

Total Hg in Fish Tissue vs. Hydrology Data

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Overview

- **There are significant relationships between**
 - days of **high (low) discharge rates** (esp. storm events) and **high (low) fish tissue Hg** content
 - Primary finding is that major storm events drive high Hg content in fish tissue up to 3 years later
- **Should not be over-interpreted**
 - Some plots suggest the regressions are driven by three large storm events and a few periods of unusually low flow rates
 - Other plots suggest a general correlation between discharge rate and subsequent fish total Hg level

Years Fish Sampled

Years Species Sampled

Year	LMB	SMB	Sucker	SunFish
1977	X	X	X	X
1978	X	X	X	X
1979	X	X	X	X
1980	X	X	X	X
1981	X	X	X	X
1983	X	X	X	X
1984	X	X	X	X
1985	X	X	X	X
1986	X	X	X	X
1987	X	X	X	X
1992	X	X	X	X
1994	X	X	X	X
1996	X	X	X	X
1999	X	X	X	X
2001		X		
2002	X	X	X	X
2005	X	X	X	X

Fish were not sampled every year.

There are 1, 2, 3 and 5 years between samples.

Relationship between discharge rates (or storm events) and total Hg in fish tissue might be confounded by delay in sampling.

Analysis should allow for up to 3-year time lag between storm event and effect observed in fish.

Major Storms

- Major storms resulting in maximum daily discharge rates of 10,000+ cfs at Harrisonton

Date	Dischrg Rate	Next Fish Samples
• 22JUN72	12300	1977
• 21JUN72	10400	1977
• 05NOV85	16400	1986, 87, 92
• 04NOV85	15000	1986, 87, 92
• 19JAN96	12500	1999, 01, 02, 05
• 06SEP96	10800	1999, 01, 02, 05
• 19SEP03	12500	2005

2001 was small sample of SMB only

Regression of Fish Tissue Hg on Discharge Data

- **Total Hg in fish tissue was adjusted for fish size through ANCOVA of $\log(\text{THg})$ on $\log(\text{Length})$, with factors Year and Station, and slope adjustments for each factor**
 - Separately for each species
- **Log(Adjusted total Hg) then regressed on maximum daily discharge rate at 0, 1, 2, and 3-year time lags**
 - Separately for each species, and station
 - Year 0 is time in current calendar year up to fish sample date

Regression

- **Visual and formal analysis show relationships between total fish tissue Hg and maximum daily discharge**
- **0, 1, 2, and 3**
- **years previous to fish sample**

Regression 2

- **Fish age was estimated from size**
- **Unadjusted total Hg was regressed on same lagged discharge rates for fish of various ages**
- **Results for fish 0-3, 0-4, 3+, or 4+ years old generally support conclusions**
- **Insufficient data to explore 3 yr only or <3 yr only**

Age-Size Relationship

- **Information and data supplied by VADEQ and Greg Murphy's thesis**
- **Age-size relationships vary according to**
 - **fish species**
 - **Only SMB, redbreast, sucker age data available**
 - **stream**
 - **may vary within a stream over river miles**
 - **Data insufficient to explore this point**
- **Only very minor differences observed between sexes**
 - **Sex differences consequently ignored**

SMB Count Per Station & Age

----- Stream=South River -----

Table of station by age

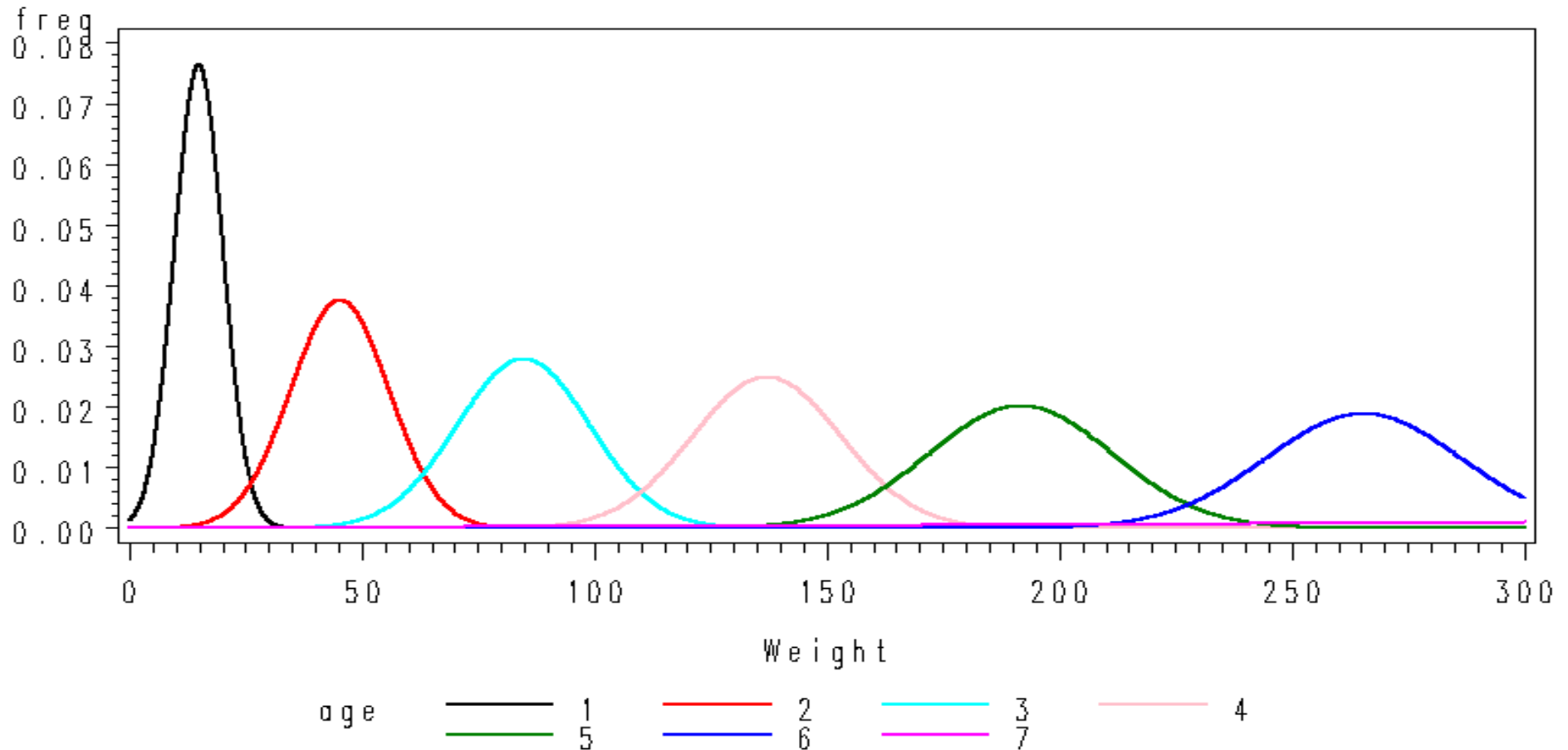
station	/ age							Total	
	1	2	3	4	5	6	7		
3	10	8	6	8	12	10	7	61	Footbridge
5	6	2	5	5	8	3	5	34	Dooms
6	9	4	5	6	8	5	11	48	Crimora
7	11	19	21	14	5	7	13	90	Grottoes
.									
Total	66	37	52	51	49	36	55	346	

----- Stream=North River -----

station	/ age							Total	
	1	2	3	4	5	6	7		
8	12	15	9	12	13	8	19	88	Near Rt. 668 bridge
Total	21	15	9	12	13	8	19	97	

Distribution of SMB Weight by Age

In South River



Separation of weights by age class is ambiguous

Age–weight and age-length relationships are available on a small sample from G. Murphy’s thesis. Age estimated on main database assuming the same relationships.

Regression of Log(Adjusted Hg) vs Year

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	9	5.03	0.0007
Year	.	.	Error	24	—	—
Year	.	.	Corrected Total	33	—	—
Year	0.65372	.	R-Square	.	.	.
Hydro	.	.	Model	4	9.32	<.0001
Hydro	.	.	Error	29	—	—
Hydro	.	.	Corrected Total	33	—	—
Hydro	0.562384	86	R-Square	.	.	.
Hydro	.	.	harriston0	1	8.87	0.0058
Hydro	.	.	harriston1	1	3.96	0.0561
Hydro	.	.	harriston2	1	6.31	0.0178
Hydro	.	.	harriston3	1	18.40	0.0002

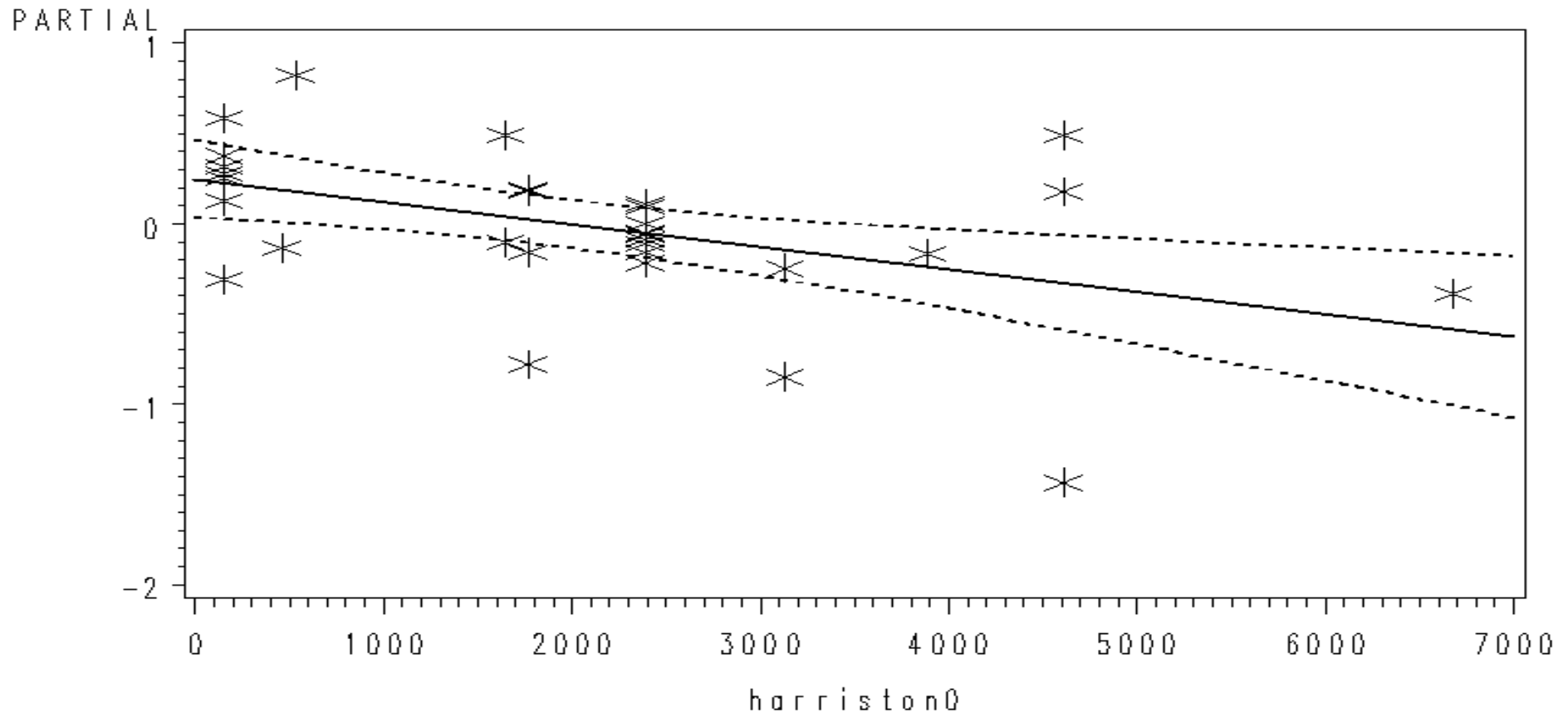
Parameter	Estimate	StdErr	tValue	Probt
Intercept	0.5825536715	0.17194901	3.39	0.0020
harriston0	-.0001335848	0.00004486	-2.98	0.0058
harriston1	-.0000543859	0.00002733	-1.99	0.0561
harriston2	-.0000465399	0.00001853	-2.51	0.0178
harriston3	0.0000745493	0.00001738	4.29	0.0002

