AN ANALYSIS OF HUNTER PARTICIPATION TRENDS AND POTENTIAL FACTORS INFLUENCING HUNTER LICENSE PURCHASE BEHAVIOR IN NEW JERSEY- AN INTERNSHIP WITH NEW JERSEY DIVISION OF FISH AND WILDLIFE

BY

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SPECIAL PROJECT REPORT

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ABSTRACT

The vast majority of funds for fish and wildlife management and habitat enrichment have been from the sale of hunting and fishing licenses and from excise taxes on hunting and fishing equipment. However, several studies have documented that hunting participation has been declining in the United States, potentially creating revenue shortfalls that impact both hunting and non-hunting conservation initiatives. State agencies are responsible for managing the harvest and hunting seasons for most game species and are therefore largely responsible for managing hunter participation, recruitment, and retention. This paper details the results of an internship with New Jersey Division of Fish and Wildlife that aimed to identify trends in hunter recruitment, retention, and license purchase behavior to help guide efforts to increase hunter participation in the state. The internship project was modeled after a recent national study involving twelve state wildlife agencies, with the addition of a GIS component and statistical analysis. Results indicate significant hunter retention issues in New Jersey and identify segments of the hunting population that would have the most significant impact on license sales.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALS	Automated Licensing System
CID	Customer Identification number
GIS	Geographic Information System
GLM	Generalized Linear Model
LULC	Land Use/Land Cover
M.S.	Master of Science
NJDFW	New Jersey Division of Fish and Wildlife
NRES	Natural Resources and Environmental Sciences
StatCom	Statistics in the Community
UIUC	University of Illinois at Urbana-Champaign

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CHAPTER 1: INTRODUCTION

1.1 Internship experience and learning objectives

From March of 2014 to July of 2015, the author completed a capstone internship experience with the New Jersey Department of Environmental Protection's Division of Fish and Wildlife (NJDFW). The internship was carried out in conjunction with the author's current employment as a Senior Biologist within the Information and Education Bureau's Hunter Education Unit under the supervision of Paul Ritter. The internship accounted for 180 hours with hours per week varying dependent on other work responsibilities. Work was completed in the Central Region Office in Upper Freehold Township, New Jersey. NJDFW is a state-government "environmental agency dedicated to the protection, management and wise use of New Jersey's fish and wildlife resources" (NJDFW 2015a).

For the capstone internship experience, the author researched the gap between hunter education graduates and hunting license sales. Although every prospective hunter in New Jersey is required to complete a hunter education course, not every graduate goes on to buy a hunting license. The aim of the capstone was to identify where intervention efforts may be helpful to increase hunting participation and retention rates among new hunters in New Jersey. Learning objectives included researching the role of hunting and license sales in wildlife and natural resource management, identifying trends in license purchase behavior among different segments of the population, and exploring potential factors that may influence hunter recruitment and retention. Hours dedicated to completing the learning objectives were spent conducting literature reviews and gathering background information; obtaining and processing data; analyzing data using Microsoft Access, ArcGIS, and statistical modeling; collaborating with NJDFW employees; and preparing periodic reports and the final capstone internship paper.

1.2 Literature Review

Hunting is a primary means of wildlife management (Carpenter 2000; Riley et al. 2003) and has contributed greatly to the advancement of scientific knowledge and research techniques. For example, recovered bands from harvested waterfowl allowed scientists to estimate North American waterfowl populations and led to the mark-recapture method known as the Lincoln-Peterson index (Lincoln 1930; White and Bishop 2010). Game harvest and subsequent manipulation of game populations facilitated the development of survival estimation methods that have been extended to apply to nongame species (Brownie et al. 1978), the effects of density dependence on population regulation (McCullough 1979),

and adaptive harvest management (White and Bishop 2010). Hunting is a means of balancing predator-prey relationships (White and Bishop 2010) and controlling overabundant populations that can lead to ecologic and economic damage (Kilpatrick and Walter 1999; Conover 2001; Côté et al. 2004). Furthermore, the vast majority of funds for fish and wildlife management and habitat enrichment have been from the sale of hunting and fishing licenses and from excise taxes on hunting and fishing equipment (Mangun and Shaw 1984; Peterson 2004; White and Bishop 2010; Williams 2010).

In New Jersey, $116 million was spent on hunting expenditures in the year 2011 (United States Department of the Interior 2013). New Jersey specifically manages more than 354,000 acres of state-owned public open space to enhance wildlife populations and provide for wildlife-oriented recreation opportunities such as hunting (NJDFW 2015b). In addition, New Jersey provides year-round hunting opportunities, including seasons for small game, waterfowl, turkey, fox, coyote, white-tailed deer, and black bear. However, hunter participation in New Jersey is primarily focused on white-tailed deer, with 95% of the state's hunters participating in deer hunting (United States Department of the Interior 2013). Hunting provides the primary means of controlling deer population sizes in the state, with 2014's annual harvest totaling 52,704 deer (NJDFW 2015c). In 2014, hunting license and permit revenue generated $8.2 million and provided approximately 53% of the total wildlife conservation revenue for the state (NJDFW, Robert Longcor, personal communication, August 4, 2015). Because these funds can be used for the general administration of the state fish and wildlife agency, they can be spent on both hunting and non-hunting related programs.

Several studies have documented that hunting rates have been declining in the United States (Enck et al. 2000; Shultz et al. 2003; Zinn 2003). Between 2001 and 2011, New Jersey showed a 30% decline in hunters (United States Department of the Interior 2013). State agencies, such as NJDFW, are responsible for managing the harvest and hunting seasons for most game species. As such, they also are largely responsible for managing hunter participation, recruitment, and retention. It is therefore critical that state-specific trends are identified in order for states to develop strategies to maximize hunter participation in their jurisdictions (Gude et al. 2012).

Recently, the National Shooting Sports Foundation funded a national study on hunter education graduates' proclivity to purchase a license (Southwick Associates 2013). The Southwick Associates (2013) study analyzed hunter education and license sales data from twelve state wildlife agencies throughout the country (Montana, Nevada, Utah, Washington, Michigan, Missouri, Nebraska, Georgia, Kentucky, Virginia, Maine, and Vermont), profiling the hunter education class of 2006 and their subsequent license buying habitats over the next six years (2006-2011). By cross-referencing each

hunter education graduate's record in the graduate database to records in each state's license sales database, trends could be developed. The results were "intended to help the hunting community understand if and where intervention efforts may be needed to maintain hunting participation among newer hunters" (Southwick Associates 2013, p. iii). Their results showed that across the twelve states analyzed, an average of 67.7% of hunter education graduates purchased at least one hunting license from 2006 to 2011, indicating that a significant portion of graduates did not buy a license after graduating. In addition, the number of graduates who bought a license from 2006 to 2011 decreased by 34.5%; only 44% of graduates bought a license after six years (Southwick Associates 2013).

In addition to identifying the percentage of graduates who purchased a license within six years, the Southwick Associates (2013) study analyzed other factors that may contribute to license purchasing behavior. Their results across the twelve states showed that individuals who graduated from a hunter education class in June and the warmer months comprised the greatest percentage of graduates who never purchased a license (Southwick Associates 2013). This indicates that the seasonality of hunter education classes could affect license purchasing behavior and that future retention efforts may benefit from minimizing classes in the summer months. They also found that in most states, graduates between the ages of 16-24 were less likely to buy a license six years after graduating. In addition, college students and those enlisted in the military were more likely to stop renewing their license within six years of graduating. They also found that graduates from highly urbanized areas showed the greatest drop-out rates (Southwick Associates 2013). These results could help direct future retention efforts by targeting specific groups of graduates that are at greatest risk for dropping out of the system. In addition to analyzing common trends across the study states, the Southwick Associates (2013) report provided individual state data to help each state agency maximize hunter participation rates in the future.

In addition to the Southwick Associates (2013) study, there are several other studies that have explored trends in hunting license sales. Gude et al. (2012) also tracked hunter education graduates' license purchase behavior over a six-year period to estimate hunter recruitment, participation, and license purchasing probabilities in Montana. Using matrix population models, Gude et al. (2012) found that males had greater recruitment rates, retention rates, and license purchasing probabilities than females; the young adult age class (19-30 year olds) had the lowest purchasing probability; and that trends in license sales in Montana were most influenced by middle-aged (31-42 year olds) and baby boomer (43-59 year olds) male license purchase probabilities. Their results suggested that license sales

and hunter participation in Montana could be most greatly influenced by programs focused on increasing recruitment and retention in older age class males.

Several other studies of hunter participation, recruitment, or retention have also made comparisons among age classes (Mehmood et al. 2003; Zinn 2003; United States Department of the Interior 2013). However, there is little consistency in the categorization of age classes among studies, ranging from age classes corresponding to traditional life stages to classes divided into roughly equal segments of years. While categorizing age into segments of roughly equal years (for example, 18-30, 31-40, 41-50, 51-60, over 60) could facilitate more direct comparisons between classes, that methodology may not accurately represent the lifestyles and behaviors characteristically associated with various life stages. Since the author's internship aimed to identify behavior differences among hunter education graduates, it was important to account for important behaviors that could influence hunting participation, such as leaving home for education or military pursuits, establishing careers and families, or retiring, when selecting age classes for analysis.

There are several other demographic factors that have been analyzed in studies of hunter participation and retention, including ethnicity (Mehmood et al. 2003; Zinn 2003; United States Department of the Interior 2013), income (Mehmood et al. 2003; United States Department of the Interior 2013), education (Zinn 2003; United States Department of the Interior 2013), and urbanization (Zinn 2003; Southwick Associates 2013; United States Department of the Interior 2013). The author's research was limited by the available information associated with each hunter education graduate (age, gender, address) but some extrapolations were made based on the graduate's county of residence and associated demographic characteristics.

1.3 Need for New Jersey hunter participation data

When the Southwick Associates (2013) report was released, NJDFW personnel realized they had missed an opportunity to contribute data to a national survey that would generate state-specific information and potentially help identify ways to increase hunter participation. As the author was exploring capstone project ideas that could fulfill an internship experience, NJDFW personnel suggested generating the same analysis for New Jersey as the Southwick Associates (2013) report produced for the twelve participating state wildlife agencies. The Southwick Associates (2013) study therefore served as a blueprint for this internship and many of the resulting tables were modeled after its results. However, in order to also fulfill academic requirements for a Master of Science (M.S.) degree, a more rigorous approach was adopted and additional analysis included statistical modeling, a Geographic Information

System (GIS) component, and inclusion of additional factors that may influence hunter participation rates and license purchasing.

Prior to this internship, NJDFW did not have a comprehensive analysis of the composition of New Jersey hunter education graduates, trends in hunter participation rates, or potential factors that may influence license purchase behavior. The data generated by this internship experience will be helpful in directing future hunter recruitment and retention efforts in New Jersey, which in turn could increase license and permit revenue that will support wildlife conservation programs throughout the state. In addition to financial benefits, maximizing hunter recruitment and retention in New Jersey is important for a variety of other reasons, as well. Ecologically, increasing hunter participation can help control overabundant wildlife populations, balance predator-prey relationships, and maintain forest health. There are also multiple public safety issues in the state related to overabundant wildlife, such as wildlife-vehicle collisions, the spread of Lyme disease and other tick-borne illnesses, and direct conflicts with humans, which may be reduced through increased hunter participation. Furthermore, improving recruitment and retention rates may help reduce property damage caused by overabundant wildlife. Increasing hunter participation in New Jersey will also help expand the constituency of outdoor enthusiasts in the state and foster a greater sense of environmental stewardship in generations of residents to come.

1.4 New Jersey Hunting License and Permit Process

Anyone ten years or older may obtain a hunting license after completing a hunter education course through NJDFW. The hunter education course consists of a free home-study DVD and workbook that are available as an online download via the NJDFW website or can be picked up at specified vendors and NJDFW field offices. Beginning in 2014, hunter education courses are offered in “Bow and Arrow” and “Firearms”; previously, “Firearms” was separated into “Shotgun” and “Rifle/Muzzleloader” courses (NJDFW 2015b). Once students have completed the home-study workbook, or alternatively completed a fee-based online hunter education course that substitutes for completion of the home-study workbook, they are required to attend a field session and pass a written exam. NJDFW offers field sessions and exams in at least one location throughout New Jersey every weekend (excluding holiday weekends) from March through November. For added convenience, sessions are also held on several weekdays throughout the year. Additionally, bow hunters must pass a proficiency requirement with their own equipment by placing at least three out of five arrows in the vital area of a 3-D deer target from 15-20 yards. After students have passed the written exam and completed the field session (and

bow proficiency test if registered for the "Bow and Arrow" class), they are issued a course completion certification from NJDFW. The hunter education certification is a lifetime credential with no expiration date. Graduates can present the course certification to a license agent; graduates of 10 to 15 years of age are issued a free Youth License while those ages 16 and older are eligible to purchase a license. Youth licenses are valid from the time of purchase until the end of the calendar year in which the youth turns 16. Youth hunters between 10 and 13 years old must be accompanied by a licensed adult 21 years or older while hunting (NJDFW 2015b).

In addition to a Bow and Arrow license and a Firearms license, NJDFW also offers a Trapper license for legal use of snares. Anyone 12 years or older who is interested in trapping in New Jersey must pass a Trapper Education course and purchase a trapping license (NJDFW 2015d).

1.5 NJDFW hunting database systems

Beginning in 2006, NJDFW began incorporating the Automated Licensing System (ALS) to track data on individual license purchasers and license types bought. The ALS is a computer-based, point-of-sale software database system that captures information at the time of sale. The 2006 annual license sales data for New Jersey was a combination of paper and electronic records as the ALS system was being phased in. As of 2007, New Jersey license sales tracking efforts have been fully electronic through the ALS. At the time of this analysis, NJDFW license year 2012 was the latest year for which ALS data had been finalized.

In addition, NJDFW maintains records of hunter education graduates using a hunter education database. From 2007 on, anyone who registers for a New Jersey hunter education course online is automatically entered into the hunter education database and assigned a unique customer identification number (CID). The CID can be used to cross-reference license buyers in the ALS system. NJDFW also accepts walk-ins (participants who did not register online) at hunter education courses but these records are not captured by the hunter education database nor manually entered after-the-fact. Their data is only captured by the license vendor at the time of a license purchase. For the purposes of this research, only hunter education graduates who registered online and were therefore added to the hunter education database were included in the author's analysis. Walk-ins account for 43.6% of attendees on average at hunter education classes, with a range from 4% in June to 55% in November (NJDFW, Nate Figley, personal communication).

CHAPTER 2: METHODS

2.1 Obtaining and preparing data

As modeled after the Southwick Associates (2013) study, and similar to Gude et. al (2012), this project tracked the license purchase behavior of hunter education graduates over a six-year period. Southwick Associates (2013) tracked the 2006 hunter education graduates' license sales from 2006-2011. As 2007 was the first complete year for the ALS system in New Jersey, this research tracked the 2007 hunter education graduates' license sales from 2007-2012. Although the six-year study periods are not identical, the author did not think this would inhibit direct comparisons to the results generated by Southwick Associates for the other twelve state wildlife agencies.

Two NJDFW personnel assisted the author with obtaining records from the ALS system and hunter education database. A text file containing all of the records of 2007 hunter education graduates was provided to the author, along with four text files for each year's license sales from 2007-2012, representing Adult, Youth, Non-Resident, and Disabled Veteran transactions.

Before analysis could begin, the data had to be organized into a functional format. Most of the data preparation was conducted in Microsoft Access, along with some intermediate tables generated in Microsoft Excel. The 2007 hunter education database file contained one record for each certificate awarded (total of 5159 records for 2007). Therefore, a single individual with the same CID may have had multiple records in the database if they completed more than one certificate (for example, a person completing Bow and Arrow, Firearms, and Trapping courses in 2007 would contain three records). In order to link each hunter to their customer sales records in the ALS (a one-to-many relationship), multiple records for the same CID in the hunter education database needed to be compressed into a single record. After importing the text file into Microsoft Access, a "Unique Customer ID" table was generated through a query process and then checked for duplicates, resulting in a new table containing 3768 records representing the unique individuals that graduated from a hunter education course in 2007.

The next step in preparing the data for analysis was to assign a hunting discipline to each hunter education graduate record. In 2007, the Firearms certificate was divided into separate Rifle and Shotgun certificates; for this analysis, any 2007 hunter education graduate who completed either a Rifle or a Shotgun course was assigned to the Firearms discipline to reflect current license titles and facilitate future comparisons. NJDFW also offers an All-Around Sportsman license for hunter education graduates

purchasing both a Firearm and Archery license (in addition to a fishing license). The following hunting discipline categories were used for this analysis:

Firearms: Rifle and/or Shotgun

Archery

Trapping

Firearms-Trap: Firearms and Trapping

All-Around: Firearms and Archery

All-Around-Trap: Firearms, Archery, and Trapping

Each 2007 hunter education graduate was assigned to one of the above disciplines to reflect which certificate(s) they completed and therefore which license(s) they were eligible to purchase.

Similarly, the license sales tables for 2007-2012 derived from the ALS also needed to be modified into a different format before conducting analysis. First, all license sales data for a single year (Adult, Youth, Non-Resident, and Disabled Veteran sales tables) needed to be imported into Microsoft Access and appended into a single table. Next, a hunting discipline needed to be assigned to each sale. Each license sale transaction in the ALS was already labeled with a "Privilege Code" that designated the specific type of license sold. For example, privilege code 1 is an All-Around Sportsman license and was therefore assigned to the All-Around discipline; privilege code 210 is a Rifle Permit and was assigned to the Firearms discipline. This process was completed for all New Jersey license sales transactions from 2007-2012 in order to track sales by hunting discipline.

As objectives for this capstone project included analyzing license purchase behavior and trends in relation to factors such as age and area of residency, it was necessary to attach additional information to each hunter education graduate record. The hunter education database included a CID, name, street address, county of residence, gender, and date of birth field for each record. Multiple records were missing county of residence information and needed to be manually provided by looking up zip code locations. The date of birth field was used to calculate age of the hunter education graduate in 2007. Age classes were then created and assigned to reflect typical life stages and model the age classes used by Southwick Associates (2013). Southwick Associates (2013) assigned hunter education graduates into one of four age classes: 10-15 years old; 16-24 years old; 25-35 years old; and 35 and older. For this capstone project, five age classes were assigned: 10-15 years old (representing youth hunters in New Jersey); 16-24 years old (typical age range of college students and/or military personnel with transient lifestyles); 25-35 years old (career- and/or family-focused individuals); 36-55 years old (stable/mid-life lifestyle); and 56 years and older (retirees and/or seniors). In addition, an "Education Number" field

contained a 12-digit number that coded for the facility location, date, and discipline of the hunter education course the customer was enrolled in. By analyzing digits in the Education Number, a field was added to the hunter education database to assign data for the month of the year that the hunter education course was taken. Once the hunter education database and license sales tables were imported into Microsoft Access and appended with additional fields, they were linked via the CID and able to be cross-referenced for analysis.

2.2 Microsoft Access Analysis

2.2.1 Southwick Associates Overall Study

Many of the internship objectives related to identifying license purchase behaviors among different segments of the population were accomplished by creating new tables and running queries in Microsoft Access. As the author was requested to generate data in accordance with the Southwick Associates (2013) study, the first step was to generate queries to mimic their overall study results and append their existing tables to include New Jersey as an additional state in the Northeast region. Queries were designed and run to address the following questions posed by Southwick Associates (2013), with the exception that this research followed the six-year period of 2007-2012 instead of 2006-2011:

-Percentage of graduates who purchased at least a single hunting license from 2007-2012

-Percentage change of 2007 graduates purchasing a hunting license through 2012

-Percent of total sales potential reached from 2007 to 2012, as 100% sales potential for a state defined by every graduate purchasing a license in all six years

-Age class with largest decrease in renewal rates from 2007 to 2012

-Age class with largest percent that never purchased a license from 2007 to 2012

-Month of graduation with highest percent of graduates who did not purchase a license within six years

Once the above queries were run in Microsoft Access and data generated for New Jersey, the "Overall Study Results" tables reported by Southwick Associates (2013) were recreated in Microsoft Excel to include New Jersey and new study averages were calculated.

2.2.2 Individual State Analysis for New Jersey

Southwick Associates (2013) also conducted more detailed analysis for each of the individual states participating in the study. The author created additional queries and tables for New Jersey to simulate the following 2007 data generated for each state:

-Hunter education graduates who purchased a license, by year

-License purchase frequency by hunter education graduates following certification

-Hunter education graduates, by age class

-License purchase frequency by hunter education graduates following certification, by age class

-Change in the percent of hunter education graduates who bought licenses from 2007 to 2012, by age class

-Hunter education graduates by month of course completion

Once the above queries were run in Microsoft Access and data generated for New Jersey, the "Individual State Results" tables and figures reported by Southwick Associates (2013) were reproduced in Microsoft Excel to display New Jersey's results.

