HABITAT EROSION PROTECTION ANALYSIS

Missouri National Recreational River
Nebraska and South Dakota

April, 2000

US Army Corps
of Engineers
Omaha District

EXECUTIVE SUMMARY

The Corps was tasked by the National Park Service to determine if erosion protection measures were needed to prevent further decline in cottonwood forest within the Missouri National Recreational River. The 1990's had three unusually high water years resulting in increased runoff and dam discharges, with resultant increased erosion. Concern about erosion of cottonwood forests was expressed by the public during public meetings held by the National Park Service and the Corps during 1999. Severe erosion was also evident in the comparison of aerial maps from 1985 to those from 1997. Forested habitat is considered a "wildlife value" for the Missouri National Recreational River and deserving of protection.

After site visits and an evaluation of potential erosion protection sites, an analysis of erosion rates, a determination of an ultimate erosion line at each site, and an evaluation of habitat value at each site, **it is the Corps' recommendation that erosion protection be pursued at five sites.** The risk of not protecting the sites, in terms of habitat units lost due to erosion, was a primary factor in this recommendation. Without bank protection, the five sites combined stand to lose 3595 habitat units due to erosion over the next 25 years, based on HEP analyses. Three of the sites are private lands; the other two are state-owned lands. Two of the sites are in Nebraska, and the other three are in South Dakota. **The Corps also recommends pursuit of conservation easements from willing sellers in addition to what is needed for construction.**

Since sufficient funding is unlikely for simultaneous pursuit of the five sites, several factors (such as habitat value, erosion rate, etc.) were considered to prioritize the sites. Based on these factors, a private-lands site on the Nebraska side (site A1) has the highest priority. It is the Corps' recommendation that erosion protection at site A1 should be the first project pursued, if funding is limited.

The most cost-effective way to protect the sites would be to construct permanent projects using quarried stone. However, this study also includes an option to construct temporary structures to protect the sites. Temporary projects could be made permanent, or allowed to erode, based on future studies. However, the cost for pursuing a temporary structure, followed by a permanent structure, could be up to two times the cost of construction of a permanent structure alone. There is also considerable uncertainty with regard to the ability of temporary structures to withstand ice movement in the Missouri River.

The Corps will first seek agency and local input on the proposed projects, then proceed with the detailed design for each structure (beginning with A1) in June. Additional opportunities for agency and public feedback would be available, should the projects proceed, through environmental compliance associated with each action.

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EXECUTIVE SUMMARY

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I. BACKGROUND

Normal river processes include both erosion and accretion as a dynamic process of sediment movement. Many species have evolved to take advantage of the changing river morphology and associated turbidity and snags. The sediment balance in the Missouri River, including the erosion / accretion balance, was disrupted by the construction and operation of the mainstem dams (and, in the lower river, the construction of the navigation channel). This report focuses on the 59-mile segment of the Missouri River below Gavins Point Dam, a segment known as the Missouri National Recreational River (Map 1).

A. Missouri National Recreational River

The Missouri National Recreational River (MNRR) is a segment of the National Wild and Scenic Rivers System (WSRS), added in 1978 by PL 95-625. There are three levels of designations in the WSRS, listed from most pristine to most developed: "wild," "scenic," and "recreational." All designations, however, require that the "values for which the river segment was designated be protected and enhanced." The following are considered values which supported the designation of the MNRR: historic, aesthetic, recreation, fish and wildlife, and geologic. Since this document focuses on the protection of wildlife habitat, erosion protection for other values (e.g. cultural or historic sites, recreational access, etc.) will not be discussed in this document.

Unlike legislation for other WSRS segments, the MNRR legislation indicated that "...the Secretary [of Interior] provide for the construction by the United States of such recreation river features and **streambank stabilization structures** as the Secretary of Army (acting through the Chief of Engineers) deems necessary and advisable in connection with the segment...." [emphasis added]. This language is the result of grass-roots efforts and congressional support for streambank protection when needed, in light of the changed conditions resulting from Gavins Point Dam. Before construction of Gavins Point Dam, landowners with eroding land one year had a good potential to be accreting new land in a future year. This balance of sediment erosion and accretion is no longer present within the MNRR. The MNRR segment is a "losing" river reach, which erodes more sediment than it accretes. A copy of the legislation and the Cooperative Agreement between the National Park Service (NPS) and the Corps can be found in Appendix A.

The NPS has the responsibility for the overall administration of the MNRR, however the Corps has a management role which is outlined in a Cooperative Agreement with the NPS. The Corps receives an annual budget for management activities within the MNRR, and can request construction funds to meet the needs of the MNRR.

B. Erosion within the Missouri National Recreational River

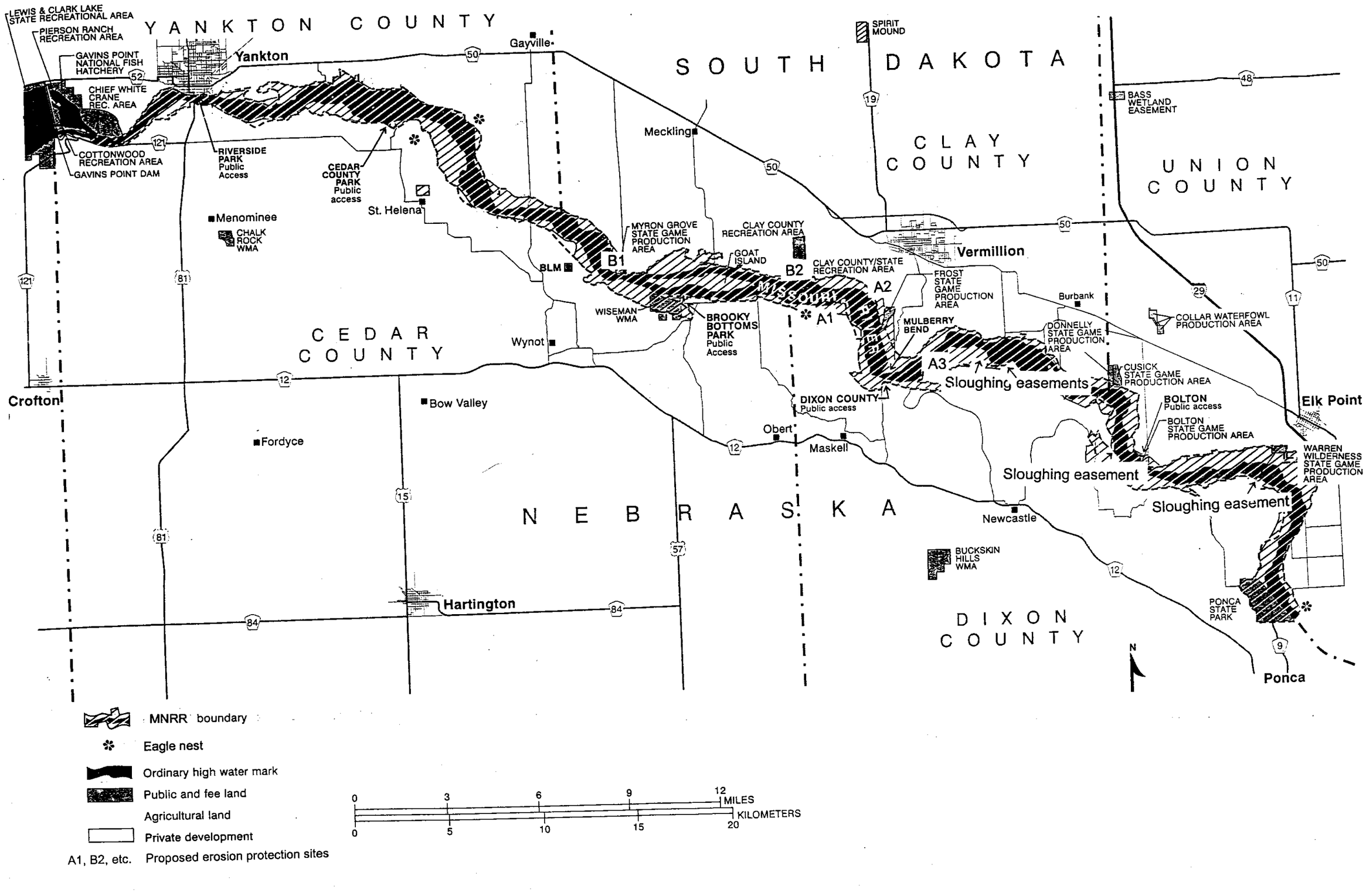
With the presence of Gavins Point Dam, much of the sediment that would have been entering the MNRR segment now deposits in the headwaters of Lewis and Clark Lake. "Sediment-hungry" water is then discharged from Gavins Point Dam. Erosion from discharges consists of bank and bed erosion, the latter resulting in riverbed degradation. Accretion still occurs in the downstream end of the segment, but is limited and does not equal the amount of erosion occurring within the reach. The "sugar sand" sediment present along many of the high banks along the MNRR is highly erodable, even when vegetated with rootstock from mature trees.

Through the efforts of local landowners, Congress recognized the erosion problem below Gavins Point Dam even before the MNRR legislation. In 1974, Congress passed Section 32 of the Water Resources Development Act in order to provide experimental high-bank erosion control at several critical erosion areas below Gavins Point Dam. Eleven projects were constructed in the MNRR during the late 1970's and early 1980's and evaluated under this authority, which was the impetus for the Section 33 program discussed below.

Congress passed Section 33 of the Water Resources Development Act of 1988 (Section 33) to address erosion and landowner losses from Fort Peck Dam to Ponca, Nebraska. The MNRR segment is included within the Section 33 program and therefore the Section 33 program can also be used to provide bank stabilization (if less expensive than the value of the eroding land) or to purchase sloughing easements from private landowners. No Section 33 structures have been built within the MNRR, however the Corps has purchased three sloughing easements totaling 221 acres under the Section 33 authority. Sloughing easements can be a useful tool to provide a balance between erosion and stabilization, however the easements are voluntary and are unpopular among many landowners.

Some landowners also have pursued construction of private bank stabilization structures within the MNRR, primarily to protect farmland, cabin areas, and boat ramps. Because bank stabilization is expensive, it is unlikely that private landowners would construct bank stabilization to protect wildlife habitat areas such as cottonwood forest.

Bank stabilization of high quality habitat is already part of the mitigation package for the Vermillion Bridge project, located within the MNRR. In order to address ecosystem impacts related to bridge construction, the USFWS included the mitigation package proposed by the South Dakota Department of Transportation as a Conservation Measure in the Biological Opinion (BO). This BO addresses impacts to bald eagles associated with the bridge project. The mitigation package includes "stabilization of the Missouri River banks to minimize erosion thereby reducing tree loss" (USFWS 1994). According to plan sheets for the bridge project, this stabilization consists of 1.2 km (approximately 4000 feet) of buried revetment to protect the Frost Game Production Area and associated lands (SDDOT 1999). This bank stabilization, endorsed by the USFWS, is consistent with current concerns over erosion of forested habitat.


YANKTON COUNTY
LEWIS & CLARK LAKE STATE RECREATIONAL AREA
PIERSON RANCH RECREATION AREA
GAVINS POINT NATIONAL FISH HATCHERY
CHIEF WHITE CRANE REC. AREA
COTTONWOOD RECREATION AREA
GAVINS POINT DAM
Yankton
Gayville
RIVERSIDE PARK Public Access
CEDAR COUNTY PARK Public access
St. Helena
Menominee
CHALK ROCK WMA
Meckling
SOUTH DAKOTA
SPIRIT MOUND
CLAY COUNTY
UNION COUNTY
BASS WETLAND EASEMENT
MYRON GROVE STATE GAME PRODUCTION AREA
CLAY COUNTY RECREATION AREA
GOAT ISLAND
CLAY COUNTY/STATE RECREATION AREA
Vermillion
BLM
B1
B2
A2
A1
MISSOURI
FROST STATE GAME PRODUCTION AREA
Burbank
COLLAR WATERFOWL PRODUCTION AREA
WISEMAN WMA
BROOKY BOTTOMS PARK Public Access
MULBERRY BEND
DONNELLY STATE GAME PRODUCTION AREA
CEDAR COUNTY
Wynot
A3
Sloughing easements
CUSICK STATE GAME PRODUCTION AREA
Crofton
Bow Valley
DIXON COUNTY Public access
Elk Point
BOLTON Public access
Obert
Maskell
BOLTON STATE GAME PRODUCTION AREA
WARREN WILDERNESS STATE GAME PRODUCTION AREA
Sloughing easement
Sloughing easement
Fordyce
NEBRASKA
Newcastle
BUCKSKIN HILLS WMA
PONCA STATE PARK
DIXON COUNTY
Hartington
Ponca
N
MNRR boundary
Eagle nest
Ordinary high water mark
Public and fee land
Agricultural land
Private development
A1, B2, etc. Proposed erosion protection sites
0 3 6 9 12 MILES
0 5 10 15 20 KILOMETERS

Local and congressional support for bank preservation is still evident. The Missouri River Bank Stabilization Association (MRBSA) passed a February 17, 1999 resolution which included the adoption of an initiative "...to find bank stabilization solutions with the Army Corps of Engineers through the possible use of land easements which could provide a river beltway along the MNRR ....private land easements could also provide an opportunity to develop increased water-accessible public use areas along the river." The Corps has received letters and phone calls requesting landowner assistance with erosion protection from the offices of Senator Hagel (NE), Congressman Bereuter (NE), Senator Johnson (SD), and Senator Kerrey (NE).

C. Decline of Forested Habitat within the MNRR

There are many acres of mature cottonwood forest within the MNRR, although the acres have decreased over time for various reasons. Some cottonwood forests have been cleared for farming; others have been logged for profit. Other cottonwood forest has been lost due to erosion, primarily due to undercutting of the unstable "sugar sand" base. Since 1985, the Corps estimates that 315 acres of mature forest have been lost due to erosion within the MNRR, based on aerial maps (discussed later within this document). That estimate does not include erosion of non-forested acres, nor does it include non-erosion losses of forested habitat. These losses are a concern, especially since there is little or no cottonwood regeneration in this reach.

As mature cottonwood forest habitat declines, the bald eagle population continues to increase. The bald eagle was downlisted from endangered to threatened, and now has been proposed for delisting as a result of its expanding population and range. A 1999 Corps bald eagle nest survey within the MNRR located three eagle nests within the MNRR. An additional nest was located this winter, and has been verified as an eagle nest. Eagle nesting has not been previously described for the MNRR in historic documents for management of the MNRR, nor in the document that led to the designation of the MNRR (Missouri River Review Report for Water Resources Development, August 1977, "Umbrella Report"). Bald eagles also nest in other new areas along the Missouri River and other river riparian areas. As numbers of bald eagles increase and their nesting and roosting ranges expand, sufficient stands of mature cottonwood forest need to be protected from clearing and erosion to support this expansion.

According to the USFWS' 1986 study on federally listed bird use within the MNRR, the cottonwood-dogwood forest appears to be the most suitable habitat type for wintering bald eagles use in the MNRR. Bank erosion is one of the most serious problems affecting bald eagle habitat in the MNRR (USFWS 1986). The cottonwood-dogwood forest was given a wildlife value of 7.9 (10 being highest) by Clapp (1977) in his thesis describing the habitat values of the MNRR.

In addition to bald eagles, mature forested habitat is valuable habitat for other raptors, wildlife, and neotropical birds, and provides a greenbelt along the river, which enhances the viewshed seen from a boat or canoe. The forested land is located in an agricultural

and prairie area, so the trees provide thermal cover, escape areas, predator cover, food, nesting habitat, and travel corridor for species adapted to deciduous forests. Species diversity is generally high in riparian corridors because they link many habitats. Numerous other raptor nests, in addition to eagle nests, are also present within the forests along the MNRR.

During the past decade, the U.S. Fish and Wildlife Service (USFWS) has become concerned about regeneration of cottonwood trees, especially in "losing" river reaches with limited accretion of new lands. Cottonwood trees establish on newly accreted lands, and accretion lands within the Missouri River have been reduced considerably since dam construction. Much accretion occurs in the headwaters of the mainstem reservoirs, however these deltas do not apparently provide habitat for cottonwood saplings, as cottonwood stands are not evident in delta areas. Young cottonwood trees are also needed to provide future habitat for bald eagles, raptors, and neotropical migratory birds.

D. 1980 Efforts for Habitat Erosion Protection within the MNRR

After the 1978 designation of the MNRR, and the development of the 1980 General Management Plan (GMP) and 1980 General Design Memorandum (GDM), the Corps and the USFWS met to prioritize high quality habitat warranting erosion protection under MNRR authority. It was agreed at that time that wildlife habitat was a "value" of the MNRR warranting erosion protection. The Corps selected seven "high bank" erosion sites with high habitat quality and forwarded those sites to the USFWS for concurrence. The USFWS added four additional high quality sites, which were of lower elevation and as such, were not included in the initial Corps list.

The Corps funded the USFWS to assign habitat values to the original seven sites and one of the USFWS sites (James River Island). The USFWS methodology was based on that previously used by Clapp (1976) and was developed specifically for use within the MNRR. The USFWS report and supporting correspondence can be found in Appendix C.

An erosion analysis was done on seven sites and an island in the Burbank area (then known as Earl Rowland's Island, RM 768) later that year by the Corps. Although all of the habitat had value, many areas were not at risk of erosion. Those areas with low erosion rates were considered for purchase of wildlife or recreation easements in order to prevent tree clearing and associated loss of habitat value. Four sites, however, did warrant erosion protection, based on erosion rates.

Erosion protection, although warranted both by habitat value and by erosion rate analysis, was not successfully pursued by the Corps. Policy concerns over use of federal funding to protect private land, as well as bank stabilization being a low budget priority, tabled the results of this early analysis. Purchase of wildlife or recreation easements was also a low budget priority during this period.

E. 1986 USFWS Eagle Habitat Study

In 1986, the Corps funded the USFWS to study and rank eagle habitat within the MNRR. One recommendation of this document was to protect the "Priority I" cottonwood-dogwood forests by placing revetment (bank stabilization) along certain priority sites, utilizing methods similar to those used on the Carl Mundt Eagle Refuge near Pickstown, South Dakota. Priority I sites were those sites with documented eagle use.

II. DETERMINATION OF CURRENT SITES - 1999 / 2000

It's been 20 years since the Corps and USFWS first evaluated habitat within the MNRR for erosion protection. A new 1999 GMP has been developed which supports appropriate bank protection with landowner donation of riverfront lands for a "greenbelt" of wildlife habitat. Eagle use in the MNRR is expanding, yet mature cottonwood forest is declining. The National Park Service is taking a more active role in the administration of the MNRR and the protection of the values for which it was designated. Several years of high (upper decile) discharges from Gavins Point Dam and associated erosion has concerned local groups and the NPS.

Conversely, USFWS concerns over the cumulative effects of bank stabilization within the Missouri River have increased, prompting the Corps to initiate a cumulative impact assessment under the Section 33 program. Three Missouri River species have been federally listed since 1980; the least tern, the piping plover, and the pallid sturgeon. Two other fish species and one mussel have been proposed for listing within the MNRR; the sturgeon chub, the sicklefin chub, and the scaleshell mussel. USFWS also has concerns over the limited amount of young cottonwood tree habitat within the Missouri River.

The NPS, as overall administrator of the MNRR, wants to preserve eroding wildlife habitat within the MNRR boundary. The Corps was tasked to determine if eroding habitat warranted protection under the MNRR authority. Many landowners have also indicated a willingness to donate life-of-project wildlife easements in exchange for protection from erosion. This process was discussed and endorsed in concept by the Corps and the NPS in the 1999 GMP.

The federal budget, while still tight, has more flexibility now than during the 1980's due to a reduction in the federal deficit. All of the above factors prompted the Corps to reevaluate habitat values and species use of eroding forested habitat.

A. Missouri River Bank Stabilization Association Sites

As part of the "scoping" process for the Environmental Impact Statement (EIS) associated with the cumulative impact study of bank stabilization on the Missouri River, public meetings were held in several states in order to solicit input on problem erosion areas. Seven erosion sites within the MNRR were identified by the president of the MRBSA after the February 1999 scoping meeting held in Vermillion, South Dakota.

Bold text indicates the sites that were selected as priority erosion protection areas by the Corps in this document. The potential sites are as follows:

1. RM 795-794 L St. Helena Bend, Miller Farm (1980 USFWS site)
2. RM 790-789 R unnamed site
3. **RM 789-788 L upstream of Myron Grove (B1)**
4. **RM 781-780 L upstream of Clay County Park (B2)**
5. **RM 779-778 R North Alabama Point (A1)**
6. **RM 780-778 L North Alabama Bend (A2)**
7. RM 765-764 R K. Sweeney Bend (Limprecht land)

B. Corps Sites

Local concerns about eroding cottonwood forest were raised during the March 1999 public meetings on the draft GMP (finalized in September, 1999). As a result of these concerns, the Environmental Section of the Omaha District Corps of Engineers (Corps) spent part of the summer, 1999, evaluating tree loss resulting from three recent high-flow water years. Aerial photography taken during 1997 (the most recent high-flow year) was compared to earlier aerial photography taken in 1985 (both at 1:2000 scale). The outline of tree-covered areas from the 1985 photography were overlaid on the 1997 aerials. The difference in the outline was then measured with a compensating polar planimeter calibrated to measure square inches. Square inches were then converted to square feet, and then acres. Using this method, overall erosion of tree-covered bankline within the MNRR was estimated to be 315 acres during the last twelve years. High "upper decile" flows during 1993, 1996, and 1997 likely contributed to this erosion rate. This exercise focused on forested habitat and doesn't include erosion acreage of sandbar or cropland. Ten primary erosion areas were initially identified, and through a comparison of land loss and risk to riparian habitat, five of these sites were submitted for further consideration. These five potential sites are as follows:

1. **RM 780-779.2 R Point with trees; eagle nest in vicinity (A1)**
2. **RM 779.3-777.7 L Trees on outside bend (A2)**
3. RM 775.9-775.2 L Point with trees
4. **RM 774.4-772.9 R Bend / point with trees (A3)**
5. RM 769.6-769.1 R Point with trees

Items 1 and 2 of the above list are also on the MRBSA list of eroding sites (A1 and A2).

