AGENDA

Coordinating Committee Meeting
Pennsylvania Cooperative Fish and Wildlife Research Unit

July 29, 2015

9:30 AM

To be held in Room 118 in the ASI Building

1. **Approval of minutes from June 17, 2014 meeting**

2. **Completed Projects (Summaries in Appendix A; yellow pages)**
   - 2.1. Diefenbach
     - 2.1.1. Dispersal timing, distances, and rates of Pennsylvania black bear
     - 2.1.2. Predicting post-harvest tree species composition based on pre-timber harvest advanced regeneration conditions
     - 2.1.3. 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
   - 2.2. Wagner
     - 2.2.1. Habitat use, movement and genetic composition of lake trout in the Niagara River and Niagara Bar
     - 2.2.2. Fish community assessment in the Eastern Rivers and Mountains Network and Integration with Existing Monitoring Data
   - 2.3. Walter
     - 2.3.1. Developing an Adaptive Management Approach for Potential Surveillance and Spread of Chronic Wasting Disease in White-tailed Deer in Pennsylvania
     - 2.3.2. Characterization of habitat for pheasant in Wild Pheasant Recovery Areas of Pennsylvania

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 female white-tailed deer in Pennsylvania
     - 3.1.3. Harvest and survival rates of hen wild turkeys in Pennsylvania
     - 3.1.4. Genetics of an insular population of bobcats and coyotes
     - 3.1.5. Allegheny Woodrat: identifying strategies to conserve a declining species
     - 3.1.6. Deer abundance and its relationship to factors that affect forest vegetation conditions
     - 3.1.7. Fall harvest and annual survival rates of female eastern wild turkeys in New York
     - 3.1.8. Snowshoe hare habitat relationships in response to northern forest management in Pennsylvania
     - 3.1.9. *Fawn survival in central and northcentral Pennsylvania

3.2. <u>Wagner</u>
   3.2.1. Characterization of spatial and temporal variability in fishes in response to climate change
   3.2.2. A decision support mapper for conserving stream fish habitats of the NE CSC region
   3.2.3. Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania
   3.2.4. Transboundary management and conservation: linking large-scale dynamics to ecological monitoring and management
   3.2.5. *Establishing a strategy for assessing risk of endocrine-disrupting compounds to aquatic and terrestrial organisms
   3.2.6. *Can plasticity protect populations from rapid environmental fluctuation?

3.3. <u>Walter</u>
   3.3.1. Surveillance and monitoring of river otter populations in Pennsylvania
   3.3.2. Spatial analysis of large mammals to assess harvest vulnerability in relation to landowner distribution
   3.3.3. Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
   3.3.4. Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife
   3.3.5. *Modeling potential habitat for pheasant population restoration

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

5. **Roster of Current Graduate Students and Post-Doctoral Researchers**

5.1. <u>Diefenbach</u>
   5.1.1. Danielle Begley – PhD Wildlife
   5.1.2. Clayton Lutz – MS Wildlife
   5.1.3. Laura Gigliotti, MS Wildlife
   5.1.4. Ethan Kibe, MS Wildlife
   5.1.5. Tess Gingery, MS Wildlife
   5.1.6. Lacey Williamson, MS Wildlife

5.2. <u>Wagner</u>
   5.2.1. Megan Kepler Schall – PhD Ecology
   5.2.2. Shannon White – PhD Ecology
   5.2.3. Steve Midway – Postdoctoral research scientist
   5.2.4. Yan Li – Postdoctoral research scientist (start date 1 Oct 2015)

5.3. <u>Walter</u>
   5.3.1. Nick Forman - MS Wildlife
   5.3.2. Charles Crawford - MS Wildlife
   5.3.3. Emily Carrollo – MS Wildlife
   5.3.4. Will Miller – PhD Ecology
   5.3.5. Lacey Williamson – MS Wildlife

6. Service on Graduate Committees (other than advisees)

6.1. Diefenbach

6.1.1. C. Crawford, MS Wildlife and Fisheries Science

6.1.2. J. Sklebo, MS Wildlife and Fisheries Science

6.2. Wagner

6.2.1. Jeff Kirby, PhD Ecology

6.2.2. Emi Fergus, PhD Fisheries and Wildlife (Michigan State University)

6.2.3. Richard Alexander, PhD Forestry

6.2.4. Didem Ikis, PhD Ecology

6.2.5. Krittika Petprakob, PhD Ecology

6.2.6. Brooks Fost, PhD Wildlife and Fisheries

6.2.7. Staci Amburgey, PhD Ecology

6.3. Walter

6.3.1. Megan Kepler Schall – PhD Ecology

6.3.2. Catherine Pritchard, PhD Wildlife

7. Courses and Workshops Taught by Unit Staff

7.1. Diefenbach

7.1.1. WFS 560 - Methods of Estimating Population Parameters, spring 2015

7.1.2. Advances in Ecology, fall 2014

7.2. Wagner

7.2.1. Hierarchical models in ecology, spring 2015

7.2.2. Hierarchical modeling workshop, The Ohio State University, spring 2015

7.2.3. Hierarchical modeling workshop, The University of Missouri, summer 2015

7.3. Walter

7.3.1. Advances in Ecology, fall 2014

7.3.2. Applied Spatial Ecology, spring 2015

8. Comments from Cooperators

9. Comments from Guests

10. Adjourn

11. An Executive Session of the Coordinating Committee will follow immediately after adjournment

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

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 Dispersal timing, distances, and rates of Pennsylvania black bear. Wendy Vreeland (Duane Diefenbach, advisor). Funding provided by PA Game Commission.

