#176

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Sediment Conditions in Backwater Lakes Along the Illinois River

by

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Contents

Summary

Based on backwater lake and land use inventory, there are about 39,000 acres or more in the Illinois river floodplain. Most of the backwater lakes are located in river reach 0 to 230 river miles. At the same time, there are about 489,000 acres of drainage and levee districts in the floodplain. Some of these areas once were parts of the backwater lakes. Due to the levee building and agricultural reclamation, the original floodplain was converted into farmlands. The competition of the land use for agriculture, wildlife hunting and feeding ground, fishing area and flood waterways has been becoming more intensive in recent years.

The sediment yield leaving the mouth of the Illinois river basin was estimated at about 12.1 million tons per year. The sediment yields from the tributaries to the Illinois river were estimated as 27.5 million tons per year. Therefore, the difference of these two sediment yields was assumed to stay in the floodplain areas. If this amount of sediment deposits in the backwater lakes and river, the thickness would be about 2.0 inches per year. If this amount of sediment spreads over the floodplain, the thickness would be 0.19 inches per year.

Lake Meredosia and Lake Depue were studied with detailed cross-section surveys. Lake Meredosia sediments come into the lake from the inlet channel. Therefore, the sediment starts to deposit in the lake once it reaches the wide open water body.

The segments of the lake near the inlet channel have higher sediment accumulation.

Lake Depue was shown to have sediment coming from the west side inlet channel at low and median flow stages. At high flow stages, the sediment could come from the east side and the island at the south side of the lake. Accordingly, the sediment accumulation is relatively uniform over all the lake.

The annual accumulation at Lake Meredosia was estimated about 0.41 inches per year. For Lake Depue, the annual accumulation is about 0.59 inches per year.

Reconnaissance surveys were made of 10 backwater lakes along the Illinois river in 1975. We selected two lakes, Swan Lake, and Sawmill Lake, for which capacity loss has been calculated. The results were combined with the Lakes Meredosia and Depue detailed surveys to show the general sediment conditions of backwater lakes along the Illinois river. Two out of the four lakes have the sediment accumulation rate at 0.33 to 0.59 inches per year. The Swan Lake has 0.18 inches per year sediment accumulation which is attributed to the high natural levee divided the river and lake.

The hydrological information for sediment condition assessment includes: (1) stage-duration curves at three pools, (2) Annual-Duration Table, (3) Annual high and low stages, range analysis, and (4) Accumulated inflow and outflow of the backwater lake. The stage duration curves indicate the downstream pool has higher fluctuation than the upstream pools.

The annual duration tables show that the river stage in low stage was controlled above the fixed level. However in high flow stage, these dams did not control the flood flow. The annual high and low stage and extreme range data indicated the river stages fluctuated ranging from 27.1 feet to 6.9 feet. The wide range of river stage variation is one of the important factors in an engineering project.

The annual accumulated rising stage times the lake surface area was assumed to be the first approximation of the annual inflow to the lake. A ratio of annual inflow and sediment deposition at Lake Meredosia was calculated as 1619 to 1 during 1938 to 1955 and 1822 to 1 during 1956 to 1975. In the future, given the annual daily river or lake stages, the first approximated lake sediment deposition can be assessed based on this ratio for different reaches of the river. The ratios of inflow and sediment deposition at other backwater lakes were not calculated in this report.

SEDIMENT CONDITIONS IN BACKWATER LAKES ALONG THE ILLINOIS RIVER

By

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Chapter 1 INTRODUCTION

The Illinois River was once a natural river. The main channel conveys the water and sediment at the normal flows. During the flood periods, the water-sediment mixture spreads over the flood plain. When the flood recedes, the water stays in the backwater lakes. This phenomena has been described by Starrett (1972). The sediment deposits in the backwater lakes. During the 1930's, a series of locks and dams were built. As a result, a series of nine pools was formed. The impoundments of these pools increases the water depth for navigation. However, the backwater inundated the original sloughs along the river. The velocity of water in these backwater areas is very low. The sediment load deposits at an accelerated rate. Accordingly, the recreational value of these areas has gradually deteriorated. In order to assess the current sediment condition, this research project was initiated.

The objective of this project is to obtain: (1) the amount of sediment deposited in backwater lakes, (2) the rate of sediment accumulation, and (3) the physical and chemical nature of the deposited sediment. This project was designated as a pilot study for the future management of these backwater lakes.

Authorlty

This study was conducted by the State Water Survey under a Cooperative Project Agreement with the Department of Business and Economic Development utilizing funds provided to the State of Illinois by the U.S. Water Resources Council under Title III of the Water Resources Planning Act. The project was 9 months in duration, lasting from 1 April 1975 to 31 December 1975. By the completion date, the State of Illinois responsibilities under the Water Resources Planning Act had been transferred to the Division of Water Resources. So, this project completion report is being provided to the Division of Water Resources.

As a followup to the study reported here, there is now underway a similiar cooperative project dealing with Future of Backwater Lakes Along the Illinois River. The duration is the one year 1 January 1976 to 31 December 1976.

Acknowledgments

This study was conducted as part of the work of the Hydrology Sections, of the Illinois State Water Survey, Dr. William C. Ackermann, Chief. The authors wish to express their appreciation to: Ralph Fisher, Division of Water Resources, who conceived and helped in the administration of this project; L.M. Pipkin, Chief of Bureau of Engineering, Division of Water Resources, who provided the 1903 Woermann Maps; Hugh Null and Jack Toll, U.S. Pish and Wildlife Service, provided boat and guide in Swan Lake and Lake Chautauqua; Dr. Neil Shimp, Richard R. Ruch, Paul B. DuMontelle and Gary Dreher of The State Geological Survey, are doing sediment sample analyses. At The State Water Survey, K.W. Kim, part-time research assistant, helped in the data analysis; John W. Brother, Jr. drafted the figures, Thomas A. Butts, provided guide in lake reconnaissance survey; Becky A. Rohl, Frances Bailey and Patti C. Welch typed the report. Berns and Clancy & Associates and Daily & Associates carried out the lake cross-sections surveys in Lakes Meredosia and DePue.

Chapter 2

INVENTORY OF LAND USE ALONG THE ILLINOIS RIVER FLOODPLAIN

In order to assess the general water and land resources in the Illinois river flood plain, we attempted to make an inventory of the land use based on four categories: (1) backwater lake, (2) river surface area, (3) drainage and levee district, and (4) non-organized farmland and other land use (road, community, industrial sites, backwater lakes and sloughs less than 50 acres, etc.). In Figure 1 is a general location map of the Lower Illinois River. Figure 2 is the same for the Upper Illinois River.

Since the Illinois river is controlled by a series of locks and dams for the navigation purpose, nine pools were formed. Because most of the backwater lakes are located in the three downstream pools, our inventory only covers: (1) Alton pool (river mile 0 to 80), (2) LaGrange pool (river miles 80 to 157) and (3) Peoria pool (river mile 158 to 230). However, this river reach of 230 miles occupies the major areas of the Illinois river flood plain.

We used the maps of the Division of Waterways report (1969) and (1971) for measuring the backwater lakes. Since there were numerous lakes located along the flood plain, we only measured the lakes with surface area larger than 50 acres. The acreage of the lake was taken from a 1970 inventory of the Department of Business and Economic Development (1971). The name of the lakes, the location of the river mile, county, and surface areas are listed in Table 1 to 3 for each pool. The drainage and levee district acreage data was taken from the 1970 inventory. Their names, the locations of river mile, county, and acreage are also shown in the Table 1

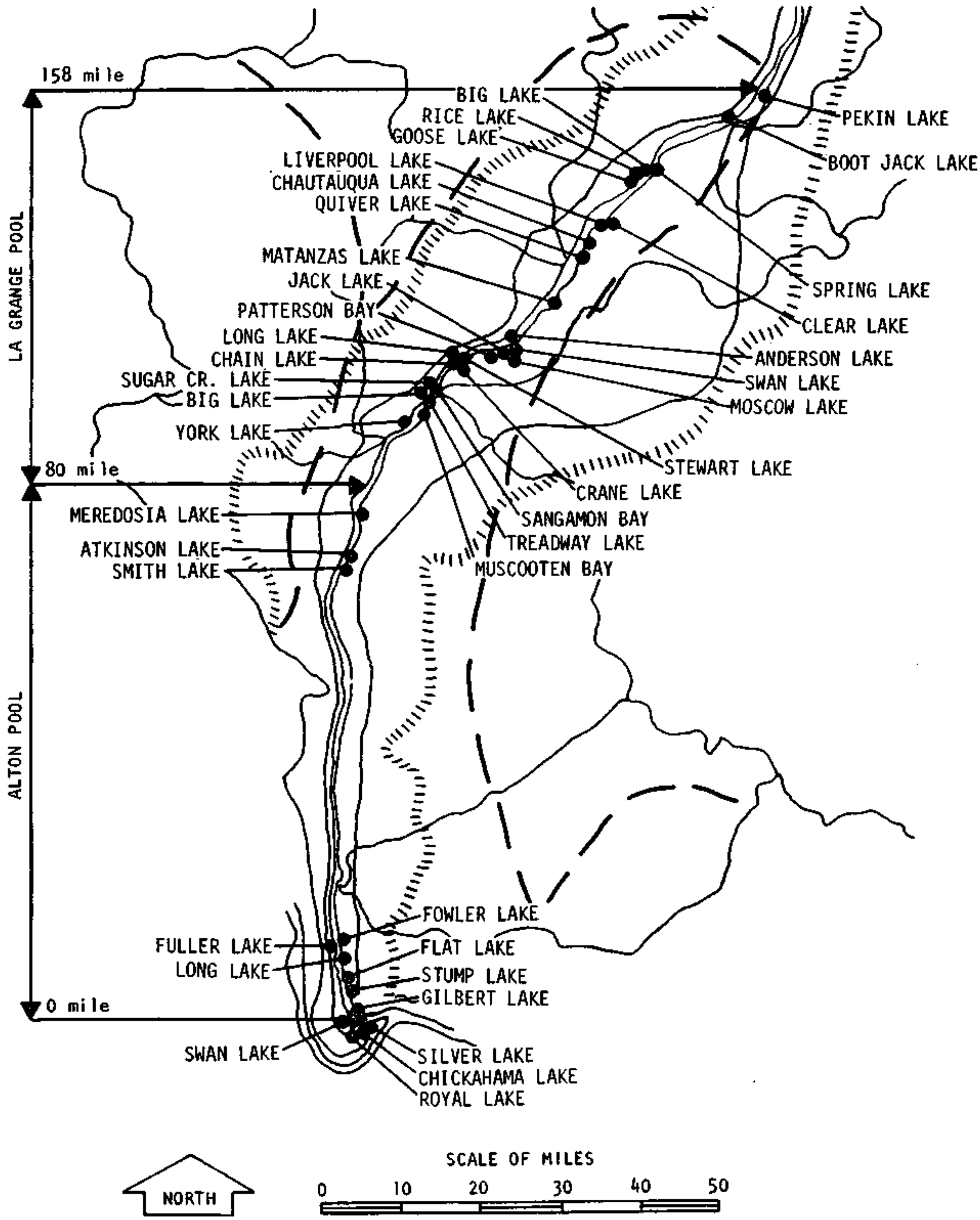
158 mile
80 mile
0 mile
LA GRANGE POOL
ALTON POOL
BIG LAKE
RICE LAKE
GOOSE LAKE
LIVERPOOL LAKE
CHAUTAUQUA LAKE
QUIVER LAKE
MATANZAS LAKE
JACK LAKE
PATTERSON BAY
LONG LAKE
CHAIN LAKE
SUGAR CR. LAKE
BIG LAKE
YORK LAKE
PEKIN LAKE
BOOT JACK LAKE
SPRING LAKE
CLEAR LAKE
ANDERSON LAKE
SWAN LAKE
MOSCOW LAKE
STEWART LAKE
CRANE LAKE
SANGAMON BAY
TREADWAY LAKE
MUSCOOTEN BAY
MEREDOSIA LAKE
ATKINSON LAKE
SMITH LAKE
FOWLER LAKE
FULLER LAKE
FLAT LAKE
LONG LAKE
STUMP LAKE
GILBERT LAKE
SWAN LAKE
SILVER LAKE
CHICKAHAMA LAKE
ROYAL LAKE
NORTH
SCALE OF MILES
0
10
20
30
40
50

Figure 1

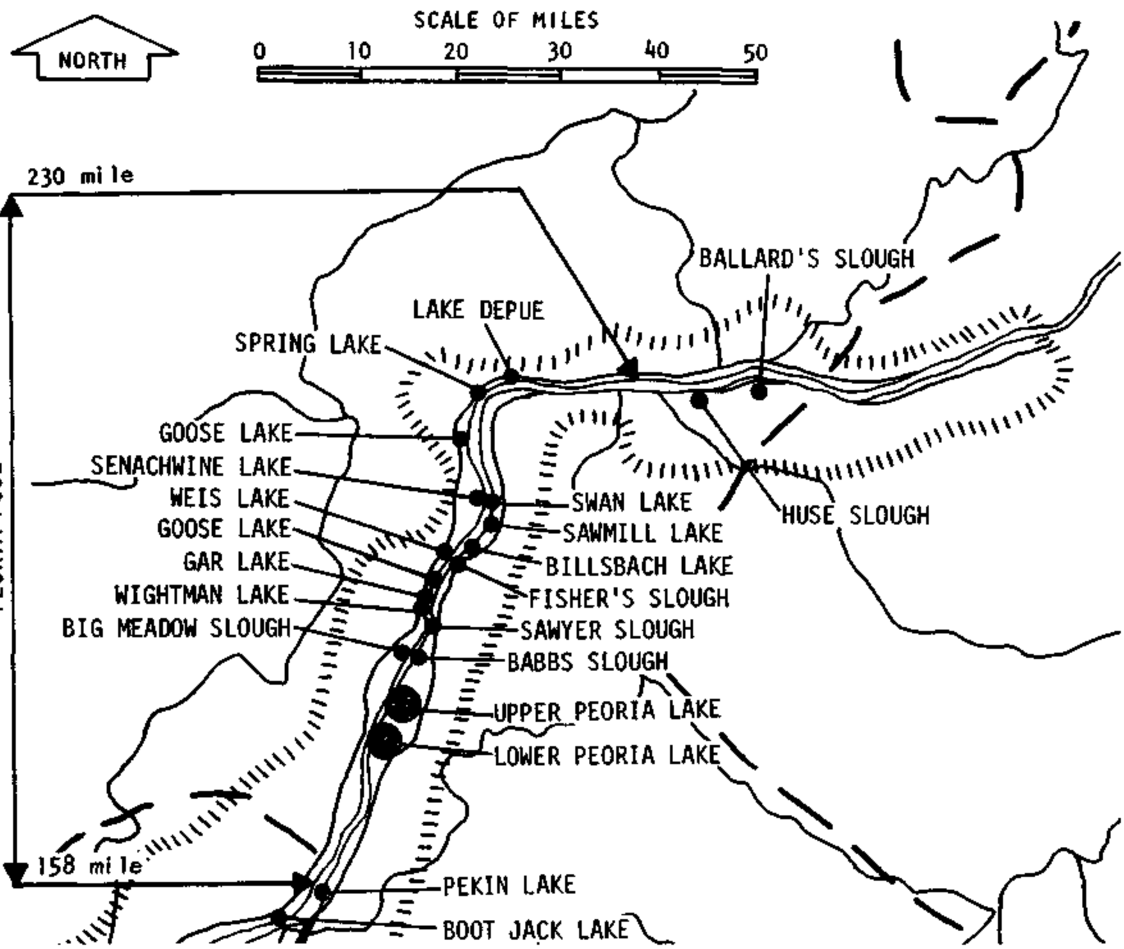
SCALE OF MILES
0 10 20 30 40 50
NORTH
230 mile
158 mile
PEORIA POOL
BALLARD'S SLOUGH
LAKE DEPUE
SPRING LAKE
GOOSE LAKE
SENACHWINE LAKE
WEIS LAKE
GOOSE LAKE
GAR LAKE
WIGHTMAN LAKE
BIG MEADOW SLOUGH
SWAN LAKE
SAWMILL LAKE
BILLSBACH LAKE
FISHER'S SLOUGH
SAWYER SLOUGH
BABBS SLOUGH
UPPER PEORIA LAKE
LOWER PEORIA LAKE
HUSE SLOUGH
PEKIN LAKE
BOOT JACK LAKE

Figure 2

to 3 for each pool. The river surface areas were also estimated based on 1969 the Division of Waterways maps. The width of the river was measured at each 5-mile interval. The surface area was computed by adding the areas of the 5 mile stream reaches. The flood plain areas were estimated based on 15 minute USGS topographic maps. The delineation of the flood plain was approximated along the bluff line of the river. In some stream reaches, we needed to use subjective adjudgement. However, for most of the reach of the river the flood plain is readily definable. The measurement interval was also 5 miles for the flood plains. The total flood plain areas and river surface acreage were shown in Table 4.

