APPENDIX F

DETAILED DISCUSSION OF SPATIALLY EXPLICIT ANALYSIS OF ADDITIONAL HOUSING UNITS IN GUSG HABITAT

SPATIALLY EXPLICIT ANALYSIS OF ADDITIONAL HOUSING UNITS IN GUSG HABITAT

Dr. David Theobald, Natural Resource Ecology Lab, Colorado State University, developed a Spatially Explicit Regional Growth Model (SERGoM v1), designed to depict the location and density of current and projected future private land housing units across the coterminous U.S. Although the current model has not yet been published (Theobald, in review), the general procedure and rationale for a previous version of the model are described in Theobald (2003). Future growth in housing units was based on Census Bureau county-level projections for population growth. The number of housing units this growth was apportioned to was determined using the county-level average of people/household, taken from 2000 census data. Growth in housing units was allocated spatially using a formula that considered recent (1990-2000) housing growth rates for a specific location and accessibility to the nearest urban core. Assumptions of this approach are that: (1) future growth patterns will be similar to those found in the past decade; (2) people/household in the future will match that in the 2000 census data; (3) future growth is likely to occur nearby current high growth areas or "hot spots"; (4) housing units cannot occur on public land, water areas, etc.; (5) growth will be concentrated in areas closer (in terms of travel time, not just distance) to urban core areas over major roads; and (6) housing density will not decline over time (housing growth projections are additive to current housing densities).

Current and projected future housing density was classified into housing density classes, as follows:

0 = Private, no housing units
1 = >80 acres per housing unit (rural)
2 = 50-80 acres per housing unit
3 = 40-50 acres per housing unit
4 = 30-40 acres per housing unit (exurban)
5 = 20-30 acres per housing unit
6 = 10-20 acres per housing unit
7 = 1.7-10 acres per housing unit (suburban)
8 = 0.6-1.7 acres per housing unit (urban)
9 = <0.6 acres per housing unit

We applied Dr. Theobald's model and resultant predicted housing density dataset in a GIS analysis to evaluate the potential acreage impacted by development in 2020 for each population of GUSG. We are not aware of any published work that indicates what level of housing development impacts or eliminates sage-grouse use of habitat There is likely to be little argument that the higher housing density classifications (i.e., classes 2-9) would impact sage-grouse negatively. Whether housing densities between class 0 (no housing) and class 1 (housing density greater than 1 unit per 80 acres) have negative impacts on sage-grouse may be debatable. Theobald's original data grouped all development greater than zero, but less than or equal to 1 unit/80 acres, into 1 development class. We further refined Theobald's data into housing density classes of 80-160, 160-320, 320-640, and >640 acres/housing unit (Table 1). Housing density is only one aspect of potential impacts; another key aspect is the

spatial pattern of future housing. If houses are clustered so that the majority of a given area is undisturbed (and the cluster and associated infrastructure is not placed in an important habitat type such as a sagebrush – wet meadow interface), impacts will be much less than if housing is uniformly distributed across the area.

As a guide in determining a level of housing density (acres/unit) acceptable to sage-grouse (and above which protection would not be cost-effective), we looked at current (2000) housing densities in areas still occupied by GUSG (see Fig. 26, pg. 157). Note that impacts to GUSG populations could lag behind development (and thus, not be detected with this approach). About 860 acres of urban (<0.6 to 1.7 acres per unit) and suburban (>1.7 to 10 acres per unit) housing occur within 1.86 miles of leks. This suggests that limited development, even at these high housing densities, will not necessarily preclude sage-grouse use. Because the SERGoM v1 model was only recently released, we have not been able to conduct an intensive analysis of the housing density at which development seems to impact sage-grouse. In this initial analysis we chose 320 acres/housing unit as the threshold below which we expect impacts, and above which we do not. This is a reasonable, and perhaps conservative, density for the following reasons: (1) over 38,500 acres within 1.86 miles of leks in the Gunnison Basin have more than 1 housing unit/320 acres now (2000), yet grouse use has continued; (2) only 4 of 41 active leks have no housing units within 1.86 miles; and (3) 35 of 41 active leks have at least some area with housing densities greater than 1 unit/320 acres. This threshold was chosen keeping in mind the large amount of public (and therefore protected) habitat in the Gunnsion Basin. We do not suggest that if the large block of public land were developed at this density (1 housing unit/320 acres) that grouse would not be impacted.

We used CDOW WRIS data to define sage-grouse activity areas. In the Gunnison Basin, we estimated the acreage impacted by housing in areas identified as (1) severe winter habitat and (2) nesting/brood-rearing habitat. For this model, nesting/brood-rearing areas were identified by including all areas within 1.86 miles (3 km) of active leks, as well as brood areas mapped by local biologists (generally a 650-1,000 foot buffer along riparian areas). Winter habitat delineation was also taken from WRIS data. In the smaller GUSG populations with substantially smaller, and more fragmented available habitats, we assumed that all occupied habitat was important to GUSG. We estimated acreage impacted by housing within the entire area delineated as occupied habitat.

The intent of this analysis is to identify areas where risk of development is important, to aid agencies and work groups in habitat protection efforts. An explicit assumption in these spatially explicit models is that demand drives the location of exurban housing. If large bodies of water, protected lands or other areas unavailable for housing development exist within a block in the data, the projected density of future houses is not reduced; they simply move to other areas within the block, or to adjacent blocks. If this assumption holds when important habitats are removed from development risk by acquisition or easement, then presumably development will shift, rather than be prevented, within some spatial scale. In other words, easements and fee title acquisitions can ensure development will not occur on a particular property, but cannot ensure development will not occur within seasonal habitats used by that population, unless all important habitats where development is projected are protected. Sage-grouse will benefit if this development is shifted from sage-grouse use areas to urban areas, coniferous forest, or other areas not used by sage-grouse, or if development is dispersed, although indirect effects from population growth may still occur. If development

is shifted from very important habitats such as leks, nesting, brood-rearing areas, or severe winter use areas to less important use areas, then sage-grouse will benefit, but only in the sense that they will be impacted less than they otherwise would have been.

The modeled housing density in 2000 is shown in Fig. 26 (see pg. 157), while projected housing densities (without intervention) in 2020 are shown in Fig. 27 (see pg. 158; note that white areas are the protected lands; i.e., public). Areas of growth in housing are identified in Fig. 28 (see pg. 159). Numerical estimates of acreage in each housing class modeled for 2000, projected to 2020, and increases from 2000 to 2020 by housing density class are shown for the smaller populations (Table 1) and for the Gunnison Basin (Table 2). The challenge in wisely allocating habitat protection dollars is to protect important areas where development will occur at a density that precludes use by sage-grouse, or will significantly impact grouse. At the same time there is little point in allocating resources to areas already impacted so as to preclude grouse use, or to areas where housing densities will be so low as to have negligible impact to grouse. Consequently we identified areas and acreages projected to increase from housing densities of 1 unit per 320 acres or larger to 1 unit per 320 acres or less. Examination of Table 1 indicates, for the most part, that housing outside of urban areas progresses through housing density classes, therefore the key areas are those that move from 1 unit per 320 acres or more to 1 unit per 160-320 acres, although occasionally densities may jump to the 80-160 acre/housing unit class.

The model predicting development to unsuitable housing densities seemed to perform poorly (underestimate development) outside the Gunnison Basin, where second home development or proximity to population centers or high growth areas such as Grand Junction, Montrose, or Telluride may trump local demographic growth as causes of development. Clearly we have a long-term need to develop better predictive models which take these factors into account. In the interim, we used another approach to identify habitats at greatest risk of development in the next 3-5 years. Typically, land is subdivided into smaller parcels prior to sale and development. It is these smaller (<80 acres) parcels that are probably most immediately susceptible to development to densities that would negatively impact grouse. Larger parcels may be subdivided, but this process will occur over a longer time horizon allowing time to respond. We mapped private land parcels by parcel size categories for each population (Figs. 1 - 12) as a tool to help agencies, work groups, and land trusts in assessing development risk and prioritizing habitat protection efforts for GUSG. We present an analysis of future development by population using both methods of assessing risk.

