



Bats and Oil & Gas Development: Best Management Practices



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The BLM's multiple-use mission is to sustain the health and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau accomplishes this by managing such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and by conserving natural, historical, cultural, and other resources on public lands.

Prepared by:
United States Department of the Interior
Bureau of Land Management
National Headquarters

Suggested Citation:
United States Department of the Interior. 2020. Best Management Practices for Bats and Oil and Gas Development on BLM-Administered Lands and Facilities. Bureau of Land Management. National Headquarters, Washington, D.C. 12 pp, March.

First Edition
2020

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ON THE COVER: **Top Left:** A brightly lit drilling rig. Photo by Shutterstock. **Top Right:** A production well close to cliff and crevice bat habitat, Roswell, New Mexico. Photo by BLM New Mexico. **Middle Right:** A covered burner stack, Farmington District Office, New Mexico. Photo by Shawn Thomas, BCI. **Bottom Left:** A well-designed production well, Casper, Wyoming. Photo by BLM Wyoming. **Bottom Right:** Pallid bat with a captured centipede. Pallid bats are a sensitive species in nearly half the western states. Photo by J. Scott Altenbach.

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1 Background.

Bats comprise nearly a quarter of all the planet's mammals with more than 1,400 known species. For their size, bats are one of the longest-lived and slowest-reproducing mammals. Bats average just one pup per year, with some species living up to 40 years in the wild¹. Bats are primary predators of insect pests that cost farmers and foresters billions of dollars annually in pest control services. Additionally, bats pollinate and disperse the seeds of hundreds of commercially valuable plants, making them both ecologically and economically vital.^{2,3}

Unfortunately, bats are also one of the most imperiled taxa, with more than half of all species known or suspected to be in decline. The primary threats to bats are habitat loss, disease, overharvest, and impacts from energy development.⁴ More than half of the 47 bat species known to occur in the U.S. are found on lands administered by the Bureau of Land Management (BLM) (see Appendix I), with the majority designated as Sensitive on one or more BLM State Sensitive lists.

The BLM manages the Federal government's onshore oil and gas program with the goals of facilitating safe and responsible energy development, while providing a fair return for the American taxpayer. The energy portfolio managed by the BLM includes oil and gas, coal, oil shale, tar sands, and increasingly, renewable energy sources such as wind, solar and geothermal. The BLM manages the Federal government's onshore subsurface mineral estate – about 700 million acres (30% of the United States) held by the BLM, U.S.

Forest Service and other Federal agencies and surface owners. It also manages some aspects of the oil and gas development for Native American tribes from the Tribal mineral estate.



A Townsend's big-eared bat, a cave and abandoned mine-roosting obligate, highly sensitive to disturbance, found across most of the important western oil and gas producing regions.

The development and use of Best Management Practices (BMPs) to avoid or reduce the impacts of permitted land uses on BLM-administered lands is a key component in the BLM's fulfillment of the 1976 Federal Land Policy Management Act (FLPMA) mandate for preservation of environmental resources while meeting its multiple use mandate. Applying BMPs aids in achieving environmentally-sound resource development and use by avoiding, minimizing, or rectifying adverse impacts and reducing impact-related conflicts. The proactive incorporation of environmental BMPs into project planning and development typically results in a more efficient environmental review process, increased operating efficiency, reduced long-term operating costs, reduced final reclamation needs, and decreased impact to the environment.

The following oil & gas and bat conservation BMPs are defined as "state-of-the-art mitigation measures designed to provide for safe and efficient operations while eliminating or minimizing undesirable impacts to the environment". They were developed to assist operators with conducting environmentally responsible oil and gas operations on federal lands and split-estate that minimize or eliminate undesirable impacts to bats and their habitat during energy exploration, production, and reclamation. The significance of the impact depends on the amount, intensity, and duration of the disturbance, the specific locations and arrangements of the disturbance, and the ecological importance of the habitats effected.

