from nearly 0 to 8 kHz (the upper frequency limit for most son graph equipment). Other sonograms are found in Gibson, et al. (1991). Thus, acoustical interference can obscure behavioral signals at a wide range of frequencies. Data comparing the frequency spectra of noise sources to the detection ability of sage grouse at each frequency are lacking. The transmission of different sound frequencies through forest habitats types has been determined (Wiley and Richards 1978, Richards and Wiley 1980), but the attenuation of noise spectra over sagebrush areas has not been determined. However, it is highly likely that all frequencies of noise will travel much greater distances from the source over sagebrush than through forested areas, because sagebrush areas have no height of leaves and branches to attenuate noise spectra.

Very low frequency (infrasonic) sound is easily detectable by at least some species of birds (Kreithen and Quine 1979, Dooling 1982) and forms a component of sage grouse mating displays (Schroeder, et al. 1999a). Low frequency sounds also propagate for great distances (Marten and Marler 1977, Morton 1975, Witkin 1977, Wiley and Richards 1978). Thus, such sources as artillery fire, seismic exploration explosions, mining, and drilling may be particularly disturbing to the birds. High frequency noises may disturb contact enhancement or warning signal functions between females and their broods or among juveniles. These calls are described as having a high frequency sound ("see-ah") by numerous authors (Girard 1937; Batterson and Morse 1948; Schroeder, et al. 1999a). Typically, high frequency sounds follow line of sight paths, or nearly so, and can easily be reflected from environmental substrates.

There appear to have been few quantitative studies of the effects of noise conducted on sage grouse. Thus, the best available scientific data are in the GBCP (1997, e.g. p. 22) and are obtained by analogy to other species. Most studies of noise effects on birds appear to have been conducted on raptors and the results of such studies have been variable. Studies on raptors and other predators may not be particularly relevant to prey species such as sage grouse. Prey must remain alert to predators, and are likely to have behavioral responses to abrupt sensory stimuli (startle responses) that disrupt feeding, courtship, or other important behaviors. Studies of other avian prey species appear to have centered on geese. There are no data on noise propagation, or on signal detection showing differences in the habitats between geese and sage grouse. Such studies appear to be appropriate guides to effects of noise on sage grouse because, like sage grouse, geese occupy open habitats, nest and forage on the ground (although the water and land mix is quite different), and face threats from both aerial and ground based predators.

Disturbance increases movements and avoidance behavior in wildlife (Bleich, et al. 1990, 1994; Côté 1996). Wildlife exposed to ORVs alter feeding and activity behaviors, stay in cover more often, and flee more easily from disturbances (Yarmoloy, et al. 1988). In various wildlife species, disturbance can also cause social disruption, including disruption of broods and consequent increases in brood mortality (Bartelt 1987, Côté 1996). Wildlife do not habituate to disturbances such as humans on foot, or low level helicopter or fixed-wing aircraft flights (Bunch and Workman 1993), and such disturbances are known to disrupt important breeding, feeding, and social behaviors in a variety of wildlife (Dwyer and Tanner 1992). Other prey species, such as geese, respond adversely to people, boats, hunting activities, aircraft (Owens 1977, Kramer, et al. 1979), loud noises (Owens 1977), and automobile traffic (Madsen 1985) with aircraft causing particular disturbance (Miller 1994). Geese can be driven away from preferred areas when aircraft approach, and aircraft disturbance can cause significant weight loss (Miller 1994). Wildlife react to helicopter noise at levels as low as 60 db, A weighted, and show strong reactions at 77 dbA (Luz and Smith 1976). Helicopter disturbance is known to have serious effects on brant (Derksen, et al. 1992). Construction of airfields to service oil well and other energy extraction developments has been a long-standing disturbance factor affecting sage grouse (Patterson 1952c, p. 281). Large swaths of sagebrush are often destroyed during construction and operation of such airfields (Patterson 1952c, p. 281). Future energy developments in sage grouse habitat, such as the plans for coal bed methane developments, will entail additional airfields and other infrastructure, greatly harming sage grouse. Sage grouse crouch or "squat down" when initially approached by aircraft (Russi 1998), and "almost invariably" flee an area when small airplanes fly overhead (Wong 2000, citing Robert Gibson). Because sage grouse rely on cryptic coloration and inactivity to evade predators, forced movements from disturbance are likely to greatly increase predation rates, and hence reduce population persistence (Wong 2000).

Breeding male passerines, particularly older experienced males, avoid roads: densities of breeding males within 200 m of a highway can be 40% less than densities of comparable habitat further away (Reijnen and Foppen 1994). For all sex and age classes, 7 of 12 studied grassland bird species showed reduced densities near roads, and density reductions occurred as far away as 1.7 km from highways (Reijnen, et al. 1996). Density reductions were correlated with noise effects, not visual effects (Reijnen, et al. 1995).

Even low noise levels can obscure important signals that sage grouse attempt to detect – for example, the wind whistling through a raptor's wings as it stoops to dive is one such signal that sage grouse need to detect quickly and accurately. Besides any effects caused while the noise source is operating, noise exposure can reduce the capability to detect acoustic signals (partial deafness) for an extensive period after the exposure or permanently (Dr. Howard Wilshire, quoted in ABC News 1999). There is an extensive human literature on such effects, which are likely to affect both mating activities and predator detection. Such effects are likely to be particularly strong in sage grouse because of the high importance of acoustic signals in their mating displays, and because they are highly susceptible to predation.

Finally, little is known about visual disturbances as distinct from acoustic ones. However, it is likely that a visual disturbance will be accompanied by noise and the disturbance effects from the combined stimuli will be enhanced. Sage grouse are more disturbed by the presence of fixed wing aircraft than by helicopters (M. Morse 1980). This has been noted for other birds and probably results from the visual resemblance of fixed wing aircraft to raptors.

The types of disturbance to lekking sage grouse have received some study. In a study in California, most disturbances were human caused (on foot, in vehicles, and human associated livestock and pets), totaling 29 of 82 incidents. (Hall and Haney 1997, p. 10). Other major disturbances were caused by pronghorn (*Antilocapra americana*, popularly termed "antelope" or "goats") which accounted for 18 of 82 incidents and Golden Eagles (25/82) and other raptors (5/82) (Hall and Haney 1997, p. 10). The raptor disturbance was greatly increased by human caused effects – powerlines had been strung through the area, increasing the number of perch sites for raptors (Hall and Haney 1997, p. 25). Likewise, human built roads in the area probably increased the disturbance by coyotes (7/82) and ravens (1/82) (Hall and Haney 1997, p. 26).

An important concern is that there appear to be synergistic interactions among disturbance sources. Visual stimuli often potentiate the effects of auditory disturbances (Taylor, et al. 1962). Thus, effects from two different disturbances are greater than if they were merely additive.

Fire

Direct fire-related mortality of sage grouse has not been documented in the literature; however, fire has strong and complex effects on sage grouse habitat. Jorgensen (1990) assembled a literature review of fire effects in sagebrush habitats, as has the USFS (Howard 1996). Prior to settlement, wildfire was the major disturbance agent in shrub-steppe habitats (CH2M-Hill 1996), but fire return intervals may have been fairly lengthy in many or most sagebrush habitats (Winward 1985, Braun 1987a), matching those in Ponderosa Pine forests (Gruell 1985, p. 103). Most species of sagebrush are killed by fire (Winward 1985; Peterson 1995; Wright, et al. 1979). Big sagebrush does not resprout after a fire and is highly susceptible to fire injury (Wright, et al. 1979, p. 7). However, early explorers found sagebrush to be both widespread and abundant in the west (Townsend 1839; Fremont 1845; Thwaites 1959; Tisdale, et al. 1969; Gambel 1974a, 1974b, 1974c; Vale 1975; Evans 1997). These vast sage lands could not have existed if stand replacement fires had been frequent. Tisdale and Hironaka (1981) suggested that fires were uncommon in the drier sagebrush types, and more frequent in areas with higher fuel loads. Within the entire interior Columbia Basin, Barrett, et al. (1997, p. 15) estimate that only 4% of the area burned annually in pre-settlement times. This is an average over all elevations of sagebrush-grass associations, and the burn rate for many sagebrush areas would have been lower. The entire sagebrush landscape cannot be treated as homogenous; instead, fire histories undoubtedly vary with elevation and with species and subspecies sagebrush composition (R. Rosentretter, personal communication), and so will the effects of fire. Together with overgrazing, fires caused by settlers are implicated in the reduction of sagebrush and of native grass and forb understories (Tisdale and Hironaka 1981). In the last several decades, probably most fires have been deliberately set to increase forage for livestock (Bunting, et al. 1987).

Depending on habitat quality before the fire and the type of fire, fire can be beneficial or harmful to sage grouse, but most fires are likely harmful. Sage grouse use sagebrush of different age classes and stand structures as lekking, nesting, brooding, and wintering grounds. Neither expansive dense sagebrush nor expansive open areas constitute optimal sage grouse habitat: Klebenow (1972) reported that in three summers of sampling, no sage grouse were observed in large acreage, dense sagebrush in southern Idaho. Besides its effects on food supplies and cover, fire interferes with movement patterns: Fischer, et al. (1997, p. 89) found that burned areas significantly altered migration. Nelle (1998) studied 20 previously burned areas in the Snake River Plains, a low elevation area in southern Idaho. Burning had long-term harmful effects on sage grouse habitat and after 14 years, sagebrush areas failed to return to pre-burn conditions (Nelle 1998, p. iii). Habitat requires many years to recover from fire – more than 20 years for nesting habitat in Idaho (Nelle, et al. 2000) – over 32 years for habitat in Montana (Wambolt, et al. 2001).

Fire that creates a mosaic of sagebrush of different ages and structures should often benefit sage grouse (Klebenow 1972). Newly burned areas interspersed with patches of sagebrush offer increased forb production while providing nesting and brooding cover (Blaisdell 1953b; Mangan and Autenrieth 1986; R. C. Martin 1990). The younger age classes of sagebrush that establish after fire offer more nutritious and palatable browse than do old sagebrush stands (Gates and Eng 1984). Additionally, burns can provide new lekking sites: sage grouse have established leks on burns in areas where open cover was lacking before fire. Sage grouse show lek and fidelity (Connelly, et al. 1994a, p. 73), and may not use burns as lekking grounds if a sufficient number of old leks are present (Benson, et al. 1991). Moreover, fire may not benefit sage grouse in drier areas: Connelly, et al. (1994a) found that forbs did not increase, and insect populations declined, after a controlled burn in xeric sagebrush habitat. Many forbs are damaged by fire (Wright, et al. 1979, p. 7). Rabbitbrush (*Chrysothamnus spp.*) is usually enhanced by fire (Wright, et al. 1979, p. 72) and this could lead to it outcompeting sagebrush seedlings as they attempt to recolonize burned areas. Braun (1987a) notes that fire is unlikely to have been a predominant ecological force in xeric areas due to the lack of fine fuels.

Fire always removes a certain amount of sage grouse food and cover. Fire initially reduces insect populations (Bock and Bock 1991, Fischer 1994) which are required by young chicks (Johnson and Boyce 1990). Griner (1939) noted that burning resulted in a decline in sage grouse in Utah. If the burn is small in relationship to the surrounding area, it will probably enhance sage grouse habitat. Fire that destroys large tracts of sagebrush, or destroys key winter habitat, can be harmful (Klebenow 1969, 1972). However, large-acreage fires do not always harm sage grouse. A 17,250-acre (6,900-ha) wildfire in mountain big sagebrush in southern Idaho burned in a mosaic pattern, leaving many unburned islands. The wildfire occurred at an ebb in the sage grouse population, so nesting sites were not limiting in the first postfire nesting season. Overall effect of the wildfire on the sage grouse population was apparently neutral: the sage grouse population increased after the fire, but this was part of a regional trend of sage grouse increase following several years of low reproduction. Martin (1990) suggested that had nesting habitat been limiting, the large-acreage fire probably would have adversely affected the sage grouse population. Pseudo-replication experiments showed that fire caused a loss of leks, and a decline in attendance of individuals at leks (Connelly, et al. 2000c, p. 93).

However, suppression of natural fires along with cattle grazing allows invasion of pinyon pine (*Pinus spp.*) and juniper (*Juniperus spp.*) into sagebrush areas (Miller and Wigand 1994; Miller and Rose 1995; Belsky 1996; Davenport, et al. 1998). Raptors and corvids use the trees as perches, and expansion of pinyon and juniper into sage grouse habitat reduces the use of these areas by sage grouse, because of increased predation (Commons, et al. 1999). By the 1980s, juniper and pinyon had spread across approximately 125,482 square miles in semi-arid regions of the western United States (Herbel 1984).

Some sagebrush species (*A. cana*, *A. filifolia*) can resprout after burning, suggesting that they evolved with fire (Braun 1998a). Big sagebrush (*A. tridentata*) is killed after burning and cannot resprout (Wright, et al. 1979), suggesting that it did not evolve with fire (Braun 1998a). Fire return intervals also differ among sagebrush species and subspecies. Natural fire return intervals are reported to be 12 to 25 years in mountain big sagebrush (*A. tridentata ssp. vaseyana*) communities, but range from 50 to 100 years in more arid sagebrush community types (Miller and Eddleman 2000, p. 17). Today, fires burn much more frequently. Moreover, even areas previously thought to be "fire tolerant" have lost sage grouse habitat from fires (D. Pulliam 1999).

Cheatgrass and other non-palatable species can invade after a fire (Pickford 1932, Stewart and Hull 1949). Once present, cheatgrass alters fire regimes to the point that many sagebrush stands are eradicated (GBCP 1997, p. 41). In the Snake River birds of prey National Conservation Area, continued cattle grazing has exacerbated cheatgrass invasion. Consequently, over 54% of the shrublands in this area have been destroyed (USGS 1999). Once cheatgrass is established, it is extremely difficult to remove and can prevent sagebrush from recolonizing an area – the endpoint of community succession has been altered (see Invasive Species section). Land managers are partly to blame for habitat conversion: after a burn areas are often seeded to crested wheatgrass instead of native vegetation, and are thus eliminated as sage grouse habitat (Wallestad 1971, Martin 1976, Braun, et al. 1977). Fire also increases soil erosion because the ground cover is removed (Blaisdell, et al. 1982, p. 19). In southern Idaho, 20% to 40% of the sage grouse habitat has been lost in just "the last 5 years due to range fires" (Healy 2001, quoting Saether-Blair). In the last 3 years, over 500,000 acres have burned in southern Idaho (Healy 2001 quoting Pellant).

Destruction of habitat by fire is increased by other anthropogenic threats for two reasons. First, fire ignitions are much more likely when humans and their developments are present in sage grouse habitats. Roads, off-road vehicle (ORV) use, oil and gas or coal developments, suburbanization, unattended campfires, agricultural operations, and other human activities can greatly increase fire risk. Fires in forests or woodlands can also spread into sagebrush areas. Second, human caused fragmentation of shrublands greatly increases cheatgrass invasion as does cattle grazing. Large, unfragmented shrubland patches are significantly less likely to be destroyed by fire than are fragmented areas (Knick and Rotenberry 2000, p. 226). Rotenberry (1998) noted that fire (often mediated by invasive species) was primarily responsible for the loss of all pristine native shrubland, whether fragmented or not (Young and Evans 1978; E. B. Allen 1988).

Individuals hired as "fire ecologists" by BLM and other land management agencies often have a psychological "love of the drip torch." Agencies will need to foster a modern and prudent ecological attitude towards the use of fire, if sage grouse and other sagebrush obligates are to be saved. The "yearn to burn" will need to be justified with hard data and rigorous analyses (quoted remarks are from a BLM biologist who wishes to remain anonymous). Moreover, fire control in sagebrush areas must be adequately funded. Idaho BLM biologist Signe Saether-Blair stated that resources were being allocated to fight forest fires, while ignoring sagebrush areas, and Idaho state Fish and Game biologist Jack Connelly stated that fire was "annihilating sage grouse habitat" (Salt Lake Tribune, Aug. 18, 2000).

Nearly all lands on which sage grouse currently occur are subject to a mandate to reintroduce fire – the Federal Wildland Fire Management Policy and Program Review (USDI and USDA 1995) requires burning consistent with land management plans. These plans and this policy may need to be recalibrated to ensure sage grouse viability. Moreover, sagebrush is not always included in reseeding mixtures following burns and crested wheatgrass, which has no value for sage grouse, is "often planted in lieu of native species" (Nevada State Office, BLM 2000a, p. 7). The National Fire Plan, which covers both USFS and BLM lands, could be catastrophic for remaining sage grouse populations unless prescribed burns are carefully considered and controlled.

Maps of recent fires in sage grouse range are available from the National Interagency Fire Center (NIFC) at http://www.fs.fed.us/eng/rsac/fire_maps.html. The maps are based on remote sensing spectroradiometric data, and fire pixels are geolocated to an accuracy of 500 meters. The satellites carrying these instruments were launched in 1999, so historic data are not available. However, various land management agencies no doubt have fire data and maps that could be georeferenced to more carefully examine habitat loss. Some states have also compiled maps showing the locations of recent fires. Nevada has prepared a map showing the large fires that have burned large amounts of sage grouse habitat in 1999 and 2000. In just the year 2000, 2% of the entire state burned. The fraction of sage grouse habitat that burned is likely much greater; moreover, fires have burned large holes in sage grouse habitat areas turning them into doughnut shaped fragments with large amounts of edge and reduced landscape integrity. Such fire induced fragmentation is shown in maps of sage grouse habitat and recent fires in Nevada.

Temporal Fire Regimes

Fire regimes can be roughly divided into three temporal periods. The earliest period would be wholly natural and occurs before aboriginal human populations reached North America. During this longest period, fires were most likely influenced by warming and drying continental interior climates characteristic of the post-Pleistocene. The middle period includes the time of Native Americans and may begin 15,000 to perhaps 50,000 years ago. Fire was probably somewhat more common during this period because of anthropogenic origin; however, fires may have been less intense because increased fire frequency reduced fuel loads. Sage grouse are known to have been extremely abundant at the close of the middle period, so Native American land management practices and hunting cannot have had especially severe negative effects on these populations. Nonetheless, native American fire practices were apparently a potent ecological force (Miller, et al. 1993) and may have benefited sage grouse by creating mosaics of forbs and grasses, and reducing canopy closure of sagebrush. Miller, et al. (1993) review some of the relevant studies for this period. Fire intervals are poorly known but probably did not exceed 30 to 50 years in most areas (Bunting, et al. 1987, Bunting 1994). In southern Idaho, fire return intervals are thought to have been 20 to 25 years in wetter regions, and 60 to 110 years in arid shrub-steppe (Tisdale and Hironaka 1981). Fires were probably patchy and small in extent except in very dry years. In Nevada, fires may not have been important in determining vegetation type (Paige and Ritter 1999, p. 6 citing McQueen).

A third fire regime begins with the introduction of livestock and the white settlement of the west, which introduced profound changes to the sagebrush shrub-steppe (Miller, et al. 1993). Areas of brush have been burned by prescribed fires, and accidental fires are more common as sparks from vehicles, commercial, industrial, and home cooking and heating uses escape control. At the same time, other areas have undergone fire suppression due to removal of fire fuels by livestock grazing, and have been invaded by conifer species. It is in this latter period that severe declines in sage grouse populations have occurred.

Overlaid across all three periods is some degree of climate change, including global warming in the last few decades, perhaps some effect of the Little Ice Age in the west a few centuries ago, and episodic drought. Climatic events from the early Holocene or late Pleistocene may exert effects on present day western landscapes.

Burning of grasslands at the sagebrush-pinyon-juniper interface probably prevented the spread of conifers into sagebrush areas (Bunting 1994, Evans and Workman 1994). Fire would not have burned uniformly and large areas went unburned for decades (Winward 1984, Braun 1987a). Of particular importance is that natural fires in the past did not operate the same way as fires do at present. Today, fires burn much larger areas, and burned areas often have large numbers of confined livestock grazing soon after the fire passes (GBCP 1997, p. 42). Another factor today is that cheatgrass invasions have likely altered fire return times for many areas. Finally, fire suppression has allowed invasion by western juniper (*Juniperus occidentalis*) and increased canopy cover by sagebrush (Kauffman 1990a, 1990b). These vegetative changes have reduced grass and forb cover, an essential habitat component for sage grouse (Winward 1991a).

Today, fires occur much more frequently than previously, tend to occur most commonly during spring and fall (rather than mid-summer), and individual fires are vastly larger than was previously the case (West 2000, Fig. 2).

Use of Fire

Howard (1996) called for a diversity of sagebrush habitat, in terms of sage grouse food and cover, as a management objective. Klebenow (1972) recommends burning sagebrush on a rotational basis to create sage grouse habitat. Different patches should be burned each year or every few years, with as long as 20 years between burning each patch. Benson, et al. (1991) recommend burning in patches of less than 100 acres in size. Because livestock may concentrate in small burns, livestock should be excluded from the burns. Fire sometimes enhances forb production (Cook, et al. 1994) and sage grouse may respond to this by foraging in burned areas (Pyle and Crawford 1996). However, sage grouse avoid large burned areas without remnant sagebrush (Benson, et al. 1991) and increases in forb production are not always obtained (Pyle 1993).

No general, overall benefits of fire to sage grouse have been documented, and some disagreement exists among the sage grouse experts in various state wildlife agencies and universities as to the benefits of fire to sage grouse. This may well result from elevational and other edaphic differences in sage grouse habitat in the respective states, and the degree and imminence of threats from cheatgrass invasion. This disagreement needs to be resolved so that management plans for use or containment of fire to improve habitat and recover sage grouse can be developed. A large body of fire effects data has been developed for forests and some of those general concepts may be applicable to sagebrush shrub-steppe. It is safe to say that fire must be used in a very careful and well monitored fashion if it is to be encouraged at all (Benson, et al. 1991; Fischer, et al. 1997; Connelly and Braun 1997; Connelly, et al. 1998a). Gains expected in multi-aged vegetative mosaics must be balanced with both potential loss of sagebrush *per se* and the risk of cheatgrass invasion. The total area burned by both wild fire and prescribed fire at 10 year intervals is unknown, but appears to be increasing (Connelly and Braun 1997).

Controlled or prescribed burns are dangerous because they often escape controls and become uncontrolled. However, BLM does not maintain statistics on how many prescribed fires burn out of control. Prediction of fire spread and intensity is particularly difficult in sagebrush areas because the fuels are discontinuous and not uniform (J. K. Brown 1982, p. 1). BLM formerly used green stripping (interruption of native or other flammable vegetation with non-flammable vegetation to form fire breaks) to reduce fire spread. However, the alien species used and the reduction and fragmentation of habitat militates against continued use of green stripping. BLM employees have stated that the use of green stripping has been suspended (Rotenberry 1998, p. 267, quoting Singe Sather-Blair).

Use of fire should be disfavored in the entire historic range of sage grouse until additional research establishes that it is both a safe and an effective management tool. This is particularly true for low elevation areas, where cheatgrass invasion appears most dangerous. However, absolute prohibitions against fire may slow recovery of forbs, which appear to be severely limiting on sage grouse populations. Forb restoration depends most strongly on elimination of grazing. However, prescribed burns in small mosaics has been suggested to accelerate forb recovery (Wirth 2000). Such burns will only be effective if an "adequate pre-burn forb community" already exists in the area to be burned (Wirth 2000). Greenhouse experiments failed to support the hypothesis of accelerated forb recovery from fire (Wirth and Pyke 1999).

If there is a single area of management actions that requires the combined consultation of state and federal wildlife biologists, academic and independent specialists, and plant ecologists, it is the use of fire in sage grouse habitat. This might be accomplished without a listing, but is much more likely if a listing were made.

Fire on Leks and Nesting Grounds

Fire that occurs outside the mating season will probably not affect postfire sage grouse use of the grounds for mating. Fall wildfires on sage grouse leks in southern Idaho had no effect on sage grouse use of the leks the next breeding season (Martin 1990). Areas immediately surrounding leks, however, are heavily used as nesting grounds, and fire in areas surrounding leks may have a negative impact on consequent use of the surrounding areas by hens. Wallestad and Pyrah (1974) recommend that sagebrush within 1.9 miles (3.2 km) of a lek not be burned in order to protect nesting habitat. This recommendation may be most applicable to areas where nesting habitat is limited, however. Also, it is now established that nesting often takes place at substantially greater distances from the lek than was believed in 1974, at the time of the Wallestad and Pyrah study (Autenrieth 1981; Wakkinen 1990; Hanf, et al. 1994; Schroeder, et al. 1999a, p. 17). There will often be a lag effect of behavioral responses to habitat manipulation for species such as sage grouse that exhibit site fidelity (Wiens 1985a). This can complicate analysis of the effects of fire. However, sage grouse selected unburned areas within a large burn for nesting, indicating that fire removed nesting cover for sage grouse (Connelly, et al. 1994a).

Gates and Eng (1984) noted that on their southern Idaho study site, which was surrounded by 120 square miles (300 km^2) of Wyoming big sagebrush, nesting habitat was plentiful. While their summer-fall prescribed fires did burn near several established leks, the fires also created an open area that sage grouse used as a lekking ground the next spring. The fire treatment apparently did not deter hens from using grounds adjacent to the burns for nesting and brooding. Most radio-collared sage grouse hens nested within 3 miles (5 km) of the lek on which they were captured the year before fire treatment. In the first summer postfire, 5 of 11 collared hens moved their brood into agricultural areas adjacent to the burn. Broods apparently made little use of the burns as foraging areas. Schlatterer (1960) and Dalke, et al. (1963) noted that following unintentional fire, sage grouse used small burned openings as leks. To create openings in homogeneous sagebrush, Klebenow (1972) recommended small fires, 1 to 10 acres (0.4-4 ha) in size.

The USFS does not recommend spring fire on sage grouse nesting grounds (Howard 1996, Autenrieth, et al. 1982; Mangan and Autenrieth 1985). USFS does not recommend the use of fire on the nesting grounds in any season if nesting habitat is limited (Howard 1996; Autenrieth, et al. 1982).

Brooding Areas

Fall spot fires burning several patches of a few acres can result in suitable brood rearing areas by increasing forb availability. Spot burns along edges of meadows where sagebrush is encroaching may also enhance brood rearing areas if adequate sagebrush-meadow ecotone is left to provide cover (Howard 1996, Autenrieth, et al. 1982). Martin (1990) noted that in southern Idaho, broods neither preferred nor avoided large burned areas ($P<0.05$). Fire in brooding areas is known to reduce food supplies for chicks (Fischer, et al. 1996a)

Wintering Areas

Klebenow (1972) does not recommend burning in winter habitat. Autenrieth, et al. (1982) recommend that fire in winter-use areas be applied cautiously: what may appear as an excess of sagebrush in summer may provide only minimal amounts of sagebrush in winter. They recommend that prior to burning, winter sage grouse distribution during peak snow conditions should be assessed so that key wintering grounds are not depleted by fire. Fire directly reduces the amount of winter habitat for sage grouse (Robertson 1991, Fischer 1994). Because wintering birds feed solely on sagebrush leaves, and require sagebrush for shelter, there is no benefit to burning in winter habitat. Burning in wintering areas should be prohibited.

Roads

Besides the obvious collision induced mortality of sage grouse, roads eliminate habitat directly because the road surface itself and the band of altered vegetation on both sides of the road and its drainage structures do not support the needed habitat characteristics for sage grouse. Roads also induce noise effects from passing traffic that can disrupt lek activities, inhibiting mating. Braun (1998a) estimated that noise effects would be disruptive as far away 1 km from a road. Additionally, raptors may use road signs and utility poles along roads as perches (Bevanger 1994). Roads also restrict movements of sage grouse and remove culturally transmitted knowledge of traditional movements from the population (SMBCP 1998, p. 22; Cultural Inheritance section of this review). Roads are particularly pernicious in their fragmenting effects on populations because they constitute linear isolating elements in the landscape – there may be no way to transit a landscape without crossing a road. Many of the effects of roads are also present for railroad lines. Roads are typically built along drainages (Miller and Eddleman 2000, p. 23) and thus differentially affect riparian areas, which are critical habitat for sage grouse.

Biologists have been concerned about the effects of roads on sage grouse since the early part of the last century. Howell (1917) feared that roads would cause local extinctions of sage grouse populations. Horsfall (1932) was particularly concerned about the rate of extirpation caused, in part, by roads. Traffic on roads, particularly paved roads or graveled through routes, causes direct sage grouse mortality by mechanical impact, or can disrupt energy budgets and behavioral activities when they must evade speeding traffic. "Large numbers of sage grouse are killed annually by vehicular traffic" (Patterson 1952c, p. 280). If the numbers of sage grouse killed by traffic collisions are fewer today than in Patterson's time that merely reflects the fact that there are far fewer sage grouse to be killed today. Vehicular speed is the primary factor in wildlife-vehicle collisions (Gunther, et al. 1998). Bean (1941) counted 11 sage grouse killed by automobiles in a small area and this mortality factor has surely increased with time and higher traffic speeds (Hays, et al. 1998 citing Schroeder, personal communication). Martin (1942) found 22 sage grouse killed in just 115 miles of travel – multiplied by the tens of thousands of miles of highways in the range, this is a very large "kill zone" for the bird. Sage grouse often prefer to walk to reach useable habitats except when snow cover increases their conspicuousness (GBCP 1997, p. 48, SMBCP 1998, p. 22). This form of locomotion greatly increases their danger from traffic. Sage grouse are highly susceptible to roadways which fragment populations (Patterson 1952c, Aldridge 1998a, 1998b). In studies conducted in the Gunnison and San Miguel Basins of Colorado, all primary and many secondary roads reduce the size of sage grouse populations (GBCP 1997, p. 47, SMBCP 1998, p. 22). Roads are known to reduce the reproductive success of many bird species. Distance from a road is correlated with nest success in sage grouse – unsuccessful hens nested an average of only 268m from a road, while successful hens nested an average of over 1 km from a road (Lyon 2000, p. 56).