As objectives for this internship included exploring a variety of factors that may affect license purchase behavior, additional queries and tables were generated beyond the Southwick Associates (2013) analysis to help identify recruitment and retention issues. The author designed the following queries for the New Jersey 2007 graduate class that were not included in the Southwick Associates (2013) analysis:

-Percentage of graduates who purchased at least a single hunting license from 2007 to 2012, by county of residence

-Percentage of graduates who purchased at least a single hunting license from 2007 to 2012, by age class

-Percentage of graduates who purchased at least a single hunting license from 2007 to 2012, by gender

-Hunter education graduates, by gender

-Hunter education graduates, by age class and gender

-License purchase frequency by hunter education graduates following certification, by gender

-Change in the percent of hunter education graduates who bought licenses from 2007 to 2012, by gender

-Hunter education graduates who purchased a license, by year and hunting discipline

Once the above queries were run in Microsoft Access and data generated for New Jersey, associated tables and figures were created in Microsoft Excel to display New Jersey's results. The above queries were intended to help shed light on how factors such as age class, gender, month of hunter education graduation, and hunting discipline may influence license purchase behavior. Once the queries were designed, data for other years could easily be input to provide an up-to-date analysis of current behaviors and trends.

2.3 GIS Analysis

In order to help identify further trends in license purchase behavior among different segments of the population, the author incorporated a GIS component into the capstone research to explore a selection of geographic and demographic factors. As the results of this capstone internship were intended to help drive hunter recruitment and retention efforts for a state agency, only New Jersey residents were considered in the geographic analysis. Therefore, records of graduates that did not reside in New Jersey were eliminated from the hunter education graduate database for this portion of the analysis. There were a total of 72 out-of-state hunter education graduates from Pennsylvania (30), New York (29), Delaware (1), Massachusetts (2), Maryland (2), Virginia (2), Florida (4), and Colorado (2). Once these records were deleted, the resulting table was imported into ArcMap 10.2. The records were then geocoded by both zip code and street address using the World Geocode Service (ArcGIS Online) Address Locator and saved as separate layers.

To determine if proximity to public hunting lands may contribute to license purchasing behavior, the distance of each graduate's residence to the nearest public hunting land needed to be calculated. However, a GIS layer of public hunting lands in New Jersey needed to be created since one did not previously exist. First, a listing of public deer hunting lands in New Jersey was obtained from the most recent edition (August 2014) of NJDFW's "Hunting and Trapping Digest". Next, all listed tracts of hunting land were selected from existing GIS layers of federal-owned and state-owned land in New Jersey and combined to create a single GIS layer of public deer hunting lands. There were additional county-owned lands that were open to hunting in New Jersey but as each county park system maintains their own map of available hunting lands, it was beyond the scope of this internship to try to include those areas as well. In addition, in some cases only special areas of federal-owned or state-owned lands were open to public hunting but the entire tract was included since delineated boundaries of those areas within the tracts were not currently available through GIS.

Once the GIS layer of public hunting lands was created, the "Near" geo-processing tool in ArcMap 10.2 was utilized to determine the straight-line distance from each hunter education graduate's house to the nearest public hunting land. Although the straight-line distance underestimated the actual travel distance by road, the author felt it still provided a useful estimate of proximity for the purposes of this analysis. Categories were then created to represent distances to public hunting lands (0-5 miles, 5-10 miles, 10-15 miles, and 15-22 miles) and each hunter education graduate was assigned into one of the categories. Microsoft Access was then used to create and run queries to determine the percent of graduates that bought a license in 2007 and the change in percent of 2007 hunter education graduates who bought licenses from 2007 to 2012 by proximity to public hunting lands, as was previously completed for age class and gender.

The next step in the GIS analysis was to explore whether demographics may influence license purchasing behavior. The 2010 census data for New Jersey was downloaded from the United States Census Bureau's website (U.S. Census Bureau 2015), imported into ArcMap 10.2, and linked to the hunter education graduate table using the zip code field. One record was eliminated from this analysis because the census data fields were blank. In addition, 23 records had to be manually linked because the zip code fields between the two tables did not match. To investigate whether ethnicity may influence license purchases, the census data fields "DP0080001: Total" and "DP0080003: White" which provided the total population and the number of white residents per zip code, respectively, were selected. Categories were then created to represent the "% White" population for each zip code (0-20%, 20-40%, 40-60%, 60-80%, and 80-100%) and assigned to each hunter education graduate. Microsoft Access was then used to create and run queries to determine the percent of graduates that bought a license in 2007, the change in percent of 2007 hunter education graduates who bought licenses from 2007 to 2012, and the population of New Jersey broken down by the "% White" categories for comparison to the composition of hunters.

The author also wanted to consider income as a potential factor affecting license purchase behavior. The U.S. Census Bureau data for New Jersey did not include income information but did provide data on housing tenure. The author decided to use the field "DP0220001: Population in owner-occupied housing units" as a way of representing income under the assumption that higher rates of owner-occupied housing (versus renter-occupied) translated to higher income. Categories were created to represent the "% Owner-Occupied" for each zip code (0-20%, 20-40%, 40-60%, 60-80%, and 80-100%) and assigned to each hunter education graduate. Microsoft Access was then used to create and run queries to determine the percent of graduates that bought a license in 2007, the change in percent of

2007 hunter education graduates who bought licenses from 2007 to 2012, and the population of New Jersey broken down by the "% Owner-Occupied" categories for comparison to the composition of hunters.

The final element in the GIS analysis was to investigate whether the level of urbanization of a graduate's residence affected license purchasing. In order to classify urbanization levels, the 2012 Land Use/Land Cover (LULC) GIS data set was obtained through the New Jersey Department of Environmental Protection. The LULC layer was produced by visually interpreting color infrared photography captured in the spring of 2012 and then classifying the images into various land use/land cover categories, such as agriculture, barren land, forest, urban, water, or wetlands (New Jersey Department of Environmental Protection 2015). Once the 2012 LULC was brought into ArcMap 10.2, all of the polygons labeled as "urban" were selected from the data set and saved as a separate GIS layer. The polygons were then dissolved to facilitate further geo-processing actions. Next, the dissolved urban LULC 2012 layer was intersected with the 2010 Census Bureau zip code layer. The "Calculate Geometry" function was then used to determine the sum of acres in each urban LULC polygon and each zip code. The urbanization level was then calculated by determining the percent of each zip code's total acreage labeled as urban (Figure 1). Finally, the "Join Field" tool was used to link the Census Bureau layer containing the new "percent urban" field to the hunter education graduate table via the zip code field (Figure 2). There were 24 records that needed to be manually linked because the zip codes did not match between the two files. Categories were then created and assigned to each hunter education graduate to represent the "% Urban" of their resident zip code (0-20%, 20-40%, 40-60%, 60-80%, and 80-100%). Microsoft Access was then used to create and run queries to determine the percent of graduates that bought a license in 2007 and the change in percent of 2007 hunter education graduates who bought licenses from 2007 to 2012 by the "% Urban" categories.

2.4 Statistical Modeling

The third component in the data analysis was to employ statistical modeling to identify which factors have greater influence on hunting license sales. All statistical analysis was performed pro bono by graduate student consultants from Statistics in the Community (StatCom) at the University of Illinois at Urbana-Champaign. An Excel file containing a record for each hunter education graduate with fields for CID, county of residence, gender, hunting discipline, age class, and license purchase data for 2007 through 2012 was provided to StatCom. Similar to Gude et al. (2012), mark-recapture data formatting was used in which a graduate was coded as 1 if at least one hunting license was purchased in a given

year and 0 if no hunting licenses were purchased (Williams et al. 2002). Personal data (name, address, and date of birth) were removed from the file before sending to StatCom to maintain confidentiality of graduates.

The statistical modeling was performed to investigate how gender, age class, and hunting discipline influenced hunter purchase probability, hunter retention probability, and hunter recruitment probability. For this analysis, if a graduate bought a license in a certain year, they were counted as a "hunter purchase" case once; if up to *w* licenses were purchased by a graduate from 2007 to 2012, they were then counted *w* times. A "hunter retention" case was defined as a graduate who bought a license in two successive years (1→1) and a "hunter recruitment" case defined as a graduate who went from not purchasing a license in a given year to purchasing at least one the following year (0→1) (StatCom, personal communication).

The main statistical analysis tool used for this project was RStudio, although SAS was also used to process data. Generalized linear models (GLMs) were used, which extend traditional linear regression by allowing for non-normal and discrete response distributions. The event whether a graduate would buy a license was a binary variable (0 or 1) following a binomial distribution with parameter *p*, representing purchase probability, retention probability, or recruitment probability. The odds of buying a license was represented by $\vartheta = p/(1-p)$, which is the ratio of the probability of buying a license (p) over the probability of not buying a license ($1-p$). Accordingly, as ϑ increases, the probability of purchasing a license increases. As is typical with GLMs, it was assumed that *logit (p) = log (p/1-p)* was a linear combination of predictors such as gender, age class, and discipline:

$$logit\ (p) = log\ (p/1-p) = \beta_0 + \beta_1 year + \beta_2 gender + \beta_3 ageclass + \beta_4 discipline + \ldots + \varepsilon$$

The response is therefore no longer whether to purchase a license but the log odds of purchasing a license (StatCom, personal communication).

2.4.1 Transition Model Analysis

A transition model code was developed and run in RStudio to explore the effects of various factors on hunting license purchase probability, hunter retention probability, and hunter recruitment probability. As its name implies, a transition model is a special generalized linear model that explains correlation by allowing past values to influence subsequent observations (Appendix B). Logistic regression and mixed linear regression were unsuitable for this study as they ignore the potential correlation among responses of the same graduate and previous license purchases, respectively. Twelve

transition models were fitted to describe the influence of gender, age class, and hunting discipline, as well as their combined effect, on each of the probabilities listed above (4 predictors x 3 responses).

Before running the models, baseline predictors had to be selected since the model results indicate the odds of a probability being higher or lower than the baseline. For the transition models used in this research, the baseline predictors were defined as males, the 25-35 age class, and the Archery hunting discipline. For each model, the coefficient of factor(s) and odds of probability were determined. A negative coefficient value indicated that the odds of the predictor decreased compared to the baseline. For example, a coefficient of "-0.68594" for the purchase probability of the gender female meant that the odds of females purchasing a hunting license decreased in comparison to the baseline gender of males. More specifically, the baseline predictor could be interpreted as exponential (-0.68594) = 0.503; the odds of purchase probability reduced 49.7% and therefore the purchase probability for females was 49.7% less than males for the particular model (StatCom, personal communication).

2.4.2 Association Model Analysis

An association analysis using a one-way ANOVA model was conducted to further explore factors influencing hunter recruitment and retention (Appendix B). Using descriptive statistics analysis and the transition information generated in RStudio, charts were created that displayed age class, discipline, and gender as predictors for recruitment and retention probability. In addition, Tukey's multiple comparisons of means were conducted for recruitment and retention using age class and discipline with a 95% family-wise confidence level in order to compare means of predictors (Appendix B).

CHAPTER 3: RESULTS

3.1 Microsoft Access Analysis

3.1.1 Southwick Associates Overall Study

The addition of New Jersey to the Southwick Associates (2013) results raised the average percent of hunter education graduates from all 13 states that purchased at least one hunting license over the six-year study period from 67.7% to 69.4%. New Jersey had the highest percent of graduates (89.3%) who purchased at least one license in the six possible years while Virginia had the lowest (43.0%) (Table 1).

Twelve of the 13 study states showed a loss of graduates purchasing a license at the end of six years, with an overall study average of a 35.3% decline (Table 2). In New Jersey, 45.2% of 2007 hunter education graduates had stopped purchasing a license by 2012. Given that only 89.3% of New Jersey graduates bought at least one license within six years of graduation and a 45.2% decrease was experienced among this group, only 49% of New Jersey graduates were buying licenses by 2012. Although New Jersey's rate is slightly higher than the Southwick Associates (2013) overall study average of 45%, it still indicates a significant retention issue within the state.

The average total sales potential reached across all 13 states was 43.0% (Table 3). The results reported for the original 12 states were "adjusted to account for years when younger graduates were not required to have a license to hunt, and only include years when graduates were of age when a license is required" (Southwick Associates 2013, p. 4). New Jersey reached 54.1% of its total sales potential between 2007 and 2012 (Table 4). Although youth hunters in New Jersey do not have to renew their license until the end of the year in which they turn 16, they still have the potential to buy a rifle permit every year and were therefore included in this analysis.

For most of the participating states, the younger age classes were more likely to drop out of the hunting population over the six-year study period (Table 5). Eight of the 13 states had the largest decrease in renewal rates among 16-24 year olds. Two states showed the highest decrease among 25-35 year olds while two other states' highest decreases were among 10-15 year olds, including New Jersey with a 58.8% decrease. As stated above however, New Jersey youth hunters are not required to renew their license every year unless they are purchasing a separate rifle permit.[1]

[1] Washington was unable to provide date of birth information for the Southwick Associates (2013) study and was therefore not included in this calculation.

As with the decrease in renewal rates discussed above, the younger age classes were more likely to have never purchased a license over the six-year study period. Of the 12 states that provided date of birth information, five had the highest percentage of never purchasing a license among 16-24 year olds, three states were in the 10-15 age class, and two were in the 25-35 age class (Table 6). New Jersey joined Vermont as the only two states that experienced the largest percent who never purchased a license in the 35 and older age range; for the purposes of inclusion in the overall study results, the 35 and older age class data reported for New Jersey was the total of the 36-55 and 56 and older age classes.

Spring and summer hunter education graduates were less likely to purchase a license within six years (Table 7). Nine of the 12 states providing necessary data had the highest percent of graduates who did not purchase a license occurring between March and June. In New Jersey, April was the month of graduation from a hunter education class that showed the lowest license purchase rates. Only three states showed lower license purchasing rates among the fall/winter hunter education graduates.

3.1.2 Individual State Analysis for New Jersey

The 2007 hunter education class in New Jersey consisted of a total of 3768 graduates. Within the six-year study period, the year that held the highest percentage of graduates purchasing a license was in 2007 with 80.4% (Table 8, Figure 3). In each of the subsequent five years, a percentage of 2007 graduates would not renew their license. The largest year-to-year decrease occurred between 2007 and 2008 with a 31.8% decline in hunters purchasing a license. In total, over the course of the six years, the number of graduates who continued to purchase a license decreased 45.2%. This points to a significant hunter retention issue as nearly half of the graduates were not purchasing a hunting license within six years of completing a hunter education course.

Most New Jersey graduates did not buy a license each year. In fact, only 26.9% bought a license in all six years after graduating (Table 9, Figure 4). From the hunter education class of 2007, 89.3% purchased at least one license during the six year period from 2007 through 2012, a higher rate than any of the 12 states from the Southwick Associates (2013) study. Of those who did purchase a license in New Jersey, nearly a third of them (30.1%) purchased all six years. This rate was higher than graduates who purchased a license at least once but less than six years over the same period.

The percentage of graduates who purchased at least a single hunting license from 2007 to 2012 was also calculated by county of residence in New Jersey and by out-of-state residence. Of the 3768 hunter education graduates in 2007, 3696 were New Jersey residents at the time. On average, 90.0% of

the in-state residents purchased at least one hunting license in the six year study period (Table 10). The percentage for the 21 counties in New Jersey ranged from 74.8% in Bergen County to 95.1% in Cumberland County. The three lowest ranking counties (Bergen, Union, and Hudson) are all located in northeastern New Jersey in a heavily urbanized area close to New York City. These three counties combined also contain less than 1% of the state-owned open space.

There were 72 graduates with out-of-state addresses from eight different states, ranging north to New York and Massachusetts, south to Florida, and west to Colorado. The average percent of out-of-state graduates who purchased at least a single hunting license was 52.8% (Table 11), indicating a clear (and expected) decrease in license purchasing as compared to in-state residents.

The percentage of New Jersey hunter education graduates who purchased at least a single license from 2007-2012 was also examined by age class and gender. There were only slight differences among the age categories, with the 36 to 55 age class showing the lowest rate of purchase at 86.6% and the 10 to 15 age class showing the highest rate at 93.0% (Table 12). Similarly, there was little variation among the rates between gender classes, with 90.0% of males purchasing at least a single license versus 83.0% of females (Table 13).

Southwick Associates (2013) classified each state's hunter education graduates by age class. For New Jersey, the author calculated that the 10 to 15 year old age class represented the largest portion of 2007 graduates, with 1232 graduates or 32.7% (Table 14). This finding is consistent with 11 of the 12 states that provided age data to Southwick Associates. The lowest percentage of New Jersey graduates (3.9%) was comprised of the 56 and older age class, with an average of 61.2 years for that age range. The author also calculated the same data for New Jersey by gender, with 90.8% of graduates identified as male and 9.2% as female (Table 15). Although a majority of male graduates was expected, the magnitude of the difference between genders was surprising and indicates a serious recruitment issue with women. When the 2007 New Jersey hunter education graduate class was broken down by both age and gender, the 10 to 15 age range still represented the largest portion of graduates for both genders, followed by the 36 to 55 age class (Table 16, Figure 5). For both males and females, the 56 and older age class had the lowest proportion of graduates.

When license purchase frequency is examined by age class, most graduates purchased a license between three and six years (Table 17). Only the 10 to 15 age class had the highest percentage of graduates purchasing one or two years, but youth licenses in New Jersey are valid from the time of purchase until the end of the calendar year in which the youth turns 16. Therefore, they may only need to purchase a license one time within the six year period depending on their initial age. Youth hunters

were included in the analysis though because they have the potential to purchase a rifle hunting permit each year. Otherwise, there was little variation to license purchase frequency among the different age classes.

License purchase frequency by gender showed a greater amount of variation. Males had the highest percentage of graduates purchasing licenses between three and six years (58.2%) while females had the highest percentage purchasing only one to two years (47.6%), indicating a retention issue with female hunters (Table 18). Females also showed a higher percentage of graduates never purchasing a license (17.0%) as compared to males (10.1%). Among all of the graduates, 10.7% never purchased a license, 33.2% purchased a license one to two years, and 56.1% purchased between three and six years.

The rate at which graduates continued to purchase a hunting license varied from a 31.5% decline in the 36 to 55 age class to a 58.8% decline in the 10 to 15 age class (Table 19, Figure 6). Again, youth hunters are not required to purchase a license every year until they reach the end of the calendar year in which they turn 16. Omitting the youth hunters, the age class with the largest decline in license purchases was 16 to 24 year olds representing a 46.1% decrease from 2007 to 2012. This could potentially be explained by graduates in that age range going away to college or pursuing military positions or careers out of state. Overall, 1368 graduates that purchased a license in 2007 were not purchasing a license by 2012, representing a 45.2% decline. Therefore, nearly half of the graduates dropped out of the hunting population by the end of six years.

As with license purchase frequency discussed above, the change in percent of 2007 graduates who bought licenses through 2012 showed a greater amount of variation by gender. At the end of six years, 43.0% of male hunters had stopped purchasing a license versus 68.1% of females (Table 20), highlighting a major retention issue among women.

The change in percent of graduates who bought licenses from 2007 to 2012 was also examined by hunting discipline. Trapping showed the greatest decline in hunters, with a 71.4% loss of graduates purchasing a license at the end of the six year study period (Table 21, Figures 7 and 8). Firearms showed a 62.4% decline while archery had a 61.8% decline. Both Archery and Firearms lost the greatest percentage of graduates in 2008 (32.0% decline from 2007 for Archery and 38.1% decline from 2007 for Firearms), the second year that graduates would be eligible to purchase a license. Trapping lost the greatest percentage of graduates in 2009 (31.6%).

The month with the highest rate of graduation for New Jersey's hunter education course was November with 747 graduates, or 19.8% (Table 22, Figures 9 and 10). Nearly 70% of graduates completed the hunter education course between August and November. July had the lowest enrollment

for hunter education classes, with only 29 graduates or 0.77% of the 2007 class. Spring graduates (March through June) tended to be slightly older than summer or fall graduates (July through November). Graduates who never purchased a license were more likely to graduate in the spring and early summer months (March through July).

3.2 GIS Analysis

The GIS analysis studied the 3696 in-state graduates from the 2007 hunter education class and did not include the 72 out-of-state graduates. Nearly three-quarters (72.0%) of the 2007 hunter education graduates lived within five miles of federal- or state-owned public hunting land (Table 23). Proximity to public hunting land did not seem to be a factor in license renewal rates since further distance did not equate to higher dropout rates at the end of the six years. The highest dropout rate (a 52.2% decline from 2007-2012) was seen in graduates living 10-15 miles from public hunting land (Figure 11). Although graduates living 0-5 miles from public hunting lands had the lowest decline in license purchases over the six years (43.9%), there was not a wide range of variation across the distance categories. However, proximity to public hunting lands may have more of an impact on whether graduates initially purchase a license in their first eligible year. Of the graduates living within 5 miles of public hunting lands, 83.1% bought a license in 2007 compared to 68.2% of graduates living 15-22 miles away (Figure 12).

