Managing GIS Resources for a University Department's Research Program

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In all cases, the most current original software vendor documentation should be taken as the authoritative source.

The use of any trademarked product mentioned within represents the opinion of the author and not the University of Alberta nor the Department of Biological Sciences.

This document was not required for the author's job, but was prepared based on her ongoing experiences as a GIS support staff and is hoped that the information provided here may be of use to anyone managing GIS resources for academic research purposes.

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ABSTRACT

The Geographic Information System (GIS) is becoming increasingly valuable in biology by making new sources of data available and opening up complementary avenues for research. In the University of Alberta's Department of Biological Sciences, there are approximately 80 graduate students – supervised by almost 20 professors – who are currently applying GIS technology for improving or developing alternative methods used in their organism, ecosystem, and other ecology-related investigations. Innovative solutions for understanding spatial relationships while adhering to the unique criteria of biological phenomena are often required in these diverse and large research projects. Methods on instructing the graduate researchers who are too busy for mainstream education, how to manage a Departmental research lab, as well as some GIS solutions to sample research problems are presented.

INTRODUCTION

We needed it, we got it, now how do we keep up with it? In this day and age, faculty and graduate students in almost any Department at any University or higher education institute are becoming progressively more informed on the merits and usefulness of incorporating GIS science and technology into their research programs. After the initial acknowledgement of the need for GIS resources to support research – and after the commitment in acquiring and setting up the dedicated space, workstations, and software has been realized – the functioning must be overseen in a way that promotes effective use by the faculty and graduate students. Whether this is a team effort or the sole responsibility of a dedicated individual, the essential tasks, issues, and solutions are presented here under the guise of a how-to document for maintaining GIS resources for a large academic department.

Who are we? The Department of Biological Sciences at the University of Alberta, Edmonton, Alberta, Canada, is one of those large departments with strong research programs and has a running annual average of around 80 graduate students – supervised by 20 faculty members in the Ecology Research Interest Group (RIG) and other allied sub disciplines – who take advantage of GIS and the related spatial technologies of remote sensing (RS), Global Positioning Systems (GPS), biotelemetry, spatial statistics, and ecological modeling to address their predominantly organism, ecosystem, and other ecology-related questions. The BioSciences GIS Facilities answer their call for state-of-the-art equipment, and the GIS Technologist fulfills the role of lab manager and multi-disciplinary spatial knowledge provider – a kind of geography broker for biologists.

There are so many of THEM and only one of ME! There are many challenges faced by one individual whose key responsibility is to make more efficient and productive use of scientific software, particularly in support of GIS, by faculty and graduate students. If providing advice and developing advanced applications weren't enough to fill the working week, running a lab and helping new users get up to speed on computing tasks commonly performed by the Ecology RIG definitely does. Short courses are key to instructing the masses on topics relevant to various research applications, and ensuring a streamlined computer laboratory in which to execute analyses is a must. Having access to networking and Information Technology (IT) expertise eases the workload. The following methods and protocol devised for the BioSciences GIS Facilities are shared with you as a model that may be adapted for other University departments in search of some nifty GIS solutions for their research programs. See ***APPENDIX A*** for a working model of task scheduling.

RESEARCH LAB

But, software license administration isn't really in my job description! A GIS may be defined as a computer-based coordination of hardware, software and “liveware” (i.e. people) to capture, store, manipulate, analyze, and display spatially referenced data. Due to the nature of the dedicated equipment, a grab bag of talents is useful for maintaining a well-run computer lab. This means that although a particular activity may not be spelled out explicitly as your responsibility, at minimum it pays to know how to do it so you will be more effective at troubleshooting the inevitable hardware and software problems of any computer lab.

Choose one primary software product to support. With many of THEM and only one of you, your brain will drain rapidly while trying to become proficient in many different interfaces while keeping abreast of the many different research projects. From the perspective of software licensing, multiple products also mean added work and extra cost that your time and budget may not be able to accommodate.

An obvious choice is the world-leading Environmental Systems Research Institute (ESRI) software. Administration-related tasks will inevitably be "in the job description" unofficially, since licensing of ESRI products have their own special system for this. Acquiring and setting up a lab license with reserve options is fairly straightforward. However, in most large departments, the IT staff holds the key to the network kingdom, and you will invariably need to rely on them (and provide them with the required information) to execute the installations. If you don't have IT staff at all, unfortunately those tasks are beyond the scope of this document (but, do see section 2 for license management resources).

In the BioSciences GIS Facilities, there are three types of labs (a research lab, a teaching lab, and individual professor labs) that house GIS software with two different methods for configuring the installs. Luckily, the University of Alberta has an education site license that is administered through the Computing and Networking Services (CNS), a campus-wide department that acts as the go-between for Biological Sciences and ESRI. The number of license seats required for the BioSciences GIS Facilities are ordered through CNS, which procures and provides the software media, license file, and hardware key. So, all that needs to be done on the BioSciences end includes:

1. Coordination of new acquisitions and annual renewal of license seats
2. Set up the license manager and the options file
3. Install the software product(s) and periodic upgrades
4. Configure server access
5. Maintain specialized hardware

1. Coordination of new acquisitions and annual renewal of license seats

Consider the ESRI-automobile analogy. Providing advice on which software product researchers need may be challenging. Some are complete newbies and will rely on your judgment; others may have used something called ArcView in the past and heard that ArcInfo is really 'difficult.' The relatively savvier will ask for ArcGIS (or ArcMap) but won't recognize that they need to decide on a **level of licensing**: ArcView, ArcEditor, or ArcInfo. Understanding the software products is the first step in licensing. The following analogy attempts to explain the differences using an automotive analogy:

ESRI is the name of the company that makes the product. ArcGIS Desktop is the make, which is designed as a standard user interface (e.g. a car has four wheels, an engine, breaks, and a steering wheel) that operates in the same manner regardless of the model. This leaves ArcView/ArcEditor/ArcInfo (= hatchback/sedan/wagon) as the model. The amount one pays increases according to the model because of the amount of space, equipment, or features: respectively less for the hatchback and more for the wagon. The same is true for ArcView 9 (lower license cost for fewer tools and functionality) and ArcInfo 9 (higher license cost for the maximum tools and functionality). Despite the differences in cost and level of functionality, all ArcGIS Desktop 9 "models" (i.e. levels of licensing) are based on the same user interface, which means if you learn one you know how to use the others. The '9' signifies the latest version of the ArcGIS software. ArcView 3.x and ArcInfo 7.x indicates an earlier version in which the interfaces between the two are not compatible.

ArcView 9 'hatchback'

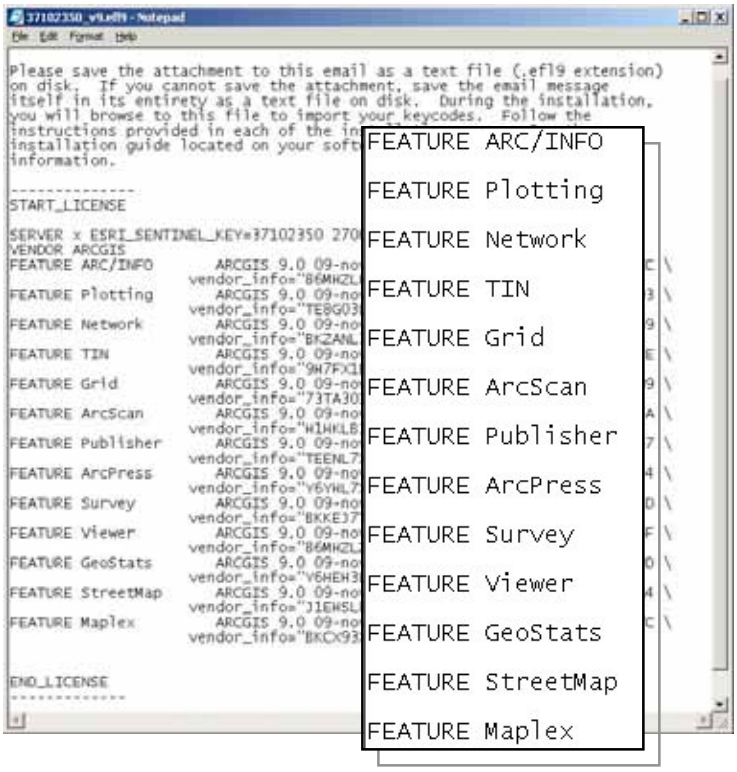
ArcEditor 9 'sedan'

ArcInfo 9 'wagon'

Note: Due to the ecological usefulness of third-party extensions that have not yet been translated for ArcGIS, some researchers may still need access to ArcView 3.x.

After determining that the minimum computer system requirements are met or preferably exceeded (www.esri.com), decide on **one of two types of ESRI ArcGIS licenses: (floating) lab or (single use) computer**. The University's CNS department distributes license seats (www.ualberta.ca/CNS/SITE), so it's just a matter of determining the totals for the Ecology RIG users and collecting accounting paperwork called 'indents' from each.

Single use license acquisition is left up to faculty, students, and staff who wish to install stand-alone GIS software on their University-owned computers. The installation wizard and key code entry for *single use* is really quite straightforward, so is not discussed here.



Organizing *lab* license seats involves submitting the total numbers for each feature to CNS, who forwards the request to ESRI, who then responds with the license file. The 2005 license file for BioSciences shown in the figure requires installation on a designated server along with a unique hardware key. An explanation of the features is beneficial in knowing what the license file unlocks (because even though you may install everything provided by the media on a particular computer doesn't mean the computer has been authorized to use it).

The following table elaborates on the license features:

Feature	Actual Product Name
ARC/INFO	ArcInfo 9
Plotting	ArcPlot
Network	ArcInfo Network
TIN	3D Analyst
Grid	Spatial Analyst
ArcScan	ArcScan
ArcPress	ArcPress
Survey	Survey Analyst
Viewer	ArcView 9
GeoStats	GeoStatistical Analyst
StreetMap	StreetMap
Maplex	Maplex

2. Set up the license manager and the options file (FLEXlm and esri.opt)

If you're new to software licensing, the absolute first thing to do is read the ArcGIS help files on the topic, which are easily accessible online, from the media, or the install directory of the software (e.g. C:\arcgis\Documentation). The following provides an overview on how BioSciences sets up floating license seats for the Windows operating system in a lab environment:

Activity	Description	Responsibility of…
Identify the computer/server that will be hosting the license manager	The full computer name is how Windows recognizes the host machine on the network. (Help Topic: Checking the hostname on Windows)	IT Staff
Obtain your site's license file of the necessary access keycodes	This is a file that gets sent from ESRI upon request of the features selected in section 1 above, and receipt of payment, naturally.	GIS Technologist
Affix the hardware key	A physical device mailed from ESRI fits on a serial port and locks the license file to the particular host machine. (Help Topic: Verifying the hardware key number)	IT Staff
Install the ArcGIS License Manager on the host machine	Insert the ArcGIS Desktop CD and choose the install option in the setup dialog, or access the LMSetup.exe in the \License directory of the CD. (Help Topic: Installing the License Manager on Windows)	IT Staff
Refer to the Help Topics under the heading Advanced License Manager Topics for information on such matters as firewall support and options files	Because you may be interested in confining use of the GIS software to dedicated computers, the license manager has a way to prevent others from "borrowing" seats.	IT Staff and GIS Technologist

The following basics are devoted to using an options file, which is a file that tailors the behavior of the license server based on user, hostname, display name, or IP address by:

- Permitting and/or denying the use of features. This identifies which users may or may not access the license server to authorize use of software installed on their computers.
- Reserving features licenses. This effectively sets aside software features that should be dedicated to the identified users.
- Control the amount of information logged about licenses.
- The esri.opt file guarantees that the research lab computers and professors' lab computers can always access the licensed features paid for; for example, you don't want to be denied use of the sole ArcInfo seat in the research lab because the research assistant to Professor Borrows (who has an ArcView license) logged on to the network prior to you and knows how to switch products in the Desktop Administrator (more on that later).

