EXHIBIT E

WITNESS REGISTRATION

Oregon Fish and Wildlife Commission

August 4, 2017

Oregon Department of Fish and Wildlife

4034 Fairview Industrial DR SE, Commission Room

PUBLIC HEARING ON: **Exhibit E: DRAFT COUGAR MANAGEMENT PLAN**

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Exhibit B
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August 4, 2017

Mr. Michael Finley
Chair
Oregon Fish and Wildlife Commission
4034 Fairview Industrial Drive SE
Salem, OR 97302

Re: Oregon Cougar Management Plan – Draft Update

Chair Finley,

The Oregon Farm Bureau Federation ("OFB") and the Oregon Cattlemen's Association ("OCA") appreciate the opportunity to respond to the *Oregon Cougar Management Plan: Draft Update ("Draft Update")*. As a reference, OFB is the state's largest general agriculture association, representing nearly 7,000 families actively engaged in farming and ranching and over 60,000 members statewide. OCA represents nearly 2,000 ranchers in Oregon and aims to help grow Oregon's beef industry and promote environmentally and socially sound economic practices in producing beef products sold worldwide.

Each year, Oregon's livestock producers suffer substantial depredation losses from cougars and other large predators.[1] Cougars are opportunistic, and a lamb, kid or calf is much easier prey than a wild animal. Our producers have firsthand knowledge of the damage that these predators can cause to a farm or ranch.

Oregon's cougar population has more than doubled since passage of Measure 18, increasing to over 6,000 cats today. Oregon's ranch families feel the pressure of this increase and lose thousands of young livestock each year to cougars and other predators. In some cases, the mothers are also impacted when they intervene to protect their young. These losses reduce the viability of family farms and impact the economic wellbeing of rural and agriculture-dependent communities.

With increased depredation statewide, this is not an issue limited to remote or rural areas of the state. Cougar sightings are increasing in metropolitan areas. This spring, residents of Tualatin, Tigard, and Troutdale witnessed increasing instances of cougars in and around schools and neighborhoods.[2][3] These conflicts reveal a growing population of cougars that is advancing into more urban areas, creating cougar-human conflicts and pet safety concerns.

OFB and OCA support the Oregon Cougar Management Plan as a balanced plan and strong management tool. It is important to keep this plan adaptive as Oregon's cougar population continues to increase, including assurances regarding how large the population can grow. As the Commission considers revisions to the management plan, we reiterate requests from our organizations' 2016 comments and provide the following response concerning the *Draft Update*:

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[1] USDA APHIS. Sheep and Lamb Predator and Nonpredator Death Loss in the United States, 2015. https://www.aphis.usda.gov/animal_health/nahms/sheep/downloads/sheepdeath/SheepDeathLoss2015.pdf

[2] "8 things to know about cougars -- and sightings -- in Oregon." The Oregonian, July 20, 2017. http://www.oregonlive.com/environment/index.ssf/2017/07/cougars_in_the_portland_metro.html

[3] English, Joe. "Photo shows cougar prowling neighborhood; schools send out notice." http://katu.com/news/local/photo-shows-cougar-prowling-troutdale-neighborhood-schools-send-out-notice

1. **Maintain emphasis on livestock damage.**
   We support consolidation of Objectives 3 and 4 in the *Draft Update* to bring livestock depredation management under one objective. This proposal simplifies the Oregon Cougar Management Plan for stakeholders and wildlife managers and keeps a focus on livestock loss resulting from cougar depredation.

   Focusing cougar management based on non-hunting damage is supported by the Oregon Department of Fish and Wildlife ("ODFW") and peer-reviewed data. For instance, the Beulah Target Area (2006-2010) was implemented to reduce livestock depredation, and ODFW saw a reduction in cougar-livestock conflicts and complaints following the removal of cougars from the area. A recent peer-reviewed study by Hiller et al. (2015) supports the same conclusion.[4]

   The *Draft Update* de-emphasizes cougar management based on the number of complaints in an area and shifts the focus to livestock damage. We support this data-driven revision. Wildlife managers have seen increased incidences of livestock damage in western Oregon, which will likely increase in the future. Small and family scale ranches are particularly vulnerable to loss. While complaints will often be higher when cougars arrive in an area, the number of complaints is not a consistent indicator of depredation pressure. And an over-reliance on complaints could lead to irregular management and leave livestock producers vulnerable to damage. Shifting the focus to livestock damage will not only provide consistency to Oregon producers but also will help ODFW allocate resources more efficiently throughout its program.

2. **Retain target areas as a cougar management tool.**
   Compared to other states, Oregon landowners have few tools available to manage cougar depredation. Target areas continue to be a powerful tool to address depredation—they keep pressure on cougars and bolster hazing and other activities that lessen damage costs to Oregon's livestock producers.

   We support the proposal in the *Draft Update* to retain target areas as an adaptive management tool for ODFW. Target areas assist in alleviating predator pressure in specific zones, giving ODFW flexibility to effectively protect families, livestock, and wildlife from cougar depredation and to manage for a population in a specific region of the state. As the Commission considers the *Draft Update*, we ask that you prioritize Objective 3 to proactively manage cougar-livestock conflicts in target areas.

3. **Update adaptive management tools.**
   It is important that the Oregon Cougar Management Plan adapt to changing cougar and human-livestock demographics. Table 17 proposes to contemporize damage parameter thresholds from a static value (i.e. not to exceed 1994 mortality) to a more dynamic parameter (i.e. 3-year average not to exceed 10-year average). OFB and OCA have heard from producers across the state, many in western Oregon, who are concerned about increasing incidences of livestock damage. We hope that updating this parameter will account for variability in predator pressures from year-to-year and will provide consistent support to livestock producers to manage the threat of cougars on their farms and ranches.

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[4] Hiller, Tim L. Demography, Prey Abundance, and Management Affect Number of Cougar Mortalities Associated with Livestock Conflicts. The Journal of Wildlife Management 79(6):978–988; 2015.

4. Expand list of adaptive management tools.

Many management zones are reaching their population cap, and conflicts are on the rise as cougars threaten human safety, livestock, and wildlife. OFB and OCA encourage the Commission to consider partnering with hunters and landowners to assist in managing cougars and controlling costs.[5] Many hunters and landowners have the expertise to address the conflicts that come with overpopulation of cougars, and our members are interested expanding predator management opportunities.

Predator management is an essential part of an overall wildlife management program, and Oregon needs a Cougar Management Plan that benefits public safety, livestock, and wildlife. The *Draft Update* is a step in the right direction, and we look forward to continued involvement with updating the Oregon Cougar Management Plan in 2017.

Thank you for the opportunity to provide input.

