West Virginia Cooperative Fish and Wildlife Research Unit

FY 2012
ANNUAL REPORT
1 October 2011 - 30 September 2012

COOPERATING AGENCIES:

U.S. Geological Survey
West Virginia Division of Natural Resources
West Virginia University
U.S. Fish and Wildlife Service
Wildlife Management Institute

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Cover Graphics: Male Indigo Bunting. USFWS
WVCFWRU logo by Marianne Dewey

Introduction and History: The West Virginia Cooperative Fish and Wildlife Research Unit

The West Virginia Cooperative Fish and Wildlife Research Unit was formed at West Virginia University on July 1, 1986. The Coop Unit is housed in Percival Hall within the Division of Forestry and Natural Resources, Davis College of Agriculture, Natural Resources and Design. It is an integral part of the Wildlife and Fisheries program within the Division of Forestry and Natural Resources.

One mission of the West Virginia Coop Unit is to address the research and technical needs of the West Virginia Division of Natural Resources, U. S. Geological Survey, U. S. Fish and Wildlife Service, and other natural resource agencies and organizations. Research and technical needs goals are met by pursuing funding for research projects, collaborating with cooperators on research projects, publishing and presenting research results, and participating in short courses and workshops for cooperators when appropriate.

The Coop Unit's research program is focused on environmental impacts at the species and ecosystem levels. Wildlife research projects focus on the effects of anthropogenic disturbances on wildlife populations such as the effects of timber harvesting on birds, woodrats, and bats, and mountaintop mining on terrestrial wildlife populations. Fisheries research projects focus on contaminants in West Virginia watersheds, brook trout restoration, rainbow trout aquaculture, and systematics and ecology of West Virginia fishes.

Graduate education is also an important mission of the Coop Unit. Cooperating with West Virginia University, the Coop Unit contributes to the quality education and training of graduate students in fisheries and wildlife at West Virginia University. Coop Unit scientists achieve educational goals by chairing graduate committees, serving on graduate committees, teaching graduate level courses and delivering guest lectures and seminars. As of September 30, 2012, 100 students have completed their degree requirements: 80 Masters and 20 Ph. D. The Unit scientists are currently supervising 7 Master's students and 10 Ph.D. students.

WEST VIRGINIA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT
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Ph.D., Memphis State University, 1989. Stress physiology, Toxicology.

ASSISTANT LEADERS

Petra Bohall Wood, Adjunct Professor of Wildlife
Ph.D., University of Florida, 1992. Wildlife/habitat relationships, raptor ecology and management.

Stuart A. Welsh, Adjunct Associate Professor of Fisheries
Ph.D., West Virginia University, 1997. Fisheries ecology, zoogeography and systematics.

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PROJECT COOPERATORS

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STUDENTS

STUDENT	DEGREE	GRADUATION DATE	ADVISOR)
Kyle Aldinger	Ph. D.	Expected May 2013	Petra Wood
Ross Andrew	M.S.	Completed May 2012	Stuart Welsh
Melissa Braham	M.S.	Expected Dec 2012	Stuart Welsh
Ryan Braham	M.S.	Expected Dec 2012	Pat Mazik
Ryan Davis	M.S.	Expected May 2015	Petra Wood
Sheila Eyler (NCTC)	Ph. D.	Expected May 2013	Stuart Welsh
Steve Foster (NCTC)	Ph.D.	Expected Dec 2015	Stuart Welsh
Cassidy Hahn	Ph.D.	Expected May 2015	Pat Mazik
Lauren Kesslak	Ph.D.	Expected Dec 2016	Pat Mazik
Carlos Martinez (NCTC)	M.S.	Expected Dec 2013	Pat Mazik
Brian Missildine (NCTC)	Ph.D.	Expected Dec 2013	Pat Mazik
Jeremy Mizel	M.S.	Completed Dec 2011	Petra Wood
Crystal Ruble	M.S.	Expected May 2013	Stuart Welsh
Jim Sheehan	Ph.D.	Expected May 2013	Petra Wood
Ken Sheehan	Ph.D.	Completed Dec 2011	Stuart Welsh
Dustin Smith	Ph.D.	Expected Dec 2015	Stuart Welsh
Daniel Sparks (NCTC)	Ph.D.	Expected Dec 2013	Pat Mazik
Nate Taylor	M.S.	Expected May 2013	Stuart Welsh
Jeff Thomas (NCTC)	Ph.D.	Expected May 2016	Stuart Welsh
Thomas Waldrop (NCTC)	M.S.	Expected Dec 2013	Pat Mazik

UNIT STAFF COURSES TAUGHT

Patricia M. Mazik, Adjunct Associate Professor of Fisheries
Aquatic Toxicology Spring 2012 3 credits

Stuart A. Welsh, Adjunct Associate Professor of Fisheries
Advanced Ichthyology Fall 2011 3 credits

Petra Bohall Wood, Adjunct Professor of Wildlife
Wildlife and Fisheries Seminar Spring 2012 1 credit

PROGRAM DIRECTION STATEMENT

The West Virginia Cooperative Fish and Wildlife Research Unit was established at West Virginia University on 1 July 1986. The Unit Leader began on 13 April 1987, and both Assistant Leaders were in place by 14 September 1987. The Unit is housed within the Division of Forestry and Natural Resources, College of Agriculture, Natural Resources, and Design. Offices and laboratories are located in Percival Hall.

The purpose of this document is to identify those general areas of fish and wildlife research that are most appropriate for study by the Unit. It is not a proposal for specific projects, but rather a definition of the types of areas of research most appropriate for the Unit given the expertise and facilities available.

The research mission of the Unit is to address fish and wildlife problems of mutual interest to all cooperators. Graduate education is also a mission. Studies will be accomplished by graduate research associates, research associates, technicians, non-thesis graduate students, graduate students working on separate thesis topics, or cooperating faculty members.

Most broadly interpreted, the cooperative agreement establishing the Unit provides access to expertise from among all segments of the University and other cooperators. However, most research will be directed by the Unit staff (Leader and Assistants) and those cooperating faculty members conducting research related to fish or wildlife resources.

There is a long-standing wildlife program in the Division of Forestry and Natural Resources, studying a broad range of terrestrial ecology problems, ranging from traditional population studies of wildlife species, to effects of forestry practices on wild animals, to social aspects of wildlife management. The Unit will enhance the wildlife and fisheries program by emphasizing research on wildlife/forestry issues inherent to West Virginia.

Research conducted through the Unit should stress functional responses of terrestrial and aquatic communities to management actions or environmental impacts. That is, we will attempt to determine how and why populations respond rather than simply to document or quantify responses. A study that evaluates management actions or examines ecological processes usually results in increased understanding of fish and wildlife community ecology and, thus has broader application than the immediate problem of concern.

Most of the Unit's research should be conducted within West Virginia or the bordering states. We will consider those occasional research opportunities that arise in areas remote to the state if they are of broad importance, or if they are logically undertaken most effectively by the West Virginia Unit.

COMPLETED PROJECTS

AQUATIC

NATURAL BARRIER ASSESSMENT AND MODELING FOR FISH COMMUNITIES IN DELAWARE WATER GAP NATIONAL RECREATION AREA

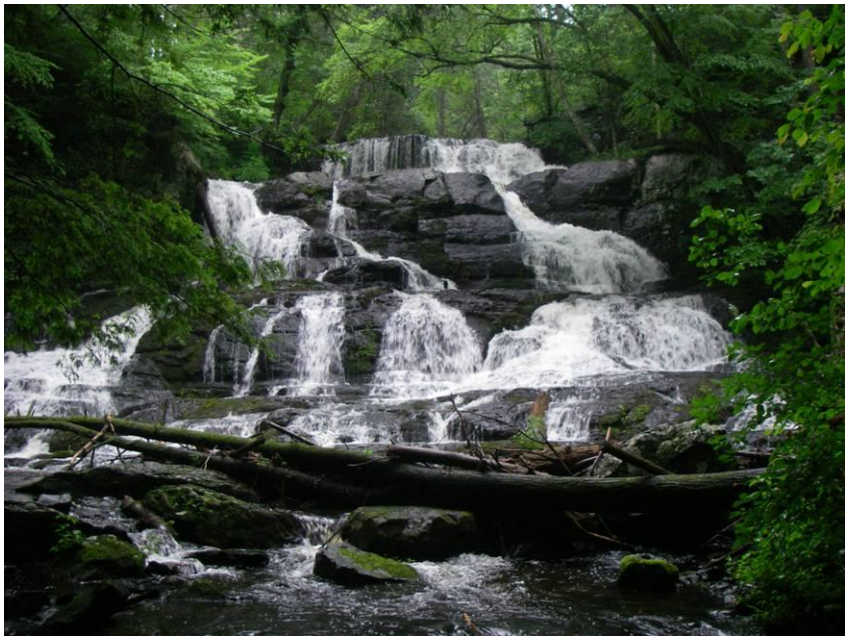
Student Investigator: Ross Andrew
Principal Investigators: John A. Young, Nathaniel Hitt, and Stuart A. Welsh,
Years Ongoing: 2010-2012
Degree Program: MS
Completed: May 2012
Funding: United States Geologic Survey – Leetown Science Center

Objectives:

1) Establish a standardized field protocol for assessment of natural barrier fish passability for resident stream salmonids.
2) Identify a barrier difficulty level and physical habitat parameters which impact fish assemblages within the study area.
3) Create predictive models for functional natural barrier occurrence using logistic regression modeling.

Results:

Habitat connectivity is essential for fish dispersal throughout a potential range. When habitat connectivity is lost due to both natural and artificial barriers, fishes lose their ability to disperse into adjacent habitats and utilize adjacent resources. Measuring fish passability through barriers is important for predicting useable habitat, genetic diversity, and invasive species threats for fish populations. We measured potential trout dispersal barriers in the Delaware Water Gap National Recreation Area in northeastern Pennsylvania and northwestern New Jersey.



Delaware Water Gap (Photo by Ross Andrew)

We measured natural barriers (waterfalls, cascades, etc.) for upstream passability of adult trout species in the area (brook, rainbow, and brown). We found barriers using two methods: 1) identification using a geographic information system and a LiDAR digital elevation model with a $1m^2$ resolution and 2) a walking census of all barriers within a given stream length. We measured natural barriers using a standardized field protocol for assessment of natural barriers and used it to measure the selected sites during the 2010/2011 field seasons. We created this new field protocol to address imprecision of simple natural barrier measurement which may not detect fish passage potential at an individual level. This method has the potential to be further refined and adjusted for use across multiple study areas similar to the USFS National Inventory and Assessment Procedure (Clarkin et al. 2005) which is used for artificial barrier (culverts and other road crossing structures) assessment.

We surveyed 123 natural barriers in the summer of 2010. These sites were remotely selected using a GIS. We surveyed 356 natural barriers in the summer of 2011. These 356 natural barriers came from 18 randomly selected watersheds within the recreation area. The entire length of each selected watershed was walked and surveyed for natural barriers in order to give a complete picture of the barrier distribution within each watershed. For natural barrier classification, a standardized scoring system was created for each step of each barrier. For each natural barrier, every step within that barrier would receive points based on its vertical drop and slope. The scoring system allowed us to assign a passage difficulty to each natural barrier based upon its physical structure.

Using the barrier data, two products were created which addressed the third objective. The first is a statistical model which uses logistic regression to determine the importance of landscape variables such as slope or geology in determining the probability of any given area having a barrier. The second product is a set of rules criteria which may be used within a GIS to create probability distribution maps for a given area which can provide prediction of barrier likelihood of occurrence throughout that area. This model is only used for natural barriers since artificial barrier occurrence can be found using the intersection of roads and streams. The probability model uses landscape characteristics of known barriers to predict the probability of other barriers using landscape characteristics in unsurveyed areas. From this modeling effort we developed appropriate model thresholds and rules criteria used to extrapolate predictions to all streams within Delaware Water Gap National Recreation Area.

In order to address the second objective, we sampled fish in each of the 18 selected watersheds during the summer 2011 field season. Sample locations were specifically chosen above and below barrier locations in order to provide evidence for differences in both fish communities and trout densities above and below barriers. Each site included 150 meters of continuous electrofishing as well as basic habitat measures such as substrate and canopy composition. Within selected watersheds, 65 paired sites were selected and sampled upstream and downstream of natural barriers using single-pass backpack electrofishing. Fish community response to barrier presence was tested using species richness and brook/brown trout density (# fish per m^2 stream area) among sites separated by natural barriers.

The first objective was met with the creation of the field protocol which produced a range of barrier difficulty for fish passage on a standardized scale from zero to one. The second object was met using simple paired comparisons of fish data above and below barriers. Barrier effects on species richness were significant overall ($P=0.031$), while overall effects on both brook and brown trout densities were insignificant ($P=0.961$ and 0.079 respectively). These results indicate that natural barriers may help define dispersal boundaries for less-capable swimming species but not the trout species of interest in this study area. The third objective was met by the creation of a predictive model and rules criteria capable of mapping areas of high likelihood of natural barriers. The best performing model included landscape variables for slope, flow accumulation (drainage area), and soil type. Higher slopes increased the likelihood of natural barrier occurrence while smaller drainage areas had a similar effect. Soil types with highly erodible, rocky compositions associated with steep slopes also increased the odds of natural barrier incidence. Further analyses are currently being conducted to improve the comparisons among sites and

account for differences in fish data based upon distance within a stream network. These analyses are being conducted as part of the process to prepare drafts for manuscript preparation and journal submission.

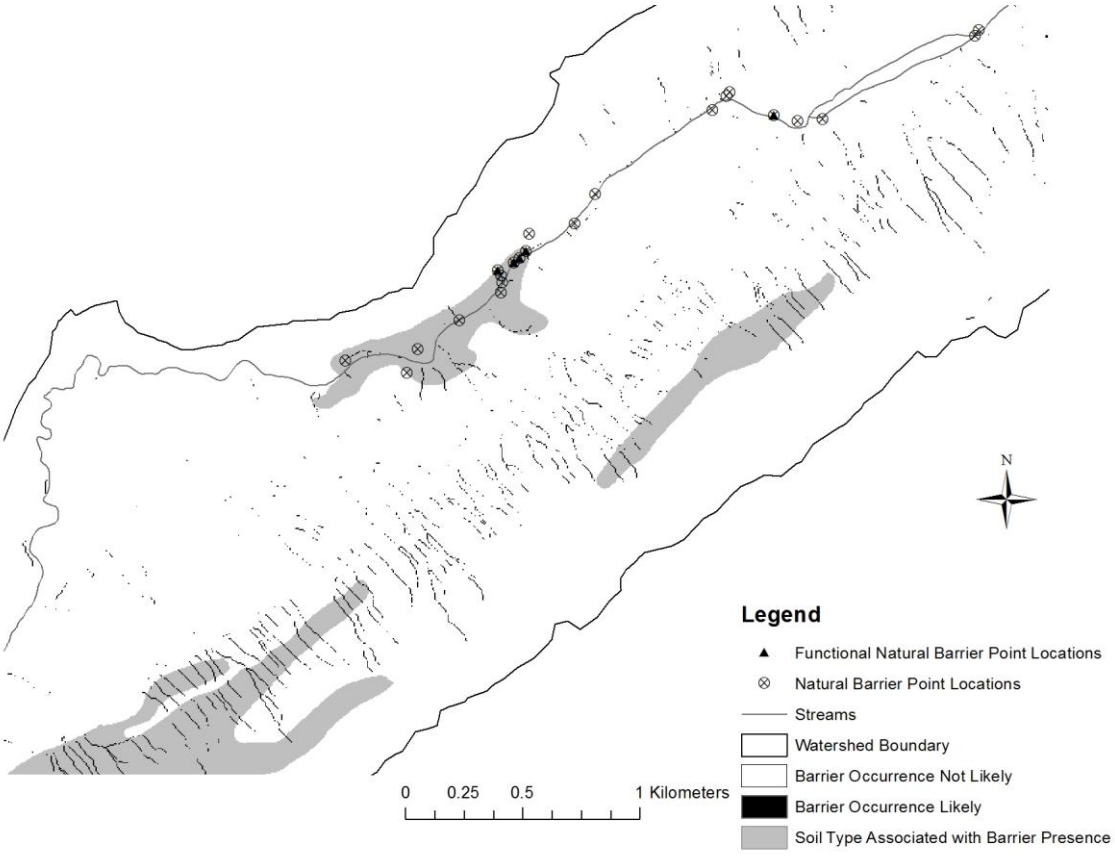


Figure 1. Final mapped output from the raster-based rules criteria for natural barrier occurrence. Areas with overlapping conditions for slope, flow accumulation, and soil type are shown as those dark areas where barrier occurrence is likely. This watershed contains the soil type associated with barrier presence. Those areas are shown in a light gray color and overlap with the actual stream in an area of high barrier occurrence.

