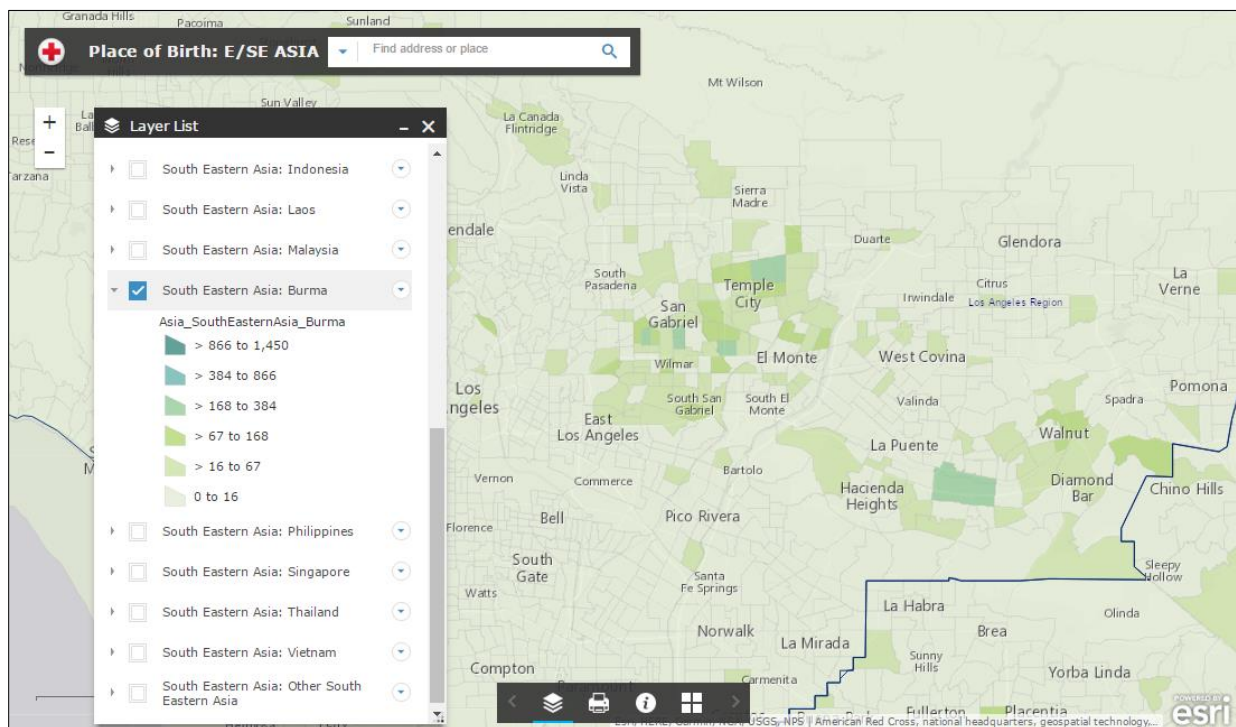

Figure 7. The Web AppBuilder app for the Eastern and Southeastern Asia map

The info widget was configured to be open at launch. This ensured that anyone who needed instructions would have instant access to them. Further, it ensured that all users would

see an important set of tips. Although the data was finally mapped, it was not necessarily easy to work with.

In fact, the data loaded slowly, and layers were all but unusable out beyond state scale. Not only was there a display limit of 2000 features at once, but many urban tracts were too small to see. Another major concern was that users unfamiliar with layer order might expect a new layer to appear on top of a current layer regardless of its position in the layer list, and become frustrated if a layer failed to appear. If too many layers were added at once, the app could stop responding altogether.

To head off possible frustration, the info panel greeted users with these warnings:

- *Zoom in* for best results.
- View only one layer at a time, or layers will stack and obscure each other.
- Layers may load slowly, due to the size of the dataset.
- Display is limited to 2000 tracts at once, missing tracts will fill in as you zoom closer.

The info panel also included graphics (Figure 8) created to help users identify icons and to demonstrate how to add a layer by checking the box beside it, a brief explanation of the data, and my contact information.

Figure 8. Instructional graphics created for the info panel

The default basemap widget was added so that users could change from Light Gray Canvas to Streets or Satellite as needed. Finally, the print widget was added so that users would be able to keep a record of their results.

4.3.3. Gallery App Template

The final component of the initial ISO App construction was the gallery, which was used as a container for the collection of eight intermediate apps. The gallery was created from an out-of-the-box configurable template available within the ArcGIS platform, called Public Gallery. The Public Gallery template offers a choice of three color themes (blue, green, and dark red), a variety of options for sorting content, and space for banner, footer, and sidebar text. The ISO Gallery was created in blue, and brief introductory text was added to the header and side panel. The template provides no option for changing the appearance of text or the size of any text area.

Gallery templates display items which have been shared to a specific group. To load the intermediate apps into this gallery, a special group was created and assigned to the template, and then the apps were shared to that group. To improve the look of the apps in the gallery, each app was given a thumbnail made from the Restoring Family Links logo (Figure 9).

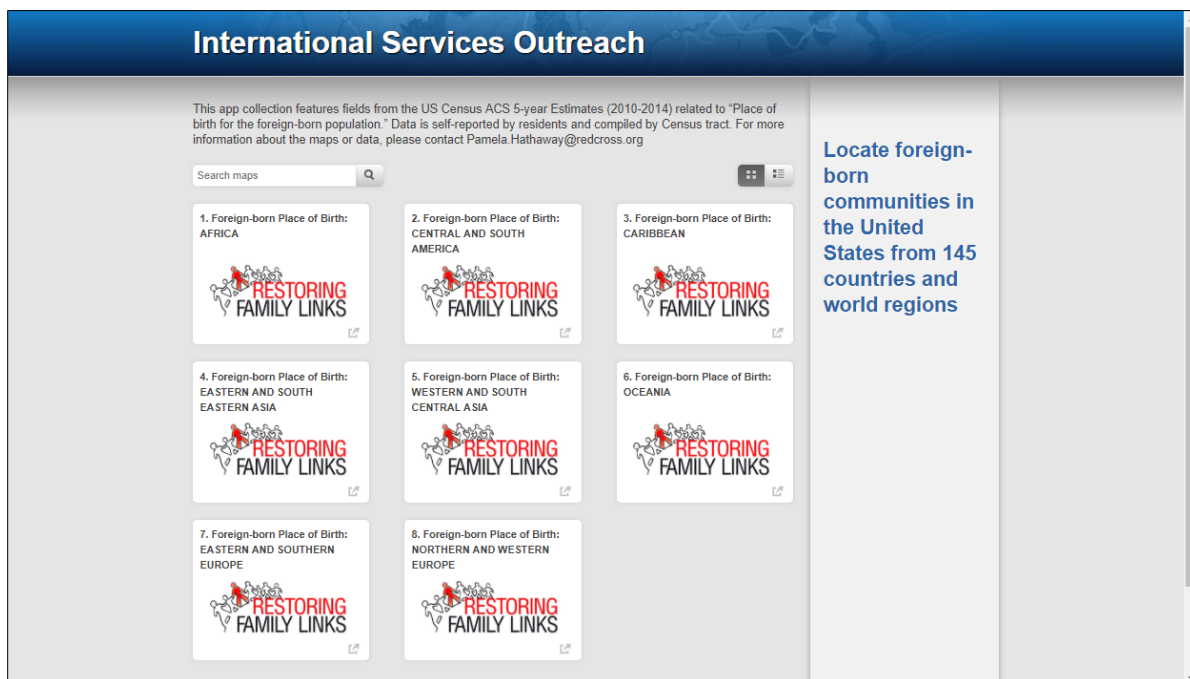The gallery and all components were shared to the RCView Organization.

Figure 9. ISO gallery screenshot

4.4. Initial Launch

Before users could open the app and read the performance warnings, they would face an unexpected obstacle, and a new functional need was soon identified by national RFL leadership. This section covers events that occurred during the initial launch period, precipitating need for complete App redesign.

4.4.1. Access Denied

In February 2017, it seemed like everyone in Disaster had been talking about RCView for months. Yet most people I spoke to in International Services had never heard of this new system. As I circulated the new ISO gallery link, some people were able to sign in with their Volunteer Connection credentials to see it, while others—including the person who had first asked for my help—could not get past the sign in screen. The reason was uncovered by a colleague calling up the line to division RCView leadership.

RCView had been developed by Disaster Services as a disaster tool; the system automatically generates accounts for people who have at least one disaster position assigned in their Volunteer Connection profile. About 75,000 accounts appeared in the RCView 'My Organization' directory at that time. International Services personnel do not have disaster positions, unless by chance they have volunteered on the disaster side at some point.

I had overlooked the most important user requirement: *access*.

For the app to be used as intended, either it would need to be shared publicly, or changes would need to be made that would affect national systems. Although my RCView user account did not restrict sharing, and the app only contained public data, in this case I considered the decision to share beyond my authority.

During the same week this problem came to light, the CEO of the American Red Cross

Los Angeles Region arranged a conference call with Jono Anzalone, the Vice President of

International Services at National Headquarters and his team so that I could personally introduce

them to the ISO App. Despite the slowly loading data, and the fact that although Mr. Anzalone

could access the app, several others on the call could not, the app was graciously and

enthusiastically received.

The access problem was escalated to Headquarters. A couple of weeks later it was

determined that I should share the app publicly.

4.4.2. A National Request

Headquarters leadership had been as surprised to hear of the completed app as I had been

to discover that users couldn't access it. I had not sought national buy-in originally because it

had evolved from a local project, to one which could be relevant in any region, simply by using

the larger dataset. But in the early Spring I received a two-part request from the National RFL

Coordinator:

1. Was there any way to make the data visible for the whole country at once? This
   would help them direct traces when more specific locations were unknown.
2. Would it be possible to make the popups easier to read?

I wanted to meet these needs for two reasons. National was asking, and the needs arose

from characteristics of the app that I'd never been happy with. I knew that I could fix the popups,

but I was reluctant to make promises about layer performance.

4.5. Redesign and Rebuild

Extensive modifications were made in response to the newly identified national needs. All layers were reconfigured, new popups were added, intermediate apps were redesigned, and the gallery was replaced with a Story Map. This section describes each of these changes.

4.5.1. Layer Changes

Every place of birth layer was configured with new visualization settings, and a set of two popups was devised for each map, as follows.

4.5.1.1. Visualization

The layers responded poorly at full scale for two reasons. First, each layer included 74,001 features. Figure 10 shows the choropleth layer for Lithuania; so many tracts are missing at this extent that it is impossible to get a sense of the how the population is distributed. The number of features would need to be reduced for optimal viewing.
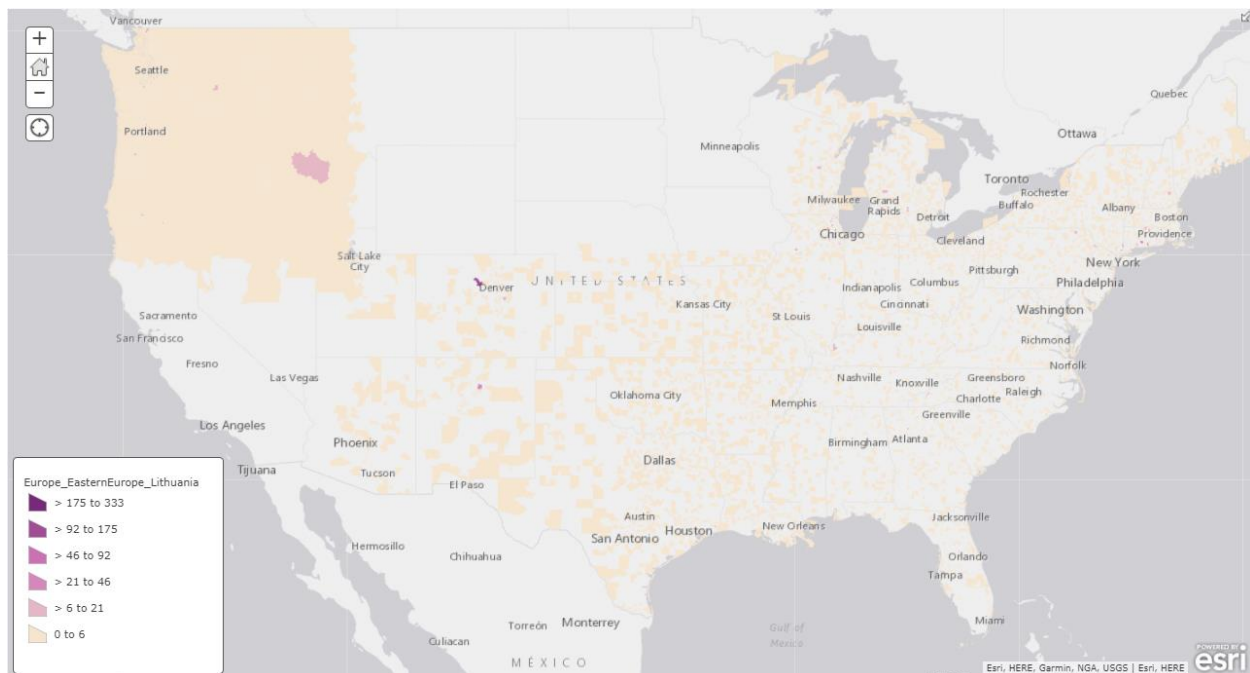

Figure 10. Choropleth layer for Lithuania viewed at national extent

Each place of birth layer was filtered to only show records where that country or region

"is not 0." This change eliminated tens of thousands of records from almost every layer,

improving the number of significant features displayed, as seen in Figure 11. However, many

tracts are too small to see at this scale. Choropleth is clearly inappropriate for this purpose even

when sufficient data can load.
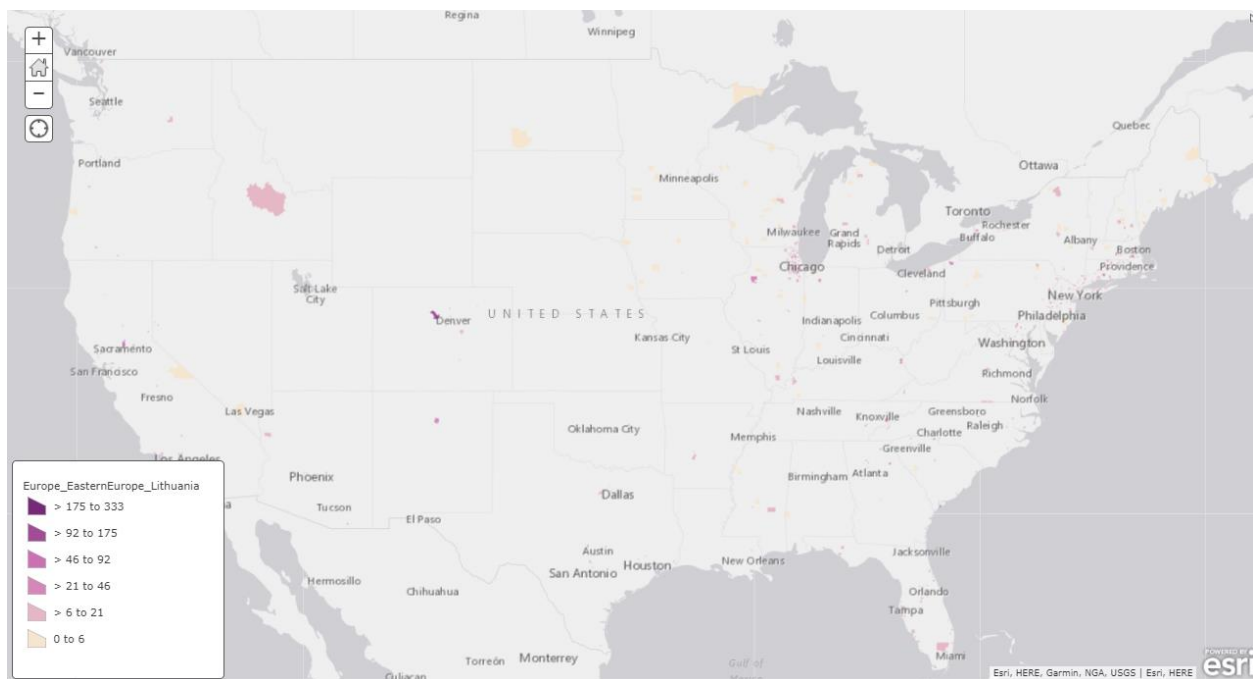
Figure 11. Choropleth layer for Lithuania filtered to show tracts with count greater than 0

Each of the place of birth layers was then reconfigured to proportional symbols, known

as "Counts and Amounts (Size)" in ArcGIS (Figure 12). Settings were left at the default, with

"Adjust size range automatically" selected, layer transparency set at 20%, and symbol shape as

basic circle. While choropleth had been slightly better at highlighting small but locally

significant populations within an unevenly distributed national dataset, filtered proportional

symbols created a superior view in most other ways.

