Relationships Between the Expansion of Agriculture and the Reduction of Natural Riparian Habitat in the Missouri River Floodplain of Northeast Montana, 1938-1982

Alexander R. Hoar and Michael J. Erwin

Abstract.--The floodplain composition is described for four points in time over a 45-year period. Broad changes in the area, density, and percent of the floodplain represented by agricultural and other developed land and three general riparian cover types are documented. Evidence is provided of the patterns and rates at which riparian cover types were lost and gained, including the conversion to agriculture and other developed types.

INTRODUCTION

Human use of the floodplain zone has often resulted in the removal of the natural riparian vegetation. This reduction has been complete and permanent in some areas of the arid west (Ohmart et al. 1977). In the Sacramento River Valley of California, the riparian forests have been reduced from an estimated 775,000 acres in the 1850's to less than 13,000 acres in 1980 (Haugen 1980). Approximately 90 percent of the cottonwood forests along the lower Colorado River was eliminated between 1600 and 1967, the major decline occurring between 1940 and 1967. Similar declines occurred on the Rio Grand River in New Mexico and Texas (Ohmart et al. 1977) and on the South Platte River in Colorado.

Why these changes have occurred is sometimes confounding, at other times straightforward. Ohmart et al. (1977) concluded that the demise of cottonwood forests on the lower Colorado River was directly related to changes in that system caused by upstream dams. Taylor (1982) studied a series of aerial photographs taken in 1940, 1954, and 1963 of a small mountain stream in California from which water had been diverted since 1940. He found that the riparian zone declined steadily throughout the 24-year period, failing to reach a state of equilibrium. He attributed the observed changes to the reduction of streambank recharge resulting from the annual dewatering of the stream. This in turn stressed the vegetation in the riparian zone. Johnson et al. (1976) found that tree growth below dams on the Missouri River became less vigorous following control of river flows and flooding. Other contributing factors were reduction of groundwater recharge, soil moisture, soil nutrient enrichment, and seedbed availability.

The most permanent destruction of riparian habitat on the middle and upper portions of the Missouri River has been caused by federal water development projects. Between Gavins Point, South Dakota and the junction of the Madison, Gallatin, and Jefferson Rivers in Montana, 838 of the 1510 river miles (or 55 percent) must now be classified as reservoir rather than as free-flowing river (MTDNRC 1979; USCOE 1977 and 1981c). A compilation of land-cover types flooded by six dams (Fort Peck Dam not included) in this river reach provides evidence that 27 percent (219,800 acres) of the total pool areas formerly consisted of trees, shrubs, and marsh; 35 percent (293,800) was grassland; 19 percent (158,400 acres) was agriculture; 18 percent (152,000 acres) was river channel; while less than one percent (5000 acres) consisted of forb and upland cover types. Thus, approximately 62 percent of the area flooded by six dams on this reach was occupied by woodland/grassland vegetation (USCOE 1981a and b); USFWS 1946, 1948, 1950, and 1952).

Little is known about how much riparian vegetation has existed in those areas of the upper and middle Missouri River floodplain that have not been inundated by reservoirs. The largest concentration of remnant gallery forests and other riparian vegetation types on the Missouri River upstream from Gavins Point, South Dakota is believed to exist now along 190 river miles in northeast Montana and northwest North Dakota. This paper documents how much riparian cover, agriculture, and other development existed in this area at different times between 1938 and 1982.
Broad changes in the floodplain composition are documented. Some general patterns and causes of change are identified and put in perspective.

**STUDY AREA**

The study area included the forests and other riparian vegetation along a 186-mile reach of the Missouri River in northeast Montana. In addition to the riparian vegetation, the study area encompassed the remainder of the "historic" floodplain and the Missouri River. The terrestrial acreage of the floodplain varied between 180,134 and 185,526 acres, depending upon the water level of the river at the time the aerial photographs were taken.

The western boundary of the study area was Fort Peck Dam. The eastern boundary was near the confluence of the Yellowstone River in North Dakota. Specifically, it was the north-south section line located in T152N, R104W that falls between Sections 8 and 9; 16 and 17; 20 and 21; and 28 and 29. Because the north and south boundaries were the extreme outer limits of the Missouri River "historic" floodplain, all of the potential riparian zone was contained therein.