AN INTERPOLATION METHOD FOR STREAM HABITAT ASSESSMENTS WITH EMPHASIS ON PRODUCING MICROHABITAT SCALE MAPS OF STREAM REACHES

Student Investigator: Ken Sheehan
Principal Investigator: Stuart A. Welsh
Years Ongoing: 2006-2011
Degree Program: PhD
Completed: December 2011
Funding: West Virginia Division Natural Resources

Objectives:
1) Establish the most effective interpolative method for producing accurate micro-scale stream habitat maps.
2) Establish interpolation method success on large and small streams of varying heterogeneity.
3) Demonstrate accuracy of most effective interpolation method in different geographic regions.
4) Show ability of interpolation method to accurately map stream habitat variables over extended reaches of stream.
5) Produce appropriate manual to guide fisheries biologists through proper data collection and the interpolative process.

Results:

Stream habitat maps are often created at varying scales by biologists for management and analysis purposes. While such maps provide invaluable information, useful fine scale maps of long reaches of stream are not frequently created due to cost (time and money), regional differences, and sampling difficulty. Previous research on small streams shows habitat interpolation utilizing geographic information systems (GIS) is capable of producing fine scale maps from coarse scale (or minimal) data with reasonable accuracy in Eastern Appalachian low order streams. However, such study lacks successful demonstration of the method for extended reaches of stream, streams in different geographic regions (Eastern and Western Mountainous regions), and streams of differing order. By comparison of GIS interpolation on four study sites, one small and one large order stream in the Appalachian region and Greater Yellowstone Ecosystem, our study examined each of these aspects. Results demonstrate the ability of minimal data interpolative stream mapping in GIS to create accurate fine scale maps of multiple stream variables. The method produced accurate fine scale maps of varying order streams for depth, flow velocity, and substrate type. The method worked similarly for streams from both Eastern and Western geographic regions. Effort in data collection and analysis was reduced greatly in time and cost. Used collaboratively with other stream assessment methods, minimal data habitat mapping holds the potential to provide detailed, spatially accurate habitat information for stream biologists and managers.

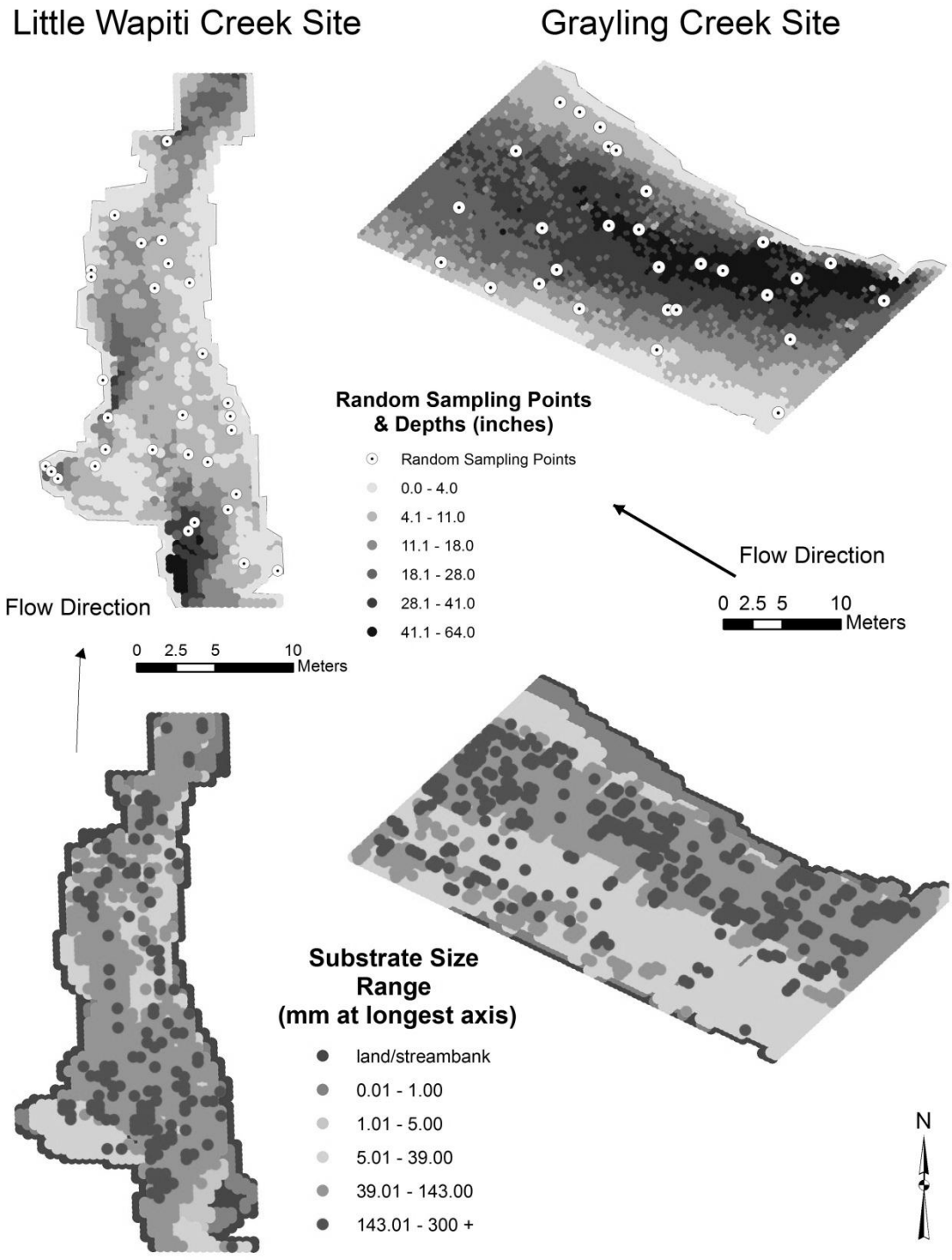


Figure 1. Little Wapiti and Grayling creeks of the Greater Yellowstone Ecosystem with 30 random sample points applied within each site. Actual substrate and depth information is also included for reference. Geographically weighted regressions were performed in a 2.5 meter radius surrounding each random sampling point.

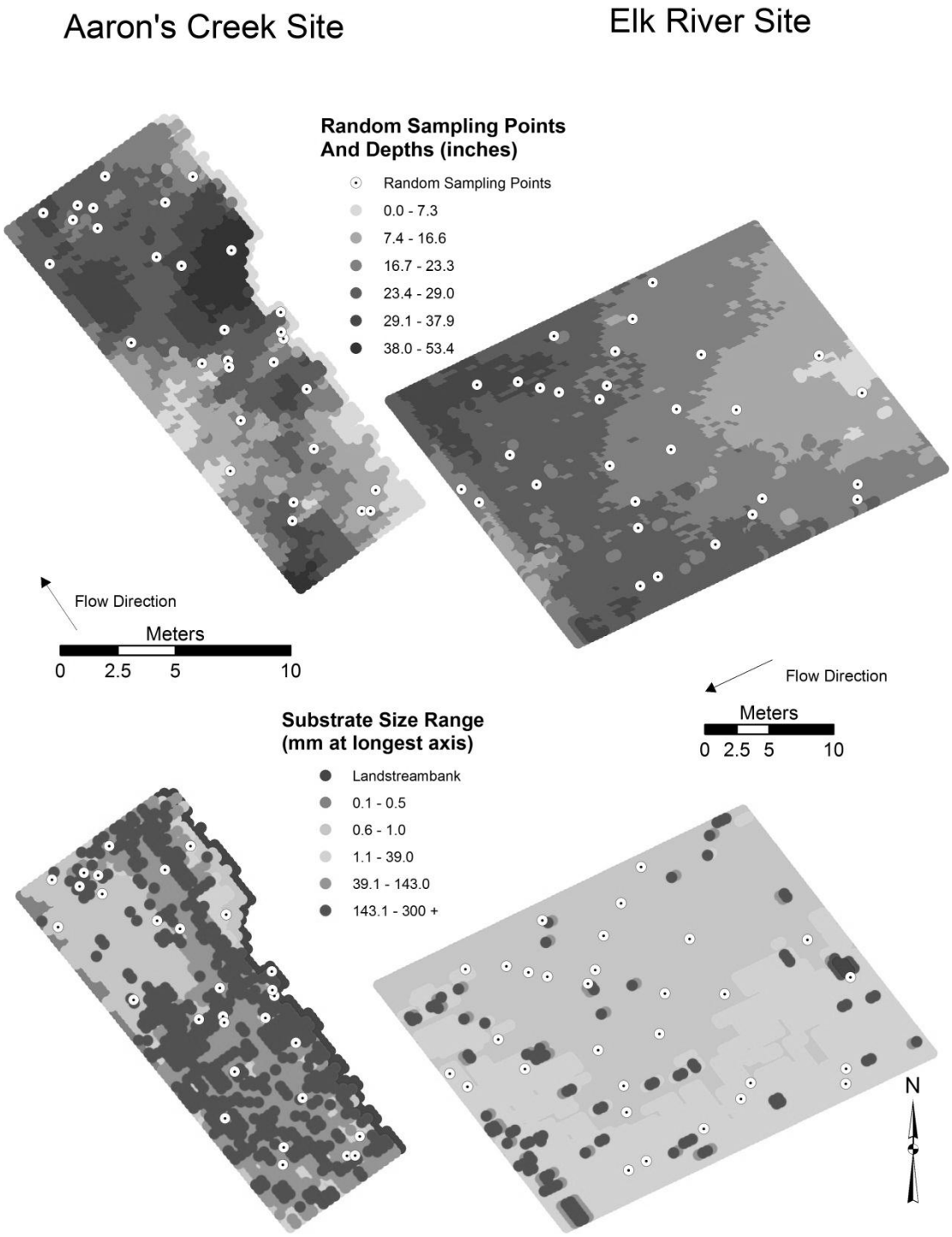


Figure 2. Aarons Creek and Elk River (Appalachian streams) with 30 random sample points applied within each site. Actual substrate and depth information is also included for reference. Geographically weighted regressions were performed in a 2.5 meter radius surrounding each random sampling point. Elk River displays greater areas of substrate homogeneity than other sites.

SUMMERSVILLE RESERVOIR AND KANAWHA FALLS ANGLER USE SURVEYS

Principal Investigator: Stuart A. Welsh
Years Ongoing: 2008-2012
Completed: May 2012
Funding: West Virginia Division of Natural Resources

Objective:
Study objectives were to obtain angler-based information on effort and catch data, including catch and harvest, size at harvest, demographics, and angler satisfaction and specialization.
Data from creel and angler surveys are useful for evaluating fisheries and fishery regulations, and aiding fishery management decisions. Creel surveys provide estimates related to catch and harvest, such as angling success, the proportion of fish released alive or harvested, and mean length at harvest. Additionally, angler surveys can provide more than biological data, including information on human dimensions, angler demographics, angler opinions, and angler expectations.

Results:
Summersville Lake
Creel and angler surveys (boat and bank anglers) were conducted at Summersville Reservoir from 28 Nov 2008 to 1 Nov 2009 with the exclusion of the month of August. Core survey questions, and some additional questions, were prepared by WVDNR prior to surveys. Angler-based information included effort, catch and harvest, size at harvest, demographics (zip code), and angler satisfaction and specialization. In addition to survey questions, walleyes from angler creels were measured (total length).

Summersville Lake, WV

Boat angler assessments followed a bus stop design, and targeted the four public boat ramp areas at Summersville (Winter Ramp - Dam Site, Salmon Run Boat Ramp, Long Point Boat Ramp, and Battle Run Boat Ramp). The bank angler assessment was conducted at ramp access points and at the Route 39 Bridge. Sample effort was stratified by weekend and week day, and included 2 days per week (1 weekend and 1 week day). Sample effort included 10 hour days where each site was visited three times. In addition to angler surveys, the creel clerk counted the numbers of vehicles in parking areas and the numbers of bank anglers during each site visit.

A total of 84 survey days yielded 165 interviews (111 were from boat anglers, and 54 bank anglers). Boat angler surveys mostly represented completed trips (98 of 111 interviews, i.e., when anglers were done fishing for the day), whereas few bank angler surveys were for completed trips (14 of 54). Twenty-one of 111 boat anglers were targeting walleye, whereas, 9 of 54 bank anglers were fishing specifically for walleye. Others targeted, black bass (60 boat anglers, 14 bank anglers), any species (25 boat anglers, 28 bank anglers), crappie (1 boat angler, 2 bank anglers), and sunfish (2 boat anglers, 0 bank anglers). Sixty-five of 165 anglers reported that they never fish for walleye at Summersville Reservoir. Of the remaining 100 responses, anglers reported from 1 to 300 walleye fishing trips per year at Summersville Reservoir (mean = 28.2, SE =5.02). Out of 144 responses, 98 indicated that they primarily fished for black bass in West Virginia, but others primarily fished for walleye (n=26), any species (14), catfish (12),

crappie (4), hybrid striped bass (2), and sunfish (1). The number of anglers targeting walleye was similar during all months of the study with a peak during the month of March (n=7), but the number of anglers targeting black bass and any species increased during the spring period of the study.

Anglers within the survey caught 71 walleyes (55 harvested, 16 released). Boat anglers harvested 61% (38 of 53 walleyes), and bank anglers kept 94% (17 of 18). Walleye anglers had higher catch rates of walleyes (0.29/hr boat anglers, 0.61/hr bank anglers) than those of all anglers (0.09/hr boat anglers, 0.11/hr bank anglers). Also, walleye anglers had higher harvest rates (0.26/hr boat anglers, 0.72/hr bank anglers) than those of all anglers (0.07/hr boat anglers, 0.10/hr bank anglers).

Anglers provided lengths for some released walleyes, and most of the harvested fish were measured. The total lengths were recorded for 60 of the 71 walleye caught with a mean size of 378.6 mm (TL, 14.9 in), SE = 4.6, range 304-455. The mean size at harvest of boat anglers (n=38, mean length =378.3, SE=5.97, range 330-455) was similar to that of bank anglers (n=17, mean length = 377.1, SE = 7.0, range 340-440 mm. Angler satisfaction with the fishing trip (on the day of the interview) ranged from low (rank = 1) to high (rank = 9), with peaks for rank 1 (35 boat anglers, 17 bank anglers) and rank 3 (15 boat anglers, 9 boat anglers)

Several questions were asked in addition to the core set of questions. One set of three questions was as follows: On an average fishing trip to Summersville Reservoir, (a) what percent of all walleye you catch do you keep?, (b) what percent of walleye you catch are greater than 15 inches?, and (c) what percent of walleye you catch greater than 15 inches do you keep? Responses for percentages of all walleyes kept ranged from 0 to 100% with peaks at 0% (11 boat anglers, 1 bank angler), 20% (6 boat anglers, 4 bank anglers), 50% (12 boat anglers, 1 bank angler), 80% (7 boat anglers, 3 bank anglers), and 100% (6 boat anglers, 4 bank anglers).

Most responses for percentages of >15 inch walleyes caught were 50% or less (46 boat anglers, 18 bank anglers), with only 15 responses over 50% (12 boat anglers, 3 bank anglers). Responses for percentages of >15 inch walleyes kept ranged from 0 to 100%, and the two highest frequencies of angler responses were for 0 % (12 boat anglers, 4 bank anglers) and 30% (10 boat anglers, 6 bank anglers).

Anglers were asked for their opinions on the size of a “keepable” and “trophy” walleye, on recent changes in the fishery, and on size and bag limits. Many anglers considered the length of a “keepable” walleye to be between 12 and 15 inches (n = 78, mean = 13.5 inches, SE =0.57). Anglers considered a “trophy” walleye to be from 18 to 35 inches (n=61, mean = 27.4, SE = 0.68). In a two-part question related to the change in the walleye fishery within the last 5 years, anglers responded to whether the overall walleye fishing has improved (7 % of responses), stayed the same (12%), worsened (7%), or did not know (74%), and if the size of the walleye has improved (4%), stayed the same (15%), worsened (22%), or did not know (59%). Angler opinions of fishing regulations changes were as follows: size limit (42% support, 4% oppose, 54% no response), bag limit (40% support, 7% oppose, 53% no response), size and bag limit (38% support, 4% oppose, 58% no response).

Kanawha Falls

Kanawha Falls of the Kanawha River, a public fishing location in southern West Virginia, supports walleye, muskellunge, and striped bass fisheries. To aid management of these fisheries, angler and creel surveys were conducted from November 2009 through April 2010, a time period when anglers were expected to target walleye, muskellunge, and striped bass. Angler demographic data were recorded for travel distances and associated travel times from angler residences to Kanawha Falls. Monthly estimates of total fishing effort, total catch, and catch rates of walleye, muskellunge, and striped bass were stratified by weekday and weekend periods and partitioned by boat anglers, bank anglers, anglers targeting each species, and all anglers. Also, angler attitudes and opinions were documented for sizes of harvestable and trophy fish, current fishing regulations, and fishing trip satisfaction.