Figure 12. Filtered proportional symbol layer for Lithuania
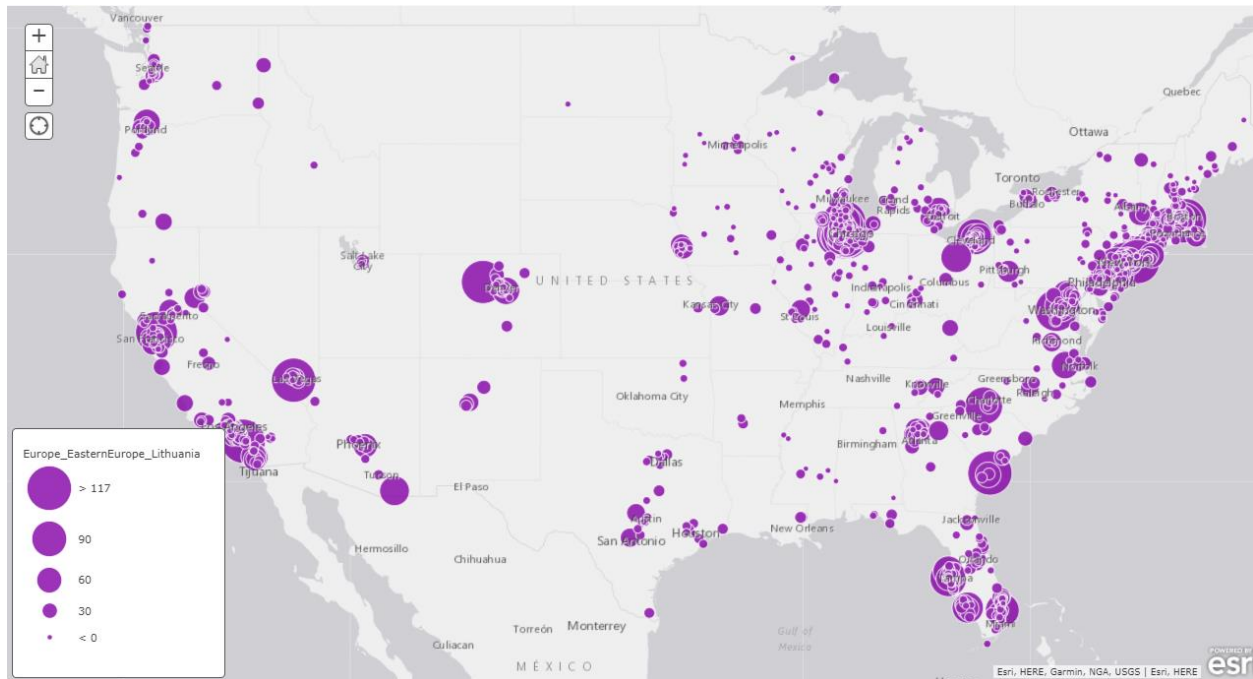
The symbol color for each layer was selected by working in order across the rainbow of standardized options. A country's national colors were not considered, due to possible unanticipated political nuance, especially in relation to conflict zones. Each symbol was given a one-pixel white border, to improve the visibility of overlapping symbols.

Although most layers still had too many features to display, missing symbols were far less significant in the new configuration, due to a common pattern of clumping. Loading speed improved as well. It would no longer be necessary to warn users to zoom in for missing records, view one layer at a time, or prepare to wait for layers.

4.5.1.2. Popup Development

Instead of configuring a custom popup for each of 145 place of birth layers, all popups were disabled. Then, two additional copies of the RFL feature service were added to each map at the bottom of the layer list to provide custom popup content for that map. The new layers in each

map were renamed Text Popup and Pie Chart. The drawing style for each was set to "location only," with 100% transparency, and popups enabled.

While the default popup (seen in Figure 13, left) had listed all of the fields in the feature service, the invisible Text Popup layer was configured to display a list of field attributes which included only the total foreign-born and place of birth fields relevant to the map it was on. For each, lengthy field names were edited to fit the width of the standard popup window (Figure 13, center).

Each Pie Chart layer was configured for "Popup Media" in the popup panel. Pie Chart was selected from among several types of charts listed in a dropdown menu. Individual countries from the current map were selected for inclusion in the chart. Regions (such as Caribbean) which represent compilations of data were excluded from the pie chart. A title and caption were added for clarity (Figure 13, right).
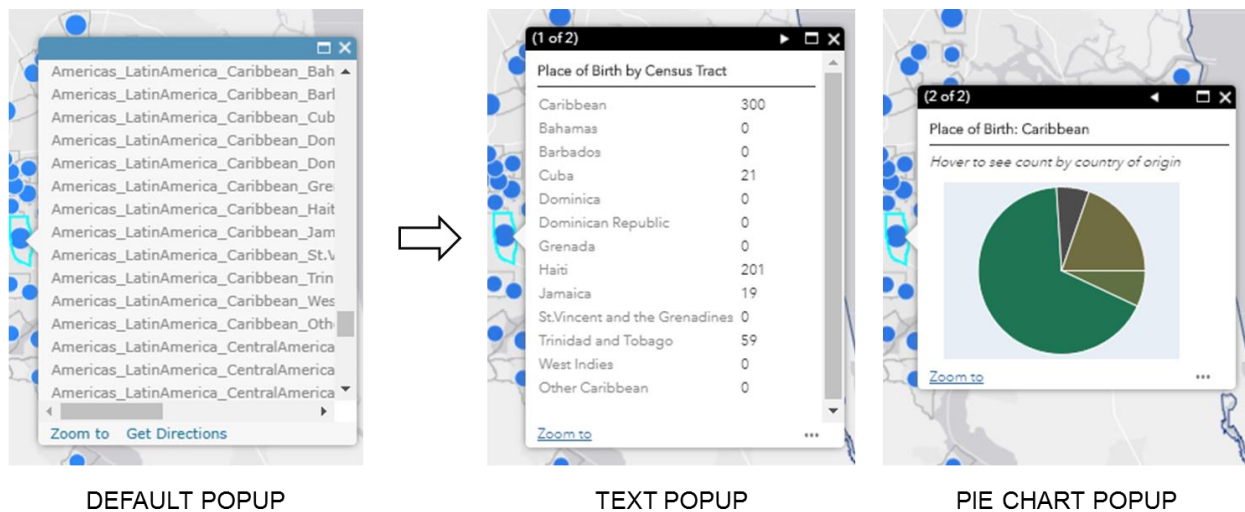

DEFAULT POPUP   TEXT POPUP   PIE CHART POPUP

Figure 13. Original default popup (left), and new popups (center/right)

4.5.2. Intermediate App Changes

Layer redesign eliminated the most serious viewing issues, so it was no longer necessary to warn users of performance problems right up front. The info panel at launch could be removed. Due to Portal settings, the print widget and search bar only worked for users who were signed in; now that the app was shared publicly, these needed to be removed as well.

Web AppBuilder apps can be redesigned or reconfigured by clicking 'Edit Application' on the app's item page. Resetting a theme restores default widgets and removes all previously added widgets.

The following changes were made to each of the intermediate apps:

- The theme was changed to Jewelry Box, with no search bar. Jewelry Box provides a streamlined look, with one widget panel anchored to the right side.

- The Legend widget was removed.

- Layer List was configured with the same settings the previous version, but now set to open on launch.

- The Basemap and Info widgets were added to the header bar; no other widgets were placed. Info panel text was reconfigured with a brief background about the data and graphics to show users how to use the layer list and popups.

- App titles, which previously had been abbreviated, were fully written out in the larger title area.

4.5.3. Story Map Architecture

I had considered using a Story Map as a container for maps in the first build, but had abandoned the idea because when maps are embedded within Story Maps, layers cannot be

accessed. The ISO App had to have layer access, but the configuration panel did not offer an option to add apps.

In the time between the first and second builds, I discovered something new about Story Maps.

4.5.3.1. Story Map Templates

Esri Story Map Templates are configurable templates designed to create multimedia presentations that may include any combination of text, maps, videos, images, and web pages (Esri 2017b). The configuration panel offers options for setting up different types of media. Apps are added to Story Maps by selecting the web page option and pasting in the URL. Apps maintain full functionality in a Story Map.

Several Story Map templates are available for download and customization, but require server access for hosting. Three versions are available for out-of-the-box use online. Since this project was undertaken with no server access, the online Story Map 'Series' template was chosen to replace the gallery.

The Story Map Series offers three layouts: Side Accordion, Bulleted, and Tabbed (Esri 2017b). Each layout displays one media page at time. In the Side Accordion layout, pages are listed vertically in a left-side panel; the Bulleted layout represents pages with numbered dots arranged vertically, or from left to right across the top. These layouts all suggest a sequential relationship between the pages. However, the Tabbed layout lists pages by name horizontally, which is more suitable for non-sequential content. The Tabbed layout was chosen for the new ISO App.

4.5.3.2. Architecture and Configuration

　　Each of the updated intermediate Web AppBuilder apps was added to a new tab in the

Story Map (Figure 14). The position for each was set to "fill available space." The template

offers an additional option to unload the page when the user navigates away; this is selected by

default. For this purpose, the box was unchecked, so that users switching back and forth between
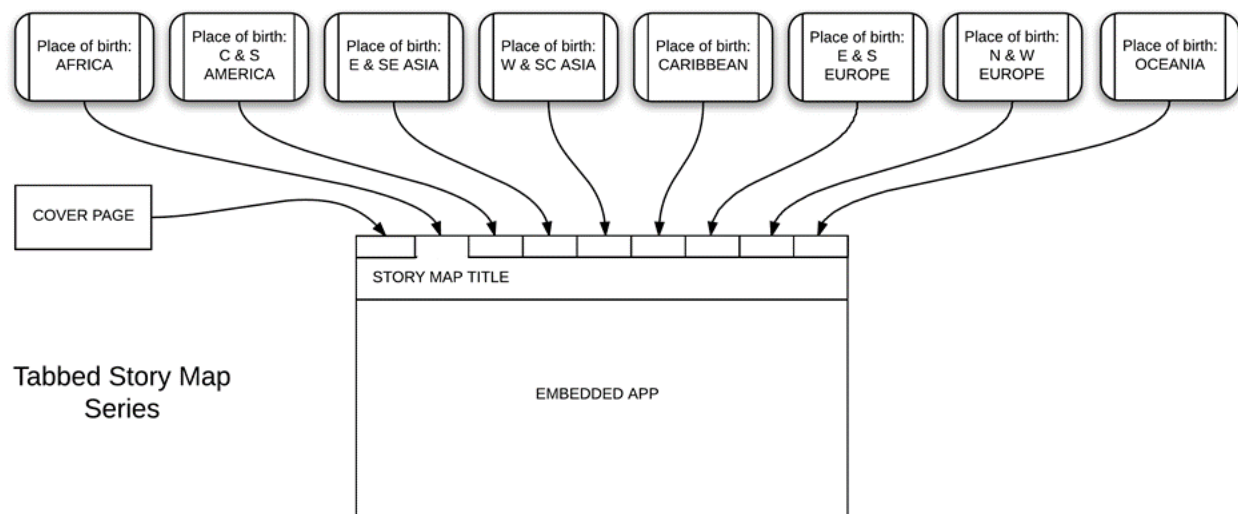
tabs would not need to reload data.

Figure 14. Updated app architecture utilizing a Story Map template

4.5.3.3. Cover Design

　　The first tab was reserved for a cover page containing a sidebar with introductory

content, and a large graphic (Figure 15). The sidebar includes an explanation of the data and

purpose of the app, a small graphic to identify map controls, an embedded video showing RFL

success stories, and four links. Since the app could be viewed by an external audience unfamiliar

with RFL, two of the links lead to public-facing RFL information pages. The other two links lead

to password protected RFL and International Services document hubs on the American Red
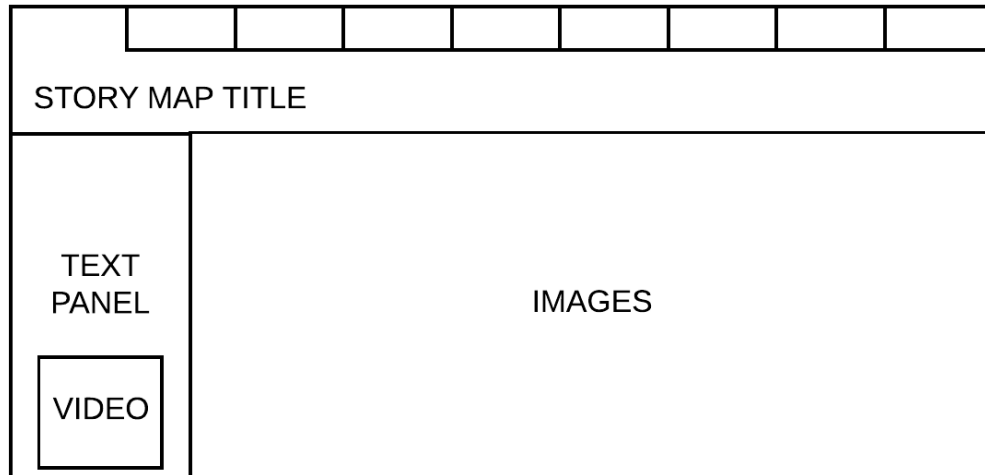
Cross intranet.

Figure 15. Story Map cover page design

The graphic was created from RFL images distributed by the International Red Cross. Microsoft PowerPoint has a graphics interface which is straightforward and easy to use compared to Adobe Illustrator or Photoshop; PowerPoint was fully adequate for this purpose.

I resized, cropped, and arranged the images in a grid. I added a subtle drop shadow to each, and then grouped the images. I selected "Save as a picture," setting the file type to PNG to preserve the transparent background between the component images. The composite image was uploaded to a Picasa account, because Story Map images must be hosted by a server and are accessed by URL. From the Story Map, I set the first tab's media type to image, added the URL, and set the position to 'center,' which would prevent the image from slipping behind the sidebar or becoming distorted.

Chapter 5 Results

The new ISO App was completed in April 2017, and introduced to American Red Cross users

during a live WebEx demonstration the following month. This chapter contains a description of

the final app design with screenshots, use case scenarios, and a discussion of feedback received

during the WebEx presentation. The app can be viewed at http://rdcrss.org/2nySNKh

5.1. The ISO App

Upon launch, the app opens to the first tab which is set up as a cover page (Figure 16).

The left sidebar provides brief introductory information about the app, with additional links and
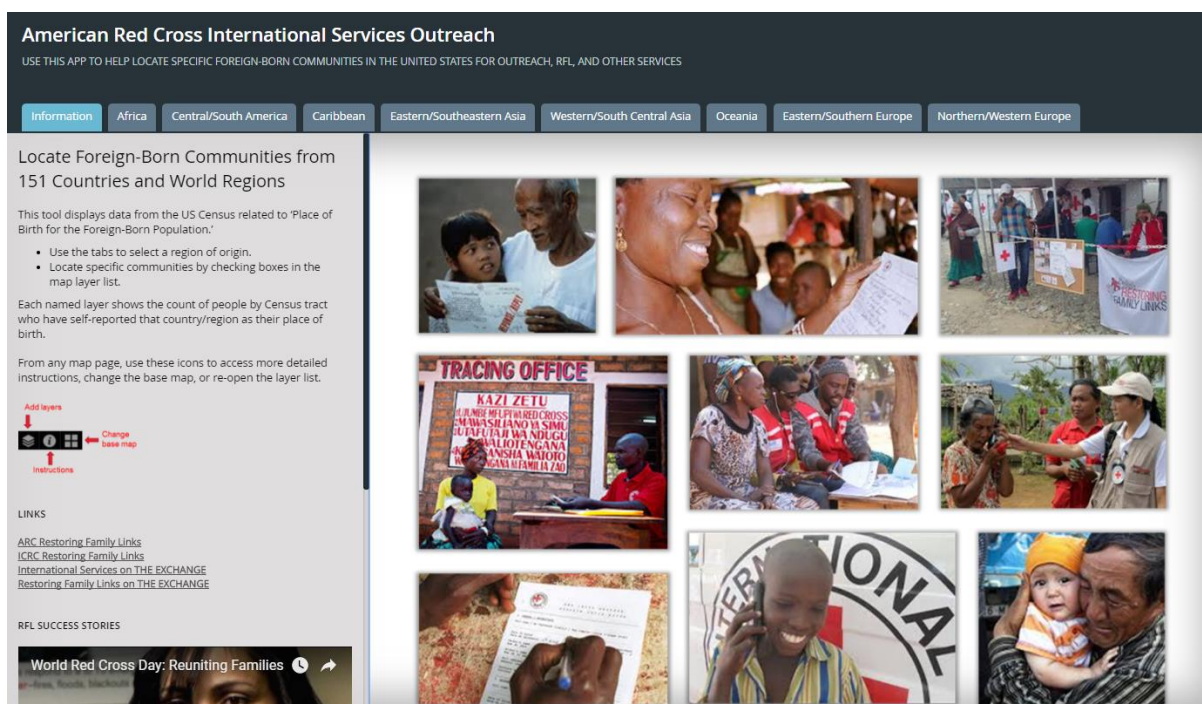
video which may be of interest to users.