Cerro Summit – Cimarron had 477 acres projected to increase to 160-320 acres per unit, and a net loss in the 80-160 class (Table 1). Cerro Summit - Cimarron has 1,943 acres in parcels of less than 80 acres in size that are at least in part within the occupied boundary, and 1,721 acres in parcels between 80 and 160 acres in size (Fig. 1). The area of most concern is the subdivided area south of Montrose Lake. Nearby Sims Mesa had a net increase of 128 acres in the < 80 and 80-160 acres per housing unit densities, which shifted from lower density areas. Sims Mesa has about 2,344 acres in parcels less than 80 acres in size that are at least in part within the occupied boundary, most of which have already been developed (Fig. 2).

Crawford had 1,186 acres projected to increase to 160-320 acres per unit, and 247 acres projected to increase to 80-160 acres per unit. Recently acquired easements by CDOW (560 acres) were subtracted, leaving 1,590 acres. Looking at parcel sizes, Crawford has one large and one small block of subdivided parcels less than 80 acres in size (Fig. 3) and

presumably at risk of development. These 2,969 acres should be the focus of habitat protection.

The Dove Creek subpopulation, and Poncha Pass populations had no areas identified to increase from 1 unit per 320-640 acres to the 160-320 or 80-160 classes. Dove Creek is largely privately owned (~85%), and perhaps because the dominant land use is crop production, a sizable portion of land parcels are less than 80 acres (Fig. 4; 4,601 acres; 17%) or 80-160 acres in size (5,095 acres; 18%, Fig. 4). Most of these parcels are not immediate development risks. Two population centers occur in this population. North and east of Dove Creek, the 2,700 acre Secret Canyon subdivision, of which about 2,000 acres occurs within occupied habitat, looms as the greatest threat (Fig. 4). Lack of access to power and water has, and likely will continue to, delay development, but even seasonal dwellings or conversion to horse pastures on parcels of 35-40 acres will be detrimental to sage-grouse. West of Dove Creek parcels are generally larger. Three parcels within the core grouse use area totaling 796 acres have been protected by CDOW with 20-year easements. Additionally, CDOW is in the final stages of fee-title acquisition of 2,354 acres in and around the core use area. The Poncha Pass population had no areas identified to increase from 1 unit per 320-640 acres to the 160-320 or 80-160 classes. Poncha Pass had 249 acres in parcel sizes less than 80 acres, and 827acres in parcel sizes from 80 to 160 acres (Fig. 5). Poncha Pass is largely publicly owned (82%; note that this percentage differs slightly from the data in Appendix D, likely due to calculation errors), and this population is too small to have major conservation benefit. Opportunities to protect or acquire privately held parcels east of Highway 285 and south of Dorsey Creek should be opportunistically explored.

Although the model indicated only 10 acres would change from no development to the 1 unit per 640 acres or more density class, and no increases to “unacceptable” housing densities in Piñon Mesa, this didn’t correspond well to our perception of development risk there. Piñon Mesa is also heavily privately owned, with 33 parcels less than 160 acres in size (Fig. 6). These parcels total about 2,000 acres, but much of the central and western portion of the occupied range is currently protected by easement or public ownership.

The model projected less than 100 acres would shift to housing densities thought to impact sage-grouse in all of the San Miguel Basin subpopulations, collectively. Potential for second home development in scenic areas like Miramonte Reservoir, Gurley Reservoir, and Iron Springs and Hamilton Mesas suggest the need for habitat protection in these areas. The San Miguel Basin population occupies six areas, each with different ownership patterns and risks of development. The Dry Creek Basin is largely (72%) publicly owned, with less than 1% of the area in small (<160) parcels (Fig. 7). Development risk is minimal, but opportunities to pursue land swaps to put heavy use areas in public (BLM) ownership should be explored. Conversely, only the periphery (~9%) of the occupied habitat for the Gurley Reservoir subpopulation is publicly owned, and about 40% of the area (3,030 acres) is made up of parcels less than 160 acres in size (Fig. 8).

The area west and south of Gurley Reservoir is already subdivided, but not yet developed. These lots are currently offered for sale, and represent an immediate conservation need. Hamilton Mesa is largely privately held, with the exception of a section (640 acres) of state school land. Parcels are generally large (Fig. 9), and threats of development are not imminent, although the location of Hamilton Mesa suggests development will occur in time. The CDOW is currently pursuing a conservation easement on Hamilton Mesa. Iron Springs Mesa is also largely privately held, with the exception of a

section of school land and some Forest Service land on the northwestern periphery. About 1,800 acres are in parcels smaller than 160 acres (Fig. 10), the most significant is a subdivided tract along sheep draw on the eastern 1/3rd of the mesa, most of which is already developed. Given the isolation of Iron Springs Mesa, high real estate values, and high private ownership and extent of development, protection from further development may not be practical. The Miramonte Reservoir subpopulation is 76% private, 24% publicly held following recent CDOW acquisition of an area platted for subdivision (note that these numbers differ from those in Appendix D; those data have not yet been updated with the new CDOW property information). Parcel size is generally large (Fig. 11), but development will occur long term without protection.

Presumably the Theobald model more accurately forecasts growth in Gunnison, where at least in sagebrush areas growth in housing should be driven by population increases and not second homes. The model indicated a net loss of severe winter and nesting/brood-rearing habitat in the 160-320 acres per housing unit density, probably because these areas shifted to the 80-160 acres per housing unit and less than 80 acres per housing unit densities (Table 2). Although it may not normally be effective to spend habitat protection dollars to prevent development in the < 80 and 80-160 acres per housing unit density classes, in this case it appears that areas with very low housing densities are moving to very high density classes. Therefore we consider the acreage projected to decline from the low density classes (4,268) to be most important, assuming these were shifting to housing densities unacceptable to grouse.

Table 1. Acres within occupied GUSG range within 2000 and 2020 housing density classes, by population.

Population	Housing Density Categories																	
	< 80 acres/unit			80-160 acres/unit			160-320 acres/unit			320-640 acres/unit			> 640 acres/unit			No housing		
	2000	2020	Δ[1]	2000	2020	Δ	2000	2020	Δ	2000	2020	Δ	2000	2020	Δ	2000	2020	Δ
Cerro Summit – Cimarron	151	153	2	363	353	-10	442	919	477	2,398	1,894	-504	3,500	3,596	96	16,288	16,188	-100
Crawford	0	0	0	0	247	247	832	2,018	1,186	1,800	489	-1,311	800	827	27	6,600	6,607	7
Dove Creek	170	173	3	227	242	15	1,685	1,645	-40	3,097	3,058	-39	9,341	9,396	55	9,003	8,949	-54
Piñon Mesa	2	2	0	7	7	0	0	0	0	1,598	1,598	0	8,181	8,188	7	11,424	11,414	-10
Poncha Pass	326	356	30	54	5	-49	615	588	-27	121	126	5	1,899	1,907	8	1,882	1,855	-27
San Miguel Basin																		
Beaver Mesa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,561	8,561	0
Dry Creek Basin	2	2	0	0	0	0	158	165	7	682	708	26	2,077	2,100	23	15,030	15,092	62
Gurley Reservoir	0	0	0	1,722	1,731	9	729	756	27	0	0	0	3,134	3,107	-27	1,292	1,240	-52
Hamilton Mesa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,628	3,628	0
Iron Springs	0	0	0	1,276	1,302	26	0	7	7	1,837	1,855	18	2,216	2,196	-20	74	77	3
Miramonte	0	0	0	151	153	2	326	326	0	392	373	-19	1,687	1,638	-49	7,212	7,299	87
Sims Mesa	988	1,050	62	109	175	66	210	126	-84	17	0	-17	0	0	0	973	986	13
Totals	1,639	1,736	97	3,258	4,215	957	4,997	6,550	1,553	11,942	10,101	-1,841	32,835	32,955	120	81,967	81,896	-71

[1] Change in acreage in housing category indicated between 2020 and 2000.

