MEETING MINUTES

Coordinating Committee Meeting
Pennsylvania Cooperative Fish and Wildlife Research Unit

Thursday, July 11, 2019
9:30 AM
Held in Room 217 in the Forest Resources Building

1. Attending representatives included: Michael Tome, USGS; Bryan Burhans and Matthew Schnupp, PGC; Tim Schaeffer and Andrew Shiels, PFBC; David Eissenstat, Department of Ecosystem Science and Management; Dean Richard Roush, College of Agriculture; Rick Bennett, USFWS

2. Minutes from June 15, 2018 meeting approved

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

3.1. Wagner

3.1.1. The significance of intraspecific diversity for the conservation of brook trout

3.2. Walter

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

3.2.2. Feasibility of using non-invasive genetic sampling and spatial capture-recapture models for population estimation of fisher (*Martes pennanti*)

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

4.1. Diefenbach

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. Distribution of predators and their relation to fawn survival

4.2. Wagner

4.2.1. Establishing a strategy for assessing risk of endocrine-disrupting compounds to aquatic and terrestrial organisms

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

4.2.3. Spatial and temporal analysis of endocrine disrupting compounds in surface waters of the Chesapeake Bay Watershed

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

4.2.5. *Fish habitat restoration to promote adaptation: resilience of sport fish in lakes of the Upper Midwest

4.2.6. 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

4.3. Walter

4.3.1. The effects of targeted removal of deer groups on the epidemiology of chronic wasting disease in wild white-tailed deer in Pennsylvania

4.3.2. Epidemiology of West Nile virus in ruffed grouse (*Bonasa umbellus*)

4.3.3. Muskrat (*Ondatra zibethicus*) ecology, population estimation, and health

4.3.4. Assessment of fence-line interactions at the captive-wild deer interface

4.3.5. *Phase II: Genetic assignment of white-tailed deer to population of origin.

5. Proposed Budget – approved

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

6.1. Diefenbach

6.1.1. Ethan Kibe, MS Wildlife and Fisheries

6.1.2. Asia Murphy, PhD Ecology

6.1.3. Amanda Van Buskirk, MS Ecology

6.2. Wagner

6.2.1. Shannon White, Postdoc

6.2.2. Catherine McClure, MS Ecology

6.2.3. Danielle Massie, MS WFS

6.2.4. Tyler Thompson, MS Wildlife and Fisheries

6.3. Walter

6.3.1. Laken Ganoe - MS Wildlife and Fisheries

6.3.2. Dominika Dec Peevey - PhD Ecology

7. Service on Graduate Committees (other than advisees)

7.1. Diefenbach

7.1.1. Laken Ganoe, MS Wildlife and Fisheries

7.1.2. Michael Perkins, PhD Forest Science

7.2. Wagner

7.2.1. Courtney Davis, PhD Ecology

7.2.2. Nathan Wikel, PhD Statistics

7.2.3. Amanda Van Buskirk, MS Ecology

7.3. Walter

7.3.1. Ellen Brandell, PhD Ecology

7.3.2. Ethan Kibe, MS Wildlife and Fisheries

8. Courses and Workshops Taught by Unit Staff

8.1. Diefenbach

8.1.1. Population Estimation and Modeling, spring 2019

8.2. Wagner

8.2.1. Quantitative Methods in Ecology, spring 2019

8.3. Walter

8.3.1. Applied Spatial Ecology in R (workshop), September 2018
8.3.2. Applied Spatial Ecology in R (course), Spring 2019

9. Comments from Cooperators

9.1. U.S. Geological Survey – Mike Tome

9.1.1. The Cooperative Research Units were removed from the President's budget for the past 2 years. However, the House budget includes a $5 million increase, although the Senate budget is uncertain.

9.1.2. John Organ retired as Chief of CRU in January. John Thompson has been acting chief and approval has been given to advertise for the position. However, the position could be moved from Reston, VA to Denver, CO, which creates some uncertainty for administrative staff.

9.1.3. The research units are an $18 million program that is leveraged by $80 million on non-federal funds.

9.2. Pennsylvania Game Commission – Executive Director Bryan Burhans and Bureau Director Matthew Schnupp

9.2.1. The PGC was recently audited by the state and received relatively minor recommendations for changes but some criticisms were unfounded.

