Szafoni

USING A GEOGRAPHIC INFORMATION SYSTEM (GIS) TO INTEGRATE DOC NATURAL RESOURCE DATA

STREAMS DATA COMPONENT

ANNUAL REPORT

APRIL 16, 1992 TO APRIL 15, 1993

Illinois Natural History Survey Report to the
Illinois Department of Conservation

Diane L. Szafoni, Peter B. Bayley,
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INTRODUCTION

The Illinois Department of Conservation (IDOC) currently manages a fish and wildlife data base, the Illinois Fish and Wildlife Information System (IFWIS) and a streams data base, the Illinois Streams Information System (ISIS). Although both have a narrative component, utilization of the two data base management systems and the mechanisms utilized to produce map output are quite different.

Data capture for the **Illinois Streams Information System (ISIS)** was begun in 1981 to meet the policy analysis and management needs of the IDOC Planning Division. It was developed and maintained through a contract with the IDOC and the Departments of Landscape Architecture and Urban and Regional Planning at the University of Illinois. ISIS was created specifically for stream inventory and classification, permit review, and development of stream management policies. It contains a wealth of information on the State's surface water of potential use to managers and researchers alike.

The ISIS data base is a relational data base organized by river and river mile index (RMI) (Hinrichs, M.A. and L. D. Hopkins, 1991) The streams in ISIS were grouped into ten river basins (Figure 1) and all streams were given numerical, 32 digit codes. Data for the streams were then measured to 0.1 mile accuracy, starting from the mouth of each stream. At present ISIS has both a narrative and a graphical component tied to the RMI for each stream reach with a drainage area greater than 10 square miles.

The narrative component of the ISIS data exist in tabular form and represent information for each stream on locational, physical, biological, chemical, cultural, recreational, and developmental characteristics. All of the information for each of these streams are stored in a topologically structured relational data base (i.e., upstream/downstream and left bank/right bank relationships are preserved).

An Autocad file (a suite of programs used primarily for computer-aided drafting) of a 1:700,000 scale representation of the streams of the state was used for graphical display. However, this graphic representation was inadequate for GIS work and an alternative was needed. In particular, the graphic capabilities were too limited and cartographically inaccurate to be complimentary with other state environmental data bases that exist or are being developed on the Illinois Geographic Information System (IGIS).

The focus of this project was to use GIS technology to create an accurate hydrologic coverage and 'tie' the tabular data points in ISIS to the coverage. The resulting coverage can then be used to integrate the data contained in both the ISIS and IFWIS data bases. Integration, as defined here, is to establish a mechanism by which both data bases can be linked via GIS concepts.

Linkage of these data bases to a cartographic base will increase the utility of this data base and provide a common topographic framework for the integration of additional

IDOC data. The conceptual design that establishes this linkage and the resultant geocoded stream network will better meet the management and planning needs of the Illinois Department of Conservation and the State of Illinois

Task 1. Respond in a timely and priority manner to all requests for information by the Governor's Land and Water Use Task Force.

Progress: The ISIS data base was used to provide information for the Critical Trends in Flowing Waters segment of the Governor's Land and Water Use Task Force report. The information used included the percent of the streams in the state that were channelized, owned by public agencies, and that have canoe access. The percent of bankside landuse in five landuse categories was also tabulated for a 25 meter band of land on each side of the streams. The ISIS landuse categories were grouped into five categories that allowed comparison with LUDA (Land Use Classification) data. The categories include: urban, agricultural (agricultural and grassland), forest (forest, wetland, and mixed), water (water and reservoir) and barren land.

Additional data requests responded to over the contract period include:

Ms. Roxann Herwig of Bay West, Inc., Five Empire Dr., St. Paul, MN, 55103-1867 requested data on various streams around the state to write Oil Spill Response Plans.

Mr. Scott Leibowicz of USEPA, 200 S.W. 35th st. Corvalis, OR, 97333 requested a copy of the ISIS Data Descriptions Manual. He had previously received ISIS elevation data from Mark Joselyn of the Illinois Natural History Survey and needed the manual to describe data collection procedures for a report.

Dr. Lewis Hopkins of the Dept. of Urban and Regional Planning, University of Illinois requested a copy of the ISIS data base for the use of students and faculty in that department. After approval from IDOC, a copy of the data base in Rbase was provided on high density 5 1/4" floppy disks.

