Fish Monitoring Data

Data Sources

Data were obtained from three sources: OREIS, Lockwood Green Technologies, and hand entry from the ED-1 MAP reports. OREIS data were received as a tab-delimited ASCII file queried from the OREIS database. The OREIS data included the population surveys of fish at EFK 6.3 from 1985 through 1997 and at BCK3.3 from 1988 through 2001. Lockwood Green data were received as Excel spreadsheets. These data included fish surveys from 1998 to 2000. Data were hand entered into Excel spreadsheets from the 1997 MAP reports.

Data Processing

SAS data analysis software was used to summarize and graph the data. The actual surface area of the stream sample was different for different sampling locations and sampling events. All of the fish population data were, therefore, reported as fish density (fish/m^2). The fish density and number of species captured were calculated for each location and sampling event (Table 1). The species were classified as piscivores or generalist feeders and as tolerant or intolerant species. The percentage of the total fish density comprising each of the three classifications (piscivore, generalist, tolerant) was calculated (Table 1). Note that tolerant species could include piscivores and generalist feeders. The data for each location and season were plotted by year to allow for a visual examination of temporal trends in the data (Figures 1 to 10).

Summary statistics were calculated for the fish density and number of species for each season and location (Tables 2 and 4). The summary statistics include the total number of samples, mean, standard deviation, coefficient of variation, maximum, minimum, and the probability for normality test. The coefficient of variation (CV) is the standard deviation divided by the mean and taken as a percent. The CV is a measure of the variability of the measurement. The probability for normality test is the probability for the Shapio-Wilk test for determining if the data are different from a normal distribution. Data with probability values less than 0.05 would be considered significantly different from normal.

A simple linear regression analysis was performed for the fish density and number of species versus year to look for a simple linear increase or decrease in the ecological measurements over time. The regression tables contain the parameter estimates for the slope, standard error, probability, R-square, and 95% lower (LCL) and upper (UCL) confidence limits on the slope. Probability values less than the alpha level chosen indicate a statistically significant slope and, therefore, a statistically significant trend. The R-square value indicates how well the linear regression fits the measurements. R-square values close to 1.0 indicate a very good fit. R-square values close to zero indicate a poor fit (Tables 3 and 5).

Plots (Figures 5 to 10), summary statistics (Tables 6, 8 and 9), and regression analyses (Tables 7, 9 and 11) were also computed for the percent generalist feeders, percent piscivores, and percent tolerant fish

References

SAS®, 2001. Copyright (c) 1999-2001 by SAS Institute Inc., Cary, NC, USA.

Proprietary Software Release 8.2 (TS2M0)

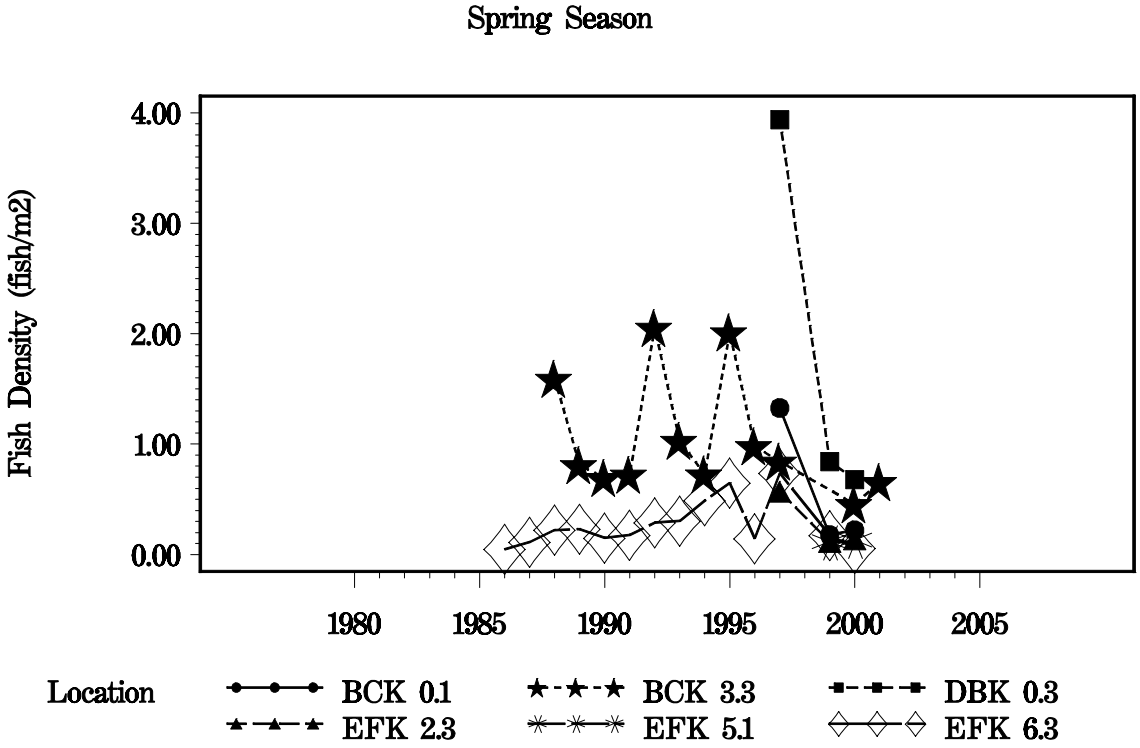

Figure 1. Fish density for the Spring sampling events.