Log(Total Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 0 Years Previous

Discharge rates Divided by 10000 for Plotting

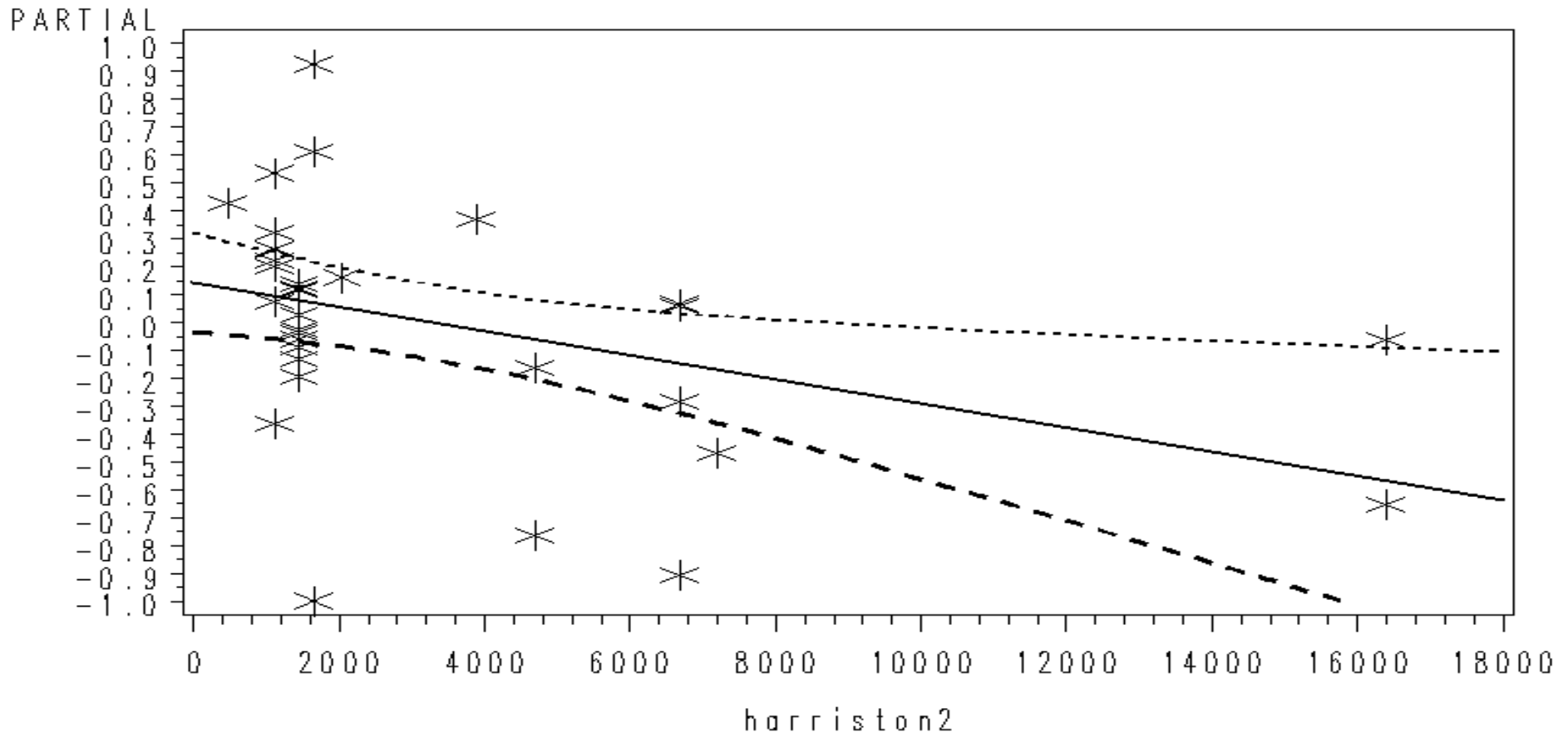


Log(Total Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 2 Years Previous

Discharge rates Divided by 10000 for Plotting



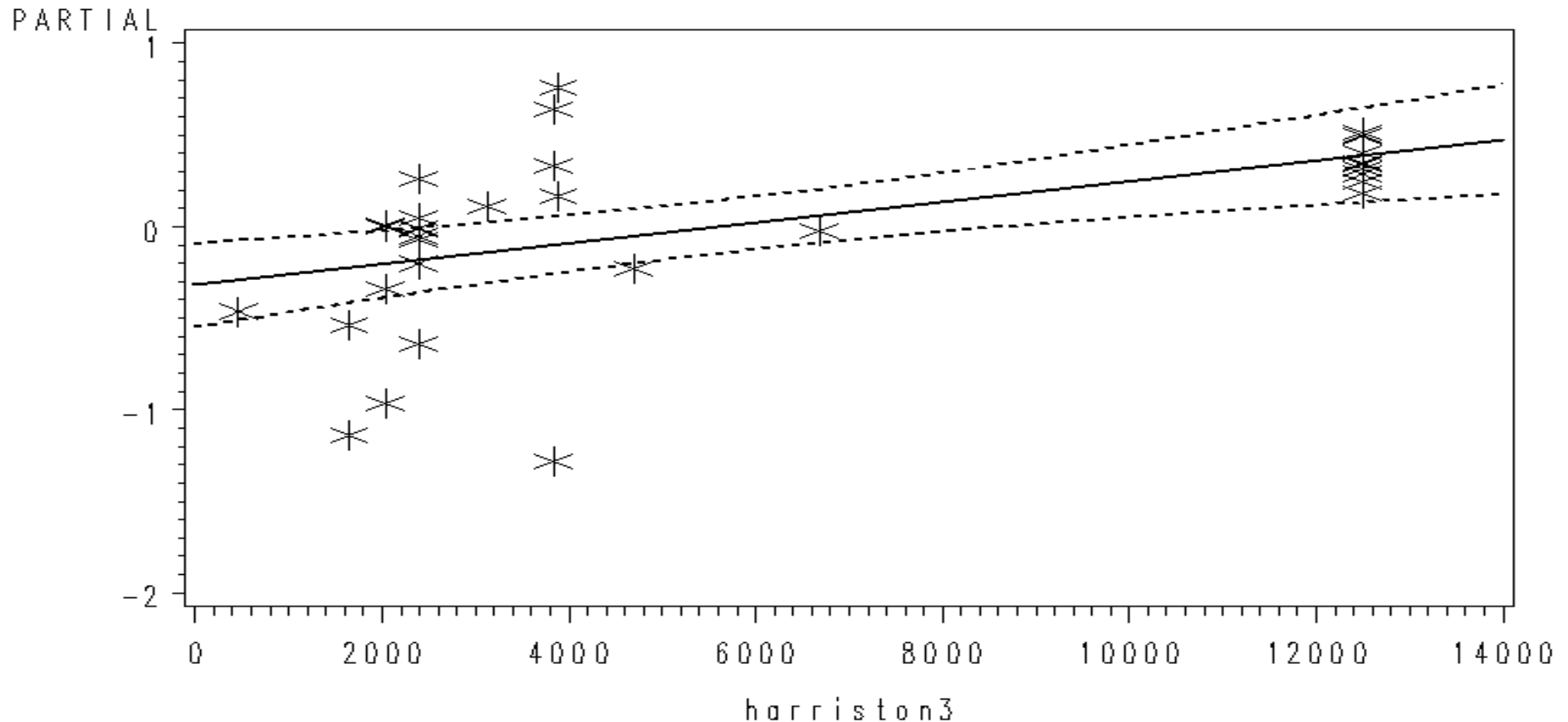
Partial regression plot showing relationship of THg vs Lag 2 discharge rate after correcting for lags 0, 1, and 3. This corresponds to ANOVA table on earlier slide. Negative slope evident.

Log(Total Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 3 Years Previous

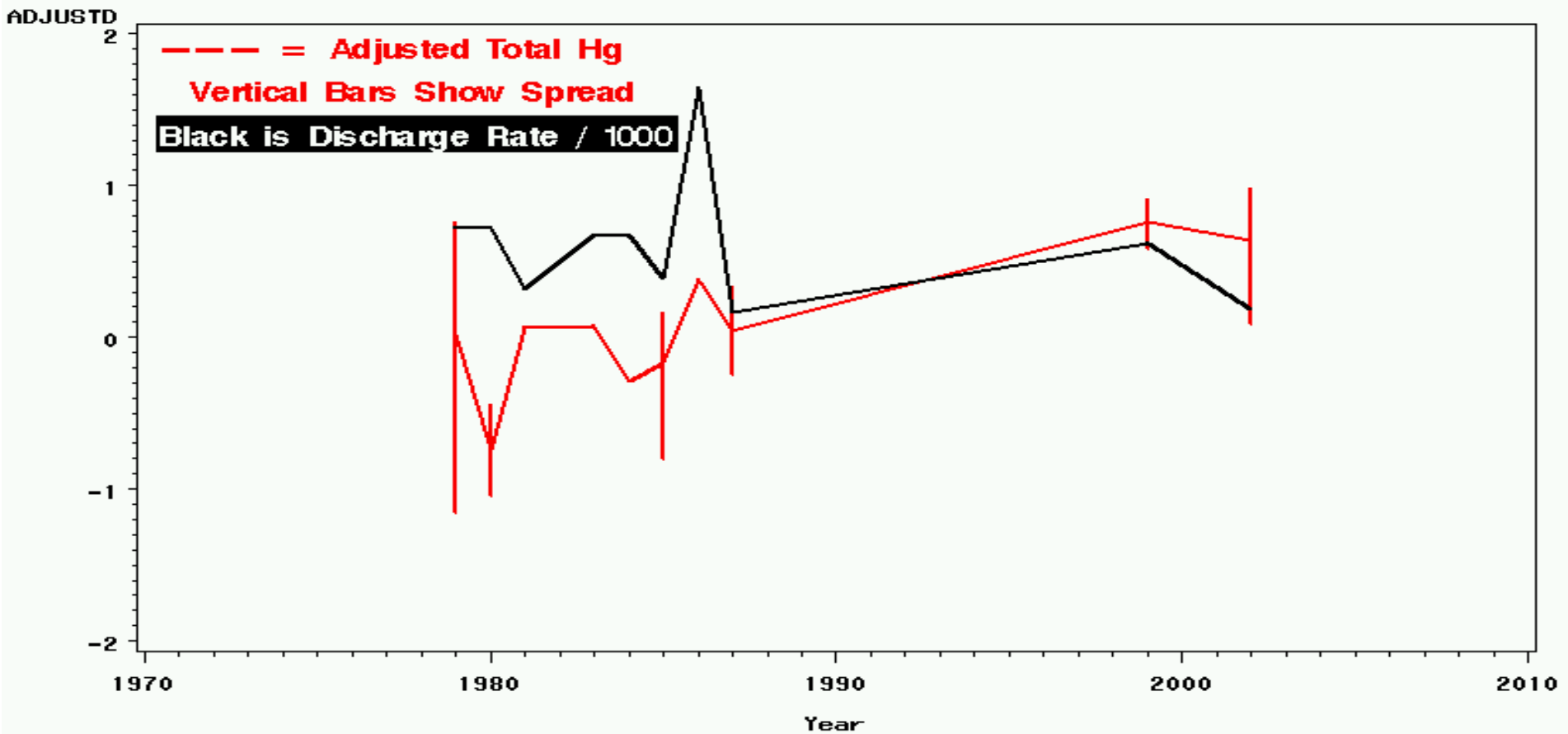
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag 3 discharge rate after correcting for lags 0, 1, and 2. This corresponds to ANOVA table on earlier slide. Regression driven only in part by high rate (occurring in 1996)

