

BLACK BEAR DATA ANALYSIS UNIT
MANAGEMENT PLAN
Upper Arkansas
DAU B-14

GAME MANAGEMENT UNITS
48, 49, 56, 57, 481, 561
SE Region

Prepared for:
Colorado Parks and Wildlife

By:
Jamin Grigg
Wildlife Biologist
Date: September 2015



DATA ANALYSIS UNIT PLAN FOR B-14

EXECUTIVE SUMMARY

GMUs: 48, 49, 56, 57, 481, and 561 (Chaffee, Fremont, Lake, and Park counties)

Land Ownership: 67% USFS, 22% Private, 7% BLM, 3% State (1.1 million acres total)

Previous Objective: Stable, no population objective for B-14

Previous Mortality Objectives: Harvest objective: 15; Total mortality objective: 18

Recommended Strategic Goal: Manage for a stable bear population

Harvest objective: 16-26

Total mortality objective: 20-30

Mortality objectives are derived and monitored through review of the age structure of bear mortality, the composition of gender in harvest, conflict/damage levels and from bear density estimates, where available.

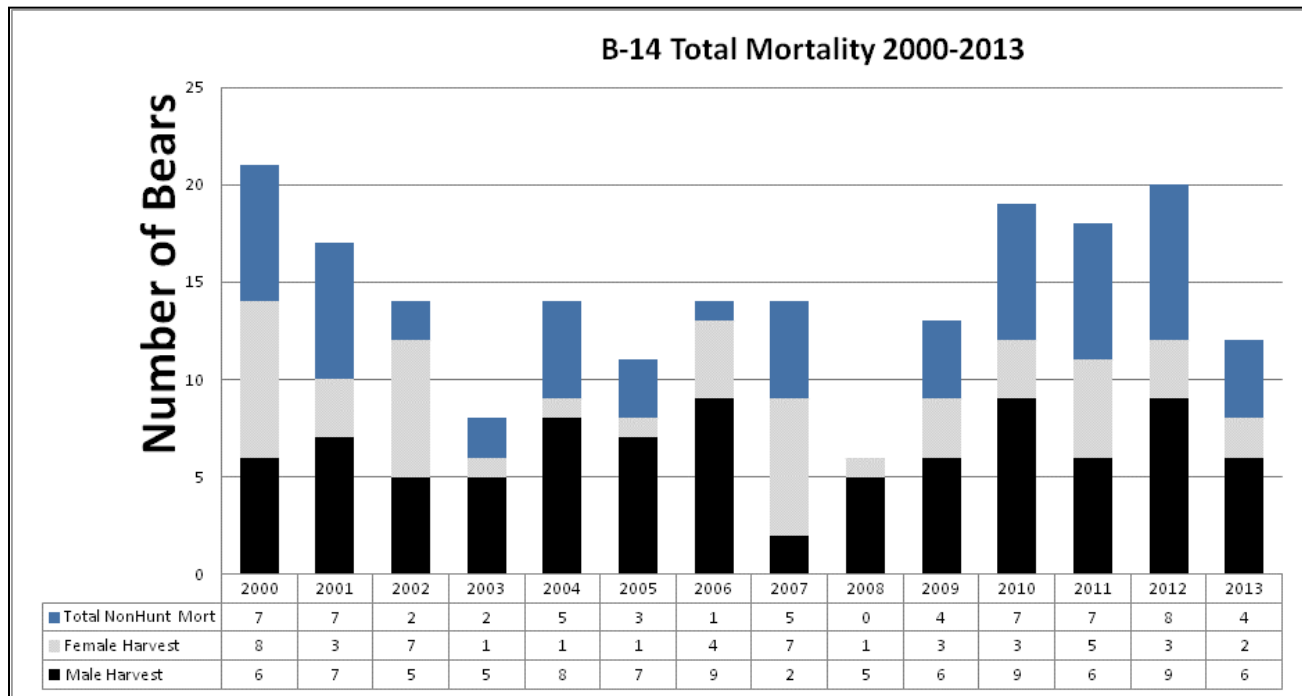


Figure 1. Total non-hunt mortality, female harvest and male harvest in B-14 from 2000-2013.

BACKGROUND

Black bear Data Analysis Unit (DAU) B-14 is located along the upper reaches of the Arkansas River basin in central Colorado and includes the towns of Leadville, Buena Vista, and Salida. The DAU includes Game Management Units (GMUs) 48, 49, 56, 57, 481, and 561 in portions of Chaffee, Fremont, Lake, and Park counties. Nearly 80% of the 1.1 million acres in the DAU is public land. Black bears utilize the entire DAU, but quality foraging habitat is limited and results in low bear densities in much of the DAU.

In general, overall annual bear mortality has been fairly consistent over the last 10 years in B-14. Since 2004, total bear mortality in B-14 has ranged from a low of 6 in 2008 to a high of 20 in 2012, with an annual average of 16 bears. The 10-year annual average of hunting mortality is 11 bears. The 30 day September rifle season has an average three-year success rate of 6%, and is responsible for approximately 80% of the annual bear harvest in B-14. Success rates in the archery, muzzleloader, and general rifle seasons are very low and generally result in only a few additional bears harvested annually. Harvest and total mortality rarely exceed current mortality objectives for maintaining a stable bear population in B-14. Game damage claims have averaged only 2 per year in B-14 for the last 10 years with an average cost of ~\$400. Like most of Colorado, conflicts between bears and humans are not uncommon in B-14 and are usually the result of bears using developed habitats and food sources that are associated with people.

A suite of habitat and population models have been developed as part of the revision of the B-14 DAU plan to help provide estimates of the projected bear population in the unit. These include a general vegetation/bear density extrapolation, a use/occupancy surface extrapolation based on habitat classifications, and two model simulations with varying constraints (liberal and conservative).

SIGNIFICANT ISSUES

In general, B-14 is a relatively low conflict bear population. That said, the most significant issue regarding bear management in the upper Arkansas River Valley relates to balancing the demands of hunters, livestock producers, local residents, and non-consumptive users of wildlife. It's important that we maintain a sustainable bear population in B-14, while at the same time an equal interest in decreasing human-bear interaction and livestock damage. This management issue and what tools should be used to address it are complex and multifaceted.

The structure of a DAU plan focuses on one specific tool, primarily hunting, out of a suite of tools including education, enforcement, and habitat modification, which can also be used to manage conflicts. Unfortunately, the types of conflicts that occur with bears and the landscapes they occur in, often preclude simple changes in licensing or hunting structure from completely resolving the problem. This DAU plan provides harvest related monitoring structures along with strategic goal alternatives that will directly impact bear population sizes in B-14.

MANAGEMENT ALTERNATIVES

The B-14 DAU is currently being managed for a stable bear population, with a total mortality objective of 10-15% of the total population size, and has averaged 13% over the last 5 years. The following three strategic objectives alternative were presented to the public in November 2014.

Stable population trend

To achieve a strategic goal of maintaining a stable bear population in B-14, harvest and total mortality rates will fall in an intermediate range. Total mortality should fall within 10-15% of the total population. Proportion of adult males in the harvest should be within 25-35%, with all females making up 30-40% of harvest. Additionally, adult females should comprise approximately 45-55% of the female harvest. Within the framework of an overall stable population, flexibility in off-take rates will be maintained to manage for minimized game damage and human/bear conflicts in localized areas of concern. Not every management index must be in complete agreement, but most should point toward a stable population.

Decreasing population trend for three years, then stable population trend

Given that current hunting license allocation is meeting or exceeding demand, it's questionable this alternative could even be achieved using hunters alone. To achieve a strategic goal of decreasing, then maintaining the bear population in B-14, harvest and total mortality rates would be in the liberal range, and then reevaluated after three years. Total mortality would increase to 15-20% of the total population size. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Populations in areas with conflict and damage could be suppressed to low levels. After three years of decreasing the population, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. Not every management index must be in complete agreement, but most should initially point toward a decreasing trend, followed by a stable trend.

Decreasing population trend

As with the previous alternative, given that current hunting license allocation is meeting or exceeding demand, it's questionable this alternative could even be achieved using hunters alone. To achieve a strategic goal of decreasing the bear population in B-14, harvest and total mortality rates would be in the liberal range. Total mortality would increase above 15-20% of the population. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Areas with conflict and damage could be suppressed to very low levels. Not every management index must be in complete agreement, but most should point toward a population being held below biotic and human

social tolerance thresholds. It is unrealistic to manage for a continually decreasing population; after 5 years of applying this strategy, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. When the three-year average harvest criteria for a DAU indicate heavy harvest of over 50% females in the total harvest and over 60% adult females in the female harvest on either a three year running average or in two consecutive years, subsequent harvest objectives and license allocations may be reduced to stabilize if other indicators, including nuisance and conflict, are in agreement.

RECOMMENDED STRATEGIC GOAL

During the DAU planning process 228 hunters, landowners, and other members of the public provided input regarding black bear management in the upper Arkansas River Valley. Approximately 93% of respondents expressed an appreciation for black bears, although 40% expressed concern about human-bear conflicts. Approximately 75% of respondents desire the black bear population to remain stable or increase over the next 10 years, while only 13% desire a decrease (remaining respondents had no opinion or were unsure). Approximately 60% of respondents were hunters in general and 40% had hunted bears specifically. Most management indices indicate the B-14 population is currently stable at approximately 200-220 bears. Human-bear conflicts within the DAU are currently at an acceptable level. There appears to be both internally and externally the desire to manage for a stable bear population in B-14, while continuing to provide hunter opportunity and minimize human-bear conflict.

The preferred alternative is to manage for a stable population of 200-220 bears in B-14. These goals correspond to an annual off-take rate of 10-15% of the total population. Proportion of adult males in the harvest should be within 25-35%, with all females making up 30-40% of harvest. Additionally, adult females should comprise approximately 45-55% of the female harvest. Within the framework of an overall stable population, flexibility in off-take rates will be maintained to manage for minimized game damage and human/bear conflicts in localized areas of concern. With a population estimate of approximately 200-220 independent bears in B-14, this will translate to an overall mortality objective of approximately 20-30 bears annually. Should human-bear conflicts noticeably increase within the DAU during the life of this Plan, the population objective and preferred alternative will be reevaluated at that time.

This plan was approved by the Colorado Parks & Wildlife Commission in March, 2016.