Sage grouse use roads to dust bathe which makes them particularly susceptible to vehicular collisions (Bean 1941). Sage grouse will also dust bathe along the margins of paved roads, so it is not only dirt or gravel roads that pose a hazard. It is unknown whether roads also serve as an attractant as a source of digestive grit, as they do for other birds. However, low traffic roads may be used as leks and thereby attract sage grouse which are then at risk of sporadic vehicular collisions. Chicks and hens tend to "forage along roads" (Barber 1991, p. 37), thus exposing them to traffic as well as to "avian and terrestrial predators" (Barber 1991, p. 37).

Roads also serve to greatly increase human impacts such as hunting, poaching, and recreational use. Generalist predators, such as coyote (*Canis latrans*) frequently hunt along roads in forests (May and Norton 1996) and may be attracted to roads in the shrub-steppe. Roads greatly increase the invasion of alien species. In the Gunnison Basin, invasion of cheatgrass is particularly evident along roads (GBCP 1997, p. 41). The danger of roads to sage grouse has long been recognized: As long ago as 1942 a Wyoming biologist expressed concern over sage grouse killed by automobiles, suggesting that Wyoming's thousands of miles of highways "undoubtedly account[ed] for many thousands of bird casualties in the course of a year" (Martin 1942, p. 9).

Finally, roads cause increased kill rates of animals and increase the visual prominence of carcasses, inflating the numbers of raptors, corvids, and other scavengers along the roadside (Knight and Kawashima 1993). Such secondary impacts then increase predation and disturbance of sage grouse (Hall and Haney 1997, p. 26). Three separate studies show that ravens are more common near highways than in open areas (Boarman and Berry 1995). Corvids are also more common where linear rights of way, such as roads, parallel each other (Knight, et al. 1995b).

Roads also alter ecosystem structure by facilitating the transport and growth of invasive species. Roads foster the entry of exotic plants by providing access for dispersal through human activities. Livestock often travel along roads, and vehicles are major transport mechanisms that spread exotic plants. When a vehicle drives through a weed infested area, seeds or other plant parts often become lodged in the tire treads and undercarriage. Propagules can travel for miles before becoming dislodged in uninfested areas (Cale and Hobbs 1991; BLM 1993c; Sheley, et al. 1997). As one example, the arrival of tansy ragwort (*Senecio jacobaea)* in Montana is directly attributed to seeds moving in on logging equipment from Oregon (Kollmeyer 1997). Tansy Ragwort is a noxious Eurasian weed that is toxic to livestock, and can outcompete native vegetation. Tansy thrives in grasslands and disturbed sites, including the compacted soil of roadbeds (Kollmeyer 1997).

Soil disturbance plays a major role in the spread of exotic plants (Elton 1958 (reprinted 2000), Mooney and Drake 1986, Hobbs and Huenneke 1992, Pickett and White 1985b). Soil disturbance caused by road building changes the microclimate of the area, allowing opportunistic exotic plants to colonize. Two studies on experimental soil disturbance (Kotanen 1997; Zink, et al. 1996) showed that when soil was excavated and biomass removed, exotic plant species colonized quickly and completely, outcompeting native vegetation. Johnstone (1986) notes that plant invasion is caused by removing a barrier that previously excluded a plant from a site. An exotic seed or propagule can lie dormant as a seed or maintain itself as a suppressed seedling until a disturbance destroys or weakens its native competitors. The exotic then enters a growth and reproductive phase, spreading throughout the area. Roads clearly remove barriers (vegetation/biomass) that exclude some exotic plants from a site. Roads produce soil compaction which can persist for decades after use of a road ends, inhibiting plant growth and altering heat storage and water vapor transport on and near the road (Trombulak and Frissell 2000). Traffic on roads, particularly unpaved ones, causes dust mobilization which inhibits plant growth and nutrition – in some cases the entire structure of the plant community is altered (Trombulak and Frissell 2000).

Roads facilitate invasions by exotic pests and pathogens. As with exotic plants, disturbance can cause "outbreaks" of exotic pests and pathogens. For example, an exotic species may be present at low levels and not drastically impact the ecosystem. With human disturbance, outbreaks can occur where one or two species rise to higher levels of abundance than in undisturbed areas (Dobson and May 1986). Roads also alter microclimates, causing outbreaks that can have serious ecological implications. Roads also provide access for intentional or unintentional human introduction of exotics, besides the stresses they exert on native species (Trombulak and Frissell 2000). Humans sometimes introduce exotics purposefully for erosion control along or near roadsides (Trombulak and Frissell 2000). Oyler-McCance (1999) found that the two most important variables explaining sage grouse use of a patch were distance from a paved road and area size. Distance to a road is a particularly strong effect: regardless of area size, each patch must be greater than 1,000 m from a road to have a greater than 50% chance of occupancy by sage grouse.

Roads directly affect over 20% or the land area of the United States (Forman 2000). The effects of roads can never be fully mitigated unless the road is completely removed and revegetated (Trombulak and Frissell 2000). Roads are persistent landscape features that constitute threats to sage grouse for long periods of time.

Off Road Vehicles

The Geological Society of America convened a special committee of experts to assess the effects of off-road vehicles (ORVs). That expert committee found that off-road vehicle (ORV) use caused "severe physical and biological consequences" (Wilshire, et al. 1977). Dr. Wilshire, at that time a USGS employee, was attacked by administrators within USGS and Interior, such as Charles Kay (Principal Deputy Assistant Secretary for Policy, Budget and Administration of the Interior Department), and a gag order was issued prohibiting contact with conservation groups (Wilkinson 1998, p. 323-328). Many studies confirm that ORVs cause significant harm to desert areas (e.g. Eckert, et al. 1979; Webb and Wilshire 1983). This damage occurs even when ORV use is minimal (Iverson, et al. 1981). In 1995, the US Government Accounting Office (GAO) studied the impacts of ORVs, and found that land management agencies such as BLM were not complying with Executive Orders 11644 and 11989; for example, monitoring of ORVs was casual and ineffective rather than systematic, "adverse impacts were seldom being documented," and corrective actions were not implemented or even "prioritized" for action (excerpted in Wilkinson 1998, p. 310).

ORVs are one of the primary mechanical toys of industrial tourists (sometimes dubbed "tourons"). ORVs are also used to some extent for industrial operations, for example, in oil and gas exploration, and by ranchers and farmers. For sage grouse, both wheeled vehicles (small ATVs as well as larger SUVs) and snowmobiles are of concern. ORVs cause alterations of grass and forb cover and reduce plant species diversity (Clampitt 1993). ORV operation is a well known cause of soil compaction and erosion, reduced water infiltration rates, and negative effects on vegetation (Adams, et al. 1982; Eckert, et al. 1979; Iverson, et al. 1981). In arid lands, the soils are "exceptionally vulnerable to ORV attack" (Sheridan 1979). Many of the effects of ORVs are discussed further in the section Military Operations.

Even light use of a truck on a shrub landscape can damage vegetation and soils (Vollmer, et al. 1976; Iverson, et al. 1981). Not surprisingly, ORV use causes decreased diversity, density and biomass of breeding birds, and ORVs have a negative effect on desert wildlife over large areas (Bury, et al. 1977). Even moderate ORV use is known to cause substantially reduced bird densities (Bury, et al., 1977; Luckenbach 1978). Affected areas can take "centuries or millennia" to recover, or may not recover at all (Wilshire, et al. 1977; Iverson, et al. 1981). In the Gunnison Basin, ORV use is "increasing and expanding into more and more sagebrush and riparian areas" (GBCP 1997, p. 50). Besides damage to vegetation, even slight ORV use increases the amount and frequency of water runoff and erosion, decreases soil porosity, infiltration capacity, effectiveness of soil stabilizers, and hydraulic resistance to overland water flow (Iverson, et al. 1981). ORVs and other motorized vehicles tend to travel in valley bottoms, which are particularly critical to grouse because these areas are one of the most important feeding areas for young birds (GBCP 1997, p. 50). Roads and trails formed by ORVs become corridors for predators and for invasive plant species (GBCP 1997, p. 50).

ORV use also is a major cause of invasion of weed seeds and other pests into grass and shrub lands (Tyser and Worley 1992, Hobbs and Humphries 1995, BLM 1996a). Seeds commonly lodge in the vehicle's chassis and can be transported "hundreds of miles" (Pyke 2000, p. 46). Landscape scale is important in understanding the invasion of weeds, and ORVs and livestock are of primary importance in introducing weeds from roadsides into grass and shrub land areas away from roads (Belsky and Gelbard 2000). Extant native grasses, forbs, and shrubs will be destroyed by even moderate ORV use, and even tree roots can be undermined, or damaged by soil compaction even though damage is not apparent (Wilshire, et al. 1977).

Snowmobile use harms wildlife, vegetation and soils. Because of their high noise levels and extreme speed, snowmobiles harass sage grouse and other wildlife far from roadheads or other entry points, causing increased metabolic rates and stress responses. ORVs present particular problems with respect to disturbance. Supervision and enforcement of snowmobile use is virtually impossible if the area is large (Malaher 1967). Often abuses involve several snowmobiles and even aircraft, all in communication by two-way radio (Malaher 1967). During the winter months, sage grouse are especially vulnerable to this harassment because they are already burdened by increased levels of stress due to low temperatures, inclement weather, reduced food supply, and the need to gain weight for the energetically demanding breeding season. Snowmobile use can also cause disruption in movement patterns, making it more difficult to locate reliable food sources. These impacts are best understood and documented for ungulates (Cain, et al.,1997; Parker, et al. 1984; Moen, et al. 1982; Severinghaus and Tullar 1975); nevertheless, many other wildlife species suffer the same sorts of direct impacts from exposure to and harassment by snowmobiles. It is certain that sage grouse within the range of snowmobile use will be harassed by noise and visual impacts. Accumulation of snowmobile exposures over the course of a winter or several seasons can result in significant long-term wildlife displacement and expanded home ranges, increasing winter stresses and energy expenditures. In many winter areas, sage grouse have very limited suitable habitat available. As a consequence, wildlife often suffer increased winter mortality in areas where snowmobiles are used, even in low intensities (Berwick 1968; Bury 1978; DeMarchi 1975; Dorrance, et al. 1975; Neumann and Merriam 1972).

In winter, snowmobile and other ORV use can cause significant damage to both exposed and unexposed vegetation. Abrasion and breakage of seedlings, shrubs, and other exposed vegetation is common (Neumann and Merriam 1972; Rongstad 1980; Ryerson, et al. 1977). Similarly, shallow roots and rhizomes (such as are found in sagebrush) can be crushed or otherwise damaged. Especially on steeper slopes, and particularly when snow levels are low, snowmobile use can lead to considerable soil erosion. For example, increased sedimentation and turbidity is known to occur both in the immediate area and throughout the watershed (Aasheim 1980). Repeated snowmobile use can lead to changes in plant density and species composition and set back seral stages (Aasheim 1980, Wanek and Schumacher 1975), and the associated loss of vegetative cover generally leads to increased soil erosion (Montana Fish, Wildlife and Parks 1993). Because ORVs generate pollution levels hundreds of times those of a modern automobile, there is significant opportunity for vegetation damage from air pollution in basins with stable air masses.

Snowmobile-induced snow compaction is implicated in numerous environmental impacts. These impacts are often overlooked, and rarely appear in NEPA documentation. For instance, snow compaction can cause considerable below-surface vegetation damage (Neumann and Merriam 1972). Significant reductions in soil temperatures may also result from snow compaction (Aasheim 1980, Rongstad 1980). This reduced soil temperature retards both soil microbial activity and seed germination (Keddy, et al. 1979). These temperature impacts may be exacerbated by physical effects from compaction of the underlying soil layers, making it more difficult for the seedling to mechanically push through material layers surrounding it. Snow compaction is also responsible for numerous and severe impacts to sage grouse because they depend on subnivean spaces (the spaces between the snowpack and the ground surface) for winter survival. Compaction lowers temperatures in subnivean spaces, which in turn leads to increased metabolic rates, and thus, increased mortality. In some cases, compaction restricts movement to the point of asphyxiation. When snow is compacted, grouse must work harder to dig for vegetation (Fancy and White 1985), increasing their energetic demand and increasing the amount of time they are exposed to harsh conditions and predators on the snow surface. Snow compaction by snowmobiles also increases the mobility of terrestrial predators such as coyotes, bobcat, and red fox (Neumann and Merriam 1972). Finally, because most of the snow compaction occurs on the first snowmobile pass, even minimal use of any area can cause considerable damage (Aasheim 1980; Gabrielson and Smith 1995; Keddy, et al. 1979). Snow compaction often retards melting of snow, altering vegetative phenology, besides leading to muddy trails and roads, which are then highly susceptible to significant damage and enlargement. For the same reason, snow compaction can lead to altered melting and discharge regimes, further increasing soil erosion (Montana Fish, Wildlife & Parks 1993). Smith (1996) recently summarized snowmobile impacts.

ORV use is accelerating and as BLM states, has shown a "dramatic increase" in just the last few years (ABC News 1999). Over half of all ORV use takes place on BLM lands (Donahue 1999, p. 187). Other federal lands are also experiencing rapid increases in ORV use (ABC News 1999). In Wyoming, one driver recently ran his vehicle "right into the middle" of a strutting ground (High Country News, May 10, 1999, Vol. 31, No. 9, p. 15).

Military Operations

The range of the sage grouse contains a large number of military bases and training areas, exacerbating the problem of habitat destruction as well as direct effects on the birds from noise and visual disturbances, and from nest destruction. Military operations include troop movements, cross-country operation of tracked and wheeled vehicles, military overflights (often very close to the ground), live firing exercises of small arms and artillery, the dropping of both live and dead (dummy) bombs, stationing of mechanized and armored combat forces, and construction of various temporary and permanent installations with their associated utility needs. The deleterious effects of ground based military operations are concentrated in the best sage grouse habitat, because both sage grouse and military trainers prefer areas with slopes of less than 10% which comprise a limited subset of lands in many areas of sage grouse habitat, particularly on the YTC in Washington (Cadwell, et al. 1997; Livingston 1998). Generally speaking, the best soils, best vegetation, and most critical habitat are in valley bottoms with slopes of less than 10%. For example, on the YTC, such areas include Selah Creek and Cold Creek, where military training activities are also concentrated.

Use of tracked vehicles ("tanks") can cause even greater damage than use of ORVs. Both operations in a straight line and turning or stopping of the vehicle (causing divots) are significant causes of erosion, sagebrush destruction and understory destruction (Watts 1998). Effects on cryptogamic crust are particularly severe (Watts 1998). Both vehicle and foot traffic are known to compact soils, increase erosion, reduce vegetative cover, facilitate the spread of alien plants, and increase fire frequency (Watts 1998). Use of tracked vehicles also results in greater fragmentation, and smaller, more closely spaced shrub patches as well as increased cheatgrass invasion (Knick and Rotenberry 1997). Moreover, these effects are documented on the ground at the YTC as affecting the sage grouse in Washington (Eberhardt and Hoffmann 1991, Stephan, et al. 1996; Livingston 1998).

Firing of tracer bullets and use of pyrotechnic devices are major sources of fire (YTC CA 1994, p. 4, section VI.H). Troop training also involves the excavation of soil for foxholes, latrines, and other uses, and the establishment of bivouacs, which damage vegetation.

Sage grouse are particularly vulnerable to human disturbance at nests and lek sites. Females are known to abandon nests and possibly their broods if disrupted by foot traffic such as troops, by vehicles, or by explosions and noise (Livingston 1998). In Washington, several important leks on the YTC are located on or adjacent to roads (Livingston 1998). These leks are likely to be abandoned if vehicles drive on the roads while sage grouse are displaying or mating. Sage grouse on the YTC have a number of unusual behaviors, such as large home ranges, atypical and extensive movements, and the seeking of areas with low levels of human disturbance, that are likely related to disturbance by military training operations (Eberhardt and Hoffmann 1991).

Military operations can also degrade habitat, and areas used for military operations for any appreciable length of time often have low levels of sagebrush cover (Cadwell, et al. 1996; Sveum, et al. 1998a). Further loss of sagebrush is particularly endangering to the birds, yet is more likely than in other areas because of the likelihood that military operations will set off fires. Even a single training exercise can do tremendous damage to sage grouse habitat. In 1995, the YTC conducted an exercise termed Cascade Sage, which impacted approximately 14% of the big sagebrush in sage grouse primary habitat, and immediately killed 1.7% of all sagebrush plants in the area, and severely damaged 7.8% of all sagebrush plants in the area (Cadwell, et al. 1996). Damaged plants, of course, may die later on, and do not provide needed cover for sage grouse, which declined following the exercise (Cadwell, et al. 1996). These deleterious effects are not unusual: training by the Washington Army National Guard in 1996 caused similar levels of habitat destruction (Stephan, et al. 1996). Nor are these isolated instances: training exercises on the scale of Cascade Sage are planned to reoccur regularly in future years. Such negative impacts will have serious cumulative effects on sage grouse. Cadwell, et al. (1996) estimated that exercises of this scale will reduce sage grouse habitat by nearly 1% per year at the YTC, a loss of 133 hectares every year. Additional losses of sagebrush are expected due to training related fires and natural mortality. Cadwell, et al. (1996) estimate that sagebrush cover would decline to merely 5.4% after 25 years of such biannual training, which is well below even the minimal level needed to support sage grouse. Stephan, et al. (1996) presented similar estimates of cumulative habitat loss from military training. However, because of the genetic and demographic factors discussed elsewhere for the YTC group of birds, this group of birds is unlikely to persist that long even without military training exercises at the projected levels. The YTC birds need habitat restoration to have any chance of survival, not habitat destruction.

Instead of mitigation or reduction of training levels, however, they are projected to increase significantly. In 1994, authorities approved a dramatic increase in military activity on the YTC from the stationing there of 2 brigades of heavy combat forces. These forces will conduct combat training operations on 49,000 acres per year, creating 89,500 miles of off-road tracked vehicles (tanks and other heavy armored vehicles such as personnel carriers) miles each year (US Army 1994).

Sage grouse habitat receives little protection on the YTC. Less than 10% of sage grouse habitat is located in light use zones established by the Cultural and Natural Resources Management Plan for the YTC, and most areas of critical habitat are used heavily during training (CH_2M-Hill 1996). The Army has proposed some voluntary actions and mitigation measures on the YTC; however, even if these actions are carried out completely, they will be woefully inadequate to conserve the grouse.

Use of tracked vehicles in military operations causes extreme fragmentation, resulting in small, closely spaced shrub patches (Knick and Rotenberry 1997). Training exercises cause repeated re-ignitions of fires at closely spaced time intervals, preventing sagebrush from reestablishing itself and causing irretrievable loss of habitat (Knick and Rotenberry 1997).

Oil and Gas Operations, Mining, and Prospecting

Prospecting and operations for oil and gas, mining, and other such resource development typically involves the use of ground vehicles and road construction. Prospecting often involves setting off underground explosions that can interfere with the low frequency mating vocalizations of male sage grouse and otherwise disturb the birds. It is known that "sage grouse use decline[s] markedly" in areas with coal, oil and gas installations (BLM undated, b, p. 33). Oil field development causes sage grouse populations to "decrease dramatically" (Braun 1987a). As oil fields mature, there is some evidence that they become less harmful to sage grouse; however, there "is no doubt that refineries, pumping stations, gasification plants, and associated developments have permanent negative impacts on sage grouse populations" (Braun 1987a). Moreover, any type of intensive development greatly increases poaching – Bay (1989) estimated a 3x increase in game violations in such areas.

Exploration activities cause noise, road creation, and disturbance that may have long-term effects (Braun 1987a). Hens from areas where leks were disturbed by natural gas development had lower nest initiation rates, traveled twice as far to reach nest sites, and were more sensitive to nest cover than hens from leks that were not disturbed (Lyon 2000). This is particularly troubling because BLM and other land management agencies attempt to mitigate disturbance by protection areas within 2 miles (or even less) of a lek. But it is precisely these areas in which females will attempt to nest farther than 2 miles from a lek (Lyon 2000, p. 23). The use of low-flying helicopters, in an attempt to avoid ground disturbing activities, can also enhance the dispersal of weed seeds, as well as create high noise levels that interfere with sage grouse activities. Aircraft over-flights are apt to be particularly disturbing to prey species such as sage grouse, as explained elsewhere in this review.

Well pads and roads drastically harm nesting success. Only 67% of hens captured near disturbance sites such as well pads or roads attempted to nest as opposed to 89% of hens in a less disturbed area (Christiansen 2000, p. 14). Moreover, only 47% of sage grouse remained within 2 miles of the disturbance sites as opposed to 89% of the birds in the less disturbed area (Christiansen 2000, p. 14). Combined, these effects reduce the number of chicks hatched by more than half (Christiansen 2000, p. 14). As significant as these results are, they underestimate the true effects of such disturbances because the birds in the control areas were nonetheless disturbed by capture and census techniques as well as other potential effects.

Besides oil and gas development, the West has been subjected to extensive industrialization in the past several decades, including the leasing of vast areas for the strip mining of coal, synthetic fuels development, coal bed methane development and similar schemes. These resource development activities require an infrastructure which is harmful to sage grouse. For example, oil and gas field facilities such as powerlines, treater stacks and storage tanks create raptor perches which greatly increase predation on sage grouse and produces sage grouse avoidance of large areas near each facility even in the absence of any predation. Moreover, human activity around facilities increases the incidence of poaching and road kill, and noise and movement causes avoidance behaviors in sage grouse.

Coal bed methane development will be especially pernicious. BLM projects that 80,000 wells will occupy the Powder River Basin of Wyoming within the next decade (Clifford 2001, p. 10). Each well disturbs approximately 4 acres on each 80 acre parcel, and well pumps add noise as well as nitrous oxide and other air pollutants over a large area (Clifford 2001, p. 10). Each well has a road, a power line and poles, and a wastewater disposal pipeline (Clifford 2001, p. 11). Heavy vehicle traffic on the roads is required, as well as attendant road construction (Clifford 2001, p. 10). Each well produces large quantities of wastewater, which is laden with Mg, Ca, and Na salts (Clifford 2001, p. 10). Thus, the coal bed methane development expected in Wyoming will destroy large amounts of the best remaining sage grouse habitat. The state of Wyoming has invited industry to drill on state lands that are checkerboarded with BLM lands in each township to avoid federal environmental impact analyses (Clifford 2001, p. 11). Coal bed methane development also entails the pumping of large quantities of ground water onto the surface. Besides the potential damages from ground water depetion, surface effects such as flooding and wet soils kill or damage sagebrush, thereby destroying sage grouse habitat (Ganskopp 1986).

Braun, et al. (2002) recently summarized some, but not all impacts of coal bed methane (CBM) development: "Impacts to sage-grouse from CBM development include direct loss of habitats from all production activities along with indirect affects from new power lines and significantly higher amounts human activity, both during initial development and during production." Coal bed methane development has begun in the Powder River Basin of Wyoming, and with development of the entire project, "over 50 % of the known sage-grouse range will be either directly or indirectly affected" (Braun, et al. 2002). Moreover, leks within ¼ mile of a CBM well, compressor station, or power line have "significantly fewer males/lek" and/or "the rate of growth is much lower when compared to other less disturbed leks" (Braun, et al. 2002). These effects are likely to persist for decades: sage grouse have not occupied leks even 15 years after disturbance for oil and gas development (Braun, et al. 2002). CBM development is especially pernicious because "severe consequences to sage-grouse" are likely; however, knowledge of those effects will "most likely come too late to result in any major initiatives to protect the birds or their habitats" (Braun, et al. 2002).

Surface coal mining directly destroys habitat and disturbs grouse. Braun (1987a) cites 5 separate studies, all "clearly demonstrat[ing] that development of surface coal mines negatively impacted sage grouse habitats and populations." Sage grouse impacted by mining were apparently unable to successfully re-establish off site and appear to be "lost from the population at a high rate" (Braun 1987a). Other types of mining also threaten sage grouse. Shaft mining can lead to the poisoning of riparian areas from leaks of heavy metals and other pollutants. Open pit mines, which are especially numerous in Nevada, damage substantial areas of habitat and pollute riparian areas. Cyanide heap leach mines can be especially disastrous to wildlife. Open pit mines also lead to tremendous amounts of dewatering of vegetation – one mine alone (the Betze-post mine in Nevada) has pumped over 100,000 acre-feet of water, enough to support a city of nearly one-half million people. Mining can expose birds to contaminants such as cadmium. Although such exposures are likely to be low in sage grouse, herbivorous species are particularly susceptible to this toxin (Dillon 2000b). Other toxins from mining activities are likely to reach sage grouse in air or water. Toxins leach from mines even when they have been abandoned. Shaft mines are not often considered threats to sage grouse; however, the many thousands of such mines within the range of sage grouse (Seattle Post-Intelligencer 2001a), and the likelihood of contamination of critical habitats such as riparian and wet areas downstream from mines means that this assumption needs to be re-evaluated. Water sources in large areas of sage grouse habitat have been contaminated by metals from mining (Seattle Post-Intelligencer

2001b), and the full extent of the contamination is not known because USGS mapping efforts were suppressed by government officials (Seattle Post-Intelligencer 2001b).

Utility Corridors and Powerlines

Pipelines, electrical transmission lines, telephone lines, and the like cause degradation of natural vegetation, soil disturbance, and the hydrological regime (Artz 1989). Recovery times for vegetation on these areas are 30 to 100 years or even longer (Artz 1989). Pipeline construction can probably be managed so as not to permanently disrupt sage grouse activities. This will require narrow disturbance zones, reseeding or replanting of native vegetation, construction limited to seasons when sage grouse are not using the area, and effective closure of roads and trails nearby.

Utility poles also represent perches for aerial predators and can serve as a behavioral deterrent to migration. Three separate studies show that ravens are most numerous near powerlines (Boarman and Berry 1995). However, the greatest danger to sage grouse near powerlines comes from raptors which use the poles as perches, providing excellent point from which to sight prey. Typically, such poles range from 13 m to over 20 m in height (Hall and Haney 1997, p. 11). Utility poles and their lines can permanently disrupt sage grouse populations (Graul 1980; Ellis 1984, 1987). Sage grouse are known to reduce their use of areas near power lines, and powerlines also produce fragmentation effects and reductions in security of sage grouse (Braun 1998a). Powerlines serve as a barrier to dispersal (Ellis 1987). In both Utah and Colorado, studies have documented the loss of all leks visible to perching raptors on powerline poles (GBCP 1997, p. 47; DCCP 1998, p. 23). Other data, including pellet counts and radio-tracking data, also support the magnitude of the effects on sage grouse. Negative effects on sage grouse extend as far away as 20 km from the powerline itself (Hall and Haney 1997, p. 25). These are much greater distances than can be accounted for by visual impacts alone (Hall and Haney 1997, p. 25). Powerlines are a severe threat to sage grouse and powerlines corridors as wide as 1 mile serve as death zones for the species through out the entire length of the powerline. Any vertical element that can serve as a raptor perch will affect sage grouse. This is not limited to powerline or telephone poles, but also includes trees (live or dead), microwave towers, military and civilian radar installations, cell phone towers, oil rigs, and similar infrastructure. These vertical elements in the landscape serve as perches for aerial predators, such as raptors, and nest and chick predators, such as corvids. Corvids are known to be more common along powerlines because they serve as perches and as nest sites (Knight and Kawashima 1993).

Powerlines also directly harm sage grouse because the birds collide with them, as do other species (Herbert, et al. 1995). The dangers of overhead wires to birds have long been recognized, and predate the invention of the telephone (Coues 1876). Sage grouse are known to fly into powerlines (Hays, et al. 1998 <u>citing</u> Connelly, personal communication). Neyer (1977) found the carcasses of 8 sage grouse who were "doubtless collision victims" based on the severe mutilation of the bodies. Borell (1939) observed sage grouse killed by telephone wires, and Trueblood (1954), Call (1979) and Blankenship (personal communication, <u>cited in</u> Hall and Haney 1997) also found such effects. In less than 4 km of powerline in Montana, 18 sage grouse carcasses were found – all within 10 m of the powerline pathway (Wilkinson 2001a, p. 1 of attachment 2). Consequently, power distribution lines even in remote areas, constitute a hazard to nearby sage grouse populations (Wilkinson 2001a, p. 1 of attachment 2). BLM biologists have had poor success in getting powerline companies to install flight diverters on their lines (Wilkinson 2001a, p. 2 of attachment 2). The protections of the ESA would ensure compliance with needed sage grouse safety measures.

Many of the data on utility corridors have probably been put into spatial form, and the remote sensing and GIS techniques noted elsewhere in this document are easily applicable to this issue. The "effects of powerlines on sage grouse are severe" (GBCP 1997, p. 47, SMBCP 1998, p. 21). Sage grouse "avoid powerlines when possible" (DCCP 1998, p. 23). Paradoxically, utility companies have often tried to create raptor perch sites to enhance wildlife, and land management agencies promote the practice (Maser, et al. 1979, 1983, 1984).

