Issue No. 17

MSU Fisheries and Wildlife

SPOTLIGHT 2021

Written and produced by graduate students

FEATURING

Sea Lamprey
Arctic Research Cruises
Waterfowl management
Fisheries education
Diversity, Equity & Inclusion
& More!

SPOTLIGHT
Issue No. 17

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LETTER FROM THE CHAIR

It is my great pleasure to welcome you to the 2021 version of MSU Fisheries and Wildlife Spotlight. In these pages is proof that our graduate students, alumni, and faculty are working on topics important to our livelihoods and conservation of our natural world. Even under the challenges imposed by the global pandemic in 2020, our Department continued to excel, a testament to the importance and relevance of our work to society.

The Spotlight is produced by our graduate students; a partial demonstration of their commitment to engaging society in our story. The 2021 issue of Spotlight offers insights into some of the work and perspectives in our Department; please recognize that it is a sample of what we do. In this issue you will read about:

- How migratory behavior in waterfowl is changing, and how human activity affects localized habitat use by waterfowl.
- A student experience on the research vessel U.S. Coast Guard Cutter Healey, one of only two ice-strengthened ships in the U.S fleet, and how that experience provided context for understanding the ecological impacts of shipping in the North Pacific.
- Research being conducted on ways to control and manage the invasive sea lamprey in the Great Lakes, including using "fear" to manipulate behavior and genomics to monitor populations.
- How one of our students taught 3rd-5th graders quantitative fisheries techniques during the Graduate Women in Science (GWIS) Girls Math and Science Day.

These projects reflect our Department's commitment to exploration, education, and engagement as important pillars of our strategic direction.

As of January 2021, I started serving as Chair of our Department; I am humbled that our Department community supported my application. For about the last 3 years, Dr. Scott Loveridge served as Chair and on behalf of the Department I thank him for his leadership. Even during a global pandemic in 2020, our Department announced formation of a new center for PFAS (per- and polyfluoroalkyl substances) research, advanced our use of environmental DNA (eDNA) to aid in conservation, played a role in monitoring for novel coronavirus in wastewater, and received a multi-country grant to examine spread of infectious disease by migratory birds – these are just a few of our accomplishments. Our Department has an active web page (https://www.canr.msu.edu/fw/) and accounts on Facebook and Twitter so look us up to stay current on our activities.

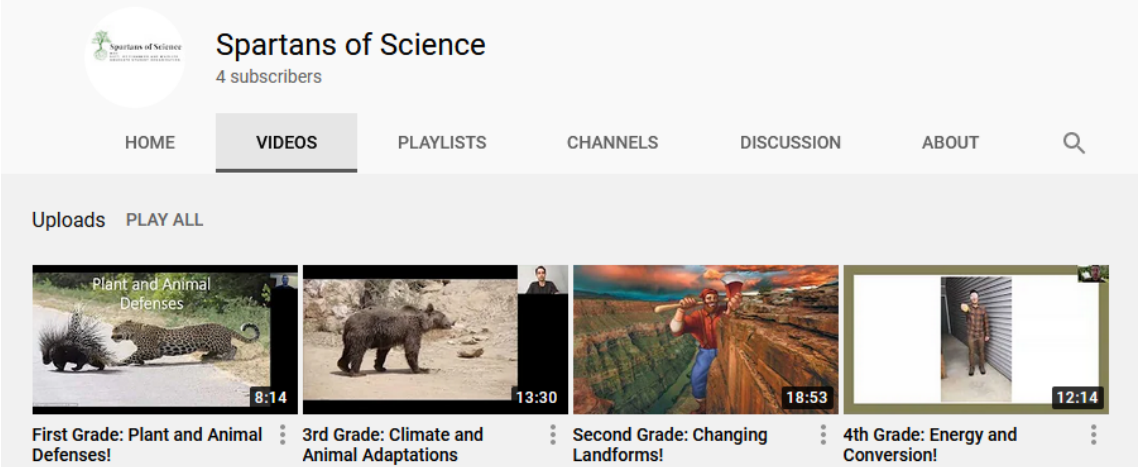
The graduate students in Fisheries and Wildlife continually amaze me with their commitment to our Department's mission; they are a critical piece of our exploration, education, and engagement activities. Enjoy this issue of Spotlight, and as always, our Department greatly appreciates your interest in and support of what we do.

Dr. Gary Roloff

GRADUATE STUDENT OUTREACH

Outreach is a form of scholarship that generates, applies, and preserves knowldge for the direct benefit of people outside the unversity system

This year's Outreach and Engagement Committee consists of **Chair Taylor Haas, Alexandra Benitez, Connor Buckley, Kandace Griffin, Jacob Kimmel, Katelyn King,** and **Jake Sawecki**. As a testament to this department and committee's enthusiasm for sharing knowledge and nature alike, the committee made the best of 2020 and focused on producing virtual content to get the word out!



Spartans of Science

This fall outreach project was designed to give students and teachers alike a break from the craziness of pandemic teaching. Built around the state of Michigan's established curricula for elementary school students, the series of videos brings a different voice to science classrooms around the state with an added spice of Grad Student flair! Contributors were Jacob Kimmel, Connor Buckley, and Tyler Firkus.

Individual Projects

Taylor Haas

Invasive Species and I: A Scientist's Tale of Working with Wildlife from Elsewhere.
MSU Extension 4-H Wild Spartans Series.

Emily Mensch

Guest Teacher for 6th/7th Graders at Bloomingdale Middle School;
Sci-Files Podcast: Novel Invasive Species Management of the Sea Lamprey

Nicole Watson

Multiple presentations of "Michigan Grayling Reintroduction: A New Hope" to Fly Fishing communities around the State; Grayling in Michigan: their past, present, and future MSU Extension Conservation Stewards Program. Nicole's Podcast appearances on Grayling Research: Freshwater Bite, Orvis Fly Fishing Guide Podcast with Tom Rosenbauer, The Fishing Podcast

2021

info	motivation to apply
Name: Tracy Melvin *Advisor: Dr. Gary Roloff* *Program: FW PhD* *Maison Teaching Fellow*	*I love teaching, and have bothered MSU in various capacities to be able to be an instructor of record. There are very few opportunities for this at MSU and in our department, but I do also suggest applying for the F.A.S.T. fellowship program and joining the CIRTL Network if you are looking to improve your teaching. The name of the course I am teaching is "21st Century Conservation: the Anthropocene, Climate Change, and 6th Extinction"*
Name: Kandace Griffin *Advisor: Dr. Michael Wagner* *Program: FW PhD* *Wallach Fellow*	*The Wallach fellowship supports my career goals of exploring wildlife ecology and conservation while engaging with stakeholders to produce community engaged scholarship and implement best practices. I am passionate about conservation and embarking on research which is relevant and meaningful to stakeholders. I also want to ensure the products of my research reach not only an academic audience, but also decision-makers and practitioners who can put these best practices into action.*
Name: Sam Betances *Advisor: Dr. Dana Infante* *Program: FW MSc* *Tanner Fellow*	*Like Dr. Tanner, I hope to conserve our valuable aquatic ecosystems and the important species they support into the future. I hope to continue the legacy of fisheries conservation, particularly with species and systems vulnerable to impacts of climate change and habitat degradation.*
Name: Chris Knupp *Advisor:Dr. Thomas Loch* *Program: FW PhD* *Glassen Fellow*	*Over the last four years of studying F. psychrophilum, I uncovered several important questions that, if answered, have the potential to "turn-the-tide" against BCWD. However, funds to do so were not available in my USDA-NIFA funded research assistantship. Thus, I applied for the Hal and Jean Glassen Conservation Medicine fellowship, which has since allowed me to devise additional experiments to begin addressing these unanswered questions.*
Name: Emily Dean *Advisor: Dr. Dana Infante* *Program: FW PhD* *Fenske Fellow*	*Fenske Project:* *For my Fenske project, I will work my mentors Lisa and Jan to facilitate the exchange of information between GLFC and potential partners, including MDNR, that will aid in barrier removal decisions in the Great Lakes region.* *Fenske Mentors:* *Lisa Walter of the Great Lakes Fishery Commission and Jan-Michael Hessenauer of the Michigan Department of Natural Resources*
Name: Janice Albers *Advisor: Dr. Cheryl Murphy* *Program: FW and Environmental and Integrative Toxicological Sciences* *Ball Fellow*	*Financial support from the project was limited so outside support was needed.*