Sincerely,

Jenny Dresler
Director of State Public Policy
Oregon Farm Bureau Federation

Jerome Rosa
Executive Director
Oregon Cattlemen's Association

[5] Oregon Department of Fish and Wildlife. 2006 Oregon Cougar Management Plan. April 19, 2016. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf

exhibit E
Jenny Presler

Demography, prey abundance, and management affect number of cougar mortalities associated with livestock conflicts

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Research Article

Demography, Prey Abundance, and Management Affect Number of Cougar Mortalities Associated With Livestock Conflicts

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ABSTRACT Balancing the ecological importance of large carnivores with human tolerances across multiple-use landscapes presents a complex and often controversial management scenario. Increasing cougar (*Puma concolor*) populations in the western United States, coupled with an increasing human population and distribution, may contribute to increased numbers of interactions and conflicts (e.g., livestock depredation) with cougars. We assessed county-level factors associated with mortalities of cougars of different sexes and ages resulting from livestock conflicts in Oregon during 1990–2009. Factors included cougar population density, human population density, proportion of the cougar population that were juvenile males, cougar harvest, prey availability, habitat conditions, and climate measured at the county level. We used generalized linear mixed models and quasi-likelihood Akaike's Information Criterion (QAIC) to rank models. Two of 26 models were competitive (ΔQAIC < 4, $\sum w = 0.72$) and both contained cougar population density and cougar harvest density; the second-best model also included proportion of juvenile males in the population. From model-averaging, we determined cougar mortalities associated with livestock conflicts increased with increasing cougar population density (95% CL = 0.48–1.37) and decreased with increasing cougar harvest density (95% CL = −0.58 to −0.02). An exploratory model including cougar population density, cougar harvest density, proportion of juvenile male cougars, beef cattle density, relative deer density, and all pairwise interactions was equal to the QAIC-top model from the previous set of 26 models. Under a scenario of a high proportion (0.40) of juvenile males, number of cougar mortalities related to livestock conflicts increased 219% when cougar population density increased from 300/10,000 km^2 to 400/10,000 km^2. In contrast, the number of cougar mortalities decreased with increasing harvest when cougar population densities were high (500/10,000 km^2), but we found no relationship at lower cougar population densities. As beef cattle densities increased, the number of cougar mortalities increased substantially (low deer populations), remained relatively low and constant (average deer population), and decreased (high deer populations). Where landowner tolerance to cougar-livestock conflicts is an issue, wildlife managers may provide expertise to reduce conflicts by increasing density of wild ungulate prey, increasing hunter-harvest, and reducing vulnerability of livestock, depending on factors that may be contributing to conflicts.

KEY WORDS cougar, damage management, harvest mortality, livestock, mountain lion, *Puma concolor.*

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Centuries of coexistence of humans and large carnivores has unfortunately included a long history of conflicts. During European settlement in North America until about the 1960s, human responses to conflicts often included the goal of extirpation of large carnivores (e.g., Kellert et al. 1996, (*Picea engelmannii*), lodgepole pine (*Pinus contorta*), and western larch (*Larix* occidentalis; Natural Resources Conservation Service 2006). Southeastern Oregon consisted of shrub-steppe vegetation dominated by sagebrush (*Artemsia* spp.) and antelope bitterbrush (*Purshia tridentata*; Chappell et al. 2001, Natural Resources Conservation Service 2006). Mean annual precipitation ranged from about 20 cm in Harney County (southeastern OR) to about 325 cm in Polk County (northwestern OR); mean annual daily temperature ranged from 3.1° C in Klamath County (southcentral OR) to 13.0° C in Douglas County (southwestern OR; Southern Regional Climate Center 2010).

Oregon had an estimated human population of 3.4 million, with the greatest human densities in the Willamette Valley (U.S. Census Bureau 2002*a*). During 1990–2010, the human population in Oregon increased 35% (U.S. Bureau of the Census 1995, U.S. Census Bureau 2010). Estimated statewide cougar populations in Oregon increased 70% from 3,000 in 1993 to 5,100 in 2003, and the number of cougars killed by humans for non-hunting purposes (e.g., damage management, human safety) also increased on average about 14%/year during the same time period (ODFW 2006). Oregon is currently divided into 6 zones for managing cougars (Fig. 1; ODFW 2006). Each zone has an annual quota (i.e., maximum number of recorded cougar mortalities regardless of source) that if reached, results in the closure of the hunting season for cougars in that zone for the remainder of that year. However, zone closure does not prohibit or otherwise affect killing cougars for damage management or human safety (ODFW 2006). During 1995–2011, zone closures occurred for 1 zone in 2001, 2 zones in 2002, and 1 zone in 2011 (ODFW 2006, 2012). A statewide hunting season is open year-round for hunters with the appropriate licenses and permits, but hunters cannot legally harvest spotted kittens or females with spotted kittens (ODFW 2006). A permit is not required by a landowner (or an authorized agent of that landowner) to kill a cougar causing damage (e.g., livestock depredation) or posing a threat to human safety.

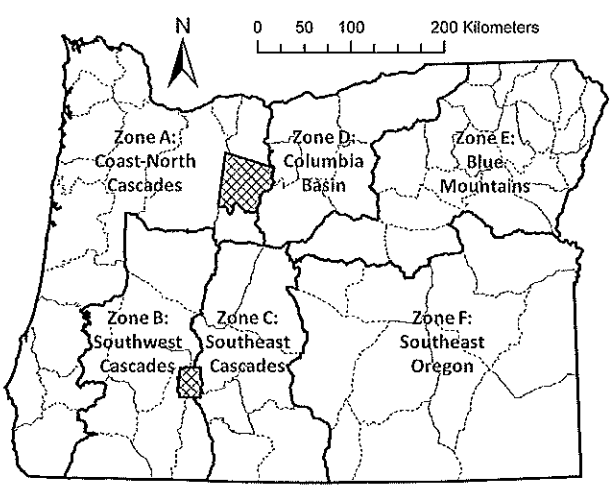

Figure 1. Zone boundaries as defined by the Oregon Department of Fish and Wildlife for the purposes of cougar management in Oregon, USA. Cross-hatched areas include major land areas either not under management jurisdiction of the state wildlife agency (northern area = Warm Springs Indian Reservation) or where hunting was not permitted (southern area = Crater Lake National Park).

METHODS

Data Collection

We used cougar mortality data collected through the mandatory reporting system during 1990–2009, which included individual sex, age class (kitten [<1 yr], juvenile [1–3 yr], adult [>3 yr]), year, and location (county) of cougar mortalities from hunter-harvest and in response to conflicts with livestock (ODFW, unpublished data). Any person killing a cougar for any purpose is required to present the skull, hide, and proof of sex to ODFW for data collection purposes, including tooth collection for aging via cementum annuli analysis (see Schroeder and Robb 2005). We obtained cougar population density and proportion of juvenile males (based on estimated sex-age population structure) estimated at the zone level from a density-dependent, deterministic population model (Fig. 2; Keister and Van Dyke 2002; ODFW, unpublished data); population data were not available at finer spatial resolutions than the zone. This population model uses age-at-harvest data for all hunting and known non-hunting mortalities and population reconstruction methods to back-calculate age and sex structure in previous years. The model makes specific assumptions about non-anthropogenic age-specific mortality and reproductive rates, and assumes that density dependence reduces reproduction and increases age-specific mortality above 75% of the potential maximum population size of about