C. South Dakota Sites

In April, 1999, the Omaha District received a written request for protection of state-owned eroding cottonwood habitat at four sites on the South Dakota side of the MNRR. These potential sites are:

1. **RM 787 L** **Myron Grove Game Production Area (GPA) (B1)**
2. **RM 781 L** **Clay County Recreation Area (B2)**
3. RM 778 L Frost Wilderness GPA
4. RM 766.8 Cusick Donnelly GPA

The Myron Grove and Clay County sites were also identified on the MRBSA list (B1 and B2). The April letter indicated that the sites were ranked in order of preference, and staff from the South Dakota Game Fish and Parks indicated that sites 3 and 4 were lower priority sites. Therefore, sites 1 and 2 were selected for continued evaluation.

III. SUMMARY ANALYSIS OF PRELIMINARY SITES

A. Preliminary Analysis of Erosion Rates

Through a preliminary analysis of erosion rates (Appendix C), several sites with low erosion rates were eliminated from consideration. The South Dakota Game, Fish, and Parks indicated that two of their four sites had lower priority (South Dakota sites 3 and 4), and those low priority sites were therefore eliminated from this preliminary analysis. The following high priority sites were then evaluated by boat:

A1	-	RM 779.5 R	Point on North Alabama Bend	private land
A2	-	RM 779 L	North Alabama Bend	private land
A3	-	RM 773.5 R	Vermillion Reach	private land
B1	-	RM 787.5 L	Myron Grove GPA	public land
B2	-	RM 781 L	Clay County Park	public land

B. Erosion Site Visit and Trip Report for the Five Priority Sites

An August 1999 boat trip was arranged to evaluate the above sites as candidates for environmental protection through bank stabilization. Representatives from the Corps, the MRBSA, South Dakota Game, Fish, and Parks, and the NPS were present. The USFWS was invited, but was unable to attend. A trip report (Appendix D) was prepared to summarize conditions at the sites, as well as to summarize options discussed with the various agencies and groups. Photographs taken during the boat trip are included in the Habitat Analysis section (Appendix F).

C. Erosion Alternatives Analysis (Erosion / Cost)

The Corps did an Alternatives Analysis (Appendix E) of the above five sites to determine a rough cost per acre protected, as well as cost per linear foot protected for use in prioritizing alternatives on a strict cost-only basis. Through an analysis of preliminary designs and associated costs, as well as an analysis of the potential for continued erosion, two of the five sites were tentatively eliminated because these sites are at or below the average erosion rate of one acre / mile / year (MNRR average erosion rate, HDR 1999). However, "average rate" erosion of high quality habitat may still be important based on

the value and scarcity of the habitat that is eroding. The importance or habitat value of the eroding habitat is addressed in Section D and Appendix F. Average annual erosion rates calculated for the sites are as follows:

A1	-	6.4 acres / mile / year
A2	-	5.9 acres / mile / year
A3	-	4.6 acres / mile / year
B1	-	0.5 acres / mile / year
B2	-	1.0 acres / mile / year

Comparative costs were estimated with each site, based on a preliminary rock-based design. These costs contain many assumptions and can only be used for comparative purposes. True construction costs will be prepared as a part of detailed design should any of these projects continue. Other comparative costs (e.g. per 1000 feet of protected bank) can be found in Appendix E. Costs per habitat unit protected will be discussed in the Environmental Alternatives Analysis and Appendix G.

A1	-	$483,900	$3,141 per acre
A2	-	$875,300	$4,610 per acre
A3	-	$378,900	$2,410 per acre
B1	-	$136,700	$27,840 per acre
B2	-	$153,100	$76,460 per acre

Traditional bank stabilization methods (with tree enhancements) were compared with non-traditional (hay bales, trees, etc.) "soft" methods for the above three sites. Costs, project lifespans, proportion of eroding area protected, accretion potential, environmental value, etc. were compared between the two stabilization methods for a subsample of three sites. "Soft" materials would not protect the sites as completely, and would lessen the potential for accretion benefits.

D. Environmental Site Visit and Trip Report for Five Priority Sites

An environmental site visit (Appendix F) was conducted to determine the value of the habitat present within the eroding portions of the five priority sites. The HEP-based methodology followed methods previously used in the MNRR (Clapp 1977; USFWS 1980). Habitat in the targeted protection zone for the five priority sites was classified according to its terrestrial cover type. The terrestrial cover types most recently used within the MNRR contained five major categories: (1) sand dune, (2) cattail marsh, (3) cottonwood-willow, (4) cottonwood-dogwood, and (5) elm-oak. Clapp (1977) identified a habitat value to wildlife for each of the five categories of habitats listed. Procedures Clapp used to subjectively rate the habitat are outlined in the Habitat Evaluation Procedures Manual (U.S. Fish and Wildlife Service, 1976). As much as possible, these same categories were used in this evaluation to determine the relative wildlife habitat suitability index (HSI) for the five potential sites to be protected by structural measures and easement acquisition.

As a result of this evaluation, the HSI for the eroding portion of the five sites is as follows (based on a scale of 1 to 10, with 10 being the highest habitat value):

A1 - 6.54
A2 - 5.23
A3 - 5.25
B1 - 7.46
B2 - 7.50

In addition to determining the HSI for eroding lands, Appendix F determined the HSI for the contiguous habitat area (erosion area plus adjacent habitat) in order to evaluate the habitat as a whole. The information on the contiguous habitat area is useful in order to determine if there is value in purchasing additional wildlife easements beyond that needed for bank stabilization on private lands.

Using the 25-year erosion prediction generated during the Alternatives Analysis (Appendix E), the total "no action" habitat unit loss was calculated for each site (summation of HSI x acres, by habitat type). These numbers represent the habitat units protected if an erosion protection structure was constructed. Habitat units have been rounded to the nearest whole number.

A1 - 1048 habitat units
A2 - 1420 habitat units
A3 - 984 habitat units
B1 - 91 habitat units
B2 - 52 habitat units

E. Site Prioritization / Recommendations

1. COST / BENEFIT TYPE ANALYSES

One way to prioritize sites by "cost / benefit" is by determining the cost of protection per habitat unit (HU), by site. This is done by taking the preliminary cost (from Appendix E) and dividing it by total HU protected (from Appendix F):

A1 - $461 / HU
A2 - $616 / HU
A3 - $385 / HU
B1 - $1502 / HU
B2 - $2944 / HU

Another means of "cost / benefit" analysis is to assume a fixed per-mile stabilization cost, and divide the HU by the length of protection needed. This method was used by the USFWS in 1980 to rank potential stabilization sites. Using this method, the sites rank as follows:

A1	-	936 HU / mile protected
A2	-	966 HU / mile protected
A3	-	1093 HU / mile protected
B1	-	239 HU / mile protected
B2	-	168 HU / mile protected

For comparison purposes, the 1980 USFWS rankings ranged from 360 HU / mile protected (sites by Yankton) to 2308 HU / mile protected (James River Island), with an average of 1124 HU / mile protected. This study limits the HU determination to the eroding part of the lands for this calculation, however the USFWS determined the HU for the entire habitat at the site (not just the land subject to erosion). If the USFWS HU determinations were limited to only the eroding lands (25-year erosion line), their HU/mile protected numbers would likely be much smaller than what is represented.

2. BIOLOGICAL ANALYSES (no cost considerations)

The most basic form of environmental prioritization has already been done in the above section by ranking the sites based on habitat units (HU).

However, due to the complexity of factors involved with these sites and the surrounding areas, a matrix approach may be best suited to determine a prioritization of resources. The habitat-unit based ranking of the five sites, although useful, does not take all current factors into account that may influence the value of the site within the MNRR. For instance, accretion potential, erosion rate, HSI per acre, forest diversity, etc. are included in a matrix designed to assist in prioritizing habitat sites for protection (Appendix G). By using this matrix, the five sites have been prioritized as follows (higher numbers have higher priority):

A1	-	21 points
A2	-	16 points
A3	-	13 points
B1	-	13 points
B2	-	11 points

The lower erosion rates at the "B" sites reduces the urgency for protection at these sites, however, habitat protection is still recommended due to the high habitat quality seen at these sites.

It is appropriate at this point to discuss concerns about the cumulative effects of past, present, and future actions and the anticipated impacts to the ecosystem. It is well documented that the Missouri River, inclusive of the MNRR, has experienced past significant cumulative effects as a result of the construction of the main stem system of dams and reservoirs, as well as the channelization and stabilization of the navigation channel downstream from the MNRR. "Normal" river processes and sediment transport, which includes flood flows and over-bank transport of organic material, no longer occurs as it once did. What remains is a highly modified system designed primarily for flood

conveyance, hydropower, and navigation. Additionally, as an indirect effect of reduced flood flows, land use changes occurred along the banks of the Missouri River. With the threat of flooding reduced, many riverbanks within the fertile floodplain were cleared of forested habitat and converted to agriculture land use. Erosion continued along the riverbanks, but accretion of new lands, as well as regeneration of cottonwood trees, is minimal.

Continued erosion of forested habitat provides organic material and structure for fish in the Missouri River. However, during recent "low flow" discharges from Gavins Point dam, it was apparent that trees and snags are plentiful in this reach of the Missouri River (unlike some other Missouri River reaches). Local river users are well aware of the multitude of snags, which can also be hazardous to small watercraft.

While we recognize the cumulative losses of river dynamics that have occurred in the MNRR reach, as well as other Missouri River reaches, we also recognize that this reach has also lost (and continues to lose) significant acres of forested habitat. Erosion will continue in this reach, with or without bank stabilization structures. Future natural regeneration of large tracts of high bank cottonwood forests is not likely. We have an opportunity to prevent the erosion of selected high-quality forested sites that are currently at risk, and the potential to design the structure to accrete lands that could further young cottonwood regeneration.

IV. PRELIMINARY RECOMMENDATIONS

A. Habitat Erosion Protection

Based on the previous discussions, **it is the Corps' preliminary recommendation that erosion protection be pursued at all five priority sites**, beginning with site A1. The average length for the proposed five sites (4300 ft) is comparable to the length protected by the mitigation for the Vermillion Bridge (4000 ft) which also protects forested habitat and which has already been recommended for implementation by the USFWS. The benefits, in terms of habitat units protected, have been identified by site, and the sites have been ranked using multiple factors. If private landowners would be willing to donate easements for wildlife habitat, the Corps would be willing to pursue the design and construction of erosion protection structures.

Because permanent structures provide the greatest level of erosion protection, and the greatest potential for accretion of new land, the Corps recommends pursuing construction of permanent structures. Permanent structures will be more efficient in erosion prevention, retaining the greatest number of habitat units per site. The cost for installation of permanent structures is much less than that of temporary structures followed by permanent structures.

Agency feedback and local support on this recommendation will be influential in what is ultimately done, as will the availability of funds for stabilization activities. If sufficient funding is available, all sites could be pursued concurrently, however a more likely

scenario would be pursuit of up to two sites concurrently, followed by other sites (in priority order) as funding becomes available. Even though priority has been tentatively established, the stabilization of the public lands sites will likely be a much faster process than stabilization of the private lands sites due to uncertainties surrounding the private lands sites (addressed later in this document). Additionally, funding for the less expensive structures may become available prior to funding for more expensive structures, and therefore it is prudent to be prepared for opportunities for moving forward with any of the five projects.

The USFWS (South Dakota) has informally voiced concerns about the placement of new permanent structures prior to the completion of the Section 33 cumulative impacts study. In order to address these concerns, the Corps has included an option of building temporary (e.g. timber) structures to protect the habitat while awaiting the results of the cumulative impact analysis on bank stabilization for this reach. Timber structures are estimated to last seven years (depending on flows and ice conditions), and when compared to the rock structures are not as efficient at slowing erosion or accreting new lands. However, timber structures could be used to balance the loss of habitat by doing nothing, and potential impact of installing a permanent structure without the benefit of the results of the cumulative impact study. If the results from the cumulative impact study indicate that bank protection at any or all of these sites is a bad idea, the timber structures would be allowed to erode and the donated easements would revert back to the landowner. However, if the results of the cumulative study indicate that the impacts from bank stabilization at these sites are negligible, these temporary structures would be fortified or replaced by permanent structures at federal cost, and the temporary donated easements would become permanent.

Construction of temporary structures, followed by construction of permanent structures at the same site would increase the per-site construction costs by 50 - 90 %, not including transportation costs for the trees. The Corps would attempt to locate sufficient red cedar trees, a local "pest" tree formerly controlled by prairie fires, for construction of the structures. However, whether sufficient red cedar trees of sufficient lengths are available is currently not known.

Based on Corps formulas for estimating tree needs, a timber structure would require the following number of trees:

A1	-	210 trees[1]
A2	-	84 trees
A3	-	72 trees
B1	-	42 trees
B2	-	60 trees

The number of trees needed is based on the length of the preliminary design of the structures. Although the bulk of the structure would be timber, experience on timber

[1] for trees 30 feet long; more trees would be needed if shorter trees were used

structures in large rivers such as the Missouri indicates that a "toe" of quarried stone would likely still be needed. Landowners would be solicited for permission to remove suitable trees from nearby lands for transportation to the sites. Transportation costs have not been included in preliminary cost estimates, because the locations for the trees is not yet known.

If concerns about the aesthetics of "hard point" structures outweigh concerns about accretion potential, then standard bank rip-rap (revetment) could be constructed. Bank revetment can be covered with topsoil and seeded. Many of the Section 32 revetment structures were constructed in this manner, and are barely visible today due to overgrowth of plants on the structures. Bank revetment, however, does not lend itself to accretion of new lands.

The above options, and potentially other alternatives, could be addressed in environmental compliance documents and Section 404 permits that would precede the construction of each new structure.

1. ANTICIPATED PROCESS FOR PROTECTION - PUBLIC LANDS

If agency feedback is favorable and bank protection of a public lands site (B1 or B2) is pursued, the Corps would first do a detailed design and cost estimate for the structure. Conceptual designs described in this report may undergo potentially significant changes based on additional survey information, since erosion is ongoing while these studies take place. Additional information on soil conditions, potential effects of wind-wave action, etc. could affect final design of the structure. Funding would then be solicited for the construction of the structure. A Section 404 permit application would be submitted, and a Permit Notice circulated to the standard "Missouri River" mailing list for public comment. An Environmental Assessment (EA) would be written and circulated to agencies (and made available to the public) for comment. A bid package would be prepared to solicit a contractor to construct the project structure. Once the environmental compliance is complete, the bid package would be advertised and awarded (assuming the availability of funding). Construction would be scheduled to avoid conflicts with the nesting activities of federally listed bird species, and would observe all other permit conditions. This is a similar business process to what was done for the construction of bank protection at Ponca State Park.

The completed structures would be turned over to the state for liability, operation, and maintenance purposes. Timber structures would not be maintained, due to the temporal nature of that type of structure. The Corps has historically maintained other permanent structures in the MNRR which have been turned over to public entities, using annual Congressional adds. In the absence of such Congressional adds, maintenance would not be likely due to limited operations and maintenance funding, and low budget priorities currently associated with structure maintenance.

2. ANTICIPATED PROCESS FOR PROTECTION - PRIVATE LANDS

If the agency feedback is favorable and bank protection is pursued for private lands sites (A1, A2, or A3), the business process would be similar to the above process, but it would have additional steps in the beginning to address the private lands issue. Generally speaking, the use of federal dollars to protect private lands is not supported by Congress. However, the protection of a MNRR value (wildlife habitat) that would be provided to the federal government through donated easement from the landowner would establish a federal interest in the land. Real Estate personnel from either the Corps or the NPS would work with the landowner, with recommendations from Corps' biologists, to establish the size and conditions of the donated easement. Terms of the easement would be determined on a case-by-case basis. Once acquired, the easement may be turned over to a local entity, such as the local Natural Resources Division, for management. The NPS, the USFWS, or the county could also be the managing agency. The design for the structure could occur concurrently with the real estate actions, as could the Section 404 activities and EA. A bid package would not be advertised, however, until all required lands are secured in an easement. This business process has yet to be pursued under MNRR authority, so the actual process may be somewhat different than what is proposed. It is estimated that an additional 6 months may be needed to address private lands issues.

The Corps would retain ownership of structures constructed on private lands. Temporary structures would not be maintained due to the temporal nature of that type of structure. Although operation and maintenance of the permanent structures is an authorized purpose of the MNRR legislation, it is still a low budget priority. In the absence of a Congressional add directing funds for the maintenance of these structures, such maintenance would not be likely due to low budget priorities.

B. Purchase of Wildlife Easements

In addition to the pursuit of erosion protection structures at the five sites, **the Corps recommends pursuing additional conservation or wildlife easements at sites A1, A2, and A3, if willing sellers are available.** The value of contiguous lands was estimated as part of Appendix F, and there is merit in having a larger habitat area reserved for wildlife, if landowners are willing and funding is available. If a given site has a willing seller, the Corps or the NPS would coordinate with the landowner on the terms of the wildlife easement. Easements would also assist in the prevention of further clearing or timbered areas for conversion into cropland.

V. REFERENCES

Clapp, James R. 1977. Wildlife Habitat Evaluation of the Unchannelized Missouri River in South Dakota. M.S. Thesis, South Dakota State University, Brookings.

HDR Engineering, 1999. Missouri River Streambank Erosion Assessment, Gavins Point Dam to Ponca, Nebraska. Prepared for the U.S. Army Corps of Engineers, Omaha District, Contract Number DACW45-97-D-0007.

National Park Service and Corps of Engineers, 1999. Final General Management Plan / Environmental Impact Statement, Missouri National Recreational River, Nebraska and South Dakota.

State of South Dakota, Department of Transportation. 1999. Plans for Proposed Project No. P0019(20)0, SD Highway No. 19, Clay County. Unpublished document.

U.S. Fish and Wildlife Service, 1980. Technical Assistance letter to Colonel Vito Stipo (see Appendix C).

U.S. Fish and Wildlife Service, 1986. Location of habitat important to federally listed bird species in the MNRR. Unpublished report. Pierre, South Dakota.

U.S. Fish and Wildlife Service, 1994. Biological Opinion on the Vermillion Bridge, letter to Mr. Donald Kamnikar, Federal Highway Administration from Richard Ruelle, South Dakota Field Office (Appendix 10A) in Environmental Assessment and Section 4(f) Evaluation, South Dakota Project P 0019(20)0 PCEMS 238H, Nebraska Project STPD-57-4(108), Missouri River Bridge near Vermillion, November 18, 1994.

APPENDIX A

Cooperative Agreement
Between the
U.S. Department of the Interior
and the
U.S. Department of the Army
for
Implementation of Section 707
of
Public Law 95-625

The Secretary of the Interior, acting through the Assistant Secretary for Fish and Wildlife and Parks, and the Secretary of the Army, acting through the Chief of Engineers, herein set forth the terms and conditions of cooperative responsibility to be accomplished pursuant to Section 707 of Public Law 95-625 (92 Stat. 3528), an act amending the Wild and Scenic Rivers Act (16 U.S.C. 1271 et. seq.). The Wild and Scenic Rivers Act is hereinafter referred to as "The Act."

WHEREAS, The recreational segment of the Missouri River in Nebraska and South Dakota was added to the National Wild and Scenic Rivers System to preserve and protect and to make available its resources for public use as generally described in the document entitled, "Review Report for Water Resources Development, South Dakota, Nebraska, North Dakota, Montana," prepared by the Division Engineer, Missouri River Division, Corps of Engineers, dated August 1977.

NOW, THEREFORE, IT IS AGREED THAT:

I. THE SECRETARY OF THE INTERIOR, ACTING THROUGH THE ASSISTANT SECRETARY FOR FISH AND WILDLIFE AND PARKS, AND THE SECRETARY OF THE ARMY, ACTING THROUGH THE CHIEF OF ENGINEERS, JOINTLY WILL:

(A) Develop and implement detailed plans for acquisition of lands and interests in lands, development, protection and management of the designated river reach incorporating those recreation and bank stabilization aspects, real estate and other requirements necessary to carry out the provisions of the act;

(B) Establish criteria and priorities for river protection measures which are compatible with designation of the segment as a component of the National Wild and Scenic Rivers System;

(C) Establish criteria and procedures to permit access for such pumping and associated pipelines as may be necessary to secure an adequate supply of water for owners of land adjacent of the river;

(D) Confer on budget allocations required to carry out the purposes of the act; and

(E) Establish a conceptual theme for the design of recreational features and development.

II. THE SECRETARY OF THE INTERIOR, ACTING THROUGH THE ASSISTANT SECRETARY FOR FISH AND WILDLIFE AND PARKS, WILL:

(A) Administer the designated segment as a Recreational River under the provisions of the act;

(B) Initiate efforts to establish a Recreational River Advisory Group which may include members representing those organizations identified in section 3(a)(22) of the act and define the duties and responsibilities of the Recreational River Advisory Group;

(C) Upon request, provide technical assistance to the U.S. Army Corps of Engineers in those instances where the Department of the Interior has unique capability by virtue of law or special expertise required for planning and implementation of the act;

(D) Determine, upon notification by the Secretary of the Army (acting through the Chief of Engineers), or otherwise, if activities are occurring or threatening to occur along the designated river segment which constitute serious damage or threat to the values for which the segment was designated; and

(E) Submit budget requirements through normal Departmental channels.

III. THE SECRETARY OF THE ARMY, ACTING THROUGH THE CHIEF OF ENGINEERS,
WILL:

(A) Submit budget requirements for project planning, acquisition of lands and interests in lands, development of interpretive facilities and features, and construction of recreational and stream bank stabilization;

(B) Submit budget requirements for operations, maintenance and replacement of such features and facilities;

(C) Notify the representative of the Secretary of the Interior and other members of the Recreational River Advisory Group about activities that are occurring along the designated river segment which constitute a threat to the values for which the river was designated and to land and interests in land acquired by the United States, and make recommendations concerning the issuance of a determination by the Secretary of the Interior as provided for in Article II(D) of this Agreement; and

(D) Notify Interior of the congressional budget hearings on the Recreational River so that Interior will be able to testify.

IV. THE SECRETARY OF THE ARMY, ACTING THROUGH THE CHIEF OF ENGINEERS, SUBJECT TO APPROPRIATIONS WILL:

(A) Conduct or cause to be conducted during detailed planning and design for implementation of the Recreational River Management Plan (incorporated herein by reference), and in coordination with appropriate agencies of the Department of the Interior:

1. A survey to determine the sites of historical and archeological resources which may be located within the river corridor;

2. A visual resource analysis to identify any outstandingly remarkable scenic areas which should be protected as part of the Recreational River;

3. An inventory and assessment of wildlife resource values which should be protected and enhanced to maintain those qualities which led to designation of the segment; and

4. A mineral resource inventory and analysis for management of these resources.

(B) Determine the extent and location of streambank stabilization structures and other works necessary to control erosion and the legal interest in lands required for the construction and maintenance of such works;

(C) Further determine, prior to the initiation of construction (or the Federal assumption of maintenance), of any streambank stabilization structure, the extent of additional related lands or legal interests in lands within the same ownership which are required to protect and enhance the river in accordance with the purposes of the act;

(D) Condition the construction or maintenance of any streambank stabilization structure, other works necessary to control erosion, or of any recreational river feature, upon the availability to the United States of such land and interests in land in such ownership as is deemed necessary to carry out such construction and maintenance and to protect and enhance the river in accordance with the purposes of the act.