A pole design that eliminates perch sites for raptors may reduce the impact of power lines on sage grouse (Braun 1998a); however, sage grouse avoid powerlines even when raptors are not perched on them (Braun 2000f; Braun, personal communication, cited in Hall and Haney 1997). Sage grouse have not returned to leks near powerlines even when the recently installed poles were retrofitted with devices which prevent raptors from perching (Hall and Haney 1997, p. 24). Thus, mitigation becomes much more costly, and rerouting or burial will be required for many powerlines.

Rapid growth of fiber optic cable communications is occurring throughout the United States. Because these cables are typically buried, they do not serve as raptor perches. Soil disturbance from cable trench digging facilitates invasion of exotic plants and removes sagebrush. However, the footprint for such trenches is relatively narrow, reducing the import of sagebrush removal. Siting of cellular communications towers and other facilities is also rapidly increasing in the United States. Such towers provide raptor perches and eliminate useable habitat. If cell telephone towers or cable corridors are placed adjacent to roads, they are likely to cause little additional harm to sage grouse.

Weather Effects

By weather, this review adopts the conventional view that weather encompasses relatively short-term changes in such variables as precipitation, temperature, wind, and solar insolation, while climate refers to longer-term changes in these factors. Weather events have direct effects on adult birds (Walsberg 1978, 1983a, 1983b; Walsberg and King 1978b; Gessaman and Worthen 1982; Root 1988a, 1988b), their eggs (Walsberg and King 1978a; Webb and King 1983a) and chicks (Webb and King 1983b). For sage grouse, weather events can reduce breeding populations by 50% (letter from Montana Dept. of Fish, Wildlife and Parks, cited in Drut 1994, p. 19, p. 40). Wet and cool conditions during the spring nesting and early brooding seasons can reduce productivity (Weichel and Hjertaas 1992). In combination with other factors, such as habitat fragmentation, grazing, and hunting, such episodic weather events as heavy rain, snowfall, or hail could easily cause multiple population extirpations within the range of the sage grouse.

Episodic weather events can also alter habitat and vegetation structure and are a recognized element in plant survival (Nelson and Tiernan 1983). Successive wet years can cause shrub die-offs across large areas (Wallace and Nelson 1990), thus destroying sage grouse habitat. Drought can also damage sagebrush. The winter of 1976-77 had nearly the lowest precipitation in recorded history and "extensive areas" of sagebrush were killed, producing the "most extensive winter injury of indigenous plants ever recorded in the United States" (Nelson and Tiernan 1983, p. 1, 15).

Climate Change and Global Warming

Climate refers to long term changes in weather. The greenhouse effect is the term used to describe the trapping of heat in planetary atmospheres by various gases. This effect is essentially unrelated to ozone layer depletion. The greenhouse effect is minimal on Mars, strong on Venus, and moderate, but apparently increasing, on Earth. Carbon dioxide (CO_2) is estimated to account for about 49% of the contribution to the greenhouse effect on Earth (Hansen, et al. 1988). Methane, nitrogen oxides (NO_x), and chloroflurocarbons (CFCs) are the main gases accounting for the remainder of the greenhouse effect (Hansen, et al. 1988). Peters and Lovejoy (1992) described global warming as the most ominous of all potential threats to biodiversity. Grover (1990) and Kareiva, et al. (1992) discuss biotic effects of global warming. Regional temperature changes can be much more extreme" than changes in global averages (Root and Schneider 1993). Interestingly, livestock are estimated to account for 15% of methane inputs to the atmosphere – each cow emits 400 liters of methane per day because it farts or belches every 90 seconds. When summed over the number of cattle on Earth, this is a very large amount of methane.

Regardless of the sources of the greenhouse effect or how significantly the greenhouse effect itself contributes to planetary warming, the warming trends are real and could have severe effects on sage grouse and their habitat. Sage grouse have several of the factors identified by Herman and Scott (1992) rendering species vulnerable to global warming effects. Prairie has been retreating westward in Recent times (T. Webb 1981), and this is likely occurring with sagebrush as well, reducing the habitat available to sage grouse. Some contractions in sage grouse distribution may already be partly caused by global warming – the possibility has never been rigorously examined. Climate change is "almost certain to become" a threat to many species "in the foreseeable future due to increasing concentrations of greenhouse gases from fossil-fuel use, land-use changes, and agriculture" (Wilcove, et al. 1998). Indeed, it appears that the ranges of some species are already being affected by global warming (Parmesan 1996). The inland West is "particularly vulnerable to global warming and to extreme moisture stress" (Covington, et al. 1994). Climate change will continue and worse, will accelerate in the future (IPCC 1996, McCarty 2001).

Although the predicted magnitudes of warming are severe, "it is the predicted rate of temperature change that poses the greatest threat to biodiversity" (Morse, et al. 1995). Climate change has been and is projected to be "rapid," and the "ability of species to survive rapid climate change may partially depend on the rate at which they can migrate to newly suitable areas" (Morse, et al. 1995). However, sage grouse migration rates are largely irrelevant because the required habitat will not trend northward sufficiently rapidly to avoid extinction.

The World Meteorological Organization's Intergovernmental Panel on Climate Change (IPCC) estimates that the central portion of North America, including the range of the sage grouse, will warm 2 °C to 4 °C by 2030 (Houghton 1990). Other models predict even greater warming of 4 °C to 7 °C (Morse, et al. 1995). Soil moisture is predicted to decline by 15% to 20% (Houghton 1990). Even intermediate warming trends, which will occur sooner, will cause a broad array of negative impacts on sage grouse and their habitat, including increased length and severity of droughts. Warming would push the entire area suitable for sage grouse and their required habitat northward. Fragmentation interacts with climate change to restrict migration because of barriers to movement (Peters and Darling 1985). Even if sage grouse were able to establish new ranges on new habitat, most of that habitat would then be in Canada, not in the United States, and the birds' status in the United States – the *sine qua non* of the Endangered Species Act – would be in even greater jeopardy.

Equilibrial general circulation models predict greater drought and decreased summer soil moisture within 50 years (Ferguson 1997) – a threat that is thus easily foreseeable. Semi-arid and arid ecosystems are considered among the most sensitive because these ecosystems often are water-limited and have marginal nutrient reserves (Shriner and Street 2001). The entire range of big sagebrush in North America will decline to only 41% of its present range (R. S. Thompson, et al. 1998, Table 2) and most of the present range will be occupied by expanding creosotebush, *Larrea tridentata* (Shafer, et al. 2001, p. 18). Warming will lead to increased invasion of alien plants (Morse, et al. 1995), such as cheatgrass. Thus, sage grouse habitat – already degraded, fragmented and reduced – will contract and fragment even more. As cheatgrass spreads at lower elevations and juniper and pinyon pine increase at higher elevations (both exacerbated by climatic change) the narrow elevational ring of sage grouse habitat will shrink, further exposing the birds and their habitat to increasing direct threats from climatic and weather events. Moreover, variability of precipitation has increased (Tsonis 1996). The effects on sage grouse could be severe because it is the population lows that are of concern for extinction risk, and such lows are exacerbated by drought years.

Sage grouse will be extinct or nearly extinct in the United States because their habitat will be almost entirely extirpated from juniper invasion. Juniper invasion is greatly enhanced by climate change. It is not the changes in temperature that are important in juniper invasion; instead, it is the direct physiological effect of increased CO_2 on plant metabolism. This effect alone will cause extinction or near extinction within 90 years. Shafer, et al. (2001) used three different response surface models to predict future plant distributions as a result of climate change. The response surface models rely upon three bioclimatic variables which are well correlated with, and good predictors of, plant species distributions in North America. Continental distributions for these and many other taxa "are largely controlled by macro-climatic variables" (Shafer, et al. 2001; Woodward 1987). The models assume a 1% per year compound increases in atmospheric CO_2 and changes in SO_4 aerosols. These changes match those of the midrange scenario prepared by the World Meteorological Organization Intergovernmental Panel on Climate Change (IPCC IS92a). If less conservative climate change scenarios had been used, complete extinction of sage grouse and sagebrush would be even more likely. All three models gave very similar results, and all three models show that the range of big sagebrush (*Artemisia tridentata*) in the United States will decline by approximately 99% or more – only a few small patches will remain in parts of central Utah and Colorado (Shafer, et al. 2001, fig. 5; Shafer 2000). The impacts on sage grouse will be even greater as they must migrate to the remaining sagebrush patches and will be prevented from doing so by numerous natural and anthropogenic barriers. Notably, these models do not incorporate the impact of juniper expansion or cheatgrass invasion. These impacts will exacerbate range contraction (Shafer, et al. 2001, p. 18). Climate change will, of course, impact other sagebrush species, grasses and forbs in varying measure.

The Endangered Species Act requires a listing as threatened if a distinct population segment of a vertebrate, a species, or subspecies is "likely to become" endangered within the "foreseeable future throughout all or a significant portion of its range…." 16 U.S.C. § 1532(20); 50 C.F.R.§ 81.1(l). Here, the outcome is not merely foreseeable, it is predictable, and has already been predicted. Moreover, endangerment will not merely occur within a significant portion of the range; instead, it will occur, and is occurring, throughout the entirety of the range.

As Shafer, et al. (2001) point out, their work is necessarily imprecise. However, even if the predictions are inaccurate by 100%, the habitat available to sage grouse in the United States will still be so small as to cause endangerment. Further, it is just as likely that the model under predicts range reductions as that it over predicts them. Climate change alone will thus cause extinction of sage grouse in the United States, if not in 90 years then in 200 years, all species, subspecies and population segments of sage grouse will become in danger of extinction in every part of its range long before that.

Climate change will also accelerate invasion and habitat conversion by exotic annual grasses. Red brome and annual desert grasses (presumably including its congener, cheatgrass) produce more biomass and seeds when exposed to increasing CO_2 levels (Smith, et al. 2000). This response is "dramatically" greater than that of native plants, and is expected to shorten fire cycles from 75 years or longer to as little as 4 to 7 years (Trent 2001, quoting a co-author, Jeff Seaman, from Smith, et al. 2000).

But climate change will not operate alone. Instead, it will operate in combination with other threats, such as degradation from cattle grazing, conversion to agriculture and other development, and landscape threats such as oil and gas development and electric powerline and cell telephone tower sitting. These threats in combination will eliminate this formerly abundant species in a much shorter time than climate change alone. When the various threats are considered in combination, the outlook for this bird is grim indeed.

Ozone Layer Depletion

Thinning of the layer of ozone in the Earth's atmosphere removes the primary barrier to the transmission of ultraviolet rays (UV). Increases in high energy UV radiation can damage plant tissues (thereby inhibiting plant growth and vigor and affecting photosynthesis), can cause thinning of avian eggshells, and can affect insect production (GBCP 1997, p. 45). Thus ozone depletion can affect sage grouse directly, as well as by reducing their food supply. Effects on eggs and young chicks will be particularly strong in areas where livestock grazing has removed radiative cover from nesting areas (Webb 1993b).

Sage grouse are particularly susceptible to increased UV radiation caused by ozone depletion because they live in areas that typically have low cloud cover, and at high altitudes where less atmosphere exists to filter out UV radiation. Ozone depletion could threaten the sage grouse in the foreseeable future across their entire range.

Air Pollution

Several Clean Air Act non-attainment areas (i.e. polluted air sheds) lie within the range of sage grouse, including one along the northern California and Nevada state lines, and one in northern Utah (Schoettle, et al. 1999, p. 4, Fig. 1). Power plants constructed in the area produce a number of harmful emissions including sulphur compounds that can produce significant environmental effects. Sulphur emissions are a "regional issue because the sulphur may travel 1,000 km in a few days" (Schoettle, et al. 1999, p. 5).

Sulphur dioxide (SO_2) and other pollutants can affect both vascular plants and, especially, cryptogamic crusts (Schoettle, et al. 1999, p. 33). Studies have shown that cryptogamic crusts are being affected by air pollutants, and these impacts include electrolyte leakage, chlorophyll degradation, and reductions in nitrogen fixation (Belnap 1991). Effects on cryptogamic crusts are of particular concern in arid environments such as sage grouse habitat because these lands "depend on the integrity of cryptogamic crusts for soil stabilization" (Schoettle, et al. 1999, p. 49) and nitrogen fixation by crusts contributes nitrogen to higher plants (Belnap 2000). Indeed, crusts are critical to both these ecosystem functions and are an essential component of arid ecosystems (Belnap and Lange 2001). A general review of the effects of air pollutants on arid lands is given by Mangis, et al. (1991).

Sulphur oxide (SO_x) and nitrogen oxide (NO_x) emission sources are common throughout the range of the sage grouse (Schoettle, et al. 1999, p. 8-9). This may come as a surprise to the many, as the West has not traditionally been thought of as having significant air emissions. However, industrial facilities have proliferated in recent years, as have vehicular sources. Consequently, "even remote areas are subject to high concentrations of [air] pollutants" (Scruggs 1991). Nearly every county within the range of the sage grouse has SO_x and NO_x sources producing hundreds of tons, and in some cases thousands of tons, of emissions per year (Schoettle, et al. 1999, p. 8-9). Another potentially important emissions source for NO_x is agriculture – "air emissions from fertilized agricultural land may be substantial," yet such emissions "are not accounted in the NO_x inventory" (Schoettle, et al. 1999, p. 41).

Ozone (O_3) emissions are increasing and are particularly damaging because ozone is a known phytotoxin and can "threaten remote ecosystems and resources far from pollutant sources" (Schoettle, et al. 1999, p. 10). Even if ozone does not kill plants outright, it can weaken native vegetation sufficiently to allow invasion by alien plant species. Indeed, "ozone has the greatest potential of any air pollutant to directly reduce growth and vigor of vegetation" in the Interior Columbia Basin (Schoettle, et al. 1999, p. 43).

Acid Precipitation

Acid precipitation – often termed acid rain – can occur as rain, snow, or particulate fallout carried by any type of precipitation. It occurs when nitrogen or sulfur oxides are released into the atmosphere. Vehicle emissions are the major source of nitrogen oxides and industrial plants are the major source of sulfur oxides.

The susceptibility of certain organisms such as lichens to acid precipitation is quite high. The susceptibility of sagebrush, forbs and grasses used by sage grouse is not clear. What is important in analyzing acid precipitation is not whether the absolute amounts generated in the west are comparable to the amounts generated in the mid-western and eastern United States. Instead, it is whether the susceptibility of sagebrush, forbs and other plants needed by sage grouse is within the range of acid precipitation reaching them. Concentrations of automobiles and trucks in Los Angeles, the San Francisco Bay Area, Denver, Salt Lake City and other cities as well as smelters and power plants such as those located in the Four Corners area and in Colorado may be generating acid precipitation in quantities sufficient to harm sagebrush, grasses or forbs needed by sage grouse.

Effects of Chemical & Radiological Agents

Use of herbicides, pesticides, and other chemical agents is known to have damaged sage grouse populations, even though the phenomenon has been little studied. Thus, effects on sage grouse are surely larger than have been reported, and limitations on the use of various chemical agents will be required to recover the bird. Both herbicides and insecticides are consumed by, and will often be bioaccumulated in insects, which are an important food source for both chicks and pre-laying hens. Thus, the most susceptible life-history stages of the bird are exposed to chemical agents (Schroeder, et al. 1999a, p. 17). Some organophosphates are known to have killed numerous young birds while leaving adults alive (Blus and Henny 1997). Sage grouse are known to have suffered mortality from strychnine-laced rodent bait, toxaphene, Aldrin and chlordane (Post 1951, Carver 1997).

Like humans, wildlife are subjected to a mix of numerous synthetic chemicals. Synergistic effects of this mixture may exceed the effects of individual contaminants by several orders of magnitude (Arnold, et al. 1996; Colborn 1995). Besides the effects of synergistic mixtures of contaminants, and the effects on susceptible life history stages, the manner in which chemical agents are tested also tends to underestimate effects in nature. Chemicals are routinely administered to well fed and well watered, healthy animals. In contrast, wildlife often go hungry, experience water stress, disease and parasite loads, face mechanical injury and immuno-challenges, often in combination – all while being subjected to chronic or acute exposures to chemical agents.

Besides the effects on habitat, water sources can be contaminated by spraying of nearby fields that drain into the water source. Breakdown of chemicals in dry soils may be particularly slow, due to lack of microbial activity in low moisture environments.

For decades the West has been used as a dumping ground for the Nation's hazardous wastes and for the siting of ultra-hazadardous facilities, such as nuclear weapons factories. To some extent, such activities have benefited sage grouse and other wildlife by excluding most other human activities. For example, the INEEL (Idaho National Engineering and Environmental Laboratory, formerly INEL) has excluded hunting and grazing because of national security concerns associated with Naval nuclear reactor and other research at the site. Hunters and other trespassers have been confronted by Naval sharpshooters perched in helicopters and other security personnel (C. Peterson, personal communication), which likely dampens some of the pleasures of poaching. Consequently, this area has been rested from grazing for approximately 50 years, and habitat and populations are both markedly superior to the surrounding area.

However, sage grouse in this area are radioactive (Connelly and Markhamer 1983). In other areas, habitat has been removed for hazardous waste dumps and production facilitates, and both sage grouse and humans are at substantial risk. For example, central Utah contains perhaps the nation's greatest concentration of hazardous facilities, including the worst emitter of toxic chemicals in the nation (Fedarko 2000, p. 116), an incinerator for nerve gas and other chemical weapons, several bombing ranges, fallout from nuclear weapons tests, radioactive mine tailings, and chemical weapons testing areas (Fedarko 2000). The area is also expected to store nuclear reactor waste fuel rods (Fedarko 2000, p. 122). Sage grouse have also been directly killed in accidents. On March 13, 1968 an F-4 Phantom military aircraft released 2,730 pounds of VX nerve gas in central Utah, killing large numbers of sage grouse as well as every other animal in the area (Fedarko 2000, p. 124). Many other such ultra-hazardous activities occur in other parts of sage grouse habitat in Nevada, Utah, Washington, and Oregon.

Effects of Herbicides

A variety of chemical herbicides have been used to remove sagebrush and other shrubs in sage grouse areas. Besides any direct effects on the birds, such chemicals are used to target habitat that the birds need. Herbicides are also used for weed control. Common herbicides used have been 2, 4-D, 2, 4, 5-T, and Tebuthiuron, often labeled as Spike 20 or Grasslan (Braun 1998b). Use of 2, 4-D was curtailed in the late 1970s but is now increasing again, as is that of Tebuthiuron (Braun 1998b). Despite the deep affection for Tebuthiuron by BLM and some other land management agencies, Braun (1998b) noted that no study has ever "demonstrate[d] any positive responses by sage grouse to any Tebuthiuron treatment anywhere in sage grouse range." Moreover, Braun examined several Tebuthiuron treated areas and found all of them to be harmful to sage grouse, at least over the short time frame of the studies conducted (Braun 1998b). Consequently, he recommended that his state agency (Colo. Div. Wildlife) not support its use at all or allow its use on state lands (Braun 1998b). Treatment of large patches (200 or more ha in size) is particularly deleterious to sage grouse (Braun and Beck 1996). Tebuthiuron is particularly damaging to sagebrush and forbs, both critical habitat components for sage grouse (Braun 1998c, p. 3). Tebuthiuron has a higher persistence time in soil and thus may be more damaging to sage grouse habitat than even 2, 4-D (Braun 1987a). Tebuthiuron is known to cause pancreatic dysfunction in vertebrates and affect digestion (Emmerich 1985). It is also more likely to be transported in runoff and subsurface waters than most other herbicides (Emmerich 1985). Worse, it can persist in soil for many years – the half-life can exceed 5 years (Emmerich 1985). Many forbs are especially vulnerable to herbicides such as 2,4-D, but these "effects have been ignored by many range scientists in their efforts to increase production of grass (Blaisdell, et al. 1982, p. 20) – the grass, of course, is destined for livestock.

Despite the lack of data showing benefits to wildlife, millions of acres have been sprayed with these herbicides since the early 1960's, and Braun (1998a) estimates that more than 25% of all sagebrush areas has been affected. About 91,000 km^2 of rangelands were sprayed between 1985 and 1990 for grasshopper control alone (Johnson and Boyce 1990). Martin and Pyrah (1971, p. 137) and Martin (1965) describe the effects of treatment of a 1,700 acre area with herbicide. Over a 3 year study after the spraying, a total of 15 sage grouse were found in sprayed areas, while 400 sage grouse were found in unsprayed areas (Martin 1965, Table III). Sprayed areas constituted 90% of the total area, but yielded only 4% of the observations of sage grouse. The difference was related to alterations in the vegetative cover of the sprayed areas. Over 90% of the sage grouse that were in the sprayed strips were within 30 m. of an unsprayed area (Martin 1965). On the YTC in Washington, hundreds or thousands of acres are sprayed with Picloram or 2, 4-D to control knapweed (Cochran 1998).

Higby (1969a) reported the extirpation of an entire wintering population of 1,000 birds from spraying in Wyoming. Moreover, the area was not repopulated for 5 years. After sagebrush was sprayed in the late 1950s in the Gunnison Basin, lek counts declined to about one-third of their former numbers near the treated area but did not decline in other areas (Hupp 1987b, p. 87, Fig. 13; Rogers 1964). Similarly, a 12,000 acre extent of sagebrush in Oregon was sprayed with 2,4-D to eliminate sagebrush. The program was effective – and winter range for 1,000 sage grouse was destroyed (Call and Maser 1985, p. 13). Effects from sagebrush spraying persist for at least 10 years (Braun and Beck 1996).

Wallestad (1975a) and Blus, et al. (1989) have noted the detrimental effects on sage grouse populations from contamination by spraying of herbicides and pesticides. Both authors discuss die-offs of birds using agricultural lands for foraging caused by chemical spraying. Besides their acute effects, many herbicides have chronic effects, and can act as endocrine disrupters. It is clear from the studies above that herbicide spraying completely destroys habitat for sage grouse. Habitat may not recover for decades after spraying.

Effects of Animal Pesticides

Pesticides have been used to kill various insects occurring in sage grouse habitat areas, including Mormon crickets, mosquitoes, and grasshoppers. Pesticides harm sage grouse populations by depleting their food supply, by acute poisoning, by chronic poisoning, and perhaps by disrupting neuronal and endocrinological systems affecting immune function, development and behavior. Sage grouse chicks die of malnutrition if deprived of sufficient numbers of insects, and spraying of pesticides has been implicated in declines of other Galliformes (Johnson and Boyce 1990). The amount of sage grouse habitat exposed to pesticide contamination is unknown as is the magnitude of pesticide spraying; however, Johnson and Boyce (1990) estimated that over 5 million acres were sprayed between 1980 and 1985 to control just one insect species, the grasshopper. Carbamate pesticides are known to harm sage grouse (Blus, et al. 1989). Blus, et al. (1989) documented the direct mortality of sage grouse from organophosphate insecticides used on cultivated crops. Birds experienced significant depression of brain cholinesterase levels (Blus, et al. 1989). Malathion and dieldrin are known to be toxic to a closely related species, the sharp-tailed grouse (McEwen and Brown 1966), and toxaphene can kill sage grouse (Hill 1984). Sublethal levels of toxicants increased susceptibility to predators in species closely related to sage grouse (McEwen and Brown 1966).

Sage grouse kills from organophosphate insecticides have also been noted in southeastern Idaho (Mondecar, et al. 1987; Blus, et al. 1989). Sage grouse entered potato and alfalfa fields that had been treated. Sage grouse that fed on sprayed alfalfa fields were especially susceptible; however, even use of the sprayed alfalfa fields for roosting or loafing caused severe effects (Wallestad 1975b; Blus, et al. 1989). Mere occupation of sprayed potato fields also caused death or severely adverse effects (Blus, et al. 1989). Sage grouse are likely most susceptible to pesticide effects during periods when energy is withdrawn from lipid stores, such as during breeding displays for males (Hupp and Braun 1989a) and egg formation for females. Birds often feed in or near croplands and there are reports that "large numbers of sage grouse died" at the interface of croplands and sagebrush (Blus and Connelly 1998). Pesticides and other contaminants cause increased variation in per capita growth rates of populations (Meyer and Boyce 1994). Sage grouse populations will be especially variable as juvenile birds are particularly susceptible to pesticide induced reductions of insect prey (Meyer and Boyce 1994). These variations increase the risk of extinction and of genetic drift.

Pesticides render habitat unsuitable for sage grouse by destroying the insect food supply needed for critical life history stages. Additionally, many pesticides have chronic effects, and can act as endocrine disruptors. After a thorough review of thousands of BLM and other agency documents, I have seen virtually no analysis of ways to reduce the impacts of pesticides on sage grouse, although such mitigation techniques are known (Stiehl and Trautwein 1991a).

Even low doses of organochlorine pesticides are known to alter important behaviors in birds, such as aggression levels, alertness, discriminatory behaviors and territorial activity (Jeffries 1973). Organophosphide pesticides are known to cause such sub-lethal effects as weight loss, reduced visual acuity, auditory detection, vigilance, food seeking behaviors, offspring caretaking, and greater susceptibility to environmental stressors, including weather effects (Grue, et al. 1983). Thus, low doses can cause death or reproductive decrements by acting synergistically with other, natural effects in the birds environment. These threats are continuing (Blus and Connelly 1998).

Effects of Endocrine Disrupters

A number of chemical compounds, some otherwise thought to be benign, have been implicated as causing subtle, but long-lasting effects, including behavioral alterations, and disruption of development. Behavioral alterations include aberrant behavior of birds during nesting (Mac 2000) – of particular import for sage grouse viability. Importantly, these effects are hypothesized to occur at concentrations several orders of magnitude below those at which either acute or chronic effects are known from conventional chemical agents. A second important concern is that effects are believed to have occurred at concentrations below detectability limits, even using the most modern analytical techniques, such as HPLC (high performance liquid chromatography) or mass spectrometry. The US Geological Survey noted that such compounds can act by mimicking natural estrogens in the body, as well as by altering the action of other sex hormones, and glucocorticoids and thyroxine (Mac 2000). In humans, large reductions in sperm counts have been attributed to endocrine disruptors, as have the recent increases in cancers of the prostrate, breast, and ovaries – all tissues which are sensitive to sex hormones (Mac 2000). Effects of these compounds have been demonstrated in birds and are known to produce transgenerational effects (Colborn, et al. 1993; Facemire, et al. 1995). Effects are a particular concern during embryonic development and endocrine disruptors " can permanently modify the organization of the reproductive, immune, and nervous systems" (Guillette, et al. 1995).

Sage grouse in areas that have been treated with Tebuthiuron (Spike) have been observed engaging in atypical behaviors. For example, during a period when most males were flocking, "one male [was] consistently alone in an area where sagebrush has been treated with Spike" (Brigham 1995a). Further, a male was observed sitting out "in the open" in "the heat of the day" even though a big sagebrush bush provided shade only 50 meters away (Brigham 1995a). Although anecdotal, such observations may reflect contaminant mediated behavioral alterations with powerful effects on individual fitness and population persistence.

Natural Factors and Environmental Variation

Environmental variation in climate, food sources, and predators is high in the areas used by sage grouse. The climate is "highly variable," causing many threats, such as grazing and fires, to act like disturbances to the ecosystem (Eddleman and Doescher 2000). The "key functional elements" of disturbance have great temporal variation (Eddleman and Doescher 2000). This contributes to significant environmental stochasticity making it even more likely that small populations of these birds will become extirpated.

Sage grouse ranges are generally xeric with high evapotranspiration rates except in northern latitudes, and low rainfall, ranging from 15 to 32 cm per year. Available moisture for plant growth is highly variable, and drought is common both seasonally and for periods lasting for several years (Palmer 1965, Braun 1998a). Drought periods seem to often exacerbate declines in sage grouse populations (Patterson 1952c, p. 68-69; Connelly and Braun 1997). Drought is believed to reduce grass and forb cover, much as grazing does, causing increased detection by predators, and decreased food availability both of forbs directly and of insects which eat and make use of the forb cover (Klebenow and Gray 1968; Peterson 1970b; Drut, et al. 1994a, 1994b; Gregg, et al. 1994; Fischer, et al. 1996b). Factors affecting populations interact, and if a major drought occurs at a time when habitat has been severely degraded by grazing and other effects, the effects on sage grouse populations could be catastrophic. Drought is known to reduce forb cover at brooding sites and cause low production of young (J. R. Young 1994b, p. 45). One prediction from global warming models is increased drought in continental interiors, such as the range of the sage grouse.

Drought impacts both plants and insect populations that sage grouse depend upon for food and cover. Drought – even severe drought occurring over multiple years – is a natural feature of the climatic regime in the habitat of sage grouse. The Service must consider the effects of such episodic events in evaluating the risk to remaining sage grouse populations. Both nesting success of females and brood survival decline severely during years with low soil moisture (GBCP 1997, p. 45). This effect is compounded if land management practices remain unchanged during years with low soil moisture (GBCP 1997, p. 45). These effects of reproductive persist into future years – the year after a drought, there will be fewer yearling males on leks (FWS, undated, b).

