Guidance for Developing a Compensatory Mitigation Plan for Wildlife Resources

MITIGATION GUIDANCE DOCUMENT MAY 2009

Introduction

The primary mission of the Colorado Division of Wildlife (CDOW) is to protect, preserve, enhance and manage wildlife and their environment for the use, benefit, and enjoyment of the people of Colorado and its visitors. Habitat protection and enhancement, along with native species preservation and conservation, are key components of the Division's strategy to design and implement programs that perpetuate the state's wildlife resource and natural heritage. The purpose of this document is to develop wildlife mitigation guidelines related to oil and gas development in Colorado. Energy development has increased nationwide as a result of America's demand for energy resources. Mineral leasing and development of oil and gas has increased commensurately. Colorado has experienced a significant increase in oil and gas production and development over the past 15 years. The number of drilling permits in Colorado has increased from 2,917 in 2004 to more than 8,027 permits approved in 2008. In 2000, 16 drilling rigs were operating in the state compared to 135 in December 2008.

In 2006 the Colorado Wildlife Commission passed an energy resolution (Appendix A) which emphasized that a balanced development of the natural gas resources be conducted in an ecologically responsible manner that minimizes impacts to the wildlife resource and encourages comprehensive assessment and mitigation of habitat impacts. CDOW recognizes the importance of energy development relative to landscape modifications, and the concomitant impacts on wildlife and wildlife habitat. As such, significant personnel and financial resources have been committed to developing the best science and process for mitigating oil and gas impacts to wildlife.

The Principles of Mitigation under HB 1298

Section 3 of HB 1298, the Colorado Habitat Stewardship Act of 2007 (34-60-128), specifically directs the Colorado Oil and Gas Conservation Commission (COGCC) to "minimize adverse impacts to wildlife resources affected by oil and gas operations." Colorado Revised Statute 34-60-103 (5.5) further defines "minimizing adverse impacts" to include avoidance, minimization and mitigation. "Mitigation" with respect to wildlife resources is defined in the COGCC's Rules to implement HB 1298 as "measures that *compensate* for adverse impacts to wildlife." These measures may include, as appropriate, habitat enhancement, on-site habitat mitigation, off-site habitat mitigation, and mitigation banking (see 100-Series definitions in the COGCC Rules). The COGCC 1200 series wildlife rules provide for avoidance of impacts to wildlife first, minimization of impacts second and mitigation third.

Further regulatory context for considering mitigation is detailed in the following COGCC rules:

216 c.(11) – Comprehensive Drilling Plans may include . . . Proposed best management practices or *mitigation* to minimize adverse impacts to . . . wildlife resources.

306 c.(2)A iii-Operator shall provide proposed *mitigation* for the affected wildlife resource.

303 d.(3)J- Information requirements of form 2A to include applicants proposed BMP's and any *mitigation* measures contained in the relevant surface use agreement.

1202 a.- requirement to consult to *mitigate* the effects of unavoidable remaining impacts

1202 d.2 – consultation not required if agreed upon wildlife *mitigation* plan is in compliance.

Consistent with the intent of HB 1298, when efforts to modify development practices fail to sufficiently avoid and minimize impacts to wildlife resources then compensatory mitigation should be considered. Compensatory mitigation is defined as the restoration, creation, enhancement for the purpose of compensating for unavoidable impacts, and is designed to offset the adverse effects of oil and gas development. As outlined by WGFD (2009): "adverse effects of oil and gas development can be divided into 7 categories: 1) direct loss of habitat; 2) physiological stress to wildlife; 3) disturbance and displacement of wildlife; 4) habitat fragmentation and isolation; 5) alteration of environmental functions and processes (e.g., stream hydrology, water quantity/quality); 6) introduction of competitive and predatory organisms; and 7) secondary effects created by work force assimilation and growth of service industries.

The goal of this document is to outline an approach ensuring that compensatory mitigation actions implemented to offset the effects of the unavoidable adverse impacts from oil and gas development are ecologically equivalent to and will persist at least as long as on-site impacts, and that they will achieve a positive outcome, or no net loss of habitat. No net loss will come from on-site actions that minimize impacts and restore impacted habitats to the extent possible, combined with timely off-site actions that provide additional benefits to compensate for residual adverse impacts (Kiesecker 2009).

> *The area of land needed to mitigate an impact will depend on the types of treatments applied, the expected improvement to the functional capacity of the land, and the effectiveness of impact abatement (management) practices being applied within the project area. There is no set or standard mitigation ratio. If 100% of the habitat function is lost on an acre of land, then enough land needs to be treated such that the expected increment of improvement multiplied by the number of acres treated equals the acre-equivalent of habitat function lost* (WGFD 2009).

Compensatory mitigation must be linked to regional ecological and spatial scales to be effective because spatial scale and habitat fragmentation are totally dependent on each other (Dale et al. 2000). In addition, compensatory mitigation to offset anticipated unavoidable adverse impacts should precede project development and actual impacts in order to avoid a temporal lag in achieving no net loss of functional wildlife habitat.

Thresholds: Background and Justification for Compensatory Mitigation

General

A sufficient and comprehensive description of the indirect impacts of natural gas development on terrestrial wildlife is provided by WGFD (2009):

> *As densities of wells, roads, and facilities increase, habitats within and near well fields become progressively less effective until most animals no longer use these areas. Animals that remain within the affected zones are subjected to increased physiological stress. This avoidance and stress response impairs habitat function by reducing the capability of wildlife to use the habitat effectively. In addition, physical or psychological barriers lead to fragmentation of habitats, further limiting access to effective habitat. An area of intensive activity or construction becomes a barrier when animals can't or won't move through it to use otherwise suitable habitat. These impacts are especially problematic when they occur within or adjacent to limiting habitats such as crucial winter ranges and reproductive habitats.*

Mule Deer, Elk, Pronghorn, and Bighorn Sheep:

In a literature review of more than 160 scientific and technical reports conducted to review the effects of energy development on ungulates, Hebblewhite (2008) concludes, "Across studies, ungulates showed avoidance responses to human development an average of 3,000 feet (1,000 meters) from the human disturbance." Specifically, significant impacts begin to manifest on ungulate species, including mule deer, pronghorn and elk, at well densities of .26 and 1.03 wells/square mile (0.1 - 0.4 wells/km2) and between .04 and .25 miles/square mile (0.18 and 1.05 km/km2) of road linear development.

Lyon (1983) developed a general model of habitat effectiveness for elk that modeled percent habitat effectiveness as a function of road density. Declines in habitat effectiveness were non-linear, indicating that much of the loss of habitat effectiveness occurred in the first 2.6 mile/sq. mi (1.6km/km2) of increasing road densities.