A total of 51 survey days within the six month sampling period yielded 48 interviews (21 boat anglers, and 27 bank anglers). Walleye, muskellunge, and striped bass anglers comprised 27, 17, and 13% of anglers within the survey, respectively. West Virginia resident anglers comprised most of the interviews (95.8%), and mean travel distances (49.1 km, 30.5 miles) and mean travel times (41.1 minutes) were estimated from angler residence zipcodes. Most angler residences (89.1%) were within 100 road kilometers (62 miles) of Kanawha Falls. For all anglers, the estimated total fishing efforts of boat and bank anglers across the 6 month sampling period were 722.1 boat hours and 476.0 bank hours, which comprised total efforts of walleye anglers (146.3 boat hours, 240.7 bank hours), muskellunge anglers (309.0 boat hours, 6.5 bank hours), striped bass anglers (179.0 boat hours, 14.8 bank hours), and anglers not targeting the three fisheries (87.8 boat hours, 214.1 bank hours). Fishing effort of anglers, however, was not consistent among months or weekday/weekend strata. Of 51 total sampling days, the creel clerk encountered walleye anglers on 10 days, muskellunge anglers on seven days, and striped bass anglers on four days. Further, on days when anglers targeting walleye, muskellunge, or striped bass were encountered, the numbers of angler party interviews were relatively low, with a maximum of two interviews for walleye anglers, two for muskellunge anglers, and three for striped bass anglers. The estimated total catch of walleye, muskellunge, and striped bass for all anglers across the 6 month sampling period was 78.0, 21.5, and 2, respectively, which included the estimated total catch of walleye anglers (47.4), muskellunge anglers (21.5), and striped bass anglers (0.0). Estimated catch rates ranged from 0.00 to 0.74 fish/hour for walleye anglers, 0.00 to 0.31fish/hour for muskellunge anglers, and 0.00 fish/hour for striped bass anglers.

Angler opinions on the size of harvestable fish ranged from 14 to 20 inches for walleye, and 15 to 20 inches for striped bass. Opinions on the size of trophy fish ranged from 25 to 36 inches for walleye, 30 to 45 inches for muskellunge, and 20 to 25 inches for striped bass. A large proportion of walleye anglers supported current regulations on size limit (69%) and creel limit (77%), and all responding striped bass anglers supported current regulation on striped bass. Angler satisfaction on the day of the interview was largely influenced by the rate of fishing success. The fishing effort and catch estimates from this angler and creel survey document the variability in late fall, winter, and early spring fisheries for walleye, muskellunge, and striped bass at Kanawha Falls, and these effort and catch data along with human dimensions data will aid future management of the fisheries.

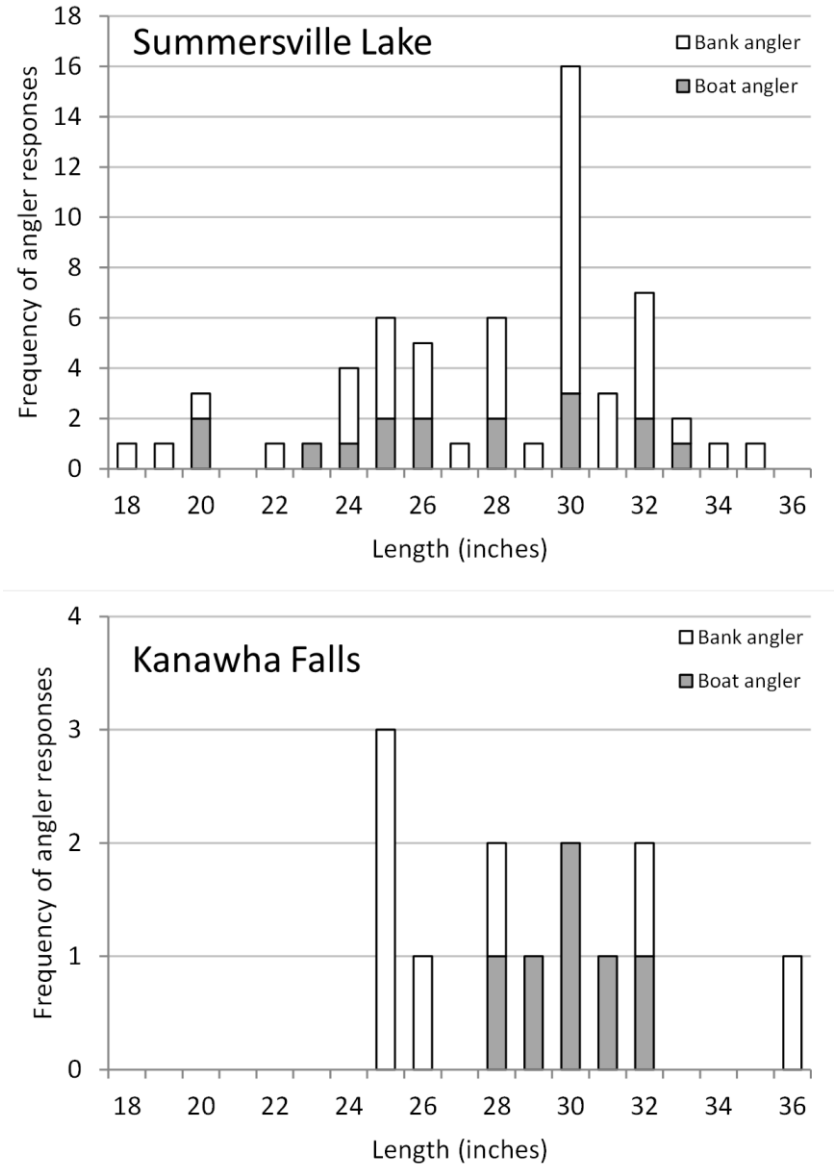


Figure 1. Lengths considered as "trophy" walleyes by anglers at Summersville Lake and Kanawha Falls.

WILDLIFE

AVIAN ASSEMBLAGES AND RED-EYED VIREO NEST SURVIVAL WITHIN MINELAND FOREST

Student Investigator: Jeremy Mizel
Principal Investigator: Petra Bohall Wood
Cooperators: John Perez, Mark Graham
Years Ongoing: 2010-2011
Degree Program: MS
Completed: December 2011

Objectives:

1. Examine patterns in bird assemblage structure within mined and reference forest and to link the bird assemblage response to variables describing habitat structure and composition.
2. Contrast nest survival of Red-eyed Vireos (*Vireo olivaceus*) breeding within mineland forest and unmined, oak-hickory forest.

Results:

Since the passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977, mined lands have generally been reclaimed to an environment characterized by severely compacted minesoils, a growth medium comprised largely of unweathered materials, and a predominance of aggressive groundcovers that inhibit native species colonization. Under these conditions, succession is arrested. Within landscapes that are fragmented by traditionally reclaimed surface mines, forest patches are smaller and forest cover on the landscape scale is reduced. As a result, forest songbirds that require large, continuous blocks of forest are negatively affected. Some pre-SMCRA abandoned minelands contain areas of uncompacted minesoils on which hardwood forest has developed in the absence of aggressive groundcovers. Despite potential differences in tree species composition, study of the relationship between habitat structure and the avian assemblage within pre-SMCRA mineland forest could provide insight into the species assemblages that future mineland reforestation efforts might yield. Study of the reproductive success of forest songbirds within pre-SMCRA mineland forest may provide some indication as to whether this habitat is capable of sustaining breeding songbird populations.

In 2010, I examined patterns in avian assemblage structure in response to the presence of two broad classes of minelands on the landscape, compacted bench minelands and loose-dumped bench minelands. I conducted fieldwork within five study sites in New River Gorge National River and Plum Orchard Wildlife Management Area (WMA). Point count transects were classified as loose-dumped benches, unmined plateau, compacted benches, and unmined steep slope. NMDS ordination indicated that minelands with loose-dumped benches had minimal effect on assemblage structure. The assemblage associated with compacted bench minelands was not discrete, but was largely discriminated from the other assemblage types. Species that use the subcanopy and midcanopy for nesting and foraging were discriminating components of compacted bench assemblages. Relative abundance of the closed-canopy guild was lower within mined forest than within unmined forest.

In 2011, focus was on the uncompacted minelands. I surveyed avian assemblages and sampled stand structure and composition along 28 fixed-width line transects (14 mined and 14 reference) established within four pre-SMCRA abandoned minelands and adjacent, unmined forest within New River Gorge National River in southern West Virginia. Minelands within these study areas were relatively wide (80-100 m wide on average) and contained mature forest (60-65 years old) that had developed from areas of loose-dumped spoil mounded atop benches and also within outslopes (Photo 1). Using an information-theoretic approach, I developed *a priori* models containing habitat and temporal covariates that I

hypothesized to influence the nest survival of Red-eyed Vireos. Within the same study area, I monitored vireo nests within three mineland forest plots and three reference forest plots. Mineland stands were dominated by yellow poplar and red maple, whereas reference stands were primarily comprised of white, scarlet, black, and chestnut oak.

Photo 1. Sixty-five year old mineland used in this study (New River Gorge NR). Photo by Jeremy Mizel.

Ordination of avian assemblages using non-metric dimensional scaling (NMDS) showed clear discrimination between mineland and reference assemblages (Figure 1). Linear and surface fitting of habitat variables showed strong correlations between the ordination and groundcover gradients, but generally non-significant relationships for gradients describing forest structure. Mineland assemblages were associated with lower levels of litter cover and depth and also had lower abundance of Ovenbirds (*Seiurus aurocapillus*), a ground-nesting and foraging species. Within mineland assemblages, the absence of a consistent pattern of relationships among species suggested a wider habitat gradient relative to reference forest.

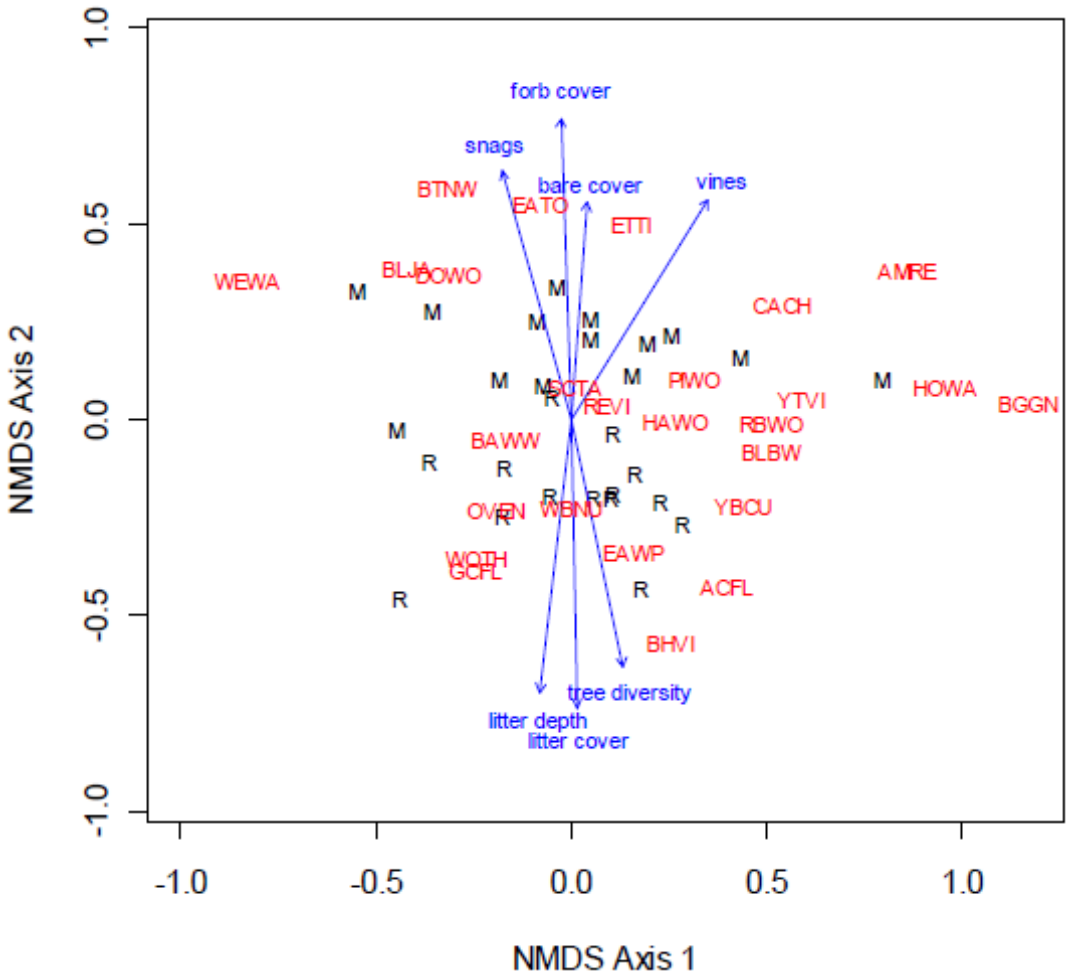


Figure 1. Dimensions 1 and 2 from a 3-dimensional non-metric dimensional scaling ordination for avian assemblages within mineland (M) and reference (R) forest in 2011. Stress was 15.3 for the 3- dimensional solution (2 convergent solutions after 6 runs). The vectors plotted are for those variables that had linear $p<0.05$ (axes 1-3). The length of the arrow corresponds to the correlative strength of the gradient-ordination relationship. Weighted mean positions for all bird species are shown.

I monitored 45 Red-eyed Vireo nests, 21 within mineland forest and 24 within reference forest. Nest survival for Red-eyed Vireos was similar within mineland and reference forest and nest patch characteristics (overstory cover and vertical foliage density) had minimal effect on nest survival. Model-averaged estimates for daily survival for mineland and reference nests were, respectively, 0.951 (CL = 0.924, 0.968) and 0.948 (CL = 0.919, 0.964). Period survival for mineland and reference nests, respectively, were 0.263 (CL = 0.125, 0.427) and 0.231 (CL = 0.107, 0.384). Classification tree modeling using forest type as the response variable indicated that reference nest sites were characterized by greater vertical heterogeneity.

Overall, this research has shown that failure to establish mineland stands in which heavy-seeded species are a component has important implications for avian assemblage structure. Within minelands, heterogeneity in edaphic conditions and the corresponding variation in forest structure likely contributed to an inconsistent pattern in avian assemblage structure.

CONTINUING PROJECTS

AQUATIC

SELECTION OF BENTHIC HABITAT BY SMALL, YELLOW-PHASE AMERICAN EELS

Student Investigator: Missy Braham
Principal Investigators: Stuart A. Welsh, David R. Smith
Years Ongoing: 2011-2012
Degree Program: MS
Expected Completion: December 2012
Funding: FirstEnergy, West Virginia Division of Natural Resources

Objectives:
To determine microhabitat selection of yellow-phase American eel based on benthic substrate types common to Atlantic Coast rivers, and examine relationships of eel length and age to microhabitat selection.

Progress:

American eels (*Anguilla rostrata*) occur in a wide range of habitats, including large rivers and small headwater streams, lakes and impoundments, and marine and brackish waters. Few studies, however, have examined microhabitat use. Microhabitats are likely important to eels for nocturnal foraging and diurnal concealment from predators. A focus on American eels has increased recently owing, in part, to economic worth (international food market and domestic bait fishery) and population decline (i.e. overharvesting, oceanic influences, habitat loss). The contribution of habitat loss to population decline is unknown, but very few studies have focused on defining eel microhabitat.

Our understanding of American eel microhabitat is based primarily on anecdotal field observations. American eels have been observed within leaf packs, root wads, sand, cobble, and soft mud substrates. Recent modeling studies could not conclude significant habitat associations of American eels in relation to substrate or other microhabitat parameters. This study aims to document benthic substrate selection in a controlled laboratory environment.

A total of 150 individual yellow-phase American eels were collected at the Millville hydroelectric dam eel ladder, Shenandoah River, West Virginia. The eels were transported to the laboratory, measured for total length, placed in holding tanks, and acclimated to the laboratory setting prior to the substrate experiment. Prior to the experiment, eels were tagged with PIT tags (passive integrated transponder) to provide identification of each individual, and allow for analysis of relationships among length, age, and substrate selection.

The experiment system encompassed three glass aquariums, each with five equally available substrates in separate removable plastic bins. The five substrates used were cobble (90-256 mm), gravel (4-16 mm), sand (0.125-1 mm), silt/clay (< 0.0625 mm), and slightly decayed leaf pack. The substrates were separated using U.S. standard sieves and a vibratory sieve shaker (gravel, sand, silt/clay), longitudinal axis measurements (cobble), and visually sorted (leaf pack).

