Knife Creek Grasslands Ecosystem Mapping Report

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SUMMARY

Ecosystem mapping was conducted for the Knife Creek Property along highway 97 south of Williams Lake. The property is a mosaic of forests and grasslands, has a mapped mule deer winter range over part of it and has grassland benchmark over portions. Two main forest types are found on the property, both dominated by Douglas-fir. Grasslands are dominated by bluebunch wheatgrass and short-awned porcupinegrass types.

Grassland encroachment polygons are identified and represent the priority restoration areas on the property. Forest structural stages are mapped, as are wildlife habitat suitability and capability for five selected species. Monitoring recommendations are given for each.

Further surveys are required to refine habitat polygon and to collect data to develop appropriate forest restoration prescriptions.

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INTRODUCTION

Grasslands are a rare and threatened ecosystem in British Columbia (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Adding to the A considerable proportion of grasslands in the Cariboo-Chilcotin have been lost to forest encroachment since European settlement of the region (Cariboo-Chilcotin Grasslands Working Groups 2001). The loss of grasslands is important since grasslands are already a rare habitat in British Columbia and a disproportionate number of threatened and endangered species inhabit British Columbia's grasslands (Cannings *et al.* 1999, Fraser *et. al.* 1999).

In 2001, the Cariboo-Chilcotin Grasslands Working Group was tasked with preparing a strategy for grassland management in the Cariboo-Chilcotin. The working group established a grassland benchmark area where the overriding management objective is to restore grassland conditions over the long-term. This benchmark area includes existing grasslands and grasslands that have become encroached by trees since the first forest cover inventories were completed in the area, about the mid-1960's.

Establishing ecosystem restoration targets for these encroached grasslands is relatively straightforward, with tree removal, special management of riparian and other sensitive sites, retention of legacy and recruitment structures and the re-introduction of low severity fire typical components of a restoration plan. Because the benchmark area has no silvicultural obligations, tree removal can be done without the need to re-establish forest cover.

Outside of the grassland benchmark, restoration treatments become more complex and the specifics of prescriptions depend upon ecological conditions of the site, historical forest structure attributes that remain, degree of change from historical conditions and the types of treatments that are practicable at the site. Additionally, restoration treatments may conflict with the objectives established for other management objectives in place.

The Knife Creek grasslands project area is located in the very dry moderate Interior Douglas-fir biogeoclimatic subzone (IDFxm) adjacent to Highway 97 south of Williams Lake. The property consists of both forested and grassland areas and part falls in the grassland benchmark area. Much of the forested portion of the property is in mapped Mule Deer Winter Range and has targets for forest structure established. Considerable treatment of these forests is possible to both restore ecological conditions and improve habitat conditions for mule deer.

METHODS

Aerial photographs were viewed in stereoscopic view to delineate units of recognizable terrain and landscape features. Units of similar ecological characteristics were encapsulated into polygons. Ecosystem components were often wither too small or too interspersed to be separated into separate polygons and in these cases, complex polygons were created with the approximate decile of each ecosystem unit identified.

The habitat preferences for critical life history periods of selected wildlife species of interest were developed and used to rate ecosystem polygons for habitat suitability and capabilty for each of the selected species. Species accounts were largely taken from earlier Terrestrial Ecosystem Mapping and Sensitive Ecosystem Inventory projects and modified to suit the Knife Creek project.

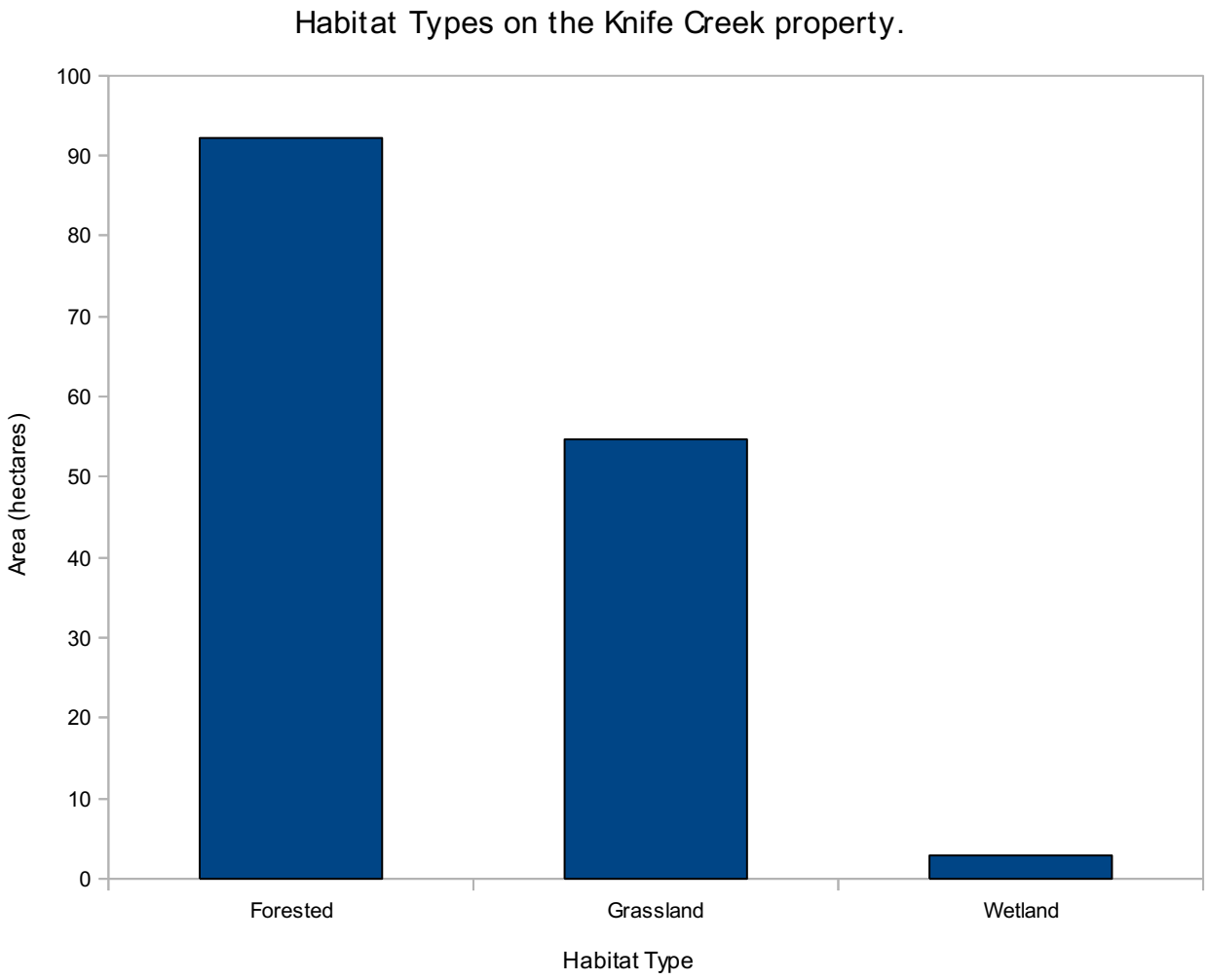
One day was spent in the field assessing forest stand conditions at two points in the forested parts of the property. The diameter at breast height and age of all trees within 11.2 m radius of the plot centre was measured. A relationship between age and diameter was developed to use in developing harvest prescription recommendations. The historical forest structure was inferred from the age profile of the stands.

RESULTS

The Knife Creek Grassland property is approximately 150 ha in size and is comprised of about 92 ha of forested sites, 55 ha of grasslands and 3 ha of wetland sites (Figure 1). About 50 ha of the property is within the Grassland Benchmark area with the 5 ha of mapped grassland areas being primarily small additional areas of

grassland adjacent to the benchmark. 78.6 ha of the property are within the Knife Creek Mule Deer Winter Range, and 4.5 ha of the property are within both the Mule Deer Winter Range and the grassland benchmark.

***Figure 1**: Area of major habitat type on the Knife Creek property.*



Ecosystems of the Knife Creek Grasslands

Fourteen terrestrial ecosystem units were mapped on the Knife Creek property (Table 1,). Three of these units are only found as secondary components of polygons dominated by other ecosystems. Over 90% of forested sites are of two ecosystem units; Douglas-fir – wheatgrass – pasture sage and Douglas-fir – Pinegrass – feathermoss units. The Douglas-fir – wheatgrass – pasture sage sites are sloping, warm aspect sites and typically have deep soils. The Douglas-fir – pinegrass – feathermoss units are the mesic site series for the area and typically have little slope and deep soils.

Over 75% of grassland sites are of two grassland units; Bluebunch wheatgrass – yarrow and short-awned porcupinegrass – pussytoes. Most of the remaining grassland area is made up of the spreading needlegrass - Descriptions of all ecosystem units present on the Knife Creek property are found in Appendix 1.

None of the mapped ecological units are red- or blue-listed by the British Columbia Conservation Data Centre.

Table 1: Areas of mapped ecosystems on the Knife Creek property.

Ecosystem Unit	Code	Area (ha)
Forested Units	Area 92.7	
Douglas fir – bluebunch wheatgrass – pasture sage	DS	49.5
Douglas fir – pinegrass – feathermoss	DP	34.1
Douglas fir – ricegrass – feathermoss	DR	5.5
Trembling aspen - prairie rose	AR	1.8
Douglas-fir - bluebunch wheatgrass - penstemon*	DW	1.0
Hybrid spruce – horsetail	SH	0.9
Grassland Units	Area 54.1	
Bluebunch wheatgrass – yarrow	WY	22.6
Short-awned porcupinegrass – pussytoes	PP	17.1
Spreading needlegrass – pussytoes	NP	8.0
Spreading needlegrass – sticky purple geranium	NG	3.4
Spreading needlegrass – cut-leaved anemone	NA	1.5
Bluebunch wheatgrass - pasture sage*	WP	1.5
Wetland Units	Area 3.1	
Open water	OW	2.1
Beaked sedge – water sedge marsh	SM	0.9
Baltic rush - field sedge wet meadow*	RF	0.1
Nuttall's alkaligrass - foxtail barley wet meadow*	AF	0.1
Total		149.9

* ecosystems found only as secondary component in polygon dominated by another ecosystem

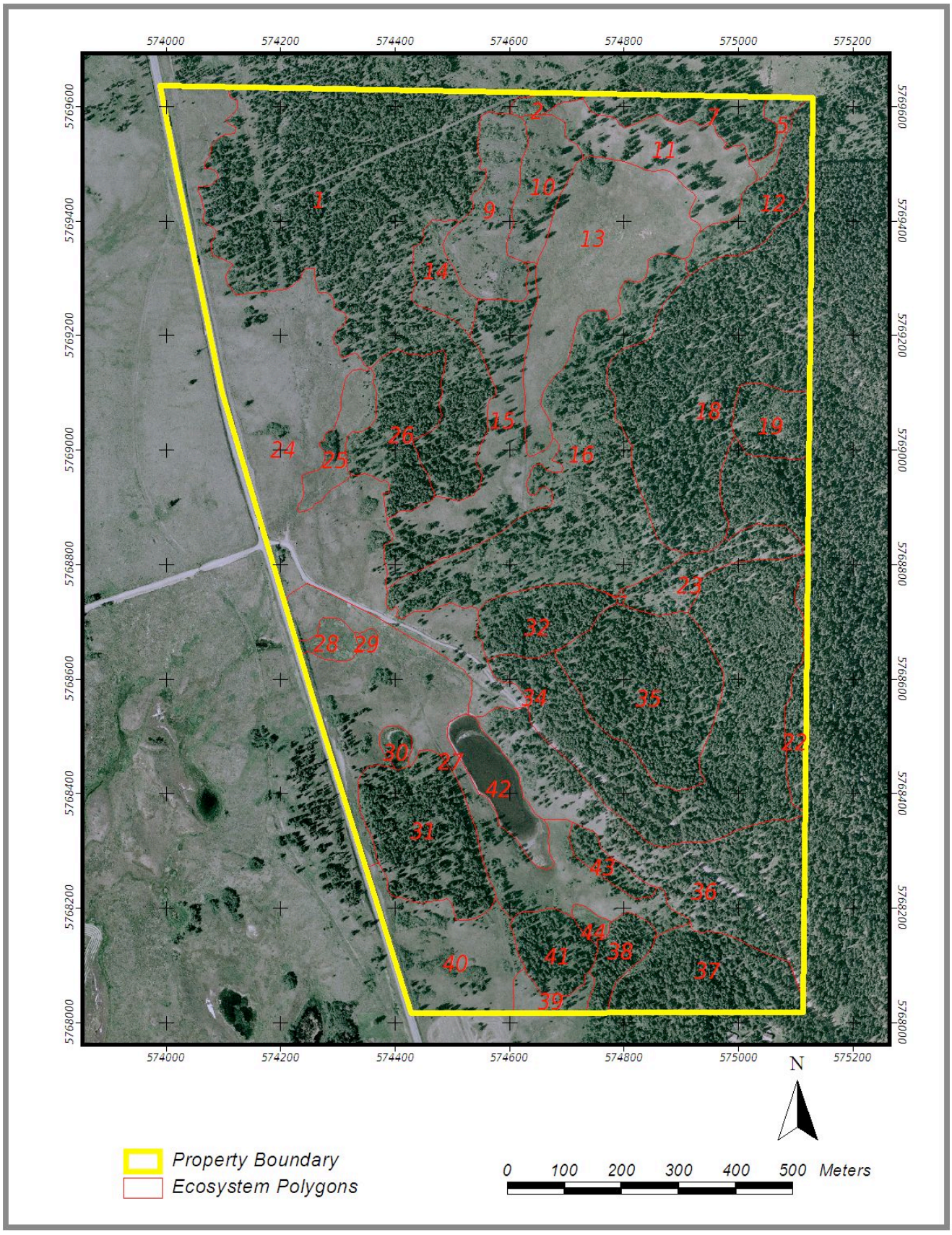


Figure 2: Ecosystem units of the Knife Creek property.

