Managing Grizzly Bear Data at the Foothills Research Institute

Abstract

The Foothills Research Institute Grizzly Bear Program (formerly the Foothills Model Forest Grizzly Bear Research Program) has passed its tenth year of grizzly bear research in Alberta, Canada. The Foothills Research Institute is a non-profit organization that works to advance the goal of sustainable resource management through on-the-ground research. The Grizzly Bear Program has grown to include many multi-disciplinary research teams to study the health, population, habitat and movement of grizzly bears. Many data management and processing techniques have evolved to more efficiently handle the growing collection of raw data. These include: an improved centralized database structure that will accommodate similar data from various sources outside our organization; a more comprehensive database to store all the DNA and genetics information; and the conversion of telemetry data processing scripts originally written in AML to python with easily accessible tools for the user.

Introduction

The Foothills Research Institute (formerly the Foothills Model Forest) is a non-profit organization founded in 1992. Over the last 17 years, the Foothills Research Institute has become a leader in developing innovative science and knowledge for integrated resource management on the forest landscape through diverse and actively engaged partnerships.[1] Now with over 100 partners, the Foothills Research Institute continues to work toward sustainable forest land use - a shared common concern for the welfare of the land and its resources. Figure 1 lists some of the current leading-edge research programs.

Aboriginal Involvement Program	Foothills Stream Crossing Program
Adaptive Forest Management Program	Geographic Information Systems Program
Communications and Extensions Program	Grizzly Bear Program
Fish and Watershed Program	Local Level Indicators Program
Foothills Growth and Yield Association	Mountain Pine Beetle Ecology Program
Foothills Landscape Management Forum	Natural Disturbance Program
	Social Science Program

Figure 1: Foothills Research Institute research programs.

The core study area is located in west-central Alberta (Figure 2), with an administrative office in the resource community of Hinton. The landbase covers 27,500 square kilometers, and includes Jasper National Park (part of a World Heritage Site), a forest management area for Hinton Wood Products (a division of West Fraser Mills Ltd.), Willmore Wilderness Park and other provincial lands. Multi-use activities occurring across the landscape include forestry, coal extraction, petroleum, tourism and recreation.[2]

Figure 2. Foothills Research Institute

Grizzly Bear Program

The mandate of the Grizzly Bear Program is to provide resource managers with the necessary knowledge and planning tools to ensure the long-term conservation of grizzly bears in Alberta. The program was initiated in 1998 as an outcome of environmental hearings of a proposed coal mine southwest of Hinton, Alberta. The goal was to increase understanding of how grizzly bears respond to human use on the landscape.

Types of research conducted include:

- Habitat mapping and landscape change using satellite imagery over the last 10 years.
- Graph theory modeling to show potential grizzly bear travel routes on the landscape.
- Resource selection function models which show the probability of grizzly bear occurrences on the landscape.
- Use of cameras on collars that give snapshots of their environments and also provides further locomotion information to indicate whether the bear is resting, foraging or travelling between GPS locations.
- DNA studies are being done to help better understand population numbers in a less invasive way. They use barbed wire and bait to get hair samples.
- Wildlife health studies stress levels in grizzly bears in different environments/habitats.

Now in it's 11th year, the Grizzly Bear Program has grown to become a multi-disciplinary, mutli-million dollar program committed to providing GIS data and models as deliverables to it's growing number of partners. The research area has grown from 10,000 km^2 in 1999 to over 300,000 km^2 today (Figure 3).

