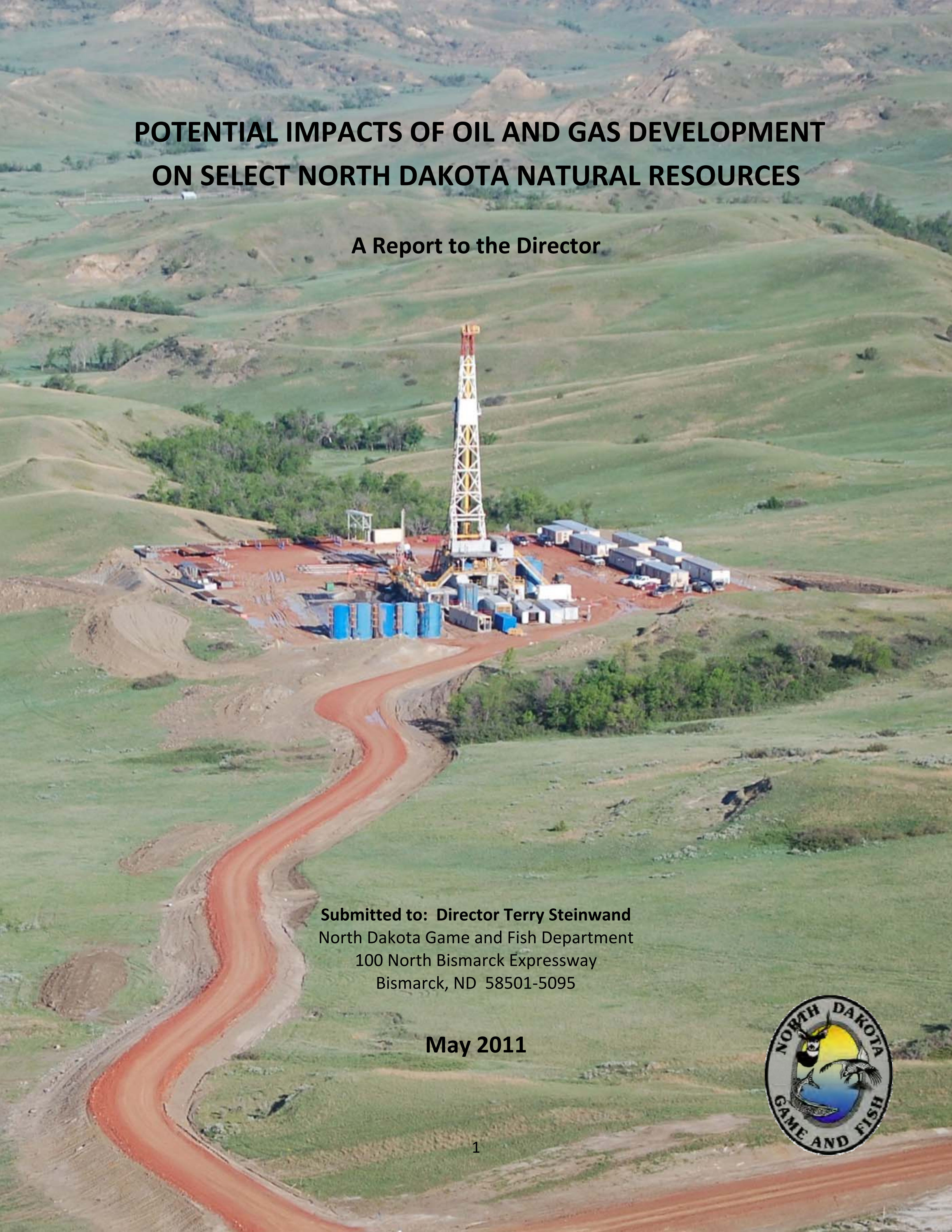

POTENTIAL IMPACTS OF OIL AND GAS DEVELOPMENT ON SELECT NORTH DAKOTA NATURAL RESOURCES

A Report to the Director

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INTRODUCTION AND BACKGROUND

Improvements in technology, increased global energy demand and the push for energy independence have resulted in a tremendous increase in gas and oil development across the United States. Locally, development and production of oil, particularly from the Bakken and Three Forks Formations, has rapidly elevated North Dakota to one of the national leaders in oil production. The energy industry has long been an important part of the North Dakota economy and the state has undergone numerous boom and bust cycles in energy development over the years. However, never has the rate of oil and gas development approached the level of recent years and projections suggest even more accelerated development in the immediate future (North Dakota Petroleum Council 2009). Figure 1 provides a depiction of well densities from the past 15 years. The recent boom in oil production from these formations has been a huge economic benefit to the State of North Dakota and is largely responsible for our ranking as one of the most financially stable states. However, huge financial gains from energy production cannot be expected without having potential impacts to North Dakotas two major industries, agriculture and tourism. As the footprint of oil development expands and the cumulative impacts to natural resources such as water supplies and wildlife habitat increase, maintaining the sustainability of our rich natural resources will become increasingly challenging.

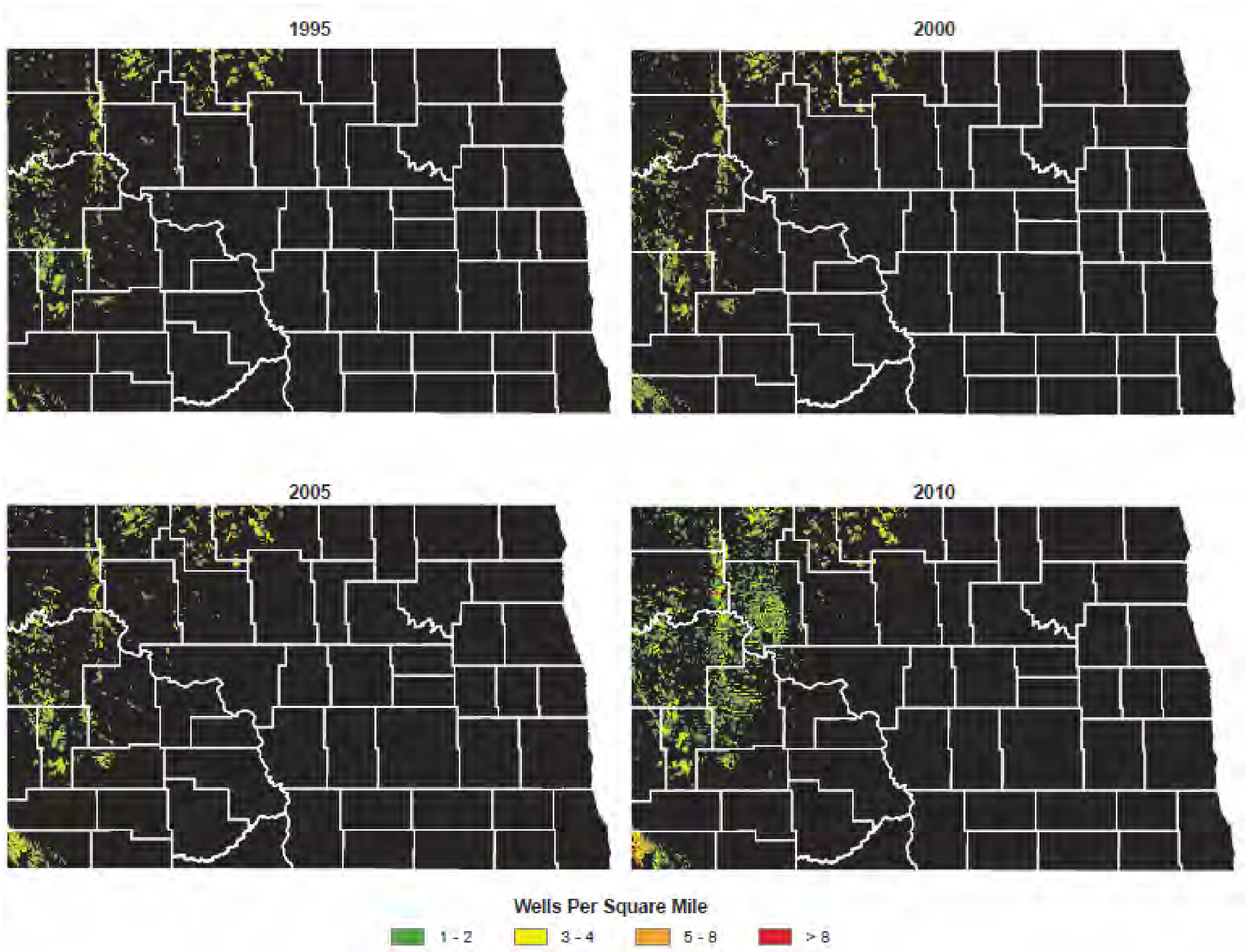


Figure 1. North Dakota well densities 1995-2010.

North Dakota is a rural state still rich in fish and wildlife resources. Not surprisingly, fish and wildlife contribute greatly to our quality of life and are important to the economy. The importance these resources play in the lives of our residents is illustrated by the popularity of hunting and fishing in the state. Annually, over 29% of our residents hunt and/or fish ranking us fourth in the nation for participation (USDOI 2006). Our fish and wildlife resources also play a vital role in tourism which is North Dakota's second largest industry. The Tourism Division aggressively markets tourism in the state and promoting our fish and wildlife resources is a major focus of their efforts. The overall contribution of natural resources to the tourism industry cannot be disputed as residents and nonresidents spent $269 million on hunting, fishing and wildlife related activities in North Dakota during 2006 (USDOI 2006). Energy development is important to our economy, but large scale development often adversely impacts fish and wildlife resources which are a vital part of our huge tourism industry. If future energy development occurs at the expense our fish and wildlife resources losses in tourism dollars can be expected and the quality of life most residents are accustomed to could be diminished.

The mission of the North Dakota Game and Fish Department is to protect, conserve and enhance fish and wildlife populations and their habitat for sustained public consumptive and appreciative use. Recognizing unprecedented growth in the state's energy industry will make our mission increasingly challenging, the ND Game and Fish Director formed an internal energy task force in February 2010. This report expands upon an initial task force document by providing a technical look at species specific impacts and potential mechanisms for mitigation. General recommendations for reducing impacts are provided in Appendix A.

Scope

The purpose of this document is to:

1). Identify the impacts associated with oil/gas activities on fish, wildlife and those individuals that use those resources.

2). Provide assessment of the cumulative effects of oil and gas development on a broad range of taxa to include both present day and future growth scenarios.

3). Define possible methods of offsetting impacts associated with oil/gas industry, with an emphasis on what is necessary to 'mitigate' the impacts associated with oil activities.

MULE DEER

1. CURRENT STATUS:

Mule deer (*Odocoileus hemionus*) were first named and described to the scientific community by Lewis and Clark as they passed through North Dakota in 1805. Presettlement distributions of mule deer in North Dakota were probably similar to what is found today (Jensen 2001). The primary range (2,829 mi^2) of North Dakotas' mule deer population is restricted to the badlands within the drainage system of the Little Missouri River. Based upon aerial spring aerial surveys of 24 permanent mule deer survey units in the badlands (291 mi^2) the average number of mule deer observed during aerial surveys was 7.8 deer per mi^2 in April 2010 (Figure 1). Overall fall mule deer doe:fawn ratios (fall recruitment) have been gradually declining over time and are more variable, particularly since about 1995 (Figure 2). Secondary mule deer range (17,278 mi^2) in the state of North Dakota is primarily located south and west of the Missouri River. Based upon aerial surveys of six monitoring blocks within the Missouri Slope during the winter of 2010, the average number of mule deer counted was 0.8 mule deer per mi^2 (3,541 mi^2).

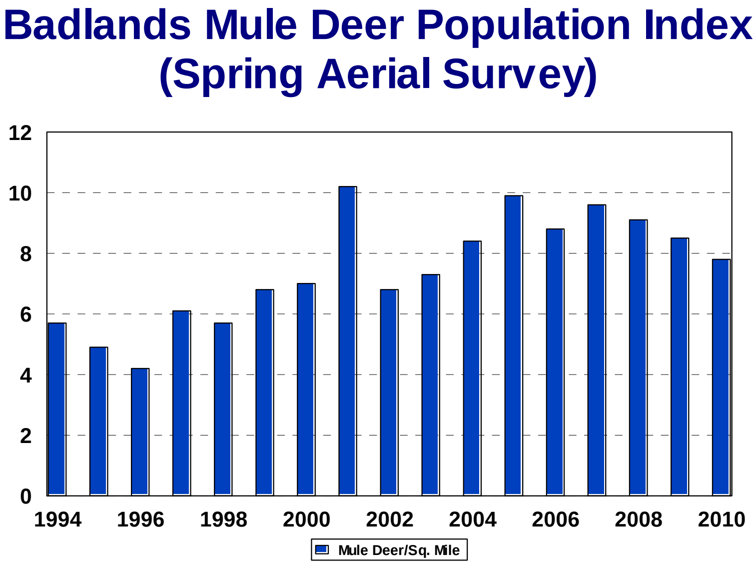


Figure 1. Overall spring mule deer population index for the badlands (1994-2010).

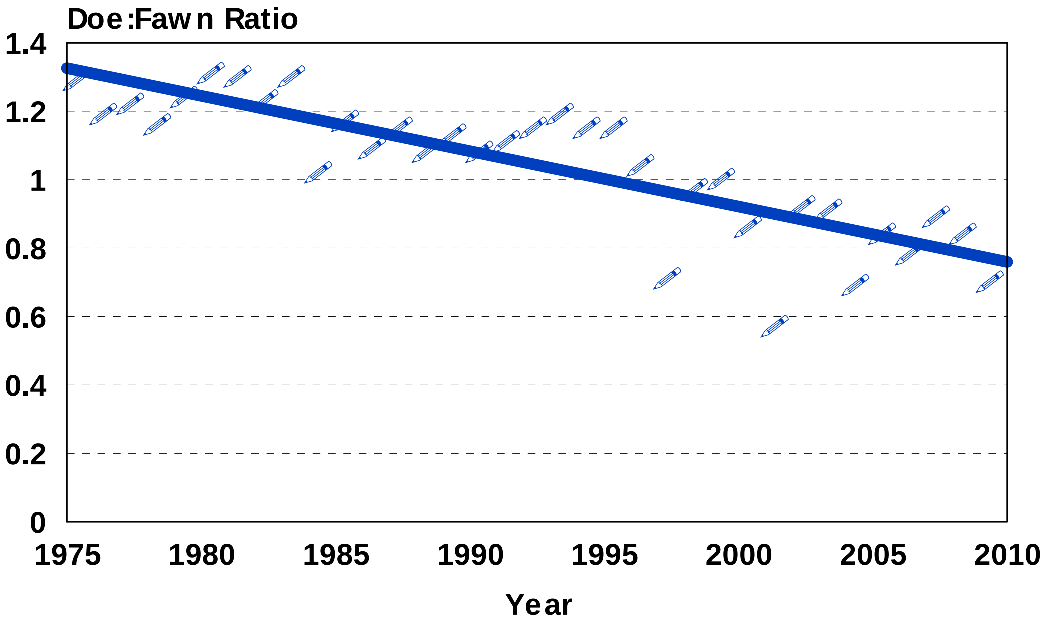


Figure 2. Overall fall mule deer doe:fawn ratio for the badlands (1975-2009).

2. HABITAT:

Mule deer range in North Dakota was divided between primary range, secondary range, and uninhabited. Primary range boundaries were based upon the badlands ecoregion type within the Little Missouri River drainage system (as defined by the EPA, level IV). Secondary range is the Missouri Slope physiographic region, as well as the breaks and rough terrain bordering the Missouri River (Sage Brush Steppe, Slope, Missouri River Coteau, and Missouri River Breaks ecoregions as defined by the EPA, level IV). The remainder of the state is classified as “uninhabited”. Based upon aerial spring aerial surveys of 24 permanent mule deer survey units in the badlands (291 mi ^{2}), the average number of mule deer counted was 6.8 deer per mi ^{2} (1991-2010). Based upon aerial surveys of six monitoring blocks within the Missouri Slope (3,541 mi ^{2}) during the winter of 2010, the average number of deer counted was 0.8 mule deer per mi ^{2}, and 2.8 white-tailed deer per mi ^{2}. Mule deer are found in the remainder of the state, but at very low numbers. During the 2009 deer-gun season hunters reported classifying 20,357 deer in hunting units north and east of the Missouri River as either mule deer or white-tailed deer. Only 381 of those deer were classified as mule deer (1.9%); and 67% of those mule deer were in hunting unit 3A1 and 3A3**.** It should be noted that portions of the secondary range north and west of the Missouri River extend into hunting units 3A1 and 3A3.

Mule deer habitat was classified as either primary or secondary range on a section (square mile) by section basis. For those sections falling along range boundaries, the entire section was classified as the type with the majority of the surface area. Sections with more than 50% classified as surface water were removed from the analysis. Figure 3 displays what we consider to be primary (2,829 mi ^{2}) and secondary (17,278 mi ^{2}) mule deer range in the state of North Dakota.

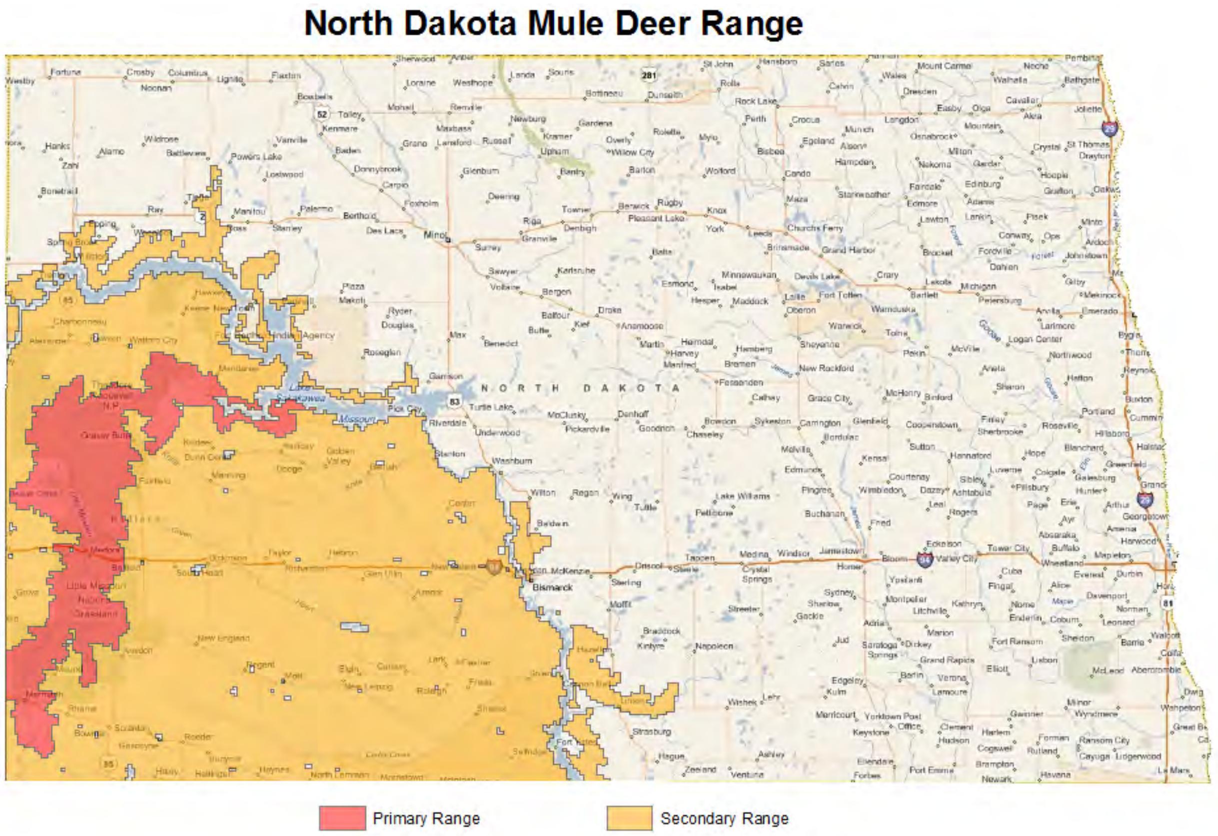


Figure 3. A map of North Dakota showing the primary (2,829 mi^2) and secondary (17,278 mi^2) mule deer range. Based on aerial surveys, observed densities on primary range average 5 to 10 mule deer per mi^2 and less than 1 mule deer per mi^2 on secondary range.

3. OIL AND GAS IMPACTS:

In 2008 a report entitled "A literature Review of the Effects of Energy Development on Ungulates: impacts for Central and Eastern Montana" was prepared for Montana Fish, Wildlife, and Parks Department by Dr. Mark Hebblewhite, University of Montana, Missoula (Hebbelwhite 2008; See Attachment). This report is an excellent reference and appears to summarize the vast majority, if not all, the available information available on this subject. Hebblewhite (2008) identified the following aspects of oil and gas (O/G) development that have been documented to influence mule deer:

1. Fragmentation and disruption of migration routes between summer and winter range. Berger's (2004) review documented 75% declines in ungulate migration for mule deer, elk, and pronghorn as a result of long-term human caused habitat fragmentation.
2. Loss of mule deer winter range due to human disturbance resulting from roads and wells. Freddy et al. (1986) found that zones of negative impact on mule deer from human disturbance can reach 0.25 miles from roads and trails; particularly if loud noises and pets are also involved. In a study by Sawyer et al. (2008), they found in undeveloped areas mule deer numbers remained constant. However, in O/G developed areas, mule deer densities declined by about 47% over a 4-year period (Sawyer et al. 2008). From this work Sawyer et al. (2006) found habitat use lower than predicted probabilities within 1.6 to 2.2 miles (2.7 to 3.7 km) of an oil or gas well. During winter, mule deer exhibited an alert/flight response to disturbances associated

> with noise and activity up to 0.29 mi from the source (Freddy 1996). A density of 4 evenly spaced well pads per section would place over 90% of surfaces within 0.29 mi. of a well pad. Mule deer in this O/G development area did not show evidence of acclimation, whereas Easterly et al. (1991) reported 29 mule deer fitted with VHF collars in eastern Wyoming were located farther away from development during drilling, but not after, when they were the same distance as before development. In short, response to O/G development can be variable. However, the indirect effects of habitat loss from O/G development are far greater than direct losses due to the footprint of well pad and roads.

Mule deer are not known to be migratory in North Dakota (Jensen 1988). However, fragmentation of habitat by roads is problematic. Summer home ranges for yearling and adult female mule deer in North Dakota averaged 583 acres (236 ha) in an area with rougher terrain and a great interspersion of vegetation types (Jensen 1988) and 855 acres (346 ha) in more open terrain with less variation in vegetation types (Fox 1989). This pattern of mule deer home ranges varying with topography has been reported in South Dakota (Severson and Carter 1978) and in Washington (Eberhardt et al. 1984). Well densities of two or more per square mile would dissect even the smaller home ranges, and break the larger home ranges into multiple smaller units. Fox (1989) reported mule deer in a developed oil field in North Dakota avoided areas within 328 feet (100 m) of a road during peak traffic periods. Additionally, use areas within 164 feet (50 m) of road and 328 feet (100 m) of a production facility was avoided for bedding sites (Fox 1989). Finally, Fox (1989) suggests that road development in oil fields increases the vulnerability of deer to be harvested by hunters and concentrating the harvest effort, this seemed particularly the case for does. Disturbance distances reported by Fox (1989) are considered very conservative and did not take into account the full array of disturbance factors reported by Sawyer et al. (2008).

Another issue not touched on by others is the loss of important limited habitat types. Deciduous green ash draws are very important feeding and bedding areas for does and fawns (Jensen 1988). The viability and condition of these deciduous woody draws have been on the decline in the North Dakota badlands for decades (unpublished NDGF data). When new oil roads go through these draws, what is not cut down is unusable for mule deer due to the narrow width of these stands and the disturbance distance from the road.

Physiological stress from increased human activity is much more difficult to assess. Fox et al (2009) reported in an Environmental Impact Statement on oil and gas development in the Glenwood Springs (NM) Resource Area that "…these impacts could ultimately have population effects through reduced production, survival and recruitment (USDI 1999)." The North Dakota Game & Fish Department has maintained a data set on mule deer since 1956 that includes spring and fall aerial surveys of 24 mule deer survey units in the North Dakota badlands. This data set has undergone preliminary analysis. During the fall surveys, all mule deer observed are classified as antlered buck, yearling and adult does, or fawn-of-the-year. In addition to big game, coyotes observed during these flights are also recorded. Management of the states deer herd on a unit by unit basis was implemented in 1975. Historical weather data for the badlands is course for much of this time period and limited to stations in Watford City, Grassy Butte, Medora, Amidon, and Bowman.

The biology of mule deer in the badlands is complex; weather, predation, and a number of other factors are known to influence fall fawn recruitment rates. As a result the required statistical analysis to tease apart these questions needs to be sophisticated and be able to incorporate time-delayed effects. In 2005 this data set was sent to Drs. Scott Nielsen and Mark Boyce at the University of Alberta who offered to conduct some pro bono analysis. The statistical program they used was a cross-sectional time series regression analysis. Based upon initial results the best predictive model used: (1) spring mule deer densities (high deer densities were negatively correlated with fawn ratios), (2) Northern Pacific Oscillation (NPO) during the growing season (moister summers positively correlated with fawn ratios), and (3) Multivariate El Nino Index (MEI) during the winter period from January to April (mild winter conditions positively correlated with doe:fawn ratios) (pers. comm., Scott Nielsen and Mark Boyce, University of Alberta April 5, 2006) (Figure 4). For most management subunits the predicted model values track well with observed ratios. However, Nielsen independently observed that there were some noted anomalies where observed doe:fawn ratios were lower than the model predicted. Nielsen questioned if something had happened in 1991 in management unit 4B/4C, and in 1999 through 2003 in management unit 4F? In 1991 there was a small spike in oil development with 78 new wells, most being drilled in subunit 4B/4C. Again, between 1999 through 2003 there were 171 new wells drilled in unit 4F. In short, stress related impacts on mule deer in their primary range may already be occurring on a population level in North Dakota. Additional analysis is required to evaluate the relative importance of O/G development influencing doe:fawn ratios.

In Fox et al. (2009) "Habitat Guidelines For Mule Deer: Great Plains Ecoregion" the categories of impact on mule deer from energy and mineral extraction activities was based upon the recommendations of Tessman et al. (2004). They are as follows: Moderate (1-4 wells and < 20 acres disturbed/section), High (5-16 wells and 20-80 acres disturbed/section), and Extreme (>16 wells and > 80 acres disturbed/section). It should be noted that these disturbance levels are less stringent than the ones currently proposed in a Wyoming Game and Fish Department (2010) report. The Wyoming report is a living document that is revised and updated on a regular basis. A square mile grid was laid over a map of North Dakota. Cells within this grid were categorized as zero wells per mi ^{2} , 1-2 wells per mi ^{2}, 3-4 wells per mi ^{2}, 5-8 wells per mi ^{2}, > 8 wells per mi ^{2}. Figure 5 summarizes the distribution and density of oil and gas wells across the state.

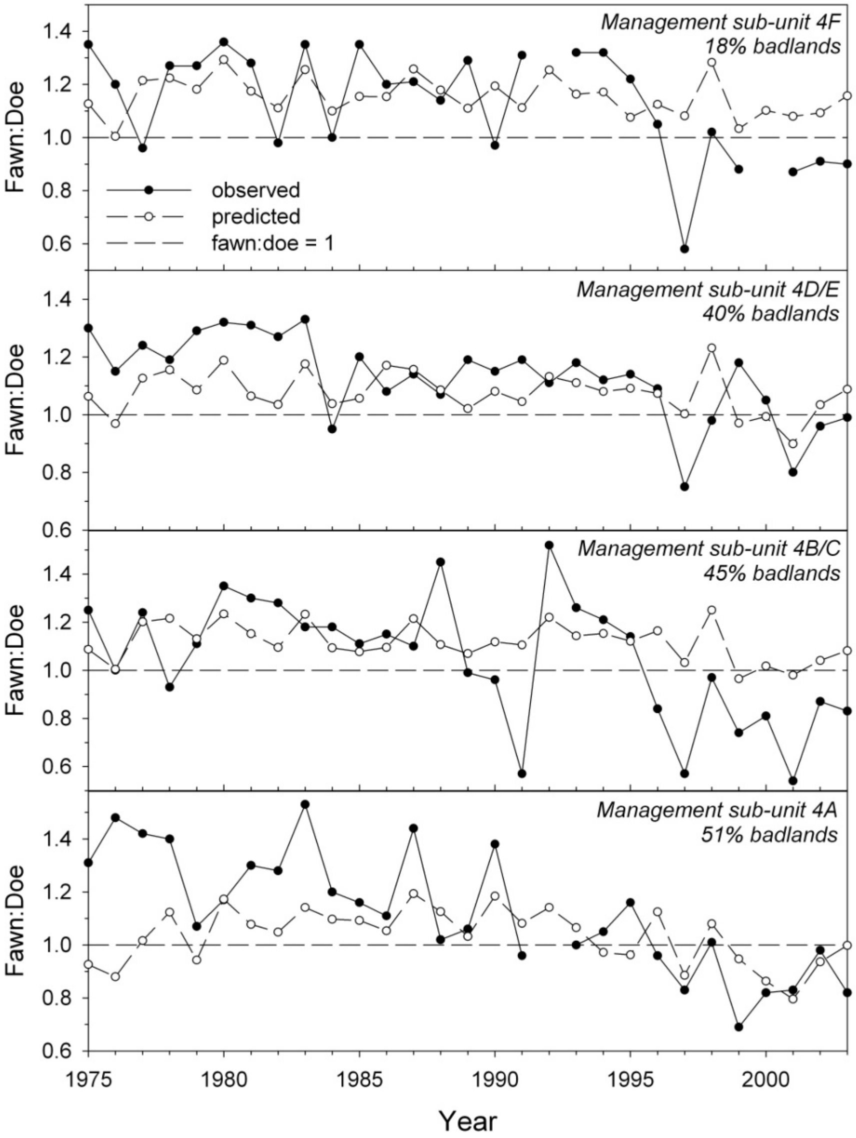


Figure 4. Predictive modeling of mule deer doe:fawn ratios in the North Dakota badlands (1975-2003). This modeling effort found: (1) spring mule deer densities (negatively correlated with fawn ratios), (2) Northern Pacific Oscillation (NPO) during the growing season (moister summers positively correlated with fawn ratios), (3) Multivariate El Nino Index (MEI) during the winter period from January to April (mild winters positively correlated with fawn ratios) to have the best predictive values. Lower than expected observed values during the mid 1980s in subunit 4B/4C and late 1990s through 2005 may suggest O/G development is negatively affecting fall mule deer doe:fawn ratios.

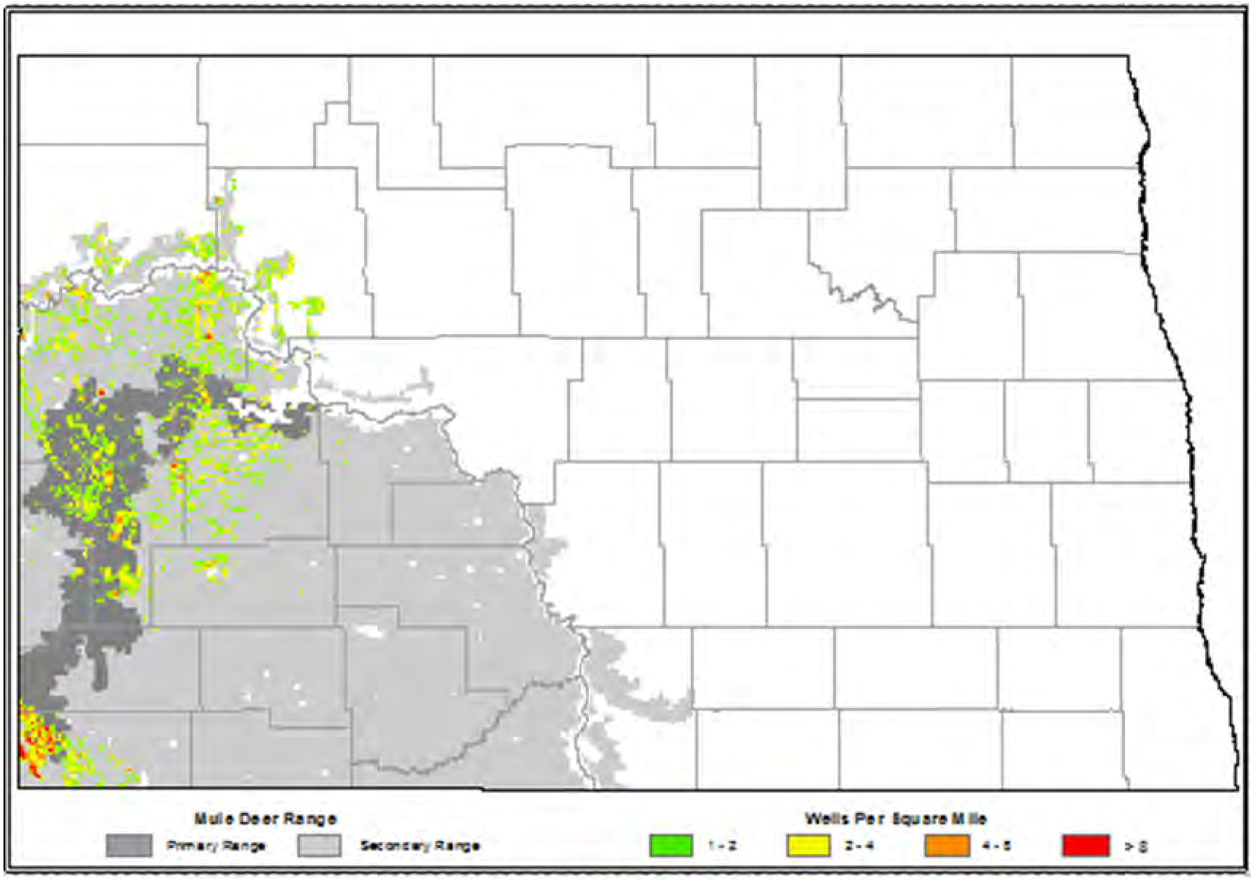


Figure 5. Map of North Dakota summarizing the distribution and density of oil and gas wells within primary and secondary mule deer range.

Currently about 18% and 1.7% of the primary mule deer range in North Dakota is moderately and highly impacted by oil wells, respectively. Much of this development has occurred over the last five years (Figure 6). Two trends are noted: both the number of individual sections impacted, and the severity of the impacts where development formerly existed, has increased dramatically over the last five years. Additionally, road densities have increased dramatically (Figure 6 and Table 1). USDI (1999) considered an area impacted if road densities exceed 3 miles of road per mi ^{2}. In 1995 less than 1% of the primary range was considered impacted by roads. The most recent data suggests 5.6% of the primary mule deer range is impacted by roads.

Expansion of Well Densities in Primary Mule Deer Range

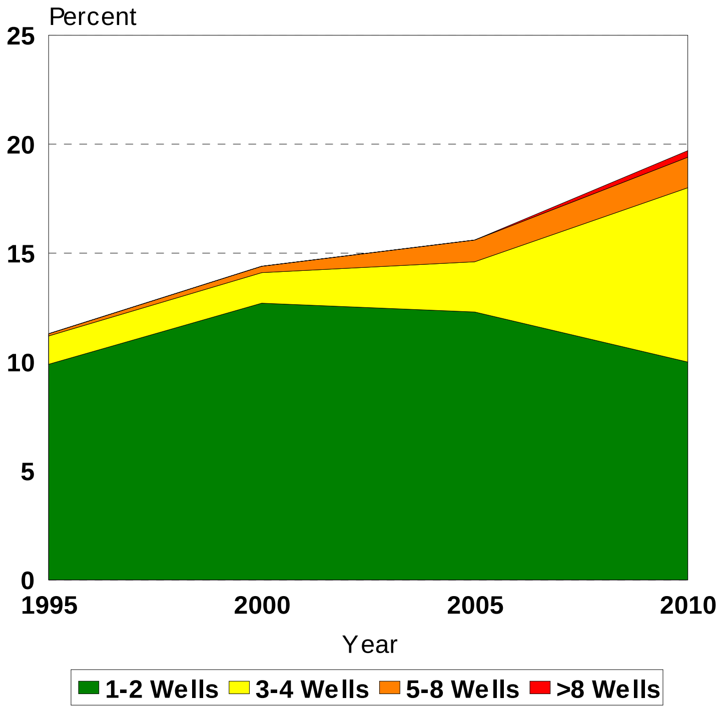
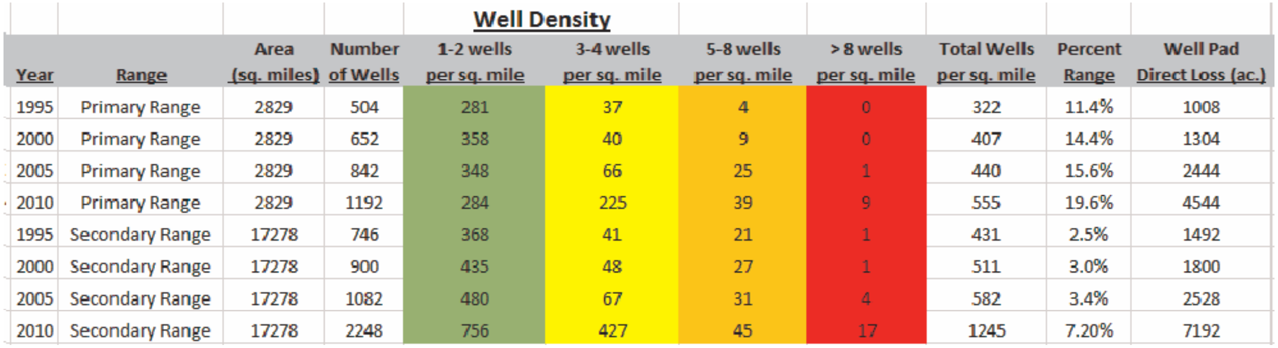


Figure 6. A graphic representation shown above displays the increase in oil and gas well densities within North Dakotas' primary mule deer range over time. Both the number of sections impacted, as well as the severity of the impacts has increased dramatically over the last five years.

Table 1. Summary of changing well densities in primary and secondary mule deer range.



				Well Density						
Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
1995	Primary Range	2829	504	281	37	4	0	322	11.4%	1008
2000	Primary Range	2829	652	358	40	9	0	407	14.4%	1304
2005	Primary Range	2829	842	348	66	25	1	440	15.6%	2444
2010	Primary Range	2829	1192	284	225	39	9	555	19.6%	4544
1995	Secondary Range	17278	746	368	41	21	1	431	2.5%	1492
2000	Secondary Range	17278	900	435	48	27	1	511	3.0%	1800
2005	Secondary Range	17278	1082	480	67	31	4	582	3.4%	2528
2010	Secondary Range	17278	2248	756	427	45	17	1245	7.20%	7192

Although more subtle, O/G development on secondary mule deer range has also increased. Currently more than 7% of secondary range (1245 mi ^{2} of the 17,278 mi ^{2}) is impacted by O/G development; a doubling since 2005.

4. MITIGATION:

Long term projections for mule deer at a population level in North Dakota are difficult to make with limited information available. "If" O/G development is affecting fall fawn recruitment and adult doe survival rates, and "If" the northern half of the badlands is heavily impacted by O/G development, mule deer numbers in the primary range could decline by 25% to 50% in the next 20 years. As stated above, O/G development impacts on mule deer fall into four general categories:

1. Direct habitat loss from well pads and roads. The habitat losses of these impacts usually involves less than 5% of the surface area.
   To mitigate these losses in primary range is problematic, as primary range (2,829 mi ^{2}) for mule deer population is restricted to the badlands within the drainage system of the Little Missouri River. Once converted it is lost until reclaimed. One possible mitigation alternative is to remove and reclaim degraded roads and well pads on public lands that preceded reclamation requirements when the leases were sold. The by-products of the drilling process have historically been pumped into a reserve pit and buried on site. This was done because removal required this material to be treated as hazardous waste. Some of these reserve pits are now eroding out and becoming exposed. By the very nature of how the Little Missouri badlands were formed, others will also be exposed over time. A trust fund could be established for dealing with this hazardous waste site on both public and private lands. On secondary mule deer range assistance could be given to reclamation of public lands with hazardous collapsing coal mines.
2. Indirect (disturbance) habitat loss from O/G development, particularly if loud noises or pets are involved, can extend from 0.25 to 2.2 miles from the well pad and roads. We calculated about 20% of primary mule deer range is currently impacted by disturbance from O/G development; this estimate is felt to be conservative.
   To mitigate indirect disturbance losses, maximize the use of centralized production and collection facilities for oil and gas outside of primary range whenever possible, and closer to major highways and pipelines. This would reduce haul truck traffic, dust and tailpipe emissions, noise, and habitat fragmentation. Gathering lines should be buried adjacent to existing roads. Work in Wyoming suggests that liquid gathering systems could substantially reduce indirect disturbance to mule deer and other wildlife.
3. Loss of important limited habitat types due to direct and indirect impacts. Deciduous green ash draws are very important feeding and bedding areas for does and fawns (Jensen 1988). When roads traverse these woody draws critical habitat is lost. Not only for mule deer but also a number of nongame species. Hutto (1995) reported that over 84% of the landbirds found in the Little Missouri National Grasslands are dependent at some level upon woodland habitat types. To fully assess losses of important limiting habitat types requires the development of new GIS layers and additional analysis.
   To mitigate losses of important limited habitat types, travel plans should direct haul and feeder roads to well pads away from these areas prior to construction. Mitigation could also include fencing cattle out of the larger woody draws that have been impacted by overgrazing and soil compaction.
4. Physiological stress from increased human activity could ultimately have population effects through reduced production, survival and recruitment. As mentioned above, completing analysis of existing data sets would be the first step in addressing the questions about the relative importance of this issue.
   To mitigate some impacts of physiological stress on mule deer due to disturbance, timing restrictions (particularly during the winter and in late May and June fawning season) on drilling could be implemented.

