Deer Hunter Demography:
Projecting Future Deer Hunters in Wisconsin

By Jennifer Huck and Richelle Winkler

Summary

The deer herd in the State of Wisconsin is kept largely in check by private hunters who purchase licenses and kill deer each fall. Not only is hunting vital to wildlife management efforts, but it is also an important cultural activity through which people become intricately connected to the natural world. However, the number of deer hunters in the state has declined in recent years, causing concern about the future of the herd and the sport. Between 2000 and 2007, Wisconsin gun deer hunters declined from 645,047 in 2000 to 600,787 in 2007 — almost 7% in eight years.
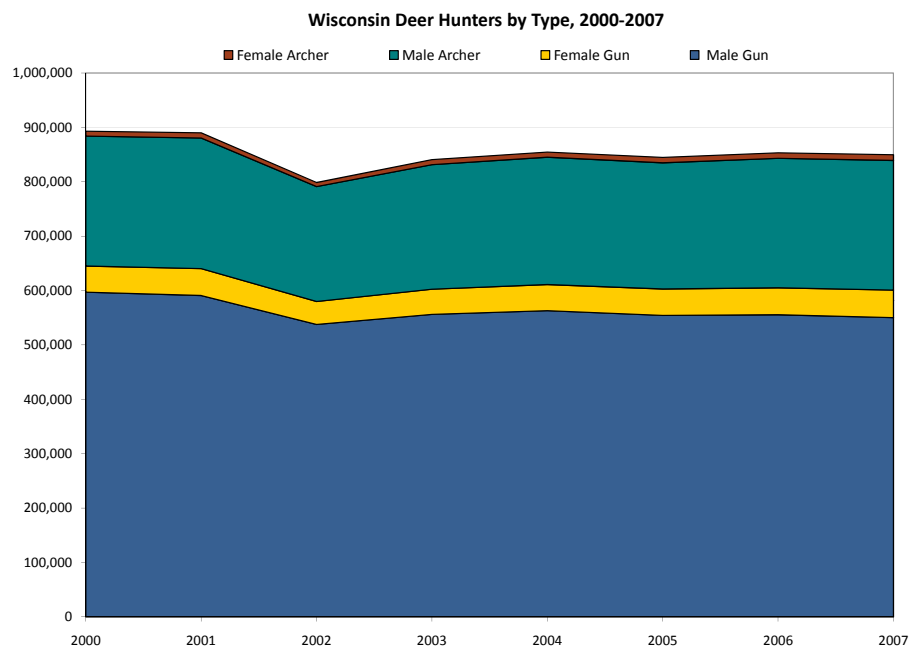
This report is the result of a study undertaken by the Applied Population Laboratory at the University of Wisconsin-Madison at the request of the Wisconsin Department of Natural Resources Wildlife Management.   It is a collaborative project between these two organizations with the goal of better understanding how the population of the state's hunters is changing over time and to project future deer hunters.

The study takes a demographic approach to analyzing the problem of declining hunters by age, sex, and type of hunter (gun vs. archer). By analyzing deer hunting with respect to the total population structure, we can learn a great deal about how the number of hunters has declined and we can predict future deer hunter participation with reasonable accuracy.

We examine the effects of time, age, and generational differences on deer hunter participation rates paying particular attention to specific events that have occurred in time, like the discovery of Chronic Wasting Disease (CWD) in the Wisconsin herd in 2002. We find that overall participation rates dropped markedly between 2001 and 2002 with the discovery of CWD, and rates continued to drop between 2004 and 2007, particularly for male gun hunters under age 65. At the same time, participation rates for male gun hunters over age 65, female gun hunters under age 30, and male archers over age 45 have generally been increasing. These changes in participation rates over time could be related to the effects of DNR programs such as "Earn-a-Buck" policy and programs to promote youth hunting in Wisconsin and/or to broader societal changes such as the empowerment of females to engage in more traditionally male activities, health improvements and accessibility for older adults, urbanization, habitat changes, accessibility of land, deer herd health, or other social and biological forces.

Certainly age plays a role in the likelihood of people to hunt, with participation rates dropping off significantly after about age 65.   At the same time, generational differences play an important role in determining hunter participation rates, independent of age. Males born during the Baby Boom (1946-1965) have been more likely to hunt than younger cohorts, regardless of age. Still, with Baby Boomers (as with all other male cohorts) male gun hunter participants tend to drop off each year as a fewer number of those who hunted one year come back to hunt the next year across all ages. Overall, recent declines in hunter numbers have occurred because of a combination of age, period, *and* cohort effects. Strategies to mediate decline should address each of these components.
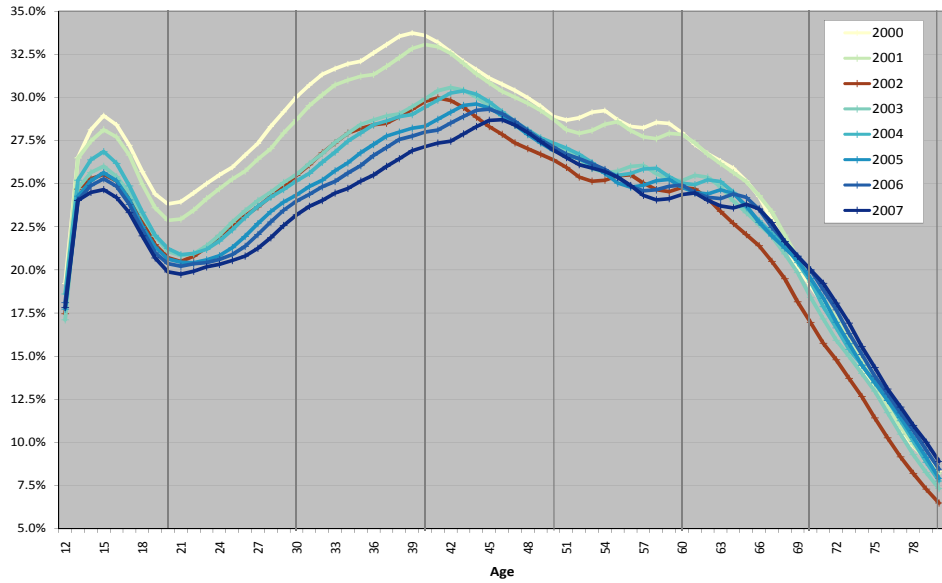
Projections of future hunters suggest that the male gun hunter population will decline in the coming years, that male archers will remain relatively stable, and the female gun hunter population will increase. Model differences are based on different assumptions about future participation rates and how they will vary by age, sex, and cohort groups.