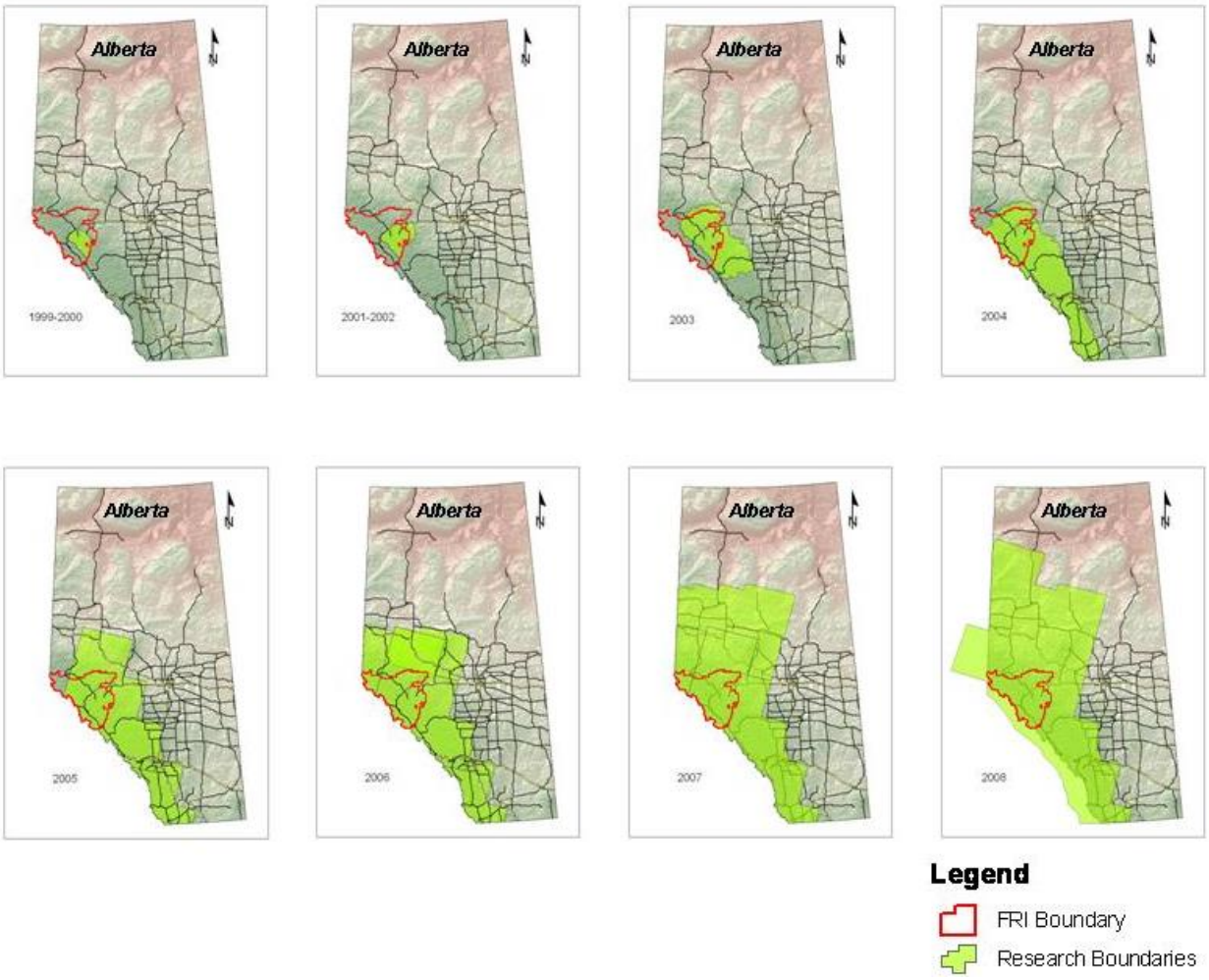


Figure 3. 10-year program growth.

On-the-ground research began in 1999 by tracking grizzly bears using GPS radio-telemetry collars. Since then, over 170 grizzly bears have been captured by researchers and fitted with GPS radio-telemetry collars (a few with cameras). To date, over 185,000 valid GPS locations have been collected. See figures 4 and 5.

Year	Number of GPS Locations
1999	6121
2000	9015
2001	11860
2002	9198
2003	11812
2004	11523
2005	57609
2006	39019
2007	19612
2008	29841

Figure 4. Number of GPS locations over the years.

