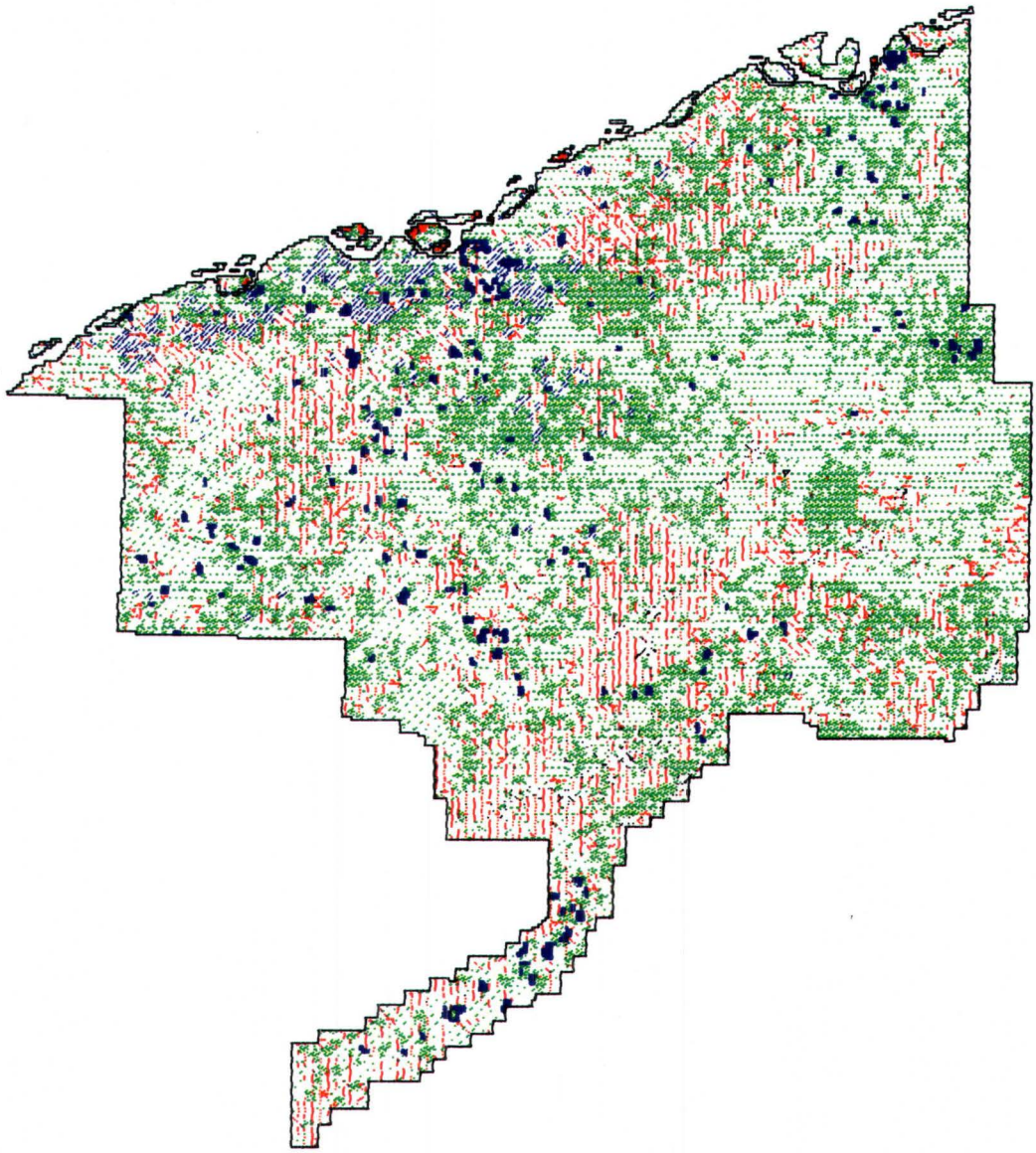
NOWITNA
NATIONAL WILDLIFE REFUGE
LAND COVER MAPPING PROJECT
USERS GUIDE



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INTRODUCTION

Title III of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA 1980) established the Nowitna National Wildlife Refuge (NNWR). Section 304 of the Act requires the Secretary of Interior to "prepare, and from time to time revise, a comprehensive conservation plan" for the refuge. Before developing a plan for the refuge, the Secretary shall "identify and describe--a) the populations and habitats of the fish and wildlife resources of the refuge; b) the special values of the refuge as well as any other archeological, cultural, ecological, geological, historical, palentological, scenic, or wilderness value of the refuge; c) areas within the refuge that are suitable for use as administrative sites or visitor facilities...; d) present the potential requirements for access with respect to the refuge...; and e) significant problems which may adversely affect the populations and habitats of fish and wildlife identified and described..." (ANILCA, 1980). Vegetation, water, and terrain (elevation, slope, and aspect) are the components of habitat and can be used in the determination of the above requirements.

The U. S. Fish & Wildlife Service (USFWS) has the responsibility for collecting the resource information to address the research, management, development and planning requirements identified in Section 304. Because of the brief period provided by the Act for data collection, habitat mapping, and habitat assessment, the USFWS in cooperation with the U.S. Geological Survey's EROS Field Office, used digital Landsat multispectral scanner (MSS) data and digital terrain data. A computer assisted digital analysis of Landsat MSS data was used because the level of detail obtained from the analysis of Landsat data, was adequate to meet most USFWS research, management and planning needs. Relative cost and time requirements were also factors in the decision to use the digital analysis approach.

