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# THE APPLICATION OF REMOTE SENSING TO RESOURCE MANAGEMENT AND ENVIRONMENTAL QUALITY PROGRAMS IN KANSAS

by

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Director
Space Technology Center
The University of Kansas

and

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The University of Kansas

April 1977

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INPUT BRANCH

An Annual Report of Work
Performed Under NASA Grant
No. NGL 17-004-024

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(April 1, 1976 - March 31, 1977)

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ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

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Sioux Falls, SD 57198

An Annual Report of Work
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No. NGL 17-004-024

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THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2291 Irving Hill Drive—Campus West Lawrence, Kansas 66045

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ABSTRACT

Activities of the Kansas Applied Remote Sensing Program (KARS) are designed to establish interactions on cooperative projects with decision makers in Kansas agencies in the development and application of remote sensing procedures. This report describes the activities of the KARS program in pursuit of its objectives during the period April 1, 1976, through March 31, 1977.

Cooperative demonstration projects were undertaken with several different agencies during this period and involved three principal areas of effort: Wildlife Habitat and Environmental Quality; Urban and Regional Planning; Agricultural and Rural Development. These projects were designed to concentrate remote sensing concepts and methodologies on existing agency problems to ensure the continued relevancy of the program and maximize the possibility for immediate operational use.

Completed projects during the period include (1) the decision to undertake reclamation programs at Douglas County Lake; (2) the planning and coordination of law enforcement activities during the Republican National Convention; (3) the decision to restructure corn pest surveys of the Kansas Department of Agriculture. Several long-term projects involving weed pest surveys have been initiated with the Kansas Department of Agriculture. Substantial decisions regarding musk thistle and redcedar control are expected from this work.

Other projects were initiated during this period and are nearing completion or awaiting final action.

# I. THE KANSAS APPLIED REMOTE SENSING PROGRAM

## INTRODUCTION

The unique contemporary problems facing officials at all levels of government have created a need for objective data gathering to supplement or in some cases replace traditional methodologies. The need for objective data gathering has been further emphasized by the increasing pressures from social, environmental and economic considerations.

The University of Kansas Applied Remote Sensing Program (KARS) has established a continuing program of activities to demonstrate the utility of remote sensing technology in data gathering for decision makers in state, regional and local agencies. Now in its fifth year, the KARS program is developing the concepts and methodologies to utilize remote sensing procedures in dealing with significant problems in Kansas related to changing urbanization patterns, rapid irrigation growth, changing agricultural needs and environmental quality. This activity is accomplished primarily through cooperative remote sensing projects with governmental agencies in Kansas on problems of immediate concern.

This report outlines the activities and accomplishments of the KARS program during the period April 1, 1976, through March 31, 1977, in pursuit of its key objectives:

To apply remote sensing techniques, analysis and systems to the solution of significant decision oriented concerns of state and local officials.

To participate cooperatively on remote sensing projects with state and local agencies in Kansas.

To effect the transfer of applicable remote sensing technology to governmental agencies at all levels as a by-product of the demonstration projects conducted in the KARS program.

To assist the personnel within Kansas agencies in the evaluation of the capabilities of the rapidly changing remote sensing systems and the benefits which might be achieved through their utilization.

Through multidisciplinary teams, to stimulate the application



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of the products of remote sensing systems to the significant problems of resource management and environmental quality in Kansas.

To guide, assist and stimulate faculty, staff and students in the utilization of information from the Earth Resources Satellite and Aircraft Programs of NASA in research, education and public service activities carried out at the University of Kansas and in the State.

The interaction which results from these cooperative projects ensures the continued relevancy of the program and maximizes the transfer of these new and emerging technological systems to operational use.

## CONTACTS WITH AGENCIES

While projects usually develop through individual contacts between agency and KARS personnel, communications also result from more general information dissemination efforts aimed at promoting widespread interest in remote sensing applications. During the past year these activities have included (1) publication of the *KARS Newsletter*, (2) publication of a *Guide to Aerial Photography and Space Imagery of Kansas*, and (3) numerous talks and presentations to public and professional organizations throughout Kansas. These have included, among others, the Kansas Association of County Engineers, the Kansas Biological Survey Workshop, the Kansas Weed Conference and the Lake Region and the Flint Hills Resource Conservation and Development Projects.

The *Guide to Aerial Photography and Space Imagery of Kansas* fills a void in Kansas remote sensing activity. It is the first comprehensive listing of aerial photography, LANDSAT imagery and Skylab data. Nearly half of the initial printing was purchased and distributed within the first month after publication. Several new contacts for decision projects have resulted from the guide which effectively describes the goals and objectives of the KARS program to potential users. The quarterly *KARS Newsletter* now reaches over 750 readers with news of current KARS projects and activities (Appendix I). Several new projects have developed from this medium.

There continues to be substantial demand for the Kansas LANDSAT Mosaic and Kansas Land Use Patterns Map published in 1974. These have greatly increased the visibility of the KARS Program across Kansas.

## COORDINATION WITH AGENCY OFFICIALS

Experience gained in the KARS Program has demonstrated that it is not sufficient to hold conferences, publish newsletters, or make occasional calls on agency personnel. A continuing association with key administrators and their staffs is carried on to develop their interest, promote KARS projects, and finally obtain agency commitment of time and resources for the projects.

During the last year we have increased personal visits to Kansas agencies. The visits are facilitating better communications between KARS and agency personnel. Agencies with which contacts have been established are listed in Table A. Contacts are maintained with all of these agencies and additional contacts actively pursued.

## NATURE OF PROJECTS

Table B indicates the range of projects completed during FY 75-76. Note in Figure 1 that projects have been distributed widely over Kansas and are particularly relevant to the terrain, land use and specific problems of these areas.

## PERSONNEL

The Applications Program is administered by Dean B. G. Barr, Professor of Engineering and Director of the University of Kansas Space Technology Center. Barr, a specialist in engineering management, has been active in transmitting new technologies to industry and state agencies for over ten years.

Dr. Edward A. Martinko, Courtesy Professor of Biological Sciences and Research Associate in the Space Technology Center, is the Project Coordinator for the KARS Program and has primary responsibility for agency contacts, scheduling and the accomplishment of demonstration projects by the joint agency-KARS teams. Dr. Martinko has had several years of experience in multidisciplinary research projects. He was a research assistant in the State Biological Survey of Kansas for two years

Table A

AGENCIES WITH WHICH CONTACTS HAVE BEEN ESTABLISHED
BY THE KANSAS APPLIED REMOTE SENSING PROGRAM

| | | |
|---|---|---|
| Municipal: | Kansas City, Kansas Department of Planning and Development<br>Kansas City, Kansas City Commission<br>Lawrence, Kansas Planning Department<br>Wichita, Kansas Planning Department | Kansas City, Kansas Mayor's Office<br>Lawrence, Kansas City Engineer<br>Lawrence, Kansas City Commission<br>Concordia, Kansas Chamber of Commerce |
| County: | Douglas, Kansas Planning Department<br>Cloud, Kansas Commissioners | Cherokee, Kansas Board of Commissioners<br>Douglas, Kansas County Extension Agent |
| State: | Kansas Forestry, Fish and Game Commission<br>Kansas Water Resources Board<br>Kansas Department of Economic Development<br>Missouri Clean Water Commission<br>Kansas Governor's Office<br>Kansas Department of Agriculture<br>Kansas Geological Survey<br>Kansas Attorney General's Office | Kansas Parks and Resources Authority<br>Kansas Department of State Planning<br>Kansas Department of Revenue<br>Kansas Department of Health and Environment<br>Kansas Department of Transportation<br>Kansas Agricultural Extension Service<br>Missouri Governor's Office<br>Missouri Department of Natural Resources |
| Regional: | Mid-America Regional Council<br>Chikaskia-Indian Hills Regional Planning Commission (Sumner, Harper, Kingman)<br>Northwest Kansas Planning and Development Commission (Cheyenne, Sherman, Wallace, Rawlins, Thomas, Logan, Decatur, Sheridan, Gove, Norton, Graham, Trego Phillips, Rooks, Ellis, Smith, Osborne, and Russell Counties, Kansas)<br>Sunflower Resource Conservation & Development District (Sumner, Harper, Kingman, Barber, Comanche, and Kiowa Counties, Kansas) | Four Rivers Resource Conservation & Development District (Jewell, Republic, Mitchell, Cloud, Ottawa, Lincoln, Ellsworth and Saline Counties, Kansas)<br>Ozarks Regional Commission<br>Big Lakes Regional Planning Commission (Pottawatomie, Riley, Geary)<br>Flint Hills Resource Conservation and Development Project<br>Groundwater Management Districts |
| Federal: | U. S. Department of Agriculture, Soil Conservation Service<br>U. S. Fish and Wildlife Service | U. S. Army Corps of Engineers, Kansas City Office<br>U. S. Environmental Protection Agency, Kansas City Office |

TABLE B

KARS PROGRAM

PROJECTS COMPLETED OR INITIATED

MARCH 1976 - APRIL 1977

| | |
|---|---|
| PROJECT: | Mapping and Monitoring Musk Thistle Infestations |
| COUNTIES INVOLVED: | Marshall, Douglas |
| COOPERATING AGENCY: | Kansas Department of Agriculture (Weed and Pesticide Division) |
| PROJECT: | Mapping Center-Pivot Irrigation in Southwest Kansas |
| COUNTIES INVOLVED: | Thirty-two counties in southwest Kansas |
| COOPERATING AGENCIES: | Kansas Forestry, Fish and Game Commission; Kansas Water Water Resources Board; Kansas Geological Survey |
| PROJECT: | Assessing Distributional Change in Eastern Redcedar |
| COUNTY INVOLVED: | Pottawatomie |
| COOPERATING AGENCY: | Kansas Department of Agriculture (Weed and Pesticide Divison) |
| PROJECT: | Land Use Mapping for Planning and Zoning |
| COUNTY INVOLVED: | Sumner |
| COOPERATING AGENCY: | Chikaskia, Golden Belt and Indian Hills Regional Planning Commission |
| PROJECT: | Law Enforcement Planning for the Republican National Convention |
| COUNTIES INVOLVED: | Wyandotte, Johnson, Leavenworth |
| COOPERATING AGENCY: | Kansas City, Kansas, Police Department |
| PROJECT: | Decision on County Line Lake, Missouri |
| COUNTIES INVOLVED: | Webster, Greene, Missouri |
| COOPERATING AGENCIES: | Missouri Department of Natural Resources, Missouri Governor's Office |
| PROJECT: | Mapping Aquatic Vegetation at Douglas County State Lake |
| COUNTY INVOLVED: | Douglas |
| COOPERATING AGENCY: | Kansas Forestry, Fish and Game Commission |
| PROJECT: | Assessing Wildlife Habitat in Strip-Mined Areas |
| COUNTY INVOLVED: | Cherokee, Crawford |
| COOPERATING AGENCIES: | Kansas Forestry, Fish and Game Commission |
| PROJECT: | Evaluation of Rangeland Vegetation |
| COUNTIES INVOLVED: | Barber |
| COOPERATING AGENCIES | Kansas Department of Agriculture (Weed and Pesticide Division), U. S. Soil Conservation Service, Sunflower RC&D Project |

# REMOTE SENSING APPLICATIONS PROJECTS

April, 1976 — March, 1977

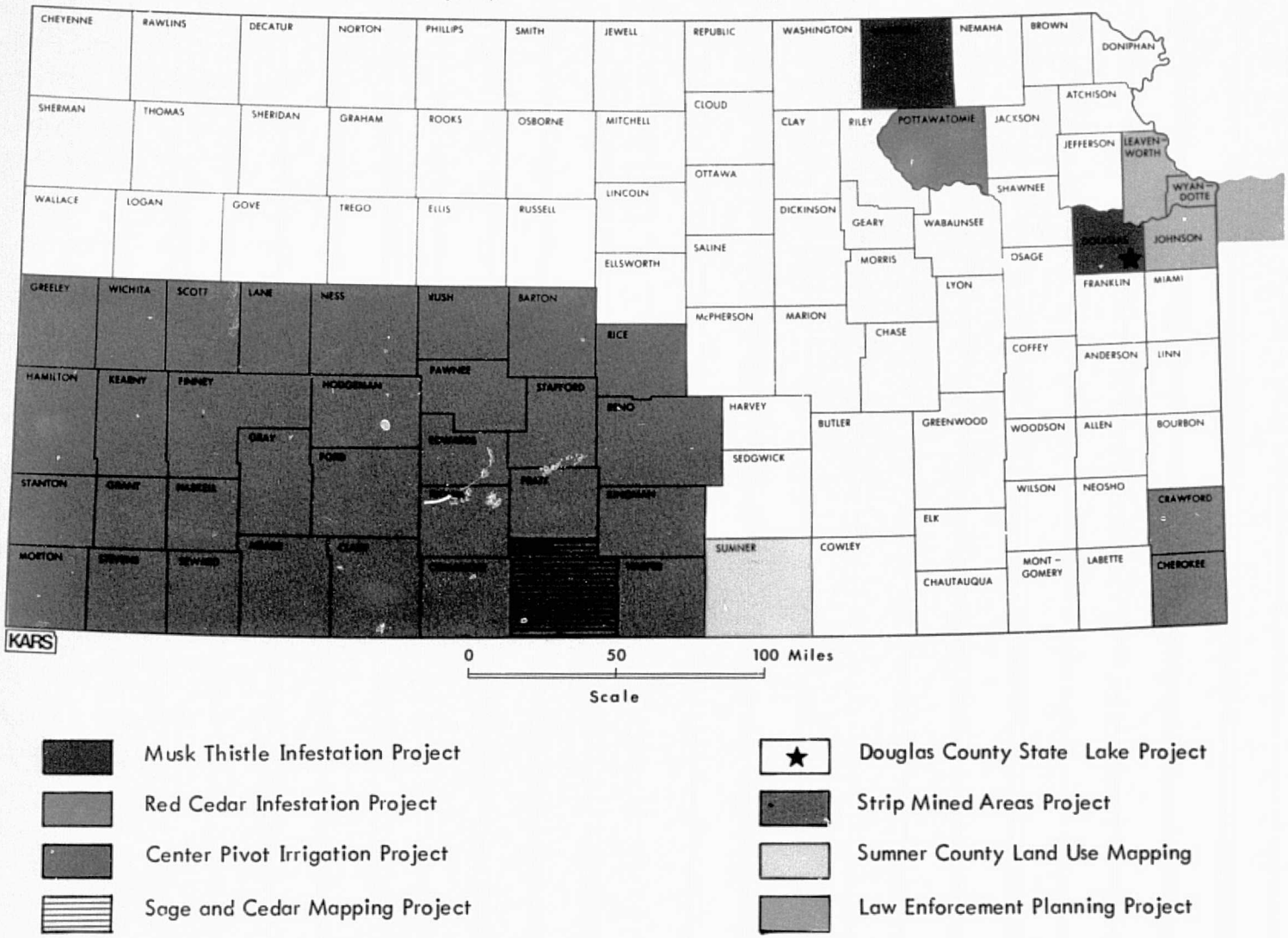


Figure 1. During the past year KARS projects have been undertaken in 41 Kansas counties.

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and has an excellent working relationship with the agricultural community.

During the past year Dr. Michael Ginevan, Research Associate in the Space Technology Center, has joined the KARS staff. He brings expertise in ecology, statistical sampling and computer data processing to the team.

Messrs. James Merchant, C. T. Traylor and Joseph Poracsky doctoral candidates in the Department of Geography with considerable professional experience as image interpreters and cartographers, carry significant responsibilities in the KARS Program. Additional expertise in various disciplines and interpretive skills is provided by Ronald Shaklee and Ted Talmon.

Projects requiring major scientific effort are staffed primarily by graduate students from the various academic disciplines assisted by faculty advisors when appropriate. Personnel from the various state and local agencies are involved in their own applications projects at no cost to the NASA grant. We continue to work with the various extension agencies in the state to gain their assistance in translating remote sensing technology to a broader audience.

## FACILITIES

The KARS laboratory located on the second floor of the KU Space Technology Center serves as the headquarters of the Kansas Applied Remote Sensing Program. Light tables, a Bausch and Lomb Zoom Transfer Scope and other equipment needed by the KARS team have been provided by the Space Technology Center for the demonstration projects. In-house graphic arts and photo services facilities offer complete cartographic and film processing services. Computation services are available both in-house and through a remote terminal to the University Computation Center.

The KARS Program has several types of equipment in its laboratory to aid in the interpretation of remotely sensed images. An Itek Color Additive Viewer/Printer (ACVP) has the ability to enlarge, superimpose, and register up to four separate black and white transparencies for viewing, printing, or color enhancement. Both LANDSAT imagery and aerial photography in 70 mm formats can be accomodated. In addition to the ACVP the KARS Program has a Variscan Rear Screen Variable Magnification Viewer. This instrument is capable of rear projection of film transparencies of any size from 35 mm to 9½ inches in format at several

enlargements up to approximately 48 times the original scale. Together these instruments complement the optical equipment in the KARS Program laboratory and expedite more involved interpretations and image analysis.

Procedures have also been established for more efficiently producing quality products for agency use. These procedures include mapping on stable base materials in negative mode and using color preseparation overlays to display data. This allows the user to separate the interpretation categories into individual displays, provides for inexpensive multiple copy reproduction, and increases the possibility that the material can be used by more than one agency.

A current file of LANDSAT, Skylab and aerial imagery is maintained in the KARS laboratory for the use of project personnel and user agencies. The LANDSAT file contains the best quality imagery for specific time periods during the year. The imagery is catalogued in an accessible file providing complete coverage of Kansas.

The KARS Program also maintains a substantial reference library for both in-house and agency use. This material includes reports, articles, periodicals, manuals, text books, etc., pertinent to applications of remote sensing.

PROGRAM OF WORK APRIL 1, 1976 - MARCH 31, 1977

AGRICULTURAL AND RURAL DEVELOPMENT PROJECTS

Mapping and Monitoring Musk Thistle Infestations of Kansas Rangeland

Musk thistle (Carduus nutans) is a serious pest of crop, range and pastureland in both northern Kansas and southern Nebraska and as such has been declared a noxious weed by the legislatures of both states.

Its presence in cropland is a particularly serious problem for alfalfa (see Figure 2) and wheat. In these situations musk thistle reduces the quality of the crop through competition for space and nutrients and, in addition, renders harvesting difficult. In range and pastureland it is of importance because of its low palatability to cattle. Further, it reduces cattle foraging activity because of its spiney leaves.

Precise national acreage estimates of infestations are unavailable because of current "windshield" and mail survey methods. However, it is known that, in the mainland United States, 360 counties of 3,068 have economically important infestations, representing approximately 30 of the 48 mainland states. More specifically, in Kansas and Nebraska, where acreage estimates are available, the infested acreage totals are estimated to be 1,062,441 and 1,196,643 respectively. Freeman Biery, Director of the Weed and Pesticide Division of the Kansas Department of Agriculture, reports that in Kansas alone, $20,000,000 annually is spent on musk thistle control.

The most effective control measure currently in use involves the application of the herbicide 2,4 Dichlorophenoxyacetic (2-4D) acid at the rate of 2 lbs. acid equivalent per acre. The pesticide is usually applied in the spring (April-May). Second applications are necessary in approximately one of 50 cases. This control measure together with the large extent of the problem results in a considerable pesticide usage in affected areas.

In spite of the extent of the control program, its success has been limited. A major factor in this lack of success has been the inability to consistently locate large infestations through present survey methods. Secondly, there is no objective procedure currently available for evaluating and monitoring the success of control procedures.

