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COALBED METHANE AND PUBLIC WILDLANDS: HOW MUCH AND AT WHAT COST?[1]

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The Wilderness Society is a 175,000-member national conservation group that focuses specifically on public land management issues. The Wilderness Society's research department has been actively involved in the analysis of energy policy, including a GIS mapping assessment of the oil and gas potential of national forest roadless areas and national monuments managed by the Bureau of Land Management (BLM). Our results were presented in congressional testimony in spring 2001 (http://www.wilderness.org/newsroom/rls051701.htm). In April 2002 we presented additional analysis and recommendations to Congress on methods for assessing the oil and gas potential of western public lands (see www.wilderness.org/eyewash/legislation.htm). The specific results for coal-bed methane presented in this paper derive directly from the energy research completed by The Wilderness Society since January 2001.

Our paper begins with background terminology in order to establish economically recoverable energy resources as the policy-relevant measure for evaluating coal-bed methane (CBM) development scenarios. We provide estimates on the amount of CBM located in public wildlands, focusing on roadless areas on our national forest and BLM-managed national monuments, followed by an examination of the economic costs from CBM extraction—costs that typically are excluded from economic analyses. We close the paper with a short discussion on access to energy resources on public land and the relationship between economic costs and the sustainable scale of CBM development, and end with recommendations on the appropriate use of taxpayer subsidies in our emerging energy policy.

BACKGROUND

We begin by noting the distinction between discovered and undiscovered resources. If resources are discovered and if they're economical to extract, they are classified as reserves. Gas reserves are, by definition, profitable to extract (Attanasi 1998). At this point, most of the political debate by the oil and gas industry and the Bush administration has been about access to undiscovered oil and gas, rather than access to already discovered oil and gas in reserve. Currently in reserve and in growth of those reserves, we have about 22 years of gas supply for the U.S. That means that, without drilling another exploratory well, we could be completely dependent on our domestic gas reserves for 23 years. With investments in conservation and efficiency, our expected gas reserves could last twice as long.

The scientists at the U.S.Geological Survey (USGS) also classify gas as conventional or unconventional based on the technology used during extraction. Conventional gas is gas that can be extracted using conventional technology, while unconventional gas cannot be produced with conventional technology. An energy policy that relies heavily on subsidies to accelerate production of unconventional gas may be pushing this gas out to market before "environmentally friendly" technology can be fully developed. The two main unconventional gases are coalbed methane and continuous-type gas also called tight sands gas. While this conference focuses on coalbed methane, it is important to remember the current push to drill for tight gas, the other unconventional gas. The USGS estimates that there is approximately five times more tight gas in the west than coalbed methane, and the dense drilling pattern required to extract tight gas has its own significant environmental impacts. It is therefore vital, when examining environmental impacts at multiple spatial scales, that the cumulative impacts from all forms of energy production be fully accounted for in the analysis.

MEAN ESTIMATES OF ECONOMICALLY RECOVERABLE CBM IS THE POLICY-RELEVANT MEASURE

When estimating quantities of undiscovered resources, the USGS makes a distinction between technically recoverable gas-oil and economically recoverable gas-oil (Figure 1). The gas in place estimated by USGS to be recoverable without regard to profit or extraction costs is termed technically recoverable gas. When the costs of production and a 12% profit margin are included, the USGS derives an estimate for economically recoverable gas. When discussing roadless area, monument or wilderness protection, or, for that, matter leasing stipulations designed to protect the environment, the opportunity cost of that protection is the amount of gas-oil estimated by the USGS to be economically recoverable.

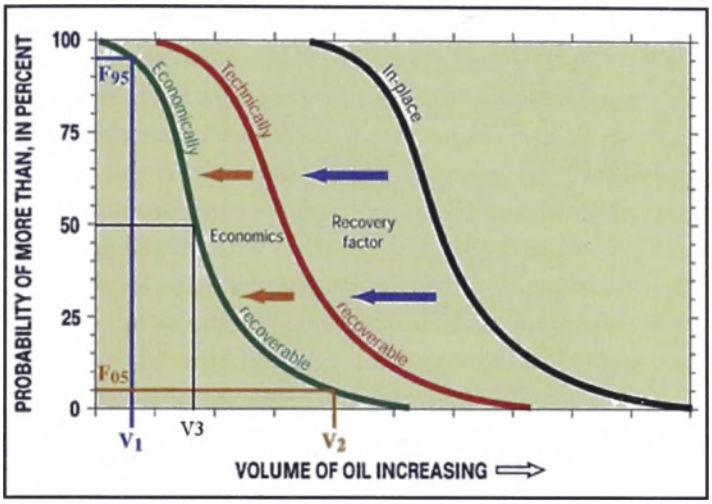


FIGURE 1 *Oil volumes and probabilities for estimating undiscovered quantities. There is a 95% chance of at least volume V1 of economically recoverable oil, a 50% chance of at least V3, and a 5% chance of at least V2 of economically recoverable oil. Source: USGS, 2001.*

The opportunity cost of a policy or action equals the *net benefits* foregone as a consequence of that policy or action. One of the common mistakes made when evaluating regulations or decisions to limit access is the use of gross revenues when estimating opportunity costs, rather than net revenues. The energy opportunity costs of the roadless policy or leasing stipulations should equal the net economic benefits of the oil or gas foregone. This is consistent with economic theory. The use of technically recoverable oil-gas, rather than economically recoverable, is similar to the incorrect use of gross revenues, rather than net revenues, when evaluating policies.

When economic criteria are considered, the amount of recoverable oil and gas drops significantly. In the Rockies, USGS scientists (Attanasi 1998) estimates that, at prices of $2.00 and $3.34 per thousand cubic feet (MCF), between 34 and 77 percent of the technically recoverable coalbed methane is profitable to extract. Similar financial constraints apply to coal bed methane (CBM) located more than 5000 feet underground (Silverman 2002). CBM located 10,000 feet underneath a roadless area or national monument would therefore have an opportunity cost of zero–regardless of whether the area remains roadless. The San Juan Basin holds approximately 84 TCF of gas in place, but only 14 percent, or about 12 TCF, is economically viable to extract (Silverman 2002). In the Upper Green River basin of Wyoming and Colorado, 90 percent of the gas is tight sands gas located in low permeability geologic strata. Scientists at the USGS (Attanasi 1998) estimate that only 7 to 15 percent of the tight gas is economical to recover–underscoring the need to rely on economically viable gas in land management and policy decisions (LaTourrette et al. 2002).

Unfortunately, some officials in the Bureau of Land Management continue to use technically recoverable gas in planning and decision documents. The recent Green River Study (2001) ignored economics and used technically recoverable criteria when examining undiscovered resources that may be potentially off-limits. The report therefore overestimated the oil and gas potential of these western public lands and the gas-oil potentially inaccessible. It is inappropriate to estimate potential CBM jobs based on technically recoverable gas. Planning documents that use technically recoverable in economic impact studies will overestimate the job potential from CBM drilling alternatives. Similarly, when estimating revenues to state or county governments, it is inappropriate to base those revenue projections on technically recoverable gas, as it will overestimate potential revenues.

The Congressional Research Service (2000) has recommended that economically recoverable resources be the basis of policy analysis. If economic constraints on production are ignored, the assessments will overestimate the quantity of oil or gas potentially off-limits. *To reiterate, if the oil-gas is not economically viable to extract, there are no adverse impacts on supply or prices from lease stipulations designed to protect wildlife, archaeological sites, recreation sites and other public resources.* Since policymakers should be concerned about the actual impacts—not the hypothetical impacts, the economically recoverable resource, as estimated by USGS, is the policy-relevant and economically correct measure of the opportunity costs of leasing stipulations, monument designation and roadless area protection.