For additional mitigation options see Wyoming Game and Fish Department (2010) report: “Recommendations for Development of Oil and Gas Resources with Important Wildlife Habitats (Version 5.0, pages 24-30)”. This is a “living” 255 page document that is updated on a regular basis (three updates since August 2009).

5. ADDITIONAL CONCERNS:

It should be emphasized that throughout North Dakota’s mule deer range, O/G impacts represent just one of several cumulative factors affecting the state’s population. Additional negative effects impacting mule deer include increased ATV use, recreational trail construction, the potential spread of diseases through baiting, and degradation of woody draws. An increasing human population in western North Dakota, due in large part to a growing O/G industry, will also likely increase disturbance to mule deer through home construction, increased vehicular traffic, increased recreational activities, increased establishment of “hobby ranches” for recreational purposes, and increased hunting pressure on all western big game species. It still remains to be seen if Coal Bed Methane Gas exploration, with its intensive footprint, will become as significant in North Dakota as it is in other areas in the West. Completing the analysis of historic survey data is judged to be the most appropriate first step in determining the relative importance of O/G development on fawn recruitment rates.

There is a great Interest in hunting mule deer in North Dakota. In 2009 10,568 hunters applied for the 2, 886 antlered mule deer licenses that were issued by the department. It should be incumbent upon all North Dakotans that the jobs and revenue associated with the O/G industry could come with a cost; namely, diminished hunting and outdoor recreational opportunities through the loss of primary habitat due to direct and indirect effects of O/G development that sustains the wildlife populations that are so highly valued by the state’s citizens.

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WHITE-TAILED DEER

1. CURRENT STATUS:

White-tailed deer (*Odocoileus virginianus*) were observed in good numbers by the Lewis and Clark expedition along the Missouri River once they got away from established Indian Villages. Presettlement distributions of white-tailed deer in North Dakota were probably found throughout the state along the major river systems and around isolated wooded buttes, but scarce over much of the prairie. White-tailed deer were nearly gone from the state by 1900 (Jensen 2001). Today, white-tailed deer are common throughout the state. Based upon winter aerial surveys of large monitoring blocks on the Coteau, the number of white-tailed deer observed during the winter of 2010 averaged 2.7 per mi^2 (6430 mi^2), and ranged from 1.9 (Zahl Monitoring Block: 1260 mi ^{2}) (Figure 1) to 4.3deer per mi ^{2} (Cando Monitoring Block: 1200 mi ^{2})in January 2010 (Figure 2). On the Slope ecoregion of the state, located south and west of the Missouri River, based on winter aerial surveys of six monitoring blocks during the winter of 2010, the average number of white-tailed deer observed was 2.8 white-tailed deer per mi ^{2} (3,541 mi ^{2}) and ranged from 1.0 to 4.8 white-tailed deer per mi ^{2}.

In portions of the state white-tailed deer migrate considerable distances and reach much higher observed densities on winter concentration areas. For example, along the Souris Des Lacs River the average number of white-tailed deer observed during the winter of 2010 was 18.8 white-tailed deer per mi ^{2} (84.6 mi ^{2}) (Figure 3). Winter deer densities frequently exceed 10 white-tailed deer per mi ^{2} in these concentration areas. It is therefore believed that forested habitat, particularly areas along major river systems, is the most important habitat component for wintering white-tailed deer. For this reason, many of these winter concentration areas have been used as winter survey areas to monitor trends in white-tailed deer numbers (Figure 4).

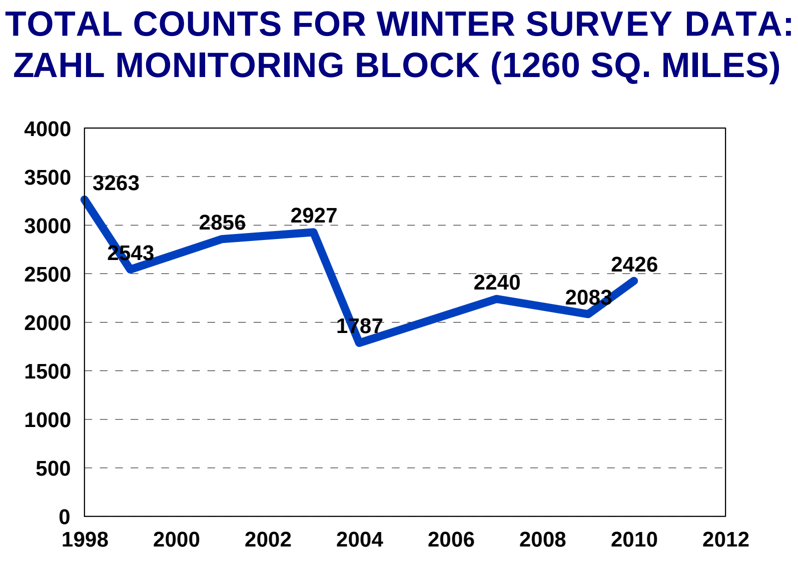


Figure 1. Winter white-tailed deer population index for northwestern North Dakota (Zahl Monitoring Block: 1998-2010).

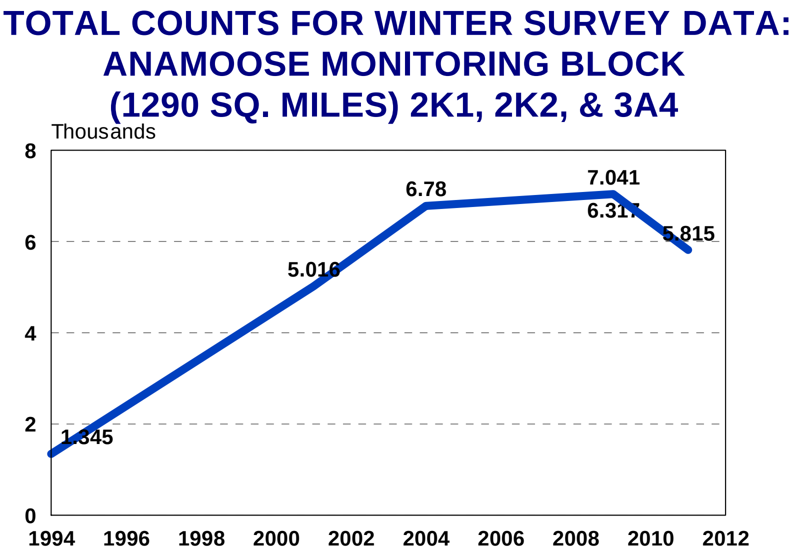


Figure 2. Winter white-tailed deer population index for northeastern North Dakota (Anamoose Monitoring Block: 1994-2010).

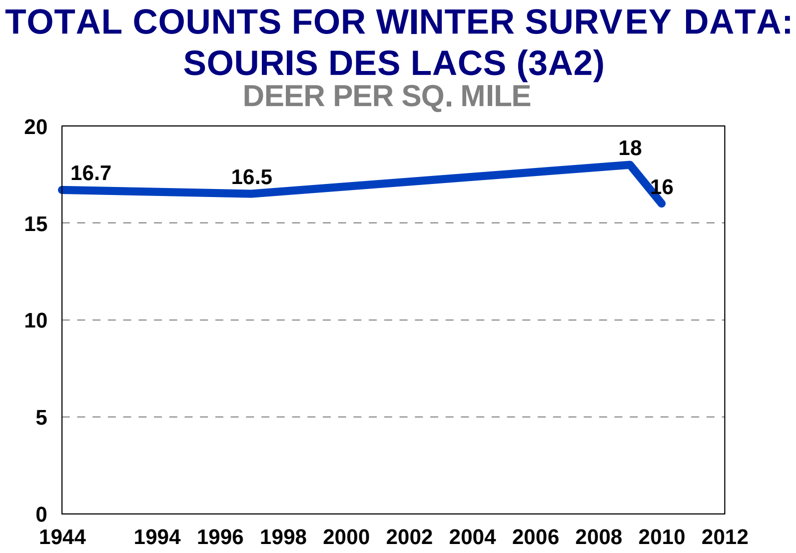


Figure 3. Forested river systems have long been used as winter concentration areas for white-tailed deer. The Souris Des Lacs area has traditionally used by white-tailed deer as a winter concentration area for decades. North Dakota Game and Fish Department aerial survey data dates back more than 60-years (1944-2010) for some survey units.

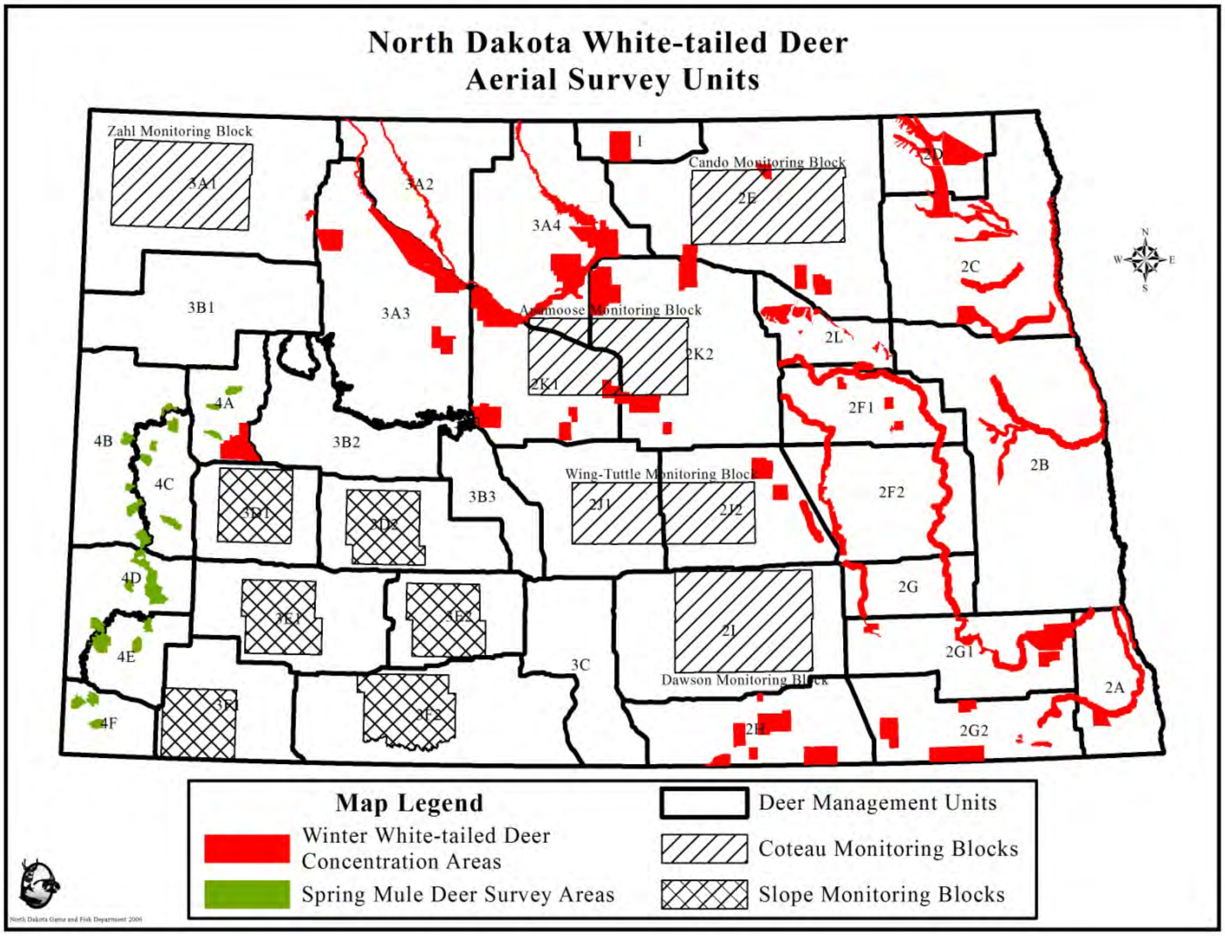


Figure 4. A map showing the distribution of white-tailed deer and mule deer aerial survey units throughout the North Dakota. The red areas denote traditional winter concentration areas used by white-tailed deer.

2. CRITICAL WINTERING HABITAT:

Because white-tailed deer are relatively common throughout North Dakota, we have focused upon winter concentration areas along major river systems. Critical wintering habitat was determined as those sections within the state with 20% or more native woody cover. Additionally, a half mile buffer along the Little Missouri River was included in the analysis because it serves as important habitat for white-tailed deer in that region of the state. Figure 5 displays what we consider to be important woodland and shrubland habitat for deer within the state of North Dakota.

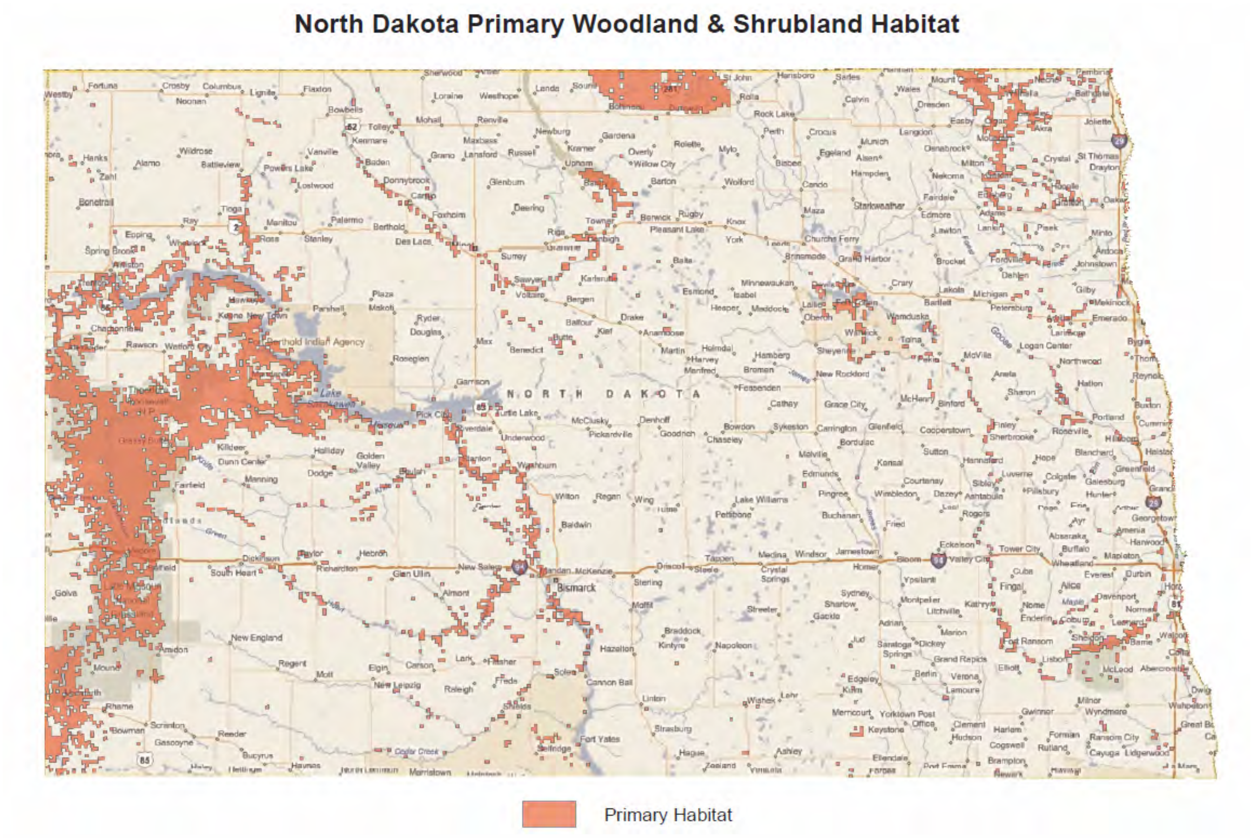

North Dakota Primary Woodland & Shrubland Habitat

Figure 5. A map of North Dakota displaying native woodland and shrubland habitat. Based on aerial surveys of monitoring blocks during the winter of 2010, observed densities on the Coteau and Slope range from 1 to 5 white-tailed deer per mi ^{2}. However, wintering white-tailed deer numbers in winter concentration areas frequently exceed 10 deer per mi ^{2}.

3. OIL AND GAS IMPACTS:

In 2008 a report entitled “A literature Review of the Effects of Energy Development on Ungulates: impacts for Central and Eastern Montana” was prepared for Montana Fish, Wildlife, and Parks Department by Dr. Mark Hebblewhite, University of Montana, Missoula (Hebbelwhite 2008). This report is an excellent reference and appears to summarize the vast majority, if not all, the available information available on this subject. Unfortunately, little work has been done on the potential impacts of oil and gas development on white-tailed deer, and as a result this species is not dealt with in either Hebbelwhite (2008), or Wyoming Game and Fish Department guidelines (2010). For this reason we used mule deer literature as the “surrogate species” for evaluating potential impacts of oil and gas development impacts on critical white-tailed deer winter concentration areas.

Hebblewhite (2008) identified the following aspects of oil and gas (O/G) development that have been documented to influence mule deer:

1. Fragmentation and disruption of migration routes between summer and winter range. Berger’s (2004) review documented 75% declines in ungulate migration for mule deer, elk, and pronghorn as a result of long-term human caused habitat fragmentation.
2. Loss of mule deer winter range due to human disturbance resulting from roads and wells. Freddy et al. (1986) found that zones of negative impact on mule deer from human disturbance can reach 0.25 miles from roads and trails; particularly if loud noises and pets are also involved. In a study by Sawyer et al. (2008), they found in undeveloped areas mule deer numbers remained constant. However, in O/G developed areas, mule deer densities declined by about 47% over a 4-year period (Sawyer et al. 2008). From this work Sawyer et al. (2006) found habitat use lower than predicted probabilities within 1.6 to 2.2

> miles (2.7 to 3.7 km) of an oil or gas well. During winter, mule deer exhibited an alert/flight response to disturbances associated with noise and activity up to 0.29 mi from the source (Freddy 1996). A density of 4 evenly spaced well pads per section would place over 90% of surfaces within 0.29 mi. of a well pad. Mule deer in this O/G development area did not show evidence of acclimation, whereas Easterly et al. (1991) reported 29 mule deer fitted with VHF collars in eastern Wyoming were located farther away from development during drilling, but not after, when they were the same distance as before development. In short, response to O/G development can be variable. However, the indirect effects of habitat loss from O/G development are far greater than direct losses due to the footprint of well pad and roads.

White-tailed deer are known to be migratory in North Dakota between summer and winter range. Average movement distances reported for white-tailed deer in North Dakota and surrounding states ranged from 6 to 27 miles; maximum movements range from 12 to 164 miles (Smith 2005) (Figure 6). Unlike western big game populations, white-tailed deer on the prairie do not have identifiable migration corridors. Based upon recent work in North Dakota, prairie white-tailed deer appear to disperse in all directions.

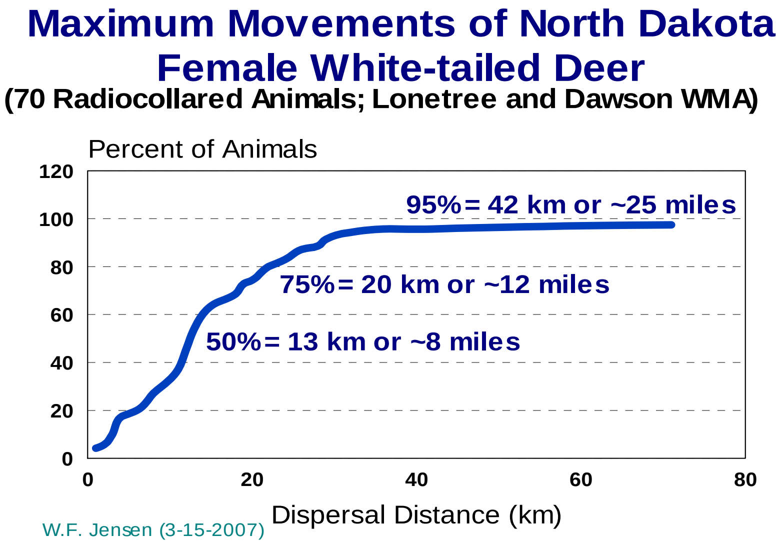


Figure 6. Summary of seasonal movements of 70 radio-collared female white-tailed deer on the Dawson and Lonetree Wildlife Management Area. More than half the deer readio-collared moved more than 8 miles between summer and winter home ranges.

Additionally, fragmentation of habitat by roads is problematic. On the Coteau, average winter home ranges for female white-tailed deer averaged 2.4 mi^2 (Smith 2005). Well densities of two or more per square mile would dissect even the smaller home ranges, and break the larger home ranges into multiple smaller units. If new oil roads go through forested habitat, much of what is not cut down is unusable for deer due to the narrow width of these riparian woodland stands and the disturbance distance from the road.

Fox (1989) reported mule deer in a developed oil field in North Dakota avoided areas within 328 feet (100 m) of a road during peak traffic periods. Additionally, use of areas within 164 feet (50 m) of a road and 328 feet (100 m) of a production facility was avoided for bedding sites (Fox 1989). Finally, Fox (1989) suggests that road development in oil fields increases the vulnerability of deer to be harvested by hunters and concentrating the harvest effort, this seemed particularly the case for does. Disturbance distances reported by Fox (1989) are considered very conservative and did not take into account the full array of disturbance factors reported by Sawyer et al. (2008).

Based upon the limited information available regarding disturbance of white-tailed deer by off-road vehicles, and all-terrain vehicles; white-tailed deer tend to be more tolerant of human activity than mule deer. However, snowmobiles caused deer to move an average of 200 feet off-trails. Under deep snow conditions, this can be very stressful. Deer frequently use plowed roads as travel corridors during the winter to travel between food and bedding areas. Running off roads into deep snow and foundering to avoid vehicular traffic would place great energetic demands upon deer, particularly fawns, during and already demanding time of the year. Under relatively low traffic volumes conditions in the area surrounding Dawson WMA, 9% of the radio-collared adult does died from Deer-Vehicle Collisions (DVC). With around the clock truck traffic servicing O/G fields, it is presumed that DVC will increase significantly in developed oil and gas fields.

Long-term impacts of physiological stress from increased human activity are much more difficult to assess. Fox et al. (2009) reported for mule deer that an Environmental Impact Statement on oil and gas development in the Glenwood Springs (NM) Resource Area found that "…these impacts could ultimately have population effects through reduced production, survival and recruitment (USDI 1999)."

In Fox et al. (2009) "Habitat Guidelines For Mule Deer: Great Plains Ecoregion" the categories of impact on mule deer from energy and mineral extraction activities was based upon the recommendations of Tessman et al. (2004). They are as follows: Moderate (1-4 wells and < 20 acres disturbed/section), High (5-16 wells and 20-80 acres disturbed/section), and Extreme (>16 wells and > 80 acres disturbed/section). It should be noted that Wyoming Game and Fish Department (2010) are more stringent. Due to time constraints this analysis has not been completed. However, it is believed currently impacts have been minimal as much of this development has occurred over the last five years and most of the development has been away from traditional winter concentration areas (Figure 7). Two trends are noted: both the number of individual sections impacted, and the severity of the impacts where development formerly existed, has increased dramatically over the last five years. Additionally, road densities have increased dramatically (Figure 7). USDI (1999) considered an area impacted if road densities exceed 3 miles of road per mi^2.

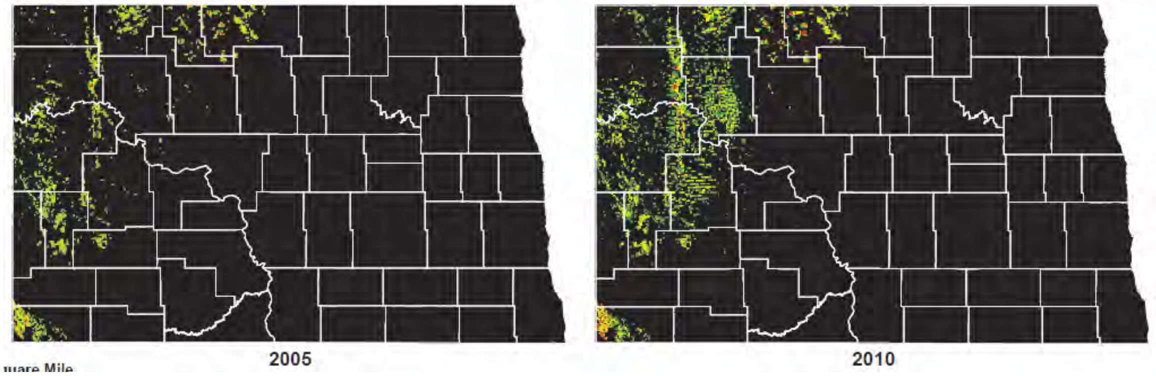


Figure 7. A graphic representation shown above displays the increase in oil and gas well densities within North Dakotas' between 2005 and 2010. Both the number of sections impacted, as well as the severity of the impacts has increased dramatically over the last five years.

4. MITIGATION:

Long term projections for impacts on white-tailed deer at a population level in North Dakota are difficult to make with limited information available. Perhaps one of the most immediate impacts will be losses of deer due to Deer-Vehicle Collisions (DVC). Based upon the return of fate of 38 radio-collared adult female white-tailed deer on the Coteau in areas with relatively low traffic volume (Dawson and Lonetree WMAs), 9% died from DVC (Smith 2005). Although less sensitive to disturbance than elk, pronghorn, and mule deer; hunted white-tailed deer reduce habitat use near roads due to human foot traffic, vehicles, and snowmobiles (Behrend and Lubeck 1968; Dorrance et al. 1975). This may be particularly problematic for white-tailed deer during the fawning season in open prairie habitat where secure hiding cover is limited. Due to the combined impacts of deer-vehicle collisions and disturbance, the increased traffic volume and round the clock activity could dramatically reduce deer numbers in established oil fields and along major highways used for hauling equipment and product. Due to a number of factors, it is believed that many of these DVC will go unreported. "If" O/G development is affecting fall fawn recruitment and adult doe survival rates due to direct losses from DVC, and indirect losses from increased stress, and "If" the critical wintering habitat is heavily impacted by O/G development, white-tailed deer numbers in the western half of the state could be significantly reduced over the next 20 years. As stated above, O/G development impacts on white-tailed deer could occur in four general categories:

1. Direct habitat loss from the well pad and roads. Critical secure fawning and wintering habitat losses would have long term effects on the carrying capacity of the region. Mitigating losses of critical wintering habitat is problematic. Once converted it is lost until reclaimed. The one possible mitigation is to develop a travel plan for unified O/G fields prior to development that insures critical wintering habitat is avoided.
2. Indirect (disturbance) habitat loss from O/G development, particularly if loud noises or pets are involved, can extend perhaps 0.25 miles or more from the well pad and roads. We assume at this time that there has been little impact to critical wintering habitat by disturbance from O/G development, as most of the development in white-tailed deer range has only occurred within the last five years.

   To mitigate indirect disturbance losses, maximize the use of centralized production and collection facilities for oil and gas outside of primary range whenever possible, and closer to major highways and pipelines. This would reduce haul truck traffic, dust and tailpipe emissions, noise, and habitat fragmentation. Gathering lines should be buried adjacent to existing roads. Work in Wyoming suggests that liquid gathering systems could substantially reduce indirect disturbance to mule deer and other wildlife.
3. Loss of important limited habitat types due to direct and indirect impacts. Forested habitats are very important feeding and bedding areas for white-tailed deer, particularly during the winter. When roads traverse these woody draws critical habitat is lost. Not only for deer but also a number of nongame species.

   To mitigate losses of important limited habitat types, travel plans should direct haul and feeder roads to well pads away from these areas prior to construction. Mitigation could also include fencing cattle out of the larger woody draws and river bottoms that have been impacted by overgrazing and soil compaction.
4. Physiological stress from increased human activity could ultimately have population effects through reduced production, survival and recruitment.

   To mitigate some of the impacts of physiological stress on white-tailed deer due to disturbance, timing restrictions (particularly during the winter and in late May and June fawning season) on drilling could be implemented.

For addition mitigation options see Wyoming Game and Fish Department (2010) report: "Recommendations for Development of Oil and Gas Resources with Important Wildlife Habitats (Version 5.0, pages 24-30)". This is a "living" 255 page document that is updated on a regular basis (three updates since August 2009).

5. ADDITIONAL CONCERNS:

White-tailed deer are an important natural resource for the citizens of North Dakota. In addition to the intrinsic values of deer, it should be remembered that: (1) Deer licenses generate more than $3.5 million annually in licenses sales for the department, and (2) deer hunters spend more than $60 million annually on gas, food, lodging, and equipment during hunting trips; much of that money is spent in small rural communities that need this economic stimulus the most. There are an estimated 110,000 hunters in North Dakota; of these hunters more than 94,000 (85%) hunt deer. More North Dakotans engage in deer hunting than any other shooting sport.

It should also be emphasized that throughout the state, North Dakota's white-tailed deer winter concentration areas are being impacted by a variety of factors. O/G impacts represent just one of several cumulative factors affecting the state's population. Additional negative effects impacting white-tailed deer include increased recreational ATV use, the potential spread of diseases through baiting, and degradation of forested river bottoms. An increasing human population in western North Dakota, due in large part to a growing O/G industry, will also likely increase disturbance to deer through home construction, increased vehicular traffic, increased recreational activities, increased establishment of "hobby ranches" for recreational purposes, and increased hunting pressure on all western big game species. It still remains to be seen if Coal Bed Methane Gas exploration, with its intensive footprint, will become as significant in North Dakota as it is in other areas in the West. Assessing losses due to DVC is judged to be the most appropriate first step in determining the relative impacts of O/G development on adult survival rates.

It should be understood by all North Dakotans that the jobs and revenue associated with the O/G industry could come with a very high cost to our quality of life; namely, diminished hunting and outdoor recreational opportunities through the loss of habitat due to direct and indirect effects of O/G development. These critical habitat components that support may species of wildlife that are highly valued by the state's citizens.

BIGHORN SHEEP

1. CURRENT STATUS:

Bighorn sheep (*Ovis canadensis*) are native to North Dakota and were first observed by non-Native Americans in 1805 by a member of the Lewis & Clark Expedition (Knue 1991). However, due primarily to diseases introduced from domestic sheep and unregulated hunting, they were extirpated from the state by 1905 (Knue 1991). The North Dakota Game & Fish Department (NDGF) subsequently reintroduced bighorn sheep in 1956 with 18 animals from British Columbia (Murdy 1956).

Following 6 out-of-state and 29 in-state translocations, the state's bighorn population increased to approximately 300 by the mid-1990s (Wiedmann 2008) but then declined to only 140 following an all-age die-off in 1997 (Stillings 1999). Consequently, the Wild Sheep Foundation – Midwest Chapter funded an additional 5 out-of-state and 6 in-state translocations to recover the depleted population, resulting in a total population of approximately 350 bighorns distributed among 16 distinct herds by 2009 (Wiedmann 2009) (Figures 1 and 2).

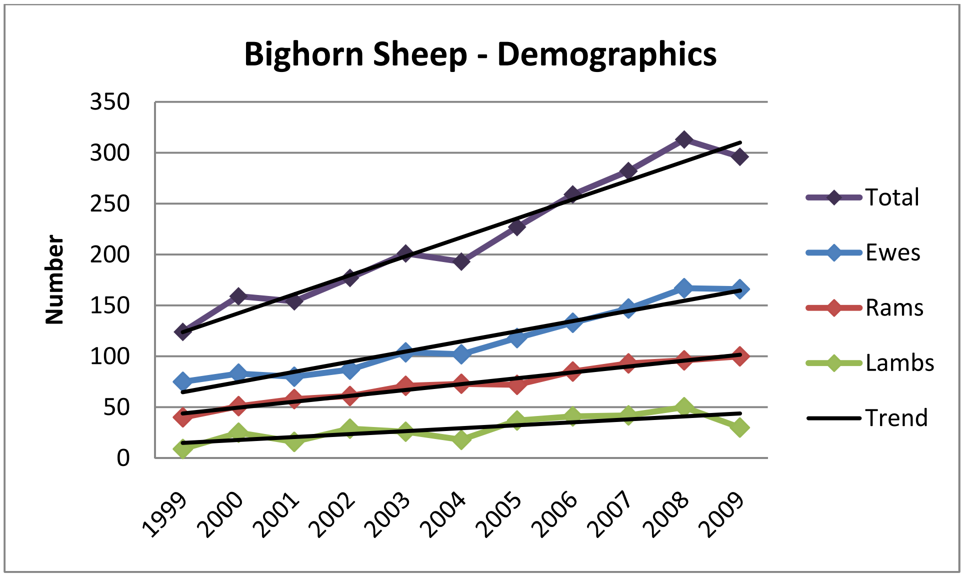


Figure 1. Minimum bighorn sheep population, 1999 – 2009.

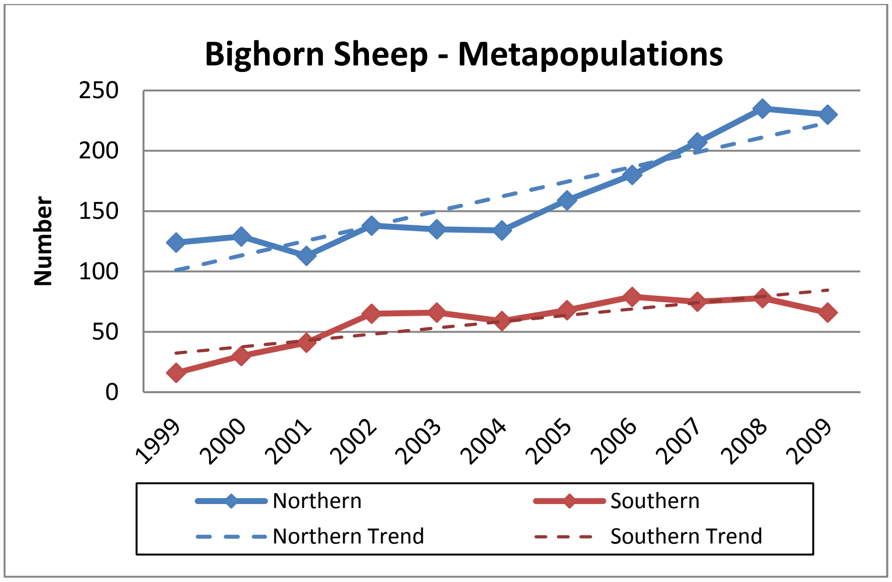


Figure 2. Bighorn sheep metapopulations, 1999 – 2009.

2. HABITAT:
Suitable bighorn sheep habitat consists of high-visibility areas containing rugged escape terrain with slopes between 27 and 85 degrees, adjacent to grassland foraging areas (Geist 1971, Hanson 1980, Elenowitz 1984, Gionfriddo and Krausman 1986, and Sweanor et al. 1996). Prior to parturition, bighorn ewes specifically select these rugged areas in which to rear their lambs (Hanson 1980, Bleich et al. 1997, and Bangs et al. 2005). Geist (1970) reported that bighorn ewes have very high fidelity to traditional lambing areas where rugged escape terrain allows precocial lambs, which are not hidden in vegetation similar to cervid fawns, to outmaneuver predators (Figure 3).

Figure 3. South Bullion bighorn ewe with newborn lamb.

North Dakota's bighorn sheep habitat is considered marginal as it falls within the eastern edge of bighorn range. Most bighorn in North Dakota occupy areas within the Little Missouri National Grassland

(LMNG), which is in 87% public and 13% private ownership (per. comm. – Arden Warm, USFS). Mean home range size is 31 mi^2 (5 – 129 mi^2) with ram home ranges typically twice that of ewes (GIS HRE – Wiedmann 2009). Two herds also occupy areas within National Park Service and Bureau of Land Management lands outside the LMNG. Ridges ranging between 2090 – 2575 feet above-sea-level with highly erodible substrates (Bluemle 1980) are typically utilized as escape terrain required by bighorn sheep (Figure 4). Short grass prairie, sedges, sagebrush, grama, saltbrush, juniper and green ash (Nelson 1961, Jensen 1988 and Fox 1989) predominates the semi-arid, continental and windy climate, with its very cold winters and very warm summers (Jensen 1974).

Figure 4. Bighorn sheep lambing habitat in North Dakota.

Holl (1982) reported that the amount of lambing habitat (i.e., escape terrain) determines the number of ewes (i.e., carrying capacity) a particular area can support. McKinney et al. (2003) found that the size and configuration of escape terrain (i.e., lambing habitat) is the primary limiting factor determining bighorn population size. Beecham (2007) stated that these two factors: fidelity to historic lambing areas and formation of nursery bands with exposed, precocial offspring, make bighorn sheep particularly vulnerable to disturbance near lambing areas.

Bighorn range for the purpose of this report (Figure 5) was delineated using a combination of telemetry data collected over 10 years from radio-marked bighorn sheep, habitat modeling (Sweanor et al. 1994), and incidental observations. Primary range (295 mi^2) includes seasonal ranges inhabited by radio-marked ewes and rams, with secondary range (531 mi^2) including areas selected for future translocations as well as ram travel corridors, which are important for genetic connectivity between herds.

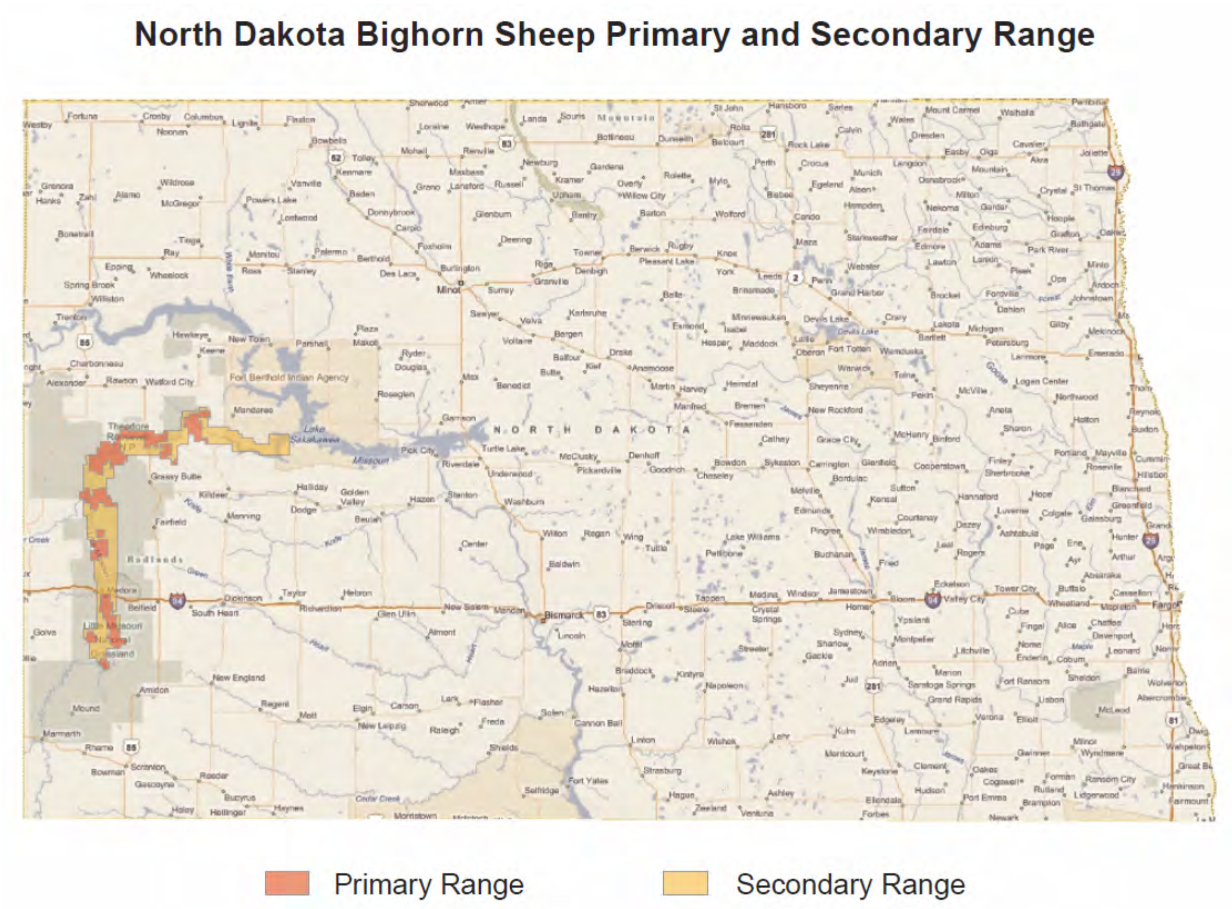
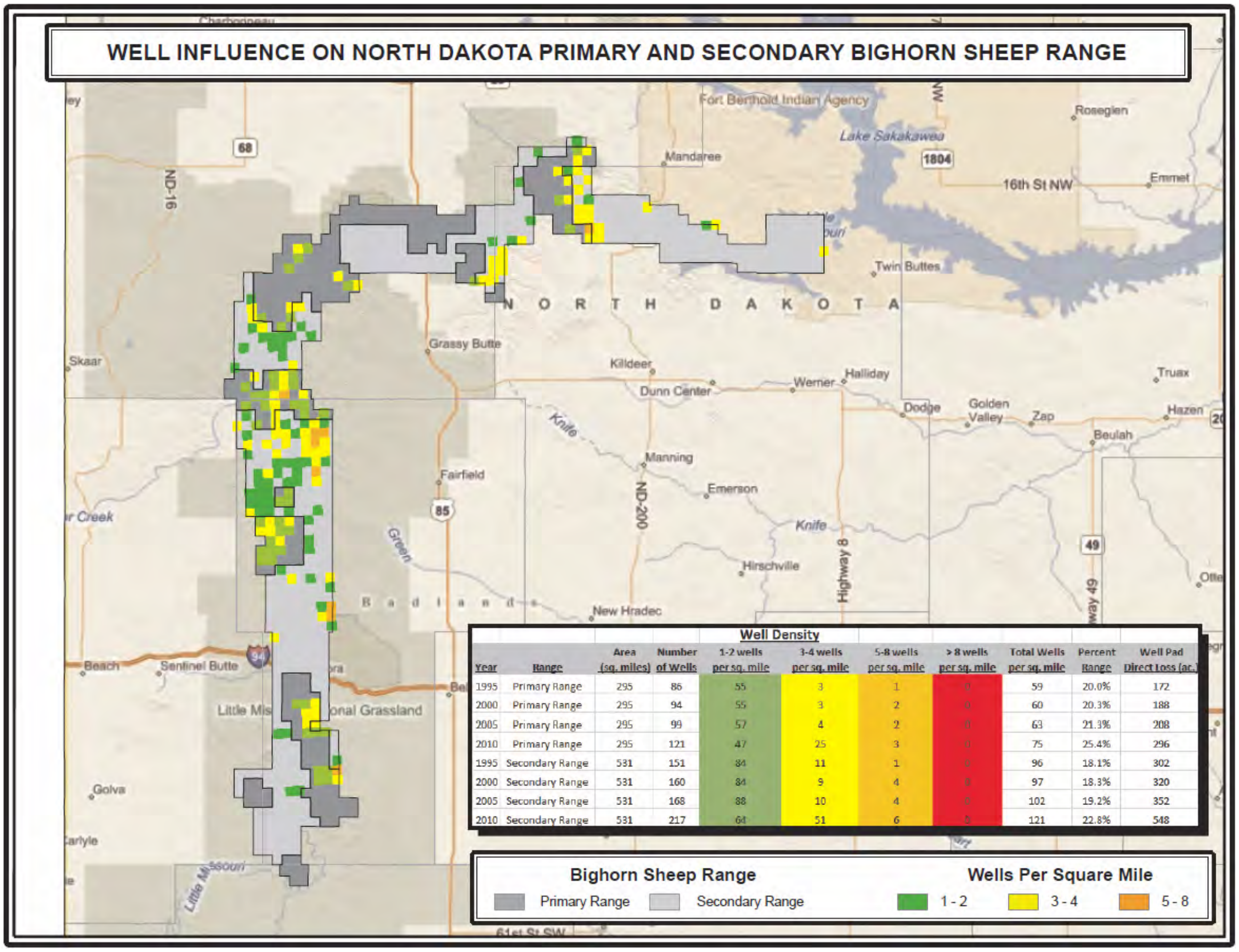


Figure 5. Bighorn sheep range.