fellows

graduate research

Managing Climate Induced Ecological Transformation for the Conservation of Global Biodiversity

benefits of fellowship

The Maison Teaching Fellowship is that perfect opportunity to give back to undergraduate education at MSU and learn teaching skillsets. I can't say enough about how great it is to develop a course from scratch and be recognized officially by the FW department. I think this is a great pipeline for bringing new ideas into the department and developing future teachers. Even the act of developing the teaching proposal was a great exercise for my future.

Exploring sea lamprey movement ecology and behavior manipulation to enhance trap efficiency

Currently, MSU does not offer a course in animal movement statistical analysis and data visualization. I plan to use the scholarship fund to attend the AniMove workshop at the Max Planck Institute of Animal Behavior, a two-week intensive workshop to learn about movement data analysis and visualization skills and applying these techniques to my dissertation data. In addition to technical skills to enhance my professional development, I will benefit by growing my professional network and presenting my MSU research on an international platform at a renowned institute.

My graduate research aims to assess how stream fish habitat may change with changing climate. In support of this goal, one of my research objectives is to develop models to predict specific habitat variables from landscape factors, including climate. Additionally, and building on my familiarity with stream habitat data, I am examining barriers to habitat data usage in management decision-making by the Michigan Department of Natural Resources. Collectively, addressing both of my research objectives will improve efforts to conserve Michigan's freshwater fishes from future threats.

I am extremely grateful to Dr. Tanner and the Tanner family for this fellowship award. This award has allowed me to attend several conferences where I was able to present my research and receive feedback from natural resource managers and researchers working across the U.S.

The overarching goal of my research is to devise enhanced methods for preventing and controlling bacterial coldwater disease (BCWD), one of the most damaging diseases of salmon and trout globally, including in the Great Lakes basin. To do so, I am studying multiple unknown facets of the disease ecology and epidemiology of the causative bacterium, Flavobacterium psychrophilum.

This generous fellowship has empowered me to build upon my previous and ongoing studies, towards simultaneously reducing the negative impacts of BCWD and improving salmon and trout conservation and stock enhancement efforts. Additionally, and despite the challenges of COVID-19, I remain hopeful that this fellowship will allow me to attend future national meetings, where I can network and share my research findings.

I strongly value Michigan's fisheries and have focused my career goals on supporting their conservation because I want to ensure the benefits these fishes provide for me, future generations of Michigan citizens, and visitors to our state will continue. My vision for my research is to provide information that supports these goals, and this fellowship will aid me in learning about the structure, function, and relationships of the many agencies that are support Great Lakes fisheries and what my potential role is in aiding them.

This fellowship provides a network of Great Lakes fisheries biologists and managers that will assist me in developing a successful career in fisheries management within the Great Lakes region.

The focus of my dissertation will be to explore the sublethal levels of polychlorinated biphenyl 126 and methylmercury impacts on an economically important Lake Michigan fish species, the Yellow Perch by constructing a fish larvae neurobehavior Adverse Outcome Pathway model. Both of these water pollutants persist for decades in the environment, cause neurological damage in fish and bioaccumulate through the aquatic food web; consequently, they have become ubiquitous in Great Lakes fish tissues. Specifically, my study will focus on multiple sublethal water pollutant exposure levels that alter the expression of genes at the molecular level, which will be identified and quantified. Gene expression alterations can impair motor and sensory functions, thus altering larval swimming and feeding behavior, which will be assessed using laboratory behavior assays. The resulting pollution dose response behavior relationships will be input parameters for simulated fish larvae as they swim around, forage for food and avoid predators in computer generated simulations; where each individual virtual larva is monitored for growth and whether it starves, gets eaten, or survives the summer.

PROVISIONAL LAND ACKNOWLEDGEMENT

We collectively acknowledge that Michigan State University occupies the ancestral, traditional, and contemporary Lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa, and Potawatomi peoples. In particular, the University resides on Land ceded in the 1819 Treaty of Saginaw. We recognize, support, and advocate for the sovereignty of Michigan's twelve federally-recognized Indian nations, for historic Indigenous communities in Michigan, for Indigenous individuals and communities who live here now, and for those who were forcibly removed from their Homelands. By offering this Land Acknowledgement, we affirm Indigenous sovereignty and will work to hold Michigan State University more accountable to the needs of American Indian and Indigenous peoples.

DIVERSITY, EQUITY, AND INCLUSION

I am a cisgender white male who is privileged – something commonly reflected in leadership throughout fisheries and wildlife in North America and other parts of the world.

I am humbled that the Department of Fisheries and Wildlife (FW) chose me to chair our department during a time of renewed racial awakening in our country. As a privileged leader in FW, I am deeply committed to creating meaningful change, with profound responsibility for the tasks ahead. Those immediate tasks include to firmly promote an authentic, community-cultivated safe and productive place for all people, and to foster the growth of such efforts.

Although I am committed to these tasks, meaningful accomplishments require effort from everyone. Fortunately, our diversity, equity and inclusion (DEI) efforts in FW are robustly supported by the excellent DEI office and team at the College level, and I encourage everyone to explore the written works and training courses offered by Dr. Quentin Tyler and Dionardo Pizaña. At one time I thought that because I worked hard my entire life and endured perceived difficulties, that I was not privileged. I was raised to "treat people how you want to be treated" and to "always show respect" for diverse perspectives. But my "worldview" of DEI was too narrow; I believed that because of my efforts I "earned" my life opportunities. This is embarrassingly wrong, and until I put real work into learning about the issues, issues that affect all of us but in disparate and unequal ways, did I realize how this perspective contributes to systemic racism and disadvantage. These words are not a message about my triumphs in learning, but rather a call to join the movement to dismantle power inequity, and, if you are like me, to start your continued, individual journey of DEI awareness – one that never ends but rather constantly evolves.

Three years ago, in response to a call from FW faculty for greater DEI integration into department operations, FW implemented our DEI Committee, which includes representation from FW undergraduate and graduate students, research associates, staff, and faculty. This committee plays a significant role in understanding the DEI climate in FW, implementing actions to address areas where we fall short, and contributes to FW's strategic plan. Advancing DEI principles is now a primary goal in the strategic plan, with tangible short- and long-term objectives. Additionally, DEI principles in the strategic plan encompass other focal parts of FW's mission, with the recognition that DEI principles form the basis for operations. The strategic plan should be ready for public release by the end of spring semester 2021.

Improving individual awareness, committed actions to change, and strategic plans are just a beginning. To bring about lasting transformation, we must broaden our efforts and invest in changing the inequitable systems and structures that are embedded in American culture. Our FW community sees and hears this, and we are working hard to understand the responsibility that the department carries for meaningful change. To all of you, FW should be viewed as a safe space for everyone. Let us know what we need to improve on, and where we have faltered. You belong here, and the intersection of your identities is what helps move meaningful work in our field forward.

