

Cougar Management Plan - Amended August 2011

# Utah Cougar Management Plan V. 2.1

## 2009 - 2021



**Utah Cougar Advisory Group**

**DWR Publication No. 09-15**

## **Utah Cougar Advisory Group Members**

### **Group Members**

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## **Utah Cougar Management Plan V. 2.0 2009-2021**

### **PLAN GOAL:**

Maintain a healthy cougar population within existing occupied habitat while considering human safety, economic concerns, and other wildlife species through 2021.

### **Introduction**

The purpose of the Utah Cougar Management Plan is to direct the management of cougars (*Puma concolor*) in Utah in accordance with the mission of the Utah Division of Wildlife Resources (Division or DWR) through July of 2021. The mission of DWR is:

*To serve the people of Utah as trustee and guardian of the state's wildlife*

In 1997, the UDWR initiated a process to obtain public input on issues and concerns with cougar management. Individuals representing many diverse points of view were invited to form the Cougar Discussion Group. The mission of this group was to aid the Division in preparing a cougar management plan that would hopefully gain agreement from diverse groups. The result of the Cougar Discussion Group was the first version of the Utah Cougar Management Plan (UDWR 1999) which directed cougar management efforts from 1999 – 2009.

This document is version 2 of the Utah Cougar Management Plan and seeks to build upon the successes of the previous plan and implement new information that has become available over the past ten years. Similar to the original, this plan was prepared with the help of individuals representing diverse interests in cougar management and conservation who formed the Cougar Advisory Group. The Cougar Advisory Group met 8 times between January and May of 2009 and all the members support this management plan.

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This document differs from the original plan in that it does not contain information on cougar natural history and ecology. This information was excluded because the Western Association of Fish and Wildlife Agencies (WAFWA) is in the process of publishing “Managing Cougars in North America”, which covers these topics in great detail and will be available on the UDWR website as soon as it is available. In addition, the WAFWA document summarizes the research and management findings which provide the basis for the management systems outlined in this plan. Chapter titles in “Managing Cougars in North America” include: Cougar Ecology and Natural History, Cougar-Prey Relationships, Assessing and Monitoring Cougar Populations, Conservation Genetics as Relevant to Cougar Management, Population Management: Cougar Hunting, Population Management: Cougar Depredation, Strategies to Manage Cougar Human Interactions, Human Dimensions of Cougar Management: Public Attitudes and Values, and Cougar Research and Management Information Needs.

This version of the Utah Cougar Management Plan also differs from the original in that it outlines management systems rather than simply defining performance targets and management strategies. In addition to defining management strategies and performance targets, a management system also outlines the specific actions that will be taken to reach and maintain performance targets.

### **Management History**

Cougars (*Puma concolor*), or mountain lions, were persecuted as vermin in Utah from the time of European settlement (in 1847) until 1966. In 1967 the Utah State Legislature changed the status of cougars to that of *protected wildlife* and since then they have been considered a game species with established hunting regulations. The Utah Division of Wildlife Resources (UDWR) developed the first Utah Cougar Management Plan in 1999 (UDWR 1999) with the assistance of a Cougar Discussion Group which guided cougar management in Utah from 1999-2009.

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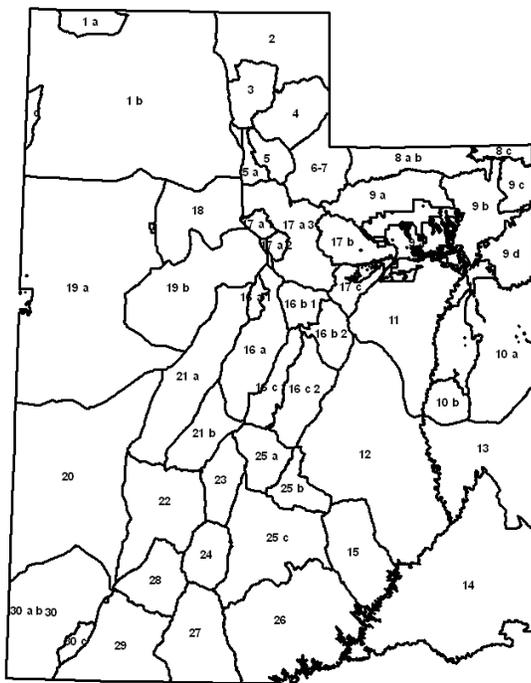
Utah's cougar harvests have been controlled on specific geographic areas, or management units (Figure 1), using three harvest strategies: harvest objective (quota), limited entry and split (limited entry followed by harvest objective). Under the *harvest objective strategy*,

managers prescribed a quota, or number of cougars to be harvested on the unit.

