# APPENDIX 2A: LANDCOVER MAPPING FOR THE YA HA TINDA ELK AND WOLF PROJECT (YHTEWP) STUDY AREA

## INTRODUCTION

The Ya Ha Tinda Elk and Wolf Project (YHTEWP) vegetation modeling study area was developed based on the 100% distribution of all radiocollared elk during the study period from 2002-2004. I buffered all collared elk locations by the 95% percentile of step-length based on 2-hour GPS telemetry locations to ensure forage models would apply to a large enough area to assess availability of forage resources to elk in resource selection analyses. I defined the summer study area as from 1 May to 30 October, and the opposite for winter. The summer study area was 5471km$^2$, whereas the winter study area was 1395 km$^2$, 25% of the summer area. Thirty-two percent of the summer study area was outside of Banff National Park (BNP) in the province of Alberta, the remainder in BNP, with <4% in Yoho National Park, British Columbia. In contrast, the winter study area was 95% in the province of Alberta. Figure A2.1 illustrates the summer and winter study areas used for forage modeling. For details on elk telemetry methods see Chapter 3 and 6. Because of the difficulty in extrapolating forage models outside the ranges of data used to develop forage models, I restricted all subsequent forage modeling to the summer and winter study areas during the respective seasons.

## EXISTING LANDCOVER MAPPING FOR THE YHTEWP STUDY AREA

At the start of the YHTEWP in 2001, consistent regional landcover map for the transboundary study area did not exist. BNP used a 1:50,000 scale Ecological Land Classification (ELC, (Holland and Coen 1983), and the province of Alberta used the 1:20,000 Alberta Vegetation Inventory, primarily aimed at timber resources. Previous efforts at Landsat landcover modeling (Wierzchowski 2000) for the study area had low classification success (Sachro 2002). In 2000, D.Zell (BNP Informatics Specialist) created a merged ELC-AVI landcover map consisting of eight vegetation types based on advice from P. Achuff (Parks Canada, National Botanist) and attribute data common to both landcover systems. Despite problems with this layer, the merged ELC-AVI coverage was the only landcover map available, and was therefore used for vegetation sampling stratification. The eight-habitats included: open conifer, pine, closed conifer, grasslands, alpine meadows, rock/ice, shrub, and other.