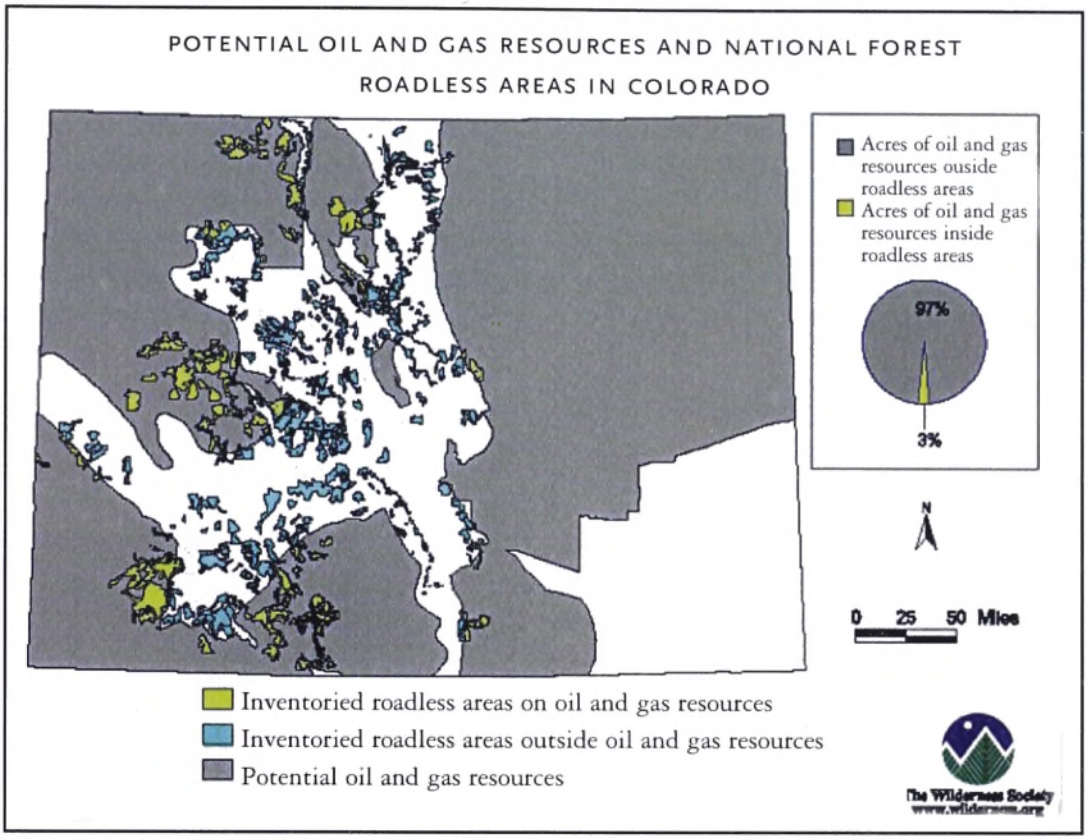
When discussing undiscovered resources, it is also important to recognize the significant uncertainty that comes with the USGS estimates. On the Y-axis of Figure 1 we have probabilities—anywhere from a 95 percent probability of V—1, a 50 percent probability of V—3, to a 5 percent probability of V—2. The Wilderness Society recommends using the mean estimate of economically recoverable oil or gas. This figure represents the best, unbiased estimate of the expected value of the economically recoverable gas–which, as discussed, correctly represents the opportunity cost of environmental protection.

One of the reasons why the environmental community and the oil and gas industry might be citing different estimates of oil and gas has to do with the chosen probability. Some pro-drilling advocates tend to cite the five-percent probability. While we support the use of mean estimates, we express considerable skepticism when it comes to quantities of undiscovered oil or gas estimated with only a five-percent probability. Estimates with just a five-percent probability can be expected to be wrong 19 out of 20 times. Predictions that are wrong 19 out of 20 times are rarely relevant in policy debates. To emphasize this point, consider the following example. If an environmental group ran a computer model that estimated global temperatures would increase 15 degrees in the next 10 years if we keep emitting carbon dioxide at current rates, but the model prediction was wrong 19 out of 20 times—would anyone take the estimate seriously? Would decision-makers, scientists, or the press give the estimate any credibility? Pro-drilling forces would certainly scoff at the scare tactics and pseudo-science behind a dire environmental prediction that may be correct only five percent of the time. With this in mind, we believe that quantities of oil and gas, estimated with just a five-percent probability, should be heavily discounted, if not ignored, by decision-makers.

Coalbed methane and public wildlands: how much?

The Wilderness Society was initially concerned about the energy potential of two major land designations: national forest roadless areas, and national monuments managed by the Bureau of Land Management (BLM) and designated by former President Clinton using the Antiquities Act. To address our concerns, we utilized USGS data and completed a GIS overlay analysis of oil and gas plays with roadless area and monument boundaries. In grey (Map 1), we have merged all the oil and gas plays in Colorado into one layer. This gives you an idea of the land in Colorado that has oil and gas potential. The other GIS layer on this map includes roadless areas, shown in two colors. In yellow are the national forest roadless areas that have oil and gas potential, while in blue are the roadless areas without oil and gas potential. As this map shows, national forest roadless areas account for only three percent of the land in Colorado with oil and gas potential. We have similar estimates and maps for all Rocky Mountain States located on our web site at www.wilderness.org/eyewash/legislation.htm.

With respect to the amount of economically recoverable coal-bed methane in roadless areas of the Rockies, we used USGS data to estimate that national forest roadless areas in the Rocky Mountains contain somewhere between 500 and 943 *billion* cubic feet of undiscovered coal-bed methane gas. Most of the CBM is in Colorado—predominantly located in roadless areas on the San Juan National Forest (Table 1). There's a little bit of roadless CBM located in Utah, mostly in the Uinta Basin. Now, to put this amount of CBM gas in perspective, if we were to drill for CBM in these roadless areas, the economically recoverable CBM would increase America's expected gas reserves by only one tenth of one percent (0.1%). In terms of the length of time this gas would be able to meet U.S. demand, CBM in national forest roadless areas of the Rockies would meet our demand for about 15 days. There is simply not a huge pot of "CBM gold" out there in our roadless areas. When all forms of energy are counted, economically recoverable oil in these roadless areas would meet total US oil consumption for approximately 21–29 days, while the economically recoverable gas would meet total US gas consumption for approximately 2 –3 months. Obviously, this gas will be produced over a much longer period of time, but this estimate provides a metric on the relative amount of economically recoverable gas-oil in national forest roadless areas.



MAP 1 *Potential oil and gas resources and roadless areas. In grey we have merged all the oil and gas plays to show the land in Colorado that has oil and gas potential. In yellow are the national forest roadless areas that have oil and gas potential, while in blue are the roadless areas without oil and gas potential. National forest roadless areas account for only 3% of the land in Colorado with oil and gas potential. Source Data: Map and pie chart obtained from the U.S. Forest Service and the U.S. Geological Survey.*

TABLE 1. ECONOMICALLY RECOVERABLE COAL-BED METHANE IN NATIONAL FOREST ROADLESS AREAS

State	Coal-Bed Methane (billion cubic feet)
Colorado	429–801
Utah	70–141
Wyoming	0.27–0.46
New Mexico	0.1–0.13
Montana	None
North Dakota	None
TOTAL	500–943

NOTE: Based on analysis of USGS data.

We repeated our oil and gas analysis for the 15 national monuments managed by the BLM (Table 2). In terms of the length of time this gas would be able to meet U.S. demand, all types gas in these monuments would meet our demand for about 7 days. We did not break out estimates for coal-bed methane because according to the USGS, there is no coal-bed methane in any of our national monuments. Some pro-drilling advocates may argue that the Grand Staircase–Escalante National Monument contains coal and hence CBM. We, however, agree with the USGS. If in fact the gas does exist, it is unlikely to be economically viable to bring to market. The CBM has, just as Kaiparowits Plateau coal has, very high transportation costs associated with bringing a resource in a remote area to market.

TABLE 2. ECONOMICALLY RECOVERABLE OIL AND GAS IN THE NEW BUREAU OF LAND MANAGEMENT (BLM) NATIONAL MONUMENTS

Monument	Economically recoverable oil as a portion of total U.S. consumption	Economically recoverable gas as a portion of total U.S. consumption
Agua Fria, NM	0	0
California Coastal, CA	13 days	5 days
Canyons of Ancients, CO	3 hrs	3 hrs
Carrizo Plain, CA	2 days	19 hrs
Cascade Siskiyou, OR	0	0
Craters of the Moon, ID	0	0
Grand Canyon–Parashant, AZ	16 mins	Less than 1 min
Grand Staircase–Escalante, UT	4 hrs	1 hr
Ironwood Forest, AZ	0	0
Kasha-Katuwe Tenet Rocks, NM	Less than 1 min	Less than 1 min
Pompey's Pillar, MT	Less than 1 min	Less than 1 min
Santa Rosa and San Jacinto Mts., CA	0	0
Sonoran Desert, AZ	0	0
Upper Missouri River Breaks, MT	1 hr	15 hrs
Vermillion Cliffs, AZ	10 mins	8 mins
Totals	**15 days, 12 hrs, 28 mins**	**7 days, 2 hrs, 11 mins**

NOTE: Data for oil and gas were obtained from the United States Geological Survey (1995). Our estimates utilized USGS mean value estimates of economically recoverable oil and gas because they provide the best unbiased estimate of the expected value of oil and gas resources. Economically recoverable oil and gas amounts were estimated with prices of $30/barrel of oil and $3.34/thousand cubic feet of gas.

