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Project Title: *Poplar Lick ORV Investigation*

Final Performance Report: *August 1, 2005 to June 30, 2007*

Submitted by (Principal Investigator):
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Final Performance Report

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INTRODUCTION

Off road vehicle (ORV) use has increased dramatically in Maryland in the past two decades. Since official designation as a public use area in 1974 the Poplar Lick ORV trail in Savage River State Forest in Garrett County has seen steadily increasing use, to a point where the trail is used by commercial ORV ride vendors weekly during the summer. Currently there are six ORV stream crossings along the approximate six mile trail, and the trail parallels the length of the stream. Poplar Lick is one of the upper Savage River tributaries that support a brook trout *Salvelinus fontinalis* population. Brook trout are Maryland's only native salmonid species, and are listed by the Maryland Department of Natural Resources (DNR) Heritage Program as a species in Need of Conservation in the Statewide Wildlife Diversity Conservation Plan. Brook trout are considered a keystone species in a coldwater ecosystem, and are an important recreational resource for angling and aesthetics.

A proposal has been made by the Maryland DNR Savage River State Forest Interdisciplinary (ID) Team to close the Poplar Lick ORV trail due to concerns about environmental damage to the resource and impacts on the Upper Savage ecosystem. Limited Maryland DNR Inland Fisheries brook trout population data (1988-1996) suggest that there has been a steady decline in abundance since the trail was opened, however not enough data are available to make a statistically valid conclusion. Information from this study will be provided to the interdisciplinary team to assist in the decision making process.

OBJECTIVES

The objectives for this study were to:

1.) Establish three permanent fish, invertebrate, water quality, and habitat monitoring stations along the main stem Poplar Lick, one upstream of the ORV trail, one mid-way downstream to the mouth, and one just above the mouth of the stream.

2.) Collect invertebrate population information in March and October/November on similar upper Savage tributaries including: the Little Savage River, Middlefork Run, Monroe Run, Big Run, Crabtree Creek, and the Upper Savage River to obtain control data on comparable streams which are not open to ORV usage.

3.) Monitor turbidity levels throughout the Poplar Lick main stem, and at the mouths of the tributaries named in Objective 2, at least twice monthly at all sites the day before a significant precipitation event and immediately following the event.
4.) Measure turbidity at designated stream crossings on the main stem Poplar Lick the day of larger ORV events, or with simulated ORV events depending on scheduling.

METHODS

Turbidity

Turbidity measurements were collected using Hydrolab QUANTA devices equipped with a turbidity probe. Units were calibrated weekly by staff at the University of Maryland's Appalachian Laboratory.

Monthly Precipitation Event Sampling. Sampling stations (Table 1) were established on all study streams, and were sampled the day before a significant precipitation event and immediately following the event (within 12 hours at most). Due to drought conditions experienced in 2005, sampling was extended through 2006 to ensure that the full time spectrum of when the trail is open to public use (April through November annually) was sampled with an added benefit of more data collected than anticipated.

Simulated ORV Episodes. Three simulated ORV episodes were conducted in 2006 (Table 2). Turbidity was measured immediately upstream and downstream of the crossings at 0, 1, 2, 3, 4, 5, and 10 minutes during the simulated event. Three levels of vehicular traffic use were evaluated to simulate various use levels: 1) two vehicle crossings (across and back), 2) 10 vehicle crossings (across and back 5 times), and 3) 20 vehicle crossings (across and back 10 times). The test vehicle used to simulate the ORV crossings was a full sized, four wheel drive pickup truck.

In-stream turbidity sampling. As an additional test of the impact of ORV crossings on turbidity (sediment transport) levels, turbidity was measured along a 50 m transect at the mouths of all study streams, at five meter intervals, starting from downstream and working upstream. The bottom was disturbed along the width of the 5 meter interval, and the highest turbidity reading for the transect was recorded. This sampling method was also done immediately below all six in-stream ORV crossings on Poplar Lick.

Fish

Brook trout population estimates were recorded at three sample stations on Poplar Lick, one downstream site, one middle site, and one upstream site (Table 3). Trout populations were estimated using the three pass regression technique outlined by Zippin (1958) utilizing the MICROFISH 2.2 software package (Van Deventer and Platts 1985). The downstream station was a historical sampling location for Maryland DNR's Inland Fisheries and Biological Stream Survey (MBSS) Divisions. Backpack electrofishing was utilized to perform three pass fish collections in a 75m stream length, following DNR Inland Fisheries and MBSS protocols.