9.2.2. CWD plan for the Disease Management Area was planned for June 8th but decided to delay and ramp up communications efforts.

9.2.3. PGC has hired 8 biologists in the past year to fill vacant and new positions

9.2.4. A wildlife health initiative has been created in partnership with the University of Pennsylvania veterinary school

9.3. Pennsylvania Fish and Boat Commission – Executive Director Tim Schaeffer and Assistant Director Andrew Shiels

9.3.1. Recruiting for a director for the Bureau of Fisheries, Director of Outreach, R3 coordinator, and an invasive species coordinator

9.3.2. Initiating a strategic plan to be completed by July 1, 2020. Will be a 3-year plan that will include climate change impacts

9.3.3. A license fee bill to allow the agency to set its own license fees has passed the House and only needs to pass the Senate.

9.3.4. Gill lice are a management problem for the agency because there is the potential for hatchery trout to be putting wild populations at risk. However, hatcheries are the responsibility of the PA Department of Agriculture.

9.4. U.S. Fish and Wildlife Service – Rick Bennett

9.4.1. Budget has been stable but the Science Applications section has been removed from the President's budget. Priorities for USFWS are related to at-risk species. In the Northeast the salt marsh sparrow is currently high priority. The Delaware River Conservation Fund has been well funded in recent years and is an opportunity for PFBC to obtain funds for conservation-related work on the Delaware River.

9.5. Wildlife Management Institute – not present

10. Adjourned at 12pm

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

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

Appendix A – Abstracts of Completed Projects (yellow pages)

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

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

APPENDIX A - Completed Projects

2.2.1. The significance of intraspecific diversity for the conservation of brook trout

Tyler Wagner (PI)

Improved understanding of eco-evolutionary dynamics can help predict species' response to current and future disturbance and aid in the development of more effective conservation strategies. However, incorporating eco-evolutionary dynamics into our understanding of species' ecology is complicated by the need to unite individual molecular and behavioral ecology with population vital rates, and understand how those relationships interact with both fine- and broad-scale habitat features. These cross-scale interactions among biotic and abiotic features are critical for explaining patterns in population demography and predicting future evolutionary trajectories; however, they are often overlooked when conducting population-level analyses because individual variation is presumed to represent random variance around a mean population-level response.

This project sought to understand how individual variation in habitat use and phenotypic and genotypic diversity influence population demography and evolutionary potential in brook trout (Salvelinus fontinalis). The four main objectives were to (1) develop a novel framework for the analysis of riverscape genetics and apply this framework to understand population connectivity in brook trout in the Loyalsock Creek watershed, Pennsylvania, (2) estimate introgression between wild and hatchery-stocked brook trout in Loyalsock Creek, (3) examine individual variation in thermal refuge use during periods of stream temperature rise, and (4) investigate the influence of individual fish behavioral phenotypes on spatial learning. The results of this study are in Dr. Shannon White's dissertation at PSU and in the following publications:

White, S.L., B.C. Kline, N.P. Hitt, and T. Wagner. In press. Individual behaviour and resource use of thermally stressed brook trout Salvelinus fontinalis portend the conservation potential of thermal refugia. Journal of Fish Biology;

White, S.L., W.L. Miller, S.A. Dowell, M.L. Bartron, and T. Wagner. 2018. Limited hatchery introgression into wild brook trout (Salvelinus fontinalis) populations despite reoccurring stocking. Evolutionary Applications 11:1567-1581;

White, S.L., T. Wagner, C. Gowand, and V.A. Braithwaite. 2017. Can personality predict individual differences in brook trout spatial learning ability? Behavioural Processes 141:220-228.

2.3.1 Assessment of PRNP genotypes and stress levels to determine potential susceptibility of elk to chronic wasting disease. Will Miller, David Ensminger, Tess Gingery, Cate Pritchard, David Walter, 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.

2.3.2 Feasibility of using non-invasive genetic sampling and spatial capture-recapture models for population estimation of fisher (*Martes pennanti*) Laken Ganoe, 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.

