Causes and Trends in Migrant Deaths along the U.S.-Mexico Border, 1985-1998

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Executive Summary

After facing a long-term, elevated wave of undocumented immigration, in the 1990s the U.S. government committed an unprecedented amount of resources to police the U.S.-Mexico border. Part of the new policing initiatives consisted of intensified border enforcement, which commenced in 1993 in the El Paso Border Patrol sector through Operation Hold the Line. While the effects of the new U.S. efforts to control the southwest borderline against unauthorized entry are still debated, it is evident to all border watchers that undocumented migration flows have been heavily affected in two major ways. Illegal border crossing patterns have been spatially restructured to circumvent areas of high border enforcement, and the whole border region, from Texas to California, has become a more dangerous area to cross for illegal entrants than before the new enforcement efforts of the 1990s. The attempts to cross the border surreptitiously away from areas of intense border enforcement and through less detected but more dangerous points, the greater use of unknown smugglers, the predatory habits of border bandits--all are examples of risk factors that have combined to make border crossings a much more dangerous experience. Not surprisingly, the increase of the risk factors has elevated the occurrence of deaths among undocumented migrants in the interval of increasing undocumented immigration in the late 1990s.

While border observers are familiar with the increasing levels of deaths among foreign transients in the U.S. southwest border regions, no attempt has been made to

assess this mortality from a standardized empirical data source, that is, a source which maintains consistent measurement criteria across time and place. Also, no attempt has been made to assess this migrant mortality across a time frame that covers time periods both before and after the implementation of intensified border campaigns in the 1990s. In this report these two methodological limitations are overcome by using a single, standardized data set--official vital registration data pertinent to the border research area under study--and subjecting this data to systematic analysis, from the standpoint of a host of causes of deaths, for the time period 1985 to 1998. A central concern of the analysis is to see if the time-series death data fluctuate with respect to the time points and areas of intensified border enforcement. In other words, a major analytical concern is to assess how intensified border campaigns are affecting the migrants' death patterns through the re-direction of undocumented migratory flows.

The study's key empirical findings include the following:

- Deaths due to exposure to extreme environmental conditions (heat or cold) is the only border-wide data series that rises sharply because of the redirection of migration flows after enhancement of border enforcement.

- A portion of the increase in environmental deaths in 1998 is attributable to the increased migration flow in the late 1990s, a portion is attributable to the unusually hot summer that year, and the remainder to redirected flows.

- Deaths due to unknown cause show a U-shaped pattern of change that is consistent with the change of the volume of undocumented migration in the 1985-1998 study period.

- Drowning deaths increase in Imperial County, California and in El Paso County, Texas. The increases in Imperial County are directly related to the re-direction of flows, but the increases in El Paso County reflect a persistent problem with drowning exacerbated by the opening of an additional canal segment, and thus cannot be specifically associated with redirected migration

- Drowning death totals in Texas outside the El Paso area were suppressed by the low water flow volume in segments of the Rio Grande River below the Amistad Reservoir.

- Auto-pedestrian accidents declined in San Diego County and in El Paso County. These declines were related to targeted enforcement that deflected flows from dangerous urban crossing locations.

- Homicide deaths of foreign transients and unidentified persons declined along the border, especially in San Diego County. The causes of these declines are manifold, and improved border control in urban crossing places, especially San Diego, is likely to be one cause of the decline.

- Other causes of death from external accidents and injury do not appear to have been restructured. and either increased or decreased in association with the spatial restructuring of undocumented immigration.

- There appears to have been a net increase in undocumented migrant fatalities along the southwest border because of spatial restructuring through 1998, since the environmental death and has increased more than other types of death have decreased. However, increases associated with restructured flows are more modest than a review of the data starting in 1993 would suggest, because 1993 appears to establish an unusually low baseline of these deaths.

- The multiplier of observed to unobserved environmental deaths is not known, so the true effects of redirection may not be fully known. In general, redirection of flows from urban to rural crossing points is likely to lead also to a re-direction to causes and places of death that decrease the probability that a death will be discovered and registered.

In conclusion, it is important to remember that behind intense strategies of border enforcement stands immigration policy. It is policy, not enforcement, that ultimately determines the migrants' mode of entry, for which there is a clear and sharp distinction in the migrants' death bill. Short of a completely controlled border or the emergence of home-country economies as or more prosperous than the United States, migrant border deaths will continue to parallel the temporal and spatial contours of undocumented immigration. Moreover, discontinuing intensified border enforcement will only mean the return of migrant border deaths to earlier patterns, not the disappearance of the death.

Introduction

This report provides the first comprehensive overview of crossing deaths of undocumented migrants along the U.S.-Mexico border. Migrant crossing deaths gained considerable public attention in the second half of the 1990s. The 1990s was a decade in which the United States devoted an unprecedented level of resources to police the southwest border against unauthorized labor migration. While the effectiveness of enhanced enforcement at reducing unauthorized entry is much debated (Hanson and Spilimbergo 1999; Massey and Singer 1995; Koussoudji 1992), it is evident to all that the spatial and to some extent social organization of undocumented migration has been restructured. There is a common perception that the border has become a more dangerous place for the migrant than was the case before enforcement changes were implemented.

The mechanism by which the border has allegedly become more dangerous is relatively simple and has now been much discussed in both journalistic and scholarly accounts. In a series of well-publicized "Operations" the Border Patrol has sought to establish and then maintain control of the border bit-by-bit, urban places first. It has done so, in part, with considerable effectiveness. The showpiece of the new border control has been the success of Operation Gatekeeper—begun in October 1994—at turning the westernmost segment of the border south of San Diego from the most to the least permeable stretch of the border. The anticipated response by the migrants was both a tactical and a strategic redirection of crossing attempts. Tactical responses included more use of subterfuge and concealment, better intelligence about Border Patrol deployment, targeted massing of crossing to overwhelm local Border Patrol units, increased use of

"rocking" and other violent assaults to intimidate Border Patrol agents, and increased circumvention of zones of effective enforcement through cross country treks and drives. Strategic responses involve shifting crossing attempts to parts of the border that are not well controlled. If western San Diego and Sunland Park, New Mexico, (a former popular crossing point abutting El Paso, Texas) were not available options to undocumented crossers after 1994 and 1995, Calexico, California, Nogales and Douglas, Arizona, and Brownsville and Laredo in Texas provided more likely possibilities. Indeed, the rush of crossers to these areas likely made the Border Patrol initially less effective there than it had been, because crossing attempts were rising faster than the new resources were being deployed to combat them. Gradually, however, the Border Patrol introduced additional urban operations in other parts of the border. It also increased resources devoted to apprehension in surrounding rural areas. Interior highway checkpoints were more consistently staffed. Increasing resources were deployed for air patrol and on-the-ground "cutting for sign" of cross-country undocumented hikers. Investments in technological aids such as sensors, lighting and night vision equipment, and patrol vehicles to improve agent efficiency also increased.

The net impact of all of these shifts on undocumented migration flows and labor supply has been much debated. The health impact for the migrants has seemed obvious. The old game of "cat and mouse" between migrant and Border Patrol has been taken to a new level and shifted to a new and apparently more dangerous playing field. Beating the Border Patrol appears to require more effort—in many cases palpably physical and dangerous effort. Long cross-country treks in the new corridors of undocumented migration—the deserts of Arizona and southeastern California, and the ranches of Texas-

- can turn deadly if you run out of water. So too can being locked by a smuggler in the cargo compartment of a train, truck or car. Smugglers can offer the would-be migrant valuable information and assistance in negotiating the border passage, but some are organized criminals who find more profit in victimizing the migrant than in rendering a service. Redirection of migration flows has also resulted in an outbreak of violence against migrants by a small subset of the ranch owners over whose land the migrants are being re-directed. It is not surprising that the border appears to be a more dangerous place for the migrant.

Nonetheless, despite the seeming obviousness of this story, there has been no systematic investigation about whether it is true. This is somewhat surprising, because there are several pertinent points to raise before the story is accepted in the form that we have laid out.

The most important of these points is that the border has always had its dangers. Urban crossing points carry their own dangers to the undocumented migrant. Those whose historical memory spans a decade will remember the violence at the San Diego border in the late 1980s, as well as the numerous auto-pedestrian accidents in which migrants were struck by cars on San Diego County freeways. One of the most tragic single incidents was also pre-Gatekeeper: the deaths of 18 migrants in a sealed boxcar in Sierra Blanca, Texas, on July 2, 1987. Julian Samora and Jorge Bustamante share stories of migrant mortality in truck cargo compartments and in the open country in *Los Mojados* (1971). The Rio Grande's reputation as a killer of migrants and a repository of the bodies of homicide victims goes back to earlier centuries (Durand & Massey 1995).

Concerning the current redirection of migrant flows, an assistant chief in the Tucson sector Border Patrol commented to a co-author that there appear to be few new paths and strategies in undocumented crossing in either a local or national sense. While, to be sure, the volume of flow through different corridors and the use of different methods has shifted, the specific paths trod by migrants have most likely been trod before—and deaths have occurred on these paths before, as a look back to data from the 1980s will show.

A second important question concerns the relative impact of redirected flows and alternative explanations of variations in migrant fatalities. Two alternatives, in particular, seem most important to consider: variation in weather conditions, and variations in the volume of undocumented migration.

Questions about weather effects are obvious, since the posited impact of redirected flows has been to expose the migrant to extremes of cold (primarily in the mountains of eastern San Diego County) and heat, in all parts of the border. Does a hot summer affect the number of deaths that occur as much as does the particular mix of paths that the migrants take through the borderlands in that year? Given the prominence of drowning as a cause of migrant mortality, a parallel question may be raised about variation in the volume of water in the rivers and canals of the border region.

Questions about the impacts of the overall volume of migration flow on death totals are important because migration flow is the risk component of the analysis of migrant mortality. When more migrants attempt a northbound journey, mortality totals at the border would be expected to rise, simply because of the increased size of the population that is placed in danger during the journey. A particular substantive question

that arises is to what extent increases in undocumented migration after the peso devaluation of December, 1994, may account for changes in undocumented mortality totals after this period.

Limitations of previous studies

Previous attempts to document the relationship between the expanded U.S. border enforcement efforts in the 1990s and migrant mortality have been plagued by a limited study period and inconsistent data sources and standards. The first academic study of migrant death along the U.S.-Mexico border used data from state vital registration systems, local police and fire departments logs, and human rights agency tallies to document the frequency and location of deaths for the period 1993 through 1997 (Eschbach, Hagan, Rodriguez, Hernandez, and Bailey 1999). A limitation of this study was the restricted study period which failed to capture long secular trends, especially to gauge the effects of U.S. border enforcement initiatives launched in the mid to late 1990s on migrant mortality. A more recent study, which relied on data provided by Mexican consulates along the border, attempted to capture this effect by focusing only on the 1994 to 2000 period (Cornelius 2000). This study suffers from the same limitation of the time interval. Like the study by Eschbach et al., it does not include the years prior to the buildup of U.S. enforcement efforts along the border. Thus, both studies, while informative in documenting deaths during particular time periods, were unable to capture patterns of border mortality before and after the highly publicized U.S. border campaign initiated to stop undocumented migration.

The limitations of these studies do not derive from analytical lapses of their authors, but rather from the limitations of data sources. Accounts of migrant mortality are

often drawn from diverse and confusing sources, making it impossible to track migrant mortality from a consistent data source. For example, reports of migrant death by media and academics alike rely on such discrepant sources as newspaper accounts, Border Patrol logs, Mexican consulate reports and human rights groups. These sources vary substantially in their coverage and definition of migrant border deaths. The Mexican consulate data, for instance, cover both sides of the border but only include the deaths of Mexican nationals. It is our understanding that these data are not collected with a consistent standard across all parts of the border, reflecting primarily the greater support and information received by the consulates in U.S. border areas served by professional medical examiners rather than by justices of the peace. Border Patrol data include all nationalities but only cover the U.S. side of the border. The Border Patrol intends to track deaths occurring in the furtherance of an attempted entry without inspection (EWI), while other sources may have a broader definition of migrant deaths, encompassing the resident undocumented alien population. Information about whether a death did occur during an EWI is elusive, especially after medical examiners, justices of the peace and sheriffs have shipped off their records to warehouse storage.

Analytical strategy of the current study

This study overcomes these earlier methodological shortcomings by relying on one data source with a consistent definition and measurement of death—the vital registration of accidental deaths of foreign transients in U.S. counties along the U.S.-Mexico border. By relying on this unique death data set we trace with consistent standards the spatial and temporal relationships of foreign transient deaths to patterns of undocumented crossings apprehension data. Specifically, we examine trends in the

number and type of fatal accidents of foreign transients by cause, we also look at the changing spatial distribution of these death areas like the southwest border area. For this analysis we present data about geographic distribution to the nine border central sectors at the southwest border.

In the sections that follow we describe the data and research methods used to analyze the patterns and characteristics of foreign transient deaths, present time trend and spatial patterns through a map series, explain the relationships between migratory flow changes and temporal patterns of migrant deaths, and describe the occurrences of deaths by different causes. We conclude by emphasizing the interaction on a temporal and spatial plane between environmental and enforcement factors and the incidence of deaths among foreign transients.

Data and Methods

Dependent Variable

Vital Registration Data

Our death data come from the only systematic data source that records information about deaths in the United States border zone: the vital registration system of the United States. This data source intentionally catalogs all deaths that occur in the United States, whatever the identity and residence of the decedent. The precise data that we use for our study are data about deaths from external accidents and injuries recorded in vital registration databases for foreign-born non-residents of the United States, for United States counties on and near the border with Mexico, for the years 1984 through 1998. These data thus track many of the most important categories of deaths that occur during the course of undocumented migration, including many kinds of deaths that occur

most frequently in this population within this region. We also include in our tabulations deaths for unknown causes (International Classification of Diseases, 9th Revision [ICD9] codes 798 and 799), and accidental/unknown cause deaths of unknown decedents in our study area. We include these deaths because interviews with law enforcement and coroner's department officials in relevant counties indicate that a substantial fraction of these decedents were undocumented border crossers.

We wish to make clear some important limitations of vital registration data for the study of death during undocumented border crossing. Vital registration data do not record the immigration status of the decedent (except for the fact of foreign or native birth), much less report whether her or she was attempting to enter the United States without inspection at the time of death. They do not record information about the activity of the decedent at the time of death. Thus, vital registration cannot be used to identify directly which individuals are dying in the furtherance of an attempted unauthorized entry without inspection by U.S. agents. Because of these limitations of the data source, this paper does not offer a count of deaths during undocumented migration. Instead, we use the phrase "foreign transients" to describe the decedents in our study.

