

**DEVELOPMENT OF A GIS
FOR THE MARYS RIVER WATERSHED
FOR FISH AND WILDLIFE ANALYSIS**

by

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Development of a GIS for the Marys River Watershed for Fish and Wildlife Analysis

ABSTRACT: GIS technology has reached a point where it can be utilized by non-professionals in a desktop environment. This paper reviews the implementation of a pilot project for developing a localized natural resource GIS. The resulting GIS was custom designed to answer questions posed by fish and wildlife biologists who need to reference data at scales up to 1:24,000. The pilot project demonstrates the feasibility of a larger system that can utilize the large volume of data available on the Internet and through government agencies.

Introduction

Geographic information systems (GIS) have come a long way from their early development in the 1960's. So far in fact, that some GIS professionals are wondering if GIS are destined to be merged with other information systems and cease to exist on their own (GIS World, 1998). GIS have become easier to use over the years and have moved from the back office cubicle to the public walk-up terminal in the library. Of course, better availability and ease of use does not mean that everyone has been quick to embrace GIS technology. Many organizations have been slow to adopt GIS because of cost and/or misconceptions as to what GIS can do and who can utilize them.

Although the natural resource field has long had a relationship with GIS, many natural resource professionals who can directly benefit from GIS have been left out of the picture. These include professionals who must answer questions by referring to file cabinets full of documents instead of quickly querying an information system. For example, fish and wildlife biologists must answer many questions relating to geographic information every day; "I need to know what species/habitat are within ¼ mile of a proposed gravel operation", "Can you send me a map of threatened species in this area?" An information system specifically designed to answer day-to-day natural resource questions is sorely needed. The Marys River Watershed GIS, whose development is discussed in this paper, was created to do just this.

The main objectives of this project were:

- develop a GIS that was customized to the needs of the end user--in this case, fish and wildlife biologists at the Oregon Department of Fish and Wildlife.

The resulting GIS combined local species and habitat data, including fish distribution, aquatic inventories, habitat inventories (fish/wildlife), game and non-game inventories, habitat/vegetation information (from GAP projects), and land use ownership, with large scale geographic information. The GIS was also

designed to have query and analysis capabilities for use with current, historic, and future data.

- design a GIS for use at the district fish/wildlife level.

The Marys River basin in Benton county, Oregon was used as the prototype “district” for two reasons: 1) The basin is in close proximity to an ODFW district office, and 2) The data available for this area represent well what can be found for much of the state.

- demonstrate that the large quantities of “free” data available over the Internet can be utilized to significantly reduce the cost for developing this type of GIS.
- provide guidelines for future projects of this type.

Literature Review

Literature about the development of a watershed-based fish and wildlife GIS is confined to large expensive projects. Federal government agencies such as the Bonneville Power Administration (BPA), United States Geological Survey (USGS), and the Environmental Protection Agency (EPA) currently have geographic information systems based on the watershed. Despite the fact that there are many references to them, they are not a fair comparison to the creation of a small watershed GIS. The National Oceanic and Atmospheric Administration created a desktop GIS for salmonid resources in the Columbia River Basin, which is a closer comparison but still utilizes small scale data for a broad area (Genovese, 1997). Even the development of EPA’s Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), which is based on a watershed approach, operates with 1:100,000 scale data (EPA, 1997).

The localized watershed-based GIS is more comparable to a municipal GIS in its scale and utility for a small area. Development of the municipal GIS has been well documented and has several guides available to assist in its creation (NYSARA, 1997).

Another reason for the comparison with a municipal GIS is that most city and county governments utilize GIS in a desktop environment, as opposed to larger systems using Unix workstations.

References were found to projects in California (Beardsley, 1997) and Kansas (West, 1994) that deal with fish and wildlife analysis on a more localized level and in a desktop GIS environment. These systems have been utilized for both analysis and decision making. The USGS GAP Analysis Program, in conjunction with the Wyoming GAP Analysis Program, have also created a desktop GIS called Refuge GAP. This system in many ways matched the objectives that were assigned to the Marys River Watershed GIS. By utilizing existing data from the Wyoming GAP Analysis and local U.S. Fish and Wildlife Service refuge information Refuge GAP provides analysis capabilities to non-GIS professionals (Herdendorf, 1997).

