Kentucky Green River Conservation Reserve Enhancement Program

Annual Program Accomplishment Report (CEP-68R)

FFY 2008

November 1, 2008

I. Executive Summary

The Green River is the most biologically diverse and rich branch of the Ohio River system. The greatest aquatic diversity occurs in a 100-mile section of unhindered river that flows from the Green River Reservoir Dam through Mammoth Cave National Park (the world's longest and most diverse cave system) in south central Kentucky. This section of the Green River Watershed includes 917,197 acres in the counties of Adair, Barren, Edmonson, Green, Hart, Metcalfe, Russell, and Taylor. Data indicates that agricultural runoff contributes high levels of sediment, nutrients, pesticides, and pathogens to the Green River and Mammoth Cave Systems. There are currently seven species listed as endangered by the U.S. Fish and Wildlife Service in the Green River System. In addition, the project area also includes several ecosystems recognized as Endangered Ecosystems of the United States, including native prairies, hardwood savannahs, canebrakes, and old-growth deciduous forest.

On August 29, 2001, the U.S. Department of Agriculture (USDA) and the Commonwealth of Kentucky agreed to implement a Conservation Reserve Enhancement Program (CREP) on the section of the Green River referenced above to restore up to 100,000 acres. The Kentucky Chapter of the Nature Conservancy is one contributor, offering permanent easements to landowners in addition to CREP contracts and offering public relations and BMP implementation assistance. The Kentucky Department of Fish and Wildlife Resources (KDFWR) is a contributor, offering wildlife biologists and cost-shared positions with NRCS to assist landowners and promoting the program to enhance participation in CREP. The Kentucky Division of Conservation was designated as the state administrative contact agency for Green River CREP, and distributes state cost share and incentive payments to landowners. Western Kentucky University plans and implements the water quality and biological monitoring for the program. Mammoth Cave National Park is also involved in the monitoring of the Green River and groundwater in the karst areas of the Green River CREP.

In late 2006 a proposal for an amendment to the Green River CREP was submitted to USDA. This proposal sought to expand the CREP region down river on the Green approximately 30 river miles to include environmentally significant watersheds downstream of the original project area, and to utilize the community-based approach of this program to more effectively protect locally unique resources and provide better service to the local landowners.

I. Executive Summary (Continued)

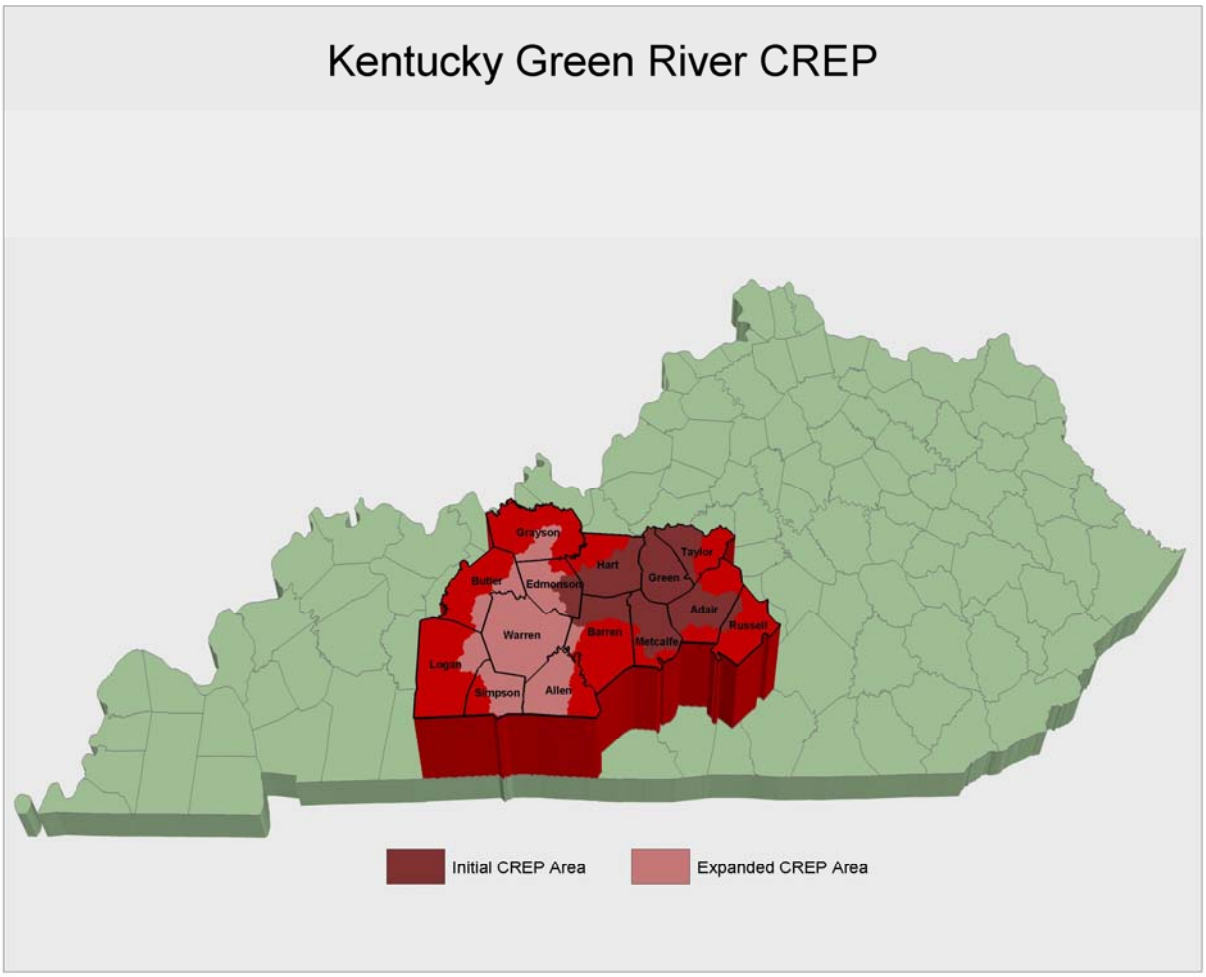
View of Green River. Photo courtesy of TNC.

The proposed additional area included all or parts of Allen, Barren, Butler, Edmonson, Grayson, Logan, Simpson, and Warren counties (See map on the following page). This area contains a total of 946,101 acres and includes counties that rank among the Commonwealth's top producers in several agricultural categories. In addition to the geographic expansion, practical changes to the program to more effectively service our local population and protect our unique natural resources were proposed. These proposals included the addition of the CP29-Marginal Pastureland Wildlife Habitat Buffer to effectively buffer sinkholes in our predominantly pastured sinkhole plain. In addition, expanded buffer widths on this practice and on CP22-Riparian Buffers on Third-Order and Larger Streams helped to more effectively meet local landscape needs.

After some discussion among USDA and partner agencies, this proposal was accepted. An amendment to our Memorandum of Agreement was drafted, and the amendment became effective on February 6, 2007.

FFY 2007 was one of change, transition and planning. FFY 2008 saw the benefits of this long anticipated amendment come to fruition. Upon the beginning of FFY 2008, numerous public relations events were being conducted and landowners were showing great interest in the program. The focus of the public meetings was in our newly added area but business was also heavy in our initial area as news of our programmatic changes, such as the addition of the CP29, greatly enhanced our ability to effectively utilize the benefits of CREP in our locally unique area.

I. Executive Summary (Continued)



Aerial view of Green River Valley.

I. Executive Summary (Continued)

When the amendment was approved and effective in late FFY 2007, much work went into planning the roll-out of this expansion; including the development of timelines, development and implementation of renewed public relations efforts, planning for and conducting training for all CREP staff both in the original and expanded area and an actual start date to begin taking inquiries. This took some time to accomplish and no inquiries were taken or public meetings held until our staff was ready to begin with the workload. Upon initiation of the public relations efforts, it became clear immediately that the interest generated from our changes was going to accomplish our goals. Within a couple of months of the initiation of our public relations, which included articles, radio ads, and public meetings, some county offices were receiving literally hundreds of inquiries. Much of this interest was in those added counties which had not had this opportunity prior to this amendment, but many were also interested in our original counties with the programmatic changes made to better suit our land use and resources. Much of this work began in FFY 2007 and spilled into early FFY 2008. The following paragraph was in last year's annual report:

> "Staff soon began to address this tremendous workload generated by our improvements and public relations. Soon after site visits started and contracts began to be written, FSA received information that soil rental rates would be reviewed nationally, and indications were that it was *possible* that some rates would increase. Staff continued work on our inquiries, but many landowners chose to wait for final contract approval until the new soil rental rates were incorporated. These rates were adopted around the first week of August, 2007. So, the acreage enrolled in our program definitely increased during FFY 2007, however, because it took a bit of preparation time, and the waiting for the rental rate increase, workload amounts dictated that most of our pending applications would not be finalized until after September 30, 2007. Our statistics for this FFY may not give an entirely clear picture of just how much interest there has been and work that has been done by our staff members."

The following pages contain several charts and graphs that will outline in more detail our accomplishments for FFY 2008. The above paragraph described the beginning of our process on workload just after the amendment was approved and initial meetings were held. As noted above, actual completed contracts in FFY 2007 totaled 3,513 acres. This was an increase over previous fiscal years; the workload at that time was not being reflected properly. For this past FFY 2008, 67,822 acres were enrolled into the Green River CREP. This is a tremendous accomplishment and reflects just how important our amendment was to this program's success.

I. Executive Summary (Continued)

Brush Spring flowing into the Green River. Photo courtesy of TNC.

