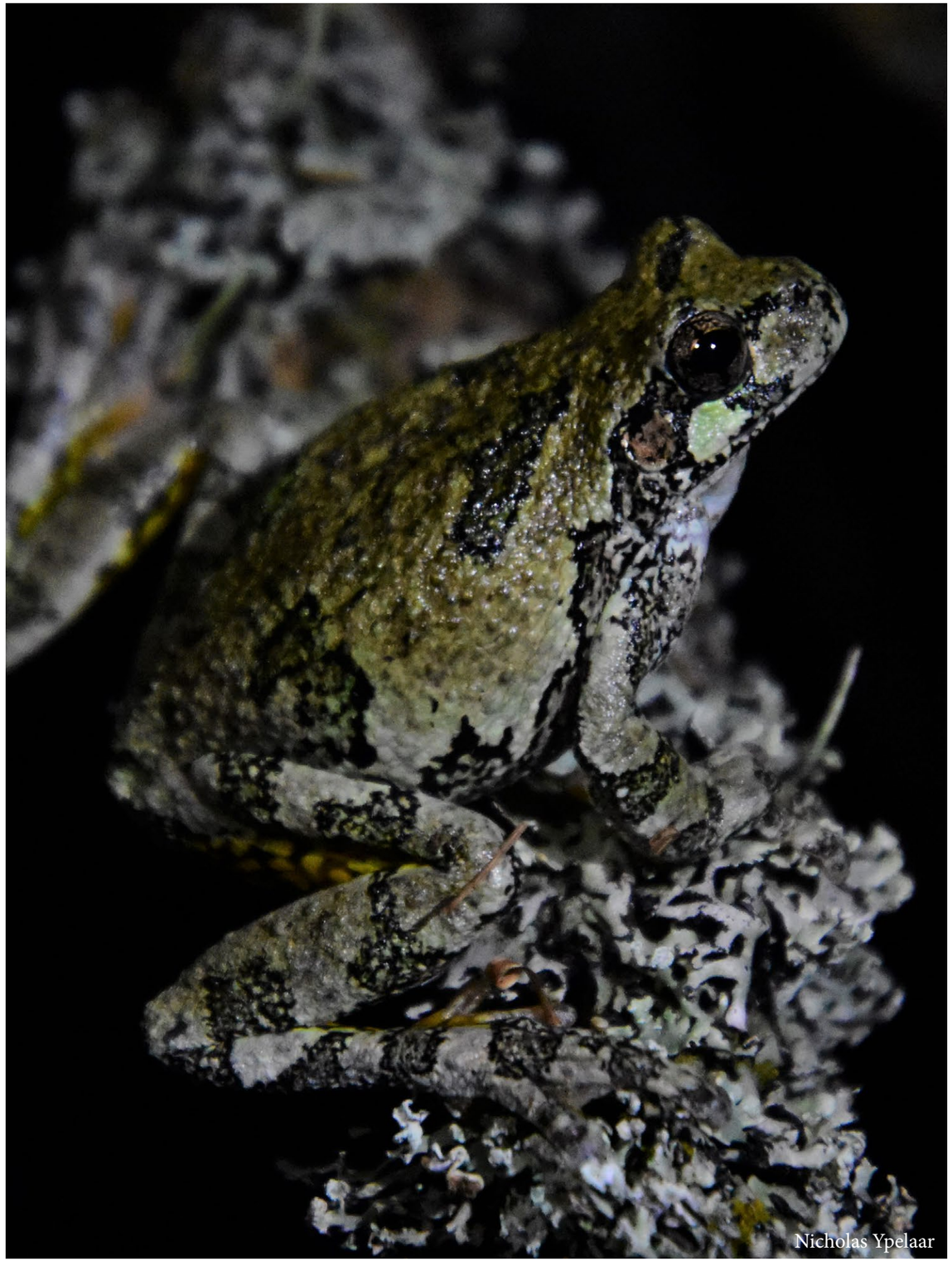
ALGONQUIN WILDLIFE RESEARCH STATION

2022
RESEARCH REPORT



Nicholas Ypelaar

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AWRS

THE ALGONQUIN WILDLIFE RESEARCH STATION IS AN INDEPENDENT NOT-FOR-PROFIT FIELD STATION IN ALGONQUIN PROVINCIAL PARK ADMINISTERED BY A VOLUNTEER BOARD OF DIRECTORS AND A SMALL TEAM OF STAFF.

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A MESSAGE FROM THE CHAIR OF THE BOARD OF DIRECTORS

Greetings friends of the Algonquin Wildlife Research Station!

First and foremost, on behalf of the AWRS Board and Staff, I extend my sincere thanks to Dr. Jackie Litzgus. Jackie, in her roles as Vice Chair (2010–2012) and Chair of the AWRS (2012–2022), put wind in the sails and steered the Station in many positive directions. It is throughout Jackie's time as Chair that the AWRS became a more professional and public-facing organization through our annual research report, on-site educational workshops, online presence, enhanced financial literacy and operational capacity, increasing involvement with educational programing in Algonquin Provincial Park, and much, much more. She has also been an amazing mentor to students (me included) involved with the turtle research program. We greatly appreciate Jackie's many years of service to the Station and wish her well in her new role as the Director of the Vale Living with Lakes Centre and Cooperative Freshwater Ecology Unit at Laurentian University. Thank you, Jackie—please visit soon, the Snapping Turtles miss you!

This research report is the culmination of umpteen insect bites, field days gone right (and wrong), and a lot of creativity and curiosity. This report is also something else in the decade-long history of the AWRS Research Report: A record-breaker for contributions. In the pages that follow you will find not only annual updates from the long-term amphibian, antler fly, small mammal, and turtle studies but also a variety of contributions from new research projects that called the Station their home over the past year. We are thrilled that these projects have shared their science—in many cases a sneak peek into ongoing discovery! Students, at the undergraduate and graduate level, are the driving force behind most of the exciting updates.

Reflecting on another field season brings back a rush of feelings from time spent on the water, in the woods, and in the pursuit of knowledge: accomplishment, camaraderie, challenge, gratefulness, and solidarity. For this, I have AWRS staff to thank in large part. As AWRS Manager, Kevin Kemmish was again integral to operations in 2022. The Station was very fortunate to have James Pinto return as Assistant Manager and work alongside Kevin on numerous infrastructure and operational improvement projects. We would not have been nearly as well fed if not for care and dedication of Farqd Barghash as Head Cook. Daniel Burns, Assistant Cook, also helped keep hunger in check and taught us about how much remains to be explored in the Wildlife Research Area with his enthusiasm for exploration. Samantha Stephens, Communications Manager, continues to bring the science conducted at the Station to life as showcased through her photography and writing. Finally, thank you to all our supporters and users—a diverse set of educators, filmmakers, students, workshop attendees, and like-minded organizations—that share a passion for the natural world, engaging with others, and training the next generation of scientists. The AWRS sincerely appreciates the numerous forms of support provided through partnership with Algonquin Provincial Park and Ontario Parks.

It is an absolute delight to share the 2022 AWRS Research Report. Please join me in celebrating the accomplishments and discovery contained herein as the Station heads into its 80th year in 2023.

Dr. Patrick Moldowan
AWRS Interim Board Chair

TERRITORY ACKNOWLEDGEMENT

We pay our respects to the traditional stewards of the land on which the AWRS exists and of Algonquin Park in its whole. The Station and much of Algonquin Park are located within unceded Algonquin territory. Algonquin Park as a whole also contains territory of the Anishinaabeg, specifically the Chippewa, Ojibwa and Nippissing, and lands under the Robinson-Huron Treaty of 1850 and the Williams Treaties of 1923. This land has also been used by Métis and other Indigenous people as it includes major travel routes on its rivers and waterways. We are always open to learning and discussion.

OUR MISSION

TO INSPIRE
Environmental stewardship, a community of collaboration, and a connection with nature through educational workshops, public events and social media.

TO EDUCATE
Scientists, the public, and policy makers by facilitating peer-reviewed publications, producing research reports, and hosting field courses and workshops.

TO CONSERVE
Biodiversity, ecological integrity, and a culture of field-based learning by providing facilities and logistical support for research projects, with an emphasis on long-term ecological studies.