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 continues to work on writing his thesis, although progress has been slow. Timing of denning of females can be predicted by the mast index developed by Mark Ternent. 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 continue to collaborate with Paul Fackler at NCSU and Alabama on a stochastic dynamic programming model for making recommendations for harvest regulations. A contract between Paul Fackler, NCSU and NWTF has been executed and the project is progressing. These SDP models incorporate a population dynamics model with accompanying uncertainties into an explicit framework for making 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).

To date we have conducted surveys to estimate abundance and monitor genetics in 2012, 2016, 2018, and 2019. We have observed populations increase from 10-14 in 2012-2016 to 23 in 2019. A comparison of the genetic structure of the current population to the founding individuals released on the island in 1989-1990 indicates a measurable loss in genetic diversity but limited evidence of inbreeding. Some of our findings were presented at the 2018 conference of The Wildlife Society and a manuscript is in preparation.

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.

Dr. Danielle Begley-Miller, who completed her degree, last year, has published two papers from her dissertation. Over the past year we have conducted a more comprehensive analysis of soil conditions on all the study areas. Nicolas Navarro completed his M.S. degree last summer.

Currently, two graduate students are working on the project, Amanda Van Buskirk (M.S.) and Michael Perkins (Ph.D.). Amanda is looking at developing an integrated population model that will use genetic surveys, FLIR surveys, and mark-recapture data from radio-collared deer. She is also investigating the effect of size and shape of DMAP areas on their ability to reduce deer densities. Michael Perkins is developing a research proposal to investigate the changes in the forest plant community in response to our deer management actions.

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 (Ph.D. in Ecology) has one manuscript submitted to a journal and plans to complete her degree in 2020.

3.2.1 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.

3.2.2 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.

3.3.3 Spatial and temporal analysis of endocrine disrupting compounds in surface waters of the Chesapeake Bay Watershed Tyler Wagner (PI), Vicki Blazer (co-PI, USGS), Kelly Smalling (co-PI, USGS)

This project that investigate the spatial and temporal variation of contaminants of emerging concern (CEC's) within the surface waters of rivers in the Chesapeake Bay watershed. The project will synthesize and analyze over four years of existing data that were collected by the United State Geological Survey (USGS) throughout the Chesapeake Bay watershed. Specifically, this project will focus on the role that extreme flow and storm events may have on the prevalence and concentration of CEC's in surface water, as well as any possible connections between nutrient levels and CEC's in surface water. Finally, we will conduct a spatial analysis to explore the role that different land cover types have on river CEC composition and concentrations. The proposed project will use Bayesian statistical modelling to meet the study objectives. The goals of this research are to increase the knowledge of the spatiotemporal dynamics of CEC's to better inform management of the Chesapeake Bay watershed. Specifically, this information will help inform land management, restoration and protection of the Chesapeake Bay.

3.2.4 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.

3.2.5 * Fish habitat restoration to promote adaptation: resilience of sport fish in lakes of the Upper Midwest Tyler Wagner (co-PI), Gretchen Hansen (PI, Univ. MN), Jordan Read (co-PI, USGS), Erin Schiep (co-PI, Mizzou), Zach Feiner (co-PI, WI DNR), Catherine Hein (co-PI, WI DNR), Pete Jacobson (co-PI, MN DNR), Joe Nohner (co-PI, MGLP, MN DNR), Samantha Oliver (co-PI, USGS), Kevin Wehrly (co-PI, MI DNR), Abigail Lynch (co-PI, USGS NCAC)