Because of these needs, KARS personnel, in cooperation with the Weed and Pesticide Division of the Kansas Department of Agriculture, initiated a long term investigation of the applicability of remote sensing tech-

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Figure 2. Dense musk thistle infestation in northern Kansas alfalfa field.

Figure 3. Musk thistle appears a "mustard yellow" color on color infrared aerial photography taken during flowering in June 1976. Concurrent field investigation indicated that heavy infestations (arrows) were composed of 60-80 plants/ square meter. Acquisition scale of this photography, taken in Douglas County, Kansas was 1:4,000.

nology to detection and monitoring of musk thistle. The purpose of this study is to develop operational data gathering procedures which will provide a better informational basis for decisions regarding allocation of control resources (primarily pesticide and manpower) and evaluation of control efforts.

Initial studies were based on the distinctive phenology of musk thistle. This species is a biennial, which overwinters in the actively growing rosette stage. It was therefore hypothesized that it might be detectable on early spring imagery since most other vegetation is dead or dormant at this time. Accordingly, a six mile transect in southeastern Marshall County, Kansas, containing known musk thistle infestations was flown on 1 April 1976. Four films (black and white panchromatic, black and white infrared, natural color, and color infrared) at three acquisition scales (1:15,000; 1:24,000; 1:42,000) were employed. Detection results were negative for all film and filter combinations at all scales.

The second attempt at detection took place on 13 June 1976. Musk thistle flowers quite synchronously in this area during mid-June, and it was felt that the distinctive hue produced by the purple flowers might provide a mechanism for differentiating it from the surrounding vegetation. Three fields in Douglas County, Kansas, were flown using five film filter combinations (black and white-red band, black and white-green band, black and white-infrared, natural color, and color infrared) at three acquisition scales (1:4,000; 1:7,500; 1:15,000). Here results were more rewarding. Detection was possible at all scales and with all film-filter combinations. Musk thistle was particularly distinctive on the two color films, showing a pinkish tinge on natural color and mustard color on color infrared (Figure 3). Further, areas less than 0.1 acres in extent were visible at 1:15,000 scale. This is particularly encouraging in that economically important infestations range upwards of 10 acres (in some cases 70 acres or more) and may therefore be detectable in the flowering stage at very small scales.

A preliminary test of this hypothesis was performed in October 1976. Ground truth was acquired from Byron Patton, Weed and Pesticide Division of the Kansas Department of Agriculture. These data consisted of 1976 maps (summer) of five dense musk thistle infestations, ranging from 8 to 70 acres in extent, in Marshall and Nemaha counties in Kansas.

LANDSAT black and white transparencies covering the areas of interest at a scale of 1:1,000,000 (bands 4, 5 and 7) taken on June 18, 1976 were used in the test. Exact locations of the three largest infestations (70, 40, and 20 acres) on the imagery were determined. The three transparencies were then examined separately on a Variscan Rear Projection Viewer at magnifications ranging up to 47x to determine if the infested areas showed distinctive tonal characteristics on any individual band. The results were negative. The three bands were then color combined pairwise and subsequently together on an Itek Color Additive Viewer/Printer to determine if this procedure could enhance discrimination of infested areas. Again, no difference between infested areas and surrounding vegetation was discernible.

While disappointing, the negative results from the rosette stage on LANDSAT imagery were not wholly unexpected. In the first case a very early spring caused a variety of vegetation types to be vigorously growing at a time when they are normally dormant. This fact was, however, not clear prior to examination of the aerial photography. More precise timing of flights might therefore result in successful detection of this stage. In addition, considerable haze was present on the LANDSAT imagery, although cloud free coverage was used. This without doubt reduced the probability of success. Further, more complete background data in the form of underflights at various times of the year may suggest more sophisticated manual detection procedures, such as the interpretation of multidate composites. Finally, machine processing of LANDSAT tapes might produce the desired result. The successful detection of the flowering stage produces grounds for optimism. Though 1:1,000,000 imagery did not prove satisfactory, much larger scales (i.e., 1:63,000) could be used to cover large areas in a very cost effective manner, if detection at such scales is possible.

Taken together these results clearly indicate the need for further study. KARS personnel are pursuing these investigations in a cooperative multidisciplinary effort with the Kansas Department of Agriculture, University of Kansas Departments of Entomology and Botany, and the Kansas State Biological Survey. Improved detection and monitoring procedures via remote sensing technology will contribute greatly to the reduction of pesticide use through improved control procedures for musk thistle.

## Assessment of Distributional Change in Eastern Redcedar

Eastern redcedar (*Juniperus virginiana*) is the most important and most widely distributed conifer in Kansas. In the central and western areas of the state, redcedar is commonly found in canyons and valleys interspersed among large tracts of rangeland and cropland. The tree has frequently been used in windbreaks and for decorative plantings near homes, and on farmsteads and ranches.

In recent years farmers and ranchers in some areas of Kansas have asserted that redcedar is becoming a serious invading pest in rangeland. Since the cedar is unpalatable to cattle, it tends to reduce the amount of forage for grazing. The problem is serious enough in some counties that the Weed and Pesticide Division (WPD) of the Kansas Department of Agriculture has been asked to consider this species for noxious weed status. Such an action would require state legislation. In anticipation that such legislation might be considered, WPD has decided to prepare firm documentation of the extent and location of distributional change in the redcedar. Freeman E. Biery, Director of the Weed and Pesticide Division of the Kansas Department of Agriculture, has requested that the KARS program evaluate remote sensing techniques as a means to provide such documentation. Evidence produced from a study of temporal change in redcedar distribution would aid WPD in deciding whether or not to support any proposed noxious weed status. Should the plant be declared a noxious weed, decisions regarding control measures, allocation of funds, and location of control activities would be forthcoming.

The initial phase of this work has involved the design and testing of a suitable interpretation procedure. A fifteen square mile test site in western Pottawatomie County was selected for examination at the suggestion of WPD. Change which has occurred between 1950 and 1973 was examined.

It was determined at the outset that redcedars could not adequately be distinquished from deciduous trees on available summer aerial photography (scale 1:20,000 or smaller). However, winter photography for 1973 was available, and redcedars could readily be distinguished after defoliation of deciduous vegetation, even on small scale (1:125,000) high altitude photography. While color infrared photography is not required for interpretation, it aids significantly, particularly on small scale imagery.

Agricultural Stabilization and Conservation Service (ASCS) black and white panchromatic aerial photographs (scale 1:20,000) flown in August 1950 served as baseline data. National Aeronautics and Space Administration (NASA) high altitude color infrared photography (scale 1:125,000) flown in November 1973 was used to detect change (Figure 4).

A grid cell data collection scheme was utilized. A ten acre grid was superimposed on the 1950 photos which were then examined stereoscopically. An estimate was made of the total acreage of woodland in each ten acre cell as a percent of the cell. Subsequently the gridded 1950 image was placed on a Bausch and Lomb Zoom Transferscope™ along with the 1973 NASA photography. This instrument allowed the interpreter to match scales, register the two photos, and directly compare the images, cell by cell, in order to detect change. Since the 1973 photos were taken in November, it was possible to distinguish redcedar from other woodland. Thus, three data elements were recorded for each cell: (1) total woodland acreage in 1973 as a percent of the cell, (2) total redcedar acreage as a percent of total woodland, and (3) an indication of increase, decrease or no change in total woodland. Statistical data summaries were compiled for each square mile (Table 1) and totaled for the entire test site (Table 2).

Although it was not possible with photos available to directly evaluate distributional change in redcedar, it was hypothesized that those cells exhibiting large percentage increases in total woodland between 1950 and 1973 would tend to have a large percentage of redcedar in 1973. Conversely, redcedars were expected to constitute a small percentage of woodland in cells exhibiting little or no percentage increase in total woodland. Both quantitative and cartographic summaries of the pilot study results were prepared.

The data offers clear evidence that woodland is expanding in many areas of the test site, and that this expansion is frequently associated with large percentages of redcedars (Table 3). WPD personnel have indicated that such information will aid significantly in their decision making with regard to the weed status of eastern redcedar. Mr. Biery has noted that the results of this pilot study provide firm evidence that the redcedar problem is one deserving futher attention by WPD.

1950 B & W Panchromatic Photo
Acquisition Scale 1:10,000

1973 Color Infrared Photo
Acquisition Scale 1:125,000

Figure 4. Aerial photography taken in 1950 and 1973 over Pottawatomie County was compared to detect change in Eastern Redcedar distribution. Redcedars appear red in the 1973 winter image.



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SUMMARY COUPEE MILE P?27E17

| CELL | FORESTY 1950 | 1973 | CHANGE | CEDAR ACRES | CEDAR % | + | 0 | - |
|---|---|---|---|---|---|---|---|---|
| 1A | 1.5 | 1.5 | 0. | 0.56 | 0.375 | | + | |
| 1B | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 1C | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 1D | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 1E | 3.5 | 5.5 | 2.0 | 3.44 | 0.625 | + | | |
| 1F | 7.5 | 7.5 | 0. | 2.81 | 0.375 | | + | |
| 1G | 2.5 | 3.5 | 1.0 | 2.19 | 0.625 | + | | |
| 1H | 3.5 | 4.5 | 1.0 | 3.94 | 0.875 | + | | |
| 2A | 6.5 | 6.5 | 0. | 2.44 | 0.375 | | + | |
| 2B | 6.5 | 6.5 | 0. | 0.81 | 0.125 | | + | |
| 2C | 2.5 | 3.5 | 1.0 | 2.19 | 0.625 | + | | |
| 2D | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 2E | 6.5 | 7.5 | 1.0 | 4.69 | 0.625 | + | | |
| 2F | 5.5 | 5.5 | 0. | 2.06 | 0.375 | | + | |
| 2G | 4.5 | 5.5 | 1.0 | 3.44 | 0.625 | + | | |
| 2H | 5.5 | 6.5 | 1.0 | 4.06 | 0.625 | + | | |
| 3A | 6.5 | 7.5 | 1.0 | 2.81 | 0.375 | + | | |
| 3B | 3.5 | 4.5 | 1.0 | 1.69 | 0.375 | + | | |
| 3C | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 3D | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 3E | 2.5 | 2.5 | 0. | 0.94 | 0.375 | | + | |
| 3F | 7.5 | 7.5 | 0. | 0.94 | 0.125 | | + | |
| 3G | 9.5 | 9.5 | 0. | 1.19 | 0.125 | | + | |
| 3H | 3.5 | 5.5 | 2.0 | 3.44 | 0.625 | + | | |
| 4A | 7.5 | 7.5 | 0. | 0.94 | 0.125 | | + | |
| 4B | 3.5 | 4.5 | 1.0 | 1.69 | 0.375 | + | | |
| 4C | 2.5 | 3.5 | 1.0 | 2.19 | 0.625 | + | | |
| 4D | 0. | 1.5 | 1.5 | 1.31 | 0.875 | + | | |
| 4E | 2.5 | 3.5 | 1.0 | 2.19 | 0.625 | + | | |
| 4F | 4.5 | 4.5 | 0. | 0.56 | 0.125 | | + | |
| 4G | 6.5 | 7.5 | 1.0 | 2.81 | 0.375 | + | | |
| 4H | 3.5 | 4.5 | 1.0 | 2.81 | 0.625 | + | | |
| 5A | 4.5 | 5.5 | 1.0 | 2.06 | 0.375 | + | | |
| 5B | 5.5 | 5.5 | 0. | 2.06 | 0.375 | | + | |
| 5C | 4.5 | 5.5 | 1.0 | 2.06 | 0.375 | + | | |
| 5D | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 5E | 0. | 0.5 | 0.5 | 0.44 | 0.875 | + | | |
| 5F | 3.5 | 3.5 | 0. | 0.44 | 0.125 | | + | |
| 5G | 4.5 | 5.5 | 1.0 | 3.44 | 0.625 | + | | |
| 5H | 2.5 | 2.5 | 0. | 0.31 | 0.125 | | + | |
| 6A | 0.5 | 2.5 | 2.0 | 2.19 | 0.875 | + | | |
| 6B | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 6C | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 6D | 0.5 | 2.5 | 2.0 | 2.19 | 0.875 | + | | |
| 6E | 0.5 | 0.5 | 0. | 0.19 | 0.375 | | + | |
| 6F | 0.5 | 0.5 | 0. | 0.19 | 0.375 | | + | |
| 6G | 6.5 | 6.5 | 0. | 0.81 | 0.125 | | + | |
| 6H | 6.5 | 6.5 | 0. | 0.81 | 0.125 | | + | |
| 7A | 3.5 | 5.5 | 2.0 | 4.81 | 0.875 | + | | |
| 7B | 0.5 | 2.5 | 2.0 | 2.19 | 0.875 | + | | |
| 7C | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 7D | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 7E | 0. | 0.5 | 0.5 | 0.19 | 0.375 | + | | |
| 7F | 1.5 | 1.5 | 0. | 0.19 | 0.125 | | + | |
| 7G | 2.5 | 2.5 | 0. | 0.31 | 0.125 | | + | |
| 7H | 7.5 | 7.5 | 0. | 0.94 | 0.125 | | + | |
| 8A | 6.5 | 7.5 | 1.0 | 4.69 | 0.625 | + | | |
| 8B | 3.5 | 5.5 | 2.0 | 3.44 | 0.625 | + | | |
| 8C | 1.5 | 3.5 | 2.0 | 3.06 | 0.875 | + | | |
| 8D | 0. | 1.5 | 1.5 | 1.31 | 0.875 | + | | |
| 8E | 0. | 0.5 | 0.5 | 0.44 | 0.875 | + | | |
| 8F | 0.5 | 1.5 | 1.0 | 1.31 | 0.875 | + | | |
| 8G | 0.5 | 1.5 | 1.0 | 0.94 | 0.625 | + | | |
| 8H | 1.5 | 1.5 | 0. | 0.94 | 0.625 | | + | |

TOTALS

| | |
|---|---|
| 1950 | 194.5 |
| 1973 | 245.0 |
| CHANGE | 50.5 |
| CEDAR ACRES | 114.50 |
| + | 43 |
| 0 | 21 |
| - | 0 |

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TABLE I

Table 2

GRAND TOTALS (15 Square Miles)

Total area - 9600 acres; total 10 acre cells - 960

| | | |
|---|---|---|
| 1950 woodland (acres) | - | 1504.5 |
| 1973 woodland (acres) | - | 1870.5 |
| Change 1950 - 1973 (acres) | - | + 366.0 |
| Acres of Redcedar (1973) | - | 947.88 |
| # cells showing increase | - | 307 |
| # cells showing no change | - | 633 |
| # cells showing decrease | - | 20 |

Table 3

| Percent Increase in Total Woodland 1950-1973 | Redcedar as Mean Percent of Total Woodland (1973) |
|---|---|
| 0 | 37 |
| 1 - 100 | 66 |
| 101 - 1,000 | 84 |
| > 1,000 | 87 |

Continued efforts by the KARS program over the coming year should provide evidence upon which WPD can base decisions regarding the need for state supported control efforts.

Mapping Center-Pivot Irrigation in Southwest Kansas

Location maps of center-pivot irrigation systems in southwest Kansas for the years 1965, 1971, 1972-1974 were originally prepared by KARS personnel as part of a cooperative project with the Kansas Forestry, Fish and Game Commission. The purpose of these maps was to determine the extent of disruption of lesser prairie chicken (*Tympanuchus pallidicintus*) habitat by center pivot irrigated farming practices. The project, as originally conceived, was highly successful. The maps provided ample evidence of the rapid increase of center pivot irrigation and suggested that this increase posed a threat to lesser prairie chicken habitat.

Further, these data served as the basis of a successful request by KFF&G for federal funding of a research program to determine the distribution and dynamics of native prairie and lesser prairie chicken populations in Kansas, and their relationship to patterns of center-pivot irrigation. (Funding in the amount of $80,000 was obtained on February 1977 from the U.S. Fish and Wildlife Service [Project W-42-R, Study 07].)

During this study, however, it became clear that expansion of center-pivot irrigation was a highly dynamic phenomenon, in that each year old systems are dismantled and new systems are implemented. The magnitude of change and large acreage covered by center-pivot irrigation systems is striking. Consultation with representatives of other state agencies suggested that this agricultural practice was a phenomenon of more general interest. Accordingly, in FY 1977 the areal coverage of the 1972-1974 maps was extended from the original 14 counties to a total of 32 counties and temporal coverage was extended to include 1975. Both tasks were accomplished through the interpretation of LANDSAT imagery.

Two maps of these data were prepared. The first is entitled "Increase in Center Pivot Irrigated Fields 1972-1975." Increases in the number of center-pivot systems, on a yearly basis, are portrayed

through a series of four inset maps, each at a scale of 1:1,400,000. The overall size of the maps is 20 x 26 inches. The second map is entitled "Center Pivot Irrigated Fields, Southwest Kansas, 1975." The overall size is the same as the first map, but a single map at a scale of 1:725,000 depicts the location and total number of center pivots as of 1975. The maps have been printed and are being distributed to state agencies at cost. The purpose of these maps is to make the information they contain more widely available to decision makers and interested citizens of Kansas.

One agency, the Entomology Division of the Kansas Department of Agriculture, has already applied these data to the decision making process. The specific usage is twofold. First, they are being used to decide on optimal locations for honeybee hives for the southwestern Kansas alfalfa seed producing industry. Most center-pivot systems in this area are devoted to corn production, and the insecticides used on corn are particularly damaging to honeybees. Knowledge of center pivot locations allows hives to be situated in such a way that the bees are able to effect the pollination of alfalfa, which is vital to seed production, while being exposed to minimum insecticide stress from adjacent corn planted center-pivot systems.

A second use of the maps is in the design of corn pest sample surveys. These surveys are of considerable importance since they serve as the basis for forecasting and monitoring corn pest outbreaks. Accurate surveys require that sampling efforts be planned to include a representative sample of agricultural holdings. This task is particularly difficult in light of the rapid expansion of center-pivot irrigated fields in areas that had previously been non-agricultural land. The Division of Entomology has used the center-pivot maps as a basis for deciding on optimal locations for these survey efforts. Dean Garwood, Director of the Entomology Division, Kansas State Department of Agriculture, notes that direct monetary savings are realized in reduced travel time and reallocation of the time formerly devoted to locating survey areas on the ground. This reduces survey time by 10-20% and results in more accurate surveys representative of all agricultural land at considerable savings.

There are numerous other potential uses of the center-pivot maps. For example, center-pivot systems use considerable amounts of ground

water. Documentation of their rate of increase and locations may therefore be used as a planning tool by groups concerned with the conservation of the limited ground water resources of southwest Kansas. These maps are expected to play a considerable role in ground water conservation and monitoring of center-pivot irrigation spread.

## WILDLIFE HABITAT AND ENVIRONMENTAL QUALITY

### Mapping Rangeland Vegetation Changes in Barber County, Kansas, 1950-1973

Ranching comprises a major portion of the agricultural economy in many Kansas counties. In some areas of the state, physical factors make it the only reasonable economic option. Rough topography, shallow soils and low rainfall tend to discourage cropping. Yet, adequate grass can be maintained to support cattle grazing operations in most instances. However in some areas, such as western Barber County, ranchers are concerned about the invasion of grassland areas by several species of woody plants.

Two species are of primary concern: eastern redcedar (*Juniperus virginiana*), and sand sagebrush (*Artemesia filifolia*). Since these plants are unpallatable to cattle, their presence may significantly reduce the quality of grassland utilization for grazing. In order to evaluate the magnitude of the problem, determine the effectiveness of control procedures, and allocate resources for future control efforts, range managers must have information concerning the distribution, occurrence, and nature of spread of the woody species.