In Pennsylvania, the black bear (*Ursus americanus*) population has expanded its range since the early 1980s. I investigated if dispersal timing, distance, and rates changed compared to previous research, and if those changes corresponded with range expansion and increasing population density. I used records of bears captured and ear-tagged <16 months of age with specific locations of tagging and recapture or dead recovery encounters (n = 466). I classified bears as dispersed if the measured distance between initial capture and final recovery was ≥13 km, which was the greatest linear distance across the average female bear home range in Pennsylvania. Based on this criterion, I classified <5% of bears as dispersing <16 months of age and dispersal occurred at 16–19 months of age. I estimated dispersal rates using logistic regression models, to investigate if dispersal differed by region or decade for males and females. Median distance dispersed was greater for males (47.03 km, n = 98) than females (25.84 km, n = 70). Region of Pennsylvania and decade were not related to the distance bears dispersed. Overall, male dispersal rate was 0.67 (SE = 0.06) and female dispersal rate was 0.28 (SE = 0.06). For males, I found that dispersal rates were 0.48 in the 1980s and increased to >0.75 in the 1990s and 2000s but did not vary by region of Pennsylvania. No single logistic regression model best explained female dispersal so I used model averaging to estimate dispersal rates by decade and region. The greatest increase in female dispersal rates occurred between the 1990s and 2000s in all regions. My results indicated a greater dispersal rate, at greater distances, for female bears than previous research in Pennsylvania but dispersal characteristics of males were similar to previous research. My results indicated that dispersal by females, especially at the edge of the species range in Pennsylvania, was likely important to the rate of range expansion of bears in Pennsylvania.

2.1.2 Predicting post-harvest tree species composition based on pre-timber harvest advanced regeneration conditions. Glenn Stauffer, Duane Diefenbach, William Kanapaux. Funding provided by U.S. Geological Survey.

The ability to regenerate forests via complete overstory removals has implications for diversity of forest community types, age class distribution, sustainable timber harvests, and wildlife habitat. A concern in eastern North America is the failure to regenerate oak-dominated stands and the dominance of less desirable tree species (e.g., black birch and red maple). We used data on the condition of stands prior to timber harvest and 20–24 years afterwards to estimate the probability of transitioning among stand types. We found that oak-dominated stands were more likely to transition to stands dominated by red maple (P = 0.470), although most stands transitioned to a post-harvest stand type containing a substantial component of oak (P = 0.780). We found that northern hardwoods stands were most likely to remain northern hardwoods stands (P = 0.475) but also transition to stands dominated by black birch (P = 0.311). The time period over which these complete overstory removal harvests occurred, 1969–1991, was when silvicultural treatments such as deer exclusion, reduction of competing vegetation, or fire were not conducted. Such activities can potentially modify transition probabilities. In an adaptive management context, our approach to modeling outcomes of complete overstory removal could be used to learn which methods (deer exclusion, fire, or reduction of competing vegetation) are most effective at achieving desired outcomes.

2.1.3 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 Hill and Duane Diefenbach. Funded by U.S. Geological Survey, Bird Banding Lab.

The extraction of natural gas from shale formations in Appalachia have become a contentious political and environmental issue partially due to concerns over habitat loss and the fragmentation and degradation of wildlife habitat. The rapid expansion of natural gas extraction from the Marcellus Play in West Virginia and Pennsylvania has become a contentious political and environmental issue over the past decade, and is ultimately projected to result in the deforestation of approximately 420,000 hectares. We are unaware of any study that has examined the effects of Marcellus shale gas development on avian populations, possibly because of the challenges of measuring habitat-specific disturbance from Marcellus development. For the years 2001-2011 we used National Land Cover Data (NLCD) and semi-annual aerial photography to quantify the growth of Marcellus-related landscape changes within 250 m of 73 North American Breeding Bird Survey (BBS) routes. We used a Bayesian hierarchical framework to estimate the effects of this Marcellus develop on 10 interior forest and nine grassland bird species using a hierarchical Bayesian framework. Marcellus development was first detected in aerial photos in 2006 and development eventually occurred within 250 m of 21 (29%) routes. By 2011 Marcellus development had replaced at least ~0.1% (71.91 ha) of the study area; 15% of the development occurred in interior forest and 26% occurred in grasslands. From 2005-2011 the study area lost 185.76 ha (0.5%) of its total forest cover, and Marcellus development was responsible for approximately 34.92 ha (18.8%) of that forest loss. Marcellus-related development caused approximately 45.81 ha (16.5%) of all interior forest lost from 2005-2011 within our study area. Most grassland bird (n = 6 of 9) and interior forest (n = 6 of 10) species experience significant declines from 2001 to 2011, but Marcellus-related landscape changes likely had small effects on their trends. Had no Marcellus-related habitat losses occurred within our study area from 2001-2011, the annual trends of grassland and interior forest bird species would have likely only increased by ~0.05% and ~0.06%, respectively, over the same time period. Our results indicate that Marcellus-related habitat loss and fragmentation in forests and grasslands increased at an approximately exponential rate from 2001 to 2011 in Pennsylvania and West Virginia, but only affected a marginal proportion of the overall landscape. Our models estimate that these landscape changes had little effect on forest interior and grassland bird species trends over that time, but other studies have projected substantial increases in localized Marcellus-related landscape changes in the future. Currently large scale studies based on BBS data (like ours) may lack the resolution necessary to detect population-level effects to grassland or forest bird populations. Moving forward we suggest that small-scale or intensively-focused studies (e.g., mark-recapture or breeding success studies) might allow researchers to quantify the direct effects (e.g., territory abandonment and reduced nesting or pairing success) of Marcellus-related development.

