



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**UTILIZING BIOLOGICAL MODELS TO DETERMINE THE
RECRUITMENT OF THE IRA BY MODELING THE VOTING
BEHAVIOR OF SINN FÉIN**

by

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March 2006

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THE IRA BY MODELING THE VOTING BEHAVIOR OF SINN FÉIN**

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ABSTRACT

Sociological models have been extensively used to predict the behavior of terrorist groups and to understand their use of terrorism. Much remains to be understood, however, concerning the factors that govern the growth or decline of these groups. Sociological models are inadequate for understanding terrorist behavior because these models typically do not account for the behavior of individuals who ignore social mores. This thesis explores the use of biological population models as a means to incorporate predator-prey behavior factors into terrorist models. This thesis also demonstrates that this method is more appropriate for examining the growth and decline of terrorist organizations through the interaction of law enforcement and terrorist recruitment efforts. After analyzing the respective strengths and weaknesses of sociological and biological models, the thesis applies a biological model, the Lotka-Volterra predator-prey model, to a highly suggestive case study, that of the Irish Republican Army. This case study illuminates how a biological model can be utilized to understand the actions of a terrorist organization, and offer predictive value that sociological models lack.

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ABBREVIATIONS AND ACRONYMS

APNI	Alliance Party of Northern Ireland
CNS	Center for Nonproliferation Studies
DUP	Democratic Unionist Party
IICD	Independent International Commission on Decommissioning
INLA	Irish National Liberation Army
IRA	Irish Republican Army
L-V	Lotka-Volterra
MEP	Member's of the European Parliament
MP-	Member of Parliament
NGCRC	The National Gang Crime Research Center
OIRA	Official Irish Republican Army
PR	Proportional Representation
PIRA	Provisional Irish Republican Army
RUC	Royal Ulster Constabulary
SAS	Special Air Service
SDLP	Social Democratic and Labor Party
SF	Sinn Féin
SNA	Social Network Analysis
TITC	Terrorist Threat Information Center
UDA	Ulster Defense Association
UDF	Ulster Defense
UDR	Ulster Defense Regiment
UFF	Ulster Freedom Fighters
USCA	Ulster Special Constabulary Association
UUP	Ulster Unionist Party
UVF	Ulster Volunteer Force

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A GUIDE TO THE ORGANIZATIONS/INDIVIDUALS INVOLVED IN THE IRISH-BRITISH CONFLICT (As mentioned in this Thesis)

Individuals

Chichester-Clark, James – Prime Minister of Northern Ireland, 1969-1971

Faulkner, Brian – Prime Minister of Northern Ireland, 1971-1974

Goulding, Cathal – IRA Chief of Staff, 1962-1969

Griffith, Arthur – Founder of Sinn Féin

Kitson, Frank – Brigadier in the British Army

Lynch, Jack – Prime Minister Republic of Ireland 1966-1973; 1977-1979

Rees, Merlyn – Secretary of State for Northern Ireland, 1974-1976

Restorick, Stephen – British Army-Last person known to be killed by the
IRA

Sands, Bobby – Commanding Officer of IRA prisoners in Long Kesh

Thatcher, Margaret – British Prime Minister, 1979-1990

Organizations

Anti H-Block Political Party – Political party of Bobby Sands

British Army – United Kingdom's standing army

B Specials – Ulster Special Constabulary Association (USCA)

Irish Republican Army (OIRA and PIRA) – Republican paramilitary force

Irish National Liberation Army (INLA) – Republican paramilitary force

Royal Ulster Constabulary (RUC) – Northern Irish Police Force

Sinn Féin – Political Party of the PIRA

Ulster Defense Regiment (UDR) – Locally recruited part time army force in
Northern Ireland

Ulster Defence Association (UDA)/(UFF) – Loyalist paramilitary force

Ulster Volunteer Force (UVF) – Loyalist paramilitary force

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I. INTRODUCTION

One of the primary missions in the war against terrorism is to investigate and analyze the participants, actions, and funding mechanisms of terrorist organizations. It allows analysts to identify and interpret clues that an impending terrorist act is going to occur. It also guides the development of policies, which will hopefully prevent terrorists from obtaining their goals. Unfortunately, examination of the literature has proven that analysts are not utilizing the most appropriate models to assess the behavior of terrorist organizations. The analysts are working with models which were developed to understand non-violent organizations. These models do not take into account behavior of a group of individuals who have no regard for social mores.

Considering the significance of obtaining accurate analyses, it is important to utilize models which do not require its subjects to have morals or non-violent behavior. One unrecognized source of models is the models used to describe the interactions between biological populations. These models were developed to incorporate competition between species and individuals, as well as fighting and organized warfare between species. The output is utilized to determine which population will succeed in a competition over resources and shared habitats. The data analysis is used to predict which individual in a population is most virulent. They expect populations to die off and to be replaced by others. Biological models are more accurate in analyzing terrorist organizations than any other method utilized thus far. This thesis will demonstrate how one particular biological model, the Lotka-Volterra predator-prey model, is more accurate in analyzing the recruitment of a terrorist organization, the Irish Republican Army, than any sociological model.

There are models available, especially those used to study violent gangs, which expect violent behavior from its study subjects. Gangs and terrorist groups are very different in their organizational structure. The social disorganization theory, which is used to study gangs, is not appropriate to study terrorist groups.

The individuals who study gangs are also utilizing models which were originally developed to understand non-violent behavior, with the violent behavior built into the model as it suited the behavior of the organization. The biological models were built initially with the violent actions expected of the subjects and therefore violent interactions between the study populations were originally incorporated into the behavior of the model. For these reasons, biological models will provide a more rigorous analysis of the behaviors seen in terrorist organizations than the models used to examine gangs.

By providing a new source of models for studying terrorism, the dynamics of a terrorist group can be better understood and provide insights towards how a government's policies might impact different terrorist organizations. This may eventually lead to the development of more accurate models and predictions, as well as eventually developing appropriate policies to halt terrorism.

The first chapter of this thesis will explain the rationale of choosing a biological model instead of a sociological one. The second chapter introduces the prey and predator populations. The prey population is the terrorist organization or, in the case of this thesis, the Irish Republican Army; the adversary, or the predator population, is the British Army. Considering the secretive nature of terrorist organizations, the population numbers of the Irish Republican Army are unknown; therefore, the populous support of the political arm of the Irish Republican Army, Sinn Féin, is used instead. The last chapter of the thesis introduces the model, the procedures taken to develop the model, and confirms that the biological Lotka-Volterra predator-prey model is an appropriate model to describe the recruitment of a terrorist organization.

II. MODELING TERRORIST ORGANIZATIONS

This chapter will explain why it is important to model terrorist organizations. It will provide examples of what types of models currently exist and a description of the traits that make a group of individuals a terrorist organization, as well as explaining why they are different from gangs (the closest social organization to terrorist organizations). This thesis also examines why models used to study gangs are not appropriate to help study terrorist organizations. Finally, there will be a discussion explaining why a biological model was selected as an alternative.

A. IMPORTANCE OF MODELING TERRORIST ORGANIZATIONS

Understanding the behavior of terrorist organizations can help determine if current policies for combating terrorism are effective and aid in the development of more suitable policies. Not many groups examine the behavior of terrorist organizations. The Center for Nonproliferation Studies (CNS) performed a literature search looking for individuals performing “computer modeling and simulation research related specifically to the dynamics of terrorist cells,” i.e., the interaction between individuals.¹ They found that there were “virtually no computational models dealing specifically with the behavior of terrorist cells in any rigorous manner.”² The models that exist are either too generic in scope (for example, dealing with groups of unspecified size) or use agents in a different domain (for example, pilots in a flight or soldiers in a troop).³ Therefore, CNS expanded their research to identify any available resources focusing on terrorist cells; the result was that there are very few resources available.⁴

¹ Gary Ackerman, *Literature Review of Modeling of the Behavior of Terrorist Cells*, (California: Monterey Institute of International Studies, 2002), 2.

² Ibid.

³ Ibid.

⁴ Ibid.

Currently, the analysis of terrorist organizations is performed by the multi-agency National Counterterrorism Center (NCTC) and the Department of Homeland Security: Information Analysis and Infrastructure Protection Directorate. NCTC works to “analyze terrorist threat related information, expertise, and capabilities to conduct threat analysis.”⁵ It is their mission to “create new knowledge from existing information.”⁶

An analytical approach for studying terrorism is important because it will help those involved in the War on Terrorism understand the behavior of terrorist organizations, determine the causes of their non-traditional manner, and predict what may occur in the future, provided particular intelligence is available. Furthermore, it will assist policy makers in identifying strategies to prevent terrorist organizations from meeting their objectives.

B. A BRIEF INTRODUCTION TO TERRORIST ORGANIZATIONS

As defined by Martha Crenshaw, “terrorism is deliberate and systematic violence performed by small numbers of people...the purpose of (which) is to intimidate a watching popular audience by harming only a few...(it) is political and symbolic, ... [and] a clandestine resistance to authority.”⁷ Terrorism can be viewed as a collection of individuals whose goal is to perform harassing, disruptive, and destructive activities as a clandestine, stateless, mobile, and

⁵ The White House, “Fact Sheet: Strengthening Intelligence to Better Protect America,” President George Bush, The White House, <http://www.whitehouse.gov/news/releases/2003/01/print/20030128-12.html> [Accessed 10 June 2004].

⁶ J Brennan, “Written Statement for the Record of John O. Brennan Director, Terrorist Threat Integration Center on Law Enforcement and the Intelligence Community before the National Commission on Terrorist Attacks Upon the United States Washington D.C., April 14, 2004,” Central Intelligence Agency, http://www.odci.gov/cia/public_affairs/speeches/2004/brennan_testimony_04142004.html [Accessed 5 June 2004].

⁷ Society for the Study of Peace, Conflict, and Violence, “Interpreting and Responding to Terrorism” Peace Psychology Division of the American Psychological Association, <http://www.webster.edu/peacepsychology/terrorismstatement.html> [Accessed 11 November 2005].

opportunistic network of committed groups.⁸ These networks are the most survivable organizational form of terrorism; and they are not fully understood by researches of terrorism. Their knowledge base is focused more specifically on recognized organizations, such as corporations, hospitals, universities, civil service bureaucracies, voluntary organizations, and organizations developed to direct the activities of social movements. In contrast, there are only some, primarily indirect, insights about terrorist organizations in the literature.⁹

Not many published studies examining the behavior of terrorist organizations exist; however, in those that do, there are thorough analyses of the behavior of terrorist organizations and of the individuals who belong to these organizations. In its basic form, terrorist organizations are considered to be just another type of organization, like a key club, or a screen actor's guild. In a September 1999 report entitled *The Sociology and Psychology of Terrorism: Who Becomes a Terrorist and Why?*, author Rex A. Hudson writes "Acts of terrorism are committed by groups who reach collective decisions based on commonly held beliefs, although the level of individual commitment to the group and its beliefs varies."¹⁰ The difference lies in how the terrorists attempt to reach their goals; instead of helping their neighbors, they use unexpected, shocking, unlawful and calculated violence against noncombatants (e.g., civilians, off-duty military, and security personnel in peaceful situations) and other symbolic targets for the "psychological purpose of publicizing a political or religious cause and/or intimidating or coercing a government(s) or civilian population into accepting demands on behalf of the cause."¹¹ Significant differences when comparing terrorist to other organizations may be summed up in the following:

⁸ Neil J. Smelser and Faith Mitchell, ed., *Discouraging Terrorism: Some Implications of 9/11*, (District of Columbia: National Academy of Press, 2002), <http://darwin.nap.edu/books/0309085306/html/> [Accessed 11 Nov 2005], 26.

⁹ Ibid., 22.

¹⁰ Hudson, *The Sociology and Psychology of Terrorism*, 34.

¹¹ Ibid., 12.

- Terrorist groups compared to known organizations (religious sects or cults):
 - Total commitment is required of their members.
 - Relations with outsiders are usually prohibited.
 - Sexual relations are regulated and sometimes banned.
 - The leaders of the organization impose conformity.
 - The leaders of the organization seek cohesiveness through interdependence and mutual trust.
 - The leaders of the organization attempt to convince individual members to believe in their particular ideology.¹²
- Terrorist groups are “typically far-flung networks that rely on secrecy, invisibility, flexibility, extreme commitment on the part of their members, and coordination of military-like activities.”¹³
- Terrorism thrives on secrecy and surprise.
 - “While terrorists operate within certain kinds of constraint on their actions, a condition of their success is to strike with surprise on often unanticipated targets, to rule no target out altogether, and to capitalize on ambiguity and uncertainty rather than defined understandings.”¹⁴
 - They will not communicate with their adversaries.¹⁵
 - They will work to ensure that their enemy does not know about their whereabouts or intentions. This information will compromise their foundation of secrecy, ultimately undermining their purpose.¹⁶
- Terrorist organizations, even though they are located within states are considered stateless, are not responsible for governing and defending national integrity, and are not directly influenced by threats to a nation.¹⁷

¹² Hudson, *The Sociology and Psychology of Terrorism*, 35.

