Appendix B

USE OF LANDSAT DATA BY THE BUREAU OF LAND MANAGEMENT OF THE DEPARTMENT OF THE INTERIOR

Introduction

This case study was prepared by the Bureau of Land Management (BLM) of the Department of the Interior to illustrate its use of Landsat data. It shows that Landsat data have become an integral part of BLM's strategy for managing the land and resources under its care.

BLM utilizes Landsat data in numerous programs. These programs use both photographs and digital tape products. Interpreted Landsat data are used to assist in mapping basic vegetation, soils, geology, and energy and mineral resources. The processes of interpretation range from very basic and efficient visual interpretations of Landsat photographs to highly technical and complex digital image processing of digital tapes. Table B-1 lists some examples of past and current programs conducted in BLM that have made use of Landsat data. BLM views Landsat and any other remote-sensing technologies as basic tools. The products of these tools are integrated and are then used within the frameworks of various programs to improve their quality and efficiency as well as to reduce program costs. Thus, Landsat data aid BLM in inventory and planning primarily by streamlining and structuring these activities.

Table 6.1 .—Examples of Past and Current Programs Utilizing Landsat Data

	f_andsat-aided program	Location	Size (acres in millions)	Status		Task/purpose
				Complete	Current	
1.	Denali Project	Alaska	3.5	x		Test and evaluate Landsat aided resource mapping in northern spruce tundra biome.
2.	AVRI Project	Arizona	2.1	x		Test and evaluate Landsat.aided resource mapping in the Southwest desert community.
3.	IVRI Project	Idaho	3.7	x		Test and evaluate Landsat-aided resource mapping in sagebrush grassland community.
4.	California Desert Plan	California	25	x		Fulfill requirements of Federal Land Policy and Management Act.
5.	Northwest Tier Pipeline	Oregon	3.0	X		Provide information for environmental statement.
6.	Taos Project	New Mexico	5.8		x	Provide information for Planning System.
7.	Havasu Project	Arizona	1.0		x	Provide basic soils prestratification.
8.	Jarbidge Project	Idaho	1.3		x	Provide information for Planning System.
9.	Mining Disturbance	Missouri	3.0		x	Detect and map mining trespass.
10.	Fuels Mapping	Alaska	5.0		x	Map fuels loading in areas in high wildfire potential.
11.	Phoenix Project	Arizona	6.3		x	Provide information for Planning System.
12.	Coeur d'Alene	Idaho	1.0		X	Update existing forest inventory.

SOURCE: Office of Technology Assessment.

Two Activities of Importance to BLM

For the purpose of this report, two activities in BLM have been selected for detailed analysis. Both are encountered daily in BLM State and district offices and both share the common thread of requiring inventory information for application to resource management. The first application is known as the planning system and requires a more generalized level of inventory data than the second program. This second program, the soil vegetation inventory method (SVIM), is a field-intensive effort that requires a detailed inventory data set. These data are used for such tasks as allocating grazing lands. For the details of the programs, the reader is referred to the manuals that are listed in the bibliography at the end of this report.

The Planning System

The BLM planning system provides a systematic approach to gathering, analyzing, and integrating multiple resource data into an overall management plan. The system permits informed and objective multiple-use decisions through identifying and reconciling conflicting land and resource uses. It is an internal management tool that helps blend diverse authorities and land use opportunities. It is also a managerial system through which the BLM Director, State directors, and district managers develop and manage the various BLM program activities. Each of these activities has a primary mission or purpose for which objectives and standards are defined. This system provides for a multiple resource program consisting of: lands, minerals, recreation, wildlife, watershed, forestry, and range. The system consists of three basic steps. These–unit resource analysis (URA), managment framework plan (MFP), activity plan–are briefly described below.

Components of the Planning System

- ***Unit resource analysis*** (URA).—URA provides a comprehensive analysis of inventory data, resource problems, conditions, users, production, quality, capabilities, and management potential for use in preparing a management framework plan. **In other words, URA provides resource** information pertinent to decisions about land use resources management in a unit of land. It also provides continuity in retaining and maintaining resource data. URA supports the multiple-use concept and is prepared by individual resource specialists.
- *Management framework plan (MFP).* —MFP reconciles conflicts in land and resource use. Planning decisions are made for specific areas so that the unique characteristics of each area are fully considered. MFP indicates what is to be done with each resource within each unit.
- *Activity* plan.–The activity plan is prepared for each individual resource unit to define the manner in which the resultant activities shall achieve the objective and constraints of the MFP. The activity plan is specific to the users and special interests involved. An allotment management plan is an example of an activity plan.

Since its development and adoption by the entire BLM in 1969, the planning system has been a major factor in BLM program activities. All BLM offices, including the Outer Continental Shelf Program, employ the technique. Its primary strength is that it has systematized the planning process, and enhanced the quality of BLM management. However, it is labor intensive. During the last 5 years, approximately $60 million have been budgeted for planning system applications, with an estimated workforce of 450 positions.

A variety of products are required in the planning system. Figure B-1 is an example of the basic unit resource analysis map depicting current vegetation. Figure B-2 is an example of a wildlife habitat overlay showing areas of Desert Tortoise habitat. Table B-2 is an example of tabular data utilized within the process. Although BLM is the primary user of the information, numerous other individuals, organizations, and private concerns have access to the data, e.g., local ranchers, environmental societies, and Federal and State Government agencies.

Soil Vegetation Inventory Method

SVIM is the BLM method for conducting basic soil and vegetation inventories. SVIM supports the planning system as well as other activities such as environmental statements. The process provides a uniform and systematic method of detailed inventory. It does not inventory all renewable resources. However, it does provide a framework for inventories of the numbers and kinds of wildlife species, and also gathers basic data for use in other resource inventories.