Prior to the substrate use experiment, a density dependence pilot study was completed to determine the appropriate number of eels to be released into each of the three aquaria. Due to the American eel's keen sense of smell substrates were air dried between trials in an effort to reduce eel scents from previous trials. The substrate use experiment consisted of nine trials during which five randomly chosen eels from holding tanks were released into each of the three aquariums. On the fourth day of the trial the substrate bins were removed and inspected for the presence of eels. After recording eel presence and eel PIT tag numbers, the post-trial eels were prepared for age determination and new individuals were released into aquaria until all subsequent trials were completed. Statistical analyses are in progress.

Ages of American eels will be determined by counting annual rings of the sagittal otolith. The pair of sagittal otoliths were removed from each eel, cleaned of extraneous tissue, and stored for subsequent processing and analysis. One of each pair of otoliths was embedded in Epoxy resin until hardened and transversely sectioned using an Isomet low speed saw. Sections were then polished using diamond film discs, etched with 5% ethylenediaminetetraacetic acid (EDTA) and stained with 0.01% toluidine blue. The stain treatment will enhance accuracy of age estimation, in part, because transmitted light through blue opaque (summer) zones will aid in the differentiating of false annuli. Once read, the ages will be used to examine possible relationships between age and substrate selection.

The information from this study will contribute to a better understanding of microhabitat use of this species within the Mid-Atlantic region. This study will (1) determine yellow-phase American eel microhabitat selection for or against certain benthic substrate types common to Atlantic Coast drainages and (2) examine relationships of eel length and age to microhabitat selection.

Figure 1. Missy Braham releasing American eels into a 125 gallon aquarium for experimental study of habitat selection.

AN EVALUATION OF THE OCCURRENCE OF MICRONUCLEI AND OTHER NUCLEAR ABNORMALITIES IN FISH FROM THE GREAT LAKES BASIN, UNITED STATES

Student Investigator: Ryan Braham
Principal Investigators: Dr. Patricia Mazik
Collaborators: Dr. Vicki Blazer, USGS Leetown Science Center
Years Ongoing: 2010 - 2012
Degree Program: MS
Expected Completion: December 2012
Funding Source: U. S. Geological Survey (RWO 55)

Objectives:

The primary objective of this study is to take an investigative approach to quantifying non-specific genetic damage to fish at various Areas of Concern (AOC) located in the Great Lakes Basin, United States. Peripheral blood samples will be collected from brown bullhead, white sucker, largemouth bass and smallmouth bass and examined for nuclear abnormalities (specifically micronuclei) in the erythrocytes. The specific objectives of this study are to: 1. Evaluate micronuclei and nuclear abnormality occurrence rates among 10 sites throughout the Great Lakes basin; 2. Evaluate micronuclei and nuclear abnormality occurrence rates among 4 possible species sampled within each site; 3. Evaluate micronuclei and nuclear abnormality occurrence rates among 2 sampling seasons within sites; 4. Examine the land use/land cover, point source discharge sites, as well as collaborate with the USGS Minnesota Water Science Center (Grand Rapids, Minnesota) to examine water and sediment chemistry data for any possible trends that may exist among micronuclei and/or nuclear abnormality occurrence rates; and 5. Statistically evaluate micronuclei and nuclear abnormality presence/absence among a priori biological explanatory variables with the objective of formulating a predictive model explaining any observed variation.

The specific land cover/land use metrics used will include, but may not be limited to, the percent of total land that is used for agriculture, industrial, forested, and wetland. The number and type of industrial facilities such as wastewater facilities, landfills and industrial plants will also be evaluated, as well as the number and location of confined animal feedlot operations (CAFO) and combined sewer overflow (CSO) points for any possible correlation to micronuclei abundance. Otoliths will be used to evaluate any age-effect observed among sampling locations. The final result should provide a biological endpoint of areas that are experiencing non-specific genetic disorders and possible causes for that endpoint.

Progress:

Ten sites were sampled during the spring 2011. Peripheral blood was collected from the caudal vein and smears were prepared on slides for all individuals collected. All blood smears were stained using Giemsa stain (Fluka Analytical, Switzerland) and cover-slipped for evaluation with light microscopy (600x). Giemsa staining was determined to be adequate for our blood smear evaluation. The results for the first 3 above-mentioned objectives are described below.

Objective 1: The occurrence rates of micronuclei (MN) and nuclear abnormality (NA) were evaluated within species among sites. Among sites where brown bullhead were collected, the Genesee and Niagara Rivers expressed MN at a relatively higher rate than the Detroit and Ashtabula Rivers. The Detroit and Ashtabula rivers expressed NA at relatively higher rates than the Genesee and Niagara Rivers. Among sites where largemouth bass were collected, the Genesee, Detroit, and Ashtabula Rivers all expressed MN and NA at approximately the same relative rate. Among sites where smallmouth bass were collected the

Saint Louis and Milwaukee Rivers expressed MN at a relatively higher rate than the Fox River and Duck/Otter Creek sites. The Saint Louis, Milwaukee and Duck/Otter creek sites expressed NA at relatively higher rates than the Fox River site. Among sites where WHS were collected, the Saint Louis River expressed MN at a relatively higher rate than the Swan and Milwaukee River sites. Swan creek expressed NA at a relatively higher rate than the Saint Louis and Milwaukee River sites.

Objective 2: Micronuclei and NA were observed at differing occurrence rates among species. For the 3 AOC sites in which brown bullhead and largemouth bass were collected, MN and NA were expressed at a relatively higher rate among the largemouth bass. For the 2 AOC sites in which white sucker and smallmouth bass were collected, MN and NA were expressed at a higher rate among the smallmouth bass. For the 1 AOC site in which brown bullhead and smallmouth bass were collected, MN and NA occurrence rates were relatively higher in the smallmouth bass.

Objective 3: Micronuclei and NA were observed within sites among 2 sampling seasons. Brown bullhead and were collected at the Ashtabula River and Conneaut Creek sites during the spring and fall of 2011. MN and NA occurrence rates were appreciably lower in the fall sampling as compared to the spring sampling (Note that the MN results only reflect the Ashtabula River site as 0 MN were observed at the Conneaut Creek site in either sampling season). Largemouth bass were collected at the Ashtabula River site during the spring and fall of 2011. MN and NA occurrence rates were appreciably lower in the fall sampling as compared to the spring sampling.

Objectives 4 and 5 are ongoing and their progress is described below.
All metrics have been incorporated into GIS using ArcMap Version 10 (ESRI Inc., Redlands, California). Basin areas have been determined be creating flow accumulation grids based on the elevation data for each site (1 arc second). Landcover/landuse has been clipped for each respective basin using the 2006 National Land Cover Dataset. A full list of permitted discharge sites (collated by the Environmental Protection Agency) has been created for each basin and sorted by discharge interest categories (such as landfills, wastewater treatment plants, residential, etc.). All CAFO and CSO sites have been requested and received for all stated except Michigan CSO point locations. All data in hand has been plotted spatially. Preliminary analysis observes a relatively high occurrence (>50%) of developed and/or agricultural land use among our AOC sites. Interestingly, the Saint Louis River site has a high occurrence (>85%) of forested and wetland combined land cover types. Further evaluation of landuse metrics and incorporation with nuclear abnormality data is ongoing.

We are collaborating with the USGS Minnesota Water Science Center to evaluate water column and sediment chemistry for legacy and emerging contaminants. We are waiting for their final report to be published prior to working with them to evaluate any correlations that can be observed among our endpoints. This collaboration and analysis is ongoing.

Otoliths were removed from all individuals and prepared for age analysis. All individuals have been aged by a single reader, however the data will not be considered final until a consensus age is reached for all individuals among two independent readers. The preliminary age data has been evaluated using the R statistical package (R Development Core Team (2009), Vienna, Austria). Preliminary age analysis suggests that ages were normally distributed within and among sites. The final evaluation of age data is ongoing.

We have developed the a priori hypothesis that age, gender and species are the likely variables that explain the majority of the variation observed among the presence or absence of micronuclei and nuclear abnormalities. Preliminary evaluation suggests that an interaction among species and age explains the majority of the observed variation in micronuclei presence/absence while species alone explains the majority of the observed variation in nuclear abnormality presence/absence. Final statistical analysis is ongoing.

DOWNSTREAM MIGRATION AND MORTALITY OF SILVER AMERICAN EELS ASSOCIATED WITH HYDROELECTRIC DAMS ON THE SHENANDOAH RIVER

Student Investigator: Sheila Eyler
Principal Investigators: Stuart A. Welsh and David R. Smith
Years: 2007 – 2013
Degree Program: PhD
Expected Completion: May 2013
Funding Source: West Virginia Division of Natural Resources, First Energy

Objectives:
Examine out-migration of silver American eels relative to five hydroelectric dams on the lower Shenandoah River. Document eel passage relative to use of dam spillways versus canals and associated intakes to hydroelectric turbines, and document the timing and environmental cues of out-migration.

Progress:

The American eel (*Anguilla rostrata*) is a catadromous fish found in rivers and streams along the Atlantic slope from Canada to northern South America. Eels spawn in the Sargasso Sea and young eels migrate up Atlantic Coast rivers and stay in upstream areas for up to 20 years. Dams along coastal rivers can impact eel migrations, both upstream and downstream. When hydroelectric facilities are associated with a dam, eels can suffer high mortality when attempting to pass downstream as adults. Because eels have been found to travel in the deeper sections of the river, they may be more likely to enter the headrace of a hydroelectric facility rather than surface and pass via the spillway. Once in the headrace, eels can continue downstream toward hydroelectric turbines which can result in mortality.

There are five hydroelectric facilities on the Shenandoah River. All facilities are run-of-the-river and are operated by FirstEnergy. Eels are present in the watershed above all five dams and the power company conducts nightly turbine shutdowns through the fall in an attempt to reduce turbine-related mortality on adult eels migrating downstream. Our study determined when and how adult eels pass through the hydroelectric stations.

Electrofishing on the Shenandoah River

During the falls of 2007 through 2010 we collected large eels in various locations of the South Fork of the Shenandoah River, all above the Luray Dam. Most eels were collected during boat electrofishing in impounded sections of the river, but several fish were caught using backpack electrofishing in the smaller tributaries and one fish was caught in a hoop-net. We implanted internal radio tags in 151 eels and released them at their capture location within two hours of capture. Ninety-six of the eels tagged were silver phase (mature), 30 were an intermediate

phase between immature and mature, and the remaining 25 were large yellow (immature) eels. We monitored eel locations using stationary arrays and manual tracking. The stationary arrays consisted of between fourteen and eighteen radio receiver/antenna combinations that passively listened for radio tags in the vicinity of the Shenandoah, Newport, Luray, Warren, Millville Dams on the Shenandoah River, and at the Little Falls Dam and Dalecarlia Reservoir on the Potomac River.

As of June 2011, 102 eels had made some downstream migration, although not all migrated out of the Shenandoah River. At the time of tagging, most of migrants were silver phase, except for ten that were intermediate phase and seven that were yellow phase. Fifty-nine eels had successfully migrated past Millville dam (lowermost dam on the Shenandoah), and 25 of those had also passed the Little Falls Pumping Station on the Potomac River. Three eels have been recorded at the Dalecarlia Reservoir of the Washington Aqueduct System.

Eels migrated past dams from early November 2007 through mid June 2008, from August 2008 through June 2009, from September 2009 through January 2010, and September through May 2011. Peak movements occurred from late fall through winter and spring. These peaks appeared to be correlated with spikes in discharge following periods of low flows based on data from the USGS gauging station in Luray, Virginia. All downstream passage occurred when water temperatures were between 3^{o}C and 23^{o}C with most passage (79%) occurring between 4^{o}C and 13^{o}C. Most (85%) eels passed the dams between 5:00 pm and 5:00 am. Most (70%) eels passed over the dam spillway versus passing through the hydro plant during their downstream migration. Radio-tagged eels passed dams during all lunar phases.

Timing and duration of silver eel migration out of the Shenandoah River was highly variable. For eels that moved past more than one dam, the length of time to complete downstream migration was highly variable. Migrating eels moved in the Shenandoah River between 50 to 123 miles after they passed their first dam. Movement between two dams occurred over a range less than one day to 208 days. Sixty-eight percent of the eels completed their downstream migrations in less than 30 days. The fastest movement between dams was an average rate of 74 miles per day (3 mph) for a fish that moved between the Shenandoah and Millville dams in 43 hours. The slowest movement was less than 0.1 miles per day for an eel that took 7 months to move between the Shenandoah and Newport Dams.

We suspect turbine related mortality had occurred at all five dams on the Shenandoah River. At least 28 of 102 migrating eels were suspected of being killed while attempting to pass through hydro stations on the Shenandoah River. Outside the shutdown period, when plants were able to operate turbines 24-hours per day, between 41% and 89% of passage events occurred through turbines. The proportion of eels passing through hydro plants was reduced to between 3% and 17% when plants turned off the turbines at night during the period of September 15 to December 15. Despite the efforts of the shut-down period, suspected turbine mortalities occurred throughout the study period, including during the night-time shutdown periods. Based on the overall mortality rates for each dam, currently there is a cumulative 65% survivorship for large eels that migrate out of the Shenandoah River from above Shenandoah Dam.

EVALUATION OF MOLECULAR BIOMARKERS FOR USE IN THE ASSESSMENT OF FISH HEALTH IN GREAT LAKES AREAS OF CONCERN

Student Investigator: Cassidy Hahn
Principal Investigators: Dr. Patricia Mazik
Collaborators: Dr. Vicki Blazer, Dr. Luke Iwanowicz - USGS Leetown Science Center
Years Ongoing: 2011 - 2015
Degree Program: PhD
Expected Completion: December 2015
Funding Source: U. S. Fish and Wildlife Service (RWO 55)

Objectives:

The primary objective of this study is to evaluate molecular techniques to assist in the assessment of the health of fish populations exposed to emerging environmental contaminants in Great Lakes Areas of Concern (AOC). Liver samples will be collected from either brown bullhead or white sucker, and either largemouth bass or smallmouth bass at each sampling site. These samples will then be used to evaluate gene expression changes through the use of Nanostring technology. Peripheral blood samples will also be collected from these individuals for use in population assessment via microsatellite analysis of genomic DNA.

Progress:

Samples have been collected in the fall of 2010, spring of 2011, and spring of 2012 from a total of 8 AOCs throughout the Great Lakes region. Using pooled tissue from collection sites, whole transcriptome databases have been created for each species of interest at the Leetown Science Center (Kearneysville, WV). Initial databases for smallmouth bass and brown bullhead were created by CoFactor Genomics (St. Louis, MO) on an Illumnia. Assembly and annotation of these databases were also provided. An additional smallmouth bass run was then performed at Duke Institute for Genome Science and Policy (Durham, NC) using 454 sequencing on a GS Junior. A hybrid assembly was then completed at the Leetown Science Center to integrate data from both runs into a single database for the smallmouth bass. White sucker transcriptome sequencing was performed at the Leetown Science Center. Genes from this run were identified through BLASTn and BLASTx searches on a local database and assembled using CLC workbench. These databases have been used for gene discovery and the creation of probes for gene expression analysis.

Ryan Braham and Cassidy Hahn collecting tissues samples from fish with Dr. Vicki Blazer

Liver samples for use with gene expression analysis have been lysed and are currently awaiting shipment to NanoString Technologies for processing. This method of evaluating gene expression is similar in sensitivity and specificity to real time PCR but allows for the examination of multiple genes and therefore a reduction in cost per gene. Samples will be sent to Nanostring Technologies in a large batch pending the completion of gene discovery in order to be as cost effective as possible.
Genomic DNA extraction from blood samples is nearly completed for 2011 samples and will begin for 2012 samples upon their completion. The formerly mentioned transcriptome databases have been used to create microsatellite markers for smallmouth bass and will be used to create additional markers for other species of interest in this study. The testing of loci for processing of microsatellite samples for smallmouth bass is underway at the Leetown Science Center and analysis should be completed for this species by spring of 2013.

CONSERVATION ASSESSMENT OF WEST VIRGINIA CRAYFISHES

Principle Investigators: Zac Loughman and Stuart Welsh
Years Ongoing: 2007-2012
Expected Completion: 2013
Funding Source: West Virginia Division of Natural Resources

Objectives:

1. Identify species in need of conservation
2. Document distribution ranges of invasive species
3. Document range expansion and conservation standing of "common" species
4. Conduct surveys for new state records and undescribed forms
5. Generate an interactive WV crayfish key and web site for public involvement and awareness

Progress:

Crayfishes have received moderate attention within the state of West Virginia. The first major work on decapods was performed by Faxon (1885), who listed only two taxa in WV. Since this initial research, several more species have been added to the crayfishes of West Virginia, with 22 known taxa residing within the state's borders as of 2006. Several of these species additions were the result of crayfish surveys throughout various ecological regions within the state. Survey efforts within the state reached their peak during the 1980's, with the last formal statewide survey of West Virginia's crayfish fauna performed by Jezerinac during the summers of 1987 and 1988.