¹³ Smelser and Mitchell, *Discouraging Terrorism*, 2.

¹⁴ Ibid., 11.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid., 13.

Furthermore, consider this principle of group dynamics:

One generally accepted principle, as demonstrated by W. Bion (in a 1961 publication), is that individual judgment and behavior are strongly influenced by the powerful forces of group dynamics. Every group according to Bion, has two opposing forces - a rare tendency to act in a fully cooperative, goal-directed, conflict-free manner to accomplish its stated purposes, and a stronger tendency to sabotage the stated goals. The latter tendency results in a group that defines itself in relation to the outside world and acts as if the only way it can survive is by fighting against or fleeing from the perceived enemy; a group that looks for direction to an omnipotent leader, to whom they subordinate their own independent judgment and act as if they do not have minds of their own; and a group that acts as if the group will bring forth a messiah who will rescue them and create a better world.¹⁸

Terrorist groups attract many individuals because they provide “a sense of belonging, a feeling of self-importance, and a new belief system that defines the terrorist act as morally acceptable and the group’s goals as of paramount importance.”¹⁹ Martha Crenshaw identified permissive factors that make these organizations attractive, particularly to political dissidents, and aid in the development of terrorist strategies, consequently motivating terrorists. “These factors are urbanization, transportation system, communications media, weapons availability, and absence of security measures.”²⁰ Studies of those countries with multiple terrorist organizations indicate that many of the people who join terrorist organizations are impacted by demographic and economic disadvantages. These countries have the highest fertility rates in the world, leading to rapid growth of the populations; these large populations place harsh economic demands on the states and create an age distribution where there are many young and a few old. The large youth populations stresses the education system and results in a high proportion of youth who are unable to find a productive economic role. This causes high unemployment, a competitive employment

¹⁸ Smelser and Mitchell, *Discouraging Terrorism*, 9.

¹⁹ Hudson, *The Sociology and Psychology of Terrorism*, 34.

²⁰ *Ibid.*, 16.

market for marginal jobs, a pressure to emigrate, and frequently large-scale social marginalization. All of this feeds into a high level of social and political dissatisfaction; as in the case of Muslim countries, “when this dissatisfaction is given meaning in the context of anti-Western and radical Muslim ideologies, a fertile breeding ground for terrorist recruits is at hand.”²¹

There are many different types of terrorist groups: nationalist-separatist, religious fundamentalist, new religious, and social revolutionary or idealist.²² Each type of terrorist organization, e.g., religious, political, environmental, has its own culture. “If religious commitment is part of the picture, they are likely to regard themselves as moral actors, doing violence to others and even to themselves for good and sufficient reasons.”²³ Known terrorist organizations are assigned a “type” based on their political background or ideology;²⁴ the counterterrorist policies utilized to counteract the terrorist organization are usually chosen based on the typology of the group. For example, a government will develop one policy to deal with a terrorist group that is fighting for religious freedom and a different policy to counteract the organizations fighting for environmental rights. Subsequently, the means of analysis to determine population dynamics proposed in this thesis does not depend on the type of organization it is.

Author Neil Smelser writes, “Terrorism is a strategy of the weak against the strong.”²⁵ Due to the commitment of its members to an extreme ideology, terrorist leaders face internal issues not encountered by benevolent organizations. Terrorist leaders need to recruit individuals whom they “regard as ideologically committed and ideologically correct. They must dedicate some of their organizational activities to maintaining that loyalty and commitment and

²¹ Smelser and Mitchell, *Discouraging Terrorism*, 39-30.

²² Hudson, *The Sociology and Psychology of Terrorism*, 15.

²³ Smelser and Mitchell, *Discouraging Terrorism*, 13.

²⁴ Hudson, *The Sociology and Psychology of Terrorism*, 15.

²⁵ Smelser and Mitchell, *Discouraging Terrorism*, 29.

preventing backsliding among members who are frequently living in societies with values, ways of life, and institutions that are different from their own and may be found seductive.”²⁶ They maintain discipline through intense personal ties, hierarchical control, and surveillance.²⁷ Terrorists may even know that their enemy can destroy them, but if they believe their enemy cannot quickly retaliate against their actions, they may proceed anyway.²⁸ Terrorists have one trait in common by living in the future, they are constantly looking for that “distant-yet imperceptibly close-point in time when they will assuredly triumph over their enemies and attain the ultimate realization of their political destiny.”²⁹

C. CURRENT MODELING EFFORTS OF TERRORIST ORGANIZATIONS

For an organization to survive, it needs to have a defined social and political structure: leadership, membership, a funding base, goals, and a mission. Even though organizations have unique structures, social theorists concluded that there are some commonalities among them. These similarities have allowed social scientists to develop theories of social behavior, i.e., the driving forces which allow an organization to survive and meet its goals.

The world has experienced many other kinds of secret, network-based organizations, and a base of knowledge about them and their operations has accumulated. Among these organizations are spy networks, gang rings such as the Mafia, drug-trafficking organizations, Communist cells, sabotage operations undertaken during wartime and during the cold war period, and extremist social and political movement organizations. In addition, network analysis as a field of study in sociology, social psychology, and elsewhere has yielded a great deal of theoretical and empirical knowledge during recent decades.³⁰

²⁶ Smelser and Mitchell, *Discouraging Terrorism*, 13.

²⁷ Ibid., 23.

²⁸ Ibid., 13.

²⁹ Ibid., and Bruce Hoffman, *Inside Terrorism*, (London: Columbia University Press, 1998), 169.

³⁰ Smelzer and Mitchell, *Discouraging Terrorism*, 24.

There are two types of models commonly used to examine the dynamics of terrorist organizations: social network analysis (SNA) models and small-group dynamic models. The reasons why these models are not appropriate for understanding terrorist organizations are explained below.

Social theorists utilize social network analysis models to understand human group dynamics; specifically, they have attempted to use these models to describe the behavioral structure of terrorist organizations.³¹ However, these models are typically used to describe organizations that have stable social structures and engage in non-terrorist activities, e.g., helping neighbors, cleaning beaches, and raising money for cancer research. Terrorist organizations do not follow the normal group dynamics motivated by philanthropy and generosity that one would find at a fire department or Rotary club. Their organizational behavior is driven more by a need to survive and ensure that their enemies do not survive. These differences are significant enough to expect that there is a better method available to predict the actions of terrorist organizations.

Due to the secretive nature of terrorist organizations, researchers have had difficulties in understanding terrorist group dynamics. As a result, social scientists instead have utilized their knowledge of small-group dynamics to aid in the understanding of terrorist group dynamics.³² However, as with SNA, utilizing models meant for small-groups are also not the most appropriate method to help understand terrorist organizations, for they are only appropriate when the organization divides itself into small groups.

D. GANGS VERSUS TERRORIST ORGANIZATIONS

Sociologists who analyze terrorist organizations have looked for help from the studies performed on gangs; this is because, in comparison, gangs have the most similar social organization. Historically, sociologists depended on social

³¹ Ackerman, *Literature Review of Modeling of the Behavior of Terrorist Cells*, 2.

³² Rex A. Hudson, *The Sociology and Psychology of Terrorism: Who Becomes a Terrorist and Why?*, (District of Columbia: Federal Research Division, Library of Congress, 1999), 34. http://www.loc.gov/rr/frd/pdf-files/Soc_Psych_of_Terrorism.pdf [Accessed 12 November 2005],

disorganization theory to develop models to understand gang behavior. Social disorganization theory describes the “failure of social institutions or social organizations...in certain communities and or neighborhoods.”³³ This theory was developed by scientists trying to understand the relationship between an organism and its environment.³⁴ In addition, sociologists utilize the same types of models for terrorist organizations as gangs because of the availability of information about gangs.

Gangs are groups which “exist for or benefits substantially from the continuing criminal activity of its members.”³⁵ A comprehensive study of gangs identified commonalities among individuals. The individuals are more likely to have a “super predator” personality trait with the following characteristics:

- They are the bullies in school who do not avoid situations where they may get hurt.
- Not likely to attend church or believe in God; they believe they are doing Satan’s work.
- Often raised in a single-mother household, they perceive that they are members of the underclass; they conceal their gang involvement from their parent(s) because most feel that their parent(s) would be embarrassed if they knew their child was in a gang.
- They usually sell cocaine and are involved in drug dealing.
- They have minimal educational credentials.
- They have fired upon police officers and have served time in prison.
- They admit that they commit crime for their own individual benefit and not for the gang.³⁶

³³ Thomas O'Connor, “Social Disorganization Theories of Crime,” North Carolina Wesleyan College, <http://faculty.ncwc.edu/toconnor/301/301lect08.htm> [Accessed 10 November 2005].

³⁴ Ibid.

³⁵ National Gang Crime Research Center, “Bomb and Arson Crimes Among American Gang Members: A Behavioral Science Profile,” National Gang Crime Research Center. <http://www.ngcrc.com/bombarso.html> [Accessed 12 November 2005].

³⁶ National Gang Crime Research Center, “The Facts About Gang Life In American Today: A National Study of Over 4,000 Gang Members,” National Gang Crime Research Center, <http://www.ngcrc.com/ngcrc/page9.htm> [Accessed 12 November 2005].

When a Chicago gang member, Jose Padilla, was in prison as a suspected al-Qaeda operative, scientists recognized a connection between gang behavior and the behavior of terrorists. National Gang Crime Research Center (NGRC) requested a review for both the public and the police of the material that identifies commonalities between gangs and terrorists.³⁷ One report compared gang members who committed arson and bomb crimes to those who did not; it indicated that, in many situations, gang members were considered urban terrorists, urban guerilla fighters, revolutionary fighters, or rebel fighters.³⁸ Because of these similarities, researchers feel that it is appropriate to use the same models for the analysis of terrorist organizations as those developed for the research of gangs.³⁹

However, the differences between gang and terrorist organizations are significant enough to consider other types of models to describe the behavior of terrorist organizations. "Terrorism...involves committing acts of violence to gain its ends, however tenuous and remote the hope that the attacked nation will comply with its demands."⁴⁰ While many gangs have local, regional, or statewide influence, they do not have the nation or world-wide effects of terrorist organizations. Terrorist organizations consider whole governments, including military, law enforcement, and legislatures, as their enemy, unlike gangs whose primary enemies are law enforcement and other local gangs. Furthermore, terrorists are not easily identified; they work in secrecy and form sleeper cells (go into hiding) if their enemy – the government their actions are focused on – knows too much about their activities. Finally, their goal is to ensure the survival of their cause, no matter what the cost. "The characteristics of terrorist organizations can be understood by tracing out the implications of the fact that terrorism must

³⁷ National Gang Crime Research Center, "Gangs and Terrorism," National Gang Research Center, <http://www.ngcrc.com/terrorism.html> [Accessed 12 November 2005].

³⁸ National Gang Crime Research Center, "Bomb and Arson Crimes Among American Gang Members."

³⁹ Ibid.

⁴⁰ Smelser and Mitchell, *Discouraging Terrorism*, 9.

be simultaneously invisible and at the same time coordinated for preparing and executing terrorist activities. Consistent with these purposes, terrorist organizations must maintain extreme secrecy, avoid record keeping, and minimize any paper trails that could reveal their internal movements, plans, and intentions.”⁴¹

Sociologists should consider models other than the ones currently used for gang research to help understand terrorist organizations. As described above, there are significant differences between the nature of gangs and terrorist organizations. These differences alone are enough to explain why the models that are appropriate for gangs are not appropriate for terrorist organizations. However, there is another valid reason, the gang models described above introduce violent behavior into models which were originally used to describe non-violent interactions. Therefore, the models used to understand the violent behavior between gangs might not be rigorous enough to completely describe the interactions between different gangs. It would be more appropriate to obtain models which were initially developed with violent interactions among its subjects to help understand terrorist organizations than to chose models which were adapted to incorporate violent behavior.

E. WHY USE BIOLOGICAL MODELS TO PREDICT THE BEHAVIOR OF TERRORIST ORGANIZATIONS?

A review of the current literature on terrorist organizations demonstrates that the models currently used are not providing very accurate predictions or analyses of the behavior of terrorist organizations. For this reason, other types of models were explored and during this investigation, the similarities among terrorist organizations and wildlife populations became evident.