SVIM evolved from a number of requirements, but the primary catalyst was the need to acquire high-quality resource data for use in developing environmental statements concerning grazing. Since its inception in 1978, it has been applied in a variety of forms throughout BLM. The major strengths of this procedure are: 1) the high-quality data that are available as a result of data collection in the field; 2) ability to integrate soils and vegetation information in the mapping process; and 3) the vast wealth of data that are available for use once the inventory is completed. The

Figure B-f.—Vegetation and Soil Associations

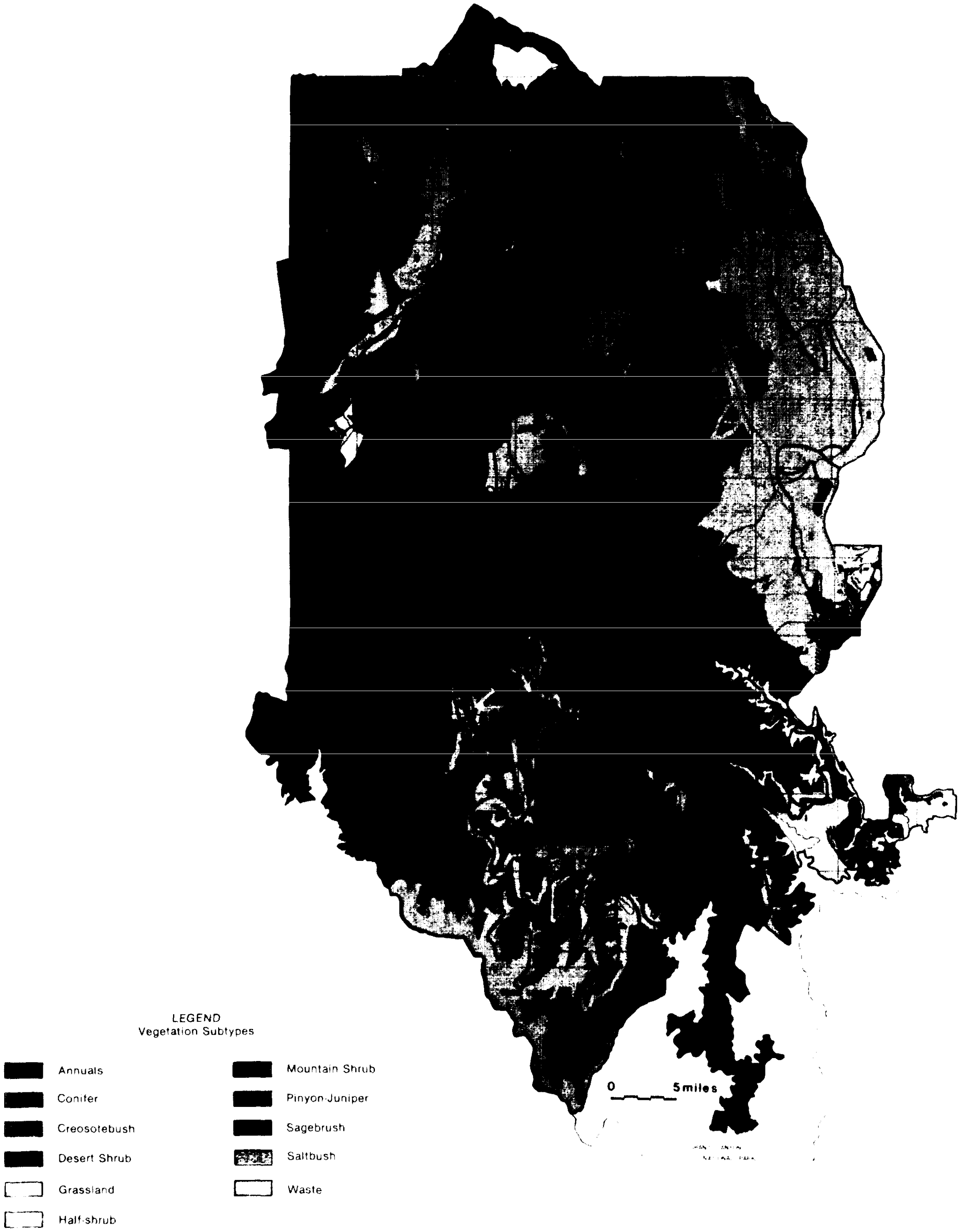


Figure B.2.— Desert Tortoise Habitat

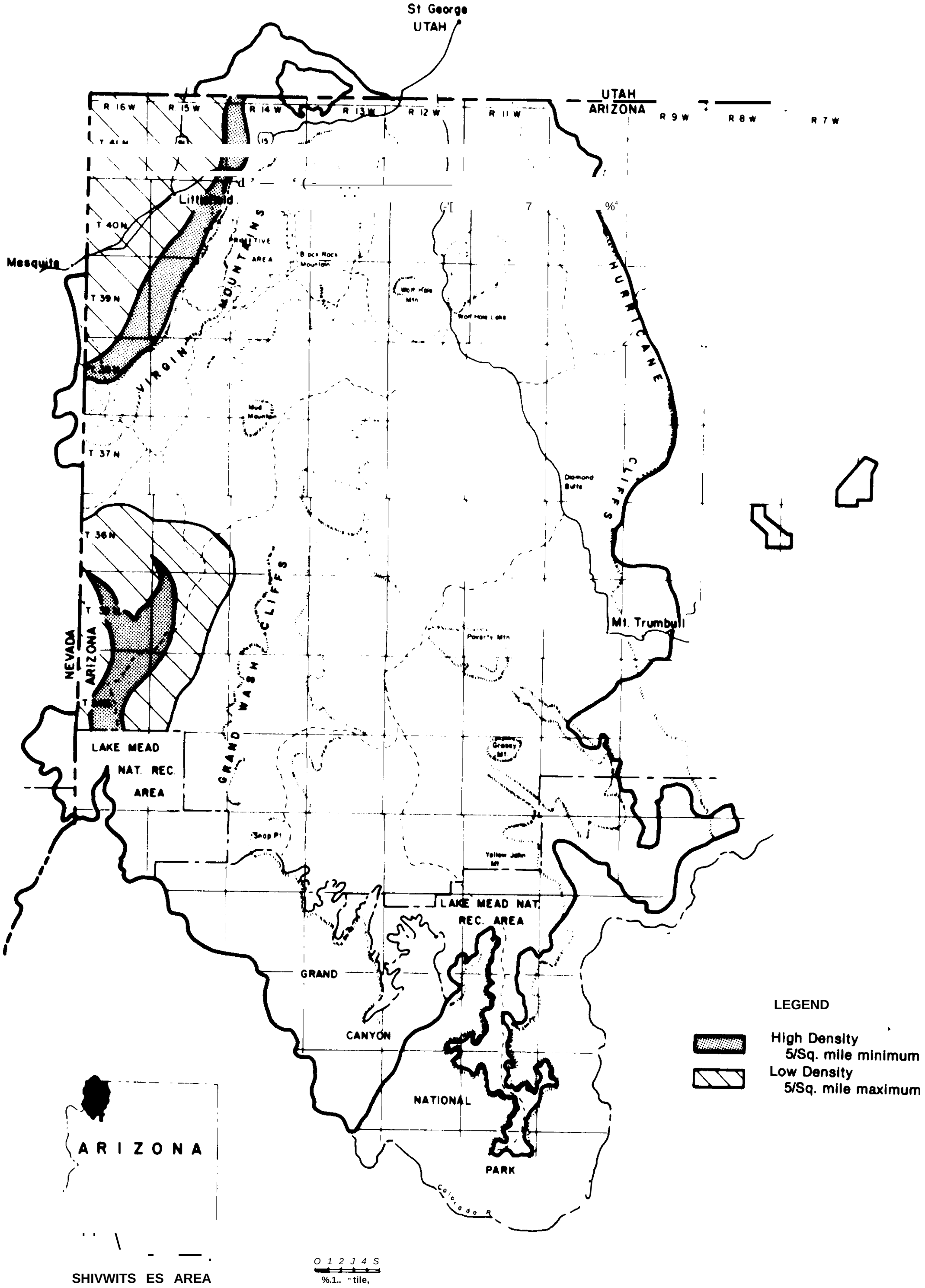


Table B-2.—Tabular Data Used in the Planning Process

Allotment	Vegetation subtype	Current key species composition		Proposed action alternative 3 future key species cornposition		Full stocking		Stocking by condition		No action		Elimination	
		Grass	Shrub	Grass	Shrub	Grass	Shrub	Grass	Shrub	Grass	Shrub	Grass	Shrub
Wolfhole Mountain	Blackbrush	T	14	T	14	T	14	T	20	T	14	T	14
	(Treatment)	—	—	(40)	(20)	(40)	(20)	(40)	(20)	—	—	—	—
	Desert shrub	8	6	8	6	8	6	8	6	8	6	8	6
	Sagebrush	4	11	4	11	4	11	4	11	4	11	4	11
	(Treatment)	(4)	(11)	(35)	(25)	(35)	(25)	(35)	(25)	—	—	—	—
	Pinyon-juniper	2	23	2	23	2	23	2	23	2	23	2	23
	(Treatment)	(2)	(23)	(40)	(20)	(40)	(20)	(40)	(20)	—	—	—	—
Wolf hole Lake	Grassland	35	12	40	12	35	12	47	12	35	12	38	12
	Sagebrush	35	0	45	0	35	0	47	0	35	0	42	0
	(Treatment)	(35)	(0)	(50)	(0)	(35)	(25)	(35)	(25)	—	—	—	—
	Annuals	5	T	10	5	5	T	10	5	5	T	9	5
Wolf hole Canyon	Desert shrub	10	18	15	23	15	23	10	24	10	18	14	21