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

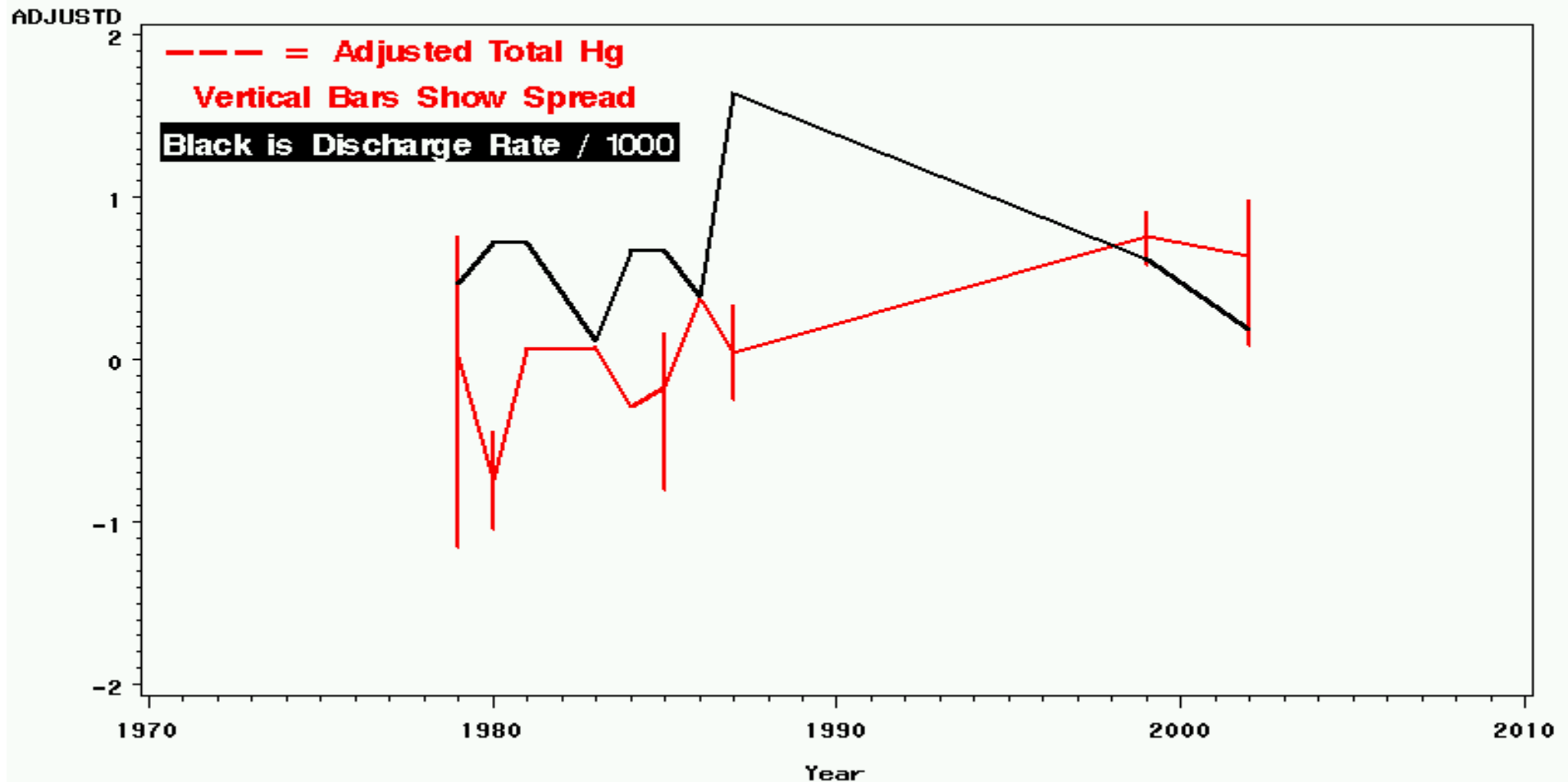
SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)
Discharge Measured at HARRISTON, 0 Years Previous
Discharge rates Divided by 10000 for Plotting



The inverse relationship is evident prior to 1985. Effect of major 1985 storm is associated with increase in 1986 Hg levels.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

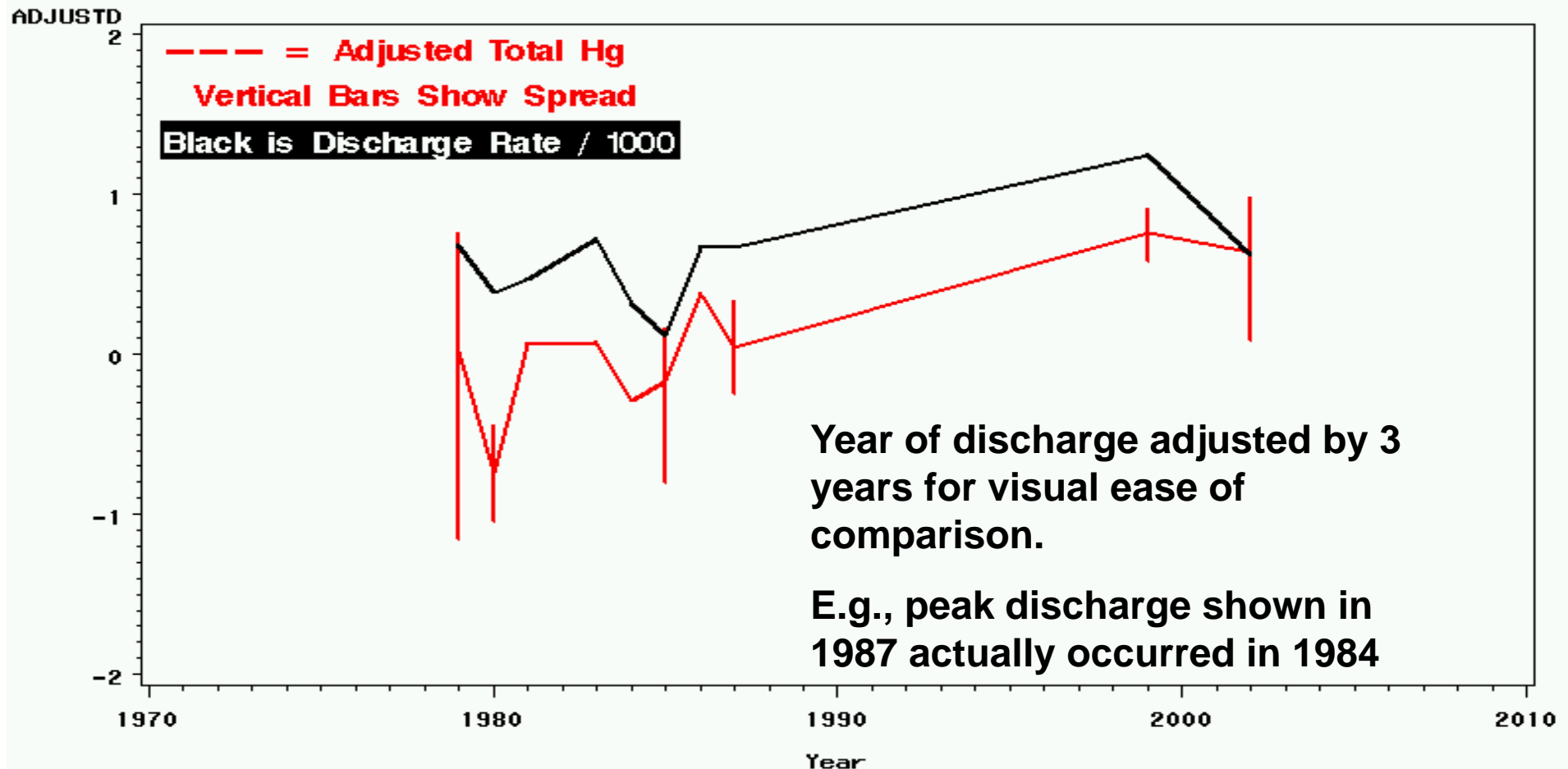
SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)
Discharge Measured at HARRISTON, 1 Years Previous
Discharge rates Divided by 10000 for Plotting



The inverse relationship is evident through most of the period 1979-2002.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)
Discharge Measured at HARRISTON, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Good correspondence between 3-year lag discharge rate and Hg levels.
Effect of 1985 major storm not seen in this plot because no fish were sampled in 1988.

Regression of Log(Total Hg) vs Year **for Fish >=3** Years old SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	5	14.40	<.0001
Year	.	.	Error	20	—	—
Year	.	.	Corrected Total	25	—	—
Year	0.782641	.	R-Square	.	.	.
Hydro	.	.	Model	4	15.76	<.0001
Hydro	.	.	Error	21	—	—
Hydro	.	.	Corrected Total	25	—	—
Hydro	0.750154	96	R-Square	.	.	.
Hydro	.	.	harriston0	1	31.18	<.0001
Hydro	.	.	harriston1	1	3.27	0.0849
Hydro	.	.	harriston2	1	0.73	0.4020
Hydro	.	.	harriston3	1	16.21	0.0006

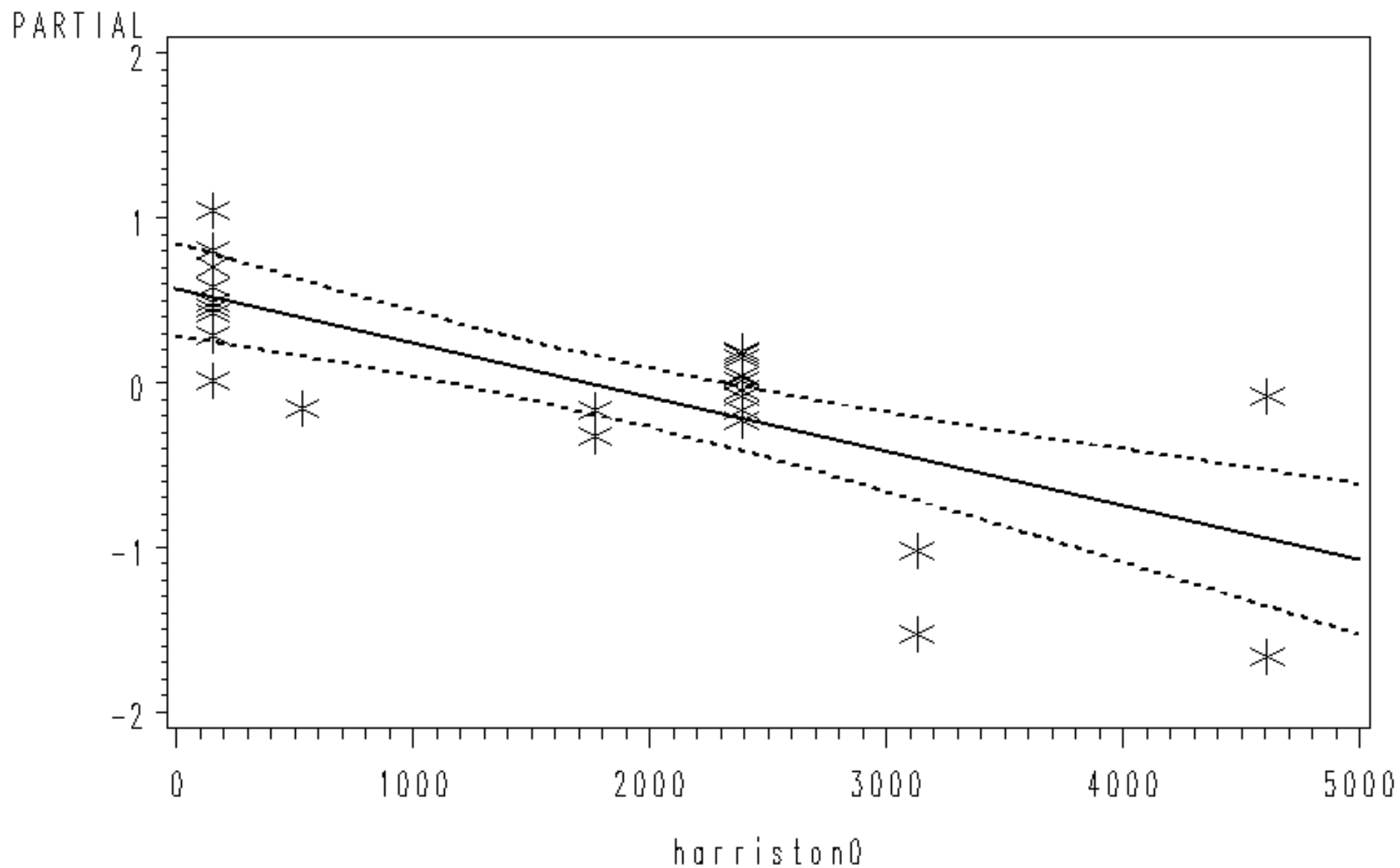
Parameter	Estimate	StdErr	tValue	Probt
Intercept	0.9599222577	0.16957375	5.66	<.0001
harriston0	-.0003356168	0.00006010	-5.58	<.0001
harriston1	-.0000555158	0.00003070	-1.81	0.0849
harriston2	-.0000472629	0.00005526	-0.86	0.4020
harriston3	0.0000841991	0.00002091	4.03	0.0006

Log(Total Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 0 Years Previous for Fish ≥ 3 Years old