The results of this inventory are summarized in Table 4. The total flood plain between the bluff lines is about 745,000 acres from river mile 0 to 230: 240,000 acres along the Alton pool, 376,000 acres along the LaGrange pool and 129,000 acres along the Peoria pool. Among these acreages, 39,000 acres or 5.2% are backwater lakes; 33,000 acres or 4.5% are river surface area; 184,000 acres or 25% are drainage and levee district and 489,000 acres or 66% are nonorganized farmland and other land use. The number of backwater lakes which were inventoried is 53; 13 of them are in Alton pool reach, 28 in LaGrange pool reach and 12 in Peoria pool reach.

Table 1a. Surface Area of Backwater Lakes Along the Alton Pool (River mile 0 to 80)

Backwater Lake			
Name	River Mile	Area	County
Silver Lake	2-3	40	Calhoun
Chickahama Lake	2-3	56	Calhoun
Royal Lake	3-4	68	Calhoun
Swan Lake	5-9	2345	Calhoun
Fuller Lake	11-12	150	Calhoun
Gilbert Lake	5-7	300	Jersey
Stump Lake	8-11	541	Jersey
Flat Lake	9-11	162	Jersey
Fowler Lake	11-12	231	Jersey
Long Lake	10-11	55	Jersey
Smith Lake	67-68	125	Scott
Atkinson Lake	67-69	277	Scott-Morgan
Meredosia Lake	72-78	1692	Morgan-Cass
Total Number = 13		Total Area = 6,042 Acres	

Table 1b. Land Acreage of Drainage and Levee Districts Along Alton Pool (River mile 0 to 80)

Drainage and Levee District			
Name	River Mile	Area	County
Nutwood D&L*	15-24	10,619	Jersey-Green
Eldred D&L	24-33	8,438	Greene
Keach D&L	33-38	7,892	Greene
Hartwell D&L	38-43	8,709	Greene
Hillview D&L	43-50	12,323	Greene-Scott
Big Swan D&L	50-57	12,749	Scott
Scott County D&L	57-63	10,245	Scott
Mauvaise Terre D&L	63-67	4,066	Scott
Valley City D&L	62-67	4,476	Pike
McGee Creek D&L	67-75	10,780	Pike-Brown
Coon Run D&L	67-71	4,361	Scott-Morgan
Willow Creek D&L	71-73	4,294	Morgan
Meredosia Lake D&L	73-80	3,750	Morgan-Cass
Little Creek D&L	75-80	1,610	Brown
Total Number = 14		Total Area = 104,312 Acres	

* D&L = Drainage and Levee District.

Table 2a. Surface Area of Backwater Lakes Along the LaGrange Pool (River mile 80 to 158)

Backwater Lake			
Name	River Mile	Area	County
York Lake	85-89	389	Schuyler
Sugar Creek Lake	95-95	121	Schuyler
Long Lake	99-100	111	Schuyler
Big Lake	93-94	108	Schuyler
Mascooten Bay	89-93	1646	Cass
Treadway Lake	93-96	615	Cass
Sangamon Bay	96-97	190	Cass
Chain Lake	99-101	423	Mason
Crain Lake	101-103	756	Mason
Stewart (Stafford) Lake	101-106	1578	Mason
Jack Lake	107-109	915	Mason
Patterson Bay	106-107	62	Mason
Mantanzas Lake	114-115	361	Mason
Quiver Lake	122-124	407	Mason
Chautauqua Lake	124-125	3562	Mason
Liverpool Lake	125-128	155	Mason
Clear Lake	130-133	1463	Mason (Consolidated)
Moscow Lake	108-110	258	Mason
Swan Lake	109-111	284	Mason
Grass Lake	111-112	463	Mason
Bath Lake	111-112	138	Mason
Anderson Lake	107-111	1364	Fulton
Rice Lake	133-137	1383	Fulton
Big Lake	133-137	1148	Fulton
Goose Lake	133-137	640	Fulton
Lost Lake	134-135	50	Fulton
Spring Lake	136-140	1285	Tazewell
Pekin Lake	154-156	105	Tazewell
Total Number = 28		Total Area = 19,980 Acres	

Table 2b. Land Acreage of Drainage and Levee Districts Along LaGrange Pool (River mile 80 to 158)

Drainage and Levee District			
Name	River Mile	Area	County
Crane Creek D&L	84-85	5,015	Schuyler
Coal Creek D&L	85-92	6,396	Schuyler
Kelley Lake D&L	100-103	985	Schuyler
Big Lake D&L	103-108	3,230	Schuyler
South Beardstown D&L	79-87	6,851	Cass
Boulevard D&L	87-88	512	Cass
Lost Creek D&L	88-90	2,740	Cass
Hager Special Slough D&L	90-93	3,698	Cass
Clear Lake D&L	90-93	2,040	Cass
Lynchburg-Sangamon Botton D&L	93-95	2,600	Mason
Seahorn D&L	111-112	1,414	Fulton
Lacey D&L	112-119	2,995	Fulton
Langellier D&L	112-119	1,967	Fulton
Kerton Valley D&L	112-119	1,628	Fulton
West Mantanzas D&L	112-119	2,577	Fulton
Thompson Lake D&L	121-126	5,233	Fulton
Liverpool D&L	126-128	3,042	Fulton
East Liverpool D&L	128-132	2,678	Fulton
Spring Lake D&L	134-148	11,798	Tazewell
Rocky Ford D&L	148-151	1,468	Tazewell
East Peoria D&L	163-165	728	Tazewell
Banner Special D&L	138-146	4,565	Fulton/Peoria
Pekin-LaMarsh D&L	149-155	2,635	Peoria
Total Number = 23		Total Area = 76,795 Acres	

Table 3a. Surface Area of Backwater Lakes Along the Peoria Pool (River mile 158 to 230)

Backwater Lake			
Name	River Mile	Area	County
Big Meadow Slough	183-185	480	Peoria
Boat Jack Lake	148-149	130	Peoria
Lower Peoria Lake	162-166	(2522)**	Peoria
Upper Peoria Lake	166-182	(12476)**	Peoria
Wightman/Gar Lake	186-189	595	Marshall
Goose/Weis Lake	189-193	1300	Marshall
Billsbach Lake	193-195	1015	Marshall
Babbs/Sawyer Slough	183-188	1875	Marshall
Sawmill Lake	197-199	630	Putnam
Senachwine Lake	198-203	3324	Putnam
Swan Lake	198-200	180	Putnam
Goose Lake	204-206	2360	Putnam
Spring Lake	210-211	262	Bureau
DePue Lake	211-214	524	Bureau
Total Number = 12		Total Area = 3149 Acres	

** This lake surface area is included in river surface area category.

Table 3b. Land Acreage of Drainage and Levee District Along Peoria Pool (River mile 158 to 230)

Drainage and Levee District			
Name	River Mile	Area	County
Crow Creek D.D.	182-183	568	Marshall
Hennepin D&L	203-207	2581	Putnam
Total Number = 2		Total Area = 3149 Acres	

Table 4. Summary of the Illinois River Floodplain Inventory

	Backwater Lake	River Surface Area	Drainage and Levee District	Non-organized Farmland and Other Land Use	Total Floodplain Area
Alton Pool (River mile 0 to 80)					
Number	13	N.A.*	14	N.A.	N.A.
Acres	6,042	9,480	104,312	120,486	240,320
Percent	2.5	3.9	43.4	50.1	100.0
LaGrange Pool (River mile 80 to 158)					
Number	28	N.A.	23	N.A.	N.A.
Acres	19,980	6,140	76,795	272,765	375,680
Percent	5.3	1.6	20.4	72.6	100.0
Peoria Pool (River mile 156 to 230)					
Number	12	N.A.	2	N.A.	N.A.
Acres	12,675	17,836	3,149	95,748	129,408
Percent	9.8	13.8	2.4	74.0	100.0
Total River Reach (River mile 0 to 230)					
Number	53	N.A.	39	N.A.	N.A.
Acres	38,697	33,456	184,256	488,999	745,408
Percent	5.2	4.5	24.7	65.6	100.0

N.A. = Not applicable.

Chapter 3

SEDIMENT YIELD ESTIMATION IN THE ILLINOIS RIVER BASIN

Introduction

The sediment sources of the Illinois river are well-known. The sediment comes from the major rivers emptying into the Illinois River. In Figure 3 is a map showing the location of these tributaries. The sediment conditions in the backwater lakes are dependent upon the sediment yield from the various parts of the Illinois river basin. In order to assess the general sediment conditions in the Illinois River, we attempt to estimate the sediment yield based on the available information.

Methodology

The Illinois River Basin was divided into 9 sub-basins as shown in Table 5 and Figure 3. The drainage areas of the sub-basin were taken from published data of the U.S. Geological Survey, Kent Ogata (1975). We used the sediment yield results published by the Upper Mississippi River Comprehensive Basin Study (1970) to estimate the annual sediment yield. This chart related average sediment yield per square mile with drainage area based on Lake Resources Area and is reproduced here in Figure 4. The Land Resources Area delineations were shown in Figure 5. Table 5 gives the areas of each Land Resources Area (LRA) for each sub-basin. Because the bluff areas along the Illinois river uses different curve in Figure 4 it is necessary to measure the total bluff area in each sub-basin. Some areas of the river basins are in the floodplain. We consider the floodplain

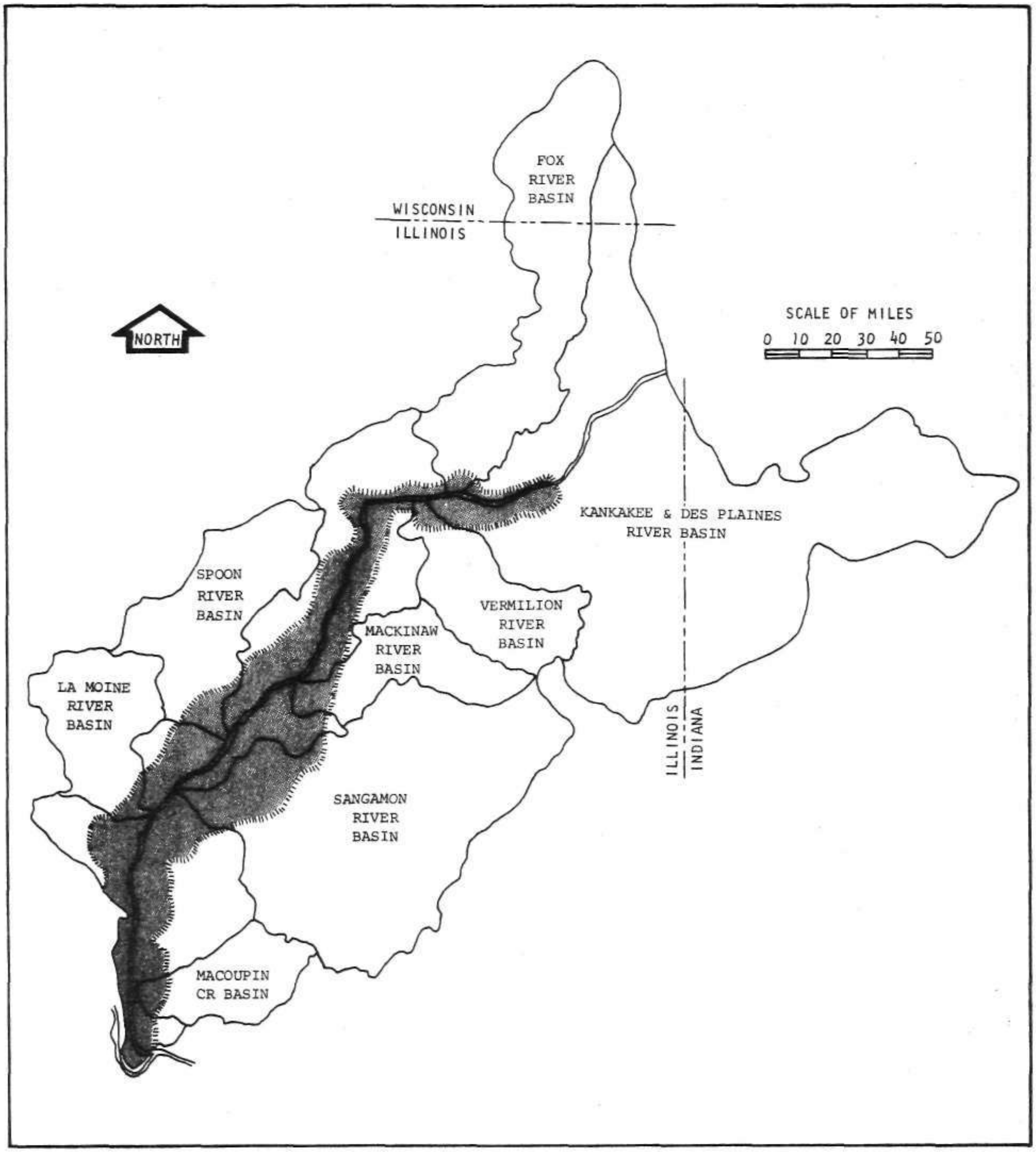
FOX
RIVER
BASIN
WISCONSIN
ILLINOIS
NORTH
SCALE OF MILES
0 10 20 30 40 50
KANKAKEE & DES PLAINES
RIVER BASIN
SPOON
RIVER
BASIN
VERMILION
RIVER
BASIN
MACKINAW
RIVER
BASIN
LA MOINE
RIVER
BASIN
ILLINOIS
INDIANA
SANGAMON
RIVER
BASIN
MACOUPIN
CR BASIN

Figure 3

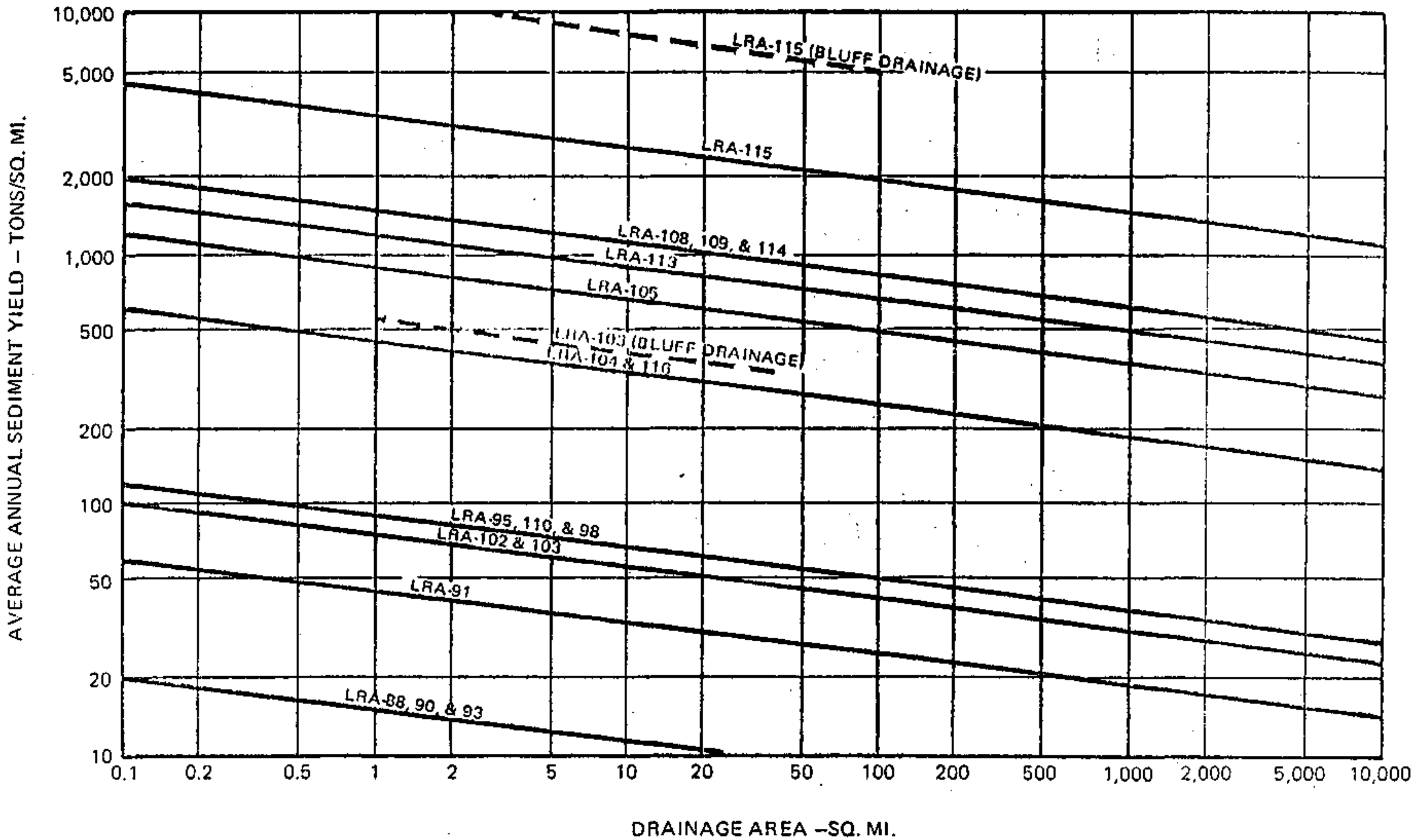
AVERAGE ANNUAL SEDIMENT YIELD – TONS/SQ. MI.
10,000
5,000
2,000
1,000
500
200
100
50
20
10
LRA-115 (BLUFF DRAINAGE)
LRA-115
LRA-108, 109, & 114
LRA-113
LRA-105
LRA-103 (BLUFF DRAINAGE)
LRA-104 & 116
LRA-95, 110, & 98
LRA-102 & 103
LRA-91
LRA-88, 90, & 93
0.1
0.2
0.5
1
2
5
10
20
50
100
200
500
1,000
2,000
5,000
10,000
DRAINAGE AREA –SQ. MI.