Compared to the entire New Jersey population, a disproportionate number of 2007 hunter education graduates lived in zip codes that were predominately of white ethnicity. Nearly 94% of the 2007 hunter education graduates lived in zip codes that were 60-80% or 80-100% white as compared to only 70.9% of the New Jersey population (Table 24). There was no clear correlation between the "% White" classification and license renewal rates. Graduates living in zip codes that were 0-20% white showed the largest decline in renewal rates, with a 71.4% decline after six years (Figure 13). However, the decline was a loss of only 5 hunters. Graduates living in zip codes that were classified as 80-100% white showed a 45.3% decline in renewal rates, or a loss of 941 hunters by 2012. There was also no clear pattern between the "% White" categories and whether graduates initially purchased a license in 2007. The range across all categories in the rate of graduates who bought a license in 2007 was 72.9% (20-40% white) to 87.5% (0-20% white).

Similarly, a disproportionate number of 2007 hunter education graduates lived in zip codes that were dominated by owner-occupied dwellings. Over 91% of 2007 hunter education graduates lived in zip codes that were 60-80% or 80-100% owner-occupied housing as compared to only 69.5% of the New

Jersey population (Table 25). Graduates living in predominately owner-occupied housing zip codes showed slightly higher initial license purchase rates and lower dropout rates than those in zip codes with 0-20% or 20-40% owner-occupied housing (Figure 13).

Hunters that lived in zip codes classified as 0-20% urban made up the highest percentage (28.2%) of the 2007 hunter education graduating class (Table 26). There did not appear to be a relationship between the level of urbanization of a graduate's resident zip code and license renewal rates. The range in the change of percent of graduates purchasing a license from 2007 to 2012 across all urbanization levels was a 47.8% decrease to a 42.8% decrease, or only a difference of 5% (Figure 13). Graduates living in less urbanized zip codes did show higher percentage rates of initially purchasing a license in 2007 than those in more urbanized areas.

3.3 Statistical Modeling

3.3.1 Transition Model Analysis

Four models were fitted to explore the effects of various predictors on purchase probability, with year and previous purchase values remaining constant. When compared to the baseline male gender, the odds of purchase probability for females decreased by exp (-0.68594) = 0.503 times, or a significant 49.7% reduction (Table 27). When compared to the baseline hunting discipline of Archery, three of the other disciplines produced significant results (Table 28). The coefficient for the All-Around discipline was -0.13559; therefore, the odds of purchase probability for the All-Around discipline decreased by exp (-0.13559) = 0.837 times, or a 12.7% reduction. Similarly, the odds of purchase probability for the Firearms discipline decreased by exp (-0.3844) = 0.681 times, or a 31.9% reduction. Trapping significantly increased purchase probability, as shown by the odds of purchase probability increasing by exp (1.05230) = 1.112, or an 11.2% growth. The changes of odds of purchase probability for All-Around-Trap and Firearms-Trap were not significant. When compared to the baseline age class of 25 to 35 year olds, the 36 to 55 year old age class increased purchase probability the most and the 10 to 15 year old age class significantly decreased purchase probability the most (Table 29). The coefficient of "ageclass10to15" was -0.93483; therefore, the odds of purchase probability for the 10 to 15 year old age class decreased by exp (-0.93483) = 0.393, or a significant 60.7% reduction. However, as noted before, youth hunters only have to purchase a license one time before the end of the calendar year in which they turn 16. The odds of purchase probability for the 36 to 55 year old age class was exp (0.15787) =1.171, or a 17.1% growth. The change of odds of purchase probability for the 56 and older age class was not significant. When gender, age class, and hunting discipline were simultaneously considered in

the transition model for purchase probability, the 36 to 55 age class with Trapping increased purchase probability the most and females with the 10 to 15 age class and Firearms significantly decreased purchase probability the most (Table 30). The 16 to 24 age class also showed a significant reduction in the odds of purchase probability as compared to the baseline. The changes of odds of purchase probability for all other age classes and disciplines were not significant. The results of the fourth model for purchase probability (combined predictors) are plotted in Figure 14.

Similarly, four models were fitted to explore the effects of the predictors on retention probability, with year remaining constant. When compared to the baseline male gender, the odds of retention probability for females decreased by exp (-0.69676) = 0.498 times, or a significant 50.2% reduction (Table 31). When compared to the baseline hunting discipline of Archery, three of the other disciplines again produced significant results (Table 32). The coefficient for the All-Around discipline was -0.20840; therefore, the odds of retention probability for All-Around decreased by exp (-0.20840) = 0.812 times, or an 18.8% reduction. Similarly, the odds of retention probability for the Firearms discipline decreased by exp (-0.41901) = 0.658 times, or a 34.2% reduction. Trapping significantly increased retention probability, as shown by the odds of retention probability increasing by exp (1.43589) = 4.203, or a 320.3% growth. The changes of odds of retention probability for All-Around-Trap and Firearms-Trap were not significant. When compared to the baseline age class of 25 to 35 year olds, the 36 to 55 year old age class increased retention probability the most and the 10 to 15 year old age class significantly decreased retention probability the most (Table 33). The coefficient of "ageclass10to15" was -1.60958; therefore, the odds of purchase probability for the 10 to 15 year old age class decreased by exp (-1.60958) = 0.120, or a significant 88.0% reduction. However, as noted before, youth hunters only have to purchase a license one time before the end of the calendar year in which they turn 16; therefore, a youth hunter who does not purchase a license every year does not necessarily represent a retention case. The 16 to 24 age class also showed a significant reduction in the odds of retention probability as compared to the baseline. The odds of retention probability for the 36 to 55 year old age class was exp (0.28015) =1.323, or a 32.3% growth. The change of odds of retention probability for the 56 and older age class was not significant. When gender, age class, and hunting discipline were simultaneously considered in the transition model for retention probability, the 36 to 55 age class with Trapping increased retention probability the most and females with the 10 to 15 age class and Firearms significantly decreased retention probability the most (Table 34). The 16 to 24 age class also showed a significant reduction in the odds of retention probability as compared to the baseline. The changes of odds of purchase probability for all other age classes and disciplines were not significant.

The results of the fourth model for retention probability (combined predictors) are plotted in Figure 15. Figure 15 also shows that purchase probability was tightly correlated with purchasing a license the previous year.

Additionally, four models were fitted to explore the effects of the predictors on recruitment probability, with year and previous purchase values remaining constant. When compared to the baseline male gender, the odds of recruitment probability for females decreased by exp (-0.62629) = 0.534 times, or a significant 46.6% reduction (Table 35). When compared to the baseline hunting discipline of Archery, one of the other disciplines produced significant results (Table 36). The coefficient for the Firearms discipline was -0.33811; therefore, the odds of recruitment probability for Firearms decreased by exp (-0.33811) = 0.713 times, or a 28.7% reduction. The changes of odds of retention probability for All-Around, All-Around-Trap, Firearms-Trap, and Trapping were not significant. When compared to the baseline age class of 25 to 35 year olds, none of the other age classes produced significant results (Table 37). Therefore, none of the age classes would significantly increase or decrease the recruitment probability over the 25 to 35 year old age class. When gender, age class, and hunting discipline were simultaneously considered in the transition model for recruitment probability, females with the Firearms discipline significantly decreased recruitment probability (Table 38). The changes of odds of recruitment probability for all age classes and other disciplines were not significant. The results of the fourth model for recruitment probability (combined predictors) are plotted in Figure 16.

3.3.2 Association Model Analysis

Among both males and females, graduates in the 10 to 15 age class comprised the largest group recruited into the hunting population (Figure 17), with recruitment defined as going from a status of not purchasing a license in one year to purchasing a license the next year (0→1). Graduates in the 56 and older age class had the lowest amount of recruits. Examining gender alone, males were much more likely to be recruited than females (Figure 18). When looking at the influence of hunting discipline on recruitment, the Firearms discipline had the greatest amount of graduates in recruitment status (Figure 19). However, Tukey's multiple comparisons of means for hunting discipline on recruitment status showed that the Firearms discipline was significantly less likely to enter recruitment status than the All-Around, Archery, and Trapping disciplines using a 95% family-wise confidence level (p-value ≤ 0.05) (Table 39). Although the 10 to 15 age class comprised the largest group of recruits (Figure 20), the only significant difference among age classes was that the 36 to 55 age class was less likely to enter

recruitment status than the 10 to 15 age class (Table 40). All other age class comparisons were not significant.

Results of the influence of gender and age class on retention status showed that both males and females in the 36 to 55 age class were most likely to enter retention status, with retention defined as purchasing a license in two consecutive years (1→1) (Figure 21). Examining gender alone, males were much more likely to be in retention status than females (Figure 22). When looking at the influence of hunting discipline on retention, the Firearms discipline had the greatest amount of graduates in retention status (Figure 23). However, Tukey's multiple comparisons of means for hunting discipline on retention status showed that the Firearms discipline was significantly less likely to enter retention status than the All-Around, Archery, and Trapping disciplines using a 95% family-wise confidence level (p-value ≤ 0.05) (Table 41). Additionally, Trapping was also more likely to enter retention status than the All-Around and Archery disciplines. As noted above, 36 to 55 year olds comprised the age class with the greatest retention (Figure 24) while 10 to 15 year olds had the lowest. Tukey's multiple comparisons of means for age class on retention status showed that the 10 to 15 age class was significantly less likely to enter retention status than all other age classes (Table 42). However, since youth hunting licenses remain valid until the end of the calendar year in which the hunter turns 16, they are not required to purchase a license every year. Even if a youth hunter does not purchase a license in two consecutive years, they may still be an active member of the hunting population and therefore do not conform to the same retention definition as the other age classes. Tukey's multiple comparisons of means also showed that 16 to 24 year olds were significantly less likely to enter retention status than graduates in the 25 to 35, 36 to 55, and 56 and older age classes. Additionally, the 25 to 35 age class was significantly less likely to be of retention status than the 36 to 55 age class.

CHAPTER 4: DISCUSSION

As noted in Gude et al. (2012), declining trends in hunter participation nationwide have been documented in recent publications (Enck et al. 2000, Peterson 2004). Although New Jersey ranked above all of the states that participated in the Southwick Associates (2013) study for the percentage of graduates who purchased at least a single hunting license within six years of completing a hunter education course (Table 1), there is ample evidence to suggest a need for improving hunter recruitment and retention efforts in the state. For example, by the end of the six-year study period, New Jersey had lost nearly half of the graduates who had purchased a license in 2007 (Table 2) and achieved only 54.1% of its total sales potential (Table 4).

The results indicate that efforts designed to have the greatest impact on license sales in New Jersey should be focused on males. Males had higher purchase probabilities (Table 27), greater retention rates (Table 31, Figure 22), and were more likely to be recruited into the hunting population than females (Table 35, Figure 18). As males comprised nearly 91% of the 2007 hunter education graduate class (Table 15), smaller changes in male parameters would have larger absolute impacts on hunter participation than correspondingly larger changes in female parameters (Gude et al. 2012).

Interpretation of results related to age class trends must be made with caution. Although the 10-15 age class was shown to decrease purchase probability the most (Table 29), was the least likely to be retained (Table 33), and showed the largest decrease in renewal rates (Table 19), it must be noted that youth licenses are valid from the time of purchase until the end of the calendar year in which the youth turns 16. Therefore, they are not required to purchase a license every year to remain in retention status, leading to difficulty in drawing direct comparisons to the other age classes. Further study that includes tracking youth graduates' license purchases after they have turned 16 could help identify any changes in trends once hunters are required to purchase a license annually. However, youth hunters in possession of a rifle while hunting or trapping must purchase a rifle permit annually and were therefore included in the analysis as having the potential to purchase a license yearly. Although the 36-55 age class contained the largest percentage of graduates that never purchased a license within the six-year study period (Table 17), statistical analysis showed that they were most likely to increase purchase probability (Table 29) and most likely to be retained (Table 33, Figure 24). Therefore, it may be beneficial to focus intervention efforts on the 36-55 age class to have the greatest impact on license sales. Although reasons for declines in age classes can only be speculated in the absence of follow-up surveys, hunters in the 16-24 age class are likely more transient as they enroll in college, join the military, or engage in other pursuits after high school. NJDFW currently has no way of tracking whether

graduates move out of state unless they are directly notified. Similarly, graduates in the 56 and older age class may find that although they have more free time after retirement, a potential loss of steady income and/or health issues brought on by progressing age may impede participation in hunting.

Statistical analysis indicated that the Firearms discipline would decrease purchase probability the most (Table 28), was the least likely to be recruited (Tables 36 and 39), and least likely to be retained (Tables 32 and 41). However, as with the trends in gender noted above, the Firearms discipline contained the largest number of graduates and therefore smaller changes would likely lead to larger impacts on hunter participation than correspondingly larger changes in other hunting disciplines. Although Trapping showed the largest decline in renewal rates (Table 21), the percent change in license purchases from 2007 to 2012 was similar across all disciplines. Additionally, statistical results indicated that Trapping would increase purchase probability the most (Table 28) and was the discipline most likely to enter retention status (Table 32). Ethical trapping requires an in-depth knowledge of equipment and animal behavior and is a traditional pastime for many families. For these reasons, trappers may be more likely to renew licenses once initially devoting efforts to learning the trade.

Proximity to public hunting lands did not seem to be a factor for hunter retention, as the decline in renewal rates was relatively consistent across all of the distance categories (Table 23, Figure 11). However, results did indicate that graduates that lived farthest from public hunting lands were least likely to initially purchase a license in 2007. As nearly two-thirds of the graduates lived within 0-5 miles of public hunting lands, access to places to hunt does not seem to be an issue for most graduates. However, for the small percentage of graduates that live 15-22 miles away from federal- or state-owned hunting lands, the distance may be enough of a deterrent to recruiting new hunters.

Similarly, urbanization level did not seem to be a factor for hunter retention, as the decline in renewal rates was relatively consistent across all of the urbanization levels (Table 26, Figure 13). However, similar to the trend noted above, graduates that lived in more heavily urbanized zip codes were less likely to initially purchase a license in 2007. Additionally, hunters living in zip codes classified as 0-20% urban comprised the largest group of graduates, indicating that New Jersey's hunting population tends to live in more rural areas that are in close proximity to hunting lands. The three counties that had the lowest percentage of graduates purchasing at least a single hunting license from 2007 to 2012 (Table 10) are heavily urbanized counties in close proximity to New York City. These three counties combined contain less than 1% of New Jersey's state-owned open space.

As noted in the Results section, a disproportionate number of 2007 hunter education graduates lived in zip codes that were dominated by owner-occupied dwellings as compared to the New Jersey

population at large (Table 25). Additionally, graduates living in predominately owner-occupied housing zip codes showed slightly higher initial license purchase rates and lower dropout rates than those in zip codes with 0-20% or 20-40% owner-occupied housing (Figure 13). By loosely associating home ownership with higher incomes, results indicate that New Jersey's 2007 hunter education class is largely comprised of higher income residents that are more likely to have extraneous income to purchase hunting equipment and annual licenses. These results are consistent with Southwick Associates (2013), which also reported that graduates living in urban centers dominated by apartments had the highest percent decrease in renewal rates in the majority of study states. Aside from representing income, home ownership may be more amenable to hunting as it likely offers more storage space for hunting stands, gun safes, and other hunting equipment. In addition, renters may be more wary to store guns or butcher harvested game in a communal setting.

There were no clear trends between ethnicity, license renewal rates, and initial purchase behavior. Although graduates living in zip codes that were 0-20% white showed the largest decline in renewal rates, they only constituted 0.2% of the 2007 hunter education class (Table 24). Similar to housing status discussed above, a disproportionate number of 2007 hunter education graduates lived in zip codes that were predominately of white ethnicity as compared to the New Jersey population at large. Nearly 94% of the 2007 hunter education graduates lived in zip codes that were 60-80% or 80-100% white as compared to only 70.9% of the New Jersey population (Table 24). It is important to note that the results generated in this analysis for "% Owner-Occupied" and "% White" queries were based on U.S. Census Bureau data at the zip code level; specific data for these factors were not associated with each hunter education graduate and therefore each graduate was assigned data based on the characteristics of their zip code of residency.

Nearly 70% of graduates completed a hunter education course between August and November. Graduates who never purchased a license were more likely to graduate in the spring and early summer months (Table 22). Therefore, NJDFW staff time and resources should be focused on late summer/fall classes. As fall classes also had the highest rates of walk-in attendees, efforts should be made to ensure that all participants pre-register for hunter education classes online. Walk-in participants are currently not entered into the hunter education database and are therefore not accounted for until they are entered into the ALS system at a licensing agent. Because walk-in students are rarely turned away from a class, hunter education classes often exceed capacity which makes preparing materials ahead of time difficult and exacerbates group management issues.

Taking all of the above factors into account, New Jersey's hunting population is comprised mostly of white males living in less urbanized areas with higher incomes and deviates from the typical composition of New Jersey's population. If NJDFW is solely interested in increasing license sales, focusing recruitment and retention efforts on white males in the 36-55 age class in rural areas of the state would most heavily impact revenue with the least amount of effort.

Although increasing revenue was the driving force behind this internship, the results have highlighted a separate issue that should be addressed by NJDFW. Focusing recruitment and retention efforts on segments of the population that would have the greatest impact on license sales may subsequently alienate subsets of hunters that are already underrepresented. For example, it would be remiss to ignore efforts focused on increasing hunting participation among females. Female hunters "may provide a strong voice for the future of hunting, not only through their individual participation but also by serving as role models, hunting advocates, and social support with a range of influences potentially larger than male counterparts" (Gude et al. 2012, p. 477). Therefore, although elevating female hunter participation may have little influence on license revenue, it could have important social, political, and cultural impacts.

Creating a more diverse and inclusive hunter population should be an equally important objective for NJDFW, albeit one requiring a different approach than efforts dedicated to boosting financial profits. Diversifying New Jersey's hunting population would require targeting recruitment and retention efforts at women, minorities, and low-income residents in urban areas. Broadening the base of support for hunting activities could help a wide range of residents establish a valuable connection to wildlife and potentially increase overall funding for wildlife conservation. Introducing typically underrepresented segments of the population to hunting could also lead to an expanded constituency of outdoor enthusiasts and help foster environmental stewardship in generations to come.

Therefore, in addition to efforts focused on increasing retention among the white male hunter base, NJDFW should be looking ahead and developing strategies to recruit a diverse constituency of hunters in the state. Pursuing this latter objective will require different strategies and allocation of resources. NJDFW personnel will need to evaluate whether these two distinct objectives are best pursued simultaneously or consecutively based on available funding, staff, and resources. Hopefully the data generated from this internship will help guide NJDFW in their decision-making.

CHAPTER 5: RECOMMENDATIONS

Increasing revenue generated by hunting license sales in New Jersey is dependent on increasing hunter participation in the state. Although hunter education classes are often filled to or above capacity, many graduates are not recruited into the hunting population or retained as hunters over multiple years. The methodology used in this analysis could serve as a foundation for more effective monitoring and evaluation of recruitment and retention programs. The following is a list of recommendations for NJDFW to help increase hunter participation in New Jersey:

- Replicate this analysis every six years to monitor changes in trends and evaluate intervention efforts. The Microsoft Access component of the methodology could be replicated fairly simply with updated data given that queries and table structures have already been designed.
- Continue to monitor youth graduates' license purchase behavior after they turn 16 to identify any changes that occur once they are required to purchase an annual license
- Determine priority of objectives (increasing license sales versus expanding hunter constituency) to help target appropriate segments of the population for recruitment and retention efforts
- Eliminate or minimize walk-ins to hunter education classes by requiring pre-registration via NJDFW's website
- Focus staff time and resources on conducting late summer/fall hunter education classes
- Communicate with other state agencies that have conducted similar analysis to design methods that might work in multiple jurisdictions
- Conduct follow-up surveys to identify reasons why graduates fail to purchase a license and/or hunters fail to renew licenses
- Expand public interest and support for hunting through public relations and social media campaigns
- Implement programs that offer opportunities for women and minorities to develop outdoor skills and foster enthusiasm for hunting (for example, reinstate Becoming an Outdoorswoman)

CHAPTER 6: INTERNSHIP EVALUATION

The capstone internship with NJDFW has been an educational experience and fulfilling conclusion to the University of Illinois' online M.S. degree program in Natural Resources and Environmental Sciences (NRES). Prior to enrolling at the University of Illinois, Urbana-Champaign (UIUC), I had diligently researched and compared a variety of online graduate degree programs in the environmental science field. The structure of UIUC's program offered enough variety of relevant courses to be able to work around a full-time career, as well as flexibility in non-thesis capstone options that could potentially allow me to craft a final project that would both satisfy degree requirements and contribute to my current work responsibilities with NJDFW. The capstone internship experience through UIUC indeed provided me the opportunity to complete degree requirements while simultaneously generating valuable data to help NJDFW increase hunter recruitment and retention and license sales.

This internship required me to draw upon and enhance various skills and knowledge that had been accrued prior to the capstone experience. Much of the data processing for this project was conducted by generating tables and running queries in Microsoft Access. Although I had previously worked in Microsoft Access to build simple databases and link tables, the complexity of this project exceeded my prior knowledge of Microsoft Access and required assistance from a co-worker to help organize the data and create queries to answer my learning objectives. I subsequently learned that most of my co-workers were not familiar with Microsoft Access at all or only had a basic understanding of the program. Over the course of my 180-hour internship, I developed a deeper knowledge of Microsoft Access that now allows me to analyze data in a more efficient and complex manner than could be performed in Microsoft Excel, which seems to be the default application for data analysis within NJDFW. I believe the knowledge gained from this internship will therefore give me an advantage over other colleagues when opportunities arise that require complex data analysis and will also help in future research projects with NJDFW.