Task 2. Complete the investigation of the applicability of using the new 'dynamic segmentation' capabilities of ARC/INFO 6.0 software to generate a River Mile Index (RMI) Coverage for the Embarras/Vermilion and the Kaskaskia basin. This coverage will be created by generating an Arc/Info coverage of hydrology using the hydrologic network from USGS 1:100,000 Digital Line Graph (DLG) data and the RMI coding scheme upon which the ISIS stream data base is based. This will be achieved by the following process:

a. Identification of stream channel intersections and places where Public Land Survey section lines cross the hydrology network as nodes on the 1:100,000 scale hydrology cover. These will be used as "tie points' to relate the RMI used in ISIS and its associated data to the corresponding points on the hydrology coverage.

b. Coding of all RMI nodes to correspond to stream data base river mile coordinate narrative files.

c. Investigate the ability of 'dynamic segmentation' to locate specific river mile locations from individual stream data sets on the 1:100,000 scale DLG hydrology cover created in task 2a.

Progress: The USGS DLG, 1:100,000 scale statewide coverage has proven to be the best source of hydrologic data for this project. The hydrographic layer of the DLG files for Illinois already resides as an arc coverage on the Illinois Geographic Information System (IGIS) at the Survey and comprises the most detailed representation of the streams and lakes available for the whole State. The US Geological Survey (USGS) produced these data by digitizing a 1:100,000 scale photographically reduced composite of the hydrography layer from the 1:24,000 USGS base map series. DLG hydrographic files are stored in a tile structure based on the 1:24,000 scale of the base map series.

The data pertinent to the Embarras/Vermilion River Basin was extracted from the statewide DLG files and modified for use in this project last year (Figure 2). The Kaskaskia and Sangamon River basins were completed this year (Figures 3 & 4). This modification involved selecting and joining the appropriate DLG tiles together and correcting for any edge distortion where the tiles abut. The resulting line coverage was 'clipped' with the outline of the river basin to produce a map of the river basin as recognized by the ISIS data base. The remaining seven River Basins in the state were also extracted from the statewide DLG files, and will be modified as those basins are processed.

The lines or 'arcs' in these coverages were checked for extraneous breaks or 'nodes'. These were deleted, leaving nodes only at stream intersections. This step was necessary so that all nodes in the coverage would have known RMI's in the ISIS data base. Because this step simplified the original DLG data, the obsolete items in the associated INFO file (INFO files contain the tabular or descriptive data for the coverage) were deleted. Only the lakes and reservoirs on ISIS streams were retained; non-connected ponds and lakes were deleted. Because ARC/INFO treats the open spaces in the lakes differently, it was necessary to add a center line to these lakes to accommodate the ISIS RMI data.

The location of the headwaters of ISIS streams were checked and modified as necessary to match the headwaters as described in the ISIS data base and as represented on the 7.5 minute topographic map sources. All of the arcs in the coverage were oriented such the they all pointed upstream. All arcs must be oriented in the same direction for the dynamic segmentation process (described below) to properly account for the proportional distances along the line segment. The items necessary for the dynamic segmentation process were added to the INFO file. These include the stream code and the upstream and downstream RMI for each of the arcs.

ISIS includes only channels with at least 10 square miles of drainage area, so fewer streams exist in ISIS then were present in the DLG data set (Figures 2, 3 &4).

These additional streams create extraneous nodes where they join with ISIS streams. The extra nodes have no RMI's in the ISIS data base and would cause problems during the dynamic segmentation processes. Therefore, a separate coverage of only the ISIS streams without these nodes was created for use during the remainder of the study.

Dynamic segmentation

A new module of the ARC/INFO software provides a method for modeling and analysis of linear features in a spatial context through a process called dynamic segmentation. This approach 'ties' ISIS tabular data to the corresponding geographic representation of the stream network in ARC/INFO. Once tied, any point or stream segment identified in ISIS can be mapped and manipulated relative to other information contained in the IGIS.

Dynamic segmentation works by imposing a linear referencing system onto existing arc coverages. The beginning and end of each arc is coded according to a linear scale. For ISIS data, this measurement scheme is the River Mile Index (RMI). The dynamic segmentation software then supports interpolation along the arcs based on the to-from (or up-down stream) measures carried within the ISIS descriptive data.

To increase locational accuracy, more RMI locations were needed than just the ISIS stream headwater and mouth locations. The number of 'tie' points were increased by intersecting the DLG generated hydrology with the Public Land Survey (PLS) section line coverage that reside in the IGIS. This step subdivided each individual ISIS stream into many, shorter arcs, each beginning and ending at a section line. The RMI values of each of these locations, present in ISIS, were transferred to the corresponding INFO file of the coverage. The use of PLS section lines imposed a 1 square mile grid onto the stream network. All data in ISIS are reported to the tenth of a mile, including the RMI's where streams cross section lines. While this greatly improves the level of accuracy, it is still a fairly coarse resolution and limits how accurately data can be expected to be located.