Discharge rates Divided by 10000 for Plotting

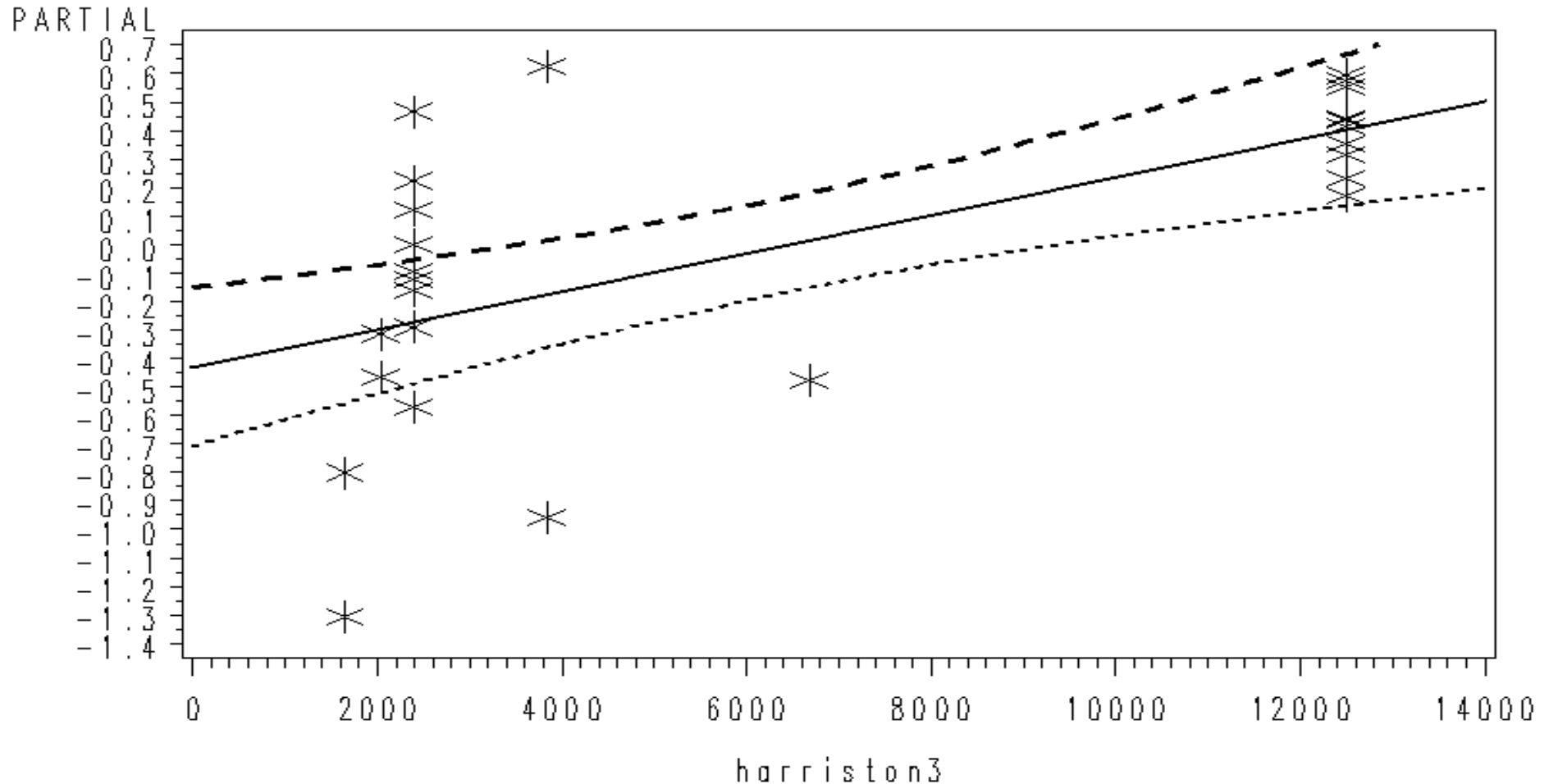


Log(Total Hg) vs Maximum Daily Discharge Rate

SMB at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 3 Years Previous for Fish ≥ 3 Years old

Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag3 discharge rate after correcting for lag 0. This corresponds to ANOVA table on previous slide. Regression driven by high rate (occurring in 1996)

Interpretation of Age-Restricted Regressions

- **Strong negative trend vs. current year discharge rates**
 - No large storm events present in same year as fish sample
 - Moderate flows may flush Total Hg from station
- **Strong positive trend vs. 3-yrs previous discharge rate**
 - Driven in large part by major storm in 1996
 - Same as with first analysis

Interpretation of Age-Restricted Regressions

- **Results are similar for SMB with age**
 - ≤ 3 yrs**
 - ≤ 4 yrs**
 - ≥ 4 yrs**
 - ≥ 3 yrs**

**Insufficient data for exactly 3 yrs old or even
2-4 yrs old**

Age estimates are only approximate

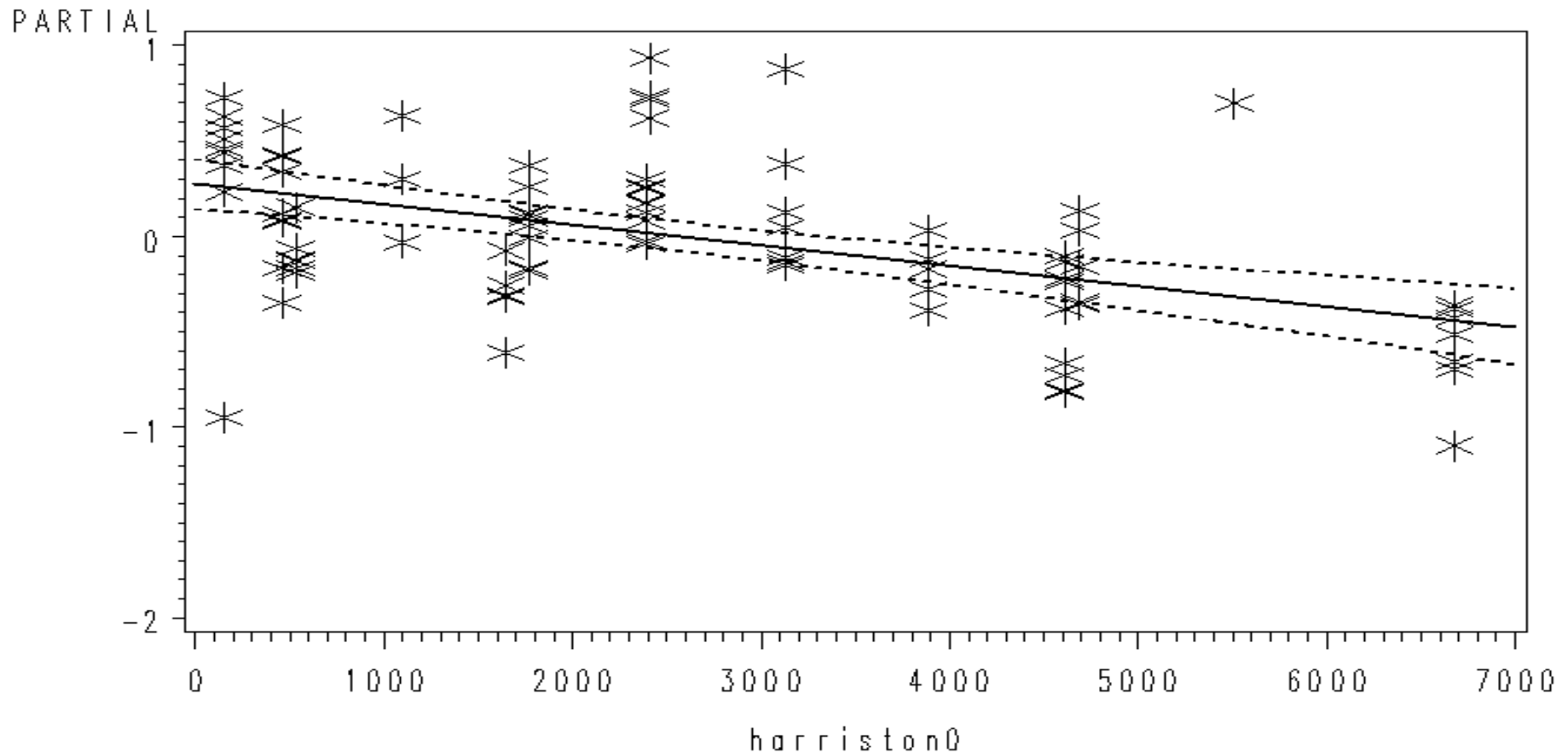
Regression of Log(Adjusted Hg) vs Year SMB at Station 7, Grottoes, VA near Grand Caverns bridge

model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	13	13.93	<.0001
Year	.	.	Error	76	—	—
Year	.	.	Corrected Total	89	—	—
Year	0.704344	.	R-Square	.	.	.
Hydro	.	.	Model	4	16.55	<.0001
Hydro	.	.	Error	85	—	—
Hydro	.	.	Corrected Total	89	—	—
Hydro	0.437823	62	R-Square	.	.	.
Hydro	.	.	harriston0	1	36.08	<.0001
Hydro	.	.	harriston1	1	5.26	0.0242
Hydro	.	.	harriston2	1	0.01	0.9310
Hydro	.	.	harriston3	1	21.53	<.0001

Parameter	Estimate	StdErr	tValue	Probt
Intercept	0.4598769318	0.13467701	3.41	0.0010
harriston0	-.0001351792	0.00002250	-6.01	<.0001
harriston1	-.0000262979	0.00001146	-2.29	0.0242
harriston2	-.0000009611	0.00001107	-0.09	0.9310
harriston3	0.0000557060	0.00001201	4.64	<.0001

Log(Total Hg) vs Maximum Daily Discharge Rate

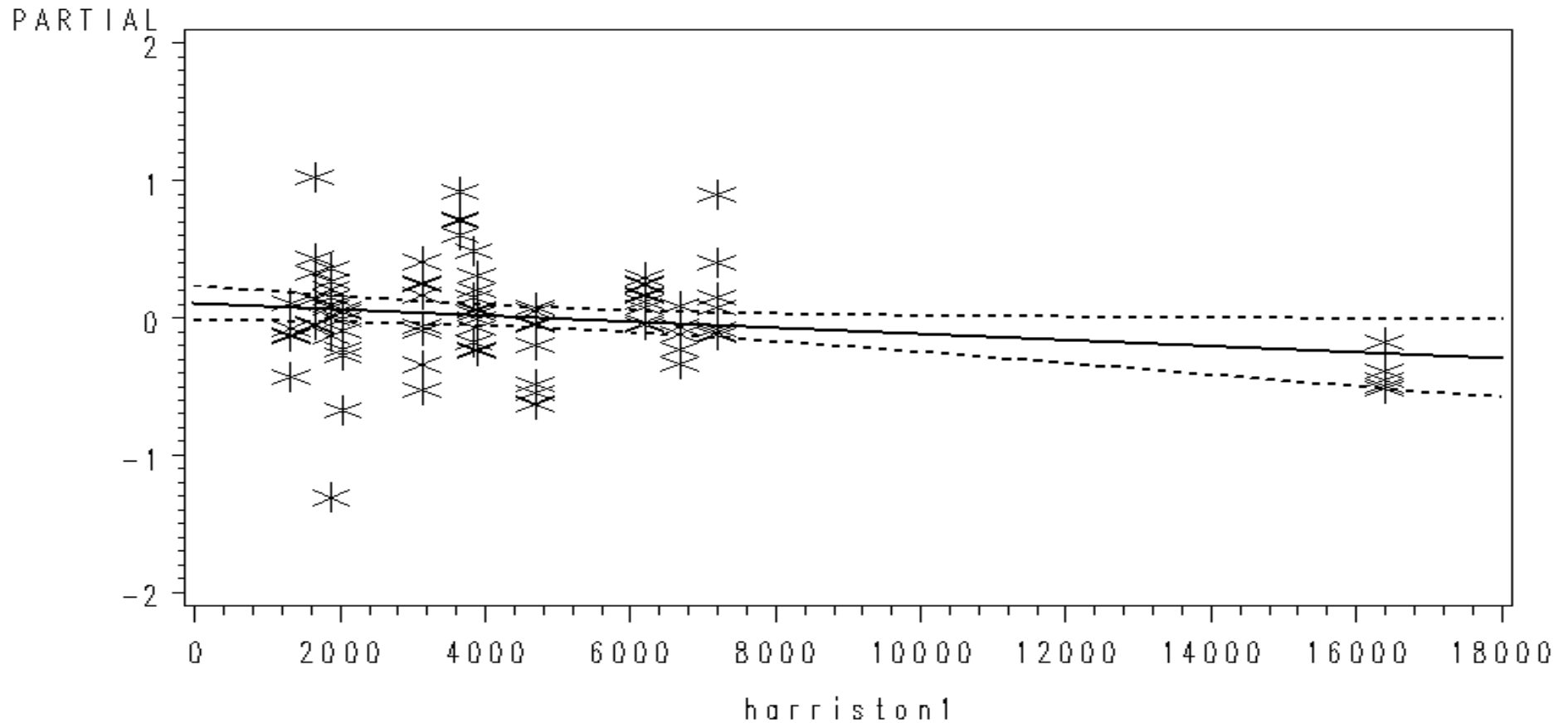
SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at HARRISTON, 0 Years Previous
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag 0 discharge rate after correcting for lags 1, 2, and 3. Downward trend appears real. No major storm event in current year of fish sample