The Kansas Applied Remote Sensing Program is working with the Sunflower Resource Conservation and Development (RC&D) Project, the U. S. Soil Conservation Service (SCS), and the Barber County Conservation District to evaluate changes in rangeland vegetation that have occurred during the last two decades in Barber County. This work has involved completion of two maps of rangeland during a 23-year period. This work will lead to decisions regarding the control measures which will be undertaken to minimize the effect of invasion of woody plant species. Because financial resources are limited, however, additional decisions will concern the areas of concentration for control efforts.

Maps showing the distribution and extent of the woody species and uninfested rangeland as they existed in 1950 and 1973 have been prepared. The maps of rangeland and woody plant species distribution as they existed in 1950 were compiled by interpreting ASCS black and white panchromatic aerial photography (scale 1:20,000) flown in that year. The interpreted data were reduced to a scale of 1:126,720 in order to overlay the Kansas Department of Transportation county highway base

map. A variety of types of imagery were used to develop the map showing the distribution of woody plant species and rangeland as of 1973. LANDSAT-1 false color composites, Skylab S190B photography, and NASA low altitude aircraft underflights were used initially. Following detection of some problems, additional data were derived from medium scale (1:45,000) black and white panchromatic photography acquired by the U. S. Soil Conservation Service in October 1973.

It was determined that the detail displayed on the 1973 imagery was insufficient to ensure acceptable accuracy of interpretation of sand sagebrush, but did allow for the mapping of eastern redcedar distributions. To supplement the inadequacies of the photos, an extensive field survey was performed to determine the current location of sand sagebrush infestations. The data obtained from the field survey provided sufficient additional information for mapping sand sagebrush infestations. The 1973 data were also mapped at a scale of 1:126,720.

The final maps were prepared as transparent color overlays to a mylar copy of the Kansas Department of Transportation Barber County road map. The Color-Key$^{T}$ proofing process was used for map production.

Both the 1950 and 1973 maps displayed the following categories:

1. Cedars in canyons - areas where eastern redcedars are found within the drainage pattern and where the eastern redcedar is the dominant vegetation type.
2. Cedars outside canyons - areas where eastern redcedars have spread beyond the drainage pattern and onto rangeland.
3. Heavy sage - rangeland areas where sand sagebrush infestations are present in concentrations greater than 25% of the ground cover.
4. Sage - rangeland areas where sand sagebrush infestations are present and which provide between 10% and 25% of the ground cover.
5. Hardwoods - indicates the presence of riparian vegetation. This does not include those areas within the drainage pattern that feature eastern redcedars as the dominant vegetation. Refers only to deciduous vegetation.

6. Other rangeland - identifies those rangeland areas that are free of eastern redcedar and sand sagebrush infestations, or where the infestations do not account for a significant percentage of the range vegetation.
7. Agricultural land - primarily identifies land that has been cultivated for grain production. Also includes acreage that shows past evidence of cultivation and which is in a fallow state and land that has been tilled or mowed for hay production purposes.

In general, no unit of land cover smaller than 20 acres in area was mapped.

The maps indicate that there has been a substantial decrease in sand sagebrush infestation since 1950. During the same period, eastern redcedar seems to have increased almost as dramatically as the sand sagebrush has declined. Range specialists from the U. S. Soil Conservation Service and the Sunflower RC&D Project are now evaluating the maps. Decisions related to control of both sand sagebrush and redcedar are expected.

Several other agencies have shown interest in the Barber County project. The invasion of redcedar onto rangeland has proven to be a vexing problem in other areas of Kansas. The Kansas Department of Agriculture, Weed and Pesticide Division, is interested in the problem and has requested data on two additional counties. The 1973 vegetation map of Barber County may also help Kansas Forestry, Fish and Game personnel to make a decision concerning whether or not to locate mule deer in the region.

## Development of Wildlife Habitat Areas in Southeast Kansas Strip-Mined Region

Between 1926 and 1969, twenty-six tracts of land scattered through northern Cherokee and southern Crawford counties, Kansas, were deeded to the state. Most of these areas had at sometime been strip-mined. The individual tracts collectively are called the Mined Land Fish and Wildlife Area and range in size from 49 - 600 acres, but average 230 acres in size. Cumulatively, the 26 tracts total nearly 6,000 acres.

The areas are managed by the Kansas Forestry Fish and Game Commission (FF&G) which is attempting to enhance fish and wildlife resources in the region.

FF&G biologists estimate that 90 - 95% of the areas are composed of strip-mine dumps. In these areas soils and drainage have been severely disrupted. Because of the variety of mining dates and types of vegetation introduced by man, the areas exhibit a number of different stages of plant invasion and succession. Small game such as the cottontail rabbit, mourning dove, bobwhite quail and fox squirrel are found throughout the areas. Some areas have deer and a fair population of fur-bearing animals.

Nearly 900 acres of water occur throughout the 26 areas. Strip-pit lakes and smaller ponds have formed in former excavations and depressions between the spoils ridges. Many lakes exhibit severe water quality problems due, for example, to pollution from sulfur bearing rocks and soils, oxygen depletion, and infertile watersheds. Nevertheless, fish populations are maintained through stocking programs.

It has been difficult for the three permanently assigned FF&G personnel to adequately survey and acquire information on these scattered areas. Limited funds make it desirable to concentrate efforts on areas of critical concern. Remote sensing techniques have been used to aid in mapping the areas, planning developmental and recreational efforts, and undertaking specific management activities.

KARS personnel are working with the Kansas Forestry, Fish and Game Commission Southeast Regional Office, Chanute, to develop remote sensing techniques that may be used to evaluate and monitor habitat conditions in the Mined Land Fish and Wildlife Area. During June 1976, large scale (1:20,000) color infrared aerial photography of the 26 management sites was flown by the University of Kansas Center for Research, Inc., Photo Services Laboratory. Enlarged color prints (scale approximately 1:5,000) of each management tract were provided to FF&G biologists (Figure 5). KARS personnel assisted FF&G staff in interpretation and use of the imagery.

The aerial photography has provided a synoptic view of the management areas. Furthermore, it has enabled FF&G biologists to cover more

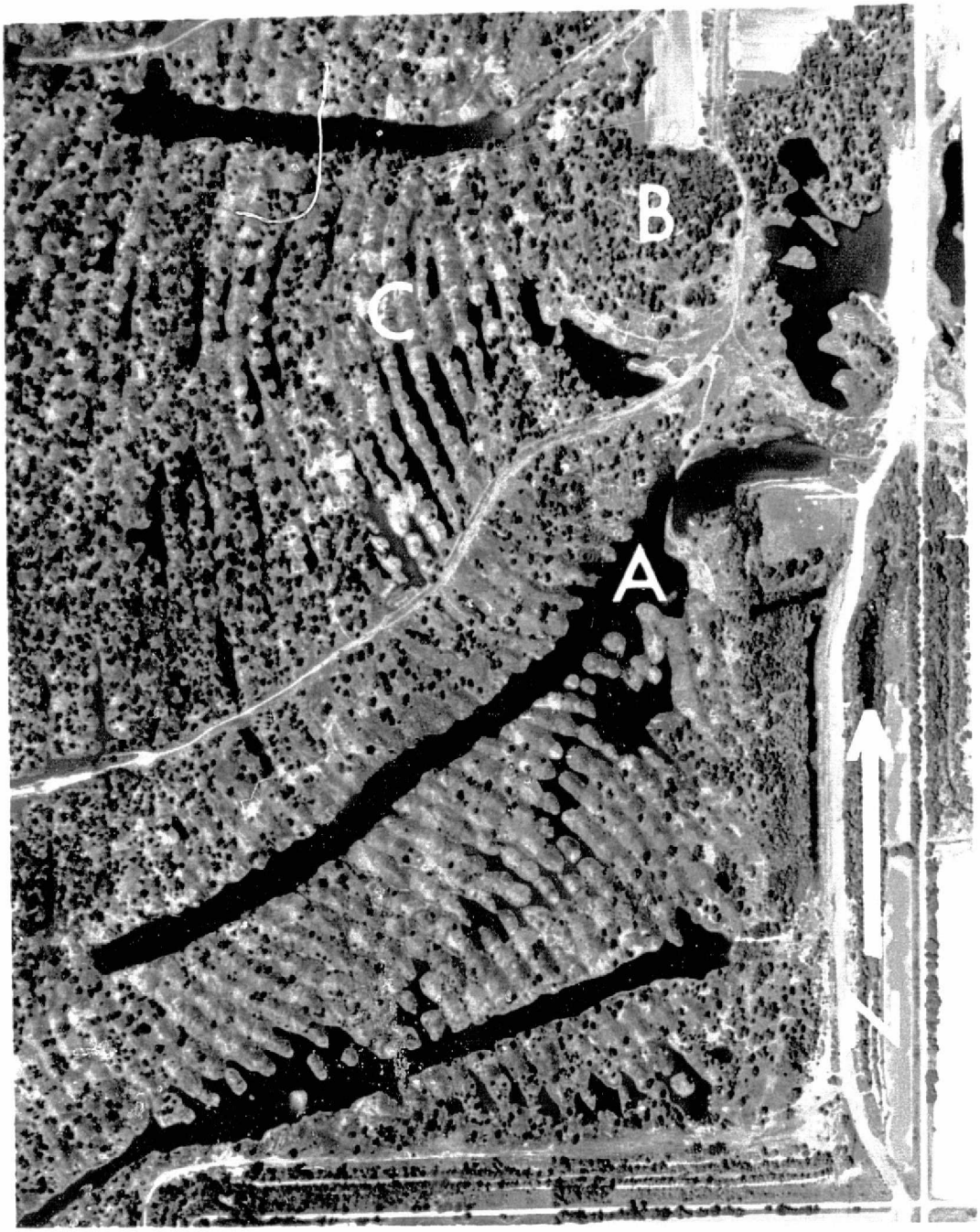


Figure 5. Strip pit lakes (A), sites having good vegetation cover (B), and sites requiring revegetation (C) are readily identified on air photo of one KF&G management area in strip mined region of southeast Kansas.



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area than previously possible and has allowed observation of phenomena previously unseen. The aerial photography has prompted decisions and actions in several areas. Patrick Bonislawsky, FF&G fisheries' biologist in the Southeast Region, has recently documented specific applications. These include:

1. *Mapping disrupted drainage patterns and previously unknown water bodies* -

   The majority of strip-mine lakes are not isolated, non-discharging bodies of water. (Water does move within the areas between strip-mine lakes and streams.) Knowledge of drainage patterns within these areas is very important in establishing a sound basis for planning. Such information, for example, can be used to avoid unwanted reentry of undesirable fish species through successful introduction of fish toxicants. Further, this information aids in surveying all waters in the area to determine strategies for monitoring water quality and delineating water pollution sources. By constructing small earthen dams at strategic locations in the area, water movement can be controlled to isolate polluted strip-mine lakes and control acid-mine drainage. Dams may also be constructed to enlarge certain strip-mine lakes in order to increase shallow water areas and thereby promote aquatic productivity. KARS photography has been utilized in mapping drainage patterns and smaller bodies of water which had not been previously detected on aerial photographs.

2. *Evaluation and Enhancement of Wildlife Habitat* -

   It is important to calculate percentage vegetation cover for each area in order to assess the value of wildlife habitat. The air photos have aided in locating bare areas (often tipple sites and highly acid areas less than 5 acres in area). Reclamation of these areas aids in improving water quality of streams and strip-mine lakes, and allows growth of desired vegetation. Field checks of denuded areas and soil sampling provides the information needed for planning measures aimed at improving the soil capabilities on these sites. Through

the use of grading to cover non-acidic spoil material, liming, and seeding with low pH resistant g[illegible]s and forbs, these areas can be made productive while abating acid-mine drainage into strip-mine lakes. KARS photography has been a useful tool in locating denuded areas where acidity was the primary factor contributing to reduced productivity. As the photo interpretation skills of the FF&G biologists increase, it is hoped that strip-mine lakes that possess a low pH can be detected.

3. *Planning and Construction of Recreational Facilities and Aids* - The construction of access trails to remote strip-mine lakes is a development priority since fishing ramps will be sited on some lakes. Wide trails permit the planting of good stands of native grasses, forbs and shrubs to improve wildlife habitat. The photography has been of considerable value in planning trails. Furthermore, FF&G has been planning for some time to publish a Mined Land Fish and Wildlife Area Fishing and Hunting Guide. This guide will show the locations of each area as well as locations of strip-mine lakes within each area, all roads, trails, boat ramps, camping areas, rest facilities, and other developments, and some tips on hunting and fishing in the area. The guide is now in preparation and is intended to promote more intensive use of the area by hunters and fisherman. The KARS photography provides the means by which accurate maps can be prepared, since previous data did not provide the detail and broad area coverage required for this effort.

4. *Monitoring Effectiveness of Management Programs* - By obtaining photography on a regular basis, the success of efforts to reclaim acid areas and establish desired vegetation on these sites can be evaluated. Changes in vegetation as a result of prescribed burning, seeding and timber clearing can also be assessed.

## Control of Aquatic Vegetation at Douglas County Lake, Kansas

Douglas County State Fishing Lake is a 184 acre (75 hectares) man-made impoundment located in northeastern Kansas near the town of Baldwin,

and is managed for recreational use by the Kansas Forestry, Fish and Game Commission (FF&G). In recent years fisheries' biologists have noted a decline in individual size and quality of game fish (primarily largemouth bass, Micropterus salmoides) taken from the 13 year old lake. A major factor contributing to this problem was thought to be vegetation growth in the lake's littoral zone which provided protection to prey species (predominately bluegill, Lepomis macrochirus), thus limiting the resources available to the bass population. The areal extent and severity of the vegetation problem was unknown, however.

The lake vegetation, comprised principally of Stonewort (Chara, sp.), Leafy Pondweed (Potamogeton foliosus) and Southern Naid (Najas guadalupensis), appeared to be distributed primarily in the lake's shallow regions in areas where sunlight penetrated to the lake bed (littoral zone). Interim measures aimed at controlling the vegetation (e.g., mixing herbicides with the water) proved ineffective. Consequently, FF&G personnel, in early 1975, proposed more drastic control measures to effect permanent change in the vegetation. However, since such measures would require a substantial comitment of time and funds and would cause disruption of public use of the lake, it was necessary to document the exact areal extent and severity of aquatic vegetation overgrowth in the reservoir before a decision on such procedures could be made. In April 1975, FF&G biologists contacted the KARS program to determine if aerial photography could be used to obtain appropriate data.

During August 1975, at the height of vegetation growth, the University of Kansas Center for Research, Inc., Photo Services Laboratory provided coverage of the lake. Aerial photography in 70 mm format was obtained using four films: natural color, color infrared, black and white panchromatic, and Kodak SO-397 water penetration film. Complete coverage was obtained at a scale of 1:9,144. Selected shoreline areas were photographed at a scale of 1:1,524. Ground truth was collected concurrently with the flights.

The extent of aquatic vegetation was mapped from the aerial photography and registered to a 1:4,800 topographic map of the lake bed. The 7-foot and 15-foot depth contours were superimposed on the final map delivered to FF&G. The relationship between areas of vegetation growth

and the shallow regions of the lake was clearly shown. Approximately 19% (36 acres, 15 hectares) of the lake's surface area was found to be affected by the vegetation growth. More importantly, 35% of the area between the shoreline and the 15 foot depth contour was severely overgrown with aquatic vegetation. This latter figure represents over one-third of the fish and food producing area of the lake.

On the basis of this information, the FF&G Commission determined that aquatic vegetation in Douglas County Lake was indeed a severe problem and decided to take the following action: *During November and December 1976, the lake was drawn down 10 vertical feet. During February 1977, after the shore area had dried, the herbicide Simazine was applied directly to the vegetated areas. During the drawdown period FF&G biologists also steepened the lake basin with earth moving equipment thereby reducing the number of shallow areas and inhibiting vegetation regrowth.* Successful reduction of vegetation should produce an increase in largemouth bass growth rates resulting in an enhanced sports fishery.

URBAN AND REGIONAL PLANNING

Land Use Mapping for Planning and Zoning in Sumner County, Kansas

Sumner County, Kansas, encompasses 3,016 square kilometers (1,182 square miles) in the south central part of the state. While the county is predominantly a rural/agricultural entity, it has, in recent years, experienced considerable development as urban centers expand and the regional population seeks new recreational sites. Concern has been expressed over the amount of agricultural land being converted to alternate land uses. Most of this growth, largely uncontrolled and unplanned, is occurring in the northern reaches of the county in response to pressures from the metropolitan area of Wichita (population: ca. 275,000), 24 kilometers (15 miles) to the north in neighboring Sedgwick County. U. S. interstate highway 35, the primary route connecting Kansas City, Wichita, and Oklahoma City, facilitates access to the eastern one third of Sumner County.

In order to regulate future development and accomodate growth from Sedgwick County, the Sumner County Commission and County Planning Board in 1975 requested assistance from the Chikaskia, Golden Belt and Indian Hills Regional Planning Commission, of which the county is a member, in the formulation of a county development plan. The substance of this plan was to include an inventory of human and natural resources, an evaluation of county growth, and recommendations for zoning and/or other methods for dealing with future growth. Significant decisions regarding future growth policy, land use patterns, and zoning would be made from the data compiled.

An important element of the plan was an assessment of current land use. Information on existing land use was initially collected by Regional Planning Commission staff using windshield survey techniques. Though a more comprehensive land use inventory was desirable, time and personnel limitations precluded such a survey. As work on the plan progressed, the Kansas Applied Remote Sensing (KARS) program contacted Regional Planning Commission personnel in order to determine the extent to which remote sensing techniques might contribute to data collection and plan formulation. Regional Planning Commission staff expressed great need for a reconnaisance land cover/land use map of the county. Time constraints placed upon the agency dictated, however, that the map would

have to be produced quickly in order to be used in the plan. KARS personnel determined that suitable imagery was available at the University of Kansas Space Technology Center, and that a compilation map could be produced within the two-week time period required by the planning agency.

Imagery of Sumner County obtained during NASA's Skylab missions in 1973 and current LANDSAT imagery of the county were on hand in the KARS laboratory. Although interpreters were somewhat familiar with the area, aerial photography and ground truth were not available to aid image interpretation because of the time period involved. Regional Planning Commission staff were informed of these circumstances, however, and agreed to field check the completed interpretation. To compensate for the absence of supportive data, land cover/land use classes were general. They were as follows:

1. Urban and built-up land
2. Cropland
3. Grassland (mostly rangeland but including some pasture areas)
4. Woodland
5. Water

In most instances, no unit area smaller than approximately 4 hectares (10 acres) was mapped.

Because of its high resolution, photography obtained from the Skylab S-190B Earth Terrain Camera (5 August 1973) was used as the primary data source. More recently obtained LANDSAT multispectral scanner (MSS) imagery (8 August 1975) was used to correct and update the land cover/land use interpretation of the Skylab photography. All imagery was enlarged to a scale of 1:126,720 using a rear projection technique.

The map delivered to the Regional Planning Commission was a copy of the original interpretation prepared on stable drafting media as an overlay to the Kansas Department of Transportation Sumner County Road map (scale 1:126,720). Colored pencils were used to represent land cover/land use categories. The map was completed and delivered within fourteen days of the original request. Field checks undertaken by Regional Planning Commission staff showed the accuracy of the generalized land cover/land use patterns mapped to be on the order

of 85-90 percent. Subsequent comparisons of the map with recently acquired land cover/land use maps of the county prepared from high altitude aerial photography by USGS under the Land Use and Data Analysis (LUDA) program bear out this conclusion.