Adverse effects of oil and gas development on bats can be divided into three general categories: 1) Disturbance and displacement, 2) direct loss of habitat; and 3) habitat degradation (i.e. roosting, foraging, and drinking), including habitat fragmentation. BMPs are designed to either avoid impacts, minimize impacts through appropriate planning and management actions, or mitigate the impact by providing replacement or substitute resources. An effort was made to narrow the focus of these BMPs to those with



A maternity colony of pallid bats (Antrozous pallidus) discovered during a warm-season survey. Photo by Joseph Monfeli, BCI.

the most direct applicability to bats and their habitats, as other BMPs have typically already been applied to address impacts to other wildlife taxa (i.e. ungulates, raptors, songbirds, etc.), some of which will also benefit bats. In all cases, BMPs should be matched and adapted to meet the site-specific requirements of the project and local environment.

The primary components of bat habitat include roosting and foraging habitat and drinking resources. Winter roosts, also referred to as cool season roosts, are used for hibernation or torpor by (non-migratory) bat species from higher elevations in southern latitudes to northern latitudes. The most commonly used winter roosts ("hibernacula") are caves, abandoned mines, cisterns, deep rock crevices, and other above or underground features with stable and cool, but not freezing, temperatures. Disturbing bats during hibernation has been demonstrated to decrease fitness and survival. Maternity (or warm season) roosts are where females give birth and raise pups and are usually chosen for their warm to hot temperatures (approximately 80° F to more than 100° F) and protection from predators. Caves and abandoned mines and rock and cliff crevices that are warm enough may be used as maternity roosts, along with trees,



Bats drink while in flight, and must drink from pooled water sources, which is why it's essential to cover all production storage pits. Photo: J. Scott Altenbach

especially in the cavities, crevices, and under the exfoliating bark of dead or dying trees (snags). The warm season roosts of several species of migratory bats is among the foliage of living trees. Most bats are extremely prone to disturbance at their maternity roosts and may even abandon their young if disturbed.

Males and non-breeding females have similar cool season roosting requirements but will use warm season roosts with a broader range of temperatures. Almost all non-hibernating bats need to drink free water daily, or frequently, and access to water is critical during the hottest and driest times of the year. Because bats drink while in flight, they need unobstructed, pooled or slow-moving water to drink.

While bats and their roosts are widely distributed across the landscape, including grasslands, playas, and agricultural habitats, those habitats with more natural structure, such as canyons, cliff faces, riparian habitats, forests, and diverse vegetation types support the greatest diversity and number bats.

2 Planning, Environmental Review & Permitting

The following recommendations are consistent with and derived from the 2007 BLM Gold Book of Surface Operating Standards for Oil and Gas Exploration and Development⁵. The BLM's Resource Management Plans (RMP's) and FLPMA-mandated environmental planning process ensures that all stakeholders – public, private, and tribal – have input on how federal lands will be used and protected during site-specific and landscape-level cumulative land management activities. This process determines what areas will be open for oil and gas leasing and any stipulations that should be attached to new leases. FLPMA prohibits unnecessary or undue degradation of public lands and makes protecting environmental values an explicit criterion for the BLM's land management activities. In accordance with 43 CFR 3162.5-1(a) and Section 6 of the standard federal oil and gas lease terms (Form 3100-11):

"Lessee shall conduct operations in a manner that minimizes adverse impacts to the land, air, and water, and to cultural, biological, visual, and other resources, and other land uses or users. Lessee shall take reasonable measures deemed necessary by lessor to accomplish the intent of this section."

This provision gives the BLM authority to stipulate reasonable protective measures necessary to reduce or mitigate impacts to wildlife habitat.

During the lease sale process, additional stipulations such as actions to protect important habitat components as referenced above, may be added, but these



Site assessment is most successful when following a collaborative approach that includes survey crews, land management agencies, and other interested partners. Photo by Jason Corbett, BCI.

should reference the planning process if the new stipulations are proposed in addition to those already specified in the RMP. Stipulations are attached to leases as a legal contract. This is where site-specific habitat features important to bats and other wildlife should receive special protection, such as buffers, seasonal closures, etc. New stipulations can't be added to an issued lease without agreement from the lease holder. Once a lease is issued, the company holding the lease must file an Application for a Permit to Drill (APD) for each new well.

