

Land-Use Changes on the Proposed Clinch River Breeder Reactor Demonstration Project Site: 1924 to 1972

R. K. McConathy

Environmental Sciences Division Publication No. 806

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42

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CLINCH RIVER BREEDER REACTOR DEMONSTRATION
PROJECT SITE: 1924 to 1972

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ENVIRONMENTAL SCIENCES DIVISION

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SUBJECT: Errata for "McConathy, R. K. 1976. Land-use changes on the proposed Clinch River Breeder Reactor Demonstration Project site: 1924 to 1972. ORNL/TM-4838."
DATE: March 5, 1976

1. The legend to Figure 2, page 3, should be changed to read as follows:
"Fig. 2. Study area showing coded pre-1942 farming areas and area of TVA CRBRDP site included in the study (stippled area)."
2. In Table 2, page 16, the 28 acres for the 1972 agriculture land-use category should be footnoted as indicated below.

Table 2. Acreage in Land-Use Categories for 1924, 1942, and 1972

Land-use category	Date		
	1924	1942	1972
Agriculture	775	732	28 ^a
Forest	592	606	1196 ^b
Culture	20	33	86
Total	1387	1371	1310

^aRepresents open grassy areas on old field sites, coded as "shrub and low vegetation" on Fig. 3f, page 11.

^bDeciduous = 620 acres; coniferous = 576 acres.

*Errata's
mailed 3-9-76*

R. K. McConathy
R. K. McConathy

INTRODUCTION

Current landscape patterns and past-use history are essential elements in determining the effect that the siting of a particular project will have on future land use of a given area. At the present time there are two programs which require land-use analysis: (1) the Clinch River Breeder Reactor Demonstration Project (CRBRDP) and (2) the development of the Oak Ridge Environmental Study Park. This report documents the use history of the CRBRDP site and is also the first in a series to describe ecological areas on the ERDA Oak Ridge Reservation meeting criteria for scientific study sites or natural areas worthy of preservation. The CRBRDP area under discussion is located in Roane County, Tennessee (Figs. 1 and 2) and is a part of the land purchased in 1942 by the United States Government for the Manhattan Project, now known as the ERDA Oak Ridge Reservation.

Protection afforded the Oak Ridge Reservation has resulted in the preservation of several natural areas whose species composition and/or stage of ecological development make them of considerable scientific value. Continued protection of unique and natural areas is a prime objective of the proposed Oak Ridge Environmental Study Park. Designation as a natural area would exclude the area from forest management activities and intensive use for environmental research. However, unique natural areas will continue to remain available for nondestructive or nonmanipulative ecological research. One such area has been identified on the north slope of Chestnut Ridge on the Grassy Creek watershed and is discussed in the Natural Area section.