Wisconsin Deer Hunters by Type, 2000-2007

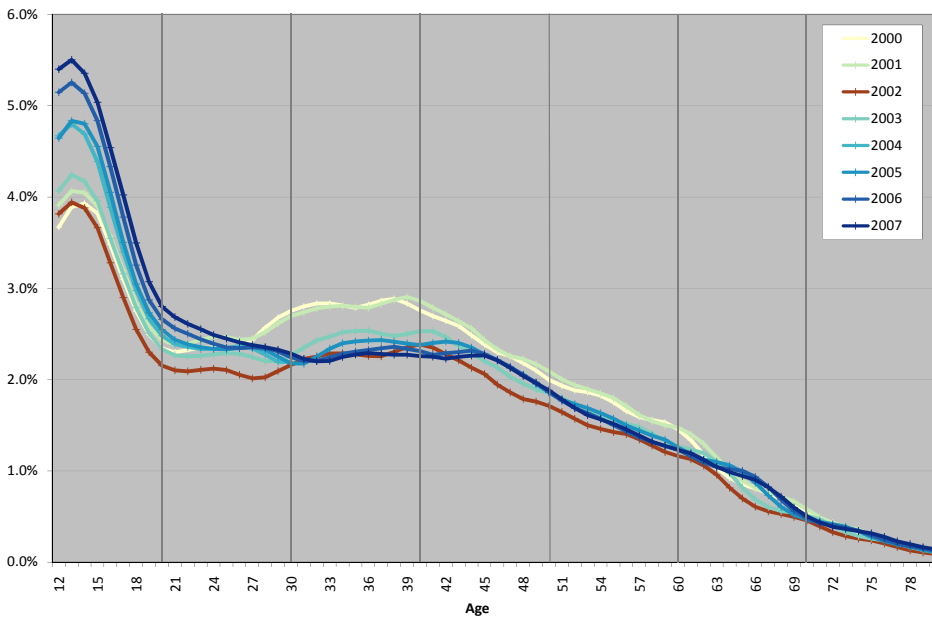Legend: Female Archer, Male Archer, Female Gun, Male Gun

Hunter Participation Rates over Time

In order to understand how hunter numbers are changing, it is important to consider hunters with respect to the total population of the state. Here, rates are calculated by age over time so that the proportion of all Wisconsin people of a certain age who purchased deer hunting licenses in a particular year can be examined. Isolating these rates by age and examining them annually allows for a comparison of how participation has changed over time and at specific time periods. In these charts lighter colors represent earlier years, and darker blues represent more recent years, except for 2002 which is shown in red because this was the year that Chronic Wasting Disease (CWD) was discovered in the Wisconsin herd.

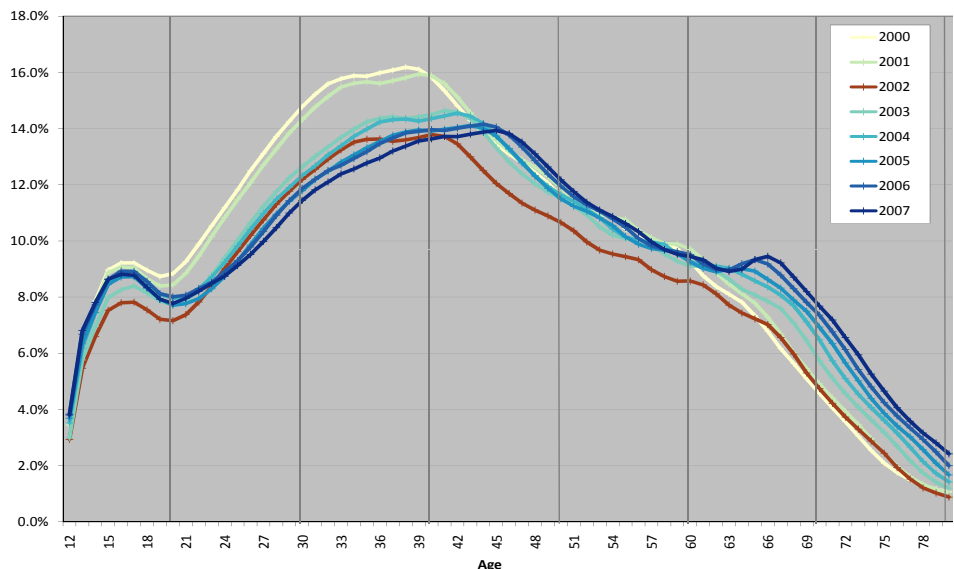**Male Gun Hunter Participation Rates, 2000-2007**

Male gun hunter rates declined steadily at almost every age between 2000 and 2007. Hunters over age 65 were the exception, experiencing increasing rates. In particular, male gun hunting rates for the population under age 47 have seen continued decline each year since 2000, with a particularly large drop off between 2001 and 2002.