Coal-Bed Methane and Public Wildlands: The Uncounted Economic Costs

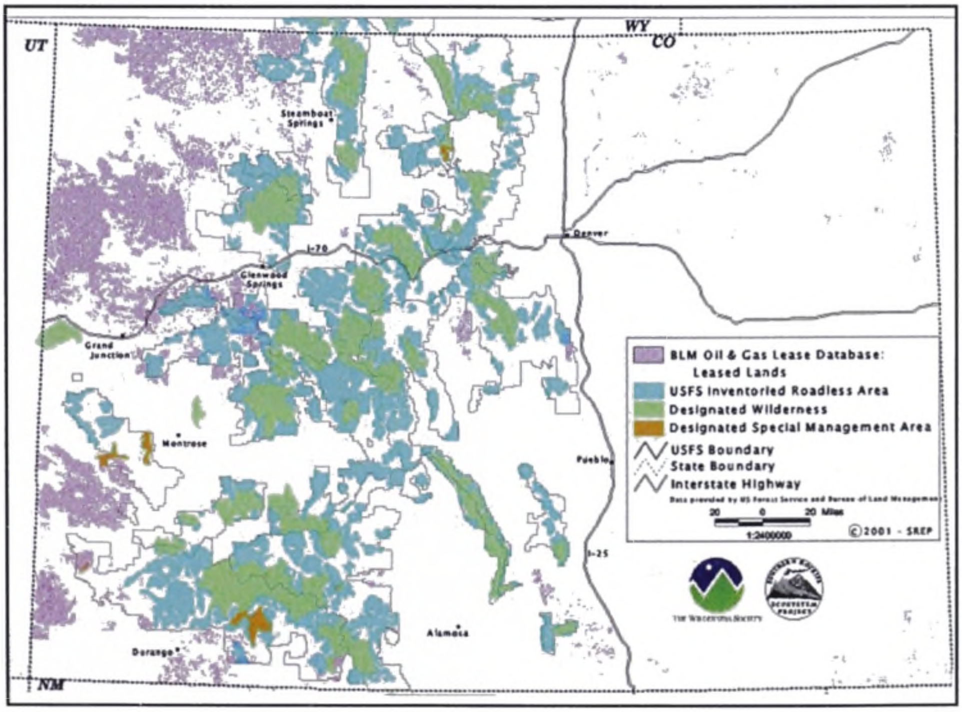
While the benefits of drilling for coalbed methane in these remote areas are relatively small, the benefits of conserving wild areas are significant. To account for the full array of goods and services generated by wildlands, economists have derived the total economic valuation framework (Krutilla 1967, Randall and Stoll 1983; Peterson and Sorg 1987; Loomis and Walsh 1992). A total economic valuation framework is the appropriate measure when comparing wilderness benefits to its opportunity costs in terms of energy resources foregone.

When evaluating CBM drilling in wildlands, the potential energy benefits from drilling should be compared to the known opportunity costs in terms of wildland benefits lost or forgone. To examine this issue, we transformed the seven benefit categories outlined by Morton (1999) into cost categories (i.e., categories of foregone wildland benefits; see Table 3). While many of these costs are difficult to estimate, academic and federal agency economists have made great advances in developing methods to value non-market costs and benefits. Included in Table 3 are methods available for estimating the economic costs, driving home the point that these costs are quantifiable and should be included in the economic calculus. Many heretofore unquantifiable wildland benefits and costs are now quantifiable and available to agency officials responsible for developing the policies and procedures for guiding public land management. (Table 3 next page).

Economic Costs to Hunters, Anglers and Other Direct Users

The first economic cost category includes the foregone benefits associated with the direct use of an area. Obviously, gas wells and waste pits are likely to negatively impact the recreational experience of many users, including hikers, hunters, and anglers. The direct use economic costs therefore include the decline in the utility of the recreational experience resulting from oil and gas drilling. Given the importance of public land for outdoor recreation, the lost of foregone recreation benefits could be significant.

Map 2 illustrates national forest roadless areas in relationship to wilderness areas in Colorado. Designated wilderness areas are shown in green while the adjacent roadless areas are shown in blue. Across the west, national forest roadless areas are, in general, adjacent to our wilderness areas and, in particular, adjacent to some of America's best-loved wilderness areas. Our public roadless areas, if left alone, are capable of sustaining the view-



Oil and Gas Leases and USFS Inventoried Roadless Areas in Colorado

MAP 2. *Designated wilderness areas are shown in green while the adjacent roadless areas are shown in blue. Our public roadless areas, if left alone, are capable of sustaining the viewsheds and quality recreational experience for current and future visitors to our wilderness areas. In purple hatchmarks are the current leases for gas. Currently, only 2% of national forest roadless areas in Colorado are under lease even though these lands have been open for leasing for over 60 years, during which there was little or no interest from industry.*

TABLE 3. THE ECONOMIC COSTS OF MINING, OIL, AND GAS EXTRACTION		
COST CATEGORY	DESCRIPTION OF POTENTIAL COST	METHODS FOR ESTIMATING COST
DIRECT USE	Decline in quality of recreation, including hunting, fishing, hiking, biking, and horseback riding. Loss of productive land for grazing and farming.	Travel cost, contingent valuation surveys.
COMMUNITY	Air, water, and noise pollution negatively impacts quality of life for area residents, with potential decline in the number of retirees and households with non-labor income and loss of educated work-force, with negative impacts on non-recreation business. Decline in recreation visits and return visits negatively impact recreation businesses. Socio-economic costs of boom-bust cycles.	Surveys of residents and businesses. Averting expenditure methods for estimating costs of mitigating health and noise impacts. Change in recreation visitation, expenditures, and business income. Documenting migration patterns.
SCIENCE	Oil and gas extraction in roadless areas reduces value of area for study of natural ecosystems and as an experimential control for adaptive ecosystem management.	Change in management costs, loss of information from natural studies foregone.
OFF-SITE	Air, water, and noise pollution decrease quality of life for local residents and decrease quality of recreation experiences for downstream and downwind visitors. Haze and drilling rigs in viewsheds reduce quality of scenic lanscapes, driving for pleasure, and other recreation activities and negatively impacts adjacent property values. Groundwater discharge can negatively impact adjacent habitat, property, and crop yields, while depleting aquifers and wells.	Contingent valuation surveys, hedonic pricing analysis of property values, preventive expenditures, well replacement costs, restoration and environmental mitigation costs, direct impact analysis of the change in crop yields and revenues.
BIODIVERSITY	Air, water, and noise pollution can negatively impact fish and wildlife species. Groundwater discharged changes hydrological regimes, with negative impacts on riparian areas and species. Road and drill site construction displaces and fragments wildlife habitat.	Replacement costs, restoration and environmental mitigation costs.
ECOSYSTEM SERVICES	Discharging groundwater negatively impacts aquifer recharge and wetland water filtration services. Road and drill site construction increases erosion, causing a decline in watershed protection services.	Change in productivity, replacement costs, increased water treatment costs, preventive expenditures.
PASSIVE USE	Roads, drilling rigs, and pipelines in roadless areas result in the decline in passive use benefits for natural environments.	Contingent valuation surveys, opportunity costs of not utilizing future information on the health, safety, and environmental impacts of oil and gas drilling.

Source: Morton 2001

sheds and quality recreational experience for current and future visitors to our wilderness areas. In addition, these roadless areas play an important ecological role by providing wildlife habitat and migratory corridors between roadless and wilderness areas. Also shown on this map in purple hatchmarks are the current leases for gas. Currently, only 2% of national forest roadless areas in Colorado are under lease even though these lands have been open for leasing for over 60 years, during which there was little or no interest from industry.

Economic costs to communities

The second economic cost category includes the socioeconomic costs to communities from promoting the boom and bust cycles associated with oil and gas extraction. Take for example, Colorado's oil shale boom and bust from the early 1980s (Figure 2). As you can see, oil, gas and mining had an employment boom in the '80s before a big bust and downward slide for the last 20 years. In Colorado, oil, gas, and mining employment currently accounts for less than 0.5% (one-half of one percent) of total employment (*www.wilderness.org/newsroom/colorado_090600.htm*). It's interesting to note that at the peak of the boom, the oil, gas and mining industries only accounted for about three percent of the employment in the state of Colorado. Similar extractive-based boom and bust employment cycles can be found in most other western states. The current emphasis on rapid oil and gas exploration by the Bush administration is pushing rural communities into another boom-bust cycle, and there are indications that the bust is already here.

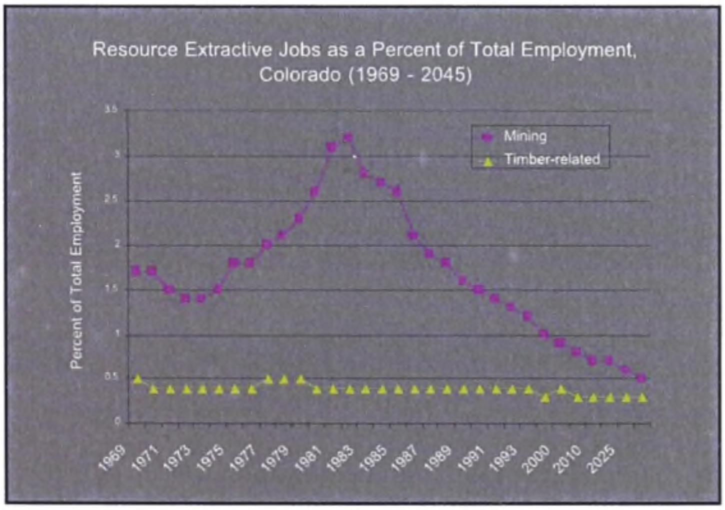


FIGURE 2 *Resource extraction employment as a percent of total employment in Colorado (1969–2045). Mining employment rose to 3.2% of total employment in 1981 before decreasing to 0.9% in 1997. Employment in the timber-related industries (includes lumber and wood products manufacturing and paper products) experienced a steady decline from 0.5% of total employment in 1969 to 0.3% in 1997. Source: Bureau of Economic Analysis, U.S. Dept. of Commerce, 2000.*

As recent employment data from western states are released, you will likely see a bump up in oil and gas employment corresponding to the 2001 spike in gas prices—followed by a drop in employment as gas prices have plummeted. In New Mexico, between November of last year and February of this year, the oil and gas industry laid off 900 workers (New Mexico Department of Labor 2002). In Wyoming, from September 2001 through February of 2002, the oil and gas industry laid off 1,500 workers, representing 12 percent of the industry's work force (Wyoming Department of Employment Research and Planning 2002).