To use the dynamic segmentation feature of ARC/INFO, the ISIS streams were assigned to 'routes' by running the 'arcsection' command; specifying the stream identification number as the delimiter for each route and the 'up' and 'down' RMI's as the unit of measure. The ISIS data can now be displayed as 'events' within the dynamic segmentation process and displayed on the final coverage.

Task 3. Convert ISIS from Rbase to Paradox data base software for the IBM-PC.

Progress: The ISIS files for the Embarras/Vermilion River Basin were transferred to the Paradox for DOS 4.0 data base. Report files are being created in Paradox to duplicate the report files available in Rbase.

Task 4. Purchase ARCVIEW for the SUN workstation and the IBM-PC and investigate the usefulness of the software for field personnel.

Progress: An ARCVIEW license is available over the Survey network system from the IGIS. We made use of the Survey license to test the usefulness of the ARCVIEW software with the ISIS covers. Several 'views' were created in ARCVIEW with the ISIS coverage and various statewide coverages available from the IGIS. This shows promise and more testing will be done with the other ISIS basin coverages as they come on line.

A PC version of ARCVIEW has been purchased and is being installed onto the Compaq 386 computer on loan from IDOC. A copy of Microsoft WINDOWS was also necessary for the installation of ARCVIEW and PC-NFS was purchased to enable using the network to access ARC/INFO coverages from the SUN workstation.

Task 5. Outline a strategy for utilizing the newly created RMI Coverage in the determination of Karr's Index of Biological Integrity (IBI) and its interface with other data sets.

Progress: This task has been delayed due to the death of Dr. Lewis Osborne.

Task 6. Develop a conceptual long-term management strategy for referencing ISIS with other pertinent Illinois stream data bases such as EPA's Biostoret and the fish data bases now being development at INHS under contract with IDOC.

Progress: The concept of the Aquatic Resource Information System (ARIS) has been developed to encompass the various data bases that are under development for the IDOC. This will include the Fisheries Analysis System (FAS), a data base of Illinois lakes and impoundments developed under F-69-R and the Stream Fish and Habitat Data base (SFHD) developed under F-120-R. Figure 5 shows how it is envisioned that information from these data bases can be used with the coverages developed in the ISIS project and accessed in ARC/INFO or ARCVIEW software.

Task 7. Design documentation for distribution showing how ISIS and dynamic segmentation can be used; it will include such things as data file definition, application program description, and interfaces with other data sets.

Progress: Documentation will be finalized as the coverages become available for IDOC staff. A computer demonstration was developed for ARC/INFO to show IDOC personnel how the new coverages can be used to display ISIS data. Figure 6 shows how one of the items in the ISIS data base can be displayed using dynamic segmentation. Now that ARCVIEW has been purchased, a similar demonstration is being developed for the PC using ARCVIEW software.

References

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Hinrichs, M.A. and L.D. Hopkins, 1991. Illinois Streams Information System: ISIS data descriptions manual. Illinois Dept. of Conservation, Springfield, University of Illinois at Urbana-Champaign, Dept. of Landscape Architecture and Dept. of Urban and Regional Planning. 135pp.