Within 10 days of receiving the Notice of Staking (NOS) or APD package, the BLM, in coordination with the operator and surface management agency or private surface owner will schedule a date for the

onsite inspection to discuss the proposal. During the onsite inspection, the parties will determine the best location for the well, road, and facilities, and identify site-specific concerns and potential environmental impacts and discuss the conditions of approval (COA) or possible environmental Best Management Practices for mitigating these impacts.

Before conducting the onsite inspection, the BLM or surface management agency will determine whether any administrative measures, laws, or regulations would affect the operational proposal, including but not limited to threatened and endangered species, riparian and wetland protection measures, or other considerations for completing a staff review or an environmental analysis under the National Environmental Policy Act of 1970 (NEPA)⁵. The BLM can attach a COA to the permit such as timing restrictions or special mitigation measures, but it can't deny the lease holder's right to develop.

2.1. COORDINATE WITH OPERATORS, RELEVANT AGENCIES & STAKEHOLDERS

Bring operators, BLM personnel and surface owners together early in the planning process to assess potential development impacts with respect to bats and other wildlife and to collaborate on an implementation plan that provides guidelines and operational constraints to avoid or minimize impacts to bats and other wildlife.

2.2. LOOK AT THE BROAD PLANNING AREA RELATIVE TO BAT HABITAT COMPONENTS

Identifying and mapping the important bat habitat components and seasonal habitat use as identified above in both the immediate area of proposed activity

as well as in the broader adjacent landscape will allow for a better evaluation of risks to bats in the affected habitats and inform overall management strategies.

2.3. INCORPORATE ADAPTIVE MANAGEMENT

Develop and implement adaptive management programs that provide for monitoring and evaluation, documents environmental changes, and implements mid-course corrections to development and operational practices. Correlate oil and gas operations with environmental changes through ongoing monitoring and evaluation and adaptively adjust future oil and gas development activities as necessary to protect wildlife resources.

2.4 DEVELOP SITE-SPECIFIC MITIGATION PLANS

Develop site-specific mitigation plans during the permit approval process that provide actions to eliminate or reduce impacts to riparian and wetland habitat and other important bat habitats such as caves, abandoned mines, and rimrock outcrops.^{6,7,8}

2.5. COMMUNICATION

2.5.1. Designate a point of contact (authorized officer) for environmental and public inquiries.

2.5.2. Proactively communicate with other state and federal wildlife agencies during all phases of planning and development.

2.7. COMPLY WITH APPLICABLE LAWS

Comply with federal, state, and local laws



A cool-season internal survey can confirm the presence or absence of hibernating bats, and can often detect significant warm-season use by the presence of guano. Photo by Jim Rolf, BCI.

2.8. IMPORTANT BAT HABITATS

2.8.1. Review District, Field Office, state wildlife agency, or Natural Heritage Program bat survey records for bat species known or expected to occur in the project area, as well as important roost sites.

2.8.2. When information on bat species presence and roost locations are not known, consider conducting bat surveys (acoustic and where appropriate, capture) during the appropriate season prior to exploration, drilling, and construction. Consult with state, university, or consulting bat biologist to determine the appropriate level of survey effort.

2.8.3. When determining effects to bat colonies or populations, consider the cumulative effects of habitat loss and degradation (i.e. other energy development, agriculture, urbanization, etc.) and plan mitigation at a landscape or regional scale.

3 Exploration, Siting, Construction, and Operations



An example of a well-developed oil and gas facility; the burner stack is covered, solar power has replaced a noise generating engine, there is a closed-loop drilling system, and the overall footprint on the landscape is minimal. Photo: BLM Wyoming

Construction and maintenance must be performed to standards that ensure the long-term health and productivity of the land. The operator's representative must ensure compliance with all plans and designs. The representative should be designated prior to construction; be accessible to the surface management agency authorized officer; have immediate access to an approved copy of the APD, including all maps, drawings, templates, and construction standards; and have the authority to make changes at the request or order of the BLM or surface management agency.