In BioSciences, the GIS Research Lab has ArcInfo-ArcGIS, the teaching lab has ArcView-ArcGIS, and individual professors' labs have either ArcView or ArcInfo installed on their computers. To ensure that each user gets the correct license seat, the options file is set up to reserve the required features, and there are many possible scenarios for doing so. For example, there must be dedicated ArcInfo-ArcGIS seats available at all times for the GIS Research Lab (and in the GIS Technologist's office, for that matter); i.e. we do not want these seats to be "accidentally" taken by another user in the building who is allowed access to the license server. These other users are the individual professors' labs, and similarly, they need to have dedicated licenses available for their exclusive use. The options file defines which features are reserved for which users, and even better, multiple users can be allowed within a defined group. In this particular case, perhaps Professor Double has two graduate students working in her lab on two computers, but has purchased a single ArcView-ArcGIS license seat. The ArcGIS software can be installed on the two computers, which can both be reserved for a dedicated seat, but only one student may access the license server at a time on either of the computers. Works out great because while one graduate student is at class then the other can do GIS. There are many possible scenarios, and the following simulates an esri.opt file to illustrate the situations that have come up in BioSciences (actual computer names have been changed):

ESRI.opt - Notepad

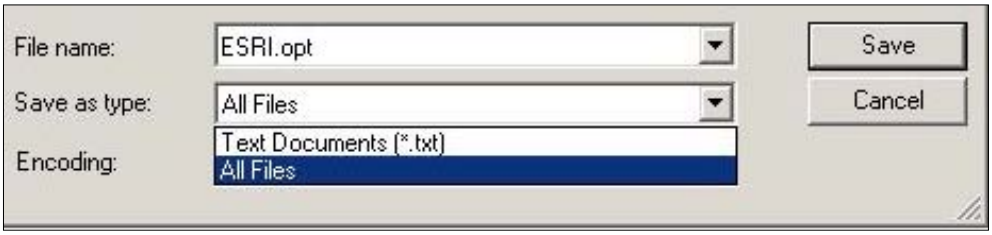
File Edit Format Help

```
# Define the groups
HOST_GROUP AQUA_LAB Zoo_1100
HOST_GROUP DOUBLE Student1 Student2
HOST_GROUP MEGAFAUNA megafauna canis alces rangifer nielsen
HOST_GROUP MEGAFAUNA_2 ursus
HOST_GROUP BIRD Z900-Bird nielsen
HOST_GROUP TECH Charlene
HOST_GROUP GISLAB Lab1 Lab2 Lab3 Lab4 LAB-TABLET

# Reserve AQUA_LAB
RESERVE 1 Viewer HOST_GROUP AQUA_LAB
# Reserve DOUBLE
RESERVE 1 ARC/INFO HOST_GROUP DOUBLE
# Reserve MEGAFAUNA
RESERVE 1 ARC/INFO HOST_GROUP MEGAFAUNA
RESERVE 3 Viewer HOST_GROUP MEGAFAUNA
# Reserve MEGAFAUNA_2
RESERVE 1 ARC/INFO HOST_GROUP MEGAFAUNA_2
# Reserve BIRD
RESERVE 2 ARC/INFO HOST_GROUP BIRD
# Reserve TECH
RESERVE 1 ARC/INFO HOST_GROUP TECH
# Reserve GISLAB
RESERVE 4 ARC/INFO HOST_GROUP GISLAB
RESERVE 1 Viewer HOST_GROUP GISLAB
```

Tips for creating esri.opt files:

- Detailed specifics on the FLEXlm syntax is available at: C:\arcgis\Documentation\License_Manager_Guide\lmrefguide.htm >>> Advanced License Manager Topics >>> The options file
- Use a standard text editing program (e.g. MS Notepad) and save as All File types using a ESRI.opt as the name and extension. When completed, load this into the license manager, or provide to IT staff to do so.



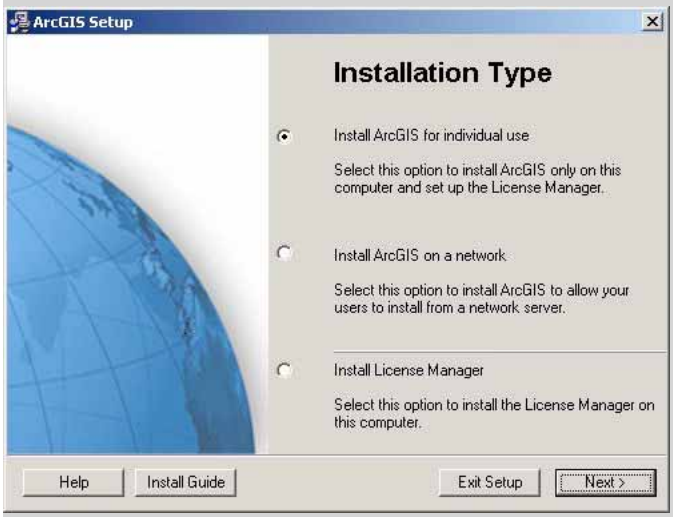
- The '#' is used for comments.
- Users may be grouped together using the keyword "HOST_GROUP" followed by an assigned name and a listing of computer names (IP addresses may be used if they are static).
- The "RESERVE" keyword is the only one used, but other actions are available. Follow "RESERVE" with the number of features, feature name, the "HOST_GROUP" keyword, and the group name.
- The features are the same as defined in the table in section 1. All features included in the license file may also be specified to reserve (or exclude), but because BioSciences (along with the rest of the University of Alberta) may receive all ESRI extensions with ArcGIS it seems redundant to incorporate them in the esri.opt file for our license manager.
- Keep in mind that a user can open several sessions of ArcView-ArcGIS or (ArcInfo-ArcGIS) but only check out one license seat.

3. Install the software product(s) and periodic upgrades

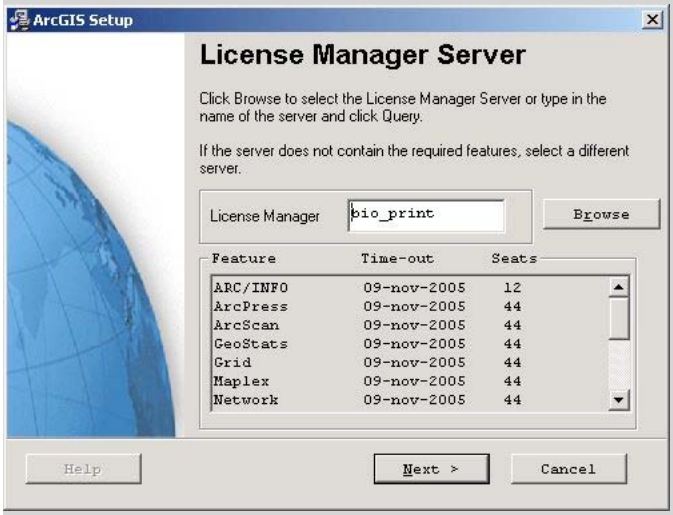
Consider how much time you want to devote to software installation on multiple machines. External software exists that copies the installation configuration from one computer to all others in a lab (e.g. our IT staff use a product named Ghost) and then locks the image down so that on reboot the settings are reset appropriately for each new user (e.g. DeepFreeze). These solutions are ideal for a lab environment, but keep in mind that operating system updates can no longer be automatic. Individual professor labs wishing to have GIS software typically require individual installs that may take up to 2 hours depending on the level of licensing and additional service packs, patches, and third-party extensions. This can be facilitated by network installs of the software (contact your IT staff).

The install disk's help topics provide you with more information: use Windows Exploring to locate the Install.html document (also accessible by clicking the INSTALL GUIDE button when the ArcGIS Setup wizard initializes). The following visually shows a series of what the dialogs look like when **installing ArcInfo-ArcGIS** software on a computer with access to an installed (floating) lab license: Log in to your computer as a user with *administrative privileges*, then insert the first CD to automatically launch the installation wizard:

1. Select the option to “Install ArcGIS for individual use” and then click NEXT to choose to browse for the license manager; click NEXT



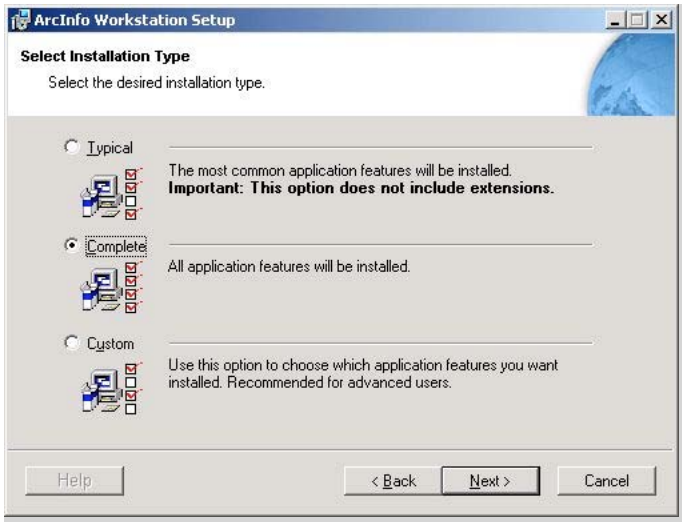
2. Type the name of the license manager machine in the text box and press the ENTER key and then click NEXT



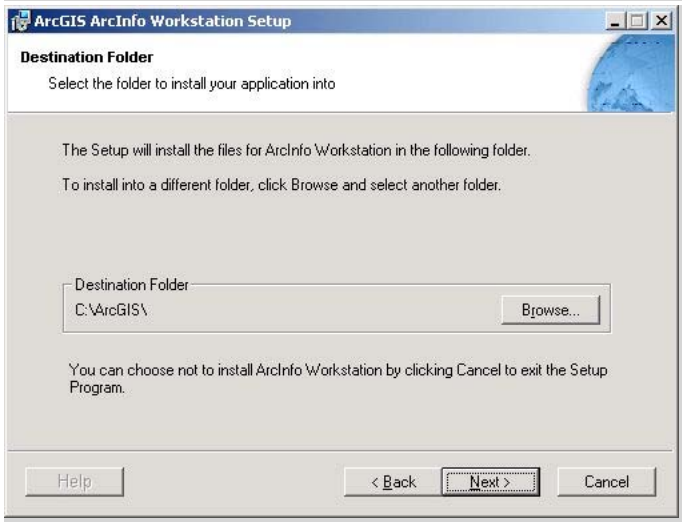
3. Click NEXT after the welcome and warning

4. Read and accept the License Agreement; then click NEXT

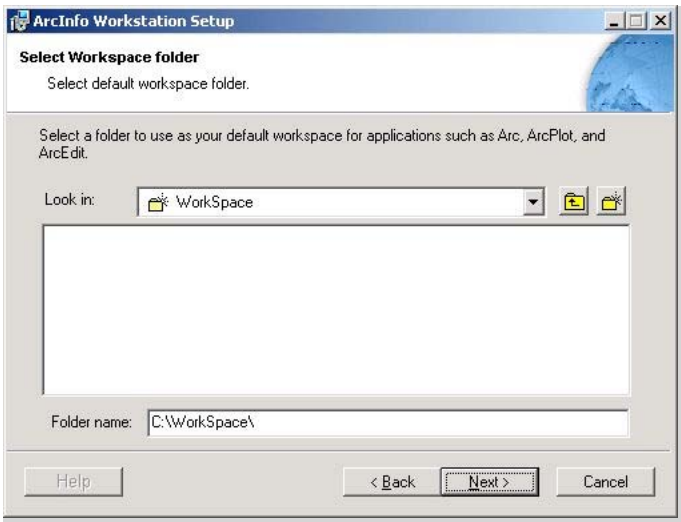
5. Select COMPLETE for the installation type and click NEXT



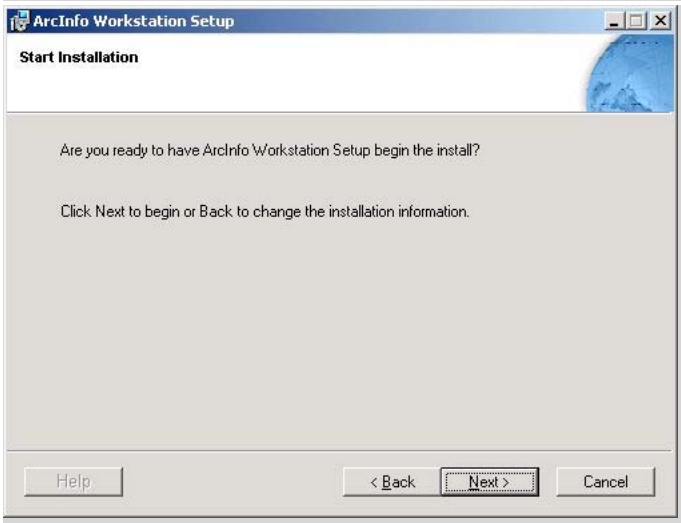
6. Click the BROWSE button and navigate to the installation location (for all products make sure to use a C:\ArcGIS directory – sometimes the installation wizard wants to install in your windows system Program Files directory, which is NOT a good idea due to the spaces in the name!) and then click NEXT



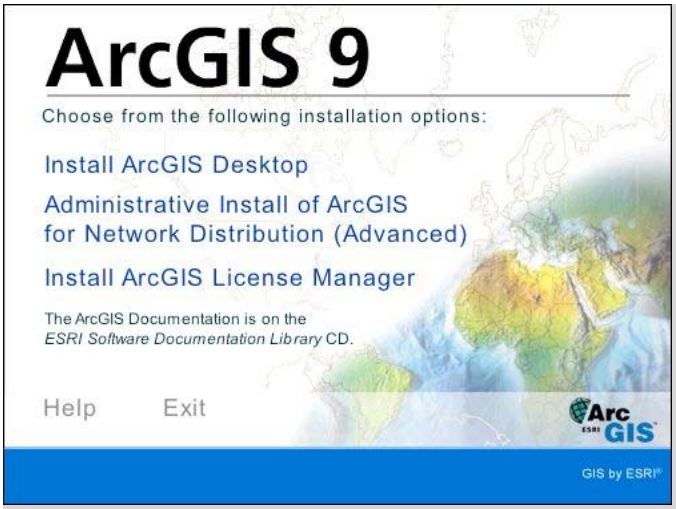
7. Select the default workspace folder and click NEXT