3. OIL AND GAS IMPACTS:
Geographic Information System (GIS) was used to analyze well and road densities (Figures 6 and 7) throughout North Dakota's primary and secondary bighorn range using a one mile scale. The number of wells added per year is also included (Figure 8). Interestingly, areas where bighorn sheep are thriving correspond with those areas with the lowest well and road densities, a caveat being that those areas also contain some of the highest quality habitat.

Lambing areas are the most critical habitats used by bighorn sheep and, because such areas are very limited in North Dakota, are the most significantly impacted by human-caused disturbances like oil and gas (O/G) development (Johnson 1983). Disturbance near bighorn nursery bands typically causes ewes and lambs to flee up to three miles (Feist 1997) from preferred lambing habitats to areas containing marginal habitat, resulting in lambs being more susceptible to various mortality factors (Horejsi 1976, DeForge 1981). Lamb mortality could also increase due to decreased foraging and nursing efficiency by ewes and lambs, respectively (King and Workman 1986, Stockwell et al. 1991).



Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
				Well Density						
1995	Primary Range	295	86	55	3	1	0	59	20.0%	172
2000	Primary Range	295	94	55	3	2	0	60	20.3%	188
2005	Primary Range	295	99	57	4	2	0	63	21.3%	208
2010	Primary Range	295	121	47	25	3	0	75	25.4%	296
1995	Secondary Range	531	151	84	11	1	0	96	18.1%	302
2000	Secondary Range	531	160	84	9	4	0	97	18.3%	320
2005	Secondary Range	531	168	88	10	4	0	102	19.2%	352
2010	Secondary Range	531	217	64	51	6	0	121	22.8%	548

Figure 6. Well density in bighorn range.

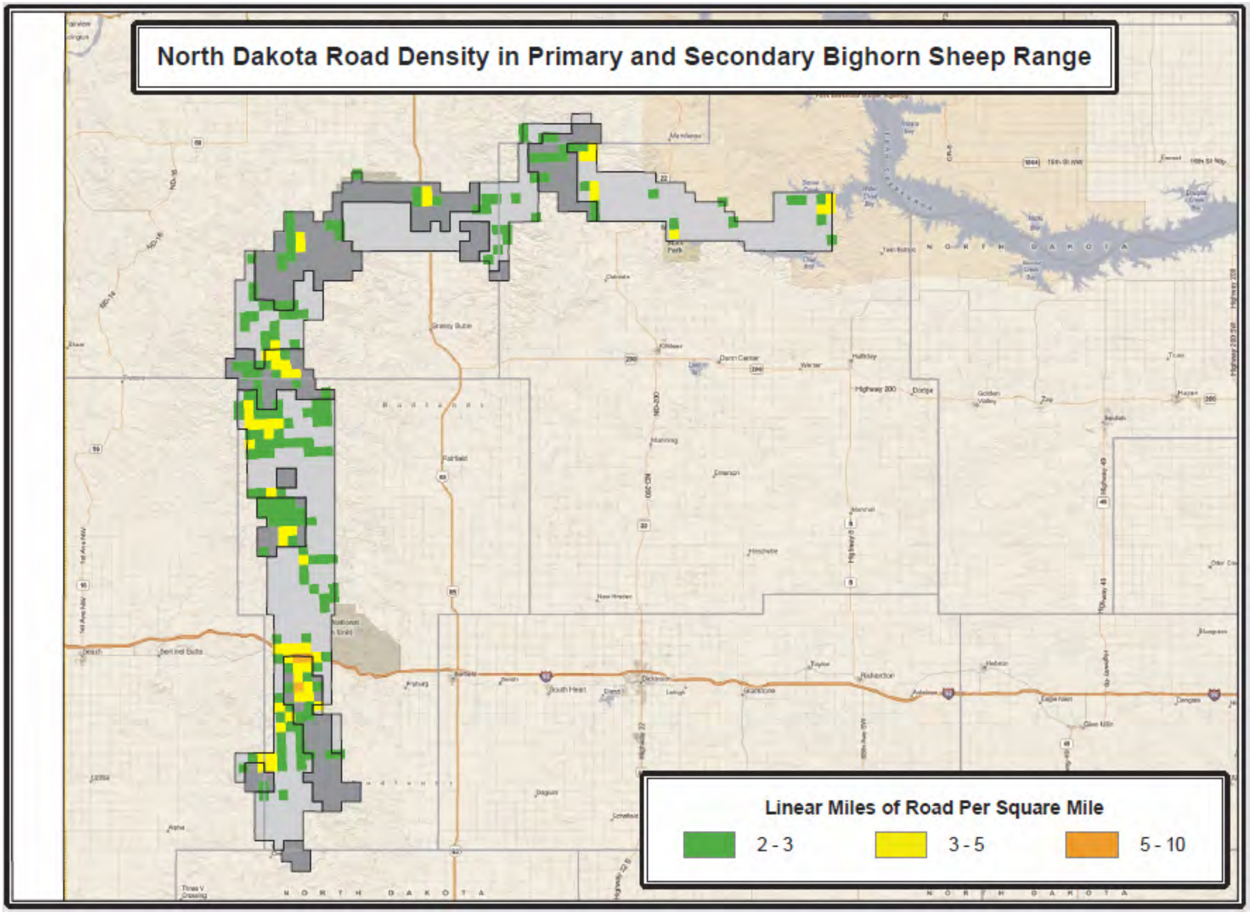


Figure 7. Road density in bighorn range.

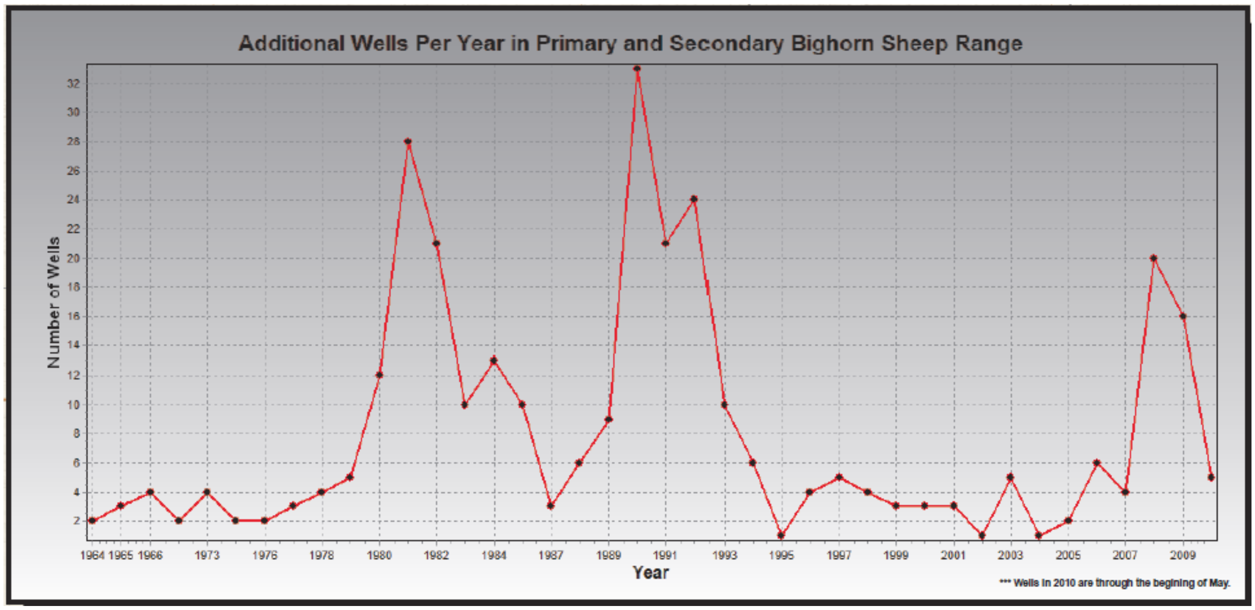


Figure 8. Wells added per year in bighorn range.

Direct habitat loss due to O/G activities can adversely affect bighorn sheep in North Dakota. In 2010 approximately 296 and 548 acres within bighorn primary and secondary range, respectively, had been lost from the construction of well pads, an increase of 72 and 81%, respectively, since 1995. In 2010 26% of bighorn primary range had at least one well per section, an increase of 27% since 1995; and 23% of bighorn secondary range had at least one well per section, an increase of 26% since 1995. The Department of Mineral Resources projected that up to 5990 new wells will be drilled in oil fields encompassing bighorn range within the next 10 years. Moreover, a far greater amount of direct habitat loss has occurred, and will occur, from accompanying oil road construction.

However, since bighorn sheep occupy precipitous terrain, disturbance associated with O/G development will likely generate significantly more negative impacts than direct habitat loss due to increased human disturbance (Figures 9 and 10). Generally, bighorn sheep avoid areas with human disturbance. Macarthur et al. (1982) found that heart rates of bighorn sheep increased when approached by humans, with heart rates actually increasing following successive trials. Such stressors (Macarthur 1979, Johnson 1983) are energetically expensive to bighorns (Webster and Blaxter 1966) and have both physiological and physical effects (DeForge 1981, MacArthur et al. 1982, Schwantje 1986, Hayes et al. 1994), which can contribute to disease outbreaks (Foreyt and Jessup 1982, Spraker et al. 1984, Bailey 1986). Jorgenson (1988) found that population size, lower survival rates, and increased lungworm loads in a bighorn herd in Alberta were attributable to increased levels of stress caused by human activities.

Figure 9. Oil well pad buttressing Magpie Creek lambing area.

Figure 10. Oil road construction through bighorn habitat near Magpie Creek.

Bighorns typically do not disperse from natal home ranges (Geist 1971); therefore, disturbance causing abandonment of critical areas may be even more significant because bighorns may be displaced to areas where suitable habitat is not available (DeForge 1981, Papouchis et al. 2001). Consequently, any loss of lambing habitat through direct habitat loss or disturbance will have an immediate and direct impact on the viability and persistence of a bighorn population. Although Sayre (1996) observed that Magpie Creek ewes in North Dakota did not permanently abandon historic lambing areas following O/G development, this was likely attributed to a very limited amount of suitable lambing habitat coupled with traditional fidelity to the area. Furthermore, although traditional lambing areas have not been deserted by the Magpie Creek ewes since the introduction of O/G development, the herd has since seen a precipitous decline in population size. Feist (1997) reported that bighorn ewes in North Dakota inhabiting areas with low disturbance consistently recruited more lambs than ewes inhabiting areas with moderate to high levels of disturbance. Lamb recruitment rates recorded by NDGF the last 10 years corroborate his findings (Wiedmann 2009).

Yarmoloy et al. (1988) predicted that animals will habituate to novel stimuli only if it is predictable, non-intrusive, and where the stimulus does not pursue the animal. Sayre et al. (2002) found that bighorn sheep in North Dakota responded most strongly to vehicles approaching to within 220 yards; however, humans on foot typically elicit much stronger responses than faster, more predictable movements of vehicles (Wehausen 1980, King 1985, Miller and Smith 1985, Sayre 1996). Papouchis et al. (2001) reported that hikers on foot caused the most severe responses to bighorn sheep, followed by vehicles and bikers; with such disturbances causing a 15% reduction in bighorn use of suitable habitat. Hicks and Elder (1979) found that although a bighorn herd in California did not appear to be declining due to human hikers, six bighorn groups may have abandoned a preferred area due to human disturbance.

Declining bighorn sheep populations corresponded to road traffic in Colorado (Keller and Bender 2007), human activities in Arizona (Etchberger et al. 1989, Schoenker and Krausman 1999), human recreation in California (Dunaway 1971), construction activities in Nevada (Leslie and Douglas 1980), and mining activities in California (Oehler 2005). Bighorn were also displaced from winter range by skiers in Alberta (Jorgenson 1988), home range size declined 28% in Montana as a result of seismic activity (Hook 1986), and bighorn were temporarily displaced in Alberta due to industrial construction (Mead and Morgantini 1988).

4. MITIGATION:

Mitigation measures are very limited regarding O/G activities within North Dakota's bighorn sheep range because bighorn are a wilderness species requiring very specific, irreplaceable habitat characteristics to persist (Geist 1971), with lambing habitat being the key component for the sustainability of a population (Holl 1982, McKinney et al. 2003). Consequently, the Wyoming Game & Fish Department (2010) recommended that …the *management prescription* [regarding O/G development] *should be "no surface occupancy" within bighorn sheep crucial winter ranges and lambing areas.* Similarly, O/G activities in North Dakota that do not address disturbance near critical lambing areas will undoubtedly have deleterious effects on the state's bighorn population. Therefore, every effort should be made to reduce disturbance near lambing areas in order prevent a change in bighorn distribution (Krausman and Hervet 1983, Hook 1986), abandonment of suitable habitat (Etchberger et al. 1989, King 1985), or alterations in activity patterns (Leslie and Douglas 1980, Hamilton et al. 1982).

The primary O/G mitigating factor should include placement of pads no closer than 550 yards from known lambing areas (Papouchis et al. 2001) and roads no closer than 220 yards (Sayre 2002). Although MacArthur et al. (1979), Wehausen (1980), King (1985), and Sayre et al. (2002) all designated 220 yards as the *minimum* threshold at which human disturbance becomes significant, that distance did not consider the presence of neonate lambs with ewes and their increased sensitivity to disturbance, which is the justification for a greater minimum distance of 550 yards for areas with prolonged, concentrated disturbance near lambing areas (e.g., well pads). Wiedmann (NDGF – unpublished data) repeatedly observed ewes with neonate lambs fleeing from escape terrain when human disturbance approached to within 600 yards. Wehausen (1980) and Sayre (1996, 2002) agreed that 220 yards likely would not be a sufficient buffer to disturbance near lambing areas, especially O/G pads where workers frequently stop, exit their vehicles, and move about on foot for prolonged periods of time.

Helicopter traffic, which frequently accompanies O/G exploration, also elicits significant responses by bighorn sheep when within 825 – 2460 feet above-ground-level (Bleich 1990, 1994, Stockwell 1991, Frid 2003); therefore, mitigation that prohibits helicopter over-flights of bighorn areas, especially during the lambing season (i.e., April – June), should also be pursued.

Additional O/G mitigating measures that would reduce activity at O/G pads that are in close proximity to bighorn areas, especially lambing terrain, should also be incorporated, including:

- Coordination with federal and state wildlife agencies to minimize O/G activity during the lambing season (April - June).
- Gating roads that route through sensitive bighorn areas.
- Placement of tank batteries away from areas with high bighorn use.
- Remote sensor equipment that would reduce daily Lease Operator traffic to pads, especially those adjacent to lambing areas.

- Consolidation of O/G rigs onto “super pads” which could lessen disturbance in more sensitive areas.
- O/G companies working collaboratively to place new pads and roads in areas with less wildlife disturbance rather than strict adherence to particular O/G leases; and sharing existing pads and roads when feasible.
- Prompt reclamation of expired pads and roads, especially those near lambing areas.
- Habitat improvement projects (e.g., prescribed fire of juniper stands) funded by O/G companies (Hurley 1986).

5. ADDITIONAL CONCERNS:

It should be emphasized that throughout North Dakota’s bighorn range, O/G impacts represent just one of several cumulative factors affecting the state’s population. Additional negative influences include fire suppression, forest encroachment, home development, recreational trail construction, disease from domestic sheep and goats, predation, and competition with livestock. An increasing human population in western North Dakota, due in large part to a growing O/G industry, will likely increase disturbance to bighorn sheep further through home construction, increased vehicular traffic, increased recreational activities, increased establishment of “hobby ranches” for recreational purposes, and increased hunting pressure on all western big game species. It remains to be seen if Coalbed Methane Gas exploration, with its intensive footprint, will become as significant in North Dakota as it is in other parts of the West.

Interest in hunting bighorn sheep in North Dakota is astounding when compared to other states. For instance, in 2010 there were 11,417 applicants for just five available lottery licenses, more than Wyoming and Idaho combined. It should be incumbent upon all North Dakotans that the jobs and revenue associated with a growing O/G industry could come with a very high cost – namely, diminished hunting opportunities through the loss of critical habitat that sustains the wildlife populations so highly valued by the state’s citizens.

PRONGHORN

1. CURRENT STATUS:

Pronghorn (*Antilocapra americana*) are native to North Dakota and were first observed during the Lewis & Clark Expedition in 1804 (Knue 1991). Historically, pronghorn were very abundant in North America and occupied all of North Dakota before becoming nearly extirpated by the late 1800s. Unregulated hunting, conversion of native prairie to row crops, and construction of fences by European settlers resulted in only a few hundred pronghorn remaining in the state by 1920. Pronghorn numbers rebounded by the early 1960s after the regulation of hunting and translocation of animals from Montana in the 1950s. Today, pronghorn are primarily distributed across western North Dakota, although small numbers do exist east of the Missouri River. After a series of ten mild winters, pronghorn steadily increased after the devastating winter of 1996-1997 (figure 1).

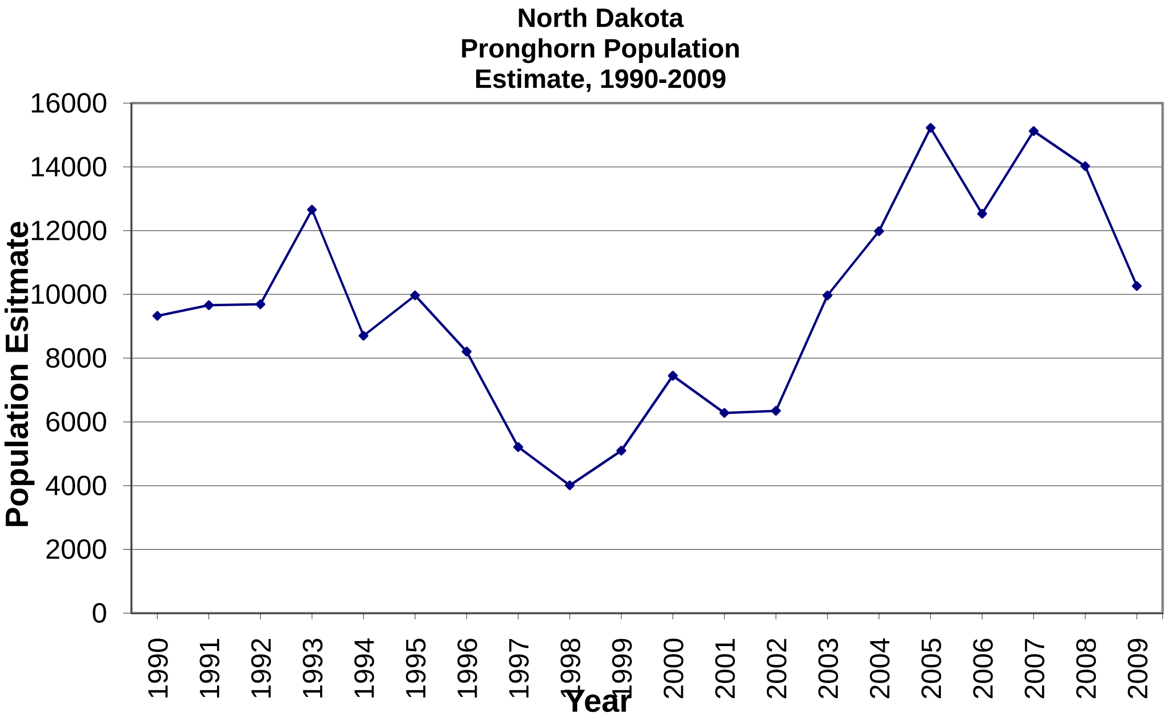


Figure 1. Pronghorn population estimate, 1990 – 2009.

2. HABITAT:

Pronghorn in North Dakota are on the eastern edge of their range and make use of open and arid landscapes in the state. They are associated with sagebrush and grassland communities in the western part of the state and have extremely large home ranges. Doe home ranges averaged 8 mi^2 in the summer and were as large as 34 mi^2, while winter home ranges averaged 17 mi^2 and were as large as 134 mi^2 (Kolar 2009). Pronghorn moved as far 139 miles to summer range and over 150 miles to winter range (Kolar 2009). Pronghorn have proved to be adaptable to the available landscape in the state, by making use of available Conservation Reserve Program grass plantings. Pronghorn are opportunistic foragers that consume forbs, shrubs, and grasses depending on the availability and nutritional status. They also take advantage of non-traditional food sources found in North Dakota such as cereal grains, corn, sunflowers, and alfalfa. Pronghorn have adapted to arid environments by becoming water conservers. They fulfill their water needs through a variety of sources, such a streams, lakes, stock tanks, dug outs, rain, snow, dew, as-well-as water in forage. Cover for pronghorn is provided by either topography or vegetation. Pronghorn utilize leeward sides of hills and buttes to find refuge from high winds and deep snow. Pronghorn will bed beneath trees and tall shrubs during periods of extreme heat. Female pronghorn use shrub and grasslands with vegetative structure that provides concealment for newborn fawns and forage for the doe. Pronghorn range for the purpose of this report (figure2) was determined using North Dakota Game and Fish Department's pronghorn management regions. Figure 3 includes locations of aerial survey locations and radio-collared animals from 2005-2008.

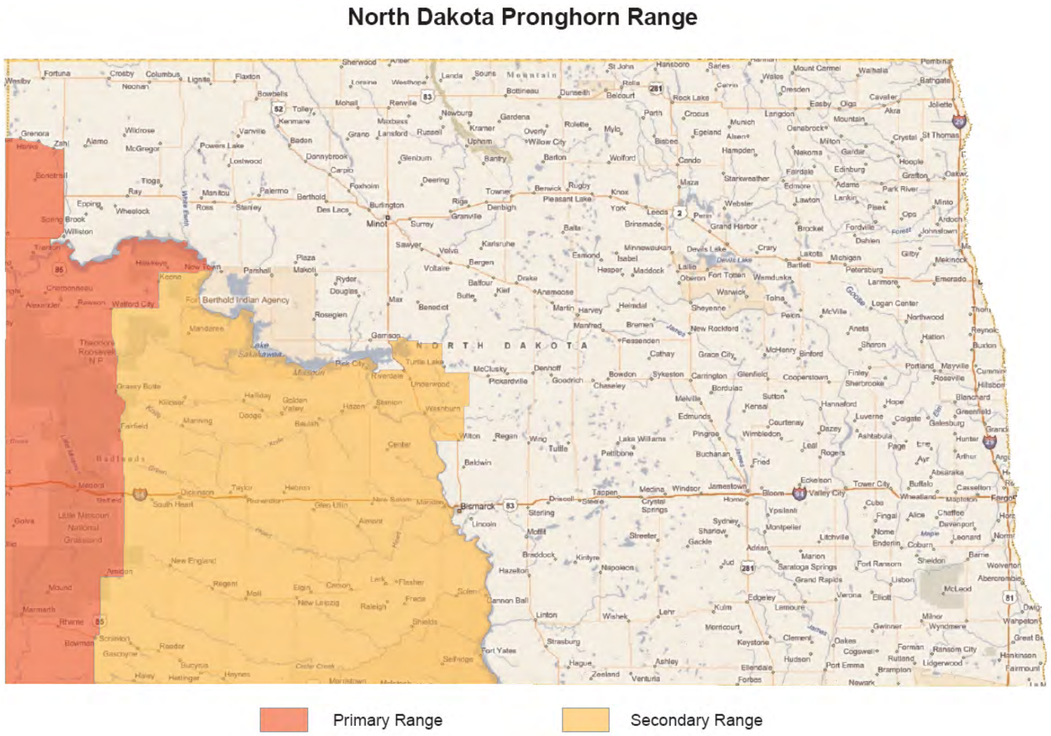


Figure 2. Primary and secondary range in North Dakota.

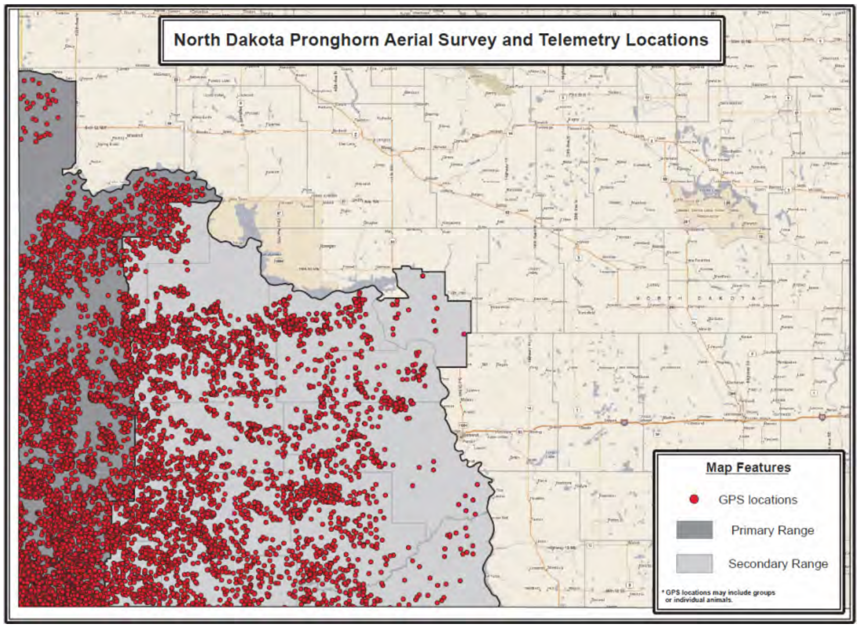


Figure 3. Locations of pronghorn from aerial survey and radio-collared animals, 2005-2008.

3. OIL AND GAS IMPACTS:

Geographic Information System (GIS) technology was used to analyze well and road densities (Figures 4 and 5) throughout North Dakota's primary and secondary pronghorn range using a one square mile scale. The number of wells added per year is also included (Figure 6).

North Dakota is on the eastern edge of pronghorn range, therefore suitable habitat is limiting in the state. Oil and gas development has been increasing in pronghorn range since 1995 (Table 1.). As of May 2010, 6,800 acres of habitat were directly lost due to oil pad construction and 17% of all square mile sections within pronghorn range have oil and gas development. This current level of development appears minor since less than 1% of total acres within pronghorn primary range have directly been lost. It is the cumulative effects (infrastructure, roads, increased vehicular traffic, fragmentation, fences) of oil and gas development that are of concern for reducing suitability of pronghorn habitat. Research suggests roads densities of greater than 2 miles of road/mi^2 begin to greatly reduce effectiveness of habitat for ungulates (Lyon 1983 and Hebblewhite 2008**).** Currently, 34% of North Dakota's primary pronghorn range has a road density of 2-3 miles of road per square mile, while 9% has 3-5 miles of road per square mile. Resource selection of pronghorn in North Dakota was examined between January, 2005 and March 2008. During the summer, pronghorn were twice as likely to use areas that were > 0.6 mi from primary roads, and were 2 times more likely to use areas > 1.9 mi from secondary roads than areas < 0.6 mi of secondary roads (Kolar 2009). Pronghorn avoided secondary roads in the winter and were 7.5 times less likely to select areas within 0.6 mi from secondary roads than they were to select areas beyond 0.6 mi (Kolar 2009). (Gavins and Komers 2006) also found that pronghorn in Alberta spent a higher proportion of time foraging at sites > 1300 ft from roads, suggesting pronghorn perceived roads as sources of increased predation. Easterly et al. (1991) reported lower pronghorn densities closer to energy development in eastern Wyoming. Researchers have reported avoidance distances varying from 0.25 mi (Autenrieth 1983) to 0.6 mi (Easterly et al. 1991) from sources of disturbance.

Based on a radio-telemetry study in the Pinedale Anticline of Western Wyoming, Berger et al. (2006) determined pronghorn avoided denser well fields associated with significant activity. Berger et al.

(2008) reported habitat loss and habitat fragmentation are affecting pronghorn distribution and that development thresholds may being reached in the study area. Pronghorn consistently avoided areas within 100 m of natural gas well pads. Berger et al. (2006) emphasize that a migration route in the Pinedale, Wyoming area likely has been used for over 6,000 years and that migration corridors need to be protected when considering energy development. Based on Wyoming Game and Fish Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats (2010), development impacts within crucial pronghorn winter range were classified as: **moderate impact**: 1-4 well pad locations or up to 20 acres of disturbance per square mile, **high impact**: 5-16 well pad locations per square mile or 20-80 acres of disturbance per square mile, and **extreme impact**: >16 well pad locations or >80 acres of disturbance per square mile. Currently, nearly 20% of the entire primary pronghorn range has oil and gas development and nearly 50% of the development is classified as moderate impact. Department of Mineral Resources is projecting an additional 2,170 and 1,500 wells in the Watford City area and Alexander areas, respectively. This increased level of development will likely result in areas with moderate impacts changing to high and extreme impact levels and greatly reducing effectiveness of habitat for pronghorn in the Northern Badlands.

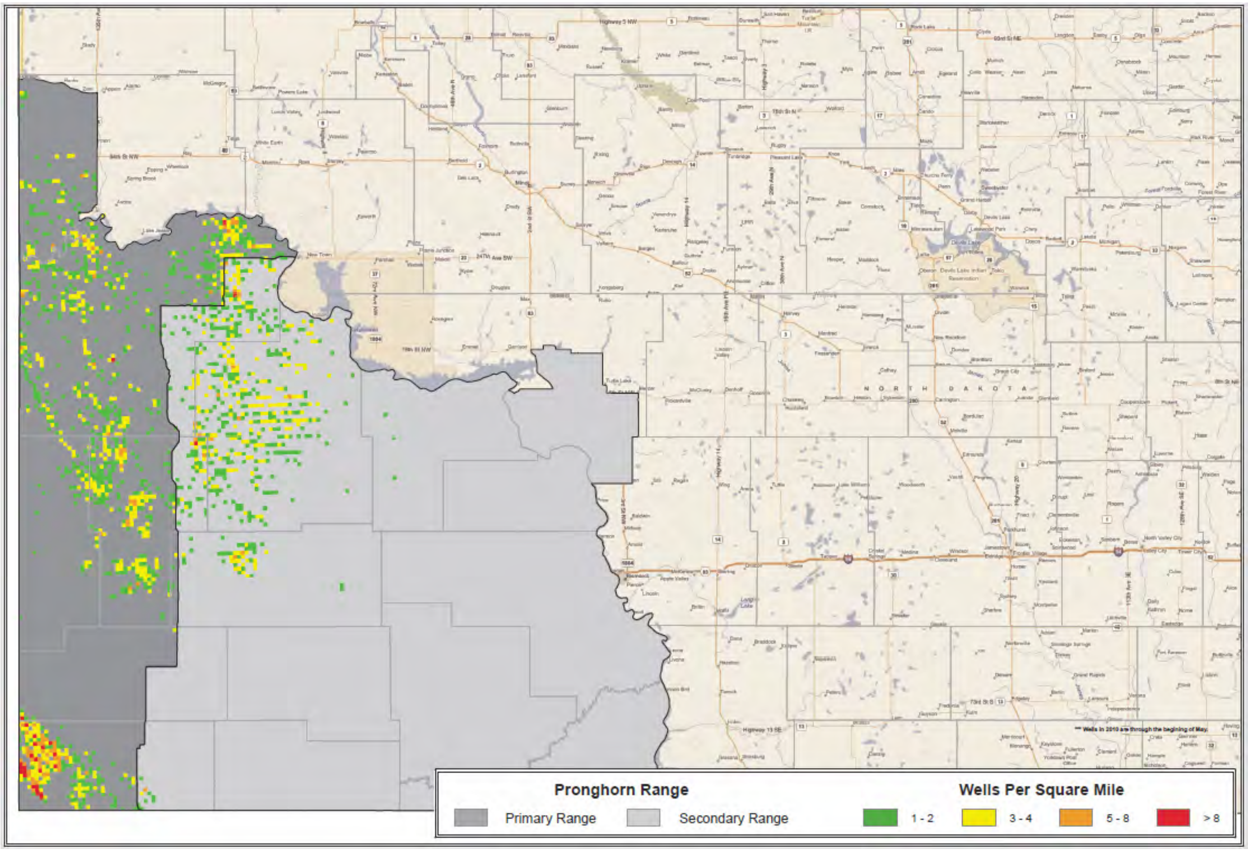


Figure 4. Map of North Dakota summarizing the distribution and density of oil and gas wells within primary and secondary pronghorn range.

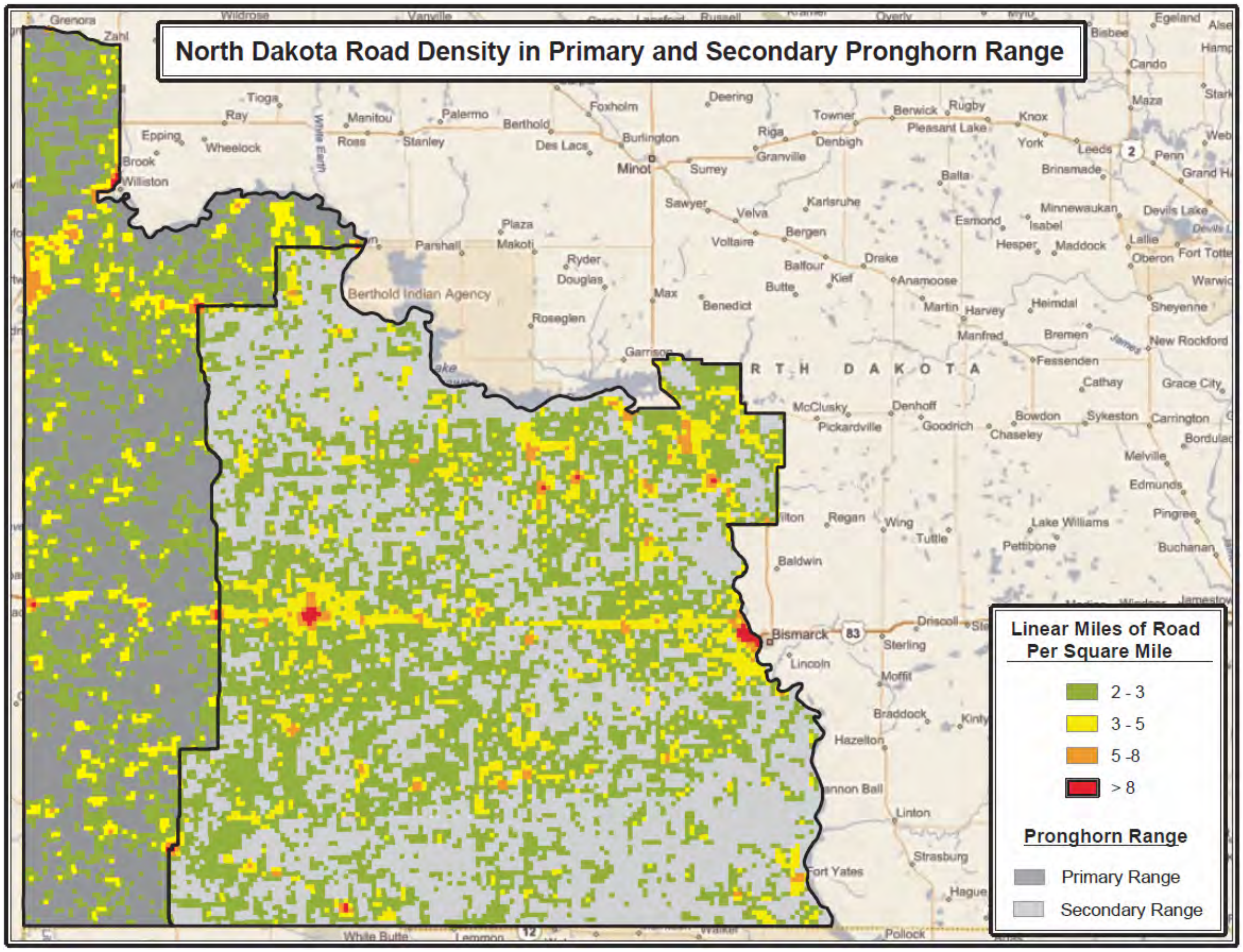


Figure 5. Map of North Dakota summarizing the distribution and density of oil and gas wells within primary and secondary pronghorn range.

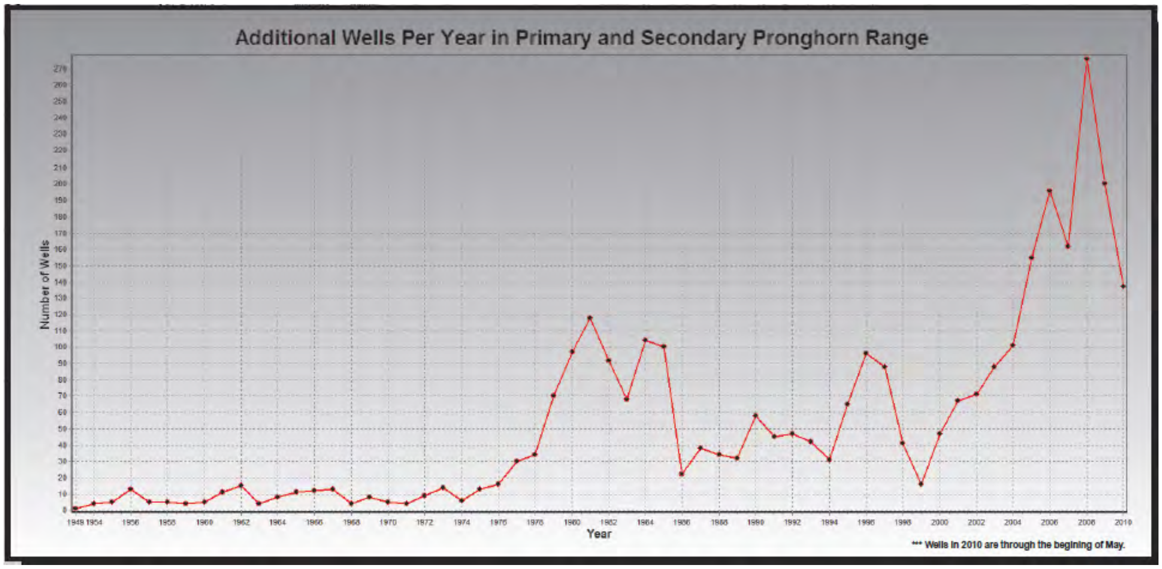
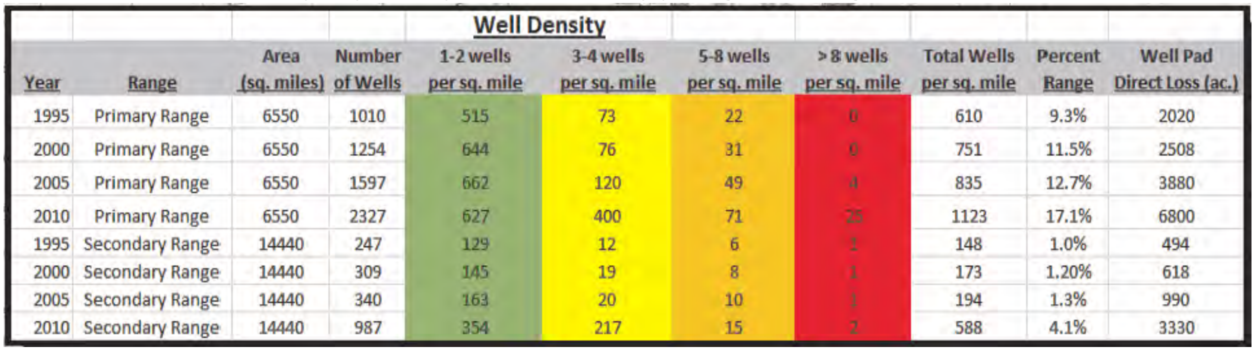


Figure 6. Additional wells per year in primary and secondary pronghorn range, 1949-2010.