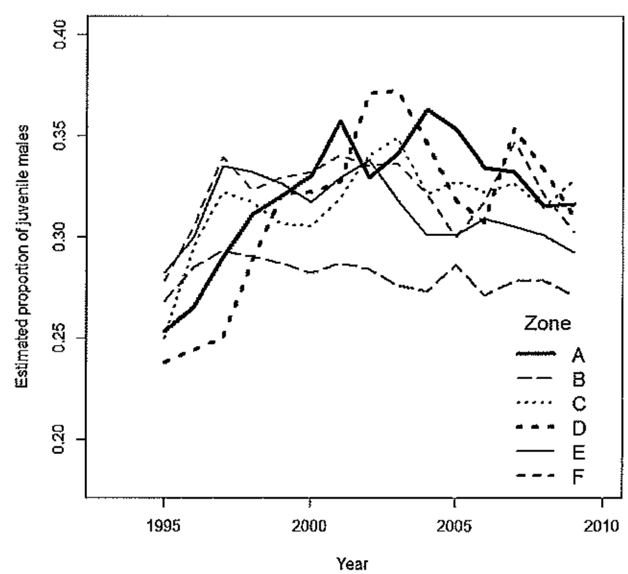

Figure 2. Estimated annual proportion of juvenile male cougars in the population for each cougar management zone in Oregon, USA. Zones included A (Coast-North Cascades), B (Southwest Cascades), C (Southeast Cascades), D (Columbia Basin), E (Blue Mountains), and F (Southeast Oregon). Estimates are based on results from a density-dependent, deterministic population model (Keister and Van Dyke 2002; ODFW, unpublished data).

8,000 cougars (Keister and Van Dyke 2002). For our purposes, the assignment of relative population sizes and proportions of juvenile males among zones and across years was important as opposed to the absolute accuracy of this model.

Ungulate species, such as deer and elk, constitute a substantial part of the diet of cougars across their range, including Oregon (Maser and Rohweder 1983, Toweill and Maser 1985, Clark et al. 2014*a*). We used annual ungulate population data collected at the wildlife management unit level (67 units in Oregon). Because we conducted our analysis at the county level, we developed a population index of ungulate abundance at the unit level. Because unit sizes and boundaries differed from counties, we assigned a unit to 1 county when ≥95% of that unit was within the boundary of a given county. In other instances, we estimated ungulate abundance for the county as a weighted average of the units based on the proportion the county comprised of each unit. This assumed ungulates were uniformly distributed within the management unit. If data were not available for a given unit during a given year, we used data from an adjacent unit with similar habitat conditions and assumed that it contributed information useful at the county level.

We used annual population abundance indices for 2 allopatric subspecies of deer (mule and black-tailed deer [*O. h. columbianus*]) and 2 allopatric subspecies of elk (Roosevelt [*Cervus elaphus roosevelti*] and Rocky Mountain [*C. e. nelson*] elk) based on population survey data (ODFW, unpublished data; ODFW 2011*a*). For black-tailed deer west of the peak of the Cascade Mountain Range, we used data collected from post-winter road surveys using spotlighting as a relative index (number of deer/km; see ODFW 2008 for field data collection methods). For mule deer east of the peak of the Cascades, we used post-winter data collected primarily from road and aerial surveys (see ODFW 2003*a* for field data collection methods). For Rocky Mountain elk east of the crest of the Cascades, and Roosevelt elk west of the crest of the Cascades, we used a relative density (number of individuals/km^2) based on data collected from post-winter aerial surveys (see ODFW 2003*b* for field data collection methods for elk). Because of differences in collection of data, we developed a standardized population index for each county-year combination. We first averaged indices for 1990 for each subspecies. We then calculated the percentage change by year from the 1990 mean for each county and subspecies and used 1 standardized, independent variable for each species (i.e., deer, elk). We used annual number of beef cattle and sheep by county (number of individuals/km^2) as the available domestic prey (National Agricultural Statistics Service 2011).

Although cougars are distributed statewide in Oregon, vegetation cover may limit cougar populations because cougars appear to select forested areas where prey abundance is high (Seidensticker et al. 1973, ODFW 2006, Jenks 2011). Therefore, we used estimates of the proportion of forest cover at the county level as a metric of relative habitat quality for 2 time periods (1990–2000, 2001–2010; K. Waddell, U.S. Forest Service, Pacific Northwest Research Station, unpublished data). Although these data were temporally limited (i.e., 10-yr periods), we could not obtain similar county-level data from another source. Therefore, we assumed annual changes in forest cover at the county level were limited. We hypothesized that weather patterns across Oregon may also affect cougar-livestock conflicts, because weather could influence domestic or wild prey availability or vulnerability. We used mean maximum temperature (°C), mean minimum temperature (°C), total precipitation (cm), and total snowfall (cm) to characterize annual weather at the county level (Western Regional Climate Center 2008). If a county contained >1 weather station, we selected the weather station with the most complete data set during our study period and nearest the center of that county to represent weather patterns within that county. We used annual estimates of human population by county (U.S. Census Bureau 2002*b*, 2011) to assess potential associations between human population and number of cougars killed for conflicts with livestock.

Statistical Analysis

We centered (subtracted the mean) and rescaled (divided by the standard deviation) all independent variables to improve model convergence (Draper and Smith 1998). To test for multicollinearity among independent variables, we used the Pearson product-moment correlation coefficient (r). If $|r| < 0.70$ for any pair of independent variables, we assumed multicollinearity did not compromise model results. If multicollinearity existed for a pair of independent variables, we did not include both variables in a model.

We modeled the annual number of cougars killed within a county as a result of livestock conflicts on characteristics of the environment and the cougar population. We assumed that the number of mortalities associated with livestock conflicts was a Poisson count variable with discrete events occurring at a constant rate within a county and a year. The expected number of events in county i and year t is $\lambda_{i,t}$. However, to control for variation in county area, we standardized rates across counties using $\lambda_{i,t} = \lambda^{a}_{i,t} A_i$, where a indicates the rate per unit area and A_i respresents an offset term (Crawley 2007). We used generalized linear mixed models with a log link function to examine how variation in features of each county and year affected $\lambda_{i,t}$. We included cougar population density in the county (cougars/km^2) in all models because we assumed the number of animals killed was related to population density. An alternative hypothesis was that a specific number of cougars will be killed regardless of population density. This hypothesis was implicit in models containing cougar population density as a predictor; if the estimated coefficient of cougar population density was not different from 0, then the rate of cougar mortalities was independent of cougar population density.

We constructed a set of a priori models, including the null model (offset only), by logically selecting from a total of 13 independent variables (each as a fixed effect) to test hypotheses regarding the dependent variable. We treated county and year as random effects on model intercepts (including the null model) and we included cougar population density as a fixed effect in all models (excluding the null model) because we expected this independent variable to be highly explanatory (e.g., Peebles et al. 2013). We assessed overdispersion of data by estimating the variance inflation factor ($\hat{c}$) based on the chi-square goodness-of-fit test and visually examined residuals for an indication of systematic lack of fit using the global model. We used quasi-likelihood adjusted Akaike's Information Criterion (QAIC) for overdispersed data and ranked models based on model complexity and fit (Burnham and Anderson 2002). If model selection uncertainty affected interpretation of model results (i.e., assessment of ΔQAIC values, weight of evidence [w], log-likelihood values; Burnham and Anderson 2002), we model-averaged across all models to reduce effects of any uninformative parameters (Burnham and Anderson 2002, Arnold 2010). Finally, we calculated the z-score (i.e., model-averaged maximum-likelihood estimate divided by the model-averaged standard error) for each independent variable to standardize parameter estimates and assess their relative values as model parameters. We used Program R (v3.1.1, www.r-project.org, accessed 18 Oct 2014) for all statistical analyses. Unless noted otherwise, we assessed parameters using 95% confidence limits (LCL = lower, UCL = upper).