Sawyer et al. (2006) found lower predicted probabilities of habitat use within 1.7 to 2.3 mi (2.7 to 3.7 km) of an oil or gas well sites, confirming that indirect effects of habitat loss from energy development were much greater than the loss of the direct footprint of energy developments. Additionally, overlap between well sites and roads plays a role on the effects of habitat loss due to avoidance and is important because of the spatial configuration of habitats in determining road impacts (Rowland et al. 2000, Frair 2005).

For mule deer crucial winter range WGFD (2009) concluded that a density of 1 well pad per square mile causes a moderate impact and a density of 2-4 well pads per square mile causes a high impact. The impact is considered extreme when densities exceed 4 well pads per square mile.

Grouse

Behavioral avoidance of energy development reduces the distribution of sage-grouse and may result in population declines if density-dependence or habitat suitability lowers survival or reproduction in displaced birds (Holloran and Anderson 2005; Aldridge and Boyce 2004). Naugle et al. (2006), and Walker et al. (2007a), concluded the density of well pads is highly correlated with other features of development and therefore comprises a suitable index representing the extent of development.

As reported by WGFD (2009), "In the Powder River Basin, sage-grouse were 1.3 times less likely to use otherwise suitable winter habitats that have been developed for energy (12 wells/4 km^2), and differences were most pronounced in high quality winter habitat with abundant sagebrush cover" (Doherty et al. 2008). WGFD (2009) specifies mitigation for sage grouse at well densities greater than 1 well per section.

CDOW anticipates that other grouse species protected by the COGCC Rules (Columbian sharp-tailed grouse, plains sharp-tailed grouse and lesser prairie chicken) are similarly affected by oil and gas development.

Riparian and Aquatic

Direct and indirect impacts to aquatic life and riparian zones were comprehensively described by WGFD (2009). Some unimpacted streams in Colorado have natural flow regimes similar to those described for Wyoming and support equally adapted biotic communities:

> *Oil and gas developments also affect aquatic ecosystems. The overall health of an aquatic habitat derives from the condition of the entire watershed including the uplands, riparian corridor and the stream channel. Impacts to the upland plant community and environment can have a very immediate impact on an aquatic system, because the condition of vegetation throughout a watershed is the major factor determining the quantity and quality of the associated flow regime. In essence the runoff is naturally regulated by healthy, diverse vegetation. Vegetation in good condition provides greater ground cover, which reduces runoff and increases infiltration rates. Furthermore, diverse plant communities contain various microsites that enable snow to melt at differing rates, thereby extending the runoff period. Collectively, these factors produce more stable base flows essential for healthy fish and riparian habitats. Reduced sedimentation is another major benefit to aquatic organisms. Healthy vegetation naturally produces a healthy water cycle. However, some unimpacted stream systems in Wyoming have a natural flow regime dominated by sharply fluctuating runoff, high sediment loads and unstable channel. These types of systems sustain a native biotic community adapted to this harsh environment. When developments alter physical conditions (i.e., stabilize flow regimes, reduce sediment loads), the opportunity exists for native species to be replaced by detrimental, non-native species.*

There is solid evidence that providing riparian buffers of sufficient width protects and improves water quality by intercepting non-point source pollutants in surface and shallow subsurface water flow (e.g., Lowrance et al., 1984; Castelle et al., 1994). In the absence of proper buffer strips, there can be a greater requirement for water treatment plants and other expensive restoration techniques. Healthy riparian buffer strips are also widely recognized for their ability to perform a variety of functions other than water quality. These functions include stabilizing stream channels; providing erosion control by regulating sediment storage, transport, and distribution; providing organic matter (e.g., leaves and large woody debris) that is critical for aquatic organisms; serving as nutrient sinks for the surrounding watershed; providing water temperature control through shading; reducing flood peaks; and serving as key recharge points for renewing groundwater supplies (DeBano and Schmidt 1989; O'Laughlin and Belt 1995). Buffer strips also provide habitat for a large variety of plant and animal species, and have become a popular tool in efforts to mitigate fragmentation by increasing connectivity of isolated habitat patches and conserving biodiversity (Rosenberg et al., 1997).

Wildlife habitat and movement corridors in riparian zones are also an important consideration when determining riparian corridor widths. Appropriate designs for species conservation depend on several factors, including type of stream and taxon of concern (Spackman and Hughes 1995). Recommended widths for ecological concerns in buffer strips typically are much wider than those recommended for water quality concerns (Fischer 1999; Fischer et al., 1999), often exceeding 100 m in width (Table 1). These recommendations usually apply to either side of the channel in larger river systems and to total width along smaller streams where the canopy is continuous across the channel. Management for long, continuous buffer strips rather than fragments of greater width should also be an important consideration. Continuous buffers are more effective at moderating stream temperatures, reducing gaps in protection from non-point source pollution, and providing better habitat and movement corridors for wildlife.

TABLE 1. Summary of recommended widths of vegetated buffer strips for various functions (from Fischer et al. 2000).

Function	Recommended Width	Authors
Improve or protect water quality	>15m	Woodard and Rock (1995)
	>25m	Young et al. (1980)
	>30m	Lynch et al. (1985)
	>9m	Dillaha et al. (1989)
	>18m	Nichols et al. (1998)
	>10m	Corley et al. (1999)
	>4m	Doyle et al. (1977)
	>19m	Shisler et al. (1987)
Reptile/Amphibian habitat	100-1000m	Burbrink et al. (1998)
	>30m	Rudolph and Dickson (1990)
	>165m	Semlitsch (1998)
	>135m	Buhlmann (1998)
Bird habitat	>60m	Darveau et al. (1995)
	>100m	Hodges and Krementz (1996)
	>100m	Mitchell (1996)
	>100m	Triquet et al. (1990)
	>150m	Spackman and Hughes (1995)
	>500m	Kilgo et al. (1998)
	>100m	Keller et al. (1993)
	>150m	Vander Haegen and deGraaf (1996)
	>40m	Hagar (1999)
	50-1600m	Richardson and Miller (1997)
	>50m	Whitaker and Montevecchi (1999)
Mammal habitat	>50m	Dickson (1989)
Maintain plant diversity	>30m	Spackman and Hughes (1995)
Maintain an unaltered microclimatic gradient	>45m	Brosofske et al. (1997)

In their review of the existing peer-reviewed scientific literature containing data on riparian buffers and nitrogen concentration in streams and groundwater of riparian zones, Mayer et al. (2006), surveyed to identify causation and trends in the relationship between buffer width and nitrogen removal capacity. They also examined Federal and State regulations regarding riparian buffer widths to determine if such legislation reflects the current scientific understanding of buffer effectiveness. Although there was a wide variance of width recommendations, they generally were consistent with the peer-reviewed literature on effective buffer width and recommended or mandated buffers from 7 to 100 meters wide. They noted an emphasis on protecting buffers against soil compaction, loss of vegetation, and stream incision, and stated that stream headwater buffers would likely be most effective at maintaining overall watershed water quality while restoring degraded riparian zones.