In 2000, 34% of Wisconsin males aged 39 purchased gun deer hunting licenses in comparison to 27% of 39 year old males in 2007. Similarly, 29% of 15 year old males gun hunted in 2000 compared to only 25% in 2007.

Female Gun Hunter Participation Rates, 2000-2007

Changes in female gun hunter participation rates varied by age between 2000 and 2007. Participation of young females (under age 30) generally increased, particularly for the youngest females. At the same time, participation rates for females over age 30 remained stable or declined somewhat.

Male archer participation rates increased markedly for hunters over age 60. However, rates declined steadily for hunters between the ages of 24 and 44. Archer participation rates for the youngest males remained relatively stable over this time period. Note: Female archers are not examined in this study due to very low numbers and participation rates.
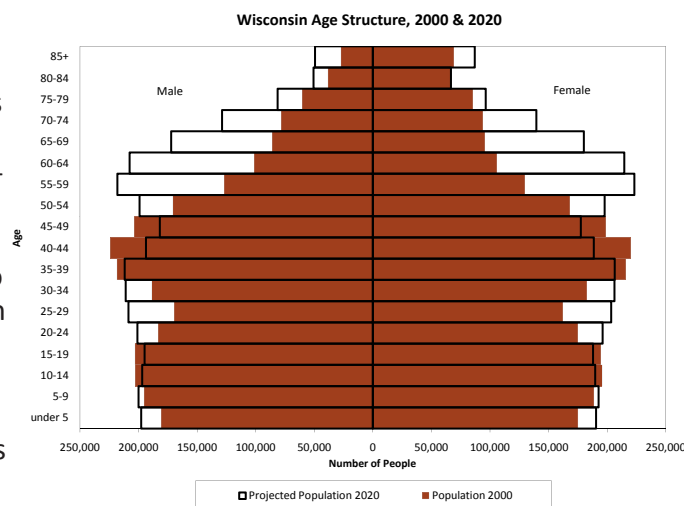
Male Archer Participation Rates, 2000-2007
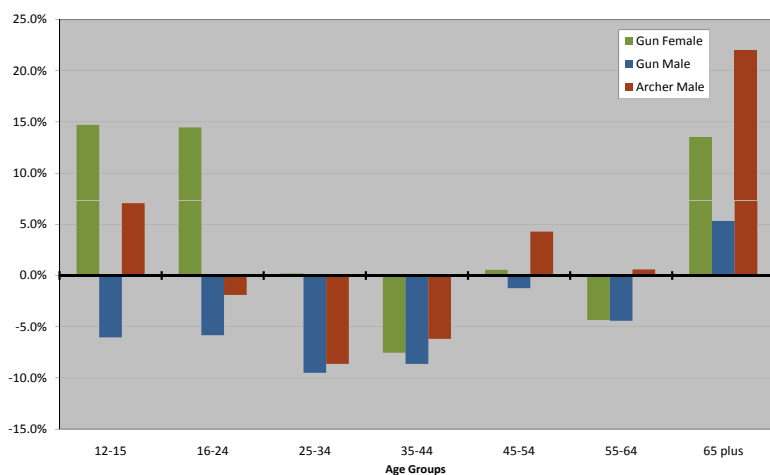
Hunter Participation Rates by Age

The charts on the previous page show that for males, participation tends to peak at middle ages, then to drop off steadily after about age 65. For females, on the other hand, participation rates are highest at the youngest ages. When people are more likely to hunt at certain ages in comparison to others, hunter numbers could shift dramatically as the composition of the total population of Wisconsin shifts in age. For example, in 2007, 41% of Wisconsin resident hunters were between ages 41 and 61 (the Baby Boom generation). What will happen to the number of Wisconsin hunters as these hunters get older and reach the ages where participation rates tend to drop off? The combination of a large number of potential hunters (people overall) in the Baby Boom generation *and* relatively high *rates* of participation for Baby Boomers has contributed to a large numbers of hunters over the last several years. Can we expect this to continue?

The chart at right shows the Wisconsin total population by age and sex in 2000 and projected for 2020. As the large cohorts of the Baby Boom generation grow older with time, the composition of the state's population will change. In particular, the number of people between the ages of 40 and 50 in 2020 is expected to be smaller than the number of people at these ages in 2000. Hunter participation rates have been among their highest for males age 40 to 50. If there is something special about this age group that makes people more inclined to hunt and the number of people at those ages declines over time, then hunter numbers might be expected to decline as well. This logic fuels the share projection model shown later in this report.
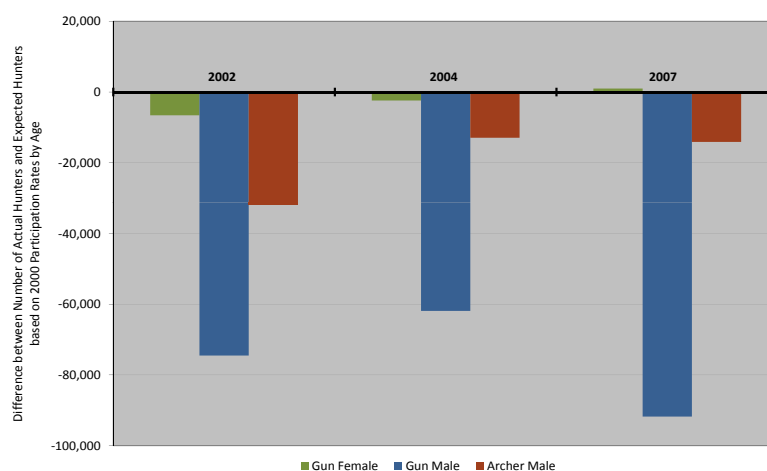