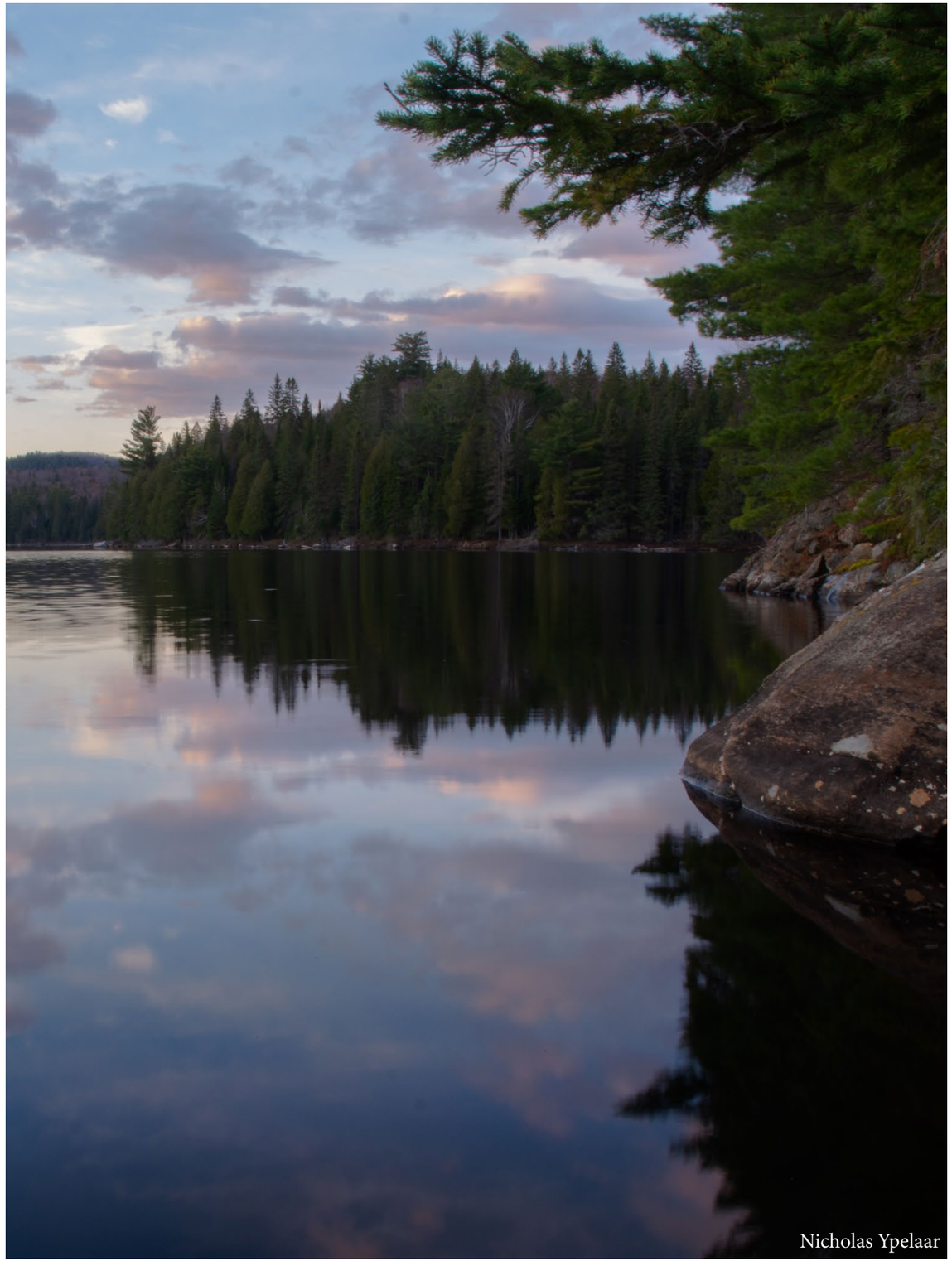
FROM THE MANAGER'S DESK

The 2022 season marked renewed beginnings for the Algonquin Wildlife Research Station. With most COVID-related restrictions eased, the Station operated at full capacity for the first time since 2019, and we were able to support a diversity of research and field courses. Courses hosted by the University of Guelph and Lakehead University were able to return, and we welcomed two new courses through the University of Western Ontario and York University. We were also excited to host the newly developed Field Research in Ecology and Evolution Diversified (FREED) course that provided hands-on field skills training to Indigenous, Black and/or racialized undergraduate students. Research-wise we continued to host the long-term projects on salamanders, turtles, and small mammals, as well as new research focused on fish genetics and restoration ecology. With the end of the 79th field season of the AWRS, we are in high spirits of where the Station can go next. Although the last few years have provided unique challenges, our ability to navigate them has ensured that we will open our doors again for our 80th season in 2023 and continue our work to support high-quality research and experiential learning for generations to come.

In our 15th annual Research Report, we aim to inform our supporters and researchers, past and present, of the important work that was accomplished over the last year. Our public outreach, workshops, and research would not be possible without our supporters. We would like to thank the MNRF, MECP and Ontario Parks for their continued support of the long-term research projects and our operations. Thank you to the Portage Store, Patreon members and donors for your continued monetary support and enthusiasm. I would like to extend a special thanks to the 2022 staff team comprised of Amanda Semenuk, Dan Burns, Farqd Barghash, James Pinto, Samantha Stephens and our volunteer Board of Directors. Without their dedication and hard work last year's successes would not have been possible. Lastly, thank you to the contributors of this report—it highlights the exceptional work being conducted at the Station and the ever growing network of knowledge rooted here in Algonquin Provincial Park.

I encourage you to visit our website, support us on Patreon or follow us on Facebook, Twitter and Instagram for news, updates and reports from the field. If you are interested in becoming part of our community, please do not hesitate to contact us by email at algonquinwildliferesearch@gmail.com or by phone at 705-633-5621.

Kevin Kemmish
Station Manager



Nicholas Ypelaar

AN UPDATE ON THE LONG-TERM TURTLE PROJECT

Written by Njal Rollinson

This year saw another successful season of long-term turtle research. For AWRS-area Snapping Turtles, 2022 marked our 50th year; that's half a century of Snapping Turtle research and the longest-running study on reptiles in the world (to our knowledge). For Painted Turtles at the Arowhon ponds, 2022 marked our 32nd consecutive year of monitoring. Although the number of Painted Turtles captured at Arowhon ponds was typical—around 450 individuals—the number of Snapping Turtles observed on Lake Sasajewun remained low, as less than 15 female Snapping Turtles were observed. The Lake Sasajewun Snapping Turtles were impacted by otter depredation in the late 1980s, and the once thriving population still shows little sign of recovery.

On a positive note, this year saw the publication of high-impact papers on Snapping Turtle vocalizations and long-term changes in primary sex ratios of Snapping Turtles on the Lake Sasajewun dam. Well done, team! This year also saw the large-scale implementation of PIT tags (passive integrated transponders) on the Arowhon Painted Turtle population, with well over 150 Painted Turtles receiving PIT tags. This means that in future years, the turtle team need only pass a transceiver over these tagged Painted Turtles to know the turtle's identity. This marks an improvement in our marking system, as when turtles are not PIT tagged, it can sometimes take over an hour to positively identify them, due to their aged shells being well-worn, and our earlier markings slowly wearing off. The 2023 season, therefore, promises to be productive as the team blasts through turtle identification, with extra time on hand to set up experiments that probe the evolutionary origins of temperature-dependent sex determination. Stay tuned! ♦

Samantha Stephens

IMPACTS OF CLIMATE CHANGE ON MATURATION PATTERNS OF PAINTED TURTLES

Written by Lillian Chan

The age and size at which individuals mature are sensitive to temperature, so they are predicted to change due to climate change. Age and size at maturity are important to organisms because they determine when an organism can reproduce and the number of offspring. However, it is unclear how age and size at maturity in long-lived organisms will respond to climate change. This is because long-lived organisms take years to mature, which increases the difficulty of obtaining enough data. The long-term Painted Turtle study in Algonquin Provincial Park, which began in 1978, offers a rare opportunity to examine age and size at maturity as it has monitored the size, growth, and reproduction of hundreds of Painted Turtles over four decades. This study generates a tremendous amount of individual-based data to answer questions on life history plasticity in long-lived animals. When male Painted Turtles mature, their front claw length increases rapidly relative to their body size. We created growth curves of male Painted Turtles' claw lengths and determined their year of maturity using this data. We were then able to investigate whether age and size at maturity have changed since the start of the long-term project.

We found that age at maturity has not changed, but size at maturity has increased from 8.98 cm to 9.95 cm over the last 40 years. This is surprising, as most studies show that reptiles tend to grow faster and attain sexual maturity at a younger age and smaller size in warm environments. We believe that our results are due to longer growing seasons and higher food availability that are caused by the warmer climate. This is allowing individuals to attain bigger sizes than they normally would. In the future, we plan to investigate the age and size at maturity trends of female turtles as well and see if these trends differ between males and females. ♦

Samantha Stephens

HATCHLING TURTLE VOCALIZATIONS & NEST EMERGENCE IN THE WILD

Written by Claudia Lacroix

For the past few field seasons, part of the turtle team's research has been dedicated to studying hatchling Snapping Turtle vocalizations and their associated social behaviours. After four years, we are excited to announce that, in 2022, our first paper on turtle vocalizations and nest emergence behaviour was published in Animal Behaviour! In this paper, we highlight that group digging efforts are beneficial to hatchling Snapping Turtles and that hatchling vocalizations within the nest have the potential to facilitate group digging efforts.

CONTINUING VOCALIZATION EXPERIMENTS

Following our previous work, we are investigating whether hatchling turtle vocalizations facilitate nest emergence. The 2022 field season marks the second year of data collection and investigation of Snapping Turtle vocalizations in the wild. During nesting season, we collected 30 Snapping Turtle nests, whose data contributed directly to the long-term study and whose clutches (16/30 nests) were used in a vocalization experiment. To ensure that hatchlings emerged in early September, when nighttime temperatures remain relatively warm, we artificially incubated the eggs in an incubator for two weeks. Then, we buried each clutch on the Lake Sasajewun dam, buried microphones in each nest and set up camera traps to continuously monitor vocalization and nest emergence behaviours. Out of 16 experimental nests, 14 nests (over 189 hatchlings) emerged successfully between August 21nd and September 15th. Most nests saw a single emergence event of up to 15 hatchlings within 24 hours, followed by smaller emergence events with 1–4 hatchlings in the days following.

We are currently analyzing our results. However, preliminary analyses from 2021 indicate that underground movement may be correlated with vocalizations within the nest. ♦

> "FOLLOWING OUR PREVIOUS WORK, WE ARE INVESTIGATING WHETHER HATCHLING TURTLE VOCALIZATIONS FACILITATE NEST EMERGENCE."

ACKNOWLEDGEMENTS

We are immensely grateful to everyone who helped with this project in 2022. From finding nesting turtles on the side of the road to processing over 1000 eggs, monitoring eggs in the incubators, monitoring nests in the wild, replacing batteries, and releasing hatchlings, we couldn't have done it without you. We'd especially like to acknowledge the help from Gabby Salvadore, Haley Morris, Jessica Leivesley, Farqd Barghash, Victoria Gee, Patrick Moldowan and the small mammal team for their dedicated assistance during each step of the project.


Samantha Stephens


Claudia Lacroix


Claudia Lacroix

PROBING THE ADAPTIVE SIGNIFICANCE OF TEMPERATURE-DEPENDENT SEX DETERMINATION

Written by Jessica Leivesley

THE MYSTERY OF TEMPERATURE-DEPENDENT SEX DETERMINATION

The Painted Turtles and Snapping Turtles in Algonquin hold an interesting secret: they, along with many other species of turtles, have temperature-dependent sex determination. This means that their sex isn't determined by sex chromosomes, but by the nest temperature they experienced as embryos. Despite being discovered over 50 years ago, we still don't understand how temperature-dependent sex determination is adaptive. It is thought that it allows males and females to develop at temperatures that maximize their fitness, however, testing this has proved difficult, and most studies must conduct experiments in an unnatural laboratory environment. Therefore, I set out to conduct a multi-year experiment in Wolf Howl Pond along the Mizzy Lake Trail. I aimed to understand how hatchling turtle survival is affected by incubation temperature. If male- (cool) or female-producing (warm) incubation temperatures affect survival differently, then this might help us understand why temperature-dependent sex determination evolved in the first place.

THE EXPERIMENT

In 2021, I collected over 200 Painted Turtle eggs from Wolf Howl Pond and incubated them at either a warm (28°C ± 3°C) or a cool (25°C ± 3°C) temperature. Once they hatched, I kept them in a lab at the University of Toronto, mimicking their overwintering conditions. At the start of the 2022 field season, I removed hatchlings from their overwinter slumber and released them back into Wolf Howl Pond. Each individual had a small white number painted on their shell to identify them. Tracking the survival of hatchlings is more difficult than doing so for adults in Wolf Howl Pond, as there are many areas perfect for a hatchling to hide that a canoe cannot reach. So, I donned my trusty wetsuit and waded/swam through parts of the pond that were inaccessible to canoe.