Is information about the deaths of foreign transients in the border region useful to study trends in deaths during undocumented migration? This is the case for two reasons. First, it appears that deaths during undocumented migration account for a substantial component of foreign transient death totals. We identify 3676 vital registration records of deaths from external accidents or injuries of foreign transients in 55 border counties for a 14-year period. Counts for recent years supplied by medical examiners, the Border Patrol, and Mexican consuls suggest an order of magnitude for deaths during EWI that is

approximately equal to, or larger than, those reported in our paper for all accidental deaths of all foreign transients. Since deaths in the United States during an attempted EWI lie within the universe of deaths of foreign transients, the overlap between the two data series must be substantial.

Secondly, the extreme rareness of many of the types of deaths that occur in the course of undocumented entry make even stronger inferences possible for these death types. In particular, deaths from hyperthermia and hypothermia, pedestrian-freight train accidents, car-pedestrian accidents on interstates, drowning in border canals, suffocation, are all unusual ways to die for all groups of human beings in the United States except one—undocumented migrants attempting to cross the border. Because of this fact, these data permit us to gain an excellent picture of trends in change in undocumented migrant mortality since before the onset of Operation Gatekeeper, even if we cannot supply an exact census of these deaths.

Taking matters one step further, it is possible to categorize deaths from external accidents and injuries into a relatively small number of types. We begin by excluding from our tabulations deaths from external accidents or injuries with no conceptual relation to undocumented border crossing—specifically, suicides, drug overdoses, medical interventions, airplane crashes, and any accident taking place at work. The remaining deaths may be coded into one of the five listed in the preceding paragraph, and just four more heuristically useful categories: motor vehicle accidents, homicides, unknown causes, and all other. All other is a convenience category encompassing such varied causes as falls and fractures, fires, poisoning, and animal bites. These causes have in common the fact that separately they are too rare for an analysis of trends to be

meaningful, and even when pooled they aggregate to too small a number of deaths to affect materially an analysis of overall death totals.

The logic of our analysis will be to examine the spatial and temporal trends in deaths in each of our nine enumerated categories: Environmental deaths from heat and cold, drowning, train accidents, auto-pedestrian accidents, suffocation, motor vehicle accidents, homicides, unknown causes, and all others. For each series we ask whether trends in distribution in space (i.e., across the border region) and time appear to be related to what we know about undocumented border crossing. By this method, we identify important trends and relationships in the data, and—equally important—indicate where none occurs.

There are two important exclusions from our data. In a few cases, medical examiners will code a natural cause of death for a death that occurs during undocumented crossing. The most common example is that heart failure might be coded as a cause of death for a person with an underlying heart condition that is aggravated by overexertion during a cross-country trek. We believe that these deaths lie within the conceptual framework of a death resulting from an attempted undocumented entry. Trends in this category of death, however, are little interest, because heart failure is too common a cause of death—the large majority of such deaths occurring to non-resident foreigners in the border zone will occur to the many millions of legal foreign visitors to the border region, and the influence of the few cases occurring during undocumented migration would be rare.

Independent Variables

Undocumented migration flow and direction of flow

Understanding changing migration flow volumes, and the spatial distribution of those flows is critical to understanding the way that the spatial restructuring of undocumented migration affects migrant mortality. Unfortunately, both the overall volume of undocumented migration and relative flow through different parts of the border is not directly measured.

Most approaches to measuring the volume of undocumented flows begin with the Border Patrol's monthly apprehension series. The logic behind this approach is that apprehensions are in part a function of undocumented flow across the border, so that the apprehension series should at least be correlated with flow. The limitation of the measure is also well understood. The correlation between apprehensions and flow is not perfect. In particular, the apprehension rate will vary with the effort and effectiveness of both the Border Patrol and the migrants. Neither of these variables is a constant. Customarily, Border Patrol effort is controlled using the Border Patrol's series on Patrol Officer hours, and perhaps additional measures of capital investment in technological equipment, or by assuming a linear time trend of improvement because of these investments. Some critics have suggested the need to control for measures of the Border Patrol's diversion from control of undocumented labor flows to the interdiction of drug trafficking. Migrant effectiveness is even less easily measured.

It is well understood that these adjustments are not fully satisfactory. In particular, perturbations in border enforcement or in demand for crossing may radically affect the relationship between apprehensions and successful entries, particularly in the short term before the other partner in the enforcement/crossing dance has had the opportunity to redirect resources to meet new challenges. In particular, diminished flows—particularly

diminished flows through a particular spot at the border--may be partially masked in the apprehension series by increased apprehension probabilities and recidivism. Likewise at spots where increasing migrant flow overwhelms locally deployed enforcement resources, an increasing apprehension series may understate the true magnitude of the increased undocumented flow through the region, because the apprehension rate decreases as a function of diminished Border Patrol effectiveness in the face of increasing entries.

With all these limitations well in mind, an adjusted apprehension series remains the only available measure of migration flow, and, in particular, of the redirection of these flows in the mid-1990s by increased and targeted enforcement. In particular, we must limit our use of the series to identify gross trends rather than precise indicators of volume.

To measure undocumented flow, we simply use the residual of the regression of the natural log of the monthly "Patrol Border" apprehensions on the log of "Patrol Border Officer hours," for the period from FY1984 through FY1999, and use the residual as a measure of flow. This step is repeated for each of the nine Border Patrol sectors, in order to produce nine sector-specific migration flow measures. Since each of these residual series has meaning only with respect to its own equation, the specific levels of each of these series are not comparable to one another. Each, however, may be used to give a rough and ready characterization of trends in migration flow through that sector, and these may be compared to trends in deaths of transient foreigners within that sector.

Weather Data

To analyze relationships between weather conditions and deaths from environmental causes, we use monthly temperature data from series made available by the National Oceanic and Atmospheric Administration (NOAA). These data report average temperature for each month. For our analysis, we decomposed the temperature data into two elements: a series of monthly means, invariant across years for each calendar month, and a series of deviations from monthly means.

We also did extensive analysis of the relation between environment and hyperthermia deaths, using data from a monthly rainfall series and a monthly drought severity index series. This analysis did not yield significant correlations with heat-related deaths, and is not discussed in this report.

Water Flow Data

Monthly water flow data were assembled for four rivers and canals that are located at or near the border, and where local informants report that migrant drowning deaths occur: the Tijuana River (San Diego County, CA), the All-American Canal (Imperial County, CA), the Colorado River (Yuma County, AZ), and the Rio Grande River, which defines the border between Texas and Mexico. Data were reported as flows measured in acre-feet per month. Data for each of the rivers was supplied by the Water Division of the International Water and Boundary Commission, and data for the All-American Canal was supplied by the Water Control Division of the Imperial Irrigation District.

The Rio Grande River is divided into several segments by a series of reservoirs, which each retain water for timed irrigation release. Water flow between the reservoirs is measured at several gauging stations at intervals along the river. Flows through gauging stations within each segment of the river are highly correlated. For analysis of Texas border drowning deaths, we associated segments of the river with each Border Patrol sector, and represented water flow through the river with data from the first (upstream) gauging station in that segment.

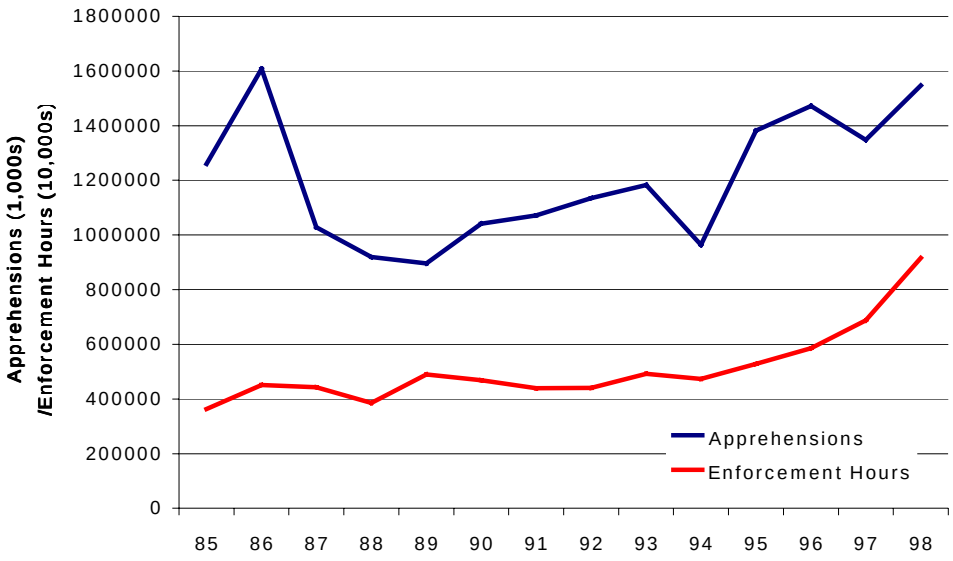
Several methodological approaches are used in this study. First, we present throughout the report annual graphical and tabular displays of associations of death and flow patterns. We also include maps showing the spatial distribution of deaths and apprehensions. Our analysis also provides a detailed analysis of yearly tallies of foreign transient deaths by cause and location.

Migration Flow Volume and Spatial Distribution

As we have already discussed above, migrant flow volume is important to our analysis in two respects. First, the overall volume of undocumented migration in a given period reflects the population at risk of dying during undocumented migration. If the migrating population doubles, or is cut in half, one would expect substantial changes in the number of deaths observed at the border, given a constant rate of mortality during migration. What information do we have about overall flow volumes in this period?

Figure 1 shows the raw apprehension series plotted against the enforcement (officer hour) series. The apprehension series shows an abrupt decline in apprehensions beginning in 1987 in the aftermath of the passage of the Immigration Reform and Control

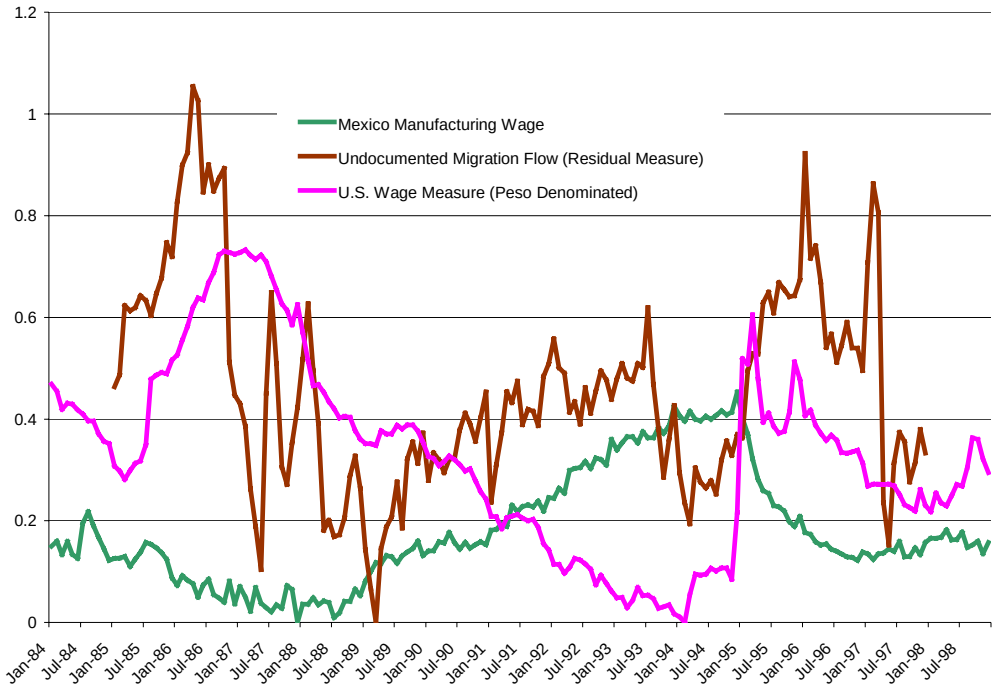
Figure 1. Southwest Border Apprehensions and Enforcement Hours, 1985-1998



Act of 1986 (IRCA). There is a steady but moderate rise in apprehensions between 1989 and 1993. Apprehensions decline abruptly in 1994--coinciding with the implementation of Operation Hold-the-Line in El Paso in 1993. Apprehensions then increase abruptly in 1995, concomitantly with the implementation of Operation Gatekeeper in October 1994 and the Mexican economic crisis consequent to the peso devaluation in December of the same year. Apprehensions remain at levels approximating those in the mid-1980s.

Figure 2 shows the residual measure of monthly undocumented flow, plotted against Mexican and United States wage series. These series have been found in previous research to be correlated with undocumented flows (All series have been converted to natural logarithms and rescaled to equal zero at their empirical minimum point in the observed range. The measures used replicate those reported by Hansen and Spilimbergo 1999). Low Mexican wages should be associated with high levels of undocumented migration, while high (peso-denominated) U.S. wages should also increase migration.

Figure 2. Residual Measure of Monthly Undocumented Flow with Mexican and U.S. Wage Data



The general trajectory of the monthly residual series follows the path of the raw apprehension series closely. This is a desirable feature of the series given the general assessment that the apprehension series is strongly correlated with flow (Espenshade 1995) and that (correlatively) the probability of apprehension is generally stable over time (Massey and Singer 1995). The series behaves less well in this period with respect to expected relationships to the wage series.

What do these data imply about undocumented flow through this period? Researchers are not in complete agreement, but certain facts seem generally agreed upon. The mid-1980s period, corresponding to the aftermath of the oil shock to Mexico's then petroleum-dependent economy, as well as to political turbulence in Central America, was a time of particularly high undocumented migration to the United States. Migration flows appear to have peaked in 1986, perhaps partly in response to the anticipated

possibility of a legalization in status for undocumented residents of the United States. IRCA reduced the flows for a brief period in the late 1980s, if only by adjusting the legal status of a portion of would-have-been undocumented migrants, removing them from the cross-border circular flow. In this period, IRCA-effects reducing undocumented flows may have competed with wage and employment pressures in a still troubled Mexican economy, resulting in flows that were substantially lower than the 1986 peak, but higher than historical flows.