An unlimited number of licensed hunters were allowed to hunt during a season that is variable in length, as the hunting season closes as soon as the quota is filled or when the season end date is reached. Under the *limited*

*entry strategy*, harvests have been managed by limiting the

number of hunters on a unit. The number of hunters was determined based upon an expectation of hunting success and the desired harvest size. Individuals were usually selected for hunting on the unit through a random drawing process. Under the *split strategy*, units started the season under the limited entry strategy, and then transitioned to a harvest objective strategy on a set date using the number of limited entry permits that remained unfilled at the time of the transition as the quota for the remaining weeks of the season.



**Figure 1. 2009 Cougar Hunt Units**

In 1996 the Utah Wildlife Board approved a Predator Management Policy (DWR Policy No. W1AG-4, last updated in 2006) that authorizes the Division to increase cougar harvests on management units where big game populations are depressed, or where big game has recently been released to establish new populations. Predator management plans are reviewed by regional staff, the Mammals Program Coordinator, and Approved by both the Wildlife Section and DWR Director. Most predator

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management plans that affect cougars have been designed to benefit mule deer (*Odocoileus hemionus*) and/or bighorn sheep (*Ovis canadensis*). Cougar harvests have been liberalized where big game populations are far below objective (<65% of target densities) under the assumption that large harvests will reduce cougar numbers and hence predation rates on big game, and therefore encourage growth of big game populations by improving survival. However, drought, habitat alteration and loss and predation all substantially impact big game populations making the effectiveness of predator management plans difficult to evaluate.

In 1999, UDWR implemented a Nuisance Cougar Complaints policy (DWR Policy No. W5WLD-5, last updated in 2006) to provide guidance for reducing damage to private property and reducing public safety concerns, and to provide direction to Division personnel responding to cougar depredation, nuisance, and human safety situations. Any cougar that preys upon livestock or pets or that poses a threat to human safety is euthanized, as are sick or injured adult cougars and kittens that are unable to care for themselves in the wild. The Division does not rehabilitate these animals. The only cougars that are captured and translocated are adults and subadults that wander into urban or suburban “no tolerance zones”, in situations where they have not been aggressive toward humans, pets, or livestock.

### **Harvest Information**

The Division began managing cougar harvests through statewide limited entry hunting in 1990 and increased numbers of permits through 1995-1996. In 1996-1997, additional harvest pressure was added by switching some management units to the harvest objective (quota) system and a record high of 1,496 Permits were sold (Table 1).

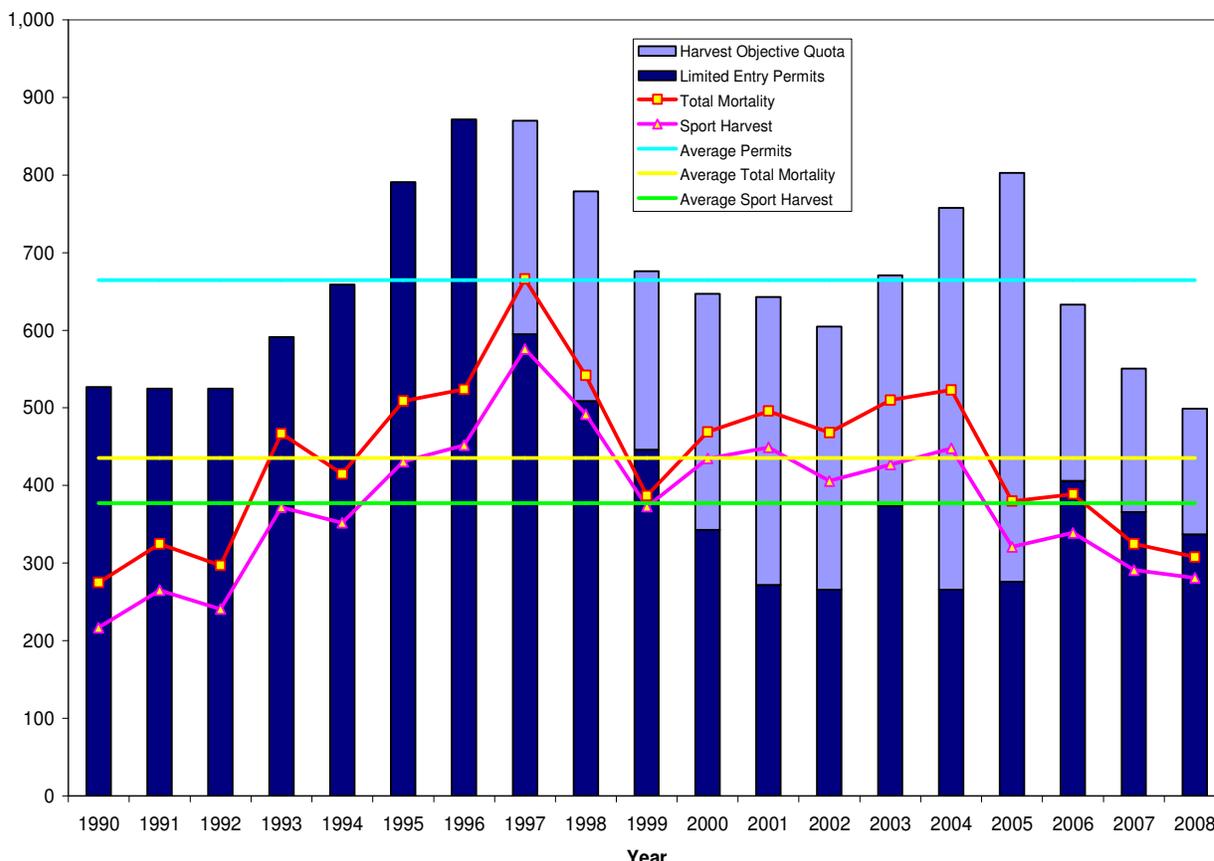
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**Table 1. Utah Cougar Permits 1990 – 2008.**

