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TO: Bureau of Land Management
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Carl L. Wambolt

RE: DEIS for the Pinedale Resource Management Plan

I am requesting the Bureau of Land Management (BLM) consider my concerns with the Draft Environmental Impact Statement (DEIS) for the Pinedale Resource Management Plan. I take this opportunity to comment on the DEIS because the Pinedale Resource Area is so ecologically important to the taxa (both flora and fauna) to which I have devoted my career (refer to my attached *resume*). I am a Professor in Montana State University's Range Science program. During my 37 years at Montana State University my research focus has been on shrub ecosystems, especially those dominated by sagebrush. My research has considered many ecological relationships with sagebrush and associated plants and wildlife. This pursuit has been partially responsible for the MSU Range Science program creating a degree in Wildlife Habitat Ecology and Management. The DEIS for the Pinedale Resource Management Plan is largely concerned with sagebrush ecosystems, but fails to consider many relevant issues in adequate detail. It is my intent to provide scientifically founded concerns that should be considered by BLM as planning proceeds for the extensive critically important sagebrush habitats found in this area so that these habitats receive adequate consideration and appropriate management.

Sagebrush—Keystone Species

Undeniably sagebrush taxa are the most important organisms (keystone species) occurring naturally within the area considered by the DEIS. This is illustrated by the fact that these taxa are the climatic dominant over the majority of the landscape. They are ecologically influential on all other organisms, both flora and fauna, within the area. Specifically, this means that other species are found in this area because of sagebrush and not in spite of it. I hope to clarify why sagebrush has been called "a nursing mother to a host of organisms that range from microscopic fungi to large mammals" by Welch (2005). The DEIS fails by any measure to recognize and address this point and the issues it encompasses. Consequently the proposed

management plan (Alternative 4) and all other alternatives in the environmental impact statement (EIS) are inadequate relative to meeting BLM's analysis and disclosure obligations under the National Environmental Policy Act (NEPA) and its planning and management obligations under the Federal Land Policy and Management Act (FLPMA).

Precisely what percentage of the area is dominated by sagebrush taxa is difficult to ascertain because of several confounding and confusing statistics provided in the DEIS. There are figures provided in the document (abstract) of 1,199,280 acres of federally administered mineral estate along with a total surface acreage of 922,880 acres administered by BLM within the planning area (abstract and table 3-27). The summary (p. v) says the preferred alternative 4 would make available 1,024,880 acres for oil and gas leasing and development. From these numbers evidently the total planning area is subject to this activity. On page v the DEIS states, "Intensively developed fields would be managed for intensive oil and gas activities while protecting wildlife habitats to the extent practicable". This statement clarifies that environmental aspects and long term ecosystem stability rank below the leasing and development of gas and oil in the area regarding BLM's priorities and concerns.

Further confusion is found in the fact that the text accompanying table 3-27 apparently does not agree with this table as to the percentages of the planning area occupied by different vegetative types. For example, table 3-27 provides acreages for Wyoming big sagebrush, mountain big sagebrush, and desert shrub vegetation communities. These important vegetative types are stated to be found in the following percentages of total vegetation: 70% Wyoming big sagebrush, 10.7% mountain big sagebrush, and 6.2% desert shrub communities, for a total of 86.9% of the Pinedale resource area dominated by sagebrush taxa. This total of 80.7% in the big sagebrush communities collectively has to be considered with a conflicting value of 68.5% that is found upon reading the text that follows table 3-27. This text has the following percentages: 52% Wyoming big sagebrush, 16.5% mountain big sagebrush. Because terminology is changed to" low-density sagebrush communities", for areas that evidently make up the tabled category of "desert shrub", this category becomes even more confused. Evidently this vegetative type has some lower percentage as do the big sagebrush taxa. The percentages given in the text following table 3-27 cannot be calculated from either the tabled value for the total acreage of 922,880 acres nor can they be derived from the 1,199,280 acres of federally administered mineral estate lands.

Regardless of the above discrepancies in the DEIS, the very large acreage of sagebrush dominated rangelands certainly justify my previous statement that *sagebrush taxa are the most important organisms (keystone species) in terms of both landscape coverage and influence on other organisms* within the entire planning area. Consequently, adequate scientifically defensible consideration of this ecosystem and the effects of management on it are crucial to fully understanding the effects of the Pinedale Resource Management Plan (RMP) on this area. I will proceed with the acreages for the BLM administered lands (86.9% sagebrush) and assume that if these are not correct, BLM will correct this confusion in the final EIS

Most importantly, considering the over whelming importance of sagebrush, it is appalling to note that within the entire DEIS, BLM referenced only 4 papers pertaining to sagebrush (see literature cited and do not confuse sage-grouse with the much larger issue of sagebrush). None of these 4 papers were peer-refereed, the normal process used by scientists to insure the information contained in a paper is worthy of publication in a scientific journal. This is particularly ironic because there are hundreds of scientific references that deal with different aspects of sagebrush ecology that should have been consulted. Welch (2005) reviewed over 1600 papers concerning big sagebrush alone. There is obviously no shortage of information about sagebrush for this DEIS. Further, to make this omission of background information for the keystone species in the Pinedale Resource Area where the ecosystem is potentially going to be subjected to many threatening activities is an enormous omission from this DEIS. This lack of consideration regarding the ecological implications of altering the sagebrush ecosystem that dominates 87% of the concerned area (table 3-27) is very evident throughout the DEIS. This *DEIS fails to consider the ecology of sagebrush ecosystems in general and specifically the keystone species, the sagebrush taxa This is a severe shortcoming in this DEIS and makes it scientifically deficient and of far less value for rational management decision-making.*. When the keystone species are negatively impacted then other important and often critical ecosystem processes and functions also suffer as I discuss throughout this memorandum.

Sagebrush—Myths

The lack of consideration for sagebrush ecology and consequently, the taxon's importance in the Pinedale DEIS has perpetuated a number of "myths" regarding sagebrush that I hope will be recognized and corrected in the final EIS. Correction of these misunderstandings is crucial if a scientifically defensible and useable RMP is to be put in place. It is my intent to call your attention to some of the larger issues that must be corrected and considered before making a decision allowing activities such as presently contained in the DEIS that have the potential to significantly alter ecosystem composition and function. I will obviously have to cite the myths very briefly here. Hopefully these myths that the DEIS is currently helping to perpetuate will receive your full attention while preparing the final EIS because each of them must be understood and appreciated if this important ecosystem is to remain functional and viable for the many organisms that depend upon it (Welch and Criddle 2003).

These myths are: 1) sagebrush is not natural, 2) wildlife exist in spite of sagebrush, 3) sagebrush is worthless as a forage, 4) sagebrush is too competitive for other plants, 5) sagebrush types have a frequent fire cycle, 6) sagebrush becomes decadent, 7) sagebrush must be burned to rejuvenate communities, 8) we must manage for young sagebrush plants that are more nutritious for those few animals that do forage upon it. I will briefly address the basis for these myths in this text as the facts regarding each myth are important as omissions from the DEIS.

Sagebrush—Quantification

The DEIS contains no adequate descriptions of community characteristics within sagebrush types. *BLM must correct this omission before an EIS can be finalized if the agency intends to comprehensively address the impacts facing this area as intended by NEPA.*

The discussion near table 3-27 mentions various sagebrush canopies of greater than 35%, surprisingly even in Wyoming big sagebrush areas. The likelihood is that traditional government methodology was followed (Bureau of Land Management 1996) to determine this sagebrush cover (the other alternative is that the coverage was estimated occularly or best guess). Thus, it is unlikely that the cover figures cited relate to most scientific literature that describes sagebrush thresholds required to sustain important wildlife populations.

Wambolt et al. (2006) concluded that sagebrush cover is currently determined with considerable variation in procedure. Such lack of standardization in sampling protocol makes monitoring of management objectives based on research methodology unreliable. This happens because the techniques used in research are more precise and carefully applied. Wambolt et al. (2006) found that percent cover in sagebrush habitats as determined by agency methods (Bureau of Land Management 1996) was up to 2.6 times greater than that from research applications.

The implications are clear. When researchers determine habitat requirements for sagebrush dependent species, those characteristics are expressed as minimal cover percentages of the sagebrush that must be maintained. Unfortunately, if sagebrush is over estimated by poor methodology in sagebrush communities, then often agencies take actions that reduce this canopy and thereby degrade the habitat for dependent animals. *This process may potentially eliminate the habitat as a functional ecosystem for these organisms.* In a best scenario the degraded-altered habitat will be significantly reduced in its carrying capacity for numerous dependant organisms. The Pinedale RMP and EIS must ensure that poor or inconsistent methodologies are not leading to inaccurate estimates of sagebrush cover, which precipitate uncalled for management actions.

Sagebrush—Planned Habitat Loss

The DEIS objectives for future management in the sagebrush type state that apparently the BLM will conduct a number of treatments to reduce sagebrush cover on the landscape. This goal is expressed for all alternatives, particularly the preferred alternative. It is alarming that *this reduction in sagebrush habitats will be additive to that lost to oil and gas development.* The ecological fallacies of these cumulative impacts are detailed throughout this response to the DEIS. It also appears necessary to point out explicitly that any variety of treatments BLM may

use to reduce sagebrush cover will often not result in anticipated increases of herbaceous production for herbivores as inferred in the DEIS (Blaisdell 1953, Daubenmire 1975, Peek et al. 1979, Anderson and Holte 1981, Kuntz 1982, McNeal 1984, Mandan and Autenrieth 1985, Sturges and Nelson 1986, Wambolt and Payne 1986, Fraas et al. 1992, Wambolt and Watts 1996, and Wambolt et al. 2001).

Illustrative of typical results detailed by these citations are the findings of Wambolt et al. (2001). They learned that Idaho fescue, the dominant grass and livestock forage species on 13 widely located sites studied in the sagebrush habitats of southwest Montana, was only benefited by burning at 1 location. At the remaining 12 sites, Idaho fescue was decreased in canopy cover at 4 locations and not impacted at the other eight. This failure to benefit from prescribed burning was also found for total perennial grasses and forbs.