These figures provide some evidence that the CBM bust has started as a result of the recent drop in gas prices. The recent job losses illustrate the economic instability and lack of local control associated with promoting rapid energy development. Communities have little control over the local economy because they have absolutely no control over global commodity prices. When prices drop, companies abandon wells, lay off workers, and leave the communities high and dry to suffer the economic consequences.

The current boom-bust cycle has generated significant costs to communities in the Powder River Basin of Wyoming–costs that must be considered by public agencies rapidly promoting energy development. Many landowners are spending thousands of dollars on attorneys in order to negotiate a surface damage agreement to protect their property (i.e. the split estate problem). Other landowners have seen dramatic declines in property values. The City of Gillete has experienced a 12 to 15 percent increase in truck traffic plus a 26 percent increase in traffic violations between 1999 and 2000 (Pederson Planning Consultants 2001). As a result, the expected life of city streets has decreased, while road operation and maintenance costs have increased. Dust from poorly constructed access roads causes health problems with horses, reduces the grass available for cattle, and negatively impacts air quality and visibility. County officials and residents area concerned that they will have to pay for clean up and restorations costs as the bonds posted by CBM companies for plugging and abandoning a well are inadequate.

As a result of recent coal-bed methane boom, Campbell County has seen an increase in larceny, traffic accidents, destruction of private property, family violence, and child abuse–resulting in the county spending money to add 36 cells to its existing jail. The fire department has seen a 40 percent increase in emergency calls between 1997 and 2000 (Pederson Planning Consultants 2001). Similar trends have occurred in other counties in the Powder River Basin. There has also been a shift in the labor force. County workers have left for CBM jobs, resulting in instability in the labor force and making it more difficult to hire public workers (e.g. policemen, firemen) at a time where the counties and cities are stretched thin to handle the increased work load. *The accelerated energy development has left many counties and communities unable to pay for or finance the increase in public service costs.* We have every reason to believe that similar costs and burdens will be placed on other communities where public and private land is threatened by energy development. The socio-economic risks and costs associated with expedited energy development must be fully accounted for as part of the NEPA process involved with current push for energy development in the west.

An historic emphasis on promoting resource extraction industries has resulted in repetitious cycles of socio-economic distress for rural communities in the west. Resource extractive workers tend to get stuck in a vicious cycle of relatively high paying jobs with frequent layoffs and unemployment. This cycle is what Freudenburg (1992), a sociologist, calls the "intermittent positive reinforcement regime," one of the most effective of all behavioral reinforcements (Freudenburg and Gramling 1994). While resource extractive workers develop high skills, such skills are not readily transferable to other jobs, and the workers become overspecialized (Freudenburg and Gramling, 1994). Investment in education and job retraining is low because "the potential return on their investment in their education is either too low or too uncertain to justify sacrifice (Humphrey et al. 1993). The resultant pattern of "rational under-investment" in the development of skill and other forms of human capital can result in reduced economic competitiveness in resource-dependent communities.

Thankfully, in the last 15 years, the economies of the Rocky Mountain States have diversified, and resource extraction makes up an even smaller part of the economy. For many of these states and communities, service jobs, retirees, recreation, and hunting are the mainstays of the economy. In the new economy, public wildlands play a direct role in sustaining the recreation and tourism businesses, and wildlands play an indirect role in attracting non-recreational businesses and retirees to western states. There is a growing body of literature suggesting that the future diversification of rural western economies is dependent on the ecological and amenity services provided by public lands in the west (Power 1996, Rasker 1995, Haynes and Horne 1997). These services (e.g. watershed protection, wildlife habitat, and scenic vistas) improve the quality of life for a trained and educated workforce, which in turn, can attract new business-

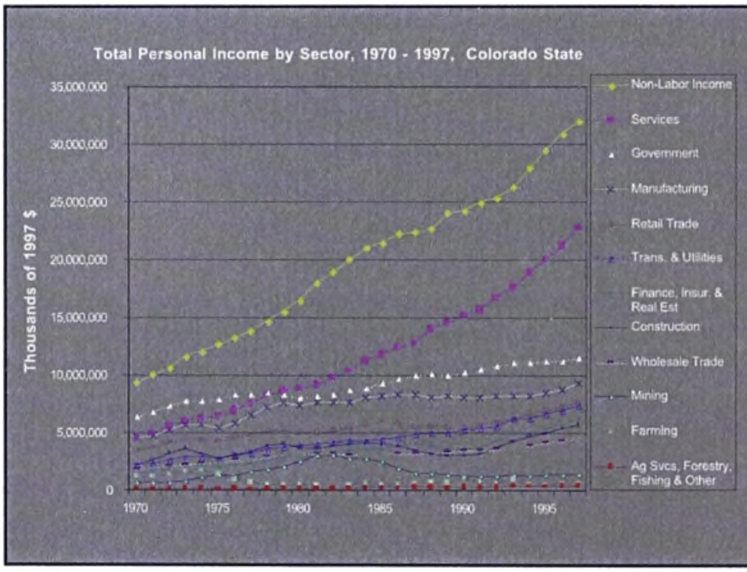


FIGURE 3 *Components of total personal income (TPI) in Colorado (1970–1997). Non-labor income, the largest component of TPI, has steadily increased in importance since 1970 and is followed by service and government.*

es and capital to communities. The natural amenities from public land provide communities with a comparative advantage over other rural areas in diversifying their economies. It is therefore important to recognize and analyze the potential negative impacts of oil and gas exploration on public land amenities and hence the economy as a whole, including the service and recreation industries, as well as on retirees and other households with investment income.

As Figure 3 shows, the number one component of personal income in Colorado and other western states is nonlabor income, which includes investment income, dividends and rent, and retirement income. The contribution of nonlabor income in the Rocky Mountain States ranges from 26 percent of total personal income in Colorado to 39 percent of total personal income in Montana, making it a significant component of our western economy. In fact, if retirees and investment income were classified as an industry, it would be the number one industry in most western states, and it is largely based on sustaining our environment and quality of life. It is therefore important to fully evaluate the negative

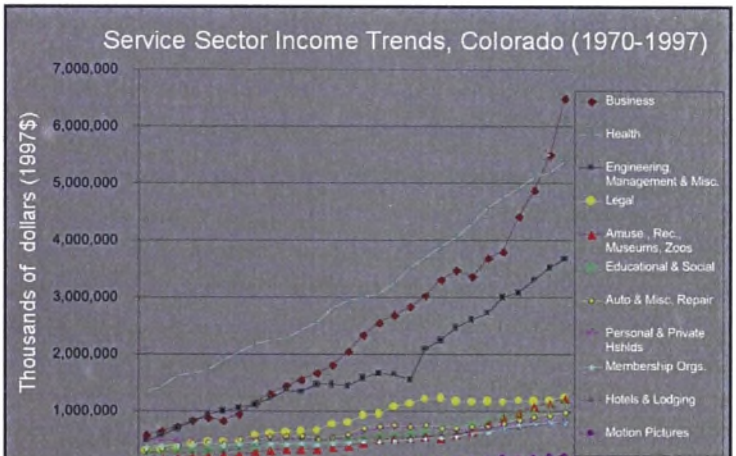


FIGURE 4 *Personal income earned from the service sector in Colorado (1970–1997). Business services were the largest and fastest growing component of the service sector between 1970 and 1997, followed by health, engineering, management, and miscellaneous services.*

impacts of a rapid expansion of coalbed methane production on a region's amenities and, hence, the potential negative impacts on retiree and investment income. As one industry speaker mentioned, on occasion his company drills gas wells on ranchettes owned by retired couples. If the drill rig goes in, despite objections of the landowner, and causes the couple's quality of life to decrease, they might move and take a significant chunk of a county or state's total personal income with them.

In addition to retirees, amenity development is bringing new workers and service businesses to the west. In Colorado, as with other western states, the service sector is the number two component of our economy. Jobs in the service sector are often mischaracterized as those of burger flippers and maids. However as Figure 4 illustrates, some of the fastest growing jobs in the service sector are high paying jobs in business, health, and engineering services. These jobs are increasing, in part, because people are moving to Colorado and New Mexico and Montana and Wyoming because they are nice places to live.

Many economists believe that amenity development has changed the dynamics of regional economic development. In the past, workers moved to where the jobs were; now, businesses and jobs are moving to locations that have a high quality workforce in place. With computers and the Internet, service workers can live wherever they want, and most workers want to live in a nice place with a clean environment. Sustaining our environment and quality of life is, therefore, a prerequisite to sustaining our economy. If CBM development degrades our environment and decreases our quality of life, however, workers may move someplace else and businesses will follow. The bottom line is that we need to carefully assess the net impacts of CBM development on our economy, taking into consideration the potential negative impacts of coalbed methane extraction on other, perhaps more important, sectors of the western economy.