OBJECTIVES

The primary objectives of the mapping project were to:

1) produce digital land cover/terrain classifications for the NNWR, using digital Landsat and terrain data.

2) provide registered Landsat data for the entire study area defined as the NNWR.

3) provide other derivative products and output products as required.

The primary objectives of this user guide are to give a brief discussion of the methodology used and describe the different types of data products produced.

AREAS OF COVERAGE

The NNWR consists of approximately 2.05 million acres of land and water in the west-central portion of Alaska. The northwest and southeast latitude/longitude coordinates of the mapped area are 65°15'/155°45' and 63°45'/152°30' respectively. The entire study area covers roughly 2 degrees of latitude and 4 degrees of longitude. Portions of 3 Landsat scenes (Table 1) were required to provide complete coverage of NNWR and the surrounding areas (Figure 1).

METHODOLOGY

A computer compatible tape (CCT) was obtained for each Landsat scene covering refuge lands. The Landsat scenes were radiometrically and geometrically corrected (registered to a 50-meter Universal Transverse Mercator [UTM] grid) and the boundaries of the refuge and the corresponding 1:250000-scale USGS quadrangles digitized. This made it possible to summarize land cover information for the entire refuge. Training blocks (sample areas containing representative land cover types) were selected for field study, and training statistics were derived from them. Figure 2 shows the location of the training blocks used in this study. A modified clustering technique was used to generate initial spectral classifications (Fleming, 1975), using the EROS Field Office computer system (HP-3000) and IDIMS software (ESL 1980).

Table 1. Landsat scenes used to map the Nowitna National Wildlife Refuge.

Path/Row	Scene I.D.	Date
79/14	17732-10255	4 Sep. 1974
79/15	17732-10325	4 Sep. 1974
81/14	25372-10555	12 July 1976