As Daubenmire (1970) stated, "range management in North America has been dominated by the narrow view that only the few plants of direct use or detriment are worth consideration". Daubenmire went on to point out that simplification of big sagebrush communities by removal of the dominant (sagebrush) has to have significant negative consequences for other organisms. Wambolt et al. (2001) agreed when they noted significant habitat deterioration did occur on their 13 study sites where big sagebrush cover, density, and production were all significantly greater in the unburned portions in 34 of 38 comparisons, even after as long as 32 years since burning.

Facts like those above are illustrative of sagebrush not being highly competitive with associated plants in habitats where they have co-evolved to more fully utilize the total resources within each environment. *Typically, we cannot expect that herbaceous plants will increase productivity following a reduction in sagebrush.* Unfortunately this unfounded logic has become an axiom of range management that is the premise for many ill-informed decisions resulting in mismanagement of valuable resources. The DEIS perpetuates these misunderstandings of the available science, and would pursue management targeted at reductions in sagebrush. These misunderstandings and the resultant scientifically unjustified management direction in the preferred alternative and other alternatives should be corrected. This matter is further discussed under: Sagebrush—Relationship with Understory.

Sagebrush—Ecosystem Values

The meager discussion that is provided sagebrush in the DEIS is typically where the main topic is "how to kill sage". *Various sagebrush killing techniques are interpreted after discussing misguided conventional wisdom which concludes that killing sagebrush will benefit other organisms*, primarily livestock. Several statements on page 3-31 illustrate the lack of appreciation for sagebrush and the habitats it dominates. The DEIS states, "The objective of most vegetation treatments is to reduce shrub cover and increase herbaceous forage production." With this lack of appreciation for the role of sagebrush, readers might be led to believe that oil

and gas development will benefit ecosystem function, as indeed it would help reduce the shrubs (sagebrush). Another statement on the same page says "In the absence of natural fire cycles, vegetation treatments are needed to maintain the proper balance of shrub and herbaceous species on the rangelands." *Upon reviewing the DEIS it is not apparent that BLM knows either about the natural fire cycle or the balance of vegetative classes to be expected in sagebrush ecosystems or other necessary facts relating to spatial and temporal patterns in these habitats.* To the contrary, there are many statements that demonstrate errors in understanding these and similar issues. Because this lack of understanding should be corrected in order to have a valid EIS and RMP, I devote a good portion of this correspondence to some of the major points regarding these issues.

BLM has a large task ahead to demonstrate that the agency has adequate knowledge relating to, let alone concern for sagebrush ecosystems and the hundreds of organisms within those systems. The DEIS states that only 5609 acres in the planning area are at the potential natural community (p. 3-32), yet BLM proposes to kill more of the climatic climax sagebrush. The reality is *BLM presents no data to demonstrate any knowledge of successional status and thereby, obviously does not account for normal ecosystem processes.* The only conclusion must be that BLM either does not recognize the potential natural community or has no appreciation for the fact that this state will be reached much sooner without further human mistakes, or both.

There are 92 mammal and 93 bird species, respectively, that have reliance on sagebrush for their habitat in addition to hundreds of lesser organisms, both plant and animal (Welch, 2005). It is interesting that, although it too is minimal, there is more consideration given to the relatively scarce organisms found within this big ecosystem than there is for the dominant species that provides habitat conditions (the keystone species-sagebrush) required by these "species of concern". *This DEIS generally fails to recognize that the scarcity of most species is a result of habitat loss, degradation, and fragmentation, all of which jeopardize the sagebrush ecosystem in the Pinedale area.*

Very rarely does the DEIS recognize reality regarding the functioning of this ecosystem. However, the first paragraph under 4.17.3 (p. 4-181) is an example of reality and discusses some of the points I made above when it states, "As acreages of surface disturbance and human activity levels increase, the quality and quantity of wildlife habitats likely will be reduced. Habitat fragmentation occurs when a contiguous habitat is intersected, divided, or segmented by disturbing activities. Fragmentation causes a reduction in usable ranges and the isolation of smaller, less mobile species; a loss of genetic integrity within species or populations; and an increase in abundance of habitat generalists that are characteristic of disturbed environments (i.e., competitors, predators, and parasites) (Harris 1984). Displaced wildlife tend to use lower quality habitats or compete with existing herds and livestock for forage and use private lands to a greater extent. Density dependency thresholds of suitable habitats for these species could be

met, which ultimately could decrease herd size and genetic variability and increase disease frequency."

The quote above from the DEIS begs the question: why is the concern voiced in this paragraph so over looked in the alternatives proposed for the area? Elsewhere, (p. 4-255) the DEIS recognizes (Berger et al 2006) that 6 of 8 migration corridors between the Greater Yellowstone Ecosystem and the Green River are already lost. The further disruption of migratory habitats is a certainty with the level of oil and gas leasing and development allowed under alternative 4. Language in the DEIS generally has the tone taken on page 153 that begs the question of why is BLM using this as an opportunity to promote the killing of the ecosystem's keystone taxon?

It is for good reason that the American Bird Conservancy has cited the sagebrush region as the most threatened bird habitat in the continental United States (Top 20 most threatened bird habitats in the U.S.). They concluded that "one would not think that a habitat type that covers such a huge expanse would be among our most threatened, but the continuing rate of degradation and poor chances of recovery make it a clear choice". Their statement is very defendable with the realization that we have already lost one-half of the sagebrush ecosystems in the western United States. Further, the remaining 50% is not only threatened to be lost by actions such as described in the DEIS, particularly the preferred alternative, but to be further degraded in its environmental qualities and fragmented into small portions that are realistically not capable of sustaining the numerous organisms that depend upon sagebrush ecosystems.

Welch (2005) titled his 210 page treatment of big sagebrush "Big sagebrush: a sea fragmented into lakes, ponds, and puddles." This title is very graphic in illustrating the loss of much (50%) sagebrush habitat and fragmentation of the remaining acreage. Unfortunately, much of the fragmented portion of the sage sea is also ecologically degraded, further magnifying the importance of good stewardship on remaining sagebrush habitats like those in the Pinedale area.

Sagebrush—Fire

Alternatives 3 and 4 are said (p. v & vi) to "...provide for prescribed and natural wildfire management to emulate historic natural fire regimes." Also, that (p.v & vi) "vegetation would be managed to support wildlife habitat..." *The discussions in the DEIS of fire in sagebrush ecosystems are again illustrative of a lack of consideration for known ecological facts pertaining to fire and interaction with wildlife habitats in sagebrush ecosystems.* Prescribed burning has been routinely used for a number of years now by agencies in sagebrush habitat types.

Unfortunately this action is usually not supported by numerous science-based studies. There is much scientific evidence documented regarding the negative impacts of fire on these habitats and the organisms that depend upon them (Byrne 2002, Connelly et al. 2000, Fischer et al. 1996, Nelle et al. 2000, Peterson 1995, Baker 2006). This DEIS consistently makes claims that are not based on science regarding such matters as the many points touted as positive about burning sagebrush. By deductive logic it is implied that other activities (oil and gas related) will not negatively impact the ecosystem by also destroying sagebrush and obviously sagebrush habitat that is so very important for many other organisms. *The fact is that BLM has produced no data or science based examples to the contrary (noted by the void of literature consulted for the DEIS) showing the claimed positive effects of fire in the sagebrush ecosystem and instead is relying on unsubstantiated conventional wisdom originating from long held bias or conjecture.* This is not science-based decision-making regarding the role of fire in sagebrush ecosystems in the Pinedale area and it should be corrected. Again relevant is Daubenmire's (1970) statement, "Range management in North America has been dominated by the narrow view that only the few plants of direct use or detriment are worth consideration".

It is clear upon examination of the evidence that sagebrush taxa evolved with very little fire in their ecosystems (Peterson 1995, Welch and Criddle 2003 Welch 2005, Baker 2006). This reasoning is simple to understand as the dominant taxa (sagebrush) collectively exhibit the following traits that would not persist if fire occurred commonly or frequently within their environment: 1) a long life expectancy, 2) highly flammable bark, 3) highly flammable essential oils, 4) low growth form susceptible to crown fires, 5) non-sprouting, 6) seed dispersal post fire season, 7) lack of good soil seed bank, 8) seed lacks fire resisting adaptations, 9) seed must lie on surface exposed to high temperatures, 10) seed lacks adaptations for long distance dispersal.

On fire, a dozen sagebrush and sage-grouse scientists (PACWPL policy paper SG-02-02 p. 11) stated that "there is no empirical evidence supporting the notion that fire has positive effects on sage-grouse over the short or long term." Additionally, they pointed out that fire removes large sagebrush plants that provide thermal and security cover as well as food, and reduces important insect populations vital to sage-grouse diet. Unfortunately, fires tend to burn the most productive and best habitats within an area, usually where grass and shrub cover are greatest, leaving the unburned portions to be the less productive sites of inferior habitat quality (Connelly et al. 2000).

Usually, sagebrush dependant species, for example sage-grouse, use only remaining sagebrush stands in burned habitats, thereby, reducing the area of occupation and their populations, if they can persist at all following fire. Byrne (2002) documented that the avoidance of these burned areas by sagebrush dependant species goes on for decades. Despite the fact that many agency personnel have supported the use of prescribed burning of sagebrush communities to supposedly enhance habitat for sagebrush dependant species, there is no adequate scientific basis that demonstrates this occurs (Nelle et al. 2000, Fischer et al. 1996).

