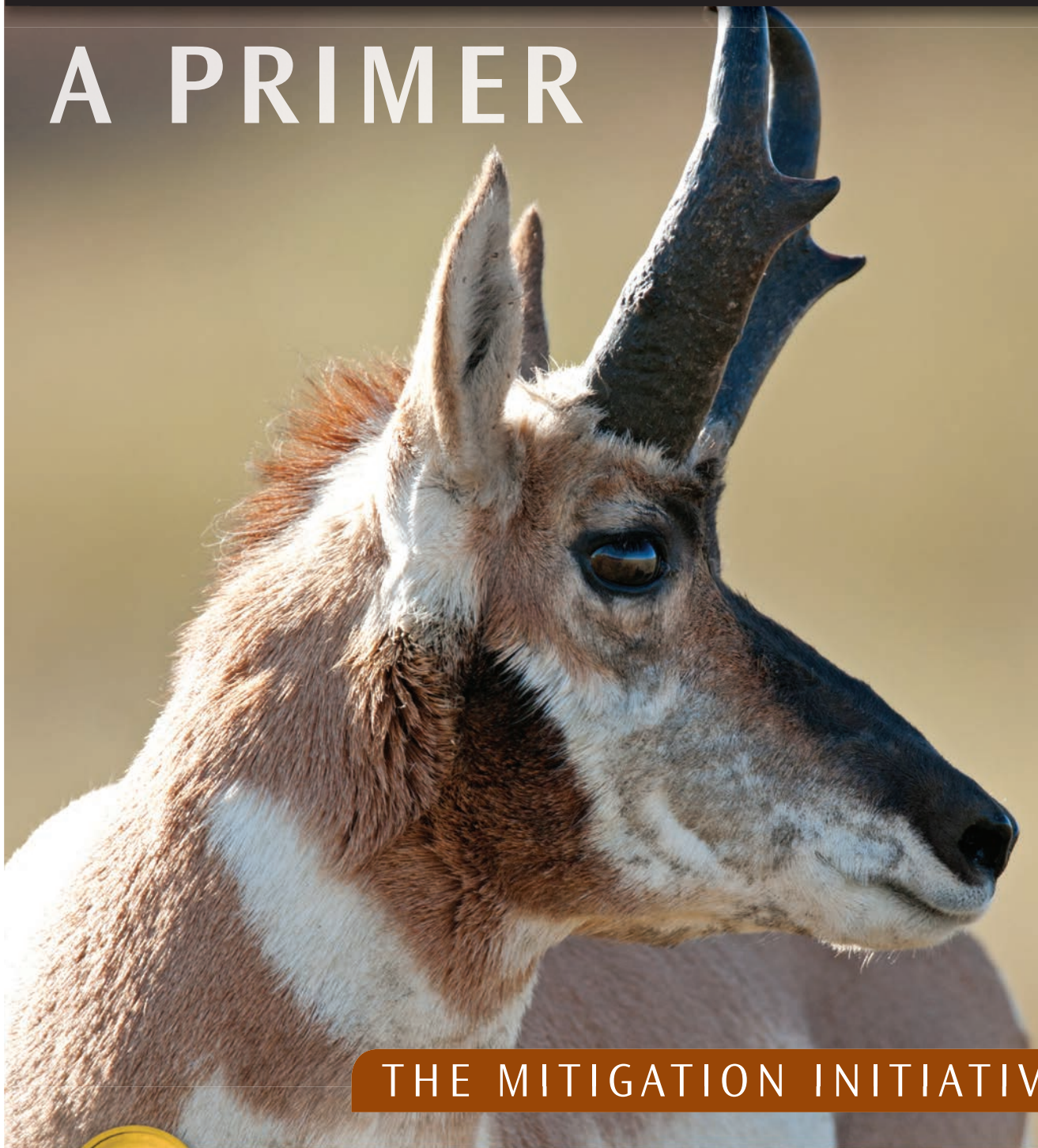


Natural Gas Development and Wildlife Mitigation

A PRIMER



THE MITIGATION INITIATIVE



UNIVERSITY OF WYOMING

RUCKELSHAUS INSTITUTE OF ENVIRONMENT
AND NATURAL RESOURCES

Environment and Natural Resources Mission Statement

The mission of the UW Environment and Natural Resources (ENR) program is to advance the understanding and resolution of complex environmental and natural resources challenges.

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Natural Gas Development and Wildlife Mitigation in Wyoming: A Primer

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Acronyms

APD	Application for Permit to Drill
BLM	Bureau of Land Management
CDOW	Colorado Division of Wildlife
CEQ	Council on Environmental Quality
COGCC	Colorado Oil and Gas Conservation Commission
CSU	Controlled Surface Use
CWA	Clean Water Act
dba	decibel
DEQ	Department of Environmental Quality (Wyoming)
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERRP	Erosion, Revegetation, and Restoration Plan
ESA	Endangered Species Act
FLPMA	Federal Land Policy and Management Act
FONSI	Finding of No Significant Impact
FY	fiscal year
HEA	Habitat Equivalency Analysis
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
HU	Habitat Unit
JIO	Jonah Interagency Office
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NSO	no surface occupancy
PAPO	Pinedale Anticline Project Office
PES	Payment for Ecosystem Services
ROD	Record of Decision
RMP	Resource Management Plan
SLT	standard lease term
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDA	Wyoming Department of Agriculture
WGFD	Wyoming Game and Fish Department
WHAP	Wildlife Habitat Appraisal Procedure
WLCI	Wyoming Landscape Conservation Initiative
WMP	Wildlife Management Plan
WOGCC	Wyoming Oil and Gas Conservation Commission



Executive Summary

Energy has long been the cornerstone of Wyoming's economy, with coal and oil historically dominating the state's natural resource extraction industry and natural gas and wind energy development leading growth in recent years. As energy development continues to expand across Wyoming, its footprint on the landscape is increasing, with important implications for wildlife. In the Intermountain West, oil and gas development is projected to directly impact 5.7 million acres (an area the size of New Hampshire) over the next 20 years, with 126,000 new wells anticipated.^{2,3} In Wyoming alone, energy companies are currently seeking approval for natural gas projects that would cover 2.3 million acres, many of which would be drilled in sagebrush shrublands and grasslands.⁴

Wildlife mitigation is the practice of avoiding, minimizing, or compensating for (offsetting) impacts to wildlife. Mitigation strategies continue to evolve, and multiple agencies and stakeholder groups have their own terms, definitions, and notions of what constitute mitigation activities. This primer draws from both working and statutory knowledge to provide a common foundation of terms and understanding for what "mitigation" and its associated activities mean in the context of wildlife and natural gas development. As more wildlife mitigation projects are undertaken and completed in Wyoming and neighboring states, it will be important that stakeholders have a shared information base and speak a common language.

Wildlife mitigation activities in Wyoming are triggered by federal permitting requirements and/or by state-level mandates, such as protection of the greater sage grouse. Guidelines for mitigation activities also exist at the federal and state levels, and these guidelines range from mandatory practices outlined in a Bureau of Land Management management directive for mitigation of surface disturbance activities to voluntary wildlife mitigation best practices proffered by the Wyoming Game and Fish Department. Much of the state's experience with wildlife mitigation has been through the Jonah Interagency Office and the Pinedale Anticline Project Office, which fund the majority of compensatory natural gas wildlife mitigation that occurs in Wyoming.

The next logical step in wildlife mitigation is to use the growing body of case studies to assess the effectiveness of specific mitigation efforts, and to use the results to derive "lessons learned" that will help shape future mitigation strategies and projects. In addition, it will be critical to continue to develop and refine methodologies to accurately assess project impacts and determine appropriate mitigation measures to compensate for those impacts. Some of the emerging approaches to mitigation that involve landscape-scale planning and species-specific metrics offer promise to advance the effectiveness of wildlife mitigation in Wyoming and the West. With its abundant energy resources and wildlife habitat, Wyoming has the opportunity to lead in this field and set a standard for the rest of the Intermountain West to follow.