Materials and Methods

Materials

Computer resources were a Dell Pentium 133mhz desktop computer with 64mb of RAM. Data were stored on an Iomega 1Gb Jaz® drive, 640 Mb CD-ROM, and hard disk drive on the computer. It was decided to use Environmental Systems Research Institute's (ESRI) ArcView GIS. Several licenses of this software were available for use within the agency and its data format is widely compatible with other software packages. Other software utilized included Microsoft Excel for spreadsheet functions and ESRI PC ARC/Info for re-projecting data sets.

Methods

The core of this project focused on five tasks:

1. Identifying user needs
2. Identifying and acquiring data sets
3. Customizing the GIS
4. Error checking
5. User training

Identifying User Needs

The first step taken was to hold several meetings with ODFW biologists who were interested in the project. Basic criteria for the GIS were determined—it would be designed to be a system that would be easy to use, could answer several different types of questions, and had a data scale of 1:24,000.

Next, in order to better determine user needs, a questionnaire was sent out to ten members of the South Willamette District Office staff asking for input as to the five most common questions that must be answered as part of their duties. Five potential users responded with a total of 30 questions. Follow-up interviews were performed with all responders to formalize their questions in a way that could be answered with a GIS. The questions were then placed within one of three classes; habitat, species, ownership/land use. The classes were used to determine how users would like to query the GIS and display information. After reviewing the questions, their number was reduced to approximately 20 by removing duplicates.

Identifying and Acquiring Data Sets

After reviewing end-user questions, data sets were identified that would be needed to answer most of the questions. A list was created of public agencies who maintain the types of data required. These agencies were contacted either by telephone or on the Internet to determine if any of their data matched the project needs.

Contact was made with seven government agencies who maintain information about the Marys River Watershed: City of Corvallis, Benton County, Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Forestry (ODF), State Service Center for GIS (SSCGIS), Environmental Protection Agency (EPA), and United States Geological Survey (USGS). These seven were not the only ones having information but merely the ones whose information was deemed necessary to answer the users' questions. All sources provided their data free of charge via either Internet or compact disk. A

summary of the data acquired from each source is in Appendix B. All of the data listed in Appendix B were entered into the GIS.

One of the basic criteria for the GIS was to have a data scale of 1:24,000. This was because the majority of local species and habitat information is recorded at 1:24,000 scale on USGS 7.5' quadrangle maps. To provide compatible scale and the most accurate information, the 1:24,000 scale was set as the target for all data contained in the GIS. Most data recorded by ODFW with GPS are stored with Universal Transverse Mercator (UTM) coordinates. The UTM was chosen as the project projection due to its familiarity to all potential users.

The seven sources of data used five different map projections, only one of which was the target projection. Due to the varied nature of the acquired data sources and their differing map projections, processing was required for all data entered into the GIS. The data from Benton County, EPA, SSCGIS, and the National Wetlands Inventory (NWI) merely required re-projection and clipping to conform with the watershed boundary. This was also true for some of the data from ODFW and USGS.

However, several data sets required extensive processing to make them compatible with the ArcView software and the project parameters. These problem data sets were the aerial photography, stream coverage, fish distribution coverage, and a road coverage.

Two sources were used for aerial photography of the area, the City of Corvallis and ODFW. The City of Corvallis maintains an orthophotographic database of its urban growth boundary which includes a portion of the lower mainstem of the Marys River. Incorporating these photos required a simple change in their georeferencing information.

The aerial photos from ODFW were 9 inch by 9 inch contact prints that needed to be scanned and then georeferenced. The process of using these photos involved many steps, starting with the photo selection. Due to the large number of photos needed to cover

the whole watershed it was decided to only incorporate a subset along the mainstem of the river. Photos were chosen that provided enough overlap to allow cropping out the middle portion which has the least distortion. A resolution of 600dpi was chosen for scanning as it provided approximately 1 meter pixels with the 1:24,000 scale photographs.