-- Dr. Gary Roloff

SEA LAMPREY: *MONSTERS OR MISUNDERSTOOD?*

Emily L. Mensch and Ellen M. Weise

With a mouth that pays homage to horror movies, sea lamprey have become an infamous invasive species in the Great Lakes. Their invasion through the expansion of the Welland Canal in 1919 decimated the valuable Great Lakes fisheries and caused remarkable harm to the economy and the ecosystem. In response, a multi-million-dollar, multi-national, annual control and assessment program was deployed to keep their numbers in check. There is now extensive research into sea lamprey biology and behavior aimed at bolstering control techniques and assessing their populations.

The villainous reputation lent to sea lamprey does not extend outside the Great Lakes. For thousands of years, sea lamprey were regarded as a delicacy by English Royals. King Henry I even reportedly died from an overdose of lamprey pie. Beyond sea lamprey populations in Europe, there are closely related species in the Pacific Northwest imperiled by migration blockages and habitat fragmentation. Between industrialization in the 19th century and overexploitation of lamprey, their numbers have plummeted.

From a research perspective, sea lamprey represent an important evolutionary species. Along with other fish like gar, coelacanths, and lake sturgeon, they are an example of a 'living fossil' – a species whose body and behavior encode important evolutionary events. Records indicate that this jawless organism's morphology (the study of an organism's size, shape and structure) has been largely unchanged for nearly 400 million years. Living fossil species are often the surviving lineage of a mostly extinct evolutionary trait, in this case the jawless vertebrate. Therefore, understanding sea lamprey traits can provide a unique insight into vertebrate evolution as a whole, making studies of this species interesting and informative beyond exclusive management purposes.

Sea lamprey are at the crossroads of conservation and invasive species management due to their varied history in different parts of the world. These opposing goals seem incompatible but results of sea lamprey research provide insight for both scenarios. From genomic assessments to sea lamprey deterrents, methods designed to keep invasive populations in check in the Great Lakes can be used to conserve counterparts in Europe and the Pacific Northwest. Here, we'll explore how studies which aim to control a 'monstrous' invasive species can also be used to generate interesting science and conserve imperiled populations, leaving it up to the reader to decide if these creatures are true monsters of the deep, or organisms complex and misunderstood.

Sea lamprey are at the crossroads of conservation and invasive species management due to their varied history in different parts of the world.

FEAR AND SEX IN THE MIGRATING LAMPREY

One current research project in the lamprey realm aims to understand and exploit how

these fish use their sense of smell. More specifically, how they use smell to navigate a gauntlet of "fear" during their migration to spawn.

Many fishes have a mechanism to smell when another member of the same species is injured or killed. This enables them to accurately assess the presence of a predator and the likelihood of a potential attack. These macabre odors, dubbed "alarm cues", are used throughout the sea lamprey's complex lifecycle but are especially important during their upstream spawning migration. Sea lamprey are semelparous, which means they migrate upstream after they stop feeding in the lakes (or the ocean, in their native range), and then mate, essentially uninterrupted, until they die. This means finding suitable mating habitat is immensely important because sea lamprey only have one chance to produce offspring and pass their genes on to the next generation.

By unlocking the chemistry of this powerful "fear" cue, lamprey behavior and movement could be manipulated which could have broad implications in management and conservation. In the Great Lakes ecosystem, alarm cues could be used as a repellent to guide fish into traps or to habitats not suitable for mating. In the Pacific Northwest, where Pacific lamprey are facing population constraints, alarm cues could be used to guide fish through fish pass systems to reach suitable mating grounds. And finally, understanding the chemistry of this alarm cue could assist in deciphering the evolution of this fear response in vertebrate species.

USING GENOMICS TO ASSESS SEA LAMPREY POPULATIONS

Population genetics data is becoming

increasingly valuable in a management context due to the plummeting costs of sequencing and an explosion of resources related to population genetics research. The cost of sequencing a human-length genome has decreased from over a hundred million dollars in 2000 to under a thousand dollars in 2015. This cost decrease is largely due to improvements in sequencing technologies, including the development of next-generation sequencing, where thousands of short DNA fragments are sequenced in parallel. As genomics research has become financially viable, databases of genetic sequences like NCBI and open access bioinformatics software make it accessible.

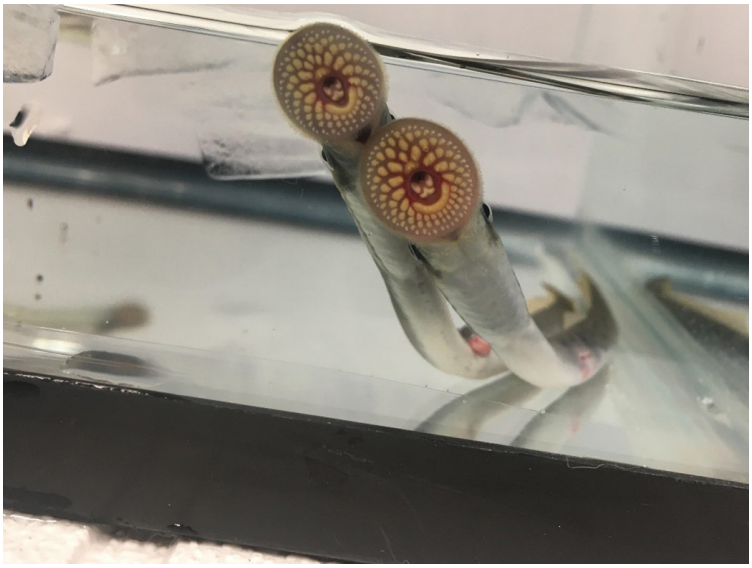
Population genomics studies provide an in-depth look at the population history and abundance of any group of individuals. Metrics related to genetic diversity and population size

are needed for assessments in both control and conservation contexts. In the Great Lakes, these metrics can assess the effectiveness of traditional control techniques, including lampricides and barriers, and supplemental control techniques like pheromone and alarm-cue methods and sterile-male release. In systems where lamprey are endangered, these same metrics can be used to evaluate spawning success and look for 'red flags' that indicate risk of extinction spirals.

Sea lamprey are an important model species in population genomics. Their genome was sequenced in 2013, and a germline (DNA in reproductive cells) genome was released in 2018. For a large-scale population study, short sections of variable DNA in thousands of individuals can be sequenced and aligned to the genome rather than sequencing the whole genome. Recently developed methods allow specific regions of the genome to be targeted for sequencing, further improving our ability to generate genome-wide data for a large number of individuals at minimal cost. This method, known as RAD sequencing, is a cost-effective way to generate the precise data needed to assess a population. These approaches are currently being utilized for sea lamprey in the Great Lakes region.

While sea lamprey may be the closest thing to a sea monster in the Great Lakes, they are also a unique and valuable species that provides insight into evolutionary processes and can be used to transfer knowledge for conservation studies. Because they are both invasive and imperiled, depending on where they are, managers need a variety of techniques to regulate these populations. In the Great Lakes, there is a 'kings ransom' of research devoted to sea lamprey behavior and biology to better control population numbers, and this research can also be used by managers in Europe to conserve dwindling lamprey populations. This provides a clear example of how researchers can harness their creativity to exploit a problem and use it to construct meaningful endeavors in science and conservation.

ALL PHOTOS: EMILY MENSCH



About the artist: Trish Brockman is a M.A. student in the Applied Forest and Wildlife Ecology Lab in the Department of Fisheries and Wildlife. While she's not in the UP chasing birds and turtles she illustrates wildlife for fun and as a side hustle. Her favorite subject is herps, but she is always looking for new ideas and critters to draw.

