MINUTES

Coordinating Committee Meeting
Pennsylvania Cooperative Fish and Wildlife Research Unit

June 17, 2014

9:30 AM

Held in Room 217 of the Forest Resources Building

Coordinating Committee attendees:

- Michael W. Tome, Supervisor, U.S. Geological Survey
- Calvin W. DuBrock, Director, Bureau of Wildlife Management, Pennsylvania Game Commission
- Leroy Young, Director, Bureau of Fisheries, Pennsylvania Fish & Boat Commission
- John Arway, Executive Director, Pennsylvania Fish & Boat Commission
- Michael G. Messina, Head, Department of Ecosystem Science and Management, PSU

1. Approval of minutes from July 24, 2013 meeting (approved)

2. Completed Projects (Summaries in Appendix A; yellow pages)

2.1. Diefenbach and Wagner
- 2.1.1. Setting objectives for managing Key deer

2.2. Wagner
- 2.2.1. Managing the nation's fish habitat in a changing climate
- 2.2.2. Seasonal movement patterns and habitat use of brook trout Salvelinus fontinalis and brown trout Salmo trutta in north central Pennsylvania

2.3. Walter
- 2.3.1. Linking bovine tuberculosis on cattle farms in Michigan to environmental variables using Hierarchical Bayesian analysis

3. New & Continuing Projects (*Requires approval by Committee; See Appendix B)

3.1. Diefenbach
- 3.1.1. Influences on the timing of denning in female black bears and its effect on harvest rates and estimates of population size.
- 3.1.2. Dispersal of black bears in Pennsylvania
- 3.1.3. Dispersal of female white-tailed deer in Pennsylvania
- 3.1.4. Harvest and survival rates of hen wild turkeys in Pennsylvania
- 3.1.5. Genetics of an insular population of bobcats and coyotes
- 3.1.6. Developing an adaptive management approach for meeting deer and forest management objectives
- 3.1.7. Allegheny Woodrat: identifying strategies to conserve a declining species
- 3.1.8. Using North American Breeding Bird Survey data to evaluate potential consequences of energy development and other land use changes on bird populations in the northeast Appalachian region

3.1.9. Deer abundance and its relationship to factors that affect forest vegetation conditions
3.1.10. Fall harvest and annual survival rates of female eastern wild turkeys in New York
3.1.11. Snowshoe hare habitat relationships in response to northern forest management in Pennsylvania – Diefenbach

3.2. <u>Wagner</u>
3.2.1. Seasonal movement patterns and habitat use of brook trout and brown trout in north central Pennsylvania
3.2.2. Habitat use, movement and genetic composition of lake trout in the Niagara River and Niagara Bar
3.2.3. Managing the nations fish habitat at multiple spatial scales in a rapidly changing climate
3.2.4. Fish community assessment in the Eastern Rivers and Mountains Network and integration with existing monitoring data
3.2.5. Modeling species response to environmental change: development of integrated, scalable Bayesian models of population persistence
3.2.6. Characterization of spatial and temporal variability in fishes in response to climate change
3.2.7. A decision support mapper for conserving stream fish habitats of the NE CSC region
3.2.8. Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania
3.2.9. Transboundary management and conservation: linking large-scale dynamics to ecological monitoring and management

3.3. <u>Walter</u>
3.3.1. Developing an Adaptive Management Approach for Potential Surveillance and Spread of Chronic Wasting Disease in White-tailed Deer in Pennsylvania
3.3.2. Surveillance and monitoring of river otter populations in Pennsylvania
3.3.3. Spatial analysis of large mammals to assess harvest vulnerability in relation to landowner distribution
3.3.4. *Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
3.3.5. *Characterization of habitat for pheasant in wild pheasant recovery areas of Pennsylvania
3.3.6. *Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife

4. Proposed Projects – to be presented at meeting

4.1. Assessing gene flow and relatedness of white-tailed deer from surveillance samples to understand potential for spread of chronic wasting disease in the northeast – Walter
4.2. Trout Ecology in Pine Creek, PA – Wagner
4.3. Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife - Walter

5. **Proposed Budget – (provided separately)**

The budget was accepted but PFBC noted that due to budget problems they may not be able to support the Unit with base funds for FY2014-2015. They have a budget shortfall and are exploring various options regarding how to support the Unit.

6. Approval of New (noted by asterisk) and Proposed Projects

The following projects were approved and signed by the Coordinating Committee:

- Trout Ecology in Pine Creek, PA
- Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
- Characterization of habitat for pheasant in wild pheasant recovery areas of Pennsylvania
- Assessing gene flow and relatedness of white-tailed deer from surveillance samples to understand potential for spread of chronic wasting disease in the northeast
- Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife

7. Roster of Current Graduate Students and Post-Doctoral Researchers

7.1. Diefenbach

7.1.1. Danielle Begley – PhD Wildlife
7.1.2. Wendy Vreeland – MS Wildlife
7.1.3. Clayton Lutz – MS Wildlife
7.1.4. Laura Gigliotti, MS Wildlife
7.1.5. Ethan Kibe, MS Wildlife
7.1.6. Jason Hill – Post-doctoral research scientist
7.1.7. Glenn Stauffer – Post-doctoral research scientist

7.2. Wagner

7.2.1. Tyrell Deweber – PhD Fisheries
7.2.2. Megan Kepler – PhD Ecology
7.2.3. Evan Faulk – MS Fisheries
7.2.4. Kelley Salvesen – MS Fisheries
7.2.5. Lori Smith – MS Fisheries
7.2.6. Steve Midway – Post-doctoral research scientist

7.3. Walter

7.3.1. Tyler Evans - MS Wildlife
7.3.2. Nick Forman - MS Wildlife
7.3.3. Charles Crawford - MS Wildlife

8. Service on Graduate Committees (other than advisees)

8.1. Diefenbach

8.1.1. E. Barton, MS Wildlife and Fisheries Science
8.1.2. C. Crawford, MS Wildlife and Fisheries Science
8.1.3. T. Evans, MS Wildlife and Fisheries Science
8.1.4. D. Munoz, MS Wildlife and Fisheries Science
8.1.5. J. Sklebo, MS Wildlife and Fisheries Science

8.2. Wagner

8.2.1. Jeff Kirby, PhD Ecology
8.2.2. Emi Fergus, PhD Fisheries and Wildlife (Michigan State University)
8.2.3. Richard Alexander, PhD Forestry
8.2.4. Didem Ikis, PhD Ecology
8.2.5. Krittika Petprakob, PhD Ecology
8.2.6. Brooks Fost, PhD Wildlife and Fisheries
8.2.7. Courtney Davis, MS Fisheries and Wildlife
8.2.8. Brenden Reed, MS Forestry

8.3. Walter

8.3.1. Tyrell Deweber – PhD Fisheries
8.3.2. Nathan Fronk, MS Wildlife
8.3.3. Lori Smith, MS Fisheries

9. Courses and Workshops Taught by Unit Staff

9.1. Diefenbach

9.1.1. WFS 596 Independent Study - Methods of Estimating Population Parameters
9.1.2. Advances in Ecology, fall 2013
9.1.3. Occupancy Modeling Workshop, 14 March 2014

9.2. Wagner

9.2.1. Independent Study: Occupancy modeling, spring 2013
9.2.2. Structured Decision Making and Adaptive Management of Natural Resources, fall 2012 (with Duane Diefenbach)
9.2.3. Advances in Ecology, fall 2013
9.2.4. Quantitative Methods in ecology, spring 2014

9.3. Walter

9.3.1. Applied Spatial Ecology, spring 2013
9.3.2. Applied Spatial Ecology Workshop, 24-25 September 2013

10. Comments from Cooperators

- **Michael Messina –** The department is now 2 years old and integration is still ongoing but going well. Recently, the department has been working on formalizing procedures with respect to graduate student application, acceptance, and evaluation procedures. Undergraduate enrollment is currently about 50 Forestry and 150 Wildlife and Fisheries Science students. The graduate program has about 28 Forestry, 20 Soils, and 35 WFS students. Dr. Michael Sheriff is the newest faculty (mammalogist) and Julian Avery is an instructor in WFS. In the past year, two searches for a new dean for the College of Agricultural Sciences failed to identify an acceptable candidate. A third search is near completion and is likely to be successful in hiring a dean.