Once scanned, the photos were georeferenced using an ArcView user extension, *Imagewarp* (McVay, 1998). This extension allows the user to pick points from a reference map and then corresponding points on the aerial photo. The photo is then converted to raster format and warped to fit the chosen points, after which it is converted back to image format. The extension provides calculation of Root Mean Square (RMS) error and will update error levels with the deletion or addition of points. The scale requirements of the project allowed an RMS error of up to 10 meters to be deemed acceptable. Ten aerial photos were scanned and georeferenced resulting in a coverage of over 35 square miles. When coupled with the existing photos from the City of Corvallis approximately one-quarter of the watershed was covered. This included 22 miles of the mainstem Marys River from the mouth upriver past the community of Wren.

Another time-consuming but surmountable problem occurred with some of the data acquired from the USGS. As previously mentioned, one objective of the GIS was to have all the data be 1:24,000 or larger in scale. However, no 1:24,000 scale stream coverage for the watershed could be found. The USGS maintains 1:24,000 scale Digital Line Graph (DLG) data for the whole United States and provides it to the public free of charge. The fact that these data overlay 7.5' topographic maps used by the biologists also makes the data highly desirable.

Unfortunately, for many GIS users the USGS data are provided only in the native Spatial Data Transfer Standard (SDTS) format. Only a few commercial GIS packages can read this native format, ArcView is not one of them. Fortunately, Sol Katz at the Bureau of Land Management (BLM) has written several conversion programs that will transfer the SDTS format to other GIS formats (Katz 1997). Multiple conversion formats are available

including DXF, MapInfo, and DLG. Because the ArcView package comes with a DXF file reader extension, the SDTS to DXF conversion format was determined to be the simplest route (Figure 1.)



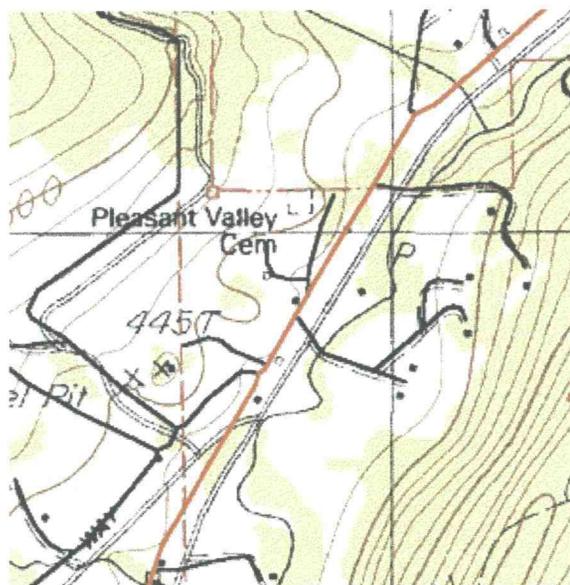
(Figure 1. SDTS Conversion Procedure)

A second problem with the native SDTS files is that they contain no attribute information for use in a GIS. A process was needed to add meaningful information to the linework. There was no automated way to perform this task so a manual approach was applied. With a hard copy of a USGS 7.5' quadrangle map in hand, individual stream segments were selected and attributes were entered into the database by referring to the map. Once this task was completed the whole watershed had a 1:24,000 scale stream coverage with feature names as attributes.

Fish distribution information for the watershed is gathered by the Oregon Department of Forestry (ODF) on USGS 7.5' quadrangle maps. This information is valuable for biologists in that a quick review of the data can form the basis for judgments made about the stream without visiting the area. The fish distribution data also posed a time consuming problem for entry in to the GIS. However, the newly created 1:24,000 stream network coverage allowed the entry of the fish distribution data onto the same linework as the hard copy maps. This was another case where the data had to be manually entered by examining a map and selecting stream segments on the screen.

The same steps used for developing the stream coverage could also have been applied to the road coverage. However, by using the U.S. Census Bureau Tiger road data a fully attributed coverage could be used with only having to re-project the data. Using the Tiger data caused deliberation because the data, although very accurate, are only 1:100,000 scale and did not meet the project scale requirements. The decision was made to

use the Tiger data and back them up by using USGS Digital Raster Graphic (DRG) files (Figure 2.). The DRGs are scanned, georeferenced USGS 7.5' quadrangle maps and provided a second source for road location information, as well as being exactly the same as the maps used in the field.



