OREGON DEPARTMENT OF FISH AND WILDLIFE
SUMMARY OF COUGAR RESEARCH IN OREGON

Over the past decade, the Oregon Department of Fish and Wildlife (ODFW) and their cooperators have completed several studies to better understand cougar biology and effects of cougars on elk populations. These research projects have either been published in peer-reviewed scientific journals, ODFW technical reports, or thesis and dissertation written by a graduate student. In general, cougar survival rates in northeast Oregon have been some of the highest reported in western North America. These high survival rates have allowed cougar populations to increase in Oregon and obtain some of the highest densities reported in western North America. Based on harvest statistics, cougar densities have likely stabilized in northeast Oregon and cougar population size is limited by available prey. Current sport harvest strategies (i.e., hunting cougars without trained dogs) are ineffective at reducing survival rates and population growth rates of cougars. However, use of dogs sanctioned by Oregon Department of Fish and Wildlife (ODFW) during lethal control of cougars in target areas appears to be effective at reducing local cougar populations, so long as sufficient numbers of cougars are removed to offset immigration from surrounding areas.

Cougars prey disproportionately upon juvenile deer and elk, which may be a mechanism by which cougars negatively affect deer and elk populations. Current work has been unable to adequately assess the population level effects of cougars on mule deer. However, ongoing research is investigating potential effects of cougars and other factors on mule deer population dynamics. Several studies have jointly, but separately highlighted the importance of cougar predation on elk population dynamics. Cougars disproportionately prey upon elk calves which results in low survival and recruitment of elk calves. This selective predation of elk calves slows population growth rates of elk, but cougar predation alone is not responsible for elk population declines, except at extremely high cougar densities. Cougars occasionally reach densities where they can cause elk populations to decline; however, these high densities are short-lived (i.e., 1-2 years) and cougar densities decline to a point where elk populations are stationary or capable of increasing. Moderate to high cougar densities coupled with harvest of female elk can produce large declines in elk populations. Consequently, harvest of female elk needs to be limited in predator rich environments to maintain or allow elk populations to increase. In the absence of harvest of female elk, most elk populations will be capable of increasing, but reductions in cougar populations could allow elk populations to increase more rapidly. However, effects are short-lived as cougar populations are capable of rapid recovery from intense lethal control. Managers must weigh the short-term benefits of increased rates of elk population growth versus the costs of control efforts to reduce cougar populations.
Most publications cited in this summary can be located at:
http://www.dfw.state.or.us/wildlife/research/index.asp

Cougar Survival

Clark, D. A., B. K. Johnson, D. H. Jackson, M. Henjum, S. L. Findholt, J. J. Akenson, and R. G. Anthony. 2014. Survival rates of cougars in Oregon from 1989 to 2011: a retrospective analysis. Journal of Wildlife Management 78:779-790.
Clark D. A., B. K. Johnson, and D. H. Jackson. In Press. Monthly and annual survival rates of cougar kittens in Oregon. Northwest Science.

Cougars have been radiocollared in Oregon since 1989, which provided an opportunity to conduct a retrospective analysis to assess causes of mortality and estimate cougar survival rates. Cougars were monitored in 3 distinct study areas: 1) Catherine Creek in northeast Oregon (1989-1996), Jackson Creek in southwest Oregon (1993-2002), and Wenaha, Sled Springs, and Mt. Emily (WSM) in northeast Oregon (2002-2011). Hunting mortality was the most common cause of death of cougars at the Catherine Creek and WSM study areas. In contrast, natural mortality was the most common cause of death at Jackson Creek. Survival rates of adult males during the Catherine Creek study when hunting cougars with dogs was legal, was substantially lower (0.57) than observed in either Jackson Creek (0.78) or WSM (0.82) when hunting cougars with dogs was illegal. Survival rates of adult females were similar at Catherine Creek (0.86), Jackson Creek (0.85), and WSM (0.85) regardless of hunting regulations. Sub-adult male cougars had lower survival rates than adult males, but sub-adult females had similar survival rates as adult females. Survival rates of cougar kittens from birth to 12 months were 0.66.

Key conclusions:

- Survival rates of cougars in Oregon are some of the highest reported in western North America.
- Hunting cougars without dogs results in low harvest success and high survival rates of cougars. Limited hunting of cougars with dogs reduced survival rates of adult males, but not females due to male-biased harvest when using this hunting method.
- The ability of managers to effectively manipulate survival rates of cougars to meet population management objectives will depend upon available hunting methods.