Invertebrates

Invertebrate populations were sampled at least once at all study streams in 2005 (Table 4). Kick samples were conducted at each sample station, insects removed and preserved, and then identified and enumerated by a DNR Inland Fisheries macroinvertebrate specialist at the Maryland DNR Lewistown Work Center. Population indices calculated per sample were: EPT Index Number, EPT Taxa, EPT/C, Dominant Family, CPOM, Diversity, Richness, HBI, Scraper/Filterer ratio, and Equitability.

Habitat

MBSS methodology (www.dnr.state.md.us/streams/pubs/2000samp_manual.pdf) was used to estimate and record habitat variables at the three Poplar Lick fish sample stations. Additionally investigators took digital pictures of any adverse ORV related impacts that were encountered in the course of the field work for this study.

Temperature

In-stream dataloggers were placed at Poplar Lick 1 (downstream site) and Poplar Lick 3 (upstream site) fish sample stations from June 1 thru September 20 2005; temperatures were recorded hourly.

RESULTS/DISCUSSION

Turbidity

Monthly Precipitation Event Sampling

Analysis of monthly pre and post precipitation turbidity data for all streams indicated that Poplar Lick had significantly higher turbidity than any of the other streams (Table 1). The statistical/analytical design used distance as a blocking factor to control for differences at each distance as found in the analysis for the in-stream turbidity sampling data (see In-stream turbidity sampling section). After controlling for the distance decay, Poplar Lick had significantly higher turbidity preceding and following precipitation events than any of the other streams (Table 5). In comparison, there were no differences among the other streams. In summary, Poplar Lick, based on both the twice monthly precipitation event sampling and the in-stream transect sampling had significantly higher turbidity levels pre and post precipitation events than any of the other streams. Turbidity levels in all streams were not significantly different from each other for either sampling (Table 5).

Simulated ORV Episodes

The results from paired t-tests clearly indicate that turbidity is substantially greater downstream of the ORV crossings than upstream for a given pair of observations when all data are compared simultaneously. However, when time after crossing is analyzed separately, a clearer picture emerges. Turbidities below crossings are significantly higher (paired t tests, $P < 0.05$) than above crossings for times 0, 1, 2, 3, 4, and 5 minutes, but are not different at 10 minutes and presumably beyond. Higher turbidity was associated with more vehicles crossing the stream ($P<0.0001$) and there were significant differences due to time after crossing ($P=0.0005$), but levels had returned to near baseline by 10 minutes. In summary, ORV crossings increased turbidity levels downstream significantly, and the more ORV disturbance, the higher the turbidity level and the longer the duration to return to pre-disturbance (upstream) levels (Figure 1).

In-stream turbidity sampling

There were substantial differences in turbidity with distance away from the crossings in Poplar Lick, with the turbidity dropping rapidly with distance for all (Table 6; Figure 2). For each crossing the 5m kick had significantly higher turbidity than all other kicks except for the sample at 10m. The 10m kick was higher only from those at 45m and 50m. In summary, the level of stored sediment below ORV crossings as determined by kick samples in Poplar Lick was significantly higher at the two sites immediately downstream of the crossings, with the level of stored sediment (as measured by the turbidity kicks) decreasing with distance downstream from the crossing.

Fish

Brook trout populations were estimated at all three Poplar Lick fish sampling stations in 2006 (Table 3). For comparison with historical data the number of fish collected per meter from the first pass was determined for the lowermost station, which was a historical sampling site for the Maryland DNR Inland Fisheries and MBSS divisions. While fluctuation in brook trout population size, particularly in headwater streams, is normal, the long term trend of decline observed for the Poplar Lick data is not normal (Figure 3). The historical data indicate a gradual, long term decline in population density for Poplar Lick, coincident with an inverse increase in the use of the ORV trail over the same time period.

Invertebrates

Invertebrate population indices were determined for April and November 2005 samples. Statistical analysis could not be done due to small sample size, but for each stream sampled all indices were indicative of unimpaired, healthy systems. The values from the three Poplar Lick stations (Table 7) were all within the ranges for the other streams, and very similar to the modal and median values for all streams (Table 8). Invertebrate populations in 2005 in Poplar Lick were indicative of a healthy, unimpaired coldwater system.

Habitat

Habitat parameters from the MBSS methodology recorded for the three Poplar Lick fish sampling stations were generally indicative of a high quality stream. The instream habitat, epifaunal substrate, shading, and pool/glide/eddy values for all three stations were all rated in the highest category, indicating a healthy, diverse habitat (Table 9). However the embeddedness values, which are a measure of how much accumulated sediment there is in the stream, were all much higher than would be expected in a high gradient mountain stream (Table 10). In addition embeddedness data from prior MBSS samplings in Poplar Lick indicate a trend of increasing embeddedness throughout the stream over the past six years (Figure 4). Overall physical habitat in Poplar Lick and surrounding forest cover are indicative of a healthy stream, however the high embeddedness and increasing trend of embeddedness over the last six years at least indicate that the system is suffering from sediment loading.