Table 1. Oil well density in primary and secondary pronghorn range, 1995-2010.



				Well Density						
Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
1995	Primary Range	6550	1010	515	73	22	0	610	9.3%	2020
2000	Primary Range	6550	1254	644	76	31	0	751	11.5%	2508
2005	Primary Range	6550	1597	662	120	49	4	835	12.7%	3880
2010	Primary Range	6550	2327	627	400	71	25	1123	17.1%	6800
1995	Secondary Range	14440	247	129	12	6	1	148	1.0%	494
2000	Secondary Range	14440	309	145	19	8	1	173	1.20%	618
2005	Secondary Range	14440	340	163	20	10	1	194	1.3%	990
2010	Secondary Range	14440	987	354	217	15	2	588	4.1%	3330

4. MITIGATION:

Since North Dakota is on the eastern fridge of pronghorn range and much of their range in the state has already been impacted by oil and gas development, it will be crucial to minimize additional disturbance from new development. Impacts to pronghorn habitat from future oil and gas development could be reduced by:

1) Conducting thorough pre-drilling impact scoping with federal and state agencies to identify potentially affected habitat type, location of drilling in relation to existing roads and wells, and seasonal importance of area to pronghorn.
2) Coordinating with state and federal wildlife agencies, and other oil companies to ensure timing and location of new drilling is in areas least detrimental to pronghorn and other wildlife.
3) To the extent technologically practicable, locating well pads, facilities and roads in clustered configurations within the least sensitive habitats. When several companies have intermingled leases, the cumulative effect could be reduced substantially if companies entered into an agreement to drill multiple wells from the same pad.
4) Using existing roads and coordinating road construction and use among companies operating in the same oil and gas field.
5) Piping (rather than trucking) liquids offsite, or enlarging storage tank capacity to minimize truck trips and eliminate trips during sensitive times of year to substantially lessen disturbances to wildlife. Sawyer et al. (2009) reported that indirect habitat loss may be reduced by approximately 38-63% when liquids are collected in pipelines rather than stored at well pads and hauled off with tanker trucks.
6) Installing, (to the extent technologically feasible) telemetry to remotely monitor instrumentation and reduce or eliminate travel required to manually inspect and read instruments.

For additional mitigation options see Wyoming Game and Fish Department (2010) report: “Recommendations for Development of Oil and Gas Resources with Important Wildlife Habitats (Version 5.0, pages 29-30 and Appendix A)”. This is a “living” 255 page document that is updated on a regular basis (three updates since August 2009).

5. ADDITIONAL CONCERNS:

Pronghorn are a unique, western big game species valued by the residents of North Dakota. Each year, over 10,000 North Dakotans apply for licenses to hunt pronghorn with a gun. Currently, with such a limited pronghorn resource and high license demand, it takes a resident between 2-7 years to draw an “any pronghorn” hunting license. It should be incumbent upon all North Dakotans that the jobs and revenue associated with the O/G industry could come with a very high cost, namely, diminished hunting opportunities through the loss of critical habitat that sustains the wildlife populations which are so highly valued by the state’s citizens. A disproportionate amount of oil development occurs on public land and increased development will further degrade habitat quality and reduce quality of outdoor experiences on these lands. The projected level of additional development and associated effects to the habitat makes it is highly unlikely that current population levels could be sustained in the future.

ELK

1. CURRENT STATUS:

Two populations of elk occupy western North Dakota. The first is located in the Killdeer Mountain area and has shown an increasing population trend since 2002. The second originates in the South Unit of Theodore Roosevelt National Park (SUTRNP) and is currently estimated near 1,000 animals. Elk move outside of the park, which provide hunting opportunities for North Dakota residents. Currently, 400 licenses are available for hunting units surrounding SUTRNP.

2. HABITAT:

The distribution of elk in the western portion of the state is included within mule deer range (figure 1.). The majority of western North Dakota's habitat is unsuitable due to high road densities (figure 2.) and lack of sufficient amount of continuous security cover. Therefore, elk reside in the remaining larger blocks of undisturbed woodland habitat and take advantage of nontraditional food sources, such as corn and oats.

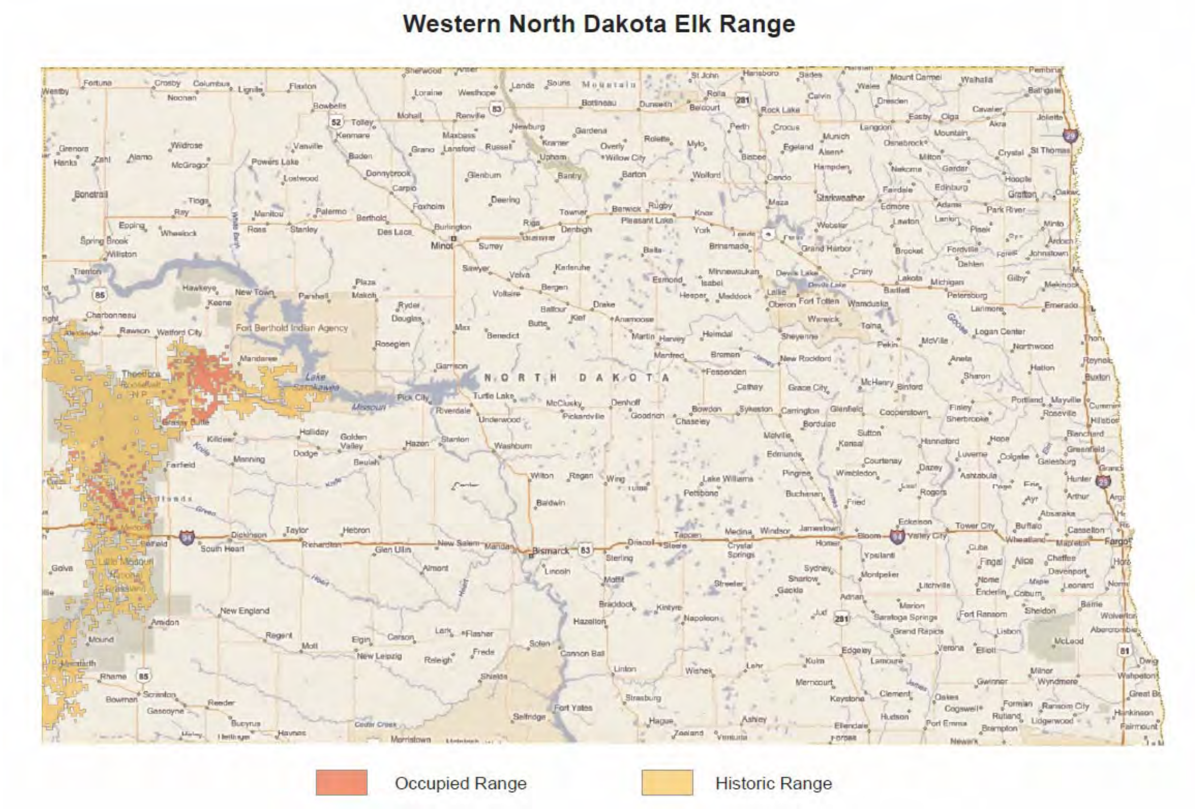


Figure 1. Distribution of elk in the western portion of North Dakota.

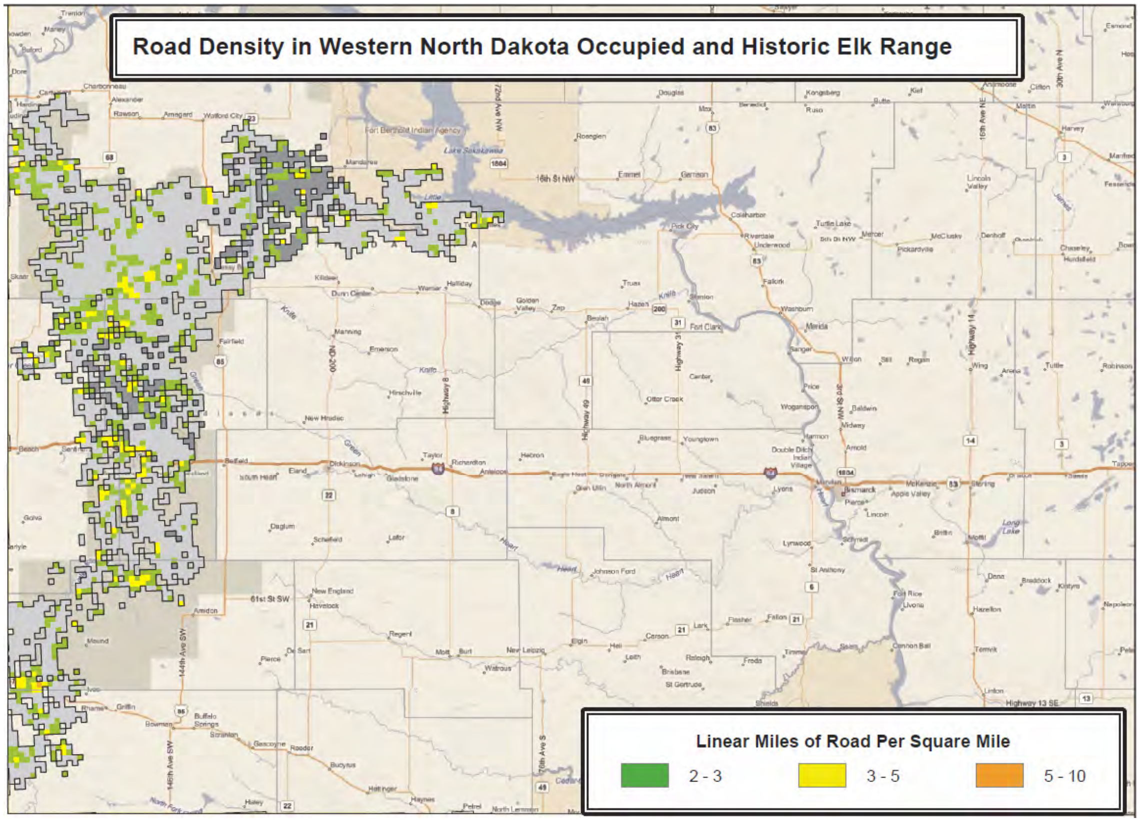


Figure 2. Road density in western North Dakota.

3. OIL AND GAS IMPACTS:

Hunted populations of elk have shown to be very sensitive to human disturbances (Lyon 1983and Hebblewhite 2008**).** (Hayden-Wing 1990) summarized results from 11 years of aerial survey monitoring on two elk ranges that were developed for oil/gas wells. Elk avoided areas during the construction phase on both the winter and calving ranges, but reoccupied these areas after intense construction ended. Elk avoided roads, active gas and oil well sites during summer months in the sage-stepped ecosystem of the Jack MarrowHills, WY (Powell 2003), strongly selecting habitats greater than 6,562 ft from these features. Avoidance of roads and well sites declined in the fall, winter, and spring when elk only avoided areas <500 m surrounding human development. During calving (15 May-30 June), elk avoided areas < 1,640 ft from roads and well sites.

Considerable research has been done that examines effects of roads and logging on elk distribution in the western United States. Impacts of vehicular-traffic on newly established roads are likely similar whether road was constructed for oil/gas or logging. Elk avoided areas with 2,461 ft of roads and 3,281-4,921 ft of active logging operations. Elk even avoided preferred foraging areas within 1,640 ft of active logging operations and human activity of all types. In general, Edge (1982) concluded elk avoided a minimum of 500 m buffer from logging activity. Lyon (1983) developed a model for habitat effectiveness as a function of road density. Declines in habitat effectiveness were non-linear, as much of the loss of habitat effectiveness occurred in the first 2.5mi/mi^2 of increasing road densities.

Elk can be very destructive to agricultural crops and fences, therefore tolerance of elk from ranchers is lower than for other wildlife. Increased vehicular disturbance from roads established from new oil and gas development may lessen effectiveness of remaining undisturbed blocks of woodland habitats that serve as elk security cover. Department of Mineral Resources is projecting an additional 2,320 wells in the Killdeer area. Currently, new oil and gas development is occurring within prime elk habitat that contains large blocks of undisturbed woodland habitat. Decreased amounts of security cover may cause elk to reduce the amount of use in these areas and increase use in areas that lead to more conflicts between elk and ranchers.

4. MITIGATION:

Mitigation recommendations are similar for elk as for pronghorn and mule deer. Impacts to elk habitat from future oil and gas development could be reduced by:

1) Conducting thorough pre-drilling impact scoping with federal and state agencies to identify potentially affected habitat type, location of drilling in relation to existing roads and wells, and seasonal importance of area to elk.
2) Coordinating with state and federal wildlife agencies, and other oil companies to ensure timing and location of new drilling is in location least detrimental to elk and other wildlife.
3) To the extent technologically practicable, locating well pads, facilities and roads in clustered configurations within the least sensitive habitats. When several companies have intermingled leases, the cumulative effect could be reduced substantially if companies entered into an agreement to drill multiple wells from the same pad.
4) Using existing roads and coordinating road construction and use among companies operating in the same oil and gas field.
5) Piping (rather than trucking) liquids offsite, or enlarging storage tank capacity to minimize truck trips and eliminate trips during sensitive times of year to substantially lessen disturbances to wildlife. Sawyer et al. (2009) reported that indirect habitat loss may be reduced by approximately 38-63% when liquids are collected in pipelines rather than stored at well pads and hauled off with tanker trucks.
6) Installing, (to the extent technologically feasible) telemetry to remotely monitor instrumentation and reduce or eliminate travel required to manually inspect and read instruments.

For additional mitigation options see Wyoming Game and Fish Department (2010) report: "Recommendations for Development of Oil and Gas Resources with Important Wildlife Habitats (Version 5.0, pages 29-30 and Appendix A)". This is a "living" 255 page document that is updated on a regular basis (three updates since August 2009).

5. ADDITIONAL CONCERNS:

Elk are a valued big game species by the residents of North Dakota. Each year, over 10,000 North Dakotans apply for a once-in-a-lifetime license to hunt elk with a gun. It should be incumbent upon all North Dakotans that the jobs and revenue associated with the O/G industry could come with a very high cost, namely, diminished hunting opportunities through the loss of critical habitat that sustains the wildlife populations which are so highly valued by the state's citizens. A disproportionate amount of oil development occurs on public land and increased development will further degrade habitat quality and reduce quality of outdoor experiences on these lands. The projected level of additional development and associated effects to the habitat makes it is highly unlikely that current population levels could be sustained in the future.

MOUNTAIN LION

1. CURRENT STATUS:

Currently, a small, relatively isolated population of mountain lions (*Puma concolor*) occurs in the Badlands region of western North Dakota (Fecske et al. 2008, Hornocker and Negri 2010). Occasionally, individual mountain lions are documented in other parts of the state (Figure 1). Outside of North Dakota, the closest breeding populations of mountain lions occur in the Black Hills, South Dakota, Bighorn Mountains, Montana, and southern Saskatchewan.

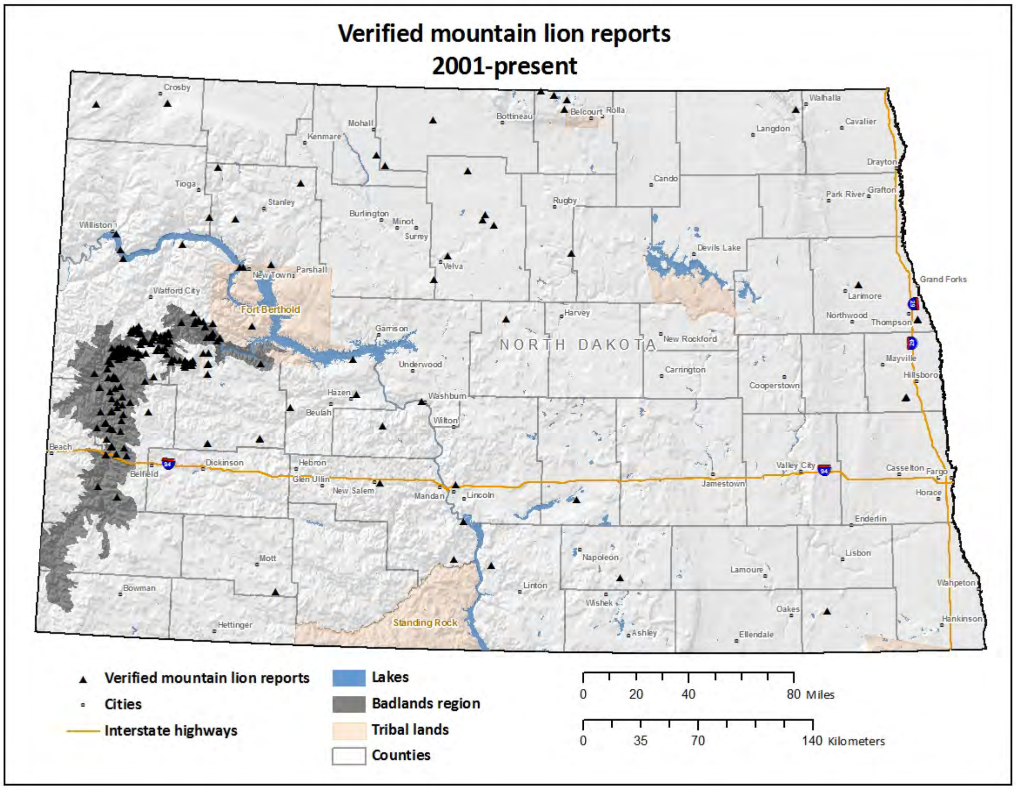


Figure 1. Verified reports of mountain lion occurrence (e.g. harvest locations, photographs, sign, etc.) in North Dakota, 2001 to present.

Historically, mountain lions once ranged over most of North Dakota, although they were considered scarce in most of the state except for the Badlands region (Bailey 1926). Records indicate mountain lions disappeared from North Dakota in the early-1900s (Bailey, Bell, and Brannon [1914] *in* Young and Goldman [1946]) with the last confirmed record of a mountain lion being harvested in 1902 (Bailey 1926). The reduction of mountain lions to undetectable numbers in North Dakota is attributed to unregulated harvest (Nowak 1976). According to Seabloom et al. (1980), there were 10 reports of mountain lions in southwestern North Dakota between 1958 and 1980. By the early-2000s, the number of reports of mountain lion occurrences documented by the North Dakota Game and Fish Department had increased such that it became apparent there was a continued presence of breeding mountain lions in western North Dakota (Fecske et al. 2008, NDGFD 2006, NDGFD 2007). Therefore, it appears that it took nearly a century of protection for the mountain lion population in North Dakota to recover to easily detectable levels.

2. HABITAT:

The key habitat component for mountain lions is stalking cover, which may be available in the form of rugged terrain or vegetation (Figures 2-3; NDGFD 2006, Currier 1983, Sunquist and Sunquist 2002, Wilson and Ruff 1999). A habitat suitability map created by the NDGFD (2006) identified the Badlands, associated Missouri River Breaklands, and Killdeer Mountains as having sufficient amounts of suitable habitat to support a small resident population of mountain lions (Figure 4). The Badlands are characterized by a variable landscape of clay slopes, steep canyons, buttes and bottomlands. Although not forested, the region is vegetated (primarily on north and east facing slopes) with thickets of small trees and shrubs, woody draws of cottonwood and green ash, and scattered stands of Rocky Mountain Juniper and ponderosa pine (Hagen et al. 2005). Bisecting the Badlands is the Little Missouri River which originates in eastern Wyoming, flows north through the Badlands and drains into Lake Sakakawea of the Missouri River. To the north of the Badlands is the Northern portion of the Missouri River Breaklands, which also has a steep, dissected topography. Uplands in this region are vegetated with shortgrass prairie and contain woody draws and riparian cottonwood forests. The Killdeer Mountains are an elevated region rising 700-1000 feet above the surrounding prairie, located east of, and adjacent to, the Badlands, in northwestern Dunn County. The mountains are vegetated by deciduous woodlands of burr oak, quaking aspen, green ash, paper birch, western black birch and American elm (Hagen et al. 2005). The most suitable areas of habitat for mountain lions comprise approximately 6% of the area in North Dakota (Figure 4).

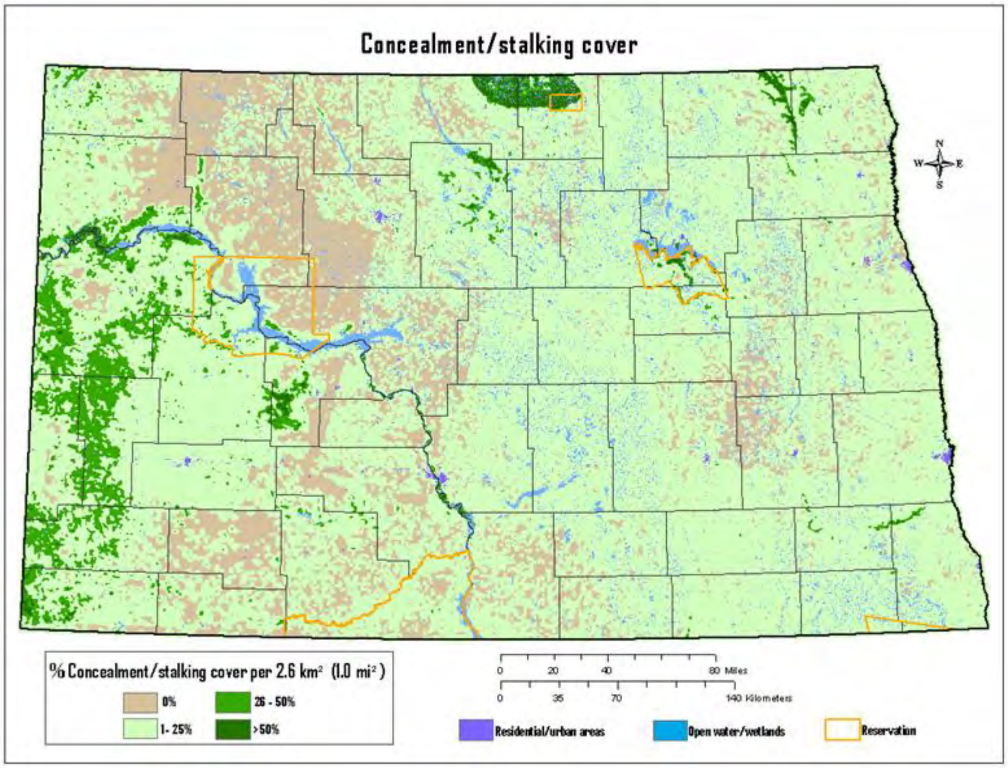


Figure 2. Available concealment or stalking cover, provided by trees and shrubs, for mountain lions in North Dakota (NDGFD 2006).

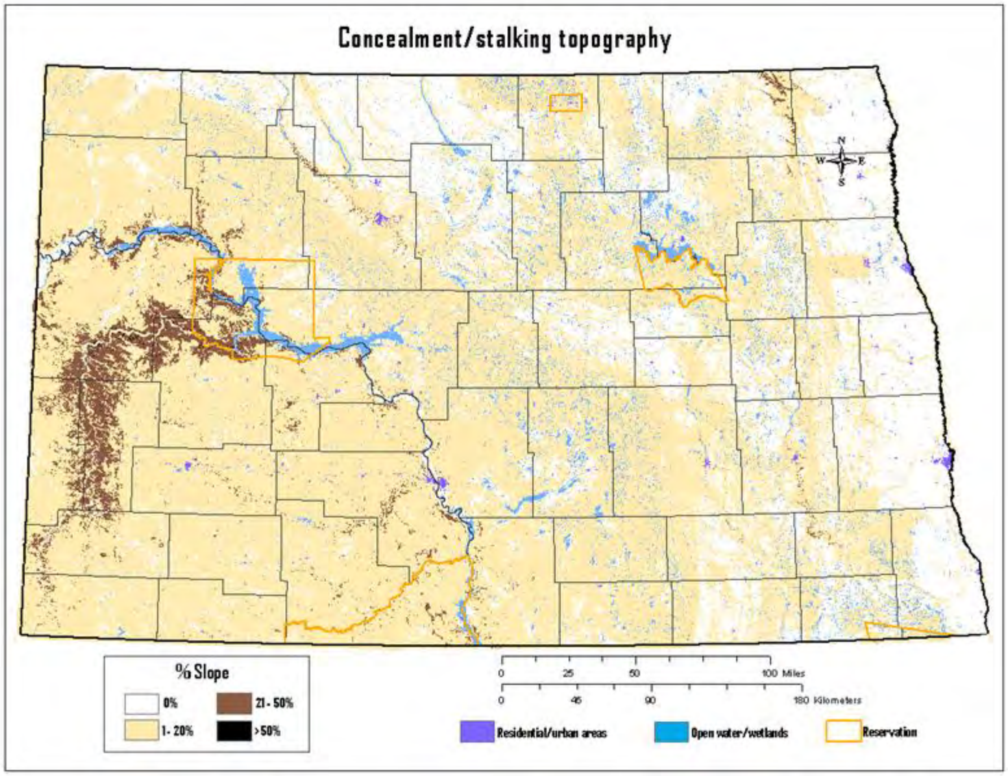


Figure 3. Available concealment or stalking cover, provided by rugged topography, for mountain lions in North Dakota (NDGFD 2006).

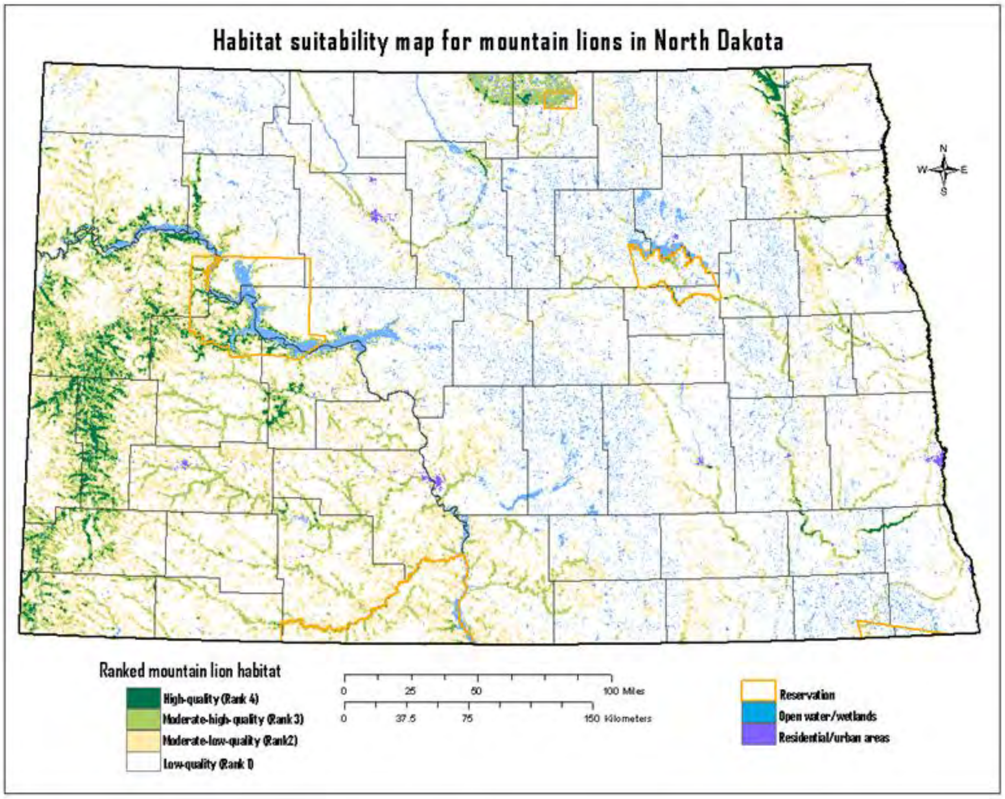


Figure 4. Habitat suitability map for mountain lions in North Dakota (NDGFD 2006).

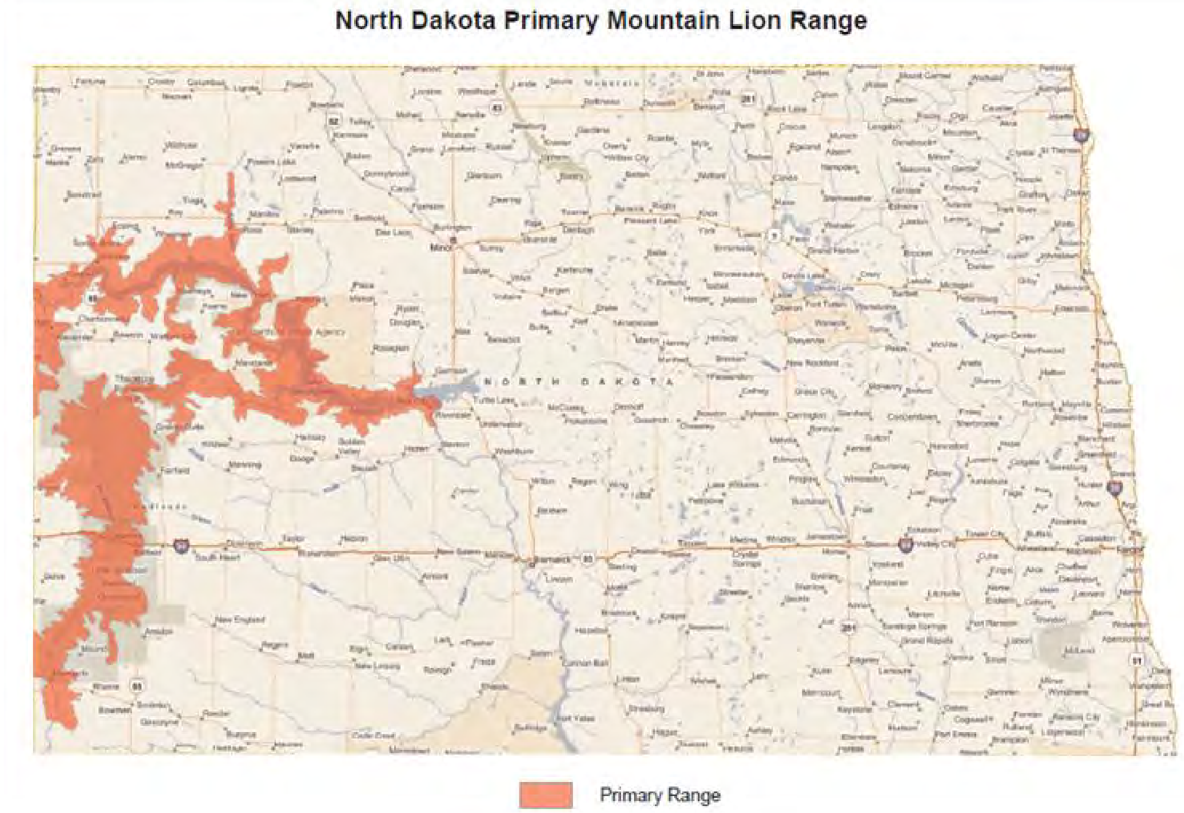


Figure 5. Primary range of mountain lions in North Dakota as designated by verified occurrences and suitable habitat (NDGFD 2006).

3. OIL AND GAS IMPACTS:

To date, no research has been conducted to examine either the direct or indirect effects of oil and gas development or activities on mountain lion populations. However, it is reasonable to assume that impacts from oil and gas development on mountain lion populations may include:

1. *Habitat loss*. Development of well pads and roads may lead to direct loss of concealment and stalking habitat available for mountain lions. Mountain lions have characteristics which make them vulnerable to large amounts of habitat loss resulting in landscape change, including large home ranges, long life-spans, and low reproductive rates (Sunquist and Sunquist 2001).
2. *Habitat fragmentation*. Development of well pads and roads may fragment concealment and stalking habitat, as well as travel corridors, for mountain lions. Crooks (2002) illustrated the sensitivity of mountain lions to habitat fragmentation where greater amounts of fragmentation were correlated with fewer mountain lions.
3. *Vehicle-related mortalities*. Increased road densities and traffic due to development, maintenance, and resource hauling may increase the number of vehicle-mountain lion collisions. Not only will mountain lions cross roads frequently because of their highly mobile nature, they are also known to travel along trails and roads if available, likely due to the ease of travel when going from one place to another (Dickson et al. 2005). Several studies have determined that vehicle collisions were a principal mortality factor for mountain lions (Beier and Barrett 1993, Currier 1983, Maehr 1997). Additionally, mountain lions are most active during crepuscular and

nighttime hours (Logan and Sweanor 2001). Traffic from oil and gas activities continues throughout all hours of the day.

4. *Disturbance*. Increased noise and activity during critical times such as kitten-rearing and feeding may have negative effects on population recruitment and health of mountain lions. It is possible that mountain lions may abandon denning areas or feeding sites due to high levels of disturbance.
5. *Reduced prey numbers*. Negative impacts of oil and gas development on primary prey of mountain lions, such as mule deer, white-tailed deer, bighorn sheep, and elk, may result in fewer food resources for mountain lions. Due to differing life history traits, it is likely that populations of prey species will suffer from negative impacts of oil and gas development and activities before mountain lions. The consequences from loss of prey would surely have damaging implications higher up the food chain.
6. *Increased mountain lion-human interactions.* Increased human activity in primary mountain lion habitat may result in increased mountain lion-human interactions. This may result not only from the sheer number of workers associated with oil and gas activities, but also the increased accessibility for recreationists to remote areas where there are mountain lions.

Currently, 17.6% of the primary range of mountain lions in North Dakota is occupied by oil well pads (Figure 6). As Figure 7 illustrates, the road density within the primary range of mountain lions is already alarming. There is a potential for 16,050 wells to be added over the next 10 years, with at least 50% of these are likely to occur in the primary range of mountain lions. Therefore, the reasonable next question is not whether mountain lions will be negatively affected by oil and gas development, but to what degree they will be affected and which of the above mechanisms will be the most important ones to mitigate?

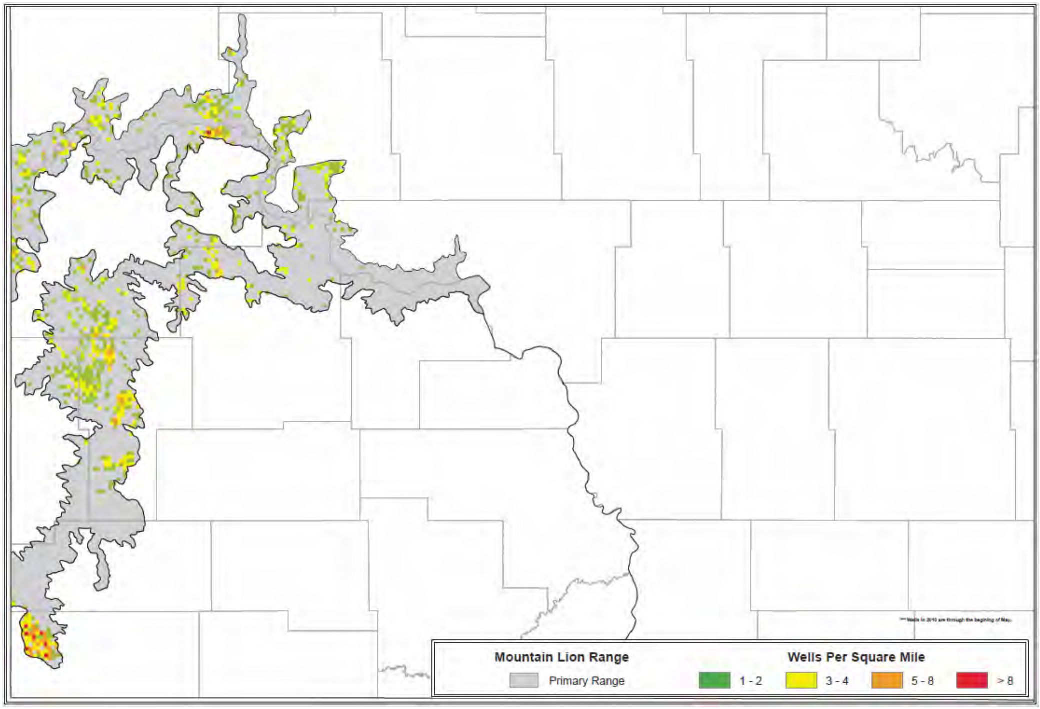


Figure 6. Density of wells within the primary range of mountain lions in North Dakota.

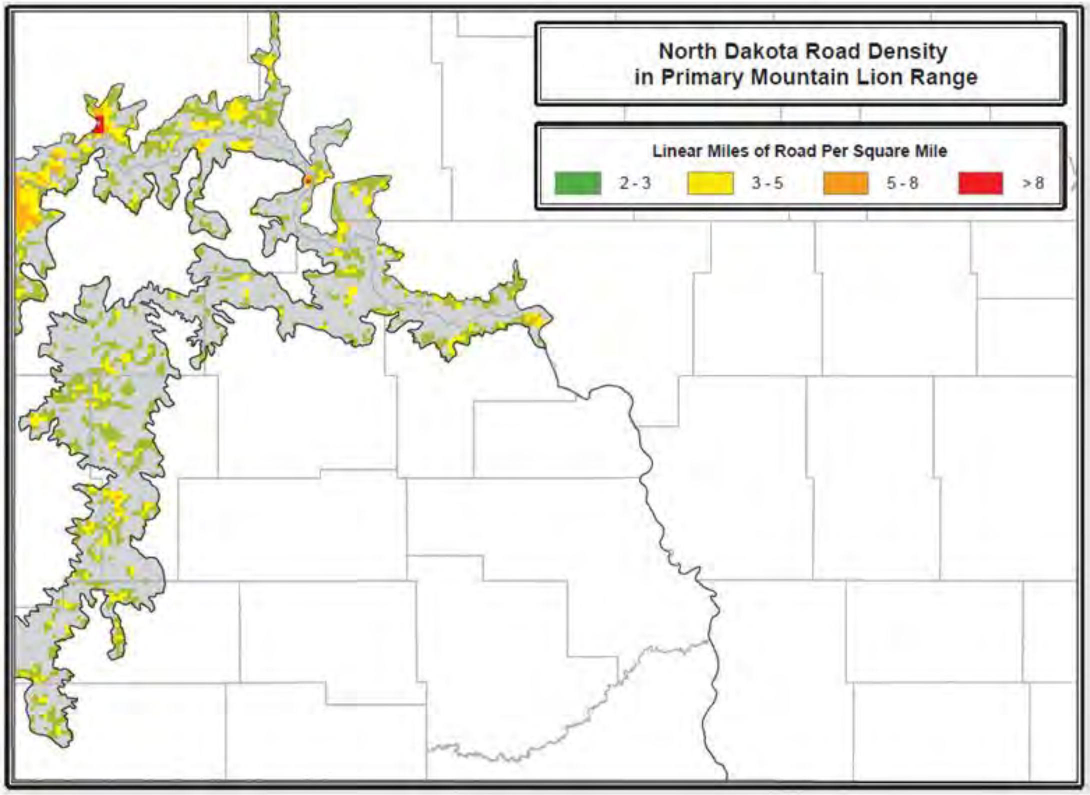


Figure 7. Density of roads within the primary range of mountain lions in North Dakota.

4. MITIGATION:

Primary mitigation efforts should be such that they reduce the loss of concealment or stalking cover for mountain lions. Roads and well pads should be placed in areas of flat or gradual topography where removal of brush and tree cover is not necessary. Also, a reduction in the overall loss of habitat could be accomplished by placing multiple wells on a single well pad, which would also result in fewer necessary roads.

Direct mortality due to vehicle collisions, as well as indirect disturbances from road traffic, on mountain lions should be minimized. The chances of vehicle-mountain lion collisions are high due to travel tendencies of the species and round-the-clock oil and gas activities. The likelihood of a vehicle-mountain lion collision may be lessened by limiting oil and gas activities that require vehicle travel to daylight hours.

Implementation of mitigation strategies that benefit prey species, such as mule deer, would also benefit mountain lions. Greater availability and diversity of food resources for mountain lions would contribute to good population health.

5. ADDITIONAL CONCERNS:

Throughout the species range, including North Dakota, it is likely not a coincidence that mountain lions have persisted and re-established in areas with remote, rugged habitats and low amounts of human disturbance. Currier (1983) described mountain lion distribution as being limited by human interference, lack of prey, and lack of stalking cover. Oil and gas development and activities have the potential to stimulate all 3 of these limiting factors via the potential impacts listed previously. Even in highly suitable habitat, mountain lions are wide-roaming, territorial predators resulting in low densities compared to their prey species and smaller predators. Therefore, it does not take many or frequent negative impacts to have significant and long-lasting harmful effects on the mountain lion population in North Dakota. Currently, North Dakota sportsmen enjoy a limited harvest season on mountain lions; this privilege may quickly disappear if additive mortality occurs due to oil and gas development and activities.

BOBCAT

1. CURRENT STATUS:

Currently, most verified reports of bobcats (*Lynx rufus*) that we have documented occur south and west of the Missouri River in North Dakota (Tucker 2010). Only occasionally, we have confirmed the occurrence of bobcats north and east of the Missouri River (Figure 1). However, we have confirmed the presence of a seemingly small breeding population of bobcats in northeastern North Dakota in the Pembina Gorge region.

