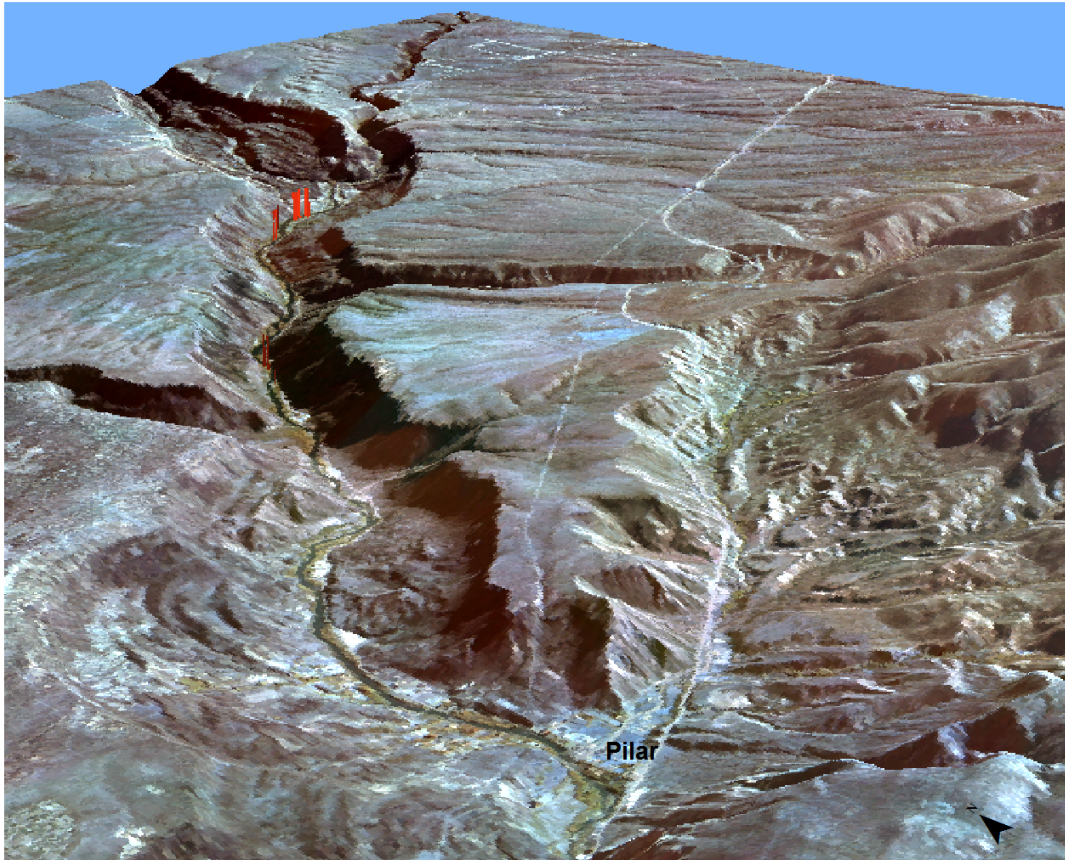# Integrated Management Tools for Monitoring Invasive Species Removal

Orilla Verde Recreation Area

Orilla Verde Recreation Area looking to the northwest. Baseline monitoring transects indicated by red bars.

Final Report

2007

Natural Heritage New Mexico Report – 07-GTR-314

The University of New Mexico

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Integrated Management Tools for Monitoring
Orilla Verde Recreation Area

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2007

Introduction

The Bureau of Land Management (BLM) has initiated a project to restore the riparian ecosystem of the Orilla Verde reach of the Rio Grande near Pilar, NM. Working collaboratively with the Bureau of Reclamation Denver Technical Service Center (BOR), Natural Heritage New Mexico at the University of New Mexico (NHNM), and local citizens, the BLM has begun removal treatments of saltcedar (*Tamarix* sp.), an exotic and invasive tree that is designated a Class C noxious weed for New Mexico. The project aims to provide flexibility in treating salt cedar and other nonnative vegetation and to reestablish native riparian vegetation, enhance wildlife habitat and minimize wildfire threats to adjacent communities (*see* http://www.nm.blm.gov/tafo/salt_cedar_ea/salt_cedar_ea.htm).

There are a number of stakeholders involved in this reach of the Rio Grande, and it is an area that is extensively used by the public for boating and recreation. Thus restoration and exotic removal must include planning to represent the needs and concerns of a diverse community, while ultimately improving the health and biodiversity of the riparian zone. Careful monitoring can inform the restoration as it occurs and help insure that the desired goals are being met. To help plan the restoration process and monitor outcomes, NHNM developed a set of integrated management tools that are set in a geographic information system (GIS) framework with an associated relational database. These tools include data and maps gathered from all the cooperators as well as publicly available imagery and spatial data. We present here the details of the content and how these tools work and provide an overview of the current status of the project.

Study Area

The Rio Grande from Taos Junction Bridge to Pilar (Orilla Verde Recreation Area) represents the large, low gradient perennial river and floodplain. The channel can carry sustained low flows around 200-300 cubic feet per second (cfs), and high flows in excess of 10,000 cfs. Channel materials range from fine sediments to large cobbles and rocks. In this stretch, the river is moderately confined and slightly entrenched, but a moderate floodplain does occur with a variety of depositional bar and terrace features that commonly occur along lower reaches of this and other large rivers. There are man-made controls in the upper

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watershed (primarily irrigation diversions in the San Luis Valley of Colorado), that can affect summer flows, but over the remainder of the year the hydrological regime is relatively natural with peak sustained high flows in spring that can inundate the floodplain. Specifically the project area is located within the BLM Orilla Verde Recreation Area, just north of Pilar, NM (T24N R11E portions of Secs. 1, 2, 10, 11, 15, 16, 21, 22, 28, 29 (approximately 8km [5 miles]; see Figure 1).

Methods

Vegetation Monitoring

Treatment was started at the upstream end of the project area and will work downstream over a number of years. In the first year treatment was concentrated in areas dominated by mostly native species where salt cedar was fairly sparse. In the summer of 2006 the BOR, in collaboration with BLM and NHNM, established a first set of vegetation monitoring transects in the treatment areas to evaluate post-treatment outcomes.

Two sets of transects were placed within the same polygon – one set of transects within the salt cedar removal area and one within the native vegetation (typically coyote willow) to have direct comparisons of treated and untreated areas (Figures 2-5). This type of monitoring will be used in all of the polygons that are treated and have enough willow to use as a reference area.