Fragmentation

Fragmentation is discussed extensively elsewhere in this review, and is also known to affect social behavior in vertebrates (D. R. Webb 1981). Webb postulated that the increase in agonistic behavior, and the decrease in amicable behavior seen in fragmented areas was caused by the difficulty of juvenile dispersal to new areas, and was unrelated to such factors as elevation, foraging time, and other non-landscape factors. Habitat fragmentation could cause similar behavioral alteration in sage grouse. For example, if juvenile sage grouse experience difficulty in dispersing to new habitat patches because of fragmentation, then the number of males at a given lek may increase. Researchers would see more males per lek, and assume that beneficial effects were taking place in that population. However, increased male density could instead lead to increased fights among birds, or such large displays that females would make incorrect choices of potential mates. Although data are lacking on the issue of crowding, it is one that must be considered for listing decisions, designation of critical habitat, and the crafting of recovery plans.

Oyler-McCance (1999) found that the two most important variables explaining sage grouse use of a patch were distance from a paved road and area size. Habitat fragmentation is increasing in the Interior Columbia Basin, the Klamath Basin and the Great Basin – particularly in upland areas that form the vast majority of sage grouse habitat (Quigley and Arbelbide 1997b, p. 761).

Habitat Recovery Time

Both sage grouse populations and their habitat evince lags in their response to improved conditions (Schroeder 2001a, p. 8). As previously discussed, sage grouse habitat may not be able to recover from certain events, such as cheatgrass invasion which can cause the complete eradication of sagebrush in an area. Other past effects include the extremely heavy grazing of the west, which took place between the late 1800s and World War II, off-road vehicle (ORV) use, and military exercises. Depletion of vegetation and loss of soil by erosion are grazing effects that may prevent full recovery of the ecosystem. Unfortunately, heavy grazing continues today. Much sagebrush habitat has been treated with herbicides such as 2, 4-D, which leads to establishment of rabbitbrush (*Chrysothamnus* spp.) rather than regrowth of sagebrush. Overgrazing and other events may have already irreversibly altered sagebrush habitat (Patterson 1952c, Yocom 1956, Autenrieth, et al. 1977; Autenrieth 1981). Even significant recovery of sagebrush steppe from desertification is "highly questionable" (West 2000, p. 20). Even complete cessation of grazing, as advocated by Kerr (1998b) and others, may not reverse degradation in some areas because the state of degradation has exceed recovery thresholds (West 2000, p. 20). Besides lag times due to various biotic interactions among species, soil formation is exceedingly slow in arid areas – taking 5,000 to 10,000 years (Belnap 2000, p. 58).

In arid and semi-arid lands, such as sage grouse habitat, forces such as grazing disturbance or altered fire regimes can cause vegetation to cross a threshold, or transition point. Once crossed, removal of the disturbance will not necessarily result in a transition to a higher successional state without substantial inputs, and does not follow classic patterns of plant succession. Examples of this are cheatgrass/medusahead monocultures (Quigley and Arbelbide 1997b, p. 766). "Most current period arid and semi-arid rangeland [areas] remain stable at one or more lower (less advanced) successional states for long periods of time" (Quigley and Arbelbide 1997b, p. 765). Much of the "sagebrush-grass area has been so modified by past use that restoration to the natural condition will not be possible during the foreseeable future, even under intensive management" (Blaisdell, et al. 1982, p. 14). Even wetter areas, such as riparian meadows require many years to recover – Dobkin, et al. (1998) studied plots after 30 years of grazing exclusion and noted that restoration "will not happen quickly." USFS researchers have also found that riparian areas often require many years to recover (Clary, et al. 1996).

Both forbs and grasses lag the removal of stressors. On Hart Mountain National Antelope [pronghorn] Refuge, elimination of grazing in 1991 led to improvements in forb covers after a lag of a few years, but only after a series of very wet years (Crawford and Drut 1993). Even after this favorable weather change, grazing removal has not yet increased grass cover, and consequently sage grouse nest success did not increase (Crawford and Drut 1993). Nest initiation did increase (Crawford and Drut 1993, p. 9), suggesting that females were nutrient starved by reduction in forb coverage caused by cattle grazing. In west-central Utah, herbaceous vegetation did not recover even after 13 years after removal of livestock (West, et al. 1984). In more mesic areas, vegetation can recover more easily. The basal cover of perennial grasses increased by a factor of 19 after removal of cattle for 25 years (Anderson and Holte 1981).

Once removed or degraded, sagebrush is difficult to reestablish (Medin and Ferguson 1972). Sagebrush has low emergence and poor seedling vigor (Eddleman 1977, 1980). Wiens (1976, p. 89) summarized the recovery time of sagebrush habitats as "notoriously slow." Even if sagebrush shrub-steppe areas can recover and reestablish themselves as good sage grouse habitat, the time this may take can be so long – 100 years or more – that sage grouse populations will not be able to persist long enough for habitat recovery to occur. The lag in sage grouse recovery may also add to the lag in habitat recovery – even if sage grouse populations are able to maintain some viability in a degraded area, the local population is unlikely to be capable of serving as a source population in a landscape sense for many decades. The Service must consider the many decades required to restore habitat in its assessment of threats to the grouse because areas of habitat will continue to be degraded and eliminated before other areas can recover and sage grouse can reestablish populations in those areas.

The most recent research on recovery times in arid areas indicates that full ecosystem recovery may not occur for literally thousands of years (Lovich and Bainbridge 1999). In the Gunnison Basin, the "long-term health of the ecosystem may have been altered, possibly irreversibly, affecting [] carrying capacity" (GBCP 1997, p. 43). Thus, significant amounts of sage grouse habitat may have been lost forever.

> "Even under themes [management scenarios] where aggressive restoration activities are planned… it is thought that the deterioration and loss of sagebrush habitat will outpace restoration success" (Saab and Rich 1997, p. 16).

Even if livestock are removed from an area, the presence of invasive weeds, overly dense stands of sagebrush, or heavy browsing by rodents and rabbits can inhibit recovery of grasses and forbs (Tisdale and Hironaka 1981). For native grasses, recovery times can also be very long – bluebunch wheatgrass will not recover from even a single season of heavy grazing for 8 years, even under the best management practices (Anderson 1991). In northwestern New Mexico, there has been no significant increases in grass cover at Chaco Canyon National Historical Park despite over 50 years of grazing exclusion (Hobbs and Huenneke 1992; Pieper 1994).

After fire, many sagebrush species do not resprout and must re-establish by seed set. This process is very slow (Britton and Clark 1985) and 30 years or more may be required to regain pre-burn sagebrush densities (Harniss and Murray 1973, Tisdale and Hironaka 1981). This time interval may be even greater in areas with lower precipitation or higher potential evapotranspiration, such as eastern Washington (Griner 1939, Pyrah 1963, Call and Maser 1985, Drut 1994). For sagebrush habitat, "a full century may be required for a landscape to recover fully" (Rotenberry 1998, p. 268).

Over Utilization of the Species

A species must be listed if it "is endangered or threatened" because of "over utilization for commercial, recreational, scientific, or educational purposes." 50 C.F.R.§ 424.11(c)(2); 16 U.S.C. § 1533(a)(1)(B). The Secretary must conduct a "review of the species' status." 50 C.F.R.§§ 424.11(c). The determination to list the species must be made "solely on the basis of the best scientific and commercial data." 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R.§ 424.11(b). The Secretary may not consider actual or "possible economic or other impacts" in the listing decision. 50 C.F.R.§ 424.11 (b).

Hunting

Sage grouse are a popular game bird. Sage grouse hunting is regulated in those states where it is allowed, and has not generally been cited as a factor in recent sage grouse declines (Autenrieth, et al. 1982; Blaisdell, et al. 1982; Johnsgard 1973, 1983). However, at least one former advocate of sage grouse hunting and a recognized expert on sage grouse, Dr. Clait Braun, now feels that hunting policy for this bird may have "negatively impacted" the species (Braun 1995d, p. 2). A thorough analysis, presented below, indicates that hunting is likely a significant factor in populations that are small, sparsely distributed, or concentrated in few areas (such as near riparian areas). Moreover, the data do not justify hunting of any sage grouse populations at this time.

Excessive hunting was likely a major factor causing early declines in sage grouse populations (Girard 1937, Batterson and Morse 1948). In historic times, sage grouse were considered a primary game species and hunting was so heavy that wagon loads of birds were carried out (Girard 1937, Rasmussen and Griner 1938, Patterson 1952c). However, analyses of habitat degradation by grazing had not been undertaken at that time, so it is unclear exactly how much of these early declines were due to hunting and how much was caused by habitat degradation. Indeed, the importance of habitat quality on wildlife populations was not widely appreciated until the efforts of Leopold (1933). Hunting mortality can depress populations well below carrying capacity (Gibson 1998).

Unfortunately, the states where hunting is allowed have powerful motivations to maintain hunting, not only in terms of direct financial benefit to their Game Programs, but also in terms of general economic benefit and prestige. It is possible that some states would fail to properly regulate hunting or other effects on the birds and their habitat. The very low population recruitment of these birds and the extraordinarily slow recovery of upland desert and shrub-steppe habitat areas also bode ill for population recovery. Even if all threats to the birds were immediately halted, many populations would likely go extinct, and others would not recover for decades, perhaps centuries. Scientists in state agencies are able to obtain some limited population data from hunting, and may favor hunting for this reason. However, the data collected are of low quality and are subject to various errors and biases.

Hunting may reduce sage grouse population size (Zunino 1987). However, low levels of hunting in large and dense sage grouse populations, particularly when restricted to birds that are not likely to breed, is probably not an important factor in reducing population sizes (Braun and Beck 1983, 1996). The problem is that the levels of harvest permitted are not proven to involve the take of merely "surplus" birds and thus are unlikely to constitute merely replacive mortality (Schroeder 2001a). Moreover, natural mortality of adults in summer and autumn is low (Schroeder 2001a, p. 7), and effects of hunting are likely to be difficult to document, even if significant (Schroeder 2001a, p. 7). Crawford and Lutz (1985) and Klebenow, et al. (1990) have particularly cautioned against heavy hunting harvest, and against harvest in years of poor productivity.

Hunting as Replacive Mortality

Of particular importance to the effects of hunting on sage grouse population viability is whether hunting truly replaces other mortality factors that would operate before the particular individual would have bred. The notion that hunting merely compensates for other mortality factors dates back at least to the time of Allen (1954, p. 131). Bergerud (1988c, section 16.3) suggested otherwise, particularly with respect to overwinter mortality. However, data for sage grouse are lacking. Crawford (1982a) noted that the notion that hunting constituted merely replacive mortality was based on studies of other gallinaceous birds, which are less susceptible to the effects of hunting than are sage grouse. For example, sage grouse congregate in wet areas and at water holes, and are easier to hunt than other upland game birds (Crawford 1982a). Hunting is known to constitute additive mortality for ptarmigan, a close relative of sage grouse (Braun 1995d, p. 3). If the sage grouse population subjected to hunting is large and hunting effort is low, then hunting mortality may be largely compensatory for other mortality factors (Crawford 1982a, p. 376). However, if populations are not large, if hunting effort is not low, or if hunting takes or causes disruption to breeding birds, then this threshold will be exceeded and hunting will not merely substitute for other forms of mortality. The fact that populations increased after hunting seasons were closed in Colorado and other states (discussed in the "Population Assessment" section), strongly argues against the notion that hunting merely substitutes for other forms of mortality.

More recent studies have also implicated hunting as a significant threat to sage grouse. In a long term study in Nevada, Klebenow, et al. (1990) found that during a time of population increase, grouse populations on unhunted areas increased by about 7 times the amount on hunted areas (Drut 1994, p. 19). Johnson and Braun (1999) used matrix projection models to incorporate age structure in assessing the impacts of hunting on sage grouse populations. Although not a full viability analysis (for example, the study did not include the effects of genetic or environmental stochasticity), their results did show that hunting should be allowed only if juvenile and adult survivorship are sufficiently high that survival rates do not limit population increase, because hunting mortality is probably additive only above some threshold level (Johnson and Braun 1999). But, it is precisely juvenile survivorship that is usually cited as the bottleneck in declining sage grouse populations. Hunting typically takes mostly naïve, juvenile birds and therefore hunting is highly unlikely to constitute mortality that merely replaces other mortality factors. Hunting also tends to reduce population productivity because "a critical part of the population, adult females, usually constitutes a large proportion of the kill" (Crawford and Swanson 1999, p. 8). Moreover, hunting differentially affects females (Connelly, et al. 2000a, 2000b).

If hunting is allowed, area restrictions must be adjusted seasonally and yearly. In Wyoming, significant take of successfully reproducing hens occurred because hens concentrated in riparian areas late in the season, exposing them to hunters (Christiansen 2000, p. 12). Such concentration in riparian areas will occur earlier in the season in years with low moisture. Moreover, vigilant enforcement will be needed to ensure that hunters stay out of closed areas – such violations are common.

The Service will need to be extremely cautious in evaluating which areas of sage grouse range can be opened to hunting after the bird is listed. Hunting is known to exacerbate Allee effects and increase extinction risk (see Allee Effects section, and Dennis 1989). Once habitat is restored and population productivity is high, quite large hunting takes should be supportable – perhaps even in the range of those related in early historical accounts elsewhere in this review. Real world data, and thorough analysis should be required before hunting is allowed – hunting should be halted until more is done to justify it than inherent biases or hopeful guesses.

Surprisingly, nearly all states allow hunting of sage grouse, even those where populations are declining rapidly and have reached extremely low levels (e.g. Utah). There are no data or analyses showing that a huntable surplus exists in any sage grouse; instead, management agencies have merely assumed that hunting will not harm population dynamics. This suggests mis-management of the wildlife resource because of political pressure within the states. If true, then the states have violated the public trust and the wildlife trust.

Poaching

Poaching is the intentional taking of birds out of season or the intentional taking of more birds than are allowed by hunting regulations. Importantly, poaching levels are not measured by the techniques used by state wildlife agencies to monitor hunting levels. Thus, few reliable estimates of the loss of birds to poaching are available. However, in Colorado, poaching has occurred in all months of the year, and is greatest in winter and in big game season (Oct. and Nov.) when more hunters are afield and the birds are concentrated (GBCP 1997, p. 48; DCCP 1998, p. 27). Roads and the use of ORVs greatly increase the level of poaching.

Incidental Take from Hunting other Species

Inadvertent killing of sage grouse by hunters looking for other birds can be a significant problem for small populations. Open seasons for other upland game birds such as chukar, pheasant, quail, and other grouse species will expose sage grouse to mortality when the open hunting areas are within the range of sage grouse. Sage grouse may also be misidentified and shot by hunters of other birds such as chukar and other partridges, pheasant, grouse and quail (YTC CA 1994). Some degree of incidental killing of sage grouse is known to occur from the hunting of blue grouse in Colorado (Toolen 1999b).

Hunting of other birds in an area inhabited by sage grouse may also disturb sage grouse even if they are not shot. Moreover, open seasons for other birds may afford an alibi for poachers or otherwise operate to conceal or obscure their operations.

Falconry

Sage grouse are a preferred prey species for many types of falconry. The extent of direct take by falconers is not known, but Braun (2000g) estimated it as fewer than 500 birds per year across the entire range of the bird. Falconry can also act as a disturbance to sage grouse and this can be a greater threat than direct killing of the bird (Braun 2000g). Falconry should not be allowed when sage grouse are winter stressed, on or near leks, or engaged in other breeding activities such as nesting (Braun 2000g). However, there are some falconers who fly their falcons at precisely those times, thus regulation is needed. The state of Colorado has such regulations (with the support of falconers), but most states do not. Currently, falconers "do not have a bag limit," and sometimes "take 50 to 60 birds a YEAR!" (Deibert 1999d, emphasis in original). The falconers "like coming to Wyoming because of the lack of restrictions" (Deibert 1999d). The Service should carefully evaluate this threat, and actively seek further information surfaces during the listing process. Afterwards, carefully controlled falconry – like other carefully restricted hunting – is a good candidate for an incidental take permit.

Bird Watching and Recreational Use

The only direct recreational use of sage grouse at present is viewing, particularly of lekking birds. Nonconsumptive uses, such as bird watching, are not always benign. Humans could disrupt lekking activities and hence mating if they – or their domestic pets – approach leks too closely. The same disruptions can occur near nest sites, but the implications could be worse, as hens have already invested considerable nutrient stores into egg production, and inadequate time for locating another nest site and relaying may exist in that season. Disturbance at a lek can reduce mating opportunities and cause decreased production (Call 1979) or even abandonment of the lek. Sage grouse flush more easily at leks subject to extensive human viewing (Braun 1987a). If humans approach a lek on foot, birds may avoid the lek for the rest of the day (Call 1979). Quiet observation from enclosed vehicles does not appear to disrupt lekking activities. However, tourists often leave their vehicles to get a closer look at the birds. State wildlife agencies appear to follow an informal policy of having a "sacrifice" lek near an all weather road to which the inquiring public is directed for viewing. Other lek locations are generally not revealed to the public. Tourists at viewing areas may need to be monitored and controlled to avoid disruption. Sedatives administered by dart guns, as have often been used for wildlife capture, are likely to be highly effective in tourist control. Disruption of nesting or lekking activities are most likely near suburban areas, areas populated by ranchettes, and popular recreation areas. Roads greatly increase disturbance in any area. For example, disturbance in the Gunnison Basin is a concern (GBCP 1997, p. 49-50) and disturbance has occurred at the Foster Flats lek near Frenchglen, Oregon (Armstrong 1988), yet the BLM has not posted a sign warning tourists to stay in their vehicles.

Recreational activities can also affect sage grouse indirectly. One example is the near extirpation of sage grouse at Strawberry Valley, UT (discussed in the Predation section). There, the infrastructure for concentrated recreational use caused accumulations of trash, greater road use led to increased road kill, and stocking of fish led to a proliferation of fish entrails – all attracted red fox. The fox then disturbed and preyed on sage grouse nests leading to almost complete reproductive failure of the sage grouse population (Bambrough, et al. 2000a).

Agricultural Operations

Mowing or plowing can directly kill sage grouse, especially young birds (DCCP 1998, p. 28). "Sagebrush beating throughout entire pastures has eliminated sage grouse use in those pastures in the short term" (Braun 1997b). These practices also alter habitats and make them unsuitable for the birds. Pesticide and other agricultural impacts are discussed elsewhere in this review.

Road Kill of Sage Grouse

Road kill of sage grouse has not been estimated; however, death of other animals from motor vehicle collisions is an important mortality factor. There is no reason to suppose that this is not important in sage grouse, especially when the number of roads fragmenting sage grouse habitat and the preference of the birds to walk is considered. Roads are a major threat both directly and in terms of habitat fragmentation and are discussed elsewhere in this review.

Scientific and Educational Purposes

Concerns have been expressed regarding the effects of scientific study on the birds, particularly with respect to lekking activities and nesting (SMBCP 1998, p. 24). Study of the birds often involves capture and marking of the birds, and may involve fitting the birds with radio transmitters. Radio transmitters are known to increase the energetic burden on passerines by about 10% (Caccamise and Hedin 1985), and likely do so to a lesser extent for sage grouse. Capture techniques include spotlighting, hand capture, use of long handled nets, and walk-in traps. All techniques involve some stress to the birds, and repeated disturbance of lekking birds causes them to become more wary and flush more easily (GBCP 1997, p. 50). Because sage grouse have extremely strong site tenacity, especially for lekking areas, the fact that they return to a lek after capture and marking (SMBCP 1998, p. 24) does not mean that they have not been severely stressed. It may be possible to examine blood corticosteroid levels to determine the degree of stress from capture and marking operations. Certainly, such methods will be needed to recover populations.

Disease and Parasitism

A species must be listed if it "is endangered or threatened" because of "disease or predation." 50 C.F.R.§ 424.11(c)(3); 16 U.S.C. § 1533(a)(1)(C). The Secretary must conduct a "review of the species' status." 50 C.F.R.§ 424.11(c). The determination to list the species must be made "solely on the basis of the best scientific and commercial data." 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R.§ 424.11(b). The Secretary may not consider actual or "possible economic or other impacts" in the listing decision. 50 C.F.R.§ 424.11 (b).

Girard (1937) and Batterson and Morse (1948) suggested that disease caused local declines in sage grouse populations. Stoddard and Kay ascribed a marked drop in 1932 in populations of birds in Utah to parasites (Lords 1951). Other scientists suggesting that disease and parasitism adversely affected populations include Grover (1944), and Honess and Post (1968). Thorne (1969) and Thorne, et al. (1982) summarized a number of diseases and parasites that threaten sage grouse. Disease outbreaks are commonly associated with drying water holes causing high bird densities (Wallestad 1975a). Death was generally caused by coccidiosis, which is the most prevalent disease affecting sage grouse (F. Simon 1940, Thorne 1969). Coccidiosis is episodic, not continuously epidemic in sage grouse (Honess 1947). Coccidiosis is transmitted by the protists *Eimera angusta* and *E. centrocerci* in contaminated water, and is more prevalent near drying water holes where the birds are concentrated (F. Simon 1940). Coccidiosis epidemics occurred in Montana during July and August when water was limited (Wallestad 1975a) and during drought in Wyoming (Scott 1942). Symptoms of coccidiosis include weakness, inability to fly, emaciation, and diarrhea leading to death (Autenrieth 1986). Maggots and beetles, which feed on sage grouse droppings and are then consumed by sage grouse, are common disease vectors (Grover 1944). *Plasmodium* and several other hematozoa are known to occur in sage grouse, including those in Colorado (Stabler, et al. 1966, 1974, 1977, 1981).

Crowding of birds, and consequent increases in disease spread, will also likely result from loss of habitat and from fragmentation (Meffe and Carroll 1997, p. 290). Such crowding will further expose birds to transmission of disease vectors, increasing the risk (Friend 1995, p. 404; YTC CA 1994). Crowding also harms habitat quality by fecal contamination and damage to vegetation (Friend 1995, p. 404). Furthermore, birds in a weakened physiological state or under behavioral stress are more susceptible to diseases and parasites. Gabrielson and Jewett (1940, p. 218) suggested that the near extirpation of the Oregon population on Hart Mountain was because of disease.

Numerous parasites are identified with sage grouse and include tapeworms (*Raillietina spp.),* protozoans (such as *Eimeria spp.),* and ticks (*Haemaphyalis spp.*). Other diseases affecting sage grouse include salmonellosis, botulism or limberneck, aspergillosis, avian tuberculosis and pasturellosis (Thorne 1969). As early as 1954, Edminster noted that at least 8 species of endoparasites and 4 species of ectoparasites were known to infect sage grouse (Edminster 1954, p. 126). Two parasites in the genus *Eimeria* were known to cause epizootics (id.).

Disease outbreaks need not kill or even cause severe physiological effects in individual birds to reduce population viability. For example, even mild malaria outbreaks can affect reproduction because male sage grouse infected with malaria attend leks significantly less frequently during the mating season (Boyce 1990). Females appear to avoid infected males during mating (Johnson and Boyce 1991; Spurrier 1989; Spurrier, et al. 1991). Thus, the sexual selection advantages of the lekking habit can easily become disrupted by even mild disease effects on individuals. As sage grouse populations become smaller and more isolated, disease threat will increase.

Exotic bird species such as quail and pheasants are often introduced for hunting. Such introductions carry substantial risk of disease and parasite spread to sage grouse. For example, the Colo. Div. of Wildlife "allows releases of exotic/introduced species which are known to be carriers of parasites/diseases harmful to sage grouse into habitats where sage grouse live" (Braun 1999a, p. 1). Moreover, introductions of sage grouse to other parts of the range can introduce potentially lethal diseases to existing birds (Davidson and Nettles 1992).

Of all the threats to sage grouse, disease and parasitism are among the most poorly studied. Disease can have severe effects on population persistence: in a 1941-42 study near Craig, Colo., disease accounted for 68% of all mortality (Sage Grouse Meeting Notes 1997, p. 8). The second greatest mortality source was unknown (14%), followed by a suite of direct anthropogenic causes (highway kill, telephone wire, and mower), which totaled 9%, equaling predation (id.).

Disease interacts with other threats – for example, small population size caused reduced variation in the major histocompatibility complex in cheetahs, and 50-60% mortality was documented in only 3 years from corona virus (O'Brien and Evermann 1988). Enhanced susceptibility to infectious disease or parasites is likely to be a common result from small population size.

Other threats, such as livestock operations, agriculture and development, are known to have extremely negative effects on sage grouse, and are novel threats unlike disease which grouse have faced for millions of years. Nonetheless, anthropogenic effects such as introductions of pheasants and other exotics, immunosuppression caused by chemical exposures, and crowding may be causing exacerbated disease effects on sage grouse.

Inadequacy of Existing Regulatory Mechanisms

A species must be listed if it "is endangered or threatened" because of "the inadequacy of existing regulatory mechanisms." 50 C.F.R.§ 424.11(c)(4); 16 U.S.C. § 1533(a)(1)(D). The Secretary must conduct a "review of the species' status." 50 C.F.R. § 424.11(c). The determination to list the species must be made "solely on the basis of the best scientific and commercial data." 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R.§ 424.11(b). The Secretary may not consider actual or "possible economic or other impacts" in the listing decision. 50 C.F.R. § 424.11 (b).

Sage grouse are or were game species in every state within their range. That a game species could be so reduced in numbers and habitat as to be endangered, shows that something is terribly wrong with management. In May and June, 2000, biologists from several states met together with USFS, BLM, and US FWS representatives to form a "Sage Grouse Framework Team" and discuss sage grouse issues. The notes from this meeting are instructive regarding the mis-management of sage grouse. Team members considered whether to conduct a "Conservation Assessment" on sage grouse, but decided that "disadvantages" of such an assessment would be that it could "give [the] listing process a 'leg up'" and could "become the basis for other listing petitions" (Sage Grouse Framework Team 2000, p. 4-5). Thus, public employees and biologists have affirmatively avoided searching for the facts on sage grouse in order to avoid a potential listing under the ESA. In evaluating petitions to list sage grouse, the Service must consider these biases against federal law, and against the basic preconditions of scientific inquiry, as threats to the species from the states, from the federal land management agencies, and from within the Service itself.

Just as fragmentation has affected the populations and habitat of the sage grouse, the existing management and regulation of the bird and its habitat is fragmented among a diverse assortment of private, state and federal entities. The best habitat is located on private lands or has been converted into housing, agricultural fields, towns, and mini-ranchettes. In the Interior Columbia Basin, only about half of the habitat is on federal lands (Raphael, et al. 2000, p. TER 69). Most of the upland habitat is on BLM lands, but management of the bird itself is under state jurisdiction. Although the states control hunting, they do not have authority over the land base constituting the bird's habitat. Most states lack state Endangered Species Acts. The state endangered species acts that do exist are toothless and do not constitute regulatory mechanisms. State wildlife agencies have often been remiss in failing to comment on NEPA documentation for actions on federal lands affecting sage grouse. When they have commented, federal agencies have affirmatively disregarded or deliberately misconstrued state agency comments (see comments re: the Oregon Dept. Fish and Wildlife elsewhere in this review).

Thus, the management of the species is as fragmented as is the range of the bird, if not more so. Sage grouse management is replete with examples of poor communication and competition among different agencies, bureaucratic inertia, lack of landscape management, and other ills that Grumbine (1990b) has previously summarized and critiqued.

Only a listing under the ESA has the power to bring in all parties, all actions, and all land management agencies to discuss these threats and recover the species. Otherwise, the present fragmentation of management ("cumulative space effects," *sensu* Meffe and Carroll 1997, p. 380) will fail to conserve the species. Only a listing under the federal ESA can assure coordination of these diverse entities which each have some jurisdiction over sage grouse.

Existing regulatory mechanisms are virtually non-existent and existing management is inadequate to conserve the bird. Although sage grouse inhabit an environment subject to extraordinary variation, management plans lack the flexibility to adjust to such fluctuations. For example, the effects of drought on sage grouse populations can be severe (GBCP 1997, p. 45) and are compounded if land management practices remain unchanged during years with low soil moisture (GBCP 1997, p. 45). Despite this, there are no regulatory mechanisms or management plans that require the alteration of land management practices in drought years.

Besides the lack of an adequate regulatory framework, existing management within the range of the sage grouse is undesirable. The grasslands, shrublands and "deserts" that make up the range of this species "are poorly represented in United States reserves" (Cooperrider 1991, p. 46). Moreover, most protected lands in the United States were not established to conserve biodiversity (Noss and Cooperrider 1994, Graf 1990), and none has been set up to conserve sage grouse. Many species in this region are declining or endangered. As but one example, 16 bird species in the Columbia Plateau have "significant" recent or long-term declining population trends and others have been extirpated from parts of the region or the entire area (Altman and Holmes 2000, p. i).

In 1995, the state of Colorado and the US Dept. of the Interior entered into a memorandum of agreement regarding management of the many native species that are in trouble in Colorado (Colorado MOA 1995). In 1999, state entities (the Western Association of Fish and Wildlife Agencies), the BLM, USFS, and FWS drafted a range-wide Memorandum of Understanding (MOU) concerning sage grouse. This MOU was drafted to promote conservation planning, habitat management, and species management (Stiver 2000). The MOU is in no way a regulatory mechanism, and was drafted specifically to avoid any regulatory language. Minutes from the 1999 meeting of the Western Association of Fish and Wildlife Agencies (WAFWA), show that the BLM and USFS emphasized their "inability to agree to any language that was, or could be perceived as, decisional" (Farschon 1999). No on the ground actions have taken place, progress is slow, and so far, the only action has been meetings to develop a "resource toolbox" to help write conservation plans (Stiver 2000). In other words, no conservation plans have even written under the MOU. These Memoranda require no action other than cooperation and collaboration between state and federal agencies. To date, no implementation of on the ground actions to reverse sage grouse declines has been taken, even though sage grouse were specifically mentioned in the Colorado MOA and are the subject of the MOU. These Memoranda are ineffective to conserve the species. Several states have formed local working groups to develop management plans for sage grouse (Hemker 2000). These working group plans are subject to all the inadequacies discussed elsewhere for the Colorado conservation plans, with the additional caveat that most other working groups have not even put together conservation plans yet. These plans are only advisory and voluntary, their reliance on consensus means that the lowest common denominator controls the process and result – not the welfare of the species that is purportedly to be conserved – and, to the extent that they are time consuming and defocus the efforts of agencies, they harm rather than help sage grouse.