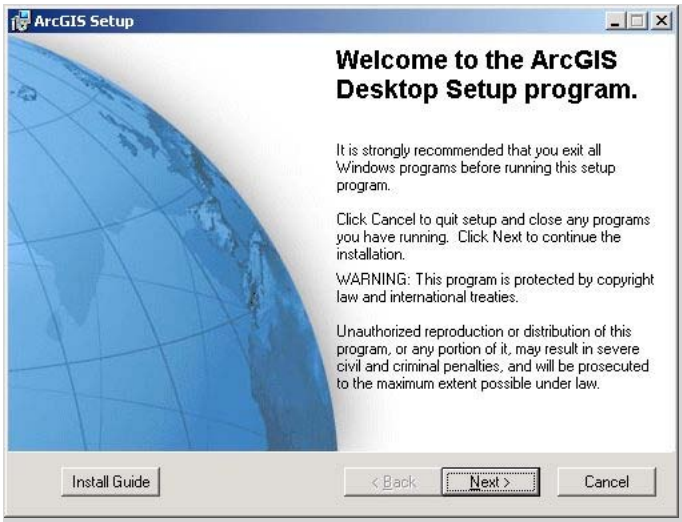
8. Click NEXT to begin installation of ArcInfo Workstation; Wait while the first CD installs, remove when prompted and insert the second CD



9. Once ArcInfo has completed its installation, insert the ArcGIS Desktop CD and select “Install ArcGIS Desktop”

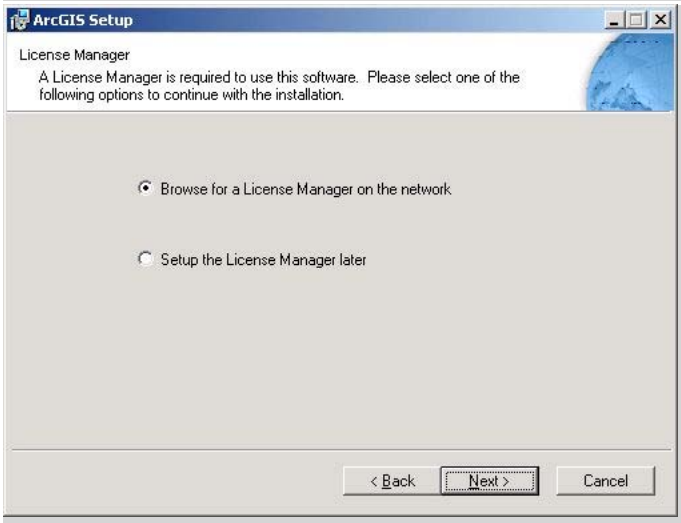


10. Click NEXT after the welcome and warning

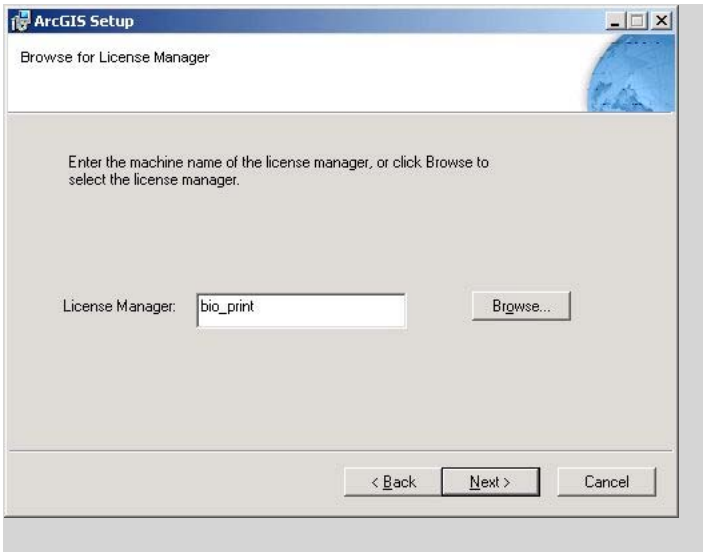


11. Read and accept the License Agreement; then click NEXT

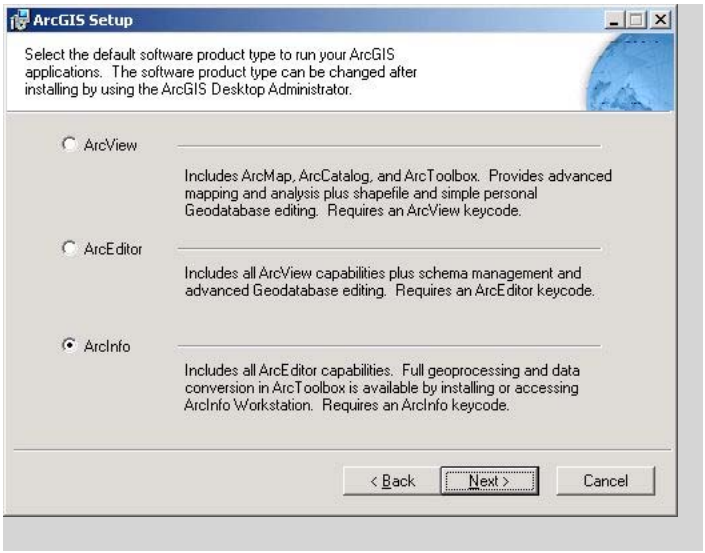
12. Click “Browse for a License Manager on the network” and click NEXT



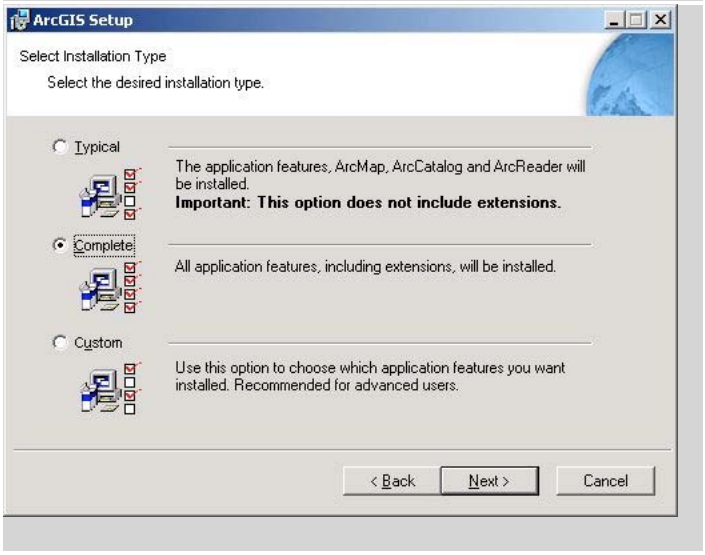
13. Type the name of the license manager machine in the text box and press the ENTER key and then click NEXT



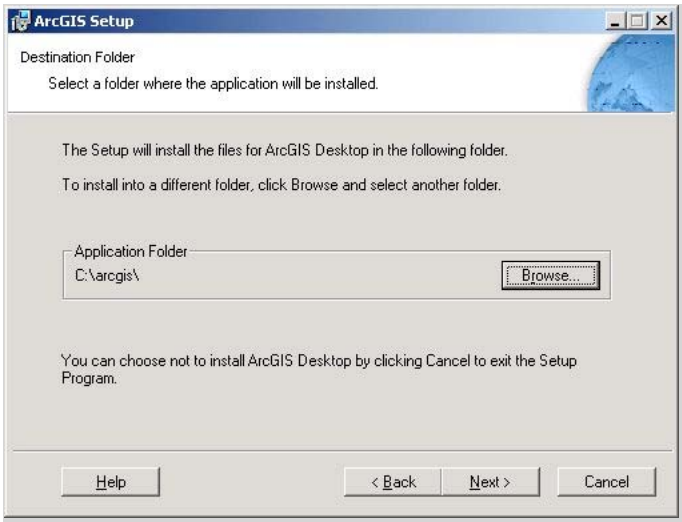
14. Select the software product (in this example: ArcInfo) and then click NEXT



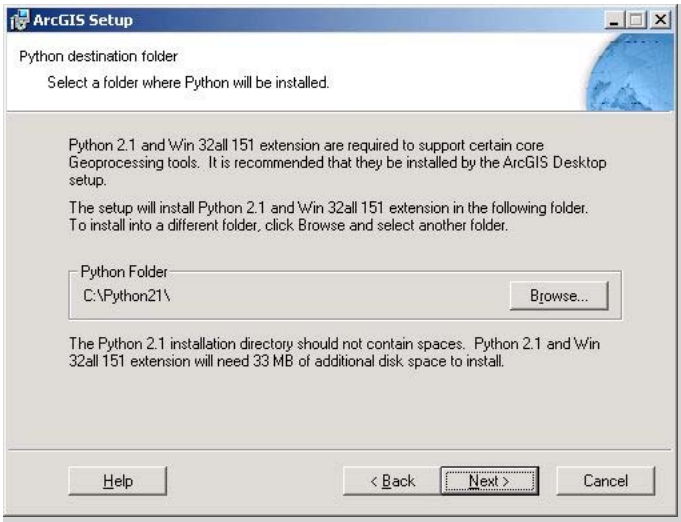
15. Select COMPLETE for the installation type and click NEXT



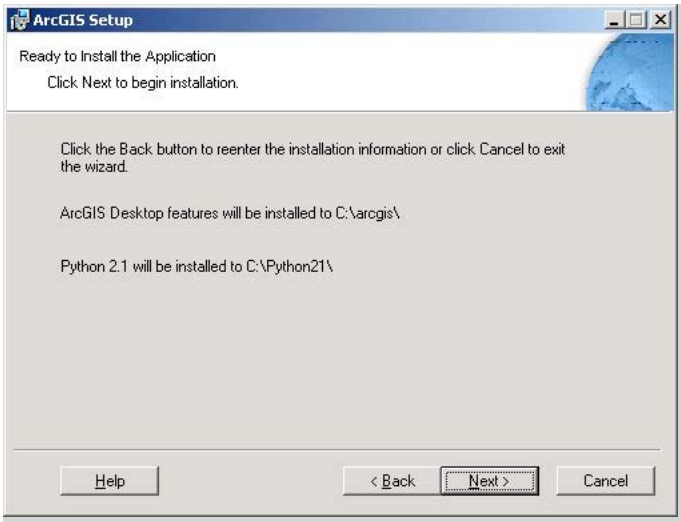
16. Click the BROWSE button and navigate to the installation location (for all products make sure to use a C:\ArcGIS directory – sometimes the installation wizard wants to install in your windows system Program Files directory, which is NOT a good idea due to the spaces in the name!) and then click NEXT



17. Click the BROWSE button and navigate to the installation location for the Python application – accept the default – and then click NEXT



18. Click NEXT to begin installation of ArcGIS

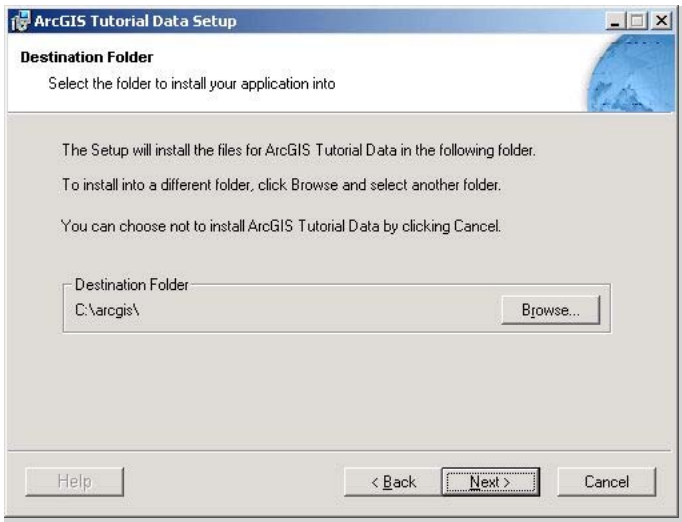


19. Click FINISH when completed

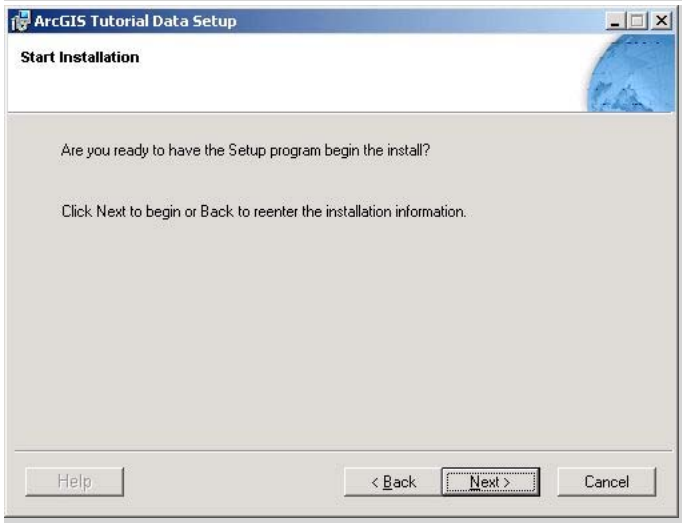
20. Select any additional installation components – the example used here is for "ArcGIS Tutorial Data" – you may wish to forgo installing any additional components if not needed and to save computer hard drive space (Note: Additional disks are required for the Developer and Crystal Reports options.)