CREP Amendment Kick-off event in Barren County in August 2007

During FFY 2008 the Green River CREP had 1,861 contracts approved, totaling 67,822.4 acres. All of our counties performed very well during this fiscal year. In our original area, Hart and Green Counties performed well with regards to acreage enrolled (both at nearly 9,000 acres), and Metcalfe County greatly increased any previous annual performances with regards to enrollment (nearly 5,000 acres). In our expanded area, Warren County enrolled more than 13,000 acres into the program. This was a tremendous effort by staff, many of which were new to this program this year. With regards to practices implemented, the CP29 Marginal Pastureland Wildlife Habitat Buffer dominated in acreage, already

I. Executive Summary (Continued)

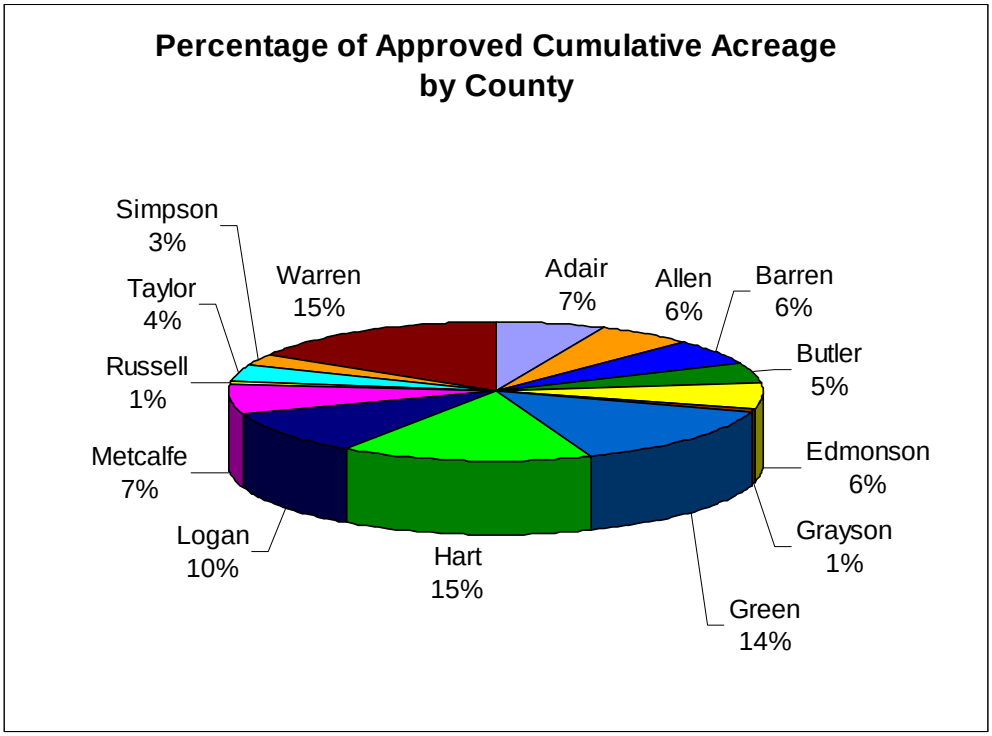
accounting for over 70% of the total acreage enrolled. This was due both to it being newly available to those in our original areas and to the fact that much of our expanded area is located on the sinkhole plane, an area of mature karst features for which this practice was initiated to assist in water quality improvement efforts. Again, the charts and graphs on the following pages will break down our enrollment during FFY 2008.

Areas such as the sinkhole plain have greatly benefited from the newly added CP-29 practice.

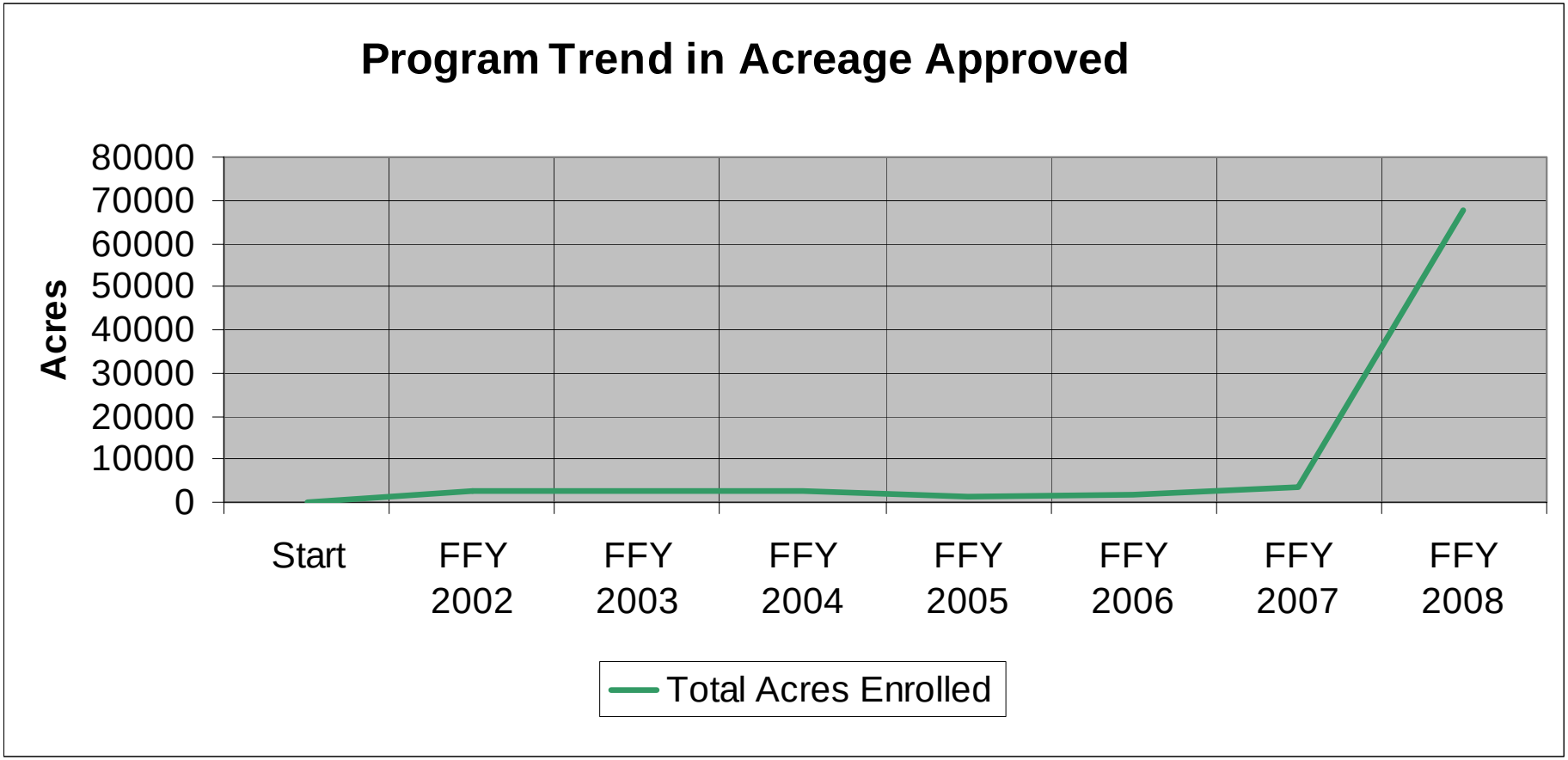
Warren County "CREP Team"

Total Acreage per County per FFY

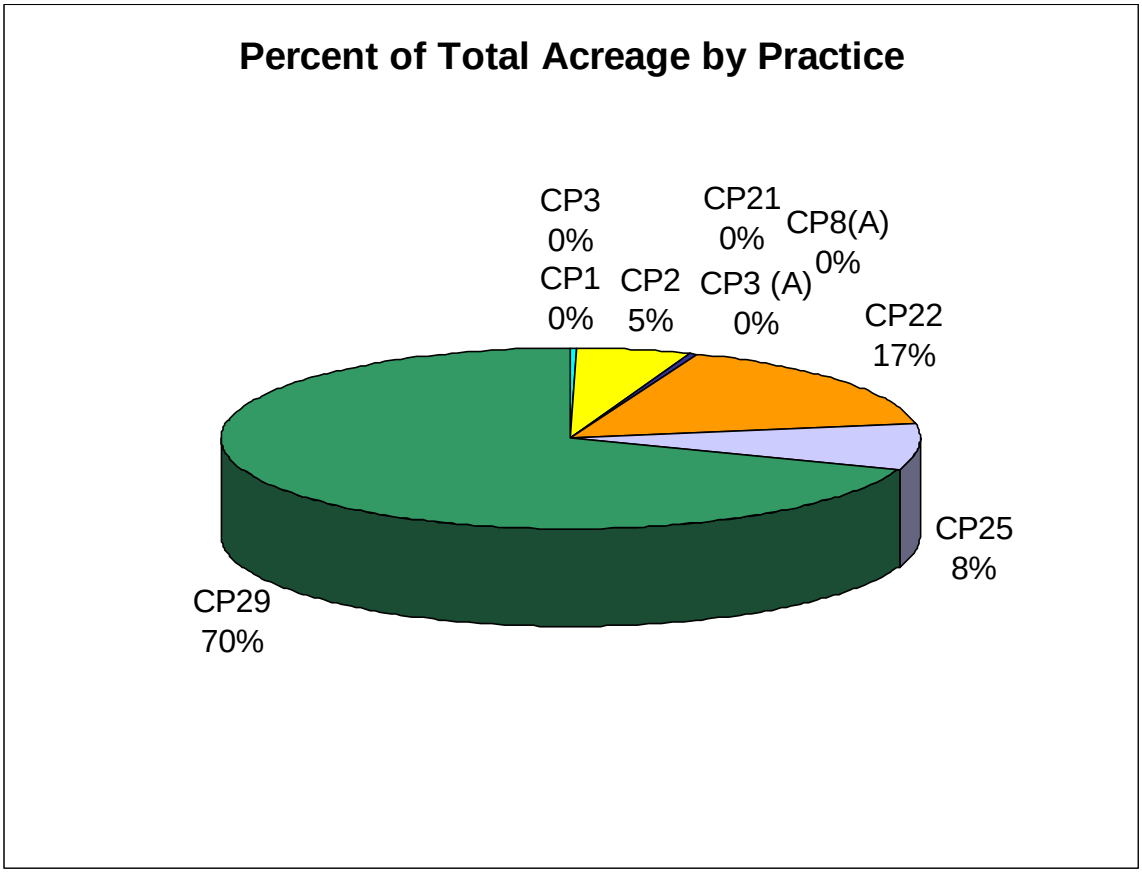
County	Total Acreage by FFY							Cumulative Total
	FFY 2002	FFY 2003	FFY 2004	FFY 2005	FFY 2006	FFY 2007	FFY 2008	
Original Area								
Adair	4.0	124.6	827.6	270.1	121.0	271.9	3895.4	5514.6
Barren	695.3	1375.10	282.9	267.3	32.7	150.6	1969.6	4773.5
Edmonson	129.8	16.0	0	0	45.3	71.0	4587.9	4850.0
Green	66.1	571.5	881.7	367.1	554.6	427.0	8901.3	11769.3
Hart	850.9	323.9	75.2	139.4	722.2	1771.5	8724.3	12607.4
Metcalfe	59.9	75.5	359.6	153.6	0	145.1	4988.8	5782.5
Russell	0	0	0	0	22.7	25.1	479.8	527.6
Taylor	915.6	319.5	189.7	200.2	185.2	574.6	797.9	3183.0
Expansion Area								
Allen						0	4851.6	4851.6
Butler	Program Not Available					0	3805.8	3805.8
Grayson						0	840.1	840.1
Logan						0	8540.5	8540.5
Simpson						73.4	2083.4	2156.8
Warren						2.6	13,356	13358.6
Total	2721.6	2806.1	2616.7	1397.7	1683.7	3512.8	67822.4	82561.0