The apprehension and residual series suggest moderately rising migration between 1989 and 1993, alongside rising Mexican wages. Commentators do not appear to have specifically addressed patterns in this period. Increases in this period may have driven by the narrowness of the economic recovery in Mexico, in which rising formal sector manufacturing wages (the series plotted) were accompanied by falling formal sector employment, and continuing difficulties of adjustment in the agricultural sector (Dornbusch and Werner 1994; Lustig 1998).

In 1994, there is an abrupt drop in apprehensions, coincident to the onset of Operation Hold-the-Line in El Paso (Bean, Chanove, Cushing, de la Garza, Freeman, Haynes, Spencer 1994). The drop is almost certainly a response to this enforcement effort, and probably does not imply a border-wide change in conditions for undocumented migration. Rather, the El Paso/Juarez border may have been unique because of its volume of commuter migration—daily journeys between two large Mexican and Mexican-origin populations. Operation Hold-the-Line imposed an abrupt change on border crossing conditions in this city, and especially affected these commuting flows, which did not, because of their local nature, reappear elsewhere on the

border. This event, while implying a real change in the El Paso border environment, probably does not imply a remarkable shift in long distance undocumented migration volume for that year, except that it marked the beginning of the process of spatially restructured flow.

Apprehensions rise sharply in 1995 and thereafter reach peaks approximating those of the mid-1980s. The residual series behaves more erratically, suggesting flow volumes higher in most of the period from 1995 through 1997 than in the early 1990s, but lower than the peaks of the mid-1980s. The evident reason for this is that the extremely sharp rise in border enforcement after 1994 provides a plausible account of at least some of the sharp rise in apprehensions in this period. Apprehension peaks like those achieved in the mid-1980s occur at the end of the 1990s in the context of a *doubling* of patrol hours and considerable capital investments in border enforcement. Esphenshade, Baraka and Huber (1997) appear to endorse this conclusion, pegging gross undocumented northbound migration in 1996 at 150,000 a month, about 25,000 less than the flow rates in the immediate aftermath of IRCA. It seems reasonable to trust the general contours of the residual apprehension series, and suggest that undocumented migration flow had dropped substantially from its 1986 peak by the end of the decade, and then recovered some but not all of its 1980s peak volume after the peso devaluation.

A secondary hypothesis, relevant to our interest in assessing the impact of flows on migrant mortality, is that Esphenshade's inference that apprehension probabilities rose after Operation Gatekeeper is consistent with the hypothesis that passage through the border zone now is not simply harder, but also somewhat longer. This may be the case if

only because a higher apprehension probability implies that a single northbound journey implies more attempted EWIs before success is achieved.

Redirection of Flows

Figures 3a and 3b trace apprehensions by Border Patrol sector over the period between 1985 and 1998. These charts show patterns of apprehensions in the western most and then the eastern most border sectors.

If we accept apprehensions as a crude indictor of undocumented flow, the changing distribution of undocumented flow is reasonably clear from these two graphs. At the start of the 1990s, San Diego and El Paso sectors share between them 70% of all apprehensions. The two sectors together peak at 800,000 apprehensions in 1992. No other sector accounts for more than 10% of all apprehensions until after 1992. The implementation of targeted enforcement in El Paso and San Diego in 1993 and 1994 began to restructure migration flows sharply, although the full effects were not realized until 1997 and 1998. Apprehension totals rose with astonishing rapidity in particular in El Centro and in the Tucson sector. Apprehensions increased 10-fold between 1994 and 1998 in El Centro. Tucson apprehensions increased more gradually but still impressively, from 50,000 in 1990 to 400,000 in 1998. Changes in Texas were not quite so dramatic, but the McAllen, Laredo and especially Del Rio sectors had large increases in apprehensions. While patterns of apprehensions do not trace patterns of flow exactly, these changes in the distribution of apprehensions are so dramatic that they make the spatial restructuring effects of targeted enforcement clear.

Figure 3a. Apprehensions in Western Border Sectors, 1985-1998

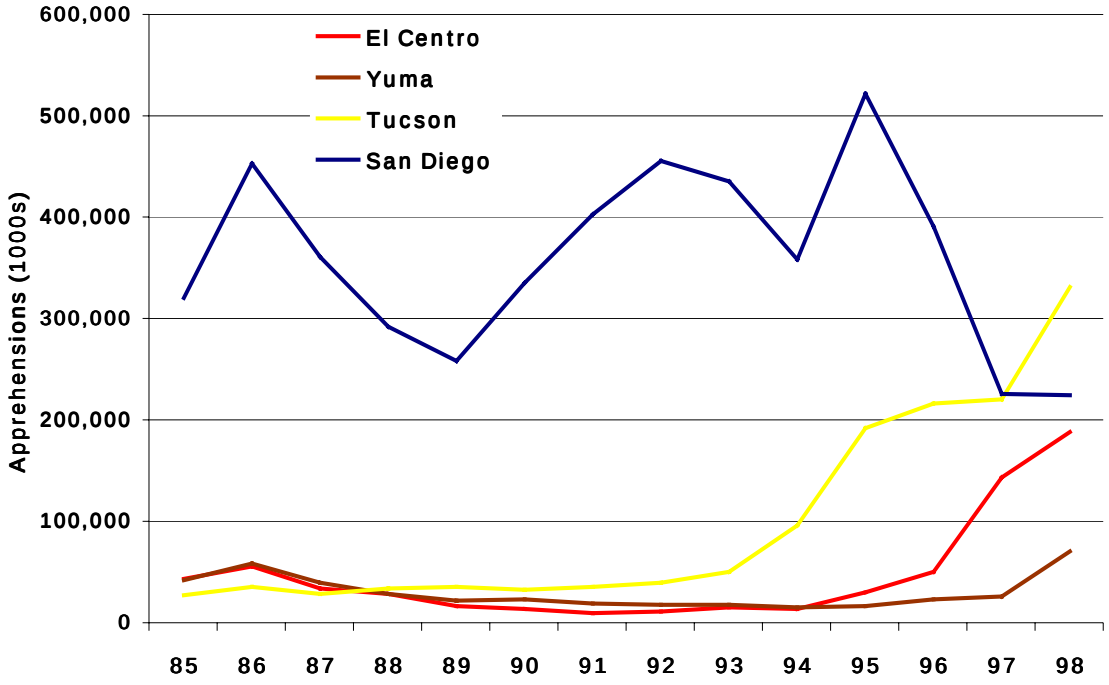
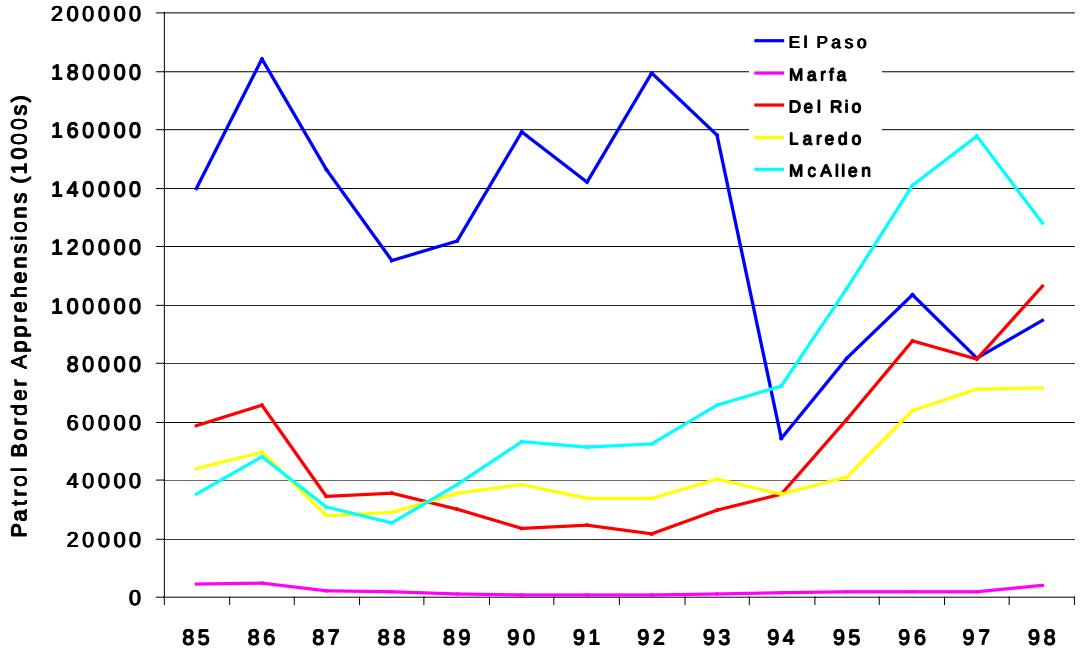


Figure 3b. Apprehensions in Eastern Border Sectors, 1985-1988



Time Trend and Spatial Analysis of Migrant Deaths

Figures 4 and 5 show accidental causes of death of foreign transients along the border from 1985 through 1998. As the figures show, there is a temporal pattern in the causes of death. Included among these deaths are those that occur during attempted undocumented entry to the United States. Changing levels and spatial structuring of undocumented migration between 1985 and 1998 may influence patterns in the figures. Accidental deaths from the major causes such as drowning, homicide, motor vehicle accident, and heat and cold/environmental conditions are high in the mid-1980s, reflecting elevated undocumented migration flows in this period. This is especially true for drowning along the Rio Grande. As undocumented migration declines in the late 1980s and early 1990s, deaths from these four leading causes decline substantially.

When undocumented migration flows increase in the mid to late 1990s, a changing pattern of causes of death emerges, reflecting not only an increase in unauthorized migration in this period but also the redirection of flows caused by changes in enforcement policies. As enforcement initiatives, such as Operation Gatekeeper and Operation Hold-the-Line, are launched in urban areas that had been popular crossing corridors for undocumented migrants, deaths due to homicides and auto-pedestrian accidents decline. On the other hand, deaths due to environmental conditions rise dramatically, as does drowning in the All-American Canal near the border in eastern California. These changes reflect a re-channeling of unauthorized crossings from urban to rural areas where the risk of death from these causes is greater. The changing pattern of causes of death are mapped in detail in Appendix 1, which includes distributions of selected causes of deaths of foreign transients by sector for each year from 1985 to 1998.

Figure 4. Deaths of Foreign Transients for Selected Causes in Southwest Border Area, 1985-1998

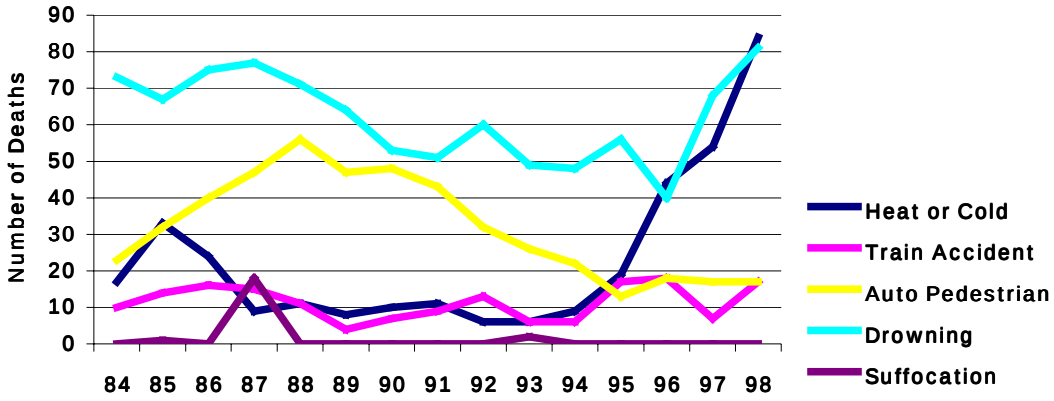
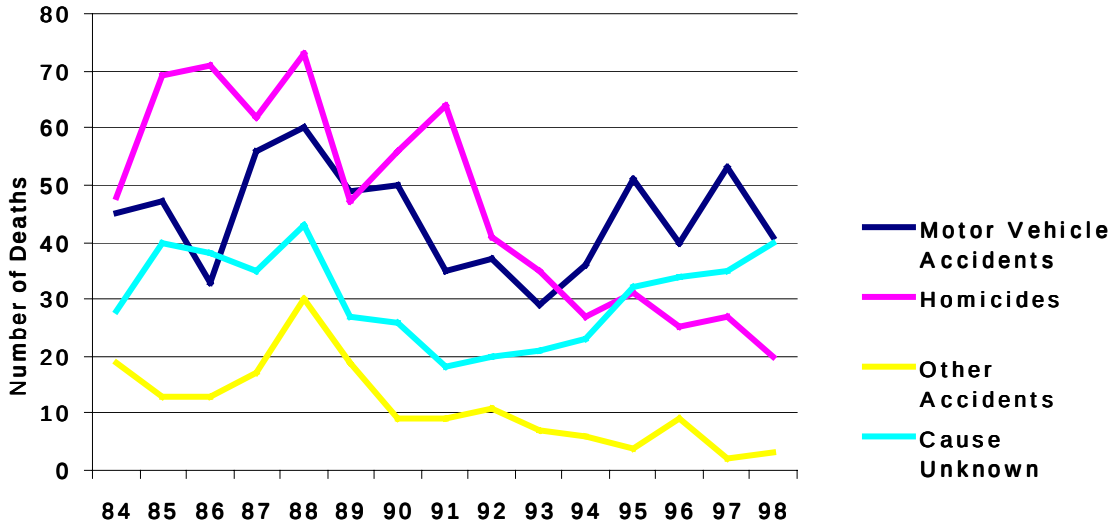


Figure 5. Deaths of Foreign Transients for Selected Causes in Southwest Border Area, 1985-1998

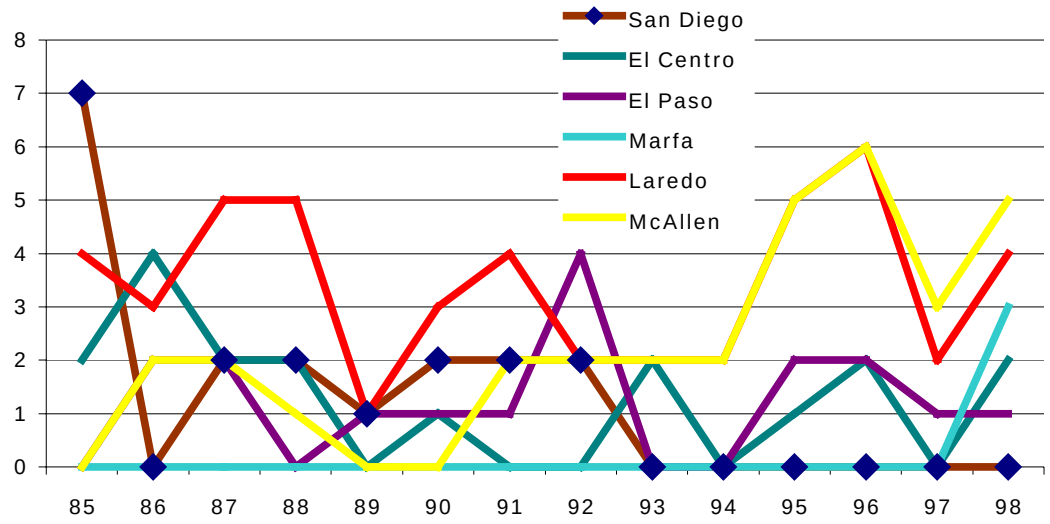


Deaths By Cause

Train Trespasser and Train Pedestrian Deaths

Deaths from train-related accidents ranked low, seventh, in the list of types of deaths. In this category we have included only cases where persons suffer an accident and die after illegally hopping a train or pedestrians who die after being struck by train. For many young men who cross the border surreptitiously headed for interior destination points, freight trains provide a convenient, but risky, means of transportation. Trains are convenient because they can be boarded at several places in their routes, and depending on the nature of their freight they can offer varying degrees of cover from detection. For example, migrants have reported finding very convenient concealment inside new cars or in the back of new pickups being transported across the vast Texas lands to distant dealerships; on the other hand, some migrants have described the risky passage riding on train tank cars filled with caustic chemicals. In the latter example, serious injuries and fatalities can occur when the migrant riders fall asleep, or for other reasons lose their grip, and fall from the moving trains. Because Border Patrol and train-company agents have increased their inspections for illegal riders on trains, some migrants who hop freight trains hide in the most secluded places, which have a higher risk of injury than an open boxcar. Of course, some train-related fatalities or serious injuries occur without the victim having boarded or attempted to board a train. Persons who stop to rest on railroads tracks after having walked long distances may be run over and killed by a passing train if they fall asleep on the tracks.