Recently, a USDA-Forest Service research paper (Welch and Criddle 2003) challenged the scientific merits of axioms of vegetation management pertaining to big sagebrush. One axiom was related to fire interval and the use of prescribed fire in sagebrush ecosystems. Regarding this axiom, the authors state "none is more speculative, that is not based on scientific investigation than this one". This statement by these authors summarizes the conclusions of other scientists regarding this axiom, which is pivotal for proposed actions in the DEIS. Consequently, this unfounded axiom should be rejected in the EIS and in management guidance provided in the RMP, and in management actions taken pursuant to the RMP.

The facts are that sagebrush ecosystems did not burn often historically nor are they capable of recovering quickly, but they can certainly be destroyed quickly by fire. The previous statement is a summation by Baker (2006) in his landmark paper discussing "fire and restoration of sagebrush ecosystems." Baker's work is the best treatment available dealing with questions such as fire interval in sagebrush types of the Western United States.

It is imperative that the facts in Baker (2006) not be ignored when discussing the concepts put forth by the DEIS. Quoting, Baker (2006) "combining the fire-scar and recovery evidence, the best available estimates of fire rotation are 325-450 years in low sagebrush, 100-240 in Wyoming big sagebrush, 70-200 years or more in mountain big sagebrush." Baker further states that "these estimates are likely low estimates because they could not be corrected for targeted sampling and they use a conservative estimate of adjacency correction, but fire rotation in sagebrush cannot be estimated more precisely at this time using available data." He further expands that "given the long rotations that characterized pre-Euro American fires in sagebrush, fire exclusion likely has had little effect in most sagebrush communities." Further, "particularly in Wyoming big sagebrush, a program of prescribed burning is unwarranted or inadvisable if maintaining and restoring sagebrush landscapes and sagebrush-dependant species is the goal. Correcting for fire exclusion by reintroducing fire is likely not a common sagebrush restoration need". Wyoming big sagebrush is the single most important taxon in the Pinedale Resource area.

The DEIS states (p. 4-160) that "vegetation treatments would be designed to reestablish the natural role of fire in the ecosystem." Until BLM recognizes what that role really is for sagebrush communities (i.e., a very limited, infrequent role) it appears that just the opposite will occur. Fire will be introduced at unnatural and scientifically unjustified scales and frequencies. Unfortunately, the tendency is for the uninformed public to think that if sagebrush needs to be reduced by fire and other means, as so often stated in this DEIS, then obviously, there is no reason for them to be concerned about sagebrush habitat loss to oil and gas related issues or other management actions. However, because the underlying bases for these claims has no scientific grounding, the further implied conclusion that other sources of sagebrush loss are not harmful also has no basis.

Sagebrush—Forage Relationships

One previously mentioned myth is that sagebrush taxa are "worthless as forage". The DEIS helps to perpetuate this as it is implied throughout that the landscape dominant in the Pinedale area has no forage value. The reality is that *hundreds of organisms feed directly on big sagebrush* (Welch 2005). Included among these organisms are both large and small mammals, birds, insects, fungi, parasitic vascular plants, and lichens. Welch and Criddle (2003) while considering the fact that these many organisms feed commonly on sagebrush foliage stated "all parts of big sagebrush are consumed – leaves and stems, pollen, achenes or seeds, root tissues, and so forth".

Large mammals known to consume big sagebrush include domestic sheep, mule deer, pronghorn, elk, Rocky Mountain bighorn sheep, and desert bighorns (Welch 2005). Numerous small mammals and a number of birds including sage-grouse, dark-eyed juncos, horned larks, and white-crowned sparrows rely heavily on sagebrush foliage. Although, it is easy to overlook the importance to lesser organisms in ecosystem function, it is apparent that sagebrush plays a major role in supporting many of these organisms including fungi and insects. Welch and Criddle (2003) cited 31 fungus species and 52 species of aphids that receive nourishment from big sagebrush alone. While my list is not implied to be complete, it does illustrate that overlooking the importance of sagebrush as a forage source for fauna of sagebrush habitats is to leave unacknowledged one of its more important contributions to the ecosystem. Failure to acknowledge this widespread importance as a forage species will lead to an inappropriate management plan and actions, or at a minimum uninformed guidance and actions.

For a forage source to be important it must have several attributes. First, it should be readily consumed as discussed above. Secondly, it needs to be abundant enough that it is a significant source of forage. Sagebrush meets this second criterion as well as it is the most abundant forage in the Pinedale resource area. Third, it should be consumed in quantities that are significant to the foraging animals. This is very evident upon exploring dietary data for the previously mentioned animals and many others. It is not uncommon for 100% of the diet at times of the year to consist of sagebrush in species like sage-grouse, pronghorn, and mule deer among others. Finally, it is important that the forage be of a sufficient quality to nutritionally satisfy the foraging animals. Sagebrush taxa are nutritionally superior to other rangeland species. This claim takes into account the facts that sagebrush taxa are very high in nutrients such as protein, carotene, and phosphorous. In addition, not only are sagebrush taxa higher in these important nutrients, but they are also much more digestible than the same nutrients in other rangeland plants (Wambolt 2004). This is true during most of the year, but is pronounced during the non-growing season when herbaceous plants have been leeched of the nutrients produced during the early portion of their annual growth cycle.

As mentioned earlier, there are hundreds of citations that apply to the topics (often myths) that I address in this letter. Instead of choosing to select a few to illustrate the science in

this forage section, I recommend studying Welch (2005) as several hundred scientific papers addressing forage relationships of sagebrush are cited and synthesized in that very comprehensive publication.

Forage value for sagebrush consumers will not be enhanced by favoring younger plants through artificial control methods. This has been proven by Wambolt (2004) when he determined the crude protein level and digestibility of 3 big sagebrush taxa were not enhanced in young sagebrush plants compared to mature individuals. Mountain, Wyoming and basin big sagebrush subspecies were studied. This research noted the lack of forage quality improvement in young sagebrush plants over older ones described as decadent by some. Again, this illustrates that land managers should not have faith in conventional wisdom that has been untested, particularly where there is research that has reached contrary conclusions. *However, the apparent problem in this DEIS is the lack of understanding of what knowledge is available regarding sagebrush and its ecosystem.* Research like this clearly indicates that sagebrush nutritional levels (or those of other species) will not increase by manipulating vegetative cover to favor early successional stages rich with young plants. *The likelihood of sustaining populations of any animal is dependant upon providing an adequate source of forage. That means not only high quality forage hopefully, as available in sagebrush taxa, but also a good quantity of forage, which obviously is provided through the climax dominant species on any landscape if palatable like sagebrush .*

Collectively, the points discussed above relating to forage values taken with the high attributes of sagebrush to furnish thermal and security cover for animals (details under Sagebrush—Mature Community) are largely why *sagebrush habitats are more often than not the location of "critical winter ranges."* Many wildlife species including the following game animals: sage-grouse, mule deer, pronghorn, elk, and bighorn sheep, commonly depend on sagebrush winter ranges that meet requirements of both forage quantity and quality. In summary, sagebrush is not only the most abundant forage available, but also the most nutritious and highly digestible forage during the majority of the year including winter. Many animals have evolved with sagebrush, and in fact, rely on it as a staple in their diets. The DEIS fails to explore the full ramifications of the various alternatives to critical winter ranges for wildlife in general and especially for non-game species, particularly in the context of forage relationships and the nutritional contribution of sagebrush to wildlife. This failure renders the DEIS inadequate to meet the requirements of full analysis and disclosure of all significant environmental impacts established by NEPA and the management alternatives presented are inadequate to meet the BLM's obligations under FLPMA.

Sagebrush—Relationships with Understory

Conventional wisdom has advocated for years that sagebrush is overly competitive and dominating, thereby suppressing understory plants. Old-school range managers used this argument to kill sagebrush believing that grass favored by cattle would increase. The facts are that many studies contradict this conventional wisdom (Blaisdell 1953, Daubenmire 1975, Peek et al. 1979, Anderson and Holte 1981, Kuntz 1982, McNeal 1984, Mangan and Autenrieth 1985, Sturges and Nelson 1986, Wambolt and Payne, 1986, Fraas et al. 1992, Wambolt and Watts 1996, Wambolt el al. 2001, Sowell et al. In Prep.). While some studies have reported an increase in herbaceous production following reduction in sagebrush composition by artificial means, these reports have generally failed to explain that other factors, such as changes in grazing management or other cultural modifications have confounded the sagebrush-understory relationship and thereby often their conclusions.

Sagebrush stands with the highest shrub cover often have the highest grass and forb cover in their understory. Conversely, stands of big sagebrush with lower cover often have the lowest herbaceous vegetation in their understory. As Welch (2005) points out, the fact that grasses and forbs are often only found under the protective cover of sagebrush does not support a view that sagebrush root systems are competitive to the point of suppressing other species. The presence of grasses and forbs under sagebrush occurs despite the fact that the greatest sagebrush root mass is concentrated directly under the shrub canopy. The literature reports that when grazing is eliminated or significantly reduced, grass cover will increase in spite of high or even increasing big sagebrush cover (McLean and Tisdale 1972, Branson and Miller 1981, Pearson 1965, Anderson and Holte 1981).

The ecological implications of the non-competitive relationships between sagebrush and associated understory plants were emphasized by Richards and Caldwell (1987). They reported that big sagebrush draws water from deep, moist soil layers and redistributes that water into the drier upper layers of the soil. This makes it available to associated plants with shallower root systems along with nutrients translocated with the water. The nutrient content of the soil found directly beneath the canopy of sagebrush is much higher in many essential elements than the shrub interspaces in the plant community (Richards and Caldwell 1987). These areas of higher nutrient loading have been referred to as islands of fertility available to benefit other plant species. Chambers (2001) noted that big sagebrush may be instrumental in water conservation by extending water near the surface soil by up to 2 weeks compared to plant interspaces. This shading effect of sagebrush canopies also reduces solar radiation, prolonging the favorable period for seedling establishment up to an additional 28 days (Pierson and Wight 1991, Chambers 2001).