HEADING SOUTH FOR THE WINTER:

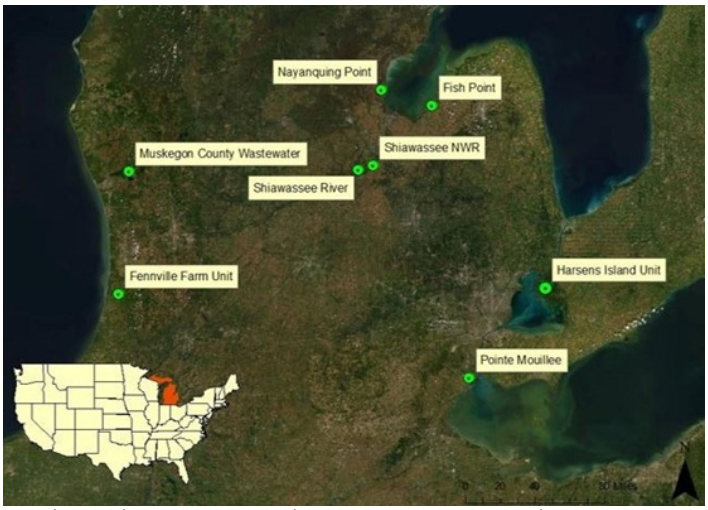
A Duck's Travel Guide on When to Hit the Road & Where to Stop Along the Way

Trey McClinton

With dawn breaking to the southeast, the sound of wings cutting through the air began to fill the sky. The soft chuckles of a duck call greeted a pair of mallards as they dipped down towards decoys floating with the wind. Then, at the legal hour, a shotgun blast christened the start of the 2020 regular duck season in Michigan's southern zone. As I walked to retrieve the bird, my thoughts drifted, as they often do, to all the factors that came together to make this moment possible.

Michigan is situated in the center of the migratory funnel that is the Great Lakes Region. Offering everything from beaver ponds in the Upper Peninsula, to the open waters of the Great Lakes, this state is truly a paradise for waterfowl and recreationalists alike. My graduate research focused on seven Managed Waterfowl Hunt Areas (MWHAs) operated by the Michigan Department of Natural Resources (MDNR) and the Shiawassee National Wildlife Refuge (NWR). These areas are located throughout Michigan's Lower Peninsula and have garnered international recognition for their role as key staging areas for autumn migrating waterfowl. A staging area is characterized as a perennially available wetland complex that provides an abundance of available food and space for waterfowl to gather before making migratory movements. Additionally, staging areas are

also generally associated with recreational opportunity and my study sites are no exception. Given the immense socio-economic value of waterfowl, there is a need to continuously reevaluate the regional and local conditions that influence use by the birds and



Study site locations in Michigan's Lower Peninsula

recreationalists alike. As such, the goal of my research was to observe trends in waterfowl migratory movements, expand upon our understanding of habitat selection on a local scale, and characterize how hunter use and success can be impacted by local conditions. To achieve this, I dove into archived waterfowl abundance and harvest datasets maintained by area managers and monitored fine scale waterfowl spatial use across two migratory periods using a novel method in camera trapping.

Waterfowl migration is driven by a combination of environmental and internal cues and understanding how these cues interact with each other has major implications for both management and recreation. Research has shown that the initiation of migratory behavior in birds (known by the German word "Zugunruhe") is triggered in the fall by day length, but is further stimulated by environmental conditions. Additional work found evidence for migration occurring later in the season, potentially due to climate change mitigating the prevalence of the severe winter weather conditions (i.e., freezing temperatures and snow) that serve as a catalyst for migratory movements. Once waterfowl arrive in an area, the condition of wetlands directly affects how they distribute themselves across the landscape. Because each species within the broader waterfowl group has slightly

Wildlife Biologist, Eric Dunton, and Biological Science Technician, Adam Rulison, spraying invasive phragmites reed at the Shiawassee NWR.

different ecological needs, managers work to provide a suite of habitat conditions through intense active management. This management consists of promoting the growth of desirable plant species through water level manipulation and planting, minimizing the spread of exotic invasive plant species, and mitigating excessive human disturbance associated with recreation.

I analyzed nearly 30 years of waterfowl abundance data against various climate, weather, and hydrology measures. These analyses suggested that the timing of bird movement through the state is trending

towards later in the year (i.e., timing of peak abundance observations). However, this trend is not uniform across species or area. With regard to the number of birds that move through the areas on an annual basis, my analyses suggest that the total number of ducks using them during a core October – mid-December migratory period is declining. These total "duck use days" coarsely track estimates of Michigan's breeding mallard populations and could be evidence of an underlying regional phenomenon. The combination of these analyses reaffirms the need for landscape level planning to manage for a suite of available habitats on a regional scale, as this would help ensure the prosperity of waterfowl and the recreation associated with them in the state.

In addition to regional migratory movements, understanding local habitat selection is paramount. To provide insights on this, I maintained 80 camera traps from August to January in the 2018 and 2019 autumn migratory periods. During this time, my cameras took more than a million photos and documented approximately 250,000 ducks. While commonly employed in natural resource related work, to my knowledge, this work is the first time since the 1960s that cameras were used as the primary tool in a formal study of waterfowl wetland use. Having come a long way in the past half century, today's units offered a way to continuously monitor species-specific waterfowl use across large wetland complexes, in response to management regimes and other local conditions without disturbing birds or the hunters pursuing them. I observed spatial and temporal shifts in duck use, primarily as a function of human disturbance. A more uniform distribution of duck use was observed prior to the beginning of hunting seasons but shifted towards high relative abundances in areas closed to hunting during the day and increasing nocturnal use of hunted areas as the season progressed.

American black ducks and mallards in a flooded agriculture unit on Harsens Island

Hunter success is largely a function of those aforementioned regional movements and local habitat selection. Despite variable timing of peak abundances and large shifts away from use of habitats open to hunting during daylight hours, duck harvest in these areas remains consistent with historical norms. Notably, these areas routinely account for approximately 10% of the state's estimated annual duck harvest totals (MDNR and US Fish and Wildlife Service unpublished data). This was observed in harvest data dating back to the 1990s, showing a level of consistency achievable only through active and intensive wetland management.

Waterfowl have immense socioeconomic value. This is likely why they are among the most studied avian groups and the only one to broadly exhibit net population increases since the 1970s. However, numerous factors

An unknown hunter and dog at Fish Point State Wildlife Area

(e.g., wetland loss and degradation, land use change, etc.) bring into question what the future of waterfowl conservation will look like. As such, there is a need to manage for both the prosperity of the group as well as the recreation associated with them. My hope is that this work will serve as a tool to help inform future management decisions on important staging areas in Michigan. As I take steps to finalize my research, I think how fortunate I am to have a graduate project that afforded a unique opportunity to learn about the many aspects of waterfowl biology that contribute to interactions, like the one I enjoyed on opening day, which may only last a moment.

ALL PHOTOS: TREY MCCLINTON

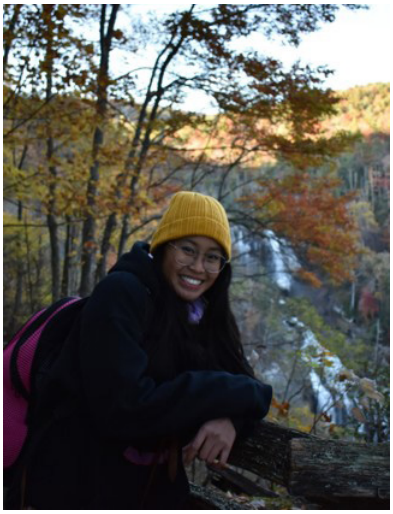
Trey McClinton is a Master's student co-advised by Dr. Dan Hayes and Dr. Dave Luukkonen. His research interests include avian ecology and habitat management, with a focus on waterfowl and wetlands. He can be reached at mcclin73@msu.edu.