The habitats inhabited by sage grouse are a little-loved landscape, and consequently, little protection has been established for this eco-region. Storms, et al. (1998) conducted a GAP analysis of the Columbia Plateau and Wyoming basin. This area covers most of the range of the sage grouse and nearly all of what has been termed the "core" states of Oregon, Idaho, and Wyoming. Less than 4% of this vast region has been protected with management focusing on biodiversity (Storms, et al. 1998). Worse, only 2.5% of the *Artemisia tridentata* land cover class is protected (Storms, et al. 1998, table 1).

Among the many other problems in management, existing management agencies are "too slow to respond with effective mitigation" when events call for it (Braun 1999a, p. 1). In particular, agencies are unwilling to adequately manage domestic livestock grazing and are unwilling to reduce "elk/deer numbers" when necessary (Braun 1999a, p. 1). For decades, federal land management agencies improperly managed wildlife on the public's lands, relying on such "clichés" as "good range management is good wildlife management," which federal agency biologists have pointed out will not suffice (Maser and Thomas 1983, p. 2). Federal agency personnel have long been ruled by a mind set to convert "soil, sunshine, and moisture" into "livestock production" and prevent these resources from "being squandered in the production of sagebrush." (Astroth and Frischknecht 1984, p. 1 quoting Woodward). Personnel were exhorted to question how long they would "let this sort of thing continue" and to devote their efforts to converting these ecosystems of "undesirable plant species, particularly sagebrush" into "rangelands" that can "best contribute to livestock production" (Astroth and Frischknecht 1984, p. 1, 27). That Woodward voiced these sentiments in 1948 is perhaps excusable. That Astroth and Frischknecht voiced the same sentiments in 1984 is reprehensible – such avoidance of multiple use considerations is illegal. FLPMA and NFMA required multiple use of these lands long before Astroth and Frischknecht revealed their antipathy for wild ecosystems. Even when reference is made to relict vegetation areas that are ungrazed, agency personnel have been careful to note that "this does not mean that pristine condition is the management objective;" instead, any remaining pristine areas to serve "only as a guide" to what an area is capable of supporting (Blaisdell, et al. 1982, p. 12). Other federal agency biologists have noted that "it is time to concede that the production of livestock has more intense, widespread influence on wildlife than any technique applied by a wildlife biologist to enhance habitat" (Maser and Thomas 1983, p. 5).

On federal lands, specific statutes apply to various agencies that manage the public lands. Besides the ESA itself, only two relevant statutes extend across agency land boundaries: the National Environmental Policy Act and the Clean Water Act. The latter is rarely applicable to sage grouse habitat issues. Multiple-use land management agencies typically have organic acts relating to how they manage the public's land that they are allowed to administer. For the BLM, the Federal Lands Policy and Management Act (FLPMA) applies, and for the Forest Service, the National Forest Management Act (NFMA) applies.

The Service cannot reasonably rely on NEPA, FLPMA, NFMA and other laws to conserve the species, because these laws are not adhered to by federal agencies. Just as is the case with the Service, hundreds – if not thousands – of federal judges have ruled that the BLM, the Forest Service and other land management agencies have broken the nation's environmental laws. In many other cases, plaintiffs have not been successful in getting courts to reach the merits of a case because of a plethora of procedural, deferential, and jurisdictional hurdles that shield federal agencies from judicial review. The erection of doctrines barring or hampering citizens from court contributes to the inadequacy of existing regulatory mechanisms. The Service must consider the track record of agency protections and the ability of citizens to review agency action when determining the adequacy of regulatory mechanisms. When agencies have a long record of deliberate violations, those agencies cannot be relied upon to obey the law in the future.

Other agencies with sage grouse populations or habitat have no particular mandate to protect the species. These agencies include various branches of the Dept. of Defense, the Bureau of Reclamation, and others. They are governed by no substantive statutes requiring wildlife protection. Thus, the protection of the ESA is especially critical on these lands. Some agencies and entities have acted not to preserve and restore sage grouse so much as to prevent a petition under the ESA. The numerous conservation plans are examples of such efforts. Another, particularly troubling, example is an offer by the head of the National Fish and Wildlife Foundation (which receives public tax money) to help the FWS "forestall[]" a petition to list sage grouse (Eno 1998).

National Environmental Policy Act (NEPA)

The National Environmental Policy Act of 1969 (NEPA, 42 U.S.C. § 4321 – et seq., Pub. Law No. 91-190) is merely a procedural act and requires no substantive outcome. Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519 (1978). It thus does not constitute a regulatory mechanism. Moreover, because substantial declines in sage grouse populations have occurred since NEPA was first passed in 1969 it has clearly been inadequate to conserve the species. Congress recognized the inadequacy of existing statutes when it passed the Endangered Species Act in 1973.

National Forest Management Act (NFMA)

The National Forest Management Act (NFMA, 16 U.S.C. § 1600 – et. seq., Pub. Law No. 94-588, 90 Stat. 2949, as amended) governs actions of the US Forest Service on the public lands it administers. One NFMA provision requires that the Forest Service "provide for diversity of plant and animal communities," 16 U.S.C. § 1604(g)(3)(B). To carry out its statutory duty, the Forest Service promulgated an administrative regulation that requires maintenance of the viability of vertebrate species on its lands (36 C.F.R.§ 219.19). The Forest Service has not maintained the viability of vertebrate species, including the spotted owl, nor has the Forest Service maintained biodiversity on the lands it manages. For example, several botanists were forced to sue the agency because forest plans did not rely on well understood landscape ecology concepts (Mlot 1992). As late as the 1990s, scientists noted that the Forest Service "abysmally misunderstood, misconstrued, or missed altogether" vast amounts of information on the effects of fragmentation from the 1970s and 1980s (Mlot 1992). Although this information had been in the scientific literature for "20 to 25 years" before forest plans came out, and was "widely accepted scientifically," the plans did not incorporate that information. A Justice Dept. attorney, who represented the Forest Service in the ensuing litigation, stated that that was "how government works. They're going to be behind the curve" (Mlot 1992). Unlike the FWS, the Forest Service is not required to use the best available science, leading to mis-management of rare species. Moreover, the viability requirement has been weakened by several court decisions that have given overweening deference to the USFS even when the top population biologists in the world disagreed (Inland Empire Public Lands Council v. United States Forest Service, 88 F.3d 754, 760 (9th Cir. 1996)), and have allowed USFS to substitute mere habitat quantity for population viability (Sierra Club v. Marita, 46 F.3d 606, 619-20 (7th Cir. 1995)). More recently, the Forest Service has attempted to do away with the administrative rule altogether. Ultimately, there is simply not sufficient habitat on USFS lands to preserve the sage grouse, no matter how well USFS acted as a steward.

Federal Lands Policy and Management Act (FLPMA)

The Federal Lands Policy and Management Act of 1976 (FLPMA, 43 U.S.C. 1701- et seq., Pub. Law No. 90-2743) governs BLM actions. Unlike NFMA, FLPMA contains no requirement to preserve the viability of any species, and has largely evolved into merely a usage planning act. There is a non-discretionary duty to ensure that the Secretary of the Interior shall prevent, by regulation or otherwise, unnecessary or undue degradation of the public lands. 43 U.S.C. § 1732; Sierra Club v. Hodel, 848 F.2d 1068 (10th Cir. 1988). However, this provision is difficult to enforce, and common law doctrines of judicial deference to administrative agencies allow the BLM itself to determine whether degradation is occurring and whether any degradation is necessary – for example, to fulfill the desire of the agency to allow cattle grazing, mining or oil and gas development. Because there is no requirement to measure degradation, it is easy for BLM to claim that there is none.

BLM is required to develop land use plans for the lands it manages. 43 U.S.C. § 1712(a). However, the agency has been given great latitude to manage for whatever goals it wishes, and these goals have primarily favored extractive economic uses over preservation of wildlife (Nolen 1996).

Other Federal Laws

The Public Rangelands Improvement Act (PIRA), 43 U.S.C. §§ 1901-1908, Pub. Law No. 94-514, recognized the degradation of grasslands, shrublands and other arid lands in the U.S. and required a national inventory of rangelands. However, PIRA requires no particular conservation efforts by any agency.

The Taylor Grazing Act, 43 U.S.C. §§ 315-316, June 28, 1934, as amended 1936, 1938, 1939, 1942, 1947, 1948, 1954 and 1976, was the first federal attempt to regulate grazing on the public's lands. The Taylor Grazing Act established grazing districts and permits for grazing, but as one legal scholar, George Coggins, noted "it causes far more problems than it solves." The vast declines in sage grouse have occurred under the operation of the Taylor Grazing Act.

The Sikes Act, 16 U.S.C. §§ 670a-670o, September 15, 1960 (74 Stat. 1052, Public Law 86-797), as amended 1968, 1974, 1978, 1982, 1986, 1988 and 1989) requires the development of conservation plans for wildlife on all public lands. BLM has not developed a comprehensive plan for sage grouse, and the species has declined under the operation of the Sikes Act.

Enforcement

Multiple use land management agencies, such as the BLM and Forest Service, may be structurally incapable of adequately managing species at risk. One important reason for this arises from the agency mission to provide for extractive commercial interests such as grazing and mining, as well as recreational interests such as off-road vehicle (ORV) use that have strong support from large industrial manufacturers. Such uses are often at odds with wildlife protection, and agencies often fall prey to the familiar phenomenon of administrative "capture" by the interests it is supposed to be regulating: "controls directed by a public regulator on the private sector...[but] in practice, the direction of interference or control is opposite ... regulatory outputs tend to correspond to the interests of the regulated party...." (Mantic 1980, p. 14). This is the familiar problem of capture of a regulatory agency by the interests it is supposed to regulate (Davis and Pierce 1994), a phenomenon first systematically analyzed by Nobel Prize winning economist George Stigler.

Management on Bureau of Land Management (BLM) Lands

The Federal Land Policy and Management Act (FLPMA), 43 U.S.C. § 1701 – et seq. controls the activities of the Bureau of Land Management (BLM) in managing public lands under its purview. Notably, FLPMA does not contain a provision requiring that the viability of wildlife populations be protected (cf. NFMA). Sage grouse have declined significantly since FLPMA was enacted in 1976, thus it is obviously inadequate to protect the species. A former biologist with the Idaho Dept. of Fish and Game was not afraid to speak out regarding BLM management:

> It would be too optimistic to presume that BLM and the Forest Service will provide sufficient sage grouse habitat. [FLPMA] has done little but produce an array of alternatives for habitat-alteration proposals. Selecting the best alternative for wildlife is so rare that it is almost nonexistent. (Autenrieth 1986, p. 775).

Autenrieth also spoke about the cause of this mis-management:

> As long as livestock men dictate BLM and Forest Service policy and as long as the people of the United States subsidize ranchers ... sage grouse and other wildlife will continue to decline. (Autenrieth 1986, p. 774).

Autenrieth's damning comments are as true today as 15 years ago. All that has changed is that sage grouse populations have declined drastically since his comments were made. The misadministration detailed here by BLM may result from the capture of the agency by extractive interests, as charged by scholars on public administration (Culhane 1981), legal commentators (Greeno 1990), and the agency's own employees (PEER 1994).

BLM is aware that sage grouse have declined 33% in just the last 30 years (BLM 2000f), and that virtually all actions undertaken by the agency present a "high" degree of risk to sage grouse populations (BLM, undated; BLM 2000f). Moreover, the agency acknowledges that sage grouse "have experienced significant population declines" and "widespread loss and degradation of sagebrush habitat across the West" (BLM 2000g). High officials within BLM are aware that "both habitat and populations have been reduced dramatically," and that sage grouse are now "at the lowest population levels ever recorded" (Daly 2001). BLM lists agricultural conversion, overgrazing by domestic livestock, invasion of exotic plants, water diversions, expansion of juniper and pinyon pine woodlands, fragmentation, and large, hot burning wildfires as threats (BLM 2000g). Fragmentation is a "problem, even for higher quality habitats" (BLM 2000g). But BLM has been remiss in taking conservation actions, or even halting actions that harm sage grouse. Petitioners and their technical consultants have reviewed nearly one thousand BLM documents (254 of which are cited in the accompanying Bibliography) and not one provides adequate monitoring, evaluation, or consideration for sage grouse. Moreover, BLM states that it does not even ***know*** what the effects of grazing are on removal of grasses and shrubs, or what the effects of removal of grasses and forbs are on sage grouse (Hecker 2000). Yet, specific management recommendations for sage grouse are readily available (WSSGTC 1999, and prev. reports). Interestly, BLM has been "managing" grazing for over a century and has been managing sage grouse to extinction for decades. Braun, et al. (1994b) note that federal land management agencies have been "reluctant to alter management practices" when that would "conflict with commodity uses, such as livestock grazing." This statement is borne out by internal documents relating to sage grouse and sagebrush ecosystem conservation. The national BLM office has delayed giving direction to the states for years even though various drafts for a national direction were presented as early as January 1999. Instead, the document was re-drafted over and over again with much time passing between the drafts (various drafts are dated 23 Jan. 1999, 6 April 1999, 7 Dec. 1999, 5 May 1999) and little change from one draft version to another. By July 2000, the direction had still not been issued – perhaps it will never be issued, except in an extremely watered-down form. One biologist characterized this as "inexcusable" and baffling "foot-dragging." Other biologists, who complained about the delays, were told to "shut up" and later were forced out of the agency. These delays appear to be the result of bureaucratic politicization, and emanate from the Office of the national Group Manager for Fish, Wildlife and Forests, Christine A. Jauhola. But the problem is endemic among BLM management personnel. It is not merely individual scientists who have criticized BLM management. The US General Accounting Office has also harshly criticized BLM mis-management (GAO 1993a).

Moreover, BLM admits that sage grouse, along with numerous other grassland and shrubland species, are "losing ground" on the lands it manages (BLM 1992, p. 5). Apparently, BLM considers its duties to conserve sage grouse troublesome. No less than three employees have been threatened by high level BLM administrators over sage grouse issues. Numerous internal memoranda discuss the "problem" of sage grouse and ways to prevent a listing. One employee noted that his "brain wrestled all night with insoluble, nonsensical sage grouse problems of its own manufacture. Awoke exhausted" (Stamm 2000). Yet there is no need to manufacture nonsensical problems – BLM has created plenty of problems for, and threats to, sage grouse on the public lands it has mismanaged. Some of these problems may indeed be insoluble – cheatgrass expansion is one – but most are easily soluble by limiting both development and livestock grazing.

Riparian habitats are critical to sage grouse as well as to other fish and wildlife species. However, BLM concedes that broad recovery of riparian areas will not occur under current grazing management (USDI 1994a, Draft EIS, p. 3-32). The agency continues to destroy riparian habitats with water developments (Rich 1999).

To a large extent, these declines and the mis-management of sage grouse habitat by BLM have occurred while the Western sage grouse was a Candidate species. Yet, BLM's policy is to conserve Candidate species (BLM Manual 6840.06C) and to alter all proposed actions to prevent further declines and the need for listing of Candidate species. This is an internal policy, and not a regulatory mechanism that the public can enforce, at least over much of the range of sage grouse. See Western Radio Services Co., Inc. v. Espy, 79 F.3d 896, 907 (9th Cir. 1996) cert. denied sub nom. Western Radio Services Co., Inc. v. Glickman, 117 S.Ct. 80, 136 L.Ed.2d 38, (1996). Because "enforcement of the law is what really counts," Evans v. Jeff D., 475 U.S. 717, 746 (1986) (J. Brennan, dissenting), the BLM has been able to destroy vast areas of sage grouse habitat without restraint and has made a mockery of its policy to conserve Candidate species. One need only compare the widespread declines in sage grouse on BLM administered lands with the length of time the species has been listed as a Candidate to see that this policy has in no way operated to conserve sage grouse and is no regulatory mechanism.

Not only has it not adequately protected sage grouse, the BLM has actively destroyed vast areas of habitat by conversion to agro-industrial livestock operations, for strip mining of coal resources, and has fragmented habitat with roads, powerlines, fences, oil and gas installations, and other industrial developments. The Western Association of Fish and Wildlife Agencies "has continually expressed concern about the management of western rangelands, most of which are administered by the Bureau of Land Management" (Braun 1987a). A common claim made by BLM employees is that sagebrush is "over-mature" or "decadent" and must be removed or degraded. This office has examined dozens of such claims in its review of BLM documents, and not once has any objective measurement been offered to establish such claims. Indeed, BLM has not even established standards or definitions as to what constitutes "over-mature" or "decadent" sagebrush. These subjective impressions by BLM personnel appear to merely be window dressing to justify alteration of native ecosystems to provide forage for domestic livestock.

BLM is to designate certain areas as Areas of Critical Environmental Concern (ACEC) pursuant to 43 C.F.R.§ 1601.0-5, if special management is required to protect natural resources. However, only about 200 such areas have been designated (Williams and Campbell 1988). The areas designated have typically been very small and often limited to wilderness areas (Cooperrider 1991). Of course, wilderness areas are already protected, so designation of an ACEC therein carries little political risk to the bureaucracy. Commentators have criticized BLM for its failure to designate ACECs (Campbell and Wald 1989).

There appears to be economic distortions in the management of funds by the BLM. The US Government Accounting Office found that BLM directs only 3% of its total appropriation to wildlife habitat management, and instead directs 34% of its budget to its three consumptive programs: range, timber, and energy and minerals (GAO 1988b). Such lack of funding constitutes additional evidence regarding the inadequacy of existing management programs.

The Bureau of Land Management has seriously mis-managed the public's lands: even when using the BLM's own definitions and rating system, over 68% of its lands are in "Unsatisfactory" condition (Wald and Alberswerth 1989, GAO 1991a). BLM mismanagement has been the subject of a large number of GAO reports, all of them critical. As Donahue points out, the mere titles of these reports constitute an indictment: titles of GAO reports contain such excerpts as "more emphasis needed on declining and overstocked allotments," "widespread improvement will be needed," "monitoring has fallen short of requirements," and "database incomplete and inaccurate" (Donahue 1999, p. 56). These GAO reports are listed in the Bibliography of this petition and incorporated herein by reference. As Hermach once noted with respect to mismanagement by the USFS, if a foreign power had abused the public's lands the way the BLM has, it would be considered an Act of War.

Some BLM offices have recognized that their management must change. For example, the Idaho State Office proposes to build exclosures around springs and wet meadow areas (Foster and Olendorff 1999). However, these exclosure will serve as raptor perches, creating a kill zone for sage grouse inside the area that was intended to be protected. Only removal of livestock from large areas will suffice to restore sage grouse. The same BLM memorandum suggests increasing the use of herbicides to control noxious weeds, and notes the inconsistent and fragmented nature of management and GIS implementation (Foster and Olendorff 1999).

BLM has requested large amounts of funding to implement what it calls the Great Basin Restoration Initiative, a huge and expensive ($25 million per year) effort to reverse cheatgrass invasion and reduce fire frequencies (Tweit 2000, p. 70). If implemented, this effort may not improve sage grouse habitat, and could further damage habitat because it emphasizes the planting of non-native grasses on vast expanses of public land (Tweit 2000, p. 70). The Great Basin Restoration Initiative appears to be an effort to restore livestock forage only, not native biodiversity. Currently, BLM is allowed to use over 21 herbicides on western lands (Shaw and Monsen 2000, p. 66). BLM herbicide use is governed by an EIS pursuant to NEPA (BLM 1991b). The Great Basin Restoration Initiative may modify that EIS to allow even more herbicide use on public lands. Although herbicides can reduce cheatgrass invasion rates, they also risk numerous reproductive effects on sage grouse, other wildlife, and humans, and are likely to damage forbs and grasses needed by sage grouse. Moreover, BLM employees, as well as the public, doubt whether BLM can properly manage for wildlife on the public's lands without being forced to do so by an outside entity. As one BLM biologist put it "the only thing that gets under a manager is T&E" (name withheld by request).

BLM does not adequately monitor, plan for, or measure sage grouse populations or habitat parameters needed to restore the species. For example, state wildlife biologists have noted that "composition and density goals in BLM range plans are not expressed in terms compatible with the sage grouse guidelines" (Grandison and Welch 1987).

There has been no significant improvement in BLM lands – which form most of the range of the sage grouse – since 1950 (Donahue 1999, p. 50, 61-64). Congress noted these "deteriorat[ions] in quality" over "substantial portions" of BLM lands when it enacted FLPMA (43 U.S.C. § 1751(b)(1), codifying section 401(b)(1) of FLPMA). But, in the ensuing years, rangeland conditions have gotten worse. BLM admits that 43% of the uplands it administers are non-functioning or are functioning at risk (USDI 1994a, Draft EIS, p. 26). BLM admits that current grazing management is unlikely to improve these BLM lands (USDI 1994a), yet BLM has implemented few if any changes in grazing on lands within the range of the sage grouse. BLM also does not adequately enforce its own regulations against grazing trespass (Donahue 1999, p. 65). Thus, livestock grazing cannot be allowed even near sage grouse habitat much less inside it, if the species is to be conserved. BLM has an odd notion of what is needed to conserve sage grouse – the agency lists both installation of water catchments and of fences as the only type of "habitat improvements" it has taken "to benefit sage grouse" (BLM 1992, p. 12). However, sage grouse do not need artificial water impoundments (and none existed when 1 to 2 million sage grouse saturated the shrub-steppe in pre-settlement times). Fences do not help grouse, they harm them. This is made abundantly clear in this review, but the publications reviewed here pre-date 1992, when BLM conducted its review. Rather than improve or even pay attention to sage grouse on all its lands that contain habitat, BLM has compiled a list of "key upland game bird areas" that will receive "increased management emphasis" (BLM 1992, p. 8, 30-34). Only a small part of sage grouse habitat is within these key areas. Moreover, BLM fails to spell out what management actions or "emphasis" it plans for these key areas and has not conducted any NEPA analysis for these key areas.

BLM has promulgated a series of vague and elastic guidelines for management of its lands," which it terms "Standards of Rangeland Health" (BLM 1997a). Despite the acknowledgement that assessment and monitoring are "critical," little such monitoring has been done. Worse, the "standards" are not objective or measurable standards at all, but instead are unverifiable narrative descriptions and subjective impressions, which are wholly unstandardized. Even these reports are rarely completed for the vast majority of the sagebrush ecosystems under BLM's purview. These guidelines appear to have been drawn to give BLM maximum bureaucratic *lebensraum*, rather than to improve the management of the public's lands. Meanwhile, BLM continues seedings as a "land treatment option," continues to "control" brush, and continues to build fences and water developments at a "steady pace" (Rich 1999).

BLM has also begun planning for a strategy to conserve sage grouse and other species in sagebrush ecosystems. The plan will be led by the Oregon BLM, which is a bit more proactive than most other state BLM offices, perhaps because of its experience with spotted owl issues. However, BLM initiated this planning only after it learned that a petition to list sage grouse was planned, and the plan's purpose is not so much to conserve sage grouse as to prevent a listing. In discussing the plan, BLM officials noted what elements would be "critical to forestalling a listing" (Lorentzen 1999). A US FWS employee (Al Pfister) stated these elements: that the plan be not only completed, but also be implemented and be effective (Lorentzen 1999). The plan has apparently not been completed or implemented at all as of yet, there is no evidence whatsoever of its effectiveness, and, of course, it does not constitute a regulatory mechanism – in fact, this plan will probably never be enforced, except by a listing under the ESA.

As numerous court cases attest, BLM has a long history of violations of our nation's environmental laws. This established course of agency conduct shows that the Service cannot rely on BLM to follow the law in the future. The Service thus should give no weight to any conservation agreements involving BLM in its decision to list, nor can the Service rely on BLM to follow the nation's environmental laws to conserve sage grouse. The touchstone of the adequacy of a regulatory mechanism is its enforcement.

BLM Management in California

BLM is updating its management plans in California. Recently, BLM appears to have reduced grazing on allotments where sage grouse still exist during the current drought (Blankenship 2001b). But, BLM has only reduced grazing near leks (Halford 2001b). Grazing must be reduced in all areas used for foraging and nesting as well, and must be reduced over areas of unoccupied habitat to allow population increases. Moreover, grazing must be reduced during non-drought times to allow vegetation to increase when moisture is available. Neither USFS or LADWP has comparable standards for grazing management (Halford 2001b).

In 1991, BLM proceeded with actions that it knew would "moderately to heavily impact[]" the Long Valley sage grouse population even though it knew that sage grouse declines were widespread and severe (Bishop Resource Area, BLM 1991, p. 4-10). The California BLM state office recently completed an EIS for rangeland health, but this document gives virtually no consideration to the needs of sage grouse and mentions them only in a few brief sentences under other upland game species (California State Office, BLM 1998, p. 3-50). By BLM's own admission, most rangelands are not improving at all (California State Office, BLM 1998, appendix 7, table 5).

BLM Management in Colorado

BLM's treatment of Fruitland Mesa, an area of public land under its administration in Colorado, is well documented, and worthy of attention as an example of BLM management of sage grouse habitat. In 1983, the BLM conducted a "plow and seed" operation "for livestock grazing" (Anonymous 1995a) and to "increase livestock forage (Uncompahgre Basin Resource Area 1994, p. 4), thereby destroying large amounts of sage grouse habitat. Immediately thereafter, lek counts declined by 50% (Anonymous 1995b). Searchers were unable to see any sage grouse in the plow and seed areas (Ferguson 1986, p. 2) or even near the plow and seed areas (Bray 1981, p. 2). By 1994, BLM finally recognized that sage grouse had "declined sharply" in this "livestock emphasis area" and proposed to improve sage grouse habitat (Uncompahgre Basin Resource Area 1994; p. 5, p. 3). Unfortunately, BLM only proposed to enhance historic lek areas by brush beating, and completely ignored the need for winter habitat, nesting habitat, food sources, brooding habitat, and other components of sage grouse needs. The BLM assumed that since the use by cattle would be past "the peak time for the sage grouse breeding season" that "no direct conflicts" would ensue (Uncompahgre Basin Resource Area 1994, p. 3). Of course, not all sage grouse are finished breeding by the peak of the season, so substantial direct impacts would occur to late nesting birds, including any that had to renest because of predation or disturbance. Worse, BLM completely neglected the high likelihood of indirect impacts by cattle grazing: removal of vegetation, erosion, and others detailed elsewhere in this review. Declines continued, and by 1996, BLM planned to interseed grasses and forbs into the areas that had been plowed and seeded with non-native species for cattle (Uncompahgre Basin Resource Area 1996). Cattle grazing was now recognized as such a severe problem that BLM proposed to spend huge amounts of money to erect and maintain electric fences in this remote location to keep cattle away from sage grouse areas. In this document, the BLM also reveals its "ultimate mission" – to "prevent wildlife species from being listed under the ESA" (Uncompahgre Basin Resource Area 1996). BLM personnel regard the potential listing of Gunnison sage grouse under the ESA as a "train wreck" (Stiles 1996). Nonetheless, BLM agrees that the bird exists in very "low numbers," has a "limited range," and has declined range wide for over 40 years (Stiles 1996).

BLM mis-management at Fruitland Mesa is not an isolated instance; instead, it is symptomatic of BLM's treatment of sage grouse and other wildlife throughout its administrative reach. For example, BLM has proceeded with destruction of habitat for the Gunnison sage grouse in the Tomichi grazing allotment in the Gunnison Resource Area despite strong scientific criticism. Dr. Jessica Young, an expert on the Gunnison sage grouse, explained to BLM that the monitoring called for in its allotment management plan (AMP) was not sustainable and that cattle removal would not occur when needed. Nonetheless, BLM proceeded, and Dr. Young's concerns were realized (J. R. Young 1999a, p. 1). This occurred despite unusually favorable range conditions that year – in more normal years, even worse degradation would occur (J. R. Young 1999a, p. 1). Dr. Young also notes that BLM shows great solicitude, greater than it does for the public's wildlife, towards the grazing permittee – who has already received $100,000 from the government for his cattle operation (J. R. Young 1999a, p. 3). Instead of protecting the public's wildlife, the BLM's actions have allowed overgrazing by cattle, have reduced the already sparse forb cover, and BLM has failed to analyze costs and benefits of rest-rotation grazing systems (in violation of NEPA). Consequently, almost none of the allotment meets standards for Public Land Health, and over half the area is static or getting worse (J. R. Young 1999a, p. 2). Another example of BLM's attitude towards wildlife is illustrated in the Sims Mesa area, where Gunnison sage grouse showed severe declines. Instead of halting livestock grazing, BLM requested permittees to restrict their grazing somewhat, but did not bother to enforce these restrictions. BLM merely began "requiring an … understanding" of how livestock grazing "will be managed to improve … sage grouse habitat" (Belt 1998). But there is abundant scientific evidence, as well as expert opinion, that the way to improve sage grouse habitat is to remove grazing.