Over the entire summer, I spent more than 37 hours looking for hatchlings. Of the 235 I released, I encountered 175 individuals at least once and had a total of 558 captures. I did not expect to recapture so many individuals after their release, so this was very exciting. I also found that incubation temperature did not affect the survival of the hatchlings; the survival of each group (warm and cool incubation temperatures) was roughly equal throughout the whole summer. While we didn't find any effect of temperature on survival, this study still provides important information to the wider scientific community. It provides a robust estimate of turtle hatchling survival during their first year, which is notoriously difficult to quantify, and it helps inform further experimental tests of temperature-dependent sex determination. For now, the mystery of temperature-dependent sex determination endures. ♦

ACKNOWLEDGEMENTS

I couldn't have run this study without the support of the staff and researchers at the Algonquin Wildlife Research Station. Particularly, Claudia Lacroix, Claire Voss, Haley Morris and Gabby Salvadore, who spent countless hours with me at Wolf Howl Pond and helped me jump in and out of the canoe (with only one incident). Also, big thanks to my supervisor Dr. Njal Rollinson; without his support, this project would not have taken place.

Victoria Gee

INVESTIGATING THE HABITUATION OF SNAPPING TURTLES

For many years, and possibly even decades, the docks at the Lake Opeongo Access Point have been associated with large, habituated Snapping Turtles that loiter in this busy area looking for handouts. Because this site is a popular tourist area, large quantities of human food are accidentally and purposefully thrown into the lake, and this appears to draw Snapping Turtles to the area. While Ontario Parks has spent considerable effort and resources studying the impacts human food has on other wildlife, especially bears, there is essentially nothing known about how human food inputs work to habituate Snapping Turtles, how this alters their behaviour, and whether the phenomenon of habituation represents a conservation concern for this species that is classified as Special Concern.

In 2022, Ontario Parks staff and the Algonquin Wildlife Research Station set out to study the habituated Snapping Turtle(s) known from the vicinity of the Opeongo Docks. Our intent was to track three individuals by placing a radio transmitter on each, and to make regular (approximately weekly) check-ins on their location. Specifically, we wanted to see how much time turtles spent at the docks (i.e., concealed from view in the cribs or overhanging dock boards), whether they spent their entire active season (approximately May–September) here, whether they were more likely to be found begging at certain times of day, and how widely turtles travelled to arrive at this rich, though artificial, summertime feeding area. We also simultaneously ran an education component to this project. Telemetry events were accompanied by an event where Algonquin Park Discovery Staff engaged with the public to discuss aspects of turtle biology and the impacts of habituating wildlife.

Henry, a well-known Snapping Turtle who is included in the Station's long-term monitoring project, was captured and outfitted with a transmitter for this project on June 24th, 2022. During his processing for this project, Henry was shuttled back to the Algonquin Wildlife Research Station. He was weighed in at 17.8 kg, and his mid-carapace

> "IN SUMMARY, WE FOUND THAT HENRY REMAINED WITHIN APPROXIMATELY 600m OF THE OPEONGO DOCKS FOR MOST OF THE SUMMER ..."

(shell) length was 41.5 cm. We then affixed the tracking unit, using marine epoxy for extra support. A long, thin, flexible antennae was affixed to his carapace with this putty to prevent it from trailing in the water while he swam.

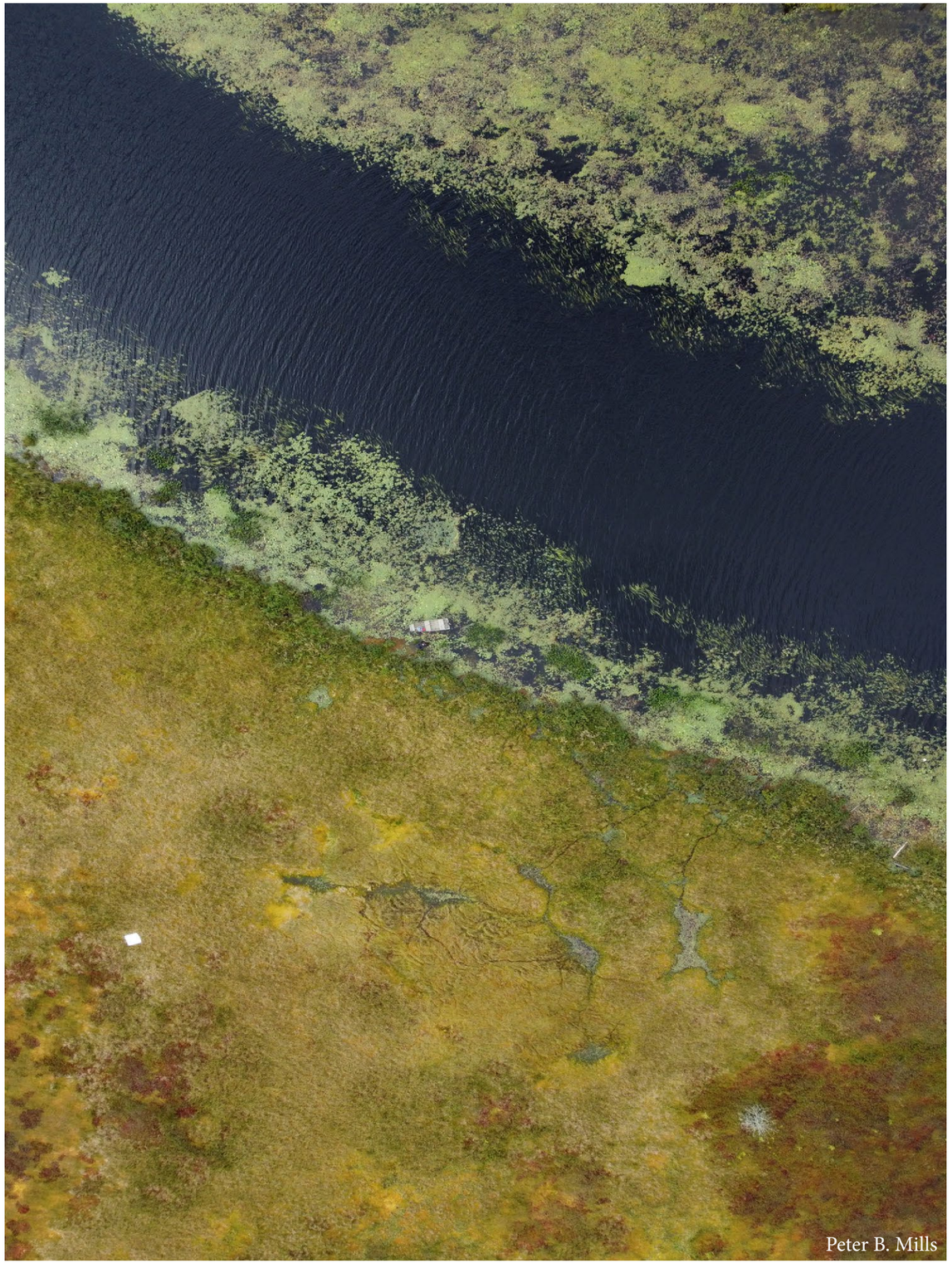
Henry's location was determined or inferred using radio telemetry 16 times in 2022. His location was determined when he was observed begging for food at the docks, or in other areas near the shore (only a limited number of tracking events involved a boat due to logistical constraints). His location was inferred through a triangulation method during all other tracking events. The triangulation method only provided coarse estimates of Henry's location, but it suited our needs because it established his generalized area (we were not interested in fine-scale movements or habitat selection). Further, because we found that Henry moved relatively little from June–September, and his summering grounds were close to, or right at the docks, the triangulation method was sufficient.

Henrique Pacheco

In summary, we found that Henry remained within approximately 600m of the Opeongo Docks for most of the summer and was most commonly within 250m of the docks. We were surprised to note that he spent relatively little time at the docks. Ontario Parks staff only noted him at the docks on two occasions (July 11th and August 11th), although park visitors reported he was begging at the docks several times when staff were not on-site. Tracking was done during the 9–5 workday, and Snapping Turtles may increase their activity at dusk and dawn during the summer, so had more tracking occurred in the early morning or evening, the number of occurrences at the dock may have increased. We confirmed one feeding event when a family confided they had been offering Henry worms from the dock on August 24th, and we suspect there were many others we missed.

Henry was tracked on November 2nd, 2022, in an attempt to find where his hibernation site was and how far this was from his summer grounds. Weak and intermittent signals made this challenging, but it appeared he was located near where the Opeongo Road crosses Costello Creek. This location is approximately 3 km southeast of his summering area at the Opeongo Docks. A tracking attempt on November 16th also failed to provide a concrete reading on his winter location and might suggest he is buried under very thick organic mats or an extremely large boulder placed in the channel of Costello Creek (ironically known as "Turtle Rock"). Further telemetry efforts in early spring of 2023 will be required to identify where he spent the winter. ♦

Peter B. Mills



Peter B. Mills

AMPHIBIANS: UNDERFOOT BUT TOP OF MIND

Written by Patrick Moldowan

BETWEEN TWO WORLDS

Many amphibian species, like the students who study them, live between two worlds. Wetland and dry land. Field station and desk chair. A lot of time spent at the latter had me anxious for fresh air as spring neared. A shallow snowpack during the winter of 2021–2022 and several mid-winter thaw events set the expectation that spring thaw would be early. My pulse quickened when project alumnus Natalia Hrynko reported an adult female Spotted Salamander marching across snow on 22 March 2022 near the Bat Lake Trail parking lot! That unusually early observation turned out to be a fluke. Fitful snowstorms in early April prolonged winter, the dormancy of the salamanders, and my time at the desk. It would be several more weeks until the salamanders boogied, but when they moved, they really moved!

