AGENDA

Coordinating Committee Meeting
Pennsylvania Cooperative Fish and Wildlife Research Unit

Friday, June 15, 2018
9:30 AM
To be held in Room 217 in the Forest Resources Building

1. **Approval of minutes from June 14, 2017 meeting**

2. **Completed Projects (Summaries in Appendix A; yellow pages)**
   2.1. Diefenbach
      2.1.1. Fawn survival in central and northcentral Pennsylvania
      2.1.2. The Deer-Forest Study: Shaping Pennsylvania's forests: effects of white-tailed deer, soil chemistry, and competing vegetation on oak-hickory forest understory plant community composition
   2.2. Wagner
      2.2.1. Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania
      2.2.2. Comparing relative abundance and population characteristics of Flathead Catfish across a range of establishment levels at the Susquehanna River
   2.3. Walter
      2.3.1. Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
      2.3.2. Modeling potential habitat for pheasant population restoration

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. Harvest and survival rates of hen wild turkeys in Pennsylvania
      3.1.3. Genetics of an insular population of bobcats and coyotes
      3.1.4. Deer abundance and its relationship to factors that affect forest vegetation conditions
      3.1.5. Distribution of predators and their relation to fawn survival
      3.1.6. *Hunter demand for the management of chronic wasting disease in Pennsylvania's deer population

   3.2. Wagner
      3.2.1. Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania
      3.2.2. Establishing a strategy for assessing risk of endocrine-disrupting compounds to aquatic and terrestrial organisms
      3.2.3. Can plasticity protect populations from rapid environmental fluctuation?

3.2.4. An investigation into the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River
3.2.5. A macrosystems ecology framework for continental-scale prediction and understanding of lakes
3.2.6. *Comparison of age and growth patterns of Flathead Catfish in invasive and native populations: A meta-analysis with implications for invasive species management in Pennsylvania

3.3. Walter
3.3.1. Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
3.3.2. Assessment of PRNP genotypes and stress levels to determine potential susceptibility of elk to chronic wasting disease
3.3.3. Analysis of stable isotopes to differentiate between pen-reared and wild-born pheasant in Pennsylvania
3.3.4. Feasibility of using non-invasive genetic sampling and spatial capture-recapture models for population estimation of fisher (*Martes pennanti*)
3.3.5. Epidemiology of West Nile virus in ruffed grouse (*Bonasa umbellus*)
3.3.6. *Muskrat (*Ondatra zibethicus*) ecology, population estimation, and health
3.3.7. *Assessment of fence-line interactions at the captive-wild deer interface

4. Proposed Budget – (next page)

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

5.1. Diefenbach
5.1.1. Danielle Begley-Miller, post-doctoral scholar
5.1.2. Ethan Kibe, MS Wildlife and Fisheries
5.1.3. Asia Murphy, PhD Ecology
5.1.4. Amanda Van Buskirk, MS Ecology

5.2. Wagner
5.2.1. Megan Schall, postdoctoral scholar
5.2.2. Catherine McClure, MS Ecology
5.2.3. Danielle Massie, MS WFS
5.2.4. Shannon White, PhD Ecology
5.2.5. Tyler Thompson, MS Wildlife and Fisheries

5.3. Walter
5.3.1. Will Miller – PhD Ecology
5.3.2. Laken Ganoe - MS Wildlife and Fisheries
5.3.3. Farshid Ahrestani - post-doctoral scholar

6. Service on Graduate Committees (other than advisees)

6.1. Diefenbach
6.1.1. N. Navarro, MS Soil Science
6.1.2. S. White, PhD Ecology

6.2. Wagner
6.2.1. Courtney Davis, PhD Ecology

6.2.2. Staci Amburgey, PhD Ecology

6.3. Walter

6.3.1. Ellen Brandell, PhD Ecology
6.3.2. David Ensminger, PhD Wildlife and Fisheries
6.3.3. Ethan Kibe, MS Wildlife and Fisheries
6.3.4. Casey Weathers, PhD Wildlife and Fisheries

7. Courses and Workshops Taught by Unit Staff

7.1. Diefenbach

7.1.1. Population Estimation and Modeling, spring 2018

7.2. Wagner

7.2.1. Quantitative Methods in Ecology, spring 2017
7.2.2. Introduction to R and hierarchical models (workshop)

7.3. Walter

7.3.1. Applied Spatial Ecology in R (workshop)

8. Comments from Cooperators

9. Adjourn

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

10.1. 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 Fawn survival in central and northcentral Pennsylvania

Juvenile survival may be the most critical component of large herbivore population growth, but how neonate survival changes over time and space is not fully understood. Neonate survival rates are influenced by maternal care, site-specific differences, and are generally characterized by year-to-year variation. Sources of white-tailed deer (Odocoileus virginianus) fawn mortality across North America include predation, natural causes (excluding predation), and both direct and indirect human-caused mortality. The relative frequency of these causes indicates which sources most affect neonate survival and can be easily compared among studies. We used a meta-analysis approach to elucidate spatial patterns in fawn survival at a landscape-scale across North America. However, comparing survival rates across time is not possible when confounded by spatial variation. Therefore, we investigated how fawn survival varied across time by conducting a neonate survival study in central Pennsylvania to compare a current estimate of neonate survival to previous estimates for central Pennsylvania in 2000–2001. Furthermore, because pre-weaned neonates (<3 months of age) are entirely dependent upon maternal care, maternal behaviors can explain variation in neonate survival rates from year-to-year. The cost, size, and weight of current bio-logging technologies (e.g. global positioning system (GPS) collars) often limit their ability to monitor mother-offspring behavior, even for large herbivores. We conducted a pilot study to evaluate the performance of a behavioral monitoring bio-logger and detail temporally dynamic patterns of maternal behaviors in white-tailed deer.

