THE UNIVERISTY OF ARIZONA
COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
Binational Migration Institute

MIGRANT DEATHS IN SOUTHERN ARIZONA:

RECOVERED UNDOCUMENTED BORDER CROSSER REMAINS INVESTIGATED BY THE PIMA COUNTY OFFICE OF THE MEDICAL EXAMINER, 1990 - 2020

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MIGRANT DEATHS IN SOUTHERN ARIZONA:
UNDOCUMENTED BORDER CROSSER DEATHS INVESTIGATED BY THE PIMA COUNTY OFFICE OF THE MEDICAL EXAMINER, 1990-2020

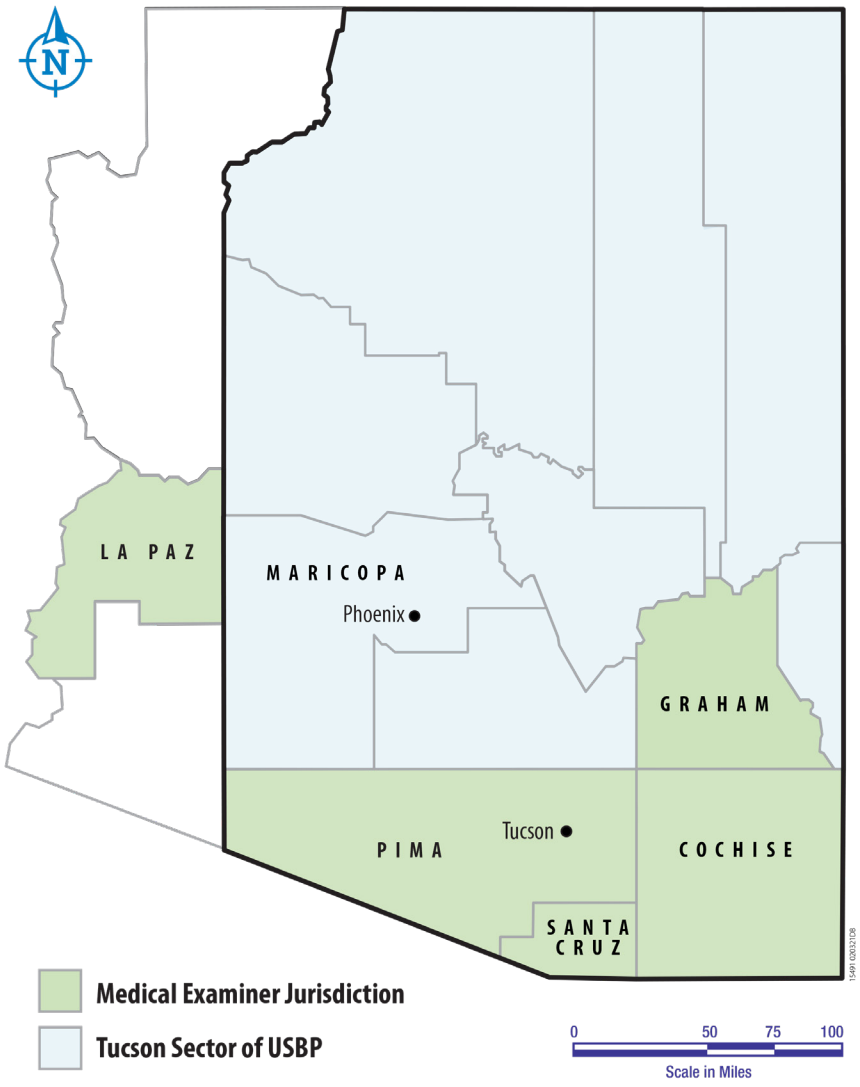
EXECUTIVE SUMMARY

Thousands of undocumented border crossers have died while attempting to cross the US-México border since the 1990s. Prior studies have found that these deaths are a consequence of increased border enforcement efforts as well as of economic, political, and social conditions in immigrant-sending countries and in the United States. The present study contributes to this expanding body of literature. Drawing on data from the Pima County Office of the Medical Examiner (PCOME), we provide information on the recovery of human remains either known or believed to be of undocumented border crossers in southern Arizona between FY 1990 and 2020. We find that during this period the remains of at least 3,356 undocumented border crossers were recovered in the region, with the majority being found since 2005. US Border Patrol apprehensions, which immigration scholars often use as proxy for undocumented migration trends, have decreased in that agency's Tucson Sector since the mid-2000s. However, the rate of recovered remains of undocumented border crossers has largely increased even as apprehensions have declined, which is a dynamic that suggests undocumented migration in southern Arizona has become increasingly dangerous. We also find that the remains of undocumented border crossers were increasingly recovered from more remote areas of southern Arizona over time, which further supports this assertion. The PCOME records we examined over our study period suggest that migrants who have died in southern Arizona are largely male (84%), and, among identified decedents, 20-49 years of age (82%) and from México (80%). Most perished due to exposure (38%) or an undetermined cause of death (48%), and were successfully identified post-mortem (64%). Nevertheless, as highlighted throughout this report, we find important changes in the breakdown of these factors across time, for which we offer possible explanations. Our hope is that policymakers and the public will consider the data presented in this report, as access to empirical evidence is crucial when formulating public policy and when addressing the root causes of critical social concerns such as border-crosser deaths along the US-México border.

ABOUT THIS REPORT

This report analyzes the numeric trends and demographic characteristics of recovered human remains of undocumented border crossers in the geographic area covered by the Pima County Office of the Medical Examiner, which is located in the city of Tucson, Arizona (see **MAP 1**). This office provides medico-legal death investigation for most of southern Arizona (Anderson 2008) and provides services to the counties of Pinal, Gila, Navajo, Apache, and Greenlee, as needed. The Pima County Office of the Medical Examiner has been responsible for the examination of approximately 95% of all undocumented border crosser remains discovered in Arizona over the past two decades (Humane Borders 2020). The data discussed in this report come from the Pima County Office of the Medical Examiner and were up-to-date as of January 31, 2021.

MAP 1. Pima County Office of the Medical Examiner Jurisdiction and Tucson Sector of the US Border Patrol



SOURCE: Dr. Gregory L. Hess, Pima County Office of the Medical Examiner

ACKNOWLEDGEMENTS

This report could not have been possible without diligent and dedicated work by both governmental and nongovernmental leaders in southern Arizona over the past two decades. First, the meticulous work of forensic professionals at the Pima County Office of the Medical Examiner has not only guaranteed access to quality data for researchers, but also has helped thousands of families to find peace and closure after the death of a loved one. The present report builds on two studies completed by the Binational Migration Institute in the Department of Mexican American Studies at the University of Arizona in 2006 and 2013. The 2006 report was generously sponsored by the Pima County Board of Supervisors, which has also been very supportive of the Pima County Office of the Medical Examiner in its efforts to evaluate and investigate suspected unauthorized border crosser deaths. We particularly wish to acknowledge Pima County Board Member, Richard Elias, an early supporter of this research whose premature passing in 2020 saddened us all. We thank M. Melissa McCormick for her work on the 2006 report, and Inez M. Duarte and Kat Rodriguez for their assistance in the data collection and entry process on the 2006 report as well. We also thank the Little Chapel of All Nations for their early and generous support. Thanks to Prescott Vandervoet for his assistance in identifying the geographic location of several cases recovered in the 1990s near Nogales, Arizona, as well as to Francisco Baires for his data entry assistance and critical insights on this important topic. We thank Gary Christopherson and John F. Chamblee for their early efforts in mapping recovered undocumented border crosser remains. We gratefully acknowledge the contributions of all those who have worked on this critical issue for years, including Maria Jimenez (1950-2020), Lois Martin (1934-2020), Coalición de Derechos Humanos, Humane Borders, No More Deaths, Tucson Samaritans, Colibrí Center for Human Rights, and the Mexican Consulate in Tucson, Arizona. We also thank the University of Arizona's Center for Border and Global Journalism, the College of Social and Behavioral Sciences, Conflucenter for Creative Inquiry, Human Rights Practice, Latin American Studies, Mexican American Studies, SBS Mexico Initiatives, School of Geography, Development & Environment, School of Sociology, The Southwest Center, Ana Tello and Mackenzie Meitner.

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A NOTE ON TERMINOLOGY

Undocumented Border Crossers (UBCs): In this report, the term "undocumented border crossers" (UBCs) refers to foreign-born non-US citizens actively involved in crossing the US-México border without authorization from the United States government. This is the terminology and definition used by the Pima County Office of the Medical Examiner. We use it herein for consistency and clarity. At times, we also use the term "migrant" when referring to undocumented border crossers, unless otherwise specified.

Fiscal Year (FY): Unless otherwise noted, we report all data in this report according to the federal fiscal year, which begins on October 1 and ends September 30 of each calendar year. Doing so allows us to make reasonable comparisons between the discovery of human remains of undocumented border crossers and the enforcement efforts of the Department of Homeland Security's Customs and Border Protection agency.

"Recovered Human Remains" and **"Recovered UBC Remains"**: Throughout this report, we refer to deceased undocumented border crossers whose remains have been recovered in southern Arizona and investigated by the Pima County Office of the Medical Examiner as "recovered human remains" or "recovered UBC remains." We do not use the term "deaths" because the true number of undocumented border crosser deaths is unknown, and the data available pertain only to those whose remains have been found. It is certain that others have died in the desert borderlands of Arizona and have not yet been recovered. Moreover, the terms "recovered human remains" and "recovered UBC remains" indicate that the death may have occurred in years prior to the discovery, as is the case for many recoveries made in this landscape.

Eras Examined: In order to better assess the data on recovered human remains believed to be undoumented border crossers in southern Arizona across time, we organized Pima County Office of the Medical Examiner data into four distinct periods: the **"Initial Funnel Effect" era**, the "**Secondary Funnel Effect" era**, the **"Tertiary Funnel Effect" era**, and the **"Localized Funnel Effect" era**. **TABLE 1** lists the eras associated with the fiscal years and provides a description of each period we examined in this study. We also provide, for each fiscal year, total southwestern Border Patrol apprehensions, Border Patrol apprehensions in the Tucson Sector, the proportion of all Border Patrol apprehensions that occurred in the Tucson Sector, and the number of UBC cases investigated by the Pima County Office of the Medical Examiner.

TABLE 1. Description of Eras, Southwestern Border Patrol Apprehensions, Tucson Sector Apprehensions, and PCOME Recovered UBC Remains (FY 1990-2020)

FISCAL YEAR	ERA	DESCRIPTION OF ERA	SOUTHWESTERN APPREHENSIONS	TUCSON SECTOR	TUCSON APPS AS % OF TOTAL USBP APPS	PCOME RECOVERED UBC REMAINS
1990	Initial Funnel Effect (1990-1999)	Pre-concentration of border enforcement efforts in southern Arizona; though Operation Safeguard launched in FY 1995, and expanded in 1997, resources did not materialize until 1999; Tucson Sector apprehensions steadily increased; UBC recovered remains remained low.	1,049,321	53,061	5%	8
1991			1,077,876	59,728	6%	7
1992			1,145,574	71,036	6%	5
1993			1,212,886	92,639	8%	11
1994			979,101	139,473	14%	11
1995			1,271,390	227,529	18%	8
1996			1,507,020	305,348	20%	13
1997			1,368,707	272,397	20%	21
1998			1,516,680	387,406	26%	17
1999			1,537,000	470,449	31%	19
2000	Secondary Funnel Effect (2000-2005)	Unauthorized migration remained displaced into southern Arizona; relatively steady volume of Tucson Sector apprehensions; 35%-plus of all apprehensions occurred in Tucson Sector; Recovered UBC remains nearly tripled.	1,643,679	616,346	37%	70
2001			1,235,718	449,675	36%	76
2002			929,809	333,648	36%	143
2003			905,065	347,363	38%	146
2004			1,139,282	491,771	43%	168
2005			1,171,369	439,079	37%	199
2006	Tertiary Funnel Effect (2006-2013)	Steady decrease in border wide and Tucson Sector apprehensions; ~30%-plus of all apprehensions still occurred in Tucson Sector, though the proportion dropped across time. At least 160 recovered UBC remains recorded each year.	1,071,972	392,074	37%	167
2007			858,638	378,239	44%	207
2008			705,005	317,696	45%	159
2009			540,865	241,673	45%	182
2010			447,731	212,202	47%	221
2011			327,577	123,285	38%	174
2012			356,873	120,000	34%	168
2013			414,397	120,939	29%	177
2014	Localized Funnel Effect (2014-2020)	Decreased proportion of apprehensions in Tucson Sector; initial decline in apprehensions in Tucson Sector followed by a steady increase, though still below pre-1993 levels and not at same rate as in other sectors; proportion of Central American apprehensions increased.	479,371	87,915	18%	119
2015			331,333	63,397	19%	135
2016			408,870	64,891	16%	139
2017			303,916	38,657	13%	135
2018			396,579	52,172	13%	118
2019			851,508	63,490	7%	124
2020			400,615	66,076	16%	209

SOURCES: Apprehension data: U.S. Citizen and Immigration Services and U.S. Customs and Border Protection, 2020; Recovered UBC remains data: Pima County Office of the Medical Examiner; Classification of eras by authors. Note: 2020 apprehension data include Title 8 Apprehensions and Title 42 Expulsions.

The "Initial Funnel Effect" era (1990-1999) represented a period in southern Arizona before undocumented migration began to concentrate in the Tucson Sector as well as before enforcement efforts associated with the "prevention through deterrence" strategy and the launch of Operation Safeguard fully materialized in the Tucson Sector. Launched in 1994, "prevention through deterrence" represented the US Border Patrol's first effort at a coordinated, nationwide strategy across all enforcement

sectors along the US-México border (US Border Patrol 1994; Andreas 2009; Dunn 2009). The strategy explicitly intended to prevent undocumented border crossing in urban areas such as San Diego-Tijuana and El Paso-Ciudad Juárez, with the expectation that undeterred migrants would be forced to cross through more remote and dangerous desert areas in which the US Border Patrol believed they would have a tactical advantage to apprehend undocumented border crossers. Though the US Border Patrol formally implemented Operation Safeguard in the Tucson Sector in FY 1995, and allocated additional resources to the initiative in FY 1997, these resources did not fully materialize in southern Arizona until FY 1999 (Cornelius 2001; Orrenius 2004; Dunn 2009). Nevertheless, as noted in Table 1, apprehensions in the Tucson Sector increased steadily, corresponding with fewer apprehensions in the Border Patrol's El Paso and San Diego Sectors, throughout the "Initial Funnel Effect" era. During this period, however, annual recovered UBC remains investigated by the Pima County Office of the Medical Examiner remained relatively low.

During the "Secondary Funnel Effect" era (2000-2005), border enforcement efforts continued to divert undocumented border crossings from the San Diego-Tijuana and El Paso-Ciudad Juárez crossing corridors into southern Arizona. This era was characterized by a relatively constant volume of apprehensions in the Tucson Sector, with at least 35% of all US Border Patrol apprehensions occurring in this region. The expansion of infrastructure associated with Operation Safeguard, such as fencing deployed in the urban centers of Nogales-Nogales and Douglas-Agua Prieta, corresponded to a concentration of recovered UBC remains in rural desert areas. UBC cases increased substantially at the PCOME during this period, nearly tripling from 70 in 2000 to 199 in 2005.

