Operation of
Flaming Gorge Dam
Draft Environmental
Impact Statement

Effects of Flaming Gorge Operation Under the 1992 Biological Opinion and the 2000 Flow and Temperature Recommendations on Sediment Transport in Green River Technical Appendix

EFFECTS OF FLAMING GORGE OPERATIONS UNDER THE 1992 BIOLOGICAL OPINION AND THE 2000 FLOW AND TEMPERATURE RECOMMENDATIONS ON SEDIMENT TRANSPORT IN GREEN RIVER TECHNICAL APPENDIX

Page No.

Effects of Flaming Gorge Operations Under the 1992 Biological Opinion and the 2000 Flow and Temperature Recommendations on Sediment Transport in Green River Technical Appendix

Mohammed A. Samad
Sedimentation and River Hydraulics Group
Technical Service Center

Joseph K. Lyons
Water Supply, Use and Conservation Group
Technical Service Center

1. INTRODUCTION

Flaming Gorge Dam is located on the upper main stem of Green River in Utah (figure 1.1). The operation of the dam influences flow and temperature regimes and the ecology of riverine biota including native fish. The U.S. Fish and Wildlife Service in the 1992 Biological Opinion (the 1992 Biological Opinion) on Operation of Flaming Gorge Dam concluded that the continuation of historic operations at Flaming Gorge Dam was likely to further reduce the distribution and abundance of the federally protected fishes found in the Green River system.

In order to mitigate this problem, the Flaming Gorge flow recommendations investigation was conducted beginning in 1992 under the auspices of the Upper Colorado River Endangered Fish Recovery Program.

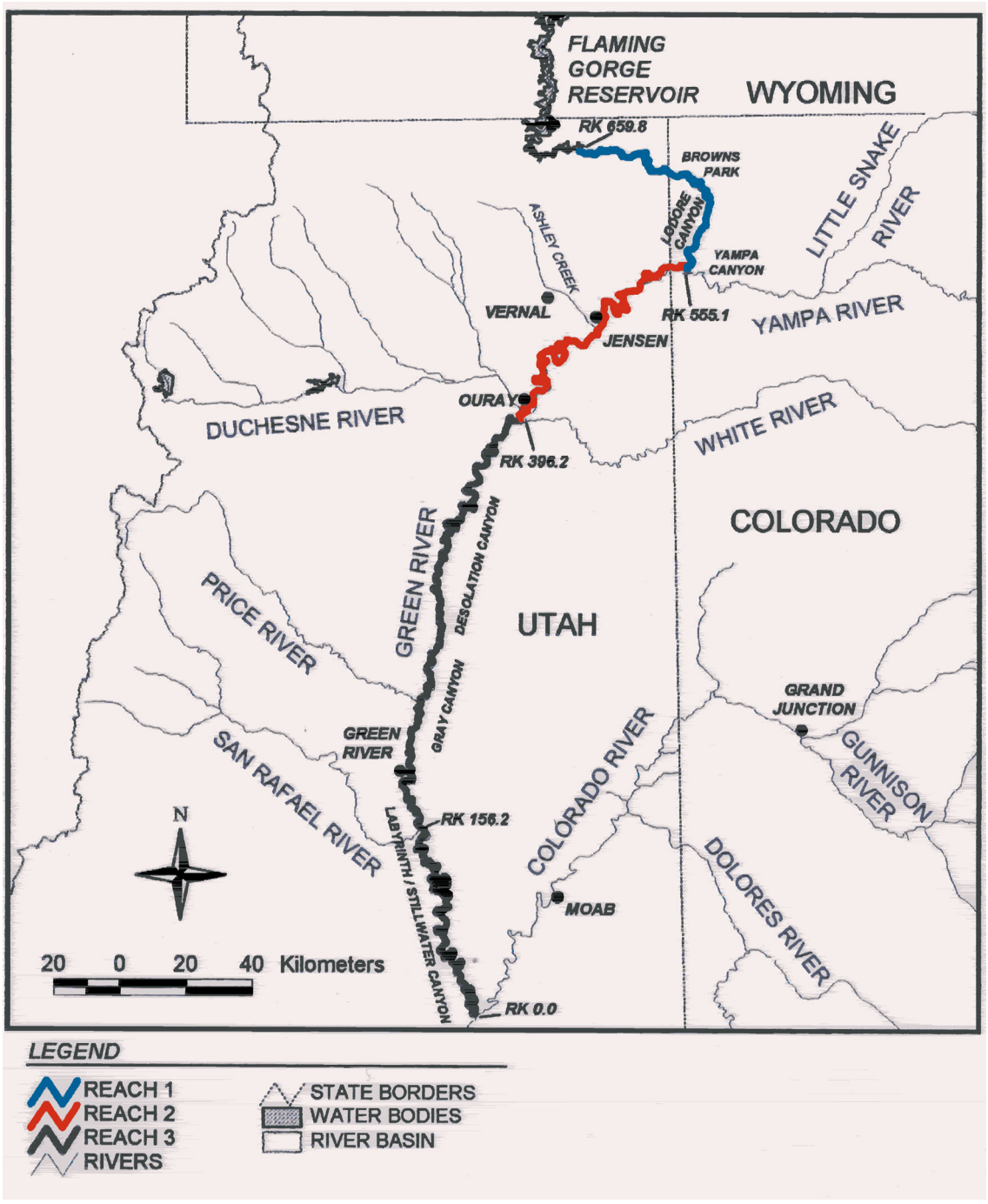

Figure 1.1—The Green River study area.

The 2000 Flow and Temperature Recommendations (the 2000 Flow Recommendations) are documented in a final report by Muth et al. (September 2000).

Clayton and Gilmore (2002) developed the simulation models of reservoir operation and streamflow for the 1992 Biological Opinion, which is referred to as the No Action Alternative, and the 2000 Flow Recommendations, which is referred to as the Action Alternative. The details of the model development and the hydrology results as well as updated flow data are presented in this report and were used to conduct the impact analysis on sediment transport in the Green River downstream from the Flaming Gorge Dam to its confluence with the White River near Ouray in Utah. This portion of the Green River has been divided into three reaches, Reach 1, Reach 2, and Reach 3 (figure 1.1) for impact analysis.

2. STUDY REACHES

The study area for impacts on sediment transport due to differences in flow pattern under the Action and the No Action Alternatives are the three reaches of Green River downstream from the Dam. Reach 1 encompasses the main stem of Green River from Flaming Gorge Dam downstream to its confluence with the Yampa River, and Reach 2 encompasses the mainstream of Green River from its confluence with the Yampa River downstream to the confluence with the White River. Reach 3 encompasses the mainstem of Green River from its confluence with the White River downstream to the confluence with the Colorado River. Long term sediment transport quantities, in terms of sand load and total load are determined for these two reaches by using available sediment rating curves and the flows for the Action and the No Action Alternatives.

3. HYDROLOGY

The hydrology of the Green River below Flaming Gorge Dam for the Action and the No Action Alternatives are presented in *Flaming Gorge Draft Environmental Impact Statement Hydrologic Modeling Report* by R. Clayton and A. Gilmore (February 26, 2002) and supplemental hydrology estimates prepared for Reach 3. The hydrologic modeling results presented in the report are used to evaluate the impacts on sediment transport under the two alternatives. The details of the hydrology model are presented in the report. The average monthly flows for Reach 1 for the Action and the No Action Alternatives are shown in figure 3.1 (all figures are located at the end of this appendix) and the average monthly flows for Reach 2 for the two alternatives are shown in figure 3.2. Figure 3.3 contains the average monthly flow estimates for Reach 3 for the two alternatives. These three figures show the differences in monthly flows for the alternatives. The flow values are also presented in tables 1 and 2 for Reach 1, table 3 for Reach 2, and table 4 for Reach 3.

Table1
Average Monthly and Annual Total Load and Flows for Reach 1

22-Jul-02
Green River Reach 1
Comparison of Alternatives
Using Sed. Rating Curve, Qs=0.000047068*Qw^2.009

Month	Action Qw	Action Qs	No Action Qw	No Action Qs	Qw Action - No Action B6-D6	Qs Action - No Action C6-E6	Percent Qw Action - No Action B6/D6	Percent Qs Action - No Action C6/E6	Action Qs (Tons)	No Action Qs(Tons)	Action Qw (ac-ft)	No- Action Qw(ac-ft)
Jan	1237.45	91.25154	1661.07	181.2136	-423.62	-89.96	74.50%	50.36%	2828.798	5617.622	76087.83	102135.2
Feb	1106.75	73.41528	1423.97	142.6705	-317.22	-69.26	77.72%	51.46%	2055.628	3994.775	61465.79	79083.07
Mar	1268.05	93.29734	1479.83	119.0108	-211.78	-25.71	85.69%	78.39%	2892.217	3689.335	77969.23	90990.95
Apr	1902.90	254.6294	2196.61	288.621	-293.71	-33.99	86.63%	88.22%	7638.883	8658.629	113230.4	130707.1
May	3227.16	789.4469	3477.64	763.5541	-250.48	25.89	92.80%	103.39%	24472.85	23670.18	198430.1	213831.7
Jun	3805.55	1100.887	2703.22	659.3657	1102.33	441.52	140.78%	166.96%	33026.61	19780.97	226446	160852.8
Jul	2247.38	416.7469	983.21	57.42264	1264.17	359.32	228.58%	725.75%	12919.15	1780.102	138186	60455.01
Aug	1620.32	142.1238	1236.71	81.59045	383.60	60.53	131.02%	174.19%	4405.836	2529.304	99629.29	76042.36
Sep	1646.83	148.5881	1370.47	98.32665	276.36	50.26	120.17%	151.12%	4457.643	2949.8	97993.19	81548.53
Oct	1479.81	124.4873	1650.36	146.1216	-170.55	-21.63	89.67%	85.19%	3859.107	4529.768	90989.66	101476.5
Nov	1398.20	114.3954	1958.98	243.9822	-560.78	-129.59	71.37%	46.89%	3431.861	7319.466	83198.68	116567.4
Dec	1329.40	105.035	1893.38	231.0781	-563.98	-126.04	70.21%	45.45%	3256.084	7163.422	81741.62	116419.6
Annual Total									105244.7	91683.37	1345368	1330110
May	3227.16	789.4469	3477.64	763.5541	-250.48	25.89	92.80%	103.39%	24472.85	23670.18	198430.1	213831.7
Jun	3805.55	1100.887	2703.22	659.3657	1102.33	441.52	140.78%	166.96%	33026.61	19780.97	226446	160852.8
Jul	2247.38	416.7469	983.21	57.42264	1264.17	359.32	228.58%	725.75%	12919.15	1780.102	138186	60455.01
Summer Total									70418.62	45231.25	563062.1	435139.5

Table2
Average Monthly and Annual Suspended Load and Flows for Reach 1

26-Jul-02
Green River Reach 1
Comparison of Alternatives
Using Sed. Rating Curve, Qs=0.0000002704*Qw^2.5781

Month	Action Qw	Action Qs	No Action Qw	No Action Qs	Qw Action - No Action B6-D6	Qs Action - No Action C6-E6	Percent Qw Action - No Action B6/D6	Percent Qs Action - No Action C6/E6	Action Qs (Tons)	No Action Qs(Tons)	Action Qw (ac-ft)	No- Action Qw(ac-ft)
Jan	1237.45	35.73213	1661.07	89.79638	-423.62	-54.06	74.50%	39.79%	1107.696	2783.688	76087.83	102135.2
Feb	1106.75	27.5201	1423.97	69.9981	-317.22	-42.48	77.72%	39.32%	770.5628	1959.947	61465.79	79083.07
Mar	1268.05	36.19474	1479.83	46.61334	-211.78	-10.42	85.69%	77.65%	1122.037	1445.013	77969.23	90990.95
Apr	1902.90	143.705	2196.61	152.803	-293.71	-9.10	86.63%	94.05%	4311.149	4584.089	113230.4	130707.1
May	3227.16	642.7417	3477.64	561.4013	-250.48	81.34	92.80%	114.49%	19924.99	17403.44	198430.1	213831.7
Jun	3805.55	963.7196	2703.22	536.3671	1102.33	427.35	140.78%	179.68%	28911.59	16091.01	226446	160852.8
Jul	2247.38	298.4767	983.21	21.30011	1264.17	277.18	228.58%	1401.29%	9252.779	660.3034	138186	60455.01
Aug	1620.32	58.53207	1236.71	28.90967	383.60	29.62	131.02%	202.47%	1814.494	896.1998	99629.29	76042.36
Sep	1646.83	62.50678	1370.47	35.90564	276.36	26.60	120.17%	174.09%	1875.203	1077.169	97993.19	81548.53
Oct	1479.81	50.92449	1650.36	60.32419	-170.55	-9.40	89.67%	84.42%	1578.659	1870.05	90989.66	101476.5
Nov	1398.20	46.60669	1958.98	127.7456	-560.78	-81.14	71.37%	36.48%	1398.201	3832.367	83198.68	116567.4
Dec	1329.40	42.38784	1893.38	120.3333	-563.98	-77.95	70.21%	35.23%	1314.023	3730.333	81741.62	116419.6
Annual Total									73381.38	56333.61	1345368	1330110
May	3227.16	642.7417	3477.64	561.4013	-250.48	81.34	92.80%	114.49%	19924.99	17403.44	198430.1	213831.7
Jun	3805.55	963.7196	2703.22	536.3671	1102.33	427.35	140.78%	179.68%	28911.59	16091.01	226446	160852.8
Jul	2247.38	298.4767	983.21	21.30011	1264.17	277.18	228.58%	1401.29%	9252.779	660.3034	138186	60455.01
Summer Total									58089.36	34154.76	563062.1	435139.5