TABLE OF CONTENTS

INTRODUCTION	7
DAU PLANS AND WILDLIFE MANAGEMENT BY OBJECTIVES.....	7
DATA ANALYSIS UNIT DESCRIPTION	9
LOCATION	9
LAND USE AND LAND STATUS	10
TOPOGRAPHY & CLIMATE.....	11
VEGETATION.....	11
MANAGEMENT HISTORY.....	13
ADMINISTRATIVE	13
HUNTING SEASONS.....	13
LICENSE ALLOCATION HISTORY	14
MORTALITY: HARVEST AND NON-HARVEST	15
GAME DAMAGE AND HUMAN CONFLICT MANAGEMENT	18
CURRENT HARVEST AND TOTAL MORTALITY OBJECTIVES	19
MANAGEMENT CONSIDERATIONS.....	19
HABITAT MODELS	19
GENERAL VEGETATION/ BEAR DENSITY EXTRAPOLATION	19
USE/OCCUPANCY DENSITY EXTRAPOLATION	20
MORTALITY DENSITY AND RATES	22
FORAGE CONDITION AND MAST PRODUCTION SURVEYS	23
POPULATION MODELS	23
MORTALITY COMPOSITION AND MANAGEMENT CRITERIA	24
SOCIAL FACTORS.....	27
STRATEGIC GOALS AND MANAGEMENT OBJECTIVES.....	27
PROCESS FOR DEVELOPING STRATEGIC GOALS AND MANAGEMENT OBJECTIVES	29
STRATEGIC GOALS	29
MONITORED DATA TO INFORM MANAGEMENT	30
MANAGEMENT OBJECTIVES AND PREFERRED STRATEGIC OBJECTIVE	31
REFERENCES	34
APPENDIX A: STRATEGIC OBJECTIVE ALTERNATIVES.....	36
APPENDIX B: PUBLIC SURVEY.....	36
APPENDIX C: PUBLIC SURVEY RESULTS.....	36

INTRODUCTION

Colorado Parks and Wildlife (CPW) manages wildlife for the use, benefit and enjoyment of the people of the state in accordance with CPW's Strategic Plan and mandates from the Colorado Parks and Wildlife Commission and the Colorado Legislature. Colorado's wildlife resources require careful and increasingly intensive management to accommodate the many and varied public demands and growing impacts from people. CPW is responsible for the maintenance of Colorado's big game at population levels that are established through a public review process and approved by the Colorado Parks and Wildlife Commission.

DAU PLANS AND WILDLIFE MANAGEMENT BY OBJECTIVES

To manage the state's big game populations, the CPW uses a "management by objective" approach (Figure 2). Big game populations are managed to achieve objectives established for Data Analysis Units (DAUs). DAUs are geographic areas that typically contain an individual big game population. For large mobile carnivores like black bears DAUs are primarily administrative constructs with generally similar habitats and/or human social considerations. DAUs are composed of smaller areas designated as game management units (GMUs), which provide a more practical framework where the management goals can be refined and applied on a finer scale, typically through hunting regulations.

The DAU plan process is designed to balance public demands, habitat and big game populations into a management scheme for the individual DAU. The public, hunters, federal and local land use agencies, landowners and agricultural interests are involved in the determination of the plan objectives through input given during public meetings, the opportunity to comment on draft plans and when final review is undertaken by the Colorado Parks & Wildlife Commission. The strategic goals and specific mortality objectives defined in the plan guide a long term cycle of annual information collection, information analysis and decision making. The end product of this process is a recommendation for numbers of hunting licenses for the DAU. The plan also specifically outlines the management techniques that will be used to reach desired objectives. CPW intends to update these plans as new information and data become available, at least once every ten years.

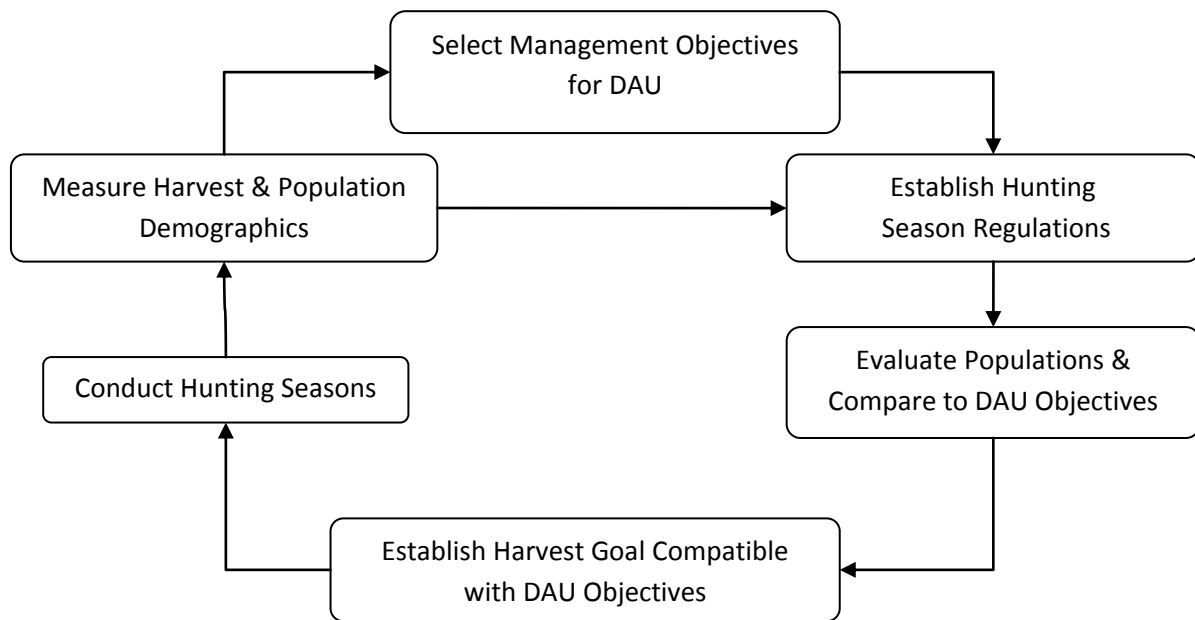


Figure 2. Management by objective process used by CPW to manage big game populations at the DAU-level.

DATA ANALYSIS UNIT DESCRIPTION

Location

Black bear Data Analysis Unit (DAU) B-14 is located along the upper reaches of the Arkansas River basin in central Colorado and includes the towns of Leadville, Buena Vista, and Salida. The DAU includes portions of Chaffee, Fremont, Lake, and Park counties. The Game Management Units (GMUs) in B-14 are 48, 49, 56, 57, 481, and 561. While managed by a number of agencies, nearly 80% of the 1.1 million acres in the DAU is public land (Figure 3). The US Forest Service (USFS) manages 67% of the land in the DAU, or 754,850 acres. The Bureau of Land Management (BLM) manages 7% of the land in the DAU, 83,420 acres. The State of Colorado manages approximately 3% of the DAU, 32,775 acres. The remaining 22% of the lands in the DAU, 252,282 acres, are in private ownership.

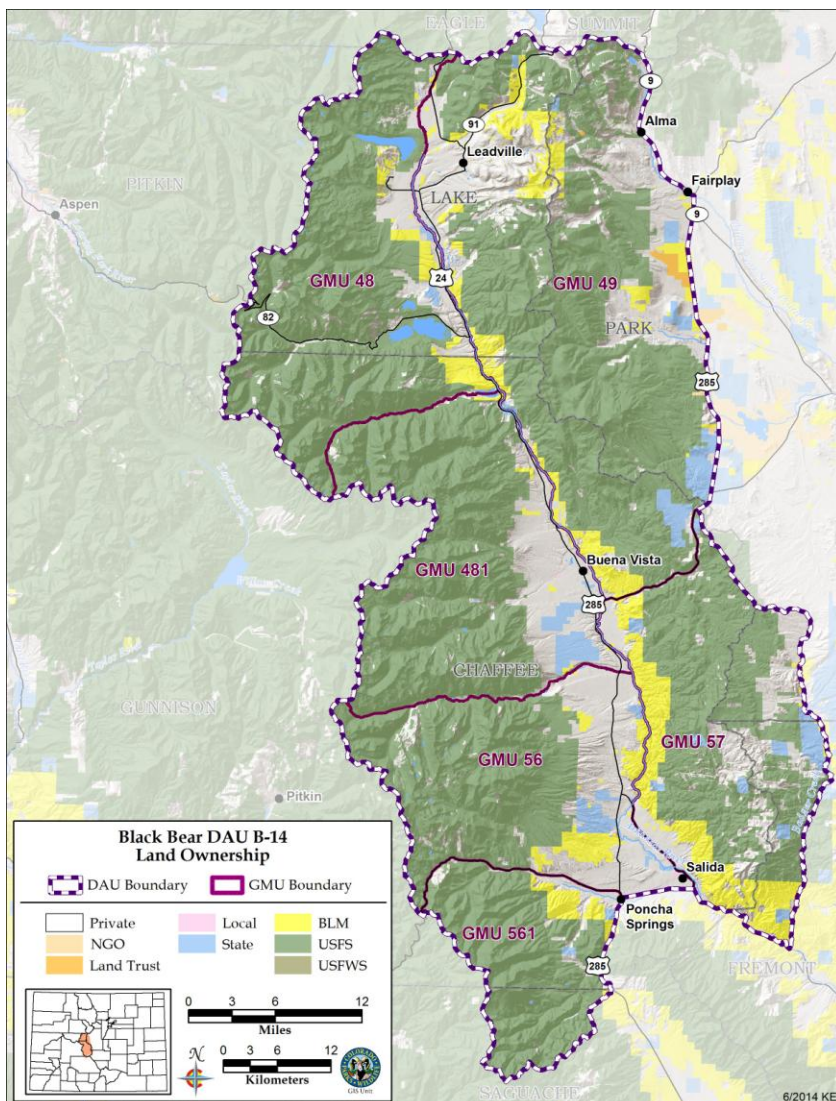


Figure 3. B-14 Location and landownership

Black bears utilize the entire DAU, though quality foraging habitat is limited and bear densities are low in much of the DAU. Only 9% of the DAU is considered summer concentration habitat and only 1% is considered fall concentration habitat (Figure 4). Human conflicts are minimal, but concentrated around towns and subdivisions. Bears tend to concentrate in the fall during hyperphagia in riparian areas and areas with high mast crop production in anticipation of hibernation.