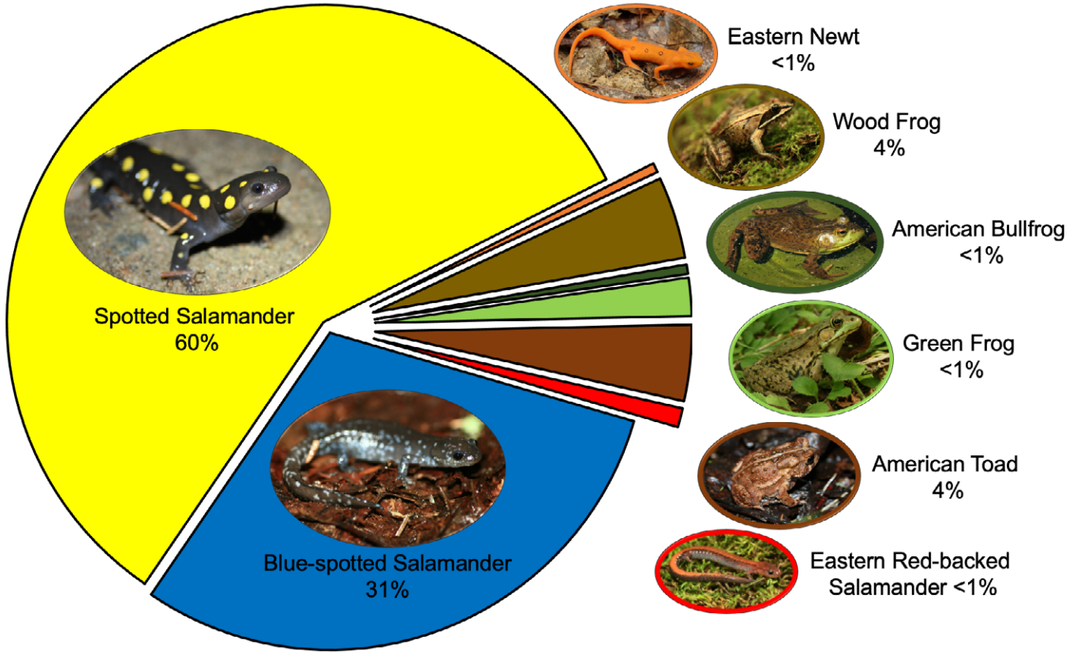
AMONGST THE LEAF LITTER

Spring 2022 was the fourth year of the amphibian census at the Bat Lake drift fence—a project grown out of the long-term Bat Lake Inventory of Spotted Salamanders (BLISS). In preceding years, tallies of seven focal species have ranged from 13,600–15,600 captures per year. That's an astounding abundance! Not to be outdone, in 2022, spanning the period of 14 April to 28 May, we set a record with 17,426 amphibian captures! Spotted Salamanders were in greatest abundance, followed by Blue-spotted Salamanders, Wood Frogs, and American Toads (Spring Peepers and Gray Treefrogs are abundant too, but their suction cup toes allow them to easily scale the drift fence and get on with their breeding frenzy without delay). In relatively low abundances were Green Frogs, American Bullfrogs, Eastern Red-backed Salamanders, and Eastern Newts (in fact, there was just one individual of the latter species in 2022!). This enormous number of captures combined with complementary data—reproduction, spatial habitat use, and climate, among other themes—provide a rich foundation from which to ask and answer questions about amphibian ecology. Recent monitoring at the drift fence is shifting this salamander-centric research project into the study of a whole amphibian community, and we'll learn more for it.

> "IN 2022, SPANNING THE PERIOD OF 14 APRIL TO 28 MAY, WE SET A RECORD WITH 17,426 AMPHIBIAN CAPTURES!"

MUSINGS FROM THE FIELD

There are clear biological explanations for the low representation of some species at Bat Lake. For example, Green Frogs, American Bullfrogs, and Eastern Red-backed Salamanders do not undertake long-distance overland migrations in the spring and so are unlikely to be encountered at a drift fence. However, one species has left us scratching our heads. What's going on with the Eastern Newt? Adults of this species are largely aquatic, but juveniles (also known as efts) can spend many years roaming and foraging on land. Twelve years of aquatic trapping has yielded only a handful of adult newts captured in Bat Lake. That's in contrast to the thousands of each Spotted and Blue-spotted Salamanders over the same time frame. During four



Above: Amphibian captures at Bat Lake in spring 2022 with each species presented as a percentage of total captures.

years of drift fence censuses, we've only observed four newts in the spring and two to four metamorphic newts per year in the late summer/autumn. Newts made up <0.0001% of all amphibian captures in spring 2022! Are newts more sensitive to the low pH conditions of Bat Lake? Is there a dispersal limitation with too few newts ever arriving at Bat Lake from nearby waterbodies to gain a population foothold? Is predation from other salamanders or competition for food stymieing the local newt population? There is no reason to be concerned about the low number of newts local to Bat Lake, but it does raise several questions. Just 25 km west of Bat Lake, David LeGros (another BLISS alumnus) encountered nearly 3,400 juvenile newts during just two years of sampling along a drift fence line! It's a no one pond fits all situation.

HIGHLIGHTS SPIEL

This year our team published a research paper about the sensitivity of Bat Lake salamanders to climate warming and their apparent slimming in response to warming temperatures. We welcomed renewed involvement—including time in the field!—of BLISS project founder Glenn Tattersall (Professor, Brock University) and new graduate student Danilo Giacometti to further investigate the relationship between warming and metabolism as a possible explanation for the slimming of salamanders. Enthusiastic students Germain Collinge Ménard, Yara Ghabra, Lillian Chan, and Claire Voss from the University of Toronto got their feet wet and hands dirty with an introduction to amphibian fieldwork. We were also joined in the field by behavioural ecologist Jim Barnett, who piqued our interest with his research about amphibian colouration and pattern, and Hugo Kitching, who filmed for a TVO natural history documentary series about the Great Lakes. And, as a personal favourite, after 15 years of salamander research, I made my first feeding observation in the wild: a post-breeding adult female Blue-spotted Salamander scarfing a (non-native)


Samantha Stephens

earthworm on a rainy night near the end of the migratory period (26 May 2022)!

STICKY & HOLDING THINGS TOGETHER

Amphibians are downright fascinating, but they're more than even that. Amphibians are a proverbial glue in many ecosystems. Their abundance can make them important predators and prey, vital linkages within the web of life. In addition, amphibians can be key indicators of environmental health. Seemingly pristine areas of the globe are experiencing amphibian declines and resultant knock-on environmental effects, heightening concerns about planetary health. Overall, our research studies amphibian populations and their biology in our shared and changing world. This project is BLISS in name and bliss in deed. ♦

ACKNOWLEDGEMENTS

Many thanks to Mariel Terebiznik who took time from her graduate studies to help launch an early field season. Spring students Germain Collinge Ménard, Yara Ghabra, Lillian Chan, and Claire Voss received an introduction to amphibian biology and were instrumental in data collection. Farqd Barghash, Robin Lloyd, and Samantha Stephens, alongside several other volunteers, were welcome company on several nighttime and early morning surveys. Gabby Salvadore and Haley Morris brought much enthusiasm for the metamorphic salamander surveys in the late summer. Thank you to Kevin Kemmish, James Pinto, Farqd Barghash, and Dan Burns for keeping everyone comfortably housed and very well fed. A special thank you to Arc'teryx Toronto for providing durable rain gear to help keep me dry during cold rainy field nights!

AN APPRAISAL OF SALAMANDERS AT BAT LAKE

Written by Patrick Moldowan

SPOTTED SALAMANDERS NEAR & FAR

The geographic range of the Spotted Salamander spans approximately 20° latitude (between 29–50°N latitude, at least), equivalent to approximately 2,000 kilometres from north to south. The northern half of the Spotted Salamander geographic distribution (approximately 1,000 km from north to south, spanning present day northern Ontario to southern Ohio) is a post-glacial landscape that was colonized by the species only recently in geological terms (<12,000 years). The northern quarter of the species' geographic range is situated in the northern (boreal) forest, whereas the southern three-quarters comprises eastern temperate forest. At 45°N latitude, the population of Spotted Salamanders at Bat Lake is within the northern quarter of the species' geographic range and at the interface of northern forest and eastern temperate forest ecoregions. Research with the Spotted Salamanders at Bat Lake is the only population study of this species in this (sub)boreal ecoregion, providing a rich opportunity for natural history, ecological, and demographic data collection. Peripheral populations, such as northern or range-edge populations, are likely to differ in interesting ways from populations nearer the core of a species' range. Peripheral populations tend to be lesser studied, disproportionately vulnerable to decline, and can be important units for conservation.

15 YEARS OF SALAMANDERS AT THE HEART-SHAPED LAKE

What can be said that hasn't been said already of the Spotted Salamanders at Bat Lake? Well, a lot as it turns out! A lot can happen in 15 years—a newborn baby becomes a testy teenager, political leaders and ideologies wax and wane, and your latest technology will become obsolete, to give just a few examples. Salamander monitoring at Bat Lake dates to the mid-1980s, although it was 15 years ago that the project known at the Bat Lake Inventory of Spotted Salamanders (BLISS) was formalized.

Long-term ecological studies provide key insights about organismal biology and environmental change, baseline data for of population monitoring, and lay the groundwork for the formulation and testing of research questions, hypotheses, and scientific theories. The first data chapter of my dissertation brought together the first 15 years (2008–2022) of ecological

"LONG-TERM ECOLOGICAL STUDIES PROVIDE KEY INSIGHTS ABOUT ORGANISMAL BIOLOGY AND ENVIRONMENTAL CHANGE ..."

and natural history data from salamander monitoring efforts at Bat Lake. Bat Lake is a large (for salamander breeding habitat), fishless, and naturally acidic waterbody surrounded by a conifer-dominated forest—an environment that differs markedly in character from that of well-studied southerly populations. Aquatic funnel trapping, drift fence census, and egg mass counts were used to sample across salamander life stages and life cycle events. Facets of salamander biology are summarized in the accompanying side panel. Compared to other populations, Spotted Salamanders at Bat Lake mature later, attain smaller

Samantha Stephens

sizes, produce fewer eggs per egg mass, and have relatively high embryonic survival at low pH conditions. The female-biased annual breeding turnout at Bat Lake is unusual among salamander and pond-breeding amphibians generally. The Spotted Salamander population at Bat Lake demonstrates many biological similarities with other populations. For example, female reproductive investment, survival from egg to metamorphosis, and body size at metamorphosis were consistent with available literature. The long-term monitoring project of salamanders at Bat Lake provides a rich springboard for continued ecological research amid ongoing environmental change.

RIGHT TOOL FOR THE JOB

Understanding population trends of wildlife is central to mitigative activities and the prevention of biodiversity loss. Long-term study is a valuable tool for understanding population trends and evaluating sampling methods is especially important for the design of long-term monitoring program. For amphibians, aquatic traps, egg mass counts, coverboards, and drift fences are common population sampling strategies, but several of these methods have unknown biases that can provide misleading information about amphibian populations. The first three methods involve sampling individuals from a much larger population and require relatively low effort, cost, and time. Because subsets of a population are being sampled with traps, egg mass counts, and coverboards, these methods can be be subject to biases. In contrast, a drift fence can be used to conduct a complete population census, but this requires a large investment of effort, cost, and time. Using the long-term dataset, we estimated multiple population 'vital rates'—survival, abundance, and sex ratio—and evaluated apparent biases arising from the use of different sampling methods. Estimates of salamander survival were on average lower and more variable compared to estimates for other populations, and abundance estimates generated from aquatic trapping data were generally lower than census population size known from salamander counts at the drift fence. Further, sex ratios estimated from aquatic trapping were strongly male skewed, whereas the census sex ratios demonstrated slight to major female skewness—opposite findings from the use of different sampling methods! Our findings suggested that aquatic trapping is probably not a viable method for estimating population vital rates of salamanders in a large, permanent waterbody with a large number of breeding adults, as at Bat Lake. We found that coverboards were not an effective strategy for sampling Spotted Salamanders in continuous forested habitat. Bat Lake is different in character from other study sites in the Spotted Salamander distribution, which provides both opportunities and challenges for long-term study of amphibians breeding at the site. ♦

Spotted Salamander facts at a glance

Based on 15 years of monitoring at Bat Lake:

Start of breeding
26 April (average), 08 April to 09 May (range)

Sex ratio of the breeding population
Unusually female-skewed, 51–65% female annually

Eggs per egg mass
72 eggs (average) up to 194 (maximum)

Reproductive investment
Females lose 24% of mass during reproduction
Males lose 19% of mass during reproduction

Embryonic survival
93% of embryos (average) per egg mass survive to hatch

Larval survival
0.8–2.9% survival from egg to metamorphosis

Adult survival
61% per year, on average

Timing of metamorphosis and dispersal
Late July through October

Size at metamorphosis
Length of a small paper clip (29 mm body length) and <1 g

Size at maturity
Length of a pen cap, 47–60 mm body length

Age at maturity
6 years for females, 4–5 years for males

Adult body size
Female: 84 mm (average), 60–104 mm (range)
Male: 73 mm (average), 47–97 mm (range)

Longevity
At least 14 years

COMPARING THE OPERATIONAL SEX RATIO OF FOUR POND-BREEDING AMPHIBIAN SPECIES

Written by Germain Collinge Ménard

Each year the salamander team welcomes undergraduate students from the University of Toronto as part of the university's Research Excursion Program (REP). In addition to assisting with the collection of long-term data, these students conduct their own research projects.