Wisconsin Age Structure, 2000 & 2020

However, the extent to which such age effects impact hunter numbers depends upon the *stability* of participation rates by age. Age effects are most important when participation rates by age are relatively consistent over time. But, Wisconsin hunter participation rates have changed significantly over the last several years. Male gun hunting rates declined at all ages below age 65 and increased above age 65 (see chart below left). Female gun hunting and male archer rates have both increased substantially at the youngest and oldest ages and declined at middle ages. Overall, these patterns suggest that time period and cohort effects may be having important influences on changing numbers of deer hunters in the State of Wisconsin. In particular, population aging may have only a moderate effect on hunter numbers in the near future as the large cohorts of the Baby Boom generation may be more likely to hunt as they reach older ages than the generations who came before them, and recruitment of young hunters will be important in the coming years.

Percent Change in Hunter Participation Rates by Age Groups, 2004-2007

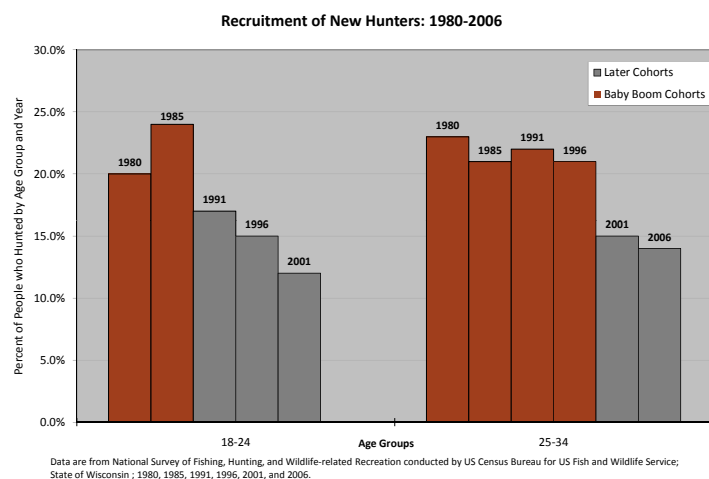Hunter Population Controlling for Age Effects, 2000-2007

In order to examine the extent to which age effects impact hunter counts, we analyzed the effect that the changing Wisconsin population composition has had on hunter decline between 2000 and 2007. The chart above right shows the difference between observed numbers of hunters in 2002 (the year CWD was discovered in the Wisconsin herd), 2004, and 2007 and the expected number of hunters that there *would have been* in each year if the same participation rates by age experienced in 2000 had remained constant and only the underlying population composition of the state had changed. In other words, it shows differences between actual hunters and the number of hunters that would have been based exclusively on age effects. Had rates by age remained constant, there would have been 91,801 *more* male gun hunters in 2007 than what Wisconsin actually had. This would have meant that hunter numbers would have *increased* based on changing age structure alone, rather than the decline experienced. This suggests that age effects do not adequately explain recent hunter decline and that share projections based on constant rates should be interpreted cautiously.

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Generational (Cohort) Impacts on Wisconsin Deer Hunting

In addition to the impacts of age or time period, people's experiences (and their likelihood to hunt) vary by generation. We examine such generational influences by analyzing hunters by the year they reached hunting age (age 12). This is their hunting cohort. Are people who came of age in some years more or less likely to hunt than people who reached hunting ages at other times? Generational (or cohort) effects stem from influences of the past that have affected certain cohorts differently than others. For instance, the generally good socio-economic and family situation of the post- World War II period in the United States influenced the developmental years of the Baby Boom generation, which in turn might influence the likelihood of that generation to hunt.

Here, we examine recent changes in hunter participation between and within cohorts. Differences between cohorts begin with hunter recruitment at younger ages. The chart below left shows the percent of the Wisconsin population (male and female together) who hunted between 1980 and 2006. The Baby Boom generations (highlighted in red) were much more likely to hunt at younger ages than subsequent generations that have followed. Since 1980, in comparison to younger generations, Baby Boomers have been more likely to hunt across their lifetime so far, regardless of age. In other words, evidence suggests that Baby Boomers were the last highly recruited cohort of hunters at younger ages.

Recruitment of New Hunters: 1980-2006

Data are from National Survey of Fishing, Hunting, and Wildlife-related Recreation conducted by US Census Bureau for US Fish and Wildlife Service; State of Wisconsin ; 1980, 1985, 1991, 1996, 2001, and 2006.
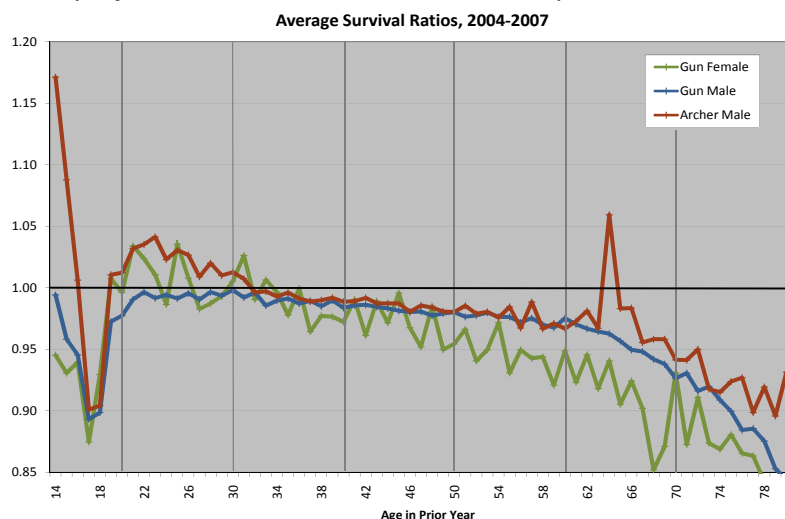
In addition to hunter recruitment, it is important to examine retention of hunters as they age forward in time. Do they continue to hunt at the same rate? Do some former hunters drop out? Do new people take up hunting? One way to understand annual hunter retention by cohort is to examine what demographers refer to as "survival ratios." These ratios compare the number of hunters at a certain age in one year to the number of hunters one year older the next year. If that ratio comparison is greater than 1.0, then that cohort added new hunters over the year. If the ratio, is less than 1.0, then that cohort lost hunters in the course of the year. We average annual ratios experienced between 2004 and 2007 (a time period after the effects of the discovery of CWD had stabilized) for each set of ages in order to examine the average "survival" of hunters from one year to the next between specific ages. This logic fuels the cohort component projection model shown later in this report.