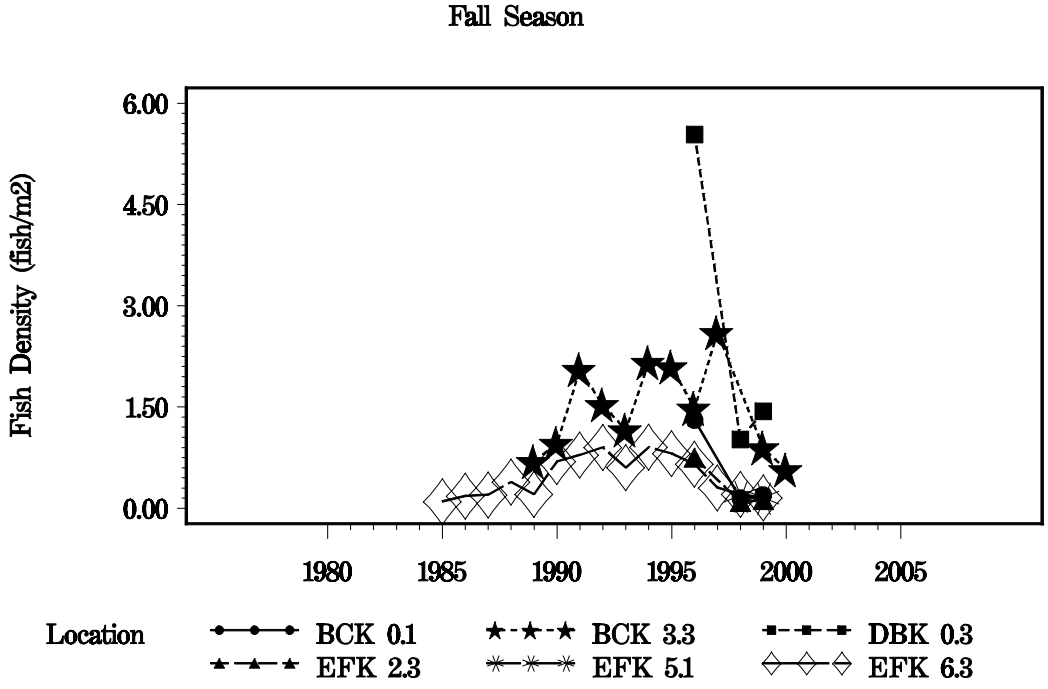

Figure 2. Fish density for the Fall sampling events.

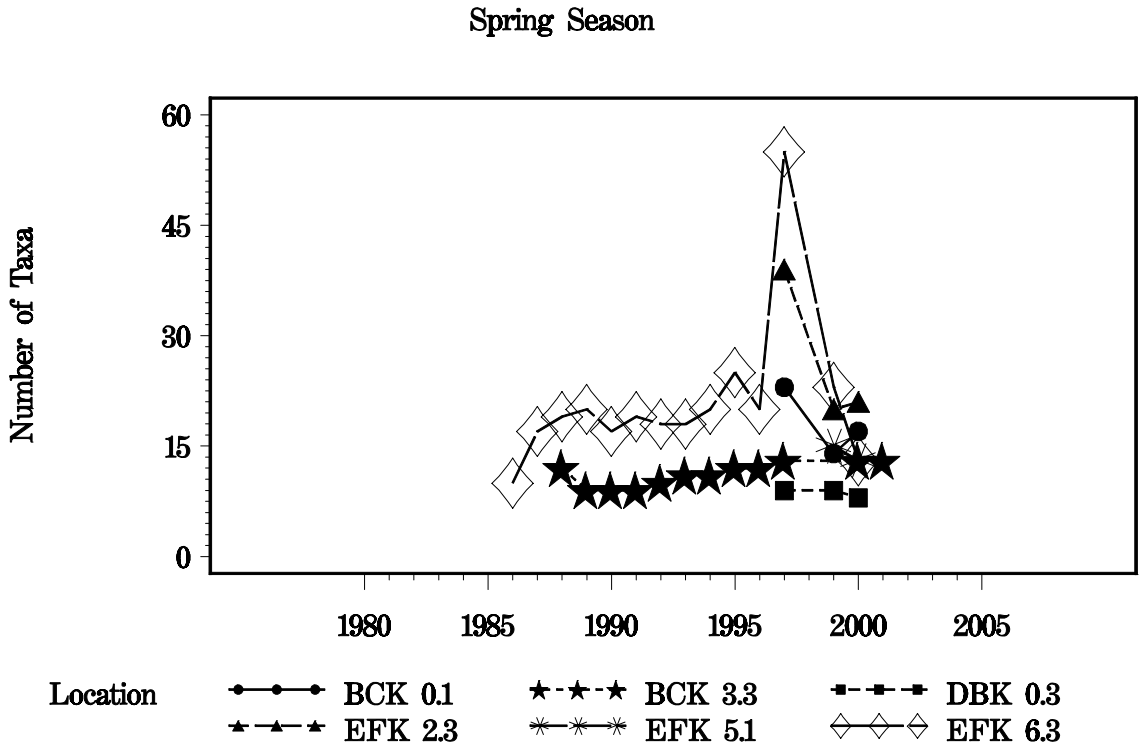

Figure 3. Number of taxa for the Spring sampling events.

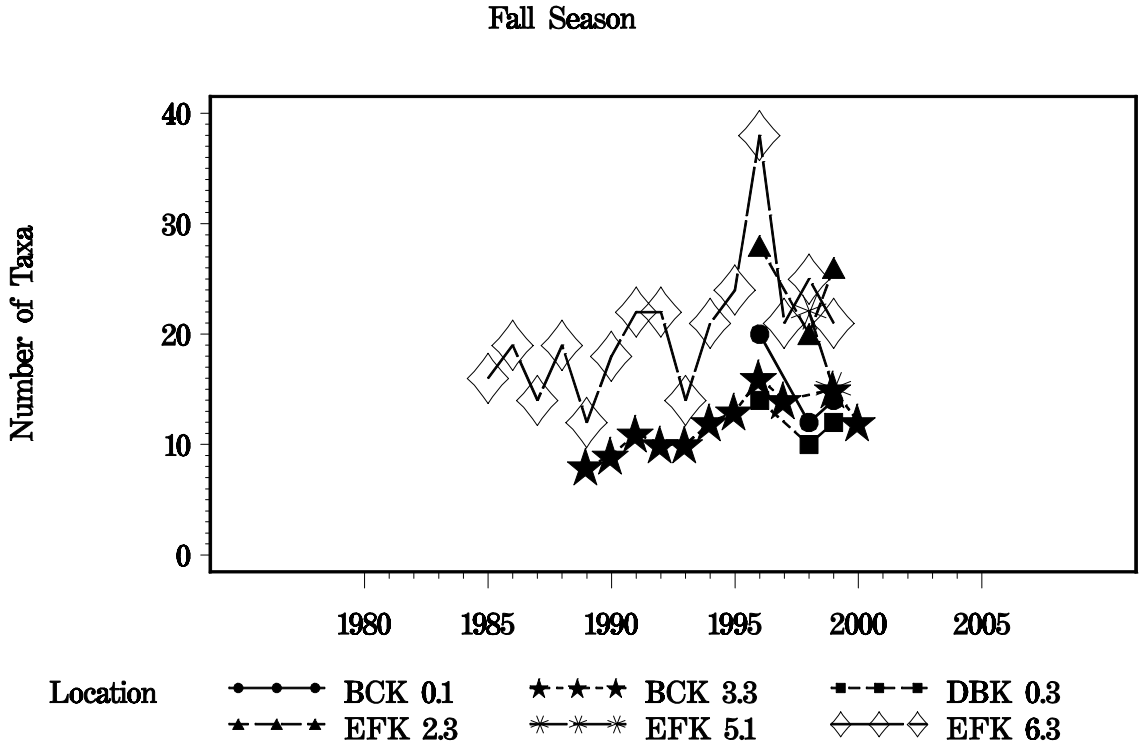

Figure 4. Number of taxa for the Fall sampling events.