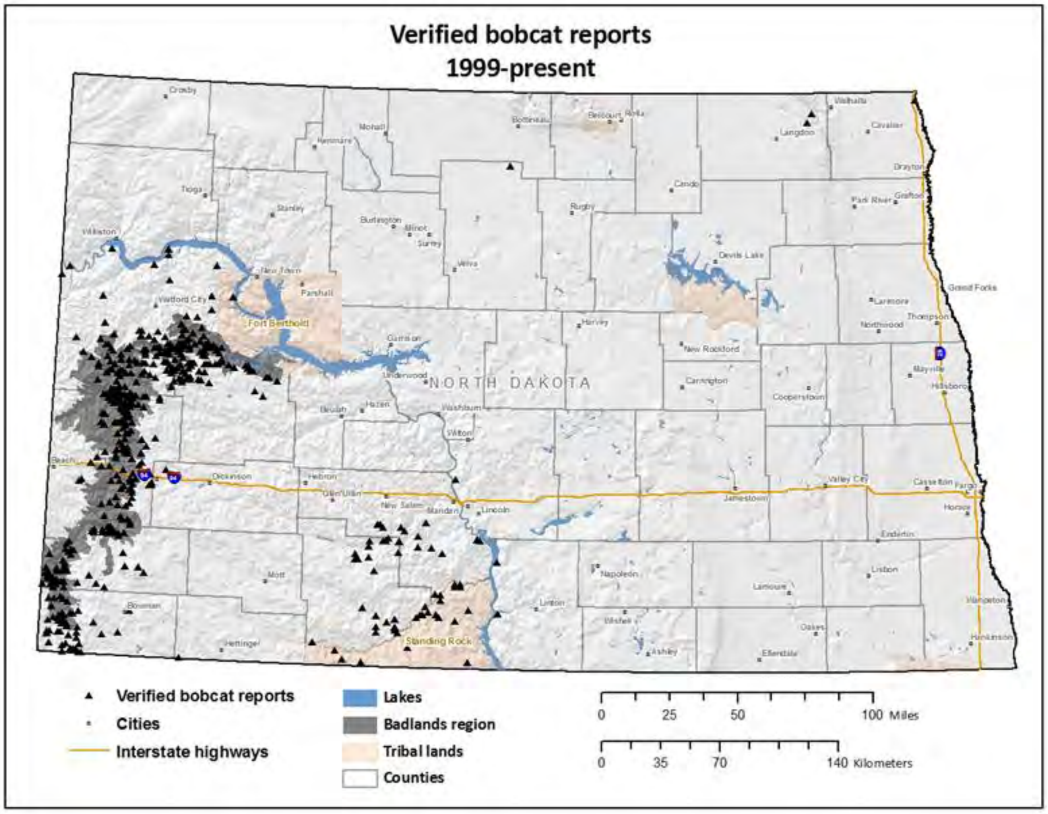


Figure 1. Verified reports of bobcat occurrence (e.g. harvest locations, photographs, sign, etc.) in North Dakota, 1999 to present.

Historically, bobcats were found in the counties adjoining the Missouri, Little Missouri, Heart, and Cannonball Rivers, similar to present day (Adams 1961). According to Bailey (1926), bobcats were always scarce in eastern North Dakota.

2. HABITAT:

Bobcats are known to use a wide variety of habitats, including forests, grasslands, brushlands, and swamps (Sunquist and Sunquist 2002). Similar to their larger felid cousin, the mountain lion, bobcats are stalk and ambush predators (Lariviere and Walton 1997). Therefore, the primary component of these habitats is their concealment and stalking cover, with a likely secondary need being protection from extreme weather (Sunquist and Sunquist 2002).

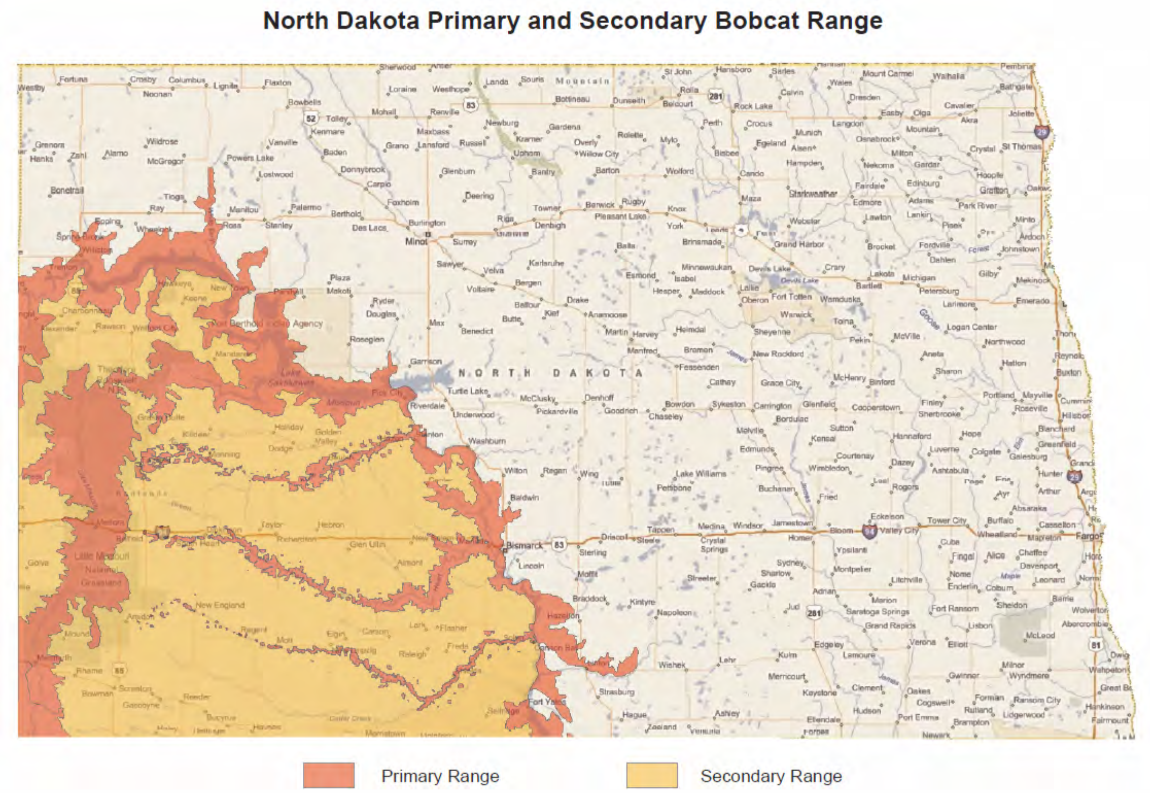


Figure 2. Primary range of bobcats in North Dakota as designated by verified occurrences and suitable habitat.

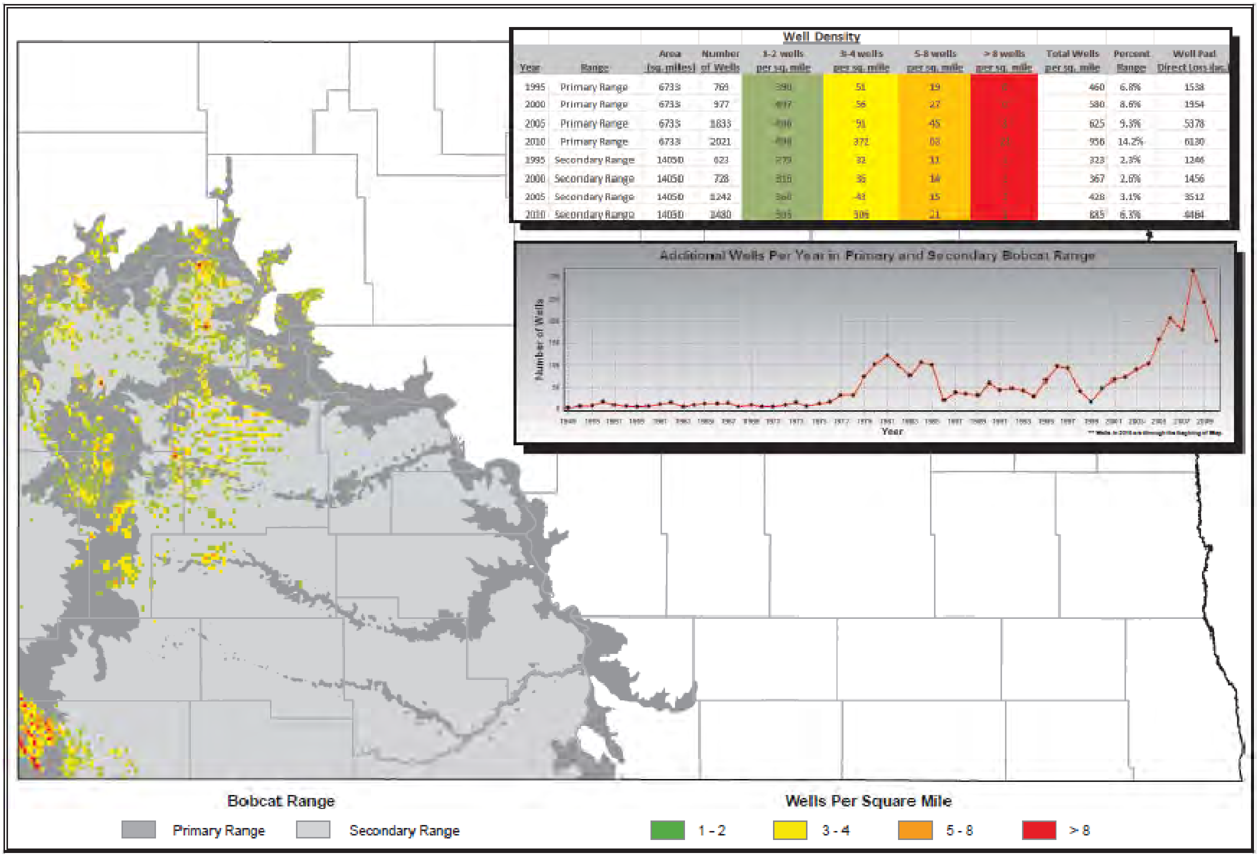
3. OIL AND GAS IMPACTS:

To date, no research has been conducted to examine either the direct or indirect effects of oil and gas development on bobcat populations. However, it is reasonable to assume that impacts from oil and gas development may include

1. *Habitat loss*. Development of well pads and roads may lead to direct loss of concealment and stalking habitat available for bobcats. Bobcats have characteristics which make them vulnerable to large amounts of habitat loss resulting in landscape change, including large home ranges, long life-spans, and low reproductive rates (Sunquist and Sunquist 2001).
2. *Habitat fragmentation*. Development of well pads and roads may fragment concealment and stalking habitat, as well as travel corridors, for bobcats. Crooks (2002) illustrated the sensitivity of bobcats to habitat fragmentation where greater amounts of fragmentation were correlated with fewer bobcats.
3. *Vehicle-related mortalities*. Increased road densities and traffic due to development, maintenance, and resource hauling may increase the number of vehicle-bobcat collisions. Not only will bobcats cross roads frequently because of their highly mobile nature, they are also known to travel along trails and roads if available, likely due to the ease of travel when going from one place to another. Additionally, bobcats are most active during crepuscular and nighttime hours (Lariviere and Walton 1997, Miller and Speake 1979). Traffic from oil and gas activities continues throughout all hours of the day.

4. *Disturbance*. Increased noise and activity during critical times such as kitten-rearing and feeding may have negative effects on population recruitment and health of bobcats. It is possible that bobcats may abandon denning areas or feeding sites due to high levels of disturbance.
5. *Accessibility*. Increase road densities may result in increased mortality due to greater accessibility by hunters and trappers (Lovallo and Anderson 1996). Bobcats are not an overly difficult animal to trap. Therefore, if harvesters are more easily able to access remote areas of bobcat habitat, they may be able to have a significant negative effect on the population sustainability.

Currently, 10% of the primary range of bobcats in North Dakota is occupied by oil well pads (Figure 3). There is a potential for 16,050 wells to be added over the next 10 years, with at least 50% of these are likely to occur in the primary range of bobcats. Therefore, the reasonable next question is not whether bobcats will be negatively affected by oil and gas development, but to what degree they will be affected and which of the above mechanisms will be the most important ones to mitigate?



Well Density

Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.
1995	Primary Range	6733	769	390	51	19	0	460	6.8%	1538
2000	Primary Range	6733	977	497	56	27	0	580	8.6%	1954
2005	Primary Range	6733	1833	486	91	45	3	625	9.3%	5378
2010	Primary Range	6733	2021	498	372	63	21	956	14.2%	6130
1995	Secondary Range	14050	623	279	32	11	1	323	2.3%	1246
2000	Secondary Range	14050	728	316	36	14	1	367	2.6%	1456
2005	Secondary Range	14050	1242	368	43	15	1	428	3.1%	3512
2010	Secondary Range	14050	2430	305	306	21	[illegible]	635	6.3%	4484

Figure 3. Density of wells within the primary and secondary range of bobcats in North Dakota.

4. MITIGATION:

Primary mitigation efforts should be such that they reduce the loss of concealment or stalking cover for bobcats. Roads and well pads should be placed in areas of flat or gradual topography where removal brush and tree cover is not necessary. Also, a reduction in the overall loss of habitat could be accomplished by placing multiple wells on a single well pad, which would also result in fewer necessary roads.

Direct mortality due to vehicle collisions, as well as indirect disturbances from road traffic, on bobcats should be minimized. The chances of vehicle-bobcat collisions are high due to travel tendencies of the species and round-the-clock oil and gas activities. The likelihood of a vehicle-bobcat collision may be lessened by limiting oil and gas activities that require vehicle travel to daylight hours. Unnecessary roads and roads no longer needed should be reclaimed without delay to reduce the length of impact these structures may have on bobcats. Additionally, road access should be limited such that greater accessibility for harvesters to bobcats does not begin to negatively impact the bobcat population.

5. ADDITIONAL CONCERNS:

Bobcats are a medium carnivore, with relatively large home ranges and low reproductive outputs. If a decline in the bobcat numbers results due to negative impacts of oil and gas development and activities, sportsmen would quickly lose some of their harvest privileges for bobcats. Limitations to harvest would need to be implemented to offset the mortality that may occur.

GREATER SAGE GROUSE

1. CURRENT STATUS:

Sage grouse (*Centrocercus urophasianus*) are the largest member of the North American grouse family and second only to wild turkey in size of all the gallinaceous birds in America. In pioneer times this grouse was the leading upland game bird in nine western states. The species was never widespread in North Dakota and is presently confined to the southwestern portion of the state. The North Dakota population is not isolated but is contiguous with sage-grouse populations in Montana and South Dakota. Sage-grouse are at the present time limited to southwestern North Dakota where scattered populations are found in three counties; Bowman, Slope, and Golden Valley. Currently, greater sage-grouse are found in Washington, Oregon, Idaho, Montana, North Dakota, eastern California, Nevada, Utah, western Colorado, South Dakota and Wyoming and the Canadian provinces of Alberta and Saskatchewan and occupy approximately 56 percent of their historical range.

After a thorough analysis of the best available scientific information, the Fish and Wildlife Service has concluded that the greater sage-grouse warrants protection across its entire range under the Endangered Species Act. This decision was made following a remand in December 2007 of the 2005 not warranted decision. However, the Service has determined that protection is precluded by the need to take action on other species facing more immediate and severe extinction threats.

As a result, the greater sage-grouse will be placed on the list of species that are candidates for Endangered Species Act Protection. This decision was based on evidence that habitat fragmentation and destruction across much of the species' range has contributed to significant population declines over the past century. North Dakota's sage grouse population has declined precipitously over the last 30 years. In 2010 only 66 male sage grouse were counted on 15 active leks down 78% from 1980 (Figure 1). If current trends persist, many local populations may disappear in the next several decades, with the remaining fragmented population vulnerable to extinction.

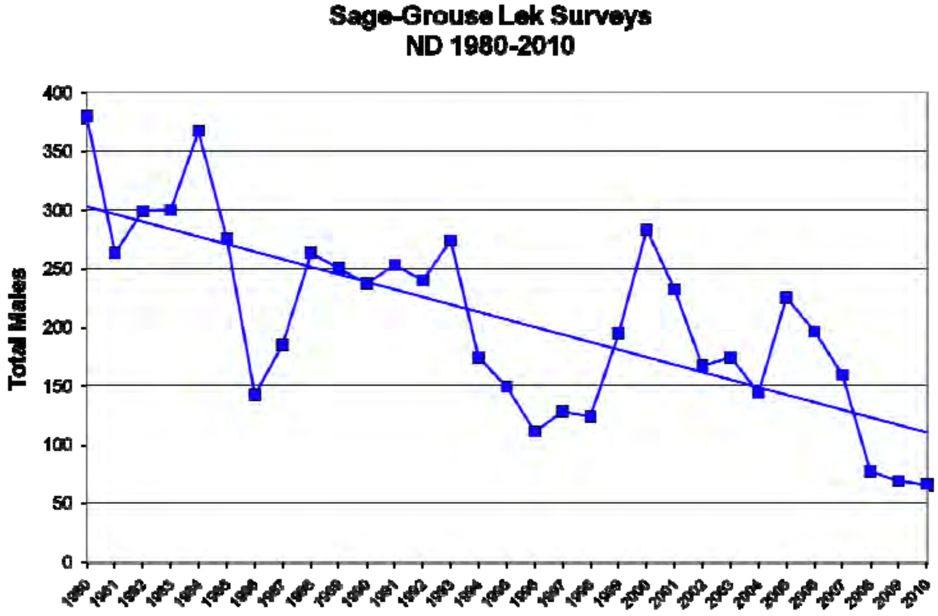


Figure 1. Sage grouse lek surveys, 1980-2010.

2. HABITAT:

In North Dakota and other areas of western United States, sage grouse are found only where big sage and closely related plants are growing. The birds utilize the sage plant for both food and cover throughout their entire annual life cycle and are sagebrush obligates. Most nests are found in this cover and over 75 percent of its annual food supply comes from the plant. In winter the grouse feeds almost entirely on sage (Connelly et al. 2004). Young birds in the first three or four months of life feed on insects, but by their first autumn have turned to the plant for their sustenance. Sage-grouse are unique because they do not have a muscular gizzard which makes their dependence on soft leafy vegetation more important. Since sage-grouse feed primarily on the herbaceous leaves of the sage plant, and does not require grit in its diet, there is no need for a highly developed gizzard. Sage grouse are landscape specialists that require large and intact sagebrush habitats to maintain populations (Schroeder et al. 1999, Connelly et al. 2000, Holloran and Anderson 2005, Doherty et al. 2008). Habitat loss and degradation are primary reasons for range-wide decreases in sage-grouse distribution and populations (Schroeder et al. 1999). Annual home ranges can be large and encompass areas greater than 2,700 km^2 (1,042 mi^2) (Schroeder et al 1999). Greater Sage-Grouse select smaller seasonal home ranges to meet specific life history needs. Seasonal home ranges of 26-52 km^2 (Connelly et al. 2000), 140 km^2 11-31 km^2, and 3-7 km^2) have been reported. In North Dakota, seasonal home ranges have high overlap and range from 107.6 km^2 – 432.4 km^2 (Swanson 2009). Figure 2 shows all pooled locations based on radio telemetry locations. Notice how “clumped” these locations are, this indicates the birds are confined to the remaining intact sagebrush habitat for all seasonal home ranges (breeding, nesting, brooding, late-season brooding, and wintering).

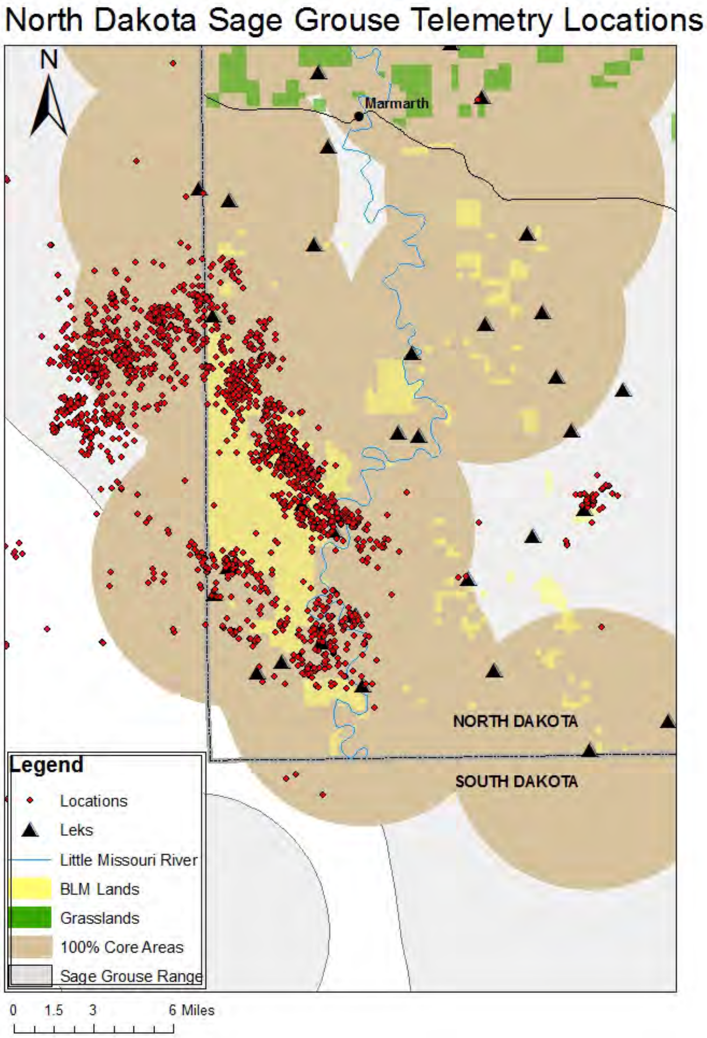
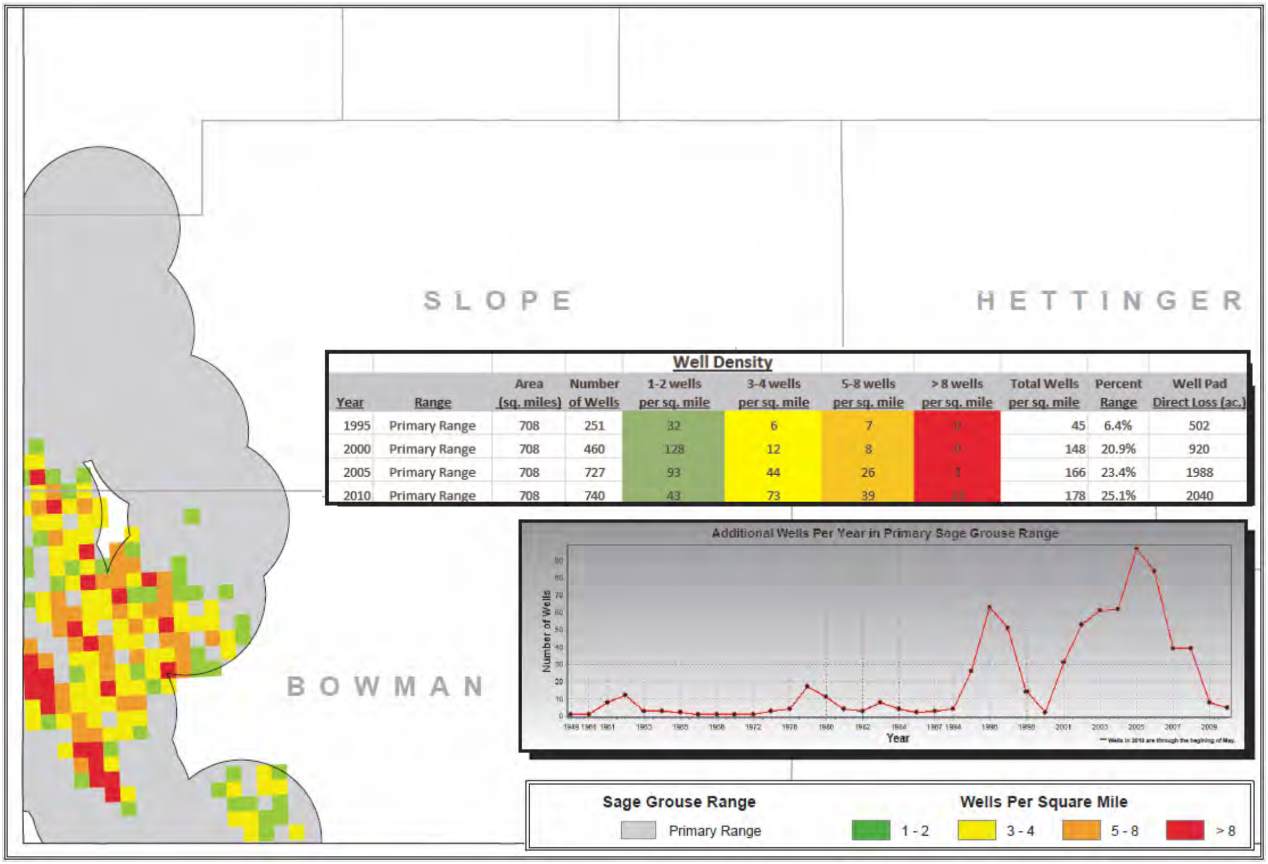


Figure 2. Sage grouse locations using radio-collared birds from 2005-2008.

3. OIL AND GAS IMPACTS:

The primary sage grouse range contains 100% of the known breeding population in North Dakota. Primary range was determined based on analyses by Doherty et al. (2009). Greater Sage-Grouse leks were used to determine known breeding population areas. Leks were buffered by 6.4 km (4.0 mi) to delineate nesting areas. This distance was chosen because 79% of nesting females initiate nests within a 6.4-km radius from lek-of-capture (Table B-1 in Colorado Division of Wildlife 2008). In North Dakota, buffers were extended to 8.5 km (5.3 mi) to account for lower population density areas and fragmented habitats. Extending the buffer provided a more realistic estimate of the area needed to protect these breeding populations, which are at high risk of extirpation (Aldridge et al. 2008). The primary range of sage grouse in North Dakota is limited to the three southwest counties, 72% of the population is in Bowman county. To assess the extent of oil and gas development, geographic Information Systems (GIS) was used to calculate well density per square mile. In 2010 oil and gas development impacted 25% of the primary range of sage grouse and 72% of the overall population respectively (Figure 3). In recent years research focused at identifying impacts of energy development has increased proportionately to development activity. Naugle et. al. (2009) conducted a thorough literature review of all studies conducted on the impacts of energy development and sage grouse. In this review he identified both direct and indirect impacts resulting from energy development. Direct impacts result when animals avoid human infrastructure (Doherty et al. 2008) or when development negatively affects survival (Holloran 2005) or reproduction (Aldridge and Boyce 2007). Indirect impacts include changes in habitat quality (Bergquist et al. 2007), predator communities (Hebblewhite et al. 2005), or disease dynamics and can be equally deleterious if cascading effects negatively influence sensitive species. Naugle (2009) identified seven studies that reported negative impacts of energy development on sage-grouse. Development in excess of one pad/1.6 mile² resulted in impacts to breeding populations (Holloran 2005). In many areas the conventional well density is eight pads/1.6 mile². At this level of development sage grouse cannot persist (Holloran 2005, Walker et al. 2007, Doherty et al. 2008). Furthermore within the Powder River Basin, WY population trends from 2001–2005 indicate lek-count indices inside gas fields declined by 82%, whereas indices outside development declined by 12%. By 2004–2005, 38% of leks inside gas fields remained active whereas 84% of leks outside of development remained active (Walker et al. 2007). Holloran (2005) showed that male lek attendance in the Pinedale Anticline decreased with distance to the nearest active drilling rig, producing gas well, and main haul road. Aldridge and Boyce (2007) studied an endangered population in Alberta, Canada, their results show low chick survival (12% to 56 days) limits population growth within the Manyberries Oil Field.

Doherty (2008) showed that sage grouse were 1.3 times less likely to use otherwise suitable winter habitats that have been developed for energy (12 wells/4 km²), and avoidance was most pronounced in high quality winter habitat with abundant sagebrush. Survival of female sage grouse decreased in the Pinedale Anticline due to impacts of development (Holloran 2005).



Well Density

Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
1995	Primary Range	708	251	32	6	7	0	45	6.4%	502
2000	Primary Range	708	460	128	12	8	0	148	20.9%	920
2005	Primary Range	708	727	93	44	26	3	166	23.4%	1988
2010	Primary Range	708	740	43	73	39	23	178	25.1%	2040

Figure 3. Impacts of oil and gas development in primary sage grouse range.

4. MITIGATION:

Since North Dakota is on the eastern fringe of sage grouse range and much of their range in the state has already been impacted by oil and gas development, it will be crucial to minimize additional disturbance from new development. Sage grouse are landscape level species which means that they require large intact contiguous tracts of sagebrush to persist. At the current level of development impacts may be substantial. The following may be used to reduce impacts on sage grouse.

1) Conduct thorough pre-drilling impact scoping with federal and state agencies to identify potentially affected habitat type, location of drilling in relation to existing roads and wells, and seasonal importance of the area for sage grouse.
2) Coordinate with state and federal wildlife agencies, and other oil companies to ensure timing and new drilling is in locations least detrimental to sage grouse and other wildlife.
3) To the extent technologically practicable, locate well pads, facilities and roads in clustered configurations within the least sensitive habitats. When several companies have intermingled leases, the cumulative effect could be reduced substantially if companies entered into an agreement to drill multiple wells from the same pad.
4) Use existing roads and coordinate road construction and use among companies operating in the same oil and gas field.
5) Pipe (rather than truck) liquids offsite, or enlarge storage tank capacity to minimize truck trips and eliminate trips during sensitive times of year to substantially lessen disturbances to wildlife
6) Install, (to the extent technologically feasible) telemetry to remotely monitor instrumentation and reduce or eliminate travel required to manually inspect and read instruments.

5. ADDITIONAL CONCERNS:

Oil and gas impacts represent just one of several cumulative factors affecting the state’s sage grouse population. Additional negative effects impacting sage grouse are conversion of native sagebrush to crop lands, potential impacts of wind development, and over utilization of grasslands by livestock producers. Sage grouse are very sensitive to human disturbance, and as with all wildlife there is a threshold of disturbance that once crossed is an inevitable downward slope for the species ability to persist.

It should be incumbent upon all North Dakotans that the jobs and revenue associated with the oil and gas industry could come with a very high cost; namely, diminished hunting and outdoor recreational opportunities through the loss of primary habitat due to direct and indirect effects of development that sustains the wildlife populations that are so highly valued by the state’s citizens.

SHARP-TAILED GROUSE

1. CURRENT STATUS:

In 1804-1805 Lewis and Clark referred to “pointed tail prairie hens” known today as the sharp-tailed grouse. As they came through the Dakota’s the expedition encountered abundant numbers of sharp-tailed grouse especially during their stay in Fort Mandan (Johnson and Knue 1989). Today sharp-tailed grouse are an important and widely hunted upland game species in North Dakota. Historically, sharp-tailed grouse (hereafter sharp-tail) hunting has played an important role in recreational hunting opportunities in North Dakota. Furthermore, the Dakota Prairie Grasslands lists the sharp-tail as a management indicator species within the Grasslands Plan, and is therefore, a species of particular concern for the US Forest Service (USFS) in land-use planning within native grasslands of western North Dakota. The status of sharp-tail in North Dakota is relatively stable. Sharp-tailed grouse are distributed across the entire state mainly associated with grasslands. Figure 1 shows the remaining intact grasslands in North Dakota. Present populations of sharp-tail grouse are stable with cyclic changes from year to year.

2. HABITAT:

Sharp-tailed Grouse are area-sensitive species that are affected by patch size and landscape composition and configuration (Grange 1948, Ammann 1957, Pepper 1972, Niemuth and Boyce 2004, Niemuth *in press*). The main habitat remaining in the northern plains is associated with remaining native grasslands (Figure 1). Average spring-to-fall home ranges (gender not provided) ranged from 1.0 km^2 (0.4 mi^2) in Colorado to 1.9 km^2 (0.7 mi^2) in Idaho (Marks and Marks 1987, Giesen and Connelly 1993). Movements of marked Sharp-tailed Grouse between breeding and wintering areas ranged from 2.6 km (1.6 mi) in Idaho to 4.5 km (2.8 mi) in Colorado.

3. OIL AND GAS IMPACTS:

The Grassland Conservation Plan for Prairie Grouse (Vodehnal, et.al 2007) authored by North America Grouse Partnership states that effects on prairie grouse populations will also occur due to energy development activities and that research should be conducted to identify potential impacts. At present, oil and gas production has invaded many native grassland areas of western North Dakota. In addition, wind turbine farms are proposed for many locations in the state. The effects of these activities on sharp-tailed grouse populations are unknown but presumed to be negative when occupying native rangelands.

Extensive work has been conducted on sage grouse and energy development. This data is currently used as our knowledge base for setting energy development guidelines on all grouse species. There is an immediate need for current research on sharp-tailed grouse response to energy development which will aid in creating guidelines for energy companies. Reliable information on the ecology of sharp-tailed grouse will provide tools for more inclusive and effective management decisions. Survival, reproduction and habitat use data will also provide insight to important variables contributing to population dynamics critical to establishing responsible harvest regulations. The gap in knowledge stretches from reliable estimates of annual variation of adult and juvenile survival (Schroeder and Baydack 2001).

Currently the North Dakota Game and Fish is conducting a research study to understand the impacts of oil and gas development on the ecology of sharp-tailed grouse, in hopes to assure the future of grouse populations in North Dakota. The objectives of this study are as follows.

1. Evaluate the persistence of sharp-tail grouse within and outside of energy development areas.
2. Quantify movements, reproduction, recruitment, and survival rates within and outside of energy development areas.
3. Model sharp-tailed grouse habitat use to create a predictive, statewide map of available sharp-tail habitat. The purpose of the model would provide a tool for proactive planning to avoid, minimize and mitigate the negative effects of development on sharp-tailed grouse in North Dakota.

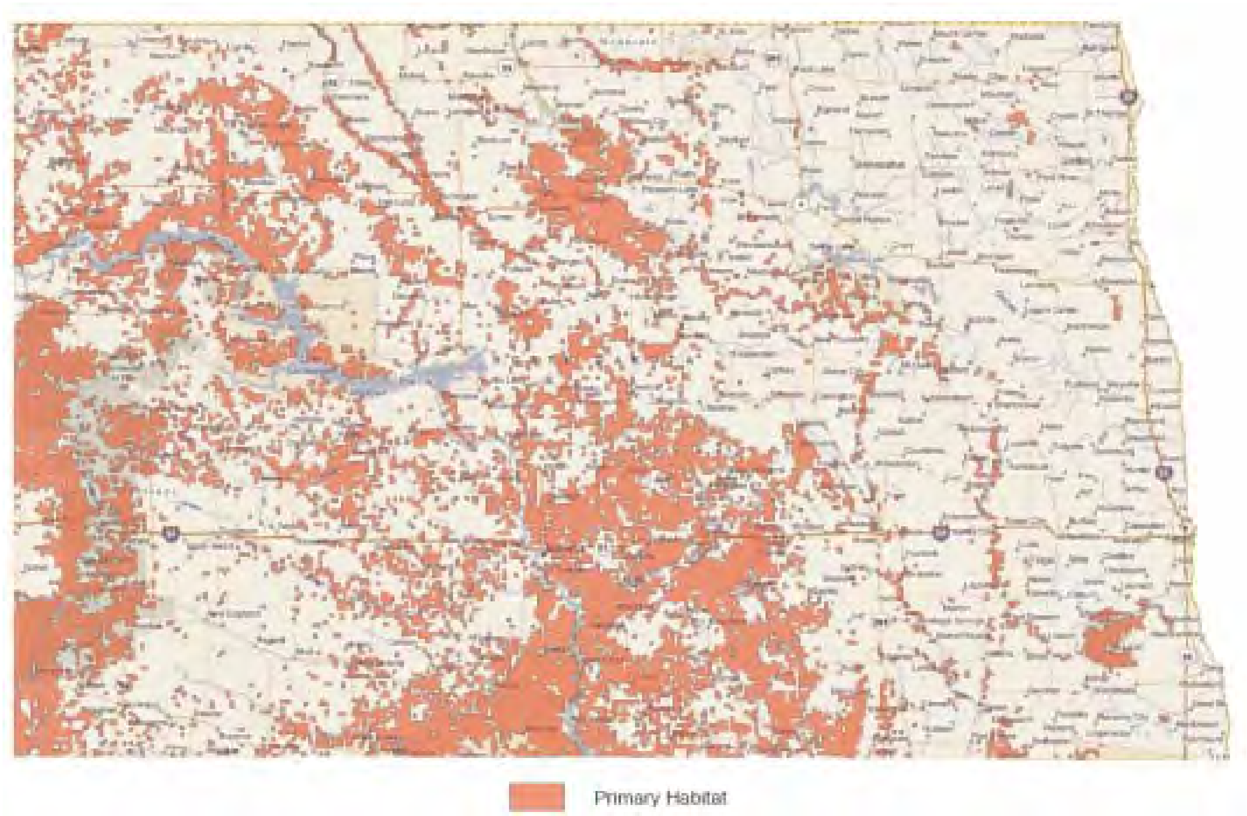


Figure 1. Primary native grassland habitat.

4. MITIGATION:

Prairie grouse are landscape level species which means that they require large intact contiguous tracts of grasslands to persist. At the current level of development impacts may be substantial. The following may be used to reduce impacts on sharp-tailed grouse

1) Conduct thorough pre-drilling impact scoping with federal and state agencies to identify potentially affected habitat type, location of drilling in relation to existing roads and wells, and seasonal importance of the area for sage grouse.

2) Coordinate with state and federal wildlife agencies, and other oil companies to ensure timing and new drilling is in locations least detrimental to sage grouse and other wildlife.
3) To the extent technologically practicable, locate well pads, facilities and roads in clustered configurations within the least sensitive habitats. When several companies have intermingled leases, the cumulative effect could be reduced substantially if companies entered into an agreement to drill multiple wells from the same pad.
4) Use existing roads and coordinate road construction and use among companies operating in the same oil and gas field.
5) Pipe (rather than truck) liquids offsite, or enlarge storage tank capacity to minimize truck trips and eliminate trips during sensitive times of year to substantially lessen disturbances to wildlife
6) Install, (to the extent technologically feasible) telemetry to remotely monitor instrumentation and reduce or eliminate travel required to manually inspect and read instruments.
7) Provide additional funding for research to identify acceptable levels of development and infrastructure.

5. ADDITIONAL CONCERNS:

Oil and gas impacts represent just one of several cumulative factors affecting the state's sharp-tail population. Additional negative effects impacting grouse include increased loss of CRP, conversion of native grasslands, potential impacts of wind development, and over utilization of grasslands by livestock producers. It is a common thought that sharp-tail grouse are more adaptable to disturbance than other grouse species, yet no research has been done to validate this opinion. With all wildlife there is a threshold of disturbance that once crossed is an inevitable downward slope for the species ability to persist.

It should be incumbent upon all North Dakotans that the jobs and revenue associated with the oil and gas industry could come with a very high cost; namely, diminished hunting and outdoor recreational opportunities through the loss of primary habitat due to direct and indirect effects of development that sustains the wildlife populations that are so highly valued by the state's citizens.

WATERFOWL

1. CURRENT STATUS:

Waterfowl that breed and are raised in North Dakota are harvested throughout the Western Hemisphere, especially in the Central and Mississippi Flyways; North Dakota has the most breeding ducks in the conterminous USA. Additionally, millions of waterfowl pass through and stage in North Dakota during spring and fall migrations. Waterfowl habitats in North Dakota have been decreasing in both quality and quantity since settlement of the prairies in the early 1800s. Despite considerable ongoing habitat destruction and degradation, waterfowl have reached recent highs in North Dakota over the past 15 years due to unprecedented wet cycles beginning in summer 1993, and again in winter 2008-2009 coupled with the Conservation Reserve Program (CRP; Figure 1). The CRP was implemented in 1985 as part of the Food Securities Act under the Farm Bill, and provides abundant, high quality nesting habitat for upland-nesting ducks. Unfortunately, CRP contracts are expiring, and will continue to expire at a relatively high rate over the next 5 years. This upcoming loss of approximately 2 million acres of nesting cover, or roughly 2/3 of that provided by CRP, will result in lower recruitment rates for ducks breeding in North Dakota. Portions of North Dakota with the greatest amounts of nesting cover that is not programmatic grass (i.e., CRP) are the Missouri Coteau and some portions of the Missouri Slope, two regions being targeted by energy development. Waterfowl are also locally abundant south and west of the Missouri River in the Missouri Plateau region of North Dakota. This region generally supports fewer ducks / square mile than areas east of the Missouri River; however, given that wetlands west of the Missouri River are generally isolated or in a “clumped” distribution, few options remain for waterfowl in certain locales after wetlands are degraded or destroyed.

2. HABITAT:

Waterfowl rely on a variety of habitats in North Dakota for breeding and staging activities; moreover, individual ducks use a variety of habitats within daily activities. Home ranges for hen mallards generally are approximately 4 square miles (Dwyer 1979, Cowardin et al. 1983) which allows for use of a variety of habitats. Multiple wetlands are often used during daily activities for resting, courtship, or foraging. The success of waterfowl as a group is owed partly to their ability to efficiently “sample” habitats to determine optimal situations. Smaller, temporary wetlands are often used by individual pairs and are necessary for courtship and foraging by breeding pairs. Shallow wetlands are important for providing abundant and diverse invertebrate communities that are relied upon by breeding hens for forage in late-spring and early-summer (Swanson et al. 1974, Murkin et al. 1982, Murkin and Kadlec 1986). Larger seasonal and semi-permanent wetlands provide habitats for all activities, particularly foraging in late-summer and in drought years, but larger wetlands can be somewhat lacking in their ability to provide seclusion for secure breeding pair territories (Kaminski and Prince 1981, Kaminski and Prince 1984). A good example of territory requirements by breeding ducks is that ten 1-acre temporary wetlands will support twice as many breeding pairs as a 10-acre semi-permanent wetland and as many breeding pairs as a 100-acre permanent wetland (Stewart and Kantrud 1973, Kantrud and Stewart 1977). However, brood rearing-habitat is generally considered to be seasonal and semi-permanent wetlands given that most temporary wetlands are dry by early-summer in most years.

Most ducks that nest in North Dakota are upland nesting species; however, canvasbacks, ring-necked ducks and ruddy ducks predominately nest over water. Mallards, gadwall, and northern pintails often nest 1 – 1.5 miles from water (Duebbert and Lokemoen 1976), as they seek secure nesting cover which is generally tall, rank grass, sometimes mixed with, or exclusively low shrubs (Duebbert et al. 1986). Larger blocks of perennial upland cover are more likely to support nesting efforts that produce nest success rates sufficient to maintain populations (Cowardin 1985, Reynolds et al 2001). However, other smaller blocks of perennial upland cover can also be productive nesting sites if predator populations are low, or the overall landscape has a relatively high proportion of perennial nesting cover comprised of grass or low shrubs (Duebbert et al. 1986).