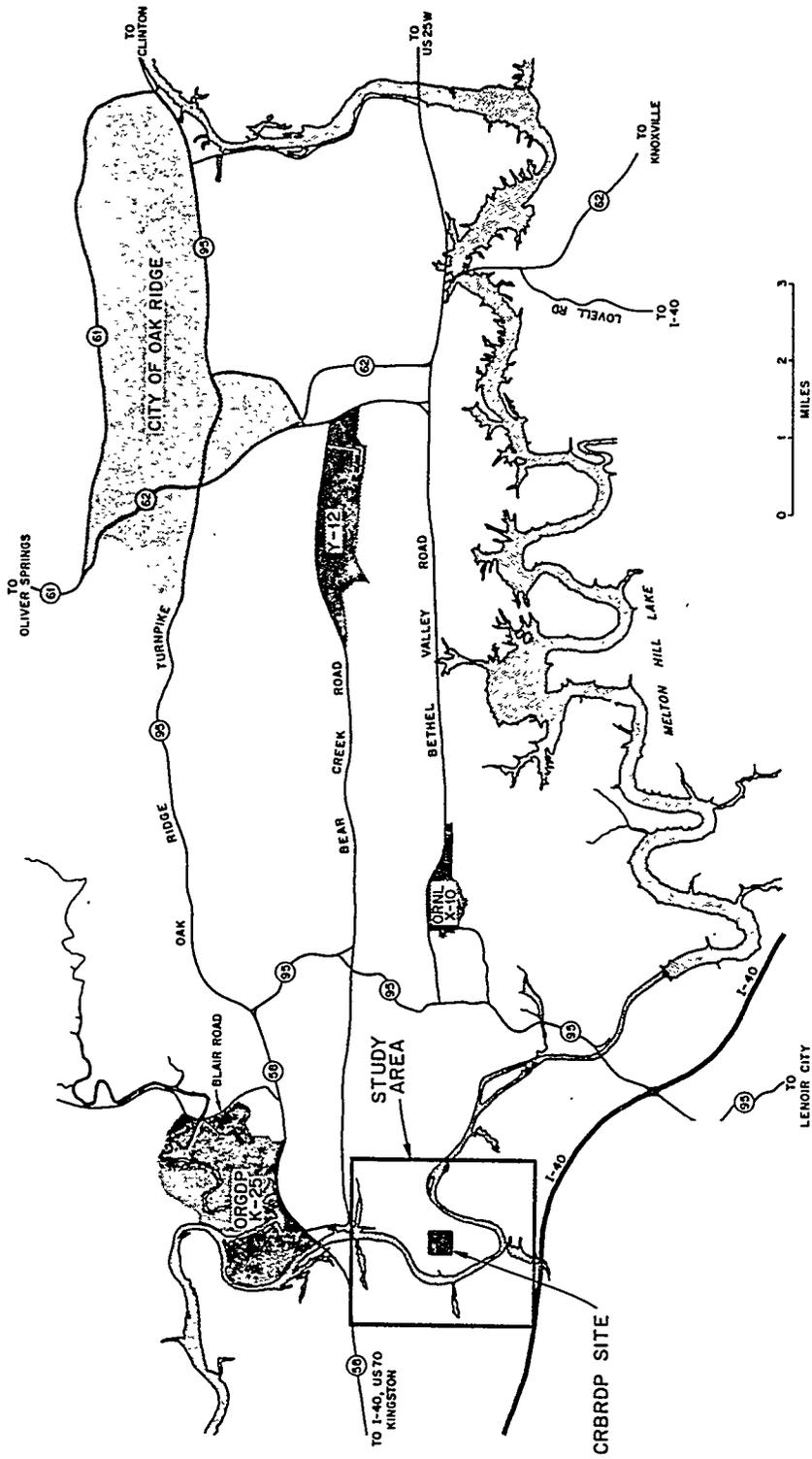


Fig. 1: CRBRDP Study Area

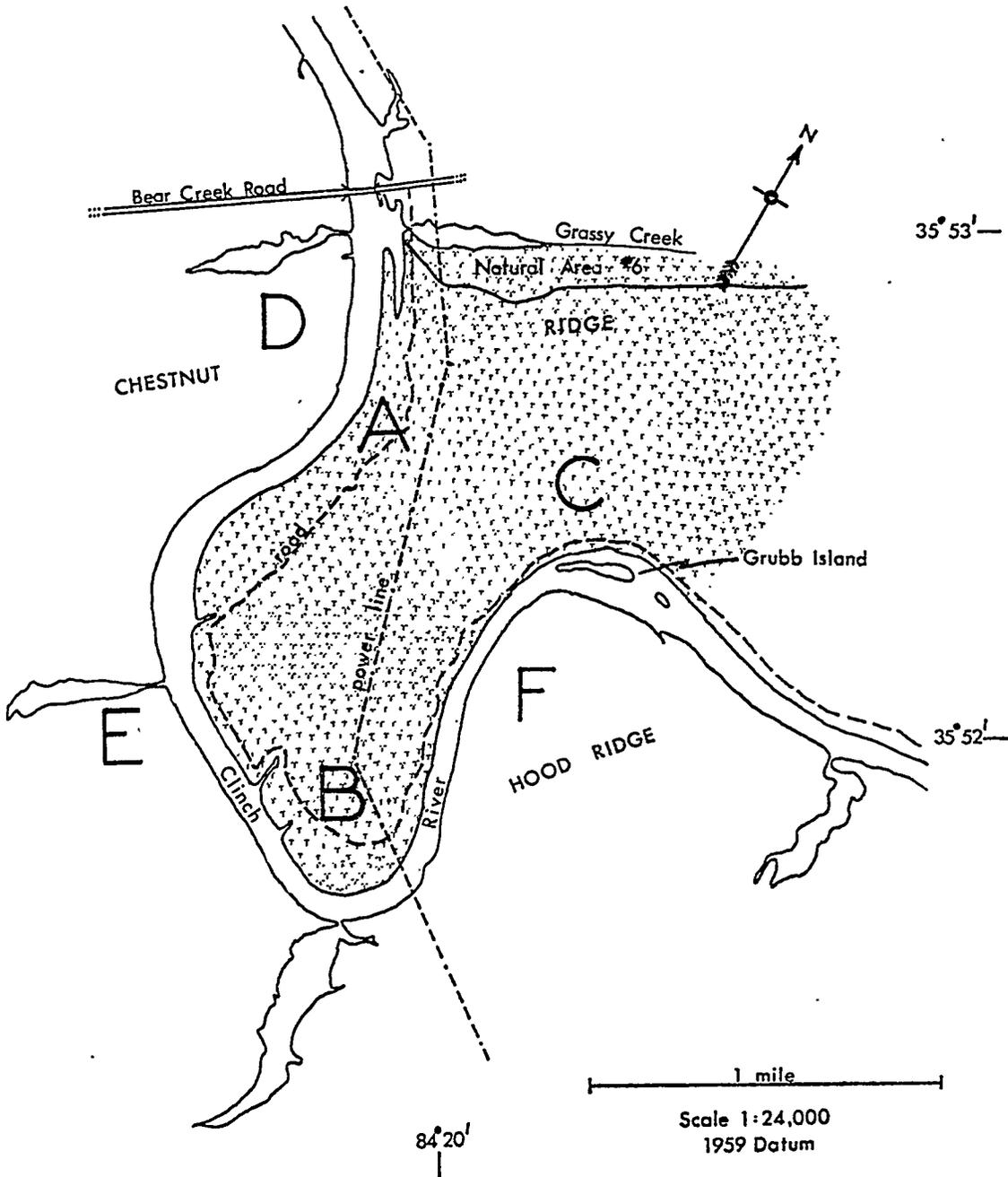


Fig. 2: Study area showing coded pre-1942 farming areas and area of ERDA Oak Ridge Reservation included in the study (stippled area).

Prior to 1942 the CRBRDP area was inhabited by families who operated subsistence type farms. Farmers first settled major stream bottoms then progressed up stream courses toward the ridge tops. The resulting agricultural land-use patterns reflected this trend and the suitability of the land for cultivation. Conversations with residents (See Appendix 1) of the area have furnished information on past land-use practices.

A general land-use history was obtained from interviews with local residents. The shallow soil found on steep slopes limited intensive farming and most of these areas were covered with deciduous forests. Land cultivated on steep slopes was cleared and used until decreased fertility and erosion limited crop yields. These areas were then allowed to revegetate and were often pastured; brush and sage grass were controlled by burning. Fields were occasionally allowed to lie unused for two or three years to increase soil organic matter and then cultivated for one or two years. These practices caused severe erosion and loss of fertility that eventually led to the land's abandonment or conversion to wood lot pasture. It can be assumed that fire was used as an agricultural tool throughout the history of the area. Fields were usually burned in the winter and pastured the following spring and summer. Fires probably spread to forested areas during control burning, resulting in appreciable changes in subsequent vegetation patterns on the burned areas. Little forest management was practiced prior to 1942. Small quantities of timber were cut for the landowners use in building construction, fence rails, and fire wood. Some timber was selectively harvested for railroad ties and some was sold to neighbors.

ANALYSIS OF LAND-USE PATTERNS

Aerial photographs of the area from 1924, 1935, 1942, 1959, 1963, and 1972 were used to prepare land-use diagrams (Appendix 2). Two sets of photographs (1942 and 1963) were not identifiable as to exact date. All photographs were black and white with the earliest four sets being panchromatic and the latest two sets infrared. The land-use diagrams (Figs. 3a to 3f) are at a scale of 1:15,106 and were prepared from an overlay of the 1935 photograph series. Agriculture fields were easy to identify, but differentiation between crop and pasture land proved difficult and the interpretation is highly subjective. Differentiation between deciduous and coniferous forest species was not possible on the photograph set for 1924, 1935, and 1942; thus all forest areas are coded as hardwood forests for these dates. A 1972 forest type map substantiated the pre-1942 forested land as predominately hardwood and aided in forest species identification (unpublished forest type map of CRBRDP site, 1974). Acreages were determined through the use of an acreage dot grid on the land-use diagrams. These acreage determinations are subject to errors of approximately 10%.