Monitoring included 25 meter permanent transects (2 or more of each type depending on the size of the polygon) with 1 m^2 plots placed at 5 m intervals. Percent cover by species and stem counts was measured in each plot. Photos were taken from each end of a transect. A permanent photo station was established within each polygon to capture the overall vegetation on the site. The database OVRA_vegmon includes all the data from the vegetation monitoring to date (Table 1).

Compilation of Sources

Data sources compiled for the project include spreadsheets, databases, GIS layers, digital photos, remotely sensed imagery, reports, and metadata. NHNM contacted all cooperators and began to create a framework to organize the various sources and design a method for dissemination. Table 1 is a list of data sources compiled including the contributor, data type, and a short description.
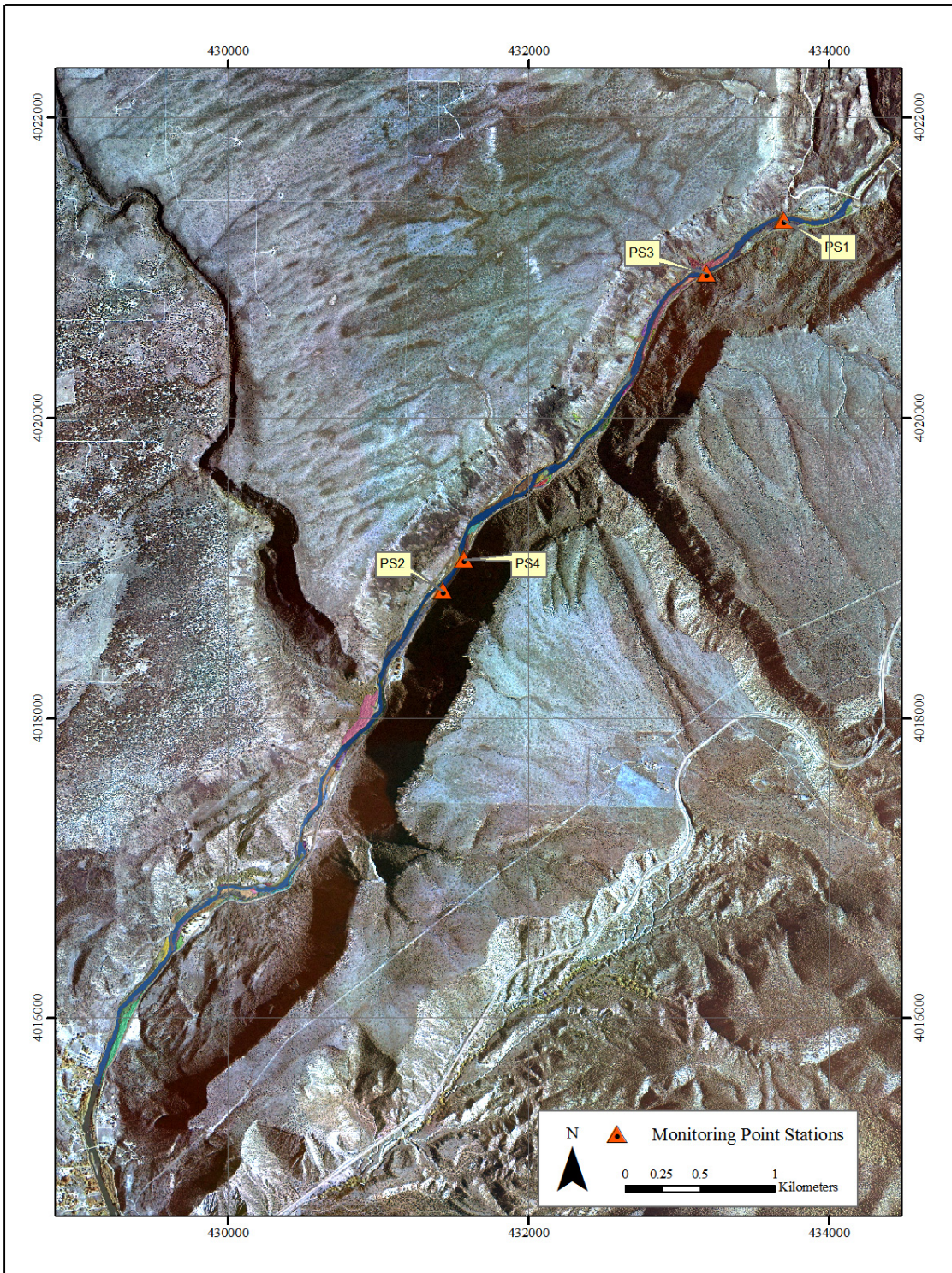
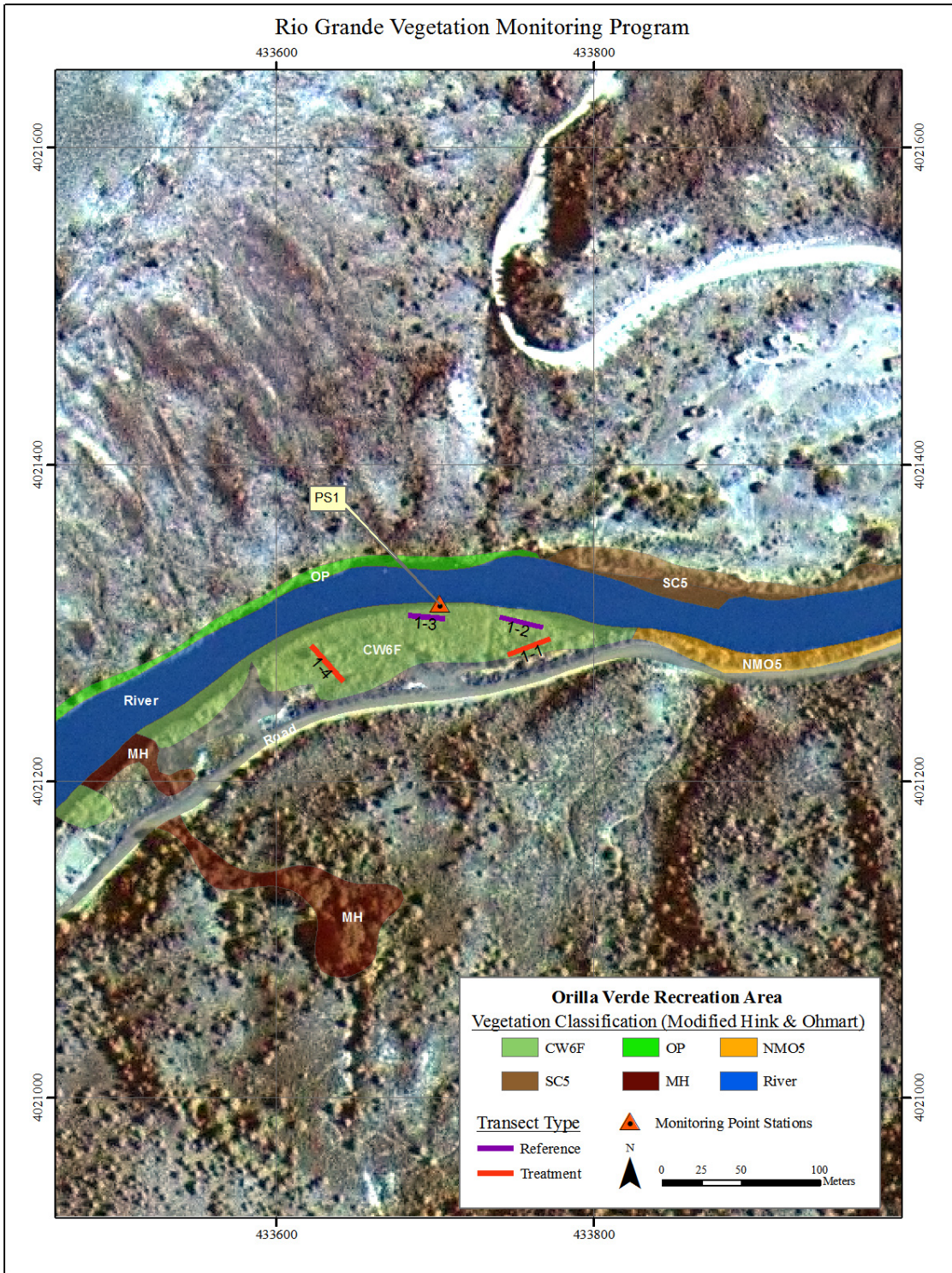Figure 1. Orilla Verde study area along the Rio Grande near Pilar, NM.

