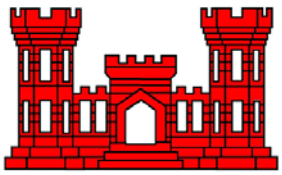
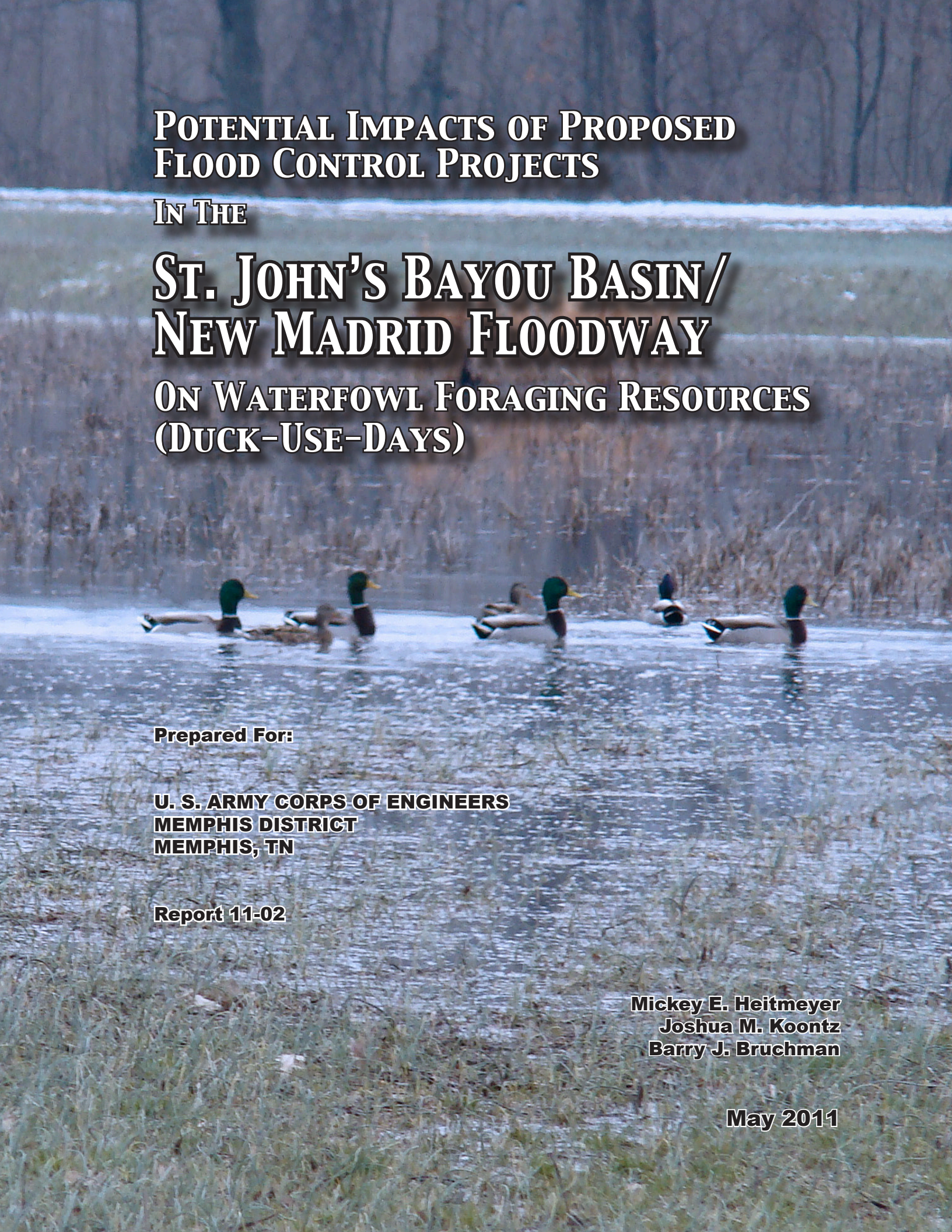
Appendix F
Part 1

Waterfowl Impacts



U.S. Army Corps of Engineers
Memphis District

Potential Impacts of Proposed Flood Control Projects In The St. John's Bayou Basin/ New Madrid Floodway On Waterfowl Foraging Resources (Duck-Use-Days)



Prepared For:

U. S. ARMY CORPS OF ENGINEERS
MEMPHIS DISTRICT
MEMPHIS, TN

Report 11-02

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May 2011

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POTENTIAL IMPACTS OF PROPOSED FLOOD CONTROL PROJECTS IN THE ST. JOHN'S BAYOU BASIN/NEW MADRID FLOODWAY (SJNM) ON WATERFOWL FORAGING RESOURCES (DUCK-USE-DAYS)

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INTRODUCTION AND BACKGROUND

The U.S. Army Corps of Engineers (USACE) proposed St. John's Bayou Basin (SJBB) and New Madrid Floodway (NMF) Project includes lands in the St. John's Bayou Basin, New Madrid Floodway, and Mississippi River Batture in portions of Scott, New Madrid, and Mississippi counties in southeastern Missouri (combined project area hereafter referred to as SJNM). Project alternatives contain works to protect over 400,000 acres of mostly agricultural land in the region from frequent backwater flooding from the Mississippi River and to reduce impounded interior runoff in the St. John's Bayou Basin in the vicinity of East Prairie, Missouri. The project also seeks to manage water to enhance natural resource conservation values and recreational opportunities using infrastructure that would be constructed for the project through various water management techniques/strategies.

Three major project alternatives have been identified for the SJNM including:

1. No Action

The No Action alternative includes two subalternative components:

1.1. Existing condition
1.2 . Future enrollment of WRP without (w/o) the project

The existing gravity outlet structure at the lower end of the St. John's Bayou Basin would continue to be operated in a manner that prevents backwater flooding from the Mississippi River. Impounded interior runoff would continue to occur when gates are closed at specified Mississippi River elevations. The gap at the lower end of the New Madrid Floodway would remain open, allowing Mississippi river backwater to enter the Floodway and inundate parts of the area. Operation of the New Madrid Floodway would continue as authorized during large flood events.

The future w/o condition anticipates certain changes to the SJNM region that includes projected future enrollment of flood-prone agriculture lands into the USDA Wetland Reserve Program (WRP).

2. Authorized Project (St. John's Bayou Basin and New Madrid Floodway, Phase I and New Madrid Floodway Closure)

Alternative 2 includes three subalternative components

2.1. St. John's Bayou Basin Improvements Only
2.2. New Madrid Floodway Improvements Only
2.3. Combined 2.1 and 2.2 Projects

These alternatives would variously enlarge and improve drainage along St. John's Bayou; construct a 1,000 cfs pumping station east of the existing gravity flow outlet at the lower end of St. John's Bayou; construct a 1,500 cfs pumping station in the New Madrid Floodway; close the 1,500-foot levee gap at the lower end of the New Madrid Floodway; construct gated box culverts in Mud Ditch; and construct other minor levee, ditch, and water-control features. Water management would impound interior runoff from December through January to provide waterfowl and other wildlife habitat.