(Figure 2. Solid red and black lines are 1:100,000 Tiger files overlaid on DRG data)

Another source of data from ODFW that required extensive work was the fish surveys. These surveys provide a valuable source of information by sampling species presence either visually or by collection. ODFW has large quantities of this type of information which has been collected over the years, but is maintained in paper format. The desire at ODFW is to have the data converted to electronic form by being entered into a database and having the paper copy archived.

The volume of paper data for the Marys River watershed was too large for complete conversion by this pilot project. However, a subbasin was chosen to develop a system for data conversion. In conference with fish biologists, a database structure was created to make maximum use of recorded data yet be flexible enough to deal with the variety of survey note formats taken over the years. The data structure included sampled

species and locational information such as basin and stream name, as well as UTM coordinates. It also included habitat information like water temperature, streamside vegetation, and substrate.. The entire database structure is given in Appendix C. In order to allow reference to the original survey report, the paper documents were scanned and can be accessed from within the GIS. This allows the user to examine the original survey report for more information. Once the data were entered into a database they were easily converted to a point coverage based on the UTM coordinate fields.

Customization

By examining the users' responses to the questionnaire and individual meetings, the types of customization needed became apparent. The users asked for the ability to click on a feature and retrieve information about it, print maps, and query by location. These tasks also had to be performed in a easy to understand environment. Almost all of the user requirements were already inherent to ArcView. However, there were many functions available that would have confused the user or offered complex analysis which was not a requirement of this project. In order to provide an easier to understand interface, many of the unneeded general functions of ArcView were removed.

Other functions were added to simplify the entry and editing of data and to allow zooming to specific locations entered by the user. These functions were created by using the ArcView programming language Avenue. This object oriented language allows access to nearly all of the capabilities of ArcView and has a relatively low learning curve. The manufacturers of ArcView maintain a Web site with user written customization tools. This allows ArcView users to add custom tools to their projects without knowing how to program in Avenue. These tools are free and the programming code can be easily manipulated in a text editor to change the tools' functions.

Error Checking

Error checking was an important part of the GIS creation. It was performed after both data conversion and interface customization. Each data set which was newly created

for this project was reviewed multiple times for accuracy by comparison to original documents. Error checking was a time consuming part of the conversion process, especially with the data which were manually entered. Custom tools were also reviewed and tested multiple times before being added to the project interface.

User Training

Materials were gathered for a training session and demonstration meeting. ESRI tutorials and ArcView training guides from the City of Corvallis formed the bulk of the training material. Due to the variety of computer skill levels of the potential users, it was decided to perform training in a one-on-one environment. This method would allow users to be trained at their own pace and provide a way to measure the kind of technical support required in the future.

Results

User Needs

As mentioned, user questions were broken into three classes. This provided a way to organize the responses from the users. The habitat class had the most questions with eleven while the species and land use class both had five. The majority of users' questions took the general form of, "What is around this location?" The other basic question asked was, "What is the extent of this feature?" Although recorded field data were generally stored in UTM coordinates, most biologists used the township, range, section (TRS) format when they asked their questions. The entire list of questions can be found in Appendix A.

Identifying and Acquiring Data Sets

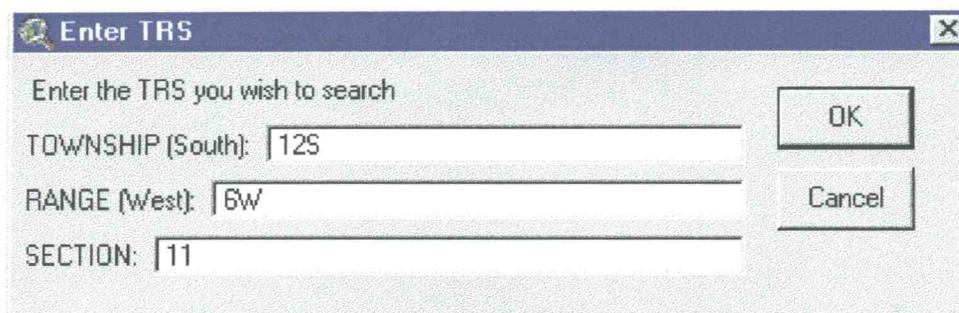
After contacting all agencies providing data it quickly became obvious that the target data scale of 1:24,000 was impossible to maintain for all information contained in the system. Thirty-two data sets were either acquired or created for input into the GIS.