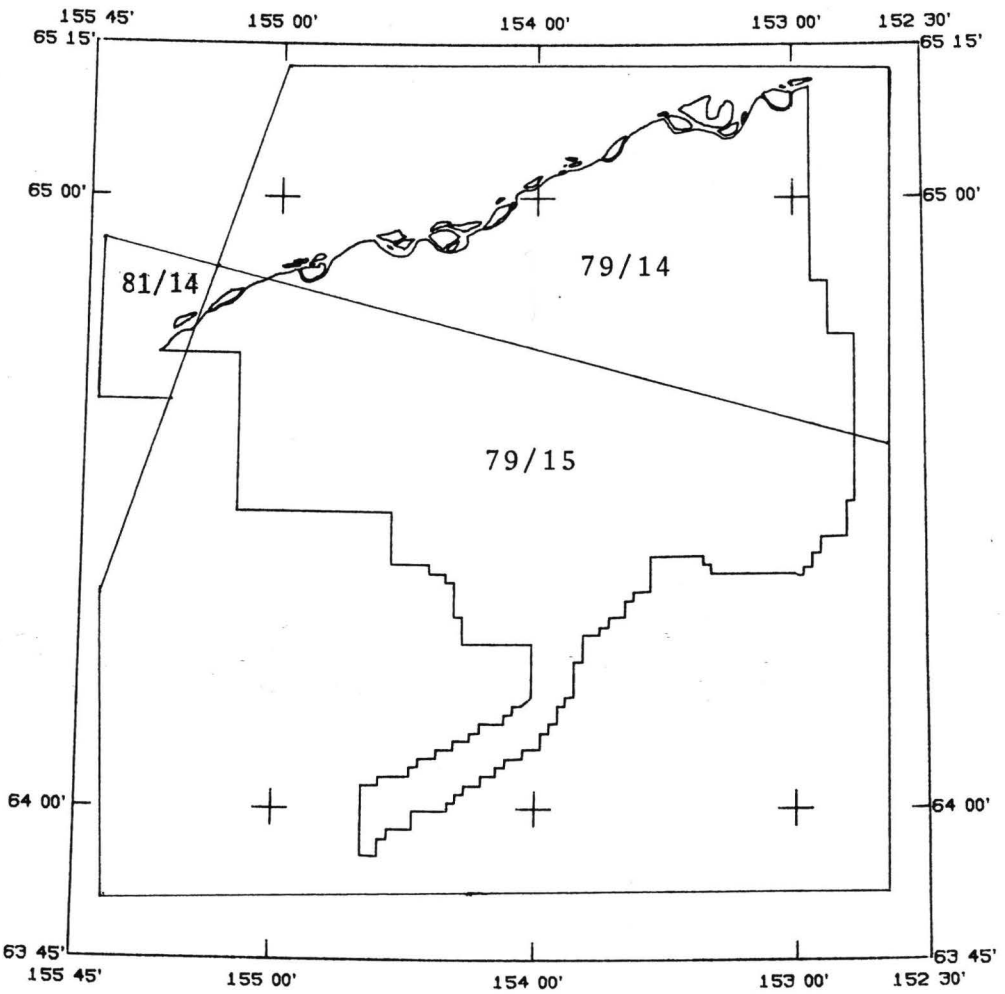

Figure 1. Location of Landsat scenes used for the Nowitna National Wildlife Refuge mapping project.

