THE RACE FOR SPACE: A SPATIAL ANALYSIS AND GEOVISUALIZATION OF THE HOLOCAUST AND WORLD WAR TWO

THESIS

Presented to the Graduate Council
of Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of SCIENCE

by

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San Marcos, Texas
December 2006

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ACKNOWLEDGEMENTS

I personally dedicate this work to Elva Baca, who counseled and consoled me throughout the production of this thesis. A great many thanks are also deserved by my Mom and Dad, and my sisters Mary and Laura. Your persistent queries with regard to the completion of this thesis no doubt enabled me to complete it two minutes sooner than I expected. Thanks to the finest geography department in the country: Texas State Geography. Warmest appreciation to all of my professors, with specific thanks to: Drs. Alberto Giordano, Yongmei Lu, F. Benjamin Zhan and Mr. Mark Carter. Your dedication and support for your students was apparent and will not be forgotten. Thanks to Allison Glass for your relentless support which helped me to keep this thesis on track and on time.

Thanks also to Ruth Mary Felsberg, Richter Tipton, Meredith Whitney, Daryl Felsberg, Billy Felsberg, "The Tiptons", Aunt Esther, Heather Felsberg I, Heather Felsberg II, Jason Lewis, Mason Lewis, Knox Lewis, Tim Hunter, Maria Louisa Baca, Arturo Baca, Christian Baca, Billy Baca Baldwin, Rene Baca, Cornelio Baca, Ben Baca, Nelia Baca, Ben Baca Jr., Lisa Baca, Ashlie Baca, Michelle Baca, Emily Baca, Durka Baca, Roman McCorkle, Elva Cantu, Shawn Baca Baldwin, Shawn's Mom & Dad, Miguel Carrera, Charles Michael Kittridge Thompson IV, Matt Johnson, Raymond and Peter, Rudy Schwartz and Wally Gonzalez. Thanks to Ms. Saundra Jane Edwards, David Perry Raybuck, Juan Soulas, Lindsay Raybuck and Noah Hopkins. Appreciation in advance to Ramona and Jack. Thanks to Dr. Robert Larsen, Dr. Ronald J. Stephenson, Dr. James Vaughan and the entire Medina Building staff for a most unique and rewarding experience. Best of luck to you all.

This manuscript was submitted on October 25, 2006.

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ABSTRACT

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The objective of this thesis was to visualize (using interactive maps) how Nazi Germany managed the movement of hundreds of thousands of people across Europe while fighting a war on several fronts. One of the prime impetuses for Hitler's instigation of World War Two is linked with Freidrich Ratzel's geopolitical theory of *Lebensraum*: the concept that a growing German population must be provided sufficient space and raw materials to grow and prosper. This leads to an interesting question: did military success (gaining *Lebensraum*) or failure (losing *Lebensraum*) affect convoy departures from France? To what extent were convoy operations expanded or curtailed as a result of battlefield success? With the intention of exploring these questions, an interactive geovisualization was created to show how these two elements (convoys departing and territorial expanse/loss) converged over space and time. It is the hope of the researcher that this study will help foster new lines of inquiry in the study of the Holocaust and World War II history in general.

CHAPTER 1

INTRODUCTION

World War Two (WWII) was arguably the single most significant event of the Twentieth Century. Since the end of the war in 1945, thousands of studies have been produced, endeavoring to enhance our collective understanding of the complex and myriad topics related to the war. In spite of the impressive amount of WWII scholarship, much remains to be explored. With the advent of Geographic Information Systems (GIS), researchers can now explore both historical places and events in new and interesting ways. War is inherently geographic. Historical GIS (HGIS), a recently established sub-discipline, seeks to apply these new geospatial technologies and techniques within the realm of historical research (Knowles 2000). In this regard, WWII holds much promise for HGIS research.

The tragic and horrifying events of the Holocaust—the systematic murder of millions of Jews—have been especially difficult to reconcile, both emotionally and academically. The Holocaust was not a singular event; rather, it was a complex and multi-faceted milieu of events which resulted in the racial persecution of millions. Most research focusing on the Holocaust has been conducted on a disaggregated, individual-level and has primarily focused on the qualitative narrative and individual biography (Jick 1998).

Spatial and Temporal Analysis of the Holocaust

This study endeavors to examine the Holocaust with a focus on the geographic by using GIS to investigate the spatial and temporal dimensions of railroad prisoner convoys during Holocaust. Using an individual-level database of Jewish prisoners deported near

Paris, France, convoy departures will be modeled from March 1942 to August 1944. This time period coincides with Nazi Germany's implementation of the "Final Solution": the secret plan to exterminate the entire Jewish population. In mapping these convoy movements I will display the estimated route (if known), the number of deportees, and the percentage killed upon arrival for each of the convoys. Additionally, this investigation will estimate the total areal extent of Nazi German control during this same time period, as territorial gains were a primary impetus for Germany's instigation of World War II (Shirer 1960).

This thesis seeks to explore if the amount of territorial space controlled by Nazi Germany affected convoy activities involving the deportation of prisoners from suburban Paris (deportees were either killed upon arrival or selected for work). In creating this visualization, there are a number of questions that I shall address:

- Did the loss of Nazi territory (*Lebensraum*) affect the number of Jewish prisoner convoys from France to Auschwitz?
- Did the loss of Nazi territory (*Lebensraum*) affect the number of deportees killed upon arrival to Auschwitz?
- What other spatial and temporal patterns exist in the movement of Jewish prisoner convoys from France to Auschwitz?
- How can Historical GIS help to visualize these spatial and temporal phenomena?

Creating a Templated Geovisualization

This study suggests maps and spatial data can not only provide informative graphics for a historical study, but can also be a central component of the analysis itself. This research further suggests that location is a key factor in understanding many of the events that occurred during World War II. An ancillary goal of this research is to demonstrate the utility of a *modular*, templated style of geovisualization. As many researchers are often interested in a common subject (in this case, the Holocaust or World War II), the higher-level goal of this project will be to show the usefulness of having easily extensible displays of geographic information.

Limitations of this Research

This study places the battle movements during World War II within the context of Jewish deportation convoys. The author acknowledges that other factors must certainly have affected the convoy operations:

- Political changes (Policy)
- Changes in workforce/ combat personnel demands
- Availability of rolling stock
- Deportation operations from other concentration camps

Although very relevant to the subject at hand, these elements are outside the scope of the current analysis. Future studies endeavoring to understand Nazi prisoner deportation operations within the context of the war would be enriched by further examination of these topics. Spatial and temporal analysis should not be considered the final determinant of deportation operations, but may provide a valuable starting point for historical investigations of policy, workforce demand, and logistical constraints.

This study is further limited by the inclusion of convoys from one geographic area: a suburb of Paris, France. Incorporation of convoys from a variety of geographic locales could broaden our collective understanding of how the Final Solution was implemented.

CHAPTER 2

HISTORICAL BACKGROUND

Was the Holocaust the planned, intentioned fruit of Germany's vitriolic policy of race? Or was the Holocaust a circumstantial evolution of policy which germinated from the failure of more "humane" policies of forced expulsion? Historians have long debated the motivations which led to the implementation of the Holocaust. Taking a historiographic approach, Christopher Browning asserts that examining the evolution of Nazi racial policy provides a better approach for reconciling these ambiguities (1992). History must be placed within context. In this section I will provide a brief historical summary of events which are likely precursors to an unprecedented genocide.

Legacy of Versailles

World War I signaled a devastating defeat to the German state. Saddled with war reparations, economic and military restrictions as well as territorial losses, this went beyond simple humiliation. To a great extent, much of the pain from this defeat and the accompanying restrictions imposed by the Treaty of Versailles, fueled the discontent in Germany for years to come. These factors, plus a devastating economic depression and unemployment, led to a climate where the legitimacy and acceptance of more radical political views gained significant traction. One of these political parties was the National Socialist Democratic Workers Party or NSDAP, also known as the Nazi party. The Nazi party went beyond setting a course for regaining national pride; they squarely laid blame for the current state of misery, and the loss of World War I itself, primarily upon the Jews (Shirer 1960; Hilberg 1961).

In 1933, Hitler's rise to power was complete. In establishing a more formalized political doctrine of racial bias, the Nazi party began a gradual restriction of human rights—especially those applying to Jews (Shirer 1960). The Nazis legitimated their racist ideology through a rickety pseudoscientific framework reinforced by centuries-old racial biases against Jews (Noakes 2004). "Blood purity" of the *Volk* was an issue of national security to be protected against at all costs – creating a biological justification for their hatred. These claims of racial superiority reinvigorated the German nation at a time when morale was low and still reeling from the economic depression. Jews were an easy scapegoat for the ever-present social unrest.

Space for Germany: Lebensraum

"*The external security of a people is largely determined by the size of its territory*."

- Adolf Hitler, in *Mein Kampf*

Using scientific justifications for racist policies was not only limited to social policy. The geopolitical theories of Friedrich Ratzel were co-opted by Hitler in *Mein Kampf*. Ratzel's theory of "*Lebensraum*" (which translates to "living space") essentially places "Darwinian natural selection within a spatial and environmental dimension," according to Woodruff D. Smith (1980). Ratzel's theory of *Lebensraum* dictated that a species' geographic boundaries were governed by several factors, central among them is the amount of space necessary to sustain the species. Ratzel further postulated that a successful and growing species must inevitably expand and meet with other species which are in competition for the same resources. The result is a Darwinian "struggle for existence" leaving the "fittest" with the spoils: land and resources. In this manner, Ratzel conceived of states as biological organisms, which if it was to survive, must seek new lands to sustain itself (Smith 1980).

This theory added a certain scientific credibility to Nazi ideologies and would play a significant role in the years to come. In the years following Hitler's meteoric rise, space—specifically *Lebensraum*—became an ever-present part of his vision for the Nazi German state (Noakes 2004). To accommodate the so called 'Master Race' Hitler stated, "in order to remain healthy, species must continually expand the amount of space they occupy" (in Noakes 2004). Many quotations similar to these can be pointed to as evidence of the importance of geography to the German dictator. To Hitler, the areal expanse of a nation represented an essential part of human struggle.

Preceding the outbreak of World War II, the German dictator devised a rather brilliant series of subterfuges, political intrigues and outright lies which significantly increased the territorial expanse of Nazi Germany. The *Anschluss* joined Austria to Germany in 1938, and later that same year, the Sudentenland of Czecholovakia was forcibly annexed. Surprisingly, this was accomplished without the formal intervention of the military. This unopposed acquisition of territory would soon end. On September 1, 1939, German forces crossed the Polish border in a 'pre-emptive' attack. This attack on Poland signaled not only the beginning of World War II, but also the start of a series of forced emigration policies. In addition to deporting or arresting those believed to be racially inferior tens of thousands were killed without compunction (Shirer 1961). Once these lands were cleared of the indigenous people, new Reich provisional governments (*Reichskommisariats*) were set up and ethnic German settlers began repopulating the cleared regions (Hilberg 1961).

The Holocaust

To define the Holocaust in any singular sense is cumbersome, if not impossible. This is due in part to the many countries and peoples affected by Nazi Germany's expansive territorial gains during the first years of World War II from 1939 to 1942. Although the vast majority of Nazi persecution focused upon the Jewish population, many other races were classified as *Untermench*, or "subhuman." What remained constant throughout the entire course of the war was an unflagging criminalization of race. Specially coordinated efforts were made to rid the European continent of all Jewish people, at first through forced emigration and eventually by large-scale killing operations. These efforts were implemented gradually. Jews and others deemed to be racially inferior were forcibly concentrated in the ghettos of the newly conquered Eastern territories (Noakes 2004).

This program of concentration was functional for Nazi Germany in at least three different respects. First, it provided a substantial amount of forced labor for the wartime industries of greater Germany. Second, these concentration camps provided a centralized and convenient locus to remove the local residents. To a more insidious end, these concentration camps also provided a fateful utility: They provided a direct network connection to the extermination centers in the East.

Vast Network of the 'Final Solution'

In the Fall of 1941, Adolf Hitler charged Reinhard Heydrich, head of the Reich Security Main Office with devising a '*Final Solution to the Jewish question'* – a coded euphemism which referred to the physical annihilation of the Jewish population. An elaborate system was thus conceived with four primary components: apprehension, concentration, deportation, and extermination (von Lang and Sibyll 1983). This system of murder was hugely complex, multinational, expensive and eventually came to be quite efficient. Additionally, the system was capable of being quite extensible; as long as the extermination or concentration camps were situated within close proximity to rail lines, new camps could be added and incorporated into the camp network.

Previous efforts, like those of the *Einsatzgruppen* (mobile killing units) were organizationally intensive and often involved the face to face, cold-blooded killing of unarmed civilian populations, including women, children and the elderly. According to the United States Holocaust Memorial Museum, "[t]he mobile killing methods proved to be inefficient and psychologically burdensome to the killers" (USHMM 2006). Thus, a more efficient and more 'humane' operation was necessary. Heydrich's plan, euphemistically termed *Aktion Reinhard,* was the mass-production, assembly line system that suited this requirement to great effect (USHMM 2006). The decentralized nature of this system—from apprehension to extermination—was bureaucratized to enhance efficiency. An added function of this bureaucratization was that it obscured culpability for the killings (Rees 2005). Many of those involved in the operation and organization of this system of mass murder remarked that they were merely doing their 'part' of the job (Arendt 1994). This most likely contributed a great deal to the success and expansion of this network of concentration and extermination.

This was the Nazis' all-encompassing plan to render their new state and most of the surrounding lands completely free of Jewish people (*Judenrein*) and others deemed racially incompatible. Interestingly, in spite of risking a war on two fronts, the deportation convoys were given a status of "War Critical," putting these operations on par with actual military efforts in the East (von Lang and Sibyll 1983). This provides a rather grim underscore for how importantly the Nazis viewed their oppressive system.

Auschwitz & Drancy

Of all the camps operated by Nazi Germany during World War II, perhaps none is more notorious than the Auschwitz-Birkenau concentration and extermination camp complex. Auschwitz held the distinction of being the only camp within the Third Reich which operated simultaneously as both a concentration *and* an extermination camp. Auschwitz also held the unique distinction of being the primary extermination center for the Reich; virtually every country occupied by or collaborating with Nazi Germany sent Jews to die at Auschwitz (Gilbert 1980). The camp system was complex, with many intermediary sub-camps and detention facilities often preceding transfer to the main concentration or extermination facilities.

Drancy was one of many camps that regularly sent convoys of deportees to Auschwitz. Located only a few minutes away from Paris, France, Drancy was initially established as an internment camp for foreign-born Jews (USHMM 1996). Eventually, perhaps because of its centrality and connectivity to major rail networks around Paris, Drancy became the primary deportation facility in France for deportations to the death camps in the East. In all, over 70,000 prisoners were deported from Drancy— most of them to their deaths (Klarsfeld 1983).

CHAPTER 3

LITERATURE REVIEW

In this chapter, I shall provide a general review of historical GIS, previous efforts of mapping the Holocaust, and geovisualization. These three components serve as guides for this study and influence the chosen methodologies in Chapter 4.

Historical GIS

Nearly all GIS incorporate data which were collected in the past. Although the date of collection may have been quite recent as in the case of some GPS data and Digital Elevation Models, these should not be considered "Historical GIS" as such. Anne Kelly Knowles, a noted historical geographer, states that:

> [t]he key difference between the historical GIS and the vast majority of GIS practiced today is that its source data typically include archival material that must be converted from analog to digital form (2000).