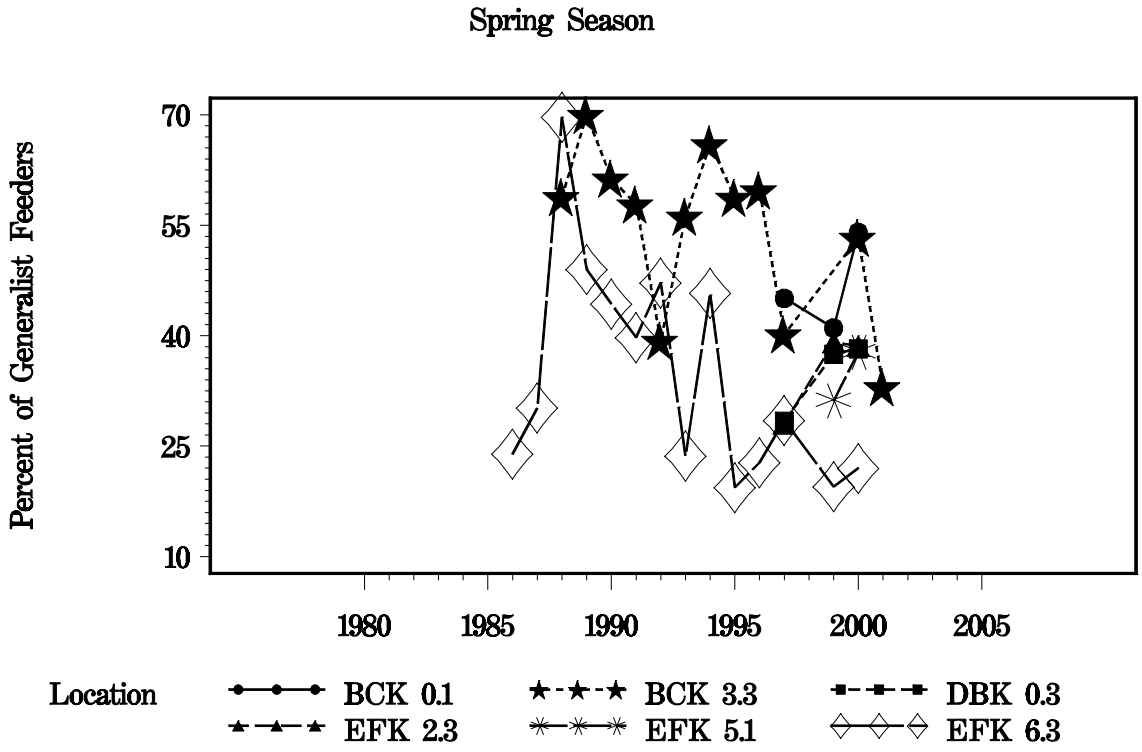

Figure 5. Percent generalist feeders for the Spring sampling events.

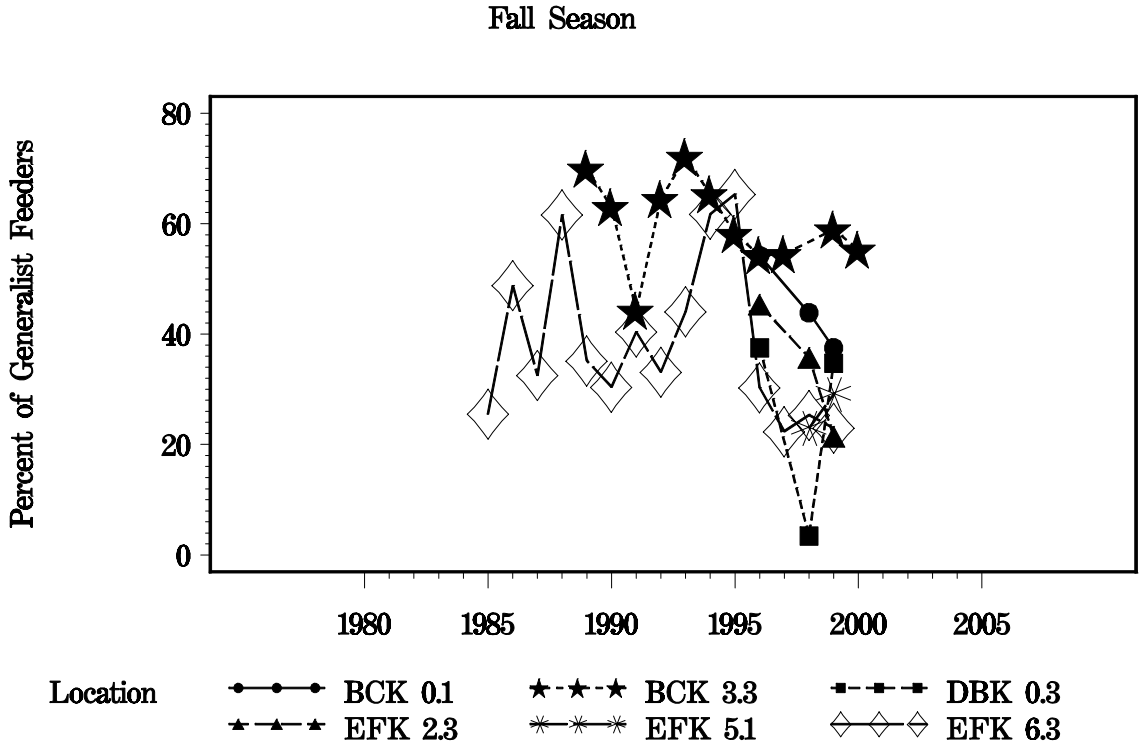

Figure 6. Percent generalist feeders for the Fall sampling events.