As described by Charles Darwin in his Theory of Natural Selection, wildlife populations survive because they are “fit” enough to pass their genes onto their

⁴¹ Smelser and Mitchell, *Discouraging Terrorism*, 22.

young. Wildlife fitness is a “measure of the selective quality of genes”⁴² or their ability to reproduce. Populations which are better “fit” than others will have a better chance of their genes surviving in the future. Fitness is dependant on feeding behavior, eating the correct food, and knowing where, when, and how to search for food. It is also dependant on their sexual behavior, choosing the appropriate mating strategy (monogamy or polygamy), and finding the appropriate mate. Finally, fitness is dependant on territorial behavior; choosing an appropriate location and size for their territory, and the appropriate defensive strategy.⁴³ In a similar way, terrorist organizations also have a specific strategy to increase their own “fitness.” This initial similarity was sufficiently strong enough to consider models used to describe wildlife populations for analyzing terrorist organizations.

Competition between individuals and species are inherent in the models used by ecologists and behaviorists. For example, models have examined how successful weapons are in defending one species against their enemy;⁴⁴ estimated the time when one species will successfully kill off another;⁴⁵ determined which species will have control over the local habitat;⁴⁶ and verified which individual in a group will dominate over the others.⁴⁷ Considering biological models already incorporate dynamics similar to those that exist

⁴² Gary Ritchison, “Lecture Notes I: Introduction and Definition, BIO 555/755 Behavioral Ecology,” Eastern Kentucky University, <http://people.eku.edu/ritchisong/behavecolnotes.htm> [Accessed 18 February 2006].

⁴³ Gary Ritchison, “Lecture Notes I: Introduction and Definition, BIO 555/755 Behavioral Ecology,” Eastern Kentucky University, <http://people.eku.edu/ritchisong/behavecolnotes.htm> [Accessed 18 February 2006].

⁴⁴ Paul Waltman, et al., “A Mathematical Model of a Biological Arms Race with a Dangerous Prey,” *Journal of Theoretical Biology* 218 (2002): 55–70.

⁴⁵ A. De Koeijer, et al. “Modeling the spread of phocine distemper virus among harbor seals.” *Bulletin of Mathematical Biology* 60, no 3 (1998): 585–596.

⁴⁶ Michael Hudson and Thomas Smith, “Plant Succession: Life History and Competition,” *American Naturalist* 130, no 2 (1987): 168–198.

⁴⁷ Allen Mazur, “A biosocial model of status in face-to-face primate groups,” *Social Forces* 64, no 2 (1985): 377–402.

between terrorist organizations and their victims, it solidified the decision that biological models are appropriate to help understand the dynamics of terrorist organizations.

For years, biologists have used models to examine community dynamics: social structure, selection of habitats and mates, relationships with prey, time of food consumption, and recruitment. Wildlife managers, facing the extinction of many different species, have used other models to predict trends, e.g., how a population disperses into a new habitat, or understanding the factors which influence or hinder the population growth, recruitment, and competition within a population. Wildlife managers make predictions knowing the current environment and what factors influence the population size of a species; they use these predictions to determine the type of management required to reestablish a species, particularly common in recovery plans. Population dynamics are used to develop the model and then the model is used to understand the outside influences on the population. Some of these models have been developed to describe a particular population, whereas more advanced models allow for changes throughout time.

Population models are used to describe population dynamics, predict population sizes, and aid in population management, especially those species which are in jeopardy of going extinct. Yet, most of these modeling activities concentrate on wildlife populations, i.e., moose, wolves, ladybugs, and grasshoppers. These are species which are believed to be driven by instincts of survival alone without the influences of the humanesque thought process. This activity has helped prevent higher-order animals from extinction, e.g., the gray wolf, West Indian manatee, and the Florida panther. In addition, they are used to examine interactions among species.

Just as biologists have developed models that predict population trends in wildlife populations, this paper addresses the use of a basic population model, Lotka-Volterra (L-V) predator-prey population model, to demonstrate its effectiveness in predicting recruitment, i.e., population trends, of a terrorist

organization; this thesis will use the Irish Republican Army as an example. The L-V model is used to describe population dynamics, particularly between two competing populations. It is a basic, supply and demand type model, where the population of one preys on another, and the size of each population has an impact on the size of the other population. By examining and understanding the population dynamics of an organization, one can determine its maturation and its phase of the evolution. For example, is the organization in a recruitment phase? Is it losing membership and support? Is it stable or is it going through significant change? By overlapping the dynamics with current events, the organizations' behavior may be well understood.

The events which occurred in Ireland during the Thirty Years War are well documented. The Irish Republican Army (IRA), once a very threatening group, has been considered less of a threat recently because of a cease-fire agreement with the British government that it has had on and off since 1997. The IRA has had tremendous influence on Irish and British politics, economics, and life. Since their cease-fire, the IRA's actions and recruitment activities have been thoroughly analyzed; this is because they are no longer considered to have a great influence on the Irish and British public. These are among the many reasons that makes the IRA is a good candidate to analyze with the selected biological model. While the history of the events of the fighting between the British Army and the IRA are well documented, it is important to note that much of the organization-level politics continue to remain confidential.

III. THE CASE STUDY

A. THE PREDATOR AND THE PREY

This chapter explains the history of the Provisional Irish Republican Army (IRA) and its political arm, Sinn Féin. It also describes the dynamics of the IRA's relationship with the British Army. Understanding these factors provides significant insight into the association between the predator and the prey.

B. THE TERRORIST GROUP: THE PROVISIONAL IRISH REPUBLICAN ARMY

Uniting the 26 counties of Ireland with the six Ulster counties of Northern Ireland was so important to some of the Irish that individuals from both Northern Ireland and Ireland fought together to remove British rule. Even though the fight to unite all of Ireland started in the 1920s, it became prevalent in the 1960s. Similar to most of the British and French colonies in the 1960s, some of the Catholic Irish within Northern Ireland desired to have their own government instead of being ruled by the British. Like other countries which fought for their independence from British rule, the members of the IRA hoped they too would succeed in unifying Ireland. Most of their actions were confined to activities within the United Kingdom, especially within the Northern Irish territories; however, they did venture away from the motherland and performed terrorist acts in other continents, including Africa, Europe, and South America as well as the United States.

The IRA utilized terrorist activities against the organizations supporting British rule, and those organizations retaliated by performing their own terrorist actions. The Provisional Irish Republican Army⁴⁸ shot, bombed, and killed British soldiers, members of the Royal Ulster Constabulary (RUC), Ulster Defence Regiment (UDF), protestant civilians, British civilians, and even their own to

⁴⁸ There are four groups calling themselves the Irish Republican Army. The largest group and the one most identified as the IRA is the Provisional IRA (Moloney, *Secret History*, 566).

release the six Ulster counties from British rule. Because of these harsh actions, they were labeled as “terrorists” by the British, Irish and international governments.⁴⁹

Many organizations fought against the IRA’s terror, including the Royal Ulster Constabulary (RUC), the British Army, and the two loyalist paramilitary organizations: the Ulster Defence Association (UDA)/(UFF) and the Ulster Volunteer Force (UVF). The RUC was the police force of Northern Ireland, but the British Army was the main security force in Northern Ireland; they both attempted to maintain peace between those who desired to unite all of Ireland with those that wanted to keep part of Ireland under British rule.

In the more than 30 years of fighting within the United Kingdom, police forces, military units, and civilians maintained a constant vigil to remain unharmed by the activities of the individuals fighting for the government of their choice. A total of 3,523 individuals were killed during the fighting in Northern Ireland, 1,111 were British security, 1,857 were civilians, 10 were Irish security, 151 were Loyalist paramilitary, and 394 were republican paramilitary.⁵⁰ Everyone was affected by the violent activities occurring in Northern Ireland.

The Provisional IRA (PIRA) is a splinter group of the original IRA which started in the 1900s. The members of PIRA felt that the members of the Official IRA were putting ideology before nationalism and were no longer fighting for the same cause. Sinn Féin, the Irish republican political organization, supported the actions of the PIRA instead of the OIRA in the political arena; they fought politically for the same causes as the PIRA, and are now considered the political

⁴⁹ Petrol, nail and car bombs were set outside of public buildings. Incendiary devices were placed in shops and department stores. Letter bombs were mailed to their enemies. They performed assassinations, kneecapping and tarred and feathered their enemies (Dewar, *The British Army in Northern Ireland*).

⁵⁰ Malcolm Sutton, *Bear in mind these dead....An Index of Deaths from the Conflict in Ireland* (Belfast, Beyond the Pale Publications: 2001). <http://cain.ulst.ac.uk/sutton/book/> [Accessed 25 September 2004].

David McKittrick, et al., *Lost Lives – The stories of the men, women and children who died as a result of the Northern Ireland troubles* (Edinburgh: Mainstream Publishing, 1999), 1493–1511.

arm of the PIRA. As of 2005, the PIRA has been abiding by a ceasefire they signed in 1997. Even though they are no longer active, they are still considered by the United States State Department a group of interest because they are still able to conduct paramilitary operations.⁵¹ Recent events (discussed in Chapter 3) may change this status. As part of the ceasefire and the Good Friday agreement, the PIRA totally disarmed to allow Sinn Féin to participate in the newly formed Northern Ireland Assembly. During the fall of 2005, the PIRA declared they were fully disarmed, thus allowing the particulars detailed in the Good Friday Agreement to be implemented.

Historians recognize the many different organizations that were involved in the terrorist and peacemaking activities in Northern Ireland, Ireland, and Britain throughout the past three decades. Nationalists were fighting against the army and RUC. The loyalists (who wanted to remain under British rule) were offended that the nationalists wanted to change their British citizenship, and were also enraged that their own (RUC, but also army) were being killed as the nationalists fought their war. In response, the loyalists retaliated and killed Catholics; the Catholics then became involved, and so on. In the end, many different groups were involved in the fighting. For the ease of understanding the dynamics involved in the Irish conflict, the struggle between the British Army and the IRA (the main antagonist groups) is the sole focus of this project.

C. THE POLITICAL PARTY: SINN FÉIN

Many different political parties played a role in the Thirty Years War. One of the most significant was Sinn Féin, established in 1901 by Arthur Griffith, the editor of *The United Irishman*. He used his position at the newspaper to support home rule by advising Irish members not to take their spots in Parliament, but

⁵¹ U.S. Department of State, "Appendix C: Background Information on Other Terrorist Groups" in *Patterns of Global Terrorism 2003 Report* (District of Columbia: Office of the Coordinator for Counterterrorism, 2004), 139–160.
<http://www.state.gov/documents/organization/31947.pdf> [Accessed 14 October 2004].

U.S. Bureau of Customs and Border Control, *Terrorist Organization Reference Guide*, (Texas: U.S. Department of Homeland Security, 2004).

rather to create a National Council in Ireland; this would bring the ruling parties from Britain to Ireland.⁵² This was ineffective, but resulted in the creation of a new political party. After a failed attempt of gathering support for a republican military campaign in 1962, Sinn Féin worked to help the working class create a coalition. Sinn Féin promoted abstention until 1969, when the IRA Chief of Staff, Cathal Goulding, proposed that Sinn Féin drop its policy of abstention; he proposed that Sinn Féin fight the elections in the Dail, Stormont, and United Kingdom Parliament in an attempt to win seats. Goulding formed the Provisional IRA with this new policy; utilizing the political arena as a vehicle to inform the public about their plight and help obtain their goals, yet they continued to abstain from the elections. Sinn Féin was not allowed to run for positions by the Stormont government; even though the government lifted the proscription in 1974, Sinn Féin continued to call on its supporters to abstain from the voting.⁵³

This changed in 1980 and 1981, when the IRA and Irish National Liberation Army (INLA) prisoners in the H-Block of the Maze prison went on a hunger strike in protest of losing their status as political prisoners. Bobby Sands, Officer Commanding IRA prisoners in Long Kesh and the leader of the strike, won the vote for Member of Parliament (MP) of Fermanagh and South Tyrone under the Anti H-Block party;⁵⁴ however, he did not take the position because he

⁵²David Boothroyd, *Politico's Guide to The History of British Political Parties* (London: Politico's Publishing, 2001), 270.

⁵³ Ibid., 274.

⁵⁴ Ibid., 13.

died during the hunger strike of 1980.⁵⁵ The support Bobby Sands received by the populace provided Sinn Féin the confidence it needed to start running in political elections.