In their discussion of NSO zones for wetlands and riparian corridors, WGFD (2009) recommended an NSO zone of 500 feet from the outermost perimeter of potentially affected areas.

> *We recommend an NSO zone extending 500 ft from the outermost perimeter of wetlands and riparian corridors to maintain habitat effectiveness and functional integrity. This distance is considered minimal given the sensitivity of many wildlife species that utilize riparian corridors and wetlands for nesting, foraging, movement corridors, and cover. For example, Ingelfinger and Anderson (2004) detected species specific impacts to breeding passerines within distances ranging from 40-1500 m from roads in a natural gas field. Reijnen et al. (1995) documented 20-98% reductions in bird densities within 250 m of roadways within wooded habitats. Nesting raptors are sensitive to disturbances up to several hundred meters depending on species (Fyfe and Olendorff 1976; White Thurow 1985; Richardson and Miller 1997). Mule deer can be sensitive to human and equipment disturbances at distances ranging from 0.2-0.3 miles (Freddy 1996) to well over a mile (Sawyer 2008). While comprehensive data are not available to identify the specific wildlife occupying any given tract of riparian habitat, it can be assumed all riparian habitats support high levels of species diversity and provide nesting habitat for a variety of passerine species. Trees are suitable nesting habitat for several raptor species if they are sufficiently isolated from disturbance, and deer occupy most riparian tracts throughout the state. In addition, a large percent of species of greatest conservation need are wetland/riparian dependent or associated. A 500-ft NSO buffer provides minimal protection to wetland and riparian habitat functions (WGFD 2009).*

COGCC rules developed through the 1298 process provide for 300 foot stream side buffers in designated Cutthroat Trout Habitat areas and in designated Gold Medal water stream reaches.

Summary

In general, the CDOW endorses and supports the findings of Sawyer et al. (2006), Hebblewhite (2008), WGFD (2009), Naugle et al. (2006), and Walker et al. (2007a) as a basis for asserting that unavoidable adverse impacts on ungulates and grouse result from oil and gas development at 1 well pad per section or less. We also endorse the findings of Lowrance et al. (1984), Castelle et al. (1994), DeBano and Schmidt (1989), O'Laughlin and Belt (1995), and WGFD (2009) in our conclusion that unavoidable adverse impacts on aquatic species and riparian systems result from oil and gas development at 1 well pad per section or less. The fundamental premise is that at higher well densities, avoidance and minimization are no longer sufficient to compensate for adverse impacts. The findings and conclusion of these studies document and support CDOW's recommendation that oil and gas facility densities equal to or greater than 1 well pad per section in all sensitive wildlife habitats and restricted surface occupancy (RSO) areas require compensatory mitigation to offset residual adverse impacts to wildlife, regardless of measures taken to avoid and minimize impacts to wildlife during development.

Compensatory Mitigation Strategies

One strategy to consider is the "protected area" mitigation concept detailed by Hebblewhite (2008). This type of mitigation identifies core areas for **multiple species** (e.g., pronghorn, mule deer, sage grouse, sagebrush, riparian habitat) that are then protected from **oil and gas development** to provide critical habitat for the identified species, and the ecosystems on which they depend (i.e., sagebrush steppe). Protected areas should be designed to ensure viable populations at some large, landscape scale that maintains populations and connectivity among populations, while allowing incremental development outside of protected core areas. Thus, the conservation value of a protected area should reflect its contribution of sustainability measured at the regional scale (Bruggeman 2005). The protected area concept can be utilized in designing and implementing onsite and offsite habitat treatments. The preservation of wildlife habitat by acquisition of fee title, conservation easements, grazing leases, and/or existing oil and gas leases are important elements of any effective long-term strategy to preserve wildlife habitat. In many cases, these may provide the only permanent solution to conflicts between the needs of wildlife and other uses (WGFD 2009).

Another strategy is to improve habitat conditions through treatments that restore or enhance the habitat. It is vital that any habitat improvement projects be focused on factors that limit populations. If this approach is taken, the alleviation of limiting factors can increase population performance, and not just shift the distribution of wildlife populations. Because of seasonal landscape movements by many wildlife species, newly created habitat developed through mitigation must be large and intensive enough to restore ecological integrity, so as to avoid a downward spiral of continued functional habitat loss despite compensatory mitigation (Race and Fonseca 1996). Habitat creation efforts must be at a sufficiently large scale to avoid population "sink" situations, or ecological traps, where demographic rates actually decline because of unforeseen factors. For example, small-scale improvements in duck nesting habitat, may not result in improvements in nest success rates because concentrating duck nesting activities may make predators more efficient at locating nests (Phillips et al. 2003). Functional landscapes provide habitat that provides rates of subpopulation growth and migration rates similar to those observed prior to habitat loss and fragmentation (Bruggeman 2005). Restoration of watersheds is extremely difficult as even small compromised areas contribute to downstream consequences as siltation increases, water temperatures fluctuate, and species diversity decreases.

A third compensatory mitigation strategy to consider is the direct payment of money. Again, an accounting metric for the amount of disturbance would be calculated. Payment could be made to existing well-established programs established to preserve and enhance habitat for a particular species or group of species that are impacted, to conduct research on oil and gas development impacts, or to fund other programs that provide suitable benefit to Colorado wildlife. This type of compensatory mitigation would result in a one-time cost to the operator per permit. In this example, the operator would know the cost up front and be able to set aside mitigation funds upon permit approval.

Compensatory Mitigation Priorities

Compensatory mitigation efforts through habitat enhancement and protection from development should be located in as close proximity to the affected area as possible and should, in all cases, benefit the wildlife population or herd unit affected by the development. On-site or local off-site mitigation is preferred over long distance off-site mitigation, provided that suitable blocks of undeveloped habitat exist on-site or locally that are not at risk from future development. Off-site and off-lease mitigation should only be considered when feasible mitigation options are not available within or immediately adjacent to the impacted area, or when the off-site or off-lease location would provide more effective mitigation than can be achieved on-site (WGFD 2009). Off-site solutions to watershed scale disturbances are largely impractical as a mitigation strategy, as damaged areas will continue to degrade and damage downstream areas unless mitigative efforts are sustained.