Agricultural lands are subdivided as shown in the descriptive legend to the land-use diagrams (Fig. 3g). Cultivated fields are those areas that were currently being cropped at each aerial photograph date and were identified by photograph tone and cropping pattern. Pasture and fallow land were identified by the absence of tillage and cropping patterns, proximity to barns, and other features such as fences, ponds, cattle paths, etc. The ability to differentiate between cultivated and fallow categories varied, depending on the photographic scale, quality, and the time

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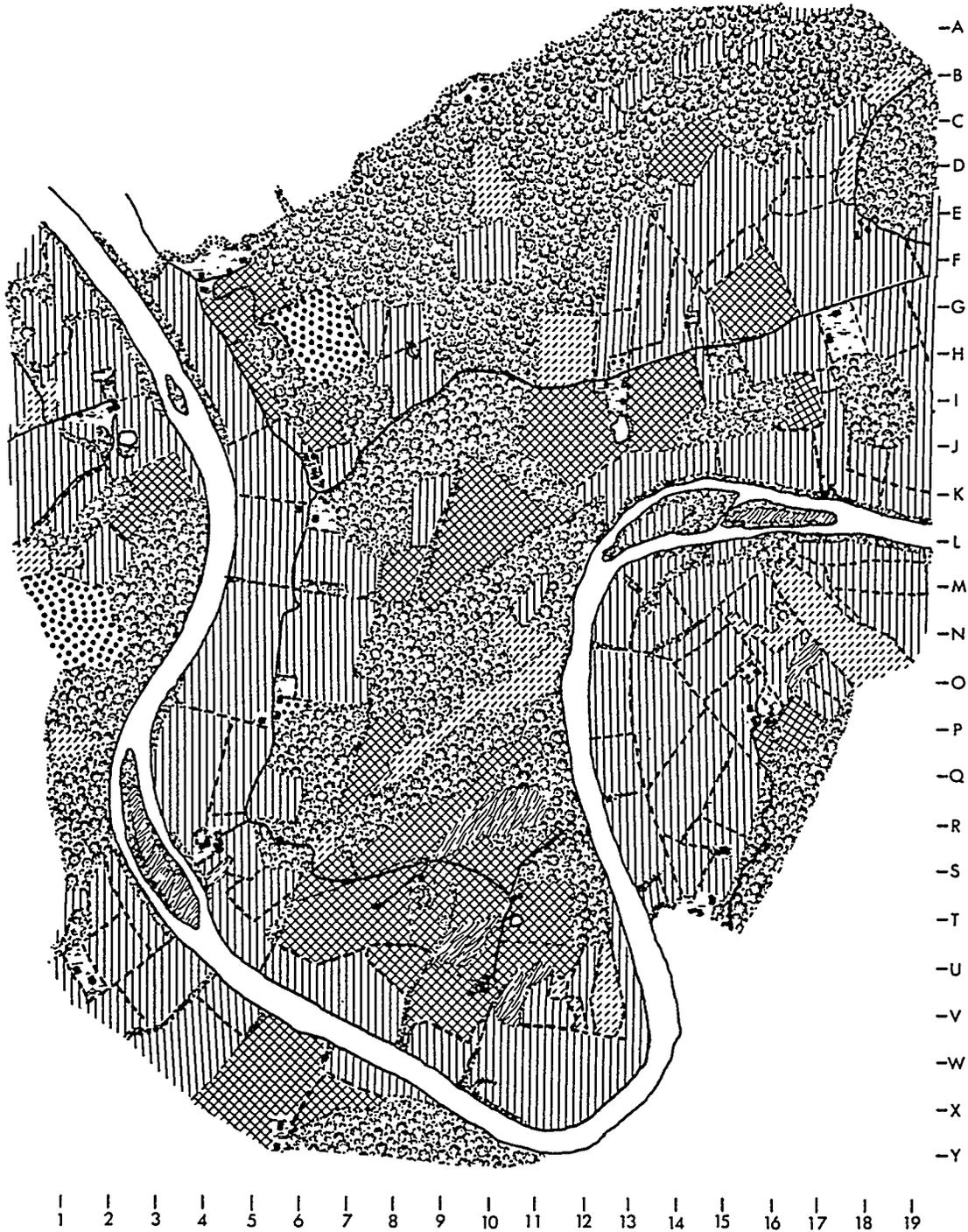


Fig. 3a. 1924 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)