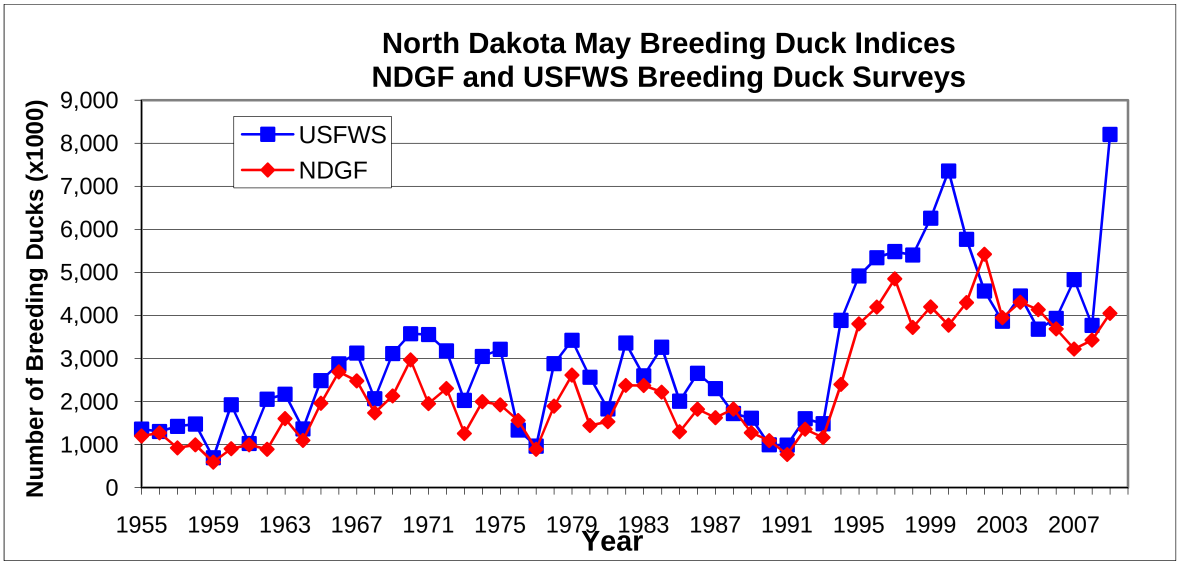


Figure 1. Breeding duck indices in North Dakota, 1955 – 2009.

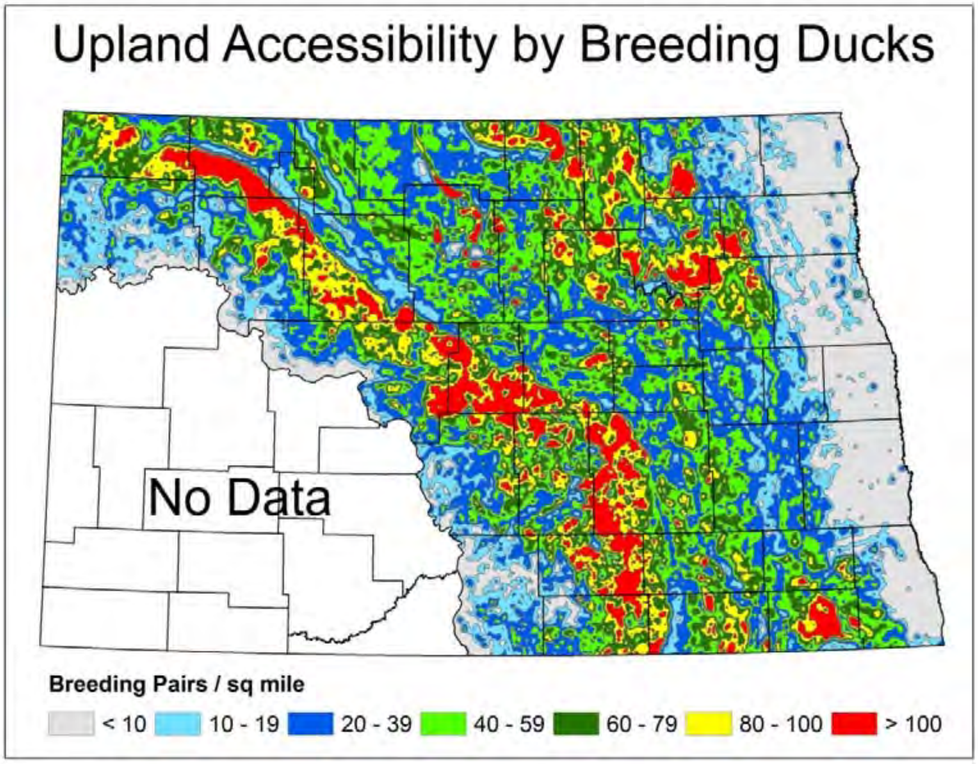


Figure 2. Accessibility to upland habitat by breeding ducks (pairs/square mile) north and east of the river based on USFWS 4 square mile surveys (USFWS, Region-6 Habitat and Populations Evaluation Team).

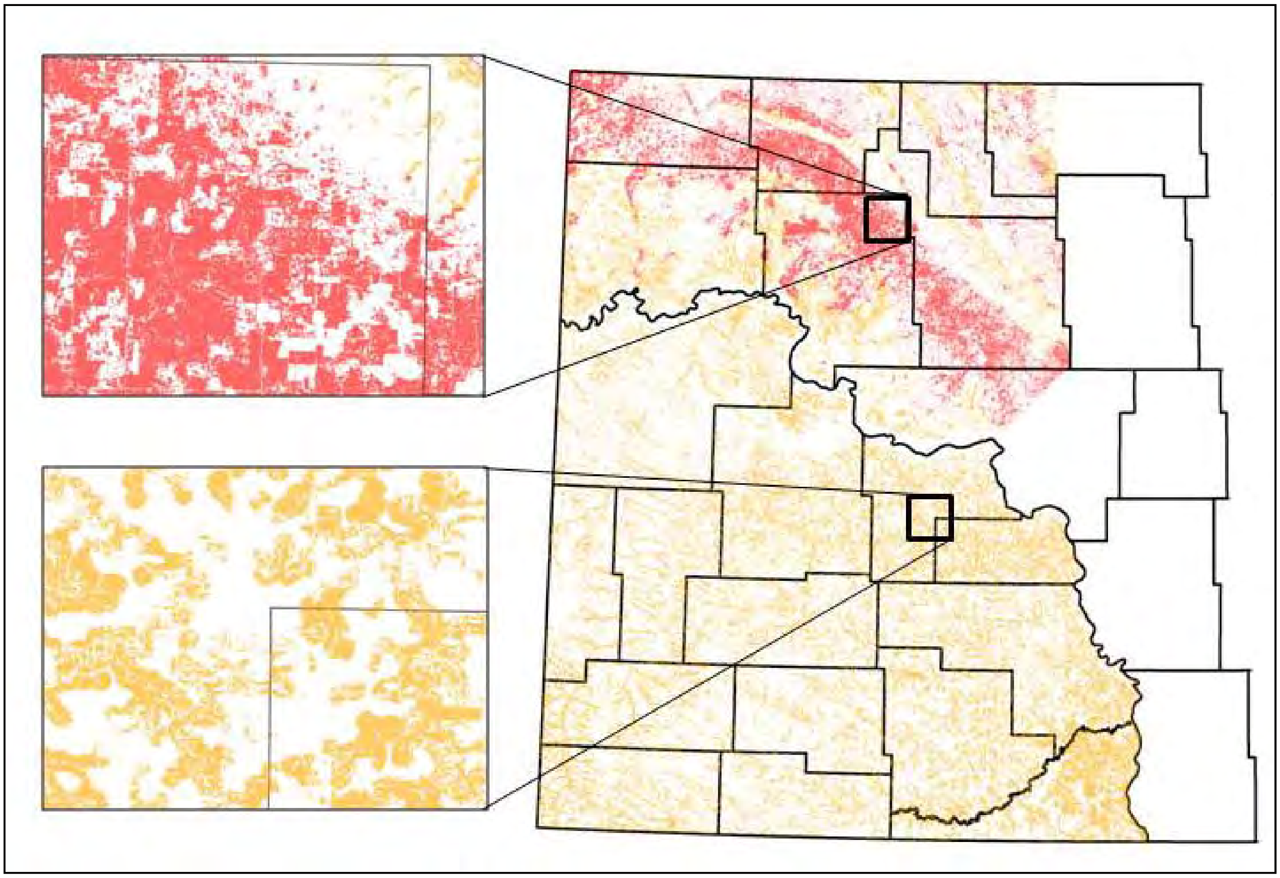


Figure 3. Upland nesting habitat for breeding ducks in western North Dakota. Red is nesting cover in high duck density areas (>40 pairs/square mile) and orange is nesting cover associated with isolated wetlands (Szymanski, unpublished report).

3. OIL AND GAS IMPACTS:

Direct mortality

Containment ponds. Waterfowl often die in open pits that are used during the drilling process. These pits can be up to one acre in size and contain contaminated water and oil. Waterfowl are killed both by poisoning and oiling. These pits are supposed to be removed within a set time frame, which is generally within a year from completion of drilling the well. Two other containment ponds that can cause mortality are “drip” tanks associated with gas releases, and overflow ponds. Occasionally, berms on well pads can be breeched allowing toxic overflows to leach into wetlands, potentially causing direct mortality of waterfowl.

Powerline strikes. Remote oil and gas well operations require some source of electricity. Generally powerlines leading to well pads are not buried and if running through or along a wetland can cause mortality through powerline strikes, especially in high disturbance areas (Blokpoel and Hatch 1976).

Hydrogen sulfide (H_2S) poisoning. Gas leaks at well sites could produce toxic H_2S leaks that are fatal to both humans and wildlife. Given that the gas is heavier than air, higher concentrations could be found near ground level, thus having greater impacts to wildlife.

Vehicle collisions with wildlife. Oil and gas development has resulted in substantial increases in road use in western North Dakota. Invariably, vehicle collisions with waterfowl will increase commensurately (Sargent 1981).

Reductions in Reproductive Vital Rates through Habitat Degradation and Destruction

Wetland degradation. Wetland degradation from construction of oil and gas well pads and roads can occur through several mechanisms: sedimentation through increased run-off, disposal or leaching of waste products and/or production water, and changes in normal run-off availability. Construction of well pads or roads in or near wetlands (Figure 4) can have the proximal effects of 1) increased turbidity through increased sediment loads, 2) altered water chemistry, 3) altered nutrient cycling, 4) decreased basin capacity (i.e., filling or draining of wetland), 5) decreased inflows to wetlands depending on placement of roads and pads relative to run-off and wetlands, and 6) unfavorable changes in wetland plant communities. *Prior to the year 2000, 1282 wetland basins with permanency greater than the "seasonal" regime north and east of the Missouri River, have had wells constructed within 110 yards (100m) of them. Since 1 January 2000, an additional 940 wetland basins with permanency greater than the "seasonal" regime north and east of the Missouri River, have had wells constructed within 110 yards of them. Estimates are not available for wetlands west of the Missouri River given that analysis has not been conducted to merge National Wetlands Inventory polygons into individual basins.* ***Based on estimates by the North Dakota Department of Mineral Resources, an additional 10,330 wetland basins with permanency greater than the "seasonal" regime north and east of the Missouri River, will have had wells constructed within 110 yards (100m) of them by the year 2020.***

Figure 4. Oil well constructed in a wetland in northeastern Williams County, North Dakota (USFWS).

In most cases, the "net" effect of these proximal effects is decreased forage production. Decreases in wetland production of macro-invertebrates and wetland plant seeds will have numerous negative effects on reproductive vital rates (Ankney et al. 1991). Decreased foraging resources for nesting hens results in smaller clutch sizes (Krapu et al. 1983, Eldridge and Krapu 1988), and can result in lower nesting probability and renesting propensity (Krapu and Reinecke 1992, Greenwood et al. 1995), and smaller, lower quality ducklings at hatch (Batt and Prince 1979, Eldridge and Krapu 1988, Rhymer 1988). Moreover, decreased invertebrate resources for ducklings results in lower growth rates (Cox et al. 1998), fledging at an older age (Lightbody and Ankney 1984), and lower survival rates (Ankney 1980, Duncan 1987).

Lower forage production in wetlands will also impact distribution of ducks during spring and fall. Spring staging waterfowl rely on abundant invertebrates to build endogenous reserves needed for nesting at northern latitudes (Krapu 1974, 1981, Afton 1984, Afton and Ankney 1991, Afton and Anderson 2001). Reduced production of wetland seeds and invertebrates will also have negative impacts to fall staging waterfowl in North Dakota. Waterfowl strive to maintain a positive energy balance during fall to fuel migrations that can span several thousand miles. While mallards and northern pintails often feed on waste agricultural crops, natural foods are also required to provide essential amino acids that are not available in anthropogenic foods. If abundant food is not available in wetlands, fewer ducks will stage in North Dakota, having negative consequences for hunting opportunities.

Destruction of wetlands. Total destruction of individual wetlands is most likely to occur through: filling of wetlands to build roads to well sites, filling of wetlands to build well pads, suffocation of wetlands by cutting off run-off through construction of roads or well pads. Generally, filling of wetlands will also involve draining wetlands which could have negative consequences to wetlands and water resources that are not in close proximity to road or well pad construction such as creation of “consolidation basins” which generally lack normal functionality and are less productive than normal functioning wetlands. Individual site determinations will be required to determine whether wetlands have been altered or destroyed.

Fewer wetlands will result in less diverse wetland communities and a lower overall carrying capacity for both breeding and migrating waterfowl. Diverse wetland communities are required given that wetlands have varying degrees of productivity through time and space. That is, not all wetlands are productive all of the time, at the same time. Moreover, waterfowl have different requirements at different times of the year that are provided by different types of wetlands.

Destruction of wetland margins. Placement of well pads and roads in wetland margins results in a direct loss of habitat. While some species of ducks will nest 1 – 1.5 miles from water, other species such as blue-winged teal, northern shoveler, lesser scaup, and redheads will nest in close proximity to water. Additionally, in agriculturally intense landscapes, wetland margins may provide the only nesting cover available to all species of upland nesting waterfowl in North Dakota. Besides nesting cover, wetland margins also provide escape cover for adult dabbling ducks that are molting flight feathers, and dabbling duck broods.

Loss of wetland margins will also negatively impact hydrology of wetlands through reduction in snow catchment potential. Wetlands without margins also lose the ability to filter runoff before it reaches the main body of water, resulting likely in degradation.

Destruction of upland nesting cover. Based on measurements from aerial photos, new well pads appear to consume approximately 4 acres. Fragmentation by well pads and well roads of once continuous blocks of perennial nesting cover could allow nest predators to travel easier and allow access to core areas of nesting habitat. Reductions and fragmentation of nesting habitat could result in lower nest success, decreased brood survival during travel from nest to wetlands, or between wetlands, and decreased hen survival. *Prior to the year 2000, an estimated 436, 270, and 706 acres of upland duck nesting cover in high duck density areas, near isolated wetlands north of the Missouri River, and west of the Missouri River, respectively, have been lost. Since 1 January 2000 through early April 2010, an estimated 500, 672, and 1344 acres of upland duck nesting cover in high duck density areas, near isolated wetlands north of the Missouri River, and west of the Missouri River, respectively, have been lost.* ***If development continues as forecasted by the North Dakota Department of Mineral Resources, an additional 7,758 acres of upland duck nesting habitat could be lost to well pad construction north and east of the Missouri River by the year 2020. Additionally, 4,057 acres of upland duck nesting habitat could be lost to well pad construction west of the Missouri River by the year 2020. These estimates are based only on well pads, and do not include acreages taken up by roads leading to wells, an estimate difficult to quantify at this time.***

Effects of Disturbance from Drilling, Well Pad Operation, and Oil and Gas Related Traffic

Indirect impacts from oil and gas well site construction can last for many years following development (Walker et al. 1987). Numbers and projections of well sites within 110 yards (100m) of wetlands are listed in the preceding section. Disturbance has potential to decrease waterfowl occupancy rates, forcing birds into other currently occupied habitat (Bergman 1973). Preliminary results suggest that occupancy rates of breeding ducks are slightly lower in wind facilities as opposed to nearby areas with similar habitat (J. Walker, Ducks Unlimited, unpublished data). Waterfowl may avoid areas with large amounts of anthropogenic disturbance (Paulus 1984, Cox and Afton 1997, Cox and Afton 2000); however, some species such as mallards are quite tolerant of disturbance. It is possible that waterfowl occupancy rates of wetlands subjected to disturbance by oil and gas development may not be lower. However, waterfowl behavior will be changed such that time spent foraging will likely be lower (Bélanger and Bédard 1989, Bélanger and Bédard 1990, Bechet et al. 2004).

Decreased forage intake coupled with increased alert and escape behaviors could decrease body condition of birds remaining in wetlands. Reductions in daily caloric intake by roughly 19% doubles the amount of time required to recoup lipid reserves (Fredrickson and Drobney 1979). Decreased body condition will result in decreased egg production reducing abilities of hens to renest and also reducing clutch size (Reynolds 1972, Ankney and MacInnes 1978, Raveling 1979, Drobney 1980, Krapu 1981). Actual disturbance may not affect initial nesting rates as dabbling ducks are known to nest in highway right-of-ways (Page and Cassell 1971); however, oil and gas related traffic is much different than normal highway traffic given larger vehicles and heavier payloads. Canvasback and redheads have been shown to abandon nests as a result of recreational boating activities (Bouffard 1983a), but dabbling ducks are often more resilient to disturbance during nesting (Rohwer et al. 2002). If initial nesting rates do not decrease, flushing rates from nests will likely be higher resulting in higher nest abandonment, lower hatch rates, and higher nest depredation (Bouffard 1983b). Lower initial nest success, followed up by lower renesting potential and smaller clutch sizes resultant from oil and gas disturbance, could have a cascading effect resulting in fewer broods which will also be smaller.

Reproductive efforts could also be further impaired by decreased fledging rates resultant from disturbance. Disturbance near wetlands where hens are rearing broods will likely result in lower occupancy and lower brood and/or duckling survival (Beard 1953). Abandonment of wetlands near disturbance will increase overland travel by broods which results in higher duckling mortality (Talent et al. 1983, Dzus and Clark, 1988, Rotella and Ratti 1992, Krapu et al. 2000). Moreover, hens may be forced to take their broods to wetlands with less abundant or lower quality forage, resulting in decreased growth rates and survival (Cox et al. 1998, Krapu et al. 2006). Decreased brood and/or duckling survival could also be realized in circumstances where hens keep their broods in wetlands near areas of high disturbance. Similar to occupancy for adult ducks, broods will spend more time using escape behaviors rather than foraging. Also, some disturbances could separate ducklings from broods during escape behaviors, resulting in decreased duckling survival.

Waterfowl generally avoid areas of high disturbance during spring and fall staging, although some longer-lived species have habituated to foraging in agricultural fields near busy highways (i.e., snow geese and Canada geese). However, as previously noted, regular highway traffic poses a more benign disturbance than traffic associated with oil and gas development. Flushing of staging waterfowl could result in decreased lipid reserves during a time when migration requires lipid accumulation (Anteau and Afton 2004, Korschgen et al. 1985). Overall, oil and gas development will likely result in fewer waterfowl staging in northwestern North Dakota, resulting in lost hunting opportunities for waterfowl hunters in North Dakota.

4. MITIGATION:

Impacts to waterfowl can be limited with avoidance of wetland habitats and taking preventative steps when constructing roads and well pads. Areas of contiguous grass larger than 40 acres should also be avoided to prevent destruction of core nesting cover for upland nesting ducks. Powerlines that are constructed across wetlands should be marked to decrease mortalities cause by powerline strikes (Anderson 1978, Brown and Drewien 1995). Additionally, flagging does not appear to be adequate in reducing mortality of birds at open pits (Esmoil and Anderson 1995). Avoiding wetland margins (the edge of wetland vegetation) by 110 yards will likely alleviate many of the impacts associated with disturbance and habitat destruction and degradation. Other options to limit disturbance to breeding waterfowl would be to curtail drilling operations May – August near wetlands. During construction of roads, culverts should be used to prevent damming or funneling of water that normally would reach a wetland basin.

Mitigation options for waterfowl in North Dakota are substantial and could be value-added as funds from energy companies may provide match for North American Wetlands Conservation Act (NAWCA) grants. These project funds could be used to protect wetlands and grasslands in high duck density areas (more than 40 pairs/square mile), conduct wetland restorations (with subsequent protection), and create wetlands in areas with lower duck densities, but large amounts of upland nesting cover available. Circumventing risk of, or at least benefiting from mineral development on mitigation tracts would be an important consideration. In most cases, public access could also be arranged for hunting on mitigation tracts. Unique opportunities may exist in the Coteau Slope region for partnering with various energy and conservation entities to create large, managed wetlands with accompanying grasslands that would provide breeding habitat and excellent hunting opportunities for waterfowl.

5. ADDITIONAL CONCERNS:

Currently, estimates and projections of acreages from development were made using assumptions and point data given that polygon GIS data is not available for oil/gas wells and roads. It would be useful to have new construction related to oil and gas development, including roads, GPS'd as an ongoing basis to create data layers for future work. Old sites and roads could be digitized from aerial photos relatively cheaply.

Waterfowl habitats face many challenges in North Dakota, which seem to be ever-increasing. Destruction and degradation from conversion to croplands and energy development is on the rise, and expirations of CRP contracts will leave many more wetlands that were protected “de facto” vulnerable to conversion. Areas impacted by oil and gas development related to the Bakken and Three-Forks Formations are some of the more pristine prairie/wetland habitats in North Dakota.

Many of the ducks that breed in North Dakota will not only be affected by oil and gas development in North Dakota, but now also by the Deepwater Horizon Oil Spill Disaster in the Gulf of Mexico. Blue-winged teal, green-winged teal, northern shovelers, northern pintails, gadwall, American wigeon, canvasbacks, redheads, and lesser scaup rely on coastal wetlands in Louisiana during winter. Moreover, rafts of up to 500,000 lesser scaup have been observed offshore in the Gulf of Mexico near the affected area. This is substantial because lesser scaup have been declining since the 1980s from approximately 7 to 8 million in the breeding population to roughly 4 million in recent years.

GOLDEN EAGLE

1. CURRENT STATUS:

The golden eagle (*Aquila chrysaetos*) is a large raptor fairly common in the badlands and Missouri River breaks and rare across the remainder of southwest North Dakota. Occasionally wintering eagles are seen statewide. Golden eagles are difficult to survey and assess population changes as monitoring can be intensive and costly. In North Dakota, Allen (1987) estimated 95 pairs of golden eagles nested in the state in the early 1980's. Knowles (2001) surveyed 213 previously documented golden eagle nests on the Little Missouri National Grassland only and found 15 of 97 potentially useable nests occupied. Of 411 potential nest sites surveyed across the breeding range in the early to mid 2000's, Coyle (2007) estimated 63 were occupied. The difference in the number of occupied nests and total surveyed nests is a result of differing survey methods and effort, not an indicator of population change.

The nesting status of golden eagles across the western United States is unclear (Kochert and Steenhof 2002). Recently the U.S. Fish and Wildlife Service contracted a survey of golden eagles across the entire western range. Aerial line transect surveys were used to estimate population sizes. A trend analysis from 2006 to 2009 found no significant trend (Nielson et al. 2010). Golden eagles do not breed until at least four years old and reproductive rates are low. Long-term monitoring (i.e. 10+ years) is needed to detect changes in population.

Figure 1. NDGF staff examine a golden eagle nest post-breeding season.

2. HABITAT:

Golden eagles favor open spaces such as grassland, shrubland, and cropland for hunting and rugged terrain for nesting. Most nests are built on clay cliffs or embankments but this raptor will also nest in trees such as cottonwood and green ash. Nests are used for many years. An eagle will add new material every year so nests may become very large (Figure 1). Some cliff nests are up to 10 feet across and may grow to 17 feet tall or even taller (Allen et al. 1988). Although capable of taking large prey such as domestic livestock or wild ungulates, eagles prey primarily on jackrabbits, ground squirrels and prairie dogs (Kochert et al. 2002). Suitable habitat for nesting golden eagles which includes rugged topography and abundant prey is limited in the state. Primary range boundaries were based upon the badlands ecoregion type within the Little Missouri River drainage system and a portion of the river breaks ecoregion of the Missouri River (as defined by the EPA, level IV). Sixty-eight percent of golden eagles nest in the Little Missouri Badlands and 13% in the River Breaks ecoregions, which together comprise the primary breeding range (Figure 2) (NDGF unpublished data). The remainder, or 19%, breed across the secondary range.

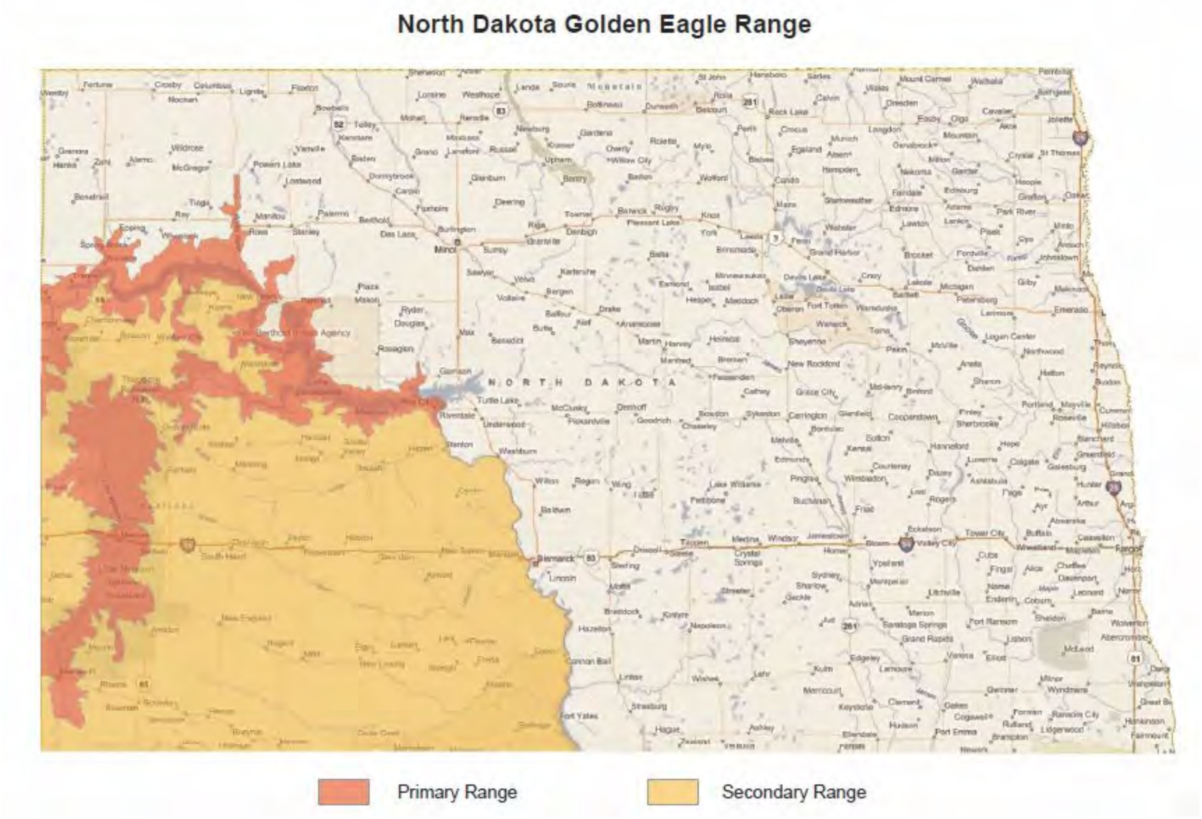


Figure 2. Golden eagle breeding range. Based on known locations of golden eagle nests.

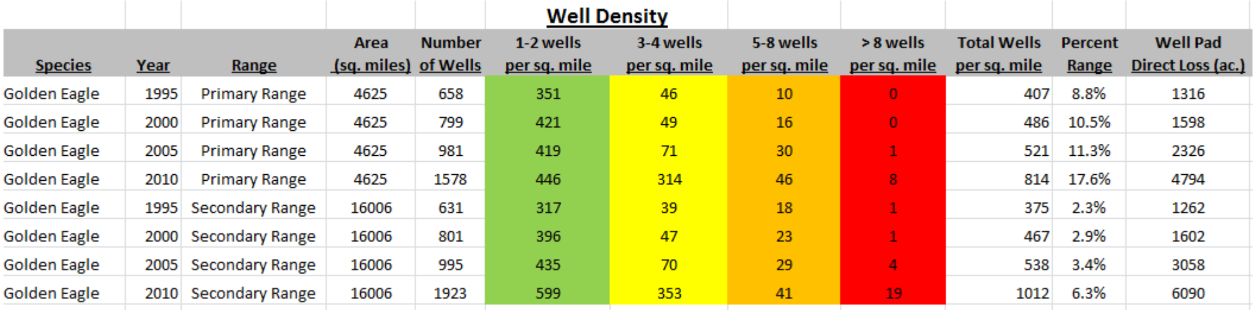
3. OIL AND GAS IMPACTS:

It is widely documented that many raptor species are sensitive to disturbance but golden eagles are particularly sensitive (Holmes et al. 1993). The breeding season, including the phases of nest construction thru fledglings departing the nest site, is the most sensitive time period. Disturbance occurs when the breeding season is interrupted and a reaction from the adults or chicks occurs. The adults may flush abruptly resulting in ejection of eggs or young from the nest, exposure of eggs or young to inclement weather or predators, or missed feedings, all which may contribute to mortality (USFWS unpublished report, Pagel et al. 2010). If disturbance is intense or persistent the pair may abandon the breeding season or nest site altogether. Disturbance is most often the result of human activities such as foot or vehicular traffic, recreational activities, human development, energy development, or other alterations of the landscape.

O/G development in North Dakota is not likely to cause the direct physical loss of eagle nests. However, the activities associated with it (i.e. on-site foot and vehicular traffic, loud noises) may cause nest abandonment if the activity occurs in close proximity to the nest and especially if in clear sight of the nest (Richardson and Miller 1997). Golden eagles have a high degree of fidelity to nesting sites and are predisposed to particular nest site attributes, such as cliff height, orientation, habitat diversity, and prey availability (Kochert et al. 2002, USFWS unpublished report). A golden eagle pair establishes a territory of 20-30 square kilometers (5,000-7,400 acres) and within that territory may build and manage several nests, up to fourteen in some instances (Kochert et al. 2002).

O/G development may displace eagles from defended nest sites and new sites lacking a disturbance factor are increasingly limited. Currently more than 17% of the golden eagle primary range is impacted by O/G development; a doubling since 1995. The impact to secondary range has also nearly doubled from 2005 to 2010 (Table 1).

Table 1. Summary of changing well densities in primary and secondary golden eagle range.



					Well Density						
Species	Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
Golden Eagle	1995	Primary Range	4625	658	351	46	10	0	407	8.8%	1316
Golden Eagle	2000	Primary Range	4625	799	421	49	16	0	486	10.5%	1598
Golden Eagle	2005	Primary Range	4625	981	419	71	30	1	521	11.3%	2326
Golden Eagle	2010	Primary Range	4625	1578	446	314	46	8	814	17.6%	4794
Golden Eagle	1995	Secondary Range	16006	631	317	39	18	1	375	2.3%	1262
Golden Eagle	2000	Secondary Range	16006	801	396	47	23	1	467	2.9%	1602
Golden Eagle	2005	Secondary Range	16006	995	435	70	29	4	538	3.4%	3058
Golden Eagle	2010	Secondary Range	16006	1923	599	353	41	19	1012	6.3%	6090

O/G development often involves the construction of utility lines to well sites. Electrocution is the second leading cause of golden eagle deaths. Of 28 immature and adult eagles studied in Idaho, 43% died from electrocution (Beecham and Kochert 1975). Of 1,428 electrocutions recorded from 1986 to 1996 in the western United States, 748 were golden eagles (Harness and Wilson 2001). Golden eagle electrocution rates are twice as frequent as bald eagles due to their propensity to perch on utility poles situated in grassland (Franson et al. 1995). Additional power lines in the eagle range will increase the likelihood of eagle electrocutions.

4. MITIGATION:

The Migratory Bird Treaty Act prohibits the “take” of migratory birds. The Act declares it illegal to pursue, shoot, wound, kill, possess, transport or sell any migratory bird, including their nests, eggs, or parts thereof. The Bald and Golden Eagle Protection Act (Eagle Act) affords additional protection to bald and golden eagles by including “disturb” as an act of take. “Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment,” (Pagel et al. 2010). The definition of “eagle nest” is “a readily identifiable structure built, maintained, or used by bald eagles or golden eagles for breeding purposes” (USFWS 2009). Eagle nests, regardless if active or inactive, should be protected for a minimum of ten years and in some cases, permanent protection may be warranted (George Allen, personal communication, 26 May 2010).

The primary O/G mitigating measure should incorporate a spatial buffer around golden eagle nest sites. The U.S. Fish and Wildlife Service developed recommendations for minimizing disturbance impacts to bald eagles (USFWS 2007) and is in the process of developing such recommendations for other raptors. Some states and federal agencies have developed their own recommendation to include both spatial and temporal restrictions. For example, the U.S. Forest Service Dakota Prairie Grasslands prohibits above-ground oil and gas facilities within 0.5 miles of a golden eagle nest and restricts other activities (i.e. prescribed burning, reclamation activities) within 0.5 miles of the nest from February 1 to July 31 (USDA 2001). This provision should be extended to all nest sites in North Dakota regardless of land ownership. In some instances, O/G development may be allowed to occur within the 0.5 mile buffer dependent upon the type of activity, the timing, and location. However, a site specific analysis should be required. O/G development, including associated roads and utility lines, should never occur within 0.25 miles of any eagle nest regardless of a site analysis. The O/G industry should avoid development completely within the 0.5 mile buffer to reduce the chance of disturbing an eagle nest and potential consequences from violating the Eagle Act.

Figure 3. O/G development within 200 yards and in plain view of a golden eagle nest. Red arrow indicates eagle nest.

To reduce eagle mortality from electrocution, utility line construction should follow *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006* (APLIC).

5. ADDITIONAL CONCERNS:

The bald eagle (*Haliaeetus leucocephalus*) is increasing in North Dakota. Nest sites are protected the same as golden eagle sites under the Eagle Act. Prior to 2000, bald eagle nests were restricted to primarily the Missouri River south of Garrison Dam. Since 2005 eagles have initiated nests across the eastern 2/3 of the state (Johnson 2009). Bald eagles are utilizing large cottonwood trees in nontraditional habitat, such as within cropland or prairie. At the time of this report no known occupied bald eagle nests are within the primary O/G development areas. However, this nesting population is expected to continue to increase in North Dakota. O/G development may deter bald eagles from expanding into certain areas. Similar disturbance issues will arise if an eagle establishes a nest and O/G development occurs in close vicinity of the nest site.

NONGAME GRASSLAND BIRDS

1. CURRENT STATUS:

Grassland bird species have shown steeper, more consistent, and more widespread declines than any other guild of North American birds (Knopf 1995). Seven of nine primary endemic grassland birds of the Great Plains breed in North Dakota. These species evolved in native grassland and long-term survival depends on this specific habitat type. Another 14 secondary, or more widespread, grassland species have declined both survey-wide and/or in North Dakota. (Table 1)

Some grasslands birds have nearly disappeared from North Dakota. The McCown's longspur was once "quite common and widely distributed over the western half of the state and throughout the northeastern quarter as well," (Stewart 1975). The population declined drastically during the early 1900's as settlers expanded in North Dakota and began farming the prairie. This species is now found only in the extreme southwest part of the state. Other species remain fairly common to abundant in North Dakota but have a limited breeding range (Figure 1). Without native grassland on the landscape, these too may all but disappear from the state.

Table 1. Summary of grassland bird population trends and priority designations.

Primary Endemic Species	**1966-2007 BBS Survey-wide[1]**	**1980-2007 BBS Survey-wide[1]**	**1966-2007 BBS North Dakota[1]**	**1980-2007 BBS North Dakota[1]**	**Species of Conservation Priority[2]**	**USFWS BCC Region 6 2008[3]**	**USFWS BCC National 2008[3]**
Ferruginous hawk	2.6	0.6	0.6	-0.6	Level I	X	
Long-billed curlew	-0.8	-0.7	--	--	Level I	X	X
Sprague's pipit	-3.9*	-3.7*	-2.0	-2.4*	Level I	X	X
Baird's sparrow	-3.4*	-3.2*	-5.0*	-7.1*	Level I	X	X
Lark bunting	-1.7*	-2.0*	-4.1*	-4.1*	Level I		
McCown's longspur	-2.0	0.3	--	--	Level III	X	X
Chestnut-collared longspur	-2.8*	-4.2*	-2.5*	-4.4*	Level I	X	
Secondary (More Widespread) Species							
Swainson's hawk	-0.3	-0.4	0.0	-1.8	Level I		X
Northern harrier	-1.2*	-0.4*	1.5	2.9	Level II		
Prairie falcon	3.6	0.7	-3.7	--	Level II	X	
Upland sandpiper	0.4	-0.9	0.4	-1.4	Level I	X	X
Burrowing owl	-1.6	2.0	-3.6	-18.3	Level II	X	
Short-eared owl	-4.1*	-3.0*	0.0	1.1	Level II	X	X
Horned lark	-2.0*	-2.4*	-3.0*	-4.6			X
Western meadowlark	-0.9*	-1.0*	-0.6	-1.0			
Dickcissel	-0.2	-0.3	-0.5	10.6	Level II		X
Savannah sparrow	-1.0*	-1.1*	3.2	4.9			
Grasshopper sparrow	-3.6*	-3.3*	-3.2*	-1.7*	Level I	X	
Vesper sparrow	-1.0*	-0.8*	0.6	-0.1			
Lark sparrow	-1.6*	-0.7*	6.2	5.6			
Clay-colored sparrow	-1.2*	-0.8*	0.7	3.7			

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[1] Breeding Bird Survey trend estimates. Sauer 2008

[2] North Dakota Comprehensive Wildlife Conservation Strategy, or State Wildlife Action Plan, designation. Hagen et al. 2005

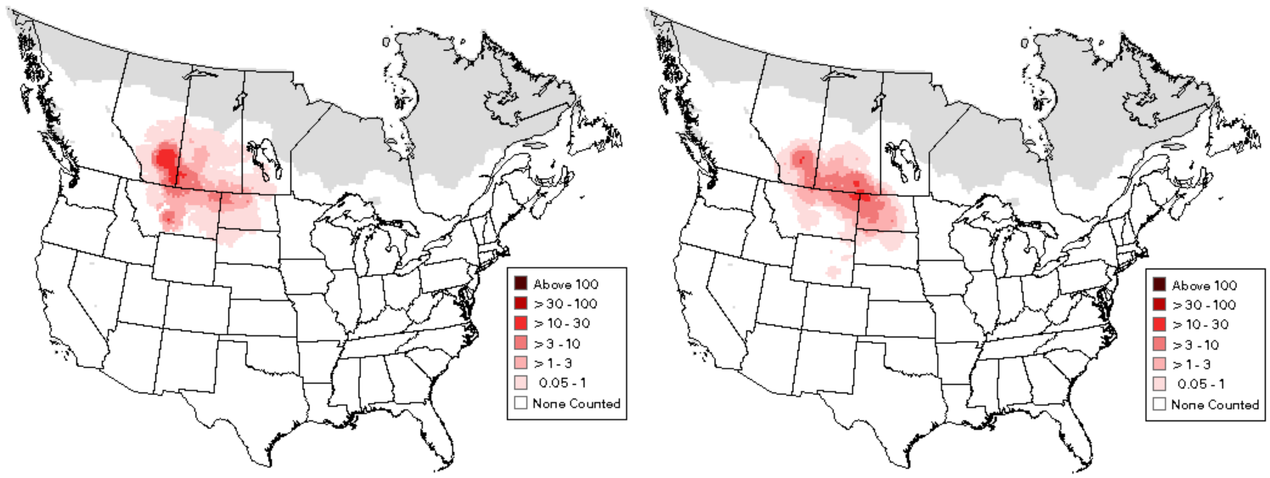
[3] U.S. Fish and Wildlife Service Birds of Conservation Concern. USFWS 2008.

*Significant ($p<0.05$), long-term declining population trend.

-- Data insufficient to determine trend estimate.

Sprague's Pipit

Baird's Sparrow



Chestnut-collared Longspur

Lark Bunting

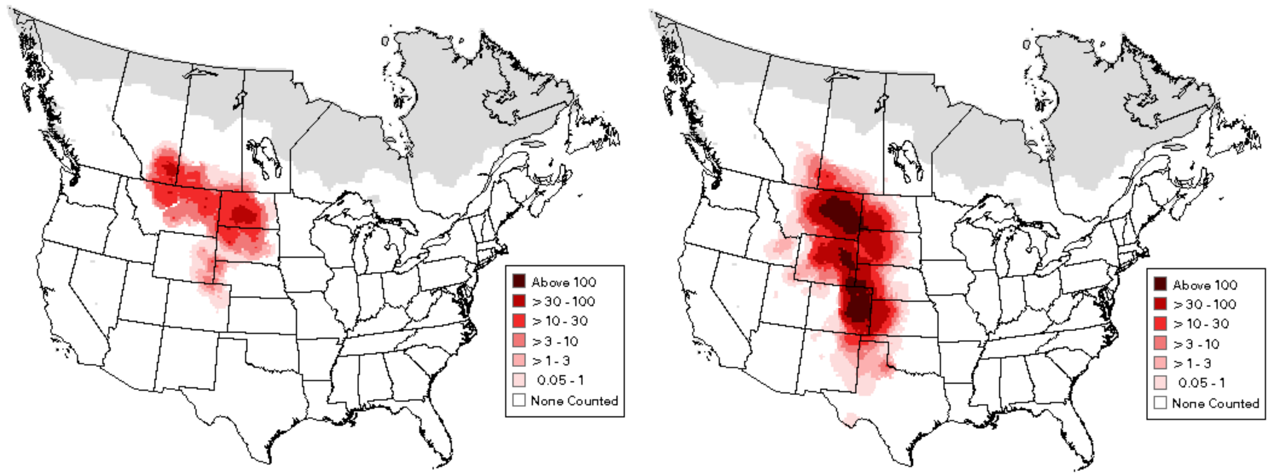


Figure 1. Relative abundance of four endemic grassland birds, based on Breeding Bird Survey data 1994-2003. Source: Sauer et al. 2008.