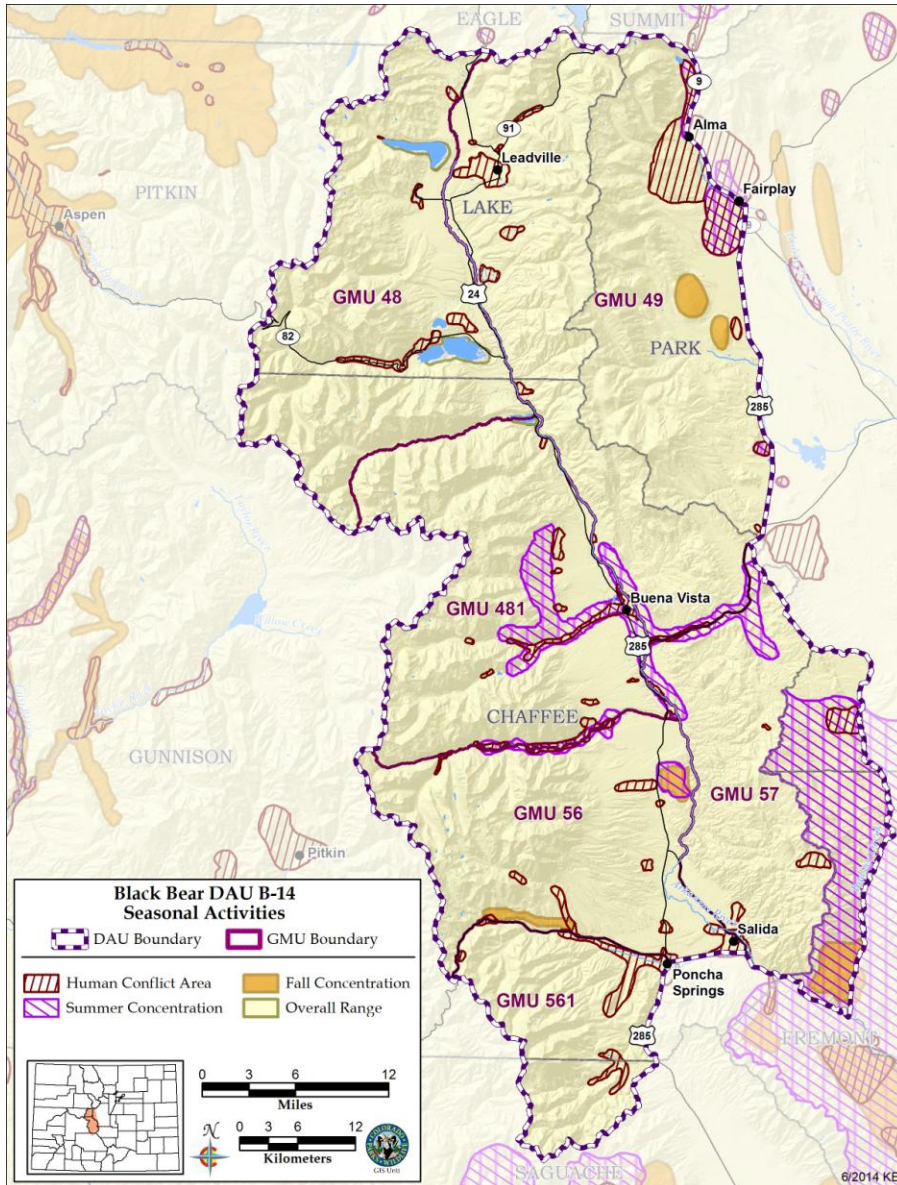


Figure 4. Black bear seasonal activities in B-14.

Land Use and Land Status

Human development in the upper Arkansas River basin, particularly expansion into mountain shrub habitats, is perhaps the dominant issue when evaluating bear management in B-14. All of the

counties in B-14 have experienced significant human population growth, as well as commensurate increases in roads, property subdivision, and development in bear habitat.

Topography & Climate

Elevations in the DAU range from approximately 6,700 feet at the confluence of the Arkansas River and Badger Creek in GMU 57, up to 14,433 feet on the summit of Mt Elbert in GMU 48, the highest mountain in Colorado. The climate in B-14 is quite varied, as expected with the wide range of elevations, but generally consistent with most high mountain valleys in the Rocky Mountains. Lower elevations are generally characterized by hot, dry summers and mild winters. Higher elevations see short, cool summers, and long, cold, snowy winters. Most annual precipitation comes in the form of snow; however summer moisture in the form of rain can have a significant impact on the growth of plant forage sources used by bears. Annual precipitation totals in the upper Arkansas River basin are usually around 10 inches, while higher elevations receive significantly more precipitation and can average 40 inches or more annually.

Vegetation

Principal vegetation classes across the DAU include lodgepole and spruce-fir mix at high elevations, aspen, and aspen/mountain shrub complexes, pinyon-juniper, and lesser amounts of Gambel oak, serviceberry, and other mountain shrub species, agricultural lands, and ponderosa pine, (Figure 5).

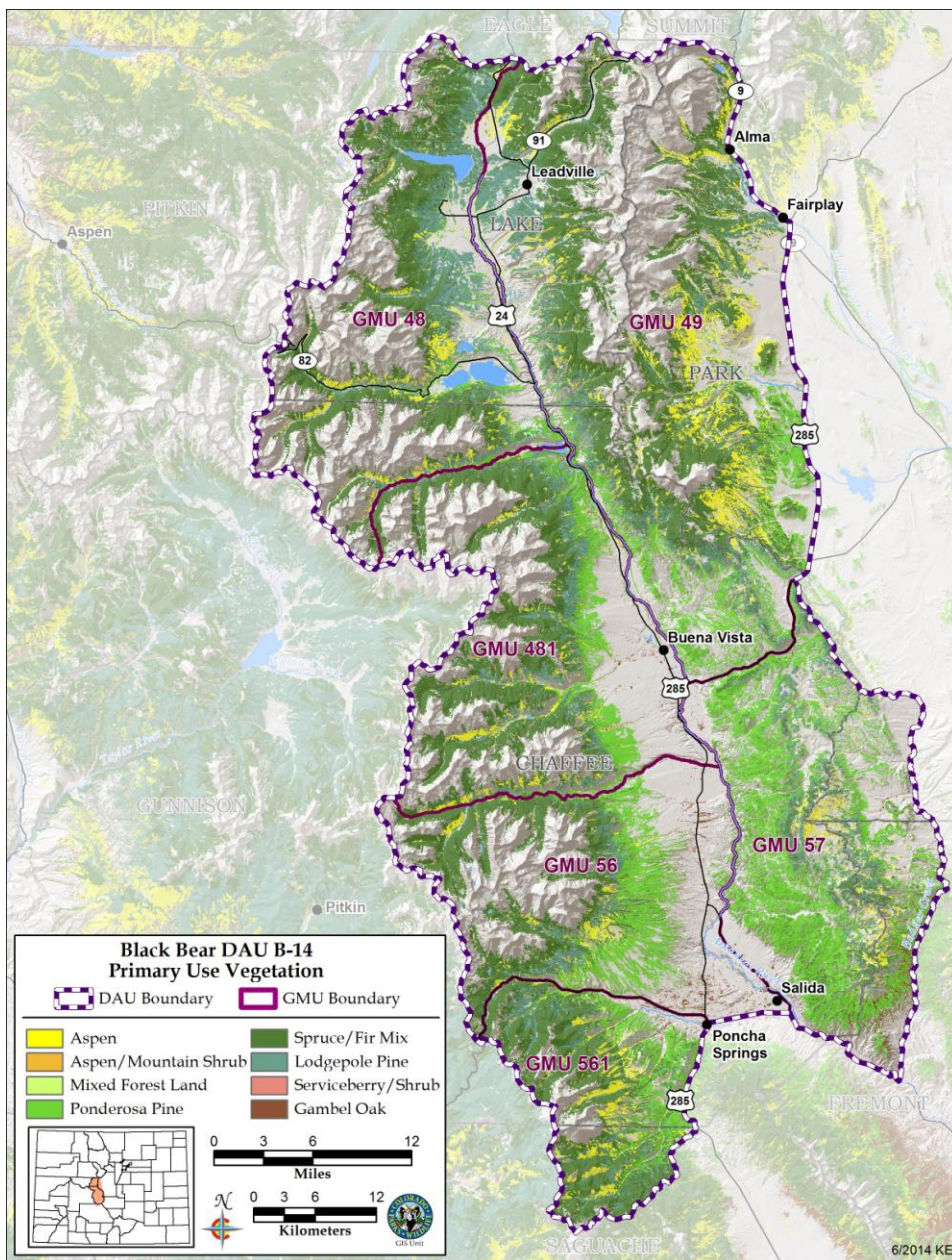


Figure 5. Primary use vegetation in B-14.

The western border of the DAU is defined by alpine tundra (above 11,500') and is characterized by sedges, forbs and stunted willows. The terrain then descends into subalpine forest (9,000'-11,500') dominated by subalpine fir, Engelmann spruce, aspen and bristlecone pine. The montane forest below (5,600'-9,000) contains primarily ponderosa pine, Douglas-fir, lodgepole pine, and aspen. Below that are semidesert shrubland areas (7,000'-8,000') supporting sagebrush, rabbitbrush, mountain mahogany, grasses and numerous forbs. Near the valley bottom, the pinon-juniper woodlands (6,800'-8,000') contain primarily pinon pine, juniper, mountain mahogany, rabbitbrush, forbs and cactus. The riparian ecosystems extend along all of the drainages and include narrowleaf cottonwood, willow, cinquefoil, current and forbs and grasses. Agricultural croplands in the DAU

consist mainly of native grass and alfalfa hay fields in the Arkansas River valley bottom and along tributaries. In certain places within the DAU there are abundant vegetation communities that support relatively high densities of bears; however, much of the DAU is marginal to poor bear habitat. In addition to natural food sources, bears living near human communities have other significant sources of high-quality nutrition in the form of anthropogenic food. This includes sources associated with human activities such as livestock, crops, trash, pet food, barbeque grills and bird feeders.

MANAGEMENT HISTORY

Administrative

The boundaries of B-14 include GMUs 48, 49, 56, 57, 481, and 561 and have been consistent since DAU boundaries were established. There have been no changes to the administrative management of B-14.

Hunting Seasons

Prior to 1935, black bears were not considered a game animal, which afforded them no protection from being shot on sight if they were encountered, or preyed on livestock. In 1935, they were awarded some protection by being classified by the state legislature as a game animal. This established limits on the annual harvest and on the number of licenses that an individual could possess. From 1935 to 1963, bears were hunted in the fall usually concurrently with the annual deer and elk seasons. In 1964, a spring hunting season was established with unlimited licenses available. This continued until 1986, when licenses for the spring season were limited (Beck 1991). The fall hunting seasons occurred concurrently with the established deer and elk seasons and licenses were unlimited until the limited September rifle seasons were established in 1989. Hunters wishing to hunt bears during the established deer and elk season still had access to unlimited licenses until 2005 when license caps were established for these licenses.

In 1992, a constitutional amendment was passed and changed bear hunting within the state by preventing bear hunting during the period from March 01 through September 01 of any calendar year and outlawed the use of bait and dogs as aids for hunting black bears. Since 1992, the annual hunting seasons have begun on September 2nd annually.

Since 2000, hunting seasons have started with an early, limited, rifle season that runs from September 2nd through September 30th each year, along with concurrent Archery, Muzzleloader, 1st, 2nd, 3rd and 4th rifle season licenses. Under the current season structure, the four concurrent seasons are 5 days, 9 days, 9 days and 5 days in length. In addition, in 2014 a private-land-only (PLO) license was established in B-14 to help alleviate human-bear conflicts on private lands. These PLO licenses are List B and are valid from Sept 2 through the end of the 4th general rifle season annually.

