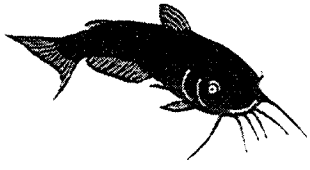
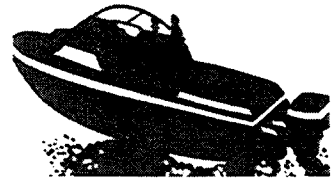
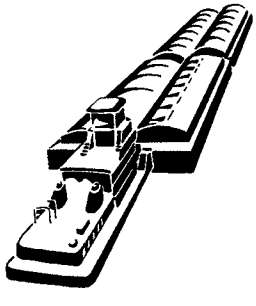
Upper Mississippi River - Illinois Waterway System Navigation Study





Commercial/Recreational Navigation Conflicts



INTERIM REPORT

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COMMERCIAL/RECREATIONAL NAVIGATION CONFLICTS

PREFACE

The work reported herein was conducted as part of the Upper Mississippi River - Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered a part of the plan formulation process for the System Navigation Study.

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. The System Navigation Study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The final product of the System Navigation Study is a Feasibility Report, which is the decision document for processing to Congress.

Daniel Fetes, Rock Island District, performed the work effort for this interim task.

INTRODUCTION

Conflicts often exist between competing activities for use of commonly needed/wanted resources. The UMR navigation system is no exception. Commercial shippers and recreational boaters need/want to use system locks in the passage between pools and may encounter conflicts in using these resources. Of primary concern are the issues of whether or not these conflicts are significant, whether or not these conflicts cause or increase commercial delays, and whether or not the system can adequately accommodate both competing activities.

It is important to note that this analysis is based on trends in number of lockages, lockage delays, and vessels locked. Trends in commodity tonnages transported are not considered to affect this evaluation.

In the following analysis, Lock Performance Monitoring System (LPMS) data were used as the basis for addressing the commercial/recreational conflicts question.

DATA COLLECTION AND HISTORICAL TRENDS

LPMS data by month and year (1980-1997) for all locks on the Mississippi River and Illinois Waterway are basic information used in this assessment. This 18-year period was chosen because it encompasses a diversity of economic and weather/river conditions in the UMR region: severe and mild recessions, recovery and expansion periods, drought years and low water, wet years and major floods, and rehabilitation of most lock and dam sites. This nearly two decades of data lends insight into recent trends in navigation system usage.

From the LPMS database, five basic data items were extracted for the analysis period: number of commercial lockages, number of commercial delays, hours of commercial delays, number of recreational lockages, and number of recreational vessels locked. Analysis of these data reveals trends of usage and potential relationships between users and system delays. Annual Trend Charts 1 thru 10 depict usage and delay trends for the UMR Locks 3, 7, 15, 17, 19, 24, 25 and IWW Locks 1 (O'Brien), 4 (Dresden), and 8 (La Grange). These lock sites were chosen for display

because they are representative of types of lock configurations or common lock usage attributes. Table 1 explains lock representations.

TABLE 1: Representative Lock Sites

Lock	River	Representation
3 & 7	UMR	Upper river, high-use recreation traffic
15	UMR	Middle river, high-use commercial traffic, with recreation high-use auxiliary lock
17	UMR	Middle river, high-use commercial traffic
19	UMR	Middle river, high-use commercial traffic, 1,200-foot lock
24 & 25	UMR	Lower river, high-use commercial traffic
O'Brien	IWW	Upper river, medium-use commercial and recreational
Dresden	IWW	Middle river, high-use commercial
La Grange	IWW	Lower river, high-use commercial

As indicated by Annual Trend Charts 1-10, the number of recreational vessels being locked has been in an increasing trend consistently throughout the UMR system, with concentrations toward the upstream reaches of both rivers. Recreational lockage trends (versus recreational vessels locked) are not so consistent, with some sites increasing, while other sites showing small decreasing trends. Commercial lockages and commercial delay hours have generally experienced small decreasing trends over the analysis period. Table 2 (page 4) presents usage trends information for selected locks. Usage trends and relationships are integral to the analysis of potential conflicts.

ANALYSIS OF POTENTIAL CONFLICTS

In assessing potential conflicts, a focused question must be asked: "What data trends/relationships might indicate a significant conflict between commercial and recreational users resulting in increased commercial delays?" The focus is on commercial delays because the UMR navigation system is primarily a commercial traffic project. Commercial traffic lockages have precedence over recreational traffic lockages.

The following trends/relationships might indicate significant user conflicts.

1. High correlations between recreational lockages (or vessels locked) and commercial delays, AND high or significantly increasing hours per delay.

2. High recreation usage AND significantly increasing commercial usage and delay hours.

3. Trends of significantly increasing growth in commercial lockages, commercial delays, and recreational lockages.

Charts 11-20 depict correlations between potentially related uses and commercial delay measurements. For each year in the analysis period, monthly totals for selected LPMS categorical data were regressed against potentially related categorical totals. The selected regression pairs

were: number of commercial lockages versus number of commercial delays; number of commercial lockages versus hours of commercial delays; number of recreational lockages versus number of commercial delays; and number of recreational lockages versus hours of commercial delays. While correlation alone does indicate causation, it is a valid starting point in a relationship search.

As illustrated in Charts 11-20, only correlations between commercial lockages and commercial delays (both number and hours) are somewhat consistently high and positive. This is obviously an expected outcome. Correlations of recreational lockages to commercial delays are not consistent, often being low, sometimes negative.

Table 4 (page 6) details annual correlations and trends for several data lockage data items. Notable items showing consistent growth trends are the number of recreational vessels locked and the number of recreational vessels per lockage. Those sites with high concentrations of recreational craft being locked process more boats per lockage. These sites also tend to experience low hours per commercial delay, indicating no significant conflicts. Throughout the UMR system, the number of recreational craft per lockage ranges from about two to five boats. Since the locks, in general, can process many more than five boats per lockage, excess capacity is indicated. The need for scheduling of recreational lockages at some sites may be an issue in the future, but capacity does not appear to be a significant issue.

CONCLUSIONS

After defining indicators of significant conflicts (see 3 points in Analysis paragraph) and then testing LPMS data for the presence of such conflict indications, generalized conclusions can be drawn.

1. The greatest number of commercial delays, total hours of delay, and average hours per delay occur at locks with the greatest concentration of commercial traffic (and generally the least relative recreational traffic).

2. Lock sites with the greatest concentrations of recreational craft being locked experience low levels of commercial delay. These sites also appear to more efficiently lock recreational craft, as measured by average number of boats per lockage.

3. Based upon data trends, correlation analysis, and recreational craft lockage capacity, it does not appear that there are significant conflicts between commercial and recreational users of the UMR navigation system which result in increasing commercial delays.

Table 3 (page 5) presents a conflicts analysis matrix for selected lock sites which are representative of the UMR navigation system. The highlighted cells for each lock site show that significant conflict indicators are not present. Tables 2 and 3 together summarize usage trends and conflict indication criteria.

TABLE 2
UPPER MISSISSIPPI RIVER SYSTEM
SELECTED REPRESENTATIVE LOCKS
1980-1997 TRENDS COMPARISON 1/

	Commercial Lckgs		Comm. Delay Hrs.		Avg. Hrs. Per Delay		Recreational Lckgs.		Recr. Vessels Locked		Recr. Vess. Per Lckg	
	Annual Average	% Growth	Annual Average	% Growth	Annual Average	% Growth	Annual Average	% Growth	Annual Average	% Growth	Annual Average	% Growth
Mississippi River:												
3	1,415	-3.26%	749	-3.80%	0.88	6.90%	3,490	1.50%	14,731	7.40%	4.2	4.70%
7	1,583	-2.80%	995	-2.90%	1.04	3.90%	3,268	-0.40%	10,923	2.50%	3.3	2.90%
15	2,761	-0.80%	5,698	0.50%	3.3	0.20%	137	3.80%	298	8.00%	2.2	2.90%
17	2,762	-1.20%	7,429	-2.30%	3.89	-1.50%	522	-0.80%	999	1.90%	1.9	3.50%
19	2,856	-1.10%	2,740	-2.50%	1.76	-2.10%	510	1.60%	1,057	2.10%	2.1	0.00%
24	3,233	-1.15%	12,644	-1.36%	4.90	0.80%	545	2.20%	1,250	2.96%	2.3	0.32%
25	3,277	-1.30%	11,629	1.70%	3.89	5.80%	767	1.30%	2,226	3.40%	2.9	1.50%
Illinois Waterway:												
O'Brien	2,838	1.70%	245	-2.10%	0.39	-3.50%	4,399	-0.20%	16,245	1.80%	3.7	2.00%
Dresden	2,982	-2.00%	2,859	-1.40%	1.72	1.90%	1,021	2.13%	3,226	5.80%	3.2	2.30%
LaGrange	3,462	-1.10%	8,204	-0.20%	3.87	3.50%	320	1.10%	859	3.60%	2.7	0.90%

1/ % Growth = slope of plotted annual totals over the analysis period.

Table 3

UPPER MISSISSIPPI RIVER SYSTEM

CONFLICTS ANALYSIS MATRIX

	LOCK USAGE 1/ (relative to total)		GROWTH TRENDS 2/				HOURS 3/	CORRELATIONS 4/		
	Comm.	Recr.	Comm. Lockages	Comm. Delays	Recr. Lockages	Recr. Vessels Locked	PER COMM. DELAY	Comm. Use To Comm. Delay	Recr. Use To Comm. Delay	SIGNIFICANT CONFLICT INDICATED?
Mississippi River Locks										
3	low	high	decrease	decrease	increase	increase	low	high	high	No
7	low	high	decrease	decrease	decrease	increase	low	high	high	No
15	high	low	stable	stable	increase	increase	high	high	low	No
17	high	low	decrease	decrease	stable	increase	high	high	low	No
19	high	low	decrease	decrease	increase	increase	medium	high	low	No
24	high	low	decrease	decrease	increase	increase	high	high	medium	No
25	high	low	decrease	increase	increase	increase	high	high	medium	No
Illinois Waterway Locks										
O'Brien	medium	medium	increase	decrease	stable	increase	low	medium	high	No
Dresden	high	low	decrease	decrease	increase	increase	medium	high	medium	No
LaGrange	high	low	decrease	stable	increase	increase	high	low	low	No
ANALYSIS KEY NOTES:		1/	High	Medium	Low		2/	Increase	Stable	Decrease
		1/	>65%	35-65%	<35%			>1%	>-1%, <1%	<-1%
		3/	>3.0 hrs	1.5-3.0 hrs	<1.5 hrs					
		4/	>.65	.35-.65	<.35					