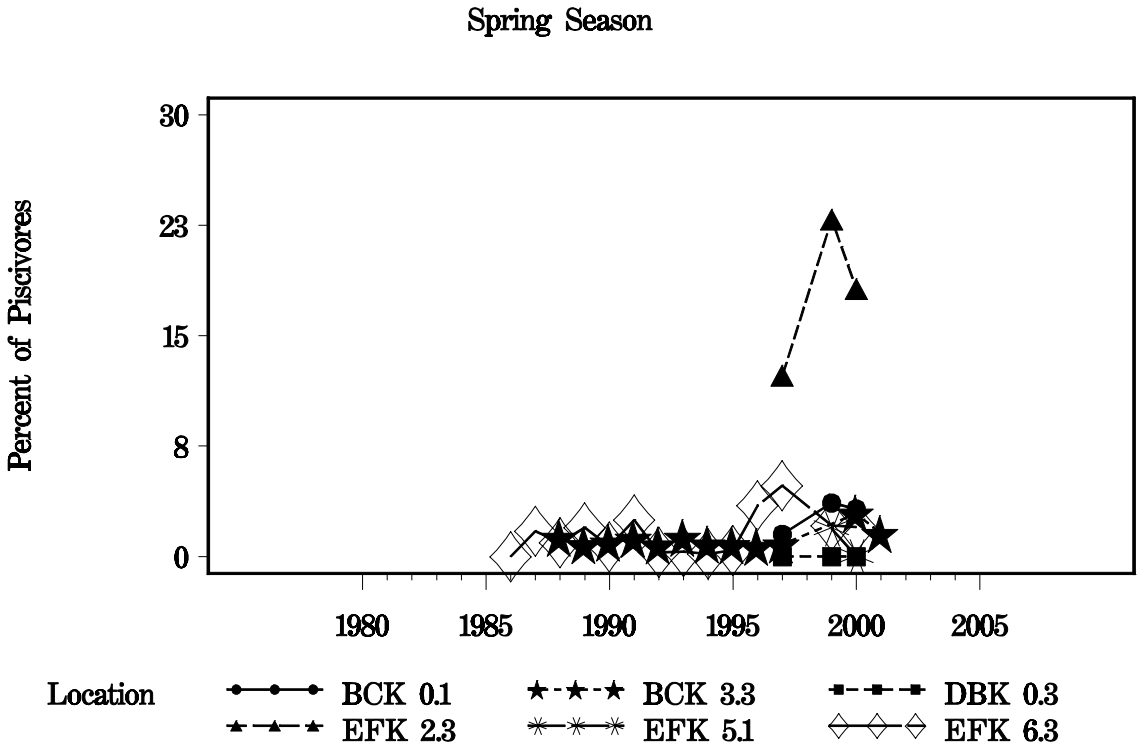

Figure 7. Percent piscivores for the Spring sampling events.

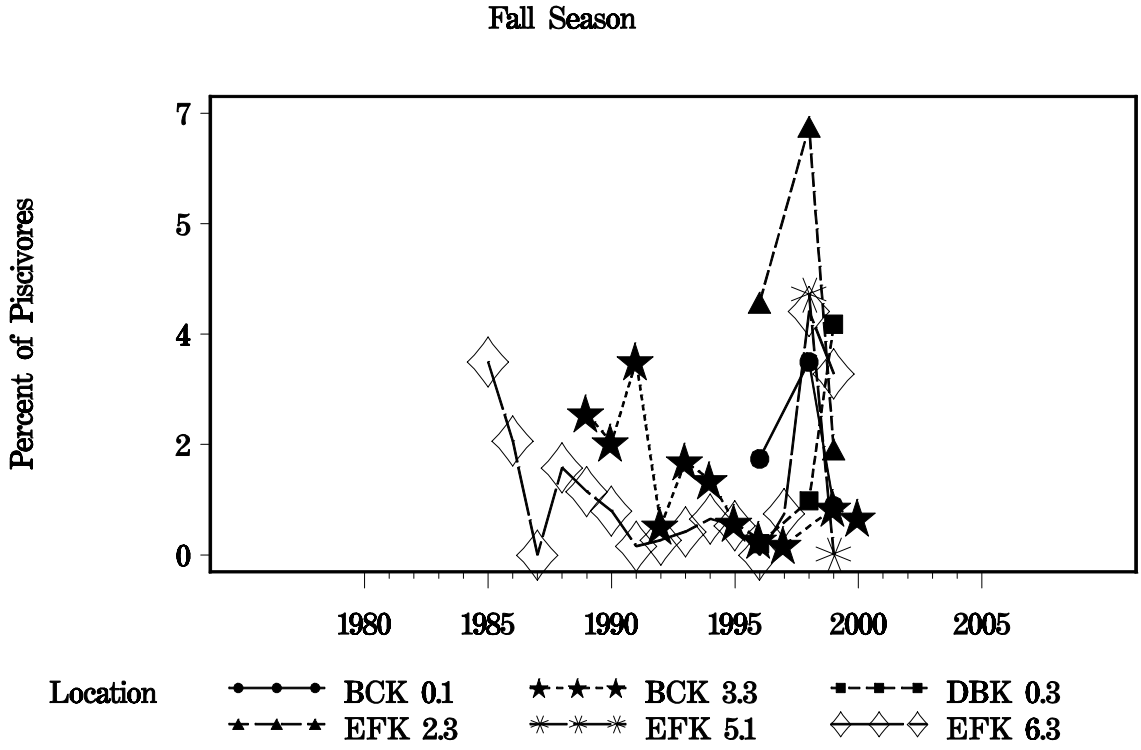

Figure 8. Percent piscivores for the Fall sampling events.