(E) Acquire in the name of the United States such additional lands and legal interests in lands required to carry out the river preservation and recreational purposes of the act in accordance with normal real estate practices of the Corps of Engineers, section 3(a)(22) of the act, and the requirements of Public Law 91-646;

(F) Design, construct, operate, and maintain the recreation and interpretive features in consonance with the Recreational River Management Plan;

(G) Design, construct, operate and maintain streambank stabilization and river preservation structures;

(H) Seek written cooperative agreements for State or local governmental participation as provided for by section 10(e) of the act; and

(I) Failing to negotiate adequate protection or willing cessation of activities which threaten the land or interests in land acquired by the United States or which threaten the values for which the river segment was designated, as determined by the Secretary of the Interior, exercise eminent domain or other appropriate remedy to prevent or terminate such adverse activities.

V. RENEGOTIATION OR TERMINATION

Either party may initiate renegotiation or termination of this agreement by 30 days written notice.

U.S. Department of the Interior

By _____ 1/4/80
Robert L. Herbst (Date)
Assistant Secretary for Fish and Wildlife and Parks

U.S. Department of the Army

By _____ 2/18/80
J.W. Morris (Date)
Lieutenant General, USA
Chief of Engineers

APPENDIX B

United States Department of the Interior
FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

AREA OFFICE: SOUTH DAKOTA—NEBRASKA
POST OFFICE BOX 250
PIERRE, SOUTH DAKOTA 57501

March 7, 1980

Mr. Bob Nebel
Corps of Engineers
Omaha District
6014 U.S. Post Office & Courthouse
Omaha, Nebraska 68102

Dear Bob:

Inclosed are maps showing four sites we feel should be added to the list of proposed bank stabilization sites you presented at the February 28 meeting at the Gavins Point Dam visitor center. These sites, as well as the seven you presented, should be evaluated by the Recreational River management planning team for possible inclusion in the FY 81 budget request for the Recreational River.

These additional sites all have significant wildlife habitat values, particularly the two high-bank islands. At the St. Helena Bend and Elk Point Dune sites, some of the better wildlife habitat is located on the low-bank land. Consequently, the policy of restricting stabilization to the high bank that was followed under Section 32 will have to be changed if these areas are going to be protected. In our opinion, this change is easily justified by the fact these areas contain many of the values that contributed to the designation of this reach as a Recreational River.

If there are any questions about any of our proposals, please contact either Larry Kallemeyn or Dewey Caster (FTS 782-5226).

Sincerely yours,

Kent D. Keenlyne

Kent D. Keenlyne
Area Supervisor, Environment

Inclosures

cc: ENV; Denver, CO

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE: SOUTH DAKOTA—NEBRASKA
POST OFFICE BOX 250
PIERRE, SOUTH DAKOTA 57501

IN REPLY REFER TO:

July 15, 1980

Colonel Vito D. Stipo
District Engineer
Corps of Engineers, Omaha District
6014 U.S. Post Office & Courthouse
Omaha, Nebraska 68102

Dear Colonel Stipo:

This is in response to the Reimbursable Funding Agreement dated April 28, 1980, requesting an inventory, evaluation, and prioritization of resources of the James River Island and seven potential bank stabilization sites within the National Recreational River reach of the Missouri River below Gavins Point Dam, South Dakota and Nebraska. We have coordinated this evaluation with the South Dakota Department of Game, Fish and Parks and the Nebraska Game and Parks Commission.

This letter is provided as technical assistance only and does not constitute a final report of the U.S. Fish and Wildlife Service as provided for under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.).

This office and the South Dakota and Nebraska Game Departments have screened and evaluated wildlife habitat within the area of each potential bank stabilization site. Our evaluation is based primarily on aerial photos on a scale of 1":1000' provided by your agency and topographic maps (1" = 24,000") on which the boundary of each stabilization structure was delineated. Nondeveloped land (natural habitat) within the proposed project areas was delineated and classified according to its terrestrial cover type. The terrestrial cover types contain 5 major categories: (1) sand dune, (2) cattail marsh, (3) cottonwood-willow, (4) cottonwood-dogwood, and (5) elm-oak. Our primary reference for habitat types and values is the types and values defined by James R. Clapp in his 1976 thesis entitled, "Wildlife Habitat Evaluation of the Unchannelized Missouri River in South Dakota." (See attachments 1 through 7.)

For our analysis, we used a dot-grid measurement for all area determinations. Although more sophisticated equipment would yield more precise measurements, the variation between methods would be insignificant at this stage of evaluation efforts.

Clapp, 1976, identified, delineated, and measured all habitats within one kilometer of the free-flowing Missouri River between Fort Randall Dam and Sioux City, Iowa. He also quantitatively described the understory and overstory of naturally vegetated habitats and subjectively assigned a habitat value to wildlife of each of the natural habitats. Procedures used to subjectively rate the habitat are outlined in the Habitat Evaluation Procedures Manual (U.S. Fish and Wildlife Service, 1976). The values derived by Clapp, 1976, were used in this evaluation to determine the relative wildlife habitat value to be protected by structural measures and through easement acquisition.

As a result of our evaluation, we have ranked the James River Island and seven potential bank stabilization sites in the order of their ecological resource values. We have restricted our evaluation to an analysis of impacts on wildlife resources with the site having the least impact and greatest opportunity to preserve wildlife habitat through easement acquisition becoming the most acceptable site. The following indicates the relative ranking:

(1) Our analysis indicates that approximately 774 acres of cottonwood-dogwood habitat dominate the James River Island. This habitat type is considered good for all terrestrial faunal groups except herptiles. Within the cottonwood-dogwood stand are open areas covered with grasses, scattered dogwood, and forbs forming a system of edges in the lower quadrant of the island. This diversity and interspersion of habitat types creates a community of plants and animals unique in the Recreational River reach of the Missouri.

Although no specific plans are available to determine the amount of bank line to be protected by structures, we firmly believe this unique area should be preserved. One hundred percent of the land protected would be nondevelopment type lands.

(2) The Burbank area contains approximately 104 acres to be directly protected by structural features. An additional 149 acres of land are considered to be subject to structural influence and easement authority; i.e. lands owned by individuals to be directly benefitted by expenditure of public funds for structure placement. Nondevelopment lands or lands of greatest value to wildlife comprise approximately 85.5 percent of the area. The subjective value of these nondevelopment habitat types (number of acres times their habitat value, Clapp, 1976) divided by the

number of miles of bank line physically protected yields a ratio of 1526.88 Habitat Units per mile of bank line modified. This admittedly subjective figure indicates that, of the seven sites where bank stabilization structure-length is known, the Burbank area yields the greatest return in terms of money expended (i.e. bank protected) and habitat to be preserved by easement acquisition.

(3) Highline Landing contains approximately 160 acres directly protected by structures. An additional 107 acres of land are considered to be subject to structural influence and easement authority; i.e. lands owned by individuals who have directly benefitted by expenditure of public funds for structure placement. Nondevelopment lands comprise approximately 93.5 percent of the area. The subjective value of these nondevelopment habitat types yields a ratio of 1108.99 Habitat Units per mile of bank line modified. This area, therefore, yields the second greatest return in terms of money expended for bank protection and habitat to be protected by easement acquisition.

(4) The Volcano Hill area contains approximately 113 acres directly protected by structural features. An additional 186 acres are considered to be subject to structural influence easement authority. Nondevelopment lands comprise approximately 72.2 percent of the land area. The subjective value of these nondevelopment habitat types yields a ratio of 890.16 Habitat Units per mile of bank line modified. This area, therefore, yields the third greatest return in terms of money expended for bank protection and habitat to be protected by easement acquisition.

(5) Fair View contains approximately 71 acres directly protected by structures. An additional 50 acres are considered to be subject to structural influence and easement authority. Nondevelopment lands comprise approximately 93.7 percent of the land area. The subjective value of these nondevelopment habitat types yields a ratio of 852.15 Habitat Units per mile of bank line modified. This area ranks fourth in terms of public expenditure for bank protection and habitat values to be protected by easement acquisition.

(6) Bolton Bend contains approximately 110 acres directly protected by structures. An additional 281 acres are considered to be subject to structural influence and easement authority. Nondevelopment lands or lands of greatest value to wildlife comprise approximately 52.6 percent of the total area. The subjective value of these nondevelopment habitat types is 824.6 Habitat Units per mile of bank line to be modified. This area yields the fifth greatest return in terms of money expended for bank protection and habitat to be protected by easement acquisition.

(7) The Yankton Reach (2 units) contains approximately 224 acres directly protected by structures. An additional 75 acres are considered to be subject to structural influence and easement authority. Nondevelopment lands comprise approximately 64.7 percent of the area. The subjective value of these nondevelopment habitat types yields a value of 359.4 Habitat Units per mile of bank line protected. This area, therefore, yields the lowest ratio for the 7 sites in terms of money expended for bank protection and habitat to be protected by easement acquisiton.

Summary

All of the respective bank protection sites have potential for the protection and preservation of wildlife habitat. Our method of ranking the sites, although subjective, is a timely and efficient method of determining the relative values of each site and for making comparisons between sites. We believe the evaluation serves the stated purpose of demonstrating where the greatest return, in terms of wildlife habitat to be preserved, can be expected for the least cost in terms of bank line modification.

Sincerely yours,

C. L. Salyer

James W. Salyer
Area Manager

Attachments - 7

cc: ENV; Denver, CO
HCRS; Denver, CO
NPS; Omaha, NE

Appendix A. Forms for Use in the Habitat Evaluation Procedures

James River Island

1. Study MNRR
2. Proposed action Bank Stabilization 2.65 mi.
3. Evaluation species
4. Sample dates
5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	774.44	7.9	6118.08
	10. 774.44		11. 6118.08

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.9

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Burbank

1. Study MNRR | 2. Proposed action Bank Stabilization 1.14 mi.

3. Evaluation species | 4. Sample dates | 5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 10.10	7.9	79.79
	(b) 96.89		765.43
Willow Cottonwood	(a) 64.29	7.5	482.18
	(b) 55.10		413.25
	10. 226.38		11. 1740.65

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.69

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Highline Landing

1. Study MNRR	2. Proposed action Bank Stabilization 1.85 m .	
3. Evaluation species	4. Sample dates	5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 9.65	7.9	76.24
	(b) 250.05		1975.40
	10. 259.70		11. 2051.64

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.9

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Volcano Hill

1. Study MNRR
2. Proposed action Bank Stabilization 1.70 mi.
3. Evaluation species
4. Sample dates
5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 11.25	7.9	88.88
	(b) 19.75		156.02
Elm Oak	(b) 149.47	6.7	1001.45
Willow Cottonwood	(a) 35.59	7.5	266.93
	10. 216.06		11. 1513.28

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.0

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Fairview Area

1. Study MNRR		2. Proposed action Bank Stabilization 1.23 mi	
3. Evaluation species		4. Sample dates	5. Target year
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 56.48	7.9	446.19
	(b) 16.07		126.95
Willow cottonwood	(a) 3.67	7.5	27.53
	(b) 33.53		251.48
	10. 109.75		11. 852.15

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.76

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Bottom Bend

1. Study: MNRR		2. Proposed action: Bank Stabilization 1.80 mi.	
3. Evaluation species		4. Sample dates	5. Target year
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 8.26	7.9	65.25
	(b) 32.60		257.54
Willow Cottonwood	(a) 98.04	7.5	735.30
	(b) 33.29		249.68
	10. 205.48		11. 1484.21

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.2

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

(a) area directly protected by structure
(b) area subject to structural influences and easement of authority

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Yankton Reach

1. Study: MNRR	2. Proposed action: Bank Stabilization 3.98 m
3. Evaluation species	4. Sample dates / 5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	(a) 33.98	7.9	268.44
	(b) 111.13		877.93
Willow cottonwood	(a) 37.89	7.5	284.18
	10. 183.00		11. 1430.55

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}}$ = 7.81

[typed for reproduction clarity - handwritten originals from USFWS are on file]

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

APPENDIX C

SUMMARY OF PRELIMINARY ALTERNATIVES ANALYSIS

PROJECT: Documentation of erosion rates on the Missouri National Recreational River, relative to considering bank stabilization measures.

LOCATION: Missouri River, mile 811 to 753

COORDINATION

* Jim Peterson	President, Missouri River Bank Stabilization Association (MRBSA)
* William Beteta	National Park Service
* Becky Latka	Omaha District, PM-AE

PRELIMINARY

1. Jim Peterson put together a list of seven sites that may be worth protecting from their ongoing bank erosion. This list was provided to the District in March 1999.

	River Mile	Description
a.	795-794 L	St. Helena Bend, Miller Farm
b.	790-789 R	
c.	789-788 L	US of Myron Grove
d.	781-780 L	US of Clay County Park
e.	779-778 R	North Alabama Point – old growth cottonwoods are gone
f.	780-778 L	North Alabama Bend
g.	765-764 R	K. Sweeney Bend (Limprecht land)

2. Planning Branch compared the 1985 and 1997 aerial photos for the 58-mile reach, estimating the loss of timber and other land. These areas are listed below.

R. Mile		Acres Lost
794	L	10.0 (area *a* from above list)
793	R	9.2
780.2	R	3.7
780	R	13.8 (area *e* from above list)
778.5	L	87.2 (area *f* from above list)
776	L	26.7 [site (3), in group described below]
774	R	34.9 [site (4), in group described below]
769.5	R	20.2 [site (5), in group described below]
755	R	14.7
753	R	20.2

3. Five sites were selected from the preceding list, based on land loss estimates and considerations of vulnerable riparian habitat. Two of the areas were also on the initial list (North Alabama Point and Bend, areas e and f), as noted above. The other sites on the initial listed were dropped from consideration, due to their limited erosion rates. The five sites selected for further analysis are as follows.

	River Mile	Description
(1)	780.0-779.2 R	Point with trees. Eagle nest in vicinity, although not at risk. (site *e* from first list).
(2)	779.3-777.7 L	Trees on outside bend – Pinkelman land (site *f* from first list).
(3)	775.9-775.2 L	Point with trees.
(4)	774.4-772.9 R	Bend/point with trees.
(5)	769.6-769.1 R	Point with trees.

AREA LOSS MEASUREMENT

Aerial photos for 1998 for the five sites in the most recent list were compared to photos from 1985 and 1990. The river's flow was similar for these three sets of aerial photos.

	Yankton M. 805.8	Gayville M. 796.0	Sioux City M. 732.2
15 Aug 1985	33,400 cfs	CRP+0.66'	32,400 cfs
18 Oct 1990	29,700 cfs	CRP-0.33'	28,800 cfs
4 May 1998	CRP-2.07'	CRP-1.65'	32,600 cfs

The area of greatest erosion within each site was identified, so that the sites could be compared for maximum erosion and total erosion. The results are as follows.

	Max. Erosion Area			Total Erosion		
Site	Length	Acres	Acres/mile	Length	Acres	Acres/mile
1	2230'	42.60	100.9	3945'	61.32	82.1
2	2100'	37.19	93.5	6930'	96.41	74.5
3	1400'	31.93	120.4	4040'	37.79	49.4
4	3340'	53.83	85.1	5970'	65.99	58.4
5	3100'	61.90	105.4	6750'	82.47	64.5

The rate of erosion for the two periods also was determined. The period between the 1985 and 1990 photos covers 5.19 years, and the 1998 photos were taken 7.54 years after the 1990 set. The erosion rates are plotted on the attached chart.

ANALYSIS OF AREA LOSS

1. Qualifications
   - Comparison between area loss estimates by Planning Branch and Hydrologic Engineering Branch: Planning's evaluation was intended to provide an approximation of the total losses in this reach, rather than to focus on any key sites. Also, that evaluation used a set of photos from a high water period (1997, flow approximately 65,000 cfs). Other factors include different interpretation of where sand deposits represent fast land or merely sandbars. These factors account for the discrepancy between the two sets of area determinations.
   - This evaluation concentrates on area losses. Selection of preferred sites ultimately will include other factors such as type of resources at risk, favorable conditions for

bank stabilization, and compatibility of any proposed work with the natural river setting.

2. Discussion

- Site 4 is not rated worst in any category. So, if only one site is to be carried further for consideration, it shouldn't be site 4. This is based strictly on comparing area losses. The type of land being eroded (e.g., scrubland versus woodland) could alter this conclusion, and this is addressed later in this document.
- Site 5 lost the most land in it "maximum loss zone." But the chart shows that almost all of this loss (about 93%) occurred before 1990. This is also true for the total loss at this site. The severe erosion at Site 5 evidently has tapered off, and it probably is too late to set up an efficient stabilization system there.
- Site 3 is the most erosive in only one category (acres/mile, in the maximum loss zone). This would put it in the same position as Site 4, where the erosion rates would not justify choosing this site to receive the protection. In fact, it would be prudent to defer any stabilization work here for another reason. The developers of a proposed bridge across the Missouri River in this area will need to address bank erosion, and their work may provide a satisfactory fix for Site 3.
- Sites 1 and 2 have the highest total area losses for the five sites, and the erosion is still strong after 1990. These two sites would be good candidates for new bank stabilization work.

3. Summary

Sites 1 and 2 should be evaluated further for a possible bank stabilization project. Site 4 could be pursued if other factors overshadow the acreage losses of Sites 1 and 2. Site 3 has considerably less erosion than sites 1 and 2, and should be removed from consideration. The severe erosion at Site 5 evidently has subsided, and a bank stabilization thus would be more beneficial elsewhere.

OTHER CONSIDERATIONS

The 18 October 1990 photos were studied to determine the extent of tree coverage in the erosion areas. [1. Photo 6-15; 2. 7-14; 3. 10-2; 4. 10-6; 5. 12.2]

- Site 1 was identified as a critical site. The area loss measurements support this conclusion. One problem with this site, though, is that the erosion terminus seems to be following a straight line across the point. If the river completes its cut through the point, the erosion may slow down on its own. Furthermore, the area of trees left on the point is quite small. Although the erosion estimates to 1998 show this to be a good candidate for stabilization, it may already be in the process of stabilizing itself.
- Site 2 has an extensive area of tree coverage in the erosion area. Of the two high-erosion sites (1 and 2), this site appears to have more valuable riparian woodland to protect.
- Although Site 4 has only a modest rate of erosion (58 acres per mile, as compared to 74 and 82 acres/mile at Sites 1 and 2), it is a large, fully wooded tract. This may in fact be limiting the erosion rate. This timber resource remains at risk, and a stabilization project could have a major impact here.

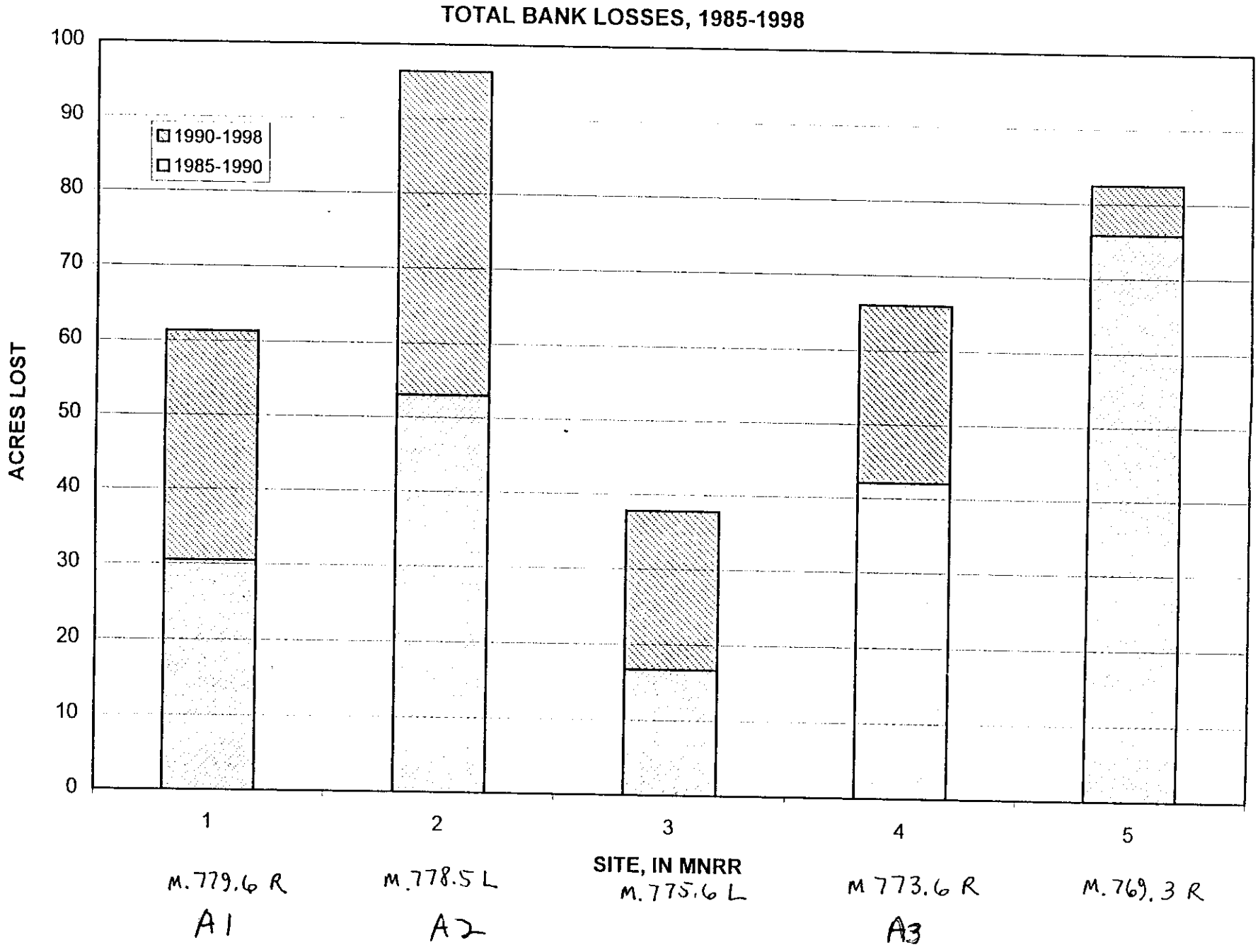
RECOMMENDATION

The information cited above supports further analysis of Sites 2 and 4. The resources at risk should be quantified, and the sites should be reviewed for any unknown property values (e.g., historic properties). The erosion loss review is not as strong for Site 1, but that site also should be pursued further, since the MRBSA defined it as a critical area.