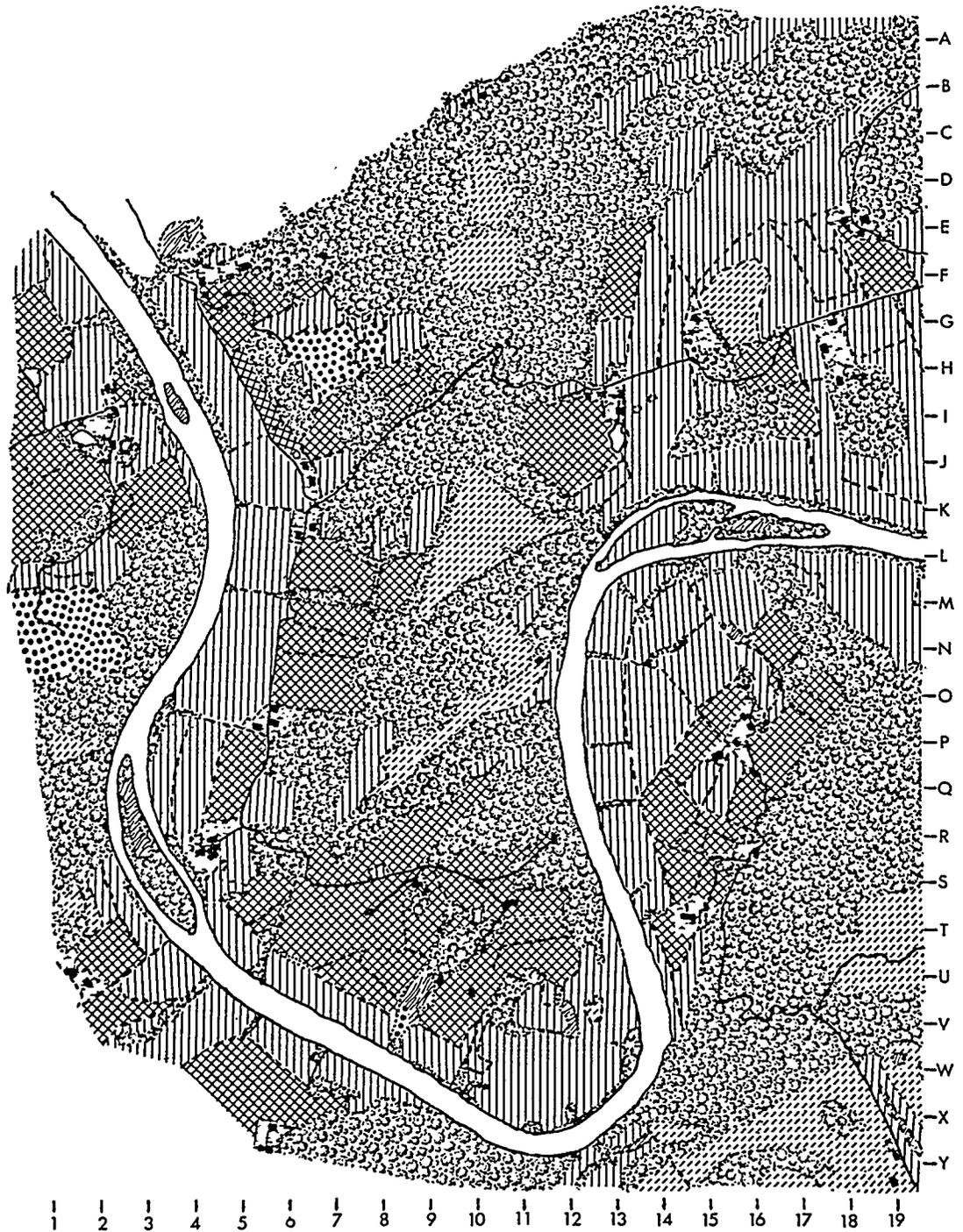


Fig. 3b. 1935 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)

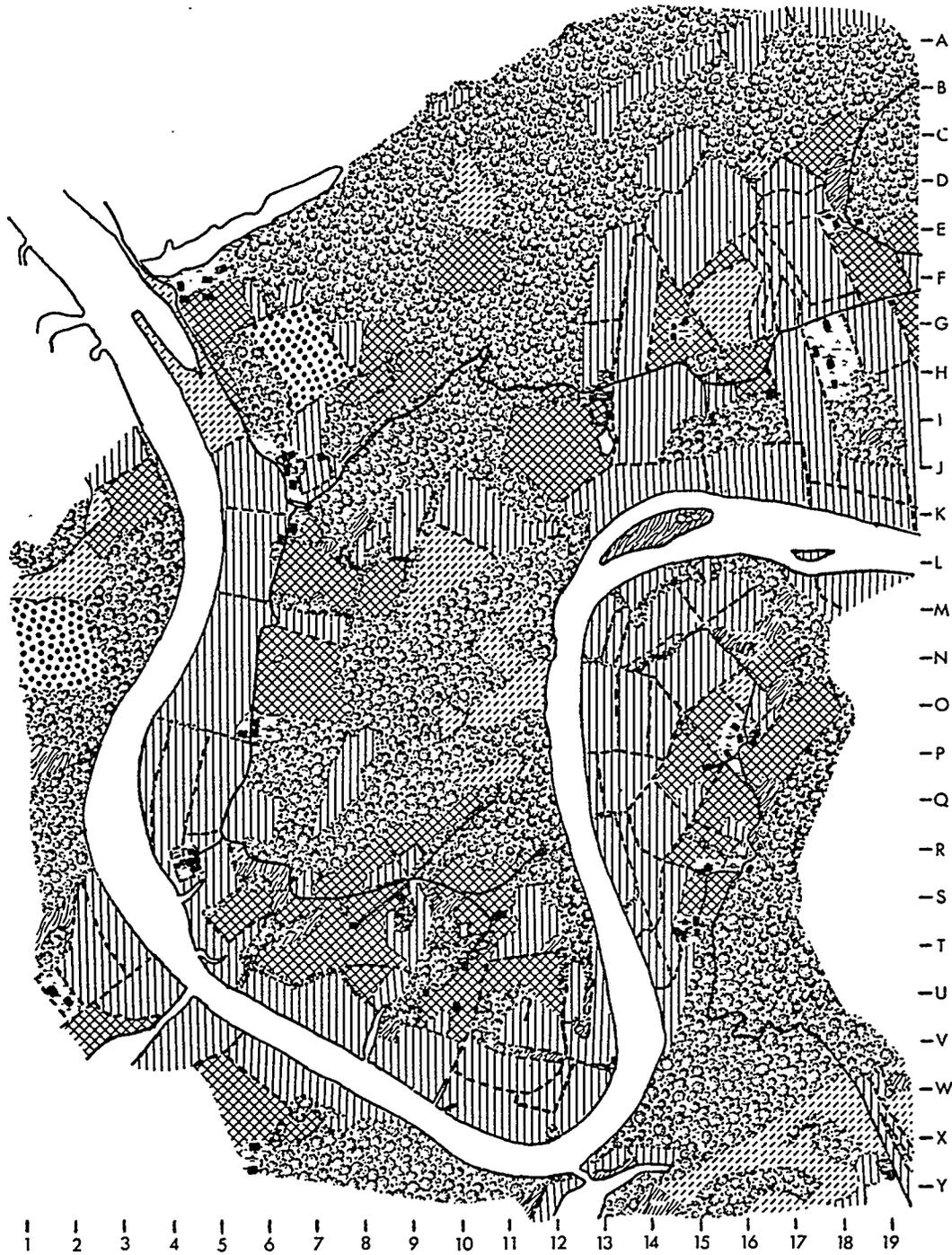


Fig. 3c. 1942 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)