Figure 16. ISO App first tab and cover page

The video, an uplifting collection of RFL success stories, was chosen to help non-Red Cross users understand the purpose of the ISO App, as well as to encourage and inspire caseworkers who may be embarking on a challenging trace. The full contents of the sidebar are shown in Figure 18 on page 53.

Users select a world region by clicking one of the tabs. Figure 17 shows the state of the intermediate apps at launch, with only American Red Cross Division boundaries visible over the Light Gray Canvas basemap, which opens at national extent. On each tab, the layer list panel is open by default.
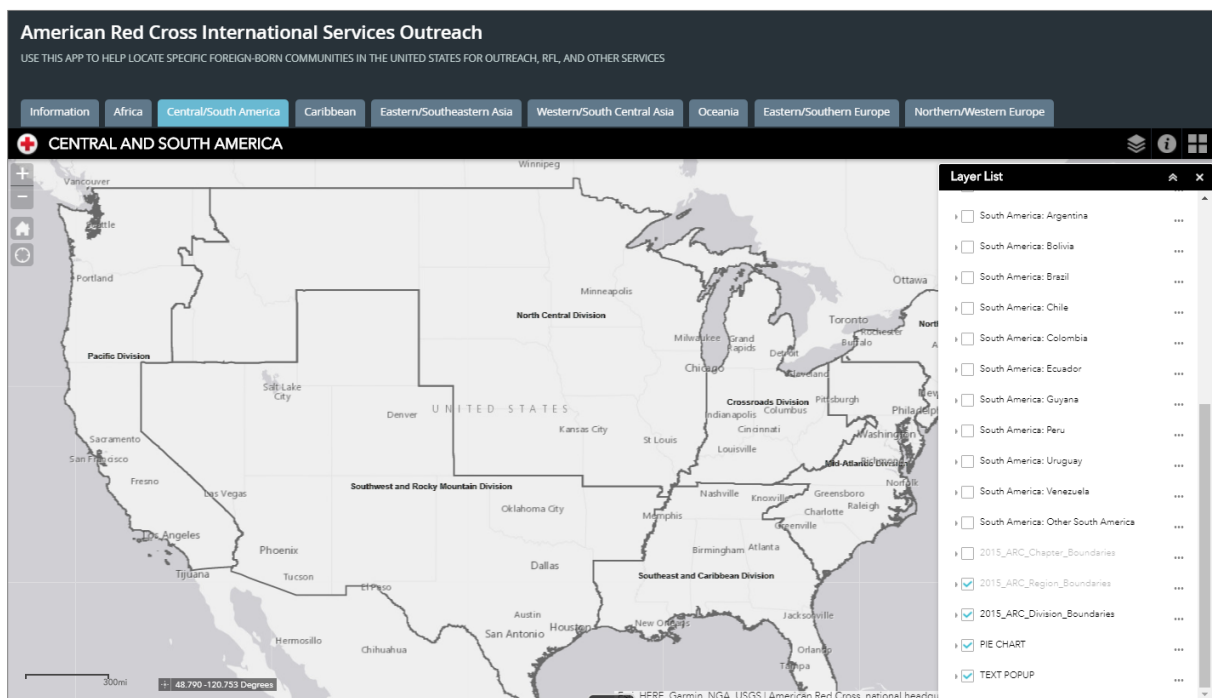
Figure 17. Initial map state

The layer list icon, basemap icon, and information icon are located directly above the panel. When an icon is clicked, that widget opens in the panel, replacing the layer list or other current widget. The information panel shows graphics which illustrate how to add layers, expand the layer to view the legend, and view popups (Figure 19, following page).
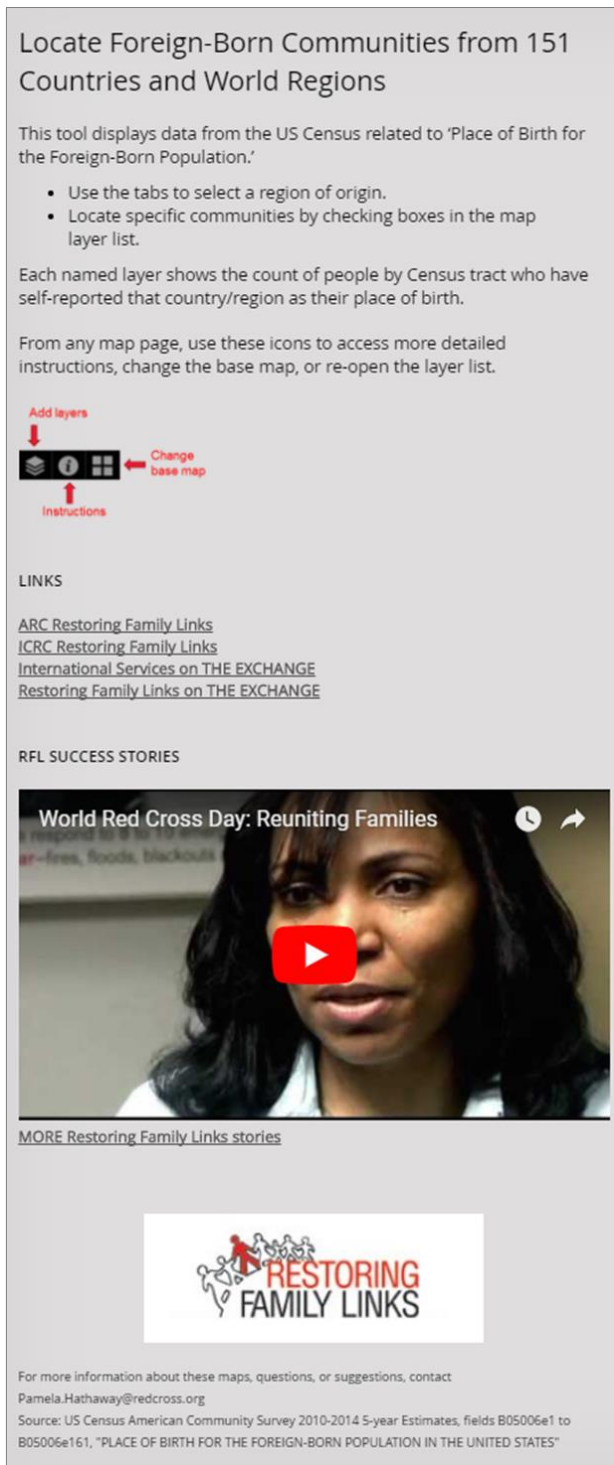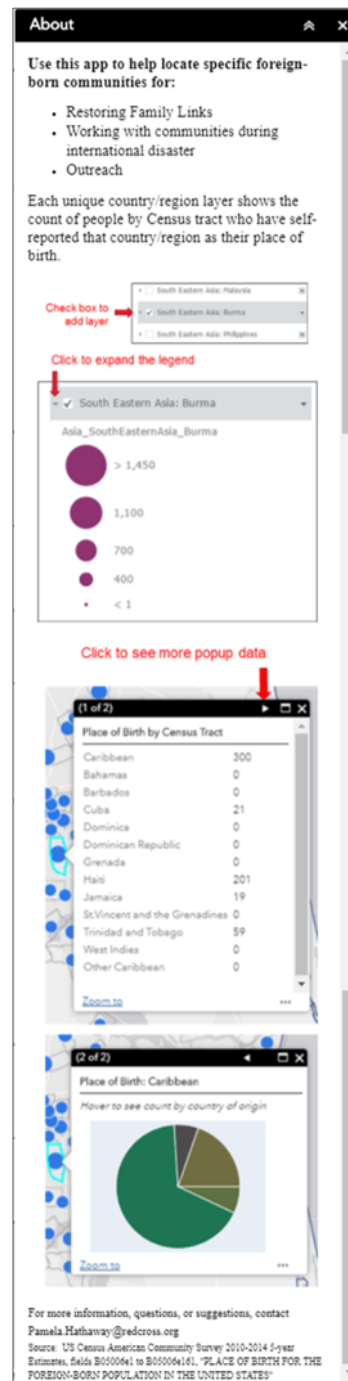
Figure 18. Cover page sidebar

Figure 19. Info widget contents

5.2. Use Cases

The first three use cases correspond to the situations laid out in Section 3.2. The fourth use case demonstrates the ISO App's ability to show data at national extent, as requested by the National RFL Coordinator after the initial build.

5.2.1. Locating a Burmese Community in Oklahoma

If the woman fleeing violence in Myanmar were to seek assistance from ICRC to locate her brother-in-law in Oklahoma, ICRC would initiate a trace on her behalf. The trace would include as much information as she is able to provide, including the sought person's last known address. This would be forwarded to the Central Tracing Agency, and then to American Red Cross National Headquarters, where it would be evaluated and then sent it to the RFL coordinator in the American Red Cross Oklahoma-Arkansas Region.

If the sought person is no longer at the last known address, or if the woman were only able to provide the state name Oklahoma, then RFL caseworkers must find other leads. Contacts within the local Burmese community may be able to help.

To find Burmese immigrants in Oklahoma, a caseworker could open the app and go to the Eastern and Southeastern Asia tab, and add the Burma layer to the map (Figure 20). This reveals Burmese population concentrated in Tulsa and Oklahoma City, with several small pockets of population in other parts of the state.
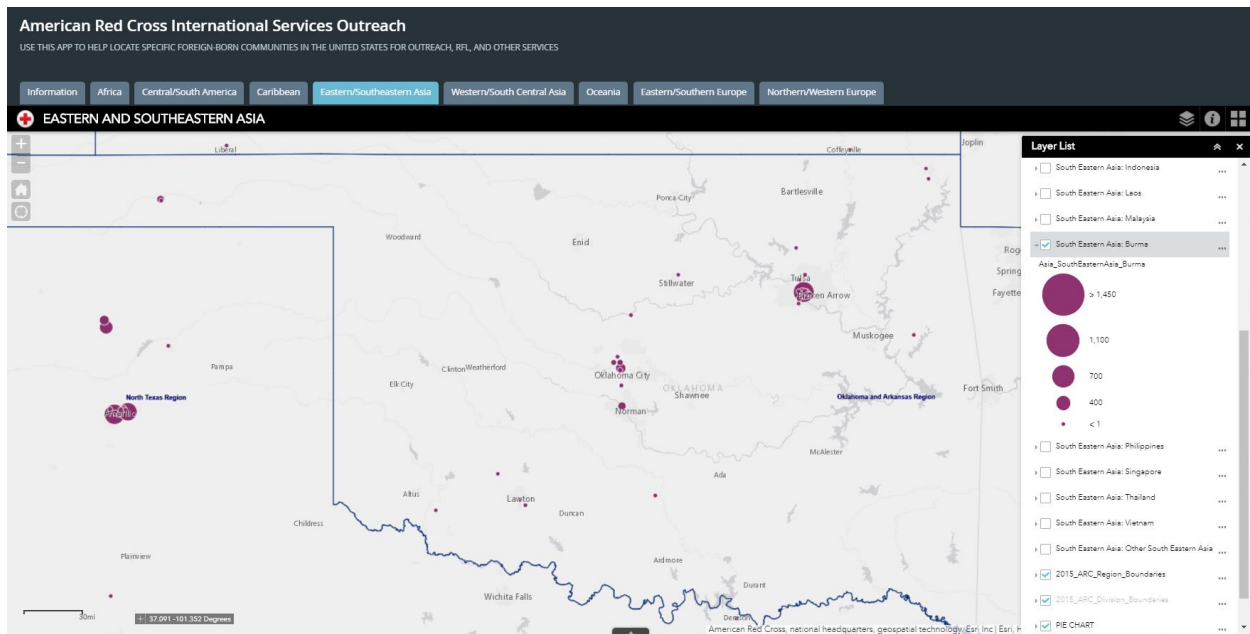
Figure 20. Population from Burma in Oklahoma and Northern Texas

A closer view of the Tulsa area is shown in Figure 21, with the Streets basemap, which allows users to identify the precise location of a tract. Population from Burma appears in eight nearly-contiguous tracts. Although the numbers themselves are still subject to margin of error, the clumping suggests there is a community here. This is an excellent place to begin a search for someone from Burma who is thought to be in Oklahoma. The tracing form includes space for religious affiliation. If religion is provided, caseworkers may find leads by contacting specific places of worship in that area.

If the communities in Oklahoma do not yield results, the trace could be redirected to Texas where caseworkers may have better luck in the Amarillo area, where other communities can be seen on the left in the previous Figure 20.
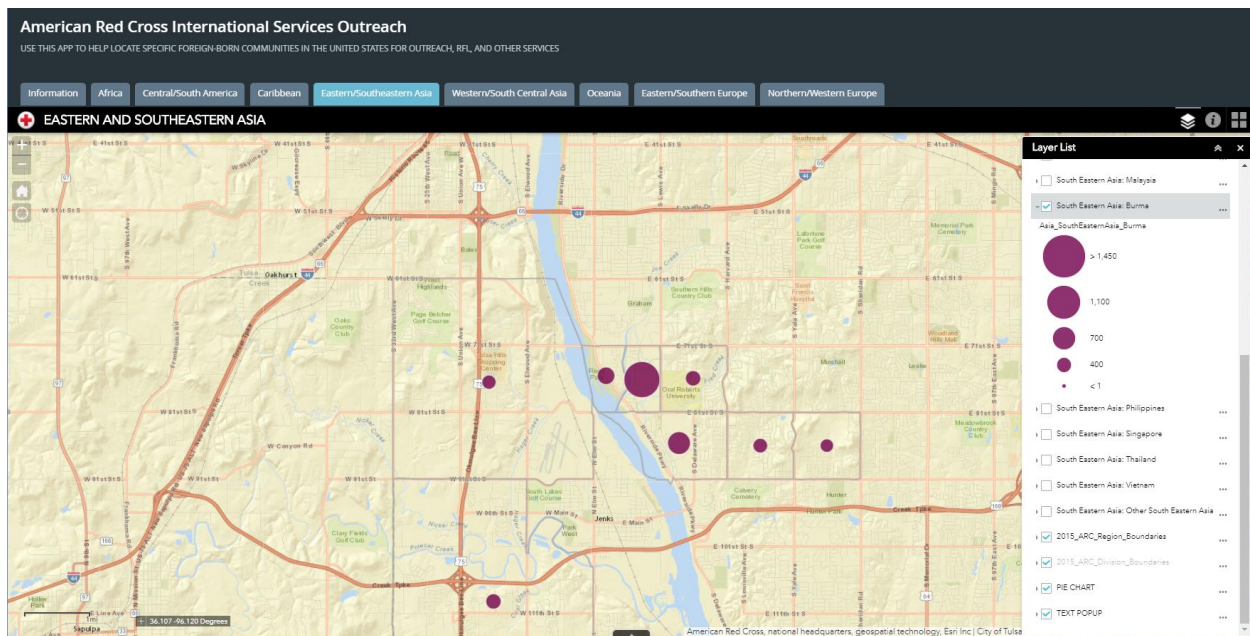
Figure 21. Population from Burma near Tulsa

5.2.2. *Locating a Cameroonian Community in Greensboro*

If someone in Cameroon were to seek help from Croix-Rouge Camerounaise to reconnect with family in Greensboro, then a volunteer from Croix-Rouge Camerounaise would take down as much information as possible which may help locate the person, and then initiate a trace. The trace would be sent to the Central Tracing Agency, and then to American Red Cross National Headquarters. If the only location information provided was Greensboro, with no state given, the trace may be sent to the Western North Carolina Region first.