Fish responses to climate change are heterogeneous across the landscape of lakes. Local habitat conditions and the abundance of other species can influence fish responses, and by manipulating these factors, fish managers may increase resilience of certain populations to warming. We propose to quantify fish responses to climate change in lakes throughout the Midwestern United States, and to identify factors that explain heterogeneity in how fish populations respond. Our objectives are to: (1) Develop statistical models of the relative abundance of multiple species of fish in lakes throughout the Upper Midwest; (2) Quantify relationships between environmental conditions, species interactions, and the abundance and recruitment of managed fish; (3) Predict abundance and recruitment of multiple fish species under future scenarios of climate change; and (4) Identify and communicate priority lakes for implementing habitat protection and restoration actions. We will develop joint species distribution models that quantify dependencies between multiple fish species and their environment. We will collate fish relative abundance and habitat data from the 8 state fisheries management agencies of our study region (Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin). Target species will include walleye, yellow perch, black bass, northern pike, cisco, and bluegill to span a range of thermal preferences and management strategies. We will simulate water temperature conditions under contemporary (1979-2019) and future (late 21st century) climate conditions. We will quantify relationships between multiple fish species abundance and recruitment, lake characteristics, and climate. The models will be used to assess how multiple fish species respond to water temperature and how that response depends on other variables. We will assess the role of harvest and stocking in influencing walleye abundance and the entire fish community on a subset of lakes where suitable data are available. We will develop a prioritization scheme for managing fish communities under climate change and communicate results via data visualization and communication tools co-produced with fisheries management agencies. By generating lake-level predictions for multiple species in tens of thousands of lakes across multiple states, our results will be relevant for prioritizing climate adaptation management decisions at lake, watershed, county, state, and regional scales.

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 The effects of targeted removal of deer groups on the epidemiology of chronic wasting disease in wild white-tailed deer in Pennsylvania

Pennsylvania's CWD infection is currently in a relatively early stage of development. This provides some hope that an effective control strategy might protect the state's white-tailed deer resource. Potential elimination of CWD in free-ranging deer has occurred (e.g., New York) so it might be possible to focus targeted removal efforts on locations where CWD positive animals are found at or beyond the fringe of an infected area. We will implement a study designed to test and evaluate a systematic approach to controlling occurrence and distribution of CWD in Pennsylvania utilizing various harvest strategies (targeted removal of deer groups, altering hunting season) in areas CWD positive deer have been found. By employing a systematic program aimed at simultaneously trying to control the prevalence level within an area while attempting to eradicate new infections along the margin of the area, investigation of potential methods for effective control of CWD outbreaks is needed by state agencies or federal parks if CWD is discovered. This research will have management implications for various agencies by: (1) removing antler-point restrictions on harvest regulations of male deer, (2) controlled localized culling of deer to potentially reduce prevalence and transmission, and (3) a combination of 1 and 2 above as well as a control area with no management actions to assess the most suitable method to decrease prevalence and minimize/eliminate transmission out of the disease management area.

3.3.2 Epidemiology of West Nile virus in ruffed grouse Dominika Dec Peevey, 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.

3.3.3 Muskrat (*Ondatra zibethicus*) ecology, population estimation, and health Laken Ganoe, David Walter, Matt Lovallo (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.

3.3.4 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.

3.3.5* Phase II: Genetic assignment of white-tailed deer to population of origin. David Walter, Chris Rosenberry (PGC). Funding by the Pennsylvania Game Commission

Genetic assignment tests, using multi-locus genotypes, employ algorithms to cluster individuals together based on genetic similarity and can be used to identify migrants when individuals assign to a population not representative of the genetic cluster they were sampled. These assignment methods can be useful for identifying the source of novel disease outbreaks particular for disease such as chronic wasting disease that can be sourced to captive or wild origins. Research on surveillance strategies, that consider demographic and environmental factors, is lacking in most states CWD has not been found. Developing surveillance strategies to maximize efficiency of sampling white-tailed deer has been recommended but requires knowledge of deer behavior, movements, and spatial connectivity of populations. 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. Phase I of this research identified 11 subpopulations with the Disease Management Areas (DMA) 1–3 in Pennsylvania and in Maryland/Virginia (see publications by Miller and others in Appedix C). Statewide assessment of subpopulation structuring would provide integral detail on potential for CWD spread throughout the state as well as a method of identifying new focal areas of the disease should they arise.

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

Honors and Awards

Shannon White (PhD Ecology) was selected as a recipient of the 2019 Alumni Association Dissertation Award and received the Distinguished Doctoral Scholar Medal from Penn State President Eric Barron.