Harvest is concentrated in the limited September rifle season as it is concurrent with the initial phases of the bear hyperphagia period. Harvest and success rates decline as hunting seasons progress through the fall months (October-November) due to bears entering the initial stages of hibernation.

License Allocation history

Although there have been changes to season structure since 1999, licenses have gone from being unlimited in number in most seasons to being either available only in the limited draw or available over the counter with caps (OTC). Overall hunting opportunity, however, has changed little.

The September rifle licenses available in B-14 have been limited and specified since 1999. From 1999-2004 archery, muzzleloading, and concurrent rifle (first, second, third and fourth big game rifle seasons) licenses were specified in B-14, but unlimited in number. Beginning in the fall of 2005, those licenses became over-the-counter (OTC) with caps. That meant that a limited number of licenses (capped number) were issued for each huntcode but licenses could be purchased without going through the limited draw (bought first-come, first-served). However, this had no functional impact on concurrent rifle season bear hunter opportunity, as the license cap was rarely reached. Archery and muzzleloader hunters did see an impact in opportunity in going from unlimited to OTC with caps, as those licenses often sell out within a few days of going on sale. Beginning in 2014, CPW instituted Private Land Only (PLO) rifle licenses within the DAU to mitigate game damage from bears.

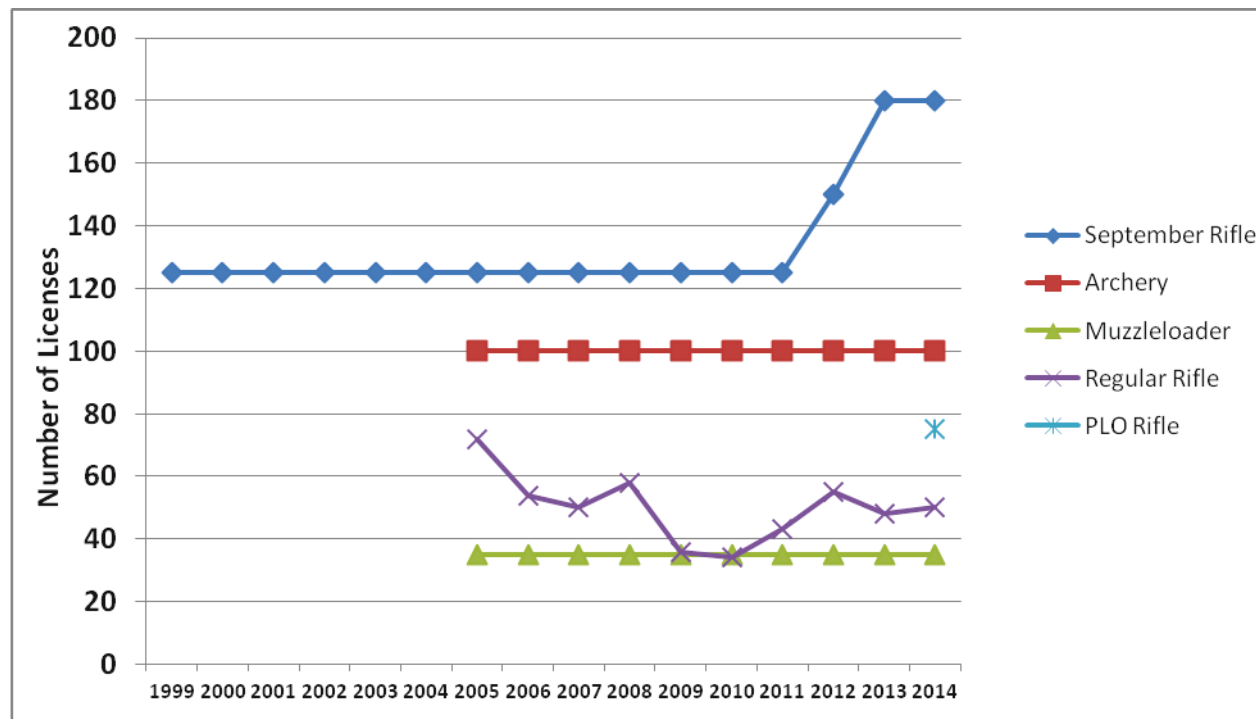


Figure 6. License allocation history in B-14.

Mortality: Harvest and Non-harvest

In general, overall annual bear mortality has remained relatively low and stable over the last 10 years in B-14. Since 2000, total bear mortality in B-14 has ranged from a low of 6 in 2008 to a high of 21 in 2000 (Figure 7). The average annual bear mortality since 2000 is 15 bears, and both the 3-year and 5-year average is 17 bears. Harvest averages approximately 70% of total mortality in the DAU, with conflict/control mortalities, road kills, etc., comprising the other 30% of mortality.

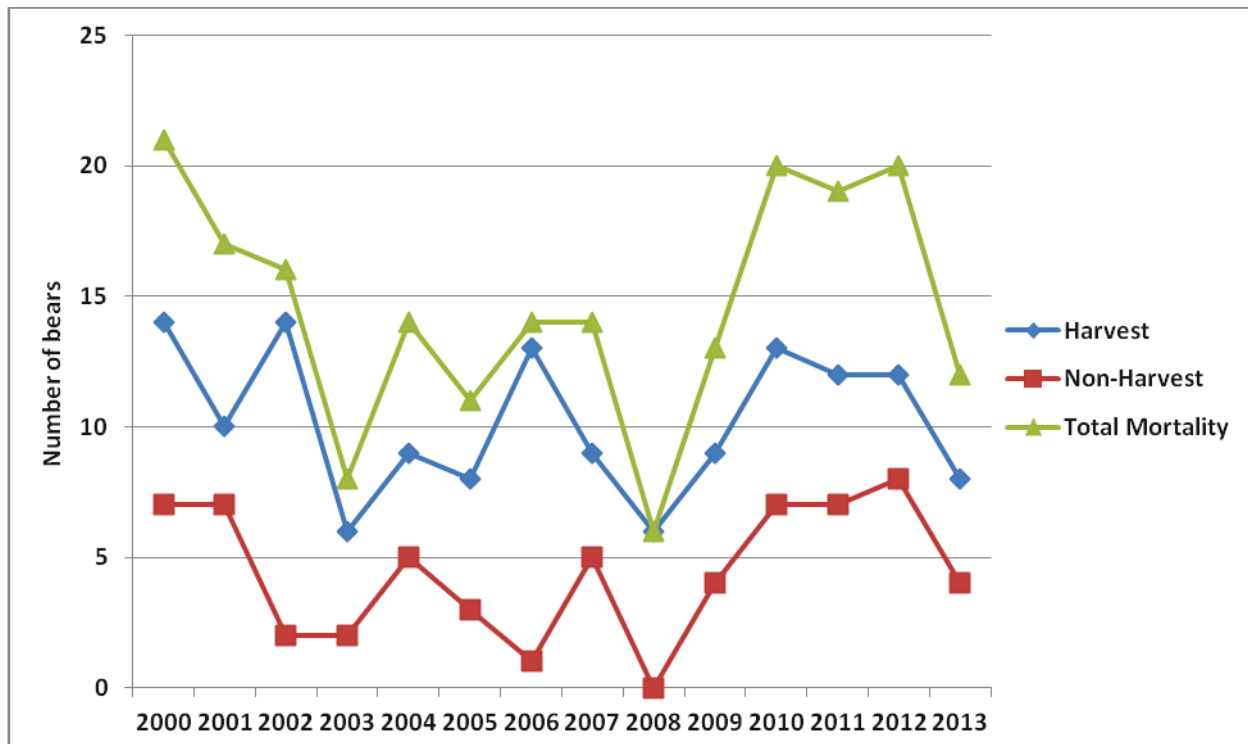


Figure 7. Total black bear mortality in B-14.

The proportion of females in B-14 harvest and total mortality tends to fluctuate, but has averaged 34% of the total mortality since 2000 (Figure 8).

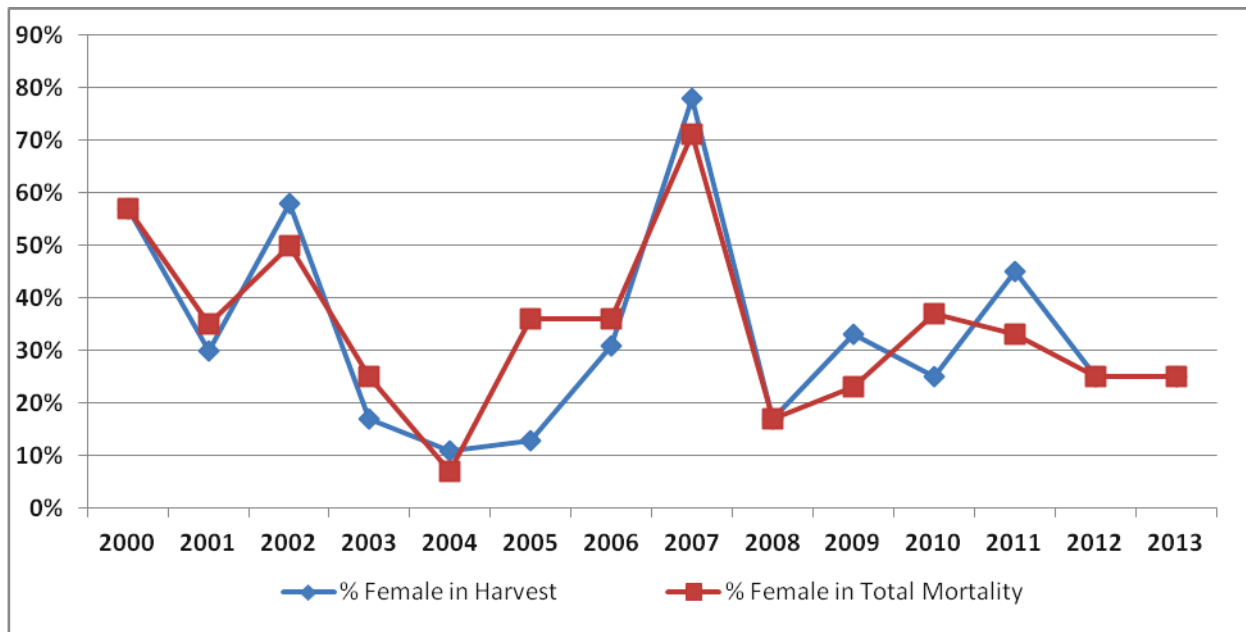


Figure 8. Proportion of females in B-14 harvest and total mortality.