I do not know if UIUC offers any sort of data analysis course that includes instruction in Microsoft Access but I think that would have been helpful knowledge to have coming into this internship. All of the Microsoft Access knowledge I have has been gained through self-instruction or via assistance from a colleague. Although my ability to analyze data in Microsoft Access has increased tremendously from my capstone project, there are still functionality features that I am unfamiliar with and would like to master. As Microsoft Access is a powerful program for building and analyzing relationships across data, I think it would be a worthwhile skill for students in the NRES program to learn and a valuable addition to a data management course syllabus.

Similarly, I had previous experience using GIS to map data points and perform basic geo-processing steps such as buffering and intersecting features. However, this capstone internship required me to take a more holistic approach to GIS analysis in terms of determining my output needs and developing a methodical multi-step plan to accomplish them. Topics discussed and exercises performed in "NRES 454: GIS in Natural Resource Management" and "NRES 455: Advanced GIS for Natural Resource Planning" proved valuable to my capstone GIS component, including projections, model building, geo-referencing, and geodatabases.

The ability to utilize GIS is a valuable asset for a NJDFW employee, as many wildlife and habitat management projects benefit from its applications. For instance, GIS is used by NJDFW to map endangered species sightings, model potential endangered species habitat to help guide land use regulatory decisions, track land use changes over time, target patrol areas for conservation officers, create driving routes for fish and game stocking, and map boundaries of wildlife management areas. Currently, NJDFW has two GIS Specialists that are dedicated to the Endangered and Nongame Species Program and who assist other bureaus as needed, but a handful of other employees have basic GIS skills and can perform simple mapping functions. I believe that this capstone project has elevated my GIS abilities above most other NJDFW employees, with the exception of the GIS Specialists, and the addition of more advanced GIS techniques to my skill set will help with future career advancement opportunities. In addition, the map of public hunting lands in New Jersey that was created during this capstone internship is a tangible product that could be used by NJDFW to promote hunting and inform the public of access areas.

Although the statistical analysis for my capstone internship was performed by StatCom consultants, "CPSC 440: Applied Statistical Methods" provided me with a strong foundational knowledge of statistical techniques and terminology. Course topics including descriptive statistics, p-values, Tukey multiple comparisons of means, and exercises in R software were beneficial when reviewing the report provided by StatCom and helped me identify significant results. I had previously taken a Biostatistics course as an undergraduate at Penn State University but the course failed to leave me with a clear understanding of statistical applications and only served to fill me with dread when enrolling in CPSC 440. However, CPSC 440 provided hands-on applications of statistics presented in a simplified manner and provided me with confidence in understanding statistical applications going into this capstone internship. Without previously taking CPSC 440, I think it would have been much more difficult and time-consuming to make sense of StatCom's results and subsequently present them in an informed manner.

Two other courses taken as part of UIUC's online M.S. degree program in NRES that were beneficial during my capstone internship were "NRES 502: Research Methods in NRES" and "NRES 499: Fundamentals of Applied Ecology", specifically the "Discussion" portion of NRES 499. Both classes provided knowledge and experience in reading and evaluating scientific literature and citing references, which were crucial during the literature review process of my capstone. NRES 499 provided hands-on experience with creating and displaying tables and graphs with proper labels, which was incredibly useful when compiling the "Figures and Tables" chapter of this paper. Also, the reflection paper assignment in NRES 502 provided the foundation for the "Introduction" chapter of this paper, as well as an initial approach to the methodology and progression of completing my capstone objectives.

As the idea for this capstone internship stemmed from a request from NJDFW for specific data, I had the Southwick Associates (2013) report to act as a template and provide a starting point. As such, I thought the internship experience would be fairly straight forward albeit tedious. However, fulfilling UIUC's graduate degree requirements mandated a more in-depth analysis to meet the key goals inherent to each capstone project. When designing my capstone project and writing my Graduate Internship Approval Form, I had to explore ways to expand NJDFW's data request that would both be a worthwhile use of my time to NJDFW and achieve the key capstone goals. The inclusion of a GIS component to help identify potential geographic and demographic factors to license purchase behavior, as well as the addition of a statistical modeling component, elevated the initial data request to a more complex and comprehensive analysis of hunter recruitment, retention, and license purchase trends in New Jersey. It has been an educational and rewarding process to take what initially seemed like a simple data-crunching process and develop it into a multi-faceted investigation able to muster the standards of academic rigor.

I hope the results of my capstone internship will be utilized by NJDFW to identify hunter recruitment and retention issues and generate approaches to improve license sales in New Jersey. I plan to present my results and recommendations to the Director of NJDFW, Assistant Directors, and fellow staff in the Hunter Education Unit. In my experience with NJDFW, it can often be difficult to see tangible results of long-term conservation projects. However, I feel that the information provided by this capstone internship could lead to perceptible improvements in hunter recruitment and retention as well as a noticeable increase in revenue from license sales.

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APPENDIX A: FIGURES AND TABLES

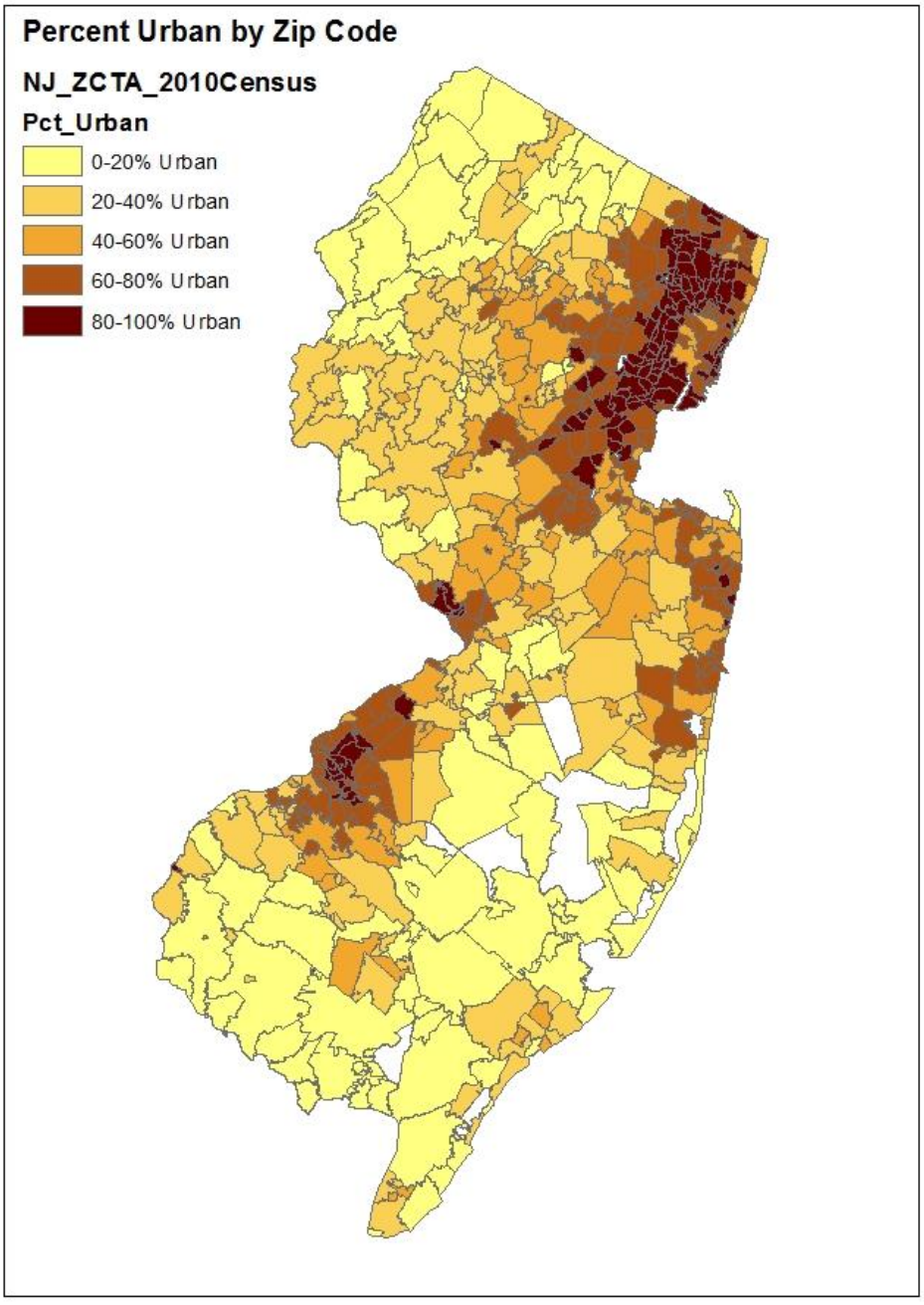

Figure 1: Percent urban classification by zip code; areas shaded white were zip codes that did not have any 2007 hunter education graduates residing in them and therefore were not classified in this analysis

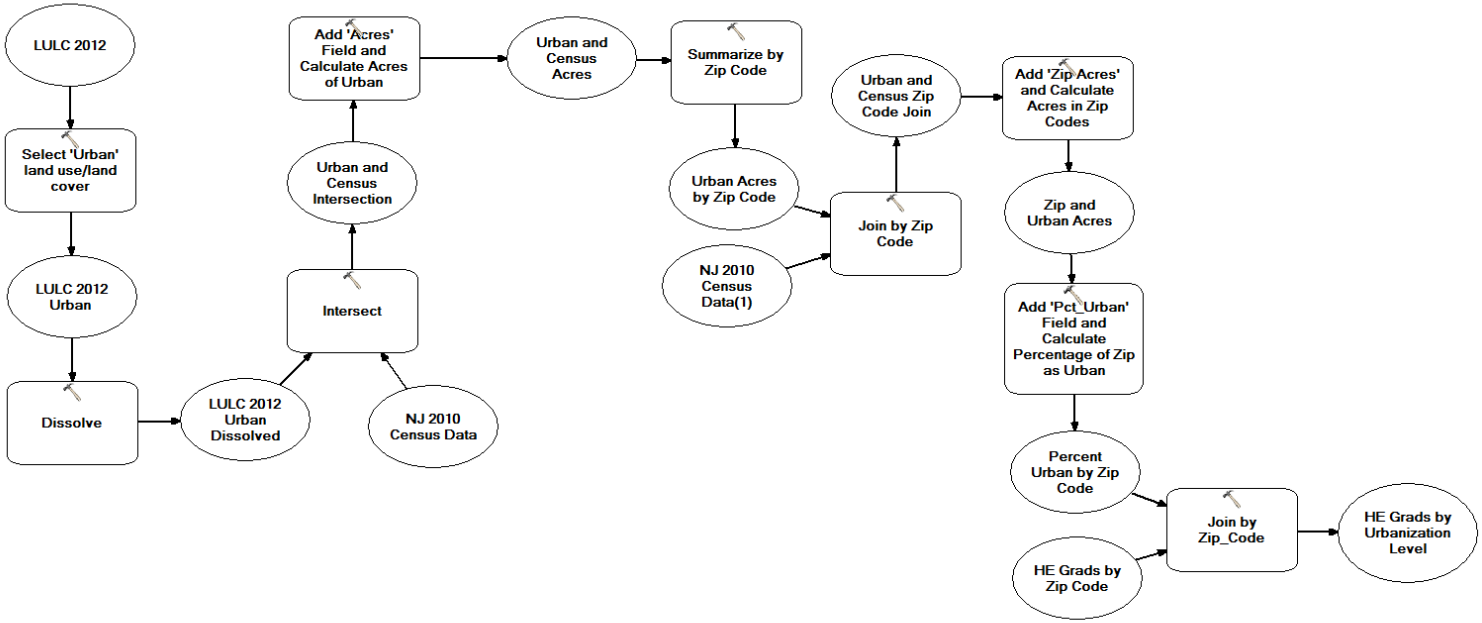

Figure 2: Conceptual model of GIS process used to determine the level of urbanization of each NJ hunter education graduate's zip code of residence.

State/Region	Percent
West	
Montana	82.8%
Nevada	70.1%
Utah	78.1%
Washington	58.8%
Midwest	
Michigan	76.7%
Missouri	70.3%
Nebraska	63.6%
Southeast	
Georgia	65.3%
Kentucky	53.0%
Virginia	43.0%
Northeast	
Maine	70.9%
Vermont	80.5%
New Jersey*	89.3%
Average (not weighted)	**69.4%**

Table 1: Percentage of graduates who purchased at least a single hunting license from 2006 to 2011, by State and Region

**2007-2012 data*

State	Percent Change
West	
Montana	-38.3%
Nevada	-46.5%
Utah	5.4%
Washington	-49.1%
Midwest	
Michigan	-34.6%
Missouri	-44.4%
Nebraska	-0.9%
Southeast	
Georgia	-32.1%
Kentucky	-53.4%
Virginia	-38.0%
Northeast	
Maine	-35.8%
Vermont	-46.2%
New Jersey*	-45.2%
Average	**-35.3%**

Table 2: Percentage change of 2006 graduates purchasing a hunting license through 2011

**2007-2012 data*

State	Percent
West	
Montana	55.8%
Nevada	40.8%
Utah	47.7%
Washington	34.6%
Midwest	
Michigan	49.0%
Missouri	46.2%
Nebraska	40.7%
Southeast	
Georgia	35.8%
Kentucky	27.4%
Virginia	26.1%
Northeast	
Maine	48.5%
Vermont	52.6%
New Jersey*	54.1%
Average	**43.0%**

Table 3: Percent of total sales potential reached from 2006 to 2011

**2007-2012 data*

Actual Sales	Sales Potential	Percent of Potential Reached
12,222	22,608	54.1%

Table 4: Percent of total sales potential reached in NJ from 2007-2012

State	Class	Percent
West		
Montana	16-24	-68.3%
Nevada	16-24	-54.8%
Utah	16-24	-24.8%
Washington	n/a	n/a
Midwest		
Michigan	16-24	-60.5%
Missouri	16-24	-55.8%
Nebraska	16-24	-39.6%
Southeast		
Georgia	25-35	-33.8%
Kentucky	10-15	-64.5%
Virginia	16-24	-62.5%
Northeast		
Maine	25-35	-46.1%
Vermont	16-24	-49.4%
New Jersey*	10-15	-58.8%

Table 5: Age class with largest decrease in renewal rates from 2006 to 2011

**2007-2012 data; New Jersey youth hunting licenses are valid from the time of purchase until the end of the calendar year in which the youth turns 16.*

State	Class	Percent
West		
Montana	25-35	33.1%
Nevada	16-24	38.5%
Utah	16-24	32.6%
Washington	n/a	n/a
Midwest		
Michigan	16-24	34.1%
Missouri	16-24	37.3%
Nebraska	10-15	40.0%
Southeast		
Georgia	25-35	37.0%
Kentucky	10-15	55.8%
Virginia	16-24	59.6%
Northeast		
Maine	10-15	34.8%
Vermont	Older than 35	22.1%
New Jersey*	Older than 35	26.3%

Table 6: Age class with largest percent who never purchased a license by state from 2006-2011

**2007-2012 data*

State	Month	Percent
West		
Montana	September	19.6%
Nevada	June	49.6%
Utah	April	26.1%
Washington	n/a	n/a
Midwest		
Michigan	June	34.8%
Missouri	December	55.0%
Nebraska	June	53.1%
Southeast		
Georgia	June	65.8%
Kentucky	March	72.9%
Virginia	December	61.1%
Northeast		
Maine	May	79.2%
Vermont	June	52.0%
New Jersey*	April	16.4%

Table 7: Month of graduation with the highest percent of graduates who did not purchase a license within six years

**2007-2012 data*

Number of 2007 HE Graduates	3768			
Year	Number of HE Graduates That Purchased A License	% of Graduates Who Bought A License	Percent Change over Previous Year	Average Age
2007	3029	80.4%	-	26.2
2008	2067	54.9%	-31.8%	31.0
2009	1917	50.9%	-7.3%	30.5
2010	1814	48.1%	-5.4%	30.7
2011	1734	46.0%	-4.4%	29.8
2012	1661	44.1%	-4.2%	29.0
Change from 2007 to 2012			**-45.2%**	

Table 8: 2007 NJ hunter education graduates who purchased a license, by year

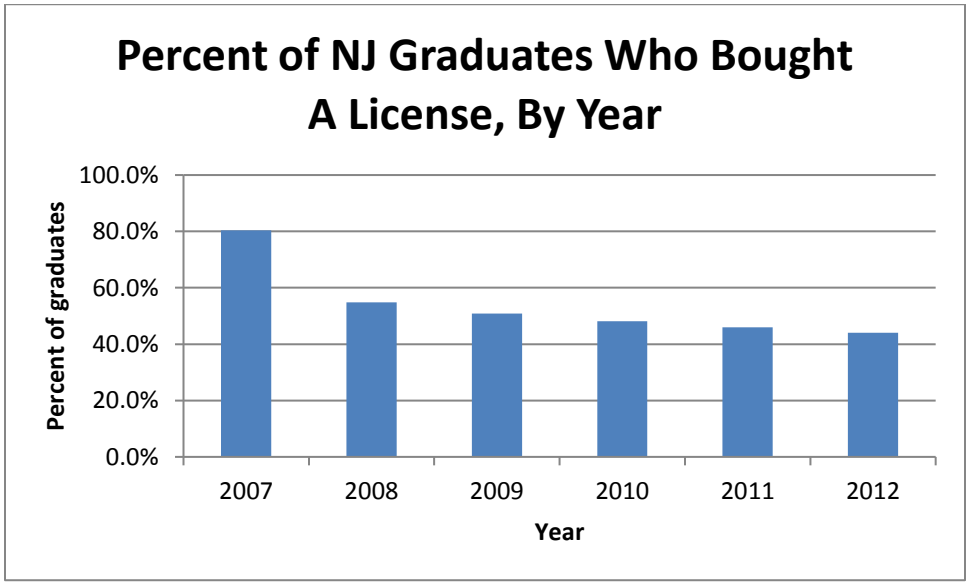

Figure 3: Percent of NJ hunter education graduates who bought a license, by year

Number of years purchased a license, 2007-2012	Number of HE Graduates	Percent	Of those who bought licenses…
0	404	10.7%	-
1	751	19.9%	22.3%
2	500	13.3%	14.9%
3	381	10.1%	11.3%
4	344	9.1%	10.2%
5	376	10.0%	11.2%
6	1012	26.9%	30.1%
Total	**3768**		
Total of those who purchased at least once	**3364**	**89.3%**	

Table 9: License purchase frequency by 2007 hunter education graduates in NJ following certification

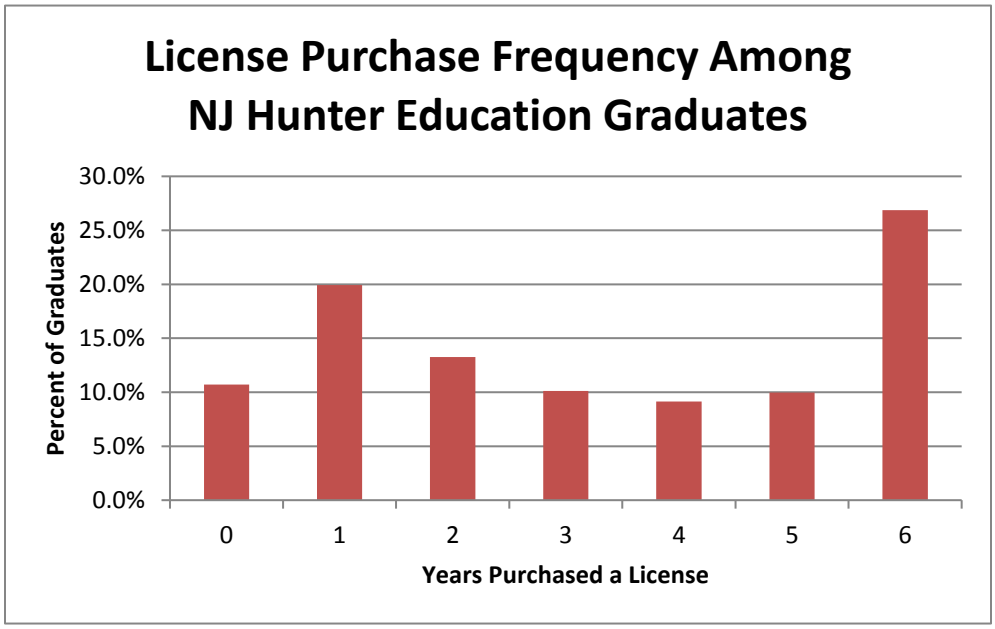

Figure 4: License purchase frequency by 2007 hunter education graduates in NJ following certification