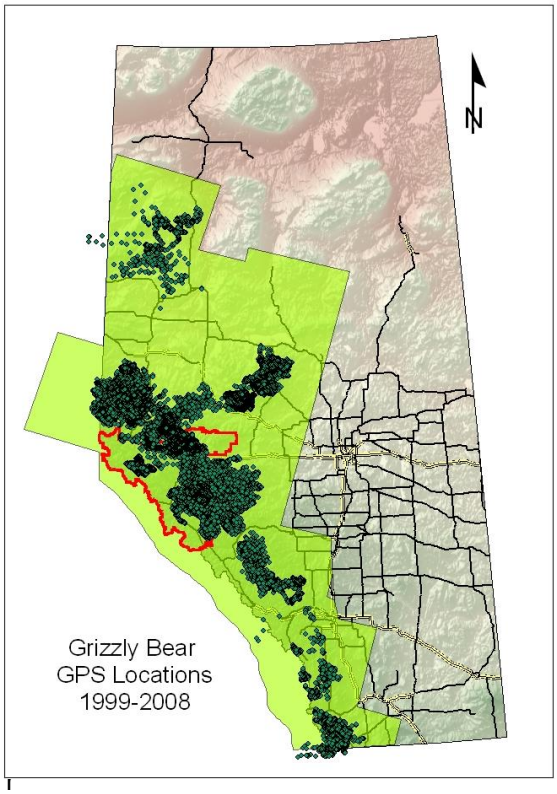


Figure 5. Map of all GPS locations collected.

Data Management Background

A program of this scale and magnitude requires efficient data handling procedures in order to maintain the integrity and accuracy of all the collected data. With such a system in place, it facilitates spatial analysis, querying and reporting. Initially, back in 1999, data collection efforts were not centrally managed and created program-wide data management issues and concerns. It was very difficult to conduct any kind of analysis when the data sources were in various formats and inconsistent with each other. To address these issues, a centrally-managed relational database was created that proved to be functional, with minimal to no duplication, easy to access and most importantly – easier to query and analyze.

The wide use of validation rules and data entry forms were designed to minimize data entry errors. The database was set up with a back-end 'master' database and front-end 'user' databases. The 'user' databases were further defined with either write-access or read-only permissions to further ensure integrity of the data. Microsoft Access was used as it was sufficient to handle the program's data management needs.

Until 2007, GPS telemetry data was loaded and stored in the same database as all the other attribute tables. It was also stored spatially in an ArcInfo coverage that was re-created each time new data was loaded into the database. Users could also load the locations table into ArcMap and use the 'Add XY Data' tool. This process was improved by creating a separate personal geodatabase which contained only the spatial telemetry locations. The master and client databases are still able to link to the locations attribute table and proceed with the same queries, forms and reports within the client databases.

Improved database design

Data collaboration opportunities with other agencies collecting grizzly bear data exist in Alberta, British Columbia and in neighboring states in the US. Keeping a consistent data structure that would eventually allow synchronization of portions of the databases would be beneficial in tracking contiguous grizzly bear populations. Maintaining a centralized provincial database would also be an asset to the long-term conservation of grizzly bears.

In 2008, a new design concept (Figure 6) was adopted by referencing a schema presented by the Northern Divide Grizzly Bear Project in Montana.[3] The database would be set up to allow access from various types of users, whether inside or outside our organization. Data sensitivities would be protected by using passwords. The database itself would be flexible, allowing the integration of datasets from other agencies.

Everything is centered on events. During an event, for example, a bear can be captured, biological samples are collected, measurements are done, photos are taken, health data is recorded, and DNA results can be processed later in a lab. More than one event category could occur during an event. Field data applies to any type of event, where applicable. Post-processing of bear data include health indicators, GPS locations, and DNA results.