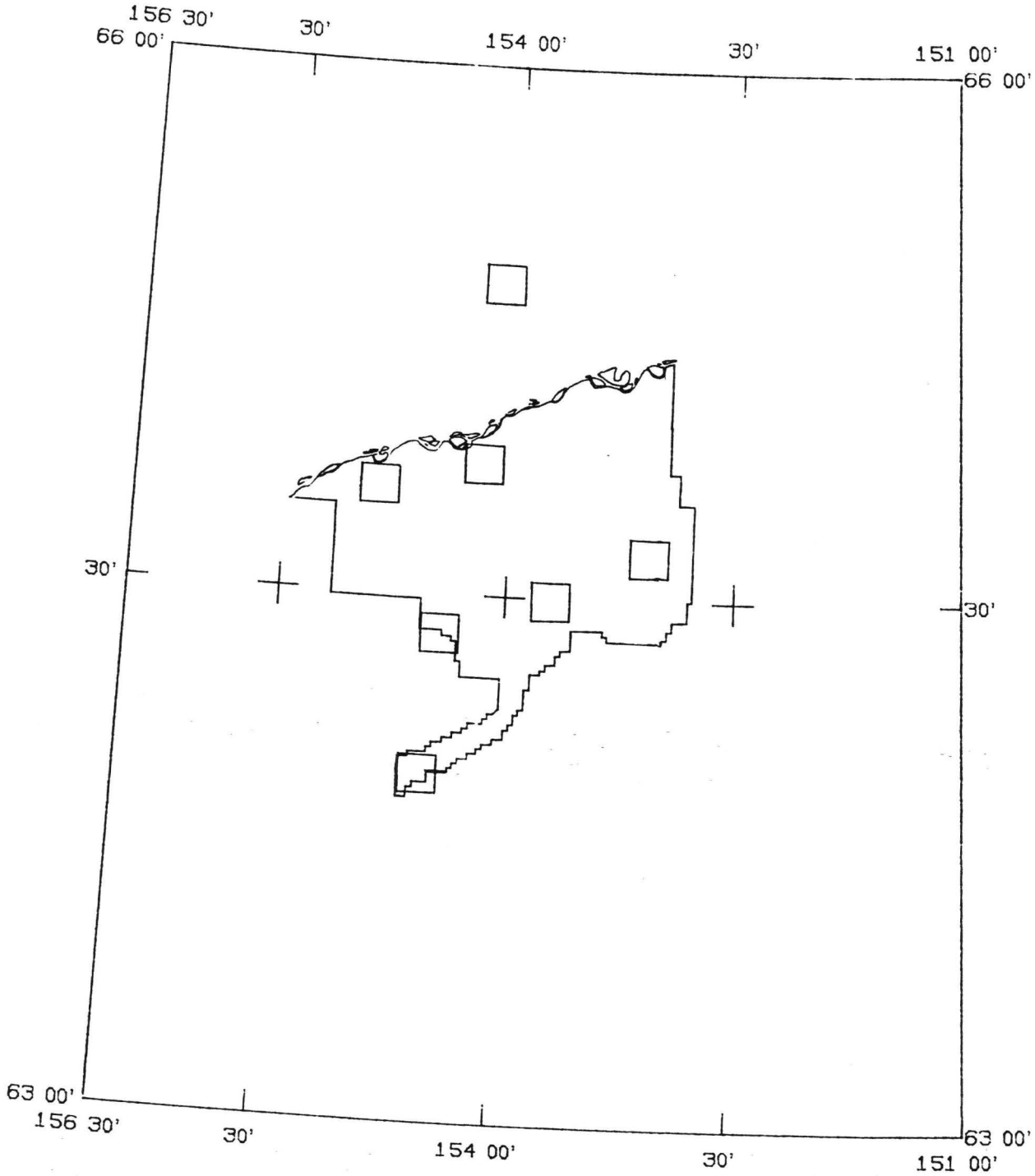

Figure 2. Location of training blocks used for the Nowitna National Wildlife Refuge land cover mapping project.

Field data on vegetation cover, structure, and composition were collected in each training block to identify land cover types corresponding to computer-derived spectral classes. Final land cover classifications, designated by USFWS personnel, were produced after applying stratification techniques to improve classification accuracy. Land cover classifications were merged with digital terrain data derived from 1:250,000-scale USGS quadrangles to improve classification accuracy and to make possible the production of additional resource data products displaying topographic variables such as elevation, slope, and aspect. The specific procedures used in producing land cover/terrain classifications and output products are detailed in Appendix A. A schematic diagram of the mapping process is shown in Figure 3.

USFWS personnel worked with EROS personnel to conduct the digital analysis required to produce land cover classifications for the refuge and coordinated with USFWS Information Resource Management personnel to ensure that the digital data were compatible with the USFWS geobased information system.

PRODUCTS

The following products were produced for the mapping project:

1) Land cover classifications of the refuge and surrounding areas. This included photographic prints of land cover in the refuge at a 1:250,000-scale.

2) Acreage estimates for each land cover type in the refuge.

3) Computer tapes of all raw and registered Landsat scenes.

4) Computer tapes containing land cover and terrain data classifications.

5) Computer tapes of resampled land cover and terrain data.

6) Elevation, slope, and aspect photographic prints of maps at a 1:250,000-scale.

7) This users guide.