Historical GIS provides the researcher with a computerized means to reconcile and manage complex, geographically referenced historical information.

One of the very first implementations of GIS technology focused upon the analysis of historical census data (Knowles 2000). With changes in population, census boundaries necessarily must also change. Attempting to reconcile changing census boundaries to reveal longitudinal population changes over time has proven to be extremely difficult. With both geographic boundaries and populations that change over time, the 'containers' (census boundaries) and the 'contents' (populations being measured) represent a complex and dynamic problem. This familiar geographic conundrum is known as the modifiable areal unit problem or MAUP (Openshaw 1983). This problem states that the results of an analysis can be significantly affected if the area boundaries are altered and/or the scale or resolution is modified.

The movements of boundaries and people needed a proper framework if they were to achieve a more meaningful and efficient expression. With the intention of addressing these issues, Ian Gregory and others have begun national historical boundary mapping projects (Southall 2004). Gregory observed that changing boundaries have "created a fundamental problem for demographic research" (Gregory 2000). These projects attempt to recognize the "problem of historical boundaries" by creating a spatio-temporal database of Great Britain's historical census boundaries and the accompanying census statistics within the historical boundaries (Knowles 2000).

Until recently, these efforts in historical GIS had focused primarily on the archival aspects of conversion (analog to digital), creation of maps and visualizations of historical places and also on data delivery. HGIS efforts appeared to be more akin to preservation efforts rather than fully-fledged analytical endeavors. One notable exception was Peter Gould's research on the geographic diffusion of AIDS (Gould and Kabel 1993).

It appears that HGIS may now be on the verge of its own meteoric rise. This is primarily due to development of new techniques in dealing with historical / temporal datasets. Recent works by Gregory have begun analyzing spatiotemporal patterns within their aforementioned historical GIS census databases (Gregory and Ell 2005). Additional works by Gregory have even shown methods of reducing interpolative errors associated with the changing boundaries within historical census datasets (Gregory 2005). Reconciling the issue of change over time continues to remain a central challenge to this burgeoning subdiscipline.

Mapping WWII and the Holocaust

The use of geospatial technologies has not gone unnoticed by historians of WWII and the Holocaust. While these exciting new tools hold much promise for historical inquiry, GIS is far from the panacea some profess it to be. The familiar problems of traditional historical work remain: gaps and ambiguity in the historical record, disparate data formats, differing data resolutions and lack of or inadequate metadata. Although GIS can help to ameliorate certain issues, the need for non-technical, qualitative historical expertise remains completely indispensable to the discipline.

In this regard, WWII is no exception. The body of work produced with a focus on WWII is absolutely staggering. The immensity of the event, the complexity of daily geopolitics, and the fact that the war spanned nearly six years certainly makes it difficult to offer a concise summary. Still, when representing the historical events of WWII, historians have been quite inventive given the tools available. Multi-thematic historical atlases were the primary means of expressing dynamic geographic information (Gilbert 2002; USHMM 1996; Pimlot 1995). Often data summary tables and charts accompanied these thematic maps.

The map is present in virtually every historical account of the Holocaust. Despite this evidence of ubiquity, few (within Holocaust research) have attempted to utilize the map as anything more than an attractive, yet informative, graphic. In his seminal work, *The Routledge Atlas of the Holocaust*, Sir Martin Gilbert makes the map more of a centralized medium of historical communication (Gilbert 2002). In this atlas, Gilbert shows the movements of frontlines and also the convoy deportation of Holocaust victims; this represents the first substantive effort to map the events of WWII alongside the Holocaust (see Figure 1). The primary weakness of Gilbert's study was a lack of available technology for visualization of geographic data. The printed map has many limitations when attempting to display temporal phenomena, and this is evident in Gilbert's *Atlas*. Temporal data are inherently dynamic. Because of this, Gilbert was only able to clearly present events of one to three particular dates with a relatively narrow thematic focus. Multiple elements could not be introduced unless they were produced in a series of two or more consecutive maps; often this spanned two to three pages.

Figure 2 displays another notable work of historical geography related to the Ho-

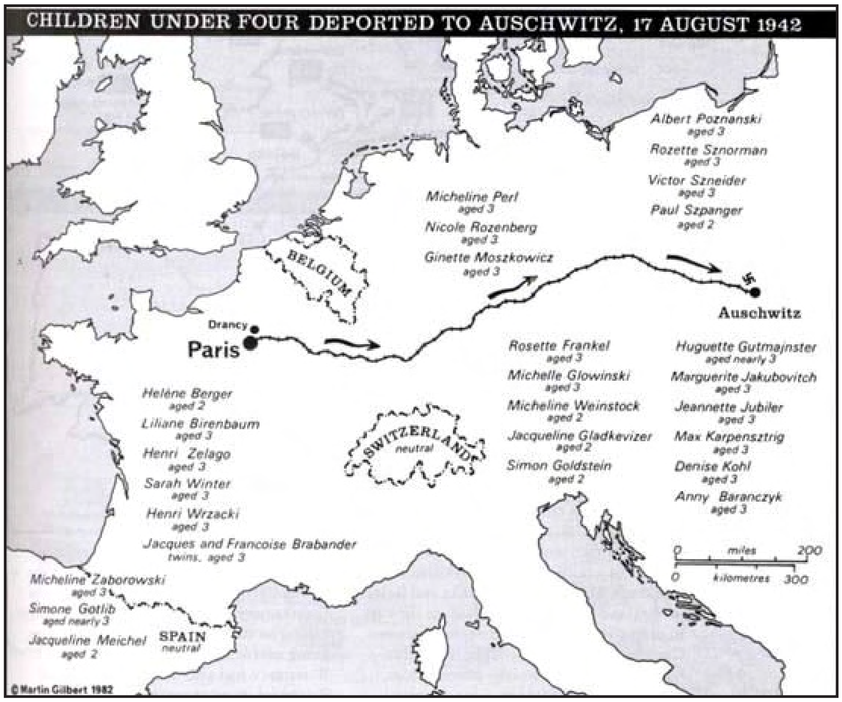


Figure 1. Example from Sir Martin Gilbert's *Atlas of the Holocaust.* (Gilbert 2002).

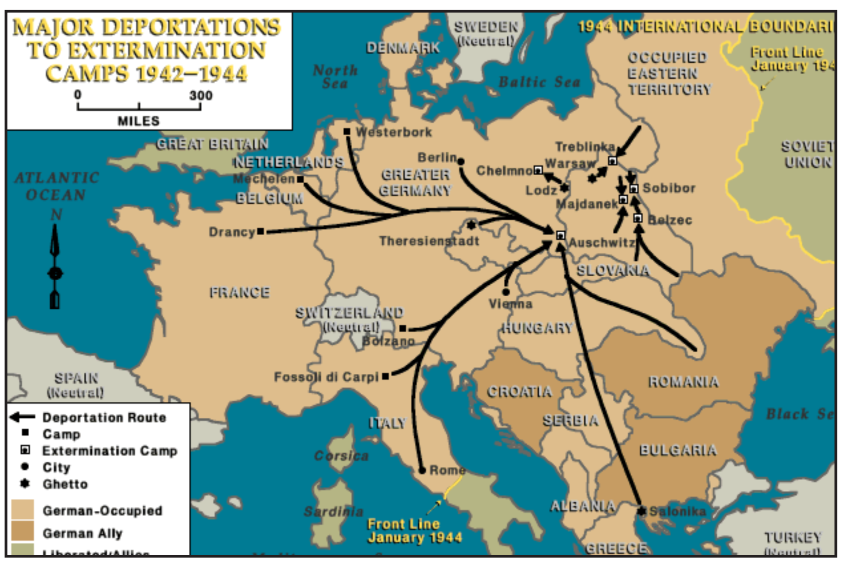


Figure 2. Example from the United States Holocaust Memorial Museum's *Historical Atlas of the Holocaust* (USHMM 1996).

locaust: the United States Holocaust Memorial Museum's *Historical Atlas of the Holocaust* (USHMM 1996). This work is quite similar to Gilbert's, but offers many anecdotes and provides a larger-scale analysis of the individual concentration and extermination camps. Because of the medium (a published book), the USHMM's *Atlas* is bounded by the same limitations of temporal visualization.

At heart, the problems experienced by Gilbert and other historians revolve around a central one central issue: representing dynamic events in a static medium (paper). While these maps were certainly helpful, they generally proved to be little more than descriptive aids to the historical narrative. Most efforts to describe the historical events of WWII were within the medium of a historically narrated atlas (Pimlot 1995). In general, the historical atlas proceeds linearly and attempts to show the significant events of the war (sometimes grouped by the smaller scale term, 'theater') as they occurred over time. The historian was limited in how much of their narrative could be explained on one map before becoming a muddled mess.

The United States Military Academy recreated many of the daily battle campaign maps for WWII (USMA 2005). Each of these maps display, at most, four separate temporal frontline positions over small-scale national areas. Depending on the battles themselves, the USMA WWII situation maps depict the progression of frontlines from a span of only one week up to a span of nearly three months. Although these maps effectively represent the major changes for frontline positions, the USMA situation maps are not without faults. One problem is that the temporal scale is inconsistent. In cases where the battle was slow-going the map could encompass a time period of two months; in other cases the time period could be a week. Although this was almost certainly done to economize effort, this lack of a consistent temporal scale can be deceptive. Another problem with the USMA situation maps is in regard to the inconsistent use of map scales. Most of the maps created by the USMA were small scale (approximately 1:10,000,000) and clearly depict the entire frontline for that particular battlefront (East, West or Italian). However, in some cases a larger scale was chosen to depict more detailed frontline changes. Presumably, this was done to more clearly depict a complex set of military maneuvers that were unsuitable for smaller scales. Although the necessity of this is apparent, the lack of any alternative small scale maps for the same time period obscures other frontline changes (if any). The map reader is left to assume that all other frontlines outside the view of the larger scale map are unchanged.

Visualizing a 'Dynamic' History

Louis Leakey, the famed archaeologist once stated, "[t]he past is the key to our future." Simply acknowledging this truism brings us no closer to reconciling the geographer's struggle with dynamic spatiotemporal phenomena. Representing and analyzing space and place over time can be quite troublesome and continues to provide a major theoretical stumbling block for geography and other disciplines that measure and analyze phenomena that change over time (Peuquet 1994). Rightfully so, "Space/Time Analysis" is one of the long-term research challenges recognized by the University Consortium for Geographic Information Science (UCGIS 2002).

Creating dynamic visualizations to represent changing geographic phenomena is one of the techniques utilized for exploratory spatial data analysis (ESDA). Creating dynamic visualizations of spatial data can aid in the discovery of spatial and/or temporal patterns. Another function of creating dynamic visualizations for ESDA is that they can often help to succinctly communicate very complex sets of information. One of the first animated representations of spatiohistorical information was created by the Walt Disney Company in 1940 (Harrower 2004). Coincidentally, this 30-second hand-drawn cartoon depicts the Nazi invasion of Warsaw in 1939. While this animation was not the most accurate of maps, it "succeeded in communicating the concept of invasion" (Harrower 2004). The primary limitations of this method involved both the time of production and overall expense.

The introduction of computer technologies in the 1960's and 1970's changed the mode of production for animations, but none of the expense. Emerging technologies are often exorbitantly expensive and early computers and their respective application developments were no exception. Figure 3 below (from Harrower) provides a history of the animation, storage and distribution. Some researchers who were able to access these new computer technologies were able to create some brilliant animated spatial representations. Waldo Tobler managed to "create new insights into a complex process" by rendering an animation which depicted urban growth in Detroit, MI (Harrower 2004). Gradually computers and animation software packages have become more affordable in addition to becoming more accessible to everyday users. The popularity of 2D and 3D animation has been punctuated further by the seemingly endless communication and distribution options of the Internet (Knowles 2000).

Presently, multimedia cartography represents a very engaging medium of communication for spatiotemporal phenomena (Kraak and Brown 2001). Multimedia cartography seeks to move geographic visualization beyond the more traditional printed map by incorporating geographic information, dynamic elements for user interaction, animations

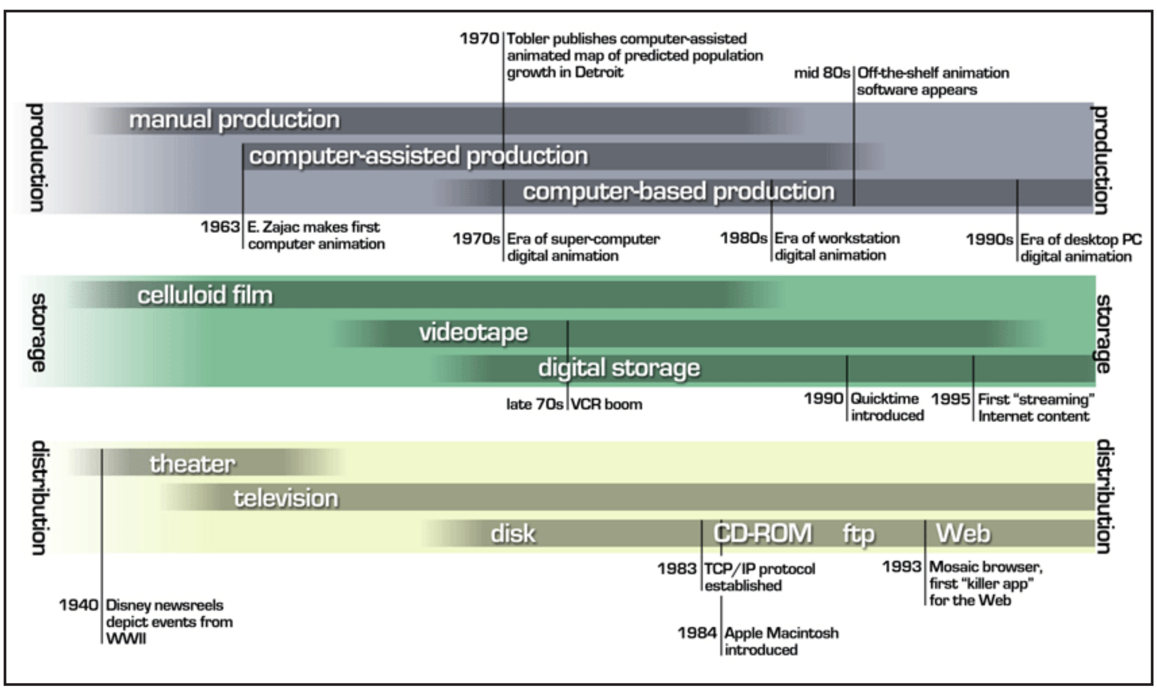


Figure 3. Timeline of the History of Animated Maps (Harrower 2004).

and multiple mediums of delivery. Maps can now be created to show change over time via multimedia software such as Adobe Flash®. Maps can also be produced with interactive user interfaces which can be quite engaging to the viewer. Many efforts have been made to produce Adobe Flash® animations of WWII and also provide some geographic visualizations of the Holocaust. The British Broadcasting Company (BBC) has a comprehensive WWII history Web site with over twenty differently themed Flash animations (Cesarini 2006). The Public Broadcasting Company (PBS) has a comprehensive history of both WWII and the Holocaust with Flash animations accompanying some of their historical narratives (Rees 2005).