There were five cities either within or near the study area, none of which exceeded a population of 10,000. Most had less than 2500 residents. Farming and grazing were the main land-uses within the area during the period studied.

**METHODS AND MATERIALS**

Included below are general descriptions of the interpretative classification system, the aerial photography and its interpretation, field verification, map production, and the digitizing and data processing systems used during this project.

**Land-Cover Classification System**

A land-cover classification was used that included general surface features that could be reliably identified on new black and white aerial photographs produced from old negative film. The system was designed to be compatible with classifications already in existence for wetlands (Cowardin et al. 1979) and riparian vegetation (Bachelor et al. 1982), but also to include features developed by humans such as agriculture, roads, residential areas, and so on.

Understory vegetation was not part of the classification because it could not be identified on older photographs. Surface cover was classified in terms of the tallest visible layer of homogeneous areas. The interpretation process was standardized so that each surface feature was interpreted in a particular order on each photo and minimum recognized sizes were established for each type. These standards are presented in Table 1.

**Table 1.--Standards for interpretation of surface features on the Missouri River floodplain.**

<table>
<thead>
<tr>
<th>Surface Feature</th>
<th>Order of Photo Interpretation</th>
<th>Minimum Polygon Size (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain</td>
<td>1</td>
<td>N.A.</td>
</tr>
<tr>
<td>Urban/Ranchyard</td>
<td>2</td>
<td>0.25</td>
</tr>
<tr>
<td>Deciduous Woodland</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>Shrub-Scrub</td>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>Herbaceous</td>
<td>5</td>
<td>0.25</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6</td>
<td>10.00</td>
</tr>
<tr>
<td>Rights-of-way</td>
<td>7</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

**Floodplain**

The first order feature was the floodplain. It was defined as a relatively flat expanse of land bordering the Missouri River (but not including the river) and extending north and south to the extreme limits of the "historic" floodplain. Contained within the floodplain were all oxbows, historic meander lines, and other telltale signs of riverine activity. So that all of the land would be classified, islands were considered to be part of the floodplain. The floodplain boundary was largely based on natural rather than man-made features such as canals, railways, or highways.

Portions of the boundary between the upland and the floodplain, and many of the original terrace contours, were indiscernible on the 1982 film (due to recent agricultural grading of upper terraces). These boundaries were clearest on the 1938 black and white photography. Thus, the floodplain boundary delineated on the 1938 photography served as the boundary within which the photography of all subsequent eras was interpreted. The boundary was arbitrarily drawn across tributary rivers or streams as they entered the Missouri River floodplain. This boundary defined the limits of the study area.

**Urban/Ranchyard**

The Urban/Ranchyard category included rural, urban, residential, commercial, and multiple-use development. Some mature trees and "L"-shaped windbreaks associated with farm and ranch sites were sometimes included in this category. In such cases, the delineation of the "yard" was somewhat subjective, depending upon the various clues visible to the interpreter.

**Deciduous Woodland**

Riparian deciduous woodlands were categorized by percent-canopy closure. Stands with less than ten percent closure were incorporated into other categories; e.g., herbaceous or shrub-scrub. All stands with a canopy closure equal to or greater than ten percent were included in the woodland type. This type encompassed extensive woodland tracts, farm woodlots, stands in and between agricultural fields, and linear windbreaks not asso-
Rights-of-way for grazing, agriculture, and other cover types, such as the herbaceous, pivot irrigated, and non-irrigated, were included in this feature. Where the canopy closure of shrubs did not fall within the bounds of these criteria, the area was classified according to the dominant vegetation type; e.g., deciduous woodland or herbaceous.

Some dominant shrub species were willow (Salix spp.), dogwood (Cornus stolonifera), green ash (Fraxinus pennsylvanica) and cottonwood (Populus spp.) saplings, western wild rose (Rosa woodsii), and snowberry (Symphoricarpos occidentalis). Other common shrub species included Russian olive (Elaegnus angustifolia), buffaloberry (Shepherdia argentea), and choke-cherry (Prunus virgintana).