Three different data scales were used with the majority of the data meeting the target scale. The breakdown of the amount of data at different scales is 17 data sets at 1:24,000, 12 at 1:100,000, 3 at 1:250,000. The list of data used and their sources are in Appendix B.

The Internet was used in almost all cases when acquiring data. Sixteen data sets were acquired using FTP, six with the world-wide-web, (WWW), eight were acquired in-house either from other projects or by being created, and two were acquired on CD. A high speed Internet connection was utilized to make file transfers as quick as possible. While no records were kept on the time spent downloading files, it is estimated that the largest file took less than thirty minutes.

Customization

Several custom tools were created for this project including a querying function that allows the user to enter a township, range and section and then zoom to that location in any of the views in the project (Figure 3.). Another custom tool demonstrates the ability to enter data via forms directly into the GIS (Figure 4.). By choosing from two pre-formatted table structures the user can enter tabular data for fish surveys or western pond turtle surveys. The relative ease by which Avenue can be learned allowed these custom tools to be created by a novice programmer in only a couple of days.



Enter TRS

Enter the TRS you wish to search

TOWNSHIP (South): 12S

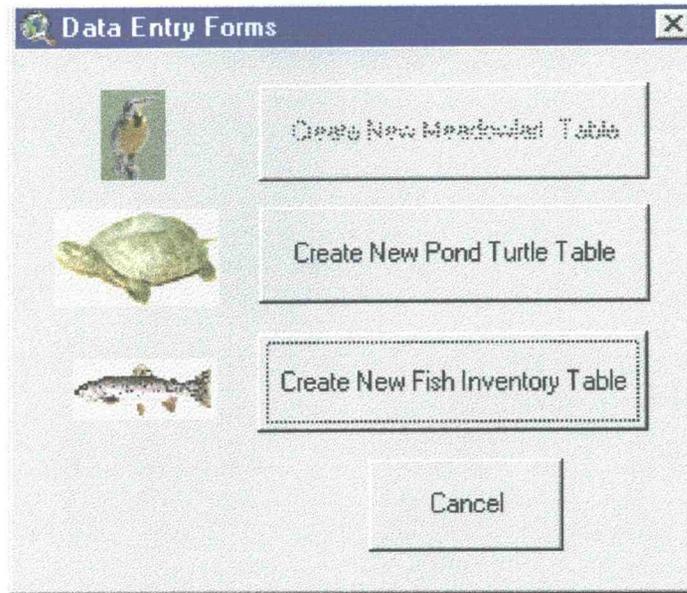
RANGE (West): 6W

SECTION: 11

OK

Cancel

(Figure 3.)



(Figure 4.)

User Training

User training and group demonstrations were not performed. No additional ArcView software licenses were available for installation onto users' computers. A group demonstration will be presented within the next two months.

Discussion

The resulting Marys River Watershed GIS provided geographic coverage of the entire watershed, and includes data sets that are of interest to natural resource professionals. It is an easy-to-use system, customized to answer questions facing ODFW biologists. Creation of this GIS served as an important pilot project for future development of GIS designed for fish and wildlife analysis at the district level. As such, it is useful to share lessons learned and to make suggestions for future GIS projects of this type.

Data Acquisition and Conversion

This project consisted of building a GIS from the ground up. Even though it was small, it posed a number of challenges that were difficult to overcome. One of the difficult portions of the project was waiting for all of the data to be acquired before moving on to the next phase. The planned timeline allowed approximately one and a half weeks to acquire the data sets, however some agencies took over one month to respond with the necessary information. Ironically, one of the most difficult agencies to get information from was ODFW. Though staff were interested in the project it was often difficult to make contact with them. These setbacks delayed project implementation.