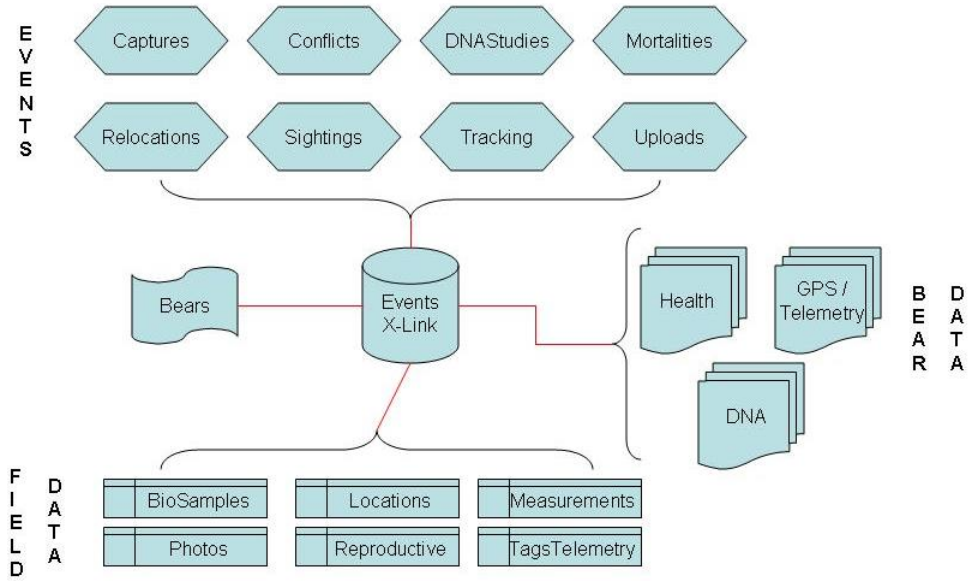


Figure 6. New database schema.

While the current database has on-going data entry, the new database is being built concurrently. By using links to the current tables, multiple queries are created and saved to load data into the new database schema. These queries are designed step by step so that the final load would be, in theory, easy! Testing is being done on the 'temporary' state of the database by creating new input forms and reports to ensure the new data structure meets or exceeds our needs. In addition, user-level password protection has been implemented to ensure the protection of sensitive data. Once the new database structure is complete, a final run of all the saved loading queries will be performed and all users will be pointing to the new database from that point on.