3.1. NOISE & VIBRATIONS

Manage noise and vibrations near important bat habitats. Constant noise produced by active oil and gas wells can interfere with the echolocation calls of bats with low-frequency echolocation calls (<35 kHz).⁹

3.1.2. Where possible, locate road building, drilling pad placement, or other construction activities at least 300' from important bat habitat features, especially caves, abandoned mines, cliffs and rim rock outcrops, boulder/talus fields, and patches of dead trees (snags). Where this is not possible, use earthen berms, walls, sheds, and/or vegetation to reduce sound levels near these important habitats.^{6,8,10, 11}

3.1.3. Consider reducing or eliminating noise from non-drilling construction or operations (i.e. operations not required to be 24/7) approximately 30 minutes before sunset until two hours after sunset near areas of high bat activity, such as riparian habitats, cliff faces and near rock outcrops, caves and abandoned mines, or other areas where pre-development monitoring showed high bat use.⁹

3.1.4. In areas previously determined by surveys to be high-quality bat habitat, as defined above, or near known roosts, consider using compression equipment such as hospital-grade mufflers to alleviate noise and design retrofits to reduce or alleviate noise associated with older compression equipment such as the exhaust of compressor engines, wellsite, and facility engines.^{8,9,10}

3.2. RIPARIAN AREAS & WETLANDS

Riparian areas, wetlands, and pooled water sources are some of the most important habitats for foraging

and drinking for nearly all U.S. bat species, especially in arid western habitats. Riparian zones also provide roosting habitat and function as movement corridors.

3.2.1. Apply No Surface Occupancy/No Ground Disturbance (NSO/NGD)] restrictions to protect riparian and wetland habitats deemed as important by BLM Field Office or District natural resource managers.^{6,7,10}

3.2.2. Extend an NSO/NGD buffer for at least 500 feet from the outermost perimeter of BLM designated wetlands and/or the edge of riparian corridors and floodplains (as determined by the BLM hydrologist) to maintain habitat effectiveness and functional integrity, except where site-specific topography or hydrology allow for exceptions.^{6,8,10}

3.2.3. Avoid locating staging, refueling, and storage areas within 500 feet of any wetland or perennial or seasonally flowing stream or river.^{6,8,10}

3.2.4. Where possible, avoid or minimize to the extent possible the removal of native riparian canopy or stream bank vegetation.

3.2.5. Locate roads as far from riparian areas and bottoms of drainages as possible and outside of BLM designated riparian habitat.

3.2.6. Where practical, design road and other linear features, such as pipeline and powerline crossings of streams, at right angles to all riparian corridors and streams to minimize the area of disturbance.

3.2.7. Use the minimum right-of-way width where pipelines cross riparian areas and streams.

3.2.8. If wetland areas can't be avoided during construction, concentrate such activity during dry conditions (that is, during late summer or fall), or when the ground is frozen during the winter.⁹

3.2.9. Promptly report spills that might affect water quality to the appropriate BLM and State agencies and offices responsible for water quality.

3.3. PITS

Pits created to separate oil from produced water (production skim pits), store drilling fluids (reserve pits), store oil field waste (centralized oil field wastewater disposal facilities/fracking pits), or to capture fluids associated with vented hydrogen sulfide gas at production wells (flare pits) represent a potential source of direct impacts to bats. Bats are affected either by becoming entrapped as they attempt to drink or feed on insects, or if they ingest oil, salt, heavy metals or other toxic compounds by drinking pit fluids or by preening their fur after contact with the surface.^{11,12}

3.3.1. All pits and open tanks should be covered regardless of size, either with impermeable covers, shade balls, or netting fine enough to prohibit the access by bats and birds.^{10, 11,12,13}



A closed-loop drilling system in the San Juan Basin, NM. Closed loop systems are preferred over open pit systems. Photo: James Ramakka