Year	Limited Entry Permits			Total	Harvest Objective Permits			Total Permits	Pursuit Permits
	Resident	Nonresident	Conservation / Convention		Resident	Nonresident	Total		
1989-90	385	142		527				527	355
1990-91	383	142		525				525	364
1991-92	383	142		525				525	524
1992-93	431	160		591				591	570
1993-94	479	180		659				659	552
1994-95	559	232		791				791	505
1995-96	611	261		872				872	627
1996-97	425	170		595			901	1,496	638
1997-98	381	128		509	472	199	671	1,180	635
1998-99	337	109		446	386	189	575	1,021	630
1999-00	259	84		343	374	170	544	887	545
2000-01	206	66		272	880	290	1,170	1,442	692
2001-02	228	30	8	266	897	300	1,197	1,463	681
2002-03	326	36	12	374	685	266	951	1,325	703
2003-04	215	29	20	264	533	209	742	1,006	772
2004-05	233	30	10	273	841	290	1,131	1,404	703
2005-06	356	38	12	406	464	222	686	1,092	730
2006-07	313	35	18	366	600	245	845	1,211	714
2007-08	278	33	26	337	587	238	825	1162	
2008-09	265	33	26	323					
<b>Total</b>	<b>6,510</b>	<b>2,014</b>	<b>80</b>	<b>8,604</b>	<b>6,132</b>	<b>2,380</b>	<b>9,413</b>	<b>18,017</b>	<b>10,940</b>
<b>Mean</b>	<b>362</b>	<b>112</b>	<b>13</b>	<b>478</b>	<b>613</b>	<b>238</b>	<b>856</b>	<b>1,001</b>	<b>608</b>

Utah’s cougar population is monitored through mandatory reporting of all hunter-harvested cougars, cougars that are killed on highways or in accidents and those taken as a result of livestock depredation. Location of kill, sex and age (through a premolar for age estimation) are recorded for every cougar killed, and provide the data used to assess management performance in relation to established target values that serve as indicators of population status. Since 1990 cougar mortality in Utah has ranged from 275 (1990) to 666 (1996) and has averaged 436 (Figure 2). Ongoing research on 2 study sites, under the direction of Dr. Michael Wolfe (Utah State University), is supplying comparative data on the dynamics of cougars subjected to varying levels of hunting harvest, which was used to refine management systems in this management plan (Choate et al. 2006, Stoner et al. 2006, Stoner et al. 2007).

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**Figure 2. Cougar Mortality and Permits 1990 - 2008**

Nearly all cougars harvested in Utah are taken with the aid of dogs. An individual hunter is restricted to holding either a limited entry permit or a harvest objective permit per season, and must wait 3 years to reapply once he/she acquires a limited-entry permit. The bag limit is 1 cougar per season and kittens and females accompanied by young are protected from harvest. Currently the cougar-hunting season runs from late November through early June on both limited entry and most harvest objective units. Some units are open year-round and some have earlier or later opening dates. Because harvest objective units close as soon as the objective (quota) is reached, hunters must call a toll-free number or check the Division website daily to ensure that the unit they plan to hunt is still open.

Pursuit (chase or no-kill) seasons provide additional recreational opportunities over most of the State. The pursuit season generally follows the hunt season, but specific units have year-round pursuit and a few units are closed to pursuit.

## **Distribution and Abundance**

Utah's cougar habitat encompasses about 92,696 km<sup>2</sup> (35,790 mi<sup>2</sup>). Cougars are distributed throughout all available habitats within the state. Residential and commercial development is incrementally reducing cougar distribution through habitat alteration and destruction, particularly along the western border of the Wasatch Mountains in northern and central Utah.