2.2.1 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.

Attempts to meet Lake Trout Salvelinus namaycush restoration goals in the Laurentian Great Lakes rely heavily on stocking hatchery lake trout strains. Currently, there are six hatchery strains that are maintained by the U.S. Fish and Wildlife Service. Of these six strains currently in production, five are of the lean morphotype and one, the Klondike strain, is of the humper morphotype. The Klondike strain was developed to introduce morphotype variation back into the Great Lakes; however, no studies have assessed the genetic relationship of the Klondike strain of lake trout to its source population in Lake Superior or to the other hatchery strains currently in production. Therefore, the goals of this study were to (1) determine if the levels of genetic diversity of the hatchery Klondike strain are consistent with wild caught lake trout from Klondike Reef, Lake Superior and (2) compare estimates of genetic diversity of the Klondike strain of lake trout to other strains of lake trout currently stocked in the Great Lakes. All hatchery strains were found to have similarly low levels of genetic diversity, even though all are genetically distinct from one another. The Klondike strain, however, showed evidence of loss of genetic diversity, specifically allelic richness, when compared to the wild source population. This loss of genetic diversity, combined with the normal level of heterozygosity in the sample, may indicate a recent population bottleneck between the wild population and hatchery strain after a generation of hatchery rearing. The maintenance of the Klondike strain of lake trout is particularly important as this is the only humper morphotype in production. If maintaining genetic diversity within the Klondike strain is important, then continued monitoring of genetic diversity should be an important consideration.

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

Stream fish communities are frequently utilized as bioindicators of water quality and stream ecosystem health, because environmental and anthropogenic processes that control and alter physicochemical properties of streams are often reflected in fish community composition. Research staff of the Eastern Rivers and Mountains Network (ERMN), an Inventory and Monitoring network of the National Park Service, annually monitor core indicators of wadeable stream condition using measures of ecological integrity; however, no continuous stream fish community monitoring existed. Given the usefulness of stream fish as bioindicators and the potential benefits of adding long-term fish monitoring to the ERMN wadeable stream monitoring program, I developed and initiated the framework and methodology of a continuous, long-term fish community monitoring program for ERMN wadeable streams. During the spring and summer of 2013 and 2014, an occupancy sampling framework was used to collect stream fish detection/non-detection data at 68 randomly-selected, spatially-balanced sites across two ERMN parks: Delaware Water Gap National Recreation Area (DEWA) and New River Gorge National River (NERI). Hierarchical community occupancy models were used to describe stream fish distribution and determine the relative importance of stream habitat, measured at multiple spatial scales, in structuring stream fish communities. Results indicated that occupancy probabilities and effects of habitat, with respect to direction and magnitude, differed among species. In most cases, natural longitudinal gradients of stream habitat were reflected in species-specific and species group-specific occupancy probabilities, but sources of anthropogenic disturbance, such species introductions, impoundments, deforestation, and water quality impairment, also influenced the frequency of species occurrence and native-introduced species dynamics. These results highlight the importance of considering multiple processes and spatial scales in describing how stream fish communities are shaped by stream habitat, and that occupancy, a potentially under-utilized state variable in large-scale stream fish community studies, may be a valuable state variable for use in long-term species monitoring programs.

2.3.1 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 provided 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 was published in the Journal of Fish and Wildlife Management and Tyler Evans (MS student) defended his thesis in December 2014.

2.3.2 Characterization of habitat for pheasant in Wild Pheasant Recovery Areas of Pennsylvania. Alyssia Church, David Walter, Duane Diefenbach. Funding provided by PA Game Commission.

The deliverable for this project was digitized GIS layers of sampled habitat on Wild Pheasant Recovery Areas.