Table 3
Average Monthly and Annual Sand Load and Flows for Reach 2

5-Sep-03
Green River Reach 2
Comparison of Alternatives
Using Sed. Rating Curve, Qs=0.0000204*(Qw)^2.16 (Sand Load)

Month	Action Qw	Action Qs (Tons/day)	No Action Qw	No Action Qs (Tons/day)	Qw Action - No Action B6-D6	Qs Action - No Action C6-E6	Percent Qw Action - No Action B6/D6	Percent Qs Action - No Action C6/E6	Action Qs (Tons)	No Action Qs(Tons)	Action Qw (ac-ft)	No- Action Qw(ac-ft)
Jan	1600.26	202.0075	2078.81	393.78564	-478.55	-191.78	76.98%	51.30%	6262.233	12207.35	98396.14	127821.2
Feb	1565.57	192.3703	1871.683	318.18166	-306.11	-125.81	83.65%	60.46%	5386.367	8909.086	86947.54	103948
Mar	2303.39	468.0288	2498.78	522.01375	-195.39	-53.98	92.18%	89.66%	14508.89	16182.43	141630.2	153644.3
Apr	5583.25	3462.457	5931.27	3737.021	-348.03	-274.56	94.13%	92.65%	103873.7	112110.6	332226.2	352935.2
May	12099.85	17185.09	12413.10	17693.026	-313.25	-507.93	97.48%	97.13%	532737.9	548483.8	743990.8	763251.5
Jun	11547.95	16068.19	10329.70	13242.874	1218.25	2825.32	111.79%	121.33%	482045.8	397286.2	687150.8	614659.6
Jul	3928.9424	2084.568	2636.43	827.90293	1292.51	1256.66	149.03%	251.79%	64621.6	25664.99	241581.3	162107.7
Aug	2081.61	339.8265	1697.02	216.88671	384.59	122.94	122.66%	156.68%	10534.62	6723.488	127993.3	104345.9
Sep	1944.14	294.1442	1645.227	194.82317	298.92	99.32	118.17%	150.98%	8824.327	5844.695	115684.6	97897.8
Oct	1933.23	291.4628	2109.61	334.42373	-176.38	-42.96	91.64%	87.15%	9035.346	10367.14	118869.5	129714.8
Nov	1854.49	268.0437	2404.08	504.55128	-549.59	-236.51	77.14%	53.13%	8041.31	15136.54	110349.8	143052.6
Dec	1730.25	237.8592	2296.61	469.55755	-566.36	-231.70	75.34%	50.66%	7373.636	14556.28	106388.9	141213.2
Annual Total									1253246	1173473	2911209	2894592
May	12099.85	17185.09	12413.10	17693.026	-313.25	-507.93	97.48%	97.13%	532737.9	548483.8	743990.8	763251.5
Jun	11547.95	16068.19	10329.70	13242.874	1218.25	2825.32	111.79%	121.33%	482045.8	397286.2	687150.8	614659.6
Jul	3928.9424	2084.568	2636.43	827.90293	1292.51	1256.66	149.03%	251.79%	64621.6	25664.99	241581.3	162107.7
Summer Total									1079405	971435	1672723	1540019

Table 4
Average Monthly and Annual Sand Load and Flows for Reach 3

20-Aug-03
Green River Reach 3
Comparison of Alternatives
Using Sed. Rating Curve, Qs=0.00(

Month	Action Qw	Action Qs	No Action Qw	No Action Qs	Qw Action - No Action B6-D6	Qs Action - No Action C6-E6	Percent Qw Action - No Action B6/D6	Percent Qs Action - No Action C6/E6	Action Qs (Tons)	No Action Qs(Tons)
Jan	2347	166	2841	319	-494.50	-153.03	82.60%	52.09%	5156.914	9900.859
Feb	2682	453	3032	614	-349.11	-161.42	88.48%	73.72%	12679.46	17199.3
Mar	3951	1286	4193	1427	-241.15	-141.53	94.25%	90.08%	39861.34	44248.89
Apr	6405	4708	6647	4806	-242.59	-97.25	96.35%	97.98%	141252.1	144169.5
May	13882	41336	14292	41491	-410.02	-154.56	97.13%	99.63%	1281430	1286221
Jun	16201	59368	15189	52639	1012.41	6729.00	106.67%	112.78%	1781051	1579181
Jul	5842	6161	4522	3314	1320.14	2846.84	129.19%	185.91%	190979.9	102727.8
Aug	3030	469	2638	342	391.33	127.50	114.83%	137.29%	14551.24	10598.8
Sep	2824	396	2523	309	300.53	87.65	111.91%	128.39%	11890.99	9261.445
Oct	2992	390	3101	409	-109.10	-18.43	96.48%	95.49%	12096.56	12667.95
Nov	2879	312	3411	539	-532.59	-227.37	84.39%	57.82%	9349.808	16170.78
Dec	2490	211	3079	421	-589.33	-209.80	80.86%	50.14%	6541.229	13044.93
Annual Total									3506840	3245392
May	13882	41336	14292	41491	-410.02	-154.56	97.13%	99.63%	1281430	1286221
Jun	16201	59368	15189	52639	1012.41	6729.00	106.67%	112.78%	1781051	1579181
Jul	5842	6161	4522	3314	1320.14	2846.84	129.19%	185.91%	190979.9	102727.8
Summer Total									3253460	2968130

4. SEDIMENT TRANSPORT ANALYSIS

The change of streamflow pattern from the No Action Alternative to the Action Alternative has impacts on the quantity of sediment transported by the Green River. The magnitude of the difference in sediment transport for the two alternatives was determined using flow duration data for each month of the year and available sediment rating curves for the three reaches of the river for each alternative.

The flow duration curves for Reach 1 are presented in figure 4.1 through 4.12, and the flow-duration curves for Reach 2 are presented in figures 4.13 through 4.24. The flow duration curves are based on daily flows presented in the hydrologic modeling report by Clayton and Gilmore (February 2002). Flow duration for Reach 3 is patterned after the modeled results for Reach 2 and historic tributary inputs in Reach 3.

Four sediment rating curves, two for Reach 1, one for Reach 2, and one for Reach 3, are used to quantify the impacts on sediment transport due to change in flow pattern in the river. Between the two rating curves for Reach 1, one is for determining total load transport and one is for suspended load transport. The one sediment rating curves for Reach 2 is for sand load transport only. The one sediment rating curve for Reach 3 is for sand load transport only.

The sediment rating curves are as follows:

Reach 1:

a) Total load rating curve by Martin et al. (1998)

Qs = 4.707x10-5 Q 2.01

b) Suspended load rating curve by Martin et al. (1998)

Qsb = 2.704x10-7 Q 2.58

Where Qs = total load, tons/day

Qsb = suspended load, tons/day

Q = water discharge, cfs

Reach 2:

Sand load rating curve by Andrews (1986) for USGS gauge Jensen, UT

Qsl = 2.04x10-5 Q 2.16

Where Qsl = sand load, tons/day

Q = water discharge, cfs

Reach 3:

Sand load rating curve by Andrews (1986) for USGS gauge Green River, UT

Qsl = 2.06x10-8 Q 2.90

Where Qsl = sand load, tons/day

Q = water discharge, cfs

The above sediment rating curves and the flow-duration curves presented in figures 4.1 through 4.24 are used in computing the sediment transport quantities for each month by utilizing the method presented in Table 2 of Strand and Pemberton (1982).

4.1 Sediment Transport Quantities for Reach 1

The total load transport quantities determined by the total load rating curve for the reach are shown in figure 4.1.1. Figure 4.1.1 shows the month-by-month total load transported by using the rating curve presented in Martin et al. (1998). The greatest difference in total load transport between the alternatives occurs in the month of July in which total load transported in the Action Alternative is more than seven times the No Action Alternative. The smallest difference in total load transport between the two alternatives is in the month of May when total load transported in Action Alternative is about 103 percent of the total load transported in the No Action Alternative.

During the peak runoff season, May through July, the Action Alternative transported about 70,000 tons of total load compared to nearly 45,000 tons transported by the No Action Alternative (a difference of 55 percent). The flow volume during the peak runoff season was about 536,000 acre-feet under the Action Alternative and about 435,000 acre-feet under the No Action Alternative (a difference of 23 percent).

On an annual basis total load transport in reach 1 is nearly same under both of the alternatives. The annual total load transported in the Action Alternative is about 105,000 tons compared to 92,000 tons transported in the No Action Alternative. This annual difference is about 14 percent. The annual modeled flow volumes were about 1,345,000 acre-feet under the Action Alternative and about 1,330,000 acre-feet under the No Action Alternative. This difference in modeled flow volumes in Reach 1 is about 1 percent. The month by month and the annual quantities of total load transported under the two alternatives and the flow values are shown in table 1.

Martin et al. (1998) also presented a suspended load rating curve for Reach 1. Their suspended load rating curve was used to compare suspended load transport quantities under the two alternatives in Reach 1. The monthly suspended loads computed by using Martin et al. (1998) rating curve is presented in figure 4.1.2. The greatest difference in suspended load transport between the two alternatives was similar to the differences noted for total load transport (figure 4.1.1). During July, suspended load transported in the Action Alternative was 14 times greater than the No Action Alternative. The smallest difference in the transport of suspended load between alternatives occurs in April when flows under the No Action Alternative carried only 6 percent more suspended load than flows under the Action Alternative.

On an annual basis, the Action Alternative carried about 73,000 tons of suspended load compared to roughly 56,000 tons carried by the No Action Alternative, a difference of about 30 percent. The monthly suspended loads along with the annual total suspended load for Reach 1 are presented in Table 2.

4.2 Sediment Transport Quantities for Reach 2

The sand load transport quantities determined for Reach 2 are shown in figure 4.2.1. Figure 4.2.1 shows the month-to-month sand load transport quantities determined by the sand load rating curve by Andrews (1986). The greatest difference in sand load transport between the two alternatives is in the month of July. The Action Alternative carried about 2.5 times more sand

load than the No Action Alterative during July. The smallest difference in sand load transport occurs during April, in which the No Action Alternative transported 7 percent more sand load than the Action Alternative.

During the peak runoff season, May through July, the Action Alternative transported about 1,079,000 tons of suspended load compared to roughly 971,000 tons transported by the No Action Alternative, a difference of about 11 percent. The flow volume during the peak runoff season was nearly 1,673,000 acre-feet under the Action Alternative and about 1,540,000 acre-feet under the No Action Alternative, a difference of nearly 9 percent.

On an annual basis the difference in sand load transport between the two alternatives is small. The Action Alternative carried about 1,253,000 tons compared to roughly 1,173,000 tons carried by the No Action Alternative, a difference of about 7 percent. The modeled annual flow volumes were about 2,911,000 acre-feet under the Action Alternative and nearly 2,895,000 acre-feet under the No Action Alternative; a difference of less than one percent. The monthly and annual sand loads for Reach 2 along with the flow values are presented in Table 3.

4.3 Sediment Transport Quantities for Reach 3

The monthly sand load transport quantities determined for Reach 3 are shown in figure 4.3.1. These month by month sand load estimates were determined using the sand load rating curve for Green River at Green River, Utah USGS gauge. Flow information for Reach 3 was estimated from the Green River Model (described in the Hydrology Appendix) results for Reach 2 and estimated tributary inflows within Reach 3.

5. CONCLUSIONS

Flow-duration comparisons for May, June and July show that flows greater than power plant capacity (4,600 cfs) occur more frequently under Action Alternative conditions than under No Action Alternative conditions. Martin et al. (1998) documented increased active channel area in reach 1 following a series of special research flow releases greater than 4,600 cfs from Flaming Gorge dam. The maximum mean daily release from Flaming Gorge during this period was 8,420 cfs.

The sediment transport quantities for Reach 1, whether considering suspended load or total load show variation between the Action and the No Action Alternatives on a month-to-month basis. This variation is greatest during the summer month of July. There is difference in monthly total load transport for the two alternatives. Relative to conditions under the No Action Alternative, implementing the Action Alternative will likely result in some additional channel deposition and erosion in the reach during May through September. Additional channel deposition in the reach is likely during October through April under the Action Alternative in comparison to the No Action Alternative. On an annual basis, sediment transport in reach 1 will be slightly greater under the Action Alternative relative to the No Action Alternative. The net result of greater frequency of flows in excess of 4,600 cfs and increased sediment transport associated with these higher flows will be greater active channel area under the Action Alternative relative to conditions under the No Action Alternative.