3. Authorized Project with Avoid and Minimize Measures

Alternative 3 includes two subalternative components

3.1. Management Scenario 1
3.2. Management Scenario 2

Under this alternative, the authorized project would be constructed, and water-control structures and other infrastructure would be strategically managed to reduce flood risks association with the flood pulse while minimizing environmental damages. Because the project area currently is a highly manipulated environment, management of water-control infrastructure and pumps could restore lost ecological functions to the project area that currently are caused by anthropogenically induced flood regimes.

Scenario 1 would have the following management (numbers are NAVD88 elevation feet amsl)

Date	Close Gate	Start Pump	Stop Pump
15 Nov – 28 Feb	287.5	289.5	288
1 Mar – 15 Apr	286	288	287
16 Apr – 30 May	284	284	282
1 June – 14 Nov	278.5	279.5	278.5

Scenario 2 would have the following management (numbers are NAVD88 elevation feet amsl)

Date	Close Gate	Start Pump	Stop Pump
15 Nov – 28 Feb	287.5	289.5	288
1 Mar – 15 Apr	284	286	285
16 Apr – 30 May	282	282	280
1 June – 14 Nov	278.5	279.5	278.5

The purpose of this report is to calculate potential impacts of the above proposed SJNM project alternatives and water management scenarios on Duck-Use-Days (DUD) for the effected project area using certified DUD calculation models (Heitmeyer 2010a, hereafter "DUD Manual").

METHODS

This report uses methods and formulas provided in the Heitmeyer (2010a) DUD manual to determine energetic requirements of waterfowl and the availability of foods in various habitat types in the SJNM. All calculations were conducted to annualize DUD effects through 100-year flood frequency events.

Data inputs to the DUD Manual used in analyses of SJNM Project Alternatives were:

1. Elevations (NAVD88) that correspond to contemporary 1-, 2-, 5-, 10-, 25-, 50- and 100-year return interval flood recurrence were determined for November (Nov), December-January (Dec-Jan), and February-March (Feb-Mar) time periods for existing and project Alternative conditions in the SJBB and NMF, separately Appendix A) All flood recurrence interval elevations were based on at least 3 consecutive days of flooding, per the 2010 DUD manual. The data separation into Nov, Dec-Jan, and Feb-Mar categories cover the period of time when waterfowl are present in the SJNM and consistently compare project alternatives relative to proposed project operation schedules.

2. Acres of 11 habitat types within the above flood frequency elevation zones, month period, and SJBB and NMF areas were determined and differences between available (flooded) habitat areas in the project Alternatives were determined (Appendix A). Habitat categories were: 1) Corn, 2) Rice, 3) Soybeans, 4) Fallow Cropland, 5) Cypress-Tupelo Forest (C-T), 6) Bottomland Hardwood Forest (BLH), 7) Floodplain Forest, 8) Grassland/Pasture, 9) Seasonal Herbaceous Wetland

(SHW), 10) Open Water/Aquatic (OW-AQ), and 11) Shrub/Scrub (S/S). Descriptions of these habitats are provided in Heitmeyer (2010b, and USACE documents for the project area. Other land cover types in the SJNM included small amounts of developed lands (such as roads, residences, building sites, cities, etc.) and other agricultural lands including winter wheat and cotton (Appendix A). These land cover categories were not analyzed for DUDs because they do not provide significant available waterfowl food sources (e.g., cotton, developed lands) or they do not require flooding for waterfowl use. For example, winter wheat provides browse used mainly by dry-land grazing geese in the SJNM and foraging on this browse does not require flooding (in fact flooding may actually reduce or eliminate wheat browse value depending on depth and timing of flooding).

Forest area in the SJNM was separated into C-T, Floodplain Forest, and BLH categories based on historic and remnant presence of forest types within flood frequency zones of the SJNM. Annualized contemporary flood frequency contour maps (Fig. 1) and potential historic vegetation community maps (Fig. 2) were used to separate relative distribution of forest types into the following percentages:

Flood frequency zone	C-T	Floodplain Forest	BLH
1-Yr	100%	-	-
2-Yr	50%	50%	-
5-Yr	25%	25%	50%
10-Yr	10%	20%	70%
25-Yr	5%	15%	80%
50-Yr	-	-	100%
100-Yr	-	-	100%

Consequently, all forest area in the 1-Yr flood frequency zone was considered C-T; forest area in the 2-Yr flood frequency zone was 50% C-T and 50% Floodplain forest; and so on.

3. Food and energy values for the above 11 habitat types, by month period and flood frequency zone, were determined from the DUD manual. These energy values were standardized to a consistent daily existence energy (DEE) for a mallard (1 mallard DEE = 452.44 kcal/day) and divided by the number of acres affected by project Alternatives (Appendix A) to determine the potential DUDs/acre/month period/habitat type/flood frequency zone (Appendix B).

(Note: If total kcal available energy is desired, Appendix B figures can be multiplied by 452.44 to determine total potential kcal/acre.).

The basic formula for calculation energy values was formula #1 from the DUD manual:

$$\textbf{\textit{Species}}_{1...m}\textbf{\textit{DUD}} = \frac{\sum(F_{1..j})(T_{1...l})}{\textbf{\textit{D}}_{1...m}}$$

Where,

F = the potential food yield (g/ha) for food types $_{1...j}$ in the habitat type $_{1...k}$
T= TME (kcal/g) of specific food types $_{1...l}$
D= DEE of species $_{1...m}$ in kcal/day and is 4x RMR
RMR = $100.7W^{0.74}$
And, W = weighted body mass of species $_{1...m}$ in kg

As an example calculation of potential food value for a habitat type (corn), month periods, and food frequency elevation zone, the below calculations indicate the data methodology:

			Kcal/ha[d]		
Food Type[a]	kg/ha[b]	TME[c]	Nov	Dec-Jan	Feb-Mar
HSD	10	2.50	17,500	13,740	8,750
INV	20	3.50	7,000	24,500	52,500
Corn	290	3.67	425,720	266,075	159,645
Total			450,220	303,900	220,895

DUD/ha for a mallard (divided by DEE= 452.44)	995.1	671.7	488.2
DUD/ha in the 2-Yr Flood Frequency Zone (divided by 0.5)	497.5	335.8	244.1
DUD/acre (multiplied by 0.892 conversion Ha to acre	443.8	299.5	217.7

[a] HSD = herbaceous seeds, INV = invertebrates, Corn = corn seeds.
[b] From Table 10 of the DUD Manual, except that INV is 20 kg/ha based on recent food availability studies in harvested crop fields in southern Illinois.
[c] From Table 16 of the DUD Manual.
[d] Food availability % used in determining food/month from Table 14 of the DUD Manual.

4. DUD amounts for Alternative 1.1 (Existing condition) were calculated and then differences (losses or gains) between Alternative 1.1 and Alternatives 1.2, 2.1, 2.2, 2.3, 3.1, and 3.2 were calculated by habitat type, time period, flood frequency zone, and SJBB and NMF areas (Appendix C).