Cumulative CREP Contracts Completed by County		
COUNTY	#CONTRACTS	ACRES/CONTRACT
Adair	251	23
Allen	136	36
Barren	146	32
Butler	96	40
Edmonson	168	29
Grayson	21	48
Green	377	31
Hart	347	35
Logan	206	41
Metcalfe	164	35
Russell	27	26
Simpson	60	36
Taylor	170	17
Warren	387	34
TOTALS	2556	32 Acres Program Average


Program Trend in Acreage Approved
Acres
80000
70000
60000
50000
40000
30000
20000
10000
0
Start
FFY 2002
FFY 2003
FFY 2004
FFY 2005
FFY 2006
FFY 2007
FFY 2008
Total Acres Enrolled

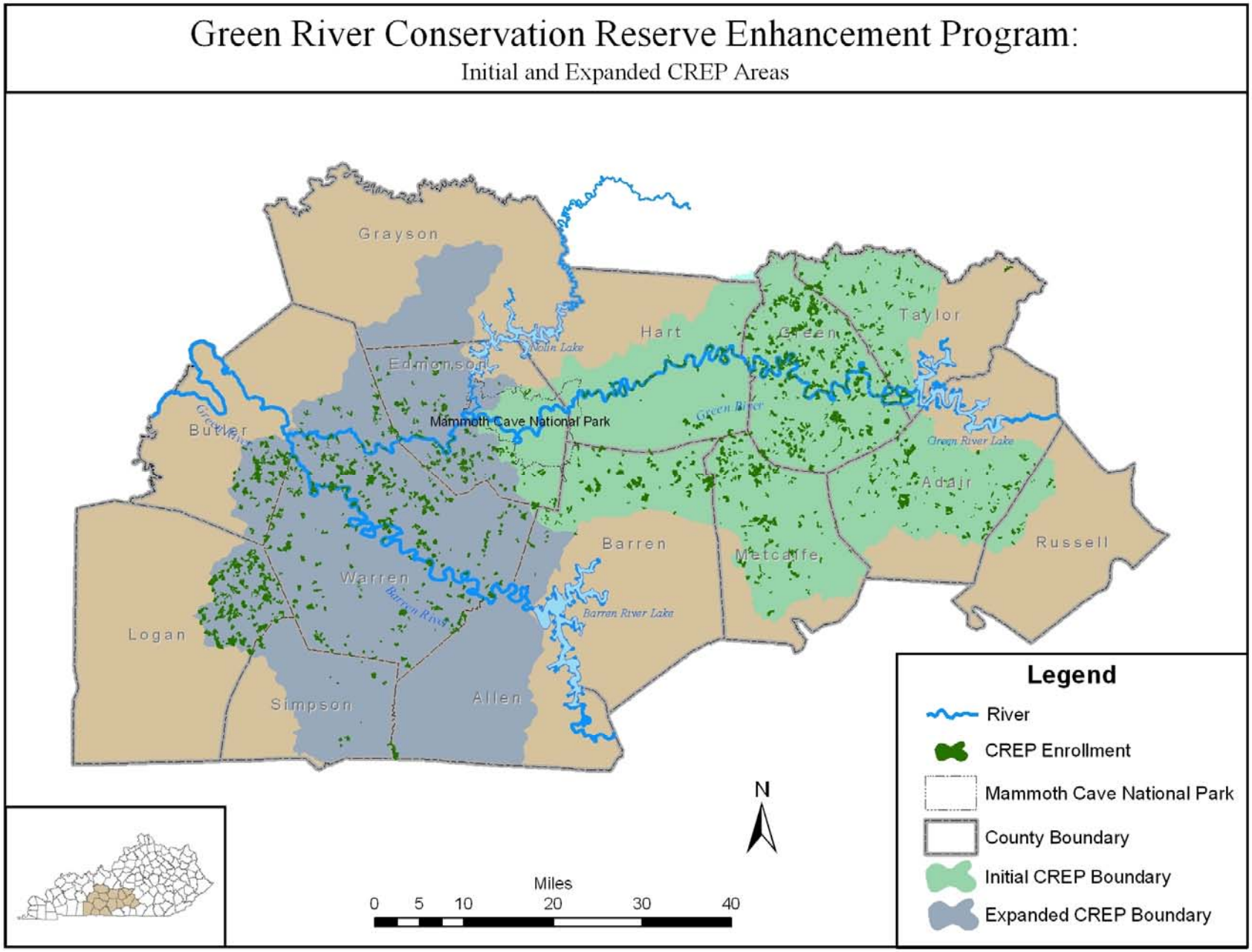
Cumulative Total Acreage by Practice				
Practice Code	Approved Contracts through FFY 2007		FFY 2008	Total
	Practice	Acres	Acres	
CP1	Introduced Grasses/Legumes	217.9	20.4	238.3
CP2	Native Warm Season Grasses	4,305.50	123.2	4,428.70
CP3	Tree Planting	15.5	23.7	39.2
CP3(A)	Hardwood Tree Planting	61.1	32.5	93.6
CP8(A)	Grassed Waterway	2.6	4.4	7
CP21	Filter Strip	1	41.7	42.7
CP22	Riparian Buffer	6,549.90	7,197	13,746.90
CP25	Rare and Declining Habitat	273.3	6,288.50	6561.8
CP29	M.P. Wildlife Habitat Buffer	3,311.80	*54,091.00*	57,402.80
Totals	All	14,738.6	67,822.4	82,561.0



Approx. 1,237 miles of streams/rivers have been buffered in the program.

Program Cumulative Payment Summary					
County	Average Acres/Contract	Avg. Rental Rate/Acre	Incentive Paid Per Acre	Total Estimated Cost-Share	Avg. Cost-Share $/Acre
Adair	23	$137	$66	$1,297,642	$205
Allen	36	$157	$76	$1,058,865	$218
Barren	32	$125	$56	$801,428	$173
Butler	40	$187	$91	$391,963	$103
Edmonson	29	$171	$83	$892,225	$177
Grayson	48	$176	$86	$203,081	$170
Green	31	$154	$74	$2,201,066	$174
Hart	35	$198	$96	$2,014,398	$150
Logan	41	$245	$120	$1,359,649	$159
Metcalfe	35	$139	$66	$938,920	$161
Russell	26	$141	$68	$163,348	$170
Simpson	36	$198	$97	$350,510	$163
Taylor	17	$133	$63	$548,563	$188
Warren	35	$215	$105	$2,293,813	$165
Region	32	$179	$87	$14,515,471	$168

FY 2008 Payment Summary					
County	Average Acres/Contract	Avg. Rental Rate/Acre	Incentive Paid Per Acre	Total Estimated Cost-Share	Avg. Cost-Share $/Acre
Adair	34	$147	$71	$632,158	$162
Allen	36	$157	$76	$1,058,165	$218
Barren	35	$140	$68	$337,938	$172
Butler	40	$187	$91	$391,963	$103
Edmonson	29	$174	$85	$840,729	$183
Grayson	40	$179	$87	$163,728	$195
Green	38	$160	$78	$1,427,569	$160
Hart	37	$210	$103	$1,257,465	$144
Logan	41	$245	$120	$1,359,649	$159
Metcalfe	41	$143	$69	$802,965	$161
Russell	30	$144	$69	$86,682	$181
Simpson	36	$200	$98	$337,852	$162
Taylor	32	$156	$76	$136,064	$171
Warren	35	$215	$105	$2,178,324	$163
Region	36	$189	$92	$11,011,951	$162


Green River Conservation Reserve Enhancement Program:
Initial and Expanded CREP Areas
Grayson
Hart
Green
Taylor
Edmonson
Nolin Lake
Mammoth Cave National Park
Green River
Green River Lake
Butler
Adair
Russell
Barren
Metcalfe
Warren
Barren River
Barren River Lake
Logan
Simpson
Allen
Legend
River
CREP Enrollment
Mammoth Cave National Park
County Boundary
Initial CREP Boundary
Expanded CREP Boundary
N
Miles
0 5 10 20 30 40

II. State and Local Partners' Financial Contribution

The Kentucky Chapter of The Nature Conservancy
(TNC)

The Kentucky Chapter of The Nature Conservancy has been a key CREP partner since the proposal was made to bring CREP to the Commonwealth of Kentucky. TNC funds, offers and holds the optional permanent easements on CREP contracts that are available in our original CREP region. In addition to the easements and associated duties, TNC has been very active with program promotion, field and office assistance to local USDA offices with program implementation, funding initiatives for CREP meetings, field days and printed public relations materials and conducting biological monitoring.

Upon the completion of this report, the Kentucky Chapter of TNC had not submitted any specific financial or labor data for this FFY.

Kentucky Department of Fish and Wildlife Resources
(KDFWR)

The Kentucky Department of Fish and Wildlife Resources has been a key partner in field implementation of the Green River CREP. KDFWR has contributed man-hours from several field positions, including KDFWR/NRCS Liaisons and Farm Bill Biologists, private lands biologists, four CREP Biologists and four CREP Technicians. One CREP Biologist and all four CREP technician positions were newly created to help meet the landowner demand for this program. KDFWR personnel adopted many duties working both directly with landowners and with NRCS District Conservationists. These biologists and technicians also helped

with the physical establishment procedures, such as on site guidance and delivery of seed drills, spray equipment, etc. These biologists and technicians also initiated landowner contacts and coordinated and/or assisted with field days and informational meetings. In total this year KDFWR dedicated 8,171 man hours to the CERP program with a total cost of $143,676.