APPENDIX B – New and Continuing Projects
(projects marked with a '*' require approval)

3.1.1 Influences on the timing of denning in female black bears and its effect on harvest rates and estimates of population size. Ethan Kibe, Duane Diefenbach, Mark Ternent. 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. Ethan Kibe has developed a graduate research project based on the activity data as well the mark-recapture data and reproduction data collected on the study site. 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 female white-tailed deer in Pennsylvania. Clayton Lutz, Duane Diefenbach, Bret Wallingford, and Chris Rosenberry. Funding provided by Pennsylvania Game Commission

Clay published the first chapter of his thesis in the Journal of Mammalogy (see Appendix C). A second chapter of factors that influence dispersal movements is nearly ready to submit to a journal. Completion of thesis is planned could occur this year.

Ultimate causes of animal dispersal have been hypothesized to benefit the dispersing individual because dispersal reduces competition for local resources, reduces the potential for inbreeding, and reduces competition for breeding partners. However, proximate cues influence important features of dispersal behavior, including when dispersal occurs, how long it lasts, and the direction, straightness, and distance of the dispersal path. Therefore, proximate cues that affect dispersal can have an impact on important ecological processes such as population dynamics, disease transmission, and gene flow. We captured and radiomarked 277 juvenile female white-tailed deer (*Odocoileus virginianus*), of which 27 dispersed, to evaluate dispersal behavior and to determine proximate cues that may influence dispersal behavior. Female dispersal largely occurred at one year of age and coincided with the fawning season. Dispersal paths varied, but were generally non-linear and prolonged. Physical landscape features (i.e., roadways, rivers, residential areas) were important influences on changing dispersal path direction and influencing where dispersal terminated. Additionally, forays outside of the natal range that did not result in dispersal were recorded in 52% of GPS-collared deer (n = 25) during the dispersal period. Our results suggest that dispersal behavior in female deer is influenced by both intra-specific social interactions and physical landscape features.

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

Fieldwork and analyses of the survival and recovery data have been completed. However, we continue to monitor hens through the 2015 nesting season (July 2015). We are currently developing a manuscript that will also incorporate harvest and hunter effort data so that we can derive population estimates and relate results to hunting activity.

We designed a study to estimate the change in harvest rate of female turkeys by shortening or lengthening the autumn hunting season by 1 week. During 2010-2014, we captured adult and juvenile female turkeys in winter (Jan-Apr) and late summer (Aug-Oct) and fitted them with leg bands or radio-transmitters to estimate autumn harvest rates. One study area received a 1-week longer season for 2 years (2011-2012) and then season lengths were reversed on the study areas for the last 2 years (2013-2014). We estimated that an additional week of hunting increased the harvest rate by 0.0176 (SE = 0.0106, 95% CI = 0.006–0.052). Over the 5 years, harvest rates were greatest in the second year of the study (0.072–0.090) and declined to 0.018–0.036. Although autumn harvest rates are relatively low (<0.10) and variable, our study provided information that managers can incorporate into decision models for recommending harvest regulations.

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

Our work from 2012 has been submitted to a journal (abstract follows). We were contacted this summer by Cumberland Island National Seashore biologist to assist with assessing genetics of coyotes on the island. In addition, we plan to return to CUIS) this coming December/January to collect more bobcat scat to continue monitoring the population.

In 1988-1989, 32 bobcats Lynx rufus were reintroduced to Cumberland Island, Georgia, USA, from which they had previously been extirpated. They were monitored intensively for three years immediately post-reintroduction, but no estimation of the size or genetic diversity of the population had been conducted in over 20 years since reintroduction. We returned to Cumberland Island in 2012 to estimate abundance and effective population size of the present-day population, as well as to quantify genetic diversity and inbreeding. We amplified 12 nuclear microsatellite loci from DNA isolated from scats to establish genetic profiles to identify individuals. We used spatially explicit capture-recapture population estimation to estimate abundance.

From nine unique genetic profiles, we estimate a population size of 14.4 (SE = 3.052) bobcats, with an effective population size (Ne) of 5-8 breeding individuals. This is consistent with predictions of a population viability analysis conducted at the time of reintroduction, which estimated the population would average 12-13 bobcats after 10 years. We identified several pairs of related bobcats (parent-offspring and full-siblings), but ~75% of the pairwise comparisons were typical of unrelated individuals, and only one individual was inbred. Despite the small population size and other indications that it has experienced a genetic bottleneck, levels of genetic diversity in the Cumberland Island bobcat population remain high compared to other mammalian carnivores.

Bobcats are a common species in North America and the reintroduction to Cumberland Island provides an opportunity to study changes in genetic diversity in an insular population without risk to the species. Opportunities for natural immigration to the island are limited; therefore, continued monitoring and supplemental bobcat reintroductions could be used to evaluate the effect of different management strategies to maintain genetic diversity and population viability. The successful reintroduction and maintenance of a bobcat population on Cumberland Island illustrates the suitability of translocation as a management tool for re-establishing felid populations.

3.1.5 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 complete and manuscript soon will be submitted to a journal. 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.