We conducted a meta-analysis of white-tailed deer fawn survival to identify patterns in survival and cause-specific mortality related to landscape characteristics, predator communities, and deer population density. We used fawn survival and cause-specific mortality data from 29 populations in 16 states across North America from studies that reported a survival rate to 3–6 months of age, sample sizes, landscape descriptions, and cause-specific mortality. We modeled the relationship of fawn survival to percentage of agricultural land cover and deer density. We detected fawn survival increased as the percentage of agricultural land cover increased. We classified cause-specific mortality as human-caused, natural (excluding predation), and predation according to agriculturally dominated, forested, and mixed (i.e., approximately equal parts agriculture and forest) landscapes. Predation was the greatest source of mortality in all three landscape types. Mixed landscapes had greater proportions of human-caused mortalities, and less mortality due to predators, when compared to forested landscapes but not when compared to agricultural landscapes. The proportion of natural deaths was similar among mixed, forested, and agricultural landscapes even though overall mortality rates differed. We failed to detect any relationship between fawn survival and deer density.

Since 2000–2001, surveillance of wildlife populations suggest varying densities of deer, black bear, and coyote populations across Pennsylvania. We assessed differences in current estimates of white-tailed deer neonate survival rates and cause-specific mortality from 2015 to 2016 in central Pennsylvania to estimations reported during 2000–2001. We collared neonates in 2015–2016 and monitored survival until 34-weeks of age, mortality, or transmitter failure. We captured 55 neonates in north-central Pennsylvania and 43 neonates in central Pennsylvania. At 26 weeks after capture current fawn survival was 0.504 (95% CI = 0.337 – 0.621) in an 88%

forested landscape in northcentral Pennsylvania and 0.708 (95% CI = 0.569–0.848) in central Pennsylvania that contained approximately 15% more agricultural land cover. In 2000, 26-week survival estimates were 0.456 (95% CI = 0.360 – 0.556) in northcentral Pennsylvania and 0.586 (95% CI = 0.488 – 0.677) in central Pennsylvania. We failed to detect any long-term change in fawn survival rates or predator abundances in the areas designated as Wildlife Management Units by the Pennsylvania Game Commission that surrounded our study areas.

2.1.2 The Deer-Forest Study: Shaping Pennsylvania's forests: Effects of white-tailed deer, soil chemistry, and competing vegetation on oak-hickory forest understory plant community composition

Several factors influence plant community composition of forest understories, including browsing by white-tailed deer (Odocoileus virginianus), competitive interactions with other plant taxa, and soil chemistry changes due to acid deposition. Each of these factors has been extensively studied throughout the northeast, but to date no studies have attempted to understand their interactions and overall influence on forest understories in the Ridge and Valley Physiographic Province of Pennsylvania. This dissertation separates the relative importance of each of these factors using several approaches. In chapter 1, I use single-species occupancy models to better understand species-specific responses to soil chemistry and removal from deer browsing. In chapter 2, I use generalized joint attribute models to assess biotic interactions in the context of environmental predictors that explained occupancy of individual species in chapter 1. Chapter 3 culminates my research by presenting short-term (3-year) results from a full-factorial experimental manipulation of plant communities using liming (to improve soil chemistry), fencing (to exclude deer browsing), and herbicide application (to remove competing vegetation). My results highlight the importance of soil chemistry in shaping occupancy of plant taxa and indicate these relationships likely alter competitive interactions between species. Exclusion of white-tailed deer had no effect on occupancy, abundance, or flowering status of deer-preferred plants after 2 years, suggesting slow or limited recovery of these taxa immediately after protection from browsing. Additionally, short-term results from the experimental manipulation indicate that liming has positive effects on forest herb abundance and flowering status, and that competitive release has been achieved in response to herbicide application for non-competing vegetation. Overall, this study demonstrates that soil chemistry and competing vegetation interact to shape plant community composition, however, results should be considered preliminary. Continuous monitoring of these communities is necessary to better understand long-term trends in response to treatment and whether shifts in community composition persist through time.

2.2.1 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 demonstrated declines in indices of relative abundance since 2005 - although indices of abundance have appeared to stabilize in recent years. 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. The goal of this research project was 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, this study provided insight into smallmouth bass ecology that is relevant to disease and fisheries management, including quantifying movement dynamics in the mainstem and tributary rivers and genetic population structure. We also examined spatiotemporal dynamics of a myxozoan parasite that may have deleterious effects on smallmouth bass, particularly young-of-year fish. This research is summarized in the PhD dissertation of Megan Kepler Schall and manuscripts referenced in Appendix C.

2.2.2 Comparing relative abundance and population characteristics of Flathead Catfish across a range of establishment levels at the Susquehanna River Tyler Wagner (co-PI), Geoff Smith (PI)

The impacts of introduced Flathead Catfish on migratory and resident fishes are well documented; however, few studies have focused on populations located in northern latitudes. Models suggest that Flathead Catfish suppress native fish biomass 5 – 50% through predation and competitive interactions. In other areas of the Atlantic Slope where Flathead Catfish occur, they often became established prior to pre-establishment data being collected, so the full extent of the implications of their introduction could not fully be assessed. Areas within the Susquehanna River Basin still have not seen establishment of Flathead Catfish populations, so this represents a unique opportunity to gather baseline data and improve our understanding of the effects this species has on native communities. The primary objective of this study is to characterize Flathead Catfish populations within a 173-km reach of the Susquehanna River to understand invasion ecology across a gradient of population establishment. In addition to quantifying growth and relative abundance in the Susquehanna River , we also performed a meta-analysis to put observed PA growth rates into a broader regional context. This work is summarized in the publication by Massie et al. in Appendix C.