In 1979, members of Sinn Féin realized that the armed-struggle was not the only way to reunify Ireland and that they needed to pursue additional measures.⁵⁶ Even though the Sinn Féin's policy changed, the armed struggle did not take second place to politics and the political philosophy, "Armalite and the Box," was born. Peter Taylor wrote, "The notion that Provisionals could move towards their goal of a united Ireland by pursuing a twin strategy of violence and politics convinced most of the doubters who by this time had realized that, were the 'Brits' to leave Ireland, it wouldn't be at the point of a gun. The 'long war' was now to be fought on two fronts."⁵⁷ The "Armalite and the Box" policy created at the 1981 Ard Fheis allowed elected Sinn Féin candidates, starting at the 1982 Northern Ireland Assembly elections, to take their positions in the local councils in Northern Ireland and allowed the party to contest elections of the North and South.⁵⁸ Members of Sinn Féin then began running for office while still maintaining its abstentionist policy until 1985; this year, they received 59% of the seats and changed their constitution to allow members to take their seats at the

⁵⁵ Merlyn Rees, Britain's Home Secretary in 1976, "abolished the special category status for all prisoners convicted of terrorist offences committed after 1 March 1976" (Taylor, *BRITS*, 227). With the hopes of reinstating their status as political prisoners, members of the IRA and INLA underwent a few different types of strikes. They tried a 'blanket' protest, where the only thing prisoners wore was a blanket because they felt that the prison uniform would have labeled them as criminals. Then they started the 'no-wash' protest. The prisoners stated when they left their cells to wash they were beaten and humiliated therefore, they were not going to leave their cells; they tried a dirty protest where they refused to wash and slop out their chamber pots, instead they smeared feces over their walls, they walked around the prison unshaven and unwashed. When this did not get them the demands they wanted, they staged "hunger" strikes, and refused to eat till their demands were met. (Margaret Thatcher, British Prime Minister 1979–1990, refused to negotiate with terrorists. She believed that they were criminals and should be treated as such.) Ten prisoners died during the successive hunger strikes because the British refused to allow them to retain the status as political prisoners (Taylor, *BRITS*, 238 and Boothroy *History of British Political Parties*, 13-14 & 273–274).

⁵⁶ Brendan Lynn, "Republicanism and the Abstentionist Tradition, 1970-1998," CAIN Web Service, <http://cain.ulst.ac.uk/issues/politics/docs/lynn01.htm> [Accessed 10 January 2005].

⁵⁷ Taylor, *BRITS*, 263.

⁵⁸ Lynn, "Republicanism and the Abstentionist Tradition, 1970–1998."

Dáil. Throughout the years, the popularity of Sinn Féin depended on the events performed by the IRA; for the purpose of this paper, individuals which supported Sinn Féin are considered to have supported the IRA.

Voting records are available since the inception of Northern Ireland. Table 1 provides the number of individuals who voted for Sinn Féin since they participated in elections. Elections in Northern Ireland changed in 1972 when Stormont parliament was suspended by the British Government and Direct Rule was implemented. The Northern Irish populus was then allowed to elect individuals for seats in the Northern Ireland Assembly, which over the years consisted of different entities: the Northern Ireland Assembly (1973 to 1974); the Constitutional Convention (1975 to 1976); the Northern Ireland Assembly (1982 to 1986); the Northern Ireland Forum (1996 to 1998) and the Northern Ireland Assembly (1998 to 2003).⁵⁹ They elected representatives MPs for the Westminster Parliament in the Westminster General Elections. In addition, they voted in local government (district council) elections. The voting procedure for the local government changed in 1973 giving more residents of Northern Ireland the ability to vote. Elections for the European parliament occur every five years, where “voting is by means of PR (Proportional Representation) with three members being returned as Members of the European Parliament (MEPs).”⁶⁰ From the values presented in Table 1, one can see that Sinn Féin did not run for political positions until 1982, and even though they had a name on a ballot, they did not initially fill those seats (due to the commitment they had to the party line).

While it was generally considered that the support for Sinn Féin increased over time, Figure 1 demonstrates that this was not always the case; increase in the support for Sinn Féin usually only occurred when cease-fires were called.⁶¹

⁵⁹ Brendan Lynn, “Introduction to the Electoral System in Northern Ireland,” CAIN Web Service, <http://cain.ulst.ac.uk/issues/politics/election/electoralsystem.htm> [Accessed 31 August 2005].

⁶⁰ Ibid.

⁶¹ Martin Melaugh, “Political party support in Northern Ireland, 1969 to the present,” CAIN Web Service, <http://cain.ulst.ac.uk/issues/politics/election/electsum.htm> [Accessed 10 November 2004].

D. THE BRITISH ARMY

The structure of the British Army is as follows: a group of soldiers, approximately 30,000 individuals, are placed into a corps consisting of two or more divisions; the corps are commanded by a lieutenant general and are grouped into a common function, i.e., Intelligence Corps, Royal Logistic Corps, or Royal Corps of Signals.⁶² A division consists of roughly 10,000 individuals, commanded by a Major-General, and has three infantry and/or armored brigades, an artillery brigade, a signal regiment, a logistic regiment, an engineer regiment, and supporting units.⁶³ Regiments are commanded by a Lieutenant-Colonel and are divided into a company; companies are a group of approximately 100 soldiers, commanded by a Major. The companies are divided into platoons, a group of roughly 30 soldiers, commanded by a Lieutenant or Second Lieutenant. Finally, the platoons are broken down into a chapter, a group of eight soldiers, who are commanded by a Corporal.⁶⁴

The British Army was an early participant in the Irish-British Conflict, primarily due to the unrest associated with the “marching season.” The marching season begins in May and lasts until August, and is a time when Protestants in Northern Ireland celebrate their historical victories. Conducted through mainly Catholic neighborhoods and often celebrating events where Protestants were victorious over Catholics, these marches quickly became centers of fighting.⁶⁵

In early 1969, the isolated incidents of conflict among the Catholics, Protestants, and police started to increase. Utilities, bus and gas stations were bombed. There was fighting at civil rights marches, sit-downs of demonstrators

⁶² Wikipedia, “Structure of the British Army,” absolute astronomy reference, http://www.absoluteastronomy.com/reference/structure_of_the_british_army [Accessed 1 June 2005].

⁶³ Wikipedia, “Structure of the British Army,” absolute astronomy reference, http://www.absoluteastronomy.com/reference/structure_of_the_british_army [Accessed 1 June 2005].

⁶⁴ Ibid.

⁶⁵ Northern Ireland: Monitoring the 1998 Marching Season, “The Marching Phenomenon and the Role of the Police,” Human Rights Watch, <http://www.hrw.org/campaigns/nireland98/phenom.htm> [Accessed 10 October 2005].

arose throughout the cities, and shops were looted.⁶⁶ The civil unrest among groups became more prevalent. The IRA originally intended to use peace and politics to obtain its goals. By mobilization of the masses, they could undermine the Northern State and gain support in the South for their policies. They tried to prevent violence, however they realized that their message was only heard when violence was used; the British Government became involved in the conflict shortly after the evening news displayed images of an unarmed Catholic Member of Parliament being beaten by a Protestant police force during a civil rights march in Derry.⁶⁷

The RUC, unprepared for the resistance they received during the marches, obtained the right to use tougher measures to enforce the peace after an emergency Cabinet meeting. They also mobilized the British Army for the sole purpose of guarding key installations and to tighten security; they did not help one side or the other.⁶⁸ The Wilson Government (Westminster) remained on the sidelines, believing that the Northern Ireland government would respond to the needs of their citizens; meanwhile, the Northern Ireland Parliament stated the Stormont Government "would not be held ransom by irresponsible and anti-social elements."⁶⁹

After the clashes at the marches started to become deadly, the police in Northern Ireland realized they were unable to maintain peace and asked for additional resources. The leaders of the Stormont Government were originally reluctant to call in British troops; for the Home Secretary stated if troops were requested, constitutional changes may result, i.e., Stormont might be suspended

⁶⁶ Facts on File News Services, "Great Britain: Army Enters Ulster Strife," *Facts On File World News Digest*, 30 April 1969, <http://www.2facts.com> [Accessed 9 December 2004].

⁶⁷ Taylor, *BRITS*, 21.

⁶⁸ Facts on File News Services, "Great Britain: Ulster Violence Renewed," *Facts On File World News Digest*, 30 July 1969, <http://www.2facts.com> [Accessed 29 November 2004].

⁶⁹ Facts on File News Services, "Great Britain: Ulster Violence Renewed."
Taylor, *BRITS*, 21.

and Direct Rule imposed. Instead, the Stormont Government drew up emergency plans to assist police if the violence intensified.⁷⁰

The Protestants thought that the troops were in Northern Ireland to kill Catholics; the Catholics, on the other hand, thought that the troops were there to fight for their safety. Both were wrong. The army was not present for the benefit of either side; their sole purpose was to maintain peace. The Prime Minister of Northern Ireland, Brian Faulkner, stated that "British soldiers had been authorized to shoot on sight anyone 'acting suspiciously'...the army was 'not prepared to take half measures with terrorists'." At a later date, he stated that these orders were only to be used during instances where firearms or explosives might be used.⁷¹

The Irish Prime Minister Jack Lynch stated the following to help the public understand his position:

Recognizing, however, that the reunification of the national territory can provide the only permanent solution for the problem, it is our intention to request the British Government to enter into early negotiations with the Irish Government to review the present constitutional position of the Six Counties of Northern Ireland.⁷²

Nationalists thought that this meant that British Government would help them with the fighting. Loyalists thought it indicated the beginning of doomsday.

Westminster was still hoping that the people of Ireland would solve its own problems. It wanted to see the current government develop policies which would enable peace. Yet, the police force was accused of brutality and unable to maintain peace, increasing the dependence on the army to maintain peace. The army had been accustomed to performing internal security and counter

⁷⁰ Facts on File News Services, "Riots in Northern Ireland; Belfast Violence," *Facts On File World News Digest*, 13 August 1969, <http://www.2facts.com> [Accessed 29 November 2004].

Taylor, *BRITS*, 23.

⁷¹ Taylor, *BRITS*.

⁷² *Ibid.*, 26.

revolutionary warfare in other countries and they were not familiar with working within their own country; consequently, many of its members were uncomfortable with the actions they had to take.⁷³

In 1969, the Labor Party, now in power, worked to gain civil rights for the nationalists, aid for economic development, jobs, and housing. The British Army took over security control and, as a result, disarmed the RUC (an unarmed police force is common practice in Britain); in addition, they disbanded the B Specials, replacing them with the Ulster Defense Regiment (UDR), a locally recruited part-time force under the command of the British Army.⁷⁴ The Westminster and Stormont governments hoped this would appease the loyalists, but the loyalists thought the two governments were bending to meet the nationalist's demands. This miscommunication resulted in more riots.⁷⁵

Even though the crime rate decreased with the army present in Northern Ireland, the tension between the loyalists and nationalists increased. The IRA's goals had changed from demonstrating against civil-rights injustices to protecting themselves from the loyalists; the loyalists continued to work to ensure that Northern Ireland remained a part of the UK and tried to prevent the IRA from obtaining its goal of removing British rule.⁷⁶

During the next marching season (1970), the Protestants bragged about their victories over the Catholics in nationalist locations; this resulted in an increase of violence between the nationalists and loyalists and forced the Westminster Parliament to respond to the hostility in Northern Ireland. The

⁷³ Taylor, *BRITS*, 33.

⁷⁴ Facts on File News Services, "Northern Ireland: UK Army Takes Security Control," *Facts On File World News Digest*, 27 August 1969, <http://www.2facts.com> [Accessed 10 December 2004].

Facts on File News Services, "Northern Ireland: News in Brief," *Facts On File World News Digest*, 24 December 1969, <http://www.2facts.com> [Accessed 10 December 2004].

Taylor, *BRITS*, 34 - 35.

⁷⁵ Taylor, *BRITS*, 35 - 36.

⁷⁶ *Ibid.*, 43.

British army was called in to protect the Irish. Instilling anger in the nationalists, the army instituted a curfew during the rioting and searched their houses for illegal weapons. On February 5, 1970, the Public Order Act went into effect, barring sit-ins and occupation of public buildings, requiring a three-day notice of demonstrations and giving the home secretary the right to ban marches. This Act was defied by the Catholics, who as a result increased their violence in response to these political actions.

“Unwillingly the Brits had handled the IRA an issue that it could exploit to justify its actions against soldiers no longer depicted as saviors but as the coerces of occupation,”⁷⁷ writes Peter Taylor. The tougher the army became, the more recruits the IRA drafted. Taylor continues, the “convention decided to continue and intensify the provision of defensive measures for the people of the Six Counties. It re-affirmed that British rule is not acceptable in Ireland under any circumstances and that every effort must be made to bring about its downfall.”⁷⁸ James Chichester-Clark, a unionist prime minister, ruled out any possibility of including Ulster Catholics in a coalition government on the grounds that the opposition Catholics in Ulster’s parliament were “opposed to the very existence of this state itself.”⁷⁹

Brigadier Frank Kitson’s plan for the British Army was to try to win back the support of the local population, but the IRA was not interested in helping the British restore order and was not supportive of the actions taken by the British Army towards their organization. The British Army and the RUC neglected to share intelligence, causing them to lose opportunities to apprehend suspected IRA members, thus benefiting the IRA. The IRA justified its attacks on British soldiers and Northern Irish police officers, stating that their actions were in

⁷⁷ Taylor, *BRITS*, 51.