3.1.6 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.

Danielle Begley began her Ph.D. research in 2014 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). In addition, soil analyses are being conducted.

3.1.7 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 third of 4 fall harvest seasons for this study will occur in 2015.

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

Fieldwork for the second and final season of the snowshoe hare project was carried out from January – June and was restricted to the northeastern study area near Long Pond, PA. We trapped a total of 29 adult hares and 4 juvenile hares this year, bringing our total number of captures for the project to 72 adults and 4 juveniles. Over the past two years we were able to obtain GPS locations from 32 hares, resulting in over 50,000 locations to use for analysis. We also recorded vegetation data at nearly 400 plots during both leaf-off and leaf-on seasons to be used for fine-scale seasonal resource selection analysis. Analysis is now underway to determine home range sizes, survival, density, resource selection and movement rates of the hare population.

3.1.9. *Fawn survival in central and northcentral Pennsylvania. Tess Gingery, Chris Rosenberry, and Duane Diefenbach. Funded by PA Game Commission.

The graduate student, Tess Gingery, will begin in August 2015. Fawns will be captured by field crews searching for fawns and located using vaginal implant transmitters (VITs) to capture fawns near the birth site. In 2015, 42 fawns were captured, most via fawn searches. In the next two field seasons we expect more VITs to be deployed and sample sizes to increase as field crews identify the most successful and efficient search strategies.

3.2.1 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.

3.2.2 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.

3.2.3 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.

3.2.4 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.

3.2.5* Establishing a strategy for assessing risk of endocrine-disrupting compounds to aquatic and terrestrial organisms. Tyler Wagner (PI), Vicki Blazer (USGS), Don Tillet (USGS), and Patrick Phillips (USGS).

The effects of endocrine-disrupting compounds (EDCs) on fish and wildlife populations are complex, affecting the development and function of the endocrine, reproductive, and immune systems (Colborn et al. 1994). The toxic mechanisms of EDCs are also often poorly understood, which reduces the ability to predict adverse outcomes from exposure and to assess risk for fish and wildlife populations. For example, EDCs may have low-dose effects, where effects are observed at doses below those used for conventional toxicological studies, and they may be characterized by nonlinear dose-response curves (Vandenberg et al. 2012). Because of the complex modes of action of EDCs, the mixture of chemical substances in the environment (e.g. additivity, synergy, antagonism, and potentiation), the potential for organisms to have multiple pathways of exposure, and difficulties in determining cause-effect relationships in field studies, measuring the probability of undesirable outcomes, i.e., assessing risk, is inherently difficult. However, assessing risk associated with EDCs is critical for informing risk management decisions. The overall goal of this research is to is to develop a strategy for assessing the risk of

EDCs to fish and wildlife populations that (1) explicitly incorporates uncertainty and expert opinion, (2) is transparent with regards to known or hypothesized causal relationships in systems of interest, and (3) develops a probabilistic representation of variability observed in nature.

3.2.6* Can plasticity protect populations from rapid environmental fluctuation? Tyler Wagner (PI).

Habitat degradation and climate change will be the leading causes of future species extinction. Theoretical models suggest species persistence will require population adaptation and migration. However, landscape habitat data used to generate models may not accurately reflect patterns of local habitat use. At small spatial scales, phenotypic plasticity may enable populations to continue occupying rapidly changing habitat mosaics despite loss of broad-scale habitat characteristics. These cross-scale interactions produce unanticipated, nonlinear patterns and dynamics which reduce the ability to predict future outcomes of climate change on species resiliency, adaptive potential, and persistence. As such, understanding how plasticity influences habitat suitability will be critical to future natural resource management.

Phenotypic plasticity is a malleable trait that is developed, in large part, through early-life interactions with the environment. Loss of genetic diversity and habitat complexity decrease population plasticity. With a reduced ability to exploit new habitats and engage in novel behavior, a decrease in plasticity results in higher susceptibility to disturbance. As such, plasticity may determine the pace for population extirpation due to habitat loss.

Natural resource management often focuses on conservation of landscapes and populations. The significance of these efforts cannot be ignored; however, the certainty of future habitat loss necessitates management become more forward-thinking and shift focus to promoting resistance and resilience. To accomplish this goal, a better understanding of emergent properties of landscapes and populations is vital. This study will examine whether population survival can be enhanced through management of the genetic and environmental controls of plasticity to increase resilience to habitat loss. This is a critical question as translocations and reintroductions are increasingly proposed to conserve or enhance biodiversity under a changing climate.

3.3.1 Surveillance and monitoring of river otter populations in Pennsylvania. Nick Forman, David Walter, Matt Lovallo. Funding 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 is completed and Nick Forman (MS student) is currently writing his thesis.

3.3.2. 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 completed and Chaz Crawford (MS student) is currently writing his thesis.

3.3.3 Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease. Will Miller, 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.