Sagebrush—Indicator of Ecosystem Health

The Policy Analysis Center for Western Public Lands (PACWPL) whose mission is to "provide relevant, science-based information and analysis of ongoing and proposed public land management policies" recently treated the topic of "Conservation of Greater Sage-Grouse on Public Lands in the Western United States: Implications of Recovery and Management Policies" (PACWPL policy paper SG-02-02). PACWPL noted that *because of the total dependence of sage-grouse on sagebrush habitat that sage-grouse may serve as an indicator species for the overall condition of the sagebrush ecosystem.* They further stated that "a decline in populations likely indicates that the sagebrush ecosystem is also in decline. Because other species of wildlife and plants are also dependant on the ecosystem condition, *most analysts view the decline of the sagebrush ecosystem at the landscape scale as a major policy issue".*

The science supporting the PACWPL statement is lost in the Pinedale DEIS. There appears to be no concern for the sagebrush ecosystem at the landscape scale within the planning area. The BLM has generally regarded the sage-grouse as a "sensitive species" and regarding that status, it would seem that the lack of concern for the grouse's habitat in the Pinedale planning area is difficult to understate. The PACWPL authors were 12 scientists that have researched sagebrush ecosystem management and sage-grouse management throughout lengthy careers. These scientists sought the criticism of additional peers that were also knowledgeable of this system before authoring this policy paper for PACWPL. The PACWPL paper should be acknowledged by BLM and its implications and application explored in the EIS and implemented in the RMP.

Sagebrush—Mature Community

The theme is conveyed throughout the DEIS that a newly developing stand of sagebrush following control methods (especially fire) will be more valuable for wildlife than the existing maturing community. There is no logic or other scientific basis for such conjecture. However, there is an enormous amount of evidence to the contrary showing that the mature sagebrush stands are more beneficial habitat for wildlife. The basis for this is found in the facts that truly mature sagebrush communities will provide a number of positive attributes for wildlife such as vertical stratification of habitat niches for numerous animals requiring that characteristic. The principles of optimizing habitat benefits in mature communities are found in Wallmo and Schoen (1980) and synthesized by Welch (2005) in terms of the sagebrush literature.

Mature sagebrush communities will have characteristics that provide more thermal and security cover as well as calving-fawning-nesting cover for numerous wildlife species, including big game animals. Mature communities have the advantage of highly interspersed age and size classes created by natural turn-over of individuals plants typical of a climatically climax species

like sagebrush. The kind of optimum habitat provided by these naturally turning-over communities is not obtainable via any scheme of sagebrush reduction.

Truly mature communities can be recognized by plant turnover due to natural mortality from shrub longevity being exceeded, with subsequent replacement of climax species by younger plants. *Interspersion of age classes on a plant to plant scale is many times more advantageous than artificially induced age classes among different stands* that would be created by sagebrush control techniques. In fact such a true climax habitat would mimic the attributes of old growth forest that biologists know is so enormously valuable to many wildlife species. Artificially created stands will only perpetuate the even-aged stands across the landscape. Most even-aged sagebrush stands today are due to the ill-advised sagebrush reduction practices of past decades. The DEIS informs that such practices will continue in the Pinedale area. The importance of ceasing such practices is even more important than in the past when considered together with the serious habitat consequences sure to be realized with the level of oil and gas development that is contemplated..

In the same manner, *sagebrush forage value will not be enhanced by favoring younger plants* through artificial control methods. Wambolt (2004) tested this hypothesis when he determined the crude protein level and digestibility of 3 big sagebrush taxa were not elevated in young sagebrush plants compared to mature individuals. Mountain, Wyoming and basin big sagebrush subspecies were compared within and among taxa. The lack of forage quality improvement in young sagebrush plants over older ones was noted despite the fact that the older plants are often described as decadent. This research indicates that sagebrush nutritional levels (or those of other species) will not increase by manipulating vegetative cover to favor early successional stages rich with young plants. The likelihood of sustaining populations of any animal is also dependant upon providing an adequate quantity of forage. The climax dominant is always present in high quantity and in the case of sagebrush it is fortunate that the climax dominant is also very nutritious at any age.

The DEIS does not acknowledge the high ecological values of mature sagebrush communities. Until BLM acknowledges these values and conducts a proper inventory of existing communities and their successional status it will be impossible to adequately plan for viable sagebrush habitats. Consequently, many desirable environmental conditions dependent on viable sagebrush ecosystems also will go ignored.

Concluding Comments

Quoting from page 4-252 of the DEIS, "Development activities under all the alternatives would result in the removal of unique attributes of vegetation communities and would also reduce the ability of vegetation resources to support other resource values." This is a very brief, yet well stated, summation of what should be expected if large scale oil and gas leasing and

development activities occur in the Pinedale area. The results would be very devastating in the 87% of the area under BLM management that is sagebrush habitat. Unfortunately this recognition of consequences is not considered throughout the DEIS.

Another quote that is appropriate to the decision-making role of BLM with this DEIS was provided by Aldo Leopold. Leopold wrote: "We end, I think, at what might be called the standard paradox of the twentieth century: our tools are better than we are, and grow better faster than we do. They suffice to crack the atom, to command the tides. But, they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it."

People that share Leopold's appreciation for naturally functioning ecosystems and the unique resources they provide react with disdain upon learning of potential disturbances to otherwise whole (or nearly so) ecosystems. Areas like those considered in the Pinedale DEIS generally function naturally until they are dismantled by a series of scientifically unsupported management actions. Ironically we are in the twenty-first century and still haunted by Leopold's warning from early in the twentieth century.

My concerns for the Pinedale area are much broader than for a single species. However, in the sagebrush ecosystem many of my concerns could be addressed by providing attention to the guidelines for sage-grouse (Connelly et al. 2000). If the known requirements for sage-grouse were followed, other sagebrush dependant organisms would benefit and prosper. At present the DEIS does not accommodate these sage-grouse guidelines. In fact, BLM does not appear to have adequate background information on this "sensitive" species to address their needs as detailed in these guidelines. The inadequate "buffer areas" proposed around known areas of importance for sage-grouse are particularly disturbing. The failure to accommodate the guidelines is not only a serious omission for the sage-grouse, but also for the sagebrush ecosystem in its entirety.

The Pacific Northwest Research Station (USDA-USFS) publishes PNW Science Findings. Their stated purpose is "To provide scientific information to people who make and influence decisions about managing land." These scientists (from our other major national public land management agency stated in their March 2007 issue, "One of the largest ecosystems in the United States is suffering a death by a thousand cuts. Although it may be hard to imagine, we are witnessing the collapse of the American sagebrush ecosystem." I add that each oil or gas location, or each ill-advised sagebrush reduction treatment, etc., equals one of the "thousand cuts". Another quote from this publication is also illuminating. PNW states, "Sagebrush habitats are declining rapidly across western North America, with over 350 associated plant and animal species at risk of local or regional extirpation."

I have briefly outlined concerns shared by many informed individuals and organizations and the reasoning supporting them in this response to the DEIS. There are occasional statements in the DEIS that demonstrate similar concern by BLM. Unfortunately, they are lost in the DEIS

which at times justifies and at other times is simply passive regarding the many changes that BLM would allow under the preferred alternative (4).

Certainly alternative 3 is preferable to the others offered in the DEIS. It would allow much less acreage to be impacted by oil and gas activities. This reduction would in turn lessen impacts on portions of the sagebrush ecosystem critically important to the presently abundant wildlife. Alternative 3 still contains serious flaws to maintain ecosystem integrity. The intent to provide for natural fire regimes is dangerous and destructive as presented. This part of alternative 3 should be modified to consider facts discussed earlier in this document. The cutbacks (22%) in AUM's for livestock grazing should be rethought also. The livestock operations have and will continue to contribute to stability in the area, whereas any oil and gas activities will provide boom and bust impacts. The cumulative effects are further environmental degradation from activities like subdivisions when ranches are no longer economically viable. BLM has management options available to provide grazing while arresting environmental degradation. Instead the DEIS takes the approach of increasing the dismantling of sagebrush habitats. Objective 5 for alternatives 3 and 4 (p. 2-104, 2-150) in the DEIS is to, "Provide [Conserve (alt. 4)] functioning sagebrush habitats on a landscape scale sufficient to support the planning area's greater sage-grouse, pronghorn, mule deer, and other sagebrush-obligate wildlife species." This is a good objective, but the protective measures to realize this are not present in alternative 4 and inadequate in alternative 3. I have briefly commented on the reasons supporting my conclusion throughout this memorandum. If BLM is sincere in striving for this objective it is necessary to revisit the many complex interactions among organisms and the abiotic resources of the Pinedale area, as highlighted in detail throughout these comments.

Reality is that none of the DEIS alternatives allow for ecosystem maintenance. All alternatives offered will allow significant erosion of the ecosystem's renewable natural resources. BLM should remember its purpose to provide stewardship for public lands that will insure their continuing multiple benefits. To do this BLM will have to develop and adopt a new management alternative that recognizes both the severity of proposed impacts on the sagebrush ecosystem and the considerable science available upon which to base an adequate in-depth consideration of these impacts.

I am hopeful that BLM will acknowledge the cumulative impacts that many proposed actions in the DEIS would have on the important sagebrush ecosystem in the Pinedale area. If this is realized, then BLM will revise management plans (alternatives) for the Pinedale area in a way that will ensure the continued functioning of the sagebrush ecosystem. This will happen if existing science and facts accepted by other public land agencies like cited above in PNW Science Findings and many of the 1600+ references available (Welch 2005) are recognized. To ignore the available facts from science would be unconscionable. To minimize loss, degradation, or fragmentation of naturally functioning sagebrush ecosystems would be the highest service BLM could provide.

I sincerely request BLM to address all the issues raised in this response regarding shortcomings in the DEIS for the Pinedale Resource Management Plan. All the points I discussed are very relevant and necessary if BLM is to maintain the area's ecological integrity and satisfy the intent of NEPA.