Given the current understanding of the relationship between wildlife populations and habitat, the following should be considered with respect to the likelihood of success regarding compensatory mitigation of energy impacts. Compensatory mitigation efforts should focus in areas where the greatest gains can be achieved, and where protection from future development can be assured to preserve mitigation efforts. Potential habitat-based mitigation approaches (in descending order of priority or effectiveness) are:

1) Protecting existing functional habitats from future development. This strategy may not have the greatest population or landscape-level response to improve existing conditions, but should be considered the highest priority if enough undisturbed habitat exists within the affected area to maintain objectives for the wildlife populations or herd units affected by development.
    a. This approach has the highest chance of success of any of the approaches described here, but may have limited application due to the lack of available undisturbed habitat, and/or the lack of available regulatory mechanisms to protect the available habitat from future development.

2) Creating new habitat or reclaiming lost habitat (e.g., cheatgrass or piñon-juniper sites that were previously sagebrush; reclamation and restocking of waters) will likely have the greatest population and landscape-level response;
    a. Creating habitat in areas not currently occupied i.e. “vacant or unknown” or those that are potentially suitable should concentrate on relatively large-scale efforts, as opposed to numerous small-scale efforts.
    b. Focus efforts to create habitat on areas that (1) have been type-converted, such as cheat-grass monocultures, extensive areas lost to fire, etc.; or (2) have successionally progressed to non-productive wildlife habitat for the species of concern.
    c. Construction of migration barriers and the establishment of new conservation-quality stocks of cutthroat trout in waters previously not treated as Designated Cutthroat Trout Habitat.

3) Restoring healthy plant communities on degraded sites (e.g., mismanaged rangelands or riparian areas) will have the next highest population and landscape-level response;
    a. Focus on degraded habitats at the landscape-level where habitat improvement can result in restoration of ecological function and biotic diversity. Careful analysis must be given to the root causes of the current community condition, the local site capability, whether ecological thresholds have been crossed, and likely limiting factors for wildlife populations. Treatments should be extensive (large in spatial extent, range, scope or quantity) enough to contribute towards solving the ecological problem, but in occupied habitats, size and distribution of treatments should be designed to minimize impacts to existing wildlife populations. Initial wildlife population response to treatments in degraded habitat may not be positive.
    b. Perform stream improvement actions by placement of Rosgen-type in-stream structures to increase suitable habitat for native species; address riparian zone damage by applying measures designed to reduce sedimentation, preserve water quality, restore vegetation and normal riparian functions.
4) Treating functioning habitats will have a low or non-measureable population and landscape-level response, and should be avoided where other options are present;
    a. If adopted for mitigation, treatments on functioning habitats should be small and distributed irregularly across the landscape. The exception may be where treating functional habitats is necessary to maintain connectivity between two large blocks of habitat at risk from current or future development.

Developing a Compensatory Mitigation Plan

Creating a compensatory mitigation plan to offset adverse impacts on wildlife resources requires the following:

1) Identifying the geographic and political boundaries of the project area, the lifespan and scope of development within the project area (well density, etc.), and the target species that will be affected by the proposed development.

2) Establishing a small local Team of subject matter experts familiar with the target species of concern and the habitats that will be adversely affected (both directly and indirectly) by the proposed development. For CDOW, the Team of subject matter experts will include:

    a. A Regional representative from Field Operations (ARM, AWM, Regional Energy Liaison, or other designee);

    b. The Regional Senior Terrestrial Biologist or their designee;

    c. The Regional Senior Aquatic Biologist or their designee; and

    d. The Regional Senior Wildlife Conservation Biologist or their designee.

Note that the local (Regional) team of CDOW subject matter species experts should stay consistent from project to project for each target species identified; local DWMs and/or Area Biologists may be added to the team when local expertise and knowledge is desired. The team of subject matter species experts may also include one biologist representing industry, and a biologist representing each Federal and/or local government agency with jurisdiction.

3) Developing a metric to determine the amount of compensatory mitigation that will be required. In other words, placing an ecological value on the land that is going to be disturbed by quantifying the amount and quality of habitats that will be adversely affected for the life of the proposed development, including both direct and indirect impacts to habitats and their use by wildlife;

4) Identifying the mitigation goals (habitat targets) for each species and the appropriate geographic constraints within which the mitigation goals or habitat targets need to be accomplished;

5) Identifying suitable mitigation sites to meet the habitat targets for each species within the geographical constraints identified. This can be accomplished in a comprehensive way on a landscape scale using Geographic Information Systems (GIS) modeling tools, or by using a simple map based approach on a project-by-project and species by species basis;

6) Once potential compensatory mitigation sites are identified, the value of the mitigation sites must be assessed by quantifying the acreage of the sites and the quality of the habitat they contain, and by assessing the long-term risk to the proposed mitigation sites from other types of development (this can be modeled in GIS based on existing development trends and risk, but also is a function of the type of habitat protection afforded to the mitigation sites once they are selected). Additionally, an evaluation of the funding needed to adequately sustain the project for the life of the project is necessary.

7) If a potential compensatory mitigation site is selected to offset impacts from a proposed project and the value of that site has been calculated, implementation of an annual monitoring plan is required prior to acceptance of that site in order to: 1) establish the baseline resource values at the site, and 2) evaluate the success of the mitigation project at achieving the goals for which it was established.

The quantity and quality of compensatory mitigation that will be deemed adequate for a proposed development project is dependent on the mitigation goals and habitat targets for the species of concern that have been identified by the local team of subject matter species experts. Once the mitigation goals and habitat targets have been met within the appropriate geographic constraints, and monitoring of the mitigation sites has confirmed that the mitigation goals and habitat targets established for the sites have been met, the compensatory mitigation project is complete.

A multiple species modeling approach that utilizes a team of subject matter species experts familiar with each species and their habitats to quantify impacts and mitigation goals for adversely impacted species is the preferred approach for identifying appropriate compensatory mitigation sites for multiple species on a landscape scale. The following example generally explains how to calculate disturbance debts and compensatory mitigation credits on a case-by-case and species-by-species basis if a multiple species modeling approach is not utilized:

Application of a metric to determine compensatory mitigation debt:

Cumulative effects include: (1) cumulative direct habitat alteration, and (2) indirect effects (for example, increased vehicle disturbance or predation associated with surface disturbances). The magnitude of cumulative effects felt by a particular wildlife population is dependent on the spatial attributes of surface disturbance, the intensity of ongoing development activities, and the resulting habitat fragmentation and isolation of key habitats for that wildlife population (Kotliar 2008).