- **Calvin DuBrock –** I am retiring August 1st of this year. I have seen the relationship between the Unit and the PGC improve over time with greater collaboration. Also, Cal Butchkoski retired in April (Greg Turner appointed to his position). Jeremy Banfield hired as new elk biologist and Justin Brown as veterinarian. Matt Hough, executive director, has indicated he will retire in January 2015. Rich Palmer recently hired as deputy executive director of operations and the deputy executive director for staff functions is being filled. Job classification specs are being revised for the wildlife biologist positions.

Base funding for the Unit is available for FY2014-2015 and discussions have been initiated to increase base funding for the 2015 fiscal year.

Management plans continue to drive research needs and the Board of Commissioners are particularly interested quail restoration, instituting an otter trapping season, and expanded bear archery seasons.

Hunting license sales seem to have stabilized and Pittman-Robertson funding and mineral royalties have greatly supplemented the agency budget.

There continues to be much skepticism regarding deer management and this may be an issue for the Deer-Forest Study as well as the direction of deer densities. Chronic wasting disease is costing the agency about $750,000 per year. We anticipate collecting and testing about 6,000 samples during the 2014-15 hunting seasons, which will push our total testing over 50,000 samples since surveillance began in the late 1990s

Other news includes**:** Eurasian collared doves have been classified as game species because of their similarity to mourning doves; white-nosed syndrome is still a problem; the Northeast Wildlife Damage Cooperative recently completed a survey about public attitudes toward wildlife problems; the PGC just initiated GoHuntPA to recruit/maintain hunters since 25% of PA residents identify themselves as hunters but <10% buy a license annually.

- **John Arway –** The agency has a $9 million shortfall for a $52 million budget. Currently, the agency has had their complement reduced from 432 to 370 employees. The PFBC is looking for non-traditional sources of support for the Unit as well as the agency, including revenue from PA sales tax and a tax on water consumption. License sales have remained relatively stable the past few years.

- **Leroy Young –** The agency is working on a new strategic plan. Also there are plans to write a black bass management plan and a revised trout management plan. In addition, walleye, muskellunge, catfish, and waterways plans are expected to be developed. The agency would also like to develop a classification system for warmwater fisheries.

  The Susquehanna River impairment status is still an ongoing issue. The agency is looking at a viral disease and rusty crayfish as potential factors affecting bass. Rusty crayfish have been banned as live bait.

  The agency is looking at changes to PNDI to address issues raised with H.B. 1576. The timber rattlesnake is being considered for state delisting.

  Marcellus permitting has provided about $1 million/yr for trout water assessment**.** The agency is looking at having volunteers assess streams.

Asian carp are getting closer to Pennsylvania. Bg Head catfish have been detected as close as 40 miles from Pennsylvania but established populations are about 400 miles away.

- **Michael Tome –** When Congress allowed sequestration to occur it has had huge impacts on the agency. Two years ago the Cooperative Research Units were within 5 positions of being fully staffed but currently there are 15 vacancies and only critical positions are being filled. Travel restrictions are acute and discretionary funding to Units is now zero. There is a hiring freeze and the agency is not expecting a budget from Congress this year.

  The Chief of CRU has been filled and an announcement is expected soon. The Deputy Chief, Jim Fleming, has retired and expect the position to be advertised soon.

  On the whole the CRU program is productive and strong because of its support from cooperators. The National Cooperators Coalition has Ken Williams (former Chief of CRU) on its board and expecting to see more activity from NCC.

11. Comments from Guests

No comments

12. Adjourn

13. An Executive Session of the Coordinating Committee followed immediately after adjournment

Appendix A – Abstracts of Completed Projects (yellow pages)

Appendix B – Summaries of New and Continuing Projects (blue pages)

Appendix C – Awards, Publications, and Presentations (green pages)

APPENDIX A - Completed Projects

2.1.1 Setting objectives for managing Key deer Duane R. Diefenbach, Tyler Wagner, and Glenn E. Stauffer. Funding provided by U.S. Fish and Wildlife Service.

The U.S. Fish and Wildlife Service (FWS) is responsible for the protection and management of Key deer (*Odocoileus virginianus clavium*) because the species is listed as Endangered under the Endangered Species Act (ESA). The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. There are a host of actions that could possibly be undertaken to recover the Key deer population, but without a clearly defined problem and stated objectives it can be difficult to compare and evaluate alternative actions. In addition, management goals and the acceptability of alternative management actions are inherently linked to stakeholders, who should be engaged throughout the process of developing a decision framework. The purpose of this project was to engage a representative group of stakeholders to develop a problem statement that captured the management problem the FWS must address with Key deer and identify objectives that, if met, would help solve the problem. In addition, the objectives were organized in a hierarchical manner (i.e., an objectives network) to show how they are linked, and measurable attributes were identified for each objective. We organized a group of people who represented stakeholders interested in and potentially affected by the management of Key deer. These stakeholders included individuals who represented local, state, and federal governments, non-governmental organizations, the general public, and local businesses. This stakeholder group met five full days over the course of an eight-week period to identify objectives that would address the following problem:

> *"As recovery and removal from the Endangered Species list is the purpose of the Endangered Species Act, the U.S. Fish and Wildlife Service needs a management approach that will ensure a sustainable, viable, and healthy Key deer population. Urbanization has affected the behavior and population dynamics of the Key deer and the amount and characteristics of available habitat. The identified management approach must balance relevant social and economic concerns, Federal (e.g., Endangered Species Act, Wilderness Act, Refuge Act) and state regulations, and the conservation of biodiversity (e.g., Endangered/Threatened species, native habitat) in the Lower Keys."*

The stakeholder group identified four fundamental objectives that are essential to addressing the problem: 1) Maximize a sustainable, viable, and healthy Key deer population, 2) Maximize value of Key deer to the People, 3) Minimize deer-related negative impacts to biodiversity, and 4) Minimize costs. In addition, the group identified 25 additional objectives that, if met, would help meet the fundamental objectives. The objectives network and measurable attributes identified by the stakeholder group can be used in the future to develop and evaluate potential management alternatives.

2.2.1 Managing the nation's fish habitat in a changing climate Tyler Wagner and Tyrell DeWeber. Funding provided by USGS, National Climate Change & Wildlife Science Center.

Brook Trout is a socially, economically and ecologically important species throughout its native range in the eastern United States (hereafter referred to as the eastern U.S.). Brook Trout have narrow habitat requirements and have already been extirpated or negatively affected throughout much of the eastern U.S. as a result of human activities and related environmental changes. These historic losses have led to an increasing interest in Brook Trout conservation and concerns over how future climate and land use changes might alter habitats and result in further losses. Increasing air temperatures resulting from climate change are expected to result in widespread losses of cold water (< ~21°C mean July water temperature) habitat in rivers and streams. Since Brook Trout are physiologically dependent upon cold water, warming is very likely result in reduced and extirpated populations throughout much of the eastern U.S. Historic and contemporary land use change has been one of the major historic drivers resulting in losses of Brook Trout populations through habitat alterations. Land use change, especially urban development, is continuing at a rapid pace in many parts of the eastern U.S. and will likely result in localized losses of Brook Trout populations where such changes occur in the future. Given the potential for climate and land use change to negatively affect Brook Trout populations, identifying potential effects for individual reaches can benefit conservation by identifying sensitive, vulnerable, and resilient river reaches. In this dissertation, I use publicly available data to identify the potential effects of projected climate and land use change on river water temperature and Brook Trout populations in individual stream reaches throughout the eastern U.S.