Polygon Number	Ecosystem Code	Decile	Structural Stage[1]	Other Ecosystems
1	DS	10	5	
2	WY	6	2	PP
5	NG	6	2	PP
7	NP	7	2	DP
9	WY	6	2	AR
10	NA	8	2	DP
11	WY	7	2	DS
12	DR	8	5	NP
13	PP	7	2	NG
14	WY	6	2	DS
15	WY	7	2	DP
16	DP	6	4	DR
18	DP	10	5	
19	DR	10	5	
22	DP	10	6	
23	DS	8	5	WY
24	WY	8	2	PP
25	NG	8	2	AR
26	DP	9	5	NP
27	PP	7	2	NP
28	SM	10	2	
29	AR	8	3	NG
30	OW	8		AF
31	DP	7	5	NP
32	DP	10	5	
34	DS	10	5	
35	DS	10	6	
36	DS	8	5	WP
37	DP	7	6	DS
38	SH	8	6	SM
39	WY	10	2	
40	PP	6	2	WY
41	DP	8	4	NP
42	OW	10	0	
43	DP	8	4	NP
44	SM	6	2	RF

[1] structural stages are as follows 1: sparse, 2: herb, 3: shrub/herb, 4: pole/sapling, 5: young forest, 6: mature forest, 7: old forest

Grassland Status on the Knife Creek property

There are approximately 9 ha of grassland benchmark area that have become forested since inventories were first conducted (Figure 3). The nature of these stands needs to be assessed in the field and appropriate options for the treatment developed. Apart from the above mentioned encroachment, no significant additional or more recent encroachment was evident on the aerial photographs. This will need to be verified with ground surveys.

Perhaps the greatest threat to the integrity of the grasslands on the Knife Creek property is the presence of invasive alien plants. Staff from the Alex Fraser Research Forest who travel frequently along the Big Meadow road through the Knife Creek property are doing a good job of controlling the spread of spotted knapweed and sulphur cinquefoil on the site, but systematic surveys and treatments are recommended to ensure that the invasive plants do not become more well established.

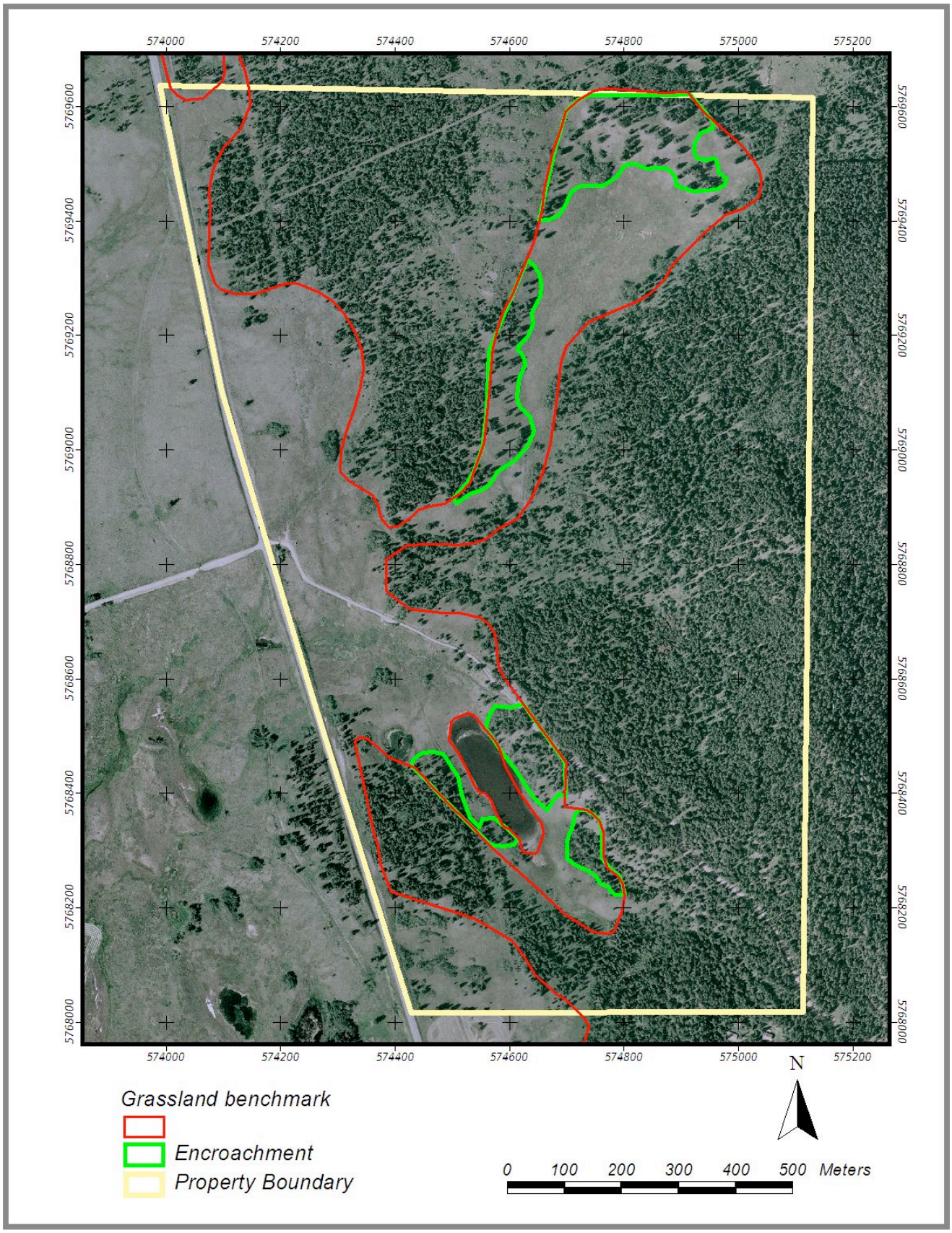


Figure 3: Areas of heavy tree encroachment into the grassland benchmark.

Current Forest Structures on the Knife Creek property.

All forests on the Knife Creek property have been harvested using some form of selection harvesting. Few large trees were seen on the ground. Two main forest ecosystems are present on the Knife Creek property (Figure 4): the sub-xeric to sub mesic Douglas-fir - Bluebunch wheatgrass - Pasture sage unit and the mesic Douglas-fir - Pinegrass – Feathermoss Unit.

Structural stage was assessed for all mapped forest polygons on the property (Figure 5). Uneven aged forests such as the Douglas-fir forests at Knife Creek are not best characterized by structural stage, as trees of a wide range of ages and sizes may be present in a given stand. Additional surveys are required to adequately assess the forest structures on the property in order to develop restoration prescriptions.

Setting targets for stand restoration and depends what targets are used to direct restoration efforts. For this project, a structure similar to that found prior to European settlement is proposed. Forests before European settlement were maintained in a more open condition due to frequent understory burning that occurred about every 10 to 15 years at Knife Creek (Iverson *et al*. 2002). Historical structures of forests can be estimated by examining existing age structures of these forests and using stem densities and distributions of trees that were present before European settlement of the area, pre-1870 to estimate these characteristics of pre-settlement forests. Stumps of felled trees that are older than this date and larger fallen trees on the ground can are added to this total.

A relationship between tree age and diameter can then be used to develop tree removal prescription to remove trees that have become established since European settlement (Figure 6). No trees examined during the fieldwork were older than the cutoff date. Further surveys should focus on stands and areas with larger, older trees or stumps.

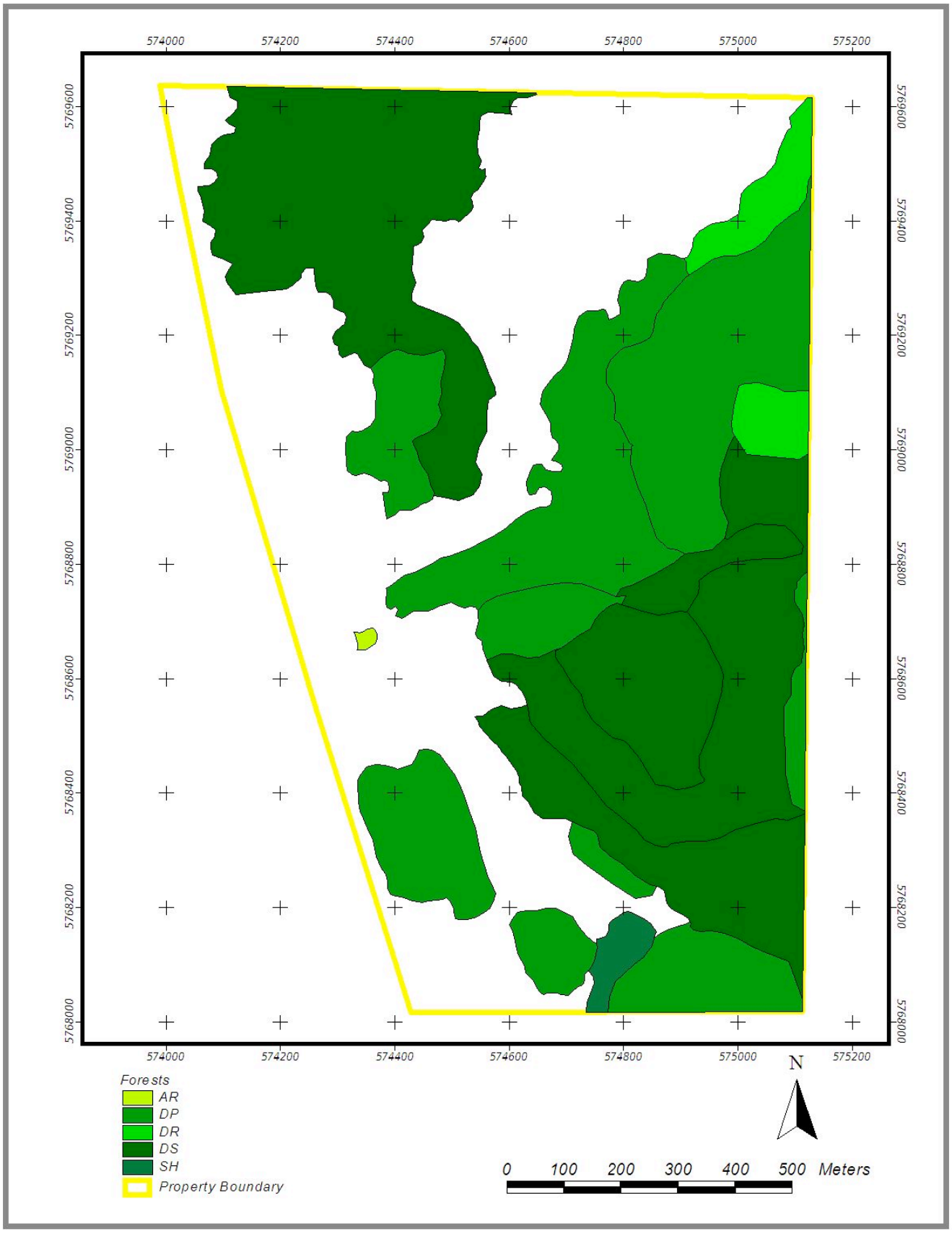


Figure 4: Forest ecosystems on the Knife Creek property. Codes are Found in Appendix 1.

