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Achieving Productivity in Wildlife Ecology Data Collection through Mobile GIS

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EXECUTIVE SUMMARY

Throughout the 2008 field season, a mobile GIS system was developed for wildlife biologists in the Columbia Basin to efficiently collect data on a mobile system that eliminates error and duplicate data while adhering to provincial government data standards. The project testing was conducted between February 2008 and September 2008 in 3 separate field data collection activities. The activities included point, line, and polygon vector data collection combined with the development of .dbf forms linked to shapefiles (.shp), and GPS triggered vertex collection. The projects collected point data on wildlife trees and species at risk (SAR), line data on ungulate survey flight paths, and polygon data on invasive weed areas. The foundation design for each activity included .dbf form development, mobile map development, and post processing activities. This integrated with the use of real-time GPS technology provided the biologists with a means to integrate what once were manual processes of data collection into a digital format of data collection.

During 9 months of testing, many ideologies and methods were developed to improve efficiencies for each unique project. The data forms were built and developed to meet the standards of the Wildlife Species Inventory (Government of British Columbia) database system in terms of data definitions and data dictionary development.

Project 1 (Aerial Ungulate Survey) utilized mobile GIS to track Flight paths and point locations of Elk (*Cervus Elaphus*) species in mobile aircraft. The GIS integrated the use of a high processing laptop (2.1 GHZ with 4GB of Ram) with a Garmin GPS Receiver. Post processing of data was conducted in ArcGIS 9.2

Project 2 (Hofert Biodiversity Study) implemented a mobile GIS to conduct field data for wetlands, Species At Risk (SAR), and weed inventories. This project integrated the use of Personal Digital Assistants (PDA) and Garmin GPS Units with ESRI Arcpad 7.1 software to collect point data. Post processing of data was conducted in ArcGIS 9.2.

Project 3 (Wildlife Tree Survey) made use of mobile GIS to collect wildlife tree data and update previous data in relation to the life and activities of wildlife trees in the East Kootenay. This project integrated similar hardware/software specifications to that of project 2.

Project 4 (Invasive Weeds Survey) used a mobile GIS to collect Polygon Data on monitored lands in the Southwest Kootenay region. This project integrated the use of Terrasync Software with data dictionary development and Trimble GPS receiver. Post processing of data was conducted in Pathfinder Office 3.0 and ArcGIS 9.2.

All data collected throughout the duration of these projects clearly implemented all aspects of GIS including data design, data collection, and data processing. Data collected in digital format in a mobile GIS improves efficiency, helps avoid duplicate data through geodatabase archiving and updating, and develops consistency in data field records on a year to year basis.

Recommendations for progressive measures in further developing a mobile GIS for Wildlife based projects include utilizing wireless technology and software development tools that have custom applications and will make the GIS more user friendly in field-based environments.

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INTRODUCTION

In February 2008, a mobile GIS system was developed to aid in field data collection for various wildlife projects in the Kootenay Region of British Columbia. The system in terms of database development, mobile map development, and GPS data collection was foundationally set up to collect vector data in point, line and polygon shapefile format. The system was developed for, and used on the following projects:

- Aerial Ungulate Survey – East Kootenay Region
- Hofert Biodiversity Survey – East Kootenay Region
- Wildlife Tree Survey – East/West Kootenay Region
- Invasive Weeds Study – West Kootenay Region

Whereas a GIS (Geographical Information System) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (GIS.com, 2008), a mobile GIS is the expansion of technology from the office into the field. In retrospect, a mobile GIS enables field – based personnel to capture, store, update, manipulate, analyze, and display geographic information (ESRI, 2008). See *Figure 1. Development Components of Mobile GIS/Digital Data Collection*