2.3.1 Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease. Will Miller, David Walter, Justin Brown (PGC), Megan Kirchgessner (VGIFW), Chris Ryan (WV DNR), Bryan Eyler (MD DNR). 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.

This project resulted in numerous products that are currently chapters of a PhD Dissertation by Will Miller (23 July 2018 Defense Date). Chapter 1 identifies microsatellite panels used to differentiate white-tailed deer in the easter US was recently submitted to BMC Genetics. Chapter 2 identifies spatial genetic structure of deer associated with the distribution of chronic wasting disease in the Mid-Atlantic Region. Chapter 3 includes genetic assignment tests that provide insight into the epidemiology of chronic wasting disease in Pennsylvania. Chapter 4 identifies spatial heterogeneity of prion gene polymorphisms in white-tailed deer and a related manuscript of a similar nature with elk was published in Bioinformatics by Miller and Walter in Appendix C. Chapter 5 will identify a resistance surface to gene flow in the Mid-Atlantic Region for detailed understanding of chronic wasting disease movement and spread and the risk to Pennsylvania's elk herd.

2.3.2 Modeling potential habitat for pheasant population restoration. Lacey Williamson, Duane Diefenbach, W. David Walter, Scott Klinger (PGC), 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. The density estimation portion of the study was recently accepted for publication in the Journal of Wildlife Management by Williamson et al. in Appendix C.

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. Ethan Kibe, Duane Diefenbach, Mark Ternent. Funded by Pennsylvania Game Commission and U.S. Geological Survey.

Ethan Kibe has completed the coursework for his degree, most of the data analysis, and is currently writing his thesis. Initial findings are that timing of denning of females can be predicted by the PGC's mast index. Weather conditions were not found to influence timing of denning. Ethan has incorporated the mast index into the Horvitz-Thompson estimator developed by Diefenbach et al. (2004), and although it helped improve precision of harvest rates it did not improve resulting abundance estimates of breeding-age females.

3.1.2 Harvest and survival rates of hen wild turkeys in Pennsylvania. Duane R. Diefenbach, Mary Jo Casalena (PGC), Paul Fackler (NCSU), Barry Grand (USGS), Amy Silvano (AL DNR). Funded by PGC, Pennsylvania Chapter NWTF, Alabama Chapter NWTF.

We are developing a stochastic dynamic programming model for making recommendations for harvest regulations. These SDP models incorporate a population dynamics model with accompanying uncertainties into an explicit framework for make decisions. This is a collaborative project with Alabama and is an interesting contrast in management approaches. Alabama has no fall season and believes that spring harvest has an impact on population dynamics, whereas in Pennsylvania the spring harvest is considered to have little effect on population dynamics but the fall hunting season needs to be monitored to prevent population declines. Funding has been provided by the PA and AL chapters as well as the national organization of NWTF and work is ongoing.

3.1.3 Genetics of an insular population of bobcats and coyotes. D. Diefenbach. L. Hansen (LANL), C. Miller-Butterworth (Penn State–Beaver), D. Hoffman (NPS), J. Jordan (Kiawah Island).

We continue to analyze tissue and scat samples from Cumberland Island, GA, Kiawah Island, SC, and mainland GA and SC to compare genetics of mainland populations with these isolated island populations. In addition, NPS is attempting to eradicate coyotes from Cumberland Island and we are conducting genetic analyses to assess whether the population was established by a single pair or multiple founders. We returned in January 2018 and obtained DNA from 67 scats, which suggests a population increase from 2016 when 37 scats provided DNA. Analyses are ongoing with a paper to be presented in October at The Wildlife Society conference.

3.1.4 Deer abundance and its relationship to factors that affect forest vegetation conditions. D. Begley-Miller, N. Navarro, D. Diefenbach, M. McDill, P. Drohan, C. Rosenberry (PGC), E. Just (DCNR). 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. In addition, in 2018 we conducted distance sampling surveys using FLIR. Vegetation data are collected at 200 plot locations (1,000 plots) of which 1 plot will be fenced to exclude deer.

Danielle Begley (Ph.D.) completed her degree in March 2018 and is currently working on the project as a post-doctoral scholar (see Appendix A for abstract of her dissertation).

For 2016-2018, DCNR provided funding to do a more comprehensive analysis of soil conditions on all the study areas. A M.S. student, Nicolas Navarro, completed fieldwork and is planning to complete his degree in summer 2018.

A new M.S. student in the Ecology program, Amanda Van Buskirk, started in May 2018. She will be working on developing integrated population models to monitor the deer population by incorporating survival, harvest, and abundance estimates to model population dynamics.

3.1.6 Distribution of predators and their relation to fawn survival Asia Murphy, D. Diefenbach, D. Miller (ESM faculty), M. Ternent (PGC), M. Lovallo (PGC), Chris Rosenberry (PGC). Funding provided by PGC.