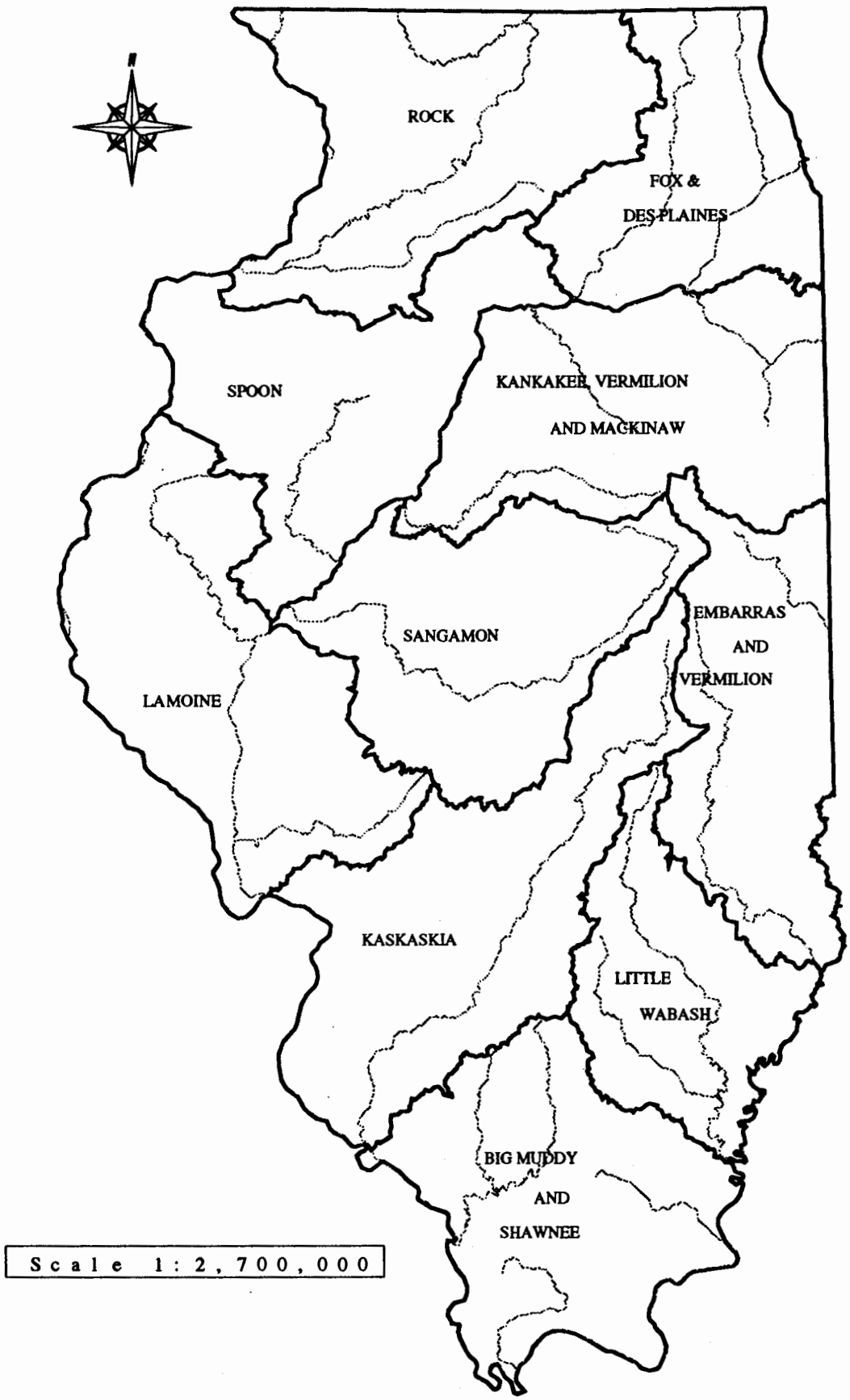

Figure 1. ISIS River Basins.