⁷⁸ Taylor, *BRITS*, 52– 53.

⁷⁹ Facts on File News Services, “British Troops Quell Northern Ireland Strife; Ireland Enters Dispute,” *Facts On File World News Digest*, 20 August 1969, <http://www.2facts.com> [Accessed 29 November 2004].

response to the way the army was treating the Catholic community.⁸⁰ The Stormont Parliament stated that “‘sinister and irresponsible’ elements sympathetic to the Irish Republic had been responsible for the current violence.”⁸¹

The British Army focused their actions on the IRA. They said, “Although our tactics were reasonably well defined, the strategy certainly was not. We had to adapt to the situation as it grew. After all, the IRA was not reacting to a long-term strategy.”⁸² Riots occurred after the army shot dead “rumored” members of IRA and the IRA retaliated. This was the pivotal turning point. The peacekeeping mission was no longer relevant, so the army actively focused their activities on defeating the IRA prompting Chichester-Clark, prime minister of Northern Ireland, to declare on television “Northern Ireland is at war with the Irish Republican Army Provisional.”⁸³

In 1976, the activities of the British Army were limited, and the RUC became the lead agency for the war against terrorism.⁸⁴ This change was made because the British government felt that the IRA would be less reluctant to fight against their fellow Irishmen as opposed to the Brits; however, as evidenced in Table 2, this did reduce the numbers of active duty army in Northern Ireland. This did not impact the activities of the Special Air Service (SAS) nor the role of the 14 Intelligence Company.⁸⁵

The British Army continued to fight in Northern Ireland, acting second in command to the RUC. In 1997, the British Army had its last casualty to the

⁸⁰ Taylor, *BRITS*, 57.

⁸¹ Facts on File News Services, “British Troops Quell Northern Ireland Strife; Ireland Enters Dispute.”

⁸² Taylor, *BRITS*, 57–58.

⁸³ Taylor, *BRITS*, 58.

⁸⁴ *Ibid.*, 197.

⁸⁵ *Ibid.*

hands of the IRA. A young soldier, Stephen Restorick, was shot by an IRA sniper team in South Armagh. The final cease-fire was called by the IRA a few months later on July 20, 1997.⁸⁶

⁸⁶ Taylor, *BRITS*, 353.

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IV. THE MODELING EFFORT

This chapter introduces the biological Lotka-Volterra predator-prey model, describes the assumptions associated with the model, and provides an explanation of how the model functions. It justifies why the British Army and the Irish Republican Army are considered the predator and prey, respectively. The population numbers utilized for the model and the output of the model are also provided. Lastly, there is an explanation about why this modeling effort is important and how it may aid in the War against Terrorism.

A. THE MODEL: LOTKA-VOLTERRA PREDATOR-PREY MODEL

Figure 2 is a graph of the deaths of the members of the British Army and the Irish Republican Army. After examining this data and the dynamics of the two main participants in the Thirty-Years War, Lotka-Volterra predator-prey model was deemed the most appropriate of all of the different types of biological models available to analyze the data.

The Lotka-Volterra predator-prey model is commonly used to describe predator and prey competition, diet selection, handling time, and intra- and inter-species relationships.⁸⁷ This model, developed in the 1920s and 1930s independently by two individuals, Alfred Lotka and Vito Volterra, is utilized to describe the fluctuating population sizes of two competing species. While there are many variations to this model, a simple supply and demand equation drives the model. There are some basic assumptions associated with the model:

1. "Prey will grow in an unlimited way when predators do not keep them under control.
2. Predators depend on the presence of their prey to survive.

⁸⁷ Fryxell, J. and P Lundberg, *Individual Behavior and Community Dynamics* (New York: Chapman & Hall, 1988). Leah Edelstein-Kesht, *Mathematical Models in Biology*. (New York: Random House, 1988), 220–221.

3. The rate of predation depends on the likelihood that a victim is encountered by a predator.
4. The growth rate of the predator population is proportional to food intake (rate of predation)."⁸⁸

The creation of this model, consistent with these assumptions, leads to the following two equations:

$$\frac{dx}{dt} = ax - bxy$$

$$\frac{dy}{dt} = -cy + dxy$$

where:

x is the prey population;

y is the predator population;

a is the growth rate of the prey population when predators are absent (it is a positive quantity with dimensions of 1/time);

c is the net death rate of the predators in the absence of prey;

xy approximates the likelihood that an encounter will occur between both species if they move randomly and are distributed uniformly throughout their habitat; and

b/d describes the efficiency of predation, converting a unit of prey into a unit of predator mass.⁸⁹

A graph of the two populations, predator and prey, fluctuates between increasing and decreasing values; on the graph, the line representing the predator is slightly offset from the line representing the prey (Figure 3).

An analysis of the graph and understanding the biology behind the equation demonstrates that one population will never be the sole reason for the extinction of another population. The relationship between the lynx and the snowshoe hare are two species which can help explain the dynamics of this

⁸⁸ Edelstein-Kesht, *Mathematical Models in Biology*, 218.

⁸⁹ Ibid., 220–221.

model: the lynx, which preys on hares, converts the energy they gain from eating the hares into producing young. As the lynx eats the hares, the hare population decreases in size and more energy from the hares is converted to energy used to reproduce. The lynx population increases and, as a result, their consumption of hares increases. As the hares are preyed upon by the lynx, there are fewer hares to support the lynx population, resulting in a decrease in the lynx population. As the lynx population decreases, the hare population recovers. As the hare population recovers, there is more food available for the lynx, and the cycle starts again. The relationship described by the model is that the lynx causes the hare population to crash and the lack of hares causes the lynx population to decrease. Because of the nature of their relationship, neither population will go extinct due solely to the interaction between the two. Other outside forces, such as a loss of habitat, introduction of disease, or a cause other than the variables of the predator-prey relationship are more significant factors that impact the survivability of the two species.

The basic Lotka-Volterra equation has been modified by many scientists to describe the interactions between different organizations.⁹⁰ It has been used to explain the dynamics between two organisms competing for the same resource, such as in disease. This model has acceptance from biologists who use it to examine the relationship between foxes and pheasants, moose and wolves, and spiders and flies. However, it is thought that because of humans' additional mental capacity – especially the ability to use emotions and manipulate their surroundings – we do not experience the basic biological rules of other organisms, thus causing biological models to be ineffective at describing the relationship between fighting human populations. As a result, sociologists developed models to understand human behavior during times of war (as described in Chapter 2). None of the existing models is successful in analyzing

⁹⁰ Pierre Auger, et al., "A predator-prey model with predators using hawk and dove tactics," *Mathematical Biosciences* 177&178 (2002):185–200.

Edelstein-Kesht. *Mathematical Models in Biology*, 210-256.

terrorist organizations, perhaps because these models cannot adequately describe the unique phenomena of terrorist groups.

Terrorist organizations utilize sleeper cells to maintain their status when they go into hiding; this enables them to sustain their allegiance to their organization while remaining hidden from their enemies. In essence, they are the low population of “hares” that always remain in the population; because of their limited visibility, they are difficult to “hunt.” Their population is sufficient to secretly recruit individuals and maintain a low level of activity. They too (just like the hares) are never removed from the population. Once the pressure from the government – the lynx – is reduced, they begin to openly recruit individuals again. This behavior, along with second cue seen in the dynamics between then two organizations described in depth below, indicates that the Lotka-Volterra model is a good model for this study.

B. THE KEY MODELING DECISION – SINN FÉIN VERSUS THE BRITISH ARMY

The terrorist organization selected for study in this thesis is the Provisional Irish Republican Army (IRA). Since 1997, the IRA has been in a permanent ceasefire; also, in the summer of 2005, after the terrorist bombing in London by al-Qaeda, the IRA declared that they were fully disarmed and no longer seeking an active terrorist role to obtain their goals of unifying all of Ireland under one rule.⁹¹ Because of these two factors, much of the information about IRA became available (particularly more so than other terrorist organizations which are still

⁹¹ On September 26, 2005, a statement was released by the IRA through the British Broadcasting Corporation that stated through the cooperation of the IICD [Independent International Commission on Decommissioning] the IRA was able to complete the decommissioning process and “verifiably put arms beyond use.” (Peter O’Neill, “Text of Irish Republican Army (IRA) Statement on Putting Arms Beyond Use, (26 September 2005),” CAIN Web Service, <http://cain.ulst.ac.uk/othelem/organ/ira/ira260905.htm> [Accessed 15 October 2005]).

active).⁹² Furthermore, the IRA's actions continue to be relevant; the events are recent enough that readers can remember some of the impacts that the IRA had on its people and the surrounding areas.

As discussed in the prior chapter, the fighting in Ireland did not just consist solely of two groups; there were a number of organizations involved, including the British Security Forces, Republican Paramilitary Groups, Loyalist Paramilitary Groups and Irish Security Forces. One might feel it would be difficult to determine the direct effect of one group on another; however, when the number of Irish Republican Army members (the number of Provisional and Original IRA members were grouped by the author of this data) killed by different organizations (Table 3) are analyzed, one clearly identifies that the British Army was its biggest predator. The death statistics were readily available for the British Army and the IRA because the deceased's loyalty to one of these organizations was revealed at their death.⁹³ The RUC kept good records and is the basic source for Northern Irish fatalities. The Belfast office of the *Irish Times* kept the same information as the RUC but included more detailed information about the victim; for example, the circumstances surrounding the death, the killer

⁹² On July 28, 2005, P. O'Neill, the Irish Republican Publicity Bureau in Dublin made the following statement indicating the disarmament of the IRA. "The leadership of Oglagh na h Eireannan has formally ordered an end to the armed campaign. This will take effect from 4 pm [1600 BST] this afternoon [Thursday 28 July 2005]. All IRA units have been ordered to dump arms. All Volunteers have been instructed to assist the development of purely political and democratic programmes though exclusively peaceful means. Volunteers must no engage in any other activities whatsoever. The IRA leadership has also authorized our representative to engage with the IICD [Independent International Commission on Decommissioning] to complete the process to verifiably put its arms beyond use in any way will further enhance public confidence and to conclude this as quickly as possible... The Army Council took these decisions following an unprecedented internal discussion and consultation process with IRA units and Volunteers... We are proud of the comradely way in which this truly historic discussion was conducted. The outcome of our consultations show very strong support amount IRA Volunteers for the Sinn Fein peace strategy... We are very mindful of the sacrifices of our patriot dead, those who went to jail, Volunteers, their families and the wider republican base. We reiterate our view that the armed struggle was entirely legitimate. We are conscious that many people suffered in the conflict... Every Volunteer is aware of the import of the decisions we have taken and all Oglagh are compelled to fully comply with these orders." (Peter O'Neill, "Text of Irish Republican Army (IRA) Statement on the Ending of the Armed Campaign, (28 July 2005)," Cain Web Service, <http://cain.ulst.ac.uk/othelem/organ/ira/ira280705.htm> [Accessed 15 October 2005]).

⁹³ A member of the IRA would generally keep their membership secret. However, during their funeral, the status of their membership usually becomes public, especially by who attends the funeral.

and the characteristics of the victim. The *Irish Times* maintains death statistics after 1971; the *Belfast Newsletter* recorded the first 100 deaths. The British Army also maintains information regarding violence and security force counter-measures.⁹⁴ Figure 2 depicts the number of deaths per year by organization. The relationship between the two is offset in a similar cyclical pattern as the Lotka-Volterra model (seen in Figure 3); this provides the confidence that the Lotka-Volterra model is a good choice to describe the population dynamics of the British Army and the IRA.

The Lotka-Volterra model mimics nature, where the predator drives the population of the prey. The pivotal event determining who should be the predator and who should be the prey is the infamous Bloody Sunday.⁹⁵ This event triggered the IRA to resume an active campaign against the British. Thus, the predator for this model is considered the British Army.⁹⁶ The prey, whose population sizes are dependant on the predator, is the Irish Republican Army.

It is difficult to distinguish an offset cyclical-wave relationship between the two groups when the population of the British Army and the IRA are compared. This is because of the British Army's unique population dynamic. The army, as described above, is a static population because the army is set to a pre-determined size. (Everyone in a platoon has a set job; if someone leaves that post, another person replaces that individual.) The size of the British Army

⁹⁴ Hewitt, C, *Consequences of Political Violence* (Vermont: Dartmouth Publishing Company, 1993), 131–132.