Mortality: Method of take

In general, overall annual bear mortality has been fairly consistent over the last 10 years in B-14. Since 2004, total bear mortality in B-14 has ranged from a low of 6 in 2008 to a high of 20 in 2012, with an annual average of 16 bears. The 10-year annual average of hunting mortality is 11 bears. The 30 day September rifle season has an average three-year success rate of 6%, and is responsible for approximately 80% of the annual bear harvest in B-14. Success rates in the archery, muzzleloader, and general rifle seasons are very low and generally result in only several additional bears harvested annually. Harvest and total mortality rarely exceed current mortality objectives for maintaining a stable bear population in B-14 (Table 1).

Table 1. Black bear harvest by method of take 2001-2013.

	September Rifle	Archery	Muzzleloader	Combined Rifle	Private Land Only
2001	8	0	1	1	n/a
2002	13	1	0	0	n/a
2003	5	1	0	0	n/a
2004	8	1	0	0	n/a
2005	8	0	0	0	n/a
2006	10	0	1	2	n/a
2007	3	5	1	0	n/a
2008	4	2	0	0	n/a
2009	7	2	0	0	n/a
2010	11	2	0	0	n/a
2011	9	1	0	2	n/a
2012	10	1	1	0	n/a
2013	8	0	0	0	n/a

Mortality: Age and gender

Beginning in 2007, a premolar was extracted from harvested bears and other deceased bears handled by CPW. These teeth were collected and submitted annually for aging via cementum annuli sectioning. The technique of counting annual rings in cementum of bear teeth is a reliable method for determining ages of black bears (Harshyne et al. 1998, Costello et al. 2004). This is especially true for bears less than five years of age. For bears five years of age or older, errors increased with the age of the bear (McLaughlin et al. 1990, Harshyne et al. 1998, Costello et al. 2004). Since most female black bears in Colorado do not reproduce until their fifth year, classification of females into sub-adult (non-reproducing) and adult (reproducing) age classes using cementum annuli is quite reliable. Therefore, all female black bears age five and over are considered adults for the purposes of harvest data analyses.

Below is a figure showing the thresholds used in analyses of sex and age classes of harvested bears for determining if a population is decreasing, stable, or increasing (Figure 9). Based on these thresholds, B14 appears to be a fairly stable population (Figure 10). Due to generally low hunter success rates and low hunter harvest, this population likely is not being suppressed by current hunter harvest.

Harvest Composition Monitoring Standards			
Age/Gender Class	Decreasing	Stable	Increasing
Adult Male Harvest in All Harvest	< 25%	25 - 35%	> 35%
Total Female Harvest in All Harvest	> 40%	30 - 40%	< 30%
Adult Female in Total Female Harvest	> 55%	45 - 55%	< 45%

Figure 9. Harvest composition monitoring standards used in evaluating if a bear population is decreasing, stable, or increasing.

DAU 14	'06-'08	'07-'09	'08-'10	'09-'11	'10-'12	'11-'13
Adult Male in All Harvest	33%	24%	35%	29%	42%	46%
Total Female in All Harvest	41%	43%	26%	34%	31%	32%
Adult Female in TotalFemale	44%	67%	86%	80%	78%	63%
Cementum N =	24	21	26	31	33	28
Mandatory Check N=	27	23	27	32	35	31

Figure 10. Age distribution of harvested bears in B-14 2006-2013.

Game damage and human conflict management

There have been 16 black bear damage claims paid out in B-14 since personal property claims were removed from CPW liability (August 2001). The majority of those claims (75%) were for beehives and hobby livestock. The average claim payment since 2002 is approximately \$400, with a range from \$80 - \$1,500.

Like much of Colorado, human conflicts with black bears in B-14 are not unusual occurrences; however, local CPW staff has indicated current conflict levels in B-14 are minimal and at an acceptable level. In many cases, human interactions with bears are reported to the CPW call centers or field staff. This subset of conflicts is documented in written form by CPW staff and range from a second hand report of a bear being seen in a town or subdivision to a physical incident between a bear and a person. Bears involved in conflicts will be handled per agency policy at the discretion of the local wildlife manager or supervisor.

Current harvest and total mortality objectives

B14 has historically had an annual harvest objective of 15 bears and a total mortality objective of 18 bears, designed to allow for a stable population. Since 2000, harvest in B-14 has never exceeded 15 bears and total mortality has reached or exceeded the total mortality in 4 years (Figure 11).

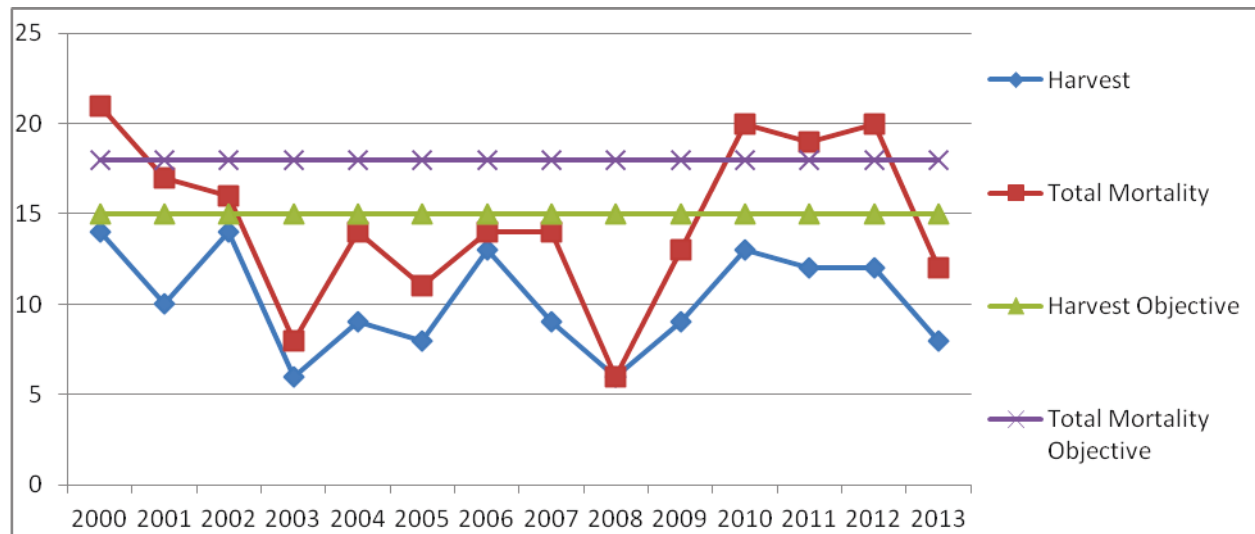


Figure 11. Annual harvest and mortality in B-14 in relation to objectives.

MANAGEMENT CONSIDERATIONS

Habitat Models

Two different habitat models have been developed to relate bear use, occupancy and forage value to project possible populations by extrapolating bear densities. The population projections use densities derived from relevant Colorado data and from literature. Managers applied densities representative of similar habitats and vegetation types in Colorado to develop population projections and then select population ranges which best represent current conditions in the DAU.

General Vegetation/Bear Density Extrapolation

The first model was developed by Gill and Beck (1991) in an unpublished report to the Colorado Wildlife Commission and was modified by Apker (2003) in an internal DOW report. This model applies subjective probable black bear densities for different vegetation types to the amount of land area of those vegetation types in the various GMUs. The vegetation type amounts for this model were derived from landsat GAP project coarse vegetation types. This vegetation/density model provides a snapshot extrapolation of possible bear population size in Colorado based on current vegetation classes and both measured and projected bear densities in those vegetation classes from the 1990s. This model and its subsequent extrapolation yield a projected bear population in B-14 of **216 black bears**.

Use/Occupancy Density Extrapolation

General classes of habitat that occur in B-14 are presented in Table 2 using CPW Basinwide GIS Vegetation Classification data. Each of these vegetation classes has been further refined relative to bear use/occupancy and relative forage value; this analysis results in a two tiered habitat ranking system presented below. Use/occupancy was defined at 4 levels; primary, secondary, edge, and out (or not bear habitat). See Table 2 for a graphic depiction of the use/occupancy habitat types in the DAU. Relative forage value was rated for primary, secondary, and edge habitat at 3 levels; high, moderate or low based upon the perceived potential of those habitats to provide forage for black bears.

Use/occupancy terms are defined as follows:

Primary - cover types that bears typically and normally are found at various times of year.

Secondary - cover types that bears occasionally use but is not preferred.

Edge - cover types infrequently used, but bears may be found in when adjacent to primary cover types.

Out - cover types that are not black bear habitat or those in which bears would only travel through.

The results of this analysis provide tables of bear habitat in terms of its relative use and state of occupancy and then for those habitats with varying levels of use, what their potential relative forage value may be. This resulted in a matrix for assigning habitat quality and subsequently for assigning bear densities to different habitat quality to extrapolate a potential population. The population results for B-14 can be incorporated into modeling or used as a comparison to independent population model runs. The 2014 population estimate is **211 bears**. Table 2 provides the results of this surface area analysis for B-14.

Table 2. B-14 bear population projection based on vegetation and density extrapolation.

GMU	Available Bear Habitat (km ²)			Bear Density (bear/km ²)			Projected Bear Population			Projected Total Bear Population
	Primary	Secondary	Edge	Primary	Secondary	Edge	Primary	Secondary	Edge	
48	336	3	208	0.08	0.04	0.008	27	0	2	29
49	693	31	314	0.08	0.04	0.008	55	1	3	59
56	248	28	160	0.08	0.04	0.008	20	1	1	22
57	358	25	94	0.08	0.04	0.008	29	1	1	30
481	319	16	170	0.08	0.04	0.008	26	1	1	28
561	243	6	43	0.17	0.08	0.017	41	1	1	43
TOTAL	2,197	108	991				198	5	8	<u>211</u>

Published black bear densities across Rocky Mountain States range from 1.35 bears/100 km² in Rocky Mountain National Park (Baldwin and Bender 2007) to 31-77 bears/100 km² in Idaho (Beecham and Rohlman 1994). However, two 2009 Colorado mark-recapture surveys indicate higher densities than those found by most studies, analyses, or management reports in the western US (44-85 bears/100 sq. k.) (Apker et al. 2010).

Although density estimates are influenced by the size of the study area and the methods by which density estimates were derived (see Apker et al. 2010); overall habitat quality in the two 2009 study areas in Colorado is probably better than that found in most other study areas. It should also be noted that both the Colorado 2009 survey areas were selected in large part because they were considered among the highest overall quality habitat in Colorado and the exact survey grid areas were structured to include mostly the highest quality cover and forage value habitat for the survey season.

Several other correlates of bear habitat use/occupancy are also available to managers in B-14 including harvest density/locations, roadkill/highway crossings, and conflict hotspots. An evaluation of B-14 harvest locations superimposed on the basic categories of bear habitat use and occupancy indicates that most harvest, and presumably most of the bears, are being found (in the fall) in primary habitat or within edge habitat that very closely adjoins primary habitat (Figure 12). The significant exception to this would be the presence of bears, as documented through roadkill, harvest and conflicts, in high densities in some localized areas of edge habitat (those associated with human food sources).