Herbaceous

The riparian herbaceous category consisted of areas with a woodland-canopy cover of less than ten percent and a shrub cover of less than ten percent. Small, non-shrub clearings within a woodland or large areas of low vegetation outside the woodland boundary with no visible evidence of farming such as furrows or hay piles, were included within the herbaceous category. Grazing was a common land-use in areas classified as this type. This category included herbs, grasses, young willows and cottonwood seedlings, wildrose, and snowberry, as well as wetland species such as cattail (Typha latifolia). Many emergent wetlands were included within this cover type as well as permanent water in oxbows, natural and man-made ponds, channels that had been dammed or naturally arrested, depressions, or excavations. This lumping was necessary because these features could not be reliably interpreted on the 1938-era photographs; thus reliable comparisons could not have been made with successive eras.

Agriculture

Agriculture was defined as any land visibly disturbed for the purpose of producing or harvesting crops. Three types of agriculture were included in this feature: flood-irrigated, center-pivot irrigated, and non-irrigated. Pastureland for grazing was difficult to identify on black and white print. It was not considered as a separate feature, but was incorporated into this and other cover types, such as the herbaceous, shrub-scrub, and deciduous woodland types.

Rights-of-way

Rights-of-way included areas developed as transportation and utility corridors. This type typically consisted of the Burlington Northern Railway, and transmission, pipeline, and Interstate Highway corridors. Miscellaneous paved and gravel roads were not included here, but were included with whatever cover type was adjacent to them.

Aerial Photography

Coverage

Complete physical coverage for the 1938, 1956, 1974, and 1982 time periods was acquired from several sources. The photographic products for the three older eras consisted of 9x9 inch, black and white, contact prints. The 1982 coverage was Kodak 2443 color infrared (CIR) film. The scale of all aerial photography was 1:24,000. These years were chosen because 1) photographic coverage for the entire area was available; 2) the Fort Peck Dam was completed in 1938, and 3) the years span a reasonable time period within which change could be assessed.

Adequacy

The black and white aerial photography used for this project was the best available. The resolving quality was generally adequate for feature identification, but considerable time was required for "keying-out" the textural, depth, and height characteristics of the surface-cover types. Poor exposure control of the black and white photography reduced the contrast on some frames, especially those of 1938 vintage. In some cases, gray tones were not consistent for the same feature on adjacent frames and there was lack of full stereo coverage. Quality of the negatives improved substantially for eras after 1938.

The 1982 CIR film had excellent resolving and exposure qualities, but no stereo coverage. Overall, the 1982 film presented distinct contrasts between features, very sharp resolution, and appropriate mid-day shadows, which assisted in making height determinations. However, classifying dense stands of cottonwood trees was difficult if they approached the height limits of the shrub-scrub and woodland categories.

Data Processing

Photointerpretation and digitizing was done by the U.S. Fish and Wildlife Service in Fort Collins, Colorado. The process of interpreting the aerial photography was divided into several phases: field orientation, interpretation, overlay production, field verification, and quality control.

Field orientation was conducted during late July of 1981. Reference points for most features in the classification system were located on the ground, photographed, and marked on aerial photographs. These reference points provided a standard for interpretation throughout the project.
Aerial photos covering 100 percent of the floodplain were interpreted using an eight-power lens and the naked eye. Delineations were made on acetate overlays. Quality control and interpretative consistency was achieved during this phase by specialists each regularly examining the other's work.

Mylar overlays for twenty-eight 1:24000 scale, USGS topographic maps were produced by standard zoom-transfer processes. Ground truthing of these final interpretative products for the 1974 and 1982 eras was accomplished during a low-altitude flight over the entire length of the study area; during a roadside survey along a 23-mile length of secondary highway; and during visits to preselected sites.

Mylar overlays for each era were digitized using the WAMS (Wetland Analytical Mapping System) digitizing system. Data analyses were performed using a geographic information system, WINDOW, developed by the U.S. Fish and Wildlife Service. A Control Data Cyber 750 mainframe computer was used for data processing.

RESULTS AND OBSERVATIONS

How much riparian vegetation existed in northeast Montana along the Missouri River during 1938, 1956, 1974 and 1982 was investigated and is reported. Broad changes in the composition of the floodplain are documented. General patterns of change are described. Causes of change are discussed and their relative effects on floodplain composition are put in perspective. Riparian cover broadly included three cover types: the deciduous woodland (or forest), shrub-scrub, and herbaceous cover types. All areas of visible agricultural disturbance and hard construction were collectively referred to as developed cover or land. Developed cover included the agriculture, rights-of-way, and urban/ranchyard cover types. Developed cover was most often void of riparian vegetation.