The compilation map prepared by the KARS Program was redrafted by the Chikaskia, Golden Belt and Indian Hills Regional Planning Commission and included in the Sumner County Development Plan. It, thus, comprises one element of the primary data base from which the Sumner County Commission will draw information needed to make growth policy and zoning decisions.

## Law Enforcement Planning for the Republican National Convention

In Fall 1975, it was announced that the Republican National Convention would be held in Kansas City, Missouri, from August 14 to August 20, 1976. The new Kemper Arena was designated as the convention site and preplanning was initiated to accommodate 40,000 to 50,000 people involved with the convention, including delegates, dignitaries and press representatives.

To offset some of the additional costs associated with law enforcement and security, congress appropriated $5.2 million for the Democratic and Republican National Conventions, the first time in history such an appropriation has been made. Of that amount $2.6 million was earmarked for New York City for the Democratic Convention and $2.6 million for Kansas City for the G. O. P. Convention. A unique situation existed in Kansas City, however, concerning the allocation of the funding. Although Kemper Arena is located entirely within the State of Missouri, it is in close proximity to the Kansas state line. In fact, the use of Kansas lodging and commercial areas was a deciding factor in the selection of Kansas City as the Convention site.

Major interstate and state highways make the Convention site, lodging and commercial areas in both states easily accesible. Since Kemper Arena is located in Missouri, however, most of the law enforcement responsibilities fall on Missouri. Nevertheless, the Kansas City, Kansas (KCK) Police Department assumed from the onset that they would receive reimbursement for the extra work required on their part to

provide normal protection to the citizens of Kansas affected by the Convention in addition to protection against terrorist or demonstration activity related to Kansas visits by the President or Vice President. Because the sovereign rights of law enforcement officials end at the political boundaries of their domain, Missouri police would be unable to provide such protection. Statements released by the Kansas City, Missouri (KCMo) Police Chief and attendant lawyers, however, indicated that only off-duty KCK policemen who worked for KCMo at the Convention site would be reimbursed, nothing more. This information and its obvious implications for taxpayers in the KCK metropolitan area prompted the KCK Police Department to submit a proposal for federal funds to the Governor's Committee on Criminal Administration (GCCA) and to seek a mutual aid law enforcement compact with three Kansas counties and 14 municipalities within the counties to provide manpower and equipment for Convention security. The GCCA, the Kansas state channel, approved the proposal and forwarded it to the Law Enforcement Assistance Administration (LEAA), the federal channel. LEAA, however, questioned the proposal and summoned representatives of the KCK Police Department to Reston, Virginia, to present its case. The three Kansas counties and various municipalities likewise had difficulty visualizing their potential security involvement with the Convention. Because of the difficulty in demonstrating the location of Kemper Arena and the subsequent impact of the Convention on KCK, Sargent Clifford Talley, Director of Planning & Research, KCK Police Department, contacted the Kansas Applied Remote Sensing Program (KARS) and requested assistance.

NASA U-2 color infrared aerial photography (nominal acquisition scale 1:125,000; May 1974) flown for KARS projects in the Kansas City metropolitan area was available. A 30 x 30 inch enlargement (3.6x of one frame) of this photography was provided April 7, 1976 to the KCK Police Department to illustrate and emphasize the spatial relationship of Kemper Arena to the adjacent Kansas counties and municipalities (Figure 6).

*On April 9, 1976 in Reston, Virginia, the KCK Police Department presented its case utilizing the NASA photography and was awarded a $350,000 grant to fund the Tri-County Convention Security Program (a mutual aid law enforcement compact).*

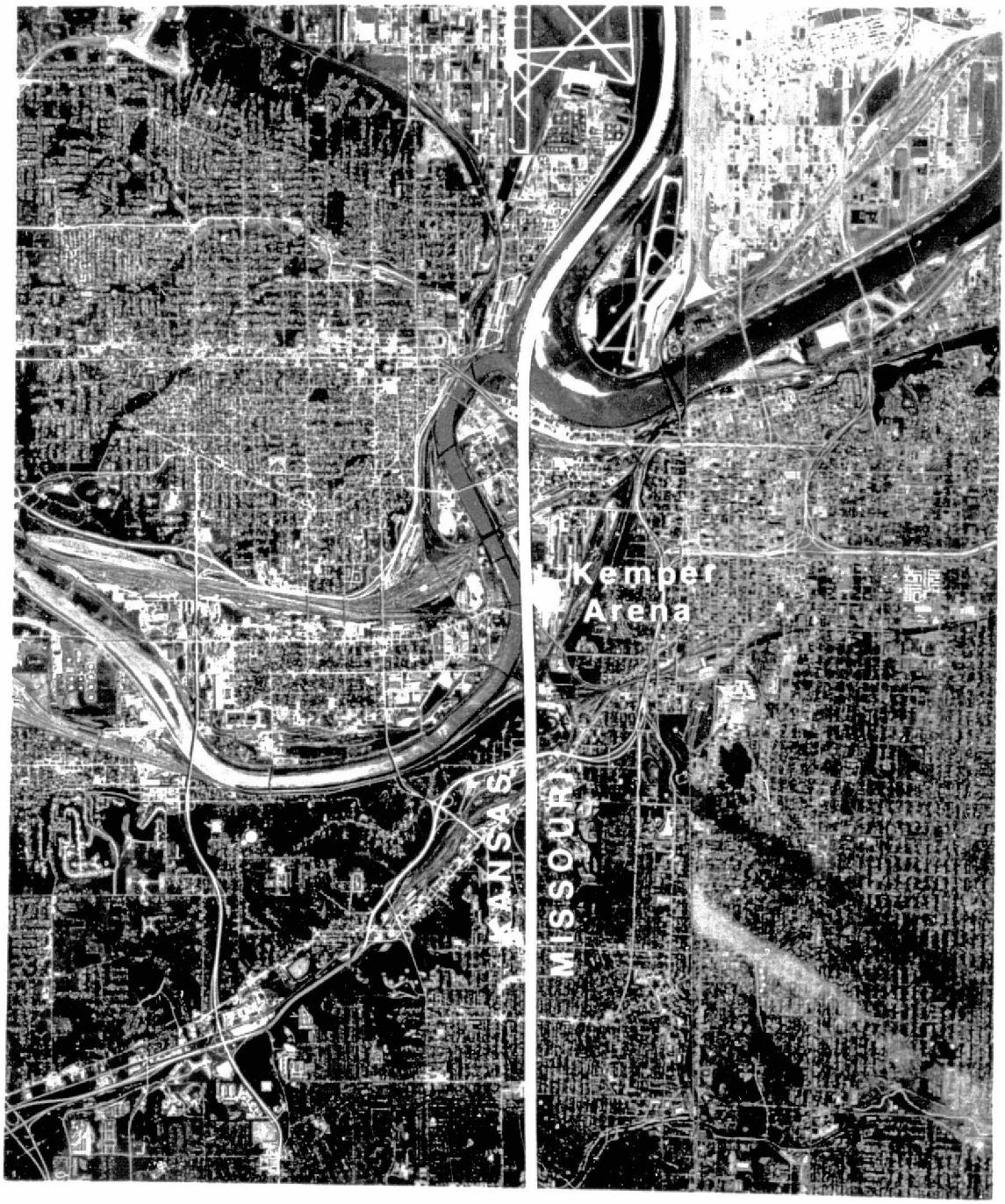


Figure 6. NASA high altitude aerial photography was used by the Kansas City, Kansas Police Department to illustrate the spatial relationship of Kemper Arena, site of the 1976 Republican National Convention, to adjacent Kansas counties and municipalities.

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The NASA U-2 photography was also used to demonstrate to local and county law enforcement the impact of the Convention site location on their jurisdictions.

*An Agreement among Johnson, Wyandotte and Leavenworth Counties and various municipalities for the purpose of establishing mutual police protection and aid in relation to the 1976 Republican National Convention was made and entered into by Kansas Law (K.S.A. 12-2901, et. seq. titled Interlocal Cooperation Act) and approved by the Attorney General Curt Schneider, on 7 July 1976.*

The purpose and intent of this aggreement was:

1. To make possible the design and implementation of a consolidated training program for officers of all sheriff's departments and police agencies.
2. To make possible the functional and physical crossing of political jurisdictional boundaries without regard to a law enforcement officer's specific jurisdictional limitations in order to maximize the use of available manpower, equipment and facilities in the event additional or emergency police protection or aid was requested.
3. To provide a system of control, planning and supervision when circumstances necessitated the utilization of manpower and equipment from outside jurisdictions.
4. To support the efforts of federal law enforcement agencies.

It was further agreed that in the event no federal funds were obtained for Convention law enforcement, each individual agency would be responsible for financing the cost of its respective personnel, equipment and facilities from the fiscal resources available to that agency.

The Republican National Convention was subsequently held with no significant law enforcement problems. This planning aided significantly in accomplishing that result.

Decision on County Line Lake, Missouri

While this project was completed in FY 1976 and discussed in the previous annual report of work performed under NASA grant NGL 17-004-024, subsequent decisions have resulted and are summarized here. The Missouri

Governor's Office and the Missouri Department of Natural Resources, in March 1975, requested that the KARS program provide a land use evaluation for the site of the proposed County Line Reservoir project that was to be located in Webster County, Missouri. The purpose of this evaluation was to resolve a controversy which had arisen concerning discrepancies between the environmental impact assessments prepared by the Army Corps of Engineers and the Missouri Department of Conservation. The main basis of these discrepancies was the acreage estimates of land use categories in the area to be flooded, which were of primary importance to the cost benefit analyses of the two reports.

The KARS evaluation was delivered on 25 April 1975 and subsequently, on 19 May 1976, Missouri Governor Christopher S. Bond recommended that the project not be pursued. It was not clear at the time, however, to what extent KARS data had played a role in this decision.

This situation was clarified in August of 1976, when KARS personnel obtained copies of Governor Bond's letter to the Corps of Engineers, which contained a detailed explanation of the negative recommendation, and a copy of the Missouri State Task Force Report on the project, which formed the basis of the Governor's decision. The latter document questioned the accuracy of the Corps of Engineers' land use assessment because of the close agreement between the KARS program land use data and that of the Missouri Department of Natural Resources (Table 4). The Governor's letter in turn informed the Corps that, because insufficient attention had been paid to agricultural values in the area to be flooded, the state found their environmental impact statement to be inadequate. Thus, KARS data played a definite and important role in the decision on County Line Lake.

Table 4

Estimates of Land Use to be Inundated by
Conservation Pool of County Line Lake
(in acres)

| | Corps of Engineers | Department of Conservation | Kansas Applied Remote Sensing Program |
|---|---|---|---|
| Forest | 3,150 | 1,371 | 1,354 |
| Forest Scrub | - | 908 | - |
| Pasture | 1,900 | 2,903 | 3,180* |
| Cropland | - | 499 | 562 |
| Grass Rotation | - | - | 546 |
| | | | 1,108 |
| Other (cemeteries, farmsteads, roads, etc.) | 950 | 319 | 141 |
| Total | 6,000 | 6,000 | 5,783 |

*Pasture classification includes 350 acres with relatively dense brush.

This shows general agreement between Department of Conservation and Kansas University Applied Remote Sensing Program data as well as wide discrepancy of Corps data.

Source: State Task Force Review of the U.S. Corps of Engineers County Line Lake Report, James River Basin, Missouri, Final Report to Governor Christopher S. Bond, May 6, 1975.

## GUIDE TO AERIAL PHOTOGRAPHY AND SPACE IMAGERY OF KANSAS

The *Guide to Aerial Photography and Space Imagery of Kansas* was created to fill the expressed needs of many Kansas agencies working with the KARS program. Specifically, it provides a useful compendium of remote sensing techniques and imagery availability to potential Kansas users.

The first section is devoted to an overview of remote sensing and includes information on the properties and mode of action of selected sensors, including cameras, scanners, and side-looking airborne radar. Following this is a more detailed discussion of aerial photography including comments on the effect of scale, film type, and film format on the utilization of aerial surveys, information on the importance and availability of base maps, and the procedures for locating and ordering imagery. The section closes with a description of the KARS program.

In the three sections which follow, LANDSAT and Skylab imagery, high altitude photography and low altitude photography are considered. Each section begins with a discussion of the formats and properties of the imagery available in the category. Following this is a listing of available imagery by source (i.e., NASA, U. S. Geological Survey). Areal coverage and location of imagery is shown by means of a map or by a table.

This publication will further the goals of the KARS program by generating an increased awareness of and greater access to remote sensing procedures, data, and the KARS program.

APPENDIX I

*KARS NEWSLETTER(s)*

Kansas Applied Remote Sensing

KARS

Newsletter

Volume 5, Number 3 July 1976

## TESTS INDICATE MUSK THISTLE DATA OBTAINABLE FROM AIR PHOTOS

KARS program researchers have recently determined that moderate to dense infestations of musk thistle (Carduus nutans) can be detected on large scale aerial photographs. This finding marks the successful completion of the initial phase of a research project being undertaken at the request of and in cooperation with the Weed and Pesticide Division, Kansas Department of Agriculture. The project is being directed by E. A. Martinko, KARS Project Coordinator and Adjunct Assistant Professor, Division of Biological Sciences. Objectives of the investigation are to determine (1) the extent to which musk thistle can be detected and identified on aerial imagery, (2) the extent to which parameters such as height, cover, density, numbers and frequency can be measured or estimated through image analysis, and (3) the relative cost effectiveness of large and small scale aerial imagery acquired at intervals of one year or more for monitoring changes in musk thistle distribution.

Musk thistle was first found in Kansas in 1932. Since that time the plant has become widely established throughout the eastern two-thirds of the state. In 1963 it was declared a noxious weed. Agricultural agencies, farmers and ranchers in Kansas annually spend some $20 million in attempts to control and eradicate the musk thistle. Successful development of techniques for delineating musk thistle infestations on aerial imagery would enable more accurate definition of its distribution, thereby assisting in more efficient and effective allocation of manpower, funds and resources for control efforts. Such techniques could also provide a means for measuring the rate and major direction of spread of the pest, and would make it possible to more readily assess the effectiveness of control measures and eradication programs over large areas.

The research undertaken by the KARS Program during spring 1976 was aimed at evaluating the detectability of musk thistle on large scale aerial photos taken during two critical stages in its growing cycle. Multiband aerial photos were flown by the KU Center for Research, Inc. Photo Services Laboratory over test sites in Marshall and Douglas Counties. Attempts to detect the thistle in the rosette stage of its development during early April proved unsuccessful. However, the musk thistle was clearly seen on photographs taken during its flowering stage in mid-June. The pest was successfully detected on black and white multiband (green, red, infrared), natural color, and color infrared films at scales of 1:4,000, 1:7,500, and 1:15,000. Further work will concentrate on correlating image data with field data, documenting interpretation techniques, and determining the smallest scale imagery which can be used to accurately provide information on the musk thistle. Additional high and low altitude flights are planned for spring 1977.

E. A. Martinko



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## LAW ENFORCEMENT PLANNING FOR G. O. P. CONVENTION

Kemper Arena, site of the 1976 Republican National Convention, is located in Kansas City, Missouri nearly astride the Kansas-Missouri state line. Kansas lodging and commercial facilities are easily accessible to the site and will be used extensively by delegates and others. As a consequence, Kansas City, Kansas (KCK) law enforcement officials felt that it was in their interest to seek federal funding to help offset some of the costs

The spatial relationship of Kemper Arena (circle), site of the Republican National Convention, to Kansas and Missouri communities is evident on this high altitude photo.

associated with additional law enforcement and security required during the convention.

A proposal for federal funds submitted by the KCK Police Department, was approved by the Kansas Governor's Committee on Criminal Administration, but was questioned at the federal level by the Law Enforcement Assistance Administration (LEAA). In June, representatives of the KCK Police Department presented their case to LEAA officials in Reston, Virginia and were able to obtain the needed funding. Enlarged U-2 color infrared photography of the Kansas City Metropolitan area, flown by NASA in May 1974 and provided to the KCK Police Department by the KARS program, was used to illustrate the spatial relationship of Kemper Arena to adjacent Kansas counties and municipalities and emphasize the potential impact on these communities.

The NASA photography, providing a synoptic view of the arena and its environs, was also used to demonstrate to local and county law enforcement officials the impact of the convention site location on their jurisdictions. A mutual aid law enforcement compact among Johnson, Wyandotte and Leavenworth Counties and various municipalities was entered into under Kansas Law on 7 July 1976. The purpose and intent of this agreement is:

(1) to make possible the design and implementation of a consolidated training program for officers of all sheriff's departments and police agencies
(2) to make possible the functional and physical crossing of political jurisdictional boundaries without regard to any law enforcement officer's specific jurisdictional limitations in order to maximize the use of available manpower, equipment and facilities in the event additional or emergency police protection or aid is requested.
(3) to provide a system of control, planning and supervision when circumstances necessitate the utilization of manpower and equipment from outside jurisdictions
(4) to support the efforts of federal law enforcement agencies.

G. E. Sheppard, E. A. Martinko

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### KARS PROGRAM 1976

*The University of Kansas Applied Remote Sensing (KARS) program is funded by the National Aeronautics and Space Administration (NASA) Office of University Affairs to assist decision makers in local, state and regional agencies in the application of remote sensing techniques to their problems and activities. Persons working in Kansas who believe that they may be able to use remote sensing in a decision making capacity are invited to contact the KARS Program at the University of Kansas in:*

*Space Technology Center*
*University of Kansas*
*Lawrence, Kansas 66045*

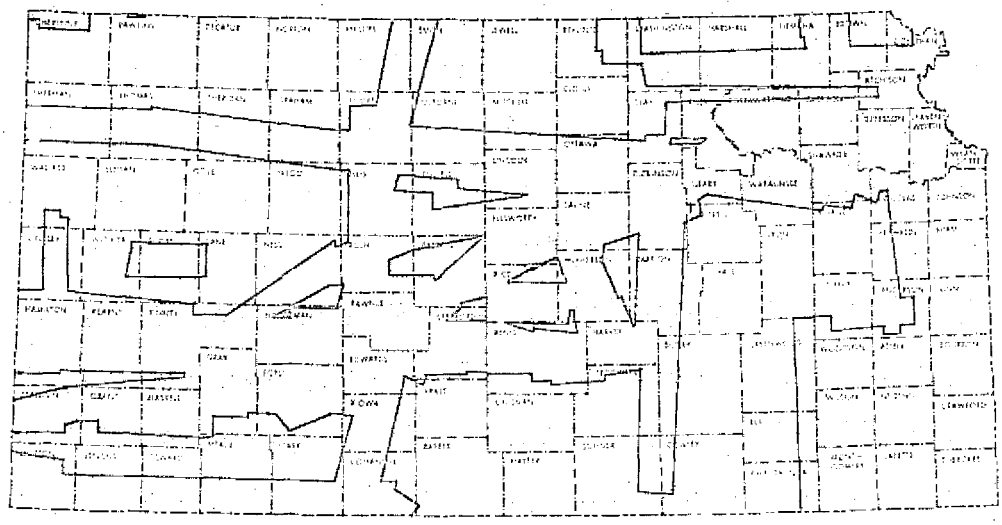
*913/864-4775 or KANS-A-N 564-47[illegible]*

## HIGH ALTITUDE AIR PHOTO COVERAGE OF KANSAS

KARS personnel during June updated an inventory of high altitude aerial photographic coverage of Kansas. Aerial photography obtained from altitudes above 55,000 feet is presently available over somewhat less than half of Kansas. The National Aeronautics and Space Administration (NASA) has flown numerous missions over the state since 1969. Some areas in northwest and southeast Kansas have been photographed only once during this period. Others, such as the Topeka-Kansas City corridor, have been covered many times.