Figure 4

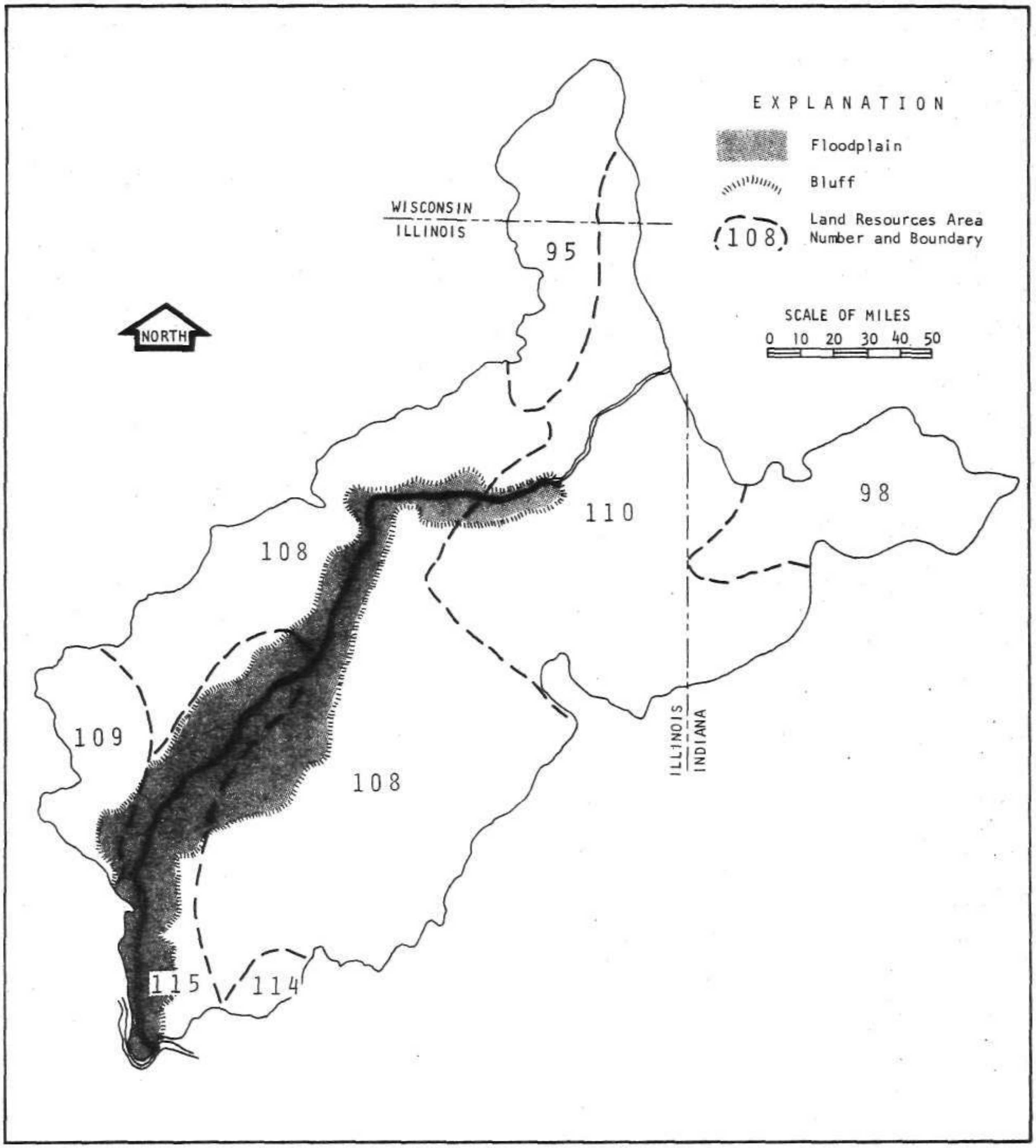
EXPLANATION
Floodplain
Bluff
Land Resources Area Number and Boundary
108
SCALE OF MILES
0 10 20 30 40 50
NORTH
WISCONSIN
ILLINOIS
95
98
110
108
109
108
115
114
ILLINOIS
INDIANA

Figure 5

Table 5. Measurement of Bluff, Floodplain and Upland Areas of the Illinois River Basin in Various Land Resource Areas (LRA's)

	Basin Name	Bluff Area (sq. mi.)	Floodplain Area (so. mi.)	Upland Area (sq. mi.)	Total Drainage Area (sq. mi.)
(1)	Illinois River Upstream of Marseilles				
	LRA 95-98-110	--	--	8,259	8,259
				(100%)	(100%)
(2)	Fox River	76.8	14.4	2,567	2,658
	LRA 108	(2.9%)	(0.5%)	(96.9%)	(100%)
(3)	Vermilion River	60.8	6.4	1,264	1,331
	LRA 110	(4.6%)	(0.5%)	(95.0%)	(100%)
(4)	Mackinaw River	112	43.2	981	1,136
	LRA 108	(9.8%)	(3.8%)	(86.4%)	(100%)
(5)	Spoon River				
	LRA 108	--	--	1,711	1,855
	115 Bluff	120	24	--	
		(6.5%)	(1.3%)	(92.0%)	(100%)
(6)	Sangamon River				
	LRA 108	--	--	5,109	5,418
	115 Bluff	131	178	--	
		(2.4%)	(3.3%)	(94.2%)	(100%)
(7)	LaMoine River				
	LRA 109	--	--	1,267	1,350
	LRA 115 Bluff	64	19.2	--	
		(4.7%)	(1.4%)	(93.8%)	(100%)
(8)	MaCoupin River				
	LRA 109	--	--	839	961
	LRA 115 Bluff	90.4	32.0	--	
		(9.4%)	(3.3%)	(87.3%)	(100%)
(9)	Direct Drain Area				
	LRA 108	--	--	1,641	
	LRA 115	--	848	1,000	5,938
	LRA 115 Bluff	2,450	--	--	
		(41.2%)	(14.3%)	(44.5%)	(100%)
	Total Area	3,105	1,165	24,637	28,906
	Percent	(10.7%)	(4.0%)	(85.2%)	(100%)

as an area where, sediment is deposited, The sediment yield in the floodplain area is considered minimum. Table 5 also shows the areas of the bluff zone, floodplain, and upland area in each sub-basin. It needs to be described here that the direct drainage area to the Illinois River is defined as the collection of all the watersheds which are not large enough to be considered as sub-basins. Generally, these watersheds are in the bluff areas.

Results and Discussions

Table 6 shows the results of sediment yield estimation. The annual sediment yields from the bluff area and upland area were calculated in terms of tons per square mile, tons per acre and total tons from each sub-basin. Because the direct drain area is a collection of all the small watersheds along the Illinois River, the total drainage area given does not reflect a real physical basin. Therefore, we assume the typical direct drainage area is 50 square miles.

The results in Table 6 indicate that the bluff has an average sediment yield of about 5500 tons per square mile or 8.7 tons per acre. The upland areas contribute about 4l8 tons per square mile or 0.65 tons per acre. As far as the per unit area sediment yield is concerned, the bluff area is about 12 times larger than that of upland area. However, because the upland area is about 8 times larger in drainage area than that of bluff area, the comparative total sediment yields are about 10.3 million tons from bluff areas and 17.2 million tons from upland areas. The average annual sediment yield entering the Illinois river basin is

Table 6. Estimation of Sediment Yield in the Illinois River Basin

	Bluff Area			Upland Area			Total Basin		
	T/Mi²	T/Ac	T	T/Mi²	T/Ac	T	T/Mi²	T/Ac	T
(1) Illinois River Upstream of Marseilles	—	—	—	31.5	0.05	260,159	31.5	0.05	260,159
(2) Fox River	—	—	—	580	0.91	1,533,288	580	0.91	1,533,288
(3) Vermilion River	—	—	—	38.5	0.06	50,997	38.5	0.06	50,997
(4) Mackinaw River	5,000	7.8	560,000	658	1.03	645,366	1061	1.66	1,205,366
(5) Spoon River	5,000	7.8	600,000	605	0.95	1,035,155	881	1.38	1,635,155
(6) Sangamon River	5,000	7.8	656,000	500	0.78	2,554,500	593	0.93	3,210,500
(7) LaMoine River	5,625	8.8	360,000	616	0.96	780,349	845	1.32	1,140,319
(8) Macoupin Creek									
LRA 108	5,000	7.8	452,000	700	1.09	377,020			
115				1800	2.81	540,000	1412	2.23	1,369,020
(9) Direct Drain Area									
LRA 115	5,961	9.3	14,602,065	1550	2.42	1,550,000			
108				600	0.94	984,300	2886	4.50	17,136,365
(10) Sum of Sub-Basins	5,549	8.67	17,230,000	418	0.65	10,309,000	953	1.49	27,541,994

1.49 tons per acre or 953 tons per square mile. The total sum of the sediment yields from all the sub-basins is about 27.5 million tons. These results are also shown in Table 7 which is a summary-sheet.

A comparison of the sediment yield from the sub-basins in Table 6 indicates that five sub-basins have sediment yields higher than 1 ton per acre. The direct drainage area sub-basin has the highest sediment yield per unit area which is 4.5 tons per acre. Then follows Macoupin Creek sub-basin which has a sediment yield of 2.23 tons per acre. Both of these sub-basins have a high percent of their acreage (41.2% and 9.4%) in the bluff area. The Mackinaw river, Spoon river and Lamoine river sub-basins have sediment yields of 1.66, 1.38 and 1.32 tons per acre respectively. The Illinois river basin upstream of Marseilles, and the Vermilion river basin contribute very insignificant sediment yields. The Pox and Sangamon river basins contribute little; being less than 1 ton per acre.

It is worthwhile to note here that the sum of the sediment yields from all sub-basins is different from the sediment yield at the mouth of the Illinois river basin. The difference is the sediment deposited in the backwater lakes and river beds. In order to assess the portion of sediment deposited in the floodplain, we assume the Illinois river basin is represented by Land Resources Area 108. The sediment yield graph in Figure 4 was then used to estimate sediment yield for the entire basin.

Table 7. Summary of Annual Average Sediment Yield Estimation, The Illinois River Basin

Items	Quantity	Units
Basin		
Total Area	28,906	square miles
	18,499,840	acres
Ploodplain Area	1,165	square miles
	745,600	acres
Bluff Area	3,105	square miles
	1,987,200	acres
Upland Area	24,637	square miles
	15,767,680	acres
Annual Sediment Yield		
Bluff Area	5,549	tons per square mile
	8.67	tons per acre
	17,230,000	tons
Upland Area	418	tons per square mile
	0.654	tons per acre
	10,309,000	tons
The Sum of Sub-Basins	993	tons per square mile
	1.55	tons per acre
	27,539,000	tons
Total Basin	420	tons per square mile
	0.656	tons per acre
	12,140,520	tons
Annual Sediment Deposition Rate in Floodplain Area		
Total Sediment Weight	15,398,480	tons
Total Volume*	11,845	acre-feet
Thickness in		
Backwater Lakes (38,697 acres)	3.67	inches per year
Backwater Lakes and River (72,153 acres)	1.97	inches per year
Floodplain (745,408 acres)	0.19	inches per year

* Assuming the dry volume weight of sediment 1300 tons per acre-foot or 60 lb. per cubic foot.

The whole basin has a sediment yield of 0.65 tons per acre or 420 tons per square mile. The total sediment yield leaving the Illinois River basin at its mouth, at Grafton is 12.1 million tons as shown in Table 7. Therefore, about 15.4 million tons of sediment can be categorized as the sediment deposited in the Illinois River floodplain. If a volume weight of 60 lb. per cubic feet or 1300 tons per acre-foot is used, this annual sediment deposition is 11,845 acre-feet.

In order to estimate the thickness of deposition, we need to know the location of the sediment deposition. The exact location of the sediment deposited is not known at present time. Three hypotheses conditions were used. First, we considered that all the sediment deposited in the backwater lakes. According to the lake inventory in Table 4, backwater lakes occupy a total area of 38,697 acres. Therefore, the sediment would deposit to a thickness of about 3.67 inches per year. The second hypothesis is that the sediment deposits in the backwater lakes and in the river bed. Both these cover 72,153 acres in the Illinois river floodplain as given in Table 4. Under this hypotheses we find that sediment deposits to a thickness calculated as 1.97 inches per year. The third hypothesis is that the sediment spreads over all the flood-plain. Under such a hypothesis the annual sediment deposition ends up about 0.19 inches per year as shown in Table 7.

Considering these three hypothetical conditions, it seems that the first and second conditions are under estimating the deposition area. The third condition is over estimating the deposition area. Therefore, an average annual sediment depostion rate for the entire Illinois River floodplain of 1.97 inches per year is over estimated and 0.19 inches per year is under estimated. According to the actual sediment survey results at Lake Meredosia given later in Table 9, the annual deposition in this lake is about 0.41 inches per year. Therefore we conclude that the deposition rate might fall in the range of 0.2 to 2.0 inches per year for the entire floodplain. This will be discussed further in later sections of this report.

Chapter 4

SEDIMENT CONDITIONS IN LAKES MEREDOSIA AND DEPUE

Lake Meredosla

Lake Meredosia is one of the numerous backwater lakes along the Illinois River. This lake stretches along the Illinois River from river mile 72 to 78 in Morgan and Cass Counties at the upper end of the Alton pool, see Figure 1. During the normal and low river stages, the Illinois River main stream conveys the water and sediment load. At the flood stage, the water spreads over the floodplain and backs into the backwater lakes. After the flood recedes, the sediment deposits in these backwater lakes. Since the completion of Alton lock and dam in 1940, this impoundment further raised the water level in the river and reduced the flow velocity. Therefore, the sediment deposition increased in the backwater lakes. Accordingly, the recreation features of fishing and hunting are gradually deteriorating in this lake. In order to assess the 1975 sediment conditions, a study was initiated and funded by the Division of Water Resources.

The sediment study included a sediment survey, and the comparison of the results with earlier surveys. Nine cross-sections were measured in our 1975 field survey as shown in Figure 6. These cross-sections were compared with the 1903 U.S. Corps of Engineers survey and the 1956 Division of Waterways maps. Figure 7 illustrates a typical example of the sediment deposition in different years. The lake capacities of the 1903, 1956 and 1975 conditions were calculated based on Eakin's Range formula in 9 segments; the segments are shown on the map in Figure 6 and the results are given in Table 8. The capacity losses were computed in acre-feet and percentage in terms of 1903 volume.