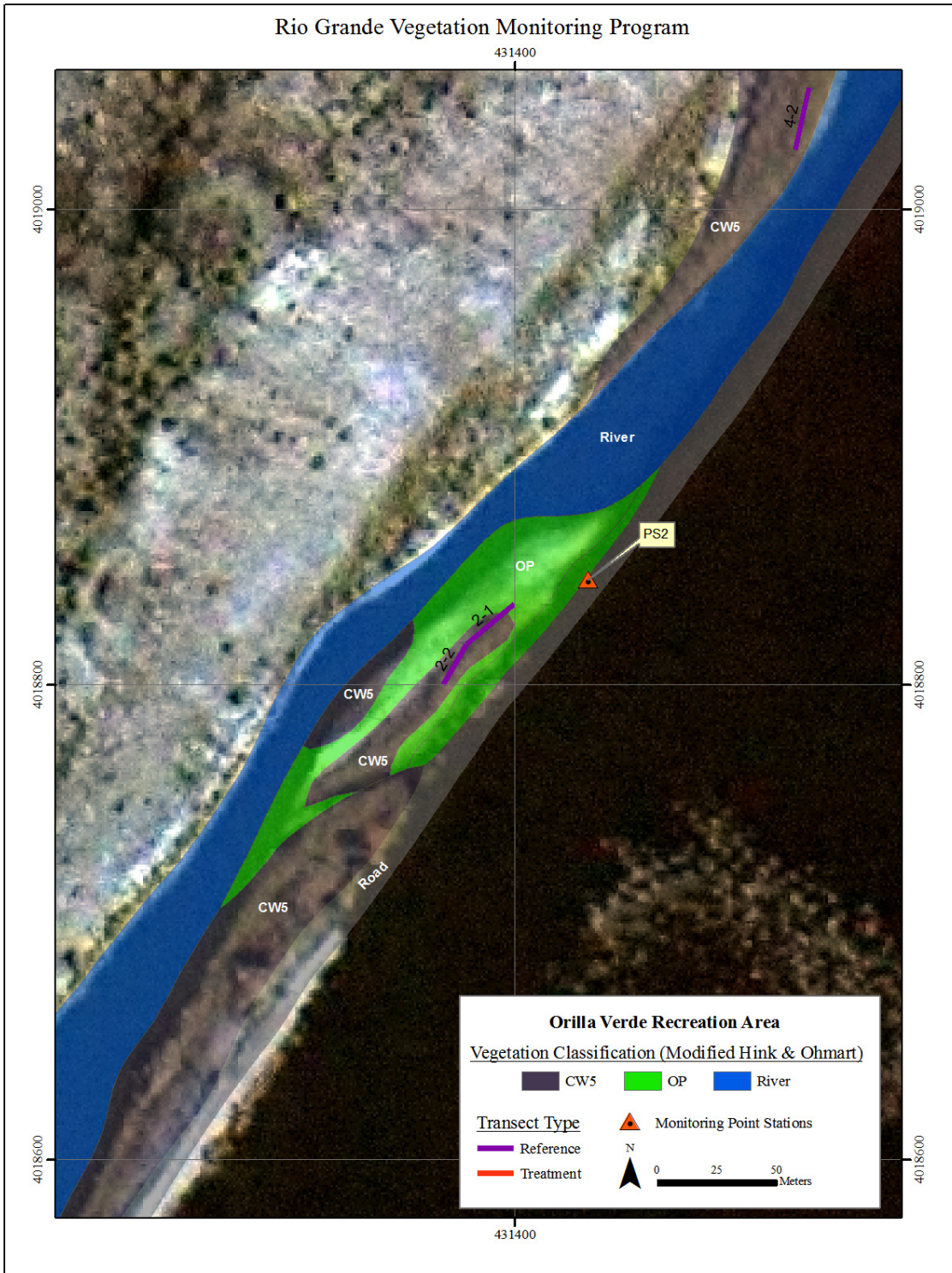Figure 2.   Monitoring site 1, Orilla Verde restoration project .