As yet another example, the BLM proposed to construct a haul road for radioactive waste through the middle of the nesting area for the "largest single colony" of Gunnison sage grouse (Guadagno 1992) which scientists considered to be of "particular importan[ce]" to the species, even though BLM had previously been informed by multiple experts that this group of birds was the last hope for the species (J. R. Young 1992b, p. 2). This road would have such an extreme volume of traffic that heavy trucks would pass the leks every 90 seconds, and would be built through critical nesting, brood rearing, and winter habitat. Besides the haul road, which would pass within 100 meters of key leks, the BLM proposed to store the radioactive mine tailings within 500 meters of the leks (J. R. Young 1992b, p. 2). The BLM even attempted to evade evaluation of the impacts of this action by refusing to prepare an Environmental Impact Statement (Guadagno 1992), and began work on the project, even though mitigation attempts were inadequate (J. R. Young 1992b, p. 3). The BLM not only ignored individual sage grouse experts, who warned of a "devastating impact" continuing for decades (J. R. Young 1992b, p. 2), but also ignored the state Div. of Wildlife, which protested the project and warned that at least half the mating population in the area would be lost (J. R. Young 1992b, p. 2).

Fire is a serious threat to sage grouse. For example, over 20% of the fire starts in the Uncompahgre area of Colorado are from human causes and fire has burned nearly 22,000 acres since 1989 (Uncompahgre Field Office Fire Management Plan 1999). Many fires are set intentionally by BLM, and it's analysis of fire effects on sage grouse is inadequate. For example, despite the extreme danger to sage grouse habitat from fire, sage grouse habitat receives the second lowest of all precautionary classifications in the Uncompahgre fire plan, and "significant prescribed burning" is expected in these areas (Uncompahgre Field Office Fire Management Plan 1999, p. 7). Moreover, no analysis of fire return intervals or of the decades needed to restore sagebrush cover has been done. Instead, BLM appears to be using fire to remove oak and confers from these areas (Uncompahgre Field Office Fire Management Plan 1999). But this removal could be accomplished by other, safer means, such as the cutting of trees. Reduction of over-mature sagebrush could be achieved by mechanical means. The EA for the Uncompahgre fire plan also fails to consider the likelihood of fire escape, cheatgrass invasion, or the myriad other effects of burning on sage grouse habitat (Uncompahgre Field Office Fire Management Plan, Environmental Assessment 1999).

BLM Management in Oregon

The Oregon state office of BLM acknowledges that sage grouse habitat in Oregon has declined by 50% of its original range, and that populations have declined by 60% in the remaining range (Bradley 1999). Moreover, the BLM admits that the species is at risk in Oregon and Washington, and has proposed development of a sage grouse conservation strategy (Bradley 1999). BLM is also aware of the importance of nesting and wintering habitat, as well as the inadequacy of simply protecting areas within 2 miles of a lek (BLM 1999c).

Despite BLM's knowledge of the demise of sage grouse, the agency has done little to alter its land management actions in the state. BLM has generated numerous Resource Management Plans (RMPs) and Allotment Management Plans (AMPs), but the agency has avoided NEPA compliance by segmenting the various plans even though they are connected actions, and even though they all affect sage grouse. A listing under the ESA would put and end to this segmentation and refusal to assess effects rangewide. BLMs plans are inadequately monitored, and contain no provisions to measure vegetation density or height – or any other habitat components that are important for sage grouse. BLM allows grazing from June through October, apparently believing that this protects sage grouse. Of course, livestock still remove vegetation needed by sage grouse, particularly for the crucial growth and development periods, and for nesting the next spring. BLM also maintains an ORV area in known sage grouse habitat.

In the Prineville area, BLM has removed brush by "burning, brushbeating, herbicide spraying, or plowing of big sagebrush" (Prineville District, BLM 1989, p. 89). Only areas inside "important mule deer wintering grounds" are spared (Prineville District, BLM 1989, p. 89). Although well aware that sage grouse are in trouble, decreasing, and depend on sagebrush, the Prineville BLM is destroying habitat at a rapid rate. The Prineville BLM is also undertaking construction projects in sage grouse nesting areas (Prineville District, BLM 1989, p. 90). It claims it will mitigate the effects of construction disturbance by not conducting the work during nesting, but there are two problems with this scheme: the constructed edifice will remain through all seasons and will likely serve as a raptor perch, and construction will occur during the brooding season, which may be even more damaging than activities during the nesting season.

In the Deschutes area, BLM has increased grazing without any monitoring of vegetation or sage grouse habitat, even though the species was a candidate for listing at the time (Hanf 1991, p. 1). In the Leslie Ranch part of the Deschutes area, sage grouse numbers declined at a rate that was statistically highly significant (Hanf 1991, p. 2). Worse, the magnitude of the declines was great – attachment 3 to the Hanf memorandum shows strong declines at most leks; only 2 leks increased, and the overall decline was -18% (Hanf 1991). This decline, in the professional opinion of BLM's own wildlife biologist "clearly reflects the deleterious impacts of heavy livestock grazing" (Hanf 1991). Despite its legal obligations, BLM has "not adhered to the management plan" even though this is even more critical during periods of drought (Hanf 1991, p. 3). Grazing by the permittee was even higher than the allowed amount (Hanf 1991). On the Leslie Ranches allotment, males declined by 58% from 1988 to 1991, leaving only 71 males in the area (Prineville District, BLM 1992a). But BLM proposes no enforceable standards for the future management of these areas. Instead, it promises it will monitor and provide flexible management (Prineville District, BLM 1992a). However, apparently no monitoring has been done, as BLM was unable to provide documents related to ongoing monitoring of sage grouse and their habitat in response to a FOIA request made in 1999. BLM is also pursuing management that it claims will increase sage grouse, but the actions undertaken are either not helpful to sage grouse or will harm them. Such inappropriate management actions include installation of guzzlers and water pipelines (Prineville District, BLM 1992b), which are not helpful to sage grouse and may deprive the birds of riparian vegetation by dewatering areas to run the guzzlers. BLM is also installing fences that serve as perches for aerial predators. Finally, BLM proposes to burn over 1,000 acres in the Leslie Ranches area, which poses a significant risk of fire escape and habitat destruction (Prineville District, BLM 1992b).

The Moffit Allotment contains one of the largest sage grouse leks on the Prineville District, as well as wintering areas and probable nesting grounds (Hanf 1989). Nonetheless, BLM allowed "heavy cattle use" that had "severe" effects on bitterbrush, removing 90% of the new years growth (Hanf 1989). All this occurred despite the BLM's Allotment Objectives to "improve ecological condition" and to "maintain or improve livestock forage" (Hanf 1989). So bad was the abuse in this allotment that the BLM's own wildlife biologist refused to sign the evaluation (Hanf 1989). This biologist was later harassed and transferred by BLM administrators.

In the Millican Valley in Deschutes County, BLM has undertaken extremely destructive actions, despite recognizing that the valley is "very important" for the "winter survival of sage grouse" (Prineville District, BLM; undated). BLM knew that the Millican Valley provided the only winter habitat during heavy snow years because of its "comparatively mild weather" and "fairly good sagebrush cover" (Prineville District, BLM; undated). In 1994, BLM promised to immediately implement actions to conserve sage grouse, but it has not done so – instead BLM appropriated lands for "use and development" which contributed to a "loss of sage grouse habitat" and did not mitigate these actions (Hanf 1995). These birds are "at risk of extirpation" (Hanf, et al. 1994, p. 10), making BLM's mismanagement even more bewildering. The only plausible explanation is that BLM administrators decided to sacrifice sage grouse to appease powerful off-road vehicle (ORV) interests in the county. Without the protection of the Act, such mis-management is certain to continue, and further waves of extinction will follow.

Status Review: Eastern Sage Grouse

Despite the serious habitat loss in the Umatilla Basin of Oregon (described above), the BLM proposes to trade away a large block of nearly 3,000 acres of sage grouse habitat in a land exchange (Prineville District, BLM 1998, comment letter of Dec. 30, 1997 from Oregon DFW). Despite the concerns of ODFW, BLM's actions will severely reduce the already limited sage grouse habitat in Juniper Canyon, which is "one of the largest and most ecologically intact examples of the shrub-steppe/grassland habitat type" (id., p. 3 of letter). BLM later "misinterpreted" the ODFW letter, necessitating an additional letter reiterating the state agency's previous points, most especially, that the proposed disposal of Juniper Canyon was ODFW's "primary concern" in the exchange (Prineville District, BLM 1998, comment letter of Feb. 18, 1998 from ODFW). BLM policy (Manual 6840, Special Status Species Management) "requires that BLM work with state agencies in achieving conservation goals" for sage grouse and similarly situated species (Bibles 1990, Attachment 1-1). BLM has not obeyed its own policy, has not given adequate deference to the state's valid concerns, and has sought to cloak its bad faith in the shroud of "misunderstanding." Listing under the ESA would put an end to such nonsense, and provide a better forum for state concerns to be expressed, thereby promoting federalism.

On the Burns BLM District, the agency has not "completed evaluations on Allotment Management Plans (AMPs) having sage grouse objectives" (Hanson 1999) despite the serious declines in sage grouse populations. Even when it issues management plans for allotments, BLM has not adequately evaluated sage grouse needs. For example, even though sage grouse are a "priority species," BLM stated that "no specific population or habitat data has been collected during the revaluation [sic] period" for the Pueblo Mountain Allotment, nor did BLM reduce the number of cattle on the allotment (Christiansen 1999, p. 5-6 of attachment).

Federal agency projects such as the Vale Project eliminated shrub cover from millions of acres of public lands in southeastern Oregon in the 1960s. By 1981, in the Burns and Vale districts alone, the BLM had altered native vegetation on 140,770 ha, had seeded alien annuals grasses on 211,682 ha, had built 4,469 miles of fence (exposing the remaining sage grouse to raptor predation), installed 477 cattle guards and built over 1,000 miles of roads (Maser and Thomas 1983, p. 11). The BLM also destroyed 749 springs, built 927 water tanks and 2,119 reservoirs, and laid nearly 800 miles of water pipe (Maser and Thomas 1983, p. 2). In brief, BLM attempted to convert the native ecosystem into an agro-industrial cattle factory, and every action taken was detrimental to sage grouse. Vale BLM proposals (such as the Bully Creek LAMP, BLM 2000c) continue to emphasize removal of sagebrush and other shrubs.

Recently, biologists in the Oregon BLM have begun to proactively draft guidelines for sage grouse habitat management. Although laudatory, such steps are too little, too late, and in themselves cannot prevent extinction. Guidelines are not regulatory mechanisms, and these guidelines have not even been finalized, much less adopted as enforceable regulations.

Despite BLM's "Oregon Sage Grouse Conservation Strategy," the BLM plans large amounts of fencing, water developments, and land exchanges in sage grouse habitat. These actions will severely harm already depleted populations of sage grouse in the state. It is hard to see the conservation in BLM's strategy.

BLM Management in Montana

In Montana, BLM has not adequately protected habitat. Consequently, populations have declined sharply on BLM lands, as shown in the Population Assessment section.

There appears to be a policy to provide only partial protection of sage grouse lekking areas within either a few hundred feet or up to ¼ mile of a lek. Every NEPA document examined from numerous field offices limits protections in this way. In addition, BLM has undertaken a vast program of chisel plowing in Montana, ostensibly to remove club moss and encourage grass growth for livestock (Brubacker 1989). The state BLM office issued chisel plowing criteria that allow habitat destruction and disturbance up to 100 feet from known sage grouse leks (Brubacker 1989). Of course, if a lek area is not "known," it will be destroyed. But even if all leks were known, these criteria would allow destruction of all habitat for every other life history stage, thus decimating sage grouse populations. Indeed, a 100 foot buffer does not even allow adequate hiding cover to reduce predation losses on the lek.

As another example, BLM has applied No Surface Occupancy (NSO) stipulations for oil and gas operations and prospecting only within ¼ mile of leks and has only applied timing stipulations within 2 miles of leks (Miles City District, BLM 1992, p. 71; 1995, p. 38; Lewistown District, BLM 1998, p. 44). In 1988, BLM allowed drilling within 500 feet of all sage grouse leks in a blanket stipulation (MT-3109-1, attached to West HiLine RMP, BLM 1988). Studies have shown that many birds nest much farther from leks than 2 miles. Also, noise and disturbance can easily carry more than ¼ mile. Worse, such stipulations provide absolutely no protection from raptors or corvids ranging many miles away from perches provided by installations, and winter, brooding, and fall habitats are completely unprotected by such stipulations. Two mile buffers are inadequate as many birds are known to nest beyond this range from leks. Also, such small buffers provide no protection for other habitat components during other parts of the life history. In 1990, BLM began requiring a 2 mile buffer, but only in the breeding season; moreover, maintenance and operations facilities were allowed even inside the buffer (State Director, MT BLM 1990). Finally, BLM appears not to have updated all plans to require even the inadequate 2 mile buffers.

Severe impacts to sage grouse habitat in Montana have resulted from BLM development activities. Past, present, and projected coal development cause "significant local impacts to wildlife" on over 1 million acres of land. These impacts occur "even if mitigation for the loss of wildlife habitat" is successful (Miles City District, BLM 1984, p. 112). The BLM rightly notes that the fact that "wildlife habitat would be destroyed" is "a significant impact" (id.). BLM also proposed destruction of sagebrush habitat by "mechanical treatments," range "improvements," and by allowing over 700,000 AUMs of grazing impacts (id., p. 113). BLM claims that the removal of needed food plants and vegetative shelter for sage grouse would somehow have "favorable impacts" (id.), although it does not offer any explanation for this surprising conclusion. BLM also proposed to construct over 100 miles of fencing, which serve as raptor and corvid perches, and to dispose of over 165,000 acres of the public's lands, which would expose any sage grouse there to development and other actions, unprotected by law (id., p. 114).

BLM has not considered the cumulative impacts of its actions on sage grouse. For example, the Malta Field Office has proposed and conducted multiple prescribed burns without considering the cumulative effects of these actions. One burn of 320 acres, on the South Alkali Creek Allotment # 5369 (Malta Field Office, BLM 1998a) is just a few miles from the Ferry

Plant prescribed burn, but the actions are analyzed in complete isolation from each other (Malta Field Office, BLM 1998a). Protection under the ESA would assure that the effects of actions on federal, state, and private lands is analyzed together. The BLM also incorrectly assumed that burning outside the nesting season would not significantly affect sage grouse – of course, burning destroys habitat for decades (until sagebrush can grow back to adequate density and height), something the BLM characterized as "temporary" (Malta Field Office, BLM 1998a; 1998b). On the Guston Coulee allotment, the Malta Field Office admits that nearly half of the range is in only "fair" condition (a rating of fair indicates that the area is sufficiently degraded as to significantly affect sage grouse), while none of the allotment is in "excellent" condition (Malta Field Office, BLM, undated). Yet, BLM admits that the "entire allotment is considered crucial nesting habitat" because it is within 2 miles of a lek (id.).

BLM continues to rely on mythological notions, not data-based grazing management, such as the Savory method, aka "HRM, Holistic Resource Management" (Pike 1987). Gammon (1978), and Herbel (1974) have reviewed Savory's recommendations as well as other rotational grazing systems and found that they offer no advantage. Other studies criticizing Savory include Noss and Cooperrider (1994), Miller, et al. (1994), and particularly Belsky (2001). Grazing systems are, at best, minor effects on herbage production on rangelands – the major determinant of herbage production is the stocking rate (Van Poolen and Lacey 1979). BLM does not even apply HRM to meet rangewide sage grouse habitat restoration goals. For example, it has not considered any habitat component except nesting habitat, and then only within 1 mile of a lek (Pike 1987). Indeed, BLM sage grouse habitat management is not designed to conserve the species, but only to "give as much consideration as is possible under the circumstances" to sage grouse and other birds that get in the way of livestock development – over 2/3 of the available forage goes to livestock (Malta District, BLM 1982).

In the Havre area, BLM has admitted that sage grouse "are a species of concern" because of "decline throughout their historic habitat" (Havre Field Office, BLM 1999, p. 12). Nonetheless, BLM proposed a prescribed burn which would harm this "crucial winter habitat for sage grouse" (id.) even though it admitted that "any loss of sagebrush … will have a negative impact on sage grouse" (Havre Field Office, BLM 1999, p. 24).

BLM appears to be misinformed about sage grouse requirements. For example, the Dillon, MT resource Area proposed to protect sage grouse by fencing "meadow sites to exclude livestock" (Dillon Resource Area, BLM 1979, WL-22.1). However, fences serve as raptor perches and this would harm sage grouse by creating a "death zone" within hundreds of feet of each fence post. BLM also intends to protect sage grouse by restricting mining in winter and spring – but only on what BLM terms "crucial" sage grouse winter ranges (Dillon Resource Area, BLM 1979, WL-5.12). Although BLM underlined the term crucial to ensure that mining and other disturbances could still occur on all other winter range, it did not define the term. Moreover, BLM apparently did not recognize (or sought to conceal from the public) the obvious fact that mining destroys habitat no matter when it is conducted.

BLM provides little protection for or consideration of sage grouse. The Butte BLM Field Office has not evaluated allotments with sage grouse habitat under its Standards and Guidelines process, it does not have any activity plans with objectives for sage grouse, and it has not developed an allotment evaluation that addresses sage grouse (Good 1999). Not surprisingly, few sage grouse remain in the Butte area although sage grouse were "commonly seen until the last 10-15 years" (Butte Field Office, BLM 1998, 3-101). Intensive surveys failed to locate any sage grouse and the largest "flocks" that have been sighted consisted of only 3 individuals (Butte Field Office, BLM 1998, 3-101). This is not isolated neglect: The Billings resource area has proposed to enhance sage grouse habitat by constructing game bird watering devices, even though sage grouse do not require free water (Billings Resource Area, BLM 1983a, p. 27). Instead, sage grouse require the plants in wet meadow areas near seeps and springs – it is these areas that BLM destroys by installation of livestock watering devices.

BLM Management in Wyoming

"Sublette County is thought to contain some of the best sage grouse habitat in the state" (Wyoming BLM 1998). Yet BLM is permitting massive oil and gas development in this and other Wyoming counties, including Sweetwater, Carbon, Lincoln, and Uintah counties in southwestern Wyoming (Wyoming BLM 1998). In Sublette County alone, 100-200 leks are likely to be affected (Wyoming BLM 1998). Some oil fields are so densely developed that they have a well on every 40 acres (Wyoming BLM 1998). Leks are known to have been abandoned when oil wells were drilled as far away as ¾ mile from the lek (Wyoming BLM 1998). Yet, BLM has only applied ¼ mile restrictions on wells, even though it knew that adequate impact data was not available and was "not sufficient to address the legal challenge" to the BLM's massive development plans (Wyoming BLM 1998).

BLM Management in South Dakota

BLM lands in South Dakota are managed by the Montana state BLM office and suffer from the same mis-management. Surface occupancy is allowed within 500 feet or ¼ mile of a lek, and no other protections are required (South Dakota Resource Area 1985, p. 69, 144).

Management on USFS Lands

Most sage grouse habitat is on BLM or private lands; nonetheless, lands managed by the US Forest Service (USFS), such as National Grasslands and the lower elevations of many National Forests, contain significant amounts of sage grouse habitat. A particular threat on lands administered by USFS is the rescissions bill which exempts grazing permit renewals from the requirements of NEPA analysis. Because these permits last for 10 years, significant damage to sage grouse can be done. As one USFS biologist put it, "most forests" are "rubber stamp renewing" grazing permit renewals. This is not an inadequate regulatory mechanism.

Forest Service scientists have admitted that they do not conduct site-specific analyses of the impacts of management actions on wildlife – the demands of assessing impacts "preclude site-specific study" of those impacts (Toth and Baglien 1986, p. 255). The reasoning is circular, and the violations of NEPA seem clear. Such issues may also apply to BLM management actions. The Forest Service is a known scofflaw – one judge noted the "deliberate and systematic refusal by the Forest Service and FWS to comply with the laws protecting wildlife." Seattle Audubon Society v. Evans, 771 F. Supp. 1081, 1090 (W.D. Wash. 1991).

In Colorado, some National Forests, such as the Grand Mesa, Uncompahgre, and Gunnison National Forests, recognize sage grouse as a Management Indicator Species (MIS). For a MIS, the Forest Service must evaluate and state planning alternatives "in terms of both amount and quality of habitat and of animal population trends of the management indicator species." 36 C.F.R.§ 219.19(A)(2). However, various projects have been approved without evaluation of their effect on sage grouse, such as the Powerline Prescribed Burn. The Forest Service has also proposed projects to improve sage grouse habitat, but they involve fire and chemical treatment (rather than mechanical brush beating) and thus involve substantial risk to the grouse. The most important habitat improvement is to increase forb and grass cover by halting grazing, but the Forest Service has not proposed such actions. Instead, in its Gunnison Basin Range Project EA, the Forest Service has claimed that grazing levels on its lands do not harm sage grouse and that it will not restrict grazing. On the Beaverhead-Deerlodge National Forest in Montana, USFS has failed to track sage grouse populations or habitat quality for over 15 years while it has renewed livestock grazing permits.

Under regulations promulgated pursuant to NFMA, the USFS is required to assure the viability of vertebrates on USFS lands (36 C.F.R.§ 219.19). USFS has not maintained viable populations of sage grouse on its lands. In fact, sage grouse on the Crooked River National Grassland in central Oregon have been completely extirpated.

Clearly, the Forest Service is not giving adequate attention to sage grouse on National Forests or National Grasslands – one USFS biologist stated that "until [a species is] proposed for listing" or listed "probably nothing is going to happen" to promote its management.

One concern regarding the livestock management for fish species on federal lands is that rather than simply reduce or eliminate grazing, the Forest Service is attempting to "attract cattle away from streams" (Duncan 1999, p. 2), including studying the use of "off-stream water systems used to attract cattle away from the stream...." (Duncan 1999, p. 4). Inevitably, cattle will be attracted away from streams and into sage grouse habitat, thus degrading that habitat even more than its present damaged state. Such efforts are not limited to the Forest Service, but are threats on all lands, where managers attempt to improve riparian conditions while maintaining livestock.

In Oregon, only 50 to 75 sage grouse remain on the Ochoco National Forest. The Ochoco National Forest has paid little attention to sage grouse. In response to a FOIA request, the Ochoco National Forest was able to find only 3 documents dealing substantively with sage grouse (Cuddy 1999). The Crooked River National Grassland was unable to locate any documents (Cuddy 1999). Only a single lek (in the Mineral planning area) is known to the Forest Service on the Ochoco National Forest (Ochoco National Forest 1997). Biologists recommended that the Ochoco National Forest monitor habitat in Buck Springs area for sage grouse as early as 1990 – yet, after 10 years, this has not been done as no documents exist showing any monitoring (Cuddy 1999).

Sage grouse once covered what is now the Crooked River National Grassland, but after plowing and planting to crested wheatgrass by homesteaders in the 1930s and by the US Forest Service in the 1960s, sage grouse were extirpated from this entire area. The Forest Service has no plans for habitat restoration on the Crooked River National Grassland – instead, the agency allows some of the most intense grazing in the state of Oregon. Stocking rates are 2 or 3 times those of comparable BLM lands. This grazing regime prevents reestablishment of sage grouse habitat.

In California, the Forest Service has allowed renewal of grazing permits with little or no monitoring, despite knowing that this would cause "direct disturbance" to sage grouse, along with "competition for forage" and removal of much of the new growth of forbs and grasses "critical for juvenile" sage grouse (Inyo National Forest 1997a, p 18). So lax is the Forest

Service's consideration of sage grouse needs that it proposed fencing as "beneficial to [sage] grouse" (Inyo National Forest 1997a, p 18). On the Dexter Creek allotment, the Forest Service allows sheep grazing, with similar disregard for, and lack of consideration of, the needs of sage grouse (Inyo National Forest 1997b).

Management on Military Reservations and with respect to National Guard Operations

In Idaho, National Guard operations have damaged sage grouse habitat by trampling, soil compaction, and disturbance. Since 1953, the Idaho Army National Guard's (IDARNG) operations have included the Orchard Training Area near the Snake River Canyon (Quinney 2000, p. 94). IDARNG has implemented a quick-response fire suppression policy since 1988 (Quinney 2000, p. 94). However, fires may have become more frequent as a result of Guard operations, so it is not clear whether fire has increased or decreased as a result of Guard operations. More recently, IDARNG has placed some big sagebrush areas off limits to military training and has limited areas where bivouacking and maneuvers are allowed. However, the Guard has allowed livestock grazing and watering tanks (which allow livestock to wander freely in arid areas) thus further damaging habitat (Quinney 2000, p. 94).

Management on DOE lands

The US Dept. of Energy (DOE) controls several sites within the range of the sage grouse. At the Hanford Site, significant portions of habitat are being considered for transfer to private ownership (Dept. Energy 1996). Transfer to local authorities has also been proposed, and would likely result in large expanses of habitat being destroyed by conversion to farming (Cassidy, et al. 1997). The Hanford Site is considered to be one of the two best areas (along with Lincoln County) for expanding sage grouse in Washington (Hays, et al. 1998).

Management on NPS Lands

Without the guidance of the Endangered Species Act, even the National Park Service has damaged sage grouse populations. Development of the Curecanti Recreation Area has caused brood habitat to become "almost totally lost," lek and nest habitats have been reduced, and winter habitat has been "reduced and/or compromised" (Braun 1999b, p. 1). At Black Canyon of the Gunnison National Monument, powerlines, raptor perches, pinyon/juniper invasion, interior fencing, and degraded sagebrush habitat are threats to the birds (Braun 1999b, p. 2).

Neither Black Canyon of the Gunnison National Monument nor Curecanti National Recreation Area has conducted or is conducting any research or other studies on the bird, and neither entity has a management plan for the species (NPS 1999c). Oddly, the NPS did not provide a copy of the letter written by Dr. Braun (Braun 1996b) in response to a FOIA request, instead claiming that it had no information regarding the bird. Two grant proposals have been submitted to conduct research on the Gunnison sage grouse, but support for even this minimal and late effort is "problematical at best" (NPS 1999c).

National Parks and Monuments

Sage grouse are not known to occur in any National Parks in any appreciable numbers. A few individuals exist in Grand Teton National Park. Grazing is still allowed in Grand Teton National Park, as well as 12 units of the National Park system. Worse, the Parks in the Yellowstone area conduct land management activities to favor elk such as burning and brush clearing, which damage sage grouse habitat. Oddly, these activities continue even though elk populations are so high that damage to vegetation is widespread.

Sage grouse were extirpated from Lava Beds National Monument shortly after the 1930s. NPS biologists recommended restoration of habitat and populations (Forsell 1961), but actions were never taken.

NPS Easements

The Gunnison sage grouse Crawford Area plan contemplates the acquisition of conservation easements by the National Park Service. Such easements, however, require that grazing and the maintenance of structures continue (such as fences, and water development structures that dewater streams and wet meadows) (CACP 1998, p. 23). Thus, NPS easements cannot conserve the grouse, among other reasons, because they fail to address two of the greatest threats to the species.

Management by the US Fish and Wildlife Service

It is not merely state and other federal agencies whose mis-management threatens sage grouse. The Service itself has mismanaged its ESA duties, including its listing responsibilities under section 4, as well as the lands in the National Refuge System. The Service has also sought to withhold documents regarding sage grouse from the public, in violation of the Freedom of Information Act (Ramirez 2001).

Management of Listing and other ESA Duties

A variety of entities, including scientists, legal commentators, and federal judges have heavily criticized the Service for mismanagement of its duties under the ESA. For example, law professors such as Rohlf (1991, 1992), Doremus (1997), and Parenteau (1998) have all criticized the Service as have other commentators, e.g. Burgess (2001), Bonnett and Zimmerman (1991), Yaffee (1982), and Lieben (1997). Governmental and scientific organizations have also criticized the Service and its handling of mandatory duties (National Research Council 1995b), as have scientists such as Wilcove, et al. (1993) and Sidle (1998a, 1998b). The Service has been criticized by the scientific society of professional scientists, the Ecological Society of America, for delaying recovery planning, for only producing recovery plans for about half the species listed, for formulating recovery plans that have such "weak goals" that over half the vertebrates with such plans" would remain in serious risk of extinction" after reaching the goals in the plans (Carroll, et al. 1996). The Service's recovery plans often "'manage for extinction' rather than for survival (Tear, et al. 1993).

Since the inception of the ESA, the Service has managed to recover and delist only a handful of species – 8 species according to the Congressional Research Service (Corn 1997); 5 species according to Schwartz (1999, p. 86 <u>citing</u> 50 C.F.R.§ 17.11, 17.12). In the 10 year period from 1984-1994, seven species or subspecies became extinct while listed under the ESA (Langner and Flather 1994; FWS 1992). Worse, the Service never considered over 200 former candidates and subspecies for listing because they were believed to have gone extinct, again due to inaction by the Service (FWS 1989, GAO 1990). The Service rarely considers species for protection on its own initiative – most species are listed as a result of petitions (GAO 1992b), and the Service has not listed any species as a result of its own review during the year 2001.