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EDUCATION

PhD. (Range Science)	University of Wyoming	1971
M.S. (Range Science)	University of Wyoming	1968
B.S. (Range & Wildlife Management)	University of Idaho	1967

EMPLOYMENT

July 1980 - Present	Professor of Range Science Montana State University Bozeman, Montana
October 1970 - June 1980	Extension Range Specialist Montana State University Bozeman, Montana
June 1967 - September 1970	Research Fellow University of Wyoming Laramie, Wyoming
June - September, 1965 & 1966	Student Assistant Bureau of Land Management Idaho Falls, Idaho

HONORS & MEMBERSHIPS

Sigma Xi
Gamma Sigma Delta
Alpha Zeta
Society for Range Management
Wildlife Federation
Governor's Range Committee
Montana Rangeland Resources Program Executive Committee
Surface Environment & Mining Executive Committee
Missouri Basin Systems Group Advisory Committee
Integrated Pest Management Committee (W-161)
Rural Areas Development Committee
Advisor to National Academy of Sciences
California Botanical Society
Shrub Research Consortium (Symposium Editor 1991-92 & 1998-99)
Mortar Board Favorite Professor Award
Award for Excellence Professor
Society for Range Management Fellow Award (International)
Associate Editor for Intermountain Journal of Sciences

COMPETITIVE GRANTS FUNDED

Bureau of Land Management Range Survey- Dillon Resource Area ($35,000) - 1976
Bureau of Land Management Range Survey - Butte/Helena Resource Area ($40,000) - 1977
CSRS - USDA (IPM) - An economic comparative analysis of control treatments for big sagebrush. ($25,000) - 1985-1987
Research - Creativity Grant - An evaluation of secondary metabolites in plant- herbivore interactions
CSRS - USDA (IPM) - High stocking rate potential for controlling big sagebrush. ($10,000)- 1987-1988
Montana Dept. of Fish, Wildlife, and Parks - Ecological relationship of bitterbrush. ($3,000) - 1988-1989
CSRS - USDA (IPM) - High stocking rate potential for controlling big sagebrush. ($34,000)- 1988-1991
Montana Dept. of Fish, Wildlife, and Parks - Browse level response of bitterbrush. ($12,000) - 1990-1992
US Forest Service - Nutritional comparison of perennial grasses under different grazing treatments. ($10,000) - 1991-1994
National Park Service, US Forest Service, MT Dept. of Fish, Wildlife, and Parks - Sagebrush ecology and mule deer relationships on the northern Yellowstone winter Range. ($37,443)- 1992-1995.
Rocky Mountain Elk Foundation and Safari Club International - Supplemental funding to - Sagebrush ecology and mule deer relationships on the northern Yellowstone winter range. ($12,000)- 1992-1995.
Bureau of Land Management, MT Dept. of Fish, Wildlife, and Parks, and Foundation for North American Wild Sheep - Bighorn sheep habitat relationships in the Highland mountains southwestern Montana. ($122,100) - 1992-1996.
Montana Dept. of Fish, Wildlife, and Parks - A comparison of burned and unburned mountain big sagebrush communities. ($12,000) - 1995-1997.
Rocky Mountain Elk Foundation – Recovery of elk browsed versus protected shrubs following fire. ($13,600) – 1998-2000.
Montana Department of Fish, Wildlife, and Parks-Browse condition and trend on Montana ungulate ranges. ($25,800 + Travel Expenses) 2000-2002.
Bureau of Land Management-Fire effects on a northern plains environment ($10,000) 2001-2002.
Policy Analysis Center -- Sage grouse policy analysis. ($6,250). 2001-2002.
Montana Dept. of Fish, Wildlife, and Parks – Sage-grouse nesting and brood-rearing habitat. ($34,400) 2003-2005.
Bureau of Land Management – Sage-grouse habitat. ($16,840) 2004-2005.
Montana Dept. of Fish, Wildlife, and Parks—Sage-grouse winter habitat. ($17,500) 2005-2006.

SOCIETY FOR RANGE MANAGEMENT ACTIVITIES

Range Science Education Council (1987 to present)
Blue ribbon committee for sagebrush habitats and sage-grouse
Regional Coordinator & author of "Rangeland Cover Types of the U.S."
Chairman and member (3 years)-- Student Affairs Committee
Chairman and member (2 years)-- Youth Range Forum
Member (3 years) -- Public Affairs Committee
Member (3 years) -- Professional Affairs Committee
Member (3 years) – Government Policy and Programs Committee
Member -- Membership Committee
Plant Judging Team Coach (7 team/3 individual awards in 12 years)
Representative at U.S. Senate Hearings on Federal Reclamation Act
Participation in Old West Regional Commission Range Program
Referee for Journal of Range Management and other Scientific Journals
Committee to select Outstanding Range Educator (3 years)
Invited speaker at annual meeting on Natural Regulation in Yellowstone
Prepared Literature Response on Natural Regulation for SRM
Recipient of Fellow Award
Representative to National Academy of Sciences
Member (3 years) – Government Policy and Relations Committee
Prepared news release on SRM-YSNP Policy

UNIVERSITY ACTIVITIES (Service Related)

MSU Faculty Council
Chairman Ag Faculty Council
Vice-Chairman Ag Faculty Council
Member Ag Faculty Council
Committee to Build Financial Support for Ag Judging Teams
Rural Area Development Wildlife and Range Committees
Range Certifying Officer
Coach -- Range Judging Team
Appeals and Grievance Board
College of Agriculture Scholastic Committee
College of Agr. Cont. Envir. Facil. Comm.
Departmental Committee on Judging Teams
Departmental Committee on Graduate Curriculum
Departmental Executive Committee
Maintain Range Plant Teaching Herbarium
Director Cooperative Park Study Unit (YNP and MSU)
National Park Service Research Review Panel
College of Agriculture Promotion and Tenure Committee
Department of Animal and Range Sciences Promotion and Tenure Committee
College of Agriculture Grievance Committee

COURSES INSTRUCTED

Vegetation of Western Wildlands
Biomes of Western Wildlands
Western Range Ecosystems
Wildlife Habitat Ecology
Principles of Natural Resource Rehabilitation
Advanced Natural Resource Ecology
Yellowstone Range Ecology (Field Course)
Graduate Seminar

PUBLICATIONS

Scholarly Publications (C.L. Wambolt - P.I.)

Woodward, J. K., C. L. Wambolt and B. F. Sowell. 200X. Greater sage-grouse winter habitat in central Montana. In prep. J. to be determined.

Woodward, J. K., C. L. Wambolt and B. F. Sowell. 200X. Greater sage-grouse nesting and brood-rearing habitat in central Montana. In prep. J. to be determined.

Sowell B. F., C. L. Wambolt, J. K. Woodward, and V. R. Lane. 200X. Relationship of Wyoming big sagebrush cover to herbaceous vegetation. Western North American Naturalist. XX: 000-000.

Wambolt, C. L. and R. J. Rens. 200X. Elk (*Cervus elephus nelsoni*) and fire impacts on mountain big sagebrush (*Artemisia tridentata vaseyana*) range in Yellowstone.

Scholarly Publications – continued

Frisina, M. R., C. L. Wambolt, W. W. Fraas, and G. E. Guenther. 2007. Mule deer and elk winter diets as an indicator of habitat competition. p. 000-000. *In:* S. Kitchen, and E. D. McArthur compilers, Proc: Shrublands under fire: disturbance and recovery in a changing world. USDA Forest Serv. Proc. RMRS-P-XX. Ogden, Utah.

Schroeder, M. A., J. W. Connelly, C. L. Wambolt, C. E. Braun, C. A. Hagen, and M. R. Frisina. 2006. Society for range management issue paper: ecology and management of sage-grouse and sage-grouse habitat-a reply. Rangelands. 28: 3-7.

Wambolt, C. L., M. R. Frisina, S. J. Knapp, and R. M. Frisina. 2006. Effect of method, site, and taxon on line-intercept estimates of sagebrush cover. Wildlife Soc. Bull. 34:440-445.

Grove, A. J., C. L. Wambolt, and M. R. Frisina. 2005. Douglas-fir's effect on mountain big sagebrush wildlife habitats. Wildlife Soc. Bull. 33:74-80.

Wambolt, C. L. 2005. Sagebrush-ungulate relationships on the northern Yellowstone winter range. p. 109-115. *In*: N. L. Shaw, M. Pellant, and S. Monsen, compilers, Proc: Sage-grouse habitat restoration. USDA Forest Serv. Proc. RMRS-P-38. Fort Collins, Colorado.

Frisina, M. R. and C. L. Wambolt. 2004. Keying in on big sagebrush. Rangelands. 26:12-16.

Johnson-Nistler, C. M., B. F. Sowell, H. W. Sherwood, and C. L. Wambolt. 2004. Black-tailed prairie dog effects on Montana's mixed-grass prairie. J. Range Manage. 57: 641-648.

Wambolt, C. L. 2004. Browsing and plant age relationships to winter protein and fiber of big sagebrush subspecies. J. Range Manage. 57: 620-623.

Wambolt, C. L. and T. Hoffman. 2004. Browsing effects on Wyoming big sagebrushplants and communities. p. 194-197.*In:* A. L. Hild, N. L. Shaw, S. E. Meyer, D. T. Booth, and E. D. McArthur compilers, Proc: Seed dynamics in shrubland ecosystems. USDA Forest Serv. Proc. RMRS-P-31. Ogden, Utah.

Wambolt, C. L., and S. Thompson. 2003. Wild ungulate impacts on browse in Montana, USA. African J. Range & Forage Sci. 20:111 (full text online—www.ingentaselect.com).

Wambolt, C. L., A. J. Harp, B. L. Welch, N. Shaw, J. W. Connelly, K. P. Reese, C. L. Braun, D. A. Klebenow, E. D. McArthur, J. G. Thompson, L. A. Torell, and J. A. Tanaka. 2002. Conservation of the greater sage-grouse on public lands in the western U.S.: implications of recovery and management policies. Policy Analysis Center for Western Public Lands. Univ. of Idaho, Caldwell. 41p.