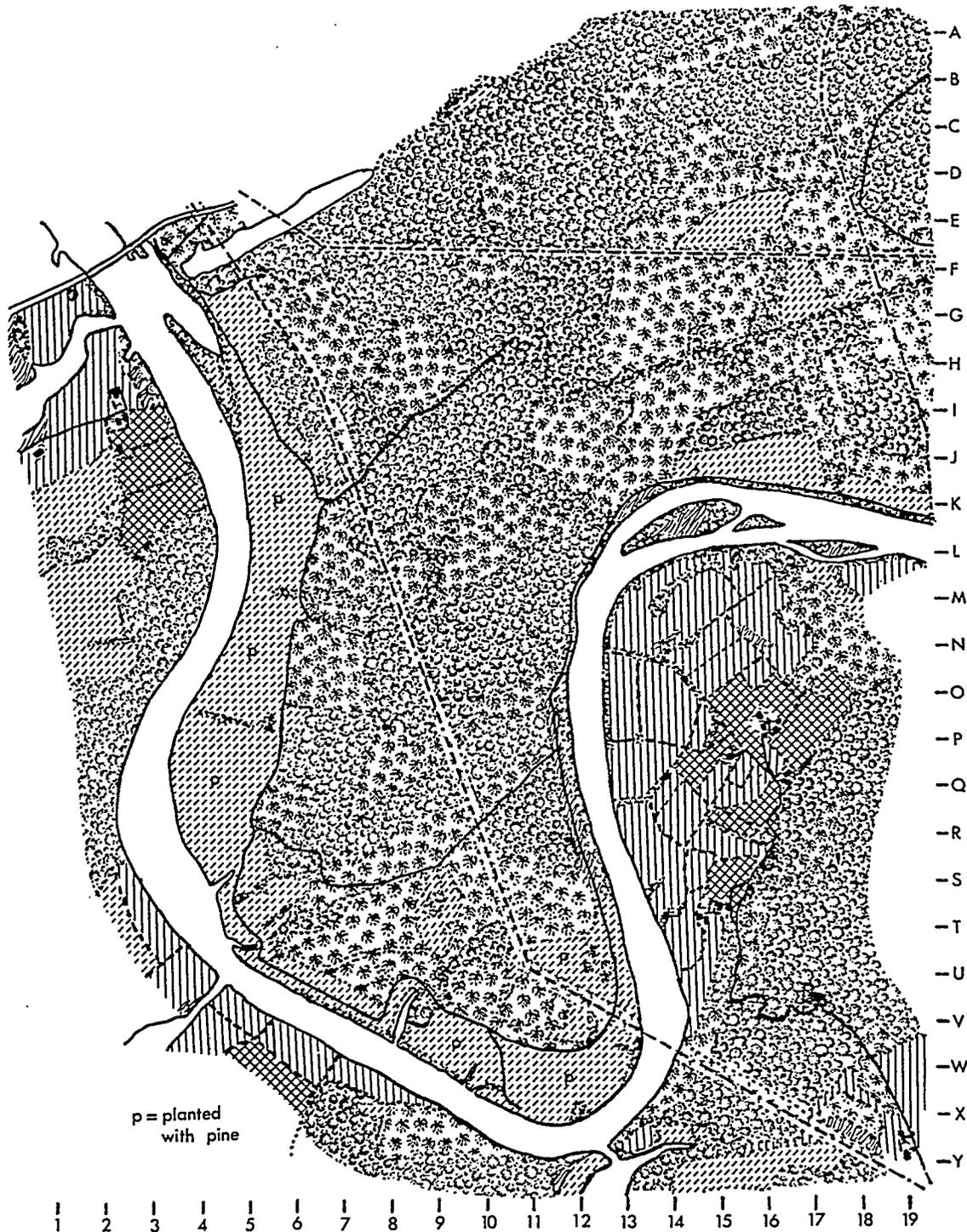


Fig. 3d. 1959 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)



Fig. 3e. 1963 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)