Although multimedia cartography can provide highly interactive and informative displays of geographic information, there are a number of shortcomings that still have yet be fully addressed. While animation of geographic data is helpful for communication and display, it is far from a rigorous analytical technique. This is primarily because current animation software is not developed as a tool for scientific analysis. The main drivers in the development of contemporary animation software are both the gaming and entertainment industries. Although researchers have become adept at conforming animation tools for their particular areas of research, the discipline would benefit greatly from the development of a more academically focused set of animation tools. Currently, most GIS software packages are woefully inadequate when it comes to translating spatial and temporal data into dynamic visualizations. Currently, to produce a true multimedia geographic visualization, the data must be exported from the GIS and manipulated within an animation software package such as Adobe Flash®. This suggests that spatial analysis and dynamic visualization functionalities should be more tightly coupled with regard to current GIS software packages. Additional improvements should be made with regard to the automation of the production process when creating animations (Harrower 2004). Currently, the process of creating map-based vector animations is rudimentary, cumbersome and still takes many hours to achieve effective results.

Geovisualization

Beyond providing a simple overview, geovisualization allows users to “explore synthesize, present, and analyze their data more thoroughly” (Longley 2005). Geovisualization of these data is perhaps the most important aspect of this study. According to geovisualization expert Alan MacEachren, geovisualization allows for the usage of dynamic visual representations to “enable creative thinking” (in Longley 2005). With increasingly rich displays of geographic information, the communication of this information becomes acutely more relevant. How these data are presented to a viewer can have profound impacts upon the overall interpretation of the subject matter.

Geographic information can be presented to the user in many different ways. Meng identifies three different types of cartographic products: descriptive, analytical and exploratory maps (2005). Descriptive maps simply store and present specific geographic information. Information cannot be queried or modified by the user; in this sense, descriptive represent a static snapshot of geographic information. Analytical maps on the contrary provide a connection to the geographic information database with tools for individual users to modify the display and query of information. Exploratory maps go beyond analytical maps by operating “as thinking instruments that should visually support its users to confirm or generate hypotheses, detect hidden concepts and value-add the underlying geodatabase” (Meng 2005). Within the context of historical geography, the overwhelming majority of cartography products are descriptive maps. This research endeavors to show the usefulness of analytical mapping and geovisualization of the Holocaust and World War II. With analytical and exploratory maps the geographic information comes to life, enabling researchers to begin asking questions of mapped historical data.

One of the more significant contributors for exploratory geovisualization research is the GeoVISTA Center at Pennsylvania State University. The GeoVISTA Center is focused on GIScience, with “an emphasis on geovisualization” (GeoVISTA Center 2006).

Modern day geographic information is being created at such prodigious levels such that it is outpacing our current ability to make sense of this “information overload.” With this in mind, the GeoVISTA Center’s research revolves around the creation of powerful visualization tools to harness, synthesize and make use of this geographic information. The GeoVISTA Center has developed a powerful tool which provides users a dynamic application development environment: GeoVISTA Studio. This tool allows users to develop their own geovisualization applications all in one program, but more importantly, the GeoVISTA Center has recognized and made efforts to remedy two of the major impediments commonly associated with developing exploratory geovisualizations. GeoVISTA Studio eliminates the need for users to learn complex computer programming languages to carry out development tasks. As a function of this, users with very little experience using GeoVISTA Studio can produce geovisualizations in a surprisingly short amount of time. This is precisely the goal of this study’s templated geovisualization: reduction of effort spent on the production of geovisualization tools.

CHAPTER 4

METHODOLOGY

In spite of their recently begun assault on Soviet Russia, Nazi Germany began a massive, continental-scale deportation of Jews and others whom were determined to be racially inferior. Deportation operations were considered "War Critical" activities according to the testimony of Adolph Eichmann, one of the central figures responsible for organizing and implementing the complex network of prisoner transports (von Lang and Sibyll 1983). As Allied armies drew nearer and an Axis defeat appeared eminent, the destruction of evidence (camp records, extermination equipment, etc.) began (Shirer 1960).

The territorial gains of an increasingly proximate enemy clearly affected their actions with regard to camp records. Did the loss of *Lebensraum* affect other activities within the Final Solution? In creating map-based, interactive displays of Nazi deportation data, I intend to address these issues:

- Did the loss of Nazi territory (*Lebensraum*) affect the number of Jewish prisoner convoys from France to Auschwitz?
- Did the loss of Nazi territory (*Lebensraum*) affect the number of deportees killed upon arrival to Auschwitz?
- What other spatial and temporal patterns exist in the movement of Jewish prisoner convoys from France to Auschwitz? (Camp Population, etc.)
- How can Historical GIS help to visualize these spatial and temporal phenomena?

In this study, the French convoys and *Lebensraum* become focal points for a spatial analysis. I will provide a quantitative estimate of the growth or shrinkage of German *Lebensraum* for each date a convoy departed from France. Did territorial shifts affect the convoy operations? In aid in answering this question, I will conduct a statistical analysis of the convoy data and estimates of *Lebensraum*. Furthermore, I will create a dynamic geovisualization of these data for ESDA. This animated geovisualization will provide the researcher with a simultaneous dynamic visualization of convoy departures and the oscillations of territorial control.

Scope of this Study

The study area for this research consists of the entire continental European war theater and the German incursions into Western Russia during World War II. The German-held territories of Northern Africa will be excluded from this study primarily because sufficiently accurate map data for the Northern Africa Nazi campaign were not available at the commencement of this thesis. Although there is a great deal of tactical relevance for these and other lands controlled by the Nazis, they do not directly impact the "Fatherland", or the territorial extensions of Germany, proper. Growth and reduction of *Lebensraum* refers to the nation-state itself, not territories procured outside of Eurasia.

This study of *Lebensraum* is being conducted alongside the French deportation convoys to the death camps (primarily Auschwitz) during the years 1942 to 1944. For this reason, all map data, measurements and analyses conducted on *Lebensraum* are conducted within the framework of these three years only.

Data

"For an understanding of the dimension and depth of the Holocaust, nothing is more immediate or poignant than a list of names."

—Raul Hilberg

Convoy Database

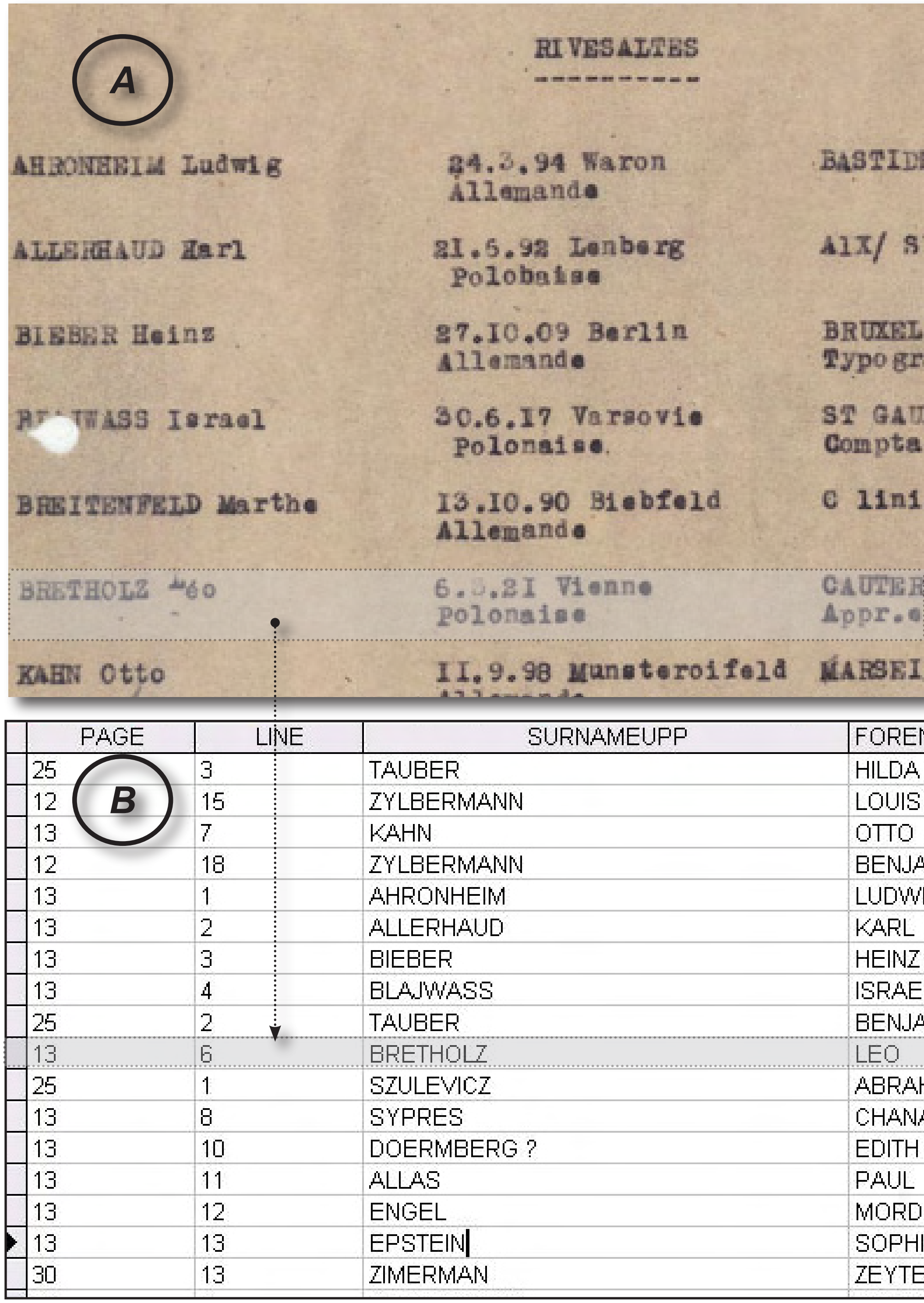
The convoys of prisoners which left greater Paris for Auschwitz were surprisingly well documented by the Nazis. Data for this study were drawn from Serge Klarsfeld's

Memorial to the Jews Deported to France 1942-1944. In this great work, Holocaust survivor Serge Klarsfeld has compiled one of the most complete lists of Jewish deportation for a single country. This is the primary source of data for this thesis. The power of Klarsfeld's compendium resides in his source: the actual Nazi convoy manifests (see Figure 4).

The United States Holocaust Memorial Museum (USHMM) subsequently rendered these data into digital format. A database was then created (Microsoft Access format) by the USHMM. Historical work in general and studies of the Holocaust in particular are often troublesome because there is often no complete and "intact" source of documents to draw information from. Klarsfeld's work is no exception. Some convoy details are left out because of omissions within the source documents, damage to the records or because documentation was missing. For example, during the final weeks of Nazi occupation, several convoys were hurriedly dispatched to the East with little or no documentation whatsoever. Using other sources, Klarsfeld and other researchers have been able to reconstruct that some convoys did in fact exist despite the absence of convoy departure manifests. Auschwitz camp records (that survived the war) usually reflected a logged entry at that a convoy from Drancy had arrived. In addition to the existence and origin of these convoys, the Klarsfeld document indicates (by convoy) the number of people selected for work and the remainder whom were sent to be killed.

Situation Maps

Maps are quite useful in attempting to understand historical military conflict. By illustrating the presence of many battles in continually changing locations, maps can help to provide a more immediate understanding through graphical visualization. In this study, maps become a central component of describing the constantly vacillating spatial extent of Nazi German territory from March 1942 to August 1944. For this purpose, small scale maps were necessary to provide a continental view of the demarcation between Axis



A

RIVESALTES

AHRONHEIM Ludwig	24.3.94 Waron Allemande	BASTIDE
ALLERHAUD Karl	21.6.92 Lenberg Polonaise	AIX/ S
BIEBER Heinz	27.10.09 Berlin Allemande	BRUXEL Typogr
BL WASS Israel	30.6.17 Varsovie Polonaise.	ST GAU Compta
BREITENFELD Marthe	13.10.90 Biebfeld Allemande	C lini
BRETHOLZ Léo	6. .21 Vienne Polonaise	CAUTER Appr.e
KAHN Otto	II.9.98 Munsteroifeld	MARSEI

B

PAGE	LINE	SURNAMEUPP	FOREN
25	3	TAUBER	HILDA
12	15	ZYLBERMANN	LOUIS
13	7	KAHN	OTTO
12	18	ZYLBERMANN	BENJA
13	1	AHRONHEIM	LUDWI
13	2	ALLERHAUD	KARL
13	3	BIEBER	HEINZ
13	4	BLAJWASS	ISRAEI
25	2	TAUBER	BENJA
13	6	BRETHOLZ	LEO
25	1	SZULEVICZ	ABRAH
13	8	SYPRES	CHANA
13	10	DOERMBERG ?	EDITH
13	11	ALLAS	PAUL
13	12	ENGEL	MORDI
13	13	EPSTEIN	SOPHI
30	13	ZIMERMAN	ZEYTE

Figure 4. Nazi Convoy Document Conversion. The (A) original Nazi documents were converted to (B) Microsoft Access convoy database (USHMM 2005).

and Allied forces. The United States Military Academy Department of History maintains an online library of many continental scale (1:6,000,000 to 1:10,000,000) military situation maps. These maps are dated and provide mostly small scale estimates of tactical locations for both Axis and Allied forces. Most of these maps are freely available for download from the United States Military Academy Web site (USMA 2006). Because of the immensity of the war theater, I have organized these campaign maps into three separate battlefronts: the Eastern Front, The Western Front (beginning in 1944) and the Italian Campaign (beginning in 1943). Supplemental map data were obtained from the Library of Congress in order to represent the Western front.

Creating the Historical GIS

Accurately modeling and measuring *Lebensraum* requires that each one of the respective fronts is indexed by date and then measured for total area. A GIS is perfectly suited for these tasks. Figure 5 provides a graphic depiction of the process. Each situ-

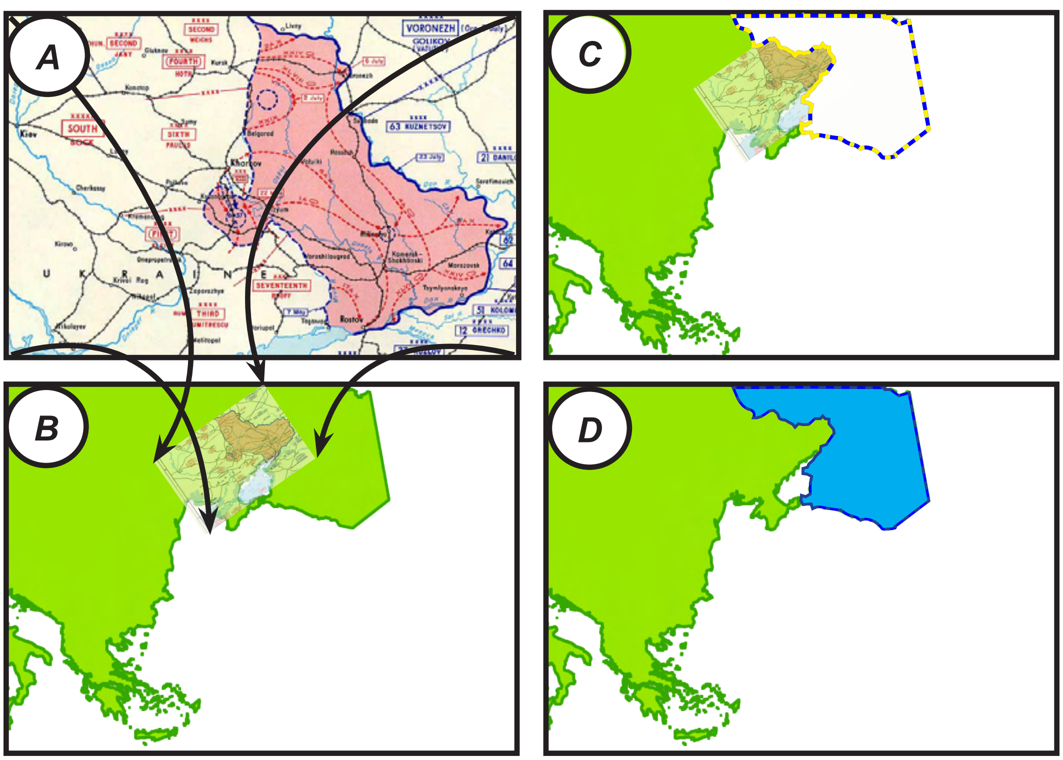


Figure 5. Frontline Extraction Process. A military situation map (A) is georeferenced with the GIS basemap (B). The frontline locations are digitized (C) so that an Allied front can be created for a particular date (D) within the GIS.

ation map (rendered in its digital form) was imported into the Environmental Systems Research Institute (ESRI) ArcGIS 9.1 GIS application to provide a "backdrop" for creating each dated GIS layer. In a process known as digitization, the frontline locations for the date of each situation map were digitally drawn and recorded into one of the three GIS frontline databases (see Table 1).