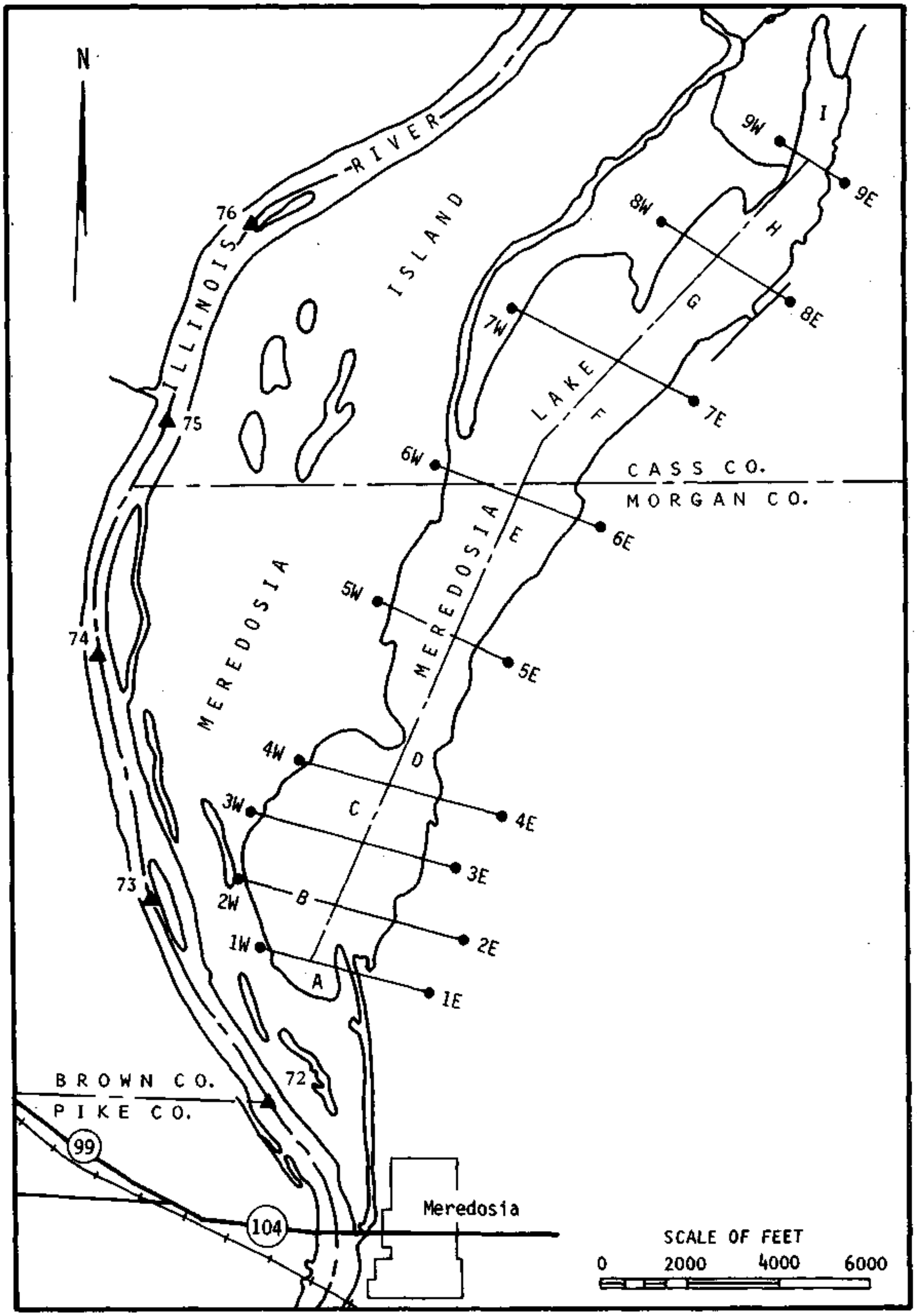
N
ILLINOIS RIVER
ISLAND
MEREDOSIA
MEREDOSIA LAKE
CASS CO.
MORGAN CO.
BROWN CO.
PIKE CO.
99
104
Meredosia
SCALE OF FEET
0 2000 4000 6000
1W 1E 2W 2E 3W 3E 4W 4E 5W 5E 6W 6E 7W 7E 8W 8E 9W 9E
A B C D E F G H I
72 73 74 75 76

Figure 6

Table 8. Distribution of Storage Loss in Lake Meredosia

Segment Number	Location Station From	To	Storage 1903	Capacity (ac-ft) 1956	1975	Capacity Loss 1903-56 ac-ft	%	1903-75 ac-ft	%
A	Channel	61+00	357.4	31.4	15.0	326	91.2	342	95.8
B	61+00	85+94	967.9	472.9	228.1	495	51.1	740	76.4
C	85+94	99+32	637.9	386.8	248.6	251	39.4	389	61.0
D	99+32	146+14	1510.8	966.9	916.2	543	36.0	594	39.4
E	146+14	182+53	1261.7	886.9	799.0	375	29.7	462	36.7
P	182+53	218+89	1469.9	1130.4	1001.2	339	23.1	469	31.9
G	218+89	258+05	1085.8	792.5	669.8	293	27.0	416	38.3
H	258+05	276+29	333.5	261.6	206.3	72	21.6	127	38.1
I	276+29	End	166.2	133.8	122.6	32	19.5	44	26.2
Lake									
Volume	(ac-ft)		7791.0	5063.3	4206.9	2728	35. %	3584	46.
Area	(acres)		1467.5	1418.0	1375.0	49	3.4%	92	6.3

The results were summarized in Table 9.

The significant findings of this study are:

(1) Lake Meredosia lost 3584 acre-feet within 72 years or 46 percent of the capacity in terms of the 1903 volume.

(2) The average annual accumulation is 49.8 acre-feet or 0.64 percent per year based on the 1903 volume.

(3) The average rate of lake bed rise is about 0.4l inches per year. Based on the 1975 capacity, the expected life of the lake is about 90 years.

(4) The capacity loss is the highest near the inlet channel as shown in Table 8 at segment A which lost 95.8%. On the other hand, the lowest capacity loss is the segemnt I located near the upper end of the lake. The rate of lake capacity loss decreases with the distance the segments are away from the inlet channel. These data indicate that most of the sediment loss was carried in by the stream flows. This influx causes a northward inflow pattern and causes the formation of a pair of islands or natural levees adjacent to the inlet channel as shown in segment B of the lake in Figure 6.

In addition to the sediment survey, the water and sediment dissolved oxygen demands among other water quality parameters were measured by the personnelof the Water Quality Section of the State Water Survey, Sediment samples at each cross-section were taken. The samples are being analyzed by the State Geological Survey.

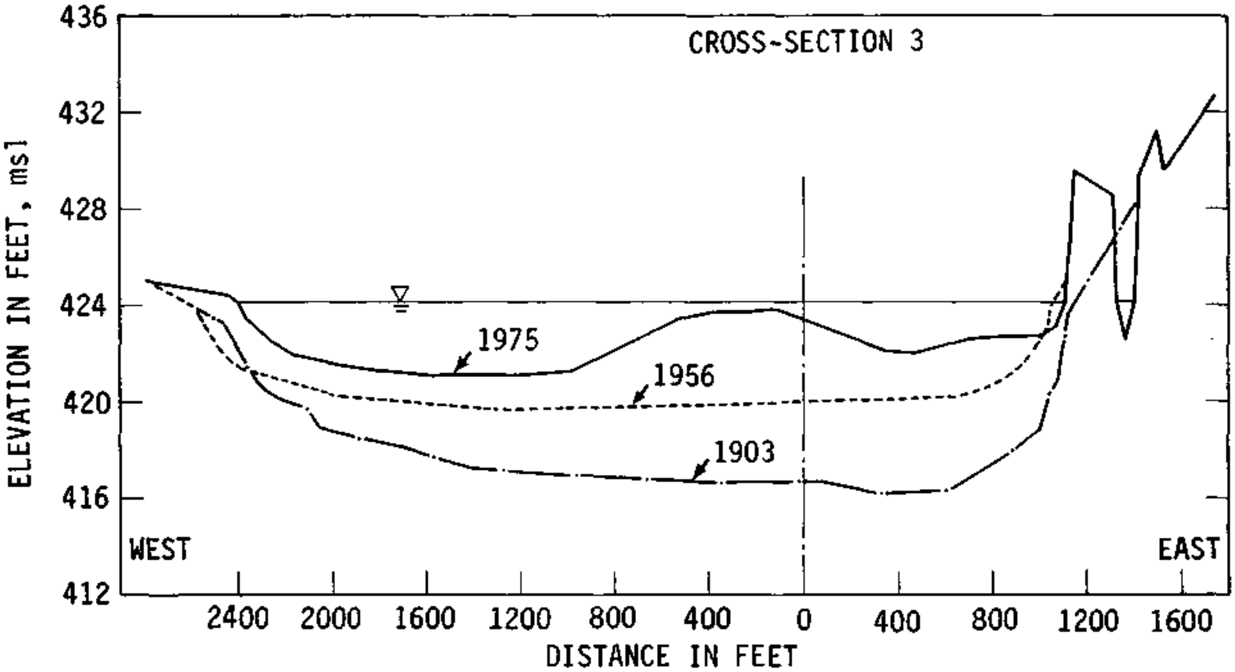
CROSS-SECTION 3
ELEVATION IN FEET, msl
436
432
428
424
420
416
412
1975
1956
1903
WEST
EAST
2400
2000
1600
1200
800
400
0
400
800
1200
1600
DISTANCE IN FEET

Figure 7

Table 9. Summary of Sediment Data on Lake Meredosia
Meredosia, Illinois

	Quantity	
Sedimentation		
1903-1956 (53 yrs)	2728	acre-feet
1956-1975 (19 yrs)	856	acre-feet
1903-1975 (72 yrs)	3584	acre-feet
Average Annual Accumulation		
1903-1956	51.5	acre-feet per year
1956-1975	45.1	acre-feet per year
1903-1975	49.8	acre-feet per year
Depletion of Storage		
Loss of Original Capacity		
1903-1956	35	percent
1956-1975	11	percent
1903-1975	46	percent
Annual Rate of Loss of Original Capacity		
1903-1956	0.66	percent per year
1956-1975	0.58	percent per year
1903-1975	0.64	percent per year
Annual Rate of Rise of Lake Bottom		
1903-1956	0.42	inches per year
1956-1975	0.37	inches per year
1903-1975	0.41	inches per year
Average depth (1975)	3.06	ft
Expected Life	90	years

Note: Lake surface elevation is assumed as 424 msl which is about the median value of the lake stage based on 40 years river stage data at Meredosia.

Lake DePue

Lake DePue is a backwater lake located on the north bank of the Illinois River just upstream from the "great bend" at Hennepin which about river mile 213 in Bureau County, see Figure 2. Lake DePue is at the upper end of the Peoria pool which stretches from river mile 157 to 230. Before World War II, Lake DePue was a highly popular boating lake, especially attractive to boat racing and sailing regattas. The former lake depth was about 18 to 20 feet according to local residents. However, considerable sediment has been deposited in this lake by flood flows of the Illinois River and probably by tributary inflow from agricultural lands to the north. This has reduced the size of the navigable part of the lake. The mouth of the lake is connected to the Illinois River by a channel, except at low river stages.

The City of DePue has proposed to restore Lake DePue as nearly as possible to its original depth. In order to develop management plans, a thorough sediment survey was needed, and was carried out in 1975.

Objectives

The objectives of this study were

(1) to take cross-sections of the sediment deposited in Lake DePue,

(2) to develop the comparative cross-sections based on the 1903 Woermann maps,

(3) to calculate the sediment deposition rate based on the 1903 and 1975 surveys,

(4) to study the variation in river stage, and

(5) to analyze the sediment samples for chemical and physical properties.

The 1975 Survey

The sediment survey was initiated by Illinois State Water Survey in summer of 1975. The job consisted of measuring 8 cross-sections on Lake DePue. The horizontal and vertical control was establised for the locations of the cross-sections. The entire survey was carried out by Daily and Associates, Peoria, Illinois. Two sediment samples were taken for volume weight, and particle size analysis. One sediment core was taken for chemical analysis.

Cross-Sections Survey of 1903

In 1903, detailed cross-sections of the Illinois River and the Des Plaines River were mapped by Mr. W.J. Woermann (1903). This set of maps covers the river from Grafton to Lockport with 58 sheets at a scale of 1 inch to 600 feet. There were about 37 sections on Lake DePue. The elevation of the maps was based on Memphis datum which is 6.630 feet lower than mean sea level, 1929-5th general adjusted as described by McKibbin and Schmidt (1954).

Comparison of the 1903 and 1975 Surveys

Based on the cross-sections of the 1903 and 1975 surveys, 8 cross-sections were developed. Figure 8 shows the location of the cross-sections in Lake DePue. Figure 9 shows water depths in 1903 and 1975 respectively for two typical cross-sections. Based on this survey we computed the volume of the lake in 1903 and 1975. The reference lake surface elevation is 441 msl which is about the normal lake level. We utilized the Eakin's method (3) to calculate the lake volume. The lake was divided into 9 segments as shown in Figure 9. Table 10 gives (1) the segments, (2) storage capacity in 1903 and 1975, (3) the lake capacity loss in acre-feet and percent of 1903 volume. The total capacity of the lake and its surface area are also given in the same table.

Results and Discussion

The results indicate that about 72.6% of the 1903 lake capacity has been filled up with sediment. The upstream or eastern segments H and I are almost completely lost to sediment. The other segments capacities have been reduced in relatively uniform manner. This is quite different from Lake Meredosia. Two possible reasons can be traced. First, the east end of Lake DePue receives inflows from the Illinois River during high river stages. Second, the natural levee along the south side of Lake DePue island is only about elevation 446 msl which is only 5 feet above the normal lake level. Therefore, the lake would receive the Illinois river water directly overtopping the natural levee more frequently than at Lake

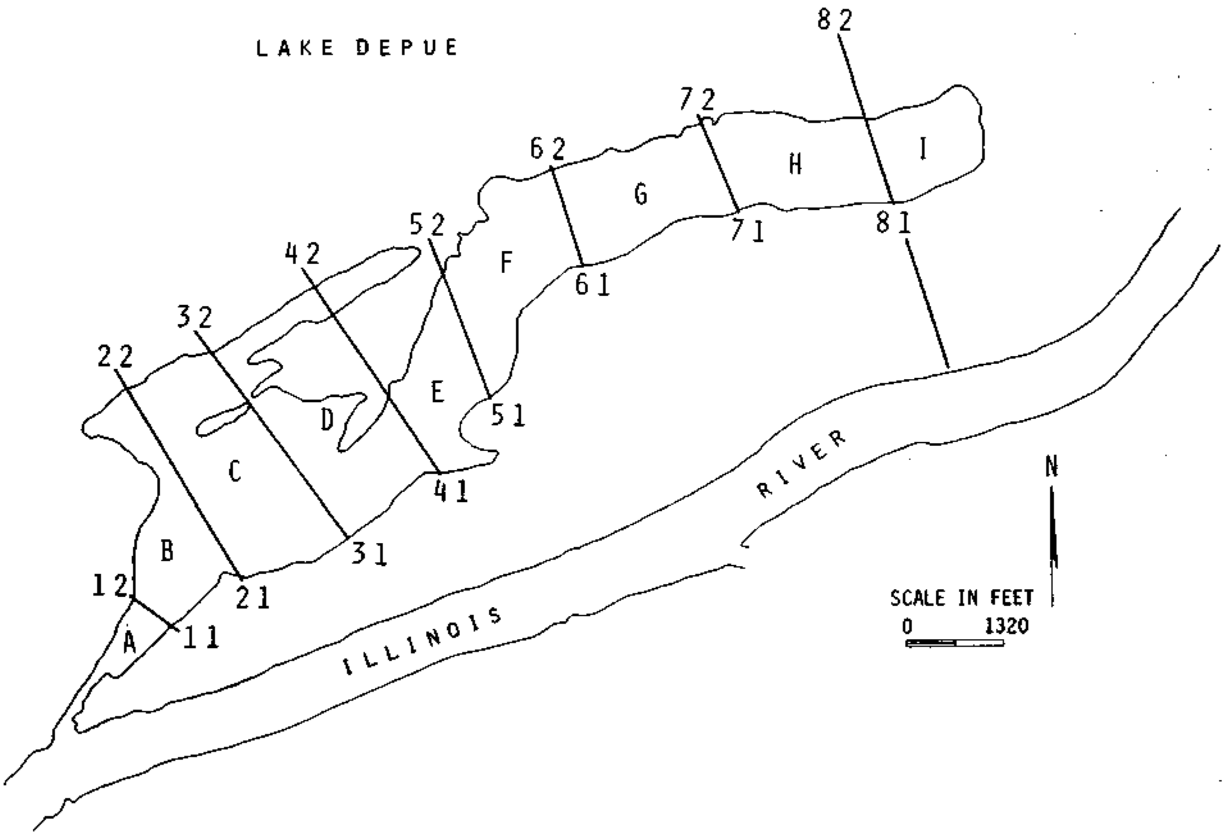
LAKE DEPUE
82
72
62
52
42
32
22
12
11
21
31
41
51
61
71
81
A
B
C
D
E
F
G
H
I
ILLINOIS
RIVER
N
SCALE IN FEET
0
1320