Game cameras can be used to model occupancy of species on the landscape as well as how two species influence the distribution of each other. This project is using capture-recapture data from game cameras to estimate the distribution and of predators and how that distribution relates to fawn survival. Asia Murphy has reviewed and organized over 200,000 photos and is beginning analysis of the data. Preliminary results show that adult deer are found nearly everywhere on the study areas whereas predators (black bear, coyote, bobcat) occur on no more than 60% of the area. Fawns appear to use non-forested habitat to avoid predators.

3.1.6* Hunter demand for the management of chronic wasting disease in Pennsylvania's deer population Melissa Kreye (PI - ESM faculty), Duane Diefenbach, W. David Walter, Chris Rosenberry (PGC) Funding provided by The Center for Rural Pennsylvania.

We will assess the total economic value of managing for CWD in deer populations using an innovative combination of stated and revealed preference methods. Relevant attitudes and perceptions of risk will also be assessed to help inform the design of CWD management programs and interventions.

The importance given to deer hunting by the people of Pennsylvania point to the need for a well-reasoned and careful approach to managing CWD. We propose to estimate changes in demand over five years by comparing demand for an aggressive deer removal policy strategy (such as the one used in Wisconsin) with a less aggressive wait and see approach. We will also assess how outreach and education efforts by the PGC may influence hunter demand by shaping their perceptions of risk. Based on economic impact estimates reported in related studies (using approaches such as IMPLAN), we expect the economic impact of CWD to Pennsylvania's larger economy over the next five years will likely be negligible. We believe at this point it is important to understand the potential impact of CWD and CWD management on hunter welfare and attitudes towards hunting. The larger impact to society would more likely be the form of non-market benefits associated in with changes in deer management and forest restoration more broadly. For the purposes of this study, a better understanding of hunter demand for CWD management, as well as measures of attitudes and risk perceptions, will be important for helping inform a targeted intervention program that is supported by hunters.

3.2.1 Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania Tyler Wagner (PI)

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.

3.2.2 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.

3.2.3 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.

3.2.4 An investigation into the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River basin

Tyler Wagner (PI), Vicki Blazer (co-PI, USGS), Megan Kepler (co-PI, PSU), Jon Niles (co-PI, Susq. Univ.)

There is currently a large effort underway to quantify endocrine disrupting compounds (EDCs) in the Susquehanna River basin and their effects on smallmouth bass populations. During this ongoing research, a large amount of effort has been, and currently is, devoted to quantifying potential EDC exposure pathways, including from the surrounding landscape through surface waters, stream sediments, and adult female smallmouth bass, as a pathway of in-utero contamination from vertical transmission. However, there is currently a paucity of information on the role of groundwater discharge into surface waters as point sources of contaminants from polluted aquifers. This is critical to understand because the use of groundwater seeps are important for smallmouth bass, particularly during spawning season, and there use is related to increased hatch success and survival of age 0 fish. In addition, previous work has shown smallmouth bass utilizing areas of groundwater upwelling for spawning in the Susquehanna River basin. Exposure to EDCs during this critical life-stage of egg development could have detrimental short- and long-term consequences on immune function and fish health. Therefore, the objective of this research is to investigate the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River basin.

3.2.5 A macrosystems ecology framework for continental-scale prediction and understanding of lakes

Tyler Wagner (co-PI), Patricia Soranno (PI, MSU), Kendra Cheruvelil (co-PI, MSU), Emily Stanley (co-PI, Univ. WI), Noah Lottig (co-PI, Univ. WI), Ephraim Hanks (co-PI, PSU), Erin Schliep (co-PI, Univ. MO), Pang-Ning Tan (co-PI, Univ. MSU), Jiayu Zhou (co-PI, Univ. MSU)

In the past decade, our understanding of how inland waters influence regional, continental, and global biogeochemical cycles has fundamentally changed. We have moved from discounting their contributions, to now recognizing these ecosystems as significant hotspots for the storage and transformation of nitrogen, phosphorus, and carbon. This realization has come about through careful and labor-intensive collection, integration, and synthesis of often-scattered data sources, combined with a variety of different approaches to extrapolate site-level measures to unsampled sites across regions and continents. Today, although this view of the role of inland waters in large-scale cycling is supported by numerous studies, substantial gaps in our understanding remain. Estimates for the same flux (e.g., organic carbon burial in lakes) often differ substantially among studies. Further, most attempts to quantify continental or global fluxes or pools come with caveats regarding the often high– and often unknown– uncertainty associated with these estimates. To better understand the role of inland waters in macroscale nutrient cycling, new approaches are needed to reduce uncertainty in extrapolating site-level estimates to larger geographical scales. The overarching goal of this research is to understand and predict nutrient patterns for ALL continental US lakes to inform estimates of lake contributions to continental and global cycles of nitrogen (N), phosphorus (P), and carbon (C), while also providing locally valuable information about conditions in unsampled lakes.

3.2.6 Comparison of age and growth patterns of Flathead Catfish in invasive and native populations: A meta-analysis with implications for invasive species management in Pennsylvania Tyler Wagner (co-PI) and Geoff Smith (co-PI)

The primary focus of this project is to compare the age and growth patterns of Flathead Catfish in invasive and native populations within Pennsylvania. In addition, we will perform a meta-analysis of Flathead Catfish growth from populations across the U.S., both native and invasive populations, in an effort to put observed Pennsylvania growth dynamics within a broader regional context. This project will provide us the opportunity to utilize data collected under a previously funded PA SeaGrant project in conjunction with new data from unsampled populations identified under the scope of this project to better understand current distribution and population characteristics. These data will then allow us to populate models currently being developed to better direct Flathead Catfish management in Pennsylvania as identified in the Pennsylvania Fish and Boat Commission (PFBC) Catfish Management Plan as well as support multijurisdictional and multispecies resource management efforts by Atlantic States Marine Fisheries Commission (ASMFC) and National Oceanographic and Atmospheric Administration (NOAA), Sustainable Fisheries Goal Implementation Team (GIT) that may be affected by invasive catfish.