For Reach 2, there are some differences in monthly sand load discharge between the two alternatives although on an annual basis the difference is small. No total load rating curve is available for Reach 2. Assuming sand load transport to be proportional to total load, sediment deposition will likely occur from October through May in Reach 2 under Action Alternative conditions relative to the conditions under the No Action Alternative. From June through September, sediment will tend to be removed from Reach 2 under the Action Alternative relative to the No Action Alternative. However, on an annual basis, the difference in sediment transport between Alternatives will most likely be small in Reach 2.

For Reach 3, the trends in sand load transport are likely to be similar to those discussed for Reach 2. Annual differences in sediment transport in Reach 3 under the two Alternatives will likely be small.

6. REFERENCES

Andrews, E D, 1986. Downstream Effects of Flaming Gorge Reservoir on the Green River, Colorado and Utah. Geological Society of America Bulletin 97, pp. 1012-1023.

Clayton, R. and A. Gilmore, 2002. Flaming Gorge Environmental Impact Statement Hydrologic Modeling Study Report, draft dated February 26, 2002. U S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Salt Lake City, Utah, 28 p.

Martin, J., P. Grams, M. Kammerer, and J. Schmidt, 1998. Sediment Transport and Channel Response of the Green River in the Canyon of Lodore Between 1995-1997, Including Measurements During High Flows, Dinosaur National Monument, Colorado, draft final report. Utah State

University Cooperative Agreements CA 1268-1-9006 and CA 1425-97-FC-40-21560, 190 p.

Muth, R., L. Crist, K. LaGory, J. Hayse, K. Bestgen, T. Ryan, J. Lyons, and R. Valdez, 2000. Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam, final report. Upper Colorado River Endangered Fish Recovery Program Project FG-53.

Strand, R. and E. Pemberton, 1982. Reservoir Sedimentation Technical Guideline for Bureau of Reclamation. U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado, 48 p.