High altitude photography is characterized by small scale (usually 1/2" = 1 mile or smaller), large area coverage (usually 175-300 sq. miles per frame), and, yet high resolution. It is consequently, quite valuable for surveying land use, urban problems, wildlife habitat, water resources, and other phenomena over expansive areas.

On the accompanying map all areas of Kansas covered with high altitude photography since 1969 are shaded (boundaries of photography are approximate). Persons wishing to determine exact dates of missions, mission number or other information can contact either: EROS Data Center, Sioux Falls, South Dakota 57198 or the KARS Program. Assistance in image acquisition, interpretation and utilization is also available from KARS personnel.



## PUBLICATION HIGHLIGHTS REMOTE SENSING APPLICATIONS IN WILDLIFE MANAGEMENT

The KARS Program has, under contract to the U. S. Fish and Wildlife Service (FWS) Office of Biological Services, prepared an eight page pamphlet reviewing selected applications of remote sensing in wildlife management. Published in April, the "summary report" was an outgrowth of work begun in Summer 1975. During that period KARS personnel undertook, with FWS, an evaluation of the utilization of remote sensing in FWS administration Region VI, a jurisdiction comprised of ten states in the northern Great Plains and Rocky Mountain region.

The pamphlet highlights some of the instances in which state and federal wildlife biologists are effectively utilizing remote sensing techniques, and points to sources of further information on remote sensing applications. It is hoped that the publication will help stimulate further experimentation with and application of remote sensing, and provoke among wildlife management discussion and interchange of ideas concerning the utility of these techniques. Copies of "Remote Sensing in Wildlife Management" are available upon request from the KARS program.

J. W. Merchant

## NASA SEEKS USER INPUTS ON LANDSAT-C DATA NEEDS

In September 1977 NASA plans to launch the third in its series of LANDSAT earth resources satellites. LANDSAT-C is to be equipped with a five band Multispectral Scanner (MSS), a two-camera Return Beam Vidicon (RBV), and the Data Collection System receiver and transmitter. Four MSS channels will be identical to those of LANDSATs 1 and 2; a fifth channel will operate in the thermal infrared. The RBV will provide high-resolution (40 meter) panchromatic imagery.

Prospective LANDSAT-C data users are invited to submit to NASA information regarding their anticipated mission and data requirements. The information received will be used to assist in making decisions regarding the scheduling of satellite operations. Inputs to NASA should be submitted in letter form by September 1, 1976 and should contain the following information: (a.) Name, address, and organizational affiliation, (b.) A statement of the nature of your interest in LANDSAT-C data with a description of the projected work to be performed. An indication should be given as to whether the intended use is considered operational in nature, a quasi-operational test of previously developed techniques, or research, etc. It would be

helpful if user groups could be specified, (c.) An estimate of LANDSAT-C coverage requirements such as geographical areas, time periods, frequency of coverage and cloud cover, (d.) An indication of sensor requirements such as all bands of MSS, thermal or visible band data only, daytime versus nighttime coverage, frequency of RBV coverage required relative to MSS coverage, etc., and (e.) An estimate of the type and amount of data required.

Letters from U. S. sources should be addressed to:
Dr. Stanley C. Freden
NASA Missions Utilization Office/Code 902
Goddard Space Flight Center
Greenbelt, Md. 20771 (301) 982-5818

with a copy to:
Mr. James R. Morrison
NASA Office of Applications/Code ERR
Washington, D.C. 20546

Letters from individuals or organizations outside the U. S. should be submitted in the same format
NASA Office of International Affairs/Code I
Washington, D.C. 20546
with copies to:
Dr. Freden and Mr. Morrison.

The complete NASA request document and addenda covering the LANDSAT-C payload, data products, planned data acquisition schedule, etc., are available in the KARS program office at the University of Kansas or may be obtained from NASA.

## UPCOMING MEETINGS

28 September - 1 October 1976 AMERICAN CONGRESS OF SURVEYING AND MAPPING - AMERICAN SOCIETY OF PHOTOGRAMMETRY FALL CONVENTION, Olympic Hotel, Seattle, Washington, For details contact Seattle ACSM-ASP Convention, Inc. 803 Seattle Municipal Bldg., Seattle, Wash. 98104.

25-29 October 1976 THE SECOND ANNUAL WILLIAM T. PECORA MEMORIAL SYMPOSIUM: MAPPING WITH REMOTE SENSING DATA, EROS Data Center, Sioux Falls, South Dakota. For information contact: Dr. Robert B. McEwen, U. S. Geological Survey, National Center, #510, Reston, Va. 22092

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Lawrence, Kansas 66045

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Kansas Applied Remote Sensing

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Newsletter

Volume 5, Number 4

October 1976

## MAPPING OF CENTER PIVOT IRRIGATED FIELDS IN SOUTHWEST KANSAS COMPLETED

The KARS program has recently completed a map of center pivot irrigated fields in southwest Kansas for 1975. The area mapped includes Barton, Rice, Reno, Kingman and Harper counties on the east and extends westward to the Colorado border. Data was compiled from interpretation of more than 70 LANDSAT images acquired between May and October 1972-1975, and ASCS and SCS air photo mosaics for the 15 counties. The map consists of two film positive overlays registered to the 1:500,000 scale USGS map of Kansas.

Maps of center pivot distribution for 1972, 1973 and 1974 are also available. Since there are considerable increases from year to year in some parts of the area mapped, such time sequenced maps may prove very useful. For instance, these maps show that Finney and Gray counties, the two areas with by far the largest numbers of center pivot irrigated fields, have shown a consistent 20-47% year to year increase during the 1972-5 period.

LANDSAT imagery useful for interpreting center pivots for 1976 is now available. Given the current base of information, it would be possible to rather rapidly update the map through 1976, should there be sufficient interest shown in such a project by prospective users.

Persons interested in obtaining more information about the availability of these maps are invited to contact the KARS Program.

Joe Poracsky

## WILDLIFE HABITAT DEVELOPMENT IN SOUTHEAST KANSAS STRIP MINED AREAS

KARS personnel are working with the Kansas Fish and Game Commission (KF&G) Southeast Regional Office, Chanute, to develop remote sensing techniques that may be used to evaluate and monitor wildlife habitat conditions in strip mined areas of southeast Kansas. KF&G wildlife biologists are attempting to significantly increase fish and wildlife populations in the region.

Large scale (1:20,000) color infrared aerial photography of 26 KF&G management areas in Cherokee and Crawford counties was flown during June 1976 by the University of Kansas Center for Research, Inc. Photo Services Laboratory. The 26 tracts total approximately 6,000 acres, with individual sites ranging in area from 49-600 acres. The photos are being used to evaluate the need for habitat reclamation programs, (e.g., seeding, liming, construction of dams and dikes, clearing and leveling) in the management areas. This data will aid KF&G biologists in allocating funds for reclamation efforts. Preliminary analysis of the CIR photography

indicates that several areas show potential for development into prime habitat for quail, mourning doves, rabbits, squirrels, and deer. The photos will also be used in the planning and establishment of new fishing and hunting trails within the KF&G management districts.

Ted Talmon

Strip pit lakes (A), sites having good vegetation cover (B), and sites requiring revegetation (C) are readily identified on air photo of one KF&G management area in strip mined region of southeast Kansas.

## PUBLICATION REVIEWS APPLICATIONS OF LANDSAT DATA

Users of data obtained from the first Earth Resources Technology Satellite (ERTS-1 now LANDSAT-1) and those wishing to know more about its capabilities, will be interested in a recent book published by the U. S. Geological Survey. The book ERTS-1, A New Window on our Planet (edited by R. S. Williams, Jr., and W. D. Carter, USGS Professional Paper 929) contains 84 brief reports on applications of LANDSAT data to problems in geology, water resources, land use mapping and planning, cartography, agriculture, forestry, environmental monitoring and other fields. Over 250 color and black and white LANDSAT images as well as other figures illustrate the publication. The book may be obtained for $13.00 from: U. S. Geological Survey, Branch of Distribution, 1200 South Eads St., Arlington, Virginia 22202.

## NATURAL AREAS SURVEY OF MISSOURI

The University of Missouri-Columbia is conducting a natural area survey of western Missouri counties within the Mid-America Regional Planning Council and the Mo-Kan Bi-State Regional Planning Commission. These two regional planning areas consist of two counties south of the Missouri River and seven counties north of the river. The project is supported through a grant from the State Inter-Agency Council for Outdoor Recreation and is being conducted through the Cooperative Fish and Wildlife Research Unit at the University of Missouri-Columbia.

KARS personnel have assisted project investigator Greg Iffrig in utilizing NASA high altitude color infrared aerial photography in the search for natural area sites. Preliminary work by Mr. Iffrig had suggested that remote sensing could be used to update the topographic maps for the region as well as provide valuable information concerning the potential of existing woodland sites. Low altitude black and white photo mosaics were initially used. It was determined, however, that for the area under consideration, use of this type of photography was too time consuming and failed to yield adequate information.

The high altitude color infrared photography seemed the most appropriate alternative. Currently an interpretation key is being developed to provide for the proper identification of forested sites. Efforts have been directed at employing this cost effective method to locate potential sites which are later checked during field work. The system has thus far been used to examine only woodland type zones. While prairie sites are also being searched for, difficulties arise in the remote sensing procedures because of the unmanageable number of potential prairie areas which may be located. Continued work should refine the technique and provide a workable system which can be used in surveys of other regions as well. Further information may be obtained from Gregory F. Iffrig, 112 Stephens Hall, University of Missouri, Columbia, Mo. 65201.

## DOUGLAS COUNTY LAND USE MAP

A land use map of Douglas County has been completed and the final products along with the project report have been delivered to the Douglas County Commissioners. The maps were prepared by the KARS Program over a three month period and were based on the interpretation of 1:24,000 scale black and white panchromatic aerial photography. The imagery was acquired over the county on May 18, 1976 by the KU Center for Research, Inc. Photo Services Laboratory. The final product consisted of eleven inked map overlays registered to USGS 1:24,000 topographic sheets. Seventeen major land use categories were identified on the maps.

Ron Shaklee

## EVALUATING PRONGHORN ANTELOPE HABITAT

In 1965, the Kansas Fish and Game (KF&G) Commission successfully re-established pronghorn antelope in Kansas. Antelope trapped in Wyoming and Montana were introduced into three counties in the northwest and two counties in the south central parts of the State. By early 1976 there were an estimated 1,000 antelope in Kansas.

The success of this effort has prompted KF&G to consider the reintroduction of antelope into other areas of Kansas beginning in Fall 1977. Several areas in the state might support antelope. During Spring 1977 KARS Program staff members will assist KF&G Big Game biologist Kent Montei in using remote sensing techniques to evaluate the suitability of habitat conditions in three proposed release sites. High altitude aerial photography and LANDSAT imagery are to be the primary data sources. Data to be collected for each site will include (1) the area, continuity and interspersion of rangeland and cropland, (2) the number and locations of barriers to migration, (3) and the degree and rate of encroachment of cropland into range areas. In each case data will be collected for an area of about 800-900 square miles.

Information provided by the KARS Program will aid KF&G biologists in selecting the site or sites in which antelope will have the greatest chance of becoming established.

Ted Talmon

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## KARS PROGRAM 1976

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*Space Technology Center*
*University of Kansas*
*Lawrence, Kansas 66045*

*913/864-4775 or KANS-A-N 564-4775*

## NATIONAL CARTOGRAPHIC INFORMATION CENTER

The National Cartographic Information Center (NCIC), established in 1974 by the U. S. Geological Survey, serves as a clearinghouse for cartographic data of the U. S. These data include maps and charts, aerial photographs, space imagery and related materials produced by more than 30 Federal agencies. In the future information will also be compiled on maps and remote sensing data produced by State and local agencies, and private firms. NCIC provides a central location to which users may turn for assistance in locating and ordering needed cartographic or remote sensing data.

The Aerial Photography Summary Record System (APSRS) is a service provided by NCIC which is of particular interest to users of remotely sensed data. The system uses maps and tabular summaries to display the status of all aerial photographic coverage of the U. S. obtained by Federal agencies. The most current APSRS information for Kansas and surrounding states is now on file in the KARS program library.

Persons wishing to utilize NCIC services or obtain further information may contact: National Cartographic Information Center, U.S. Geological Survey, 507 National Center, Reston, Virginia 22092 (Phone: 703/860-6045). Users in the Midwest may find it more convenient to contact the NCIC regional office at: Mid-Continent Mapping Center, U. S. Geological Survey, 1400 Independence Road, Rolla, Missouri 65401 (Phone: 314/364-3680 ext. 107).

## SYMPOSIUM TO FOCUS ON MACHINE PROCESSING OF REMOTELY SENSED DATA

The Laboratory for Applications of Remote Sensing (LARS), Purdue University, has announced that the Fourth Symposium on Machine Processing of Remotely Sensed Data will be held June 21-23, 1977. The symposium will focus on all areas of theory, implementation, and applications of machine processing of remotely sensed data including, for example, classification techniques, multi-temporal data registration, processing of LANDSAT data and applications in geology, agriculture, forestry, environmental monitoring, land use planning and other fields. Papers dealing with the symposium themes are solicited. For further information contact: Dr. John C. Lindenlaub, Laboratory for Applications of Remote Sensing, Purdue University, 1220 Potter Drive, West Lafayette, Indiana 47906.

## UPCOMING MEETINGS

27 February - 5 March 1977 AMERICAN SOCIETY OF PHOTOGRAMMETRY/AMERICAN CONGRESS ON SURVEYING AND MAPPING, Washington, D.C. For information contact: Dr. Frank J. Wobber, ASP/ASCM Convention, 14 Goshen Ct., Gaithersburg, Maryland 20760.

29-31 March 1977 SIXTH ANNUAL REMOTE SENSING OF EARTH RESOURCES CONFERENCE, The University of Tennessee Space Institute, Tullahoma, Tenn. For information contact: Dr. F. Shahrokhi, Conference Director, The University of Tennessee Space Institute, Tullahoma, Tenn. 37388.

25-29 April 1977 ELEVENTH INTERNATIONAL SYMPOSIUM ON REMOTE SENSING OF ENVIRONMENT, Environmental Research Institute of Michigan, Ann Arbor, Mich. For details contact: Dr. Jerald J. Cook, Environmental Research Institute of Michigan, P.O. Box 618, Ann Arbor, Michigan 48107

21-23 June 1977 FOURTH PURDUE SYMPOSIUM ON MACHINE PROCESSING OF REMOTELY SENSED DATA, Laboratory for Applications of Remote Sensing, Purdue University, West Lafayette, Indiana. For Information contact: Dr. John C. Lindenlaub, Laboratory for Applications of Remote Sensing, Purdue University, 1220 Potter Drive, West Lafayette, Indiana 47906.

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# Newsletter

The University of Kansas Lawrence, Kansas January 1977 Volume 6, Number 1


## NASA REVIEW OF KARS PROJECTS

On November 18, 1976, Mr. Joseph Vitale, National Aeronautics and Space Administration (NASA) Office of University Affairs, met with KARS program personnel to review the progress of project work. NASA has funded the KARS program since 1972 to assist public agencies working in Kansas in applying remote sensing techniques to their problem solving and decision making. Mr. Vitale is NASA's contract monitor for the KARS program and approximately 20 similar programs in other states.

Morning and afternoon meetings emphasized work that has been, or will soon be undertaken in the areas of environmental quality, agricultural analysis, wildlife habitat evaluation, and plant and insect pest control. Representatives of the Kansas Fish and Game Commission and the Kansas Department of Agriculture, with whom KARS personnel work, attended the meetings to discuss with Mr. Vitale their agency's utilization of data obtained through remote sensing. KARS program personnel presented the results of recently completed projects including evaluation of aquatic vegetation in Douglas County State Lake, waterfowl habitat management at Cheyenne Bottoms Waterfowl Management Area, mapping disturbed drainage patterns in strip mined areas of southeast Kansas, and recreational planning on the Republican River. Current and forthcoming projects discussed included mapping of musk thistle and eastern redcedar infestations on Kansas rangeland, assessing pronghorn antelope habitat in western Kansas, assisting in corn pest surveys of the Kansas Department of Agriculture, and evaluating various habitat and environmental parameters at Cimarron National Grassland.

Mr. Vitale evaluated KARS efforts in the areas mentioned above and provided valuable input toward delineating the scope and direction of ongoing and future projects. KARS personnel are now evaluating and initiating projects for the coming year aided by the results of this review. Those working in Kansas who are interested in using remote sensing in a decision making capacity are urged to contact the KARS Program.

## GUIDE TO AERIAL PHOTOGRAPHY AND SPACE IMAGERY OF KANSAS

The KARS Program has published a Guide to Aerial Photography and Space Imagery of Kansas. The 62 page publication indexes all aerial photography acquired over Kansas by state and federal public agencies such as ASCS, USGS and NASA. In addition, the document indicates the availability of space imagery obtained from both LANDSAT and Skylab. Maps are used to delineate areas of coverage in many instances.

An introductory section outlines basic concepts of remote sensing, factors of scale, and fundamentals of locating and ordering imagery. Each section (e.g., LANDSAT) is prefaced with a brief discussion of the sensor/image system. Complete information on ordering photography and space imagery is provided. The Guide may be obtained for $2.00 per copy, to cover duplication costs and postage, from Mrs. J. Metcalf, Kansas Applied Remote Sensing Program, University of Kansas Space Technology Center, 2291 Irving Hill Drive, Lawrence, Kansas 66045. Checks should be made payable to the Center for Research, Inc., (KARS).

## SYMPOSIUM ON MAPPING IN KANSAS

A symposium on "Mapping in Kansas" will be held at the University of Kansas Space Technology Center Tuesday, April 12, 1977. The Kansas Geological Survey will sponsor the symposium which will review the newest types of mapping techniques in Kansas. Map users will be introduced to the latest published maps. The symposium will begin at 8:30 a.m. and end at 4 p.m. There will be no charge for the one-day event, but interested persons are asked to register with: Mr. Tom McClain, Kansas Geological Survey, 1930 Avenue "A" Campus West, Lawrence, Kansas 66045.

Topics to be discussed will include: slope maps, topographic maps, land use maps, orthophotoquads, flood plain maps, orthophotomaps, prime agricultural

land maps, soils maps, county topographic maps, photorevisions, aerial photography, satellite imagery, metrication of maps and large scale urban maps.

## LANDSAT COVERAGE ADJUSTMENT

NASA reports that adjustments in the orbit of LANDSAT-1 will soon change the frequency with which a given area is imaged. Beginning in February 1977, LANDSAT-1 coverage will follow LANDSAT-2 coverage by 6 days, and then LANDSAT-2 will follow LANDSAT-1 coverage by 12 days. Previously the two satellites had combined to provide coverage of an area every 9 days.

## SECOND CENTER PIVOT IRRIGATION MAP PREPARED AND PRINTED

In response to great interest in the KARS Program's recently completed map, "Center Pivot Irrigated Fields, Southwest Kansas, 1975", a second map has been prepared. The new map, entitled "Increase in Center Pivot Irrigated Fields, 1972-75" covers the same 32 counties as the first map. These counties include Barton, Rice, Reno, Kingman and Harper and all others westward to the Colorado line. Increases in the number of center pivot systems on a yearly basis are portrayed through a series of four inset maps, one for each year from 1972 through 1975.