County	Licenses Sold	Total Graduates	% Purchased
New Jersey			
Bergen	169	226	74.8%
Union	70	84	83.3%
Hudson	32	38	84.2%
Passaic	155	181	85.6%
Monmouth	227	263	86.3%
Somerset	90	102	88.2%
Morris	241	269	89.6%
Ocean	288	320	90.0%
Mercer	91	101	90.1%
Hunterdon	171	189	90.5%
Essex	88	97	90.7%
Middlesex	169	185	91.4%
Salem	101	110	91.8%
Burlington	209	226	92.5%
Warren	189	204	92.6%
Camden	154	166	92.8%
Cape May	92	99	92.9%
Atlantic	162	173	93.6%
Sussex	304	322	94.4%
Gloucester	170	179	95.0%
Cumberland	154	162	95.1%
Average In-State	**3326**	**3696**	**90.0%**

Table 10: Percentage of NJ resident graduates who purchased at least a single hunting license from 2007-2012, by county of residence

State	Licenses Sold	Total Graduates	% Purchased
Pennsylvania	21	30	70.0%
New York	7	29	24.1%
Delaware	1	1	100.0%
Massachusetts	1	2	50.0%
Maryland	2	2	100.0%
Virginia	1	2	50.0%
Florida	3	4	75.0%
Colorado	2	2	100.0%
Average Out-of-State	**38**	**72**	**52.8%**

Table 11: Percentage of out-of-state hunter education graduates who purchased at least a single hunting license from 2007-2012, by state

AgeClass	Percent
10 to 15	93.0%
16 to 24	88.5%
25 to 35	87.5%
36 to 55	86.6%
56 and older	87.1%

Table 12: Percentage of NJ graduates who purchased at least a single hunting license from 2007-2012, by age class

Gender	Percent
Male	90.0%
Female	83.0%

Table 13: Percentage of NJ graduates who purchased at least a single hunting license from 2007-2012, by gender

Age Class	Number of Graduates	Average Age	%
10-15	1232	12.5	32.7%
16-24	794	19.3	21.1%
25-35	646	29.6	17.1%
36-55	949	43.9	25.2%
56 and older	147	61.2	3.9%
Total	**3768**		**100.0%**

Table 14: 2007 NJ hunter education graduates, by age class

Gender	Number of Graduates	%
Male	3421	90.8%
Female	347	9.2%
Total	**3768**	**100.0%**

Table 15: 2007 NJ hunter education graduates, by gender

Age Class and Gender	Number of Graduates	%
10-15 Female	130	3.5%
16-24 Female	62	1.6%
25-35 Female	63	1.7%
36-55 Female	85	2.3%
56 and older Female	7	0.2%
10-15 Male	1102	29.2%
16-24 Male	732	19.4%
25-35 Male	583	15.5%
36-55 Male	864	22.9%
56 and older Male	140	3.7%
Total	**3768**	**100.0%**

Table 16: 2007 NJ hunter education graduates, by age class and gender

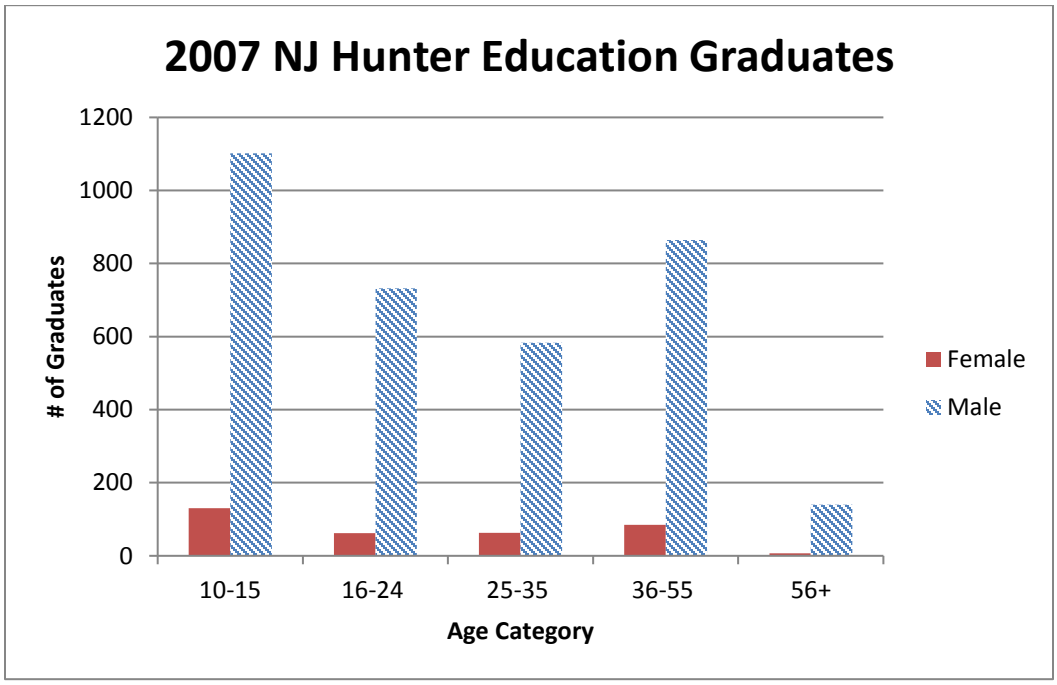

Figure 5: 2007 NJ hunter education graduates, by age class and gender

		Number of years purchased a license, 2007-2012		
Years of Age	**Number of Graduates**	**None**	**One-Two**	**Three-Six**
10-15	1232	7.0%	56.7%	36.4%
16-24	794	11.5%	28.3%	60.2%
25-35	646	12.5%	21.7%	65.8%
36-55	949	13.4%	16.3%	70.3%
56 and older	147	12.9%	22.4%	64.6%
Total	**3768**	**10.7%**	**33.2%**	**56.1%**

Table 17: License purchase frequency by 2007 NJ hunter education graduates following certification, by age class

		Number of years purchased a license, 2007-2012		
Gender	**Number of Graduates**	**None**	**One-Two**	**Three-Six**
Male	3421	10.1%	31.7%	58.2%
Female	347	17.0%	47.6%	35.4%
Total	**3768**	**10.7%**	**33.2%**	**56.1%**

Table 18: License purchase frequency by 2007 NJ hunter education graduates following certification, by gender

Age	Number of Graduates	% of 2007 Grads	Year of Purchase		Change	
			2007	2012	N	%
10-15*	1232	32.7%	1056	435	(621)	-58.8%
16-24	794	21.1%	614	331	(283)	-46.1%
25-35	646	17.1%	500	308	(192)	-38.4%
36-55	949	25.2%	742	508	(234)	-31.5%
56 and older	147	3.9%	117	79	(38)	-32.5%
Total	**3768**	**100.0%**	**3029**	**1661**	**(1368)**	**-45.2%**

Table 19: Change in the percent of 2007 NJ hunter education graduates who bought licenses from 2007-2012, by age class

**NJ youth licenses are valid from the time of purchase until the end of the calendar year in which the youth turns 16*

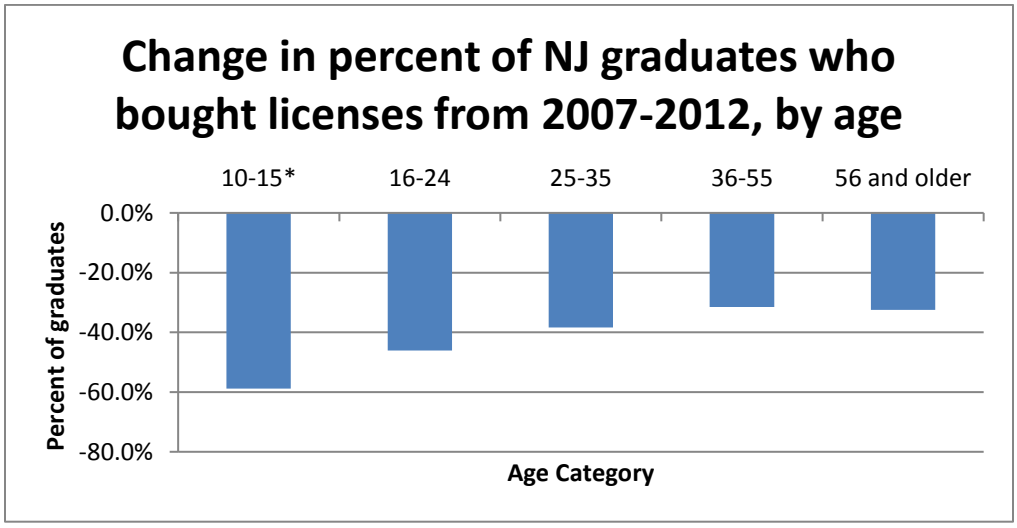

Figure 6: Change in the percent of 2007 NJ hunter education graduates who bought licenses from 2007-2012, by age class

**NJ youth licenses are valid from the time of purchase until the end of the calendar year in which the youth turns 16*

Gender	Number of Graduates	% of 2007 Grads	Year of Purchase		Change	
			2007	2012	N	%
Male	3421	90.8%	2772	1579	(1192)	-43.0%
Female	347	9.2%	257	82	(175)	-68.1%
Total	**3768**	**100.0%**	**3029**	**1661**	**(1368)**	**-45.2%**

Table 20: Change in the percent of 2007 NJ hunter education graduates who bought licenses from 2007-2012, by gender

Number of 2007 HE Graduates	Archery	1262		Firearms	3016		Trapping	140	
Year	Number of HE Graduates That Purchased A License	% of Graduates Who Bought a License	Percent Change Over Previous Year	Number of HE Graduates That Purchased A License	% of Graduates Who Bought a License	Percent Change Over Previous Year	Number of HE Graduates That Purchased A License	% of Graduates Who Bought a License	Percent Change Over Previous Year
2007	950	75.3%	-	2311	76.6%	-	74	52.9%	-
2008	646	51.2%	-32.0%	1430	47.4%	-38.1%	79	56.4%	6.8%
2009	574	45.5%	-11.1%	1309	43.4%	-8.5%	54	38.6%	-31.6%
2010	555	44.0%	-3.3%	1259	41.7%	-3.8%	48	34.3%	-11.1%
2011	505	40.0%	-9.0%	1171	38.8%	-7.0%	39	27.9%	-18.8%
2012	482	38.2%	-4.6%	1133	37.6%	-3.2%	40	28.6%	2.6%
Change from 2007 to 2012			**-61.8%**			**-62.4%**			**-71.4%**

Table 21: Change in the percent of 2007 NJ hunter education graduates who bought licenses from 2007-2012, by hunting discipline

Archery = Archery + All-Around + All-Around-Trap

Firearms = Firearms + Firearms-Trap + All-Around-Trap

Trapping = Trapping + All-Around-Trap + Firearms-Trap

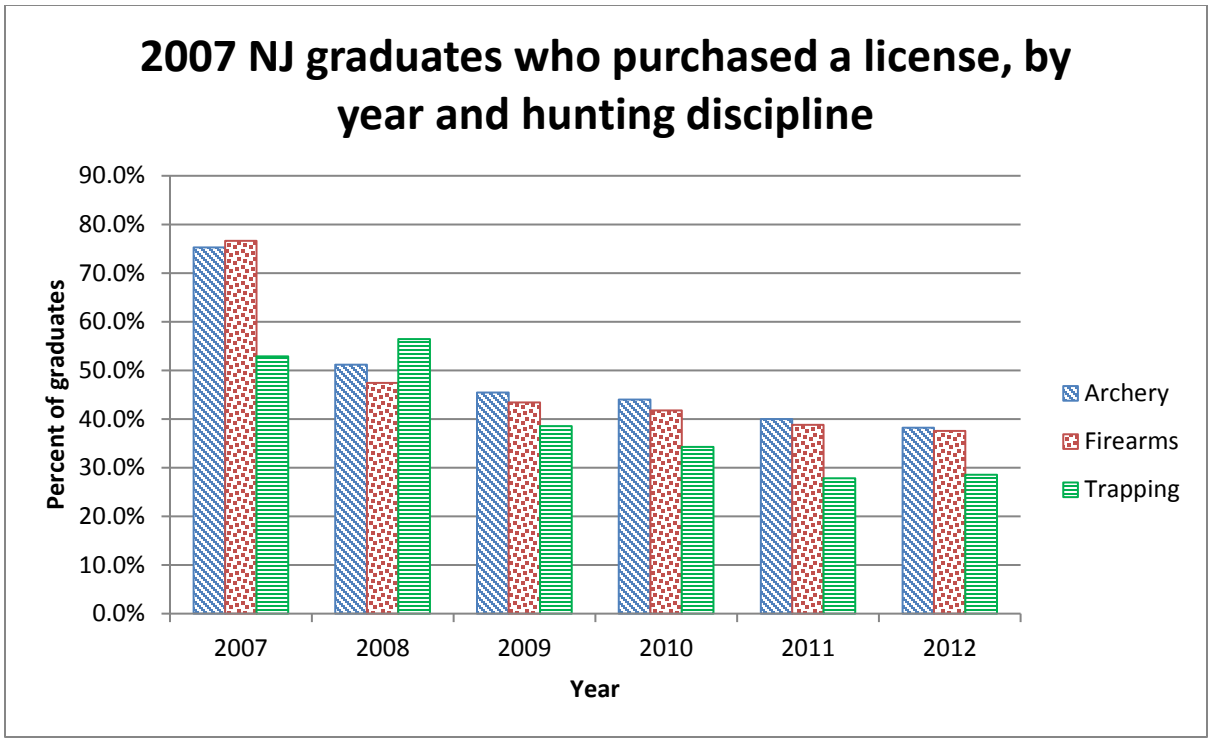

Figure 7: 2007 NJ hunter education graduates who purchased a license, by year and hunting discipline

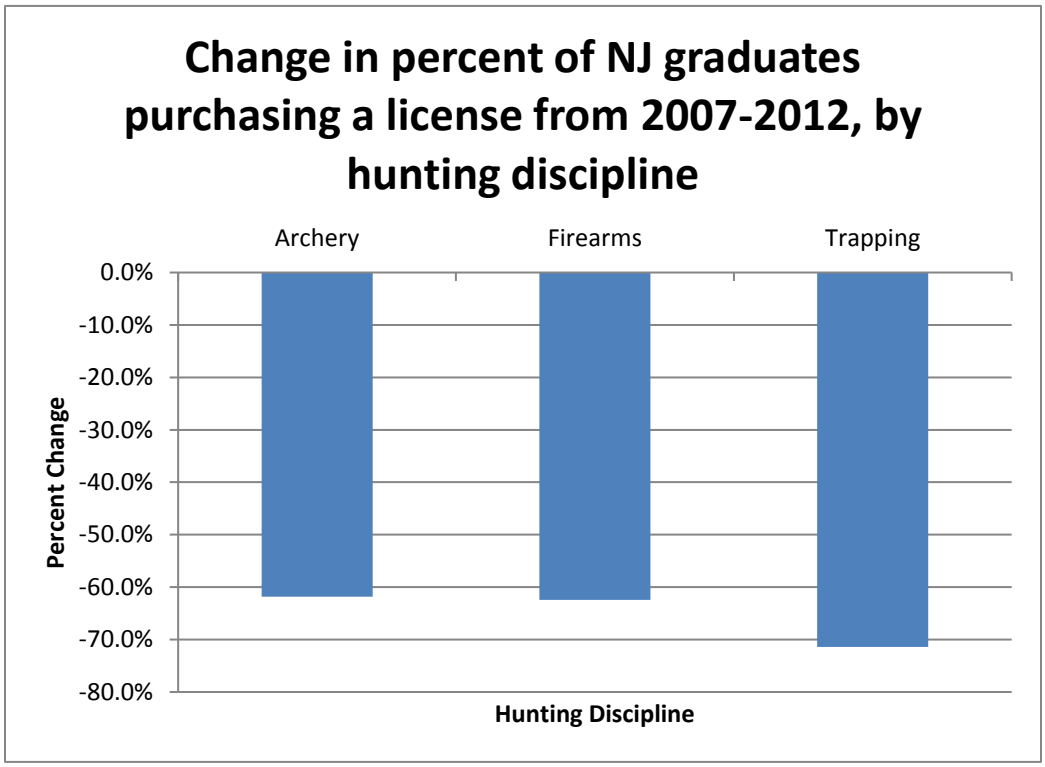

Figure 8: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by hunting discipline

Month	Number of Graduates who completed the HE course	Average Age	Number of Graduated Who Never Purchased	Percent of Total Who Never Purchased a License	Average Age of Graduates Who Never Purchased a License
March	478	28.9	62	13.0%	29.6
April	335	29.5	55	16.4%	31.5
May	263	29.1	39	14.8%	30.5
June	106	28.1	17	16.0%	28.5
July	29	24.7	4	13.8%	22.0
August	433	24.6	41	9.5%	29.0
September	699	25.9	48	6.9%	29.9
October	740	26.8	68	9.2%	30.7
November	747	25.0	74	9.9%	29.9

Table 22: 2007 NJ hunter education graduates, by month of course completion

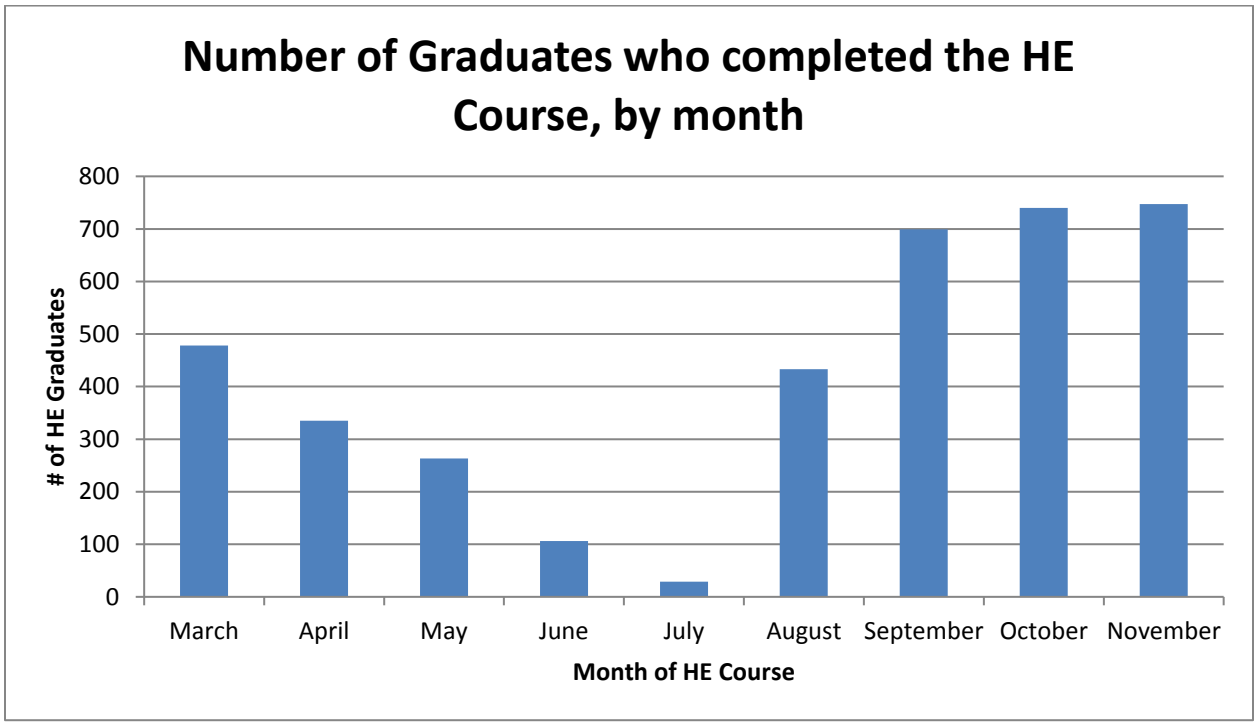

Figure 9: Number of 2007 hunter education graduates in NJ, by month of course completed