LAB SPOTLIGHT: Dr. Jean I. Tsao

Dr. Jean I. Tsao is jointly appointed in the Department of Fisheries and Wildlife and Large Animal Clinical Sciences. She also is a faculty member in the graduate programs Comparative Medicine and Integrative Biology, Ecology, Evolution and Behavior, and the graduate specialization in Fish and Wildlife Disease Ecology and Conservation Medicine.
She has served as an editor for the journal Ticks and Tick-borne Diseases, as a member of the HHS Tickborne Disease Working Group Subcommittee for Disease Vectors, Surveillance, and Prevention, and most recently on the panel that developed the 2020 Guidelines for the Prevention, Diagnosis, and Treatment of Lyme disease. Dr. Tsao is grateful for the opportunity to mentor and work with students from a variety of backgrounds and academic programs including the sciences, public health, and veterinary medicine.

Peter Fowler is originally from the Northwest where he attended school for commercial photography. After working for 10 years in advertising, he returned to school for science graduating from University of Washington with a B.S. in Biochemistry and a B.A. in Sociology. He moved to Michigan with his spouse in 2014 to attend veterinary school at Michigan State University. After graduating with a DVM in 2020, he joined the College of Medicine and Integrative Biology PhD program with an interest in epidemiology, conservation medicine and One Health.
He joined the lab as part of his first year rotations in May 2020 and has spent the summer studying the northward expansion of the lone star tick into Michigan. He hopes to continue working toward a career in disease ecology with a focus on improving human and environmental health. He also loves bats.

Michelle Volk is a first-year PhD student in the Fisheries & Wildlife Department. Her research will be investigating the distribution, genetics, and spread of blacklegged ticks and Borrelia burgdorferi, the bacteria that causes Lyme disease. She hopes to investigate the genetic diversity of B. burgdorferi and elucidate ecological and genetic factors that are contributing to the geographic spread and increased prevalence of ticks and tick-borne diseases in North America.
Michelle is originally from Glen Ellyn, Illinois. She received her bachelor's degree in Biology from New York University in 2017 where she conducted research on influenza genetics and developed an interest in vector-borne diseases and epidemiology. She then received her Master's degree from the University of Maine in 2020 where she studied the effects of winter climate on blacklegged tick overwintering survival and distribution in Maine.



Sarah Nguyentran grew up in Jacksonville, Florida, and graduated from the University of Florida with her B.S. in Entomology in 2018 and her M.P.H. in Environmental and Global Health in 2019.
She worked within the lab this summer as a Midwest Center of Excellence for Vector-Borne Disease fellow, conducting active field surveillance to evaluate blacklegged tick distribution and density in the southern Lower Peninsula of Michigan. This was valuable field and acarological experience to continue fueling her interests in infectious and vector-borne disease, and will provide insight into how blacklegged tick populations and the threat of Lyme disease are expanding in the eastern Midwest.
She intends to pursue a career in veterinary medicine, hopefully continuing to learn and work at the nexus of environmental, animal, and human health in zoonotic disease. Currently, she is working as a COVID-19 contact tracer in Florida, but hopes to one day revisit Michigan's great lakes and deciduous forests.

Joey Pastori is currently a senior at Michigan State University majoring in microbiology with a minor in epidemiology. He is originally from the city of Troy in southeast Michigan. He joined the lab in 2019 as a field technician and spent that summer sampling for blacklegged ticks across both of Michigan's peninsulas. He continued working in the lab as the school year progressed, extracting DNA from the ticks collected to determine the prevalence of Borrelia burgdorferi, the pathogen that causes Lyme disease.
After graduation he will begin graduate research in the lab studying genetic diversity of Anaplasma phagocytophilum. He will help develop and apply a multi-locus sequence typing system whereby he will analyze and compare the sequences of several housekeeping genes for A. phagocytophilum detected from ticks collected from different locations throughout the midwestern and northeastern U.S.

Belinda Wilson is a senior undergraduate student dual majoring in Fisheries and Wildlife and Animal Science. She is from St. Louis, MI and lives on a small family farm with many cats, dogs, chickens, ducks, and turkeys.
She has been a part of the lab since spring 2019 and has worked on several projects. She has been working on a long-term study looking at the role of songbirds in maintaining tick populations at Fort Custer Training Center (Augusta, MI). She has also been working at the Burke Lake Banding Station for the past two fall banding seasons collecting ticks off the birds that are mist netted there. All the ticks she collects get assayed for Borrelia and Anaplasma in the lab. She also got her first tick sampling field experience this summer and loves "ticking" across Michigan!
She hopes to continue working in the field of wildlife disease ecology and One Health in her future career.

Viva Kobbekaduwa is a fifth year PhD student in the Comparative Medicine and Integrative Biology program in the College of Veterinary Medicine. Her research focuses on the eco-epidemiology of Anaplasma phagocytophilum, the agent of human and canine granulocytic anaplasmosis. She aims to create a disease risk map of A. phagocytophilum in Michigan to inform the public of the risk of contracting anaplasmosis. She is also improving the understanding how A. phagocytophilum is maintained between ticks and wildlife in the Midwest.

Viva is originally from Sri Lanka, a tropical island in the Indian Ocean. She has a bachelor's degree in Zoology from Sri Lanka. During her undergraduate days she has worked on the phylogenetics of endemic lizards of Sri Lanka and on gastro-intestinal parasites of crocodiles and leopards of Sri Lanka.

She is interested in disease ecology, conservation medicine and One Health. She hopes to continue conducting research in disease ecology and conservation medicine of zoonotic diseases.

Allison Luchenbill is a recent Fisheries & Wildlife graduate from MSU, receiving a concentration in Disease Ecology & Management and a minor in Science, Technology, Environment, and Public Policy. She is from Durand, MI and grew up immersed in agriculture and natural resources.

Allison spent the summer and fall working as a research technician, conducting sampling across southern MI to evaluate the increasing distribution of blacklegged ticks, lone star ticks, and pathogens they transmit. She is passionate about the field of zoonotic disease research and applying One Health to disease management strategies.

Allison is also interested in the public health and environmental justice sectors. As such, she is currently working as a case investigator for the Michigan Department of Health and Human Services in the COVID-19 response effort. Understanding the intersections between human and wildlife health guide her as she continues to grow as a wildlife professional.

Megan Porter obtained her B.S. from Northern Michigan University in Zoology/ Animal Biology (2012), her D.V.M.from Michigan State University (2015), and is completing her M.S. degree in Comparative Medicine and Integrative Biology. For her thesis research, using a One Health approach, she recruited a statewide network of veterinarians to collect ticks from companion dogs over three years to track the spread of emerging ticks in Michigan, improve public health surveillance, and predict the future emergence of ticks and tick-borne disease. She has also served to identify ticks and communicate with the public for The Tick App, a smartphone app developed with colleagues at the Midwest Center of Excellence for Vector Borne Disease and Northeast Center of Excellence for Vector Borne Disease.

A native of Leslie, MI, Megan moved to Maine in January 2020 to become the Public Health Educator at the Maine Center for Disease Control and Prevention and has been working tirelessly in the battle to monitor and prevent COVID-19 transmission. Megan enjoys public outreach, and pre-pandemic she could often be found on hiking trails with a drag cloth and vial of ticks chatting with passersby.

"To have and to lose"

A paradox of access to fish in fishing communities

Edith Gondwe

"Koka!!!Koka!!!Koka!!!"