⁹⁵ Bloody Sunday was an event which had its roots in a statement given eighteen months before the date. "The Belfast magistrate concluded that every soldier had a common-law duty to suppress riot 'by every means in his power'" (Geraghty, *Irish War*, 39). "British soldiers has been attacked and killed in the conflict and did, on that day (30 January 1972), come under some form of hostility. But the weight of evidence suggests that the killings of Bloody Sunday were utterly unjustified; and their consequences, personally and politically, were dire." (English, *Armed Struggle*, 152).

⁹⁶ T. Geraghty, *The Irish War: The Hidden Conflict between the IRA and British Intelligence* (Baltimore: The Johns Hopkins University Press, 2000), 39.

changed as the number of platoons in Ireland changed, with little to no impact due to the number of casualties. The number of British Army personnel in Ireland by year can be seen in Table 2.

The British Army and the Royal Ulster Constabulary intelligence reports revealed that the Irish Republican Army was organized in cell structures; this makes it difficult to ascertain the actual size of the membership.⁹⁷ After a thorough examination of the available information, the best estimate of the membership of the IRA was that it peaked around 1,500 in the mid-1970s. This number decreased to roughly 500 members during the 1994 cease-fire, coinciding with the adoption of a new organization of the IRA in 1979.⁹⁸ The members of the IRA were considered a “reasonably stable group of people.”⁹⁹ Psychiatric examinations generally determined them to be a group of individuals with “clear ideals and goals” and had leadership and support from other members of the group.”¹⁰⁰ While these individuals appeared to be just like our neighbors, they must have believed that their cause was worth the terror.

Many members of the IRA were arrested and jailed, decreasing the size of their organization and further creating the need for the cells or 'active service units'. The 'cell structure' was not only adopted in response to declining popularity in nationalist areas, but also for strategic reasons to avoid penetration by the security forces. Roughly 3,000 individuals were charged with terrorist offenses between 1976 and 1979. Most of these individuals were charged with terrorist offenses based on confessions obtained under interrogation, implying to the leadership of the IRA that their volunteers were unable to withstand the pressures of interrogation. To counteract this, IRA leadership minimized the amount of information provided to each individual; limiting the amount of

⁹⁷ Patrick Bishop and Eamonn Mallie, *The Provisional IRA* (London: Heinemann, 1987), 322.

⁹⁸ Martin Melaugh, “Estimates of the Strength of Paramilitary Groups,” CAIN Web Service, <http://cain.ulst.ac.uk/issues/violence/paramilitary2.htm> [Accessed 2 January 2005].

⁹⁹ Bishop and Mallie, *The Provisional IRA*, 15.

¹⁰⁰ Ibid.

information the arrested individual would provide the army or the police about the IRA when under duress. A cell, or a basic IRA unit, consisted of only three to four members; they were known to each other by pseudonyms and they had no knowledge of the names of their superiors. Their actions were directed to the group by an anonymous controller.¹⁰¹

Because the population numbers were not readily available, a different method was required to determine the rough population estimate of the IRA for the model. As discussed above, Sinn Féin was the political arm of the struggle of the Catholic Irish; therefore, the numbers of individuals voting to support Sinn Féin gives a rough estimate of those in support of the IRA. Because of Sinn Féin voting abstention until 1982, this study was limited to the last 20 years of the conflict. Consequently, public support of Sinn Féin was considered as the population of the IRA.

C. KNOWN POPULATION NUMBERS

There is voting data for almost all years since 1982. By taking the percentages of individuals who voted for Sinn Féin and using the number of votes to determine the number of individuals supporting Sinn Féin, the support for the terrorist organization was determined. In the years that voting did not occur, data for those years were interpolated by taking the average of neighboring years, as presented in Table 4. The number of British Army troops in Northern Ireland is included in Table 2. For the years that data was not available, the numbers were interpolated using the surrounding years. The number of votes was originally provided as percentages, as documented in Table 1; the numbers listed in Table 5 were calculated by multiplying the percentage by the total number of votes, providing an explanation why the data is not listed in whole numbers. The same procedure was performed to obtain number of British Army personnel in the years where no numbers were reported.

¹⁰¹ Bishop and Mallie, *The Provisional IRA*, 322-323.

D. THE MODEL

Because the two populations, the British Army and Sinn Féin were not within the predetermined assumptions of the Lotka-Volterra model (Section “The Model: Lotka-Volterra Predator-Prey Model”) the model was modified to meet the anomalies. The first adaptation introduced a term placing a limit on the size of the population, called the carrying capacity. The carrying capacity is the maximum size a population can reach; this is due to the environment’s ability to sustain a maximum number of individuals. After the carrying capacity is reached, the population will slightly increase, then, quickly decline; a stable population will remain at the carrying capacity. Carrying capacity is calculated by making the growth rate dependant on the density. Thus, a term, which creates a density-dependent growth rate, is as follows:

$$g(N) = r(1 - \frac{N}{K})$$

where:

N is the population size;
 r is the intrinsic growth rate; and
 K is the carrying capacity.

When the change in population size over time is equal to zero, then $N = K$. When the change of population size over time is greater than zero, the population is less than the carrying capacity; when the change in population size is less than zero, the population is more than carrying capacity. As individuals compete for food, habitat and other limited resources during crowded conditions, an increase in the net population mortality is observed. The effects are most pronounced when there are increasing encounters between individuals.

The second term represents a mortality rate proportional to the rate of paired encounters.

$$\frac{dN}{dt} = rN - \frac{r}{KN}$$

where:

N is the population size;
 r is the intrinsic growth rate;
 K is the carrying capacity; and
 t is the change in time.

When there is competition between species as in a predator prey scenario, the carrying capacity is still in effect and this variable must be included in the formula. Therefore, the final formulas have a term which contains a term of self-regulation.

$$\frac{dx}{dt} = \frac{ax(K - x)}{K} - bxy$$

$$\frac{dy}{dt} = -cy + dxy$$

In the case of terrorist groups, limiting factors would be such components as money, housing, arms, communication, etc.

There are a few deviations of the relationship described by the model that need to be considered when examining the relationship between Sinn Féin and the British Army. The first anomaly concerns the predator's (the British Army) population change over time. When an individual dies in the British Army, that person is replaced by another soldier, so the population remains static unless the number of platoons is changed; this creates a difference of 30 soldiers at a time as opposed to one. Therefore, the model was altered to incorporate these data. Secondly, the carrying capacity of the population (the number of individuals the system can maintain) was also incorporated into the model.

Using the actual number of troops for the predator and the parameters listed below for Equation 2 and MatLab Version 7.0.1.24704 (R14) Service Pack 1, the number of prey was determined.

Equation 2:

$$dy = yc - yAb - \left(\frac{y^2 e}{K} \right)$$

Parameters:

A = British Army population

b = 0.005, the hunting efficiency of the British Army

c = 100, the recruitment rate of the IRA

e = 500, rate at which the IRA reaches carrying capacity

K = 400000, the carrying capacity of the IRA

Figure 4 shows the comparison of the actual number of votes for Sinn Féin versus the predicted number of votes. Visual inspection demonstrates that although the numbers are different, the trends are consistent.

Visual inspection of the data is important, but it is also valuable to conduct statistical analyses to indicate the strength of the similarities between the observed data and the expected or predicted data. There are many tests which test the differences between the expected and observed data. A very common test is the chi-square. This test is used to examine the goodness of fit, or when one set of numbers differs from what might be expected by chance. Chi-square is a non-parametric test of significance examining whether or not two samples are different. Because it is non-parametric, it does not require the sample data to be normally distributed; however, the population from which the sample is drawn does need to be normally distributed. Other assumptions include the sample must be randomly drawn from the population; the data must be reported in raw frequencies; measured variables must be independent; values and categories on independent and dependent variables must be mutually exclusive and exhaustive; and observed frequencies cannot be too small. Considering it is a

non-parametric test, the data can be run on nominal, interval and ordinal data. Examination of the data proves that in the actual population less than 95.45% of the data is within two standard deviations of the mean, thus the data is not normal and it needs to be transformed for the chi-square test to produce accurate results. Performing a Kolmogorov-Smirnov test on the data indicated that the data was consistent with a log normal distribution.¹⁰² Therefore, a base 10-log transformation was applied to the data. After the transformation, it was found that the chi-square value of the data was 0.999907 and had a p value > 0.1, thus the null hypothesis is accepted, and there are no described differences between the data.

Pearson's R and Spearman's R are two additional tests used to describe the correlation between the two datasets. Both are correlation statistics intended to measure interval scales. Pearson's R correlation assumes that the two variables are measured on an interval scale and determines the extent that two variables are proportional to each other. Spearman's R is a non-parametric test and is only sensitive to ordinal arrangement of values; therefore, it is not impacted by curvilinearity in the data. Both values provide a correlation coefficient, which ranges from a value of +1.0 to -1.0. The value of +1.0 represents a perfect positive correlation and a value of -1.0 represents a perfect negative correlation.¹⁰³ Pearson's R for the non-transformed data (the data does not need to be in a normal distribution) is 0.8077 and the Pearson's R for the transformed data is 0.6835. The Spearman's R for the data ranked into ordinal numbers is 0.609.

Analyses of the data proves that the population of support for Sinn Féin is consistent with the model. Changing the parameters does not have a significant impact on the model; changes cause the distribution to shift to the right or left, but the general trends of the model remain the same.

¹⁰² "Kolmogorov-Smirnov Test," College of Saint Benedict/Saint John's University, www.physics.csbju.edu/stats/KS-test.html [Accessed 18 January 2006].

¹⁰³ "Basic Statistics," StatSoft, www.statsoft.com/textbook/stbasic.html [Accessed 18 January 2006].

When comparing the modeled population to the actual voting population, there are many similarities. As terrorist activity decreased in Northern Ireland and the IRA maintained their ceasefire, the British Army decreased the presence of the army in the region; this eased tensions and allowed the British Army to increase the army presence in areas which needed a stronger military presence.¹⁰⁴ The decrease in the number of army personnel (the predator) resulted in a drastically increase in Sinn Féin votes in the latter years, particularly the late 1990s; this phenomena was predicted by the model.

A final way to analyze the model's effectiveness is to the correlate the data with the history of the war in Northern Ireland, which also supports that the model is accurate. The decrease in support in the mid 1980s occurred when the Anglo-Irish Agreement, (strengthening the relationship between the British and Republic of Ireland) was not a republican agenda.¹⁰⁵ As seen in Table 1, votes for the unionist block increased as votes for the nationalists decreased. The decrease in support in 1994 was probably due to a cease-fire; Sinn Féin and IRA both promised that there would be no cease fire, yet the Army Council voted to support a four- month cease fire.¹⁰⁶ The model diverges from the actual data from 1997 to the present; this is expected because the IRA agreed to a cease-fire, changing the dynamics between IRA and the British Army.

The model itself cannot predict the number of individuals in support of the IRA in a particular year, but rather, it can be used to predict the trends of support, and, more specifically, *popular* support. Popular support influences recruitment efforts, the size, and the impact of the actions taken by the IRA. This demonstrates that further development of biological models may be used to predict the recruitment of terrorist organizations.

¹⁰⁴ Wikipedia, "Structure of the British Army."

¹⁰⁵ Boothroyd, *The History of British Political Parties*, 275.

¹⁰⁶ Ed Moloney, *A Secret History of the IRA* (New York: W.W. Norton & Company, 2002), 546.

E. THE MODELED DATA

It was difficult to find the actual numbers of the membership of the IRA. This may be because I do not have security clearance to gain access to the data; however, I feel it is because of the secretive nature of terrorist organizations. I think it would be difficult for any individual, with or without a security clearance, to determine the actual membership. Without this data, another means of calculating membership data must be determined. Sinn Féin, a political party in support of the actions of the Irish Republican Army, was a good selection because their elections are open and individuals can freely elect whom they desire to support. This type of analysis cannot be performed for every terrorist organization; however, this thesis demonstrated that the trends of support can be determined by analyzing how the population numbers of the British Army changed over time. This indicates preliminary support to the original hypothesis – terrorist organizations are working under the same stressors as wildlife populations. An adaptation of this model may help governments analyze the trends in these organizations and assist in determining their approach to eliminating terrorism. Further research, such as greater analysis of social organization, is necessary; however, this is a good first step to identifying the drivers of the “terrorist” social organization. Future modeling should be developed to recognize trends and help identify how governments may counteract these organizations. The success of this model to predict past trends of the interaction of Sinn Féin and the British Army also indicates that the use of biological models in developing a better understanding of terrorist population dynamics as opposed to gang models or a sociological-focused studies.

V. CONCLUSION

Policymakers use the output of models to develop tactics for fighting the war on terrorism. In order for governments to succeed in this war, it is important for tactics to be developed from models that are accurately describing their subject's behavior. A review of the current literature demonstrates that models currently used to understand the dynamics of terrorist organizations are not providing an accurate analysis or prediction of the behavior of terrorist organizations. The analysts are depending on sociological models. These models are not suitable because they do not incorporate the use of violent behavior vectors into their formulas; they are utilizing non-violent models to describe violence between individuals, and the results are inaccurate. If the current models were appropriate, there would be many more published resources available on modeling terrorist organizations.

