AGENDA

Coordinating Committee Meeting
Pennsylvania Cooperative Fish and Wildlife Research Unit

July 28, 2016

9:30 AM

Held in Room 118 in the ASI Building

1. **Cooperators attending**
   - 1.1. U.S. Geological Survey – Michael Tome, Supervisor
   - 1.2. PA Game Commission – Wayne LaRoche, Director, Bureau of Wildlife Management
   - 1.3. PA Fish & Boat Commission – John Arway, Executive Director, and Andy Shiels, Chief, Bureau of Fisheries
   - 1.4. Wildlife Management Institute – Steve Williams, President
   - 1.5. U.S. Fish and Wildlife Service – not represented

2. **Approval of minutes from July 29, 2015 meeting**
   - 2.1. Minutes approved (motion to accept minutes made by John Arway, seconded by Wayne LaRoche, approved by voice vote)

3. **Completed Projects (Summaries in Appendix A; yellow pages)**
   - 3.1. <u>Diefenbach</u>
     - 3.1.1. Dispersal of female white-tailed deer in Pennsylvania
     - 3.1.2. Snowshoe hare habitat relationships in response to northern forest management in Pennsylvania
   - 3.2. <u>Wagner</u>
     - 3.2.1. Transboundary management and conservation: linking large-scale dynamics to ecological monitoring and management
   - 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. Assessing landowner and landscape characteristics of domestic cervid facilities to assess threats to free-ranging wildlife

4. **New & Continuing Projects (* Requires approval by Committee; See Appendix B)**
   - 4.1. <u>Diefenbach</u>
     - 4.1.1. Influences on the timing of denning in female black bears and its effect on harvest rates and estimates of population size
     - 4.1.2. Harvest and survival rates of hen wild turkeys in Pennsylvania
     - 4.1.3. Genetics of an insular population of bobcats and coyotes
     - 4.1.4. Deer abundance and its relationship to factors that affect forest vegetation conditions
     - 4.1.5. Fall harvest and annual survival rates of female eastern wild turkeys in New York

4.1.6. Fawn survival in central and northcentral Pennsylvania
4.1.7. *Distribution of predators and their relation to fawn survival

4.2. Wagner
4.2.1. Characterization of spatial and temporal variability in fishes in response to climate change
4.2.2. Linking fish health, contaminants, and population dynamics of smallmouth bass populations in the Susquehanna River, Pennsylvania
4.2.3. Establishing a strategy for assessing risk of endocrine-disrupting compounds to aquatic and terrestrial organisms
4.2.4. Can plasticity protect populations from rapid environmental fluctuation?
4.2.5. *Comparing relative abundance and population characteristics of Flathead Catfish across a range of establishment levels at the Susquehanna
4.2.6. *An investigation into the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River
4.2.7. *A macrosystems ecology framework for continental-scale prediction and understanding of lakes

4.3. Walter
4.3.1. Landscape genetics of white-tailed deer to assess population structure for surveillance of chronic wasting disease
4.3.2. Modeling potential habitat for pheasant population restoration
4.3.3. *Assessment of PRNP genotypes and stress levels to determine potential susceptibility of elk to chronic wasting disease
4.3.4. *Analysis of stable isotopes to differentiate between pen-reared and wild-born pheasant in Pennsylvania

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

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

6.1. Diefenbach
6.1.1. Danielle Begley – PhD Wildlife
6.1.2. Ethan Kibe, MS Wildlife
6.1.3. Tess Gingery, MS Wildlife
6.1.4. Lacey Williamson, MS Wildlife
6.1.5. Asia Murphy, PhD Ecology

6.2. Wagner
6.2.1. Megan Kepler Schall – PhD Ecology
6.2.2. Shannon White – PhD Ecology
6.2.3. Tyler Thompson – MS, WFS
6.2.4. Yan Li – Postdoctoral research scientist