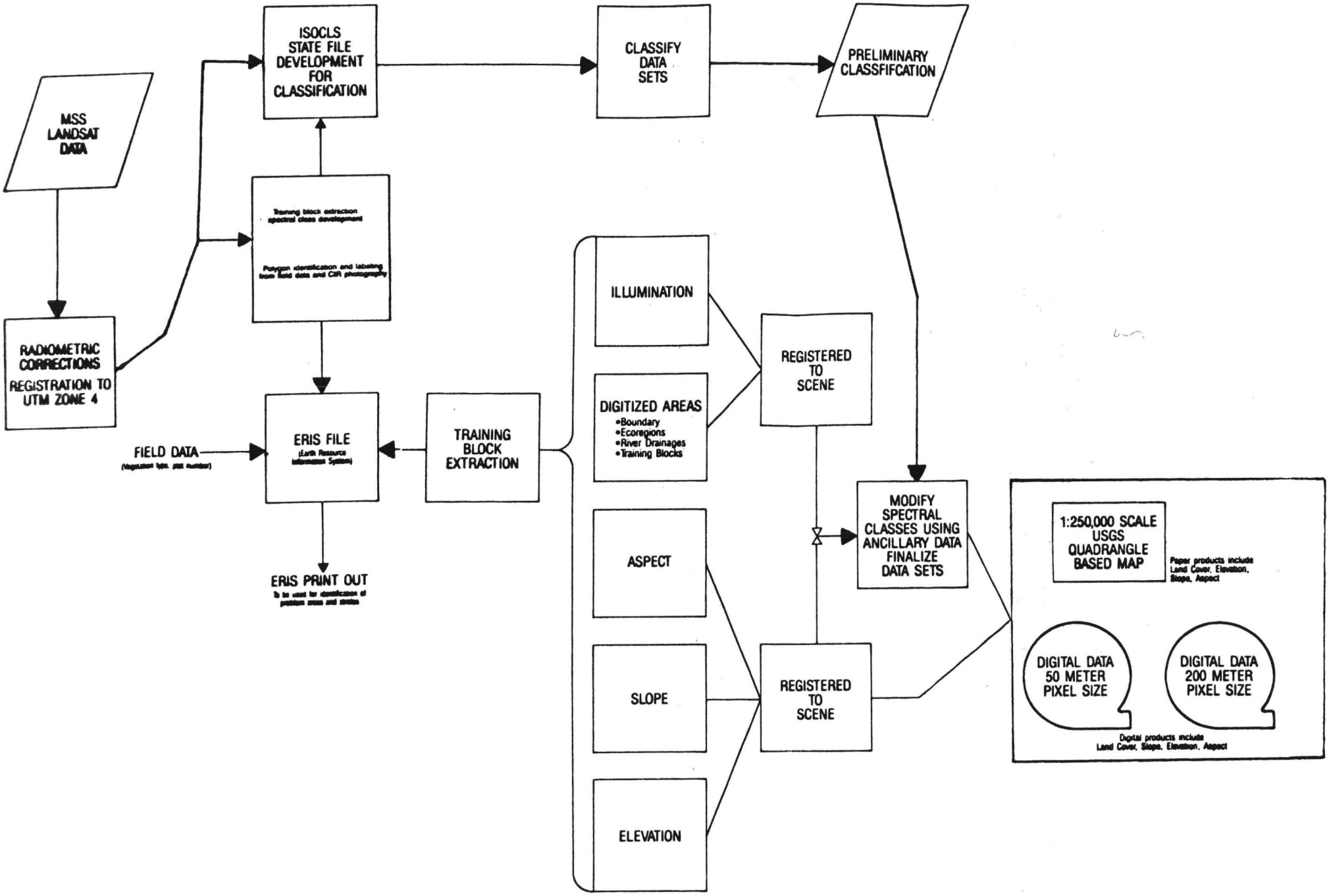

Figure 3. Schematic diagram of the mapping process used to produce the land cover classification of the Yukon Flats National Wildlife Refuge.