Post Hoc Analysis

We conducted 2 post hoc analyses following model selection and averaging, which we acknowledge may be considered a form of data dredging; however, we took this approach to fully investigate data to increase our understanding of complex systems (Burnham and Anderson 2002). First, we conducted a post-hoc analysis to address the alternative hypothesis that a small, fixed number of cougars cause depredations. We removed cougar population density from each of the a priori models described above and re-ran the analysis. If the alternative hypothesis was valid, then this set of models would have a top model with QAIC scores close to or better than the top model in the a priori model set.

Second, we constructed an exploratory model using only independent variables with coefficients that were significant ($\alpha = 0.05$) in ≥ 1 of the top 13 models ranked during the model selection process. We also included all pairwise interactions of these independent variables in the exploratory model. We then used 10-fold cross validation (Picard and Cook 1984) to evaluate the exploratory model based on predicted and observed values and QAIC to compare this model with the full model set previously constructed.

RESULTS

The annual number of cougar mortalities related to livestock conflicts averaged 22.0 (SD = 5.2) during 1990–1994; mean number of mortalities increased by 14.0/year during 1996–2000, then varied but averaged 101.8/year (SD = 8.7) during 2001–2009 (Fig. 3). Our full data set contained information on 756 county-year combinations. After deleting county-year combinations with missing data for 1 or more independent variables, our subset for analyses contained 400 county-year combinations.

Of the independent variables selected for model construction, no pairs exhibited multicollinearity. We constructed 26 models, including the global and null models, to test our hypotheses. The global model describing number of cougar mortalities showed moderate overdispersion ($\hat{c} = 3.6$) and residuals showed no systematic lack of fit. Because data were moderately overdispersed, we used QAIC to rank models. The top 13 models had ΔQAIC < 7.64 and $\sum w = 0.96$; only 2 models had ΔQAIC < 2 (Table 1). The top 2 models contained cougar harvest density; cougar population density was included in all models except the null model. We model averaged over the full set to minimize the effect of uninformative parameters. Two model parameters (cougar population density, cougar harvest density) had 95% confidence limits of coefficient estimates that excluded 0 (0.48–1.37 and −0.58 to −0.02, respectively) and z-scores >2, suggesting that these parameters had value (Table 2).

In re-analyzing the 25 a priori models without cougar population density, the best model had a QAIC score 5.5 units greater than the best model in the a priori set, and a log-likelihood score that was greater than all 13 models in the 95% confidence set. Thus, we concluded that cougar population density was an essential independent variable. The same 2 models (cougar harvest density, cougar harvest density + population proportion of juvenile male cougars) were ranked as the first and second QAIC-best models, respectively, confirming the importance of harvest density as an independent variable.

In the second post-hoc analysis, 5 independent variables (cougar population density, cougar harvest density, population proportion of juvenile male cougars, beef cattle density, deer relative density index) differed from 0 ($P < 0.05$) in at least 1 of the top 13 models. Including these variables and 2-way interactions, at $\alpha = 0.05$, 9 fixed effects or interactions were significant (Table 3). This model ranked approximately equal to the top model with ΔQAIC = 0.13.

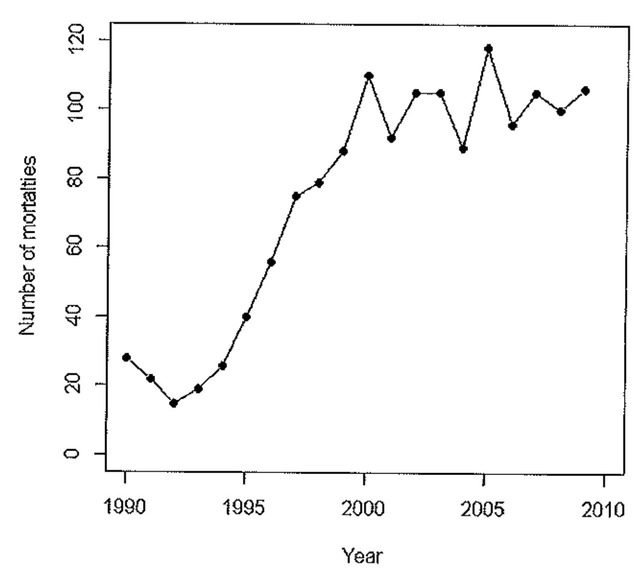

Figure 3. Annual number of cougar mortalities related to livestock conflicts during 1990–2009, Oregon, USA.

Table 1. Model selection results of top 13 models from a set of 26 based on Akaike's Information Criterion using quasi-likelihood adjustments (QAIC; Burnham and Anderson 2002) to predict number of cougars killed/100 km^2, Oregon, USA, 1990–2009, where K = number of model parameters, ΔQAIC = difference in relation to best model within the set, and w = QAIC weight. Data included 400 county-year combinations; all models contained cougar population density as a fixed effect and county and year as random effects on the intercept.

Model		K	ΔQAIC	w
1	Cougar population density + cougar harvest density	5	0.00	0.46
2	Cougar population density + cougar harvest density + population proportion of juvenile male cougars	6	1.11	0.26
3	Cougar population density + cougar harvest density + population proportion of juvenile male cougars + proportion forest cover + human population density	8	4.53	0.05
4	Cougar population density	4	5.51	0.03
5	Cougar population density + cougar harvest density + population proportion of juvenile male cougars + beef cattle density + sheep density + deer relative density index + elk relative density index	10	5.83	0.02
6	Cougar population density + deer relative density index	5	5.86	0.02
7	Cougar population density + population proportion of juvenile male cougars	5	5.98	0.02
8	Cougar population density + proportion forest cover	5	6.44	0.02
9	Cougar population density + beef cattle density + sheep density	6	6.59	0.02
10	Cougar population density + beef cattle density + sheep density + deer relative density index	7	6.78	0.02
11	Cougar population density + human population density	5	7.43	0.01
12	Cougar population density + total annual snowfall	5	7.45	0.01
13	Cougar population density + mean minimum annual temperature	5	7.51	0.01

Using this model, and regardless of the proportion of juvenile males in the cougar population, density of cougar mortalities increased with increasing cougar population density (Fig. 4) with the effect being stronger at greater proportions of juvenile males in the population. Under a scenario of a relatively high proportion (0.40) of juvenile males, when the cougar population density (number of individuals/10,000 km^2) increased 33% from 300 to 400, cougar mortalities increased 138% from 3.2/10,000 km^2 to 7.6/10,000 km^2; a 25% increase in population density from 400 to 500 resulted in a similar increase in mortalities of 139% (7.6/10,000 km^2 to 18.2/10,000 km^2).