Estimation of Cougar Densities

Davidson, G. A., D. A. Clark, B. K. Johnson, L. P. Waits, and J. R. Adams. 2014. Estimating cougar densities in northeast Oregon using conservation detection dogs. Journal of Wildlife Management 78:1104-1114.

Davidson, G. A., D. A. Clark, B. K. Johnson, L. P. Waits, and J. R. Adams. 2015. A second trial of using conservation detection dogs to estimate cougar populations in northeastern Oregon. Technical Report. Oregon Department of Fish & Wildlife, Salem, OR.

Estimating densities of cougar has been difficult because of their large home ranges, low densities, and elusive and solitary behavior. In response to this difficulty, ODFW developed a novel technique to estimate cougar densities in northeast Oregon. During the spring of 2011, ODFW surveyed a 220-km^2 area using conservation detection dogs trained to locate cougar scat over a 4-week sampling period in the Mt. Emily Wildlife Management Unit in northeast Oregon. Genetic information was extracted from scat samples which allowed unique identification of individual cougar. During the 2011 study, 272 scat samples were collected and individual identification was determined from 73 samples that represented 21 cougar (9 males and 12 females). Using spatial capture-recapture models, the mean density of 5.1 cougars/100 km^2 was estimated. ODFW repeated this study during the fall of 2012 in an area adjacent to the 2011 study area. During the 2012 study, 310 scat samples were collected and individual identification was determined from 53 samples that represented 18 cougar (7 males and 11 females). Using the 2012 survey information, the estimated densities of cougars was 5.8 cougars/100 km^2. The consistent results of surveys across 2-years in adjoining areas suggest that estimating cougar densities using scat detection dogs could be feasible at a broader scale at considerably less effort over a shorter duration than traditional methods used to estimate cougar densities.

Key conclusions:

- These studies demonstrated the feasibility of using scat detecting dogs to estimate cougar populations. This technique provides a repeatable and defensible method to directly estimate and compare cougar densities in separate areas.
- Costs associated with estimating cougar densities using scat detecting dogs is substantially lower than previous methods that relied on extensive capture of cougars over several years.
- Our preliminary studies were conducted at a small spatial scale relative to cougar population distribution. Additional analysis of sampling design protocols is needed to implement these studies on a larger spatial scale.

Cougar Population Growth Rates and Effects of Lethal Control

Clark, D. A. 2014. Population growth rates and simulated responses of cougar populations to density reduction under variable immigration and emigration. Pages 96-137 in D. A. Clark, author. Implications of cougar prey selection and demography on population dynamics of elk in northeast Oregon. Dissertation. Oregon State University, Corvallis, OR.

Cougar populations are thought to be increasing in much of western North America; however, empirical data to support this claim are sparse. ODFW developed a population model to estimate population growth rate of cougars when hunting cougars with dogs was legal and extremely limited (1989-1994) and when hunting cougars with dogs was illegal but widespread and regulated by a quota system (2002-2011). Modeled cougar populations that were hunted with dogs increased at a mean rate of 21% per year. Harvest was primarily focused on male cougars during this time which allowed cougar populations to continue to increase. Modeled cougar populations that were hunted without the use of dogs increased at a rate of 17% per year. Cougar survival rates could be reduced an additional 12% and still allow maintenance of simulated populations. To reduce a hypothetical, local cougar population by 50% over a 3-year period, between 28-48% of the population would need to be removed annually depending on the level of immigration from surrounding areas. After achieving a 50% population reduction, a hypothetical, local cougar population would recover to pretreatment population size within 2-6 years depending on the level of immigration from surrounding populations. Intensive reductions in cougar population size could result in substantial changes to the age and sex composition of cougar populations. This could have unintended consequences for effects of cougars on prey and interactions between humans and cougars.

Key conclusions:

- The high survival rates and reproductive potential of cougars observed in Oregon suggests cougar populations are capable of rapid increases (15-20% per year) in the absence of high human caused mortality rates when cougar populations are below their prey-limited population density (i.e., cougar populations will not increase indefinitely).
- Due to low success rates, implementation of current hunting methods will likely be an ineffective management tool to manipulate cougar populations to meet population management objectives.
- To effectively reduce cougar populations at localized scale (e.g., a target area) intensive levels of lethal control will be required to overcome immigration from surrounding areas.
- Cougar populations are highly resilient and capable of rapid recovery from population reductions.
- Shifts in the age and sex composition of cougar populations should be expected following lethal control efforts. This could have unintended consequences for effects of cougars on prey and interactions between humans and cougars.