The cumulative disturbance associated with construction, drilling, completion, and production of oil and gas development that cannot be avoided or minimized in Sensitive Wildlife Habitat Areas (SWHA) or areas of Restricted Surface Occupancy (RSO) will be calculated using the following threshold criteria. For those sensitive wildlife habitats defined in the COGCC rules, (i.e., mule deer critical winter ranges, mule deer severe winter range, elk winter range, pronghorn winter concentration, bighorn sheep winter range, elk production areas, Columbian sharp-tailed grouse and plains sharp-tailed grouse production areas, greater sage-grouse and Gunnison sage-grouse production areas, lesser prairie chicken production areas, Designated Cutthroat Trout Habitat, Gold Medal waters) when surface facility density exceeds 10 well pads per 10-square mile area (one well pad per section on average), compensatory mitigation will be required.

Surface facility density will be determined from the presence of oil and gas well pads within a ten square mile radius of a Form 2A, or within the boundary defined by a CDP or Wildlife mitigation plan. The acreage basis for compensatory mitigation debt will be the amount of surface that is directly disturbed plus the additional area on which habitat functions are impaired by noise, activities and other disturbance effects.

The acreage basis for compensatory mitigation debt will be characterized by the full field development scenario, or the reasonably foreseeable development scenario as determined by discussions with the operators and, where appropriate, Federal land management agencies. Surface disturbances including construction, drilling and completion operations, pipeline construction and reclamation, access roads, well pads not fully drilled or reclaimed to interim reclamation, and wells in production will all be considered when calculating the compensatory mitigation debt.

Compensatory mitigation debt is calculated from determining the area of surface disturbance and buffering this direct impact by 30 to 500 meters depending upon site specific details such as species affected, topography, aspect, habitat type, and by consideration of BMP commitments that minimize disturbance. (Appendix B provides a surface disturbance to well density graph developed by Hebblewhite (2008) that can be utilized to determine the area affected with regard to varying disturbance buffers).

Factors that increase the importance of habitats near proposed well locations, and thus the disturbance buffer are:

- documented high densities of the species of concern at or near the proposed well location during limiting life stages (e.g., breeding) or limiting seasons (e.g., critical winter range)
- a limiting habitat type is present at or adjacent to well location and there is limited availability of this habitat type in the surrounding area
- aquatic or riparian habitat affected by the well location
- absence of other development types within species tolerance buffer
- absence of existing oil and gas development within species tolerance buffer.

Factors that decrease the importance of habitats near proposed well locations and thus the disturbance buffer are:

- absence of limiting habitat at or adjacent to well location
- proximity to State Highway or County Road
- proximity to other types of development within species tolerance buffer
- multiple existing developments and/or structures within species tolerance buffer
- presence of existing oil and gas development within species tolerance buffer

For example: a CDP that encompasses 26,000 acres of fee title mineral estate along the Colorado River bottom. Sensitive wildlife habitats comprise 18,716 acres of the CDP area. The CDP proposes forty eight surface locations with a concomitant network of roads and pipelines to develop the gas resource. The entire development is in an area where the existing and proposed well density exceeds one gas facility per square mile. Applying the minimum buffer of 100 feet (30 m) to the planned surface disturbance within the sensitive wildlife habitat equates to a *minimum* compensatory mitigation debt of 4,141 acres. Applying a 300 foot (100 m) buffer (determined to be reasonable by professional opinion and literature reference for riparian habitats) to the planned surface disturbance equates to approximately 12,127 acres of compensatory mitigation debt. Note that application of the 300 foot (100 m) buffer indicates that 65% (12,127/18,716 acres) of the sensitive wildlife habitat is impacted by the proposed development. The total compensatory mitigation debt thus ranges from a minimum of 4,141 acres to a maximum of 12,127 acres. This debt would be further defined by the valuation of mitigation process described below to arrive at a final compensatory debt obligation. To retire this debt, the operator could implement any of the compensatory mitigation strategies detailed above and in Appendix D (i.e., restoration and enhancement, conservation, etc.).

Assigning a Value to Mitigation efforts

Mitigation can be categorized and valued based on the treatment duration and type, the location of the mitigated property, the ownership of the land, and the size of the parcel being mitigated (**Table 2**). Mitigation values are intended to emphasize factors that are important for wildlife, habitat and the CDOW's mission. ***Each mitigation value has been assigned a subjective mitigation ratio multiplier for this example. Note that the science team established for the development of a compensatory mitigation plan for a particular species or group of species would assign the mitigation values and ratio multipliers described below. The values and ratios would be applied on a case by case basis considering local and landscape scale conditions/status.*** We have included in the last table several INDEPENDENT factors, each of which is calculated separately.

TABLE 2 – Mitigation Values and Mitigation Ratio Multipliers

Mitigation values by: treatment duration and type	Mitigation Ratio Multipliers (Mitigation Area : Disturbed Area)
Protected in perpetuity, e.g., Conservation Easement	1:1
Protected long term, e.g., management agreement or lease > 10 years	3:1
Protected moderate term, e.g., management agreement or lease >5 years but < 10 years	5:1
Habitat enhancement or restoration, or projects protected < 5 years	8:1

Mitigation values by: Location	Mitigation Ratio Multipliers (Mitigation Area : Disturbed Area)
Mitigation completed within highest priority geographic area (as defined by CDOW)	1:1
Mitigation completed within desired geographic area (as defined by CDOW)	2:1
Mitigation completed within like habitat (as defined by CDOW)	4:1

Mitigation values by: Ownership	Mitigation Ratio Multipliers (Mitigation Area : Disturbed Area)
Public land	1:1
Private land	2:1
Private lands adjacent to public land	1:1
Private lands holdings within public land	1:1

Mitigation values by: Parcel Size	Mitigation Ratio Multipliers (Mitigation Area : Disturbed Area)
Parcel size >640 acres	0.75:1
Parcel size 160 - 640 acres	0.9:1
Parcel size 60 -160 acres	3:1
Parcel size < 60 acres	5:1

Miscellaneous INDEPENDENT mitigation values		Mitigation Ratio Multipliers (values < 1 are credits)
Creates additional access for public hunting and/or angling		0.75:1
Benefits other species of concern as defined by CDOW		0.5:1[1]
Arrangement of habitat types- CDOW Consultation	(most desired)	0.5:1
	(desired)	0.75:1

[1] Note that benefits to a particular species of concern may have higher or lesser value to CDOW in a specific geographic area, and the mitigation ratio multiplier for mitigation that benefits a high interest species in that geographic area may be adjusted accordingly by the science team associated with the compensatory mitigation plan.

Calculating and Applying Mitigation Credits

Calculating mitigation values takes into account the variety of mitigation types possible and the multiplier effect of each. Some of the mitigation values increase the number of acres toward the mitigation credit, while others reduce the acres. This methodology of values and mitigation ratio multipliers is meant to be used cumulatively, as described below. When applied against disturbance debts, the method offers a great deal of flexibility to the operator.