Cougar mortalities did not increase as the density of cougars harvested increased when the estimated cougar population was at minimum (30/10,000 km^2) or mean (200/10,000 km^2) values, and remaining independent variables were held constant at their respective mean values (Fig. 5). However, when the estimated cougar population density was at maximum (500/10,000 km^2), the density of cougar mortalities related to livestock conflicts decreased with increasing harvest density. For example, our model predicted a 5-fold increase in harvest density would result in a 60% decrease in density of cougar mortalities related to livestock conflicts.

The number of cougar mortalities as a function of number of beef cattle was relatively constant at about 1.0–1.5/10,000 km^2 over the range of densities of beef cattle when deer density was average (Fig. 6). When deer were more abundant (i.e., 200% increase in deer density index relative to the average), the number of mortalities per 10,000 km^2 decreased 75% between 0 and 10,000 beef cattle/10,000 km^2, and decreased to $\leq$1.0 with densities of beef cattle $\geq$10,000 using the constant maximum for deer density. In contrast, when deer are scarce, the density of cougar mortalities increased sharply with increasing density of beef cattle.

Our evaluation of the exploratory model using 10-fold cross validation resulted in the least-squares equation $y = 0.29 + 0.91x$, where y = observed number of cougar mortalities (from data) and x = predicted number of cougar mortalities (based on cross validation of exploratory model; Fig. 7). Ninety-five percent confidence limits for the intercept and slope were −0.05 to 0.62 and 0.85 to 0.97, respectively, the coefficient of determination (r^2) was 0.67, and the residual standard error was 2.94 with 398 degrees of

Table 2. Model-averaged estimates for each fixed effect to predict number of cougars killed/km^2 associated with livestock conflicts, Oregon, USA, 1990–2009. Estimates are based on independent variables that were centered (subtracted the mean) and rescaled (divided by the standard deviation). Data included 400 county-year combinations and the model contained county and year as random effects on the intercept; LCL = lower 95% confidence limit, UCL = upper 95% confidence limit.

Fixed effect	Estimate	LCL	UCL	z-score
Cougar population density	0.92	0.48	1.37	4.06
Cougar harvest density	−0.30	−0.58	−0.02	2.07
Population proportion of juvenile male cougars	0.04	−0.07	0.15	0.68
Beef cattle density	0.01	−0.04	0.07	0.52
Deer relative density index	−0.01	−0.06	0.03	0.52
Proportion of forest cover	0.03	−0.10	0.16	0.49
Annual mean maximum temperature	0.002	−0.01	0.01	0.46
Sheep density	−0.01	−0.03	0.02	0.43
Annual mean minimum temperature	−0.002	−0.01	0.01	0.40
Elk relative density index	0.003	−0.02	0.01	0.34
Human population density	−0.01	−0.06	0.04	0.31
Total annual snowfall	−0.001	−0.01	0.01	0.27
Total annual precipitation	0.002	−0.003	0.003	0.10

Table 3. Exploratory model estimates for each fixed effect and all combinations of 2-way interactions (represented by :) to predict number of cougar mortalities/100 km^2 associated with livestock conflicts, Oregon, USA, 1990–2009. Estimates are based on independent variables that were centered (subtracted the mean) and rescaled (divided by the standard deviation). Data included 400 county-year combinations and model contained county and year as random effects on the intercept ($\sigma^2_{county} = 2.07$ and $\sigma^2_{year} = 0.03$).

Parameter	Estimate	SE	z-value	Pr(>|z|)
Intercept	−4.35	0.30	−14.47	<0.01
Deer relative density index	−0.41	0.09	−4.43	<0.01
Cougar population density	0.90	0.23	3.87	<0.01
Beef cattle density	0.13	0.08	1.65	0.10
Cougar harvest density	−0.05	0.15	−0.34	0.73
Population proportion of juvenile male cougars	0.02	0.08	0.28	0.78
Beef cattle density:deer relative density index	−0.33	0.07	−4.90	<0.01
Cougar population density:beef cattle density	0.44	0.11	4.05	<0.01
Population proportion of juvenile male cougars:beef cattle density	0.19	0.06	3.03	<0.01
Population proportion of juvenile male cougars:cougar harvest density	−0.22	0.10	−2.21	0.03
Deer relative density index:cougar harvest density	0.15	0.07	2.08	0.04
Cougar population density:cougar harvest density	−0.21	0.10	−2.03	0.04
Cougar population density:deer relative density index	0.13	0.07	1.87	0.06
Cougar population density:population proportion of juvenile male cougars	0.12	0.10	1.14	0.26
Population proportion of juvenile male cougars:deer relative density index	−0.06	0.06	−1.03	0.30
Beef cattle density:cougar harvest density	0.02	0.07	0.23	0.82

freedom. Interpretation suggests relatively small differences in y-intercepts between the least-squares line and $y = x$, and between slopes (i.e., 95% CL did not include 1). An increase of 1 predicted mortality results in 0.91 observed mortalities, indicating that the model is slightly biased high. As the number of mortalities increased, the disparity between predicted and observed mortalities increased (Fig. 7).

DISCUSSION

We confirmed that cougar population density was associated with the number of cougars killed for conflicts with livestock. We also found evidence that only at high cougar population density did the density of cougar mortalities related to livestock conflicts decrease as harvest density increased (Fig. 5). Although we could not provide evidence of a causal relationship, densities of mortalities related to hunter-harvest and to livestock conflicts appear to have an inverse relationship within the limits of our data. In hunted populations, harvest may be a primary mortality factor (e.g., Lambert et al. 2006, Clark et al. 2014*b*), and if harvest mortality is additive, we might expect an inverse relationship between mortality sources. Contrary to hypotheses presented by others (e.g., Peebles et al. 2013), our results indicate that hunter-harvest may be a useful tool in managing conflicts under some circumstances, such as in Oregon. Such differences in conclusions may be related to differences in lengths of study periods, dependent variables examined, independent variables used to test hypotheses, cougar population characteristics, harvest levels, or other factors.

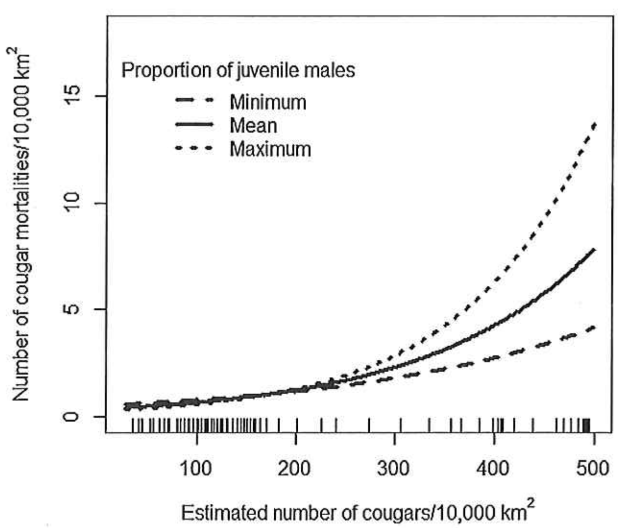

Figure 4. Number of cougar mortalities related to livestock conflicts as a function of estimated population density of cougars, with varying proportions (min. = 0.20, mean = 0.30, max. = 0.40) of juvenile male cougars in the population during 1990–2009, Oregon, USA. Data included 400 county-year combinations (distribution shown as rug plot on x-axis) and all other independent variables were held constant at mean values.