SCIENTIFIC AND OFF-SITE ECONOMIC COSTS

A third economic cost category includes the scientific costs in terms of the decline in natural areas for research. Natural areas are important for studying natural processes and for providing reference conditions to help guide adaptive ecosystem management outside natural areas. Economic costs that occur off the site comprise the fourth cost category. Off-site costs include air pollution and the negative impacts on human health from fine particulates, visual impacts from the haze will reduce the quality of life for local residents and decrease recreational experiences for visitors to regional parks and wilderness, increased water treatment costs for downstream users, and potential negative impacts on property values.

Many of the off-site costs are a result of the water discharged during CBM development. The amount of water discharged from CBM wells in Wyoming has skyrocketed in recent years, increasing from approximately 98 million gallons (300 acre feet) per year in 1992, to 5.5 billion gallons (17,000 acre feet) per year in 1999 (Wyoming State Engineer's Office cited in Darin 2000). The surge in water flow has resulted in erosion in ephemeral stream channels and sediment downstream in the main river channel. The water discharged from oil and gas wells is highly saline with a very high sodium absorption ratio (SAR)–a ratio that affects how water interacts with soil. Water with a high SAR can permanently change chemical composition of soils, reducing water permeability and thereby decreasing native plant and irrigated crop productivity. These off-site impacts have the potential to increase water treatment costs for communities and homeowners downstream, cause a decline in range productivity, and increased crop costs for downstream farmers.

THE ECONOMIC COSTS TO BIODIVERSITY AND ECOSYSTEM SERVICES

The increased water production facilitates the spread of noxious weeds that replace native species unable to survive the unnaturally high flow of water and the saturated soil. The spread of noxious weeds, when combined with the loss and fragmentation of wildlife habitat by drill pads, waste pits and roads, negatively impact biodiversity, the fifth economic cost category. Roads are a number one source of sediment in a forest or rangeland. If we allow more poorly constructed roads to be built in search of CBM, we will have more sediment in our streams. Photo 1, from an overflight of the Upper Green River Basin in Wyoming, gives you an idea of the road fragmentation and the density of drilling necessary to extract tight sands gas. So, once again, although this conference is on CBM, when discussing the impacts of CBM development, we need to keep in mind the cumulative impacts from all forms of energy development and resource extraction.

PHOTO 1 *Overflight photo of habitat lost and fragmented as a result of the roads and drill pads from drilling for tight sands gas in the Upper Green River Basin of Wyoming. Photo credit: Peter Aengst.*

The sixth economic cost category includes the loss or decline in ecosystem services such as aquifer recharge, wetland function, and watershed protection. Roadless areas protect private property from floods and lowers water treatment and reservoir maintenance costs for downstream communities. Watershed protection is an important role for public lands because wildlands contain the headwaters of many of America's rivers, and controlling development, road construction and hence erosion on private lands is more difficult due to concerns over private property rights. The national forests are well suited for this important ecosystem service as the EPA estimates that 3,400 public drinking water systems are located in watersheds containing National Forest System

TABLE 4. NATIONAL FOREST ROADLESS AREAS WITH HIGH LANDSLIDE SUSCEPTIBILITY FOR SELECT STATES

STATE	ACRES OF ROADLESS AREAS WITH HIGH RISK OF LANDSLIDES*	PERCENT OF FS ROADLESS AREAS WITH HIGH SUSCEPTIBILITY TO LANDSLIDES
Colorado	1,146,000	33
Wyoming	645,000	21
Montana	564,000	15
Utah	492,000	14

NOTE: This is a conservative estimate of roadless acres classified as highly susceptible to landslides, as these totals did not consider the 21 million acres in roadless acres allocated to prescriptions that do not allow road construction and reconstruction, some of which may have high susceptibility to landslides (USDA FS Watershed Specialist Report, 2000).

land, and about 60 million people live in those 3,400 communities (Sedell and others 2000).

In addition to keeping sediment from access roads and drill sites out of community water sources, roadless areas protect communities from sediment produced by mass wasting (e.g. landslides). Mass wasting from landslides and debris flows is a key source of sediment, particularly in western forests, and many of the roadless areas are at high risk from landslides. In Colorado and Wyoming, for example, over 1,146,000 and 645,000 acres of roadless areas, respectively, have high susceptibility to landslides (Table 4). While landslides are a natural process, management activities like road construction and logging accelerate the incidence of mass wasting by several orders of magnitude (LaFayette, 2000). For example, a joint FS and BLM study in Oregon and Washington found that of 1290 slides reviewed in 41 subwatersheds, 52% were related to roads, 31% to timber harvest, and 17% to natural forest (USDA Forest Service 1996). The Forest Service concluded that the Roadless Area Conservation Rule "would have a considerable beneficial effect on water quality, particularly in Regions 1 and 4."

The rapid development of CBM also jeopardizes acquifer recharge. As Figure 5 shows, there has been a huge increase in coalbed methane permits in Wyoming, more drilling, in fact, than several environmental documents predicted or even addressed. To be conservative, before any more CBM drilling is phased in, the public needs a more complete understanding of the cumulative impacts of drilling and de-watering on ecosystem services such as aquifer recharge. If there is one resource more valuable than oil and gas in the west it is water. So we urge conservative decision-makers to display some caution and stick to their conservative principles with respect to our water resources specifically and our natural resources generally.

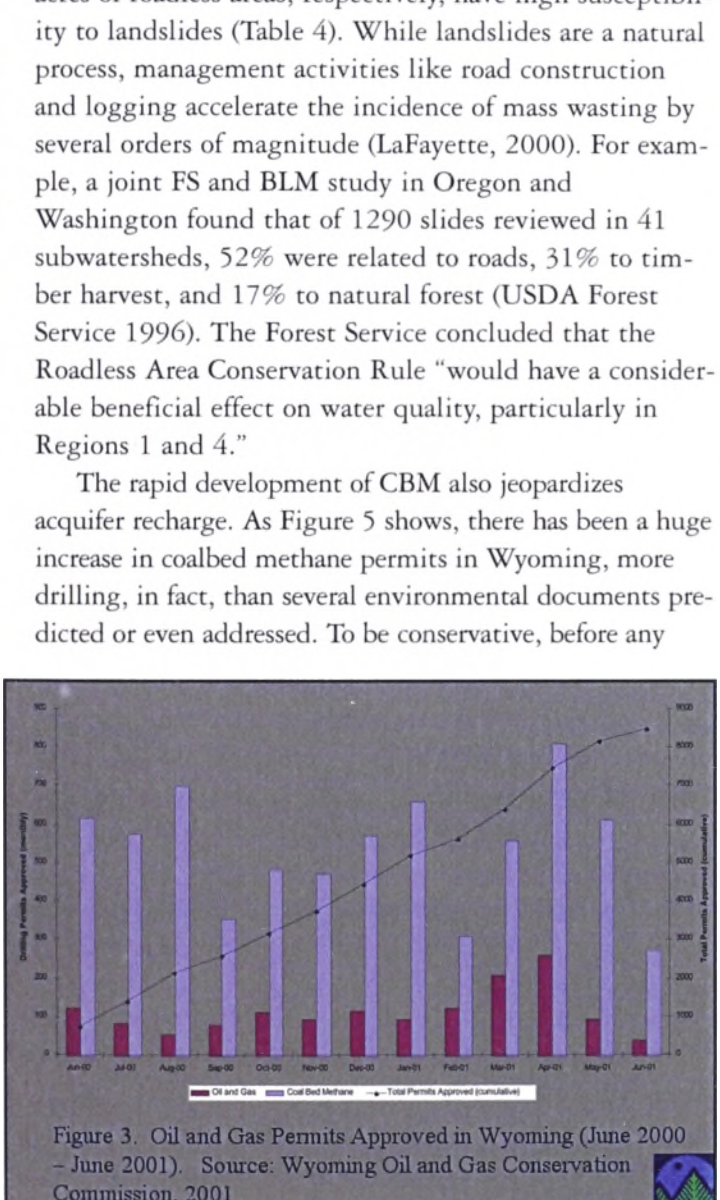


FIGURE 5 *Oil and gas permits approved in Wyoming (June 2000–June 2001). Source: Wyoming Oil and Gas Conservation Commission, 2001.*

WILDLAND PASSIVE USE BENEFITS LOST OR FOREGONE

The last cost category includes the loss of passive use benefits from CBM development. Economists and the courts have recognized that wildlands generate substantial passive use benefits, including option, existence and bequest values (Clawson and Knetsch 1966; Walsh and Loomis 1989). Option value is like an insurance premium that people are willing to pay over and above their expected recreation benefits to maintain the option, for themselves or for their children, of visiting wildlands in the future (Weisbrod 1964; Krutilla 1967). Existence value is the psychic value a person enjoys from just knowing that a wildlands exist—regardless of whether the person will ever visit an area (Krutilla and Fisher 1985). Bequest value represents what the current generation might be willing to pay to bequest wildlands to future generations. Researchers have found that the passive use benefits of wildlands are typically greater than the other benefits included in the total economic valuation framework (Walsh and others 1984; Walsh and Loomis 1989; Walsh and others 1996). If CBM development occurs in roadless areas or national monuments, for example, these passive use values will be lost or seriously compromised.