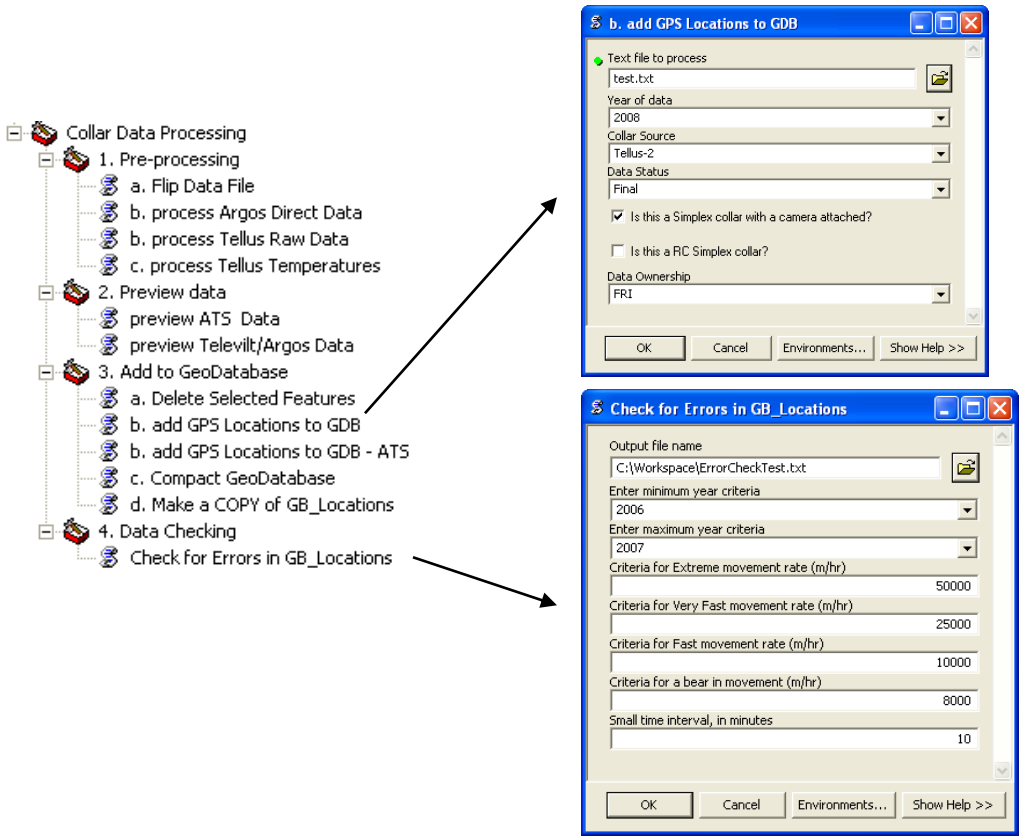
Managing genetics data

DNA and genetics information is currently tracked using Microsoft Excel spreadsheets. The data originates from various sources and has proven a challenge to incorporate into a relational database. This task is still in progress, but the goal is to have linkages between the biological samples from grizzly bears and the genetic data. Once it is integrated within the master database, genetics information will be tied to a biological sample which in turn, is part of an event. From the event, it can be associated with all available information to that event. The genetics data will also be used to determine family trees and population distribution and diversity.

Handling telemetry data

Telemetry data was originally processed programmatically with AML scripts and menus. Awk was also used to parse the raw telemetry input text files. Using ODBC connections in the script, the data was loaded into the Microsoft Access database table for GPS locations. These processes required the user to have access to an ArcInfo workstation license and to also have the knowledge and skills to run the scripts and understand potential errors.

In 2007, the AML code was manually translated into python script. Awk was no longer required as python has its own tools to read and parse text. The scripts were loaded into a toolbox and presented in a logical order to guide users on a step-by-step process.



Users have found these tools highly beneficial. Besides being really easy to use, the layout of the tools guides (and reminds) the user of the steps to take, and therefore saves time, ensures quality control, and is reliable. Another great advantage is that these tools and scripts only require an ArcView level license, which keeps our small pool of ArcInfo licenses free for users who require them. The process run-time is also faster.

The transition from AML to python was very beneficial as I was learning python on my own and this was an excellent task for it. The ArcGIS Desktop Help section called: "Python Equivalents to AML Functions" and I found it very useful during the transition. A few challenges existed with processing the dates and times from the input raw text files. The raw dates and times were in Greenwich Mean Time and needed to be split and changed to the local Standard Time. The 'timedelta' object in the 'datetime' module in python was used for the calculation:

```
GMT_DateTime = datetime.datetime(fYear, fMonth, fDay, fHour, fMin, fSec)
MST_DateTime = GMT_DateTime - datetime.timedelta(hours = 7)
```

Once the final processing and loading of the spatial telemetry data was done, the updated feature class was meant to be loaded into the open ArcMap project using gp.SetParameterAsText. This is a step for the user processing the data to view and visual verification of potential location errors. This is a known issue (NIM009358) and has not been fixed as of ArcGIS 9.3 SP1.

Summary

As the Foothills Research Institute Grizzly Bear Program continues to grow, spatial and non-spatial datasets are continually evolving to meet research requirements. These multi-user datasets are managed to be flexible and functional and to allow efficient GIS analysis. The database design changes will be beneficial in supporting multiple types of users, ensuring that everyone has the most recent information available. The tools for loading the raw GPS telemetry locations enable the researchers to process the data and move on to their analyses quickly.

The sound management of all these datasets will ensure that the Grizzly Bear Program continues to provide resource managers with the necessary knowledge and planning tools to ensure the long-term conservation of grizzly bears in Alberta.

References

1. About the Foothills Research Institute, http://foothillsresearchinstitute.ca/pages/About/default.aspx

2. Foothills Research Institute, 2007-08 Annual Report; Research Growing Into Practice, October 2008, 30pp.

3. Macleod, A.C., J.B. Stetz, K.C. Kendall, T.A. Graves, R.M. Mace, T. Chilton. 2007. Comprehensive Databases: A Powerful Research and Management Tool. Poster for the 18th International Conference on Bear Research & Management in Monterrey, Mexico.