The above referenced CREP Biologists and CREP Technicians, which are supervised by KDFWR in partnership with NRCS, have greatly aided in the following tasks for this program: assisting with program promotion, planning, contract writing and modifications; on-site measurements and practice layout; site visits during practice installation; practice evaluation, final and annual status reviews; providing technical guidance on vegetation plantings which includes site preparation, planting, and post-planting management to ensure successful stand establishment; and assisting District Conservationists with writing and/or modifying participants' contracts.

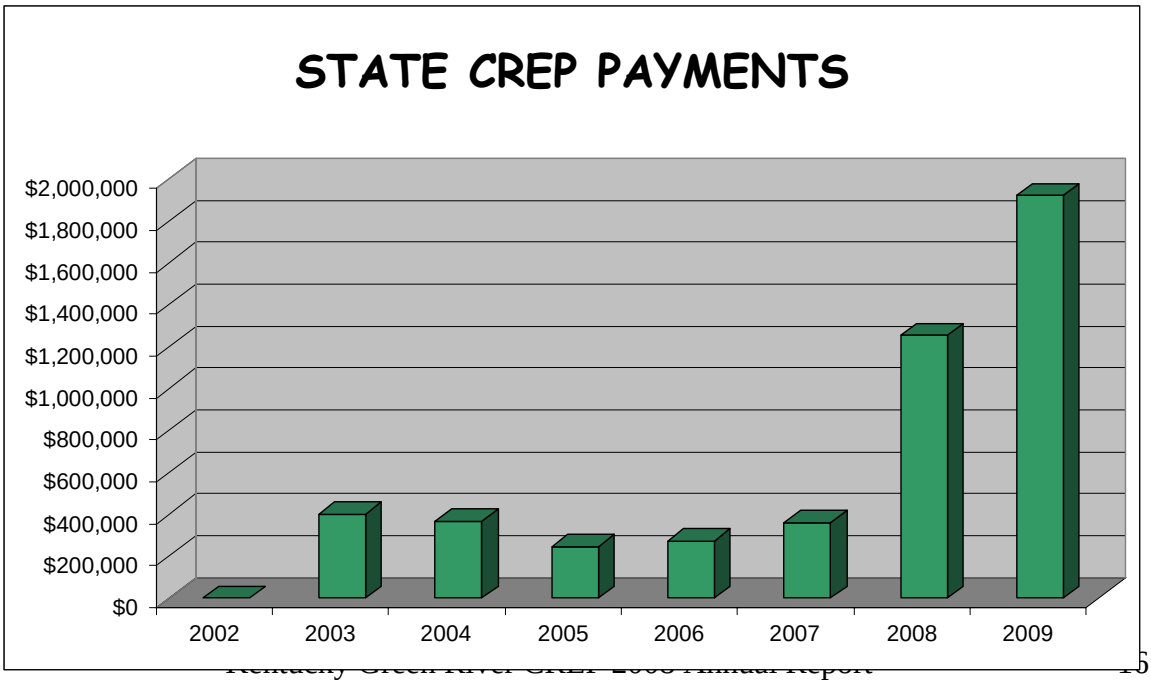
Additional costs to KDFWR not covered by the above referenced activities are as follows: cost-shared funding for CREP Coordinator position - $17,000; and cost share provided directly to landowners for implementation/management of CREP practices - $76,696.

KDFWR Biologist on native warm-season grass seed drill

Kentucky Division of Conservation (KDOC)

The Kentucky Division of Conservation is the state contact agency for the Green River CREP. The Division administers the financial portion of CREP (state cost share and incentive payments), and works closely with local conservation districts and partner agencies in the promotion and administration of the program. In addition, the Green River CREP Coordinator works through, and is primarily funded by, the KDOC. The following is payment information on state contributions to CREP contracts:

COUNTY	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	TOTAL
ADAIR		$48,696.00	$28,939.00	$58,710.00	$145,093.00	$327,161.00	$139,396.00	$747,995.00
ALLEN						$145,378.00	$208,959.33	$354,337.33
BARREN	$209,177.00	$99,662.00	$18,799.00	$12,561.00	$9,859.00	$76,405.00	$95,514.59	$521,977.59
BUTLER							$219,898.00	$219,898.00
EDMONSON	$10,688.00				$4,669.00	$15,105.00	$240,322.00	$270,784.00
GRAYSON							$37,219.00	$37,219.00
GREEN	$3,757.75	$48,788.00	$108,997.00	$98,124.00	$134,420.00	$210,738.46	$361,490.00	$966,315.21
HART	$79,947.50	$57,508.00	$21,433.00	$3,829.40	$36,220.00	$97,700.50	$352,592.00	$649,230.40
LOGAN						$22,723.00	$272,237.00	$294,960.00
METCALFE	$5,541.00	$26,670.00	$14,335.00	$52,931.00	$11,492.00	$230,311.00	$126,862.53	$468,142.53
RUSSELL					$3,255.00	$9,696.00	$34,707.00	$47,658.00
SIMPSON						$6,929.00	$1,384.27	$8,313.27
TAYLOR	$94,176.00	$88,634.00	$55,743.00	$50,091.00	$18,079.00	$13,906.78	$58,252.00	$378,881.78
WARREN						$100,170.50	$549,920.00	$650,090.50
TOTAL	$403,287.25	$369,958.00	$248,246.00	$276,246.40	$363,087.00	$1,256,224.24	$2,698,753.72	$5,615,802.61



CREP Native Warm-Season Grass Field

CREP BMP's Offered by the Commonwealth

Kentucky Division of Forestry
(KDOF)

The Kentucky Division of Forestry has been primary in providing technical assistance and guidance with tree planting practices within the Green River CREP. In addition to the tree planting specific practices (CP-3A), all riparian buffers (CP-22) are required to have a minimum of 50' or 100' of trees planted (depending on stream order) adjacent to the water body. In addition to technical guidance and assistance, KDOF personnel have also assisted landowners with tree seedling orders, most of which are through our State nursery. During FFY 2008, KDOF has written 175 CREP Practice Plans, encompassing 1,311 acres. The agency worked over 752 hours on CREP activity (including plan writing and site visits).

Green River CREP Tree Planting in Edmonson County

Federal Green River CREP Matrix

Federal CREP									
Practice Code	**Practice Description**	**Land Eligibility**	**Crop History**	**Base C/S**	**PIP**	**SIP** Acres X Full Years (not>10yrs) X $10	**SRR Incentive (ac/yr) % x SRR)**	**Maintenance Payment** ac/yr	**Maintenance w/fence //and water** ac/yr
CP1	Introduced Grasses and Legumes	HEL	Yes	50%			50%	$4	
CP2	Native Grasses	HEL	Yes	50%			75%	$4	
CP3	Tree Planting	HEL	Yes	50%			100%	$4	
CP3A	Hardwood Tree Planting	HEL	Yes	50%			100%	$4	
CP4B	Permanent Wildlife Habitat Corridors	HEL	Yes	50%			75%	$4	
CP4D	Permanent Wildlife Habitat	HEL	Yes	50%			75%	$4	
CP8A	Permanent Grass Waterways	NA	Yes	50%	40%	X	75%	$4	
CP9	Shallow Water Areas for Wildlife	NA	Yes	50%	40%		75%	$4	
CP10	Grass Cover-already established	HEL	Yes	0			50%	$4	
CP11	Tree Cover –already established	HEL	Yes	0			50%	$4	
CP12	Wildlife Food Plots	HEL	Yes	0			50%	N	
CP15A	Contour Grass Strips	NA	Yes	50%	40%		50%	$4	
CP21	Filter Strips	NA	Yes	50%	40%	X	75%	$4	$8//$9
CP22	Riparian Buffers	NA	Yes or MP	50%	40%	X	100%	$6	$8//$9
CP23	Wetland Restoration	Wetland	Yes	50%	**	**	100%	$4	
CP23A	Wetland Restoration Non-Floodplain	NHE	Yes	50%	**	**	100%	$4	
CP25	Rare and Declining Habitat	HEL	Yes	50%			100%	$4	
CP29	Marginal Pastureland Wildlife Habitat Buffer	NA	MP	50%	40%	X	100%	$4	$8/$9

Green River CREP

State CREP Cost Share/Incentive Matrix

State Practice Code	Federal Practice Code or Practice Description	State Cost Share Rate	State Incentive Rate	State Incentive Rate w/ Easement Option
KREP1	CP1	25%	25%	75% *
	CP2	25%	25%	75% *
	CP3	25%	25%	75% *
	CP3A	25%	25%	75% *
KCREP2	CP8A	25%	25%	75% *
	CP15A	25%	25%	75% *
	CP21	25%	25%	75% *
	CP22	25%	25%	75% *
	CP29	25%	25%	75% *
KCREP3	Livestock Water System	25%	25%	75% *
KCREP4	Fence	25%	25%	75% *
KCREP5	Stream Crossing	25%	25%	75% *

* Incentive available if permanent easement is offered on noted practice, and in watershed of federal contract.

- Cost share and incentive payments combined cannot exceed $7,500 per practice per state fiscal year.
- Each applicant or operation is limited to $20,000 total per state fiscal year, not to exceed $40,000 in any two consecutive program years.

III. Monitoring and Evaluation

Western Kentucky University is responsible for the organization and implementation of a comprehensive monitoring and evaluation plan to determine the success of program goals. This effort is funded through various grant sources, and is being implemented within the watershed. The following monitor summary was submitted by Scott Grubbs, Ph. D., Biology Department, WKU.

ANNUAL REPORT

Assessing changes across spatial and temporal scales due to conservation practices associated with the Kentucky Conservation Reserve Enhancement Program in the Upper Green River Basin

Annual report submission to:

National Resources Conservation Service

771 Corporate Drive, Suite 210

Lexington, KY 40503-5479

Project director:

Scott Grubbs, Ph.D.