The "Tertiary Funnel Effect" era (2006-2013) was characterized by a decline in apprehensions in the Tucson Sector, while still constituting at least 20% of all southwestern border apprehensions. The US Border Patrol expanded tactical infrastructure including interior checkpoints and surveillance towers associated with its "defense in depth" strategy, which sought to deploy enforcement chokepoints to force migrants to traverse a greater distance and increase opportunities for detection and interdiction by US authorities. The introduction of Operation Streamline in the Tucson Sector further increased the consequences of apprehension for undocumented border crossers, imposing large-scale federal prosecution and the sentencing of migrants for violating criminal statutes against "unlawful entry" and "unlawful re-entry" (Launius and Boyce 2013; Martínez, Slack, and Martínez-Schuldt 2018). PCOME recorded at least 160 recovered UBC remains each year during this period, with a measurable shift of

Title: ***Our Lady of Guadalupe Migrant Shrine – Quijotoa Mountains, Arizona 2003***
Photographer: Michael Hyatt
Photograph: michael-hyatt.com

Title: *Caritas (from Caritas: The Immigrant in the Word suite)*
Linoleum relief print, 2011
Artist: Ramiro Rodriguez
http://www.ramirorodriguez.com

recoveries toward increasingly remote and difficult terrain.

The "Localized Funnel Effect" era (2014-2020) represents a period in which the proportion of southwestern Border Patrol apprehensions occurring in the Tucson Sector dropped below 20%. Moreover, the number of Tucson Sector apprehensions during this period dropped to levels not recorded in the region since FY 1993. This era was also characterized by an increase in apprehensions of Central Americans in the Tucson Sector, particularly of Guatemalans. Rather than attempting clandestine entry in remote desert corridors, many of these migrants opted to petition for asylum at an official port of entry or to seek out US officials soon after crossing in semi-urban areas. Though generally lower than during the Secondary and Tertiary Funnel Effect eras, the number of recovered UBC remains during this period exceeded those during the Initial Funnel Effect era, with the overall pattern of recoveries shifting toward "west desert" areas including the Tohono O'odham Nation Reservation and the Ajo corridor, where the climactic and environmental conditions of southern Arizona are at their most extreme.

INTRODUCTION

Hundreds of undocumented migrants have died each year while crossing the US-México border since the mid-1990s. As we have discussed in prior studies (Martínez et al. 2013; Martínez et al. 2014; Boyce, Chambers, and Launius 2019; Chambers et al. 2019; Chambers 2020), this tragedy is a consequence of several interrelated economic, social, and political factors. These factors include **1)** border enforcement and securitization practices instituted in the mid-1990s that effectively displaced undocumented border crossers into the most remote and dangerous regions of the borderlands (Eschbach et al. 1999; Cornelius 2001, 2005; Nevins 2002; Rubio-Goldsmith et al. 2006; Martínez et al. 2013; Boyce 2019; Boyce et al. 2019; Chambers et al. 2019), **2)** the long history of the US economy's reliance on labor from México (Cornelius 1998; Gonzalez 2011; Ngai 2014), and **3)** neoliberal economic reform during the 1990s that displaced hundreds-of-thousands of *campesinos* throughout México (Garcia Zamora 2009; Wise 2009).

While these factors still contribute to migrant deaths along the US-México border, several notable changes have occurred since the 2010s in terms of the demographic trends associated with migration in the borderlands as well as policy changes focusing on asylum seekers. By the mid-2010s, there was an influx of Central American and Mexican nationals seeking asylum in the United States. In the late 2010s, three important policy changes altered the asylum-seeking process. The first change was the "metering" of asylum seekers at ports of entry on the Mexican side of the US-México border, which limited the number of individuals "allowed to access the asylum process each day at ports of entry across the border" (American Immigration Council 2020). "Metering" began as early as February of 2016 at

Photo by: Samuel N. Chambers

the San Ysidro port of entry and was expanded across the border by the Trump administration in April of 2018 (American Immigration Council 2020). The second change was the 2019 Migrant Protection Protocols (MPP; also referred to as the "Remain in Mexico" policy), which required asylum seekers to await their immigration hearing in México (US Department of Homeland Security 2020). Most recently, on March 20, 2020 the US federal government categorically suspended the country's asylum program, citing the COVID-19 pandemic as a pretext to refuse entry to and immediately return all new asylum-seekers arriving at the US-México border to México, and in some cases, to Central America. It is likely that these policies collectively contributed to migrant deaths in southern Arizona, as asylum-seekers became simultaneously discouraged from pursuing their lawful right to seek asylum in the United States and disillusioned about the likelihood of a successful outcome, opting instead to attempt to undertake a clandestine desert crossing.

Prior research has empirically demonstrated an association between increased border security measures and migrant fatalities (Eschbach et al. 1999; Eschbach, Hagan, and Rodriguez 2003; Cornelius 2001; 2005; Rubio-Goldsmith et al. 2006; Jimenez 2009; Martínez et al. 2013; Soto and Martinez 2018; Chambers et al. 2019; Chambers 2020). The 1990s and 2000s saw dramatic increases in the fortification of the US-México border in the form of additional Border Patrol agents, the use remote surveillance, and the construction of physical barriers (Dunn 1996, 2009; Andreas 1998, 2009; Miller 2014; Boyce 2016) and simultaneous increases in reported migrant deaths in remote regions of the border (Eschbach et al. 1999; Eschbach et al. 2003; Cornelius 2001, 2005; Chambers et al. 2019). Prior studies have illustrated that segmented border militarization resulted in the "funnel effect," or the redistribution of migratory flows into remote and dangerous areas such as southern Arizona (Cornelius 2001, 2005; Rubio-Goldsmith et al. 2006). In brief, US border security measures were not as effective in their stated goal of reducing the number of clandestine migrant crossings as they were at increasing fatalities. The funnel effect refers to this dynamic, which resulted from a shift of migration routes into dangerous geographies.

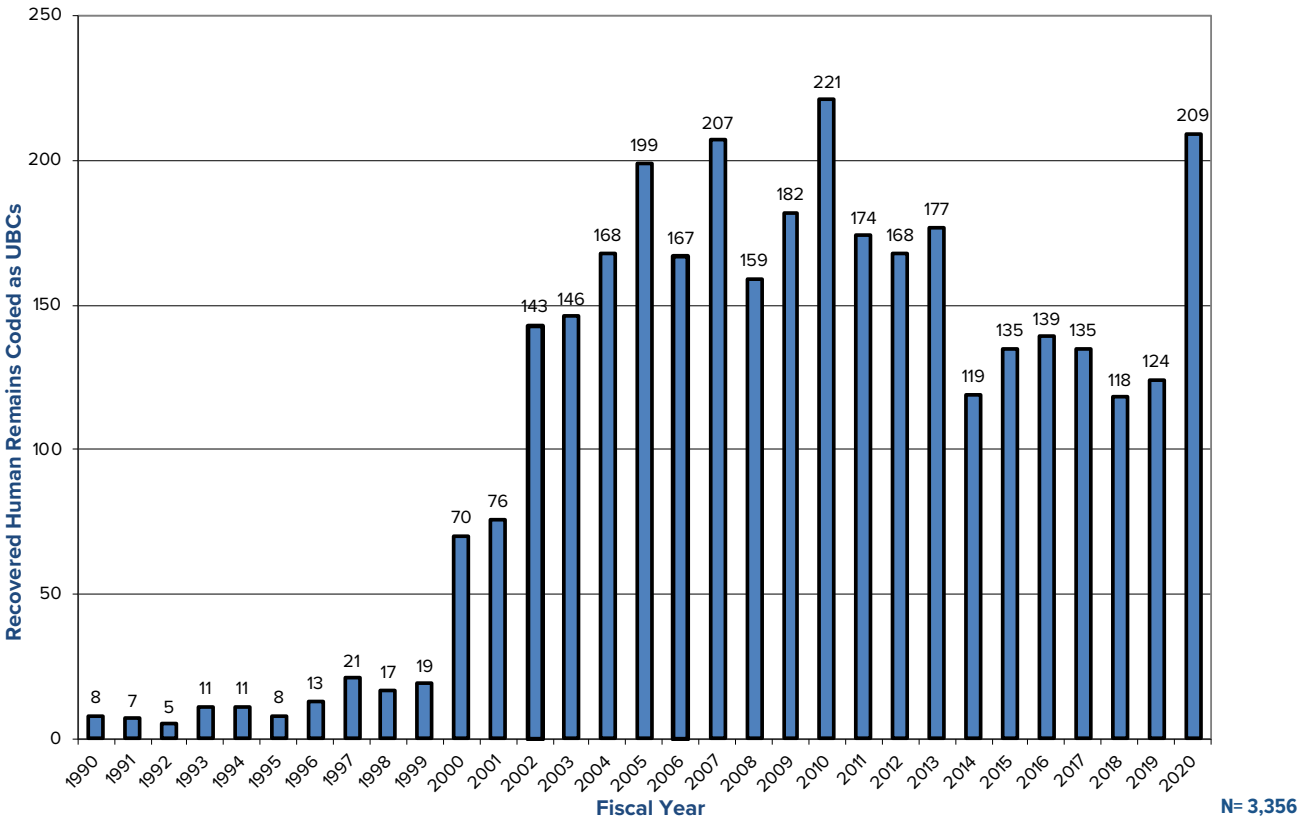
The Pima County Office of the Medical Examiner (PCOME), in Tucson, Arizona, continues to be the single agency that investigates the highest number of migrant deaths in the United States. Moreover, despite devoted and diligent work to identify the dead, the PCOME now manages the records for more unidentified remains per capita than any other medical examiner's office in the country. Arizona ranks 14th in the nation in terms of population, but second for the number of unidentified remains entered into the National Missing and Unidentified Persons System (NamUs), behind California. In a similar vein, though the counties constituting the PCOME's jurisdiction account for just 0.39% of the total US population (American Community Survey 2015-2019), PCOME cases make up 10% of unidentified decedents (UID) cases in the entire United

States entered into NamUs. Segmented border enforcement efforts stemming from the "prevention through deterrence" strategy (i.e., Operation Hold the Line, Operation Gatekeeper, Operation Safeguard, and Operation Rio Grande) led the Border Patrol's Tucson Sector, an area partially covered by the PCOME, to become the single most traversed clandestine crossing corridor for migrants along the entire US-México border from 1998 to 2012. For example, between 1990 and 1997, 20% or less of all US Border Patrol apprehensions occurred in the Tucson Sector. By 1999, the Tucson Sector accounted for more than 30% of all apprehensions, with this proportion peaking at 47% in 2010, before dropping to 29% by 2013 (see **TABLE 1**). This redistribution of undocumented migration into southern Arizona led to an increase in recovered UBC remains investigated by the PCOME throughout most of the 2000s and early 2010s. Apprehensions in the Tucson Sector dropped precipitously during the Tertiary Funnel Effect era (2006-2013) and during most of the Localized Funnel Effect era (2014-2020); however, the discovery of UBC remains continued in alarming numbers in southern Arizona. In fact, the PCOME recorded a staggering 209 recovered UBC remains in 2020, the second-highest number on record.

RECOVERED UNDOCUMENTED BORDER CROSSER REMAINS

Between FY 1990 and 2020, the PCOME investigated the recovered remains of 3,356 undocumented border crossers (see **FIGURE 1**). Over one-third of these decedents, or 1,202 cases, remained unidentified at the publication of this report, and therefore their status as undocumented border crossers is predicted rather than certain. Beginning in 2001, the PCOME began to classify deceased individuals believed to be undocumented migrants, whether identified or not, as "Undocumented Aliens," or "UDAs," then later changed the terminology used to "Undocumented Border Crossers" or "UBCs." As defined by PCOME leadership, UBCs are "individuals of foreign nationality who died while crossing

FIGURE 1. PCOME Recovered Human Remains Coded as UBCs, FY 1990-2020

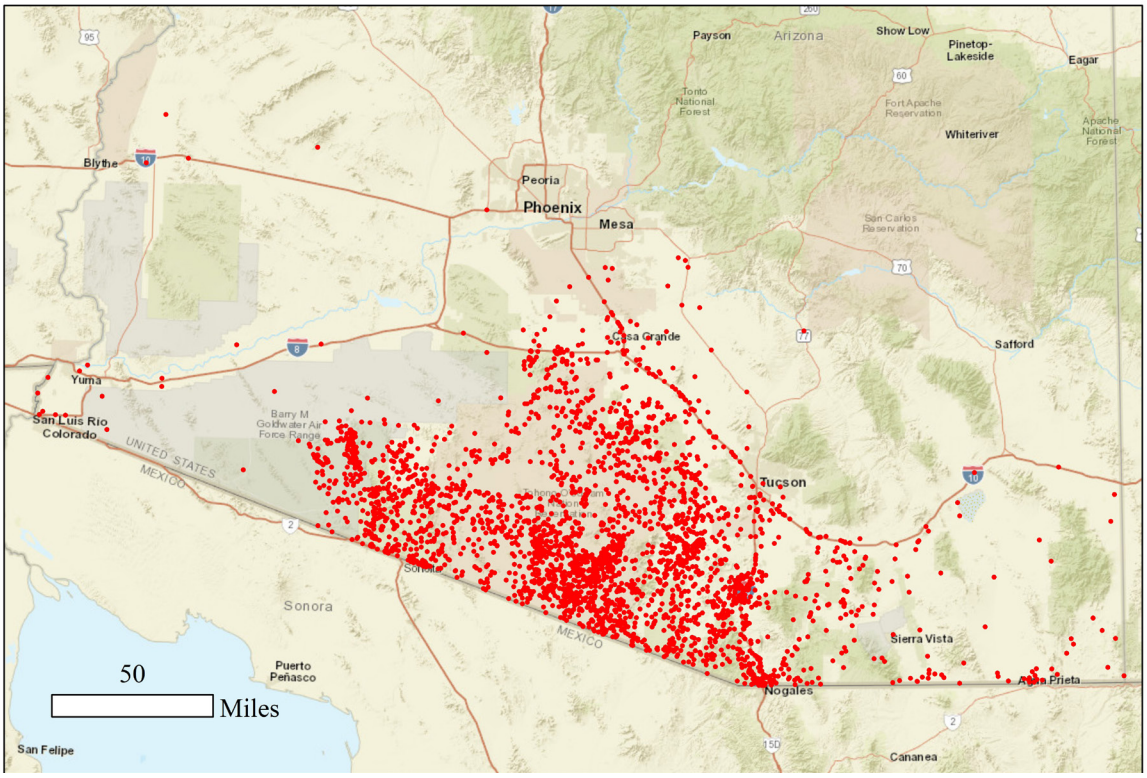


the border clandestinely" (Anderson and Parks 2008). Factors contributing to a UBC determination include the geographic location where the remains were recovered; clothing or personal effects (including foreign currency and Mexican voter identification cards); association with a group of migrants in transit; and anthropological or genetic assessments of ancestry.