Ben Kline (undergraduate, Wagner Lab) was awarded the Best Student Presentation Award at the Virginia/West Virginia state chapter meeting of the American Fisheries Society for his work examining the relative roles of biotic interactions and environmental conditions in structuring stream fish communities. Ben also was awarded the Cooper Award at the Pennsylvania Chapter AFS meeting.

Duane Diefenbach was presented the 2019 Distinguished Alumni Award by the Wildlife Alumni Association, University of Maine.

Peer-reviewed Publications

Diefenbach

Diefenbach, D. R., G. L. Alt, B. D. Wallingford, C. S. Rosenberry, and E. S. Long. 2019. Effect of male age structure on demography and breeding behavior in white-tailed deer. Journal of Wildlife Management. In press.

Begley-Miller, D. B., D. R. Diefenbach, M. McDill, P. Drohan, C. Rosenberry, and E. Just. Soil Chemistry, not short-term (2 year) deer exclusion, explains occupancy of several understory plant taxa in forests affected by acid deposition. AoB Plants. In press.

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Rosenberry, C. S., and **D. R. Diefenbach.** 2019. A comparison of spatial variation of deer harvests between small and large management units in Pennsylvania. Wildlife Society Bulletin. 43:71–76; DOI: 10.1002/wsb.939

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Wagner

Soranno*, P.A., **T. Wagner***, S.M. Collins, J-F Lapierre, N.R. Lottig, and S.M. Oliver. In press. Spatial and temporal variation of ecosystem properties at macroscales. Ecology Letters. (* co-leads)

White, S.L., B.C. Kline, N.P. Hitt, and **T. Wagner.** In press. Individual behaviour and resource use of thermally stressed brook trout Salvelinus fontinalis portend the conservation potential of thermal refugia. Journal of Fish Biology.

Schall, M.K., T. Wertz, G.D. Smith, V.S. Blazer, and **T. Wagner**. In press. Movement dynamics of smallmouth bass (Micropterus dolomieu) in a large river-tributary system. Fisheries Management and Ecology.

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Pregler, K.C., R.D. Hanks, E. Childress, N.P. Hitt, D.J. Hocking, B.H. Letcher, **T. Wagner**, and Y. Kanno. Accepted. State-space analysis of power to detect regional brook trout population trends over time. Canadian Journal of Fisheries and Aquatic Sciences.

Yan, L. and **T. Wagner**. Accepted. Does incorporating gear selectivity during macroscale investigations of fish growth reduce size-selective sampling bias in parameter estimates? Canadian Journal of Fisheries and Aquatic Sciences.

Midway, S.R., **T. Wagner**, and G.H. Burgess. 2019. Trends in global shark attacks. PLoS ONE.

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Walter

Miller, W.L., J. Edson, P. Pietrandrea, C. Miller-Butterworth, and **W. D. Walter**. 2019. Identification and evaluation of a core microsatellite panel for use in white-tailed deer (*Odocoileus virginianus*). BMC Genetics 20:49.

Schneider, A.L., A.T. Gilbert, **W.D. Walter**, G.S. Vandeberg, and J.R. Boulanger. 2019. Spatial ecology of urban striped skunks (*Mephitis mephitis*) in the Northern Great Plains: A framework for future oral rabies vaccination programs. Urban Ecosystems 22:539–552.

Miller, W.L. and **W. D. Walter.** 2019. Spatial heterogeneity of prion gene polymorphisms in an area recently infected by chronic wasting disease. Prion 13(1):65-76; https://doi.org/10.1080/19336896.2019.1583042

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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. 82(8):1680–1688; DOI: 10.1002/jwmg.21545

Presentations at Scientific Meetings

Diefenbach

Diefenbach, D. R. The Impossible Dream: Managing White-tailed Deer to Meet Forest Management Objectives, University of Maine, April 2019. INVITED.

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. The Wildlife Society Annual Meeting, 7-11 October 2018, Cleveland, OH, USA.

Gingery, T. M., D. R. Diefenbach, B. D. Wallingford, and C. S. Rosenberry. Space Use of White-tailed Deer Neonates Using Micro-GPS Units. The Wildlife Society Annual Conference, 7-11 October 2018, Cleveland, OH, USA.