TABLE 4
CORRELATIONS AND TRENDS, 1980-1997

L/D 3

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.998	0.9956	0.9991	0.8516	0.6741	0.8416	0.942	0.884	0.88	0.8792	0.9183	0.9461	0.8999	0.9196	0.8578	0.8972	0.9480	0.9521
Comm Lck to Hrs Del	0.921	0.9159	0.8611	0.7728	0.3401	0.7859	0.6656	0.7918	0.6406	0.8733	0.9216	0.8744	0.8244	0.8563	0.7982	0.8406	0.8961	0.8451
Rec Lck to No. Delays	0.524	0.578	0.3838	0.5698	0.7794	0.8106	0.8828	0.8609	0.7807	0.8740	0.9521	0.8447	0.8956	0.1742	0.9632	0.7039	0.8388	0.9237
Rec Lcks to Hrs Dely	0.766	0.7662	0.5489	0.3262	0.8685	0.2788	0.4107	0.7263	0.1539	0.6592	0.8863	0.7923	0.8683	0.1121	0.9211	0.5338	0.8935	0.8557
Rec Ves to Hrs Delay	0.722	0.7273	0.5458	0.3137	0.8699	0.2817	0.4505	0.7555	0.1226	0.5622	0.8404	0.7941	0.8504	0.1294	0.8601	0.5699	0.8692	0.8005

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	1724	1917	1773	2056	1815	1464	1314	1355	1455	1386	1625	1342	1272	796	936	1065	1130	1047	1415	-0.033
Recr Lockages	3071	3093	3161	2957	2821	3432	3187	4046	3909	3843	3670	3825	3561	2805	4092	4031	3718	3601	3490	0.015
Delay Hours	696	884	765	1392	1260	564	666	593	762	769	1146	767	744	419	417	541	591	499	749	-0.038
Number of Delays	1652	1828	1729	1185	944	646	608	625	742	729	917	697	647	344	437	511	517	475	846	-0.042
Recr Vessels	8765	9216	10143	10082	9760	11262	11518	16397	17620	19629	17798	17913	17857	10397	20211	19924	19392	17282	14731	0.074
'Hrs/Delay	0.42	0.48	0.44	1.17	1.33	0.87	1.10	0.95	1.03	1.05	1.25	1.10	1.15	1.22	0.95	1.06	1.14	1.05	0.88	0.069
'Recr Vessels Per Lckg	2.9	3.0	3.2	3.4	3.5	3.3	3.6	4.1	4.5	5.1	4.8	4.7	5.0	3.7	4.9	4.9	5.2	4.8	4.2	0.047

L/D 7

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.92	0.9653	0.9988	0.9185	0.9544	0.9394	0.9184	0.9291	0.9106	0.8876	0.9559	0.9170	0.9418	0.9152	0.8740	0.9230	0.9187	0.9405
Comm Lck to Hrs Del	0.761	0.6482	0.8536	0.862	0.6267	0.5565	0.3589	0.8465	0.9125	0.8993	0.9090	0.7785	0.9239	0.7534	0.8612	0.8912	0.8747	0.9257
Rec Lck to No. Delays	0.411	0.6101	0.4997	0.557	0.5524	0.794	0.8506	0.7891	0.8398	0.8107	0.9479	0.8747	0.8313	0.0524	0.9447	0.7084	0.7878	0.9365
Rec Lcks to Hrs Dely	0.287	0.3858	0.3298	0.3951	0.0609	0.0749	0.0244	0.6783	0.7133	0.6819	0.9439	0.8153	0.7542	0.0416	0.9317	0.5430	0.7625	0.9098
Rec Ves to Hrs Delay	0.21	0.3076	0.2761	0.3838	0.0445	0.12	0.0609	0.747	0.6353	0.5293	0.9381	0.8353	0.6995	0.0900	0.9028	0.6301	0.7761	0.8687

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	2271	2387	1788	2094	2130	1558	1497	1417	1529	1433	1695	1471	1383	871	1062	1273	1355	1280	1583	-0.028
Recr Lockages	3060	3018	3198	3045	2989	3398	3549	4107	4087	3882	3342	3406	2888	2480	3410	3274	2917	2780	3268	-0.004
Delay Hours	1192	1551	1120	1592	1275	802	1029	705	720	812	1410	1036	947	562	577	763	914	908	995	-0.029
Number of Delays	1860	2002	1750	1283	1049	667	694	676	765	796	986	887	820	457	529	650	720	670	959	-0.036
Recr Vessels	8787	8174	8299	9261	9025	9470	10738	12755	13618	13751	12577	12551	11310	6685	12381	13441	11107	12686	10923	0.025
'Hrs/Delay	0.64	0.77	0.64	1.24	1.22	1.20	1.48	1.04	0.94	1.02	1.43	1.17	1.15	1.23	1.09	1.17	1.27	1.36	1.04	0.039
'Recr Vessels Per Lckg	2.9	2.7	2.6	3.0	3.0	2.8	3.0	3.1	3.3	3.5	3.8	3.7	3.9	2.7	3.6	4.1	3.8	4.6	3.3	0.029

L/D 15

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.955	0.9695	0.965	0.9218	0.9471	0.9759	0.899	0.9397	0.9771	0.9670	0.9542	0.9653	0.9426	0.9681	0.9602	0.9472	0.9535	0.9646
Comm Lck to Hrs Del	0.08	0.5927	0.1853	0.6769	0.8775	0.8415	0.6479	0.5291	0.8851	0.8892	0.7380	0.6831	0.7817	0.8304	0.7309	0.8151	0.7691	0.8883
Rec Lck to No. Delays	0.755	0.4259	0.1008	0.2446	0.4798	0.4037	0.0339	0.6583	0.5655	0.6922	0.3292	0.7054	0.1338	0.1214	0.5906	0.2344	0.1358	0.5686
Rec Lcks to Hrs Dely	-0.01	0.081	-0.234	0.1264	0.4374	0.2994	-0.174	0.3382	0.6521	0.7086	0.1792	0.3777	0.0518	0.1185	0.2938	0.1140	0.0117	0.5341
Rec Ves to Hrs Delay	-0.041	-0.022	-0.222	0.085	0.4445	0.1748	-0.183	0.4652	0.6748	0.7956	0.1792	0.4466	0.1424	0.1481	0.2806	0.2092	0.1127	0.6743

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	2745	3058	2828	3205	2955	2199	2350	3000	3270	2842	3080	2891	2811	2093	2415	2748	2743	2470	2761	-0.008
Recr Lockages	81	115	102	66	58	90	216	88	503	69	79	80	31	207	466	102	63	58	137	0.038
Delay Hours	7324	4902	3721	9100	3613	1777	1697	7707	7929	6088	9247	5788	7676	3915	2626	6671	8648	4128	5698	0.005
Number of Delays	1563	1774	1571	2217	1596	947	949	1750	2390	2007	2350	2010	2045	1307	1251	1912	1945	1526	1728	0.005
Recr Vessels	131	245	139	91	90	202	392	144	1479	109	142	140	53	434	1032	218	185	144	298	0.080
'Hrs/Delay	4.69	2.76	2.37	4.10	2.26	1.88	1.79	4.40	3.32	3.03	3.93	2.88	3.75	3.00	2.10	3.49	4.45	2.71	3.30	0.002
'Recr Vessels Per Lckg	1.6	2.1	1.4	1.4	1.6	2.2	1.8	1.6	2.9	1.6	1.8	1.8	1.7	2.1	2.2	2.1	2.9	2.5	2.2	0.029

L/D 17

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.972	0.9782	0.9821	0.9664	0.9778	0.9037	0.9575	0.9635	0.9748	0.9859	0.9661	0.9611	0.9752	0.9515	0.9493	0.9533	0.9767	0.986
Comm Lck to Hrs Del	0.44	0.2602	0.6125	0.6202	0.8406	0.3917	0.1056	0.4748	0.8375	0.8916	0.7614	0.7349	0.8079	0.3123	0.798	0.72	0.8995	0.917
Rec Lck to No. Delays	0.378	0.498	0.431	0.5757	0.0487	0.2249	0.2145	0.6338	0.327	0.5809	0.2176	0.6037	0.58	0.6383	0.8081	0.5612	-0.044	0.588
Rec Lcks to Hrs Dely	-0.121	-0.246	0.8611	0.0753	-0.1902	-0.23	-0.361	0.3019	0.4559	0.522	-0.082	0.5703	0.1604	-0.057	0.8306	0.6161	-0.067	0.518
Rec Ves to Hrs Delay	-0.111	-0.241	0.7712	0.0635	-0.1781	-0.225	-0.35	0.3944	0.4149	0.5308	-0.149	0.6054	0.2478	-0.061	0.8404	0.6274	-0.119	0.459

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	3053	3248	2977	3421	2829	2139	2114	2869	3153	2955	3236	2967	2953	1841	2005	2736	2758	2469	2762	-0.011
Recr Lockages	628	541	476	312	405	699	610	641	722	662	474	508	498	141	669	536	448	425	522	-0.008
Delay Hours	9930	7634	4889	14617	4543	5291	5648	15858	6374	7771	12636	5498	6738	9534	1772	6157	4971	3869	7429	-0.023
Number of Delays	2064	2172	1836	2714	1865	1149	1194	2001	2319	2311	2650	2116	2144	1113	1050	1997	1982	1675	1908	-0.009
Recr Vessels	920	797	913	544	641	1170	999	1172	1391	1410	811	1063	968	216	1418	1349	1029	1176	999	0.019
'Hrs/Delay	4.81	3.51	2.66	5.39	2.44	4.60	4.73	7.93	2.75	3.36	4.77	2.60	3.14	8.57	1.69	3.08	2.51	2.31	3.89	-0.014
'Recr Vessels Per Lckg	1.5	1.5	1.9	1.7	1.6	1.7	1.6	1.8	1.9	2.1	1.7	2.1	1.9	1.5	2.1	2.5	2.3	2.8	1.9	0.035

L/D 19

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.975	0.9768	0.9991	0.9536	0.961	0.9501	0.9592	0.9555	0.9733	0.9838	0.9739	0.9735	0.9714	0.9728	0.9499	0.9747	0.9843	0.9808
Comm Lck to Hrs Del	0.8	0.6885	0.9953	-0.1	0.5116	-0.478	0.8257	0.8171	0.9316	0.9181	0.5944	0.1272	0.0307	0.5663	0.7108	0.94	0.8483	0.8960
Rec Lck to No. Delays	0.585	0.4924	0.9429	0.3424	0.039	0.2631	0.1788	0.7009	0.4609	0.5356	0.5127	0.6605	0.7396	0.8389	0.7993	0.7180	0.4245	0.6494
Rec Lcks to Hrs Dely	0.506	0.2643	0.942	-0.251	-0.3541	-0.304	0.0001	0.5151	0.5521	0.5587	0.2113	0.0250	0.0945	0.4917	0.7440	0.6241	0.1595	0.5393
Rec Ves to Hrs Delay	0.46	0.3026	0.9306	-0.249	-0.3342	-0.289	0.0121	0.5266	0.541	0.3448	0.1034	0.0993	0.1732	0.4233	0.7726	0.6670	0.1219	0.4943