6.3. Walter
6.3.1. Will Miller – PhD Ecology
6.3.2. Lacey Williamson – MS Wildlife

7. Service on Graduate Committees (other than advisees)

7.1. Diefenbach

7.1.1. J. Sklebo, MS Wildlife and Fisheries Science

7.1.2. S. White, PhD Ecology

7.2. Wagner

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

7.2.2. Didem Ikis, PhD Ecology

7.2.3. Krittika Petprakob, PhD Ecology

7.2.4. Brooks Fost, PhD Wildlife and Fisheries

7.2.5. Staci Amburgey, PhD Ecology

7.3. Walter

7.3.1. Megan Kepler Schall – PhD Ecology

7.3.2. Catherine Pritchard, PhD Wildlife

7.3.3. Tess Gingery, MS Wildlife and Fisheries

7.3.4. Ethan Kibe, MS Wildlife and Fisheries

8. Courses and Workshops Taught by Unit Staff

8.1. Diefenbach

8.1.1. WFS 560 - Methods of Estimating Population Parameters, spring 2016

8.2. Wagner

8.2.1. Hierarchical modeling in ecology, Virginia Institute of Marine Science

8.3. Walter

8.3.1. Advances in Ecology, fall 2015

8.3.2. Workshop in Applied Spatial Ecology, 29-30 September

8.3.3. Applied Spatial Ecology, spring 2016

9. Comments from Cooperators

9.1. PA Game Commission – The agency values the research and collaborations of the Unit. Currently, the agency is seeking a license fee increase and hopes that a legislative bill will be passed this session.

9.2. Wildlife Management Institute – As the only non-governmental member of the coordinating committee, WMI has been working with the Cooperator Coalition to seek full funding from Congress for the CRU program. A couple of states would like to add a unit to their land grant university.

9.3. U.S. Geological Survey – The CRU program currently has about 25 vacancies so many units have one or more vacant positions. The President's budget calls for an increase for the CRU program, but that budget is not expected to be addressed by Congress. About 94% of operating costs go to salaries so unfilled vacancies allow retention of employees given the flat budgets of recent years. Also, USGS has begun implementing data management procedures whereby research projects will be required to develop a data management plan, data review, etc.

9.4. PA Fish and Boat Commission – PFBC published a history of fishing and boating in Pennsylvania, titled "To Protect, Conserve, and Enhance." Health of the Susquehanna River continues to be a major concern with regard to smallmouth bass. Agency is working to diversify their sources of funding but currently still dependent on license sales and boat registration fees, and excise tax on sportfishing equipment. The PFBC initiated stocking of trophy trout on select delayed-harvest streams – currently evaluating angler response. The agency's monitoring of the status of the timber rattlesnake suggests that it may be de-listed. About 99 Wild Trout Streams have been approved each quarter over the past year. Pennsylvania currently has over 10,000 miles of certified trout waters.

10. Adjourn – 1:00pm

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

11.1. New projects were approved; project approval forms on file

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 of female white-tailed deer in Pennsylvania. Clayton Lutz (M.S. student), Duane Diefenbach. Funding provided by PA Game Commission.

Dispersal is a common life-history trait across taxa and is ecologically important because it influences gene flow, population dynamics, colonization, and the spread of disease. The reasons animals disperse can be separated into two categories: proximate and ultimate causes. Proximate causes provide cues for dispersal to occur and can influence the characteristics of the dispersal event. Ultimate causes of dispersal refer to the evolutionary advantages of dispersal and why dispersal persists on the population level. Documenting an organism's dispersal behavior and identifying factors that influence that behavior are crucial not only to understanding the basic ecology of a species, but also for providing critical information for the conservation and management of that species. Although dispersal is an important component of white-tailed deer (*Odocoileus virginianus*) ecology and management, it remains understudied and most analysis has focused on the dispersal of males. I investigated dispersal behavior patterns in female white-tailed deer to better understand proximate and ultimate causes of dispersal.