As part of this study photographs of conditions and events resulting from ORV impacts were also taken as investigators performed field work. These photos provide compelling evidence as to the adverse impacts ORV use has had along the Poplar Lick stream length. Pictures are included in this report in Appendix A.

Temperature

Water temperature data showed that the temperature regime in Poplar Lick is within the range that brook trout tolerate. However on several days in July and August maximum daily temperatures at the Poplar Lick 1 site exceeded 20^{0}C, which is stressful and potentially lethal if sustained over 24 hours. Water temperatures at the Poplar Lick 3 upstream site, where the ORV trail begins, did not exceed 20^{0}C.

CONCLUSIONS

The Poplar Lick system is unique in that it is completely encompassed by state forest lands, no agriculture or development occurs along its length, and its headwater is a state owned lake. The lake effectively functions as a filter, trapping and removing any potential sediment from the upstream watershed. Water quality, habitat, and biological impacts in the stream below the lake are directly related to events occurring in and along the stream corridor.

A variety of parameters were investigated as part of the Poplar Lick SWG investigation, some of which have established vital baseline values for future monitoring. Biologically the stream is in good shape based on invertebrate indices, yet there is a long term decline in brook trout numbers at the lowermost station. Angling pressure and harvest may be part of the reason, but it is also likely that physical disturbance and more usage along the ORV trail has impacted brook trout numbers. Physical habitat indices indicate that the stream has good habitat and shading, but that there has been an increase in embeddedness throughout the stream since at least the year 2000. Embeddedness describes how deeply stream rocks are buried in the stream bed, and is an indicator of sediment loading and deposition.

However the most striking finding is the difference between turbidity levels in Poplar Lick compared to the other streams in the study. Development and agriculture occur within the Crabtree, Middlefork, and Upper Savage River systems, the Little Savage has a large impoundment in its headwaters, Monroe Run has no human disturbances, and Big Run has an asphalt road running alongside almost its entire length, yet all of these streams had significantly lower turbidities for the tests performed than Poplar Lick. Poplar Lick flows at a significantly higher turbidity level than all the other streams prior to a precipitation event, and at a higher turbidity level following a precipitation event than all the other streams. Poplar Lick has at least as, and in most cases, a more protected watershed than all the other study streams, plus a headwater lake that functions as a sediment filter. The only variable for Poplar Lick that is different from the other streams is that for approximately 4.5 miles of its length it has an ORV trail beside it and crossing it (6 times).

The conditions recorded during this study indicate that the Poplar Lick system is impacted from more turbidity and associated sediment input and deposition than what is occurring in streams without an ORV trail. In addition there are biological warnings, i.e. a decreasing trend in brook trout numbers, and physical habitat warnings, i.e. the increasing trend in embeddedness observed, that suggest that the system is stressed and is being negatively impacted by the presence of the ORV trail. Photo documentation clearly shows that adverse impacts will occur when an ORV trail is so closely associated with a stream, regardless of efforts to minimize and control impacts. Based on the results of this investigation, the presence of the ORV trail along Poplar Lick is adversely affecting the water quality of the system, and the health of system is in decline.

LITERATURE CITED

Van DeVenter, J. S. and W. S. Platts. 1985. MICROFISH 2.2 interactive software program. Microsoft Corporation.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management 22(1): 82-90.

Table 1. Turbidity values from monthly pre and post precipitation events for all stream sampling stations, 2005 – 2006.