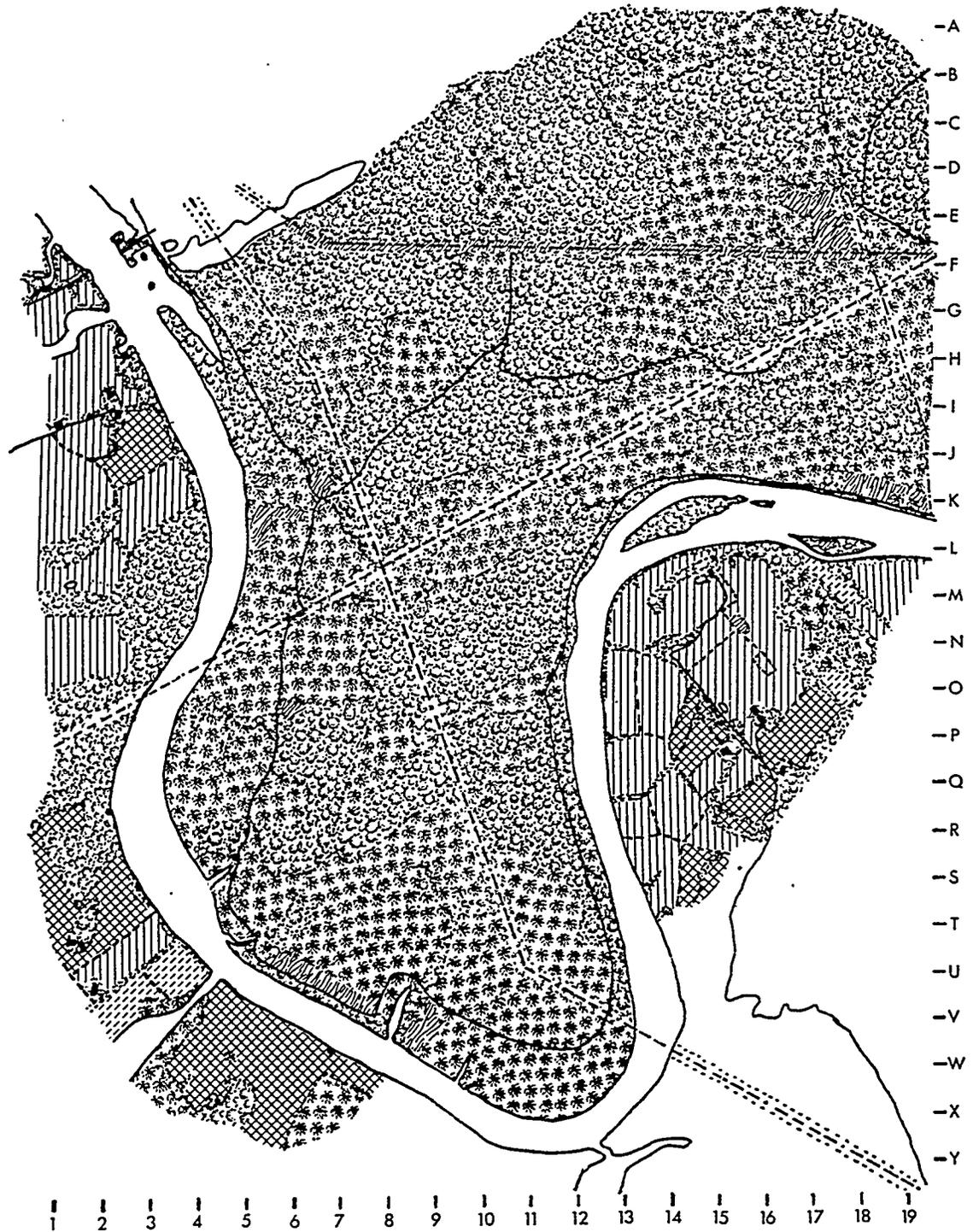


Fig. 3f. 1972 land-use diagram for the CRBRDP site and adjacent farming areas. (See Fig. 3g for descriptive legend.)

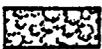
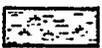
I. Agriculture	
A. Cultivated fields	
B. Pastures and fallow fields	
C. Abandoned fields and overgrown cleared areas	
D. Orchards	
E. Ponds	
II. Forest	
A. Hardwood forest species	
B. Coniferous forest species	
C. Shrub and low vegetation	
D. Forest boundaries	
III. Cultural	
A. Buildings	
B. Buildings grounds (gardens, barn yards, yards, etc.)	
C. Fences and field boundaries	
D. Roads	
E. Power lines	
F. Natural gas pipe line	
IV. Rivers	
	

Fig. 3g. Descriptive legend for land-use diagrams (figs. 3a to 3f).

of year the photograph was taken. Abandoned fields and overgrown cleared areas could be used for pasture, but these areas appeared to contain heavier ground brush and small trees than was desirable for a pasture. Unimproved pasture land would fall into this category. These areas were generally found on the steeper slopes where the thinner soils were easily damaged, requiring a recovery period between cropping. Erosion of these areas was common. Orchard areas were conspicuous by their evenly spaced rows of small trees. Ponds were more apparent on some photographs than others and were identifiable by tone and shape.

There were several general areas of farming prior to 1942 that will be assigned code letters for ease of discussion (Fig. 2). Areas A, B, and C were purchased by the Federal government in 1942 and now are part of the ERDA Oak Ridge Reservation and the CRBRDP site (Figs. 1 and 2). Areas D, E, and F have been farmed continuously since 1924 and will serve as a reference for natural succession patterns that have occurred on the ERDA Oak Ridge Reservation.

A grid coordinate system is used to identify specific locations on the land-use diagrams. Locations will be listed with the letter coordinate first and then the number coordinate (i.e., F-12).

LAND-USE INTERPRETATION

Forests

The present forest vegetation pattern is a result of the original forest as influenced by pre-1942 agriculture practices, natural succession, and forestry practices after 1942. Table 1 lists the tree species present in 1972 and those assumed present in 1924. The species

Table 1: 1972 Forest Species Listing

Common name	Scientific name ^a
American beech	<u>Fagus grandifolia</u> Ehrh.
American chestnut	<u>Castanea dentata</u> (March.) Borkh.
American elm	<u>Ulmus americana</u> L.
Ash	<u>Fraxinus</u> sp.
Basswood	<u>Tilia americana</u> L.
Black cherry	<u>Prunus serotina</u> Ehrh.
Blackgum	<u>Nyssa sylvatica</u> Marsh.
Black walnut	<u>Juglans nigra</u> L.
Boxelder	<u>Acer negundo</u> L.
Buckeye	<u>Aesculus</u> sp.
Chestnut oak	<u>Quercus prinus</u> L.
Dogwood	<u>Cornus florida</u> L.
Hackberry	<u>Celtis occidentalis</u> L.
Hickory	<u>Carya</u> sp.
Magnolia	<u>Magnolia</u> sp.
Northern red oak	<u>Quercus rubra</u> L.
Red elm	<u>Ulmus rubra</u> Muñil.
Red maple	<u>Acer rubrum</u> L.
Sassafras	<u>Sassafras albidum</u> (Nutt.) Nees
Scarlet oak	<u>Quercus coccinea</u> Muenchh.
Southern red oak	<u>Quercus falcata</u> Michx.
Sugar maple	<u>Acer saccharum</u> Marsh.
Sweetgum	<u>Liquidambar styraciflua</u> L.
Sycamore	<u>Plantanus occidentalis</u> L.
White oak	<u>Quercus alba</u> L.
Willow	<u>Salix nigra</u> Marsh.
Yellow poplar	<u>Liriodendron tulipifera</u> L.
Cedar	<u>Juniperus virginiana</u> L.
Loblolly pine ^b	<u>Pinus taeda</u> L.
Shortleaf pine	<u>Pinus echinata</u> Mill.
Virginia pine	<u>Pinus virginiana</u> Mill.
White pine	<u>Pinus strobus</u> L.

^aSource: Harlow, W. M. and Harrar, E. S. 1958. Textbook of dendrology. McGraw-Hill Book Co., Inc., New York.

^bOnly species not assumed present in 1924.

composition of the area has remained relatively stable since 1924 with the exception of loblolly pine and American chestnut. Loblolly pine was planted on old fields as part of an AEC planting program in the early 1950s. American chestnut, destroyed by disease in the 1920s and 1930s, was replaced mainly by chestnut oak.