The Binational Migration Institute produced reports similar to the present study in 2006 and 2013. The 2006 report, titled "The Funnel Effect," demonstrated that border enforcement strategies undertaken in the late 1990s and early 2000s effectively pushed undocumented border crossers into extremely remote areas of Arizona's border with Sonora, México, where they perished in great numbers (Rubio-Goldsmith et al. 2006). The subsequent 2013 report, titled "A Continued Humanitarian Crisis," updated the 2006 report with additional data from the PCOME, and found that the number of recovered UBC remains in southern Arizona each year had not decreased between 2006 and 2012. The present study finds that UBC cases in the region have averaged around 145 each year since 2012, far exceeding those throughout the 1990s. **FIGURE 1** illustrates that although recovered UBC remains decreased in the region after peaking in 2010, they once again increased from 124 in 2019 to 209 in 2020. Though there was a decrease in southern Arizona in the early 2010s, evidence suggests a corresponding increase in recovered UBC remains in South Texas during this same period, although they have leveled off in that region in recent years (Leutert, Lee, and Rossi 2020).

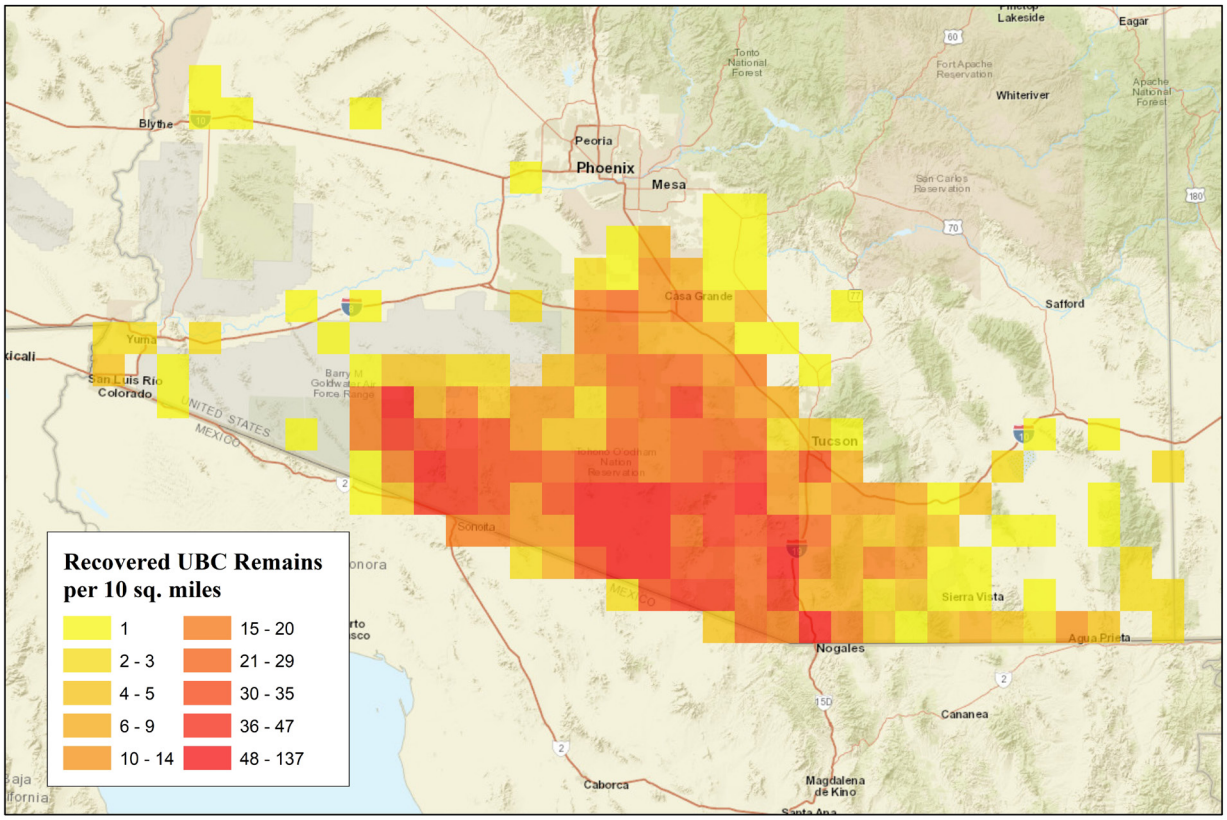
MAPS 2 AND 3 illustrate the geographic distribution of 3,297 recovered UBC remains investigated by the PCOME between 1990 and 2020, depicted as individual points as well as according to the number of recovered UBC remains per 10-Square miles. The maps exclude 59 cases in which the global positioning system (GPS) coordinates were unknown or invalid. As depicted, recovered UBC remains tend to be concentrated in Santa Cruz County and southwestern Pima County, particularly in the Tohono O'odham Nation Reservation and Organ Pipe Cactus National Monument, which represent some of the harshest terrain in the state.

MAP 2. PCOME Recovered Human Remains Coded as UBCs, FY 1990-2020



N= 3,297 (excludes 59 cases for which GPS coordinates are missing/invalid)

MAP 3. PCOME Recovered Human Remains Coded as UBCs per 10-Square Miles, FY 1990-2020



N= 3,297 (Excludes 59 cases for which GPS coordinates are missing/invalid)

Increased border enforcement and immigration policy changes have clearly contributed to the number of recovered UBC remains investigated by the PCOME over the past two decades. Nevertheless, other factors also warrant consideration. For instance, since calendar year 2011, 78 UBC cases investigated by the PCOME have come from Cochise County, with the office officially taking on the investigation of Cochise UBC cases on July 1, 2012. Moreover, recent increases in the number of recovered UBC remains (i.e., from 2019 to 2020) should be interpreted with caution, as the year that a UBC's remains were recovered may not coincide with the individual's year of death. For instance, PCOME verified that at least 44 UBC cases from 2019 and 2020 were additional partial remains of cases from prior years. We must be clear that those cases are not reflected in 2019 and 2020 estimates in the present study but rather have been appropriately merged with corresponding cases from earlier years. Nevertheless, considering that the PCOME has approximately 150 UID UBC cases yet to be profiled via DNA, this number is likely to increase significantly in the coming years. In short, each of these aforementioned factors have contributed to the UBC caseload investigated by the PCOME since the early 2010s as well as to the rate of recovered undocumented border crosser remains discussed in the following section.

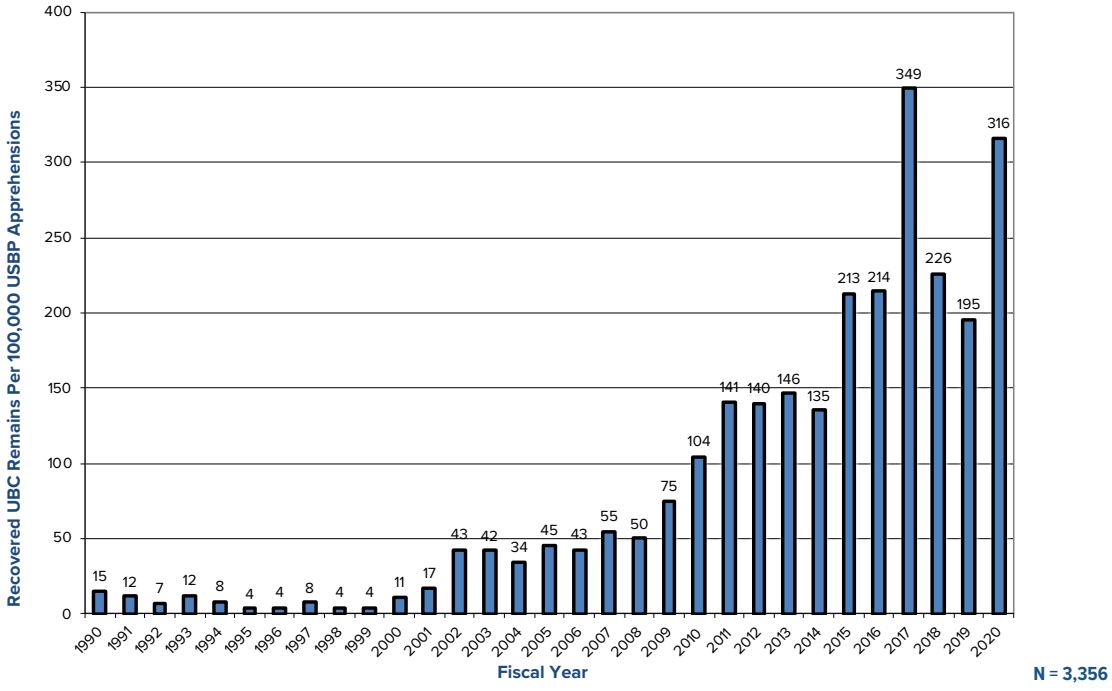
Although beyond the scope of the present study, the increase in the number of recovered UBC remains investigated by PCOME between 2019 and 2020 may also be associated with changes in asylum policy. Justified as a "public health" response to the COVID-19 pandemic, the United States formally suspended its asylum program on March 20, 2020, preventing asylum-seekers from exercising their rights under US and international law to lawfully petition for asylum at an official port of entry. Related to this change was the immediate return of most migrants apprehended while attempting clandestine entry to the closest port of entry in México, regardless of nationality. The effects of these

policy changes were two-fold: first, the suspension of asylum made clandestine border crossing the only feasible option for entry to the United States, possibly funneling individuals who might otherwise have lawfully petitioned for asylum into remote and dangerous desert areas. Second, the practice of immediate return effectively returned border enforcement to a previous era that policymakers frequently characterized and criticized as "catch-and-release," allowing coyotes (human smugglers) to encourage multiple border crossing attempts in rapid succession, even if one attempt results in apprehension. These patterns, last observed during the Secondary Funnel Effect period, likely reduce peoples' ability to physiologically recover and survive the difficult environmental and climactic conditions encountered in the Arizona desert (Vallet 2012). The present study does not provide an empirical analysis of the relationship between changes in asylum policy and recovered UBC remains, though this association warrants closer consideration in future research.

APPROXIMATE RATE OF RECOVERED UNDOCUMENTED BORDER CROSSER REMAINS

FIGURE 2 shows the number of annual recovered UBC remains standardized to 100,000 US Border Patrol apprehensions each year. While it is possible to explain the increase in recovered UBC remains in southern Arizona as simply a function of more undocumented border crossers traversing the area, the data presented in **FIGURE 2** suggest that this may not be the case. Although not a precise measure of undocumented crossings, previous research found that apprehensions have fluctuated and have been positively correlated with undocumented migration flows (Espenshade 1995). When we considered US Border Patrol apprehensions as a proxy for undocumented migration, we found that the rate of recovered UBC remains in the region increased exponentially since 1999. For instance, this rate increased from an average of 32 recovered UBC remains per 100,000 apprehensions during the "Secondary Funnel Effect" era (2000-2005), to an average of 95 per 100,000 apprehensions in the "Tertiary Funnel Effect" era (2006-2013), and once again to an average of 244 per 100,000 apprehensions throughout the "Localized Funnel Effect" era (2014-2020). These data suggest that undocumented migrants may be crossing for longer periods and through terrain that is more treacherous in recent years to avoid detection by US authorities, thereby elevating the risk of death associated with attempted crossings. A geospa-

FIGURE 2. Approximate Rate of Recovered UBC remains in the Tucson Sector using PCOME Recovered Human Remains Coded as UBCs, FY 1990-2020



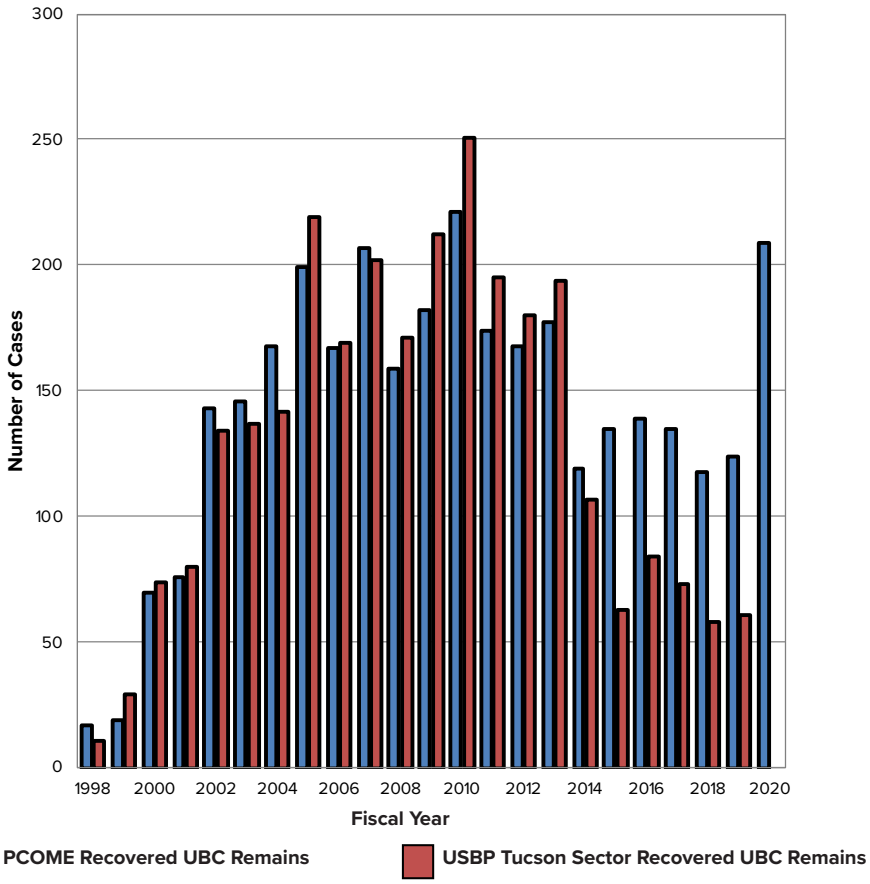
tial analysis conducted by Boyce, Chambers, and Launius (2019) supports this assertion. The authors found that, between 2012 and 2015, undocumented migrants crossing through the 800-square-mile area of southern Arizona's Altar Valley "became more likely to use water at cache sites along more rugged routes of travel" (2019: 28). Soto and Martínez (2018) also found that recoveries of UBC remains in Pima County increasingly clustered in remote western regions of the county across time.

PCOME DATA AND US BORDER PATROL ESTIMATES

The US Border Patrol began recording recovered UBC remains in each of its nine sectors in 1998. The US Border Patrol's Tucson Sector includes most of the state of Arizona, ending about 30 miles west of Lukeville, Arizona, in the Organ Pipe Cactus National Monument. As such, the Tucson Sector encompasses an area that exceeds the jurisdiction of the Pima County Office of the Medical Examiner (see **MAP 1**).