Some project data sets were quite easy to acquire and took little or no time. These include all information from the Oregon SSCGIS. Because they maintain an FTP server with all the desired information it was a simple and quick process of downloading the files. The City of Corvallis also provides easy access to all their GIS data via CD-ROM. The CD's are available for a minimum charge to the general public. This method of acquisition was also helpful because it did not require using any archival storage space.

Another challenge was that a large amount of the data was captured at 1:100,000 scale which was not acceptable for localized analysis. The trade-off was made with background data sets such as the transportation, and political boundaries, which were not as important to analysis for the end users. However, critical data sets such as vegetation, streams, taxlot ownership, and wetlands were acquired at the 1:24,000 scale.

As had been the hope, there were minimal costs associated with the physical acquisition of the data. All transfers except one were made via Internet or mail. The use of the Internet was a vital portion of this project and many hours were spent on-line reading about other projects and data sources. Several web sites that provided the most helpful information were ESRI (<http://www.esri.com>), USGS (<http://www.usgs.gov>), Oregon SSCGIS (<http://www.sscgis.state.or.us>), EPA (<http://www.epa.gov>). These sites provided

data, assistance with watershed GIS, and programming help, without them the project would certainly have taken much longer or not been completed at all.

The conversion of the acquired data took longer than expected. Scanning and georeferencing of the aerial photographs took approximately 20 hours alone, which was half the expected time for all the data. This was by far the most time consuming part of the data conversion process. The other manual data entry tasks in the project also took longer than anticipated. Entering the fish distribution for each stream in the watershed took 16 hours and adding feature names for all streams took 9 hours.

Customization

In developing the customized portions of the ArcView GUI every attempt was made to utilize pre-written tools developed by others. This served two purposes; it reduced the time required to learn Avenue by seeing how the tools were constructed, and the pre-written tools could immediately be utilized within the project.

Questionnaire Responses

To properly evaluate the usefulness of the GIS, it should be determined whether or not the GIS was able to address all the natural resource questions gathered from the users. Although the system was found to answer 57% of the questions posed by biologists, it could not address all the biologists' questions with the available data sources (Appendix A). Some questions were very specific and required data sets that were larger in scale than the best that were acquired. For example, the question, "Where is the nesting habitat for western pond turtles?" could not be answered within an acceptable accuracy. This was because Western Pond Turtles build nests on south facing low sloped areas with specific soil types. These conditions can occur in micro habitats that could not be identified accurately with the scale of data in the GIS.

Other questions required the creation of new datasets which would have been too costly for this project to produce. The question "Does this stream have an appropriate forest buffer?" would require acquiring more recent aerial photography in order to digitize the stream-side vegetation.

Future projects can deal with the issues discussed above in several ways. By acquiring larger scale data sets, such as a 10 meter DEM, GIS analysis can produce more accurate results. Another option would be to perform field surveys to gauge the accuracy of the existing data. By visiting areas identified in a coarse analysis and rating their potential a model could be developed for using existing data. Acquiring additional datasets could be accomplished by further researching existing sources or by purchasing data from contractors or data-warehouses.

Other Recommendations for Future Projects

This project made good use of free resources, existing equipment and materials in order to keep costs at a minimum. However, in examining the project results it is clear that there were serious overruns in time expended on certain portions of the project. Several guidelines can be formed that will allow similar future projects of this type to go much smoother and faster.

Hardware

Technology is changing rapidly and computers are faster and cheaper than ever. GIS development requires extensive computing power for processing large data sets. This project made use of existing equipment that was several years old and therefore much slower than other current computer systems. Many parts of this project were slowed by the processing capability of the computer used. The georegistration of the aerial photographs, for example, would have been greatly sped up by using a newer, faster computer. It is recommended that future projects should be undertaken utilizing the best computing resources that can be acquired.

Software

Utilizing PC Arc/Info required that many data sets had to be split into smaller segments in order to have their projections changed. Smaller segments had to be used because this software package is limited to processing under 10,000 arcs per coverage. This problem was overcome and the results were satisfactory. However, the extra time

involved with being forced to perform this process slowed progress and made the work more difficult. An investment in Arc/Info is recommended for projects of this size or larger to allow faster manipulation of the data in the GIS. Versions of Arc/Info are now available that utilize the Windows NT operating system which is more familiar to the general user than Unix. Therefore, an investment in a stand-alone workstation is no longer necessary. A Windows NT system is seamlessly compatible with existing Windows 95/98 environments.