Department of Biology and Center for Biodiversity Studies

Western Kentucky University

Bowling Green, KY 42101

Date:

November 12, 2008

III. Monitoring and Evaluation (Continued)

Background

In 2001 the Upper Green River Basin was established as the geographic entity of Kentucky's U.S.D.A. Conservation Reserve Enhancement Program (CREP). The main goal of the nearly 40,000 ha Kentucky CREP is to reduce nonpoint source pollution loading (e.g., sediment, industrial fertilizer) into the mainstem of the Upper Green River and principle tributaries by recruiting landowners into incentive-based 10-15 yr. cooperative agreements of best management practices aimed to eliminate riparian-based agricultural and animal husbandry practices. Specific measurables that are incorporated in CREP goals are multifaceted and include (a) 10% reduction of sediment, nutrients, and pesticides entering the river and its tributaries from agricultural sources, (b) enhancement of aquatic and riparian habitat, (c) enhancement of aquatic wildlife populations habitat, (d) restoration of riparian habitat corridors, (e) reconnection of landscape-level ecological processes, (f) establishment of riparian buffers around sinkholes, (g) restoration of non-riparian wetlands, and (h) protection and restoration of subterranean ecosystems.

Outline of individual tasks

Task 1: NRCS/CREP GIS mapping and analysis activities

Task 2: Hydrology, sediment and water quality activities

Task 3: Direct terrestrial monitoring activities

Task 4: Project enhancements and pilot studies

III. Monitoring and Evaluation (Continued)

Task 1
NRCS/CREP GIS mapping and analysis activities

Task 1 Manager
Ouida W. Meier, Ph.D., Center for Biodiversity Studies, Western Kentucky University

Workplan overview
GIS mapping and analysis of land use in the Upper Green River Basin, and to begin to analyze historic and project water quality and biological data. Two projects have been established, with brief descriptions and documentation of products

III. Monitoring and Evaluation (Continued)

Task 2
Hydrology, sediment and water quality activities

Task 2 Manager
Stephen Kenworthy, Ph.D., Department of Geography and Geology, Western Kentucky University

Workplan overview
Task 2 will assess the effects of changes in land use and implementation of soil conservation practices on patterns of sediment transport and storage in the Upper Green River basin. The project involves: 1) field measurements of suspended sediment fluxes on the Green River and from surface and subsurface tributaries to estimate modern rates of transport and short-term storage, and 2) characterization of flood plain sediments and patterns of channel migration to estimate historical rates of sediment remobilization and storage. Understanding the historical and modern patterns and rates of sedimentation will help resource management agencies to maximize the environmental benefits of soil conservation efforts in the Upper Green River basin.

Four projects have been established but no report or updates have been submitted.

III. Monitoring and Evaluation (Continued)

Task 3
Direct terrestrial monitoring activities

Task 3 manager
Albert J. Meier, Ph.D., Department of Biology, Western Kentucky University

Three projects have been established, with brief descriptions and documentation of products:

Activity 1: **Analysis and mapping of stream bank vegetation of the Green River.**

Workplan overview
Our CREP/NRCS monitoring responsibilities within the Upper Green River Basin are to map streamside vegetation along the Green River and conduct point-based vegetation surveys.

Update. Research has previously been conducted by J. Michael Butler focused on erosion frequency associated with riparian land use on the Green River in central Kentucky. Since the Barren River lies within the Green River watershed, this research has been expanded to include the Barren River. We canoed the length of the Barren River, from the dam located at Barren River Lake to the confluence with the Green River. Students took images of each severe erosion site, recorded the position of the site using a GPS unit, recorded the estimated height and length in meters, noted the side of the river where the erosion occurred, and took notes on possible causes (i.e., land use). As well as looking for erosion sites, the students also marked the position of the beginning and end of forest along the river (noting the side of the river). The presence of cane growing along the river was also marked with a GPS unit and an estimated length of the stand was recorded.

Products – No product to date.

Activity 2: **Bio-acoustic monitoring of riparian corridor wildlife.**

Workplan overview

Our CREP/NRCS monitoring responsibilities within the Upper Green River Basin are to develop catalogs of bird and frog calls, set up 20 recording stations, gather calls for at least two seasons, analyze calls, and relate calling to landscape level land use.

Update. Current efforts have implemented an automated recording system named "SongCatchers" by the Meier Lab at WKU's biology department. These devices consist of a 12 volt, 12 amp hour battery supplying power to a digital recorder, digital microphone, and a remote timing device manufactured by Dr. Cambron and students from the WKU Department of Engineering. With the use of BASIC programming, this timer regulates the SongCatcher's operation, recording for three minutes on an hourly cycle. This yields 10 $\pm$ 1.1 days of recordings on average (variation in life of the battery a function of temperature, humidity, and repeated use of rechargable batteries). A sampling period, then, with 20

III. Monitoring and Evaluation (Continued)

SongCatchers along the upper Green River watershed can yield approximately 4,800 files/recordings. Recording sessions have been established in the early breeding season (May-June) as well as late breeding sessions in mid-July.
The primary objective is to establish spatial, climatic, and temporal relationships of various species of neotropical songbirds to the Green River watershed through the use of acoustic autosampling. One challenge which presents itself with the acquisition of such large volumes of data (we currently store approximately 10,000 audio recordings from the field) is an expedient yet efficient method of analysis.

SongScope, an acoustic analysis software tool from Wildlife Acoustics ™, has been used in efforts for the batch autoanalysis of this large dataset. The program allows the user to annotate bird songs from a small sample of files, making it possible to generate a detection model known as a recognizer. In one example, a Carolina Wren detector was validated against its training data with 100% accuracy. Further verification against the data set as a whole is currently underway, with systematic elimination of false positives possible by adjusting the parameters which define the model's vector states. When a recognizer model is complete, it can then be run against a large dataset. One batch detection of 1971 audio files (3 minutes each) generated 5,793 detections of Carolina Wren calls.

This dataset was then used to assess relationships with adjacent land use to the Green River. One such example of a simple regression showed a significant negative correlation with pasture land to Carolina wren songs; pasture cover was calculated through GIS applications at 100 and 500 meter radii scales around the recording device.

In addition to this example, there have been previous analyses which have taken place on smaller datasets through the use of by-ear analysis. When regressions were calculated on these data, significant relationships to adjacent forest were found in such species as mourning doves, northern bobwhites, blue-grey gnatcatchers, and yellow-billed cuckoos. With several positive responses, current batch detections are being performed on common yellowthroats and indigo buntings with hopes to find stronger significant relationships in response to CREP restoration. In addition to the continued efforts in identifying relationships with various bird species, a catalog of frog and toad species and their calls will be archived, with recognizers for frog and toad species also possible. Frog and toad calls as well as bird songs are now also being extracted from field recordings and archived as local templates of the species' call. These are currently being put onto the internet via WKU's Center for Biodiversity Studies' webpage.

Continued efforts with SongScope in the analyses of this data have established working relationships with Dr. Rafael Marquez at Madrid's National Museum of Natural Sciences as well as the creator of SongScope and owner of Wildlife Acoustics, Ian Agranat. Several recordings have been edited as examples of the local dialects of various bird species in the Green River watershed and are currently stored in a bioacoustic archive maintained by Dr. Marquez and the Madrid NMNS at the website http://www.fonozoo.com.

III. Monitoring and Evaluation (Continued)

Products – Four presentations during 2008:

1. Use of SongScope sound recognition software in the identification of breeding bird communities along the Upper Green River Watershed, Kentucky. Albert J. Meier, Jonathan L. Bowers, Cabrina L. Hamilton, Aaron Hulsey, Rafael Márquez, Matthew Skaggs, and Ouida Meier. Ecological Society of America, August 2008, Milwaukee, WI.

2. Influences of land use, habitat scale, and weather on bird calling activity. Matthew Skaggs, J. L. Bowers, Albert J. Meier, Cabrina L. Hamilton, T. Aaron Hulsey and Ouida Meier. Society for Conservation Biology. July 2008, Chattanooga, TN.

3. Landuse changes and stream conditions in the Green River watershed: overview and impacts of the Conservation Reserve Enhancement Program. Ouida Meier, Albert J. Meier , Scott Grubbs and Steve Kenworthy. 2008, July 2008, Chattanooga, TN.

4. Influence of land use, habitat scale, and weather on bird-calling activity, an update. Jonathan L.Bowers, Albert J. Meier, Cabrina L. Hamilton, Aaron Hulsey, Rafael Márquez, Matthew Skaggs, and Ouida Meier. Kentucky Chapter of the Wildlife Society, February 2008, Mammoth Cave National Park, KY. ***First Place in the student competition***

Activity 3: **Analysis of Restoration of Grasslands**

Workplan overview

Conservation Reserve Enhancement Program (CREP) is replacing pastures with tall grass fields in the Upper Green River watershed in Kentucky. We surveyed 10 sample sites, each with one CREP and one pasture field, to determine the influences of tall grass restoration on vegetation community composition. The native grasslands in the area are deep soil barrens (DSB) which extensively covered the karst Pennyroyal Plain of southwestern Kentucky and north-central Tennessee. The barrens developed on deep, fertile soil about 4,000 BC from regular burning by Native Americans. All barrens were in agricultural production by the mid-1800s. The Fort Campbell Military Reserve, which has been regularly burned since 1942 to clear for training, is the best post-settlement DSB site today. Data from vegetation surveys conducted on Fort Campbell Military Reserve (Chester et. al. 1997) found C4 perennial grass domination and 342 taxa. We used this data to compare species composition, species richness, and vegetation structure of CREP and pasture sites with that of DBS to access their similarity to a historical state.

To perform the floristic surveys, we extended a transect down the long axis of each CREP field (experimental treatment plot) and each pasture (control treatment plot), and ten one-m^2 quadrants were installed at equal distances along the transect. Data was collected summer and fall 2005 and spring 2006. Rooted vascular plant species presence and stem

III. Monitoring and Evaluation (Continued)

Activity 3: **Analysis of Restoration of Grasslands (Continued)**

Workplan overview (Continued)

densities at twenty-five cm, seventy-five cm, and one hundred fifty cm were surveyed. Split Plot ANOVAS with a General Linear Model procedure were performed to analyze the data.

Our results showed structural heterogeneity differed considerably between control and experimental treatment plots. Control and experimental treatment plots both displayed relatively low structural heterogeneity in spring and high structural heterogeneity in summer. However, in fall, structural heterogeneity was relatively low in control plots and high in experimental plots. Temporal differences in structural diversity between the two treatment groups is attributable to the differing flowering phenologies of nonnative C3 perennial grasses (dominant in pasture plots) and native C4 perennial grasses (dominant in restoration plots).