The last statewide cougar population estimates were developed in conjunction with the Utah Cougar Management Plan in 1999 (UDWR 1999). These estimates used extrapolations of cougar densities from published studies in the southwestern United States to: 1) the total area within all management units that comprise cougar range, and 2) the total amount of occupied cougar habitat within Utah. The habitat quality within each management unit was classified as either high, medium or low based on vegetative characteristics, terrain ruggedness (following Riley 1998) and prey density. Cougar densities derived from research within Utah, California and New Mexico were associated with each habitat quality level (UDWR 1999b). High quality habitat was assigned a density range of 2.5-3.9 cougars/100 km<sup>2</sup>, medium quality habitat was assigned a density of 1.7-2.5 cougars/100 km<sup>2</sup> and a density of 0.26-0.52 cougar/100 km<sup>2</sup> was assigned to low quality habitat.

The first statewide population estimate of 2,528-3,936 cougars resulted from summing unit population estimates. The number of cougars on each unit was estimated by first multiplying the total area contained within the unit by the highest density of the range assigned to it, and then by the lowest density of the range assigned to it.

For comparison, a second estimate of 2,927 cougars statewide was generated based upon mean cougar densities and total occupied cougar habitat within the state. Each management unit's cougar population was estimated by extrapolating the mean cougar density assigned to the unit (based on the respective range indicated above) to the amount of occupied cougar habitat within the unit, and unit estimates were summed to obtain the statewide figure. The two methods produced population estimates that

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show considerable agreement, but they should be only viewed as general approximations of the statewide cougar population.

## **Issues and Concerns**

At the initial meeting of the Cougar Advisory Group the following list of issues and concerns were identified by the group members. Subsequent meetings focused on developing, objectives, strategies and management systems to address the issues and concerns identified

### **Outreach / Education**

- Educate public about true relationship between cougar and prey populations.
- Educate hunters on sex/age identification
- Educate the general public about cougars and cougar safety

### **Population Management / Harvest Management**

- Explore season timing
- Non resident issues (pursuit permits, commercial vs recreational)
- Explore ways to increase cougar populations on public land
- Explore three year proclamation
- Provide timely data for permit recommendations
- Manage at a broader geographic level (three year proc)
- Simplify the management criteria (performance targets)
- Revisit performance criteria and try to meet them with recommendations
- Minimize year to year permit variations
- Avoid large swings in permit recommendations
- Identify areas for light harvest strategies (source sink management)
- Explore targeting females and leaving older age males (help on sheep ranges)
- Explore source sink management
- Manage to protect adult females

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### Predator Management

- Move away from predator management plans
- Reduce units under predator management
- Deal with predator management plans in this process
- Protect big game populations when needed

### Livestock Depredation

- Develop process to deal with chronic depredation areas
- Identify the sex of depredating lions
- Develop a way to deal with chronic depredation problems

### Research

- Compare ungulate and lion populations
  - Develop monitoring system to measure deer herd response on units under predator management
- Explore using population reconstruction to estimate the population
- Explore mark recapture population estimates (DNA sampling)

## **Objective, Strategies and Management Systems**

### Outreach and Education

#### **Objective 1:**

Increase awareness and appreciation within the general public for the role of cougars in Utah's ecosystems by 10% through 2021.

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### **Strategy:**

1. Pursue development and implementation of the new Living with Wildlife Program in Utah; an effort generated by the Conservation Outreach Section of the Division of Wildlife Resources.

### **Objective 2:**

Reach and educate 10% of the general public about cougar safety by 2021.

### **Strategy:**

1. Pursue development and implementation of the new Living with Wildlife Program in Utah; an effort generated by the Conservation Outreach Section of the Division of Wildlife Resources.

### **Objective 3:**

Contact a minimum of 30% of the big game hunting public that belong to sportsmen's organizations about the relationship between cougar and prey populations annually for the purpose of increasing the understanding of the true effect cougars have on big game populations.

### **Strategies:**

1. Develop an educational presentation highlighting cougar-prey interactions geared toward hunting/conservation organizations such as Sportsmen for Fish and Wildlife, Mule Deer Foundation, Rocky Mountain Elk Foundation, Utah Bowman's Association....
2. Write articles addressing cougar prey interactions for publication in sportsmen magazines/news letters published by hunting/conservation organizations such as: Sportsmen for Fish and Wildlife, Mule Deer Foundation, Rocky Mountain Elk Foundation, Utah Bowman's Association....
3. Explain cougar-prey interactions through radio, television and print media.

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4. Periodically assess big game hunter opinions about the effect of cougars on big game populations.

### **Objective 4:**

Educate all cougar hunters on how to determine the age/sex of cougars to increase harvest selectivity through 2021 and continue to educate Division employees tagging cougars.