GIS Database Name	***Dates***	***Description***
Allied_AdvanceEAST	12/05/41 to 9/29/44	GIS layers of the Eastern Front
Allied_AdvanceWEST	6/6/44 to 8/26/44	GIS layers of Western Front
Allied_AdvanceSOUTH	7/11/43 to 8/25/44	GIS layers of Italian Front

Table 1. The Three GIS databases and their Temporal Extents.

The frontlines are not represented as lines, but instead are represented as polygonal areas of territory *taken from* Nazi Germany. There are three justifications for using this approach. Firstly, it is more efficient to represent the changing frontlines from the Allied perspective since it does not require repeatedly representing the vast territorial borders of Nazi Germany. This enabled this researcher to focus digitization efforts only with regard to the territories which were changing. Another reason for choosing to represent the frontlines as areas instead of lines is because of the focus on *Lebensraum*. Because this research is specifically concerned with measuring the area controlled by Nazi Germany, polygonal geographic representation seemed the natural choice. Another justification becomes apparent when considering the development of the animated geovisualization. This issue will be discussed in the section *Creating the Geovisualization* below.

Calculating Lebensraum

After all map data were digitized for each of the three fronts, area calculations were performed for each of the 56 GIS layers (in Km^2). Recall that these are measuring not German territory, but Allied incursions *into* German territory. Subsequently, each of the attribute tables were exported and re-indexed by date which provided a summary table of area estimates for each of the three fronts. Since the available map data for each of the respective fronts rarely occurred on the same day, there are gaps in the summary table. This underscores a significant limitation with regard to the accuracy of the areal estimates of *Lebensraum* in this study. Until intermediate situation map data become available, area calculations for unknown dates are estimated via a simple interpolation between known values (from Frontline Date 1 to Frontline Date 2). For example, if there is a calculated estimate of 40,000 Km^2 for April 10, 1943 and a calculated area estimate of 50,000 Km^2 for April 20, 1943, then each day in between those two known dates is incremented positively 1000 Km^2 from the previous date. See Figure 6 below.

Date	*Lebensraum*
2/18/1943	**1,216,249 km^2**
2/19/1943	?
2/20/1943	?
2/21/1943	?
...	
3/15/1943	?
3/16/1943	?
3/17/1943	?
3/18/1943	**1,231,286 km^2**

Process to populate unknown *Lebensraum* values:

A) # Days between two known measurements: **28**
B) *Lebensraum* difference (km^2): **15,037**
C) Daily value to increment (B/A): **537**

D) Formula for each intermediate date:

Previous Day *Lebensraum* + 537

Figure 6. Interpolating *Lebensraum*. Example Interpolation of Area Between Known Values for Dates Between February 18, 1943 and March 18, 1943.

Once the area interpolation was completed for each date on all three battlefronts (East, West and Italian), the database was merged to show total an estimated area of daily Allied territorial gains for the dates December 5, 1941 to August 26, 1944. November, 18,1942 represents what is considered to be the "high water mark" of *Lebensraum* for the Third Reich. It was on this date that the German advances were halted at Stalingrad and steadily pushed back until the conclusion of the war. This date provides this study with the furthest extent of *Lebensraum* during the war: an estimated 4,751,400 Km^2.

The Klarsfeld convoy table and the daily Allied territorial gains table were then joined based on their shared date indices. This enabled German territorial estimates to be attributed to the Klarsfeld convoy summaries, providing an estimate of how much territory Germany held on each date a convoy departed to Auschwitz. Figure 7 illustrates the required interpolation to accomplish this..

With all major calculations complete, a comprehensive table (Convoy Summary Table) was produced which enable the researcher to statistically analyze convoy deportations in the context of *Lebensraum*. The Convoy Summary Table contains 996 rows of data: each row representing one day. For each row, an estimate of *Lebensraum* is given. If a convoy departed on a particular date, a boolean column (ConvoyDeparted) indicates 1. For all dates where no convoys departed, ConvoyDeparted indicates 0.

***Lebensraum* for:** **August 1, 1943**

Name of Front		Area Calculation
Allied_AdvanceEAST	=	1,226,217 km^2
Allied_AdvanceSOUTH	=	19,957 km^2
Allied_AdvanceWEST	=	0 km^2
Sum of Allied Fronts (for August 1, 1943)	**=**	**1,246,175 km^2**

(Maximum Possible *Lebensraum*) 5,419,504 km^2
(Sum of Allied Fronts) – 1,246,175 km^2

***Lebensraum* for August 1, 1943 = 4,173,329 km^2**

Figure 7. Example of *Lebensraum* Calculations for August 1, 1943.

Creating the Geovisualization

Although the preceding methods for data creation and analysis are quite necessary for this research, they can only explain a part of this highly complex and dynamic event. To communicate the results of this study beyond simply reporting statistics and probabilities, a highly interactive animated Web map was produced. This map provides the researcher with a visual corollary to the statistical investigation of *Lebensraum* and the French deportation convoy database. There were three main components to constructing this Web-based geovisualization: animating GIS data, user interactivity and dynamic database-driven statistics.

Precursors to Animating GIS Data

A number of issues required attention before attempting to create the computer animation. Initially, one must identify both the probable user and also the likely mode of delivering the presentation. Perhaps the most critical issue involved in creating this geovisualization is properly identifying the audience. After careful consideration, the three most likely users were determined to be: historians of the Holocaust, historical geographers, and the general audience with an interest in learning more about the Holocaust and/or World War II.

As mentioned above, this animation will be Web-based and deployed over the Internet. An immediate consideration must be given as to the overall size of the animation file, with larger files taking significantly longer periods of time for users to view or download. Taking this into account, Adobe's Flash 8, a vector-based 2-D animation program, proved to be the most appropriate tool for creating this geovisualization. Flash has a well-established reputation as the premiere 2-D vector animation software program - specializing in Web-based delivery. Vector-based animation files are smaller and take much less Internet bandwidth thereby making them much more easy to access and view over the Web.

Further consideration was given to the conversion of the GIS data to a vector format compatible with Flash. Flash does not recognize the ArcGIS 9.1 vector format (*.shp). Exporting each GIS database from ArcGIS 9.1 in Adobe Illustrator format (*.ai) retained the vector paths for each one of the frontline GIS databases. Adobe Illustrator files are directly recognized and usable by Flash.

Animating GIS Data

Once all GIS data were converted to a usable state within the Flash Integrated Development Environment (IDE), each one of the fronts were segregated into individual layers (WestData, EastData, and ItalianData). Each front had to be animated separately. Although there are numerous intermediate and repetitive steps, the process is quite elementary. The idea is to show a geographic representation of the frontlines change dynamically over time. Each situation map date that was digitized represents a geographic "snapshot" for that particular battlefront. Within Flash, the developer has the ability to "tween" (a process of morphing one object into another) one date's GIS data to the next date with GIS data, creating intermediate frames by interpolating the shapes between dates. By tweening each date of available data together in an ascending pattern, one is provided with a representation of geographic objects (in the present case, frontlines) changing over time.

Within Flash, morphing objects via tweening can be an arduous process. Often, when tweening complex shapes with many vertices (such as a shape with coastal territories), the application is unable to recognize the proper path to morph to. The resulting animation does not resemble anything remotely like a moving frontline. The shape being morphed flips, turns and contorts in unexpected ways until it reaches its target. To correct this, the developer must add "morph targets" which provide point-to-point hints guiding the object in its morph interpolation process. Unfortunately, adding morph targets must be done manually for each tween in the animation. Since less complex objects are much easier for Flash to recognize and morph properly. Thus, in the interest of making an efficient use of effort within this project, all tweening occurs with the three Allied fronts.

This, however, only gives our geovisualization an animation of Allied territorial movements. To instead provide a visualization of changing German occupied territories, each of the three animated fronts was converted into a mask. This allowed portions of an "Allied Territory" image to be revealed once the mask object moves over it within the animation, giving the impression that Axis territories are moving. Ultimately, this saved many hours of production time since the complex lines of the coastal areas did not have to be repetitively drawn or tweened to. Using a mask to reveal territories proved to be much more efficient than creating growing or shrinking territories. Figure 8 provides a graphic representation of the masking process.

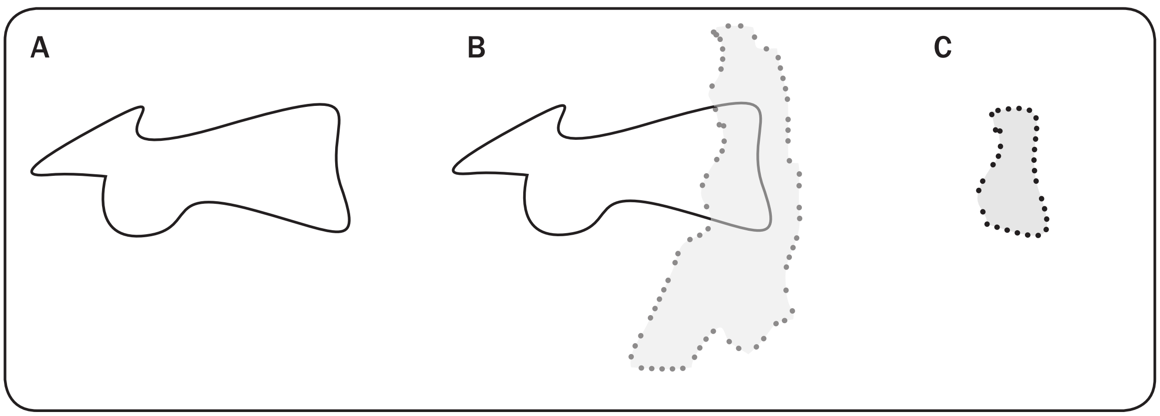


Figure 8. Example of Masking Technique. The original shape (A) cannot be seen until it is intersected by a mask (B). Only this intersection is revealed (C).

User Interactivity

Several elements of interactivity were incorporated into the geovisualization to enhance the user experience and also to allow the user to control the map animation. Standard media control buttons allow the user to pause, rewind, fast-forward, step back, step forward. An additional control was added which allows the user to control the dated timeline by clicking and then dragging to the left or to the right. Yet another element which provides a user enhanced control of the animation is the "Convoy Table." Once a convoy is selected within the Convoy Table, the animation skips to the date the convoy left and the animation is paused. For more advanced users, an optional window may be displayed to show more detailed statistics regarding the latest convoy displayed. To enable this option, the user can reveal this window by clicking the “Convoy Stats” check box. The user also has the option of dragging both the Convoy Statistics and Selected Convoy Statistics boxes to anywhere within the visible space of the animation. This is meant to provide greater flexibility by allowing the user to dynamically customize the interface. Alternatively, the user can deselect this option which removes both the Selected Convoy Statistics box and the Convoy Table.

Dynamic Data

In further consideration to file size and conserving bandwidth, every effort was made to create a “data-driven” application. Without dynamically updated data, every element within the animation (including statistical figures) remains static — disconnected from the database. Each of the hundreds of statistical estimates would require manual change in the event of mistakes. Of course, this would be quite inefficient and would also contribute to a significantly higher file size since each change must, by necessity, be separate text or graphical objects. To avoid these problems, all statistics displayed within the geovisualization are generated dynamically via scripted data queries. When the user selects a convoy in the “Convoy Table” an action is triggered which references the statistical database and updates the “Convoy Details” statistics box with the relevant statistics for that convoy.

There are two primary means of connecting a Flash project with an external data source: Extensible Markup Language (XML) or via a web service such as Active Server Pages (ASP). After much research and experimentation, the XML format provided the best option for this geovisualization. Considerations of time, extant knowledge of the subject matter and convenience all played a role in this decision. Connecting to a data source via a web service requires extensive knowledge of implementing server-side scripts as well as having access to a server running web services. There are several advantages to using a web service with Flash. One can script connections to relational databases such as MySQL or PostgreSQL, providing users powerful query capabilities and the ability to update and store information. Robust as these options are, this functionality was not necessary for this research. XML provides an easy to understand structure and is well-known for its flexibility. More importantly, XML can be accessed and displayed without the need for scripts or programming outside of the Flash Integrated Development Environment (IDE).

The Convoy Summary Table was initially stored in Microsoft® Excel format (*.xls). Flash cannot directly access data in Excel format, so it was necessary to convert the Convoy Summary Table an XML file. Using a custom function, the data were restructured from the familiar Excel tabular format into the XML tagged markup. With these data and their schema stored in an XML document, they are now readable directly within Flash. Using Flash's XML Connector, DataSet, and DataGrid components enables the developer to create a connection to the new XML document (called "convoydatanew.xml"). Figure 9 provides a visual representation of the component relationships within Flash. The XML Connector is the data component which establishes the link between the Flash project and the XML document and verifies the schema of the incoming XML data. The DataGrid user interface component serves to display the information drawn from the XML file. The DataSet data component serves as the "glue" between the XML Connector and the DataGrid. Configuring these three components allows for the display of an interactive, selectable "Convoy Table" within the animation.

Another function of creating a dynamically updated geovisualization becomes evident when changing or updating information. If at a later date the statistical data must be updated or modified, the script can be altered to immediately incorporate the changes into the geovisualization. Dynamically updating saves the researcher from the tedious task of unnecessarily arduous and repetitious updates.