The operational sex ratio (OSR) of a population refers to the number of reproductive males relative to available reproductive females; this can inform our understanding of how the population might grow, disperse, and react to environmental change. Previous studies have suggested that male-biased sex ratios may be widespread among amphibians due to females not reproducing every year ("reproductive skipping")—although this has not yet been broadly assessed in North American species.

My objective was to offer a descriptive analysis of OSR for four species of amphibians coexisting at Bat Lake in Algonquin Park—the American Toad, Wood Frog, Spotted Salamander and Blue-spotted Salamander. I also intended to see whether there was a relationship between OSR and environmental variables such as precipitation, temperature, and lunar cycles. I used migration data collected from the Bat Lake drift fence in the 2018, 2019 and 2021 breeding seasons.

Based on evidence of reproductive skipping in other amphibians, I expected OSR to be male-biased for all species. What I found instead was that while OSR was male-biased in toads and frogs across all seasons, it was consistently female-biased in Blue-spotted Salamanders, and varied widely in Spotted Salamanders, with a female bias in 2018, a male bias in 2019, and a near-even ratio in 2021. My results also implied an association between moonlit nights and female-skewed sex ratios in both salamander species.

> "PREVIOUS STUDIES HAVE SUGGESTED THAT MALE-BIASED SEX RATIOS MAY BE WIDESPREAD AMONG AMPHIBIANS DUE TO FEMALES NOT REPRODUCING EVERY YEAR ..."

This challenges our assumptions that female salamanders consistently skip reproductive years, which would result in male-biased sex ratios across the board. It is possible, however, that females that do engage in reproductive skipping only skip certain years based on specific environmental conditions. Additionally, evidence of male-biased sex ratios in American Toads and Wood Frogs can be a useful tool for wildlife management and wetland conservation across the continent, given these species' broad ranges. ♦

ACKNOWLEDGEMENTS

Thank you to Patrick Moldowan and Dr. Njal Rollinson for their guidance and access to previous and ongoing research, as well as to everyone at the AWRS, and student researchers from past years for collecting and digitizing the data used in this project.

Samantha Stephens

WHY TO SPOT A SPOTTED SALAMANDER

Written by James B. Barnett

After a long, cold, and often monochrome winter, what could be a more welcome herald for the approaching spring than the profusion of bright yellow spots that annually meander clumsily, but purposely, towards Bat Lake? The migration of Spotted Salamanders (*Ambystoma maculatum*) is truly a feast for the eyes, but such a mass aggregation of brightly coloured animals also allows us a glimpse into a hidden world of evolutionary and ecological trade-offs.

In May 2022, I joined the salamander team at AWRS to ask why Spotted Salamanders are so vividly spotted? Aposematism has long been recognised as the answer. The bright conspicuous colours warn potential predators of toxic skin secretions and allow the salamanders to go about their lives (mostly) undisturbed. But what is the 'goal' of aposematism? To be detected? Recognised? Distinguished from palatable alternatives? … maybe all of the above? Many years of research on a wide range of species has generally supported the notion that brighter, larger, more contrasting, more symmetrical, and more distinct patterns are all more likely to be learnt and avoided by predators.

So, how well do Spotted Salamanders fit into this standard paradigm? Bold and eye-catching, yes, but spots are irregularly placed and highly variable, and the salamanders themselves are nocturnal and fossorial, spending most of their lives underground away from the prying eyes of predators. These are all characteristics more often associated with cryptic species, and high contrast, irregular patterns are frequently used to break up an animal's outline into a series of unrecognisable shapes that blend into different parts of the background.

It is now well established that rather than necessarily being distinct and mutually exclusive defensive strategies, camouflage and aposematism exist of a spectrum from highly cryptic to highly salient. The patterns we see in nature evolve as a compromise or combination of functions depending on factors including defence strength, habitat heterogeneity, and the particular mix of predation threats. However, many questions remain unanswered in our understanding of how animals manipulate colour to combine these different functions.

This is where we are turning our attention, working to disentangle the different components of salamander colouration to understand the evolutionary trade-offs involved. Colour calibrated photographs taken in the field last year are now allowing us to explore colour, brightness, and the distribution of pattern as viewed by ecologically important observers, including tetrachromatic birds and dichromatic mammals, which see the world in a way quite different from our own experience. So, how does the spotted salamander exploit observer visual perception? Where and when are they most conspicuous and can they be cryptic? And to whom? Keep an eye out, we hope to be able to shed new light on these questions very soon. ♦

Image on right: The colours of Spotted Salamanders may be highly conspicuous or cryptic depending on the context and time of day. Colours as viewed by a trichromatic human (top), a dichromatic mink or coyote (middle), and a monochromatic raccoon or as viewed at night (bottom).

A SANCTUM FOR AMPHIBIANS

SALAMANDERS IN THE PARK MAY BE FREE FROM PATHOGENS CAUSING WORLDWIDE DECLINES

Written by Léa Fieschi-Méric

In 2019, I came to Algonquin Park to conduct research on salamanders. Beyond the fascinating experience it was to live in a research station with like-minded scientists, to 'commute' from my cabin to study-sites by canoe, and to be everyday surrounded by breathtaking landscapes, working in Algonquin Park was also an immense source of joy for me as an ecologist. Indeed, the park offers an ecosystem rather protected from anthropogenic disturbances and is home to healthy amphibian populations – in contrast with Europe, where I come from.

THE CHYTRIDIOMYCOSIS PANZOOTIC

While we humans have been stunned by the recent COVID-19 pandemic, amphibians have suffered their own worldwide disease outbreak for a few years now. The deadly chytridiomycosis—a fungal disease that disrupts the fragile skin of amphibians, through which they normally breathe and hydrate—has caused mass amphibian die-offs and several species extinctions in the past decades. In Europe, this disease has been particularly devastating; skin-devouring fungi have curtailed Dutch salamander populations by more than 99% in just a few years, and while doing fieldwork in the Pyrenees, I have seen carpets of dead frogs washed up on the shore of the lakes – a bloodcurdling vision I will never forget.

DISEASE SCREENING IN THE PARK

In contrast with my experience in Europe, seeing the thriving amphibian populations of Algonquin Park was reassuring. To verify that they were not infected by chytridiomycosis (some individuals can be asymptomatic), I conducted pathogen screenings in various locations in the park and on several amphibian species. Gently rubbing individuals with a swab was enough to collect their skin microbes, which I could then analyze in the lab. I found that all my samples were free from chytrid fungi. These results suggest that chytridiomycosis might not be a threat to amphibians in Algonquin Park, at least for now.

PRESERVING REFUGES FOR AMPHIBIANS

While the absence of chytrid fungi among my samples from the park is very encouraging, constant vigilance is necessary to prevent the introduction of deadly pathogens in this preserved environment. Many simple actions can be undertaken to reduce spillover risk, such as spraying shoe soles with a disinfectant before going on hikes, refraining from displacing individuals, and reporting sick or dead amphibians to biologists at the Visitor Center or to the Canadian Herpetological Society. In the midst of the current amphibian crisis, each of us can contribute to preserve oases free from pathogens, which may be crucial for the survival of these amazing animals. ♦

> "THE RESULTS SUGGEST THAT CHYTRIDIOMYCOSIS MIGHT NOT BE A THREAT TO AMPHIBIANS IN ALGONQUIN PARK, AT LEAST FOR NOW."


Samantha Stephens


Samantha Stephens

ACKNOWLEDGEMENTS

I thank my PhD supervisors, David Lesbarrères and Mathieu Denoël, for the opportunity to conduct research in the park. I am grateful to Noah Loiselle, César Doublet and more generally to all the members of the AWRS for their assistance in the field. Many thanks to Patrick Moldowan and Peter Mills for recommending study sites and to Jake Kerby for sharing his expertise with pathogen screening protocols!

THE ECOLOGICAL PHYSIOLOGY OF SPOTTED SALAMANDERS: INTEGRATING LAB & FIELDWORK

Written by Danilo Giacometti & Glenn Tattersall

BACKGROUND

Shrinking body size is a consequence of climate change that has been recently described in Spotted Salamanders from Bat Lake, Algonquin Provincial Park. This change in body condition was explained by warmer summers and autumns recorded over a 12-year monitoring period (2008–2019). Under a realistic scenario of climate change, further changes in body size are expected to take place in this population. It is in this context that we devised our research program, which focusses on understanding how temperature influences the behaviour and physiology of Spotted Salamanders.

> “ULTIMATELY, OUR WORK SHOULD PROVIDE A BROADER VIEW OF THE ECOLOGY, BEHAVIOUR & PHYSIOLOGY OF SPOTTED SALAMANDERS”

WHY TEMPERATURE?

Warming temperatures are a threat to amphibians. In fact, changes in temperature are one of the major causes behind recent population declines and/or local extinctions of amphibian species. The extent to which a population is affected, however, depends largely on how temperature interacts with other environmental attributes, such as wind speed, precipitation, or altitude. Due to the unique elevational and climatic characteristics of Bat Lake, Spotted Salamanders from that population live close to a climatic range edge. This means that relatively small changes in temperature can have a large impact over these animals. This is particularly relevant, given that climate change effects have already been described in the Bat Lake population.

OUR PROJECTS

Since 2022, we have been studying three temperature-dependent aspects of the biology of Spotted Salamanders: metabolic rates, rates of evaporative water loss, and behavioural thermoregulation. Metabolic rates are a measure of how much energy salamanders need and expend. In most organisms, rising temperatures lead to increased energetic costs. In turn, prolonged exposure to warm temperatures may cause energetic stress. In amphibians, rates of evaporative water loss go hand in hand with metabolic rates, given that these animals use their skin for breathing and hydration. As such, increased temperatures can speed up dehydration. If warm temperatures persist for a long period, this can also lead to death. Behavioural thermoregulation is the main means of body temperature control in amphibians. Studying the thermal biology of Spotted Salamanders can give insight into whether or not these animals prefer a specific range of temperatures. Coupled with information collected in the field, we can establish if these temperatures are readily accessible to animals in their habitat, or if they are living at relatively harmful temperatures.