Cougar Kill Rates and Prey Selection

Clark, D. A., G. A. Davidson, B. K. Johnson, and R. G. Anthony. 2014. Cougar kill rates and prey selection in a multiple-prey system in northeast Oregon. Journal of Wildlife Management 78:1161-1176.

ODFW implemented a 3-year study in the Mt. Emily Wildlife Management Unit (WMU) in northeast Oregon to document cougar diets, kill rates, and prey selection patterns. During the study, 25 adult cougars were marked with global positioning system (GPS) collars and monitored over a total of 7,642 days. Potential kill sites were identified through the clusters of GPS locations. Through field investigation of potential kill sites, researchers located 1,213 prey items killed by cougars, of which 1,158 (95%) were deer or elk. Cougars killed on average 1.0 ungulates/week over the course of the year, but cougars killed 1.5 times more frequently during summer when juvenile ungulates dominated diets. Female cougars with kittens killed more frequently than solitary females or male cougars. This is likely in response to increased energetic requirements of females with kittens. Diets of male cougars had roughly equal amounts of elk (52%) and deer (48%), whereas diets of females were dominated by deer (75%). The increased body size of male cougars likely allowed them to be more effective predators of elk. Juvenile ungulates (i.e., fawns and calves) were strongly selected by cougars; however, seasonal differences existed. During summer, cougars strongly selected for elk calves, but switched to deer fawns during winter. The patterns of election for juvenile elk and deer suggested wildlife managers should consider the potential negative effects of cougars on ungulate populations in areas where juvenile recruitment has been chronically low.

Key conclusions:

- Cougars will kill more frequently during summer when diets are dominated by juvenile ungulates and less frequently during winter when diets include more adult individuals.
- The strong selection of juvenile ungulates by cougars suggests this may be a mechanism by which cougars limit recruitment and population growth rates of deer and elk. However, many factors contribute to variability in juvenile recruitment and predation may be largely compensatory.
- The strong differences in predation patterns according to cougar sex have important implications for harvest or management strategies used to manipulate cougar populations to benefit deer or elk populations. Male cougars may have a greater effect on elk populations and females may have greater effects on deer populations.

Survival of Calf Elk and Effects of Cougars

Rearden, S. N. 2005. Juvenile survival and birth-site selection of Rocky Mountain elk in northeastern Oregon. Thesis. Oregon State University, Corvallis, OR.

Griffin, D. A., M. Hebblewhite, H. S. Robinson, P. Zager, S. M. Barber-Meyer, D. Christianson, S. Creel, N. C. Harris, M. A. Hurley, D. H. Jackson, B. K. Johnson, W. L. Myers, J. D. Raithel, M. Schelgel, B. L. Smith, C. White, and P. J. White. 2011. Neonatal mortality of elk driven by climate, predator phenology and predator community composition. Journal of Animal Ecology 80:1246-1257.

Johnson, B. K., D. H. Jackons, R. C. Cook, J. G. Cook , P. K. Coe, S. L. Findholt, S. N. Rearden, J. H. Noyes, and R. G. Anthony. In preparation. Effects of nutritional condition of female elk, weather, and cougar densities on reproduction and survival of juvenile elk in Oregon.

During a 7-year study conducted in the Wenaha and Sled Springs Wildlife Management Units in northeast Oregon, ODFW captured and radio-collared 460 elk calves. Fates (live or dead) of calves were determined from radio signals and field crews investigated mortalities as soon as possible to determine cause of death. Most calf mortality occurred during the first 16 weeks of life when calves were small and vulnerable to predation. Of elk calves that died, cougars were responsible for >70% of mortalities. Survival rates were higher in Sled Springs than Wenaha and monthly survival rates increased over time at both study areas. Early born calves had higher survival rates than later born calves. Survival of elk calves was lower during years with higher cougar densities. At mean cougar densities and birth dates, survival rates of elk calves were 0.36 and 0.26 for Sled Springs and Wenaha, respectively. Survival of elk calves was not strongly associated with nutritional condition of cow elk and variation in cougar density explained the overwhelming amount of variation in calf survival from year to year.

Key conclusions:

- Calf survival does not appear to be strongly influenced by nutritional condition of cow elk. However, nutrition is a strong determinant of pregnancy rates.
- Cougars were responsible for the majority of calf mortalities and annual variation in cougar densities explained the majority of variation in calf survival.
- Heavy predation of elk calves by cougars may help explain low calf recruitment rates observed in northeast Oregon.
- Despite heavy predation on elk calves, this study was not designed to determine the effect of cougars on elk population dynamics.