Figure 8

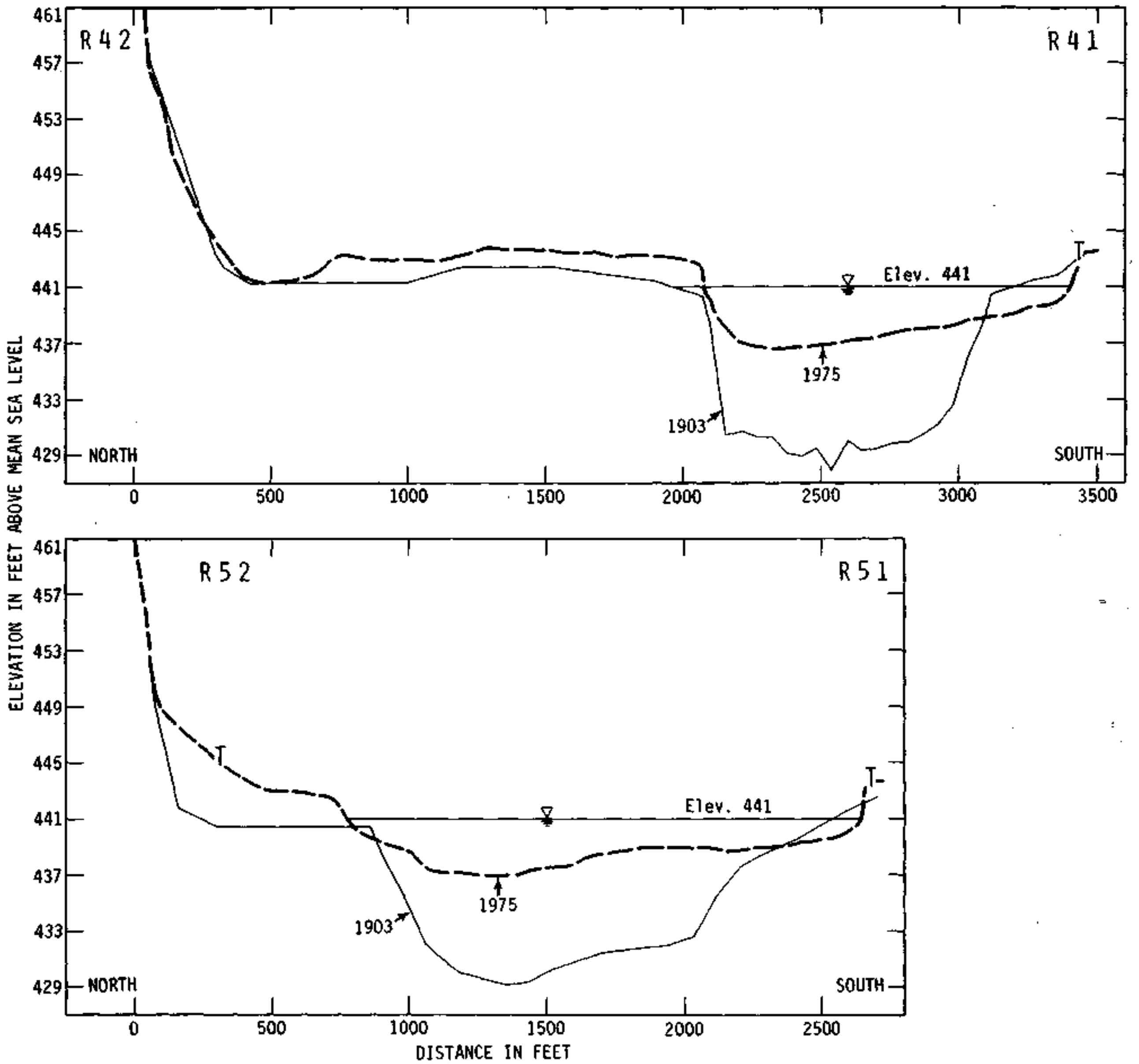
R42
R41
Elev. 441
1975
1903
NORTH
SOUTH
R52
R51
Elev. 441
1975
1903
NORTH
SOUTH
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
DISTANCE IN FEET
461
457
453
449
445
441
437
433
429
0
500
1000
1500
2000
2500
3000
3500

Figure 9

Table 10. Distribution of Storage Loss in Lake DePue

Segment Number	Location Station		Storage Capacity (ac-ft)		Capacity Loss	
	From	To	1903	1975	ac-ft	%
A	Channel	12-11	77.3	14.3	63.0	81.5
B	12-11	22-21	181.7	53.5	131.2	71.0
C	22-21	32-31	330.6	126.3	204.3	61.8
D	32-31	42-41	413.8	152.3	261.5	63.2
E	42-41	52-51	295.9	124.2	171.7	58.0
F	52-51	62-61	461.2	174.4	286.8	62.2
G	62-61	72-71	507.7	108.2	399.5	78.7
H	72-71	82-81	363.1	24.4	338.7	93.3
I	82-81	END	202.4	0.0	202.4	100.0
Lake Volume	(ac-ft)		2836.7	777.6	2059.1	72.6%
Lake Area	(acres)		578.4	479.1	99.3	17.2%

Meredosia. Consequently, the sediment is rather uniformly deposited in Lake DePue.

Table 11 summarizes the total sediment data. The significant findings are:

(1) From 1903 to 1975, the capacity of Lake DePue was reduced from 2837 ac-ft to 778 ac-ft, or 72.6% capacity loss. In terms of annual deposition rate, the lake lost 28.6 ac-ft or 1.01% per year.

(2) The change of lake volume mostly is due to the rising of the lake bed. It was estimated that the annual rate of the rise is 0.59 inches per year. The expected time for the lake to fill with sediment to normal lake level is about 33 years.

Table 11. Summary of Sediment Data on Lake DePue

	Quantity	
Sedimentation 1903-1975 (72 yrs)	2059	acre-feet
Average Annual Accumulation 1903-1975	28.6	acre-feet
Depletion of Storage Loss of Original Capacity 1903-1975	72.6	percent
Annual Rate of Loss of Original Capacity 1903-1975	1.01	percent per year
Annual Rate of Rise of Lake Bottom 1903-1975	0.59	inches per year
Average Depth (1975)	1.62	feet
Expected Years to Fill Up to 441. msl.	33	years
Volume Weight (dry weight) Upper End	42.1	lb/cu ft
Lower End	44.1	lb/cu ft

Note: Lake surface elevation is assumed as 44l MSL which is about the median value of the lake stage based on 40 years river stage data at Hennepin.

Chapter 5

RECONNAISSANCE SURVEYS OP SELECTED BACKWATER LAKES

Introduction

The backwater lakes inventory shown in Tables 1 to 4 lists 53 backwater lakes along the river. The purpose of this project is to make a general investigation of the current sediment conditions in these backwater lakes. We selected Lake Meredosia and Lake DePue for detailed studies. This was due to the fact that these two lakes were requested by the State and local people for developing a plan to manage the lakes. In addition of these two studies, we also selected 11 backwater lakes for reconnaissance survey. The results of the 1975 reconnaissance surveys of 3 lakes have been compared with earlier surveys. All these results are reported in this section.

Reconnaissance Survey

The 11 lakes selected for reconnaissance survey are shown in Table 12. Most of these lakes are considered as big lakes. For 2 lakes results were compared with the earlier surveys and results are presented as follows.

Swan Lake

This lake is located at river mile from 5 to 9 in Calhoun and Jersey counties, see Figure 10. The U.S. Fish and Wildlife manages this lake as part of the Mark Twain National Wildlife Refuge. The lake surface area is 1853 acres. Few creeks drain to the lake. The Metz Creek Is the one with the largest drainage

Table 12. List of Backwater Lakes for Detailed and Reconnaissance Survey

	Lake Name	Map No.	River mile	Surface Area (acres)	County and Near Town
1.	Swan Lake[*4]	2,3[*1]	5	1853	Calhoun, Crafton
2.	Meredosia[*5]	26, 27, 28	71	1691	Morgan, Meredosia
3.	Muscooton Bay	32, 33	89	377	Cass, Browning
4.	Anderson Lake	43, 45, 46	110	1363	Pulton, Marbletown
5.	Mantanzas	47, 48	115	361	Mason, Havana
6.	Chautauqua	50, 51, 52	125	3562	Mason, Havana
7.	Pekin	63, 64	155	133	Tazewell, Pekin
8.	Peoria Lake (upper and lower)	67, 68, 69, 70 71, 72, 74	165	6000[*3]	Peoria, Peoria
9.	Babbs Slough	75, 76, 77	185	1875	Marshall, Lacon
10.	Sawmill[*4]	80, 81	197	630	Putnam, Henry
11.	DePue[*5]	87, 89	210	524	Bureau, DePue
12.	Huse Slough	183, 185[*2]	221	200[*3]	Bureau, DePue
13.	Ballard	123., 124[*2]	248	200[*3]	LaSalle, Marseilles

Note: [*1] Map Numbers from the Report for Recreational Development on the Illinois River Backwater Area, Division of Waterways 1969

[*2] Map Numbers from Map Atlas of Upper Illinois River, Division of Waterways, 1971

[*3] surface water area estimated

[*4] reconnaissance survey made

[*5] detailed survey made

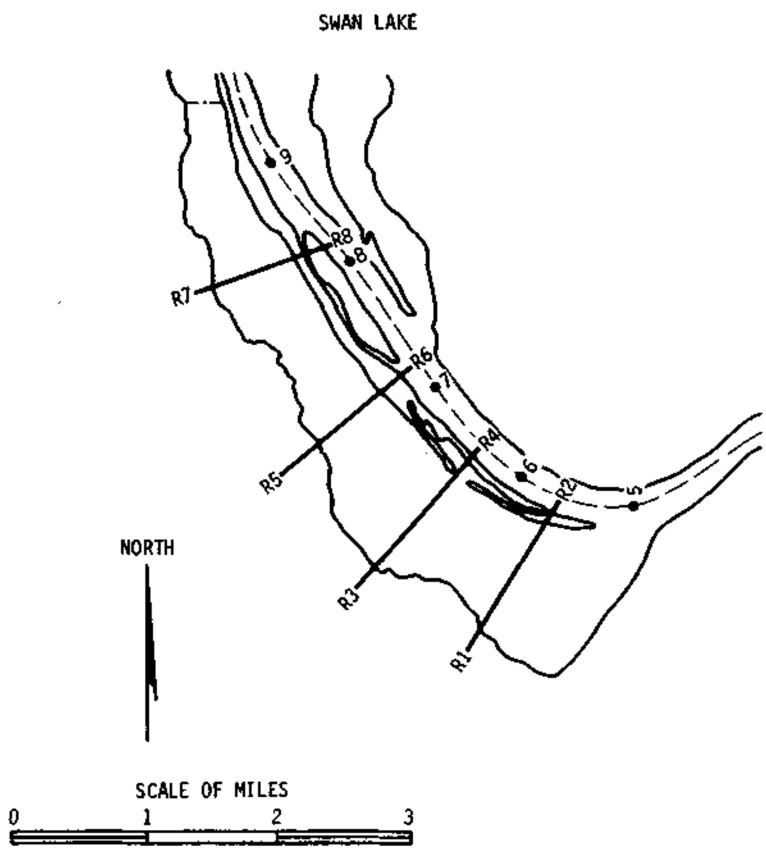
SWAN LAKE
9
R8
8
R7
R6
7
R5
R4
6
R2
5
R3
R1
NORTH
SCALE OF MILES
0
1
2
3

Figure 10

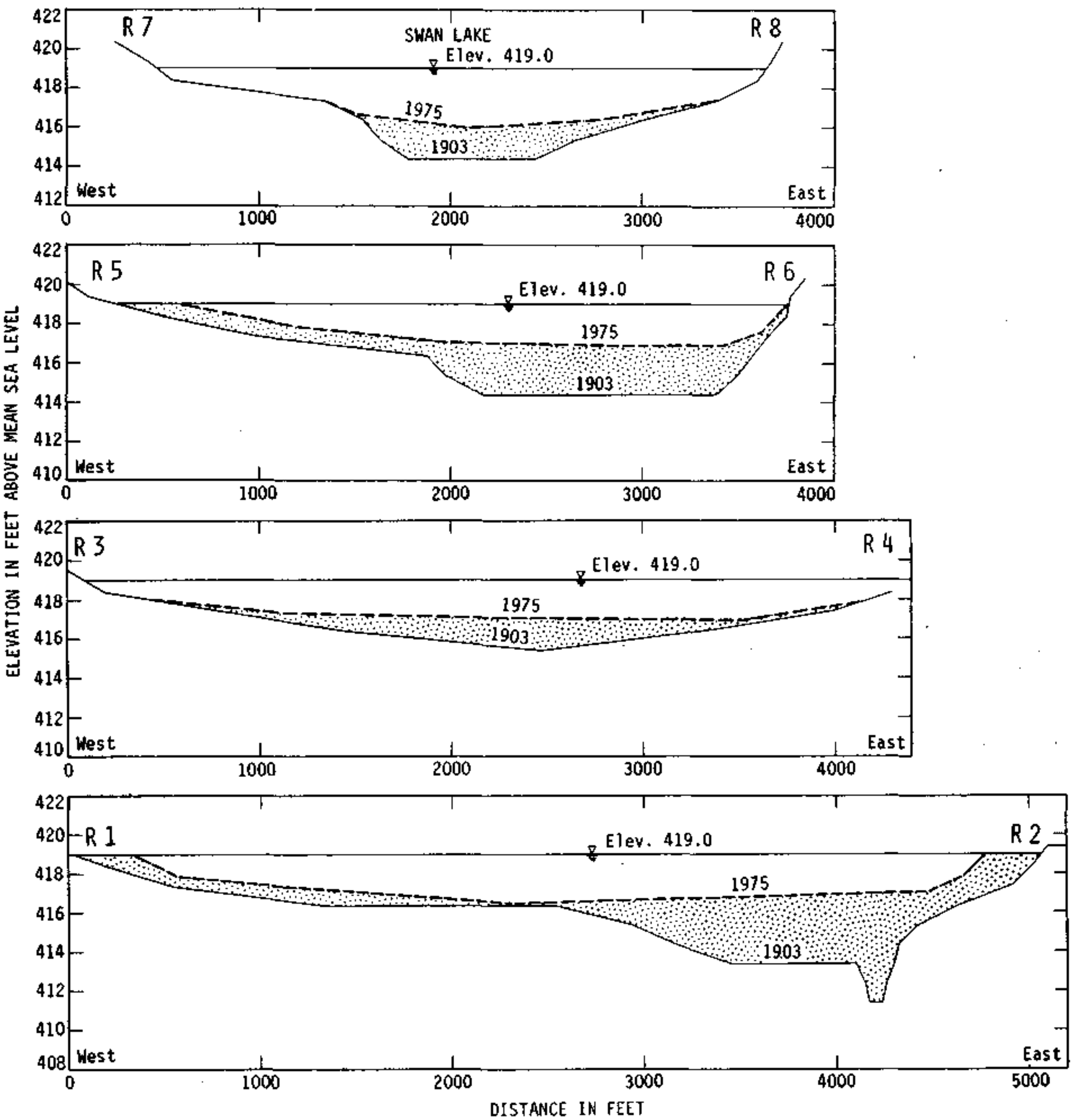
SWAN LAKE
Elev. 419.0
R 7
R 8
R 5
R 6
R 3
R 4
R 1
R 2
1975
1903
West
East
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
DISTANCE IN FEET
0
1000
2000
3000
4000
5000
408
410
412
414
416
418
420
422

Figure 11

area. Except for one creek near R3-R4 cross-section, shown in Figure 10 no apparent deltas have formed at the mouths of the creeks.

According to information from Mr. Hugh Null, Manager of the Swan Lake National Fish and Wildlife Service, and Mr. Jerry Gumings, biologist of the Mark Twain Water Fowl Refuge, the luxuriant aquatic vegetation in the lake disappeared completely after 1971. The biological, chemical and physical reasons are unknown to date. It was speculated that sediment may have something to do with it.

Four cross-sections, located as shown in Figure 10, were developed as base-line information according to the 1903 Woermann Maps. In order to match these cross-sections, three depth soundings were performed at these locations in 1975. The results of this survey are shown on the cross-sections in Figure 11. The capacity loss was calculated based on the Eakin's Range Formula as shown in Table 13.

The results indicate that the inlet segment had the highest capacity loss of 51.3% or 392 ac-ft since 1903. The other segments range from 27.2% to 47.3%. The total capacity loss is 2033 ac-ft or 42.2% since 1903. The lake surface area changed only 10%. In terms of annual deposition rate, Swan Lake lost about 28.2 acre-feet per year. The lake bed has risen about 0.18 inches per year over the life of the lake.