Figure 3.1
Green River Reach 1: Average Monthly Flows

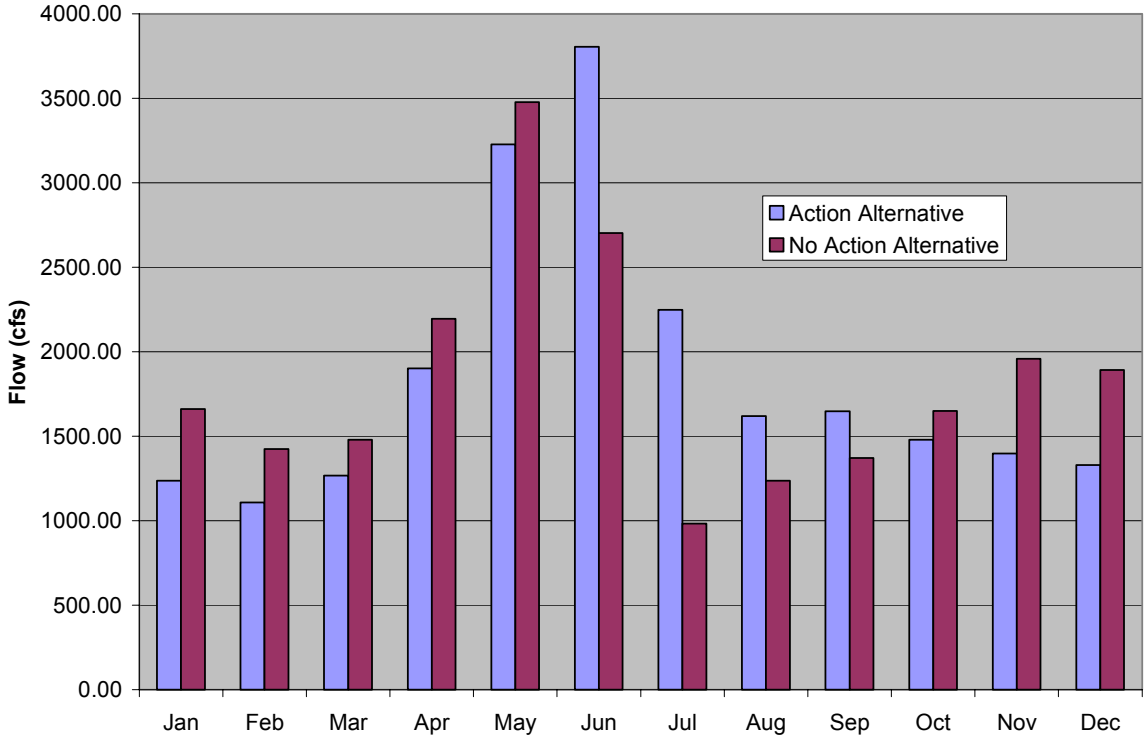

Figure 3.2
Green River Reach 2: Average Monthly Flows

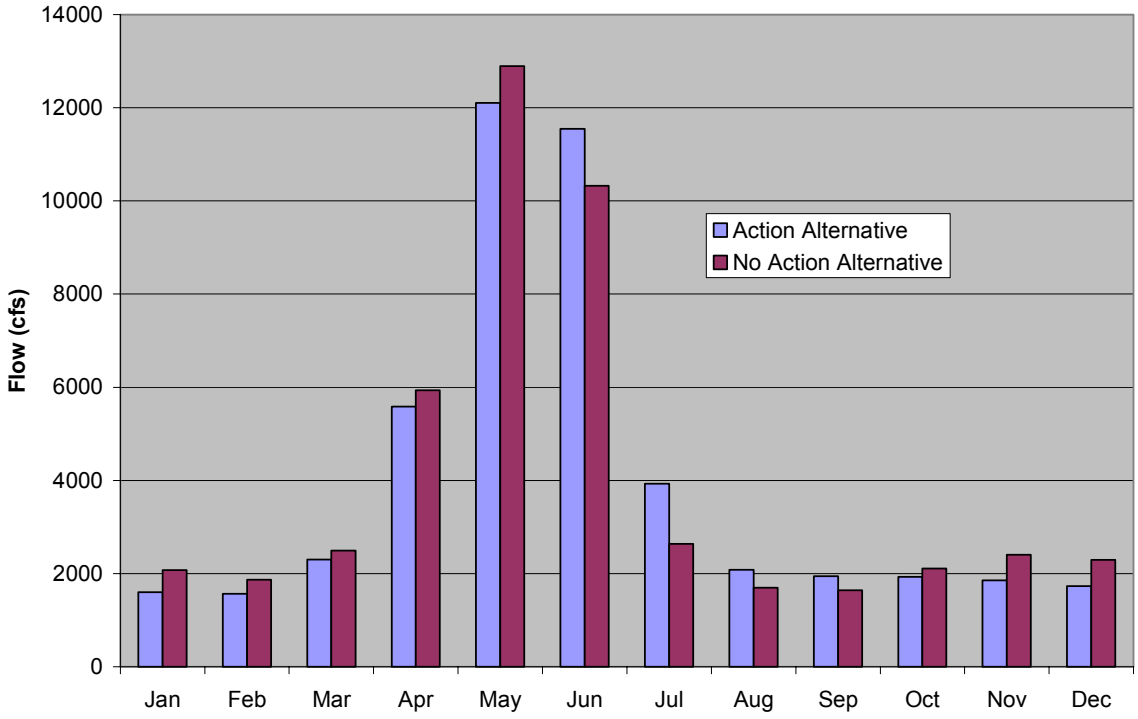

Figure 3.3
Green River Reach 3: Average Monthly Flows

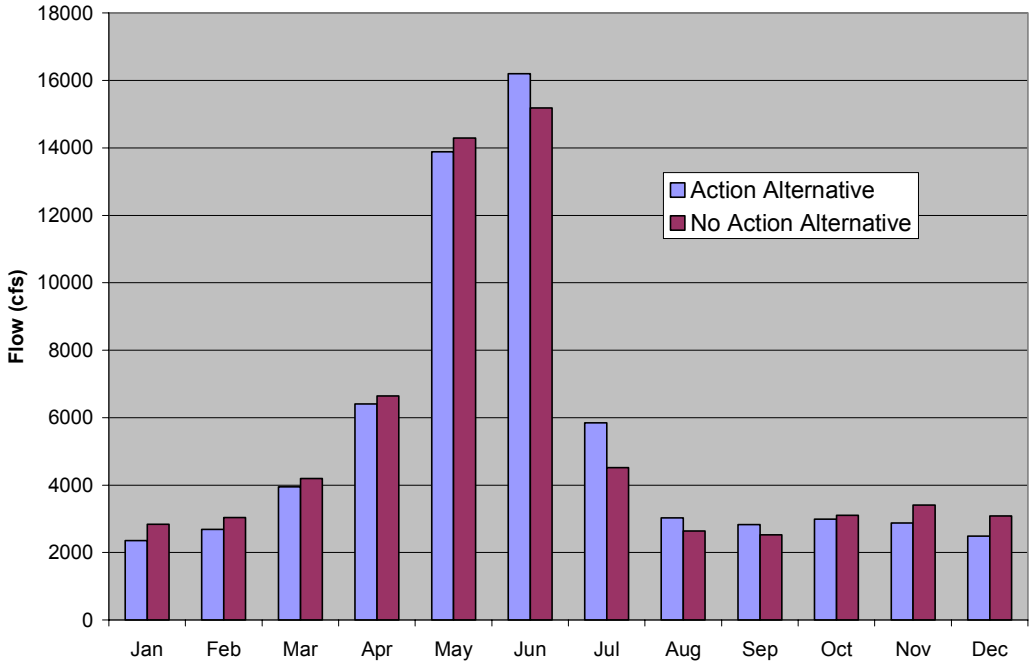

Figure 4.1:Reach One Flows in January

Modelled vs. Historic

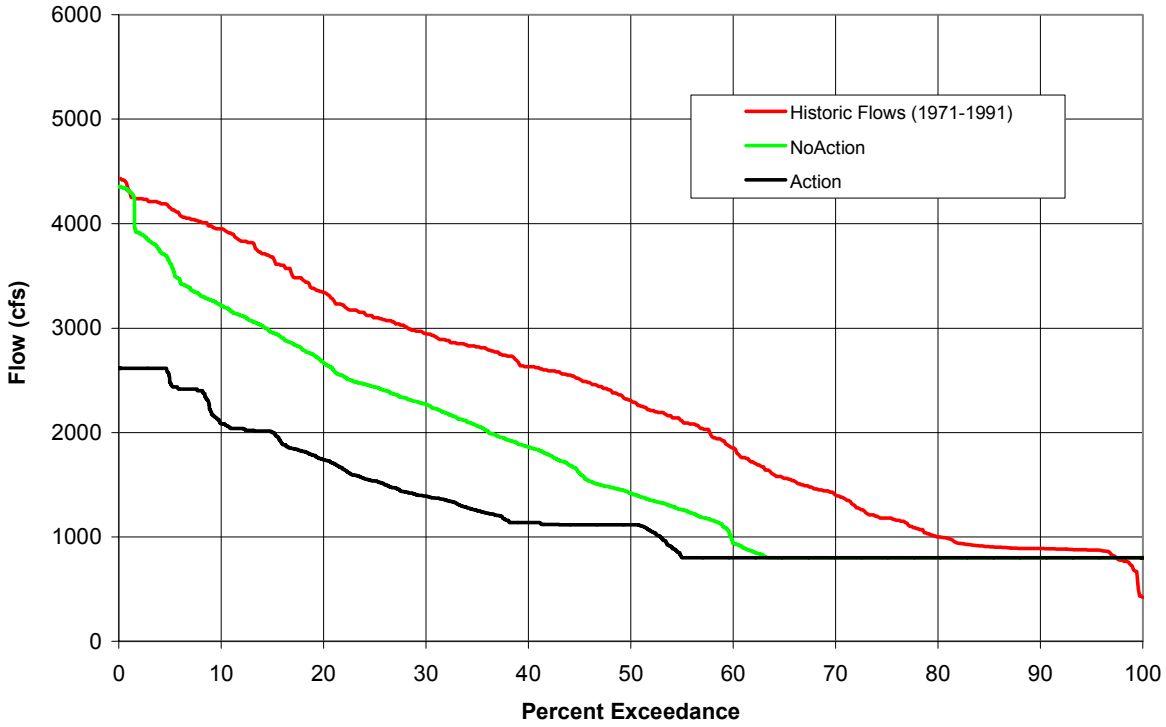

Figure 4.2: Reach One Flows in February

Modelled vs. Historic

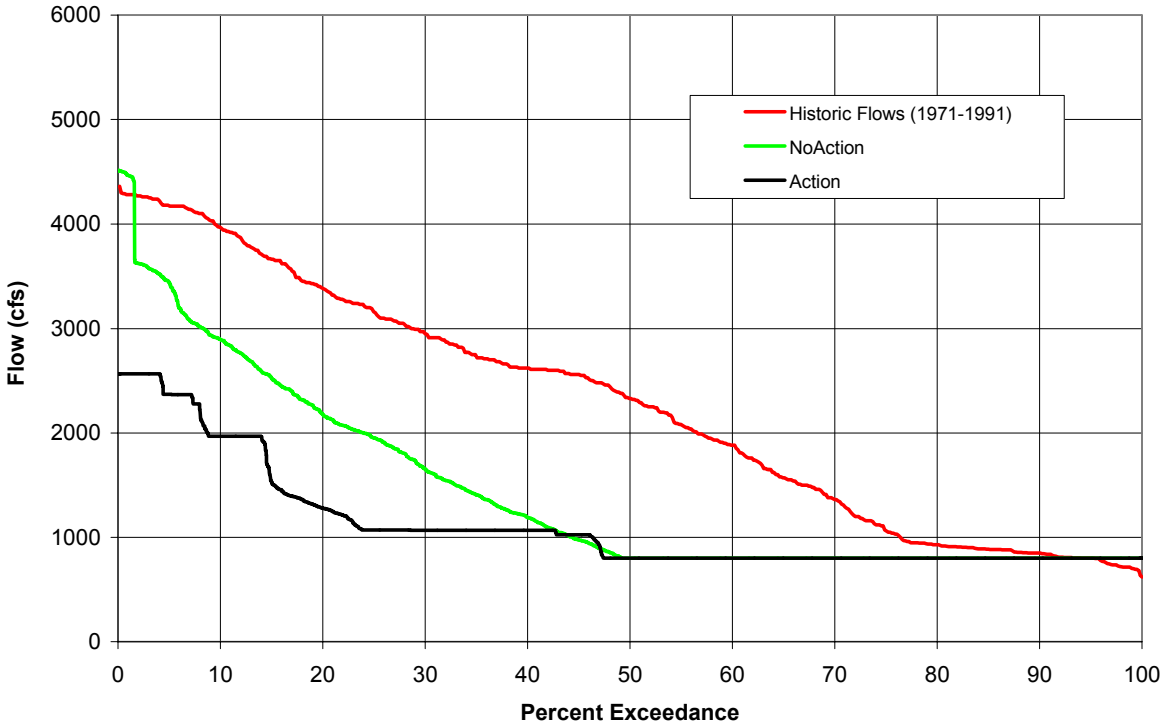

Figure 4.3: Reach One Flows in March

Modelled vs. Historic

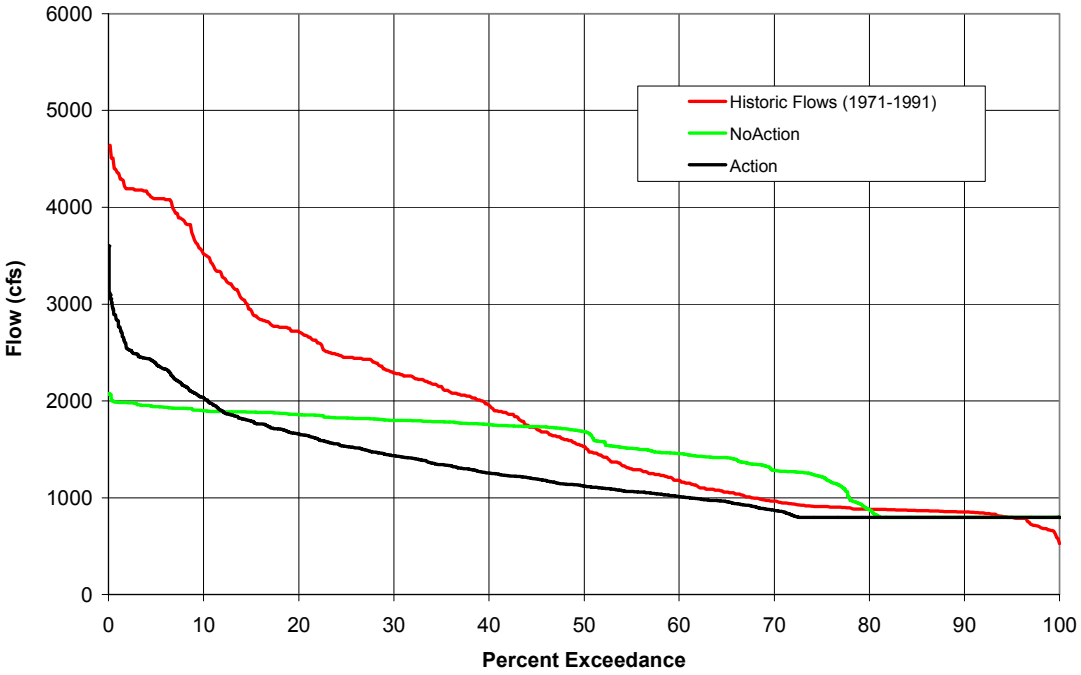

Figure 4.4: Reach One Flows in April

Modelled vs. Historic