As **FIGURE 3** illustrates, recovered UBC remains in the Tucson Sector reported by US Border Patrol closely mirrored those documented by PCOME, with Border Patrol estimates exceeding PCOME cases during the period 2005-2013 (US Border Patrol 2020). This is logical, considering PCOME's jurisdiction is geographically smaller than—and subsumed within—the Tucson Sector (with the exception of La Paz County). However, beginning in 2014, PCOME cases began to exceed estimates reported by Border Patrol, and in recent years, have done so by as much as two-fold (US Border Patrol 2020). Given this divergence since 2014, we caution readers against relying on US Border Patrol recovered UBC remains estimates for the Tucson Sector in order to generalize about migrant deaths in southern Arizona.

FIGURE 3. PCOME Recovered Human Remains Coded as UBCs and US Border Patrol Recovered UBC remains in the Tucson Sector, FY 1998-2020



NOTE: USBP Tucson Sector Recovered UBC Remains for FY 2020 were not publicly available at the publication of this report.

FACTORS EXAMINED IN THIS REPORT & PROPORTIONS

In this report, we provide information on factors relevant to recovered UBC remains in southern Arizona: confirmed cause of death, identification rates, condition of the remains, and demographic characteristics including biological sex, age, and country of origin.

Between 1990 and 2020, the PCOME examined the remains of 3,356 migrants. **TABLE 2** illustrates the proportions for cause of death, identification rates, condition of the remains, and demographic characteristics of recovered UBC remains investigated during this period. Sample sizes noted in **TABLE 2** vary due to different degrees of complete information available for each factor examined.

TABLE 2. Causes of Death and Demographic Characteristics of PCOME Recovered Human Remains Coded as UBCs, FY 1990-2020

	PERCENT/MEAN
CAUSES OF DEATH[1]	
Undetermined	48%
Exposure	38%
Motor Vehicle Accident	7%
Other Miscellaneous Causes[a]	4%
Homicide	3%
IDENTIFICATION[1]	
Identified	64%
Unidentified	36%
CONDITION OF REMAINS[2] (8-ITEM BODY CONDITION SCALE)	
(1) Fully Fleshed	31%
(2) Decomposed	11%
(3) Decomposed with focal skeletonization	7%
(4) Skeletonization with mummification	10%
(5) Skeletonization with articulation/ligamentous attachments	9%
(6) Complete skeletonization with disarticulation	11%
(7) Complete skeletonization with bone degradation	22%
(8) Burned/Other	0%
DEMOGRAPHIC CHARACTERISTICS	
Biological Sex[1]	
Male	84%
Female	15%
Unknown	1%
Age[3]	31.1 years (mean)
0-9 years	0%
10-19 years	11%
20-29 years	36%
30-39 years	31%
40-49 years	15%
50-59 years	5%
60-69 years	1%
70+ years	0%
Country of Origin[4]	
Mexico	80%
Guatemala	12%
El Salvador	3%
Honduras	3%
Other Countries	2%
Unknown Country	1%

a. "Other" causes of death include drowning, suicide, natural causes, cases pending investigation, electrocution, envenomation, overdose and other miscellaneous causes.

1. N = 3,356 (among all decedents)
2. N = 3,232 (among 2000-2020 cases)
3. N = 2,148 (among identified decedents)
4. N = 2,154 (among identified decedents)

Note: Percentages may not sum to 100 due to rounding

CAUSE OF DEATH

For each case, we grouped the cause of death into five possible categories: exposure to the elements, homicide, motor vehicle accident, other, and undetermined. Our use of the term "cause of death" deviates from the conventional use by medical examiners who utilize it to describe the disease or trauma that directly caused an individual's biological death. Examples of causes of death as used by medical examiners include exposure to the elements, gunshot wound to the head, blunt force impact of the torso, etc. On the other hand, "manner of death" describes how the death came about, and includes five categories: natural, accident, suicide, homicide, or undetermined. Conventionally speaking, the manner of death for a migrant who was lost in the desert while crossing and succumbed to the elements would be accidental, while the cause of death would likely be exposure to the elements. On the other hand, the cause of death resulting from a motor vehicle accident involving an undocumented border crosser may be blunt force trauma, while the manner of death would also be accidental. For the sake of clarity and parsimony, this report uses elements from definitions of both "cause of death" and "manner of death" to construct the cause of death categories most relevant for the population under study. Though we include in our analyses cases with causes of death we categorized as "other" (e.g., drowning, suicide, natural causes, cases pending investigation, electrocution, envenomation, drug overdose, other miscellaneous causes, etc.), we limit our discussion to differences between undetermined, exposure, motor vehicle accident, and homicide, as these are the most prevalent causes of death among undocumented border crossers.

The cause of death in 48% of UBC cases was undetermined. Approximately 38% of UBC deaths were due to exposure or probable exposure, followed by motor vehicle accident (7%), other miscellaneous causes (4%), and homicide (3%). For undetermined deaths, the medical examiner was unable to assign a definitive cause of death due to the degree of decomposition or lack of compelling evidence of any one cause of death. However, considering the remote desert location where US authorities recovered these remains, it is likely that the cause of death for a large percentage of these undetermined cases was exposure. A recent study, which examined the spatiotemporal relationship between local climate conditions, distance walked, and the projected increase of undocumented border-crossers' core body temperatures, supports this hypothesis (Chambers, McMahan, and Bongers 2020).

Photo by: Samuel N. Chambers

IDENTIFICATION RATES

Thirty-six percent of all cases categorized as UBCs by the PCOME between 1990 and 2020 remained unidentified at the publication of this report. In addition to causing anguish for families of the missing, unidentified remains also pose a methodological challenge for researchers—the issue of missing information. Successful identification is essential for ascertaining information

for some variables of interest in this report. For instance, it is possible to determine the biological sex of an unidentified individual via forensic anthropology or genotyping, but impossible to establish their precise age at the time of death or their country of origin. More complete information exists for some variables than for others, hence the variation in sample sizes for different factors examined.

As noted in **TABLE 2**, the PCOME successfully identified 64% of the 3,356 UBCs it investigated. This rate of identification is notable given the often highly decomposed and fragmented nature of remains recovered from the desert. The PCOME stands out both in terms of data transparency and identification rates, the latter achieved thanks to close partnerships with consulates[1], nongovernmental organizations[2], and other government offices. As discussed below, identification rates have varied over time.

CONDITION OF THE REMAINS

The PCOME established an eight-point scale used to assess the conditions of the remains of confirmed UBCs ranging from "1" (i.e., Fully fleshed) to "7" (i.e., Complete skeletonization with bone degradation). Cases coded "8" consist of burned remains or those in "other" conditions. The PCOME developed this body condition scale in 2013 as a way to compress variable postmortem intervals into a simplified scale and retroactively applied this scale to recoveries dating to January 1, 2000. As noted in **TABLE 2**, among the 3,232 cases examined, 31% were "Fully fleshed," 11% "Decomposed," 7% "Decomposed with focal skeletonization," 10% "Skeletonization with mummification," 9% "Skeletonization with articulation/ligamentous attachments," 11% "Complete skeletonization with disarticulation," and 22% "Complete skeletonization with bone degradation." Only three cases were coded "Burned/Other."

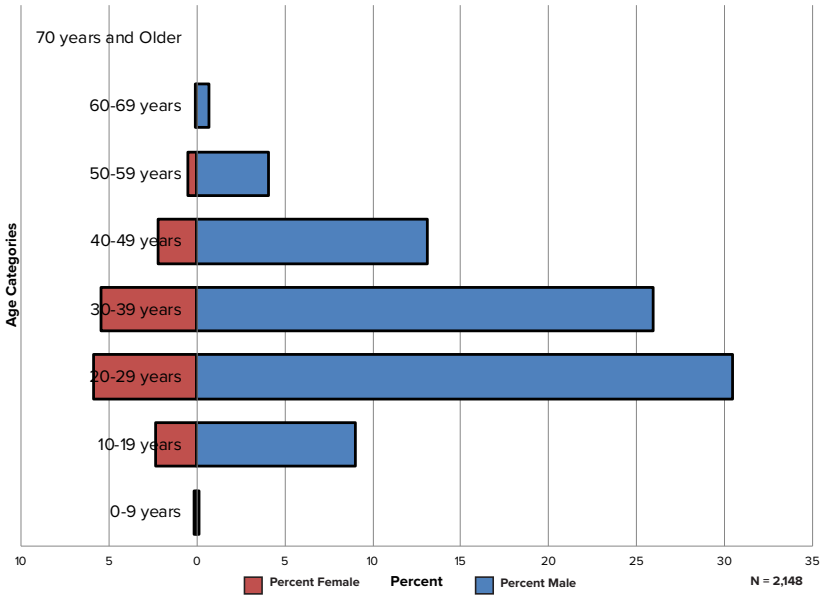
Photo by: Samuel N. Chambers

DEMOGRAPHIC CHARACTERISTICS

Records from the PCOME provide information on important demographic characteristics of UBCs who perished in southern Arizona. In this report, we discuss UBCs' biological sex, age, and country of origin. As noted above, while biological sex is likely to be determined during a forensic examination for both unidentified and identified remains, ascertaining a person's exact age and place of origin are contingent upon the success of identification.

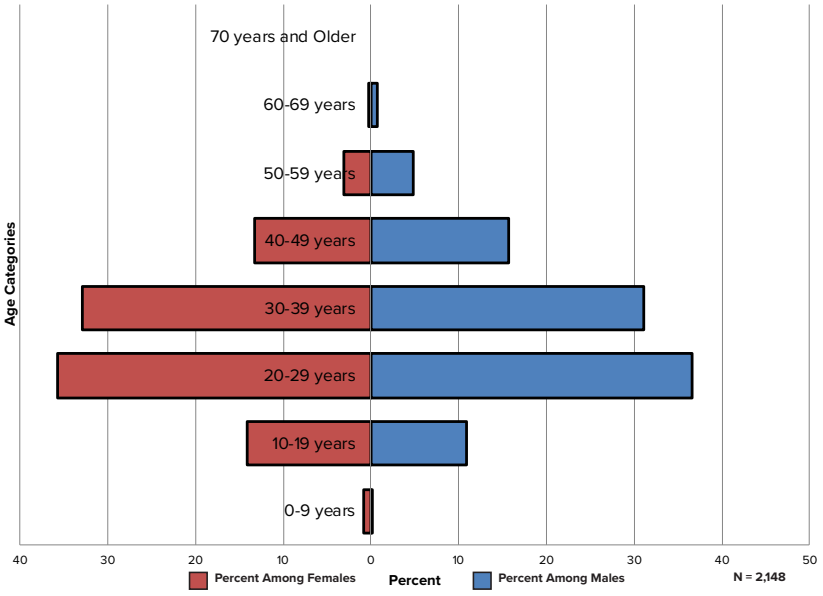
Most decedents were male (84%), with biological sex unknown in less than 1% of cases due to the fragmented condition of some skeletal remains recovered. As previously discussed, 2,154 (64%) UBCs examined between 1990 and 2020 had been identified at the publication of this study. Among identified UBCs, the mean age was 31.1 years (median of 30 years). As illustrated in **TABLE 2**, 11% were 10-19 years old, 36% were 20-29 years old, 31% were 30-39 years old, and 15% 40-49 years old. **FIGURE 4** (below) illustrates a population pyramid for all identified migrants by age and sex categories. About 30% and 26% of identified UBCs were males between the ages of 20-29 and 30-39, respectively. Thirteen percent of decedents were males between the ages 40-49, while 9% were males 10-19 years old.

FIGURE 4. PCOME Recovered Human Remains Coded as UBCs, Age and Sex Categories as a Percent of Identified Decedents, FY 1990-2020



Because males make up about 84% of all UBCs, they are overrepresented within all age categories. However, when examining the age categories separately for males and females (**FIGURE 5**), the distribution across age categories is much more even. In other words, 36% of female UBCs fell in the 20-29 age category, compared to 37% among males. Similarly, 33% of female UBCs were between 30 and 39 years of age at the time of death compared to 31% of male UBCs who fell in the same age range.

FIGURE 5. PCOME Recovered Human Remains Coded as UBCs, Age Categories among Identified Female Decedents and Age Categories among Identified Male Decedents, FY 1990-2020



Existing research on undocumented migration emphasizes that one's place of origin plays an important role in shaping various migration-related outcomes (Massey, Durand, and Malone 2002; Hagan 2008; Slack and Martínez 2018; Martínez, Slack, and Martínez-Schuldt 2018; Martínez-Schuldt and Martínez 2020). In terms of place of origin, we provide information at the country-level. Thirteen Latin American countries as well as India and Jamaica are represented among identified UBCs whose remains were recovered; however, the overwhelming majority (97%) of identified decedents originated from México, Guatemala, El Salvador, or Honduras.

TABLE 2 illustrates a breakdown of country of origin among identified UBCs. As noted, the majority of identified UBCs (80%) were of Mexican origin, followed by Guatemalans (12%), Salvadorans (3%), and Hondurans (3%). Country of origin was unknown in less than 1% of cases among identified UBCs.

CHANGES ACROSS TIME

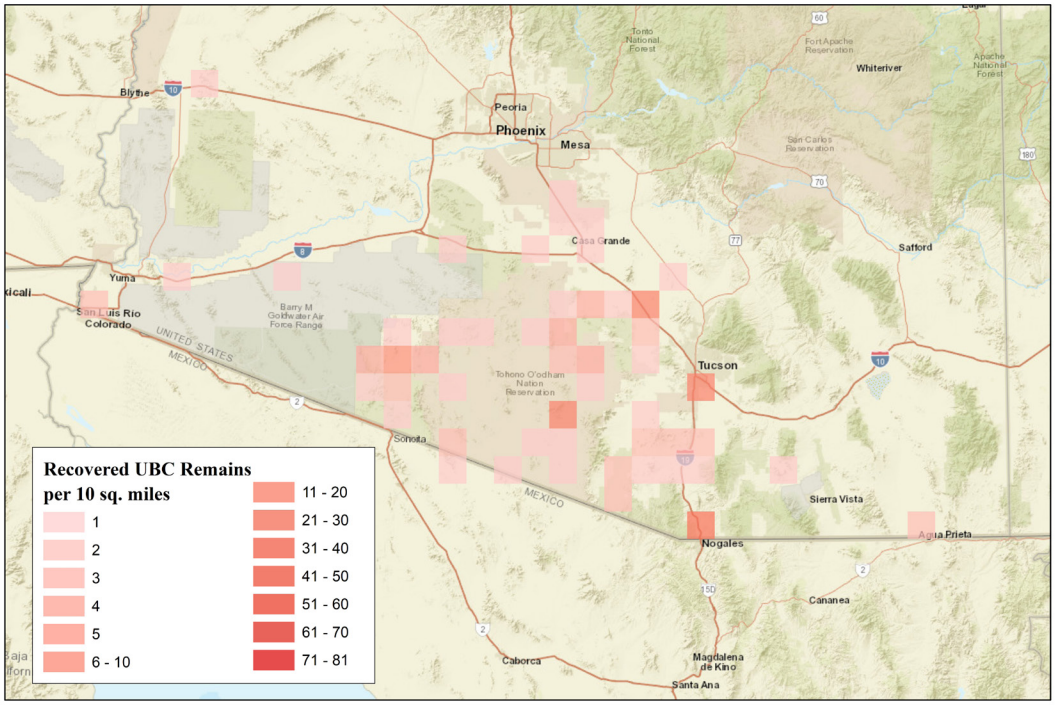
In this section, we examine changes in recovered UBC remains data compiled by PCOME over four notable periods: the "Initial Funnel Effect" era (1990-1999), the "Secondary Funnel Effect" era (2000-2005), the "Tertiary Funnel Effect" era (2006-2013), and the "Localized Funnel Effect" era (2014-2020). We provide a detailed description of each period in the preceding "A Note on Terminology" section.