Log(Total Hg) vs Maximum Daily Discharge Rate

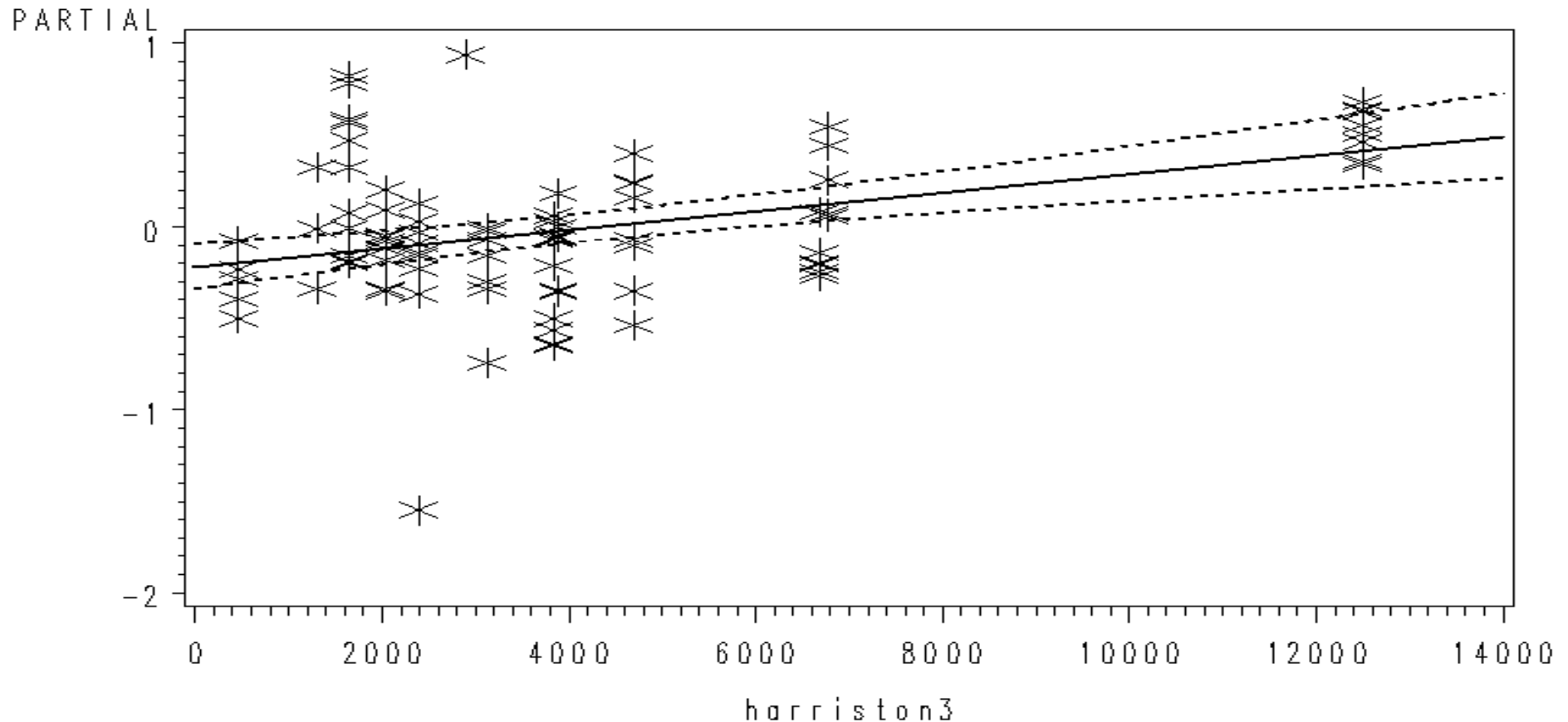
SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at HARRISTON, 1 Years Previous
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag 1 discharge rate after correcting for lags 0, 2, and 3. Slight negative slope due largely to high discharge rate in 1985.

Log(Total Hg) vs Maximum Daily Discharge Rate

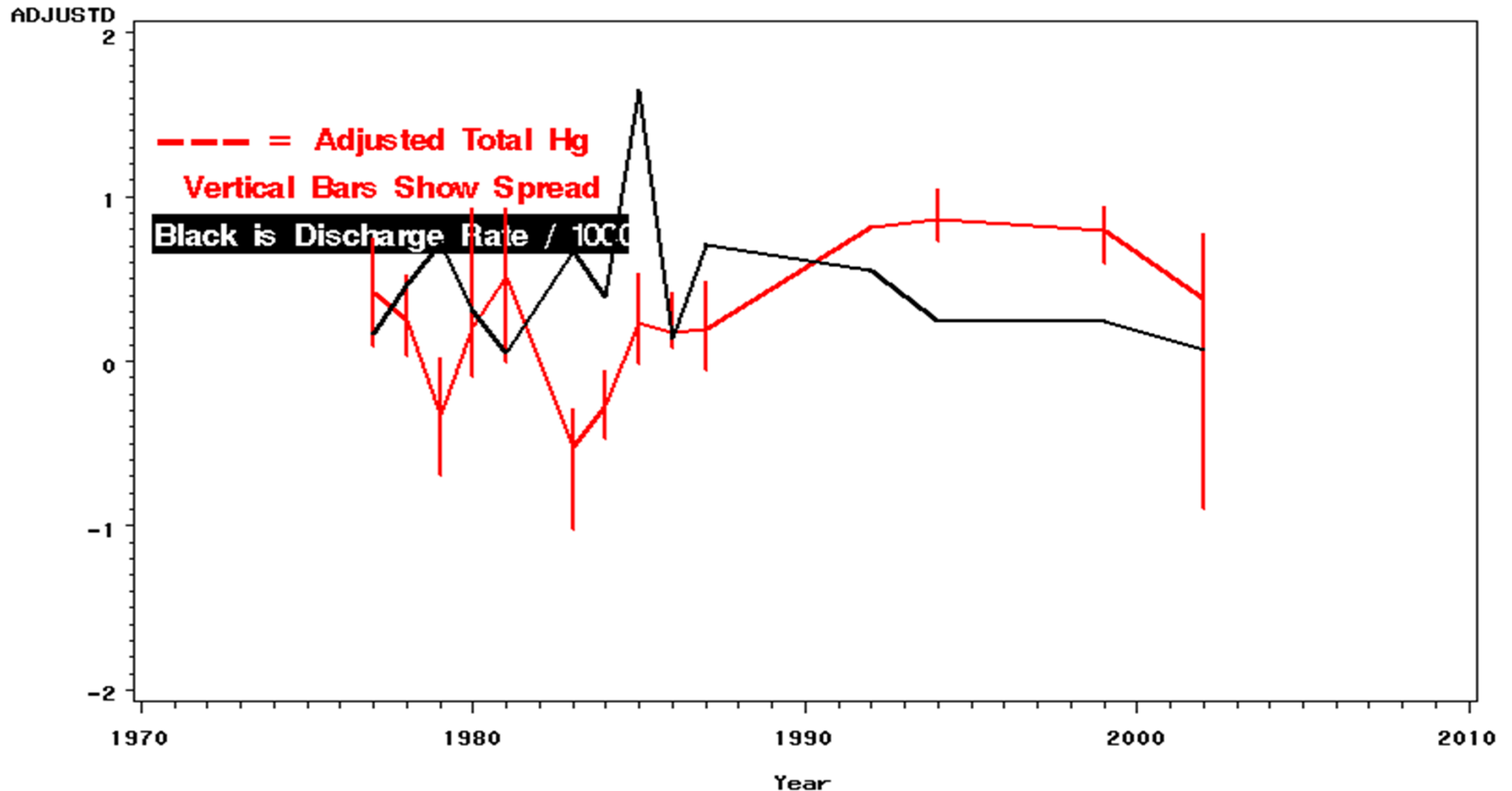
SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at HARRISTON, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag 3 discharge rate after correcting for lags 0, 1, and 2. This corresponds to last line of ANOVA table on previous slide. High discharge rate is from 1996. Positive slope only partly due to 1996 rate.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

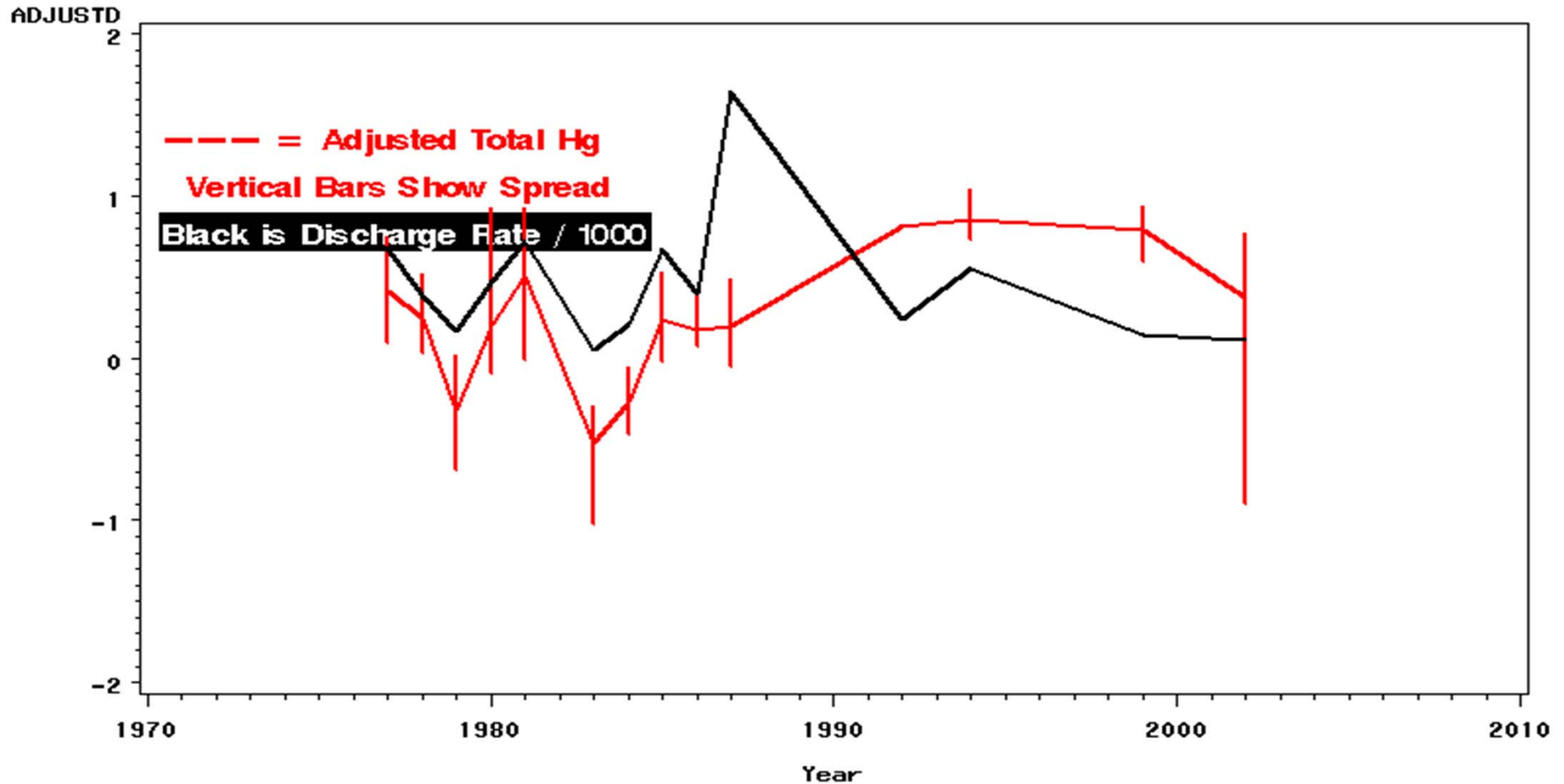
SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at Harriston, 0 Years Previous
Discharge rates Divided by 10000 for Plotting



Peak discharges match with decreases in Hg. Major storm in 1985 was after fish were sampled.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