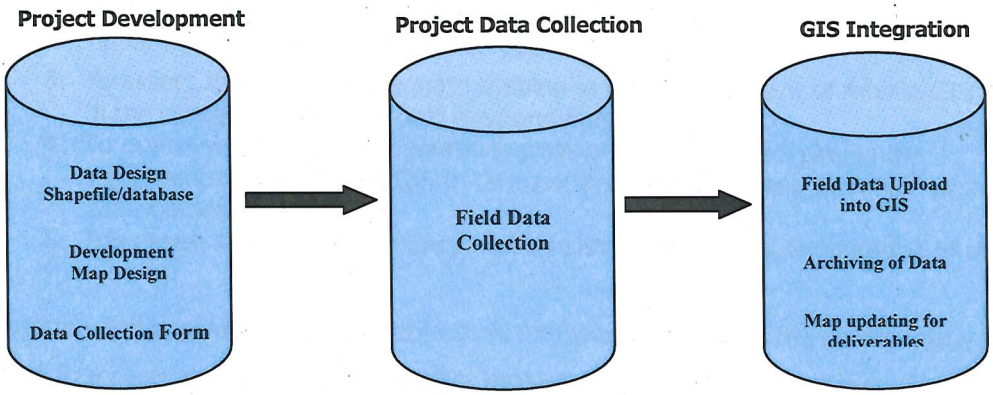


Figure 1. Development Components of Mobile GIS/Digital Data Collection

Using a mobile computing device such as a PDA connected with a GPS or an all-in-one system (mobile computer and GPS as one unit), a mobile GIS can fundamentally be applied to several different field applications including municipal, utilities, energy, and natural resources.

The development of a mobile GIS for wildlife applications requires a level of accuracy in data development and system functionality due to the consideration of remote locations, field time expenses, and temporal accuracy.

Taking these factors into consideration, field testing of the mobile GIS within the context of this project incorporated both digital and manual data collection so that there was a guaranteed system in case any hardware devices failed.

OBJECTIVES

The purpose in the development of a mobile GIS and testing of this project include the following objectives:

1. To establish a system that would enable field workers to collect data in a digital format using GPS and .dbf data forms in a GIS framework.
2. Too integrate data collection standards (Wildlife Species Inventory (WSI) standards) through the development of digital .dbf's in which data is to be collected. The development and collection of .dbf's in a digital format will improve accuracy in data entry, decrease data redundancy, improve GIS integration efficiency, and allow for updating of database on a year to year basis.
3. To assess the need for adequate training in the development of mobile GIS as a tool in the overall operation in field environments.
4. To assess what roles GIS operations plays and field workers play in the implementation of mobile GIS in terms of pre-field, field, and post-field systems development.
5. Too assess the overall efficiency and consistency in the implementation of the system

In assessing and implementing these objectives into the project plan, the methodology was tested on four separate field – related wildlife projects that would incorporate credibility into final recommendations and conclusions based on the established objectives.

METHODOLOGIES AND OUTCOMES

Field testing of this project incorporated the use of a computing device linked to a GPS receiver. Maps were developed using ArcGIS 9.2 by the GIS department and layers and maps were exported into ArcPad format from the ArcGIS platform. ArcPad based maps and layers were uploaded to an SD Card and placed onto the mobile computer unit. Data was collected in point, line, and polygon shapefiles. The following equipment was used to conduct the testing of mobile GIS systems:

Hardware Units

The testing conducted in this project included using the following hardware combinations: *(See Appendix A: Hardware Specifications)*:

- HP iPAQ PDA with Garmin GPSMap 60Csx (attached via cords)
- Panasonic Toughbook with Garmin GPS
- HP iPAQ PDA with Garmin Map 10 Bluetooth
- Trimble GeoXM with Terransync 2.4

Software

The testing conducted in this project included using the following *software (See Appendix B: Software Specifications):*

- ESRI ArcGIS 9.2
- Terrasync
- ESRI ArcPad 7.1

Project Test Area 1 – Aerial Ungulate Survey

An ungulate aerial survey was conducted in the East Kootenay Trench region of British Columbia in February 2008. The purpose of this project was to conduct a count of Elk species (*Cervus Elaphus)* in defined ungulate winter ranges as specified by the BC Ministry of Environment Wildlife Branch. An Ungulate Winter Range (UWR) is defined as an "area that contains habitat that is necessary to meet the winter habitat requirements of an ungulate species" (Government

of British Columbia, 2008) . UWR models are based on vegetation cover, forest canopy, slope aspect, elevation, and hill shading.

Methodology included map creation and data collection in ESRI ArcGIS framework and the process of exporting data to ArcPad format and displaying data on a laptop computer connected to a GPS. Real-time GPS was used to plot flight lines and collect data points using a customised data form for the ungulate survey.

