United States Department of Defense

US Army Corps of Engineers - Rock Island District

UPPER MISSISSIPPI RIVER - ILLINOIS WATERWAY
SYSTEM NAVIGATION STUDY

Executive Summary --
ACCIDENTS AND HAZARDOUS SPILLS TASK

The purpose of this study was to use statistical methods to explain the rate of accidents by navigation pool. The investigation was to be based on a time series examination by pool of accidents with freight traffic in tons, number of barges in tows, number of tows, time of day, weather, and water levels as potential explanatory variables be included in the analysis. The objective was to develop a predictive model to determine what changes, if any, in accident levels coincide with a change in the level of navigation traffic, *assuming other variables are held constant*.

The primary resource used for this study was a time series of reported navigation accidents (incidents) compiled by the U.S. Coast Guard under a data base denoted as CASMAIN, for the period 1980 to 1991. A successor to CASMAIN, MINMOD, was initiated by the Coast Guard in 1992. Although the study was oriented to the longer time series provided by CASMAIN, MINMOD, as a successor to CASMAIN, was also analyzed for its potential applicability for statistical analyses appropriate to the study. Average annual accident rates for both databases are shown in tables 1.15 and 1.16.

The analyses of CASMAIN indicated that no consistent statistical relationships could be observed or inferred between accidents and pool traffic. For most pools the correlations between accidents and traffic were virtually nonexistent or meaningless in the sense of being counter intuitive such that negative correlations existed. High positive correlations were almost uniformly non-existent between reported accidents in CASMAIN and annual levels of waterway traffic.

The primary study problem was the very low volumes of annual reported accidents in most pools that had little if any correlation with observed changes in annual waterway traffic. Beyond the paucity of data, typically involving less than 10 reported accidents per pool per year, the time series did not contain information relative to tow speed, direction of tow, water levels or weather conditions as envisioned by the Scope of Work. Attempts to integrate changes in pool water levels compiled on a daily or weekly basis with very small numbers of pool accidents dispersed throughout the year were not practical given the paucity of data for a twelve month period.

The initial analyses of MINMOD, 1992 to 1994, yielded an increase in the number of substantial positive and negative correlations between accidents and waterway traffic for certain pools. However, the navigation pool results are insufficient to infer that causal, statistical relationships exist from which a predictive model could be developed because of the very short time frame and inconsistent positive and negative correlations which occurred. An extension of the MINMOD analyses to include four years through 1995 was performed. The four year MINMOD correlations were generally lower and more inconsistent relative to positive and negative correlations, analogous to CASMAIN results, compared to the initial three year MINMOD time series correlations.

It is not possible to develop a consistent predictive model using statistical methods or explain the rate of accidents by navigation pool using these time series (CASMAIN and MINMOD) for the Upper Mississippi River and Illinois Waterway pools. The very small numbers of reported accidents within a year and relatively large fluctuations in the numbers of accidents in CASMAIN and the limited observations for three or four years in MINMOD are not suitable for statistical time series analyses envisioned in the Scope of Work. Therefore, the effort was changed to allow for collection of an additional year of MINMOD to repeat the statistical analyses for four years and provide a methodology to update this analyses by obtaining additional data as the MINMOD time series progresses beyond 1995.

Table 1.15
Average Annual Accident Rates by Pool For All CASMAIN Records 1980-1991

Pool	Number of Incidents	Number of Tows	Number of Tons	Pool Length (Miles)	Accidents/Tons	Accidents/ (Tons/Pool Length)	Accidents/Tow
UPPER MISSISSIPPI							
UMR Mile 0 to L&D 27	69.58	9,990	76,444,421	185.1	0.000000914	0.0001691	0.00705
Lock & Dam 27	7.25	9,990	76,444,421	17.8	0.000000094	0.0000017	0.00073
L&D 26 - Melvin Price	5.92	7,640	69,516,410	38.5	0.000000086	0.0000033	0.00077
Lock & Dam 25	3.75	3,314	34,738,723	32.0	0.000000111	0.0000035	0.00115
Lock & Dam 24	3.50	3,316	34,668,860	27.8	0.000000102	0.0000028	0.00106
Lock & Dam 22	3.00	3,153	33,441,958	23.7	0.000000087	0.0000021	0.00094
Lock & Dam 21	2.75	3,120	32,838,780	18.3	0.000000079	0.0000014	0.00085
Lock & Dam 20	3.17	3,007	31,809,223	21.1	0.000000102	0.0000021	0.00109
Lock & Dam 19	4.92	2,912	31,157,661	46.2	0.000000162	0.0000075	0.00173
Lock & Dam	4.08	2,878	29,705,770	26.6	0.000000134	0.0000036	0.00140