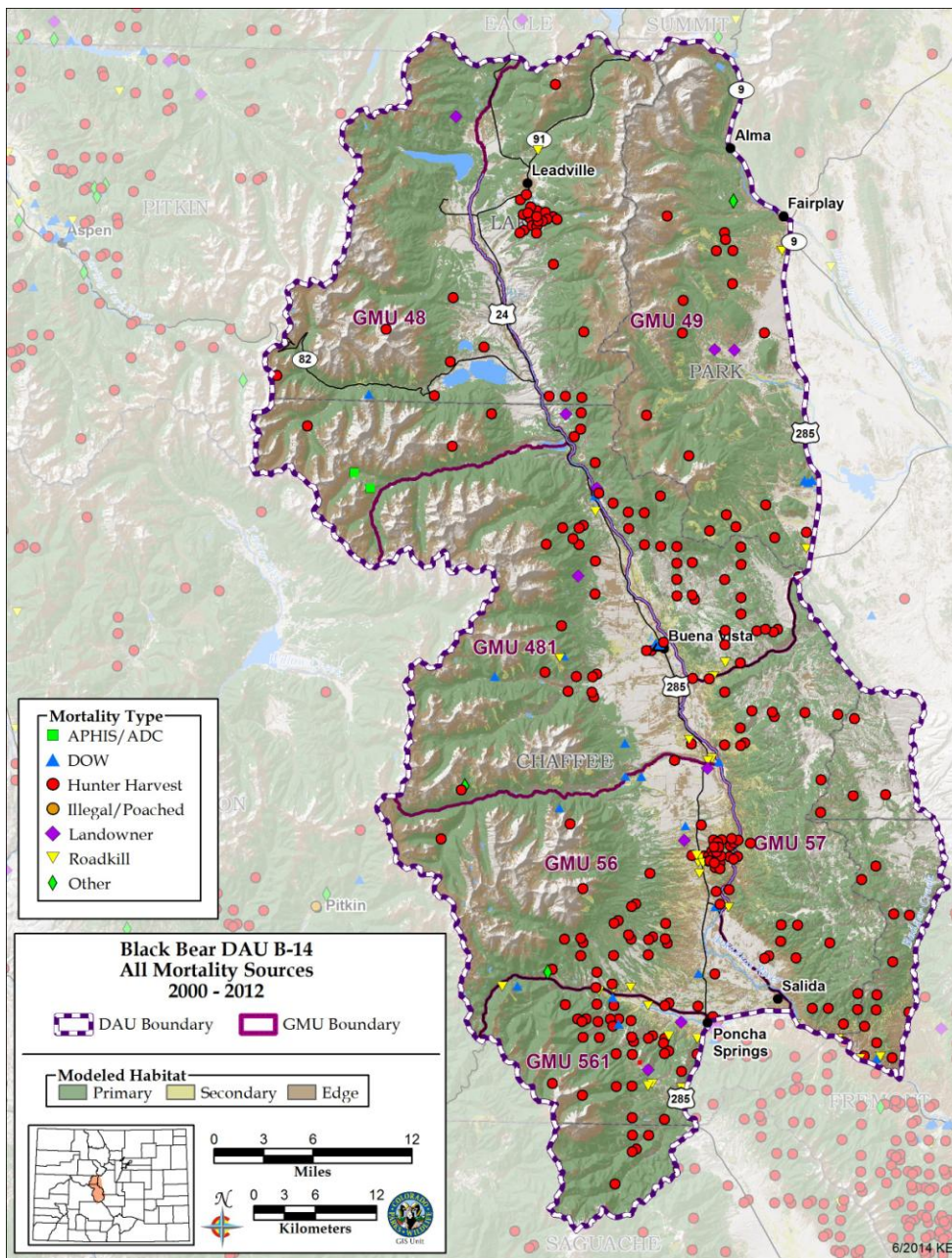


Figure 12. Location of B-14 bear mortalities in relation to bear habitat classes.

Mortality Density and Rates

The amount of human-caused mortality in relation to the amount of suitable habitat available is another method to gauge the impacts of human-caused mortality on black bear populations. This can be useful in illustrating impacts on a more local scale and standardizing mortality between DAUs with varying habitat suitability. The number of human-caused mortalities can be divided by the area of primary and secondary habitat.

Thus B-14 with 2,305 km² of primary and secondary habitat and an average of about 16 bears killed per year over the past 10 years = a mortality density of 1.44 bears/100km². Then assuming that the bear population is approximately 200 - 220 bears based on the habitat models, the median bear population density in the DAU is approximately 10.9 bears/100km². Using these figures to calculate a mortality rate yields 1.44/10.9 = 13.2%. It is likely that some human-caused non-harvest bear mortality occurs in B-14 that is undetected, but it is unlikely that the average ten-year total mortality exceeds the mortality rate that would result in a stable population trajectory.

Miller (1990) demonstrated that under optimal conditions of reproduction and survival, maximum sustainable total mortality for black bears could be as high as 14.2%. Beck and White (1996 unpublished) conducted black bear population simulation analyses which, given their assumptions, produced stable bear populations with annual mortality at up to 15%.

It is unlikely that bears annually experience optimum reproduction and survival conditions due to environmental variation affecting forage conditions and black bear vulnerability to mortality factors. Therefore, we have formulated mortality rate thresholds associated with different management strategies which are somewhat lower than the foregoing:

Table 3. Mortality rate thresholds based on strategic goals.

Strategic Goal	Mortality Rate Threshold
Increasing	5 – 10%
Stable	10 – 15%
Decreasing	15 – 20%

Forage Condition and Mast Production Surveys

Forage conditions influence bear reproductive success and certain gender and age specific survival rates due to changes in vulnerability to mortality (Beck 1991, Costello et al. 2001). Therefore, managers consider forage conditions when formulating annual management recommendations. Mast production surveys have been conducted since 2008 in B-14 (Table 4). Following survey protocols developed by Costello et al. (2001), we made only slight modifications to provide a basic five-point matrix of fall mast fruit production for Gambel oak, juniper spp., chokecherry, and serviceberry. Forage condition results within DAUs can then be represented numerically to reflect annual forage conditions. These results can provide managers objective information about relative forage conditions over time and use that with their professional judgment to influence management recommendations. Taking it a step further, the results can be used as one of the many population model inputs as a factor influencing birth rates and cub survival in the population models.

B-14 generally has lower mast production potential than much of Colorado, and the bear population is therefore exceptionally dependent on what limited natural food sources are available.

Table 4. Forage condition scores in B-14 2010 - 2013

YEAR	2010	2011	2012	2013
SCORE (1 poor, 10 very good)	5.67	4.40	3.54	4.25

Mortality Composition and Management Criteria

Black bear vulnerability to harvest and other mortality factors varies depending upon differences in habitat, hunter effort or pressure, access, and forage conditions. Bears are less vulnerable where cover is dense over large geographic areas. They are more vulnerable where vehicle access is good. The greatest influence in annual variation in bear vulnerability is forage conditions. When natural forage quality or availability is poor, bears must become much more mobile in search of food, especially during fall hyperphagic periods. Increased mobility tends to result in bears being more visible to hunters, more likely to encounter human food sources, more frequently found along or crossing roads, and more concentrated in areas where there may be relatively more forage available. All of these tendencies can result in increased hunter harvest, increased human conflict mortality, more roadkills and other forms of mortality.

Not all segments of bear populations are equally vulnerable however, regardless of other influences. Hunting pressure affects harvest rate, which affects age structure, sex ratios, and densities of black bear populations. Adult males are typically most vulnerable because they are bold (often use open areas) and have larger home ranges. Sub-adult males are slightly less vulnerable. Consequently, the adult male segment of a population is the first to be reduced under hunter pressure. As harvest rates increase, the proportion of sub-adult black bears (those less than 5 years old) in the harvest typically increases, whereas the proportion of adult males declines. A low percentage of adult males (≥ 5 years old) in the harvest may be an indication of over-harvest. This criterion is a more sensitive indicator of black bear population levels than median age (Idaho Dept. of Fish and Game 1998). The mean percent of adult males in the harvest in relatively stable populations in Idaho (Beecham and Rohlman 1994) and New Mexico (Costello et al. 2001) under moderate to high harvest levels was 30% and 28%, respectively. Studies of black bear populations in Alaska, Virginia, and Arizona showed similar relationships between lightly and heavily hunted populations. Therefore, 25% to 35% adult males in the harvest could indicate a stable black bear population. Levels lower than 25% may indicate a higher level of harvest, which has reduced the adult male segment of the population; whereas levels higher than 35% may indicate a much lighter harvest level. Based on the last 5 years of harvest data in B-14, it appears that current harvest levels could be indicative of a stable to slightly increasing population, as adult males have comprised 39% of the total harvest since 2009 (Figure 13).

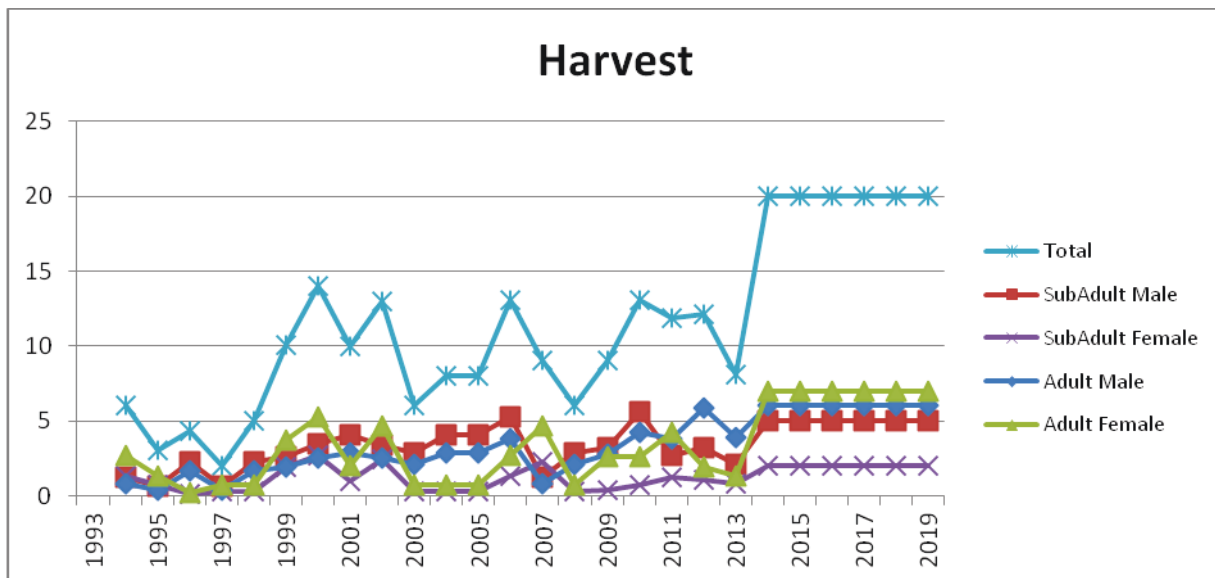


Figure 13. Bear harvest in B-14 by proportion of age class and gender (projected through 2019).