PRODUCT DESCRIPTIONS-HARD COPY

LAND COVER CLASS DESCRIPTIONS

Based on information acquired in the field, discussions with USFWS personnel, and Landsat spectral discrimination, seven major land cover classes were recognized: Forest, Broadleaf Scrub, Dwarf Scrub, Herbaceous, Scarcely Vegetated, Water, and Other. Included in these major classes are 16 subclasses (Table 2). A complete description of each of the major classes and subclasses can be found in Talbot 1986.

Acreage estimates for each land cover class within the refuge were summarized and listed in Table 3. Final hard copy land cover maps for the refuge were produced at a 1:250,000-scale in the form of photographic prints. Each map contained collar information which included: map title, a list of vegetation classes, locational diagram of the refuge with respect to the State of Alaska, scale bar and latitude/longitude tick marks. Each land cover class was depicted on the map as a color. The color scheme used was based on input from USFWS and USGS/EROS personnel.

TERRAIN CLASS DESCRIPTIONS

Terrain class maps were produced from the elevation, slope, and aspect digital data and produced for each USGS 1:250,000 quadrangle. Elevation classes were broken into the following catagories (in meters): 0-76, 77-152, 153-304, 305-456, 457-610, and 611-763. Slope classes were broken into 0-2%, 3-5%, 6-10%, 11-15%, 16-25%, 26-40%, 41-70%, and 71% and higher. The aspect classes were broken into the four cardinal directions: north, south, east, and west. All of the maps contained the water classes and the aspect map contained the 0-2% slope class. Collar information included: map title, scale, locational diagram, map legend, latitude/longitude, and tick marks.

PRODUCT DESCRIPTIONS-DIGITAL

GENERAL

Digital data are stored at USGS/EROS on CCT's in either an IDTRANS or TRANSFER format. Digital data stored in the IDTRANS format are used at USGS/EROS for internal processing. The TRANSFER format is usually used when data are shipped to other U.S. government agencies or the private sector. Images are generally written on a TRANSFER tape with one image line per record and one image per file. Images may be band-by-band or line-by-line. If the data format is floating point, either a

Table 2. Land cover classes used for the Nowitna National Wildlife Refuge mapping process.

CLASS NUMBER	CLASS NAME
0	Background
1	Closed Needleleaf Forest
2	Open Needleleaf Forest
3	Needleleaf Woodland
4	Broadleaf Forest/Tall Scrub
5	Mixed Forest
6	Lowland Broadleaf Scrub
7	Subalpine Broadleaf Scrub
8	Dwarf Shrub-Graminoid Tussock Peatland
9	Prostrate Dwarf Shrub Tundra
10	Graminoid Marsh-Meadow
11	Clear Water/Aquatic Forb
12	Turbid Water
13, 15	Scarcely Vegetated Floodplain/ Mud Flat
14	Scarcely Vegetated Scree
16	Shadow
18	Digitized Hydrography
19	Alluvial Scrub

Table 3. Acreage esitmates for each land cover class in the Nowitna National Wildlife Refuge.

CLASS NAME	CLASS VALUE	PIXCOUNT	ACRES	PERCENT
CLOSED NEEDLELEAF	1	590341.00	364653.64	17.71%
OPEN NEEDLELEAF	2	730602.00	451292.86	21.92%
NEEDLELEAF WOODLAND	3	257016.00	158758.78	7.71%
BROADLEAF FOREST/TALL SHRUB	4	617129.00	381200.58	18.52%
MIXED FOREST	5	760196.00	469573.07	22.81%
LOWLAND BROADLEAF SCRUB	6	64160.00	39631.63	1.93%
ALLUVIAL SCRUB	19	6859.00	4236.80	0.21%
SUBALPINE BROADLEAF SCRUB	7	41769.00	25800.71	1.25%
DWARF SHRUB-GRAMINOID TUSSOCK PEATLAND	8	78035.00	48202.22	2.34%
PROSTRATE DWARF SHRUB	9	2166.00	1337.94	0.06%
GRAMINOID MARSH-MEADOW	10	80212.00	49546.95	2.41%
CLEAR WATER	11	75121.00	46402.24	2.25%
TURBID WATER	12	9522.00	5881.74	0.29%
SCARCELY VEGETATED FLOODPLAIN/MUD FLAT	13 & 15	2537.00	1567.10	0.08%
SCARCELY VEGETATED SCREE	14	150.00	92.66	.00%
SHADOW	16	799.00	493.54	0.02%
DIGITIZED HYDROGRAPHY	18	16316.00	10078.39	0.49%
TOTAL		3332930.00	2058750.86	100.00%