5. Acres of BLH and SHW (such as moist-soil impoundments) needed to compensate for losses in DUD's (or that were potentially gained if differences were positive) were determined using the below food availability/energy estimates/acre (from the DUD Manual) for these habitats and month periods:

Month Period	Potential DUD acre in managed BLH	Potential DUD acre in managed SHW
November	1,839.00	4,978.60
Dec-Jan	1,935.30	4,149.72
Feb-Mar	1,519.89	3,210.40

RESULTS

St. John's Bayou Basin

Based on the above methodology of calculating DUD's, the SJBB currently has the potential to support about 6 million DUD's (Table 1), most of which occurs from December through March. The largest DUD amounts are within the 2-, 5-, and 10-year flood frequency zone. BLH in the 5-year zone contributes 909,468 DUD's in the combined Dec-Mar period, which is 14.8% of the total (Appendix C).

Future projected increases in WRP acreage, without the project, would potentially add 860,786 DUD's to the SJBB (Table 1); the largest increase would be gains in BLH in the 5-year flood frequency zone and SHW in the 2- and 5- year zones (Appendix C)

The authorized project in the SJBB alone would provide a net increase in DUD's by nearly 600,000 (Table 1). This increase is caused by a large gain in flooded C-T, Floodplain Forest, Open Water, and SHW in the 1- and 2-year flood frequency zones during Dec-Jan when the flood-control gates are closed and water is impounded behind the gates, when otherwise water would drain into the relative low stage Mississippi River. During Feb-Mar, the authorized project includes pumping interior runoff from the SJBB, which reduces flooded area and DUDs by 909,565 (Table 1). The primary lost DUD amount in Feb-Mar is caused by reduced flooding in BLH and soybean acreage in the 5-year flood frequency zone.

When the lost/gained DUD's are considered relative to the equivalent amount of waterfowl food and acres of BLH or SHW that would be potentially be gained or lost from the project alternatives, the without project would gain an equivalent of 519.7 acres of BLH or 231.3 acres of SHW, respectively and the authorized project would gain an equivalent of 178.1 or 83.8 acres of BLH or SHW, respectively for all months combined Nov-Mar (Table 2). If specific month periods are considered, then the primary lost DUD acreage value from the authorized project would be equivalent to 598.4 or 283.3 acres of BLH and SHW, respectively in Feb-Mar.

New Madrid Floodway

Total existing DUD's in the NMF are about 13.5 million (Table 3). The largest amounts of existing DUD's are from soybean acreage in the 2-, 5-, and 10-year flood frequency zones during Feb-Mar. While soybean land has low food availability compared to most other habitat types (Appendix B), the large total soybean acreage in the NMF ultimately contributes large amounts of DUD's (Appendix C). BLH acres in the 5- and 10-year zones also contribute large amounts of existing DUD's during the combined Dec-Mar period (Appendix C).

Future projected increases in WRP acreage in the NMF without the project would potentially increase DUD's by almost 800,000 (Table 3). Most of this increase is from new BLH in the 5- and 10-year flood frequency zones and SHW in the 2- and 5-year zones (Appendix C).

The authorized project in the NMF (Alternative 2.2) has little loss of DUD's in Nov, moderate loss of DUD's during Dec-Jan, and large DUD losses during Feb-Mar (Table 3). DUD's are actually gained from Alternative 2.2 during Dec-Jan in the 1- and 2-year flood frequency zones, (Appendix C), but are lost during all other months and flood frequency zones. The greatest DUD losses are from reduced flooding of BLH in the 5- and 10-year zones from Dec-Mar and reduced flooding in soybean acreage in the 2-, 5-, and 10-year zones (Appendix C).

DUD losses in the avoid-and-minimize Alternatives 3.1 and 3.2 are 48% and 44% less than in Alternative 2.2 (Table 3). Alternatives 3.1 and 3.2 have relatively low and similar losses in DUD's during Nov and Dec-Jan, but have large losses during Feb-Mar when closed flood-control gates prevent backwater flooding from the Mississippi River into the NMF. As with Alternative 2.2, the largest losses in DUD's during Feb-Mar are caused by reduced flooding of soybean acreage in the 2-, 5-, and 10-year flood frequency zones and reduced flooding of BLH in the 5- and 10-year zones. Reduced flooding of C-T and Floodplain Forest in the 2-year zone also is substantial.

Future WRP without the project would increase DUD's equivalent to 463.1 acres of BLH or 216.2 acres of SHW, respectively (Table 4). In other alternatives, losses in DUD's would be equivalent to 5,533.9, 2946.9, and 3,188.1 acres of BLH, respectively in Alternatives 2.2, 3.1. and 3.2. Similar equivalent losses in DUD's for SHW would be 2,609.7, 1,393, and 1,507 acres of SHW in Alternatives 2.2, 3.1, and 3.2, respectively.

DISCUSSION

The DUD Manual methodology of calculating potential DUD's within the SJNM provides a certified and validated way to evaluate the waterfowl carrying capacity of the region (the Existing Condition DUD's) and potential changes that might occur under various project alternatives. These data then can be used to determine relative losses/gains under the different alternatives and what, if any, mitigation might be needed to compensate for losses. The gains and losses also can be determined relative to specific areas (SJBB and NMF), month periods, habitat types, and flood frequency zones.

In general, the DUD analyses provided in this report indicate:

1. Both the SJBB and NMF potentially can support large numbers of waterfowl from December through March; DUD potential in November is relatively low because of low average rainfall and runoff and extremely rare backwater flooding from the Mississippi River during November.

2. Future projected increases in WRP acreage would potentially increase DUD's in both the SJBB and NMF by about 800,000 to 850,000 DUD's.

3. The authorized project has the potential for a net gain (all month periods combined) of 598,243 DUD's in the SJBB, primarily because of large increases in flooding during Jan-Dec caused by closing flood-control gates and allowing water to impound mainly in the 1-, 2-, and 5-year flood frequency zones. This increase occurs because little natural overbank flooding from the Mississippi River occurs in the SJNM during December and January. The authorized project also increases DUD's in the NMF in the 1- and 2-yr flood frequency zones in Dec-Jan, but is countered by larger losses in higher elevation flood frequency zones during these months. In both the SJBB and NMF, the authorized project causes losses in DUD's during Feb-Mar.

4. The largest losses of DUD's in the SJNM occur during Feb-Mar in the NMF from the authorized project. Avoid-and-minimize Alternatives 3.1 and 3.2 reduce total net DUD losses by 48% and 44% compared to Alternative 2.2.

5. The amount of BLH and SHW acres that would be needed to compensate for lost DUD's range from 1,507.2 acres of SHW under Alternative 3.2 to 5,533.9 acres of BLH in the NMF under Alternative 2.2.

LITERATURE CITED

Heitmeyer, M.E. 2010a. A manual for calculating duck-use-days to determine habitat resource values and waterfowl population energetic requirements in the Mississippi Alluvial Valley. Greenbrier Wetland Services Report 10-01. Blue Heron Conservation Design and Printing LLC. Bloomfield, MO.