For male gun hunters, cohorts tend to lose hunters between the ages of 15 and 20, retain current hunters between ages 21 to 37, experience a moderate loss between ages 40 and 61, and decline significantly at ages above 61. Female gun hunting cohorts tend to lose members at ages 15 to 20, then to gain participants aged 21 to 37, remain stable at ages 38 to 49, and drop off significantly above age 50. Male archers tend to experience cohort gains at ages 20 to 48, slight loss at ages 49 to 64, a marked increase at retirement age 65 to 66, then decline above age 66.

These survival ratios by age may vary across cohorts. In comparison to older generations (born before 1946), Baby Boomers may be more likely to continue to hunt as they grow older because they are staying healthier and living longer, retiring earlier, and have higher income than any cohort that has come before them.

Average Survival Ratios, 2004-2007

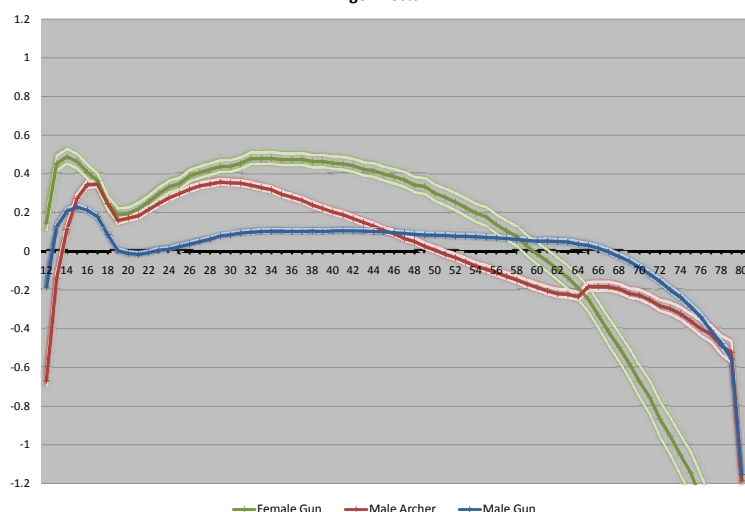## Summary of Recent Trends in Hunter Participation

Examining patterns of hunter participation by time period, age, and cohort offers a snapshot of how the Wisconsin hunter population has changed in recent years. Several indicators point to the fact that the hunter population (especially male gun hunters) is declining. These declines are somewhat related to the changing age structure of the Wisconsin population, yet participation rates for male gun hunters have declined at almost every age, suggesting that the time period is a more important factor in hunter decline. In addition, cohort groups of hunters tend to lose participation as time passes, as the retention or "survival" of hunters from one year to the next is relatively low. Evidence suggests that generational differences are an important explanation for changing numbers of hunters as well. Likely, hunter numbers have been declining due to a combination of time period, age, and cohort effects that work in conjunction with one another.

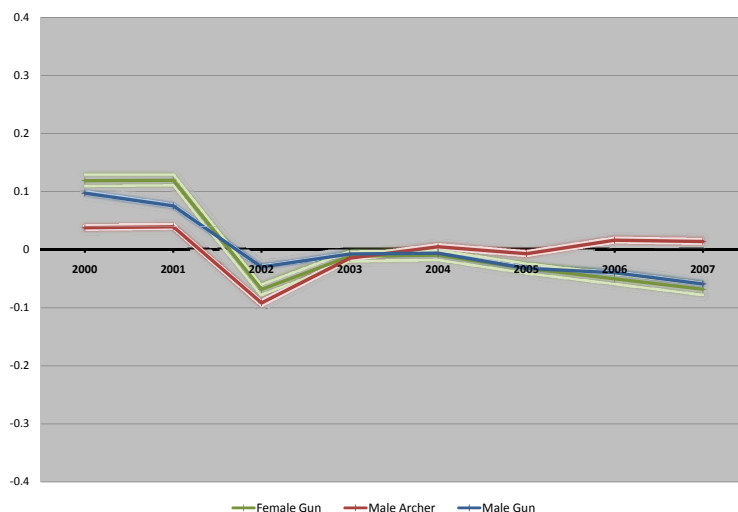# Age, Period, and Cohort Analysis of Recent Deer Hunter Trends

As discussed, age, time period, and generation (cohort) all impact the likelihood of people to deer hunt. Age effects are relatively straightforward and related to life course events that tend to occur at particular ages (like going away to college, having children, or retiring) and physiological changes that occur as our bodies mature. Time period effects could represent specific events that occur at a certain moment in time, like the discovery of CWD in the Wisconsin herd, or more gradually occuring biological, social, economic, and cultural changes that have transpired over the last few years (i.e., programs promoting youth hunting, habitat change, or economic recession). Cohort effects refer to experiences of different generations and reflect social and cultural transformations that occured in the past or that have occurred very gradually over a long period of time and have impacted different age groups in different ways (i.e., the empowerment of women to pursue activities traditionally associated with males only). Thinking about changes in the deer hunter population in these ways offers a first look into how and why the population is changing and how it might continue to change over the next several years.