Date	*Precip event*	*Pop 1*	*Pop 2*	*Pop 3*	*Pop 4*	*Pop 5*	*Pop 6*	*L Sav*	*M Fork*	*Monroe*	*B Run 1*	*B Run 2*	*B Run 3*	*Crabtree*	*U Sav*
7/6/2005	Pre	45	42	44	39	35	33	27	22	20	25	22	19	33	39
7/7/2005	Post	332	311	295	298	258	268	122	148	89	100	77	66	221	345
8/25/2005	Pre	42	45	38	36	35	33	25	24	27	28	26	22	32	35
8/26/2005	Post	285	282	295	256	244	229	189	159	112	122	100	95	189	264
9/28/2005	Pre	25	22	23	21	19	20	18	17	12	22	22	20	28	32
9/29/2005	Post	486	475	399	386	400	375	321	227	110	125	109	101	344	411
10/6/2005	Pre	22	21	22	19	21	23	21	15	12	23	20	19	22	29
10/7/2005	Post	154	152	160	146	142	139	100	89	76	89	88	75	218	245
10/24/2005	Pre	24	23	21	23	20	21	17	16	13	19	18	18	26	31
10/25/2005	Post	122	114	121	120	115	112	87	100	122	132	122	118	221	289
11/14/2005	Pre	32	31	32	30	27	28	21	22	18	22	22	22	28	29
11/15/2005	Post	542	532	540	526	525	503	322	287	196	225	198	187	488	599
4/21/2006	Pre	45	44	46	45	45	43	46	33	27	38	36	36	43	41
4/22/2006	Post	355	342	322	340	326	333	198	212	123	145	144	129	376	436
5/7/2006	Pre	32	31	31	30	31	33	25	29	21	26	26	25	32	38
5/8/2006	Post	145	146	142	141	145	126	112	126	98	122	121	122	221	298
5/15/2006	Pre	41	40	43	44	40	41	32	31	19	33	36	28	29	27
5/16/2006	Post	227	210	215	200	206	198	124	115	100	132	120	123	200	309
6/21/2006	Pre	46	41	42	42	40	42	25	29	21	36	34	34	28	33
6/22/2006	Post	588	567	587	533	510	512	211	267	198	199	176	155	322	498
6/28/2006	Pre	28	28	25	24	27	25	21	22	26	34	31	32	37	42
6/29/2006	Post	145	153	141	146	150	136	87	56	53	65	65	60	176	210
7/20/2006	Pre	36	32	35	33	31	32	22	28	15	37	35	35	26	32
7/21/2006	Post	242	236	231	235	208	211	127	99	65	89	90	82	221	278
8/9/2006	Pre	21	21	20	22	21	23	18	22	14	20	22	20	21	30
8/10/2006	Post	349	321	300	311	288	275	227	187	134	152	152	145	332	367
9/5/2006	Pre	18	16	17	20	17	17	21	15	12	22	21	22	23	26
9/7/2006	Post	45	44	40	42	42	41	29	30	15	42	28	27	76	101
9/22/2006	Pre	18	18	18	17	18	17	21	14	17	25	24	25	19	22
9/23/2006	Post	466	442	409	411	400	401	221	388	212	276	255	230	229	322
10/4/2006	Pre	14	14	12	13	14	12	18	12	10	20	20	20	18	24
10/5/2006	Post	125	121	118	115	117	112	121	100	56	88	89	85	134	198
10/26/2006	Pre	17	17	17	15	16	16	23	15	12	23	22	23	19	27
10/27/2006	Post	365	345	340	321	320	315	221	188	170	200	185	171	299	411
11/7/2006	Pre	18	18	20	17	16	16	15	14	10	21	20	20	18	22
11/8/2006	Post	121	112	110	104	100	98	65	44	32	33	30	25	112	145
11/15/2006	Pre	31	32	32	30	31	30	24	22	17	26	24	20	22	28
11/16/2006	Post	489	467	430	427	400	354	232	188	156	201	187	178	322	542

Table 1 Key:

Abbreviation	*Full name*	*Sample station geographic coordinates*
Pop 1	*Poplar Lick 1 (mouth)*	*N 39 35.118 W 79 05.588*
Pop 2	*Poplar Lick 2*	*N 39 35.315 W 79 05.986*
Pop 3	*Poplar Lick 3*	*N 39 35.862 W 79 07.087*
Pop 4	*Poplar Lick 4*	*N 39 36.074 W 79 07.184*
Pop 5	*Poplar Lick 5*	*N 39 36.241 W 79 07.291*
Pop6	*Poplar Lick 6*	*N 39 36.547 W 79 08.866*
L Sav	*Little Savage*	*N 39 37.008 W 79 01.463*

Abbreviation	*Full name*	*Sample station geographic coordinates*
M Fork	*Middle Fork*	*N 39 30.823 W 79 09.239*
Monroe	*Monroe Run*	*N 39 32.985 W 79 08.690*
B Run 1	*Big Run 1 (mouth)*	*N 39 32.603 W 79 08.392*
B Run 2	*Big Run 2*	*N 39 34.608 W 79 09.828*
Crabtree	*Crabtree Creek*	*N 39 30.261 W 79 09.290*
U Sav	*Upper Savage*	*N 39 35.893 W 79 04.982*

Table 2. Location of Poplar Lick ORV trail crossings used for the simulated ORV testing, 2006.