Figure 3. Monitoring site 2, Orilla Verde restoration project.
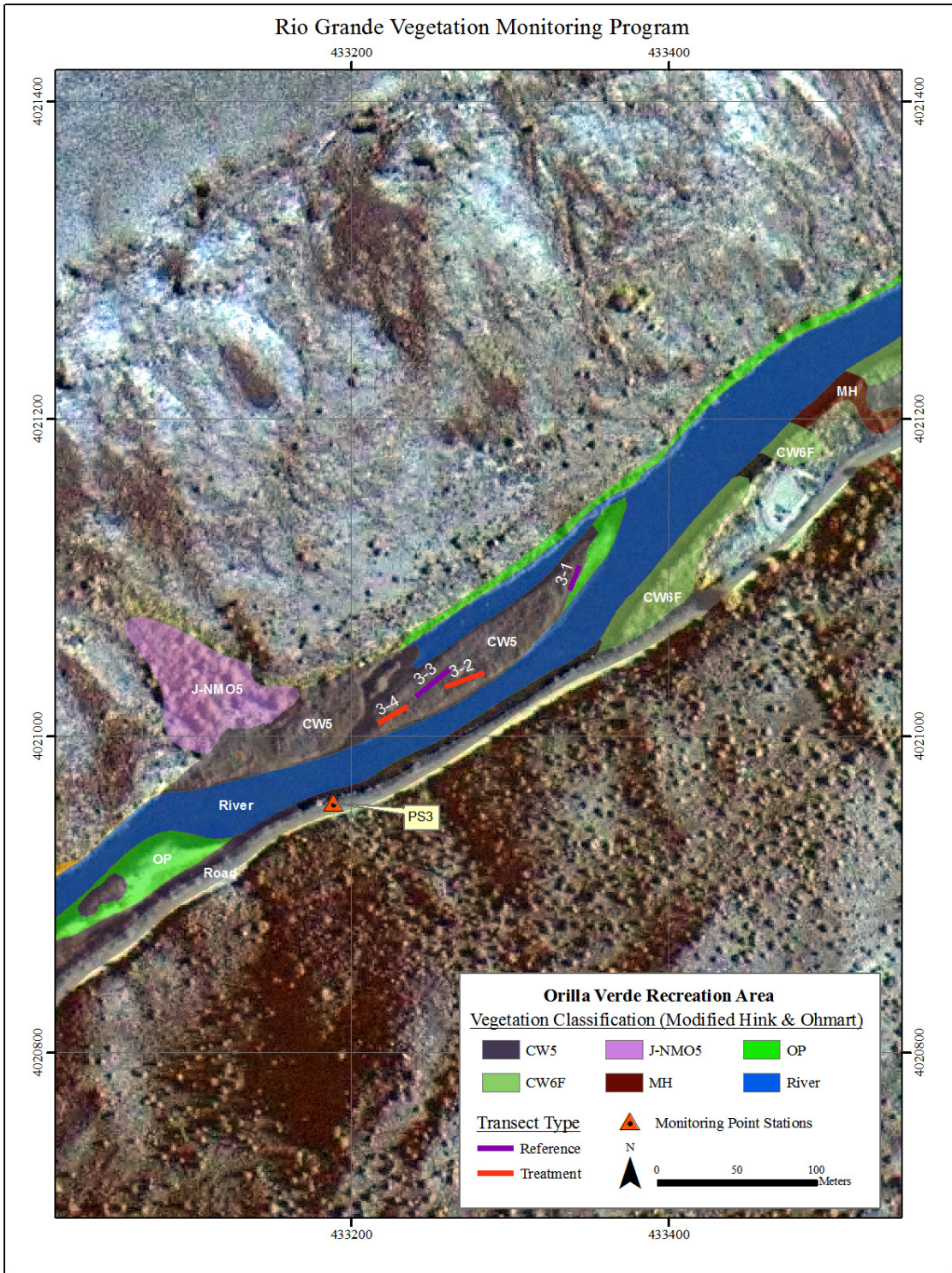
Figure 4. Monitoring site 3, Orilla Verde restoration project.
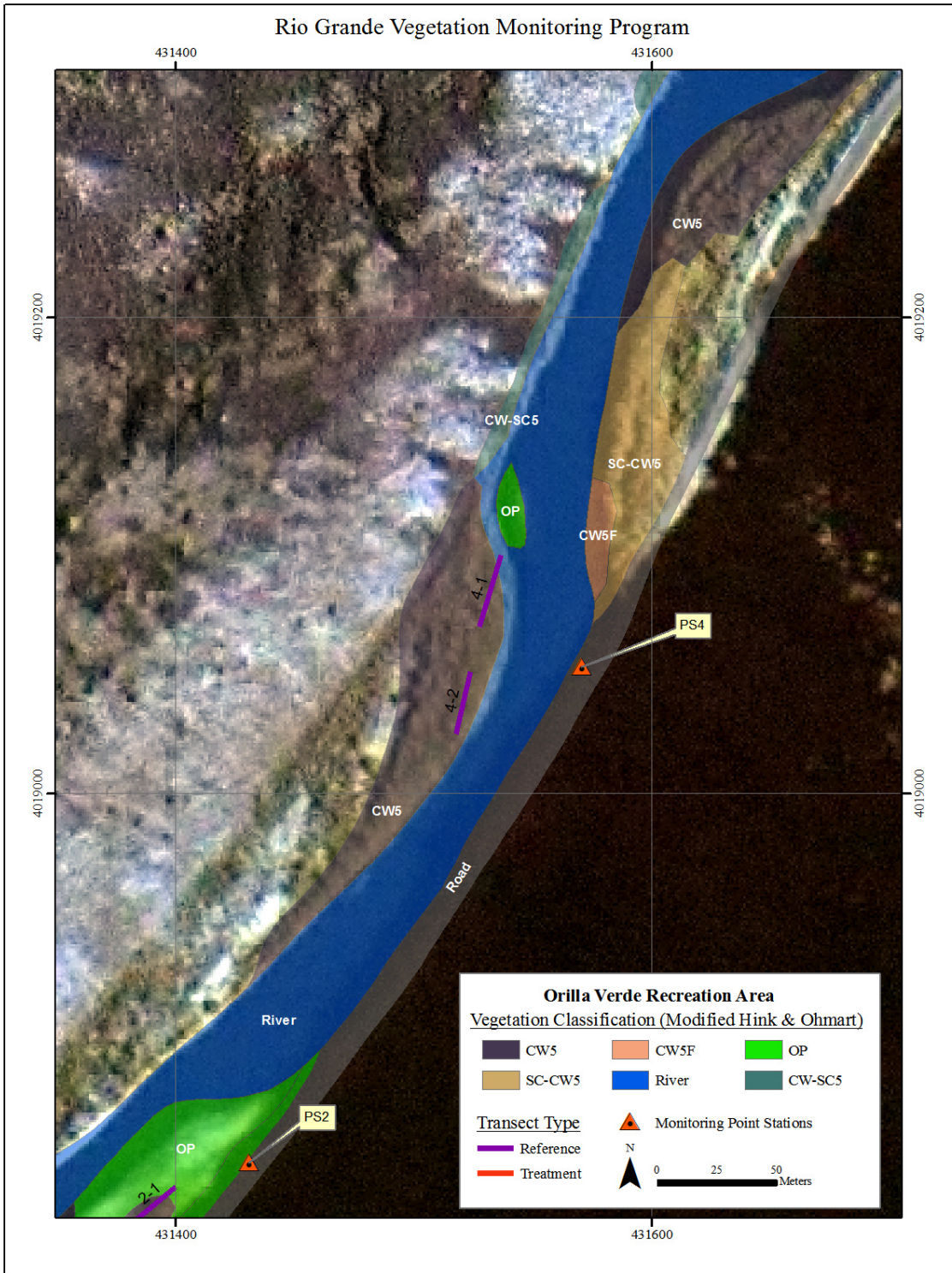
Figure 5. Monitoring site 4, Orilla Verde restoration project .