Areas of rapid expansion of center pivot irrigation are quite evident. The scale of the insets is approximately 1:1,400,000 and all four are printed on a single 20 x 26 inch sheet. The KARS program has produced these maps under NASA grant NGL 17-004-024 for Kansas state, regional and local agencies, and other public agencies working in Kansas. Agencies, schools, or other public groups wishing to obtain the map should contact the KARS Program.

J. Poracsky

## KARS PROGRAM 1977

*The University of Kansas Applied Remote Sensing (KARS) program is funded by the National Aeronautics and Space Administration (NASA) Office of University Affairs to assist decision makers in local, state and regional agencies in the application of remote sensing techniques to their problems and activities. Persons working in Kansas who believe that they may be able to use remote sensing in a decision-making capacity are invited to contact the KARS Program at the University of Kansas in c/o:*

*Space Technology Center*
*University of Kansas*
*Lawrence, Kansas 66045*

*913/864-4775 or KANS-A-N 564-4775*

*The Kansas Applied Remote Sensing Newsletter is published in January, April, July and October by the University of Kansas Applied Remote Sensing (KARS) Program having facilities located in the Space Technology Center, Nichols Hall, The University of Kansas. Publication of the KARS Newsletter is supported by NASA Office of University Affairs Grant No. 17-004-024. Contributions of research findings, announcements of meetings, publications, and information pertinent to remote sensing applications in Kansas or the Midwest/Great Plains region are encouraged. Inquiries and contributions should be addressed to J. W. Merchant, Editor, KARS Newsletter. All correspondence related to specific projects should be addressed to the person indicated.*

The University of Kansas Center for Research Inc.
KARS Newsletter
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

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APPENDIX II

SUPPORTIVE LETTERS

KANSAS DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
TOPEKA, KANSAS 66612

ROY FREELAND
SECRETARY

Weed and Pesticide Division
FREEMAN E. BIERY, *Director*
1720 SOUTH TOPEKA AVENUE
TOPEKA, KANSAS 66612
Phone (913) 296-2263

November 24, 1975

Professor B. G. Barr
Executive Director
Space Technology Center
West Campus
University of Kansas
Lawrence, Kansas 66045

Dear Professor Barr:

I have learned of a research project of the space technology program concerning the infestation of pasture land with red cedar. It is my understanding that the investigative work is being done in Barber County, Kansas.

We have another area of Kansas which appears to have a growing problem with red cedars infesting the pastures. This area is Riley and Pottawatomie counties.

We need to know more about the extent of infestation. Also, we need to determine the extent of spread of the problem by looking back or looking ahead via aerial photography.

Senator Dole's office has become interested in the problem and we are in need of supplying information for him and other persons concerned with the apparent problem.

Would it be possible for the space program to extend its work to give us needed information on the situation in Riley and Pottawatomie counties.

We look forward to hearing from you.

Sincerely yours,

Freeman E. Biery

Freeman E. Biery, Director
Weed & Pesticide Division

FEB:mls

KANSAS DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
TOPEKA, KANSAS 66612

ROY FREELAND
SECRETARY

Weed and Pesticide Division
FREEMAN E. BIERY, *Director*
1720 SOUTH TOPEKA AVENUE
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Phone (913) 296-2263

November 24, 1975

Professor B. G. Barr
Executive Director
Space Technology Center
West Campus
University of Kansas
Lawrence, Kansas 66045

Dear Professor Barr:

It is my understanding that services provided by the Space Technology program might be available to assist in agriculture production programs.

The Weed and Pesticide Division of the Kansas State Department of Agriculture has the responsibility of administering the Kansas Noxious Weed Law. This law requires the control of certain weeds declared noxious by legislative action. Among these noxious weeds, one of great concern is "Musk Thistle".

Musk Thistle manifests itself primarily as a winter annual, spreads and propagates by seed carried by a parachute like attachment. Each year, due to mobile seed propagation, the location of this plant has to be discovered for proper control. The plant shows as a rosette in the early spring before most other plants become green.

It is our feeling that low level aerial photography could locate infestations of this weed pest in time to obtain a satisfactory control during the limited time available in the spring. Chemical control is only satisfactory for a period of approximately 2 weeks in the spring. Infestations of the weed needs to be located in a relatively short period of time. Without photography, infestations are located by ground survey which is too slow and costly.

At the present time, Kansas farmers are spending nearly $20,000,000.00 annually to control Musk Thistle. This weed is an invader and is endangering the state by its method of spreading.

We wish to learn if a pilot research program could be conducted to determine if aerial photography by the space program could assist in the Kansas Musk Thistle control program.

We look forward to learning more about the possibility of your assistance.

Sincerely yours,

Freeman E. Biery

Freeman E. Biery, Director
Weed & Pesticide Division

FEB:mls

KANSAS DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
TOPEKA, KANSAS 66612

ROY FREELAND
Secretary

DIVISION OF ENTOMOLOGY
DEAN GARWOOD, Director
1720 South Topeka Avenue
Topeka, Kansas 66612
Phone 296-3016

December 23, 1975

Dr. B. G. Barr, Executive Director
Space Technology Center
University of Kansas
West Campus
Lawrence, Kansas 66044

Dear Dr. Barr:

The land-use pattern maps you supplied recently were received in time to be used by my field survey staff in conducting part of our annual corn pest survey. From this limited use we are able to estimate that a saving in man-hours and travel cost of about $1,500 would have been realized had the land-use maps been available for use during the entire survey. I feel we will be able to document considerable benefit from our use of the land-use and pivot irrigation maps in our surveys to be conducted in early 1976.

Maps showing the distribution of several crops grown in the state would be of great value to the production and marketing of these crops and to the increased efficiency of this Division's survey and regulatory operations. I, therefore, ask that you consider the possibility of furnishing us with information giving the distribution of alfalfa, soybeans, spring grains (oats and barley), and commercially grown sod in the State. Such information would be of great help in our efforts to meet threats from the alfalfa weevil, soybean cyst nematode and cereal leaf beetle pests, to assist producers in increasing alfalfa seed and honey production and to insure the orderly movement of Kansas farm products in interstate and foreign commerce.

Very truly yours,

H. Dean Garwood
Director

HDG:skc

JOHN E. REARDON
MAYOR

ALLAN P. MEYERS
CHIEF

# City of Kansas City, Kansas

DEPARTMENT OF POLICE

June 2, 1976
Ref. No.: 070-76

Dean B. G. Barr
Satellite Applications Laboratory
K.U. Space Technology Center
Lawrence, Kansas 66045

Dear Dean Barr:

I would, at this time, like to personally thank you for your efforts in giving us the use of the reconnaissance photo of our city. The photo was of immeasurable assistance in our efforts to receive a federal grant for the 1976 Republican Convention to be held at the Kemper Arena. The map was a unique aid in perceiving the spatial relationships of the convention areas of activities.

Any time that we can be of assistance to you, please feel free to contact us.

Sincerely,

Allan Meyers

Allan Meyers
Chief of Police

AM:ht

Map Under Separate Cover

CHIKASKIA, GOLDEN BELT & INDIAN HILLS
ASSOCIATIONS OF LOCAL GOVERNMENTS

Serving Barber, Barton, Comanche, Edwards, Harper, Kingman,
Kiowa, Pawnee, Pratt, Rush, Stafford, and Sumner Counties

November 2, 1976

Jim Merchant
The University of Kansas
Center for Research, Inc.
2291 Irving Hill Drive
Campus West
Lawrence, Kansas 66045

Dear Jim:

In your letter of September 24, you asked for information about how your land use maps were used in Sumner County. I wrote Jo Jones in Oklahoma, asking for specific information about how she used your maps. Unfortunately she has not found time to answer, as of yet.

In a general sense, I can tell you how they were used. Your data was one of the sources of information that was used to put together a general land use map (commercial, residential, industrial, ect.) which was then used to project future land use, and to delineate the actual zoning districts.

If you need more specific information, I would be glad to go over your land use maps and compare them with ours and attempt to determine what information was derived from your maps.

Sincerely,

Garner Stoll

Garner Stoll
Associate Planner

GS:tc

ADMINISTRATIVE COORDINATING BOARD OFFICE
COUNTY COURTHOUSE BOX 301 PRATT, KANSAS 67124
Telephone: 316-672-5541

# CHIKASKIA, GOLDEN BELT & INDIAN HILLS ASSOCIATIONS OF LOCAL GOVERNMENTS

*Serving Barber, Barton, Comanche, Edwards, Harper, Kingman, Kiowa, Pawnee, Pratt, Rush, Stafford, and Sumner Counties*

March 1, 1976

Mr. Jim Merchant
University of Kansas Center for Research, Inc.
Kansas Applied Remote Sensing Program
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

Dear Jim:

As you know, the Regional Planning Commission is assisting the Sumner County Planning Board in their planning process. Regarding information on existing land use, the staff has -- via windshield survey -- updated the 1968 Sumner County Road Map. Our principal concern in Sumner County is the loss of agricultural land to increasing urban development, especially in the northern half of the county where "sprawl" from Sedgwick has occurred. It is the intent of the county to establish zones for this development, along with the necessary regulations. A land use map with the scale and elements we discussed would greatly assist us in determining existing land use patterns. This information along with information on natural features will, in effect, provide the basis for Sumner County's plan.

Sincerely,

Jo Jones

Jo Jones
Associate Planner

JJ:vsh

ADMINISTRATIVE COORDINATING BOARD OFFICE
COUNTY COURTHOUSE BOX 301 PRATT, KANSAS 67124
Telephone: 316/672-5541

STATE OF KANSAS
Forestry, Fish and Game Commission

SOUTHEAST REGIONAL OFFICE
222 WEST MAIN
SUITE C AND D
CHANUTE, KANSAS 66720

November 1, 1976

Mr. Ted Talmon
Research Scientist
University of Kansas Center for Research, Inc.
2291 Irving Hill Drive, Campus West
Lawrence, KS 66045

Dear Ted:

Thanks for the phone call and notification we will be receiving both prints and films of mined land photography. We plan to use the prints and films in association with follow-up ground observations in making the following decisions:

1. Establish in the course of a drainage where it would be most feasible functionally and economically to alter, trap or divert acidic flows of water in to pits, away from pits and/or streams.

2. Establish where surface areas could be reclaimed or partially altered so as to significantly eliminate any large amounts of acid runoff.

3. Locate interior strip pits, the extent of their drainage and where dams could be constructed to enlarge, isolate or contain that pit.

4. Demarcation of potential access points where walkways can be constructed into the interior of large mined land acreages.

5. Deliniation of mined land problem areas where substantial game habitat diversity does not exist and where it can be feasibly improved by land treatment practices or partial reclamation.

Ted, these explanations may be rather broadly stated but as you know, we have several tangents leading to and away from any decisions we make. Other decisions will most likely evolve later once we establish a more definite relationship between projected colors and vegetation-land classifications.

Hope the above is adequately explained for your purposes.

Very truly yours,

Johnny Ray

Johnny Ray
Regional Fisheries Supervisor
Southeast Region

JR/kg

STATE OF KANSAS
Forestry, Fish and Game Commission

NORTHEAST REGIONAL OFFICE
215 SOUTH SETH CHILDS ROAD
MANHATTAN, KANSAS 66502

September 20, 1976

Mr. D. G. Barr
Satellite Application Program
University of Kansas Space Technology Center
Lawrence, KS 66045

Dear Dr. Barr:

This letter is to thank you for your assistance in the photographing of Douglas State Fishing Lake in order to determine the extent of vegetation coverage.

Enclosed is a copy of a letter from our Chief of Fisheries, Roy Schoonover, informing me of the Commission's action approving our recommendations to attempt to improve the situation. Your efforts in attaining and preparing area and coverage maps from aerial photographs reenforced our recommendations tremendously.

Again, we appreciate your assistance.

Sincerely,

Leo Dowlin

Leo Dowlin
Regional Fisheries Supervisor

DLD:lc

Enclosure

cc: Bob Hartmann
Mike Bronoski

STATE OF KANSAS
Forestry, Fish and Game Commission

Box 1028
PRATT, KANSAS 67124
(316) 672-6473

September 16, 1976

Leo Dowlin
Northeast Regional Office
215 South Seth Childs Road
Manhattan, Kansas 66502

Dear Leo:

Reference is made to the plan which you have prepared for aquatic plant control in the Douglas State Fishing Lake. This plan included a number of alternative proposals, several of which involved the lowering of the water level in the lake.

You are hereby advised that at the regular meeting held on July 15, 1976, the Kansas Forestry, Fish and Game Commission approved this aquatic plant control plan for the Douglas State Fishing Lake. This plan is to be implemented during the fall of 1976.

Very truly yours,

Roy E. Schoonover
Chief
Fisheries Division

RES:kld

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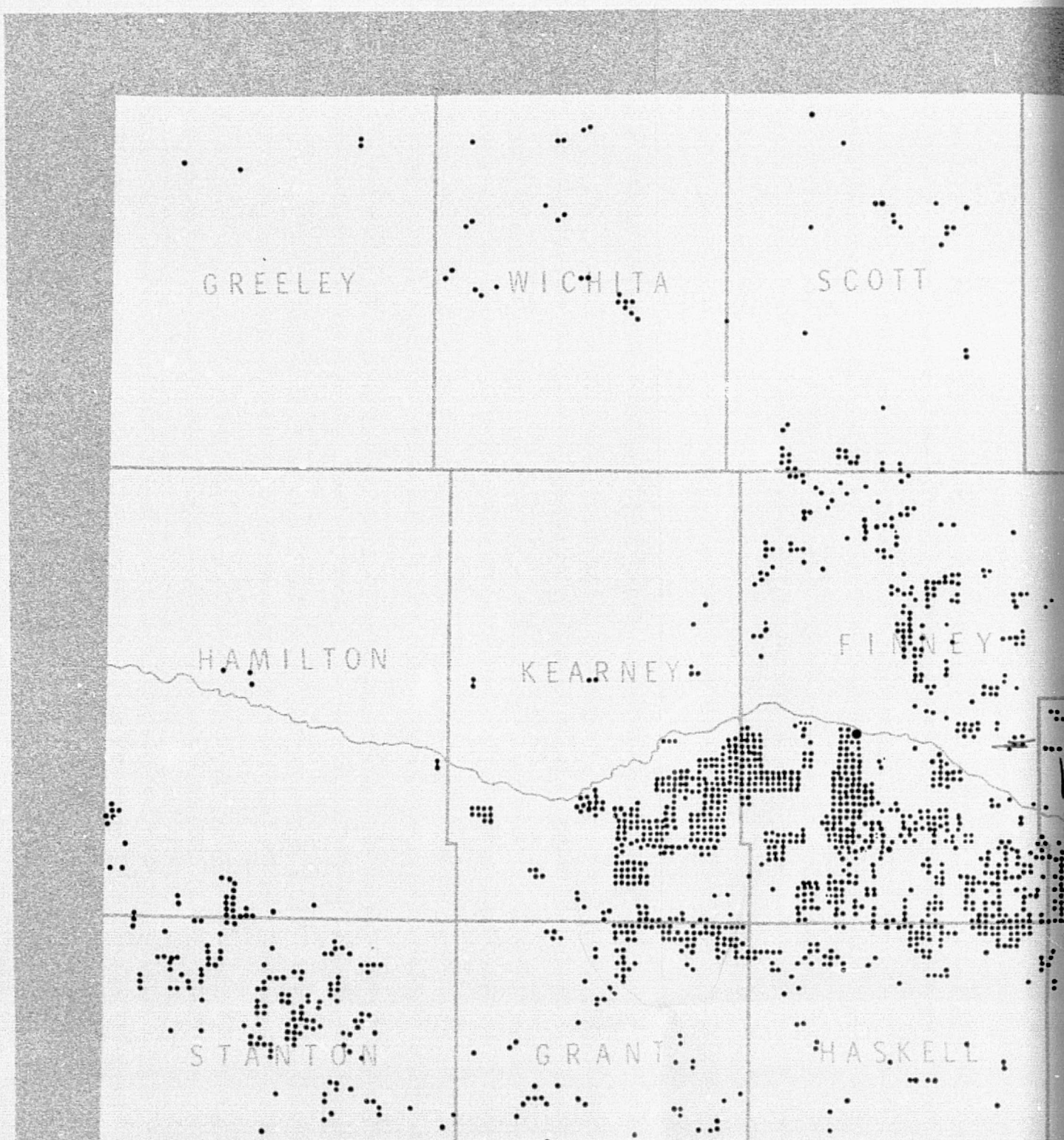

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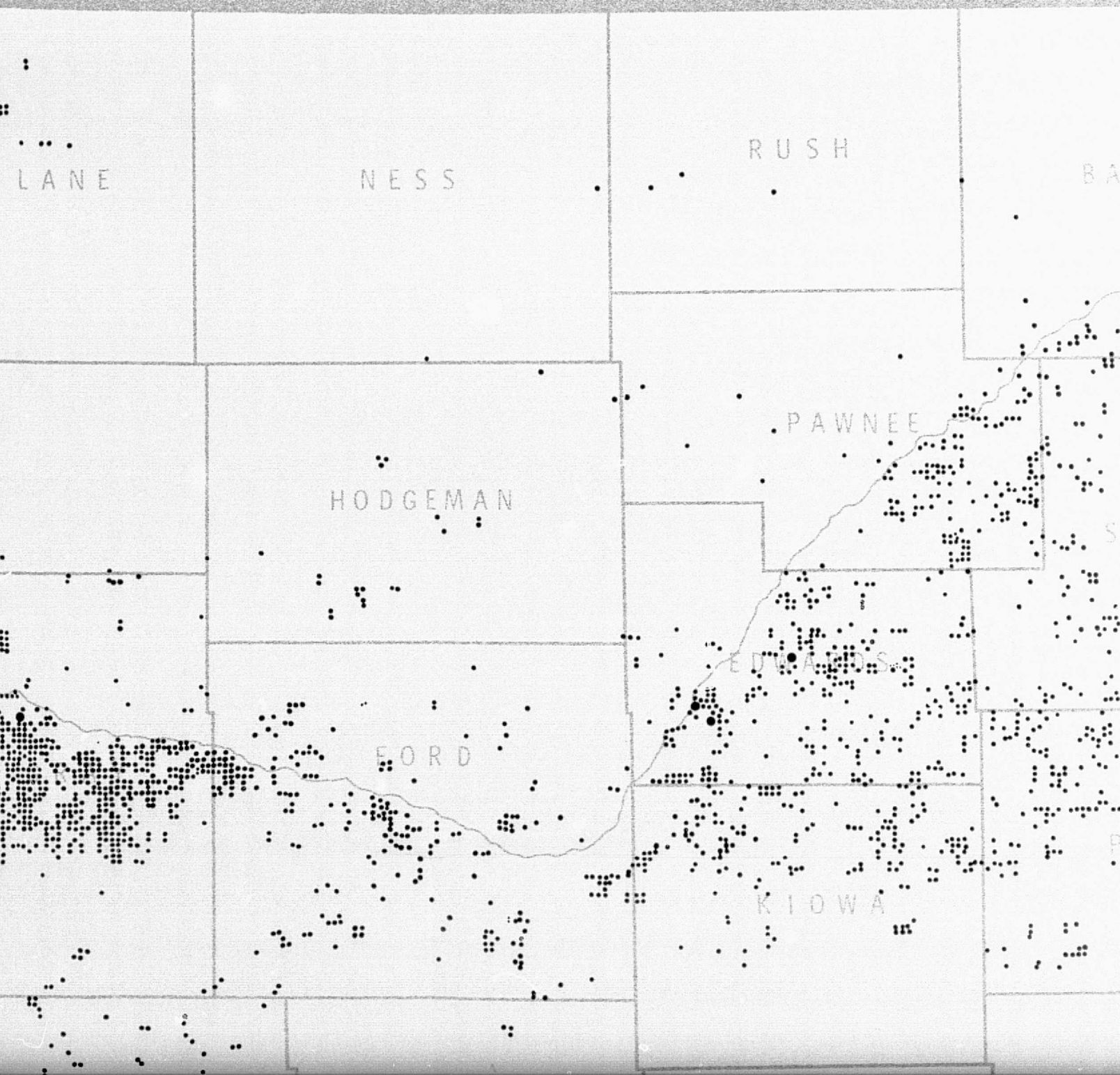
# TER-PIVOT IRRIGATED FIELDS, SOUTHWEST KANSAS, 1975