The present study builds on two previous reports published by the Binational Migration Institute at the University of Arizona. Using PCOME records, Rubio-Goldsmith and colleagues (2006) examined changes between what they termed the "Pre-Funnel Effect" (1990-1999) and "Funnel Effect" (2000-2005) eras. In a report subsequently published in 2013, we reexamined changes between these periods and included an additional period (2006-2012) that we called the "Late Funnel Effect" era. In the present study, we examine changes in a new era we describe as the "Localized Funnel Effect" period (2014-2020, with 2013 constituting the final year of the "Late" or "Tertiary" Funnel Effect period). Some of the sample sizes and estimates reported in this study may differ from those reported by Rubio-Goldsmith and colleagues (2006) as well as Martínez and colleagues (2013) due to the positive identification of decedents, confirmed cause of death, the (rare) recoding of deaths as non-UBCs, and the merging of cases that constituted remains of the same individual.

CHANGES IN GEOSPATIAL CONCENTRATION

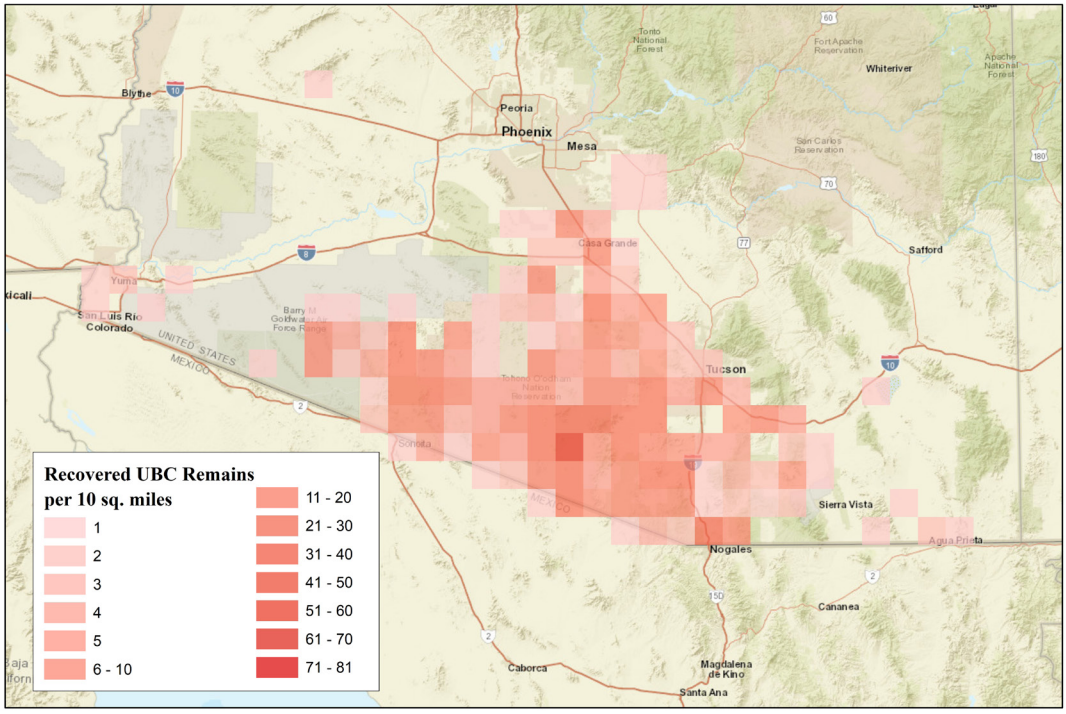
MAPS 4-7 illustrate the geographic distribution of recovered UBC remains investigated by PCOME per 10-square miles during the Initial, Secondary, Tertiary, and Localized Funnel Effect eras. Once again, the maps exclude 59 cases in which GPS coordinates were unknown or invalid. As depicted in **MAPS 4-7**, recovered UBC remains became increasingly concentrated in western Pima County across time, particularly between the Tertiary and Localized Funnel Effect eras.

MAP 4. PCOME Recovered Human Remains Coded as UBCs, Initial Funnel Effect Era (1990-1999)



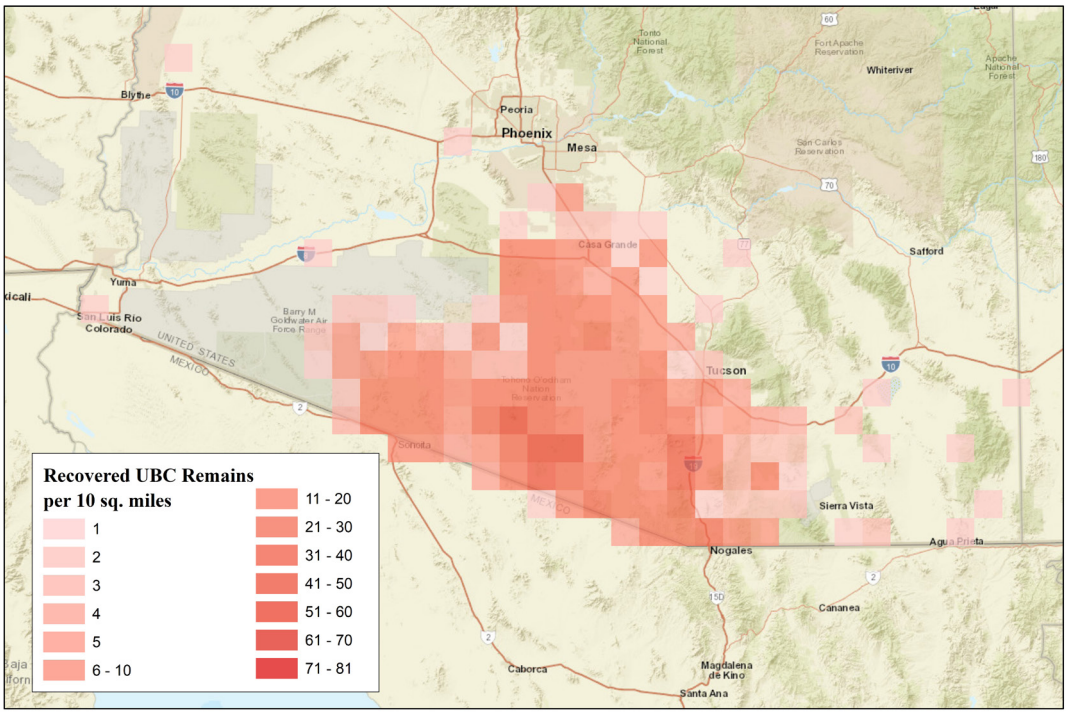
N = 105 (Excludes 15 cases for which GPS coordinates are missing/invalid)

MAP 5. PCOME Recovered Human Remains Coded as UBCs, Secondary Funnel Effect Era (2000-2005)



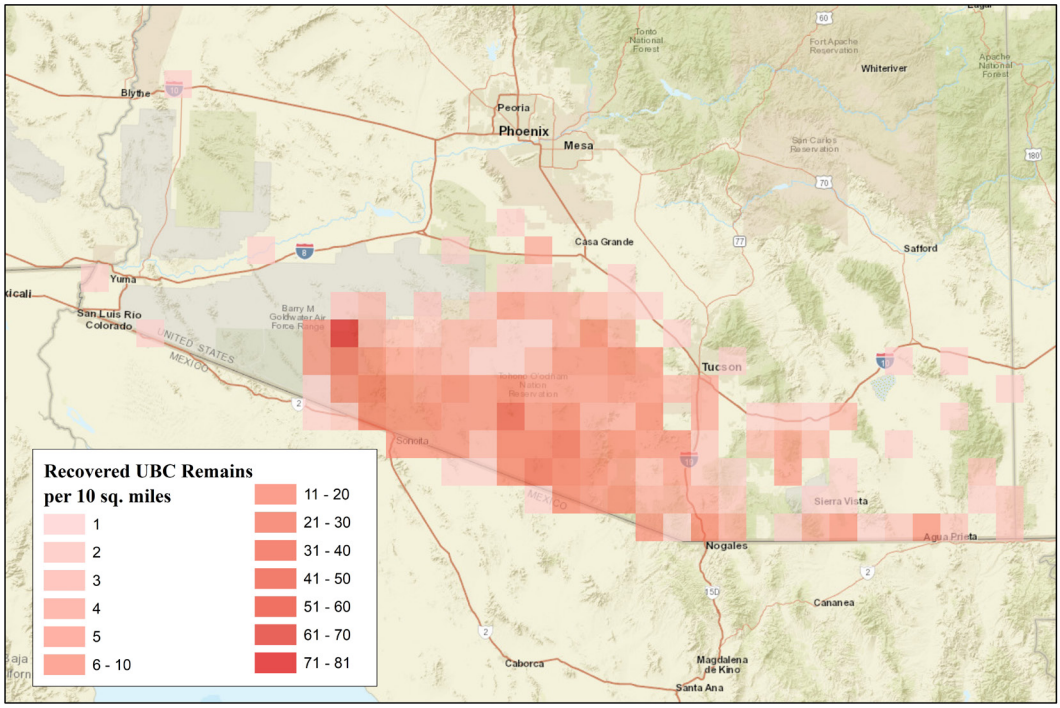
N = 771 (Excludes 31 cases for which GPS coordinates are missing/invalid)

MAP 6. PCOME Recovered Human Remains Coded as UBCs, Tertiary Funnel Effect Era (2006-2013)



N = 1,442 (Excludes 13 cases for which GPS coordinates are missing/invalid)

MAP 7. PCOME Recovered Human Remains Coded as UBCs, Localized Funnel Effect Era (2014-2020)



N = 979 (No missing GPS data)

We assessed differences in the geospatial concentration of recovered UBC remains across the four eras we examined by conducting several Getis Ord-Gi* tests of significant clustering. **MAPS A-C** of the Appendix provide the results of these geospatial tests.

From the Initial to the Secondary Funnel Effect Era, we found significant shifts in the clusters of recovered UBC remains from the I-10 corridor between Tucson and Phoenix and I-8 near Yuma to the eastern and western portions of the Quinlan and Baboquivari Mountains on the Tohono O'odham Nation Reservation and in Buenos Aires National Wildlife Refuge (see **MAP A**).

Between the Secondary and Tertiary Funnel Effect Era, we found a significant shift in clustered recovered UBC remains from Cabeza Prieta National Wildlife Refuge and the Altar Valley to the eastern, western, and southern extremities of the Tohono O'odham Nation Reservation and surrounding areas (see **MAP B**).

From the Tertiary to the Localized Funnel Effect Era, we found a notable shift in clusters of recovered UBC remains from all areas near Nogales, Tucson, and Phoenix to new clusters to the west and east: one in Organ Pipe National Monument and Cabeza Prieta and the other in the Sierra Vista-Doulas region of Cochise County (see **MAP C**). As discussed earlier in this report, the PCOME officially began handling Cochise County UBC cases on July 1, 2012, which partially helps explain the emergence of the latter cluster.

Finally, we found that the clustering of recovered UBC remains was relatively constant within Tohono O'odham Nation Reservation, with no significant shifts in clustering between the Secondary and Tertiary eras nor the Tertiary and Localized eras (see **MAPS B AND C**).

TABLES 3 AND 4 illustrate the changes in causes of death and demographic characteristics across the four periods. We also report the number of recovered UBC remains during each period. Bold percentages denote that the change in each factor under consideration from one period to the next is statistically significant.

TABLE 3. Causes of Death, Identification, and Body Condition of PCOME Recovered Human Remains Coded as UBCs, by Era

	"INITIAL FUNNEL EFFECT" (FY 1990-1999)	"SECONDARY FUNNEL EFFECT" (FY 2000-2005)	"TERTIARY FUNNEL EFFECT" (FY 2006-2013)	"LOCALIZED FUNNEL EFFECT" (FY 2014-2020)
	N = 120	N = 802	N = 1,455	N = 979
CAUSES OF DEATH				
Undetermined	28%	**19%**	**47%**	**76%**
Exposure	39%	**62%**	**38%**	**20%**
Motor Vehicle Accident	19%	**11%**	**6%**	**2%**
Other Miscellaneous Causes[a]	8%	4%	5%	**1%**
Homicide	6%	4%	4%	**1%**
IDENTIFICATION				
Identified	67%	**79%**	**67%**	**48%**
8-ITEM BODY CONDITION SCALE				
Fully Fleshed (BCS=1)	-	46%	**33%**	**14%**
Complete skeletonization with bone degradation (BCS=7)	-	12%	**20%**	**32%**

a. "Other" causes of death include drowning, suicide, natural causes, cases pending investigation, electrocution, envenomation, overdose and other miscellaneous causes. Note: Bold percentages indicate a statistically significant change from the previous era beyond the 0.05-level. Percentages may not sum to 100 due to rounding.

CHANGES IN CAUSE OF DEATH

The PCOME determination of exposure, the leading cause of death in the Initial and Secondary Funnel Effect eras, became the second most common cause of death after undetermined in the Tertiary Funnel Effect and Localized Funnel Effect eras. Individuals who died from exposure perished due to hyperthermia or hypothermia, often coupled with dehydration. For undetermined deaths, the medical examiner was unable to assign a definitive cause of death due to the degree of decomposition or lack of compelling evidence of any one cause of death. The state of decomposition may also affect the ability to determine a precise postmortem interval, which might place the time of death during a specific season in a given year. Due to intensified border enforcement efforts, migrants are increasingly crossing through more remote areas in order to avoid detection (Soto and Martínez 2018; Boyce et al. 2019; Chambers et al. 2019). For those who die in remote areas, there is a longer period between death and recovery, which means greater decomposition and additional challenges in establishing cause of death. As previously mentioned, given the remote location where these remains were recovered, it is likely that the cause of death for a large percentage of these undetermined cases was exposure, but this cannot be confirmed. However, when we combine exposure and undetermined cause of death in one category, these cases made up 81% of cases in the Secondary Funnel Effect era, 85% of cases in the Tertiary Funnel Effect era, and 96% of cases in the Localized Funnel Effect era.

Another significant change between eras relates to the percent of deaths due to motor vehicle accidents. In the Initial Funnel Effect years, motor vehicle accidents accounted for 19% of UBC fatalities. In the Secondary Funnel Effect period, UBC deaths due to motor vehicle accidents dropped to 11%, and dropped once again in the Tertiary Funnel Effect era to 6%. Most recently, this percentage fell to 2% in

Photo by: Samuel N. Chambers

the Localized Funnel Effect era. These changes suggest that people have altered their crossing strategies because of increased enforcement, relying less on the use of roadways or motor vehicles to facilitate a crossing and more on traversing through remote areas on foot.