Consequently, the Service's own data show that more species are declining than are improving (National Research Council 1995b), and that as of 1993, more listed species have gone extinct than have been recovered (Mann and Plummer 1995, p. 240). An audit of the Service's ESA program by the Inspector General found that from 1980 to 1990 alone, 34 species became extinct without ever receiving the protections of the ESA (Inspector General – USDI 1990). The reason is that the Service has "not effectively implemented a domestic endangered species program" (Inspector General – USDI 1990). Only part of the problem is caused by funding shortfalls, and these funding shortfalls are, in turn, the result of deficient funding requests from the Service. For example, The Interior Department requested only $1.3 million for species protection efforts for fiscal year 2002, even though it acknowledges that $120 million is required just to eliminate the species listing backlog and respond to court orders (Seelye 2001, p. A14). The Service has also improperly delayed listing actions through the use of its listing priority systems. The ESA requires the Service to use a "scientifically based priority system" to list and delist taxa, and this system must be based on the "degree of threat" to the taxa (H.R. Conf. Report. No 97-835, at 21, reprinted in 1982 USCCAN 2862). The Service has not done this. Instead, it has created a series of listing priority guidances (LPG) and petition management guidances (PMG) that prioritize species actions based on other factors (e.g. 1983 Guidelines, 48 Fed. Reg. 43,102-43,103; 1996 Guidelines, 61 Fed. Reg. 24,722). As a former FWS biologist noted, instead of using its funds to protect species as Congress directed, the FWS has "seemingly unrestricted use of public funds to carry on litigation and other actions to thwart or delay appropriate classification and regulation…" (Nowak 1997).

The result is to delay listing taxa that are in great danger of extinction. For example, the 1996 guidance allows the Service to ignore a candidate species with a high priority for listing while it is processing species that it has already proposed for listing – even if their priority is lower. The temptation for the Service to propose species for listing in order to delay action on species with greater needs but also a higher political profile is great. And, typically, the Service only proposes species for listing if they will not cause any political controversy. Congress was concerned about exactly such delays in listing by the Service, and established provisions in the Act for judicial review of the Service so that courts could separate real delays from those caused by "the foot-dragging efforts of a delinquent agency" (H.R. Conf. Rep. No. 97-835 at 22, reprinted in 1982 USCCAN 2860, 2863). Delays further endanger species. The National Research Council (1995b, p. 159-160) has pointed out that decisions must often be made on incomplete data which might be bolstered after a delay – but, that the delay itself "carries a risk" to the species (Ludwig 1999, p. 307).

Easter-Pilcher (1996), Tear, et al. (1995) and Wilcove, et al. (1993) have all criticized the arbitrariness of listing decisions. Moreover, the Service typically waits too late in the slide of a species towards extinction to list it under the Act, often precluding successful recovery and engendering additional economic and societal costs (Wilcove 1993; Wilcove, et al. 1993). The Service has delayed action under the ESA until too late, at the "crash and burn stage" of a slide toward extinction (Houck 1993 at 292; Orians 1993). As the Ecological Society of America points out, delays in listing of species, in designating critical habitat, and in recovering species "bring these species even closer to extinction," "restrict the options available for achieving recovery," and "increase the eventual cost of the recovery process" (Carroll, et al. 1996).

The Service's own scientists and other employees have been forced to criticize the Service for its illegal actions, inactions, and the politicization of its duties. The Public Employees for Environmental Responsibility has termed the Service's behavior towards the statute it is sworn to uphold as a "war of attrition" (PEER 2000). As another FWS employee has noted, the FWS has "consistently missed statutory deadlines for listing and deliberately allowed politics to influence listing decisions" (Sidle 1998a). Indeed, the FWS "is often working against" its function to classify and protect wildlife pursuant to the ESA (Nowak 1997).

The Service has most frequently attempted to excuse its shirking of these duties by claiming that it lacks the funding and resources to fulfill the mandatory requirements of the ESA. However, the Service has routinely misallocated its time, monies, and resources. For example, employees have wasted time on tasks that are not mandatory, instead of focusing on required tasks. As but one example of the latter, FWS employee Terry Ireland has attended numerous conservation plan meetings rather than review a sage grouse petition that was submitted to the Service regarding the Gunnison sage grouse. Moreover, the mismanagement of its listing responsibilities and other mandatory duties is pervasive throughout the Service from biologists in the field to the highest administrative levels. The Service has repeatedly requested less funding from Congress than it needs to perform its mandatory duties. Most recently, the Service admitted that "the listing program is not proposed at a level that would allow the Service to meet all of the Act's requirements and deadlines." (Trezise 2000). The Secretary blames this inadequate request on "other compelling needs" such as "habitat conservation planning, candidate conservation agreements, and species recovery plans." However, these activities, while important, are either not required by the ESA or do not have mandatory deadlines under the ESA as do listing and critical habitat designation (and likewise do not carry the mandatory protections of listing and critical habitat), and for the Secretary to request funds for discretionary activities while not requesting sufficient funds for his mandatory duties compounds the illegality of the Service's behavior.

But it is not merely law professors, scientists and the agency's own employees who have criticized the Service's execrable record in enforcing the Endangered Species Act – numerous federal judges have also harshly criticized the Service. In a case involving the Service's refusal to list the Canadian lynx, Judge Gladys Kessler stated that the Service applied an "incorrect legal standard, in clear violation of the plain wording" of the ESA, "relied on glaringly faulty factual premises," and "ignored the views of its own experts." Defenders of Wildlife v. Babbitt, 958 F.Supp. 670, 685 (D.D.C. 1992). Judge Bilby found that the Service rejected a listing petition first "because the goshawks are too homogenous… and then rejected [a second time] because there are too many variations of goshawks." Southwest Center for Biological Diversity v. Babbitt, 980 F.Supp. 1080, 1083 (D. Az. 1997). In another case, Judge Bilby evaluated the Service's policy on distinct population segments, and found the Service's "attitude incredulous." Southwest Center for Biodiversity v. Babbitt, 926 F.Supp. 920, 927 (D. Az. 1996). Another court rejected the Service's habitat conservation plan for the Alabama beach mouse, observing that the plan "was devoid of any rational basis," and noting that it relied on "insufficient, inadequate, and out of date data." Sierra Club v. Babbitt, 15 F.Supp.2d 1274, 1283-84 (S.D. Ala. 1998). When the Service rejected the listing of the Canada Lynx, Judge Kessler found that the Service had based its decision on "glaringly faulty factual premises" that fly "in the face of the overwhelming evidence gathered … by the [Service's own] biologists." Defenders of Wildlife v.

Babbitt, 958 F.Supp. 670, 681 (D.D.C. 1997). Judge Bunton reviewed the Service's the decision not to list the Barton Springs Salamander and found that the Secretary "failed to follow proper procedures..., failed to allow comment on issues that were fundamental ...missed virtually every statutory deadline provided by the ESA ... and considered factors other than those contemplated by the ESA." Save Our Springs v. Babbitt, 27 F.Supp.2d 739, 748 (W.D. Tex. 1997). There are numerous other such cases where federal judges have excoriated the Service (e.g. "Service disregarded all expert opinion on population viability, including that of its own expert" Northern Spotted Owl v. Hodel, 716 F.Supp. 479 (W.D. Wash. 1988). Another judge noted the "deliberate and systematic refusal by the Forest Service and FWS to comply with the laws protecting wildlife." Seattle Audubon Society v. Evans, 771 F. Supp. 1081, 1090 (W.D. Wash. 1991). If individual citizens were guilty of such behavior, they would likely be jailed for contempt.

Congress has also criticized the Service – when it created the "warranted but precluded" category, it referred to the Service and cautioned against "the foot-dragging efforts of a delinquent agency." H. Conf. Rep. No. 97-835 at 22 (1982), reprinted in 1982 USCCAN 2860, 2863; as noted by the court in Center for Biological Diversity v. Norton, 254 F.3d 833, 838 (9th Cir. 2001).

As of 1996, over 3,000 species were listed as "candidates" under the Endangered Species Act (Carroll, et al. 1996). The Service's use of candidate designations and the claim that species are "warranted [for listing], but precluded" by other work has been termed a "black hole" by Prof. Oliver Houck (1993, p. 286), perhaps the most prestigious legal commentator on the Endangered Species Act. The Nature Conservancy estimated that 165 unlisted species, including 30 vertebrates, 84 invertebrates, and 51 plants have become extinct while the FWS focused its attention on "higher priority" matters (Houck 1993, p. 286, n. 65. The Ecological Society of America criticized the Service for allowing over 114 species to languish in the "warranted but precluded" category for two or more year, and allowing 56 species to remain in that black hole for 8 years or more (Carroll, et al. 1996). On September 19, 1997, the USFWS deleted five species from the list of "candidates" for listing as threatened or endangered. The reason for the action is that the five species, which had been in candidate status for years without any steps taken toward listing, had gone extinct in the meantime. The prioritization process that the Service uses to consider which species to consider for listing first does not take into account the protective effects that the listing of one species could have on other species and on ecosystems, nor does it consider the ecological role or importance of a species in its ecosystem (Carroll, et al. 1996).

The Service also appears to be abusing its emergency listing authority. The Service emergency listed 10 species from 1980 through 1988 (Lieben 1997, p. 1351 and n. 219), and emergency listed 6 species from 1988 through 1995 (Lieben 1997, p. 1351 and n. 220), yet has not exercised its emergency listing authority since 1995 – not even once (Lieben 1997). The Service has been requested to use its emergency listing authority by petitioners, and the "duty to consider emergency listings" is "part of the petitioning process" Friends of the Wild Swan v. US FWS, 945 F.Supp. 1388, 1395 (D.Or. 1996). Congress mandated that The Service exercise its emergency authority "to prevent a significant risk to the well-being" of species (Endangered Species Act Amendments of 1988, Sen. Rep. No. 100-240 at 7 (1987), reprinted in 1988 USCCAN 2700, 2707). The emergencies faced by species have not declined since 1995; instead, the Service has illegally avoided its duties under the Act.

Status Review: Eastern Sage Grouse

The Service has not acted to uphold the ESA with respect to sage grouse. For example, the Service has affirmatively sought to undermine potential petitions and the listing procedure: "Mr. Ireland [a FWS employee based in Grand Junction, Colo.] is trying to keep all the players in the loop so a petition is not started" and is "trying to slow things down" (Summary of North Park Working Group Meeting 1999). Such actions are per se arbitrary and capricious and implicate violations of the Service's duties and trust responsibilities. Mr. Ireland then stated that conservation plans could provide some "relief or relaxation from [ESA] listing" (id., p. 2) and that after a listing "grazing will not be shut down at all" (id., p. 3). Service employees have discussed the Significant impacts of a listing petition and the advantage of "being pro-active" to "divert potential litigation" (Parker 1998, attachment). The ESA mandates various affirmative duties on the FWS to evaluate threats to the species and to use the best available science in its evaluation, but employees have contemplated abrogating those duties. Personnel noted that if the sage grouse were petitioned range-wide, "US FWS could conclude [that the listing was] 'not warranted' if [the] petition [was] not good" (Anonymous FWS document 1999, p. 2, Rich Howard speaking). Almost immediately after the American Lands Alliance held a public meeting to discuss the plight of sage grouse, the Service held a conference call (Anonymous FWS document 1999). FWS employees discussed how to evaluate the danger to sage grouse but without moving towards protection for the species. As early as Jan. 1999, FWS intended to ensure that a sage grouse petition would be "going to [the] bottom of the pile" (Anonymous FWS document 1999, p. 3, Rich Howard speaking). FWS decided they would "have to call it [the status review] something else" to "keep [it] out of listing" procedures (Anonymous FWS document 1999, p. 3, Chuck Davis speaking). The FWS admitted that they already "have data" but "need synthesis" (Anonymous FWS document 1999, p. 3, Chuck Davis speaking). Although the Service has the data, it has taken no steps on its own to consider protection for sage grouse. The Service is not allowed to consider economic or any non-scientific issues when deciding on listing a species. Yet, the Service constructed a Regulatory Action Alert prior to the listing of the Washington population of sage grouse that discussed the "potential importance to industry" and which Congressional Districts were involved in the area covered by a listing (FWS 2001c).

Yet, it is rarely the biologists in the Service who delay listings, craft inadequate critical habitat designations and recovery plans, or otherwise break the law. Instead, political appointees and administrators have frequently interfered with the biological findings by agency employees. It was just such politically motivated actions that cause Judge Jones to remand the bull trout listing case to the Service, that led to the series or remands in the lynx listing cases, and that led to formation of an organization dedicated to ethical and professional service to the public, the Public Employees for Environmental Responsibility, PEER, (2001 S St. NW, Washington, DC 20009; www.peer.org). As Yaffee (1982, p. 89) noted in his critique of the Service's carrying out of its ESA duties, "political considerations are increasingly incorporated at higher levels of the bureaucracy."

Because these issues are raised in a rule-making petition pursuant to the Administrative Procedures Act, the Service must consider the degree to which its own legal violations constitute a threat to the species.

Management on National Wildlife Refuges

Most National Wildlife Refuges have been set up to produce waterfowl for hunters to shoot. Accordingly, the Refuge system has largely been operated as a series of duck farms, not as natural ecosystems. Most waterfowl refuges have a developed aspect with steep banks forming hard edges along the margins, rather than gentler slopes which would create the moist riparian soils that promote plant growth favored by sage grouse, particularly late in the brooding season. One refuge (Hart Mountain in Oregon) was set up to protect pronghorn (*Antilocapra americana*), an Artiodactyl that is the only species in its Family and occupies grasslands and shrublands. Proper management for pronghorn should also conserve sage grouse. However, sage grouse on this refuge have seriously declined, continue to decline, and will likely continue to decline for some time (J. Crawford, personal communication, March 2000). This may be the result of overgrazing – livestock were not removed from Hart Mountain until a lawsuit forced them off in the 1991. Sage grouse habitat quality improved after grazing was eliminated (Crawford and Drut 1993).

Independent scientists have expressed numerous concerns regarding the failure of the National Wildlife Refuge system to protect various species of wildlife and biodiversity in general. Much of this criticism has centered on the failure to regulate cattle grazing and on pollution. Cattle grazing and haying occur at 123 National Wildlife Refuges. Few Refuges have voluntarily removed or even reduced grazing; instead, this has typically occurred only when directed by a federal judge. Grazing and haying consume 50% of refuge funds and 55% of staff time (Fleischner 1994). Strassmann (1983, 1987) showed that these activities directly impeded wildlife conservation. This grazing continues even though Strassmann (1987, p. 42) found that grazing does "more harm than good."

The fact that at least one National Wildlife Refuge (Kesterson, in California) had to be declassified because of water pollution (Ohlendorf 1990), and that other refuges, notably the Klamath Basin Refuges, are used for farming row crops of absolutely no benefit to wildlife, indicates that establishment of National Wildlife Refuges has not provided adequate protection to wildlife or to the ecosystems on which they depend.

Conservation Reserve Program

The Conservation Reserve Program (CRP) was created by the Food Security Act of 1985, and allows land parcels to be set aside from agricultural production for temporary and indefinite time periods. Farmers need not keep land in the CRP and can remove land from the CRP when they wish. Economic incentives are provided to farmers to keep land in the program but as economic conditions change, farmers can opt out. These set asides have been used to enhance some parcels of sage grouse habitat, notably in Washington state. The CRP was designed to reduce soil erosion, not protect wildlife. Although better than nothing, such programs have numerous problems. One problem is that most of the acreage is in parcels of less than 100 acres, and often they become population sinks, rather than sources, for birds. Predators can easily find these small parcels amid the cultivated fields in which they are embedded. In some cases, cultivation or livestock feeding operations may even attract more predators to the area than would otherwise be the case. For example, ravens are attracted by the grain spread in livestock feeding operations. Once in the vicinity, it is easy for these nest predators to locate any sage grouse nests nearby. Furthermore, the CRP program is not based upon wildlife values. A 100 acre plot in the middle of a wheat field has tremendous edge effect, thereby allowing easy access for predators. Studies of CRP lands using GIS, remote sensing, and habitat modeling have shown that vegetation structure was unsuitable for game birds, resources needed by game birds were not present (resources that were not limiting on game birds were provided), and birds suffered nest disruption in CRP lands from agricultural operations, thus creating a population sink (Roseberry, et al. 1994).

The plantings on CRP lands provide little benefit to sage grouse – 87% of the program lands are planted in grasses, and 67% of those are exotics (Campa and Hanaburgh 1999, p. 211). The CRP program is also very costly. In Montana, the public actually spends more on "renting" CRP lands than it would cost to buy those lands (George Wuerthner, personal communication). As Wuerthner states: "Farmers typically get $50 an acre in Montana (payment varies from place to place in the country so it's more in places like Iowa). But they get this for ten years. [i.e.] 50 x 10 equals $500/acre over ten years. You can often buy this same land for $100-200 an acre outright. So we are paying far more than the land is ultimately worth and we get no guarantees that these lands won't be turned back into wheat fields or whatever in ten years." Economic analyses of the CRP in other states have not been conducted, but this expense ratio is probably typical for most Western states.

The CRP had more than 160,000 acres enrolled within the sage grouse range as of the late 1980s, including 60,000 acres in Douglas County (Hays, et al. 1998). The CRP appears to provide some benefit to sage grouse by providing some cover for nesting (NWEA 1999, p. 30 citing Schroeder, personal communication). The most beneficial CRP lands are those adjacent to remnant shrub-steppe patches. However, sage grouse habitat in Douglas County is still vulnerable (Hays, et al. 1998). Much of the habitat needed by sage grouse is not enrolled in the CRP, nor do the CRP lands offer protections adequate to conserve the grouse. Brush control, chemical spraying, and conversion of sagebrush areas continue, causing additional loss and degradation of sage grouse habitat (Tirhi 1995; Hays, et al. 1998). Many CRP lands have been planted with crested wheatgrass, which is rarely used by sage grouse or other wildlife (Hofmann and Dobler 1988).

Moreover, CRP protections are temporary. Thousands of hectares of habitat currently enrolled in the CRP could be converted to agricultural fields as soon as 10 year long contracts expire. Moreover, recently changed standards for CRP lands may "require replanting of significant acreage under existing contracts" (FWS 2001d, 66 Fed. Reg. 22984, 22993) – thus, further decreasing their value to wildlife. Perhaps most importantly – the CRP program has failed to halt the severe declines in sage grouse populations to date. There is thus no reason to expect that it will do so in the future. Finally, it is unclear whether the CRP program provides a significant benefit to wildlife or whether it is merely a politically motivated farm support program.

Management by the States

The states have a very poor record of conserving sage grouse. Significantly, state fish and wildlife departments typically believed sage grouse populations to be in much better shape than independent scientists who have studied the data. As but one example, ODFW published an analysis of sage grouse in Oregon immediately which came to significantly more optimistic conclusions than that of Drut (1994). As explained here, those conclusions are unwarranted.

Although many states have endangered species acts, these acts are weak and rarely have much impact on wildlife (George 1998). State conservation agreements are inadequate to conserve sage grouse. They are voluntary and unfunded or underfunded, and have a poor track record. Although states can regulate hunting, the majority of habitat is either on federal lands or on private lands. Instead of being able to regulate the species, state "wildlife agencies are relegated to an advisory role on habitat manipulation proposals and usually are left to minimizing detrimental impacts. Seldom, if ever, is a project designed to benefit wildlife." (Autenrieth 1986, p. 774). Thus, even if states were not in the thrall of extractive interests, they would be unable to conserve the birds, merely to lessen the damage.

State fish and wildlife agencies and their employees appear more concerned with protecting their "turf" than with conserving sage grouse. For example, state agencies have been concerned about "a federal takeover" of sage grouse by the US FWS, and an Idaho employee, "Jack Connolly [Connelly] expressed concern" that FWS was even considering a status review "because he felt it gave the NGO's [environmental groups] more ammunition to pursue a listing" (Deibert 1999c). This points up the lack of concern for conservation by state agencies and employees. It is perhaps not surprising that state agencies would be hostile to a listing under the ESA. When a game animal falls to such an imperiled status, it shows severe mis-management by the states, and as the states well recognize "demonstrates a failure by landowners, other agencies, and their own Department to do a good job in managing the resource" (Howard 1999, p. 2).

Management in Oregon

The state of Oregon is widely regarded as having the preeminent land use planning system in the United States. Oregon's land use planning laws have been in place since 1973 and are a considerable source of state pride, as well as a source of controversy. Oregon has established urban growth boundaries (UGBs) and all urban development – as well as the extension of city services – are to take place within those boundaries. Development is restricted on rural and farm lands outside the UGBs. However, Oregon's land use planning was designed to cluster development and preserve farm lands and open space, not specifically to maintain wildlife habitat. That Oregon's land use planning laws are inadequate to assure conservation of sage grouse is evident from the significant declines that have occurred since land use planning was enacted. Moreover, the land use planning act is subject to alteration either by the legislature or by citizen initiative, and several attempts to reduce restrictions on development have been proposed. Finally, significant development has taken place in the eastern part of the state despite the presence of land use planning. Although it is not clear how much of this development has occurred in historical sage grouse habitat, it is precisely the drier, eastern portion of the state that once harbored large numbers of sage grouse.

Although the Oregon land use planning system is the most restrictive of any state's, it has failed to halt declines in sage grouse populations. Therefore, land use planning in other states can have no expectation of protecting sage grouse habitat.

The Oregon Dept. of Fish and Wildlife (ODFW) has a very poor track record of monitoring sage grouse populations and compiling that information. The agency has been aware for years that "much of our Oregon data is sketchy" (Denney 1980). Independent, outside sage grouse experts have noted this problem as well. ODFW apparently has not assessed habitat within the state at all. Moreover, the ODFW has been very reluctant to provide public records regarding sage grouse to the public, and has sought to delay and deny access at virtually every turn. This suggests that the agency has something to hide. Moreover, ODFW employees have attempted to deflect university research scientists from studying the effects of "livestock utilization of forage" on sage grouse (Lemos 1997, p. 1). The agency's attitude towards sage grouse is not one of conservation or of stewardship of a public resource. Rather than address threats to the existence of the sage grouse, ODFW employees instead regard potential action to protect sage grouse under the ESA as a "listing threat" (Van Dyke 1999, p. 1, 7). ODFW has not implemented a conservation strategy based on objective or impartial scientific research; instead, "the intent behind these [conservation strategy] efforts is to satisfy USFWS that the listing of the bird in Oregon is not necessary" (Van Dyke 1999, p. 2). The motivation behind ODFW make its conclusions suspect, and the Service should carefully evaluate all analyses – much less opinion – from this agency.

Management in Utah

Utah lags far behind Colorado in its attempts to arrest the decline of the Gunnison sage grouse. A Conservation Agreement for species in San Juan County is still unfinished, and a draft has been circulated for review. Mapping and delineation of sage grouse use areas has not even been carried out. The state wildlife agency and the Utah field office plan to pay $3,000-$4,000 for a technician to delineate sage grouse use areas. This technician, who will be employed part-time (if hired at all) will have the additional responsibilities of working with private landowners to enhance sage grouse habitat, and will monitor usage of enhancement projects. This is a very ambitious use of the small amount of funding provided, and all these activities will obviously not get accomplished. Moreover, nothing at all is planned for other parts of the Gunnison sage grouse's historical range in other counties in Utah.

A draft "concept" of a conservation plan has been written (San Juan Draft Concept Plan 1997); however, there has been little action taken on its provisions. These provisions merely contemplate the gathering of information without any action being taken to protect the species. Indeed, the concept plan explicitly lists "enhancement of personal income" as a goal. A conservation agreement has also been drafted (Utah Draft Conservation Agreement 1998) but it is unclear whether it is based on the concept conservation plan. The conservation agreement includes a goal to enhance sage grouse habitat, but the actions associated with this goal primarily involve mapping and delineation of various habitat and use areas (Utah Draft Conservation Agreement 1998). The conservation agreement is thus far from any on the ground actions, and the only management actions called for are extremely vague and non-specific. Overall, the conservation agreement simply does not contemplate specific actions adequate to conserve the species, even if it were implemented in its entirety.

Management in Idaho

In 1996, the Idaho Dept. Fish and Game drafted conservation plans, which included actions to prevent further loss of sagebrush, to monitor effects of agricultural chemical use, and to reduce hunting pressure. These plans are not regulatory mechanisms and have not even been implemented (Cade 1999). Instead, even after 4 years, they are "still being discussed by local working groups," and the "original objectives for the year 2000 have been pushed into the indefinite future" (Cade 1999).

Management in Colorado

Colorado attempts to manage sage grouse by regulating hunting. No other state regulatory controls exist. Colorado does not have a comprehensive land use planning system, and has few controls on development of any sort. Thus, suburbanization and ranchettes are likely to continue to eliminate remaining sage grouse habitat.

Moreover, it appears that the Colorado Dept. of Wildlife (CDOW) has been remiss in its general management of sage grouse. As late as 1978, the CDOW had failed to implement any systematic population assessments (CACP 1998, p. 2). Instead the "searches and counts were sporadic," and the CDOW allocated personnel and funding elsewhere (CACP 1998, p. 2). This all occurred despite the fact that CDOW had been requested to document sage grouse status and trends as early as the 1950s (CACP 1998, p. 2). Perhaps an even more startling fact is that Gunnison sage grouse hunting in the Crawford Area was not ended until 1994, even though the number of grouse had sunk to less than 90. CDOW personnel operate with only one eye on science – the other eye is fixed on politics. For example, one memorandum notes that even though a critical population will become extinct without active habitat management, the required habitat manipulation may nonetheless not be possible "considering the present political climate" (Braun 1995g, p. 1). These facts make assertions of conservation actions to take place in the future suspect – either the CDOW lacks the interest in conserving the species, or it lacks the power. In either event, prompt listing under the ESA is a necessity.

Threats from disease and parasites are imminent and ongoing. The Colo. Div. of Wildlife "allows releases of exotic/introduced species which are known to be carriers of parasites/diseases harmful to sage grouse into habitats where sage grouse live" (Braun 1999a, p. 1). Colorado does not have a comprehensive land use planning system, and has few controls on development of any sort. Thus, suburbanization and ranchettes are likely to continue to eliminate remaining sage grouse habitat.

Conservation Plans

Even though the present regulatory climate has brought sage grouse to the brink of extinction, neither federal nor state agencies have altered regulatory mechanisms within the range of the bird. Instead, federal or state agencies have begun to implement "conservation plans." State personnel admit that a major goal of such conservation plans is to "try to prevent Federal action concerning the grouse" (Wait 1997). If state wildlife agencies had made good faith efforts to actually conserve sage grouse populations attempts to write conservation plans with a goal to prevent Federal listing would not be needed.

To date, only a few conservation plans have been written (Braun 1996a). Indeed, there is still "reluctance" to "fully implement" conservation actions regarding grazing on some allotments in the Gunnison Basin (Braun 1996a). The conservation plans avoid conflicts over grazing by simply ignoring the issue. Instead, they assume that increased grass and forb production will – somehow – magically provide adequate habitat for both cattle and sage grouse. Conservation plans must be "exposed to public notice and comment" to be valid (Save Our Springs v. Babbitt, Civ. No. MO-96-CA-168 (W.D.Tex. 1997) at 9). Moreover, conservation plans must include "tangible steps to reduce the immediate threat to the species," and cannot rely on "promises of proposed future action" to preclude a listing (id.).

The Gunnison Basin, Colorado conservation plans form a framework for developing conservation actions. These consist of public education, research into causes of sage grouse declines, monitoring of populations, mapping and inventory of habitat, and similar assessments (Gunnison Basin Sage Grouse Conservation Plan 1997, p. 18). The conservation plans are thus useful tools to organize data collection and research, and may function to educate the public. They fall far short, however, of what is required to avoid a listing under the ESA. These conservation actions and conservation plans are not regulatory mechanisms, the actions do not yet exist, and both the plans and actions they contemplate are inadequate to insure conservation of the species. They thus fail each test for adequacy when considering a listing under the ESA.

The conservation plans do not themselves require the implementation of any actions, and needed actions have not been implemented. For example, the Gunnison Basin Sage Grouse Conservation Plan (GBCP) contemplates that implementation of actions under the plan will not be completed for 15 years (Gunnison Basin Sage Grouse Conservation Plan, GBCP 1997, p. 18). By then, Gunnison sage grouse will likely either be extinct or will be present in such small, scattered populations that it will not be possible to prevent the extinction of the species. The GBCP itself recognizes this time lag problem with conservation measures, although it does nothing to alleviate the problem. The plan states, "it may take several years for an actual increase in cover, and the establishment of desirable species" after implementing a "vegetation management plan" (GBCP 1997, p. 19). The plans even admit that some actions could prove ineffective. For example, "a drought could negate or reduce the positive effects" of "vegetation management through improved livestock grazing" (GBCP 1997, p. 19). Despite this recognition, the plans do not provide for any safety margins or "fall-back" options in such cases. The San Miguel Basin Conservation Plan (SMBCP 1998) is so far merely an "outline of the Draft Conservation plan" (SMBCP 1998, front cover), and does not even estimate a time when conservation measures will be fully implemented except to note that it will "require a lengthy period" (SMBCP 1998, p. 16). The San Miguel plan merely establishes a wholly voluntary "process" and "framework" in which, someday perhaps, a true plan will be implemented. Similarly, participation by private landowners in the Crawford Area Conservation Plan (CACP) "will be strictly on a volunteer basis" (CACP 1998, p. iii). While these rosy speculations are appropriate for a children's fairy tale, they will not conserve the sage grouse. Such vague agreements require nothing, and have been uniformly rejected by every court that has examined the issue.