Table 1. Data sources compiled for the Orilla Verde restoration project .

Contributor	Original Data Type	Description	File Name or Folder[2]
BOR	Access Database (.mdb)	Database includes several tables of measured and descriptive field plot data tied by a unique ID to polygons of the GIS feature class layer (VegetationClassification) of the vegetation map.	OVRA_vegmap
BOR	ESRI Shapefile (.shp)	The vegetation map is based on the Hink & Ohmart riparian classification, modified by BOR to include information on willow flycatcher habitat. The field PolyID links to the database (OVRA_vegmap) for attributes about the polygon. Metadata.	VegetationClassification
BOR	Access Database (.mdb)	Database includes several tables of measured and descriptive monitoring data.	OVRA_vegmon
BOR	Jpeg photos (.jpg)	Digital site photos for 2006 monitoring.	\pics\PicsMonitoring06\
BOR	Jpeg photos (.jpg)	Digital site photos for 2004 vegetation classification	\pics\PicsVegMap04\
BOR	Microsoft Word (.doc)	Report to BLM on the methods and results of the vegetation mapping in 2004.	\links\OVRA_VegMapping2004.pdf
BOR	Microsoft Word (.doc)	Report to BLM on the methods and results of the vegetation monitoring in 2006.	\links\OVRA_Monitoring2006.pdf
NHNM	Raster (.img)	10-meter digital elevation model (DEM). Also have the DEM in feet (dem_ft.img). Metadata.	\images\dem10m.img
NHNM	Raster (.ecw)	Mosaicked four 2005 digital orthophoto quarter quads into a seamless image. Metadata.	\images\mosaic_photos.img
NHNM	Raster (.img)	Created a shaded relief image using the DEM. Metadata.	\images\OV_shadedrel.img
NHNM	Raster (.img)	Created a seamless digital raster graphic (DRG) of the 1:24,000 USGS quadrangle maps over the study area. Metadata.	\images\drg.img
NHNM	ESRI Personal Geodatabase (.mdb)	Downloaded the National Hydrography Dataset geodatabase (NHDGeo) for the study area. Contains streams, waterbodies, hydrologic networks, and gaging station points. Metadata.	\geodb\NHDH1302.mdb\

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[2] In some cases NHNM changed the name and format of the original datasets compiled.

Contributor	Original Data Type	Description	File Name or Folder[2]
NHNM	ESRI Personal Geodatabase (.mdb)	Created a personal geodatabase to hold the vector layers for the project area. Layers were either compiled from other sources, created by NHNM, or created from databases supplied by BOR. The list of feature class names given in the box to the right have hyperlinks to the metadata.	\geodb\OrillaVerdeProject.mdb\ ClipArea Contour10_10m GNIS HUC12 LandOwnership OV_Roads TigerRoads USGS_Quadrangles VegetationClassification VegMon_Transects VegMon_XYPointStation VegMon_XYTransectPoints

Developing a Framework for the Data

Cross-compatibility issues are inherent technological constraints that often limit the usefulness of data. Fortunately, the constraints under this project can be solved with minor adjustments to table and field naming conventions used by the contributors. For example, using joins or relates (*see* Appendix A - Glossary of Terms) in ESRI ArcGIS to Microsoft Access database tables, the table and field names must not have spaces, e.g. Stem Counts should be StemCounts. NHNM made adjustments like these to the two databases provided by the BOR.

Additionally, we added fields to the Access tables to provide links (via joins or relates) to fields in the GIS. Figure 6 diagrams the relationships between the ESRI Geodatabase feature classes (*see* Appendix A - Glossary of Terms) and the Access database tables and fields. For example, the feature class VegetationClassification is a vegetation map that contains little of the tabular information actually collected from extensive field work. However, when joined to one of the Access tables, TerraceHeight in the OVRA_vegmap.mdb, using the PolyID field as the "join field", additional measured and descriptive data are available to the user.

NHNM added field descriptions in the Access databases for all tables based on information provided by the BOR and gleamed from the actual data. By opening up the individual tables of the Access databases and mouse-clicking over any field, the field description will display in the bottom bar of the Access window (Figure 7).