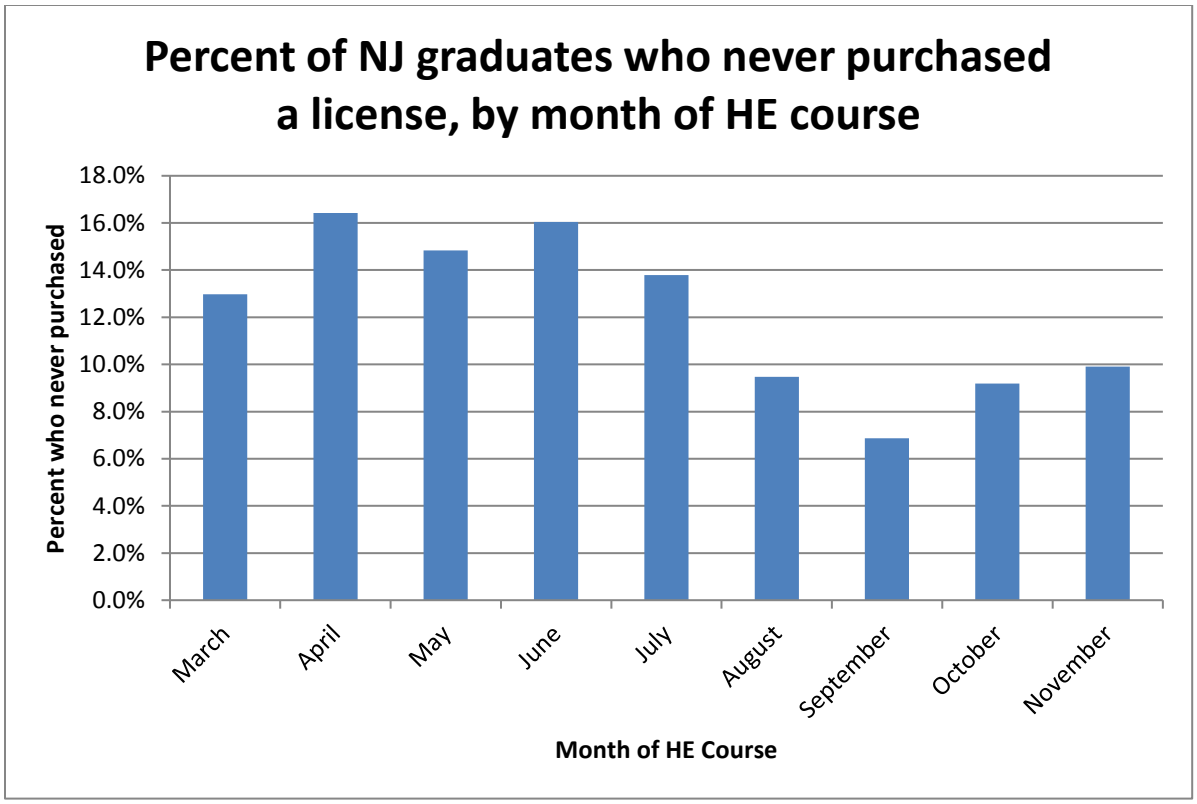

Figure 10: Percent of NJ graduates who never purchased a license between 2007 and 2012, by month of course completed

Distance to open space	Number of Graduates	% of 2007 Grads	Year of Purchase		Change		% Bought in 2007
			2007	2012	N	%	
0-5 miles	2662	72.0%	2213	1242	(971)	-43.9%	83.1%
5-10 miles	652	17.6%	498	268	(230)	-46.2%	76.4%
10-15 miles	294	8.0%	228	109	(119)	-52.2%	77.6%
15-22 miles	88	2.4%	60	33	(27)	-45.0%	68.2%
Total	**3696**	**100.0%**	**2999**	**1652**	**(1347)**	**-44.9%**	

Table 23: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by distance to public hunting lands

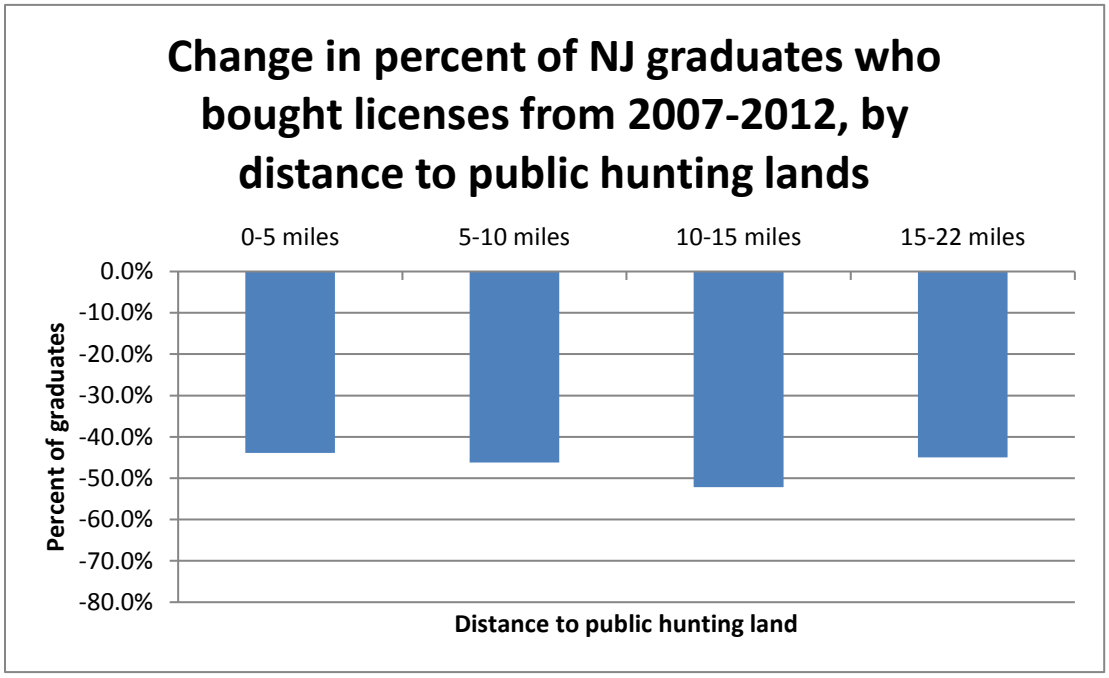

Figure 11: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by distance to public hunting lands

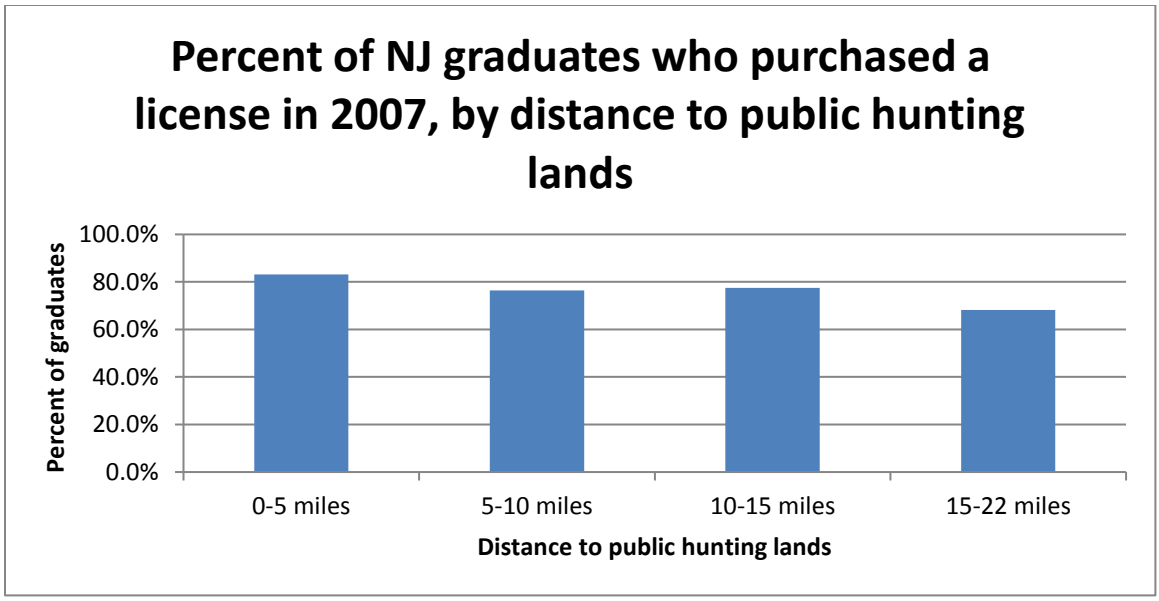

Figure 12: Percent of New Jersey hunter education graduates who purchased a license in 2007, by distance to public hunting lands

% White	Number of Graduates	% of 2007 Grads	Year of Purchase		Change		% Bought in 2007	% of NJ Popn
			2007	2012	N	%		
0-20%	8	0.2%	7	2	(5)	-71.4%	87.5%	4.7%
20-40%	48	1.3%	35	27	(8)	-22.9%	72.9%	8.9%
40-60%	182	4.9%	152	71	(81)	-53.3%	83.5%	15.6%
60-80%	891	24.1%	730	418	(312)	-42.7%	81.9%	29.6%
80-100%	2567	69.5%	2075	1134	(941)	-45.3%	80.8%	41.3%
Total	**3696**	**100.0%**	**2999**	**1652**	**(1347)**	**-44.9%**		

Table 24: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by percentage of white population by zip code

% Owner Occupied	Number of Graduates	% of 2007 Grads	Year of Purchase		Change		% Bought in 2007	% of NJ Popn
			2007	2012	N	%		
0-20%	16	0.4%	11	5	(6)	-54.5%	68.8%	2.5%
20-40%	53	1.4%	40	20	(20)	-50.0%	75.5%	14.3%
40-60%	251	6.8%	208	110	(98)	-47.1%	82.9%	13.6%
60-80%	1281	34.7%	1060	606	(454)	-42.8%	82.7%	33.4%
80-100%	2095	56.7%	1680	911	(769)	-45.8%	80.2%	36.1%
Total	**3696**	**100.0%**	**2999**	**1652**	**(1347)**	**-44.9%**		

Table 25: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by percentage of owner-occupied residences by zip code

% Urban	Number of Graduates	% of 2007 Grads	Year of Purchase		Change		% Bought in 2007
			2007	2012	N	%	
0-20%	1042	28.2%	904	499	(405)	-44.8%	86.8%
20-40%	987	26.7%	830	475	(355)	-42.8%	84.1%
40-60%	537	14.5%	429	224	(205)	-47.8%	79.9%
60-80%	687	18.6%	510	278	(232)	-45.5%	74.2%
80-100%	443	12.0%	326	176	(150)	-46.0%	73.6%
Total	**3696**	**100.0%**	**2999**	**1652**	**(1347)**	**-44.9%**	

Table 26: Change in percent of NJ hunter education graduates purchasing a license from 2007-2012, by percentage of urban land use/land cover by zip code

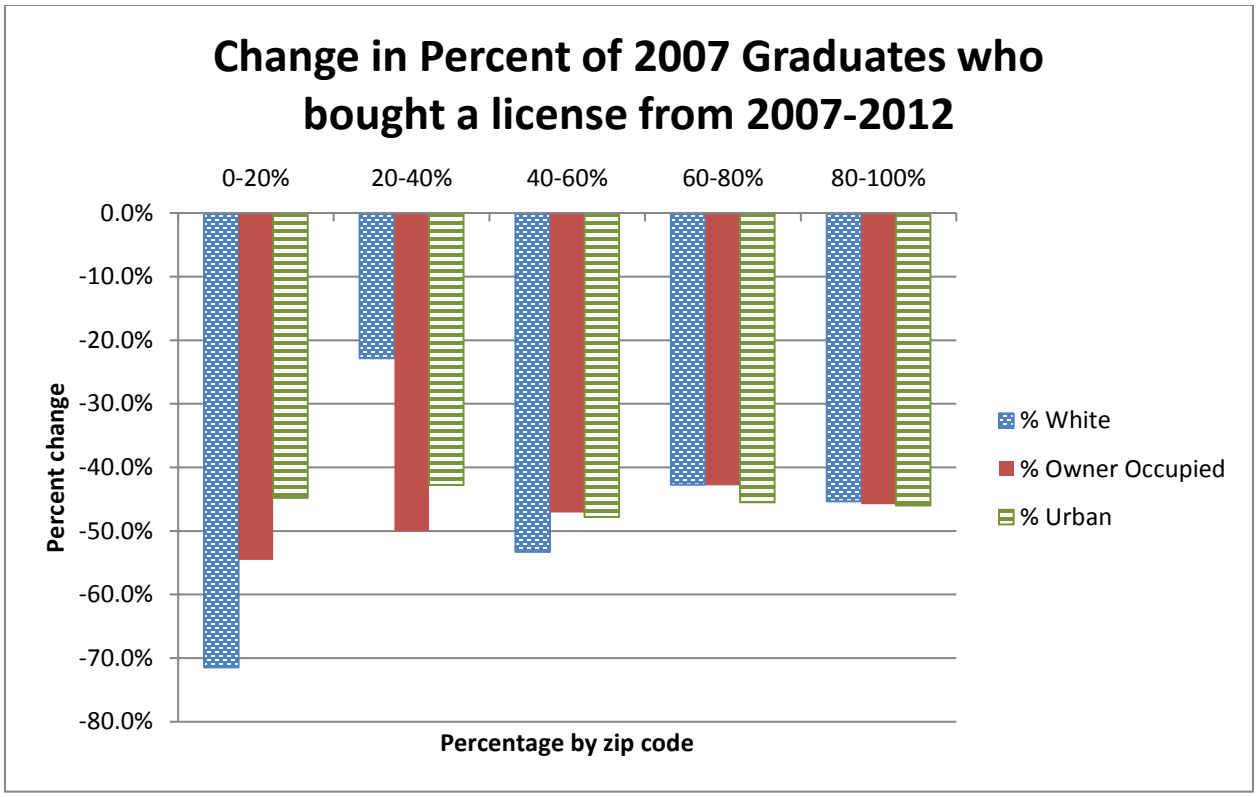

Figure 13: Change in percent of 2007 graduates who bought a license from 2007-2012, by various demographic factors

```
Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.73207    0.14246 -19.178   <2e-16 ***
year          0.11024    0.01326   8.312   <2e-16 ***
previous      2.81461    0.03978  70.751   <2e-16 ***
genderFemale -0.68594    0.06639 -10.332   <2e-16 ***
```

Table 27: Transition model results for the predictor “Gender” on purchase probability

```
Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)               -2.52682    0.14885 -16.976  < 2e-16 ***
year                       0.10896    0.01328   8.206 2.29e-16 ***
previous                   2.78751    0.03989  69.874  < 2e-16 ***
disciplineAll-Around      -0.13559    0.06262  -2.165   0.0304 *
disciplineAll-Around-Trap  0.46713    0.53471   0.874   0.3823
disciplineFirearms        -0.38440    0.05014  -7.666 1.77e-14 ***
disciplineFirearms-Trap    0.10602    0.39819   0.266   0.7900
disciplineTrapping         1.05230    0.13326   7.897 2.86e-15 ***
```

Table 28: Transition model results for the predictor “Hunting Discipline” on purchase probability

```
Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -2.26277    0.14868 -15.220  < 2e-16 ***
year                 0.09353    0.01330   7.033 2.02e-12 ***
previous             2.70860    0.04018  67.410  < 2e-16 ***
ageclass10 to 15    -0.93483    0.05541 -16.871  < 2e-16 ***
ageclass16 to 24    -0.21855    0.05873  -3.721 0.000198 ***
ageclass36 to 55     0.15787    0.05743   2.749 0.005979 **
ageclass56 and older 0.05783    0.10239   0.565 0.572206
```

Table 29: Transition model results for the predictor “Age Class” on purchase probability

```
Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)               -1.89679    0.15592 -12.165  < 2e-16 ***
year                       0.08524    0.01339   6.366 1.94e-10 ***
previous                   2.64720    0.04043  65.470  < 2e-16 ***
ageclass10 to 15          -0.88766    0.05592 -15.874  < 2e-16 ***
ageclass16 to 24          -0.22881    0.05908  -3.873 0.000107 ***
ageclass36 to 55           0.17173    0.05824   2.949 0.003189 **
ageclass56 and older       0.02981    0.10436   0.286 0.775177
disciplineAll-Around      -0.09143    0.06351  -1.440 0.149981
disciplineAll-Around-Trap  0.50140    0.51651   0.971 0.331680
disciplineFirearms        -0.33553    0.05128  -6.543 6.04e-11 ***
disciplineFirearms-Trap   -0.08098    0.40072  -0.202 0.839858
disciplineTrapping         0.84548    0.13464   6.279 3.40e-10 ***
genderFemale              -0.66408    0.06741  -9.852  < 2e-16 ***
```

Table 30: Transition model results for the combined predictors “Gender”, “Hunting Discipline”, and “Age Class” on purchase probability

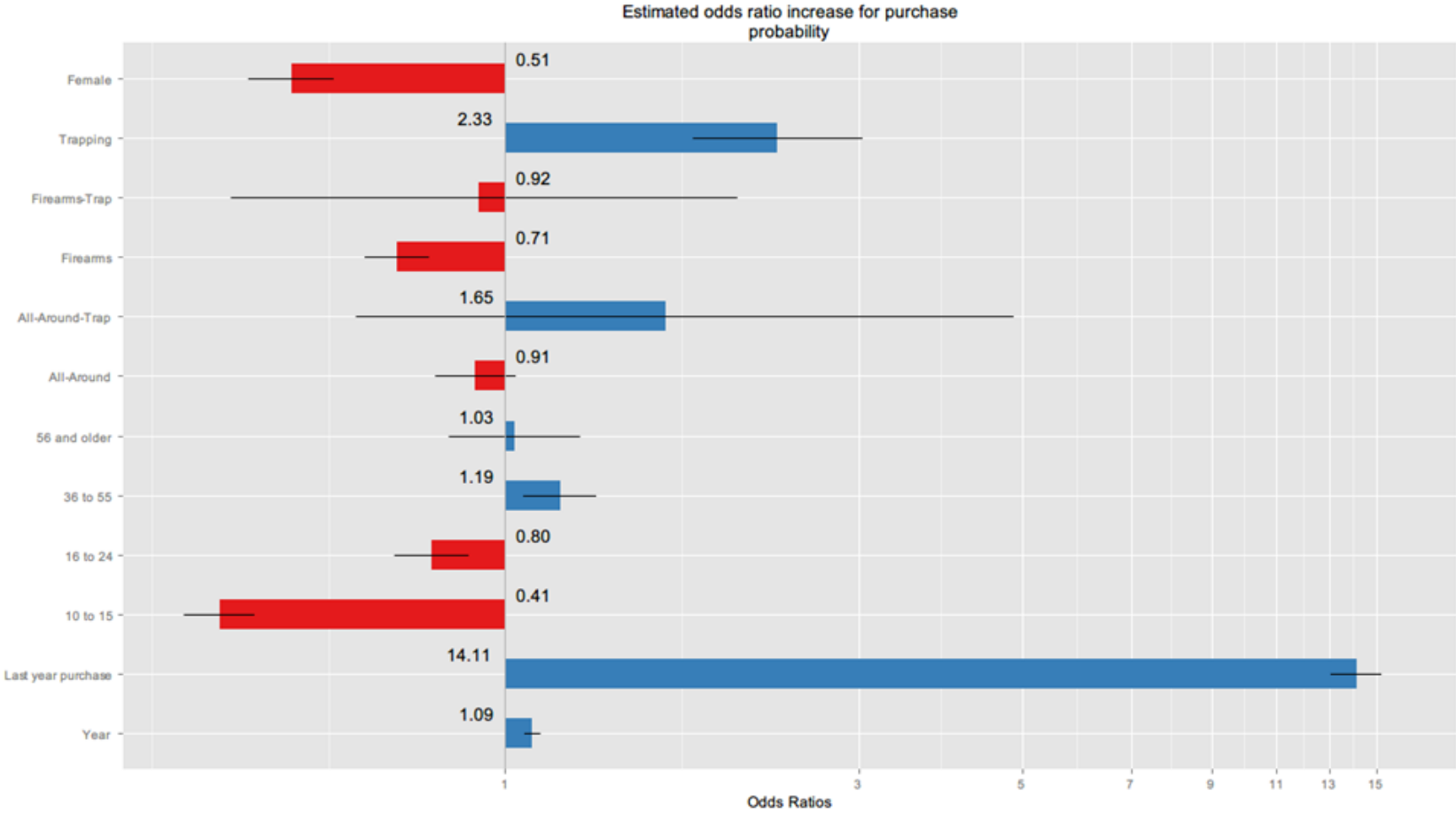

Figure 14: Plot displaying how the odds ratio of purchase probability is influenced by various predictors. Blue boxes (right of the center line) indicate an increase of the odds and red boxes (left of the center line) indicate a decrease of the odds. An increase of odds implies an increase in probability and vice versa. The horizontal line embedded in each box indicates the confidence interval of the effect. If the line spreads across 0, then it is undetermined whether the effect is positive or negative under the 95% significance level. If the line does not spread across 0, then the sign (positive or negative) of the effect is what the box indicates with a 95% confidence interval.

```
Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.19600    0.15771  -7.584 3.36e-14 ***
year          0.24428    0.01643  14.867  < 2e-16 ***
genderFemale -0.69676    0.08291  -8.404  < 2e-16 ***
```

Table 31: Transition model results for the predictor “Gender” on retention probability

```
Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)                -0.99085    0.16571  -5.979 2.24e-09 ***
year                        0.24302    0.01646  14.761  < 2e-16 ***
disciplineAll-Around       -0.20840    0.07761  -2.685  0.00725 **
disciplineAll-Around-Trap  -0.06001    0.57047  -0.105  0.91623
disciplineFirearms         -0.41901    0.06239  -6.716 1.86e-11 ***
disciplineFirearms-Trap     0.34414    0.55032   0.625  0.53174
disciplineTrapping          1.43589    0.19646   7.309 2.70e-13 ***
```

Table 32: Transition model results for the predictor “Hunting Discipline” on retention probability

```
Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)          -0.47948    0.17244  -2.780 0.005428 **
year                  0.21286    0.01701  12.515  < 2e-16 ***
ageclass10 to 15     -1.60958    0.07210 -22.324  < 2e-16 ***
ageclass16 to 24     -0.34972    0.07711  -4.535 5.75e-06 ***
ageclass36 to 55      0.28015    0.07856   3.566 0.000363 ***
ageclass56 and older  0.19017    0.14362   1.324 0.185456
```