I. Introduction



Energy has long been the cornerstone of Wyoming’s economy, with coal and oil historically dominating the state’s natural resource extraction industry. Over the past decade, natural gas production has surged in Wyoming, nearly doubling.¹ Natural gas and other forms of energy development are impacting increasing amounts of land, much of which is important habitat for wildlife. In the Intermoun-

tain West, oil and gas development is projected to directly impact 5.7 million acres (an area the size of New Hampshire) over the next 20 years, with 126,000 new wells anticipated.^{2,3} In Wyoming alone, energy companies are currently seeking approval for natural gas projects that would cover 2.3 million acres.⁴

Energy development is resulting in landscape-scale transformation of high-quality wildlife habitat, primarily through habitat fragmentation.⁵ Numerous studies have shown that infrastructure, roads, and human activity associated with energy development can negatively affect wildlife populations.⁵⁻⁸ In Wyoming, the majority of new wells will be drilled in sagebrush shrublands and grasslands, which support mule deer, pronghorn antelope, and greater sage-grouse, among other species.⁵

As the United States continues to capitalize on this abundant domestic energy source, western states will accrue economic benefits while facing challenges of mitigating impacts of natural gas development, including wildlife impacts. Mitigation strategies for offsetting wildlife impacts from natural gas activities continue to evolve, and multiple agencies and stakeholder groups have their own terms, definitions, and notions of what constitute mitigation activities. This primer draws from both working and statutory knowledge to provide a common foundation of terms and understanding for what “mitigation” and its associated activities mean in the context of wildlife and natural gas development.* Much of the key terminology and many of the concepts within this paper, however, apply to multiple forms of energy and industrial development that impact wildlife populations.

The Council on Environmental Quality’s (CEQ’s) definition of mitigation provides the intellectual framework for federal agency mitigation activities. As defined by CEQ, mitigation includes the full spectrum of activities that can be undertaken to avoid, minimize, restore, or offset impacts of energy development (Definition 1A).

* In addition to wildlife mitigation, mitigation activities can address air quality, cultural resources, livestock, and recreation; however, for the purposes of this publication, we focus on mitigation of natural gas development’s impacts to wildlife and their habitats. For additional information on all mitigation activities, see Ref. 9.

Definition 1A | Mitigation

Mitigation includes:

- (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
- (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- (e) Compensating for the impact by replacing or providing substitute resources or environments.

Source: Ref. 10



Though Definition 1A provides the legal underpinnings for federal government strategies for activities such as wetlands mitigation or Endangered Species Act implementation, in practice, wildlife mitigation in Wyoming follows a simplified three-step process (Definition 1B).

Both CEQ and those engaged in the practice of wildlife mitigation agree on a hierarchy of activities: first seek to avoid and minimize impacts, and then compensate for impacts that do occur (Figure 1).

Definition 1B | Mitigation

Mitigation includes:

- (a) Making efforts to avoid impacts;
- (b) Minimizing remaining impacts; and
- (c) Compensating for unavoidable impacts.

Source: Ref. 11

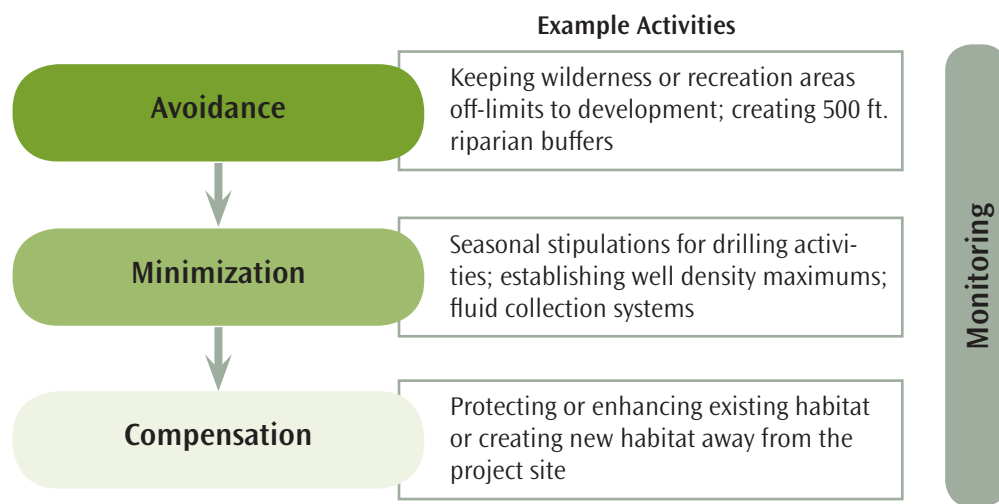


Figure 1. The Mitigation Hierarchy

II. The Mitigation Hierarchy: A Glossary of Terms

Step 1: Avoidance

Land managers and energy developers first seek to **avoid** impacts—both **direct and indirect**—to wildlife and **habitats**. Avoidance requirements for oil and gas development are generally enforced through oil and gas leases, which include **standard lease terms** and **no surface occupancy stipulations**. Bureau of Land Management (BLM) resource management plans (RMPs) and other federal agency planning documents may also designate certain areas as unavailable for oil and gas leasing.



Definition 2 | Avoidance

To circumvent, or bypass, an impact altogether by not taking a certain action or parts of an action.

Example: Making mule deer crucial winter range unavailable to development.

Sources: Refs. 10 and 12

Definition 3 | Direct impacts

Ecological, aesthetic, historic, cultural, economic, social, or health effects that are caused by an action and occur at the same time and place.

Example: Replacement of native vegetation with well pads and access roads.

Sources: Refs. 10, 13, and 49

Definition 4 | Indirect impacts

Effects that are caused by an action but are later in time or farther removed in distance.

Example: Human activity associated with natural gas development displaces animals from their preferred habitat.

Additional detail: Indirect impacts include changes in habitat quality and animal distribution, stress, and/or activity caused by increased human disturbances associated with development (e.g., noise, traffic, human use).

Sources: Refs. 10 and 14

Definition 5 | Habitat

The resources and conditions present in an area that promote occupancy, survival, and reproduction by a given organism.

Example: A mixture of sagebrush nesting cover and forb/grass forage used by greater sage-grouse during nesting season.

Source: Ref. 15

Definition 6 | Standard Lease Terms (SLTs)

Provisions applied to all leases (of the same type), regardless of special circumstances.

Example: Lessee must conduct operations in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, and other resources, and to other land uses or users.

Additional detail: BLM provides oil and gas SLTs in Form 1300-11.

Sources: Refs. 14 and 16

Definition 7 | No Surface Occupancy (NSO)

Stipulations that prohibit operations directly on the surface of parts or all of a leased federal tract, though oil and gas reserves on these leases may be reached from other locations via directional drilling; NSOs can be applied to a lease when there are lands of special cultural, historical, or ecological value.

Example: NSO within 100-year floodplains.

Additional detail: NSO stipulations are used only when other stipulations are determined insufficient to adequately protect public interest; to apply an NSO stipulation, the BLM field office Resource Management Plan or the National Environmental Policy Act (NEPA) document prepared for leasing must show that less restrictive stipulations were considered and determined to be insufficient.

Sources: Refs. 12 and 14



Step 2: Minimization

After avoiding impacts altogether, the next action is to **minimize** impacts, which is generally required through lease stipulations, including **controlled surface use** stipulations or **seasonal stipulations**.

Definition 8 | Minimization

Reducing impacts to the smallest practicable amount or degree.