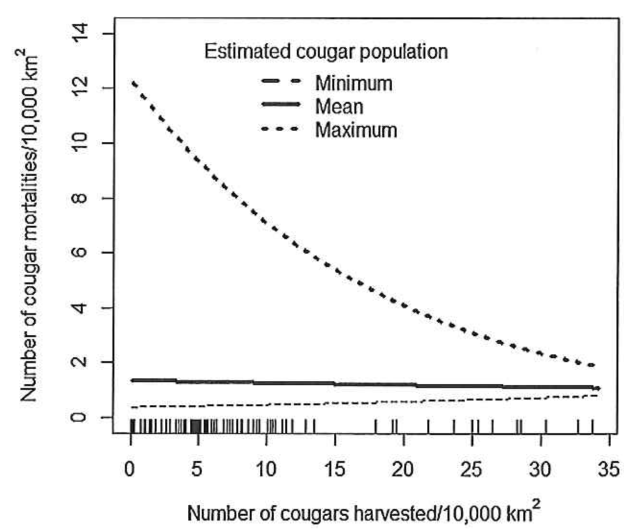

Figure 5. Number of cougar mortalities related to livestock conflicts as a function of harvest density of cougars, with varying density (min. = 30/10,000 km^2, mean = 200/10,000 km^2, max. = 500/10,000 km^2) of cougars in the population during 1990–2009, Oregon, USA. Data included 400 county-year combinations (distribution shown as rug plot on x-axis) and all other independent variables were held constant at mean values.

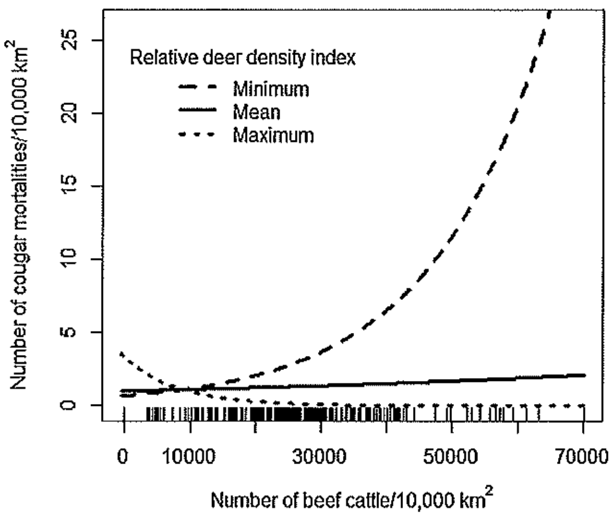

Figure 6. Number of cougar mortalities related to livestock conflicts as a function of density of beef cattle, with varying density indices (min. = 80% decrease, mean = 10% decrease, max. = 200% increase) of deer during 1990–2009, Oregon, USA. Data included 400 county-year combinations (distribution shown as rug plot on *x*-axis) and all other independent variables were held constant at mean values.

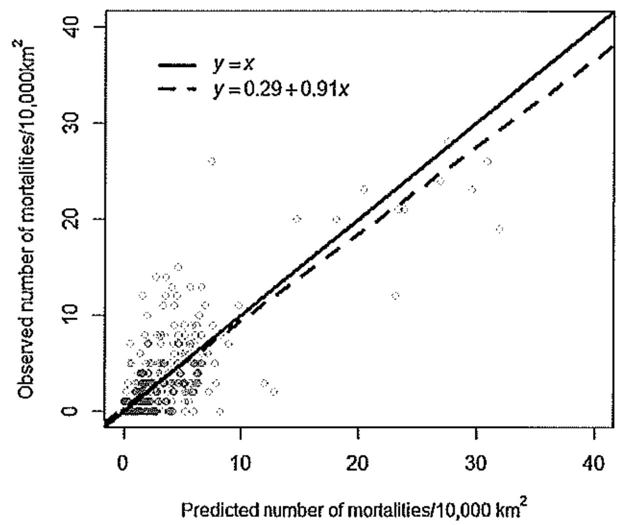

Figure 7. Comparison of observed (data) and predicted (10-fold cross validation of exploratory model) number of cougar mortalities related to livestock conflicts during 1990–2009, Oregon, USA. Data included 400 county-year combinations.

Under relatively low densities of beef cattle (e.g., <2.0/km^2), the number of cougar mortalities associated with livestock conflicts was generally low during our study regardless of deer density (Fig. 6). Similarly, Teichman et al. (2013) reported that low cattle densities (0.3/km^2) did not influence cougar-human conflicts in British Columbia. However, with relatively low deer densities, the number of cougar mortalities increased substantially with increasing density of beef cattle. Although deer densities were based on a relative index and not directly comparable to the absolute densities of beef cattle, the increasing number of cougar mortalities may be associated with decreasing abundance of deer, increasing abundance of cattle, or increased vulnerability of cattle as prey. For jaguars (*Panthera onca*) in Brazil, there was evidence that depredation rates increased with increasing availability of livestock and decreasing availability of caiman (*Caiman crocodilus yacare*) as prey (Cavalcanti and Gese 2010). Similarly, jaguars in a protected park in southern Brazil seemed to increase predation on livestock outside of the park as abundance and diversity of wild ungulates decreased, but livestock depredation rates were still considered low (de Azevedo 2008). In times of prey scarcity, African lions (*Panthera leo*) seemed to select for stray livestock and during times that reduced probability of encounters with humans, thereby balancing benefits with costs (Valeix et al. 2012). With Oregon (and other western states) experiencing long-term declines in mule deer populations (ODFW 2003*a*), an increase in conflicts with cougars may occur in areas with vulnerable densities of beef cattle.

Our model also predicted that as the estimated cougar population density increased, the number of cougar mortalities associated with livestock conflicts increased, and this relationship was affected by the proportion of juvenile males in the population. At a high proportion of juvenile males, we found evidence to expect an increasing number of cougars would be killed for conflicts with livestock as the cougar population density increased (Fig. 4), which is consistent with the Troubled Teens hypothesis (Stover 2009). The usual interpretation of an increase in conflict is that hunter-harvest has altered the age structure of the population (e.g., Lambert et al. 2006, Peebles et al. 2013). The proportion of subadult cougars in harvested samples declines with increasing harvest levels, a consequence of their greater vulnerability to harvest than other age classes (Anderson and Lindsey 2005). Nonetheless, conflicts decreased with increasing hunter-harvest, or at worst remained constant at low to average densities of cougars.