The complicated thing about an age-period-cohort analysis is that these factors work simultaneously making it difficult to separate effects caused by each individual component. In other words, it is difficult to tell whether it is a group's age at the moment, something about the time period, and/or a cohort issue that is affecting participation rates. The previous charts and discussion have attempted to distinguish these effects; yet, the three continue to compound one another. In order to isolate the effects of age, period, and cohort and to individually examine each, we implement an Age-Period-Cohort (APC) statistical analysis aimed at understanding how each of these factors works independently of the others to impact the Wisconsin deer hunting population. Using data from 2000 to 2007 on the number of licenses sold by single year of age (12 to 80+), we estimate the independent effects of age, period, and cohort on changes in the Wisconsin deer hunter population. The charts below show the result of this analysis by likelihood to purchase a hunting license. Values below the zero axis represent decreased likelihood of hunting at that age, cohort, or time period; values above the zero axis represent increased likelihood to hunt. The lighter colored lines bordering the estimates represent 95% confidence intervals.
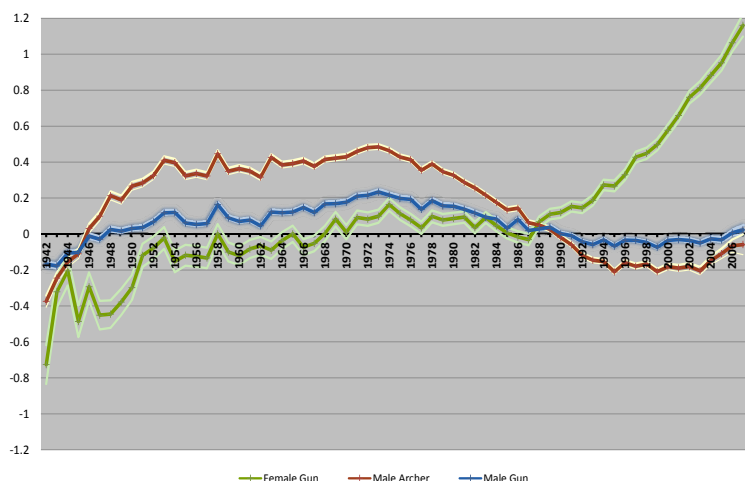
Age Effects

Legend: Female Gun, Male Archer, Male Gun

Period Effects

Legend: Female Gun, Male Archer, Male Gun

Cohort Effects

Legend: Female Gun, Male Archer, Male Gun

Female gun hunters (shown in green) are more likely to hunt at younger ages. In particular, cohorts born after 1980 are significantly more likely to hunt than any other females, independent of age effects. Controlling for age and cohort effects, females have been less likely to hunt since 2002.

Male gun hunters (blue) are most likely to hunt as teens. After age 65, the likelihood of men to gun hunt decreases steadily. Males are most likely to bow hunt (red) between ages 16 and 50. Archers are unique in that over the last couple of years, they have been *more* likely to hunt, while the likelihood of gun hunting for males and females has declined. For all males (bow and gun), cohorts who started to hunt 1950 to 1982 are most likely to hunt, and particularly those who came of age 1970-1975. Male cohorts coming of age in 1990 and after are less likely to hunt, independent of age.

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Future Deer Hunter Projections: Data and Methods

The two sources of data used in generating projections are (1) counts of deer hunting license purchases by single year of age, sex, and license type (gun or archer) provided by the Wisconsin Department of Natural Resources Wildlife Management for the years 2000 to 2007, and (2) estimates and forecasts of the total population of the State of Wisconsin by single year of age and sex provided by Emeritus Professor Paul Voss at the Applied Population Laboratory. These forecasts were created using a cohort-component method of forecasting in May 2007.

There are three distinct types of projection methods used in this study. The first method is known as a ratio (or share) method of forecasting. In this method, a subset of the population (in this case, deer hunters) is expressed as a proportion of the total population (here, the State of Wisconsin). Hunting rates are calculated by dividing the number of hunters in one age and sex category by the Wisconsin population in that age and sex category. For instance, 33% of all 46 year old males in Wisconsin in 2007 were gun deer hunters. This method offers insight into how changes in Wisconsin's population composition may affect future numbers of hunters in the coming years.

The Share Model shown here averages participation rates for 2005, 2006, and 2007 by age to generate a constant rate that is applied to a forecast of the total Wisconsin population by age and sex. The model assumes that the average participation rates between 2005 and 2007 will remain stable and that changes in the structure of the base population (the total Wisconsin population) will drive changes in the hunter population. This model is well-suited for situations in which it is believed that participation rates by age will remain stable over time, but would produce unrealistic estimates of future hunters if participation rates continue to change as expected. For this reason, the share model might be used as a gauge against which to compare other projection models or to examine the future effects of changing age composition on hunter numbers, but it is not likely a realistic projection of future hunters, given past trends, period and cohort effects.