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	3115	3435	3052	3482	3000	2176	2213	2929	3309	2963	3326	3047	3078	2006	2096	2838	2829	2513	2856	-0.012
Recr Lockages	439	464	371	397	418	557	569	513	537	669	577	617	620	163	576	546	543	607	510	0.016
Delay Hours	3674	2721	1754	7100	4467	2422	917	2031	2237	2118	3397	2734	3404	2151	1476	2330	2443	1940	2740	-0.025
Number of Delays	1735	1862	1508	2162	1568	839	893	1442	1696	1634	2022	1758	1972	1083	1041	1698	1662	1415	1555	-0.005
Recr Vessels	772	886	730	813	862	1173	1012	1075	1303	1536	1385	1571	1349	230	1059	953	1010	1300	1057	0.021
'Hrs/Delay	2.12	1.46	1.16	3.28	2.85	2.89	1.03	1.41	1.32	1.30	1.68	1.56	1.73	1.99	1.42	1.37	1.47	1.37	1.76	-0.021
'Recr Vessels Per Lckg	1.8	1.9	2.0	2.0	2.1	2.1	1.8	2.1	2.4	2.3	2.4	2.5	2.2	1.4	1.8	1.7	1.9	2.1	2.1	0.000

L/D 24

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.999	0.9991	0.9358	0.9727	0.979	0.9709	0.9604	0.9776	0.9807	0.9873	0.9911	0.9963	0.9987	0.9774	0.9706	0.9874	0.9933	0.9710
Comm Lck to Hrs Del	0.831	0.8216	0.0959	0.5054	0.672	0.4099	0.7234	0.7389	0.7557	0.7781	0.7133	0.8942	0.9825	0.6057	0.8744	0.7357	0.6975	0.7390
Rec Lck to No. Delays	0.571	0.4196	0.3659	0.6214	0.1744	0.5092	0.3989	0.7383	0.5259	0.7547	0.4771	0.6333	0.9713	0.7811	0.7547	0.7154	0.1904	0.5995
Rec Lcks to Hrs Dely	0.649	0.2279	-0.088	0.3116	0.1465	0.4533	0.3641	0.7466	0.3657	0.8804	0.0129	0.4271	0.9806	0.4924	0.7484	0.7768	0.0407	0.3164
Rec Ves to Hrs Delay	0.672	0.1049	-0.095	0.5721	0.127	0.6014	0.366	0.6749	0.4171	0.8390	0.0046	0.3878	0.9619	0.5122	0.7013	0.7510	0.0737	0.2276

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	3603	3599	3421	3746	3525	2649	2836	3362	3678	3252	3727	3399	3439	2434	2565	3196	3081	2684	3233	-0.011
Recr Lockages	478	437	432	342	415	602	537	580	597	680	607	730	709	169	731	547	544	664	545	0.022
Delay Hours	8379	8271	9400	39948	10423	4597	4800	11468	16881	15654	22550	10062	14435	7510	3862	16302	14853	8192	12644	-0.014
Number of Delays	3425	3522	2644	3042	2576	1610	1728	2486	3003	2776	3269	2671	2918	1767	1661	2675	2572	2055	2578	-0.013
Recr Vessels	1039	923	885	803	922	1251	1192	1407	1492	1621	1507	1673	1633	227	1681	1432	1233	1577	1250	0.030
'Hrs/Delay	2.45	2.35	3.56	13.13	4.05	2.86	2.78	4.61	5.62	5.64	6.90	3.77	4.95	4.25	2.33	6.09	5.77	3.99	4.90	0.008
'Recr Vessels Per Lckg	2.2	2.1	2.0	2.3	2.2	2.1	2.2	2.4	2.5	2.4	2.5	2.3	2.3	1.3	2.3	2.6	2.3	2.4	2.3	0.003

L/D 25

CORRELATIONS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.998	0.997	0.998	0.994	0.992	0.997	0.996	1.000	0.999	1.000	1.000	1.000	1.000	0.970	0.975	0.987	0.990	0.975
Comm Lck to Hrs Del	0.827	0.873	0.671	0.598	0.591	0.347	0.575	0.763	0.795	0.900	0.838	0.875	0.932	0.619	0.262	0.710	0.825	0.761
Rec Lck to No. Delays	0.588	0.451	0.549	0.606	0.185	0.449	0.420	0.690	0.532	0.687	0.553	0.611	0.971	0.706	0.729	0.722	0.171	0.569
Rec Lcks to Hrs Dely	0.702	0.340	0.479	0.048	-0.113	0.544	0.008	0.772	0.491	0.807	0.115	0.546	0.937	0.506	0.130	0.706	0.027	0.569
Rec Ves to Hrs Delay	0.761	0.231	0.358	0.098	-0.100	0.607	0.039	0.748	0.559	0.770	0.061	0.559	0.913	0.504	0.121	0.614	0.034	0.279

ANNUAL TRENDS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	3571	3711	3583	3835	3651	2689	2946	3442	3685	3266	3759	3413	3435	2435	2589	3198	3085	2692	3277	-0.013
Recr Lockages	646	656	578	527	610	857	898	776	877	1099	919	1108	871	189	1011	651	687	851	767	0.013
Delay Hours	8740	7318	6861	23956	11433	5001	4220	13024	16232	12999	14159	9785	22425	7178	6910	18573	12244	8269	11629	0.017
Number of Delays	3399	3524	3274	3600	3406	2477	2702	3257	3507	3269	3766	3421	3446	1883	1653	2634	2521	2072	2990	-0.021
Recr Vessels	1578	1449	1385	1535	1628	2365	2384	2555	2947	3097	2634	3372	2746	394	3186	2178	2043	2594	2226	0.034
'Hrs/Delay	2.57	2.08	2.10	6.65	3.36	2.02	1.56	4.00	4.63	3.98	3.76	2.86	6.51	3.81	4.18	7.05	4.86	3.99	3.89	0.058
'Recr Vessels Per Lckg	2.4	2.2	2.4	2.9	2.7	2.8	2.7	3.3	3.4	2.8	2.9	3.0	3.2	2.1	3.2	3.3	3.0	3.0	2.9	0.015

IWW - O'brien

CORRELATIONS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.5777	0.747	0.5141	0.6787	0.6246	0.3522	0.1418	-0.391	0.0397	0.5468	0.7797	0.7141	0.2706	0.7568	0.3969	0.6626	0.697
Comm Lck to Hours Del	0.0114	0.4033	0.483	0.7193	0.7574	0.1974	0.1836	-0.278	0.1896	0.5967	0.7756	0.7787	0.3239	0.6739	0.589	0.7348	0.827
Rec Lck to No. Delays	0.9796	0.9407	0.921	0.3388	0.9154	0.7895	0.8078	0.8675	0.952	0.9539	0.898	0.8486	0.743	0.8393	0.3109	0.889	0.341
Rec Lcks to Hours Dely	0.4348	0.2464	0.8795	0.2805	0.6221	0.8371	0.7237	0.774	0.5741	0.903	0.8772	0.5027	0.4507	0.7551	-0.063	0.8256	0.128
Rec Ves to Hours Delay	0.5052	0.2423	0.8243	0.2918	0.6013	0.7397	0.7497	0.7883	0.6381	0.9594	0.9225	0.425	0.3804	0.7062	-0.077	0.8388	0.091

ANNUAL TRENDS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	2779	2364	3025	2543	2675	2599	2751	2766	2265	2547	2667	2723	2825	3701	3275	3655	3086	2838	0.017
Recr Lockages	4464	4767	4532	4406	4147	3930	4189	4605	4694	4545	4802	4152	4293	4243	4610	4177	4220	4399	-0.002
Delay Hours	701	843	146	127	125	157	153	135	107	113	146	185	180	326	224	285	209	245	-0.021
Number of Delays	588	461	609	523	489	550	550	553	455	490	559	573	627	1034	781	973	748	621	0.038
Recr Vessels	14470	14668	14831	13713	14850	15010	16544	17869	17680	15697	17275	14701	15337	17165	19490	17517	19352	16245	0.018
'Hrs/Delay	1.19	1.83	0.24	0.24	0.26	0.29	0.28	0.24	0.24	0.23	0.26	0.32	0.29	0.32	0.29	0.29	0.28	0.39	-0.035
'Recr Vessels Per Lckg	3.2	3.1	3.3	3.1	3.6	3.8	3.9	3.9	3.8	3.5	3.6	3.5	3.6	4.0	4.2	4.2	4.6	3.7	0.020

IWW-Dresden

CORRELATIONS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.8902	0.9604	0.8079	0.9769	0.9577	0.889	0.9712	0.9668	0.9758	0.9117	0.9017	0.9177	0.9645	0.8885	0.915	0.9695	0.924
Comm Lck to Hours Del	0.7129	0.4411	0.468	0.9397	0.8561	0.6249	0.8694	0.8947	0.9017	0.8216	0.7842	0.8617	0.8729	0.6917	0.25	0.8783	0.495
Rec Lck to No. Delays	0.5681	0.672	-0.011	-0.3971	0.5948	0.4691	0.1763	0.858	0.858	0.8173	0.8285	0.9426	0.0437	0.6963	0.3625	0.7902	0.586
Rec Lcks to Hours Dely	0.1045	-0.023	-0.049	-0.2982	0.2261	0.1219	0.1292	0.7495	0.7495	0.607	0.6972	0.9171	-0.336	0.5371	0.3434	0.4096	0.148
Rec Ves to Hours Delay	0.094	-0.002	-0.058	-0.2452	0.224	0.0869	0.2547	0.7582	0.7582	0.5983	0.63	0.8993	-0.361	0.6293	0.3767	0.4485	0.173

ANNUAL TRENDS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	4118	3751	3423	3048	3123	3334	2899	2963	2832	2937	2716	2701	2748	3001	2262	2413	2428	2982	-0.020
Recr Lockages	683	767	823	925	917	991	1230	1286	1286	1190	1238	1164	1034	1047	505	1031	1244	1021	0.021
Delay Hours	5378	3885	4573	2516	2299	2389	2091	2009	2009	2320	2125	2026	1888	3322	5719	1934	2120	2859	-0.014
Number of Delays	2783	2529	2224	1757	1716	1792	1385	1433	1433	1567	1438	1376	1366	1749	1369	1170	1225	1665	-0.026
Recr Vessels	1878	2234	2140	2350	2620	2787	3299	4251	4251	3717	4648	3817	2870	3938	1574	3758	4710	3226	0.058
Hrs Per Delay	1.93	1.54	2.06	1.43	1.34	1.33	1.51	1.40	1.40	1.48	1.48	1.47	1.38	1.90	4.18	1.65	1.73	1.72	0.019
'Recr Vessels Per Lckg	2.7	2.9	2.6	2.5	2.9	2.8	2.7	3.3	3.3	3.1	3.8	3.3	2.8	3.8	3.1	3.6	3.8	3.2	0.023