2. HABITAT:

“Prairie” is a large area of level or rolling land that has a cover of grasses and forbs and is predominantly treeless, and may also be referred to as grassland. “Native” refers to land that has never been cultivated or otherwise disturbed from its natural state. Endemic grassland birds evolved in this landscape comprised of over 1,000 prairie plant species, large herbivores, drought and fire. Some aspects of the habitat that prairie provided which were lost when it was converted to cropland may be reestablished, such as with the Conservation Reserve Program (CRP). Although CRP is very beneficial to grassland nesting birds, especially if in juxtaposition with other grassland, the diversity and ecosystem of native prairie cannot be replaced.

Native prairie is crucial habitat for grassland nesting birds and many other species of wildlife (e.g. Richardson’s ground squirrel, spadefoot toad, Western hognose snake). Grassland birds have higher occurrence and density, less predation, and higher nest success in larger prairie patches. Reproductive success is highest in large blocks of intact grasslands and wetlands for a suite of grassland nesting birds (Stephens and Walker 2007). Many species, such as the Sprague’s pipit, Baird’s sparrow, and chestnut-collared longspur, are area sensitive and favor large tracts of grassland (Johnson and Winter 1999). Brown-headed cowbird brood parasitism is lower in larger blocks of grassland (Shaffer et al. 2003).

Statewide an estimated 70% of the native prairie has been converted to agriculture, urban cities, roads, and other man-made developments (Hagen et. al 2005). Some large blocks of native prairie remain on the landscape, such as within the Missouri Coteau, the glacial lake deltas or sand prairies of McHenry County, the badlands, and the rolling breaks of the Missouri River. Figure 2 represents the larger areas of primary native grassland habitat. This is the most important habitat for ferruginous hawk, Sprague’s pipit, Baird’s sparrow, long-billed curlew, marbled godwit, chestnut-collared longspur and burrowing owl.

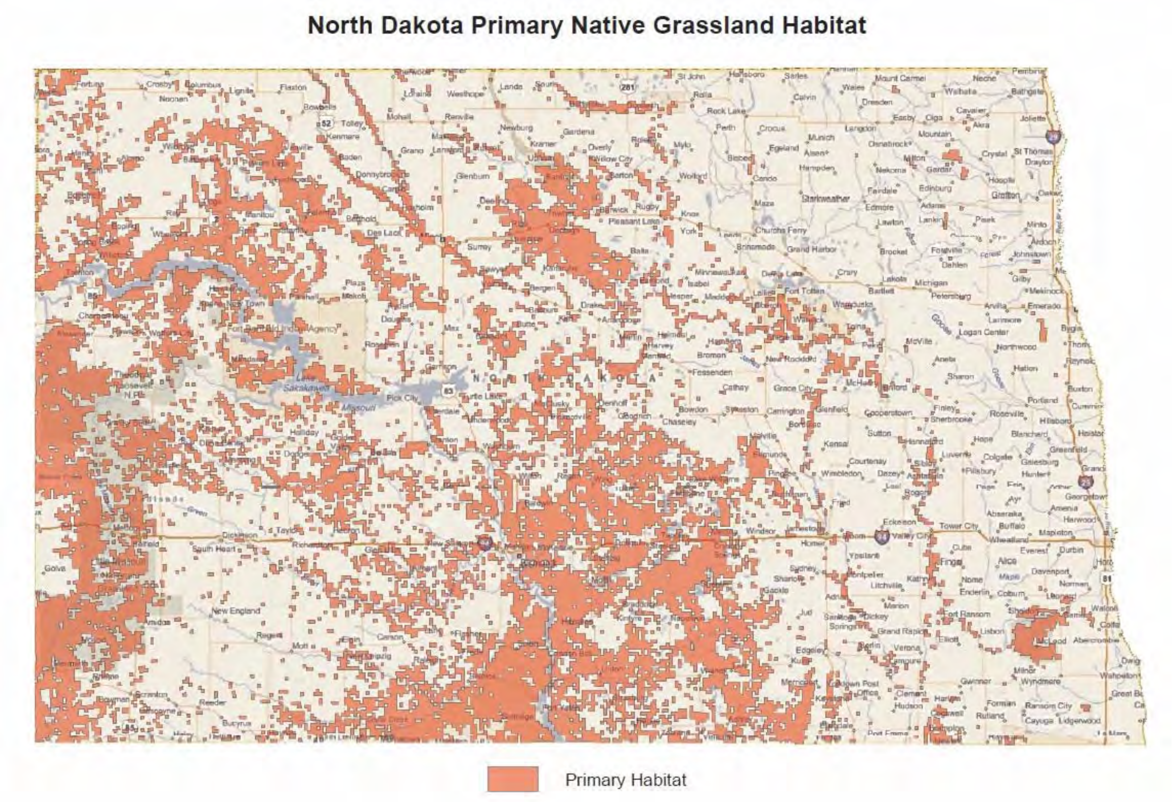


Figure 2. Key native prairie habitat for a suite of grassland birds.

3. OIL AND GAS IMPACTS:

O/G development impacts grassland nesting birds directly by destroying native prairie by way of road development to well sites and well pad construction. More than 6,700 acres of land within the primary native grassland range has been converted to well pads (Table 2).

Table 2. Summary of changing well densities in primary native prairie.

				Well Density						
Year	Range	Area (sq. miles)	Number of Wells	1-2 wells per sq. mile	3-4 wells per sq. mile	5-8 wells per sq. mile	> 8 wells per sq. mile	Total Wells per sq. mile	Percent Range	Well Pad Direct Loss (ac.)
1995	Primary Range	16671	677	311	45	22	1	379	2.3%	1354
2000	Primary Range	16671	848	410	47	28	1	486	2.9%	1696
2005	Primary Range	16671	1098	425	78	42	3	548	3.3%	2696
2010	Primary Range	16671	2123	618	389	51	20	1078	6.5%	6796

O/G development contributes to fragmentation. Grassland fragmentation occurs when large, contiguous areas of similar habitat are separated by a dissimilar feature (e.g. road, shelterbelt, utility line). At a landscape level, ferruginous hawks are negatively associated with fragmentation (McCarthy 2006). Road construction as a part of oil development is fragmenting habitat with a medium to high probability for ferruginous hawk nests (Figure 3). The ferruginous hawk is also sensitive to disturbance. Reproductive success for ferruginous hawks in Utah was negatively influenced where active wells were placed too close to nest sites (Keough 2006).

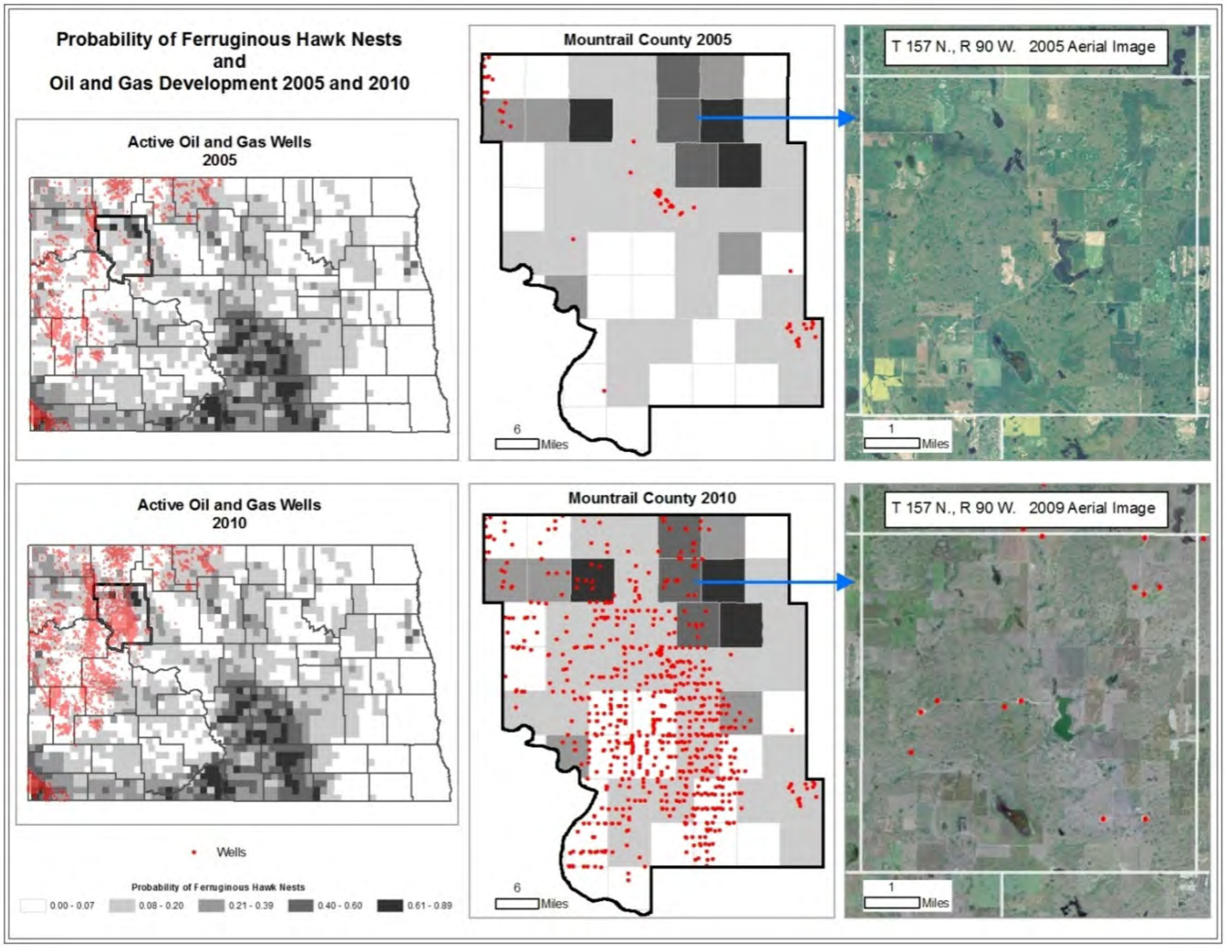


Figure 3. Ferruginous hawk nest probability and O/G development.

Oil production produces waste fluids or E&P waste (exploration and production waste) which is a potential hazard to a variety of wildlife. The waste is either stored in closed tanks, tanks with an open top, or open pits (Figure 4). It is estimated 500,000-1 million birds are killed annually in oil pits (Trail 2006). More than 172 bird species have been recovered from oil pits and four of the top five species were ground feeding passerines (Trail 2006). The meadowlark and lark bunting are two of those five species. Other grassland birds found in oil pits include but are not limited to burrowing owl, Swainson's hawk, grasshopper sparrow, savannah sparrow, and chestnut-collared longspur. As O/G development increases in North Dakota the number of birds and other wildlife killed in oil pits will likely increase too.

Figure 4. An open oil pit (left) and a passerine (right) trapped in the waste fluid. Flagging is not an effective tool to deter avian use of oil pits. Photos courtesy of U.S. Fish and Wildlife Service.

4. MITIGATION:

The primary O/G mitigating factor should be to minimize the destruction and fragmentation of native prairie. Wells should be sited off of existing roads. If a road must be constructed to a well site, the least destruction to native prairie should be sought. For example, if a lease exists on 320 acres of land of which half is native prairie and half existing cropland, the oil well should be placed on the cropland.

To offset impacts of O/G development on native prairie, contributions should be made towards conservation easements or land acquisition of other primary native prairie habitat outside of the core O/G development areas. This will protect the prairie in its natural state. As a secondary option, CRP or other planted grassland, hayland, or subprime farmland could be substituted for native prairie if measures are taken to improve it for the benefit of primary endemic grassland birds. Such measures could include restoring the land to a high diversity of native grass and forbs, implementing sound grazing practices, and removing tree rows which attract predators and brown-headed cowbirds.

To reduce wildlife mortality at oil field waste pits, oil operators should follow solutions outlined by the Environmental Contaminants Program of Region 6 of the U.S. Fish and Wildlife Service. Suggested measures include using closed containment systems (the preferred solution), eliminating pits or keeping oil off of open pits or ponds, and use effective and proven wildlife deterrents or exclusionary devices such as netting. Flagging (as seen in Figure 4), reflectors, and strobe lights are ineffective deterrents. O/G operators who do not follow suggested measures should be fined the appropriate monetary value of species lost to the state due to the destruction or injury of the species caused by improperly maintained oil pits.

As with the golden eagle, spatial buffers should be placed around certain raptor nests. (Table 3). The ferruginous hawk is particularly sensitive to disturbance and O/G development in close proximity to the nest may cause abandonment.

Table 3. Recommended spatial buffers for nests of breeding raptors.

Species	O/G Development Minimum Distance (miles)
Ferruginous hawk	1.0
Swainson's hawk	0.25
Prairie falcon	0.5
Burrowing owl	0.25
Golden eagle*	0.5
Bald eagle*	0.5

* Reiterated from previous section.

5. ADDITIONAL CONCERNS:

Native prairie is at risk from other threats, namely conversion to cropland. Cumulatively in the Missouri Coteau of both North and South Dakota, it is estimated 5.2% of the native prairie was converted to cropland from 1989-2003 (Stephens et al. 2008). Recent high commodity prices continue to encourage more conversion. Invasive species such as Kentucky bluegrass, smooth brome, Russian olive, and leafy spurge also contribute to the degradation of native prairie.

Grassland birds and other non-hunted wildlife are typically not as highly valued by the state's citizens such as with mule deer, sharp-tailed grouse, waterfowl, and other hunted species. But most people do enjoy watching a golden eagle soar or hearing those first meadowlarks singing after a long winter. Wildlife watching is increasing nationwide. Birders in particular are growing in number. These avid bird watchers travel from other states and even countries to add the Sprague's pipit or Baird's sparrow to their life list. It's a small but growing economic benefit to the state of North Dakota.

AQUATIC RESOURCES

1. CURRENT STATUS:

North Dakota Game and Fish currently manages approximately 65 natural lakes and impoundments within the primary oil and gas (O/G) development area of Western North Dakota. In addition, the Williston Reach of the Missouri River and the lower Yellowstone River (Figure 1) along with Lake Sakakawea (Figure 2) are extremely ecologically important regions of the Missouri River System (MRS) within the primary O/G development zone.

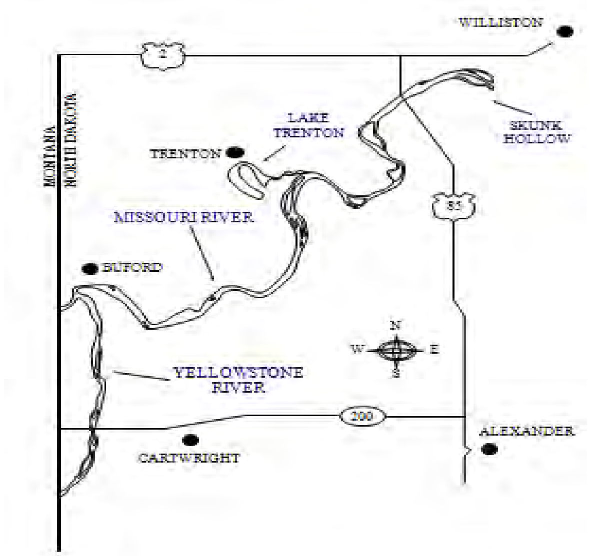
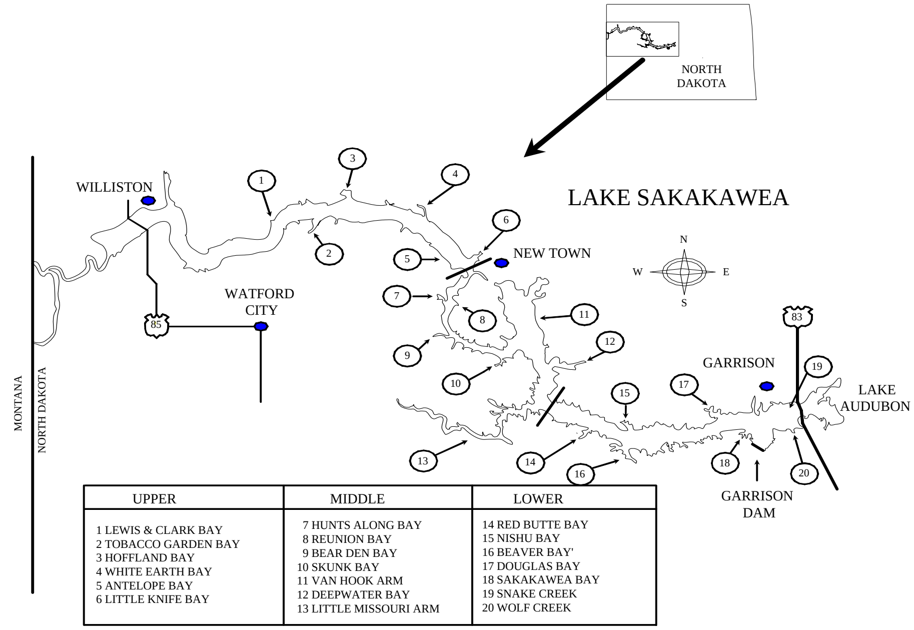


Figure 1. Schematic map of the Williston Reach of the Missouri River System.



UPPER	MIDDLE	LOWER
1 LEWIS & CLARK BAY	7 HUNTS ALONG BAY	14 RED BUTTE BAY
2 TOBACCO GARDEN BAY	8 REUNION BAY	15 NISHU BAY
3 HOFFLAND BAY	9 BEAR DEN BAY	16 BEAVER BAY'
4 WHITE EARTH BAY	10 SKUNK BAY	17 DOUGLAS BAY
5 ANTELOPE BAY	11 VAN HOOK ARM	18 SAKAKAWEA BAY
6 LITTLE KNIFE BAY	12 DEEPWATER BAY	19 SNAKE CREEK
	13 LITTLE MISSOURI ARM	20 WOLF CREEK

Figure 2. Map of Lake Sakakawea showing standard survey locations and regions.

Although Game and Fish does little active management on them, a number of MRS tributaries are important for not only maintenance of biological diversity but also for their substantial contribution to the sportfish populations of Lake Sakakawea and the Williston Reach. Major tributaries include the Little Muddy River in the Williston Reach and Tobacco Garden Creek, White Earth Creek, Little Knife Creek, Shell Creek, Deepwater Creek and the Little Missouri River on Lake Sakakawea.

Angling opportunities throughout the primary O/G region are very diverse. Natural lakes and reservoirs throughout the region primarily serve local anglers and are managed for a variety of species, including yellow perch, walleye, northern pike, largemouth bass, smallmouth bass, bluegill and rainbow trout. The MRS within the O/G region supports an outstanding sport fishery that is extremely important to the local and regional economy. Annually about 30% of North Dakota resident anglers fish the MRS. Even though the drought of the last decade dramatically impacted the sport fishery of Lake Sakakawea, it still remains one of the most popular fisheries in the state. During most years anglers expend over 1 million hours of open water fishing effort on Lake Sakakawea (Figure 3). Annual angler expenditures have approximated $40 million in some years (Schultz and Rosenberger 2004) and sportfish harvest on Lake Sakakawea has exceeded 500,000 in some years (Fryda et al. 2010).

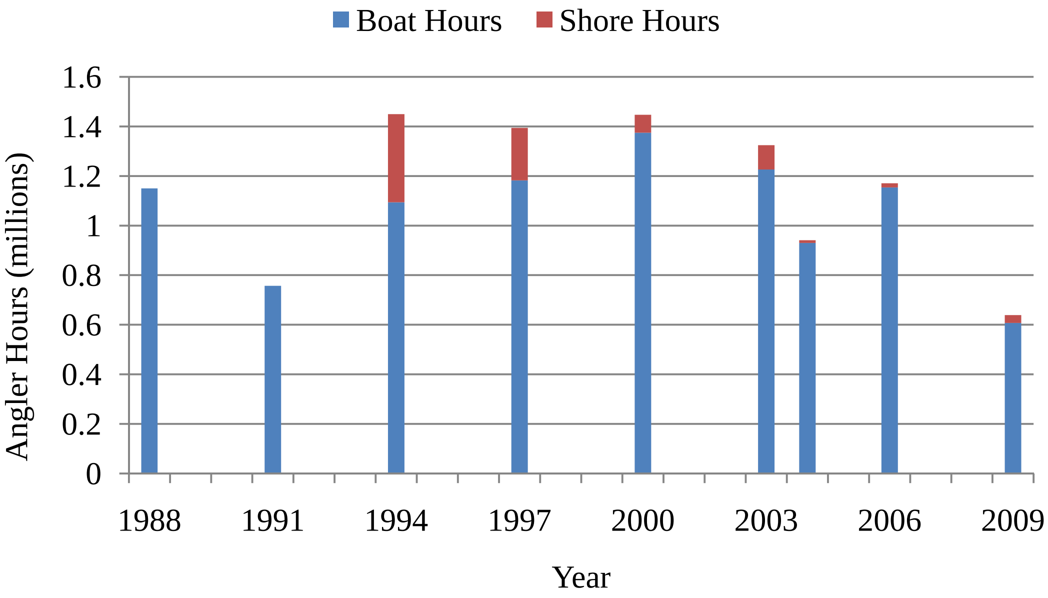


Figure 3. Estimated angler effort for Lake Sakakawea, 1988-2009. Shore effort was not estimated in 1988 or 1991.

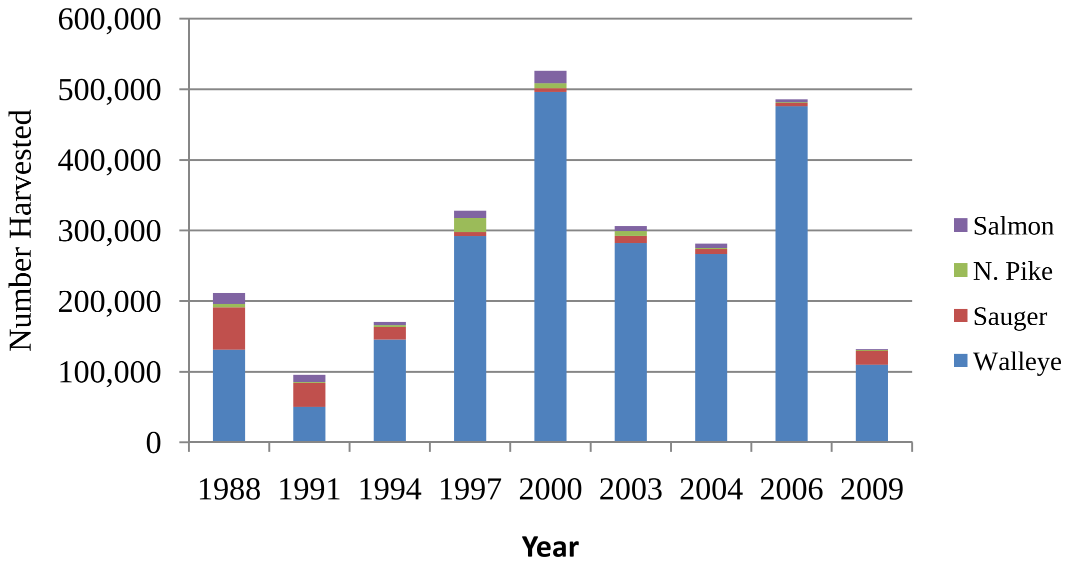


Figure 4. Angler harvest of the major sport fish in Lake Sakakawea, 1988-2009.

The Williston Reach of the MRS and the lower Yellowstone River support an exceptional paddlefish snag fishery that is jointly managed by ND Game and Fish and the Montana Fish, Wildlife and Parks (Scarnecchia et al. 2008). Snaggers historically expended 50-70,000 hours of effort to harvest 1,500 to more than 2,000 paddlefish, but more restrictive harvest caps in recent years have reduced the annual effort to approximately 20,000 hours and a harvest of 1,000 fish (Figure 5).

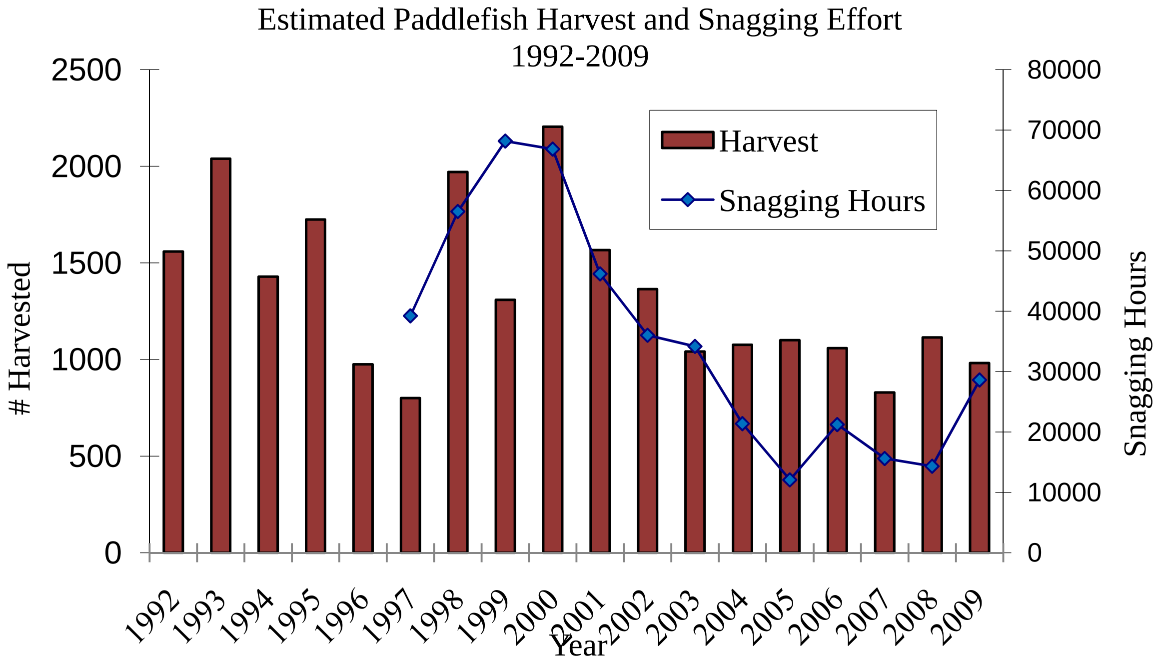


Figure 5. Estimated paddlefish harvest and snagging effort in the Williston Reach, 1993-2009.

The large recreational base supported by the outstanding sport fishery includes numerous boat ramps, docks and other developed amenities throughout Lake Sakakawea and the Williston Reach of the Missouri River (Table 1). The NDGF along with other entities manage over 35 recreation areas within the Williston Reach and Lake Sakakawea.

Table 1. Number of Missouri River System Development Amenities within the primary O/G development area of North Dakota.

	Recreation Sites	Usable Boat Ramps	Public Courtesy Docks	Cleaning Stations	Toilets
Williston Reach	3	3	1	0	4
Sakakawea[a]	35	48	65	21	51

[a] - assuming Lake Sakakawea is at the base of flood control pool (1838 ft. msl).

2. HABITAT:

Maintaining adequate water quality and quantity are the primary challenges facing fisheries management in the O/G development area of Western North Dakota. The dry climate of the region (generally 14 – 16 inches of annual precipitation) combined with frequent droughts often leaves adequate surface water in short supply. District lakes are especially prone to water shortages as most have storage capacities of less than 5,000 acre-feet with many well below 1,000 acre-feet. Water quality issues facing district lakes are exacerbated by the large watershed to surface ratio of most lakes. Poor grazing and land management practices coupled with the erosive nature of the soils in the arid region often lead to excessive levels of sedimentation and nutrients. While several EPA 319 studies have documented water quality issues on several district lakes, applying Best Management Practices (BMP) in sufficient quantity to large watersheds has been problematic. Relevant to the MRS, water level management is also a primary challenge. Local precipitation influences river flows and reservoir elevation but water level issues are generally much more systemic in nature than district lake levels. Flows into Lake Sakakawea are highly variable both seasonally and annually (Figure 6) and long-term droughts have caused reservoir elevations to fall below the critical level of 1825 msl resulting in a greatly compromised sport fishery at times (Figure 7).

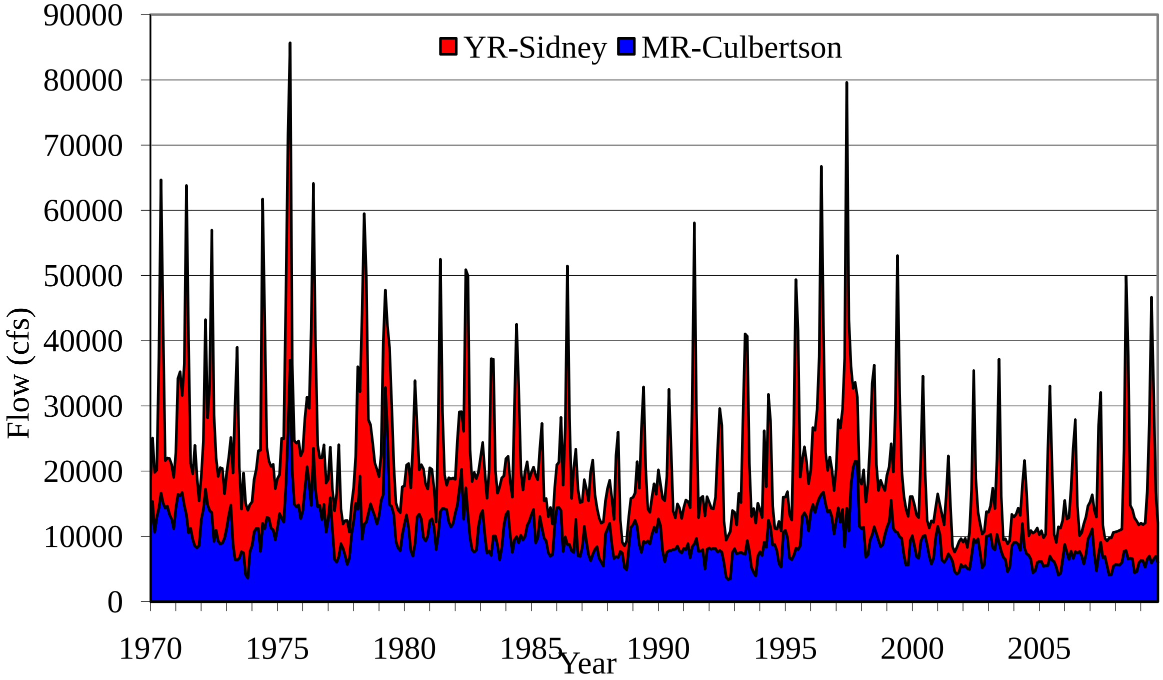


Figure 6. Average monthly flows in the Missouri and Yellowstone rivers above Lake Sakakawea, 1970-2009 (USGS data). Flows are stacked to illustrate combined inflow.

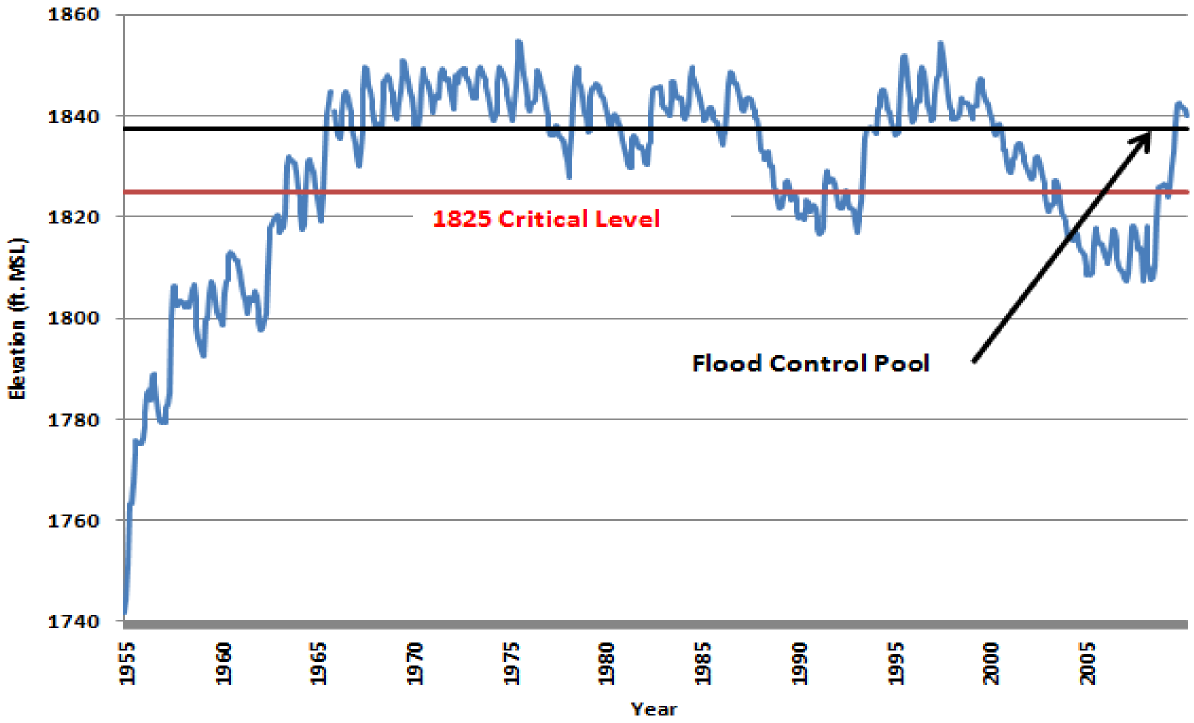


Figure 7. Maximum monthly water levels on Lake Sakakawea, 1954-2009.

Impoundment of the MRS has transformed the aquatic environment into a biologically diverse community of both native and non-native fishes. Forty-three native species and 22 non-native (including unknown patronization) species of fish (Table 2) have been identified by the North Dakota Game and Fish Department (NDGFD) during sampling of North Dakota's MRS since 1956 (this does not include any sub-basin tributary sampling). In 2009 alone, forty-six species were documented in North Dakota including six introduced coldwater species.

Table 2. Fish species list including number of years captured (through 2009) by the department, patronization and overall status – Missouri River System^{z}. Red font denotes species recovered in 2009.

SPECIES	Williston Reach (19 years)	Lake Sakakawea (53 years)	Garrison Reach (19 years)	Lake Oahe (43 years)	Patronization	Overall Status in the MRS
Pallid sturgeon*	12	15		7	N	SD
Shovelnose sturgeon	13	26	17	26	N	U
Paddlefish*	17	32	16	17	N	S
Shortnose gar	6	12	19	35	N	S
Gizzard shad			6	7	N	a
Goldeye	12	53	18	43	N	S
Lake whitefish		18			I	S
Cisco	1	18	14	3	I	S
Coho salmon		8		1	I	A
Chinook salmon		32	16	6	I	S
Rainbow trout		28	14	2	I	S
Brown trout		21	16		I	S
Lake trout		9	3		I	S
Cutthroat trout			11		I	S
Rainbow smelt		37	18	18	I	S
Northern pike	12	53	19	39	N	S
Common carp	13	53	19	43	I	S
Banded killifish			7		I	U
Brassy minnow	1	4	2	1	N	U
W. Silvery minnow	3	30	6	12	N	S
Plains minnow	3	21	3	5	N	S
Fathead minnow	2	43	18	25	N	S
Creek chub	1	17		8	N	U
Flathead chub*	3	15	1	3	N	S
Sturgeon chub*	2				N	U
Sicklefin chub*	1	1			N	U
Golden shiner	4	27	11	23	N	U
Emerald shiner	7	35	18	21	N	S
Common shiner		9	12	5	N	U
Sand shiner	1	6	6	2	N	U
Spottail shiner	2	30	19	32	I	S
Red shiner		1	7		N	U
N. Redbelly dace*		4	1		N	U
Finescale dace*			1		N	U
Longnose dace		1	4	4	N	U
River carpsucker	12	50	19	39	N	S
Longnose sucker	3	12	19	10	N	S
White sucker	8	53	19	40	N	S
Blue sucker*	7	16	18	29	N	S
Smallmouth buffalo	18	46	16	29	N	S
Bigmouth buffalo	18	52	19	37	N	S
Shorthead redhorse	7	51	18	38	N	S

Table 2 cont.. Fish species list including number of years captured (through 2009) by the department, patronization and overall status – Missouri River System[z]. Red font denotes species recovered in 2009 (cont.).

SPECIES	Williston Reach (19 years)	Lake Sakakawea (53 years)	Garrison Reach (19 years)	Lake Oahe (43 years)	Patronization	Overall Status in the MRS
Black bullhead	11	52	15	33	N	S
Yellow bullhead*	6				I	U
Channel catfish	12	53	19	42	N	S
Flathead catfish*		3		12	N	SD
Stonecat	3	27	6	8	N	U
Tadpole madtom	3	15	2	11	N	S
Burbot	3	42	16	23	N	S
Brook stickleback		9	9	2	N	U
White bass	13	40	19	43	I	S
Green sunfish		6	1	17	I	U
Pumpkinseed	1	9	5	19	U	U
Orangespotted sunfish	2	9	14	26	U	U
Bluegill		6	18	30	I	U
Smallmouth bass		38	18	20	I	S
Largemouth bass	2	1	15	10	I	U
White crappie	13	53	13	39	I	S
Black crappie	13	53	18	41	I	S
Iowa darter		9	7		N	U
Johnny darter		34	18	16	N	S
Yellow perch	10	53	19	41	N	S
Walleye	13	53	19	42	N	S
Sauger	12	53	18	41	N	S
Freshwater drum	12	53	17	41	N	S

[z] – note: sampling effort among reaches is not equal.

Patronization

N - Native
I - Introduced
U - Unknown (may be native to North Dakota but unsure for the MRS)

Current Status

SD - Significant Decline
S - Stable to increasing
U - Unknown (often due to a small sample size and/or infrequent collections)
A - Absent (no longer stocked)
a - recently recovered in Lake Oahe; newly established in North Dakota
* - official North Dakota species of conservation priority

North Dakota's MRS contains the states only federally listed endangered species, the pallid sturgeon. Additionally, 7 MRS fishes are identified in the North Dakota Wildlife Action Plan (Hagen et al. 2005) as 'Species of Conservation Priority (Table 3)

Table 3. Missouri River System 'Species of Conservation Priority' identified in the North Dakota Game and Fish Department's Wildlife Action Plan.

Species	**Level-I**[a]	**Level-II**[b]	**Level-III**[c]
Sturgeon Chub	X		
Sicklefin Chub	X		

Blue Sucker	X		
Paddlefish		X	
Northern Redbelly Dace		X	
Flathead Chub		X	
Flathead Catfish			X

[a] Species in greatest need of conservation.
[b] Species in need of conservation, but that have had support from other wildlife programs.
[c] Species in moderate need of conservation, but are on the edge of their range in North Dakota.

Williston Reach of the MRS

Of the approximately 350 miles of the Missouri River System (MRS) in North Dakota, there are roughly 50 miles of the Yellowstone and Missouri rivers above Williston that remain semi-natural in terms of form and function. This area, termed the Williston Reach, is truly unparalleled not only in North Dakota but throughout the Missouri River Basin, due primarily to the influences of the Yellowstone River (Power and Dyke 2002).

The Williston Reach is unique along the entire MRS because it exhibits characteristics of two very dissimilar rivers. The Yellowstone River is basically unregulated, displaying seasonally high flows of turbid water (Power and Dyke 2002). The average annual flow of the Yellowstone River at Sidney, Montana is 12,380 cfs (based on 96 years of record). The maximum instantaneous flow was estimated at 159,000 cfs on June 2, 1921. The lowest annual mean flow (5,672 cfs) occurred in 2004 (Fryda et al. 2010). Unfortunately due to upstream water depletions, the flows of the Yellowstone River have decreased approximately 24% from historical flows.

Within North Dakota the Williston Reach of the MRS has experienced the least amount of change. Not surprisingly, the fishery remains dominated by turbid, native riverine species such as paddlefish, sauger, buffalo (spp.), and river carpsucker (Table 2). The Williston Reach fishery is also substantially influenced by Lake Sakakawea. The Yellowstone-Sakakawea stock of paddlefish likely became far more abundant in the first two decades after Lake Sakakawea initially filled due to the establishment of good rearing habitat in upper Lake Sakakawea (Scarnecchia et al. 2008). Additionally, the Williston Reach appears to have a strong influence on sauger population dynamics in Lake Sakakawea with good reproduction linked to favorable flows from the Yellowstone (Fryda 2002). The sport fishery of the Williston Reach is dominated by paddlefish (snagging) in May, sauger during the spring and fall months, and channel catfish throughout the open water period. Walleye and northern pike also provide limited fisheries.

The Williston Reach is also the primary habitat of North Dakota's only federally endangered fish species, the pallid sturgeon. Extensive amounts of pallid sturgeon research and recovery efforts are currently being done in the Williston Reach by various federal agencies. Details on current research can be found at http://www.moriverrecovery.org/recover.htm. Additionally the Williston Reach is the stronghold of several North Dakota Species of Conservation Priority (Table 3), including sturgeon chub, sicklefin chub, blue sucker, paddlefish and flathead chub (Hagen et al. 2005).