Efforts within the state to identify conservation threats, potential state records, and conservation concerns since the publication of Jezerinac et al. have been disjunct in nature. Key species (*Cambarus* (*H.*) *elkensis*, *Cambarus* (*P.*) *veteranus*), have received attention since Jezerinac's effort, while the majority of taxa have remained understudied. Conservation concerns have arisen since the publication of Jezerinac et al. that were not of major consequence in the 1980s to crayfish populations. Land use issues, stream alteration, invasive species, and habitat loss have occurred throughout the state in areas with diverse crayfish populations, and the ultimate impact of these activities on crayfishes remains poorly understood.

This research will provide a manual or guide to the crayfishes of West Virginia. Given recent developments in electronic media, an interactive key to the crayfishes of West Virginia with multiple pictures of a species, list of key characters, and current range maps is a possibility that did not exist during the initial statewide crayfish survey. This product would be one output of a current statewide

crayfish census, and would make it possible for field biologists across West Virginia to ID specimens in the field via an electronic and interactive identification key.

Using a probabilistic-random sampling of stream sites, we have sampled crayfishes from approximately 10 sites from each 10 digit sub-basin within the Cheat, Elk, Potomac, Youghiogheny, Greenbrier, Guyandotte, James, and Tug Fork river drainages, as well as drainages from the northern panhandle of WV. Analyses of these data are underway, and the remainder of the state will be sampled in future efforts. Separate efforts will also target burrowing crayfishes.

In addition to the overall distributional information on the WV crayfish fauna, some interesting findings of this work include rediscovery of *Cambarus veteranus*, and the discovery and description of a new species of *Cambarus* in the Greenbrier River drainage, *Cambarus smilax*.

Cambarus veteranus (Big Sandy Crayfish) has been a focal species of this work due to its rarity when the state received its initial statewide census in the mid 1980's. Jezerinac et al. determined that *C. veteranus* likely would be extirpated due to land use practices and stream degradation in the West Virginia coal fields. Several investigators have focused on determining the conservation status of *C. veteranus* in the last decade in West Virginia; during these efforts zero *C. veteranus* were observed. In the summer of 2009, all historic locations (n = 17) and additional locations determined through a probabilistic site selection design, were surveyed in the Guyandotte, Bluestone, and Tug Fork river basins to determine if the West Virginia population had been extirpated. Resultant of this effort, *C. veteranus* was discovered at 1 historic station for the species, in Pinnacle Creek, Wyoming County. In addition to the rediscovery of the Pinnacle Creek population, another population was discovered in Dry Fork, a tributary to the Tug Fork River. This population represents a new basin record for the species in West Virginia and appears to be more stable than the Pinnacle Creek population.

The first species description, resultant of specimens collected during this study, was recently published in the *Proceedings of the Biological Society of Washington*. The new species, *Cambarus smilax* (Greenbrier Crayfish), is the third endemic crayfish for West Virginia. *Cambarus smilax* is endemic to streams occurring in the Greenbrier River system, and reaches its highest population densities in the headwaters of the Greenbrier River, specifically the East and West Forks of the Greenbrier, Thorny Creek, and Deer Creek. Populations of this animal are stable but are limited to the Greenbrier River system.

Cambarus veteranus, Pinnacle Creek, Wyoming County, West Virginia

CAPTIVE PROPAGATION, REPRODUCTIVE BIOLOGY, AND EARLY LIFE HISTORY OF THE DIAMOND DARTER (*Crystallaria cincotta*)

Student Investigator: Crystal Ruble
Principal Investigators: J.R. Shute, Pat Rakes, and Stuart A. Welsh
Years Ongoing: 2008 – 2013
Degree Program: MS
Expected Completion: May 2013
Funding Source: West Virginia Division of Natural Resources, U.S. Fish and Wildlife Service

Objective:
To estimate parameters of reproductive biology and early life history of diamond darters.

Progress:

The diamond darter, previously recognized as the crystal darter, was described as a new species in January 2008, with only a single extant population in the lower Elk River. This species historically occurred over a wider range within the Ohio River drainage, but populations have been extirpated from Kentucky, Ohio, and Tennessee. On 26 July 2012, the U.S. Fish and Wildlife Service published a proposed rule in the Federal Register to list the diamond darter and to designate critical habitat under the Endangered Species Act.

Little information is available on reproductive biology and early life history of the diamond darter, but these data can be obtained through studies of captive breeding and rearing. Propagation of rare fishes in the laboratory is an important tool for the conservation of species with declining populations and limited distribution ranges. Propagation not only allows for the study of reproductive biology and early life history, but also provides an opportunity for reintroduction programs or long-term captive populations. This research involves a partnership with Conservation Fisheries, Inc., Knoxville, TN (CFI, Co-directors J.R. Shute and Pat Rakes). The research is being conducted at CFI, where successful captive propagation of rare or endangered fish species has been demonstrated for over 20 years. Diamond darters were collected from the Elk River, WV, and housed in separate aquaria at Conservation Fisheries, Knoxville, TN. The general strategy for breeding and rearing young in the laboratory is described on the CFI webpage; http://www.conservationfisheries.org/projects/propagation.htm. Data on early life history included clutch size, egg size and development, as well as data on larval fish and juvenile development and growth rates. Egg viability and survival rates of larval and juvenile darters were estimated, and behaviors of larval and juvenile darters were documented.

Captive propagation of diamond darters during spring 2009 was unsuccessful. Of three captive individuals, one large female became noticeably gravid, but the other two individuals may have been immature males or possibly females. Prior to propagation efforts, observational studies of these darters documented sand-burrowing, a behavior associated with habitat specificity. Also, the darters were crepuscular foragers, and burrowing behavior was not associated with lie-and-wait feeding as previously documented for the genus by some researchers. The darters were often buried in the sand during the day (often with head exposed), and on top of the sand, but inactive, at night. The darters were often unsuccessful at attempts to burrow into pebble-sized substrate, but easily burrowed in sand. These observations support habitat specificity and indicate that habitat alteration associated with sedimentation or loss of sandy habitats possibly could impact populations.

Two additional individuals (a male and female) were collected in September 2009 and transported to the Conservation Fisheries, Inc. facility on 1st of October 2009. These two individuals were placed in

quarantine for a month, and then moved into a tank with the existing three individuals. The diamond darters spawned in spring 2010; eggs were first observed on 8 April 2010, where gravel siphoning recovered 27 eggs and 3 larvae. Of these eggs, only 3 were obviously fertile and developing, 18 were obviously infertile, and another 6 were uncertain based on opaqueness of the chorion. The good eggs and the heavy yolk sac larvae were set up in a small shoe box sized tray with a flow through screen on the same system of the adults. Eggs were about 1.8mm and heavy yolk sac larvae were 6.7 – 7.2 mm. Over the next two days several more hatched and were transferred to a 30 gallon feeding tub. Several more larvae were passively collected in the catch also, totaling 10 added to the feed tub by the 13th of April. The feed tub was supplied with a regulated source of newly hatched brine shrimp nauplii, *Ceriodaphnia dubia* neonates and adults, Instant Algae, as well as marine *Brachionus sp.* with a reservoir that fed out for 8 seconds every 2 minutes during daylight hours. On 13 April, only 3 larvae were found in the tub, and two were recovered and photographed. These larvae were much larger (between 9.8 – 10 mm with a large gape size) and still had a large yolk sac, a surprising find given that most other darter larvae that CFI has worked with absorb their yolk sac within a couple days of hatch and swim up. With this gape size, they should be able to easily consume the food provided, however their gut content was empty and they still had a bit of yolk sac left. By 16 April, these larvae were dead, never showing signs of feeding.

On 16 April, an additional 25 eggs and larvae were collected, 11 of which were infertile, and three were recently hatched larvae. Only 10 of these were transferred to the feeding tub for rearing, many fertile eggs succumbed to fungus. Over a time span of 7 days all the eggs hatched and were transferred to the tub. Losses were noted on the 25th, 26th, and 30th of April. By the 3rd of May only one individual remained. It was removed from the tub and photographed to document yolk sac, size and general appearance. Surprisingly, this remaining larva had relatively large teeth, yet had no gut content. The larva measure 10.8 mm and had a gape length of 1 mm, with a total lower jaw length of 1.4 mm. The larva failed to feed on invertebrates, but the relatively large gape size and teeth suggests predation on other fish larvae. On 26 April, another 45 eggs were collected, but all appeared to be infertile. On 28 April, another 26 bad eggs were found, and only one egg that had vertebral development, but with fungal infection. Spawning was also documented on 7 May (11 eggs), 14 May (2 eggs), and 21 May (17 eggs), but eggs were affected by fungal infection.

During spring of 2011, the three older darters displayed signs of old age and died. We expected longer life spans, but our data suggest that the life span may be as short as three years. The two younger darters remained alive, and the female spawned, but only 4-5 larvae were collected with passive and active methods. Similar to results from the previous year, the larvae did not survive. An additional 12 adult diamond darters were collected for the 2012 breeding period, and results were similar to previous studies, where larvae were produced but did not survive.

BIOLOGICAL MONITORING OF AQUATIC COMMUNITIES OF CHEAT LAKE AND CHEAT RIVER DOWNSTREAM OF THE LAKE LYNN HYDRO STATION

Student Investigator: Dustin Smith
Principal Investigator: Stuart A. Welsh
Years Ongoing: 2011 - 2012
Degree Program: PhD
Expected completion: Dec 2015
Funding Source: West Virginia Division of Natural Resources, FirstEnergy

Objectives:
A five-year biomonitoring project was initiated March 2011 for Cheat Lake and its tailwaters. The project (partitioned into nine tasks) is a continuation of previous work by West Virginia Division of Natural Resources. Three tasks of the proposed work focus on Cheat River and Cheat Lake tailwaters (Tasks 1 – 3), and 6 tasks will focus on Cheat Lake (main lake and embayments).

1. Fish biomonitoring downstream of Cheat Lake
2. Benthic macroinvertebrate resource biomonitoring downstream of Cheat Lake
3. Water quality biomonitoring downstream of Cheat Lake
4. Fish biomonitoring of Cheat Lake and Cheat embayments
5. Walleye population monitoring and stock assessment
6. Monitoring of adult walleye movement
7. Physical and chemical water quality characteristics of Cheat Lake
8. Aquatic Vegetation Mapping of Cheat Lake
9. Create a bathymetric map of Cheat Lake

Progress:

For this study, Cheat Lake was divided into three major study areas: the Cheat embayments (Rubles Run – 56 acres, and Morgan Run – 37 acres); lower Cheat Lake, downstream of I-68 bridge to Lake Lynn hydro station; and upper Cheat Lake upstream of the I-68 bridge to the head of the lake. The 3.7-mile section of Cheat River downstream from the hydro station was defined as the Cheat tailwater area located in the first 1.1 miles, and Cheat River between the Cheat tailwater area and the confluence of Cheat River with the Monongahela River (lower 2.6 miles).

Currently, objectives 1, 2, 3, 4, 5, 6, 7, and 9 are ongoing, and the work for the remaining study objectives will soon be underway. Quarterly progress reports are provided to the funding agencies. In summary, water samples have been collected multiple times from Cheat Lake tailwater, Grassy Run, and Cheat River downstream of Grassy Run. Water quality characteristics have been measured at 1-meter profiles at three water quality stations within Cheat Lake. Electrofishing surveys and gill net surveys have been conducted at all study stations within both the lake and downstream of the dam. Benthic macroinvertebrates have also been collected downstream of Cheat Lake in the tailwater section. Also, a bathymetric map of Cheat Lake has been created using sonar, GPS technology, and GIS-based interpolation techniques.

For water quality monitoring, the Cheat Lake tailwaters have averaged a pH 6.5, dissolved oxygen levels of 8.3 mg/l, and average conductivity levels of 118 µs/cm. Water quality in Grassy Run, an acidic tributary to the Cheat River, as expected has exhibited the worst water quality for all three stations with an average pH of 2.9 and conductivity of 1073 µs/cm. In general, Cheat River water quality downstream

of Grassy Run reflects the impacts of acid mine drainage (AMD) from Grassy Run with an average pH of 5.4 and an average conductivity of 238 µs/cm.

Physical and chemical water quality profiles have been conducted 16 times during 2011 and 2012. The primary focus of these limnological profiles is to monitor the pH of Cheat Lake which is still impacted by upstream AMD sources, and to monitor the stratification of water temperature and dissolved oxygen within the lake. Depressions in pH (less than 6.0) have occurred occasionally within the lake, primarily in the early spring when the combined effects of AMD and acidic snowmelt impact the lake. Otherwise, lake pH has been satisfactory, remaining above 6.0 the majority of the time. Stratification of water temperature and dissolved oxygen does occur in lower Cheat Lake from approximately June-September. In general, the upper half of the water column is characterized by warmer water with suitable dissolved oxygen levels (above 5.0 mg/L), while the lower half of the water column is characterized by much colder water with increasingly less dissolved oxygen (less than 5.0 mg/L). This phenomenon occurs primarily in the lower portion of Cheat Lake which is characterized by much greater depths.

Night boat electrofishing and gill netting have been conducted during May 2011, October 2011, and May 2012 in Cheat Lake. In total, 379 fishes have been captured with gill nets, while 2,019 have been collected using electrofishing. The upper lake which retains many riverine characteristics has consistently produced a greater abundance of fish compared to both the lower lake and embayment areas. The embayment areas have produced the lowest fish abundances. Largemouth bass and spotted bass have been most abundant in embayment areas, while smallmouth bass are more abundant in the upper lake. Green sunfish, bluegill, and pumpkinseed are most abundant in the lower lake. Walleye, yellow perch, white bass, and channel catfish are typically most abundant in the upper lake. Smaller forage species also differ dependent on lake area. Mimic and emerald shiners are very abundant in the upper lake and fairly abundant in the lower lake, but are uncommon in embayments. Conversely, logperch and brook silversides are most abundant in the embayments and lower lake. Gizzard shad are typically most abundant in the lower and upper lake, while golden redhorse are most abundant in the upper lake.

Night boat electrofishing, tow barge (pram) day electrofishing, and gill netting have been conducted during July, September (pram only), and October 2011 in the tailwaters and river downstream of Cheat Lake. In total, 967 fishes have been captured with boat electrofishing, 113 with gill nets, and 745 with pram electrofishing. An abundance of small forage fish primarily represented by mimic shiners, emerald shiners, and bluntnose minnows were collected in both the tailwater and river sections. In the tailwaters, mimic shiner was the most abundant forage fish, while in the river emerald shiners were more abundant. There were also several species of game fishes collected in both the tailwaters and river section including smallmouth bass, spotted bass, largemouth bass, channel catfish, walleye, sauger, yellow perch, and white bass. Smallmouth bass and channel catfish were the most abundant game fishes collected, although largemouth bass and sauger were quite abundant near the mouth of the Cheat River. In addition, benthic macroinvertebrate sampling was completed in July and November 2011. The tailwater area just below the dam has a relatively low abundance of macroinvertebrates, likely stemming from the variation in outflow from the upstream dam. The family Chironomidae (midges) accounts for most of the invertebrates in the tailwaters just downstream of the dam. Two sites are sampled for macroinvertebrates approximately one mile downstream of the dam, and support a much greater abundance of macroinvertebrates. However, the macroinvertebrate community at these sites has low diversity mainly comprised of tolerant taxa. Macroinvertebrates from the families Chironomidae and Hydropsychidae (net-spinnning caddisflies) account for most of the macroinvertebrates at these downstream stations.

Research on adult walleye movement was started in early December 2011. Thus far, 14 adult walleyes have been successfully implanted with transmitters. Ten of these 14 fish are currently active, with 4 of the fish currently missing. Fish locations have been determined using both submerged, stationary receivers and active tracking. Walleyes were captured primarily with boat electrofishing. In total, 58 walleyes were captured during four nights of sampling in December 2011 (including tagged fish).

Figure 1. Dustin Smith holding a 28-inch Cheat Lake walleye.

Most walleyes ranged in length from 13-15 inches. While the entire lake area was sampled in attempts to capture adult fish large enough to tag (> 16 inches), all tagged fish were captured in the middle lake. Thirteen of the 14 fish tagged were implanted at the Cheat Lake Park and released in the main lake adjacent to Morgans Run Embayment. Fish displayed strong site fidelity, with all active fish returning to near their capture location upstream (5-7 miles) within a few weeks. Tagged fish remained near their original capture locations until late February when fish started to make upstream movements, likely in order to reach spawning habitat. By early March, tagged fish had moved to the head of Cheat Lake to spawn. Preliminary analysis of the data suggest that upstream movements corresponded to a combination of increased water temperature, a decrease in lake elevation followed by a significant increase in lake elevation, and an increase in incoming river flow. A minimum of 4 of the 10 fish that moved to the head of the lake, proceeded to move upstream of the first riffle and into the Cheat River, possibly to spawn in the next riffle/run area upstream of the lake approximately 1 mile. Two tagged fish continue to use this area upstream of the first riffle. Most fish remained near the spawning location until June when downstream movement increased. Currently, 8 of the 10 active fish (males) are primarily using the upper lake area, while the 2 female fish are further downstream in the middle lake. Our plans are to continue monitoring our 10 active tagged fish and to tag an additional 30 adult walleye in Fall 2012.