3.3.1 Landscape genetics of white-tailed deer to assess population structure for surveillance and management of chronic wasting disease.

David Walter, Justin Brown (PGC), Chris Rosenberry (PGC). Funding by the Pennsylvania Game Commission

Chronic wasting disease (CWD) is a fatal, transmissible disease that affects both captive and free-ranging cervids. 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.

3.3.2 Assessment of PRNP genotypes and stress levels to determine potential susceptibility of elk to chronic wasting disease.

David Walter, Justin Brown (PGC), Jeremy Banfield (PGC). Funding by the Pennsylvania Game Commission

Reintroduction of elk in Pennsylvania in the early 1900s has resulted in a sustained population that is experiencing low recruitment in recent decades. Although human habituation has occurred in some areas, elk continue to occupy various landscapes likely experiencing varying levels of human disturbance or stress. Little is known on the subpopulation-level effects on elk that occupy these disparate landscapes within their limited range in Pennsylvania. Furthermore, chronic wasting disease (CWD) was recently been found within 25 km of the border of elk range in a captive cervid facility that could potentially impact the elk population. A detailed assessment of subpopulation differences in elk physiology and genetics is needed to assist managers in refining elk management within their range in Pennsylvania. Use of stress hormones and genetic susceptibility to disease would assist management of this elk population that is currently being managed solely based on elk density within each sub-unit. Currently, 200 samples of elk tissue and feces have been collected from checkstations from elk harvested during the hunting season by the Pennsylvania Game Commission (PGC). Additional samples will be collected during the fall 2016 harvest and laboratory analysis and results will be summarized.

3.3.3 Analysis of stable isotopes to differentiate between pen-reared and wild-born pheasant in Pennsylvania. David Walter, Scott Klinger (PGC). Funding by the Pennsylvania Game Commission

The PGC started artificially propagating pheasants in 1915 to release in the spring so they could naturally breed and then be hunted in the fall, but it was later found that winters were not an issue and the population started to increase. Annual harvest in Pennsylvania was ≥1.2 million birds in the 1970's, but has declined to 217,000 in 1998, with most birds that are harvested likely to have been raised and released by PGC. Because origin of pheasant in the wild unknown (i.e., pen-reared or wild-born), a method to identify origin would be necessary. Stable isotopes of carbon and nitrogen can provide this method because isotope values in feathers of pheasant reared on commercial feed would be expected to be different from those consuming natural forage. We have collected feather samples from hunter harvested and pen-reared birds along with feathers from pheasants from Montana to assess stable isotopes in pheasant. Mixing models will be used to determine potential dietary contribution of commercial feed and expected isotope values in feathers to differentiate between origin of pheasants. This information will assist in our understanding of annual survival of pen-reared pheasants or presence\viability of established populations of pheasants in Wild Pheasant Recovery Areas in Pennsylvania.

3.3.4 Feasibility of using non-invasive genetic sampling and spatial capture-recapture models for population estimation of fisher (*Martes pennanti*) David Walter, Matt Lovallo (PGC), Jeff Larkin (Indiana University of Pennsylvania)

The fisher (*Martes pennanti*), a member of the weasel family, was reintroduced into Pennsylvania in the 1990s due to extirpation in the early 1900's. Since then, the fisher population in Pennsylvania has experienced considerable increases in size and distribution across the state. Original population estimates involved sightings by Wildlife Conservation Officers, accidental captures by trappers, and telemetry techniques. This study was designed to test the feasibility of using spatial capture-recapture models from non-invasive genetic sampling of hair snares on fishers to estimate population size. Hair snares are much less expensive and less invasive than traditional capture techniques. Using microsatellites from samples retrieved from hair snares, individuals will be identified genetically. Repeated sampling of individuals will then allow spatial capture-recapture models to be used to estimate population size. The study will be completed at locations to initially test the feasibility of this technique with hopes of applying it statewide in the future. It is important to estimate the population of fishers in Pennsylvania accurately for management purposes and use by the Pennsylvania Game Commission to create bag limits for the species during the trapping season.

3.3.5 Epidemiology of West Nile virus in ruffed grouse David Walter, Lisa Williams (PGC), Justin Brown (PGC)

Since its arrival in North America in 1999, West Nile virus (WNV) has had unprecedented adverse effects on the health of native bird species. In Pennsylvania, WNV was first documented statewide in 2002, soon after which population declines were observed in Pennsylvania ruffed grouse (*Bonasa umbellus*) and since then grouse populations have not recovered. Subsequent outbreaks of WNV are correlated with reductions in population indices of hunter flush rates and summer sighting survey (brood) data. In Spring 2015, the Unit assisted the Pennsylania Game Commision by purchasing radiotransmitters to monitor wild grouse hens and collect eggs for a challenge study of naïve individuals inoculated with the WNV virus. Forty percent of chicks died within a week post-inoculation, and long term survival was questionable for an additional 30–50% of chicks. Recent research indicates there may be an interaction between habitat quality/quantity and the effect of WNV on grouse populations. More information is needed on the epidemiology of WNV with respect to ruffed grouse because nearly all research and monitoring has focused on WNV risk in human environments. Our objectives are to identify the mosquito species that coexist with ruffed grouse in early successional habitat, which mosquito species are important vectors of WNV for ruffed grouse, and which environmental factors increase the risk of WNV exposure to ruffed grouse. This information will result in background data to model the epidemiology of WNV across Pennsylvania to determine the ruffed grouse populations most at risk from the virus.