Pits created to capture oil waste, drilling fluids, and other liquid by products of oil and gas extraction can entrap or harm bats if they ingest compromised water and should be covered regardless of size. Photo: USFWS

3.3.2. Do not construct reserve pits in washes or stream beds or any other perennial or intermittent water courses that have a hydrological connection to wetlands, streams, or rivers.^{6,7,8,10,14}

3.3.3. Closed-loop drilling systems that sit within secondary (and perhaps tertiary) containment are preferable to open pit systems and should be considered best practice, however, where these systems still store water in open fracking tanks, these should be covered as referenced in 2.2.3.1 above.^{6,7,8,10}

3.3.4. Locate pits away from known or potential roost sites.^{9, 13}

3.3.5. In steep-sided (>45%) clean water containments where trapping hazard may exist, provide wildlife escape ramps, rafts, or ladders, depending on configuration. Escape mechanisms should be designed for effectiveness at any reasonably anticipated water level.^{8,13}

3.3.6. Where possible, construct alternative fresh-water sources adjacent to or near permanent pits to provide wildlife with an alternative safe water

source and contribute to dilution of any potentially ingested toxic compounds.¹³

3.4. CAVES, ABANDONED MINES, BOULDER FIELDS/TALUS SLOPES & OLD CISTERNS

Caves, abandoned mines, boulder fields/talus slopes, and old cisterns are most frequently used as either maternity, or “warm season” roosts or hibernacula or “cold season” roosts”, or migratory stop overs. Living trees and dead trees (“snags”) and old buildings are primarily used as warm season roosts.

3.4.1. A .25-mile radius or 1,000’ buffer NSO conservation zone should be established around known maternity roosts or hibernacula. Where this is not feasible, suspend operations including road and pipeline construction, blasting, and drilling from mid-October to mid-March for hibernacula, and early April to late August for maternity roosts.^{9,13}

3.4.2. Survey all old buildings, wells, and cisterns slated for modification or demolition. If bat colonies are found, these structures should be maintained where possible. If they must be removed, old buildings should be removed during the cool season (late



Bats potentially using the cliff and crevice habitat near this facility would have benefited from a greater buffer between the operations and habitat. Photo: BLM NM

fall to early spring) when bats are less likely to be present, and cisterns or wells should be remediated during the warm season (late spring to early fall) when bats won't be hibernating.

3.4.3. Consider the placement of alternate habitat such as bat houses or bat condos (extra-large bat houses) near currently occupied structures when they are scheduled to be razed.¹³

3.4.4. Many bat species will use several snags or partially dead trees as maternity roosts over the course of a season. Maintain all snags not deemed a safety hazard and avoid removing snags, snag patches, and the largest living trees in forest stands and woodland habitats during all exploration, construction, and operations activities.^{13,15}



Uncovered burner/vent stacks have been responsible for numerous bird and bat mortalities. All burner/vent stacks should be covered. Photo: James Ramakka

3.4.5. Co-locate project features (e.g., roads and utility lines) and cluster project features (e.g., multi-pad wells and on-pad tank batteries) to reduce forest clearing.^{7,8,9,10}

3.4.6. Cap all open vent stacks and vertical hollow pipes such as exhaust stacks, heater-treaters, separators, and dehydrator units with screen cones or other devices that will prevent bats from entering and or roosting in such units.^{6,7,8,10,13}

3.5. LIGHT POLLUTION

Bats are particularly affected by light pollution and most species avoid bright, short wavelength light. The effects to bats include changes to roost emergence times, roost quality, foraging and commuting patterns, prey abundance and availability, habitat quality, and risk of predation.^{16,17}

3.5.1. Avoid the use of lighting when not absolutely necessary for safety or other concerns.

3.5.2. Keep Important bat habitats such as waterways, hedgerows, riparian habitats, and roosts dark by managing presence, timing, or the direction of lighting, or the use of berms, vegetative screening, or other light barriers.^{15,16}