IWW-Lagrange

CORRELATIONS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Comm Lck to No. Delays	0.9286	0.9422	0.3284	-0.1743	-0.287	-0.008	0.6141	0.1847	0.6307	0.2259	-0.2842	-0.145	0.2206	-0.1343	0.5917	0.8551	0.144
Comm Lck to Hours Del	0.467	0.2355	-0.124	0.1637	-0.26	0.078	0.3997	0.8134	0.267	0.5075	-0.1752	0.3542	0.2483	0.1156	0.7427	0.734	0.202
Rec Lck to No. Delays	0.0612	-0.192	0.417	0.3772	0.7062	0.5981	0.3536	0.3988	0.0118	0.278	0.8146	0.4534	-0.262	0.5965	0.2009	-0.264	0.234
Rec Lcks to Hours Dely	-0.242	0.1037	0.378	0.0263	0.3952	0.1763	-0.1122	-0.208	-0.446	-0.206	0.7462	-0.135	-0.229	-0.0555	-0.255	-0.347	-0.272
Rec Ves to Hours Delay	-0.228	0.0722	0.3691	0.0035	0.2882	0.1612	-0.0766	-0.2	-0.403	-0.206	0.7036	-0.131	-0.229	-0.0717	-0.24	-0.309	-0.269

ANNUAL TRENDS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	AVG.	(slope) Growth
Comm Lockages	4124	4332	3969	3675	3302	3237	3104	3283	3180	3517	3294	3328	3172	3504	3456	3256	3115	3462	-0.011
Recr Lockages	67	152	286	319	603	301	169	600	568	181	546	630	7	434	223	92	264	320	0.011
Delay Hours	27518	9432	4086	2821	3212	1841	15016	5387	8796	5225	1700	3905	730	5295	12273	20732	11495	8204	-0.002
Number of Delays	4055	4208	2117	1843	2175	1135	2124	2246	2905	1320	1253	2205	67	1999	2047	2491	1879	2122	-0.022
Recr Vessels	162	346	777	845	1822	784	422	1399	1508	428	1480	1679	14	1168	680	261	827	859	0.036
Hrs Per Delay	6.79	2.24	1.93	1.53	1.48	1.62	7.07	2.40	3.03	3.96	1.36	1.77	10.90	2.65	6.00	8.32	6.12	3.87	0.034
'Recr Vessels Per Lckg	2.4	2.3	2.7	2.6	3.0	2.6	2.5	2.3	2.7	2.4	2.7	2.7	2.0	2.7	3.0	2.8	3.1	2.7	0.009