<u>Sawmill Lake</u>

This lake is located at the river mile from 197 to 198 in Putnam County, see Figure 12. The Clear Creek drains to the

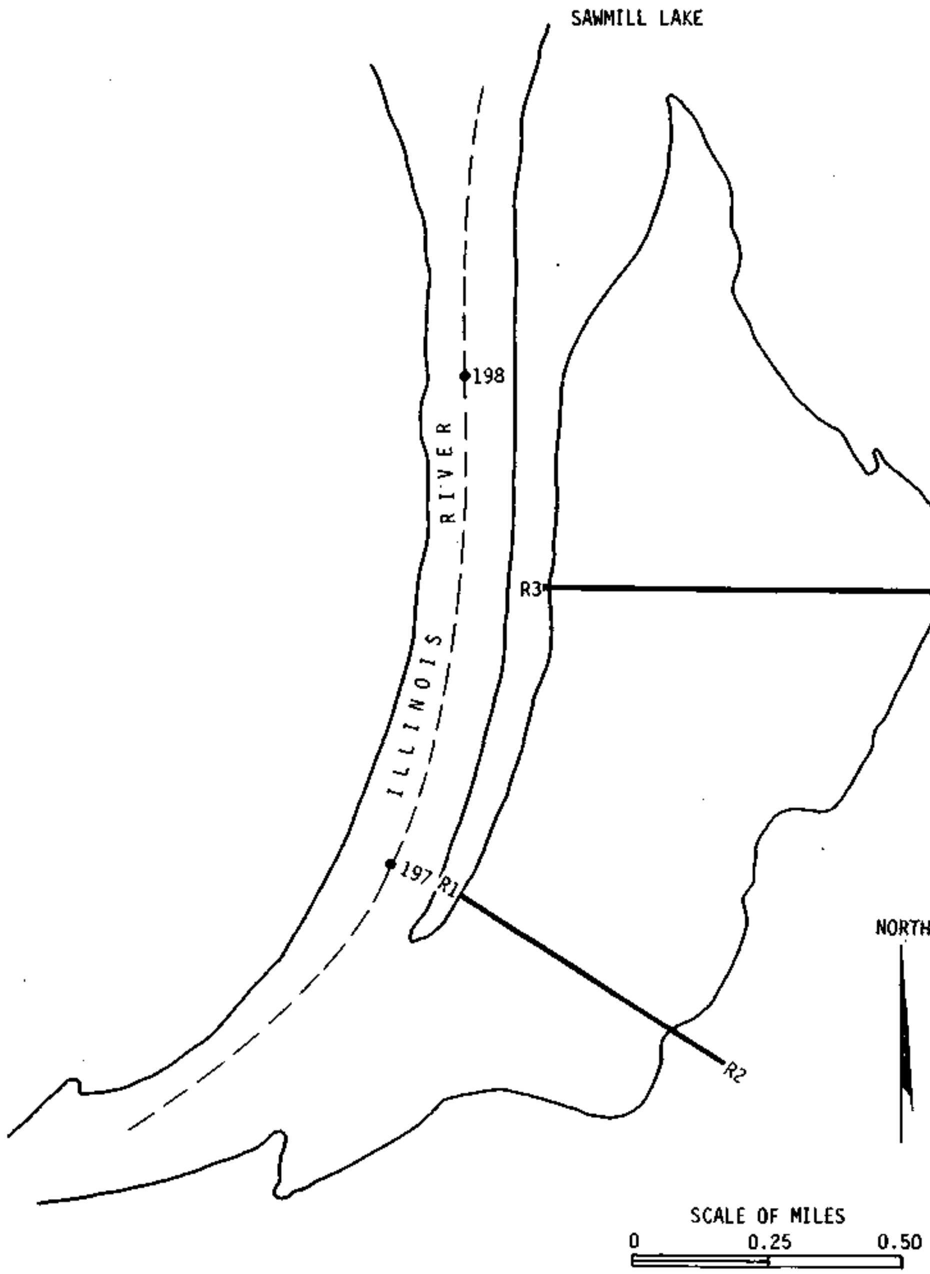
SAWMILL LAKE
198
RIVER
ILLINOIS
197
R1
R2
R3
R4
NORTH
SCALE OF MILES
0
0.25
0.50

Figure 12

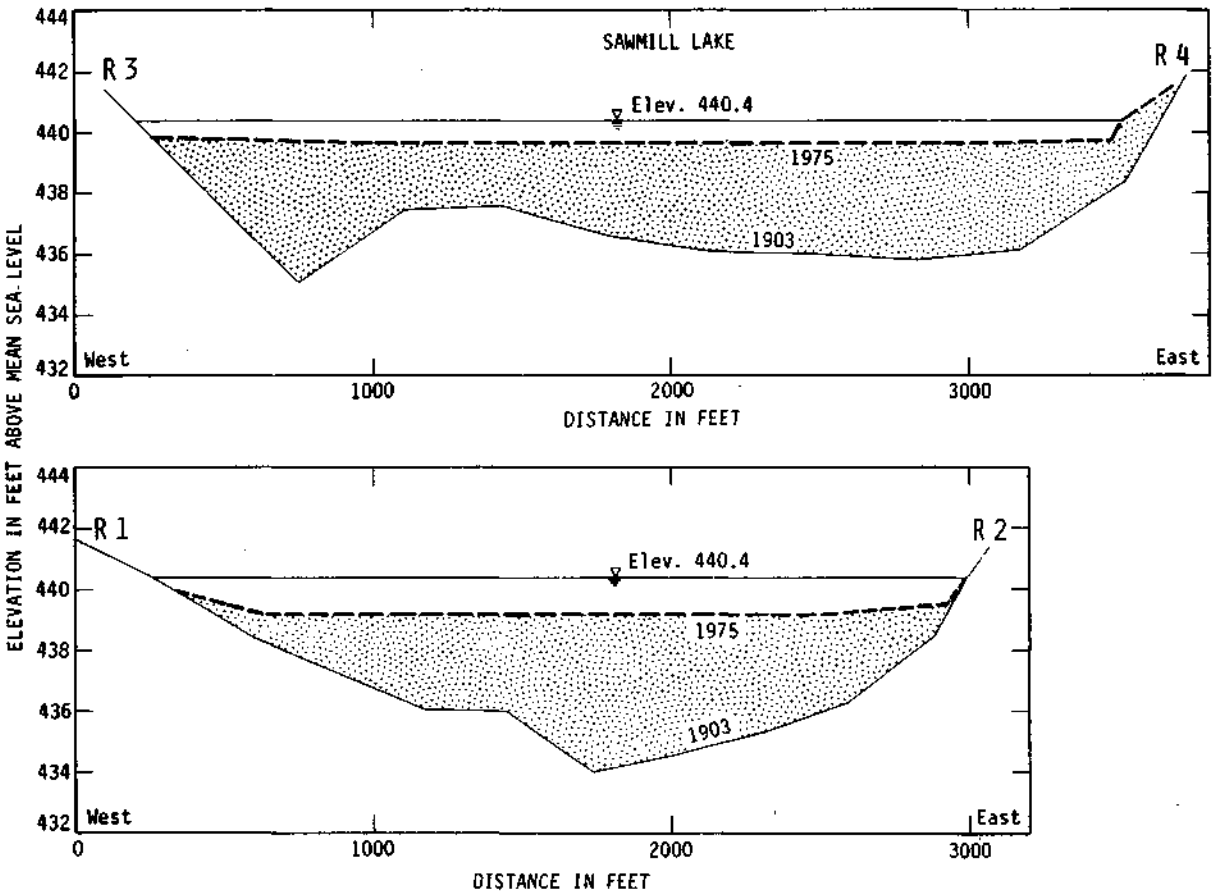
SAWMILL LAKE
R 3
R 4
Elev. 440.4
1975
1903
West
East
DISTANCE IN FEET
R 1
R 2
Elev. 440.4
1975
1903
West
East
DISTANCE IN FEET
ELEVATION IN FEET ABOVE MEAN SEA-LEVEL

Figure 13

Table 13. Distribution of Lake Capacity Loss in Swan Lake

Segment Number	Location Station From	Location Station To	Storage Capacity 1903 (ac-ft)	Storage Capacity 1975 (ac-ft)	Capacity Loss (ac-ft)	Capacity Loss (%)
1	Inlet	R1-2	764	372	392	51.3
2	R1-2	R3-4	1139	718	421	36.9
3	R3-4	R5-6	1071	621	450	42.0
4	R5-6	R7-8	1339	706	633	47.3
5	R7-8	End	503	366	137	27.2
Lake Volume	(ac-ft)		4816	2783	2033	42.2
Area	(acres)		2060	1853	207	10.0

northern end of the lake. The drainage area is relatively small. The surface area was estimated as 608 acres.

Two cross-sections were developed based on the reconnaissance survey which included three sounding points on each cross-section. The northern end of the lake was too shallow for access during the survey. The 1903 baseline information was used to illustrate the change of the cross-sections as shown on the map Figure 11 and on the cross-sections in Figure 13. The lake capacity was calculated as shown in Table 14.

This lake lost about 1792 acre-feet or 82% since 1903. However, the surface area has been reduced only from 798 acres to 608 acres or 24% during the same time period. The sediment deposited rather uniform throughout the lake.

Table 14. Distribution of Lake Capacity Loss in Sawmill Lake

Segment Number		Location Station		Storage Capacity 1903	1975	Capacity Loss	
		From	To	(ac-ft)		(ac-ft)	(%)
1		Inlet	R1-2	338	70	268	79
2		R1-2	R3-4	1195	216	979	82
3		R3-4	End	577	94	483	84
Lake Volume	(ac-ft)			2110	381	1729	82
Area	(acres)			798	608	190	24

Chapter 6

DISCUSSION OP RESULTS

The sedimentation results of two detailed surveys and two reconnaissance surveys are in Table 15. This table shows: (1) the time period between two surveys, (2) the surface elevation used as reference, (3) lake surface area, (4) lake capacity, (5) loss of lake capacity, (6) annual capacity loss rate, and (7) annual deposition thickness.

The significant findings are:

(1) The annual rate of lake capacity loss is highest in Sawmill lake, 1.13% per year. Swan lake and Lake Meredosia have the annual capacity losses of 0.59% and 0.65%.

(2) In terms of the annual deposition thickness, the Sawmill lake leads with 0.47 inches per year. The other lakes range from 0.18 to 0.43 inches per year.

(3) According to the sediment yield estimation in Chapter 3, the range of sediment deposition thickness is 2.0 to 0.2 inches per year. The measured results for four lakes show the lake beds rising at a rate of about 0.18 to 0.43 inches per year. This generally seems to be in line with the range of the estimates based on sediment yield.

Table 15. Summary of Sediment Survey on Four Lakes

	Items	Units	Swan Lake	Lake Meredosia	Sawmill Lake	Lake DePue
(1)	Age of Lake 1903-1975	Year	72	72	72	72
(2)	Water Elevation, Pool, River Miles	ft(msl)	419	424	440.4	441
(3)	Water Surface Area		Alton (5-9)	Alton (72-76)	Peoria (197-199)	Peoria (202-203)
	1903	Acres	2060	1468	798	578
	1975	Acres	1853	1375	608	479
(4)	Lake Capacity					
	1903	ac-ft	4816	7791	2110	2837
	1975	ac-ft	2783	4207	381	778
(5)	Loss of Lake Capacity	ac-ft	2033	3584	1729	2059
		percent	42.2	46.0	81.5	72.6
(6)	Annual Capacity Loss Rate	ac-ft	28.2	49.8	24.0	28.6
		percent	0.59	0.65	1.13	1.01
(7)	Annual Deposition Thickness	inches	0.18	0.43	0.47	0.59

Chapter 7

HYDROLOGIC INFORMATION ON THE ILLINOIS RIVER FOR SEDIMENT CONDITION ESTIMATION ON BACKWATER LAKES

In order to understand sediment movement and deposition, we need to understand the basic mode of sediment transport. Vanoni (1975) has an authoritative new book on the subject. It is known that the stream runoff is the major transport agent of the sediment load. A thorough hydrologic study of the Illinois River is not a major objective of this project. However, development of the following hydrologic information was considered vital to the sediment study:

(1) State-Duration Curves for three pools of long time record,

(2) Table of Duration of Daily Flows,

(3) Accumulated Inflow and Outflow of the backwater lake,

(4) Annual high and low stages, range analysis.

The methodology used in the data analysis is described in the following section. A few potential applications of this information are illustrated.

Stage-Duration Curves

In Figure 14 is given a profile of the Illinois River showing the various pool levels. The stages of the reach of the Illinois River which we studied can be depicted by three pool levels. Because the Illinois River is so flat, the river stage in the same pool does not vary significantly. We selected three stage stations

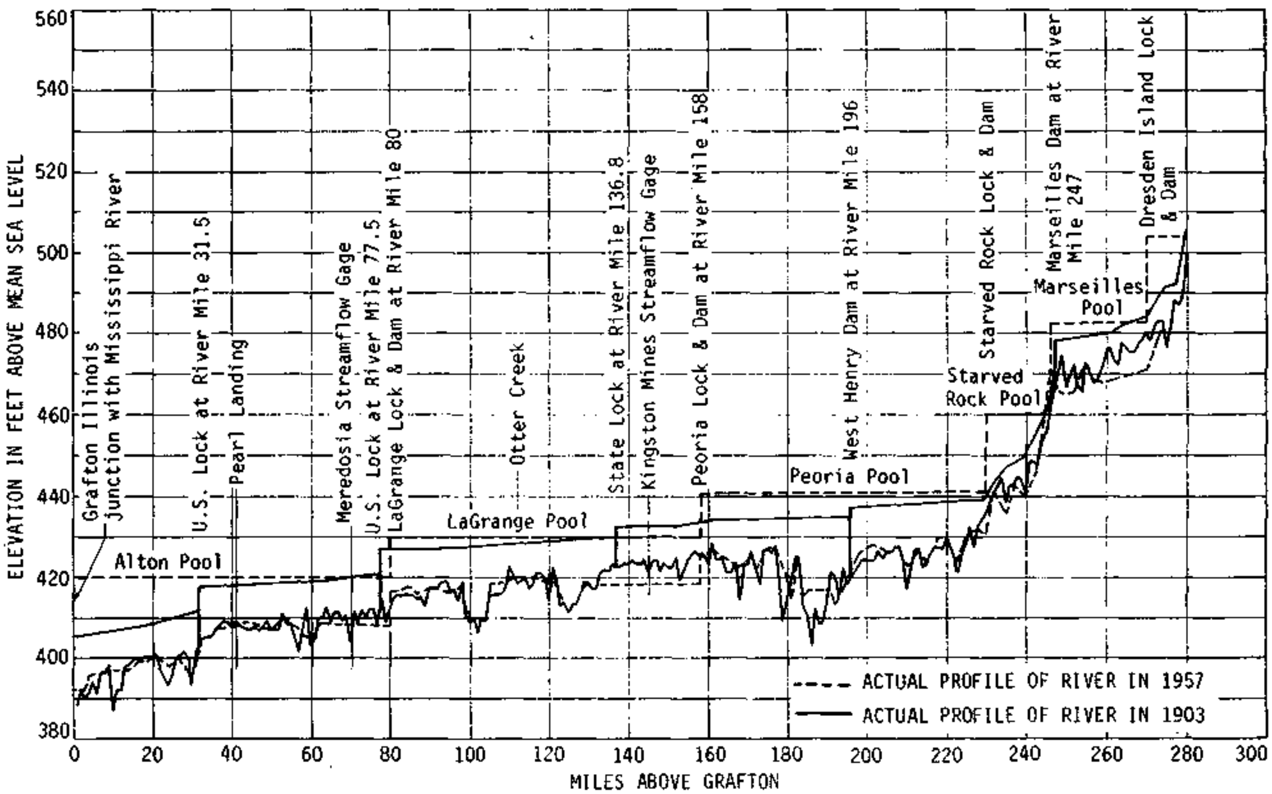
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
MILES ABOVE GRAFTON
Grafton Illinois Junction with Mississippi River
U.S. Lock at River Mile 31.5
Pearl Landing
Meredosia Streamflow Gage
U.S. Lock at River Mile 77.5
LaGrange Lock & Dam at River Mile 80
Otter Creek
State Lock at River Mile 136.8
Kingston Mines Streamflow Gage
Peoria Lock & Dam at River Mile 158
West Henry Dam at River Mile 196
Starved Rock Lock & Dam
Marseilles Dam at River Mile 247
Dresden Island Lock & Dam
Alton Pool
LaGrange Pool
Peoria Pool
Starved Rock Pool
Marseilles Pool
ACTUAL PROFILE OF RIVER IN 1957
ACTUAL PROFILE OF RIVER IN 1903

Figure 14

to present the pool levels: Meredosia station (river mile 70) presents the Alton pool; Liverpool station (river mile 127) presents the LaGrange pool; Hennepin station (river mile 208) presents Peoria pool. The daily stage data of these stations are observed by U. S. Corps of Engineers. The three stations selected for study here are shown in Table 16. The normal pool levels of the Illinois river are shown in Figure 14.

Based on these daily stage readings, we sorted the data into duration tables. Stage-duration curves were developed at three stations as shown in Figure 15. The median stages (50% recurrence probability) are 424.5 feet at Meredosia (Alton pool, 434.1 feet at Liverpool (LaGrange pool), and 442.0 feet at Hennepin (Peoria pool).

Table 17 shows the river stages of different recurrence probabilities for the three pools. In order to assess the pool fluctuations, we calculated the stage differences from the median values as shown in Table 17. The results indicated that at 1% recurrence probability, the Peoria pool has deviated 10.0 feet from median, the LaGrange pool 11.9 feet, and Alton pool 15.3 feet. This indicates that the downstream pool has a higher fluctuation than the upstream pools. The possible reason is that the three pools have relatively similar storage capacity. The downstream pools have larger drainage areas. Therefore, stream runoff into the downstream pools is relatively higher than that of upstream pools. Accordingly, the stage fluctuation of downstream pool is higher than that of the upstream pools.

Table 16. Daily Stage Stations on Illinois River Selected for Use

Pool Name (River Mile)	Stream Gage (River Mile)	Data Duration
Alton (0-80)	Meredosia (70)	1938 - 1974
LaGrange (80-158)	Liverpool (127)	1932 - 1974
Peoria (158-230)	Hennepin (20[illegible])	1932 - 1974

Table 17. Stage Duration tables for Three Pools

	Peoria Pool (Hennepin)		LaGrange Pool (Liverpool)		Alton Pool (Meredosia)	
Probability	Stage	Difference from Median	Stage	Difference from Median	Stage	Difference from Median
99%	452.0	+10.0	446.0	11.9	439.8	15.3
95%	449.0	+ 7.0	442.5	7.8	435.4	10.9
90%	447.0	+ 5.0	440.5	6.4	433.0	8.5
50% (median)	442.0	± 0.0	434.1	± 0.0	424.5	± 0.0
10%	440.1	- 1.9	431.0	- 3.1	420.6	- 3.9
5%	439.9	- 2.1	430.9	- 3.2	420.4	- 4.1
1%	439.5	- 2.5	430.5	- 3.6	419.9	- 4.6

The curves in Figure 15 also show how many days of a year the stream stage will be above a fixed stage. For the backwater lakes these curves show how often the backwater lakes reach a particular stage. This is a basic tool to estimate the total inflow-outflow budgets of these lakes. Based on this water budget, the associated sediment load might be described and assessed.