Danilo Giacometti

In another project, our goal is to characterise changes in underground conditions in Bat Lake. Due to their secluded nature, little is known about ‘where Spotted Salamanders go’ when they are not breeding in ephemeral ponds or outside their burrows searching for food at night after a rainfall. Given this, we are monitoring seasonal changes in temperature and gas levels (O_2 and CO_2) of burrows potentially used by Spotted Salamanders. By combining information collected in nature and in the lab, the results of our projects should help us understand which aspects of salamander biology are the most sensitive to climatic change. Ultimately, our work should provide a broader view of the ecology, behaviour, and physiology of Spotted Salamanders. ♦

ACKNOWLEDGEMENTS

We thank Ontario Parks, the Ministry of Northern Development, Mines, Natural Resources and Forestry, and the Algonquin Wildlife Research Station for allowing us to conduct our research in Algonquin Provincial Park. We are grateful to all the people involved in the Bat Lake Inventory of Spotted Salamanders (BLISS) for all your help and support. Research funding was provided by a Natural Sciences and Engineering Research Council of Canada Discovery Grant to Glenn J. Tattersall (RGPIN-2020-05089).

PITCHER PLANTS & SALAMANDERS: A NEW SPECIES IN THE SPOTLIGHT

Written by Amanda Semenuk

We've talked a lot about secrets from the bog; an area seldom explored with many discoveries to be made. Since 2018, we've followed a population of pitcher plants that, in addition to their typical diet of small insects and other arthropods, have also quietly been consuming dozens of juvenile Spotted Salamanders as they first emerge from their natal site each year. This chapter of the story is particularly exciting because it includes the capture of a new species, one previously unrecorded as victims to the carnivorous pitcher traps of Northern Pitcher Plants.

(ANOTHER) SECRET REVEALED

By late August of 2022, pitcher plants began preparing for winter dormancy as their growing season wound down. For this year's brood of Spotted Salamanders, however, the excitement was just beginning. Following an early onset of egg mass-laying the previous spring, the metamorphic salamanders began their emergence—the arduous transition from life in water to the terrestrial world—but in late July, almost two weeks earlier than in recent years! Though several species of salamanders show accelerated development for the purposes of predator avoidance, this strategy renders useless in this case, as the perennial pitcher plants are always there first, waiting in the bog mat for this year's newcomers. Among the burst of emerging juveniles, our initial survey of the plants revealed a record-breaking 15 captures of the 50+ salamanders that would become entrapped within the leaves of our 90 study plants that season. What continued as a seemingly typical field season later brought another revelation when a second look at a trapped salamander revealed that it was indeed a Blue-spotted Salamander. To our knowledge, this, along with two other Blue-spotted Salamanders found in pitchers shortly after, are the first records of this species to be successfully captured by a Northern Pitcher Plant. These findings were intriguing for several reasons and raised two important questions:

First, Blue-spotted Salamanders and Spotted Salamanders, both mole salamanders of the genus *Ambystoma*, share much of the same behaviours and life history strategies. Of the thousands of salamanders that emerge from the natal site each summer, between 100–700 emerging Blue-spotted Salamanders follow the same path as their yellow-spotted counterparts across the pitcher plant-laden bog mat. Given this behavioural overlap, why have we not observed Blue-spotted Salamanders trapped within pitcher leaves prior to this field season?

"WHAT CONTINUED AS A SEEMINGLY TYPICAL FIELD SEASON LATER BROUGHT ANOTHER REVELATION WHEN A SECOND LOOK AT A TRAPPED SALAMANDER REVEALED THAT IT WAS INDEED A BLUE-SPOTTED SALAMANDER."

Second, our current understanding is that there is no overlap in the vertebrate species caught by the Northern Pitcher Plant between Algonquin Park and other North American bogs. Most other reports come from northeastern United States, where observers have found Red-backed Salamanders, Eastern Newts, and even a Five-Lined Skink trapped in pitcher plant leaves, the first two of which live and breed close to our study population of pitcher plants. What conditions lead to some of these potential prey animals being caught over others? In other words, why are some salamander species more susceptible to pitcher traps than others in areas where all species are present?

Amanda Semenuk

Naturally, in answering these questions we must consider the relative likelihood of whether the salamanders are not entering the pitcher traps in the first place, or some species have an easier time escaping once inside, as indicated by frogs at our site. On several occurrences throughout surveys, Green and Wood Frogs would scramble, seemingly with intent, into the pitchers to avoid approaching disturbances. Their body plan, however, makes all the difference as the frogs are capable of sticking to the slippery inner surface of the leaf before hopping or climbing to safety. We have not found a single corpse or evidence otherwise to indicate the death of frogs by the traps of Northern Pitcher Plants.

In any event, though not every field season reveals a discovery as immediately impactful as this one, what we do know is the importance of studying ecosystems such as bogs and their inhabitants cannot be overstated. Due to their characteristic low nutrient levels, bogs are harsh environments, but they are also an important habitat for the unique species that have evolved there. In spite of their harshness, they are sensitive ecosystems that are threatened by pollution, ecological destruction and habitat destruction. Discoveries like this are reminders of how little we understand about these ecosystems and underscore the importance of wildlife research. ♦

ACKNOWLEDGEMENTS

Sincere appreciation to Olivia Pawlick-Potts and Drayke Evans for their unrestrained enthusiasm when searching for "salamander soup". For their continued support and inspiration, I want to thank Patrick Moldowan and Samantha Stephens. This project would not be possible without the invaluable co-supervision of Dr. M. Alex Smith (University of Guelph) and Dr. Shoshanah Jacobs (University of Guelph).

AN UPDATE ON THE SMALL MAMMAL PROJECT

Written by Bryan Hughes

2022 marks the 71st consecutive year for the Algonquin small mammal project. The small mammal research team welcomed two Laurentian undergraduate students, Kiara Duval and Julia Goss, who helped with ongoing small mammal trapping research while also conducting their own undergraduate research projects.

SMALL MAMMAL RESEARCH OVERVIEW

Trap efforts persisted along the 17 designated Algonquin traplines from May through August, and the research team captured a total of 419 unique individuals, including Deer Mice, Red-backed Voles, Jumping Mice, Red Squirrels and even some Flying Squirrels. Populations of small mammals can generally be modeled using a high-low abundance cycle, where a high abundance year typically follows a low abundance year. For our 2022 season, we considered this a relatively high population, meaning our research team had plenty to do! Each year, the small mammal research team undergoes trap effort to gather data on small mammal population dynamics, behaviour, and various environmental trends. This year, we placed an emphasis on examining the behaviour of animals in hopes of gathering a better understanding of the evolution of various strategies within the Algonquin ecosystem.

UNDERGRADUATE PROJECTS

Alongside the normal trapping schedule, our team underwent the development and implementation of two undergraduate research projects. Kiara Duval was interested in the impact human-developed structures, such as roadways, have on the evolution of behaviours and life history strategies in small rodents. Meanwhile, Julia Goss used anogenital distance as a measure of masculinization in female rodents. For both projects, the team collected important data, including morphological traits such as individual weight, age, sex and anogenital distance and used a series of behavioural tests to measure animal personality types. The team also used non-invasive fecal sampling to collect samples that will later be used for steroid hormone analyses. These measurements allow us to gain insight into the stress, behaviour and life history of individual animals.

> “THIS YEAR, WE PLACED AN EMPHASIS ON EXAMINING THE BEHAVIOUR OF ANIMALS IN HOPES OF GATHERING A BETTER UNDERSTANDING OF THE EVOLUTION OF VARIOUS STRATEGIES WITHIN THE ALGONQUIN ECOSYSTEM.”

A LOOK INTO ANIMAL PERSONALITY

Bryan Hughes, a master’s candidate at Laurentian University, led the small mammal team while conducting tests to measure animal personality and pace of life. An animal’s pace of life includes the development of physical characteristics and the physiological mechanisms that help facilitate function. An animal’s personality is a series of repeatable behaviours that can be defined as an ongoing strategy. An individual that is more keen to explore and move a greater distance may fall into one personality, while a more shy and less explorative individual would count as another. By using a series of behavioural tests, we are able to predict different personality types among different species, including those that are docile, exploratory, aggressive, or highly social. Combined with our data on physiology, namely the measurement of stress hormones, we can use this information to predict evolutionary trends and strategies among different species and between different individuals of the same species.

Victoria Gee

Understanding these trends can be important for understanding how an ecosystem functions, and how species coexist within similar environments. Deer Mice, Red-backed Voles and Woodland Jumping Mice are three species of rodent that are found most abundantly within Algonquin. Despite occupying the same habitat and having many similar features, such as diet, the three species manage to coexist. That remains possible because of slight differences in pace of life, where different species occupy minute aspects of the environment. ♦

ACKNOWLEDGEMENTS

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LONG-TERM FLYING SQUIRREL MONITORING PROJECT

Written by Rebekah Persad & Paige Brunelle

This year marked the 21st year of the long-term monitoring project for flying squirrels in and surrounding Algonquin Park. Since 2002, Dr. Jeff Bowman and his team have conducted annual research on the flyers throughout Algonquin Park. This research investigates the range boundary dynamics of flying squirrels. Climate warming continues to bring on warmer winters, which allows Southern Flying Squirrels to expand their range northward, consequentially intruding on Northern Flying Squirrel territory. The team began studying the effects of the shifting range limits for both species and exploring the potential for hybridization since the two species are now often found in the same area. These effects have already been found at several other sites in Central On-

WHY ALGONQUIN PARK?

Before the 2000s, Southern Flying Squirrels were not yet found within the boundaries of Algonquin Park. Today, the park sustains both Southern and Northern Flying Squirrel species. The park is situated between Southern Flying Squirrels' historic northern limits and Northern Flying Squirrels' southern limits. To investigate how Southern Flying Squirrels are shifting their range, yearly population monitoring is conducted to identify occurrence patterns, assess temporal changes in range, and investigate changes in population genetics.