Livestock depredation rates may differ by sex or age for some carnivores. Where radiomarked Eurasian lynx (*Lynx lynx*) in Norway had access to domestic sheep, all male lynx regardless of age killed sheep, killed them more frequently than female lynx, and were responsible for almost all multiple-killing events (Odden et al. 2002). The generally high prevalence of male involvement in livestock depredations seems to hold for many solitary carnivores, perhaps because males typically have larger home ranges, and therefore potentially higher encounter rates with livestock, than females of the same species (Linnell et al. 1999). A positive association had been estimated between carnivore body mass and body mass of their prey (Carbone et al. 1999). Thus, male cougars also may select for larger prey species, such as elk, whereas female cougars may select for deer (Anderson and Lindzey 2002, Clark et al. 2014*a*), so large domestic livestock species may be more vulnerable to male than female cougars. However, number of human-cougar conflicts in British Columbia varied seasonally by sex, with males more frequently reported during summer and females during winter (Teichman et al. 2013). Also, sex of jaguar was not associated with kill rates of livestock in Brazil (Cavalcanti and Gese 2010).

Conflict with livestock following conservation and recovery of large carnivore populations is a complex worldwide management issue (Linnell et al. 1999, Treves and Karanth 2003). As abundance and composition of wildlife species change, predicting predator-prey relationships becomes increasingly difficult. Oregon will be subject to future compositional changes in predator communities and therefore predator-prey interactions, assuming that gray wolves (*Canis lupus*) continue to increase in abundance and distribution within the state (ODFW 2014). Presence of wolves may result in changes in spatiotemporal patterns, reduced predation of certain wild ungulate species, and prey switching by sympatric cougars due to interference and exploitative interactions (Kortello et al. 2007, Griffin et al. 2011). Disentangling the competing hypotheses of relationships among hunter-harvest, predator and prey populations, and human-carnivore conflicts (Treves 2009) can be used to inform policy makers to effectively develop and meet human-carnivore conflict objectives.

MANAGEMENT IMPLICATIONS

Based on our results, several options of varying feasibility may exist for managers and livestock owners to address unacceptably high levels of cougar-livestock conflicts and reduce the number of cougars killed in response to livestock damage. In areas with high densities of cattle and low densities of deer, removing some or all livestock should be considered to decrease vulnerability to depredation, although the feasibility of this option depends on whether this action is logistically or economically tractable for livestock owners. Landowners may also seek guidance from state wildlife agency biologists to assess deer populations and determine whether deer harvest should be decreased, or if large-scale habitat improvements to increase deer populations may be effectively implemented on their properties (e.g., Mule Deer Initiative [ODFW 2011*b*]) to increase prey densities. However, direct research is lacking to assess other potential effects (e.g., increased cougar densities) that may result from increasing prey populations specifically to address livestock depredations by cougars (Laundré and Hernández 2010).

Increasing or redistribution of harvest of cougars can also be conducted if deemed necessary, particularly if harvest can be selective for juvenile males. Hunters using trained dogs correctly identified sex of cougars in the field 70% of the time, but the sex of juveniles may be more difficult to accurately identify than for adults (Beausoleil and Warheit 2015). Proper training of hunters may increase accuracy of pre-harvest identification, potentially increasing the feasibility of this option in states that allow the use dogs to hunt cougars. Although private landowners can attempt to increase cougar harvest by increasing access to hunters, there may not be enough interest from hunters to do so, especially if opportunities to hunt ungulates on those same properties are limited. Because we conducted our analysis at the county level, implementation of the aforementioned options may have to occur across a large spatial extent to be effective, increasing the complexity of implementing several options. Finally, there is limited evidence that increasing levels of lethal removal by trained professionals of cougars in areas with unacceptably high levels of livestock conflicts may reduce those conflicts (Kirsch et al. 2009), although clearly this is not likely to meet objectives of reducing the number of cougars killed for conflicts with livestock.

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Exhibit B
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August 3, 2017

VIA ELECTRONIC MAIL – odfw.commission@state.or.us

Oregon Fish and Wildlife Commission
4034 Fairview Industrial Drive SE
Salem, OR 97302

Re: Oregon Cougar Management Plan Draft Update (2017)

Dear Chair Finley and Members of the Commission:

Please consider the following comments of Humane Oregon on the Draft Update of the Oregon Cougar Management Plan. By way of background, Humane Oregon was formed in 2014 to help advocate for humane treatment of animals in Oregon's political process and elections. We are a moderate but progressive animal welfare organization, with board members from many different places within Oregon's animal welfare community. We are not affiliated with any other state or national organization. We have reviewed the draft cougar plan update and offer the following comments on behalf of our board and many supporters.

General Comments on Cougar Management

Our comments are guided by our following general views on cougar management in Oregon:

1. Cougars deserve the space (habitat) and tolerance they need to survive and thrive in Oregon, in reasonable balance with people, pets, livestock and other species of wildlife.

2. Cougars should not be killed in response to exaggerated or unsubstantiated risks or conflicts with humans, pets, livestock or other wildlife populations.

3. Cougars should not be killed to resolve risk or conflict unless it is clear that doing so will resolve the risk or conflict and there are no reasonable non-lethal alternatives.

4. Cougars hunted or killed for management purposes, as well as cougars hunted for sport, should not be killed in a manner that most Oregonians consider inhumane, as reflected in part by the ballot measure that prohibits hunting cougars with dogs.

Specific Comments on Management Plan

The general management approach of the draft plan is to maintain cougar populations above specified minimums (3,000 statewide), to set quotas for cougar mortalities, to allow hunting year-round until those quotas are reached, and to allow cougars to be killed to resolve livestock damage and human safety risks even after the quotas are reached. The plan also provides for the Department to direct killing of cougars in "target areas" based on specified thresholds of conflict with people, pets, livestock or other wildlife populations. Department-directed killing, as well as killing by landowners claiming danger or damage from cougars, can be done using dogs to track and tree or corner the cougars. The plan encourages use of education and non-lethal means to resolve conflict and risk but does not clearly define the point at which the response moves from non-lethal to lethal action.

Against this framework, we have the following specific comments:

1. Public Opinion. We support the plan's goal of a management program that "incorporates the desires of the public," (p. VIII). In this regard, we support the plan's recognition that many Oregonians care about cougars even if they do not hunt them, live around them or even see them, (pp. VIII). As the plan acknowledges, "[a]lthough many Oregonians may never see a cougar, they find satisfaction in the knowledge that cougars still remain in Oregon and that their existence is not threatened," (p. 1). The desires of those Oregonians need to be respected to the same extent as the desires of hunters, ranchers and rural residents.

   The plan should include more specific reference and recognition of the substantial majority of Oregonians who voted to prohibit hunting cougars with dogs in 1994, and who voted against repealing that prohibition in 1996. Instead, the plan discusses, as though representative of public opinion generally, a 2002 survey in six southern Oregon counties, only one of which voted with the majority in 1996 to keep cougars protected from hunting with dogs (we do not have the county-by-county results for 1994), (p. 1). That discussion should be eliminated or qualified as not representative of the entire state. The plan also discusses survey results in Colorado and Washington, which seem to us to have very little relevance to what Oregon's cougar management plan should say.

   The plan claims "[c]ougar management is complicated by the dichotomy of sentiment toward cougars among Oregon residents," (p. II). We wonder whether that is really true, given the election results on the ballot measures and the weight of public comments when cougar issues arise in statewide public forums, or whether the Department gives undue weight to some minority perspectives. In our view, the clear majority of Oregonians wants cougars to survive and thrive in Oregon, doesn't want them killed as a first response to perceived risk or conflict, and doesn't want them hunted with dogs.