Chart 1 - UMR Lock 3 Annual Trends

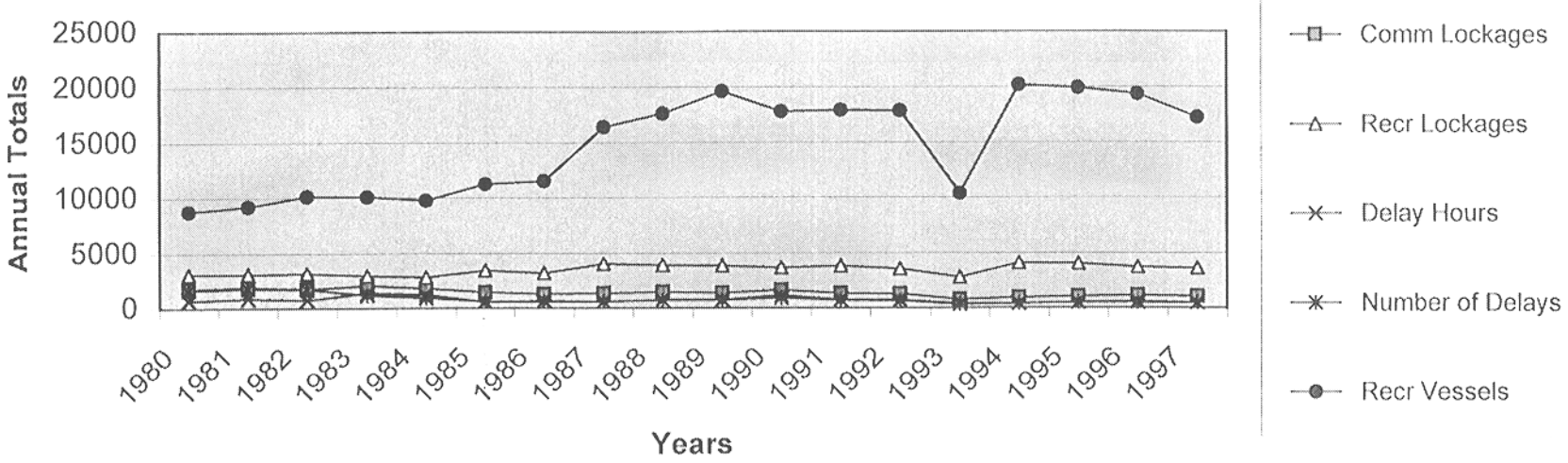

Chart 2 - UMR Lock 7 Annual Trends

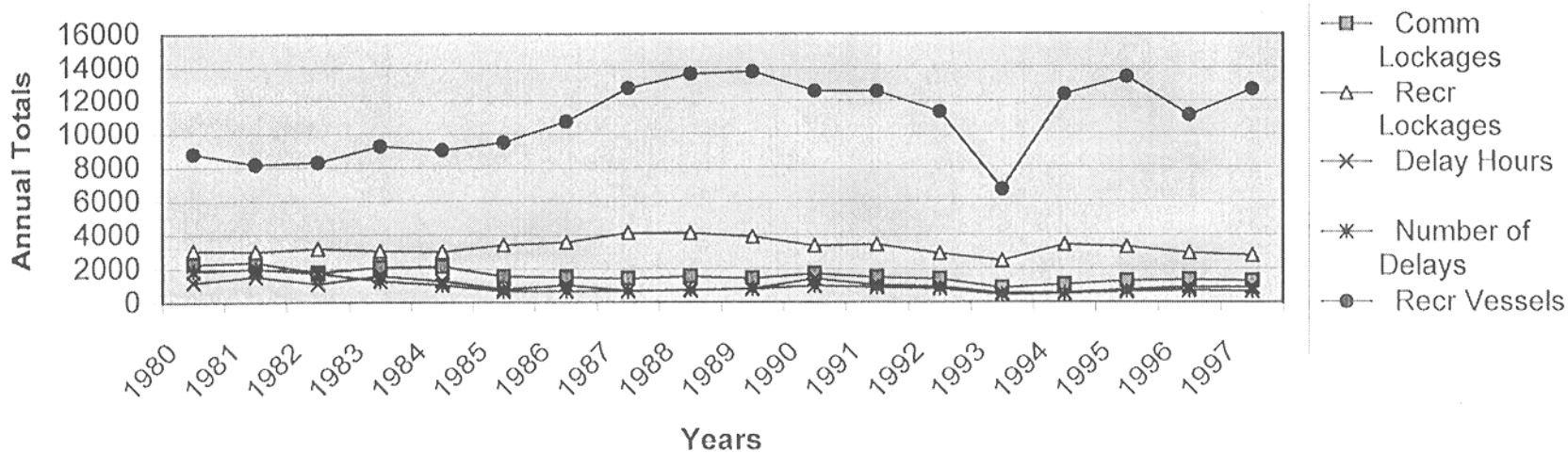

Chart 3 - UMR - Lock 15 (main) Annual Trends

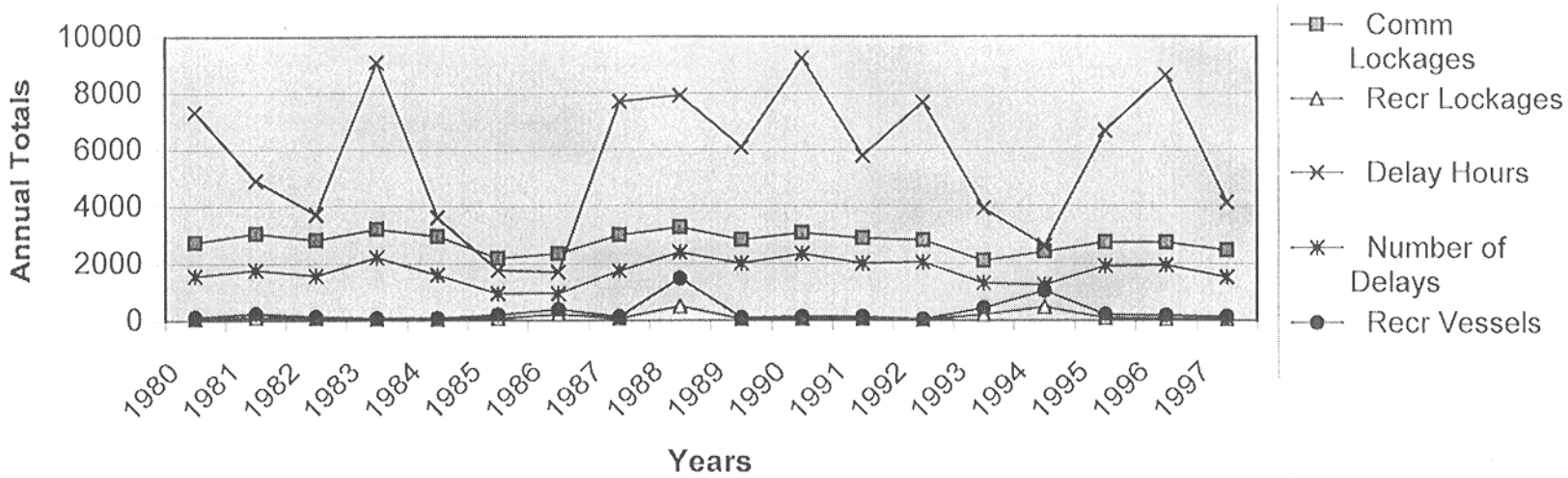

Chart 4 - UMR Lock 17 Annual Trends

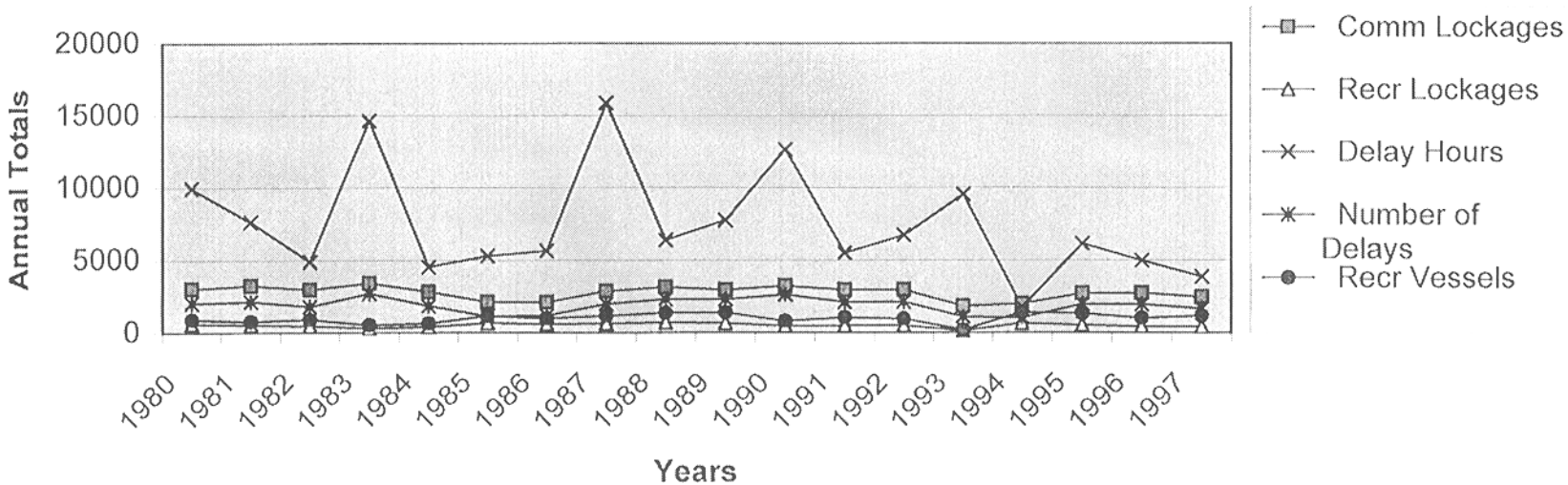

Chart 5 - UMR - Lock 19 Annual Trends

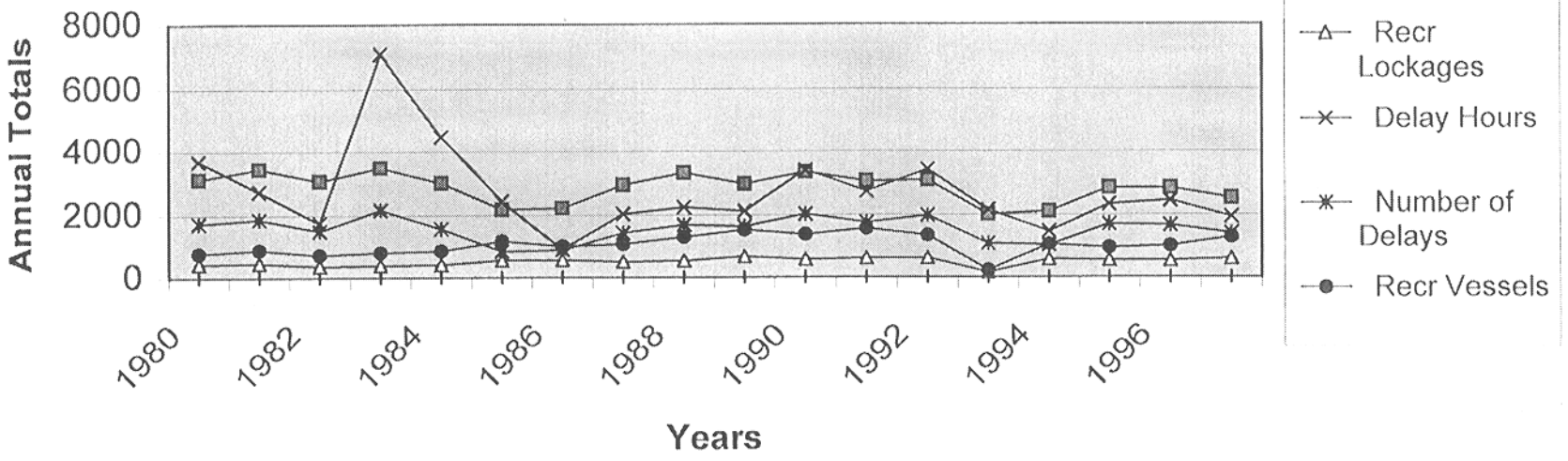