Table 2. Acreage of seasonally important habitat (habitat within 1.86 miles [3-km] of leks, or areas identified as used by broods or during severe winters) projected to be within 2000 and 2020 housing density classes, in the Gunnison Basin.

	Housing Density Categories							
Gunnison Basin	**< 80 acres/unit**	**80-160 acres/unit**	**160-320 acres/unit**	**Totals, <320 acres/unit**	**320-640 acres/unit**	**> 640 acres/unit**	**No housing**	**Totals, >320 acres/unit**
2000 housing densities	19,212	10,991	10,846	41,049	8,131	9,756	40,426	58,313
2020 housing densities	22,980	13,454	8,707	45,141	5,732	8,020	40,293	54,045
Difference	3,768	2,463	-2,139	4,092	-2,399	-1,736	-133	-4,268

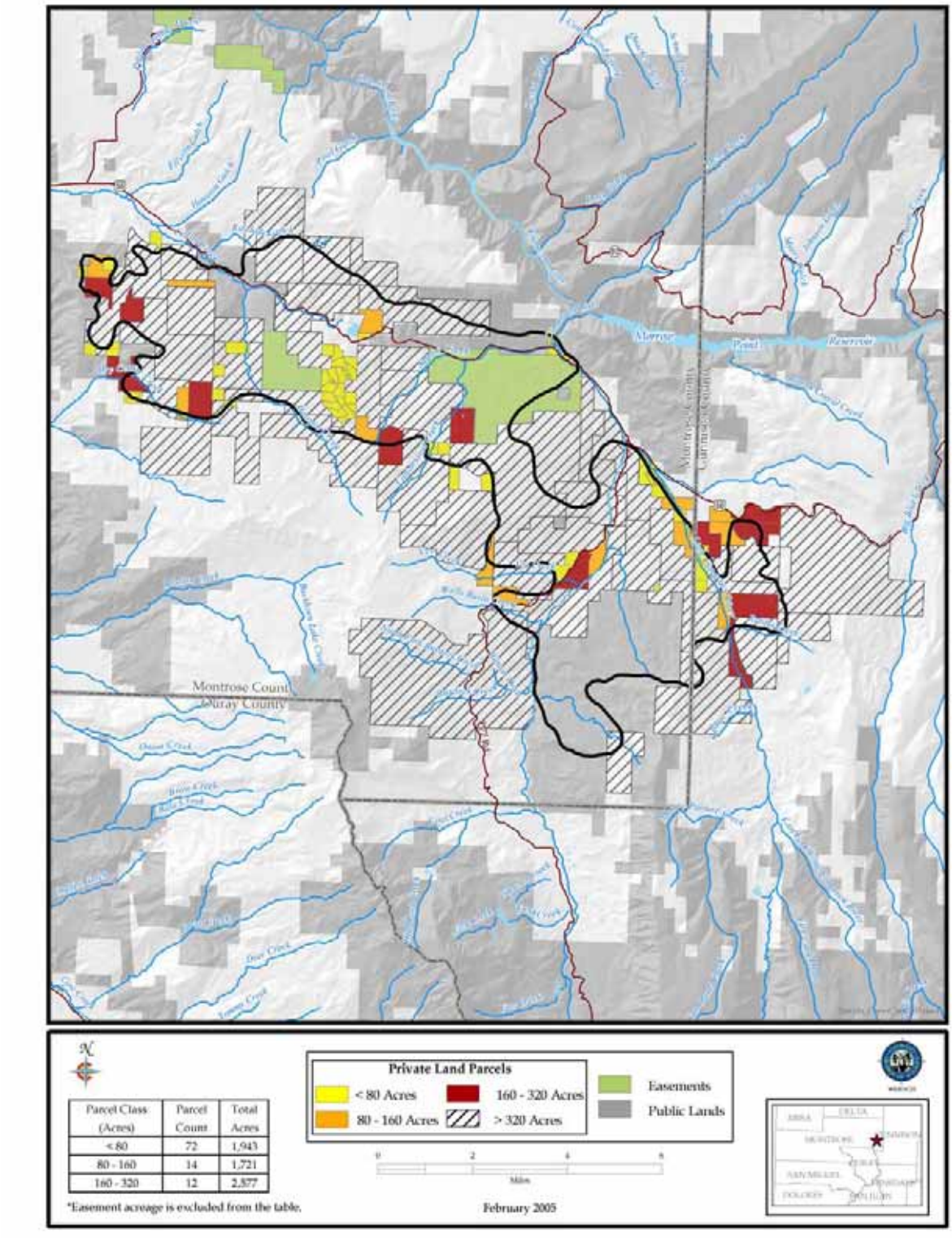


Fig. 1. Private land parcels that fall within or intersect occupied range of the Cerro Summit – Cimarron subpopulation of GUSG.