Hewlett-Packard 3000 or IBM format may be specified. Data may be read onto the tape at either 1600 or 6250 bits/inch (bpi). All data relating to this project have been delivered to USFWS at 1600 bpi using the Hewlett-Packard 3000 floating point format.

An attempt was made to standardize the pixel size and UTM origins of the data. For this project most, if not all, of the final data sets were produced at three different pixel sizes: 50 x 50 meter, 100 x 100 meter, and 200 x 200 meter. Pixel sizes were predetermined by the USFWS prior to the finalization of the land cover classification. All of the data which has been transfered to the USFWS covered under the Interagency Service Agreement is summarized in Appendix B.

LAND COVER

The land cover images contain up to 16 different classes (Table 2). The data is byte data. The lowest class, 0, is a background or fill class. The class descriptions corresponding to each class number may be found in Talbot 1986.

ELEVATION DATA

The digital elevation data were derived from digital terrain data created by the Defense Mapping Agency (DMA). The DMA generated the data by digitizing contour lines, spot elevations, and stream and ridge line data from the 1:250,000-scale USGS quadrangles. The contour intervals range from 50 to 200 feet. These data were then converted to a rectangular grid of values, producing elevation estimates spaced every 0.01 inches on each 1:250,000-scale map (approximately 200 feet on the ground). The data are integer data and can range in values from 0 to about 3000 meters. The data is recorded in one meter increments.

SLOPE DATA

The slope data were computed using the digital elevation data. Slope is computed as percent slope, i.e. units of rise per 100 units of run. The data is byte data and is recorded in one percent increments. Values can range from 0 to 255.

ASPECT DATA

The aspect data were computed using the digital elevation data. Aspect is computed clockwise from north in degrees. The data are byte data with values from 0 to 180: 0 and 180 = north, east = 45, south = 90, and west = 135. Values increase in two degree increments.

ACKNOWLEDGEMENTS

This project was funded by an interagency service agreement between the U.S. Fish and Wildlife Service and the U.S. Geological Survey/EROS Anchorage Field Office, contract number 14-16-0007-85-7501. Field and botanical assistance was provided by Steve Talbot. Appreciated are David Carneggie and Mark Shasby for their support and review of this report.

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Fleming, M. D., 1975, Computer aided analysis of Landsat data: a comparison of three approaches including modified clustering approach: West Lafayette, Indiana, Purdue University Laboratory for Applications of Remote Sensing, LARS Information Note 072475, 9 p.

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APPENDIX A

PROCEDURES FOR LAND COVER CLASSIFICATION USING LANDSAT CCT'S

Preprocessing

1. Enter Landsat Data (CCT format) into IDIMS

2. Display and select Landsat subscenes

3. Perform radiometric corrections

   a. Destrip to correct for detector miscalibration
   b. Fix bad data lines

4. Perform geometric corrections

   a. Select control points from Landsat data and maps for image registration
   b. Digitize control points and map boundaries
   c. Generate transformations and rotate Landsat scenes
   d. Register Landsat image to 50 meter UTM grid

5. Produce strata mask for study areas

6. Digitize refuge boundaries

7. Mosaic and register DEM data

Image Training and Classification

1. Select training blocks for study area in each Landsat scene

2. Apply IDIMS clustering algorithm (ISOCLAS)

3. Produce statistics of the spectral classes within the training blocks

4. Produce photographic image of each Landsat training block and color coded cluster map

5. Prepare for field investigations

   a. Acquire aerial photographs of cluster blocks for annotation in field
   b. Develop strategy for aerial reconnaissance and on-the-ground investigations

APPENDIX A

6. Field verification

   a. Describe land cover type associated with each cluster class
   b. Collect auxiliary information when appropriate, e.g. wildlife habitat value, soils, quantitative plant description, etc.