Station	***Coordinates***
Poplar ORV 1	N 39 35.118 W 79 05.588
Poplar ORV 2	N 39 35.315 W 79 05.986
Poplar ORV 3	N 39 35.315 W 79 05.986

Table 3. Poplar Lick fish sampling station brook trout population estimates and geographic locations for 2006.

Station	***Population estimate, adults (kg/ha)***	***Population estimate, YOY (fish/ha)***	***Geographic coordinates***
Poplar 1 (downstream)	30 +/- 1.97	14 +/- 1	N 39 35.11 W 79 05.44
Poplar 2 (middle)	28 +/- 0.9	47 +/- 5.2	N 39 35.05 W 79 07.75
Poplar 3 (upstream)	23 +/- 0.8	41 +/- 6.7	N 39 37.01 W 79 08.47

Table 4. Invertebrate kick sample stations for the Poplar Lick SWG ORV study, 2005 – 2006.

Station	***Full Name***	***Geographic coordinates***
Pop 1	Poplar Lick Run 1	N 39 35.120 W 79 05.575
Pop 2	Poplar Lick Run 2	N 39 35.295 W 79 05.987
Pop 3	Poplar Lick Run 3	N 39 35.813 W 79 07.132
M Fork	Middlefork creek	N 39 30.823 W 79 09.239
B Run 1	Big Run 1	N 39 32.603 W 79 08.392
B Run 2	Big Run 2	N 39 32.980 W 79 08.657
B Run 3	Big Run 3	N 39 34.608 W 79 09.828
Crabtree	Crabtree creek	N 39 30.276 W 79 09.245
Monroe	Monroe run	N 39 32.985 W 79 08.690
U Sav	Upper Savage River	N 39 35.853 W 79 04.982
L Sav	Little Savage River	N 39 32.603 W 79 08.392

Table 5. Combined turbidity analysis, monthly pre and post precipitation event and in-stream turbidity transects at the mouth. Shaded areas are not significantly different from one another.

	Big Run	***Crabtree***	***Little Savage***	***Middle Fork***	***Monroe Run***	***Poplar Lick***	***Upper Savage***
Big run						0.0035	
Crabtree						0.0012	
Little Savage						0.0108	
Middle Fork						0.0001	
Monroe Run						0.0069	
Poplar Lick							
Upper Savage						0.0179	

Table 6. Significance testing results for pooled turbidity values for in-stream kick samples (5 – 50m, 5m intervals) for sampling immediately below the six Poplar Lick ORV crossings, 2006. Shaded areas are not significantly different from one another.

Distance (m)	5	10	15	20	25	30	35	40	45	50
5			0.023	0.0005	0.0005	0.0001	0.0001	0.0001	0.0001	0.0001
10									0.0306	0.0153
15								0.0321	0.0092	0.0018
20										0.023
25									0.016	0.0013
30										
35										
40										
45										
50										

Table 7. Invertebrate population indices for April and November 2005, SWG Poplar Lick study.

April samples

	Pop 1	*Pop 2*	*Pop 3*	*M Fork*	*B Run 1*	*B Run 2*	*B Run 3*	*Crabtree*	*Monroe*	*U Sav*	*Lit Sav*
Richness				25	30	25	32		27		25
HBI				1.58	1.55	2.05	2.03		2.13		2.24
CPOM				0.01	0.05	0.05	0.03		0.03		0.26
Diversity				3.75	3.59	3.31	3.1		3.27		3.3
Equitability				0.76	0.57	0.56	0.38		0.48		0.56
IBI (MBSS)				3.7	3.7	3.7	3.7		3.4		3

November samples

	Pop 1	*Pop 2*	*Pop 3*	*M Fork*	*B Run 1*	*B Run 2*	*B Run 3*	*Crabtree*	*Monroe*	*U Sav*	*Lit Sav*
Richness	20	21	17	24	16	17	21	15	23	29	
HBI	1.69	1.4	1.51	1.16	1.69	1.65	1.89	1.48	1.52	1.95	
CPOM	0.07	0.08	0.18	0.06	0.05	0.02	0.17	0.13	0.15	0.04	
Diversity	3.66	3.79	3.34	3.42	3.48	2.77	3.79	3.12	3.78	3.86	
Equitability	0.91	0.96	0.85	0.64	1	0.56	0.96	0.82	0.87	0.73	
IBI (MBSS)	3.7	3.7	3.9	3.9	3.9	3.22	3.9	3.7	4.1	3.9	

Table 8. Descriptive statistics for November 2005 invertebrate indices, Poplar Lick SWG Investigation.