Chart 6 - UMR - Lock 24 Annual Trends

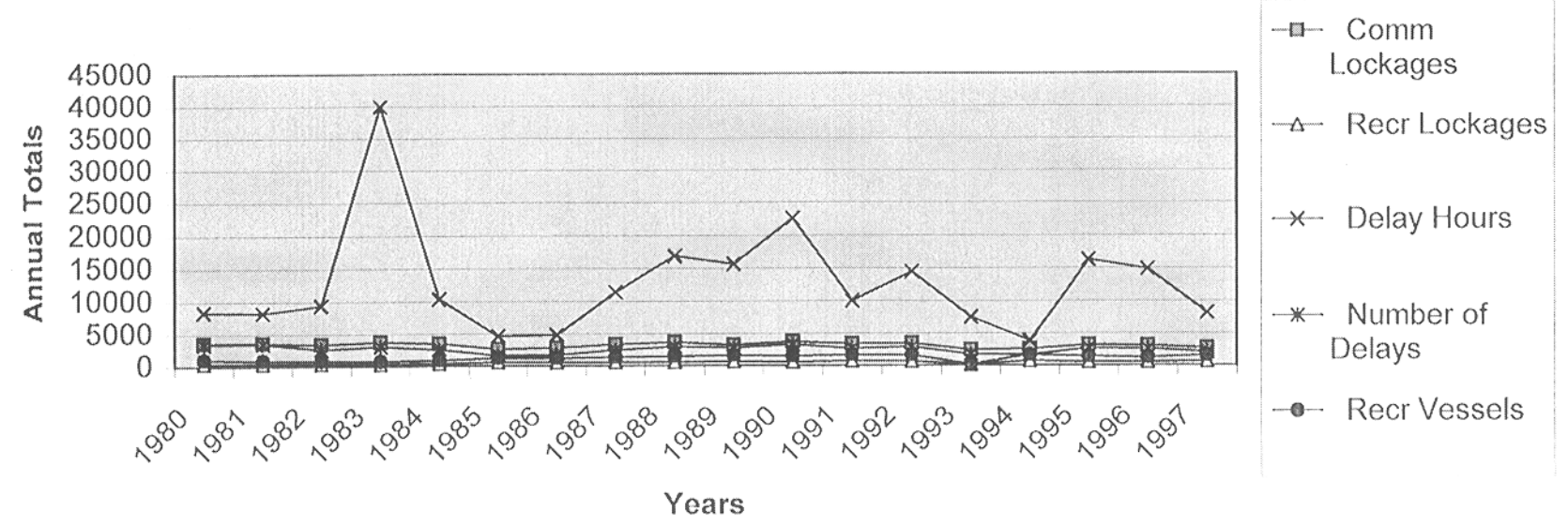

Chart 7 - UMR Lock 25 Annual Trends

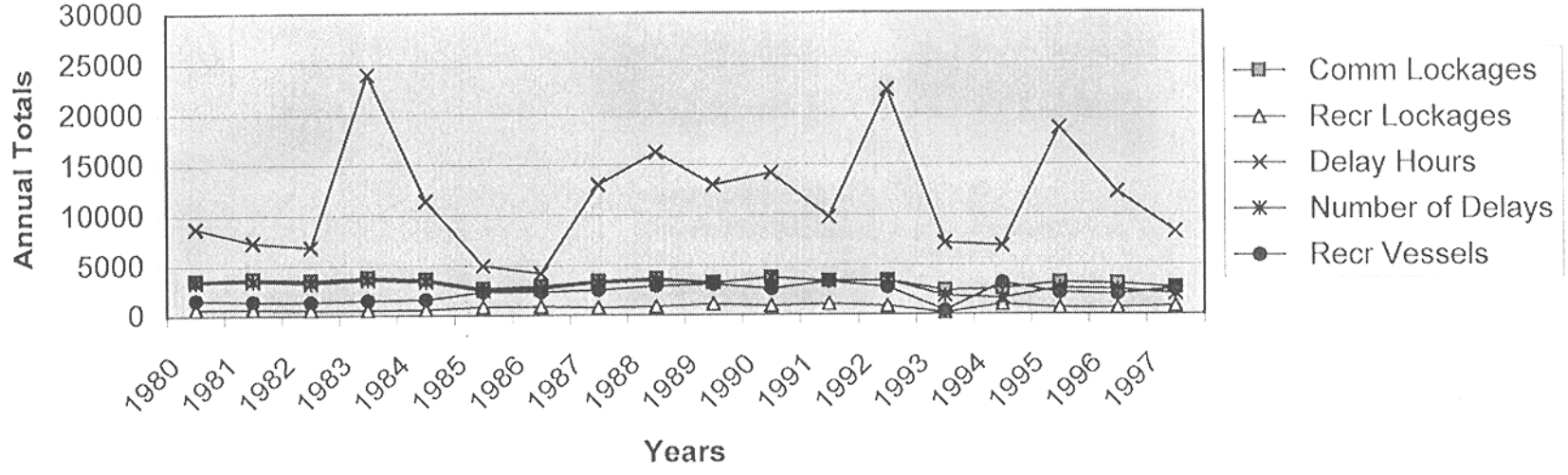

Chart 8 - IWW - O'Brien Lock Annual Trends

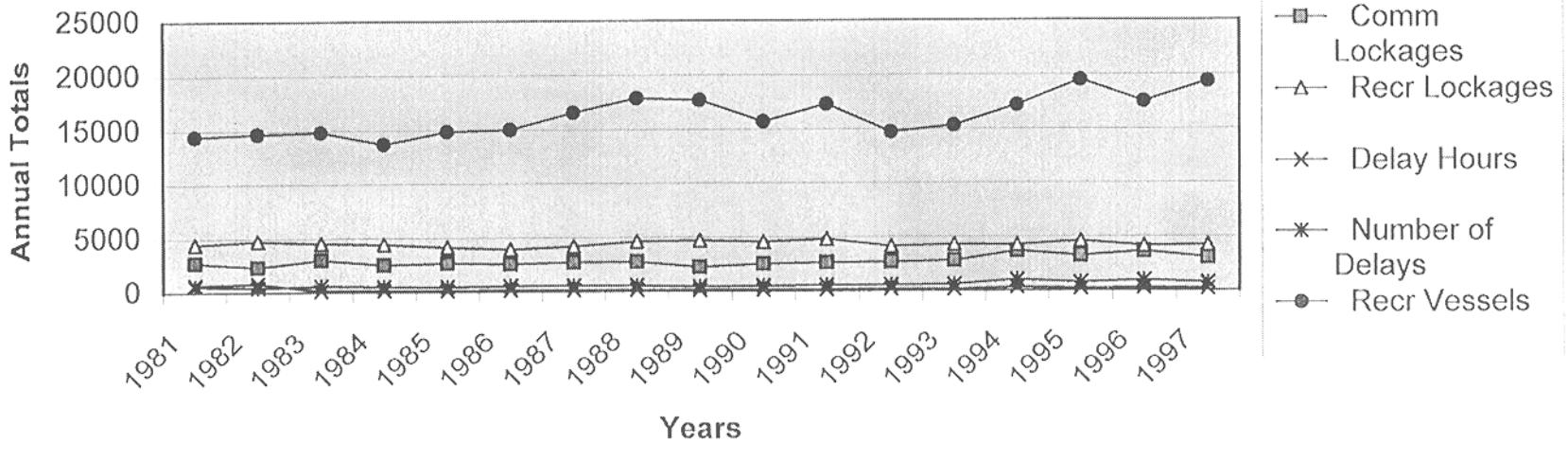

Chart 9 - IWW - Dresden Lock Annual Trends

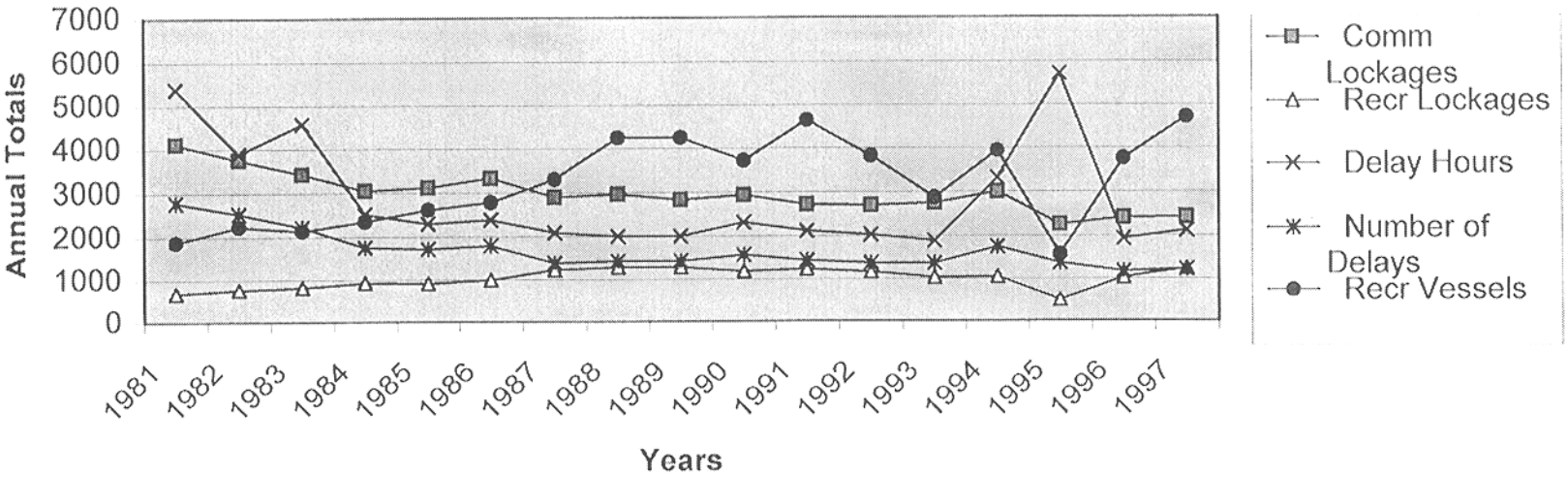

Chart 10 - IWW - LaGrange Lock Annual Trends

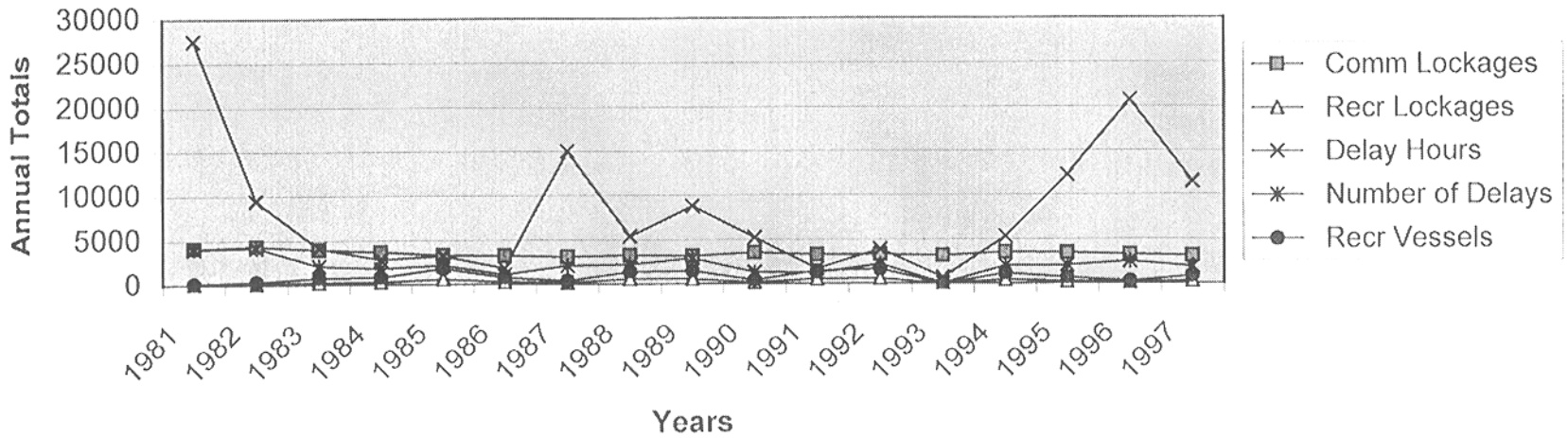