There, caseworkers in would begin looking for Cameroonian communities in the vicinity of Greensboro. They may already be aware of many African communities scattered throughout the area. Figure 22 shows individuals from all African countries by tract in the Greensboro area. More than seventy circles appear on the map.
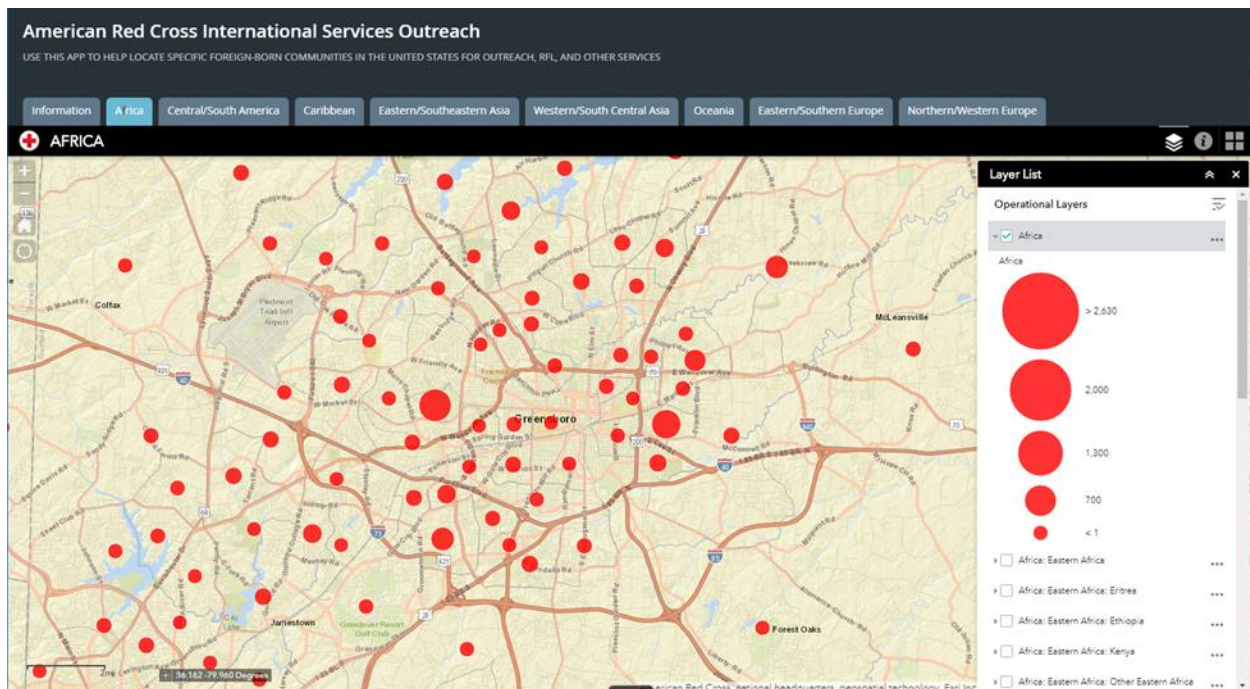
Figure 22. Estimate of immigrants from Africa in Greensboro, NC

Are individuals from Cameroon dispersed as well, or is there a cohesive community or focal point located somewhere within those 70 tracts? If a Cameroonian community exists in or near Greensboro, where should caseworkers even begin to look for it?

Figure 23 shows the Cameroon layer added to the same map; only one tract indicates population from Cameroon. A popup reveals that the circle represents an estimate of 105 people. The ISO App delivers leads, not promises. There is no guarantee that the sought person resides in that tract, that a cohesive community exists in that tract, or that this is even the *right* Greensboro (there is also a Greensboro in Georgia). The count in this lone tract may be many more than 105, or many fewer. But for a caseworker wondering where to begin this search, the app provides a clear answer: the tract represented by that blue circle.
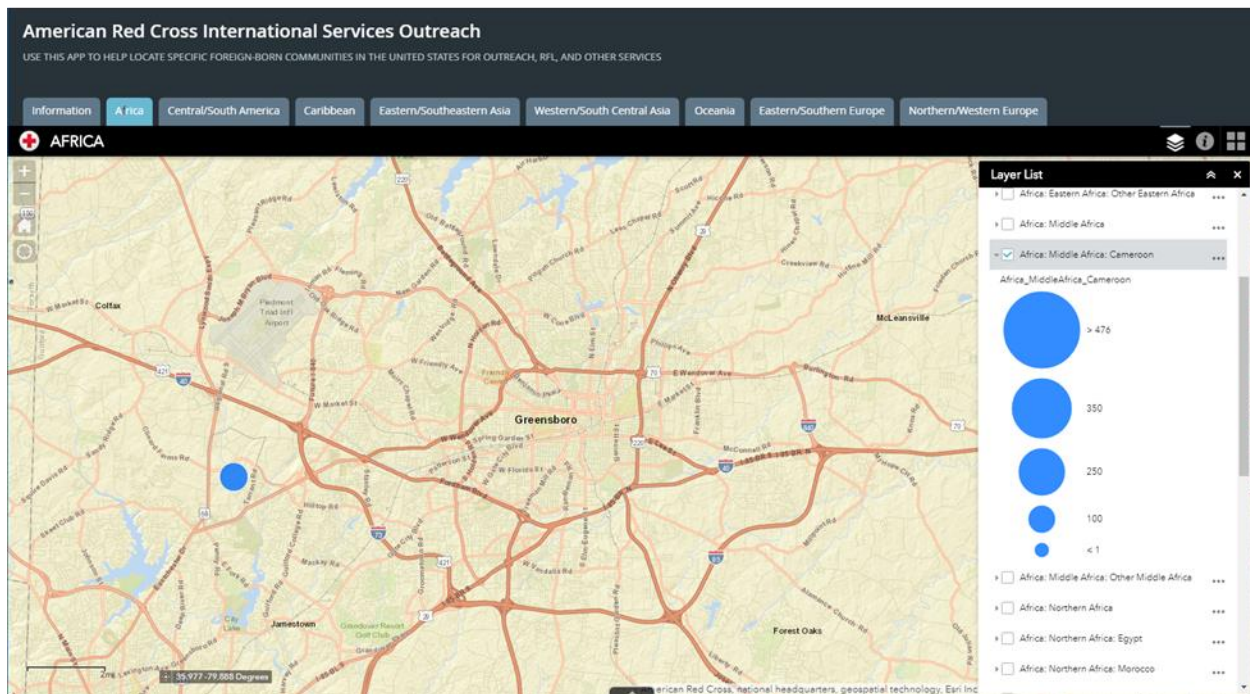
Figure 23. Estimate of immigrants from Cameroon in Greensboro, NC

5.2.3. *Connecting with the Local Fijian Community*

If a significant typhoon or other disaster were to strike the nation of Fiji, cutting off communications, the American Red Cross may conduct outreach to ensure that those with family in the affected area are aware of services to help them restore contact with loved ones. Red Cross regions within the Pacific Division would be ready to aid large populations known to be along the West Coast. But what about other Red Cross regions?

The Fiji layer, added from the Oceania tab, shows smaller pockets of Fijian population around the country. Figure 24 reveals that Ste. Genevieve, MO (pop. 4500) on the Mississippi River is home to some 286 individuals born in Fiji. With this information, staff from the American Red Cross Eastern Missouri Region would be able to reach out to this community, which may otherwise have been missed by volunteers working from a regional office more than 60 miles away. Other regions checking their local area may also find small but locally significant populations which may otherwise have been overlooked.
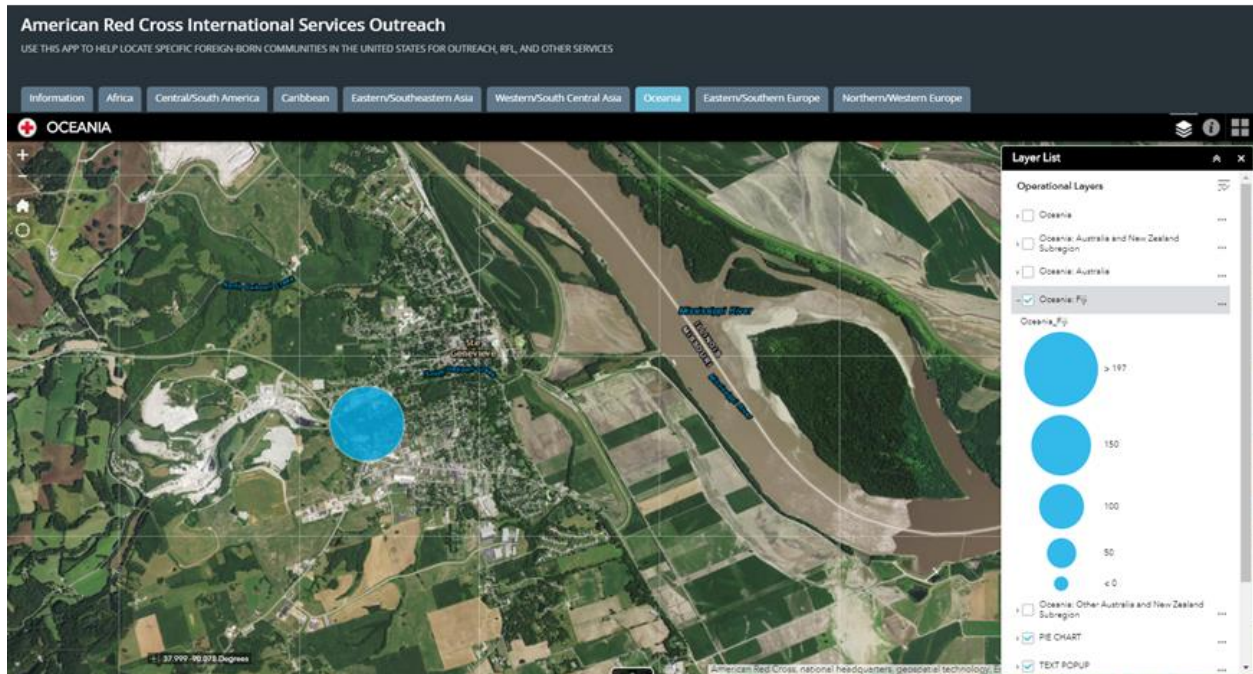
Figure 24. Fijian communities at national extent and in Ste. Genevieve, MO

5.2.4. Viewing Population Distribution at National Extent

App users seeking a high-level view of a population's distribution around the country can view data for the continental United States or greater extent. This information may help direct or re-direct a trace request when more precise location information is unavailable, or when other leads run dry.

Figure 25 and Figure 26 show the distribution of immigrants from Vietnam and Macedonia, respectively, viewed at national extent. The Vietnamese population (Figure 25) is widely dispersed in tracts throughout much of the United States, with a large center of population in Southern California. For tracing purposes, the Vietnamese population shows such wide dispersion that the map would be unlikely to help direct effort at this level. However, if the location could be narrowed down to a state or county, it may be possible to pick out tracts with numbers that are locally, if not nationally, significant.

59
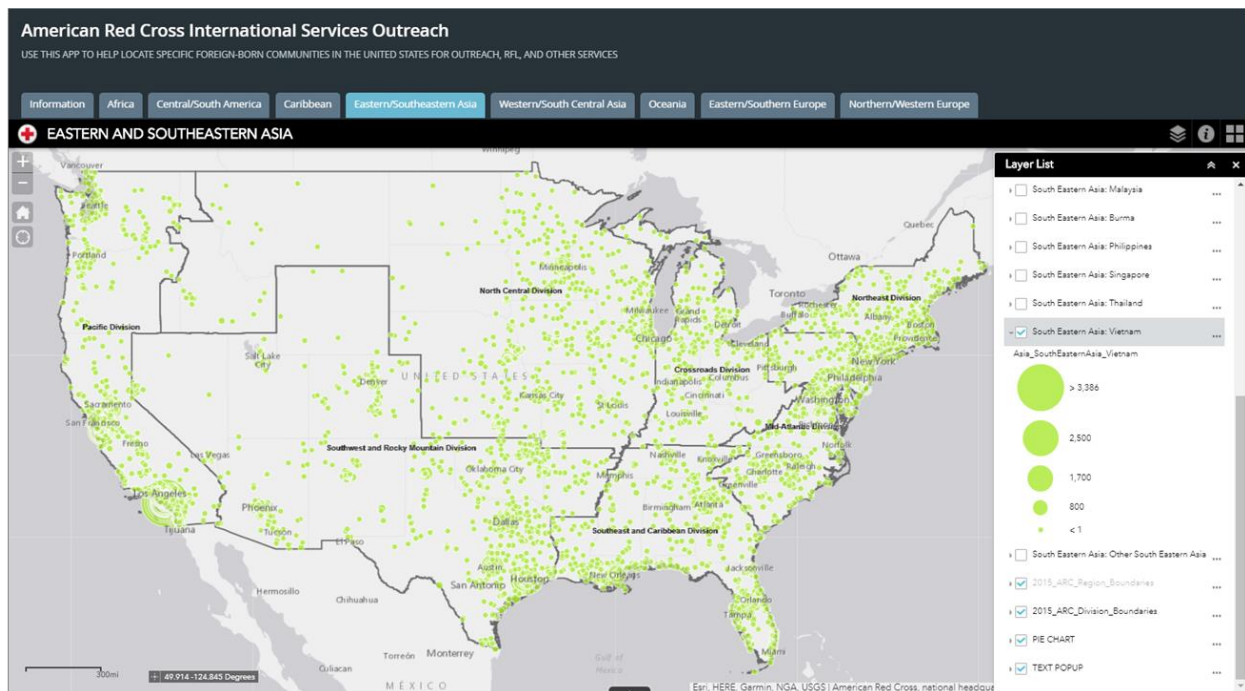
Figure 25. Dispersal pattern of Vietnamese immigrants at national extent

In contrast, the Macedonian population (Figure 26) is heavily concentrated in Patterson, New Jersey, Gary, Indiana and surrounding areas, with relatively few communities scattered through the West. A Macedonian trace could be forwarded immediately to the American Red Cross New Jersey Region, from there to the Indiana Region, and then on to the Northern Illinois-Chicago Region if necessary. The sought person may not live in any of those places, but from a national perspective, this map offers valuable leads, and contacts within these focused communities may provide more leads.
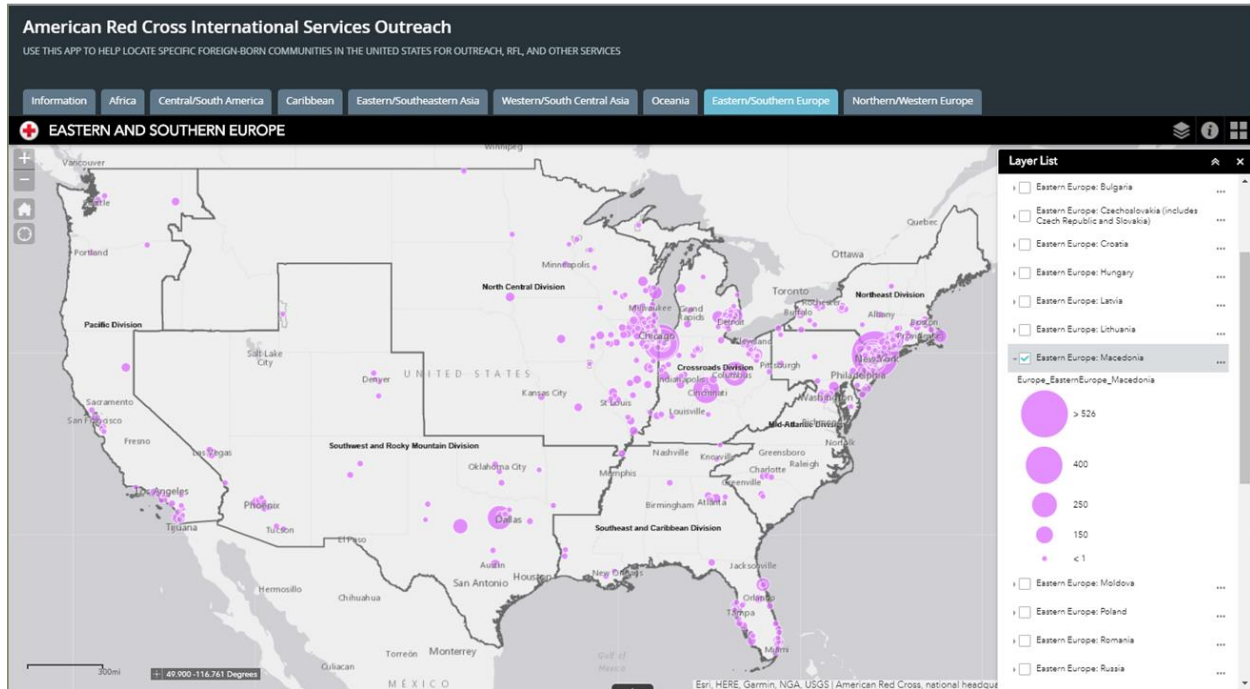
Figure 26. Dispersal pattern of Macedonian immigrants at national extent

5.3. Launch and WebEx Demonstration

The ISO App was announced in the American Red Cross internal email newsletter, The Cross Connection, in April and May 2017. In those announcements, employees and volunteers throughout the organization were invited to attend a live App demonstration via WebEx scheduled for May 15, hosted by International Services.