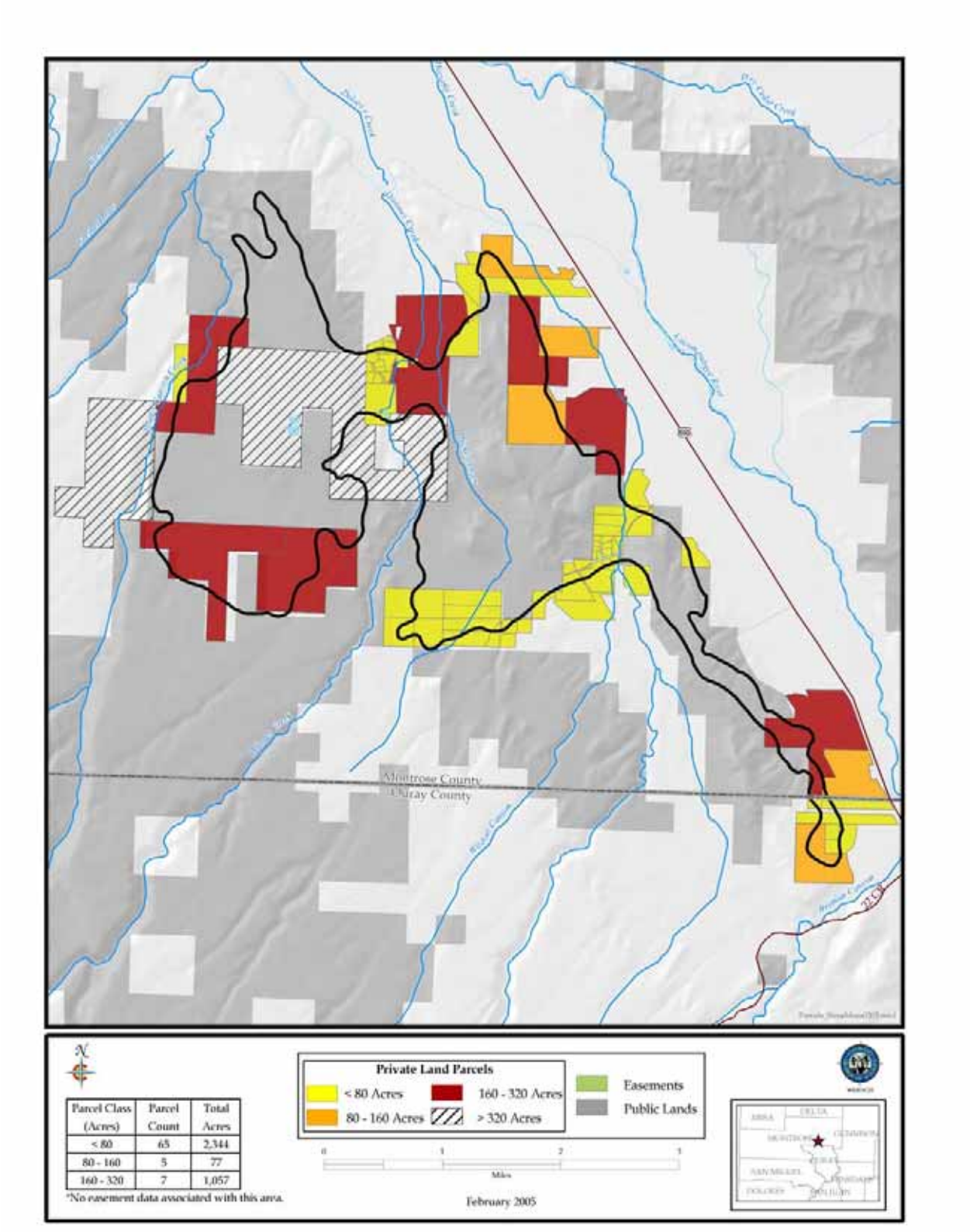
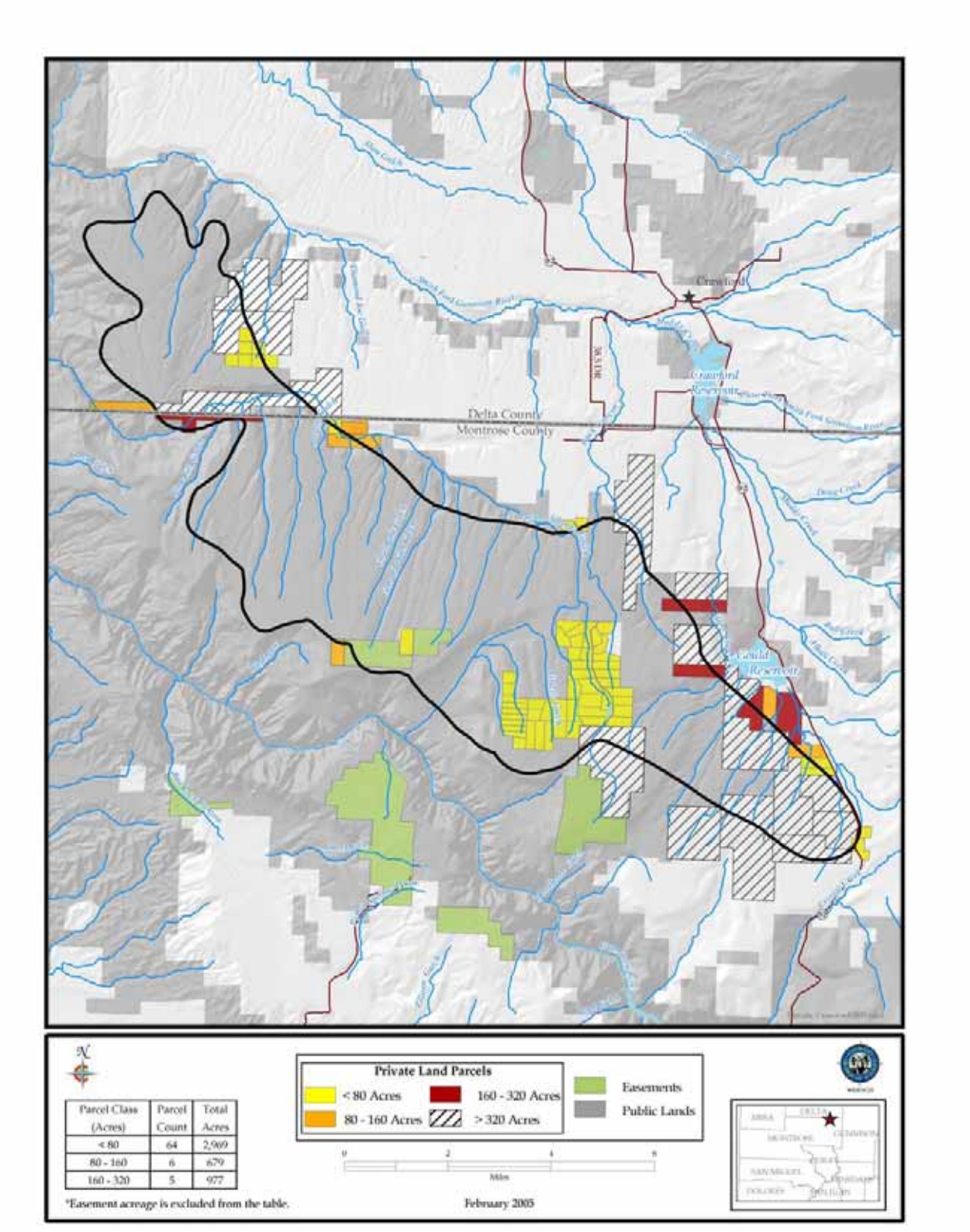


Fig. 2. Private land parcels that fall within or intersect occupied range of the Sims Mesa subpopulation of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	64	2,969
80 - 160	6	679
160 - 320	5	977

*Easement acreage is excluded from the table.

Fig. 3. Private land parcels that fall within or intersect occupied range of the Crawford population of GUSG.