The second type of method is a Cohort Component method. Survival ratios (as discussed previously) depict changes in hunter rates, year to year and age to age. They measure the effects of people coming into and going out of hunting. The ratios are calculated for several pairs of years and then an average of retention ratios between 2004 and 2007 is calculated for each age. For example, the average ratio for 13 to 14 year old male gun hunters is 1.059. This means that the number of 14 year old male hunters is on average 5.9% larger each year than the number of 13 year old hunters the previous year. Only the survival ratios for the youngest ages (12 to 13 and 13 to 14) of male gun hunters show increases; all other ratios show decreases as cohorts age over time. The same is not true for male archers or female gun hunters: they show more increases from age to age, year to year. The cohort component model captures the effect of age, recent period changes, and to a lesser extent "generational" (or cohort) trends because it follows cohorts of hunters over time. This model assumes that the average rates of transfer into and out-of hunting by cohorts at particular ages in recent years will continue into the future.

The third method takes an Age-Period-Cohort (APC) regression model approach to projecting future hunters. The APC model employs statistical estimates of the liklihood of hunting by age, period, and cohort (as shown in the charts on page 5) between 2000 and 2007 and applies these estimates to future age structure, cohorts, and time periods.[1] First, the effect of every age group (12 to 80+), period (2000 to 2007), and cohort group (1932 to 2007) is estimated. These liklihood estimates are then transformed to provide rates of participation that are combined for each year in the projection horizon. The age effect is assumed to remain stable into the future, the period effect is assumed to continue to decline as it has in the last three years, and the effect of incoming cohorts is assumed to be the average of the 1985 to 1994 cohorts for males and the 1995 cohort for females. The APC model best incorporates age, period, and cohort effects. It is unique in that it assumes that younger generations of females are significantly more likely to hunt than previous generations, and it assumes that the Baby Boom generation will continue to hunt as they reach older ages (up to age 70) than older generations who came before them. Note: this is a new type of model that has not been well tested.

A final modification was made in each of these projections regarding race/ethnicity. The minority population of Wisconsin is growing at a rapid rate and has a relatively young age structure. It would be misleading to apply hunting rates of today to an increasingly minority population of tomorrow because of differences in the likelihood to hunt by race/ethnicity. According to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, in 2006, 89% of the total Wisconsin Population were white,[2] while 97% of hunters were white. Similarly, in 2006, 70% of the total U.S. population were white, while 93% of all hunters were white. These statistics indicate that hunting is an overwhelmingly white recreational activity. Rather than applying hunting rates to the total Wisconsin population, we assume that 97% of hunters in each age, sex, and license category are white and 3% are minority, create rates of participation for both white and minority populations based on estimates of the Wisconsin white and minority populations, and apply those rates to the projected white and minority populations.

The Future of Deer Hunters in Wisconsin: Projections

Male Gun Hunters

Projections of the male gun hunter population suggest that the number of future hunters over the next several years will decrease considerably.   Both the Cohort Component and APC models indicate declining numbers of male gun deer hunters. The Cohort model assumes that the low levels of hunter retention that were experienced in the recent past will continue into the future. Based on the survival ratios, between the ages of 18 and 65, cohorts lose an average of 1.9% of their hunters each year as hunters age over time. Above age 65 these decreases are more pronounced.   This leads to a low projection of only about 428,000 male gun hunters by the year 2030, substantially lower than the about 550,000 hunters in 2007. If hunters continue to drop out of hunting and new young hunters enter hunting at rates similar to what they have in the recent past, then the Cohort model should reasonably predict the number of future male gun hunters. The APC model assumes that participation rates of the Baby Boom generation will remain relatively high as this group ages until at least age 70, but that declining period effects and lower participation rates of younger cohorts will lead to hunter decline. Modifications to make hunting land more accessible to an aging population might be necessary to fulfill this projection.

The Share model assumes that participation rates will *not* continue to decline as they have since 1980, but rather that participation rates will remain stable in the future. This model shows what future numbers of male gun hunters will be *if* age effects were the only factor affecting hunter population change.
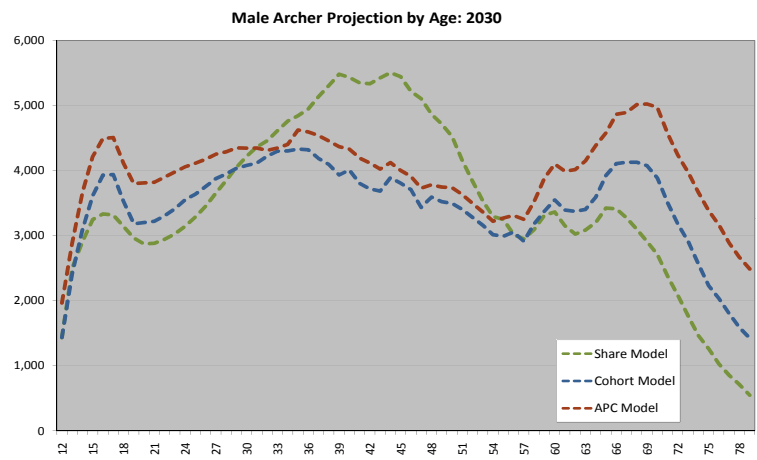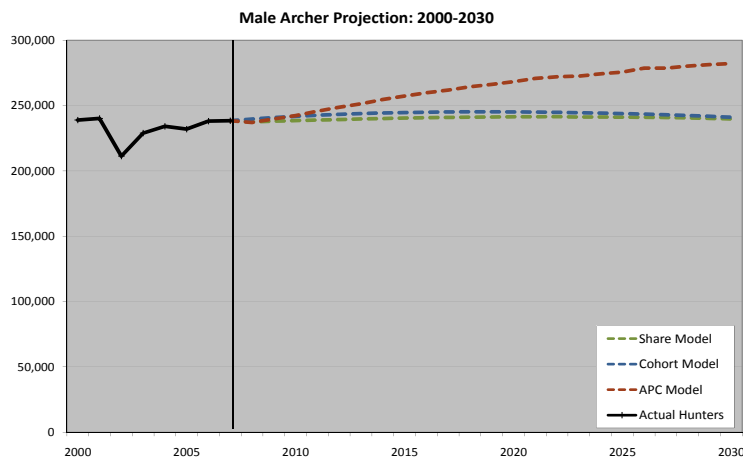