21. Read and accept the License Agreement; then click NEXT

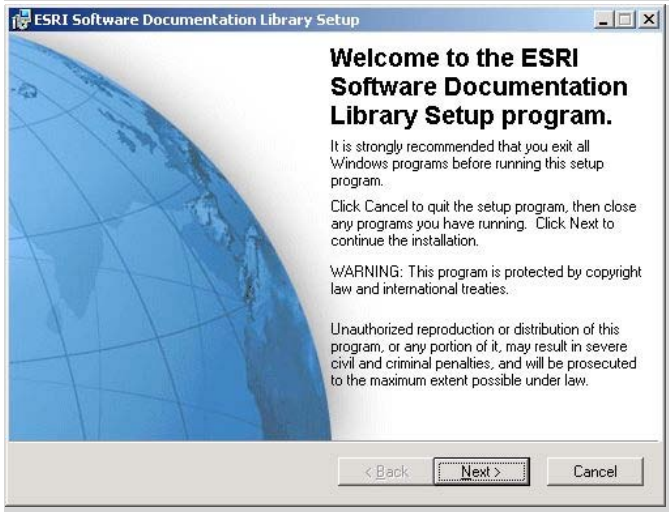
22. Click the BROWSE button and navigate to the installation location for the tutorial data – accept the default – and then click NEXT



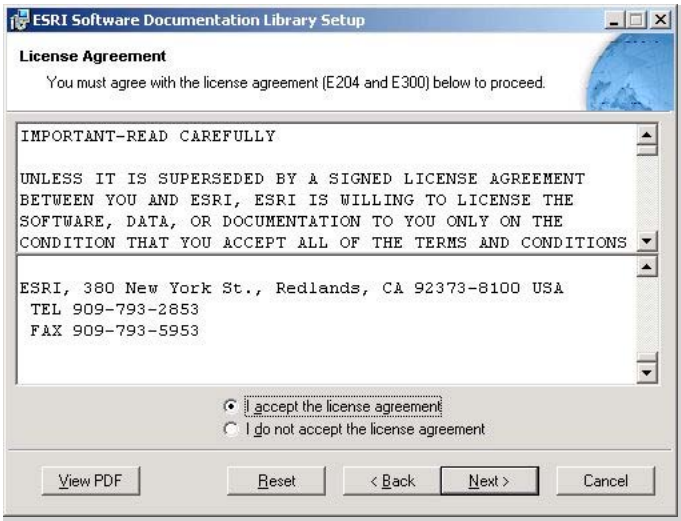
23. Click NEXT to begin installation of ArcGIS; upon completion, follow the installation wizard for any other additional component checked at step 20.



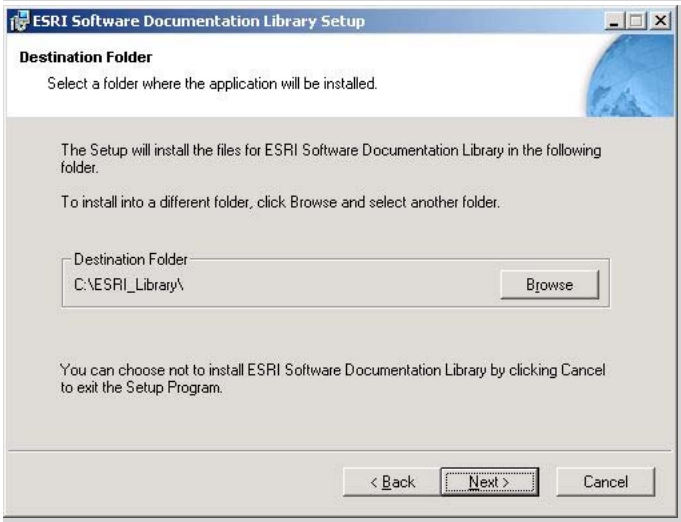
24. Insert the ESRI Software Documentation Library CD and after reading the welcome and warning, click NEXT



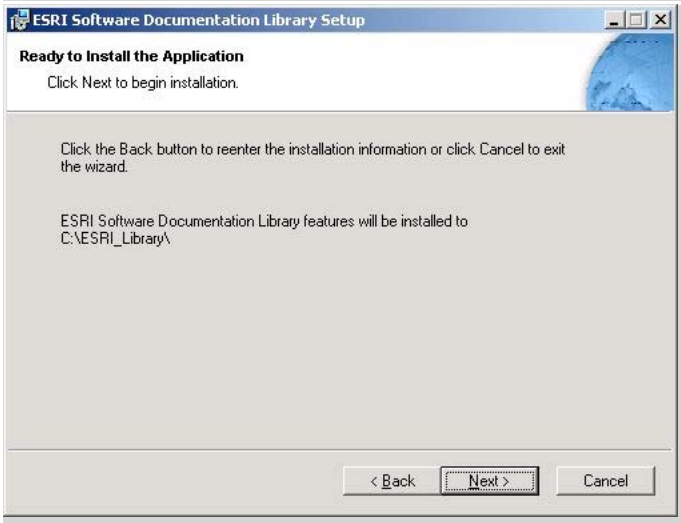
25. Read and accept the License Agreement; then click NEXT



26. Click the BROWSE button and navigate to the installation location for the library files – accept the default – and then click NEXT



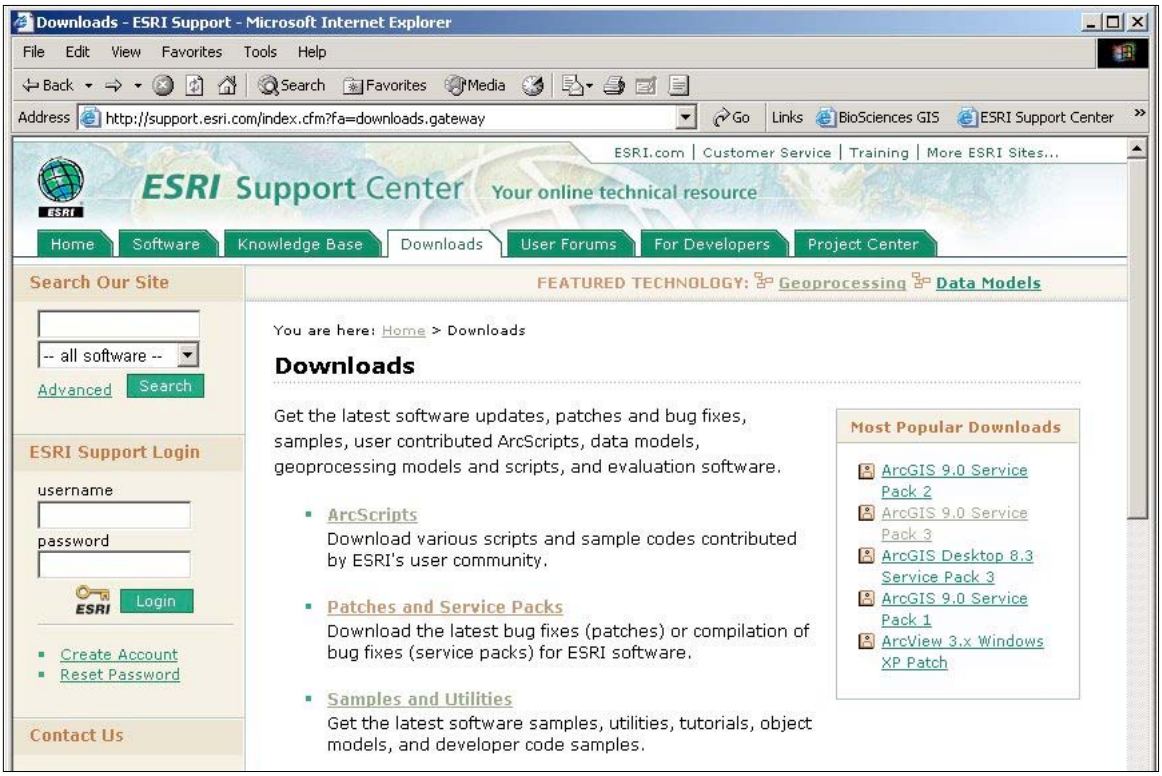
27. Click NEXT to begin installation of the Library



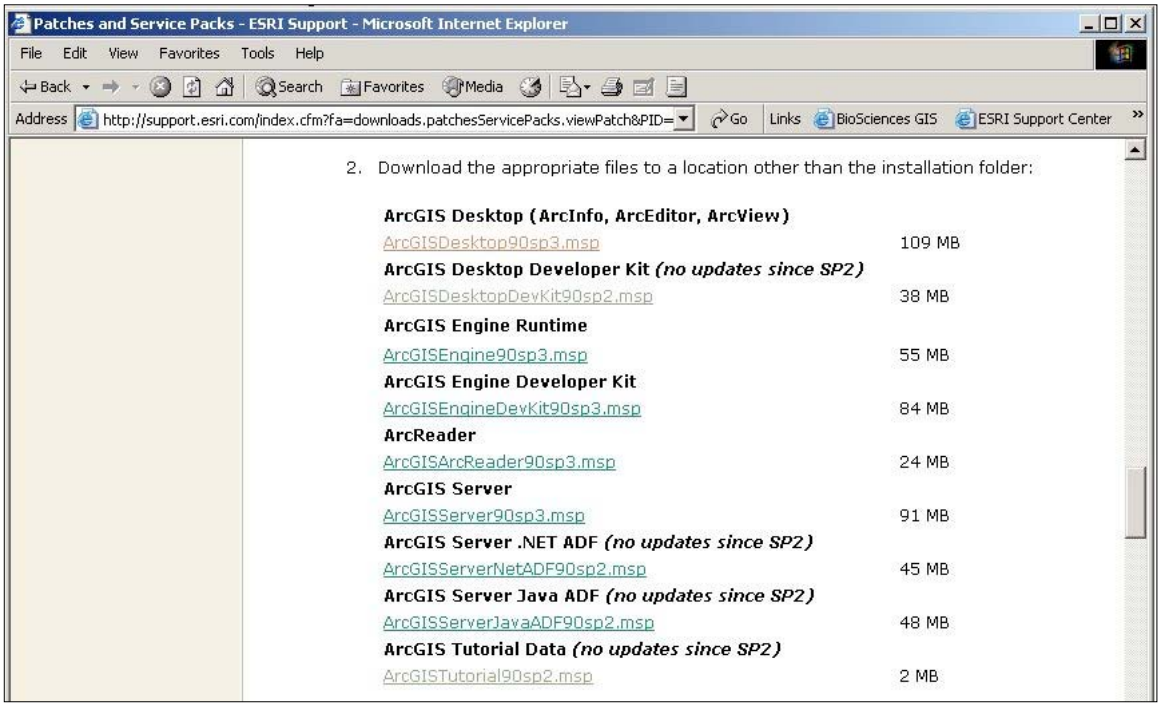
28. Click FINISH when completed

The variations to the above steps for installing a (floating) lab licensed seat depends on the software product; e.g. for ArcView you do NOT install the Workstation CDs at all.

Once the installation is complete, it's a good idea to periodically check for **service packs, patches, extensions, and other goodies**. One stop shopping for these can be found at support.esri.com. The home page announces new items of interest, and the Downloads page links to Patches and Service Packs, ArcScripts (third party scripts and extensions for free enhancement of the out-of-the box functionality of all ESRI products), and other useful products and models.

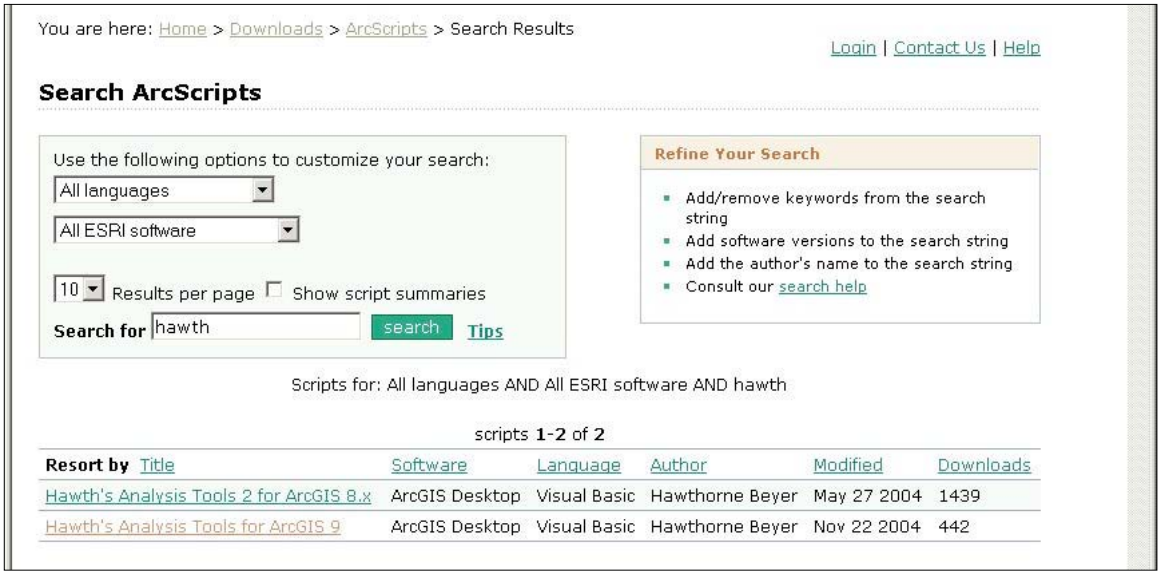


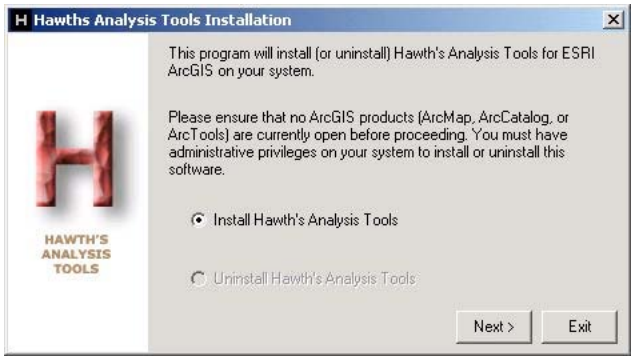
Navigate to the Patches and Service Packs page to locate the latest service pack or patch.