The ArcGIS geodatabase, delivered in combination with a map document (*see* Appendix A - Glossary of Terms) can be useful in disseminating and controlling the way data are viewed. The personal geodatabase can store raster, vector, and tabular data. Since the limit on the personal geodatabase is 2 gb, we have chosen to store the raster data outside the database; the current size of the raster data is 676 mb. Similarly, the access tables could be imported into the geodatabase; however, at this time we have chosen to use them in a
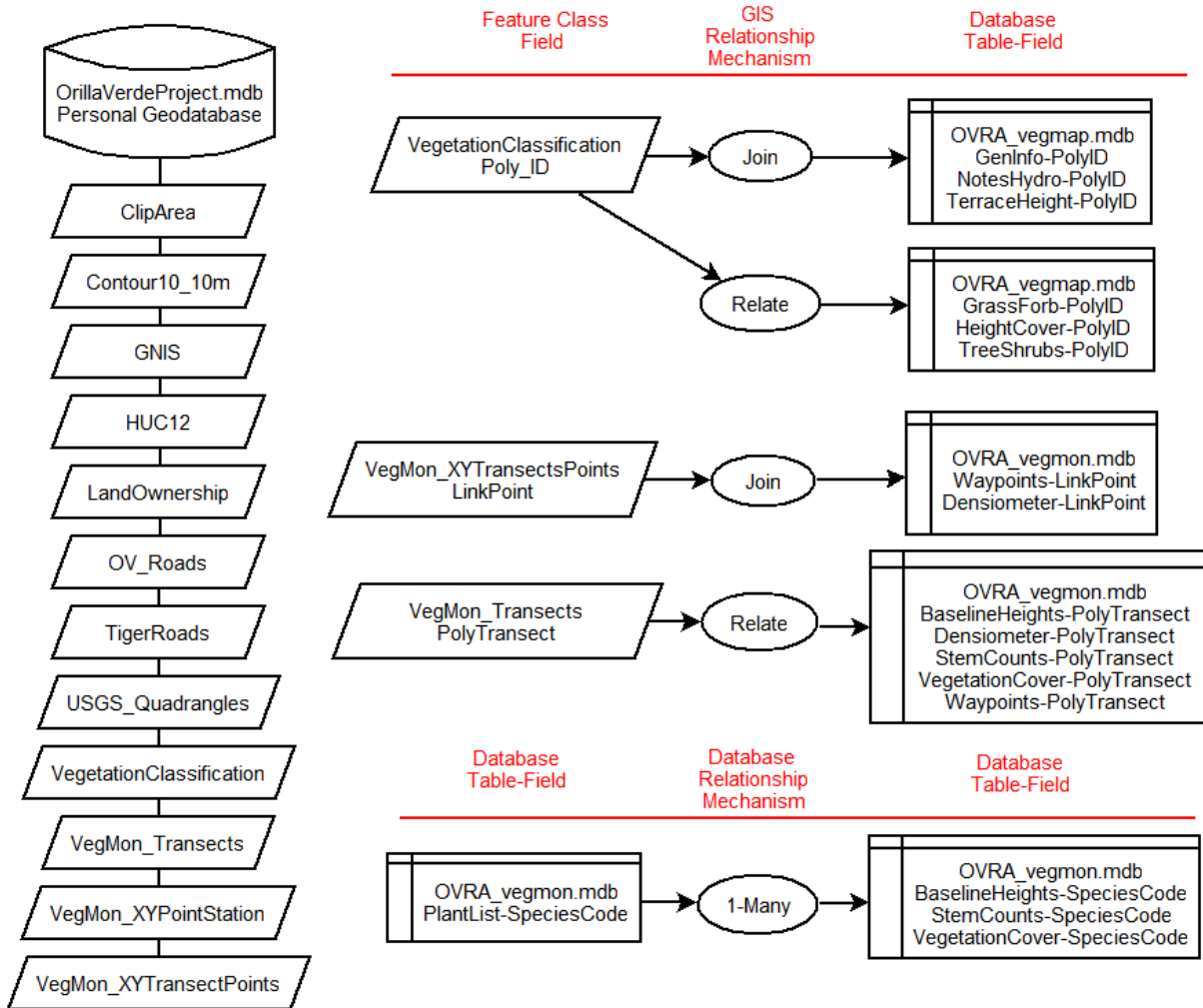
Figure 6. Diagram of relationships between GIS and Access tables for the Orilla Verde restoration project.

relationship to their native environment. The decision behind this is due to the following: (1) often a database is relatively more dynamic than a GIS and (2) queries and relationships are more sophisticated in Access, and (3) users are more apt to have Access skills rather than GIS skills. However, if changes to the database only occur once a year, it may be easier to incorporate the tables into the personal geodatabase and create the joins and relates in the ArcMap map document. See Appendix B for instructions on establishing (1) a database connection to the Access database in ArcCatalog, (2) creating joins and links in ArcMap, and (3) methods for viewing joins and links in ArcMap.

NHNM has created a map document (OrillaVerdeInvasive.mxd) in ArcGIS ArcMap for viewing the compiled GIS data. When data are downloaded to the cooperators individual computers, make sure there are no ReadOnly constraints on any of the folders. A simple letter-size map at 1:3,000 scale is also available in the Layout View of the map document for easy manipulating and printing to take into the field. The map document is set to relative path to make it more portable between computers. However, if some data layers in the map document do not display and a red explanation mark appears to the left of the layer in the table of contents, right-click and use set data source. If the data have been transferred to your computer and the file names and order remain the same, this should not be an issue. Figure 8 represents the general outline of the data compiled as of this report.

Digital site photos were acquired by BOR and placed into two folders mentioned in Table 1. At present, no effort has been made to develop a mechanism to link the photos to the GIS or Access database; although the monitoring photos are labeled intuitively such that we could associate LinkPoint or PolyTransect fields to the photos. The vegetation map photos would require more information to match them to plots sites.

Figure 7. Screenshot of Access field descriptions Orilla Verde restoration project database

Discussion

The database and GIS presented with this report represent a standardized tool set for all cooperators on this project that can be used for future project planning and analysis, and long term storage of information. As restoration proceeds these tools can provide for the addition of new monitoring sites as well as track ongoing yearly data from those established in 2006. While one future goal is standardization of the table structure in the database and creation of data entry forms to streamline data entry, the database can be adaptively modified as feedback from users is received and methods change. Accordingly, the following are a set of issues to be considered during future database development:

- Database design
  - forms
  - table relationships
- GIS design
  - A feature class (*see* Glossary of Terms) that indicates the extent of the treatment and monitoring polygons.
  - user-friendly database connectivity
  - additional datasets needed
  - is ArcMap suitable or ArcReader with Published maps
- Field collection
  - additional data to collect
  - archival methods for photos
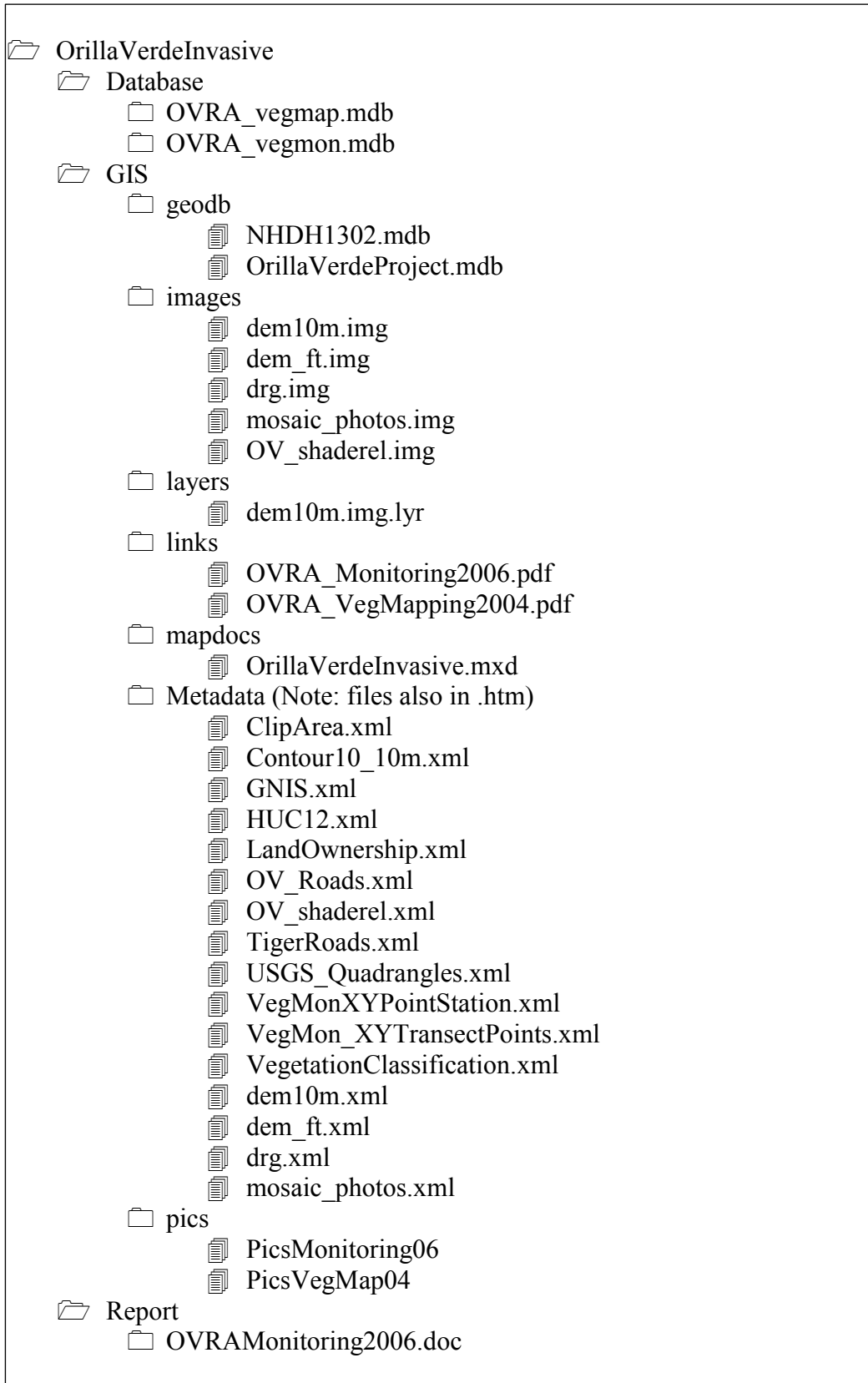 - recording of treatment regimes

```
📂 OrillaVerdeInvasive
   📂 Database
          🗀 OVRA_vegmap.mdb
          🗀 OVRA_vegmon.mdb
   📂 GIS
          🗀 geodb
                 🗐 NHDH1302.mdb
                 🗐 OrillaVerdeProject.mdb
          🗀 images
                 🗐 dem10m.img
                 🗐 dem_ft.img
                 🗐 drg.img
                 🗐 mosaic_photos.img
                 🗐 OV_shaderel.img
          🗀 layers
                 🗐 dem10m.img.lyr
          🗀 links
                 🗐 OVRA_Monitoring2006.pdf
                 🗐 OVRA_VegMapping2004.pdf
          🗀 mapdocs
                 🗐 OrillaVerdeInvasive.mxd
          🗀 Metadata (Note: files also in .htm)
                 🗐 ClipArea.xml
                 🗐 Contour10_10m.xml
                 🗐 GNIS.xml
                 🗐 HUC12.xml
                 🗐 LandOwnership.xml
                 🗐 OV_Roads.xml
                 🗐 OV_shaderel.xml
                 🗐 TigerRoads.xml
                 🗐 USGS_Quadrangles.xml
                 🗐 VegMonXYPointStation.xml
                 🗐 VegMon_XYTransectPoints.xml
                 🗐 VegetationClassification.xml
                 🗐 dem10m.xml
                 🗐 dem_ft.xml
                 🗐 drg.xml
                 🗐 mosaic_photos.xml
          🗀 pics
                 🗐 PicsMonitoring06
                 🗐 PicsVegMap04
   📂 Report
          🗀 OVRAMonitoring2006.doc
```

Figure 8. File layout for the Orvilla Verde restoration project database.

Appendix A – Glossary of Terms

| Term	Description
feature class	In ArcGIS, a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads."
hyperlink	A reference (link) from one point in an electronic document to another document or another location in the same document (the target). Activating the link, usually by clicking it with the mouse, causes the browser to display the target of the link.
join	In ArcGIS, appending the fields of one table to those of another through an attribute or field common to both tables. A join is usually used to attach more attributes to the attribute table of a geographic layer. A join works on a one-to-one relationship between the tables.
layer	In ArcGIS, a reference to a data source, such as a shapefile, coverage, geodatabase feature class, or raster, that defines how the data should be symbolized on a map. Layers can also define additional properties, such as which features from the data source are included. Layers can be stored in map documents (.mxd) or saved individually as layer files (.lyr). Layers are conceptually similar to themes in ArcView 3.x.
map document	In ArcMap, the file that contains one map, its layout, and its associated layers, tables, charts, and reports. Map documents can be printed or embedded in other documents. Map document files have a .mxd extension.
raster	A spatial data model that defines space as an array of equally sized cells arranged in rows and columns, and comprised of single or multiple bands. Each cell contains an attribute value and location coordinates. Unlike a vector structure, which stores coordinates explicitly, raster coordinates are contained in the ordering of the matrix. Groups of cells that share the same value represent the same type of geographic feature. The rasters for the OVRA are either in ERDAS Imagine format (.img) or ERMapper compressed image format (.ecw). Additional add-in software is required to view .ecw files, ArcGIS will display .img.
relate	In ArcGIS, an operation that establishes a temporary connection between records in two tables using a key common to both. A relate can work on a one-to-one or one-to-many relationship between tables.
shapefile	A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class. A shapefile is composed of at least 3 files - .shp, .dbf, .shx.

Appendix B – Working with Access Databases in ArcGIS

The following is a tutorial for establishing (1) a database connection to the Access database in ArcCatalog, (2) creating joins and links in ArcMap, and (3) methods for viewing joins and links in ArcMap. Note: Tables from Access databases can be added to the ArcMap map document without the OLE DB connection; however, any changes made to the Access database will not be reflected in the tables. Following the instructions below, will keep the GIS up-to-date with any changes occurring in the Access database.