3.3.4 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. Captive cervid facilities are common in some states in the U.S. with Pennsylvania having over 1000 captive deer facilities accounting for over 25,000 individual deer. Laws and regulations regarding captive facilities are usually minimal, but recently have become more common and enforced due to increases of disease in captive cervids. With how likely disease can occur in captive facilities because of aggregation and confinement over prolonged periods, and how easily disease can be spread from captive facilities to wild deer populations, a more complete understanding of captive facilities will aid wildlife and agricultural managers in understanding this dynamic. We examined the landscape characteristics of captive cervid facilities in Pennsylvania to understand where wild cervid populations may be most at risk for disease transmission from captive cervids or vice versa. We solicited and received land parcel layers, location of captive facilities, and environmental predictors (e.g., state game lands, forest cover) that were available at the county level in Geographic Information System format from 48 counties in Pennsylvania. We were able to examine landscape characteristics for 920 captive cervid facilities that were considered “active” operations. Our results could assist agencies with identifying areas at high risk for disease transmission between captive and wild deer to more efficiently sample the over 1,000 captive operations and one million wild deer in Pennsylvania.

3.3.5 **Modeling potential habitat for pheasant population restoration.** Lacey Williamson, Duane Diefenbach, W. David Walter, Scott Klinger. Funding by Pennsylvania Game Commission.

The Pennsylvania Game Commission (PGC) has established several Wild Pheasant Restoration Areas (WPRAs) with specific population density goals (10 hen pheasants per square mile). Research being conducted on these areas provides an opportunity to evaluate under which habitat conditions wild pheasant populations have met established pheasant density goals. If additional WPRAs are going to be considered in Pennsylvania it would be useful to have a predictive model to assess existing landscapes to determine if pheasant restoration is possible or what habitat changes would be required to ensure success of the WPRA. Our primary goal will be to develop a habitat-based model to evaluate a landscape and predict the success of restoring wild pheasant populations to some defined pheasant density goal. In addition, this model could be used to identify habitat management actions required to increase the likelihood of success in pheasant population restoration to develop a habitat-based model to evaluate the landscape and predict the success of restoring wild pheasant populations to some defined pheasant density goal. In addition, this model could be used to identify habitat management actions required to increase the likelihood of success in pheasant population restoration.

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

Honors and Awards

Shannon White was awarded a National Science Foundation Graduate Research Fellowship.

Megan Kepler Schall was awarded a travel grant by the AFS- Fish Health Section to attend the Annual AFS-Fish Health Section Meeting.

Tyler Wagner was promoted to GS-14 and adjunct professor of fisheries ecology.

Will Miller received the Best Student Presentation Award at the annual meeting of the Pennsylvania Chapter of The Wildlife Society.

Theses and Dissertations

Evans, T.S. 2014. Chronic wasting disease in the Central Appalachian region of the United States. Thesis, The Pennsylvania State University, University Park, PA, 81 pp.

Faulk, E.A. 2015. Patterns in distributions of stream fishes in the Eastern Rivers and Mountains Network: A multi-species occupancy approach. Thesis, The Pennsylvania State University, University Park, PA.

Salvesen, K.E. 2015. Lake Trout restoration in the Great Lakes: From hatchery to natural reproduction. Thesis, The Pennsylvania State University, University Park, PA

Vreeland, W.C. 2015. Dispersal timing, distances, and rates of Pennsylvania black bear. Thesis, The Pennsylvania State University, University Park, PA.

Peer-reviewed Publications

Buderman, F. E., D. R. Diefenbach, C. S. Rosenberry, B. D. Wallingford, and E. S. Long. 2014. Effect of hunter selectivity on harvest rates of radio-collared white-tailed deer in Pennsylvania. Journal of Wildlife Management 78:1456-1465.

DePasquale, C., **T. Wagner**, G.A. Archard, B. Ferguson, and V.A. Braithwaite. 2014. Learning rate and temperament in a high predation risk environment. Oecologia 176:661-667.

DeWeber, J.T. and **T. Wagner**. Accepted. Translating climate change effects into everyday language: an example of more driving and less angling. Fisheries.

DeWeber, J.T and **T. Wagner**. 2015. Predicting brook trout occurrence in stream reaches throughout their native range in the eastern United States. Transactions of the American Fisheries Society 144:11-24.

Evans, T.S., K.L. Schuler, and **W.D.Walter**. 2014. Surveillance and monitoring of white-tailed deer for chronic wasting disease in the northeastern United States. Journal of Fish and Wildlife Management 5(2): 387–393.

Filstrup, C.T., **T. Wagner**, P.A. Soranno, E.H. Stanley, C.A. Stow, K.E. Webster, and J. A. Downing. 2014. Regional variability among nonlinear chlorophyll-phosphorus relationships in lakes. Limnology and Oceanography 59:1691-1703.

Johnson, H.E., J.W. Fischer, M Hammond, P. Dorsey, **W. D. Walter**, C.W. Anderson, and K.C. VerCauteren. 2014. Evaluation of techniques to reduce deer and elk damage to agricultural crops. Wildlife Society Bulletin 38(2):358–365.