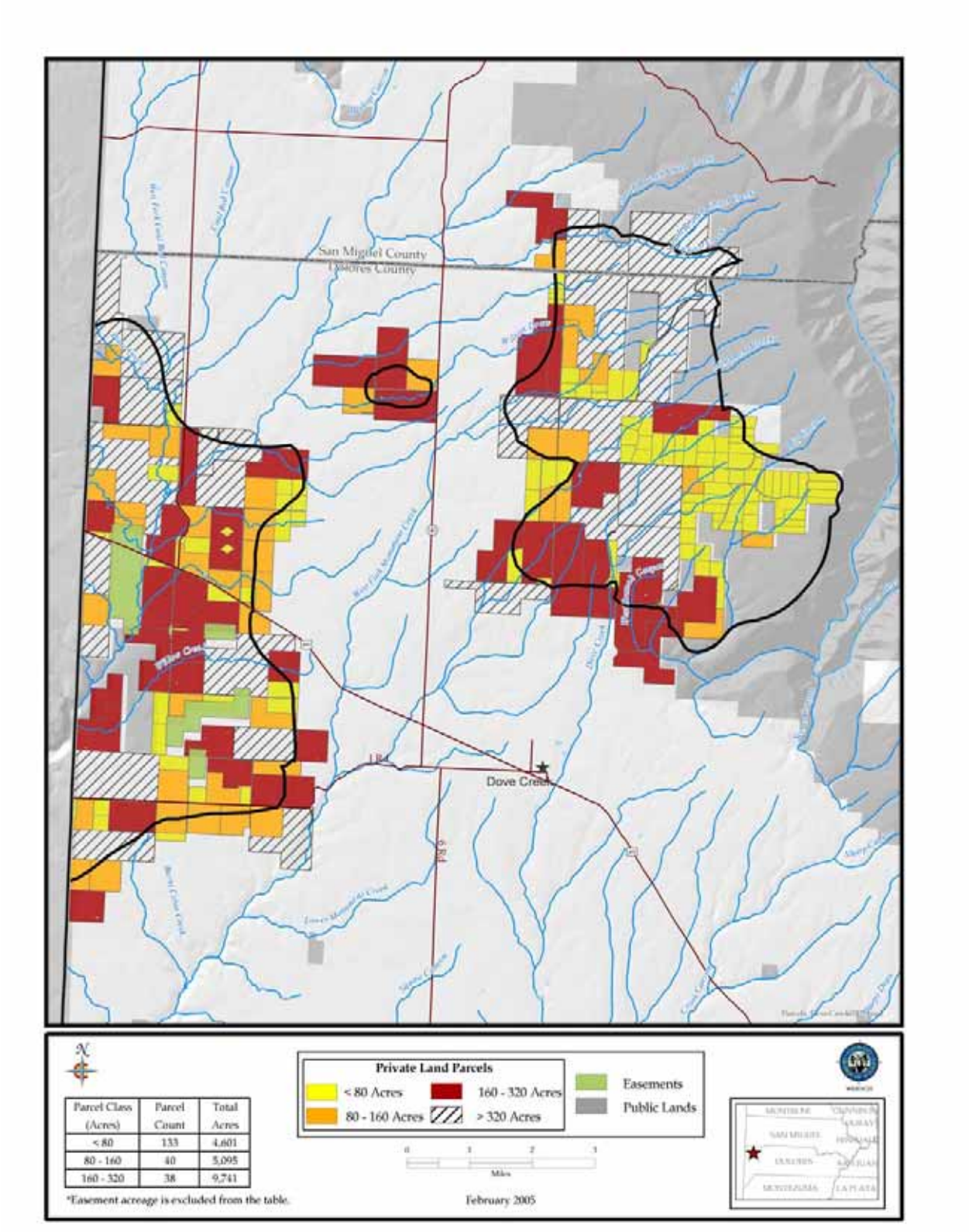
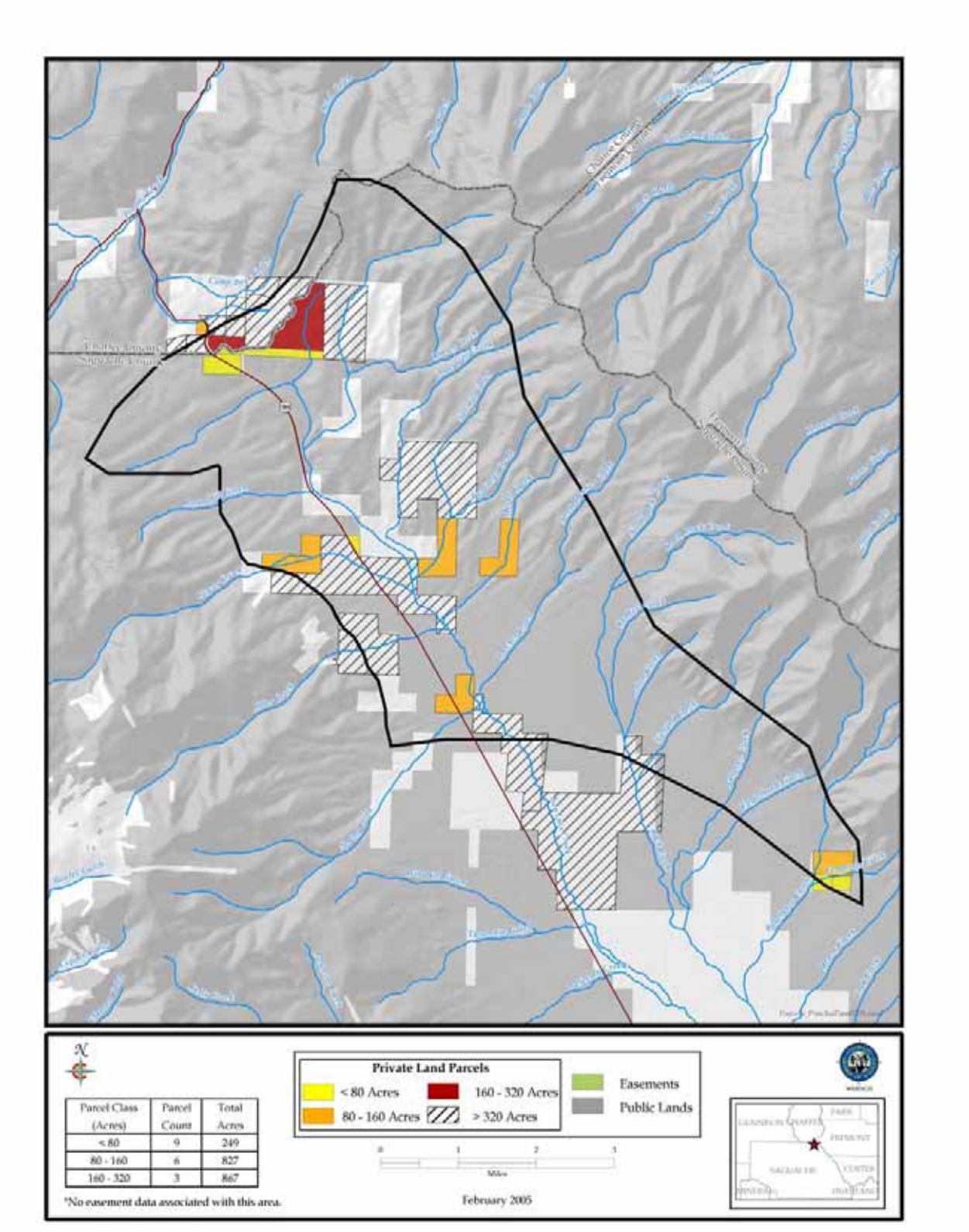


Fig. 4. Private land parcels that fall within or intersect occupied range of the Dove Creek subpopulation of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	9	249
80 - 160	6	827
160 - 320	3	867

Fig. 5. Private land parcels that fall within or intersect occupied range of the Poncha Pass population of GUSG.