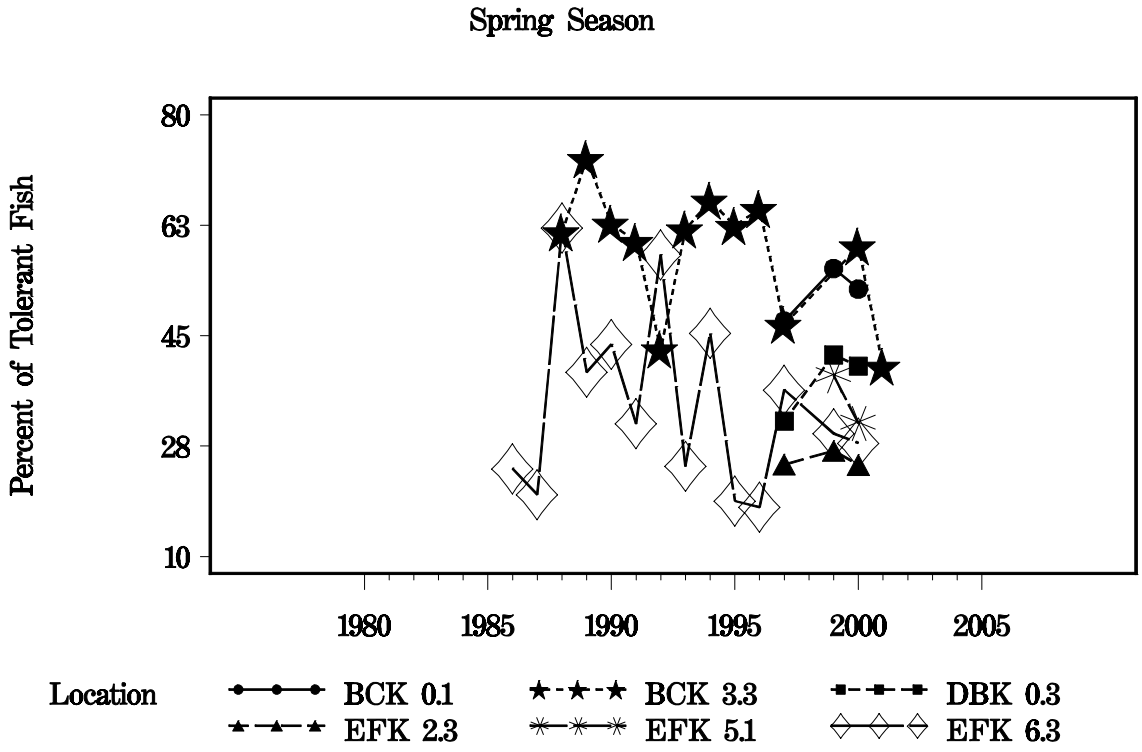

Figure 9. Percent tolerant fish for the Spring sampling events.

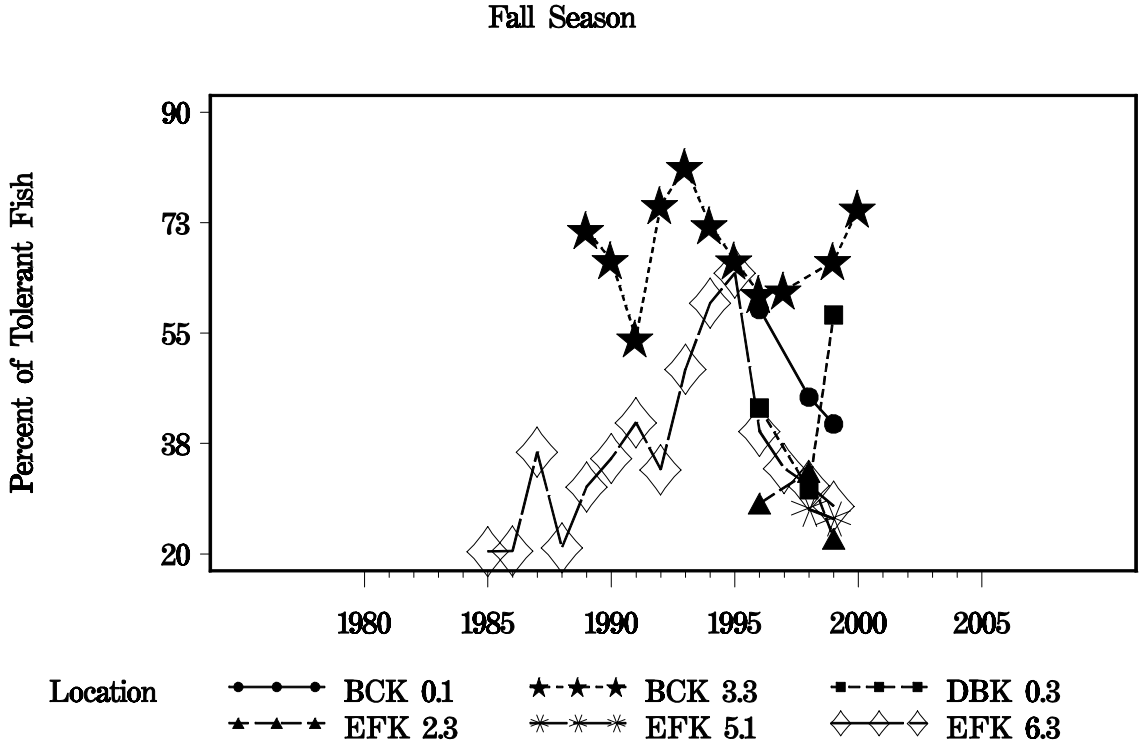

Figure 10. Percent tolerant fish for the Fall sampling events.