During the WebEx, I presented the app remotely to an audience of approximately 35 people. After introducing the RCView platform, I gave a tour of the app capabilities and map controls, presented several use cases, and provided information about the data and how it should be used.

The WebEx slide show itself was constructed within a Story Map Series template in the Bulleted layout. The full ISO App was embedded in the first page of the Story Map, and static slides were embedded as images in each of the other pages (Figure 27).
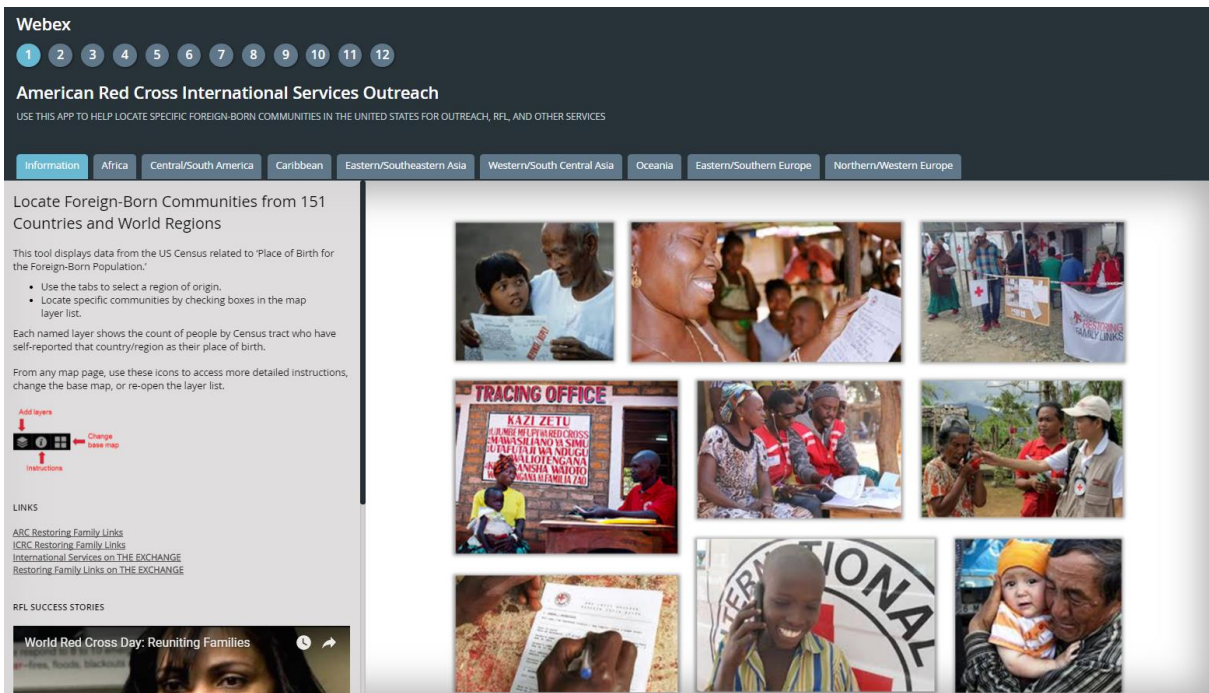
Figure 27. ISO App embedded within another Story Map for presentation via WebEx

This format allowed me to quickly switch back and forth between the live app and slides during the presentation. I was also able to pre-load the data for the use case demonstrations. After the demo, attendees had thirty minutes for questions and discussion. No questions were asked about the use of widgets, popups, layers, or other map controls. However, two topics were brought up repeatedly by attendees:

- How could the data be utilized for disaster response?

- When would the app be updated with newer data?

There are many ways that the ISO App's data could be used in Disaster. For instance, early notice of community makeup would help Red Cross more quickly accommodate specific religious, cultural, or dietary needs in a shelter. However, the ISO App was specifically set up to show the location of communities, not to display the makeup of locations. The original default popup had showed all fields, but the newer Text popup only showed the fields relevant to each

tab. To find the makeup of a specific location in the ISO app, users would need to locate that tract on eight tabs and check the popup for each. The challenge would be to find a way to present the data in a format more suited to disaster use.

As to the age of the data, I explained that the ACS 5-Year estimates run about 1-2 years behind. The ACS 2014 5-Year Estimates had been the most recent release when I began to consider the data in December 2016. It was important to remember that the app's purpose is not to deliver an accurate count of individuals. Rather, the purpose is to identify potential immigrant communities, which otherwise may be difficult or impossible to locate. While counts and margins of error are likely to change from year to year, whole communities are much less likely to show significant movement during that time.

The data question was rephrased and brought up again by other WebEx attendees. My explanation, rephrased and repeated, did not seem to satisfy them. I had failed to recognize that their core concern of these attendees was not about the numbers. They needed to find new immigrants. This need would soon be addressed in subsequent work, which is discussed in the following chapter.

Chapter 6 Conclusions

This chapter begins with a discussion of the ISO App's major strengths and weaknesses, and a description of subsequent work done after completion of the project, which was inspired by additional immigrant data needs identified during the Webex. The subsequent work was used almost immediately during the 2017 Atlantic hurricane season. The chapter concludes with a discussion of future work with ACS data to support the mission of American Red Cross, and thoughts for GIS volunteers who may be able to help other organizations connect with meaningful data.

6.1. Application Strengths

This project began as an effort to identify the location of possible immigrant communities in Los Angeles for American Red Cross. With expansion of the dataset, the project gained potential to help organizational users around the country. Technology limitations created challenges, and mistakes were made along the way. Interest from National Headquarters provided the impetus to revise the app. Although the initial layer design caused significant performance issues which complicated app use, and even required that users be warned of how to proceed for best results, these issues were mostly eliminated in the rebuild. The final version, cohesively repackaged in a Story Map template, is a substantial improvement in both design and function.

The ISO App successfully meets its goal to identify the location of possible immigrant communities, by delivering a comprehensive set of ACS Place of Birth fields to potential users in all parts of the country. These users have never had access to immigrant data at this actionable level of detail.

6.2. Application Weaknesses and Limitations

Although ACS data is integral to the app's function, there are some challenges associated with its use. First, these numbers are estimates and have margins of error. Margin of error fields are not considered here, because the app is not intended for statistical analysis. If users place too much importance on the actual numbers, they may begin to view the data in terms of 'right' or 'wrong,' rather than on a sliding scale of 'maybe.' For a caseworker beginning a search, any lead is better than no lead at all. Another challenge to using ACS is that the most recent dataset is labeled one to two calendar years behind the current year, which creates a perception that the app is out of date.

One of the principal limitations of this project was the requirement to use out-of-the-box components available within the RCView Portal. This prevented use of any advanced map, layer, or display capabilities provided by the ArcGIS API for JavaScript, or external applications such as AGOL Assistant.

Advanced customization with the ArcGIS API for JavaScript may have allowed improvement in the loading speed and display of layers. The ISO App utilizes a large dataset; despite layer changes in the second build, the layers still require more loading and drawing time than other layers to which users may be accustomed. This works contrary to the user expectation of quick response, noted by Buckley (2012) in Chapter 2. Although Web AppBuilder and portal mapping capabilities allowed for some basic customization of web map elements, it was not possible to fully optimize map function and display utilizing out-of-the-box components.

AGOL Assistant is an application that can be used to access the JSON file of a Story Map directly within a user's ArcGIS Online account, within which one can edit the default color scheme (Evans 2017). Use of AGOL Assistant would have allowed branding the ISO App with

American Red Cross colors. However, at the time the app was built, AGOL Assistant did not work with the SAML authentication required by the RCView Portal. AGOL Assistant has since been updated to support SAML, and so color modifications will be possible in future work.

Finally, mobile use of the ISO App remains problematic. The Story Map Series template includes a mobile layout; however, if a mobile device user attempts to pan or zoom after a layer has been added, the app may freeze and then reload to the cover page. The cause of this failure is unclear.

6.3. Subsequent Work

During the WebEx demonstration, feedback from attendees brought two concerns to light: how can newer immigrants be located, and how can immigrant community data be used for disaster? These new needs inspired subsequent work carried out during Summer 2017. This section includes a description of two new feature services created as a direct result of that feedback, and how they were used during the Hurricane Harvey and Hurricane Irma disaster responses.

6.3.1. Newer Immigrants

The ACS Tract geodatabase includes fields for year of entry for the foreign-born population. These 105 fields (B05007e1 through B05007e106) are subcategorized by decade of entry, citizenship status, and world region. The fields which are most relevant to locating new immigrants are estimates of those who entered in 2010 or later. Tracts with large populations of newer immigrants are assumed to hold an ongoing attraction for new immigrants; this may not be accurate for every community, but again, this data offers leads, not promises.

Data is further broken down by citizenship status: naturalized U.S citizen, not a U.S. citizen, and a composite of both. The American Red Cross does not ask about citizenship status.

The composite fields were chosen for their neutrality, and to eliminate any chance of misunderstanding that may arise from American Red Cross mapping citizenship status.

The year of entry data is provided for eight world regions: Asia, Europe, Caribbean, Central America/Mexico, Central America/Other, South America, Americas, and "Other Areas" (presumably Africa and Oceania). Seven fields were extracted from the geodatabase and copied to a feature class: each region (Americas omitted), entering 2010 or later, and of composite citizenship status.

6.3.2. Predominant Community

This experimental layer identifies tracts where more than 50% of the foreign-born population is from one country. Working in ArcGIS Pro, I created a ModelBuilder tool with additional Python scripts to iterate through each of the individual countries in the place of birth feature class used for the RFL feature service. For each tract in which a single country's foreign-born population was more than 50% of the total foreign-born population, that country's name would be written to a new field called GRTR_50.

The resulting layer is a patchwork of color across the United States. Approximately one third of the tracts in the United States have a predominant community; these communities originate from more than 100 countries. This data may help provide notice for possible language and cultural needs during disaster, as well as identify areas for targeted outreach for International Services and preparedness efforts.

6.3.3. Hurricane Harvey and Hurricane Irma

Harvey made landfall in Texas as a Category 4 Hurricane on August 25, 2017, creating catastrophic damage and flooding across the southern part of Texas. That day, NPR reported that Border Patrol planned to continue to operate checkpoints, unlike the previous year during

Hurricane Mitch when checkpoints were closed (Rose 2017). On August 29, The New York Times reported that among Houston's estimated 600,000 undocumented immigrants, anxiety was high. Would going to a shelter put them at greater risk than staying home?

A joint Border Patrol and Immigration and Customs Enforcement (ICE) announcement had declared that "routine enforcement would not be conducted at evacuation sites or shelters," yet Border Patrol maintained a visible presence in the city. Images of Border Patrol vehicles parked near the Convention Center mega shelter appeared in social media, as agents in boats participated in rescue efforts in Houston. "Mixed signals coming from immigration authorities" fueled rumors (Romero 2017).

Within the American Red Cross, there was considerable concern for those who had chosen to take their chances rather than seek safety in a shelter. After the hurricane passed, a delegation from Cruz Roja Mexicana, the Mexican Red Cross, flew in to assist with community outreach. I was contacted by a colleague working alongside Cruz Roja in Houston, who was seeking any data that would help them identify areas with newer Latino immigrants.

I had already created the new feature classes in ArcGIS Pro, but had not published them. I quickly added a calculated field to the Newer Immigrants feature class, into which I summed the Mexico, Other Central America, South America, and Caribbean fields. This would be the Latin America total.

I published both feature services, and set up a new Story Map to assist with outreach (Figure 28) showing two views: density (normalized by ALAND), and count by tract. Density was included for efficiency, while the count would help locate the largest numbers.
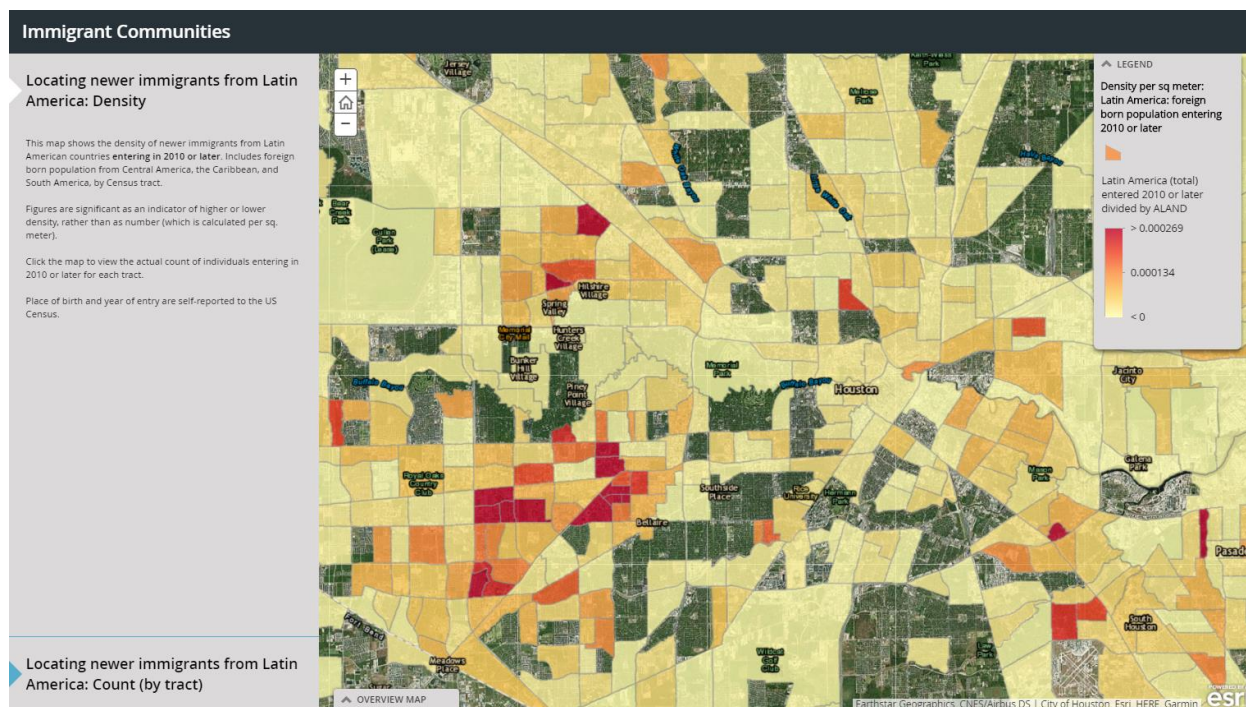
Figure 28. Houston-area immigrants from Latin American countries entering in 2010 or later, by density

Later in the Harvey response, the density view was added to an app for planning feeding routes, along with other vulnerability layers.

Hurricane Irma formed in the Atlantic on August 31. While the Harvey response carried on in Texas and Louisiana, American Red Cross began to stage personnel in Florida in advance of Irma's arrival. I joined the Irma response as GIS lead in Orlando on September 7, three days before landfall.