In Chapter 1, I quantitatively assessed the representativeness of stream flow and water temperature data from United States Geological Survey (USGS) gages throughout subregions of the conterminous United States, including the eastern U.S. This analysis was beneficial because prior to predicting attributes of almost 200,000 stream reaches in the eastern U.S., it was important to know how well available sampling data from a limited number of sites characterized the greater population of streams. I identified substantial biases for seven landscape attributes in one or more regions across the conterminous United States. Streams with small watersheds (< 10 km2) and at high elevations were most often underrepresented, and biases were greater for water temperature gages and in arid regions throughout the conterminous United States. Similar landscape bias was evident in the eastern U.S., but I demonstrated how including water temperature data from additional sources resulted in a dataset that represented the population of stream reaches well. Although I did not use the same methods, I also determined the degree to which sampling data represented the larger population of stream reaches in Chapters 2 and 3.

River water temperature is one of the most important determinants of habitat quality for Brook Trout and is likely to be altered by climate and land use change. In Chapter 2, I developed a model to predict river water temperatures under current conditions and future scenarios of climate and land use change. The final model included air temperature, landform attributes and forested land cover and predicted mean daily water temperatures with good accuracy (root mean squared error ~ 1.9 °C) for training and validation datasets. Predictions also matched expected spatial and temporal trends with cooler temperatures in headwaters, at higher elevations and latitudes, and in April and October. The model can be used to reasonably estimate thermal characteristics of stream reaches throughout the eastern U.S. to support ecosystem and resource management broadly. I demonstrate in Chapters 3 and 4 how predicted water temperatures from the model can be used to predict Brook Trout occurrence under current conditions and future scenarios of climate and land use change.

In Chapter 3, I develop a species distribution model to predict Brook Trout occurrence probability based on water temperature characteristics predicted by the model described in Chapter 2 and landscape characteristics. I used a hierarchical logistic regression model that performed well at both training and validation datasets (area under the receiver operating curve ~ 0.78). Predicted water temperature had a strong negative effect on Brook Trout occurrence probability that did not vary throughout the region. The effects of agriculture and developed land covers were weakly negative, but an interaction suggested that agricultural land cover resulted in an increased sensitivity to water temperature. The effect of soil permeability was positive, but decreased as EDU mean soil permeability increased. The model provides a further understanding of how Brook Trout are shaped by habitat characteristics in the region and is the first to provide maps of stream reach-scale predictions, which can be used to support ongoing conservation and management efforts.

In Chapter 4, I used the models developed in Chapters 2 and 3 to identify potential changes in thermal habitat and Brook Trout occurrence probability resulting from projected climate and land use change. The timing, magnitude and location of predicted changes in maximum 30 day mean river water temperature varied greatly among three downscaled climate models, with average increases by 2087 ranging from 1.21 to 2.55 °C. As a result of warming, occurrence probability was predicted to be greatly reduced throughout the region, and between 56,440 (42.7%) and 109,237 (82.6%) of potential Brook Trout habitat was predicted to be lost. Land use change was predicted to result in localized increases in river water temperature and losses of 5,976 (4.5%) stream reaches with potential Brook Trout habitat. Given the magnitude of predicted losses, conservation actions will likely be more successful in the long term if the potential changes resulting from climate and land use change are incorporated into the planning process. My dissertation provides information to support this planning process by providing a suite of decision support tools that can be used to help understand potential changes for individual stream reaches, a scale at which many conservation activities are likely to be relevant.

2.2.2 Seasonal movement patterns and habitat use of brook trout *Salvelinus fontinalis* and brown trout *Salmo trutta* in north central Pennsylvania Tyler Wagner and Lori Smith. Funding provided by PA Fish & Boat Commission.

The eastern Brook Trout Salvelinus fontinalis faces a variety of threats largely due to anthropogenic alterations to the landscape and climate change. However, one threat that has implications for Brook Trout population management is the introduction of non-native Brown Trout Salmo trutta, as potential negative impacts of Brown Trout on Brook Trout populations have been documented. For resource management agencies, understanding the temporal and spatial movement patterns and habitat requirements of any species is essential for conserving existing populations and restoring habitats that once supported self-sustaining populations. I employed radio biotelemetry to quantify movement and habitat use of Brook Trout and Brown Trout from September 2012 through February 2013. I equipped 55 Brook Trout and 45 Brown Trout, distributed among five interconnected streams in North Central Pennsylvania, with radio-transmitters. To identify potential relationships between movement and covariates, I used generalized additive mixed models. Thalweg profiles of the streams were also surveyed to quantify available residual pool habitat and I used discrete choice models with random effects to evaluate Brook and Brown Trout habitat use. To corroborate observations in Brook Trout movement made through radio-tracking, Brook Trout fin clips were taken for microsatellite analysis.

Average total movement was greater for Brown Trout (2,924 ± 4,187 m) than for Brook Trout (1,769 ± 2,194 m). Maximum net movement was 10,317 m and 11,273 m completed by a Brook Trout and Brown Trout, respectively. Results indicated a large amount of among-fish variability in movement of both species with the majority of movement coinciding with the on-set of the spawning season and increases in stream flow. Microsatellite analysis revealed consistent findings to those in radio-tracking: indicating a moderate to high degree gene flow among study populations. There was an overall preference for pool versus non-pool habitats; however, habitat use of pools was non-linear over time. Brook Trout displayed a greater preference for deep (0.35-1.4 m deep) pool habitats over shallow (0.1-0.35 m deep) pool and non-pool habitats. Conversely, Brown Trout selected for all pool habitat categories similarly. Habitat use of both species was found to be scale dependent. At smaller spatial scales (50 m), habitat use was primarily related to time of year and fish size. However, at larger spatial scales (250 m and 450 m) habitat use varied over time according to the study stream a fish was located. Maximum water depth, length of cover and average water velocity occupied was time-dependent, with Brook and Brown trout occupying shallower maximum water depth, smaller lengths of cover and greater water velocities through the spawning season. Brown Trout were also found to occupy greater maximum water depths and lengths of cover in comparison to Brook Trout. Variations in seasonal movement patterns and habitat use of Brook and Brown Trout highlight the importance for management agencies to consider a diversity of in-stream habitat features and stream connectivity when restoring and protecting habitats and populations of Brook Trout.

2.3.1 Linking bovine tuberculosis on cattle farms in Michigan to environmental variables using Hierarchical Bayesian analysis David Walter, Rick Smith, Michael VanderKlok, Kurt VerCauteren, Funding by the Michigan Department of Agriculture and the National Wildlife Research Center, USDA/APHIS/WS

Bovine tuberculosis is a bacterial disease caused by *Mycobacterium bovis* in livestock and wildlife with hosts that include Eurasian badgers (*Meles meles*), brushtail possum (*Trichosurus vulpecula*), and white-tailed deer (*Odocoileus virginianus*). Risk-assessment efforts in Michigan have been initiated on farms to minimize interactions of cattle with wildlife hosts but research on *M. bovis* on cattle farms has not investigated the spatial context of disease epidemiology. To incorporate spatially explicit data, initial likelihood of infection probabilities for cattle farms tested for *M. bovis*, prevalence of *M. bovis* in white-tailed deer, deer density, and environmental variables for each farm were modeled in a Bayesian hierarchical framework. We used geo-referenced locations of 762 cattle farms that have been tested for *M. bovis*, white-tailed deer prevalence, and several environmental variables that may lead to long-term survival and viability of *M. bovis* on farms and surrounding habitats (i.e., soil type, habitat type). Bayesian hierarchical analyses identified deer prevalence and proportion of sandy soil within our sampling grid as the most supported model. Analysis of cattle farms tested for *M. bovis* identified that for every 1% increase in sandy soil resulted in an increase in odds of infection by 4%. Our analysis revealed that the influence of prevalence of *M. bovis* in white-tailed deer was still a concern even after considerable efforts to prevent cattle interactions with white-tailed deer through on-farm mitigation and reduction in the deer population. Cattle farms test positive for *M. bovis* annually in our study area suggesting that the potential for an environmental source either on farms or in the surrounding landscape may contributing to new or re-infections with *M. bovis*. Our research provides an initial assessment of potential environmental factors that could be incorporated into additional modeling efforts as more knowledge of deer herd factors and cattle farm prevalence is documented.