Figure 6. Deaths in Train-Pedestrian or Train- Tresspasser Accidents, Selected Sectors, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
85	7	2	0	1	0	0	0	4	0	14
86	0	4	1	3	2	0	1	3	2	16
87	2	2	2	0	2	0	0	5	2	15
88	2	2	0	0	0	0	1	5	1	11
89	1	0	1	0	1	0	0	1	0	4
90	2	1	0	0	1	0	0	3	0	7
91	2	0	0	0	1	0	0	4	2	9
92	2	0	0	1	4	0	2	2	2	13
93	0	2	0	0	0	0	0	2	2	6
94	0	0	0	0	0	0	2	2	2	6
95	0	1	1	1	2	0	2	5	5	17
96	0	2	0	1	2	0	1	6	6	18
97	0	0	0	1	1	0	0	2	3	7
98	0	2	0	2	1	3	0	4	5	17
All	18	18	5	10	17	3	9	48	32	160

Because relatively few cases occur each year, it is not possible to discern a significant pattern of deaths due to train-related accidents, nor any relationship to border enforcement campaigns. Yet a couple of observations can be made. First, there is a dynamic fluctuation of the ebb and flow of the total number of train-related deaths. From 1985 to 1993 the direction of the number of deaths changes three times from increasing to decreasing. Moreover, an increase in the deaths appears to parallel an increase in migration flow only in the 1994-1996 period, but only to drop sharply again from 1996-1997, and rise sharply again in 1997-1998.

Secondly, the two greatest numbers of deaths due to train-related accidents occur in the Laredo and McAllen sectors, which are the settings of heavy train traffic, some of which is related to the dramatic increase of NAFTA-driven commerce to and from Mexico. Indeed, the Laredo area, which is the unquestioned land port capital of the NAFTA trade, had the largest number of train-related fatalities, 48, in the 14-year run of our time series. The McAllen sector, which reports the second highest cumulative number of train-related deaths, 32, is the beginning of railroad lines that stretch for hundreds of miles into the interior to the metropolitan areas of San Antonio, Houston and beyond. Particularly significant for surreptitious migrant travel is the fact that the railroad lines cross large tracts of desolate terrain in the southern region of the state.

Law enforcement informants suggested that a large portion of foreign-transients who are killed in train-trespasser accidents and train-pedestrian accidents are undocumented migrants who see the train or its tracks as a likely route to the interior. The absence of any apparent effect of the spatial restructuring on this death type does not

vitiate this judgement, because of the rarity of this type of death—at least as recorded in vital statistics databases.

Suffocation

Suffocation is a rare cause of death. Only 21 cases exist in our database. Among these 18 occurred on a single day, July 2, 1987. These deaths occurred in the cargo compartment of a train in which 19 migrants were concealed. The Border Patrol discovered the deaths during a train check in Sierra Blanca, Hudspeth County, Texas. This was the single deadliest mortality incident reported in our database in the 14-year study period. We do not know the circumstances of the other reported deaths, and do not know whether they occurred in furtherance of an attempted undocumented entry.

Deaths in the cargo compartments of vans, trucks, and trains are an extremely difficult kind of death to track through vital registration of deaths. Border Patrol officials and news agencies periodically report finding migrants in the cargo compartments of load vehicles in distressed conditions (Annerino 1999). These situations are sometimes discovered some distance from the border. For example, in the late 1990s an incident was reported in Ohio, involving the transport of undocumented farm workers.

Does this method of transport lead to deaths of migrants on a scale surpassing those reported here? We can not know with certainty. Deaths during concealment in a cargo compartment may occur for reasons other than suffocation, such as, for example, hyperthermia, a motor vehicle accident, or from a pre-existing condition such as heart disease that is aggravated by conditions in concealment. Some deaths that occur in these circumstances never come to the attention to officials because of the interest of smugglers

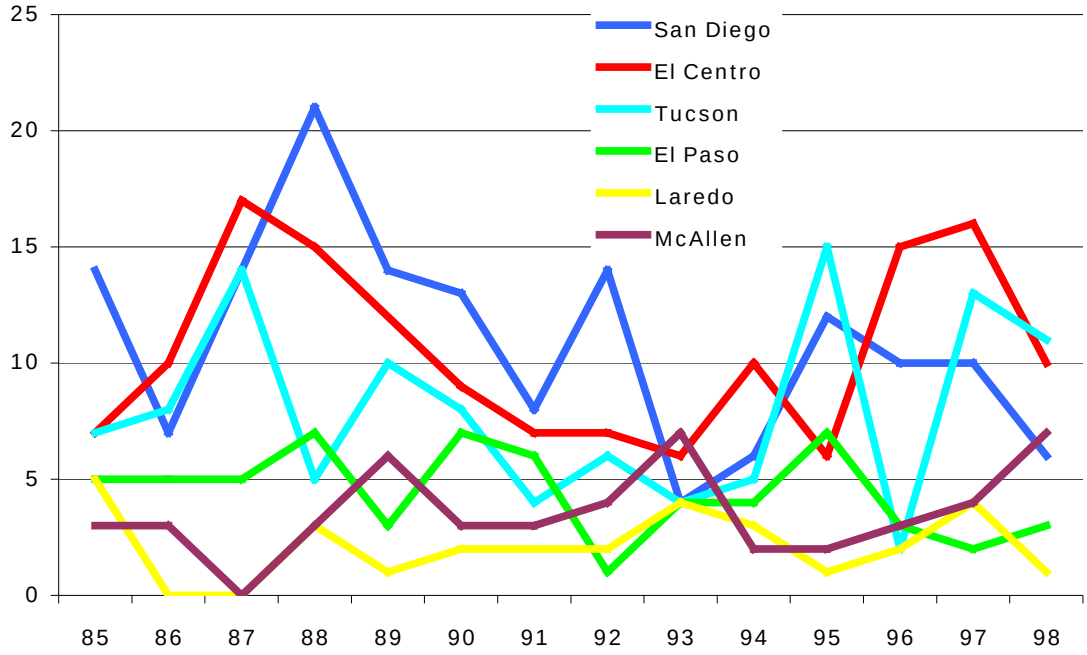
in concealing these deaths, since their discovery by law enforcement officials could lead to charges of murder or manslaughter against the smuggler.

Motor Vehicle Accidents

Deaths due to motor vehicle accidents rank third in the types of death we have listed. We can expect this category of deaths to occur more often in urban centers near popular border crossing areas, since urban settings have greater numbers of motor vehicles and a greater volume of vehicular traffic. Motor vehicle accidents are the leading cause of accidental deaths among the United State population at large. Migrants will share these risks insofar as they use motor vehicles as a means of transportation through the border area. The relatively high rate of deaths from auto accidents in the general population implies as well that foreign visitors who are legally present in the United States experience auto accident fatalities at some rate, contributing to observed death totals in the data series.

Risks may be elevated for undocumented migrants compared to other populations insofar as migrants ride in cargo compartments to escape detection, or in over-crowded load vehicles that lack sufficient passenger restraints, or if drivers use high speeds to avoid apprehension by the Border Patrol. Allegations that high speed chases endangered migrants, agents and others led the Border Patrol to adopt a policy severely restricting agent use of high-speed chases after August 1992. Since that time, there have been persistent allegations that violations of the policy have resulted in fatal accidents. Border Patrol officials contend that drivers of vehicles transporting undocumented migrants adopt high speeds upon spotting a Border Patrol vehicle even if no pursuit occurs.

Figure 7. Deaths from Motor Vehicle Accidents for Selected Sectors, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	14	7	1	7	5	4	1	5	3	47
1986	7	10	0	8	5	0	0	0	3	33
1987	14	17	1	14	5	5	0	0	0	56
1988	21	15	1	5	7	2	3	3	3	60
1989	14	12	2	10	3	1	0	1	6	49
1990	13	9	4	8	7	2	2	2	3	50
1991	8	7	1	4	6	2	2	2	3	35
1992	14	7	1	6	1	0	2	2	4	37
1993	4	6	0	4	4	0	0	4	7	29
1994	6	10	1	5	4	4	1	3	2	36
1995	12	6	6	15	7	1	1	1	2	51
1996	10	15	4	2	3	1	0	2	3	40
1997	10	16	2	13	2	1	1	4	4	53
1998	6	10	1	11	3	1	1	1	7	41
All	153	147	25	112	62	24	14	30	50	617

Together, the San Diego and El Centro sectors account for almost half of the 617 cases of motor vehicle accident deaths in our time-series data. For six of the 14 years in our time series, the San Diego and El Centro sectors account for over 50% of the motor vehicle accident deaths, and in a seventh year they account for 49.1%. The overall occurrence of deaths related to motor vehicle accidents generally parallels the U-shape pattern of northbound undocumented migrations flows across the U.S.-Mexico border, with an exception in the mid to late 1980s. The number of deaths related to motor vehicle accidents dropped from 1985 to 1986 but climbed sharply in 1986-1989, declined through the early 1990s, and start increasing after 1993 with a couple of downturns.

This pattern reflects the strong influence of the San Diego and El Centro sectors. In the three eastern sectors of El Paso/New Mexico, Laredo, and McAllen, the incidence of deaths related to motor vehicle accidents actually increases during the early 1990s, when the incidence is low in the western sectors of the border. The urban influence is evident throughout the time series, as the sectors with a greater urban area accumulate a larger number of deaths than the sectors with a smaller urban area.

The time-series data suggest a temporal-spatial shifting of deaths related to motor vehicle accidents. Simply, from 1985 to 1992, the San Diego sector accounted for the largest percentages of the deaths in three-fourth of the years, but in the years from 1993 to 1998, the largest percentages of the deaths occurred in sectors east of the San Diego sector in all but one year. Because this shift started a year before the implementation of Operation Gatekeeper in 1994, it is not possible to view this enforcement campaign as the source of the shift. Nevertheless, it is possible that as a contextual force the campaign reinforces the effects of other factors in shifting the higher incidences of these deaths east of the San Diego sector. Yet, this argument should not be pressed too strongly, since it does not appear to hold consistently across the borderline. After the implementation of Operation Rio Grande in the McAllen sector, the number of deaths due to motor vehicle accidents did not increase in the adjacent sector.

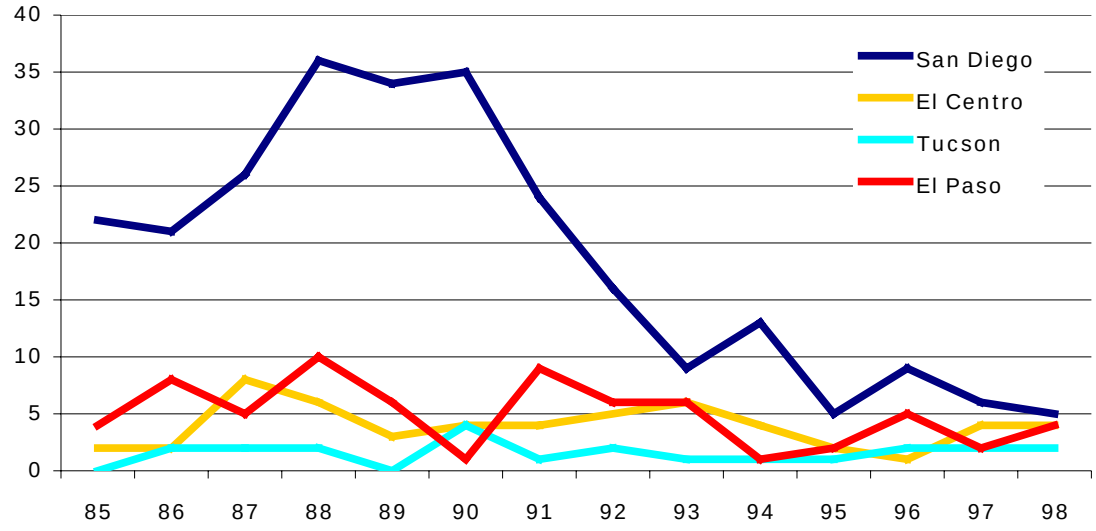
Cross-correlograms and multivariate analysis generally does not show a relationship between our residual measures of undocumented migration flow through a sector and motor vehicle deaths in that sector, with the marginal exception of the Tucson and El Centro sectors. A likely explanation of this finding is that the majority of motor vehicle accident deaths of transient foreigners in the border region pertain to foreign visitors in the United States who are legally present rather than to undocumented migrants. The post-Gatekeeper flooding of the two exceptional sectors with undocumented border crossers may explain their status, simply because recent increases in undocumented migration through them has significantly increased the size of the foreign transient population in them.