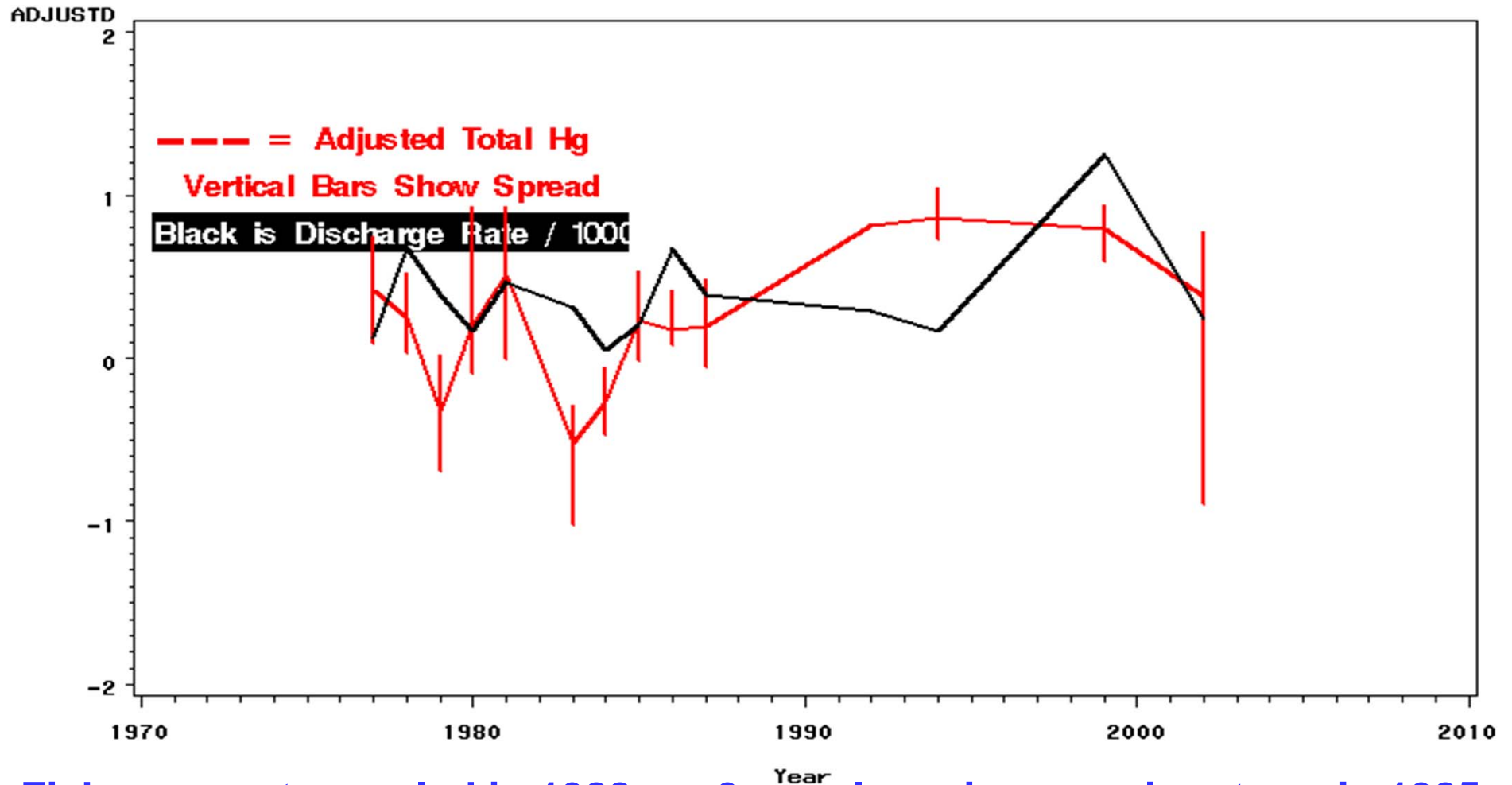
SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at Harriston, 2 Years Previous
Discharge rates Divided by 10000 for Plotting



Good tracking except for 1985 major storm event.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

SMB at Station 7, Grottoes, VA near Grand Caverns bridge
Discharge Measured at Harriston, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Fish were not sampled in 1988, so 3-year lag misses major storm in 1985. Relationship between 3-year lag discharge rate and Hg less compelling than that between 2-year lag, but this corrects for 1985 major storm effect not seen in previous plot.

Regression of Log(Total Hg) vs Year for Fish GE 3 Years old SMB at Station 7, Grottoes, VA near Grand Caverns bridge

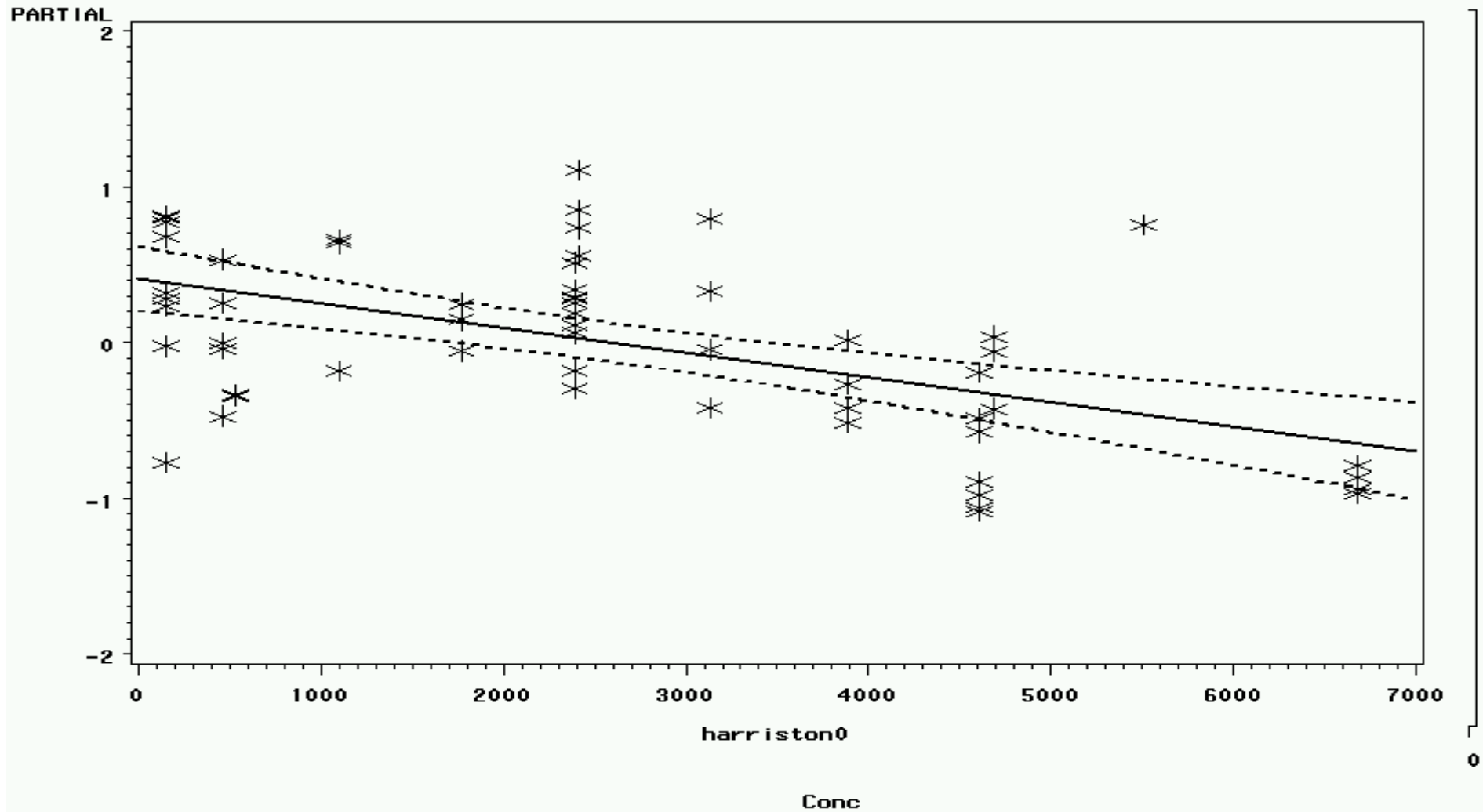
model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	12	12.08	<.0001
Year	.	.	Error	47	—	—
Year	.	.	Corrected Total	59	—	—
Year	0.75515	.	R-Square	.	.	.
Hydro	.	.	Model	2	22.15	<.0001
Hydro	.	.	Error	57	—	—
Hydro	.	.	Corrected Total	59	—	—
Hydro	0.437364	58	R-Square	.	.	.
Hydro	.	.	harriston0	1	23.83	<.0001
Hydro	.	.	harriston3	1	19.93	<.0001

Parameter	Estimate	StdErr	tValue	Probt
Intercept	0.3952407575	0.12751200	3.10	0.0030
harriston0	-.0001579078	0.00003235	-4.88	<.0001
harriston3	0.0000711987	0.00001595	4.46	<.0001

So, when age is restricted to 3+ years, pattern of negative trend in current year and positive trend in 3-year lag still evident.

Log(Total Hg) vs Maximum Daily Discharge Rate

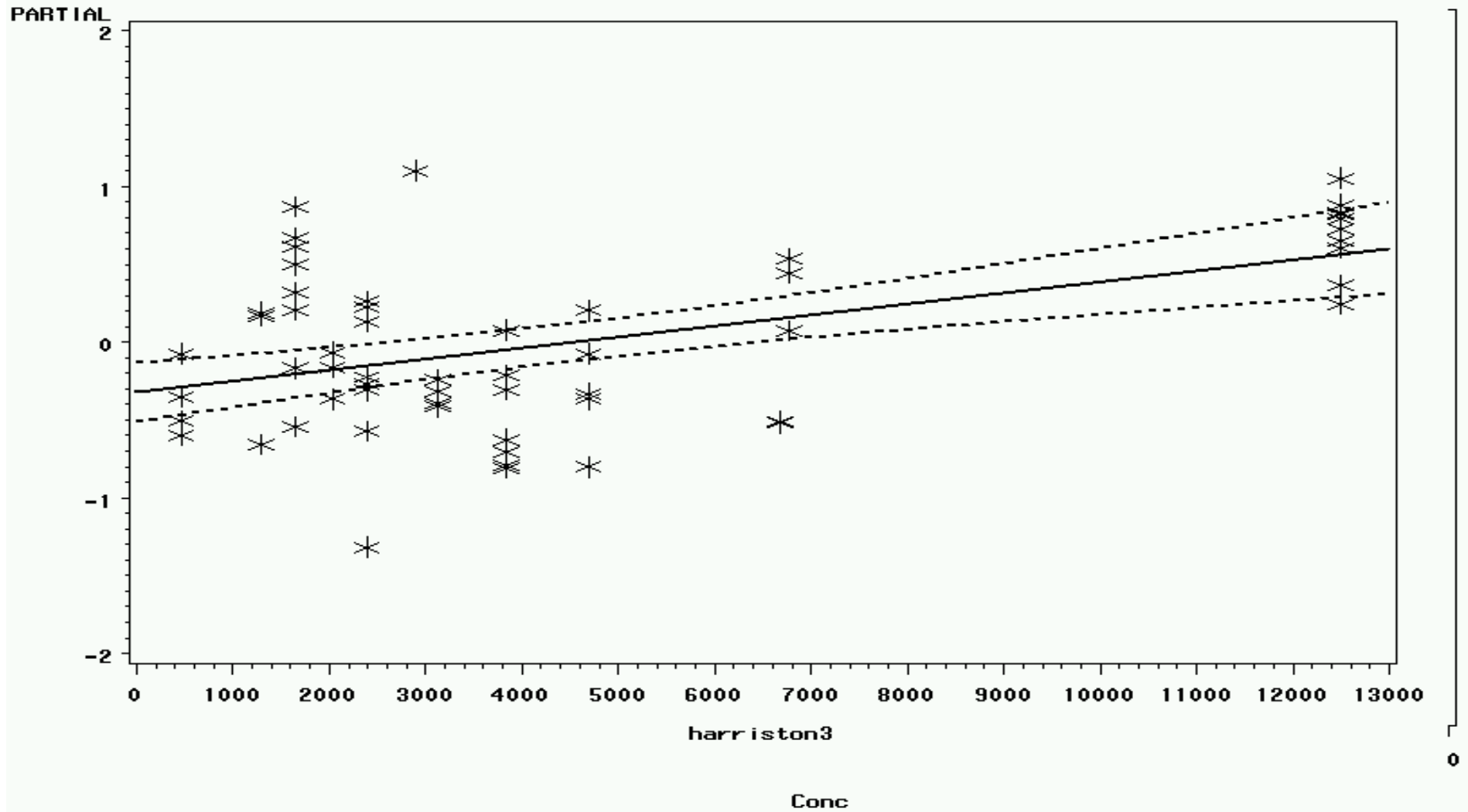
SMB at Station 7, Grubee, VA, near Grand Caverns bridge
Discharge Measured at HARRISTON, 0 Years Previous for Fish GE 3 Years old
Discharge rates Divided by 1000 for Plotting



Downward trend in current year is clear. No major storm events occurred in current year prior to sample. SMB were sampled at station 7 in 1996 after the 1996 storm event.