	Creosotebush	9	22	9	22	9	22	9	29	9	22	9	20
	Annual grass	20	T	25	T	25	T	25	T	20	T	23	T
	Sagebrush	20	5	25	10	25	10	25	10	20	5	23	T
	(Treatment)	(20)	(5)	(40)	(20)	(40)	(10)	(40)	(10)	—	—	—	—
	Grassland	44	11	60	11	60	11	59	11	44	11	56	11
	Pinyon-juniper	16	T	16	T	16	T	16	T	16	T	16	T
Mine Valley	Creosotebush	T	5	T	5	T	5	T	5	T	5	T	5
	Desert shrub	10	20	15	25	10	20	15	27	10	20	14	23
	Blackbrush	T	15	T	15	T	15	T	15	T	T	T	T
	Grassland	55	10	70	10	55	10	74	10	55	10	64	10
	Sagebrush	5	10	5	10	5	10	5	10	5	10	5	10
	Pinyon-juniper	T	5	T	5	T	5	T	5	T	5	T	5
Cedar Pockets	Pinyon-juniper	T	5	T	5	T	5	T	5	T	5	T	5
	Desert shrub	10	20	15	25	10	20	13	27	10	20	12	23
	Joshua tree	10	15	15	25	10	15	10	20	10	15	13	23
	Grassland	55	10	70	10	55	10	74	10	55	10	64	9
Shelly	Grassland	42	16	52	21	42	16	57	16	42	16	49	20
Snyder	Grassland	53	3	68	3	53	3	71	3	53	3	64	3
	Sagebrush	31	T	41	T	31	T	41	T	31	T	39	T
Unallotted	Desert shrub	5	10	5	10	Same as current species composition							

SOURCE: Bureau of Land Management

process also has a few weak points. For example, the detail that is listed as a strength is also a weakness because of the labor-intensive nature of detailed field work. Similarly, without a means of automatically handling the data, the voluminous amount of data available are not readily usable. Another related weakness is the cost of these inventories. Recently programs have been developed on the mainframe computer system at Denver Service Center to store and manipulate the tabular data collected in SVIM. In addition, a linear optimization model has been developed to allocate vegetation production among the competing uses. To date, this tabular data has not been tied to a digitized mapping process.