This generally negative finding about the relationship between undocumented migration, its restructuring, and motor vehicle accidents is important simply because of the quantitative prominence of this cause of death among all kinds of accidental deaths. This series was one that could potentially have contained large redirection effects, simply because the category is large. No such effects are apparent.

Auto-pedestrian Deaths

Auto-pedestrian accidents are a reasonably common type of fatal accident in the United States, accounting for between 5,000 and 6,000 deaths of Americans in any given year. Like other motor vehicle–involved accidents, the commonness of this cause of death raises questions about what fraction of these accidents in our database are in fact those of undocumented migrants. In two of the nine Border Patrol sectors examined in this study, however, foreign transients are or were at particular risk to death by vehicles. In the San Diego and El Paso sectors, would-be crossers have historically had to navigate busy highways to successfully reach the United States.

Figure 8. Auto-Pedestrian Deaths for Selected Sectors, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	22	2	1	0	4	0	0	1	2	32
1986	21	2	0	2	8	0	0	3	4	40
1987	26	8	1	2	5	0	0	1	4	47
1988	36	6	1	2	10	0	0	0	1	56
1989	34	3	1	0	6	0	0	1	2	47
1990	35	4	0	4	1	2	0	1	1	48
1991	24	4	1	1	9	0	0	0	4	43
1992	16	5	0	2	6	0	0	1	2	32
1993	9	6	0	1	6	0	0	2	2	26
1994	13	4	0	1	1	0	0	0	3	22
1995	5	2	0	1	2	0	0	1	2	13
1996	9	1	1	2	5	0	0	0	0	18
1997	6	4	0	2	2	0	0	2	1	17
1998	5	4	0	2	4	0	0	1	1	17
All	261	55	6	22	69	2	0	14	29	458

In the San Diego sector, the majority of migrant deaths in auto-pedestrian accidents have occurred south of the San Clemente checkpoint on Interstate 5 at San Onofre, just north of the city of San Diego. When Interstate 5 was the principal corridor for northbound migration into the California interior, undocumented migrant groups would ride in vehicles to a location just south of the San Clemente checkpoint in hope of finding the checkpoint closed. If the checkpoint was open, however, the migrants would dash across the northbound lanes of Interstate 5 to a very narrow strip of land between the interstate and the Pacific Ocean. As Figure 8 shows, the number of auto-pedestrian deaths in San Diego remained especially high from 1985 through 1994, averaging about 24 deaths a year. The number of auto-pedestrian deaths was sharply reduced in 1995 after the California Department of Transportation, with the encouragement of the Border Patrol, erected a barrier fence in the median of Interstate 5 running three miles to the south of the Border Patrol's San Clemente checkpoint (interview with Charles Geer, Patrol-Agent-in-Charge, San Clemente Border Patrol Station, June 1998).

In El Paso, would be crossers have historically been at risk of auto-pedestrian accidents while crossing the border highway (Loop 375) that extends from the Paso del Norte Bridge in downtown El Paso to the Zaragoza Bridge. This stretch of highway runs parallel to the Rio Grande River and is an obstacle that would-be migrants must overcome to enter the United States through this stretch of the El Paso corridor. Though certainly not at the frequency of deaths along Interstate 5 in San Diego County, migrants have historically been killed by moving vehicles while dashing across El Paso's high-speed Loop 375.

One of the strategies of Operation Hold-the-Line, an enforcement initiative launched in El Paso in September 1993, was the placement of Border Patrol agents along the levee between the Rio Grande and Loop 375. Stationing Border Patrol agents along the levee virtually eliminated attempts to cross Loop 375 and thereby reduced migrant risk to death by highway auto-pedestrian accidents (Bean et al 1994). Indeed, as our time series data show, the number of auto-pedestrian deaths to foreign transients in the El Paso sector declined substantially in 1994 after Operation Hold-the-Line was implemented, and has remained stable since.

In sum, the downward trend in foreign transient deaths due to auto-pedestrian accidents reflects two factors: 1) the specific solution of the median fence to the dangerous situation created by migrant's response to the San Clemente checkpoint, and 2) the successful deterrence efforts of enforcement initiatives at well established crossing points in San Diego and El Paso.

Because of the relative commonness of pedestrian accidents in the general population, it cannot be presumed that all deaths from auto-pedestrian accidents in places other that those two discussed above occurred among undocumented migrants. Indeed, the only sector where the residual measure of migration flow and the number of auto-pedestrian deaths are correlated is the San Diego sector.

Environmental Deaths

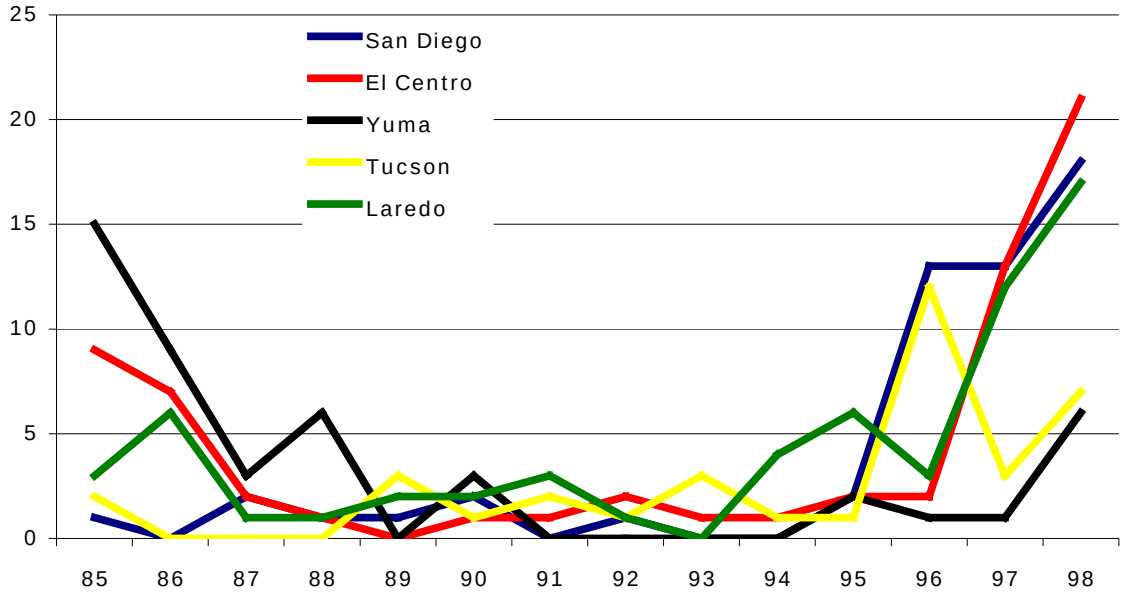
Concern about the effects of the deflection of migration flows from urban to rural crossing points has, first and foremost, been focused on deaths from environmental causes. There is good reason for this concern. The 328 deaths from heat-related causes (267 deaths), hypothermia (53 deaths) and other environmental conditions (8 deaths)

contribute just nine percent of all deaths in our 14-year database, but are 28% of those in 1998. Nor were 84 deaths in 1998 a single year oddity. Deaths due to exposure to harsh environmental conditions (extreme heat or cold) has a striking pattern that closely parallels the fluctuation--and deflection--of undocumented migratory flows into the United States in the southwest border in the study's 14-year time series. The total number of deaths drops steadily from 1985 to 1987. Between 1987 and 1994, environmental causes accounted for three to five percent of all deaths of transient foreigners. Both the numbers and percentage of these deaths increased monotonically thereafter to the extremely high levels (28%) observed in 1998.

When compared to the mortality rate from environmental causes for the resident American population, these death totals are extraordinary. The mortality rate from heat exposure due to weather conditions for Americans under age 55 is substantially less than one per million. Yet in counties on or near the Southwest border, deaths from weather-related heat exposure were more common in 1998 for all foreign-transients (which population includes millions of legal foreign visitors) than were motor vehicle accidents.

The geographical and temporal pattern of increased environmental deaths precisely fits those expected under a model that explains them by the redirection of flows of undocumented migrants. It is important to disaggregate the total count of deaths by area due to exposure to harsh environmental conditions in order to see what is driving the sharp increase in the late 1990s. When this is done, what immediately becomes clear is that the sharpest increase of these deaths occur in the El Centro, eastern San Diego, and Laredo areas. The first two sites were primary areas were migrant flows were re-channeled after the implementation of Operation Gatekeeper in western San Diego County. The patterns for the first two sites follow a sequential pattern consistent with the hypothesis that they emerge as a result of the deflection of undocumented migration by Gatekeeper, beginning in eastern San Diego County in 1996, and in El Centro in 1997.

Figure 9. Death by Environmental Causes, Selected Sectors, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	1	9	15	2	0	0	3	3	0	33
1986	0	7	9	0	0	2	0	6	0	24
1987	2	2	3	0	1	0	0	1	0	9
1988	1	1	6	0	2	0	0	1	0	11
1989	1	0	0	3	1	0	0	2	1	8
1990	2	1	3	1	0	0	1	2	0	10
1991	0	1	0	2	0	0	1	3	4	11
1992	1	2	0	1	0	0	1	1	0	6
1993	0	1	0	3	2	0	0	0	0	6
1994	0	1	0	1	0	0	1	4	2	9
1995	2	2	2	1	0	0	2	6	4	19
1996	13	2	1	12	1	0	6	3	6	44
1997	13	13	1	3	1	0	5	12	6	54
1998	18	21	6	7	1	0	8	17	6	84
All	54	63	46	36	9	2	28	61	29	328

Much farther to the east, in the Laredo sector, a sharp rise in environment-related deaths is also evident after 1997. The Laredo sector is a major, contemporary, crossing point for illegal entrants. Moreover, the stretch from Laredo to interior labor markets such as San Antonio and Houston starts with desolate, arid terrain that is a natural environment to mainly cactuses, rattlesnakes, coyotes and other predatory animals. The terrain is so challenging that the names of some local land tracks have been adopted by tire and truck national manufactures as brand names for their most rugged products. Apprehension data suggest that the Laredo and Del Rio sectors each picked up undocumented migration flows as a result of more effective control of the border in other sectors.

In the hot summer months, migrants trying to trek through these desolate areas add to the count of deaths from heat-related environmental causes As the migratory flow increased in the late 1990s so the did the number of environment-related deaths in the Laredo sector. The post-1993 years also had environment-related death increases in the more remote Del Rio and Marfa sectors in Texas, and in the Yuma sector in Arizona. There is also some possibility that a portion of the increase in registered death totals in this period reflects the swifter recovery of remains of deceased migrants, because of the rapid increase in the number of migrants and Border Patrol agents who now work in remote desert and ranch terrain. Migrants who have passed through the south Texas region frequently report coming upon the skeletal remains of less fortunate migrants.

The data suggest that there are essentially no rural parts of the border that are safe to enter on a cross-country trek. While the Marfa and Yuma sectors show the fewest deaths in recent years, this occurs essentially because this terrain may be the most difficult to cross (see Annerino 1999 for a discussion of the difficult conditions in the Yuma area). These patterns indicate that the death risks migrants face due to harsh environmental conditions are a common denominator across the border in the areas to which undocumented EWIs have increasingly been re-directed.

Analysis of the statistical relationship between migration flow and environmental deaths confirms what is obvious both the spatial patterns. There is a strong correlation between each sector-specific residual migration flow indicator and heat-related deaths, except for El Paso and San Diego. These correlations corroborate what is obvious from the extreme rarity of this type of death: heat-related deaths occur overwhelmingly in the context of undocumented border crossing, so that the volume of undocumented flow throw a sector is the principal predictor of the occurrence of these deaths. The two exceptional sectors, El Paso and San Diego, are consistent with the rule. They are the two primary "deflect from" sites of urban-targeted enforcement. In these cases, cross-country treks, with their associated environmental risks, increased within sector but away from the zone of intensified urban enforcement. The rising death totals from environmental causes in these two sectors occurred at the same time that overall undocumented migration was declining within them.

One important question about environmental deaths concerns the extent to which variation in these rates is explained by variations in temperature rather than by variations in the magnitude and direction of migration flow. Eight-five percent of heat-related deaths occur in June though September. But do heat-related death counts increase during particularly hot summers? What is the magnitude of such effects compared to the effect of redistributed migration flow?

One reason that these questions are interesting is that the final year of our panel, 1998, was the year with the highest number of deaths from heat-related causes. The central and south Texas region also experienced the hottest summer in the study period in this year. In Laredo, Texas, monthly mean temperatures were 4.6 degrees Fahrenheit above the 20th century average in May, 5.3 degrees above average in June, 3.3 degrees above average in July, and 0.1 degrees above average in August, and 1.4 degrees above

average in September. The El Centro-Yuma-Tucson temperatures were not so extreme, but were slightly above average in July (+1.3 degrees in El Centro) and especially in August (+4.6 degrees in El Centro). This was the hottest August in these sectors in the study period, and it was in August that heat-related deaths were concentrated in these sectors in this year. Was it the unusually hot weather that explains the unusual number of heat-related deaths this year?

To address these questions about weather effects, we estimated poisson models in which we regressed monthly deaths from heat-related environmental causes on our residual measure of migration flow (all sectors pooled), the monthly mean temperature in the Laredo area in Texas, and deviations from monthly means in the Laredo and El Centro areas. The monthly mean is invariant throughout the study period, and captures the strong effects of seasonal differences in temperature on heat-related deaths. Though it is measured at only one place at the border, the correlation between this variable and the same variable in all other sectors is nearly perfect (r=.99 for most pairwise comparisons). The two deviation measures capture the month-to-month variations around these means. This variable is measured at two places on the border—El Centro and Laredo—because these two sectors record the largest number of environmental deaths. The deviation measures for these two sectors are strongly correlated with those for adjacent sectors (Del Rio and McAllen for Laredo; Yuma and Tucson for El Centro) such that additional temperature deviation measures produce problems of multi-collinearity. Measures of drought conditions in the same sectors were dropped from the model because they did not reveal significant relationships with temperature variables in the model.