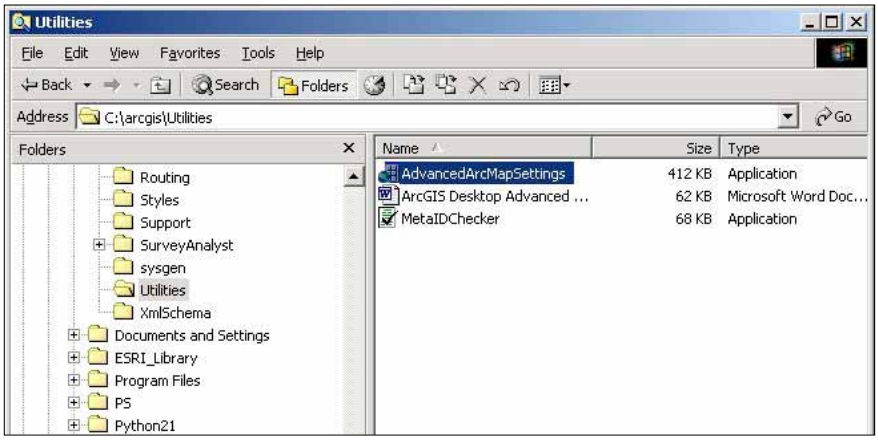
Often, the most recent files you need are posted in the "Most Popular Downloads" box. This example is about Service Pack 3. Once you have found the main page, read through all the information, locate the download link you need, and click on it to start downloading the executable file. Once copied to the local hard drive (e.g. C:\temp), double click on it to run. The installation wizard works the exact same way as when installing the original software product.

Finally, check out arcscripts.esri.com from the Downloads page for additional goodies in the form of third party extensions. An absolutely excellent one developed by Hawthorne Beyer for various ecological applications is *Hawth's Analysis Tools*:

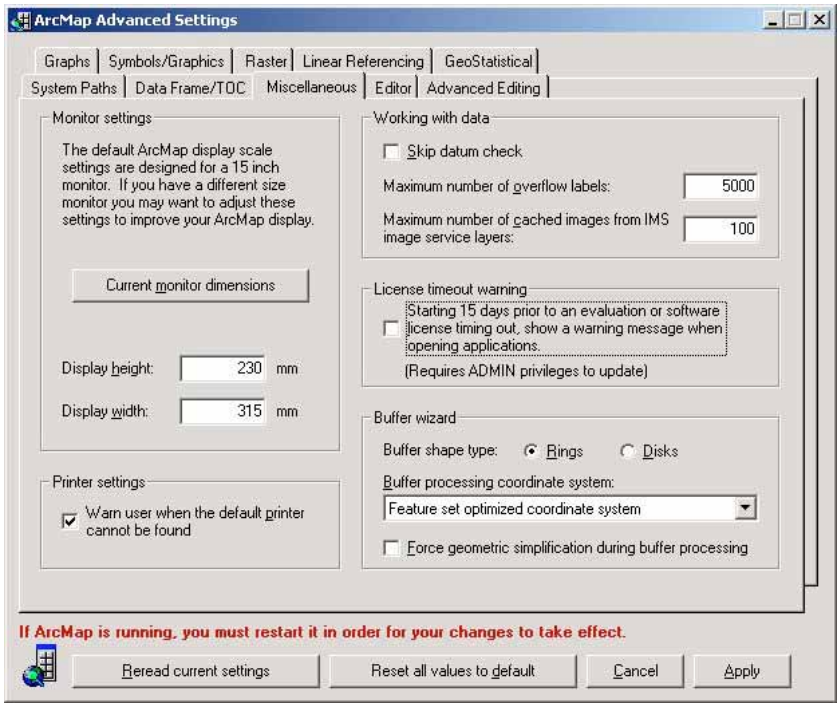




Click on the title link to access the main page, click on the DOWNLOAD button and after reading the disclaimer, click the ACCEPT button at the bottom of the page. Once copied to the local hard drive (e.g. C:\temp), unzip, open the folder, and double click on the htools_setup.exe to run the installation wizard. Follow the default steps. Another useful extension is the *Enhanced Shapefile Creator*, also downloadable from arcscripts.esri.com.



Not exactly a service pack (but this does get affected by new service pack installations), the *ArcMapSettings.exe* application is useful for behind-the-scenes configuring of the software product after installation. Access the program through C:\arcgis\Utilities and double click to run. The main setting you'll want to modify, especially when the software is on the research lab computers, is to remove the pesky License Timeout warning. Click on the MISCELLANEOUS tab, and uncheck the "Starting 15 days prior to an evaluation or software license timeout, show a warning message when opening applications." This particular warning is usually just annoying to the student users who trust that you will take care of it without their needing to know when it is happening. Upon careful consultation of ArcGIS Desktop Help files, you may want to tweak a few other settings for ArcMap. Click on the APPLY button and then CANCEL to close.

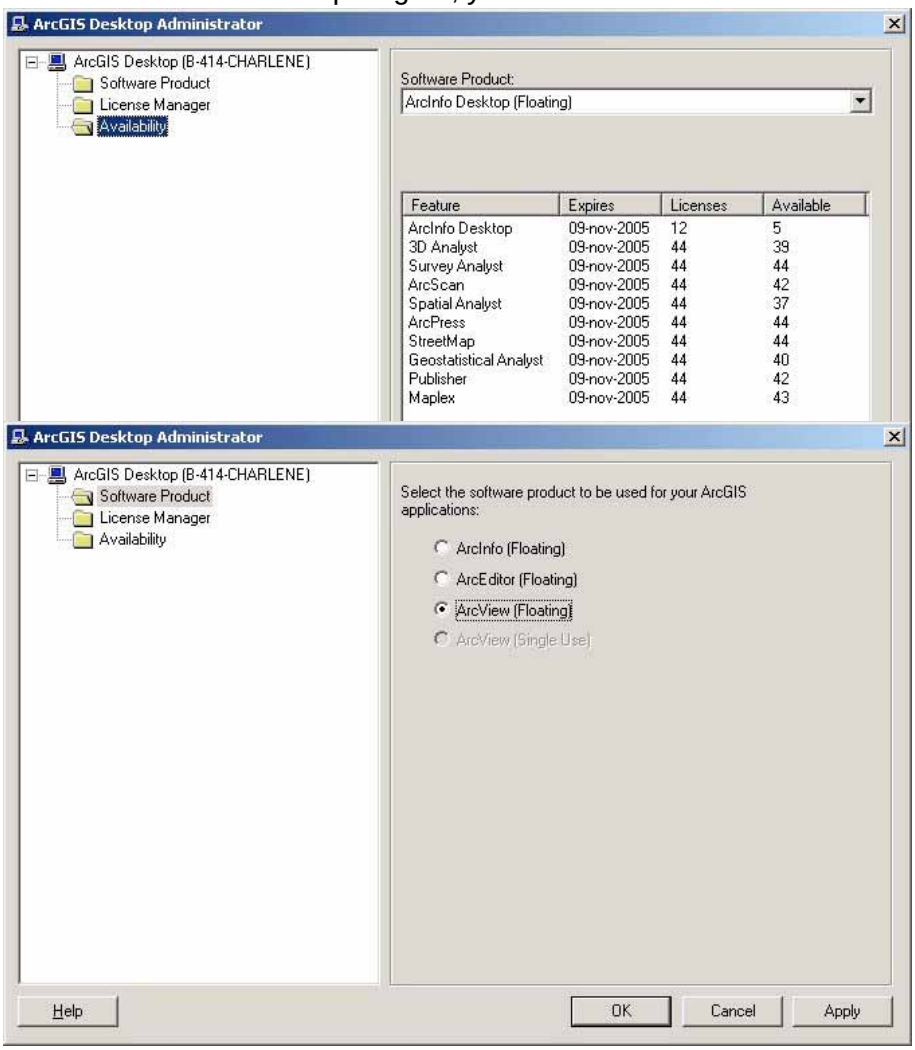


One last 'goody' worth mentioning, especially for Canadian spatial data users, is the *North American transformation grid file for Canada (NTV2)*. This is ideal for projecting between NAD 27 <<<>>> NAD83, but it does not come packaged with the software. It can be downloaded for free at: http://www.esricanada.com/english/bottom/free.asp. Click on NTV2, fill out the required information, download the ntv2_gsb.zip file to your hard drive, unzip, and then copy the NTV2_0.GSB file to C:\arcgis\pedata\ntv2\Canada (you will need to create the \canada folder).

The *ArcGIS Desktop Administrator* is an application you access after installation to continually monitor usage, switch between products on one computer, and change the license manager machine if needed (not shown here).

You can find it at: Start >>> Programs >>> ArcGIS >>> Desktop Administrator.

As the GIS support staff, you may need to view the availability of licenses throughout the Department, and the Desktop Administrator provides quick access to this information via clicking on the AVAILABILTY folder. In the example figure, you see that out of 12 available ArcInfo seats, only 5 are available. This changes as users shut down and start up various ArcGIS applications.



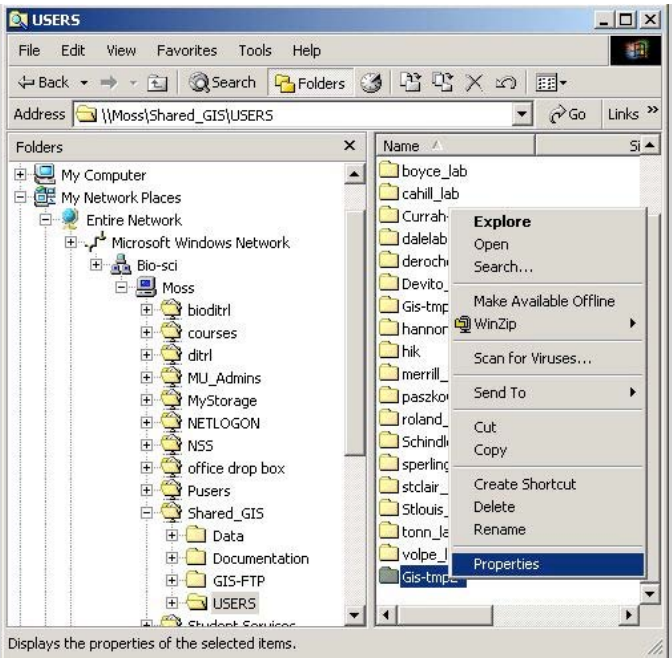
Switching the SOFTWARE PRODUCT is a breeze, especially in the case of Professor Megafauna where four computers in the lab may have ArcInfo installed, but only one ArcInfo seat is available for use. The users may choose an ArcView seat if the ArcInfo one is already in use – this allows more flexibility because then any of the computers has the higher software capability with no restriction (i.e. having to install ArcInfo-ArcGIS) except when more than one student requires use of it.

4. Configure server access

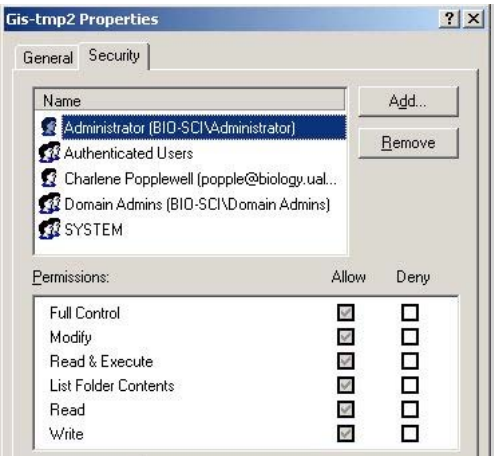
Assisting with data storage opens up another can of worms because operating systems, networking, and the like are more suited to the realm of IT staff than GIS support staff. Knowledge on operational basics, along with server permissions, enables GIS support staff to more effectively help users manage their large spatial databases. In BioSciences, a 300 GB server is committed to the GIS users. Semi-secure access is allowed by setting security permissions so that students in each professor lab may save their GIS files to the lab directory in which no other professor lab may access – this is particularly important when one lab has a data sharing agreement granting only those students use of the data. Similarly, read-only directories are instituted for common data (e.g. ESRI, tutorial, and short course data) and documentation directories (e.g. ESRI user manuals) that should not be altered while on the server but may be copied for use and modification elsewhere. Also, a File Transfer Protocol (FTP) site is provided in which one general-purpose user ID and password enables the transferring of data. This user ID and password may be shared with other organizations who may be providing or accepting GIS-related files.