Two particular points of interest from the analysis follow: 1) four of the five most frequent species (80%) found in CREP sites were native to deep soil barrens, while two of the five most frequent species (40%) found in pasture sites were native to deep soil barrens, and 2) many species native to deep soil barrens were found in CREP fields yet were not included in the CREP seed mixtures.

Our data and analysis shows CREP sites are much more similar to current deep soil barrens, and by extension, to a historical grassland state, than pasture sites in both vegetative structure and species composition. Species native to deep soil barrens became established in CREP sites despite not being included in the seed mix. Further data analysis and writing our underway.

Update – Avian use of grasslands within the CREP region. Winter avian and vegetation surveys were conducted to examine the possible effects of CREP plantings on vegetation structure and avian guild richness compared to pastures/ hayfields. Nineteen fields were surveyed (ten CREP and nine pasture/ hayfields) for vegetation structure characteristics and avian guild richness during winter. All fields were located on private land in Warren, Hart, and Green counties, Kentucky.

Avian surveys were conducted from 01 December 2007 to 23 February 2007 between sunrise and noon. Surveys were not conducted in rain to decrease effects of variable weather. Two observers conducted each survey to minimize effects of single observer bias and error. The two observers communicated and compared survey tallies during counts to insure accuracy. Fields were divided into parallel transects about fifty meters wide across the length of the fields. The number of transects varied by field size. Point surveys were conducted along transects at varying intervals that allowed the transects to be fully surveyed without overlapping surveyed areas (about 3 points per transect). Each point survey lasted three minutes. Bird species presence was tallied within the point if the species was observed perched in the field, observed within the edge of the field, heard calling within the field, observed flying over the field, or observed feeding over the field. Only birds identified

III. Monitoring and Evaluation (Continued)

Activity 3: **Analysis of Restoration of Grasslands (Continued)**

Workplan overview (Continued)

to species were included. Surveys of paired CREP fields and pastures were completed on the same morning with the same methodology. Each field was surveyed once.

Vegetation surveys were conducted between 02 January 2007 and 22 March 2008. Vegetation structure, percent bare ground, and percent lodging/litter were surveyed within one m^2 sampling plots. A transect was established down the middle length and width of each site. The location of the sampling plots along transects were determined using a random numbers table. Four sampling plots were placed on each transect. Percent bare ground was defined as the percent area of ground with exposed soil. Percent lodging/litter was defined as the percent area covered with dead organic matter by horizontal matting or as area fully covered by leaning dead vegetation. Stem density measurements were taken within the following areas: stems exceeding 0.25, 1.0, and 1.5 m in height and emerging from 0.0025 m^2 (1/400 sample frame), 0.25 m^2 (1/4 sample frame), and 1 m^2 (1 sample frame) squares, respectively (fig 1.). Edge effects were avoided by excluding the first and last fifteen meters of each transect.

Planned analysis includes examining the avian guild and species richness and vegetation structure within CREP and pasture/hayfields. Multivariate analysis will be used to determine possible influences of the vegetation structure on avian community composition.

Update – Summer Avian and Vegetation Surveys. Summer 2008 avian and vegetation surveys are also included in this past year's avian/ vegetation survey work. Avian and vegetation surveys were conducted on 12 CREP sites and 12 pasture/hayfield sites within the Upper Green River Watershed, KY. These fields included sites surveyed in the 2007/ 2008 winter survey. Avian and vegetation surveys were conducted between May and July 2008 between sunrise and noon. Survey methods for both avian and vegetation surveys were identical to the winter survey methods.

An initial analysis has been conducted. Mann-Whitney U tests were used to compare avian species richness and vegetation structural differences between CREP sites and pasture/hayfield sites. Stepwise linear regressions were used to examine relationships between vegetation structure and avian communities. Avian survey results showed five of seventeen species found in the twenty-four sites were found significantly more abundant in CREP sites than in pasture/hayfields sites. Zero species were found significantly more often in pasture sites than CREP sites. CREP sites also contained a higher species richness average than pastures. In addition to species analysis, avian species were classified into six guilds for avian guild analysis. Grassland generalists showed a positive, significant relationship with percent lodging/litter and stem density at 25 cm (df: 2,21, adjusted r^2=.432, p=0.001). Successional/ Scrub showed a positive, significant relationship with percent lodging/litter and stem density at 25 cm (df: 2,21, adjusted r^2 = .499, p=0.0003). A simple linear regression was performed to verify this significant result between Grassland generalists and Successional/ Scrub and percent lodging/ litter and stem density at 25 cm.

III. Monitoring and Evaluation (Continued)

Activity 3: **Analysis of Restoration of Grasslands (Continued)**

Workplan overview (Continued)

Update – Summer Avian and Vegetation Surveys(Continued)

Simple linear regression did not produce significant results indicating autocorrelation with CREP. Only percent lodging/litter showed a significant difference (p = 0.003, z adjusted = 2.95) between CREP and pasture fields within vegetation analysis results. CREP fields showed a trend toward having a higher point than pastures, but the result was not significant (p = 0.088, z adjusted = 1.70).

Further multivariate analysis will be performed to determine possible influences of vegetation structure on avian community composition. We will also compare avian and vegetation surveys to past surveys completed at these study sites.

Products – Five presentations during 2008:

II. Conservation research in Kentucky. Albert J. Meier. 2008. Kentucky Conservation Association. ***Invited Speaker***.

III. Avian community composition within pastures and tall grass plantings in the Upper Green River Watershed, Kentucky. Aaron T. Hulsey, Cabrina L. Hamilton, Wayne Mason, Albert J. Meier. 2008.

IV. Avian community composition within tallgrass plantings and pastures in the Upper Green River watershed, Kentucky. Aaron T. Hulsey, Wayne Mason, Cabrina L. Hamilton, and Albert J. Meier**.** 2008. Ecological Society of America, August 2008, Milwaukee, WI.

V. Pastures and tall grass plantings influence avian community composition within the Upper Green River Watershed, Kentucky. Aaron T. Hulsey, Cabrina L. Hamilton, Wayne Mason, Albert J. Meier. 2008. Kentucky Chapter of the Wildlife Society, February 2008, Mammoth Cave National Park, KY.

VI. Community influences of tall grass restoration in the Upper Green River Watershed. Cabrina Hamilton, Albert J. Meier, Adam DaTillo, and Patrick Lawless. 2008. Kentucky Chapter of the Wildlife Society, February 2008, Mammoth Cave National Park, KY. ***Second Place in the student competition*****.**

Update – Small Mammal Monitoring. To date we have completed one phase of the small mammal CREP monitoring project, the enclosure phase. Using prairie voles as a model, we found that they are respond more favorably in terms of reproduction and survival to CREP plantings with a higher proportion of grasses. This is not surprising as they are primarily grazers. We are currently monitoring whole small mammal communities in experimental plantings at the Upper Green River Biological Preserve (216 traps), and are continuing to

III. Monitoring and Evaluation (Continued)

Activity 3: **Analysis of Restoration of Grasslands (Continued)**

Workplan overview (Continued)

Update – Small Mammal Monitoring

monitor small mammal populations in ten CREP fields in Taylor and Greene counties, as well as in ten nearby improved pastures, for a total of 980 traps in those two counties. Monitoring on all these sites will continued through May, 2008. Two M.S. theses (one complete, one in progress) will result from this work.

Products – no presentations or manuscripts to date

Activity 4: **Seminars and Workshops**

Dr. Harold Figueroa, professor in the Bioacoustics Research Program of the Cornell Laboratory of Ornithology and developer of XBAT, an extensible sound analysis application. Presented a workshop on the use of XBAT and visited the Green River CREP region. Dr. Rafael Marquez of Madrid's National Museum of Natural Sciences assisted in the workshop.

Task 4
Project Enhancements and Pilot Studies

Task 4 manager
Scott Grubbs, Ph.D., Department of Biology and Center for Biodiversity Studies, Western Kentucky University

Workplan overview
My CREP/NRCS monitoring responsibilities within the Upper Green River Basin reside with biological and ecological assessments that focus on fish and macroinvertebrate communities. This is my sixth summer of conducting field research and has involved comprehensive biological monitoring and collection of environmental parameters. Monitoring activities has been established on each of 60 stream segments, including 14 along the main-stem of the Upper Green River and 46 collectively from each of the sub-basins (mainly Russell Creek, Big Pitman Creek, Little Barren River, and Big Brush Creek). Three broad projects have been established, with brief descriptions and documentation of products.

III. Monitoring and Evaluation (Continued)

Activity 4: **Seminars and Workshops (Continued)**

Workplan overview (Continued)

1. Distributional patterns of riverine fishes in the Upper Green River Basin
This project has evolved over time, developing into a series of three distinct units:

a. Assessing spatial relationships between fish assemblages and watershed- and reach-scale environmental variables:
Extensive sampling for stream and riverine fishes has occurred by S. Grubbs in the Upper Green River Basin since 2001. Each of the 53 samplings segments was sampled twice, either once each in 2001 and 2002, once each in 2001 and 2003, or twice in 2003. With the inclusion of the additional Green River and sub-basin segments, there was the additional need to conduct fish sampling in the same manner as the 53 segments between 2001 and 2003. Sampling was been completed in August 2005 for the remaining sites. Data analyses have been addressing the impact of land-use practices, especially pasture-hay and row cropping activities. Several sets of data analyses are ongoing, and two have been completed resulting in the publication of each to a peer-reviewed scientific journal (see below).