PREPARED BY: Jerry Tworek ED-HF
Revised 03 Aug 1999

ATTACHMENTS

- Chart: Total Bank Losses, 1985-1998
- 5 photocopies of 1998 aerial photo, 1"=1000'


TOTAL BANK LOSSES, 1985-1998
ACRES LOST
100
90
80
70
60
50
40
30
20
10
0
1990-1998
1985-1990
1
2
3
4
5
SITE, IN MNRR
M.779.6 R
M.778.5 L
M.775.6 L
M 773.6 R
M.769.3 R
A1
A2
A3

APPENDIX D

CENWO-ED-HF (11-2-240c) 22 September 1999

MEMORANDUM THRU CENWO-ED-HF
CENWO-ED-H

FOR FILES

SUBJECT: Trip Report for August 1999 River Inspection – Missouri National Recreation R.

1. **Introduction:** Planning Branch is evaluating erosion areas on the Missouri National Recreation River where federal bank stabilization efforts might be appropriate. This is being coordinated with the National Park Service, which oversees the Recreational River. We are investigating whether there are any sites in the reach between Gavins Point Dam and Ponca State Park where it would be in the government's interest to protect and enhance values for which the river received its recreational designation. The District reviewed the erosion rates at five sites, and concluded that two of those sites have already lost much of their erosion-prone land. The South Dakota Department of Game, Fish and Parks recommended that four areas under their jurisdiction should be considered for stabilization assistance. Of those, they feel that two carry a higher priority. Thus, our mission was to inspect five erosion sites, and to discuss possible remedies.

2. **Preliminary Site Investigations:** The boat for our inspection was supplied by the Gavins Point Project, with John Baldwin as the operator. John and I set out from the Mulberry Bend ramp in a flat-bottom boat on the afternoon of 23 August 1999. We proceeded upstream into the Vermillion River Chute bank stabilization area, meeting up with Ms. Jean Smith. She is the administrator of the G. Walker Shaw farm, which runs along about 8000 feet of this group of stabilization structures. Ms. Smith had been in touch with the District directly and through her congressmen, since February of this year. She has submitted documentation of erosion losses, and contends that the federal structures have failed to protect the farmland.

   Ms. Smith was accompanied by Terry Pellman, Mike Isaacson and Gerald Beach. Mr. Isaacson is the resident farmer on the Shaw farm, and Mr. Pellman is a farm asset manager for a bank. Mr. Beach was representing a landowner upstream from the Shaw property. Our group except for Mr. Beach boarded the boat, and we made our way upstream through the shallow channel on the south side of the island. We reached the one area along the Shaw reach where the revetment is showing significant weakness. Mr. Isaacson pointed out that although there clearly is rock missing from the revetment, its deterioration is not rapid at this time. Certainly, the shallow channel does not carry a strong current during times of average flow. John and I agreed that a repair here is not urgent. The weak area is about 250 feet long. The revetment then follows the high bank, leaving it sheltered by low land. The farm's eroding land is riverward of the line of stabilization structures, and thus is not subject to those structures' protection.

3. **Erosion Assessments - 24 August 1999:** John Baldwin brought the Lund 371 down to the Mulberry Bend ramp on 24 August, where the District group met up with the Park Service and a representative of the Missouri River Bank Stabilization Association. The dam was releasing 38,800 cfs. We set out at 10:00, with the following team:

John Baldwin	Gavins Point Project
Becky Latka	Planning Branch
Luke Wallace	Planning Branch
Jerry Tworek	Hydrologic Engineering Branch
Phil Campbell	National Park Service
Lauren Johnson	National Park Service
Darrel Curry	Missouri R. Bank Stabil. Assn.

The South Dakota Department of Game, Fish and Parks (GFP) met us on the water, after putting their boat in at Clay County Park. Their contingent comprised Steve VanderBeek, Brian Humphrey and Jeff Vanmeeteren. We worked our way upstream to the uppermost site.

B1 – Mile 787.5L, Myron Grove Game Production Area:

GFP pointed out that the main erosion is on the upper third of this 4000-foot bankline. The worst erosion was during the high water of 1997, with the bank losing 30 to 50 feet. This area is forested mostly by cottonwoods, with some cedars. The water runs shallow near the bank, and snags are in place all along this site. While the bank continues to erode, sediment has built up near the shore. This has caused the public boat ramp at the downstream end of this area to become inaccessible. The erosion and sedimentation problems possibly could be addressed with bendway weirs, which would direct flow away from the vulnerable bank and toward the boat ramp. Adding tree snags to those already there would help protect the bank from waves as well as the current. Sediment Range 822.0 can provide information at the upper end of this area.

B2 – Mile 781.0L, Clay County Park:

GFP's other high priority site is at the forested area just upstream of Clay County Boat Ramp. The bank here is about ten feet high, and most of the trees are cottonwoods. The property upstream of this timberland is protected by broken concrete, and a 4-year old revetment protects the boat ramp grounds. This leaves a 1500-foot gap where the timberland is under attack. Rock structures would be appropriate in this gap, basically building in from the effective riprap on either end. When I spoke with Clay County Commissioners last year about this area, I mentioned that a system of hardpoints might be a practical approach, to leave some of the bank unarmored. This would be about as effective as continuous armor, but would allow deer and other wildlife access to the water. The revetment at the ramp grounds has a substantial refusal, which would fit with hardpoint hydraulics.

A1- Mile 779.5R, Point on inside of North Alabama Bend:

This area is one of the three sites (along with A2 and A3) that the District erosion analysis determined to be of a high priority for stabilization. The erosion has been severe as the river continues to attack the point. The resulting shoreline upstream of the point now is nearly a straight line. The point extended about 1000 feet north from that line in 1985, but now extends only 350 feet. If the erosion follows the pattern shown between 1985 and 1998, it would diminish once the remainder of the point is gone. The tree-covered point represents only 5 percent of this 4000-foot eroding bankline. Over 60 percent is timberland on the upstream (west) end, and the area just upstream of the point comprises about 33 percent of this site. The water is about 20 deep, 40 feet out from the 12-foot high bank. This deeper water would minimize the effectiveness of a tree snag design like discussed above for area B1. The indication for this site is either a series of short hardpoints, or bank armor. Recognizing the apparent slowing of erosion along the overall site, Mr. Curry noted that

it might be best to concentrate on protecting the point. His suggestion seems to fit well in the bank's evolving configuration. Securing the point remnant with an adequate refusal (along with a short revetment) would interfere with the river's southward sweep, and of course, would protect the timberland. There is an eagle nest about a quarter mile back from the point, so the river eventually could take out the nest tree if the erosion would move unobstructed to the south, across the point.

A2 – Mile 779.0L, North Alabama Bend:

This area extends for 1¼ miles, along both low (4') and high (10') banks. The soil is mostly sand (as is generally the case for these old vegetated sandbars). The water was ten feet deep, ten feet out from the bank. The key resource is timber, primarily cottonwoods. A flow diversion system could be effective here, using bendway weirs or Iowa vanes. One drawback with that approach would be the significant engineering design needed to properly transition the flow back into the "natural" flow downstream. South Dakota's Frost Wilderness is just downstream, and the approach for the future Missouri River bridge will be along and south of that state land. High amounts of material probably would be needed due to the project length and the deeper water (compared to B1).

A3 - Mile 773.5R, Downstream from Mulberry Bend stabilization project:

This was identified as Site 4 in the recent erosion analysis. It is timberland on an old sandbar. The old river channel on its upstream end is conspicuous, with its lack of trees. The riverbank along this timberland is 10 to 12 feet high. The river has cut a deep scallop along this 6000-foot stretch. The noteworthy characteristic is the shallow depth in the resulting cove. The water was 3 to 4 feet deep fifteen feet out from the bank. That depth appeared to hold steady over much of the erosion scallop. In contrast to site A1, the erosion is fairly slow at the point on this area's downstream end. Existing snags in this cove are indicative of a practical means of slowing the erosion and enhancing accretion. Bendway weirs combined with tree assemblages could restore the flow pattern that existed fifteen years ago. The weirs would be submerged (except for an occasional pile of stone to alert boaters), and the additional trees would blend in with the natural snags. Range 806.3 is in the middle of this site, providing additional hydrographic information.

4. **Summary of Erosion Observations:** The inspection team looked at five sites on 24 August 1999. South Dakota GFP was on hand for the two areas furthest upstream (B1 and B2). The District plans to do an erosion analysis on those two sites along the lines of that done for the "A" sites. Information to this point indicates that the five sites are worth further consideration for bank stabilization. (Two other areas initially suggested by GFP have been set

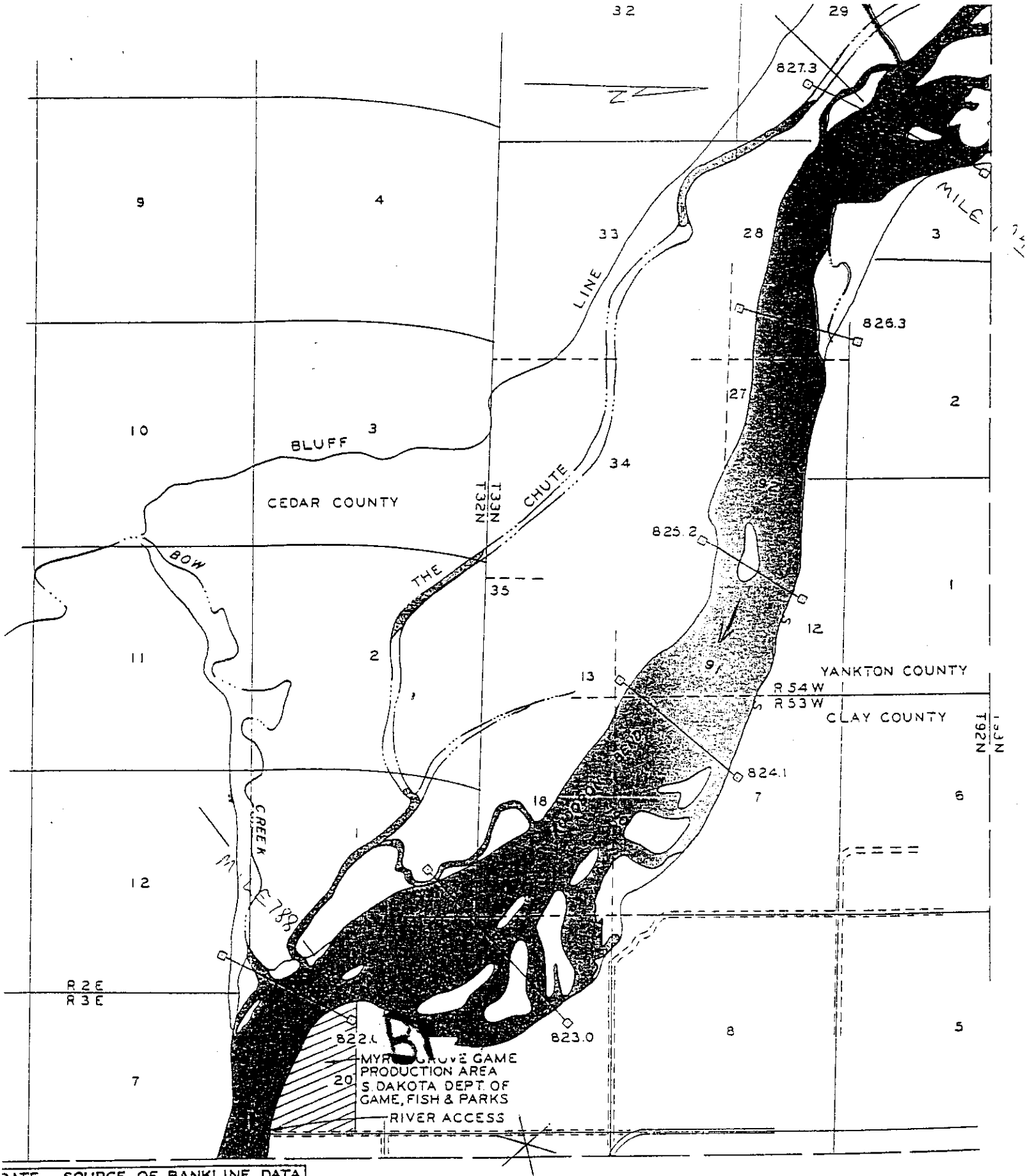
aside due to their lower priority. The District's earlier analysis also moved two sites out of contention, at mile 776L and 770R). The five priority sites are summarized below.

	Mile	Length (feet)	Recommendation	Conditions for Stabilization
B1	787.5L	4000	bendway weirs and tree snags	good
B2	781 L	1500	series of hardpoints	good
A1	779.5R	250	refusal and revetment	good
A2	779 L	6800	bendway weirs	fair
A3	773.5R	6000	bendway weirs and tree snags	good

5. **Pending Actions:** The District will continue to analyze these five sites. We will estimate the erosion rates at Sites B1 and B2 by comparing aerial photos, as was done for site A1 through A3. Survey information at the available ranges will be reviewed, to further assess elevations and erosion trends. The participating agencies will review the District's analyses, and offer their recommendations. The analysis then would move to a preliminary layout of recommended stabilization measures, to estimate costs.

JEROME J. TWOREK
Sediment & Channel Stabilization Section
Hydrologic Engineering Branch
Engineering Division

CF:
CENWO-PM-AE (Latka, Wallace)
CENWO-PM-C (Timp)
CENWO-OD-GP (Baldwin)



DATE	SOURCE OF BANKLINE DATA
1980	U.S.C. OF E. AERIAL PHOTOS

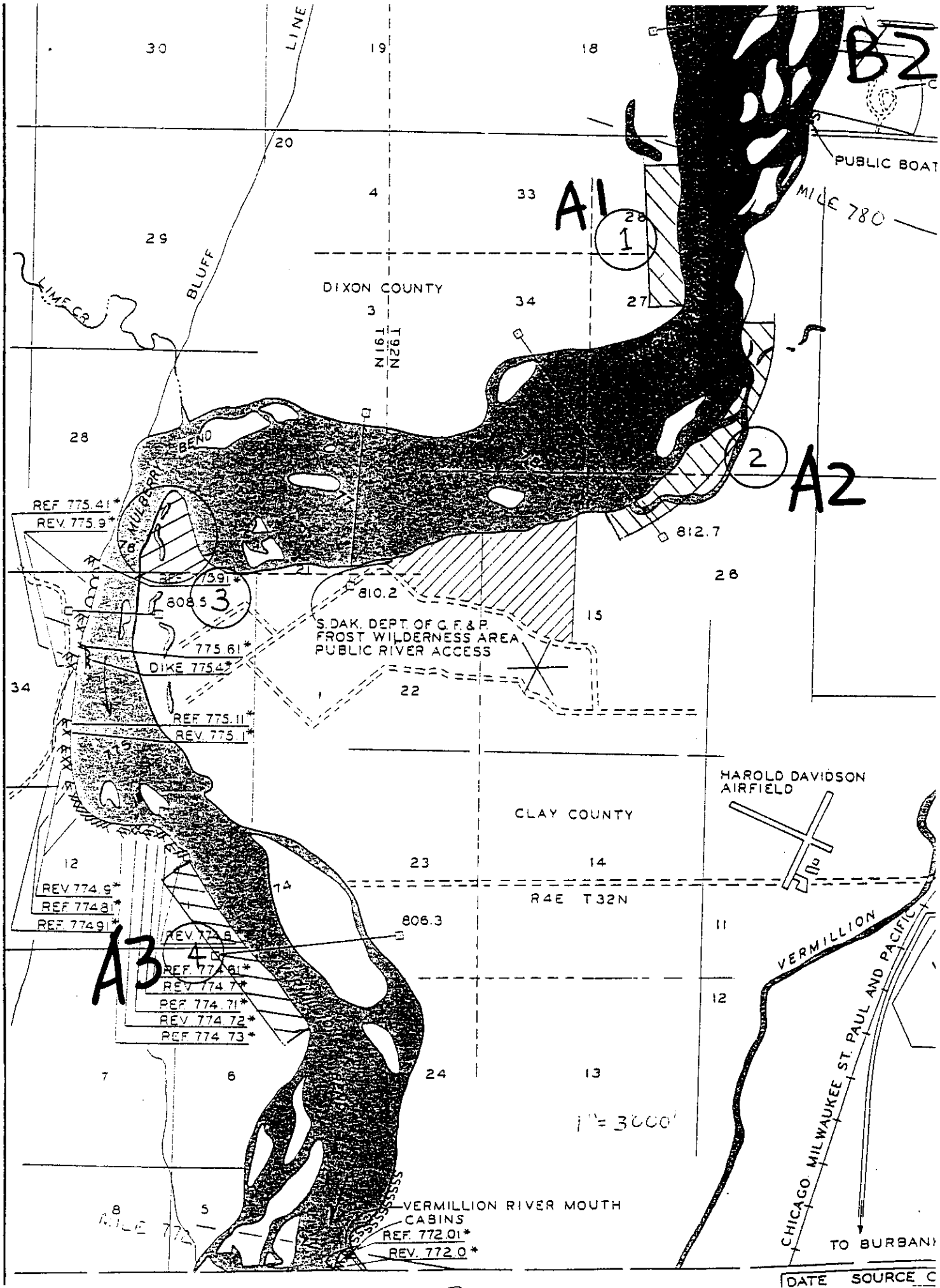
* Structure Number Based On 1960 River Mileage

SCALE IN FEET

2000 0 2000 4000

GEND:

6


30
19
18
LINE
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4
33
29
28
27
34
3
T92N
T91N
BLUFF
LIME CR
DIXON COUNTY
B2
A1
A2
A3
PUBLIC BOAT
MILE 780
1
2
3
4
REF 775.41*
REV 775.9*
MULBERRY BEND
REF 775.91*
808.5
812.7
810.2
775.61*
DIKE 775.4*
S. DAK. DEPT. OF G. F. & P.
FROST WILDERNESS AREA
PUBLIC RIVER ACCESS
15
22
REF 775.11*
REV 775.1*
HAROLD DAVIDSON
AIRFIELD
CLAY COUNTY
12
23
14
REV 774.9*
REF 774.81*
REF 774.91*
R4E T32N
806.3
11
REV 774.8*
REF 774.61*
REV 774.7*
REF 774.71*
REV 774.72*
REF 774.73*
VERMILLION
7
6
24
13
1"=3000'
8
5
MILE 772
VERMILLION RIVER MOUTH
CABINS
REF. 772.01*
REV. 772.0*
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
TO BURBANK
DATE
SOURCE

APPENDIX E

Erosion Analysis at Potential Bank Stabilization Sites
Missouri National Recreational River
March 2000

Preface: This document represents a thorough revision of an erosion analysis done in October 1999. Therefore, this March 2000 report supercedes the October 1999 write-up.

LOCATION: Missouri River, mile 811 to 753

COORDINATION
- National Park Service
- South Dakota Department of Game, Fish and Parks (GFP)
- Missouri River Bank Stabilization Association

REFERENCE
- HDR Engineering, Inc., *Missouri River Streambank Erosion Assessment, Gavins Point Dam to Ponca*, April 1999
- *Summary of Preliminary Alternatives Analysis* (revised 3 Aug 1999)
- Trip report by ED-HF dated 22 Sep 1999, for August 1999 River Inspection

BACKGROUND

The District evaluated erosion rates at five sites on the Missouri National Recreational River, to determine where bank stabilization measures would be cost effective. That review process concluded that the erosion at two of those sites had slowed to the point that bank stabilization efforts no longer would be practical. At the same time, the SD Department of Game Fish and Parks suggested that four wildlife areas are in need of bank protection. Their own preliminary assessment determined that two of the four areas (Frost Wilderness and Donnelly-Cusick game production areas) were of a lower priority. As a result, the coordination group listed above will closely evaluate a total of five sites (three from our preliminary assessment, and the two high-priority sites proposed by GFP). These areas are listed below.

Table 1 – Primary Candidates for Bank Stabilization

B1	mile 787.5 L	Myron Grove Game Production Area	GFP
B2	mile 781 L	Clay County Park	GFP
A1	mile 779.5 R	Point on North Alabama Bend	District prelim.
A2	mile 779 L	North Alabama Bend	District prelim.
A3	mile 773.5 R	Vermillion Reach	District prelim.

RECENT EROSION

The District compiled erosion data for the period of 1985-1997, as documented in the HDR Engineering, Inc. reference indicated above. Figures 1 and 2 show the average per-mile erosion for both banks between Yankton and Ponca State Park. The erosion at the nine areas of existing federal bank stabilization areas is shown as zero on the charts. Excluding those areas, the right bank has an average erosion rate of 1.2 acres per year, and average left-bank erosion is 1.0 acre per year. The key erosion rates are summarized in Table 2, in ascending order of erosion.