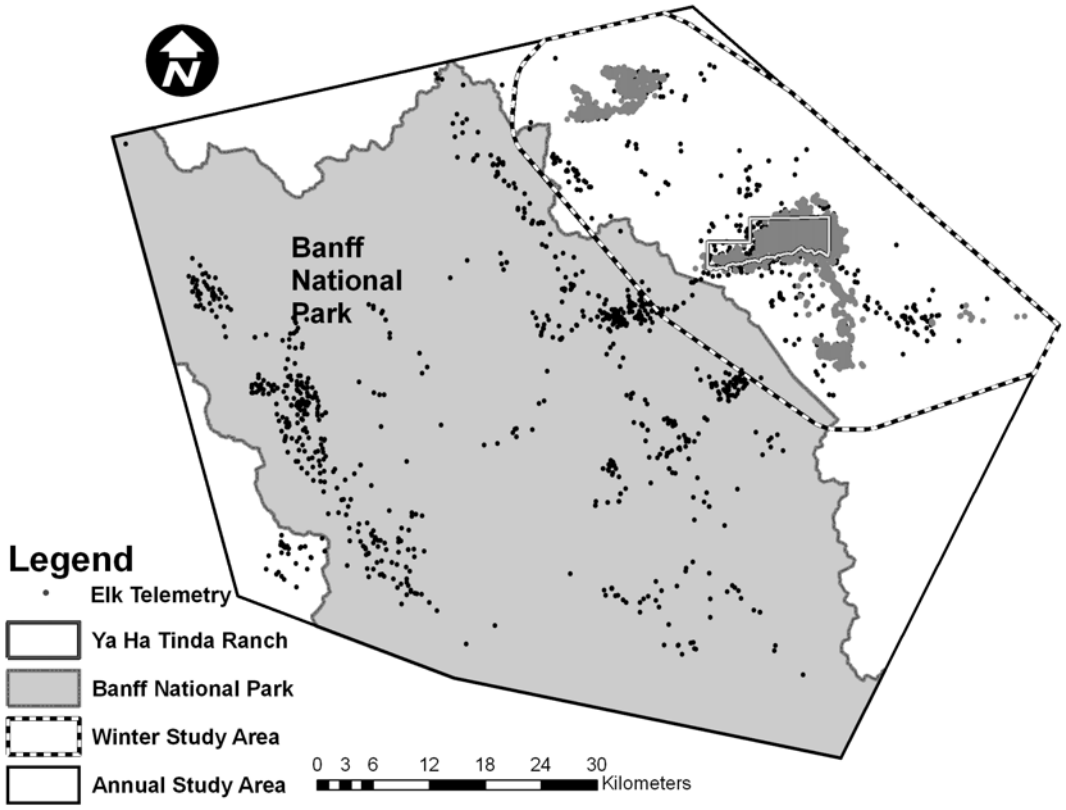


FIG. A2.1. Study area used in forage modeling based on distribution of winter (●) and summer (●) elk telemetry (VHF and GPS) locations encompassed with a buffer based on the 95% percentile step-length in any 2-hour period, Feb 2002 to Dec 2004.

***Phase 3 Foothills Model Forest Grizzly Bear Project (FMFGBP) Landcover Map***

In the Fall of 2004, the Foothills Model Forest Grizzly Bear Project (FMFGBP) completed Phase 3 of their expanded landcover mapping initiative which extended south to Hwy 1. This landcover mapping initiative was developed following an integrated decision tree approach (IDTA)(see Franklin et al. 2001, McDermid et al. 2004) for detailed description of the methods). Classification accuracy, measured using the kappa statistic, of the Phase 3 landcover map averaged 82% (McDermid et al. 2004). While few field validation points were used from the study area for the development of the landcover classification, ongoing efforts by the FMFGBP will extend landcover mapping south to the U.S. border in Phase 4 of the mapping efforts. Moreover, Phase 4 (to be completed Dec 2005) will include vegetation plots from this study as well as additional field plots collected in cooperation with Parks Canada during 2005. Because of the continuity of landcover types through Phases 1-3 to date for this landcover map, these habitat models based on Phase 3 will be easily adapted to the Phase 4 landcover maps produced by 2006.

### *Collapse of Landcover Categories for YHTEWP*

Phase 3 of the FMFGBP Landcover map had 15 landcover categories (Table A2.2). Because several landcover types were very rare within the study area, I combined them through reclassification of the FMFGBP Phase 3 maps. I reclassified Rock, Snow/Ice/Shadow as the combined category Rock/Ice; Treed and Open Wetland as Wetland, and later combined these with Dry Herbaceous because investigation revealed almost no treed wetland within my study area (<1 $km^2$ or <<1% of the study area). Treed wetland is typically associated with Upper and Lower Foothills areas, represents a more boreal-white spruce forest type. This resulted in a reduction from 15 to 11 categories, which I combined with other modifications including burned and alpine landcover types.

### *Modifications Required for the YHTEWP Study Area*

*Prescribed burns*

Prescribed burns are an important landcover disturbance in the eastern slopes study area (White et al. 2003). I obtained prescribed and natural fire GIS data from Parks Canada and AB-SRD. Methods used to map fire boundaries have changed over the 20-year history of prescribed fires in the study area, from coarse airphoto mapping for early burns, to fire boundary detection with remote sensing using the normalized burn index of Key and Benson (2003). Attribute data associated with prescribed and natural fire polygons included; stand origin or year of burn, burn size, location, and season of burn, spring/summer/fall. I defined fire age according to the number of full growing seasons that had passed following the burn. I considered a full growing season as having occurred if the burn date was spring (<June 1) in a given year. Thus, a 5 May burn in 2000 that was sampled in August 2001 had two full growing seasons of vegetation growth, whereas a 15 July burn in 2000 sampled in August 2001 only had one growing season.