3.3.6* Muskrat (*Ondatra zibethicus*) ecology, population estimation, and health David Walter, Lisa Williams (PGC), Justin Brown (PGC)

Declines in muskrat (Ondatra zibethicus) harvest has been observed across North America, with many states recording larger than 50% decline in muskrat harvest within the past few decades. Harvest rates are historically used as indicators of population status, thus declines in muskrat harvest simulate a decline in the muskrat population. This study was designed to investigate the survival, movements, and potential threats to muskrats. To understand muskrat movements, muskrat will be trapped and implanted with a transmitter within various aquatic ecosystems. Using mark-recapture data, population size and survival estimates will be assessed. The analysis of blood from live-trapped muskrats and organ samples from trapper-harvested muskrats for exposure to various diseases will be undertaken as well. Expanding the knowledge of muskrat movements, creating baseline population estimates and survival rates, and understanding the exposure of muskrats to different diseases or toxicological factors will increase the knowledge of the muskrat and the potential reasons for their population decline.

3.3.7* Assessment of fence-line interactions at the captive-wild deer interface

The Pennsylvania Department Agriculture (PDA) has recommended secondary fencing to captive cervid facilities in attempts to prevent transmission of chronic wasting disease between wild and captive cervids through fence-line contact. Fence designs have been evaluated for their ability to exclude various cervid species along with their costs and efficacy in achieving project objectives. Objectives of the study are integral to choice of fence design and structure (e.g., chain-link versus 2-strand electrified) because a fence used to exclude cervids (e.g., 3-m high woven wire) would not be effective at preventing interactions of cervids at the captive-wild interface as compared to a double-barrier fence design. Evaluation of fence-line interactions has been evaluated in mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) in Colorado and in white-tailed deer in Michigan. Efficacy of prevention of cervid interactions at the captive-wild interface, however, has not been assessed using double barrier fencing as proposed by PDA for deer herds in Pennsylvania enrolled in the Herd Certification Program which this project intends to address.

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

Honors and Awards

Tyler Wagner was awarded the *2017 CRU Scientific Excellence Award* for excellence in furthering the mission of the Cooperative Research Units Program.

Tyler Wagner received the *Edward D. Bellis Award* to recognize faculty members in the Intercollege Graduate Degree Programs in Ecology for outstanding contribution and dedication to educating and training graduate students in the program.

Tyler Wagner was coauthor on a paper that received the Robert L. Kendall Award for the Best Paper in the Transactions of the American Fisheries Society for 2017.

Shannon White (PhD Ecology) received the following awards and recognition:

- *The J. Brian Horton Award*. The Horton Award recognizes outstanding achievement and service to the graduate community by a student in the Intercollege Graduate Degree Program in Ecology at Penn State.
- *Best Student Paper*, Pennsylvania Chapter of the American Fisheries Society
- *Marty Seldon Graduate Scholarship*, Wild Trout Symposium
- *Best Student Writing Award*, National Chapter of the American Fisheries Society

Peer-reviewed Publications

Diefenbach

Gigliotti, L. C., B. Jones, M. Lovallo, and **D. R. Diefenbach**. 2018. Snowshoe hare multi-level habitat use in Pennsylvania in relation to prescribed burning. Journal of Wildlife Management 82:435-444 DOI: 10.1002/jwmg.21375.

Gigliotti, L. C., and D. R. Diefenbach. 2018. Risky behavior and its effect on survival: snowshoe hare behavior under varying moonlight conditions. Journal of Zoology 305:27-34. doi:10.1111/jzo.12532

Gigliotti, L. C., D. R. Diefenbach, M. J. Sheriff. 2017. Geographic variation in winter adaptations of snowshoe hares. Canadian Journal of Zoology 95:539-545.

Gingery, T. M., D. R. Diefenbach, B. D. Wallingford, and C. S. Rosenberry. 2018. Landscape-level patterns in fawn survival across North America. In press.

Tucker, M. et al. 2018. Moving in the Anthropocene: Global reductions in terrestrial mammalian movements. Science 359:466-469. DOI: 10.1126/science.aam9712

Williamson, L. T., **W. David Walter**, S. R. Klinger, and **D. R. Diefenbach**. 2018. Incorporating detection probability to estimate pheasant density. Journal of Wildlife Management. (Accepted)

<u>*Wagner*</u>

Wagner, T. and E.M. Schliep. Accepted. Combining nutrient, productivity, and landscape-based regressions improves predictions of lake nutrients and provides insight into nutrient coupling at macroscales. Limnology and Oceanography.

White, S.L., W.L. Miller, S.A. Dowell, M.L. Bartron, and **T. Wagner.** Accepted. Limited hatchery introgression into wild brook trout (Salvelinus fontinalis) populations despite reoccurring stocking. Evolutionary Applications.

Oliver, S.K., C.E. Fergus, N.K. Skaff, **T. Wagner**, P-N. Tan, K.S. Cheruvelil, and P.A. Soranno. 2018. Strategies for effective collaborative manuscript development in interdisciplinary science teams. Ecosphere (4):e02206.
10.1002/ecs2.2206

Stow, C.A., K.E. Webster, **T. Wagner**, N. Lottig, P.A. Soranno, C. YoonKynug. 2018. Small values in big data: the continuing need for appropriate metadata. Ecological Informatics 45:26-30.