Data

The free data currently available are generally more than adequate for this type of GIS. In some cases the data do require more processing steps before they become useful, but it is worth the effort. Newer versions of Arc/Info are also capable of directly converting the USGS SDTS file format which makes the investment in this software very attractive. More GIS data are being created every day by government agencies and non-profit groups that would be useful in a small watershed GIS. The Internet is quickly becoming the medium of choice for transfer of these data as it requires less manpower and reduces staff time over conventional transfer techniques.

Although only one-quarter of the watershed depicted on aerial photos was input into the Marys River Watershed GIS, this is probably one of the more valuable data layers in the system. The photos provide a backdrop for most of the GIS data that is easy for novice users to understand. Aerial photographs are widely used in the natural resource field and the potential users have experience reading them. Therefore they can quickly derive locational relationships between features using a familiar data source. Aerial photography should definitely be a high priority data source for a similar GIS.

Personnel

This project was undertaken only by one person, which slowed progress significantly. Volunteers with computer skills could easily be utilized to assist with data entry or some of the less technical portions of the system construction process. Other persons with GIS skills such as interns could also provide valuable time saving assistance.

Utilizing this type of labor, which is currently abundant within ODFW and other natural resource agencies, could keep costs down and allow funds to be spent elsewhere on equipment or data.

GIS Community

Networking with other government agency GIS staff provides a valuable resource when seeking data or advice on equipment and techniques. Most public agency GIS staff are happy to provide recommendations as to contacts for information or data sets. In addition, there are several GIS user groups that can be used as starting points to make contacts in the local GIS community. These groups also provide a means of connection to GIS vendors which make product demonstrations and allow a closer inspection of products than can be made by reading a brochure.

Time and Funding

A pilot project such as this one has to have limits as to how deep it will go. Certainly more data could have been acquired but more time would have been required. A complex version of this project incorporating more data from ODFW would require upwards of one year. This estimate is made with the assumption of assistance from volunteers or interns as well as cooperation from data contributors.

Increased funding is also necessary for future projects of this type. Time was under-budgeted for several portions of the project and corrections would call for increased funding. As mentioned, better equipment is also necessary for GIS work and inputting larger data sets, which would be required with a bigger project. Some data sources for this project could not be acquired because of cost, such as new or color infrared photography and a higher resolution DEM. An increased budget would allow for acquisition of these and other data sets which would augment the analytical capabilities of the GIS.

Finally, a successful project requires a full time staff person to provide coordination of activities and technical expertise in GIS. According to the Oregon

Department of Administrative Services the current salary range for state government employees with these types of qualifications are \$24,000 to \$37,000 per year. The higher end of the scale indicates more supervisory tasks. An estimated cost implementation is located in Appendix D.

Conclusion

This project has proven that a local watershed GIS can be constructed using existing data and resources at low cost. The recommendations indicate that a more complex project or implementation of a GIS over a larger area would necessitate increased funding and time commitments.

The enthusiasm of potential users of such a system indicate that a watershed based GIS is an idea whose time has come. Data conversion from paper reports to digital databases would be the most time consuming portion of a large scale project. However, with volunteer assistance and pre-constructed data entry forms both the time and the cost of transfer can be greatly reduced.

Although this project was designed to be self contained, there have already been plans to augment the data contained within the system. Several requests for data from the system have also been made from sources outside ODFW. These facts show that a local fish and wildlife GIS is definitely needed. Hopefully, this project will demonstrate this need well enough for actions to be taken to create a district or regional system within ODFW.

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Appendix A

User Criteria Questions

Habitat:

- What is the habitat condition in this area?
- Where is the nesting habitat for western pond turtles?
- Where are the farm ponds within ¼ mile of river system?
- Where are all the known and potential red-legged frog and western pond turtle breeding sites?
- *What wetlands are within this TRS?
- What is the water quality in this area?
- *What is the current distribution of oak woodlands?
- *Are there any native grasslands left?
- Where is suitable habitat for willow flycatcher?
- *How much of a particular habitat type do we have in the project area?
- Are there downstream fish barriers to this stream reach?