Products – Thirteen presentations (since 2004), two published manuscripts, and one manuscript in progress:

Presentations

i. Kentucky's Upper Green River Basin: an assessment overview of biotic and ecological integrity. Scott A. Grubbs, Kentucky Governor's Conference for the Environment, October 2008, Lexington, KY.

ii. Fish assemblage relationships to watershed- and reach-scale environmental variables in a U.S.D.A. Conservation Reserve Enhancement Program landscape in central Kentucky, U.S.A. Scott A. Grubbs, Ecological Society of America, August 2008, Milwaukee, WI.

iii. Fish assemblage relationships to watershed- and reach-scale environmental variables in a U.S.D.A. Conservation Reserve Enhancement Program landscape in central Kentucky, U.S.A. Scott A. Grubbs, North American Benthological Society, June 2008, Salt Lake City, UT.

iv. Stream fishes in Kentucky's Upper Green River Basin: an assessment of the influence of watershed- and reach-scale environmental variables. Scott A. Grubbs, Southeastern Fishes Council, November 2007, Chattanooga, TN.

v. Stream fishes in Kentucky's Upper Green River Basin: an assessment of the influence of watershed- and reach-scale environmental variables. Scott A. Grubbs, Kentucky Academy of Science, November 2007, Louisville, KY.

vi. Influence of watershed- and reach-scale environmental variables on the speciose darter

assemblage of a central Kentucky (U.S.A.) landscape. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, International Society of Limnology, August 2007, Montreal, PQ, CANADA.

vii. Lotic fish assemblages in Kentucky's Upper Green River Basin: implications of watershed size and land-use patterns. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, North American Benthological Society, June 2007, Columbia, SC.

viii. Lotic fish assemblages in Kentucky's Upper Green River Basin: implications of watershed size and land-use patterns. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, The Nature Conservancy- Upper Green River Conference, April 2007, Campbellsville, KY.

ix. Lotic fish assemblages in Kentucky's Upper Green River Basin: implications of watershed size and land-use patterns. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, Kentucky Academy of Science, November 2006, Morehead, KY.

x. Longitudinal patterns of fish assemblages in small unregulated sub-basins: evaluating reach- and watershed-scale parameters. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, Ecological Society of America, August 2006, Memphis, TN.

xi. Factors influencing lotic fish assemblages in the Upper Green River – Kentucky CREP region. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, Kentucky Academy of Science, November 2005, Richmond, KY.

xii. Longitudinal profile of the fish assemblage of a 4th-order stream in the Nolin River Basin, Kentucky. Christopher Thomas and Scott A. Grubbs, Kentucky Academy of Science, November 2005, Richmond, KY.

xiii. Factors influencing lotic fish assemblages in the Upper Green River – Kentucky CREP region. Scott A. Grubbs, Ouida D. Meier, and Albert. J. Meier, North American Benthological Society, November 2005, New Orleans, LA.

III. Monitoring and Evaluation (Continued)

Products (Continued)

Manuscripts

i. Grubbs, S. A., O. D. Meier, and A. J. Meier. 2008. Assessing the influence of watershed-and reach-scale environmental variables on the speciose darter (Percidae: *Etheostoma*, *Percina*) assemblage of a central Kentucky (U.S.A.) landscape. Verhandlungen Internationale Vereinigung für theoretische und angewandte Limnologie ***(in press).***

Abstract: As part of a larger study examining the influence of land-use at multiple spatial scales on the structure of fish and macroinvertebrate assemblages in Kentucky's Upper Green River Basin, herein we assessed the relationship between abundance patterns of darters (*Etheostoma*, *Percina*) and environmental variables across several subbasins. A canonical correspondence analyses (CCA) performed in a forward selection procedure retained six variables, but also removed agriculture land-use and most indicators of anthropogenic perturbation. A second CCA identified only watershed area, summer baseflow and temperature as important to structuring darter assemblages. An unweighted pair-group method analysis plus indicator species analysis identified taxa that characterized the partitioning of stream reaches. Stepwise multiple linear regressions were then used to model the relationships between the significant indicator species and the retained CCA variables. Watershed area and percent urban land-use were the prominent variables linearly related to the abundance of individual species, whether independently or combined with other parameters in multiple models. These results correspond with prior analyses in this basin, namely that species abundance patterns of whole fish assemblages are reflective of natural, background environmental variation and the sole variable indicative of environmental perturbation is small-scale urban (5–8 %) within only one subbasin.

ii. Grubbs, S. A., O. D. Meier, and A. J. Meier. 2007. Longitudinal patterns of fish assemblages in small unregulated subbasins: evaluating reach- and watershed-scale parameters. Hydrobiologia 592: 211-223.

Abstract: Fish assemblage relationships with environmental parameters were studied in four small unregulated subbasins in the speciose Upper Green River Basin of central Kentucky, U.S.A. One subbasin drains into a tributary of the Green River and produced the lowest species (28) richness. The three other subbasins drain directly into the Green River and supported 41 – 62 species. Parameters were partitioned into watershed- and reach-scale spatial categories. Fish richness was positively correlated with watershed area for the two largest subbasins and for the three Upper Green River subbasins combined. Watershed area per stream segment and stream-size related environmental parameters at the reach scale produced the highest loadings of a Principle Components Analysis (PCA). Overall, both PCA Axes 1 and 2 for all subbasins were reflective either of watershed area or stream-size parameters. Small loadings were produced by all watershed-scale land-use parameters and all reach-scale water chemistry parameters. A Detrended Correspondence Analysis (DCA) performed for each subbasin showed that several fish species were associated mainly either with small, upland segments or conversely the largest, deeper segments. Each subbasin yielded significant correlations between the environmental PCA loadings and fish assemblage DCA site scores. These results indicated that within the regional scale, and in absence of steep disturbance gradients, stream fish assemblages can reflect natural hydrologic and geomorphic gradients.

b. Longitudinal variation in the fish community along the upper Green River below the Green River Lake:
The stretch of the Green River between the Green River Lake and Mammoth Cave National Park was sampled twice for fishes, once in 2003 and again in 2007. This project was addressing if longitudinal changes in temperature and habitat resulted in gradual shifts in the fish fauna. This project formed the research basis of a recently-graduated Master's of Science Degree in Biology.

Products – One Master's Thesis, one presentation (since 2004) and one manuscript submitted for publication:

Thesis

Wilsey, J. 2008. The Importance of impoundment and base geology on the longitudinal distribution of a riverine fish assemblage. M.S., Thesis, Western Kentucky University.

Abstract: The impoundment of flowing waters may result in several impacts downstream of a reservoir, including decreased mean and variability in temperature, altered hydrologic regimes and reduced habitat availability. These types of alterations can negatively affect fish communities. Twelve sites were sampled along the upper Green River in central Kentucky, U.S.A., in order to address the influence of impoundment on downstream fish communities. Significant differences in overall (May 2005 – August 2006) daily mean and maximum temperature, and individual seasonal daily mean, minimums and maximum temperatures revealed that there were three thermal sections within the study area: (1) a cooler section influenced by reservoir release patterns, (2) a warmer section downstream receiving surface inputs from the non-karst tributaries, and (3) a cooler section flowing through the well-developed, downstream karst region. A principal component analysis (PCA) of physical data supported the longitudinal thermal patterns. The lowest fish richness and Shannon diversity were from the two most upstream sites. A PCA of fish species data indicated that the two most upstream sites were distinct from the remaining 10 downstream sites. An indicator species analysis revealed the same biotic trend, with *Etheostoma bellum* and *E. zonale* as significant indicators of the 10 downstream sites. Linear regressions showed significant positive relationships between both *E. bellum* ($p = 0.002$) and *Campostoma oligolepis* ($p = 0.043$) abundance and mean daily temperature, while the latter species was positively related also to mean velocity ($p = 0.007$). Overall, this study was able to detect differences among key environmental variables and changes in fish species abundance patterns along the longitudinal course of a regulated river downstream of an impoundment.

Presentations

i. Longitudinal variability in fish community structure along the Upper Green River below the Green River Lake: assess the influence of habitat and thermal variability. Josh Wilsey and Scott A. Grubbs, November 2007, Kentucky Academy of Science, Louisville, KY.

III. Monitoring and Evaluation (Continued)

Manuscripts

i. J. Wilsey and S. A. Grubbs. Assessing the importance of impoundment and base geology on the longitudinal distribution of a riverine fish assemblage. ***Submitted to Hydrobiologia***

Abstract: The impoundment of flowing waters may result in several impacts downstream of a reservoir, including decreased mean and variability in temperature, altered hydrologic regimes and reduced habitat availability. These types of alterations can negatively affect fish communities. Twelve sites were sampled along the upper Green River in central Kentucky, U.S.A., in order to address the influence of impoundment on downstream fish communities. Significant differences in overall (May 2005 – August 2006) daily mean and maximum temperature, and individual seasonal daily mean, minimums and maximum temperatures revealed that there were three thermal sections within the study area: (1) a cooler section influenced by reservoir release patterns, (2) a warmer section downstream receiving surface inputs from the non-karst tributaries, and (3) a cooler section flowing through the well-developed, downstream karst region. A principal component analysis (PCA) of physical data supported the longitudinal thermal patterns. The lowest fish richness and Shannon diversity were from the two most upstream sites. A PCA of fish species data indicated that the two most upstream sites were distinct from the remaining 10 downstream sites. An indicator species analysis revealed the same biotic trend, with *Etheostoma bellum* and *E. zonale* as significant indicators of the 10 downstream sites. Linear regressions showed significant positive relationships between both *E. bellum* ($p = 0.002$) and *Campostoma oligolepis* ($p = 0.043$) abundance and mean daily temperature, while the latter species was positively related also to mean velocity ($p = 0.007$). Overall, this study was able to detect differences among key environmental variables and changes in fish species abundance patterns along the longitudinal course of a regulated river downstream of an impoundment.

c. Comparative ecological study of *Etheostoma kantuckeense* and *E. lawrencei*: *Etheostoma kantuckeense*, or the Highland Rim darter, is endemic to upland streams in the Upper Barren River Basin of southern Kentucky and northern Tennessee. *Etheostoma lawrenci*, or the Upland darter, is known only from small streams in the Upper Green River, Upper Salt River, and Upper Cumberland River Basins of central Kentucky. Both species are members of the *E. spectabile* species complex and inhabit similar types of habitat. Because these two species are indicative of good water quality conditions of small, upland streams it is imperative to conduct detailed ecological and life history studies to better understand the types of stream habitat these species across stream reaches and throughout the year, especially since headwater streams in the Upper Green and Upper Barren are characterized as intermittent or temporary. This project presently forms the research basis for a Master's of Science Degree in Biology student.