The composition of the floodplain was not stagnant, but was dynamic throughout the period studied. Since 100 percent of the study area was inventoried for all four eras, no statistical analyses were performed. Differences were assumed to be real. Composition was described in terms of several measures. These were the area, density, and percent of the floodplain represented by each cover type. Broad changes were documented in terms of the net gain or loss of a cover type between eras.

General patterns are described based on these changes. These patterns and the magnitude of the changes were directly influenced by events caused by both humans and nature. These events included, but were not limited to, the conversion of riparian vegetation to cultivated farmland; the erosion of the shoreline by the Missouri River; the reduction of forests and shrubs by mechanical and chemical means as well as by burning; the abandonment of developed land and subsequent regrowth of riparian cover; the conversion of developed land to pasture-land; natural succession; and growth. (Due to the height categories of the shrub-scrub and woodland types in the classification, plus inability to differentiate between the photographic signature of the herbaceous type and the seedling stage of woody species, homogeneous areas dominated by woody species could have been classified as any riparian type depending on whether the area was in a seedling, sapling, or mature stage of growth.) The effect of each event was not determined, but the results of cumulative effects were summarized in terms of broad categories of change.

Floodplain Composition

Several measures are presented in Table 2 for each cover type that together describe the floodplain composition in each era.

<table>
<thead>
<tr>
<th>Kinds of measurements</th>
<th>Developed Land</th>
<th>Riparian Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
<td>Rights of way</td>
</tr>
<tr>
<td>Percent of the floodplain</td>
<td>1938</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>1956</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>1974</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>55</td>
</tr>
<tr>
<td>Density (a./sq.mi.)</td>
<td>1938</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>1956</td>
<td>301</td>
</tr>
<tr>
<td></td>
<td>1974</td>
<td>325</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>349</td>
</tr>
<tr>
<td>Acres per cover type</td>
<td>1938</td>
<td>43,592</td>
</tr>
<tr>
<td></td>
<td>1956</td>
<td>84,809</td>
</tr>
<tr>
<td></td>
<td>1974</td>
<td>94,263</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>100,475</td>
</tr>
</tbody>
</table>
In 1938, the riparian herbaceous type occupied more than half (52 percent) of the floodplain. It was the dominant cover type. Agriculture, a development type, occupied approximately a quarter (24 percent) of the floodplain. It was the second-most dominant cover type. The shrub-scrub type occupied a larger percentage (14 percent) of the floodplain than did woodlands (10 percent). Urban/ranchyards and rights-of-way occupied the smallest percentages of the floodplain (0.6 and 0.2 percent, respectively).

In 1982, agriculture occupied over half (52 percent) of the floodplain. At this time, it was the dominant cover type. The herbaceous type occupied approximately a quarter (26 percent) of the floodplain; the shrub-scrub type occupied only 5 percent. Urban/ranchyards and rights-of-way occupied small percentages of the floodplain. These were 0.8 and 0.5 percent, respectively. This order of cover dominance was set before 1956.

General Changes

Between 1938 and 1982, the total acreage of riparian cover declined by 58,910 acres (from 140,215 to 81,305 acres), while developed cover increased by 57,789 acres (from 45,199 to 102,988 acres). However, most of the decline of riparian cover occurred before 1956, by which time it had been reduced by 47,164 acres (from 140,215 acres to 93,051 acres). During this same time span, (1938-1956) developed cover increased by 41,884 acres (from 45,199 to 87,083 acres). The average annual decline of riparian cover between 1938 and 1956, was estimated to have been 2482 acres per year. The average annual increase of developed land was estimated to have been 2204 acres per year during the same period. The changes that occurred between 1938 and 1956 were the largest of the study period.

A list of cover types, ordered by percent of net change in acreage, would have agriculture in the number one position. Agriculture increased 130 percent over the entire study period; rights-of-way increased 120 percent; urban/ranchyards increased 33 percent; forests increased 26 percent; herbaceous cover decreased 50 percent; and the shrub-scrub type decreased 61 percent.