Walter, W.D., R. Smith, M. Vanderklok, and K.C. VerCauteren. Linking bovine tuberculosis on cattle farms to white-tailed deer and environmental variables using Bayesian hierarchical analysis. Plos ONE 9(3): e90925.

APPENDIX B – New and Continuing Projects

3.1.1 Influences on the timing of denning in female black bears and its effect on harvest rates and estimates of population size. D. R. Diefenbach, M. A. Ternent, E. Kibe. Funded by Pennsylvania Game Commission and U.S. Geological Survey.

We continue to fit females with specially-designed radio-collars that monitor activity as well as standard VHF transmitters. Mark Ternent and I have identified a graduate research project based on the activity data as well the mark-recapture data and reproduction data collected on the study site. Ethan Kibe has been accepted into the WFS program for a M.S. degree and the plan is for him to develop a proposal and complete fieldwork and then enroll full time to complete his coursework and thesis.

The motivation for this research is that population estimates of breeding-age females lack precision and accuracy because currently there is no way to predict the proportion of females in the den during the hunting season and, thus, the harvest rate for this age class. If other factors, such as food availability or weather conditions, can be used to predict the proportion of females denned prior to the hunting season, then it may be possible to obtain more accurate population estimates.

3.1.2 Dispersal of black bears in Pennsylvania. W. C. Vreeland, D. R. Diefenbach, and M. A. Ternent.Funding provided by the Pennsylvania Game Commission and Penn State University.

The black bear (*Ursus americanus*) is one of the most studied animals in North America. In Pennsylvania, bear research has been ongoing since the early 1980s but has provided minimal information on dispersal because research has focused on adult female productivity and few juveniles have been radio-collared. In contrast, thousands of bears have been tagged and recovered since 1980 but capture and recovery location is limited to county and township. Unfortunately, using township centers is not accurate enough to assess dispersal but Pennsylvania has >400 records where the exact capture and recovery location has occurred. Those results suggest that dispersal rates differ by sex, as expected, and wildlife management unit (WMU). Dispersal rates differed somewhat by decade, with the greater rate exhibited in the 1990s compared to the 1980s and 2000s. Dispersal rate of females ranged from 8-25% and males ranged from 25-75%. Wendy has completed analysis of the data and is writing her thesis. Completion of the degree will occur in 2014.

3.1.3 Dispersal of female white-tailed deer in Pennsylvania. Clayton Lutz, Duane Diefenbach, Bret Wallingford, and Chris Rosenberry. Funding provided by Pennsylvania Game Commission

Clayton has completed a draft of the first chapter of his dissertation and we plan to submit this as a manuscript to the Journal of Mammalogy (abstract follows). A second chapter of factors that influence dispersal movements will be the next task to complete (second chapter of thesis). Completion of thesis is planned to occur within the next year.

Dispersal behavior is ecologically important because it influences gene flow, population dynamics, colonization, and the spread of disease. Hypotheses for the ultimate cause of dispersal suggest it is a beneficial strategy for the disperser because it reduces competition for local resources, reduces competition for breeding partners, and reduces the potential for inbreeding. Dispersal behavior in white-tailed deer is predominantly displayed by juvenile males; however, dispersal has also been displayed by juvenile females. Timing of female dispersal during the fawning season and the low rate of female dispersal suggest that competition for mates and reducing inbreeding potential are not ultimate causes of female dispersal. We propose that an ultimate cause of female dispersal is the competition for adequate fawning habitat such that as space becomes limited by the density of individuals in the habitat, the rate and distance of dispersal is likely to increase. To test this hypothesis, we conducted a meta-analysis of female dispersal data from 13 populations of white-tailed deer. We found a positive relationship between dispersal rate and deer per forested km^2 ($r^2 = 0.763$, $P = 0.000$, $df = 9$), and dispersal distance and deer per forested km^2 ($r^2 = 0.548$, $P = 0.014$, $df = 8$). Our results suggest that female dispersal is caused by the exclusion of subordinate juveniles by adult females as they compete for isolation during parturition. This mechanism of density dependent exclusion at parturition results in the disperser establishing a new adult range where it can occupy a position of higher social standing and have adequate habitat for its future fawning needs. Thereby the resulting enhancement of social standing and local resources is ultimately beneficial for the disperser.

3.1.4 Harvest and survival rates of hen wild turkeys in Pennsylvania. Duane R. Diefenbach, Mary Jo Casalena, Wendy Vreeland. Funding provided by Pennsylvania Game Commission.

The objectives of this project are to (1) estimate female turkey harvest rates and survival rates by age and fall season length to determine the effects of varying season length on harvest and survival rate, and (2) investigate if there is a relationship between fall mast crop and age-specific harvest rates. The number of banded hens has been excellent and sample sizes have generally been met or exceeded for both study areas. The final fall hunting season will occur in 2014 and then final analysis of the data can begin. Preliminary analyses indicate low harvest rates (0.033-0.089) and annual survival of about 50%. Estimating differences before and after the switch in season lengths is not possible until all data have been collected.

3.1.5 Genetics of an insular population of bobcats and coyotes. D. Diefenbach. L. Hansen, C. Miller, J. Bohling. Funding provided by Penn State University.

Twenty-eight bobcats were reintroduced to Cumberland Island in 1988-89 and tissue samples were collected from each animal released on the island. Bobcats still exist on the island but whether the population has undergone a genetic bottleneck is unknown as is the current number of bocbats on the island. Also, in the past several years coyotes naturally became established on the island but the number of individuals on the island is unknown. We returned to the island in January 2012 and collected over 80 scats of coyote and bobcat. We identified 9 bobcats and 3 coyotes from genetic analysis of scat samples. Heterozygosity of alleles suggests that the population is not experiencing inbreeding depression. Although some genetic analyses have been completed, Dr. Miller is investigating additional techniques with other aspects of the DNA material to try to gain more information from the samples collected.

3.1.6 Developing an adaptive management approach for meeting deer and forest management objectives

William Kanapaux, Glenn Stauffer, and Duane Diefenbach. Funding provided by U.S. Geological Survey

Bill Kanapaux accepted a full-time, permanent position and is only peripherally involved in the project. Glenn Stauffer has stepped in to help wrap up this project. We continue to enter data from the Bureau of Forestry's timber sale files into a database that can be used to develop adaptive models to predict forest management outcomes. Most of the data in these files, which date back to the 1960s, has existed only in paper form until now. The data are being linked with existing digital data on stand structure in state forests at 20 to 24 years post-harvest. Most of the statistical code has been written in R so that its methods are easily shared.

3.1.7 Allegheny woodrat: Identifying strategies to conserve a declining species

Glenn Stauffer, Duane Diefenbach, W. Mark Ford, Angela Fuller, Petra Wood. Funding provided by USGS and PGC.