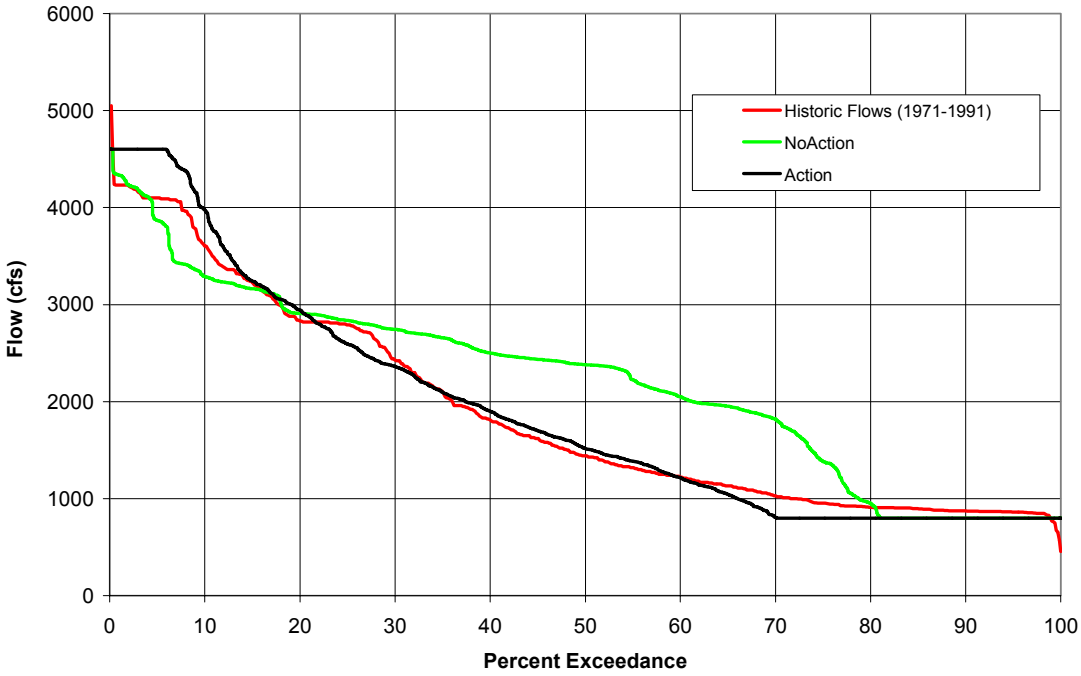

Figure 4.5: Reach One Flows in May

Modelled vs. Historic

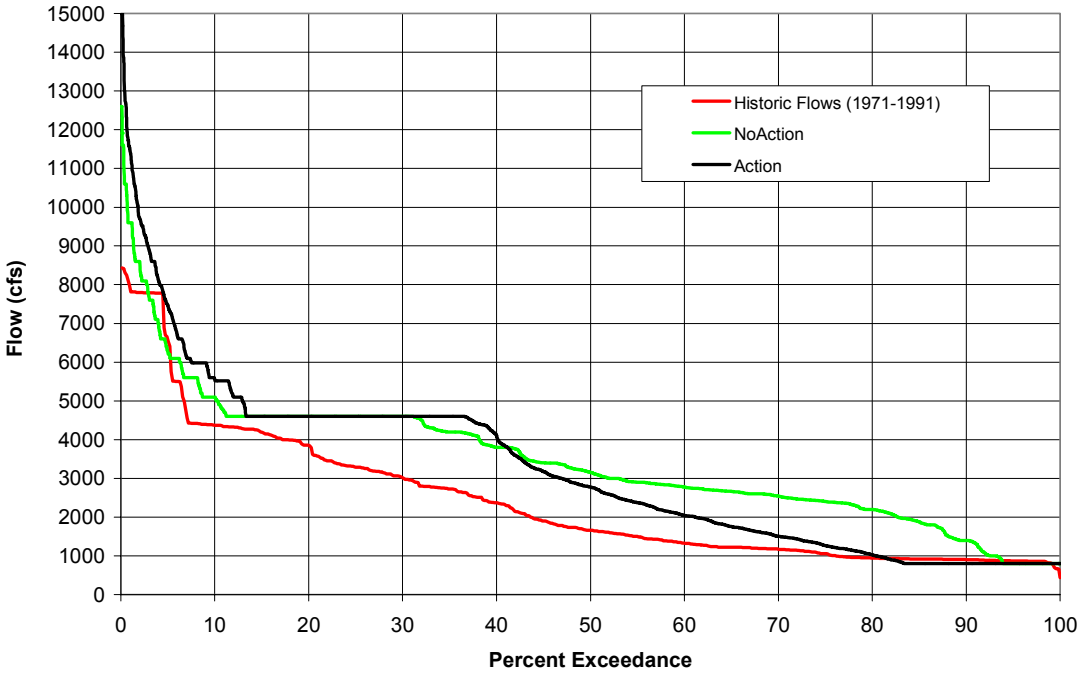

Figure 4.6: Reach One Flows in June

Modelled vs. Historic

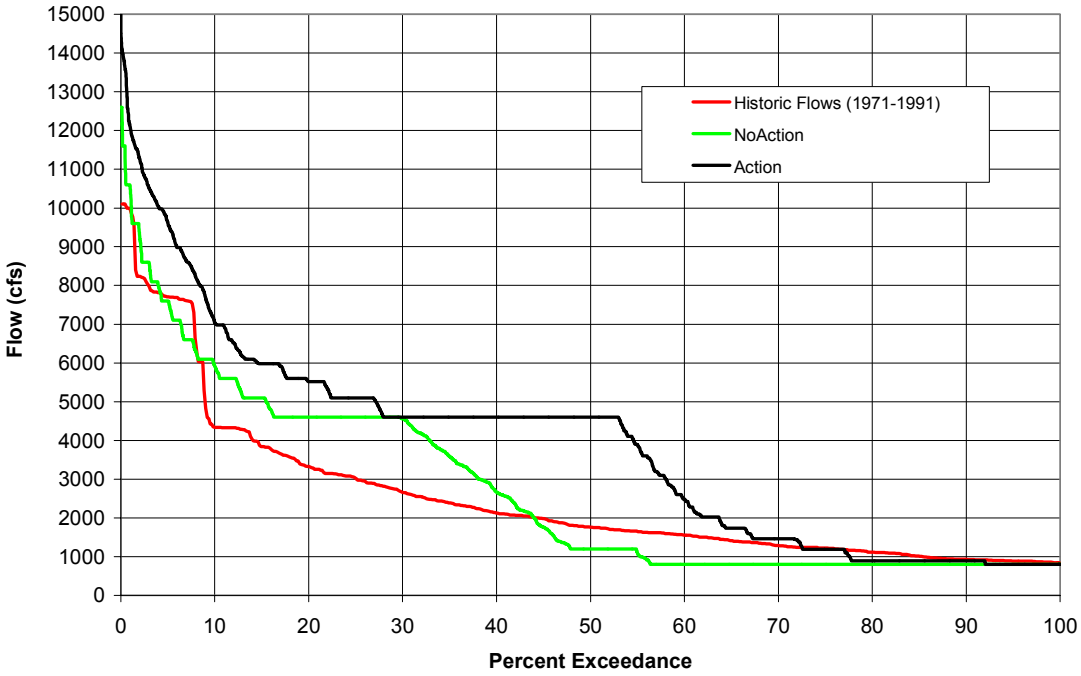

Figure 4.7: Reach One Flows in July

Modelled vs. Historic

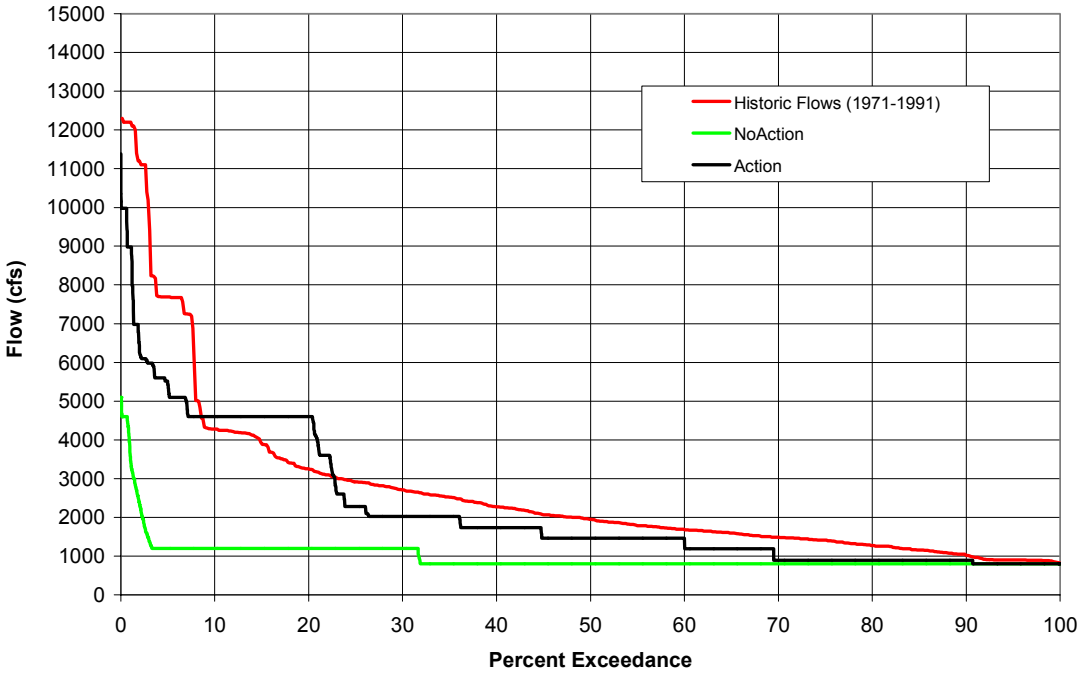

Figure 4.8: Reach One Flows in August

Modelled vs. Historic

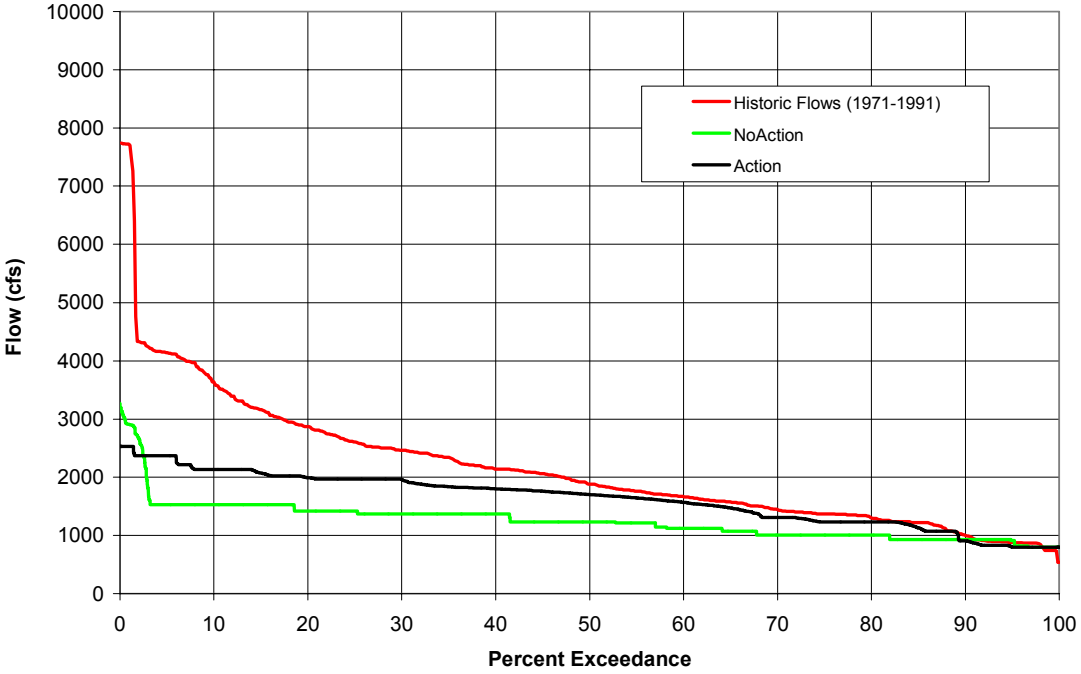

Figure 4.9: Reach One Flows in September

Modelled vs. Historic

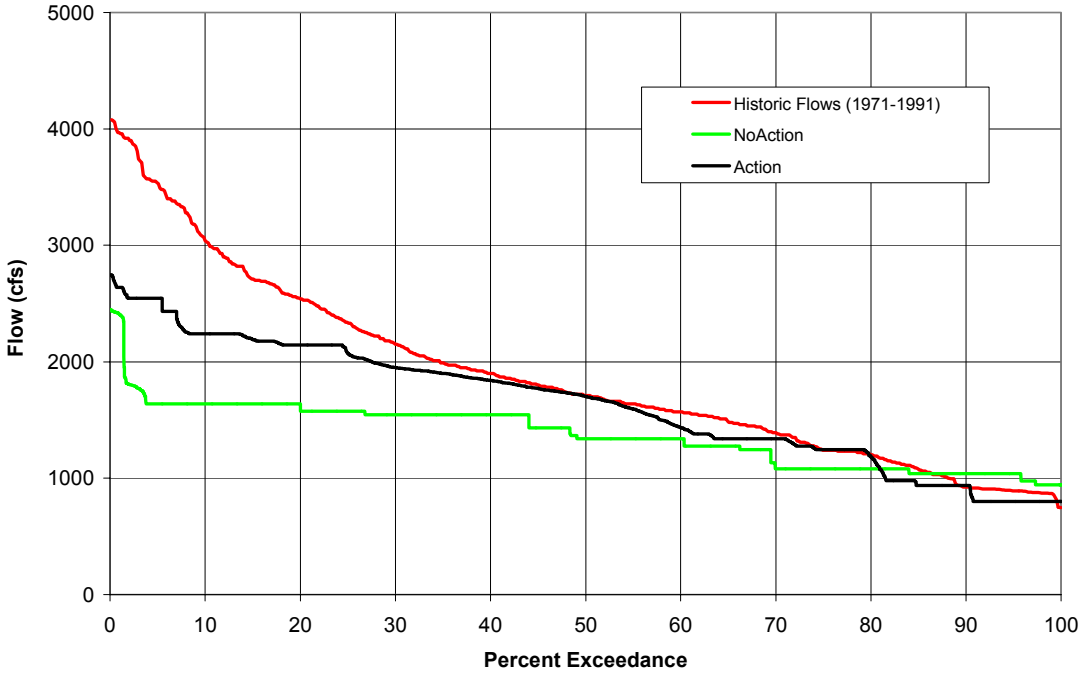

Figure 4.10: Reach One Flows in October

Modelled vs. Historic

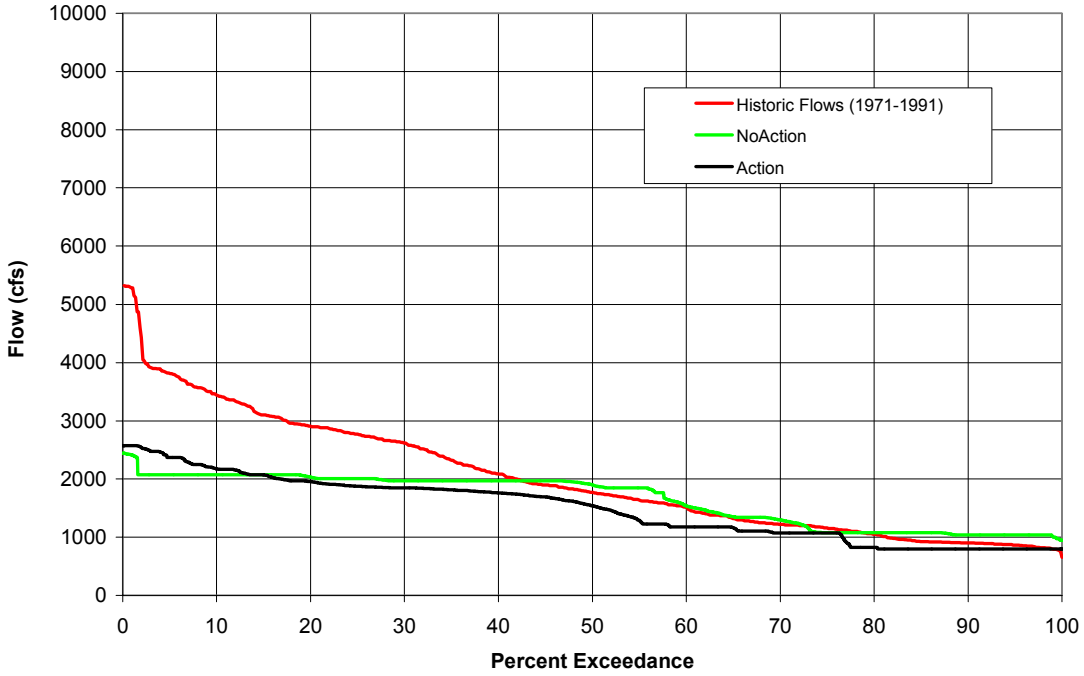