3.5.3. Use narrow-spectrum lights with no or little UV content such as low-pressure sodium and amber LEDs.¹⁵

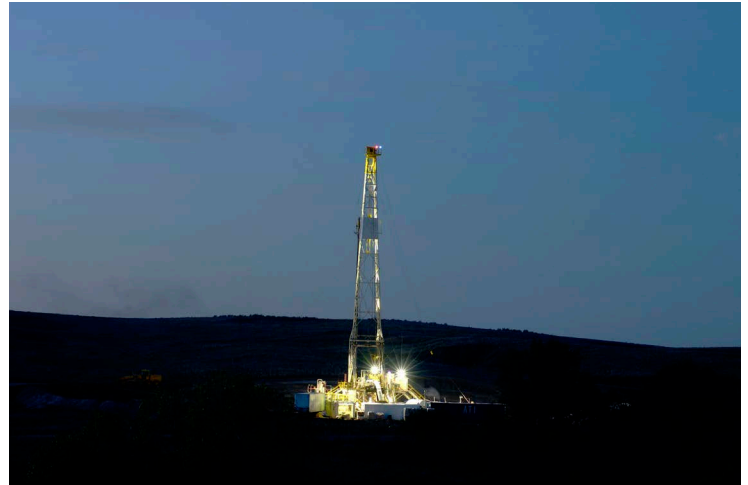
3.5.4. Avoid broad-spectrum blue-white lights with high UV content, such as high-pressure sodium and mercury halide lamps, as they have the greatest negative effect on bats and insects.¹⁵

3.5.5. Use lighting control technologies such as timers and motion detectors to reduce the time that lighting is used.^{15,16}

3.5.6. Reduce lighting intensity.

3.5.7. Shield and direct lighting to reduce light spill-over and illumination of important habitat components (includes the use of light screening; i.e. berms, hedgerows, etc.). Avoid pointing light upward or horizontally.^{15,16}

3.5.8. Where possible, use enclosed flare systems for gas flaring associated with oil and gas and similar operations^{7,10}



Use the full suite of mitigation measures to reduce the negative effects of lighting at remote energy facilities which may be the only source of light for miles. Photo: Shutterstock

4 Reclamation & Monitoring

4.1. RECLAMATION

Reclamation should always be planned prior to construction to ensure success and the Surface Use Plan should include both interim and final reclamation. Salvaging topsoil, proper placement of roads and pads, and implementing interim reclamation will make final reclamation easier, more efficient, and less expensive.

4.1.1. During the life of the development, all disturbed areas not needed for active support of production operations should undergo “interim” reclamation in order to minimize the environmental impacts of development on other resources and uses.

4.1.2. Reclamation standards should be based on vegetation cover and species composition measured within the plant community prior to disturbance, or within an undisturbed reference area on an ecologically-similar site near the operation.

4.1.3. Use appropriately diverse reclamation seed mixes that mirror an appropriate reference area for the site being reclaimed (see also species-specific recommendations).

4.1.4. Close and reclaim roads not necessary for development immediately, including removing all bridges and culverts, and recontouring/reclaiming all stream crossings.

5.2.4. Replace all riparian vegetation removed during development at a rate of at least 3:1.

4.1.5. Re-shaping disturbed channels to their approximate original configuration or other geomorphological configuration and ensuring they are properly stabilized.⁷

4.1.6. Replace all riparian vegetation removed during development at a rate of at least 3:1.⁷

4.1.7. Begin reclamation of disturbed wetland/riparian areas as soon as possible after project activities are complete and continue until successful reclamation is achieved. Restore both form and function of impacted wetlands and riparian areas and mitigate erosion.^{7,10,12}

4.1.8. Re-shaping disturbed channels to their approximate original configuration or other geomorphological configuration and ensuring they are properly stabilized.⁷

4.1.9. All excavations and pits must be closed by backfilling when they are dry and free of waste and graded to conform to surrounding terrain.^{7,10,12}

4.2. MONITORING

When exploration, construction, or operations are located near known significant (as determined by BLM or State biologists) maternity or hibernacula sites, these colonies should be monitored to ensure bats

are not disturbed as evidenced by sharp reductions in colony size or location.