Effects of Cougars on Recruitment of Elk Calves

Johnson, B. K., P. K. Coe, and R. L. Green. 2013. Abiotic, bottom-up, and top-down influences on recruitment of Rocky Mountain elk in Oregon: a retrospective analysis. Journal of Wildlife Management 77:102-116.

Lukacs, P. M., M. Hebblewhite, B. K. Johnson, H. Johnson, M. Kauffman, K. M. Proffitt, P. Zager, J. Brodie, K. Hersey, A. A. Holland, M. Hurley, S. McCorquodale, A. Middleton, M. S. Mitchell, M. Nordhagen, J. J. Nowak, D. P. Walsh, and P. J. White. In preparation. Declines in juvenile elk recruitment across the western United States are associated with recolonizing predators, habitat, and climate conditions. Journal of Animal Ecology.

Using a long-term dataset spanning 1977-2005, ODFW investigated potential effects of abiotic, bottom-up, and top-down factors on pregnancy rates and recruitment of juvenile elk into the adult population. ODFW tested for the effects of elk density, winter temperature and precipitation, summer precipitation, winter severity, and densities of cougars on the landscape on both pregnancy rates and recruitment of elk. Pregnancy rates were greater for older cow elk and higher during years with increased amounts of precipitation in August, and in areas with higher cougar densities. Pregnancy rates were lower during years following a severe winter and in elk populations with higher densities. Recruitment of calves into the adult population was higher during years with increased August precipitation the previous year, lower elk densities, and lower cougar densities. In summary, annual variation in pregnancy, juvenile-at-heel, and recruitment was most influenced by August precipitation, whereas long-term trends in recruitment were most influenced by cougar densities.

Key conclusions:

- Pregnancy rates of elk tended to be high and variation in pregnancy were primarily explained by nutrition and climatic patterns. Increased nutritional resources on summer range that allow cow elk to enter the breeding season at higher nutritional condition will allow for increased pregnancy rates.
- For elk populations living in areas with few predators, low recruitment was explained by inadequate nutritional resources. These elk populations could benefit from habitat manipulations to improve nutritional resources.
- At high cougar densities, cougars are capable of limiting recruitment of juvenile elk into the adult population. Cougars appear to negatively affect recruitment, but it is unknown to what degree this influences elk population growth rates because this study was not designed to assess overall population dynamics of elk.

Effects of Cougars on Population Dynamics of Elk

Clark, D. A. 2014. Dynamics of elk populations in northeast Oregon: influence of cougar predation, female harvest, and nutrition mediated by climate. Pages 142-186 in D. A. Clark, author. Implications of cougar prey selection and demography on population dynamics of elk in northeast Oregon. Dissertation. Oregon State University, Corvallis, OR.

J. Brodie, H. Johnson, M. Mitchell, P. Zager, K. Proffitt, M. Hebblewhite, M. Kauffman, B. Johnson, J. Bissonette, C. Bishop, J. Gude, J. Herbert, K. Hersey, M. Hurley. P. M. Lukacs, S. McCoquodale, E. McIntire, J. Nowak, H. Sawyer, D. Smith, and P. J. White. 2013. Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. Journal of Applied Ecology 50:295-305.

ODFW developed a population model from empirical data to investigate the relative influence of top-down, bottom-up, and climatic variables on population growth rates of elk. Dynamics of simulated elk populations in northeast Oregon were influenced by a suite of factors, but harvest of female elk had the strongest negative effect on population growth rates. Population growth rates of elk declined with increasing cougar densities due to reduced survival of juvenile elk in the presence of high cougar densities; however, elk populations were still capable of increasing at high cougar densities so long as harvest of female elk was minimal. A delay in mean juvenile birth dates reduced juvenile survival, but had minimal effect on population growth rates of elk. August precipitation and winter severity, which were used as surrogates for nutritional condition of females, also had minimal effects on population growth rates of elk. Furthermore, elk density had almost no effect on population growth rates. While many factors can influence elk population dynamics, this population model suggested top-down forces were the primary factors influencing elk population dynamics. Human harvest of female elk had the greatest effect on elk populations followed by increased cougar densities, which results in reduced survival of juvenile elk. Harvest of female elk in the presence of high density cougar populations can result in substantial declines in elk populations in a single year. However, cougars alone are unlikely to cause reductions in elk populations unless cougar densities are extremely high. Cougar densities in Oregon are typically within a range of values that will slow population growth rates of elk, but not high enough to prevent elk populations from increasing.