Table 33: Transition model results for the predictor “Age Class” on retention probability

```
Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)                -0.12685    0.18205  -0.697 0.485930
year                        0.20249    0.01713  11.822  < 2e-16 ***
ageclass10 to 15           -1.56941    0.07274 -21.577  < 2e-16 ***
ageclass16 to 24           -0.36648    0.07766  -4.719 2.37e-06 ***
ageclass36 to 55            0.27560    0.07937   3.472 0.000516 ***
ageclass56 and older        0.12870    0.14557   0.884 0.376624
disciplineAll-Around       -0.13696    0.08164  -1.678 0.093413 .
disciplineAll-Around-Trap   0.29652    0.59562   0.498 0.618607
disciplineFirearms         -0.36290    0.06599  -5.499 3.82e-08 ***
disciplineFirearms-Trap     0.09091    0.57516   0.158 0.874416
disciplineTrapping          1.12198    0.20103   5.581 2.39e-08 ***
genderFemale               -0.65916    0.08933  -7.379 1.59e-13 ***
```

Table 34: Transition model results for the predictor “Gender”, “Hunting Discipline”, and “Age Class” on retention probability

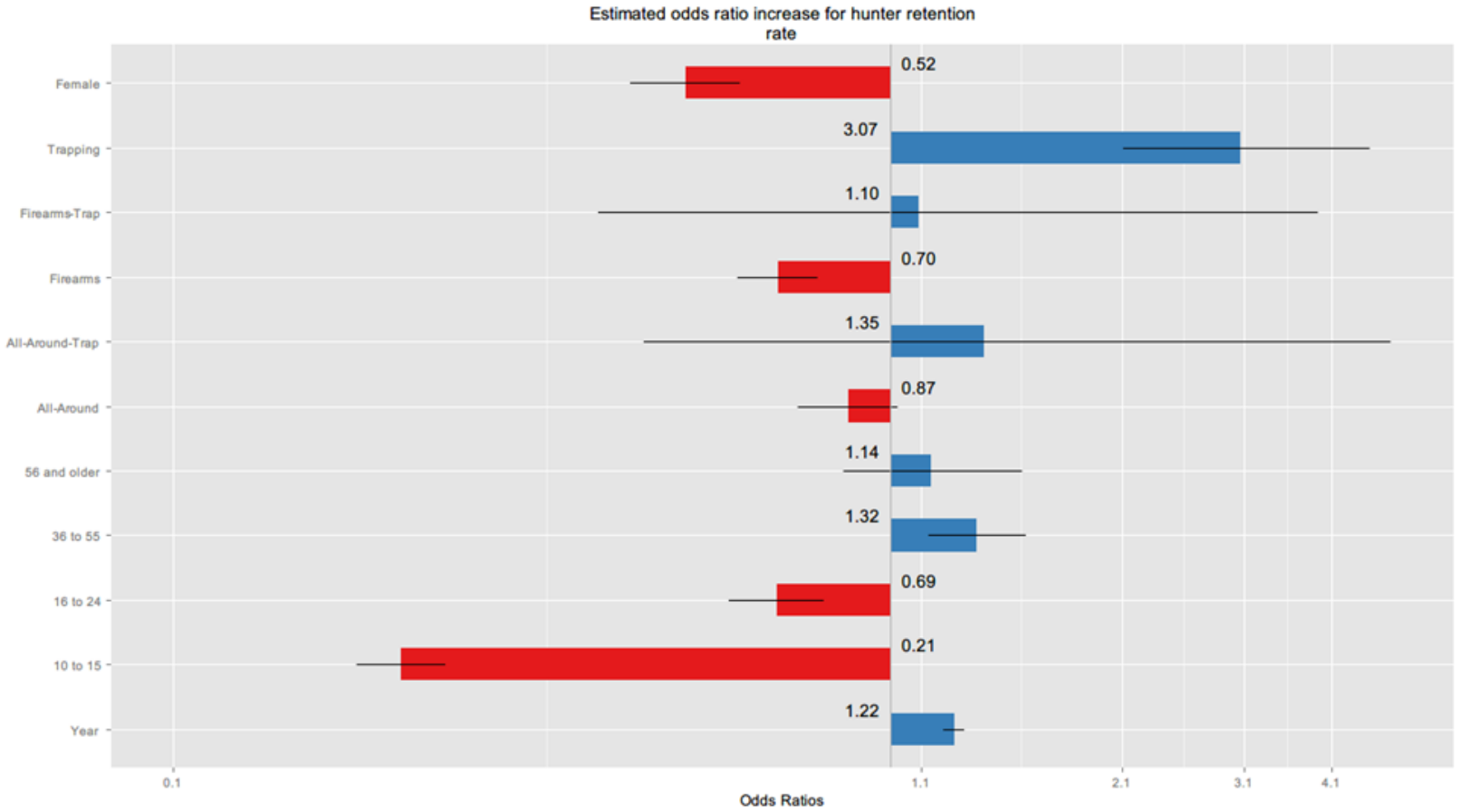

Figure 15: Plot displaying how the odds ratio of retention probability is influenced by various predictors. Blue boxes (right of the center line) indicate an increase of the odds and red boxes (left of the center line) indicate a decrease of the odds. An increase of odds implies an increase in probability and vice versa. The horizontal line embedded in each box indicates the confidence interval of the effect. If the line spreads across 0, then it is undetermined whether the effect is positive or negative under the 95% significance level. If the line does not spread across 0, then the sign (positive or negative) of the effect is what the box indicates with a 95% confidence interval.

```
Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   0.27542    0.24278   1.134    0.257
year         -0.18195    0.02371  -7.675 1.66e-14 ***
genderFemale -0.62629    0.11036  -5.675 1.39e-08 ***
```

Table 35: Transition model results for the predictor “Gender” on recruitment probability

```
Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)                0.45787    0.25591   1.789 0.073587 .
year                      -0.18419    0.02372  -7.766 8.11e-15 ***
disciplineAll-Around      -0.01492    0.10773  -0.139 0.889841
disciplineAll-Around-Trap  1.44586    0.82797   1.746 0.080764 .
disciplineFirearms        -0.33811    0.08821  -3.833 0.000127 ***
disciplineFirearms-Trap   -0.37678    0.77085  -0.489 0.624993
disciplineTrapping         0.33369    0.25114   1.329 0.183947
```

Table 36: Transition model results for the predictor “Hunting Discipline” on recruitment probability

```
Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)          0.16848    0.25601   0.658    0.510
year                -0.18338    0.02378  -7.711 1.25e-14 ***
ageclass10 to 15     0.15014    0.09588   1.566    0.117
ageclass16 to 24     0.05162    0.10961   0.471    0.638
ageclass36 to 55    -0.11519    0.11443  -1.007    0.314
ageclass56 and older -0.19505    0.20840  -0.936    0.349
```

Table 37: Transition model results for the predictor “Age Class” on recruitment probability

```
Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)               4.461e-01  4.713e-02   9.464  < 2e-16 ***
year                     -2.491e-02  4.104e-03  -6.069 7.68e-09 ***
ageclass10 to 15          2.732e-02  1.654e-02   1.652  0.10036
ageclass16 to 24          7.302e-03  1.866e-02   0.391  0.69600
ageclass36 to 55         -7.005e-03  1.916e-02  -0.366  0.71514
ageclass56 and older     -1.795e-02  3.344e-02  -0.537  0.59204
disciplineAll-Around     -6.216e-05  1.982e-02  -0.003  0.99750
disciplineAll-Around-Trap 3.068e-01  1.929e-01   1.591  0.11341
disciplineFirearms       -4.614e-02  1.604e-02  -2.877  0.00451 **
disciplineFirearms-Trap  -2.084e-02  1.269e-01  -0.164  0.86974
disciplineTrapping        6.537e-02  5.085e-02   1.285  0.20036
genderFemale             -6.766e-02  1.587e-02  -4.262 3.29e-05 ***
```

Table 38: Transition model results for the predictor “Gender”, “Hunting Discipline”, and “Age Class” on recruitment probability

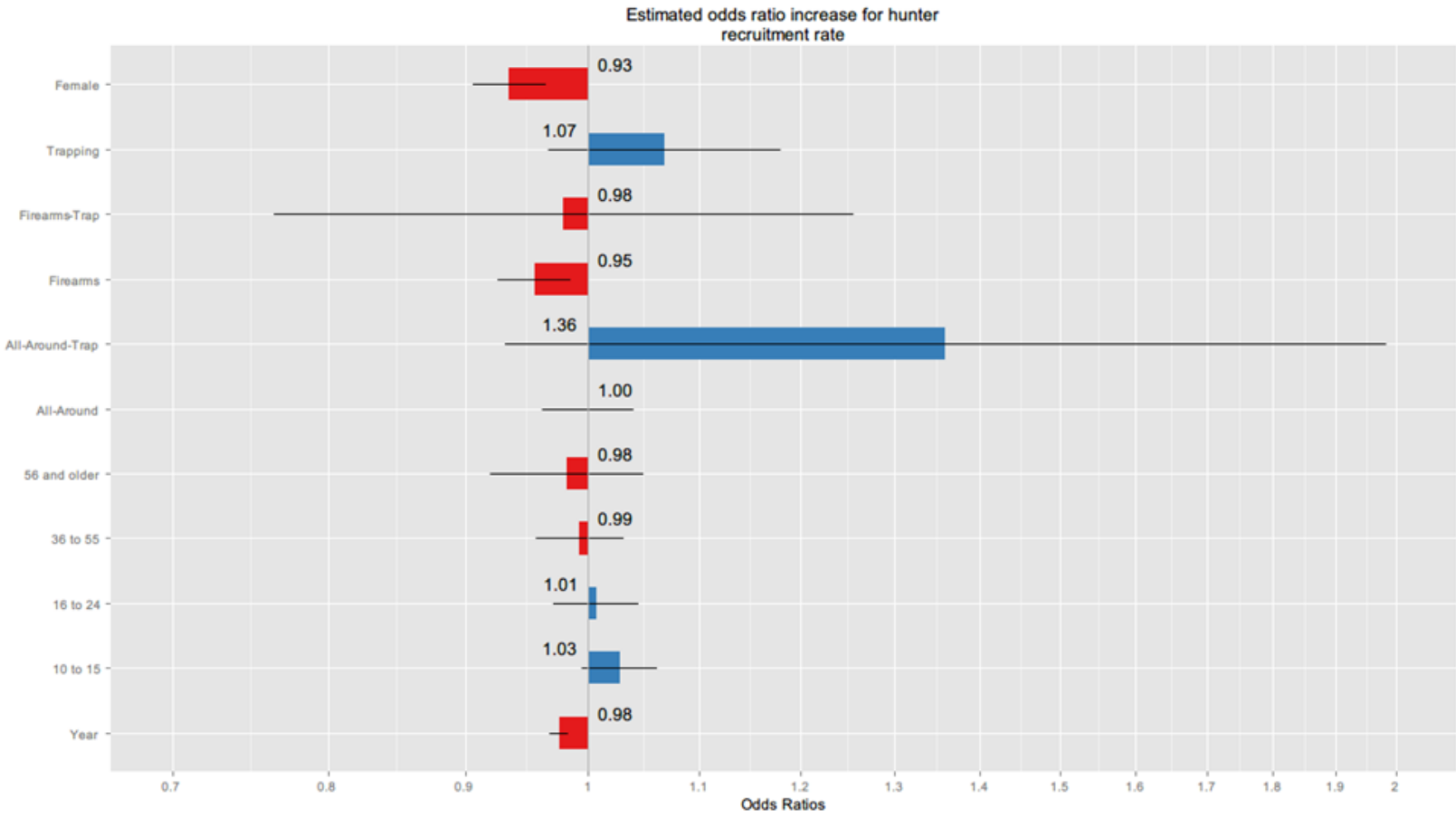

Figure 16: Plot displaying how the odds ratio of recruitment probability is influenced by various predictors. Blue boxes (right of the center line) indicate an increase of the odds and red boxes (left of the center line) indicate a decrease of the odds. An increase of odds implies an increase in probability and vice versa. The horizontal line embedded in each box indicates the confidence interval of the effect. If the line spreads across 0, then it is undetermined whether the effect is positive or negative under the 95% significance level. If the line does not spread across 0, then the sign (positive or negative) of the effect is what the box indicates with a 95% confidence interval.

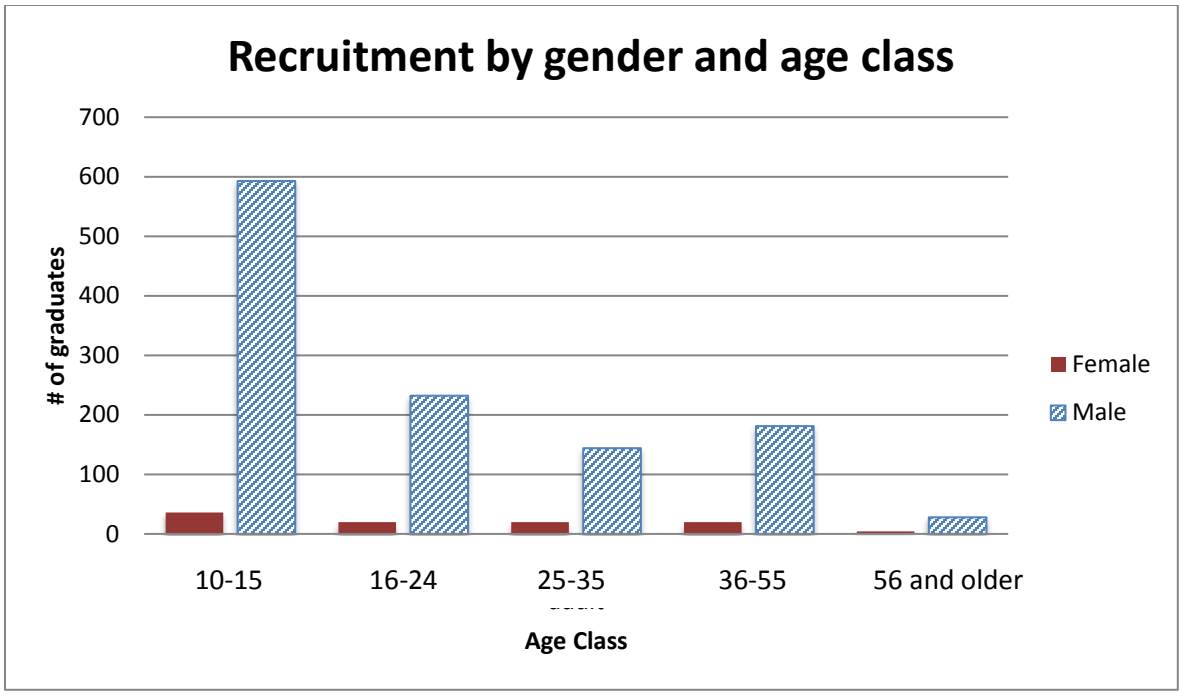

Figure 17: Recruitment of 2007 hunter education graduates over a six-year period from 2007-2012, by gender and age class. Recruitment is defined as going from a status of not purchasing a license (0) to purchasing a license (1).

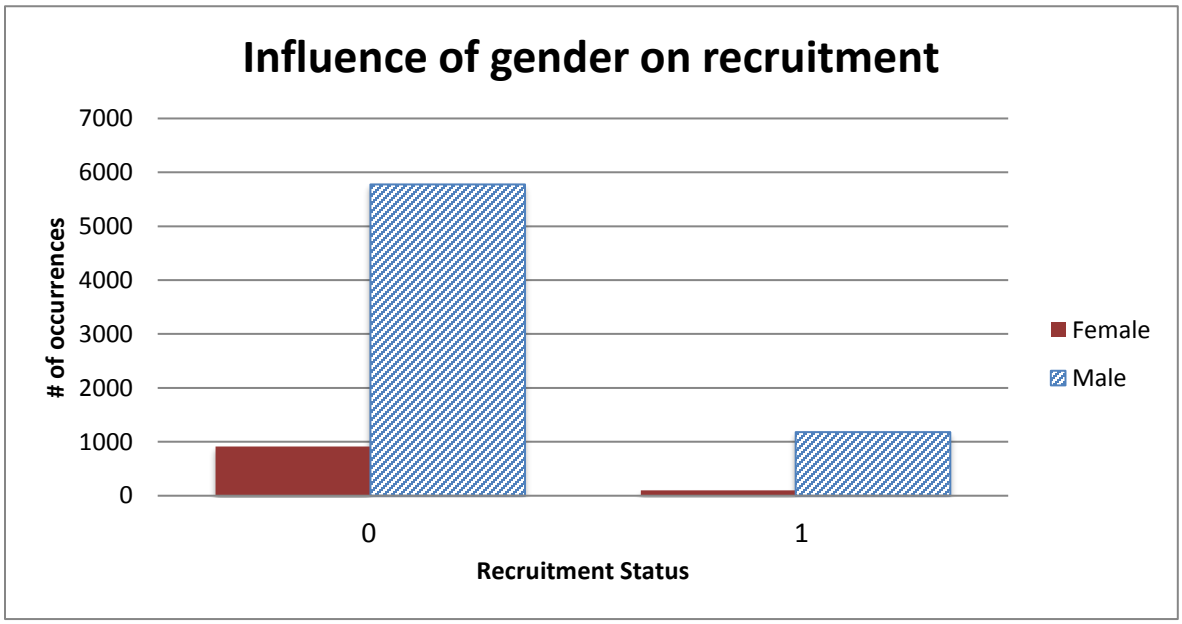

Figure 18: The influence of gender on recruitment status, where 0 represents no recruitment (no purchase of a license from one year to the next, 0→0) and 1 represents a recruitment case (purchase of a license since the previous year, 0→1).

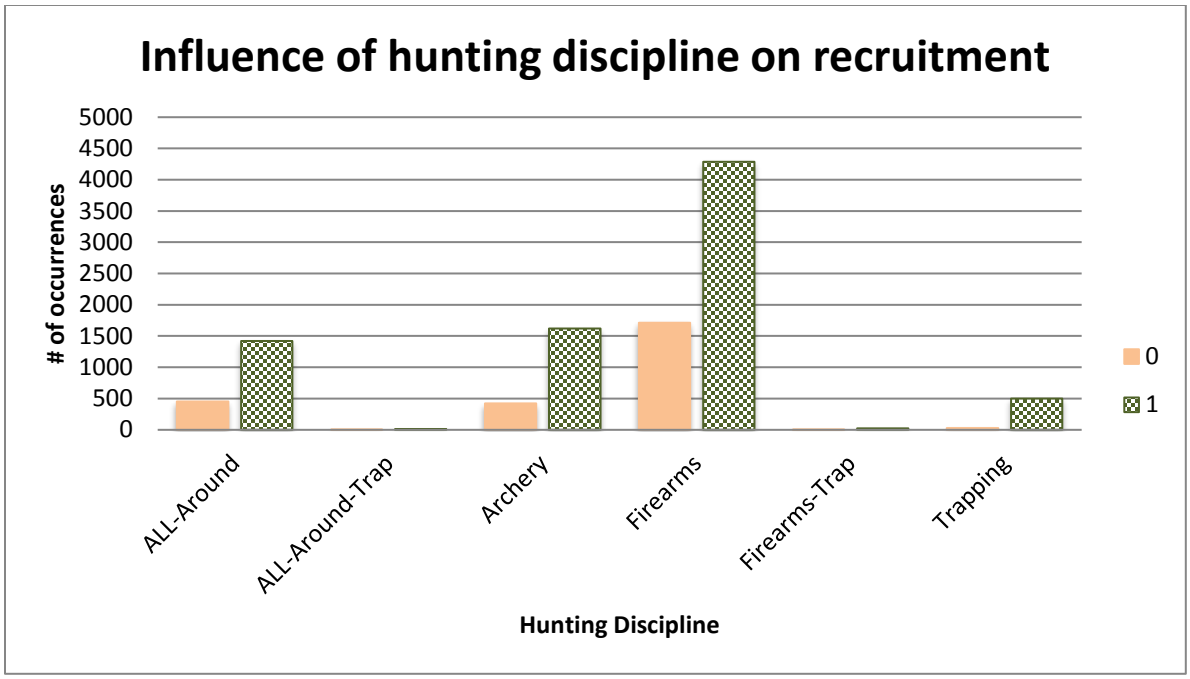

Figure 19: The influence of hunting discipline on recruitment status, where 0 represents no recruitment (no purchase of a license from one year to the next, 0→0) and 1 represents a recruitment case (purchase of a license since the previous year, 0→1).

	diff	lwr	upr	p adj
All-Around-Trap-All-Around	0.3099838969	-0.116810785	0.736778579	0.3030630
Archery-All-Around	0.0003220612	-0.043571283	0.044215406	1.0000000
Firearms-All-Around	-0.0442757923	-0.076986647	-0.011564938	0.0016066
Firearms-Trap-All-Around	-0.0471589602	-0.327455756	0.233137836	0.9968697
Trapping-All-Around	0.0653030459	-0.046261611	0.176867703	0.5528431
Archery-All-Around-Trap	-0.3096618357	-0.736661658	0.117337986	0.3047631
Firearms-All-Around-Trap	-0.3542596892	-0.780255256	0.071735877	0.1668046
Firearms-Trap-All-Around-Trap	-0.3571428571	-0.866032350	0.151746636	0.3420272
Trapping-All-Around-Trap	-0.2446808511	-0.683826493	0.194464791	0.6064340
Firearms-Archery	-0.0445978535	-0.079884505	-0.009311201	0.0042865
Firearms-Trap-Archery	-0.0474810214	-0.328090076	0.233128033	0.9967840
Trapping-Archery	0.0649809847	-0.047365891	0.177327860	0.5660766
Firearms-Trap-Firearms	-0.0028831679	-0.281961680	0.276195344	1.0000000
Trapping-Firearms	0.1095788382	0.001111356	0.218046321	0.0460270
Trapping-Firearms-Trap	0.1124620061	-0.186304606	0.411228618	0.8922337

Table 39: Tukey multiple comparisons of means for hunting disciplines on recruitment status, using a 95% family-wise confidence level (p-value≤0.05 is significant). A positive estimate of difference means the first discipline is more likely to become a retention status than the second one; a negative estimate of difference means the first discipline is less likely to become a retention status than the second one.