We then estimated two models that added two alternative measures of migration flow through the sectors from El Centro to Tucson and from Del Rio to McAllen. The first was simply the proportion of all apprehensions that occurred in one of these six sectors. This measure follows a U-shaped path between 1985 and 1998. In 1985, 41% of apprehensions were in these sectors. This figure declines to 28% in 1992, before rising after Hold-the-Line and Gatekeeper to 75% in 1998. The second model uses the apprehensions-residual measures of migration through the Laredo and El Centro sectors. The models include a 12-month lag on the dependent variable because of the seasonality of the heat-death series, and assumes that the series is first-order auto-regressive.

Table 1. Poisson models of monthly heat-related environmental deaths

Variables	Coefficients (Standard Errors)		
	(1)	(2)	(3)
Migration Flow-Full Border (Apprehension Residual)	0.925* (0.4441)	0.196 (0.4877)	1.827*** (0.4885)
Mean Temperature for Month in Laredo (Constant across years)	0.1378*** (0.0153)	0.146*** (0.0146)	0.148*** (0.0151)
Deviation from monthly mean-El Centro	0.0125 (0.0243)	0.034 (0.0234)	0.031 (0.0234)
Deviation from monthly mean-Laredo	0.213*** (0.359)	0.1278*** (0.0376)	0.102** (0.0391)
Percent apprehensions in 6 "deflect to" sectors[a]			4.089*** (0.5660)
Migration Flow—Laredo Sector (Apprehension Residual		0.580*** (0.1091)	
Migration Flow—El Centro Sector (Apprehension Residual)		0.980** (0.3813)	
12 month lag of deaths	0.107*** (0.0124)	0.0520*** (0.0152)	0.047** (0.0469)
Constant	-10.943*** (1.263)	-13.158*** (1.243)	-13.595*** (1.3219)
Wald Chi sq. (d.f.)	266.11 (5)	345.59 (7)	330.61 (6)

a) Sectors are El Centro, Yuma, Tucson, Del Rio, Laredo, McAllen.
* $p < .05$ ** $p < .01$ *** $p < .001$

The resulting models confirm expected relationships (Table 1). Monthly mean temperature has a substantial relationship to the number of deaths. Monthly deviations—the annually variable component of the temperature series, have a relative weak relationship, and only the Laredo deviation shows a statistically significant relationship in the final models. The border-wide migration flow measure is positively associated with the number of deaths in two models, and the sector-specific flow measures show a substantial relationship to heat-related deaths.

We use the third model to predict the number of deaths that would have occurred in 1998 under different scenarios reflecting assumptions about the spatial distribution of undocumented migration along the border and variation in temperature. The results imply that the overwhelming majority of the increase in heat-related deaths in 1998 compared to previous years is attributable to the redirection of undocumented migration to central/south Texas and to the El Centro/Arizona corridors. The first row of Table 2 reports that 69 heat-related deaths were observed in 1998. The second row reports that the model predicted 68 deaths for this year, assuming the observed values of the right-hand side variables in the model—a close fit to the observed number of deaths. The third row reports that if all positive deviations of the two monthly temperature series were reset to zero, but with migration flows distributed as actually observed in 1998, we would expect about 50 deaths. This assumption would imply a scenario in which monthly mean temperatures never exceeded their long run average for a given month, with the spatial distribution of migration exactly as it occurred. This scenario implies a substantial decrease in the number of deaths, indicating that the high summer temperatures did contribute to the high number of deaths in this year. If both temperatures and the volume

of migration flows remain as actually observed in 1998, but with the apprehensions distributed as they were in the period between 1985-1992 (approximately 2/3rd in the El Paso or San Diego sectors), then expected heat-related deaths drop to 13. Adjusting temperature levels to never exceed monthly means removes three additional deaths.

Table 2. Estimated Number of Heat-Related Deaths under Various Scenarios

Assumptions	Number of Deaths
Actually Observed Number of Heat-Related Deaths	69
Predicted: All Variables as Observed in 1998	68
Predicted: Monthly Temperature Deviations > 0 are set equal to 0 All other variables as observed in 1998	50
Predicted: Percent apprehended in 6 "redirect-to" sectors are set equal to 1985-1992 average (34%) All other variables as observed in 1998	13
Predicted: Monthly Temperature Deviations > 0 are set equal to 0 Percent apprehended in 6 "redirect-to" sectors are set equal to 1985-1992 average (34%) All other variables as observed in 1998	10

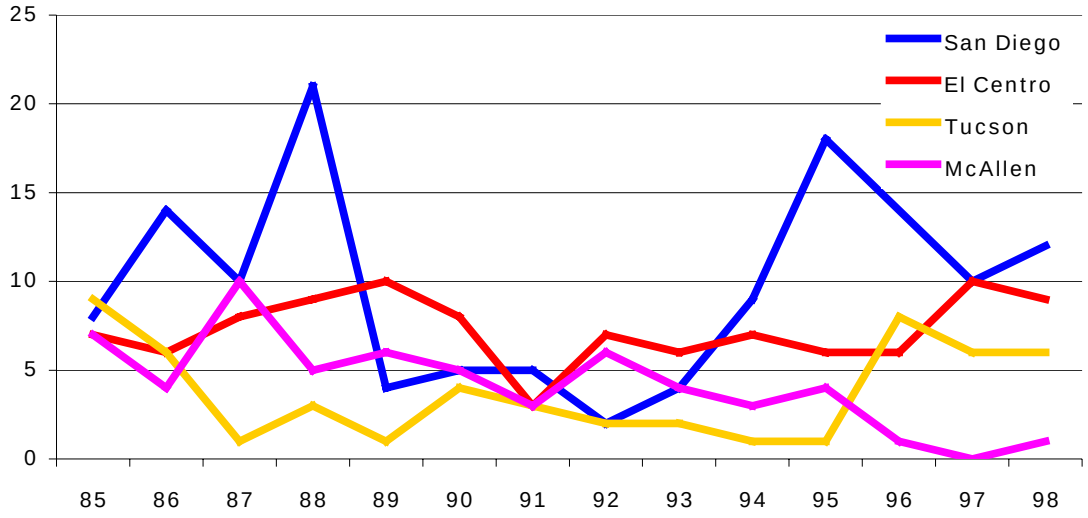
All the findings about heat-related environmental deaths tell a consistent story. Cross-country treks through the southwestern deserts and ranch lands are dangerous for persons who are not experienced and equipped for such activities. During the period of high undocumented migration flows in the mid-1980s, many immigrants undertook such journeys, with consequently high mortality from weather-related causes. Between 1987 and 1994, the number of such deaths was reduced to the range of about 10 per year. At that point, increased, urban-targeted border enforcement redirected a substantial portion of undocumented migrant flows back to traditional rural crossing corridors, and deaths from environmental causes have attained unprecedented levels.

Hypothermia deaths fit the same model as well. Half of environmental deaths from exposure to cold temperatures (26 deaths) occur in San Diego County. Among these deaths, 21 occur in the period between 1996 and 1998. These deaths primarily occur in the mountains of east San Diego County, an area known for its "long thermometer," in which temperatures drop precipitously from daytime highs to nighttime lows. This mountainous region emerged as a more prominent crossing corridor after Operation Gatekeeper effectively closed western San Diego crossing points.

Cause of Death Unknown

When cause of death is reported as unknown on a death certificate, the discovered corpse is usually so decomposed or dismembered that it is impossible to determine the cause of death. In some cases, only skeletal remains identify the dead. Despite these shortcomings, the coroners, medical examiner investigators, and sheriffs we interviewed along the border agreed with our assessment that many of the reported 432 deaths from unknown causes during the 1985-1998 study period are undocumented migrant crossing deaths. Coroners have compared the skeletal remains to descriptions of missing person's lists and have determined that they do not meet any of those criteria. Thus, these officials believe that those factors, in conjunction with the isolated location where the bodies are found, provide evidence that these were in fact undocumented migrants.

Figure 10. Unknown Causes of Death, Selected Sectors 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	1	9	15	2	0	0	3	3	0	33
1986	0	7	9	0	0	2	0	6	0	24
1987	2	2	3	0	1	0	0	1	0	9
1988	1	1	6	0	2	0	0	1	0	11
1989	1	0	0	3	1	0	0	2	1	8
1990	2	1	3	1	0	0	1	2	0	10
1991	0	1	0	2	0	0	1	3	4	11
1992	1	2	0	1	0	0	1	1	0	6
1993	0	1	0	3	2	0	0	0	0	6
1994	0	1	0	1	0	0	1	4	2	9
1995	2	2	2	1	0	0	2	6	4	19
1996	13	2	1	12	1	0	6	3	6	44
1997	13	13	1	3	1	0	5	12	6	54
1998	18	21	6	7	1	0	8	17	6	84
All	54	63	46	36	9	2	28	61	29	328

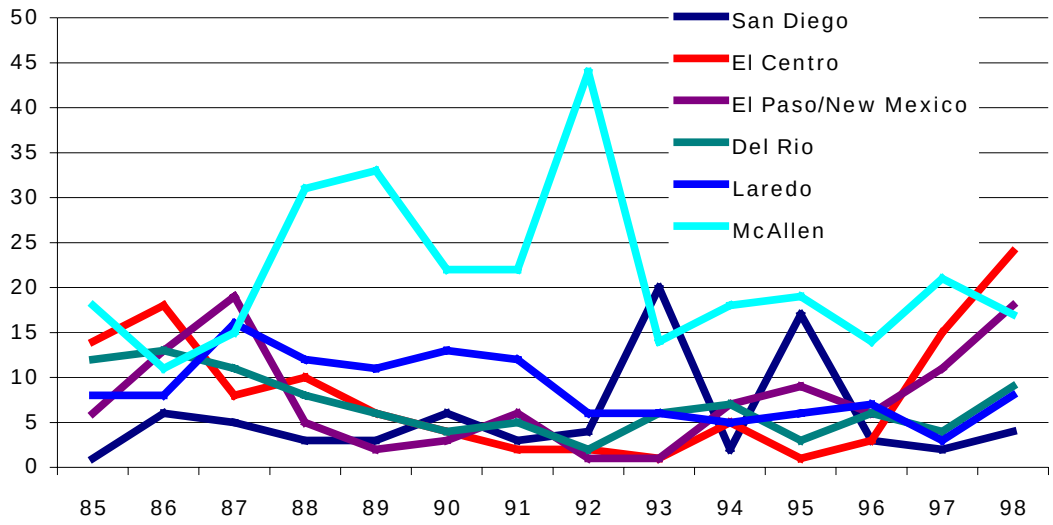
As Figure 10 shows, deaths from unknown causes appear to be directly related to levels of undocumented flows. Death totals are high in the mid-1980s in San Diego and El Centro, reflecting the large flows that passed through these well-established crossing corridors during that period. The reduction in deaths to unknown causes in the early and mid-1990s is consistent with a reduction in migration flows during this period. Recall that deaths due to all causes declined during the late 1980s and early 1990s and resumed high levels in the mid to late 1990s following increases and redirections of undocumented flows. Deaths to unknown causes follow the same pattern, beginning to rise again in the mid 1990s in several sectors, but especially in San Diego, followed by El Centro and Tucson. One possible additional explanation of increases in deaths from unknown causes is that the additional traffic by migrants and Border Patrol agents in remote areas has increased the rate at which skeletal remains are discovered in remote areas.

Given the condition and location of the corpses when discovered, it is also likely that deaths from unknown causes are an extension of environmental deaths. Many of the decomposed bodies discovered in San Diego were found in the desolate mountains and canyons in the eastern part of San Diego. Similarly, the skeletal remains discovered in the Tucson sector were found in the desert corridor between Lukeville and Tucson, including the Tohono O'Odham Indian Reservation. Because so many of these bodies are found in remote areas like the Arizona deserts, sheriffs, police officers, and Border Patrol agents alike suspect that there are more bodies of migrants that remain undiscovered along the border (Annerino 1999).

Drowning

Drowning is the most common cause of death reported in the database, accounting for 860 deaths, or almost one-quarter of all deaths for the 14-year study period. The McAllen sector had the most drowning deaths, with 299 (35% of the total.) In the late 1980s, McAllen typically contributed more than half of all drowning deaths, and reported 44 in 1992. All other Rio Grande border sectors except generally unpopulated Marfa contribute an appreciable total. The El Centro sector emerges in 1997 as a major center of drowning deaths after a period of relative quiet since 1990. The All American Canal is the chief site of deaths in this sector. Yuma—which is bordered by the Colorado River— has relatively few deaths for this cause, with these concentrated in the 1980s. In the Tucson sector, eight of 20 recorded drowning deaths occurred in a single day in 1997, when eight undocumented migrants were trapped in a storm sewer beneath Douglas, Arizona.

Figure 11a. Drowning Deaths for Selected Sectors, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso/ New Mexico	Marfa	Del Rio	Laredo	McAllen	All
1985	1	14	7	1	6	0	12	8	18	67
1986	6	18	4	1	13	1	13	8	11	75
1987	5	8	3	0	19	0	11	16	15	77
1988	3	10	0	2	5	0	8	12	31	71
1989	3	6	0	3	2	0	6	11	33	64
1990	6	4	0	0	3	1	4	13	22	53
1991	3	2	1	0	6	0	5	12	22	51
1992	4	2	1	0	1	0	2	6	44	60
1993	20	1	0	1	1	0	6	6	14	49
1994	2	5	0	3	7	1	7	5	18	48
1995	17	1	0	0	9	1	3	6	19	56
1996	3	3	1	0	6	0	6	7	14	40
1997	2	15	3	9	11	0	4	3	21	68
1998	4	24	1	0	18	0	9	8	17	81
All	79	113	21	20	107	4	96	121	299	860

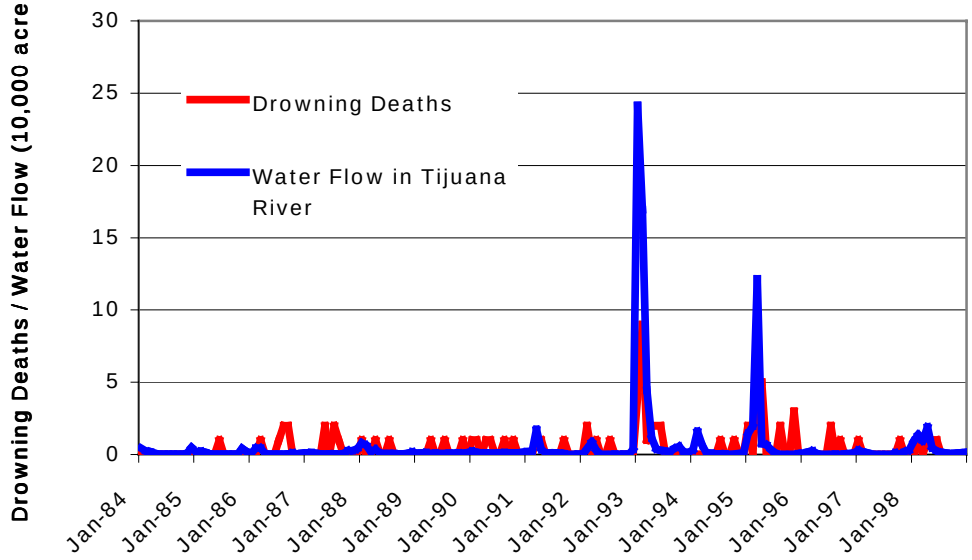
Drowning deaths raise separate analytic issues in the different places where they occur: San Diego, El Centro and along the Rio Grande. We address each in turn.