The networking configurations of a server are beyond the scope of this document and it is assumed that you have access to IT staff to grant you permission to modify the security settings for users. Instructional guidelines on setting security can be found in the Windows operating system help documentation in more detail than the provided overview. Set up a shared directory accessible to everyone on the network, ensure that you have administrator privileges for this shared directory, and create a login ID for each generic lab user. Contacting IT staff is the only option in BioSciences for these services. The following shows how to create a directory with security settings using ***Windows 2000***:

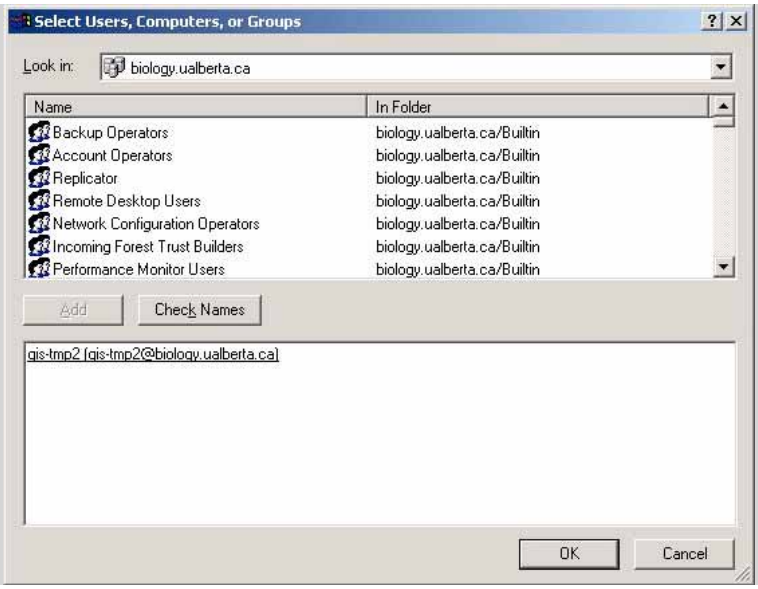
1. Open Windows Exploring
2. Navigate to the shared directory on the network server
3. Create a folder (sub-directory)
4. Right-click on the folder and choose PROPERTIES



5. Select the security tab and then click the ADD button

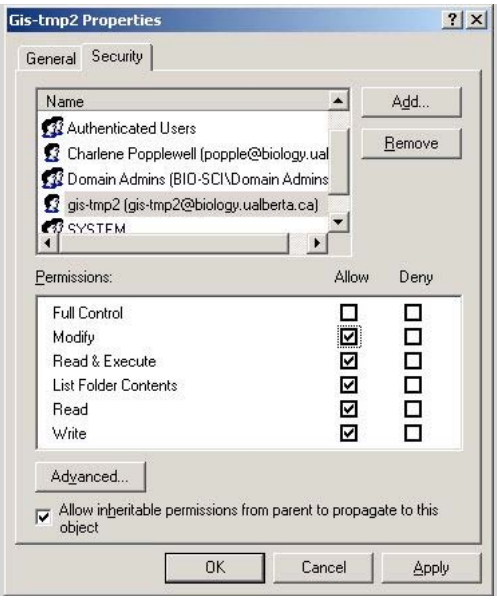


6. Type the user name (previously set up by IT staff) and click the CHECK NAMES button; select the appropriate user(s) and click OK

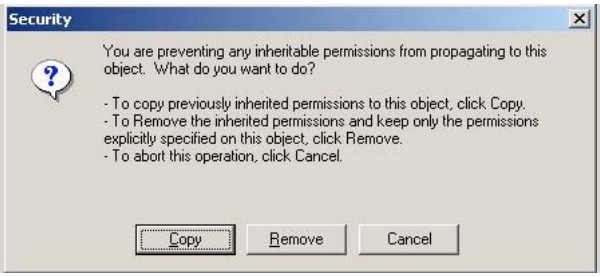


8. Click the check box to allow MODIFY (i.e. all permissions *except* Full Control)

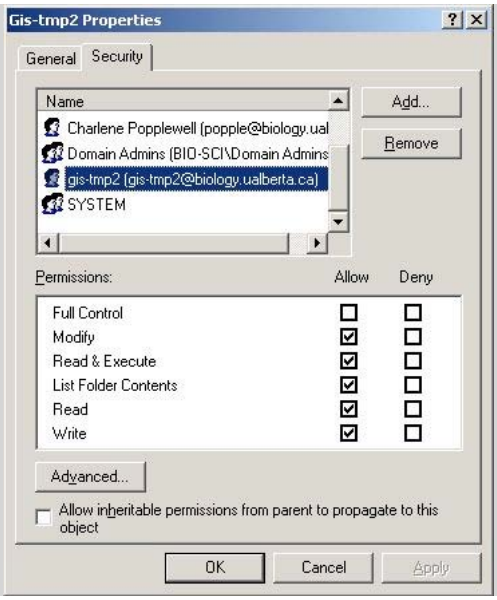
9. Uncheck the "Allow inheritable permissions…"



10. Click the COPY button when the dialog appears



11. Click the OK button to apply the changes and dismiss the dialog window



5. Maintain specialized hardware

Workstations, a digitizing tablet, scanner, printing and plotting equipment are major cost investments. ESRI whitepapers provide insight on system requirements and recommendations for outfitting a lab with the hardware portion of GIS. After the initial purchasing and assembly (not included here), the day-to-day operation generally involves troubleshooting and stocking of consumables (e.g. ink cartridges and paper). Not too difficult – just keep the user manuals handy and provide some step-by-step instructions on how to use the equipment. For example:
http://www.biology.ualberta.ca/facilities/gis/uploads/instructions/AVColorPlotting.pdf
http://www.biology.ualberta.ca/facilities/gis/uploads/instructions/AVPolygonDigitizing.pdf

The BioSciences GIS Facilities has the following monthly maintenance schedule performed on the THIRD Thursday of each month:

1. Clean (delete user files from) and defragment hard drives (with prior notification).
2. Check plotter ink levels and place order if more needed.
3. Check paper roll status and place order if more needed (order 2 rolls each time).
4. Update with any new software upgrades, service packs, and patches (done less frequently than once a month, but is best done during regular servicing).

RESEARCH ASSISTANCE METHODS

Graduate students are at the appropriate level of education for undertaking robust research in their chosen subject matter. The Bachelors degree prepared them to apply typical methodologies in biology, but often these researchers plan to draw on GIS and spatial statistical methods without the benefit of previous formal instruction. Some graduate students are lucky enough to have statistics and/or GIS professors on their thesis committee. For the rest, a dedicated GIS support staff should be a welcome addition to large academic departments. There are virtually limitless responsibilities that could be included in the staff's position description, and often the mere association of a topic with GIS technology (e.g. GPS) may be implicitly anticipated as part of the support. The following topics on GIS research assistance are discussed:

1. Education
2. Documentation
3. Data
4. Applications
5. Programming
6. Networking

1. Education

Helping the masses learn/improve GIS software skills. Users who are up to speed on how to intelligently apply the sciences and tools of GIS are the aspiration of a robust research department. In the absence of a good undergraduate foundation in GIS, graduate students should complete undergraduate-level credit courses related to the spatial sciences, if their schedule permits. However, the offering of alternative learning in the form of online and non-credit courses can be more practical to graduate students who are too busy for the mainstream avenues of education.

Being part of a University that holds an ESRI education site license means excellent opportunities in terms of online training, as well as ESRI's general online support. Every UofA student, faculty, or staff member, has free unlimited access to select online courses at **ESRI's Virtual Campus** (campus.esri.com) in conjunction with the University of Alberta's ESRI Educational Site License agreement. A valid @ualberta.ca e-mail address and access codes obtained by request from CNS are all that is needed.

By instructing several students at the same time on useful hands-on applications, rather than instructing individual students several times over is much more time efficient. The GIS Technologist in BioSciences has filled a previous vacant niche with **short courses** not only because of the learning opportunities, but that they promote the informal networking of graduate students who communicate GIS ideas and data sources with each other as well. Developing a short course is no small task, and for beginner instruction the ESRI Virtual Campus courses are highly endorsed, but for teaching specific and advanced applications a short course is a great medium.

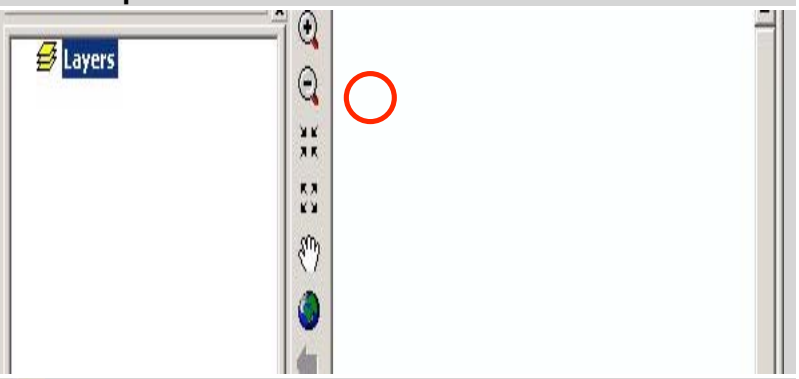
Due to large numbers of beginners in the BioSciences GIS Facilities, the following topics have been developed/instructed using entirely ecological examples:

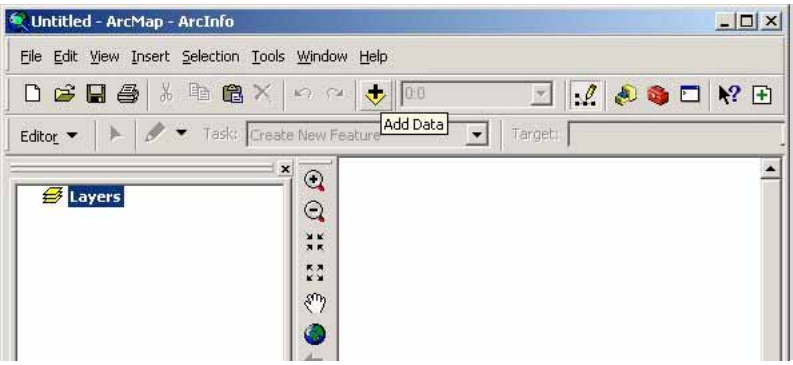
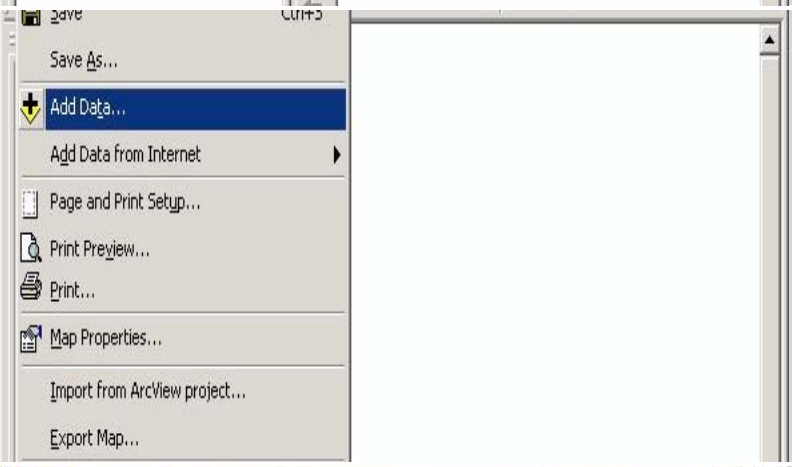
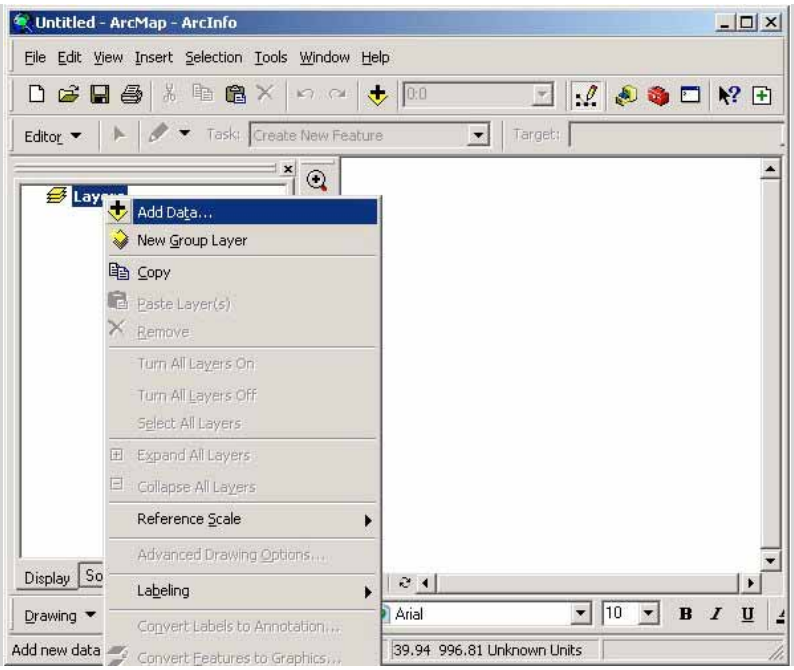
- GIS Project Issues
- Querying and Creating Maps
- Analyzing Vector Data
- Analyzing Raster Data
- More Raster Analyses
- Spatial Referencing
- Visualizing in 3D
- Managing Canadian Digital Data
- Editing and Creating Layers
- More topics under development…

2. Documentation

How to create 'how-to' documents. Common solutions can be modified for many research projects, so sitting down for one-on-one consultation with each individual researcher is not time-effectual or even necessary in some cases. Everyone has his or her own learning style. Some have the gift of being shown ONCE where to point and click to access GIS functionality and retain it for life; others require additional text to refer to again and again. Developing useful technical documents on applying GIS functionality is invaluable and posting them on the web reduces the number of times universal questions must be dealt with on an individual basis. The following suggests tips and tricks for creating methodology documents.