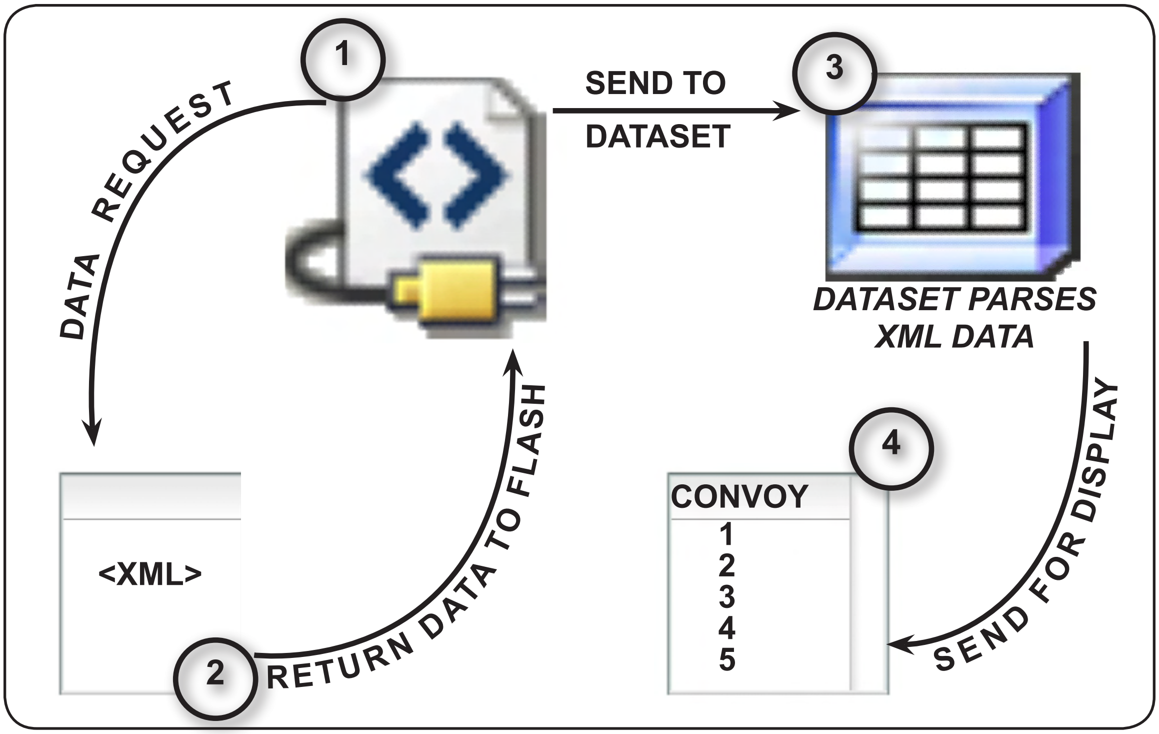


Figure 9. XML Data Access. The XML Connector (1) links to the XML document (2) and returns data. These data are sent to the DataSet component (3) which sends a parsed version of this information for display in the DataGrid component (4).

Templated Geovisualization

The secondary goal of this research is to provide historians and others within the academic community an opportunity to use this geovisualization and customize it for their own academic work. Because of the expansiveness of World War II as a topic of investigation, there are certainly many intersections of research. It is conceivable that many others may have an interest in mapping and locating their geographies of interest. Towards this end, efforts were made to create an animated geovisualization of World War II which displays frontline movement. Within this geovisualization, frontline movements were modeled and analyzed in juxtaposition to the convoy deportations from France. This effort used a copy of the same geovisualization for *Lebensraum*, but retains only the animations of the respective battlefronts. This is intended for historians and other researchers whom are interested in depicting the changes in frontline location in the context of their own historical research.

CHAPTER 6

RESULTS

This research sought to examine possible relationships between the areal expanse of Nazi German occupied territories and the implementation of the so-called "Final Solution to the Jewish Question." In this study, Jewish prisoner convoys from France were analyzed. Creating a historical GIS of World War II battlegrounds (from 1942 to 1944), enabled this researcher to represent the areal change of Axis territory over time. Four research questions were posed:

- Did the loss of Nazi territory (*Lebensraum*) affect the number of Jewish prisoner convoys from France to Auschwitz?
- Did the loss of Nazi territory (*Lebensraum*) affect the number of deportees killed upon arrival to Auschwitz?
- What other spatial and temporal patterns exist in the movement of Jewish prisoner convoys from France to Auschwitz?
- How can Historical GIS help to visualize these spatial and temporal phenomena?

Lebensraum and Convoys

What follows is a detailed description of convoy activity and the corresponding changes in *Lebensraum*. Results will be presented within the context of the major battles fought during this time period. This reference is not meant to indicate a certain causality for territorial change, although that may very well have been the case.

The first three months of the Final Solution saw a comparatively small number of deportations from France. Only one convoy left France from March to May, 1942. This period coincides with the latter stages of the Soviet Winter Counteroffensive of 1941/42. During this three month period, German territorial losses averaged approximately 13,000 km^2 per month. The following month (June 1942) saw a dramatic increase of convoy activity; four convoys left during this month. Three of these four convoys would depart within one week of the massive German Summer Offensive of 1942 (begun on June 28th).

The months of June through September 1942 would see Germany's deepest eastward incursions into Russian territory during the entire war. During these months, German occupied territory grew by approximately 60,000 km^2 per month as the Axis offensive sought major gains in Southern Russia. This five month period is also noteworthy because of the volume and frequency of convoy activity: 34 convoys during in 76 days – roughly one convoy every two days. This grouping of deportations accounts for approximately half of all convoys sent from France. This rush of deportation activity abruptly ceased on the last day of September, 1942 and did not resume again until early November 1942 when four convoys were sent within one week.

A week after these last four convoys of 1942, German forces were locked in what some consider the most decisive battle of the entire Russian campaign– the Battle of Stalingrad (Shirer 1960). After November, German forces found themselves overwhelmed, surrounded and losing ground fast. The Battle of Stalingrad was costly not only with respect to total lives lost (estimated +- 800,000) but German forces lost virtually all of the territory seized since May 1942. When the Axis forces which were surrounded in Stalingrad finally surrendered in early February 1943, German territorial losses had amounted to well over 400,000 km^2 in just three months. No convoys departed from France during this massive Soviet counteroffensive.

Following these major losses, German forces managed a minor counteroffensive of their own beginning in late February and then continuing until March 1943, allowing the Axis to retake the city of Kharkov. At the time of this brief German counteroffensive, a total of eight convoys were sent to Auschwitz. The remainder of the spring and early summer of 1943 saw very little few convoys (one convoy in June) and no major combat operations. Soviet forces utilized this brief lull to their advantage, digging in defensively as the Germans were reequipping their armies for yet another offensive – this time directed at closing the Kursk salient (a bulge which forms along a frontline).

The Battle of Kursk was begun on July 5^{th} 1943. After advancing slowly over a period of four weeks, the German offensive stalled in the face of a bitter Russian defense. The net territorial gain from the stifled German offensive on Kursk was relatively small: just over 3,000 km^2. At the time of the Battle of Kursk, two convoys left Paris for Auschwitz. This would prove to be Germany's last major offensive along the Eastern front. A week after the instigation of the German offensive at Kursk was the opening of a second front on the Italian island of Sicily. Allied forces invaded Italy on July 11^{th} 1943 and made quick work of the island with a complete capture of its 25,000 km^2 in just a little over one month.

The two convoys (57 and 58) sent in July 1943 would be the last Nazi transports made within the context of a Nazi German territorial gain. After August 1943, Germany would sustain substantial and continual territorial losses, with a monthly average loss of close to 100,000 km^2 until the liberation of Paris in August 1944. In spite of this profound loss of territory and the problematic tactical issues of conducting a war on two fronts, convoy operations became much more consistent. Although Nazi prisoner convoys would never reach the prolific levels of the summer of 1942, French deportations would occur on a much more regular basis. An average of two convoys departed in each of the remaining twelve months until the liberation of the French capitol.

June 1944 saw the Allied invasion of Normandy on the northern coast of France, bringing a third battlefront for the Axis to contend with. By this time in 1944, Allied forces had captured over half of the Italian peninsula and had recently captured the capitol, Rome, on June 4th. In Italy alone, over 110,000 km^2 were taken by the Allies in the eleven months since the launch of the Italian Campaign of 1943. On the Eastern front, Germany lost a staggering 800,000 km^2 in that same eleven month period. It is quite easy to surmise the inevitable fate of the once-proud Nazi state, especially considering the new front in the West had quickly swelled to an areal expanse of over 5,000 km^2 less than three months after the landings in Normandy. The Allies were quickly converging upon the German homeland.

Even as the Allied forces began to widen their hold on German occupied lands, the convoys continued to depart. During July, most Axis territorial losses were sustained on the Eastern front, with the Western Allied beachheads meeting stiff Axis resistance. At this time, Paris was less than 200 kilometers from the Allied front. With these huge losses of territory and the Allied front steadily advancing towards the primary convoy departure point north of Paris, the Nazis somehow found the time to schedule three more convoys to Auschwitz.

In late July 1944, the Western Allied forces launched Operation Cobra, which eventually provided the decisive breakthrough for Allied forces in the West. The success of this attack yielded the greatest monthly Allied territorial gain thus far. In the month of August alone, the Allies gained a surprising 198,466 km^2 on their way to liberating the French capitol. On August 25th, German forces surrendered but not before sending the final three convoys.

Generally speaking, the first year and a half of the Final Solution appears to operate in concert with the "battle success" of the Germany military (see Figure 10). When Germany made significant territorial gains (such as the German Summer Offensive of 1942), more convoys were sent to Auschwitz. Likewise, when the Axis was dealt a significant blow on the battlefield (later in 1942, losing the Battle of Stalingrad), there were substantially fewer convoys departing Paris for Auschwitz. The final year of con-

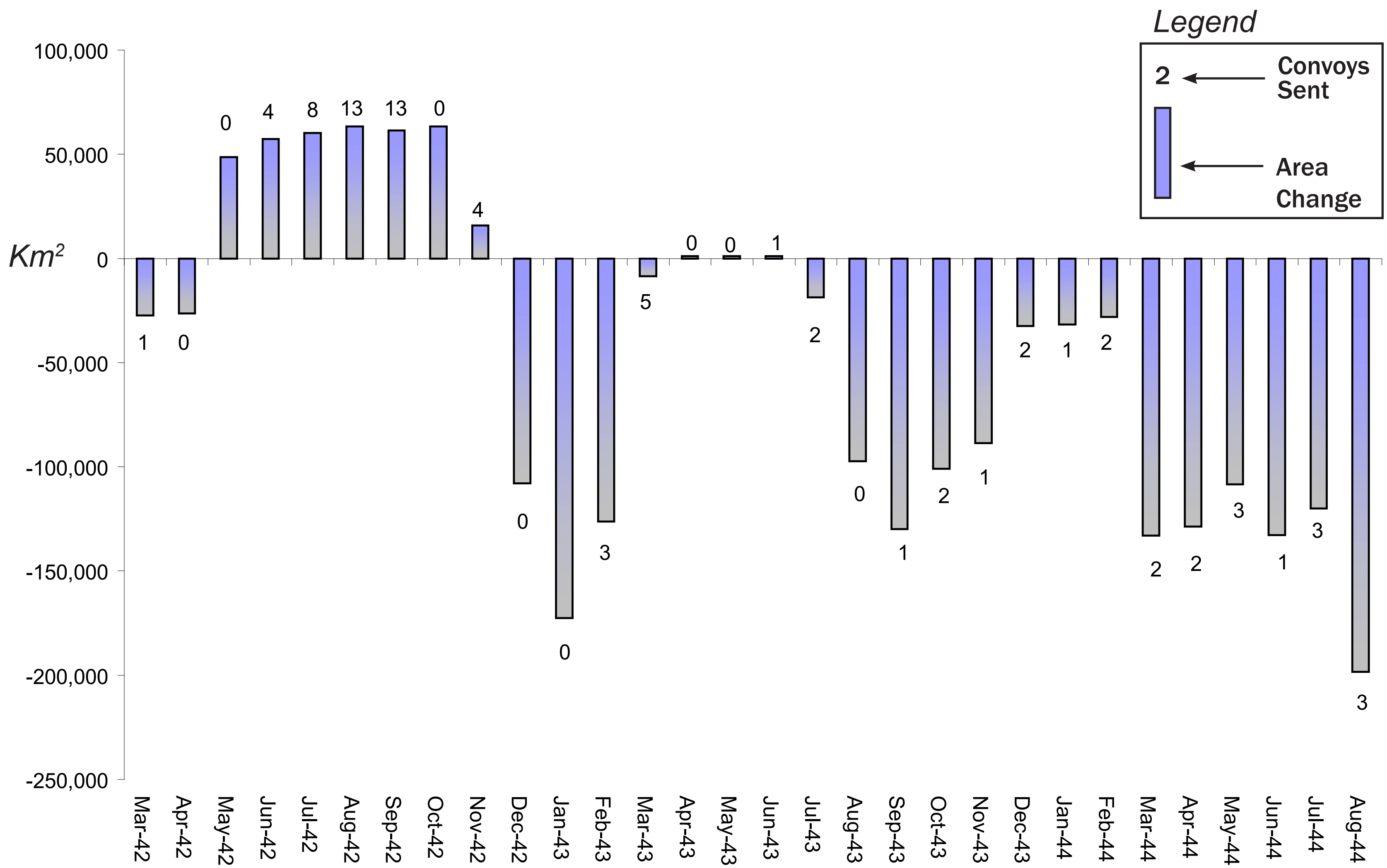


Figure 10. Monthly Summary: Area and Number of Convoys.

voy activity (September 1943 to August 1944) is quite different from the first. While the volume of convoys would never reach the frenetic levels of Summer 1942, convoy departures would achieve an unusual consistency in spite of the persistent, month-to-month losses of territory. Beginning in September 1943, at least one convoy per month would leave for Auschwitz until the Allied liberation of Paris. This final year of Nazi occupation corresponds with a monthly average loss of 100,000 km^2.

Statistical Analysis of Convoys and Lebensraum

Setting the total convoys departed per month as the dependent variable and the total kilometers squared as the independent variable reveals a few interesting statistical trends. In attempting to identify a statistical relationship between these two variables, a simple linear regression was performed for the entire temporal extent of the convoy data (see Figure 11). Over the entire two and a half years of convoy activity, linear regres-

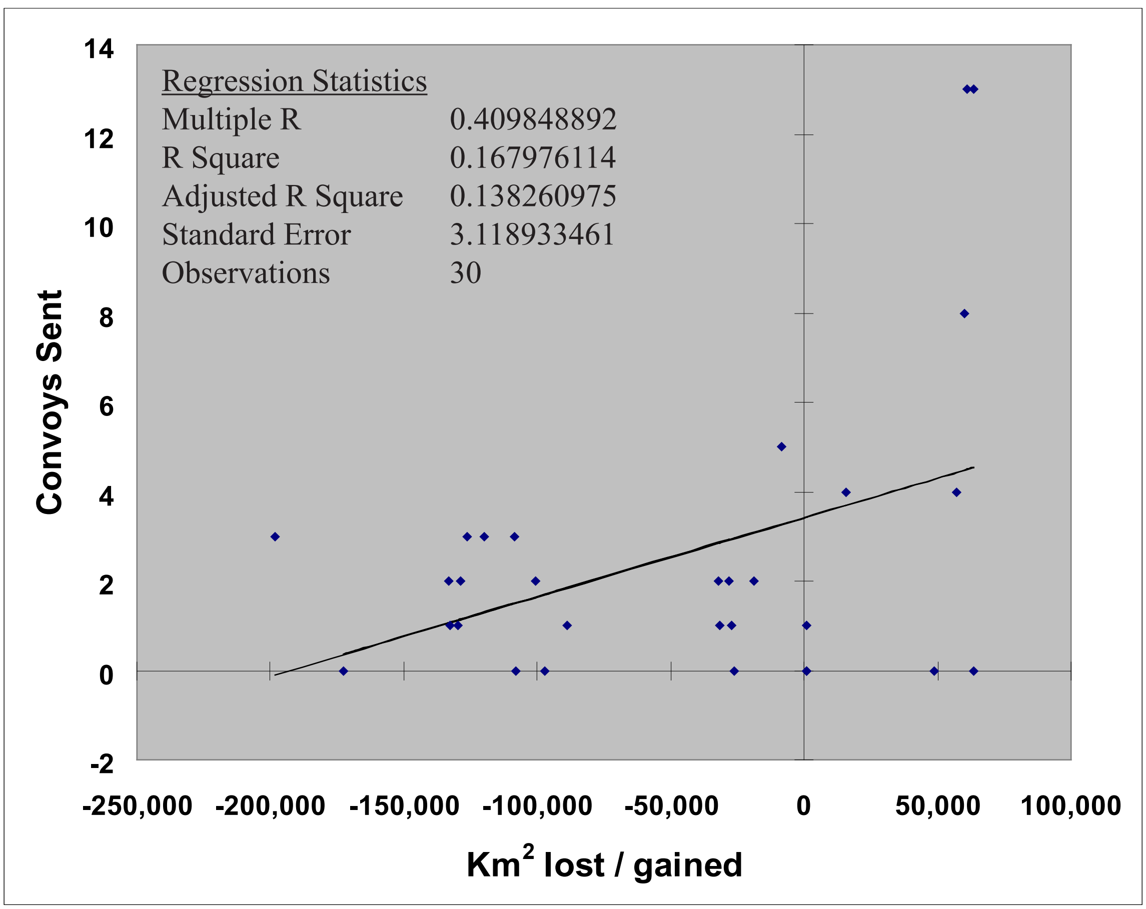


Figure 11. Convoy Regression Chart: All Convoys.

sion analysis reveals a weak positive relationship between territories gained/lost and total convoys sent per month (r^2 value of .167). As mentioned above, the final year of convoy activity is quite different than the first year (see Figure 12). When performing a regression analysis which only considers the first year and a half (before September 1943), the positive relationship is moderately improved (r^2 value of .237). A separate regression analysis was performed for the final year of convoy activity, revealing a relatively weak negative relationship (r^2 value of .187). These results suggest that battlefield success may have played more of a role in the earlier stages of the Final Solution as it concerns convoy activity.