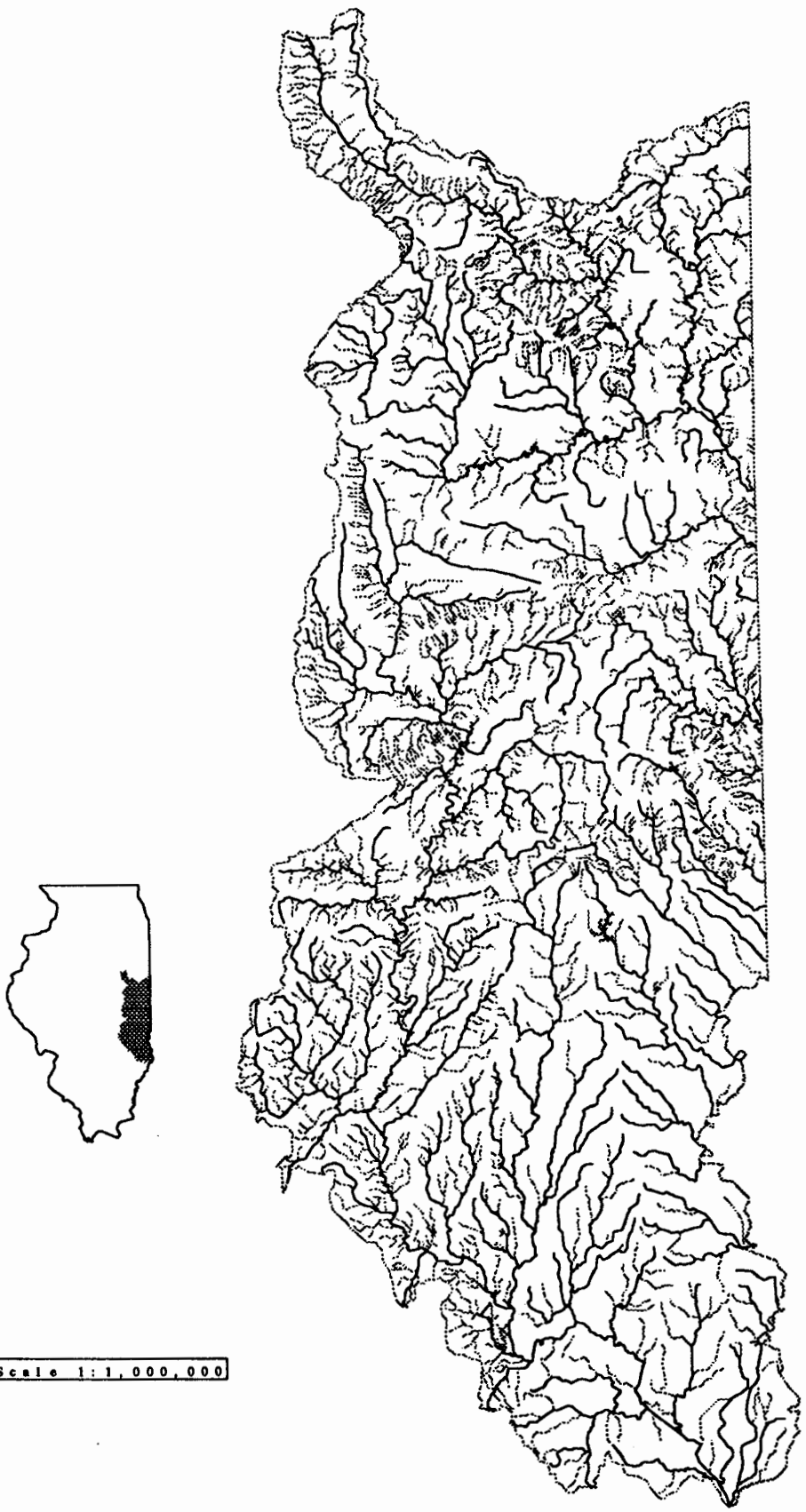

Figure 2. The Embarras and Vermilion River Basins Dark lines represent ISIS streams.