To calculate the total mitigation credits for an action, the operator would first divide the number of acres by the mitigation ratio multiplier for the respective treatment and duration. That number would be divided successively by the mitigation ratio multiplier for the respective location; by the mitigation ratio multiplier for the respective land ownership; by the mitigation ratio multiplier for the respective parcel size; by the mitigation ratio multiplier for creating public hunting and/or fishing access; by whether or not the project benefitted other species of concern; and lastly divided by a CDOW habitat consultation factor of whether or not the project provide high quality habitat for the wildlife species being mitigated. This last factor could vary by area or habitat type, based on what is limiting within the development area. However, CDOW would provide information about high priority habitats upfront to the operator.

EXAMPLE 1: An operator would like to provide 90 mitigation credits to offset disturbance of a development. They intend to fund an 80-acre conservation easement outside of the highest priority area. The protected parcel is a private holding. The easement would allow public access and provides some protection for another species of concern. To determine the mitigation credits for that parcel:

# Acres	Divided by Mitigation Ratio Multiplier	Mitigation Type	= Mitigation Credits (carry to next row -column 1)
80	1	protected in perpetuity	80
80	2	Within desired geographic area	40
40	1	Private inholding on USFS land	40
40	3	Parcel size 60-160 acres	13.33
13.33	0.75	Creates public hunting access	17.77
17.77	0.5	Benefits other species of concern	35.55
		Total Mitigation Credits	**35.55**

In this case, the operator did not achieve the 90 mitigations credits needed for a particular development and would need to provide an additional 54.45 credits.

EXAMPLE 2: An operator would like to provide 90 mitigation credits to offset disturbance of a development. They plan on funding a habitat enhancement (hydro-mow) project to reduce pinyon encroachment in sagebrush. They are working with a private landowner within the highest priority geographic area. The protected parcel is approximately 300 acres and they plan on treating approximately half of the parcel. The habitat was evaluated by CDOW and found to have an arrangement of habitat types most desired by CDOW. The landowner refuses to allow public access. To determine the mitigation credits for that parcel:

# Acres	Divided by Mitigation Ratio Multiplier	Mitigation Type	= Mitigation Credits (carry to next row -column 1)
150	8	Habitat enhancement	18.75
18.75	1	Within highest priority geographic area	18.75
18.75	2	Private land	9.375
9.375	0.9	Parcel size 160-640 acres	10.75
8.44	0.5	CDOW Habitat Consultation	21.5
		Total Mitigation Credits	**21.5**

In this case, the operator achieves 21.5 mitigation credits. They still need 68.5 mitigation credits to meet their mitigation requirement of 90.

Monitoring of Mitigation Sites

Industry's desire for flexibility must be balanced with CDOW's need to ensure functioning wildlife habitats through compensatory mitigation. Evaluation and monitoring are integral and necessary components of all compensatory mitigation. The basic hypothesis is that the proposed compensatory mitigation is sufficient, and that evaluation and monitoring are used to assess the validity of this assumption and to provide a framework to continually assess progress towards the objectives of the mitigation.

Monitoring must assess the end point objectives of the mitigation. Typically this will be based on habitat-oriented success criteria that can be extrapolated to wildlife population demographics of survival, reproduction, density, occupancy etc. Since mitigation accounting systems and compensatory mitigation techniques are aimed at conserving wildlife populations, the measure of success for habitat-based mitigation projects should be based on habitat quality and quantity, habitat use, and/or wildlife population demographics.

The following process is recommended for establishing success criteria and a monitoring plan for a compensatory mitigation project:

1) When developing the compensatory mitigation plan, the local team of subject matter experts (Team) should describe how key physical and biological habitat components are functionally interconnected or interdependent, how the key habitat components affect the population demographics and CDOW population objectives for wildlife populations included in the plan, and which of these components are limiting in the project area for each species;
2) The Team should objectively assess the existing condition of all major ecological components of the compensatory mitigation site based on quantitative inventory and monitoring data. Suitable references areas and baseline conditions should be established early in the process. If adequate resource data are not available, include a means of collecting the information in the monitoring plan;

3) The Team should identify specific, measureable goals (success criteria) for the compensatory mitigation site based on the habitat components at the site that limit wildlife populations, and the desired condition (properly functioning condition) of those habitat components;
4) Finally, the Team should establish a timeline for achieving the identified success criteria and articulate that timeline in a formal monitoring plan. The monitoring plan should include:
    a. A timeline for achieving the goals (success criteria) established for the compensatory mitigation site;
    b. annual goals that must be met each year to move towards achieving the ultimate success criteria;
    c. remedial actions that will be taken if the annual goals are not achieved;
    d. a monitoring protocol that describes the quantitative and qualitive methods that will be used to measure success, and the frequency of monitoring until success is achieved;
    e. a monitoring report. (see Appendix C).

A fundamental requirement of successful evaluation and monitoring is to incorporate this process into an adaptive management context. Careful attention to sampling design and analysis (including the appropriate sampling scales, covariates, and power analysis) and the potential for replicating studies across field offices will be necessary to monitor mitigation adequately (Kotliar 2008).

Adaptive Management/Compliance

Given the uncertainty regarding the effectiveness of compensatory mitigation for wildlife resources, an "adaptive management" approach will be necessary. This type of management requires that mitigation be based on outcomes and performance and not solely on activities conducted (e.g., acres treated). Assumptions about the type and quantity of habitat improvements needed to mitigate a given level of impact must be quantified and continually monitored and evaluated. In an adaptive management approach, habitat improvements would be regarded as experiments, the outcomes of which would be monitored for success, both from a vegetative community viewpoint, and from the perspective of the demographic response of wildlife populations. The effectiveness of the mitigation must also be continually monitored and evaluated, with mitigation efforts adjusted upwards if management goals are not attained. Thus, it is critical that the proponent of a compensatory mitigation plan commit to specific success criteria and continued mitigation and monitoring efforts until the success criteria are achieved.

Walters (1997) criticizes many management agencies for missing the critical point of adaptive management – experimentation, controls, and adequate monitoring – without these key steps, there is no difference between adaptive management and "regular‟ management that seeks only to satisfy short-term objectives without ensuring that long-term problems are adequately addressed.

The following diagram from Hebblewhite (2008) depicts the adaptive management cycle.

Fig.1 From Hebblewhite, M. 2008. Conceptual diagram of adaptive resource management as defined by Walters (1986, adapted from http://www.cmar.csiro.au/research/mse). Critically, management experiments are designed to contrast results of management experiments on key ecological indicators between control and treatment areas.

Nichols and Williams (2006) highlight the key components of adaptive management and their relevance to monitoring, which are summarized below.