While in Orlando I made two additions to the previous impromptu Story Map, this time tailored to Florida needs. First, I added a Web AppBuilder app with the five major immigrant groups in Southern Florida only: Cuba, Jamaica, Haiti, Dominican Republic, and Philippines (Figure 29). Next, I added a map displaying the Predominant Community layer, identifying tracts where more than 50% of the foreign-born population is from one country (Figure 30).

Figure 29. Place of birth layers for use during Hurricane Irma, showing Haitian and Cuban communities in the Miami area

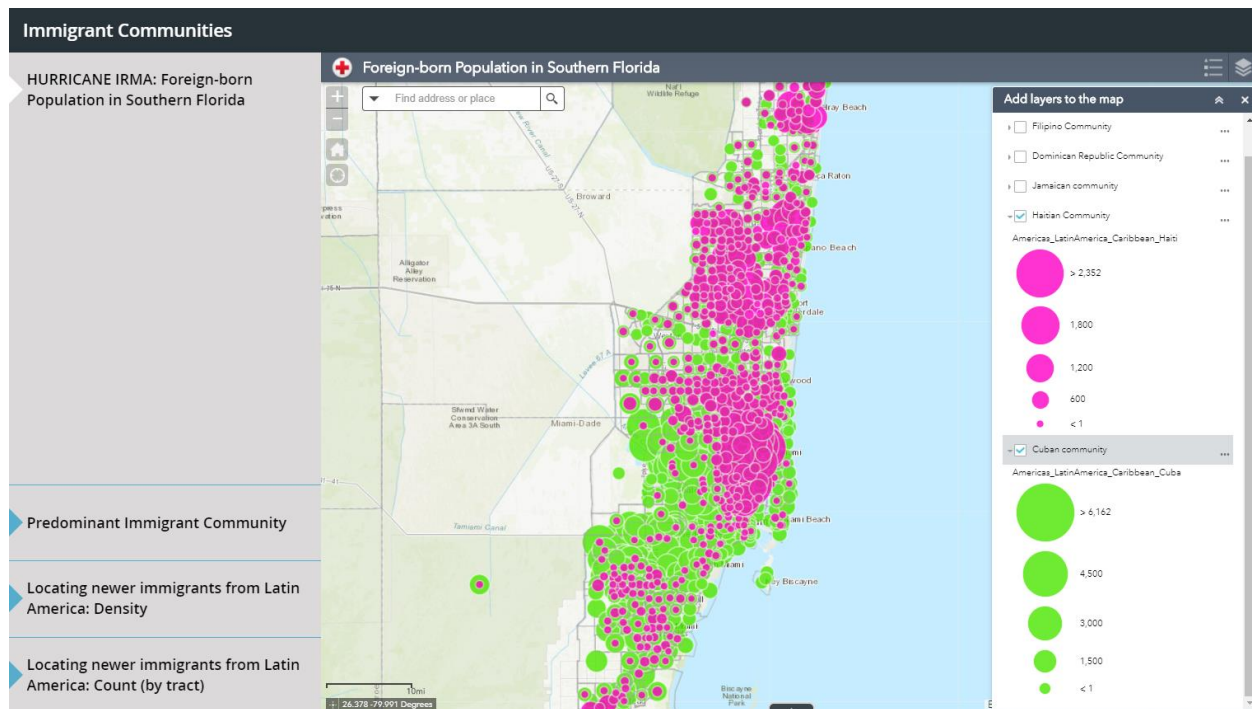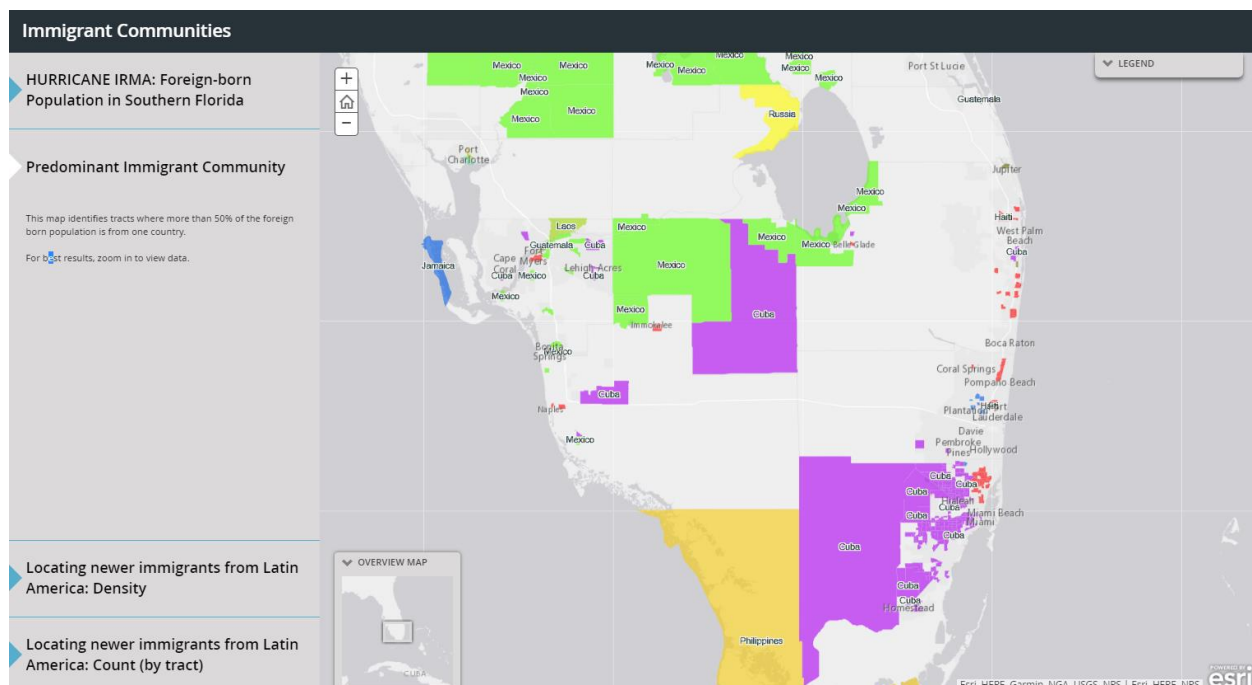Figure 30. Predominant Community layer for use during Hurricane Irma

Additionally, I provided these layers to the Spiritual Care Lead Chaplain for the Florida response, in an app featuring places of worship. Later, the Newer Immigrant density layer was added along with other vulnerability layers to an app for bulk distribution (emergency cleanup supplies) route planning.

6.4. Future Work

Future work inspired by this project is in two areas: within American Red Cross, and beyond American Red Cross.

6.4.1. Within Red Cross

The hurricanes created such immediate need for immigrant data in a disaster setting that there was little time to experiment with different methods of data classification for the Newer Immigrant layer, or to set up each new app with deliberate attention to detail. Now that the 2017 Atlantic hurricane season is over, I will continue work to develop one or more map products that are set up to deliver immigrant data specifically for use during a disaster response.

As I observed in Orlando, disaster-related Internet issues may prevent large datasets from loading. Many users may need to share limited bandwidth, or may be working in a temporary headquarters with inconsistent Wi-Fi coverage. Therefore, disaster products using immigrant data should be created with limited resources in mind.

Although I do not have plans to update the full ISO App at this time, I do plan to add map layers for one or more countries which have been added since the 2014 data release. A place of birth field for Somalia was added to the 2015 ACS dataset; there may be other additions in the 2016 5-Year Estimates, set to be released soon.

There are many ACS fields which may be of use to other Red Cross lines of service. These will be considered for additional projects.

6.4.2. Beyond Red Cross

The ACS is filled with lesser known or obscure fields that may speak directly to the mission of different nonprofits and humanitarian organizations. But the potential impact is lost when organizations are unaware the data exists, they don't know how to use it, or they lack the resources to access it. These organizations need help from GIS volunteers who can work with them to find out what their needs are, and then take initiative to show them what is possible.

This project began with a single question: did I know of any maps showing where to find immigrant communities in Los Angeles? It grew into an app with potential to help reunite families, and inspired additional work to help find new immigrants in need of disaster relief.

This thesis offers an example of one way to extract ACS data so that it can be put to work for an organization. Appendix B contains instructions for creating a pivot table index that will simplify browsing ACS geodatabases, to find the most for relevant fields. But GIS volunteers are the key to helping organizations connect with data that may change lives.

References

American Red Cross. 1988. *Volunteer 2000 Study: Volume 1 Findings and Recommendations.* White Paper, American Red Cross.

———. 2013. *Red Cross Launches Online Volunteer Connection System.* March 11. Accessed October 3, 2017. http://www.redcross.org/news/press-release/Red-Cross-Launches-Online-Volunteer-Connection-System.

———. 2017a. *Career Opportunities.* Accessed November 20, 2017. http://www.redcross.org/about-us/careers.

———. 2017b. *Mobile Apps.* Accessed November 18, 2017. http://www.redcross.org/get-help/how-to-prepare-for-emergencies/mobile-apps.

———. 2017c. *National Level Maps.* August 5. http://maps.redcross.org.

Berry, Lisa. 2017. *2010 Census Data Now Available in the Living Atlas.* June 28. Accessed November 10, 2017. https://blogs.esri.com/esri/arcgis/2017/06/28/census-data-now-available-in-the-living-atlas/.

Breakstone, Carole D., and Tammy S. Anderson. 2017. *Census Data API User Guide.* United States Census Bureau. https://www.census.gov/content/dam/Census/data/developers/api-user-guide/api-guide.pdf.

Buckley, Aileen. 2012. "Designing Great Web maps." *Arc User*, Summer: 50-53.

Cable, Justin. 2013. "The Racial Dot Map." https://demographics.virginia.edu/DotMap/index.html.

Delsol, Christine. 2015. "The many culturally rich ethnic neighborhoods of Los Angeles." 2. http://www.sfgate.com/travel/article/The-many-culturally-rich-ethnic-neighborhoods-of-6062875.php#item-39786.

Dent, Borden, Jeffrey Torguson, and Thomas Hodler. 2008. *Cartography: Thematic Map Design.* Boston: McGraw-Hill.

Edin, Per-Anders, Peter Fredriksson, and Olof. 2003. "Ethnic Enclaves and the Economic Success of Immigrants: Evidence from a Natural Experiment." *The Quarterly Journal of Economics* 118: 329-357. http://www.jstor.org.libproxy1.usc.edu/stable/25053906.

Esri. 2014. "The American Community Survey: An Esri White Paper." https://www.esri.com/library/whitepapers/pdfs/the-american-community-survey.pdf.

———. 2017a. "2017 Esri Demographic and Business Data List." Accessed November 10, 2017. http://downloads.esri.com/esri_content_doc/dbl/us/2017_ACS_2011_2015_Tract.pdf.

———. 2017b. *Story Maps.* Nov 11. https://storymaps.arcgis.com/en/.

———. 2017c. *Survey123 for ArcGIS.* Accessed November 19, 2017. https://survey123.arcgis.com/.

———. 2017d. *Understand the relationship between Portal for ArcGIS and an ArcGIS Online subscription.* Accessed November 21, 2017. http://server.arcgis.com/en/portal/latest/administer/linux/choosing-between-an-arcgis-online-subscription-and-portal-for-arcgis.htm.

———. 2017e. *Web AppBuilder for ArcGIS.* Accessed November 10, 2017. http://doc.arcgis.com/en/web-appbuilder/create-apps/what-is-web-appbuilder.htm.

———. 2017f. *What's included with Business Analyst?* Accessed November 19, 2017. http://www.esri.com/software/businessanalyst/.

Evans, Owen. 2017. *Customizing theme colors in Map Journal and Map Series.* March 4. Accessed September 27, 2017. https://developerscorner.storymaps.arcgis.com/customizing-theme-colors-in-map-journal-and-map-series-6e45b84c277e.

Galster, George. 2001. "On the Nature of Neighbourhood." *Urban Studies* 38 (12): 2111-2124.

Geier, Stephanie. 2015. "18 Ethnic Micro Neighborhoods in the 5 Boroughs of NYC." *Untapped Cities.* November 13. https://untappedcities.com/2015/11/13/18-ethnic-micro-neighborhoods-in-the-5-boroughs-of-nyc/.

ICRC. 2009. "Restoring Family Links: Presenting the Strategy for a Worldwide Network." Geneva: International Committee of the Red Cross.

———. 2014. *Living with Absence: Helping the Families of the Missing.* Geneva: International Committee of the Red Cross.

———. 2017a. *Fundamental Principles.* Accessed November 2, 2017. https://www.icrc.org/en.

———. 2017b. *History of the ICRC.* Accessed August 14, 2017. https://www.icrc.org/en.

———. 2017c. "Looking for Family Members." *Restoring Family Links.* Accessed August 5, 2017. https://familylinks.icrc.org.

IFRC. 2017a. *History.* Accessed July 20, 2017. http://www.ifrc.org/en/.

———. 2017b. *National Societies.* Accessed August 5, 2017. http://www.ifrc.org/en.

Logan, John R., Seth Spielman , Hongwei Xu & Philip N. Klein. 2011. "Identifying and Bounding Ethnic Neighborhoods." *Urban Geography* 32 (3): 334-359. doi:https://doi.org/10.2747/0272-3638.32.3.334.

Logan, John R., Wenquan Zhang, and Richard D. Alba. 2002. "Immigrant Enclaves and Ethnic Communities in New York and Los Angeles." *American Sociological Review* 67: 299-322. doi:10.2307/3088897.

MacDonald, Heather, and Alan Peters. 2011. *Urban Policy and the Census.* Redlands: Esri Press.

Migration Policy Institute. 2017. *U.S. Immigrant Population by Metropolitan Area.* Accessed November 17, 2017. https://www.migrationpolicy.org/programs/data-hub/charts/us-immigrant-population-metropolitan-area.

Missing Maps. 2017. *Missing Maps.* Accessed Jan 15, 2018. http://www.missingmaps.org/.

Muehlenhaus, Ian. 2013. *Web Cartography: Map Design for Interactive and Mobile Devices.* Boca Raton: CRC Press.

O'Donnell, Jim. 2012. "Touring Chicago's Ethnic Neighborhoods." *Around the World in Eighty Years.* November 26. http://www.aroundtheworldineightyyears.com/touring-chicagos-ethnic-neighborhoods/.

Romero, Simon, and Jordan, Miriam. 2017. "It Was an Uneasy Time for Immigrants in Texas. Then the Rains Came." *The New York Times*, August 29. Accessed 11 16, 2017. https://www.nytimes.com/2017/08/29/us/immigration-harvey-border-patrol.html.

Rose, Joel. 2017. "Border Patrol Says Checkpoints Will Remain Open During Hurricane Harvey." *NPR News*, August 25. Accessed November 17, 2017. https://www.npr.org/2017/08/25/546109886/border-patrol-says-checkpoints-will-remain-open-during-hurricane-harvey.

Tedrick, James. 2014. "Integrating the Census Data API with ArcGIS Applications." Esri UC 2014. Accessed August 20, 2017. https://community.esri.com/docs/DOC-1768.

Tomnod. 2017. *Tomnod.* Accessed January 15, 2018. https://www.tomnod.com/.

US Census Bureau. 2008. *A Compass for Understanding and Using American Community Survey Data: What General Data Users Need to Know.* Washington, DC: U.S. Government Printing Office. Accessed September 30, 2017. https://www.census.gov/content/dam/Census/library/publications/2008/acs/ACSGeneral Handbook.pdf.

———. 2014. "American Community Survey and Puerto Rico Community Survey 2014 Subject Definitions." Technical Documentation. Accessed June 30, 2017. https://www2.census.gov/programs-surveys/acs/tech_docs/subject_definitions/2014_ACSSubjectDefinitions.pdf.

———. 2015. "American Community Survey 5-Year Estimates, 2010-2014 Tract." [Geodatabase] US Census Bureau. Accessed December 1, 2016. https://www.census.gov/geo/maps-data/data/tiger.html.

———. 2016. *When to Use 1-year, 3-year, or 5-year Estimates.* October 1. Accessed September 30, 2017. https://www.census.gov/programs-surveys/acs/guidance/estimates.html.

———. 2017a. *Census API: Datasets in /data and its descendants.* Accessed November 19, 2017. https://api.census.gov/data.html.

———. 2017b. *Geographic Terms and Concepts - Core Based Statistical Areas and Related Statistical Areas.* Accessed November 17, 2017. https://www.census.gov/geo/reference/gtc/gtc_cbsa.html.