The acreage occupied by forests in the CRBRDP area changed drastically after 1942. Table 2 lists the acreage of each major land-use category for three dates. From 1924 to 1942 no real change in forested area occurred, but from 1942 to 1972 forested area doubled. If the 1972 acreage is classified into deciduous and coniferous species, each occupied approximately 50% of the forest land. Examination of the pre-1942 photographs indicates that the forests were composed principally of deciduous species. During the period from 1948 to 1954, 411 acres of abandoned field and pasture land were planted with four coniferous species: loblolly pine, white pine, Virginia pine, and shortleaf pine (Fig. 3d). Thus, the 1972 forest acreage is the combination of pre-1940 forest and abandoned agriculture lands being converted to pine plantations. The hardwood stands, for the most part, have existed since before 1924 with some acres gained from natural regeneration of hardwood species along fence lines, the river bank, and around old home sites. Coniferous stands have resulted from natural succession of old fields and cleared land prior to 1942, and to the planting of old fields and pastures in the early 1950s. During the period from 1973 to 1975, ORNL Forest Management harvested 66 acres of pine due to pitch canker (Fusarium lateritium Nees. em. S. & H. f. pini Hept.) infestation and 112 acres of pine attacked by the Southern pine beetle [Dendroctonus frontalis (Zimm.)] on the CRBRDP site.

Table 2: Acreage in Land-Use Categories for 1924,
1942, and 1972

Land-use category	Date		
	1924	1942	1972
Agriculture	775	732	28
Forest	592	606	1196 ^a
Culture	20	33	86
Total	1387	1371	1310

^aDeciduous = 620 acres

Coniferous = 576 acres

Several species associations are present in the area. Cedars are found along old fence lines and on areas once cleared and then abandoned. The cedar-pine forest cover type (cedar with shortleaf pine or Virginia pine) became established on abandoned field areas and covers approximately 165 acres. The natural pine cover type (Virginia pine and/or shortleaf pine with some mixed hardwood present) is found on approximately 120 acres of old field areas. The principal hardwood cover throughout this site consists of white oak, northern red oak, chestnut oak, yellow poplar, hickory, maple, black gum, ash, and beech in various species combinations and occupies approximately 381 acres. The 22 acres bordering the Clinch river are occupied by sycamore, American elm, boxelder, maple, and willow. The remaining area consists of small acreages of various other cover types. The thin strips of red elm trees called "river breaks" were planted along fence rows perpendicular to the river and were used to retard water erosion and catch the rich top soil carried by river flood waters (area F) (Hensley and Moyer, personal communication). The forests on Hood Ridge today are composed of dogwood, white pine, maple, hickory, tulip poplar, red oak, white oak, and sweetgum.

Agriculture

Prior to 1942, farming in areas A, B, and C appeared identical to that practiced in areas D, E, and F. Cultivated crops were generally confined to the level areas bordering the river or at the base of the surrounding hills. In areas A and B the only land continuously cultivated was between the road and the river. Fields on the steeper ground fluctuated between crops and abandonment, for example, the triangular field at L-10 and the square fields at F-10 1/2 and H-11 1/2 on Figs. 3a to 3c.

Other fields were abandoned before 1924 and overgrown with pines, for example the narrow field at P-9, the triangular field at P-1 1/2, and the field at N-17 on Fig. 3. Fields were expanded at F-6, L-8, and D-16 on Figs. 3a to 3c. The areas totally abandoned appeared to be badly eroded. The farm land of area B seems to have eroded prior to 1924, except along the river, and was being used as pasture or allowed to revert to coniferous forest. Area C was relatively flat with one round hill at F-15 to G-15 (Figs. 3a to 3c) where the land was allowed to revert to forest. Other fields in area C sustained cultivation from 1924 to 1942.

Areas D, E, and F showed little change during the 1924 to 1942 period. Area E was badly eroded prior to 1924, especially the fields upslope from the river. The farming area in the lower right corner (Y-18, Fig. 3a) was badly eroded prior to 1924. Conversations with C. W. Hensley and M. W. Moyer furnished the following history. The Hensley and Moyer families grew corn and tobacco on areas F and B; also, lespedeza and alfalfa were cultivated for hay. Tobacco was planted on the best soil, then moved to better soil when soil fertility declined. Corn was not fertilized before 1940 and as soil fertility in corn fields decreased, the land was planted to hay crops or allowed to lie fallow for three to four years before corn was again planted. Grubb Island was cropped or pastured and used to raise hogs at least until 1935, and the orchards of area F grew apples and peaches. The field at X-13 (Fig. 3d) earlier was planted to corn, and today grows potatoes. Indian relics have been found around this field indicating an old Indian camp site. A publication describing the location of other prehistoric Indian sites on the CRBRDP site area has been published by Fielder (1974). Identification of several

early buildings by Mr. C. W. Hensley is as follows: U-10, T-8, and V-10 . . . family home sites; U-9 . . . a house converted to a barn; T-8 1/2 . . . a barn; T-10 1/2 . . . a barn and crib; and T-10 was a garden (Figs. 3a to 3c).

Agriculture ceased after 1942 on the CRBRDP site when the government procured the land. Areas A, B, and C reverted to forests through natural succession and planting of pine, and areas D, E, and F remained relatively unchanged. Area D, a farm owned by the Smith family, has stable land-use patterns on the photographs, except for the area (N-1, Figs. 3a to 3c) that was a peach orchard and vineyard prior to 1942. This area was abandoned and recultivated periodically. Area E was allowed to reforest where past erosion damaged the soil. The fields bordering the river remained in cultivation and pasture. The field at V-1 (Figs. 3a to 3f) has been enlarged and today is used for pasture.

Ponds appear and disappear from figure to figure. Area D has had the largest number of ponds during the period from 1924 to 1972. The two ponds on the Smith farm (J-2) in 1935 were located in sink holes. Today these sink holes collect water after heavy rains, then drain. The ponds in area F are also in sink holes. Recently one sink hole was bulldozed to hold water and the other fills during heavy rain, then drains slowly.

The agricultural use of areas A, B, and C showed a constant cultivation pattern up to 1942. Fields on steep slopes and on poor soil were periodically cultivated, with some fields abandoned to forest succession. Data in Table 2 show a slight decrease in agricultural acreage from 1924 to 1942. Area B was damaged by erosion prior to 1924 and was used for

pasture and allowed to reforest on the steeper slopes. Areas D, E, and F have remained almost unchanged since 1924, with the exception of area E where erosion-damaged areas were removed from cultivation. Orchards present prior to 1942 have been abandoned or cultivated for crops.