Annual Duration Table

The duration curve of a station is a long time average record. There are no indications of annual variations. In order to indicate the annual variation, the observed daily data were sorted based on yearly sequences. The Tables 18 and 20 indicated that frequency distribution of the river stages. Due to navigation use, the low stages are kept above the minimum levels. This minimum level at Alton pool is 419 feet msl; LaGrange pool is 429 feet msl; and Peoria pool Is 440 feet. Before the Peoria dam was built in 1939, the data indicated the river stage was below 440 feet for prolonged periods. On the other hand, the high stages cannot be effectively controlled by these three dams. This can be seen from the great fluctuation of the high river stage.

Annual Maximum Stage, Minimum Stage and Extreme Range

Besides the duration tables presented above, the annual high and low stages are important, Table 21 shows the annual high stage, low stage and extreme range at the Meredosia station since 1938.

Table 18. Duration Table of Daily Lake Stage at Meredosia (Alton Pool)

Year	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447
	Lake Level, feet above MSL																													
1938	0	0	1	12	57	41	33	19	20	10	17	79	37	4	5	5	6	4	4	6	5	0	0	0	0	0	0	0	0	0
1939	5	16	116	37	15	23	24	10	25	15	11	15	14	7	5	8	11	4	6	0	0	0	0	0	0	0	0	0	0	0
1940	0	46	117	79	64	29	13	6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	1	57	70	40	55	36	10	24	7	8	9	20	19	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	15	19	34	26	44	35	25	34	17	26	21	12	14	22	6	2	5	6	1	1	0	0	0	0	0	0	0	0
1943	0	0	47	60	25	13	7	9	14	22	17	14	20	40	13	7	13	6	3	3	3	3	3	3	4	4	3	2	5	2
1944	0	2	103	95	30	8	11	11	10	4	4	4	9	18	14	4	4	4	4	4	3	3	4	3	2	8	0	0	0	0
1945	0	0	10	49	66	63	37	9	2	20	13	10	11	20	18	12	11	8	6	0	0	0	0	0	0	0	0	0	0	0
1946	0	1	38	38	41	22	36	31	6	21	40	32	14	16	16	7	3	2	4	5	0	0	0	0	0	0	0	0	0	0
1947	0	6	33	73	44	19	23	30	11	7	12	3	2	13	11	5	15	10	11	14	14	0	0	0	0	0	0	0	0	0
1948	0	2	74	62	35	37	23	14	11	20	16	25	13	4	2	4	3	3	3	4	5	5	0	0	0	0	0	0	0	0
1949	0	5	65	50	43	44	29	28	9	14	19	13	12	6	9	8	5	6	0	0	0	0	0	0	0	0	0	0	0	0
1950	0	1	41	60	31	11	11	13	4	8	10	11	15	27	31	29	18	25	6	5	6	2	0	0	0	0	0	0	0	0
1951	0	0	0	13	30	44	31	32	28	17	17	15	6	11	50	18	11	12	15	6	9	0	0	0	0	0	0	0	0	0
1952	0	5	69	43	16	25	9	7	4	21	33	40	24	8	23	14	11	6	8	0	0	0	0	0	0	0	0	0	0	0
1953	0	19	95	37	21	21	28	37	22	6	6	15	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	62	52	79	24	17	6	12	23	34	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	5	55	62	18	22	15	19	21	40	40	29	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	33	101	70	50	39	17	9	24	14	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	8	46	43	52	35	31	14	8	13	7	29	34	7	3	5	18	4	7	0	0	0	0	0	0	0	0	0	0	0
1958	0	1	45	52	49	67	37	14	5	18	11	2	8	11	14	22	9	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	3	25	48	46	44	44	12	14	25	22	19	20	7	8	11	6	6	5	0	0	0	0	0	0	0	0	0	0	0
1960	0	2	38	63	16	22	20	4	14	20	26	22	18	16	15	7	8	6	7	12	4	6	0	0	0	0	0	0	0	0
1961	0	0	25	49	37	29	30	40	15	20	20	24	14	10	7	14	4	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	9	79	63	17	19	12	12	5	15	25	19	32	12	20	8	4	3	4	4	4	4	8	0	0	0	0	0	0	0
1963	0	27	111	99	60	15	19	13	6	5	4	4	7	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	26	111	113	35	21	9	8	4	14	1	2	3	3	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	9	32	62	51	16	12	10	32	26	35	25	13	4	6	13	13	5	0	0	0	0	0	0	0	0	0	0	0
1966	0	10	67	60	16	14	12	26	9	23	32	20	30	17	11	3	4	5	6	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	30	36	43	16	40	33	17	38	26	8	17	16	24	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	8	52	35	49	37	25	17	22	21	20	19	34	9	4	5	2	7	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	1	35	22	31	38	30	21	25	31	22	19	21	22	15	22	9	1	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	12	25	37	37	43	21	19	19	27	26	4	7	5	7	12	20	7	17	12	7	1	0	0	0	0	0	0
1971	0	0	46	65	80	36	37	13	6	10	14	25	21	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	4	30	34	10	24	59	63	67	33	23	17	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	3	35	24	18	21	12	8	20	28	11	9	12	18	16	30	13	18	3	11	14	9	12	6	5	0	3	0	0
1974	0	0	41	28	31	39	17	3	1	7	6	6	17	9	15	16	23	22	13	10	8	11	15	16	7	4	0	0	0	0

Table 19. Duration Table of Daily Gage Height at Liverpool (LaGrange Pool)

Year	Lake Level, feet above MSL																							
	428	429	430	431	432	433	431	435	436	437	438	139	440	441	442	443	444	445	446	447	448	449	450	151	152
1932	0	0	0	0	9	117	52	35	29	35	11	35	13	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	93	66	23	11	37	51	7	7	16	10	11	12	4	4	9	4	0	0	0	0
1931	0	0	0	0	102	198	31	7	12	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	39	28	17	52	28	26	30	33	59	29	8	4	7	5	0	0	0	0	0	0	0
1936	0	0	20	105	70	51	17	40	13	6	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	15	113	74	36	39	31	19	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	5	6	63	42	27	11	27	19	37	51	15	11	6	4	8	0	0	0	0	0	0	0	0
1939	0	0	91	85	22	21	5	15	33	15	17	27	12	13	5	4	0	0	0	0	0	0	0	0	0
1910	0	0	121	136	19	35	7	7	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	0	19	81	12	57	32	21	21	7	14	22	15	4	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	21	35	31	58	57	33	24	11	21	11	18	18	9	3	9	0	0	0	0	0	0	0	0
1943	0	0	12	69	31	10	12	14	17	21	24	37	20	19	11	5	3	4	3	3	3	2	3	4	5
1944	0	1	67	153	19	9	16	0	11	4	6	19	20	9	5	7	3	3	3	3	8	0	0	0	0
1945	0	0	25	67	71	55	27	16	12	28	23	16	8	5	4	8	0	0	0	0	0	0	0	0	0
1946	0	0	10	77	28	42	29	17	31	22	16	16	22	9	4	5	4	0	0	0	0	0	0	0	0
1947	0	0	36	86	53	38	17	14	17	7	2	16	18	18	23	15	5	0	0	0	0	0	0	0	0
1948	0	0	58	80	55	29	28	17	16	17	13	21	5	6	5	4	5	7	0	0	0	0	0	0	0
1949	0	0	31	101	39	44	37	25	14	31	13	6	7	7	7	0	0	0	0	0	0	0	0	0	0
1950	0	0	13	73	13	18	17	11	4	13	12	10	48	28	25	7	4	3	6	0	0	0	0	0	0
1951	0	0	2	8	25	17	38	29	39	16	23	48	30	17	29	4	5	5	0	0	0	0	0	0	0
1952	0	0	13	86	31	22	21	8	23	15	18	27	28	25	19	0	0	0	0	0	0	0	0	0	0
1953	0	3	71	88	57	20	29	31	19	10	16	18	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	12	58	72	63	12	10	11	13	40	24	9	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	2	39	92	11	20	22	13	22	42	28	36	8	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	72	128	50	59	7	5	20	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	12	58	30	37	15	20	19	48	10	10	17	19	5	5	0	0	0	0	0	0	0	0	0
1958	0	0	18	89	35	90	27	12	7	12	19	18	17	11	10	0	0	0	0	0	0	0	0	0	0
1959	0	0	31	53	18	31	19	27	15	28	10	28	16	12	10	4	0	0	0	0	0	0	0	0	0
1960	0	0	29	88	32	29	12	2	11	30	13	31	25	5	6	12	4	7	0	0	0	0	0	0	0
1961	0	0	23	16	72	53	39	19	30	28	31	9	4	5	6	0	0	0	0	0	0	0	0	0	0
1962	0	0	25	115	29	21	15	12	7	23	29	30	23	5	9	4	5	4	7	2	0	0	0	0	0
1963	0	0	108	83	77	19	8	11	5	6	4	11	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	1	98	151	52	22	8	4	4	9	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	6	59	53	55	20	6	7	32	15	31	11	8	25	4	0	0	0	0	0	0	0	0	0
1966	0	0	59	77	21	15	28	18	12	15	17	13	23	17	3	11	3	0	0	0	0	0	0	0	0
1967	0	0	27	56	52	11	36	6	30	31	9	22	24	19	6	3	0	0	0	0	0	0	0	0	0
1968	0	0	4	73	67	39	35	17	28	12	16	9	16	9	5	6	0	0	0	0	0	0	0	0	0
1969	0	0	3	56	38	50	23	17	28	51	31	28	18	12	4	0	0	0	0	0	0	0	0	0	0
1970	0	0	1	15	38	46	49	22	23	17	35	15	18	9	17	27	15	7	3	4	4	0	0	0	0
1971	0	0	10	117	74	30	30	7	7	16	13	15	16	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	4	19	38	25	6	17	15	86	57	44	21	4	0	0	0	0	0	0	0	0	0	0
1973	0	0	14	33	33	20	9	14	10	15	9	12	24	41	17	21	23	7	15	5	5	7	0	0	0
1971	0	0	35	39	54	20	21	3	2	2	10	12	18	28	27	11	10	11	20	5	1	3	0	0	0
*1975	0	0	20	19	19	7	17	9	4	8	40	43	40	27	14	4	0	0	0	0	0	0	0	0	0

* incomplete record

Table 20. Duration Table of Daily Case Height at Hennepin (Peoria Pool)

Year	Lake level, feet abeve MSL 436	437	438	439	440	441	442	443	444	445	446	447	445	449	450	451	452	453	454	455	456	157	458	159	460
1932	0	0	0	12	107	71	25	30	28	36	39	15	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	90	60	37	17	26	42	18	16	11	12	7	7	11	3	4	4	0	0	0	0	0
1934	0	0	0	34	218	61	20	16	7	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	40	31	15	56	39	21	38	53	33	21	9	5	3	1	0	0	0	0	0	0	0	0
1936	0	0	58	42	26	32	100	40	20	22	9	2	4	5	6	0	0	0	0	0	0	0	0	0	0
1937	0	0	20	85	39	28	24	31	23	33	30	30	9	10	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	2	77	55	20	19	31	23	34	57	33	4	5	5	0	0	0	0	0	.0	0	0	0	0
1939	0	0	0	2	89	150	25	22	11	15	20	16	7	6	1	0	0	0	0	0	0	0	0	0	0
1940	0	0	0	0	94	238	22	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	0	0	0	45	187	57	24	20	5	19	6	2	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	0	0	0	44	143	65	22	25	10	11	15	7	14	4	5	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	58	113	27	17	15	25	30	22	12	17	2	3	3	6	1	4	2	2	5	1	0
1944	0	0	0	0	30	195	31	3	4	21	11	11	7	15	2	4	4	5	0	0	0	0	0	0	0
1945	0	0	0	0	19	198	61	36	17	4	8	3	3	4	5	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	58	165	43	25	13	19	14	14	2	7	5	0	0	0	0	0	0	0	0	0	0
1947	0	0	0	0	63	168	28	13	15	16	12	12	23	10	5	0	0	0	0	0	0	0	0	0	0
1948	0	0	0	0	52	201	26	16	10	12	15	14	5	3	2	4	6	0	0	0	0	0	0	0	0
1949	0	0	0	0	63	163	62	19	13	11	16	6	12	0	0	0	0	0	0	0	0	0	0	0	0
1950	0	0	0	0	9	137	37	21	12	20	44	24	21	16	9	5	2	2	2	4	0	0	0	0	0
1951	0	0	0	0	6	101	64	37	24	31	42	17	15	10	11	7	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	32	140	45	23	15	25	29	37	16	4	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	57	221	42	18	12	7	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	39	196	31	15	23	28	9	13	4	2	2	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	43	150	36	59	21	20	27	9	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	101	187	42	10	8	18	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
1957	0	0	0	0	46	129	53	50	34	6	17	13	5	6	6	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	5	217	63	17	17	10	13	5	8	3	7	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	23	137	84	29	18	18	17	12	17	7	3	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	12	179	18	27	35	38	12	12	10	6	9	4	4	0	0	0	0	0	0	0	0
1961	0	0	0	0	35	171	68	50	17	9	5	3	3	3	1	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	39	149	45	30	31	21	15	3	4	9	4	4	3	5	3	0	0	0	0	0	0
1963	0	0	0	0	90	225	23	10	4	4	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	79	246	27	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	3	156	58	23	35	17	23	11	19	1?	3	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	42	128	66	29	25	16	2C	12	13	4	3	4	3	0	0	0	0	0	0	0	0
1967	0	0	0	0	13	163	57	33	21	13	31	20	6	3	2	3	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	2	160	101	34	25	12	7	5	8	6	6	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	7	139	47	65	40	27	18	12	10	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	6	96	75	49	27	10	15	14	24	30	14	3	3	1	2	2	4	0	0	0	0
1971	0	0	0	0	9	207	70	21	16	14	17	11	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	28	61	32	52	70	65	30	22	6	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	8	112	39	23	14	15	24	27	26	26	10	13	15	4	q	0	0	0	0	0	0
1974	0	0	0	0	6	114	40	4	26	13	26	19	38	27	13	11	6	16	4	4	0	0	0	0	0
*1975	0	0	0	0	0	0	7	25	38	32	24	17	27	6	2	3	0	0	0	0	0	0	0	0	0

* incomplete record

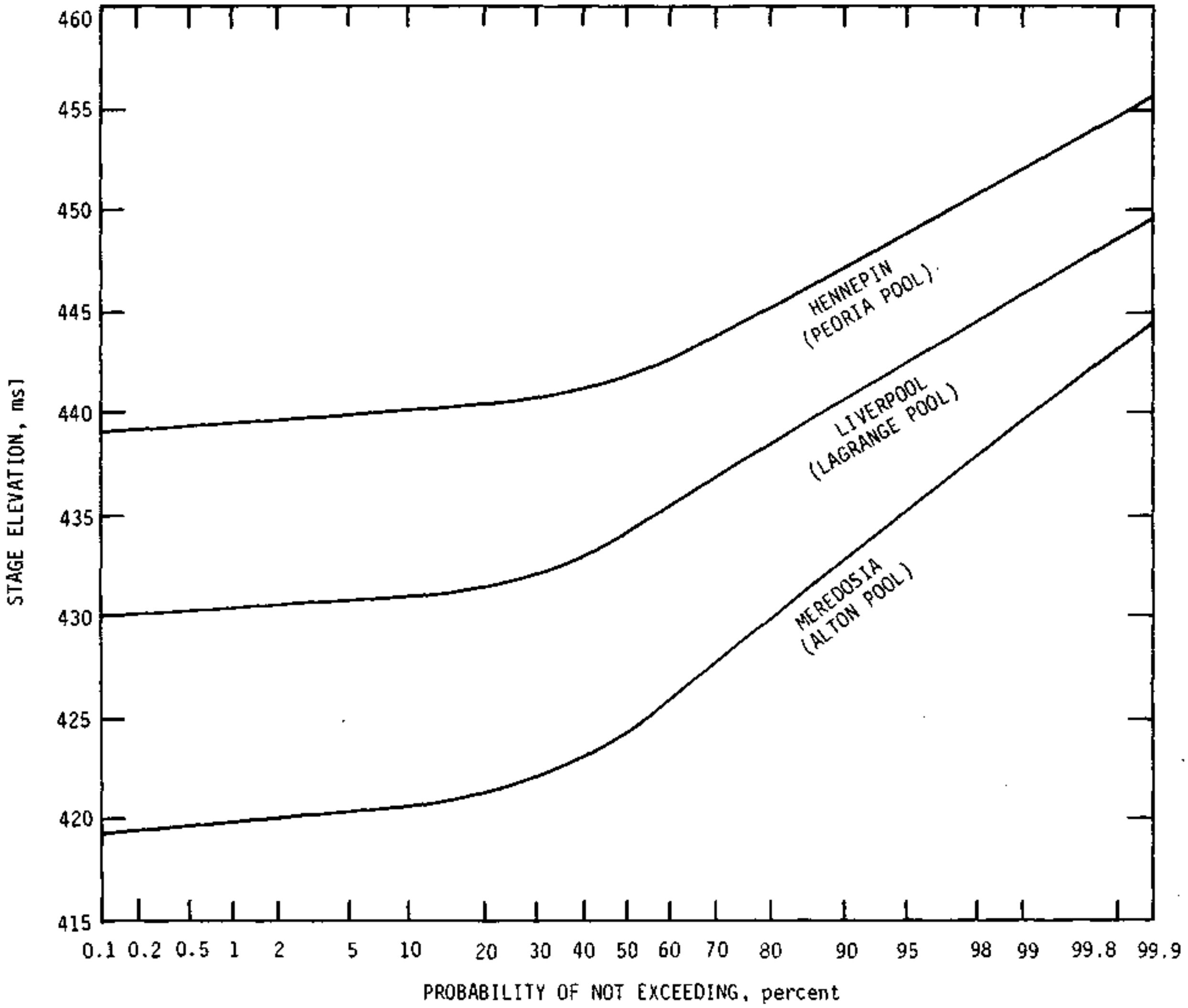
460
455
450
445
440
435
430
425
420
415
STAGE ELEVATION, msl
0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9
PROBABILITY OF NOT EXCEEDING, percent
HENNEPIN (PEORIA POOL)
LIVERPOOL (LAGRANGE POOL)
MEREDOSIA (ALTON POOL)