Species:

- *What species are within this TRS?
- *Where are the known sensitive species locations?
- *What species of concern occur within some distance of a particular project?
- *Can you send me a map of the area showing the habitat, nest site, etc.?
- What is the history and current activity status of the site?

Ownership, Land Use and Management:

- *What pictorially are the adjacent land uses?
- *What is the zoning of the project area?
- *What does this area look like?
- *Who are the landowners in the project area?
- Does this stream reach have an appropriate forest buffer?

Note: Questions marked with a ‘*’ were found to be answered by the GIS. Non-marked questions could not be completely answered with available resources.

Appendix B

Data List and Sources

Coverage	Acquisition Agency	Data Scale	Acquisition Method
Benton County Taxlots	Benton County	1:24000	FTP
EPA cerclis	EPA	1:24000	WWW
EPA intakes	EPA	1:24000	WWW
EPA npdes	EPA	1:24000	WWW
EPA rcra	EPA	1:24000	WWW
EPA tri	EPA	1:24000	WWW
EPA wells	EPA	1:24000	WWW
NWI Wetlands	NWI USFWS	1:24000	FTP
Air Photos (scanned)	ODFW	1:24000	In House Source
Vegetation (Klock)	ODFW	1:24000	In House Source
Vegetation (10 hec EAC)	ODFW	1:100000	In House Source
Fish Inventory	ODFW	1:24000	In House Source
Aquatic Inventory-habitat	ODFW	1:100000	FTP
Aquatic Inventory-reach	ODFW	1:100000	FTP
Winter Steelhead	ODFW	1:100000	FTP
Coho	ODFW	1:100000	FTP
Meadowlark range	ODFW	1:100000	In House Source
Marbled Murrelet	ODFW	1:24000	In House Source
Bald Eagle	ODFW	1:24000	In House Source
Western Pond Turtle	ODFW	1:100000	In House Source
ONHP Wetlands	SSCGIS	1:24000	FTP
Watershed	SSCGIS	1:100000	FTP
County Boundaries	SSCGIS	1:100000	FTP
Cities	SSCGIS	1:250000	FTP
TRS	SSCGIS	1:250000	FTP
100K Roads	SSCGIS	1:100000	FTP
100K Highways	SSCGIS	1:100000	FTP
W. OR Forest Ownership	SSCGIS	1:250000	FTP
DLCD zoning	SSCGIS	1:100000	FTP
24K Streams	USGS	1:24000	FTP
DRG	USGS	1:24000	CD-ROM
DEM	USGS	1:24000	CD-ROM

Appendix C

Fish Survey Data Structure

NAME	TYPE	DESCRIPTION
Ident	Character	Unique location identifier- usually the stream name plus integer
Basin	Character	Major basin name
Subbasin	Character	Major subbasin name
Subbasin2	Character	Minor subbasin name
Stream	Character	Stream name
Trs	Character	Township range and section
Utm_e	Decimal	UTM easting
Utm_n	Decimal	UTM northing
Date	Decimal	Date
Temp	Decimal	Temperature in degrees Fahrenheit
Flow	Decimal	Stream flow in cfs
Substrate	Character	Stream bed substrate
Width	Decimal	Stream width
Depth	Decimal	Stream depth
Riparian_c	Character	Riparian cover type - based on Aquatic Inventory Proj. typing
Method	Character	Survey method type
Purpose	Decimal	Survey purpose
Species	Character	Sampled species - based on Aquatic Inventory Proj. typing
Comments	Character	Comments

Appendix D

Cost Implementation Recommendation

Personnel:	1 FTE GIS Specialist	\$30,000
Hardware:	Windows NT workstation	\$5,000
	Plotter	\$6,000
	Color printer	\$600
	Scanner	\$750
Software:	Arc/Info for NT	\$9,000
	ArcView	\$1,000
	Graphics Package	\$500

Note: This recommendation does not include other costs such as data, storage media, and Internet access.