Walleye population monitoring and stock assessment surveys have been conducted in Cheat Lake during March and April 2012. Gill nets are used to capture walleyes throughout the lake to assess the status of the population and the success of walleye stocking efforts. Only 9 walleye were captured during 3 sampling efforts during March/April 2012. However, it is most likely that the walleye population was greatly underrepresented during our surveys. Most adult walleye were likely upstream of our netting areas near the head of the lake. Information from our acoustic tagged walleyes indicated that most fish were occupying this area in preparation for spawning. In addition, walleye sampling has historically been less productive during the spring as opposed to the fall sampling. Fall sampling efforts (November 2012) will likely provide better indication of the status of the walleye population.

A bathymetric map of Cheat Lake was created in 2011 using sonar, GPS technology, and GIS-based interpolation techniques. Depth data with GPS coordinates were recorded from transects using boat-mounted sonar gear. These data were imported into a GIS, where interpolation and contour line mapping techniques were used to produce a bathymetric map of Cheat Lake. This component of the study will be

useful in determining habitat preferences of walleye and also areas that are vulnerable to water level fluctuations.

ASSESSMENT OF AGE, DIET, AND GROWTH OF YELLOW PERCH IN CHEAT LAKE, WEST VIRGINIA

Student Investigator: Nate Taylor
Principal Investigator: Stuart A. Welsh
Years Ongoing: 2012-2012
Degree Program: MS
Expected completion: May 2013
Funding Source: West Virginia Division of Natural Resources, FirstEnergy

Objectives:
To evaluate age/size structure, estimate growth rates, and determine summer diet composition of yellow perch in Cheat Lake

Progress:

Cheat Lake, a reservoir located near Morgantown, WV, supports a productive yellow perch fishery. The fishery is unique because few yellow perch fisheries are available within WV. For management of this Cheat Lake fishery, research is needed on age and growth of yellow perch.

Cheat Lake (Photo by Jim Hedrick, WVDNR)

During July 2012, a total of 194 yellow perch (48–316 mm total length) were collected with a boat electrofisher from four areas within Cheat Lake: shallow areas upstream of Quarry Run, upper lake (a mudflat located near the I-68 bridge and the confluence of Crammys Run), lower lake (consisting of waters between the confluence of Canyon Run to the newly created swimming area), and embayments (Morgans Run and Rubles Run). Additional sampling will include seining shallow areas and employing passive entrapment gears (fyke nets) in deeper areas of the lake.

Currently, otoliths and stomach contents are being prepared for age determination and diet analysis. Upon completion, this study will provide growth curves based on sex, age, and size structure of the population, as well as diet composition of multiple age classes.

Figure 1. Nate Taylor holding a Cheat Lake yellow perch.

EFFECTS OF CORRIDOR H HIGHWAY CONSTRUCTION ON BENTHIC MACROINVERTEBRATE AND FISH COMMUNITIES

Principal Investigators: Stuart Welsh, Jim Anderson, and Lara Hedrick
Years Ongoing: 2002-2011
Expected Completion: May 2013
Funding Sources: West Virginia Division of Highways

Objective:
To identify and compare changes in the benthic macroinvertebrate communities within watersheds impacted by construction of Corridor H, a four lane highway.

Progress:

This study was initiated in response to commitments made by the West Virginia Division of Highways established during the environmental impact assessment update for Corridor H. As part of the conditions for constructing the highway, the WVDOH must establish a long-term investigation focused on providing community level information on stream ecosystems. The current list of streams that will be impacted by construction is as follows: Baker Run/Long Lick and tributaries, Beaver Creek, Big Run, Lost River, Pheasants Run, Patterson Creek, tributaries of Elk Lick, Middle Fork of Patterson, Walnut Bottom Run, and Waites Run. In 2005 two new watersheds were added to the study as part of the Parsons Avoidance Study - Mill Run and Big Run, located east of Parsons, WV.

In fall 2011 and spring 2012, benthic macroinvertebrate samples were collected in three areas, Patterson Creek, Walnut Bottom, Beaver Creek. Sample collection in the Big Run and Mill Run watersheds have been suspended at this time. Samples in the three areas were collected on the main stem of Patterson Creek, Middle Fork of Patterson Creek, Elklick Run, tributaries of Elklick Run, the main stem and tributaries of Walnut Bottom, the main stem and tributaries of Beaver Creek, and the main stem and tributaries of Mill Run and Big Run. Benthic macroinvertebrate samples from 2011-2012 are currently being picked and identified in the laboratory.

Work to be completed in 2012-2013 includes identification of benthic macroinvertebrate samples collected during 2010-2011. Selected metrics associated with the West Virginia Stream Condition Index (WV-SCI) will be calculated for these benthic macroinvertebrate samples. Benthic macroinvertebrate collections will be made in the fall of 2012 and the spring of 2013 at all sites. An annual report will be submitted to the WVDOH.

UPSTREAM MIGRATION AND USE OF FISHWAYS BY AMERICAN EELS IN THE SHENANDOAH RIVER

Principal Investigator: Stuart A. Welsh
Years: 2003 – 2013
Expected Completion: 2013
Funding Source: West Virginia Division of Natural Resources, FirstEnergy

Objectives:
Examine upstream migration of American eels through monitoring of eel-specific fishways on hydroelectric dams of the lower Shenandoah River.

Progress:

The American eel is a migratory species with extensive upstream migrations in rivers during the yellow phase of its life cycle. Given recent concerns of population declines, studies have focused on obstructions to migration, specifically in relation to dams and associated influences on upstream migration. Improving technologies for upstream eel passage has been listed as a high research priority. Managers of fisheries and those of hydroelectric facilities have installed eel-specific fishways (commonly called eel ladders) on some rivers to assist eels in passing dams during upstream migration. However, little is known about eel movements and behaviors near dams and eel ladders, and few dams have been evaluated for ladder effectiveness.

There are five hydroelectric facilities on the Shenandoah River. All reservoirs are run-of-the-river. The dams and associated hydropower facilities are operated by FirstEnergy. An eel ladder was installed in 2003 on Millville Dam within the lower Shenandoah River. This ladder has passed over 17,000 eels during the period of 2003 to present. Recently, ladders have been installed upstream at Warren and Luray dams, but these ladders have passed relatively few eels. Additional installations of ladders are planned for dams upstream at Newport and Shenandoah, VA.

Based on data collected at the Millville ladder, upstream migrant eels average 30 cm in length (primarily ranging from 19 cm to 50 cm), and range from 3 to 10 years in age. Eels often use the ladder during time periods near the new moon or periods of increasing river discharges. Eels are nocturnal and primarily use

the ladder at night. The largest numbers of eels have passed the Millville ladder during high river discharges of spring and fall, and relatively few eels move upstream during low flow periods of summer.

Millville Plant (photo by Sheila Eyler)

American eel (photo by Brandon Keplinger, WVDNR)

DISTRIBUTION AND HABITAT USE OF THE DIAMOND DARTER

Principal Investigator: Stuart Welsh,
Collaborators: Dustin Smith, Nate Taylor
Years Ongoing: 2012
Expected Completion: August 2012
Funding Source: West Virginia Division of Natural Resources

Objectives:
To document distribution and quantify habitat use of diamond darters within the Elk River, West Virginia

Progress:

The diamond darter *Crystallaria cincotta*, a recently-described darter of the Ohio River drainage, is known from the lower 36 km of the Elk River, Kanawha and Clay counties, WV (Welsh and Wood 2008). The species occurred previously over a wider range within the Ohio River drainage, but populations are thought to be extirpated from Kentucky, Ohio, and Tennessee (Welsh et al. 2009). The diamond darter is a rare species, given that the only extant population is restricted to the Elk River drainage in West Virginia. Further, relatively few individuals have been collected from the Elk River, and observations of the species have been largely restricted to two sections of the river at Mink Shoals and Clendenin, WV. In November 2009, the diamond darter was included as a candidate for listing as endangered or threatened (USDOI 2009). On 26 July 2012, the U.S. Fish and Wildlife Service published a proposed rule in the Federal Register to list the diamond darter and to designate critical habitat under the Endangered Species Act.

Data are lacking on distribution and habitat use of the diamond darter, in part, because the species has been difficult to collect with conventional sampling gears, such as seines and electrofishers. Sampling efforts throughout the lower Elk River drainage have largely been unsuccessful at finding diamond

darters, but unsuccessful collections may result from either species absence or non-detection by sampling gear. During 13-14 September 2011, 25 diamond darters were observed using a new sampling method which used spotlights to locate diamond darters at nighttime. The 25 individuals observed during this two-night sampling period exceeded the previous total number of diamond darter observations. This spotlight sampling method, given its high success rate, provides a promising new approach to further document the distribution of diamond darters within the lower Elk River. Furthermore, the ability to find diamond darters provides an opportunity to quantify habitat used by this species.

For this study, a total of 15 sites will be surveyed for diamond darters during June through August 2012. As of the first week of August, half of the sites have been surveyed and habitat use has been documented for over 50 diamond darters within the lower Elk River from Mink Shoals upstream to Clendenin, WV. The additional sites will be sampled during mid to late August, and a final report will be provided at the end of August 2012. The report will include the new distribution data for the diamond darter, and an analysis of habitat use data.

Figure 1. A diamond darter photographed at night with underwater camera within Elk River, near Elk View, WV during July 2012.

WILDLIFE

ECOLOGY AND MANAGEMENT OF GOLDEN-WINGED WARBLERS ON HIGH-ELEVATION PASTURELANDS ON THE MONONGAHELA NATIONAL FOREST, WEST VIRGINIA

Student Investigator: Kyle Aldinger
Principal Investigator: Petra Bohall Wood
Cooperators: Dan Arlington, Rich Bailey, Cathy Johnson, Rob Tallman
Years Ongoing: 2008-Present
Degree Program: PhD
Expected Completion: May 2013
Funding Sources: National Fish and Wildlife Foundation, US Natural Resources Conservation Service, US Geological Survey, US Fish and Wildlife Service, US Forest Service, WV Division of Natural Resources

Objectives:

1. Evaluate the response of Golden-winged Warblers to habitat management.
2. Quantify site-fidelity, survival, and movements of banded males, females, and nestlings.
3. Monitor broad-scale Golden-winged Warbler and associated bird species populations on pastures relative to vegetative characteristics and grazing intensity.

Progress:

Golden-winged Warblers (*Vermivora chrysoptera*, GWWA) are one of the most rapidly declining songbird species in North America, with especially dramatic declines in West Virginia (1966-2010 Breeding Bird Survey [BBS] annual average decline -8.9% year^{-1}, n = 44 routes). Current population trend estimates using BBS data in West Virginia may be unreliable because GWWA occur on few survey routes. Hence, targeted research is necessary to reliably track population trends and determine strategies for stabilizing or increasing populations. Key limiting factors for this species may include habitat availability on breeding and wintering grounds, migratory obstacles, Brown-headed Cowbird (*Molothrus ater*) brood parasitism, climate change, and hybridization, genetic introgression, and competition with the closely-related Blue-winged Warbler (*V. cyanoptera*, BWWA). Complicating conservation efforts, GWWA and BWWA produce fertile hybrids, the Brewster's Warbler (BRWA) and the rarer Lawrence's Warbler (LAWA). Our research primarily has focused on active and abandoned pasturelands on and around the Monongahela National Forest, although GWWA also breed on reclaimed minelands in southern West Virginia. Regardless of the source of habitat, GWWA breeding territories consistently contain a mixture of grasses, herbaceous vegetation, raspberry/blackberry (*Rubus spp.*), shrubs, saplings, and a few trees in a forested landscape.

We located and monitored 39 successful (39%), 46 failed (46%), 14 abandoned (14%), and 1 unknown fate (1%) GWWA nests (n=100) from 2008–2012. Over the same time period we found 15 nests of mixed species parentage with GWWA x BRWA hybrid pairings most common (6 ♂ BRWA x ♀ GWWA, 5 ♂ GWWA x ♀ BRWA, 1 ♂ BWWA x ♀ GWWA, 1 ♂ GWWA x ♀ BWWA, 1 ♂ BRWA x ♀ BWWA, 1 ♂ BWWA x ♀ LAWA). In 2012, we found the first ♂ BWWA x ♀ BWWA nest, which was successful, for the project on a site near Elkins, Randolph County. Phenotypically pure GWWA nests had 11.8 ± 2.6 (SE) shrubs 1-2 m tall, 8.4 ± 1.7 shrubs >2 m tall, and 3.5 ± 1.3 saplings (>0.5 m tall and 1-10 cm diameter at breast height [DBH]) within a 5-m radius. Random plots average lower with 9.9 ± 3.0 shrubs 1-2 m tall, 7.7 ± 1.7 shrubs >2 m tall, and 2.3 ± 0.9 saplings. Nests had more woody stems >10 cm DBH within an 11.3-m radius (5.1 ± 1.3) than random plots 3.9 ± 0.9. When present, these woody stems had larger DBH at nests (17.0 ± 1.2 cm) than random plots (13.6 ± 0.4 cm). Shrubby St. Johnswort (*Hypericum prolificum*) and Hawthorn (*Crataegus sp*) were the most abundant shrub species, with both *H. prolificum* and *Crataegus* dominating the lower height class and *Crataegus* dominating the taller height class. Hickory (*Carya sp*) was the most abundant sapling species, comprising almost 25% of all saplings present at nests. Management for GWWA that focuses on creating habitat with horizontal and vertical structural diversity can be accomplished by encouraging establishment of plant species with different growth forms (e.g., *Crataegus* and *H. prolificum*).

The Elkins GWWA population has experienced precipitous declines during 2008-2012 (Fig. 1a), while the Marlinton population has remained relatively stable during 2009-2012 (Fig. 1b). Total numbers of BWWA and hybrid males and females increased at both areas. Preliminary analyses of vegetation data collected at fixed locations over the course of the study revealed that woody basal area has increased at both study areas, from 0.8 to 5.2 m^2/ha in Elkins and 0.6 to 3.4 m^2/ha in Marlinton. With the average basal area at GWWA nests being 4.5 m^2/ha, the habitat in Elkins may have passed a threshold beyond which BWWA begin to replace GWWA. Grass cover also increased consistently (73-93%) at the Marlinton study area. Other variables (e.g., climatic) may be contributing to observed trends since many of the vegetative characteristics we measured (e.g., vegetation cover and density) remained relatively stable during the study.

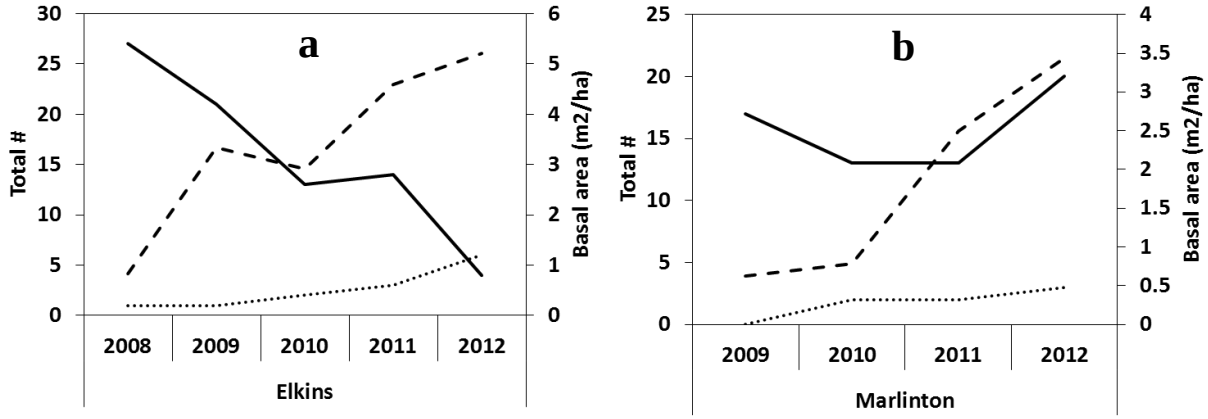
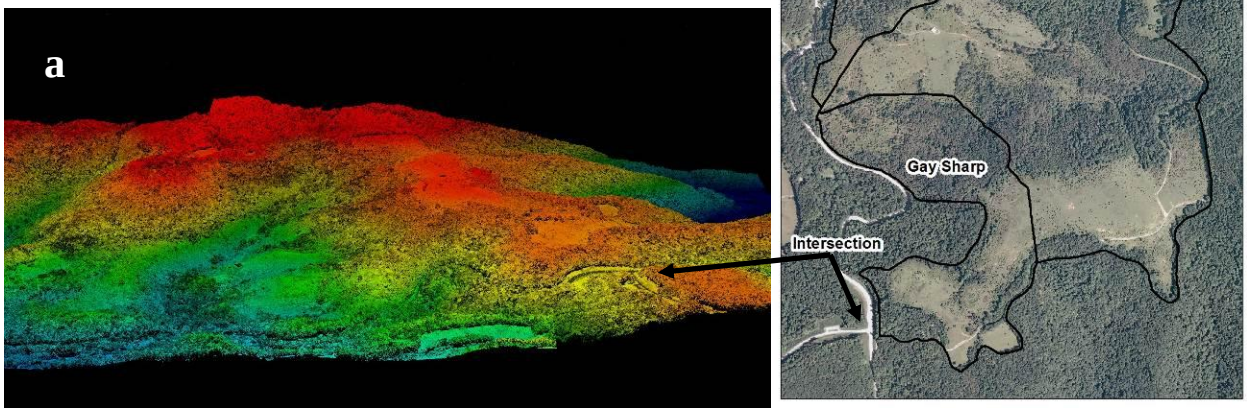


Figure 1. Population trends of territorial GWWA males (solid line) and breeding BWWA and hybrid individuals (dotted line) at the Elkins (a) and Marlinton (b) study areas. Basal area of trees (dashed line) increased at both study areas.