Examples: Consolidated pad construction and directional drilling of multiple wells from a single pad to reduce surface disturbance; liquid gathering systems, or pipelines that carry natural gas, condensate, and water liquids and therefore reduce truck traffic.

Source: Ref. 17

Definition 9 | Controlled Surface Use (CSU)

Use and occupancy is allowed (unless restricted by another stipulation), with identified resource values requiring special operational constraints that may modify the lease rights.

Example: Stipulations for a particular parcel to minimize light and sound pollution and therefore reduce disturbance to a specific species.

Source: Ref. 18

Definition 10 | Seasonal stipulations (or timing limitations)

Lease stipulations that prohibit activity during certain times of year.

Example: March 15–July 1 restriction on drilling activities near greater sage-grouse nesting habitat.

Additional detail: Seasonal stipulations do not typically apply to operational activities, but rather, apply during drilling.

Source: Ref. 14

Step 3: Compensation

When—after avoidance and minimization measures are implemented—there still will be a net loss of wildlife habitat or other impacts to habitat or wildlife populations, managers or energy developers can engage in **compensatory mitigation** (see Box 1) to offset impacts, which can be conducted **on-site** or **off-site**. On- or off-site mitigation can be **in-kind** or **out-of-kind**.



Definition 11: On-site mitigation

Mitigation of the actual area affected by the action causing the impact.

Example: Installation of wildlife friendly fencing on the project site.

Additional detail: Federal agencies generally specify that on-site mitigation measures should be prioritized over off-site measures whenever possible.

On-site mitigation is different from reclamation activities, which are required as part of an operator's reclamation plan to restore habitat and surface disturbance.

Sources: Refs. 17 and 19

Definition 12: Off-site mitigation

Compensating for resource impacts by replacing or providing substitute resources or habitat at a different location than the project area.

Examples: Conserving winter range in an area not part of the drilling lease to compensate for winter range fragmented by drilling activities; conservation easements outside of the drilling lease.

Additional details: BLM's policy is that "off-site mitigation is a supplemental mitigation practice identified on a case-by-case basis and must be based on the need to address important resource issues that cannot be acceptably mitigated on-site." The U.S. Fish and Wildlife Service (USFWS) also prioritizes on-site mitigation, then off-site mitigation in proximity and in the same ecological region as the project area, and lastly, mitigation farther away but in the same ecological region.

For energy development, off-site mitigation is voluntary and may be proffered by a project proponent to reduce impacts to wildlife and/or assist with permit approvals.

Sources: Refs. 17 and 19

Definition 13: In-kind

Providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same as or closely approximate those lost.

Example: Preserving or enhancing juniper woodlands habitat away from a project area if juniper woodlands are impacted on the project site.

Additional detail: BLM's policy is that in-kind mitigation is generally preferred to out-of-kind mitigation.

Sources: Refs. 17 and 19

Definition 14: Out-of-kind

Providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically or biologically different from those lost.

Example: Preserving sagebrush habitat off-site, though juniper woodlands habitat is impacted on-site. Out-of-kind compensation may include conservation or mitigation banking, research, or cash payments.

Source: Ref. 17

Box 1: What is “Compensatory Mitigation”?

The term “compensatory mitigation” was originally defined in guidelines to Section 404 of the Clean Water Act, which details how developers impacting wetlands must compensate for impacts incurred. The definition is:

The restoration (reestablishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of wetlands for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

When applied in the context of natural gas development, this definition could be interpreted to encompass all mitigation activities implemented in response to impacts that cannot be prevented (avoided or minimized), that is, any on-site or off-site mitigation activities that alleviate or offset an impact that has occurred or will occur.

However, the exact definition of “compensatory mitigation” in the context of offsetting impacts to natural gas development is unclear. The Bureau of Land Management (BLM) 2008 “Instructional Memorandum on Offsite Mitigation” never uses the term “compensatory mitigation,” nor does the agency mention it in any of its current policy documents. BLM’s 2005 “Instructional Memorandum on Interim Offsite Compensatory Mitigation” (which the 2008 memo replaces and nullifies), says:

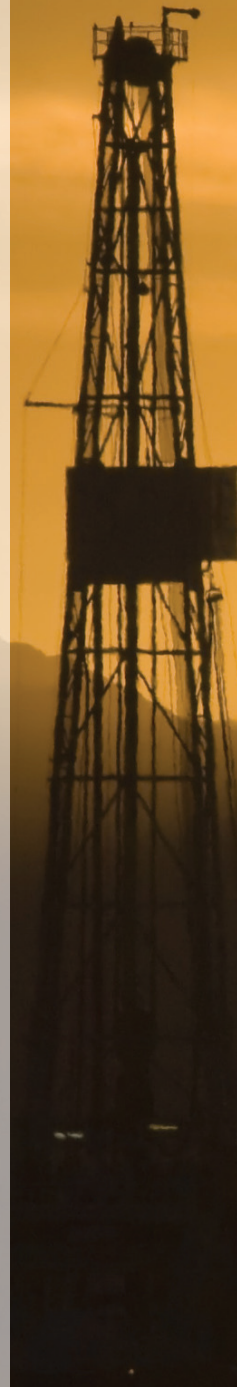
“Compensatory Mitigation: As defined by CEQ, this means compensating for the impact by replacement or providing substitute resources or environments.

This offsite mitigation can be immediately adjacent to the area impacted but can also be located anywhere in the same general geographic area.” (emphasis added)

Following these guidance documents, BLM has used “compensatory mitigation” on a project-specific basis. For example, BLM’s Jonah Infill Drilling Project Record of Decision charges the Jonah Interagency Office (JIO) with managing “compensatory mitigation funds,” and also uses “compensatory mitigation” as a synonym for “off-site mitigation.”

In sum, the lack of firm definition of the term in the context of energy development, its lack of clarity in the context of on-site or off-site mitigation, and various contexts in which it has been used, leave the definition of “compensatory mitigation” outside of wetlands mitigation somewhat nebulous.

Sources: Refs. 19–22



Monitoring

Monitoring is used to assess the effectiveness of mitigation, if measurable management goals are in place. Resource managers increasingly are employing **adaptive management** techniques to incorporate monitoring information into mitigation practices.



Definition 15: Monitoring

The orderly collection, analysis, and interpretation of resource data to evaluate progress toward meeting resource management objectives.

Examples: Population counts, measuring reproductive success, movement observations, and winter use surveys for mule deer.

Sources: Refs. 14 and 18

Definition 16: Adaptive management

A process that promotes flexible and iterative decision making that can be adjusted in the face of uncertainties and as outcomes from management actions and other events become better understood through monitoring and other means.

Example: Enhancing habitat, changing operation practices, enhancing off-site mitigation measures, or voluntarily suspending leases if greater sage-grouse numbers decline beneath a certain threshold.

The Pinedale Anticline Record of Decision outlines an adaptive management process in which there are specific mitigation triggers for sensitive species; for example, if there is a 15 percent decline in the population estimate of the Sublette mule deer herd unit in any year, or cumulatively over all years (compared to a reference area), then mitigation activities are required.

Additional detail: Adaptive management consists of several basic steps, including: 1) assessing the problem, 2) designing management (i.e., mitigation activities) and monitoring plans and creating measurable and quantifiable triggers, 3) monitoring, 4) evaluating the effectiveness of management activities using data from monitoring, and 5) if trigger levels are met, adjusting management based on new understanding.