A TYPICAL DAY OF FIELDWORK

It's a jam-packed week from dawn to dusk! On average, a grid of twenty traps is placed throughout each woodlot, using a combination of the same woodlot sites each year, with occasional visits to new sites. This year we put out forty traps and visited four sites within Algonquin Park. We secure Tom-

"BEFORE THE 2000s, SOUTHERN FLYING SQUIRRELS WERE NOT YET FOUND WITHIN THE BOUNDARIES OF ALGONQUIN PARK. TODAY, THE PARK SUSTAINS BOTH SOUTHERN & NORTHERN FLYING SQUIRREL SPECIES."

ahawk traps to wooden platforms approximately 2 meters up the trunk of a tree; typically, taller than we are! At dusk, traps are baited with apple slices and sunflower seeds. Fresh cotton is placed inside traps for bedding. The next morning, we wake up just before dawn and head to our first site. Sometimes, we're skunked out—no squirrels are trapped that day despite our efforts. On other days, we find success. When we find a squirrel in a trap, we determine if it is a Northern or Southern Flying Squirrel. Typically, Northerns weigh more than Southerns and have darker brown fur and tints of black fur at the base of their skin. We also collect a DNA sample to determine the genetic makeup of the individual, which can provide information about potential hybridization. We then determine the squirrel's sex and collect morphological measurements to inform estimates of body condition. Before we release it back into the wild, we place an ear tag on the individual for future identification. After checking all our morning traps, we have lunch and then head out before dusk to set up the traps once again. We do this for another four or five nights!

Jacob Bowman

Paige Brunelle

Samantha Stephens

RESULTS

Southern Flying Squirrels have expanded into Algonquin Park over the last 20 years, with 2022 marking the start of an increase in the Southern Flying Squirrel population in Algonquin Park. The initial research from 2002–2004 caught 0.24 Northern and 1.27 Southern Flying Squirrels per 100 trap nights. Flying squirrels continued to be monitored annually from 2002 up to the present day. This year, we caught 1.2 Northern and 2.5 Southern Flying Squirrels per 100 trap nights. Comparatively, using the same standard in 2021, we caught 1.5 Northern and no Southern Flying Squirrels. Over the last 20 years, an abundance of data has been collected on flying squirrels inhabiting and surrounding the park, and researchers will continue to monitor these populations in the future.

OTHER CONTRIBUTIONS

This year kickstarted the weeklong program called FREED (Field Research in Ecology and Evolution Diversified), which provides workshops for Indigenous, Black and/or racialized undergraduate students. We provided a live-trapping demonstration of flying squirrels as part of this program. Rebekah Persad, a Trent University master's student, led workshop participants through the tall pines to trap squirrels at night. We came up empty-handed on the first two trap checks, but to our surprise, on the final trap check, we found a female Northern Flying Squirrel! Rebekah demonstrated the processing protocol for the students and then released the squirrel back into the forest. ♦

ACKNOWLEDGEMENTS

This research is supported by Trent University, NSERC, and the Ontario Ministry of Natural Resources and Forestry. Thank you to the summer students, volunteers, and researchers who have helped collect this data for 20 years.

RESTORING THE UNDERSTORY OF CACHE LAKE'S PINE PLANTATION

Written by Jason Phoenix & Stephen Murphy

After a year of COVID-19 restrictions, this summer, we managed to get our understory restoration project off the ground (so to speak). The purpose of this 4-year project is to improve soil quality and to facilitate the regeneration of understory vegetation in a 50-year-old Red Pine plantation at Cache Lake. In the long term, this plantation will be restored to native forest.

HISTORY OF CACHE LAKE

Cache Lake's north shore is intimately tied to the history of Algonquin Park itself. In 1897, shortly after the Park was established, Park Headquarters were moved here, and over the following decades, this site became a major hub of tourism and Park administration. The Highland Inn was constructed on the site in 1908, and by the 1940s, the shoreline was filled with buildings. In 1954, a major new policy was introduced: to begin restoring the Park to its natural condition. Over the next few years, the hotel and surrounding buildings were demolished, and Park Headquarters was moved to East Gate. In the 1970s, a Red Pine plantation was established across the bare hillside to simulate a natural forest environment and facilitate the growth of native species. The plantation received minimal management in the 50 years after planting, however, so today it has skinny, unhealthy trees and a largely absent understory.

> "THIS IS THE FIRST EXPERIMENTAL TEST OF WINDTHROW GUARDS & WE HOPE TO DETERMINE WHETHER THEY ARE ACTUALLY EFFECTIVE IN PREVENTING WINDTHROW"

RESTORING THE PLANTATION

In 2021, the Park initiated a multi-decade project to accelerate the plantation restoration. Park staff implemented two treatments: opening the canopy by harvesting unhealthy pines and managing invasive plants (e.g., non-native Honeysuckle and Japanese Knotweed). They also asked our research group to help restore the plantation understory, which was in a poor state after spending 50 years under a dense pine canopy. Our contribution to the project has therefore been to establish an experiment grid (64m x 64m) in which we are testing two additional treatments. The first involves planting shrubs across the site with the expectation that they will enhance seedling recruitment of native understory species, which will spread outwards over time. For this treatment, we transplanted 128 Beaked Hazel shrubs during spring 2022. The second experimental treatment is windthrow guards, a novel technique that uses rings of herbaceous plants around woody species to protect them from being uprooted by strong winds. Canada Goldenrod was used for the windthrow guard treatment, with 768 transplants forming rings around the hazel shrubs. A mortality census conducted later in the summer indicated that 99% of the shrubs and 87% of the goldenrod survived the transplanting process. Our ultimate goal is to determine whether the shrub treatments improve soil quality and facilitate the restoration of native understory cover and diversity. As far as we know, this is also the first experimental test of windthrow guards, and we hope to determine whether they are actually effective in preventing windthrow.

Jason Phoenix


Jason Phoenix

Jason Phoenix

THE FUTURE OF THIS SITE

Over the next few years, the site will be monitored for changes in understory vegetation cover and soil quality to determine whether the experiment has successfully restored a healthy understory. Afterwards, the Park will continue to thin the plantation trees every 10–12 years to allow more understory recruitment, including native hardwood saplings. As the Red Pines are removed, deciduous species will begin to dominate, and a young hardwood forest will be established in 30–40 years. ♦

ACKNOWLEDGEMENTS

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FUN WITH FISHY FRIENDS

Written by Amanda Meuser & Amy Pitura

Amy Pitura and Amanda Meuser are master's students at the University of Guelph in the Mandeville lab. Their projects focus on the same study species, and their field season was planned and executed equally by the two of them and assisted by an undergraduate student, Teaghan Frauley.

A TALE OF TWO THESES

Our thesis projects share a central theme of studying anthropogenic disturbance impacts on wild fish populations, focusing on hybridization (Amanda) and demographic history (Amy). Anthropogenic disturbances can alter the chemical and physical characteristics of streams and watersheds in both the short and long term, and fish populations will respond to disturbance in various ways. As disturbances can alter the environment and change local niches, more species can overlap in range than in the past, which can lead to increasing instances of hybridization. Amanda aims to characterize these instances of hybridization by investigating how the frequency and type of hybrids vary between minnow species and how the type and degree of disturbance across the sampling locations affects hybridization outcomes. Disturbance also influences shifts in population dynamics, such as population splits, size changes (i.e., bottlenecks or growth), and migration. The genetics of modern fish can provide insight into the demographic history of their populations, and Amy's goal is to compare demographic history trends to anthropogenic disturbance trends.

A SUCCESSFUL TRIP

Our study species include Creek Chub (*Semotilus atromaculatus*) and eight species they may be hybridizing with: Common Shiner, Central Stoneroller, Western Blacknose Dace, Striped Shiner, Longnose Dace, Hornyhead Chub, River Chub, and Rosyface Shiner. Of these nine species, Creek Chub, Western Blacknose Dace, Longnose Dace, and Common Shiner are found in Algonquin Park. These three species are common throughout Ontario and eventually made up most of our 2022 samples, so it's perfect that we found them in Algonquin.

We designed our projects around having a gradient of disturbance intensities and types. Southern Ontario has an extensive history of agricultural land use, and there were no streams available for us to sample that were free of agricultural or urban influence. With over a century of protection, no history of agricultural disturbance, and non-agricultural disturbances well documented and monitored, Algonquin's streams were the perfect foil to southern Ontario's intensive agriculture and urbanization. As well, the efforts of the AWRS and Ontario Parks make this one of the most accessible locations to study low-disturbance streams. While our stay wasn't long at the Wildlife Research Station, it certainly left us with happy memories to dwell on for the remainder of our field season. The 8-night stint in late May 2022 at the Station was the first real start to our field season, and it was a successful start, at that.

"OUR THESIS PROJECTS SHARE A CENTRAL THEME OF STUDYING ANTHROPOGENIC DISTURBANCE IMPACTS ON WILD FISH POPULATIONS, FOCUSING ON HYBRIDIZATION (AMANDA) & DEMOGRAPHIC HISTORY (AMY)."

A male Creek Chub in spawning colours and tubercles Amy Pitura

IN THE WORKS

We performed DNA extractions on all 900+ samples from our fieldwork season in the fall of 2022, including the 74 samples collected from Algonquin. We also had a reference genome made, using long-read whole-genome sequencing, of one Creek Chub sample, which we will use to assemble our sequencing data. As of January 2023, we are preparing the samples for high-throughput sequencing to produce a large genomic dataset. Sequencing will happen in February, after which we will use bioinformatic techniques and software programs to analyze the data. Amanda will assess admixture between the species to inform of the amount of hybridization occurring, and Amy will model demographic parameters of proposed demographic histories for each population. Results from our two research projects will quantify aspects of how anthropogenic disturbance has affected native minnow species and will go on to support conservation efforts of parks like Algonquin. ♦

ACKNOWLEDGEMENTS

We would like to thank Kevin, Patrick, Farqd, and everyone else at the AWRS for making our stay memorable and offering advice that made our fieldwork successful. We would also like to thank Dr. Liz Mandeville for advising us on our master's projects and Teaghan Frauley for assisting us during the entire fieldwork season. Finally, we would like to acknowledge that this research was undertaken thanks in part to funding from the Canada First Research Excellence Fund through the Food From Thought Program at the University of Guelph.

A male Blacknose Dace in spawning colours Amy Pitura

Creek Chub and Chrosomus spp. Dace schooling in Simms Creek Amy Pitura

WHO ARE THE BEST ANTLER FLY PARENTS?

Written by Chris Angell

Chris Angell conducted his PhD research at the AWRS using Antler Flies as a model to answer various evolutionary ecology questions. The Antler Fly was first described by Western science right here at the Station!

As people get older, their bodies get weaker, their skin more wrinkled, and their hair turns gray. This process is called "senescence" or simply "aging." Medical science has further shown that senescence can affect not only an individual but can also impact their children in a variety of ways. When this happens, it's known as a "parental age effect." Trisomy 21, the chromosomal difference that causes Down Syndrome, is more common in children born to older mothers. Children of older men historically tended not to live as long. We see the same sort of things in other mammals, such as deer or elephants, but often find the opposite in reptiles and fish: because they keep growing throughout their lives, older mothers can lay bigger, more nutritious eggs, and their offspring are often healthier than those of young mothers.