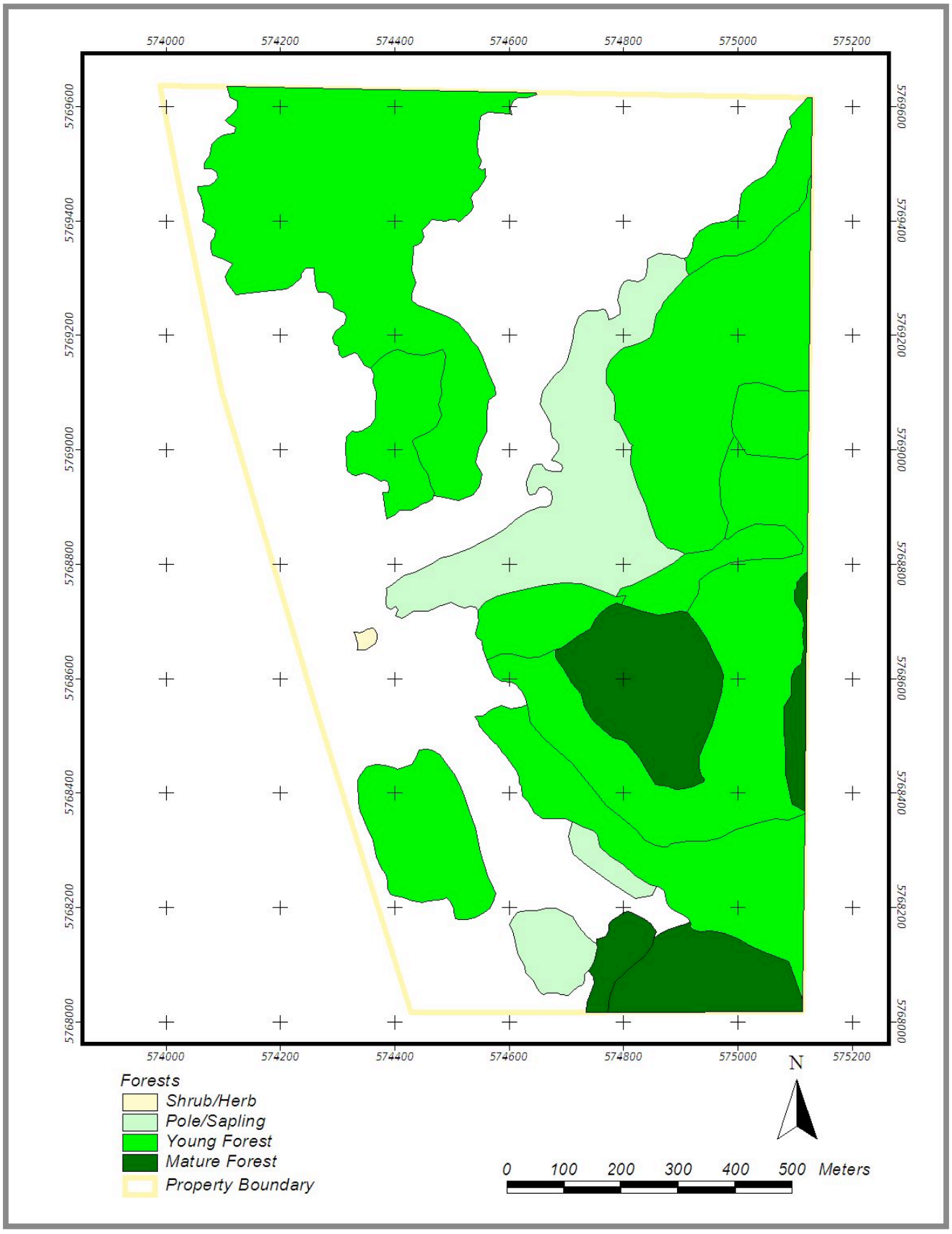
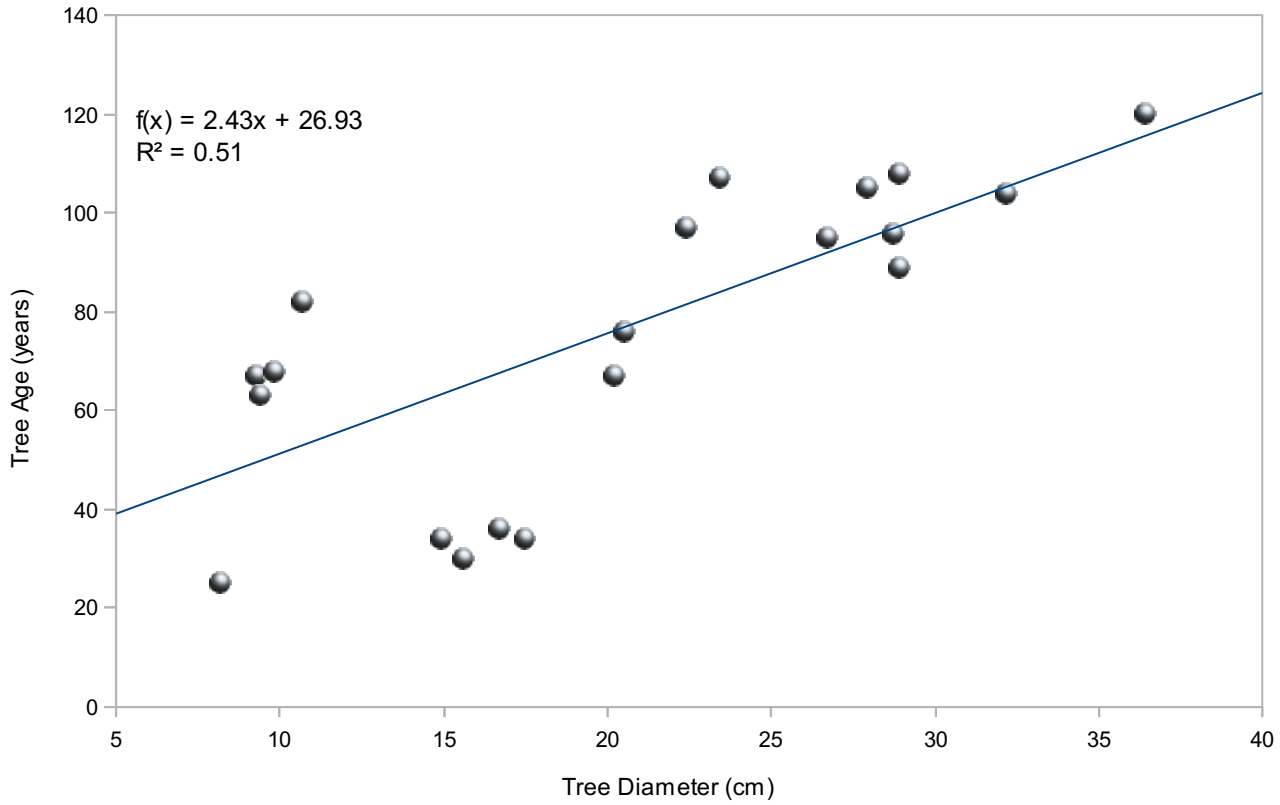


Figure 5: Forest structural stage for all forest polygons on the Knife Creek property.

Figure 6: Relationship between tree diameter and age for Douglas-fir trees sampled on the Knife Creek grasslands.



Wildlife Habitats of the Knife Creek Grasslands

Six wildlife species were selected for analysis (Table 1). The six species are known or possible residents of the Knife Creek property and all, apart from mule deer, are listed by the BC Conservation Data Centre as either threatened or endangered (red-listed) or of special concern (blue-listed). Mule deer were added because much of the forested parts of the Knife Creek property are in the Knife Creek Winter Range, and the importance of the grassland areas along the east side of Highway 97 as mule deer spring range.

Table 2 Wildlife Species Mapped for the Knife Creek Grasslands.

Species	Scientific Name	Code	Presence at Knife Creek	Life Requisites Rated
Mule Deer	Odocoileus hemionus	M-ODHE	known	Winter – living Spring - living
Badger	Taxidea taxus	M-TATA	known	All Year - Reproducing/living
Lewis' woodpecker	Melanerpes lewisi	B-LEWO	suspected	Spring - Reproducing
Long-billed Curlew	numenius	B-LBCU	possible	Spring - Reproducing
Painted turtle	Chrysemys picta	R-CHPI	possible	Spring - Reproducing

Mule Deer

The Knife Creek mule deer winter range is found on the eastern side of the Knife Creek property. This units occupies about 78.5 ha of the unit and most of this area is forested (Figure 7). All of the Mule Deer Winter Range on the Knife Creek property is designated as high habitat stand structure type apart from a small area of steep terrain hat is limited to moderate stand structure type and some grassland area around a small pond. This represents a target basal area of greater than 27 cm^2 with more than 15 cm^2 in stems greater than 37.5 cm diameter at breast height (dbh).

Surveys are required to assess the state of the forests in these areas to see where they stand with respect to these habitat targets. From preliminary surveys, it appears that non of these forest will meet either basal area target.

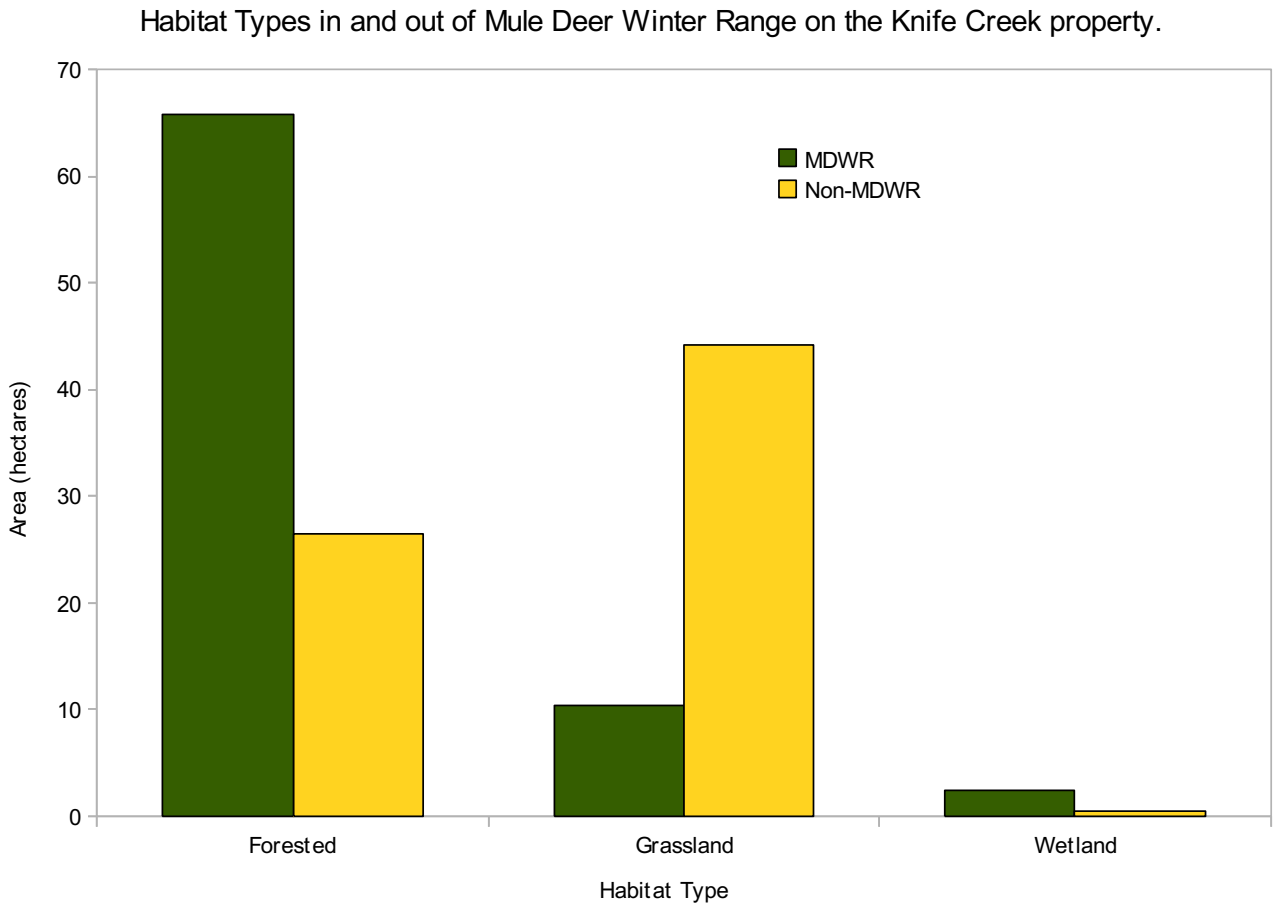


Figure 7: Area of habitat types in and out of Mule Deer winter ranges on the Knife Creek property.

The forests of the Knife Creek property have the potential to provide very good mule deer winter habitat. Their low elevation and proximity to open range result in some of the best potential winter range in the Cariboo. Most of the forested area on the property are dominated by Douglas-fir and are on mesic or drier sites. As a result most of the forests are rated as having very good habitat potential (Figure 8).