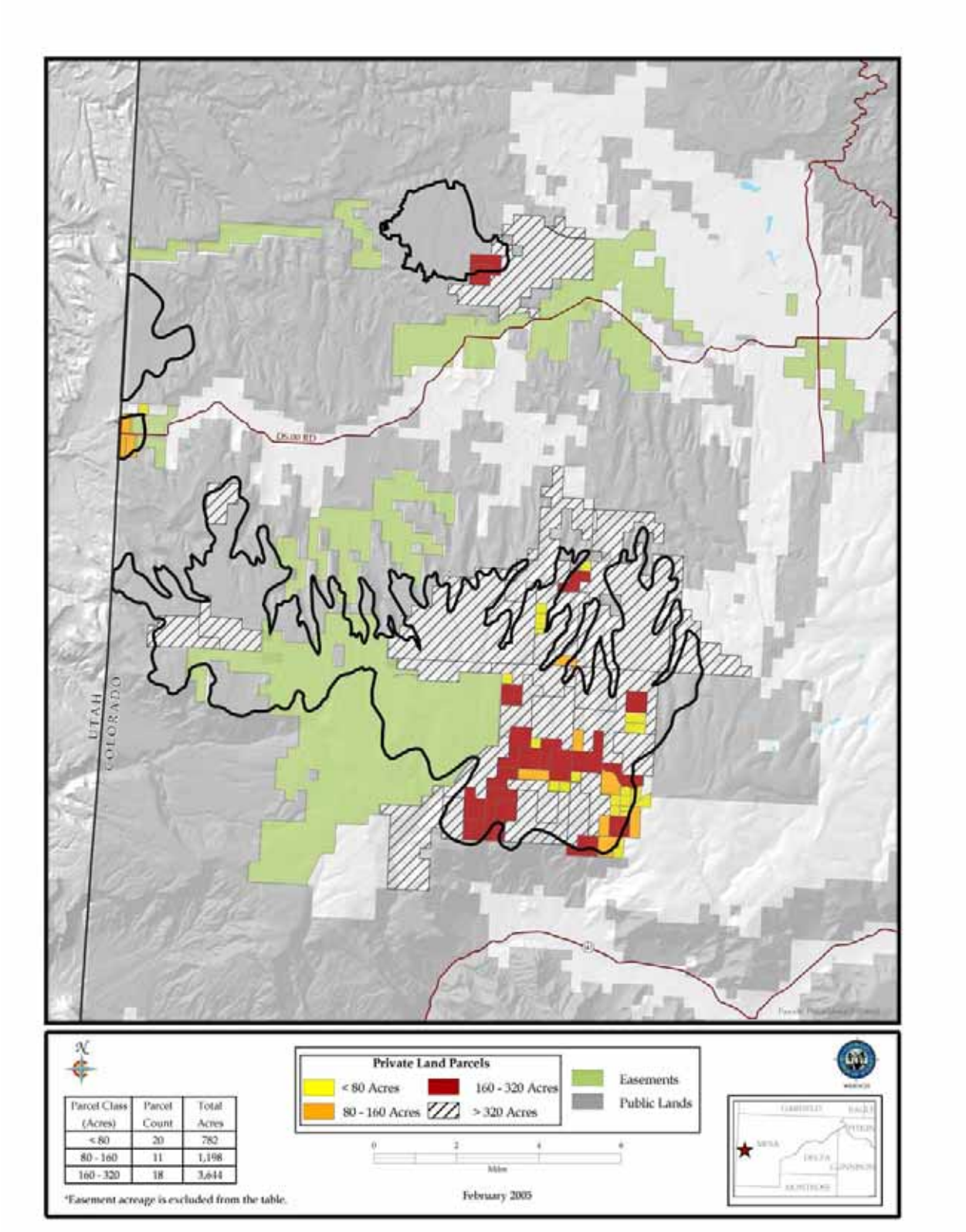
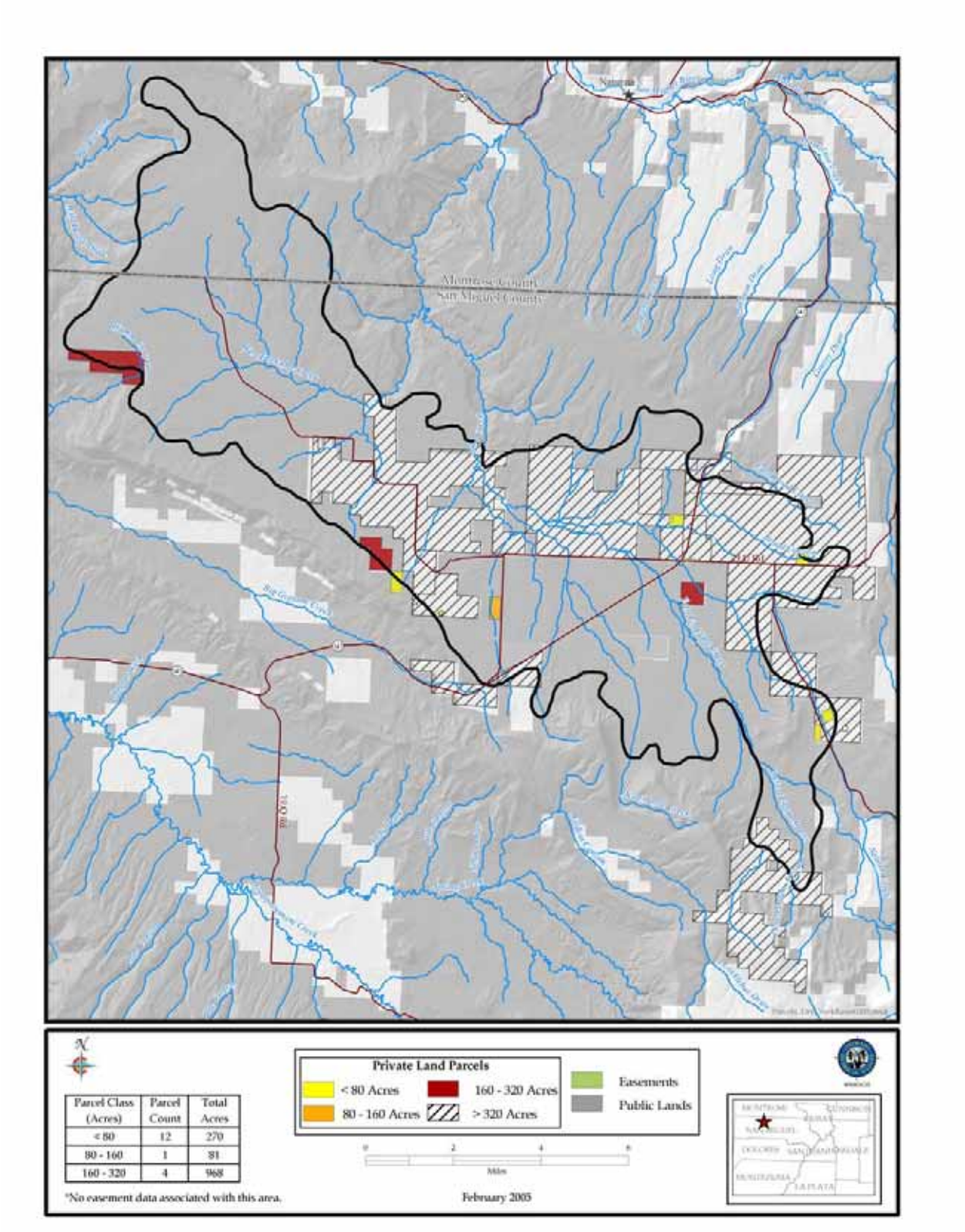


Fig. 6. Private land parcels that fall within or intersect occupied range of the Piñon Mesa population of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	12	270
80 - 160	1	81
160 - 320	4	968

Fig. 7. Private land parcels that fall within or intersect occupied range of the Dry Creek Basin subpopulation of GUSG.