Chart 11 - UMR Lock 3 Correlations

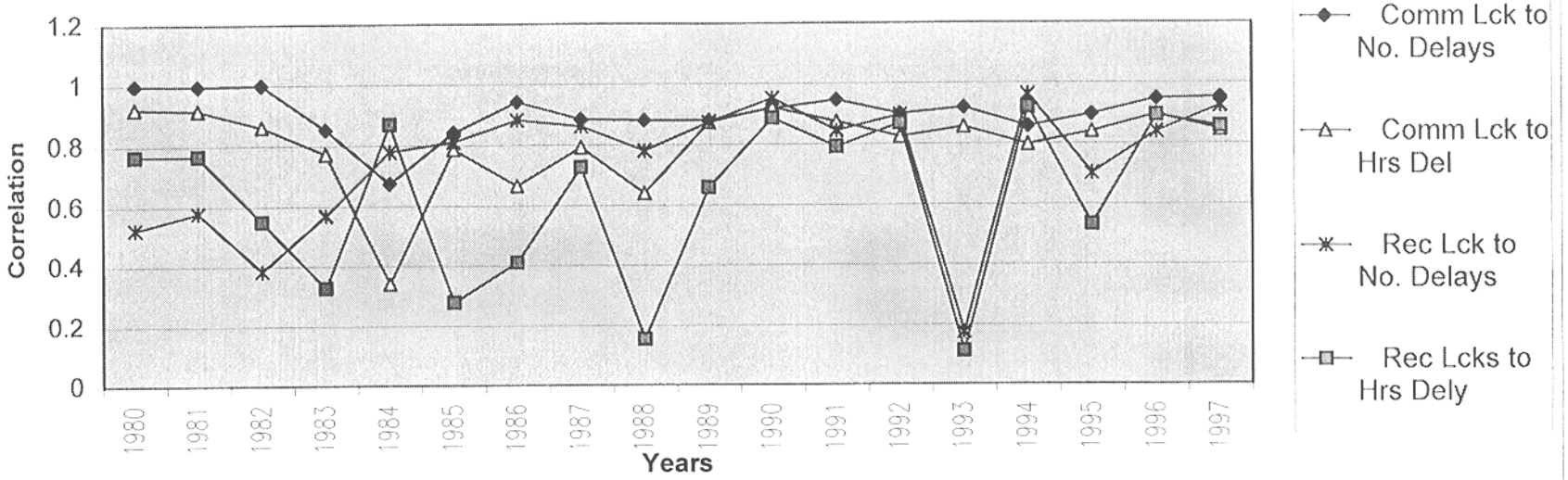

Chart 12 - UMR Lock 7 Correlations

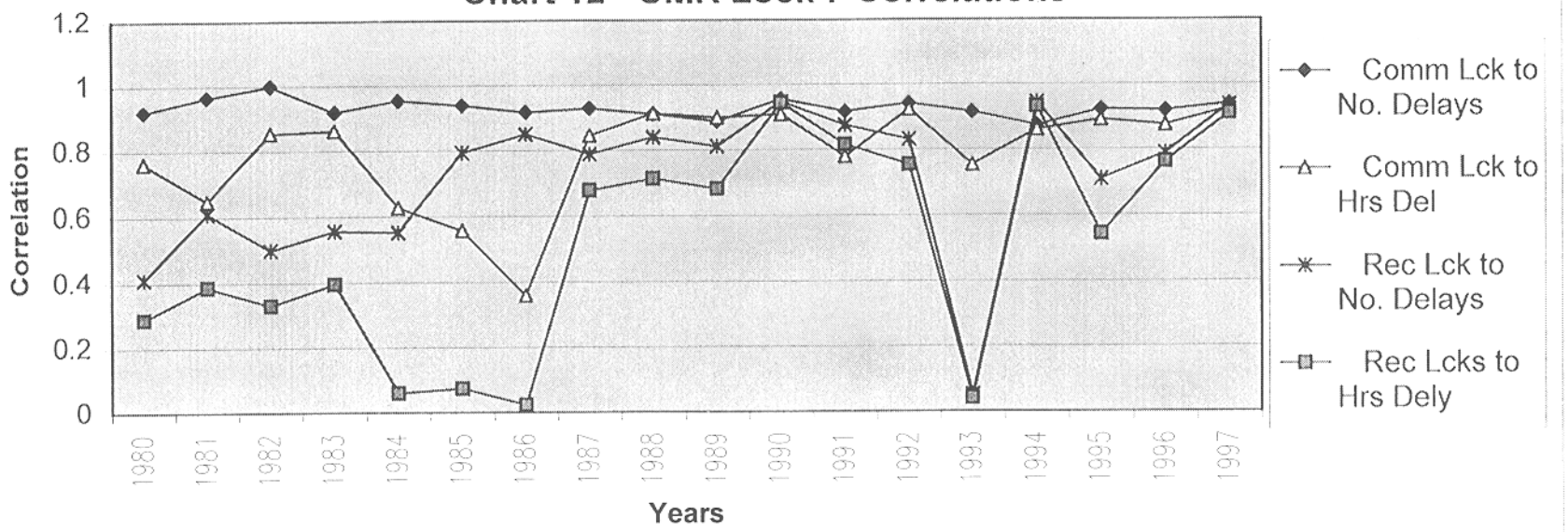

Chart 13 - UMR - Lock 15 (main) Correlations

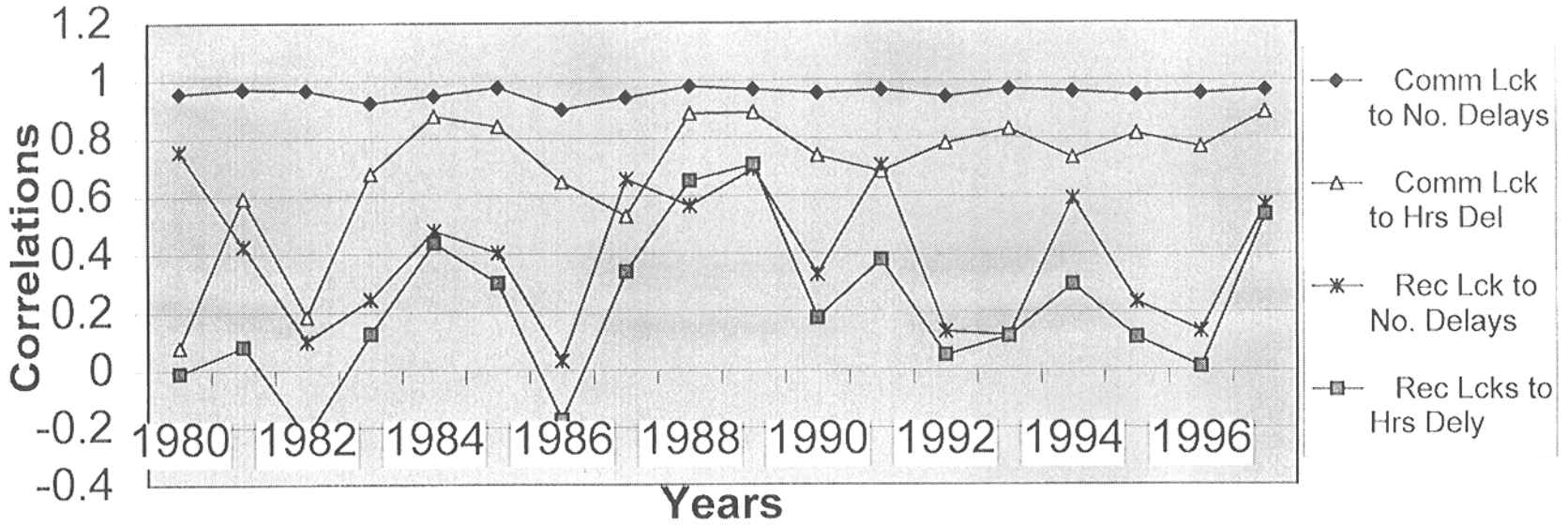

Chart 14 - UMR - Lock 17 Correlations

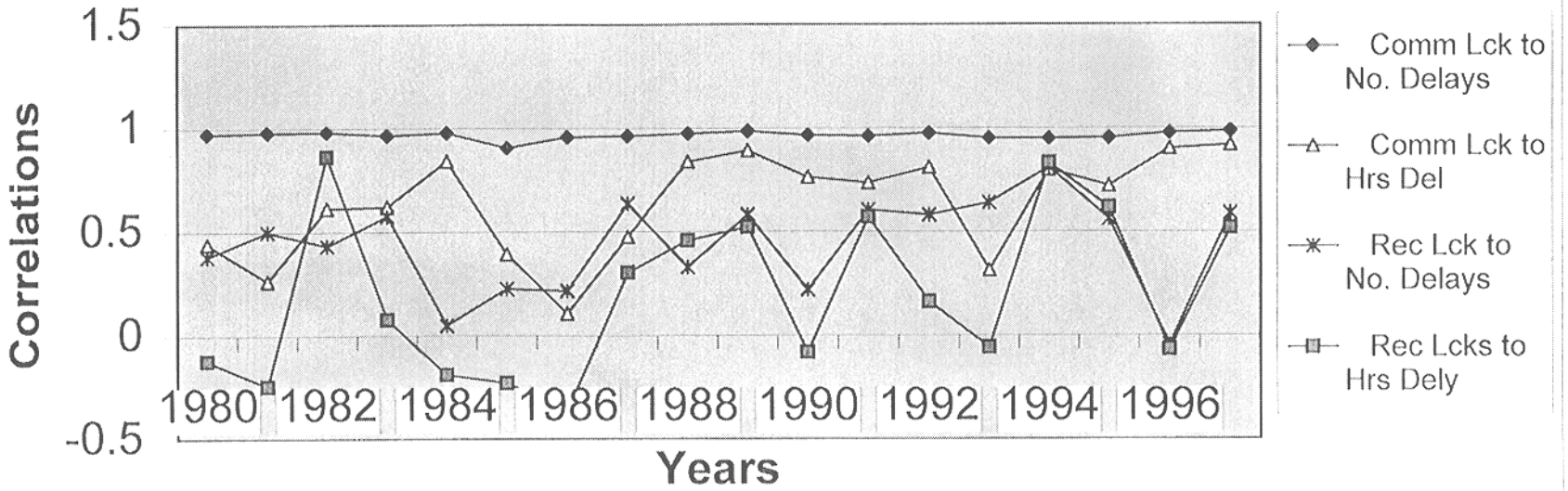

Chart 15 - UMR - Lock 19 Corrrelations

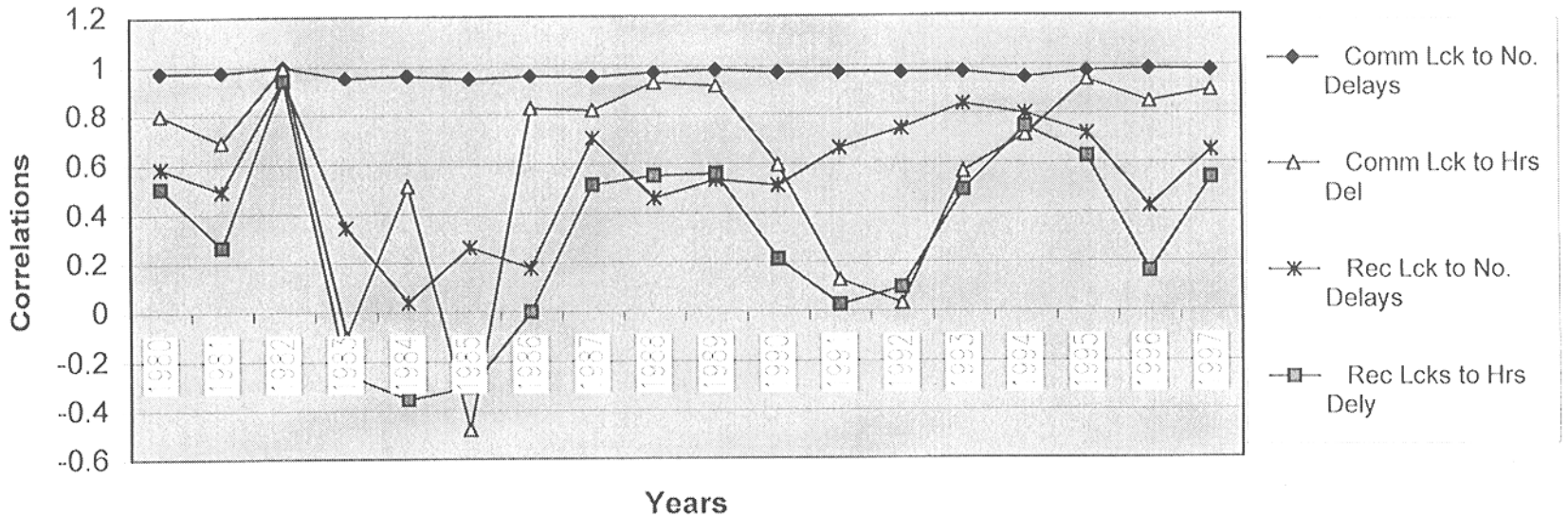