Substantial media attention has focused on increased drug trafficking-related violence throughout México since former Mexican president Felipe Calderón declared a war on drug trafficking organizations in 2006. This has led to the concern of a possible "spill over" effect of drug trafficking related violence into the United States. Yet, with the exception of a few well-publicized and isolated incidents, there is little evidence supporting the notion of a "spill over" effect. PCOME records suggest that the percent of UBCs that had been victims of homicide remained unchanged at 4% in both the Secondary and Tertiary Funnel Effect eras—with the Tertiary period coinciding with Calderon's declaration of the war on drug trafficking organizations in México. Moreover, homicide-related deaths among UBC decreased to 1% of all deaths in the Localized Funnel Effect era.

This finding does not suggest that undocumented migrants are not at risk of falling victim to drug trafficking-related violence during attempted crossings. However, it is likely that much of the violence migrants experience tends to be in México. Prior research has found that unauthorized migrants are at risk for kidnapping, robbery, extortion, assault and even murder by organized crime groups during undocumented migration attempts and after deportation to Mexican border towns (Slack et al. 2013; Slack, Martinez, and Whiteford 2018; Slack 2019; Slack and Martinez 2020).

Finally, it is important to note that our classification of "homicide" not only includes migrants who were possibly killed by drug traffickers, coyotes (human smugglers), bajadores (border bandits), or other migrants, but also consists of migrants who were killed during an encounter with US officials. We note this distinction considering the qualitatively distinct roles these various actors play in the undocumented migration process. For the sake of this report, we do not disaggregate between these types of homicides. A closer examination of this distinction warrants future consideration.

CHANGES IN IDENTIFICATION RATE AND BODY CONDITION SCALE

As noted in **TABLE 3**, the PCOME's identification rate increased from 67% in the Initial Funnel Effect period to 79% in the Secondary Funnel Effect era. However, identification rates fell again to 67% during the Tertiary Funnel Effect era and then again to 48% percent in the Localized Funnel Effect era. As discussed below, several factors have contributed to the decreased rate of positive identifications made by the PCOME.

Changes in Body Condition Scale scores help explain the decrease in identification rates across time. The percentage of UBC cases coded as "Fully fleshed" fell from 46% in the Secondary Funnel Effect era to 33% in the Tertiary Funnel Effect period and once again to 14% in the Localized Funnel Effect era. Additionally, the proportion of UBC deaths coded as "Complete skeletonization with bone degradation" increased from 12% in the Secondary Funnel Effect era to 20% in the Tertiary Funnel Effect Era, and then again to 32% in the Localized Funnel Effect era. The work of PCOME forensic practitioners to identify the dead has become progressively more difficult as the remains recovered from the desert have been recovered in later states of decomposition and skeletonization. In addition to facing cases that are more challenging in the Localized Funnel Effect period, PCOME forensic practitioners have also been constrained in their success due to inconsistent funding sources for DNA profiling.

TABLE 4. Demographic Characteristics of PCOME Recovered Human Remains Coded as UBCs, by Era

	"INITIAL FUNNEL EFFECT" (FY 1990-1999)	"SECONDARY FUNNEL EFFECT" (FY 2000-2005)	"TERTIARY FUNNEL EFFECT" (FY 2006-2013)	"LOCALIZED FUNNEL EFFECT" (FY 2014-2020)
DEMOGRAPHIC CHARACTERISTICS				
Female[1]	13%	22%	**16%**	**8%**
Age[2]	28.9 years	30.1 years	**31.4 years**	32.2 years
0-9 years	0%	0%	0%	0%
10-19 years	22%	14%	11%	**6%**
20-29 years	39%	39%	**34%**	36%
30-39 years	22%	26%	**34%**	34%
40-49 years	11%	15%	15%	17%
50-59 years	7%	4%	4%	6%
60-69 years	0%	0%	1%	1%
70+ years	0%	0%	0%	0%
COUNTRY OF ORIGIN[2]				
Mexico	76%	**91%**	**80%**	**67%**
Guatemala	5%	4%	**12%**	**22%**
El Salvador	1%	2%	3%	3%
Honduras	0%	1%	2%	**6%**
Other Countries	0%	2%	2%	2%
Unknown Country	18%	**0%**	0%	0%

1. among all decedents. 2. among identified decedents. Note: Bold percentages indicate a statistically significant change from the previous era beyond the 0.05-level. Percentages may not sum to 100 due to rounding.

CHANGES IN DEMOGRAPHIC CHARACTERISTICS

BIOLOGICAL SEX

Overall, females have accounted for 15% of all recovered UBC remains examined at PCOME since 1990 (see **TABLE 1**). However, there have been significant changes in the proportion of female UBCs across the four periods we examined. As illustrated in **TABLE 4**, approximately 13% of UBCs during the Initial Funnel Effect era were female. This percentage increased to 22% during the Secondary Funnel Effect era, and decreased to 16% in the Tertiary Funnel Effect period. Most recently, the proportion of female UBCs decreased to 8% in the Localized Funnel Effect era. One of the many consequences of

increased border enforcement has been the decreased probability of migrants returning to their countries of origin, ultimately transforming would-be seasonal migrants into long-term residents (Massey, Durand, and Pren 2015; Martínez, Slack, and Martínez-Schuldt 2018). Historically, migration from México to the United States has been a gendered process, with men making up the majority of migrants (Massey et al. 2002; Wilson 2010). However, due to heightened enforcement, men began to stay for longer periods in the United States, often settling permanently. This led to an increase in the migration of women for the purposes of family reunification. This notable change may explain the increase in female UBCs between the Initial and Secondary Funnel Effect eras.

Nevertheless, the number of women migrating in an undocumented manner appears to have fluctuated over the past decade. It is possible that the family reunification process has slowed as women have successfully reunited with their male family members in the United States. US Border Patrol apprehension data partially support this notion. For example, in 2007 females made up approximately 20% of all apprehensions in the Tucson Sector, however, this proportion fell to 14% in 2018. Interestingly, this trend has not held in recent years. By 2019, females accounted for 24% of Tucson Sector apprehensions but only represented 13% UBC cases the same year, which suggests females are underrepresented among recovered UBC remains compared to their share of apprehensions. Broader changes in crossing strategies among women toward efforts to petition for asylum (e.g., turning one's self over to US Border Patrol), rather than attempting clandestine transit through remote desert areas, may partially account for this discrepancy.

AGE

TABLE 3 illustrates that the average age of identified UBCs increased from 30.1 years in the Secondary Funnel Effect era to 31.4 years in the Tertiary Funnel effect period ($p < 0.05$). Though not noted in **TABLE 4**, we also found that the mean age among identified UBCs increased by 2.2 years between the Secondary Funnel Effect era and the Localized Funnel Effect period ($p < 0.001$). It is possible that interior immigration enforcement programs in effect during this period, such as the federal government's Secure Communities or 287(g), as well as state level anti-immigrant initiatives, such as Arizona's SB 1070, disproportionately affected older, more established immigrants residing in the United States rather than younger recent migrants involved in seasonal work. Prior research has found that migrants who have established homes, forged strong social ties, and resided in the United States for longer periods of time may be less deterred by these types of interior removal programs, and more likely to attempt a repeat undocumented crossing upon deportation (Slack et al. 2013; Martínez et al. 2018). These findings may partially explain why the average age of UBCs has increased over the past several years. However, the population of México is aging and birth rates have decreased, so it is also possible that this difference is due in part to broader demographic changes occurring within the country (The Economist 2010; Passel, Cohn and Gonzalez-Barrera 2012). Nevertheless, researchers should pay further attention to the effect that interior removal programs have had on changing the profile of undocumented border crossers.

COUNTRY OF ORIGIN

TABLE 4 provides information on changes over time with regard to identified UBCs' national origin. As noted, we found several important changes across the four eras examined. During the Initial Funnel Effect era, approximately 76% of UBC were from México, with country of origin not known in an additional 18% of cases. Though we cannot decisively conclude, it is probable that a large majority of these cases were of Mexican nationals. Data from the Secondary Funnel Effect era (2000-2005) support this assertion. Ninety-one percent of identified UBCs during this period were from México,

4% were from Guatemala, 2% from El Salvador, 1% from Honduras, and 2% from other countries, with no missing information for country of origin in the Secondary Funnel Effect era. The proportion of Mexicans decreased to 80% during the Tertiary Funnel Effect era, while the share of Guatemalans increased to 12%. Most recently, during the Localized Funnel Effect period, the share of Mexicans once again decreased to 67%, while the proportion of Guatemalans increased to 22%. We also found that the proportion of Hondurans increased to 6% from 2% in the previous period. These changes in country of origin across time among identified UBC decedents are likely a consequence of increased migration among Central Americans, particularly since 2014.

The Appendix of this report provides several figures illustrating trend data on causes of death, biological sex, age, and country of origin between FY1990-2020. Marginal changes from one year to the next should be interpreted with caution due to small sample sizes.

CONCLUSION

The number of recovered undocumented border crosser (UBC) remains examined by the Pima County Office of the Medical Examiner (PCOME) has increased substantially since FY 2000. In fact, these cases have exceeded 115 each year since FY 2001, averaging around 162 cases per year between 2002 and 2020. This increase has coincided with intensified enforcement along the US-México border, further supporting previous studies that have asserted that border militarization redistributed migration into remote areas like desolate regions of southern Arizona, resulting in increased risk of death (Eschbach et al. 1999; Eschbach et al. 2003; Cornelius 2001, 2005; Nevins 2002; Rubio-Goldsmith et al. 2006; Martínez et al. 2013; Boyce 2019; Boyce et al. 2019; Chambers et al. 2019).

The increase in recovered UBC remains examined by the PCOME in southern Arizona over the past 20 years is not simply a consequence of more migrants crossing through southern Arizona. This is evidenced by US Border Patrol apprehension data, often used by researchers as a proxy for undocumented migration flows, which indicate a steady though at times fluctuating decrease in apprehensions over the past two decades in the Tucson Sector. Drawing on these data, we find that the approximate rate of recovered UBC remains in southern Arizona increased substantially since the early 2000s. This suggests that migrants' clandestine travel in southern Arizona occurs over longer periods routed through more remote areas to avoid detection by US authorities, thus increasing the probability of death. Though fewer migrants are crossing, they continue to die (or be recovered) in large numbers and are perishing in some of the most treacherous and rugged terrain within southern Arizona (Soto and Martínez 2018; Boyce et al. 2019; Chambers et al. 2019). We echo prior research that has called attention to the continued "funneling" of migrants at the local level within the very same regions of the border that bore the initial brunt of the "funnel effect," such as southern Arizona and South Texas (Soto and Martínez 2018).

The present study also identified several important changes in the characteristics of recovered UBC remains investigated by the PCOME over time. First, as previously noted, the remains of UBCs have been recovered from increasingly more remote regions of southern Arizona. Similarly, the proportion of recovered UBC remains in a skeletonized state has increased since the early 2000s, making identification and establishing a definitive cause of death more difficult. Second, we also found that the proportion of female UBC decedents decreased since the early 2000s, while the share of Central Americans among identified UBC decedents has increased since this period. These latter changes are possibly functions of the shifting demographic profile of undocumented border crossers—including an increase of would-be asylum seekers—as well as broader changes in immigration enforcement policy.

While this report is focused on data from the PCOME pertaining only to the Arizona portion of the US-México border, it is important to be cognizant of the fact that the deaths of migrants occur in each US border state. Remote areas along the California-Baja California border experienced notable increases in migrant deaths when the prevention through deterrence strategy first began in the early 1990s (Cornelius 2001). Deaths then appeared to shift east into southern Arizona in the early-to-mid-2000s, evidenced by the near two-fold increase in the number of recovered UBC remains investigated by the PCOME between 2001 and 2002. This report demonstrates that recoveries have remained near all-time highs in southern Arizona. Meanwhile, the number of recovered UBC remains spiked in South Texas in the 2010s before leveling off in the latter part of the decade. A recent report focused on Texas found that the remains of at least 1,519 UBCs were recovered from 16 counties in South Texas between 2012 and 2019 (Leutert et al. 2020).

Understanding the causes of and solutions for undocumented migration and migrant deaths requires an understanding of the extent of these phenomena. At present, the true number of migrant deaths occurring across the border on an annual basis is unknown. Nevertheless, the PCOME continues to collect valid and reliable data on recovered human remains of suspected UBCs in southern Arizona and, most importantly, is committed to identifying the deceased. Both tasks are of paramount importance. The former should help inform policymakers about the consequences of current immigration and border enforcement policies, while the latter helps provide closure to the families that have lost loved ones who died while traversing the Sonora-Arizona border in search of a better life. Our hope is that policymakers consider the data presented in this report when forming policy decisions about immigration and border enforcement.

Photo by: Samuel N. Chambers

REFERENCES

American Community Survey, 2015-2019 (5-Year Estimates). Accessed via Social Explorer. https://www.socialexplorer.com/explore-tables

American Immigration Council. 2020. "Policies Affecting Asylum Seekers at the Border: The Migrant Protection Protocols, Prompt Asylum Claim Review, Humanitarian Asylum Review Process, Metering, Asylum Transit Ban, and How They Interact." Fact Sheet. Washington, DC. January 29. https://www.americanimmigrationcouncil.org/research/policies-affecting-asylum-seekers-border

Anderson, Bruce E. and Bruce O. Parks. 2008. "Symposium on Border Crossing Deaths: Introduction." *Journal of Forensic Sciences* 53(1):6-7.

Andreas, Peter. 1998. "The US Immigration Control Offensive: Constructing an Image of Order on the Southwest Border." Pp. 341-356 in Crossings: Mexican Immigration in Interdisciplinary Perspectives, edited by M.M. Suárez-Orozco. Cambridge, MA: Harvard University Press.

Andreas, Peter. 2009. *Border Games: Policing the US-México Divide.* Ithaca, NY: Cornell University Press.

Boyce, Geoffrey A., 2016. The rugged border: Surveillance, policing and the dynamic materiality of the US/México frontier. *Environment and Planning D: Society and Space* 34(2): 245-262.

Boyce, Geoffrey A., 2019. "The Neoliberal Underpinnings of Prevention through Deterrence and the United States Government's Case against Geographer Scott Warren." *Journal of Latin American Geography* 18(3):192-201.

Boyce, Geoffrey A., Chambers, Samuel N. and Sarah Launius. 2019. "Bodily Inertia and the Weaponization of the Sonoran Desert in US Boundary Enforcement: A GIS Modeling of Migration Routes through Arizona's Altar Valley." *Journal on Migration and Human Security* 7(1):23-35.

Chambers, Samuel N. 2020. "The Spatiotemporal Forming of a State of Exception: Repurposing Hot-Spot Analysis to Map Bare-Life in Southern Arizona's Borderlands." *GeoJournal* 85:1373-1384.

Chambers, Samuel N., Geoffrey A. Boyce, Sarah Launius, and Alicia Dinsmore. 2019. "Mortality, Surveillance and the Tertiary "Funnel Effect" on the US-Mexico Border: A Geospatial Modeling of the Geography of Deterrence." *Journal of Borderlands Studies*:1-26. DOI: 10.1080/08865655.2019.1570861.