The main goal of this project is to develop and parameterize a decision model to guide patch-level management of Allegheny woodrats. Based on a conceptual model revised in 2013, we wrote various R-scripts to stochastically project woodrat metapopulations forward (for many different scenarios and initial conditions). We identified a suite of possible management actions and defined a utility function that combined the proportion of the metapopulation occupied and the probability of persistence after 80 years, and to some extent, cost. In general, decision outcomes seem fairly insensitive to starting conditions; the uncertainty in management effects and the variability in vital rates and projection results swamp the slight differences among management options.

Simplifying the projections to include dynamics of only a single site for a shorter time period (and appropriately redefining utility) helped to reduce uncertainty in outcomes, but considerable uncertainty remains. These results underscore the need for experimentation to clarify the effects of various management alternatives in the face of considerable environmental variability.

Survival analysis of woodrat data from Indiana is nearly complete. Results suggest variability related to age, sex, time, and site, but other individual-level or site-level covariates (e.g. heterozygosity, juvenile weight, population size) poorly correlated with survival. We also obtained and converted to electronic form 20+ years of capture data from several sites in MD. These data will be incorporated into a range-wide survival analysis.

3.1.8 Using North American Breeding Bird Survey data to evaluate potential consequences of energy development and other land use changes on bird populations in the northeast Appalachian region

Jason M. Hill, Duane Diefenbach. Funding provided by USGS, Patuxent Wildlife Research Center

Migratory bird conservation places increasing emphasis on the need for predictions of the consequences of environmental change on bird populations and on continued monitoring for ongoing assessments of environmental change on bird populations. The North American Breeding Bird Survey (BBS) is often the only source of population status information for model development, and the continuing nature of the BBS makes it a potential data source for testing model predictions and assessing consequences of environmental change on bird populations. We used aerial photos and the USGS National Land Cover Data to measure the growth of Marcellus shale development within 250 m of all active BBS routes in the Appalachian Mountain region (n = 73 routes) between 2001-2011. From 2006, when we first observed Marcellus activity adjacent to BBS routes, to 2011 we documented 71.9 ha of Marcellus development along 21 (29%) BBS routes; this development represents <0.1% of the landscape adjacent to BBS routes. These changes to the landscape (e.g., road building and well pad construction) primarily replaced forests (48.6%) and hayfields and pastures (26.3%). Within those forested acres, loss of core forest (i.e., forest that is >100 m from non-forested boundaries) was especially notable with 52.1 ha of core forest being lost; on average each 1-ha of actual forest loss resulted in 1.49 ha of core forest loss due to Marcellus development.

We then examined changes in BBS count data for 28 bird species on these 73 routes from 2001-2011 using over-dispersed Poisson regression models in a Bayesian framework. We chose bird species that primarily occur in or occupy core forests or grasslands (i.e., hayfields, rangelands, and grasslands). We related changes in the expected count of these 28 species over time to changes in the amount and configuration of core forest and grasslands. On average core forest birds declined from 2006-2011 by 1.48% per year, and grassland birds declined by 2.30% per year. Each 100-ha of grasslands and core forest along a route increased the expected count of grassland and core forest birds by 1.83 and 1.48 birds of that habitat, respectively. Despite using 10 years of data from 73 routes our results were only sensitive enough to detect a change of at least 4.64 % per year for core forest birds and 2.75% per year for grassland birds. Given that habitat loss along BBS routes due to Marcellus was quite small, we simulated how much habitat loss would have been needed between 2006-2011 to result in a statistically significant and declining trend. For grassland birds on average, we estimated that a loss of 7% of existing grassland habitat along routes would have created a statistically significant and detectable negative trend. For core forest birds on average, our models predicted that a 30% loss of existing core forest habitat along the BBS routes would result in a statistically significant and detectable declining trend. Our results do not suggest that core forest birds are less sensitive to habitat loss than grassland birds. Rather, the relative insensitivity of our results of core forest birds to habitat loss was likely a result of their relatively low abundance along routes (on average < 5 individuals of core forest bird species were expected along each route). We are currently refining these models and trying to develop other metrics for gauging how forest birds and grasslands birds respond to habitat loss.

3.1.9 Deer abundance and its relationship to factors that affect forest vegetation conditions.

Danielle Begley, Duane Diefenbach, Marc McDill. Funding provided by PGC and DCNR Bureau of Forestry.

The Pennsylvania Game Commission (PGC) has developed a decision model for antlerless deer harvest allocations based on deer browsing impact as measured by the FIA in addition to estimates of tree seedling density. Similarly, the Pennsylvania DCNR Bureau of Forestry uses a vegetation monitoring protocol and the Deer Management Assistance Program to manage deer on state forests. This research proposes to stabilize deer populations at different densities on four study areas and quantify changes in vegetation with respect to other forest conditions (seed production, advanced tree regeneration, etc.) and management actions (e.g., herbicide to remove competing vegetation).

Adult male and female deer are fitted with satellite GPS collars, deer pellets are collected in April to estimate deer density via genetic analyses and spatial capture-recapture models. Vegetation data are collected at 200 plot locations (1,000 plots) of which 1 plot will be fenced to exclude deer.

This summer Danielle Begley began her Ph.D. research to study the interactive effects of deer browsing, soil acidification, and competing vegetation on vegetation conditions. Her study involves treating additional vegetation plots with lime (increase pH) and herbicide (remove competing vegetation).

3.1.10 Fall Harvest and Annual Survival Rates of Female Eastern Wild Turkeys in New York. Duane Diefenbach, Wendy Vreeland, Alyssia Church. Funding provided by NY DEC, Division of Fish, Wildlife, and Marine Resources.

The primary form of population management for wild turkeys is by conducting a fall either-sex harvest. However, harvesting more than 10% of the fall population is believed to lead to a decrease in future turkey population abundance (Healy and Powell 1999). Currently, fall harvest rates in New York are unknown and harvest and survival rates likely vary according to management unit or physiographic region. To effectively manage wild turkey populations, without over harvesting the resource, it can be useful to know the rate at which hen turkeys are harvested in the fall. Personnel of the New York Department of Environmental Conservation (NY DEC) capture and leg band hen wild turkeys. Capture information is provided to the Pennsylvania Cooperative Fish and Wildlife Unit to manage a database of hen wild turkeys captured in New York. Leg bands are imprinted with a unique alphanumeric sequence, a toll-free number maintained by The Pennsylvania State University, and notification of a $100 reward. The second of 4 fall harvest seasons for this study will occur in 2014.

3.1.11. Snowshoe hare habitat relationships in response to northern forest management in Pennsylvania – Laura Gigliotti and Duane Diefenbach

This project is examining patterns of habitat use and survival of snowshoe hares in Pennsylvania. The results of this project will hopefully be used to make informed management decisions in order to create and maintain habitats that will sustain snowshoe hare populations in the state.

Fieldwork was conducted in SGL 029 in Warren County and land encompassing SGL 038 and the Bethlehem Water Authority in Monroe County. Starting in January we trapped snowshoe hares and fitted them with GPS or radio collars in order to track them. We captured 43 hares in the northeast study area and 16 hares have died to date. In the northwest study area we captured 12 hares, with 5 hares having died.

3.2.1 Habitat use, movement and genetic composition of lake trout in the Niagara River and Niagara Bar. Tyler Wagner and Meredith Bartron. Funding Provided by USFWS.