The mobile GIS platform for this project was our first test project and showed to be effective in plotting flight lines for Ungulate Flights which displayed in real-time the course of the flight patterns and allowed biologists, pilots, and recorders to know they had flown the course of their project area (Wildlife Treatment Units, Contours, Roads, Water Features).

The data form used for this project was a developed application through the ESRI Developers Network and modified to fit the standards of our project. Unfortunately the use of this data form was very limiting for this project due to the limitation of not being able to edit data points plotted. Data ended up being recorded manually while flight lines were recorded and visualised on an ArcPad real-time map.
(See Appendix C. ArcPad Ungulate Mapping)

Project Test Area 2 – Hofert Biodiversity Survey/Inventory

A biodiversity survey was conducted in June 2008 to assess the Hofert Property in the East Kootenay for species – at – risk, wetlands, invasive weeds and general ecology. The Hofert Property is owned and maintained by *The Nature Trust of Canada* and has been allocated as a protected conservation area.
An area map was constructed of the Hofert boundary and several database files were designed in Wildlife Species Inventory (WSI) format to collect data on. These species included:

- Flammulated Owl (Location and Nesting Sites)
- Lewis's Woodpecker (Location and Nesting Sites)
- Amphibians

- Bird Atlas

The BC Ministry of Environment WSI Network is managed by the Ecosystems Information Section and the purpose is obtain and maintain data, store data, and provide professionals and public access to information about wildlife species in British Columbia.

Further Methodology included developing customised data forms using a Data Form Wizard ArcPad application (*See Appendix D. Example of Data Collection Form)* . This application was successful in building customised forms for each species of interest. The application also allowed the user to choose which attributes to incorporate into the data collection for editing purposes.

Data was plotted and saved on a PDA device and exported into ArcGIS upon completion. This project was effective for data collection in shapefile format in ArcPad and bringing into a program based GIS. As well, this project clearly displayed the efficiency in these methods for data collection and post processing of data in ArcGIS.

PROJECT TEST 3 – Invasive Weeds Study

Throughout the summer of 2008, invasive weed control was conducted in the West Kootenay region of British Columbia. Invasive weeds are typically exotic or non-native plants that have been introduced to an area without their natural predators. They also have the capacity to move into a habitat and reproduce so aggressively that they displace the original vegetation (Government of British Columbia, 2008). The purpose of this test project was to collect data on monitored areas for weed spreading and area introduction.

Methodology for this test project incorporated data being logged onto Trimble Devices in point, line, and area data forms. A data dictionary was designed using Terrasync software and data was collected within this dictionary. Trimble was effective in the collection of area files. Biologists and field workers reported problems with satellite reception on a regular basis and this was ineffective in their day-to-day operations.
(*See Appendix E. Manual Treatment Weed Areas – Deer Lake 2008)*

PROJECT TEST 4 – Wildlife Tree Survey

Throughout the summer of 2008, a wildlife tree survey was conducted in the East and West Kootenay. A wildlife tree is a snag that provides habitat areas for nesting birds and other animals. The purpose of this test project was to inventory current wildlife trees and new potential trees that would serve the purpose of the definition.

Methodical surveys were conducted in the Newgate area (East Kootenay) and the Pend D'Oreille area (West Kootenay) areas of British Columbia. Methodology included the development of custom data forms in WSI formats and data was collected with selected attributes in the developed forms. Over 250 data points were collected using ArcPad mapping with a data collection form.

Biologists reported that the PDA was an effective tool for data collection and 2-5 m accuracy in wildlife tree location. There was some equipment failure in day to day operations including general system shutdown.

(*See Appendix F. Mapping Project for Wildlife Trees)*

CONCLUSIONS AND RECOMMENDATIONS

The wildlife mobile GIS project was tested on 3 separate project areas in wildlife inventory and enhancement. The project was successful in meeting the following defined objectives:

1. **To establish a system that would enable field staff to collect data in a digital format using real time GPS and .dbf data forms.**

   This objective was met in establishing connectivity between all facets of the system including database design, cartography design, data collection, and GIS integration

2. **To assess the need for adequate training in the development of mobile GIS as a tool in wildlife field operations.**

   Training programs were conducted with field workers in the

implementation of a digital system for data collection.