	Median	*Mode*	*Range*	*Mean*
Richness	21	21	15- 29	20.33
HBI	1.52		1.16 – 1.95	1.58
CPOM	0.08		0.02 – 0.18	0.09
Diversity	3.48	3.79	2.77 – 3.86	3.48
Equitability	0.85	0.96	0.56 – 1.00	0.82
MBSS	3.9	3.9	3.22 – 4.10	3.80

Table 9. Selected Poplar Lick fish sampling station MBSS habitat rating values 2006.

Station	***Instream habitat***	***Epifaunal substrate***	***Shading***	***Pool/Glide/Eddy***	***Embeddedness***
Poplar 1	16	17	92	16	35
Poplar 2	16	17	92	15	35
Poplar 3	16	17	97	15	30

Table 10 . Poplar Lick embeddedness values from 2000 – 2001 (MBSS data) and 2005 – 2006 (SWG study data) for all three Poplar Lick fish sampling stations.

Station	***2000***	***2001***	***2005***	***2006***
Poplar 1	10	15	30	35
Poplar 2	20	20	25	35
Poplar 3	na	na	30	30

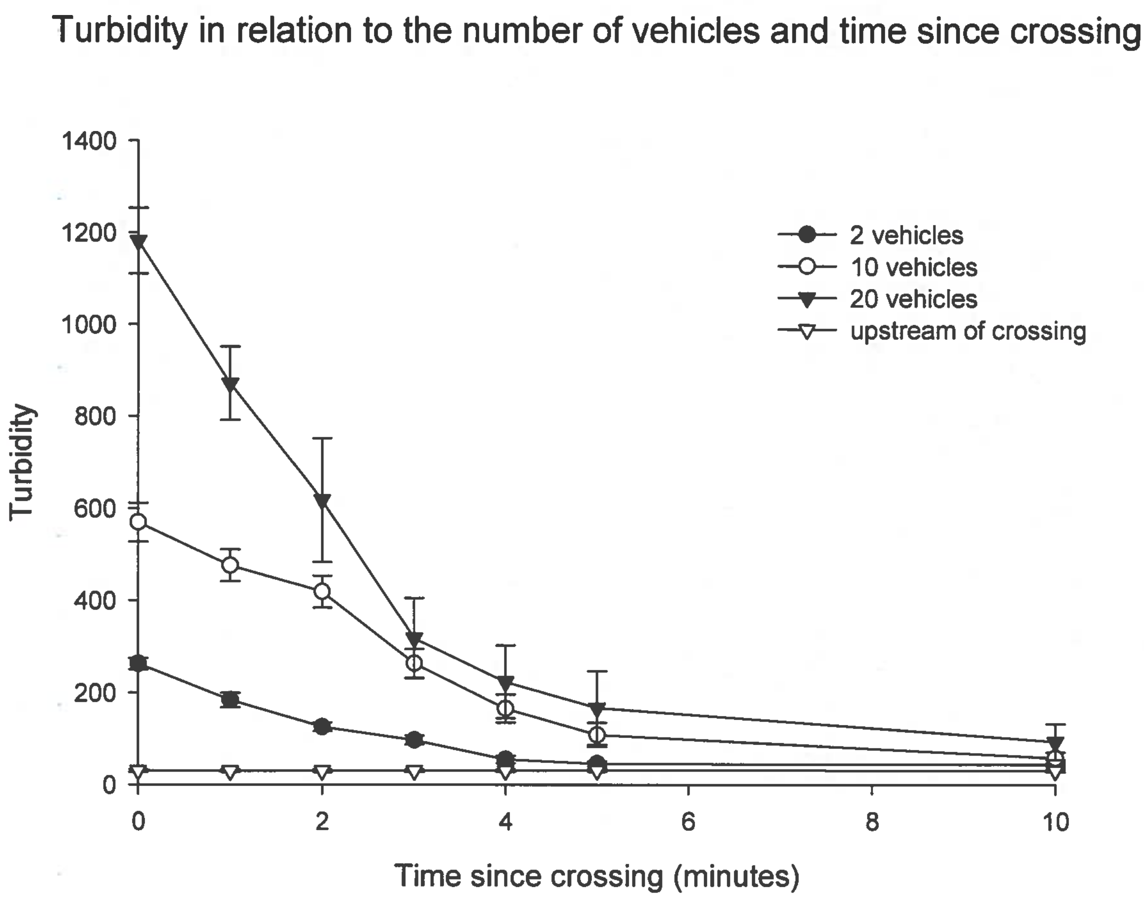

Figure 1 Combined turbidity values versus time for Poplar Lick simulated ORV testing at three crossings, 2006.