As harvest levels increase and additional adult and sub-adult males are removed from an area, the proportion of females in the harvest begins to increase (Fraser et al. 1982, Kolenosky 1986, Beecham and Rohlman 1994), because female are least vulnerable, especially if accompanied by cubs. The average percent females in the harvest of black bear populations under moderate and high hunting pressure in Idaho (Beecham and Rohlman 1994) and New Mexico (Costello et al. 2001) was 35% and 40%, respectively. Beecham and Rohlman (1994) suggest a desired proportion of female harvest of 35% to maintain a stable population, whereas Beck (1991) suggested maintaining <40% females in harvest. Therefore, a range of 30% to 40% females in the total harvest could indicate a stable black bear population. Data Analysis Unit B-14 appears to be in the middle of the stable range using this indicator, with a 31% female harvest rate over the last 5 years. Proportions higher than 40% may suggest reduction of the number of females in the population. Monitoring this criterion helps ensure a stable reproductive portion of the population and the ability of the population to rebound in the event of a decline.

With increasing harvest of a black bear population, younger females are removed and older females become more common in the harvest. Thus, the proportion of adults in the female harvest should rise with harvest rates, increasing mean age of females in the harvest (Kolenosky 1986, Beecham and Rohlman 1994). This phenomenon is especially important with late-reproducing species like bears, since removing adult females has the enhanced effect of not only reducing the number of bears in the population, but also decreasing reproductive potential of the population and, thus, its ability to respond to declines. The delayed response of slow reproducing populations to reductions was noted by Harris (1984) and was demonstrated in modeling efforts by Miller (1990), who predicted black bear populations reduced by 50% would take an average of 17 years to recover if hunting pressure was reduced by 25%.

The percent of adults in the female harvest, rather than mean or median age of the females in the harvest, can also be used to gauge the presumed population trajectory. Averaged over a three-year period, this criterion provides a more meaningful measurement of female harvest age structure, especially in areas with small sample sizes. The mean percent of adult females in the harvest of two New Mexico black bear populations under moderate and high harvest pressure was 55% and 70%, respectively (Costello et al. 2001). The mean percent adult females in the Wyoming statewide female black bear harvest from 1994-2005 was 47%, with a range of 32% - 57%, suggesting that 45 - 55% adult female harvest provides a stable proportion of adult females (Wyoming Game and Fish Dept. 2007). In B-14, adult females have comprised 76% of the female harvest since 2009, indicative of a population being harvested at a high rate using this criterion.

Looking at criterion independently could give very different results than when considering them together. For instance, looking only at a reduced percentage of adult males in the harvest may indicate a population is moving from light to moderate harvest. However, evaluating the other criteria may show a low proportion of females and lower proportion of adult females in the harvest, indicating a much lower level of harvest than looking at males alone. Alternatively, a high percentage of adults in the female harvest, assessed independently, would indicate population reduction. However, when the percent adult males and percent females in the harvest are both in the population increase or stable range, the population might actually be thriving. This situation might occur when the DAU is adjacent to or has an area providing a source of immigrating black bears. Source areas can be defined as areas of suitable habitat with little to no human-caused mortality that may provide dispersing bears to surrounding areas (Beecham and Rohlman 1994, Powell et al. 1996). Areas adjacent to sources may have a lower proportion of adults in the harvest due to sub-adults dispersing to occupy vacant home ranges of harvested bears. These areas may also be able to rebound more quickly from overharvest (Beecham and Rohlman 1994). Dispersing subadult males may also supplement surrounding populations and absorb much of the harvest to the point where female harvest remains low and adult females comprise a higher proportion of the population. Evaluating these various trends in conglomerate, B-14 appears to be a relatively stable black bear population.

To better evaluate harvest data, black bear seasons are set for a five year period as with most other big game species in Colorado. We recommend that harvest objectives and attendant license allocations be set for three-year periods. This allows for a more complete analysis of the effects of harvest by holding dates and quotas the same for each three-year season cycle. In order to increase the sample size of the harvest data and to reduce the influence of high or low annual harvest rates due to environmental or other factors, three-year running averages will be used in harvest data analyses rather than analyzing annual data independently. While the evaluation of harvest criteria will be analyzed using a three-year average, data from the previous 10 years (two black bear generations) or longer should be analyzed to illustrate longer-term trends in harvest and related population trends.

Social Factors

The social factors that influence management scenarios in B-14 include game damage and human conflicts. There have been 16 black bear damage claims paid out in B-14 since personal property claims were removed from CPW liability (August 2001). The majority of those claims (75%) were for beehives and hobby livestock. The average claim payment since 2002 is approximately \$400, with a range from \$80 - \$1,500. Direct, significant human conflicts with black bears in B-14 typically involve a bear seeking out easy food sources including trashcans and/or pet food. Occasionally, there are conflicts associated with a bear entering or attempting to enter a home, cabin, trailer or car. These conflicts are dealt with by CPW field staff differently depending on the severity of the incident, other site-specific qualities and whether the bear in question had been previously handled by the CPW. There is a CPW policy on handling bears that have already received a first “strike”, as well as procedures to follow if a bear makes physical contact with a person.

STRATEGIC GOALS AND MANAGEMENT OBJECTIVES

Process for Developing Strategic Goals and Management Objectives

Public Process

Local CPW staff met in August 2014 to develop feasible alternatives for strategic objectives for B-14. Three alternatives were developed based upon modeled population estimates, damage and nuisance issues, and hunting opportunity. These alternatives are outlined in APPENDIX A: STRATEGIC OBJECTIVE ALTERNATIVES. These alternatives were used merely as a basis for discussion; the introduction of other alternatives was strongly encouraged throughout the initial public input process.

In December 2014, initial public input was solicited. A survey was available in both printed and online formats in an effort to obtain public input on bear population goals and other comments directly related to management. The full document is available in APPENDIX B: PUBLIC SURVEY.

Approximately 4,300 postcards were mailed out to a cross-section of interested stakeholders, including B-14 license holders and landowners in Chaffee, Fremont, Lake, and Park Counties requesting their input via the online or written survey. Information was provided to obtain a hard copy of the survey.

A total of 216 individuals responded to the online survey, and 12 surveys were returned in printed format. The full results and analysis are available in full detail in APPENDIX C: PUBLIC SURVEY RESULTS.

Following public input, a draft plan was reviewed by CPW staff. All public input received in written form was incorporated into this document. The first draft was available for public comment in December, 2014. The draft plan was also made available to impacted federal, county and local municipality land management and natural resource agencies for comment.

Following public review of the draft plan, all input was reviewed and incorporated. A preferred strategic objective was selected (In addition, in 2014 a private-land-only (PLO) license was established in B-14 to help alleviate human-bear conflicts on private lands. These PLO licenses are List B and are valid from Sept 2 through the end of the 4th general rifle season annually.

Management Objectives and Preferred Strategic Objectives will be presented to the Parks and Wildlife Commission in January, 2016.

Strategic Goals

Total mortality and harvest objectives are presented as ranges necessary to achieve the strategic goal of the DAU. Annual monitoring of mortality, gender and age structure, Colorado black bear density study, and annual forage condition survey results are all incorporated into determining annual mortality objectives. However, the models and their results have not been validated with demographic data from Colorado bear populations. Moreover, the data that has been collected and used for model inputs result from relatively new efforts. We anticipate that the models will change and be improved over time and thus should be viewed as presumptive estimates.

Therefore, although the plan identifies mortality and age and gender objectives, these are initial values. Modeling will be conducted every other to every third year, while other mortality data and demographics are collected and analyzed annually. Population extrapolations based on predicted densities, range-wide or within vegetation associations, will be re-evaluated as new data is gathered via research and mark-recapture surveys.

While unlikely, objectives may be periodically adjusted in order to achieve the DAU strategic goals based on changes in the information sources above. Specific objectives will be documented in annual objective sheets approved by the Parks and Wildlife Commission. These objective sheets will also govern annual license levels to achieve the DAU strategic goals.

B-14 Strategic Goal Alternatives

Stable population trend

To achieve a strategic goal of maintaining a stable bear population in B-14, harvest and total mortality rates will fall in an intermediate range. Total mortality, should fall within 10-15%; of the total population. Proportion of adult males in the harvest should be within 25-35%, with all females making up 30-40% of harvest. Additionally, adult females should comprise approximately 45-55% of the female harvest. Within the framework of an overall stable population, flexibility in off-take rates will be maintained to manage for minimized game damage and human/bear conflicts in localized areas of concern. Not every management index must be in complete agreement, but most should point toward a stable population.

Decreasing population trend for 3 years, then stable population trend

Given that current hunting license allocation is meeting or exceeding demand, it's questionable this alternative could even be achieved using hunters alone. To achieve a strategic goal of decreasing, then maintaining the bear population in B-14, harvest and total mortality rates would be in the liberal range, and then reevaluated after three years. Total mortality would increase to 15-20% of the total population size. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Populations in areas with conflict and damage could be suppressed to low levels. After three years of decreasing the population, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This

information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. Not every management index must be in complete agreement, but most should initially point toward a decreasing trend, followed by a stable trend.

Decreasing population trend

As with the previous alternative, given that current hunting license allocation is meeting or exceeding demand, it's questionable this alternative could even be achieved using hunters alone. To achieve a strategic goal of decreasing the bear population in B-14, harvest and total mortality rates would be in the liberal range. Total mortality would increase above 15-20% of the population. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Areas with conflict and damage could be suppressed to very low levels. Not every management index must be in complete agreement, but most should point toward a population being held below biotic and human social tolerance thresholds. It is unrealistic to manage for a continually decreasing population; after five years of applying this strategy, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. When the three-year average harvest criteria for a DAU indicate heavy harvest of over 50% females in the total harvest and over 60% adult females in the female harvest on either a three year running average or in two consecutive years, subsequent harvest objectives and license allocations may be reduced to stabilize if other indicators, including nuisance and conflict, are in agreement.

Monitored Data to Inform Management

All known dead black bear, from both harvest and non-harvest sources, are checked by CPW staff to obtain biological information. The proportion in total mortality of each gender will continue to be closely monitored on an annual basis to assure that female mortality rates are not contrary to the DAU strategic goals. Age structure in total mortality and reproductive history are derived from extraction of a premolar tooth from bears when bear harvest and non-hunt mortality is reported through the mandatory check.