Chart 16 - UMR - Lock 24 Correlations

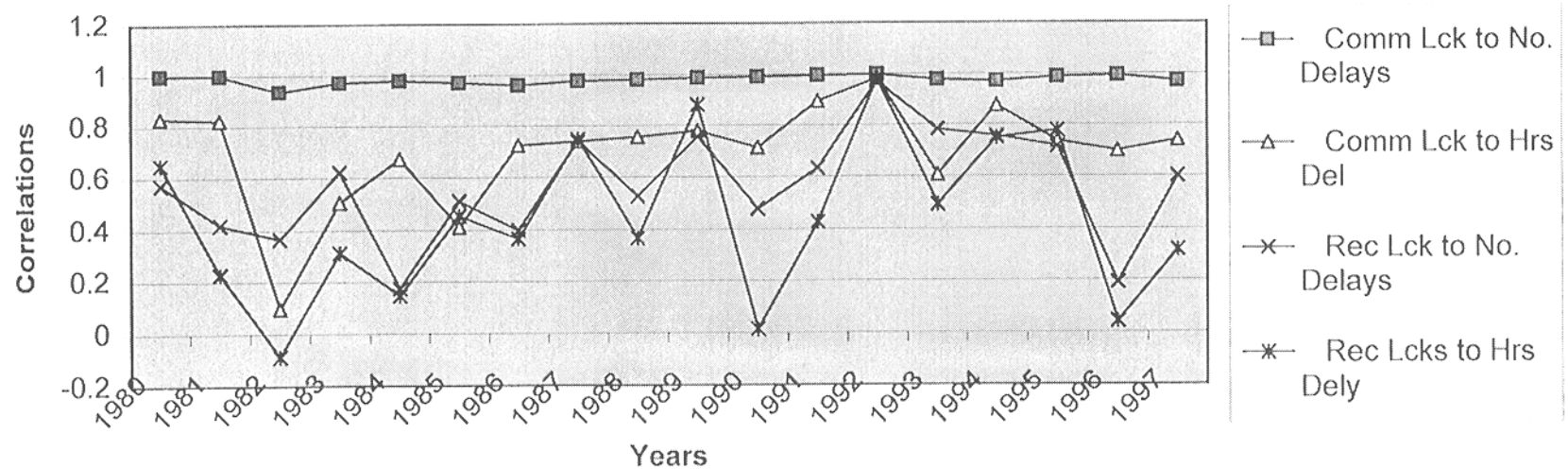

Chart 17 - UMR Lock 25 Correlations

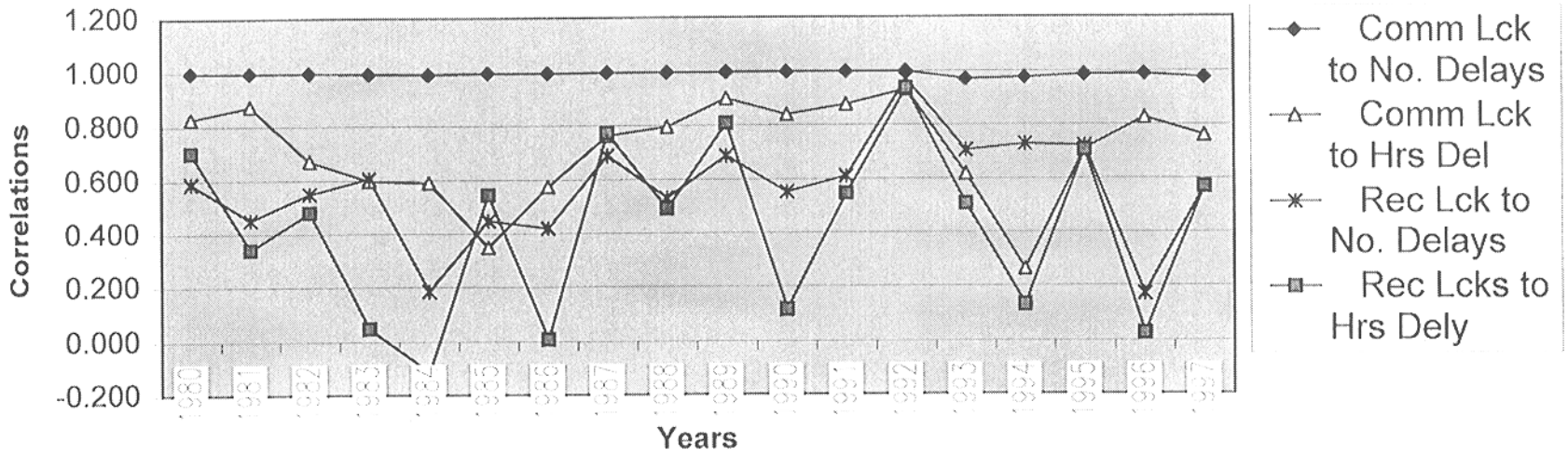

Chart 18 - IWW - O'Brien Lock Correlations

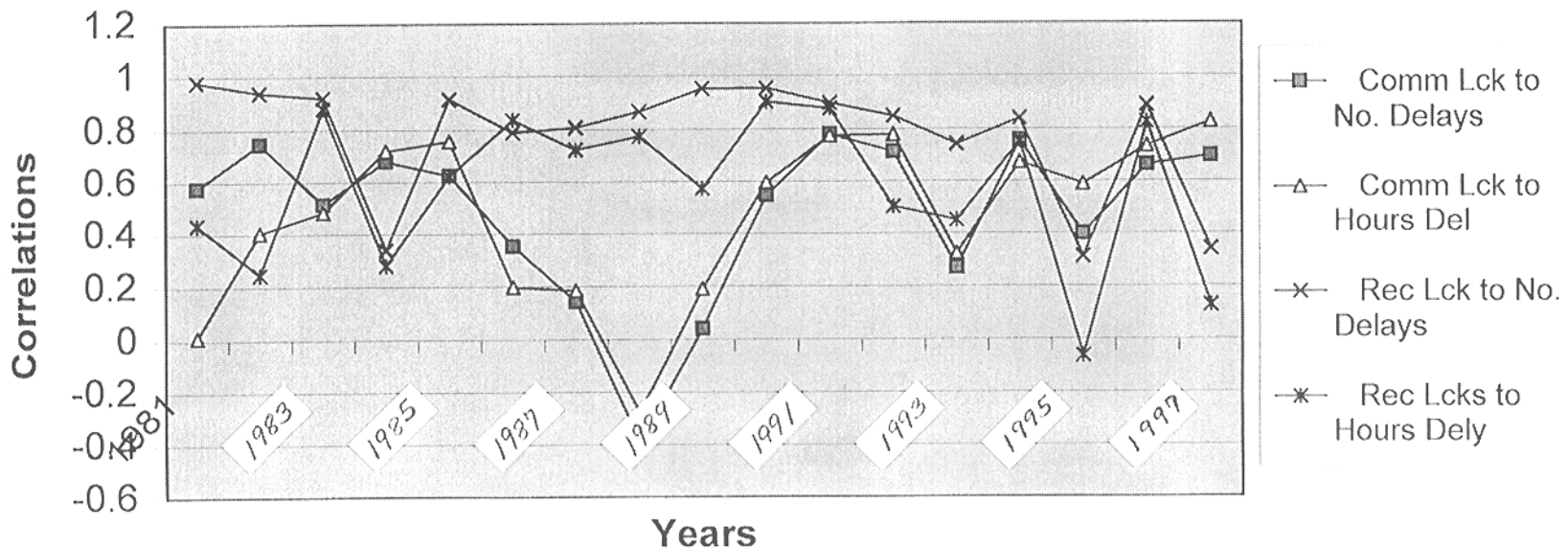

Chart 19 - IWW - Dresden Lock Correlations

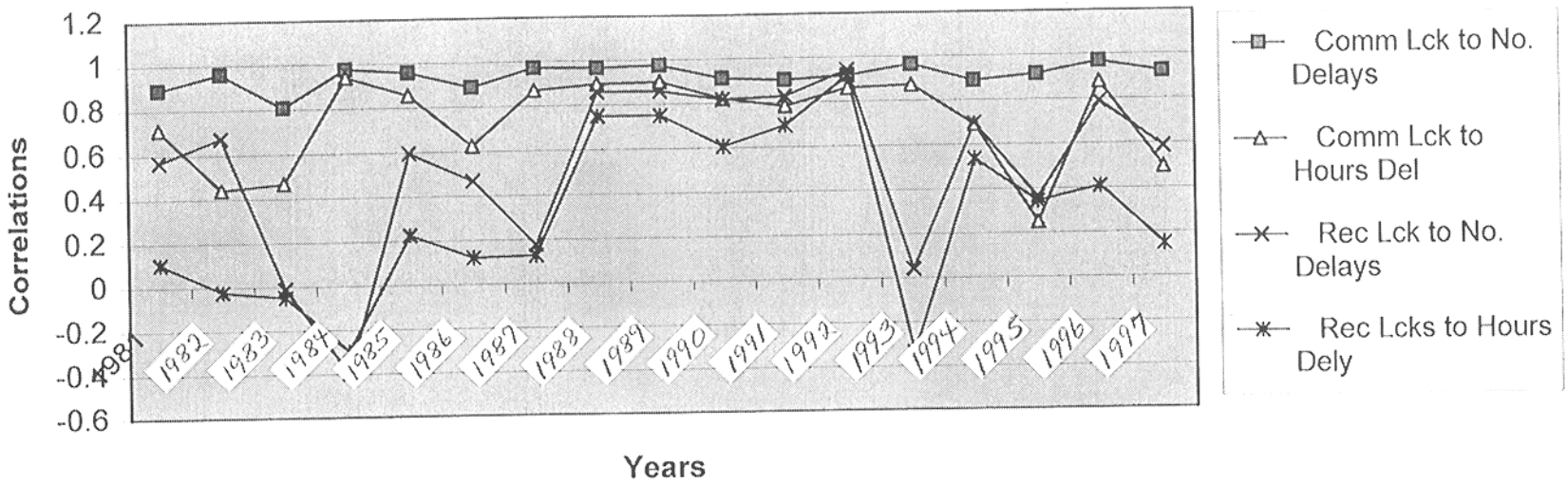
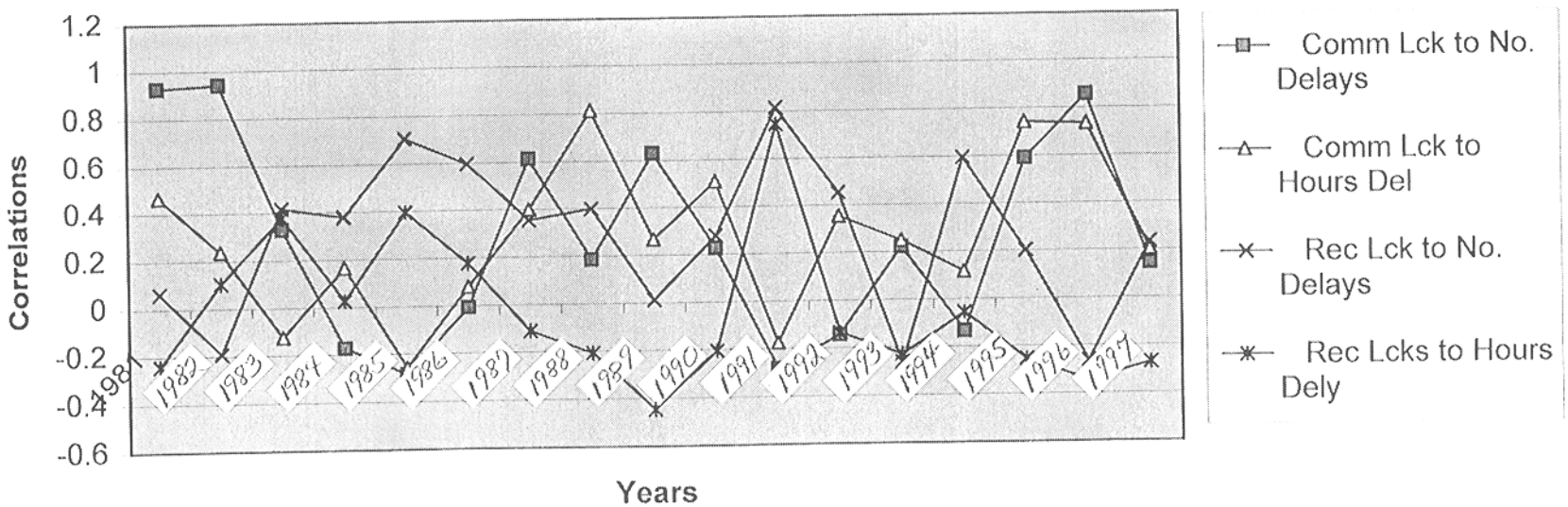
Chart 20 - IWW - LaGrange Lock Correlations