### **Strategies:**

1. Continue to publish and refine information about sex and age identification techniques in the Cougar Guidebook.
2. Produce a voluntary online orientation course for cougar hunters. In 2015 evaluate effectiveness of orientation course to determine if desired results have been obtained. If not, modify course and re-evaluate in 2021. If determined successful in 2015 consider mandatory course for all cougar hunters.
3. Modify harvest reporting form to gather data on effectiveness of orientation course.
4. Survey unsuccessful cougar hunters to gather data on effectiveness of orientation course.
5. Obtain good digital photographs of cougars for sex and age identification education purposes. Examples: treed cougars, lactating females and track and paw sizes for sex and age differentiation.....
6. Explore ways to reward hunters for selective harvest.
7. Train Division employees responsible for tagging cougars at least bi-annually.

## **Cougar Population Management**

### **Objective:**

Manage populations in a manner that recognizes cougar ecology by incorporating: source-sink dynamics(Lindzey et al. 1992, Ross and Jalkotzy 1996 Sweanor et al. 2000, Logan and Sweanor 2001, Robinson et al. 2008, Cooley et al. 2009), large geographic and temporal scales (Murphy 1983, Logan and Sweanor 2001, Stoner et al. 2006, Robinson et al. 2008, Cooley et al. 2009), and the importance of adult females to population persistence (Lindzey 1992, Ross and Jalkotzy 1996, Logan and Sweanor 2001, Martorello and Beausoleil 2003, Anderson and Lindzey 2005, Stoner et al. 2006, Robinson et al. 2008, Cooley et al. 2009). This will be accomplished by adjusting harvest rates in accordance with the following performance targets, management system and strategies at a management area scale\* through 2021.

\* Cougar management areas were designed around units where annual adult deer survival is being tracked with radio-collars (deer-survival units). Units were grouped into management areas with the deer-survival unit that was most representative.

### **Performance Targets\*:**

**Primary Target** - Proportion of adult females in the harvest between 17% and 20% (within a management area over 3 years)

**Secondary Target** - Cougars treed per day averages between 0.25 and 0.35 (within a management area over 3 years)

\*A third performance target may be added if a method for tracking cougar densities is developed over the course of this plan

### **Management System\*:**

Harvested adult females above 20% reduce tags / quota by 10%

Harvested adult females above 23% reduce tags / quota by 20%

Harvested adult females below 17% increase tags / quota by 10%

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Harvested adult females below 14% increase tags / quota by 20%

Cougar treed per day below 0.25 and adult females above 20% reduce tags / quota an additional 5%

Cougars treed per day above 0.35 and adult females below 17% increase tags / quota an additional 5%

Adult females between 17% and 20%, but cougars treed per day above or below 0.25-0.35 maintain tags / quota within 5% of the previous recommendation.

Decrease the tags / quota for units transitioning out of PMPs by 40-60% for the first 3 year cycle and do not include the data from these units in the performance target analysis until after they have been out of a PMP for one 3-year recommendation cycle (data should be included in the analysis of the performance target that unit was under during the previous 3-year cycle).

\*If primary and secondary performance targets are in conflict with each other disregard the secondary target and reduce or increase tags according to the primary target.

### **Strategies:**

1. Implement the management system as follows (See Figure 4):
  - a. Adjust quotas at the management area scale (Figure 3).
  - b. Apply quotas for each management area with a female sub-quota
    - i. Female sub-quota will initially be set between 25%-30% of the management area quota and will be adjusted if necessary during subsequent 3-year cycles in order to meet the primary performance target within management areas

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1. Female sub-quotas may be different between management areas if deemed necessary to meet the primary performance target.
  - ii. A minimum harvest objective will be set for units within management areas that have bighorn sheep populations – these units will not close unless the minimum harvest has been met
- c. Use either limited entry or split hunt strategies on units managed under this management system
  - i. Harvest on limited entry units applies to the management area quota and female sub-quota.
- d. Keep harvest recommendations stable for 3 years before making adjustments (3-year proclamation).
  - i. Maintain the option of adjusting harvest recommendations at shorter intervals to account for exceptional circumstances such as:
    1. Large (>30%) annual declines in big game herds (consider entering into a Predator Management Plan).
    2. Adult female cougars in the harvest > 30%
- e. DWR regional wildlife staff will be responsible for the distribution of tags / quotas to the units within the eco-region (Figure 3).
  - i. Mammals program staff will calculate tag increases / reductions within the eco-region