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. I tracked 229 radiomarked (VHF collars, n = 204; GPS collars, n = 25) juvenile female white-tailed deer in 4 study areas in Pennsylvania to evaluate dispersal behavior and to determine proximate cues that influence dispersal. I observed dispersal in all 4 study areas, with an overall dispersal rate of 11.8%. Female dispersal largely occurred at 1 year of age with an average dispersal date of 6 June, which coincides with the fawning season. Dispersal paths varied, but were generally non-linear (average straightness = 0.579), long distanced (average dispersal distance = 18.0 km), and prolonged (average duration = 355 hrs). Physical landscape features (i.e., roadways, rivers, residential areas) were important influences on changing dispersal path direction and influencing where dispersal terminated, however topography did not influence dispersal direction. Additionally, forays outside the natal range that did not result in dispersal were recorded in 52% of GPS-collared deer during the dispersal period. Our results suggest that dispersal behavior in female deer is influenced by both intra-specific social interactions, particularly during the fawning season, and physical landscape features.

The characteristics of dispersal behavior can provide insight into the ultimate causes and evolutionary strategies of dispersal. Hypotheses for the ultimate cause of dispersal suggest it is a beneficial strategy for the disperser because it reduces competition for local resources, reduces competition for breeding partners, and reduces the potential for inbreeding. Dispersal behavior in white-tailed deer predominantly occurs in 1-year-old males; however, females of the same age also disperse. The timing of female dispersal during fawning season and low dispersal rates suggest that competition for mates and reduced inbreeding are not ultimate causes of female dispersal, as suggested for males. I proposed that female dispersal is the result of competition for space when pregnant females seek to isolate themselves before and after parturition. To test this hypothesis, I conducted a meta-analysis of female dispersal rates from 12 populations of white-tailed deer and predicted dispersal rate and distance were positively related to deer density. I found a positive relationship between dispersal rate and deer per forested km^2 and between dispersal distance and deer per forested km^2. These results are consistent with the hypothesis that female dispersal is density-dependent and caused by the exclusion of subordinate 1-year-olds as adult females seek isolation before and after parturition.

2.1.3. Snowshoe hare habitat relationships in response to northern forest management in Pennsylvania. Laura Gigliotti (M.S. Student), Duane Diefenbach

Differences in biotic and abiotic characteristics can lead to geographic variation in the ecology of species and populations. Investigating intraspecific variation over large geographic extents can provide insights into the ecological drivers of population dynamics, which is especially important for predicting how future climatic conditions will affect ecological processes. The snowshoe hare (Lepus americanus) is an excellent species to investigate geographic variation in ecological dynamics because it has a geographic range that encompasses a wide range of climates and habitat types. Although the population dynamics of snowshoe hares in the northern portion of their range are well-studied, information on southern populations is limited. I investigated the ecology, habitat use, and winter thermal dynamics of snowshoe hares in Pennsylvania and compared these data to previous research on other hare populations.

From January 2014 – June 2015 I trapped and monitored snowshoe hares to estimate body condition, survival rates, home range size, and home range overlap. I found that hares in Pennsylvania had greater body mass in relation to their structural size, higher annual survival, and larger home ranges than populations from higher latitudes. Home range overlap occurred frequently and I did not find that hares temporally partitioned their home ranges to minimize interaction with nearby hares. Also I trapped three snowshoe hares that exhibited uncharacteristic brown winter coat coloration, indicating potential differences in the winter molt patterns or color morphs.

Using locations collected from GPS collars I examined snowshoe hare seasonal habitat use at the stand-level and at fine-scale microhabitats. I determined that during both summer and winter hares preferred areas of mature scrub oak or conifers and avoided open habitats. At the population level, hares preferred areas with dense understory vegetation and high canopy coverage, although I found substantial individual variability in habitat preferences. My research highlights the importance of incorporating multiple scales of analysis into habitat use studies, as well as accounting for individual variation in habitat preferences.

Finally, I investigated geographic differences in snowshoe hares' responses to winter temperatures by comparing winter pelage characteristics and heat production between hares in Pennsylvania and the Yukon, as well as investigated the influence of temperature on resting spot selection and movement rates. I found that hares from Pennsylvania had shorter and less dense winter coats than hares from the Yukon and that the Pennsylvania population had less visible white in their winter coats. Hares in the Pennsylvania population also produced less heat than the Yukon population, indicating a lower metabolic rate. Snowshoe hares did not select for resting spots that offered them thermal advantages, but selected locations providing visual obstruction from predators. Movement rates were associated with ambient temperature, with the lowest hourly movements occurs at the extreme high (>4 ºC) and low (<-10 ºC) ends of the temperature range. Results of this research support the suggestion that snowshoe hares have the ability to adapt to local climatic conditions via their pelage characteristics, metabolism and behavior.