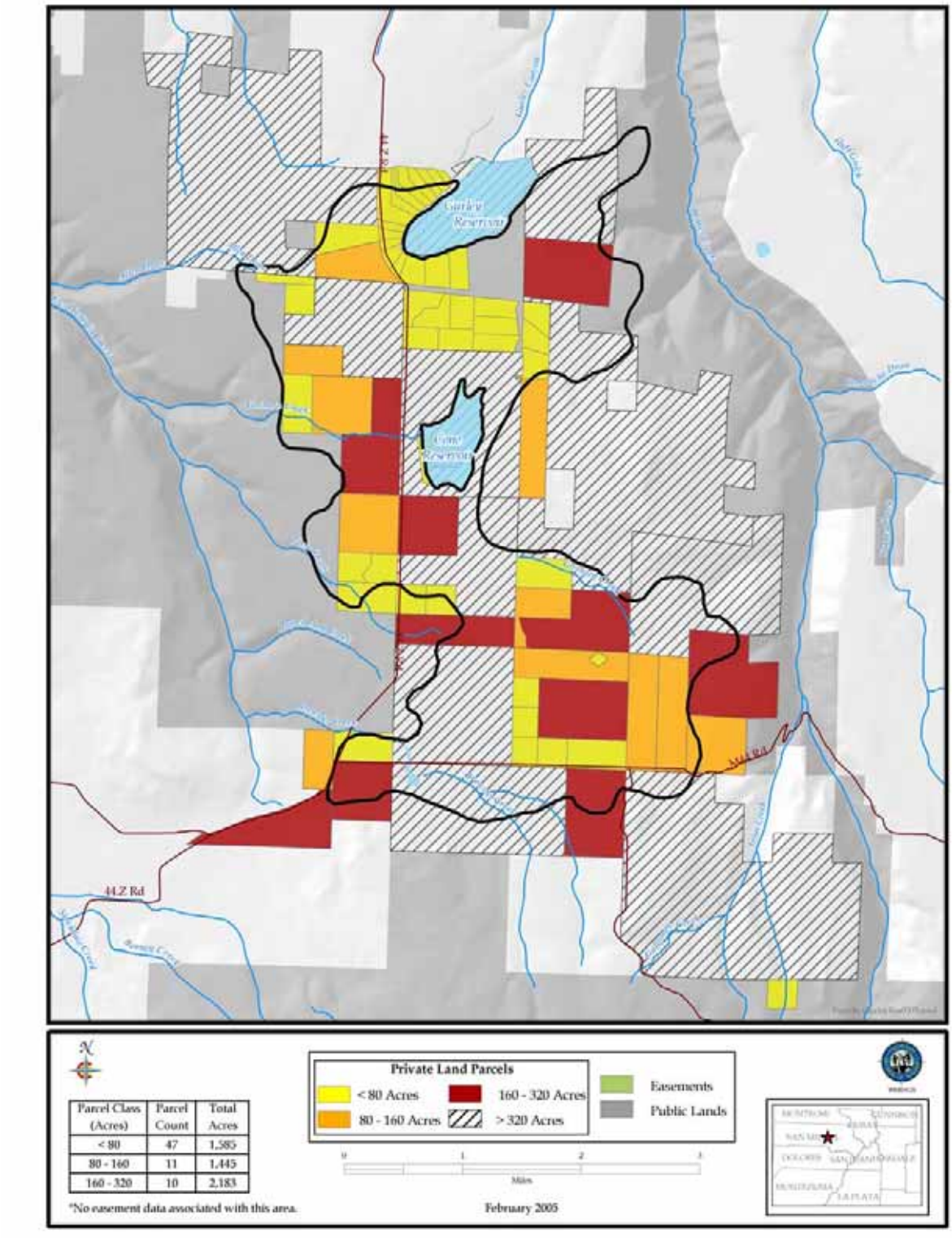
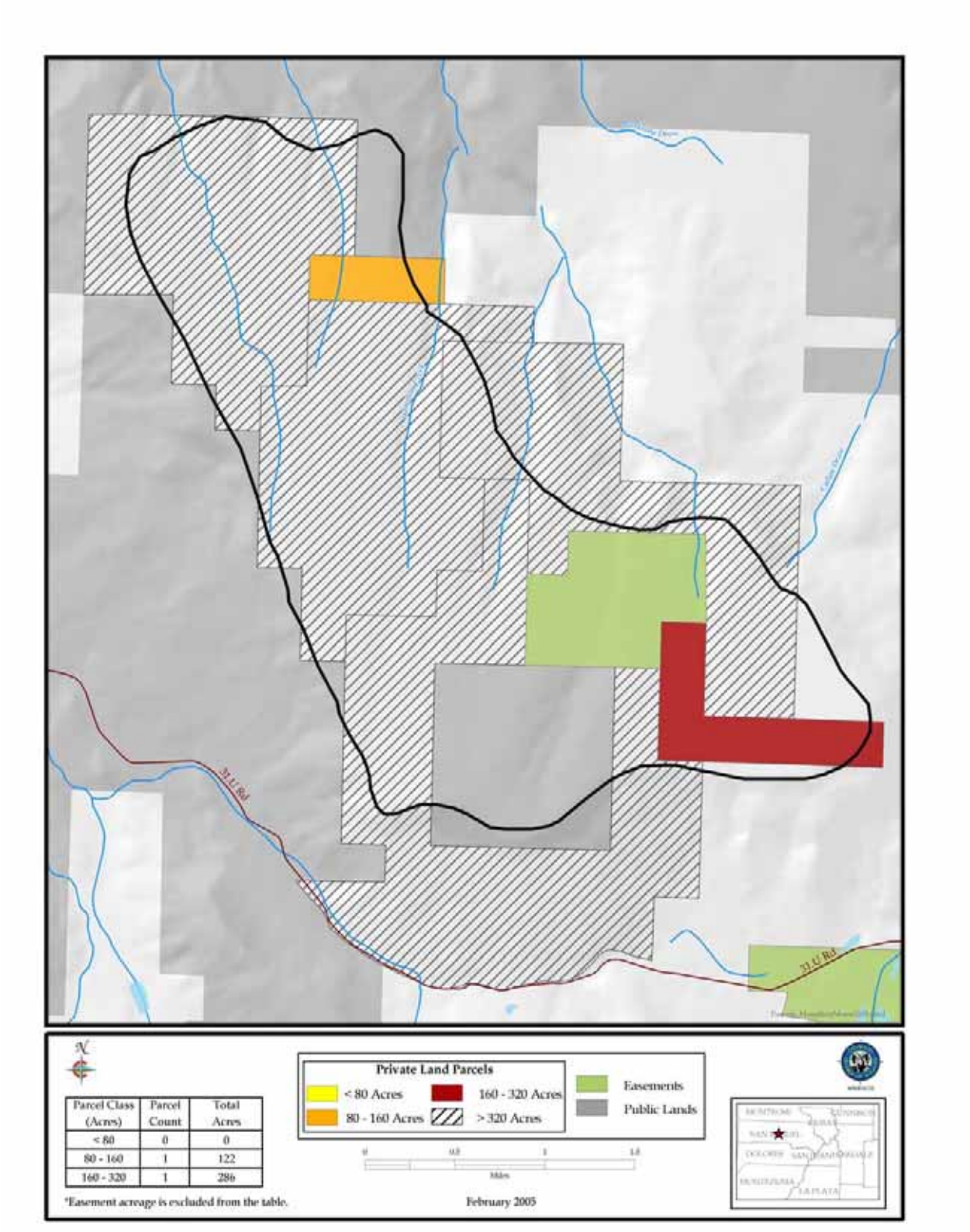


Fig. 8. Private land parcels that fall within or intersect occupied range of the Gurley Reservoir subpopulation of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	0	0
80 - 160	1	122
160 - 320	1	286

Fig. 9. Private land parcels that fall within or intersect occupied range of the Hamilton Mesa subpopulation of GUSG.