Heitmeyer, M.E. 2010b. An assessment of historic land cover for the St. John's Bayou Basin New Madrid Floodway region. Greenbrier Wetland Services Report 10-05. Blue Heron Conservation Design and Printing LLC. Bloomfield, MO.

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TABLES

Table 1. Duck-use-day (DUD) analyses for the St. John's Bayou Basin comparing DUD's in the existing condition (Alternative 1.1) and gains (+) or losses (-) in DUD's without the project (but with future WRP projections) (Alternative 1.2) and with the authorized project (Alternative 2.1).

Month Period	Alt. 1.1 Existing condition	Alt. 1.2 Δ Without project	Alt 2.1 Δ Authorized project
November	218,166	+7,375	-93,549
Dec-Jan	2,335,420	+326,128	+1,601,357
Feb-Mar	3,606,117	+527,283	-909,565
All months combined	6,159,603	+860,786	+598,243

Table 2. Acres of Managed Bottomland Hardwood Forest (BLH) or Seasonal Herbaceous Wetland (SHW) potentially gained (-) or lost (-) based on the Duck-use-day (DUD) analyses for the St. John's Bayou Basin comparing DUD's in the existing condition and gains (+) or losses (-) in DUD's without the project (but with future WRP projections) (Alternative 1.2) and with the authorized project (Alternative 2.1).

Month period and habitat	Alt. 1.2 Δ Without project	Alt. 2.1 Δ Authorized project
November		
BLH	+4.3	-50.9
SHW	+1.6	-18.8
Dec-Jan		
BLH	+168.5	+827.4
SHW	+65.5	+385.9
Feb-Mar		
BLH	+346.9	-598.4
SHW	+164.2	-283.3
All months combined		
BLH	+519.7	+178.1
SHW	+231.3	+83.8

Table 3. Duck-use-day (DUD) analyses for the New Madrid Floodway comparing DUD's in the existing condition (Alternative 1.1) and gains (+) or losses (-) in DUD's without the project (but with future WRP projections) (Alternative 1.2), with the authorized project (Alternative 2.2), and Alternatives 3.1 and 3.2.

Month Period	Alt. 1.1 Existing condition	Alt. 1.2 Δ Without project	Alt. 2.2 Δ Authorized project	Δ Alternative 3.1	Δ Alternative 3.2
November	132,310	+29,126	-85,926	-15,426	-15,426
Dec-Jan	5,299,733	+395,294	-1,446,738	-340,740	-340,740
Feb-Mar	8,069,675	+369,406	-7,203,625	-4,198,527	-4,565,165
All months combined	13,501,738	+793,826	-8,736,289	-4,554,693	-4,921,331

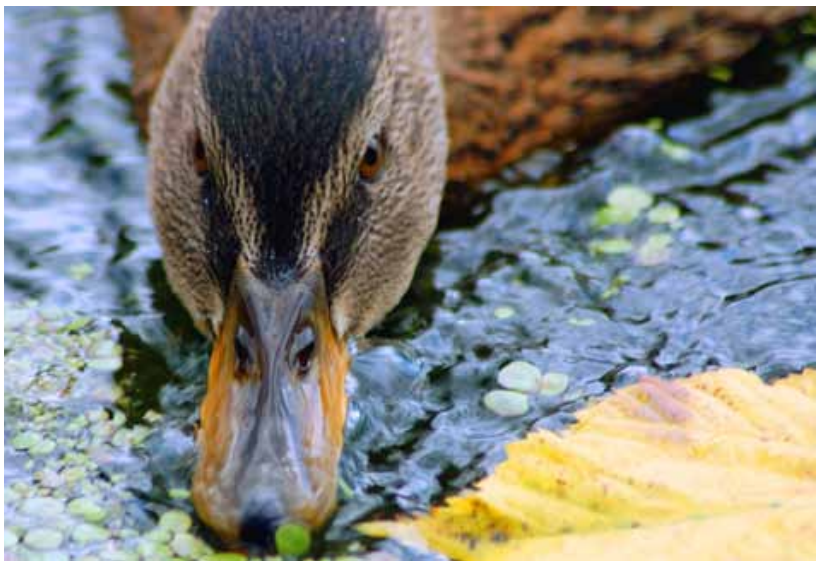
Table 4. Acres of Managed Bottomland Hardwood Forest (BLH) or Seasonal Herbaceous Wetland (SHW) potentially gained (-) or lost (-) based Duck-use-day (DUD) analyses for the New Madrid Floodway comparing DUD's in the existing condition and gains (+) or losses (-) in DUD's without the project (but with future WRP projections) (Alternative 1.2), with the authorized project (Alternative 2.2), and Alternatives 3.1 and 3.2

Month period and habitat	Alt 1.2 Δ Without project	Alt 2.2 Δ Authorized project	Δ Alternative 3.1	Δ Alternative 3.2
November				
BLH	+15.8	-46.7	-8.4	-8.4
SHW	+5.8	-17.3	-3.1	-3.1
Dec-Jan				
BLH	+204.3	-747.6	-176.1	-176.1
SHW	+95.3	-348.6	-82.1	-82.1
Feb-Mar				
BLH	+243.0	-4739.6	-2762.4	-3003.6
SHW	+115.1	-2243.8	-1307.8	-1422.0
All months combined				
BLH	+463.1	-5533.9	-2946.9	-3188.1
SHW	+216.2	-2609.7	-1393.0	-1507.2

FIGURES AND APPENDICES LIST

B. DUD energy amounts/acre for habitat types by month period and flood frequency zone. (Total of 3 Excel spreadsheets).

C. DUD amounts in the Existing St. John's Bayou Basin and New Madrid Floodway related to habitat type, month period, and flood frequency zone and comparisons of losses or gains in DUD's for project alternatives. (Total of 22 Excel spreadsheets).