– These are the words you hear being screamed repeatedly on the shores of Lake Malawi, in Southern Africa. Literally translated to "pull, pull, pull," this is the sound of fishermen pulling to shore a boat from the night's harvest of fish. Standing at the beach are traders and community members, all waiting for an opportunity to buy some of the fish. Young, old, male, and female, everyone has their eyes fixed on this incoming boat. I feel a knot of excitement inside me – fish!!! You see, I love fish. Oh, I do!!! I could eat fish every day, all year around. I turn and look at the people on the shore, and imagine my surprise that they do not look as excited as I feel. Instead, one can see that they all seem to be holding their breath in trepid anticipation. But why?

"Achimwene, bwanji nanga nkhope kusasangalala?" ("Excuse me sir, why do you look worried?"), I ask one of the men standing close to me. In a worried voice, this man answers that they are not sure if they will be able to buy the fish. He goes on to explain to me that to access fish is a problem, because fish trading starts right before the boats reach the shore. In fact, he goes on to say, the fish is sold about six times by the time it arrives at the shore. Here, the fish is further sold to more people before the local processors or consumers have access to the fish. But how can this be true? It sure does sound unbelievable.

The story that follows is that of "organized" trade, where you have to be part of an inner circle to access fish. Sadly, this story continues to describe how, for female fish traders, trading sex for fish is nearly their only option to be able to buy the fish. Male fishers prey on the desperation of the female traders, trading sexual favors for access to buy fish. Sad, just sad, it is.

I sit down to talk more to the gentlemen, all the while, my heart is racing. In my head, I am already thinking how the issue of environmental degradation of the lake, due to overfishing and climate change, trickles all the way down to the humans that depend on these resources. You see, it is easy to use these big words of "exploited resources," "overfishing," and "climate change" to easily get the attention of donor communities and public funding. But what does it mean to the average person who is living through the consequences of overfishing and poor trade

management day after day? Of course, it is an accepted phenomenon that for countries like Malawi, where fish represent their main source of protein, the impacts named above are very real. Yes, the scientific evidence itself is compelling and surely warrants attention. But for today, let us turn and look at these people by the shore awaiting their chance to buy fish.

When we say fish is the most affordable animal protein source, there is a context we must attach to this explanation. The most abundant fish species caught in Malawi are small pelagic fish, called Usipa. These fish grow to an average length of 10 to 20 cm, and are often sold in heaps, either fresh or processed (i.e., sun dried or parboiled). The reason why fish are accessible to most poor Malawian households (60% of whom survive on less than one dollar per day) is because of its divisibility. Imagine an average family of five people. If they have a budget of 75 cents to buy meat, it becomes quite difficult and expensive to divide chicken or beef in a way that each family member gets a fair portion. Small fish become the answer to this problem. Furthermore, since small fish are sold in small heaps, it becomes the cheapest and most valuable option for many families.

In my attempt to try and understand the reasons for the concerned faces at the shore, another explanation is offered to me. Due to a high demand for fish in the cities, fish traders charge higher prices for the fish. Ultimately, making the fish unaffordable to people in the coastal fishing communities. They explain to me that small fish used to be regarded as a poor man's food, with the wealthier, urban dwellers preferring to eat meat and chicken every day. However, recent trends of health consciousness have altered the eating habits of most urban dwellers. Oh yes, young and old urban dwellers are now seeking fish, indigenous vegetables, and poultry to make up the majority of their health-centric diet. While this is a good thing for traders, as it means increased demand from high-end earners, it is a calamity for the fishing communities. Since traders know there is demand in urban areas, they drive up the price to meet this demand. This leaves people in the community, living on one dollar per day, to compete with more affluent communities for the same resource – fish. It sounds like a joke, but alas, fish is at times more expensive at the shores near where they were caught than in the cities. These poor people in the community must pay the opportunity cost for the fish to be sold to them and not to be taken to urban areas where traders are guaranteed sales at higher prices.

You see, there is a difference in throwing around words on the importance of fish to fishing communities and creating true change.

What does this mean then to us, my dear learned friends, who sit down year after year to come up with "conservation projects," "rehabilitation projects," and/or "empowerment projects" to implement in these fishing communities? Do we truly understand what fish mean to these people? You see, there is a difference in throwing around words on the importance of fish

to fishing communities and creating true change. Pause. Think. Food. The basic need of every human to survive. That is what we are talking about. What can we do to translate our complex projects and programs so that households in fishing communities like that in our story have access to the very protein and micronutrients they require to have and maintain a healthy lifestyle? What can we do to make sure that children growing up in these communities do not fall victim to the triple burden of malnutrition?

What do we do then, you ask? To be honest, that is something I am still struggling to answer as well. I have come to realize that to understand the impacts of the harmful environmental practices being implemented in the fisheries sector, we need to prioritize understanding the impact on the human communities that rely on this vital resource. As a researcher with limited understanding of the unique situation that these fishing communities are reliant on, I seek to answer that question through my attempt at carrying out food and nutrition security research in the context of a fisheries sector that is marred by many environmental challenges. I can only hope that my answers are practical and useful, to help ensure fish have a place on the plates of households in these fishing communities.

My name is Edith Gondwe, a second year PhD student in the Department of Fisheries and Wildlife. My research areas of interest are on the linkages of fish and food and nutrition security, livelihood analysis, governance systems, gender dynamics and value chains in fisheries systems, with a special interest in small scale fisheries. I am advised by Dr. Abigail Bennett. My planned graduate research for my thesis is set to investigate relationships of capital assets and food security; and intrahousehold bargaining power on nutrition security in small scale fishing households in Malawi.
My motivation to apply for the Pattullo Fellowship, which focuses on environmental issues, was because of my research interest on understanding food and nutrition security in fishing households and its linkages to environmental issues that surround the fishery systems. As I highlight in my literary piece, titled "**To have and to lose": A paradox of access to fish in fishing communities**, environmental issues such as overfishing adversely affects the livelihoods of people in fishing communities, leading to high prevalence rates of malnutrition, especially among vulnerable groups (under five children and pregnant women). Further on, understanding the link of conservation programs in fishery systems and impact on livelihoods of communities is most likely to result in more sustainable outcomes.

Alumni Corner: Dr. Gretchen Hansen

What did you work on while you were a student at MSU?

I worked with Dr. Mike Jones on an adaptive management experiment, evaluating a new method for assessing invasive sea lamprey populations in Great Lakes tributaries for prioritizing lampricide treatments. I also analyzed historical sea lamprey data for patterns in growth and recruitment.

Where are you now and what do you do?

I am an assistant professor of fisheries ecology at the University of Minnesota. I live in Minneapolis, Minnesota – my hometown!

What motivated you to apply for your current position?

I was working as a research scientist for the Minnesota DNR when my current position became available. I had not been interested in an academic position prior to this point and was very happy as a state agency scientist. When the position was advertised, I already lived in the Twin Cities and it seemed like a good fit in terms of research focus, so I decided to apply to learn more about the position and the department. The thing that most motivated me to accept this position was the opportunity to mentor students and post-docs and to take an active role in shaping the future of the fisheries profession in our changing world.

What is your favorite thing about your current position?

Hands down, my favorite thing is mentoring students and post-docs and working to create a supportive, inclusive, and successful lab environment.

What experiences at MSU best prepared you for your current position?

So many things!

My research at MSU involved extensive collaboration with managers and policy makers from state and federal agencies, an experience that has been critical for my success doing large-scale applied research. My research project as a master's student directly informed policy at the Great Lakes Fishery Commission. I realize now that I was fortunate to be involved in such a project, as most research does not connect to policy so directly. Having this experience early on and learning from Dr. Jones about how to connect research to policy laid a foundation for my research philosophy and approach to collaboration with agencies.