*Modeling pre-burn vegetation type*

Given the importance of pre-burn condition on elk forage (Sachro 2002) I modeled differences in forage availability for elk between different burned habitats. However, spatial resolution of geographic data and vegetation mapping data was insufficient to match the eight burned community types identified within a portion of the study area (Sachro 2002). Mismatches between provincial AVI and Parks Canada- ELC classifications prevented further reliable discrimination of pre-burn forest type. Moreover, satellite data used to develop the FMFGBP Phase-3 landcover map was collected after burns occurred. Thus, a multi-step approach was

adopted to remedy this problem. First, I assessed the pre-burn cover types using the merged ELC-AVI data. Over 81% of the burned area was burned forests, with conifer/pine (39%), followed by closed conifer/spruce (30%), grasslands (13%), open conifer (12%), shrubs (5%), and <1% deciduous. Unfortunately, vegetation data was unable to separate spruce and pine.

Fortunately, concurrent analysis of vegetation differences in different conifer stands following fire indicateed that forage biomass responses between spruce, pine, and mixed conifer were similar (Fig. A2.2, Munro et al. 2005). Therefore, burns were classified as: (1) forest (conifer, pine, open conifer, and deciduous), (2) grasslands (alpine and grassland herbaceous, rock, and open wetland), and (3) shrublands, using ELC-AVI. Rock was included as grassland because burned-rock was assumed a herbaceous cover type. I merged the prescribed burns with these reclassified landcover types to obtain 3 new landcover categories: (1) burned-forest, (2) burned-grassland, and (3) burned-shrubs.

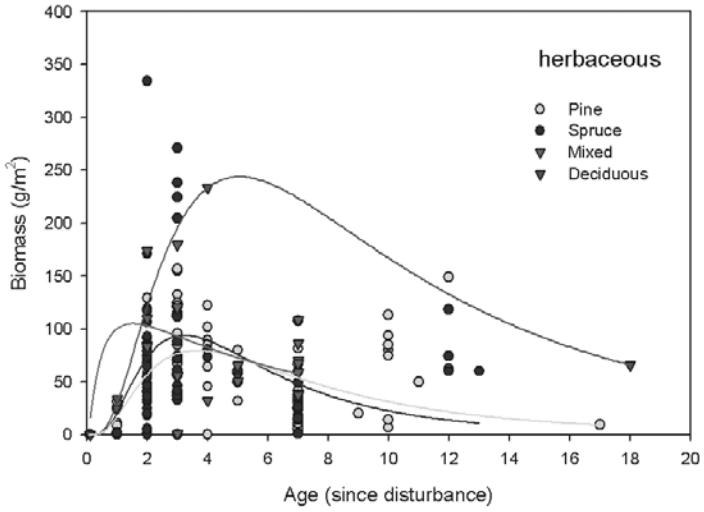


FIG A2.2. Total herbaceous forage biomass ($g/m^2$) as a function of age since fire (disturbance) and landcover type, eastern slopes study area.

*Fire age-classes*

Because the effect of fire on vegetation and elk forage vary with time-since fire, I modeled forage biomass within the three burn types in discrete burn age-classes. I determined discrete age-classes for time-since burn following concurrent fire-vegetation analyses by Munro et al. (2005) that developed forage biomass versus fire age regressions for herbaceous, forb, graminoid, and shrub biomass (Fig. A2.2). The age classes include:

1) Age 0-1, where vegetation response is suppressed and forage biomass lower,

2) Age 2-4, where vegetation response is maximal in response to the burn,

3) Age 5-14, the time during which vegetation response declines to low levels, and

4) Age 14+, return to pre-burn conditions.

I included dummy variables for burned habitat type-age classes (i.e., age 0-1 burned-forest) in statistical analyses of forage biomass (see below). Following the development of statistical models for 2002-2004 predictions, I back-calculated the actual burn age during each year and reclassified all burns within the study area to their respective burn-age class. For example, the Dogrib burn was age 1 in 2002, 2 in 2003, and 3 in 2004, which would be classified in age 0-2 for the first 2-years, and in the second, 2-5 year old age-class during 2004.