San Diego

San Diego records relatively few drowning deaths—79 in the entire study period. The majority of these occur in two years—1993 and 1995. A large majority of these deaths occurred in the Tijuana River. The Tijuana River crosses the border from Mexico to the United States at an acute angle, about five miles east of the Pacific Ocean at Imperial Beach, and just over half a mile to the west of the termination of Interstate 5 at the San Ysidro port of entry. The river is thus a part of a section of the border that, before Operation Gatekeeper, was *the* primary crossing point for undocumented migration to the United States.

At the point that it crosses the border, the Tijuana River is a paved channel for storm run-off that typically lacks significant water flow. Measured water flow was zero for nine months in the 15 years between 1984 and 1998; it totaled below 1000 acre feet for 93 of these 180 months, and was above 10,000 acre feet just 10 months in this period. In flooding in January/February 1993, water flow exceeded 410,000 acre-feet in a two-month period, and continued at 45,000 acre-feet in March. In March 1995, the channel again flooded to 122,000 acre-feet. Of the 79 drowning deaths of foreign transients and unidentified persons in San Diego County, 30 were recorded within four months of these two incidents, when bodies were discovered after floodwaters receded.

Figure 11b. Drowning Deaths of Foreign Transients in San Diego Sector and Water Flow in Tijuana River, 1984-1998



San Diego medical examiner's investigators included the 1993 and 1995 Tijuana River drowning victims in a list of probable undocumented migrant fatalities. The timing of these flood events before and after the implement action of Operation Gatekeeper is coincidental. The deaths do not imply any redirection effect of sector-specific enforcement, nor do the subsequent reduction of deaths from this cause imply an enforcement-related mortality reduction. It is likely that future Tijuana River flooding will result in fewer deaths, because of the elimination of this area as a major crossing corridor. However, through December 2000, the Tijuana River had not surpassed a water flow of 20,000 acre-feet in any month since the 1995 flood.

Except for the flood years of 1993 and 1995, drowning death totals for foreign transients for the two sector counties in our study area (San Diego and Orange) never exceed six in any year. This is a moderate total for two counties with a coastline, numerous interior streams, and a large population of legal foreign visitors. Poisson

regression models show a slight positive association between our apprehension-residual measure of undocumented migration through the San Diego sector and monthly drowning death counts that is not statistically significant.

Imperial County

The primary water hazard in Imperial County, California, is the All-American Canal. This canal carries water diverted from the Colorado River at the Imperial Dam north of Yuma, Arizona, for hydroelectric generation and irrigation in the Imperial Irrigation District. The canal travels 82 miles, generally paralleling the U.S.-Mexico border, and drops 175 feet over its course. There are hydroelectric generation stations at the canal's five drops, and at other points. Water flow in April and July peaks typically exceeds 300,000 acre-feet for the month through the canal's Drop 1. The canal is 150 to 200 feet wide and 7-20 feet deep (Imperial Immigration District Fact Sheet and Water Control Division Flow Reports).

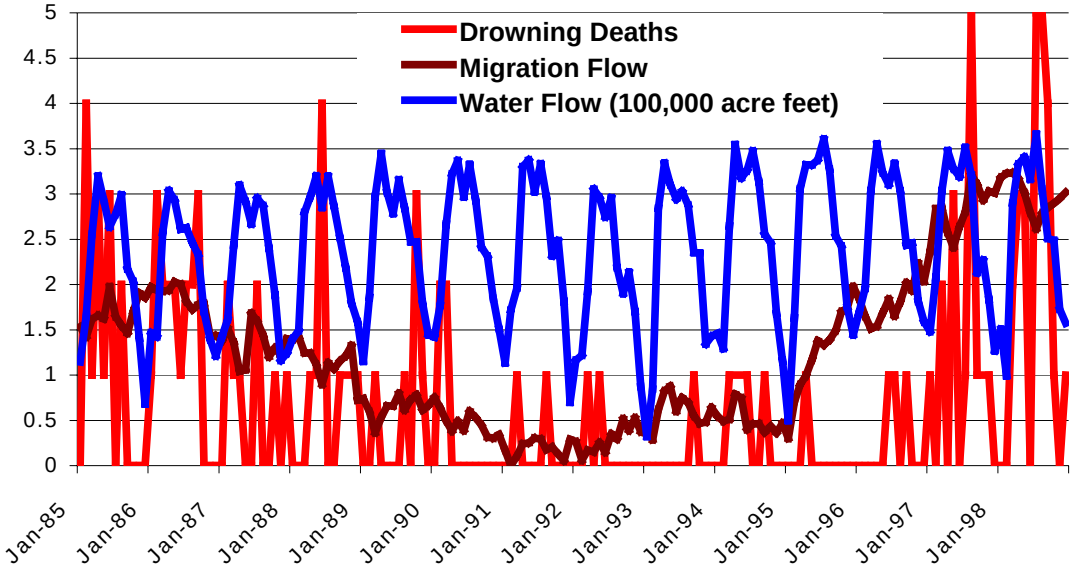
Drowning deaths of foreign transients in the All American Canal are primarily those of undocumented migrants. The canal is dangerous because of its swift flow. The Sheriff's department in Imperial County reported that children from the abutting Mexican community of Mexicali have, on occasion, drowned in the canal, and that in such instances Mexican authorities will typically retrieve the body so that the death will go unrecorded in U.S. vital registration databases.

Figure 11c shows the strong relation between undocumented migration flow through the El Centro sector, and drowning deaths in the sector. The figure charts these two monthly series, as well as the monthly water flow volumes (100,000 acre-feet) in the

canal. The water flow volume has a strong seasonal pattern, reflecting the scheduled management of irrigation releases, with slightly higher peaks towards the end of the series. Both the migration flow and the drowning death series show a strong U-shaped pattern, with deaths and inferred migration flows highest in the late 1980s, and then rising sharply after 1996.

A poisson regression model explaining monthly deaths as a function of water flow and migration flow confirms that both variables are strongly associated with the monthly count of drowning deaths in this sector. The magnitude of the migration flow effect implies that had migration flow volumes attained the levels in 1992 that they did in 1998, deaths would have totaled 15 in that year, instead of the two that are observed and predicted by the model.

Figure 11c. Monthly Drowning Deaths and Migration Flow Through El Centro Sector, Water Flow in All American Canal, 1985-1998



Rio Grande

Drowning deaths in the Texas Border area present a more complex picture. Drowning deaths in counties bordering the Rio Grande contribute 627 drowning deaths over the 14-year study period. This is approximately one-sixth of the deaths for the entire study period for all causes. The largest number of these deaths occurred in Hidalgo and Cameron counties in the McAllen sector, particularly through 1992. The Laredo and Del Rio sectors each contributed a substantial number of drowning deaths in this same period. For each of these three sectors, drowning totals are generally flat after 1993. In El Paso, by contrast, drowning death totals increased at the end of the series, particularly in 1997 and 1998. It should be remembered that the river is shared between two nations, and that the figures reported in this paper are those from United States vital registration data only. Less systematic evidence collected from local officials in Mexico suggest that Mexican officials handle a like number of cases (Eschbach et al 1999).

One persistent question about Rio Grande drowning deaths concerns to what extent these deaths are those of undocumented border crossers, and to what extent they are those of residents of Mexican communities that border the Rio Grande who die during some other activity than undocumented migration. Law enforcement officials and health personnel on both sides of the border opined that many of the decedents were undocumented migrants, but such evidence is not systematic. Mexican communities bordering the river have populations totaling in the millions, and some members of these communities use the river and its banks for recreation and household chores. It seems certain that at least some portion of the deaths in the river pertains to the non-migrating population of these communities.

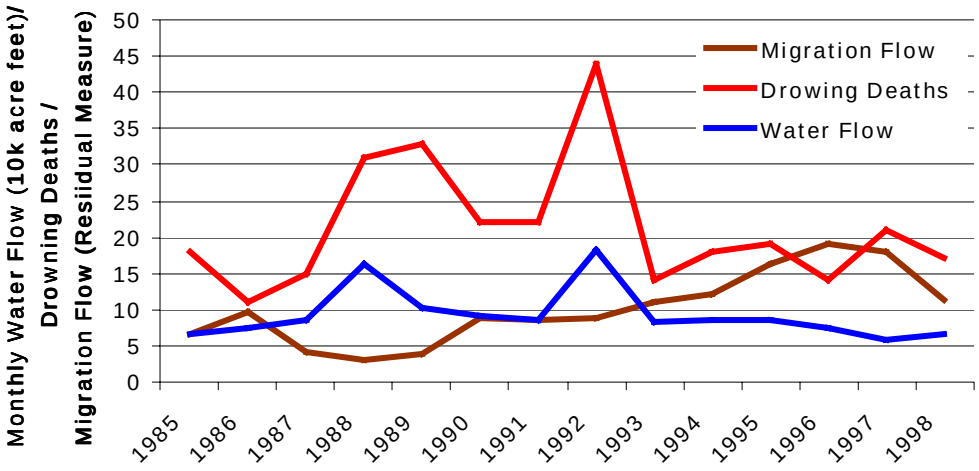
A second question about Rio Grande drowning concerns the relative importance of river flow volume and migration flow as an explanation of levels of drowning death. Water flow through the Rio Grande is much more variable than is water flow through the All-American Canal and the Tijuana River. Water flow in the Rio Grande is determined in part by irrigation cycles, with significant irrigation releases in the spring. However, the river flow is subjected (like the Tijuana River and unlike the All-American Canal) to periodic flooding, and to long cycles of fluctuation reflecting the precipitation and drought conditions within its watershed.

In the last several years of the study period, the watershed of the Rio Grande has experienced severe drought conditions. This has occurred at just the time that targeted enforcement redirected increased migration to this section of the border. By contrast, in the early 1990s, river flow was generally much higher, while migration flow was relatively low. As a result, cross-correlograms show that water flow in the river and migration flow through the McAllen, Laredo and Del Rio sectors are strongly and negatively correlated in the current period. There is no reason to suspect that a causal relation exists between river flow volume and migrants' decisions about whether to cross over the Rio Grande rather than to choose some other crossing route. The coincidence however, means that increasing streams of migrants have been fortunate that the river is a less formidable barrier than in past years

An examination of Figure 11d, which compares the graph comparing the time paths of drowning deaths, water flow below the Anzalduas Dam, and migration flow for the McAllen sector suggests that water flow is much the more important determinant than migration flow. (This fact is confirmed in multivariate poisson regression models, in

which migration flow is negatively but insignificantly correlated with drowning death counts.)

Figure 11d. Water Flow in Rio Grande, Migration Flow and Drowning Deaths, McAllen Sector, 1985-1998



Water flow in the segment of the river below the Amistad Reservoir has been particularly far below historic levels in recent years. This section of the river forms the international border for both the Del Rio and Laredo sectors. Water flow below the reservoir averaged 2.2 million acre-feet per year for the years between 1985 and 1994, but just 1.1 million acre-feet between 1995 and 1998. As in the McAllen sector, water flow is correlated with monthly drowning death totals, but migration flow measured with apprehension-residuals is not.

Water flow conditions in El Paso are substantially different from those south of the Amistad Reservoir. Water flows through El Paso were not unusually low in the late 1990s. In El Paso, more than the main channel of the river, the swift-flowing irrigation canals paralleling the river may pose the greatest danger to migrants. Drowning death

totals increased sharply for this county in 1998. El Paso sector border patrol officials attributed this result to the opening of a new canal segment in that year.

This survey of the drowning deaths in different parts of the border finds several key facts. 1) Drowning has historically been the quantitatively most important accidental cause of death of foreign transients, and probably of undocumented immigrants, in the border region, accounting for almost a quarter of deaths in the database. 2) There is little evidence that the changing conditions of crossing have affected drowning death totals except in one place—the All-American canal in Imperial County, California in the El Centro Border Patrol Sector. 3) South Texas east and south of Del Rio, and particularly the lower Rio Grande Valley (McAllen sector), are the primary spots on the border where these drowning deaths have occurred. It appears, however, that water flow rather than migration flow explains the time trend in this segment of the river, as it does in the Tijuana River in California. Because drowning accounts for such a large portion of deaths, sharp fluctuations in water levels can have a dramatic impact on the overall safety of undocumented migration.

That there are no readily apparent re-direction effects of enforcement with respect to Rio Grande drowning seems reasonable for two reasons. The first reason is simply the low water flow volume in the south Texas portion of the river since 1995, reducing the probability of drowning. Second, the river is a constant rather than a variable feature of the Texas-Mexico border. Whether a migrant crosses in an urban or rural location, he or she needs to get across the river. Redirections of migration to different points along the river are not, a priori, re-directions to more dangerous locations. In fact, the immediate El Paso border may be the most dangerous river crossing point on the Texas border

because its canal system forms an additional danger to migrants. Re-direction of undocumented migration from the city of El Paso itself is thus a re-direction away from a serious hazard. Perhaps the re-directed migrant will encounter greater dangers at another spot, but perhaps not. In either case, it will not necessarily be the case that re-direction from El Paso to other areas would lead to an expected increase in deaths by drowning.

One question that remains about drowning in the Rio Grande is whether future increases in water flow, when they occur, will interact with the growing prominence of the Del Rio sector as corridor of undocumented migration to increase the number of drowning deaths in that segment of the border.