Table 1. Fish Data from ED-1 Locations Summarized by Sampling Event

Location	Year	Season	Fish Density (fish/m2)	Number of Taxa	Percent Generalist Feeders	Percent Piscivores	Percent Tolerant Fish
BCK 0.1	1996	Fall	1.31	20	54	2	59
BCK 0.1	1997	Spring	1.33	23	45	2	47
BCK 0.1	1998	Fall	0.15	12	44	3	45
BCK 0.1	1999	Spring	0.18	14	41	4	56
BCK 0.1	1999	Fall	0.20	14	38	1	41
BCK 0.1	2000	Spring	0.22	17	54	3	52
BCK 3.3	1988	Spring	1.59	12	59	1	61
BCK 3.3	1989	Spring	0.81	9	70	1	73
BCK 3.3	1989	Fall	0.69	8	70	2	71
BCK 3.3	1990	Spring	0.69	9	61	1	63
BCK 3.3	1990	Fall	0.96	9	63	2	67
BCK 3.3	1991	Spring	0.72	9	58	1	60
BCK 3.3	1991	Fall	2.05	11	44	3	54
BCK 3.3	1992	Spring	2.05	10	39	1	43
BCK 3.3	1992	Fall	1.53	10	64	0	75
BCK 3.3	1993	Spring	1.03	11	56	1	62
BCK 3.3	1993	Fall	1.16	10	72	1	81
BCK 3.3	1994	Spring	0.72	11	66	1	66
BCK 3.3	1994	Fall	2.16	12	65	1	72
BCK 3.3	1995	Spring	2.01	12	59	1	62
BCK 3.3	1995	Fall	2.09	13	58	1	66
BCK 3.3	1996	Spring	0.98	12	60	1	65
BCK 3.3	1996	Fall	1.48	16	54	0	61
BCK 3.3	1997	Spring	0.84	13	40	1	47
BCK 3.3	1997	Fall	2.60	14	54	0	62
BCK 3.3	1999	Fall	0.89	15	59	1	66
BCK 3.3	2000	Spring	0.46	13	53	3	59
BCK 3.3	2000	Fall	0.57	12	55	1	75
BCK 3.3	2001	Spring	0.66	13	33	2	40
DBK 0.3	1996	Fall	5.54	14	38	0	43
DBK 0.3	1997	Spring	3.94	9	28	0	31
DBK 0.3	1998	Fall	1.02	10	3	1	30
DBK 0.3	1999	Spring	0.84	9	38	0	42
DBK 0.3	1999	Fall	1.44	12	35	4	58
DBK 0.3	2000	Spring	0.68	8	38	0	40
EFK 2.3	1996	Fall	0.75	28	45	4	28
EFK 2.3	1997	Spring	0.57	39	28	12	25
EFK 2.3	1998	Fall	0.09	20	36	7	33
EFK 2.3	1999	Spring	0.11	20	39	23	27
EFK 2.3	1999	Fall	0.13	26	21	2	22
EFK 2.3	2000	Spring	0.14	21	39	18	25
EFK 5.1	1998	Fall	0.17	22	23	4	27
EFK 5.1	1999	Spring	0.11	15	31	2	39
EFK 5.1	1999	Fall	0.14	15	29	0	26
EFK 5.1	2000	Spring	0.12	13	38	0	31
EFK 6.3	1985	Fall	0.10	16	26	3	20
EFK 6.3	1986	Spring	0.05	10	24	0	24
EFK 6.3	1986	Fall	0.18	19	49	2	20
EFK 6.3	1987	Spring	0.11	17	30	2	20

Table 1. Fish Data from ED-1 Locations Summarized by Sampling Event (continued)

Location	Year	Season	Fish Density (fish/m2)	Number of Taxa	Percent Generalist Feeders	Percent Piscivores	Percent Tolerant Fish
EFK 6.3	1987	Fall	0.20	14	33	0	36
EFK 6.3	1988	Spring	0.22	19	70	1	62
EFK 6.3	1988	Fall	0.39	19	62	1	21
EFK 6.3	1989	Spring	0.23	20	49	2	39
EFK 6.3	1989	Fall	0.21	12	35	1	31
EFK 6.3	1990	Spring	0.15	17	44	1	44
EFK 6.3	1990	Fall	0.69	18	30	1	35
EFK 6.3	1991	Spring	0.18	19	40	2	31
EFK 6.3	1991	Fall	0.79	22	40	0	41
EFK 6.3	1992	Spring	0.29	18	47	0	58
EFK 6.3	1992	Fall	0.90	22	33	0	33
EFK 6.3	1993	Spring	0.30	18	24	0	24
EFK 6.3	1993	Fall	0.60	14	44	0	49
EFK 6.3	1994	Spring	0.49	20	46	0	45
EFK 6.3	1994	Fall	0.90	21	62	1	60
EFK 6.3	1995	Spring	0.65	25	19	0	19
EFK 6.3	1995	Fall	0.81	24	65	0	65
EFK 6.3	1996	Spring	0.15	20	23	3	18
EFK 6.3	1996	Fall	0.65	38	30	0	39
EFK 6.3	1997	Spring	0.74	55	29	5	36
EFK 6.3	1997	Fall	0.30	21	22	1	34
EFK 6.3	1998	Fall	0.21	25	25	4	31
EFK 6.3	1999	Spring	0.17	23	19	2	29
EFK 6.3	1999	Fall	0.16	21	23	3	28
EFK 6.3	2000	Spring	0.06	13	22	2	28

Table 2. Summary Statistics for Fish Density

Location	Season	Total Number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for Normality Test
BCK 0.1	Spring	3	0.57733	0.65219	112.967	1.33000	0.17937	0.77815
BCK 0.1	Fall	3	0.55150	0.65727	119.179	1.31000	0.14939	0.77950
BCK 3.3	Spring	12	1.04735	0.53754	51.324	2.05303	0.45667	0.81421
BCK 3.3	Fall	11	1.47093	0.67815	46.103	2.60246	0.56667	0.94060
DBK 0.3	Spring	3	1.82070	1.83715	100.904	3.94000	0.68000	0.78720
DBK 0.3	Fall	3	2.66538	2.49838	93.734	5.54000	1.01754	0.81917
EFK 2.3	Spring	3	0.27413	0.25653	93.579	0.57000	0.11369	0.79100
EFK 2.3	Fall	3	0.32259	0.37051	114.857	0.75000	0.09255	0.78716
EFK 5.1	Spring	2	0.11343	0.01051	9.267	0.12087	0.10600	1.00000
EFK 5.1	Fall	2	0.15550	0.02051	13.187	0.17000	0.14100	1.00000
EFK 6.3	Spring	14	0.27002	0.21143	78.302	0.73745	0.04742	0.84616
EFK 6.3	Fall	15	0.47349	0.29972	63.300	0.90486	0.09990	0.87135