Figure 4.11: Reach One Flows in November

Modelled vs. Historic

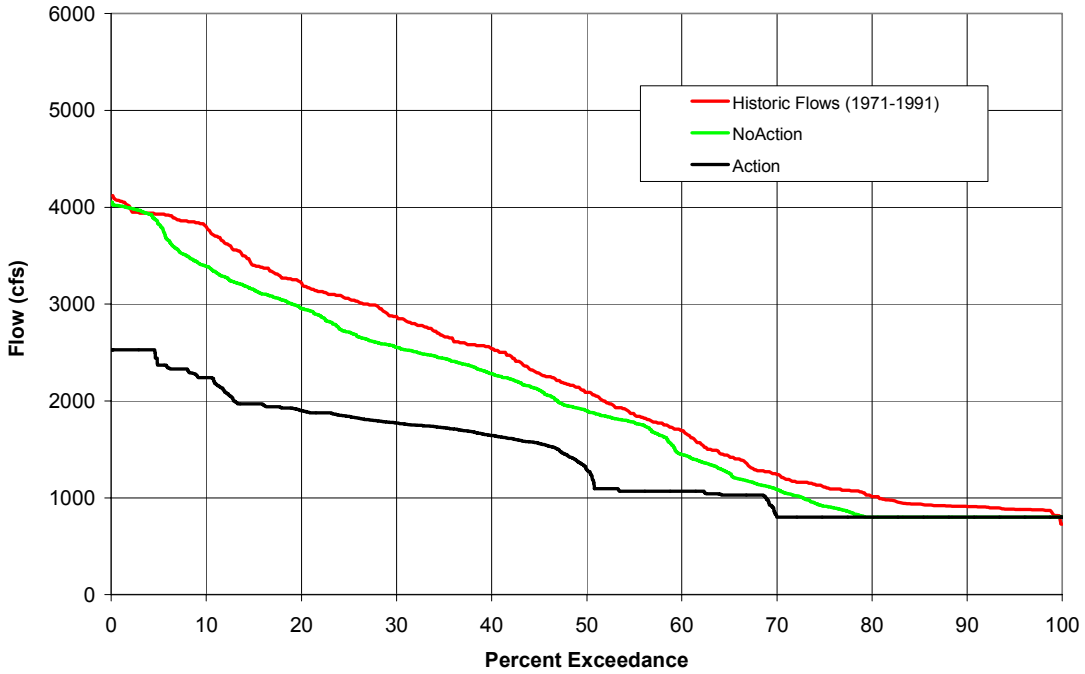

Figure 4.12: Reach One Flows in December

Modelled vs. Historic

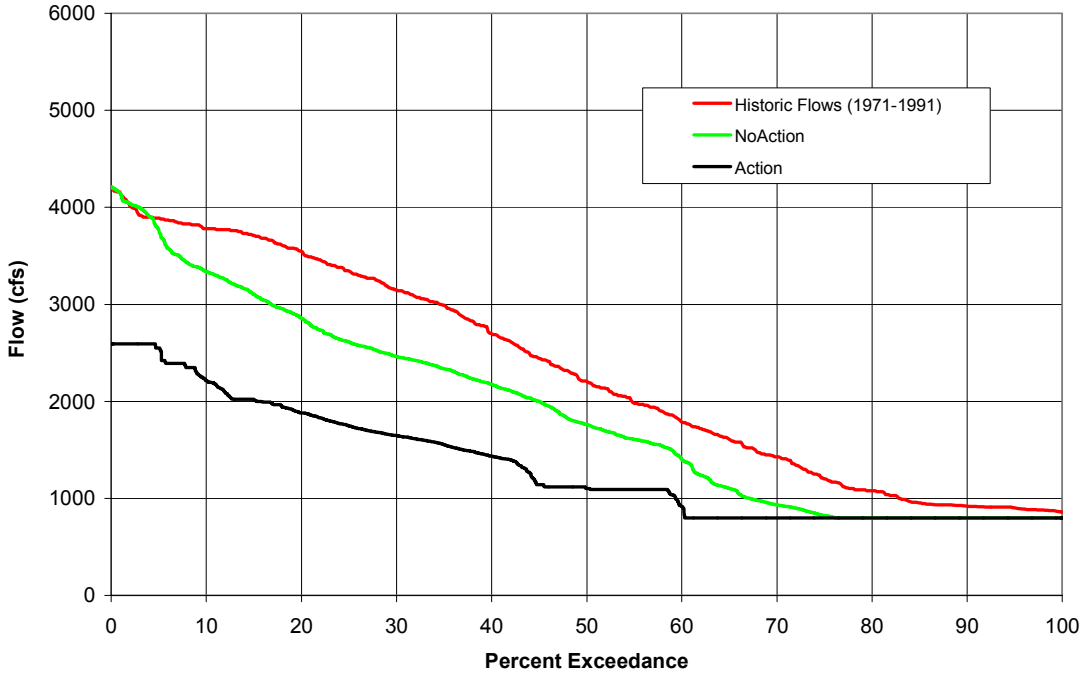

Figure 4.13: Reach Two Flows in January

Modelled vs. Historic

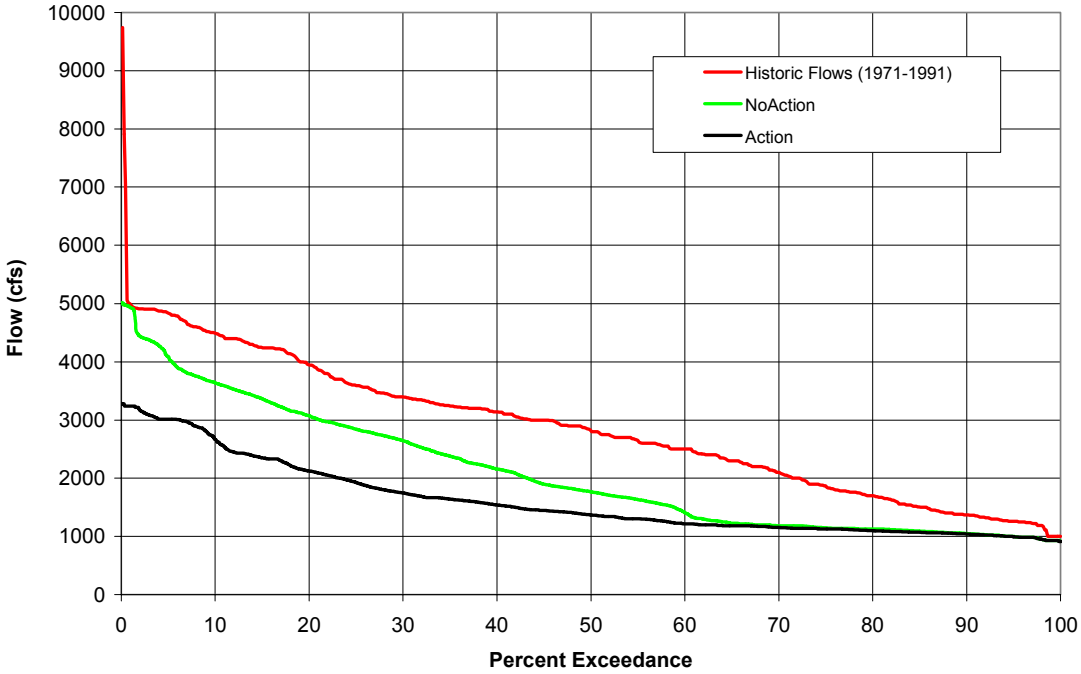

Figure 4.14: Reach Two Flows in February

Modelled vs. Historic

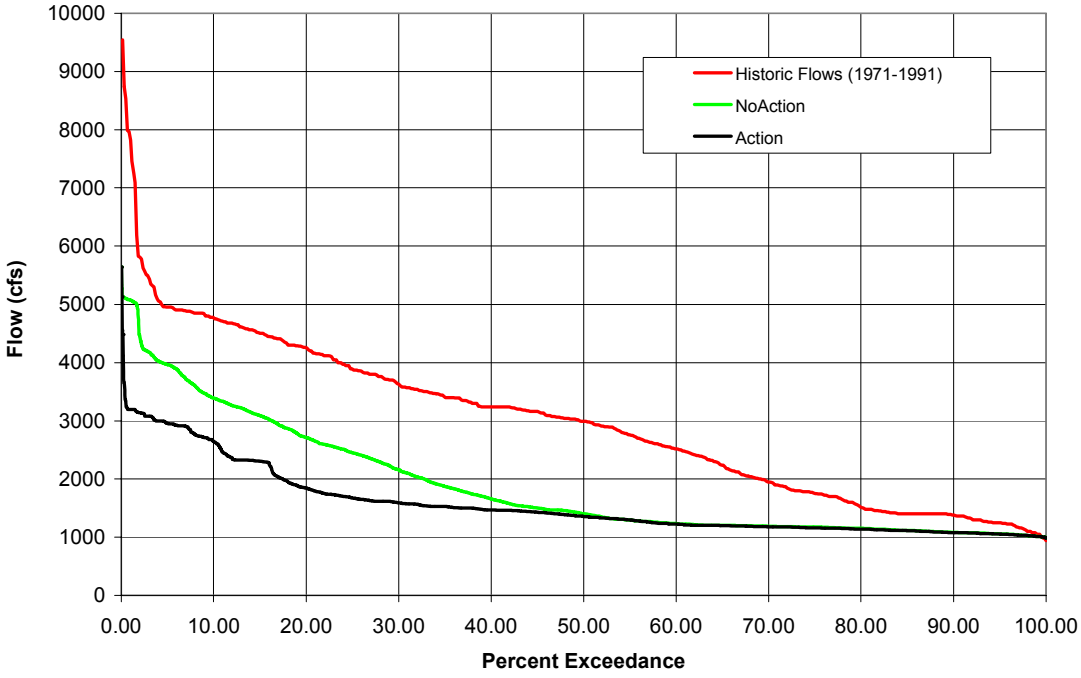

Figure 4.15: Reach Two Flows in March

Modelled vs. Historic

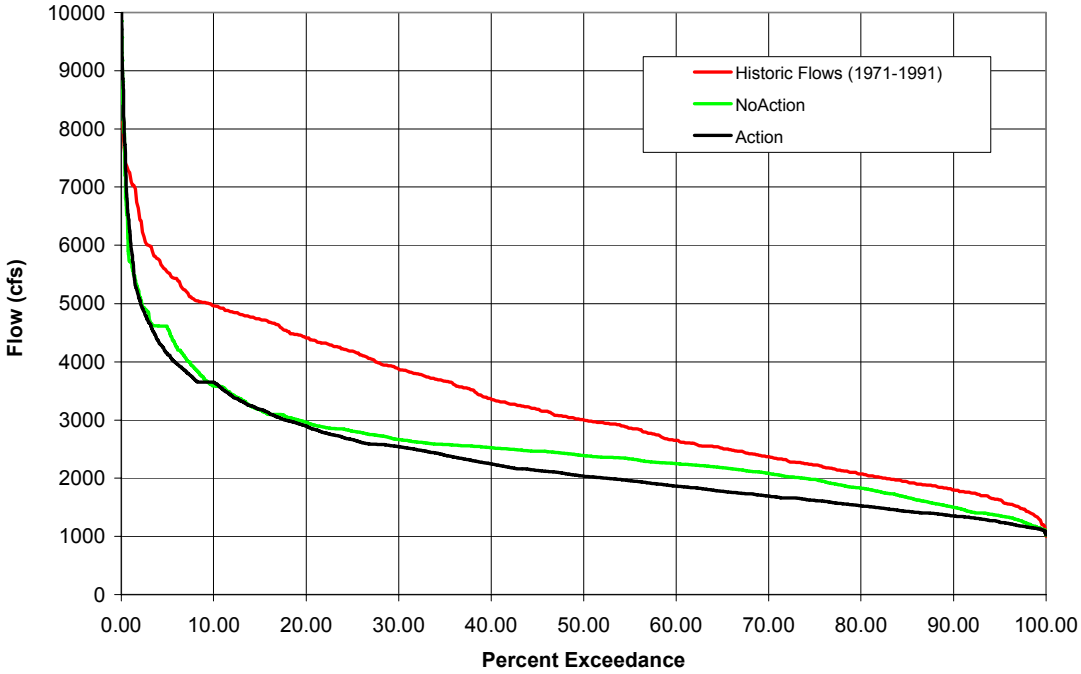

Figure 4.16: Reach Two Flows in April

Modelled vs. Historic

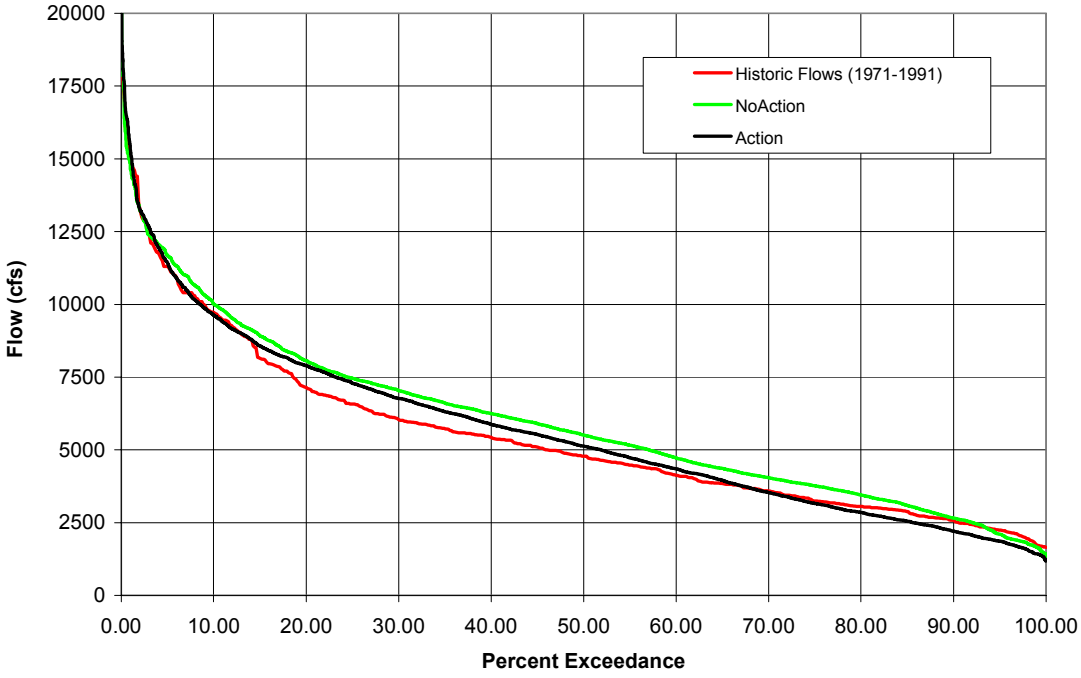

Figure 4.17:Reach Two Flows in May