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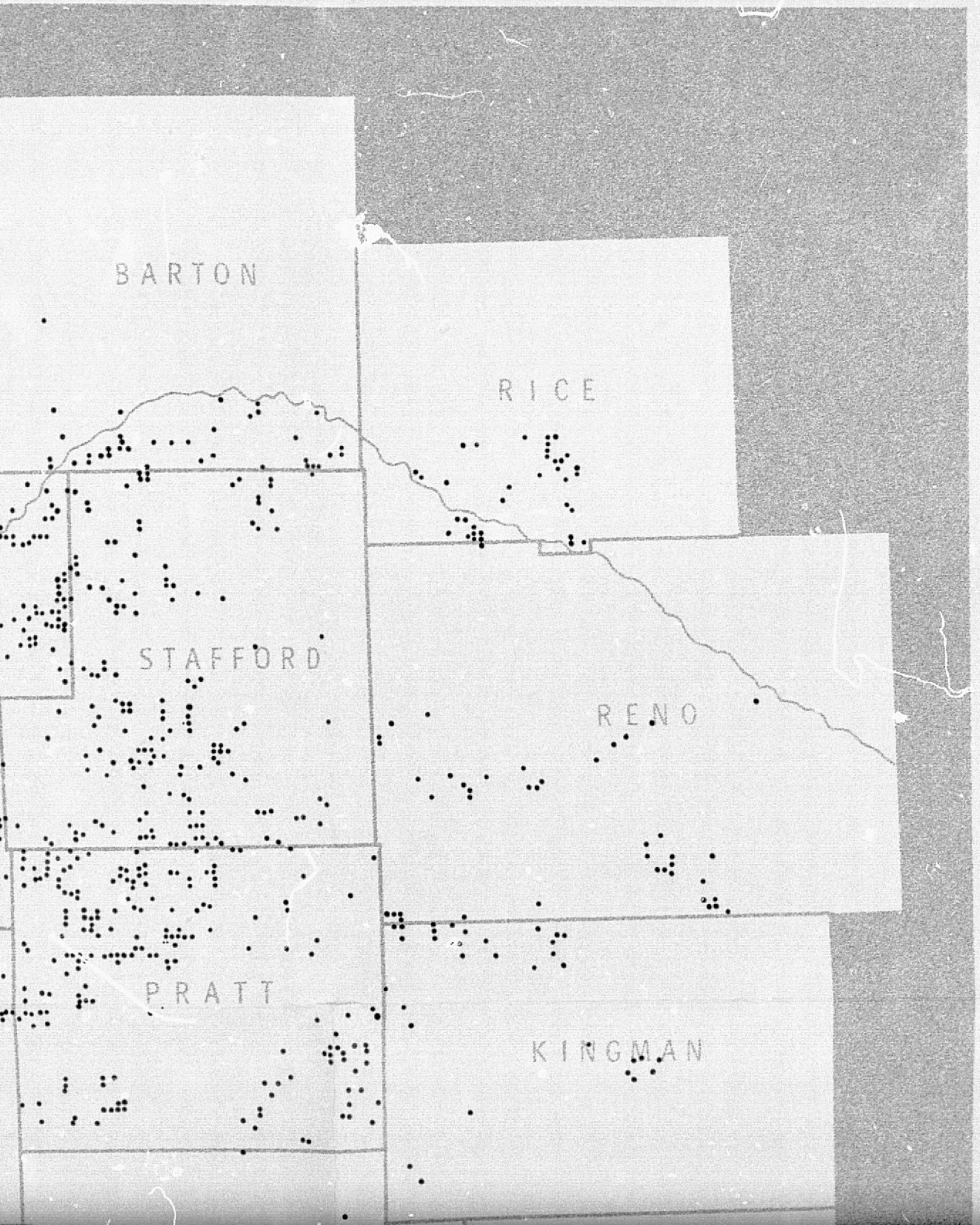

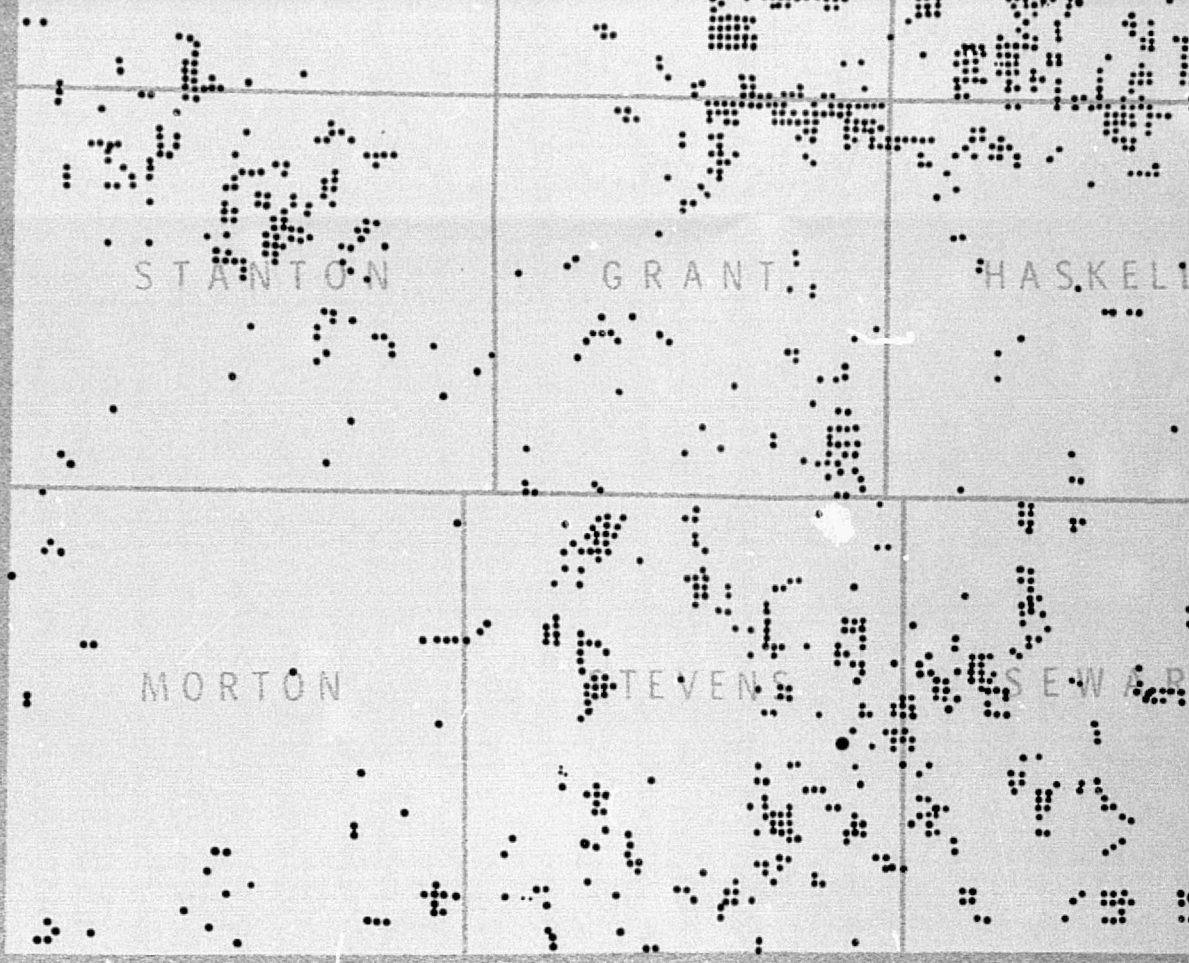


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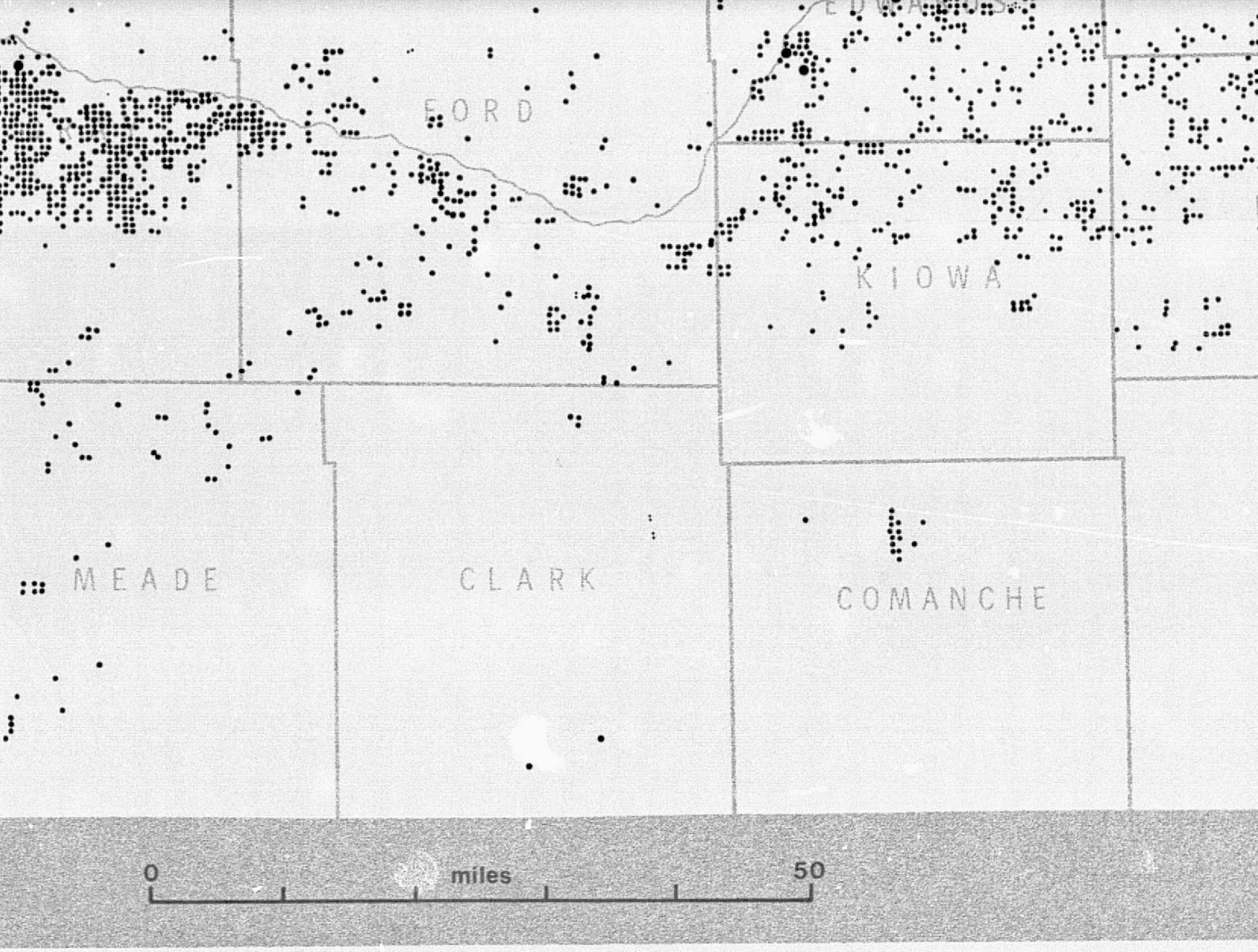
Prepared by the Kansas Applied Remote Sensing (KARS) Program, Space Technology Center, University of Kansas. The original compilation was prepared at a scale of 1:500,000 utilizing a combination of LANDSAT Imagery and conventional aerial photography. Compilation and final graphic preparation by Joseph Poracsky.

KARS




Interpretation of center-pivot irrigated fields is primarily based on a characteristic circular or near-circular shape. This procedure results in a very high level of accuracy, although a few center-pivot irrigated fields may be missed. Precise sizes of center-pivot irrigated fields vary greatly, but for the purposes of this map have been grouped into three categories:

- Small — less than 1/2 mile diameter (usually about 1/4 mile)
- Medium — approximately 1/2 mile diameter
- Large — approximately 1 mile diameter.

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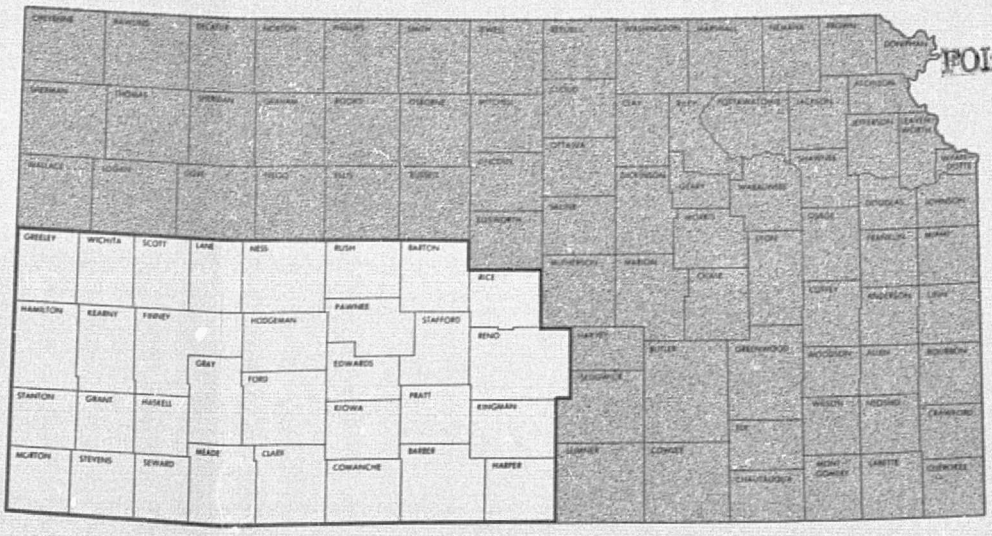
PRATT

KINGMAN

BARBER

HARPER

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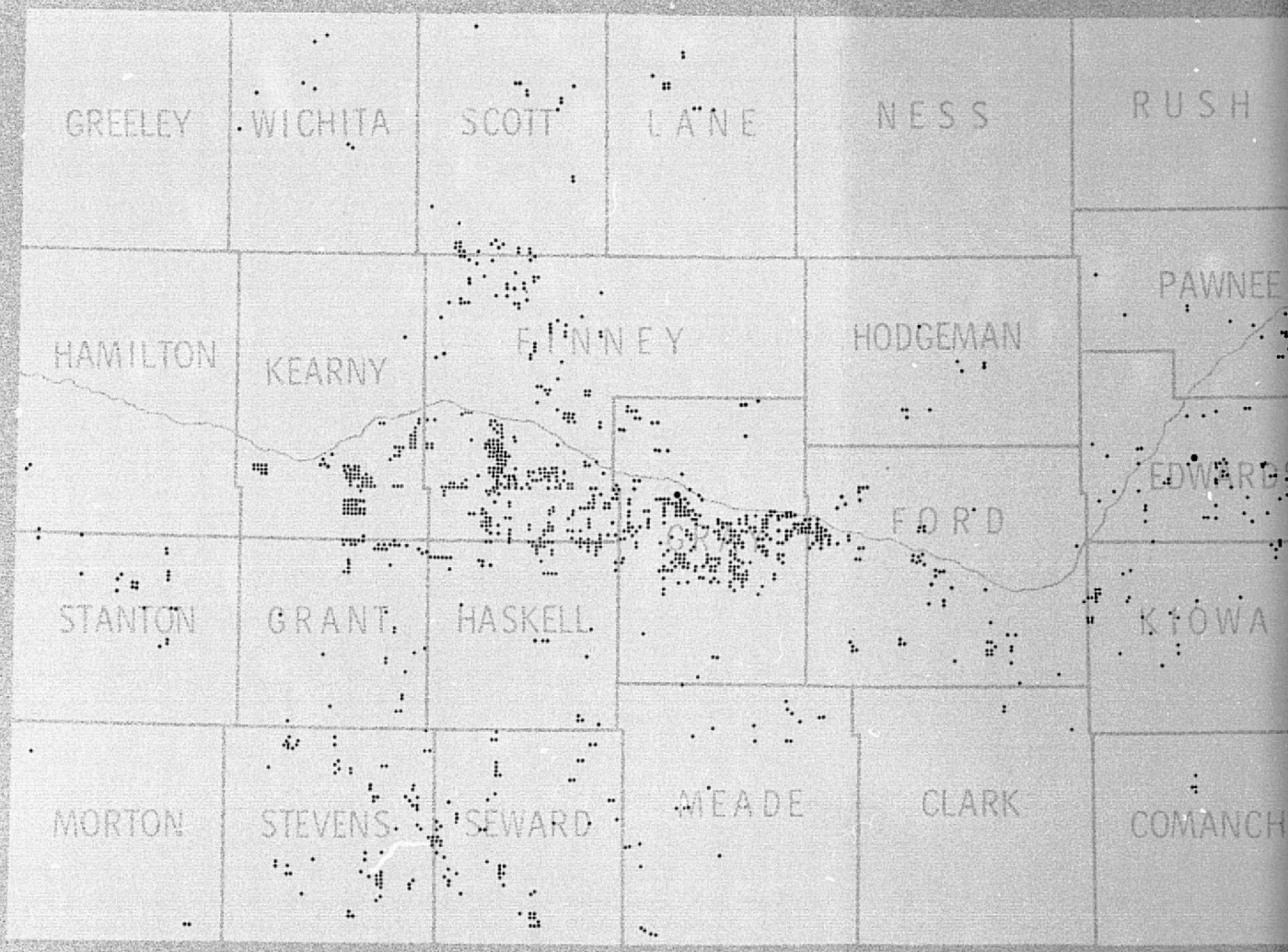


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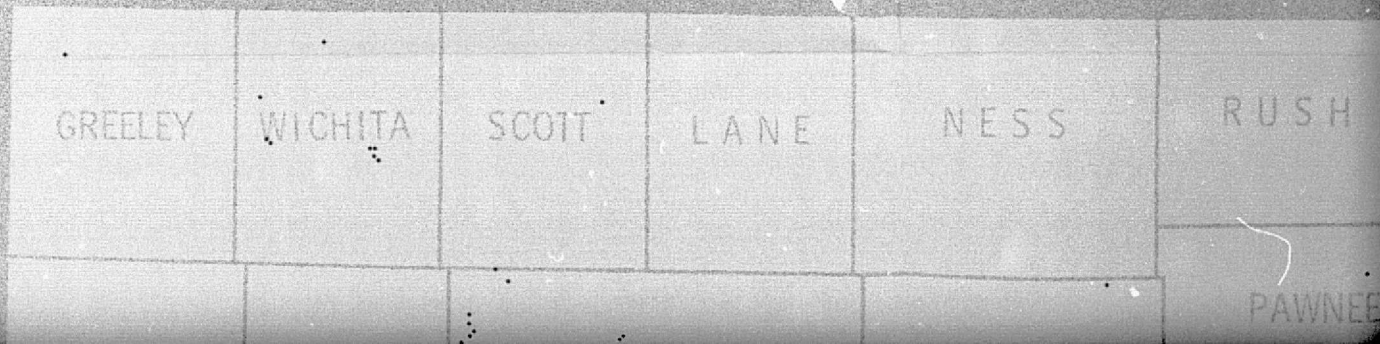