Restoration of lake trout (*Salvelinus namaycush*) to the Great Lakes has focused on hatchery supplementation, and successful restoration is measured in part by the establishment of naturally reproducing and self-sustaining populations. Currently, two hatchery strains are stocked into Lake Ontario: the Seneca strain and the Traverse Island/Lake Superior strain, but low numbers of wild lake trout exist in the basin. Monitoring of the Niagara River and Niagara Bar by the USFWS Lower Great Lakes Fish and Wildlife Conservation Office has previously identified spawning by lake trout. However there is uncertainty with regard to the location and amount of wild reproduction, and which hatchery strains may be spawning in the wild. Understanding the reproductive contribution of hatchery and wild fish is important to assess progress towards the goal of lake trout restoration in Lake Ontario (Schaner et al. 2007). In addition, although naturally reproducing lake trout have been identified in assessment surveys since 1994, there is still a paucity of information related to potential spawning locations (i.e., habitat use) and fish movement dynamics during the spawning season. For example, it is currently unknown when lake trout enter the river system for spawning, how long fish remain in the system, and the amount of heterogeneity in habitat use and movement that exists among and within strains of lake trout. The goal of this project is to develop a better understanding of spawning behavior (movement and habitat use) and identify the source (hatchery strain or wild) of the lake trout that are naturally reproducing in the Niagara River/Niagara Bar area of Lake Ontario. All field and laboratory work and data analysis has been completed. Kelley Salvesen (MS student) is currently writing her thesis.

3.2.2 Managing the Nations Fish Habitat at Multiple Spatial Scales in a Rapidly Changing Climate. Tyler Wagner and Paola Ferreri. Funding provided by USGS.

Successful conservation and management of aquatic habitat and the fisheries within these systems is predicated upon the ability to forecast future environmental change. Water needs for consumption and energy production, agricultural and urban development, climate change, and invasive species endanger freshwater habitat and their associated biological communities at levels greater than terrestrial and marine systems. As a consequence, fish habitat quality and quantity and subsequently aquatic species are declining nationwide. An important first step in managing the nation’s fish habitat is a comprehensive assessment of the current state of habitat at national, regional and local scales. Assessment of habitats that are most in need of management and assessing the threats associated with these habitats, will allow managers to better prioritize conservation and restoration actions. A robust assessment should allow for an understanding of the current state of aquatic habitat from the national to regional scales, and ultimately to the local management scale. Assessments, however, represents a static picture of the past; and successful management of aquatic habitat will require a capacity to forecast changes in habitat as a result of future changes in climate, land-use, and other natural and anthropogenic factors. *Successful conservation and management will need to answer the fundamental question, what are the critical habitat and resource strategies to conserve in order to maintain freshwater biodiversity, freshwater fisheries and ecosystem function in the future?* Potential climate-induced changes in the biophysical processes that drive freshwater ecosystems coupled with human-induced, land-use change have resulted in declining aquatic habitat condition nation-wide. Coupling multiscale habitat evaluation with downscaled climate information will allow managers to understand where critical resources must be protected and prioritize future management actions.

The goal of this project is to provide guidance to aquatic resource managers and decision makers for managing brook trout habitat. We propose to provide information and tools that will facilitate the conservation and management of aquatic resources in the face of global climate and land-use change. Our approach will address the following questions: (1) where are the brook trout habitats in need of conservation as climate changes and causes unanticipated changes in the environment? (2) What are the commonalities and differences in the effects of climate and land-use changes?

We will develop: 1) a medium resolution assessment of vulnerable brook trout habitat across the northeast U.S. (Pennsylvania) appropriate for NFHAP partnerships and state agencies, and 2) relatively high resolution data about current and future habitat status so that local managers and stakeholders can identify the appropriate spatial scale where brook trout are most vulnerable to climate and land-use changes. We will develop statistical methods to derive possible future changes in regional climatic variables (e.g., temperature, precipitation, solar radiation) needed to quantify associated changes in hydrology, anthropogenic disturbance, and fish habitat and assess the biological response of brook trout at the regional and local scales.

3.2.3 Fish community assessment in the Eastern Rivers and Mountains Network and Integration with Existing Monitoring Data Tyler Wagner, Funding provided by NPS.

The National Park Service (NPS) has initiated a long-term ecological monitoring program, known as “Vital Signs Monitoring”, to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition. The term "vital signs" refers to a relatively small set of information-rich attributes that are used to track the overall condition of park natural resources and to provide early warning of situations that require intervention. We define vital signs as a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values.

Although stream fish communities were not selected as a ‘vital sign’, it is widely accepted that monitoring fish communities in wadeable streams has important advantages over sampling shorter-lived taxa (e.g., macroinvertebrates). For example, fish life history and habitat requirements are better understood compared to macroinvertebrates. As a result, fish communities are widely used indicators of environmental quality, with many states developing indices that incorporate metrics of fish community structure and composition – these indices are expected to be incorporated into regulatory frameworks (e.g., aquatic use standards). Although it would be ideal to have a continuous fish monitoring program throughout the ERMN, budgetary limitations prevent it. Consequently, methodology is needed to estimate the current condition of fish communities in ERMN wadeable streams in a rigorous and repeatable manner. Estimates of the current fish community’s condition at ERMN stream sites would complement data collected on an annual basis (i.e., Vital Signs Monitoring) and enable an integrated measure of ecosystem condition that can be monitored over time. Therefore, the specific objectives of this study are to:

(1) Characterize fish communities in selected ERMN stream reaches, and (2) combine fish community data with existing monitoring data (e.g., macroinvertebrates) to provide an integrated measure of stream ecological condition.

Field work in the Delaware Water Gap is ongoing. Approximately 35 stream sites have been sampled, with two site-revisits completed on most sites. Field work will continue in the Delaware Water Gap until mid-August.

3.2.4 Characterization of spatial and temporal variability in fishes in response to climate change

3.2.4 Characterization of spatial and temporal variability in fishes in response to climate change Brian Irwin (GA Coop Unit), Tyler Wagner, Jim Bence (Michigan State University); Funding provided by Northeast Climate Science Center, USGS

The NECSC has a stated project goal, for its Great Lakes Fisheries Response to Climate Change priority area, "to develop information that can predict fish population response to climate change and other land use/water use interactions." To achieve this goal, we will build upon recently completed analyses of fish population data in the Great Lakes basin to help predict how spatial and temporal variation in fish populations may respond to climate change and other important drivers. We suggest that shifting variance structure can be indicative of population-level responses to climate change. Our research will help elucidate the extent to which quantifiable responses in spatial and temporal variability occur in different forms of fish population data. For example, we have already assembled multiple long-term data series for both predator and prey fish populations in the Great Lakes Basin (described below). We believe an important step to achieving the NECSC goal is characterizing spatial and temporal variability of fishes in response to seasonal environmental changes and longer-term climate change. Our work is unique in that we aim to quantify individual variance components and not only a mean response or a response in total variance.

3.2.5 A decision support mapper for conserving stream fish habitats of the NE CSC region Criag Paukert (PI, MO Coop Unit), Tyler Wagner (co-PI), Dana Infante (co-PI, MSU), Joanna Whittier (co-PI, Univ. Missouri), Jana Stewart (co-PI, USGS Water Science Center); Funding provided by Northeast Climate Science Center, USGS

Human impacts occurring throughout the NE CSC, including urbanization, agriculture, and dams, have multiple effects on the region's streams which support economically valuable stream fishes. Changes in climate are expected to lead to additional changes in stream habitats and fish assemblages in multiple ways, including changing stream water temperatures. To manage streams from current impacts and future changes, managers need region-wide information for decision-making and developing proactive management strategies. Our project meets that need by integrating results of a current condition assessment of stream habitats based on fish response to human land use, water quality impairment, and fragmentation by dams with estimates of which stream habitats may change in the future. Results will be available for all streams in the NE CSC region through a spatially-explicit, web-based viewer, the Climate Change Visualization and Integration of Ecological and Watershed Resources (CCVIEWeR). With this tool, managers can evaluate how streams of interest are currently impacted by land uses and assess if those habitats may change with climate. These results, available in a comparable way throughout the NE CSC, provide natural resource managers, decision-makers, and the public a wealth of information to better protect and conserve stream fishes and their habitats.