Wambolt, C. L. and M. R. Frisina. 2002. A guide to Montana sagebrush. Mont. Fish, Wildlife & Parks. Misc. Bul.

Wambolt, C. L. and M. R. Frisina. 2002. Montana sagebrush: A taxonomic key and habitat descriptions. Intermountain J. Sciences. 8:46-59.

Frisina, M.R., C. L. Wambolt, B. Sowell, S. J. Knapp, M. Sullivan, and C. Johnson. 2001. A balancing act: sagebrush-sage-grouse-prairie dogs. Rangelands. 23:17-19.

Wambolt, C.L. 2001 Mule deer foraging preference among five sagebrush (*Artemisia* L.) taxa. Western North American Naturalist. 61:490-494.

Scholarly Publications – continued

Wambolt, C.L. and T. Hoffman. 2001. Mountain big sagebrush age distribution and relationships on the northern Yellowstone winter range. p. 330-335. *In*: E. D. McArthur and D. J. Fairbanks, compilers, Proc: Shrubland Ecosystem Genetics and Biodiversity. USDA Forest Serv. Proc. RMRS-P-21. Ogden, Utah.

Wambolt, C.L., K.S. Walhof, M.R. Frisina. 2001. Recovery of big sagebrush communities after burning in south-western Montana . J. Environmental Manage. 61:243-252.

Wambolt, C.L., T. Hoffman, and H. Sherwood. 2000. Browsing effect on Wyoming big sagebrush by antelope and other ungulates. p.73-76. *In*: J. K. Fischer ed. Proc: 17th Biennial Pronghorn Antelope Workshop, Lake Tahoe. Pub. Calif. Dept. of Fish & Game.

Wambolt, C.L. and H.W. Sherwood. 1999. Sagebrush response to ungulate browsing in Yellowstone. J. Range Manage. 52:363-369.

Wambolt, C.L., T.L. Hoffman, and C.A. Mehus. 1999. Response of shrubs in big sagebrush habitats to fire on the Northern Yellowstone Winter Range. p. 238-242 . *In:* E.D. McArthur, W.K. Ostler, and C.L. Wambolt, compilers, Proc: shrubland ecotones. USDA Forest Serv. Gen. Tech. Rep. RMRS-P-11. Ogden, Utah.

Wambolt, C.L. 1998. Sagebrush and ungulate relationships on Yellowstone's northern range. Wildlife Soc. Bull. 26(3):429-437.

Wambolt, C.L., R.S. White, and T.P. Walton. 1998. An effective method of measuring seed dissemination. Intermountain J. Sciences. 4: 27-32.

Wambolt, C.L., W.W. Fraas, and M.R. Frisina. 1998. Bitterbrush (*Purshia tridentata* Pursh) growth in relation to browsing. Great Basin Naturalist. 58:28-37.

Wambolt, C.L., M.R. Frisina, K.S. Douglass, and H.W. Sherwood. 1997. Grazing effects on nutritional quality of bluebunch wheatgrass for elk. J. Range Manage. 50:503-506.

Hoffman, T.L. and C.L. Wambolt. 1996. Growth response of Wyoming big sagebrush to heavy browsing by wild ungulates. p. 242-245. *In*: J.R. Barrow, E.D. McArthur, R.E. Sosebee, and R.E. Rausch, compilers, Proc. - Symposium on shrubland ecosystem dynamics in a changing environment. USDA Forest Serv. Gen. Tech. Rep. INT-GTR-338. Ogden, Utah.

Wambolt, C.L. 1996. Mule deer and elk foraging preference for 4 sagebrush taxa. J. Range Manage. 49: 499-503.

Wambolt, C.L., W.W. Fraas, and M.R. Frisina. 1996. Variation in bitterbrush (*Purshia tridentata* Pursh) crude protein in southwestern Montana. Great Basin Naturalist. 56: 205-210.

Wambolt, C.L. and M.J. Watts. 1996. High stocking rate potential for controlling Wyoming big sagebrush. p. 148-150. *In*: J.R. Barrow, E.D. McArthur, R.E. Sosebee, and R.E. Rausch, compilers, Proc. - Symposium on shrubland ecosystem dynamics in a changing environment. USDA Forest Serv. Gen. Tech. Rep. INT-GTR-338. Ogden, Utah.

Watts, M.J. and C.L. Wambolt. 1996. Long-term recovery of Wyoming big sagebrush after four treatments. J. Environmental Manage. 46:95-102.

Wagner, F.H., R.B. Keigley, and C.L. Wambolt. 1995. Ungulate herbivory of willows on Yellowstone's northern winter range. J. Range Manage. 48:475-477.

Scholarly Publications – continued

Wambolt, C.L. 1995. Elk and mule deer sagebrush preferences. Montana AgResearch. Mont. Ag. Exp. Sta. 12: 35-40.

Wambolt, C.L., W.H. Creamer, and R.J. Rossi. 1994. Predicting big sagebrush winter forage by subspecies and browse form class. J. Range Manage. 47:231-234.

Wambolt, C.L. 1994. Northern Rocky Mountains cover types. p. 27-39 *In*: T. Shiflet, editor, Rangeland Cover Types of the United States. Soc. for Range Manage. Denver, Colorado.

Beverlin, G. W. and C. L. Wambolt. 1993. Distribution and habitat of Montana *Chrysothamnus*. *In*: J. Cook Compiler, Proc. Montana Academy of Sciences. 50:37-52.

Guenther, G.E., C.L. Wambolt, and M.R. Frisina. 1993. Characteristics of bitterbrush habitats that influence canopy cover and mule deer browsing. J. Environmental Manage. 37: 175-181.

Creamer, W.H., C. L. Wambolt, and R. J. Rossi. 1992. Comparison of three groups of variables for prediction of big sagebrush forage production. p. 217-221. *In*: W.P. Clary, E.D. McArthur, D. Bedunah, and C.L. Wambolt, compilers, Proc. - Symposium on Ecology and Management of Riparian Shrub Communities. USDA Forest Serv. Gen. Tech. Rep. INT-289, Ogden, Utah.

Fraas, W. W., C. L. Wambolt, and M. R. Frisina. 1992. Prescribed fire effects on a bitterbrush-mountain big sagebrush-bluebunch wheatgrass community. p. 212-216. *In*: W.P Clary, E.D. McArthur, D. Bedunah, and C.L. Wambolt, compilers, Proc. - Symposium on Ecology and Management of Riparian Shrub Communities. USDA Forest Serv. Gen. Tech. Rep. INT-289, Ogden, Utah.

Wambolt, C. L. and G. W. Beverlin. 1992. Taxonomy of Montana *Chrysothamnus*. *In*: J. Cook Compiler, Proc. Montana Academy of Sciences. 51:33-38.

Bray, R. O., C. L. Wambolt, and R. G. Kelsey. 1991. Influence of sagebrush terpenoids on mule deer preference. J. Chemical Ecology. 17:2053-2062.

Winkler, G., and C. L. Wambolt. 1991. Range extension, description, and habitat for *Haplopappus macronema* ssp. *linearis* (Asteraceae). Prairie Naturalist. 23:101-106.

Wambolt, C.L., R.G. Kelsey, R.O. Bray, T.L. Personius, and K.D. Striby. 1991. Wildlife reactions to sagebrush crude terpenoids. p. 37-40. *In*: Fisser H.G., ed., Proc. of the seventeenth Wyoming shrub ecology workshop. 1988, Jackson, WY. Laramie, WY: University of Wyoming, College of Agriculture, Department of Range Management.

Wambolt, C. L., T. P. Walton, and R. S. White. 1990. Sprouting and seedling establishment in plains silver sagebrush (*Artemisia cana Pursh.* ssp. *cana*). Great Basin Naturalist. 50:201-207.

Wambolt, C. L., R. G. Kelsey, A. F. McNeal, T. L. Personius, and K. D. Striby. 1990. Forage relationships of select sagebrush taxa. p. 21-24. *In*: Fisser, H.G., ed., Proc. of the fourteenth Wyoming shrub ecology workshop. 1985, Rock Springs, WY. Laramie, WY: University of Wyoming, College of Agriculture, Department of Range Management.

Watts, M. J. and C. L. Wambolt. 1990 An economic comparison of Wyoming big sagebrush controls. Montana AgResearch. Mont. Ag. Exp. Sta. 7:17-19.

Wambolt, C. L., T. P. Walton, and R. S. White. 1989. Seed dispersal characteristics of plains silver sagebrush. Prairie Naturalist. 21:113-118.

Scholarly Publications – continued

Watts, M. J. and C. L. Wambolt. 1989. Economic evaluation of Wyoming big sagebrush (*Artemisia tridentata*) control methods. Weed Technology. 3:640-645.

Personius, T. L., C. L. Wambolt, J. R. Stephens, and R. G. Kelsey. 1987. Crude terpenoid influence on mule deer preference for sagebrush. J. Range Manage. 40:84-88.

Striby, K. D., C. L. Wambolt. R. G. Kelsey, and K. M. Havstad. 1987. Crude terpenoid influence on in vitro digestibility of sagebrush. J. Range Manage. 40:244-248.

Wambolt, C. L., R. G. Kelsey, T. L. Personius, K. D. Striby, A. F. McNeal, and K. M. Havstad. 1987. Preference and digestibility of three big sagebrush (*Artemisia tridentata*) subspecies and black sagebrush (*A. nova*) as related to crude terpenoid chemistry. p. 71-73. *In*: F.D. Provenza, J.T. Flinders, and E.D. McArthur, compilers, Proc. - Symposium on Plant - Herbivore Interactions. USDA Forest Serv. Gen. Tech. Rep. INT-222, Ogden, Utah.

Wambolt, C. L. and A. F. McNeal. 1987. Selection of winter foraging sites by elk and mule deer. J. Environmental Manage. 25:285-291.