Figure 1 - Estimated Erosion, Left Bank
Missouri River, 1985-1997
Yankton to Ponca State Park

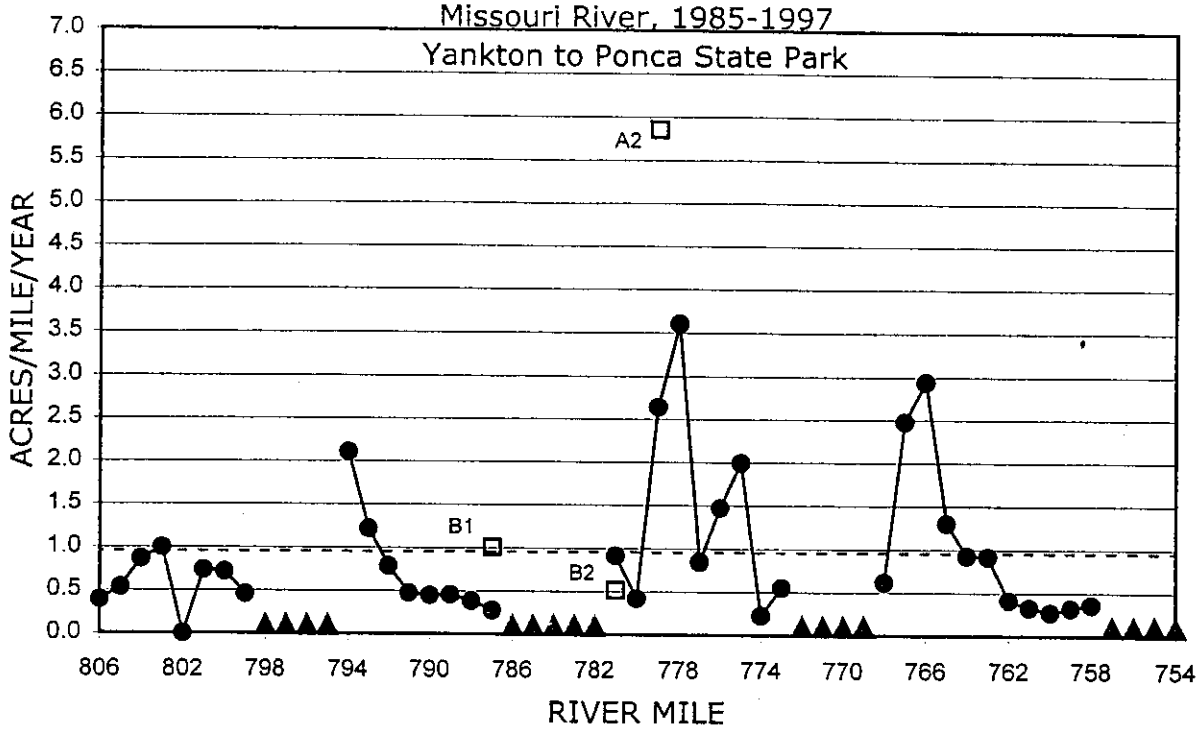
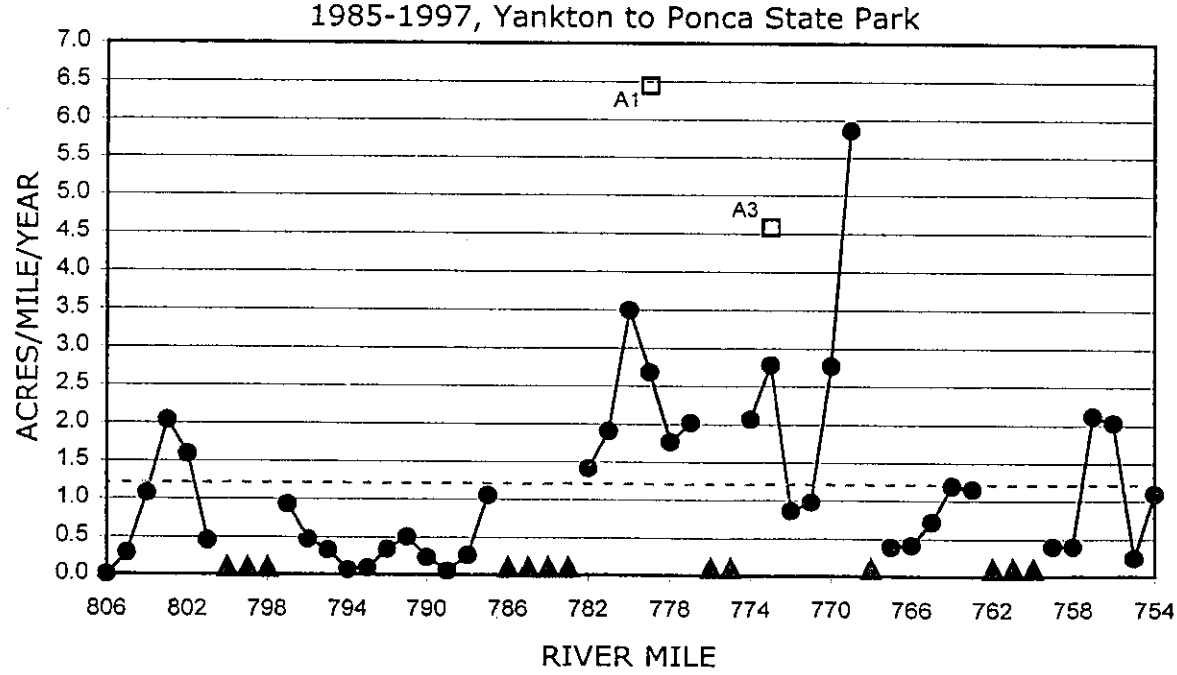


Figure 2 - Estimated Erosion - Right Bank, Missouri River
1985-1997, Yankton to Ponca State Park



Notes for Figs 1 and 2: Dashed line marks the avg. erosion; triangles show existing fed. bank stabilization.

As a general note, approximately 64 percent of the erosion in this reach is attributable to the bank, with riverbed degradation comprising the remaining 36 percent (Waterways Experiment Station, Tech Report CHL-98-1, March 1998).

Table 2
Missouri River Average Annual Bank Erosion Rates, Yankton to Ponca, 1985-1997

Area	Acres/mile
Site B2	0.5
Site B1; avg. for L. bank	1.0
average for right bank	1.2
Site A3	4.6
Site A2	5.9
Site A1	6.4

The August 1999 analysis for the A sites looked at the bankline change between 1985 and 1998. Comparing the aerial photographs of 1985 to 1990, we concluded that the change in that period for the two GFP sites was negligible. Therefore, the analysis shifted to the most recent period, 1990-1998. The losses in that latest period were found to be 5.9 acres for Site B1 and 2.0 acres for B2. This is considerably less than the three A sites, where losses were between 21.9 and 43.5 acres. Comparison is facilitated by looking at the erosion per 1000 feet of bank. The B sites are significantly lower than the A sites in this category also, as shown below in Figure 3.

POTENTIAL BANK STABILIZATION

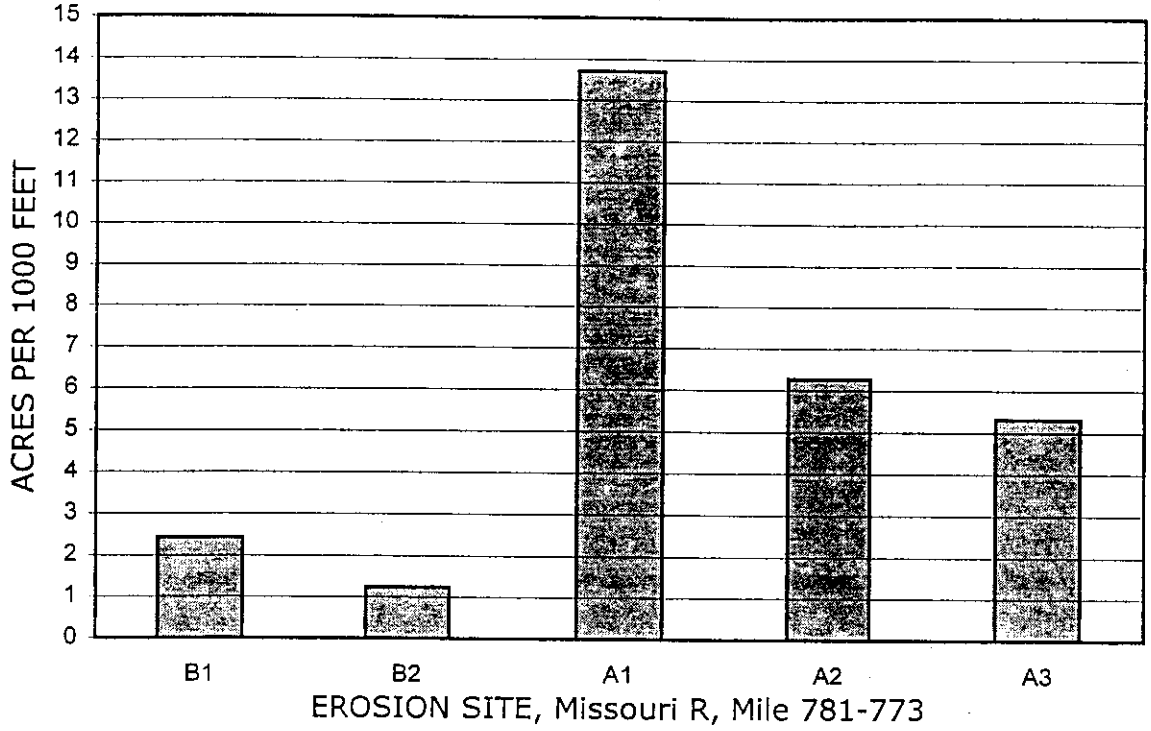
The inspection team discussed methods for stabilizing the various sites during our 24 August 1999 tour. As a result of those discussions, the District Hydrologic Engineering Branch proceeded to evaluate a "likely" stabilization method for each of the five areas, as outlined below. Additional information was available from recent sediment range surveys in three of the areas. Range 822.0 cuts through the B1 area, but it is downstream of the active erosion area. Range 812.7 further documented erosion at area B2, and showed a depth (about 17') near the bank that would require a significant amount of rock for weirs or hardpoints. The most recent survey at Range 806.3 in the A3 area (in 1995) confirmed that water depths are less than five feet for several hundred feet out from the right bank.

B1 – Myron Grove Game Production Area, Left Bank

We had envisioned a continuous system of bendway weirs along most of this mile-long bankline at the Myron Grove area. This would address the heavy erosion on the upper third, and would stabilize the rest, while providing for some deeper flows to the silted-in boat ramp. However, the aerial photos revealed that the active erosion is basically confined to that upstream one-third, so that it wouldn't be practical to stretch the stabilization system all the way down to the ramp. Since our primary goal is to control bank loss, the ramp sedimentation problem should be addressed through a different program. The convex bank configuration doesn't lend itself to bendway weirs, since their upstream orientation would not align properly with the current. We therefore switched our focus to hardpoints. Each hardpoint would include a couple of cabled tree units (probably three trees per unit), to camouflage the rock, add flow roughness, and improve fish

habitat. These would mimic the snags that are evident at this site. The tree units would be used for all the other weir and hardpoint projects at the other sites.

Figure 3 - Bank Erosion, 1990-1998



The first hardpoint would be located at the apparent east property line (as observed on the aerial photo). The maximum spur length on the hardpoints was set to the average width of bank loss for the 1990-1998 period, 105 feet. The average spur length is 77 feet. A set of seven hardpoints would protect 2020 feet of bank, requiring 4270 tons of stone.

B2 – Clay County Park, Left Bank

This area of trees has a 1615-foot bank between existing riprap. Again, a system of hardpoints would be a reasonable approach for protecting this site. The gaps between hardpoints would preserve the natural bank, rather than paving it with rock. Each hardpoint would not extend beyond the 1990 bank alignment at that location. The result is one hardpoint spur at 70 feet long, and an overall average length of 47 feet for all 10 spurs. This system would take 4560 tons of stone. It would include cabled/anchored trees.

A1 – Point at North Alabama Bend, Right Bank

As was discussed in the preliminary analysis, the aerial photographs indicate that the 4000-feet of eroding bank (1985-1990) now has its erosion potential concentrated along the eastern-most 1000 feet. The remaining point coincides with a 500-foot wide stand of trees. The stabilization effort focused on this timberland, as the primary resource at risk in area A1. A 50-foot refusal would cut off any erosion into the main stand of trees. Since this west tree boundary does not extend to the water's edge, the refusal would continue toward the river along a northeast diagonal,

connecting to the actual timber/water interface. The result would be a total refusal length of 400 feet, with an additional 230 feet of armor on the bank. This would require 3150 tons of rock, protecting 500 feet of bank. The deep water along the eroding bank would make it impractical to add tree assemblages.

A2 – North Alabama Bend, Left Bank

This area has active erosion along 7000 feet of bank. Bendway weirs could produce an effective deflection system, but they would require a high rate of stone due to the deeper water (as compared to the other hardpoint/weir locations discussed herein). The maximum encroachment was set at 1/10 of the 2000-foot wide channel. The maximum upstream orientation for the fourteen weirs would be 25°. This system would require 31,270 tons of stone, and would protect 6970 feet of bank.

A3 – Vermillion Reach

The erosion in this area has cut deep into timberland, but the downstream point has remained mostly intact. The result is a deep cove, where the 1990-1998 loss is up to 300 feet. The maximum encroachment for the weirs was set at 250 feet, well within that erosion band. The stabilization measure would start at the opening of an old chute, even though the first 500 feet downstream from the chute saw minimal erosion since 1990. The first three weirs thus would merely transition the flow into the main stabilization system, with weir lengths of 25, 50 and 80 feet. The middle weirs in this system would have an upstream angle of about 25°, but the downstream three at the point would be set at 0° (perpendicular to the bank). This project would comprise 12,800 tons of stone, in twelve weirs.

COST ESTIMATES, BASED ON RECENT EROSION

Excavation and placement of cabled trees were added to the stone quantities for the potential stabilization measures. The estimated costs then were tabulated relative to the length of protected bank, and to the theoretical acreage protected This last parameter merely takes the most recent bank loss information (1990-1998), and assumes a similar amount of land would be lost if stabilization measures are not implemented. *These cost estimates are primarily for comparing alternatives. Estimates made after actual site surveys are expected to vary considerably from these preliminary numbers.*

EROSION TRENDS

As noted above, the erosion rates were determined for two periods, 1985-1990 and 1990-1998. This was a good tool for assessing the near-term erosion. However, the long-term trend is difficult to see based only on two periods. Consequently, we expanded the evaluation to look at older sets of aerial photographs, 1972 and 1978. The result was four periods of erosion estimates, each covering between 5.2 and 7.3 years. Adding the earlier periods to the analysis verified some conclusions that the recent data produced. In addition, it allows us to project how the sites will fare in the future. The historical record between the 1972 and 1998 photo series comprises 25.7 years. Future erosion was projected for the same length of time, to the year 2024.

Just as the erosion for sites B1 and B2 was negligible between 1985 and 1990, the erosion at those sites in the two study periods up to 1985 also did not reveal any critical trends. The photo record for sites A1 through A3, however, shows significant erosion prior to 1985. This is documented in the following sketches (Figures 3 through 5), which are taken from the aerial photos.

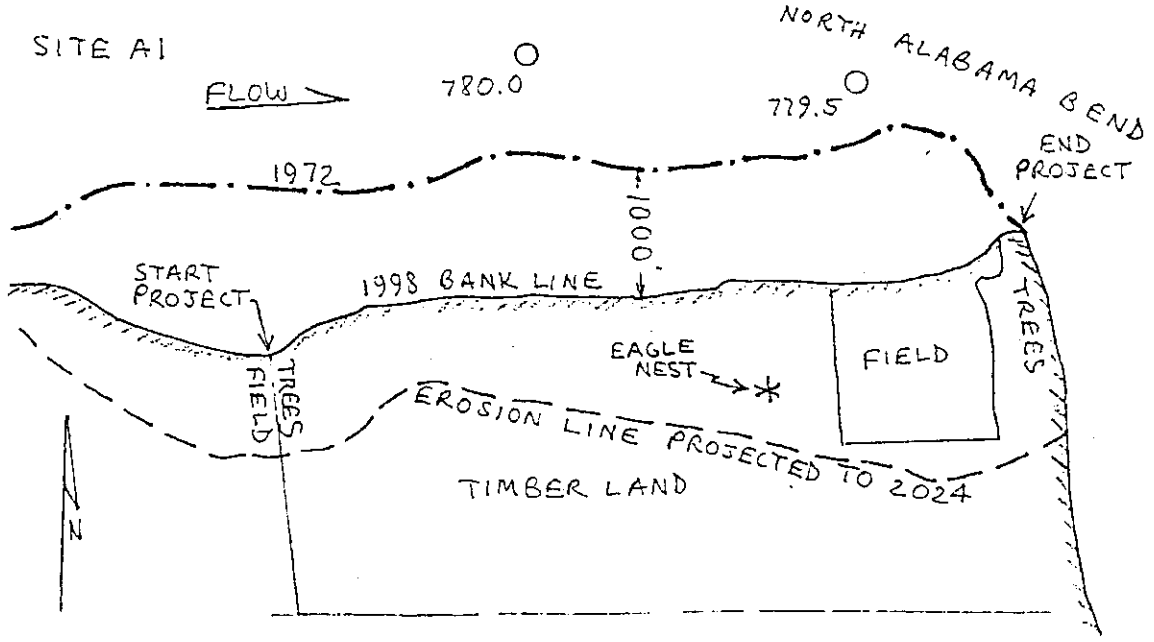
Table 3 – Estimated Stabilization Costs
Relative to Most Recent Erosion (1990-1998)

Site	Stabil. Measure	Protected Bank, ft.	Total Cost	Cost per 1000 ft.	Cost per acre
B1	Hardpoints	2020	$136,700	$ 67,650	$ 27,840
B2	Hardpoints	1615	153,100	94,810	76,460
A1*	Refusal, revetment	500	89,400	178,800	13,040
A2	Bendway weirs	6975	875,300	125,500	20,020
A3	Bendway weirs	4770	378,900	79,400	14,950

* Additional evaluation described below determined that stabilization for all of site A1 may be warranted. Therefore, this site will take on the designation as either A1a (minimal protection) or A1b (full protection).

The most significant change to the erosion estimates from inclusion of the 1972-1985 period is the heavy erosion that occurred along the west portion of site A1 prior to 1985. Although the more recent erosion was given a heavier weighting in the projection estimates, the residual trend for 1972-1985 on this westerly stretch remains significant. Consequently, an arrangement for protecting all of site A1 was added, with the designation A1b. A series of long hardpoints (i.e., dikes) is a reasonable design for this long, straight bankline. Each of the ten stone dikes for this site would include sets of cabled trees on their downstream side. The hardpoints would be up to 250 feet long, compared to the 800-foot wide erosion zone between 1972 and 1998. The project would protect 5930 feet of bank. The cost per unit length of bank for the various sites is shown in Figure 7.

Figure 4. Successive bank lines at Site A1, 1972-1998



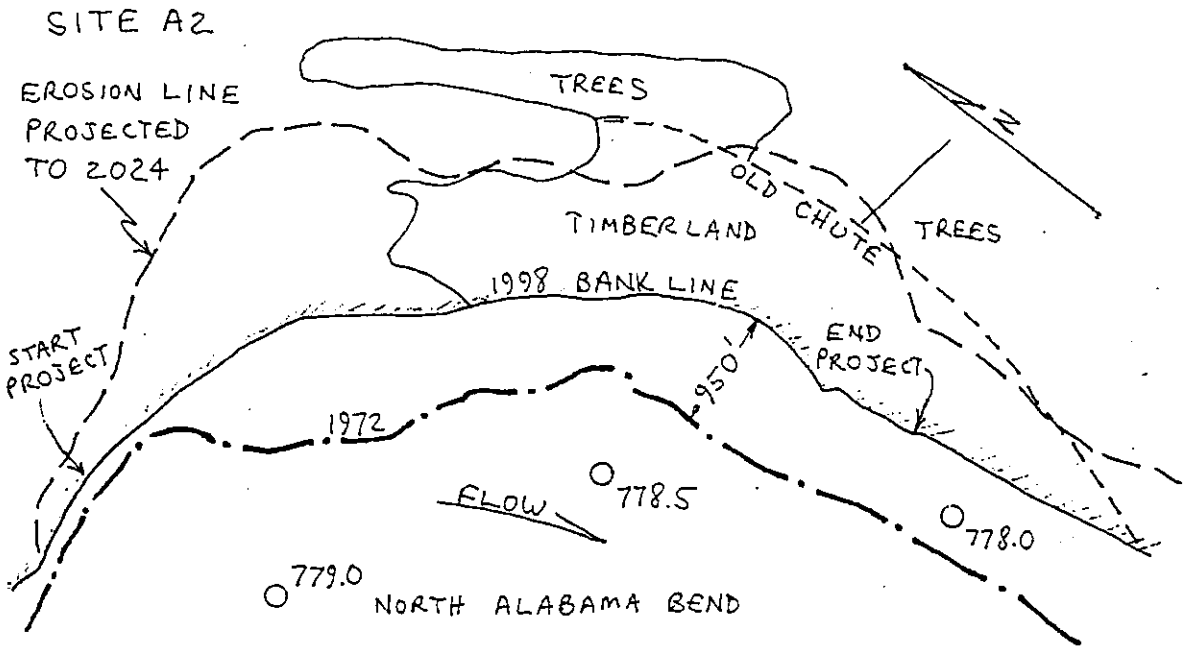


Figure 5. Successive bank lines at Site A2, 1972-1998

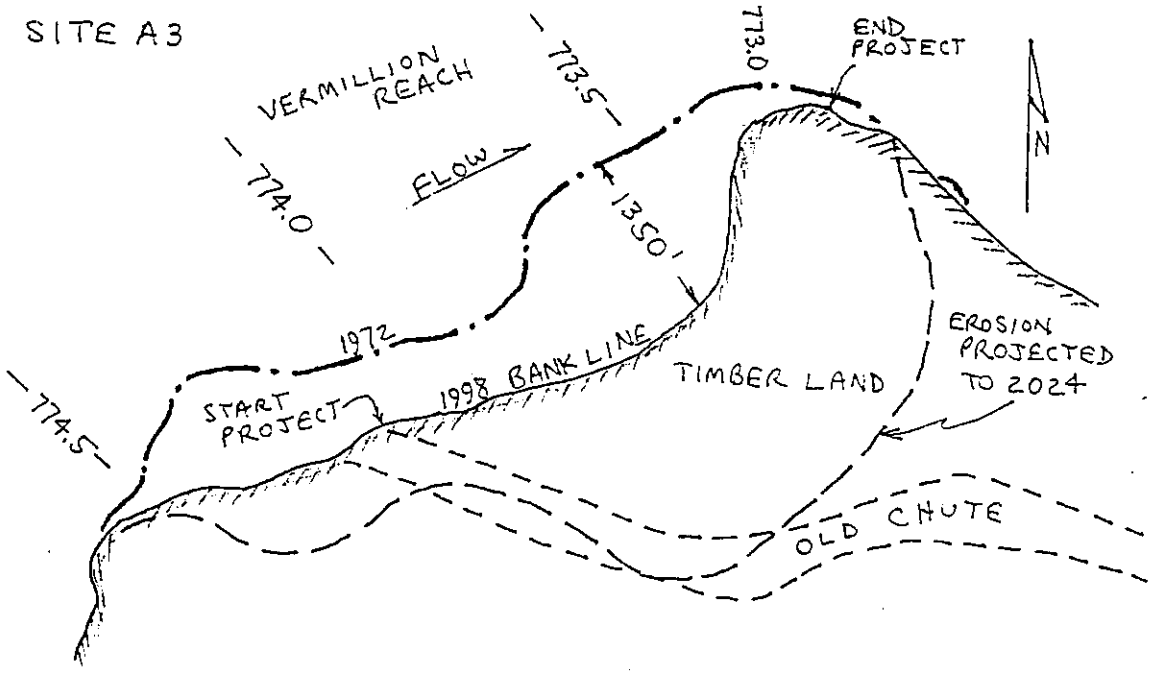


Figure 6. Successive bank lines at Site A3, 1972-1998

COST ESTIMATES, BASED ON PROJECTED EROSION

The projected erosion for the next 25 years was factored into the project cost, thereby yielding different unit costs from those shown in Table 3. The cost estimates for the projected erosion are