*Alpine habitats*

I used the 2200m elevation contour to delineate alpine and non-alpine ecoregions (i.e. subalpine and montane) for the YHT study area (Holland and Coen 1983). All open habitat types (i.e. grassland or shrubs above 2200m in elevation) were classified as alpine herbaceous and alpine shrub landcover classes. Other vegetative landcover classes that occurred >2200m, such as forested cover classes (e.g., open, closed conifer) were not reclassified as alpine.

### *Final Ya Ha Tinda Landcover Map*

I recombined burns and alpine habitats with the FMFGBP Phase 3-landcover map into 16 total classes. The burned habitats were subdivided into an additional 10 age-classes, for a total of 26 classes. These classes are summarized in Table A2.1, along with their area ($km^2$) and proportional representation of the elk and vegetation modeling study area. Note the dominance of the rock/snow/ice landcover class comprised 38% of the study area. Collapsed to simple open/closed/rock habitat categories, which were used during phenological model development, the study area is comprised of 19% open habitats, 43 % closed habitats, and 38% rock and ice. Ignoring the rock/ice component, 31% of the study area was open and 69% closed.

Table A2.1. Final Ya Ha Tinda Elk and Wolf study area reclassified and modified Foothills Model Forest Grizzly Bear project (FMFGBP) Phase-3 landcover map, including open (1) and closed habitat (0) classification.

| Phase 3 Landcover Types | | Reclassified Landcover Types | | | ($km^2$) / % | |
|---|---|---|---|---|---|---|
| 1 | Open coniferous forest | 1 | Open Conifer | -(0) | 399 | 6% |
| 2 | Moderate coniferous | 2 | Moderate Conifer | -(0) | 1605 | 24% |
| 3 | Dense coniferous | 3 | Closed Conifer | -(0) | 865 | 13% |
| 4 | Broadleaf forest | 4 | Deciduous | -(0) | 4 | <1% |
| 5 | Mixed forest | 5 | Mixed forest | -(0) | 92 | 1% |
| 6 | Forest regeneration | 6 | Forest regeneration | -(1) | 91 | 1% |
| 7 | Upland herbaceous | 7 | Herbaceous | -(1) | 155 | 2% |
| 8 | Shrubs | 8 | Shrubs | -(1) | 262 | 4% |
| 9 | Open wetland | 9 | Water | (N/A) | 48 | 1% |
| 10 | Treed wetland | 10 | Rock/Snow/Shadow | (N/A) | 2497 | 38% |
| 11 | Water | 11 | Cloud | (N/A) | 9 | <1% |
| 12 | Barren land | | Burn-Forest | -(1) | 187 | 3% |
| 13 | Snow/Ice | 12 | 0-1 years old-(1) | | | |
| 14 | Cloud | 13 | 2-4 years old-(1) | | | |
| 15 | Shadow. | 14 | 5-14 years old-(1) | | | |
| | | 15 | 14+ years old-(0) | | | |
| | | 16 | Salvage Logged 0-1 years-(0) | | | |
| | | 17 | Salvage Logged 2-4 years-(0) | | | |
| | | | Burn-Grassland-(1) | | 29 | <1% |
| | | 18 | 0-1 years old-(1) | | | |
| | | 19 | 2-4 years old-(1) | | | |
| | | 20 | 5-14 years old-(1) | | | |
| | | 21 | 14+ years old-(1) | | | |
| | | | Burn-Shrub-(1) | | 12 | <1% |
| | | 22 | 0-1 years old-(1) | | | |
| | | 23 | 2-4 years old-(1) | | | |
| | | 24 | 5-14 years old-(1) | | | |
| | | 25 | Alpine-Herbaceous | -(1) | 232 | 4% |
| | | 26 | Alpine-Shrubs | -(1) | 107 | 2% |