It would be logical to think that gang models would be an appropriate method to understand terrorist organizations. However, as described by this thesis, gangs and terrorist organizations are very different from each other. Gang researchers are utilizing models that integrate violent behavior into models, which were originally developed to study non-violent behavior. Therefore, gang models do not provide the rigorous analysis needed to understand the behavior of terrorist organizations.

This thesis introduces an alternative and more appropriate method for modeling terrorist behavior. It capitalizes on models that were developed to explain the violent behavior in animals and plants as is seen in terrorist organizations. Biological models are used to describe competition between individuals as well as populations. The models were developed to examine the use of weaponry between individuals, to determine when one species caused another to go extinct, and to identify which species will survive in a fight over resources. Biologists have also used the same models to examine community dynamics. They have used models in many different biological communities to

describe their social structure, selection of habitats, mates, and prey, time of food consumption and recruitment. Considering biological models already incorporate the dynamics that exist between terrorist organizations and their victims, as well as provide the population dynamics of a selected population, it was only natural to examine whether or not they were appropriate to help understand the dynamics seen in terrorist organizations.

For the case study, this thesis utilized a Lotka-Volterra predator-prey model to describe the recruitment behavior of a terrorist organization. Even though the examination was relatively simple and preliminary, it was successful in describing the trends seen in the case study population. This method is more appropriate for examining the growth and decline of terrorist organizations through the interaction of law enforcement and terrorist recruitment efforts than any other method presented thus far. Biological models were developed to incorporate competition between species and individuals, as well as fighting and organized warfare between species. They look to determine which population will succeed in a competition over resources and shared habitats. The results of the case study demonstrate how a biological model can be utilized to understand the actions of a terrorist organization, and offer predictive value that sociological models lack. This can result in a change of the current tactics (i.e., policies) developed to fight terrorism; hopefully, making them more appropriate.

The model utilized in this thesis is an appropriate method to analyze the recruitment of terrorist organizations. Luckily, this is not the only behavior of terrorist organizations that can be explained by biological models. Examination of the biological literature proves that other types of biological models are available to be modified, exactly as described in this thesis, to aid in the analysis of other aspects of terrorist organizations. Additional research should focus on identifying and developing these models to help fight the War on Terrorism.

APPENDIX

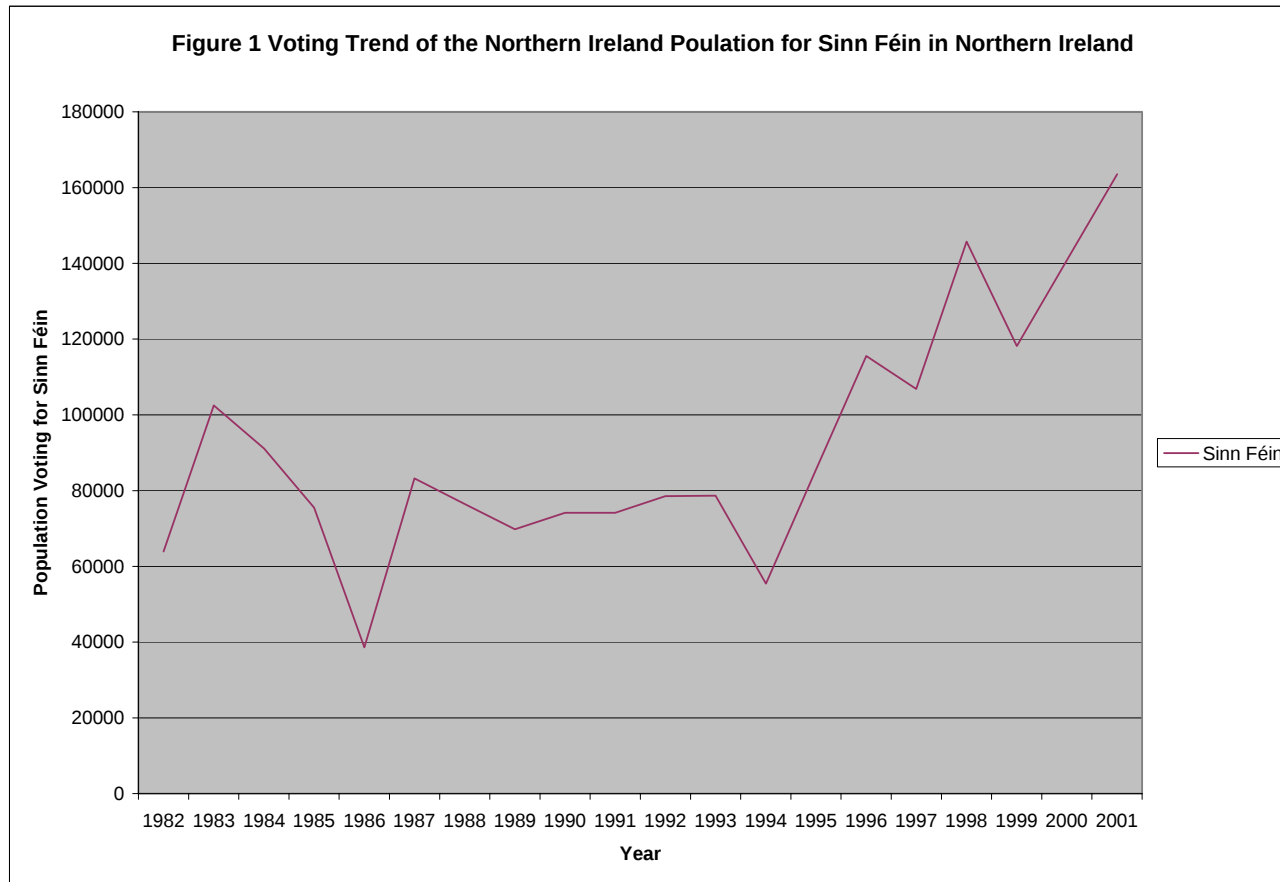


Figure 1. Voting Trend of the Northern Ireland Population for Sinn Féin in Northern Ireland