Walton, T. P., R. S. White, and C. L. Wambolt. 1986. *Artemisia* reproductive strategies: A review with emphasis on plains silver sagebrush. p. 67-74. *In*: E.D. McArthur and B.L. Welch, compilers, Proc. - Symposium on the Biology of *Artemisia* and *Chrysothamnus*. USDA Forest Serv. Gen. Tech. Rep. INT-200, Ogden, Utah.

Wambolt, C. L. and G. F. Payne. 1986. An 18-year comparison of control methods for Wyoming big sagebrush in southwestern Montana. J. Range Manage. 39:314-319.

Wambolt, C. L. and G. F. Payne. 1986. Controlling Wyoming big sagebrush. Montana AgResearch. Mont. Ag. Exp. Sta. 3(3):1-6.

Wambolt, C.L. 1980. Livestock management in riparian habitats. Proc. Western Sec. Amer. Fisheries Soc. Kalispell, MT. 6 p.

Wambolt, C. L. 1973. Conifer water potential as influenced by stand density and environmental factors. Can. J. of Botany. 51:2333-2337.

Theses Completed by Advisees

Woodward, J. 2006. Greater sage-grouse (*Centrocercus urophasianus*) habitat in central Montana.

Lane, V. 2005. Sage-grouse (*Centrocercus urophasianus*) nesting and brood-rearing sagebrush habitat characteristics in Montana and Wyoming.

Thompson, S. 2002. Browse condition and trend on Montana ungulate ranges.

Rens, R. 2001. Elk effects on sagebrush-grassland after fire on Yellowstone's northern range.

Grove, A.J. 1998. Effects of Douglas fir establishment in southwestern Montana mountain big sagebrush communities.

Walhof, K.S. 1997. A comparison of burned and unburned big sagebrush communities in southwest Montana.

Theses – continued

Hoffman , T. L. 1996. An ecological investigation of mountain big sagebrush in the Gardiner basin.

Mehus, C. A. 1995. Influences of browsing and fire on sagebrush taxa of the northern Yellowstone winter range.

Fraas, W. W. 1992. Bitterbrush growth and reproductive characters in relation to browsing in southwest Montana.

Creamer, W. H. 1991. Prediction of available forage production of big sagebrush.

Bray, R. O. 1990. The influence of selected *Artemisia* compounds on mule deer preference.

Guenther, G. E. 1989. Ecological relationships of bitterbrush communities on the Mount Haggin Wildlife Management Area.

Winkler, G. L. 1987. Montana *Chrysothamnus*.

Personius, T. L. 1985. The influence of crude terpenoid constituents on mule deer preference for big sagebrush and black sagebrush.

Striby, K. D. 1985. The in vitro digestibility and utilization of big sagebrush and black sagebrush.

McNeal, A. F. 1984. Site characteristics and effect on elk and mule deer use of the Gardiner winter range, Montana.

Walton, T. P. 1984. Reproductive mechanisms of plains silver sagebrush (*Artemisia cana cana*) in southeastern Montana.

Abstracts of Papers Presented at Scholarly Meetings

Frisina, M. R., C. L. Wambolt, W. W. Fraas, and G. E. Guenther. 2006. Mule deer and elk winter diets as an indicator of habitat competition. Symposium on Shrublands under fire: disturbance and recovery in a changing world. Cedar City, Utah.

McArthur, E. D., S. G. Kitchen, and C. L. Wambolt, et al. 2006. The Shrub Research Consortium: a model for regional, common interest research and management. Symposium on Collaborative watershed management and research in the Great Basin. Consortium of 9 Agencies and Universities, Reno, Nevada.

Woodward J., C. L. Wambolt, and B. F. Sowell. 2006. Sage-grouse winter habitat in central Montana. Proc. Soc. Range Mgt. 59th Ann. Meeting. Vancouver, British Columbia.

Wambolt, C. L. 2005. Ecology of sagebrush ecosystems. Proc. Introduction to fire effects III. National Interagency Fire Center. Boise, Idaho. (INVITED PAPER).

Frisina, M. R. and C. L. Wambolt. 2005. Habitat competition from diet overlap of elk and mule deer. Proc. Soc. Range Mgt. 58th Ann. Meeting, Fort Worth, Texas.

Lane, V., J. Sika, J. Rotella, B. F. Sowell, and C. L. Wambolt. 2005. Sage-grouse nesting and brood-rearing habitat in central Montana. Proc. Soc. Range Mgt. 58th Ann. Meeting. Fort Worth, Texas.

Wambolt, C. L. 2004. Sagebrush habitat ecology. Proc. Introduction to fire effects II. National Interagency Fire Center, Boise, Idaho. (INVITED PAPER).

Abstracts of Papers Presented at Scholarly Meetings – continued

Wambolt, C. L. 2004. Relationships of fauna in sagebrush habitat types. Proc. Introduction to fire effects. National Interagency Fire Center. Boise, Idaho. (INVITED PAPER).

Wambolt, C. L., and M. R. Frisina. 2004. Montana rabbitbrush. Proc. Soc. Range Mgt. 57th Ann. Meeting, Salt Lake City, Utah.

Frisina, M. R. and C. L. Wambolt. 2003. Montana sagebrush: A taxonomic key and habitat descriptions. Proc. Soc. Range Mgt. 56th Ann. Meeting, Casper, Wyoming.

Johnson, C. M., B. F. Sowell, H. W. Sherwood, and C. L. Wambolt. 2003. Black-tailed prairie dog effects on Montana's mixed grass prairie. Proc. Soc. Range Mgt. 56th Ann. Meeting. Casper, Wyoming.

Thompson, S. K. and C. L. Wambolt. 2003. Browse condition and trend on Montana ungulate ranges. Proc. Montana Chapter of the Wildlife Society. Lewistown, Montana.

Wambolt, C. L. 2003. Sagebrush forage relationships. *In*: Sagebrush Ecosystem Symposium. Proc. Soc. Range Mgt. 56th Ann. Meeting, Casper, Wyoming. (INVITED PAPER).

Wambolt, C. L. 2003. Ungulate relationships to sagebrush communities and fire. Proc. Introduction to fire effects. National Interagency Fire Center. Boise, Idaho. (INVITED PAPER).

Wambolt, C. L. 2003. Wild ungulate impact on browse in Montana, USA. Proc. VII International Rangeland Congress. Durban, South Africa.

Thompson, S. K. and C. L. Wambolt. 2002. Browse condition and trend on Montana ungulate ranges. Proc. Soc. Range Mgt. 55th Ann. Meeting. Kansas City, Kansas.

Wambolt, C. L. 2002. The role of sagebrush in a natural ecosystem. Proc. Sagebrush . Idaho State Univ. Pocatello, ID. (INVITED PAPER).

Wambolt, C. L. and T. L. Hoffman. 2002. Browsing effects on Wyoming big sagebrush plants and communities. Symposium on Seed Dynamics in Shrubland Ecosystems. Laramie, Wyoming.

Wambolt, C.L. 2001. Sagebrush-ungulate relationships on the Northern Yellowstone Winter Range. Proc. Sage-grouse habitat restoration symposium. Boise, Idaho.

Rasmussen, G. A., N. Haynes, B. F. Sowell, C. L. Wambolt, M. J. Watts, and H. Sherwood. 2001. A strategy used by livestock producers to deal with drought risks on rangelands. Proc. Soc. Range Mgt. 54th Ann. Meeting, Kona, Hawaii.

Sherwood, H.W., C.L. Wambolt, B.F. Sowell, M.J. Watts, and A. Rasmussen. 2001. Methodology to determine the coverage for the range-pasture crop insurance program. Proc. Soc. Range Mgt. 54th Ann. Meeting. Kona, Hawaii.

Sowell, B.F., C.L. Wambolt, H. Sherwood, M.J. Watts, and A. Rasmussen. 2001. Implications of range-pasture crop insurance. Proc. Soc. Range Mgt. 54th Ann. Meeting. Kona, Hawaii.

Wambolt, C.L., B. Sowell, H. Sherwood, M.J. Watts, and A. Rasmussen. 2001. A program for range crop insurance Proc. Soc. Range Mgt. 54th Ann. Meeting. Kona, Hawaii.

Abstracts of Papers Presented at Scholarly Meetings – continued

Wambolt, C.L. and T. L. Hoffman. 2000. Mountain big sagebrush age distribution and relationships on the northern Yellowstone winter range. Symposium on Shrubland Ecosystem Genetics and Biodiversity. Provo, Utah.

Wambolt, C.L. 2000. Habitat relationships of native ungulates in sagebrush communities. Symposium: Sagebrush steppe communities: origin, ecology, impacts and resources. Proc. Soc. Range Mgt. 53rd Ann. Meeting. Boise, Idaho. (INVITED PAPER)

Rens, R. and C.L. Wambolt. 2000. Recovery of elk-browsed versus protected shrubs following fire on Yellowstone's northern range. Proc. Soc. Range Mgt. 53rd Ann. Meeting. Boise, Idaho.

Wambolt, C.L., T.L. Hoffman, and C.A. Mehus. 1998. Response of big sagebrush subspecies to fire on the Northern Yellowstone Winter Range. Symposium on shrubland ecotones. Ephraim, Utah.

Wambolt, C.L. 1998. Sagebrush ecology on the Northern Yellowstone Winter Range. Proc. Soc. Range Mgt. 51st Ann. Meeting. Guadalajara, Mexico.

Wambolt, C.L. 1997. Elk and mule deer interelationships with sagebrush taxa on the Northern Yellowstone Winter Range. Proc. The Wildlife Society. 4th Ann. Conf. Snowmass, Colorado. (INVITED PAPER)

Wambolt, C.L. 1997. Natural Regulation – science or dogma? Soc. Range Mgt. 51st summer meeting. Billings, Montana. (INVITED PAPER)

Grove, A.J., C.L. Wambolt, and M.R. Frisina. 1997. Effects of Douglas-fir encroachment on big sagebrush communities. Proc. Soc. Range Mgt. 50th Ann. Meeting. Rapid City, South Dakota.