18							
Lock & Dam 17	0.75	2,867	29,077,912	20.1	0.000000028	0.0000006	0.00029
Lock & Dam 16	4.67	3,036	27,358,485	25.7	0.000000173	0.0000044	0.00159
Lock & Dam 15	5.75	3,186	23,850,800	10.4	0.000000249	0.0000026	0.00178
Lock & Dam 14	3.25	2,850	24,740,228	29.2	0.000000132	0.0000039	0.00117
Lock & Dam 13	4.42	2,138	20,448,593	34.2	0.000000220	0.0000075	0.00211
Lock & Dam 12	2.17	2,088	20,273,249	26.3	0.000000110	0.0000029	0.00110
Lock & Dam 11	2.83	1,842	17,828,647	32.1	0.000000155	0.0000050	0.00151
Lock & Dam 10	1.92	1,917	17,682,613	32.8	0.000000109	0.0000036	0.00098
Lock & Dam 9	4.42	1,631	15,857,680	31.3	0.000000264	0.0000083	0.00273
Lock & Dam 8	7.25	1,578	15,015,229	23.3	0.000000491	0.0000115	0.00480
Lock & Dam 7	4.83	1,652	14,528,869	11.8	0.000000348	0.0000041	0.00311
Lock & Dam 6	1.92	1,607	14,508,343	14.2	0.000000135	0.0000019	0.00123
Lock & Dam 5A	2.25	1,585	13,075,220	9.6	0.000000172	0.0000017	0.00140
Lock & Dam 5	3.25	1,522	13,038,460	14.7	0.000000245	0.0000036	0.00213
Lock & Dam 4	4.08	1,535	13,005,084	44.1	0.000000300	0.0000132	0.00257
Lock & Dam 3	3.42	1,569	12,438,042	18.3	0.000000280	0.0000051	0.00227
Lock & Dam 2	7.42	1,700	13,002,012	32.4	0.000000584	0.0000189	0.00454
Lock & Dam 1	0.50	1,338	1,568,210	5.8	0.000000343	0.0000020	0.00039
Lower St. Anthony L & D	0.00	1,340	1,547,430	0.3	0.000000000	0.0000000	0.00000
Upper St. Anthony L & D	1.33	997	1,027,294	11.1	0.000000733	0.0000081	0.00074
ILLINOIS WATERWAY							
IWWS RM 0 to LaGrange	0.25	3,603	32,517,955	80.2	0.000000007	0.0000006	0.00006
New LaGrange	0.00	0	0	77.5	0.000000000	0.0000000	0.00000
Peoria	2.75	3,888	30,588,749	73.3	0.000000092	0.0000067	0.00075
Starved Rock	1.33	3,433	22,794,167	13.6	0.000000057	0.0000008	0.00039
Marseilles	2.00	3,277	20,852,098	26.9	0.000000102	0.0000027	0.00068

Brandon Road	0.25	3,643	17,137,637	5.9	0.000000016	0.0000001	0.00007
Lockport	0.83	3,672	16,739,046	34.4	0.000000048	0.0000017	0.00022
T.J. O'Brien	0.25	2,433	6,376,473	0.9	0.000000043	0.0000000	0.00011

Table 1.16
Average Annual Accident Rates by Pool For All MINMOD Records: 1992-1995