Due to a limitation of available small scale situation maps, there are periods when

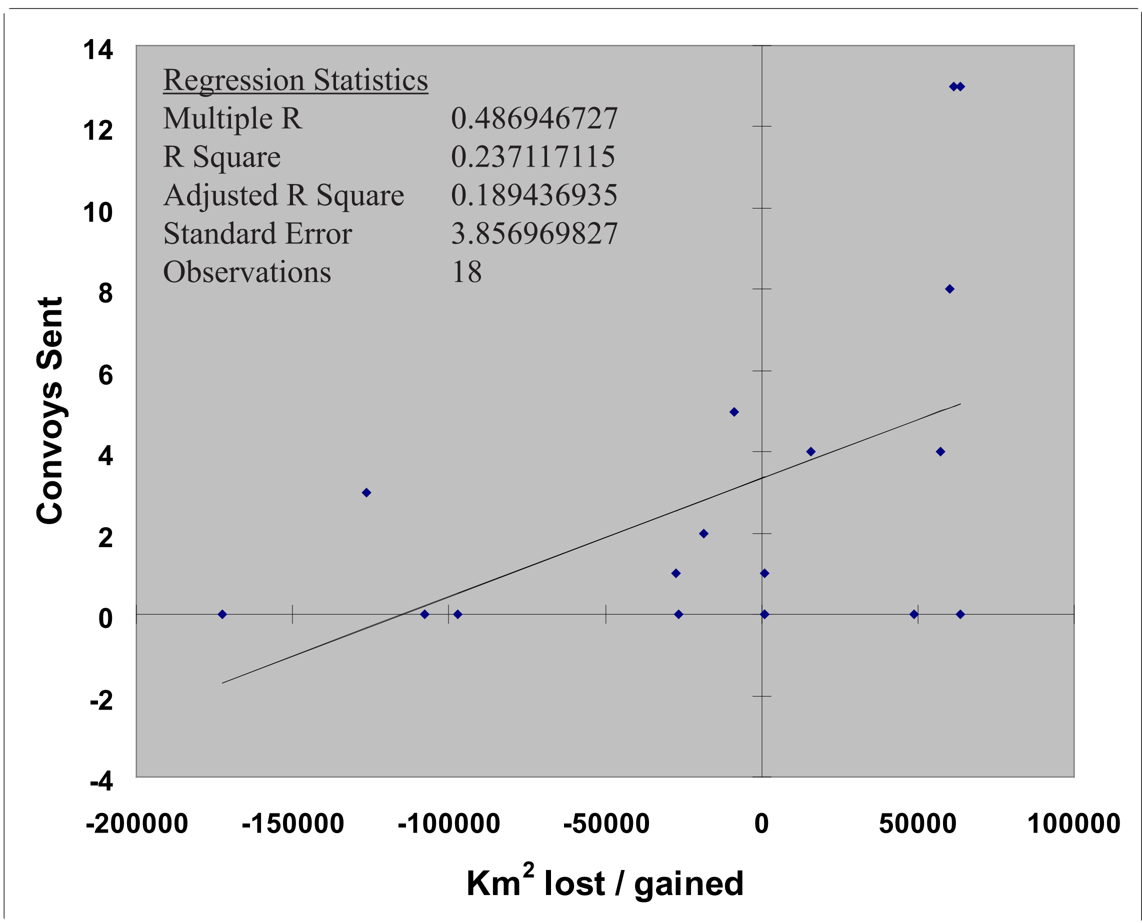


Figure 12. Convoy Regression Chart: All Convoys before Sep. 1943.

battle movements are overly "coarse". That is, the interpolation from one frontline measurement to another misses the intermediate movements of the frontlines. This interpolation error may have caused territorial measurements to be over or understated. In other cases, certain lost territories were actually tactical withdrawals. Although this research provides a good small scale representation of battle movements during World War II, more complete map data would help to provide a continuous model of battle movement.

There is one instance where these issues definitively affected the resulting statistical analysis. In February and March of 1943, the German army launched a counterattack designed to recapture the city of Kharkov while at the same time withdrawing forces from an area to the north. The net effect of this maneuver was a territorial loss of approximately 8,600 km^2. In spite of the loss of territory, this resulted in what many historians consider Germany's last major victory of the war. Around the time of this counteroffensive, eight convoys departed for Auschwitz. Although the capture of territory may provide a good measure of battle success, it is certainly not an absolute measure of battle success. Further research would benefit from a classification scheme which would properly identify whether territory was taken away or tactically given away.

Perhaps the most surprising aspect of this research involves the sudden change in convoy activity beginning in September of 1943. Previous convoy activity appears to be relatively predictable; when German military was successfully capturing territories, more convoys departed from France. After August of 1943, this pattern changed completely. Convoys departed with greater consistency even as Axis defeats began to mount. From this point onward, Germany incurred 12 consecutive months of territorial loss. This consistency becomes quite evident in Figure 13 below. The year of 1942 is characterized by a high frequency of convoys and then a complete cessation of all convoy activity. The year 1943 is first characterized by three clusters of convoys then a final quarter of consistent month-to-month departures. The year 1944 continues this trend of consistency until the liberation of Paris in August of 1944.

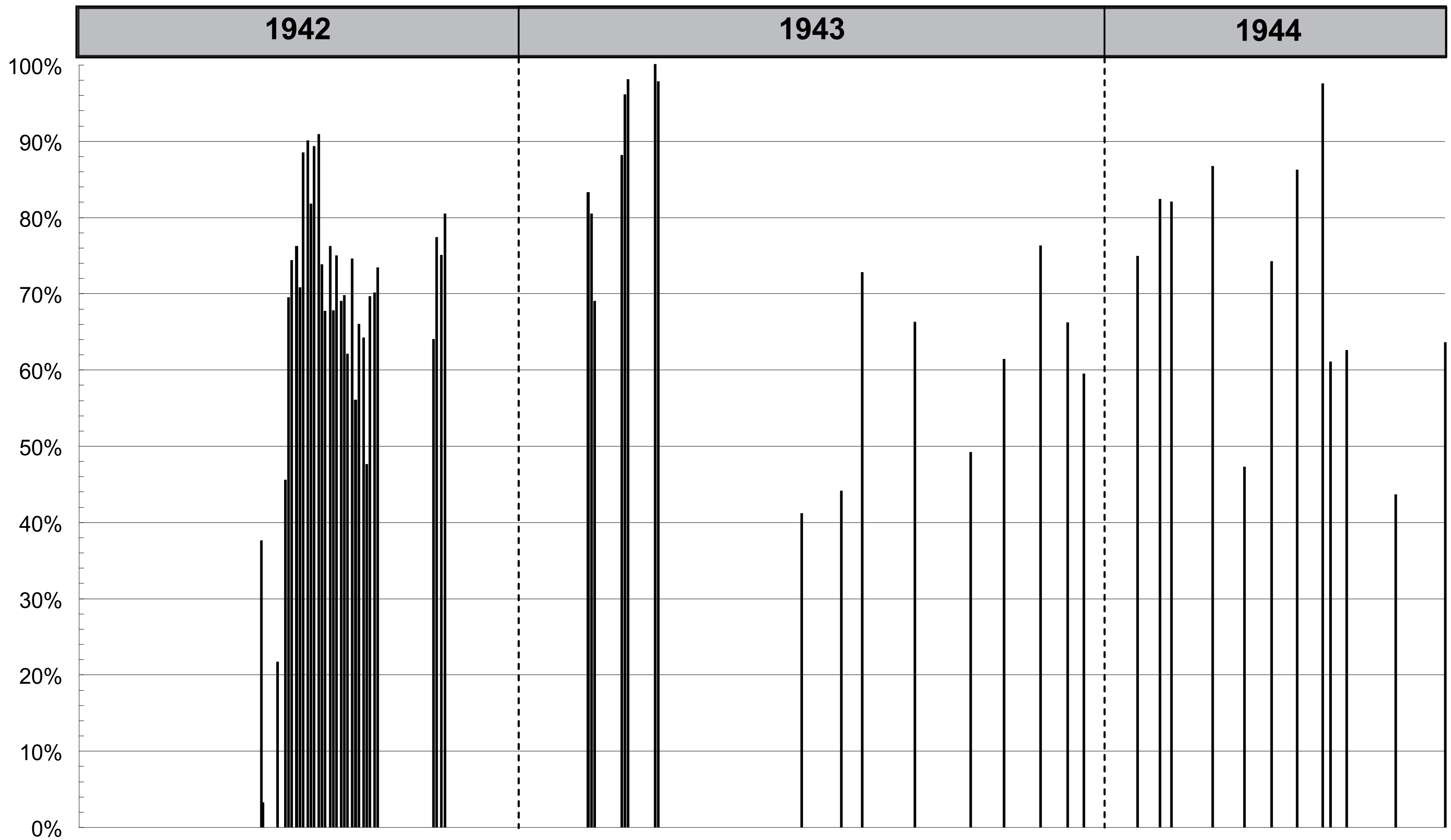


Figure 13. Convoy Frequency / Percent Killed on Arrival.

Lebensraum and Deportees Killed on Arrival

This analysis further sought to examine whether the gain or loss of *Lebensraum* had an effect upon the number of deportees killed upon their arrival to Auschwitz. In this study, the number of deportees killed upon arrival is necessarily dependent upon convoys departing. Thus, a degree of colinearity must be acknowledged. Another issue to consider when preparing these data for statistical analysis concerns the months in which no convoys departed. Left alone, this would show 8 months in which no deportees were killed upon arrival; this would produce a significant bias. In actuality, 6 of the 8 months mentioned above had no convoys which departed from France. To control for the latter of these two issues, I chose to examine the percentage of prisoners killed upon arrival only for the months in which convoys departed.

Setting the percentage of deportees killed upon arrival as the dependent variable with the total kilometers squared as the independent variable yielded a very weak statistical relationship. Over the entire two and a half years of convoy activity, linear regression analysis reveals a very weak negative relationship between territories gained/lost and percentage of prisoners killed on arrival (r^2 value of .112). Percent killed on arrival fluctuates such that it does not appear to be affected by changes in *Lebensraum*.

Qualitative Issues

Another issue which may have served to weaken the statistical results of this study was the clear influence of politics. In October of 1942, Germany seized its greatest monthly amount of territory: over 63,000 km^2. The preceding months of August and September were also noteworthy, not only in terms of territories gained (both totaled over 60,000 km^2) but also with regard to convoys sent (13 convoys were sent for each month). Interestingly, in October 1942 no convoys departed from France. In researching the original work of Serge Klarsfeld at the United States Holocaust Memorial Museum in Washington, DC this anomalous stoppage of convoy activity was clarified. Below is an excerpt from his *Memorial to the Jews Deported from France 1942-1944*.

> Following a meeting in Berlin held on August 28, the Germans planned to deport a convoy a day starting in October. Faced by an increasingly indignant French public, however, Petain (Chief of the collaborationist French state) and Laval balked at this plan (Klarsfeld 1983).

This example underscores how convoy activity can be affected by a multiplicity of factors. Regrettably, a full policy analysis of Germany and collaborationist France is not possible within the scope of this thesis. Future studies of convoy departures from France should include a robust analysis of social and political policies of the Third Reich.

Aside from the clear influence politics, bureaucratic and logistical factors also served to confound some of the findings within this research. In some cases, "orders" for trains were made months in advance, preceded by round-ups and the eventual concentration of different population groups. In the above example regarding convoys from October 1942, orders for trains were made at least one month in advance. The three convoys during the month of February 1943 had originally been scheduled for January 1943 but was postponed because of a lack of prisoners to deport (Klarsfeld 1983). These "orders in advance" and postponements help to highlight another limitation of this research. In this study, convoys departing on a particular date (or within a particular month) are compared with estimates of *Lebensraum* during that same time. Because decisions to order the trains often are made at a time well before the date of departure, one cannot assume a direct correspondence between the estimates of *Lebensraum* on a particular date and the departure of a convoy on that same date. Thus, a temporal offset is necessary which would compare *Lebensraum* from a previous date to the departure of convoys at a later date. A complete historical record of administrative requests for trains notwithstanding, the value of this offset remains difficult to estimate with any accuracy.

The primary reason for the postponement in the example above was most likely due to a lack of "deportable" prisoners (Klarsfeld 1983). Here, the term "deportable" can be defined differently depending upon the date one is referring to. Nazi racial policy changed over time. Initially, the term meant all "stateless Jews" living within France.

Jews of French nationality, those whom were half Jewish, Jews married to Aryans and others were spared from the initial sortie of deportations in 1942. Beginning in 1943, the Nazis made the term much more inclusive. Roma, Sinti and Jews, regardless of their nationality were deported to concentration and extermination camps. These bureaucratic and logistical definitions affected the number of eligible deportees and by extension, the number of trains ordered to deport them.

Geovisualization

The design and production of the geovisualization was comprised in two phases. The initial design efforts focused on providing a dynamic animation of WWII frontlines and convoy departures for ESDA. The resulting Flash animation provides both a smooth and representative flow of the major battles in addition to an illumination of the convoy route when a convoy has departed. A dynamic chart provides the user with the cumulative total of deportees killed as well as the percentage of deportees killed from the most current convoy. Basic navigation was created which allows the user to control the animation (start and pause only). As a result of this preliminary effort, distinct spatial and temporal patterns were observed. The researcher can clearly perceive the expanse of *Lebensraum* and massive convoy departures as German forces plunged deeply into Soviet territory. Also visible is the drop off of convoy activity after the losses at Stalingrad. This first, exploratory stage contributed greatly to the generation of research questions for this analysis.