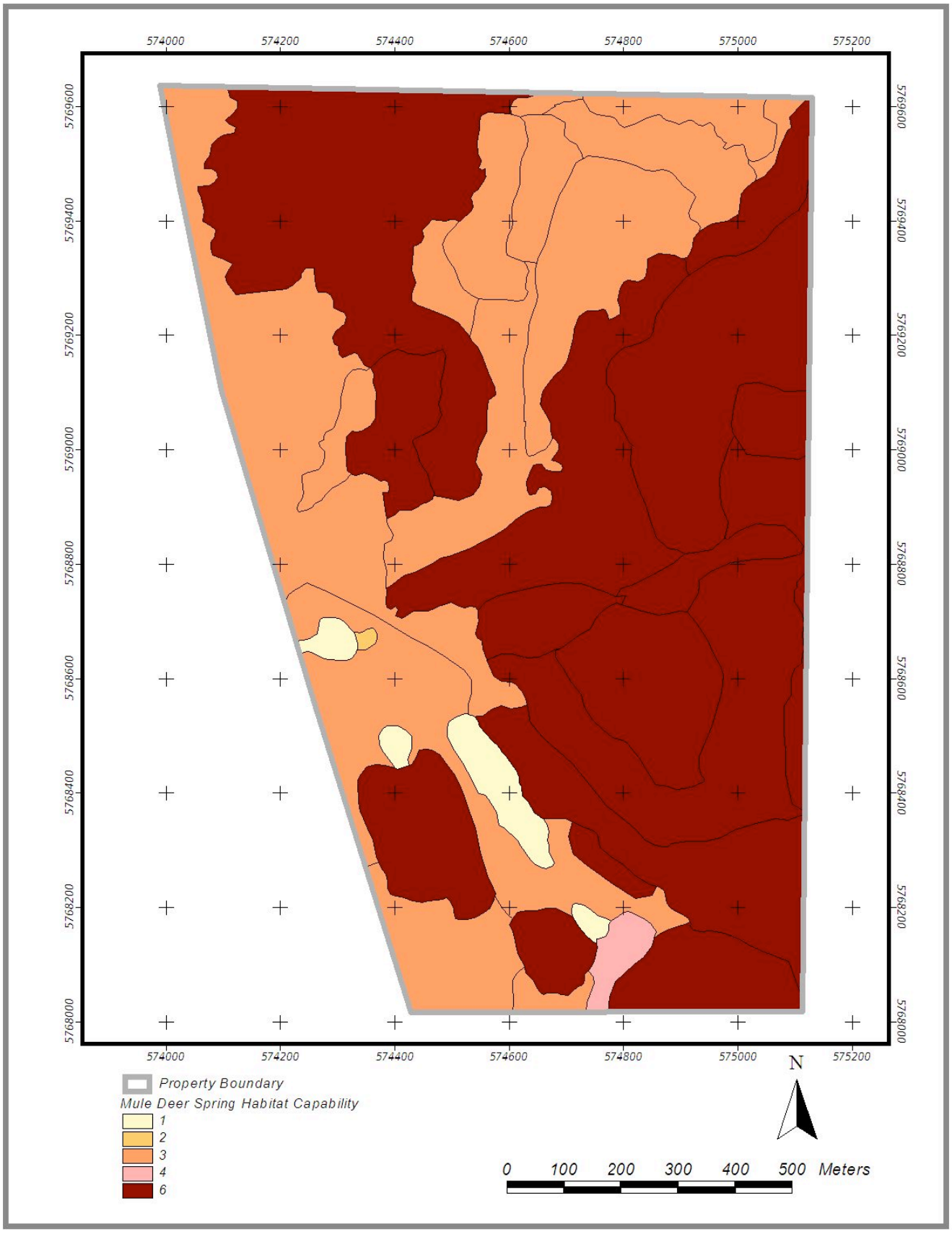


Figure 8: Mule deer winter habitat capability on the Knife Creek property.

The capability of the site to for Mule Deer spring range is much generally good (Figure 9). Most of the open sites with a warm aspect are rated very good, those with level aspects are good andd cool aspect or depressional sites aremoderate andd this with the low elevation of the site means these areas green-up early in the spring, providing high quality food to mule deer early

Mule Deer Suitability

As most of the forest stands on the Knife Creek property have high densities of small stems and lack larger trees, the winter habitat suitability is greatly reduced (Figure 10). The three polygons with mapped mature forest are rated as good, while all other forested polygons are rated moderate.

Mule deer spring habitat suitability is rated as generally good (Figure 11). As most of the grassland areas have not had significant livestock grazing for many years, they are assumed to be have healthy grassland communities that can provide high quality food early in the growing season.

Badger Habitat

All polygons were rated equally for badger habitat capability and suitability on the Knife Creek property. The grassland polygons were rated based upon soil depth, and slope (Figure 12).

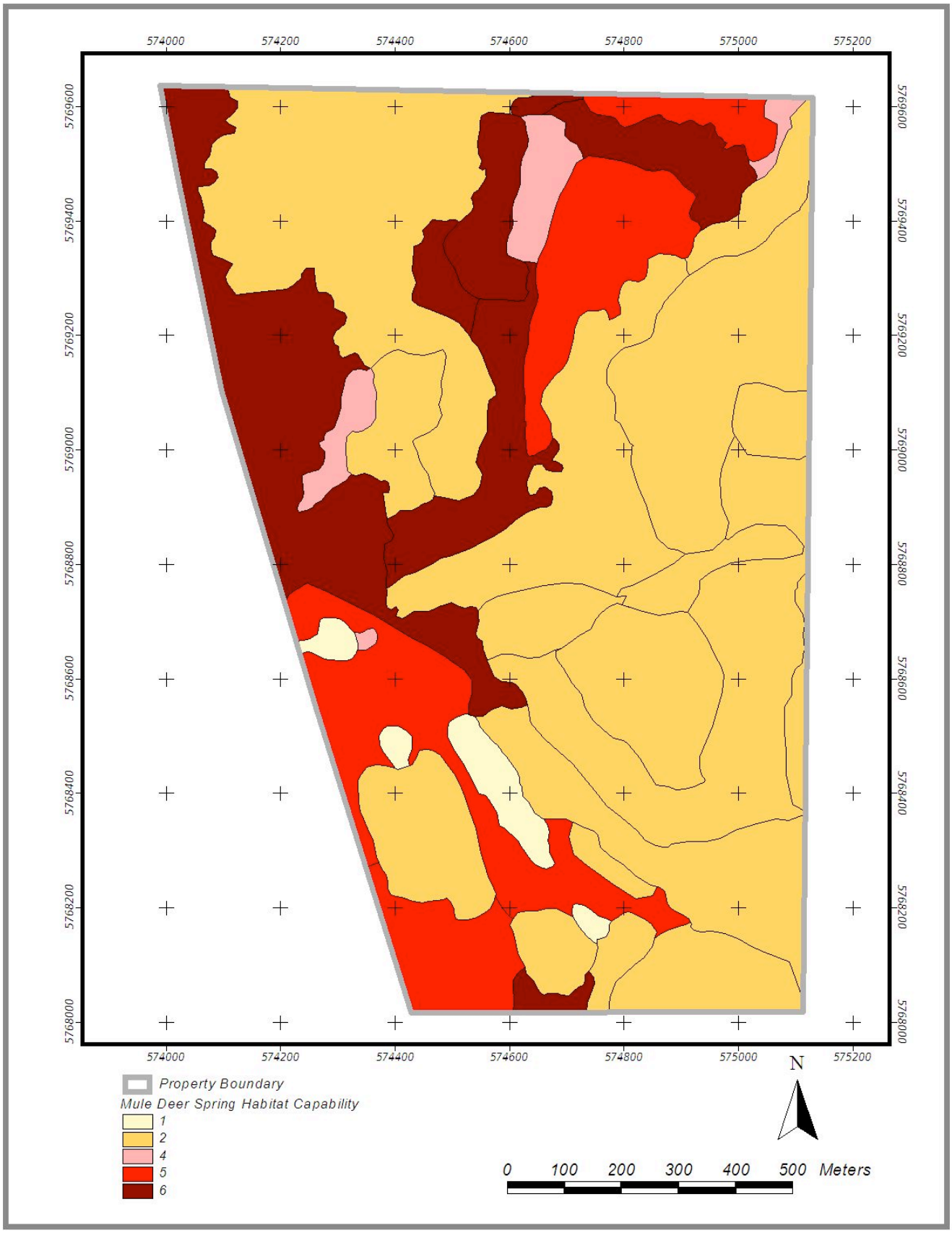


Figure 9: Mule deer spring habitat capability on the Knife Creek property.

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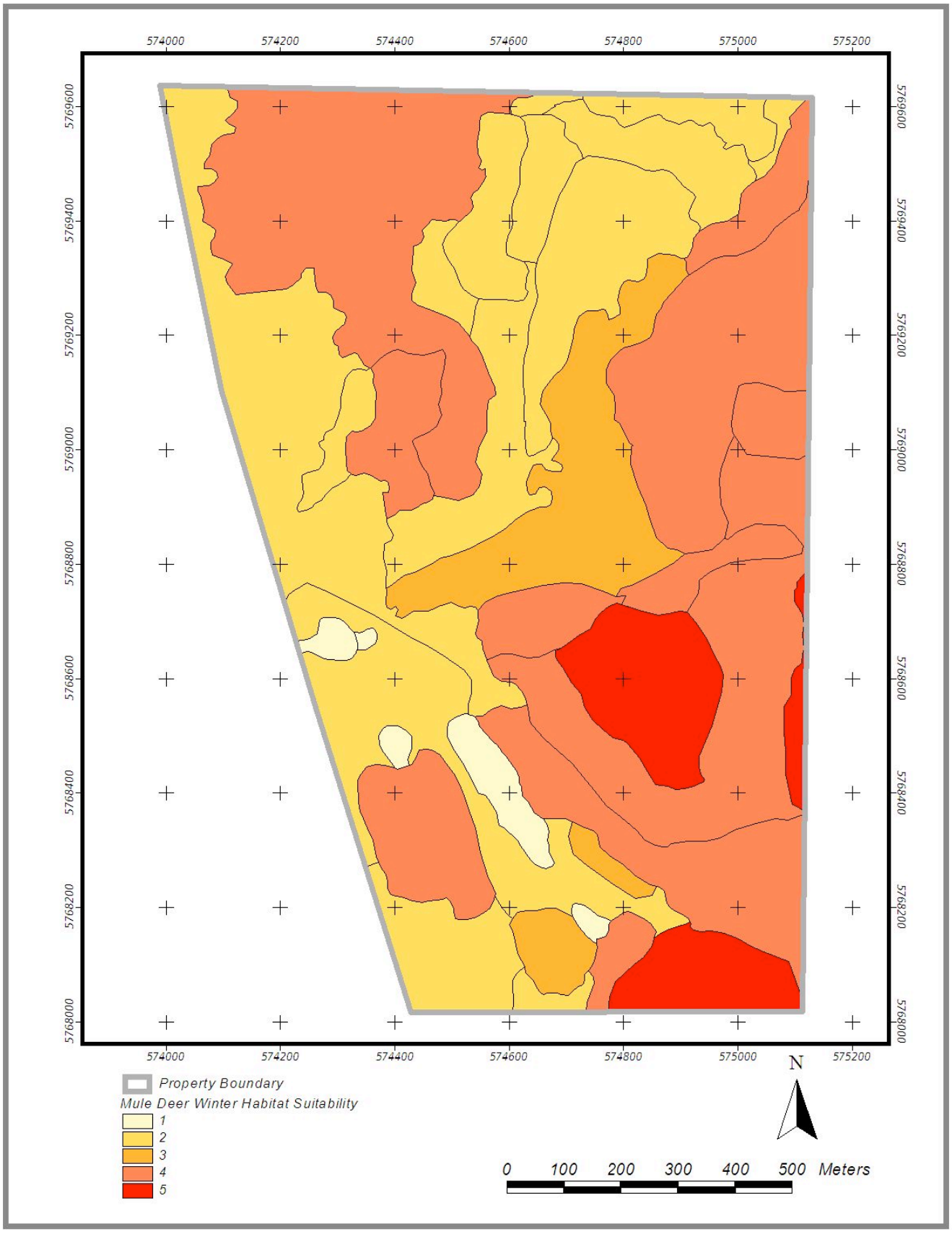

Figure 10: Mule deer winter habitat suitability on the Knife Creek property.