Wen, Ming, Diane S. Lauderdale, and Namratha R. Kandula. 2009. "Ethnic neighborhoods in multi-ethnic America, 1990-2000: resurgent ethnicity in the ethnoburbs?" *Social Forces* 425-460.

Zelinsky, Wilbur, and Barrett A. Lee. 1998. "Heterolocalism: an alternative model of the sociospatial behaviour of immigrant ethnic communities." *International Journal of Population Geography* 4: 281.

Zhou, Min, Yen-Fen Tseng, and Rebecca Kim. 2008. "Rethinking Residential Assimilation: The Case of a Chinese Ethnoburb in the San Gabriel Valley, California." *Amerasia Journal* 34: 53-83. doi:10.17953/amer.34.3.y08124j33ut846v0.

Appendix A 2014 ACS Fields in the RFL Feature Service

The following table lists the census short name and new field name for the 156 fields which were extracted from the 2014 ACS 5-Year Estimates tract geodatabase, and published in the RFL_Place_of_Birth_by_Tract feature service. Fields marked with an asterisk were not included as layers in the ISO App.

Short Name	New Field Name	*not used in ISO App
B05006e1	Total*	
B05006e2	Europe*	
B05006e3	Europe_NorthernEurope	
B05006e4	Europe_NorthernEurope_UnitedKingdom	
B05006e6	Europe_NorthernEurope_UnitedKingdominc.CrownDependencies_England	
B05006e7	Europe_NorthernEurope_UnitedKingdominc.CrownDependencies_Scotland	
B05006e8	Europe_NorthernEurope_Ireland	
B05006e9	Europe_NorthernEurope_Denmark	
B05006e10	Europe_NorthernEurope_Norway	
B05006e11	Europe_NorthernEurope_Sweden	
B05006e12	Europe_NorthernEurope_OtherNorthernEurope	
B05006e13	Europe_WesternEurope	
B05006e14	Europe_WesternEurope_Austria	
B05006e15	Europe_WesternEurope_Belgium	
B05006e16	Europe_WesternEurope_France	
B05006e17	Europe_WesternEurope_Germany	
B05006e18	Europe_WesternEurope_Netherlands	
B05006e19	Europe_WesternEurope_Switzerland	
B05006e20	Europe_WesternEurope_OtherWesternEurope	
B05006e21	Europe_SouthernEurope	
B05006e22	Europe_SouthernEurope_Greece	
B05006e23	Europe_SouthernEurope_Italy	
B05006e24	Europe_SouthernEurope_Portugal	
B05006e25	Europe_SouthernEurope_Portugal_AzoresIslands	
B05006e26	Europe_SouthernEurope_Spain	
B05006e27	Europe_SouthernEurope_OtherSouthernEurope	
B05006e28	Europe_EasternEurope	
B05006e29	Europe_EasternEurope_Albania	

Short Name	New Field Name	*not used in ISO App
B05006e30	Europe_EasternEurope_Belarus	
B05006e31	Europe_EasternEurope_Bulgaria	
B05006e32	Europe_EasternEurope_Croatia	
B05006e33	Europe_EasternEurope_Czechoslovakia_incl_CzechRepublic_and_Slovakia	
B05006e34	Europe_EasternEurope_Hungary	
B05006e35	Europe_EasternEurope_Latvia	
B05006e36	Europe_EasternEurope_Lithuania	
B05006e37	Europe_EasternEurope_Macedonia	
B05006e38	Europe_EasternEurope_Moldova	
B05006e39	Europe_EasternEurope_Poland	
B05006e40	Europe_EasternEurope_Romania	
B05006e41	Europe_EasternEurope_Russia	
B05006e42	Europe_EasternEurope_Ukraine	
B05006e43	Europe_EasternEurope_Bosnia_and_Herzegovina	
B05006e44	Europe_EasternEurope_Serbia	
B05006e45	Europe_EasternEurope_OtherEasternEurope	
B05006e47	Asia*	
B05006e48	Asia_EasternAsia	
B05006e49	Asia_EasternAsia_China*	
B05006e50	Asia_EasternAsia_China_excl_HongKongandTaiwan	
B05006e51	Asia_EasternAsia_HongKong	
B05006e52	Asia_EasternAsia_Taiwan	
B05006e53	Asia_EasternAsia_Japan	
B05006e54	Asia_EasternAsia_Korea	
B05006e55	Asia_EasternAsia_OtherEasternAsia	
B05006e56	Asia_SouthCentralAsia	
B05006e57	Asia_SouthCentralAsia_Afghanistan	
B05006e58	Asia_SouthCentralAsia_Bangladesh	
B05006e59	Asia_SouthCentralAsia_India	
B05006e60	Asia_SouthCentralAsia_Iran	
B05006e61	Asia_SouthCentralAsia_Kazakhstan	
B05006e62	Asia_SouthCentralAsia_Nepal	
B05006e63	Asia_SouthCentralAsia_Pakistan	
B05006e64	Asia_SouthCentralAsia_SriLanka	
B05006e65	Asia_SouthCentralAsia_Uzbekistan	
B05006e66	Asia_SouthCentralAsia_OtherSouthCentralAsia	
B05006e67	Asia_SouthEasternAsia	
B05006e68	Asia_SouthEasternAsia_Cambodia	
B05006e69	Asia_SouthEasternAsia_Indonesia	
B05006e70	Asia_SouthEasternAsia_Laos	
B05006e71	Asia_SouthEasternAsia_Malaysia	
B05006e72	Asia_SouthEasternAsia_Burma	

Short Name	New Field Name	*not used in ISO App
B05006e73	Asia_SouthEasternAsia_Philippines	
B05006e74	Asia_SouthEasternAsia_Singapore	
B05006e75	Asia_SouthEasternAsia_Thailand	
B05006e76	Asia_SouthEasternAsia_Vietnam	
B05006e77	Asia_SouthEastern_OtherSouthEasternAsia	
B05006e78	Asia_WesternAsia	
B05006e79	Asia_WesternAsia_Iraq	
B05006e80	Asia_WesternAsia_Israel	
B05006e81	Asia_WesternAsia_Jordan	
B05006e82	Asia_WesternAsia_Kuwait	
B05006e83	Asia_WesternAsia_Lebanon	
B05006e84	Asia_WesternAsia_SaudiArabia	
B05006e85	Asia_WesternAsia_Syria	
B05006e86	Asia_WesternAsia_Yemen	
B05006e87	Asia_WesternAsia_Turkey	
B05006e88	Asia_WesternAsia_Armenia	
B05006e89	Asia_WesternAsia_OtherWesternAsia	
B05006e91	Africa	
B05006e92	Africa_EasternAfrica	
B05006e93	Africa_EasternAfrica_Eritrea	
B05006e94	Africa_EasternAfrica_Ethiopia	
B05006e95	Africa_EasternAfrica_Kenya	
B05006e96	Africa_EasternAfrica_OtherEasternAfrica	
B05006e97	Africa_MiddleAfrica	
B05006e98	Africa_MiddleAfrica_Cameroon	
B05006e99	Africa_MiddleAfrica_OtherMiddleAfrica	
B05006e100	Africa_NorthernAfrica	
B05006e101	Africa_NorthernAfrica_Egypt	
B05006e102	Africa_NorthernAfrica_Morocco	
B05006e103	Africa_NorthernAfrica_Sudan	
B05006e104	Africa_NorthernAfrica_OtherNorthernAfrica	
B05006e105	Africa_SouthernAfrica	
B05006e106	Africa_SouthernAfrica_SouthAfrica	
B05006e107	Africa_SouthernAfrica_OtherSouthernAfrica	
B05006e108	Africa_WesternAfrica	
B05006e109	Africa_WesternAfrica_CaboVerde	
B05006e110	Africa_WesternAfrica_Ghana	
B05006e111	Africa_WesternAfrica_Liberia	
B05006e112	Africa_WesternAfrica_Nigeria	
B05006e113	Africa_WesternAfrica_SierraLeone	
B05006e114	Africa_WesternAfrica_OtherWesternAfrica	
B05006e116	Oceania	

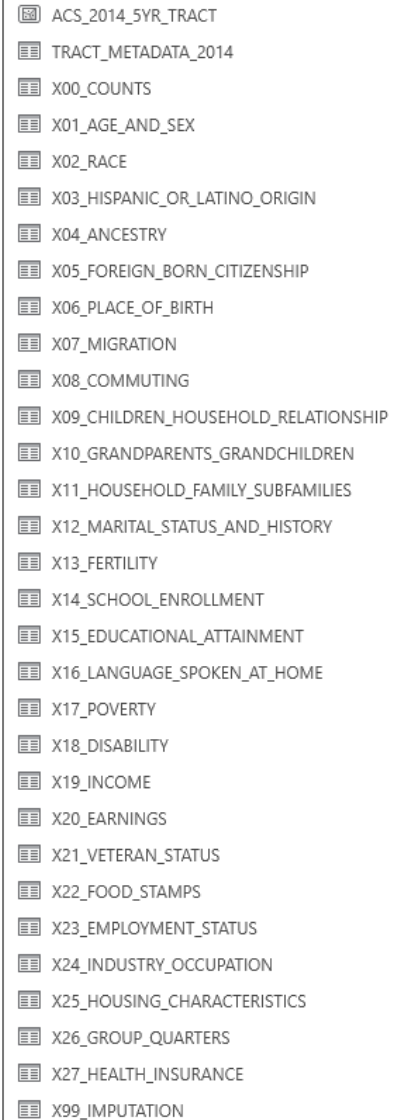| Short Name	New Field Name	*not used in ISO App
B05006e117	Oceania_Australia_and_NewZealandSubregion	
B05006e118	Oceania_Australia	
B05006e119	Oceania_OtherAustralian_NewZealand_Subregion	
B05006e120	Oceania_Fiji	
B05006e122	Americas*	
B05006e123	Americas_LatinAmerica*	
B05006e124	Americas_LatinAmerica_Caribbean	
B05006e125	Americas_LatinAmerica_Caribbean_Bahamas	
B05006e126	Americas_LatinAmerica_Caribbean_Barbados	
B05006e127	Americas_LatinAmerica_Caribbean_Cuba	
B05006e128	Americas_LatinAmerica_Caribbean_Dominica	
B05006e129	Americas_LatinAmerica_Caribbean_DominicanRepublic	
B05006e130	Americas_LatinAmerica_Caribbean_Grenada	
B05006e131	Americas_LatinAmerica_Caribbean_Haiti	
B05006e132	Americas_LatinAmerica_Caribbean_Jamaica	
B05006e133	Americas_LatinAmerica_Caribbean_St.VincentandtheGrenadines	
B05006e134	Americas_LatinAmerica_Caribbean_TrinidadandTobago	
B05006e135	Americas_LatinAmerica_Caribbean_WestIndies	
B05006e136	Americas_LatinAmerica_Caribbean_OtherCaribbean	
B05006e137	Americas_LatinAmerica_CentralAmerica	
B05006e138	Americas_LatinAmerica_CentralAmerica_Mexico	
B05006e139	Americas_LatinAmerica_CentralAmerica_Belize	
B05006e140	Americas_LatinAmerica_CentralAmerica_CostaRica	
B05006e141	Americas_LatinAmerica_CentralAmerica_ElSalvador	
B05006e142	Americas_LatinAmerica_CentralAmerica_Guatemala	
B05006e143	Americas_LatinAmerica_CentralAmerica_Honduras	
B05006e144	Americas_LatinAmerica_CentralAmerica_Nicaragua	
B05006e145	Americas_LatinAmerica_CentralAmerica_Panama	
B05006e146	Americas_LatinAmerica_CentralAmerica_OtherCentralAmerica	
B05006e147	Americas_LatinAmerica_SouthAmerica	
B05006e148	Americas_LatinAmerica_SouthAmerica_Argentina	
B05006e149	Americas_LatinAmerica_SouthAmerica_Bolivia	
B05006e150	Americas_LatinAmerica_SouthAmerica_Brazil	
B05006e151	Americas_LatinAmerica_SouthAmerica_Chile	
B05006e152	Americas_LatinAmerica_SouthAmerica_Colombia	
B05006e153	Americas_LatinAmerica_SouthAmerica_Ecuador	
B05006e154	Americas_LatinAmerica_SouthAmerica_Guyana	
B05006e155	Americas_LatinAmerica_SouthAmerica_Peru	
B05006e156	Americas_LatinAmerica_SouthAmerica_Uruguay	
B05006e157	Americas_LatinAmerica_SouthAmerica_Venezuela	
B05006e158	Americas_LatinAmerica_SouthAmerica_OtherSouthAmerica	

Short Name	New Field Name	*not used in ISO App
B05006e159	Americas_NorthernAmerica*	
B05006e160	Americas_NorthernAmerica_Canada*	
B05006e161	Americas_NorthernAmerica_OtherNorthernAmerica*	

Appendix B Create a Pivot Table Index for Browsing ACS Fields

ACS geodatabases are available for download at https://www2.census.gov/geo/tiger/TIGER_DP/.

The figure, right, displays the full contents of the ACS Tract geodatabase. Almost 36,000 attributes are organized in tables by topic; each attribute is identified by census short name code. The Metadata table lists each code and corresponding full name, or field definition. Each definition may be more than 300 characters long, with as many as eight levels of subcategory.

Use the instructions in this section to create an index to simplify browsing geodatabase contents, locating desired fields, and retrieving corresponding codes. The process involves converting the Metadata table to Excel, parsing the definition into successive columns at each colon-delimited subcategory, and then constructing a pivot table sorted with a series of slicers.

ACS_2014_5YR_TRACT
TRACT_METADATA_2014
X00_COUNTS
X01_AGE_AND_SEX
X02_RACE
X03_HISPANIC_OR_LATINO_ORIGIN
X04_ANCESTRY
X05_FOREIGN_BORN_CITIZENSHIP
X06_PLACE_OF_BIRTH
X07_MIGRATION
X08_COMMUTING
X09_CHILDREN_HOUSEHOLD_RELATIONSHIP
X10_GRANDPARENTS_GRANDCHILDREN
X11_HOUSEHOLD_FAMILY_SUBFAMILIES
X12_MARITAL_STATUS_AND_HISTORY
X13_FERTILITY
X14_SCHOOL_ENROLLMENT
X15_EDUCATIONAL_ATTAINMENT
X16_LANGUAGE_SPOKEN_AT_HOME
X17_POVERTY
X18_DISABILITY
X19_INCOME
X20_EARNINGS
X21_VETERAN_STATUS
X22_FOOD_STAMPS
X23_EMPLOYMENT_STATUS
X24_INDUSTRY_OCCUPATION
X25_HOUSING_CHARACTERISTICS
X26_GROUP_QUARTERS
X27_HEALTH_INSURANCE
X99_IMPUTATION

Contents of the ACS Tract geodatabase

Convert and prepare the data:

1. Convert the ACS geodatabase Metadata table to Excel using the Table to Excel tool in ArcMap or ArcGIS Pro.

2. In Excel, format the data as a table.

3. Apply a text filter to the Short Name column, selecting for records that contain **m**. This will show all records for margin of error fields, which will be deleted in the next step to reduce the data by half (estimate and corresponding margin of error fields share identical codes, apart from an **e** or **m** identifier).

4. From the HOME tab, **Find & Select > Go to Special > Visible cells only**. With all visible cells selected, DELETE.

5. All blank cells will be deleted in this step. From the HOME tab, **Find & Select > Go to Special > Blanks**. DELETE (this is a resource intensive process that may take time).

6. Add a column to the table. Copy and paste the Full_name column into it to create a duplicate column. This column will be parsed in the next step.

7. From the DATA tab, select **Text to Columns**. In the Convert Text to Columns Wizard, select **Delimited**.
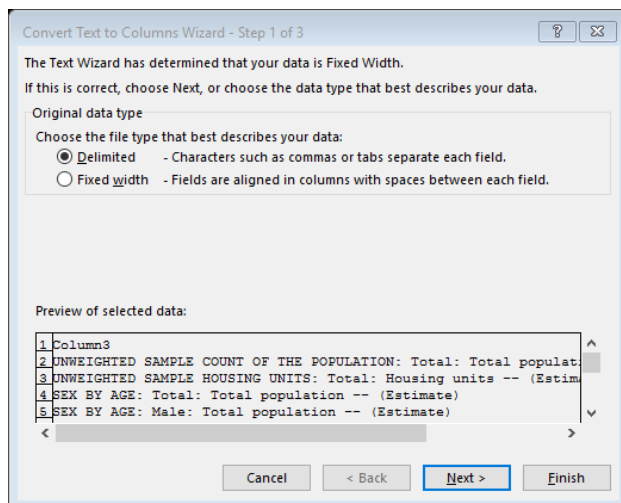
8. Select **Other**. Type a colon in the Delimiter box, and Finish. This will split the duplicate definition column into eight columns.