Overall snowshoes hares in Pennsylvania exhibited differences in body condition, survival, home range sizes, winter pelage characteristics, and heat production than previously studied populations at northern latitudes, highlighting the importance of understanding southern populations in order to better describe range-wide patterns. In the face of potential changes in climate and habitat quality, recognizing potential range-wide variation in population dynamics will be critical for managing this species, as well as other species with large geographic ranges, in the future.

2.2.1 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.

2.3.1 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 otter have been studied in North America with non-invasive genetic sampling (NGS) using fecal samples, but these studies often have low success rates for amplification and genotyping of genetic material. We collected river otter feces at a variety of habitat types across 9 counties in northeastern Pennsylvania during the winter months of 2013 and 2014, and sampled sites multiple times in a mark-recapture framework. We extracted DNA from fecal samples, and amplified 10 microsatellite markers for assignment of samples to individuals. We constructed spatial capture histories for individuals based on the location and occasion on which samples were collected, and then used those capture histories in a spatial capture-recapture model to estimate population size and density for each year. The density estimates (2013: 3.7 otter/100 km2, 95% CI 1.49–4.94 otter/100 km2; 2014: 4.5 otter/100km2, 95% CI 2.4-9.3otter/100km2), are the first reported for Pennsylvania. Our genotyping success rate was higher than previous NGS studies on river otter (53.5%), and was comparable to studies on other otter species that sampled in the winter and used a storage buffer for preservation. This is the first study to use non-invasive genetic sampling in a spatial capture-recapture framework to estimate river otter population size. This study demonstrates the potential for enumeration of elusive wildlife populations using an opportunistic sampling design across a patchwork of private and public land, and demonstrates protocol for high DNA yield from river otter fecal samples.

Nick Forman (MS student) graduated in December 2015 after completing his thesis and currently works as a Research Scientist for the Wisconsin Department of Natural Resources.

2.3.2. 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.

Project is completed, the MS student has left the program without completing the thesis but manuscripts are being completed for publication.

2.3.3. 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

Pennsylvania is second only to Texas in number of captive cervid facilities with over 1000 within the state. These facilities can pose a large risk to wild deer populations because of disease transmission issues, and in particular pose a serious threat via the spread of chronic wasting disease (CWD). Current regulations exist to prevent disease spread, but are minimal and often hard to enforce. Our objective was to identify areas of use by owners of captive cervid facilities in Pennsylvania, and hence identify areas that are potentially most at risk for CWD transmission between captive and wild deer because of captive facility presence. In order to achieve this objective, we first identified environmental and facility characteristics that were related to CWD transmission and were selected for by captive facility owners, and then used these variables to create a predictive surface of areas with a potential for greater risk of CWD transmission from captive to wild deer populations or vice versa due selection of areas by captive facility owners. We used multiple Geographic Information System layers and information from 841 captive facilities to create six variables to include in our models. These variables included elevation, land cover, distance to public lands (federal and state), wild deer density, facility stocking density, and facility deer movements. Wild deer density, stocking density, and movements were all categorized to better represent our data and make for a more appropriate analysis. Land cover was grouped in four categories (i.e., water/wetlands, urban, forest, agriculture). Negative binomial regression was used to assess our 13 *a priori* models. Our regression analysis indicated that agriculture was the most influencing factor affecting areas selected by captive facility owners with positive coefficients and confidence intervals that did not overlap zero. High wild deer density, average stocking density, and elevation also had varying influence on areas selected by facility owners. Model results can be used to identify areas with the highest risk of CWD transmission in the state between wild deer and captive facilities to assist wildlife managers in assessing where CWD surveillance and monitoring will be most effective.

Emily Carrollo (MS student) graduated in May 2016 after completing her thesis and currently works as a Research Technician for the Pennsylvania Game Commission.

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 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 and we continued to monitor hens through the 2015 nesting season. I have developed an integrated population model to estimate population size in each study area. In addition, I am working with Dr. Paul Fackler, North Carolina State University to develop a stochastic dynamic programming model for making recommendations for fall harvest regulations.