ND Game and Fish is currently involved in numerous paddlefish monitoring and research activities within the Williston Reach. Most activities are undertaken in cooperation with staff from the University of Idaho. Early in 2008 ND Game and Fish, MT Fish, Wildlife and Parks, and the University of Idaho finalized a joint paddlefish management plan for Montana and North Dakota paddlefish stocks and fisheries (Scarnecchia et al. 2008). The extensive amount of paddlefish research conducted on the Williston Reach has provided a tremendous amount of information relative to critical habitat areas for paddlefish. The Lake Sakakawea/Yellowstone stock of paddlefish is likely one of the most scientifically understood populations in the world. Much of the information gained over the years was instrumental in development of maps presented in this report that delineate sensitive areas to avoid for water depot development. The extensive knowledge of this stock of paddlefish has highlighted the need to maintain high river flows to enhance paddlefish reproduction, particularly on the Yellowstone River, as well as high water levels within Lake Sakakawea to enhance survival and growth of juvenile paddlefish.

Lake Sakakawea

Garrison Dam located at river mile 1390, was closed in April of 1953, creating the largest of the Missouri River mainstem reservoirs, Lake Sakakawea. At a maximum surface elevation of 1855 feet mean sea level (msl), the lake has a storage capacity of approximately 23.8 million acre feet and covers 385,615 surface acres (Figure 2). Approximate dimensions of the lake at 1838 ft. msl (base of flood control pool) include: total length of nearly 200 miles, shoreline of 1,346 miles, average depth of 62 feet, and maximum depth of 177 feet. The drainage basin covers approximately 181,400 square miles. The historic exchange rate of water for Lake Sakakawea is 1.4 years. The average annual summer surface temperature is 19^{o} C which is colder than all other mainstem reservoirs.

Since Lake Sakakawea filled in 1967, the reservoir has fluctuated from a high of 1854.9 ft. msl in July 1975 to a low of 1805.8 ft. msl in May 2005. This 50 foot fluctuation amounted to a difference between high and low water marks of 172,884 surface acres and 13,959,592 acre-feet of water. At 1805.8 ft. msl Lake Sakakawea contained approximately 40% of full pool volume. In August 1995 and July 1997, Lake Sakakawea reached elevations of 1852 and 1854.4 ft msl respectively, which are the second and third highest levels on record. Conversely, during the most recent drought Lake Sakakawea largely remained below the previous droughts low of 1815 ft. msl from 2004 – 2008.

Lake Sakakawea supports a diverse fish community of native and introduced species. Since fisheries investigations began in the 1950's a total of 58 species have been sampled including 42 native and 16 introduced (Table 1). The Lake Sakakawea sportfishery is dominated by walleye with sauger, northern pike and Chinook salmon rounding out the top sportfish (Brooks and Fryda 2010).

Lake Sakakawea is subjectively divided into three regions based on criteria outlined by Kimmel et al. (1990) to evaluate spatial differences in fish populations within the reservoir (Figure 10). Region 1 represents the upper-third riverine zone and includes the following sampling stations: Lewis and Clark State Park, Tobacco Garden Bay, Hofflund Bay, White Earth Bay, Antelope Flats and Little Knife Bay. The mid-section transition zone or Region 2 includes: Reunion Bay, Hunts Along Bay, Bear Den Bay, Skunk Bay, Van Hook Arm, Deepwater Bay and Little Missouri Bay. Region 3 is the lower third lacustrine zone of the reservoir and includes: Red Butte Bay, Nishu Bay, Beaver Bay, Douglas Bay, Sakakawea Bay, Snake Creek Area and Wolf Creek Area. The vast majority of O/G activity related to Lake Sakakawea is located in Regions 1 and 2 of the reservoir. Unfortunately, these regions also harbor some of the most ecologically critical areas of the reservoir for both sportfish and Species of Conservation Priority. Perhaps most notably is that the turbid headwater regions (generally above White Earth Bay) of Lake

Sakakawea are critically important rearing areas for age-0 and age-1 paddlefish (Fredericks 1994; Fredericks and Scarnecchia 1997; Scarnecchia et al. 2008).

For the purposes of this report an extensive description on the Lake Sakakawea fishery will not be attempted. An exhaustive report on the historic and present status of the Lake Sakakawea fishery can be found in Fryda et al. 2010. Instead, this report will concentrate on what our long-term data sets indicate are possible conflicts with O/G development. North Dakota is fortunate to have over a 40 year data set on the Lake Sakakawea fishery. Many of these long-term surveys provide exceptional insight into which areas of the reservoir are the most ecologically sensitive and have the most chance of experiencing significant impact due to O/G development.

Much of the most biologically significant areas of aquatic habitat in North Dakota's MRS lie well within the boundaries of the primary O/G development area. Consequently, responsible O/G development is critical not only for sportfishery management but also for maintenance of biological diversity.

3. OIL AND GAS IMPACTS:

In ND the three primary areas of concern for aquatic resources due to O/G development include 1) direct impacts due to spills, 2) impacts due to water usage, and 3) impacts to anglers and recreational infrastructure. The most critical of these primary issues differs among district lakes and the MRS.

District Lakes

As mentioned earlier, the most critical issue facing district lake management in the primary O/G development area is one of water volume. Current hydrofracking techniques used to develop the Bakken and Three Forks Sanish formations use tremendous amounts of water. This is especially critical given the general arid nature of the region.

Shaver (2010) outlined water availability for oil well development in ND during the 2010 Missouri River Natural Resources Conference. The presentation outlined 1) water demand for oil development 2) surface water availability other than the MRS, 3) ground water availability, and 4) surface water from the MRS. Projections suggest the 1,500 to 1,800 wells per year over the next 10 years will drilled within the primary O/G development area. Water volumes required to fracture new wells generally range from 1.5 to 4.0 million gallons per year resulting in an annual water demand of 69,000 acre-ft/year to 331,000 acre-ft per/year. As mentioned before, district lakes generally have storage volumes of less than 5,000 acre-feet with many less than 1,000 acre-feet. Using water from district lakes for O/G development should not be permitted under any circumstances do to already chronic water shortage issues. Additionally Shaver (2010) noted that other surface waters (primarily tributaries) and shallow aquifers were already over taxed in many locations and are not desirable options for future O/G development.

Trenton Lake located near Williston is the only oxbow lake on the MRS in North Dakota capable of supporting a viable sport fishery. Unfortunately, Trenton Lake provides a good case history on the huge impact that can result from allowing the O/G industry access to the limited water quantities that are available in district lake waters. Prior to the fall of 2009, the only existing water withdrawal permit (#3570) from Trenton Lake was issued by the State Water Commission (SWC) in 1982 to Steve Mortenson. The permit was for 92 acre-feet of water to be used by Mr. Mortenson for irrigation. Mr. Mortenson was issued a second temporary permit (#1400A) in October of 2009 for an additional 500 acre-feet of water for a water depot for industrial water sale to the O/G industry. In February of 2010, Mr. Mortenson applied for a conditional water permit for 5,000 acre-feet of water. During the public review and agency comment period, NDGF expressed to the SWC its serious concerns regarding the fish, wildlife and recreational impacts associated with the use of this volume of water from Trenton Lake. Trenton Lake has a total volume of only 2,800 acre-feet of water, so a request to annually remove 5,000 acre-feet of water raised huge concerns regarding the lake's fish and wildlife resources. The events surrounding Trenton Lake water permits dramatically illustrate the importance of excluding to the extent possible industry from securing water from anywhere but the MRS. Furthermore this case largely illustrates the failure of the water permitting process to adequately consider public trust responsibilities when allocating surface waters.

Williston Reach and Lake Sakakawea

To the extent possible industry should be encouraged to secure water from the MRS and rely on existing intakes and depot locations. Current fracking techniques require large quantities of water and annual water demands for O/G development may exceed 300,000 acre-feet in coming years (Shaver 2010). While this amount of water withdrawal would critically deplete ground water and district lake surface waters it represents a relatively small percentage of Lake Sakakawea's full pool volume of 23.8 million acre-feet. Water level management will always be a challenge to management of the Lake Sakakawea fishery. However, the quantities of water withdrawn will likely not be overly taxing on the MRS water regime.

The two major areas of potential impact on MRS aquatic resources due to O/G development include direct loss of biota due to spills and water intakes and the secondary effects to recreational infrastructure resulting from the dramatic increase in truck traffic. Unfortunately, much of the most intense O/G development pressure coincides with areas where NDGF surveys consistently show the highest abundances of both adult fishes (Figure 8) and young-of-year fishes (Figure 9). Standard sampling locations that consistently show the highest catch rates as well as high O/G development pressure include locations in the Van Hook Arm and most locations in the upper region of the reservoir from Little Knife to Lewis and Clark State Park. Additionally many of these same areas have shown to be critical habitat areas for paddlefish rearing (Scarnecchia et al. 2008). Significant direct losses of aquatic biota in these areas could result from industrial spills as well as improperly placed and designed water intakes. A secondary impact of intensified O/G development in these areas is the substantial impact to the infrastructure of recreational areas. Poorly placed water depots will add additional stress to already overtaxed roads and have the potential to significantly impact recreation users of the MRS. As stressed before all efforts should be made to encourage industry to combine future intakes with existing intake locations. Additionally, future approved water depots should avoid major recreational areas.

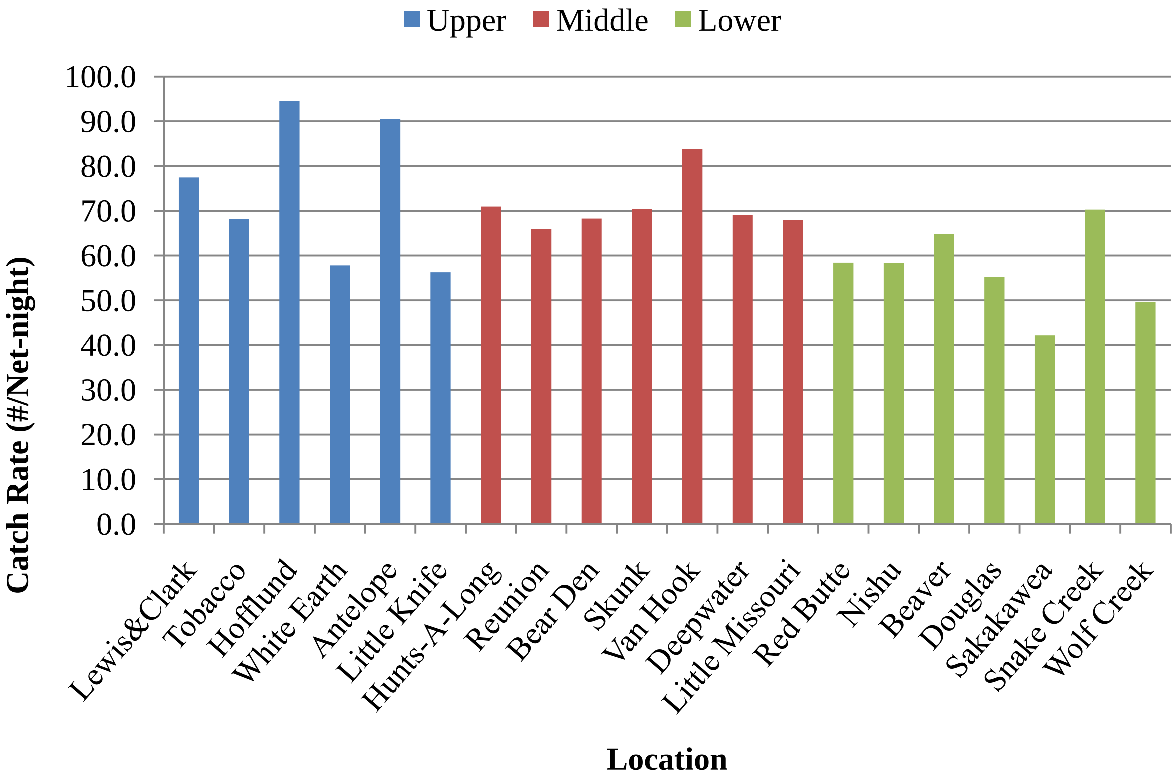


Figure 8. Mean catch rate of adult fish by location in 250 ft gill nets, Lake Sakakawea, 1968-2009.

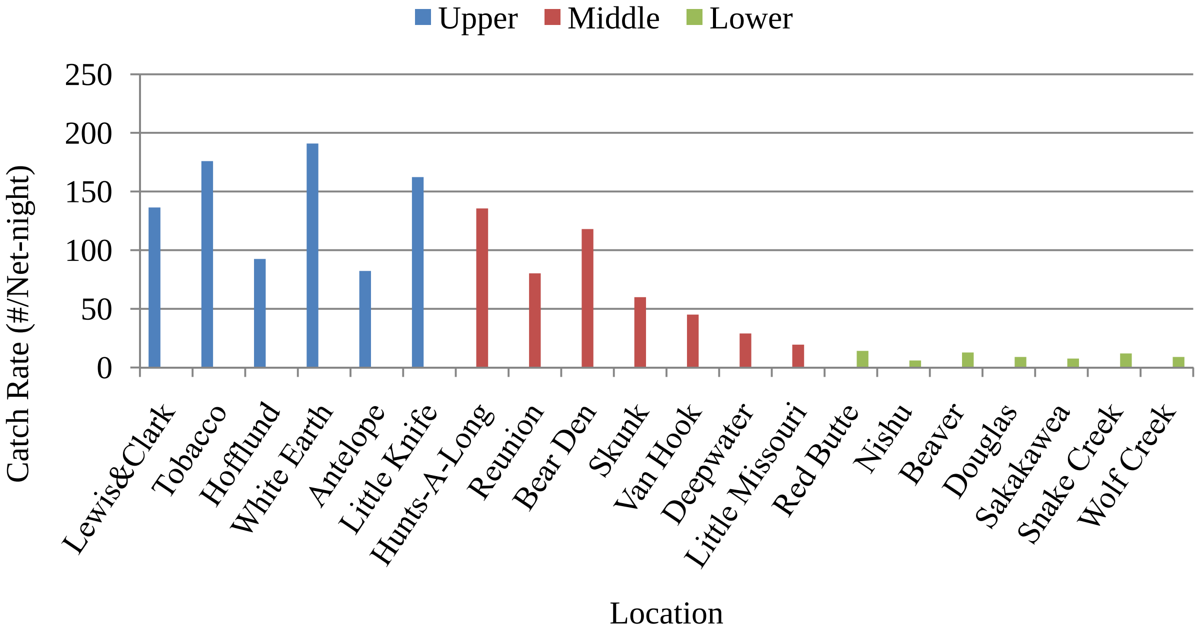


Figure 9. Mean catch rate of YOY fish by location in gill nets, Lake Sakakawea, 1970-2009.

4. MITIGATION:

Generalized strategies to minimize O/G development impact, including spill prevention are presented in the introductory portion of this document. In this chapter only aquatic specific impact avoidance strategies will be addressed. These include spill response in critical areas, riparian protection and water intake guidelines.

Spill Response

In 1997 the U.S. Fish and Wildlife Service produced the Oil Spill Response Planning Report for the Yellowstone and Missouri Rivers Confluence Area. The project was initiated to minimize the environmental impacts of an oil spill on important fish, wildlife, recreational, and cultural resources in the environmentally sensitive areas of the Williston Reach (USFWS 1997). The report attempted to facilitate timely and effective spill response among oil companies, State and Federal Agencies and irrigation districts.

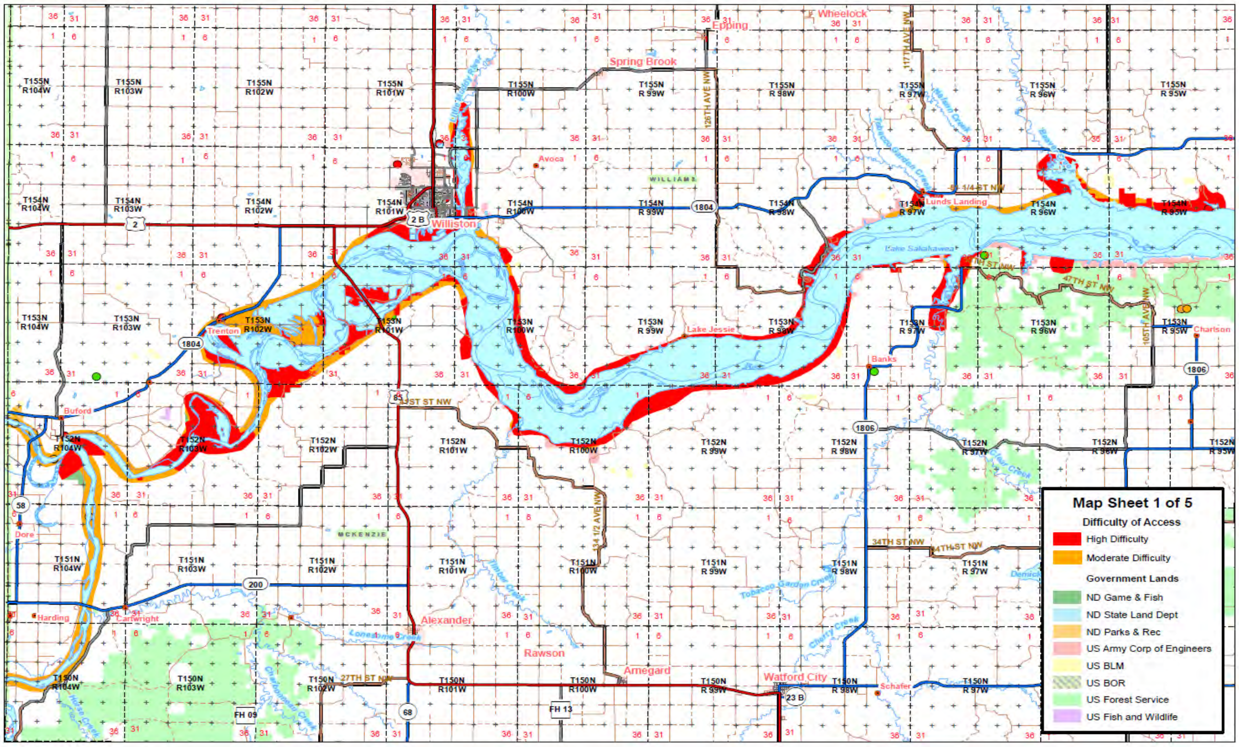
Recommendations in the report included:

> The Fish and Wildlife Service and North Dakota Game and Fish Department should work with the North Dakota Industrial Commission to identify high risk spill sites adjacent to important endangered species habitats or other important natural resource areas.
>
> The ND Industrial Commission should require the highest level of protection possible at these high risk spill sites. Such as:
>
> > Spill Prevention Control and Counter Measures Plans (SPPC Plans) should be kept current and on file at the ND Industrial Commission.
> >
> > Wells and storage facilities located in areas grazed by cattle should be fenced.
> >
> > Operators should be able to deploy containment equipment and experienced spill response personnel within 4 hours of the reported spill.
> >
> > Containment dikes should be installed around all high risk spill sites, be constructed of impermeable material, and be able to contain all hazardous substances on site.
>
> The ND Department of Health should develop guidelines for when a spill is considered ‘cleaned up’ and give final clearance before the owner is to resume operation.
>
> A cooperative agreement should be developed between the ND Division of Emergency Management, the U.S. Fish and Wildlife Service, and the ND Game and Fish Department so that the Service and the Department are notified when hazardous substances are spilled into waters of the United States, such as lakes, rivers and wetlands.

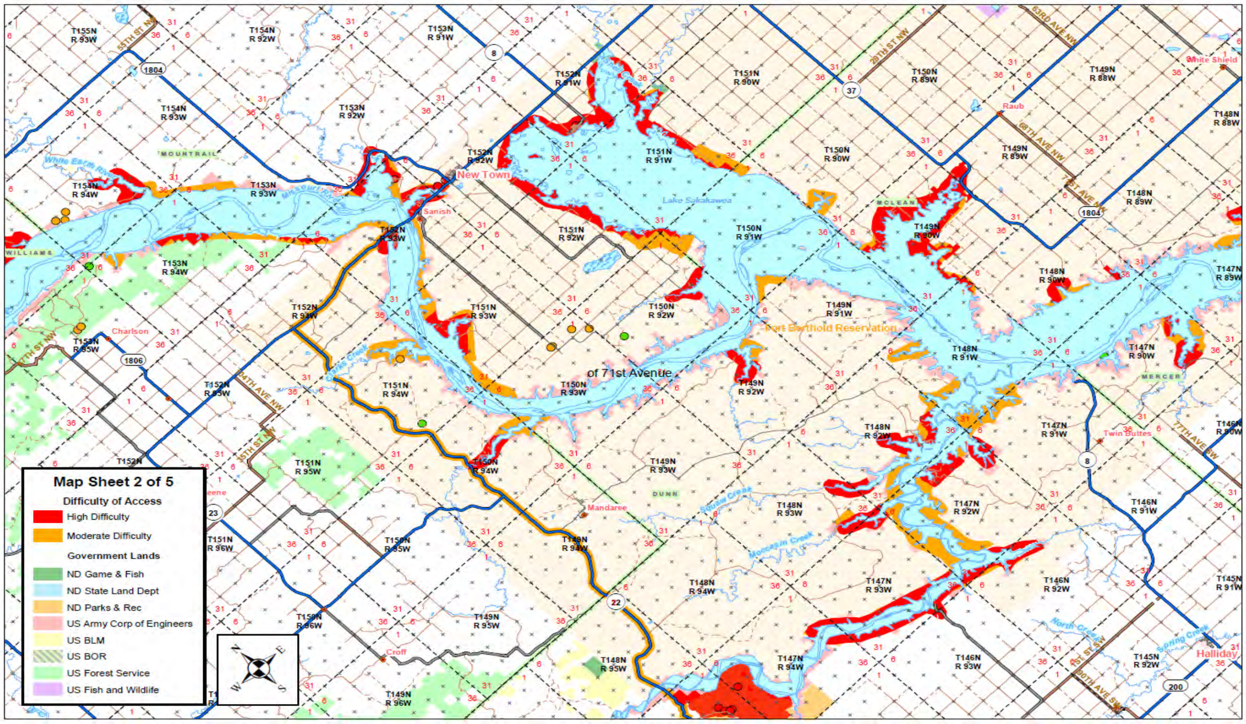
The initial guidance provided by this report was noteworthy and relevant at the time. However, the rapid expansion of O/G development in these critical and the dated nature of the report indicate these efforts should be revisited to more appropriately reflect contemporary conditions.

Water Intakes.

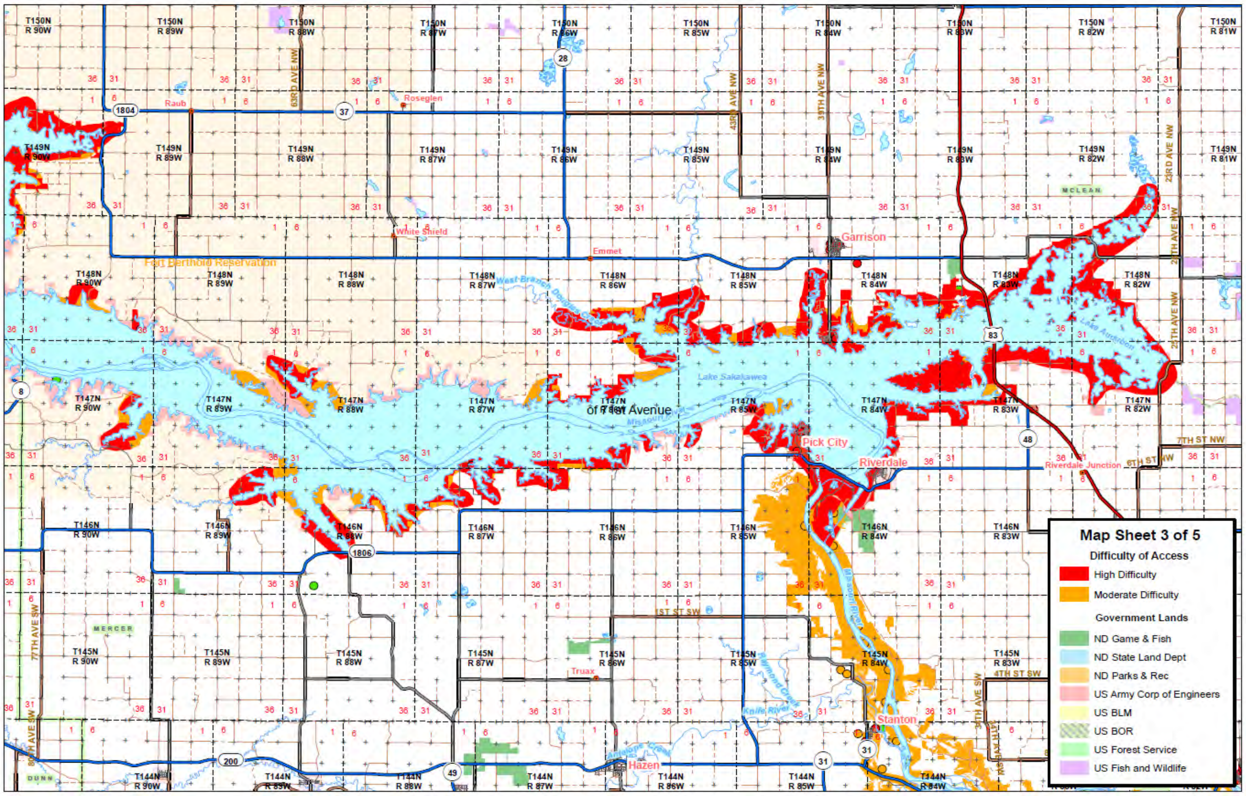
Recent efforts by the State Engineers Office have focused on developing a more streamlined process for water depot development on the MRS. The amount of time required to complete the proper Corp of Engineers permitting process is directly related to the potential damage to historical, cultural and fish and wildlife resources. State and federal agencies were consulted and a series of maps of the MRS in North Dakota were developed to delineate which areas would likely have the least difficulty in obtaining permits for future water withdrawal. Maps of the entire MRS were developed but only Maps 1 – 3 are depicted below for the purposes of this report. Agencies consulted in development of these maps included the Corps of Engineers, State Water Commission, Game and Fish, ND Historical Society, U.S. Fish and Wildlife Service and the ND Parks and Recreation Department. These maps are not definitive in nature but provide a good ‘first cut’ level of guidance for potential water users.



Map 1.


Map Sheet 2 of 5
Difficulty of Access
High Difficulty
Moderate Difficulty
Government Lands
ND Game & Fish
ND State Land Dept
ND Parks & Rec
US Army Corp of Engineers
US BLM
US BOR
US Forest Service
US Fish and Wildlife
New Town
Lake Sakakawea
Fort Berthold Reservation
Mandaree
Twin Buttes
Halliday
MOUNTRAIL
MCLEAN
DUNN
MERCER
WILLIAMS

Map 2.


Map Sheet 3 of 5
Difficulty of Access
High Difficulty
Moderate Difficulty
Government Lands
ND Game & Fish
ND State Land Dept
ND Parks & Rec
US Army Corp of Engineers
US BLM
US BOR
US Forest Service
US Fish and Wildlife
Garrison
Pick City
Riverdale
Stanton
Hazen
Lake Sakakawea
Fort Berthold Reservation
White Shield
Emmet
Roseglen
Raub
Truax
MCLEAN
MERCER
DUNN

Map 3.

North Dakota Game and Fish routinely provides comment on proposed water intakes around Sakakawea. The following are current guidelines for water intakes on the Missouri and Yellowstone Rivers in North Dakota.

Water intakes shall not be located in areas identified by resource agencies as primary spawning and nursery areas for T&E species or species of special concern.

Intake velocity shall not exceed ½ foot per second, except in areas identified by resource agencies as secondary spawning and nursery areas, the intake velocity shall not exceed ¼ foot per second.

Intake screens with a mesh opening of ¼ inch or less shall be installed, inspected annually, and maintained.

For Johnson intake screens, the maximum width between wires shall not exceed 1/8 inch.

Only floating intakes shall be installed in the Yellowstone River and in that portion of the Missouri River above river mile 1519 in Williams and McKenzie Counties to minimize potential impacts to larval pallid sturgeon.

- Intakes shall be located over water with a minimum depth of 20 feet.
- If the 20 foot depth is not attainable, the intake shall be located over the deepest water available at the start of the irrigation season.
- If the water depth falls below 6 feet the intake shall be moved to deeper water or maximum intake velocity limited to ¼ foot per second, with intake placed over maximum practicable attainable depth.

Intakes located in Lake Sakakawea, below river mile 1519, and the Missouri River below Garrison Dam shall be submerged.

- At the beginning of the irrigation season, the intake shall be placed at least 20 vertical feet below the existing water level.
- The intake shall be elevated 2 to 4 feet off the bottom.
- If the 20 foot depth is not attainable, then the intake velocity shall be limited to ¼ foot per second, with intake placed at maximum practicable attainable depth.

Pumping plant sound levels shall not exceed 75 DB at 50 feet.

The project area shall be kept clean and free from discarded material.

Fuel storage tanks above ground shall be diked, curbed or other suitable means provided to prevent the spread of liquids in case of leaking in the tanks or piping. Such dike, curbed area or device shall have a capacity at least equal in volume to that of the tanks plus 10 percent.

Riparian Protection

Responsible O/G development close to or within stream habitats and riparian corridors is especially critical. Impacts to riparian habitats can occur both during the development stage (increased erosion) and production stage (spill and or/infrastructure failure) of O/G development (American Fisheries Society 2010). To reduce the risk of potential impacts in sensitive stream and riparian corridors, Wyoming Game and Fish (2009) proposed the following guidelines which have been slightly modified to for North Dakota.

– No drilling activity or disturbance should be permitted within 500 feet of a riparian area, wetland or stream channel. Apply a standard NSO stipulation to all riparian zones and a 500-ft corridor extending from the outermost limit of the riparian habitat.

– Drilling should not be permitted on slopes exceeding 25%.

– Line reserve pits with a suitable, impermeable barrier to prevent possible contamination of soil and groundwater.

–Design drill pad sites to disperse storm water runoff onto upland sites using proper erosion and sediment control techniques. Construct sediment retention ponds in situations where excess storm water may transport sediment into streams.

– Discharges from other than reserve pits should meet NDDOH standards or otherwise assure the discharged water is of suitable quality.

– All pipeline crossings of a watercourse should be protected against surface disturbances and damage to the pipeline, to prevent a possible spill event.

– Pipelines that convey fluids should be fitted with shutoff valves at all high quality stream crossings based on a case by case consultation with the NDGF biologists.

– Any pipeline crossing of a stream should be accomplished by boring underneath the stream. Trenching may be used for stream crossing based on a case by case consultation with the NDGF biologists. If the pipeline crossing will be trenched, consult with NDGF biologist to determine avoidance periods during critical fish spawning seasons, time limits for instream excavation work, and other management practices that apply.

– Pipeline crossings can be installed through ephemeral streams by trenching. Use appropriate size riprap to stabilize stream banks. Place riprap from the channel bottom to the top of the normal high water line on the bank at all stream crossings. We recommend double-ditching techniques to separate the top one foot of stream bottom substrate from deeper soil layers. Reconstruct the original layers by replacing deeper substrate first.

– Design road crossings of streams to allow fish passage at all flows. Types of crossing structures that minimize aquatic impacts, in descending order of effectiveness, are:
a) bridge spans with abutments on banks; b) bridge spans with center support; c) open bottomed box culverts; and d) round culverts with the bottom placed no less than one foot below the existing stream grade. Perched culverts block fish passage and are unacceptable in any stream that supports a fishery.

– Locate and construct all structures crossing intermittent and perennial streams such that they do not destabilize the channel or increase water velocity.

– Avoid stripping riparian canopy or stream bank vegetation if possible. It is preferable to crush or shear streamside woody vegetation rather than completely remove it. Any locations where vegetation is stripped during installation of stream crossings should be revegetated immediately after the crossing is completed.

– Staging, refueling, and storage areas should not be located in riparian zones or on flood plains. Keep all chemicals, solvents and fuels at least 500 feet away from streams and riparian areas.

– Hydrostatic test waters released during pipeline construction could alter stream channels, increase sediment loads and introduce potentially toxic chemicals or invasive species into drainages. Avoid discharging hydrostatic test waters directly to streams.

– Hydrostatic test waters should be dispersed onto an upland site using proper erosion and sediment control techniques.

– Pipelines that parallel drainages should always be located outside the 100-year floodplain. Construct pipeline crossings at right angles to all riparian corridors and streams to minimize the area of disturbance.

– Where pipelines cross riparian areas and streams, use the minimum practical width for rights-of-way.

– Instream activity restrictions may be necessary to protect fish spawning habitat in certain streams. These restrictions will be identified in Section 404 permits issued by the U.S. Army Corps of Engineers (COE) or through the notification process under nationwide permits, as applicable. In such cases, the COE will consult regional fisheries or statewide fisheries personnel at the Department’s local or Bismarck offices, respectively. We encourage companies to consult the Department’s fisheries personnel for advice regarding appropriate practices and design considerations when planning instream activities.

IMPACTS ON NATURAL RESOURCE USERS

The impact of oil and gas exploration on habitat and individual species has been documented to a much greater degree than has the secondary impacts such as those impacting the people using natural resources which are referred to as social impacts in this report. Very little has been written discussing or documenting the social impacts of the industry. This may be because many of these impacts have not been identified or realized until much later after most of the actual exploration work has been completed. The responsibility for preventing and mitigating these impacts is also not clear. While social impacts may occur because of oil and gas exploration, they may also be the result of the actions of organizations and individuals unrelated to the industry. The only thing clear about social impacts is that they are probably the most controversial since impacts considered negative by some are viewed as positive by others.

The most notable social impact is the change in population occurring throughout the areas encompassing the Bakken and Three Forks formations. At a time when most of the nation is either recovering from, or still in a recession, North Dakota's economy is booming because of oil and gas development. Oil and Gas development requires skilled and un-skilled labor and people from other parts of the country are quickly moving here in search of employment. As the local populations grow the need for housing and other goods and services is also growing. Most communities in this region of the state are experiencing severe housing shortages. This has led to many small "settlements" popping up in a totally unplanned or controlled manner. State parks, wildlife management areas, gravel pit areas and private lands are all being sought out for these small "settlement" developments. According to Williston Mayor Ward Koeser, "despite efforts to provide more housing units, the speed in which oil activity has ramped up and workers have shown up has made it impossible to keep up."(Williston Herald, 2010) In January, Job Services had about 475 listings for the Williston area, not including hundreds of oil jobs not listed on their site. Now, five months later, they estimate there are about 1,100 job openings." Koeser also stated that, "if we had 1,000 homes available they would be filled in about a month."(Williston Herald, 2010) Fortunately for sellers, but unfortunately for buyers, homes which only 5 years ago sold for $60,000, now regularly and quickly, sell for two or three times that amount. Apartments which rented for $400 per month 5 years ago are now being rented for $2,500 per month by oil companies for their employees. This certainly makes it difficult for young sportsmen to be able to afford to live in the area or rent hotel/motel rooms during hunting or fishing trips.

The increased population results in additional pressure being placed on natural resources including:

- Increased demands on water resources as well as the generation of wastes and other pollution. Additional lagoon space, water mains and other infrastructure are needed in many small communities. Inadequate or non-existent sewage treatment facilities results in improper discharges or illegal dumping of sewage which can enter local watersheds increasing pollution which can have a negative effect on fishing and hunting.
- Increased demand for public services such as schools, law enforcement and health care all reduce the resources available to address natural resource concerns.
- Public lands and waters all are impacted with more users as the increasing population looks for areas in which to recreate. Human nature dictates that people like to "get away" from the crowd. More users make it more difficult to accomplish this.
- Increased hunting and fishing place more pressure on finite resources. Oil and gas facilities are either closed to hunting, for safety reasons, or not worth hunting because wildlife is displaced,

or are aesthetically unappealing. This places more pressure on public areas diminishing the quality of hunting.

- The quality of hunting/fishing/outdoor experiences that many constituents have become accustomed to over the years is being diminished. More people entering lotteries for limited licenses equals more competition for these licenses. Sportsmen who used to get a buck license every or every other year will have to wait for longer periods of time to get their preferred license.

In addition to attracting people looking for work, oil and gas development also creates additional access to otherwise remote areas through the building, or upgrading, of roads and pipelines. Most areas developed for oil and gas require improved roads to handle heavy truck traffic. A member of SRF Consulting recently reported that “5% truck traffic in an urban area is considered huge.”(Williston Herald, 2010) He stated that “Williston’s truck traffic accounts for 16%.”(Williston Herald, 2010) All this traffic needs access to where the oil and gas is produced. This provides access to previously inaccessible or un-developed areas placing even more pressure on wildlife resources as many species are reported to avoid these areas (see previous species reports). To many sportsmen, additional roads are a negative impact of the oil and gas industry. However, some would view it as a benefit. Some resource users feel the easier it is to get to an area the better, yet most would agree that more access negatively impacts the quality of the hunt. In many areas of the country, including North Dakota, large tracts of undeveloped landscapes offer some of the wildest and most unique landscapes in the United States. These lands contain scenic areas and recreational opportunities enjoyed by many residents and non-residents alike (Save Roan Plateau 2004). Once an oil field is developed, an area’s scenic qualities and recreational opportunities are diminished as these values also play an important role in the quality of the hunt.

Air quality is also affected. North Dakota is blessed with some of the cleanest air in the nation. Drilling in Colorado produces emissions of nitrogen oxides, sulfur oxides, particulate and hazardous substances such as benzene (Save Roan Plateau 2004). Constant flare-offs that regulate gas pressure release heavy metals and other toxic substances into the air (Save Roan Plateau 2004). By traveling through the areas being drilled it is abundantly clear the amount of particulate matter and dust present in the air is greatly increased due to the increased traffic. The fracking process used in most of the drilling area requires approximately 4 million gallons of water per well. That equates to almost 500 truck loads of water going to each well site alone. Including trucks used to haul sand and other chemicals, trucks to move the rig in and out and trucks to haul out the salt water and oil and the extent of increased traffic in these areas is dramatic. Hunters and anglers in western North Dakota now need to be extremely aware of the traffic. Traveling on gravel roads, where many hunters and resource users travel while going to and from hunting areas, is not the experience it once was. Hundreds of large trucks regularly travel these roads now, not only creating hazards on the roadway but also virtually destroying the road surface as well creating another set of driving hazards.

The impacts of oil and gas development on people utilizing natural resources in North Dakota may not be fully realized for some time. The diminished enjoyment of our natural resources will not take place overnight, but rather over the course of many years. North Dakota currently has such high quality natural resources, considerable deterioration could occur before user groups realize the full extent of their loss. They will have no past reference to measure the quality that will have been lost.

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APPENDIX A

Potential Mechanisms or Tools to Help Alleviate Oil/Gas Impacts

Impact avoidance:

There are a plethora of ways to reduce impacts from oil/gas development (Sportsmen 2010). They range from seemingly simple steps such as such as keeping vehicles and equipment clean and free of weed seeds to more complex concepts such as using remote monitoring on well pads. The ideas put forth here are fairly ambitious large picture mechanisms that if implemented would result in meaningful impact reductions.

A. Co-locate multiple wells on one site. Current technology allows directional drilling for a distance of up to 2 miles horizontally. Assuming that mineral leases were not an obstacle, well pads could accommodate up to 4 wells and provide 8 section spacing. This would greatly reduce the number of well sites, associated roads, power lines, etc.
B. Encourage different oil companies to share minerals (joint minerals) on 640 acre and 1280 acre spacing. If companies were more agreeable to joint minerals, fewer wells would be required.
C. Encourage well sites that pipe the raw product (oil, water & gas) to a centrally located 'separation' facility. Pipelines could be placed in the road right of way. This would greatly reduce daily traffic such as saltwater and oil tankers.
D. Promote underground electrical lines where possible.
E. Encourage oil companies to use electronic monitoring technology and/or surveillance cameras to reduce or eliminate daily maintenance trips. Maintenance trips could be reduced to every other day or every 3 days if more remote monitoring were used.
F. In sensitive areas where ground water or surface waters (wetlands, creeks) are present, or in erosive areas where stability is an issue, oil companies should capture the cuttings and drillings fluids in a closed loop system and haul it away to an approved disposal site.
G. Encourage directional boring of utilities and pipelines in rugged areas or in crossing drainages and wetlands.
H. Require testing of production water prior to its use for de icing roads.
I. Encourage oil companies to 'unitize' wells to allow for co mingling of production.
J. Discourage pads and roads from being located on native prairie and woodlands. Often pads are located on land of lesser value (grazing land) than cropland.
K. Provide access to oil companies to obtain NWI maps or maps designating wetlands, especially temporary and season wetlands as often companies are putting roads and pads in wetlands that they are not even aware of.
L. Encourage the Oil and Gas Commission to increase personnel to complete inspections of existing wells. It currently appears that the majority of staff are working on new wells and older wells are not being inspected. Its likely that numerous small scale problems are occurring without being reported.
M. Require native grass seed on new roads, especially native prairie.
N. Utility corridors should be established to utilize the same routes to the degree possible. Currently there are pipelines being routed all over the landscape taking the most direct route with little thought being given to reducing impacts to habitat.

Mechanisms or practices to offset impacts by oil/gas development:

A. Implement projects that maintain and/or enhance habitat to sustain or reestablish optimum wildlife populations (juniper control in bighorn sheep areas, native grass plantings, wetland restoration).
B. Preserve unique habitat through purchase of conservation easements (development easements along river systems, grassland easements on tracts of native prairie).
C. Acquire crucial/critical habitat when acquisition represents the best option for sustaining this habitat (sagebrush steppe, riparian areas in the Yellowstone confluence).
D. Improve coordination and consultation with the energy industry through addition of staff (are PR/DJ funds being put to their intended purpose as increasing staff time is spent on processing energy related development work).
E. Fund research to document population level impacts of energy development. A goal of this research should be to determine the point at which continued incremental or piecemeal development causes unacceptable declines in fish and wildlife populations.

In carrying out the aforementioned aspects of habitat maintenance and preservation, consideration should be given toward establishing an access program on lands where habitat improvement/maintenance is implemented. The program could be fashioned after the Department's PLOTS program.