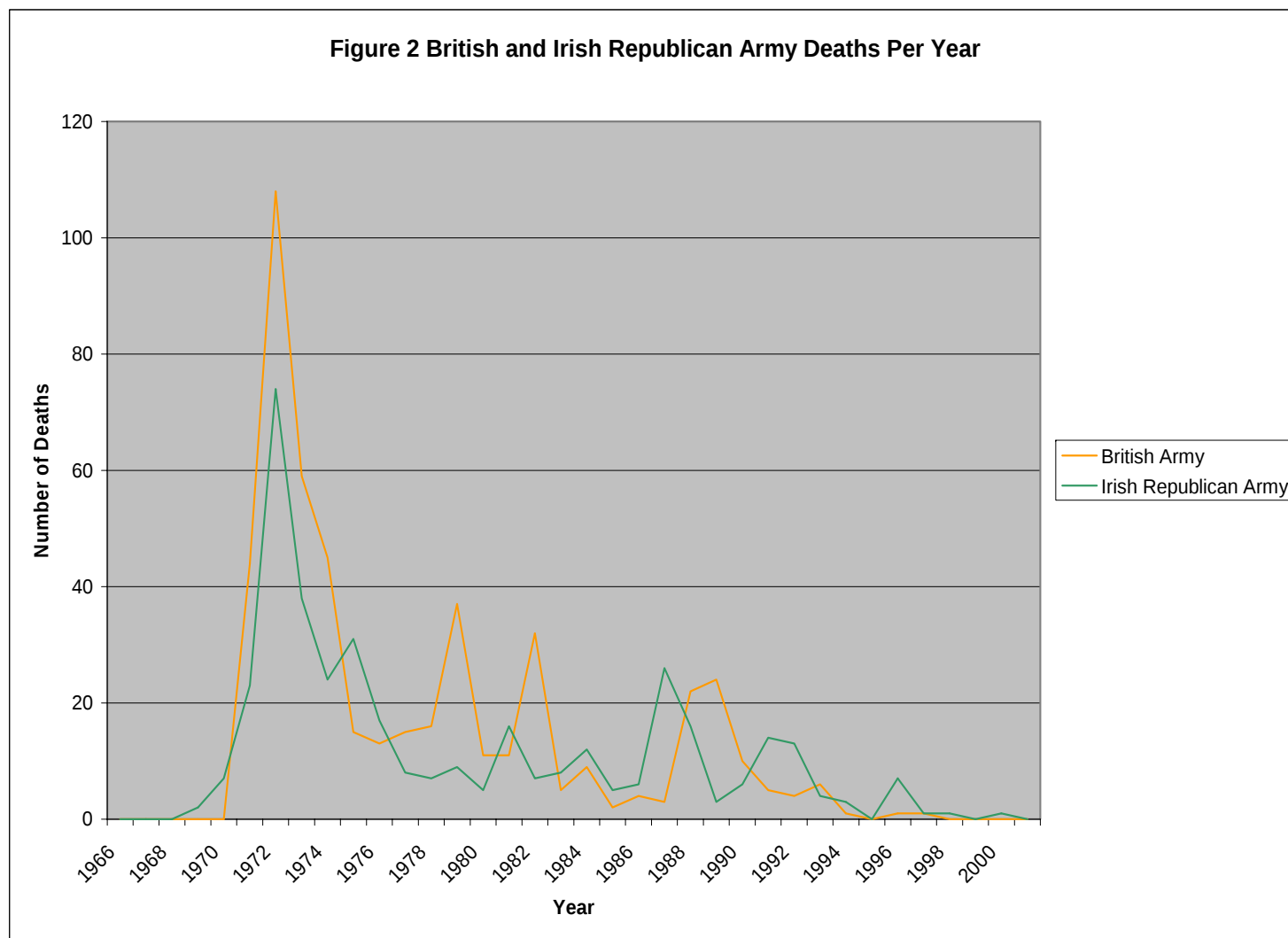


Figure 2. British and Irish Republican Army Deaths Per Year

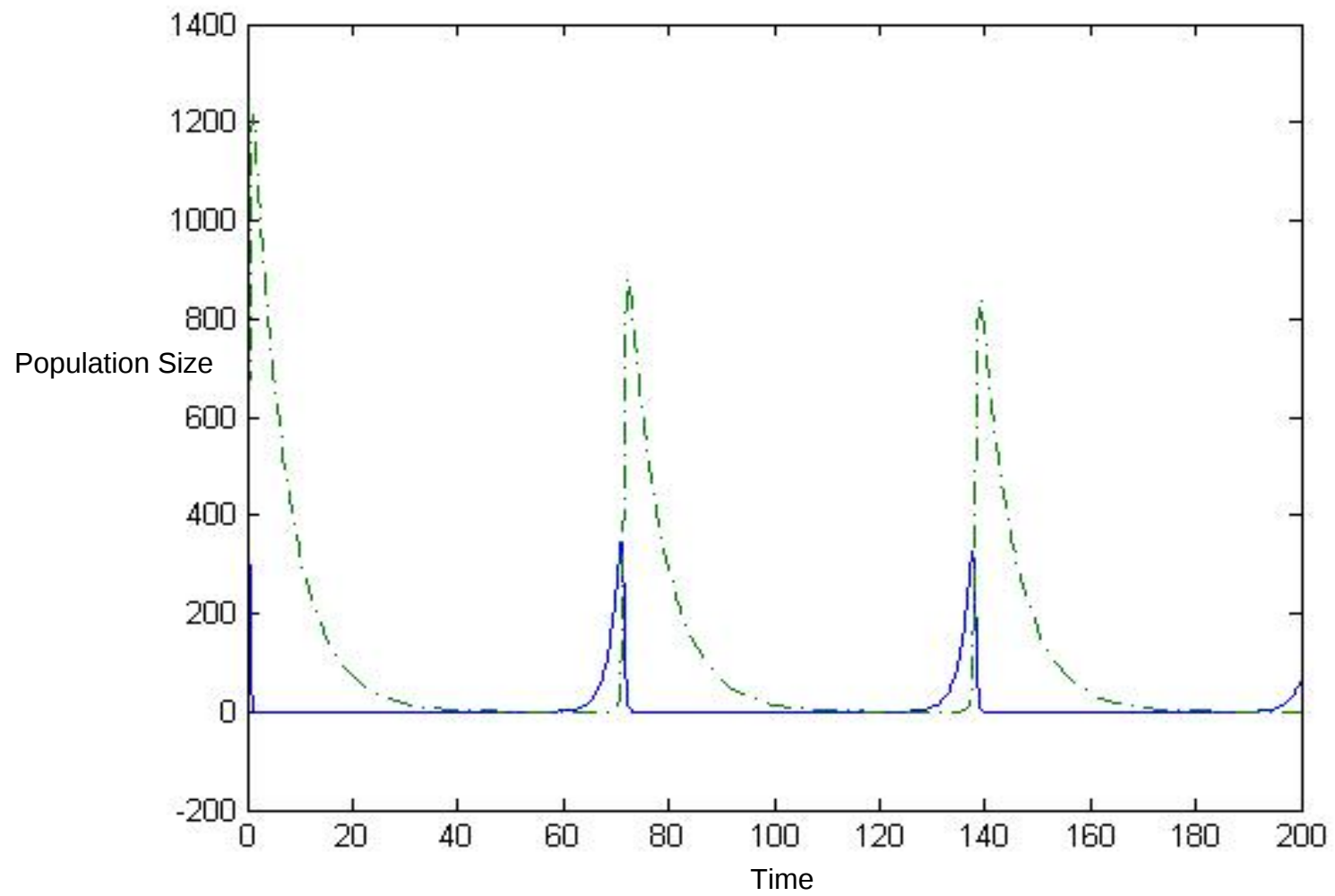


Figure 3. Cyclic Nature of Lotka-Volterra Equation

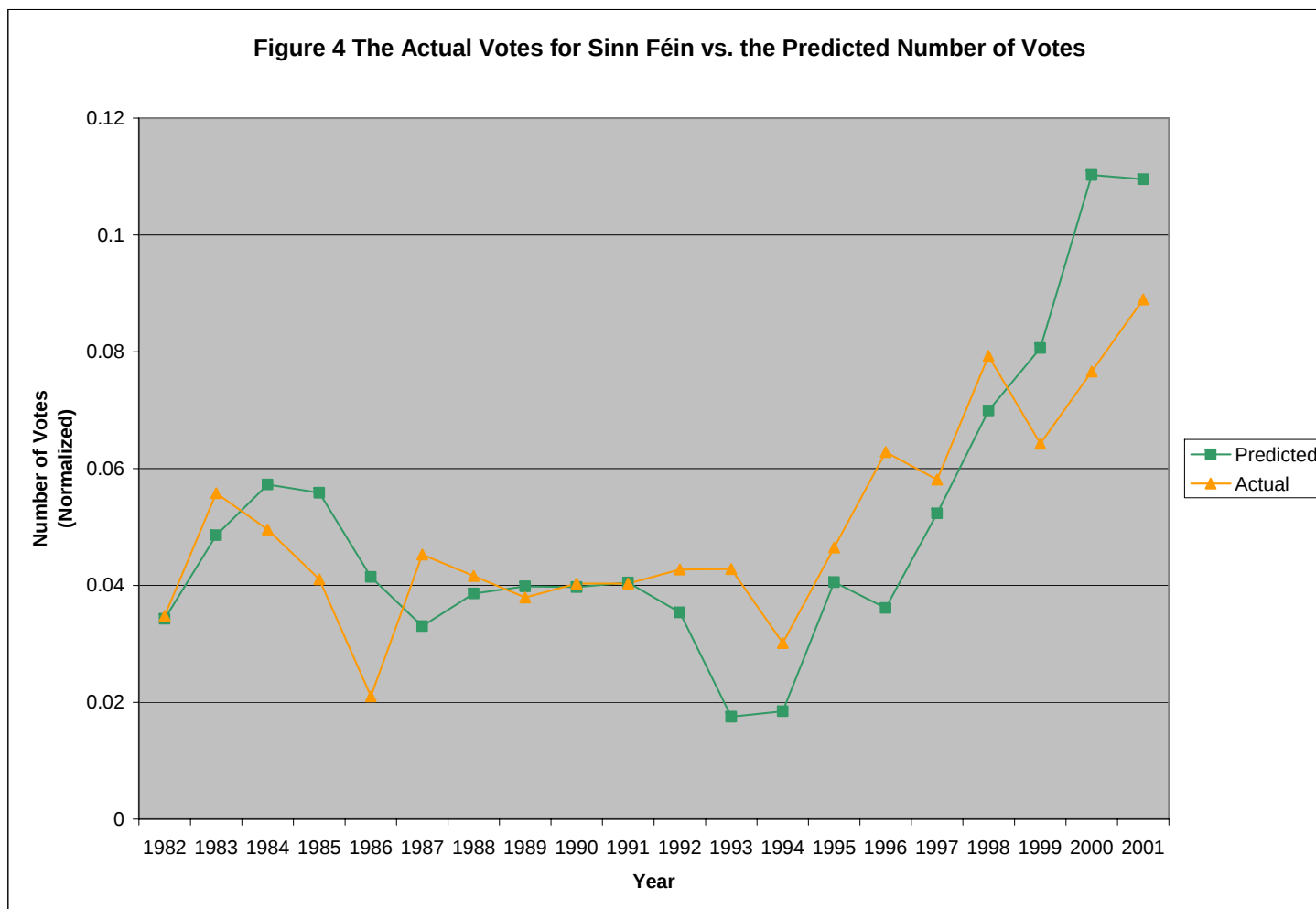


Figure 4. Actual Votes for Sinn Féin vs. Predicted Number of Votes

Election	Total Unionist	Total Nationalist	Unionist Bloc			Nationalist Bloc			Non Confessional		Other
			UUP	DUP	Other U.	SDLP	SF	Other N.	APNI	Other Non	
1969 Stormont	67.4	18.8	61.1	-	6.3	-		18.8	-	8.1	5.7
1970 Westminster	58.8	23.3	54.3	-	4.5	-		23.3	-	12.6	5.1
1973 Local Government	56.6	19.2	41.4	4.3	10.9	13.4		5.8	13.7	2.5	8.0
1973 Assembly	61.9	24.1	29.3	10.8	21.8	22.1		2.0	9.2	2.6	1.0
1974 Westminster	64.2	26.9	32.3	8.2	23.7	22.4		4.5	3.2	2.4	3.3
1974 Westminster	62.1	29.8	36.5	8.5	17.1	22.0		7.8	6.3	1.6	0.2
1975 Constitutional Convention	62.5	25.9	25.8	14.8	21.9	23.7		2.2	9.8	1.4	0.4
1977 Local Government	50.8	24.7	29.6	12.7	8.5	20.6		4.1	14.4	0.8	8.3
1979 Westminster	59.0	28.1	36.6	10.2	12.2	19.9		8.2	11.8	-	2.1
1979 European	59.0	31.3	21.9	29.8	7.3	24.6		6.7	6.8	-	2.9
1981 Local Government	57.3	22.8	26.5	26.6	4.2	17.5		5.3	8.9	1.8	8.2
1982 Assembly	59.4	28.9	29.7	23.0	6.7	18.8	10.1	-	9.3	2.7	0.7
1983 Westminster	57.0	31.3	34.0	20.0	3.0	17.9	13.4	-	8.0	1.9	1.6
1984 European	58.0	35.4	21.5	33.6	2.9	22.1	13.3	-	5.0	1.3	0.3
1985 Local Government	56.9	32.0	29.5	24.3	3.1	17.8	11.8	2.4	7.1	1.6	1.8

1986 Westminster By-elections	71.5	18.7	51.7	14.6	5.2	12.1	6.6	-	5.5	3.1	1.2
1987 Westminster	54.9	32.5	37.8	11.7	5.4	21.1	11.4	-	10.0	2.6	-
1989 Local Government	54.9	32.5	31.4	17.8	5.7	21.2	11.3	-	6.8	2.1	3.7
1989 European	56.2	34.7	21.5	29.9	4.8	25.5	9.2	-	5.2	1.1	2.8
1992 Westminster	55.8	33.5	34.5	13.1	8.2	23.5	10.0	-	8.7	-	2.0
1993 Local Government	50.8	34.6	29.0	17.2	4.6	21.9	12.5	0.2	7.7	1.0	5.9
1994 European	54.0	38.8	23.8	29.2	1.0	28.9	9.9	-	4.1	0.5	2.6
1996 Forum	52.9	36.9	24.2	18.8	9.9	21.4	15.5	-	6.5	2.5	1.2
1997 Westminster	50.5	40.2	32.7	13.6	4.2	24.1	16.1	-	8.0	0.7	0.3
1997 Local Government	47.5	37.6	27.8	15.6	4.1	20.7	16.9	-	6.5	-	8.4
1998 Assembly	47.4	39.6	21.3	18.0	8.1	21.9	17.7	-	6.5	2.0	4.5
1999 European	52.2	45.5	17.6	28.3	6.3	28.1	17.4	-	2.1	-	0.2
2001 Westminster	52.7	42.7	26.8	22.5	3.4	21.0	21.7	-	3.6	1.0	-
2001 Local Government	47.0	40.1	22.9	21.4	2.7	19.4	20.7	-	5.1	0.6	7.1
2003 Assembly	51.7	40.7	22.7	25.7	3.3	17.0	23.5	0.2	3.7	1.0	2.9
2004 European	48.6	42.2	16.6	32.0	-	15.9	26.3	-	-	-	9.2
2005 Westminster	51.8	41.8	17.7	33.7	0.4	17.5	24.3	-	3.9	0.2	2.2

2005 Local Government	48.8	40.7	18.0	29.6	1.2	17.4	23.3	-	5.0	0.2	5.4
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Table 1. Voting Percentages in Northern Ireland¹⁰⁷

¹⁰⁷ Martin Melaugh, "Political party support in Northern Ireland, 1969 to the present," CAIN Web Service, <http://cain.ulst.ac.uk/issues/politics/election/electsum.htm> [Accessed 10 November 2004].

Year	British Army Personnel
1969 (Jun)	2700
1970 (Jan)	8100
1971	11800
1972	22800
1972 (Jul)	30300
1973 (Jan)	26000
1974	23900
1975	22700
1976	22800
1977	21900
1978	22200
1979	21200
1980	19300
1981	19100
1982	18011
1983	17125
1984	16468
1985	16194
1986	16908
1987	17931
1988	17593
1989	17430
1990	Not Reported
1991	Not Reported
1992	17417
1993	Not Reported
1994 (Jul)	19500
1995	Not Reported
1996	Not Reported
1997	Not Reported
1998	15500
1999	15500
2000 (Jun)	13500
2001	13000

Table 2. The Number of Reported British Army Personnel by Year in Northern Ireland¹⁰⁸

¹⁰⁸ Fionnuala McKenna, et al., "Background Information on Northern Ireland Society-Security and Defense," CAIN Web Service, <http://cain.ulst.ac.uk/ni/security.htm#03> [Site Accessed 29 October 2004].

Organizations in Northern Ireland	Number of Individuals Per Organization Killed by British Army Personnel
British Army	5
Civilian	151
Civilian Political Activist	1
Irish National Liberation Army	5
Irish People's Liberation Organization	1
Irish Republican Army	96
Irish Republican Army Youth Section	12
Official Irish Republican Army	9
Official Irish Republican Army Youth Section	2
Royal Ulster Constabulary	2
Ulster Defense Association	6
Ulster Defense Regiment	2
Ulster Volunteer Force	5
TOTAL	297

Table 3. Number of Individuals by Organization Killed by the British Army¹⁰⁹

¹⁰⁹ Malcolm Sutton, *Bear in mind these dead....An Index of Deaths from the Conflict in Ireland*, (Belfast, Beyond the Pale Publications: 2001). <http://cain.ulst.ac.uk/sutton/book/> [Accessed 25 September 2004].

Year	British Army
1966	0
1967	0
1968	0
1969	2700
1970	8100
1971	11800
1972	30300
1973	26000
1974	23900
1975	22700
1976	22800
1977	21900
1978	22200
1979	21200
1980	19300
1981	19100
1982	18011
1983	17125
1984	16468
1985	16194
1986	16908
1987	17931
1988	17593
1989	17430
1990	17423.5
1991	17423.5
1992	17417
1993	18458.5
1994	19500
1995	17500
1996	17500
1997	17500
1998	15500
1999	15500
2000	13500
2001	13000

Table 4. The Number of British Army Troops in Northern Ireland Utilized For Modeling Efforts

Election	Number of Votes
1982 Assembly	63945.12
1983 Westminster	102499.95
1984 European	91147.161
1985 Local government	75475.396
1986 Westminster By-elections	38609.208
1987 Westminster	83237.328
1989 Local government	69744.617
1989 European	49202.612
1992 Westminster	78509.3
1993 Local government	78638.25
1994 European	55426.833
1996 Forum	115520.88
1997 Westminster	127332.324
1997 Local Government	106841.293
1998 Assembly	145771.005
1999 European	118112.766
2001 Westminster	175852.677
2001 Local Government	163544.076
2003 Assembly	162626.58

Table 5. The Number of Votes for Sinn Féin in Northern Ireland

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