3. **To assess the overall efficiency and consistency in the implementation of the system**

   The project showed improved efficiency measures throughout the monitoring of this objective. The improvements included using the system as an efficient means for locating areas of interest, and implementing data standards in data design aspects of the project.

Consideration should be given to those objectives that may be obtained with further development of standards in digital data collection for wildlife practices in British Columbia. The standards over a temporal study period will enable one to establish effective conclusions on the impacts of mobile GIS on data consistency, efficiency of integration into GIS, and effectiveness of eliminating data duplication in Enterprise GIS systems.

The following recommendations should be considered for further development of mobile GIS in Wildlife Field Data Collection:

1. **TRAINING** – Formalised training needs to be conducted with all biologists/contractors who will be using this system to conduct surveys. This training needs to focus on:
   - Overview of mobile GIS environment (ArcGIS, ArcPad, PDA, Windows Mobile)
   - Exporting to ArcPad Framework from ArcGIS 9.2
   - Building customised data forms in ArcPad
   - Saving and storing data
   - Troubleshooting problems
2. **FIELD TESTING –** Further field testing needs to be conducted using the current system. Field testing has been conducted creating point, line, and polygon features. The system showed positive results in all areas and met the project objectives. Additional testing could also be tested on program project areas that incorporate inventory style data collection.
3. **ADDITIONAL FIELD EQUIPMENT CONSIDERATIONS –** Testing was conducted using PDA/GPS equipment connected with cords which was inefficient at times. Other issues in testing included poor satellite reception, weather proofing for computer devices, and data form development. It is recommended that to meet efficiency needs within the

program in terms of data collection, we should use the PDA/Garmin system with weather proof casing for data collection standards with 2-5 m accuracy.

4. **STORAGE OF FIELD DATA** - Users of ArcPad in field collection operations have the option to store/reuse/ and edit data on a year – to – year basis which fits into several inventory, monitoring, and enhancement style projects. As these projects are revisited yearly, data can be updated in ArcPad and resubmitted/archived into a Geodatabase. Unfortunately ArcPad only has the ability to operate using Shapefile format, therefore the recommendation for storing field data that will be used and updated yearly for data collection is within the Geodatabase framework and not in coverage format.

5. **DEFINING ROLES IN MOBILE GIS IMPLEMENTATION –** One consideration in the implementation of a Mobile GIS is to define the roles of the GIS department and the field workers. For example, will the GIS department be responsible for creating the maps and databases used to collect data in the field? Obviously, implementing a new system such as this will create additional workload for the GIS department, but will minimize the amount of post field data entry for field workers.

6. **MOBILE GIS PROJECT ASSIGNMENT –** An overview of projects needs to be conducted to see which projects will benefit from the use of this system as a form of data collection. To this date, the project has solely been conducted on inventory style projects, however there is potential for further project application with further knowledge development of software/hardware capabilities.

Evidently, in the implementation of any new system into a program, the development time of the system will be the most costly portion of the project. This includes systems development, field testing, training, and GIS implementation. In the short term, the value-added aspect of field time and systems development may be costly, however in the long term, a digital data collection model and application will benefit wildlife field applications. As systems develop, and technologies evolve, the potential for conservation and wildlife programs to adopt mobile GIS systems as an effective means for data integrity, data updating, efficiency, and data integration will become and integral component to the lifespan of a program's internal GIS.