Figure 7 - Estimated Cost Per 1000 Feet of Bank Stabilization
(Stone Construction)

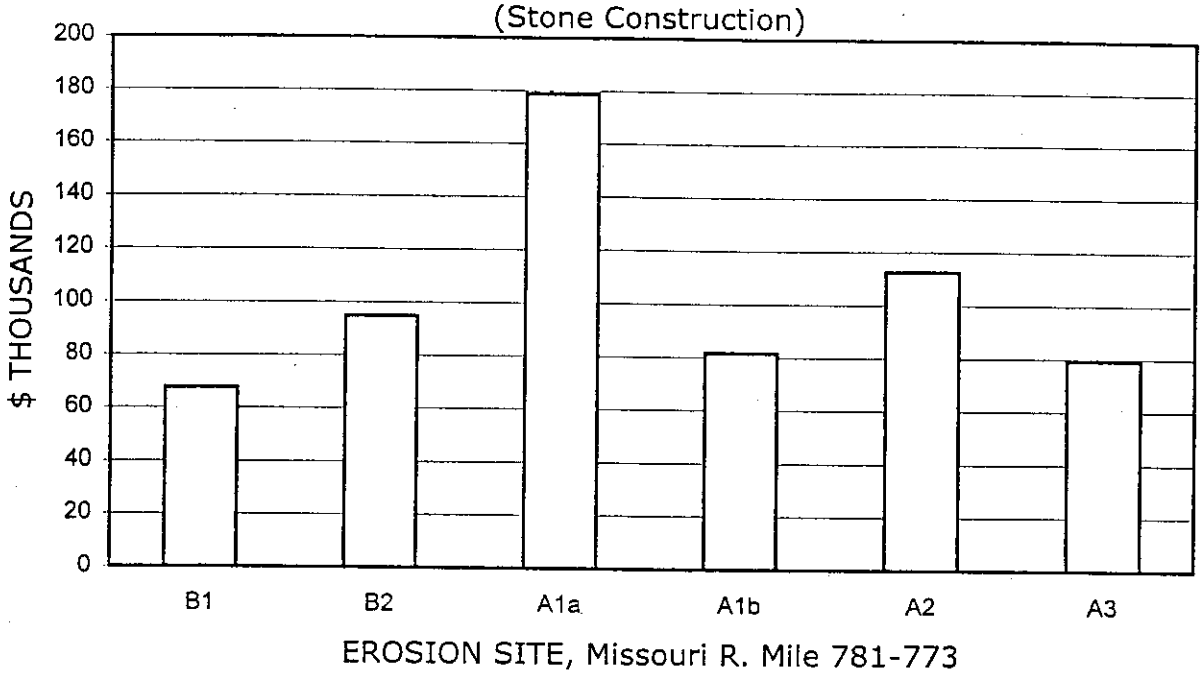
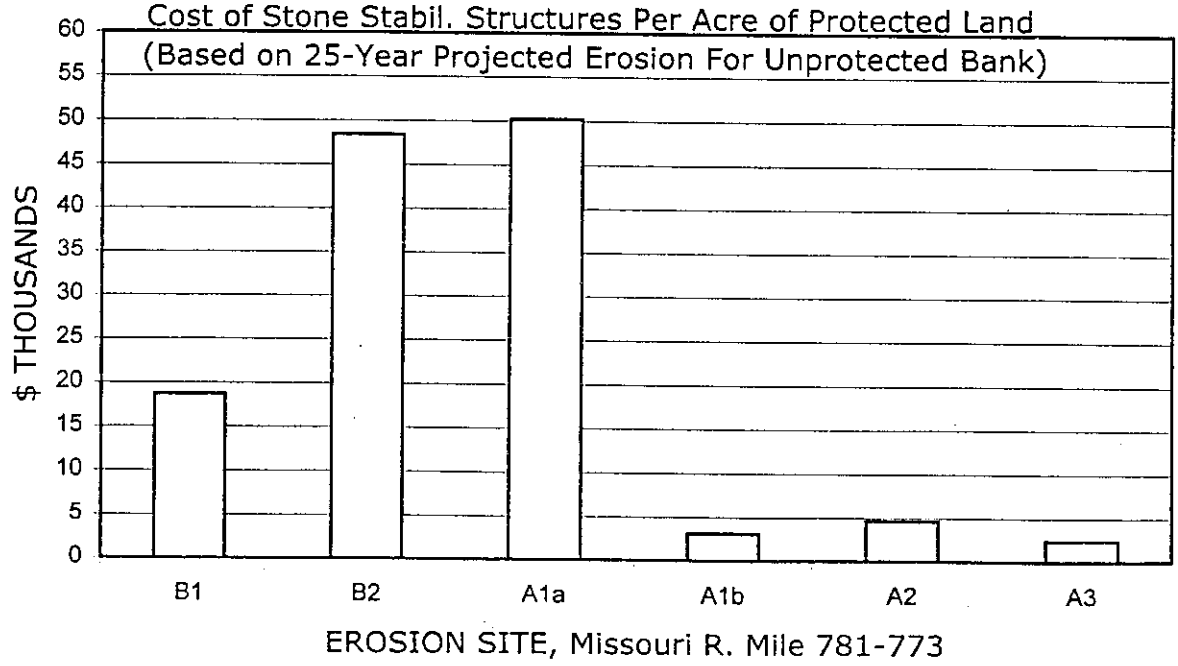


Figure 8
Cost of Stone Stabil. Structures Per Acre of Protected Land
(Based on 25-Year Projected Erosion For Unprotected Bank)



shown in Table 4, which lists two bank lengths for site A1 (as discussed above). The cost per acre also changes somewhat for site A3, where the total amount of bank protection will vary according to how the future erosion will leave the downstream point at that site. These costs are depicted in Figure 8.

Table 4 – Estimated Stabilization Costs
Relative to Projected Bank Erosion

Site	Stabil. Measure	Protected Bank, ft.	Total Cost	Cost per 1000 ft.	Cost per acre
B1	Hardpoints	2020	$136,700	$ 67,650	$ 27,840
B2	Hardpoints	1615	153,100	94,810	76,460
A1a	Refusal, revetment	500	89,400	178,800	13,040
A1b	Dikes	5930	483,900	81,600	3,140
A2	Bendway weirs	7775	875,300	112,600	4,610
A3	Bendway weirs	4770	378,800	79,400	2,410

ALTERNATIVE METHODS

The above cost comparison among the eroding sites focused on a typical method of stabilization for each location. Specifically, this was based on the high level of confidence and durability that stone structures provide. However, biological stabilization materials such as dead trees and hay bales oftentimes are cheaper, and also may improve aquatic habitat. The following discussion looks at a potential bio-stabilization method for three of the sites (hardpoints, weirs and revetment). Actual plantings of willows or other stabilizing vegetation was not considered, due to the high concentration of sand on these eroding banks. Certainly, natural revegetation would the banks' overall stability, but this requires some primary stabilization to be in place first.

Site B1 – Myron Grove GPA: Hardpoints

The conventional arrangement of hardpoints for this site would protect 2020 feet of bank, with the longest structure reaching out 105 feet. The shallow water along this bank makes it feasible to disrupt the flow using cabled trees in lieu of stone. The resulting tree dikes (or spokes) would be the same length as the rock structures, but their downstream effect would be less. The downstream zone of protection for the hardpoints was assumed to be 3.75 times the length of the hardpoint. This rate was reduced by a factor of 2/3 for the tree spokes, recognizing their permeability and variable configuration. The spoke system for this site would consist of one 50-foot structure, and eight 100-foot spokes. The 1610 tons of stone that would be placed as a root for the stone structures (for the conventional hardpoint design) would simply be placed on the bank at the landward ends of the spokes (180 tons each). The landward 50 feet of each spoke would have three sets of the cabled 3-tree units described earlier. The outer 50 feet would require only two units. The total tree units for site B1 thus would be 8x3 + 9x2 = 42 units. The basic cost for this design is $42,700 for stone and $49,100 for the tree units, for a total of $91,800.

Site A1a – North Alabama Point: Revetment

Deep water along this area would limit the effectiveness of non-traditional measures such as the cabled trees proposed for site B1. Here, the riverbed drops off from the bank at a 1V:2H

slope. Just as the stone design for Site A1 concentrates on armoring of the bank, bio-stabilization material could be anchored directly on the bank. The material could consist of hale bales or cabled trees. A stone refusal still would guard against the armor being flanked. This design also would require stone to stabilize the bank toe. Half of the stone armor for the conventional design thus would be retained for this alternative design. The refusal will be scaled back, to reflect the reduced effectiveness and durability of this alternative design. Specifically, the rate of stone in the refusal will be reduced by a factor of ¾, and its 400-foot length will be shortened to 350 feet. The 230 feet of anchored bales or trees would have an estimated cost of $20,700, and the 1895 tons of stone would be $50,200. Excavation would add $3900, for a total cost of $74,800.

Site A3 – Vermillion Reach: Weirs

This stretch along the right bank presently has an extensive area of shallow water (approximately 3 feet deep at normal flows). This provides opportunities for a variety of stabilization measures. For example, an *Undercurrent Stabilizer System* could capture sediment that moves along this bank. However, the bendway weirs proposed as the conventional design for this site would function the same as the stabilizer system's submerged geotextile bags. Sea bags possibly could be configured in such a way to protect the bank and encourage accretion here. Similarly, a design with *Iowa Vanes* might produce the desired results. Actual designs for placing the sea bags or the *Iowa Vanes* are outside the scope of this evaluation. A simplified non-traditional method would substitute cabled trees for the stone in the bendway weirs, as was put forth for the hard-points at site B1. Again, the number of structures would increase, since each tree structure would have a smaller zone of protection. The tree dikes would be between 50 and 250 feet long, with each fifty feet typically requiring 3 tree units. This dike system would comprise 14 dikes, using 102 tree units. The stone specified for weir roots (3420 tons) for the conventional design will be distributed to the 14 tree dikes, to be placed on the bank at the dikes' landward end. The tree units would cost an estimated $112,700, and the stone would add $90,600. The non-traditional design for this site thus would cost $203,300.

EFFECTIVENESS OF NON-TRADITIONAL METHODS

Two significant differences between stone structures and bio-stabilization (i.e., non-traditional) methods are durability and effectiveness. The stone is placed according to a specific gradation, so that the resulting structure acts as a unit. Flow around and over such structures is fairly predictable. Also, the stone structures can resist many riverine forces (current, eddies, floating ice and debris, etc.). Structures made of trees incorporate great variability, and the water and sediment response through them thus is less predictable than for stone. In addition, the trees likely would be damaged or displaced as ice and other forces work against them. The bio-stabilization materials also will naturally deteriorate, at a rate many times higher than stone.

The reduced performance of bio-stabilization structures relative to stone (due both to the structures' design performance and the eventual deterioration of the non-traditional structures) also is reflected in any secondary effects. In the case of sites B1 and A3, the dikes or weirs are designed to produce accretion. The increased permeability of the tree dikes (along with anticipated breaks) would reduce that likely accretion.

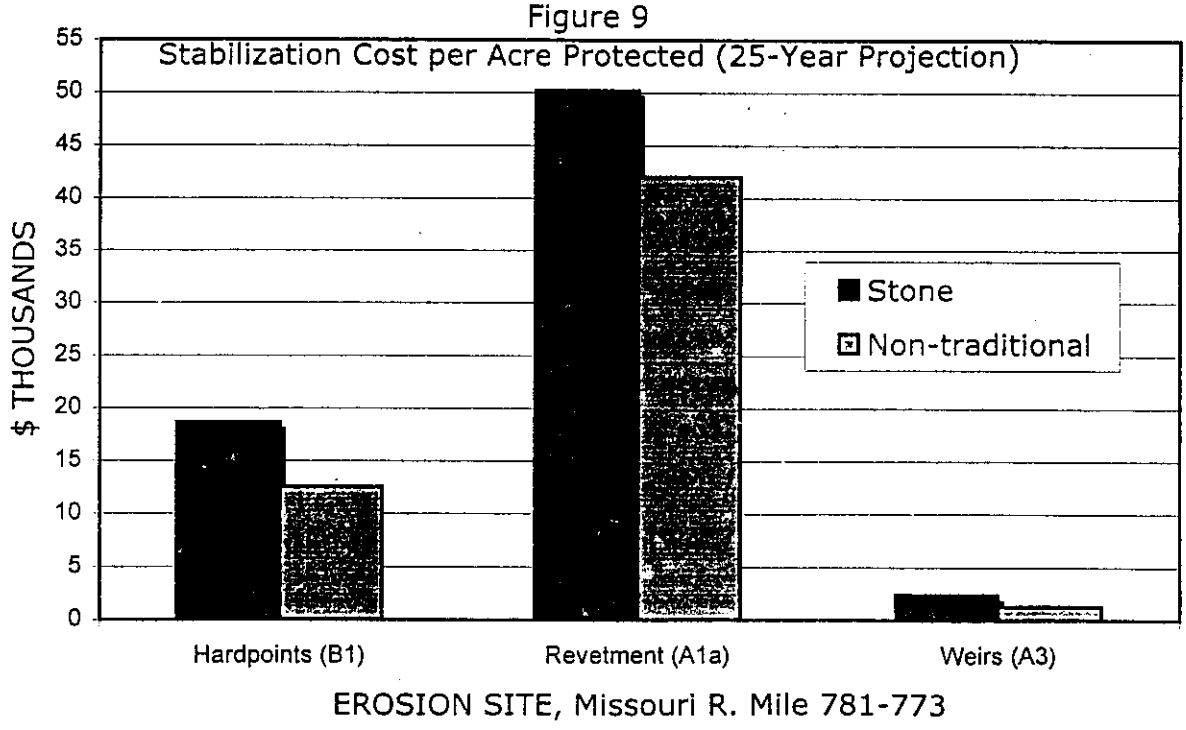
The non-traditional designs are favorable due to lower costs and their more natural appearance. They also tend to be superior to stone as aquatic habitat. Table 5 shows the expected costs and

effects of the stone and non-traditional designs for the three primary sites. The comparative costs are also presented in Figure 9.

Table 5 – Stabilization Costs and Effects

	Hard Pts. B1	Revet. A1a	Weirs A3	Non-traditional Construction B1	A1a	A3
Effective Bank Protection, feet	2020	500	4770	1720	480	4300
Accretion, acres	0.60	0	2.13	0.51	0	2.74
Design Life, yrs.	25	25	25	7	7	7
Cost, thousands Total	136.6	89.4	378.9	91.8	74.8	203.3
Per 1000' of bank	67.6	178.8	79.4	45.4	149.6	42.6
Per acre	18.7	50.2	2.4	12.5	42.0	1.3

Figure 9



EROSION SITE, Missouri R. Mile 781-773

The estimated reduction in effectiveness reflects the inherent weakness of the non-traditional structure in matching the stone structure performance. In addition, more rapid deterioration on the non-stone structures would allow localized bank erosion, and reduced accretion. The loss of bank protection using non-traditional materials for these three sites could be between 5 and 15 percent.

The estimated area of accretion assumes that one sixth of the dike field area will fill in. For example, site B1 has an average dike length of 77 feet, along 2020 feet of bank. The assumed accretion area there is 77 x 2020 / 6 = 25,920 sq. ft., or 0.6 acre. Table 6 lists the estimated accretion for the stone designs (hardpoints, weirs and dikes), and Table 7 summarizes how a non-traditional design compares to three typical stone structures.

The estimate for potential accretion is based on the structural configurations chosen for this analysis. The primary criterion for targeting a particular design for each site was stabilization effectiveness at a reasonable cost. In fact, different designs could be pursued, if the criteria would tip toward other factors, such as accretion potential and aquatic habitat. For example, a notched breakwater or an underwater sill might be able to produce more accretion, but at a higher cost, or with less reliable bank protection. The accretion estimates thus could change as the actual site designs are developed.

Table 6
Accretion Estimate for Stone Stabilization Designs

Site	Bank Protection feet	Accretion Potential acres	acre/1000'
B1	2020	0.60	0.30
B2	1760	0.32	0.18
A1b	6020	3.78	0.63
A2	6970	3.90	0.56
A3	4770	2.13	0.45

Table 7
Non-traditional Stabilization Relative to Stone Structures

	Site B1	Site A1a	Site A3
Bank Protection	85%	95%	90%
Expected Accretion	75%	---	130%
Aquatic Habitat	125%	---	115%
Design Life	30%	30%	30%
Cost	65%	85%	55%

The above discussion on stone structures versus non-traditional stabilization measures includes the short revetment originally proposed for site A1. That presentation included the revetment for that site, to give a broader treatment to the comparison between typical and non-traditional stabilization. However, the more thorough analysis of erosion trends (going back to 1972) effectively removes the rationale for pursuing the abbreviated bank armoring at that site. The erosion trend suggests that the right side of North Alabama Bend will continue to erode along nearly ten times the bank length that the short revetment would protect. Consequently, Alternative A1a is dropped from consideration, in favor of a series of dikes (Alternative A1b).

CONCLUSIONS

In terms of erosion rates, the three A sites are better candidates for bank stabilization efforts. Those sites show more severe erosion, based either on the most recent bank comparison (1990 to 1998) or the trend developed over the last 25 years. None of those three sites is consistently superior to the others based on the different criteria of erosion severity (acres per mile), cost per 1000 feet or cost per acre. Furthermore, this evaluation was isolated to erosion rates, without considering actual habitat values of the eroding land. Consequently, the comparisons presented above will be integrated into the overall evaluation, where the comparison of alternatives will include all pertinent factors for the sites. The conceptual stone designs for the five sites are hardpoints (sites B1 and B2), dikes (A1b), and bendway weirs for sites A2 and A3.

PREPARED BY: Jerry Tworek CENWO-ED-HF 31 March 2000

APPENDIX F

1 December 1999

MEMORANDUM THRU CENWO-PM-AE

FOR FILES

Subject: Trip Report for November 1999 River Inspection

1. Introduction:

The Planning Branch is investigating five erosion sites in the reach between Gavins Point Dam and Ponca State Park. The purpose of this investigation is to evaluate the extent of erosion and the quality of habitat threatened. This program is being coordinated with the National Park Service, which oversees the Recreational River. Site selection methodology was determined in Section II of the Habitat Erosion Protection Analysis. Bob Nebel, Luke Wallace, and Katie Vollmer were sent to analyze these sites to determine whether it would be in the government's best interest to preserve the characteristics for which the river received its recreational designation.

2. Site Investigation Methods:

Data was collected through visual terrestrial observation. Bio-diversity level and wildlife usage in a given area as well as animal tracks and scat were noted as evidence of wildlife habitation. We also noted obvious forage areas as an indication of wildlife.

This data was then used to perform a HEP-based analysis to determine a numerical habitat value for each site. The HEP analysis and a site-by-site biological analysis are attached. Tree density and dominant tree species as well as shrubs, grasses and other vegetative forms were identified, to the best of our ability for the season The observations were then interpreted into a numerical "habitat value" based on Clapp methodology.

3. Site Narrative:

On the morning of 17 November 1999, we left Omaha District Office for the first site located at river mile 773.0, Nebraska site near Mulberry Bend boat ramp. At 11:00am we reach site A-3. The effect of erosion along the bank was clear on arrival. We ventured along the bank, noting habitat quality and wildlife usage. Approximate time spent at this site was about four hours, returning to the vehicle at 3:00p.m.

On the way to site A-1, Nebraska site, an estimated 40 to 50 wild turkeys were spotted along Hanson Road. There was some difficulty in reaching this site. By 3:50p.m, despite the difficulty, the site was reached. Two hours were spent at the site, which was evaluated for tree density, habitat quality, and wildlife usage. Luke Wallace pointed out that the value of this site would increase significantly if a conservation easement, which included the area adjacent to site, was established.

November 18, 1999

We arrived at site B-1, Myron Grove Game Production area in South Dakota at 7:45am and almost immediately spotted two white-tailed deer. This area contains extremely large cottonwood trees with considerable debris on the forest floor. We walked the site thoroughly and recorded all findings. Bob Nebel commented that due to the rarity of this type of habitat, this site might very well be a high priority candidate for bank stabilization. Perhaps an expanded investigation of this area's historical condition maybe required in assigning an appropriate value. We returned to the vehicle at 9:10am and headed for the next site.