Pool	Number of Incidents	Number of Tows	Number of Tons	Pool Length (Miles)	Accidents/Tons	Accidents/ (Tons/Pool Length)	Accidents/Tow
UPPER MISSISSIPPI							
UMR Mile 0 to L&27	181.5	8,211	77,752,458	185.1	0.00000233	0.00043183	0.0223
Lock & Dam 27	29.3	8,211	77,752,458	17.8	0.00000038	0.00000672	0.0035
L&D 26 - Melvin Price	26.5	6,263	67,612,990	38.5	0.00000040	0.00001537	0.0043
Lock & Dam 25	13.5	2,925	33,532,967	32.0	0.00000041	0.00001314	0.0046
Lock & Dam 24	19.3	2,922	33,570,591	27.8	0.00000065	0.00001809	0.0072
Lock & Dam 22	6.8	2,786	32,237,319	23.7	0.00000022	0.00000514	0.0025
Lock & Dam 21	8.8	2,802	31,681,144	18.3	0.00000026	0.00000484	0.0030
Lock & Dam 20	12.5	2,745	30,427,607	21.1	0.00000043	0.00000899	0.0047
Lock & Dam 19	37.8	2,519	29,675,049	46.2	0.00000133	0.00006152	0.0160
Lock & Dam 18	27.3	2,441	27,972,557	26.6	0.00000103	0.00002738	0.0115
Lock & Dam 17	5.8	2,387	27,218,482	20.1	0.00000021	0.00000428	0.0025
Lock & Dam 16	66.0	2,686	26,059,356	25.7	0.00000270	0.00006947	0.0262
Lock & Dam 15	18.5	2,936	24,819,410	10.4	0.00000071	0.00000738	0.0060
Lock & Dam 14	42.3	2,540	24,413,919	29.2	0.00000165	0.00004827	0.0160
Lock & Dam 13	18.3	1,781	19,632,611	34.2	0.00000101	0.00003460	0.0113
Lock & Dam 12	52.0	1,715	19,243,555	26.3	0.00000301	0.00007907	0.0340

Lock & Dam 11	10.5	1,682	17,323,072	32.1	0.00000063	0.00002009	0.0063
Lock & Dam 10	11.0	1,540	16,681,136	32.8	0.00000071	0.00002333	0.0076
Lock & Dam 9	9.8	1,275	14,493,309	31.3	0.00000065	0.00002041	0.0075
Lock & Dam 8	22.0	1,213	13,256,531	23.3	0.00000151	0.00003567	0.0166
Lock & Dam 7	15.8	1,148	12,293,882	11.8	0.00000139	0.00001580	0.0146
Lock & Dam 6	8.0	1,177	12,562,991	14.2	0.00000061	0.00000867	0.0066
Lock & Dam 5A	5.8	1,043	10,792,231	9.6	0.00000056	0.00000534	0.0057
Lock & Dam 5	12.0	1,038	10,819,351	14.7	0.00000109	0.00001603	0.0115
Lock & Dam 4	13.0	1,022	10,577,870	44.1	0.00000123	0.00005417	0.0127
Lock & Dam 3	7.5	1,017	9,942,828	18.3	0.00000063	0.00001148	0.0062
Lock & Dam 2	32.0	1,032	9,841,437	32.4	0.00000326	0.00010556	0.0310
Lock & Dam 1	0.3	1,119	1,684,041	5.8	0.00000015	0.00000084	0.0002
Lower St. Anthony L & D	1.0	1,068	1,574,837	0.3	0.00000062	0.00000019	0.0009
Upper St. Anthony L & D	0.0	1,112	1,669,055	11.1	0.00000000	0.00000000	0.0000
ILLINOIS WATERWAY							
IWWS RM 0 to LaGrange	19.0	3,372	35,947,696	80.2	0.00000054	0.00004320	0.0057
New LaGrange	76.8	3,372	35,947,696	77.5	0.00000208	0.00016157	0.0224
Peoria	103.0	3,867	33,029,380	73.3	0.00000306	0.00022438	0.0261
Starved Rock	15.3	3,014	23,627,060	13.6	0.00000064	0.00000865	0.0050
Marseilles	54.5	2,707	21,233,661	26.9	0.00000247	0.00006651	0.0199
Dresden Island	8.0	2,712	19,379,558	14.5	0.00000043	0.00000617	0.0031
Brandon Road	6.3	2,936	17,245,169	5.9	0.00000034	0.00000201	0.0021
Lockport	6.5	2,909	17,102,357	34.4	0.00000036	0.00001250	0.0021
T.J. O'Brien	0.5	3,184	10,438,171	0.9	0.00000006	0.00000005	0.0002

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