3.1.3 Genetics of an insular population of bobcats and coyotes. D. Diefenbach. L. Hansen, C. Miller.

We returned to Cumberland Island National Seashore in January 2016 to collect more bobcat and coyote scat to continue monitoring the population. The park is doing intensive trapping of coyotes to reduce the population and we plan to use genetic analyses to determine how many founders there were to the population. In addition, we are collecting bobcat tissue from mainland bobcats and bobcats on Kiawah Island, SC to compare island and mainland genetics.

3.1.4 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 (Ph.D.) is completing her third and final field season in 2016 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).

For 2016-2017 DCNR has provided funding to do a more comprehensive analysis of soil conditions on all the study areas. A new M.S. student, Nicolas Navarro, has begun fieldwork in July 2016.

3.1.5 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 last of 4 fall harvest seasons for this study will occur in 2016.

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

During the second year of this three-year study, the winter trapping season resulted in the capture of 125 total deer of which 28 were recaptures, 97 were new deer, and 20 received vaginal implantations. Following adult captures, the 2016 fawn season resulted in the capture of 57 fawns, 32 of which were caught in the Susquehannock State Forest, and 25 in Rothrock and Bald Eagle state forests. Daily observations of fawns continue as crews monitor survival status. Survival of fawns until two months of age was approximately 0.69. Preliminary results were presented at the Pennsylvania Wildlife Society meeting in April. A committee for Tess Gingery's thesis research has been established and a proposal approved. Primary objectives for the project include 1) a review of survival and cause specific mortality in Pennsylvania white-tailed deer fawns in comparison to survival rates seen in 2000-2001, 2) a meta-analysis of fawn survival patterns across North America, and 3) analysis of maternal behaviors and the influence of these behaviors on fawn survival.

3.1.7 *Distribution of predators and their relation to fawn survival Asia Murphy (Ph.D. Ecology), Duane Diefenbach, David Miller (ESM faculty), Mark Ternent (PGC), Matt Lovallo (PGC), Chris Rosenberry (PGC)

A Ph.D. student, Asia Murphy, began in June 2016 to collaborate with Mark Ternent and Matt Lovallo to assist with deploying camera traps and capturing black bears. Her research is to model predator distributions (black bear, coyote, bobcat, red fox, gray fox) and relate those distributions to the survival of white-tailed deer fawns.

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 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.

3.2.3 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); Funding provided by 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.

3.2.4 Can plasticity protect populations from rapid environmental fluctuation? Tyler Wagner (PI); Funding provided by USGS and R.K. Mellon Freshwater Initiative; Susquehanna University

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.

3.2.5* 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); Funding provided by Pennsylvania Sea Grant

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. Surveys will focus on the reach of the Susquehanna River extending from the Pennsylvania-Maryland border (Conowingo Pool) upstream to the confluence of the West Branch Susquehanna River at Sunbury. This reach includes areas with Flathead Catfish populations at varying degrees of establishment. Specifically, we will focus on estimate the (relative) abundance and age and growth characteristics of invasive Flathead Catfish in three reaches of the mainstem Susquehanna River.

3.2.6* 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.); Funding provided by NSF

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.

3.2.7* 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); Funding provided by NSF

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.

3.3.1 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.

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

Field work has been completed and the crowing count surveys completed this year will be used to examine the population trend throughout the years of the study. A graduate committee met in April and approved the objectives of the project, with the chapters of the thesis being a review and summary of the introduction of pheasants in Pennsylvania, population estimation on the study areas, and a predictive model for pheasant population size based on habitat characteristics. Analysis of the crowing count data has begun. Data collected surveying the frequency of crowing and an observer's ability to hear a pheasant at various distances is being used to obtain estimates of the probability of detection and more accurate population estimates.

3.3.3* Assessment of PRNP genotypes and stress levels to determine potential susceptibility of elk to chronic wasting disease. David Walter, Justin Brown, Jeremy Banfield. 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.