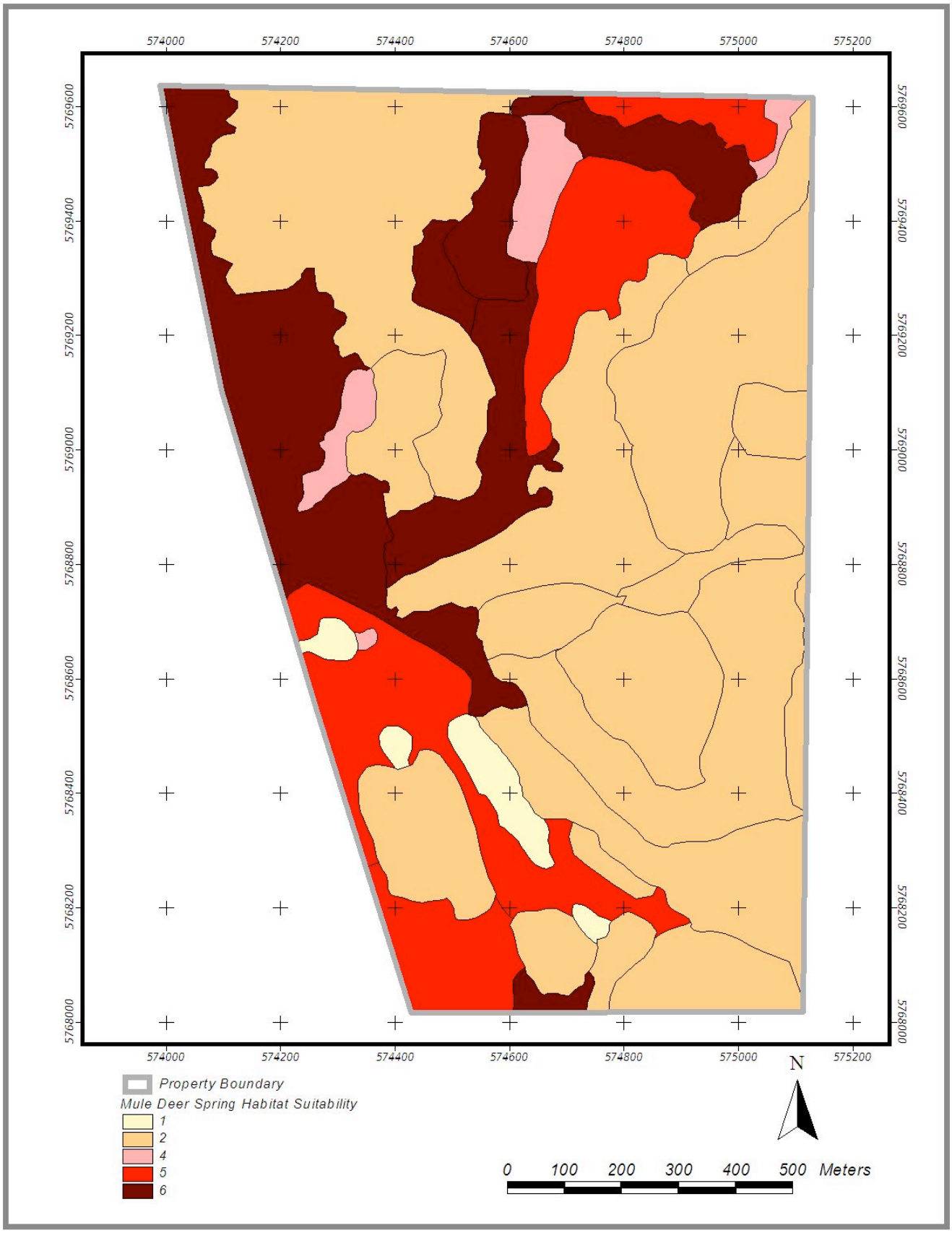

Figure 11: Mule deer spring habitat suitability on the Knife Cree property.

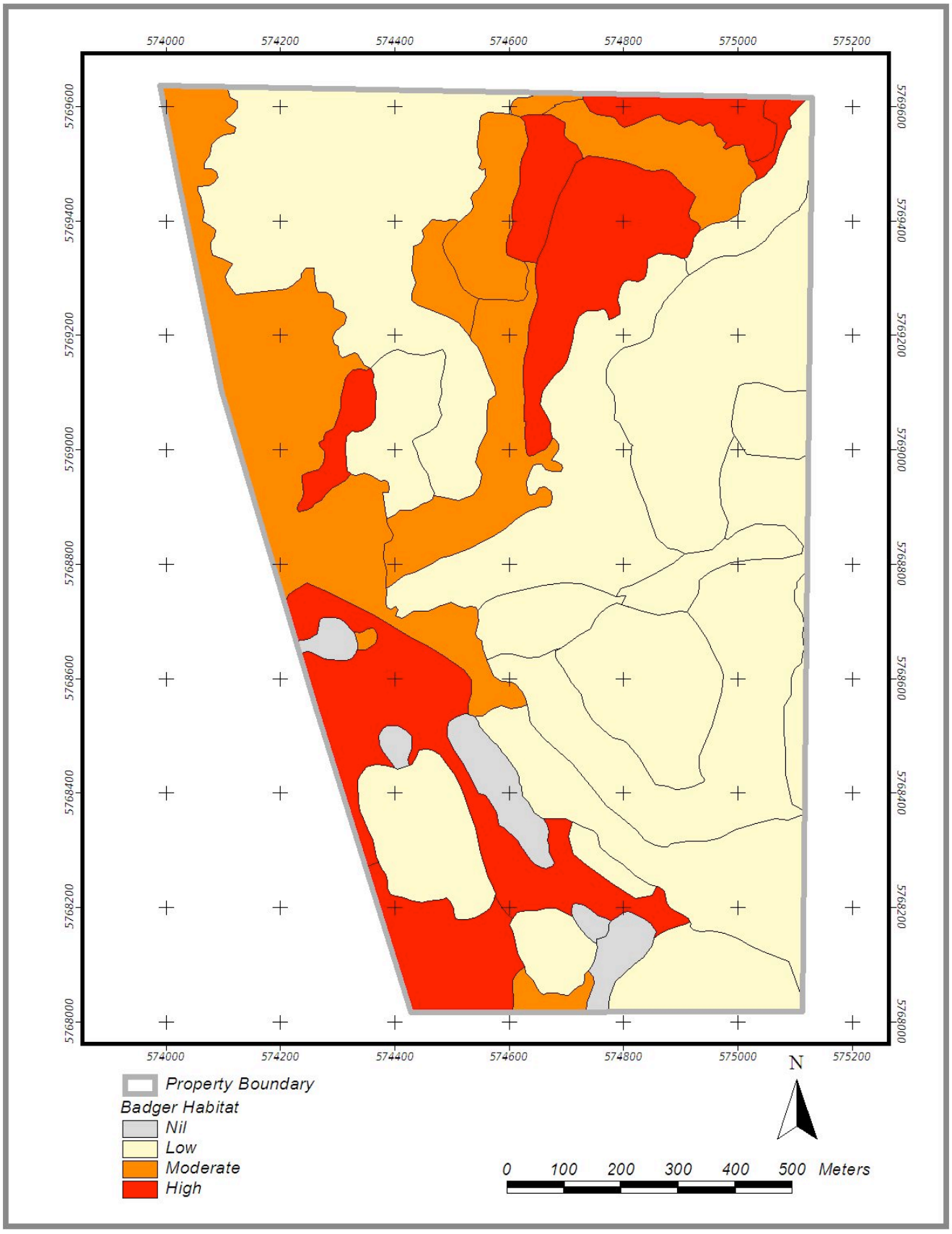

Figure 12: Badger habitat suitability and capability on the knife Creek property.

Painted Turtle Habitat

Painted turtle habitat restricted to two small wetlands or ponds on the property. The potential for these areas to support painted turtles is rated to be high (Figure 13). As these polygons were dry at the time of the field visit, the habitat suitability was rated as low (Figure 14). Further field work is required to confirm the soil texture and state of usual water levels in these wetlands.

Long-billed Curlew Habitat

Habitat capability and suitability was rated the same for all polygons on the Knife Creek property. Level or gently sloping grassland polygons were rated as High, and more steeply sloped grassland polygons were rated as moderate. The condition of the grasslands at these polygons needs to be confirmed to verify the accuracy of these ratings.

Lewis' Woodpecker Habitat Capability

The forested polygons on the Knife Creek property generally have a high capability to supply Lewis' woodpecker nesting habitat (Figure 16). Forests of Aspen were rated moderate. However, since there are few suitable nesting trees in any of the forests, the habitat suitability is rated as low over most of the property. The mature conifer forest polygons are rated moderate for Lewis' woodpecker habitat suitability (Figure 17).

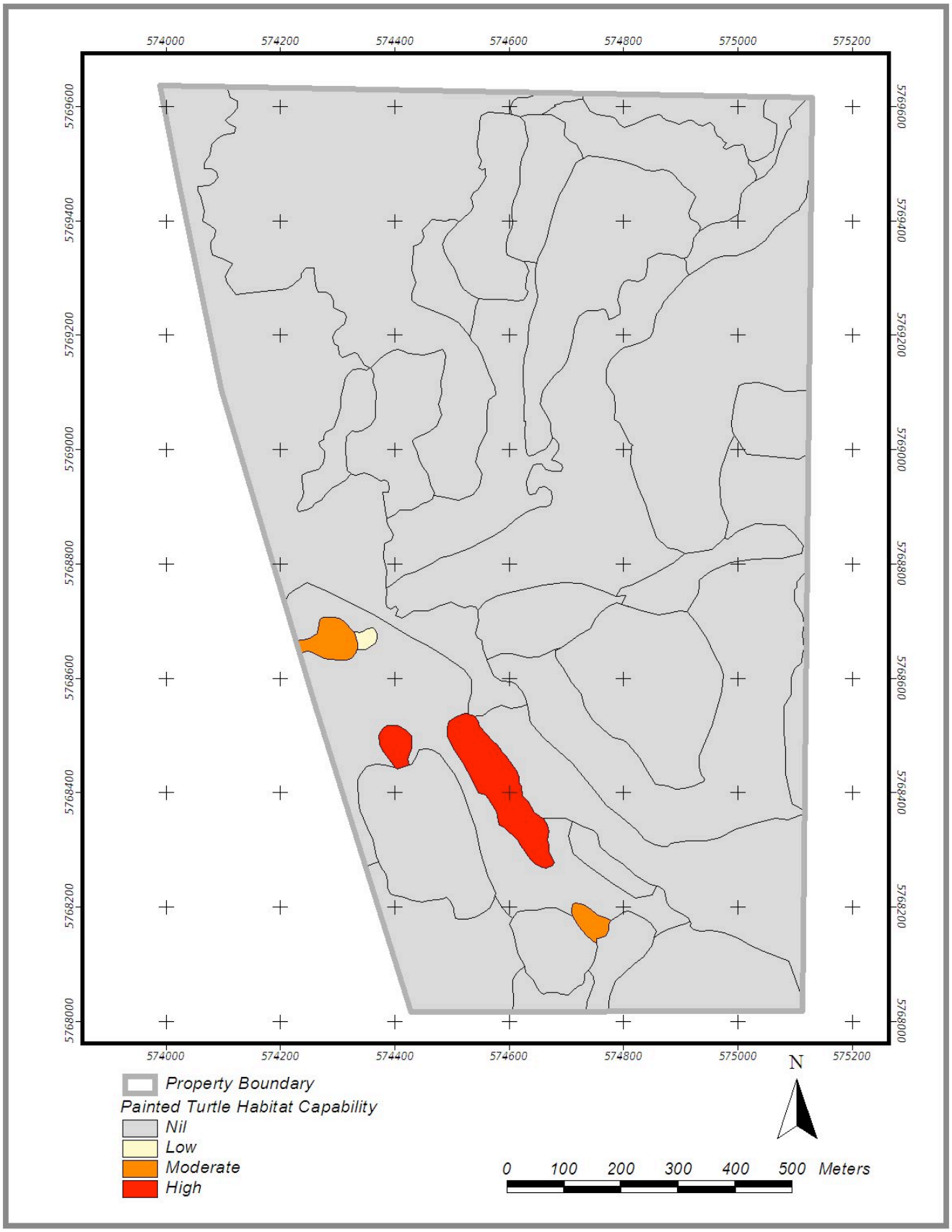

Figure 13: Painted turtle habitat capability on the Knife Creek property.

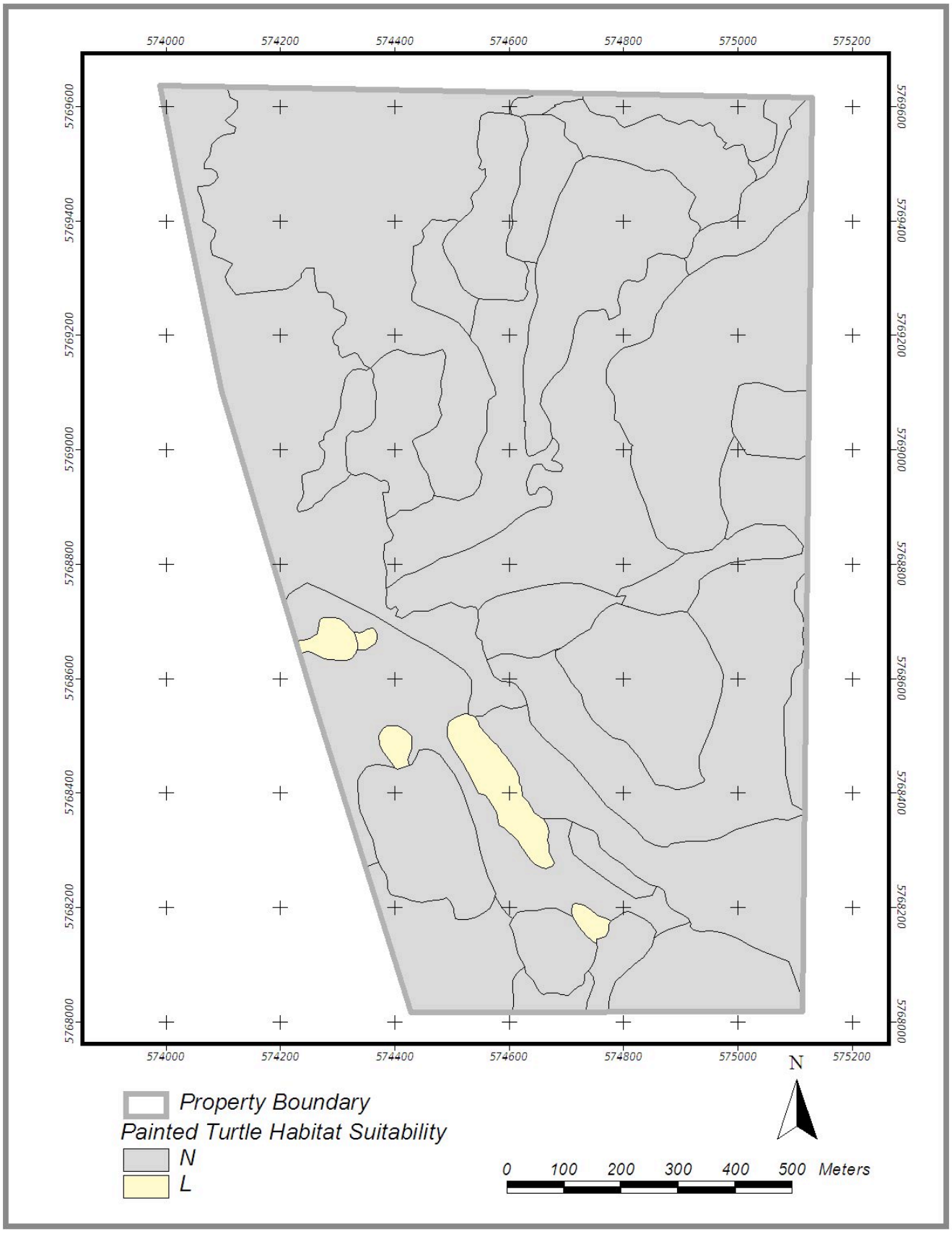

Figure 14: Painted turtle habitat suitability on the Knife Creek property.