- *Adaptive management is a sequential decision process that is especially useful when there is a high degree of uncertainty about the outcome of management actions.*
- *Management decisions are informed through a process that includes:*
  - *-developing management objectives;*
  - *-identifying potential management actions;*
  - *-developing or adapting models of system response to management actions;*
  - *-measures of confidence in the models; and*
  - *-monitoring data that provide estimates of system states.*
- *At each decision point, the appropriate management actions are evaluated for particular management objectives; the appropriate action is based on the estimated state of the system and the predicted responses of the system to management actions.*

• Once the management action is implemented, monitoring is used to test the predictions of the model.

• This approach is iterative and implemented at each subsequent decision point, based on new estimates of system states and updated models.

Regardless of the approach taken, adaptive management is a paradigm that is fundamental to the success of evaluating and monitoring mitigation. Without proper evaluation, the success or failure of mitigation cannot be determined, and the regulatory obligation to prevent adverse impacts to wildlife will be compromised.

Failure to achieve performance measures in a timely manner, as detailed in a compensatory mitigation plan, could result in permit, wildlife management plan (WMP), and/or comprehensive development plan (CDP) non-compliance. It is proposed that non-compliance result in future permit denial until the mitigation is successful, and or the non-compliance issue resolved.

CONCLUSION

Compensatory mitigation should be implemented when other operational strategies employing avoidance and minimization are not sufficient to eliminate adverse impacts to target species, or when well pad densities exceed 1 well pad per section in the sensitive wildlife habitats identified in HB 1298 and discussed in this document. Consultation with CDOW personnel will be critical in designing and evaluating compensatory mitigation strategies. Habitat treatments should be designed and implemented at a scale which will maintain or enhance the ecological integrity of the area, and benefit the species considered for the mitigation. Evaluation and monitoring of all mitigation strategies will be necessary to determine if the adverse impacts have been ameliorated, and if any additional effort is required. Finally, utilizing an adaptive management framework will be critical to successful implementation of any mitigation strategy.

Appendix A

Colorado Wildlife Commission

Energy Resolution

In response to the rapid increase in oil and gas development in the State of Colorado, the Colorado Wildlife Commission passed an energy resolution in 2006 which declared the following with respect to energy development policy in Colorado.

Whereas the Colorado Wildlife Commission upholds the legislative declaration under Colorado Revised Statutes, Title 33 Wildlife and Parks and Outdoor Recreation, Article 1 "Wildlife-General Provisions" that wildlife and their environment are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of the people of this state and it's visitors; and

Whereas hunting, angling and wildlife viewing contribute more than $2 billion annually to the economy of the State of Colorado, benefiting local economies and providing more than 30,000 jobs in such fields as manufacturing, retail sales, and wildlife related service industries such as, outfitting and guiding, etc,; and

Whereas wildlife in the State of Colorado provide extrinsic economic benefits, as well as intrinsic, positive enhancement of wildlife-related experiences for both residents of and visitors to the State of Colorado; and

Whereas the Colorado Wildlife Commission recognizes that significant energy development has occurred and will continue in habitats where important wildlife species exist in Colorado; and

Whereas the Colorado Wildlife Commission is concerned about the potential loss of species and impacts that could result in federal listing under the Endangered Species Act; and

Whereas the Colorado Wildlife Commission acknowledges that the estimated reserves of oil and natural gas are substantial within the State of Colorado which would likely lead to drilling additional oil and gas wells over the next 10 to 20 years; and

Whereas industrial disturbance to the landscape will likely result in greater impacts to wildlife and its habitat, and may create habitat fragmentation; and

Whereas the Colorado Wildlife Commission recognizes the important role energy companies play in providing clean, safe and efficient energy for America's homes and businesses; and

Whereas the Colorado Wildlife Commission recognizes the substantial economic contribution of the energy industry resulting from jobs, taxes, mineral royalties, etc,; and

Whereas the Colorado Wildlife Commission acknowledges that the technological advances of industry may necessitate that more flexible consideration be given to energy development proposals.

Therefore be it resolved that the Colorado Wildlife Commission encourages responsible development of the State's economic mineral resources through the use of the best available technology to minimize environmental impacts to Colorado's wildlife and wildlife habitat.

Be it further resolved that the Colorado Wildlife Commission urges development to occur in as ecologically responsible a manner as possible, which balances multiple resources, conserves energy, reduces industry's environmental footprint, and preserves habitat for multiple wildlife species;

Be it further resolved that the Colorado Wildlife Commission petitions Federal and State Agencies to collaborate with the Colorado Division of Wildlife with respect to energy development projects.

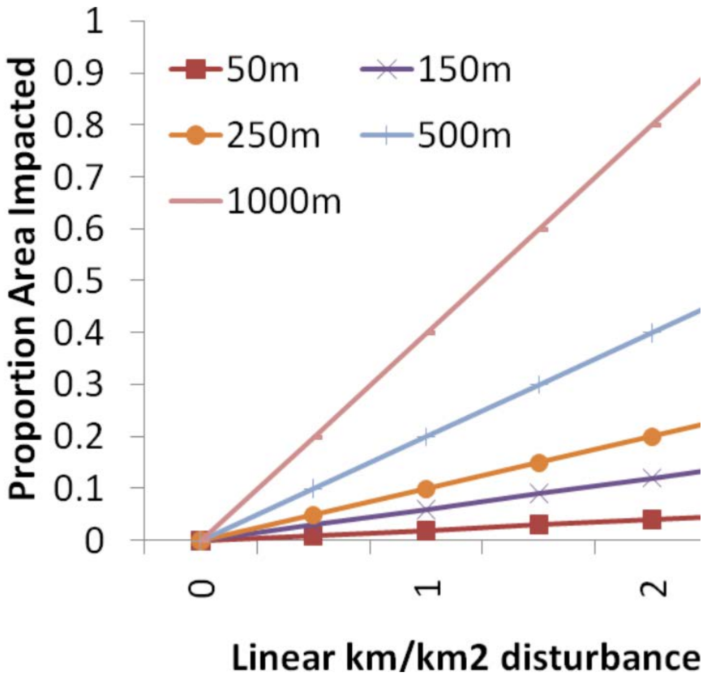
Be it further resolved that the Colorado Wildlife Commission encourages Federal, State, Counties and Local Agencies to comprehensively assess and mitigate where necessary energy development-related habitat impacts throughout Colorado.

Be it further resolved that the Colorado Wildlife Commission encourages industry to collaborate with the Colorado Division of Wildlife on research and monitoring projects that will assist with measuring and minimizing impacts now and in the future.