## 2. Review performance targets after 2015

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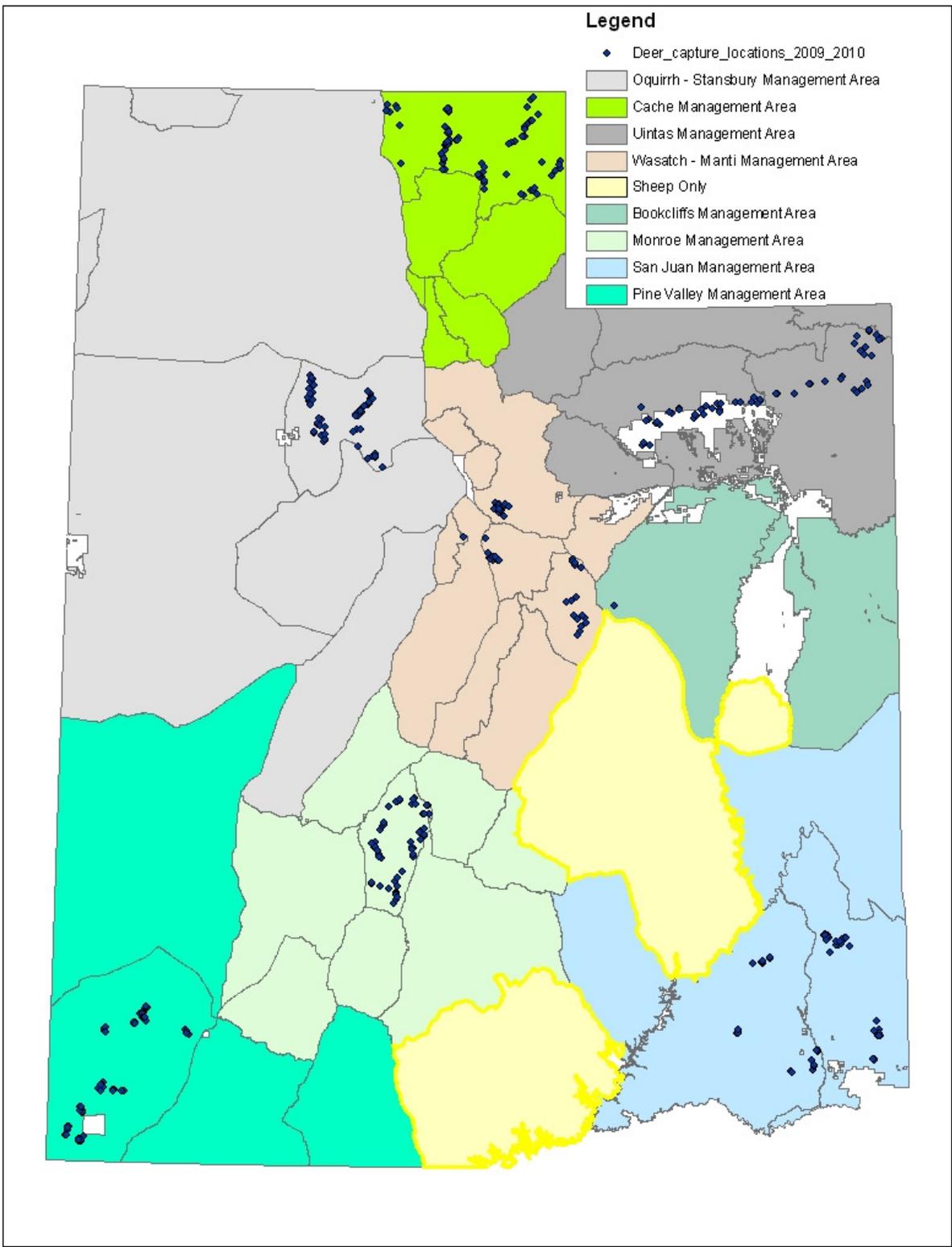