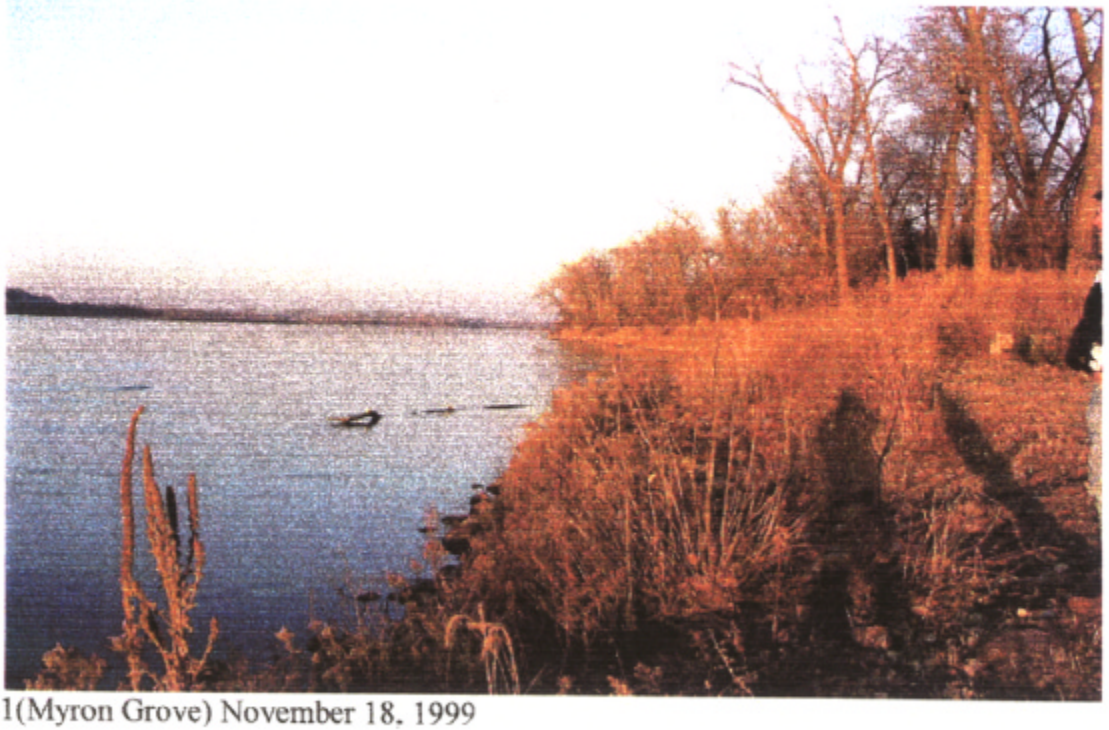
We reached site B-2, Clay county recreational area, South Dakota at 9:35am. On arrival, we assessed the degree of erosion along the bank and appraised habitat quality by way of terrestrial observation. Special notes were taken regarding the number of downed trees and level of human usage. Further examination of this area's historical condition may be required in assigning an appropriate value.

At 12:30pm we arrived investigate site A-2, Large Bend, South Dakota. We drove as close to the site as we were able and then walked the rest of the way. We ended observations from that area then set out to view the erosion site from the state land side. At 1:30pm, we arrived at our location. After a considerable walk, we reached the edge of the river. We examined the site to the best of our ability in the given amount of time and then left for Omaha, Nebraska; arriving there at about 5:30pm.

Site A-3 (November 17, 1999)

Site A-3 (November 17, 1999)

Site A-1 (November 17,1999): Eagle nest.



Site B-1(Myron Grove) November 18. 1999

Site B-1(Myron Grove) November 18. 1999

Site B-2 (November 18, 1999) Clay County Recreational Area

Site A-2 (November 18, 1999)

Prepared by

Katie Vollmer
Environmental Specialist
USACE

Habitat Evaluation Methodology
Five Sites for Potential Bank Stabilization
59-Mile Portion of the Missouri National Recreational River
Gavins Point Dam to Ponca State Park

Five sites within the 59-mile portion of the Missouri National Recreational River between Gavins Point Dam and Ponca State Park were evaluated to determine the value of the habitat present at each site. On November 17th and 18th of 1999, all five sites were visited by personnel from the U.S. Army Corps of Engineers. During the site visits, all identifiable plant species and their relative abundance were recorded. In addition to plant species, all animal species observed were also recorded, along with any evidence of animal use. Evidence of animal use included nests, tracks, game trails, feathers, scat, burrows, browsed vegetation, deer rubs, and trees damaged by beavers. The value of the habitat present at sites that showed evidence of heavy use by wildlife was determined to be higher relative to sites that did not appear to be as heavily used by wildlife.

The habitat data collected was used to classify each type of habitat observed into one of six habitat types. Five of these habitat types, which include cattail marsh, cottonwood dogwood, cottonwood willow, elm oak, and sand dune, were classified as defined by James R. Clapp in his 1977 thesis entitled, "Wildlife Habitat Evaluation of the Unchannelized Missouri River in South Dakota." The sixth habitat type that we considered was cropland. Clapp chose not to evaluate cropland in his 1977 study. Although Clapp chose not to evaluate cropland, we determined that cropland does have some inherent value to wildlife, and therefor should be evaluated in this study when present. This information was then used to perform a Habitat Evaluation Procedures (HEP) analysis for each site using the assigned habitat values to wildlife that Clapp defined in his 1977 thesis for each habitat type used.

In order to perform the HEP analysis, the area (in acres) of each habitat type present at each site was measured. The area of each type of habitat was measured by outlining the different habitat types on 1" = 1,000' digital orthometric aerial photographs. The different habitats at each site were then measured with a compensating polar planimeter calibrated to measure square inches. Square inches were then converted to square feet, and square feet were converted to acres. Once the area was determined for the different habitats present at each site, the area measurements (in acres) were used in the Habitat Evaluation Procedure (HEP), and habitat units were calculated for each site.

Two mean habitat suitability indexes (HSI) were calculated using the HEP procedure for each site except Site A-2. One HSI was calculated for the habitat that is predicted to erode if no project is built, and a second HSI was calculated for the entire habitat area present adjacent to the area predicted to erode. At Site A-2, a mean HSI was only calculated for the area predicted to erode. A HSI was not calculated for the entire habitat area present adjacent to the area predicted to erode at Site A-2, because this area was too large and it was not clear how many land owners owned these lands.

The same base habitat values described by Clapp in his 1977 thesis were used for the six different habitat types present in our study. Modifications to the base habitat values were made as described below in **Table 1.**

Table 1
Modifications Of Base Habitat Value By Habitat

Habitat	Base Habitat Value	Ungrazed Habitat	Heavy Use By Wildlife	Use By Rare or T&E Species	High Human Use (Campground)	Good Grass Ground Cover
Cattail Marsh	7.8	NA	+.5	+.5	-.5	NA
Cottonwood Dogwood	7.0	+1	+.5	+.5	-.5	NA
Cottonwood Willow	6.5	+1	+.5	+.5	-.5	NA
Elm Oak	5.8	+1	+.5	+.5	-.5	NA
Sand Dune	4.4	NA	+.5	+.5	-.5	+.5
Cropland	3.5	NA	+.5	+.5	-.5	NA

- These numbers were added or subtracted from the base habitat value when applicable.

Rationale

Ungrazed Habitat: Woodland areas that have not been used to graze livestock were considered to be considerably more valuable to wildlife than grazed areas. For this reason a value of +1 was added to the base habitat value of woodland areas that have not been grazed.

Heavy Use by Wildlife: A value of +.5 was added to the base habitat value of the habitat at sites that showed evidence of heavy use by wildlife. Evidence of wildlife use included actual visual sightings of wildlife species, tracks, nests, burrows, scat, buck rubs, beaver slides, and trees damaged by beavers. Use by wildlife was considered to be heavy when there was considerably more evidence of wildlife use at a particular site when compared to the others.

Use by Rare or Threatened or Endangered Species: A value of +.5 was added to the base habitat value of the habitat present at a site if a rare, state listed threatened or endangered, or federally listed threatened or endangered species is know to inhabit or use the site.

High human Use (Campground): A value of -.5 was subtracted from the base habitat value of the habitat present at sites in which a portion or all of the habitat receives a high degree of human disturbance. This would include sites in which there are areas such as campgrounds or picnic areas within them. High levels of human disturbance generally make the habitat less suitable to wildlife.

Good Grass Ground Cover: A value of +.5 was added to the base habitat value of sand dune habitats in which a healthy stand of native grasses were present.

Cropland: This study recognized the fact that cropland does have some inherent value to wildlife. A base habitat value of 3.5 was chosen because a previous Habitat Evaluation Procedure (HEP) analysis performed by the USFWS on one of the Papillion Creek flood control dams determined that the value of cropland to wildlife was about ½ that of woodland habitat. The base habitat value for cottonwood dogwood habitat is 7.0. One half of 7.0 is 3.5.

SITE A-1
Nebraska Site Near Eagle Nest
11/17/1999

General Description: This area consists of a long and narrow stand of a thick cottonwood dogwood forest that does not appear to have been grazed. However, where the forest continues to the south across a fence and into the next section, cattle do graze among the trees. There is a small corn field adjacent to the forest to the west. On the west and south sides of the corn field is a much larger stand of trees that is less dense and more open than the forest that is subject to erosion to the east. This larger, less dense forest contains a large bald eagle nest that was active during the spring of 1999.

Dominate Plant Species
*Percent cover estimates based on visual observation, no quantitative scientific method was used

Cottonwood 70%
Slippery Elm 20%
Eastern Red Cedar 5%
Green Ash 5%

Other scattered tree species included hackberry, mulberry, and Russian olive

Understory consisted of red osier dogwood, smooth sumac, greenbrier, bittersweet, and poison ivy.

Animal species sighted or for which evidence of their presence was observed

White-tailed Deer in forest
Bald eagle flew over head
Barred owl
Red-tailed hawk
American robin
Blue jay
Crow
Heavy beaver use at northern most point adjacent to the river

Overall thoughts on this site: The ungrazed portion of this woodland area seems to have considerable value to wildlife. It contains some large cottonwoods and a few snags. The canopy contains several different layers and there are a number of fruit and berry producing shrubs and vines. However, this woodland is pretty narrow and is located directly adjacent to a corn field. I think that the value of this area would be very great if the entire diverse treed area to the west could be included in a conservation easement along with the area under consideration for protection from erosion. The density and diversity of the small, ungrazed area appears to be somewhat rare in the immediate vicinity and probably provides important refuge for wildlife in the area. Protecting this area along with the entire diverse woodland area to the west would preserve a very significant wildlife habitat complex. Site A-1 by itself, however, is probably not quite as valuable as some of the other sites.

*Site visit conducted during the fall when there were very few leaves left on the trees

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site A-1 Erosion Area (Eagle Nest)

1. Study MNRR
2. Proposed action: Bank Stabilization (Habitat)
3. Evaluation species
4. Sample dates: 11-17-99
5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1 (eagle nest)+.5	22.73	9.0	204.57
Cottonwood dogwood (grazed) (Eagle Nest)+.5	71.85	7.5	538.88
Cottonwood dogwood (ungrazed)+1	11.94	8.0	95.52
Cropland (eagle nest)+.5	37.88	4.0	151.52
Cropland	15.14	3.5	52.99
Cattail Marsh	.52	7.8	4.06
	10. 160.06		11. 1,047.54

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{1,047.54}{160.06} = 6.54$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site A-1 Entire area (Eagle Nest)

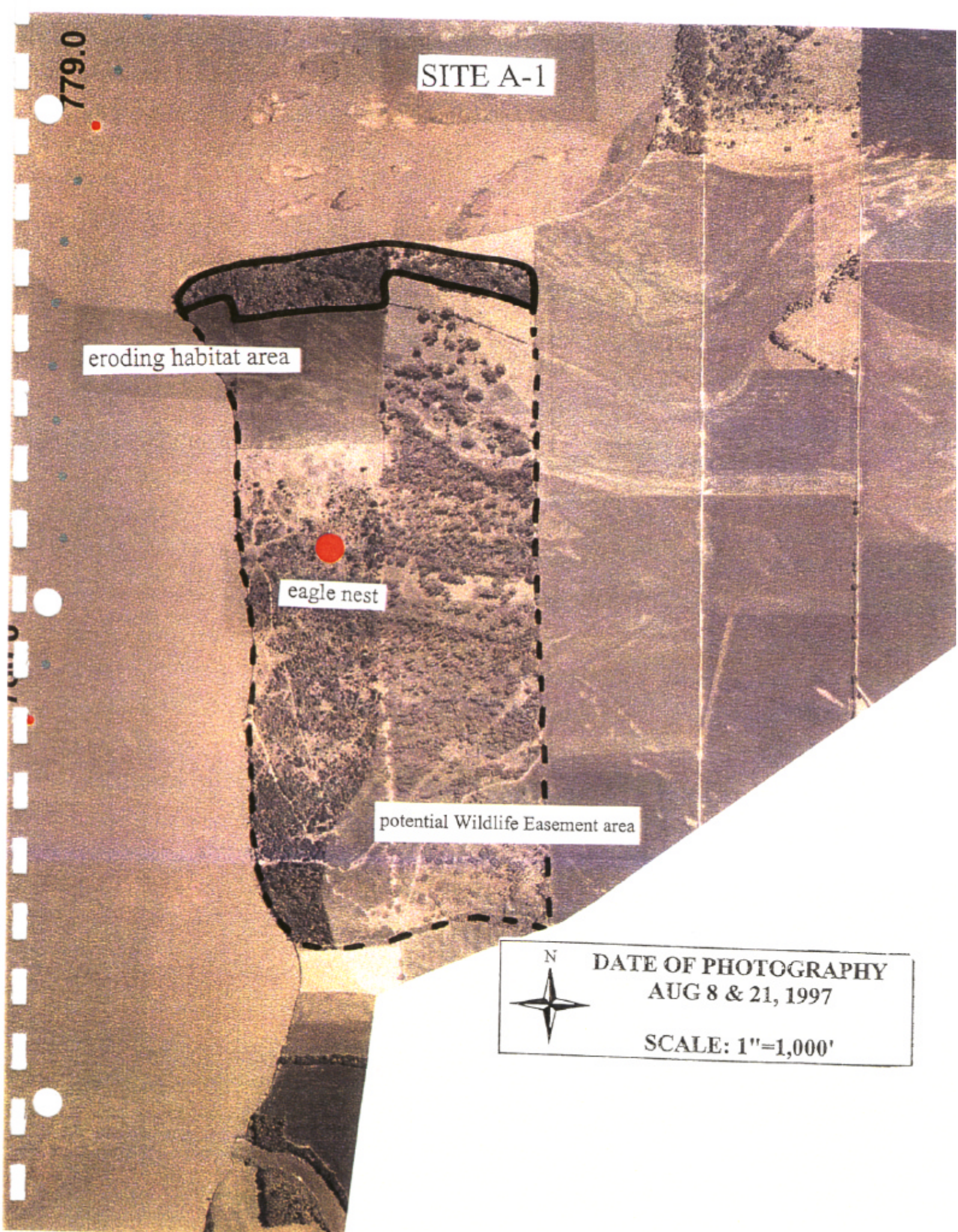
1. Study MNRR		2. Proposed action Bank Stabilization (Habitat)	
3. Evaluation species		4. Sample dates 11-17-99	5. Target year
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1 (eagle) .5	33.06	9.0	297.54
Cottonwood dogwood (grazed) (eagle) .5	295.68	7.5	2217.60
Cropland	37.88	1.5	56.82
	10. 366.62		11. 2,571.96

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{2571.96}{366.62} = 7.0$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Photo 1. Wooded point of Site A1 that could benefit from bank protection. An eagle nest was documented deep within the wooded grove during the spring, 1999.

Photo 2. Looking upstream from wooded portion of Site A1 at eroding cropland. This portion of the eroding site is approaching equilibrium.


779.0
SITE A-1
eroding habitat area
eagle nest
potential Wildlife Easement area
N
DATE OF PHOTOGRAPHY
AUG 8 & 21, 1997
SCALE: 1"=1,000'

SITE A-2
Large Bend (South Dakota)
11/18/1999

General Description: This is a very large area that is almost entirely an old sand dune. The vegetation is savanna-like with scattered medium sized cottonwoods among a grassland that has been almost entirely taken over by planted sweet clover. The area subject to erosion is almost entirely this kind of sand dune habitat. Farther inland there is a natural levee. Behind the levee the elevation drops significantly into an old chute. The chute is full thick vegetation with various canopy levels made up of horsetail cattails, cottonwoods elms, dogwoods hackberries, bittersweet, and a large number of other species.

Dominate Tree Species
*Percent cover estimates based on visual observation, no quantitative scientific method was used

Cottonwood 95%
Slippery elm 5%

Other plant species in order of dominance

Sweet clover
Sand dropseed
Switch grass
Smooth brome grass

Animal species sighted or for which evidence of their presence was observed

White-tailed deer
Fox squirrel
Cottontail rabbit
Beaver

Overall thoughts on this site: I think that this site ranks second to last of the five sites because of its low diversity and wide open nature. This habitat does add some diversity to the overall area however, so it does have some wildlife value. The land further inland beyond the probable erosion line is very diverse and highly valuable, however, this area is already dsignated as a game management area and it is not at risk to be eroded.

*Site visit conducted during the fall when there were very few leaves left on the trees

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site A-2 Erosion Area

1. Study MNRR
2. Proposed action Bank Stabilization (Habita)
3. Evaluation species
4. Sample dates 11-18-99
5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood	111.34	7.0	779.38
Sand Dune	87.92	4.4	386.85
Cropland	72.43	3.5	253.50
	10. 271.69		11. 1,419.73

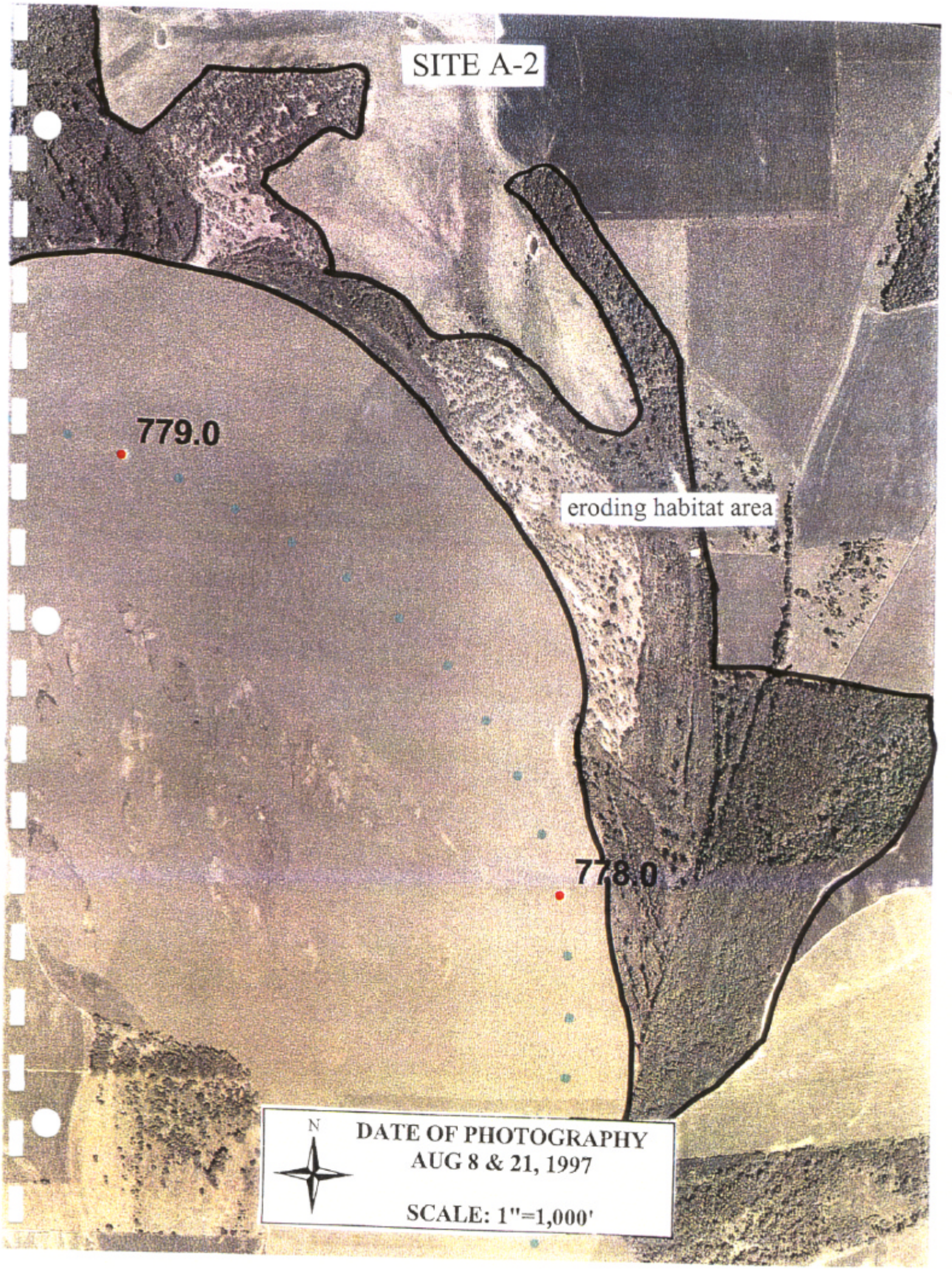
12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{1,419.73}{271.69} = 5.23$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

SITE A-2

Photo 3. Site A2 looking upstream. Note fallen tree with root wad near shore.

Photo 4. Looking downstream at Site A2. Note overhanging turf.


SITE A-2
779.0
eroding habitat area
778.0
N
DATE OF PHOTOGRAPHY
AUG 8 & 21, 1997
SCALE: 1"=1,000'

SITE A-3
Nebraska Site Near Mulberry Bend Boat Ramp
11/17/99

General Description: The eroding part of this area was an old sand dune that did not appear to have been grazed recently. It appeared savanna-like with scattered patches of trees and shrubs interspersed within a grassland with lots of small hills and swales. On the eastern side of this site around the point, the elevation drops into a chute along the river that is currently a cattail marsh with horsetail, cattails, willows, and various other wetland plants. There were also some sandbars present on the downstream side of the point during the site visit.

Dominate Tree Species
*Percent cover estimates based on visual observation, no quantitative scientific method was used

Cottonwood 85%
Eastern red Cedar 5%
Green Ash 5%
Russian Olive 5%

Shrubs Listed in Order of Dominance

Red Osier Dogwood
False Indigo
Smooth Sumac
Bittersweet
Willows

Grasses, Forbes, and Others Listed in Order of Dominance

Canada Wild Rye
Sand Dropseed
Switchgrass
Prairie Dropseed?
Sweet Clover
Partridge Pea
Asters
Horsetail

Animal species sighted or for which evidence of their presence was observed

Signs of heavy use by deer
Beaver use along entire shoreline
Nest of white-footed or deer mice under tree
Several bluebirds
Dark-eyed junco
American gold finch
Yellow-shafted flicker
Downy woodpecker
Belted kingfisher
Ring-necked pheasant
Crow tracks
Raccoon tracks
Red fox tracks
Coyote tracks
Fox squirrels and several fox squirrel nests

4 or 5 large mammal dens (coyote or fox?)