LIDAR (**Li**ght **D**etection **a**nd **R**anging) data were collected during June 2012 and will help to answer questions about GWWA habitat use at multiple spatial scales. The Hoover and Gay Sharp range allotments in Pocahontas County were selected because of the high density of GWWA and large area (Fig. 3). There have been no published studies using LIDAR data to describe GWWA habitat even though such data provide a detailed look at highly sought after metrics not practically obtained in the field (e.g., vertical and horizontal vegetation structure).

Figure 3. Subset of LIDAR data (a) showing the Hoover and Gay Sharp range allotments from the west. Warmer colors indicate higher elevations. The 2009 aerial photo (b) shows the same area with the US219 and WV150 intersection for reference.



Return rates for adult males and females one year after banding was consistently around 50%. However, only 29% of males banded in 2011 returned in 2012. Of 18 adults banded at the beginning of the project in 2008, only a single female was detected in 2012 on the Forinash site where she originally was banded. Aged as a second-year female in 2008, she was 5 years old during the 2012 breeding season. A male aged as after second-year in 2008 occupied the same territory until 2011, making him 5+ years old. We have detected 13 GWWA and 1 BRWA returning as adults (9.6%) that were initially banded as nestlings (n=146). These data will provide important information on dispersal and survival of returning second-year individuals, a part of the GWWA life cycle that has had little or no documentation.

We conducted point counts at 130 locations between 20 May and 9 June 2012 and recorded a total of 3,656 individuals of 100 different species. GWWA, BWWA, and BRWA were detected at 26.9% (59 individuals), 1.5% (3 individuals), and 2.3% (3 individuals) of locations, respectively. Species most commonly occurring with GWWA were American Goldfinch (*Carduelis tristis*), Cedar Waxwing (*Bombycilla cedrorum*), Chestnut-sided Warbler (*Setophaga pensylvanica*), Eastern Towhee (*Pipilo erythrophthalmus*), Field Sparrow (*Spizella pusilla*), and Indigo Bunting (*Passerina cyanea*).

IMPACTS OF MOUNTAINTOP MINING ON TERRESTRIAL ECOSYSTEM INTEGRITY: IDENTIFYING LANDSCAPE THRESHOLDS FOR AVIAN SPECIES

Postdoctoral Research Associate: Doug Becker
Principal Investigators: Petra Bohall Wood and Michael Strager
Cooperator: Christine Mazzarella, U. S. Environmental Protection Agency
Years Ongoing: 2012-2013
Expected Completion: December 2013
Funding Sources: Environmental Protection Agency

Objective:
Identify avian community abundance landscape thresholds in response to changing landcover and landscape metrics from mountaintop mining.

Progress:

Largely missing from the environmental assessments of mountaintop mining are its effects on terrestrial resources. Environmental assessments discuss the numerous forest types found in the region, but do not articulate likely effects of mountaintop mining on the forest types themselves and do not rigorously quantify the effects of mountaintop mining on the numerous terrestrial species. The specific goal of our research is to identify how changes in landcover affect avian species abundance.

Using existing datasets, we conducted a preliminary *Threshold Indicator Taxa ANalysis* (*TITAN*) of bird populations in the mountaintop removal/valley fill region (MTRVF) of West Virginia. TITAN is a relatively novel approach to threshold analysis which has been used effectively in aquatic ecosystems. We found that thresholds in the amount of forest cover do exist beyond which bird populations can change (Fig. 1). Individual species' relative abundance thresholds followed expected patterns; many forest interior species (e.g. Magnolia Warbler, Golden-crowned Kinglet, Blue-headed Vireo and Hooded Warbler, among others) had negative responses to increasing forest edge density and declines in mature forest. In contrast, many interior edge and early successional species responded positively (e.g. Orchard Oriole), but thresholds occurred over a wider range of values. However, due to limitations of the available data, the thresholds generated were not precise. More broadly sampled metrics representative of the complete natural range of available habitats on the landscape are necessary for the best results. Therefore, we initiated a study to identify precise thresholds in the amount of mature forest and mining habitat that could be used to inform assessments for mountaintop mining.

Hooded Warbler female

Orchard Oriole

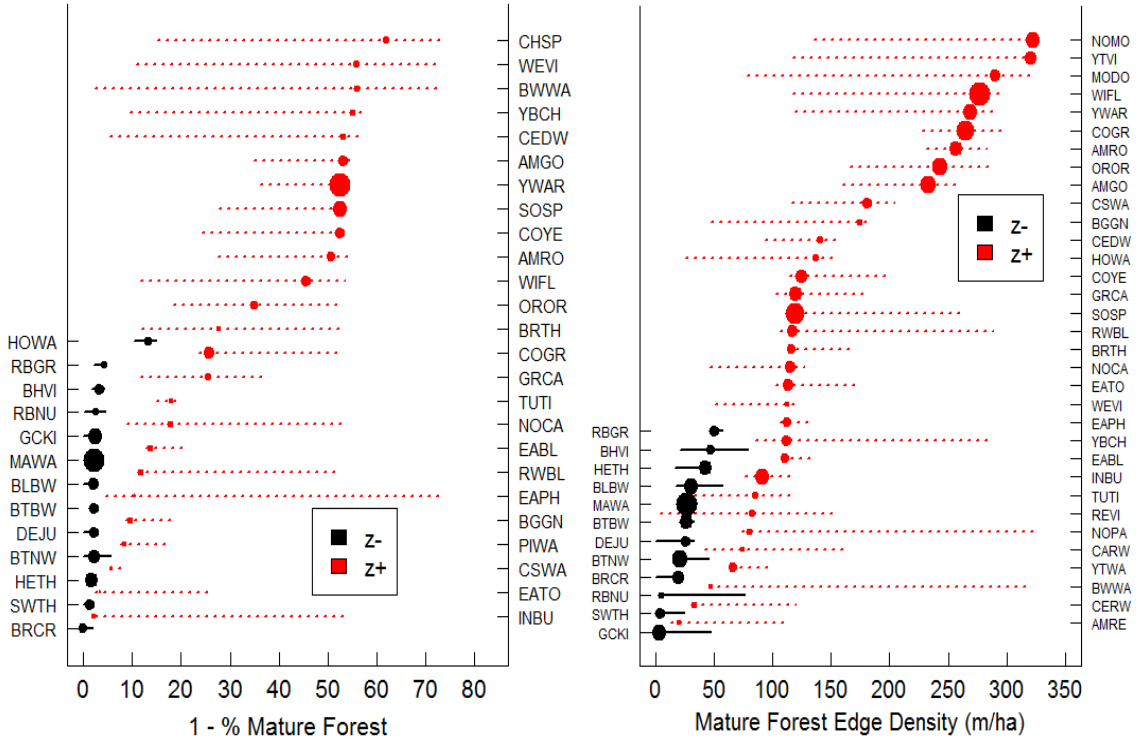


Fig. 1. Preliminary TITAN output indicating relative abundance thresholds and 95% confidence intervals for significant avian species for 1- percent mature forest and mature forest edge density. Z+ species had a positive response to exceeding their threshold, while Z- species had a negative response. Species with larger circles are more significant.

Our study area is the MTRVF region in southwestern West Virginia and northeastern Kentucky. In May-July 2012, we conducted 353 point count surveys in West Virginia (Fig. 2) using standard avian sampling protocols. Specific mines sampled were chosen to maximize the geographic distribution within this region given limitations with access to some locations and to maximize sampling of internal forest patches within the greater mineland matrix (Fig. 3) allowing us to sample the full range of percent mature forest cover available in the landscape. In the 2013 breeding season, we will sample additional points at different mines in West Virginia and expand into northeastern Kentucky

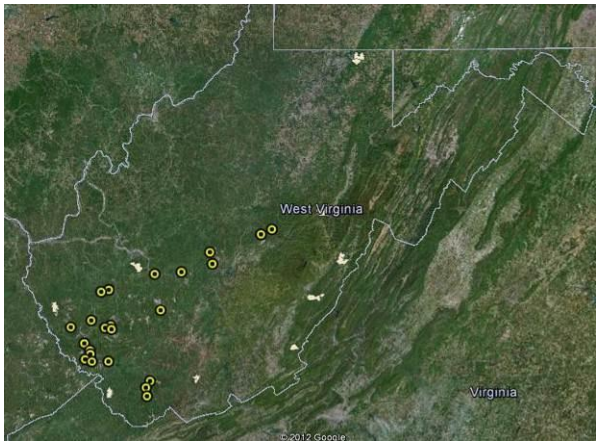


Fig. 2. Locations of mines sampled in May-July 2012.

Fig. 3. Internal forest patch within reclaimed mineland.

The avian count data collected in 2012 and 2013 will be combined with the data used in the preliminary analysis. This larger and more comprehensive dataset will be analyzed with *TITAN* threshold analysis. We will examine positive and negative habitat thresholds for individual species as well as the overall avian community in response to landscape habitat metrics derived using feature extraction in ArcMap. The landcover around each point will be classified into five groups (mature forest, mining barren, mining shrub/grass, other barren, other grass/shrub). We will calculate nine metrics [forest edge density, % core mature forest (>50m from an edge), % mature forest, % mining, % total barren, % total grassland and shrubland, distance to closest mine edge, aspect, and landform position (ridgetop, slope, bottom)] within a 1-km radius of each count location and determine avian thresholds for each metric separately. We will use a random forest modeling technique to test the relative importance of each of these variables.

IMPACT OF MARCELLUS SHALE DEVELOPMENT ON SHRUBLAND SONGBIRD NEST SUCCESS AND ABUNDANCE

Student Investigator: Ryan Davis
Principal Investigator: Petra Bohall Wood
Cooperators: Rick Hammack, Harry Edenborn
Years Ongoing: 2012-Present
Degree Program: M.S.
Expected Completion: May 2015
Funding Sources: U.S. Department of Energy

Objectives:

1) Quantify avian abundance, community composition, and nest success rates on shrubland sites before and after development of a Marcellus shale gas well.
2) Gather data on luminance and ambient noise levels before, during, and after development.
3) Determine if changes in avian abundance, community composition, and nest success occurred after development of the Marcellus Shale well.
4) Examine the relationship of these changes to the accompanying changes in luminance, ambient noise levels, and vegetative composition.

Progress:

Extraction of gas from the Marcellus shale formation has increased dramatically in recent years due to technological advancements, namely hydraulic fracturing ("fracking"), that enable companies to reach these previously untapped deposits. These new techniques leave a much larger footprint than conventional oil and gas infrastructure does, and there is growing concern over the potential environmental impacts of hydraulic fracturing methods. Avian concerns mostly relate to habitat fragmentation and loss due to the large area of land that is converted from forest to well pads, gas lines, and roads. There has been an upswing in research being conducted on the various impacts of Marcellus shale gas extraction and development commensurate with growing implementation of the practice, but most examines the changes in avian communities on forested landscapes. We will be assessing the local-scale impacts of development in an already highly-fragmented landscape context to fill the gap in research.

Shrubland songbirds are a highly imperiled guild across much of North America due to reductions in forest disturbance and thus rapidly-diminishing habitat. We will accordingly focus on this suite of species, quantifying abundance, community composition, and nest success because they are important indices to avian community health. Changes in avian metrics on the study area in years following well

development will suggest that Marcellus development in early-successional habitats may threaten shrubland songbird communities in already-fragmented landscapes. If impacts are not detected, it may be the case that development should occur on these highly-impacted areas rather than on forested landscapes where drilling has been suggested to be more detrimental.

Our study areas are located in southwestern Pennsylvania and include a site where Marcellus well development will occur and a reference site. Both areas include patches of shrubland habitat. During 2012 breeding season, pre-development data were gathered; avian abundance, community composition, and nest success were quantified at both sites. Baseline luminance and noise levels also were recorded and vegetation composition and structure were sampled. All sampling will be repeated in subsequent years during and after development of the well.
We used 10-minute unfixed-radius point counts to measure avian abundance and composition. In subsequent analyses, we will account for detection probability using distance estimations and a time-removal method. There are 8 shrubland points at the well site, 7 at the reference site, and 3 forested points at each. Each point was sampled 3 times. For initial data summaries, we excluded flyovers and detections greater than 70 meters from the observer. At shrubland points, this resulted in 1042 total detections of 55 unique species, 792 detections at the well site (of 49 unique species) and 250 at the reference site (48 unique species). Mean number of detections (17.3/point) and species (18.5/point) at the well site were slightly higher than at the reference site (15.8 detections and 15.9 species).

Figure 1. Focal species from left: Field Sparrow, Eastern Towhee (male), Blue-winged Warbler (male).

Nests were found and monitored for 3 focal species: Field Sparrow (*Spizella pusilla),* Eastern Towhee (*Pipilo erythrophthalmus*), and Blue-winged Warbler (*Vermivora cyanoptera*) (Figure 1). Nest success rates were calculated initially with the Mayfield method and will be analyzed further using logistic-exposure models. Of 118 nests found , 67 were at the well site and 51 at the reference site. Our nest success rates (Table 3) are similar to those reported in the literature.

Table 3. Nest success results for each site and species. Success rate is the unadjusted ratio of nests that fledged. Probability of Survival is calculated with the Mayfield method which accounts for observation days. BWWA = Blue-winged Warbler, EATO = Eastern Towhee, FISP = Field Sparrow, MTS = well site, HSP = reference site.

	Nests Found	Number Failed	Success Rate	Probability of Survival
BWWA total	8	4	.5	.43
BWWA MTS	5	3	.4	.34
BWWA HSP	3	1	.67	.21
EATO total	19	16	.15	.07
EATO MTS	14	13	.07	.06
EATO HSP	5	3	.4	.11
FISP total	91	69	.24	.15
FISP MTS	48	42	.13	.10
FISP HSP	43	27	.37	.21

SONGBIRD POPULATION RESPONSE TO GAS WELL DEVELOPMENT IN THE CENTRAL APPALACHIANS

Student Investigators: James Sheehan, Doug Becker, Jeremy Mizel
Principal Investigator: Petra Bohall Wood
Cooperator: Harry Edenborn
Years Ongoing: 2008-2012
Expected Completion: December 2012
Funding Source: U. S. Department of Energy

Objectives:

1. Determine how oil and gas activities influence distribution and relative abundance of songbirds.
2. Determine how oil and gas activities influence Louisiana Waterthrush territory density, nesting success, and site fidelity.
3. Develop spatially explicit habitat models to aid land managers in mitigating habitat disturbance from oil and gas activities.

Progress:

West Virginia is known for its extensive tracts of mature hardwood forest and high diversity of flora and fauna. Oil and gas (O&G) exploration and development activities in West Virginia are increasing, particularly for Marcellus shale gas (Fig. 1). O&G activities can impact wildlife populations by changing habitat structure and through effects of noise and human presence. This project is quantifying effects of habitat impacts, both positive and negative, on avian populations and linking these effects with land cover changes to develop spatially explicit habitat models that will aid land managers in mitigating these disturbances.

We established 144 point count locations throughout the ~3,416 ha study area in northwestern West Virginia in both ridgetop and riparian habitat. Points were surveyed during the 2008-2012 breeding seasons to determine abundance, diversity, and distribution of songbirds. Point counts sampled areas with current Marcellus activity, areas with past O&G activity, and mature forest reference areas. Analyses of 2008-2011 data found differences in species relative abundances and distribution attributable to changes in habitat from O&G activity.