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# Southwest Kansas
# ENTER-PIVOT IRRIGATED FIELDS

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# IELDS, 1972-75

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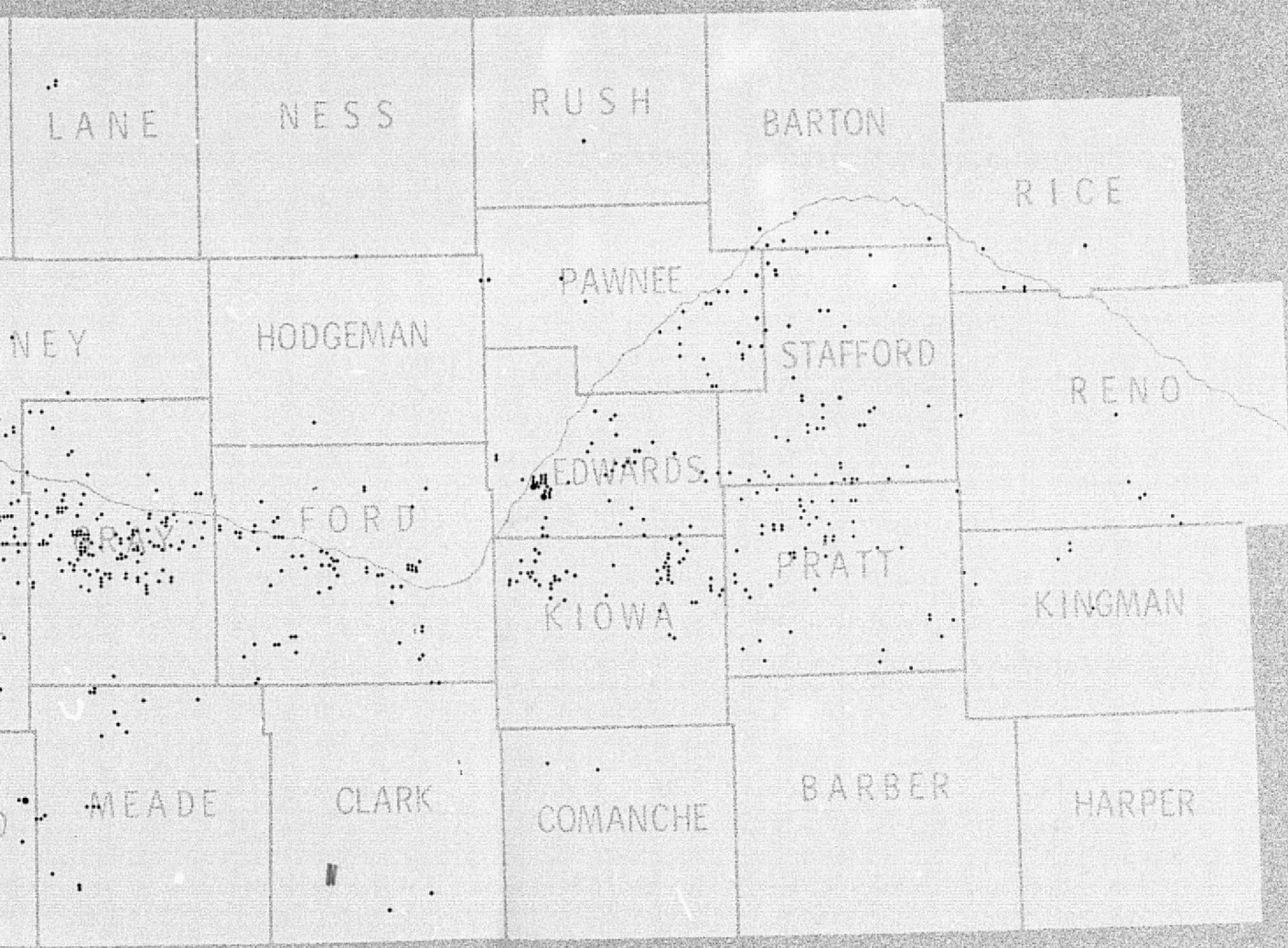


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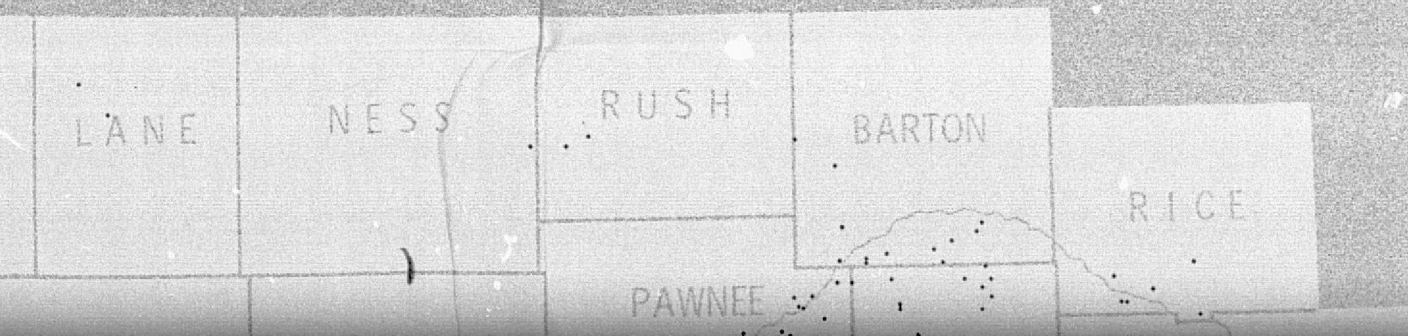

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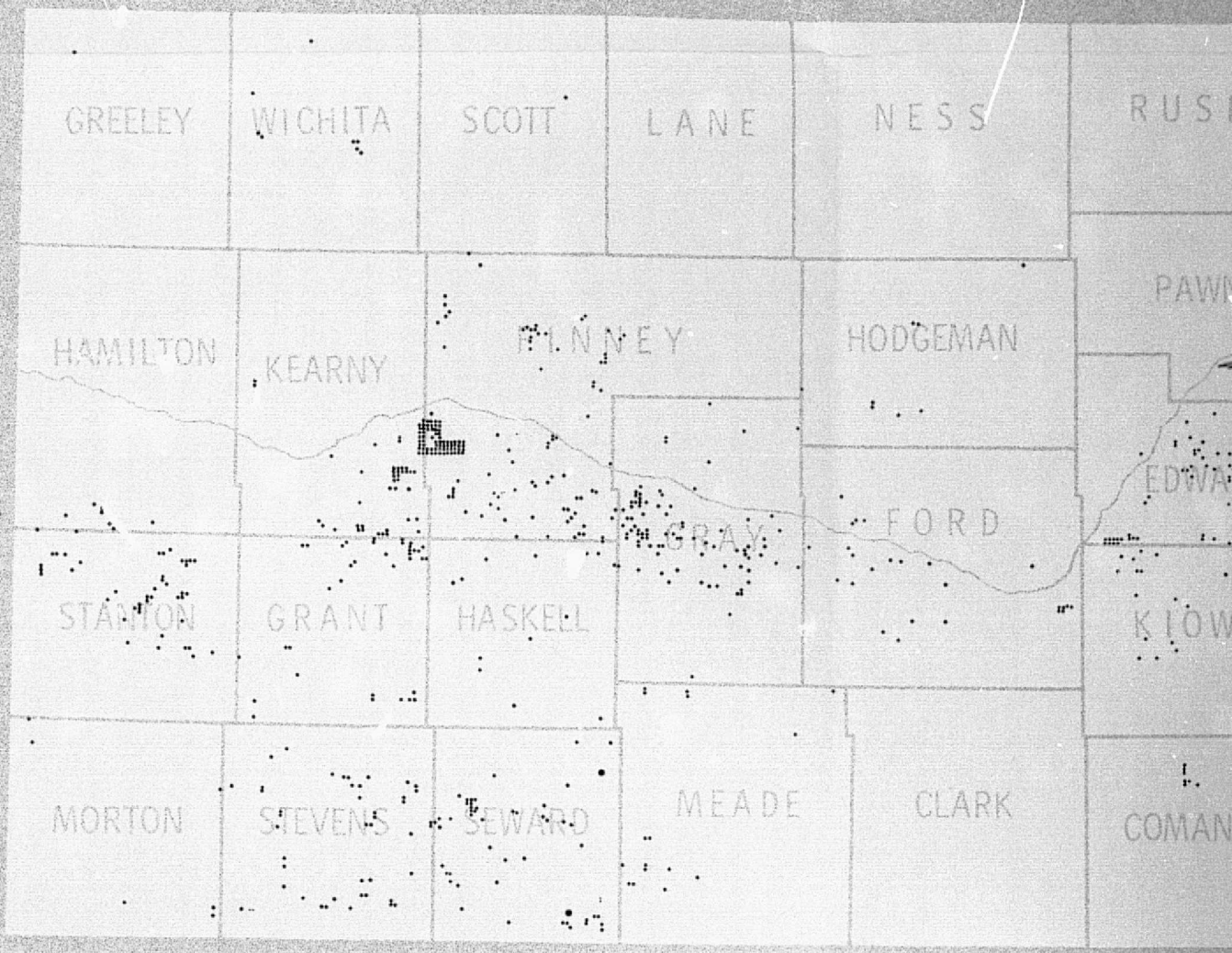


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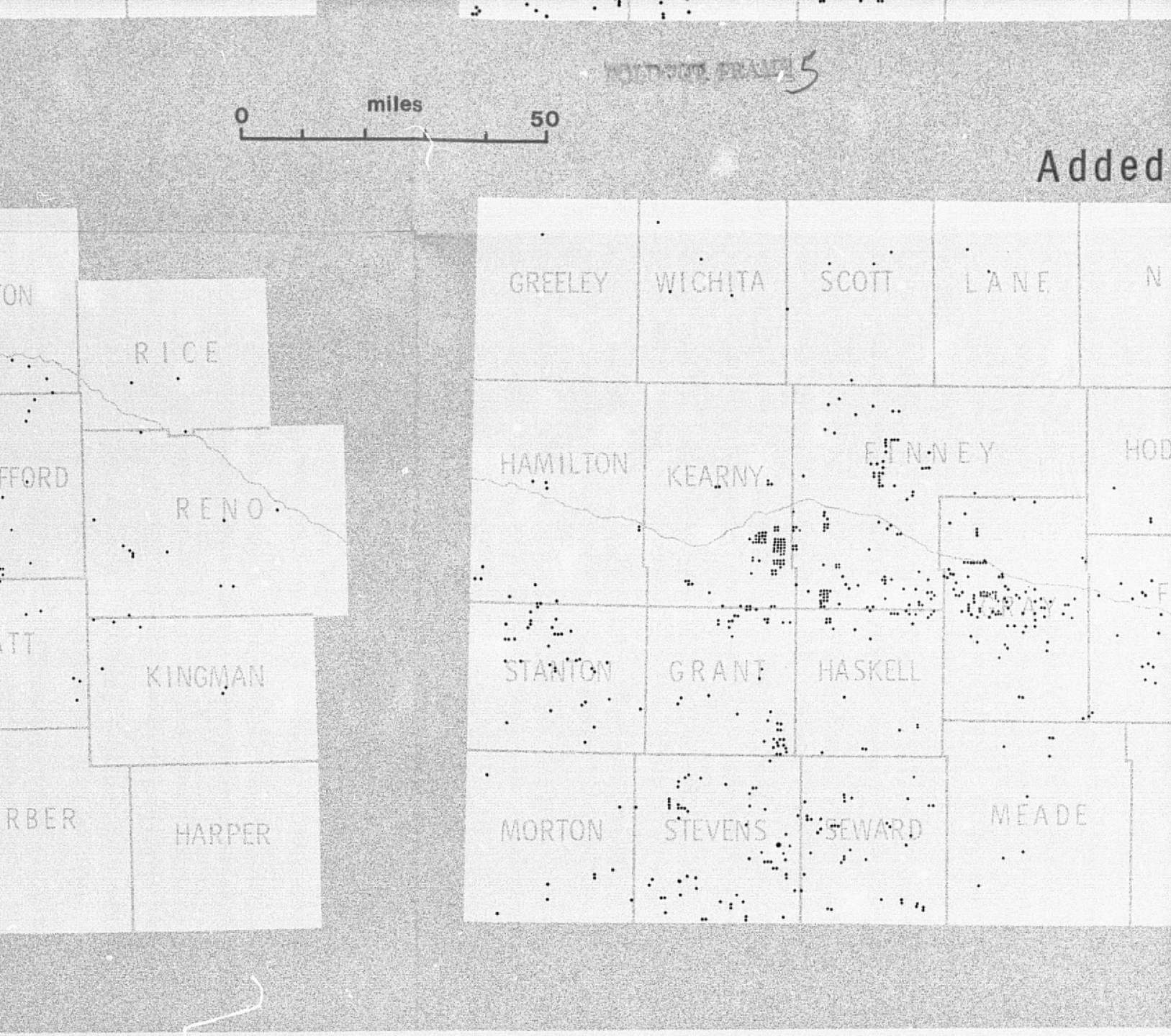


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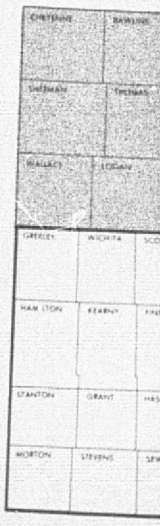
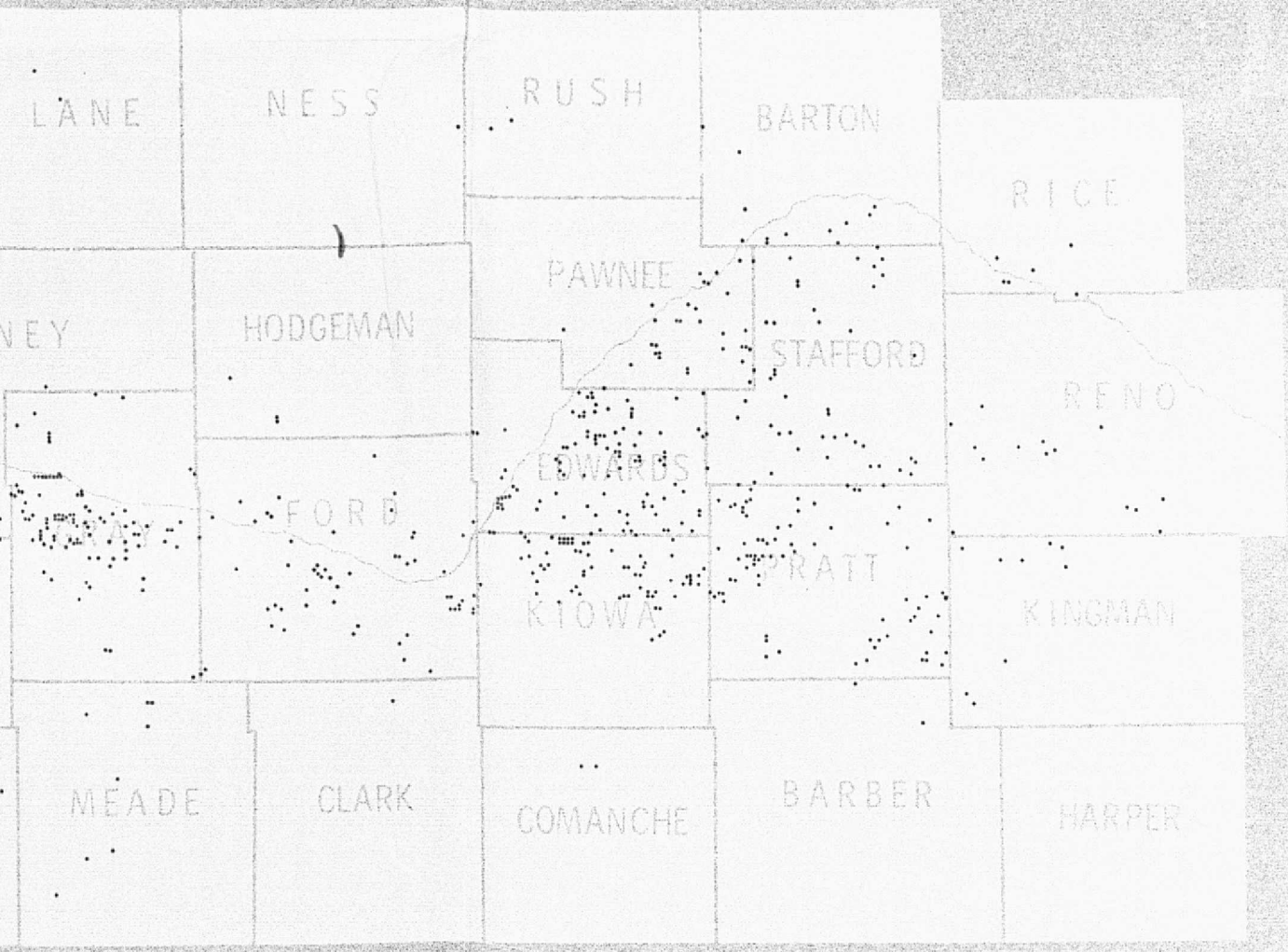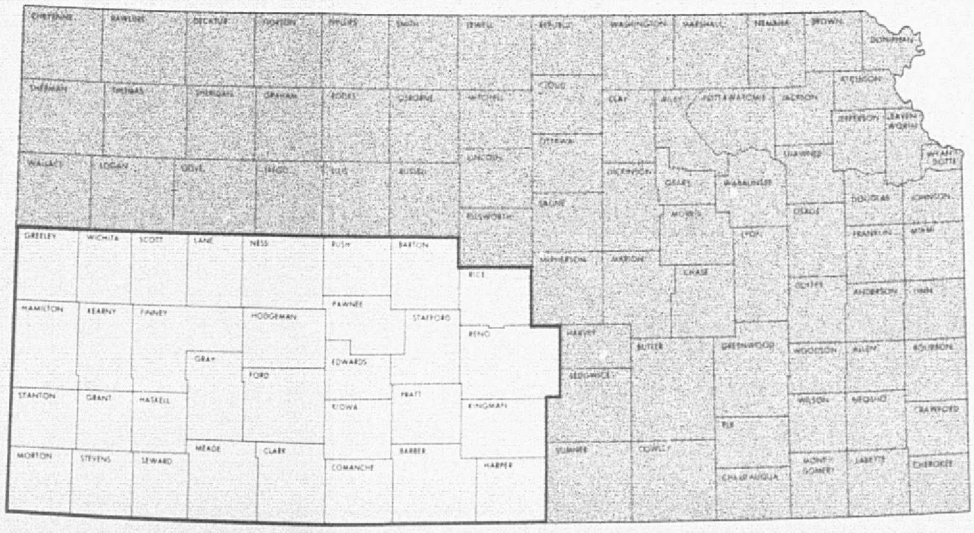
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