Miller-Butterworth, C., L. Hansen, D. Hoffman, A. Russell, **J. Edson**, and **D. R. Diefenbach**. Population genetics of two contrasting island populations of bobcats. The Wildlife Society Annual Meeting, 7-11 October 2018, Cleveland, OH, USA>

Murphy, A., D. Miller, and **D. R. Diefenbach**. Examining habitat partitioning between Pennsylvania's apex carnivores and a common prey species (white-tailed deer fawns). The Wildlife Society Annual Conference, 7-11 October 2018, Cleveland, OH, USA.

Begley-Miller, D. R., D. R. Diefenbach, M. E. McDill, C. S. Rosenberry, and E. Just. Evaluation of Short-term (3 Year) Understory Plant Community Responses to Deer Exclusion, Herbicide, and Lime Application in Central Pennsylvania. Annual Meeting of the Ecological Society of America, 5-10 August 2018, New Orleans, LA, USA.

Diefenbach, D. R., G. L. Alt, B. D. Wallingford, C. S. Rosenberry, and E. S. Long. Effect of male age structure on demography and breeding behavior in white-tailed deer. International Deer Biology Congress, 5-10 August 2018, Estes Park, CO, USA.

Murphy, A. U., D. Miller, and **D. R. Diefenbach**. Examining Habitat Partitioning between Pennsylvania's Apex Carnivores and a Common Prey Species (White-tailed Deer Fawns; Odocoileus virginianus). North American Congress for Conservation Biology, 21-26 July 2018, Toronto, Canada.

Wagner (selected presentations)

White, S.L., **W.L. Miller**, S.A. Dowell, M.L. Bartron, and **T. Wagner**. 2018. Limited hatchery introgression into wild brook trout populations despite reoccurring stocking. Annual Meeting of The American Fisheries Society, Atlantic City, New Jersey.

Sweka, J.A. and **T. Wagner**. Effects of stream discharge on young-of-year brook trout density in North Central Pennsylvania. Annual Meeting of the American Fisheries Society, Atlantic City, NJ.

Kline, B., S.L. White, N. Hitt, and **T. Wagner**. Resource use by brook trout (Salvelinus fontinalis) in a thermally complex environment. Annual Meeting of The American Fisheries Society, Atlantic City, New Jersey.

Wagner, T., E. Schliep, G. Hansen, B. Bethke, and P. Jacobson. 2018. C'mon, everyone's doing it: joint distribution models for studying spatiotemporal dynamics of fish communities and their habitat . Annual Meeting of the American Fisheries Society, Atlantic City, NJ.

Smith, G.D., **M.K. Schall**, V.S. Blazer, H.L. Walsh, and **T. Wagner**. 2019. The role of disease in altering the population structure of Smallmouth Bass in the Susquehanna River Basin. International Association for Great Lakes Research (IAGLR).

Schall, M.K., V.S. Blazer, H.L. Walsh, G. Smith, T. Wertz, and **T. Wagner**. 2019. Quantifying spatial variability in young of year smallmouth bass disease infections in the Chesapeake Bay Watershed. International Association for Great Lakes Research (IAGLR), Brockport, NY.

Walter

Walter, W.D. was the eastern US representative for USGS to a briefing to House and Senate Committee staffers to assist in understanding on chronic wasting disease for future funding initiatives to address research and management of the disease in Washington, D.C., 20–21 June (Invited Oral – 2 days)

Schneider, A.L., A.T. Gilbert, **W.D. Walter**, G.S. Vandeberg, and J.R. Boulanger. 2019. Spatial Ecology of Urban Striped Skunks (Mephitis mephitis) in the Northern Great Plains. International Urban Wildlife Conference, Portland, OR.

Ganoe, L, M. Lovallo, J. Brown, and **W.D. Walter**. 2019. Muskrat (Ondatra zibethicus) ecology and health. The Pennsylvania Chapter of the Wildlife Society, State College, PA.

Ganoe, L.S. and **W.D. Walter**. 2018. Muskrat (Ondatra zibethicus) movements, survival and disease. The Wildlife Society Annual Meeting, Cleveland, OH.

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. (Contributed Oral)