Products – Three presentations (since 2004):

Presentations

i. A comparative ecological study of two disjunct, congeneric species of darters in Kentucky: *Etheostoma kantuckeense* and *E. lawrencei.* Bjorn V. Schmidt and Scott A. Grubbs, November 2008, Southeastern Fishes Council, Chattanooga, TN.

ii. A comparative ecological study of two disjunct, congeneric species of darters in Kentucky: *Etheostoma kantuckeense* and *E. lawrencei.* Bjorn V. Schmidt and Scott A. Grubbs, November 2008, Kentucky Academy of Science, Lexington, KY.

iii. Fish assemblage patterns in relation to environmental parameters in the Upper Barren River Basin of Kentucky, with emphasis on the distribution of *Etheostoma kantuckeense*. Bjorn V. Schmidt and Scott A. Grubbs, November 2007, Kentucky Academy of Science, Louisville, KY.

2. Distributional patterns of aquatic macroinvertebrates in the Upper Green River Basin

Similar to the research questions that have been addressed pertaining to fish species distributional patterns, this project has developed considerable and now consists of four active projects :

a. Assessing spatial relationships between macroinvertebrate assemblages and watershed- and reach-scale environmental variables

These involve a set of data analyses that parallel the fish data analyses (see below), yet focus on macroinvertebrate communities and are likewise in progress.

Products – One presentation (since 2004) and one manuscript in progress:

Presentations

i. Watershed- and reach-scale influences on macroinvertebrate assemblages in the Upper Green River Basin. Laura Claus and Scott A. Grubbs, November 2007, Kentucky Academy of Science, Louisville, KY.

b. Influence of spatial scale and local-scale hydrologic, geomorphic, and thermal variability on macroinvertebrates communities along the mainstem of the Upper Green River.

This project was developed in collaboration with Dr. Stephen Kenworthy (Department of Geography and Geology, WKU). Sampling sites have been established at 10 segments from immediately below the Green River Lake through Western Kentucky University's Upper Green River Biological Preserve (and not through Mammoth Cave National Park as originally proposed). Quantitative macroinvertebrate sampling has occurred during baseline flow conditions. Replicate samples (n = 4) were taken at three scales (1, 10, and 50 m^2) in each segment and related to (a) local-scale hydrologic (e.g., surface velocity) and geomorphic parameters (e.g., % embeddedness), (b) temperature (e.g., mean daily temperature), and (c) selected nutrient parameters (e.g., mean nitrate levels). We are still working through macroinvertebrate identifications.

Products – no presentations or manuscripts to date

III. Monitoring and Evaluation (Continued)

c. Assessing relationships between lotic crayfish assemblages and environmental variables of central Kentucky's Upper Green River Basin

Sampling for crayfish started in May 2006 and focused on all 46 subbasin stream segments. The mainstem of the Upper Green River was not sampled. Sampling has occurred in riffles (areas of the stream bottom with shallow water and flowing rapidly over coarse substrates) and runs (shallow portions of the stream with relatively smooth flow and may or may not have coarse substrates). Data analyses addressing species abundance patterns and their relationship to environmental parameters was completed, and formed the research basis of a recently-graduated Master's of Science Degree in Biology.

Products – One Master's Thesis, one presentation (since 2004) and one manuscript in progress:

Thesis

Ngulo, E. 2007. The environmental factors regulating the distribution of crayfish in the Upper Green River Basin, Kentucky, U.S.A. M.S., Thesis, Western Kentucky University.

Abstract: Despite the importance of crayfish in aquatic systems there are major issues threatening their conservation. These include invasive species, habitat alterations, and species with restricted geographical ranges. There is limited information regarding native range, habitat requirements, life histories and biological interactions between other crayfish species. In order to examine the relationship between lotic crayfish assemblages and environmental variables at both the watershed and reach scales, data were collected from 46 stream segments in the Upper Green River Basin of Kentucky, U.S.A. An independent sample t-test compared crayfish densities between segments with gravel - small cobble, and large cobble - small boulder substrates and revealed non-significant differences for both all and large (>15 mm) carapace length individuals. In the gravel - cobble and cobble - small boulder segment a series of one-way ANOVA's showed significant effects of subbasin location and stream size on both crayfish density and species richness whereas in the large boulder segment there were no significant differences. An exploratory canonical correspondence analysis in forward selection procedure was performed to reduce the number of environmental variables in the gravel - cobble and cobble - small boulder segment and large boulder segment. The second CCA performed between crayfish species and environmental variables showed strong relationships with several environmental variables in the gravel - cobble and cobble - small boulder segment. Significant variables elucidated were summer mean temperature, depth, and total phosphate. The second CCA in the large boulder segment, however, failed to find strong relationships between the crayfish and environmental variables. Further testing using multiple linear regression stepwise forward selection analysis demonstrated that crayfish were responding to total phosphorous, percent riffle, percent run, gravel, cobble, boulder, total phosphate and ammonia in the gravel - cobble and cobble - small boulder segment. In the large boulder segment multiple linear regression demonstrated the crayfish were responding to summer mean temperature, ammonia, depth, total phosphorous, percent riffle, percent run, and percent cobble. Correspondence analyses were conducted separately for gravel - cobble and cobble - small boulder segment and large boulder segment and some species showed strong associations with each other. The results indicated that stream size gradients, and not percent land use, were linearly related to both diversity (richness) and density.

Presentations

i. Assessing relationships between lotic crayfish assemblages and environmental variables of central Kentucky's Upper Green River Basin. Eva Ngulo and Scott A. Grubbs, November 2006, Kentucky Academy of Science, Morehead, KY.

d. Constancy of riverine macroinvertebrates and the influence of impoundment within Mammoth Cave National Park

Constancy of, defined as persistence and stability, and assessing the influence of Lock & Dam #6 on, macroinvertebrate assemblages inhabiting the Green River at Mammoth Cave National Park, Kentucky, was evaluated based on data collected in 1993-1995, 2001-2002, 2004, and 2006. Several data analyses have been completed and several are in progress and forthcoming.

Products – Three presentations since 2004, one published manuscript, and one manuscript in progress:

Presentations

1. Constancy of macroinvertebrate assemblages at Mammoth Cave National Park, Kentucky. Scott A. Grubbs, Jason M. Taylor, and Greg P. Pond. March 2004, Kentucky Water Resources Research Institute, Lexington, KY.

2. Constancy of macroinvertebrate assemblages at Mammoth Cave National Park, Kentucky. Scott A. Grubbs, Jason M. Taylor, and Greg P. Pond. June 2004, North American Benthological Society, Vancouver, BC, CANADA.

3. Constancy of riverine macroinvertebrates at Mammoth Cave National Park. Scott A Grubbs, The Nature Conservancy- Upper Green River Conference, April 2006, Campbellsville, KY.

Manuscripts

i. Grubbs, S.A. and J.M. Taylor. 2004. The influence of flow impoundment and river regulation on the distribution of riverine macroinvertebrates at Mammoth Cave National Park, Kentucky, U.S.A. Hydrobiologia 520: 19-28.

Abstract: The effects of impoundment by a low-head dam and hypolimnetic release from a reservoir on benthic macroinvertebrate assemblages were studied in two lowland rivers. The first river (Green River) was initially divided into three zones (impounded, transitional, erosional) according to hydrological characteristics. The entire reach of the second river (Nolin River) lacked shallow runs or riffles. Only the Green River erosional zone was free-flowing with a linear sequence of riffle-run-pool reaches. A detrended correspondence analysis showed that the Green River impounded and transitional zones were taxonomically indistinguishable while the Green River erosional zone and the Nolin River were each distinct. A canonical correspondence analysis revealed that higher surface velocity, higher summer water temperatures and more turbid conditions, and lower water temperatures were contributing parameters to the separation of the Green River erosional zone, Green River transitional/impounded zones, and the Nolin River, respectively, in ordination space. A series of one-way ANOVA's testing for differences of macroinvertebrates assemblages between the three Green River zones according to five metrics showed that the Green River erosional zone demonstrated significantly higher values and the transitional and impounded zones were ecologically similar.

3. Evaluating spatial patterns of algal biomass accrual, and relationships to base geology, thermal patterns, and nutrient limitation, along the upper Green River
This project was newly added during summer 2008 and serves as the research basis of a current M.S. student in Biology.

Products – One presentation since 2004.

Presentations

I. Why is the Green River Green? An assessment of algal biomass and nutrient levels along a longitudinal gradient in the Upper Green River. Mary D. Penick and Scott A. Grubbs. November 2008, Kentucky Academy of Science, Lexington, KY

IV. Recommendation

Partner Listing:

USDA Farm Service Agency
USDA Natural Resources Conservation Service
The Office of the Governor
The Kentucky General Assembly
The Kentucky State Nature Preserves Commission
The Kentucky Soil and Water Conservation Commission
Kentucky Division of Conservation
Kentucky Division of Forestry
Kentucky Division of Water
The Kentucky Department of Fish and Wildlife Resources
The Nature Conservancy
Mammoth Cave National Park
Kentucky's Soil and Water Conservation Districts
Western Kentucky University

Thanks to the partner agencies and organizations for their commitment to this project and to the landowners and natural resources of this unique area. Also, thanks to those partner agency personnel that supplied information for the completion of this report.

The success of the Green River CREP during this federal fiscal year truly represents what this program was designed to do. Partner agency personnel identified gaps in CRP program policy and design with our local geographic and land use characteristics, and created an amendment that truly embodies the intent of CREP. This is evident with our accomplishments, and the enrollment data and conservation benefits speak for themselves.

With drastically increased interest and workload, partner agencies reacted positively, with USDA (FSA and NRCS) creating CREP "teams", made up of field personnel from all partner agencies, to be assigned to areas with extraordinarily heavy interest. These teams were instrumental in completing daunting workloads in several of our larger counties. In addition, one very evident positive for the geographic expansion, was that partner agency staff had experience with the program, thus, when the program was brought into a new area, we were much better prepared and organized with regards to planning and public relations efforts. The difference in the quality and organization of outreach from initial program roll-out to this expansion was substantial. From early work on our remaining inquiries, it appears as though our acreage goal will be attained within the next FFY. It cannot be overstated that the amount and quality of work by all CREP partner agency field staff has contributed immensely to the rather immediate success of this amendment.

IV. Recommendation (Continued)

In addition to our accomplishments already documented in this report, the Kentucky Green River CREP Partnership received the prestigious 2007 Two Chiefs' Partnership Award. This award, which is given by the U.S. Forest Service and USDA Natural Resource Conservation Service, recognizes outstanding partnerships in forest conservation work among Conservation Districts, State Foresters, the USFS, and NRCS. The award was presented in November, 2007.