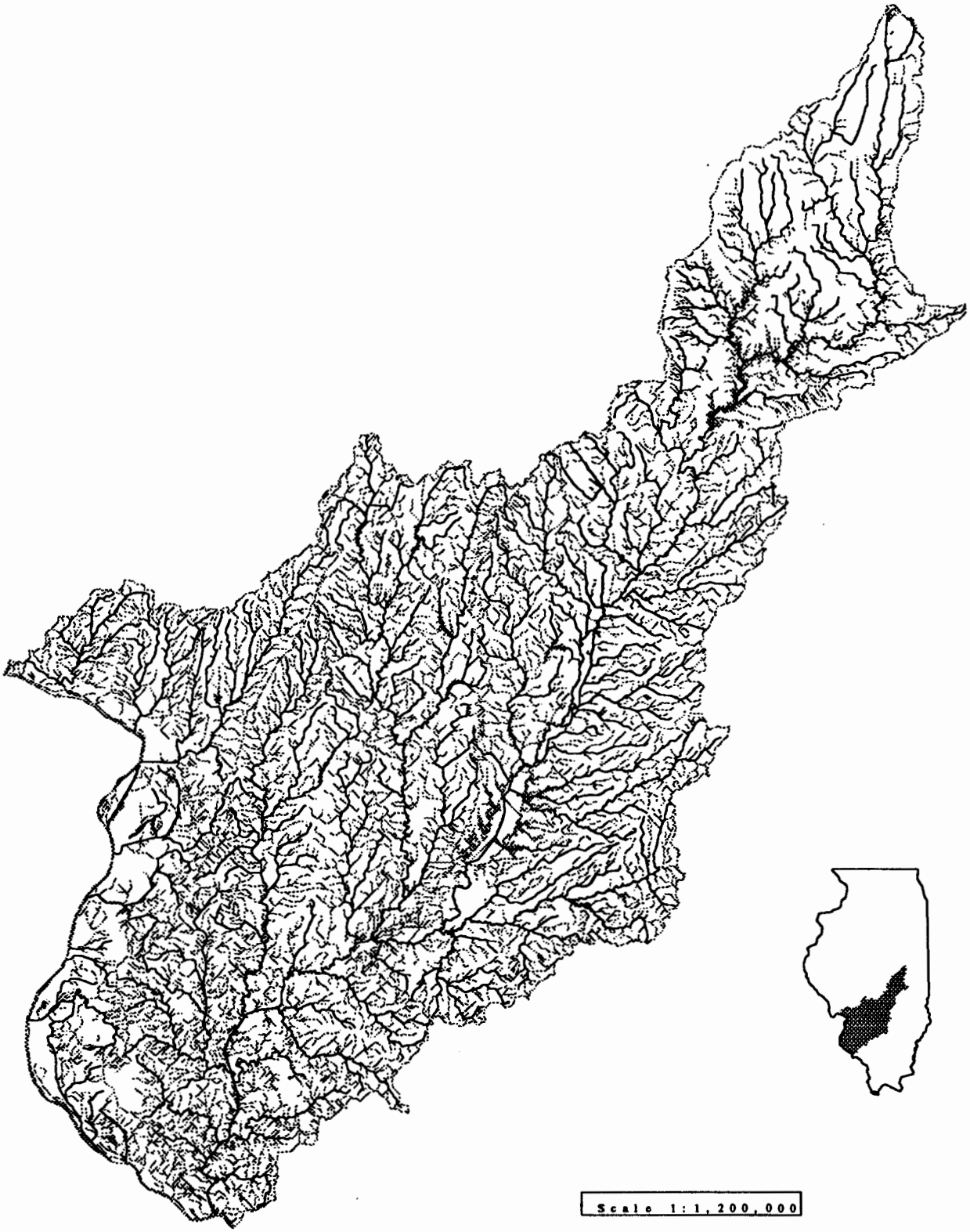

Figure 3. The Kaskaskia River Basin
Dark lines represent ISIS streams.