The second phase of geovisualization development involved significant enhancements to the interactivity and dynamicism of the Flash movie itself. The primary motivations for this second stage are in homage to Waldo Tobler's animated geovisualization of Detroit, Michigan. In order to "create new insights into a complex process" ala Tobler, the researcher should be presented with an extensible, customizable interface which can help them to better visualize WWII and the Holocaust.

Geovisualization Controls

With Tobler's axiom in mind, the geovisualization controls were significantly improved and given much greater flexibility. The initial geovisualization only allowed the user to control the passage of time by using the "play" and "stop" buttons. In the revised geovisualization, the user has the ability to control the timeline with the original buttons or with two new controls: clicking and dragging the timeline cursor or clicking on a convoy record in the Convoy Table. For users with an interest in examining particular convoy information, a more detailed statistical view may be accessed by checking the "Toggle Convoy Stats" check box. When this "Toggle Convoy Stats" is checked, both the Convoy Table and the Selected Convoy Statistics box become visible and accessible to the user (See Figure 14). In the future, the user will also have the ability to activate different sets of historical borders. This future add-on feature will provide a valuable historical reference for users and allow them to further customize the interface.

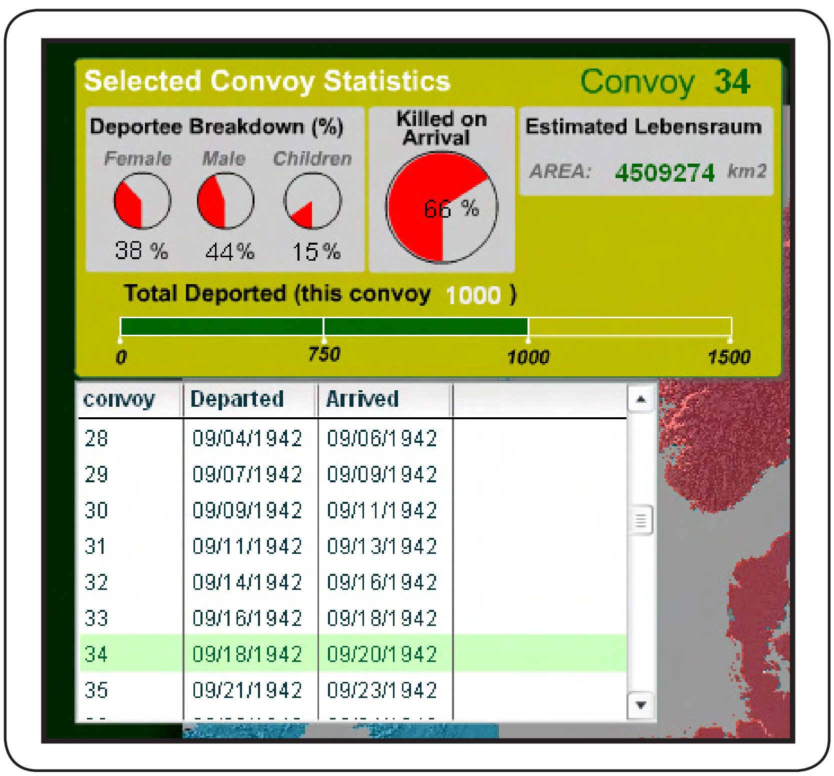


Figure 14. Optional Panels. New Selected Convoy Statistics and Convoy Table are now visible.

Templated Geovisualization

With the geovisualization now complete (see Figure 15), we can now turn to the longitudinal goal of this study: demonstrating the utility of a templated geovisualization for historical research. The idea behind this is simply to conserve the amount of effort the academic community expends on creating animated maps of WWII. As mentioned above, there is currently a disconnect between geospatial software applications and dynamic representations of spatiohistorical data. Many intermediate steps must be taken by researchers to fill this gap.

Creating a templated geovisualization gives researchers of WWII and the Holocaust a valuable "jump start" with regard to dynamically animating the frontline positions for three major theaters of war. One only needs to customize the animation to suit their own needs. Both the GIS data and the Flash animation source files will be made available; freely downloadable at the Web site (http://www.geosites.evans.txstate.edu/holocaust-geography). Two versions will be made available:

1. <u>Thesis version</u>. This version will be the exact same geovisualization data as discussed within this thesis. A "read me" file will also be included.
2. <u>Frontline version</u>. This version will contain only the animated frontline representations. This version is intended for WWII researchers or enthusiasts whose interests are outside the bounds of the Holocaust or convoy deportations. A "read me" file will also be included.

With an interest in measuring the use, distribution and modification of these source files, each visitor wishing to download the GIS or geovisualization source files will be required to register their name and email address. An online group forum will also be made available for registrants. It is the hope of this researcher that a collaborative community interested in historical visualizations may be fostered as a result.

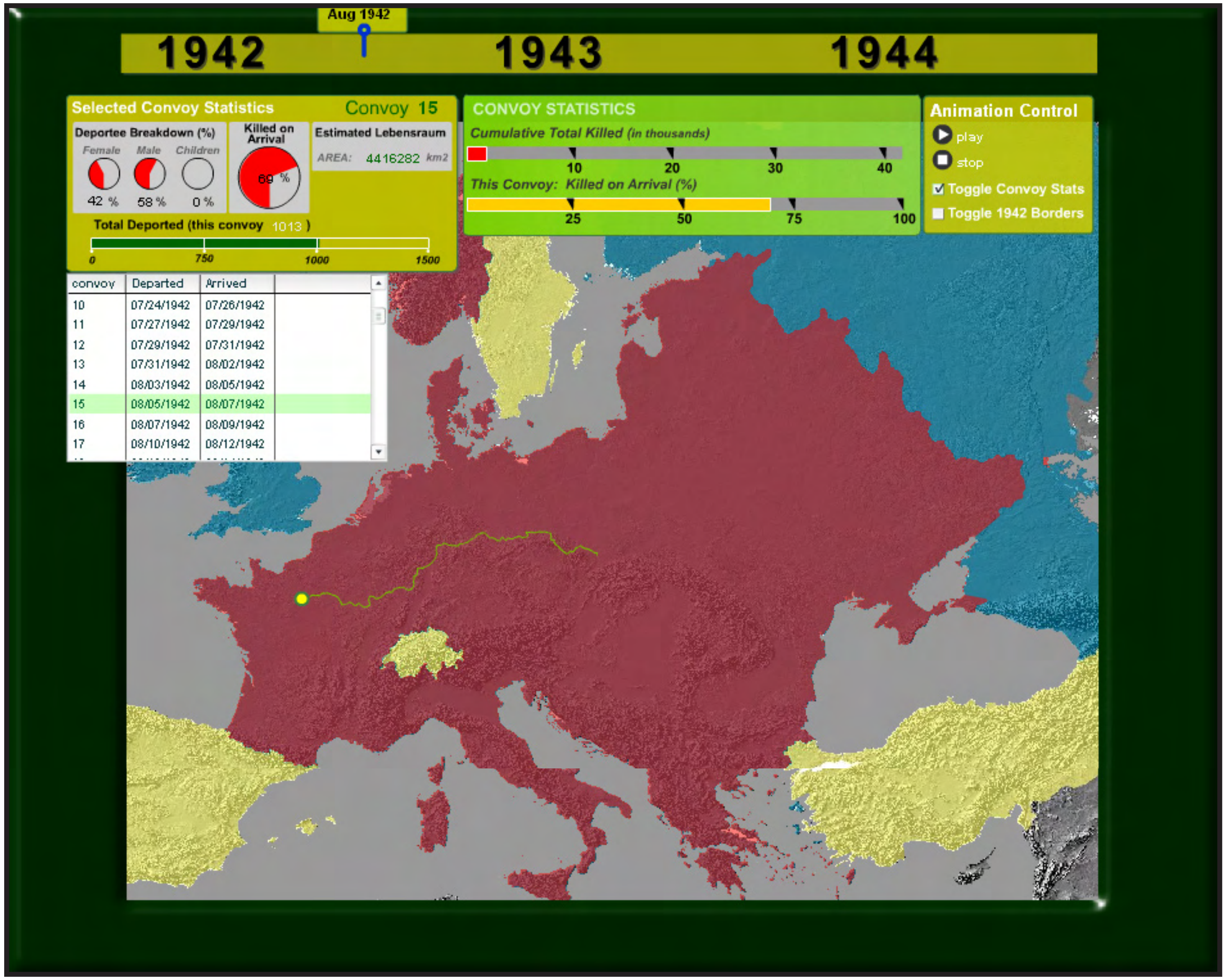


Figure 15. The Completed Geovisualization Interface.

CHAPTER 7

CONCLUSIONS

With the development of new tools comes the opportunity to revisit old questions and problems from a new perspective (Knowles 2000). History is often complex, multi-dimensional and can be quite difficult to reconcile. GIS technologies provide historical researchers tools to explore the past in exciting new ways. In the present case, utilizing GIS within historical research of the Holocaust holds much promise. This study investigated the Holocaust and World War II with a special focus on the geographic. This has been one of the first efforts to examine the Holocaust using spatial analysis by mapping and analyzing the changes of German territorial control during the years 1942 to 1944.

Using an interactive geovisualization and statistical analysis, two distinct spatio-temporal trends were identified. The first year and a half of convoy activity (March 1942 to August 1943) corresponds positively with the ebb and flow of the Germany military: as more territory was captured, increasingly more convoys were sent. Inversely, as the German military experienced defeat and lost territory, very few or no convoys departed France. The final year of deportations (September 1943 to August 1944) saw a reversal of this trend as convoys departed from France on a far more consistent basis. Convoys were sent with a surprising consistency — seemingly with little regard to the rapidly evaporating domain of German territorial control.

These observed spatial and temporal patterns provide an interesting perspective on how Nazi convoy activity from France was or was not affected by battlefield success. The results of this research are, however, far from achieving any level of generalizability.

Qualitative issues beyond the scope of this study clearly impacted the convoy activity. There is sufficient evidence to suggest that political considerations curtailed an entire month of convoys in the fall of 1942. Aside from the influence of politics, delays or cancellations of convoy orders were also likely to have been the result of administrative or logistical concerns rather than specific battlefield conditions. Yet another limitation brought to light in this analysis focused on the question: how far in advance were the orders for a convoy deportation given before the convoy physically departed for Auschwitz? Linking past decisions (ordering the convoy trains) to future occurrences (the convoys departing) will continue to be a troublesome issue to contend with in the absence of more complete information. This research suggests that battlefield success did have an affect upon deportations from France. However, without a more thorough assessment of the aforementioned qualitative issues, it is impossible to ascertain the degree to which gains or losses of *Lebensraum* affected the convoy departures.

This research also showcased the value of dynamic geovisualization. By creating interactive displays of geographic information, this thesis demonstrated that geovisualization can be a valuable tool for exploratory analysis, generating research questions and ultimately displaying the results of one's analysis.