Sources: Refs. 24, 25, and 29

Table 1. Mitigation Terminology Overview.

on-site mitigation	Takes place in the <i>impacted area</i> (e.g., lease area)
off-site mitigation	Takes place at a <i>different location</i> from the impact (e.g., outside of the lease area)
in-kind mitigation	The substitute resources are physically and biologically <i>the same or closely approximate</i> those lost
out-of-kind mitigation	The substitute resources are <i>physically or biologically different from</i> those lost
compensatory mitigation	Activities that <i>offset the unavoidable adverse impacts</i> that remain after all practicable avoidance and minimization measures have been undertaken

III. Wildlife Mitigation and Natural Gas Development in Wyoming



Mitigation Triggers

Mitigation obligations can arise under a variety of federal statutes, including the Clean Water Act (CWA), the Endangered Species Act (ESA), and the National Environmental Policy Act (NEPA; see Table 2). When federal lands and minerals are involved, mitigation for natural gas development in Wyoming frequently arises and is addressed through NEPA’s environmental impact assessment process (Figure 2), while mitigation obligations are often imposed through BLM’s statutory authority under the Federal Land Policy and Management Act (FLPMA). The federal government (primarily the BLM) manages 30 million acres, or 48 percent, of the surface estate in Wyoming; BLM also administers nearly 42 million subsurface mineral acres.²⁶ Consequently, most natural gas development involves federal permitting and review. In addition to federal mitigation triggers, mitigation activities can also be spurred by state-supported permitting processes, initiatives, and other regulations.

Table 2. Federal Mitigation Triggers. This publication primarily details mitigation activities in Wyoming that are National Environmental Policy Act–driven.

Clean Water Act (CWA) wetlands mitigation	Authority is designated under §404 of CWA to mitigate for impacts to wetlands. This process uses a watershed approach for mitigation site selection.
Endangered Species Act (ESA) mitigation	§7 of the ESA requires the USFWS to consider one-time and cumulative effects of federal agency actions on threatened and endangered species and their habitats, and authorizes the imposition of requirements to minimize the impacts of authorized takes (“take” refers to the killing, harassing, or disturbing of an endangered species); §10 authorizes taking of threatened or endangered species if a Habitat Conservation Plan is developed that will minimize <i>and mitigate</i> impacts of the taking. [emphasis added]
National Environmental Policy Act (NEPA) mitigation	Environmental impact statements generated under the NEPA process must identify potential measures to mitigate identified impacts. NEPA provides pathways both for the permitting agency to identify mitigation measures and for the project developer to offer mitigation measures.

Source: Ref. 27

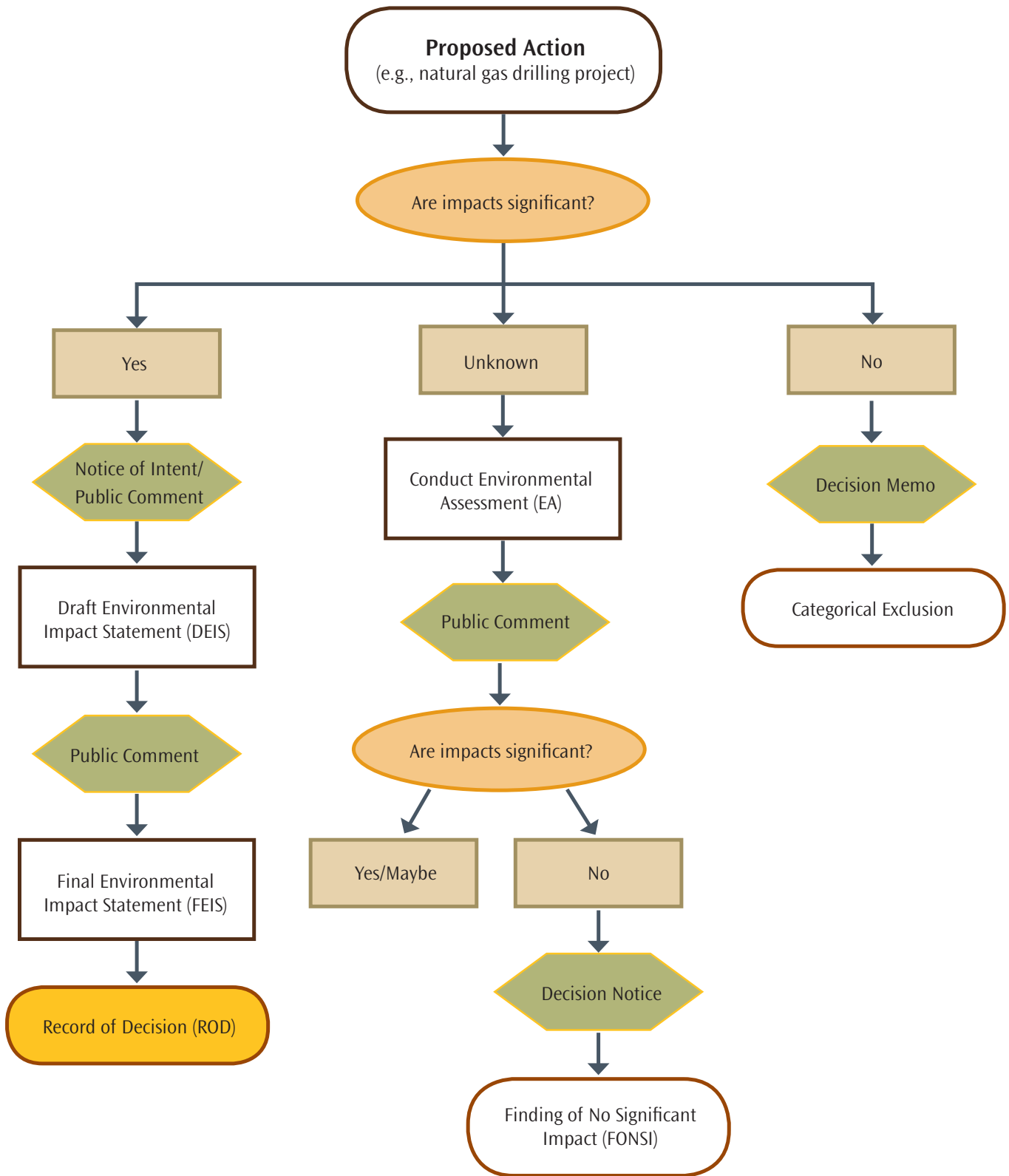


Figure 2. Stages of the National Environmental Policy Act (NEPA) Review Process. Mitigation measures are generally outlined in a project’s Record of Decision (ROD).



Federal Mitigation Triggers

For resource extraction on federal lands or of federal minerals, mitigation activities are generally triggered by the review of a permit application under the NEPA process. They are first scoped through an Environmental Assessment (EA) or Environmental Impact Statement (EIS), and then codified in a Record of Decision (ROD).

State-level or Species-specific Mitigation Triggers

State-level and/or species-specific policies may also influence wildlife mitigation activities. Natural gas development that does not involve federal minerals or surface land is permitted through the Wyoming Oil and Gas Conservation Commission (WOGCC); the Wyoming Department of Environmental Quality (DEQ) oversees permitting for the environmental impacts of these projects. In addition, species-specific policies, such as the State of Wyoming's Sage-grouse Core Population Area Policy and Executive Order and BLM's Instructional Memorandum on Sage-grouse Conservation, can trigger or inform mitigation activities.

Definition 17: Environmental Assessment (EA)

An analytical document prepared with public input to determine whether impacts of a proposed federal action will be significant, thereby requiring an Environmental Impact Statement (EIS) for a particular project or action. If an EA determines the proposed action will not have significant effects (a Finding of No Significant Impact, or FONSI), an EIS is not required and the EA FONSI documents agency compliance with NEPA.

Example: The 2005 Environmental Assessment for the Bitter Creek Shallow Oil and Gas Project, Sweetwater County, Wyoming, completed by the BLM Rock Springs Field Office. This EA yielded a Finding of No Significant Impact of the project's environmental effects.