3.2.6 Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania

Tyler Wagner (PI); Funding provided by USGS Chesapeake Bay Priority Ecosystem Science Program, PFBC (base funding)

Smallmouth bass are an important fishery throughout much of the United States and in Pennsylvania, in particular. For instance, the Susquehanna River and many of its tributaries provide a heavily sought out recreational smallmouth bass fishery that results in revenue for state agencies and local economies. In addition, smallmouth bass represent an important component of river food webs. However, populations have recently been in decline in several rivers, with adult smallmouth bass population numbers on the decline throughout much of the Susquehanna River basin causing concerns about poor recruitment and future reproductive potential (Shuman 2012). Since 2005 there have been five consecutive year classes with below average reproductive success in the middle and lower Susquehanna River. In addition, the West Branch Susquehanna River and upper Susquehanna River smallmouth bass populations have been affected by disease. As a result, smallmouth bass fisheries are receiving considerable attention by the PA Fish and Boat Commission and other state and federal agencies.

Although the cause of the decline in smallmouth bass numbers is not currently known, several factors are hypothesized to be contributing factors, including environmental contaminants, thermal and oxygen stress, eutrophication, and disease (Smith 2010, V. Blazer, USGS, pers. comm. 2012). Bacteria and viruses, including bacterial species of Aeromonas and Flavobacterium, have been isolated from smallmouth bass collected from Pennsylvania rivers (Blazer pers comm. 2012). Dissolved oxygen and water temperature have been reported to be outside of smallmouth bass optimal ranges during the time of year when disease outbreaks on young-of-year have occurred (Chaplin and Crawford 2012). In addition, emerging contaminants, including endocrine disrupting compounds, are a concern because of the presence of adult intersex in fish sampled throughout various parts of the Susquehanna River basin (Blazer, pers comm 2012).

The goal of this research project is to reduce uncertainties related to the causal factors responsible for the observed decline in smallmouth bass (and disease outbreaks in young-of-year) in the Susquehanna River and selected tributaries. Specifically, we will attempt to examine fish health and contaminant levels if smallmouth bass populations and examine historical data to link past population dynamics to those currently observed.

3.2.7 Transboundary management and conservation: linking large-scale dynamics to ecological monitoring and management

Tyler Wagner (PI), Brian Irwin (GA Unit, co-PI), Joe Zydlewski (ME Unit, co-PI), Steve Midway (postdoc)

A central challenge to natural resource management is to understand and predict ecological responses to management and environmental change over large spatial scales. It is recognized, however, that the management and conservation of many important ecological systems and the services they provide must be addressed at spatial scales that transcend jurisdictional and political boundaries. Although transboundary approaches are necessary to understand large-scale phenomenon (e.g., species range), it remains unclear in many cases how best to address the inherent complexities in managing ecosystems at large (e.g., regional) spatial scales. It is also often unclear how to link large-scale system dynamics with on-the-ground decision-making processes, which are often done using adaptive management principles. For example, a critical component for successfully implementing adaptive management is the development of a rigorous monitoring program, which provides a critical feedback loop for learning about system dynamics. It is unclear, however, how the interplay between components acting at different, hierarchical scales will affect the ability of natural resource managers to detect changes in important state variables (e.g., animal abundance, occupancy, etc.) at transboundary spatial scales. Thus, our overarching objective is to use freshwater stream fish populations as model systems to develop a framework and tools for addressing the inherent challenges in performing trans-boundary research and for linking large-scale dynamics to ecological monitoring and management.

3.3.1 Developing an Adaptive Management Approach for Potential Surveillance and Spread of Chronic Wasting Disease in White-tailed Deer in Pennsylvania
Tyler Evans, David Walter, Walt Cottrell, Duane Diefenbach, Funding by USGS and Pennsylvania Game Commission

Chronic wasting disease (CWD) is a transmissible spongiform encephalopathy that was first detected in 1967 in a captive research facility in Colorado. In the northeastern United States, CWD was first confirmed in 2005 in New York and West Virginia, and has also been found in Maryland, Virginia, and Pennsylvania. We examined demographic and environmental factors in the central Appalachian region to assess the spatial distribution of CWD in white-tailed deer (*Odocoileus virginianus*). The objectives of our study were to (1) apply Bayesian hierarchical modeling to harvest location data of white-tailed deer tested for CWD in the region since 2005, (2) identify model(s) that best described the spatial distribution of CWD, and (3) map probability of CWD infection.

Demographic covariates included age and sex, and environmental covariates included elevation, slope, riparian corridor, percent clay in the soil, and percent of three habitat types (developed, forested, open). For each deer, environmental covariates were extracted within 6 km^2 grid cells as this size reflected our estimate of the 99% size of home range for white-tailed deer in the region using Brownian Bridge Movement Models. The model with the most support contained random spatial effects and percent habitat and accounted for 94.4% of the overall weight for the candidate set of models. Percent forest cover appeared to have the strongest correlation with the distribution of CWD in the region, with increased risk of CWD occurring in areas that had lower amounts of forest cover. Our results will assist resource managers in understanding the spatial distribution of CWD not only within the study area, but also in surrounding areas where CWD has yet to be found. Efficiency of disease surveillance and containment efforts can be improved by allocating resources used for surveillance into areas that are at a greater risk for infection.

A historical overview of CWD in the northeast is in press in the Journal of Fish and Wildlife Management and the primary modeling manuscript will be submitted in late-summer 2014. Tyler Evans (MS student) is currently writing his thesis.

3.3.2 Surveillance and monitoring of river otter populations in Pennsylvania
Nick Forman, David Walter, Matt LovalloFunding by the Pennsylvania Game Commission

River otters (*Lontra canadensis*) are of interest to wildlife managers because of their role as tertiary consumers in riparian ecosystems, and economic significance as furbearers. River otters are difficult to monitor because of their cryptic behavior, however the use of non-invasive genetic methods targeting scat has been shown to be an effective monitoring method for populations of river otter. River otters are of particular interest in Pennsylvania because of their history of near-extirpation, and their subsequent reintroduction and spread across the state over the past 30 years. We used non-invasive genetic sampling with a capture-recapture framework to estimate population size and density in northeastern Pennsylvania. From January to April 2013 and 2014, we collected scat samples from latrines on lakes and rivers across seven counties, with sites revisited at least three times. We used primers designed for eleven polymorphic microsatellites in two multiplex PCR reactions to obtain genotypes for DNA extracted from scat samples. A consensus genotype at a microsatellite loci was conditional upon two identical heterozygous genotypes for two or greater runs, and at least three identical runs for a homozygote genotype. Of the 629 samples collected, our sample success rate for each month, with success demonstrated by ability to reach a consensus genotype at seven or greater loci for a sample, was 51.2% in January (80/156), 59.9% in February (109/182), and 60.7% in March (153/252). We were able to identify 144 unique individuals, with the number of observations per individual ranging from one to seven.

Genetic analysis of scat samples collected in 2014 is currently underway. Nick Forman (MS student) is currently writing portions of his thesis.