In the 3 years since the SVIM inventories were established, an estimated $14 million have been spent on them. They have covered about 32 million acres and have required 7,200 work-months. A skill mix of vegetation, soil, forestry, wildlife, and range conservation specialists, wildlife specialists, etc. have been involved in these inventories.

Transition to the Use of Landsat Data

BLM has followed an organized approach in the test, evaluation, and implementation of Landsat data. A complete description of that approach can be found in several reports (see bibliography). In 1977, *BLM,* National Aeronautics and Space Administration (NASA), and the **U.S.** Geological Survey EROS Program agreed on a phased program to implement this technology in BLM. The program was designed to provide BLM an opportunity to test the technology in an operational manner, to evaluate the results of the tests, and finally to implement those aspects of the technology most suited to assist BLM data collection and resource management needs. During this transfer of remote-sensing technology to BLM, BLM assimilated the procedures and equipment into a small core staff housed within an existing research and development (R&D) organization at the Denver Service Center. From this core staff of three persons, the present Branch of Remote Sensing (BRS) grew. A continuing process of reporting and reviewing the status of the program was followed that resulted in many changes to the program. These changes were implemented on a test site basis. Since the project was structured to test the technology in three diverse areas, changes in program orientation were made at the onset of activities in each subsequent test site. This procedure provided BLM: 1) time to plan carefully and implement the changes, 2) ability to build upon each test site in a systematic fashion, and 3) prevention of unnecessary and costly changes within each phase of the program. At this time, the program has been incorporated in the operations of BLM; and Landsat-assisted programs are currently being conducted in several areas.

In addition to the program just described, a number of other factors have caused the BLM to use Landsat data. For example, the congressionally mandated California Desert Plan (CDP) utilized Landsat imagery because of tight schedules and funding. in this study Landsat data were used to view the unit at a broad scale from which areas for intensive study were chosen. These areas were then sampled with finer scale methods appropriate to the resource requirement, e.g., aerial photography. Vegetation, soil geology, energy, and mineral resources were included **in the effort. Without Landsat, it is questionable that CDP** would have been accomplished within the time and cost constraints. **In addition, there is the natural process whereby technology is used by personnel in the field because of the acute** needs for data that exist at the working level. That is, if a technology can be utilized to acquire information needed at the field level then it is often used without prior knowledge of management. **There is no doubt that the methodology would have gained use and acceptance in** BLM, but the major program described in the preceding paragraph caused a more organized and Bureau-wide adoption.

Transition to Space Data

It is of paramount importance that the reader keep in mind the closing words of the first paragraph of this report: “Landsat data aid the BLM in inventory and planning by streamlining and structuring these activities.” Landsat data are used to improve inventory quality, to enhance data retention and renewal, and to reduce inventory costs. The use of Landsat data has not led to replacing programs. Thus, Landsat is primarily a new tool that is available to the resource specialist to enhance his product. BLM is currently developing guidelines to the field offices for the use of this new tool and is becoming increasingly dependent on it to effect required operating economics.

USER ACCEPTANCE

Whether field people will accept and utilize new approaches and whether management will believe results obtained through these new concepts, are major factors in the transition, In any organization, the “field type” is notoriously concerned that any change may adversely affect his ability to do the field work that is so necessary for good management practices. Similarly, management personnel are reluctant to change something that heretofore has worked well. These are valid concerns that were recognized in the project planning stages of this program. In order to combat these fears an extensive educational program was incorporated as an integral part of the study. Since the beginning of the program, training courses in remote sensing have been a mainstay of each phase of the project. The sessions have covered basic photo interpretation procedures as well as advanced digital image processing. In addition, they have addressed a variety of subjects—vegetation, geology, soils, etc. To date, over 750 BLM resource specialists have received training through these programs. This training is continuing on an annual basis, and in the near future, special sessions specifically oriented to managers are planned.

Program Continuity

In the last **5** years **BLM has made a substantial commitment to the use of Landsat data. This commitment represents a major investment of labor and equipment. Thus, the continuation and improvement of the Landsat system is of vital interest to BLM. At this time, it is understood that Landsat D’ is the last satellite authorized** for the program. The prospect of terminating the Landsat program will greatly affect the future decisions of BLM toward continued use of Landsat data. Reluctance to adopt a full-scale program can be expected. Managers must have a guarantee that data will continue to be available before they can be asked to embrace the technology. BLM is willing to consider other alternatives, such as using data from the proposed Japanese and European satellites. However, these satellites are not in orbit and can only be considered as potential alternatives. In addition, there doesn’t appear to be any assurance that the desired private sector takeover of Landsat is likely. Thus, to a user organization like BLM, the picture is confusing and bleak. In the face of continued increasing costs for all services, BLM shall seek to make its limited inventory dollars stretch even further. Present policies do not seem to guarantee the continuity of Landsat/ Earth Resource Satellite data needed for BLM to make a complete switch to reliance on satellite data.

For the immediate future, the continuing availability of Landsat MSS data is required for programs that are under way or planned. In addition, BLM has a longer term requirement for data of greater spectral and spatial resolution. At present, the available Landsat data barely meet some BLM requirements. In order to realize the full potential of such capability, data of increased resolution are mandatory. At present, we can only streamline and economize by utilizing Landsat as a sampling frame. in the future, we must provide increasingly detailed data or face a stagnation of the program and a consequent halt in transition to these powerful tools. Thus, both the current multispectral scanner and the future thematic mapper data are of great interest to BLM.

Acquisition of Hardware and Software

As an integral part of the joint BLM-NASA-EROS program, BLM acquired and installed a digital image processing system at the Denver Service Center. This system is currently being used to support inventory projects in BLM. The system includes a complete Earth resources data processing software package. It is projected to have a lo-year lifespan, but is modular in nature to allow for both software and hardware improvements. As the need for Landsat data increase, additional processing capability in terms of other systems or approaches must be considered. For example, BLM anticipates inventorying 30 million acres annually on the single system currently in operation at the Denver Service Center. Depending upon support requirements for BLM inventories this figure will fall far short of the total requirements of BLM. Thus, further acquisition of hardware and software may be necessitated by the transition to Landsat-aided inventories.