Sources: Refs. 10 and 12

Definition 18: Environmental Impact Statement (EIS)

A document that examines environmental and other consequences of proposed federal actions in greater detail than an EA; an EIS is required for "major federal action[s] significantly affecting the quality of the human environment."

Example: A Final Environmental Impact Statement was issued by the BLM in early 2006 for the Jonah Infield Drilling Project. The public was able to comment on the EIS for 30 days, and then the BLM issued an ROD for the project.

Sources: Refs. 12 and 28

Definition 19: Record of Decision (ROD)

A federal decisional document prepared to record the selected alternative of an Environmental Impact Statement and any accompanying mitigation measures.

Example: The Jonah Infill Drilling Project, Sublette County, Wyoming, Record of Decision, which outlines drilling terms and required mitigation activities for the Jonah Field.

Source: Ref. 22



Guidelines for Mitigation Activities

Multiple sources provide guidelines for mandatory or voluntary mitigation activities for natural gas development in Wyoming.

The BLM has mandatory nationwide standards for oil and gas leasing and statewide standards for all surface leasing. Additional region-specific standards may be developed and outlined in a BLM field office Resource Management Plan. For example, a natural gas operator in Wyoming will follow mitigation measures outlined in:

- Form 3100-11, “Offer to Lease and Lease for Oil and Gas,” a standard nationwide permitting document that outlines many of the SLTs.³⁰ Form 3100-11 requires that operations be conducted “in a manner that minimizes adverse impacts to the land, air, water, cultural, biological, and visual elements of the environment, as well as other land uses or users”;
- A statewide directive, Wyoming BLM’s “Standard Mitigation Guidelines for All Surface Disturbing and Disruptive Activities,” which provides Wyoming-specific avoidance and minimization measures (e.g., avoidance of 25% slopes, construction prohibited when soil is frozen or saturated);¹⁶
- Resource Management Plans that outline field office-specific lease stipulations (including seasonal stipulations specific to an area), such as the Pinedale RMP;¹² and
- Any mitigation stipulations outlined in a project’s ROD or EA Decision Record. At times, an ROD will include voluntary mitigation measures (such as a special mitigation fund).

The Wyoming Game and Fish Department (WGFD) also suggests voluntary best practice avoidance, minimization, and off-site compensatory mitigation practices for loss of wildlife habitat to oil and gas development.³¹

Major Sources of Wildlife Mitigation Funding

Industry and federal sources provide most funding for wildlife mitigation activities in Wyoming that pertain to natural gas development. Entities with the largest funding pools for wildlife mitigation are the Jonah Inter-agency Office (JIO) and Pinedale Anticline Project Office (PAPO), which are funded by natural gas operators, and the Wyoming Landscape Conservation Initiative (WLCI), which is primarily funded by the federal government (Table 3).

Table 3. Major Sources of Wyoming Wildlife Mitigation Funding.

<p>Pinedale Anticline Project Office (PAPO)</p>	<p>Total funding: \$36.0M</p>
<p>Purpose: Established in 2008 to oversee mitigation and monitoring activities for the Pinedale Anticline Project Area, a large natural gas field that comprises ~300 square miles in western Wyoming. PAPO seeks to provide “overall management of on-site monitoring and off-site mitigation activities that primarily focus on mule deer, pronghorn, and greater sage-grouse.”</p> <p>Funding: A maximum of \$36 million, which the project area’s natural gas operators provide on a \$7,500 per-well-spudded (initiated) basis. As of August 31, 2011, \$16.5 million has been contributed.</p> <p>Example projects: Conservation easements; wildlife-friendly fencing; mule deer winter range fertilization.</p> <p>Organizational structure: Staffed by employees of the Wyoming Department of Agriculture (WDA), Wyoming Game & Fish Department (WGFD), Wyoming Department of Environmental Quality (DEQ), and the Bureau of Land Management (BLM).</p> <p><i>Sources: Refs. 9 and 29</i></p>	
<p>Jonah Interagency Office (JIO)</p>	<p>Total funding: \$24.5M</p>
<p>Purpose: Established in 2006 to oversee mitigation funds meant to offset the “major unavoidable impacts” of natural gas production from the Jonah Field in western Wyoming. Operators are authorized to have one drill pad on every 10 acres over the 30,500-acre field, with a project life of about 75 years. The project Record of Decision (ROD) authorizes 46 percent (14,030 acres) of the field to be disturbed at one time, with a rollover credit system for acres that have been reclaimed.</p> <p>Funding: \$24.5 million specifically for off-site mitigation; funding is provided voluntarily by the area’s operators, primarily Encana. Of the total, \$16.5 million is to be used to mitigate wildlife impacts, and \$8 million can be used to mitigate other resource impacts, perform monitoring, or accomplish other activities.</p> <p>Example projects: Conservation easements; message signs on roads in wildlife crossing areas; habitat improvement projects; prescribed burns; constructing raptor nest platforms and water trough bird ramps; wildlife friendly fencing.</p> <p>Organizational structure: Staffed by representatives from WDA, DEQ, WGDF, and BLM.</p> <p><i>Sources: Refs. 9 and 22</i></p>	
<p>Wyoming Landscape Conservation Initiative (WLCI)</p>	<p>Per year avg. funding: ~\$1M</p>
<p>Purpose: A long-term, science-based program that was established to assess and enhance aquatic and terrestrial habitats at the landscape scale in southern Wyoming. One of WLCI’s management priorities is “identify[ing] the most effective and needed restoration, reclamation, and mitigation activities, as well as locations where conservation benefits may be maximized.”</p> <p>Funding: Disbursed \$1.1 million in Fiscal Year 2010 (October 1–September 30). Funding primarily comes from the U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), and BLM.</p> <p>Projects: Fencing projects, riparian area restoration, and conservation easements; WLCI has funded 47 habitat conservation projects to date, though not all can be categorized as wildlife mitigation.</p> <p>Organizational structure: WLCI is an interagency working group that includes the Department of the Interior (BLM, USFWS, USGS, National Park Service, Bureau of Reclamation, and the Great Northern Landscape Conservation Cooperative), the U.S. Department of Agriculture (U.S. Forest Service and Natural Resources Conservation Service), WDA, Southwest Wyoming Conservation Districts, Southwest Wyoming County Commissions, and the WGFD.</p> <p><i>Source: Ref. 32</i></p>	

Specific Mitigation Activities

Traditionally, mitigation in Wyoming and across the United States has occurred on a project-by-project basis,³ though impacts of energy development on wildlife can be cumulative within and across projects.^{5,31} Increasingly, off-site mitigation is being used to offset impacts to habitat.³ Appendix I provides a list of specific wildlife mitigation activities taking place in Wyoming in response to natural gas development.

In addition, the mitigation activities and guidelines of other states may provide insights for future mitigation activities in Wyoming (Table 4).

Table 4. What Are Other States Doing in Wildlife Mitigation?