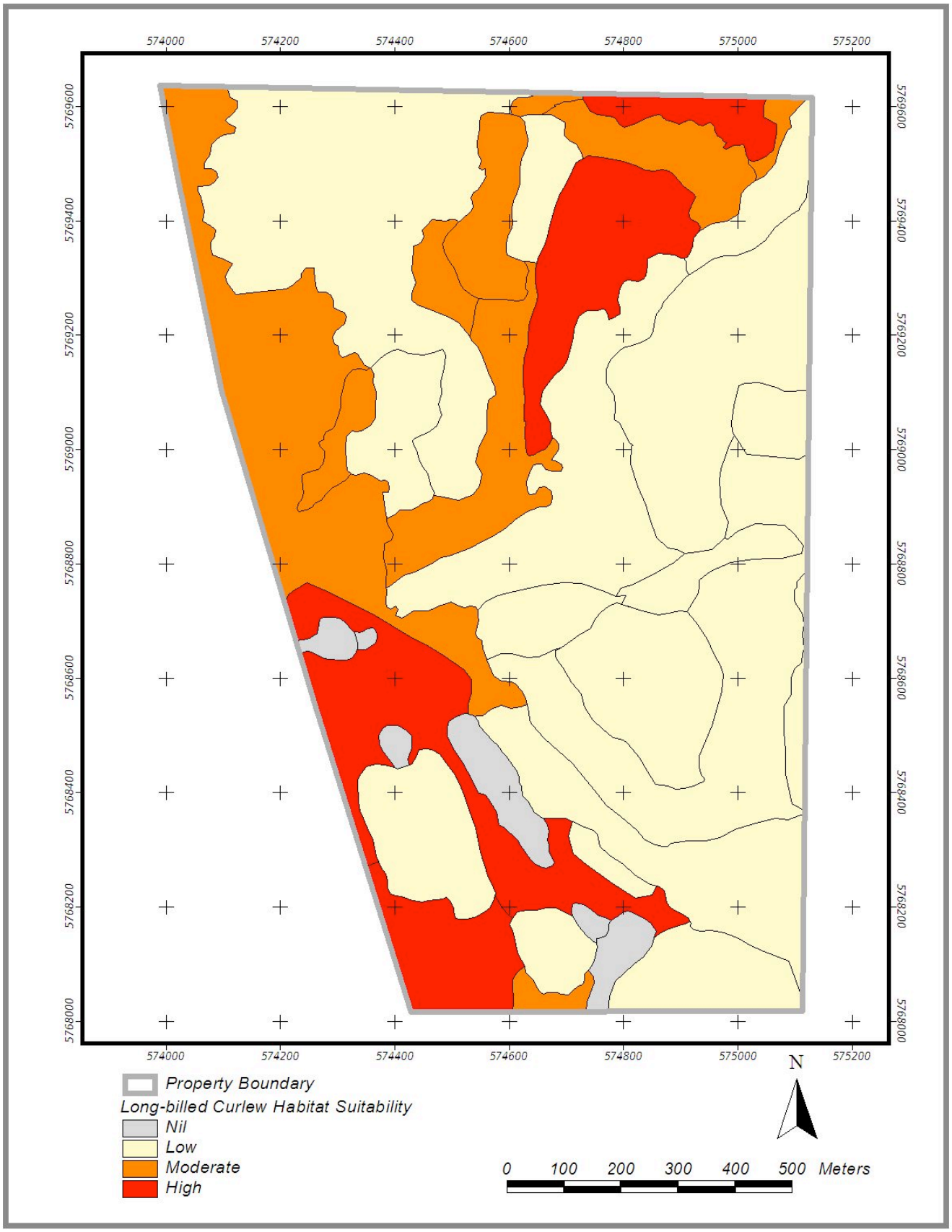

Figure 15: Long-billed curlew habitat capabilty and suitability on the Knife Creek property.

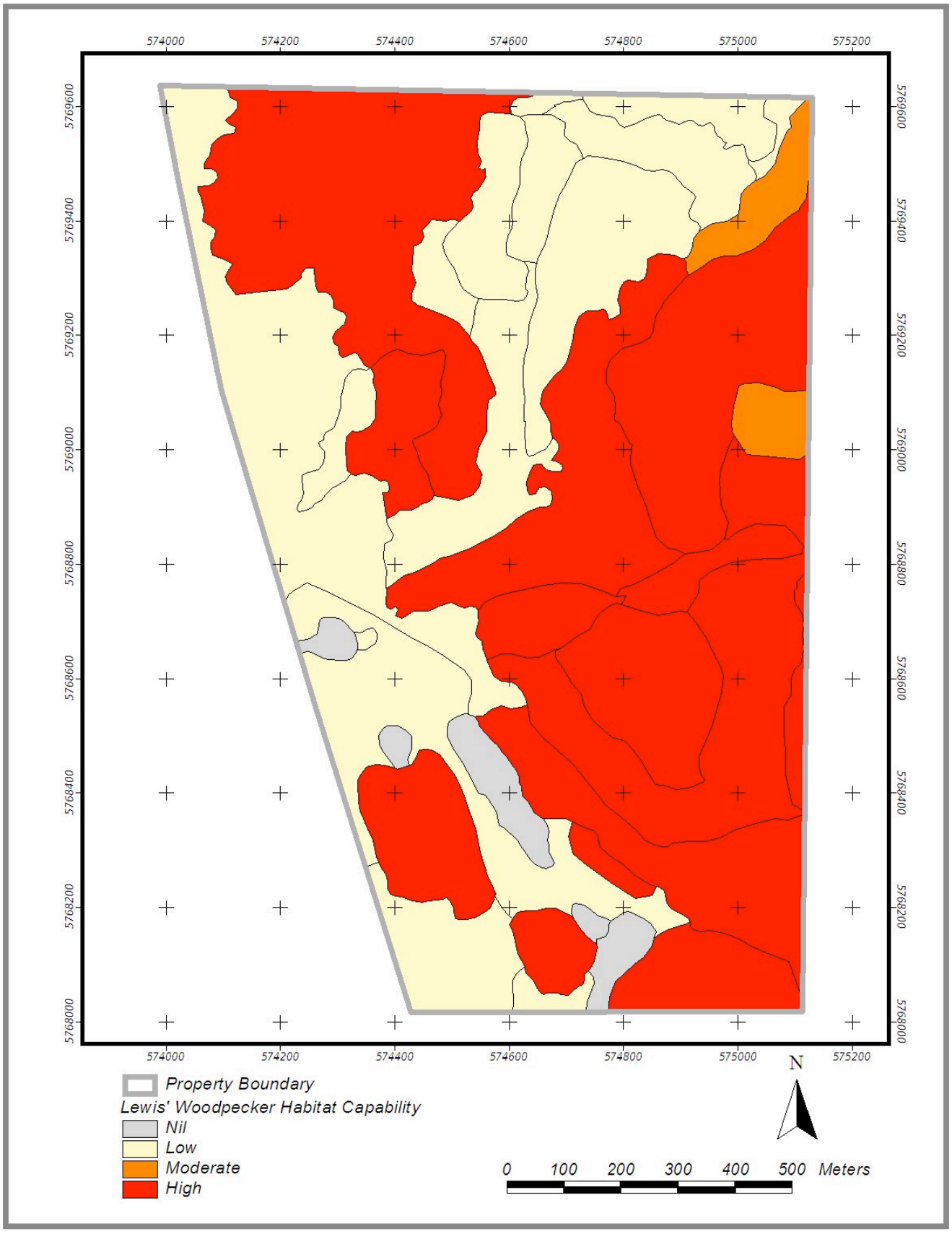

Figure 16: Lewis' woodpecker habitat capability on the Knife Creek property.

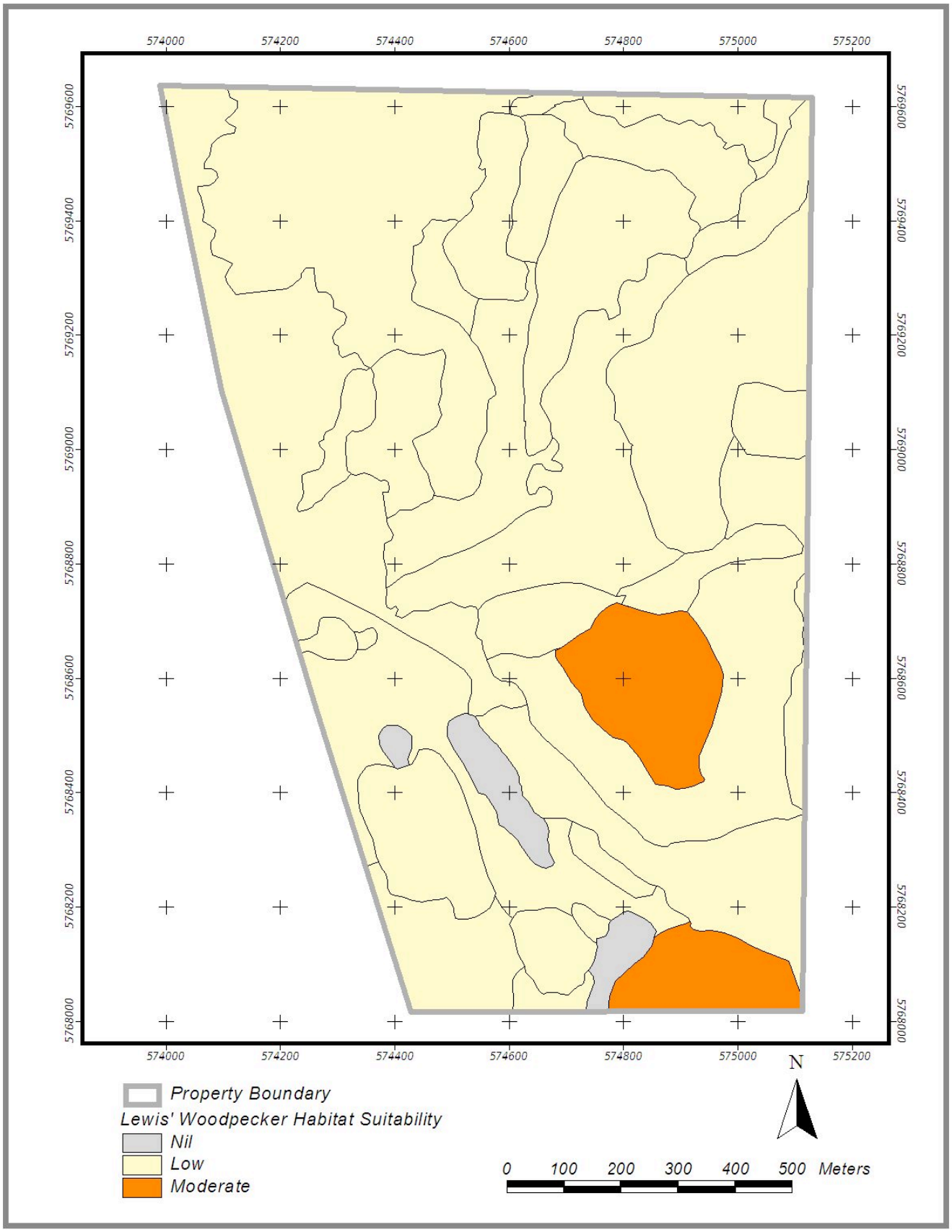

Figure 17: Lewis' woodpecker habitat suitability on the Knife Creek property.

DISCUSSION

Grassland Restoration Areas

The priority for grassland restoration at the Knife Creek property should be the areas of encroached grasslands in the grassland benchmark area. The total area encroached is approximately 10 ha and could be restored at reasonable cost. Hand-felling and loping is the preferred method of tree removal to avoid damage to grassland with the use of heavy machinery. If felled material is too plentiful, piling the material for winter burning is preferred. For these polygons, all recent encroachment should be removed. Encroachment trees can be identified by small size and by having living limbs very close to the ground. Trees that are not recent encroachment have large crowns, have the tree canopy "lifted" by exposure to low intensity fire and often bear fire scars or charred bark. These trees should be retained.