Log(Total Hg) vs Maximum Daily Discharge Rate

SMS at Station 7, Grubbe, IA, near Grand Covered bridge
Discharge Measured at HARRISTON, 3 Years Previous for Fish GE 3 Years old
Discharge rates Divided by 1000 for Plotting



Upward trend evident even without major storm event in 1996.

Regression of Log(Total Hg) vs Year for Fish >=3 Years old SMB at Station 7, Grottoes, VA near Grand Caverns bridge

model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	12	12.08	<.0001
Year	.	.	Error	47	—	—
Year	.	.	Corrected Total	59	—	—
Year	0.75515	.	R-Square	.	.	.
Hydro	.	.	Model	4	12.40	<.0001
Hydro	.	.	Error	55	—	—
Hydro	.	.	Corrected Total	59	—	—
Hydro	0.474158	63	R-Square	.	.	.
Hydro	.	.	harriston0	1	17.79	<.0001
Hydro	.	.	harriston1	1	2.58	0.1140
Hydro	.	.	harriston2	1	1.68	0.1999
Hydro	.	.	harriston3	1	24.27	<.0001

Parameter	Estimate	StdErr	tValue	Probt
Intercept	0.3340555101	0.20845566	1.60	0.1148
harriston0	-.0001446125	0.00003429	-4.22	<.0001
harriston1	-.0000358499	0.00002232	-1.61	0.1140
harriston2	0.0000387183	0.00002984	1.30	0.1999
harriston3	0.0000856356	0.00001738	4.93	<.0001

This is included to show that the previous regression using only lags 0 and 3 did not distort the results and lag 1 trend seen w/ all data not evident.

Regression of Log(Adjusted Hg) vs Year

SMB at Station 3, Waynesboro City Park north of DuPont footbridge

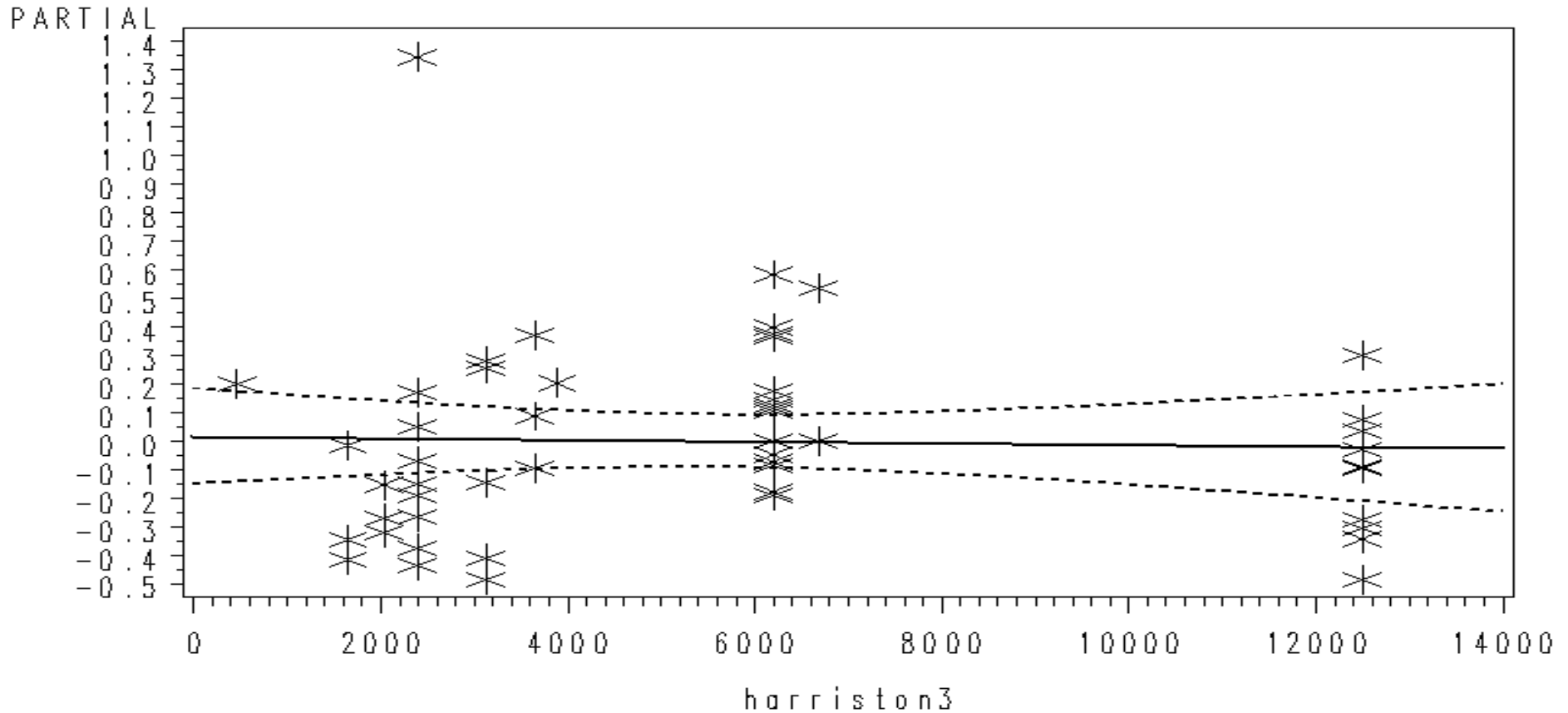
model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	10	1.65	0.1188
Year	.	.	Error	50	—	—
Year	.	.	Corrected Total	60	—	—
Year	0.248505	.	R-Square	.	.	.
Hydro	.	.	Model	4	0.84	0.5057
Hydro	.	.	Error	47	—	—
Hydro	.	.	Corrected Total	51	—	—
Hydro	0.066862	27	R-Square	.	.	.
Hydro	.	.	harriston0	1	2.45	0.1244
Hydro	.	.	harriston1	1	0.05	0.8171
Hydro	.	.	harriston2	1	0.36	0.5540
Hydro	.	.	harriston3	1	0.06	0.8011

Parameter	Estimate	StdErr	tValue	Probt
Intercept	-.8590413206	0.12481442	-6.88	<.0001
harriston0	0.0000255356	0.00001632	1.56	0.1244
harriston1	-.0000037183	0.00001599	-0.23	0.8171
harriston2	-.0000117897	0.00001978	-0.60	0.5540
harriston3	-.0000035963	0.00001420	-0.25	0.8011

Total Hg values at station 3 were uniformly low. Regression and plots do not indicate relationship where none exist.

Log(Total Hg) vs Maximum Daily Discharge Rate

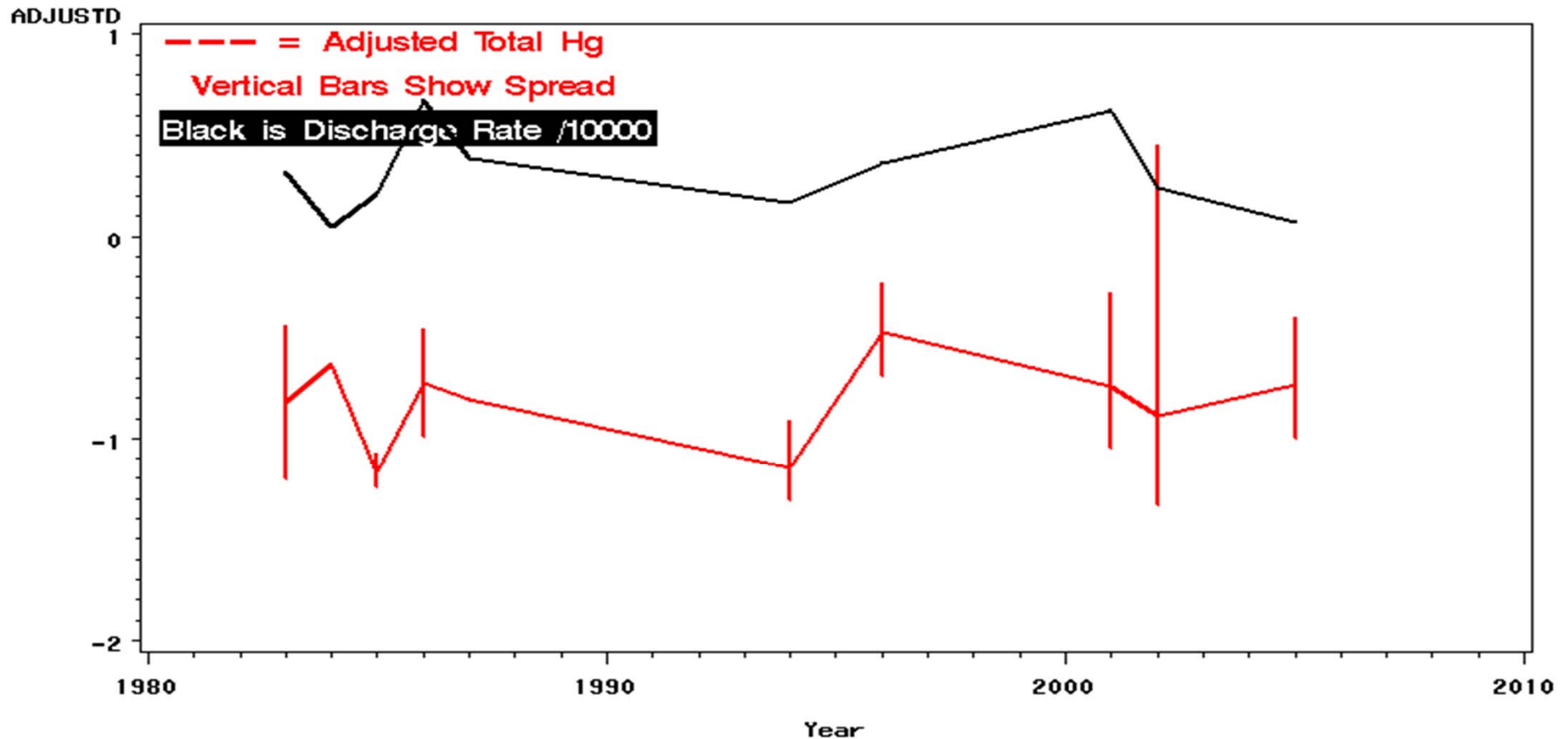
SMB at Station 3, Waynesboro City Park north of DuPont footbridge
Discharge Measured at HARRISTON, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing little relationship of THg vs Lag3 discharge rate after correcting for lags 0, 1, and 2. This corresponds to ANOVA table on previous slide.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

SMB at Station 3, Waynesboro City Park north of DuPont footbridge
Discharge Measured at HARRISTON, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Tracks poorly up to 1985, well 1986-1997, poorly 1997-2001 and 2002-2005. Weak correlations in line with preceding ANOVA table.