Walhof, K.S., C.L. Wambolt, and M.R. Frisina. 1997. A comparison of burned and unburned big sagebrush communities in southwest Montana. Proc. Soc. Range Mgt. 50th Ann. Meeting. Rapid City, South Dakota.

Wambolt, C.L., J.A. Fortney, and T.L. Hoffman. 1996. Browsing effect on Wyoming big sagebrush by antelopeand other ungulates. Proc. 17th Biennial Pronghorn Antelope Workshop. Brockway, California.

Wambolt, C.L., M.R. Frisina, K. Douglass, and H. Sherwood. 1996. Grazing effect on the nutritional quality of bluebunch wheatgrass. Proc. Soc. Range Mgt. 49th Ann. Meeting. Wichita, Kansas.

Hoffman, T.L. and C.L. Wambolt. 1995. Growth response of Wyoming big sagebrush to heavy browsing by wild ungulates. Symposium on shrubland ecosystem dynamics in a changing climate. Las Cruces, New Mexico.

Wambolt, C.L. and M.J. Watts. 1995. High stocking rate potential for controlling Wyoming big sagebrush. Symposium on shrubland ecosystem dynamics in a changing climate. Las Cruces, New Mexico.

Fortney, J.A. and C.L. Wambolt. 1995. Sagebrush response to browsing or protection on the Northern Yellowstone winter range. Proc. Soc. Range Mgt. 48th Ann. Meeting. Phoenix, Arizona.

Hoffman, T.L. and C.L. Wambolt. 1994. Mountain big sagebrush production as related to age and site characteristics. Proc. Soc. Range Mgt. 47th Ann. Meeting. Colorado Springs, Colorado.

Mehus, C.A. and C.L. Wambolt. 1994. Reestablishment of three big sagebrush and five rabbitbrush taxa following burning. Proc. Soc. Range Mgt. 47th Ann. Meeting. Colorado Springs, Colorado.

Abstracts of Papers Presented at Scholarly Meetings – continued

Wambolt, C.L. 1993. Mule deer and elk preference among four sagebrush taxa on the northern Yellowstone winter range. Proc. Soc. Range Mgt. 46th Ann. Meeting. Albuquerque, New Mexico.

Creamer, W. H., C. L. Wambolt, and R. J. Rossi. 1991. Comparison of three groups of variables for prediction of big sagebrush forage production. Symposium on Ecology and Management of Riparian Shrub Communities. Sun Valley, ID.

Fraas, W. W., C. L. Wambolt, and M. R. Frisina. 1991. Prescribed fire effects on a bitterbrush-mountain big sagebrush-bluebunch wheatgrass community. Symposium on Ecology and Management of Riparian Shrub Communities. Sun Valley, ID.

Wambolt, C. L. and G. W. Beverlin. 1991. Taxonomy of Montana *Chrysothamnus*. Proc. Montana Academy Sciences 51st Ann. Meeting. Billings, MT.

Creamer, W.H. and C. L. Wambolt. 1990. Prediction of big sagebrush forage production. Proc. Soc. Range Mgt. 43rd Ann. Meeting. Reno, Nevada.

Wambolt, C. L. and G. W. Beverlin. 1990. Distribution and habitat of Montana *Chrysothamnus*. Proc. Montana Academy Sciences 50th Ann. Meeting. Missoula, MT.

Guenther, G.E., C.L. Wambolt, and M.R. Frisina. 1989. Ecological relationships of bitterbrush communities on the Mount Haggin Wildlife Management Area. Proc. Soc. Range Mgt. 42nd Ann. Meeting. Billings, Montana.

Wambolt, C.L. 1988. Wildlife reactions to sagebrush crude terpenoids. Wyoming Shrub Ecology Workshop. Jackson, Wyoming.

Bray, R. O., C. L. Wambolt, and R. G. Kelsey. 1987. Influence of compounds found in *Artemisia* on mule deer preference. Proc. Soc. Range Mgt. 40th Ann. Meeting. Boise, Idaho.

Winkler, G. L. and C. L. Wambolt. 1987. A new taxon in *Chrysothamnus parryi*. Proc. Soc. Range Mgt. 40th Ann. Meeting. Boise, Idaho.

Winkler, G. L. and C. L. Wambolt. 1987. *Chrysothamnus* taxa in Montana. Proc. Soc. Range Mgt. 40th Ann. Meeting. Boise, Idaho.

Walton, T. P., R. S. White, and C. L. Wambolt. 1985. Seed dispersal, emergence, growth and survival of plains silver sagebrush (*Artemisia cana* Pursh. *cana*). Proc. Soc. Range Mgt. 38th Annual Meeting. Salt Lake City, Utah.

Wambolt, C. L. 1985. Forage relationships of sagebrush taxa. Wyoming Shrub Ecology Workshop. Rock Springs, WY.

Wambolt, C.L., R.G. Kelsey, T.L. Personius, K.D. Striby, A.F. McNeal, and K.M. Havstad. 1985. Preference and digestibility of three big sagebrush subspecies and black sagebrush as related to crude terpenoid chemistry. Symp. on Plant-Herbivore Interactions. Snowbird, UT.

White, R. S., T. P. Walton, and C. L. Wambolt. 1985. Factors affecting sexual and asexual reproduction in plains silver sagebrush (*Artemisia cana* Pursh. *cana*). Proc. Ecol. Soc. of Amer. Missoula, MT.

Personius, T. L., C. L. Wambolt, and R. G. Kelsey. 1984. The influence of secondary plant metabolites on mule deer preference for big sagebrush (*Artemisia tridentata*). Proc. Soc. Range Mgt. 37th Annual Meeting. Rapid City, South Dakota.

Abstracts of Papers Presented at Scholarly Meetings – continued

Walton, T.P., R.S. White, and C.L. Wambolt. 1984. Factors affecting reproduction in plains silver sagebrush. Fort Keogh Livestock and Range Research Station Field Day Proceedings, Miles City, MT, p. 51-53.

Walton, T. P., R. S. White, and C. L. Wambolt. 1984. Reproductive mechanisms of plains silver sagebrush (*Artemisia cana cana*) in southeastern Montana. Proc. Soc. Range Mgt. Rapid City, South Dakota.

Walton, T.P., R.S. White, and C.L. Wambolt. 1984. *Artemisia* reproductive strategies: A review with emphasis on plains silver sagebrush. Symp. on the Biology of *Artemisia* and *Chrysothamnus*. Provo, Utah.

Walton, T. P., R. S. White, and C. L. Wambolt. 1984. Seed dispersal, emergence, growth, and survival of plains silver sagebrush. Proc. Livestock Range Research Station Symposium. MilesCity, MT.

McNeal, A. F. and C. L. Wambolt. 1982. Range condition and habitat type preference of elk and mule deer on the Gardiner unit of the Northern Yellowstone winter range. Proc. Soc. Range Mgt. 35th Ann. Meeting. Calgary, Alberta.

Striby, K. D., C. L. Wambolt, K. M. Havstad, and R. G. Kelsey. 1982. Forage value relationships of four woody *Artemisia* taxa on elk and mule deer winter range in southwestern Montana. Proc. Soc. Range Mgt. 35th Ann. Meeting. Calgary, Alberta.

Wambolt, C. L. 1980. Livestock management in riparian habitats. Proc. Western Sec. Amer. Fisheries Soc. Kalispell, Montana.

Wambolt, C. L. 1979. Riparian habitat - to manage or not to manage. Proc. of a Symposium. The future of fish and wildlife resources in Montana. Soil Cons. Society, Amer. Fisheries Soc., Soc. Amer. Foresters and the Wildlife Soc. Missoula, Montana.

Wambolt, C. L. 1976. Problems associated with western strip mining. Wisconsin Public Serv. Comm. Energy Inquiry. Univ. of Wisc., Madison, Wisconsin.

Wambolt, C. L. 1975. Reclaimability of western lands as related to environmental conditions. Comm. on Energy and the Environment Nat'l. Acad. of Sci. Washington, D. C.

Wambolt, C. L. 1975. Ag lender's range school: a new approach to educating range users. Proc. Soc. Range Mgt. 28th Ann. Meeting. Mexico City, Mexico.

Wambolt, C. L. 1974. Pryor Mountain complex: a model of changing attitudes toward natural resources. Proc. Soc. Range Mgt. 27th Ann. Meeting. Tucson, Arizona.

Wambolt, C. L. 1971. Moisture stress in woody plants as influenced by environmental factors. Proc. Soc. Range Mgt. 24th Ann. Meeting. Reno, Nevada.

Wambolt, C. L. 1969. Size, density, growth rate and age of Rocky Mountain juniper and interrelationships with environmental factors. Proc. Amer. Soc. Range Mgt. 22nd Ann. Meeting. Calgary, Alberta.

Technical Bulletins

Wambolt, C. L. 1981. Montana range plants. Coop. Ext. Ser. Mont. St. Univ. Bull 355. 27 pp.

Leininger, W. C., J. E. Taylor, and C. L. Wambolt. 1977. Poisonous range plants in Montana. Coop. Ext. Ser. Mont. St. Univ. Bull. 348. 60 pp.

Wambolt, C. L. 1976. Montana range seeding guide. Coop. Ext. Ser. Mont. St. Univ. Bull. 347. 22 pp.

Wambolt, C. L. 1973. Range grazing systems. Coop. Ext. Ser. Mont. St. Univ. Bull. 340. 13 pp. (revised in 1979).

Wilson, R. and C. L. Wambolt. 1972. Fertilizer guide: native range. Coop. Ext. Ser. Mont. St. Univ. Mgt. Guide 610.09.

Book Reviews for Scholarly Journals

Wambolt, C. L. Practices and problems of land reclamation in Western North America. *In*: American Scientist. (M. K. Wali, ed.).2.