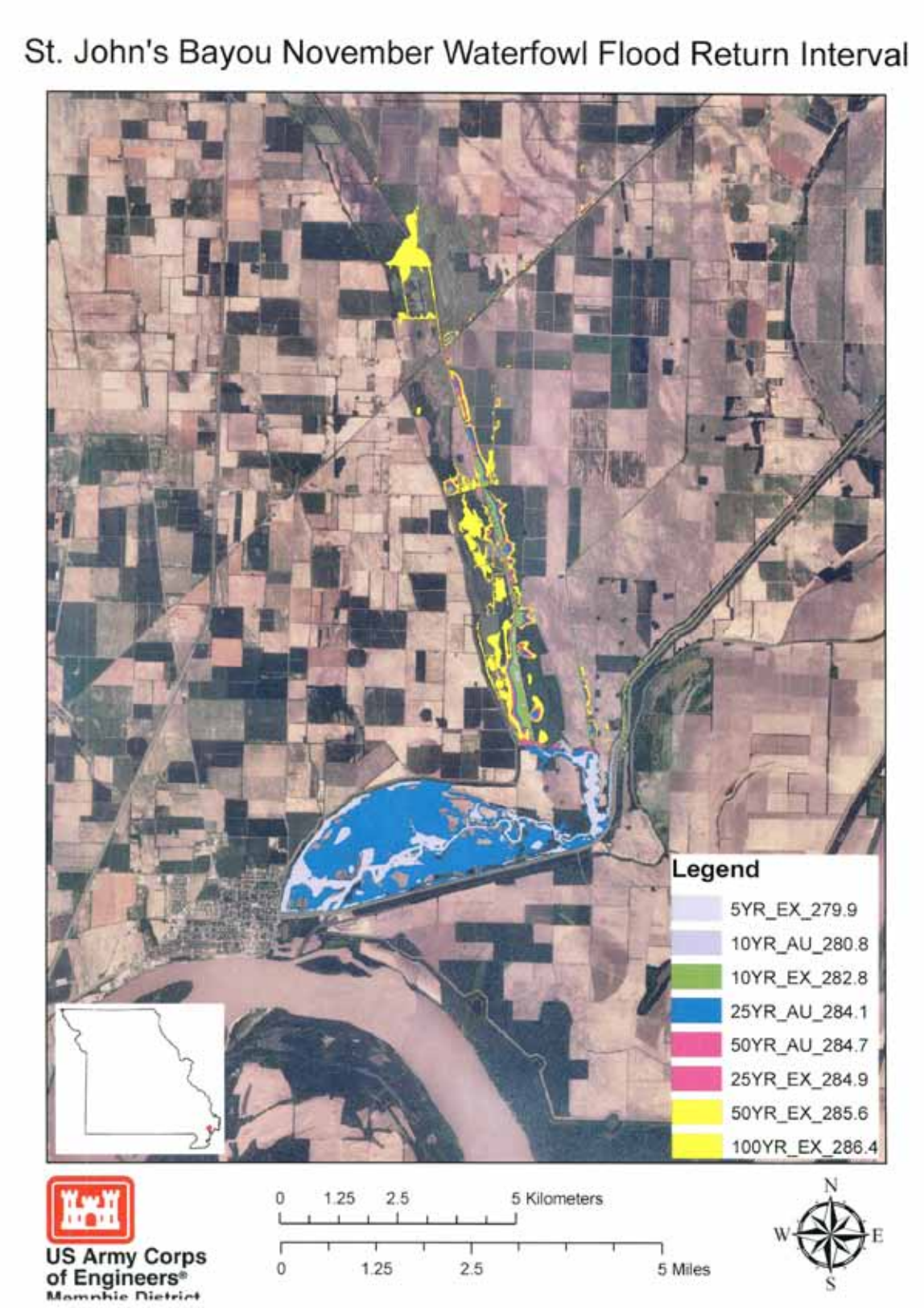


Figure 1. Flood frequency elevation (NAVD88) contour intervals for the St. John's Bayou Basin during November for existing (EX) and authorized (AU) project conditions.

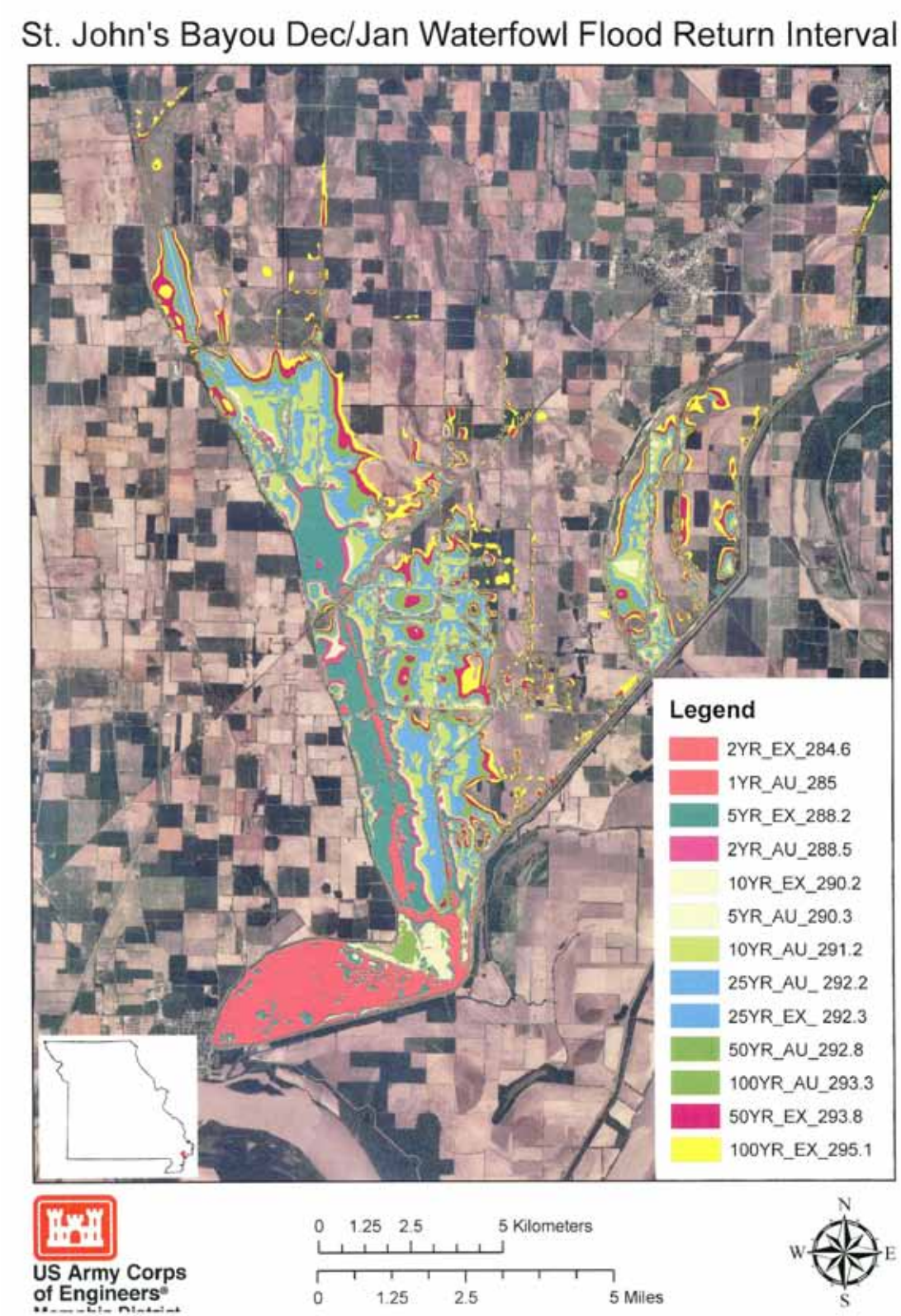


Figure 2. Flood frequency elevation (NAVD88) contour intervals for the St. John's Bayou Basin during Dec-Jan for existing (EX) and authorized (AU) project conditions.