3.3.4* Analysis of stable isotopes to differentiate between pen-reared and wild-born pheasant in Pennsylvania. David Walter, Duane Diefenbach, Scott Klinger. 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.

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

Honors and Awards

Tyler Wagner was awarded the *2016 CRU Scientific Excellence Award* for excellence in furthering the mission of the Cooperative Research Units Program.

Tyler Wagner and **Tyrell DeWeber** (former Wagner PhD student) were awarded the *National Fish Habitat Award for Excellence in Scientific Achievement* to recognize outstanding achievement in the use of science to improve fish habitat conservation. This award was given to Wagner and DeWeber for their work on Brook Trout conservation and management in the eastern U.S.

Duane Diefenbach was awarded the *2015 Natural Resource Education Champion Award* in recognition of outstanding contributions to Natural Resource Extension in Pennsylvania by the Pennsylvania Association of Natural Resource Extension Professionals.

Will Miller received $500 from *The Wildlife Society Student Travel Grant* to attend annual meeting in Winnipeg, Manitoba.

Will Miller received 3rd place at the *Best Student Poster Award for Research in Progress* at the Wildlife Society Annual Meeting in Winnipeg, Manitoba.

Theses and Dissertations

Carrollo, E.M. M.S. in Wildlife and Fisheries Science, 2016. Exploration of methods for analyses of resource selection using location-based data.

Forman, N.S. M.S. in Wildlife and Fisheries Science, 2015. River otter population monitoring in Northeastern Pennsylvania using non-invasive genetic sampling and spatial capture-recapture models.

Gigliotti, L., M.S. in Wildlife and Fisheries Science, 2016. Ecology, habitat use and winter thermal dynamics of snowshoe hares in Pennsylvania.

Lutz, C. L., M. S. in Wildlife and Fisheries Science, 2015. Dispersal behavior in female white-tailed deer.

Peer-reviewed Publications

Davis, L.A. and **T. Wagner**. 2016. Scale-dependent seasonal pool habitat use of sympatric wild Brook Trout and Brown Trout populations. Transactions of the American Fisheries Society 145:888-902.

Casalena, M. J., R. Everett, **W. C. Vreeland**, I. D. Gregg, and **D. R. Diefenbach**. 2016. Timing of spring wild turkey hunting in relation to nest incubation. Proceedings of the National Wild Turkey Symposium 11:237-247.

Diefenbach, D. R., L. Hansen, J. Bohling, and C. Miller-Butterworth. 2015. Population and genetic outcomes 20 years after reintroducing bobcats (Lynx rufus) to Cumberland Island, Georgia USA. Ecology and Evolution 5:4885–4895. doi: 10.1002/ece3.1750.

Diefenbach, D. R., S. L. Rathbun, **J. K. Vreeland**, D. Grove, and **W. J. Kanapaux**. 2016. Evidence for range contraction of snowshoe hare in Pennsylvania. Northeastern Naturalist 23:229-248.

Diefenbach, D. R., **W. C. Vreeland**, M. J. Casalena, M. V. Schiavone. 2016. Retention of riveted aluminum leg bands by wild turkeys. Journal of Fish and Wildlife Management. doi: http://dx.doi.org/10.3996/072015-JFWM-064.

Evans, T.S., M. Kirchgessner, B. Eyler**,** C.W. Ryan, and **W.D. Walter**. 2016. Habitat influences distribution of chronic wasting disease in white-tailed deer. Journal of Wildlife Management 80(2): 284–291.

Fischer, J.W., C.R. Blass, **W.D. Walter ,** C.W. Anderson, M.J. Lavelle, W.H. Hall, and K.C. VerCauteren. 2016. Evaluating a strategy to deliver vaccine to white-tailed deer at a landscape level. Wildlife Society Bulletin 40(2):394–399.

Fischer, J.W., D. McMurtry, C.R. Blass, **W.D. Walter ,** J. Beringer, and K.C. VerCauteren. 2016. Effects of repeated simulated removal activities on feral swine movements and space use. European Journal of Wildlife Research. 62(3):285–292.