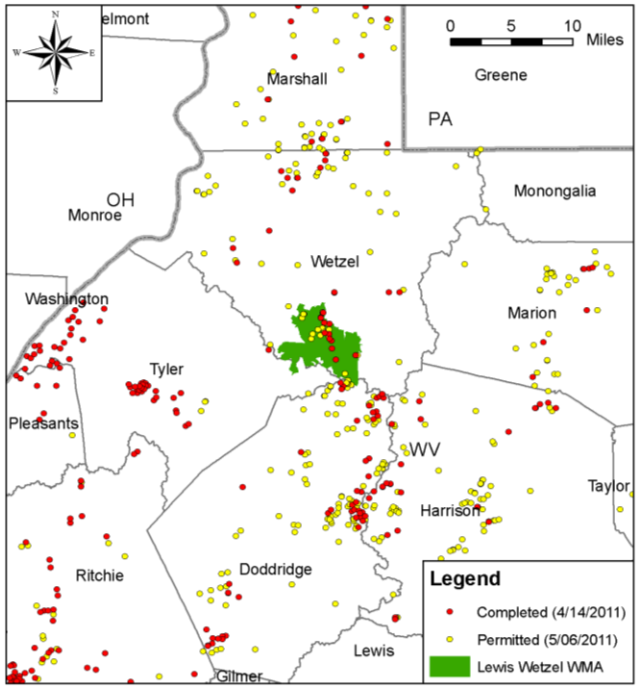


Fig. 1. Permitted and completed Marcellus gas wells (as of April-May 2011) in the study area and surrounding region (obtained from the West Virginia Geological and Economic Survey http://www.wvgs.wvnet.edu/).

Relative abundance of species such as Indigo Bunting (Fig. 2) that favor edge habitat increased likely due to vegetation development along new O&G-related impacts. However, the mature forest-associated Worm-eating Warbler declined in overall abundance and their distribution shifted away from impacted areas (Fig. 3). Brown-headed cowbirds, a nest parasite, increased in occurrence particularly along new O&G impacts. As O&G activities continue on the study area, including new Marcellus well pad construction and associated infrastructure (access roads and pipelines), we expect the avian community to continue to shift.

Fig. 2. Male Indigo Bunting.

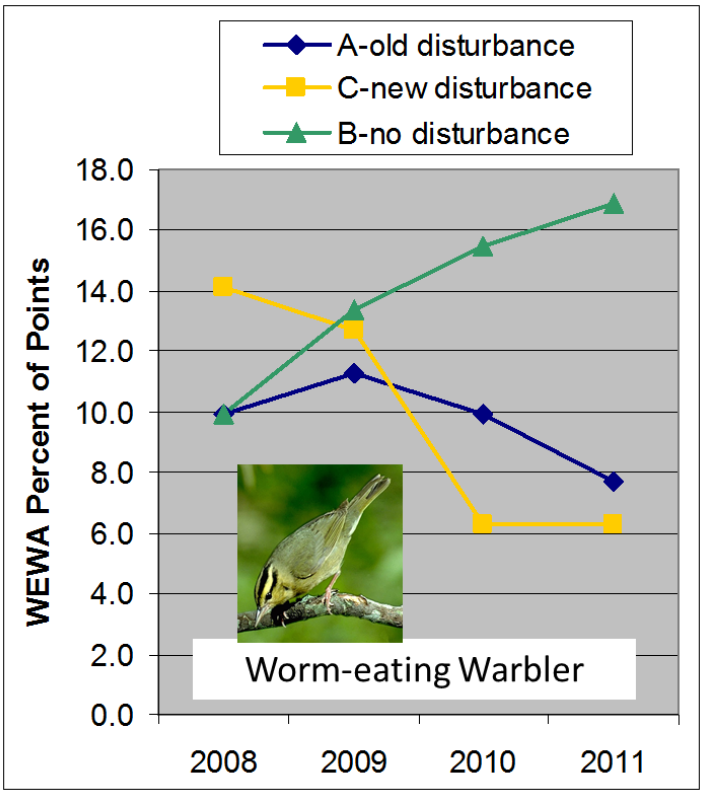


Fig. 3. Worm-eating warbler occurrence.

Fig. 4. Louisiana Waterthrush incubating.

To study the effects of O&G activities on the stream-dependent Louisiana Waterthrush (Fig. 4) in 2009-2011, we searched approximately 44 km of 1st and 2nd -order tributary streams for nests to quantify nesting success, used territory mapping to determine territory density, and used mark/resighting to quantify return rates.

Study streams had a mean of 21.7% (± 3.0 SE) of their length impacted by gas development (range 0-46.2 %). Waterthrush territory density was not related to the percentage of stream length impacted by gas development ($\chi^2 = 0.023$, df = 1, $p = 0.88$). Mean territory density was 1.4 (range 0.9-1.8) territories/stream km. Adult return rates were 57% in 2010 and 63% in 2011. All adults were resighted on the same stream they were initially banded and 22 of 25 (88%) were detected within 250 m of their territory center from the previous year. High site fidelity in our study area could mask immediate impacts of O&G activities. Additionally, every stream had unimpacted stream segments and waterthrush in some cases shifted their territories and nests to unimpacted areas.

Overall nesting period survival for 126 nests was 0.440 (CI = 0.287, 0.581). Survival for nests located within impacted territories (0.422, CI = 0.249, 0.585) was similar to that of nests within unimpacted territories (0.453, CI = 0.286, 0.604). Clutch size was similar for nests located in impacted (mean=4.8, SE=0.16) and unimpacted (mean=4.6, SE=0.13) territories (n=92 nests; t=-1.31, *P*=0.19). Number of fledglings per nest attempt also was similar for nests located in impacted (mean=2.3, SE=0.33) and unimpacted (mean=2.7, SE=0.25) territories (n=122 nests; t=0.84, *P*=0.41). We likely observed no demographic differences because all territories contained unimpacted habitat.

Finally, we assessed stream and riparian habitat quality using the EPA Rapid Bioassessment protocol (EPA index) for high gradient streams and a Louisiana Waterthrush Habitat Suitability Index (HSI) at nest locations. The EPA index is based primarily on instream characteristics while the HSI focuses more on bank characteristics and surrounding riparian habitat. HSI scores (arcsine-transformed) were significantly lower for nests within impacted territories ($L = 24.38$, df = 1, $p < 0.0001$) (Table 1) as were EPA scores ($L = 9.11$, df = 1, $p = 0.003$). These differences suggest a reduction of nest site quality in nesting areas impacted by O&G activity.

USE OF A HIGH RESOLUTION SATELLITE IMAGE AND DIGITAL ELEVATION MODEL TO PREDICT THE RIDGE FOREST BIRD COMMUNITY, AND FACTORS LEADING TO SONGBIRD SPECIES DISTRIBUTION PATTERNS AND CERULEAN WARBLER CLUSTERING AT THE LEWIS WETZEL WILDLIFE MANAGEMENT AREA, WV

Student Investigator: Jim Sheehan.
Principal Investigator: Petra Bohall Wood
Cooperators: Harry Edenborn, Randy Dettmers, T. Bentley Wigley
Years Ongoing: 2010-Present
Degree Program: Ph.D.
Expected Completion: May 2013
Funding Sources: Department of Energy, U.S. Fish and Wildlife Service, National Fish and Wildlife Foundation

Objectives:

1. Determine if remote sensing information from a satellite image and a digital elevation model can successfully predict the avian community found on mature hardwood-forested ridges.
2. Use this remote sensing information along with field habitat data to study the distribution patterns of territories of ridgetop cerulean warblers, ovenbirds, and hooded warblers.
3. Investigate how territories of cerulean warblers cluster in relation to topography, forest structure and composition, and conspecific presence.

Progress:

The ridgetops of the heavily forested region of northwestern West Virginia harbor a rich avian community important to the native biodiversity of the Central Appalachians. These ridges also are the focus of much energy industry activity, particularly development of Marcellus Shale natural gas. The Marcellus well pads and associated infrastructure (access roads and pipelines), and other anthropogenic impacts such as development of the region's abundant conventional gas and oil resources, have the potential to affect a significant portion of the region's ridgetops and associated breeding bird species, including large populations of the sharply declining Cerulean Warbler.

Use of remote sensing information has proven useful for studying avian habitat relationships. One objective of this project is to examine predictive relationships between two high-resolution datasets, a leaf-on 2009 multispectral Quickbird satellite image and a 3-meter digital elevation model (DEM), and a 2010-11 ridgetop avian point count survey of the Lewis Wetzel Wildlife Management Area in Wetzel Co. WV. Continuous forest in the image (Figure 1) appears to reflect a structural gradient from smooth, unbroken canopy with an open understory to rough, broken canopy with abundant gaps and high structural diversity found in the field. These two forest structural types support different avian communities, and textural and spectral information obtained from the image will be used in conjunction with fine-scale topographic variables calculated from the DEM for the point count locations to analyze the avian data. If predictive relationships are found, this remote sensing information could be an important tool applied at broader spatial scales and in lieu of intensive field surveys for examining implications of energy industry activities on the ridge forest bird community.

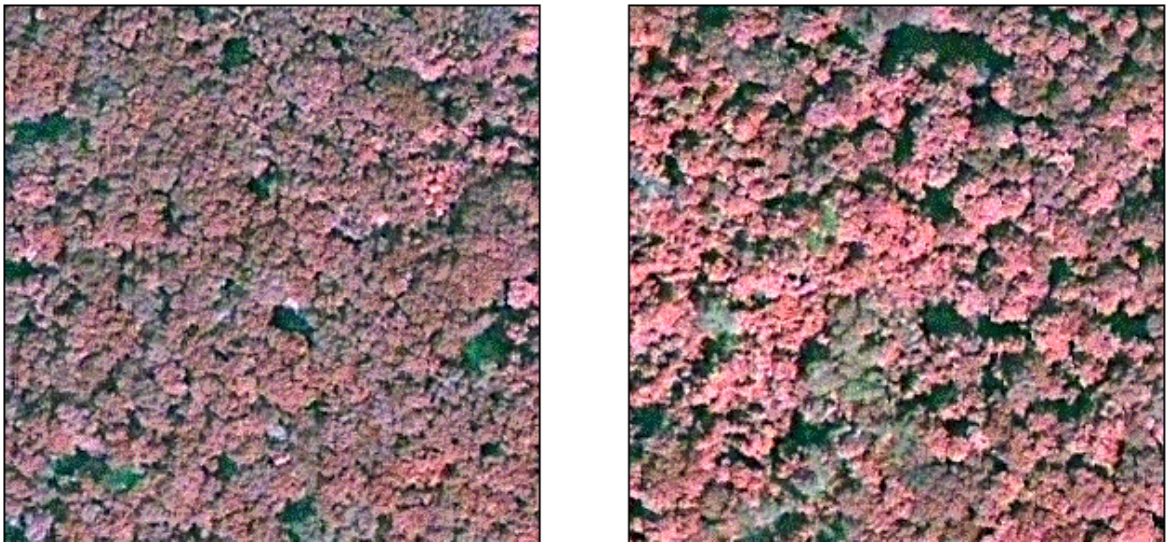


Figure 1. Two ridgetop forest canopy types: "smooth" unbroken canopy (left) and "rough" broken canopy (right).

The other two objectives of this project use the distribution patterns of three territorial songbirds, obtained from focal ridgetop transect surveys in 2010 and 2011. Ovenbirds, Hooded Warblers, and Cerulean Warblers are widespread and abundant at the site, and differ in the forest habitat components they require for breeding (Figure 2). Comparing and contrasting their distribution patterns will be used to examine potential underlying factors responsible for their occurrence. This analysis will use remote sensing information obtained for the ridge transects from the satellite image and the DEM, along with territory habitat information collected in the field. For the Cerulean Warbler, the final objective is to infer if habitat, sociality, or both, may be driving factors underlying where they occur, and in particular where they strongly cluster at the site. Understanding factors responsible for their observed distribution patterns could be particularly valuable in the management of this species of high conservation priority in the Central Appalachians.

Figure 2. Three focal ridgetop songbirds: the ground nesting Ovenbird (left), shrub nesting Hooded Warbler (center), and upper canopy nesting Cerulean Warbler (right).

DEVELOPMENT OF TIMBER HARVESTING MANAGEMENT GUIDELINES FOR CERULEAN WARBLERS

Principal Investigator: Petra Bohall Wood
Cooperators: Randy Dettmers, Ben Wigley, David Buehler, Pat Keyser, Jeff Larkin, Amanda Rodewald
Years Ongoing: 2012-2013
Expected Completion: May 2013
Funding Source: US Fish and Wildlife Service

Objective:
Develop timber harvesting management guidelines that will benefit Cerulean Warbler and associated species and that can be implemented throughout the Central Appalachian region.

Progress:
Our research group recently completed a 6-year study in the central Appalachian Region evaluating response of Cerulean Warblers and associated avian species to a variety of timber harvesting practices common in the region. Using results from this study, relevant literature, and input from cerulean experts and land managers, we are developing timber harvesting management guidelines that will benefit Cerulean Warblers and associated species and that can be implemented throughout the central Appalachian region.

The Management Guidelines document will include sections addressing the following topics:

1. Conservation status of the Cerulean Warbler
2. Cerulean Warbler habitat associations with landscape-scale forest cover and configuration, topography, and stand-level vegetation structure and composition
3. Results from the forest management research project with respect to responses of Cerulean Warbler and associated forest birds to different forest harvest treatments in terms of territory density, nest success, stand-level habitat selection, and short-term changes in the bird community.
4. Forest management recommendations including landscape-scale, stand-scale, and temporal considerations for the range of desired future forest conditions that would represent high quality habitat for Cerulean Warbler and associated forest birds.

These guidelines will be distributed to forest and wildlife managers throughout the Appalachian Region and will be a major component of the Appalachian Mountains Joint Venture Focal Area conservation strategies currently being developed.


Shelterwood harvest 4 yrs after harvesting – by Jim Sheehan male cerulean warbler – photo by Matthew Shumar

OTHER

IDENTIFICATION AND DELINEATION OF CONSERVATION AREAS IN SIX WEST VIRGINIA COUNTIES AND REFINEMENT AND CUSTOMIZATION OF A CONSERVATION AREA GIS TOOL TO ASSIST IN COUNTY LEVEL PLANNING: PHASE I AND II

Principle Investigator: Patricia M. Mazik
Co-Investigators: Mr. Michael Schwartz and Mr. Joseph Hankins, The Conservation Fund's Freshwater Institute
Years of Project: 2007 - 2013
Expected Completion: December 2013
Funding Source: West Virginia Division of Natural Resources

Project Summary:
The objective of this project is to advance the interests of WVDNR in conserving wildlife habitat at the county planning level in West Virginia. Accomplishing this objective will require The Conservation Fund (TCF) to create a prioritized conservation network comprised of core areas and corridors connecting these areas for the following landscape elements: forest, wetland, grassland, and aquatics. Creation of this network requires a substantial effort in terms of developing modeling approaches and the creation of the datasets necessary to support the project. Thus, WVDNR and TCF will work cooperatively to develop the data and methodologies necessary to produce the final product – Conservation Priority Areas.

Phase I:
Phase I of the project covered the three counties of the Eastern Panhandle and served as a proof of concept as to the modeling approaches to be used to identify Conservation Priority Areas across the state. The project scope was reduced from six to three counties due to the excessive resources required to revise the project scope and methodologies from what was originally intended. The original scope presumed the availability of data that was not present.

WVDNR and TCF worked together to refine species distribution modeling approaches and produced a matrix of species requirements for patch and connectivity modeling, along with subset of preliminary species distribution models for a select group of terrestrial Species in Greatest Need of Conservation (SGNC). The final output of this Phase was a raw non-prioritized conservation network consisting of forest, wetland, grassland, and aquatic core areas. Corridors connecting the core areas for forest, wetlands, and aquatic areas were developed as well. Other outcomes consisted of testing models for creating species habitat patches and corridors as well as the creation of disturbance layers to aid in the identification of undisturbed habitats.

Phase II:
This phase of the project will produce a prioritized conservation network for the entire state of West Virginia utilizing data and methods created during Phase I. The network will be comprised of core forest, wetland, grassland, and aquatic areas connected by corridors (excluding grassland). Network prioritization metrics will include elements for biodiversity, condition, and landscape context. The final prioritized network will be developed using the Overlay Analyst tool being developed by WVU.

To date TCF has updated a protected lands database for the state and identified preliminary forest and grassland core areas. Development of new tools to identify corridors and species habitat patches is ongoing in cooperation with Colorado State University. Identification of the remaining elements of the conservation network will be completed over the next year.

PUBLICATIONS, THESES, DISSERTATIONS, PRESENTATIONS, AND HONORS, AWARDS, AND APPOINTMENTS

SCIENTIFIC PUBLICATIONS

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Mizel, J. Dec 2011. Avian assemblages and red-eyed vireo nest survival within mineland forest. MS Thesis, West Virginia University, Morgantown.

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AWARDS

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