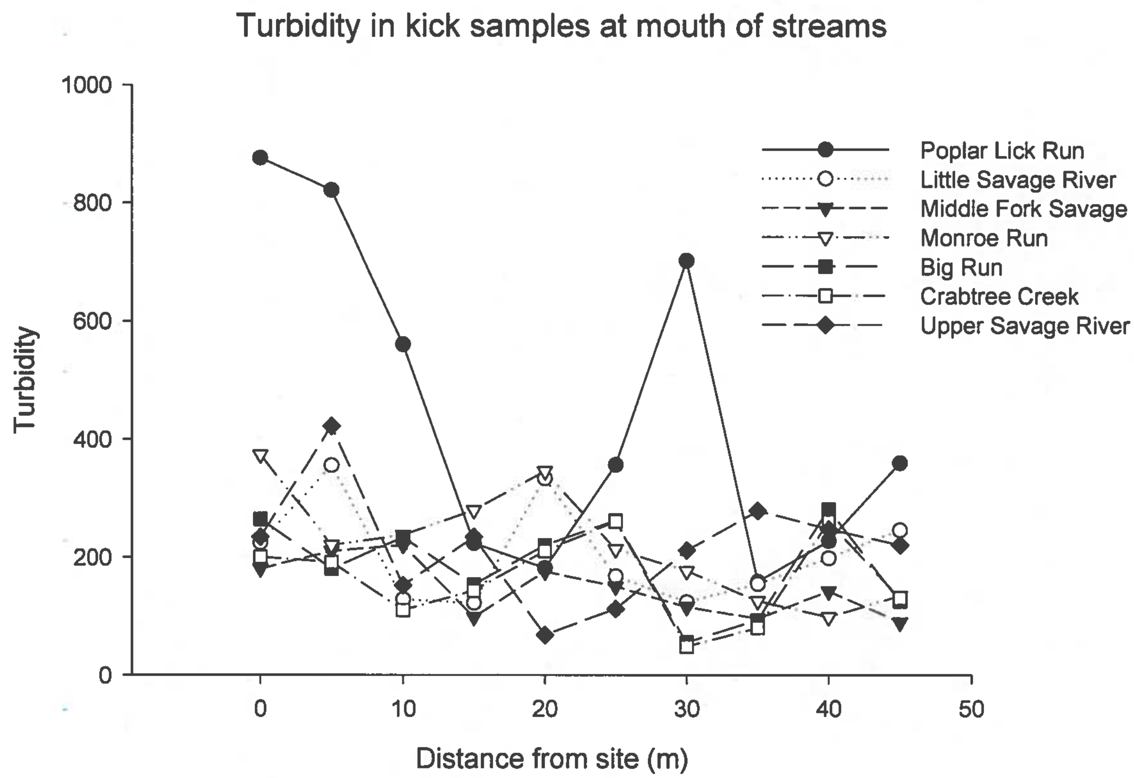

Figure 2. Turbidity levels from in-stream kick samples transects at the mouths of all sample streams.