Applications of Landsat in the Planning System

The BLM-NASA-EROS wildland vegetation resource inventory project was specifically designed to test and evaluate the use of Landsat data for application in the planning system. BLM conducted a test program in three test sites in Alaska, Arizona, and Idaho, which are representative of the lands managed by BLM. The program was conducted in phases, in which each phase had increasing complexity. In this manner, it was possible to answer basic questions concerning the technology prior to expending funds on subsequent phases, The results of this program were extremely successful, and portions of the technology have been used in BLM. Table B-3 illustrates some of the management opportunity map overlays that are currently being used in the planning system. These particular overlays resulted from the Landsat-aided analysis in the Arizona project and are typical of the requirements of the planning system. Table B-4 illustrates the tabular data that are available as a result of this program. This information is also applicable to the planning system. The true utility of this technology lies in the flexibility of the data base that is developed as part of the analysis. Joining Landsat data with ancillary data in a geographic data base provides a previously unheard-of dimension to the planning system. A typical database may consiste of the following elements.

- computer classes representing land cover from Landsat data;
- slope, aspect, elevation;
- photo interpretation data;
- sources of water;
- road net;
- production for forest, woodland, and rangeland resources;
- ground data;
- administrative units; and
- soil information.

Although Landsat is only one aspect of this broad data base, it is in fact the foundation underpinning other data. From this data base, the types of products listed in table B-3 can be produced. Figure B-3 illustrates a basic map of current vegetation produced from this technology for use in URA. An example of another product of the data base is shown in figure B-4. Depicted here is its use to delineate areas of high potential for Desert Big Horn Sheep habitation. The digital nature of this data base provides a great deal of flexibility. Products can be made at extremely low cost, and they can also be revised in an economical and efficient manner. The data base is also very easily revised as new information becomes available,

Benefits, Budget, and Personnel

The costs of developing the data base from Landsat data are very attractive. By contrast, the process of producing necessary map overlays by hand is labor inten- - sive, time consuming, and is by nature subjective. The study project maintained detailed records of costs, both recurring and nonrecurring. The costs associated

Table B-3.—Management Opportunity (Arizona Strip District)

Management products	Scale	Management parameters	Current use	Potential use
Potential juniper—pinyon cutting/burning areas	1 :126,720	Vegetation: ua percent juniper—pinyon Elevation: 5,000-6,000 ft Slope: 0-15 percent Aspect: within % mile of a road.	Two areas identified for tree use permits	High for EA, AMP, HMP.
Potential blackbrush treatment areas	1 :126,710	Vegetation: high component blackbrush with grass understory Elevation: 4,500-5,000 ft Slope: variable Aspect: north, northeast.	Used in programmatic blackbrush - sagebrush burning EA	High for EA, AMP, HMP, EIS.
Potential antelope habitat	1:126,720	Vegetation: Great Basin desert shrub, plains grassland Elevation: 4,000-6,000 ft Slope: 0-20 percent Aspect: variable.	Being used for HMP	High for HMP, URA, and MFP.
ESL overlay sagebrush treatment areas	1:126,720	Vegetation: 50 percent sagebrush with perennial grass understory Elevation: variable Slope: less than 15 percent Aspect: variable 10-acre minimum.	Available for office use	High for EIS implementation EA's, and AMP's, HMP.
ESL overlay rangeland suitability	1 :126,720	Current production of usable forage above 20 lbs/acre Located within 4 miles of water Elevation: variable Slope: less than 51 percent Aspect: variable.	Available for office use	To prove suitability of allotment.
Potential mule deer summer range	1 :126,710	Vegetation: juniper-pinyon, ponderosa pine Elevation: above 6,000 ft Slope: variable Aspect: variable.	Available for office use	High for HMP, URA, and MFP.
Potential mule deer intermediate range	1 :126,720	Vegetation: variable Elevation: 5,000-6,000 ft Slope: 0-100 percent Aspect: variable.	Available for office use	**High for HMP, URA, and MFP.**
Potential mule deer winter range	1 :126,720	Vegetation: variable Elevation: 3,000-5,000 ft Slope: 0-100 percent Aspect: variable.	Available for office use	High for HMP, URA, and MFP.
Potential burning areas	1 :126,720	Vegetation: sufficient grass understory for natural reseeding Elevation: 4,250-6,240 ft Slope: variable Aspect: variable.	Available for office use	High for EA, AMP, HMP.

Table B“3.—Management Opportunity (Arizona Strip District) (Continued)

Management products	Scale	Management parameters	Current use	Potential use
Potential juniper. pinyon burning areas	1:126,710	Vegetation: juniper-pinyon, 35 to 50 percent, mountain shrub, 7 percent, Mojave Desert shrub, 7 percent Elevation: 5,000-6,000 ft Slope: 0-15 percent Aspect: variable.	Available for office use	High for EA, AMP, HMP.
Potential burning areas	1:126,710	Vegetation: sufficient grass understory for natural reseeding Elevation: 3,250-5,750 ft Slope: variable Aspect: variable.	Available for office use	High for EA, AMP, HMP.