Chambers, Samuel N., Ben McMahan, and Coen C.W.G. Bongers. 2020. "Developing a Geospatial Measure of Change in Core Temperature for Migrating Persons in the Mexico-US Border Region." *Spatial and Spatio-temporal Epidemiology* 35:100363.

Cornelius, Wayne A. 2005. "Controlling 'Unwanted' Immigration: Lessons from the United States, 1993-2004." *Journal of Ethnic and Migration Studies* 31(4):775-794.

Cornelius, Wayne A. 2001. "Deaths at the Border: Efficacy and Unintended Consequences of US Immigration Control Policy." *Population and Development Review* 27(4):661-685.

REFERENCES CONT. 1

Cornelius, Wayne A. 1998. "The Structural Embeddedness of Demand for Mexican Immigrant Labor: New Evidence from California." Pp. 115-144 in Crossings: Mexican Immigration in Interdisciplinary Perspectives, edited by M.M. Suárez-Orozco. Cambridge, MA: Harvard University Press.

Dunn, Timothy J. 1996. *The Militarization of the US-México Border, 1978-1992: Low-Intensity Conflict Doctrine Comes Home.* Austin, TX: University of Texas Press.

Dunn, Timothy J. 2009. *Blockading the Border and Human Rights: The El Paso Operation that Remade Immigration Enforcement.* Austin, TX: University of Texas Press.

Eschbach, Karl, Jacqueline Hagan, Nestor Rodriguez, Ruben Hernandez-Leon, and Stanley Bailey. 1999. "Death at the Border." *International Migration Review* 33(2):430-454.

Eschbach, Karl, Jacqueline Hagan, and Nestor Rodriguez. 2003. "Deaths during Undocumented Migration: Policy Implications in the New Era of Homeland Security," in *In Defense of the Alien*, 26:37-52.

Espenshade, Thomas J. 1995. "Unauthorized Migration to the United States." *Annual Review of Sociology* 21:195-216.

García Zamora, Rodolfo. 2009. "Migration Under NAFTA: Exporting Goods and People." Pp. 79-83 in *The Future of North American Trade Policy: Lessons from NAFTA*, convened by K.P. Gallagher, E.D. Peters, and T.A. Wise. The Frederick S. Pardee Center for the Study of the Longer-Range Future, Boston University. Report, November.
http://www.bu.edu/pardee/files/2009/11/Pardee-Report-NAFTA.pdf

González, Juan. 2011. *Harvest of Empire: A History of Latinos in America.* New York, NY: Penguin Books.

Hagan, Jacqueline Maria. 2008. *Migration Miracle: Faith, Hope, and Meaning on the Undocumented Journey.* Cambridge, MA: Harvard University Press.

Humane Borders. 2020. Arizona OpenGIS Initiative for Decreased Migrants.
https://humaneborders.info/app/map.asp

Jiménez, María. 2009. "Humanitarian Crisis: Migrant Deaths at the US-México Border." ACLU of San Diego and Imperial Counties and México's National Commission of Human Rights. Report, October 1.

Leutert, Stephanie, Sam Lee, and Victoria Rossi. 2020. M*igrant Deaths in South Texas.* Strauss Center for International Security and Law, The University of Texas at Austin Report. Available at:
https://www.strausscenter.org/wp-content/uploads/Migrant_Deaths_South_Texas.pdf

Launius, Sarah and Geoffrey A. Boyce. 2013. "Warehousing the Poor: How Federal Prosecution Initiatives like Operation Streamline Hurt Immigrants, Drive Mass Incarceration and Damage US Communities." *DifferenTakes 82.*

REFERENCES CONT. 2

Martínez, Daniel E., Robin C. Reineke, Raquel Rubio-Goldsmith, Bruce E. Anderson, Gregory L. Hess and Bruce O. Parks. 2013. *A Continued Humanitarian Crisis at the Border: Undocumented Border Crosser Deaths Recorded by the Pima County Office of the Medical Examiner, 1990-2012*. Binational Migration Institute, Department of Mexican American Studies, University of Arizona. Available at: https://bmi.arizona.edu/sites/default/files/publication-files/Martinez%20et%20al.%202013%20A%20Continued%20Humanitarian%20Crises.pdf

Martínez, Daniel E., Reineke, Robin C., Raquel Rubio-Goldsmith, and Bruce O. Parks. 2014. "Structural Violence and Migrant Deaths in Southern Arizona: Data from the Pima County Office of the Medical Examiner, 1990-2013." *Journal on Migration and Human Security* 2(4): 257-286.

Martínez, Daniel E., Jeremy Slack, and Ricardo Martínez-Schuldt. 2018. "Repeat Migration in the Age of the Unauthorized Permanent Resident: A Quantitative Assessment of Migration Intentions Post-Deportation." *International Migration Review* 52(4):1186-1217.

Martínez-Schuldt, Ricardo D. and Daniel E. Martínez. 2020. "Destination Intentions of Unauthorized Mexican Border Crossers and Familial Ties to US Citizens." *The Sociological Quarterly.* DOI: 10.1080/00380253.2020.1733448

Massey, Douglas S., Jorge Durand, and Nolan J. Malone. 2002. *Beyond Smoke and Mirrors: Mexican Immigration in an Era of Economic Integration.* New York, NY: Russell Sage Foundation.

Massey, Douglas S., Jorge Durand, and Karen A. Pren. 2015. "Border Enforcement and Return Migration by Documented and Undocumented Mexicans." *Journal of Ethnic and Migration Studies* 41(7):1015-1040.

Miller, Todd. 2014. *Border Patrol Nation: Dispatches from the Front Lines of Homeland Security.* San Francisco, CA: City Lights Books.

Nevins, Joseph. 2002. *Operation Gatekeeper: The Rise of the "Illegal Alien" and the Making of the US-México Boundary.* New York, NY: Routledge.

Ngai, Mae M. 2014. *Impossible Subjects: Illegal Aliens and the Making of Modern America.* Princeton, NJ: Princeton University Press.

Orrenius, Pia M. 2004. "The Effects of US Border Enforcement on the Crossing Behavior of Mexican Migrants." Pp. 281-298 in *Crossing the Border: Research from the Mexican Migration Project*, edited by J. Durand and D. Massey. New York, NY: Russell Sage Foundation.

Passel, Jeffery, D'Vera Cohn, and Angela Gonzalez-Barrera. 2012. *Net Migration from México Falls to Zero—and Perhaps Less.* The Pew Hispanic Center, Report, April 23.

REFERENCES CONT. 3

Rubio-Goldsmith, Raquel, M. Melissa McCormick, Daniel Martinez, and Inez Magdalena Duarte. 2006. *The "Funnel Effect" and Recovered Bodies of Unauthorized Migrants Processed by the Pima County Office of the Medical Examiner, 1990-2005.* Tucson, AZ: Binational Migration Institute, Mexican American Studies and Research Center, University of Arizona, Report, October. https://bmi.arizona.edu/sites/default/files/publication-files/The%20Funnel%20Effect%20and%20Recovered%20Bodies.pdf

Slack, Jeremy. 2019. *Deported to Death: How Drug Violence Is Changing Migration on the US-México Border.* Oakland, CA: University of California Press.

Slack Jeremy and Daniel E. Martínez. 2018. "What Makes a Good Human Smuggler? The Differences between Satisfaction with and Recommendation of Coyotes on the US-México Border." *The ANNALS of the American Academy of Political and Social Science* 676(1):152-173.

Slack, Jeremy and Daniel E. Martínez. 2020. "Post-Deportation Geographies: Immigration Enforcement and Organized Crime on the US-México Border." *Annals of the American Association of Geographers.* DOI: 10.1080/24694452.2020.1791039

Slack, Jeremy, Daniel E. Martinez, Scott Whiteford, and Emily Peiffer. 2013. *In the Shadow of the Wall: Family Separation, Immigration, Enforcement, and Security.* Tucson, AZ: The Center for Latin American Studies, University of Arizona. Report, March. https://www.researchgate.net/publication/284349191_In_the_Shadow_of_the_Wall_Family_Separation_Immigration_Enforcement_and_Security

Slack, Jeremy, Daniel E. Martínez, and Scott Whiteford. 2018. *The Shadow of the Wall: Violence and Migration on the US-México Border.* Tucson, AZ: University of Arizona Press.

Soto, Gabriella, and Daniel E. Martínez. 2018. "The Geography of Migrant Death: Implications for Policy and Forensic Science." Pp. 67-82 in *Sociopolitics of Migrant Death and Repatriation: Perspectives from Forensic Science* edited by K. Latham and A. O'Daniel. Cham, Switzerland: Springer International Publishing AG.

The Economist. 2010. "When the Niños Run Out: A Falling Birth Rate and What it Means." April 22. http://www.economist.com/node/15959332

US Border Patrol. 1994. *Border Patrol Strategic Plan 1994 and Beyond: National Strategy.* Washington, DC. https://www.hsdl.org/?abstract&did=721845

US Border Patrol. 2020. "Southwest Border Sectors: Southwest Border Deaths by Fiscal Year." Washington, DC. https://www.cbp.gov/sites/default/files/assets/documents/2020-Jan/US%20Border%20Patrol%20Fiscal%20Year%20Southwest%20Border%20Sector%20Deaths%20%28FY%201998%20-%20FY%202019%29_0.pdf

US Department of Homeland Security. 2019. "Policy Guidance for Implementation of the Migrant Protection Protocols." Memorandum. Washington, DC. https://www.dhs.gov/sites/default/files/publications/19_0129_OPA_migrant-protection-protocols-policy-guidance.pdf

REFERENCES CONT. 4

Vallet, Maryada. 2012. *Post-Deportation Health: A Humanitarian Assessment.* Tucson, AZ: No More Deaths. https://www.nomoredeaths.org/abuse-documentation/post-deportation-health/

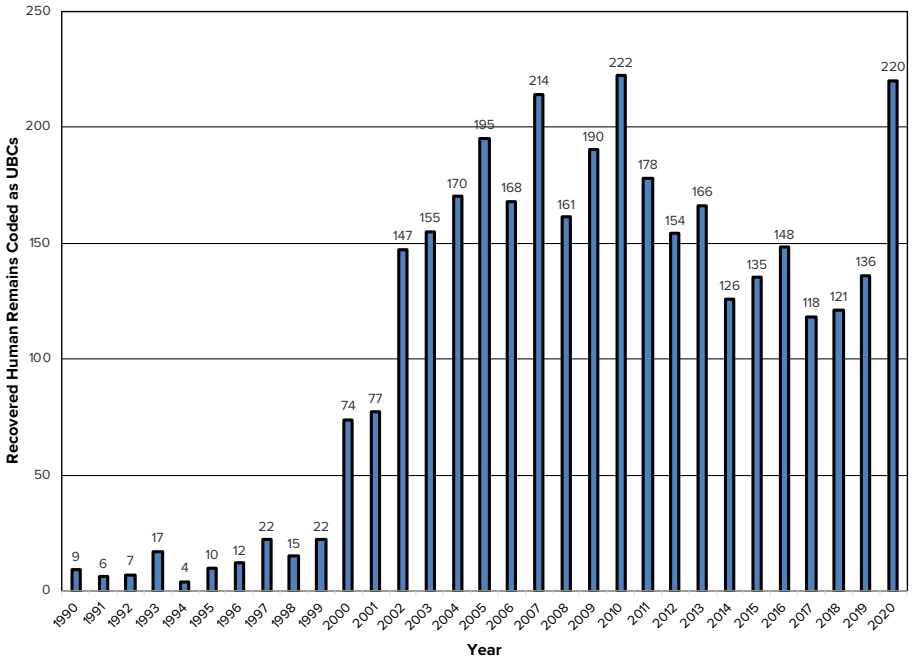
Wilson, Tamar Diana. 2010. "The Culture of Mexican Migration." *Critique of Anthropology* 30(4):399-420.

Wise, Timothy A. 2009. "Reforming NAFTA's Agricultural Provisions." Pp. 35-42 in *The Future of North American Trade Policy: Lessons from NAFTA,* convened by K.P. Gallagher, E.D. Peters, and T.A. Wise. The Frederick S. Pardee Center for the Study of the Longer-Range Future, Boston University. Report, November. http://www.bu.edu/pardee/files/2009/11/Pardee-Report-NAFTA.pdf.

APPENDIX: Additional Figures and Maps

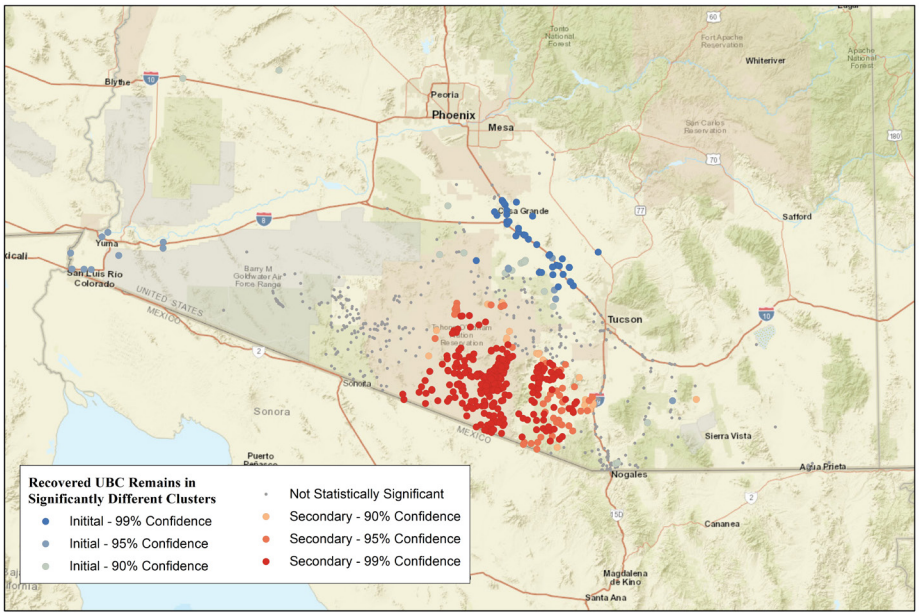
This section provides additional figures illustrating counts of recovered human remains coded as UBCs by the Pima County Office of the Medical Examiner by calendar year, as well data on cause of death, biological sex, identification rates, mean age, and country of origin between FY1990-2020. Readers should interpret marginal changes from one year to the next with caution due to small sample sizes. Maps A-C illustrate the geographic concentration of recovered UBC remains across the eras we examined.