The conservation plans make no requirements on private landowners; instead, such action is purely voluntary (GBCP 1997, p. 19; SMBCP 1998, p. 3 "strictly voluntary"; CACP 1998, p. 3 "strictly voluntary"). Even if private lands are needed for conservation of the species, all land uses will be permitted, apparently including subdivision, because landowner participation is strictly voluntary.

Nor do the plans even assure funding for conservation actions: for example, the GBCP specifically contemplates that "[i]nadequate funding may preclude the completion of an action in a given period." In such cases, the "implementation sequence" would be adjusted" – that is, deferred (GBCP 1997, p. 19). The plans explicitly defer on the ground actions. For example, increased attempts to reduce poaching will not begin until 2009 (GBCP 1997, p. 20). Mitigation of utility corridors – which already exist – will not begin until 2006 (GBCP 1997, p. 20). Again, this deferral of action may itself be deferred if funding is inadequate (GBCP 1997, p. 19).

The plans are not regulatory mechanisms in any sense. "The process or mechanism [to implement the plan] is generally to rely on each [working group] member or entity to implement to the best of their ability actions for which they have responsibility ." (GBCP 1997, p. 19). Thus, the actions in the plans are voluntary even if they are not explicitly deferred by the plan's timetable, or implicitly deferred by "inadequate funding." They will doubtless be deferred by the plans reliance on each entity being able to explain that they couldn't complete the actions for which they were responsible, but to the best of their ability, they did whatever they wanted. This is not a regulatory mechanism. The San Miguel Plan mentions the authority of the county to regulate land use but does not explain the limits of that authority or the degree to which it has been exercised in the past (SMBCP 1998, p. 29-30). In fact, one of the chief dangers to the bird is development (Braun 1998a). The county's authority over land development has not proven effective in the past. Thus, even if the authority to control land use were truly a regulatory mechanism, it has been shown inadequate. Without true regulations on land use, there is no guarantee that the county will exercise its authority in the future. The San Miguel Basin plans other assumptions also fail as adequate regulatory mechanisms. The plans impose no new regulatory scheme, instead relying on the same regulatory mechanisms – or lack thereof – that have allowed the severe declines in Gunnison sage grouse. The San Miguel Basin plan does mention the authority of the FWS under the ESA, but this presupposes that the bird has been listed (SMBCP 1998, p. 30). Thus, the plans cannot function as adequate regulatory mechanisms sufficient to prevent listing of the bird – the only true regulatory mechanism is listing under the ESA. The San Miguel Basin plan also notes the establishment of Memoranda of Agreement and of Memoranda of Understanding among various federal agencies and between FWS and the state of Colorado (SMBCP 1998, p. 30). None of these qualify as regulatory mechanisms as a matter of law. Nor have the programs contemplated by the Memoranda even been drawn up and agreed to, much less implemented. The only regulatory program discussed at all by the San Miguel Basin plan is the ability of the Colorado Div. of Wildlife to regulate poaching and harassment (SMBCP 1998, p. 29). This has been ineffective to conserve the Gunnison sage grouse as seen by the severe declines in the bird. Moreover, it can only address one of many threats.

Even if all of the conservation plans were completely implemented immediately, they would prove inadequate to conserve the Gunnison sage grouse. The Gunnison Basin plan contemplates a minimum spring population goal of 867 males for a total of population of 2,601 grouse. The plan contemplates an "optimum" spring population goal of 1,200 males for a total of population of 3,600 grouse (GBCP 1997, p. 37). There are numerous problems with this scheme. First, although the plan acknowledges that the best scientific data now show that minimum viable population sizes of 5,000 are required to ensure against species extinction (GBCP 1997, <u>citing</u> Lande 1995), it does not incorporate this finding into its goals. Even the "optimum" of 3,600 birds is far short of an adequate population size, being only 72% of that number. The plan even acknowledges that in the past there may have been 10,000 birds in the Gunnison Basin, twice the number estimated in 1969 (GBCP 1977, p. 37). Thus, the 1969 population was already greatly reduced from its historic numbers and may have not been large enough to assure viability in any event. The San Miguel Basin plan does not contemplate that population size will reach that of a viable population from the already extremely small population present there (SMBCP 1998, p. 7). The San Miguel Basin plan hopes to achieve only 480 birds, even after 15 years.

Even if it did achieve that goal, the genetic bottleneck effect found in small populations is likely to cause depressed reproductive success.

Second, the plans ignore effective population size (N_e) arising from the variance in reproductive contributions among male birds. As discussed previously, N_e for sage grouse is far lower than that for populations with random mating. This is well established in the scientific literature, and even appears in undergraduate textbooks, yet the plans do not account for this factor in their goals, even though the GBCP acknowledges that inbreeding depression is likely in Gunnison sage grouse (GBCP 1997, p. 6). Oddly, the San Miguel Basin plan, although written later than the Gunnison Basin plan, does not even acknowledge the reduction in effective population size. Instead, the San Miguel Basin plan makes an error in the opposite direction: it assumes that actual population sizes will be larger than the counted population because there are about "2 females for every male" (SMBCP 1998, p. 6). But the studies it bases this assertion on are not cited. The Crawford Area Conservation plan repeats this estimate, asserting that "studies across western North America" have found this to be the approximate sex ratio in spring (CACP 1998, p. 2). But, again no citations to the literature are given, and sex ratios of 1:1 are more likely in adult, breeding populations that are not hunted. It is not appropriate to use spring breeding numbers in any event as not all those grouse will breed.

Third, the plans make optimistic assumptions about the relation of the numbers of grouse counted to the actual numbers. As explained in the Methodology section above, Jenni and Hartzler (1978) cautioned that evening counts at leks do not properly represent morning lek counts, yet the plans do not specify when lek counts will be made. Jenni and Hartzler (1978) also cautioned that hens visit multiple leks, multiple times, and thus counts of hens will generate overly optimistic population estimates. Counts of males at leks will not correctly represent population sizes (Jenni and Hartzler 1978, yet the plans all assert that their census numbers are conservative estimates.

Fourth, the plans rely on spring population sizes only. Not all grouse will mate, and not all females will successfully raise broods. Thus, spring population size alone is not an adequate measure of population viability; instead, spring census estimates represent the maximum number of birds present including "floaters" and other surplus birds from an evolutionary standpoint.

Fifth, the plans incorrectly assume that if a certain number of birds are present in a vast geographic area such as the Gunnison Basin, then those birds exist in a single population linked by gene flow. It is highly unlikely, however, that the grouse in the Gunnison Basin are a single population. Instead, they are almost surely fragmented into numerous small population isolates. In discussing "population" goals, the plans make no allowances for effects of habitat fragmentation on the birds, and instead only call for "well distributed" lek areas (GBCP 1997, p. 37). It is not the distribution of lek areas that is the problem. As explained above, a major problem causing endangerment is the fragmentation of habitat causing fragmentation of populations into small, isolated groups of birds that no longer experience gene flow with other isolates. The plans have not adopted any goals to reduce habitat fragmentation, and thus will surely fail to conserve the Gunnison sage grouse.

The ineffectiveness of these conservation plans, and their inadequacy as regulatory mechanisms is evident when viewing what the advocates of these plans list as their accomplishments. For example, the table of accomplishments for the plans lists few on the ground actions to restore habitat or even arrest the imminent and ongoing threats to the bird

(Gunnison Sage Grouse Conservation Plan Accomplishments 1998). Instead, the type of accomplishments listed in this table include such things as selling T-shirts, lecturing to kindergarten and elementary school students, paying ranchers not to graze small areas of the public's land, mapping vegetation, and printing color brochures. Most of these are fun and worthwhile activities, but rather than act to conserve the grouse, they merely distract from needed actions. As such, they could form a useful adjunct to recovery plans once the species is listed – they cannot substitute for a listing. Much hard work and negotiation has gone into these plans. Yet, far from assuring the conservation of the species, the Sage Grouse Conservation Plans are plans for extinction of the sage grouse, simply because they are so ineffective.

In general, all of these conservation plans read as though they were concocted to advocate for minimal effects on established interest groups, and to paint the rosiest possible picture of the Gunnison sage grouse. The conservation plans do not present a sober assessment of the population status of the grouse, nor do they propose effective measures to arrest its alarming decline. In fact, at least some plans have "the potential for more harm than good" for sage grouse (Braun 2002a). This Plan identifies hunting, predators, and lack of grazing as threats, while it "turns a blind eye" to real threats, such as "housing developments, oil production, roads, timing of grazing, more fencing, more power lines, … Tebuthiuron, etc." (Braun 2002a). The North Park "Conservation" Plan "will not do any good" (Braun 2002a). Conservation Plans for Gunnison sage grouse are better, but have come "too late for Dove Creek, Glade Park/Pinon Mesa, and Poncha Pass" (Braun 2002a).

Taken together, or considered separately, the conservation plans for the sage grouse are inadequate to conserve the species; because of their lack of enforceability and emphasis on protecting vested interests rather than protecting the grouse, they represent extinction plans for the sage grouse.. Even worse, even if each conservation plan were completely effective, the extinction risk for the sage grouse would still be high. None of the conservation plans would provide connections among the isolated populations that are the subject of each individual plan. Thus, at best, the sage grouse would eventually consist of isolated and non-viable populations, each of which would then become extinct. As Storch (1997) noted in a study of several grouse species closely related to sage grouse: "attempts to stabilize a population below minimum viable population size will fail unless dispersal from neighboring populations occurs." Unfortunately, "travel corridors for sage grouse throughout their range are becoming restricted" thus preventing gene flow among these scattered isolates (Braun 1999a, p. 3).

Ultimately, conservation plans are literally that – mere plans. Actions on the ground must be taken if sage grouse are to be conserved. Importantly, the success of these actions must be quantitatively monitored if the effectiveness of the actions is to be assessed. Yet, land management agencies and wildlife agencies do not have adequate data collected to determine whether planned actions would be effective or not. As Lord Kelvin (the 19th Century scientist who united heat theory) once said: "when you measure … you know." The converse is also true.

Management by Private Parties

Within the historic range of the sage grouse, private land typically is more fertile, has more forb and grass cover, better soils, and has better hydrological status than public lands (SMBCP 1998, p. 25; DCCP 1998, p. 26). Private lands are typically those located near streams (SMBCP 1998, p. 25). It has been said that the public lands in the United States are those that no one wanted during the period of Western settlement and homesteading. It is thus not surprising that private lands impact sage grouse populations to a disproportionate degree.

Yet no regulatory mechanisms protect the birds on private lands (with the limited exception of hunting seasons). Besides being the best former habitat, private lands constitute nearly half (47%) of the range of the Gunnison sage grouse. Because private lands are so important to sage grouse (SMBCP 1998, p. 25), especially for the very limited early brood rearing habitat, even perfect conservation efforts on all federal lands would be unlikely to ensure the continued survival of the species. Thus, listing under the ESA is essential to conserve sage grouse species.

Suborning of Agency Personnel and Administrative Capture

Another factor affecting the inadequacy of existing regulatory mechanisms is the suborning of both state and federal agencies by powerful extractive interests. The Service must therefore consider the degree to which proper management regimes will, in fact, be carried out by these agencies, as well as whether scientists have the independence to perform adequate studies and to make unbiased recommendations.

The objective nature of scientific inquiry has been a maxim for decades. Only recently have critics claimed that the self-correcting nature of modern science lacks objectivity. Unfortunately, several studies bear out this problem. University faculty "with industry ties are more likely to report research results that are favorable to a corporate sponsor" and "are more likely to conduct research that is of lower quality" than comparator researchers (Cho, et al. 2000 – reviewing results of 6 studies). Notably, the studies Cho reviewed are all experimental or clinical in nature – these are the types of studies that ought to be least influenced by a lack of objectivity. Studies that are non-experimental in nature, and rely instead on observational or descriptive techniques (as do much of the literature on sage grouse and related issues) are less likely to be self-correcting precisely because they lack experimental controls. Although bias is not inherent in such studies, it is likely to be more common. The person doing the research can also be a source of bias. University scientists, who often possess tenure, ought to be more reliable than government scientists who can be transferred at the whim of a politically motivated bureaucrat. However, no area of inquiry is too abstract or arcane to escape political attack. National Science Foundation and university grants were denied to a politically active mathematician (Rorabaugh 1989, p. 104-105). Moreover, such transfers and demotions have happened many times to scientists and managers in both federal and state governments. On other occasions, transfers or demotions have been threatened, but opposition from public interest organizations has prevented them.

University scientists who have conducted work on sage grouse, sagebrush and other land management issues are usually lodged in Schools of Agriculture, which are closely tied to industrial and agricultural interests. The bias inherent in such close ties has been criticized by journalists (Marston 1993). Marston notes that Colorado legislators have attempted to intimidate professors at the state universities regarding water issues in the state, and suggests that land grant universities have not provided useful information on solving contemporary natural resources problems, because they are either too "cowed" or "too trained" to do so (Marston 1993). Marston notes that during the 1970's, Johanna Wald (attorney for the Natural Resources Defense Council) was told by every range science professor she talked to, that "everything [was] fine" regarding grazing on the public's lands, belying the crisis in grazing reform. The student clinic at the University of Oregon law school was also attacked during the spotted owl campaign and ultimately forced off campus. The Service should take into account the quality of the data and analyses conducted by any scientist whose employer or granting sources are subject to bias. A regulatory mechanism that is based on biased science is per se inadequate.

A more pernicious and subtle lack of objectivity relates to bias in the selection of questions to be investigated. Problems may not be researched if funding is unavailable for political reasons, if the likely results may harm the agency doing the research, or if an individual scientist – unconsciously, or not – believes that no problem exists worth investigating. Such beliefs may be based on political or cultural motivations, such as co-optation of an agency scientist by the entity that the agency is supposed to be regulating, a phenomenon so common that it bears its own term "administrative capture." In such cases, the self-correcting schema of experimental hypothesis testing is never given a chance to function. Science, *strictu sensu*, is not done at all.

Even when struggling to perform their tasks, scientists can be interfered with by their administrative superiors. With respect to sage grouse alone, at least three BLM scientists have been harassed and threatened with unpleasant transfers (the civil service equivalent of firing), and one academic scientist at the University of California at Riverside related that his Dean was "looking over [his] shoulder" at his work. At a major midwestern university, another sage grouse scientist expressed concern about being denied access to public lands as well as grant and contract funding. In another case, a university sage grouse researcher in Colorado had the road to the study site closed to entry, and lost the use of trailers and other logistic support after writing a letter of concern regarding land management effects on sage grouse. Such attacks on scientists, dubbed "science suppression," are legion and have been detailed in various works, such as Wilkinson (1998) and Marston (1993).

The Future for Sage Grouse

Vast decreases in distribution and population numbers of sage grouse have already taken place. The range has been greatly reduced by 60%, population numbers have plummeted by 90% or more, and the remaining range is highly fragmented. But worse is yet to come.

According to Dr. Clait Braun (2001h, 2001i), within approximately 20 years, the northern sage grouse will be completely eradicated from 5 more states and provinces: Alberta, Saskatchewan, Washington, North Dakota, and South Dakota. Additional extirpation will take place in other states and sage grouse will then persist only in "central Montana, central and western Wyoming, northern Colorado (2 counties), northern Utah (4 counties), northern Nevada, south central and eastern Oregon," and several disjunct populations in southern Idaho (Braun 2001i). As bad as this assessment sounds, it may be overly optimistic. For example, juniper invasion and fires are likely to extirpate sage grouse from south central Oregon in less than 20 years.

Within 50 to 100 years, sage grouse will be completely eradicated from all of North America with the possible exception of a small area in parts of central Utah and Colorado. This will happen because of climate change and the consequent contraction of the range of big sagebrush (*Artemisia tridentata*) in the United States by approximately 99% or more – only a few small patches will remain in parts of central Utah and Colorado (Shafer 2000; Shafer, et al.

2001, fig. 5). Moreover, Braun (2001h, 2001i) predicts that sage grouse will become extinct in these areas within only 20 years. Thus, the remaining range of big sagebrush will not contain any sage grouse, assuring extinction of all species within 100 years.

Gaps in Information Needed to Conserve the Species

"We know enough about sage grouse habitat requirements (extensively published) to manage rangelands to maintain or enhance sage grouse populations" (Braun 1999c). Additional research is not needed to begin restoration now. Nonetheless, scientists typically desire additional research on any topic. This is part of the culture of science, that additional knowledge is a worthy goal. In the present case, however, actions must be taken now to restore sage grouse populations and habitat, and there is no reason to wait. Although additional scientific study, particularly of habitat fragmentation and gene flow, is useful it is not necessary. The Service must avoid the bureaucratic temptation to "study the problem to death" – something that will violate the ESA and cause the sage grouse to become extinct. Likewise, the Service must avoid the temptation to create a "false uncertainty" (sensu William Curtiss, personal communication 1996) that there is insufficient knowledge to conserve sage grouse, when the reality is that the threats and the steps needed to alleviate those threats are both quite clear. Even when information actually is incomplete, action to prevent extinction is required by the ESA. As Murphy and Noon (1991) admonished with respect to critical habitat: "failure to act because of incomplete information is imprudent."

Legal and Conservation Status

Sage grouse do not have any federal conservation status, although various federal agencies consider it to be of special status. As detailed elsewhere, these agency designations have done little or nothing to conserve the species, and what purported protections are afforded by various agency regulations and organic acts are often violated.

Partners in Flight has rated sage grouse in the Columbia Plateau of Oregon and Washington with a priority score of 89 – no species in the region has a higher score (Altman and Holmes 2000, Appendix A). The Nature Conservancy's National Heritage Program tracks sage grouse, but the data it relied upon are old and out of date. The Service has not produced a recent status review of sage grouse, in part because it wishes to avoid a listing and is afraid that an updated status review would result in a listing (discussed elsewhere in this document). Since the Service last examined the status of sage grouse, much new information has come to light regarding the threats to the species, and the degree of endangerment. Sage grouse populations have drastically declined since the Service last examined its status, yet no new regulatory mechanisms have been put in place and many conservation groups and states have not updated or reexamined their assessments of sage grouse status.

Oregon

Oregon has listed sage grouse as a sensitive species in the Blue Mountains and portions of the Columbia Basin (Marshall 1992). However, the bird has probably already been extirpated from those areas.

Colorado

The Gunnison sage grouse is unprotected by a threatened or endangered listing by the state of Colorado; instead, it has been assigned to the category SC, state species of Special Concern (http://www.dnr.state.co.us/wildlife/T&E/list.asp), and is considered a sensitive species in Colorado. SC is a designation by the state Wildlife Commission, not a statutory category. Neither status carries any regulatory significance, and neither provides any management actions adequate to conserve the species. County regulations, such as land use permitting and zoning, have been ineffective in halting, much less reversing, threats to the species. The Northern sage grouse is apparently unprotected in Colorado.

Utah

The Gunnison sage grouse is considered a sensitive species in Utah. This status carries no regulatory significance, and provides no management actions adequate to conserve the species. Apparently, Utah has done nothing to protect Northern sage grouse.

Monitoring Programs

Besides the collection of wings from wing barrels and other very limited measures of hunting take, few monitoring programs exist. Most states have made a desultory effort to count birds at leks, but such programs are inhibited by lack of funding, poor standardization, and erratic effort. Dobkin (1995) criticized the data gathering methodology of the various states, but there have been few changes made.

Habitat Restoration

Little or nothing has been or is being done to restore sage grouse habitat; instead, federal and state efforts have been aimed at increasing livestock grazing on sage grouse habitat, with concomitant degradation of sage grouse habitat. These effects are described further above.

Importance of Sage Grouse

Sage grouse have significant aesthetic value because of their vivid and unusual mating displays, and also possess unusual digestive and detoxification abilities which are of significant scientific interest and possible economic importance. Sage grouse are economically important in many rural counties (Loft 1998) and, of course, would be more economically important if there were more of them. Recreational value for bird watching and hunting is great. Moreover, because of their discovery by the Lewis and Clark expedition and the dependence on them as a food source by Indians and early pioneers, sage grouse possess significant historical importance. Their cultural significance to various Indian tribes is unquestioned, they may have religious significance to various tribes as well.

Contemporary understanding of ecological communities posits that the loss, removal, or reduction in numbers of individual species can cause dramatic changes in ecological communities, including the extinction of other species. Recently, Berlow (1999) showed that even weak ecological interactions can have important effects on ecological processes. Sage grouse may be strongly influenced by ant and beetle abundance as these prey species are critical in both juvenile nutrition and the nutrition of hens during the pre-laying period. Forbs are now widely acknowledged in the scientific literature as a critical component of sage grouse habitat because they serve as protein sources for hens and juveniles, as a physical vegetative feature that provides concealment from predators, and as a substrate and food source for insects, which sage grouse require at critical life history periods.

The converse is also true: sage grouse are important components of shrub-steppe ecosystems, and serve as prey for a wide variety of predators. The importance of sage grouse as competitors, mutualists, or disturbance sources is unknown, but any vertebrate formerly present is such huge numbers across such vast spaces was likely an important determinant of community structure and processes. Typically, ecosystem dynamics are driven in large part by a relatively "small number of biotic and abiotic variables on whose interactions the balance of [other] species are, in a sense, carried along" (Holling 1992, Lawton 1994, Perrings 1995). In the sagebrush shrub-steppe, it is sage grouse around which such interaction variables cluster.

Sage grouse can also serve an important role as what has sometimes been referred to as "umbrella" species. By protecting the sage grouse, the Service would also be protecting a large number of sagebrush obligates and other species that use sagebrush habitats.

Similarly, protection of sage grouse would reduce the workload on the Service because protection of this species would obviate the need for additional protections on other species with similar habitat requirements. The Service would thus not need to address a potential avalanche of petitions to list the myriad species in this ecosystem type that will otherwise follow.

The Service is requested to consider the importance of protecting sage grouse in providing a means whereby the ecosystems upon which other endangered species and threatened species depend may be conserved.

Protection of Sagebrush Ecosystems

All state wildlife agencies agree that "sage grouse are an important indicator of the overall health" of "the sagebrush shrub-steppe ecosystem" (MOU 1995). Sage grouse are acknowledged to have "key herbivory functions" in the interior Columbia Basin (Quigley and Arbelbide 1997c, p. 1609). Highly placed BLM officials recognize that "hundreds of special status fish, wildlife, and plant species" in sagebrush ecosystems are "at risk" (Jauhola 2001). Petitioners request that the Service recognize and consider the importance of sage grouse as a keystone species, as an ecological dominant, and as an umbrella species, which can protect numerous other species in the western United States. Petitioners request that the Service incorporate such considerations into all aspects of its section 4 responsibilities under the Endangered Species Act. The effects of habitat degradation on sage grouse and other species in sagebrush ecosystems is not new. Carhart (1954) recognized that at least 4 species of birds were dependant on sagebrush, and other authors expressed concern even earlier (e.g. Hornaday 1916). Because of their area requirements, sage grouse can also function as a focal species, *sensu* Lambeck (1997). In Idaho, GAP analysis shows that protecting sage grouse would also protect large numbers of other vertebrates that are currently unprotected (Kiester, et al. 1996). The same is likely to be true in other states.

As the Oregon BLM has noted, sage grouse are a "good indicator of sagebrush habitat health." By protecting the sage grouse, the Service will also be protecting an entire ecosystem type, the sagebrush shrub-steppe, and the other species that depend on this ecosystem. This fulfills the statutory purpose of the Endangered Species Act, 'to provide a means whereby the ecosystems upon which endangered or threatened species depend may be conserved…." 16 U.S.C. § 1531(b). The Service recognizes that the conservation of such ecosystems is "a primary purpose of the Act." 59 Fed. Reg. 34273, Friday, July 1, 1994. The Service adopted the "Ecosystem Approach to Fish and Wildlife Conservation" on July 1, 1994, explaining that "species will be conserved best not by a species-by-species approach but by an ecosystem conservation strategy that transcends individual species." 59 Fed. Reg. 34273. By listing sage grouse under the protections of the ESA, the Service has a chance to comply with that policy. Moreover, the Service should take into consideration the importance of ecosystem conservation when assigning priorities in the listing process.

Sage grouse function as a "keystone food resource" (Terborgh 1986; Meffe and Carroll 1997) supporting many predator species in the sagebrush shrub-steppe. Sage grouse populations affect both predator populations and plant populations and community dynamics. Extinction or reduction in numbers of sage grouse could be a primary extinction or effect that necessarily causes multiple extinctions of numerous other species in sagebrush ecosystems because of food web interactions and other community level effects (Terborgh 1976, Wilcox and Murphy 1985). As the National Biological Service noted, a "significant decline in a once-dominant or keystone species could have profound ecological ramifications," and these "ecosystems-wide effects could occur long before a pivotal species becomes rare enough for listing as endangered" (Noss, et al. 1995).

Sage grouse serve as both an indicator and as a key species affecting many other species in sagebrush shrub-steppe ecosystems. Among birds, the sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), and sage sparrow (*Amphispiza belli*) require big sagebrush habitat (Belthoff, et al. 1995; Reynolds and Trost 1981). These obligate species (Paige and Ritter 1999, p. 33-37) have habitat requirements similar to those of sage grouse (Welch, draft manuscript, Ch. II, p. 15) and there is a high degree of overlap between the source habitats for sage grouse and those for these species (Rich and Altman 2001). Fragmentation is significantly impacting these bird species (Knick and Rotenberry 1995b). Moreover, many grassland and shrub dwelling bird species have declined within the range of the sage grouse (Peterjohn, et al. 1995).

Protection of sage grouse is also highly likely to protect many rare plants. Rare plants are often found in the areas inhabited by sage grouse. For example, a BLM botanist lists a dozen or more rare plants in just the Mono area of California which the California Dept. of Fish and Game has ranked as threatened or very threatened (Halford 2001a).

Welch reviews a number of other sagebrush obligate species and their habitat requirements (Welch, draft manuscript, Ch. II, p. 15-18). For example, many mammals depend upon sagebrush ecosystems. Pygmy rabbits (*Sylvilagus idahoensis* or *Brachylagus idahoensis*) is also a sagebrush obligate (Green and Flinders 1980, Lyman 1991), as is the sagebrush vole (or sage vole) (*Lagurus curtatus*) (Maser 1974, Carroll and Genoways 1980, Larrison and Johnson 1973). Welch reviewed the literature on facultative associations of other mammals with big sagebrush (Welch, draft manuscript, Ch. II, Table 2.2 and p. 24-34) and of facultatively associated bird species (Welch, draft manuscript, Ch. II, Table 2.1). Numerous reptiles are also associated with big sagebrush (Welch, draft manuscript, Ch. II, Table 2.9). Protection of sage grouse would protect many other birds species such as loggerhead shrike (*Lanius ludovicianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), sage thrasher (*Oreoscoptes montanus*), and green-tailed towhee (*Pipilo chlorurus*) which use sagebrush and shrub habitats (Altman and Holmes 2000, Appendix C) as well as other bird species that would benefit from restored habitats within shrub-steppe ecosystems, such as vesper sparrow (*Pooecetes gramineus*), long-billed curlew (*Numenius americanus*), black-throated sparrow (*Amphispiza bilineata*) and others (Altman and Holmes 2000, Appendix C). Many non-vertebrates are also obligate species of sagebrush, and Welch describes sagebrush as a "mini-ecosystem with big sagebrush as the keystone species," and one that includes 52 species of aphids, 10 or more species of parasitic hymenopterans feeding on the aphids, and an unknown number of ladybird beetles, fungi, lichens, moths and other insects, ants, and aphid species attending the ants (Welch, draft manuscript, Ch. III and p. 9). Many of the species already listed as threatened or endangered in the intermountain West "are associated with rangeland ecosystems" (Flather, et al. 1998). By protecting sage grouse, the Service will be protecting this entire ecosystem, thereby protected the myriad of species found there (Simons, et al. 1988; FWS 1995; Flather, et al. 1998). As BLM recognizes, "sage grouse are considered to be an umbrella species," so conservation of sagebrush habitats needed by sage grouse will benefit a multitude of other sagebrush habitat species of concern" (Nevada State Office, BLM 2000a, p. 8). Because of the large number of obligate species, and even larger number of facultatively associated species, protection of the sagebrush shrub-steppe is thus "important for conservation of biodiversity" 59 Fed. Reg. 34274, Friday, July 1, 1994.

In the past, the Service has not considered ecosystem effects in its listing priorities because ecosystem "information is seldom available at the time a species is considered" (1983 Guidelines, 48 Fed. Reg. 43098, 43101, Sept. 21, 1983). Here, extensive information is provided to remove that barrier. The Service promised to consider "ecosystem importance" on an ad hoc basis (id.), and petitioners formally request such consideration here.

With respect to the rest of the Interior Columbia Basin, a high degree of rarity, endemism and biodiversity is found within the range of the sage grouse (Marcot, et al. 1998, p. 91). Protecting sage grouse habitat will thus protect many concentrations of ecological integrity.

Request to Apply Trust Doctrines

Petitioners request the Service to apply the legal doctrines known as the Wildlife Trust Doctrine and the Public Trust Doctrine in its consideration of this petition. Petitioners further request the Service to exercise all its trust responsibilities in all matters affecting the species discussed herein, including the Indian Trust Doctrine as respecting the importance of these species as cultural symbols, as religious objects, and as food sources, both currently and in historic times.

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Dedicated to Denzel

and to every state and federal public servant who had the guts to tell the truth – even when it hurt.

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