My cohort of graduate students at MSU remains great friends and collaborators to this day. In addition to the value of these friendships, this experience taught me the importance of creating a cohesive group for getting through graduate school. My fellow grad students were my support system, made me laugh every day, taught me about different approaches to science, taught me how to code, and together we survived Jim Bence's population dynamics class. As a PI, I now work hard to create a sense of community and collaboration among my students and post docs so they might have a similar experience.

Dr. Mike Jones was and is an amazing mentor. He has a unique ability to adapt his advising style to the individual needs of his students, and I try to do the same in my current role as a PI. He also is a world class facilitator of meetings and workshops, a skill that is incredibly valuable in a professional life full of meetings. I strive to emulate his approach to meetings and collaboration. The only downside of having observed and learned from Mike is that I now suffer through many meetings that are poorly facilitated and wish he were there to keep things moving!

Do you have any advice to share with current fisheries and wildlife students?

Build your network and cultivate relationships with fellow students, faculty, and agency personnel. Fisheries is a small world and knowing people in different positions will serve you well in the future. Cultivate skills that are valuable for a wide variety of possible careers. It is unlikely that you will find a job in your exact area of study, but skills like critical thinking, writing, quantitative analysis, leadership, and facilitation will be valuable no matter where you end up.

Enjoy yourself. Graduate school can be all consuming, but it doesn't have to be. Remember to take time for your mental and physical health and enjoy the flexibility that comes with being a graduate student.

BREAKING THE ICE

Connecting Data and Reality on an Arctic Research Cruise

KELLY KAPSAR

The bright orange garment I'm struggling into looks something like the strange love child of a traffic cone and a spacesuit. This seems fitting because I feel as though the Arctic Ocean, where we're headed, is nearly as isolated as outer space. If I do end up in the water, I want to stand out like a roadblock in the middle of the ocean so there's no chance I'm overlooked and left in the wake of the giant ship that I've just fallen off.

The ship is the U.S. Coast Guard Cutter *Healy*, one of only two ice-strengthened ships in the U.S. fleet. The Healy serves as a research vessel transporting scientists to remote portions of the ice-covered poles to collect data for many disparate scientific fields: biology, climatology, ecology, chemistry, oceanography. Equipped with all kinds of lab equipment (including refrigerators and freezers, which I find ironic given the frigid temperatures we're heading into), the *Healy* is a data collecting machine.

PHOTO: Lindsey Leigh Graham

I've ended up on this three-week trip through bizarre circumstances involving a wonderful friend who made the right introductions and a couple of perfunctory follow-up emails. Researchers spend weeks writing proposals to get time on this ship, and yet here I am, along for the ride. People seem slightly confused when I say that I'm just here to volunteer.

My own dissertation research doesn't extend beyond the 190 square inches of my computer screen. I've only known the region of the Arctic that we're headed into, up through the Bering Strait between Alaska and Russia and into the Arctic Ocean, as blue pixels illuminated on my laptop. While I study the ecological impacts of shipping in the North Pacific, my research primarily relies on data collected by satellites. These satellites

give me information about ship movements, ice distribution, and the paths of marine mammals. All without ever leaving my desk.

So when people ask me what I'm doing here, struggling to stand in the pumpkin-colored Michelin Man suit, I say that I want to experience my study area. Not just as pixels on a screen, but as frigid salt water and high winds, as long hours of sieving sediment, and as searching blank horizons for the 10-foot-high spray of a whale's exhaled breath.

Once the safety drill has ended and my space suit has been stored for safe keeping, I quickly climb up to the bridge. Situated at the front of the ship and about 80 feet above the sea surface, the bridge commands a 180-degree view of the surrounding ocean. While aboard the *Healy* I've been given two jobs. My first job is working on the benthic team, sieving samples grabbed from the ocean floor using a giant claw known as a van Veen grab. My second job is monitoring for marine mammals. This job was a late addition to my duties but one that I am extremely excited about.

After a few hours of observing from the bridge, I quickly learn that identifying whales involves more than knowing what they look like. I've memorized the pictures in the guidebooks that I brought along, but it has become readily apparent to me that whales spend a lot of time under water, rarely presenting a full-bodied portrait like the illustrations in my guidebook. Over time, and with the help of the extremely kind bird observers who tolerate sharing the miniscule desk space that we were allotted, I begin to learn the more useful cues for identifying whales. Fin whales tend to be alone. Humpback whales make a triangle shape with their backs as they submerge. Grey whales don't have dorsal fins, but they do have knobs along their back that you can just make out before their flukes emerge.

In addition to whales, we see many other interesting creatures atop the waters. On one particularly strange twilit evening, I see a boulder floating towards us. That is, until it rolls over and reveals the foot-long tusks of an adult walrus whom we had woken up from a relaxing face-first nap in the Arctic Ocean.

Puffins flying by remind me of winged footballs. Unlike many of the other birds I see, puffins pump their wings rapidly and incessantly as though they are frantically trying to make it in time to their own wedding (for which they are impeccably dressed).

However, despite the many amazing things above the surface, the biggest surprises come from under the sea. While I'd always known in the back of my mind that there must be things at the bottom of the ocean, I never appreciated just how much there could be. And how alive it could be!

Dredging up sediment from the sea floor reveals a wriggling mass of angry creatures seeking to burrow their way back to their formerly dark and quiet lives. Tiny shrimp-like amphipods

are bright red, about the size of a black bean, and wriggle in your hand. Creepy toothed worms hide in tubes shaped like miniature ice cream cones. And of course, clams. I had always thought that clams moved slowly, like snails. But I was proved very wrong the day I saw an irate clam stick its tongue-like foot out of the side of its shell and bury itself entirely in the mud in the span of a few short seconds.

When I'm at home, it's so easy for me to get caught up in the pixels on my computer screen, breaking up entire oceans into thousands of equally-sized squares, each with a color or value corresponding to a variable: shades of blue for open water and white for sea ice. Sea surface temperature, distance to land, ocean depth. It's easy to forget that these data points encapsulate the lives of millions of creatures, from the tiniest of amphipods to the largest of whales.

This trip to the Arctic serves as a grounding point for me. Staring out across the ocean brings me an overwhelming sense of awe and respect for the enormous complexity of a region that is often characterized as remote, barren, and isolated. I am also amazed by the dedication of the scientists and crew who spend long hours working to solve their piece of the puzzle that is the functioning of the changing Arctic ecosystem. I am humbled to realize the enormity of what we know, and the even larger share of the things that we still do not fully understand.

Just as daunting is the amount we do know but that I still have yet to learn. Sometimes when I feel overwhelmed by this realization, as is often the case in graduate school, I think of a whale. A grey whale swimming through the Bering Sea on her way south for the winter. I think about what she must be thinking. What her concerns are. The things that I know that she'll never see, and the things she'll experience that I can never understand. Thinking of her helps me position my research, but also myself, in this vast world. My experience on the *Healy* is a humbling reminder of what my research is all about and why I became a scientist: to bridge the gap between the world scientists study and the world as it is; to bridge the gap between computer screens and the Bering Strait; between me and that whale.

PHOTO: Lindsey Leigh Graham

ALL PHOTOS (IF NOT SPECIFIED): KELLY KAPSAR

ONE Fish, TWO Fish, MANY Fish, FEW Fish

emily morgan liljestrand

Outreach supplies drudged up from the basement and into the light.