State	Mitigation Strategy	Description	Details
Colorado	Wildlife Mitigation Plans (WMPs)	Voluntary comprehensive plans negotiated with the Colorado Division of Wildlife (CDOW)	<ul style="list-style-type: none"> Streamlines permitting, as WMPs eliminate the need for consultation among operators, surface owners, and staff of CDOW and the Colorado Oil and Gas Conservation Commission (COGCC) on potential wildlife impacts of individual permits Enables long-term, landscape-scale mitigation planning CDOW has entered into seven WMPs that together cover operations on ~321,350 acres of habitat in western Colorado WMP content includes operator commitments to avoidance and minimization measures, mitigation practices on- and off-site, and funding for research
	Voluntary density and timing restrictions	Limits well density in certain sections and sets restrictions on activities during certain times of the year when there may be impacts to wildlife	<ul style="list-style-type: none"> Voluntary agreement oil and gas operators can make with the COGCC to limit density to three well sites per section (640 acres) Under this agreement, ground-disturbing activity is halted between January 1 and March 31, or a biologically appropriate alternative 90-day period Provides operators with an opportunity to address potential impacts to wildlife habitat before applying for a permit Companies that adopt these restrictions are not required to consult with CDOW
Oregon	Wildlife Habitat Mitigation Policy	Oregon Department of Fish and Wildlife policy that provides clear guidance for state mitigation goals	<ul style="list-style-type: none"> Categorizes habitat on a scale of 1–6, with 1 being “irreplaceable, essential and limited,” and 6 being habitat that has “low potential to become essential or important habitat” Establishes mitigation goals for each category of habitat and preferred strategies to avoid or mitigate impacts
Texas	Wildlife Habitat Appraisal Procedure (WHAP)	Texas Parks and Wildlife Department procedure to assess quality of habitat, assess habitat impacts, and stipulate mitigation requirements	<ul style="list-style-type: none"> Includes a quantitative evaluation procedure for habitat quality (establishing a baseline habitat value) Provides formulas for calculating compensation acres needed Outlines factors that may affect acquisition priority or management strategies

Sources: Refs. 33–35

IV. Compensatory Mitigation Metrics



Mitigation metrics are needed to assess the amount of mitigation that will adequately compensate for unavoidable impacts and determine if mitigation goals have been achieved. By default, “habitat” is the most common measure for mitigation activities, and it is often quantified by acreage. Acreage mitigation ratios are sometimes used to determine how much mitigation is required; for example, with a mitigation ratio of 3:1, three acres are reclaimed, restored, or protected for every one acre impacted by development. In general, mitigation ratios are either pre-defined, calculated through a specified method (i.e., the Habitat Evaluation Procedure, detailed in Table 5), or are assigned ad hoc by a regulatory agency.³ As a result, state fish and wildlife agencies and federal land management agencies often use very different approaches to calculate impacted acres and determine how many mitigation acres are required (Table 5).

Table 5. Example Habitat Assessment and Mitigation Requirement Metrics.

Agency	Approach	Details
U.S. Fish and Wildlife Service (USFWS)*	Habitat Evaluation Procedure (HEP)	<ul style="list-style-type: none"> Developed in the late 1970s through the early 1980s as a species/habitat approach to habitat assessment; assesses quality and quantity of habitat Habitat quality for selected target wildlife species is documented with an index, the Habitat Suitability Index (HSI) HSI values range from 0.0 to 1.0, with 1.0 representing optimal habitat conditions for the target species The HSI values are multiplied by the area (in acres) of available habitat to obtain Habitat Units (HUs) for individual species These measures can then be used to quantify the effects of mitigation/compensation
National Oceanic and Atmospheric Administration (NOAA)	Habitat Equivalency Analysis (HEA)	<ul style="list-style-type: none"> Determines the amount of compensation or replacement habitat that provides the biological functions and services equivalent to those that were lost (in response to natural resource damages, not in anticipation) Assumes the public is willing to accept a 1:1 trade-off between the service lost and the service gained by restoration Example: for an oil spill in a lake, losses would be assessed for interim loss of marsh services and mortality and loss of growth to fish, shellfish, and birds; NOAA staff then determine the number of acres of lost services and an equivalency of acres that would replace the loss of habitat services
U.S. Army Corps of Engineers (USACE)	Wetlands banking and mitigation credits system	<ul style="list-style-type: none"> Calculations for mitigation activities required differ on a state and regional level Mitigation ratio is often 1:1 and is measured in acreage or linear feet There are over 100 wetlands assessment tools used for this process
Bureau of Land Management (BLM)*	Mitigation: disturbance ratios	<ul style="list-style-type: none"> BLM determines mitigation ratios on a case-by-case basis and can apply a range to each project; often the agency applies a 3:1 (mitigation to disturbance) acreage ratio This ratio only accounts for direct impacts to habitat (and not indirect impacts) The Pinedale Anticline Record of Decision requires a 3:1 enhancement to disturbance ratio for on-site and off-site mitigation measures
Wyoming Game and Fish Department (WGFD)	Recommendations for development of oil and gas	<ul style="list-style-type: none"> Has no standard mitigation ratio Mitigation area is dependent on “the types of treatments applied, the expected improvement to the functional capacity of the land, and the effectiveness of management practices within the project area” Agency philosophy similar to the USFWS’s HEP: WGFD says that the “mitigation amount should be set where the expected increment of improvement multiplied by the number of acres treated should equal the acre-equivalent of habitat function lost”

* These agencies also utilize HEA methodology.

Note: For a comprehensive list of environmental performance measurement methodologies, see Appendix 5 of Ref. 36.

Sources: Refs. 29, 31, and 37–42.

Ideally, mitigation ratios would be tailored to a project by considering: 1) the chosen compensation mechanism (e.g., restoration, preservation), 2) the equivalence of the offset activity (in-kind versus out-of-kind), 3) the conservation significance of the impacted and mitigated acres, 4) the location of mitigation acres (on-site versus off-site), 5) any temporal lags between project impacts and offset maturity,

and 6) the risks of the mitigation (offset) activities not achieving their intended goals.⁴¹ However, there is no single existing methodology that effectively captures all of these elements or objectively assesses impacts to wildlife from energy development and determines the extent of appropriate mitigation measures.





V. Emerging Approaches to Wildlife Mitigation

With the expansion of natural gas development across the United States, new ways of thinking about mitigation activities are emerging. Novel methods proposed include landscape-scale approaches that map mitigation activities for a state or region, algorithms for site selection of off-site mitigation activities, species-specific mitigation strategies, and payment for ecosystem services.

Landscape Approaches

Selecting mitigation sites piecemeal rather than through systematic regional planning may reduce conservation benefits.²³ Just as some state agencies are engaging in long-term, landscape-scale mitigation planning (see Table 4), others are looking to establish landscape-level conservation methodologies to better address the cumulative impacts of energy development. The WGFD recognizes the merit of this approach, stating: “A landscape approach is essential to plan and mitigate large-scale energy developments because impacts from such developments are not limited to the actual project area, nor are mitigation opportunities.”³¹

Researchers from The Nature Conservancy support a landscape-scale approach to mitigate impacts of energy development on wildlife and outline a specific process to achieve this aim.^{3,43} In their method, “Development by Design,” they first determine a conservation portfolio of sites that represent priority habitats and then map the sites against oil and gas development potential. Where areas of high oil and gas potential exist, they seek to re-draw the conservation portfolio boundaries to accommodate those sites while preserving similar habitat elsewhere; conversely, if there are areas of habitat that are critical to a popula-

tion’s survival, those can be placed off-limits to development or developers can engage in additional practices to avoid or minimize impacts in these areas. The next step of their process is to assess and map proposed mitigation actions within the context of the conservation portfolio and minimum viability needs of target species (i.e., species of conservation concern, such as the greater sage-grouse). This process estimates the contribution of off-site mitigation activities (offsets) to conservation goals and could provide a metric for out-of-kind mitigation actions, better informing off-site mitigation planning.

Mitigation Site Selection

Choosing effective locations for off-site mitigation is difficult. Land management agencies typically encourage locating off-site mitigation activities as close to the impact site as possible.^{17,19} However, sites close to the project area may or may not provide the greatest conservation benefits.²³

To address this challenge, a Marxan[†] algorithm may be used for site selection of offsets that searches for suitable mitigation sites at increasing spatial extents from a disturbed area.²³ Applied to mitigation activities, the software can choose offset sites as close to the disturbed site as possible that also meet conservation objectives.[‡] This method and other site-selection techniques can be combined with landscape-scale conservation planning to inform a comprehensive mitigation strategy.