APPENDICES

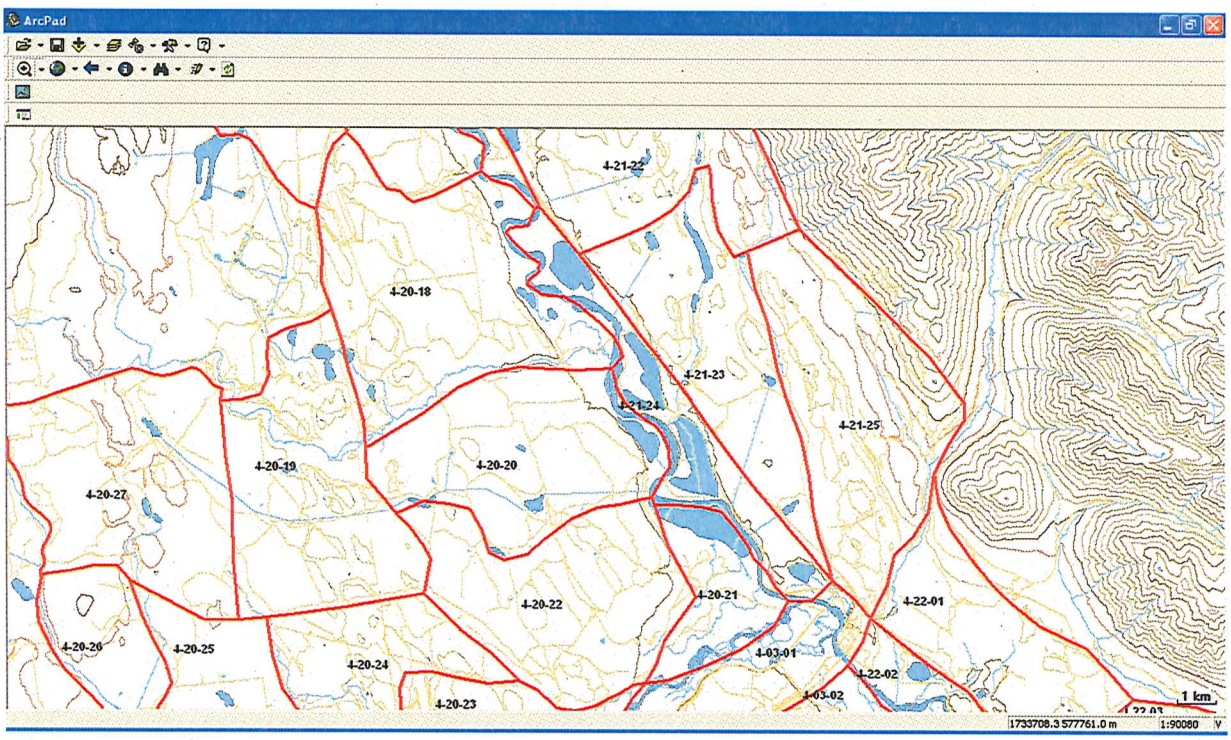
APPENDIX A. Hardware Specifications

DEVICE	PICTURE	PURPOSE
HP iPAQ 2790 PDA		Used for Data Collection
Garmin GPS Map 60Csx		GPS receiver attached to computing device. Collects data at 2 – 5m accuracy
Garmin 10 Deluxe Bluetooth		GPS receiver with Bluetooth connection to computing device. Collects data at 2 – 5m accuracy
Trimble Geo XM		GPS/PDA functionality integrated into one. When used with external antenna, it collects data at sub – metre accuracy.
Panasonic Toughbook 52		Laptop computing device