Haley, N.J., C. Siepker, **W.D. Walter**, B.V. Thomsen, J.J. Greenlee, A.D. Lehmkuhl, and J.A. Richt. 2016. Antemortem detection of chronic wasting disease prions in nasal brush collections and rectal biopsies from white-tailed deer by real time quaking-induced conversion. Journal of Clinical Microbiology 54(4):1108–1116.

Haley, N.J., C. Siepker, L.L. Hoon-Hanks, G. Mitchell, **W.D. Walter**, M. Manca, R.J. Monello, J.G. Powers, M.A. Wild, E.A. Hoover, B. Caughey, and J. Richt. 2016. Seeded amplification of chronic wasting disease prions in nasal brushings and recto-anal mucosal associated lymphoid tissues from elk by real time quaking-induced conversion. Journal of Clinical Microbiology. 54(4):1117–1126.

King, D.T., J.W. Fischer, B. Strickland, **W.D. Walter**, F.L. Cunningham, and G. Wang. 2016. Winter and summer home ranges of American white pelicans (*Pelecanus erythrorhynchos*) captured at loafing sites in the southeastern United States. Waterbirds *In press.*

Lutz, C. L., **D. R. Diefenbach**, C. S. Rosenberry. 2016. Proximate influences on female dispersal in white-tailed deer. Journal of Wildlife Management. DOI: 10.1002/jwmg.21106.

Midway, S.R. and **T. Wagner.** 2015. The first description of oarfish Regalecus glesne (Regalecidae) ageing structures. Journal of Applied Ichthyology 1-4.

Miller, W.L., J.W. Snodgrass, and G.E. Gasparich. The importance of terrestrial dispersal for connectivity among headwater salamander populations. Ecosphere 6(10): 188. http://dx.doi.org/10.1890/ES15-00302.1.

Oliver, S.K., P.A. Soranno, C.E. Fergus, **T. Wagner**, L.A. Winslow, C.E. Scott, K.E. Webster, J.A. Downing, and E.A. Stanley. 2016. Prediction of lake depth across a 17-state region in the U.S. Inland Waters 6:314-324.

Wagner, T., **S.R. Midway**, T. Vidal, B.J. Irwin, and J.R. Jackson. 2016. Detecting unusual temporal patterns in fisheries time series data. Transactions of the American Fisheries Society 145:786-794.

Soranno, P.A., K.S. Cheruvelil, **T. Wagner**, K.E. Webster, and M.T. Bremigan. 2015. Effects of land use on lake nutrients: The importance of scale, hydrologic connectivity, and region. PLoS ONE 10(8): e0135454.

Technical Data

Walter, W.D. and J.W. Fischer. Datasets to accompany The Manual of Applied Spatial Ecology. Online: < ftp://data1.commons.psu.edu/pub/commons/walter_datasets/>

Presentations at Scientific Meetings

Begley-Miller, D. R., **D. R. Diefenbach**, M. E. McDill, C. S. Rosenberry, and E. Just. 2016. Greater than the Sum of its Parts: Understanding Forest Habitat in the Context of Deer, Soil Chemistry, and Competing Vegetation. Annual meeting of the Pennsylvania Chapter of The Wildlife Society, 16 April 2016, State College, PA.

Casalena, M. J., **W. C. Vreeland**, R. Everett, I. Gregg, and **D. R. Diefenbach**. Timing of spring wild turkey hunting in relation to nest incubation. National Wild Turkey Symposium, 15 January 2016, Tuczon, Arizona.

Cheruvelil, K.S., S. Yuan, S. Collins, C.E. Fergus, C. Filstrup, E. Norton Henry, J-F. Lapierre, C. Scott, P. Soranno, P-N. Tan, **T. Wagner**, K. Webster. Including the freshwater landscape in a multi-themed regionalization system to capture macroscale patterns. The 2015 Ecological Society of America Annual Meeting, August 9 – 15.

Collins, S.M., S.K. Oliver, J-F. Lapierre, E.H. Stanley, J. Jones, **T. Wagner**, P.A. Soranno. 2016. What drives lake nutrients at continental scales, and why is it so hard to predict nutrient ratios? Association for the Sciences of Limnology and Oceanography.