Male Gun Hunter Projection: 2000-2030

Male Gun Hunter Projection by Age: 2030

Male Gun Hunters	Actual			Projected				
	2000	2005	2007	2010	2015	2020	2025	2030
Share Model				561,192	568,105	572,232	573,600	572,214
Cohort Model	597,025	554,223	550,162	535,813	509,917	482,333	454,772	427,790
APC Model				536,317	520,989	498,982	469,686	436,317

Male Archers

The male archer population is projected to remain relatively flat in the coming years. The Share and Cohort Component models predict similar numbers of hunters, indicating that participation rates have been relatively stable in recent history. The APC model assumes that the Baby Boom will continue to hunt into older ages and that archery will continue to become more popular as it has in recent years. With these assumptions, the APC model projects moderately increasing numbers of archers.

Male Archers	Actual			Projected				
	2000	2005	2007	2010	2015	2020	2025	2030
Share Model				238,530	240,431	241,368	241,143	239,809
Cohort Model	238,939	232,011	238,399	241,760	244,659	245,141	243,901	241,002
APC Model				242,319	257,232	268,280	275,669	282,132

Male Archer Projection: 2000-2030
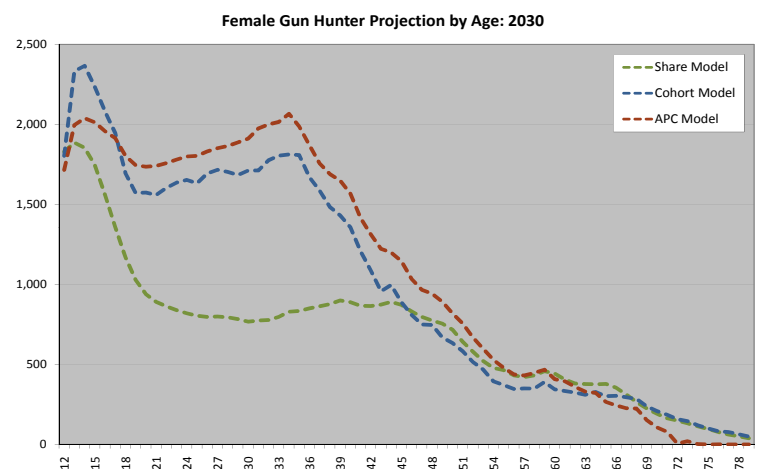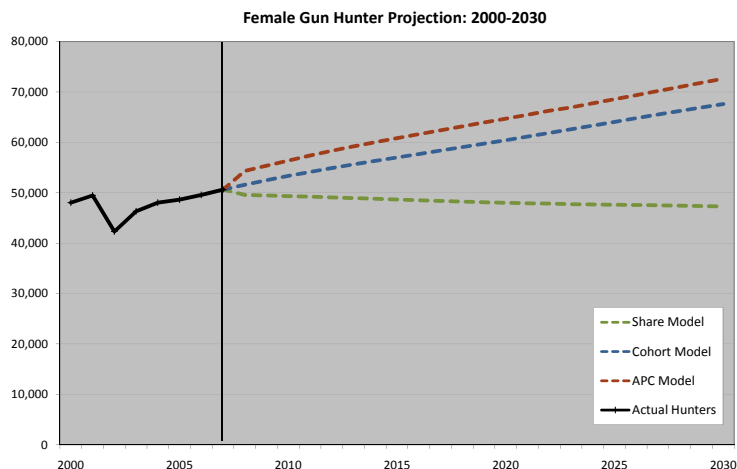

Male Archer Projection by Age: 2030

Female Gun Hunters

The Cohort Component and APC projection models suggest that numbers of female gun hunters will increase considerably in the coming years. The Share model, on the other hand, projects little growth. Because the Share model *only* considers age effects and assumes that participation rates by age will remain constant, it does *not* take into account the increased inclination of younger generations of females to hunt.   Rather, the Share model assumes that participation rates of recent generations of females will drop off considerably as these women reach age 20.

The Cohort Component and APC models allow participation rates to vary over time in relation to cohort effects. These models are particularly affected by the fact that more and more young females are hunting. The Cohort model assumes that the recently large cohorts of female hunters will, for the most part, continue to hunt through middle adulthood after a drop off in the late teens and early twenties. The APC model is heavily influenced by cohort effects. It assumes that there has been a substantive change in more recent generations that encourages females to hunt to an extent that was never experienced by previous cohorts. In other words, the APC model is largely based on the observation that younger

continued below

Female Gun Hunter Projection: 2000-2030

Female Gun Hunter Projection by Age: 2030

Female Gun Hunters	Actual			Projected				
	2000	2005	2007	2010	2015	2020	2025	2030
Share Model				49,330	48,659	48,008	47,622	47,286
Cohort Model	48,022	48,632	50,625	53,338	57,005	60,430	64,061	67,601
APC Model				56,383	60,833	64,706	68,555	72,637

cohorts of women are more likely to hunt. The model assumes that these younger generations will continue to hunt as they grow older and that new incoming cohorts of females will also be similarly likely to hunt.

The differences in 2030 projections by age between the Share and the more cohort-based models reflect this conceptual difference. Whereby the Share model assumes rates by age will remain constant, the Cohort and APC models assume a generational shift in the likelihood of females to hunt.