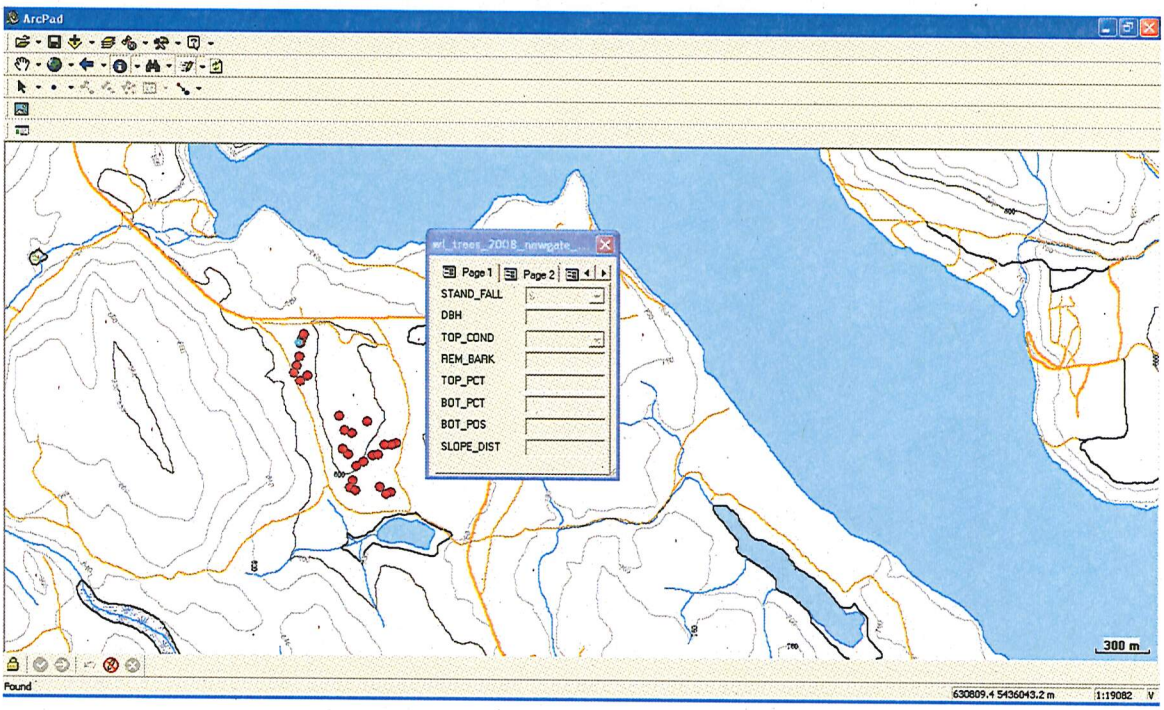
APPENDIX B. Software Specifications

Software Name	Software Function
ESRI ArcPad 7.1	• Mobile Mapping/Data collection software used for collecting, editing, manipulating points, lines, and polygons in shapefile format • Used to build data collection forms using form creation wizard • Installed on HP iPAQ,
ESRI ArcGIS 9.2	• Software used to store, edit, create, manipulate and integrate field data
Trimble Terrasync	• Software used in conjunction with Trimble Units • Mobile data collection software used to collect points, lines, and areas