Of those cover types that increased, only agriculture increased throughout the study period. The maximum acreages for rights-of-way, urban/ranchyards, and woodlands appear to have occurred during the mid-1970's; by 1982, acreages for the latter two types were less than they had been since 1938. The rights-of-way category changed little between 1974 and 1982.

Observed changes in areal extent were not uniform for each type, nor were they similar between types, but a pattern was observed. Data presented in Table 2 provides evidence that the herbaceous type declined until 1974 and then increased; shrub-scrub declined throughout the study period; and forests increased until 1974 and then declined. The largest decrease of herbaceous acreage took place between 1938 and 1956, when a net loss of 54 percent took place (52,203 acres; from 96,804 to 44,601 acres). The largest decline in the shrub-scrub type occurred between 1956 and 1974, when a net loss of 37 percent took place (7485 acres; from 20,003 to 12,548 acres). Between 1974 and 1982, 37 percent (13,893 acres; from 37,082 to 23,189 acres) of forests were eliminated. Forest acreages declined more than any other cover type between 1974 and 1982. Also during this period, the herbaceous acreage increased 9430 acres (from 38,849 to 48,279 acres). These patterns of riparian decline appear to be the result of the cumulative effects of several broad categories of change. The influence of each category is not detectable from the data presented in Table 2. Further analyses were necessary in order to place in perspective the patterns and causes of the riparian decline.

Causes of General Changes

The observed changes in the riparian types noted above resulted from three broad categories of loss or gain. These categories of change were: 1) loss to development, 2) loss to the River, 3) and loss (or gain) due to other causes.

An areal loss and a gain occurred whenever the classification of a parcel changed from one era to the next. For example, if woodland was converted to cropland, a "loss" would have occurred in the amount of woodland and a "gain" would have occurred in the amount of cropland. But, when a woodland was cleared to create new pasture, a loss of woodland as well as a gain of herbaceous area would have occurred. And, if a stand of sappling cottonwoods had grown above the height category for the shrub-scrub type, a loss would have occurred for this type while a gain would have occurred in the amount of woodlands. Interactions such as these between cover types were not investigated. But, evidence is provided that adds another dimension to the broad patterns of change described above. Specifically, data are provided on the relative influence of each category of change on each riparian type.

The amount of loss (or gain) attributable to each category was measured for each riparian type during each time period. These amounts were then divided by the number of years in the period. Chronologically, these were 19, 18, and 8 years. These rates are presented in Table 3 in terms of acres per year. Estimating loss (and gain) as a rate, rather than as the sum of change, facilitated comparisons of change between periods of unequal length.

In order to simplify calculating the rates at which individual riparian types were lost, all developed types were combined. Between 1938 and 1982, approximately 97.5 percent (85,894 acres) of all riparian cover converted to a developed type was converted to agriculture, 1.7 percent (1498 acres) was converted to urban/ranchyards, and 0.8 percent (698 acres) was converted to rights-of-
The rate of change of loss accounted for only seven percent of the total riparian losses during the entire period. However, some of each riparian type was developed during every period, but substantially more of the herbaceous type was lost to development than any other type. Development accounted for 65, 64, and 79 percent (chronologically) of all herbaceous losses. The rate at which each riparian type was lost to development changed over time. The rate of loss declined for both the herbaceous and shrub-scrub types, while it increased for the forest type. It appears that as the amount of herbaceous and shrub area declined, more emphasis may have been placed on converting woodlands to agriculture.

"Loss to the river" included the loss of riparian cover from the shores of islands as well as the mainland, due to bank erosion by water. It also included loss of riparian cover from an area downstream from Fort Peck Dam, where earth was removed and used to construct the Dam. Since then this excavated area has filled with water. Floods occurred during the study period that influenced the amount of riparian cover lost to the river. A total of 12,238 acres of riparian cover was lost to the river during the study period. This type of loss accounted for only seven percent of the total riparian losses during the entire period. Loss of each cover type was lost to the river than was lost to any other category during the same period.