As you work through a GIS analysis that you need to instruct others on how to do, **capture screen displays** of how the program should look at key stages. This is accessed through the keyboard shortcut keys: Alt-Print Screen (copy the active window and temporarily store to the Windows clipboard) and Ctrl-Print Screen (copy to the clipboard the entire desktop including any visible windows and the task bar). The screen capture can then be pasted directly into any word processing document that is able to receive contents of the windows clipboard. MS Paint can be used to modify the screen capture by first pasting the screen capture, cutting and/or editing, and then pasting in another application (or pasting and saving in MS Paint to create an image file for importing. The examples shown below are for MS Office-type applications, but the formatting and alignment functionality should be available in similar software (just search the Help files).

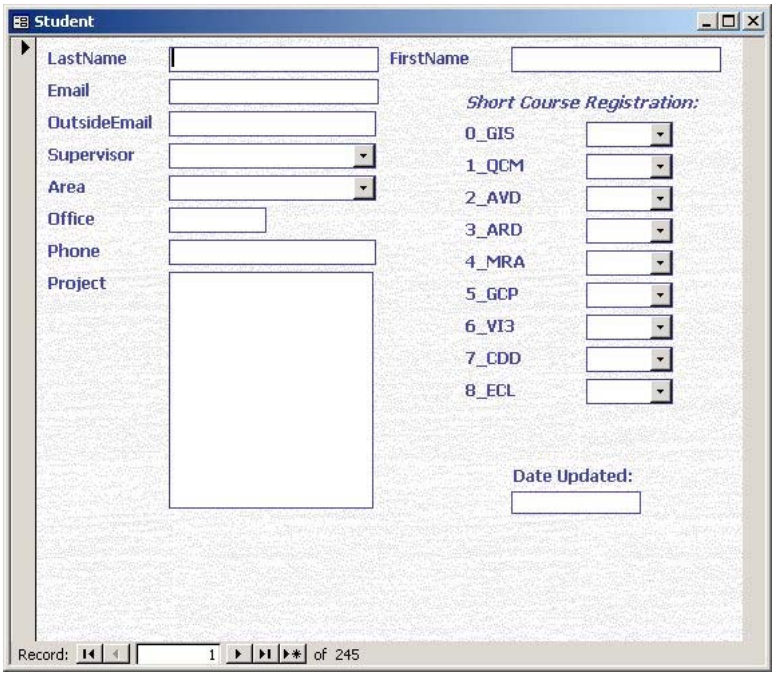
Example: Add Data…	**Screen Capture**
Click on the ADD DATA button – *this example shows the entire ArcMap document captured through Alt-Print Screen, pasted into MS Word (i.e. this paper) with the appropriate button circled (circle shape added using the MS Word Drawing toolbar)*	
Click on the ADD DATA button – *this example shows the ADD DATA button selected and copied from the above screen capture when viewed in MS Paint and then pasted in MS Word*	

Example: Add Data…	**Screen Capture**
Click on the ADD DATA button – *this example shows the ADD DATA button highlighted along with the ToolTip text while the mouse pointer was hovering over it; Ctrl-Print Screen was used to capture the display and then pasted into MS Paint where the desired window area was selected*	
Choose FILE >>> ADD DATA – *this example was copied via Ctrl-Print Screen and then pasted in MS Paint for selection and copying*	
Right click on LAYERS and choose ADD DATA – *this example was also copied with Ctrl-Print Screen while the mouse pointer hovered over the context menu*	
Right click on LAYERS and choose ADD DATA – *this example was selected and copied from MS Paint*	

Web page authoring is a wonderful device for sharing your documentation files and providing further resources. A good web site includes contact information on where to go for consultation, computer lab activity, schedules, archived technical advice, and outside web links to name a few. The Questions & Answers (Q&A) page seems to be a standard with any site and is an excellent location to post solutions to common queries that are often asked over and over and over…. How to create your own web presence is not included in this paper, but a listing of pages to maintain – based on the BioSciences GIS Facilities website (www.biology.ualberta.ca/facilities/gis) – are offered as suggestions:

Heading	Topic	Description
Main	Home	Introductory page with a summary on where to quickly navigate as well as immediate contact information.
	GIS Lab (B418)	Location and access restrictions (if any) for using the specified hardware and software.
	People	The faculty and staff responsible for the on-going evolution of the GIS facilities.
	Research	Where to showcase the fascinating research going on in the Department
	UofA's GIS Brochure	On-campus source for GIS education, facilities, software, data, and contact information for the primary departments applying GIS to research. Not exactly required of any one department's website except perhaps one that gets a lot of enquiries.
Help	GIS Technologist	Who to go for help and consultation on GIS and what s/he can do for you.
	Office Hours	The schedule for reserving a timeslot with the GIS Technologist.
	Instructions	Where researchers can access instructions and documentation on how to perform common GIS tasks.
	Q&A	Also known as the FAQ, an offering of advice on software/data acquisition, printing, file storage, suggested citation formats for software/data, and "What ESRI Virtual Campus courses are available for free to the UofA community?"
Links	Education	A list of GIS-related courses offered at the University of Alberta, locally, and online links.
	Web Resources	A smattering of useful links on Ecology, Free GIS Data & Resources, General Utilities, GPS and Telemetry, Remote Sensing Resources, Software in the GIS Lab, Statistical & Spatial Software, Tutorials & Online References, and University of Alberta Resources.
	Alberta & Canada	Valuable web sites for obtaining a variety of vector and raster digital data from online Canadian and Alberta sources. Less broad than the data links in the Web Resources page, tailor the content to researchers' general study areas of interest.

A monthly **digital newsletter** is a useful forum for getting the word out to the entire Department or a listserv without inundating everyone's e-mail boxes each time a GIS newsworthy event or topic arises. Anyone who signs up for the GIS User Group e-mail list will be the first to receive edited announcements on the free short courses, events, and other GIS-related resources for the Department of Biological Sciences. See ***APPENDIX B*** for an example newsletter that is sent out at the beginning of each month; especially useful for giving advance notice of hard drive cleaning.



This GIS User Group list is facilitated by a **database** (MS Access) that houses researchers' and students' names, e-mail addresses, working project titles, area of specialization, registration for short courses, etc. Outside of the department contacts are included in the list, but can be excluded when sending out Department-only messages.

3. Data

Data collection is usually the responsibility of the researchers. However, they may need varying levels of assistance when dealing with data sharing agreements, simple downloading and processing of publicly available online spatial data, and even help with planning the specialized collection of their own data to ensure they get as close to what they require for appropriate analyses. There are several places for researchers to pick up base data as well as their own research data, including: licensed government data, industry-related projects, field data collection, online sources, and digital conversions.

Some academic institutions have (as does the University of Alberta) access to comprehensive **licensed government databases** for teaching and research purposes. The Library – the logical choice – acts as repository and mediator for licensed databases and generally provides additional services with respect to spatial data resources (www.library.ualberta.ca/subject/maps/spatialdata). The customary packaging of metadata files with these sophisticated databases makes them a very attractive option indeed.

Professional affiliations among professors and various **industries** (agriculture, energy, engineering, forestry, tourism, etc.) are another avenue, and definitely involve strict data sharing agreements that may require consultation with the university Research Services Office (www.rso.ualberta.ca). It may be necessary to negotiate metadata and/or processing support.

Part of any Ecology RIG researcher's program will invariably involve trudging through the elements of the great outdoors in search of all there is to know about a particular organism or ecosystem. This may involve several of the technologies related to GIS: mapping, remote sensing, GPS, biotelemetry, and databases for managing such attributes as weather and biophysical observations. A well-informed (i.e. GIS-literate) graduate student will be better prepared to efficiently collect **field data** so that s/he can incorporate them into a GIS as easily as possible by analysis time. The promotion and implementation of careful metadata documentation will ensure that consistent and user-friendly spatial data are obtained from the outings. It's difficult to assist a graduate student transform GPS coordinates to a desired projection when the receiver's projection settings are not known!

Perceived as the easiest data option are the **online sources** of publicly available spatial data files. A quick search of the Internet results in copious numbers of web pages devoted to free GIS data. Left to their own devices, resourceful researchers will have no problem finding lots of not-so-useful as well as potentially useful files in a myriad of formats. Hosting exceptionally beneficial links on a Departmental website and posting documentation on how to process files into useable formats, projections, and the like, are the most effective way to keep on top of the ever-changing data acquisition opportunities online. Again, the promotion and implementation of careful metadata documentation will ensure that consistent and user-friendly spatial data are obtained from the online forays. It is good practice (and just plain common sense) to download every supplementary file with "readme," "help," "meta," or "metadata" in the name.

If the appropriate spatial files are unavailable by any other means then they must be created. Hardcopy maps and air photos can be converted through scanning or **digitizing**. Scanning may be a challenge because conventional flatbed scanners may not be wide enough for air photo dimensions. Access to a drum scanner (CNS website: www.ualberta.ca/CNS) is needed to capture large-format maps in their entirety. Digitizing – heads-up (on-screen) or heads-down (tablet) – is the most laborious effort that graduate students could subject themselves to, especially when their very small research organisms of choice are sampled across vast areas. Imagine scanning a hundred high-resolution air photos, performing meticulous georeferencing, and mapping out useful habitats based on interpretation and field knowledge with no prior experience. Sometimes the best support of the GIS Technologist is to look the other way if the odd cup of coffee shows up in the no food/drink policy GIS research lab…

One final note about data… The creators of the data work hard to provide users with the best available products for research, so please acknowledge these sources. Of course, just as there are formatting specifics for scientific journal articles and books, the following offers some guidelines for **citing data** (and software):
http://library.owu.edu/citing222.html and http://library.mcmaster.ca/maps/mapcite.htm

Author. Title from series [format]. Edition. Scale. Series, sheet number. Place of publication: Publisher, date.

EXAMPLES:

Natural Resources Canada. "Athabasca" [computer file]. 2nd ed. 1:50,000. National Topographic Database (NTDB), NTS map sheet 083I11. Sherbrooke, Quebec: NRCan Digital Topographic Data, 1998.

Environmental Systems Research Institute. ESRI Data and Maps [computer file]. Redlands, California: Environmental Systems Research Institute, 2003.

To find out the particulars of your dataset, consult the metadata or contact the organization that provided it.

4. Applications

But, the methods and models must be biologically appropriate. The intent of this section is neither to insult other disciplines that apply GIS "less" narrowly nor to dismiss those with similar peculiarities. For GIS in the BioSciences, applications in ecological modeling and spatial analyses involve evaluating and providing the researchers with approaches as well as developing custom tools for them to apply to their data. Modeling infrastructure and cartographic generalities can withstand a little bending of the rules. Not so when biological organisms and habitats are not clear-cut geometric shapes, are more dynamic than can be adequately modeled with available data, and just won't behave in a way to make analyses easy (e.g. conform to some arbitrary administrative boundary). Some example issues include:

- Marine/aquatic organisms are simply not capable of moving across land, and distance measures in a GIS must account for this.
- In reality, home ranges probably do not encompass much non-habitat, therefore an estimator must balance this with data quantity and quality (e.g. a kernel estimator offers a better solution than a minimum convex polygon).
- A static map does not provide the complete picture for organisms on the move through space and time

Because of the wide variety of applications, a lot more could be said than what is here. It is a balancing act that challenges you to adapt the tools and data representations in such a way as to not simplify the biological phenomena beyond recognition while not "blowing up" the computer. Happily, GIS in biology is by and large like GIS everywhere, and the out-of-the box functionality caters to the majority of users' needs if you can adapt yourself to "think outside of the box" while applying the common tools in clever ways.