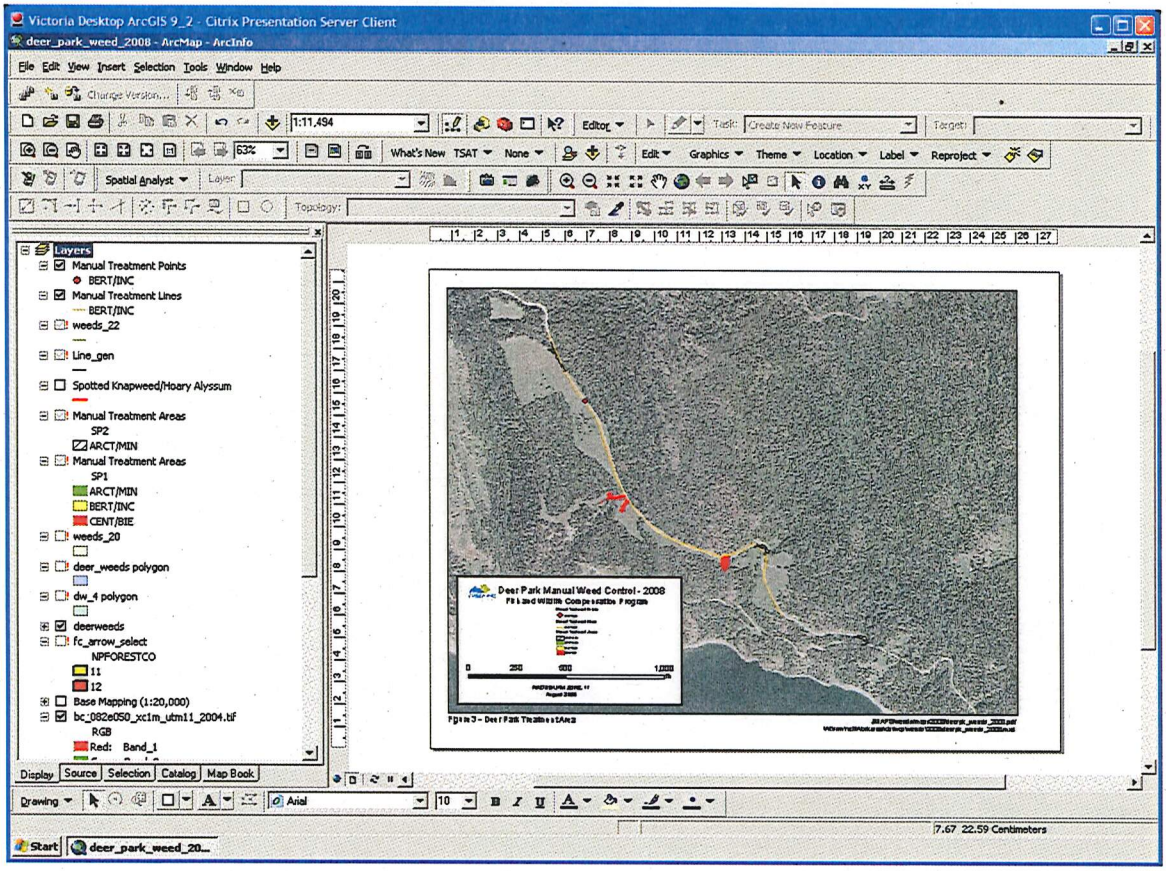
APPENDIX C. ArcPad Ungulate Mapping



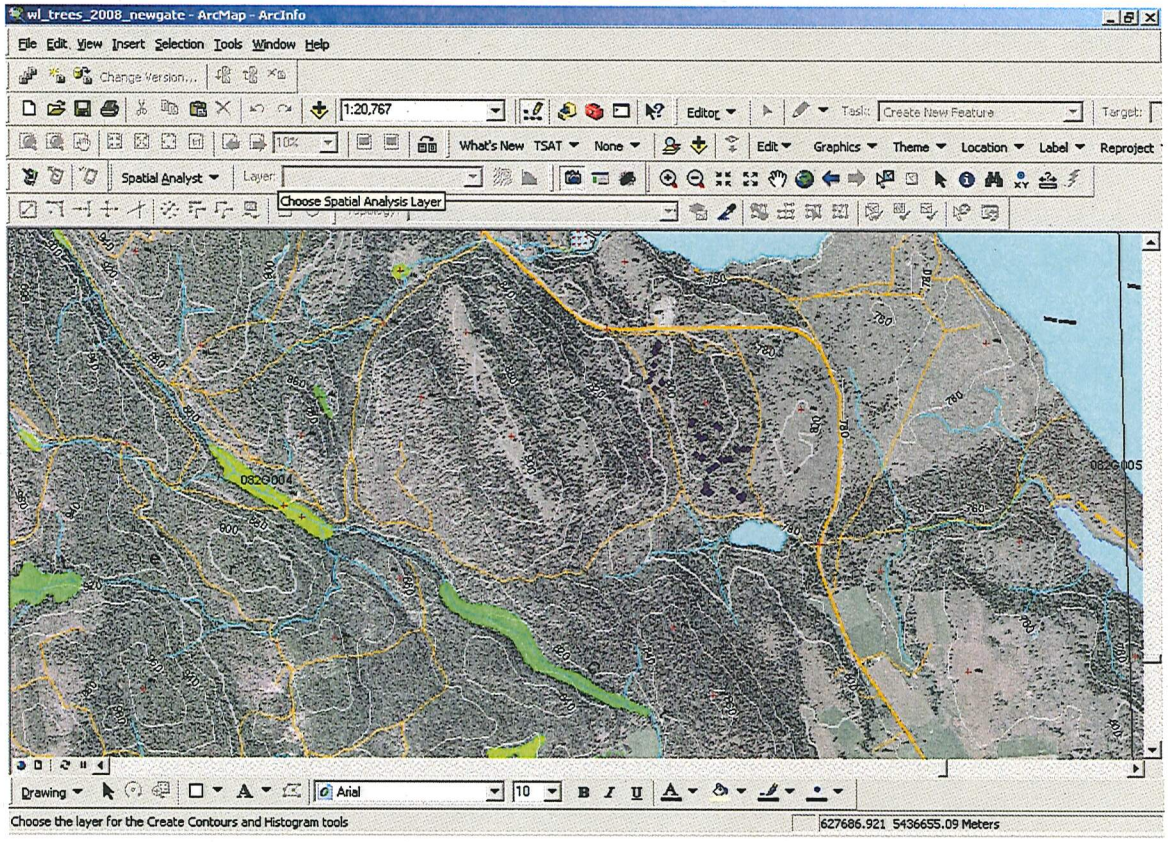
APPENDIX D. Example of Data Collection Form



APPENDIX E. Manual Treatment Weed Areas – Deer Lake 2008



APPENDIX F. Wildlife Trees Project



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