DISCUSSION AND CONCLUSIONS

Based on our analysis of USGS data, it is clear that drilling public wildlands in the west will do little to affect our energy future. We should, therefore, not assume that extracting energy resources is the highest and best use of our public lands–because in many cases it is not. Public lands provide greater benefits to society when left in their wild and roadless condition for current and future generations to enjoy. The marginal benefits from wildland conservation are, in most cases, much greater than the marginal costs in the form of the undiscovered, economically recoverable energy resources foregone

As the RAND report (LaTourrette et al. 2002) correctly points out, much of the potentially restricted oil and gas resources in the west would never be developed because they are inaccessible for other reasons. *The oil and gas leasing stipulations that dictate where, how, and when exploratory drilling may be conducted in order to protect wildlife and the environment are not, in many cases, binding constraints on energy production.* Economics, terrain and technology may in fact play more important roles in determining the "economically viable resource."

When examining the economically viable resource, it is important to recognize the cumulative and increasing economic costs associated with increasing the scale of production beyond the "sustainable scale." While increasing the scale of production typically decreases the financial costs to a producer (i.e. economies of scale), larger scale projects will, in general, increase the non-market economic and community costs, resulting in what we will call the "diseconomies of scale." The socio-economic and environmental constraints on the scale of oil and gas production should limit development of recoverable CBM resources to a more sustainable scale based on the assimilative capacity of the ecosystem and community

While CBM development on a small scale may have limited negative impact on communities and ecosystems, as the scale of production increases, the ability of those systems to assimilate the impacts is jeopardized. For example, as the scale of coal-bed methane increased in the Powder River Basin of Wyoming, the increase in traffic, crime and immigrants overwhelmed the capacity and budgets of communities and counties for handling these problems. While the CBM may be financially recoverable, local community concerns over the cumulative negative impacts from future production will increase the economic costs and may prevent additional development (i.e. increasing the scale of development) from actually occurring.

Similarly, the cumulative negative impacts of CBM production on clean air and clean water may be a constraining factor on the scale of production—irrespective of whether the CBM is financially or technically feasible to extract. The amount of CBM wells drilled in Wyoming have increased dramatically resulting in the surface disposal of thousands of gallons of water with a very high sodium absorption ratio. *To be sustainable and to maintain water quality, the increase in SAR water should not exceed the SAR assimilative capacity of the regional river systems.* As the scale of CBM production increases, it is more likely that the cumulative quantities of SAR water will exceed the assimilative capacity of regional watersheds. The SAR assimilative capacity of the regional watershed should therefore be used to help define a sustainable scale of CBM development.

Similar scale arguments can be made with respect to the negative impacts of CBM production on air quality. Based on an analysis by Bob Yunke of the Environmental Defense Fund (2002), the total emissions associated with developing the more than 50,000 wells expected in the Powder River will exceed Clean Air Act limits in the surrounding Class I airsheds (Northern Cheyenne Reservation in Montana and the Badlands National Park in South Dakota). As a result of CBM development in the Powder River, there could be a 60 percent decrease in visibility in the Badlands on peak air pollution day. The loss of clear skies will reduce the quality of life for local residents and decrease the quality of the recreational experiences in nearby wilderness areas and national parks–all of which will translate to negative economic impacts on local communities.

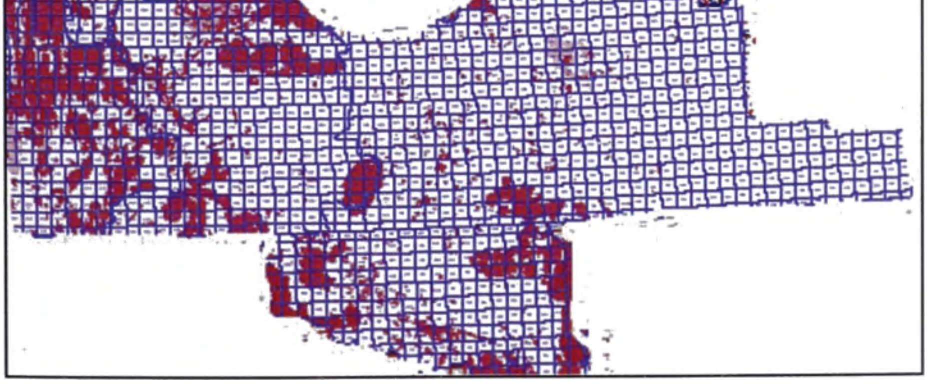
To summarize, the assimilative capacity of communities and ecosystems represent binding constraints on the scale of oil and gas production that should limit future production, even though the oil-gas may be financially feasible for a corporation to produce. Cumulative impacts and constraints on the scale of production should therefore be considered when assessing economically viable resource and when fully accounting for the economic costs of CBM development.

To help address the sustainable scale issue, we recommend that public agencies and private companies immediately begin to scientifically collect, monitor and analyze the cumulative impacts of CBM development from the watershed and landscape perspective–a perspective that should include both public and private lands. We firmly believe it is vital that the public fully understand the potentially irreversible, cumulative environmental impacts from energy development in the Rocky Mountains–impacts on our aquifers, our air and water quality, wildlife species and cropland productivity—before we allow industry to increase the scale of CBM production by phasing in more development.

We also recommend that the BLM increase the bonding requirements for companies drilling for oil and gas on public lands. History has shown that the costs of restoring abandoned drill pads have been greater than the bonds posted. Increasing bonding requirements will provide taxpayers with assurance that there will be sufficient money to pay for the damages to their public land from CBM development. Increasing environmental bonding requirements can reduce the need for regulation and represents a cost-effective method for internalizing the environmental costs into energy production decisions. If, in fact, as one industry official trumpeted at the CBM Conference, CBM development produces "clean water," then increasing the bonding requirements should not be much of an added burden to the "good actors" in industry. If the water is clean and the damages are minimal, companies will get their bonds back. Increased bonding requirements will also help weed out those "bad actors" whom many in industry seem concerned about, yet no one seems to know.

While some industry officials at the CBM Conference questioned the integrity of many of the claims made by the environmental community, from our perspective, integrity begins with companies accepting responsibility for their own actions. Integrity requires CBM companies to accept responsibility for the cumulative negative impacts that CBM development has had on the environment and communities. Integrity begins with monitoring the cumulative environmental impacts of your company's actions, and ends with providing sufficient bonding to pay for the damages caused by such actions. Denying environmental problems or calling them "spurious" is neither credible nor helpful in promoting a dialogue with integrity.

Switching to the issue of access, we do not believe lack of access is a problem. Rather, we believe that industry has too much access to public land. Consider, for example, the road access problem. The national forests contain 383,000 miles of official roads and 52,000 miles of user-created roads–and these are conservative estimates. We have more roads than we can maintain. The Forest Service alone has an $8.4 billion backlog of deferred road maintenance and improvements. Currently the national forest budget can only pay for maintaining 18 percent of the roads. The BLM has similar road problems. Since we cannot maintain the roads we already have on our public lands, why build any more? A taxpayer question worth pursuing is: if we allow more roads to be built to access coal-bed methane or other energy resources, who is going to pay to close or maintain the roads? Also, who is going to pay the costs to maintain the energy infrastructure (e.g. holding ponds, pipelines, etc.) if and when the economic bust comes? We already



DRILLING OPPORTUNITIES IN THE GREATER GREEN RIVER STUDY AREA

MAP 3 *Drilling opportunities in each township (indicated with blue squares) in the DOE Green River Study Area for the Base Case analysis. The red shade toward the northwest indicates more protective lease stipulations for crucial elk winter range, raptor habitat, and sage grouse nest sites near the Wind River Range and the Bridger-Teton wilderness complex southeast of Yellowstone and Grand Teton National Parks. The lighter areas indicate land where drilling is not restricted and shows that industry has access to a majority of the landscape in the Green River Basin.Source: Dept. of Energy may 2001*

TABLE 5. BLM ACREAGE BY OIL AND GAS STIPULATIONS (1995)

STATE	STANDARD STIPULATIONS (% OF TOTAL)	SEASONAL AND OTHER STIPULATIONS (% OF TOTAL)	NO SURFACE OCCUPANCY (% OF TOTAL)	OFF-LIMITS (% OF TOTAL)
Colorado	45	46	5	4
Montana	58	38	2	2
New Mexico	84	10	1	5
Utah	64	26	6	4
Wyoming	49	46	3	3
5-State Total	**61**	**32**	**3**	**4**

SOURCE: Bureau of Land Management, 1995

have thousands of abandoned wells scarring public land and threatening human health; why drill more?

With respect to regional access to energy resources in the Rocky Mountains, the BLM is currently examining access to oil and gas as required by the Energy Policy and Conservation Act of 1999. The BLM will focus on five basins in the Rocky Mountains: the Powder River, the Montana Overthrust Belt, the San Juan Basin, the Uinta-Piceance Basin, and the Upper Green River Basin. Final reports for these five basins will be completed by November 2002.

Map 3 is from the Department of Energy's recent Green River study (2001). While critical of the report (www.wilderness.org/newsroom/pdf/doe_greenriver_071001.pdf), this interesting map illustrates drilling opportunities in southwestern Wyoming and the northwestern corner of Colorado. The lighter areas indicate land where drilling is not restricted and shows that industry has access to a majority of the landscape in the Upper Green River Basin. This result is consistent with BLM data (1995) in Table 5 indicating that more than 95 percent of the public estate managed by the BLM in Wyoming is open to leasing. Most of the potentially restrictive leasing stipulations in the Upper Green River Basin are on the Bridger-Teton National Forest moving north up the Wind River and Gros Ventre ranges toward Yellowstone National Park and south toward Grand Tetons—plus leasing stipulations protecting places such as Flaming Gorge National Recreation Area in Wyoming and Steamboat Lake State Park in Colorado.