SOURCE: Office of Technology Assessment,

Table B-4.-Grand Planning Unit

Area: 31,688 acres; 12,777 hectares; 2 percent of planning unit

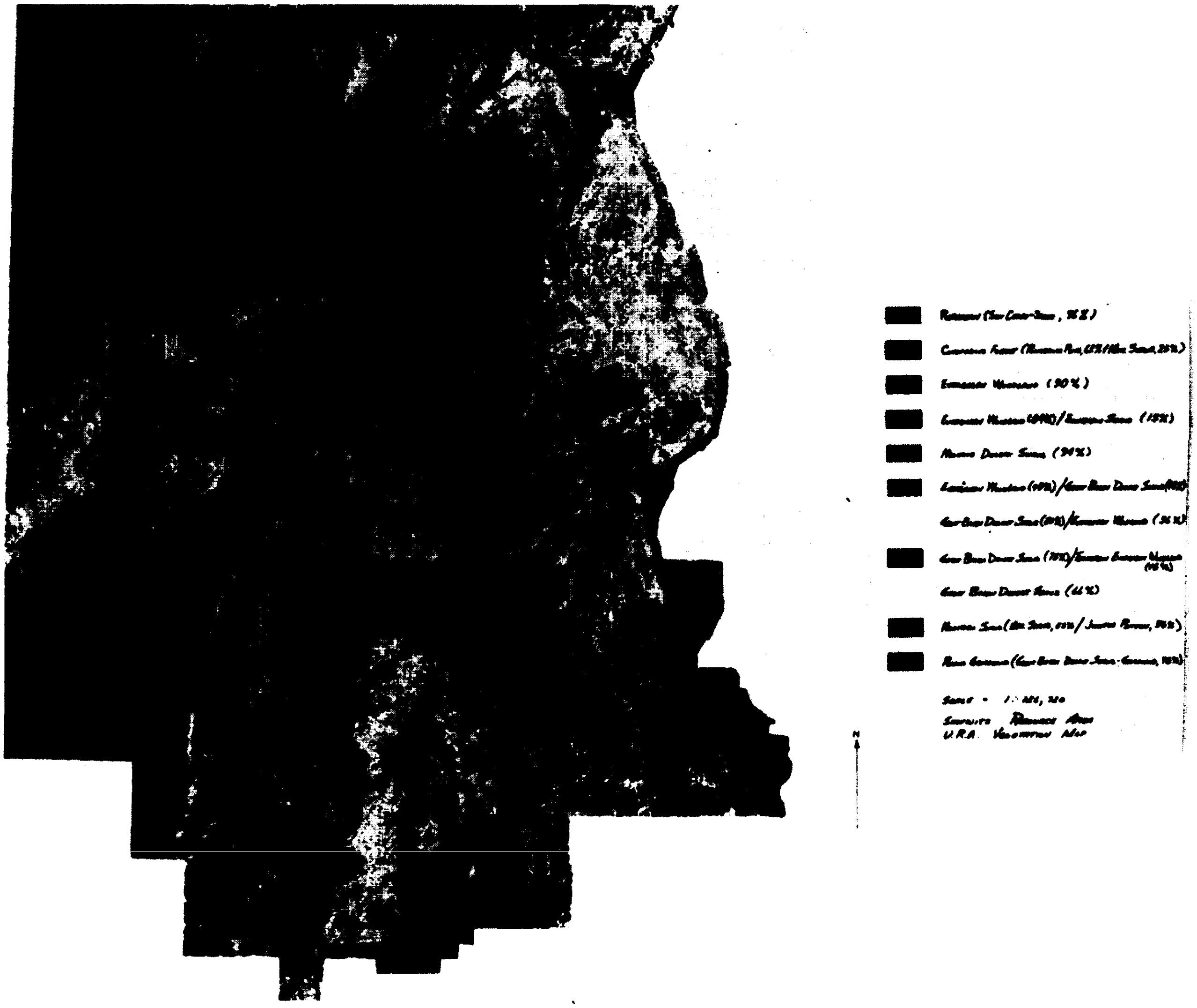
Elevation			Slope			Aspecty		
Class (ft.)	Acres	Percent area	Class percent	Acres	Percent area	Class	Acres	Percent area
3,000	402	1	0-5	22,759	72	NW	2,646	*8*
3,500	771	2	6-10	3,443	11	N	4,510	*14*
4,000	3,101	10	11-20	2,650	8	NE	5,857	*18*
4,500	3,975	13	21-50	2,364	7	E	7,406	*23*
5,000	11,487	36	51-100	439	1	SE	2,434	
5,500	11,249	35	100	33	1	s	2,703	:
6,000	681	2				Sw	3,420	11
6,500	22	1				w	2,712	9

Cover type description based on photo data, 212 photo plots

	Evergreen woodland	Mohave desert shrub	Great Basin desert shrub	Mountain shrub	Plains grassland
	Juniper-pinyon shrub. .. .22	Mixed desert shrub. 1	Big sagebrush . . . .1 Big sagebrush-perennial grass. ...7 Big sagebrush-mixed shrub .. ...17 Big sagebrush-tree. . . . .8 Fourwing saltbush . . . .1 Blackbrush . . . .3 Blackbrush-tree . . . .2 Blackbrush-other desert shrub. ..14 Snakeweed . . . .14 Little rabbitbrush 4	Mixed chaparral .. ..1 Turbinella oak 3	Grama-galleta-shrub-steppe . . . .1 Cheatgrass shrub. ...1
Total, percent	22	1	71	4	2

SOURCE: Office of Technology Assessment.