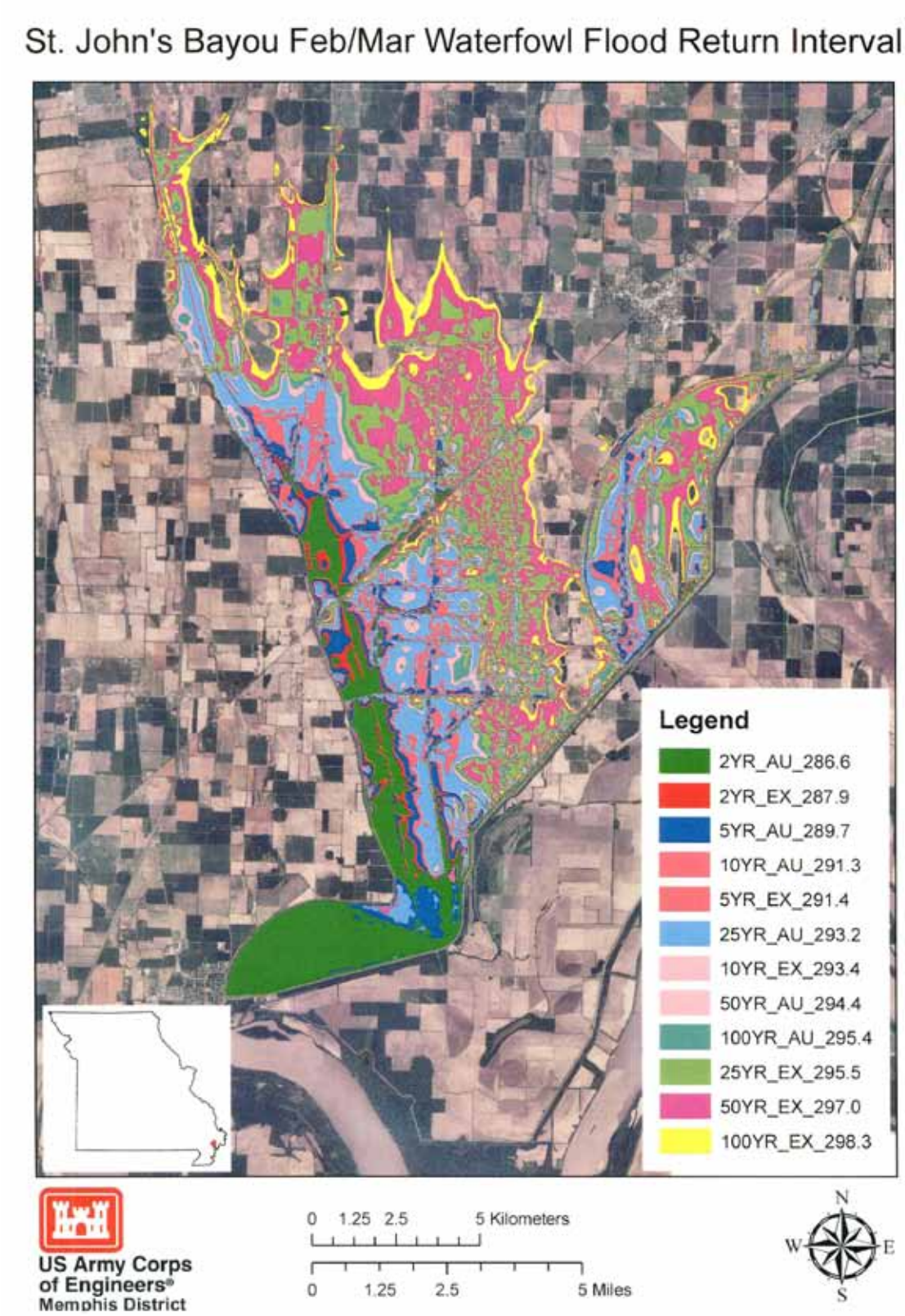


Figure 3. Flood frequency elevation (NAVD88) contour intervals for the St. John's Bayou Basin during Feb-Mar for existing (EX) and authorized (AU) project conditions.

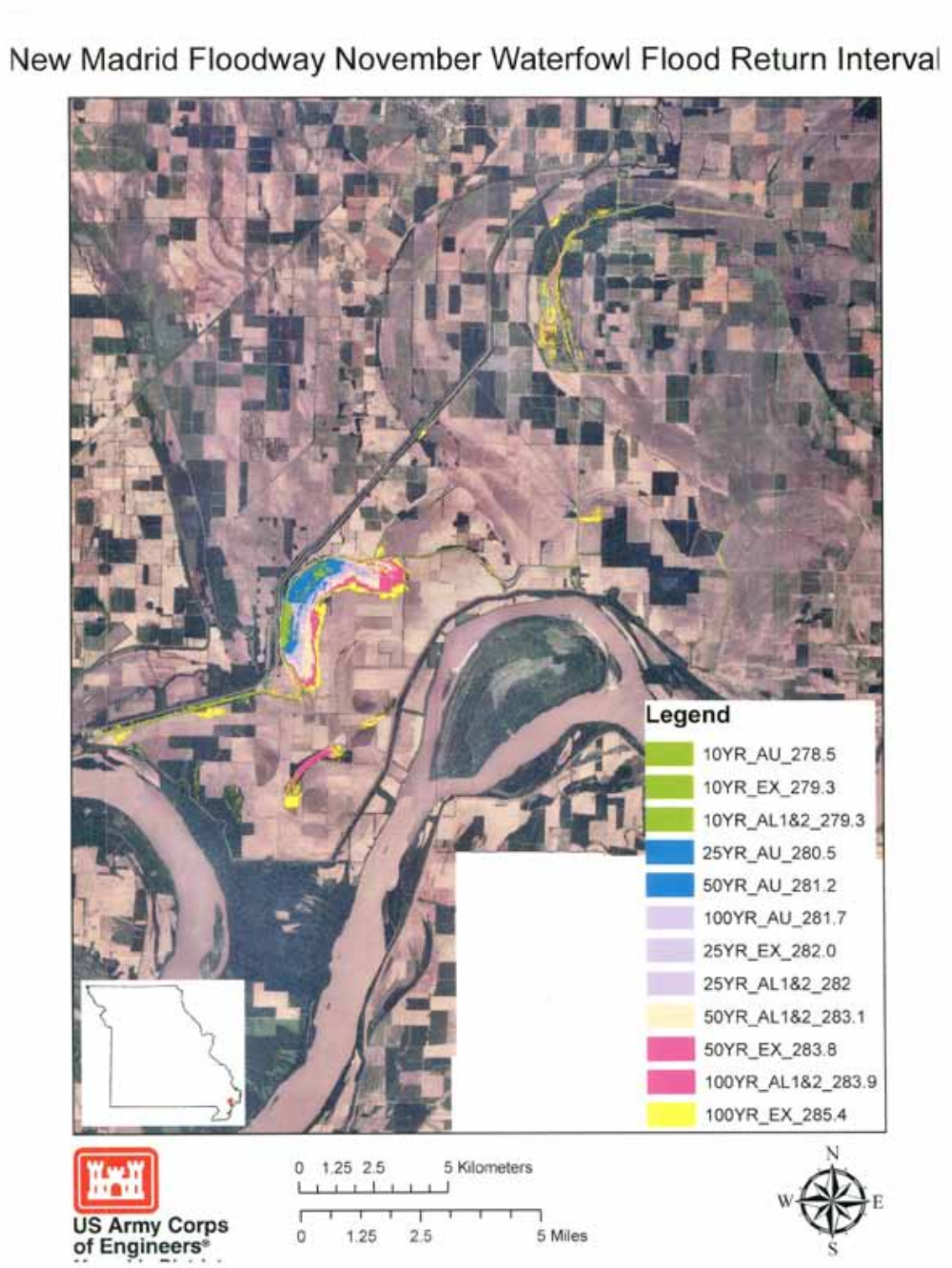


Figure 4. Flood frequency elevation (NAVD88) contour intervals for the New Madrid Floodway during November for existing (EX) and authorized (AU) project conditions.