This map highlights two things: One, industry has access to a majority of the land out there; and two, when you examine access to oil and gas, you need to take a landscape perspective and include both private and public land. The ecological impacts from energy extraction cannot be separated across ownership boundaries and neither should the resources. A strict focus on public land will underestimate the full access industry has to gas and oil in a region–and this would be especially true in the Powder River Basin, where most of the landscape is privately owned.

It is important to recognize that while leasing stipulations might reduce access to oil and gas, they help conserve the other multiple uses enjoyed by the public on their land. Seasonal closures, necessary to protect raptor nest sites and critical elk habitat, for example, conserve the wildlife and other multiple uses under which public land is managed. Legislative intent and public sentiment indicate that public lands should not be for the exclusive use of the oil and gas industry. The oil and gas industry already has too much access to public lands; they certainly do not need any more.

The current fixation on access to undiscovered resources in remote wildlands overestimates the importance of undiscovered resources in reducing market instability and reducing the energy prices paid by

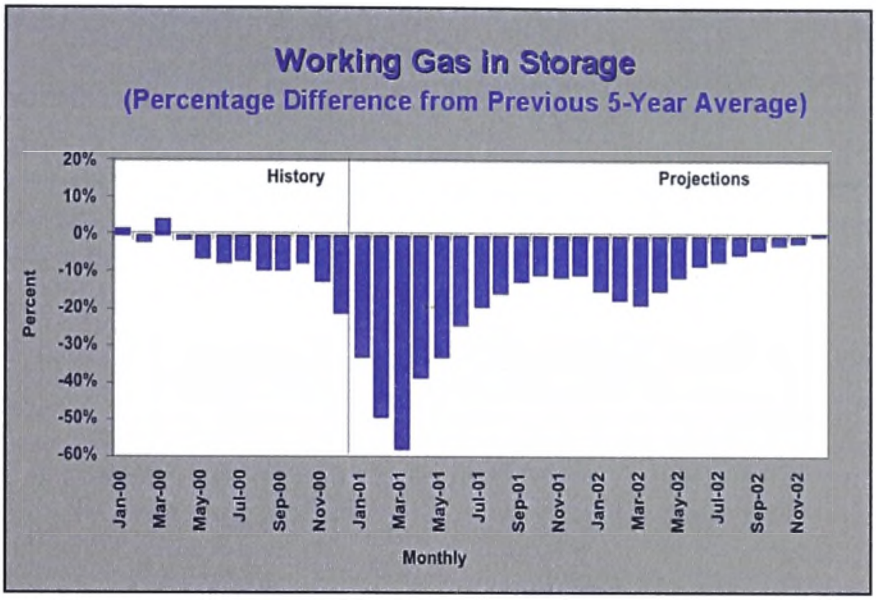


FIGURE 6 *During the last half of 2000 and the first half of 2001, gas inventories were at historic lows.*

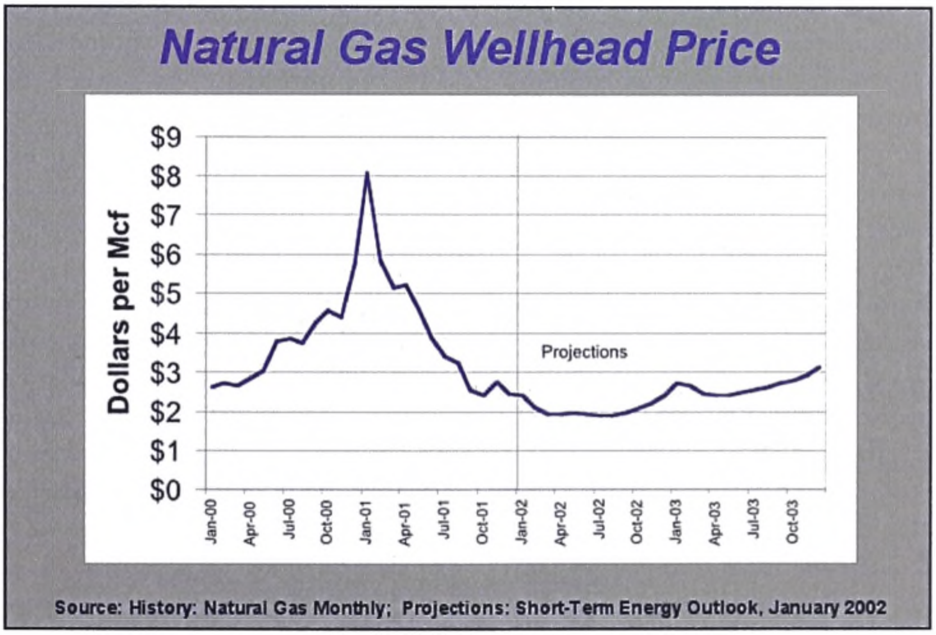


FIGURE 7 *Very low levels of working gas in storage contributed to the price spike.*

consumers (Morton 2002). Decision-makers concerned about high energy prices and price volatility (the main components of the energy "crisis") would be better served by focusing on transporting gas from existing reserves into short-term storage. The shortage in underground storage was perhaps the dominant causal factor in the spike in gas prices, the market instability, and the ephemeral energy crisis of 2001.

The amount of gas in underground storage is a major supply factor influencing short-term market price and market instability (DOE 2001). With relatively inelastic demand for energy in the short-term, lower levels of working gas in storage (short-term supply) will, in general, lead to higher energy prices. Figures 6 and 7 clearly illustrate the recent inverse relationship between gas in storage and gas prices—the lower the storage levels the

TABLE 6. COMPARISON OF TAXPAYER SUBSIDIES-INCENTIVES FOR OIL AND GAS DRILLING IN SENATE AND HOUSE VERSIONS OF THE 2002 ENERGY BILL

Energy Bill Subsidy-Incentive	House Bill (H.R. 4)	Senate Bill (S. 517)
Tax incentives	$1.1 billion	$3.2 billion
Tax credits	$2.8 billion	$1.4 billion
Royalty relief	$7.4 billion	n/a
Deep water technology.	$3.0 billion	n/a
Royalty-in-kind	$1.4 billion	n/a
Total	**$15.7 billion**	**$4.6 billion**

SOURCE: U.S. PIRG, 2002

higher the price. From January 2000 through September 2001, working gas in storage was significantly below the 5-year average, resulting in the increased price volatility, which is reflected in the spike in natural gas wellhead price. Gas inventories were not the only inventories that were low; similar inventory shortages occurred in all the major energy markets.[2]

An energy policy requiring industry to maintain a higher minimum underground storage level will reduce price volatility and the cause of high energy costs for consumers and businesses. In contrast, an energy policy subsidizing drilling public wildlands will do little to address the root causes of the 2001 "energy crisis", nor will it reduce the energy costs for families–despite claims to the contrary made by industry officials.

We believe that taxpayer subsidies to corporations for drilling marginal gas and oil wells in our public wildland are misdirected (Table 6). These subsidies are not needed and are part of a shortsighted energy policy based on the quixotic pursuit of energy independence via more domestic drilling. Of particular concern for communities impacted by CBM development is the $2.8 and $1.4 billion in tax credits included in the House and Senate bills, respectively. This incentive extends and modifies the tax credit for companies extracting CBM and tight sand gas. Additional subsidies for CBM drilling, in addition to running counter to the "free market" philosophies of the Bush administration, will be like pouring gasoline on a fire already burning out of control.

With respect to oil, regardless of whether there are subsidies, high access to resources, or high investment in drilling technology, the downward trend in America's crude oil production will continue. In other words, we have already discovered the best reserves America had to offer. *Of the 4.6 million oil wells worldwide, 3.4 million have been drilled in the U.S and a majority of America's wells were dry wells (Udall and Andrews 2002)*. Why subsidize the drilling of more dry wells? Rather than propping up old industries and sacrificing America's remaining wildlands, taxpayer subsidies would be far better spent promoting new markets in alternative energy, efficiency and conservation.

Adopting an energy policy based on energy efficiency and conservation will reduce air pollution, cut transportation and home heating bills for families, and lower the capital and operating costs for businesses. If we lower the energy required to produce America's goods and services, we become more competitive in the global market place, and we reduce the chance that constraints on expanding our energy supply will constrain our economic growth.

There are also more jobs associated with investing in alternative energy, conservation and efficiency. Oil and gas corporations are capital intensive and have low employment multipliers. In contrast, industries involved in carrying out energy conservation measures—manufacturers of electrical, wind, and solar equipment and the construction jobs associated with home or office weatherization programs—are labor intensive and have high employment multipliers. Labor intensive businesses with higher multipliers generate more jobs per dollar invested by producers, consumers, or the government. For example, an energy policy that provides $1 million in tax relief to encourage consumer investment in energy efficiency will generate more jobs than a policy providing the same tax relief to oil and gas corporations for drilling marginal wells.