In 2009 and 2010, hair snag surveys were conducted in two locations in Colorado. Additional hair snag survey areas may be established in the future during the term of this DAU plan. Results about bear density, gender, and possibly age structure from these surveys may be incorporated into the habitat model/density extrapolations.

Because of low reproductive rates, black bear populations cannot sustain high harvest levels over prolonged periods. Research has shown that high harvest levels can quickly reduce black bear populations to levels where severe reductions in harvest quotas and season lengths may be necessary

for greater than 10 years for full recovery of a population (Miller 1990, Beecham and Rohlman 1994). Therefore, the following harvest criteria will be assessed at the DAU level, with each DAU strategic goal set to achieve the criteria for reduced, stable, or increasing black bear numbers.

Total mortality and proportion of mortality by age and gender

Monitoring harvest and overall mortality totals in relation to projected population size will be important in interpreting mean age and relative proportions of age/gender classes as indices. The desired proportions and total mortality off-take range will be based on the preferred strategic objective. Table 5 outlines the guidelines that will inform management decisions based upon the selected strategic goal.

Table 5. Harvest composition indicators.

Criteria		Adult Males in Total Harvest	Females In Total Harvest	Adult Females in Female Harvest	Total Off-take Rate
Strategic Goal	Suppression	< 25%	> 40%	> 55%	15 – 20%
	Stable	25 – 35%	30 – 40%	45 – 55%	10 – 15%
	Increasing	> 35%	< 30%	< 45%	5 – 10%

Other conditions

Other conditions that will be monitored in B-14 to ensure that the strategic goals are met include hunter success rates and satisfaction (anecdotally), annual fall forage condition monitoring and amount and number of game damage claims and human conflicts.

Forage condition monitoring

Collected annually, this data can be used when projecting reproductive rates, cub survival, vulnerability to harvest and other factors related to modeling and predicting population trends for the upcoming year. Annual forage condition/mast production surveys are conducted in representative GMUs in DAU B-14. Results of these surveys are incorporated into population modeling efforts, as are mortality, age and gender structure data.

Game damage & human conflict

Levels of submitted game damage claims and documented conflicts between humans and bears will be evaluated anecdotally on an ongoing basis. In most cases, management efforts will be targeted at individual bears/locations that are involved in these situations. Management actions include a wide array of techniques and strategies that are employed on a case by case basis. In addition, in 2014 a private-land-only (PLO) license was established in B-14 to help alleviate human-bear conflicts on

private lands. These PLO licenses are List B and are valid from Sept 2 through the end of the 4th general rifle season annually.

Management Objectives and Preferred Strategic Objective

The specific total mortality and harvest objectives are based on present information and assumptions about population status and trajectory. These represent starting points in an ongoing process. Annual changes to mortality and harvest objectives are anticipated based on new information and evaluation of monitored data. Annual quantitative objectives will be documented in DAU objective sheets approved by the Parks and Wildlife Commission during annual regulation cycles.

Using the two different models/techniques to project plausible bear population sizes in B-14 yields the following 2014 posthunt population estimates:

Table 6. Population estimates for B-14 from two competing models.

SOURCE	TOTAL POPULATION
Vegetation/ Bear Density Extrapolation	216
Use/Occupancy Density Extrapolation	211

For purposes of calculating mortality objectives to correspond with the strategic goal in the DAU, the 2014 extrapolated post-hunt population of 220 independent bears will be used. Overall mortality and hunter harvest objectives will be calculated based on this population projection and application of the harvest criteria that are appropriate for the selected strategic goal.

Mortality Objectives

Total Mortality Objective

The preferred alternative is to manage for a stable population of bears and maintain hunter opportunity and success rates, while minimizing human-bear conflicts. These goals correspond to an annual off-take rate of 10-15% of the population.

With a population estimate of approximately 200 - 220 independent bears in B-14, this will translate to an overall mortality objective of approximately 20-30 bears annually.

Hunter Harvest Objective

Annual hunter harvest objectives are determined by deducting the 3-year running average amount of non-hunter mortality from the total mortality objective. The 3-year running average of non-hunter mortality for 2012 - 2014 is 4 bears. Based on an initial total mortality objective of 20-30 bears annually, the resulting hunter harvest objective will be 16-26 bears.

Harvest Composition in Hunter Harvest Objective

Based on the preferred alternative of initially suppressing the population, the initial harvest composition criteria are outlined in Table 7.

Table 7. Preferred alternative harvest composition criteria.

Harvest Composition	Criteria
Adult Males in Total Harvest	25 - 35 %
Females in Total Harvest	30 - 40%
Adult Females in Female Harvest	45 - 55%
Total Annual Mortality	10 - 15%

REFERENCES

- Apker, J. A., P. Lukacs, J. Broderick, B. Dreher, J. Mao, A. Vitt 2010. Non-Invasive DNA-Based Black Bear Density Estimates in Colorado - 2009. Internal Colorado Division of Wildlife Memo.
- Baldwin, R. A. and L. C. Bender. 2007. Population demographics, habitat utilization, critical habitats, and condition of black bears in Rocky Mountain National Park. Rocky Mountain National Park, Estes Park, Colorado. 244pp.
- Beck and White (1996 unpublished)
- Beck, T.D. 1991. Black bears of west-central Colorado. Colorado Division of Wildlife Report Number 39. 86pp.
- Beck, T. D. 1995. Development of black bear inventory techniques. Colorado Division of Wildlife. Wildlife Research Report. Federal Aid Project W-153-R-8, Job Progress Report. 11pp.
- Beck, T. D. 1997. Development of black bear inventory techniques. Colorado Division of Wildlife. Wildlife Research Report. Federal Aid Project W-153-R-10, Final Report. 11pp.
- Beecham, J.J. and J. Rohlman. 1994. A shadow in the forest: Idaho's black bear. The University of Idaho Press, Idaho, 245pp.
- Costello, C.M., D.E. Jones, K.A. Green Hammond, R.M. Inman, K.H. Inman, B.C. Thompson, R.A.
- Deitner, H.B. Quigley. 2001. A study of black bear ecology in New Mexico with models for population dynamics and habitat suitability. Final Report Federal Aid in Wildlife Restoration Project W-131-R. 197 pp.
- Costello, C.M., K.H. Inman, D.E. Jones, R.M. Inman, B.C. Thompson, H.B. Quigley. 2004. Reliability of the cementum annuli technique for estimating age of black bears in New Mexico. Wildlife Society Bulletin 32:169 - 176.
- Fraser, D.G., J.F. Gardner, G.B. Kolenosky, and S. Strathearn. 1982. Estimation of harvest rate of black bears from age and sex data. Wildlife Society Bulletin 10:53 - 57.
- Gill, R. B. and T. D. Beck. 1990. Black bear management plan. Colorado Division of Wildlife Report Number 15. 44pp.
- Graham, V.K. 2001. Black bear management guidelines for bear DAU B-17. Colorado Division of Wildlife. 3 pp.

Grogan, R.G. 1997. Black bear ecology in Southeast Wyoming: The Snowy Range. M.S. Thesis, University of Wyoming, 84pp.

Harris, R.B. 1984. Harvest age structure as an indicator of grizzly bear population status. M.S. thesis, University of Montana, Missoula. 204pp.

Harshyne, W.A., D.R. Diefenbach, G.L. Alt, G.M. Matson. 1998. Analysis of error from cementum-annuli age estimates of known-age Pennsylvania black bears. *Journal of Wildlife Management* 62:1281 - 1291.

Idaho Dept. of Fish and Game. 1998. Idaho black bear management plan, 1999 - 2010: Status and objectives of Idaho's black bear resource. 77pp.

Kolenosky, G.B. 1986. The effects of hunting on an Ontario black bear population. *International Conference on Bear Research and Management* 6:45 - 55. Page 38 of 39

McLaughlin, C.R., G.J. Matula, Jr., R.A. Cross, W.H. Halteman, M.A. Caron, AND K.I. Morris. 1990. Precision and accuracy of estimating age of Maine black bears by cementum annuli. *International Conference on Bear Research and Management* 8:415-419.

Miller, S.D. 1990. Population management of bears in North America. *International Conference on Bear Research and Management* 8:357 - 373.

Powell, R.A., J.W. Zimmerman, and D.E. Seaman. 1996. Demographic analyses of a hunted black bear population with access to a refuge. *Conservation Biology* 10:224 - 234.

Wyoming Game and Fish Department. 2007. Wyoming black bear management plan. 59pp.

APPENDIX A: STRATEGIC OBJECTIVE ALTERNATIVES

Stable population trend

To achieve a strategic goal of maintaining a stable bear population in B-14, harvest and total mortality rates will fall in an intermediate range. Total mortality, should fall within 10-15%; of the total population. Proportion of adult males in the harvest should be within 25-35%, with all females making up 30-40% of harvest. Additionally, adult females should comprise approximately 45-55% of the female harvest. Within the framework of an overall stable population, flexibility in off-take rates will be maintained to manage for minimized game damage and human/bear conflicts in localized areas of concern. Not every management index must be in complete agreement, but most should point toward a stable population.

Decreasing population trend for 3 years, then stable population trend

To achieve a strategic goal of decreasing, then maintaining the bear population in B-14, harvest and total mortality rates would be in the liberal range, and then reevaluated after three years. Total mortality would increase to 15-20% of the total population size. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Populations in areas with conflict and damage could be suppressed to low levels. After three years of decreasing the population, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. Not every management index must be in complete agreement, but most should initially point toward a decreasing trend, followed by a stable trend.

Decreasing population trend

To achieve a strategic goal of decreasing the bear population in B-14, harvest and total mortality rates would be in the liberal range. Total mortality would increase above 15-20% of the population. Proportion of adult males in the harvest can be low, even below 25%, with total female harvest rates going over 40%. Additionally, adult females could comprise over 55% of the total female harvest. Areas with conflict and damage could be suppressed to very low levels. Not every management index must be in complete agreement, but most should point toward a population being held below biotic and human social tolerance thresholds. It is unrealistic to manage for a continually decreasing population; after 5 years of applying this strategy, the sex and age composition of mortality and harvest would be reexamined to determine if the increased harvest had impacted the population. This information, combined with analysis of damage and nuisance complaints, would inform decisions on whether to continue with higher harvests, or whether the population was within an acceptable range. If so, overall harvest and mortality could be decreased to stabilize the population. When the three-year average harvest criteria for a DAU indicate heavy harvest of over 50% females in the total harvest and over 60% adult females in the female harvest on either a three year running average or in 2 consecutive years, subsequent harvest objectives and license allocations may be reduced to stabilize if other indicators, including nuisance and conflict, are in agreement.

APPENDIX B: PUBLIC SURVEY

APPENDIX C: PUBLIC SURVEY RESULTS