Modelled vs. Historic

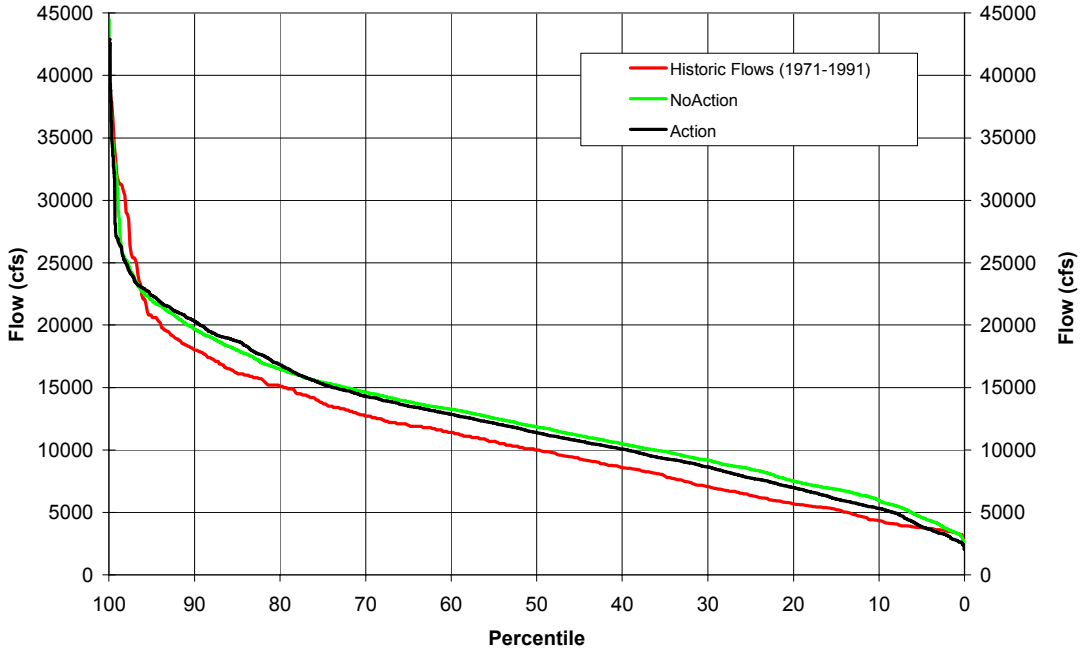

Figure 4.18: Reach Two Flows in June

Modelled vs. Historic

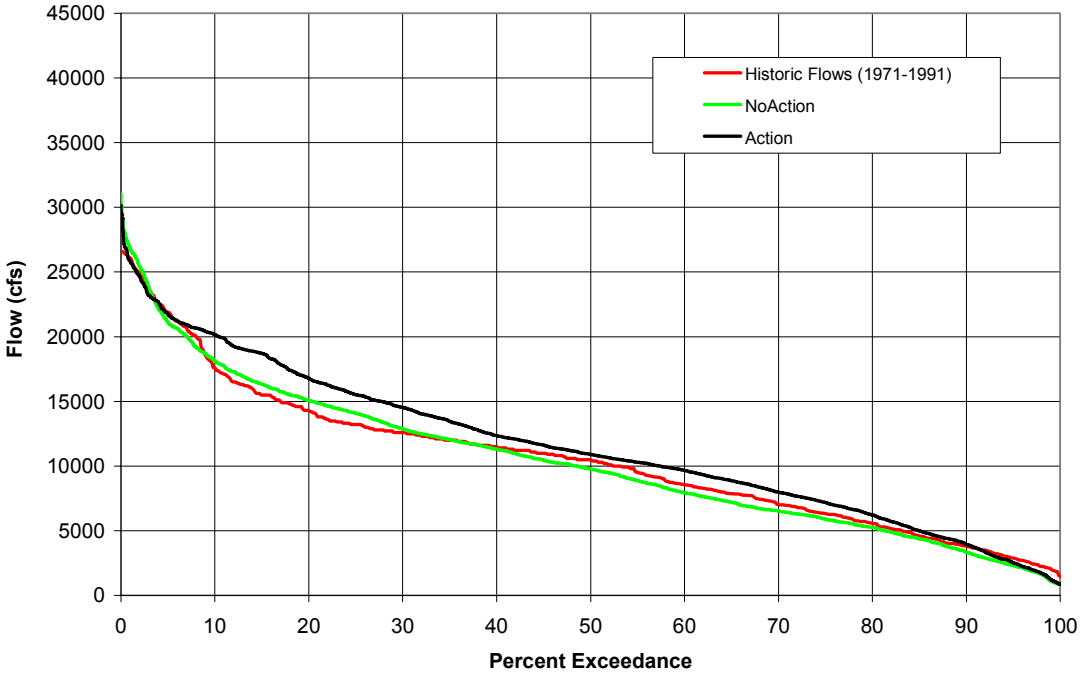

Figure 4.19: Reach Two Flows in July

Modelled vs. Historic

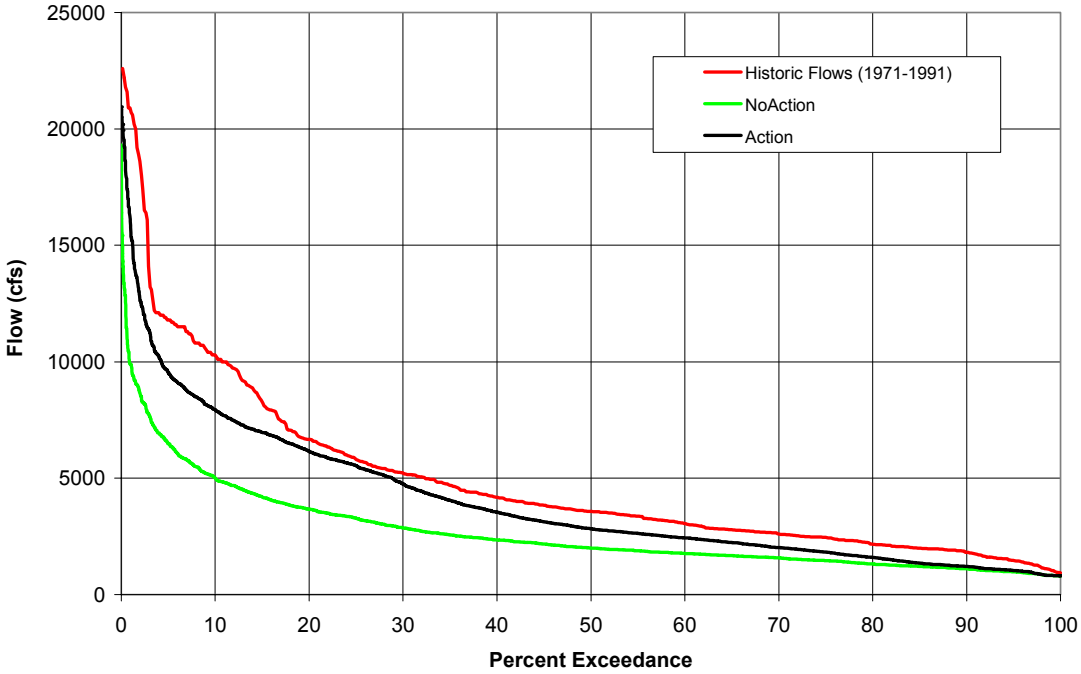

Figure 4.20: Reach Two Flows in August

Modelled vs. Historic

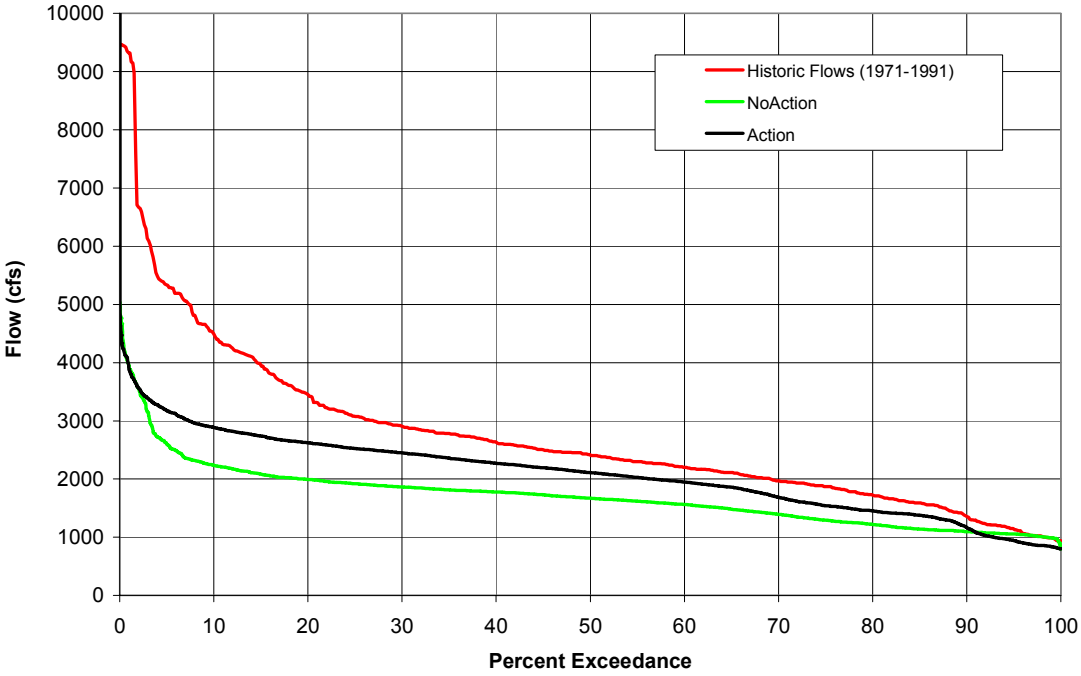

Figure 4.21: Reach Two Flows in September

Modelled vs. Historic

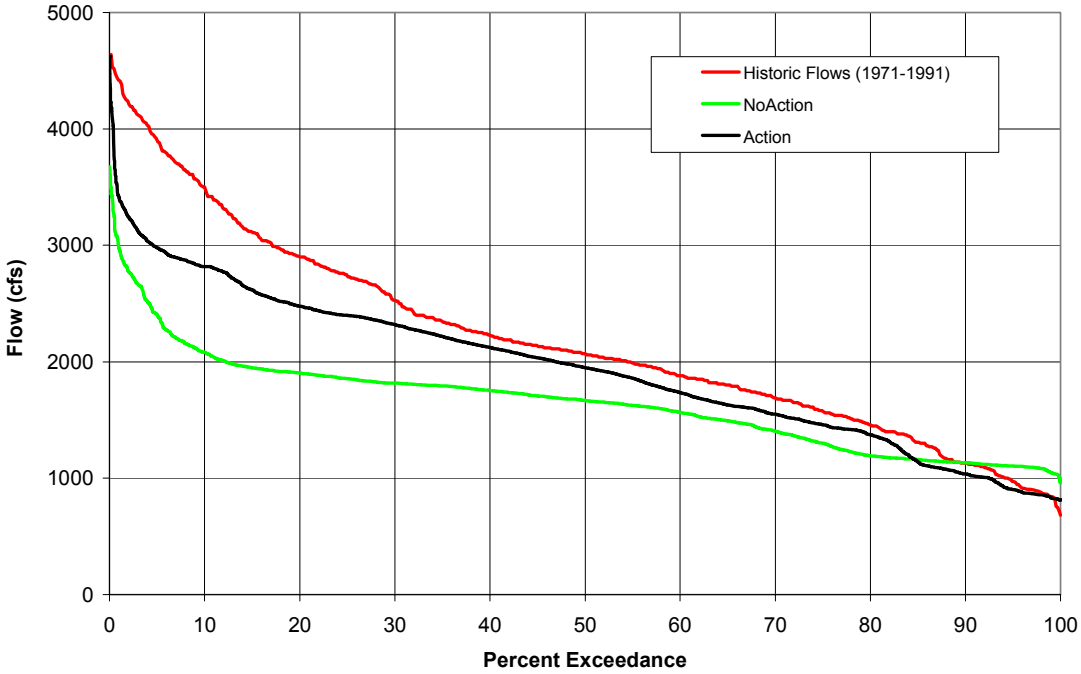

Figure 4.22: Reach Two Flows in October

Modelled vs. Historic

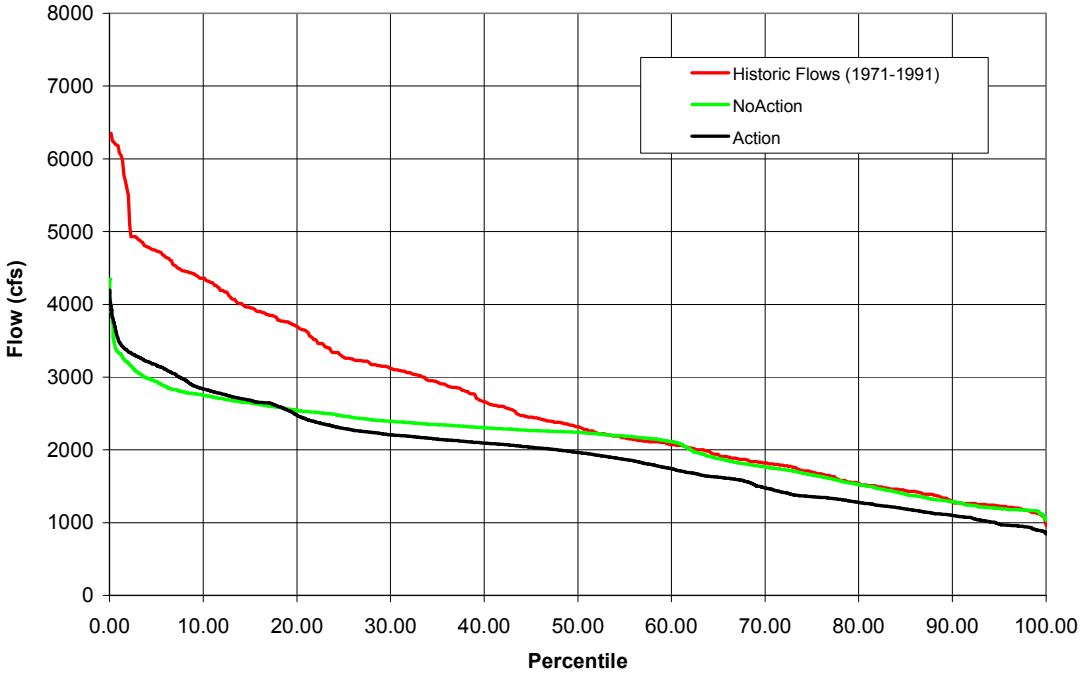

Figure 4.23: Reach Two Flows in November

Modelled vs. Historic