- Saw bird and mammal tracks almost everywhere we looked

Overall thoughts on this site: Of all of the sites we looked at, this site showed the most evidence of heavy use by wildlife. However, because of the fact that the site was located on sand in a relatively open savanna-like area, the evidence of wildlife use might just be easier to see on this site than on others. This site is also part of a very large contiguous area that is not under cultivation and is somewhat isolated from human disturbance. The portion of this site that is eroding is part of the sand dune habitat. I do not think that this portion of the site alone is quite as valuable as the Myron Grove area because it does not contain good winter cover or as many food sources. However if a conservation easement could be obtained for this entire area including the chute with cattail marsh habitat, this site would move up toward the top of my list of importance because of its size and diversity of habitat.

*Site visit conducted during the fall when there were very few leaves left on the trees

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site A-3 (Eroded Area)

1. Study	2. Proposed action
MNRR	Bank Stabilization (Habitat)
3. Evaluation species	4. Sample dates 11-17-99 / 5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Sand Dune (good nature grass cover)+.5 (heavy wildlife use)+.5	158.77	5.4	857.36
Cottonwood dogwood (ungrazed)+1	5.74	8.0	45.92
Cropland	23.05	3.5	80.68
	10. 187.56		11. 983.96

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{983.96}{187.56} = 5.25$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site A-3 (Entire Area)

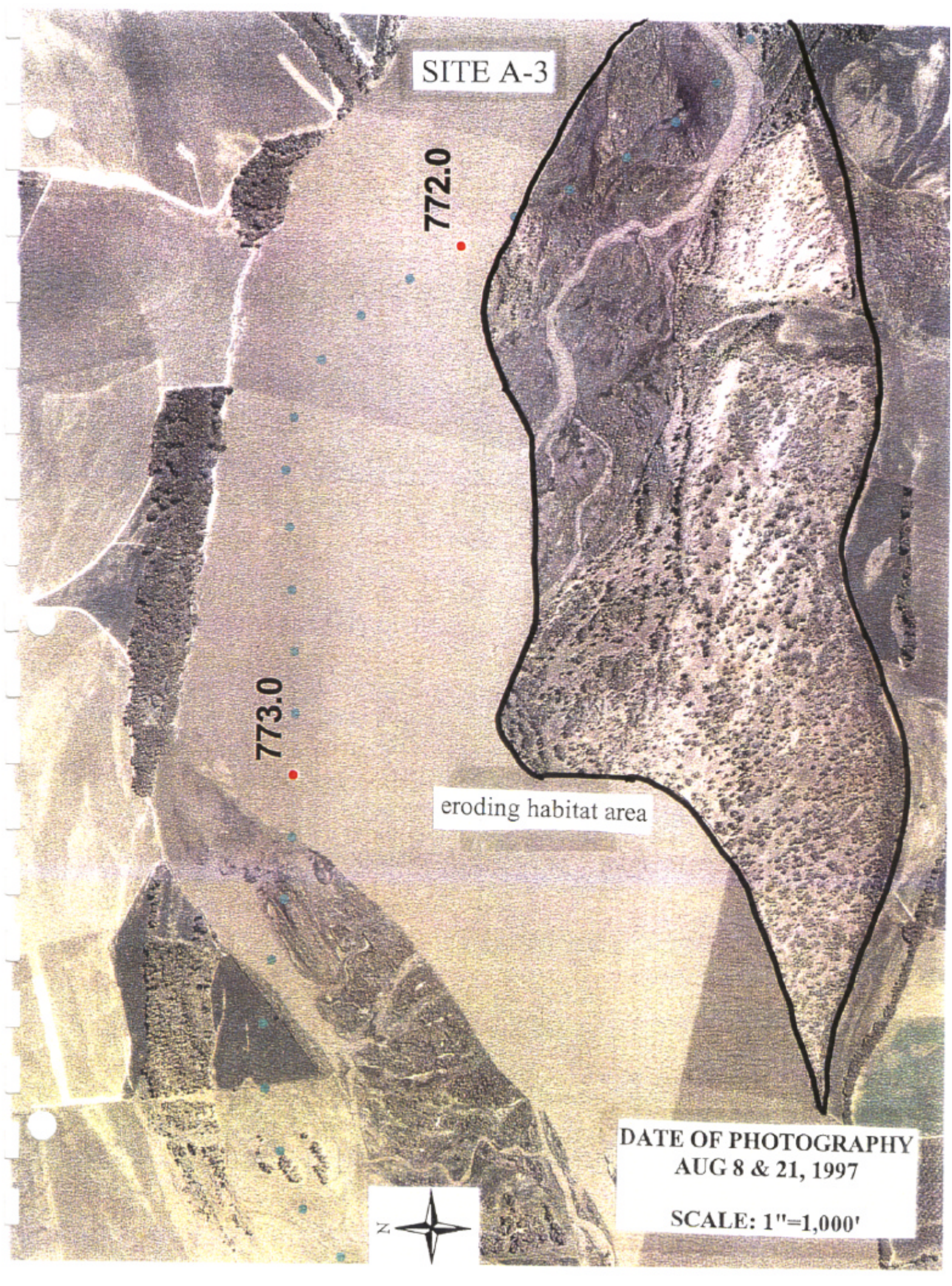
1. Study MNRR		2. Proposed action Bank Stabilization (Habita	
3. Evaluation species		4. Sample dates 11-17-99	5. Target year
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Sand Dune	345.73	5.4	1866.94
(good nature grass cover) .5			
(heavy wildlife use) .5			
Cattail Marsh	145.78	8.3	1209.97
(heavy wildlife use) .5			
	10. 491.51		11. 3076.91

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{3076.91}{491.51} = 6.26$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Photo 5. Site A3. Note "sugar sand" soils and fallen tree with root wad.

Photo 6. Site A3, looking downstream at eroding grove of trees. Note fallen trees and overhanging turf.


SITE A-3
772.0
773.0
eroding habitat area
DATE OF PHOTOGRAPHY
AUG 8 & 21, 1997
SCALE: 1"=1,000'
N

SITE B-1
Myron Grove Game Production Area (South Dakota)
11/18/1999

General Description: This site was an old-growth cottonwood-dogwood forest. There were several very large, old cottonwood trees (some partially or entirely dead) spread throughout the site that stuck out above the canopy. There were several different layers of canopy, good thermal cover, lots of leaf litter, and several species of fruit and berry producing shrubs and vines. There was no apparent evidence that this site has ever been grazed. However, the portion of the site adjacent to the heavy erosion area seemed to be less dense with a sparser understory and a lot of deadfall, which seems to suggest that there has been some sort of disturbance in this portion. Several very large, old cottonwoods are getting undercut and are about to fall in the river. Erosion is heavy with lots of large snags with rootwads attached lying along the river bank in the water.

Dominate Tree Species
*Percent cover estimates based on visual observation, no quantitative scientific method was used

Slippery Elm 50%
Hackberry 25%
Cottonwoods (very large and old) 10%
Eastern Red Cedar (some quite large) 15%

Shrubs Listed in Order of Dominance

Red Osier Dogwood
Smooth Sumac
Buckthorn or Black Cherry?

Other Plant Species

Greenbrier
Poison Ivy
Bittersweet

Animal species sighted or for which evidence of their presence was observed

White-tailed deer
Cottontail rabbit
Crow roosting area
Beaver den in rootwad of tree that has fallen in the river along with several trees downed by beaver

Overall thoughts on this site: Of the eroding areas, this site seems to be the most unique and has the greatest overall value to wildlife. The very large, old cottonwoods scattered widely among a forest of younger trees of various species and sizes suggests that this is a very old site that is changing from a cottonwood dominated forest toward a climax forest dominated by trees other than cottonwoods. The eroding portion of the site is less dense and diverse than the main portion of the site, but still has considerable value to wildlife.

*Site visit conducted during the fall when there were very few leaves left on the trees

Appendix A. Forms for Use in the Habitat Evaluation Procedures

1. Study: Site B-1 (Erosion Area) Myron Grove MNRR
2. Proposed action: Bank Stabilization (Habitat
3. Evaluation species:
4. Sample dates: 11-18-99
5. Target year:

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1	9.64	8.5	81.94
(Heavy use by wildlife)+.5			
Cropland	2.53	3.5	8.86
	10. 12.17		11. 90.8

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{90.8}{12.17} = 7.46$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site B-1 (Entire Area) Myron Grove

1. Study MNRR
2. Proposed action Bank Stabilization (Habitat)
3. Evaluation species
4. Sample dates 11-18-99
5. Target year

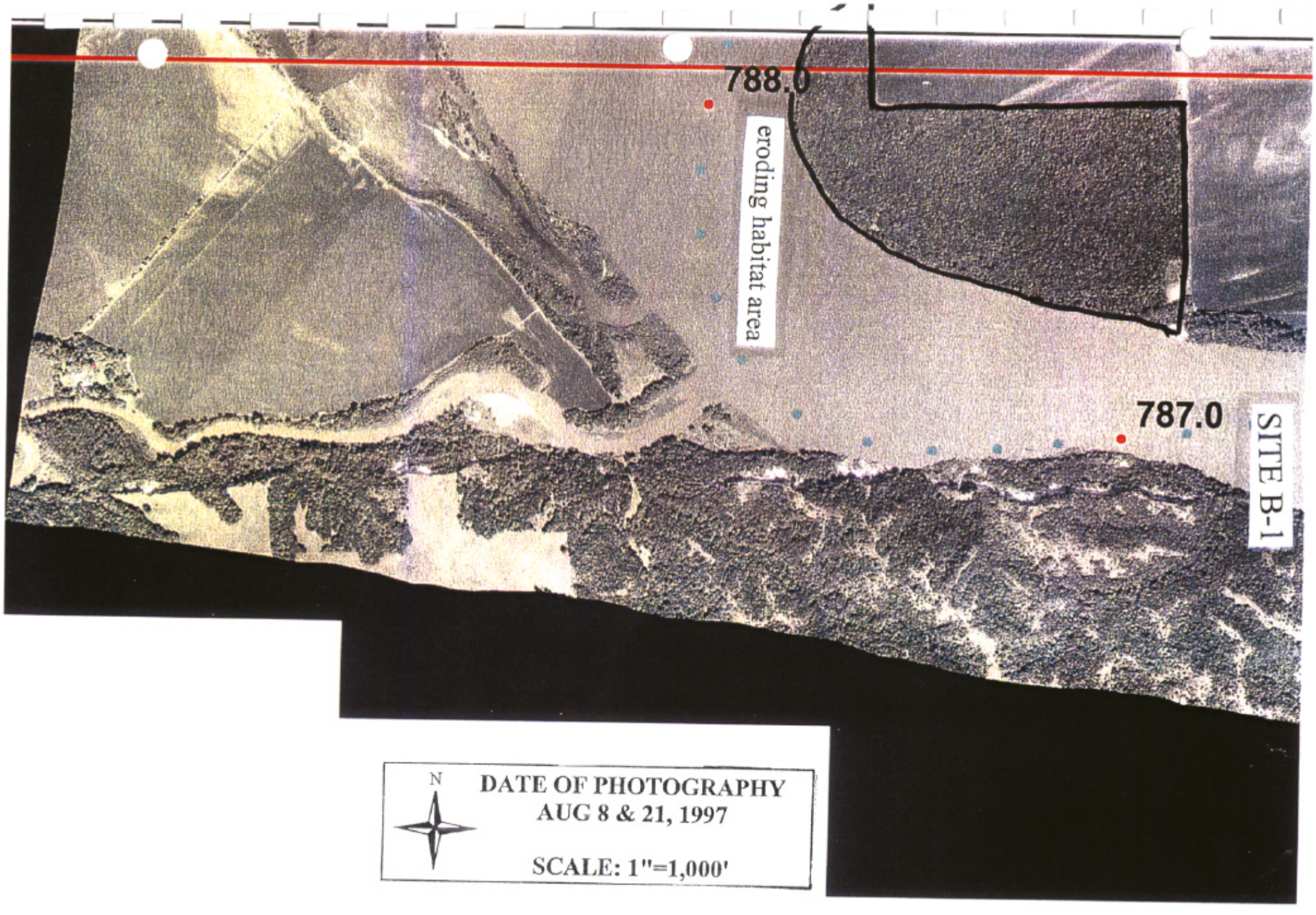
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1	112.03	8.5	952.26
(heavy use by wildlife) .5			
	10. 112.03		11. 952.26

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{952.26}{112.03} = 8.5$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Photo 7. Myron Grove, Site B1. Mature grove of trees eroding over "sugar sand" soils.

Photo 8. Site B1. Note several fallen trees with turf and root wad along shoreline.


788.0
eroding habitat area
787.0
SITE B-1
N
DATE OF PHOTOGRAPHY
AUG 8 & 21, 1997
SCALE: 1"=1,000'

SITE B-2
Clay County Lakeside Use Area (South Dakota)
11/18/1999

General Description: This site consists of a cottonwood-dogwood forest that is thinner near the river and gets thicker as you move north. A campground and circular drive is located in the center of the site. It appears that some sort of disturbance killed a large number of the larger trees. Smooth sumac and dogwood are colonizing the open areas. The canopy has two distinct layers of evenly sized larger trees and evenly sized small trees and shrubs.

Dominate Tree Species
*Percent cover estimates based on visual observation, no quantitative scientific method was used

Cottonwood 70%
Slippery elm 15%
Green ash 10%
Eastern red cedar 5%

Shrubs listed in order of dominance

Red osier dogwood
Smooth sumac

Other plant species in order of dominance

Poison Ivy (Very dense near river)
Greenbrier
Bittersweet
Sweet clover (Near river)
Switchgrass (Near river)

Animal species sighted or for which evidence of their presence was observed

Yellow-shafted flicker
American robin
Ring-necked pheasant
Crow

Overall thoughts on this site: I would rank this site last based on the habitat present within the probable ultimate erosion line. There is not that much erosion projected to occur, and the habitat that would erode is mostly open edge habitat with scattered medium aged cottonwoods with scattered grass, sweet clover, and lots of poison ivy. The habitat further north away from the river is more valuable, but there is a campground located in the center of the area that fragments the habitat and introduces more human disturbance.

*Site visit conducted during the fall when there were very few leaves left on the trees

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site B-2 (Erosion Area) Clay County

1. Study MNRR	2. Proposed action Bank Stabilization (Habitat)	
3. Evaluation species	4. Sample dates	5. Target year

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1	6.89	7.5	51.68
(campground)-.5			
	10. 6.89		11. 51.68

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{51.68}{6.89} = 7.5$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Appendix A. Forms for Use in the Habitat Evaluation Procedures

Site B-2 (Entire Area) Clay County

1. Study MNRR	2. Proposed action Bank Stabilization (Habitat)	
3. Evaluation species	4. Sample dates 11-18-99	5. Target year

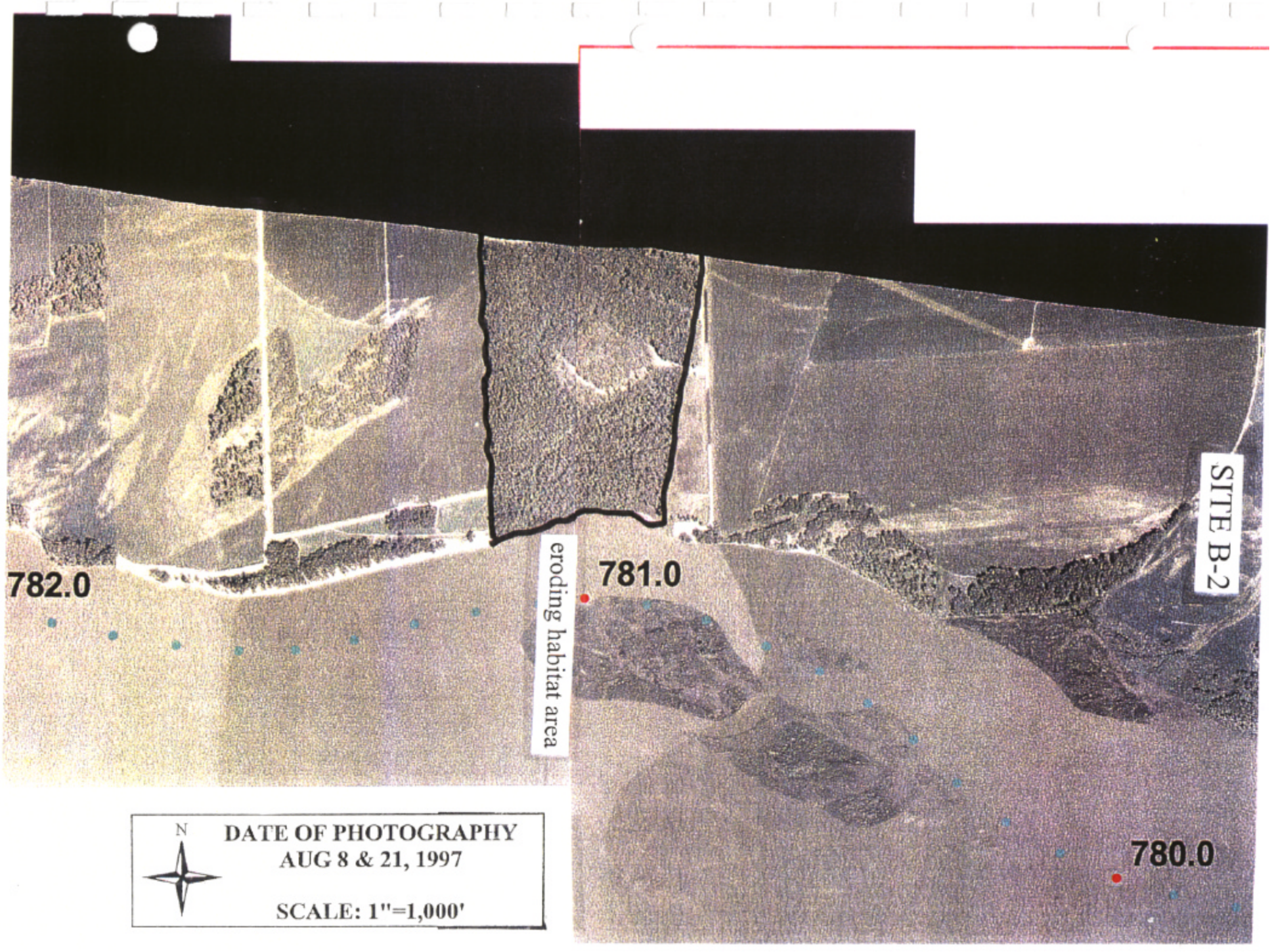
6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Cottonwood dogwood (ungrazed)+1 (campground)-.5	92.33	7.5	692.48
	10. 92.33		11. 692.48

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{692.48}{92.33} = 7.5$

Form A-2. Determination of Evaluation Species mean HSI in available habitat.

Photo 9. Clay County, Site B2. Erosion of shrub / tree complex.

Photo 10. Site B2 erosion with overhanging turf.


782.0
781.0
780.0
eroding habitat area
SITE B-2
N
DATE OF PHOTOGRAPHY
AUG 8 & 21, 1997
SCALE: 1"=1,000'

APPENDIX G

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A1 Date 3-30-00 State Nebraska

River Mile location 779 R Name N. Alabama Bend (RB)

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	3
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			2
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	3
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		3
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	4
				TOTAL SCORE		21

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A2 Date 3-30-00 State South Dakota

River Mile location 779 L Name N. Alabama Bend (LB)

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	3
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	3
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			1
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	2
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		3
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	4
				TOTAL SCORE		16

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A3 Date 3-30-00 State Nebraska

River Mile location 773.5 R Name Vermillion Reach

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	3
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	2
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			1
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	2
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		2
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	3
				TOTAL SCORE		13

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number B1 Date 3-30-00 State South Dakota

River Mile location 787.5 L Name Myron Grove GPA

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	1
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	4
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		0
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	2
				TOTAL SCORE		13

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number B2 Date 3-30-00 State South Dakota

River Mile location 781 L Name Clay County Park

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	1
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	4
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		0
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	0
				TOTAL SCORE		11

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

APPENDIX G

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A1 Date 3-30-00 State Nebraska

River Mile location 779 R Name N. Alabama Bend (RB)

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	3
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			2
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	3
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		3
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	4
				TOTAL SCORE		21

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A2 Date 3-30-00 State South Dakota

River Mile location 779 L Name N. Alabama Bend (LB)

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	3
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	3
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			1
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	2
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		3
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	4
				TOTAL SCORE		16

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number A3 Date 3-30-00 State Nebraska

River Mile location 773.5 R Name Vermillion Reach

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	3
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	2
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			1
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	2
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		2
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	3
				TOTAL SCORE		13

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number B1 Date 3-30-00 State South Dakota

River Mile location 787.5 L Name Myron Grove GPA

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	1
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	4
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		0
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	2
				TOTAL SCORE		13

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year

Proposed Method
Wildlife Habitat Erosion Protection Prioritization
Missouri National Recreational River
March, 2000

Site ID number B2 Date 3-30-00 State South Dakota

River Mile location 781 L Name Clay County Park

Metric	Scoring Criteria					Score
1. Average HSI per acre (Clapp Method) (overall value to wildlife)	5 -10 to 8.1	4 - 8.0 to 6.1	3 - 6.0 to 4.1	2 - 4.0 to 2.1	1 - <2	4
2. Eroding HU per site (HEP) (HU lost if not protected)	5 - >2000	4 - 1999 - 1500	3 - 1499 - 1000	2 - 999 - 500	1 - <499	1
3. Intense eagle use (erosion area)	2 - nest on site	1 - communal roost	0 - occasional use			0
4. Layered forest[1]	2 - multiple layers	1 - two layers (trees/understory)	0 - no understory			2
5. Young cottonwood trees[2] (<12 inches diameter)	2 - present	1 - not present, but potential[3]	0 - no potential[4]			0
6. Scarce/rare habitat within MNRR (visual est. of aerial maps)	5 - <1%	4 - <5%	3 - <10%	2 - <20%	1 - <30%	4
7. Accretion potential (acres) (with structure in place	3 - >3 acres	2 - 2.9 to 2 acres	1 - 1.9 to 1 acre	0 - >0.9		0
8. Erosion rate (acres/mile/year)	5 - >7	4 -6.9 to 5.0	3 - 4.9 to 3.0	2 - 2.9 to 1.0	0 - <1[5]	0
				TOTAL SCORE		11

[1] for highest score, need diversity in canopy layers; presence of fruit-bearing trees and shrubs; presence of snags
[2] although not useful for this calculation, this may be useful for future evaluations, so was retained
[3] existing low elevation suitable for cottonwood regeneration
[4] "perched" site
[5] MNRR average erosion rate is 1 acre/mile/year