2. Cougar Populations. We support the aspect of the plan that allows cougar populations to grow above the established minimum levels deemed necessary for cougar survival.

3. Killing Cougars to Resolve Conflict. The plan relies heavily on cougar "removals" to resolve conflict even though, according to the lengthy discussions on cougar biology and behavior, it is not clear from the science that killing cougars reduces conflict, (p. 12). For example, the plan acknowledges that "[s]ome studies have indicated a relationship between intensive cougar removals and an *increase* in livestock depredation and human-cougar conflicts due to an influx of juvenile males," (p. 38 (emphasis added)). Also for example, increased killing of cougars to recover mule deer populations in the Steens and Warner target areas was found to *not* benefit the deer population, (p. 61). The science on these issues needs to be better resolved before management relies so heavily on killing cougars as the way to reduce conflict and protect other wildlife populations.

4. Triggers for Measuring Conflict. The proposed test in the plan for whether conflicts with people, pets or livestock justifies targeted killing of cougars is whether the three-year average of cougar killings to resolve specific conflicts is greater than the ten-year average. This test strikes us as arbitrary and problematic. First, we do not see in the plan any social or biological justification for the measure as an indicator of unacceptable conflict. Second, there apparently is no test for whether the variation from the 10-year average is statistically significant, meaning it could be just a random variation instead of an indication of more conflict. Third, there is no screen to determine whether the specific conflict killings used to measure conflict were in fact the result of conflict (i.e., were justified).

5. Impacts on Ungulates. The plan would allow cougars to be targeted for more killing in an area with depressed ungulate (deer, elk, etc.) populations based only a possibility that cougars are to blame, (p. 59). If cougars are going to be targeted for that reason, despite inconsistent evidence that it helps solve the problem, the plan should at least require a stronger finding that cougars are a significant cause of the problem in the first place. According to research discussed in the plan, that does not go without saying, (pp. 10, 11).

6. Non-lethal Methods. The plan should be more specific about requiring education and non-lethal methods to resolve a specific cougar conflict before the Department conducts

or directs killing of cougars to resolve conflict. The plan also should provide separate, stronger criteria for conflict killings in zones where mortality quotas have been exceeded. In those zones, more effort should be made to resolve the conflict with non-lethal methods first.

7. Killing With Dogs. The plan should specifically require that any killing of cougars authorized by the plan be attempted first without the use of dogs. The majority of Oregonians consider that method inhumane and the Department should respect that judgment.

Comments on Background Data and Information

The draft plan also includes significant discussion on cougar biology and research, the status of cougar populations, and the history and status of cougar management in Oregon, (Chapter II). We have the following comments on this portion of the plan:

1. Hunter "Success Rates." References to changes in the hunter "success rate" since 1994, which seem designed to subtly advocate for resumption of hound hunting, should be eliminated or more clearly qualified to reflect the dramatic changes in licensing practices (giving a license to everyone who buys a "Sport Pac") and licensing fees (now 70% lower than 1997 even before adjusting for inflation). The nature of the cougar "hunters" for whom the "success rate" is measured has clearly changed from a person who specifically buys a license for cougars and targets cougars to numerous hunters hunting other species who happen to have a cougar tag in case they might see one, (p. 27). Thus, for example, Table 6 (p. 30) misleadingly suggests that the cougar hunting "success rate" dropped from roughly 40% and to roughly 2% with no apparent explanation besides Measure 18. In fact, the table is comparing apples and oranges. If the number of cougar hunters in 1994 (probably targeting cougars) grew at the same rate as the general population of Oregon, there were 469 real cougar hunters in 2016. Taking out the 66% of cougars killed pursuing other game (p. 27), the "success rate" of real cougar hunters was about 37 percent, which is not dramatically different from the pre-Measure 18 "success rate."

2. Poaching. The plan does not have a good explanation for estimates of cougars killed by poachers, (p. 32). First, although the discussion refers to an estimate of "less than 1%," it is not clear if that is the number included in the population model. Second, the assumption that people are unlikely to poach cougars because taxidermists won't process the hide without an ODFW "seal" (if we are tracking the explanation) seems unrealistic to us. (We don't see why the ability to taxidermy would make or break a decision to poach or why all taxidermists can be assumed to be so scrupulous.) The assumption that

poaching would ordinarily generate a complaint to OSP also seems unrealistic. (We doubt anyone would be in a position to witness it in many cases.) Third, the telemetry studies suggest illegal kill rates higher than those apparently assumed in the model.

3. Cougars Killed by Hunters. The number of cougars killed by hunters in 2016 (measured by "Harvest Check In") is approximately 80% higher than the number of cougars killed by hunters before Measure 18 prohibited the use of dogs, (p. 30). We think this defeats any argument that dogs are necessary to successfully hunt cougars.

4. Livestock Damage and Humane Safety/Pet Conflict. The total number of cougars taken on livestock damage and human safety/pet conflict in Oregon, which apparently is treated as a measure of conflict with cougars, seems to us relatively stable since approximately 2000, (p. 33). (As with much of the data presented in the draft plan, there appears to be no test of statistical significance for changes, or attempt to account for other possible explanations for changes, which we think are necessary for drawing conclusions.) The Adaptive Management Section also acknowledges this, (p. 61 ("[e]xcept for Zone A, non-hunting cougar mortalities due to human safety/pet conflicts have been stable throughout most of the state and complaints are also stable or declining"). While the numbers were much lower before Measure 18, they rose rapidly (from 10 to 40, or 300 percent) while hunting with dogs was legal. All of this contradicts the popular narrative that Oregon is experiencing an epidemic of cougar conflict brought on by increasing cougar populations.

5. Complaints. "With the exception of Zone A, [even] cougar *complaints* [from 2007 through 2016] are stable or declining across much of Oregon (Table 10)," (p. 38 (emphasis added)). In fact, "[w]ith the exception of Zone A," complaints have declined across *all* of Oregon. This further contradicts the popular narrative that Oregon is experiencing an epidemic of cougar conflict brought on by increasing cougar populations.

   "ODFW staff speculate that declining cougar complaints may be due to the local public being familiar with how to live with cougars, [knowing] how to resolve their issue, or [being] familiar with their legal options," and that the opposite may be true where complaints have increased (i.e., people are newly encountering cougars), (p. 33). However, speculation is not a good basis for a management plan. It could also be just because there is less conflict.

6. Population Growth Rates – Hunting With Dogs Or Not. A model used by the Department for estimating growth in cougar populations estimates that "the cougar population subjected to hunting with dogs was increasing at a faster rate than one that was not hunted with dogs," (pp. 40-41). We hope this will eliminate arguments, and subtle

suggestions in the plan, that resumed sport hunting with dogs is necessary to prevent runaway growth of cougar populations in Oregon. We also think the plan should express the growth rates in a consistent format in this section (both as a percentage, for example) to avoid obscuring the point.

7. Self-regulation of Cougar Populations. We would like to see more discussion on research regarding the extent to which cougar populations will "self-regulate" without hunting, target removals and lethal conflict management.

Thank you for considering our comments on this important issue.

Sincerely,

Brian Posewitz

Brian Posewitz
Board Member and Administrator