Massie, D.L., G.D. Smith, T.F. Bonvechio, A.J. Bunch. D.O. Lucchesi, **T. Wagner**. In press. Spatial variability and macroscale drivers of growth for native and introduced Flathead Catfish populations. Transactions of the American Fisheries Society.

DeWeber, J.T. and **T. Wagner**. 2018. Probabilistic measures of climate change vulnerability, adaptation action benefits, and related uncertainty from maximum temperature metric selection. Global Change Biology.

Schall, M.K., V.S. Blazer, R.M. Lorantas, G.D. Smith, J.E. Mullican, B.J. Keplinger, and **T. Wagner**. 2018. Quantifying Temporal Trends in Fisheries Abundance using Bayesian Dynamic Linear Models: A Case-Study of Riverine Smallmouth Bass Populations. North American Journal of Fisheries Management 38:493–501.

Li, Y., T. Wagner, Y. Jiao, R. Lorants, and C.A Murphy. In press. Evaluating spatial and temporal variability in growth and mortality for recreational fisheries with limited catch data. Canadian Journal of Fisheries and Aquatic Sciences.

Filstrup, C.T., **T. Wagner**, S.K. Oliver, C.A. Stow, K.E. Webster, E.H. Stanley, and J.A. Downing. 2018. Evidence for regional nitrogen stress on chlorophyll a in lakes across large landscape and climate gradients. Limnology and Oceanography 63:324-339.

Hansen, G.J.A., S.R. Midway, **T. Wagner**. 2018. Walleye recruitment is less resilient to warming water temperatures in lakes with abundant largemouth bass populations. Canadian Journal of Fisheries and Aquatic Sciences 75:106-115.

Peoples, B., S.R. Midway, J.T. DeWeber, and **T. Wagner**. 2018. Catchment scale determinants of nonindigenous minnow richness in the eastern United States. Ecology of Freshwater Fish 27:138-145.

Lottig, N.R., P.-N. Tan, **T. Wagner**, K.S. Cheruvelil, P.A. Soranno, E.H. Stanley, C.E. Scott, C.A. Stow, and S. Yuan. 2017. Macroscale patterns of synchrony identify complex relationships among spatial and temporal ecosystem drivers. Ecosphere 8(12).

Soranno, P.A., L.C. Bacon, M. Beauchene, K.E. Bednar, E.G. Bissell, C.K. Boudreau, M.G. Boyer, M.T. Bremigan, S.R. Carpenter, J.W. Carr...**T. Wagner**... and 70 co-authors. 2017. LAGOS-NE: A multi-scaled geospatial temporal database of lake ecological context and water quality for thousands of U.S. Lakes. GigaScience 6:1-22.

Yuan, S., J. Zhou, P-N., Tan, E. Fergus, **T. Wagner**, and P.A. Soranno. Accepted. Multi-Level Multi-Task Learning for Nested Geospatial Data. The IEEE International Conference on Data Mining series (ICDM).

Schall, M.K., M.L. Bartron, T. Wertz, J. Niles, V.S. Blazer, and **T. Wagner**. 2017. Evaluation of genetic population structure of Smallmouth Bass in the Susquehanna River Basin, Pennsylvania. North American Journal of Fisheries Management 37:729-740.

Grossman, G.D., R.F. Carline, and **T. Wagner**. 2017. Brown trout (*Salmo trutta*) in Spruce Creek Pennsylvania: a quarter-century perspective. Freshwater Biology 62:1143-1154.

Collins, S.M., S.K. Oliver, J.F. Lapierre, E.H. Stanley, J.R. Jones, **T. Wagner**. and P.A. Soranno. 2017. Lake nutrient stoichiometry is less predictable than nutrient concentrations at regional and sub-continental scales. Ecological Applications 27:1529-1540.

Vidal, T. E., B. J. Irwin, T. Wagner, L. G. Rudstam, J. R. Jackson, and J. R. Bence. 2017. Using Variance Structure to Quantify Responses to Perturbation in Fish Catches. Transactions of the American Fisheries Society 146:584-593.

Walter

Carrollo, E.M., H.E. Johnson, J.W. Fischer, M. Hammond, P.D. Dorsey, C.W. Anderson, K.C. VerCauteren, and Carrollo, E.M., H.E. Johnson, J.W. Fischer, M. Hammond, P.D. Dorsey, C.W. Anderson, K.C. VerCauteren, and W. David Walter. Influence of precipitation and crop germination on resource selection by mule deer (Odocoileus hemionus) in southwest Colorado. Scientific Reports

Miller, W.L. and **W.D. Walter**. 2017. CWDPRNP: a tool for cervid prion sequence analysis in program R. Bioinformatics. 33(19):3096–3097.

Technical Report

Carlson, C.M., Hopkins, M.C., Nguyen, N.T., Richards, B.J., Walsh, D.P., and **Walter, W.D.** 2018. Chronic wasting disease—Status, science, and management support by the U.S. Geological Survey: U.S. Geological Survey Open File Report 2017-1138, 8 p., https://doi.org/10.3133/ofr20171138.