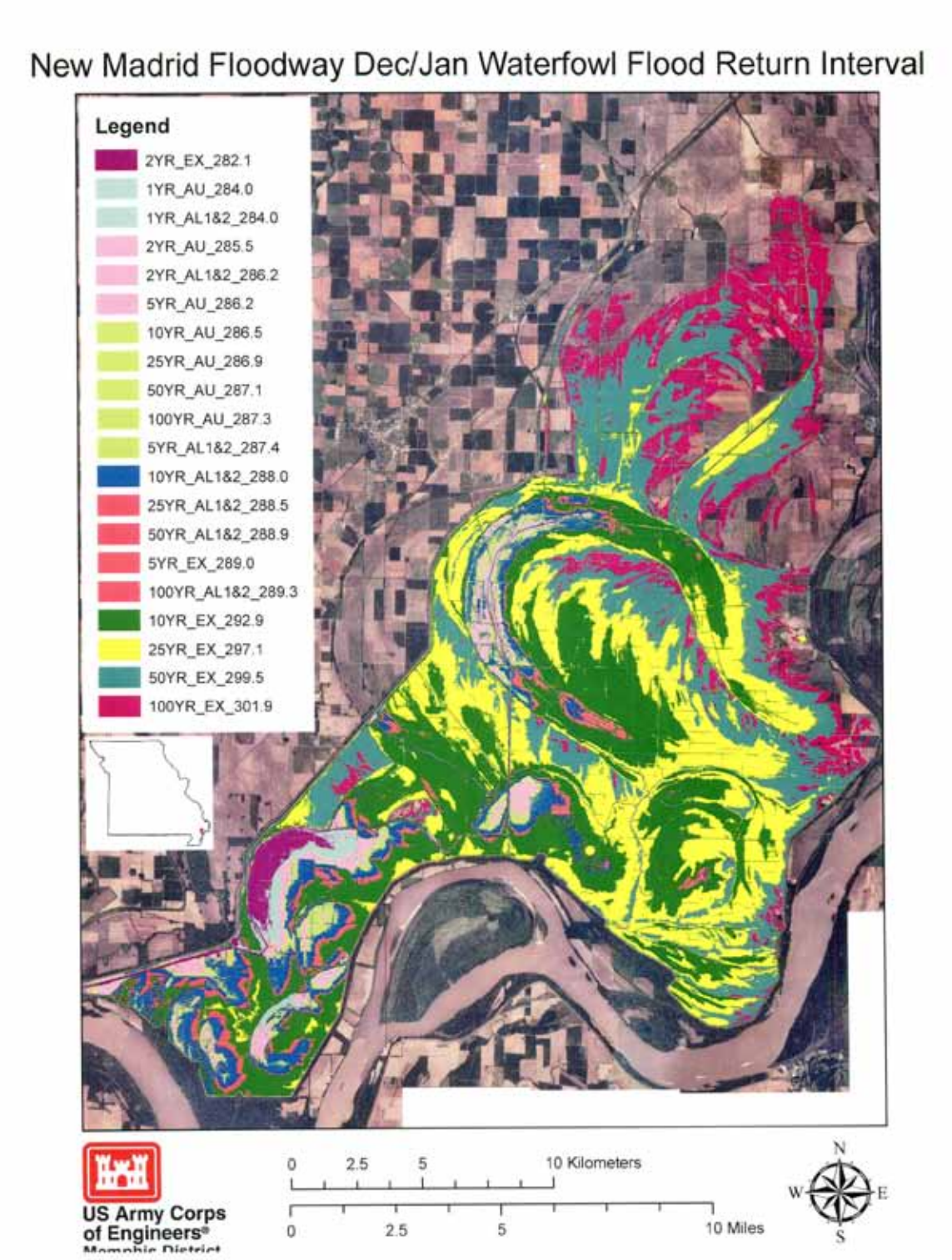


Figure 5. Flood frequency elevation (NAVD88) contour intervals for the New Madrid Floodway during Dec-Jan for existing (EX) and authorized (AU) project conditions.