Homicide

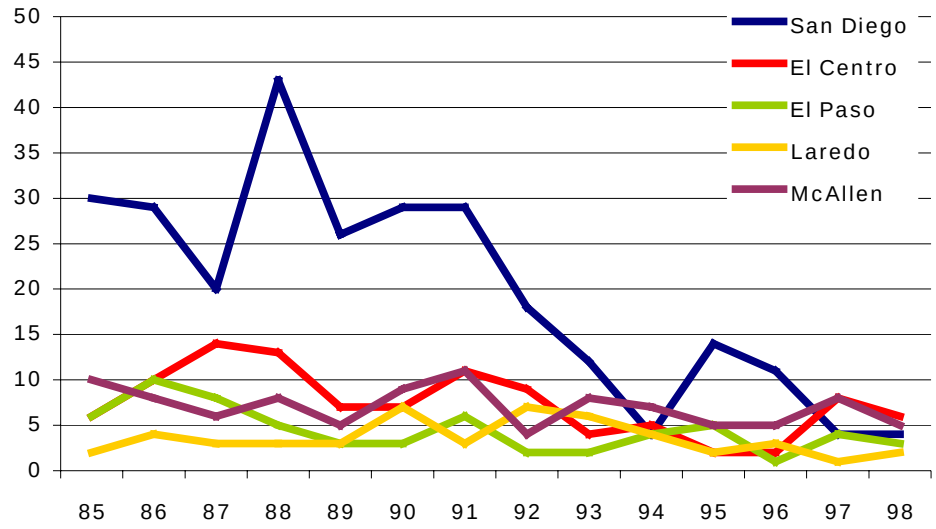
The assault and murder of undocumented migrants during their northbound journey has long been an important element of the folklore of border crossing. Migrants may be vulnerable because of their need to carry cash to finance their northbound journey, and because of their need to place trust in strangers (traveling companions and smugglers) during their northbound journey. Personal accounts of migrant journeys frequently cite the migrants' mistrust of both local police in the U.S. and Mexico and Border Patrol agents. This mistrust has the important secondary effect of cutting the migrant off from the protection of law enforcement agents. The need to cross in remote areas of the border makes the migrant vulnerable to assault and murder by criminals working the border area. Criminals working these areas have the advantage that the migrants are deliberately selecting areas for their absence of Border Patrol or other law enforcement presence. The borderline is also an impenetrable barrier for the law

enforcement agents of both Mexico and United States, while the criminal may easily cross it.

The western San Diego County border in the late 1980s and early 1990s was notoriously an area of considerable danger to the migrants. Undocumented migrants gathered for their attempts to run the gauntlet of U.S. border enforcement into the interior of the United States on the U.S. side of the borderline. Mexican police have no jurisdiction in this area. The Border Patrol concentrated its resources on preventing penetration to the interior, and did not contest the migrants' effective seizure of the border area. As a result, the immediate border area was effectively out of control of any law enforcement authority. In this void migrants were vulnerable to attacks by bandits working the border area. Joseph Wambaugh (1984) dramatized the disorder in a colorful account of the San Diego border crimes unit. Newspaper accounts in this period also documented the frequency of attacks on migrants.

In an interview with one of the coauthors, Gus de la Vina and Johnny Williams (respectively Western regional director and San Diego sector chief at the time of Operation Gatekeeper, now Chief, U.S. Border Patrol and Western regional director), pointed to a determination to rectify this state of affairs as one of the primary motives in increasing Border Patrol control of the San Diego border area in the years leading up to the implementation of Operation Gatekeeper. In the aftermath of the Gatekeeper initiative, INS officials claimed the restoration of order and reduction of crime in the San Diego border area as evidence of the successes of intensified enforcement (Meissner 1997).

Figure 12. Homicide Deaths for Selected Sectors



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	30	6	4	10	6	0	1	2	10	69
1986	29	10	0	9	10	1	0	4	8	71
1987	20	14	0	9	8	1	1	3	6	62
1988	43	13	0	0	5	1	0	3	8	73
1989	26	7	0	1	3	0	2	3	5	47
1990	29	7	0	0	3	0	1	7	9	56
1991	29	11	0	0	6	0	4	3	11	64
1992	18	9	0	1	2	0	0	7	4	41
1993	12	4	0	0	2	0	3	6	8	35
1994	4	5	0	0	4	0	3	4	7	27
1995	14	2	0	1	5	0	2	2	5	31
1996	11	2	0	0	1	1	2	3	5	25
1997	4	8	0	1	4	0	1	1	8	27
1998	4	6	0	0	3	0	0	2	5	20
All	273	104	4	32	62	4	20	50	99	648

Trends and Spatial Distribution of Homicide

There were 648 recorded homicide deaths in the 14-year study period (Figure 12). Homicide deaths peaked in 1988 at 73 deaths. Homicides declined by nearly 70% between 1991 (64 deaths) and 1998 (20 deaths). Among these decedents a striking, 41 (6%) were killed by a law enforcement agent, encompassing Border Patrol, customs agents, and other federal, state, and local police. Vital registration data do not identify the specific police agency that was involved in a particular homicide.

Spatial and temporal patterns in the data are generally consistent with the claim that increased and targeted enforcement in the San Diego border area has reduced the incidence of homicidal assaults in the border. San Diego County accounted for 42% of all deaths over the entire study period and area. San Diego's share of homicides was generally highest in the late 1980s and early 1990s. In the five year period from 1988 to 1992, the 145 deaths in the San Diego sector counties were just over half (52%) of the deaths reported in the entire study area. In the five year period between 1994 and 1998, the San Diego sector counties had fallen to just 37 deaths, and accounted for just 30% of the deaths in the entire border area.

There is no evidence that the decline in homicide deaths in San Diego occurred through a redistribution of these deaths to other areas. Rather, San Diego's share declined because the decline in homicides in this sector was faster than the decline elsewhere. In the remainder of the study area, homicide deaths of foreign transients peaked at the beginning of the study period—there were 174 homicides between 1985 and 1989, and 93 between 1994 and 1998.

Despite the decreases in homicide totals reported in U.S. vital registration data, criminals do continue to target migrants at remote border crossing areas, on both sides of the border. Agents in the San Diego Border Patrol sector still routinely encounter migrants who require medical attention for injuries sustained in assaults in the border area (communication from Ralph Thomas, USBP, San Diego).

One question that arises concerns how many foreign transient murder victims were undocumented border crossers. We investigated this point by searching the online archives of the *San Diego Union* for press accounts of the deaths as these were reported within a two-week window of the death or the discovery of the body. Among the 38 deaths that we could match, 13 were reported as deaths of undocumented migrants in the act of crossing, or as occurring at or near the border. In another four cases, law enforcement officials described the decedents as border bandits. (Human rights activists disputed some of these attributions.) A large number of the deaths occurred outside of the border area, and could not be attributed to undocumented migrants.

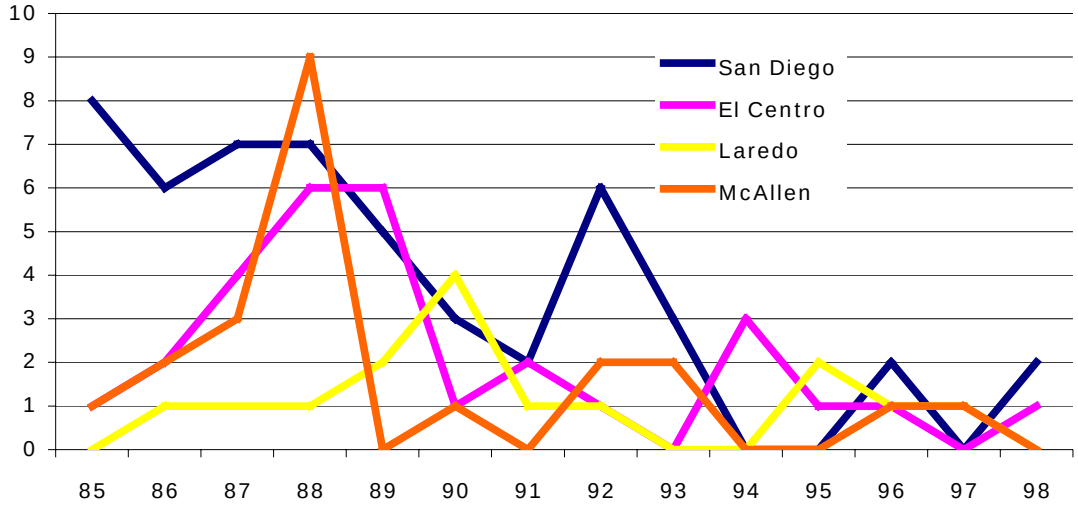
It would be simplistic to imply that enhanced border enforcement in the San Diego Sector or elsewhere was entirely responsible for drops in homicides among foreign transients (and others) in and near the city of San Diego, in a period in which the homicide rate in the United States was more generally in secular decline. At the same time, the increased control of the sector's western edge did reduce a significant mortality risk, if only by reducing the number of migrants passing through the area. It is not clear to what extent the risks were simply redistributed—the El Centro sector does experience a small increase in homicides in 1997 and 1998 while migration flows were increasing

there. Otherwise, however, the entire study area generally reported fewer homicides each year after Gatekeeper than did San Diego by itself in the late 1980s.

All Other Causes of Death

All other causes of death is a residual category encompassing all other accidental death types that we saw as possibly emerging from undocumented migration. These include poisoning, falls, fractures, fires, and animal bites. The most important fact about this series is that it contains relatively few cases—152 for the entire 14 year period. There are a declining number of cases in this category over time. The single worst year for deaths of this type was 1998. In an accident that year, a roof collapsed on a store in Brownsville, Texas, killing 14, including 8 non-citizens. This incident was not related to undocumented migration.

Figure 13. All Other Causes of Death by Selected Sector, 1985-1998



Year	San Diego	El Centro	Yuma	Tucson	El Paso	Marfa	Del Rio	Laredo	McAllen	All
1985	8	1	1	0	2	0	0	0	1	13
1986	6	2	0	0	1	0	1	1	2	13
1987	7	4	0	0	0	0	2	1	3	17
1988	7	6	2	2	2	1	0	1	9	30
1989	5	6	0	1	3	0	2	2	0	19
1990	3	1	0	0	0	0	0	4	1	9
1991	2	2	0	1	3	0	0	1	0	9
1992	6	1	0	0	1	0	0	1	2	11
1993	3	0	0	0	1	0	1	0	2	7
1994	0	3	0	2	1	0	0	0	0	6
1995	0	1	0	0	0	0	1	2	0	4
1996	2	1	0	1	1	0	2	1	1	9
1997	0	0	0	0	0	0	0	1	1	2
1998	2	1	0	0	0	0	0	0	0	3
All	51	29	3	7	15	1	9	15	22	152

Conclusions

This survey has attempted to review comprehensively how changes in the structure of undocumented migration have also changed patterns of migrant mortality. We have done so by using what we believe to be the only systematic source of information about mortality in this population that can takes us back to before the implementation of those policies in the early to middle 1990s: vital registration death data. We acknowledge that it is an imperfect data source for this purpose. It does not classify deaths as those of undocumented migrants. Some of its records may be miscoded. Some cases are missing from its tabulations because officials never discovered the deaths. Nonetheless, we believe that we have been able to learn a good deal from this exercise about principal trends in migrant mortality.

The most important empirical result has been to confirm that undocumented migrants have come to experience an extraordinarily high rate of mortality from heat exposure and other weather-related causes. Levels of mortality from this cause are substantially higher than they were in the mid-1980s, when undocumented migration flows were probably somewhat larger than they are today. These increases are particularly disturbing for two reasons. First, most credible observers who work in the southwestern environment suggest that the observed deaths represent some portion of the total that occur, with the remainder of bodies undiscovered. Second, if the current structuring and magnitude of enforcement and migration flow continue, there seems to be no end in sight for deaths of this type. Further iterations of the cat-and-mouse game

between migrant and border enforcers seem unlikely to make matters any better, given the difficulty of the terrain on which the "game" is being played.

The other obvious secular increase that we see in migrant mortality at the border lies in the dangers of the border near to Imperial County, California, and Yuma, Arizona. These have long been among the most dangerous spots on the border because of their fast moving waters, and their waterless deserts. It is unfortunate that Imperial County in particular was left so exposed as a primary corridor for migration that was deflected from the Tijuana/San Diego border. Deployment of border enforcement resources and effective barrier construction can reduce the dangers of undocumented crossing when they effectively re-direct attempted EWIs away from hazardous crossing points. The El Centro sector came to perceived as a relatively easy place to beat the Border Patrol in the late 1990s because growth in enforcement resources there did not keep pace with the growth to the east and west. The physical challenges of the natural and built environment in this sector appear to be among the deadliest on the border.

Counterbalancing these increasing dangers in recent years, our research also calls attention to the dangers of the situation at the border at San Diego and other urban crossing points before Operation Gatekeeper. These areas had their own dangers and associated mortality rates, with murder and auto-pedestrian accidents being most visible in San Diego. In strictly quantitative terms, net changes in the mortality of "foreign transients" in the border regions have been subtle, though the mix of locations and reasons for the deaths have changed. We also note that with a slightly longer view than has been customary recently, there are some respects in which the mortality patterns we

see today are like those of the mid-1980s, when there were significant undocumented migration flows through some of the same rural corridors that are used today.

A third finding, a little surprising to us, is the lack of responsiveness of most cause specific mortality series to changes in enforcement and crossing patterns. The absence of apparent relationship to restructured migration does not imply that decedents in these categories are not in some instances undocumented migrants. It does imply the absence of systematic visible impacts on cause-specific mortality patterns for "foreign transients" by substantial changes in the structure of undocumented migration.

A final point that emerges from our study is that previous research and discussion about the dangers at the border has probably over-emphasized the importance of border control strategy as the explanatory factor that lies behind a given level of undocumented migrant mortality. This is the case because the baseline of accidental death increases whenever the migrant is taken out of the seat of the motor coach, and put on the ground with the need to beat the Border Patrol by stealth or physical prowess. Undocumented migration has always had its dangers. These did not suddenly emerge with the spatial restructuring of undocumented migration in the 1990s.

The long-term solution to migrant mortality at the border lies in reducing the demand for undocumented entry in the United States by reducing the sharp differences in the efficiencies of the economies of neighboring countries. In the meantime, the most promising policy solutions that might be adopted to address the mortality are those that acknowledge the persisting demand in the United States for Mexican labor. Programs that expand channels of legal migration will be the most effective way to address the level of

migrant mortality at the border, because they remove the migrants from the rivers, canals, ranches, and deserts, and put them back in the seats of the motor coach and airplane.

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