Kepler, M.V., **T. Wagner**, and J.A. Sweka. 2014. Comparative bioenergetics modeling of two Lake Trout morphotypes. Transactions of the American Fisheries Society 143:1592–1604.

Lutz, C. L., D. R. Diefenbach, C. S. Rosenberry. 2015. Population density influences dispersal in female white-tailed deer. Journal of Mammalogy 96:494-501.

Laake, J. L., D. Johnson, **D. R. Diefenbach**, M. A. Ternent. 2014. Hidden Markov Model for Dependent Tag Loss and Survival Estimation. Journal of Agricultural, Biological, and Environmental Statistics 19:522-540.

Midway, S.M., **T. Wagner**, and B. Tracy. 2014. A hierarchical community occurrence model for North Carolina stream fish. Transactions of the American Fisheries Society 143:1348-1357.

Midway, S., **T. Wagner**, B. H. Tracy, G. M. Hogue, and W.C. Starnes. 2015. Evaluating changes in stream fish species richness over a 50-year time-period within a landscape context. Environmental Biology of Fishes 98:1295-1309.

Midway, S. R., **T. Wagner**, S. Arnott, P. Biondo, F. Martinez-Andrade, and T. Wadsworth. 2015. Spatial and temporal variability in growth of southern flounder (*Paralichthys lethostigma*). Fisheries Research 167:323-332.

Perles, S.J., **T. Wagner**, B.J. Irwin, D.R. Manning, K.K. Callahan, and M.R. Marshall. 2014. Evaluation of a regional monitoring program's statistical power to detect temporal trends in forest health indicators. Environmental Management 54:641-655.

Smith, L.A., **T. Wagner**, M.L. Bartron. 2015. Spatial and temporal movement dynamics of brook Salvelinus fontinalis and brown trout *Salmo trutta*. Environmental Biology of Fishes.

Soranno, P.A., E.G. Bissell, K.S. Cheruvelil, S.M. Collins, C.E. Fregus, C.T. Filstrup, J-F. Lapierre, N.R. Lottig, S.K. Oliver, C.E. Scott, N.J. Smith, S. Stopyak, S. Yuan, M.T. Bremigan, J.A. Downing, C. Gries, E.N. Henry, N.K. Skaff, E.H. Stanley, C.A. Stow, P-N. Tan, **T. Wagner**, and K.E. Webster. 2015. Building a multi-scaled geospatial temporal ecology database from disparate data sources: Fostering open science and data reuse. GigaScience 4:28.

Wagner, T., and **S. R. Midway**. 2014. Modeling spatially varying landscape change points in species occurrence thresholds. Ecosphere 5(11):145. http://dx.doi.org/10.1890/ES14-00288.1

Walter, W.D., D.P. Onorato, and J.W. Fischer. 2015. Is there a single best estimator? Selection of home range estimators using area-under-the-curve. Movement Ecology 3. http://link.springer.com/article/10.1186/s40462-015-0039-4

Walter, W.D., C.M. Kurle, and J.B. Hopkins, III. 2014. Applications of stable isotope analysis in mammalian ecology. Editorial to Special Issue on Stable Isotopes in Mammals, Isotopes in Environmental and Health Studies 50(3): 287–290.

Walter, W.D. 2014. Use of stable isotopes to identify dietary differences across subpopulations and sex for a free-ranging generalist herbivore. Isotopes in Environmental and Health Studies 50(3): 399–413.

Technical Reports

Walter, W.D. and J.W. Fischer. Manual of Applied Spatial Ecology. Online: http://ecosystems.psu.edu/research/labs/walter-lab

Presentations at Scientific Meetings

Carrollo, E., Justin Brown, **W.D. Walter**. 2015. Is there a risk for disease transmission between captive cervids and wild deer in Pennsylvania? Pennsylvania Chapter of the Wildlife Society Annual Meeting

Daniel, W., N. Sievert, D. Infante, C. Paukert, J. Stewart, J. Whittier, **T. Wagner**, K. Herreman, and Y. Tsang. FISHTAIL: A decision support mapper for conserving stream fish habitats of the NE CSC region. Midwest Fish and Wildlife Conference, Indianapolis, IN.

Diefenbach, D. R., and W. A. Link. Using integrated population models to monitor game species. International Statistical Ecology Conference. 1-4 July 2014, Montpellier, France.

Faulk, E. and **T. Wagner.** 2014. Stream Fish Communities in the Delaware Water Gap National Recreation Area: A Multi-Species Occupancy Approach. American Fisheries Society, 144th Annual Meeting, August 17-12.

Filstrup, C.T., S.K. Oliver, E.H. Stanley, C.A. Stow, **T. Wagner**, K.E. Webster, and J.A. Downing. 2015. Regional land use influences nitrogen subsidy-stress effects on lake phytoplankton. Association for the Sciences of Limnology and Oceanography 2015 Aquatic Sciences Meeting, February 2015, Granada, Spain.