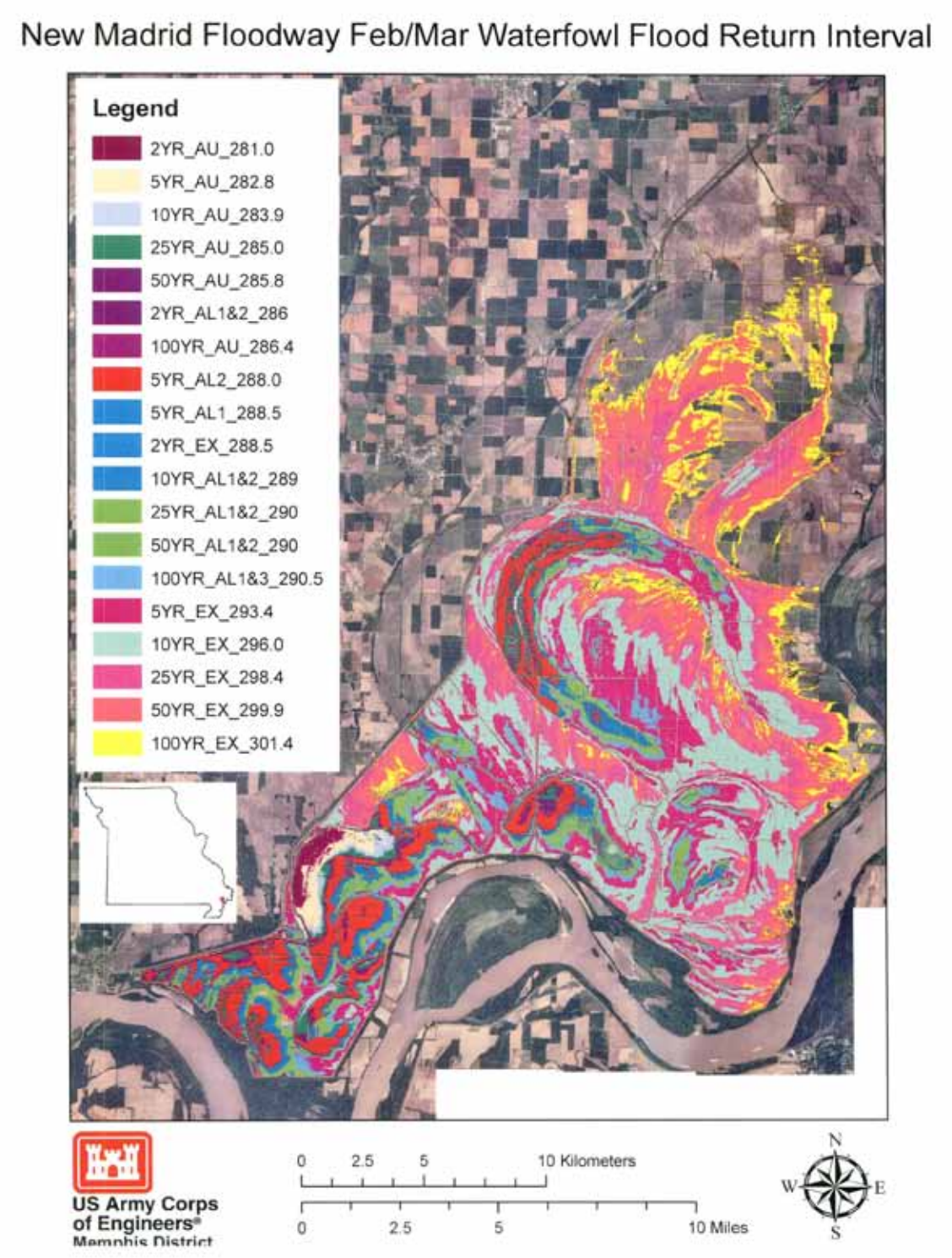


Figure 6. Flood frequency elevation (NAVD88) contour intervals for the New Madrid Floodway during Feb-Mar for existing (EX) and authorized (AU) project conditions.

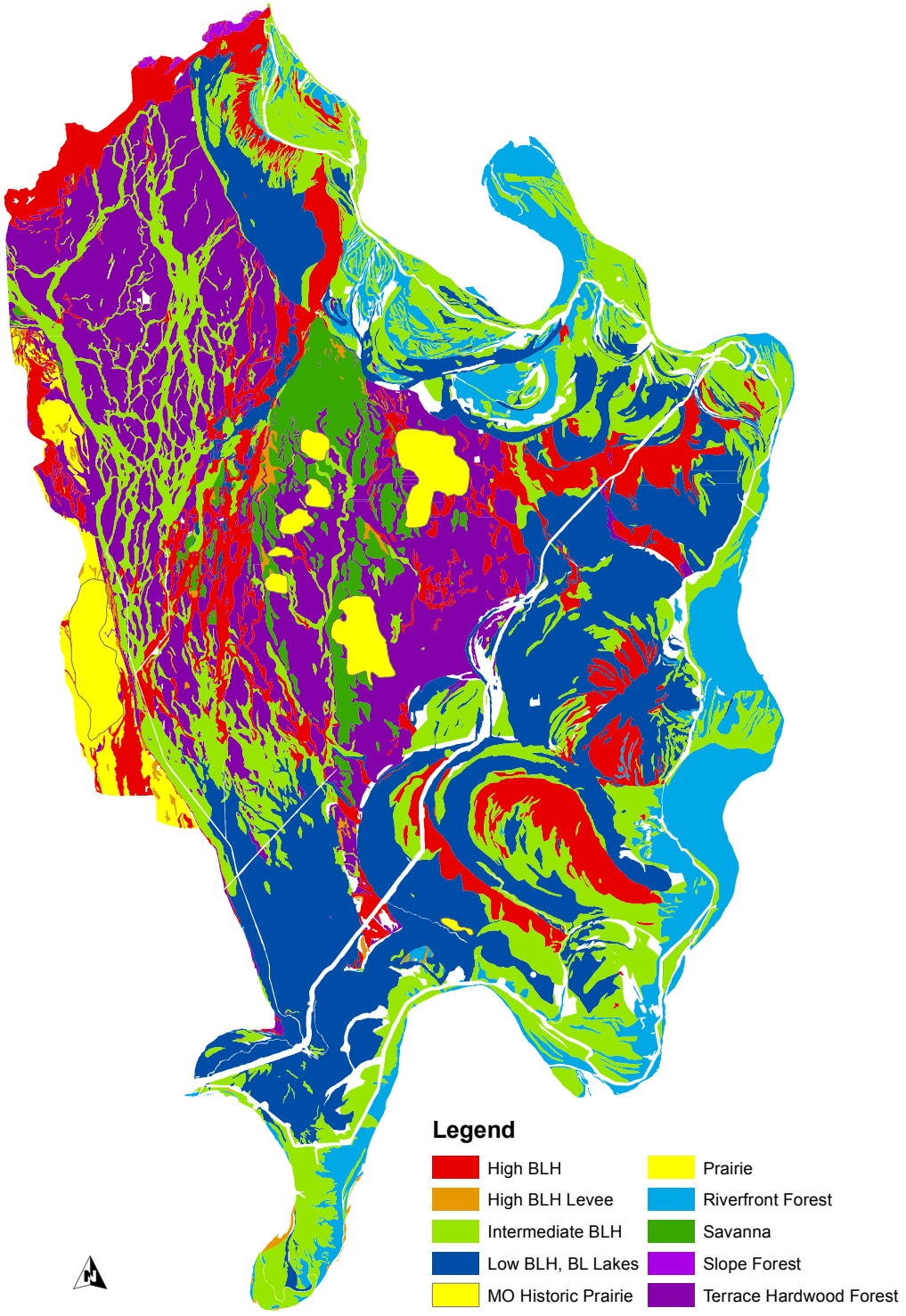


Figure 7. Map of potential distribution and types of historic vegetation communities in the St. John's Bayou Basin and New Madrid Floodway (from Heitmeyer 2010b).

NOTES:

ERRATA

The revised analyses of changes in duck-use-days (DUDs) for the new project Alternative 4 compared to the future without the project indicated gains in DUDs in all month periods except Alternative 4.1 during February and March (Table 1). Even this estimated loss of about 2.7 million DUDs under Alternative 4.1 during February and March is almost 58% lower than the loss of DUDs in this month period for Alternative 2. Alternative 4 is similar to Alternative 3 except that the NNF structure would not be closed and pumps would not be used until floods are greater than 289.5 feet. Alternative 4.2 would reforest agricultural lands below 289.5 while Alternative 4.1 would not. Consequently, substantial gains in DUDs accrue in all month periods under Alternative 4.2 because of the high potential food production in reforested areas. The gain of nearly 4.3 million DUDs during December and January is extremely high and the gain of about 1.4 DUDs in February and March is the only project scenario where DUDs increase during this time period. Collectively, Alternative 4, especially Alternative 4.2 represents up to a 5x reduction of loss of DUDs compared to other Alternatives, with an overall effect of mostly substantial gains in waterfowl habitat values.