Figure B-3.–Current Vegetation Map

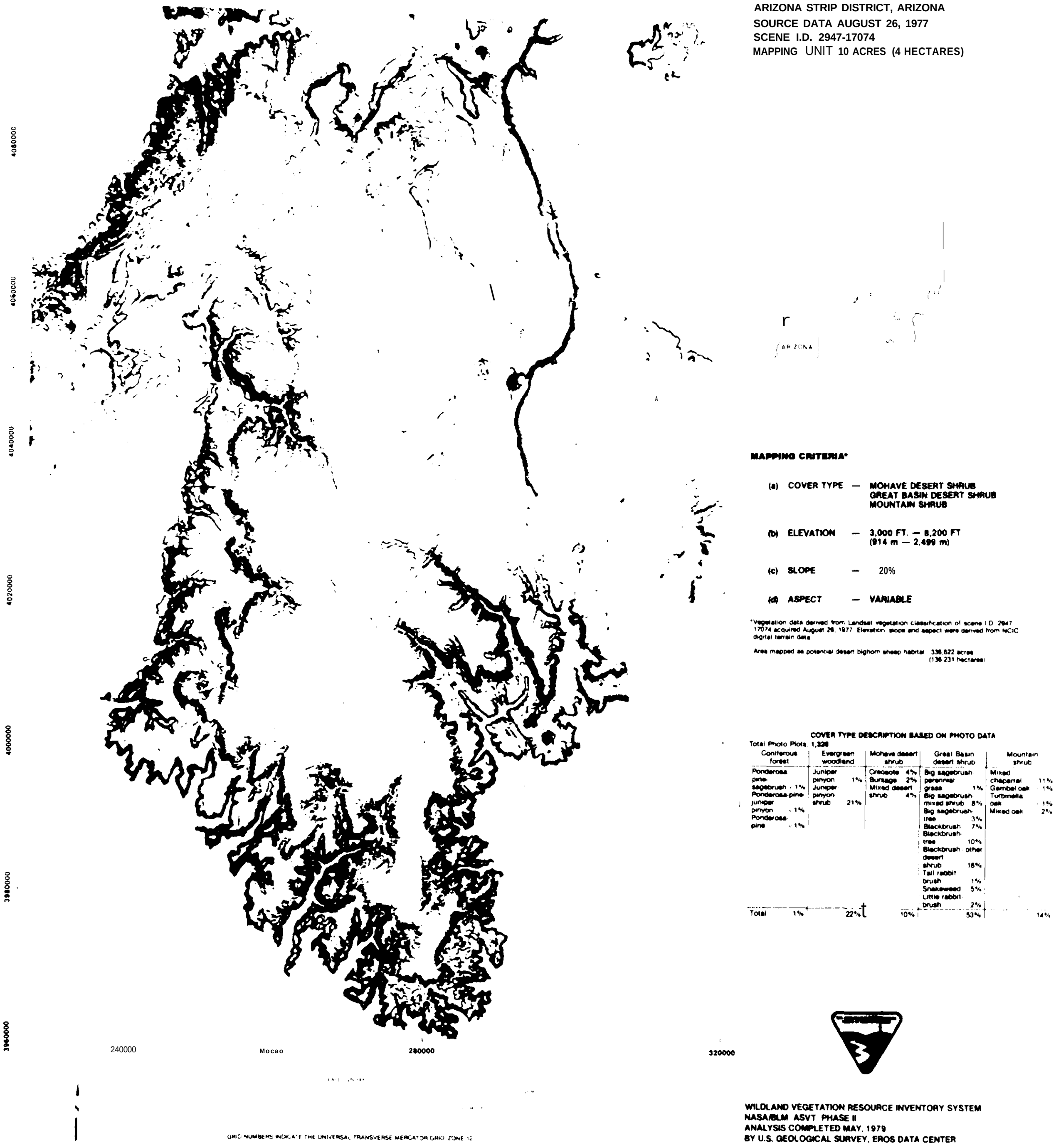


with producing the detailed maps in the project were $0.07 per acre. This includes establishing the data base, which includes Landsat classification results, digital terrain data (elevation, slope, and aspect), photo interpretation results, ground data collection results, and digitized ownership boundaries. The geographically referenced data base allows extraction of subsequent information by coordinates of any scale and in any practical form. The cost associated with this secondary data extraction is $0.0006 per acre. These costs are in 1980 dollars and are subject to a number of considerations. For example, it is possible to study larger areas without increase in the unit cost per acre. Similarly, the complexity of the area could cause an increase in the unit cost.

Potential Applications of Landsat to SVIM

The BLM-NASA-EROS wildland vegetation resource inventory project concluded that using Landsat data has the potential to reduce the cost of SVIM inventories. Consequently, a program was conducted in fiscal year 1981 to test and evaluate the feasibility of this concept. The objective of the study was to determine the utility of Landsat and ancillary data when combined with soils data in generating site writeup area

Figure B.4.—Potential Desert Bighorn Sheep Habitat



ARIZONA STRIP DISTRICT, ARIZONA
SOURCE DATA AUGUST 26, 1977
SCENE I.D. 2947-17074
MAPPING UNIT 10 ACRES (4 HECTARES)

MAPPING CRITERIA*

(a) COVER TYPE — MOHAVE DESERT SHRUB
GREAT BASIN DESERT SHRUB
MOUNTAIN SHRUB

(b) ELEVATION — 3,000 FT. — 8,200 FT
(914 m — 2,499 m)

(c) SLOPE — 20%

(d) ASPECT — VARIABLE

*Vegetation data derived from Landsat vegetation classification of scene I.D. 2947-17074 acquired August 26, 1977. Elevation, slope and aspect were derived from NCIC digital terrain data.

Area mapped as potential desert bighorn sheep habitat: 336,622 acres (136,231 hectares)

COVER TYPE DESCRIPTION BASED ON PHOTO DATA

Total Photo Plots: 1,326

Coniferous forest		Evergreen woodland		Mohave desert shrub		Great Basin desert shrub		Mountain shrub	
Ponderosa pine-sagebrush	< 1%	Juniper-pinyon	1%	Creosote	4%	Big sagebrush-perennial grass	1%	Mixed chaperral	11%
Ponderosa-pine-juniper-pinyon	< 1%	Juniper-pinyon-shrub	21%	Bursage	2%	Big sagebrush-mixed shrub	8%	Gambel oak	< 1%
Ponderosa pine	< 1%			Mixed desert shrub	4%	Big sagebrush-tree	3%	Turbinella oak	< 1%
						Blackbrush	7%	Mixed oak	2%
						Blackbrush-tree	10%		
						Blackbrush-other desert shrub	16%		
						Tall rabbit brush	1%		
						Snakeweed	5%		
						Little rabbit brush	2%		
Total	1%		22%		10%		53%		14%

WILDLAND VEGETATION RESOURCE INVENTORY SYSTEM
NASA/BLM ASVT PHASE II
ANALYSIS COMPLETED MAY, 1979
BY U.S. GEOLOGICAL SURVEY, EROS DATA CENTER

GRID NUMBERS INDICATE THE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 12

(WA) maps for SVIM inventories. A test site in Wyoming where SVIM data collected by traditional means is available for quality and cost comparison has been identified for this program. The project was conducted in two phases. Part one tested and evaluated the hypothesis on a site that is covered by a SVIM inventory. The results of this test are not yet available. However, once feasibility is demonstrated, the process will be defined in detail and implemented in a new area. Careful cost records will be maintained so that a definite conclusion can be reached on cost savings.