FIGURE A. Pima County Office of the Medical Examiner Recovered Human Remains Coded as UBCs, Calendar Year 1990-2020



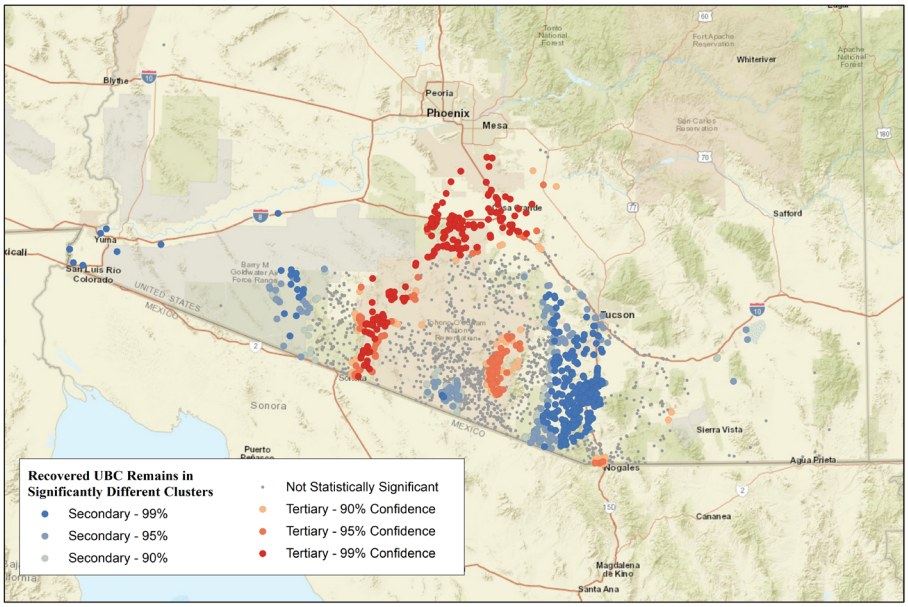
N = 3,399

MAP A. Recovered UBC Remains in Significantly Different Clusters, Initial (1990-1999) versus Secondary Funnel Effect Era (2000-2005)



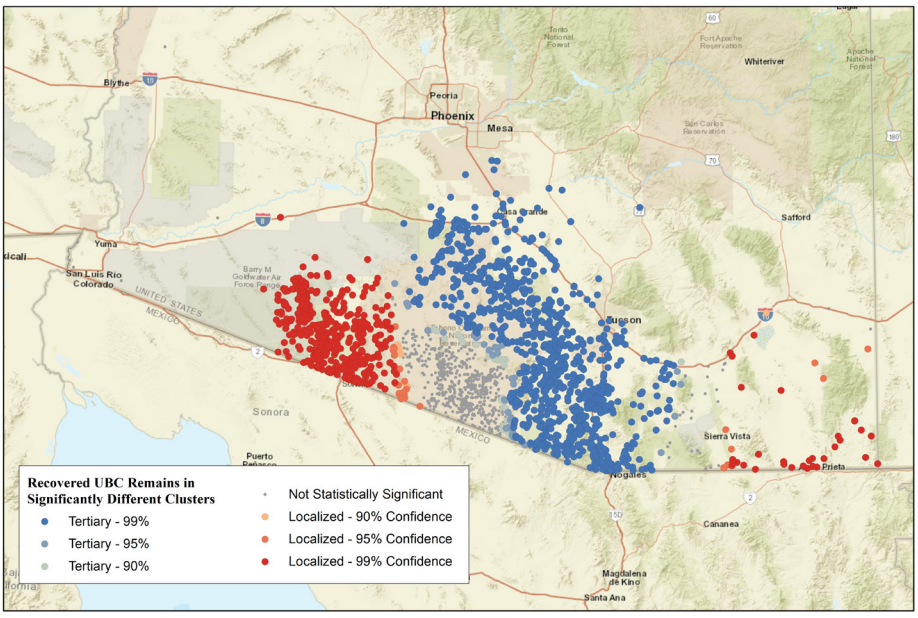
N = 876

MAP B. Recovered UBC Remains in Significantly Different Clusters, Secondary (2000-2005) versus Tertiary Funnel Effect Era (2006-2013)



N= 2,213

MAP C. Recovered UBC Remains in Significantly Different Clusters, Tertiary (2006-2013) versus Localized Funnel Effect Era (2014-2020)



N = 2,421

FIGURE B. PCOME Recovered Human Remains Coded as UBCs by Cause of Death, FY 1990-2020

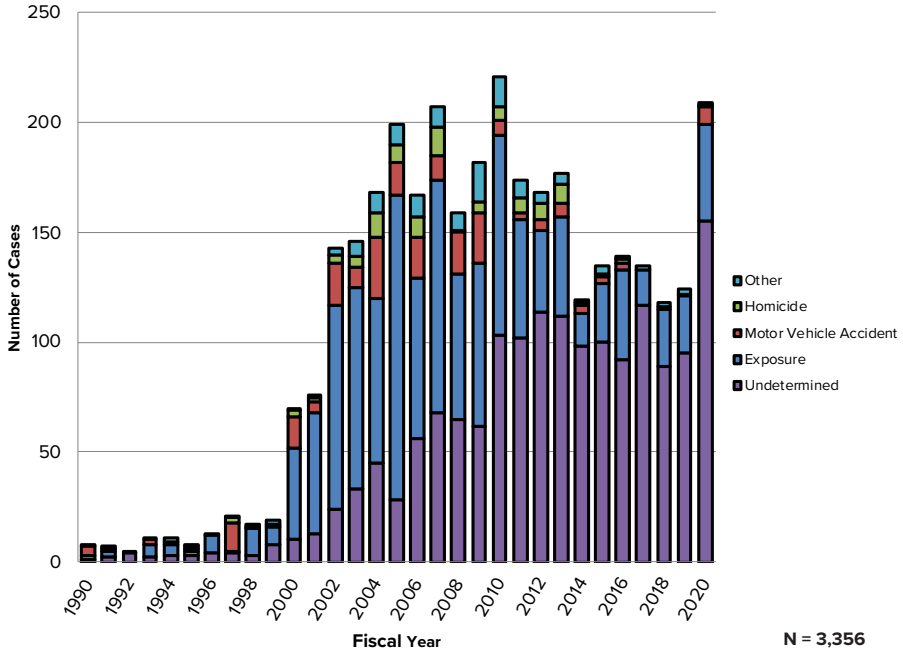


FIGURE C. PCOME Recovered Human Remains Coded as UBCs by Sex, FY 1990-2020

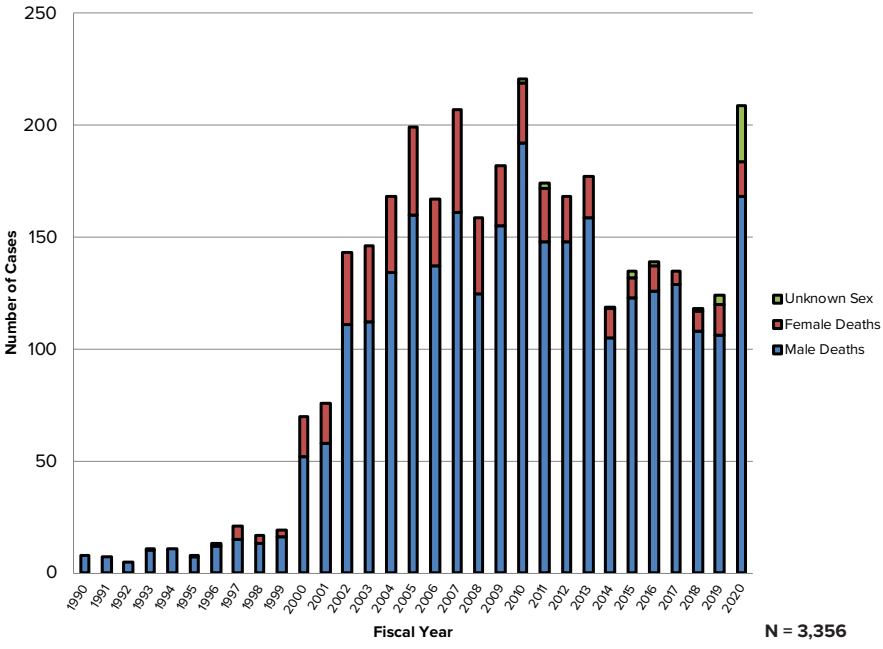


FIGURE D. PCOME Recovered Human Remains Coded as UBCs by Identified and Unidentified, FY 1990-2020

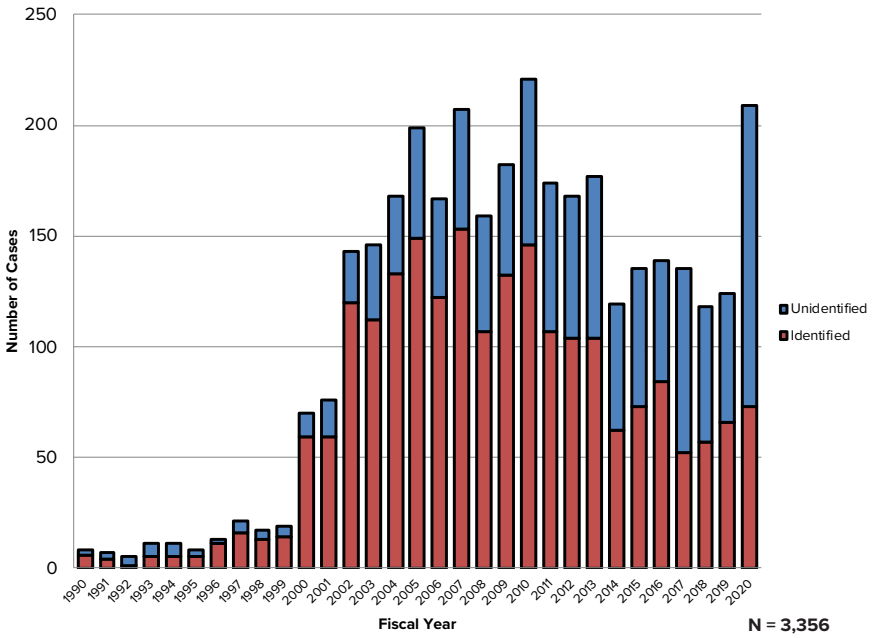


FIGURE E. PCOME Recovered Human Remains Coded as UBCs by Mean Age among Identified Decedents, FY 1990-2020

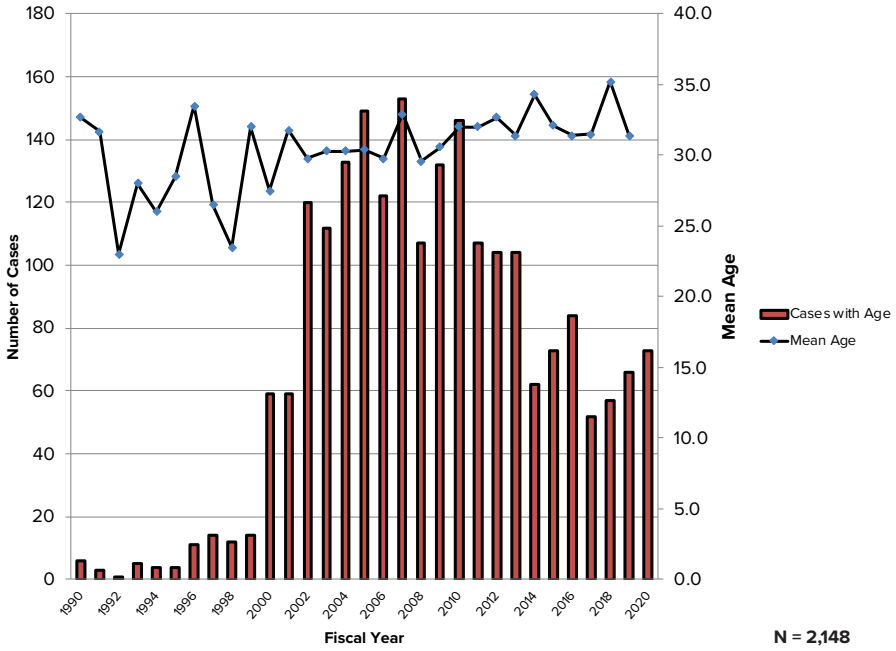
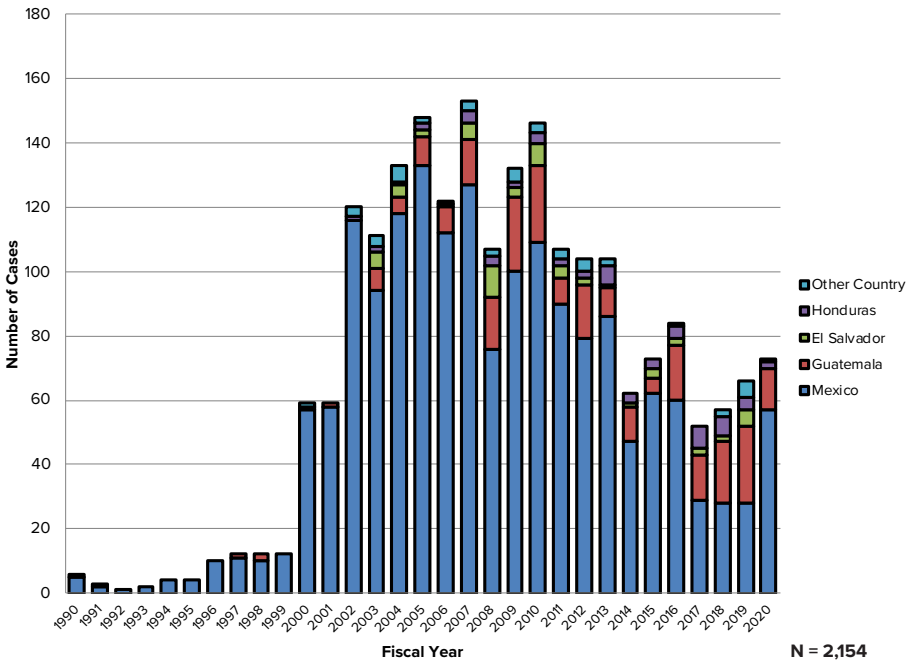


FIGURE F. PCOME Recovered Human Remains Coded as UBCs by Country of Origin among Identified Decedents, FY 1990-2020



CONTACT INFORMATION

BINATIONAL MIGRATION INSTITUTE

Arizona has one of the most active, militarized, and deadly border areas in the United States. This harsh and complicated situation has profound consequences for the state, the nation, and US relations with México. BMI's interdisciplinary focus has been shaped by the ways in which immigration policies and practices affect the lives of hundreds of thousands of migrants and Arizona residents. Please visit the website: www.bmi.arizona.edu

DEPARTMENT OF MEXICAN AMERICAN STUDIES

The Department of Mexican American Studies is committed to contemporary applied public policy research on Mexican Americans. As the leading public policy research center addressing issues of concern to this minority group in Arizona, the Department works collaboratively with key community agencies in promoting leadership and empowerment of Mexican Americans within the state and the nation. Please visit the website: www.mas.arizona.edu

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PIMA COUNTY OFFICE OF THE MEDICAL EXAMINER

The mission of the Pima County Office of the Medical Examiner-Forensic Science Center is to provide accurate, timely, compassionate and professional death investigation services for the citizens of Pima County, Arizona. Core functions include: postmortem examinations, screening deaths for public health significance, forensic anthropology/odontology services, certification of death certificates prior to cremation, organ/tissue donation approvals, organ transplant approvals in cases under OME jurisdiction, courtroom testimony, disaster response and teaching services.
Please visit the website: www.pima.gov/cmo/ome

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