Regression of Log(Adjusted Hg) vs Year

SUCKER at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

model	rsquare	ratio/rsqr	Source	DF	FValue	ProbF
Year	.	.	Model	12	17.11	<.0001
Year	.	.	Error	119	—	—
Year	.	.	Corrected Total	131	—	—
Year	0.633048	.	R-Square	.	.	.
Hydro	.	.	Model	4	5.25	0.0006
Hydro	.	.	Error	118	—	—
Hydro	.	.	Corrected Total	122	—	—
Hydro	0.150995	24	R-Square	.	.	.
Hydro	.	.	harriston0	1	3.17	0.0776
Hydro	.	.	harriston1	1	0.13	0.7146
Hydro	.	.	harriston2	1	0.21	0.6456
Hydro	.	.	harriston3	1	18.51	<.0001

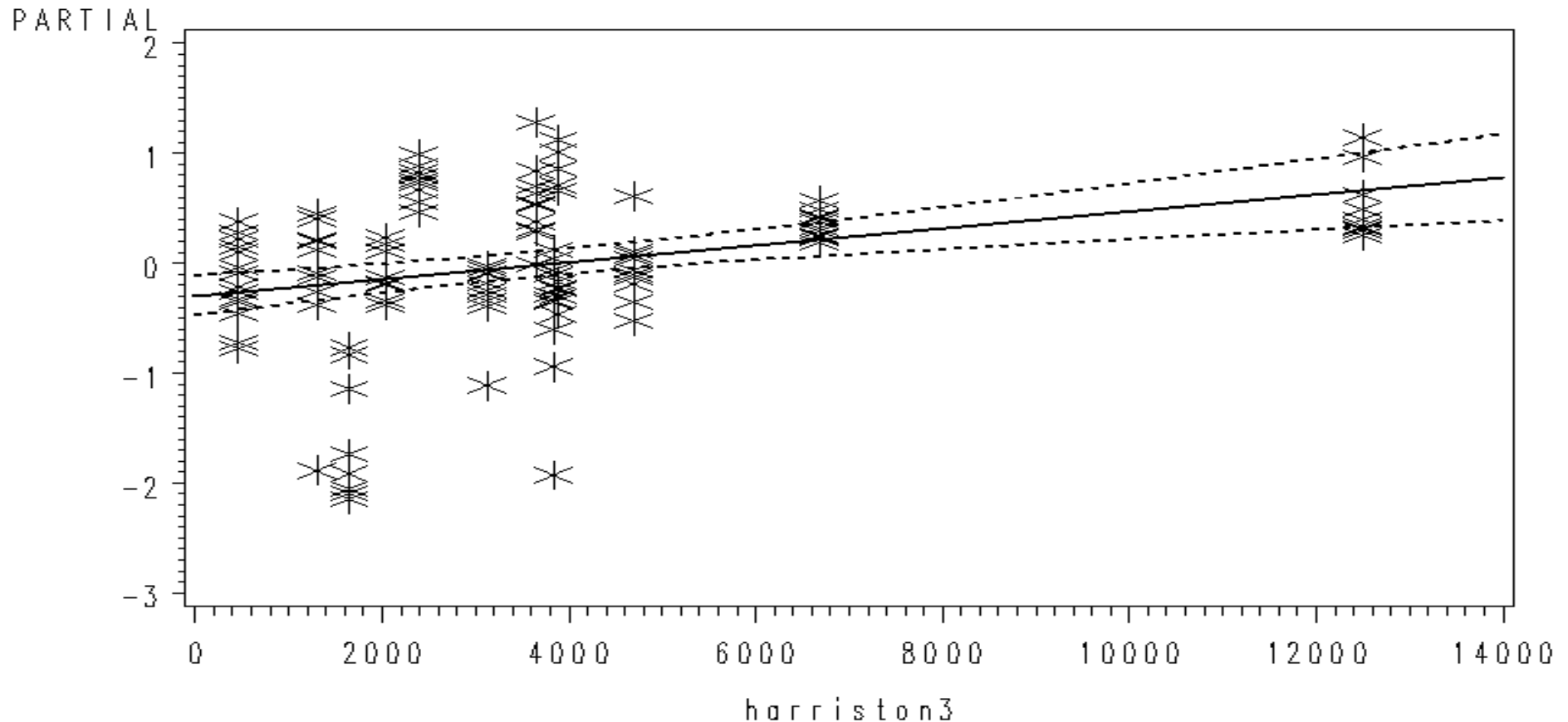
Parameter	Estimate	StdErr	tValue	Probt
Intercept	-.6693693940	0.18216695	-3.67	0.0004
harriston0	0.0000347976	0.00001954	1.78	0.0776
harriston1	-.0000058214	0.00001588	-0.37	0.7146
harriston2	0.0000069879	0.00001515	0.46	0.6456
harriston3	0.0000849751	0.00001975	4.30	<.0001

Log(Total Hg) vs Maximum Daily Discharge Rate

SUCK at Station 5, Dooms, VA near Rt. 611 bridge (above dam)

Discharge Measured at HARRISTON, 3 Years Previous

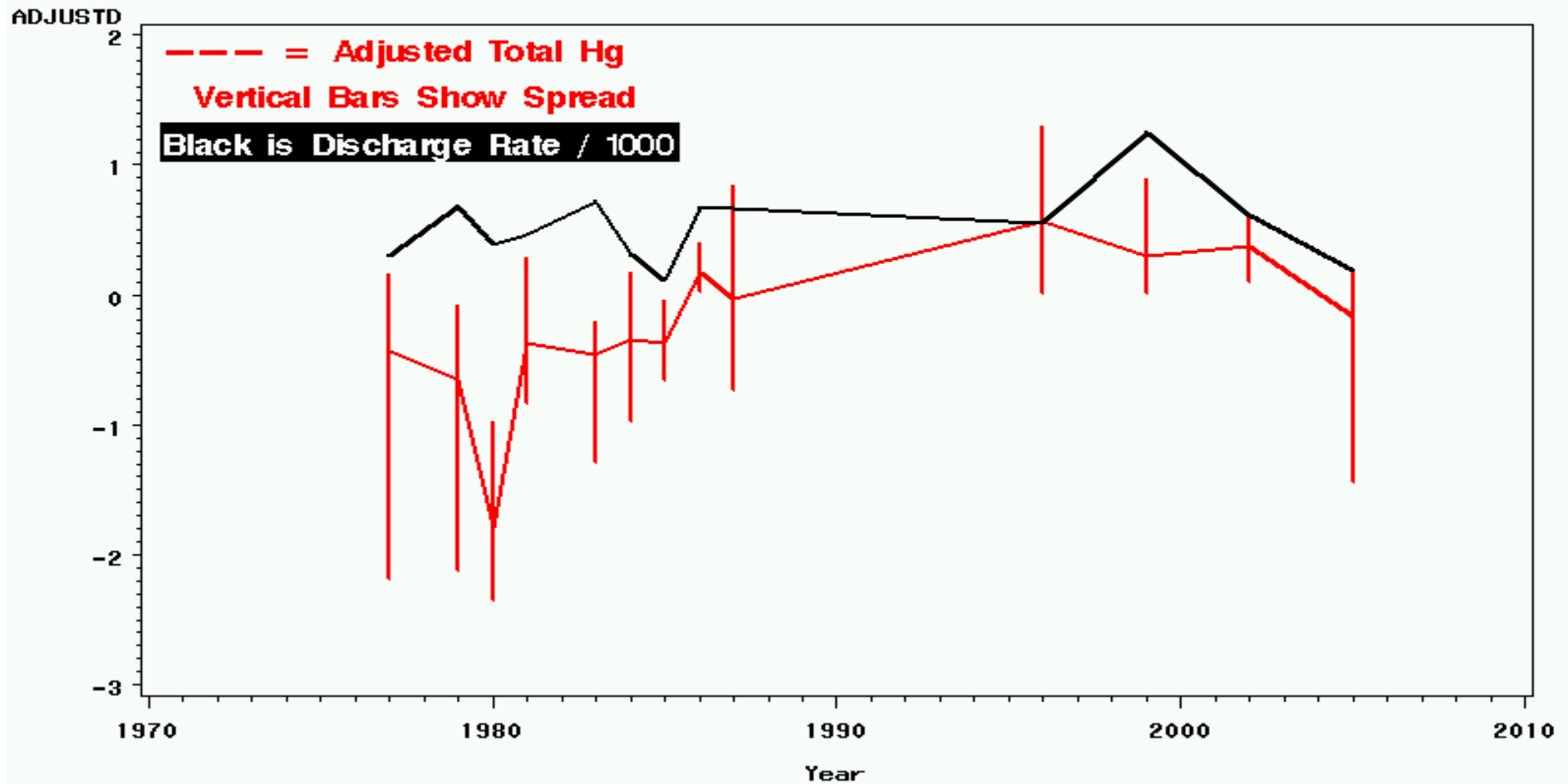
Discharge rates Divided by 10000 for Plotting



Partial regression plot showing relationship of THg vs Lag 3 discharge rate after correcting for lags 0, 1, and 2. This corresponds to ANOVA table on previous slide. Positive slope not due entirely to storm 1985 event.

Log(Adjusted Hg) vs Maximum Daily Discharge Rate

SUCK at Station 5, Dooms, VA near Rt. 611 bridge (above dam)
Discharge Measured at HARRISTON, 3 Years Previous
Discharge rates Divided by 10000 for Plotting



Relationship between Total Hg and lag 3 discharge rate murky.

Slopes of Significant Regressions Adj THg Slopes of Significant Regressions

----- SPECIES=REDB -----

station	YEAR			
	0	1	2	3
3	9.63			11.18
5	4.78			9.66
6	2.59	3.83	1.85	5.10
7	4.76			4.87
8		3.83		

----- SPECIES=SMB -----

station	YEAR			
	0	1	2	3
3				
5	-13.4		-4.65	7.45
6		-6.12		4.11
7	-13.5	-2.63		5.57
8				

Slopes of Significant Regressions

----- SPECIES=SUN -----

station	YEAR			
	0	1	2	3
3	6.98			
5				9.53
6		2.44		5.36
7			2.28	4.09
8				

Slopes of Significant Regressions

----- SPECIES=SUCKER -----

station	YEAR			
	0	1	2	3
3		-8.28	5.91	
5				8.50
6	3.66			7.94
7	6.54	3.08	1.83	2.45
8		-6.54		11.38

There is some consistency in the slopes wrt discharge 3 years previous at stations 5, 6, 7 (Dooms, Crimora, Grottoes).

Note: Slopes multiplied by 100000 for easy reference.

Slopes of Significant Regression
Fish Aged 3+ Yrs

----- SPECIES=REDB -----

YEAR	0	1	2	3
station				
3	9.58			11.34
5				9.48
6		3.76	1.27	6.42
7	4.27			4.78
8		3.73		

Slopes of Significant Regression
Fish Aged 3+ Yrs

----- SPECIES=SMB -----

YEAR	0	1	2	3
station				
3				
5		-33.6		8.42
6		-10.7	-4.78	
7		-14.5		8.56
8				

Slopes of Significant Regression
Fish Aged 3+ Yrs

----- SPECIES=SUCK -----

YEAR	0	1	2	3
station				
3		-12.1	11.49	
5				11.56
6				9.58
7	6.04			
8				6.95

There is rough consistency in the slopes wrt discharge 3 years previous at stations 5, 6, 7 (Dooms, Crimora, Grottoes) with previous regression, with two notable exceptions.

Summary of Significant Regressions for Adjusted THg

-----species=SUNFISH -----

	YEAR			
station	0	1	2	3
3	1	0	0	0
5	0	0	0	1
6	0	1	0	1
7	0	0	1	1
8	0	0	0	0

----- species=SMB -----

	YEAR			
station	0	1	2	3
3	0	0	0	0
5	0	-1	0	1
6	0	-1	0	1
7	-1	0	1	1
8	0	0	0	0

-----species=REDBREAST ---

	YEAR			
station	0	1	2	3
3	1	0	0	1
5	1	0	0	1
6	1	1	1	1
7	1	0	0	1
8	0	1	0	0

----- species=SUCKER -----

	YEAR			
station	0	1	2	3
3	0	-1	1	0
5	0	0	0	1
6	1	0	0	1
7	1	1	1	1
8	0	-1	0	1

1=significant positive correlation
-1=significant negative correlation
0=non-significant correlation

Summary of Significant Regressions

-----species=LMB -----

station	YEAR			
	0	1	2	3
3	1	0	0	0
5	0	0	0	0
6	0	0	0	0
7	1	-1	1	-1
8	-1	1	0	0

1=significant positive correlation

-1=significant negative correlation

0=non-significant correlation

There were relatively few large mouth bass caught at these stations (next slide), which may account for the different patterns for this species.

Fish Tissue Sample Sizes

Full Sample Size
species

	LMB	REDB	SMB	SUCK	SUN
station					
3	3	76	61	160	150
5	44	104	34	132	192
6	28	386	48	168	521
7	22	89	90	137	172
8	9	103	88	127	167

Summary

- A significant percent of variation in adjusted fish tissue Hg is “explained” by the maximum daily discharge rate in the 3 years prior to fish sampling
 - In most cases, there is an apparent **3-year lag** between high discharge rates and high Hg
 - 3-yr lag may be artifact of interval between storm events and fish sample date

Summary

- **Note: The month of fish sampling is often not known**
 - Adds some vagueness to time lag
- **Evidence that major storms bring total Hg into river and eventually into fish tissue**
- **True time delay between storm and subsequent increase in fish tissue Hg needs additional data to verify/refine conclusion**