Surveys for smaller more recent encroachment should be conducted as these areas are most easily and cost-effectively treated when the encroachment is small. When encroaching trees are small enough to cut with brush saws they can efficiently cut and left on site greatly reducing treatment costs.

Surveys for invasive alien plants should also become formalized and carried out frequently. Hand pulling invasive plants can be carried out during surveys and is practicable at the current levels of infestation. This will ensure that any current infestations are not allowed to spread and will minimize the occurrence of new sites.

Forest Treatment Areas and Targets

Further surveys are needed before specific treatments can be developed for the forested areas of the Knife Creek property. The historical stand structures to be used as the basis for prescriptions in forested sites outside the mule deer winter range need to be determined. Once these historical structures are known, prescriptions that begin to recreate those conditions can be developed.

Forested sites inside the mule deer winter range have set targets for basal area. Surveys need to collect stand structure information so that prescriptions that can help the stands develop those characteristic can be developed. Generally removing some proportion of the smaller, suppressed stems from these stands will help the remaining stems grow more quickly and develop larger crowns for snow interception.

Wildlife Species Monitoring

During field work on the site, observation on presence and habitat attributes for the selected species should be made. Spring surveys for long-billed curlew, painted turtle, Lewis' woodpecker should be considered. Knowing whether these species are present can help refine treatment priorities.

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APPENDIX 1

ECOSYSTEM UNIT DESCRIPTIONS

Biogeoclimatic Subzone	Site Series Code	Site Series Name	Site Series Description
IDFxm	AF	Nuttall's alkaligrass - Foxtail barley wet meadow	saline wet meadows with foxtail barley and often with Distspi and/or Puc
IDF	AG	Arrowgrass Marsh	seasonally inundated
IDF	AR	Trembling Aspen - Prairie rose	Trembling aspen stands in moist depressions; often thicker eolian caps t areas; shrubby undergrowth usually dominated by rose and snowberry; Calarub/ Poa pra also present; sometimes occurs adjacent to wetlands;
IDF	DP	Fd - Pinegrass - Feathermoss	gentle slope, deep, medium-textured soils * Noncorrelated Unit, talk with Ecologist
IDF	DR	Fd - Ricegrass - Feathermoss	moist sites of lower slope receiving position, deep medium-textured soils Unit, talk with Regional Ecologist
IDF	DS	Fd - Bluebunch wheatgrass - Pasture sage	significant slope, warm aspect, deep, medium-textured soils * Noncorre Regional Ecologist
IDF	DW	Fd - Bluebunch wheatgrass - Penstemon	significant slopes of warm aspects, medium textured shallow soils over b Noncorrelated Unit, talk with Regional Ecologist
IDF	NA	Spreading needlegrass - Cut-leaved anemone	significant slope; cools aspect deep, medium - textured soils. *non corre contact regional ecologist
IDF	NG	Spreading needlegrass - Sticky purple geranium	gentle slopes to depressions; moisture receiving sites; deep medium- te correlated unit - please contact regional ecologist
IDF	NP	Spreading needlegrass - Pussytoes	level to gently sloping sites; deep, medium- textured soil. *non correlate contact regional ecologist
IDF	PP	Short-awned porcupine grass - Pussytoes	level to gently sloping sites; deep medium- textured soils. *non correlate contact regional ecologist
IDF	RF	Baltic rush - Field sedge wet meadow	deep, medium-textured soil; wet meadow dominated by baltic rush and f forms a fringe around wetlands
IDF	SH	Sxw - Horsetail	gentle slope or depressional areas with deep, fine-textured soils *Noncc with Regional Ecologist

Biogeoclimatic Subzone	Site Series Code	Site Series Name	Site Series Description
IDF	SM	Beaked sedge - Water sedge marsh	Marsh dominated by beaked sedge and or water sedge; deep, fine-textu
IDF	WP	Bluebunch wheatgrass - Pasture sage	significant slope, warm aspect, unstable surface soils; deep coarse - tex correlated unit - please contact regional ecologist
IDF	WY	Bluebunch wheatgrass - Yarrow	gentle slope; medium - textured soils. *non correlated unit - please conta ecologist

APPENDIX 2

SPECIES ACCOUNTS

Mule Deer

Ecology and Key Habitat Requirements - General

Mule deer occupy a home range made up of spring, summer, and winter ranges and migration routes. Mule deer often use alpine or high-elevation habitat in summer and migrate to valley bottoms and lower slopes for the winter. Deer normally show a high degree of fidelity to specific winter ranges as well as to individual home ranges (Ihsle Pac *et al.* 1988). Densities of mule deer within the study area vary throughout the year, but the area is used by a large number of deer during the spring. Deer are widely dispersed in summer and probably occur in very low numbers in the study area. Because of their secretive behaviour, use by females with young is most difficult to document.

Critical habitat for mule deer is thought to be winter range, but high quality spring range is also important for survival. Availability of good winter habitat and the severity of winter weather are the main factors controlling the numbers and distribution of mule deer in the study area. Mule deer prefer areas where snow depths are less than 30 cm, and are excluded from areas where snow depths exceed 50 cm (Simpson and Gyug 1991; Telfer and Kelsall 1979). The study area lies within the Knife Creek Mule Deer winter range.

The best winter range consists of high and moderate crown closure coniferous forests particularly Douglas-fir ed of larger and older trees. Arboreal lichens are important foods during the winter which tend to be more abundant on older trees.

Habitat Use- Life Requisites

The critical life requisites that will be rated for mule deer is security (SH) habitats rated for Winter Food, and for Spring Food.

Food Habitat

Mule deer winter diet is dominated by Douglas-fir litterfall and arboreal lichens. Spring diets are dominated by various herbs that are greening up during the spring after snowmelt. Spring habitat consists generally of non-forested south aspects, cultivated fields and wetlands, which green up early. During the spring, summer and fall months, herbaceous plants and grasses are preferred to shrubs. Spring habitats must support short-term intensive use by many animals. Forest cover adjacent to spring ranges may be important to enable extensive seasonal use.

Mule deer winter habitat is most often associated with valleys on south-facing, gentle-moderate sloping areas with mature or old growth Douglas-fir forests. Snow depths within these stands are reduced, and food is readily available in the form of Douglas-fir foliage and lichens, which fall from large trees. In some cases, Douglas-fir may make up 90% of winter diets. Douglas-fir foliage from older trees is the most common food item in the winter diet of mule deer, and foliage from the crowns of older trees is more nutritious than that from young trees. Other important winter foods, when available, include saskatoon, snowbush, Douglas maple, willow and red-osier dogwood. Shrubby, open areas are used if snow depths are less than 50 cm. On windy days, deer may use topographic features to minimize effects of wind-chill while feeding.

Ratings

There is a detailed level of knowledge regarding the habitat requirements of mule deer in British Columbia, so a 6-class ratings scheme will be used.

Ratings Assumptions

1. Structural stages 1-4 have minimal winter value for food or shelter due to heavy snowpacks.

2. Structural stages 2 and 3 may provide high-quality deer food habitat during the growing season.

Badger

Ecology and Habitat Requirements

Badger distribution in BC is correlated with the occurrence of major prey species and preferred biogeoclimatic zones: Bunchgrass (BG), Ponderosa Pine (PP), and Interior Douglas-fir (IDF) (Rahme et al. 1995, jeffersonii Badger Recovery Team 2004). Other zones they have been reported from include: Interior Cedar-Hemlock (ICH), Montane Spruce (MS), Sub-Boreal Pine-Spruce (SBPS), Sub-Boreal Spruce (SBS), Engelmann Spruce-Subalpine Fir (ESSF) and even Alpine Tundra (AT) (Newhouse and Kinley 2000a, Apps et al. 2001, Weir et al. 2003, Adams and Kinley 2004). Badgers occur from 300 m up to about 2800 m, but occurrence is usually greatest near valley bottoms (Adams and Kinley 2004).

There is at least one known badger den in the project area. Badgers are known from grassland areas along highway 97 both north and south of the project area.

Badgers are solitary, nocturnal carnivores of open habitats, highly specialized for digging and spending much of their time in underground burrows. Badgers are less active in the winter and spend most of their time in burrows (Weir et al. 2003, jeffersonii Badger Recovery Team 2004), and will occasionally enter a state of torpor (Messick and Hornocker 1981, Apps et al. 2001). Burrows are used throughout the growing season as well, especially during the day and for maternity sites. A new burrow may be dug each day in summer, but are often reused, while one burrow may be used for the entire winter (Sargeant and Warner 1972, Long 1973). Burrows have an elliptical entrance 20-30 cm wide, and maternity dens have branched main channels and side tunnels (Lindzey 1976). Mating occurs in June and July (Weir et al. 2005), but implantation is delayed until February and young are born about April (Adams and Kinley 2004); this allows Badgers to mate in summer when they are the most active and likely to interact, and raise young in the spring when food is most abundant. Litter size is generally one to four (Messick and Hornocker 1981), but appears to be lower in BC, at one or two young per litter (Newhouse and Kinley 2004). Young disperse in their first summer, and may travel up to 110 km to locate a suitable home range (Messick and Hornocker 1981).

Only yearling or older males will reproduce, but some females will mate their first summer, at an age of only four to five months (Messick and Hornocker 1981). Badgers generally hunt for fossorial or semi-fossorial prey, primarily Columbian Ground Squirrels, Northern Pocket Gophers and Yellow-bellied Marmots (Hoodicoff 2003). Badgers are opportunistic and will also eat other rodents, amphibians, snakes, hares, chipmunks, birds, eggs, insects, fish, carrion and even vegetation when prey availability is low (Rahme et al. 1995, Cannings et al. 1999, Newhouse and Kinley 2000a, Hoodicoff 2005, Kinley and Newhouse 2005).

Home range sizes vary considerably, with male home ranges larger than those of females. Overlap occurs between neighboring animals, particularly during the breeding season (Messick and Hornocker 1981, Newhouse and Kinley 2002b, Hoodicoff 2003). Home range sizes in BC appear to be much larger than further south in their range, with female and male home ranges, respectively, up to 11 and 258 km2 in the Thompson (Hoodicoff 2003) and averaging 35 and 301 km2 in the East Kootenays (Kinley and Newhouse 2005). Core areas within home ranges are used more extensively (average of 82% of telemetry locations in the Thompson), particularly in fall and winter (Hoodicoff 2003).

Badgers appear relatively tolerant of human disturbance, and have been observed in agricultural, rural and even urban areas (Hoodicoff 2003). Despite their valuable role in control of rodents such as marmots and pocket gophers, Badgers have often been persecuted as pests (Adams and Kinley 2004), as have their prey species. Highway and train rights-of-way are often used for burrowing and as travel corridors, and road or train mortality in the Thompson area has been reported as 36% to at least 46% of deaths, although the studies may have been biased towards animals located close to transportation corridors (Hoodicoff 2003, Weir et al. 2003, Weir et al. 2005). In an Idaho study area, highway mortality was 59% of Badger deaths, or 65% excluding animals shot for study purposes (Messick and Hornocker 1981).

General Living (Food and Security/Thermal Habitat)

Badgers require deep, friable soils for digging and abundant prey, particularly pocket gophers, ground squirrels or marmots (Rahme et al. 1995). They occur most commonly in open habitats of lower elevations (BG, PP and

IDF biogeoclimatic zones) of the dry interior valleys. Habitats preferred by Badgers were generally associated with relatively open forest or non-forest, both natural and anthropogenically-altered, including grassland, cultivated fields and pastures, and road and powerline rights-of-way, and negatively associated with canopy closure (Apps et al. 2002, Weir et al. 2003). Sites with 35% tree cover or less were preferred; sites with 6-15% cover were highly preferred; and sites with 0-5% were used extensively (Newhouse and Kinley 2000a). Most burrows were located in habitat types dominated by grasses and low shrubs (Hoodicoff 2003).

Soils characteristics appear to be the most important factor in habitat suitability, related to both burrowing (ease of digging and burrow stability) and availability of fossorial prey. Burrows generally tend to be located in glaciofluvial and glaciolacustrine soils, of generally medium texture (silt loam to sandy loam) with low to medium (<35%) coarse fragment content (Newhouse and Kinley 2000a, Newhouse and Kinley 2000b, Apps et al. 2001, Apps et al. 2002, Hoodicoff 2003, Weir et al. 2003, Hoodicoff 2005).

Although grasslands and open forests that are overgrazed have lower carrying capacities for rodents and Badgers (Rahme et al. 1995), many ground squirrel colonies exploited by badgers were on lands that had been heavily grazed (Newhouse and Kinley 2000a). Where ground squirrels are absent, Badgers are more reliant on small mammals that inhabit well-structured grasslands, and livestock grazing may affect prey populations (*jeffersonii* Badger Recovery Team 2004).

Badgers have been positively associated with southern aspects (Apps et al. 2002, Packham 2004), although this does not appear to be a strong or consistent preference. A negative association with slope and terrain ruggedness has been reported as well (Apps et al. 2002), which may be at least partly related to soil texture and/or depth.