9. Add a new column to the table beside the Short_name column. In the top cell of that table column type the formula

=LEFT(B2,3)

where B2 is the corresponding cell in the Short_name column. ENTER. This will populate the new column with the first 3 characters of the Short Name code; the numbers match the geodatabase table number where that field is located. (Optional: use Find & Replace to substitute table names for table numbers)

10. Rename all column heading as needed; a numbered sequence is sufficient for the parsed definition subcategories. Delete the Object ID column.

Build the Pivot Table

11. Select any cell in the table. From the INSERT tab, select **Pivot Table**. Click OK to add a pivot table to a new sheet.

12. From the DATA tab, select **Refresh All** to update column names.

13. In the PivotTable Fields panel, check the box for Short name and Full name, or drag them

into the Row area, ensuring that Short name is placed above Full name.
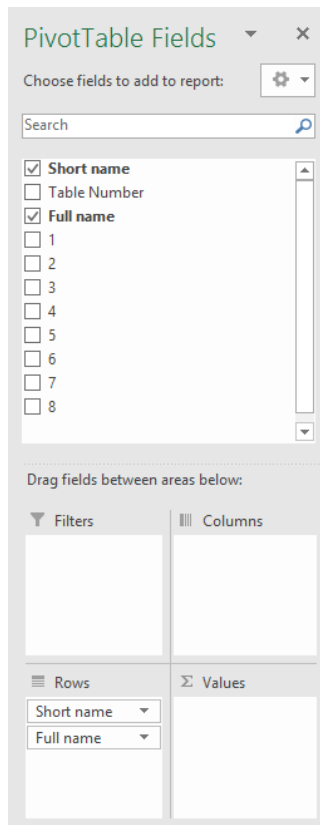
14. From the Pivot Table Tools DESIGN tab set the following parameters:

   a. **Subtotals > Do not show subtotals**

   b. **Grand Totals > Off for Rows and Columns**

   c. **Report Layout > Show in Compact Form**

   d. **Blank Rows > Insert Blank Line After Each Item**

15. All data should now appear in column A on the worksheet. Highlight that worksheet

column. From the HOME tab select **Format > Column Width**. Set to a moderate width,

such as 65.

16. With the column still highlighted, click **Wrap Text**. The table should now look

something like this, with each code and corresponding full definition listed together in

one column:

17. Click within the pivot table to activate the Pivot Table TOOLS tab. **Analyze > Pivot Table Options > Options**. In the window, **uncheck** the box to Autofit column widths. This will prevent the table from reformatting the column width. Click OK.
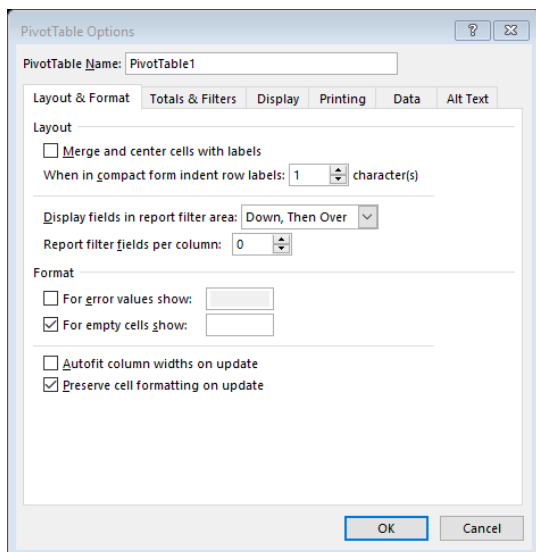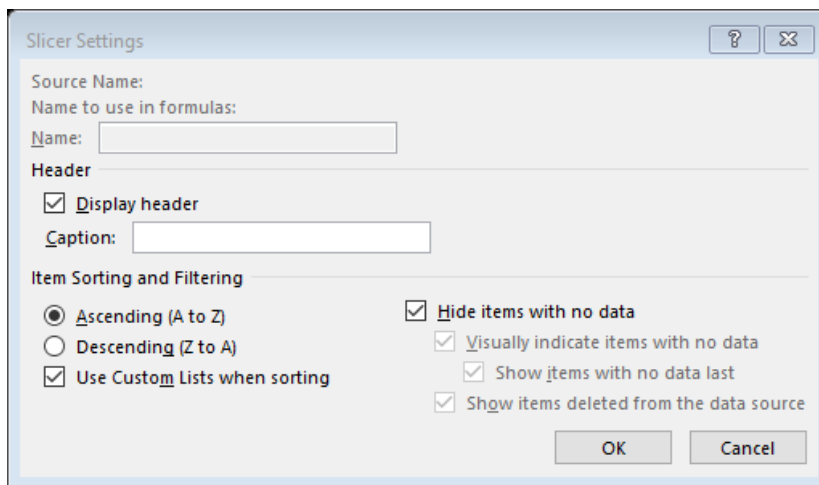

18. From the Pivot Table Tools ANALYZE Tab, select **Insert Slicer**. Check the box to create a slicer for each of the fields *except* Short name and Full name. Nine slicers will be added to the worksheet.
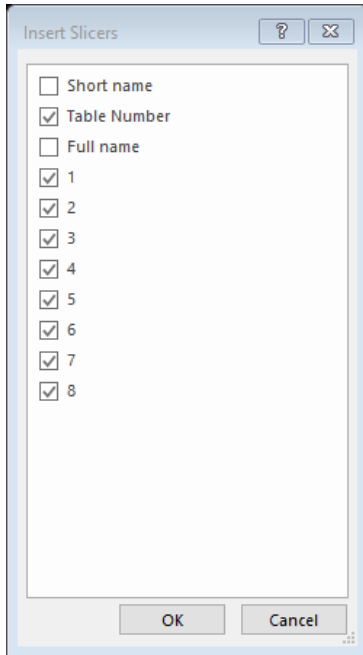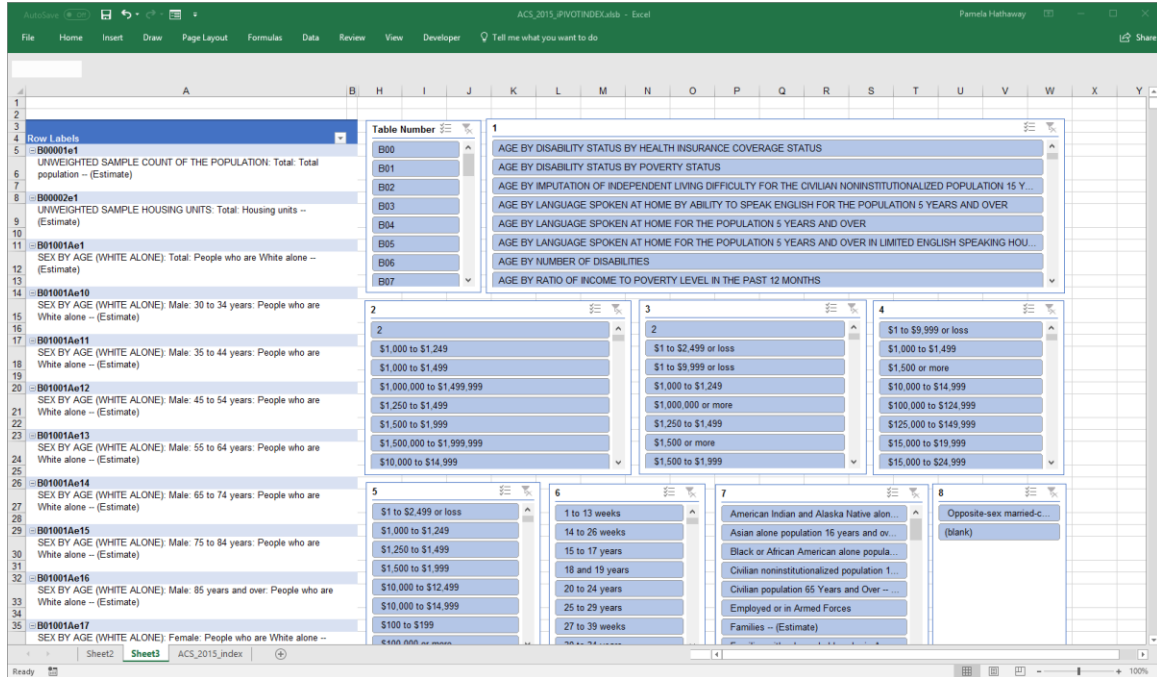
19. With all slicers on the worksheet selected, on the SLICER tab, select **Slicer Settings >**

Hide items with no data. Click OK.

20. Arrange the slicers beside the pivot table, adjusting the width of each as needed.

21. **Important: Save the table now *before testing the slicers*.** Working with slicers can be resource intensive and may cause Excel to stop working.

Test the Index

22. Use the slicer buttons to explore topics and subcategories. With each selection, the list of fields in the pivot table is reduced to match the slicer parameters. Continue to refine a topic by making choices in each slicer, until only the desired fields—narrowed from a list of more than 17,000—are left in the table.
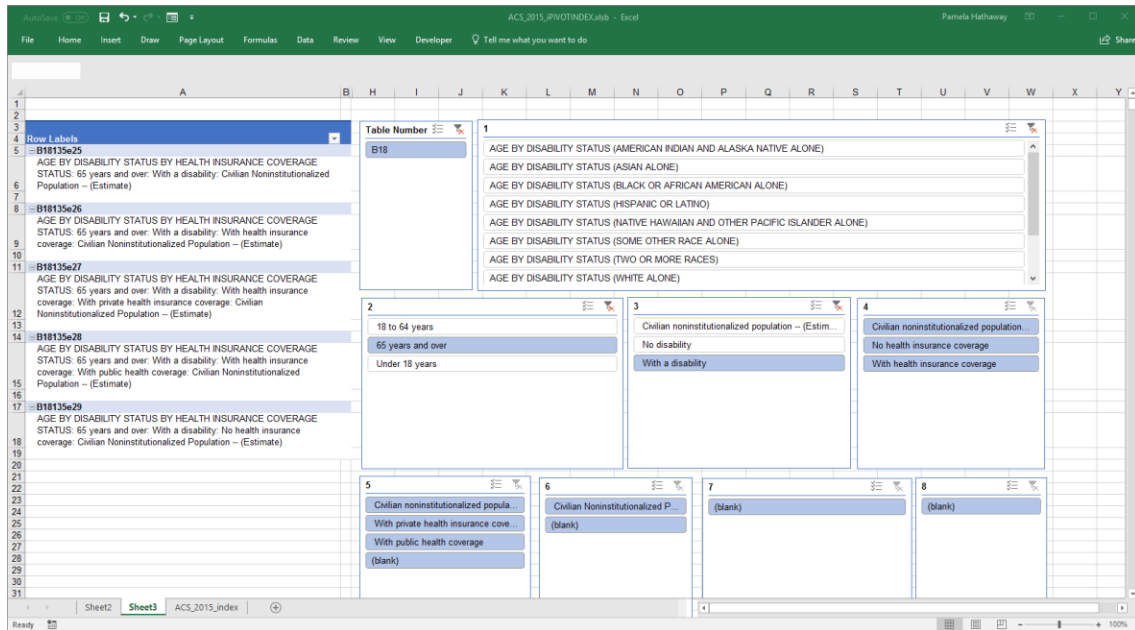
23. Clear each slicer by clicking the red X in the top right corner of each. *Note: clearing the Table slicer is a resource intensive process which may take more than a minute to complete*.

Optional: Add a Button with macro to clear ALL filters

24. Save the file as a macro-enabled workbook (.xlsm) or binary workbook (.xlsb).

25. From the INSERT tab, select **Shapes**, and then add a shape to the worksheet to act as a button. Format and label the button if desired.

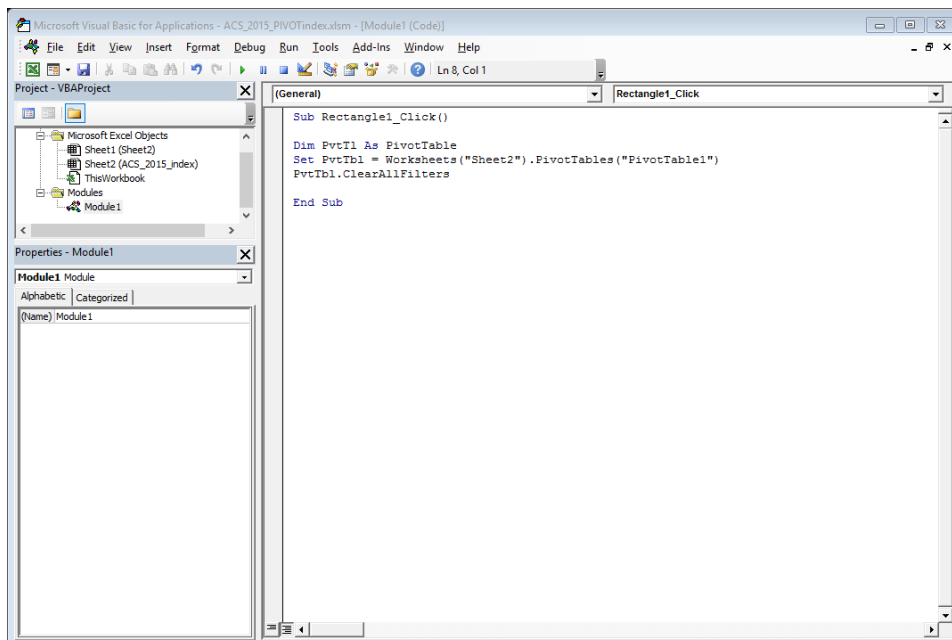26. Right Click the button shape; select **Assign Macro.**
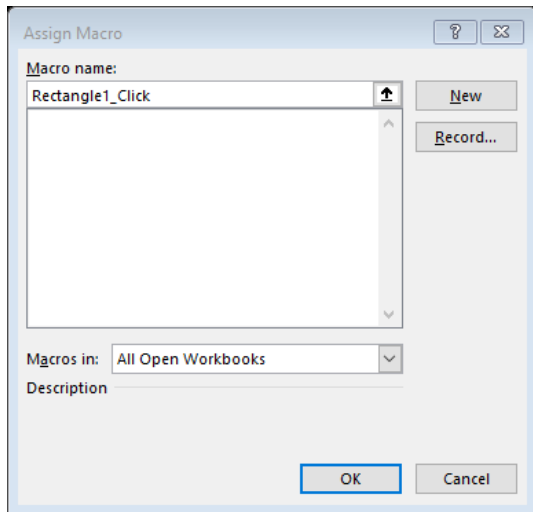
27. In the Assign Macro window, select **New**.

28. In the Visual Basic window, add the following VBA commands between the Sub tags

    (change the worksheet name and pivot table name if necessary; VBA is case sensitive):

    > **Dim PvtTl As PivotTable**
    > **Set PvtTbl = Worksheets("Sheet2").PivotTables("PivotTable1")**
    > **PvtTbl.ClearAllFilters**

29. Click Save in the upper left corner of the VBA window. Close the window. The button

    will now clear all slicers with one click.

30. To edit the button label or shape formatting after a macro has been set, right click and select Format Shape.

Important: _Save a backup copy. In the event the large pivot table causes Excel to stop working, the file may be damaged and unrecoverable._

Additional Notes:

- If the pivot table containing all data is too difficult to sort, **consider saving additional copies of the final file for subsets of the data.** For each subset, delete unnecessary rows from the source table, and then refresh the workbook from the data tab. Reducing the size of the data will significantly speed up sorting and clearing filters.

- It may be helpful to save the pivot table index as a binary workbook (.xlsb), a format optimized for performance with very large worksheets. The binary format is macro-enabled.

- If you have added the VBA button to the workbook, then upon opening the file later you may see a warning about active content or notification that macros have been disabled; for the button to function, ensure that macros are enabled/allowed.