Presentations at Scientific Meetings

Diefenbach

Begley-Miller, D. R., **D. R. Diefenbach**, M. E. McDill, C. S. Rosenberry, and E. Just. Soil chemistry and interspecific competition influence understory forest composition in central Pennsylvania: Implications for wildlife. 2018 Pennsylvania Chapter of The Wildlife Society Annual Conference, State College, PA. (Contributed Oral)

Gingery, T. M., D. R. Diefenbach, C. S. Rosenberry, B. D. Wallingford. Landscape-level Patterns in White-tailed deer Fawn Survival in North America. Southeast Deer Study Group Meeting, 21 February 2018, Nashville, TN. (Contributed Oral)

Diefenbach, D. R. Linking research and management to improve decision making. 20 February 2018. Southeast Deer Study Group Meeting, Nashville, TN. (Invited Oral)

Navarro, N., P. J. Drohan, M. McDill, and **D. R. Diefenbach**. Analysis of White-Tailed Deer (Odocoileus virginianus) Forage Nutrient Content across Northern Appalachian USDA Ecological Sites. Soil Science Society of America annual meeting, 22-25 October 2017, Tampa, FL, USA. (Contributed Poster)

Gingery, T. M., D. R. Diefenbach, B. D. Wallingford, and C. S. Rosenberry. Landscape-level patterns in white-tailed deer fawn survival in North America. Annual meeting of The Wildlife Society, 27 September 2017, Albuquerque, NM. (Contributed Oral)

Begley-Miller, D. R., D. R. Diefenbach, M. E. McDill, C. S. Rosenberry, and E. Just. 2017. Soil chemistry and its effect on central Pennsylvania's forest wildlife habitat. Annual meeting of The Wildlife Society, 27 September 2017, Albuquerque, NM. (Contributed Oral)

Williamson, L. T., S. R. Klinger, **D. R. Diefenbach**, W. D. Walter. 2017. Density Estimation and Habitat Modeling for Pheasant Population Restoration in Pennsylvania. The Wildlife Society Annual Meeting, Albuquerque, NM. (Contributed Oral)

Diefenbach, D. R., Buderman, F. E., and L. C. Gigliotti. Efficiency of joint known-fate and tag-recovery models for estimating harvest rates of large animals. EURING Technical Meeting, 2-7 July 2017, Barcelona, Spain. (Contributed Poster)

Wagner

Collins, S.M., S. Yuan, P.-N. Tan, S.K. Oliver, J.F. Lapierre, K.S. Cheruvelil, E. Fergus, N.K. Skaff, J. Stachelek, **T. Wagner**, P.A. Soranno. 2018.c. Society for Freshwater Science, Detroit MI.

Thompson, T.J., V. Blazer, A. Sperry, M. Briggs, and **T. Wagner**. 2018. Groundwater as a source of emerging contaminants to streams of the Chesapeake Bay Watershed. . Society for Freshwater Science, Detroit MI.

White, S.L. and T. Wagner. 2018. With Connectivity Comes Challenges: Brook Trout Metapopulation Dynamics Reveal Unique Management Challenges. Society for Freshwater Science, Detroit MI.

Oliver, S.K., S.M. Collins, P.A. Soranno, **T. Wagner**, E.H. Stanley, J.R. Jones, C.A. Stow, and N.R. Lottig. 2018. Long-term changes in lake nutrient concentrations across the upper Midwest and northeast United States: how does Wisconsin stack up? Wisconsin Lakes Partnership Convention, Stevens Point, WI.

White, S., W. Miller, S. Dowell, M. Bartron, and **T. Wagner**. 2018. Limited hatchery introgression in wild brook trout populations in a northcentral Pennsylvania watershed. The Pennsylvania Chapter of the American Fisheries Society.

Kline, B. S. White, N. Hitt, and **T. Wagner.** 2017. Personality predicts success at using thermal refugia in brook trout (Salvelinus fontinalis). Susquehanna River Symposium, Bucknell University.

Thompson, T., T. Wagner, V. Blazer, A. Sperry, and M.A. Briggs. 2017. Groundwater as a source of emerging contaminants. Susquehanna River Symposium, Bucknell University.

Walter

Ganoe, L.K., C. Bocetti, J. Larkin, **W.D. Walter**. 2017. Feasibility of remote mark-recapture methods on fisher (Pekania pennanti) in Clarion County. The Wildlife Society Annual Meeting, Albuquerque, NM.

Miller, W.L. and **W. D. Walter.** 2017. Genetic susceptibility of eastern cervid populations to chronic wasting disease. The Wildlife Society Annual Meeting, Albuquerque, NM.

Miller, W.L. and **W. D. Walter**. 2018. Genetic assignment tests provide insight into the epidemiology of chronic wasting disease in Pennsylvania. The Pennsylvania Chapter of The Wildlife Society, State College, PA

Williamson, L. T., S. R. Klinger, **D. R. Diefenbach**, **W. D. Walter**. 2017. Density Estimation and Habitat Modeling for Pheasant Population Restoration in Pennsylvania. The Wildlife Society Annual Meeting, Albuquerque, NM.

Walter, W.D. 2017. Truths and Myths about Chronic Wasting Disease, USDA/APHIS/WS, Harrisburg, PA (Invited Seminar).

Walter, W.D. 2017. Truths and Myths about Chronic Wasting Disease, Indiana Chapter of the Wildlife Society, West Lafayette, IN (Invited Seminar).

Walter, W.D. 2017. CWD genetics in the wild and model results outline potential for spread within Pennsylvania, Pennsylvania Department of Agriculture, Harrisburg, PA (Invited Seminar).

Walter, W.D. 2018. Truths and Myths about Chronic Wasting Disease, PA Forests Web Seminar Series (Invited Webinar).