Figure 15

Table 21. Annual High and Low Stage, Extreme Range at Meredosia Station (1938-1974)

Year	High Stage	Low Stage	Range	Rank	High Stage	Low Stage	Range	Probability
1938	438.0	420.4	17.6	1	446.7	418.4	27.1	2.6
39	436.0	419.0	17.0	2	444.7	418.8	24.3	5.3
1940	425.3	418.4	6.9	3	443.3	418.8	23.9	7.9
41	431.6	419.5	12.1	4	442.8	419.0	23.2	10.5
42	433.7	420.1	13.6	5	440.5	419.1	20.6	13.2
43	446.7	419.6	27.1	6	440.4	419.1	19.9	15.8
44	443.3	419.4	23.9	7	438.9	419.1	19.5	18.4
45	436.1	419.5	16.6	8	438.8	419.2	19.3	21.1
46	437.0	419.8	17.2	9	438.5	419.3	19.0	23.7
47	438.5	419.5	19.0	10	438.5	419.3	18.8	26.3
48	438.8	419.5	19.3	11	438.1	419.4	17.6	28.9
49	435.0	419.5	15.5	12	438.0	419.4	17.4	31.6
1950	438.5	419.7	18.8	13	437.0	419.4	17.3	34.2
51	438.1	420.7	17.4	14	436.3	419.5	17.2	36.8
52	436.0	419.3	16.7	15	436.2	419.5	17.0	39.5
53	429.8	418.8	11.0	16	436.1	419.5	16.9	42.1
54	429.1	419.5	9.6	17	436.1	419.5	16.8	44.7
55	429.9	419.3	10.6	18	436.0	419.5	16.7	47.4
56	426.9	419.1	7.8	19	436.0	419.5	16.7	50.0
57	436.1	418.8	17.3	20	436.0	419.5	16.6	52.6
58	433.7	419.6	14.1	21	435.7	419.5	15.7	55.3
59	436.2	419.4	16.8	22	435.5	419.6	15.5	57.9
1960	438.9	419.4	19.5	23	435.0	419.6	15.1	60.5
61	433.7	419.5	14.2	24	433.7	419.6	14.2	63.2
62	440.4	419.8	20.6	25	433.7	419.6	14.1	65.8
63	431.4	419.1	12.3	26	433.7	419.7	13.6	68.4
64	432.5	419.2	13.3	27	433.7	419.8	13.3	71.1
65	435.7	420.0	15.7	28	432.8	419.8	13.0	73.7
66	436.0	419.1	16.9	29	432.5	419.8	12.3	76.3
67	432.8	419.8	13.0	30	431.6	420.0	12.1	78.9
68	436.3	419.6	16.7	31	431.4	420.1	11.9	81.6
69	435.5	420.4	15.1	32	431.4	420.4	11.1	84.2
970	440.5	420.6	19.9	33	429.9	420.4	11.0	86.8
71	431.4	419.5	11.9	34	429.8	420.4	10.6	89.5
72	433.7	422.6	11.1	35	429.1	420.6	9.6	92.1
73	444.7	420.4	24.3	36	426.9	420.7	7.8	94.7
74	442.8	419.6	23.2	37	425.3	422.6	6.9	97.4

The extreme range is defined as the difference between the annual maximum and minimum stages. These data were ranked. Their duration curves were plotted in Figures 16 and 17.

The results indicate that the extreme high stage occurred in 1943 with the maximum high stage of 446.7 feet msl. The annual' low stages were in a narrow band of 419 to 420 feet msl. The major reason is due to the pool level control at Alton Lock and Dam. The extreme stage fluctuation range occurred in 1943 of 27.1 feet. The smallest range occurred in 1940 with 6.9 feet. The LaGrarge and Peoria Pools were not analyzed.

Accumulated Inflow and Outflow to Backwater Lakes

One of the factors affecting the sediment deposition is the inflow to the backwater lake. There are no recording gages in the backwater lakes. Therefore, direct observations of the inflow record are not available. However, due to the flat pool level, the stream stage station can depict the lake stage very closely. The first approximation of the inflow per year can be calculated as the accumulated rising stage, times the lake surface area. The accumulated rising stream stages at Meredosia from 1938 to 1974 are shown in Table 22. For the purpose of matching with the 1956 and 1965 surveys, we calculated the 1956 to 1974 total inflow as 1,559,000 ac.-ft and the 1938 to 1955 total inflow as 1,417,000 acre-feet. Based on the sedimentation results, given in Table 9, the sediment desposited during 1956 to 1975

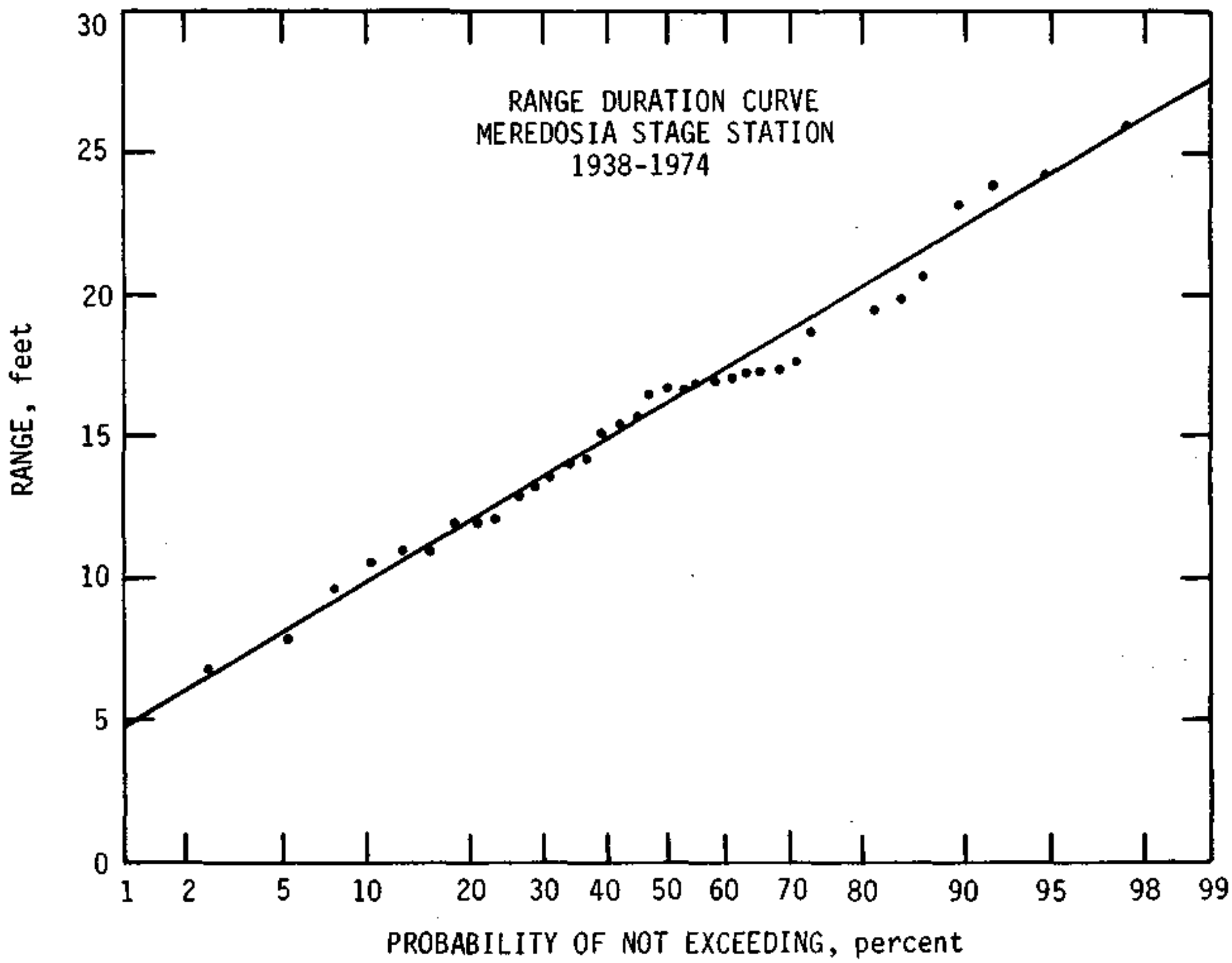
RANGE DURATION CURVE
MEREDOSIA STAGE STATION
1938-1974
RANGE, feet
30
25
20
15
10
5
0
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
PROBABILITY OF NOT EXCEEDING, percent

Figure 16

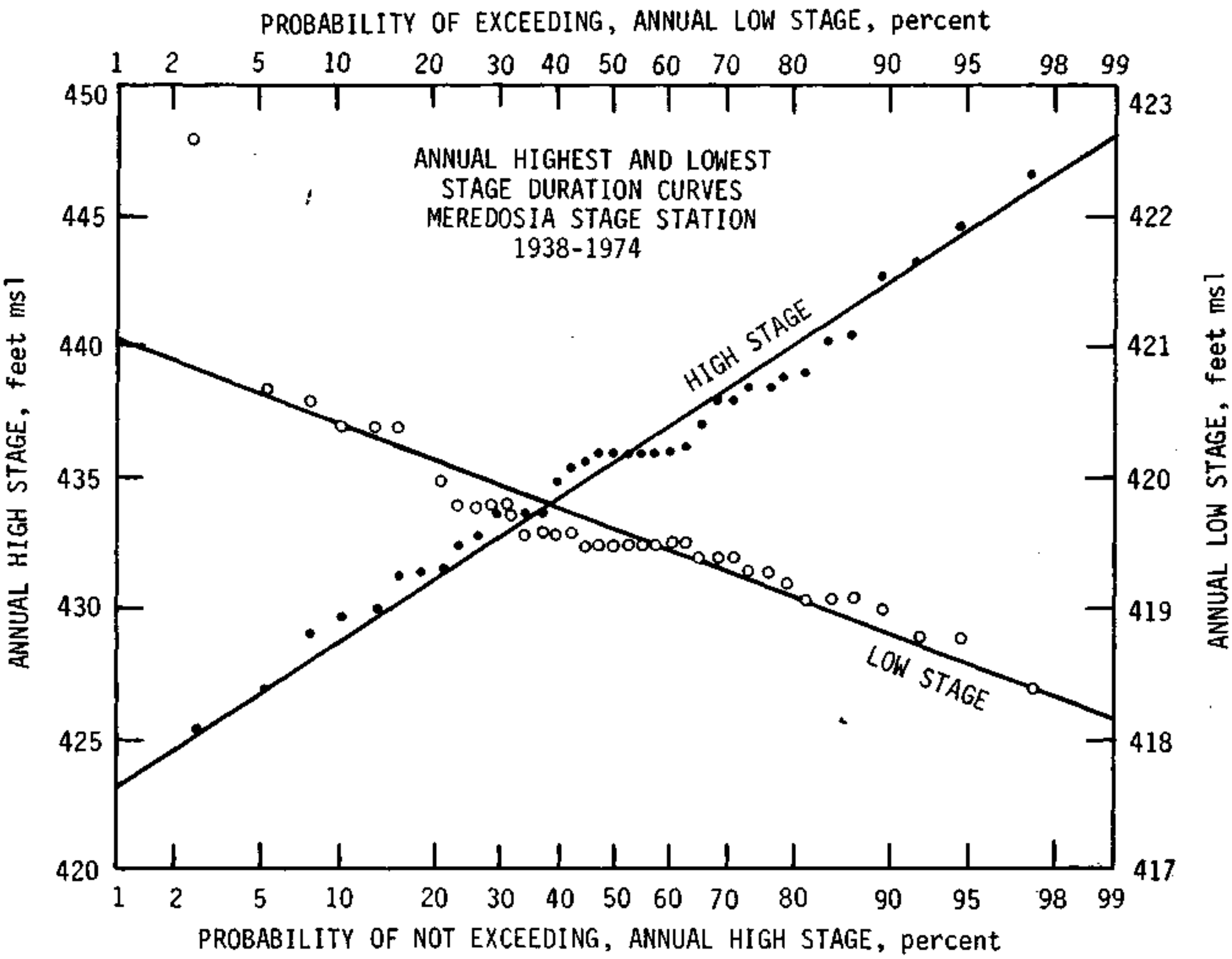
PROBABILITY OF EXCEEDING, ANNUAL LOW STAGE, percent
1 2 5 10 20 30 40 50 60 70 80 90 95 98 99
ANNUAL HIGHEST AND LOWEST
STAGE DURATION CURVES
MEREDOSIA STAGE STATION
1938-1974
HIGH STAGE
LOW STAGE
ANNUAL HIGH STAGE, feet msl
450
445
440
435
430
425
420
ANNUAL LOW STAGE, feet msl
423
422
421
420
419
418
417
1 2 5 10 20 30 40 50 60 70 80 90 95 98 99
PROBABILITY OF NOT EXCEEDING, ANNUAL HIGH STAGE, percent

Figure 17

Table 22. Accumulated State Change at Feredosia (1938-1974)

Year	Accumulated (ft) Rising Stage	Falling Stage	Net (ft)	Remarks
1938	31.8	34.9	-3.1	(1) Total Inflow of (1956 to 1974) 1134 x 1375 = 1,559,250 acre-feet in 19 years = 82,066 acre-feet/year
1939	55.8	56.3	-0.5	
1940	51.7	51.4	0.3	
1941	61.3	55.6	5.7	
1942	74.7	69.1	5.6	
1943	60.0	69.9	-9.9	
1944	54.1	55.0	-0.9	
1945	58.1	54.7	3.4	(2) Total Inflow of 1938 to 1955 1030.6 x 1375 = 1,417,075 acre-feet in 18 years = 78,726 acre-feet/year
1946	67.8	71.8	-4.0	
1947	61.4	60.1	1.3	
1948	65.9	67.5	-1.6	
1949	61.5	52.4	9.1	
1950	49.2	57.1	-7.9	
1951	74.3	70.1	4.2	
1952	43.5	48.2	-4.7	(3) Average Inflow and Sediment Deposition Ratio
1953	48.8	50.4	-1.6	
1954	51.9	49.5	2.4	
1955	58.8	60.3	-1.5	
1956	51.1	49.4	1.7	1938 to 1955 1619:1
1957	56.4	51.4	5.0	1956 to 1975 1822:1
1958	51.3	57.8	-6.5	
1959	61.7	56.5	5.2	
1960	53.0	57.6	-4.6	
1961	77.1	73.6	3.5	
1962	46.6	51.3	-4.7	
1963	45.4	44.4	1.0	
1964	55.3	56.1	-0.8	
1965	78.3	69.9	8.4	
1966	59.8	64.9	-5.1	
1967	67.3	58.3	9.0	
1968	67.1	72.0	-4.9	
1969	64.4	70.7	-6.3	
1970	66.9	64.5	2.4	
1971	59.3	55.9	3.4	
1972	49.4	45.8	3.6	
1973	68.2	68.8	-0.6	
1974	55.8	61.6	-5.8	

was 856 acre-feet. Therefore we can derive the ratio of the total inflow and sediment deposition as 1822 to 1. Similarly, for 1938 to 1955, the ratio of total inflow and sediment deposition is 1619 to 1. These hydrologic study results seem to be generally in line with the sediment deposition rates measured in Lake Meredosia.

Chapter 8

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