Figure 3. Cougar Management Areas

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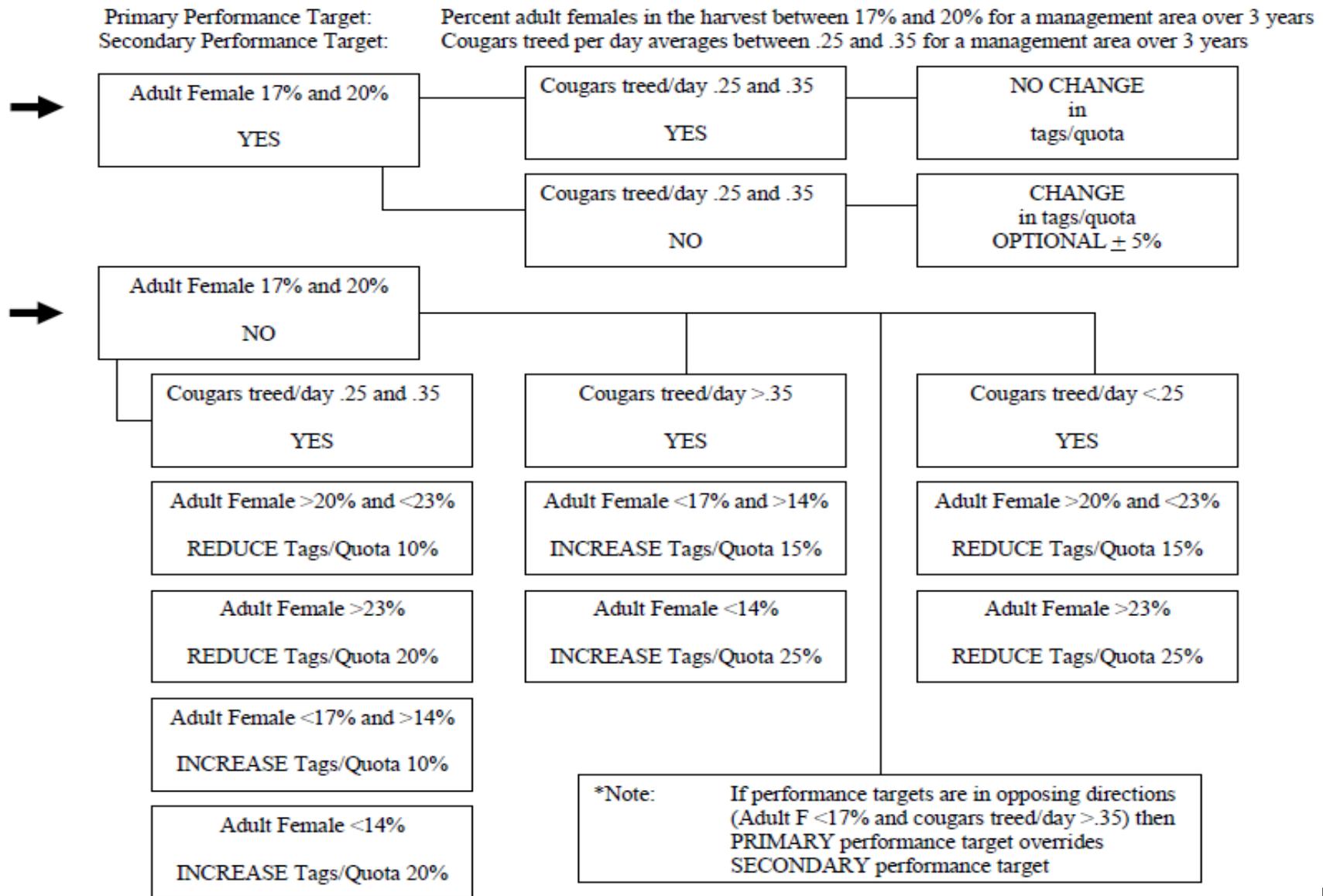


Figure 4.

## **Managing Cougar Populations Under Predator Management Plans**

### **Objective:**

Manage cougar populations to reduce predation on big game herds that are chronically below objective (see policy for managing predatory wildlife species W1AG-04) when cougar predation is a potential limiting factor to herd growth / recovery. This will be accomplished by adjusting harvest rates in accordance with the following performance targets and management system for units within each management area that have an approved Predator Management Plan (PMP) through 2021.

### **Performance Target:**

Proportion of adult females in the harvest > 25% (within a management area over 3 years)

### **Management System:**

Proportion of adult females in the harvest during the previous 3 years < 20% - New quota = average previous harvest during the previous 3 years +100%

Average Proportion of adult females in the harvest during the previous 3 years 20 - 25% - New quota = average previous harvest + 50%

Proportion of adult females in the harvest during the previous 3 years > 25% - New quota = average previous harvest during the previous 3 years +0%

Increase the tags / quota for units transitioning into PMPs by 50-75% for the first 3 year cycle and do not include the data from these units in the performance target analysis until after they have been under a PMP for one 3-year recommendation cycle (data should be included in the analysis

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of the performance target that unit was under during the previous 3-year cycle).

### **Strategies:**

1. Determine need for managing cougars under PMPs. If necessary, develop a Unit PMP and begin managing cougars under the management system identified for the three year period.
  - a. Including cougars in a PMP may be appropriate under the following circumstances:
    - i. Adult deer survival below 85%
    - ii. Adult bighorn sheep survival < 75% under normal winter conditions and in the absence of disease
    - iii. Large reductions (> 40%) in big game herds resulting from winter loss, disease, prolonged drought conditions.... to avoid the creation of a predator pit.
    - iv. Substantial potential that prey switching (alternate prey source) is negatively impacting sensitive big game herds. For example, if a bighorn sheep herd is located in an area with a healthy deer or elk herd and it isn't growing despite favorable habitat conditions and the absence of disease.
2. Implement the management system as follows:
  - b. Adjust quotas at the management area scale.
  - c. Apply quotas for each management area with a female sub-quota
    - i. Female sub-quota will initially be set between 40%-50% of the management area quota and will be adjusted if necessary during subsequent 3-year cycles in order to meet the primary performance target within management areas
      1. Female sub-quotas may be different between management areas if deemed necessary to meet the primary performance target.