DeWeber, T. and **T. Wagner**. 2015. Is That the Best Metric for Predicting Climate Change Effects on Brook Trout? American Fisheries Society Annual Meeting, Portland, Oregon.

DeWeber, T. and **T. Wagner**. 2015. Predicting Mean Daily River Water Temperature to Identify Brook Trout Habitat. American Fisheries Society Annual Meeting, Portland, Oregon. Invited.

Fergus, C.E., A.O. Finley, P.A. Soranno, **T. Wagner**. Examining the nutrient-color paradigm across macroscales: Multivariate spatial relationships among lake phosphorus, water color, and chlorophyll. The 2015 Ecological Society of America Annual Meeting, August 9 – 15.

Fergus, C.E., A.O. Finley, P.A. Soranno, **T. Wagner**. Examining the nutrient-color paradigm across macroscales: Multivariate spatial relationships among lake phosphorus, water color, and chlorophyll. The 2015 Ecological Society of America Annual Meeting, August 9 – 15.

Filstrup, C.T., **T. Wagner**, C.A. Stow, S.K. Oliver, E.H. Stanley, K.E. Webster, J.A. Downing. 2016. Nitrogen stress effects on lake phytoplankton vary by region based on land use. Association for the Sciences of Limnology and Oceanography.

Gingery, T. M., **D. R. Diefenbach**, B. D. Wallingford, and C. S. Rosenberry. White-tailed deer fawn behavior and survival in Pennsylvania. Annual Meeting of the Pennsylvania Chapter of The Wildlife Society, 16 April 2016, State College, PA.

Ikis, D., E. Post, and **T. Wagner**. 2015. Bird Occupancy Dynamics in Alaskan Wetlands: Why different size ponds matter? Ecological Society of America Annual Meeting.

Lapierre, J-F., S.M. Collins, D. Seekell, P.A. Soranno, K.S. Cheruvelil, P-N. Tan, C.E. Fergus, N. Skaff, **T. Wagner**, M.T. Bremigan. 2016. Aligning spatial scales improves understanding of biogeochemical relationships between climate, landscape, and limnological properties. Association for the Sciences of Limnology and Oceanography.

Lapierre, J-F., S.M. Collins, C. Scott, K.S. Cheruvelil, P-N. Tan, M.T. Bremigan, **T. Wagner**, and P.A. Soranno. The role of spatial structure in determining the strength of the relationships among climate, landscape and limnological properties. The 2015 Ecological Society of America Annual Meeting, August 9 – 15.

Li, Y. and **T. Wagner**. 2016. Assessing the impacts of endocrine disrupting compounds on fish population dynamics: a case study of smallmouth bass in Pennsylvania, USA. National Conference on Ecosystem Restoration.

Lottig, N.R., P-N. Tan, K.S. Cheruvelil, C.E. Scott, E.H. Stanley, P.A. Soranno, C.A. Stow, **T. Wagner**, S. Yuan. 2016. Long-term patterns and drivers of water quality at sub-continental spatial scales. Association for the Sciences of Limnology and Oceanography.

Oliver, S.K., S. Collins, K.S. Cheruvelil, P.A. Soranno, E.H. Stanley, J-F. Lapierre, N. Lottig, and **T. Wagner**. 2016. Long-term change in lake nutrient concentrations: where are we now? Association for the Sciences of Limnology and Oceanography.

Scott, C.E., C.E. Fergus, S.M. Collins, J-F. Lapierre, N.R. Lottig, C.T. Filstrup, N. Skaff, E.H. Stanley, P-N. Tan, **T. Wagner**, P.A. Soranno, and K.S. Cheruvelil. Understanding the response of lake water quality at macroscales to measures of regional and global climate. The 2015 Ecological Society of America Annual Meeting, August 9 – 15.

White, S.L., C. Gowan, **T. Wagner**, V.A. Braithwaite. 2015. Boldness impairs spatial learning ability in brook trout. American Fisheries Society Annual Meeting, Portland, Oregon.

Williamson, L. T., D. R. Diefenbach, W. D. Walter. Modeling potential habitat for pheasant population restoration in Pennsylvania. Annual Meeting of the Pennsylvania Chapter of The Wildlife Society, 16 April 2016, State College, PA.