5. Programming

And if you still have time after all that… You can really improve graduate researchers' effective use of GIS by providing (brief) scripting and (more lengthy) programming in languages compliant with ArcObjects. Batching is the golden word here. The ability to set up repetitive tasks in a model, script, or extension is indeed a powerhouse in your grab bag of talents as GIS Technologist-bordering-on-Analyst. The latest release of ArcGIS 9 offers even more functionality for your programming accomplishments that can seem almost guru-like to those you support:

- Visual Basic for Applications (VBA) in the form of expressions in the Field Calculator and macros in ArcGIS' embedded VB Editor
- Process flow models in ModelBuilder
- Scripts in Python
- Developing with ArcObjects
- Spatial Analyst's Raster Calculator functions

The simplest of all programming tasks is seen the instant you tap into the Field Calculator, which is accessed when calculating values in an attribute table. Simple functions, mathematical operations, or concatenation on fields effortlessly output new values for table records. ESRI staff (ArcGIS Desktop Help files and Online Support support.esri.com) and other savvy individuals (e.g. www.ian-ko.com's EasyCalculate) offer free VBA code snippets for calculating geometric properties of area, perimeter, coordinates, conversions, angles, etc. Examining theirs and searching for more online (and perhaps a little reading on the syntax of VBA) should arm you with the know-how to customize your own code snippets that can be saved, shared, and loaded again for similar tasks. The following examples show how to make **advanced field calculations using VBA statements** (A) borrowed from ArcMap's help topic on the "Making field calculations" entry on updating area for a shapefile and (B) developed by the author to subtract the preceding date value from the current record to find the mid value as the Field Calculator iterates through the table:

EXAMPLE A (calculate area – from ArcGIS Desktop Help):

1. In the shapefile's attribute table, right click the heading of a Double data type field
2. In the Field Calculator, check the Advanced box
3. In the first text box type (or copy and paste) the following VBA pre-logic script:

```
Dim dblArea as double
Dim pArea as IArea
Set pArea = [shape]
dblArea = pArea.area
```

4. In the second text box type:

```
dblArea
```

EXAMPLE B (calculate middle date between two records – from the author):

1. In the shapefile's attribute table, right click the heading of a Date data type field
2. In the Field Calculator, check the Advanced box
3. In the first text box type (or copy and paste) the following VBA pre-logic script:

```
Static iMidValue As Integer
Static oldDate As Date
Dim sourceField
'set the source field name as needed
sourceField = [THEDATE]
'check if first record
If ([OID] = 0) Then
iMidValue = Day(sourceField)/2
'store current date
oldDate = sourceField
Else
'get mean date
iMidValue = (DateDiff("y", oldDate, sourceField))/2
oldDate = sourceField
End If
```

4. In the second text box type:

```
iMidValue
```

Note: Please consult the ArcGIS Desktop Help for complete details on implementing the code. Also, for both examples and after you write your own useful snippets, click on the Save button and store the expression in a *.CAL file for future use and sharing.

Because of the (re)launch of **ModelBuilder** with ArcGIS 9, users have access to a powerful visual scripting environment. The resulting process flow models are not only useful for executing multiple steps and setting up easy-to-use interfaces for geoprocessing, but are invaluable documentation for what you have performed. Creating a generic model that a user simply needs to select data inputs, parameters, and supply outputs, is quite an effective way to provide GIS support to the masses. All the information you need to learn how to work with ModelBuilder is provided in:

- ArcGIS Desktop Help
- ESRI software documentation manuals
- A couple of the ESRI Virtual Campus courses campus.esri.com

VBScript and JScript, along with the ESRI-supported **Python**, have made batch processing, conditional scenarios, and application development more accessible. Really good documentation and support can be found at:

- ArcGIS Desktop Help
- Online websites www.python.org
- …and a few good books currently on the market…

Developing with ArcObjects is a task for when you have a large chunk of time to devote to it. Refer to the following for helpful resources:

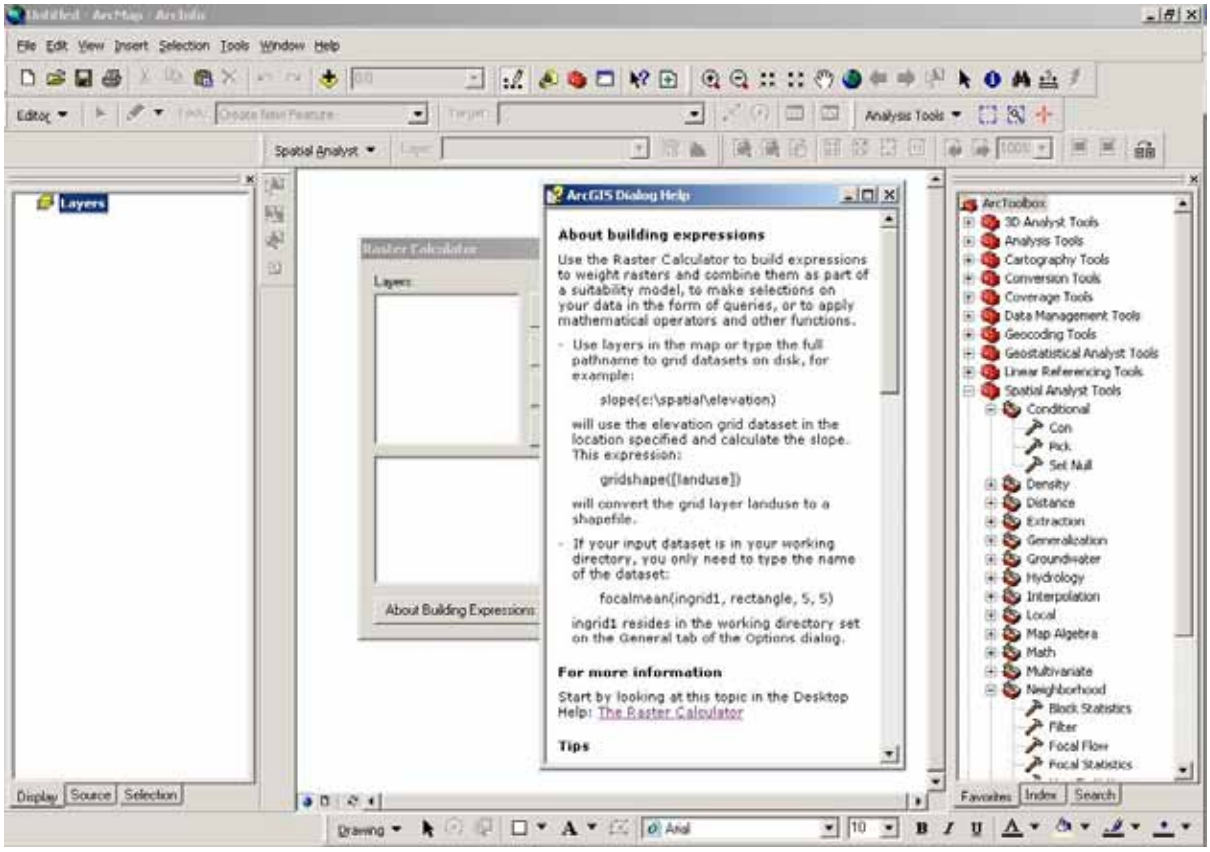
- Desktop_Developers_Guide.pdf
- ESRI Support Center Online support.esri.com
- ArcObjects Online arcobjectsonline.esri.com
- ArcGIS Developer Online arcgisdeveloperonline.esri.com
- Microsoft Developer Network (MSDN) Library msdn.microsoft.com/library
- …and many books currently on the market…

Spatial Analyst's Raster Calculator functions are an untapped method for batching several raster analyses as well as calculating complex raster-based models. Most users are familiar with the basic Map Algebra capabilities, but do you know that you can set up several functions in the calculator to perform sequences of tasks?

Click on the ABOUT BUILDING EXPRESSIONS button in the calculator for a "cheat sheet." See ArcGIS Desktop Help for a variety of useful topics: "The Raster Calculator," "Map Algebra rules," and each individual "tool" name (e.g. MOSAIC, SLOPE, CON, etc.). ESRI Online Support has an excellent reference at:
support.esri.com/search/KbDocument.asp?dbid=21488

EXAMPLE (extracts the proportion of a particular landcover class within a 10 cell radius):

```
pclass3 = FOCALMEAN(CON([landcover] == 3,1,0),circle,10,DATA)
pclass2 = FOCALMEAN(CON([landcover] == 2,1,0),circle,10,DATA)
pclass1 = FOCALMEAN(CON([landcover] == 1,1,0),circle,10,DATA)
```



6. Networking

The other kind of networking. Not to be confused with the practice of linking computing devices together with hardware and software that supports data communications across these devices, but rather meeting regularly with other campus support staff. Having a coffee break with staff from other departments, the library, and IT is time well spent for sharing ideas, coordinating application development, reducing duplication of programming, and learning some hot new tip that will make your life as a solo geography broker easier. Casual discussion of GIS activities may result in mutual education!

An outstanding networking opportunity is to engage in organizing a **GIS Day** event. UofA's GIS Day (2003 and 2004 www.ualberta.ca/~gis) helped bring together various GIS users across campus in to one room where we shared ideas and showcased various research and education applications.

*** Additional support for GIS support staff is available through the software company – ESRI has excellent online support services (support.esri.com) with searchable technical documentation, user forums, and downloads.

PROFESSIONAL DEVELOPMENT

Last but not least, successful ongoing maintenance of GIS resources for research purposes cannot be done effectively if the responsible personnel are not abreast with the latest advances in the science and technology. A lot of the educational options available to graduate researchers should be tested by you as the GIS support staff before recommendation and to better assist other users; this also helps keep your skills sharpened. Reading the latest publications and attendance at local professional meetings, live demonstrations, and seminars are usually low-cost opportunities to learn something new. And once a year, a comprehensive course on programming, modeling, or a new technique is invaluable.

Some good online examples include:

- Courses http://campus.esri.com
- Training http://www.geoconnections.org/publications/training_manual/e/
- Text books and references http://www.eohandbook.com
- Plus many more…

One of the best things about GIS is that you can always keep on learning new things…

ACKNOWLEDGEMENTS

Lots of thanks to colleagues who have offered various tips and tricks that I've incorporated into the day-to-day management of the BioSciences GIS Facilities: Hawthorne Beyer, Cary Wells, Scott Wierstra, Lorne LeClair, Valery Companiytsev, Emily Herd, Gordana Brouilette, Leah Vanderjagt, David Jones, Shasta Rudyk, Medina Hansen, and many others.

APPENDIX A – TASK SCHEDULING

Lab Responsibilities

Task	Time of Year	Amount of Time/Year
1. Coordination of new acquisitions and annual renewal of license seats	October (i.e. as per CNS)	Under 1 day (spread out over several)
2. Set up the license manager and the options file (FLEXlm and esri.opt)	October/November	Under 1 hour
3. Install the software product(s) and periodic upgrades	One initial set up with 1 to 2 times per year for upgrades, service packs, etc. (i.e. depends on software vendor)	1.5 to 2 hours PER COMPUTER for full software upgrade (multiply this by the number of machines)
4. Configure server access	One initial set up with occasional changes as they arise (e.g. new professor)	Under 0.5 hour
5. Maintain specialized hardware	One initial set up per item plus yearly check on performance for digitizer, monthly stocking of consumables for print devices	Under 0.5 hour for digitizer; stocking varies with use

Research Assistance Duties

Task	Time of Year	Amount of Time/Year
1. Education	Fall/Winter semester short courses	10%
2. Documentation	Ongoing	10%
3. Data	Ongoing	10%
4. Applications	Ongoing	50-60%
5. Programming	Ongoing	10-20%
6. Networking	Meetings as needed	6-8 hours

Professional Development Activities

Task	Time of Year	Amount of Time/Year
Networking	As needed; GIS Day in November	Included in above
Meetings/conferences	Varies; may be included with courses below	10+ days
Courses	Varies; good rule of thumb is to set aside 2 hours per week	
Reading scientific and trade publications	Include this with courses above	

APPENDIX B – GIS USER GROUP NEWSLETTER EXAMPLE

Sept2004 - Notepad

File Edit Format Help

September 2004 GIS Announcements

GIS IN THE DEPARTMENT OF BIOLOGICAL SCIENCES

1. Messages from the GIS Technologist
2. Important Maintenance of the GIS Lab Computers - Sept 16th
3. ArcGIS 9.0 Now Available
4. GIS Website Updates
5. GIS in Ecology Short Courses
6. ESRI Regional User Conference - Edmonton - Sept 9th and 10th

1.....

MESSAGES FROM THE GIS TECHNOLOGIST

It's September, the beginning of a brand new semester, and the entire

If you are new to the Department and have GIS in mind for your researc

Simply reply to this message or e-mail charlene.nielsen@ualberta.ca to

If you know of any incoming graduate students, staff, or faculty who w

2.....

IMPORTANT MAINTENANCE OF THE GIS LAB COMPUTERS - THUR SEPT 16th!

Attention current GIS Users:

THURSDAY, SEPTEMBER 16, 2004 - Be advised that there will be a schedul

Regular monthly hard drive cleaning occurs on the THIRD THURSDAY of ea

It is your responsibility to ensure that your data is backed up to net

Consult the GIS "Q&A" page (at http://www.biology.ualberta.ca/faciliti

P.S. If you are paranoid like me you should ALWAYS make sure your data

3.....

ARCGIS 9.0 NOW AVAILABLE

The latest, greatest version of ArcGIS software has been or will be in

Over the next couple of months I will be in contact with individual la

4.....

GIS WEBSITE UPDATES

http://www.biology.ualberta.ca/facilities/gis/

If you are looking for mostly free data and useful resources, see the

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