Cultural features

Cultural features as outlined in the descriptive legend for land-use diagrams (Fig. 3g) are considered to be those objects constructed by man or changes caused by man. Probably the most notable change appears on Fig. 3c where the water level of the Clinch River increased due to the construction of Watts Bar Dam, thus backing water up tributary stream valleys and inundating two islands (S-3 and I-3, Figs. 3b and 3c). Grubb Island was reduced in size from about 24 acres in 1924 to 7 acres in 1972. A new island was formed at the L-17 location (Fig. 3c). Other cultural changes prior to 1942 consist of a road relocation (I-9 to H-13, Figs. 3a and 3b) and the addition and removal of some buildings. There were eight major homesites on the proposed CRBRDP site prior to 1942. Building changes were hard to detect from photograph set to photograph set because of forest cover and the small photographic scale.

Cultural changes after 1942 consist of power line rights-of-way, a gas line, and road construction. Power line construction was in response to electrical requirements at the Oak Ridge Gaseous Diffusion Plant. The power line from E-6 to F-19 on Fig. 3e was abandoned prior to 1972. A total of approximately 80 acres of power line rights-of-way crossed the area in 1972. The gas line runs from K-19 to A-17 on Figs. 3d to 3f. After 1942 the previously existing road was extended around the perimeter of the area and named the Grubb Island patrol road. Old roads have been

marginally maintained in recent years and new ones constructed (mainly dirt or gravel) for use by power line maintenance crews and forest management personnel.

NATURAL AREA

An area of undisturbed forest whose unique species composition qualified it as a natural area is located within the study site. The boundaries of the natural area are shown on Fig. 2. The forest community along Grassy Creek, the northern most boundary of the study area, contains species and communities which are very rare locally and are typical of Braun's generalized mixed mesophytic association found in the Appalachian plateau. On the lower slope basswood, sugar maple, and buckeye are dominant with magnolias, oaks, elm, cherry, and tulip poplar as co-dominants. The shrub layer is very dense and is composed mainly of paw-paw [Asimina triloba (L.) Dunal] and sugar maple seedlings. Herbaceous plants include little brown jug (Asarum canadense L.), blue cohosh [Caulophyllum thalictroides (L.) Michx.], bugbane [Cimicifuga racemosa (L.) Nutt.], doll's eyes (Actaea pachypoda Ell.), and walking fern (Asplenium rhizophyllum L.). Other ground cover species include several species of ferns, jack-in-the-pulpit [Arisaema triphyllum (L.) Schott], rue anemone (Anemone quinquefolia L.), grape (Vitis sp.), hepatica [Hepatica americana (DC.) Ker.], and Solomon's seal [Polygonatum biflorum (Walt.) Ell.].

Further up the slope the overstory changes to sugar maple with a few hickories and oaks. There is an occasional beech, sweet gum, buckeye, and ironwood [Ostrya virginia (Mill.) K. Koch]. The shrub layer is composed mainly of sugar maple seedlings but also contains spice bush

[Lindera benzoin (L.) Blume], strawberry bush (Euonymus americanus L.), hydrangea (Hydrangea arborescens L.), and buckeye seedlings. Ground cover in this area is composed of bugbane, foam flower (Tiarella cordifolia L.), and a different little brown jug [Hexastylis arifolia (Michx.) Small].

The upper slope is yet another mixed mesophytic association with beech and sugar maple as codominants. In this drier zone, cedars, hickories, tulip poplar, flowering dogwood, and sassafras also occur. The shrub layer is composed primarily of overstory tree seedlings. Extensive patches of parasitic beech-drops [Epifagus virginiana (L.) Bart.] occur under beech trees but little other ground cover is present, consisting mainly of scattered Christmas ferns [Polystichum acrostichoides (Michx.) Schott] and Virginia creeper [Parthenocissus quinquefolia (L.) Planch]. This natural area is further described by Kitchings and Mann (1976).

CONCLUSION

The CRBRDP site land-use history provides an interesting contrast between areas where agriculture has proceeded uninterrupted since before 1924 (areas D, E, and F) and areas where farm land was abandoned in 1942 and has been allowed to revert to forest (areas A, B, and C). Farming land-use patterns have not drastically changed since 1924 outside the Oak Ridge Reservation study area except on those areas damaged by erosion. The forest species on abandoned farm land have followed the natural successional trends common to this region of the Southeast from 1942 to 1972. Some areas also have been modified by the introduction of pine plantations.

The land-use history of the CRBRDP site indicates natural plant succession on marginal agricultural fields has been slow, and that management practices (i.e., pine planting) have increased the economic worth of abandoned farm lands in a relatively short time. Looking at value in a different context, the artificially produced pine communities are not as valuable as plant communities derived from natural succession in supporting a diverse natural wildlife population. Thus, future perturbations of the landscape will involve decisions concerning the use of management practices to reclaim damaged soil and vegetation in a short time, or allowing natural succession to slowly heal the impact. These decisions would be based on the necessity for future economic gain from the land and justification of the concomitant input of initial management effort. These decisions can be framed against the land-use plan for the ERDA Oak Ridge Reservation (ERDA, 1975).

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Kitchings, T., and L. K. Mann. 1976. A description of the terrestrial ecology of the Oak Ridge Environmental Research Park. ORNL-TM-5073. 44 pp.

Energy Research and Development Administration. 1975. Oak Ridge Reservation Land-Use Plan. Oak Ridge Operations. ORO-748. August. 47 pp.

Appendix 1: Persons contacted for land-use history assistance.

Name	Address	Address map coordinates
Mr. E. Conrad, Jr.	Rt. 2, Lenoir City, TN	T-15
Mr. C. W. Hensley	Rt. 2, Lenoir City, TN	V-17
Mr. W. M. Moyer	Rt. 2, Lenoir City, TN	P-16
Mr. Rupert Smith	Rt. 3, Box 148, Kingston, TN	H-3
Mr. J. H. Woodard	Rt. 2, Lenoir City, TN	Y-19

Appendix 2: Further identification of aerial photographs.

Year	Photographs taken by	Date
1924	(Information not available)	
1935	Bowman-Park	25 May 1935
1942	(Information not available)	
1959	195TRS Air National Guard	13 March 1959
1963	Kentucky Air National Guard	
1972	Environmental Systems, Alcoa, TN	

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| 55. N.T. Edwards | 93. H.H. Shugart |
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