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- ii. A minimum harvest objective will be set for units within management areas that have bighorn sheep populations – these units will not close unless the minimum harvest has been met
    - iii. The sheep only management area (Figure 3) consists of low elevation primarily snow-free habitat, as a result too few cougars are harvested from this area to analyze relative to performance targets.
  - d. Use either split or harvest objective hunt strategies on units under PMPs
  - e. Keep harvest recommendations stable for 3 years before making adjustments (3-year proclamation).
    - i. Maintain the option of adjusting harvest recommendations at shorter intervals to account for exceptional circumstances such as:
      - 1. Continued substantial (>20%) annual decline in big game herds where there is a PMP already in place.
      - 2. Adult female cougar in the harvest > 40% for units within an eco-region that are under a PMP
  - f. DWR regional wildlife staff will be responsible for the distribution of tags / quotas to the units within the eco-region that are managed under PMPs.
    - i. Distribute tag increases / reductions within the eco-region based on the amount of cougar habitat in a particular eco-region within each administrative region boundary (see table under population management).
3. Evaluate ungulate population response after three years to determine need to continue or discontinue predator management direction.

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- g. Units should not remain under PMPs for more than 2 management cycles except under extraordinary circumstances such as:
  - i. Continued high potential for prey switching to cause declines in sensitive big game herds.
  - ii. Large declines in big game herds not associated with cougar predation (e.g. significant winter mortality) that occurs while the unit is under a PMP
4. When possible enter or leave PMPs focused on cougars on the three year recommendation cycle.

### **Managing Chronic Cougar Depredation**

#### **Objective:**

Work to resolve all chronic\* cougar depredation problems on private land by removing the offending animal(s) with the cooperation of APHIS Wildlife Services, livestock producers and houndsmen through 2021.

\*In order for a depredation problem to be considered chronic for the purpose of this objective it must meet the following criteria:

1. The depredation is occurring on private land;
2. The depredation has occurred in same area for 3 consecutive years or 4 out of five years and;
3. WS has attempted to remove the offending animal(s), but has been unsuccessful.

#### **Strategies:**

1. WS increase efforts and/or bring cougar specialists in from other areas to help resolve chronic depredation problems – option to implement after 2 years.

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2. Division request that WS continue efforts to remove the offending animal after livestock have left the area, or before they have arrived to resolve chronic depredation problems – option to implement after 2 years.
3. The Division may authorize the livestock owner, an immediate family member or an employee of the owner (not someone specifically hired to take cougar) to remove the offending animal beyond the 72hr period stipulated in Utah Admin Code R657-10-21 – implemented after year 3.

Conditions to the authorization to remove a cougar(s) should include:

- i. The time period during which the cougar(s) can be removed;
- ii. A description of the geographic area from which a cougar(s) can be removed;
- iii. A description of the cougar(s) authorized to be removed (i.e. male, female.....)
- iv. Other relevant conditions

Any cougars removed are considered depredating cougars and are subject to the reporting and possession requirements in the Utah Admin. Code R657-10-21

4. DWR and WS will work with the houndsmen community to develop a list of houndsmen that are willing to volunteer their time to help livestock owners resolve chronic depredation issues.

### **Cougar Research**

**Objective:**

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Increase base understanding through continued research designed to address questions relative to cougar management in Utah through 2021. Potential research projects are listed below in order of priority.

### **High Cost Research Priorities (> \$100,000 / Year)**

1. Investigate DNA mark-recapture for population estimation – Currently part of USU Research Contract
2. Prey selection and predation rates by cougars; combined with deer study could elucidate prey selection among hunters, cougars, and the deer population; need radioed deer.
3. Cougar human interactions – Westside of SL valley –
  - a. How often do cougar go into residential areas vs. how often are they detected
  - b. Changes in cougar habitat use following development
4. Niche partitioning of cougars and coyotes and their effects on mule deer and elk; would require radioed coyotes and prey. – Camp Williams
5. Cougar bighorn sheep relationships
6. Indirect effects of predation risk on foraging behavior of livestock.
7. Effects of a keystone predator on biodiversity (ala Yellowstone wolf recovery on elk and vegetation).

### **Low to Moderate Cost Research Priorities (< \$100,000 / Year)**

1. Predation sites and kill composition by cougars (possible Dustin Mitchell thesis project).
2. Examining the depredation records of the DWR and seeing the influence or efficacy of removing cougars and subsequent livestock depredations. Does removing cats affect future depredations? Are there depredation hotspots? What age and sex class is removed for livestock depredations and does the effect what comes in the next time?
3. Modeling the long-term data set for examining cougar population ecology and demographics; population persistence; possible PhD student interested in population models.

**Strategies:**

1. Continue collaborative research efforts to maximize knowledge base, funding sources and available resources.
2. Explore new funding sources and ways to leverage those resources.
3. Whenever possible use Division employees enrolled in the educational assistance program to conduct research.
4. Re-visit prioritized list before 2021 if research direction or funding change or new opportunities become available.

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