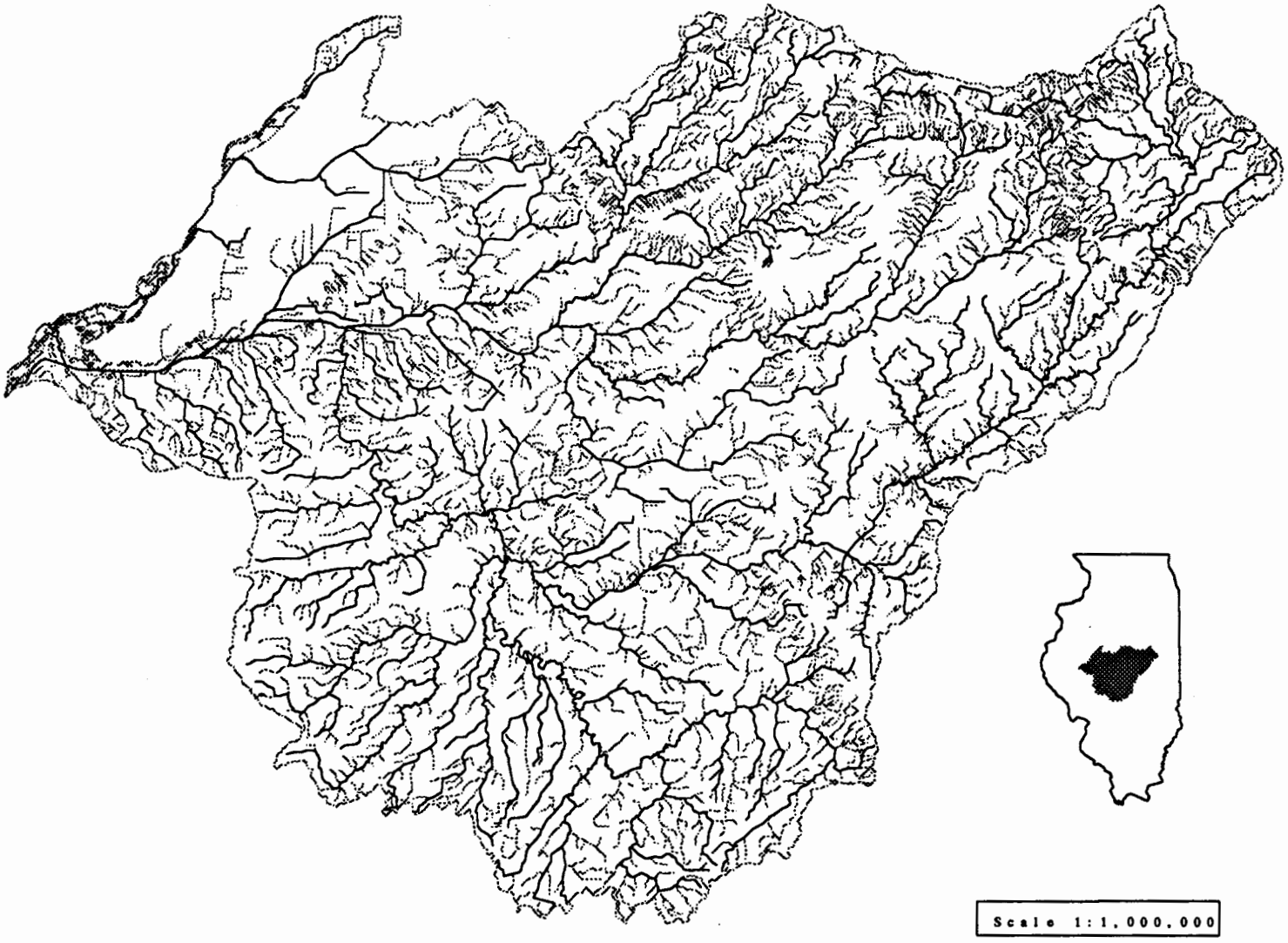

Figure 4. The Sangamon River Basin
Dark lines represent ISIS streams.

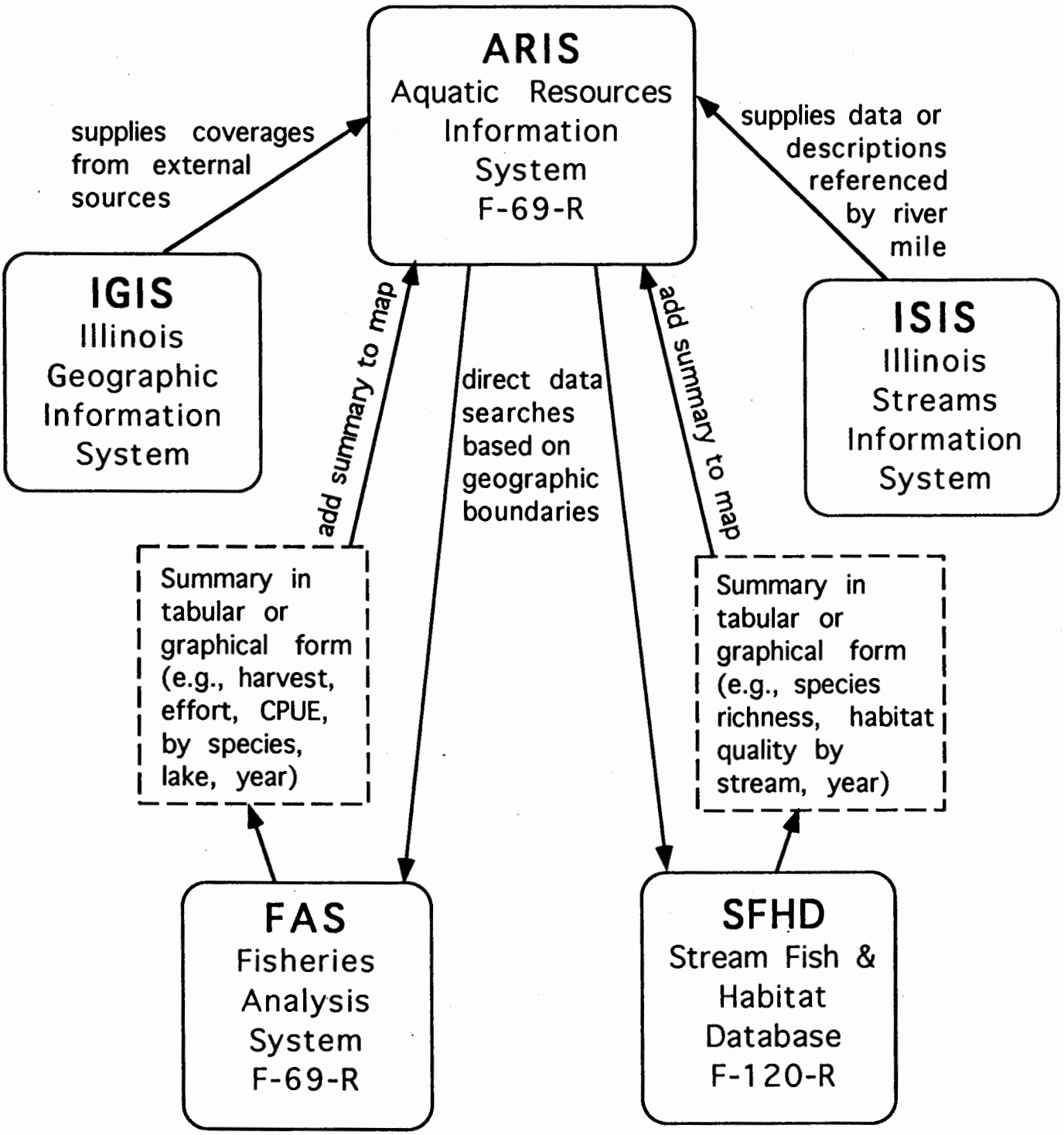

Figure 5. A concept of how a GIS-based overlay, ARIS, can summarize and relate data from different databases for a variety of outputs