In addition to the direct jobs created via investments in energy conservation, such investments indirectly create thousands of additional jobs by directly reducing the energy bills of families. Lower energy bills free up consumer spending, which represents two-thirds of our economy. The re-spending of the savings from lower energy bills creates additional income and jobs in industries, services, and suppliers in which the savings are spent. Most of this spending will occur in relatively labor-intensive industries.

A 1996 Department of Energy study examining the benefits to Colorado from accelerating investments in energy efficiency and renewable energy concludes that Colorado would have a net gain of 8,400 jobs, consumers would save $1.2 billion from lower energy bills, and everyone would enjoy cleaner air as air pollution would be reduced by 133,000 tons. The cleaner environment in turn improves the quality of life for local residents—maintaining Colorado's comparative economic advantage by retaining a talented workforce that attracts new businesses to the state.

Paying energy bills represent a significant leakage of financial resources from a local economy. Economists for the State of Nebraska estimate that 80 percent of every dollar spent on utility bills leaves the community and the state. Energy conservation benefits communities by sealing the economic "leaks," thus keeping local money circulating longer in the local economy. Similar benefits can accrue to state, cities, and small communities that promote energy conservation. Quite simply, the inefficient use of energy unnecessarily raises the cost of living and doing business in an area. State, local, or national policies that promote energy conservation and efficiency will lower energy costs, stimulate job creation, and improve the quality of life for local residents—a win-win-win situation. In contrast, energy policies that subsidize CBM development are not needed, will exacerbate boom and bust economic cycles, and will likely decrease the quality of life for many local residents.

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References

Attanasi, E.D. 1998. Economics and the 1995 National Assessment of United States Oil and Gas Resources. US Geological Survey Circular 1145.

Clawson, M. and J.L. Knetsch. 1966. Economics of outdoor recreation. The John Hopkins University Press for Resources for the Future, Baltimore, MD.

Corn, M.L., B.A. Gelb and P. Baldwin. 2001. The Arctic National Wildlife Refuge: The Next Chapter. Congressional Research Service. Updated August 1, 2001.

Darin, T. 2000. Coal-bed methane coming to a town near you. Frontline Report. Wyoming Outdoor Council. Spring 2000.

Ecological Society of America, 1999. Letter to Forest Service Chief Dombeck on the Roadless Area Conservation Rule.

Freudenburg, W.R. 1992. Addictive economies: extractive industries and vulnerable localities in a changing world economy. Rural Sociology. Vol. 57:305–332.

Freudenburg, W.R. and R. Gramling. 1994. Natural resources and rural poverty: A closer look. Society and Natural Resources. Vol. 7.

Gauthier-Warinner, R.J. 2000?. Oil and gas development. In: Drinking water from forest and grasslands: A synthesis of the scientific literature. USFS GTR SRS-39. S. Research Station.

Harmer, D. 2000. Roadless Area Specialist Report. Analysis of effects for recreation, wilderness, scenic quality, and recreation special uses. USDA Forest Service.

Haynes, R.W. and A.L. Horne. 1997. Economic Assessment of the Basin. In T.M. Quigley and S.J. Arbelbide (eds.), An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: Volume IV. 1715–1870.

Humphrey, C.R. et al. 1993. Theories in the study of natural resource-dependent communities and persistent poverty in the United States. In Persistent poverty in rural America., ed. Rural Sociological Society Task Force on Persistent Rural Poverty. Boulder, CO: Westview Press.

Krause, J. 2000. Roadless Area Specialist Report. Effects analysis for the FS Road System. USDA Forest Service.

Krutilla, J. V. 1967. Conservation reconsidered. American Economic Review. 57:777–786.

Krutilla, J.V. and A.C. Fisher. 1985. The economics of natural environments. Resources for the future, Washington, DC.

LaFayette, R. 2000. Roadless Area Specialist Report. Analysis of effects for watershed health. USDA Forest Service.

Laitner, S. and M. Goldberg. 1996. Colorado's energy future: energy efficiency and renewable energy technologies as an economic development strategy. Reported prepared by Economic Research Associates for the Department of Energy

Laitner, S., S. Bernow and J. DeCicco. 1998. Employment and other macroeconomic benefits of an innovation-led climate strategy for the United States. Energy Policy, Vol. 26 (5):425–532.

LaTourrette, T. et al. 2002. Assessing Gas and Oil Resources in the Intermountain West: Review of Methods and Framework for a New Approach. RAND Science and Technology.

Loomis, J.; Walsh, R. 1992. Future economic values of wilderness. In: C. Payne,; and others. (Eds.) The economic value of wilderness. Southeastern Forest Experiment Station. GTR SE–78.

Loomis, J. 1993. Integrated public lands management. Columbia University Press, New York.

Loomis and Richardson, 2000. The economic benefits of Forest Service roadless areas. Report prepared for The Wilderness Society.

Morton, P. 1999. The economic benefits of wilderness: theory and practice. University of Denver Law Review. Volume 76, No. 2 pp. 465–518.

Morton, P. 2000. Wildland economics: theory and practice. In: Cole, David N.; McCool, Stephen F. 2000. Proceedings: Wilderness Science in a Time of Change. Proc. RMRS-P-000. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. http://www.wilderness.org/standbylands/conferenceabstracts.htm#wildecon.

Morton, P. 2001. Testimony before the Subcommittee on Forests and Public Land Management Committee on Energy and Natural Resources, United States Senate, April 26, 2001. http://www.wilderness.org/eyewash/legislation.htm.

Morton, P. 2001. The Department of Energy's "Federal Lands Analysis Natural Gas Assessment": A Case of Expediency over Science. The Wilderness Society, Denver, CO. http://www.wilderness.org/newsroom/pdf/doe_greenriver_071001.

Morton, P. 2002. Testimony before the Subcommittee on Energy and Mineral Resources, Committee on Resources, U.S. House of Representatives. April 18, 2002, http://www.wilderness.org/eyewash/legislation.htm.

Pederson Planning Consultants, 2001. Appendix D in the Wyoming Energy Commission, Preliminary Progress Report to the Wyoming Legislature, Joint Minerals, Business and Economic Development Committee, December 14, 2001. Draft Report commission by the Wyoming Energy Commission. 34 pages.

Peterson, G. L.; Sorg, C. F. 1987. Toward the measurement of total economic value. USDA Forest Service. GTR RM-148. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Power, T. 1995. Economic well being and environmental protection in the Pacific Northwest: a consensus report by Pacific Northwest economists. Missoula, MT: University of Montana.

Power, T.M. 1996. Lost landscapes and failed economies: the search for a value of place. Island Press, Covelo, CA.

Randall, A.; Stoll, J. 1983. Existence value in a total valuation framework. In: (R, Rowe and L, Chestnut (eds.), Managing Air Quality and Scenic resources at the National Parks and Wilderness areas. Boulder, CO: Westview Press.

Rasker, R. 1994. A new look at old vistas: the economic role of environmental quality in western public lands. University of Colorado Law Review. Volume 52, Issue 2 Pp. 369–399.

Rasker, R. 1995. A new home on the range: economic realities in the Columbia River Basin. The Wilderness Society, Bozeman, MT.

Renner, M.G. 1992. Saving the earth, creating jobs. World Watch, Jan.-Feb. 1992. Pp. 10–17.

Sedell, J. et al. 2000. Water and the Forest Service. USDA Forest Service, Policy Analysis, Washington, DC.

Silverman, M. 2002. Location of CBM resources in the intermountain states; location/scope of current plays and likely future plays. Paper presented at the Coalbed Methane Conference, University of Colorado Natural Resources Law Center, April 4&5, 2002, Denver, CO.

Udall, R and S. B. Andrews. 2002. When will the joy ride end? Community Office of Resource Efficiency, Aspen, Colorado, 81612.

USDA Forest Service, 2000 Forest Service Roadless Area Conservation Rule, Final EIS.

USDA Forest Service, 2001. Final Regulatory Flexibility Analysis for the Roadless Area Conservation Rule.

USDA Forest Service, 2001. Regulatory Impact Analysis. The Roadless Area Conservation Rule.

US Department of Energy. 1996. The Jobs Connection: Energy use ad local economic development. (www.eren.doe.gov.cities_counties/elecjob.html) Last visited August 16, 2001.

US Department of Energy, 2001. Federal Lands Analysis Natural Gas Assessment, Southern Wyoming and Northwestern Colorado http://www.fossil.energy.gov/oil_gas/reports/fla/.

US Department of Energy, 2001. Energy Information Administration Short-Term Energy Outlook, January, April and December 2001.

US Geological Survey, 1995. The 1995 National Assessment of United States Oil and Gas Resources. CD-ROMs.

US Geological Survey (USGS). 2001. Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis. USGS Fact Sheet FS-028-01.

US Public Interest Research Group. 2002. Analysis if key provisions in the House and Senate Energy Bills.

Weisbrod, B. 1964. Collective consumption services of individual consumption goods. Quarterly Journal of Economics 78:471–477.

Western Organization of Resource Councils, 1999. Coal-bed methane development: boon or bane for rural residents? Billings, MT.

Yuhnke, R. 2002. Air quality and CBM development. Paper presented at the Coalbed Methane Conference, University of Colorado Natural Resources Law Center, April 4&5, 2002, Denver, CO.