Ratings

This model employs a 4-class rating scheme because there is insufficient knowledge of habitat requirements to use a 6-class scheme yet there is sufficient knowledge to go beyond a 2-class rating scheme. This complies with the recommended rating scheme in the RIC (1999) standards manual.

Ratings Assumptions -General Living all year – Security/Thermal, Food (LIA)

- Grasslands, shrub-steppe, open Py/Fd forest (<35% canopy cover) and cutbanks rated up to High; other open habitat up to Moderate
- Early structural stage (2) of closed forest rated up to Moderate
- Aspect - No effect on rating
- Slope - Steep rated up to Moderate; very steep rated up to Low
- Soil Texture - Medium textures rated up to High; very fine (clay/silt) and coarse (sandy or high coarse fragment content) rated down 1
- Soil Depth - Shallow rated up to Moderate; very shallow rated Nil

Painted Turtle

Ecology and Habitat Requirements

Painted Turtles are found in ponds, lakes and slow-moving water with muddy bottoms, often with emergent aquatic vegetation (Gregory and Campbell 1984). The vast majority of seasonal activities, such as feeding, mating, sleeping and other activities, are generally carried out in the water (Gregory and Campbell 1984; Macartney and Gregory 1985). Time spent on land is minimal and restricted to brief excursions during the summer nesting season and occasional overland movements between lakes (Macartney and Gregory 1985), particularly if ponds dry up. Painted Turtles are generally active during daylight although nest-digging and egg-laying usually occur in early morning and late evening (Gregory and Campbell 1984). The length of the active season and hibernating period is governed by water temperature, as is onset of breeding activity (Gregory and Campbell 1984). Activity begins in the spring when water temperature reaches 10oC, but feeding does not begin until it is about 14oC (Blood and Macartney 1998). Painted Turtles hibernate during the winter.

Adult Painted Turtles are omnivorous, feeding on insects, crayfish, other arthropods, tadpoles, and many aquatic plants (Nussbaum et al. 1983, Brown et al. 1995). Adults may also scavenge on dead animal matter (Gregory and Campbell 1984, Blood and Macartney 1998). Juveniles are almost completely carnivorous, feeding mainly on small invertebrates, then switching to frogs and fish, and eventually becoming increasingly herbivorous as they grow older (Nussbaum et al. 1983, Gregory and Campbell 1984). Algae, moss, Lobelia, turtles, snails, mussels, dragonflies, crickets, bugs, caterpillars, flies, beetles, rose bugs, wasps, ants and trout fry have all been recorded in the diet of Painted Turtles (Orchard 1988). Foraging occurs almost entirely in water because they cannot swallow unless the food is suspended in the water (Blood and Macartney 1998).

Painted Turtles are ectotherms, and therefore basking is an important part of thermoregulatory behaviour (Gregory and Campbell 1984). In addition to raising the body temperature, basking in the hot sun rids the turtle shell of algae and promotes shedding (Blood and Macartney 1998). Turtle can frequently be seen basking in large aggregations, sometimes piled two or three deep, on suitable sites such as logs, mud banks, or other objects above water (Gregory and Campbell 1984).

Female Painted Turtles normally reproduce at 5-6 years, males at 3-4 years (Brown et al. 1995). In British Columbia, females do not reproduce until they are seven or eight (Blood and Macartney 1998). Courtship and mating usually take place in the spring and mating occurs in shallow water (Gregory and Campbell 1984). Egg laying occurs during June and July in the northern portion of the Painted Turtle's range, but can occur as early as May (Nussbaum et al. 1983). Clutch sizes normally range from 6-18 eggs (Gregory and Campbell 1984, Macartney and Gregory 1985). Although in some parts of their range these turtles can produce more than one clutch per year, in BC only one is produced (Nussbaum et al. 1983, Blood and Macartney 1998).
Nesting occurs on land, usually in the late afternoon or early evening, usually within 150 m of water (Nussbaum et al. 1983, Gregory and Campbell 1984). Eggs incubate for 70-80 days (Macartney and Gregory 1985). In BC, most eggs or hatchlings appear to overwinter in the nest and emerge the following spring (Nussbaum et al. 1983, Gregory and Campbell 1984, Macartney and Gregory 1985).

General Living All year (Food and Security/Thermal Habitat

Ponds, lakes, marshes, quite backwaters of rivers, slow rivers or streams with muddy bottoms are required for all life requisites of Painted Turtles (Nussbaum et al. 1983, Gregory and Campbell 1984, Brown et al. 1995). Margins and other shallow portions of lakes provide the necessary habitat for feeding, basking, security from predators, and hibernation (Macartney and Gregory 1985). Painted Turtles prefer floating logs, branches, or other emergent objects

that lie offshore or over deep water for basking (Nussbaum et al. 1983, Macartney and Gregory 1985, Brown et al. 1995). When suitable basking sites are absent or limited in number, turtles will burrow into warm mud (up to 31˚C) in shallows along lake margins (Macartney and Gregory 1985). Painted Turtles forage on the bottom of lakes and ponds, generally at depths of less than three metres (Orchard 1988).

Ratings

This model employs a 4-class rating scheme because there is insufficient knowledge of specific habitat requirements to use a 6-Class scheme yet there is sufficient knowledge to go beyond a 2-class rating scheme. This complies with the recommended rating scheme in the RIC (1999) standards manual.

Ecosystem Attributes

Ratings Assumptions

Reproducing – Security/Thermal (RE)

- Site Series • Ecosystem units where digging is fairly easy including beaches, flood plains, shrubby fields, roadsides, gravel or soil roads and pastures rated up to H
- Structural Stage • No effect.
- Aspect • w (warm and > 25% slope) rated up to M k (cool and >25% slope) rated N
- Slope • Flat to moderately sloped ground rated higher than steeper ground
- Drainage • Poorly drained soils rated N, Moderately well drained to well drained soils rated up to H
- Soil depth • Less than 10 cm deep rated N
- Soil texture • Loose surface layer, fairly compact subsurface layer, composed of a mixture of small to medium size gravels and fine silts/sands with low organic content rated up to H
- • High coarse fragment content (cobbles and larger) in surface layers (top 10cm) rated N
- Other • Ecosystem units relatively free of surface vegetation rated up to H
- • Soils containing root masses rated N
- • Ecosystem units containing aspen or cottonwood rated N because soil is too moist and
- high root density

Long-billed Curlew

Ecology and habitat requirements

Frequents grassy steppes, not necessarily near water, as well as newly-ploughed fields, green hayfields, meadow, pastures (Campbell *et al.* 1990); does not have to be near water (Stevens 1995). Areas with tall grass, greater than 20 cm high, are not heavily used (De Smet 1992)

Breeding range is restricted to the dry grasslands of the southern interior (Campbell *et al*. 1990). Long-billed curlews nest in short-grass and mid-grass prairies and grassy meadows (De Smet 1992); main nesting habitat consists of prairie grasslands; also found in fallow fields, damp grassy hollows, oat, wheat, barley fields (Ohanjanian 1992).

Habitat Structure

Use structural stage 2 (herb) - low vegetation (<30 cm) grassland or rangeland for nesting. Large contiguous openings of native grassland with low vegetative profile are needed (BC Environment 1997). Vegetation with a low profile, low vertical density, and low shrub cover are used for nesting and brood rearing. Open areas with tall, dense vertical vegetation are avoided (Campbell *et al.* 1990, Ohanjanian 1987, Pampush 1980, Pampush and Anthony 1993). Long-billed curlews may prefer heavily grazed areas for nesting but still require some bunchgrass for cover (Bryan and Mulholland 1992). Large contiguous openings of at least 250 m wide are preferred for nesting. Nests are simply depressions in the ground, usually lined with grasses, bits of cow dung or a few twigs (Cannings *et al.* 1987)

Habitat Capability, Suitability and Effectiveness

The capability of a habitat to support nesting is dependent on many different factors. The primary factor is the size of the open area and the absence of visual obstructions. However, Long-billed Curlews are also sensitive to human disturbances. Regular human or livestock activity has a negative impact on curlews during incubation and brood rearing periods thereby decreasing the effectiveness of the habitat. Human disturbance and range use has not been mapped in the Terrestrial Ecosystem Mapping (TEM) and is therefore not modeled.

Nesting habitat suitability is affected by the characteristics of the vegetation in the area. Nest sites are found in areas where the vegetation is short and sparse. The ccondition of the grasslands has not been mapped, however some assumptions can be drawn about the grass condition depending on the grazing history of the site.

Lewis Woodpecker

Ecology and Habitat Requirements

Lewis' Woodpeckers migrate from there summer ranges in the central interior of British Columbia to southern wintering areas arriving back from mid-April to mid-May (Campbell et al. 1990). Lewis' woodpeckers congregate into flocks up to 40 birds before beginning fall migration in September and most birds are gone by the end of September (Cannings *et al.* 1987, Campbell *et al*. 1990, Cooper *et al*. 1998).

Typical breeding habitat consists of open ponderosa pine forest or cottonwood stands and less commonly Douglas-fir. Lewis' Woodpeckers are cavity nesters, and will excavate their own cavities, but also uses natural cavities or those excavated by other woodpeckers (Rodrick and Milner 1991). Although entire feeding areas are defended in the winter, only the immediate area around the nest is defended in the breeding season (Bock 1970). They may breed in loose colonies in some regions (Cannings et al. 1987). Lewis' Woodpeckers appear to show some site fidelity, as nest cavities are often reused in subsequent years (Cooper and Beauchesne 2000, Linder 1994).

The Lewis' Woodpecker eats a variety of insects, fruit, and seeds. Invertebrate prey taken are generally flying insects, or those caught on the ground or gleaned from vegetation (Cannings et al. 1987), and include beetles, ants, bees, wasps, grasshoppers, true bugs, and spiders (Cooper. 1998). Fruits and berries are an important part of the diet in summer and fall. Surplus food is often stores in cache sites, including cracks in trees or telephone poles (Cooper et al. 1998). No Lewis' woodpeckers overwinter in the Cariboo.

Predators of this woodpecker are mainly avian, and include American kestrels, merlins, Cooper's hawks, red-tailed hawks, and prairie falcons (Cooper et al. 1998).

Reproducing

Security/Thermal Habitat

The distribution of Lewis' Woodpeckers is closely related to ponderosa pine forests (Tolbaske 1997), but it is likely the open structure rather than the tree species that is important (Cooper et al. 1998). They have three primary types of breeding habitat: open ponderosa pine forest, open riparian woodland, and logged or burned Douglas-fir or mixed forest (Tolbaske 1997), but will also use grasslands with scattered trees, farmland, orchards and urban areas (Cannings et al. 1987, Campbell et al. 1990).

Open or park-like ponderosa pine forest is the major breeding habitat, except at low elevations, where riparian habitat is the main breeding habitat, particularly cottonwood groves since they are open and usually have dead trees and abundant insect populations (Rodrick and Milner 1991). Closed-canopy deciduous stands are sometimes used, but only trees at the edge of a stand next to open areas are used (Cooper et al. 1998).

They also frequent selectively logged or burned coniferous forest that is structurally similar to open ponderosa pine forest (Rodrick and Milner 1991) although the use of these stands persists only as long as the forest structure remains suitable (Cooper. 1998).

Most nests in BC have been located in ponderosa pine (35%) and cottonwood (33%) trees (Campbell et al. 1990). Higher breeding densities appear to occur in cottonwood groves, but this may be due to observer bias, and the majority of breeding likely occurs in ponderosa pine (Cannings et al. 1987). Productivity is apparently higher in open ponderosa pine forests than cottonwood habitats (Cooper et al. 1998).

While all breeding habitats are open, which is related to the foraging methods of hawking and gleaning, some trees are needed for perches and nesting (Rodrick and Milner 1991). An important component of the habitat is brushy undergrowth that supports abundant insect populations (Rodrick and Milner 1991). Optimum habitats have canopy closure <30% and shrub cover >50% (Sousa 1983). However, Lewis' Woodpeckers studied in Wyoming, California and the east Kootenays used sites with much lower shrub densities, ranging from 13.4 to 16.5% (Gebauer 2002).

Snags or trees with heartrot are required for nesting and roosting. Multiple cavities are required, as the male will brood at night while the female roosts in another cavity (Cooper et al. 1998). I n Washington and Oregon, one 30.5 cm dbh snag/0.4 ha provided maximum nesting density (Sousa 1983). Reported heights of nests in BC range from 1.0m (fallen pine) to 30.5m, with most nests recorded between 3.5 and 9 m (Campbell et al. 1990, Cannings et al. 1987).

Ratings

A 4-class rating scheme is used because there is insufficient knowledge of habitat requirements to use a 6-Class scheme yet there is sufficient knowledge to go beyond a 2-class rating scheme. This complies with the recommended rating scheme in the RIC standards manual (1999).

Ratings Assumptions - Reproducing – Security/Thermal

- Open Fd forest, grassland/shrub-steppe, rock outcrop and talus rated up to Mod.
- Structural Stage 6 and 7 rated up to High; 5 up to Moderate.
- Aspect and slope have no effect on habitat ratings.