[†] Marxan is conservation-planning software that can incorporate site-specific spatial design criteria (Ref. 44).

[‡] Kiesecker et al. (Refs. 3 and 23) use the Jonah Field as a case study to test this algorithm.



Species-specific Mitigation

While mitigation activities often focus on habitat types, at times managers may want to target mitigation toward specific species. To do so, they must first quantify impacts to the species and set species-specific mitigation goals. This approach to mitigation also can be blended with, and complementary to, landscape-level mitigation planning.

Researchers have used predictive models and build-out scenarios to anticipate impacts of energy development on specific species, using the greater sage-grouse as a case study.² This type of forecasting can inform decision makers about the potential tradeoffs between species conservation and energy development before a project is built. Building on this work, a greater sage-grouse case study also was used to test a species-specific, biologically based “currency” for mitigation offset quantification and evaluation of impacts of energy development.⁴⁵ This method forecasts impacts of energy development on the greater sage-grouse and then relates population performance to development intensity. Where wildlife population data are available, this accounting system could replace those based on habitat, allowing managers to protect at least an equal number of animals in similar landscapes as are impacted through development.

Payment for Ecosystem Services

Payment for ecosystem (or environmental) services (PES) is another emerging model for mitigating energy development. PES is a voluntary transaction where an “ecosystem service provider,” such as a landowner, is paid for agricultural, forestry, or water management practices that are expected to continue or improve an ecosystem service, or a benefit people obtain from an ecosystem (see Ref. 46

for further details on ecosystem services). The ecosystem service provided must be additional to what would have occurred were the payment not made.⁴⁷ PES can be used for both unavoidable impacts and to compensate for interim impacts while reclamation is taking place. Currently, The Nature Conservancy, University of Wyoming, and Sublette County Conservation District are scoping the feasibility of a PES initiative focused on wildlife habitat and watershed health values in Wyoming’s Upper Green River Basin.⁴⁸

IV. Conclusion

Intensive natural gas development in the Intermountain West, and Wyoming in particular, provides a wealth of experience from which land managers and developers can learn how to more effectively mitigate impacts to wildlife. Yet, a common vernacular around wildlife mitigation is just now emerging, drawing heavily on terminology from more mature fields such as wetlands mitigation. As more wildlife mitigation projects are undertaken and completed in Wyoming and neighboring states, it will be important that stakeholders have a shared information base and speak a common language. The next logical step will be to use the growing body of mitigation case studies to assess the effectiveness of specific mitigation efforts, and to use the results to derive “lessons learned” that will help shape future mitigation strategies and projects. In addition, it will be critical to continue to develop and refine methodologies to accurately assess project impacts and determine appropriate mitigation measures to compensate for those impacts. With its abundant energy resources and wildlife habitat, Wyoming has the opportunity to lead in this field and set a standard for the rest of the Intermountain West to follow.

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Appendix I: Example Wyoming Wildlife Mitigation Activities for Natural Gas Development

	Location	Mitigation Action
Avoidance (On-site)		
Surface disturbance avoidance	All BLM-permitted activities in WY	No well pad, road, or other construction shall be conducted in or with frozen materials, or during periods when the soil is saturated, or when watershed damage is likely to occur. ¹
	All BLM-permitted activities in WY	Surface-disturbing activities shall not be conducted on slopes in excess of 25% or within 500 feet of surface water and/or riparian habitat. ¹
	All BLM-permitted activities in WY	No surface occupancy will be allowed in special management areas (e.g., known threatened or endangered species habitat, areas suitable for consideration for wild and scenic rivers designation). ¹
	All BLM-permitted activities in the Pinedale region	Federally-managed 100-year floodplains will have no permanent structures constructed within their boundaries unless it can be demonstrated on a case-by-case basis that there is no physically practical alternative. ⁶
	Jonah Field	No surface occupancy will be allowed within 300 feet of Sand Draw. ²
Wildlife avoidance	Pinedale Anticline Project Area	Avoidance of Mesa Breaks deer crucial winter range. ³
	Pinedale Anticline Project Area	New roads and trails should not cross prairie dog colonies. ³
	All BLM-permitted activities in the Pinedale region	Well pads, access roads, and other aboveground facilities will not be located within 825 feet of an active raptor nest, within 1,000 feet of an active ferruginous hawk nest, or within 2,640 feet of any bald eagle nest. ⁶
	All BLM-permitted activities in the Pinedale region	Avoid surface disturbance within 0.25 mile of an occupied greater sage-grouse lek. Linear disturbances such as pipelines, seismic activity, etc., could be granted exceptions since they do not have long-term, continuous activity associated with them that could impact breeding success. ⁶
	Pinedale Anticline Project Area	No activity on certain leases for at least 5 years; this collectively includes 49,903 acres of which 16,954 acres are within big game crucial winter range and 37,019 acres are within 2 miles of a greater sage-grouse lek. ³
	All BLM-permitted activities in the Pinedale region	Avoid activities and facilities that create barriers to the seasonal movements of big game and livestock. ⁶

Minimization (On-site)		
Surface disturbance minimization	Pinedale Anticline Project Area	Consolidated pad construction and development and directional drilling of multiple wells from a single pad to reduce surface disturbance. ³
	All BLM-permitted activities in the Pinedale region	Removal and disturbance of vegetation will be kept to a minimum through construction site management (e.g., using previously disturbed areas and existing easements, limiting equipment/materials storage yard and staging area sizes, etc.). ⁶
	Jonah Field	Well pads and associated roads and pipelines would be located to avoid or minimize impacts in areas of high value (e.g., threatened, endangered, proposed, and candidate species [TEP&C] or BLM Wyoming Sensitive [BWS] species habitats, wetland/riparian areas). ²
	Jonah Field	Operators are encouraged to use closed loop drilling systems for all drilling operations, particularly in areas of critical wildlife habitat. ²
	Pinedale Anticline Project Area	To maintain sufficient undisturbed or minimally disturbed habitats to protect wildlife habitat values on either side of the New Fork and Green Rivers, in the "MA 5" area a maximum of two well pads and 40 acres of surface disturbance per section will be allowed. ³
Seasonal stipulations	All BLM-permitted activities in WY	To protect important big game winter habitat, activities or surface use will not be allowed from November 15 through April 30 within certain areas. The same criteria apply to defined big game birthing areas from May 1 through June 30. ¹ **However, the Pinedale Anticline ROD exempts developers from seasonal stipulations usually applied to big game (pronghorn and mule deer) and greater sage-grouse. ³
	Pinedale Anticline Project Area	Restricted development from November 1st to August 15th within 1 mile on either side of the middle of the New Fork River to protect raptor habitat. ³
	All BLM-permitted activities in the Pinedale region	Surface disturbing and disruptive activity prohibited within 0.5 mile of occupied burrowing owl nests from April 1 through August 15. ⁶
	All BLM-permitted activities in the Pinedale region	If an active mountain plover nest is found in the survey area, the planned activity should be delayed 37 days, or one week post-hatching. If a brood of flightless chicks is observed, activities should be delayed at least 7 days. ⁶
	Jonah Field	Surface-disturbing and disruptive activities prohibited in greater sage-grouse nesting and early brood-rearing habitat within 2.0 miles of an occupied lek, or in identified greater sage-grouse nesting and early brood-rearing habitat outside the 2.0-mile buffer from March 15 through July 15. ²
	All BLM-permitted activities in the Pinedale region	Road closures may be implemented during crucial periods (e.g., wildlife winter periods, spring runoff, calving and fawning seasons, saturated soil conditions). ⁶
	All BLM-permitted activities in the Pinedale region	Crossings of ephemeral, intermittent, and perennial streams associated with road and utility line construction will generally be restricted until after spring runoff and normal flows are established. ⁶
Traffic minimization	Pinedale Anticline Project Area	Liquids gathering system to reduce the amount of truck traffic associated with production. ³
	Jonah Field	To protect plant populations and wildlife habitat, project-related travel is restricted to established project roads; no off-road/right-of-way travel would be allowed, except in emergencies. ²
	Jonah Field	Operators will utilize remote telemetry or equivalent technology at all wells to minimize well monitoring trips (unless proven to the satisfaction of the Authorized Officer on a case-by-case basis that installation of remote telemetry or equivalent technology would not be technically or economically feasible, or that another method would create less environmental impact). ²