If you exit left out of the elevator on the basement floor of MSU's Natural Resources building, and walk past the conference room with green walls, past Dr. Brian Roth's wet lab, and even past Jill Cruth and Jim Schneider's offices, there's a perpendicular sparse hallway. In the last room on the left of that oft overlooked hallway lies the FW storage room. The contents of the lockers are lab-specific and, because of the diverse research interests of our department, can run the gamut from broken centrifuges to electrofishing nets to camera traps. But twice a year I wiggle my way around all that equipment to retrieve my favorite bit of "research" supplies – two decorated cardboard boxes, some pipe cleaners, and about 500 small plastic fish.

These supplies were purchased back in 2019 by the FW Graduate Student Organization (GSO) using funds earmarked for outreach activities. I specifically requested them to use at the Graduate Women in Science (GWIS) Girls Math and Science Day. This annual event invites mid-Michigan 3rd-5th graders to explore the diversity of science. The specific discipline I wanted to introduce them to was "quantitative fisheries," and I just needed to design an appropriate lesson plan that would appeal to my audience.
I knew the average 3rd-5th grader would not be familiar with "quantitative fisheries" and I could not blame them. It wasn't even until after my undergraduate degree that I learned about how you could input fisheries data into computer models that then output statistics like abundance and population death rate. Though I love the diversity of mathematical models in fisheries, I wouldn't be able to cover everything in the 30-minute time limit. Then it hit me, why not teach them Lincoln-Petersen!

A "Lincoln-Petersen" estimator is a population tagging model commonly used in quantitative fisheries where a sample of individuals are captured, tagged, and released. Scientists use the number of tagged fish that are recaptured to estimate the number of fish in a closed population. I decided an approximate activity would make for a great hands-on opportunity where students could practice their multiplication and division skills while simulating real experimental protocol!

The aforementioned boxes served as our fictional "lakes." I filled each with an unknown population (N) of plastic fish. I invited

the participants to work as a team, "fishing" out small portions of the population (a total of n individuals), then "marking" them with segments of cut up pipe cleaner before returning them to their lake. After "mingling" for a bit with the rest of the fish (i.e., shaking the box really hard), the population was re-sampled. The ratio of tagged fish (t) to total fish (T) in the second sample is roughly equal to the *total* number of tagged fish to the *total* population, i.e.,

$$\frac{t}{T} = \frac{n}{N}$$

And since we knew t, T, and n, we could use some simple algebraic finagling to predict N. The students eagerly demonstrated their long division skills by solving the equation on the whiteboard, often to the fifth decimal place! The lesson ended when I revealed the real number of fish in each lake and pointed out how much harder it would have been to count them all by hand, rather than using a handful of "tags" and pinch of math.

The activity was not without its struggles. It took some trial and error to determine the best number of fish to have in the lake and how many to sample. Tag too few fish and you could seriously bias the estimates. For example, if your second sample has no tagged fish in it, the equation works out to N=∞! I've gotten some great feedback from my amazing assistants, all of whom are graduate students in the Department of Fisheries and Wildlife. They've pointed out how I could adjust my language, using phrases like "number of fish" instead of "population size," and to pose discussion questions that relate the activity back to broader ideas like conservation. I look forward to using this constructive criticism to keep making my outreach even better.

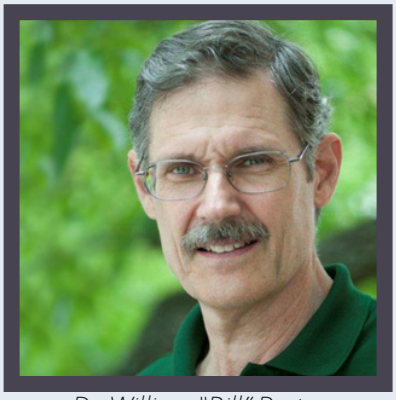
From left to right, Mimi Gong, Samantha Strandmark, Emily Liljestrand (Author), and Lydia Wassink, just after completing the last of four workshop sessions.

I anticipate that Girls Math and Science Day won't happen again until 2022 at the earliest. Though the majority of my research items have moved to my home office, I'm a little pleased whenever I remember that stuffy locker in a storage room at the end of an oft overlooked hallway in the basement of the Natural Resources building. And when the world gets a little less dangerous, I'm sure there will still be eager and bright junior scientists ready to learn how to use math to count fish.

ALL PHOTOS: EMILY LILJESTRAND

Emily Liljestrand is a Ph.D. candidate with Dr. James Bence. She is interested in using novel statistical and modeling methods to improve fisheries stock assessment. She can be reached at liljest3@msu.edu or her personal website https://sites.google.com/view/emilyliljestrand/

IN MEMORIAM
DR. BILL PORTER



Dr. William "Bill" Porter

The Department of Fisheries and Wildlife mourns the loss of Dr. William "Bill" Porter, who passed away from cancer on October 23, 2020. Bill was a dedicated colleague, researcher, teacher, leader, and mentor.

After a distinguished 30-year career at SUNY College of Environmental Science and Forestry, Bill came to Michigan State University in 2010 to become its first Boone and Crockett Professor of Wildlife Conservation. During his time at MSU, he founded the Boone and Crockett Quantitative Wildlife Center (QWC), developed and taught courses focused on wildlife policy and leadership in the natural resources, and mentored six post-doctoral scholars, 13 Ph.D. students, four M.S. students, and numerous undergraduate students.

Bill's work in the QWC focused on applied science aimed directly at wildlife conservation. His research was dedicated to making a difference in four key areas: land-use change, emerging wildlife diseases, climate change, and sustainable management of wildlife. Bill worked in close collaboration with the Michigan Department of Natural Resources and many other organizations on species of interest to the stakeholders of Michigan, including wolves, bears, deer, woodcock, songbirds, and his first ecological love: the wild turkey.

Bill was devoted to producing the next generation of wildlife conservation leaders. He fostered creative problem solving in his students and encouraged training in collaborative leadership and effective communication skills. He emphasized open communication and building solid relationships. The QWC became a second home for his mentees; past and present students became an extended family network within the profession. Bill believed in the power of traditions. Being a member of the QWC meant high expectations for dress code and conduct in the office and away at conferences. Being a member of the QWC also meant receiving a homemade birthday cake and card every year, celebrating a waffle party before the winter holidays, gathering each summer at his home, and celebrating with dinner after a successful defense.

IN MEMORIAM

DR. BILL PORTER

Among Bill's heroes were the founding fathers of wildlife conservation, Theodore Roosevelt, Aldo Leopold, and other well-known giants. For the past and present students of the QWC, Dr. Bill Porter stands in their company. A quote by Theodore Roosevelt hangs in the QWC student offices, and Bill presented a framed copy of the quote to each student upon completion of their degree. It was and is a statement of what Bill was trying to instill in his students.

"It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat."

His devotion to his mentees and to the advancement of science-based wildlife conservation was unending, and his contributions to wildlife research and management were exemplary in his five-decade career. We will miss his leadership for ourselves, for conservation throughout Michigan, and for the broader wildlife community.

We lost Bill to cancer but his legacy will live on. We will miss you in the arena, Bill.

-Students of the Boone and Crockett Quantitative Wildlife Center
(Chris Hoving, Nick Jaffe, Leslie Skora, Noelle Thompson, and Jonathan Trudeau)

Department of Fisheries & Wildlife
Michigan State University
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fw photo contest winners

Chris Henderson. King Lake near Covington, MI.

Chris Henderson. Bald eagle near Bruce Crossing, MI.

Nick Jaffe. Southern Appalachia rainforest.

Cydney Andrew. Cardinal in Heritage Park.

Trish Brockman. Orienteering with Wandering Washtenaw in Milan, MI.

Kandace Griffin. Sea Lamprey Oral Disk.

Cydney Andrew. Sac Bay Sunset.

Trey McClinton. Camera trap of a coyote walking across a frozen wetland.

Connor Buckley. Saguaro National Park.