Appendix B

Graphical depiction of surface area disturbance in relation to well and road density

From: Hebblewhite, M. 2008. A literature review of the effects of energy development on ungulates: implications for central and eastern Montana. Montana Fish, Wildlife and Parks, Miles City, USA.



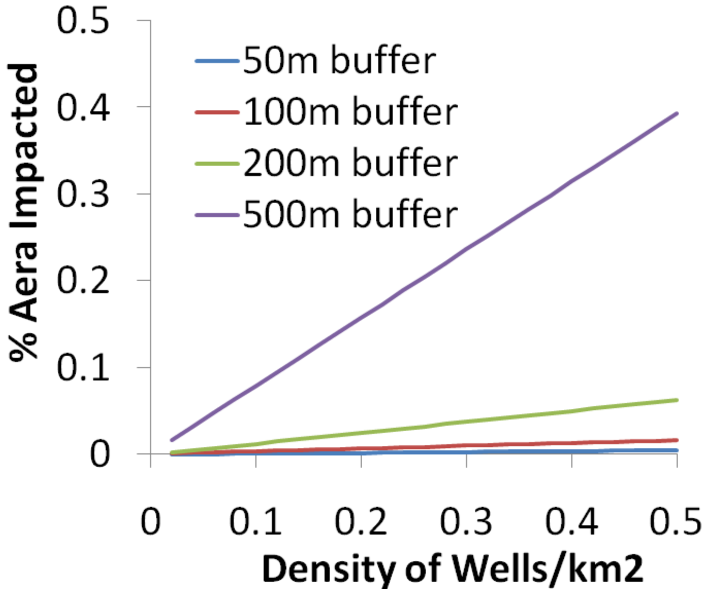


Fig.11. Simple algebraic models for the effects of increasing wildlife buffer avoidance size as a function of linear disturbance and the density of wells, assuming no overlap of buffers of disturbances – an unlikely biological scenario. However, these are useful as guidelines because the actual effects of overlap will be landscape specific, although they will tend to cause the relationships to decline asymptotically to a lower % total area impacted.

Appendix C

Compensatory Mitigation Monitoring Report Outline

I. Monitoring Report Content

A. Project Information

1. Project name
2. Applicant name, address, and phone number
3. Consultant name, address, and phone number (if appropriate)
4. COGCC Form 2As for which compensatory mitigation is being established
5. Acres of impact and type(s) of habitat impacted
6. Date project construction commenced
7. Indication of mitigation monitoring year (i.e. first, second, third, etc.)
8. Amount and information on any required performance bond or surety, if any

B. Compensatory Mitigation Site Information

1. Location of the site (regional map may be appropriate)
2. Specific purpose/goals for the compensatory mitigation site
3. Date mitigation site construction and planting completed
4. Dates summary of previous maintenance and monitoring visits
5. Name, address, and contact number of responsible parties for the site
6. Summary of remedial action, if any

C. Location Map

D. Site Map (usually no larger than 11 x 17 unless a different scale is requested by the project manager).

The map should include the following information:

1. Habitat types as described in the approved mitigation plan
2. Locations of any photographic record stations
3. Landmarks
4. Location of sample points

E. List of CDOW-Approved Success Criteria

F. Tabulated Results of Monitoring Visits, Including Previous Years, Versus Success Criteria

G. Summary of Field Data Taken to Determine Compliance with Success Criteria

H. Problems Noted and Proposed Remedial Measures

Appendix D

Potential Compensatory Actions

ACTION	IMPLICATIONS
Habitat Creation/Enhancement	
-Creation of new habitat (same or more beneficial type of habitat (vegetative type, season of use, species of wildlife)	Would remediate impacts to wildlife habitat by creating new habitat that was previously unsuitable for the species or season that is impacted. However, an extended lag period may occur before beneficial remediation occurs.
-Enhance/restore degraded habitat	Would remediate impact to wildlife habitat by expanding the carrying capacity of impacted types, season of habitat. However, an extended lag period may occur before beneficial remediation occurs.
-Enhance existing occupied, functioning habitat	Some marginal benefit, but habitat is already operating at close to carrying capacity. An extended lag period may occur before any beneficial remediation occurs.
Land Tenure Adjustments	
Fee Title/Conservation Easement acquisition or donation—surface rights in perpetuity	No remediation of impacts created by oil and gas development, but would provide future protection forever from other types of surface development (e.g., housing development).
Fee Title/Conservation Easement acquisition or donation—surface rights for a fixed term	No remediation of impacts created by oil and gas development, but would provide limited future protection from other types of development (e.g., housing development).
Purchase, Retirement, Donation, Set-aside—subsurface development rights in perpetuity	No remediation of impacts created by a specific development but could create refuges where habitat would be protected forever from future oil and gas development.
Purchase, Retirement, Donation, Set-aside—subsurface development rights for a fixed term	No remediation of impacts created by a specific surface development but could create short-term protection of habitat areas that would allow better long-term planning, temporary refuges, and could lead to landscape scale phased development.

Exceptional Application of Aggressive BMP's	
Field-wide application of operational practices that result in major reduction of disturbance to wildlife and that far exceed the industry standard (e.g., 3-phase gathering, centralized water distribution/fracturing)	Provides a level of impact **minimization** (especially the reduction of disturbance) that far exceeds the industry standard—does not provide for remediation of unavoidable impacts.
Enhanced Reclamation	
On-site reclamation/restoration efforts of demonstrable benefit to affected wildlife and that far exceed the industry standard (e.g., greatly enhanced seed mix, use of containerized stock, establishment of mature plants, irrigation, etc.	No immediate remediation of development specific impacts, but could significantly improve both the time required to restore productive habitat for certain species or seasonal habitats affected and the eventual effectiveness of those habitats. However, these benefits may be offset in time by many years due to the operational life of well pads or other facilities.
Public Access for Hunting/Fishing	
Provide or ensure continuation of public access to high quality hunting or fishing areas	Provides no remediation of unavoidable oil and gas related impacts, but would provide an important benefit for CDOW's constituents that may be an appropriate **exchange** for those impacts.
Research Participation/Support	
Financial and/or operational assistance with CDOW research programs designed to answer specific questions related to oil and gas impacts	Provides no remediation of unavoidable oil and gas related impacts, but would answer questions that would lead to better future planning, impact minimization, and impact remediation.
Mitigation Banking/Cash Mitigation	
Cash payment to an established mitigation bank or	Provides the resources necessary to complete one or more of the mitigation activities listed above, and to pool resources to complete large

wildlife mitigation trust fund as compensation for unavoidable impacts to wildlife and wildlife habitat	scale or expensive key projects. However, it removes all responsibility for achieving the mitigation from industry and transfers it to someone else, likely CDOW, and burdens the recipient with administrative responsibilities.

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