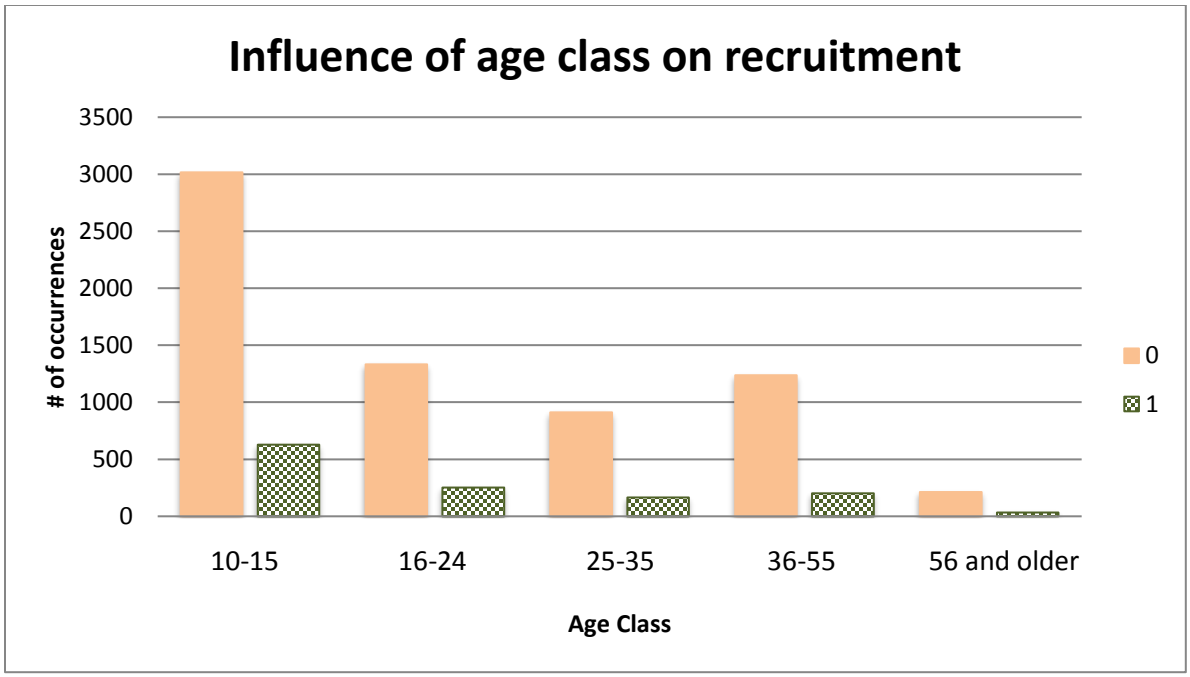

Figure 20: The influence of age class on recruitment status, where 0 represents no recruitment (no purchase of a license from one year to the next, 0→0) and 1 represents a recruitment case (purchase of a license since the previous year, 0→1).

	diff	lwr	upr	p adj
10 to 15-25 to 35	0.019959688	-0.01473795	0.054657331	0.5171207
16 to 24-25 to 35	0.006532770	-0.03297412	0.046039663	0.9914561
36 to 55-25 to 35	-0.012877806	-0.05318138	0.027425766	0.9072923
56 and older-25 to 35	-0.022476839	-0.09313709	0.048183409	0.9086610
16 to 24-10 to 15	-0.013426919	-0.04351264	0.016658804	0.7411176
36 to 55-10 to 15	-0.032837494	-0.06396199	-0.001713002	0.0326736
56 and older-10 to 15	-0.042436527	-0.10829415	0.023421097	0.3984134
36 to 55-16 to 24	-0.019410576	-0.05581940	0.016998246	0.5921798
56 and older-16 to 24	-0.029009608	-0.09752307	0.039503857	0.7768324
56 and older-36 to 55	-0.009599033	-0.07857496	0.059376892	0.9955948

Table 40: Tukey multiple comparisons of means for age class on recruitment status, using a 95% family-wise confidence level (p-value≤0.05 is significant). A positive estimate of difference means the first discipline is more likely to become a retention status than the second one; a negative estimate of difference means the first discipline is less likely to become a retention status than the second one.

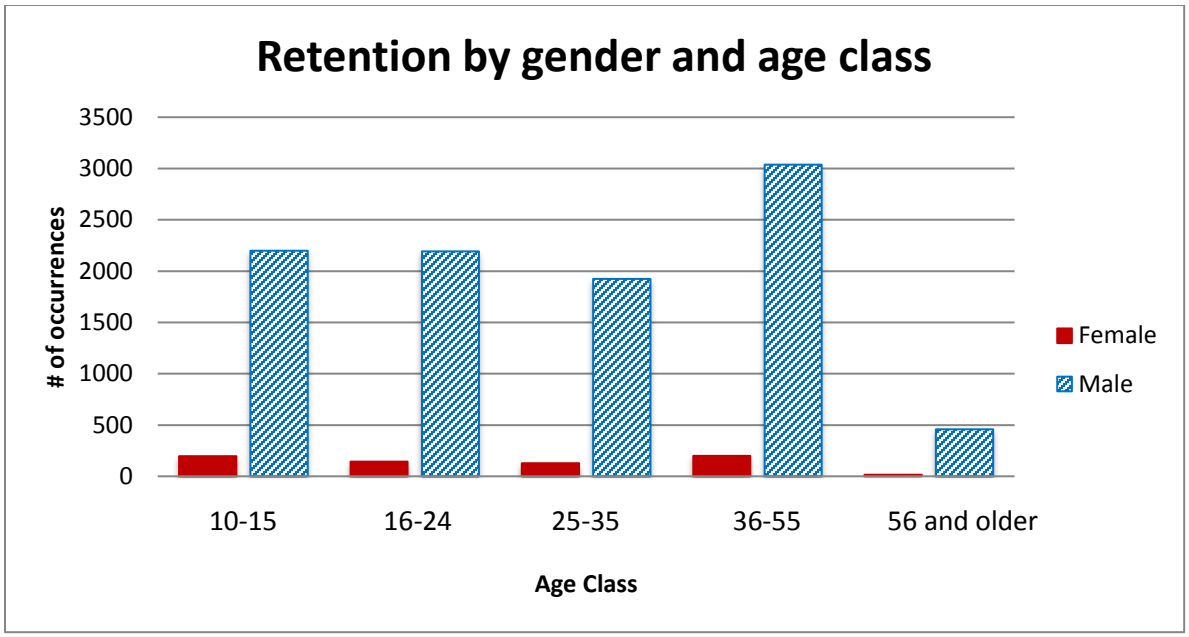

Figure 21: Retention of 2007 hunter education graduates over a six-year period from 2007-2012, by gender and age class. Retention is defined as purchasing a license in two consecutive years (1→1).

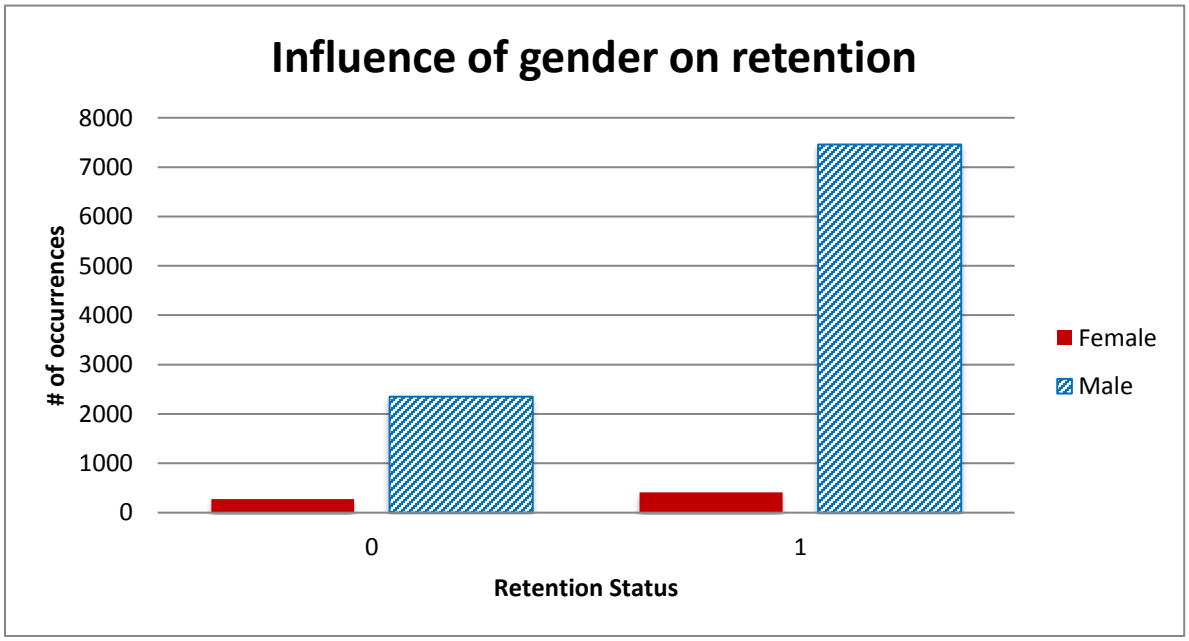

Figure 22: The influence of gender on retention status, where 0 represents no retention (purchase of a license in one year but not the next, 1→0) and 1 represents a retention case (purchase of a license in two consecutive years, 1→1).

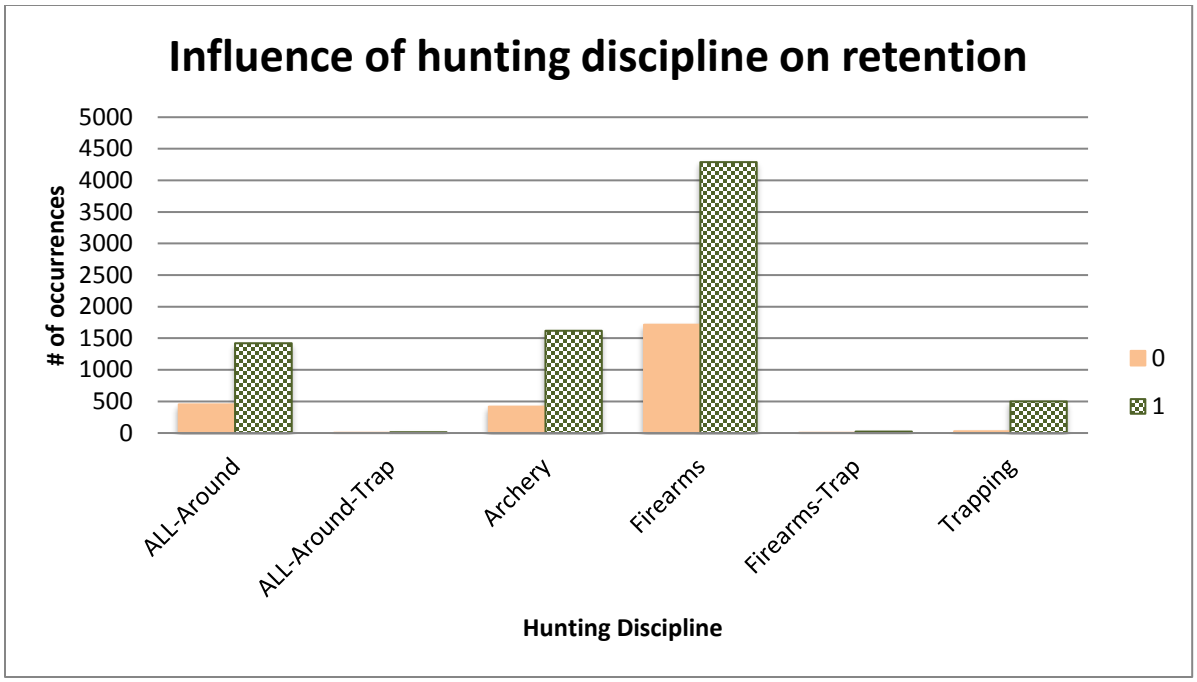

Figure 23: The influence of hunting discipline on retention status, where 0 represents no retention (purchase of a license in one year but not the next, 1→0) and 1 represents a retention case (purchase of a license in two consecutive years, 1→1).

	diff	lwr	upr	p adj
All-Around-Trap-All-Around	0.031865569	-0.250572929	0.31430407	0.9995451
Archery-All-Around	0.036509532	-0.002689918	0.07570898	0.0846894
Firearms-All-Around	-0.043060540	-0.075481511	-0.01063957	0.0021347
Firearms-Trap-All-Around	0.088545731	-0.153343167	0.33043463	0.9032445
Trapping-All-Around	0.185894710	0.125672027	0.24611739	0.0000000
Archery-All-Around-Trap	0.004643963	-0.277678417	0.28696634	1.0000000
Firearms-All-Around-Trap	-0.074926109	-0.356387382	0.20653516	0.9742577
Firearms-Trap-All-Around-Trap	0.056680162	-0.313021837	0.42638216	0.9979915
Trapping-All-Around-Trap	0.154029141	-0.131971035	0.44002932	0.6415127
Firearms-Archery	-0.079570072	-0.110963385	-0.04817676	0.0000000
Firearms-Trap-Archery	0.052036199	-0.189717104	0.29378950	0.9900972
Trapping-Archery	0.149385178	0.089709452	0.20906090	0.0000000
Firearms-Trap-Firearms	0.131606271	-0.109140863	0.37235340	0.6263428
Trapping-Firearms	0.228955249	0.173496122	0.28441438	0.0000000
Trapping-Firearms-Trap	0.097348979	-0.148689300	0.34338726	0.8699968

Table 41: Tukey multiple comparisons of means for hunting disciplines on retention status, using a 95% family-wise confidence level (p-value≤0.05 is significant). A positive estimate of difference means the first discipline is more likely to become a retention status than the second one; a negative estimate of difference means the first discipline is less likely to become a retention status than the second one.

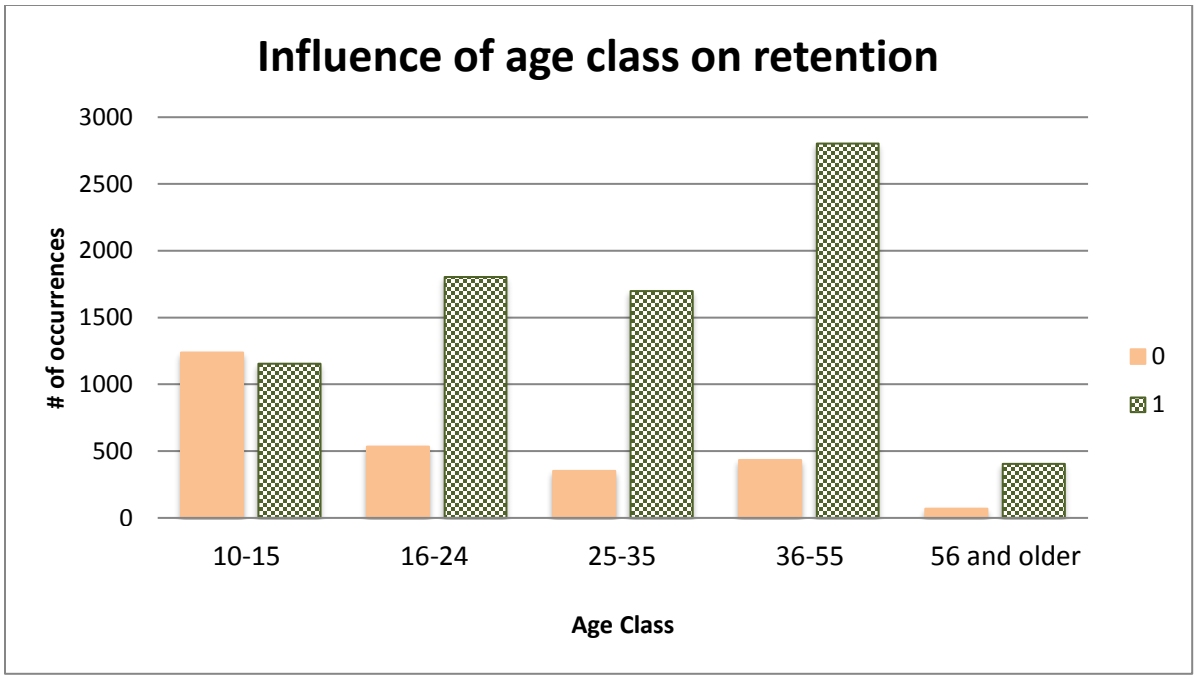

Figure 24: The influence of age class on retention status, where 0 represents no retention (purchase of a license in one year but not the next, 1→0) and 1 represents a retention case (purchase of a license in two consecutive years, 1→1).

	diff	lwr	upr	p adj
16 to 24-10 to 15	0.28937605	0.25710857	0.32164354	0.0000000
25 to 35-10 to 15	0.34632435	0.31293707	0.37971163	0.0000000
36 to 55-10 to 15	0.38373669	0.35382638	0.41364700	0.0000000
56 and older-10 to 15	0.37197424	0.31619516	0.42775332	0.0000000
25 to 35-16 to 24	0.05694830	0.02337036	0.09052623	0.0000369
36 to 55-16 to 24	0.09436064	0.06423766	0.12448362	0.0000000
56 and older-16 to 24	0.08259819	0.02670478	0.13849160	0.0005342
36 to 55-25 to 35	0.03741234	0.00609280	0.06873189	0.0098844
56 and older-25 to 35	0.02564989	-0.03089737	0.08219716	0.7293333
56 and older-36 to 55	-0.01176245	-0.06632901	0.04280411	0.9768870

Table 42: Tukey multiple comparisons of means for age class on retention status, using a 95% family-wise confidence level (p-value≤0.05 is significant). A positive estimate of difference means the first discipline is more likely to become a retention status than the second one; a negative estimate of difference means the first discipline is less likely to become a retention status than the second one.

APPENDIX B: STATISTICAL MODELS

Transition Model:

One models the conditional distribution of the responses, Y_{ij}, on covariates, x_{ij}, and past responses, Y_{i1}, $Y_{i2},\ldots,Y_{i,j-1}$, where
Y_{ij} = purchase probability, retention probability, or recruitment probability
X_{ij} = gender, discipline, age class, or gender + discipline + age class
Y_{i1}, $Y_{i2},\ldots,Y_{i,j-1}$ = purchase of a license in a given year
Let $H_{ij} = \{Y_{i1},\ldots,Y_{i,j-1}\}$ = history of past responses.
The conditional mean of the transitional model is $\mu_{ij}^{C} = E[Y_{ij} \mid H_{ij}, \mathbf{x}_{ij}]$.

We consider transition models where the conditional mean satisfies the equation

$$g(\mu_{ij}^{C}) = \mathbf{x}_{ij}'\boldsymbol{\beta}^{**} + \sum_{r=1}^{s} f_r(H_{ij}, \boldsymbol{\alpha}),$$ for suitable functions f_r and parameters α.

Past responses (or functions thereof) are treated as additional explanatory variables.
The present is affected by the past through the sum of s terms, where
s = purchase probability, retention probability, or recruitment probability of previous year(s)

Adapted from http://faculty.washington.edu/yanez/b540/lectures/lectureWk082010-2x2.pdf

Association Model (one-way ANOVA):

One models the relationship between the response and treatment for the one-way ANOVA by
$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$, where
Y_{ij} = recruitment or retention probability
μ = overall mean
τ_i = i-th treatment effect for gender, discipline, or age class
ε_{ij} = random error
Adapted from http://www.itl.nist.gov/div898/handbook/prc/section4/prc432.htm

Tukey's multiple comparison of means:

The formula for Tukey's test is given by

$$q_s = \frac{Y_A - Y_B}{SE},$$

where,
Y_A = larger of two means being compared between disciplines or age classes
Y_B = smaller of two means being compared between disciplines or age classes
SE = standard error

Adapted from http://www.itl.nist.gov/div898/handbook/prc/section4/prc471.htm