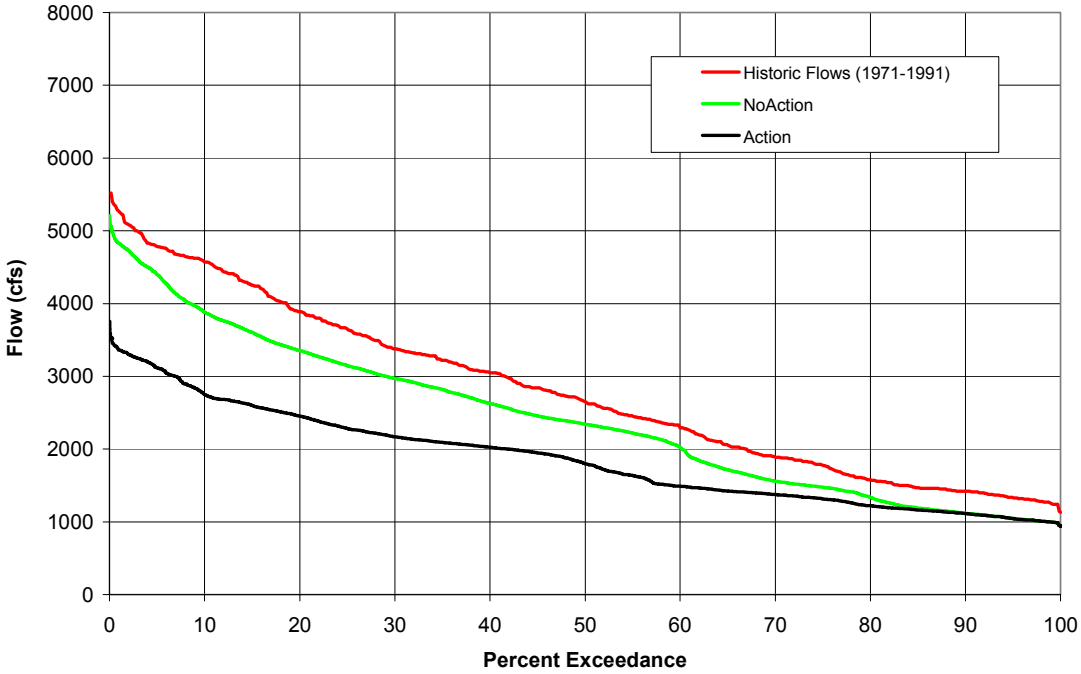

Figure 4.24: Reach Two Flows in December

Modelled vs. Historic

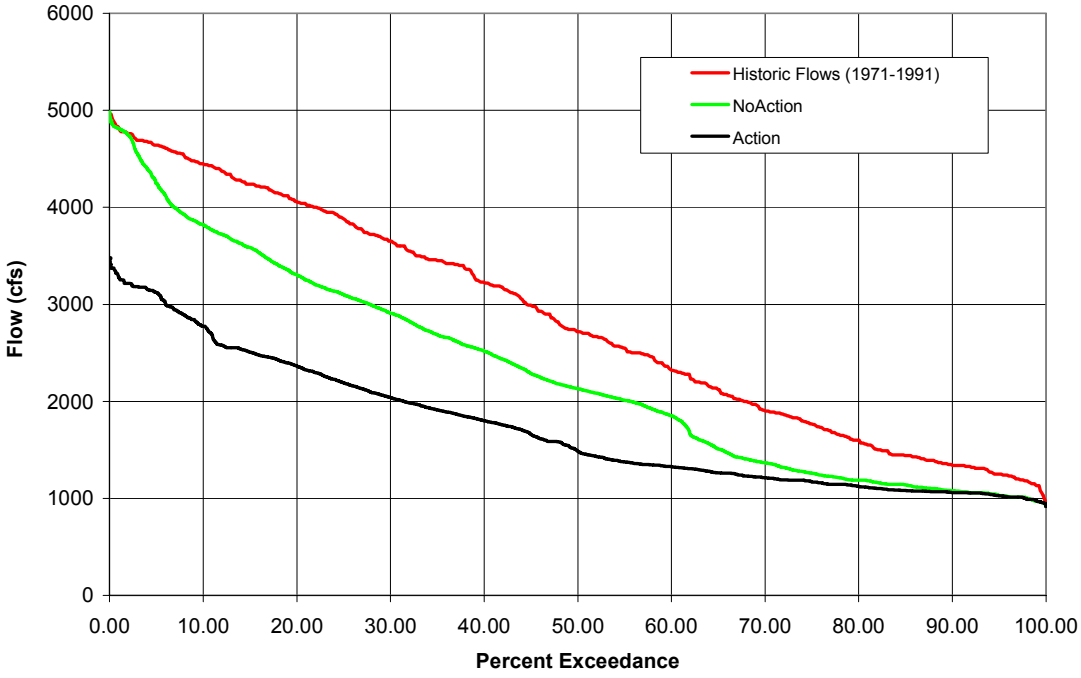

Figure 4.1.1
Green River Reach 1: Total Load Using Sediment Rating Curve by Martin et al.(1998)

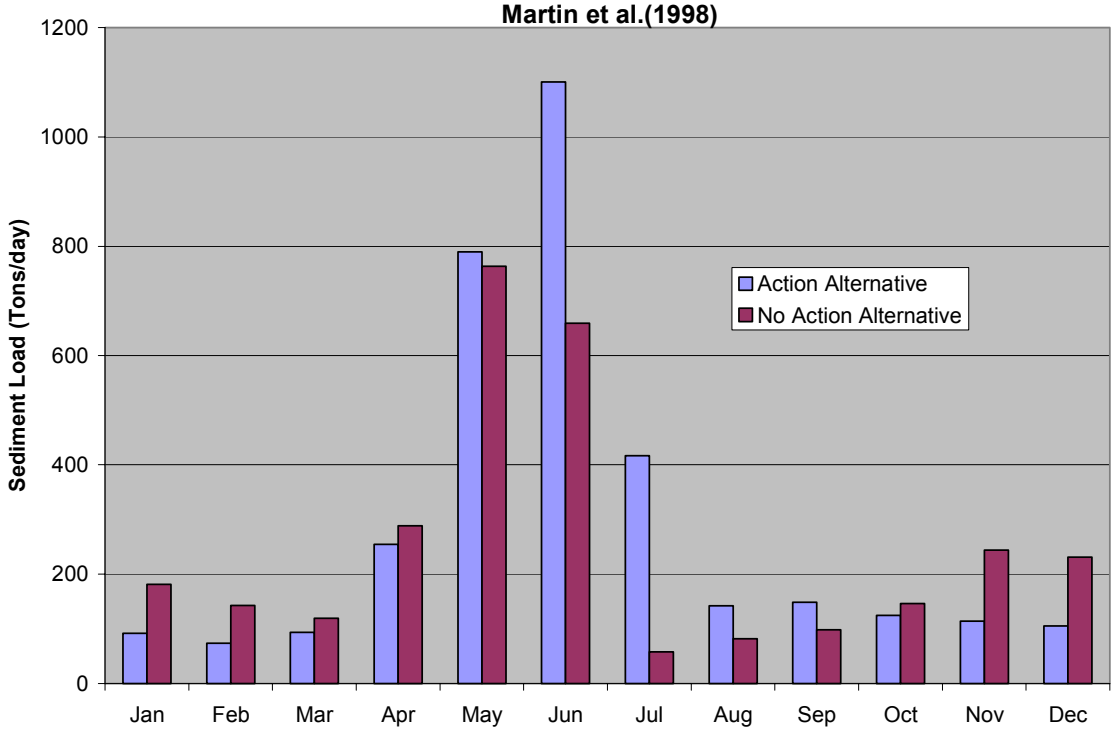

Figure 4.1.2
Green River Reach 1: Suspended Load Using Sediment Rating Curve By Martin et al.(1998)

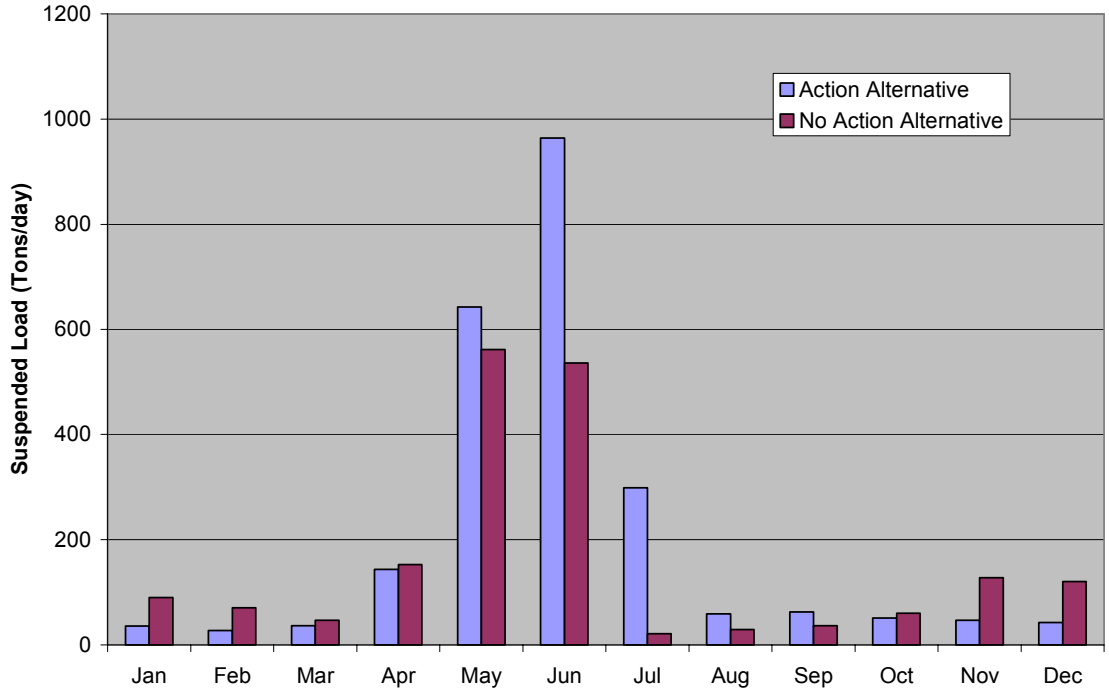

Figure 4.1.3
Green River Reach 2: Sand Load Using Sediment Rating Curve by Andrews (1986)

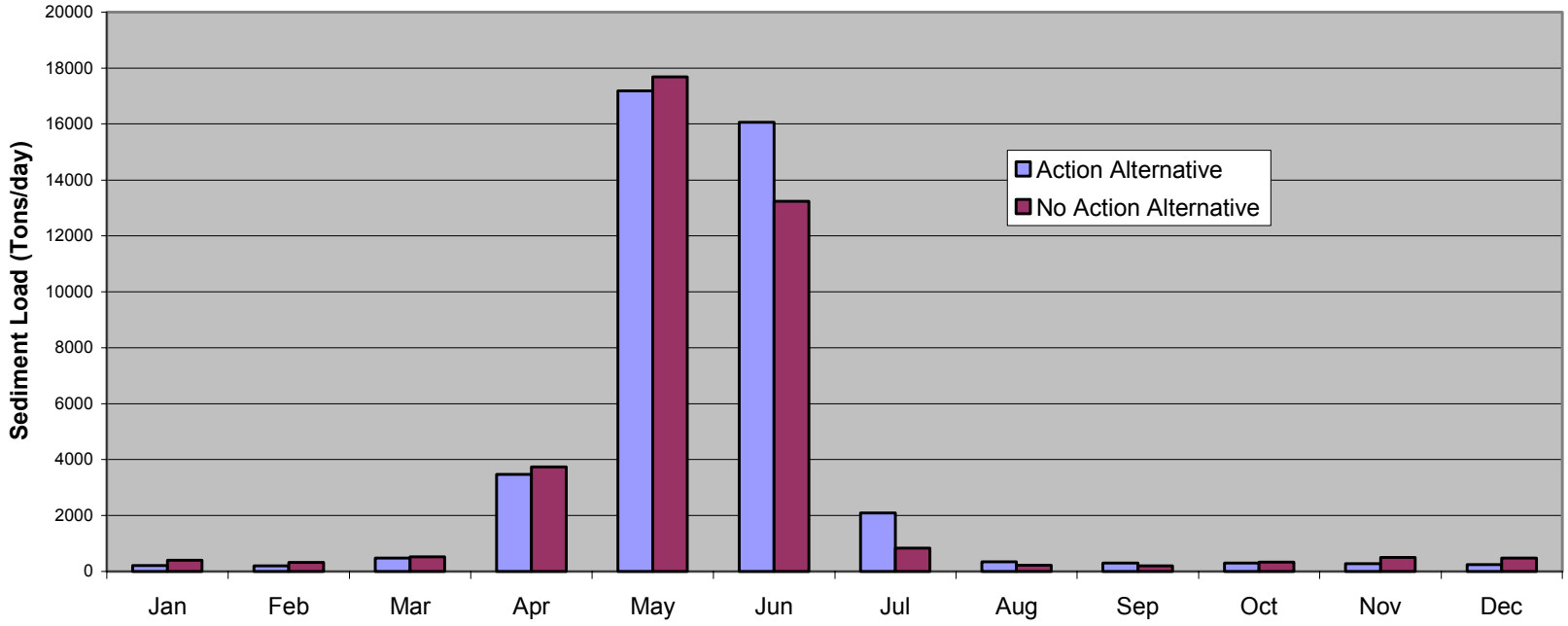

Figure 4.1.4
Green River Reach 3: Sandload Using Sediment Rating Curve by Andrews (1986)