"Loss (or gain) to other causes" accounted for all other effects of reduction and growth of riparian vegetation caused by humans and nature that resulted in the conversion of one type into another. A gain occurred whenever developed land reverted to riparian cover (28,932 acres in total), and when new riparian growth occurred on soil deposited by the river (not specifically calculated). The rate of change was quite volatile with each cover type undergoing periods of loss and gain. Only three periods of loss occurred and they were staggered, one in each time period. The increase in forest loss attributable to this category was acute between 1974 and 1982, when a rate of gain of 673 acres per year dropped to a loss of 1185 acres per year.

CONCLUSIONS

There is much concern over the loss of riparian habitat, especially in the western United State, because of the importance of this habitat to fish and wildlife resources. Although studies conducted elsewhere have documented the loss of this habitat, information was not available on the status of riparian habitat on the Missouri River in Montana. This fact plus the observations of numerous biologists that rather large blocks (20 to 80 acres) of trees were being cleared in the mid-to-late 1970's along the reach of Missouri River reported upon here, with unknown habitat consequences, led to this study.

A cursory examination of data in Table 2 may lead one to believe, at least in the case of forests, that there is not much reason for concern about loss of this type in the study reach. There was actually more of the forest type in 1982 (23,189 acres) than there was in 1938 (18,374 acres). However, closer examination shows that there was an increase of forests from 1938 through 1974, followed by a substantial loss between 1974 and 1982. The data reflect a gain of 102 percent in this type in the 36-year interval between 1938 and 1974, followed by a 32 percent loss in just eight years between 1974 and 1982. Further confirmation of this reversal is shown in Table 3. The annual rate of "gain due to other causes" of the woodland type declined from about 680 acres per year between 1938 and 1974 to a loss of 1185 acres per year between 1974 and 1982. If the rate of loss observed between 1974 and 1982 continues into the future, there is valid reason to be concerned about the longevity of the cottonwood forests in this reach of river.

Table 3.--Estimated loss (or gain) of riparian cover types attributable to categories of change over time.

<table>
<thead>
<tr>
<th>Categories of change for each time period</th>
<th>Riparian Cover Types</th>
<th>Deciduous Woodland</th>
<th>Scrub Woodland</th>
<th>Scrub Scrub</th>
<th>Herbaceous Scrub</th>
<th>Herbaceous Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss to development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1938 through 1956</td>
<td></td>
<td>106</td>
<td>248</td>
<td>2123</td>
<td>2477</td>
<td></td>
</tr>
<tr>
<td>1956 through 1974</td>
<td></td>
<td>167</td>
<td>234</td>
<td>904</td>
<td>1306</td>
<td></td>
</tr>
<tr>
<td>1974 through 1982</td>
<td></td>
<td>455</td>
<td>218</td>
<td>1519</td>
<td>2192</td>
<td></td>
</tr>
<tr>
<td>Loss to the River</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1938 through 1956</td>
<td></td>
<td>52</td>
<td>109</td>
<td>237</td>
<td>398</td>
<td></td>
</tr>
<tr>
<td>1956 through 1974</td>
<td></td>
<td>26</td>
<td>40</td>
<td>28</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>1974 through 1982</td>
<td></td>
<td>96</td>
<td>159</td>
<td>118</td>
<td>373</td>
<td></td>
</tr>
<tr>
<td>Loss (gain) to other causes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1938 through 1956</td>
<td>(688)</td>
<td>(.92)</td>
<td>388</td>
<td>(392)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1956 through 1974</td>
<td>(673)</td>
<td>140</td>
<td>612</td>
<td>(1145)</td>
<td></td>
<td></td>
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<tr>
<td>1974 through 1982</td>
<td>1185</td>
<td>(.38)</td>
<td>2816</td>
<td>(1669)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

255
Throughout the study period, most agricultural development may have included within the herbaceous and other cover types that may have been lost or mechanically altered during the initial phases of agricultural development. These would probably have included seasonal and temporary wetlands that form in topographic depressions, as well as permanent wetlands in oxbows, channels that had been naturally arrested, and low areas of subterranean irrigation. Those that were not impacted during initial development may well have been altered due to agricultural grading of upper terraces, which by 1982 had been extensive enough to obliterate many of the original terrace contours from an aerial view. Wetlands are an important component of the riparian community, but were not included in the inventory or the subsequent analyses, due to the poor resolving power of the black and white prints that were available.

Information provided in this study provides some insights into how dynamic the surface composition of the riparian system has been in terms of agricultural development and natural events.

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