7. Return to IDIMS and edit cluster statistics and pool and/or delete cluster classes

8. Produce preliminary classification based on edited cluster statistics

9. Evaluate preliminary classification based on edited cluster statistics

10. Post-classification refinement where necessary to improve classification accuracy. This step may be facilitated by several approaches, two of which are presented:

    a. Stratification based upon physiognomic, soil or other resource data

       (1) Digitize boundaries of strata
       (2) Produce and apply strata mask
       (3) Identify cluster classes for each strata
       (4) Combine classifications for all strata
       (5) Reclassify entire study area

    b. Merge DEM digital terrain data with Landsat data

       (1) Define control points for DEM
       (2) Generate transformation between latitude/longitude (DEM) and UTM grid
       (3) Register DEM to UTM grid
       (4) Generate slope and aspect data
       (5) Define strata based on combinations of elevation, slope, and aspect
       (6) Identify cluster classes within each strata

APPENDIX A

Generate Output Products

1. Generate digital tape file for classification of refuge

2. Produce acreage estimate for the refuge

3. Produce 1:250,000-scale photographic prints of the final land cover classification of the refuge

APPENDIX B

The following source data is relevant to all images listed below.

Coverage: Nowitna National Wildlife Refuge

UTM Northing	= 7260000	Number of Lines	= 3600
UTM Easting	= 350000	Number of Samples	= 3800
UTM Zone	= 5	Pixel Size (in meters)	= 50
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1388	4
Elevation	Integer	IDT 1191	3
Slope	Byte	IDT 1191	2
Aspect	Byte	IDT 1191	1
Refuge Mask	Byte	IDT 1187	2
Refuge Boundary	Byte	IDT 1187	1

The following source data is relevant to all images listed below.

Coverage: Nowitna National Wildlife Refuge

UTM Northing	= 7260000	Number of Lines	= 1800
UTM Easting	= 350000	Number of Samples	= 1900
UTM Zone	= 5	Pixel Size (in meters)	= 100
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1192	1
Elevation	Integer	IDT 1192	7
Slope	Byte	IDT 1192	10
Aspect	Byte	IDT 1192	4
Refuge Mask	Byte	IDT 1192	13
Refuge Boundary	Byte	IDT 1192	15

APPENDIX B

The following source data is relevant to all images listed below.

Coverage: Nowitna National Wildlife Refuge

UTM Northing	= 7260000	Number of Lines	= 900
UTM Easting	= 350000	Number of Samples	= 950
UTM Zone	= 5	Pixel Size (in meters)	= 200
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1192	2
Elevation	Integer	IDT 1192	8
Slope	Byte	IDT 1192	11
Aspect	Byte	IDT 1192	5
Refuge Mask	Byte	IDT 1192	14
Refuge Boundary	Byte	IDT 1192	16

The following source data is relevant to all images listed below.

Coverage: Preliminary Classification of Path/Row 79/14 for NNWR

UTM Northing	= 7330000	Number of Lines	= 3600
UTM Easting	= 380000	Number of Samples	= 2800
UTM Zone	= 5	Pixel Size (in meters)	= 50
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1184	1

APPENDIX B

The following source data is relevant to all images listed below.

Coverage: Preliminary Classification for Path/Row 79/15 for NNWR

UTM Northing	= 7215000	Number of Lines	= 2700
UTM Easting	= 350000	Number of Samples	= 3400
UTM Zone	= 5	Pixel Size (in meters)	= 50
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1185	1

The following source data is relevant to all images listed below.

Coverage: Preliminary Classification for Path/Row 81/14 for NNWR

UTM Northing	= 7200000	Number of Lines	= 512
UTM Easting	= 324000	Number of Samples	= 512
UTM Zone	= 5	Pixel Size (in meters)	= 50
		Tape Format	= IDTRANS

TYPE OF IMAGE	DATA TYPE	EROS FIELD OFFICE TAPE LOCATION	FILE
Landcover	Byte	IDT 1183	4