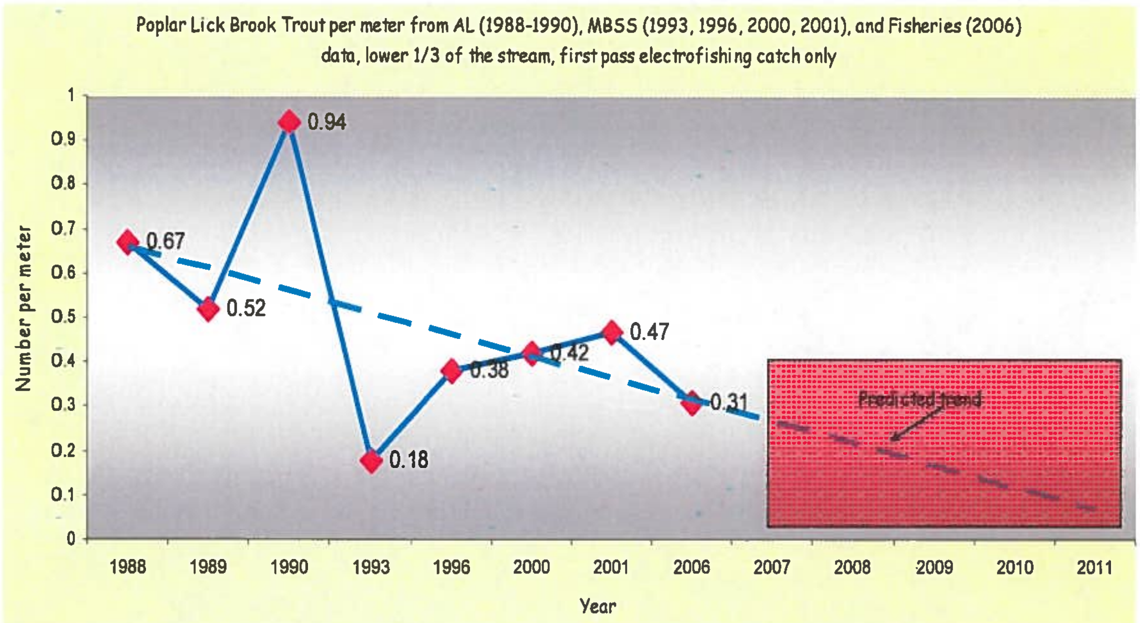

Figure 3. Poplar Lick Brook trout per meter, lowermost sample station, 1988 – 2006.

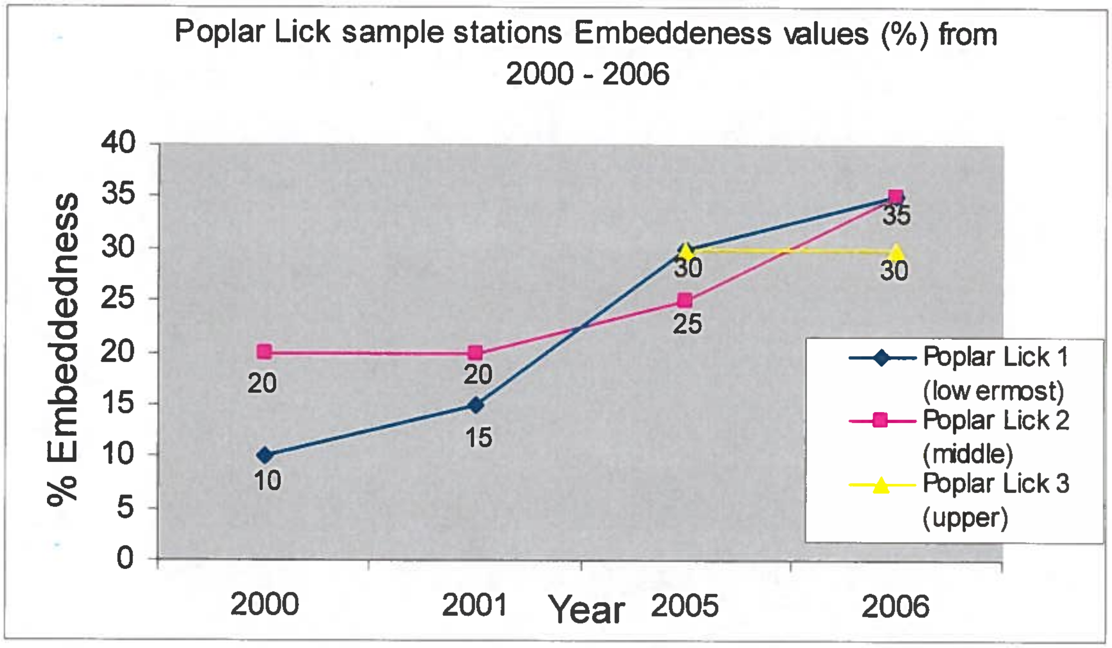

Figure 4. Poplar Lick embeddedness values for all three fish sampling stations, 2000 – 2001, and 2005 – 2006.

Appendix A.

Digital photographs of conditions encountered by investigators that adversely affect the Poplar Lick stream and surrounding ecosystem.

1) Turbid water from an ORV passage running down the road and into the stream.

2) Turbid water, widening of stream channel, bank erosion, forest canopy opening at a Poplar Lick ORV channel.

3) Illegal off trail damage to vernal pool/amphibian breeding area, with drainage directly under the road into the stream.

4) Illegal off trail ORV damage.


5) Sediment deposition directly downstream of an ORV crossing in Poplar Lick.


6) Sediment deposition directly into a Poplar Lick tributary as part of maintaining the Poplar Lick ORV access road.

7) Sediment deposition on amphibian eggs in a vernal pool alongside Poplar Lick where illegal off trail riding was occurring.

8) Damage to a spring fed tributary from ORV off trail riding.

9) Stream channel widening, canopy opening, bank erosion, bare earth runoff.

10) Eroded banks, stream channel widening, canopy opening, bare earth runoff.