Establishing a connection to Access

Setting an open database communication (ODBC) in ArcGIS to an Access database is machine specific. The full path connection is stored (e.g. D:\BLM\OrillaVerdeInvasive\TheAccessDatabase.mdb), rather than being a relative path (…\OrillaVerdeInvasive\TheAccessDatabase.mdb). Once the connection is established, and the database is not moved or renamed, the connection will remain and be accessible in any ArcMap map document.
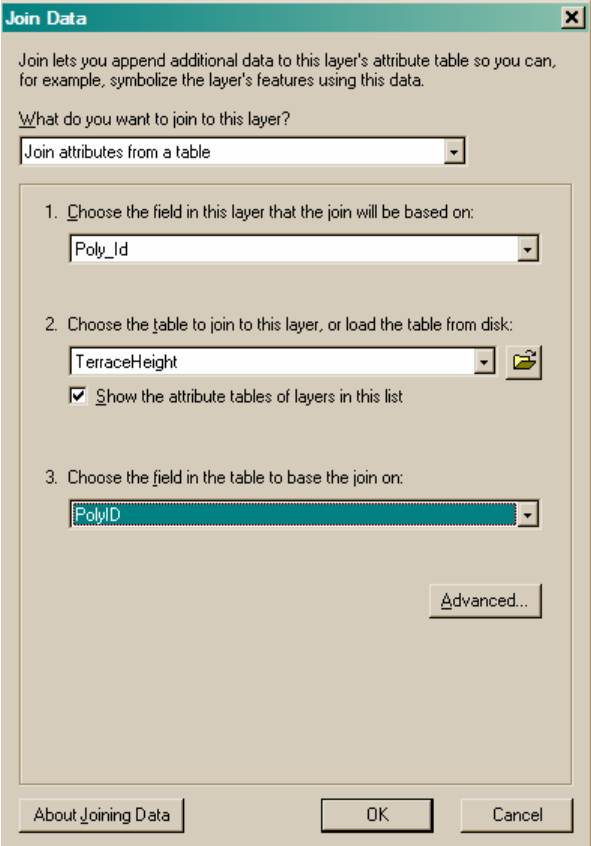
1. Double-click Database Connections in the Catalog tree.
2. Double-click Add OLE DB Connection.
3. In the Provider tab, click Microsoft Jet 4.0 OLE DB Provider.
4. Click Next or click the Connection tab.
5. Provide the required connection information. In the first box click the "…"tab and locate the OVRA_vegmap.mdb database. There is no security on either of the databases for this project so keep the default fields as they are where Admin is the User name and Blank password is checked.
6. Click Test Connection.
7. Click OK if the connection test was successful.
8. Type a new name for the connection such as OLE DB VegMap.
9. Press Enter.
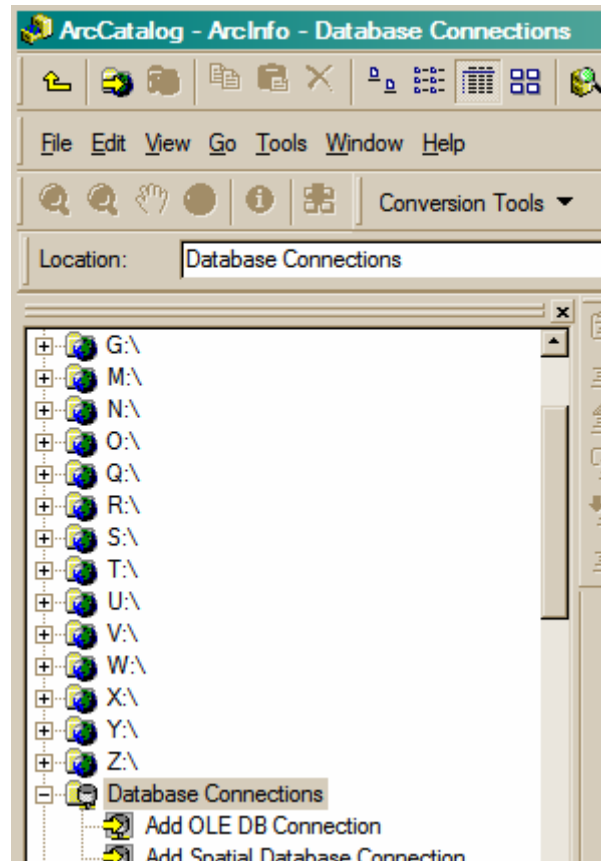
Creating Joins and Relates in ArcGIS to Access Tables and Viewing Results

Open the map document *OrillaVerdeInvasive.mxd*. The first set of instructions perform a join from an ArcGIS geodatabase feature class and a table in Access. The join will remain until you Remove the Join. Alternatively, you may want to make the join permanent, in this case, after you have performed the following steps, you would create a new layer with the join.

1. Click the Add Data button ![add data icon].
2. Navigate to the OLE DB connection you made to the VegMap Access database and add all the tables (shift-click for all).
3. Click Add.
4. Click the Source tab at the bottom of the table of contents.
5. Right-click the table TerraceHeight and click Open. Note the field PolyID. This is the field we will use to create a Join to the vegetation map (VegetationClassification).
6. Close the table.
7. Right-click the feature class layer VegetationClassification – Joins and Relates – Join.
8. In the Join Data form (*see* example), choose from the drop-downs the tables and field you wish to join.
9. Click OK.
10. Right-click the feature class VegetationClassification – Open Attribute Table. You will see to the far right in the table the Access table joined to the matching records in the map. Only those PolyIDs that have corresponding terrace information will have data, otherwise Null. You could have chosen to click on the Advanced button in the Join Data form to only see those records where the two datasets match.
11. You can symbolize the vegetation map based on the newly joined fields.

If the relationship between the GIS is 1-many, you would want to create a Relate between the ArcGIS geodatabase feature class and the table. The table HeightCover is a good example of this type of relationship, e.g. PolyID L020 has 4 height categories with their corresponding percent covers (CovPercent). The following are instructions for creating a Relate and viewing the results. You may want to remove the Join performed in the previous exercise to isolate the results of this relate.

1. Right-click the table HeightCover and click Open. Note the field PolyID. This is the field we will use to create a Relate to the vegetation map (VegetationClassification). Note there are multiple records for any unique PolyID.
2. Close the table.
3. Right-click the feature class layer VegetationClassification – Joins and Relates Relate.
4. In the Relate form, choose from the drop-downs the fields you see in the figure.
5. Click OK.
6. Open the attribute table for the VegetationClassification and select PolyID L122. Click the Options tab at the bottom of the attribute table and choose Related Tables – Veg-HeightCover:HeightCover.
7. The HeightCover table will open up with the records highlighted that correspond to the L122 PolyID.
8. You can also view the records from both tables of a Relate using the identify button. The two Identify Results at right show the veg map data in the first set and the second is the related height cover.
9. You cannot symbolize your data based on the Relate.