Erosion minimization	Jonah Field	All well pads, roads, pipelines, and other facilities will be engineered and constructed to minimize sediment discharge onto adjacent undisturbed land or down-channel from the project. ²
	All BLM-permitted activities in the Pinedale region	Pipeline right-of-ways (ROWS) would be located to minimize soil disturbance. Where practical, mitigation would include locating ROWs adjacent to access roads to minimize ROW disturbance widths or routing pipeline ROWs directly to minimize disturbance lengths; direct-line routes may be preferable in areas with high well pad densities. ⁶
Noise	Jonah Field	Operators will utilize flareless completions for all wells within the JIDPA (to reduce noise) unless proven to the satisfaction of the Authorized Officer on a case-by-case basis that flareless completion operations would not be technically or economically feasible or would be unsafe, and that WDEQ has issued a permit to conduct well completion flaring for that specific well. ²
	All BLM-permitted activities in the Pinedale region	In selecting a site for a compressor facility, a well pad or other permanent facility, the distance from the edge of an occupied greater sage-grouse lek will be sufficient to result in a noise level increase from operating facilities no greater than 10 decibels (dBA) above background noise to protect greater sage-grouse. ⁶
Wildlife mortality minimization	All BLM-permitted activities in the Pinedale region	Reserve, workover, and evaporation pits and other areas that contain hydrocarbons would be adequately protected to prevent access by migratory birds and other wildlife. ⁶
	All BLM-permitted activities in the Pinedale region	All new production facilities that have open-vent exhaust stacks will be equipped to prevent bird and bat entry or perching on the stack. ⁶
	Jonah Field	To minimize wildlife mortality due to vehicle collisions, operators will advise project personnel regarding appropriate speed limits (i.e., 35 mph). ²
Fencing minimization	All BLM-permitted activities in the Pinedale region	ROW fencing is to be kept to a minimum, and fences, where necessary, would meet BLM and WGFD specifications for facilitating wildlife movement. ⁶
Compensatory (On- or Off-site) – JF: for Jonah Field; PA: for Pinedale Anticline		
Conservation easements	Cottonwood Ranches (JF)	Three conservation easements on 4,600 acres; water efficiency projects, riparian restoration, and intensive grazing management on a large scale (40,000 acres) that will address sagebrush obligates. Location chosen for wildlife values that mimic those found in Jonah Field (in-kind mitigation). ⁴
	Carney Ranch (JF)	Conservation easement and management plan on 3,410 acres of land that is part of pronghorn migration corridor and crucial winter range. ⁴
	Sommers-Grindstone Conservation Project (JF & PA)	Conservation projects on 19,000 deeded acres located at three locations along the Green River in northern Sublette County and at an important corridor and buffer area between the Bridger-Teton National Forest and the Green River. This project includes conservation practices to maintain/enhance valuable wildlife habitat. ⁴
	Cross Lazy Two Ranch (JF)	Conservation easement on the 4,410-acre Cross Lazy Two Ranch that will be managed via a conservation/habitat management plan. ⁴
	Diamond H Ranch (JF)	Conservation easement and conservation plan is on approximately 3,000 acres of “high quality wildlife habitat” that are undergoing significant small-tract home development. ⁴

Habitat/water improvement	Noble-Cora Peak Wildlife Project (JF)	This project includes three separate components: 1) upgrading an existing spring and installing a diversion to divert sediments away from the spring; 2) drilling and installing a new watering well with facilities for wildlife and livestock; and 3) drilling a well and installing a second watering facility in northeast area of allotment. The water improvement projects will provide drinking water for pronghorn and mule deer, as well as livestock, and create essential habitat for sage-grouse rearing. ⁴
	Mesa Mule Deer Habitat Improvement (PA)	Rangeland fertilization to offset impacts to the wintering mule deer and year-round greater sage-grouse populations. ⁵
	Elk Mountain/Red Canyon Prescribed Burn (JF)	Prescribed burning of 20,000 acres in a mosaic pattern to improve regeneration of desired upland plant communities for various wildlife species, including sage-grouse. ⁴
	Ryegrass Mowing (JF)	Mowing of sagebrush to restore the early-seral portion of the sagebrush community and benefit sage-grouse and pronghorn by increasing grass and forb diversity in the understory vegetation. ⁴
	Squaretop Water Wells (JF)	This project includes improving three watering facilities and creating a “wildlife only area” in each location. An overflow on each well will create a pond or greenup zone that will be fenced for wildlife-only access. ⁴
	Boundary-Sublette Allotment Project (JF)	This project provides wildlife and livestock drinking water by drilling two new wells and upgrading two wells south of the Jonah Field. ⁴
	Arambel Reservoir (JF)	Habitat improvement, including treatment of 5-acre test plots using a Lawson Aerator. Snow fence construction to add moisture for increased reclamation success, test of weed control methods, and repair of dam on Arambel Reservoir. ⁴
	Raptor Nest Platforms (JF)	Constructs and places nesting platforms for ferruginous hawks. ⁴
Wildlife safety	Wildlife-Friendly Fencing (JF & PA)	Wildlife-friendly fencing for pronghorn and other big game migration. ^{4,5}
	Dynamic Message Signs (JF)	Four dynamic message sign boards placed along Sublette County highways to advise drivers of wildlife crossing concentration areas. These portable signs are most beneficial during migration seasons and help protect antelope migration corridors at highway crossings. ⁴
	Range Improvement Water Trough Bird Ramps (JF)	Installation of wildlife escape ramps in all BLM range water improvement tanks. ⁴

¹ Bureau of Land Management (BLM), n.d., Wyoming BLM Standard Mitigation Guidelines for All Surface Disturbing and Disruptive Activities, available at: www.blm.gov/pgdata/etc/medialib/blm/wy/wildlife/baldeagle.Par.4022.File.dat/be-appa.pdf.

² BLM, 2006, Record of Decision—Jonah Infill Drilling Project, Sublette County, Wyoming (March), available at: <http://www.blm.gov/wy/st/en/info/NEPA/documents/pfo/jonah.html>.

³ BLM, 2008, Record of Decision—Final Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project (September), available at: <http://www.blm.gov/wy/st/en/info/NEPA/documents/pfo/anticline/seis.html>.

⁴ BLM, 2011, Jonah Interagency Office and Pinedale Anticline Project Office Monitoring and Mitigation Projects (April), available at: <http://www.wy.blm.gov/jio-papo/newsletter/2011/apr.pdf>.

⁵ Pinedale Area Project Office (PAPO), 2011, PAPO Monitoring and Mitigation Projects (rev. 5-3-2011), available at: http://www.wy.blm.gov/jio-papo/papo/projects/2011_status.pdf.

⁶ BLM, 2008, Record of Decision and Approved Pinedale Resource Management Plan (November), available at: http://www.blm.gov/wy/st/en/programs/Planning/rmps/pinedale/rod_armp.html. Appendix 3 specifically outlines mitigation guidelines for the BLM Pinedale Region, Appendix 5 outlines best practices for the area’s operators, and Appendix 12 provides a table of all seasonal wildlife stipulations.