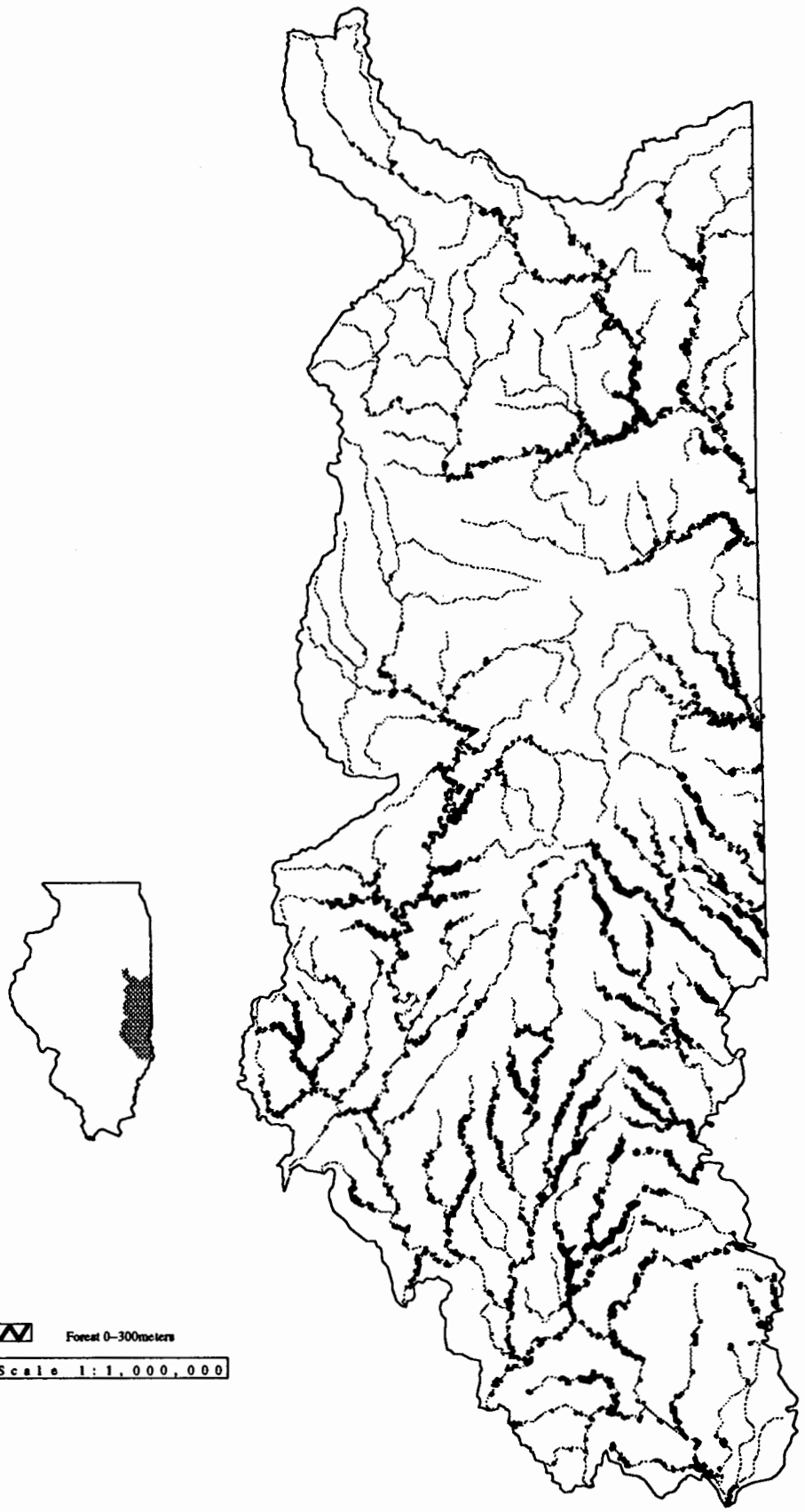

Figure 6. Forest vegetation in the Embarras and Vermilion River Basins.