3.3.3 Spatial analysis of large mammals to assess harvest vulnerability in relation to landowner distribution

Charles Crawford, David Walter, Mark Ternent, Matt Lovallo, Funding by Pennsylvania Game Commission

Black bear population growth and expansion along with anthropogenic disturbance of traditional bear habitat over the past several decades has directly led to increased human-bear interactions and subsequently increased conflicts in Pennsylvania. Harvest has been suggested as a viable management tool for suburban black bear but the viability of this strategy has not yet been extensively studied. Hunting as a strategy to mitigate human-bear conflicts hinges largely on the presence of targeted black bear populations on parcels of land open to hunting in defined management units during the hunting season. The objectives of our study were to (1) map land parcels within our study sites that were open to hunting whether privately or publicly held, (2) apply resource selection functions to black bear GPS location data collected during the hunting season between 2010 to 2013, and (3) identify covariates that best described black bear resource selection. We retrieved land parcel data from 3 urban-suburban regions in Pennsylvania in geographic information system format to identify parcels that were >10 ha in size that were used by GPS-collared black bear. To define parcels in our study site open to hunting, the Pennsylvania Game Commission conducted a landowner survey of all parcels within the 90% fixed kernel home range of all GPS locations. A total of 78 bears were collared resulting in 114,450 locations for determining size of home range and resource selection of black bear. Surveys were sent to 6,754 landowners that resulted in usable responses from 4,647 recipients for a response rate of 68.8%. Covariates in the resource selection function included open to hunting, distance to road, land cover type, elevation, slope, aspect, and urbanization. Our results will assist resource managers in understanding resource selection of black bear near suburban areas where human-bear conflict is a growing concern of state agencies.

Data analysis of bear locations and parcel-specific data is currently underway using program R. Chaz Crawford (MS student) is currently writing portions of his thesis.

3.3.4* Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease.

David Walter, Justin Brown, Megan Kirchgessner, Chris Ryan, Bryan Eyler. Funding by the Pennsylvania Game Commission

Chronic wasting disease (CWD) is a fatal, transmissible disease that affects both captive and free-ranging cervids. The disease is endemic to southwestern Wyoming, north-central Colorado, and western Nebraska, but has been found in Wisconsin and more recently, West Virginia, Virginia, Maryland, and Pennsylvania. State agencies are responsible for managing white-tailed deer throughout the northeast. Deer behavior can facilitate disease spread, as dispersing males have been documented to move >100 km and philopatry in females can exacerbate direct transmission within matriarchal groups. Certain prion gene alleles are associated with reduced risk of CWD, though none of the prion genotypes characterized in deer are completely protective against infection. Male dispersal distance was greater and genetic admixture was higher for deer in more open than forested landscapes indicating the potential for disease dynamics to differ regionally based on landscape configuration and composition. Using data collected over a broad geographic scale, we would be able to map with considerable detail the landscape genetics of deer. These data would allow us to deduce patterns of potential transmission pathways of CWD, predict admixture between infected and susceptible deer, and delineate potential management actions. To maximize the efficiency of surveillance efforts and to understand the population structure of white-tailed deer in the northeast, landscape genetics of deer in the region needs to be examined. Landscape genetics can provide the necessary framework to understand landscape features, dispersal characteristics of deer, and transmission and spread of CWD through assessment of population structure throughout a region.

3.3.5* Characterization of habitat for pheasant in wild pheasant recovery areas of Pennsylvania. David Walter, Duane Diefenbach, Alyssia Church, Scott Klinger, Colleen DeLong, Ian Gregg. Funding by Pennsylvania Game Commission.

Currently 4 Wild Pheasant Recovery Areas (WPRAs), with 10 study areas for pheasant research and monitoring, have been establishedin Pennsylvania to investigate if the trap and transfer of wild pheasants from mid-west and western states can establish sustainable, huntable populations of wild pheasants in Pennsylvania. The PGC has collected detailed habitat patch data that can be compared to pheasant population densities to build a Predictive Pheasant Habitat Model (PPHM). However, the habitat patch data is not in a GIS data base. The conversion of the habitat patch maps to a GIS, digital data base will allow robust and spatial analysis of the habitat data. A more effective and predictive Pheasant Habitat Model can then be developed and applied across Pennsylvania. This will allow the identification of potentially suitable pheasant habitat and identify the amount and location of habitat restoration needed to produce sustainable and huntable pheasant populations. Project deliverables will include 1) raster or polygon layer of habitats for each of the 160 buffered circles with associated metadata to include latitude-longitude of sampling point, habitat category for each habitat patch to Anderson Level IV codes or equivalent, and hectares for each habitat patch. 2) a KML file and GIS shapefile for all habitat patches and habitat circles, and 3) summary of habitat categories for all buffered circles included in the PGC Pheasant Model (developed land, cropland, forest land, and hayland and pasture) for the 3 WPRAs provided by field operations.

3.3.6*Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife. David Walter, Kyle Van Why, Justin Brown, David Zellner. Funding by the Pennsylvania Game Commission

Domestic cervid facilities include the confinement of cervids such as deer, elk, and swine for the purpose of sport hunting, hobby farms, and breeding facilities. Pennsylvania has the second most domestic cervid facilities in the US behind Texas with about 1,044 facilities. Although detailed information is available for most facilities, such as herd size, species, and location, landowner and landscape characteristics are largely unknown for domestic cervid facilities in

Pennsylvania. There are two primary objectives of this research: (1) distribution and density of domestic cervid facilities as potential sources of disease to free-ranging wildlife, and (2) characteristics of facilities that contain domestic swine as potential sources of feral swine.

Bayesian hierarchical modeling of landowner and landscape characteristics for domestic cervid facilities in Pennsylvania. Assess relationship between domestic swine facilities and current known range of feral swine in Pennsylvania

Appendix C – Awards, Publications, and Presentations
(Unit personnel and students in bold)

Honors and Awards

Shannon White received a University Graduate Fellowship for her first year as a PhD student in the Ecology Program (starting fall 2014) and top-up awards in years 1 and 3 of her program

David Walter was promoted to GS-13

Duane Diefenbach received the Caesar Kleberg Award for Excellence in Applied Wildlife Research from The Wildlife Society

Theses and Dissertations

DeWeber, J. T. 2014. Potential climate and land use change effects on brook trout in the eastern United States. The Pennsylvania State University.

Smith, L. 2013. Seasonal movement patterns and habitat use of brook trout *Salvelinus fontinalis* and brown trout *Salmo trutta* in north central Pennsylvania. The Pennsylvania State University.

Peer-reviewed Publications

Buderman, F. E., D. R. Diefenbach, M. J. Casalena, C. S. Rosenberry, B. D. Wallingford. Accounting for tagging-to-harvest mortality in a Brownie tag-recovery model by incorporating radio-telemetry data. Ecology and Evolution 4:1439-1450.

Detar, J. D. Kristine, **T. Wagner**, and T. Greene. 2014. Evaluation of Catch-and-Release Regulations on Brook Trout in Pennsylvania Streams. North American Journal of Fisheries Management 34:49-56.

Deweber, J.T. and **Wagner. T.** 2014. A regional neural network model for predicting mean daily river water temperature. Journal of Hydrology 517:187-200.

Deweber, J.T., Y., Tsang, D.M. Krueger, J.B. Whittier, **T. Wagner**, D.M. Infante, and G. Whelan. 2014. Importance of understanding landscape biases in USGS gage locations: Implications and solutions for managers. Fisheries 39:155-163.

Fernandez, C.W., M.L. McCormack, **J.M. Hill**, S.G. Pritchard, and R.T. Koide. 2013. On the persistence of Cenococcum geophilum ectomycorrhizas and its implications for forest carbon and nutrient cycles. Soil Biology and Biochemistry 65:141-143.

Fischer, J.W., **W.D. Walter**, M.A. Avery. 2013. Brownian bridge movement models to characterize home ranges of avian species. The Condor 115(2): 298-305.

Hill, J. M., and **D. R. Diefenbach**. 2013. Experimental removal of woody vegetation does not increase nesting success or fledgling production in two grassland sparrows (Ammodramus) in Pennsylvania. Auk 130:764-773.

Hill, J. M., and **D. R. Diefenbach**. 2013. Occupancy patterns of declining grassland sparrow populations in a fragmented and forested landscape. Conservation Biology. DOI: 10.1111/cobi.12210

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