Key conclusions:

- Population growth rates of elk are primarily influenced by survival of adult females and juveniles. Pregnancy rates had minimal effects on population growth rates of elk because they tended to be high and invariable.
- Harvest of female elk by humans had the greatest negative effect on population growth rates of elk. Female harvest can have profound effects on elk populations in the presence of a full suite of carnivore species.
- In the absence of female harvest, growth rates of elk populations were governed by juvenile survival. Cougars have a large effect on survival rates of juvenile elk and are capable of slowing population growth rates of elk through predation on juvenile elk.
- Despite cougars slowing population growth rates of elk in northeast Oregon, densities of cougars observed in northeast Oregon rarely reach a level where cougars would cause elk populations to decline. Combinations of high cougar densities and female elk harvest can result in substantial declines in elk populations.

Highlights of the Jackson Creek Cougar Study in Southwestern Oregon
(Please contact DeWaine Jackson, ODFW wildlife research project leader, Roseburg, phone 541-440-3353, for details before citing results)

- CAPTURE
  - Jackson Creek Study area was 518 km^2
  - Study spanned December 1992 - September 2003
  - Captured 114 cougars
  - Including recaptures there were 259 cougar handling events
  - Sex ratio of captures was equal : 58 male - 56 female
  - Age of captures were 32 adults, 12 subadults, 70 kittens
  - Monitoring of radio-marked cougars ranged from 5 – 2750 days
  - 67 cougars were monitored > 1year
  - At end of study, 31 cougars were still being monitored, 71 had died, and 12 were of unknown status

- SURVIVAL / MORTALITY
  - Annual Kaplan-Meier survival estimates (modified for staggered entry) for adult males averaged 0.77
  - Annual Kaplan-Meier survival estimates (modified for staggered entry) for adult females averaged 0.86
  - Annual survival rates varied from 0.56 - 1.0 for males and 0.69 - 1.0 for females
  - 71 mortalities occurred (31 females, 40 males) 6 of which were related to capture
  - The highest cause of adult mortality was related to parasites and disease
  - Cougar to cougar interactions (infanticide, cannibalism, fighting) were the highest mortality factors for subadults and kittens
  - At high population density research documented natural mortality caused by an internal parasite that caused large lesions or ulcers at the pyloric region of the stomach and the cougar died from internal bleeding and/or infection
    Ferguson et al. 2011. CYLICOSPIRURA SPECIES (NEMATODA: SPIROCERCIDAE) AND STOMACH NODULES IN COUGARS (PUMA CONCOLOR) AND BOBCATS (LYNX RUFUS) IN OREGON. Journal of Wildlife Diseases 47(1), pp. 140–153.

- HOME RANGE SIZE / DENSITY
  - Home range (minimum convex polygon) of adult males was approximately 200 mi^2 (518 km^2) – some home range overlap
  - Home range (minimum convex polygon) of adult females was approximately 70 mi^2 (181 km^2) – much home range overlap
  - Based on several data, estimated population density in April 1999 was 1adult/15 mi^2 (1 adult/38.8 km^2)
  - Made another estimate in June 2001, after considerable natural mortality, and density was 1 adult /22 mi^2 (1 adult/56.9 km^2)
  - Adults comprised approximately ½ of the population in both estimates

- DISPERSAL
  - Subadults became independent from the mother at 16 months of age (range 9-23)
  - 78% of the females established a home range adjacent to or overlapping the natal home range
  - All subadult males dispersed from the study area
  - Subadult males dispersed farther than females (average 82 km vs 36 km)
  - Dispersal direction was random (i.e. no significant directional movement from the center of the study area)
  - No dispersing male survived >2 years after becoming independent

- REPRODUCTION
  - 21 litters were documented
  - Average litter size was 3.2 (for kittens < 10 days of age)
  - Had litters in every month of the year, but 70% occurred between February and July
  - Although difficult to document, kitten survival was limited

- PREY INTERACTIONS
  - Documented 71 kills: 56 black-tailed deer (79%) and 15 elk (21%)
  - 17 of the kills were by male cougar, 49 by female cougar and 5 were of unknown gender
  - 65% of the male cougar kills were elk
  - 98% of the female cougar kills were deer
  - Limited data on kill rate indicated 8 days between kills; but also observed four extended periods (10-day, 14-day, 14-day and 18-day) without documenting an ungulate kill for radio-collared adult females.