Table 3. Regression Statistics for Fish Density

Location	Season	Total Number of Samples	Slope Estimate (Fish/m^2/y)	Standard Error	Pr > |t|	R^2	95% LCL on Slope	95% UCL on Slope
BCK 0.1	Spring	3	-0.39858	0.15306	0.2334	0.8715	-2.3433	1.5462
BCK 0.1	Fall	3	-0.40144	0.15490	0.2344	0.8704	-2.3697	1.5668
BCK 3.3	Spring	12	-0.04080	0.03885	0.3184	0.0993	-0.1274	0.04577
BCK 3.3	Fall	11	0.00093006	0.06278	0.9885	0.0000	-0.1411	0.1430
DBK 0.3	Spring	3	-1.15271	0.34315	0.1842	0.9186	-5.5129	3.2075
DBK 0.3	Fall	3	-1.49486	0.66369	0.2660	0.8353	-9.9279	6.9381
EFK 2.3	Spring	3	-0.15582	0.06265	0.2434	0.8609	-0.9518	0.6402
EFK 2.3	Fall	3	-0.22547	0.08942	0.2404	0.8641	-1.3617	0.9107
EFK 5.1	Spring	2	0.01487	.	.	1.0000	.	.
EFK 5.1	Fall	2	-0.02900	.	.	1.0000	.	.
EFK 6.3	Spring	14	0.01512	0.01312	0.2717	0.0996	-0.01347	0.04371
EFK 6.3	Fall	15	0.01490	0.01812	0.4258	0.0494	-0.02425	0.05405

Table 4. Summary Statistics for Number of Taxa

Season	Location	Total Number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for Normality
Spring	BCK 0.1	3	18.0000	4.5826	25.4588	23	14	0.96429
Fall	BCK 0.1	3	15.3333	4.1633	27.1522	20	12	0.92308
Spring	BCK 3.3	12	11.1667	1.5859	14.2023	13	9	0.86738
Fall	BCK 3.3	11	11.8182	2.5226	21.3453	16	8	0.97401
Spring	DBK 0.3	3	8.6667	0.5774	6.6617	9	8	0.75000
Fall	DBK 0.3	3	12.0000	2.0000	16.6667	14	10	1.00000
Spring	EFK 2.3	3	26.6667	10.6927	40.0975	39	20	0.78936
Fall	EFK 2.3	3	24.6667	4.1633	16.8784	28	20	0.92308
Spring	EFK 5.1	2	14.0000	1.4142	10.1015	15	13	1.00000
Fall	EFK 5.1	2	18.5000	4.9497	26.7554	22	15	1.00000
Spring	EFK 6.3	14	21.0000	10.4587	49.8034	55	10	0.63368
Fall	EFK 6.3	15	20.4000	6.1621	30.2064	38	12	0.86561

Table 5. Regression Statistics for Number of Taxa

Location	Season	Total Number of Samples	Slope Estimate (Taxa/y)	Standard Error	Pr > |t|	R^2	95% LCL on Slope	95% UCL on Slope
BCK 0.1	Spring	3	-2.35714	1.85577	0.4246	0.6173	-25.9369	21.2226
BCK 0.1	Fall	3	-2.28571	1.48461	0.3667	0.7033	-21.1495	16.5781
BCK 3.3	Spring	12	0.29174	0.07795	0.0038	0.5835	0.1181	0.4654
BCK 3.3	Fall	11	0.55049	0.14447	0.0042	0.6173	0.2237	0.8773
DBK 0.3	Spring	3	-0.28571	0.24744	0.4544	0.5714	-3.4297	2.8583
DBK 0.3	Fall	3	-0.85714	0.98974	0.5456	0.4286	-13.4330	11.7187
EFK 2.3	Spring	3	-6.50000	2.59808	0.2421	0.8622	-39.5117	26.5117
EFK 2.3	Fall	3	-1.14286	2.47436	0.7245	0.1758	-32.5826	30.2968
EFK 5.1	Spring	2	-2.00000	.	.	1.0000	.	.
EFK 5.1	Fall	2	-7.00000	.	.	1.0000	.	.
EFK 6.3	Spring	14	0.90832	0.63185	0.1761	0.1469	-0.4684	2.2850
EFK 6.3	Fall	15	0.77143	0.31665	0.0300	0.3134	0.08735	1.4555

Table 6. Summary Statistics for Percent of Generalist Feeders

Season	Location	Total Number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for Normality
Spring	BCK 0.1	3	46.7352	6.6363	14.1997	54.0323	41.0606	0.95517
Fall	BCK 0.1	3	45.1920	8.4265	18.6460	54.1985	37.5000	0.98175
Spring	BCK 3.3	12	54.5230	11.2650	20.6610	69.9620	32.9949	0.89643
Fall	BCK 3.3	11	60.0190	8.0065	13.3399	72.1068	44.2238	0.96740
Spring	DBK 0.3	3	34.7206	5.4633	15.7350	38.2353	28.4264	0.80588
Fall	DBK 0.3	3	25.2498	18.9321	74.9792	37.5451	3.4483	0.81090
Spring	EFK 2.3	3	35.2637	6.2338	17.6776	39.0845	28.0702	0.78046
Fall	EFK 2.3	3	34.1615	12.0428	35.2526	45.3333	21.4047	0.98701
Spring	EFK 5.1	2	34.4340	4.6696	13.5610	37.7358	31.1321	1.00000
Fall	EFK 5.1	2	26.0096	4.3394	16.6838	29.0780	22.9412	1.00000
Spring	EFK 6.3	14	34.6869	14.9115	42.9887	69.6682	19.3878	0.87511
Fall	EFK 6.3	15	38.6469	14.6026	37.7848	65.3442	22.3684	0.87881

Table 7. Regression Statistics for Percent of Generalist Feeders

Location	Season	Total Number of Samples	Slope Estimate (%/y)	Standard Error	Pr > |t|	R^2	95% LCL on Slope	95% UCL on Slope
BCK 0.1	Spring	3	2.25898	3.71096	0.6519	0.2704	-44.8933	49.4112
BCK 0.1	Fall	3	-5.50820	0.30115	0.0348	0.9970	-9.3347	-1.6817
BCK 3.3	Spring	12	-1.57010	0.69961	0.0487	0.3350	-3.1289	-0.01128
BCK 3.3	Fall	11	-0.76119	0.69646	0.3028	0.1172	-2.3367	0.8143
DBK 0.3	Spring	3	3.45066	0.94063	0.1694	0.9308	-8.5012	15.4025
DBK 0.3	Fall	3	-3.23235	11.96507	0.8320	0.0680	-155.26	148.80
EFK 2.3	Spring	3	3.80565	1.47356	0.2352	0.8696	-14.9177	22.5290
EFK 2.3	Fall	3	-7.52152	2.36266	0.1938	0.9102	-37.5419	22.4989
EFK 5.1	Spring	2	6.60377	.	.	1.0000	.	.
EFK 5.1	Fall	2	6.13684	.	.	1.0000	.	.
EFK 6.3	Spring	14	-1.74225	0.83567	0.0591	0.2659	-3.5630	0.07851
EFK 6.3	Fall	15	-0.63496	0.88833	0.4874	0.0378	-2.5541	1.2842