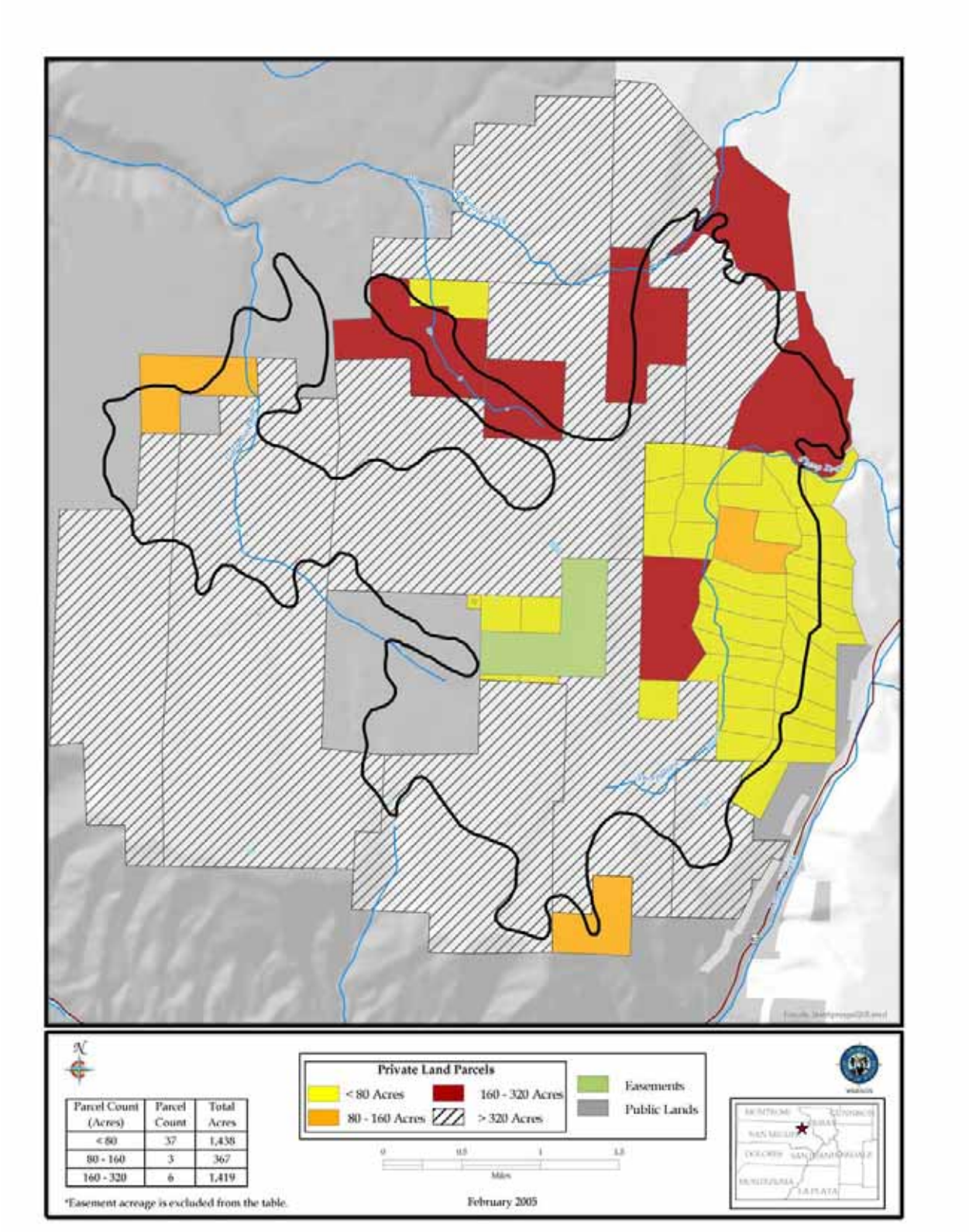
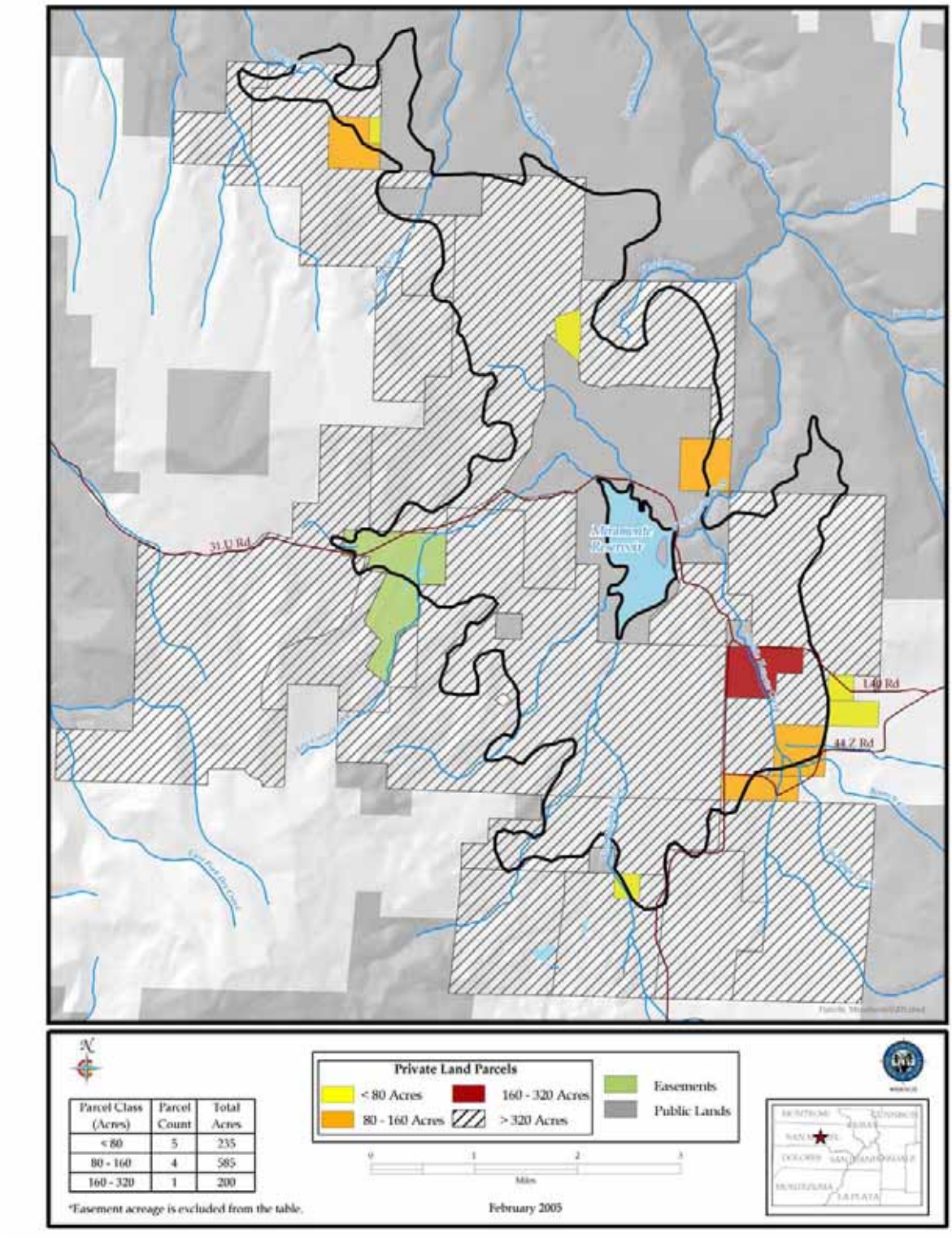
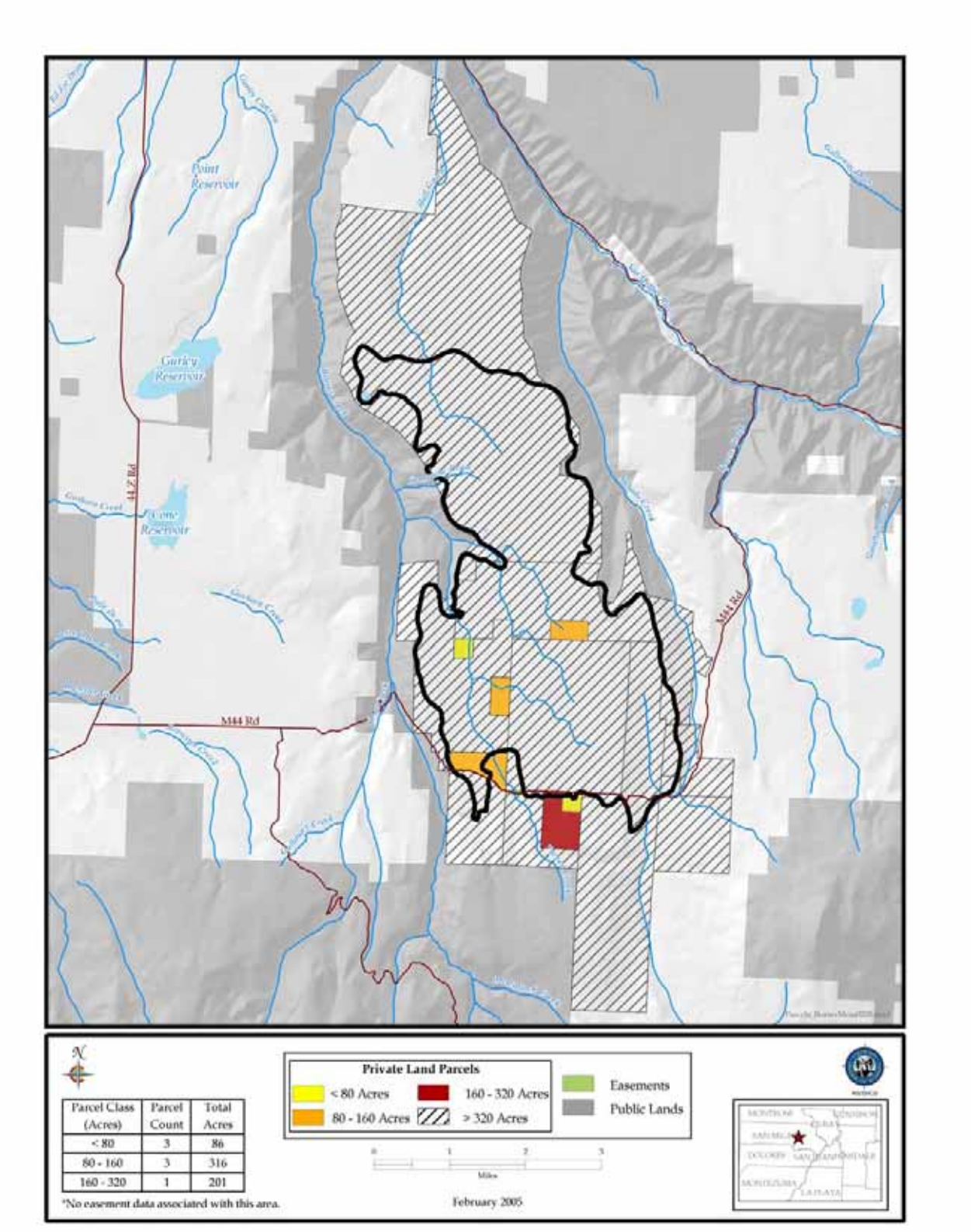


Fig. 10. Private land parcels that fall within or intersect occupied range of the Iron Springs subpopulation of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	5	235
80 - 160	4	585
160 - 320	1	200

Fig. 11. Private land parcels that fall within or intersect occupied range of the Miramonte subpopulation of GUSG.



Parcel Class (Acres)	Parcel Count	Total Acres
< 80	3	86
80 - 160	3	316
160 - 320	1	201

Fig. 12. Private land parcels that fall within or intersect occupied range of the Beaver Mesa subpopulation of GUSG.