Hill, J. M., J. F. Egan, **G. E. Stauffer**, and **D. R. Diefenbach**. Habitat availability is a more plausible explanation than insecticide acute toxicity for U.S. grassland bird species declines. Annual Conference of The Wildlife Society, 23 October 2014, Pittsburgh, Pennsylvania.

Just, E. M., **D. R. Diefenbach**, T. Crandall, S. Lehman, C. Nicholas, and J. Brodnicki. A Decision Model for Managing White-Tailed Deer on Pennsylvania State Forests. Annual Conference of The Wildlife Society, 23 October 2014, Pittsburgh, Pennsylvania.

Kepler, M.V., V. Blazer, **T. Wagner**, H. Walsh, G. Smith. 2014. Evaluation of potential disease causing agents in young of the year smallmouth bass in the Chesapeake Bay Watershed. International Symposium on Aquatic Animal Health. Portland, OR. August 31 – 5 September.

Lorantas, R., **T. Wagner**, D. Arnold, J. Detar, M. Kaufmann, K. Kuhn, R. Lorson, R. Wnuk, and A. Woomer 2015. Characterizing survival of Smallmouth Bass from Age 0 to Age 1 in Pennsylvania river sections using electrofishing survey gear catch rate and regression residuals. The Annual Northeast Fish & Wildlife Conference.

Schall, M.K., **T. Wagner**, V. Blazer, and T. Wertz. Movement dynamics of Smallmouth Bass in the Susquehanna River basin. Pennsylvania-Ohio 2015 Joint American Fisheries Society Annual Meeting, 25–27 February 2015.

Schall, M.K., V.S. Blazer, **T. Wagner**, T. Wertz, and G. Smith. 2015. Investigation of contaminants and disease characteristics of young of the year Smallmouth Bass in the Susquehanna River basin, PA. AFS-Fish Health Section Annual Meeting, Ithaca, NY. July 13-15.

Vidal, T., B. J. Irwin, **T. Wagner**, L. G. Rudstam, J. R. Bence, and J. R. Jackson. Using variance structure to quantify perturbation induced ecological reorganization. Warnell Graduate Student Symposium, University of Georgia, Athens, GA.

Vidal, T., C. Jansch, B. J. Irwin, **T. Wagner**, J. R. Bence, J. R. Jackson, L. G. Rudstam, and W. W. Fetzer. 2014. Using variance structure as statistical indicators of large scale ecological change. Annual meeting of the American Fisheries Society, Québec City, Québec, Canada.

Irwin, B. J., T. Vidal, **T. Wagner**, J. R. Bence, J. R. Jackson, L. G. Rudstam, and W. W. Fetzer. 2014. Shifting variance structure as an indicator of large-scale ecological change. Annual meeting of the Ecological Society of America, Sacramento, CA.

Miller, W.L., J. Brown, **W.D. Walter**. 2015. Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease. Pennsylvania Chapter of the Wildlife Society Annual Meeting

Siepker C., N. Haley, **W. Walter**, L. Hoon-Hanks, R. Monello, J. Powers, B. Thomsen, J. Greenlee, A. Lehmkuhl, G. Mitchell, T. Nichols, E. Hoover, J. Richt. 2015. Clinical Stage of Infection is Critical in the Antemortem Diagnosis of Chronic Wasting Disease in Deer and Elk. Prion Conference, Fort Collins, CO (Poster).

Walter, W.D., and **T.S.Evans**. 2015. Influence of habitat and demographic components on exposure to chronic wasting disease in white-tailed deer in the eastern United States. Prion Conference, Fort Collins, CO (Poster).

Carrollo, E., H.E. Johnson, J.W. Fischer, M. Hammond, P.D. Dorsey, C. Anderson, K.C. VerCauteren, **W.D. Walter**. 2014. Mule deer resource selection of agricultural crops in southwestern Colorado. The 21st Annual Wildlife Society Conference, Pittsburgh, PA (Poster)

Evans, T.S., M. Kirchgessner, B. Eyler, C.W. Ryan, and **W.D. Walter**. 2014. Bayesian hierarchical modeling of chronic wasting disease in the central Appalachian region. The 21st Annual Conference of the Wildlife Society, Pittsburgh, PA, 26 October 2014.

Crawford, C.S., M.A. Ternent, M.J. Lovallo, and **W.D.Walter**. 2014. Resource selection and harvest vulnerability of *Ursus americanus* near suburban areas of Pennsylvania: a landholder approach. The 21st Annual Conference of the Wildlife Society, Pittsburgh, PA, 26 October 2014.

Forman, N.F., T. Hardisky, M.J. Lovallo, and **W.D. Walter**. 2014. Monitoring river otter populations in northeastern Pennsylvania using non-invasive genetic sampling and spatial capture-recapture models. The 21st Annual Conference of the Wildlife Society, Pittsburgh, PA, 26 October 2014.

Vreeland, W. C., D. R. Diefenbach, M. Ternent. Dispersal Timing, Distance, and Rate of Pennsylvania Black Bear. Annual Conference of The Wildlife Society, Pittsburgh, Pennsylvania. 23 October 2014.