Initial studies indicate a potential for significant savings in field work and product preparation. Savings in personnel in the form of time and work efficiency are possible. Once again, a new mix of personnel (technologists/resource specialists) will be required, but these will be persons already involved in these programs. The budget appropriated for the test phase of this program is approximately $100,000.

Effects of Programs Utilizing Landsat Data

Technical Impacts

The most substantial technical byproduct of this program has been the acquisition by BLM of a complete off-the-shelf remote-sensing digital image processing system and associated software. The acquisition of this equipment at a cost of approximately $500,000 (cost of equipment and facilities) represented a sharp departure from previous philosophies in the organization, It was a recognition by management of the need to bring space age technology to bear upon the problems associated with resources management.

As the program has evolved, it has also become obvious that there is a growing potential requirement for a distributed system. BLM field offices will also need to be capable of conducting routine analysis of Landsat data. This will be a function of schedules, availability of resources, and the individual field office technological capabilities. In addition, the field offices will need to reach and revise their Landsat data base, It may also be useful for BLM offices to use the processing capability at the EROS Data Center (EDC). Similarly, BLM Alaska will use the EDC Field Office system in Anchorage.

Preliminary tests of the system have been very positive. Its products have been determined to have direct application in management activities. They have also been found to be as accurate, and in some instances more accurate, than those that are produced by more conventional means. Furthermore, the products are more easily produced and, as a result, more readily available to field personnel. The geographically referenced digital data base containing Landsat data and ancillary information has proved to be an extremely valuable management tool.

The importance of the geographically referenced data base that results from this technology is just beginning to be realized. The accuracy of the information, the timeliness with which products can be produced and revised, the ease with which the data base can be revised, and the low cost to use the data base as well as its low initial cost are all factors which will generate increased use of this technology.

Different Personnel Requirements

As a result of this program, BLM has experienced an influx of technical specialists who have complemented the existing BLM expertise. These individuals consist of foresters, botanists, range conservationists, geologists, systems analysts, physicists, etc., who by virture of formal education or work-related experience have become specialists in the field of remote sensing. Table B-5 provides a list of individual technical skills now found in BRS (new organization resulting from this program) at the Denver Service Center (DSC). Table B-6 is a list of individual skills supporting the BLM remote-sensing R&D programs. An unusual skill mix exists in these groups. Such a skill mix is mandatory in order to: 1) be responsive to BLM resource management requirements, and 2) implement successfully a technical program at the field level. The advent of this technology has also affected operations and personnel at the field level. Most BLM offices that become involved in the program appoint remote-sensing coordinators who are normally persons within the existing organization such as soil scientists, foresters, and range conservationists. Once selected, these persons receive intensive training in the technology and then work in concert with their BLM counterparts at DSC for the duration of the project.

Economic Effects

To compare overall planning system costs with Landsat costs is not realistic. Since Landsat data are

Table B=5.—Individual Skills Supporting BLM Remote-Sensing R&D Programs

Remote Sensing Skills—Branch of Remote Sensing
Forestry
Geology
Wildlife Biology
Botany
Remote-Sensing Skills—TGS Contractor
Forestry
Earth Resources
Biometrics
Range Science
Environmental Monitoring
Wildlife Biology
System Analyst
Programing

SOURCE: Bureau of Land Management.

Table B-6.—Remote-Sensing Skills—Division of Scientific Systems Development

Remote-Sensing Skills—Division of Scientific Systems Development
Geology
Remote-Sensing **Science**
Statistics
Cartography
Computer Systems
Physics

SOURCE: Bureau of Land Management

utilized to support the planning system, only those parts of the latter which are replaced by methods using Landsat data may be considered. A small example that illustrates potential savings is the generation of a habitat map involving vegetation, slope, aspect, elevation, disturbance corridors, and sources of water at a scale of 1:126,720 (1/2 inch = 1 mile) for a 2 million acre area. This would cost on the order of $500, if the Landsat geographic data base were used, The same product produced by hand in the traditional manner would typically cost at least $2,500. To produce the map by traditional means would take a matter of weeks, while the Landsat-derived map could be produced in a matter of hours (from an established data base). The former would be subject to the bias of the analyst, while the latter would be objective within the criteria specified. In addition, the traditional map would be difficult, costly, and time consuming to revise, but the Landsat map could be quickly modified and regenerated, The Landsat map would also be inherently more accurate and could be legally defended if required.

In another example, BLM proposes to streamline the process of SVIM inventory by incorporating Landsat data with SVIM. Such action is expected to reduce costs by approximately 20 percent.

Institutional Effects

BLM Landsat remote-sensing program has produced some institutional benefits, It has caused exchange of information and cooperative projects that are still in progress between BLM and other Federal, State, and local governments. Such exchanges are also occurring between BLM and industry and BLM and the academic community. Examples of some of these are:

- Geological Survey, National Park Service, NASA, Forest Service, Corps of Engineers, Soil Conservation Service, and Bureau of Indian Affairs.
- University of California–Berkeley, Riverside; University of Arizona, and University of Alaska.
- Raytheon, IBM, Geospectra Corp., ESL, Inc., and Technicolor Graphic Services.

It is estimated that 3 work years have been dedicated to coordinating and managing these efforts in the last 5 years.

International Effects

The current programs have not affected world trade, prices, or the competitive position of the United States. Nor have they affected the current system on international land use policy formulation. However, they have led to some international cooperation between BLM and Mexico and BLM and Australia. In a recent project, BLM provided extensive support and cooperation to Australia. An Australian scientist worked at the BLM facility in Denver to do a Landsat analysis on the BLM image processing system. BLM is also supporting a project between the United States and Mexico to map desertification indicators in two test sites in Mexico and one in the United States.

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