4.2.1. Monitor conditions or events that may indicate environmental problems such as significant chemical spill or leak, multiple bat mortalities, or severe erosion into tributary drainages.^{6,8,10}

4.2.2. Develop a plan for monitoring and mitigating pits and pit-related mortalities and report any mortality events to the appropriate BLM and State environmental staff.¹⁴

4.2.3. Conduct stream channel monitoring in in reaches and riparian habitats potentially affected by exploration, construction and operations for erosion, degradation, and riparian vegetation integrity⁷



All post-closure sites in high-use areas should be monitored on at least a quarterly basis, though more frequent monitoring may be necessary and would be recommended by the evaluation team on a site-specific basis. Photo: BLM

Resources

LITERATURE CITED

- ¹Hill J. E., and J. D. Smith. 1984. Bats: a natural history. University of Texas Press, Austin, Texas.
- ²Boyles, J. G., P.M. Cryan, G.F. McCracken, and T. H. Kunz. 2011. Economic importance of bats in agriculture. *Science* 332: 41–42.
- ³Kunz, H.K., Braun de Torrez, E., Bauer, D., Lobo, T. and T.H. Fleming. 2011. Ecosystem services provided by bats. *Ann. N.Y. Acad. Sci.*
- ⁴Pierson, E. D. 1988. Tall Trees, deep holes, and scarred landscapes: conservation biology of North American bats. Pp. 309-325 in *Bat Biology and Conservation* (T.H. Kunz and P.A. Racey eds.). Smithsonian Institution Press, Washington, D.C.
- ⁵United States Department of the Interior and United States Department of agriculture. 2007. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development. BLM/ WO/ST-06/021+3071/REV 07. Bureau of Land Management. Denver, Colorado. 84 pp.
- ⁶Colorado Division of Wildlife's Actions to Minimize Impacts to Wildlife Resources. Colorado Division of Wildlife, Denver, Colorado. October 27, 2008.
- ⁷Coal Bed Methane, Best Management Practices, A Handbook. Western Governors Association, April 2006.
- ⁸Oil and Gas Development Guidelines. Conserving New Mexico's Wildlife Habitats and Wildlife. New Mexico Game & Fish Department, Santa Fe, New Mexico, August 2007.
- ⁹Potential Impacts of Shale Gas Development on Bat Populations in the Northeastern United States. A Report Submitted to The Delaware Riverkeeper Network, Bristol, PA. by Bat Conservation International, Austin, Texas. June 2012.
- ¹⁰Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats. Version 6.0, Revised April 2010. Wyoming Game and Fish Department, Cheyenne, Wyoming.
- ¹¹O'Shea, T. J., A. L. Everette, and L. E. Ellison. 2001. Cyclodiene insecticide, DDE, DDT, arsenic and mercury contamination of big brown bats (*Eptesicus fuscus*) foraging at a Colorado Superfund site. *Archives of Environmental Contamination and Toxicology* 40:112–120
- ¹²Esmoil, B. 1995. Wildlife mortality associated with oil pits in Wyoming. *Prairie Naturalist* 27(2):81-88
- ¹³Ellison, L. E., M. B. Wunder, C. A. Jones, C. Mosch, K. W. Navo, K. Peckham, J. E. Burghardt, J. Annear, R. West, J. Siemers, R. A. Adams, and E. Brekke. 2003. Colorado Bat Conservation Plan. Colorado Committee of the Western Bat Working Group. <http://www.wbwg.org/colorado/colorado.htm>.
- ¹⁴Ramirez, P. Jr. 2005. Oil field-produced water discharges into wetlands: Benefits and risks to wildlife. *Environmental Geosciences*, V. 12, No. 2 (June 2005), P. 65-72.
- ¹⁵Range-wide Indiana Bat Protection and Enhancement Plan Guidelines for Surface Coal-Mining Operations. February 2013, U.S. Fish and Wildlife Service, Office of Surface Mining, Reclamation, and Enforcement, and the Interstate Compact Mining Commission.
- ¹⁶Stone, E.L. 2013. Bats and lighting: Overview of current evidence and mitigation guidance. Bats and Lighting Research Project, University of Bristol, www.batsandlighting.co.uk
- ¹⁷Patriarca, E. and P. Debernardi. 2010. Bats and Light Pollution. Part of the project *Bats and lighting of monumental buildings*. UNEP/ EUROBATS.