Table 8. Summary Statistics for Percent of Piscivores

Season	Location	Total Number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for Normality
Spring	BCK 0.1	3	2.7931	1.13658	40.692	3.6498	1.5038	0.89131
Fall	BCK 0.1	3	1.7897	1.16252	64.955	3.0612	0.7813	0.96161
Spring	BCK 3.3	12	1.1411	0.62270	54.570	2.9197	0.6711	0.70261
Fall	BCK 3.3	11	1.1328	0.92505	81.663	3.0686	0.1575	0.89891
Spring	DBK 0.3	3	0.0000	0.00000	.	0.0000	0.0000	.
Fall	DBK 0.3	3	1.5670	1.84307	117.615	3.6585	0.1805	0.89027
Spring	EFK 2.3	3	17.7833	5.31453	29.885	22.8873	12.2807	0.99578
Fall	EFK 2.3	3	4.1532	2.56098	61.663	6.7873	1.6722	0.99732
Spring	EFK 5.1	2	0.9434	1.33416	141.421	1.8868	0.0000	1.00000
Fall	EFK 5.1	2	2.0588	2.91162	141.421	4.1176	0.0000	1.00000
Spring	EFK 6.3	14	1.5300	1.40261	91.674	4.8105	0.0000	0.89307
Fall	EFK 6.3	15	1.1419	1.22034	106.866	3.8627	0.0000	0.83347

Table 9. Regression Statistics for Percent of Piscivores

Location	Season	Total Number of Samples	Slope Estimate (%/y)	Standard Error	Pr > |t|	R^2	95% LCL on Slope	95% UCL on Slope
BCK 0.1	Spring	3	0.64530	0.37043	0.3317	0.7522	-4.0614	5.3520
BCK 0.1	Fall	3	-0.10338	0.75399	0.9133	0.0185	-9.6838	9.4770
BCK 3.3	Spring	12	0.07096	0.04178	0.1203	0.2239	-0.02213	0.1640
BCK 3.3	Fall	11	-0.18118	0.06072	0.0154	0.4973	-0.3185	-0.04382
DBK 0.3	Spring	3	0	0	.	.	.	.
DBK 0.3	Fall	3	1.04241	0.60762	0.3360	0.7464	-6.6782	8.7630
EFK 2.3	Spring	3	2.44365	2.47654	0.5043	0.4933	-29.0238	33.9111
EFK 2.3	Fall	3	-0.46598	1.61050	0.8207	0.0772	-20.9293	19.9974
EFK 5.1	Spring	2	-1.88679	.	.	1.0000	.	.
EFK 5.1	Fall	2	-4.11765	.	.	1.0000	.	.
EFK 6.3	Spring	14	0.13735	0.08273	0.1228	0.1868	-0.04290	0.3176
EFK 6.3	Fall	15	0.02551	0.07535	0.7403	0.0087	-0.1373	0.1883

Table 10. Summary Statistics for Percent of Tolerant Fish

Season	Location	Total Number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for Normality
Spring	BCK 0.1	3	51.8159	4.1786	8.0643	55.6600	47.3684	0.98436
Fall	BCK 0.1	3	48.1005	9.4911	19.7318	58.7786	40.6250	0.91461
Spring	BCK 3.3	12	58.4497	9.9740	17.0643	73.0038	40.1015	0.87773
Fall	BCK 3.3	11	68.2926	7.6554	11.2096	81.3056	54.1516	0.97953
Spring	DBK 0.3	3	37.8775	5.6173	14.8301	41.9643	31.4721	0.87222
Fall	DBK 0.3	3	43.7467	13.8871	31.7444	57.9268	30.1724	0.99857
Spring	EFK 2.3	3	25.2891	1.2743	5.0390	26.7606	24.5455	0.75540
Fall	EFK 2.3	3	27.8132	5.3143	19.1070	33.0317	22.4080	0.99907
Spring	EFK 5.1	2	34.9057	5.3367	15.2888	38.6792	31.1321	1.00000
Fall	EFK 5.1	2	26.2954	1.0797	4.1060	27.0588	25.5319	1.00000
Spring	EFK 6.3	14	34.1291	14.0472	41.1591	62.0853	17.8218	0.91796
Fall	EFK 6.3	15	36.2034	13.1945	36.4454	64.5274	20.4082	0.90535

Table 11. Regression Statistics for Percent of Tolerant Fish

Location	Season	Slope Estimate (%/y)	Standard Error	Pr > |t|	R^2	95% LCL on Slope	95% UCL on Slope
BCK 0.1	Spring	2.03538	1.82766	0.4658	0.5536	-21.1873	25.2581
BCK 0.1	Fall	-6.17823	0.66000	0.0678	0.9887	-14.5644	2.2079
BCK 3.3	Spring	-1.19142	0.65955	0.1010	0.2460	-2.6610	0.2782
BCK 3.3	Fall	0.00603	0.70873	0.9934	0.0000	-1.5972	1.6093
DBK 0.3	Spring	3.24201	1.73559	0.3129	0.7772	-18.8108	25.2948
DBK 0.3	Fall	3.29827	8.47186	0.7636	0.1316	-104.35	110.94
EFK 2.3	Spring	0.15253	0.82017	0.8829	0.0334	-10.2688	10.5738
EFK 2.3	Fall	-1.23830	3.25118	0.7683	0.1267	-42.5485	40.0718
EFK 5.1	Spring	-7.54717	.	.	1.0000	.	.
EFK 5.1	Fall	-1.52691	.	.	1.0000	.	.
EFK 6.3	Spring	-0.70583	0.89594	0.4461	0.0492	-2.6579	1.2463
EFK 6.3	Fall	1.18877	0.74892	0.1365	0.1623	-0.4292	2.8067

THIS PAGE INTENTIONALLY LEFT BLANK.