APPENDIX A: ACTIONSCRIPT

Code for the Map Animation

```
//Start Movie:  Convoy Detail Box & DataGrid Invisible
_root.mystats_mc._visible = false;
_root.convoysDataGrid._visible = false;
//On Frame 1 of timeline:::
//Make the convoy stats boxes draggable
on (press) {
		_alpha = 50;
		startDrag(this);
}
on (release) {
		_alpha = 100;
		stopDrag();
}
// Scrub Control for Timeline (adapted from FlashKit.com)
this.onLoad = function() {
 _global.played = “played”;
 _global.toggle = false;
 _global.origX = this.slide._x;
 _global.origY = this.slide._y;
 _global.dragged = “no”;
 _global.factor = 980;
```

```
 _global.percentage = factor/_root._totalframes;
 this.lineclip._width = factor+this.slide._width;
 this.lineclip._x = origX;
 this.lineclip._y = origY+this.lineclip._height/4;
};
this.slide.onEnterFrame = function() {
 if (dragged<>"yes") {
 this._x = Math.ceil((_root._currentframe*percentage)+origX-1);
 } else {
 _root.gotoAndStop(Math.floor((this._x-origX)/percentage)+1);
 }
};
this.slide.onPress = function() {
 _global.dragged = "yes";
 _root.convoystats_mc.stop();
 this.startDrag(false, origX, origY, origX+(factor*Math.ceil(_root._framesloaded/_root._
totalframes)), origY);
};
this.slide.onRelease = function() {
 var dropFrame:Number = _root._currentframe;
 _root.convoystats_mc.gotoAndPlay(dropFrame);
 _root.gotoAndPlay(dropFrame);
 _global.dragged = "no";
 stopDrag();
 if (played == "played") {
 _root.play();
 _global.toggle = false;
```

```
 }
};
this.stopbut.onRelease = function() {
 if (toggle<>true) {
 _root.stop();
 _global.played = "stoped";
 this.gotoAndStop("playit");
 } else {
 _root.play();
 _global.played = "played";
 this.gotoAndStop("stopit");
 }
 _global.toggle = !toggle;
};
//Scrub Date Text
_root.onEnterFrame = function() {
var thisFrame:Number = _root._currentframe;
var frameYear:Number;
var frameMonth:Number;
if(thisFrame>29){
	_root.slide.markerdate_txt.text = "Dec 41";
}
};
//Hover Caption Code (from Kirupa.com)

slide.onRollOver = function() {
```

```
captionFN(true, "Drag This To Control Movie", this);
this.onRollOut = function() {

captionFN(false);

};

};
mystats_mc.onRollOver = function() {

captionFN(true, "Drag Me!", this);
this.onRollOut = function() {

captionFN(false);

};

};
b3.onRollOver = function() {

captionFN(true, "Click on a Convoy in the table to jump to the date in the timeline.",
this);
this.onRollOut = function() {

captionFN(false);

};
```

```
};
captionFN = function (showCaption, captionText, bName) {

if (showCaption) {

_root.createEmptyMovieClip("hoverCaption", this.getNextHighestDepth());
cap.desc.text = captionText;
cap._width = 7*cap.desc.text.length;
cap._alpha = 75;
//
if ((bName._width+bName._x+cap._width)>Stage.width) {

xo = -2-cap._width;
yo = -17;

} else {

xo = 2;
yo = -17;

}
hoverCaption.onEnterFrame = function() {

cap._x = _root._xmouse+xo;
cap._y = _root._ymouse+yo;
cap._visible = true;
```

```
};
} else {
delete hoverCaption.onEnterFrame;
cap._visible = false;
}
}
//Resize Male, Female and Child Pie Charts
//Child
_root.mystats_mc.ChildfirstSide._xscale = 50;
_root.mystats_mc.ChildfirstSide._yscale = 50;
_root.mystats_mc.ChildsecondSide._xscale = 50;
_root.mystats_mc.ChildsecondSide._yscale = 50;
_root.mystats_mc.childRing_mc._yscale = 50;
_root.mystats_mc.childRing_mc._xscale = 50;
_root.mystats_mc.childRing_mc._x = _root.mystats_mc.ChildsecondSide._x - 15;
//Male
_root.mystats_mc.MalefirstSide._xscale = 50;
_root.mystats_mc.MalefirstSide._yscale = 50;
_root.mystats_mc.MalesecondSide._xscale = 50;
_root.mystats_mc.MalesecondSide._yscale = 50;
_root.mystats_mc.maleRing_mc._yscale = 50;
_root.mystats_mc.maleRing_mc._xscale = 50;
_root.mystats_mc.maleRing_mc._x = _root.mystats_mc.MalesecondSide._x - 15;
//Female
_root.mystats_mc.FemalefirstSide._xscale = 50;
_root.mystats_mc.FemalefirstSide._yscale = 50;
```

```
_root.mystats_mc.FemalesecondSide._xscale = 50;
_root.mystats_mc.FemalesecondSide._yscale = 50;
_root.mystats_mc.femaleRing_mc._yscale = 50;
_root.mystats_mc.femaleRing_mc._xscale = 50;
_root.mystats_mc.femaleRing_mc._x = _root.mystats_mc.FemalesecondSide._x - 15;
//Getting Data from the DataGrid
//convoysDataGrid is the DataGrid component instance
var myListener = new Object();
myListener.cellPress = function(event) {
	var theSelectedItem = convoysDataGrid.selectedItem;
	var convoyValue = theSelectedItem.convoy;
	var dep_dateValue = theSelectedItem.dep_date;
	var frameValue = theSelectedItem.frame;
	var arr_dateValue = theSelectedItem.arr_date;
	var total_depValue = theSelectedItem.total_dep;
	var dep_locValue = theSelectedItem.dep_loc;
	var arr_locValue = theSelectedItem.arr_loc;
	var dep_monthValue = theSelectedItem.dep_month;
	var dep_yearValue = theSelectedItem.dep_year;
	var dep_monthValue = theSelectedItem.dep_month;
	var total_depValue = theSelectedItem.total_dep;
	var num_maleValue = theSelectedItem.num_male;
	var num_femValue = theSelectedItem.num_fem;
	var num_childValue = theSelectedItem.num_child;
	var num_killaValue = theSelectedItem.num_killa;
	var lebensValue:Number = theSelectedItem.lebens;
	_root.mystats_mc.leben_txt.text = Math.round(lebensValue);
```

```
        _root.mystats_mc.convoy_txt.text = convoyValue;
        _root.mystats_mc.total_dep_txt.text = total_depValue;
        _root.mystats_mc.num_male_txt.text = num_maleValue;
        _root.mystats_mc.num_fem_txt.text = num_femValue;
        _root.mystats_mc.num_child_txt.text = num_childValue;
        _root.mystats_mc.num_killa_txt.text = num_killaValue;
// Pie Chart Variables and calculations
        var num_killa:Number = _root.mystats_mc.num_killa_txt.text;
        var total_dep:Number = _root.mystats_mc.total_dep_txt.text;
        var num_child:Number = _root.mystats_mc.num_child_txt.text;
        var num_fem:Number = _root.mystats_mc.num_fem_txt.text;
        var num_male:Number = _root.mystats_mc.num_male_txt.text;
        KOApieValue = (num_killa / total_dep)*100;
        ChildpieValue = (num_child / total_dep)*100;
        FemalepieValue = (num_fem / total_dep)*100;
        MalepieValue = (num_male / total_dep)*100;
        _root.mystats_mc.myChild_txt.text = Math.round(ChildpieValue);
        _root.mystats_mc.myNumber_txt.text = Math.round(KOApieValue);
        _root.mystats_mc.myFemale_txt.text = Math.round(FemalepieValue);
        _root.mystats_mc.myMale_txt.text = Math.round(MalepieValue);
showKOAPie(_root.mystats_mc.myNumber_txt.text);
showChildPie(_root.mystats_mc.myChild_txt.text);
showFemalePie(_root.mystats_mc.myFemale_txt.text);
showMalePie(_root.mystats_mc.myMale_txt.text);
actionBars();
timelineJump(frameValue);
}
```

```
function timelineJump(frame){
	_root.gotoAndStop(frame);
	_root.convoystats_mc.gotoAndStop(frame);
	trace(frame);
}
function actionBars(){
	//for the Total Killed on Arrival
	var maxKill:Number = 1500;
	var minKill:Number = 0;
	var totalKill:Number = _root.mystats_mc.total_dep_txt.text;
	var scalePercent:Number = (totalKill / maxKill)*100;
	_root.mystats_mc.mytotalBar._xscale = scalePercent;
	//for the Percent of total
}

function showKOAPie(percent){
	// spin the half-circle clips within the two masked movies
	// to reveal them based on the percent (0-100) passed
	if (percent < 50){
		_root.mystats_mc.firstSide.halfcirc._rotation = 180*percent/50;
		_root.mystats_mc.secondSide.halfcirc._rotation = 0;
	}else{
		_root.mystats_mc.firstSide.halfcirc._rotation = 180;
		_root.mystats_mc.secondSide.halfcirc._rotation = 180*(percent-50)/50;
	}
}
function showChildPie(percent){
```

```
        // spin the half-circle clips within the two masked movies
        // to reveal them based on the percent (0-100) passed
        if (percent < 50){
                _root.mystats_mc.ChildfirstSide.halfcirc._rotation = 180*percent/50;
                _root.mystats_mc.ChildsecondSide.halfcirc._rotation = 0;
                _root.mystats_mc.ChildfirstSide
        }else{
                _root.mystats_mc.ChildfirstSide.halfcirc._rotation = 180;
                _root.mystats_mc.ChildsecondSide.halfcirc._rotation = 180*(percent-
50)/50;
        }
}
function showFemalePie(percent){
                // spin the half-circle clips within the two masked movies
        // to reveal them based on the percent (0-100) passed
        if (percent < 50){
                _root.mystats_mc.FemalefirstSide.halfcirc._rotation = 180*percent/50;
                _root.mystats_mc.FemalesecondSide.halfcirc._rotation = 0;
                _root.mystats_mc.FemalefirstSide
        }else{
                _root.mystats_mc.FemalefirstSide.halfcirc._rotation = 180;
                _root.mystats_mc.FemalesecondSide.halfcirc._rotation = 180*(percent-
50)/50;
        }
}
function showMalePie(percent){
                // spin the half-circle clips within the two masked movies
```

```
        // to reveal them based on the percent (0-100) passed
        if (percent < 50){
                _root.mystats_mc.MalefirstSide.halfcirc._rotation = 180*percent/50;
                _root.mystats_mc.MalesecondSide.halfcirc._rotation = 0;
                _root.mystats_mc.MalefirstSide
        }else{
                _root.mystats_mc.MalefirstSide.halfcirc._rotation = 180;
                _root.mystats_mc.MalesecondSide.halfcirc._rotation = 180*(percent-
50)/50;
        }
}
convoysDataGrid.addEventListener(“cellPress”, myListener);
```

APPENDIX B: CONVOY DATA TABLE

Convoy	Dep_Date	Arr_Date	Dep_Loc	Arr_Loc	Total_Dep	Num_male	Num_fem	Num_child	Num_KillA	Lebensraum
1	3/27/1942	3/30/1942	Compiegne	Auschwitz	1112	1112	0	0	0	4,267,516
2	6/2/1942	6/7/1942	Compiegne	Auschwitz	1000	1000	0	0	0	4,288,245
3	6/22/1942	6/24/1942	Drancy	Auschwitz	1000	933	67	0	0	4,327,736
4	6/25/1942	6/27/1942	Pithiviers	Auschwitz	1000	1000	0	0	0	4,333,659
5	6/28/1942	6/30/1942	Beaune-la-Rolande	Auschwitz	1038	1004	34	0	0	4,339,583
6	7/17/1942	7/19/1942	Pithiviers	Auschwitz	938	809	119	0	0	4,377,098
7	7/19/1942	7/21/1942	Le Bourget/Drancy	Auschwitz	1000	879	121	0	375	4,381,047
8	7/20/1942	7/23/1942	Drancy	Auschwitz	827	394	430	0	26	4,383,022
9	7/22/1942	7/24/1942	Le Bourget/Drancy	Auschwitz	1000	615	385	0	0	4,386,971
10	7/24/1942	7/26/1942	Le Bourget/Drancy	Auschwitz	1000	370	630	0	0	4,390,920
11	7/27/1942	7/29/1942	Le Bourget/Drancy	Auschwitz	1000	248	742	0	0	4,397,260
12	7/29/1942	7/31/1942	Le Bourget/Drancy	Auschwitz	1000	270	730	0	216	4,401,487
13	7/31/1942	8/2/1942	Pithiviers	Auschwitz	1049	690	359	0	0	4,405,714
14	8/3/1942	8/5/1942	Pithiviers	Auschwitz	1034	52	982	0	470	4,412,055
15	8/5/1942	8/7/1942	Beaune-la-Rolande	Auschwitz	1013	588	426	0	703	4,416,282
16	8/7/1942	8/9/1942	Pithiviers	Auschwitz	1069	209	860	0	794	4,420,509
17	8/10/1942	10/12/1942	Le Bourget/Drancy	Auschwitz	1006	525	475	0	766	4,426,849
18	8/12/1942	8/14/1942	Le Bourget/Drancy	Auschwitz	1007			0	712	4,431,076
19	8/14/1942	8/16/1942	Drancy	Auschwitz	991				876	4,435,303
20	8/17/1942	8/19/1942	Le Bourget/Drancy	Auschwitz	997			664	897	4,441,643
21	8/19/1942	8/21/1942	Le Bourget/Drancy	Auschwitz	1000			373	817	4,445,870
22	8/21/1942	8/23/1942	Le Bourget/Drancy	Auschwitz	1000			544	892	4,450,097
23	8/24/1942	8/26/1942	Drancy	Auschwitz	1000			518	908	4,456,437
24	8/26/1942	8/28/1942	Le Bourget/Drancy	Auschwitz	1000			320	737	4,460,664
25	8/28/1942	8/31/1942	Le Bourget/Drancy	Auschwitz	1000			280	676	4,464,891
26	8/31/1942	9/2/1942	Le Bourget/Drancy	Auschwitz	1000	475	377	148	761	4,471,232
27	9/2/1942	9/4/1942	Le Bourget/Drancy	Auschwitz	1000				677	4,475,459
28	9/4/1942	9/6/1942	Le Bourget/Drancy	Auschwitz	1013				759	4,479,686
29	9/7/1942	9/9/1942	Le Bourget/Drancy	Auschwitz	1000	565	435	122	689	4,486,026
30	9/9/1942	9/11/1942	Drancy	Auschwitz	1017				709	4,490,253
31	9/11/1942	9/13/1942	Le Bourget/Drancy	Auschwitz	1000				620	4,494,480
32	9/14/1942	9/16/1942	Le Bourget/Drancy	Auschwitz	1000	640	340	60	745	4,500,820
33	9/16/1942	9/18/1942	Le Bourget/Drancy	Auschwitz	993	586	407	0	556	4,505,047
34	9/18/1942	9/20/1942	Le Bourget/Drancy	Auschwitz	1000	437	384	150	659	4,509,274
35	9/21/1942	9/23/1942	Pithiviers	Auschwitz	1000	532	462	163	641	4,515,615
36	9/23/1942	9/24/1942	Le Bourget/Drancy	Auschwitz	1000	644	342	200	475	4,519,842
37	9/25/1942	9/27/1942	Le Bourget/Drancy	Auschwitz	1004	473	531	127	698	4,524,068
38	9/28/1942	9/29/1942	Le Bourget/Drancy	Auschwitz	904			100	633	4,530,409
39	9/30/1942	10/2/1942	Le Bourget/Drancy	Auschwitz	210				154	4,534,636
40	11/4/1942	11/6/1942	Le Bourget/Drancy	Auschwitz	1000	468	514	200	639	4,608,607
42	11/6/1942	11/8/1942	Le Bourget/Drancy	Auschwitz	1000	478	504	221	773	4,612,834
44	11/9/1942	11/11/1942	Le Bourget/Drancy	Auschwitz	1000	384	560	150	750	4,619,175
45	11/11/1942	11/13/1942	Le Bourget/Drancy	Auschwitz	745	350	391	106	599	4,623,402
46	2/9/1943	2/11/1943	Le Bourget/Drancy	Auschwitz	1000	447	545	130	832	4,267,264
47	2/11/1943	2/13/1942	Le Bourget/Drancy	Auschwitz	998	499	477	175	802	4,253,040
48	2/13/1943	2/15/1943	Le Bourget/Drancy	Auschwitz	1000	466	519	150	689	4,238,816
49	3/2/1943	3/4/1943	Le Bourget/Drancy	Auschwitz	1000			45	881	4,196,811
50	3/4/1943	3/9/1943	Le Bourget/Drancy	Cholm	1003	937	66	5	963	4,195,737
51	3/6/1943	3/8/1943	Le Bourget/Drancy	Cholm	1000				980	4,194,663
52	3/23/1943	3/25/1943	Le Bourget/Drancy	Cholm	997	639	355	15	997	4,188,405
53	3/25/1943	3/27/1943	Le Bourget/Drancy	Cholm	1008	527	472	119	985	4,188,479
55	6/23/1943	6/25/1943	Le Bourget/Drancy	Auschwitz	1018	561	457	160	418	4,191,834
57	7/18/1943	7/20/1943	Paris	Auschwitz	1000	522	430	126	440	4,184,657
58	7/31/1943	8/2/1943	Paris	Auschwitz	1000	514	480	95	727	4,173,446
59	9/2/1943	9/4/1943	Paris	Auschwitz	1000	551	441	130	662	4,069,802
60	10/7/1943	10/10/1943	Paris	Auschwitz	1000	564	436	0	491	3,910,898
61	10/28/1943	10/30/1943	Paris	Auschwitz	1000			125	613	3,846,697
62	11/20/1943	11/23/1943	Paris	Auschwitz	1200	634	556	164	914	3,776,380
63	12/7/1943	12/10/1943	Paris	Auschwitz	1000	575	422	161	661	3,736,286
64	12/17/1943	12/20/1943	Paris	Auschwitz	850	501	345	99	505	3,725,511
66	1/20/1944	1/22/1944	Drancy	Auschwitz	1155	632	515	221	864	3,688,977

Convoy	Dep_Date	Arr_Date	Dep_Loc	Arr_Loc	Total_Dep	Num_male	Num_fem	Num_child	Num_KillA	Lebensraum
67	2/3/1944	2/6/1944	Drancy	Auschwitz	1214	662	552	184	999	3,674,718
68	2/10/1944	2/12/1944	Drancy	Auschwitz	1500	686	814	279	1229	3,667,693
69	3/7/1944	3/10/1944	Drancy	Auschwitz	1501	812	689	178	1300	3,621,011
70	3/27/1944	3/30/1944	Drancy	Auschwitz	1000	609	416	119	472	3,532,305
71	4/13/1944	4/16/1944	Drancy	Auschwitz	1500	646	854	300	1112	3,456,905
72	4/29/1944	5/1/1944	Drancy	Auschwitz	1004	398	606	174	865	3,385,941
73	5/15/1944			Kovno	878	878	0	37	856	3,329,096
74	5/20/1944	5/23/1944	Drancy	Auschwitz	1200	565	632	191	732	3,311,655
75	5/30/1944	6/2/1944	Drancy	Auschwitz	1004	534	470	104	627	3,273,609
76	6/30/1944	7/4/1944	Drancy	Auschwitz	1100	600	550	162	479	3,128,805
80	7/21/1944	-	-	-	-	-	-	-	-	-
81	7/30/1944	-	-	-	-	-	-	-	-	-
77	7/31/1944	8/3/1944		Auschwitz	1300	-	-	300	826	3,004,873
78	8/11/1944	-	-	-	-	-	-	-	-	-
79	8/17/1944	-	-	-	-	-	-	-	-	-
82	8/22/1944	-	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-	-	-
84	-	-	-	-	-	-	-	-	-	-
85	-	-	-	-	-	-	-	-	-	-
86	-	-	-	-	-	-	-	-	-	-

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