BCI AND BLM RESOURCES

United States Department of the Interior and
United States Department of Agriculture. 2007.

Surface Operating Standards and Guidelines for
Oil and Gas Exploration and Development.

BLM/WO/ST-06/021+3071/REV 07. Bureau of
Land Management. Denver, Colorado. 84 pp.

Intermountain Oil & Gas BMP Project. University
of Colorado at Boulder. [http://www.oiland-
gasbmpps.org/](http://www.oiland-gasbmpps.org/)

Compilation of Publicly Available Sources of
Voluntary Management Practices for Oil and
Gas Exploration & Production (E&P) Wastes As
They Address Pits, Tanks, and Land Application
. U.S. Environmental Protection Agency, Office
of Solid Waste and Emergency Response, Office
of Resource Conservation and Recover. April
1, 2014. [https://www.epa.gov/sites/production/
files/2016-04/documents/og_ep_vol_wste_mgt_
prctcs_compilation_040114.pdf](https://www.epa.gov/sites/production/files/2016-04/documents/og_ep_vol_wste_mgt_prctcs_compilation_040114.pdf)

Compilation of Publicly Available Sources of
Voluntary Management Practices for Oil and
Gas Exploration & Production (E&P) Wastes as
they Address Pits, Tanks, and Land Application.
U.S. Environmental Protection Agency, Office of
Solid Waste and Emergency Response, Office
of Resource Conservation and Recover. April 1,
2014.

STRONGER. State Review of Oil and Gas
Environmental Regulations, Inc. 2017 Guidelines.
www.strongerinc.org

Appendix I

BAT KNOWN TO OCCUR ON LANDS ADMINISTERED BY THE BLM

(29 Species)

FAMILY PHYLOSTOMATIDAE

Choeronycteris

Choeronycteris mexicana – Mexican long-tongued bat

Leptonycteris

Leptonycteris nivalis – Mexican long-nosed bat

Leptonycteris yerbabuenae – lesser long-nosed bat

Macrotus

Macrotus californicus – California leaf-nosed bat

FAMILY VESPERTILIONIDAE

Antrozous

Antrozous pallidus – pallid bat

Corynorhinus (Plecotus)

Corynorhinus townsendii – Townsend's big-eared bat

Eptesicus

Eptesicus fuscus – big brown bat

Euderma

Euderma maculatum – spotted bat

Idionycteris

Idionycteris phyllotis – Allen's big-eared bat

Lasionycteris

Lasionycteris noctivagans – silver-haired bat

Lasiurus

Lasiurus blossevillei – western red bat

Lasiurus cinereus – hoary bat

Lasiurus xanthinus – western yellow bat

Myotis

Myotis auriculus – southwestern myotis

Myotis californicus – California myotis

Myotis ciliolabrum – western small-footed myotis

Myotis evotis – long-eared myotis

Myotis lucifugus – little brown myotis

Myotis occultus – Arizona myotis

Myotis septentrionalis – northern (long-eared) myotis

Myotis thysanodes – fringed myotis

Myotis velifer – cave myotis

Myotis volans – long-legged myotis

Myotis yumanensis – Yuma myotis

Parastrellus

Parastrellus (formerly *Pipistrellus*) *hesperus* – canyon bat

FAMILY MOLOSSIDAE

Eumops

Eumops perotis – Western mastiff bat

Nyctinomops

Nyctinomops femorosaccus – pocketed free-tailed bat

Nyctinomops macrotis – big free-tailed bat

Tadarida

Tadarida brasiliensis – Mexican free-tailed bat