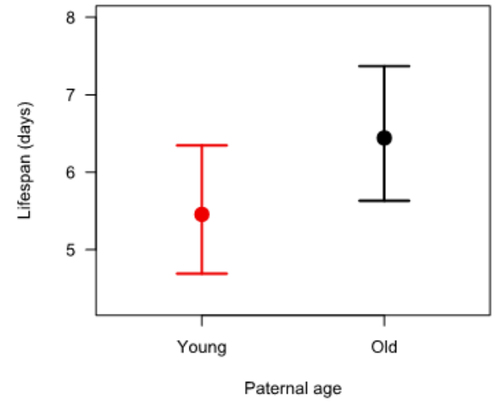
Parental age effects (both positive and negative) are known from a variety of vertebrates, but very little is known about the effects of parental age in invertebrates. Invertebrates, especially insects, are by far the most common and most diverse group of animals, but they're easily overlooked. In March of this year, we published an article in The American Naturalist ("Maternal and paternal age effects in antler flies: A field experiment") where we set out to fill that knowledge gap with the help of the mighty Antler Fly (*Protopiophila litigata*). Male Antler Flies generally spend their whole adult lives on the surface of a single shed moose antler. This means, despite their small size, it's relatively easy to track male Antler Flies in the wild and measure their survival and performance in nature. This has made them a wonderful model species for studying how insects age in the wild.

In May of 2018, my PhD supervisor, Howard Rundle, undergrad assistant Rebecca Janacek, and I set up an experiment in our lab at the University of Ottawa. We took "young" and "old" Antler Fly mothers and fathers and mated them together in every combination. The young parents were about 2 days of age post-maturity, and the old parents were a whopping 12 days old—bear in mind that adult Antler Flies normally live only about a week in the wild, so a 12-day-old fly is no spring chicken! We then drove their offspring to the AWRS to release them and see whether the children of old flies died younger or struggled to find mates.

To our surprise, we found no such thing. In fact, we saw the opposite. Although there was no difference in mating success depending on parental ages, old fathers tended to have longer-lived offspring. In retrospect, this makes a lot of sense because an Antler Fly's genes influence how long they live. If some parents had "short life" genes and some had "long life" genes, most of the parents that made it to the ripe old age of 12 days probably had "long life" genes, so that was what they passed onto their lucky offspring. On the other hand, more of the young parents were likely to be passing on "short life" genes. This phenomenon is called selective disappearance, and it's an important way that longevity (or not) can influence a population over time, whether that's humans, livestock, or Antler Flies.

I went into this experiment with a pretty strong suspicion of how it would turn out, and I am delighted to have been proven wrong. It made me think about Antler Fly populations in a new way and realize something I'd been overlooking about them. That's the beauty of the scientific process. You can look forward to more insights from these fascinating insects, before the Antler Flies are done with me! ♦


Samantha Stephens



Offspring of old fathers tended to live a day longer on average than offspring of young fathers.


Samantha Stephens

Asa Coleman

FROM CLASSES & ASSIGNMENTS TO TURTLES & SMALL MAMMALS

Written by Victoria Gee

The Station has long recognized the value of immersive hands-on learning experiences for young professionals working in the natural sciences. Today, as the world faces numerous challenges related to the destruction of natural spaces, communicating stories of science has become essential. This year, the Station expanded its mission of providing hands on training to those working in the field of science communication, by welcoming two Environmental Visual Communications placement students. Andrea Moreau developed a branding guide and social media strategy, while Victoria Gee helped produce two videos for our Patreon members.

What started as a school placement project turned into a home away from home. For nine weeks, I lived and worked at the Algonquin Wildlife Research Station (AWRS), but not as a researcher. Instead, I worked closely with and documented the folks who dedicated countless hours to important biological research.

My time within Algonquin didn't begin during the hottest time of the year, it actually began on a snowy Thursday in February during my Applied Project Placement class. As part of the Environmental Visual Communications (EVC) graduate certificate program, each student is required to join an environment-based organization and complete a placement with them. On this snowy afternoon, I was introduced to the life and importance of the AWRS as Communications Manager Samantha Stephens spoke about a placement opportunity for a lucky EVC student.

EVC is quite the experience on its own. As part of the program, students learn and work at the Royal Ontario Museum in Toronto. Each week brought a new adventure; whether we were telling stories about the mummy in the basement, out documenting a climate strike, or even learning about lighting techniques for environmental photography—there was always something exciting to learn and do.

This program brought together all my passions. Since I was little, I've had a love for photography and design. This love, combined with my background in environmental biology, was the perfect fit for EVC. The cherry on top was learning that I could spend most of my summer surrounded by the very nature I grew up thriving in. To my great surprise, I was chosen as the successful student to join the AWRS community over the summer as the Communications Intern. Fast forward to May, and my bags were all packed, stuffed into the car, and off I went to Algonquin Provincial Park.

My primary role was to document the work of the long-term turtle and small mammal research projects. For 2 months, I woke up before sunrise to push my way through trees and branches for the perfect shot of a Deer Mouse being processed. I swatted mosquitos away from my hands as I sat patiently in a canoe, waiting for Painted Turtle hatchlings to swim towards the surface for a photo. I interviewed researchers to learn about their work and the importance of the decades-long studies conducted at the Station. I helped collect data when an extra pair of hands was needed. I was on-site during an impressive re-capture of an old favourite, Henry the Snapping Turtle, and documented the process of placing a tracker on his carapace. All of this work went into two day-in-the-life style videos about the long-term research projects I followed along with.

Even though my background is related to environmental studies, I never participated in fieldwork during my undergrad. Working alongside the researchers was a dream come true. Special thanks to Samantha and everyone at the Station for welcoming this bright-eyed EVC student into your home! ♦

PUBLICATIONS

2022 PEER-REVIEWED RESEARCH PAPERS

Addison EM & M Pybus. 2022. **Populations and site selection of *Dirofilaria ursi* (Nematoda: Onchocercidae) in American Black Bears (*Ursus americanus*).** Journal of Wildlife Disease 58(3): 584–591.

Angell CS, R Janacek, & HD Rundle. 2022. **Maternal and paternal age effects on male Antler Flies: a field experiment.** American Naturalist 199(3): 436–442.

Fellin E & AI Schulte-Hostedde. 2022. **Effects of ticks on community assemblages of ectoparasites in Deer Mice.** Ticks and Tick-borne Diseases 13(1): 101846.

Fellin E & AI Schulte-Hostedde. 2022. **Tick infestation effects on hemoglobin levels of Deer Mice (*Peromyscus maniculatus*).** Parasitology 149: 209–217.

Kell SJ, N Rollinson, RJ Brooks & JD Litzgus. 2022. **Nesting in close quaters: Causes and benefits of high-density nesting behaviour in Painted Turtles**. Canadian Journal of Zoology 100: 208–218.

Lacroix C, CM Davy & N Rollinson. 2022. **Hatchling vocalizations and beneficial social interactions in subterranean nests of a widespread reptile.** Animal Behaviour 187: 233–244.

Leivesley JA, EG Nancekivell, RJ Brooks, JD Litzgus & N Rollinson. 2022. **Long-term resilience of primary sex ratios in a species with temperature-dependent sex determination after decades of climate warming.** The American Naturalist 200(4): 532–543.

Moldowan PD, GJ Tattersall, & N Rollinson. 2022. **Climate-associated decline of body condition in a fossorial salamander.** Global Change Biology 28: 1725–1739.

Schwarzkopf L. 2022. **Homage to reptiles and amphibians as model systems: One ecologist's view.** Journal of Herpetology 56: 45–55.

Wheeldon T & B Patterson. 2022. **Dispelling myths about the origins of wolf-coyote hybrids and related *Canis* species in Ontario.** The Canadian Field-Naturalist 136: 139–144.

MEDIA

2022 MEDIA APPEARANCES

GENERAL

Cottage Life TV. 2022. 'Loons: a Cry from the Mist' [*online*] filmed at the Station featuring alumnus Doug Tozer.

Wilderness and Canoe Symposium. February 2022. 'Wilderness as a living laboratory: 75 years of wildlife science at the Algonquin Wildlife Research Station' [*virtual talk* | *online recording*] by Patrick Moldowan.

Wildlife Photographer of the Year. 2022. Inargual *Horizons* recognition [*online*] featuring images of Station research by Samantha Stephens.

SALAMANDERS

Radio Canada: La Semaine Verte. January 2022. Episode 'Les champignons tueurs d'amphibiens.' [*TV* | *available online*] featuring Léa Fieschi-Méric.

Radio Canada: Moteur de Recherche. July 2022. Episode 'Les salamanders, ces curieux amphibiens.' [*radio* | *available online*] featuring Léa Fieschi-Méric.

The Raven. 2022, Vol. 63, No. 3. 'What's in a Pitcher Plant?' [print | *online*] written by Amanda Semenuk.

Close-up Photographer of the Year 04. 2022. 'Nature's Pitfall' image [*online* | *accompanied by widespread media coverage*] by Samantha Stephens awarded Animals Winner & Overall Winner.

National Wildlife Magazine. May 2022. Instagram take-over for Amphibian Week [*online*] featuring images by Samantha Stephens of research by Léa Fieschi-Méric, Patrick Moldowan and Amanda Semenuk.

National Geographic Magazine (Spain). January 2022. 'Una Trampa Mortal' [print] image by Samantha Stephens featuring research on salamander-eating pitcher plants.

National Geographic & Disney+. 2022. 'America the Beautiful' series. [*available on Disney+*] featuring salamander-eating pitcher plants filmed at the Station.

TVO & Smithsonian Chanel. 2022. 'Great Lakes Untamed' series. [*online*] featuring salamander migration and breeding filmed at the Station.

DEFENDED THESES & STUDENT PROJECTS

The AWRS has been a host to many graduate and undergraduate students since its inception in 1944. We continue to provide exceptional opportunities for students to gain invaluable knowledge in field biology. Listed here are the students that graduated from their studies in 2022.

GRADUATE

Muir, C. 2022. Effect of landscape tree species composition on beetle (Coleoptera) communities in a temperate hardwood forest. ***MFC Thesis***, Daniels Faculty of Forest Conservation, University of Toronto.

Phoenix, J. 2022. Rapid Understory Restoration of a Thinned Red Pine Plantation in Algonquin Provincial Park. ***MES Thesis***, School of the Environment, Resources and Sustainability, University of Waterloo.

Terebiznik, M. 2022. Ontogenetic shifts in sex ratios and the evolution of temperature-dependent sex determination. ***MSC Thesis***, University of Toronto.

SUPPORTERS & MAJOR USERS

As a not-for-profit, the AWRS and the long-term projects we host rely on the financial and logistical support of many individuals, institutions and organizations. We would like to thank all of our users, supporters and contributors for their generosity. We are truly grateful for your belief in the mission of the AWRS. In spring 2020, we launched a new way to support the Station—our Patreon membership community. We have over 30 members in this community who support the Station with a monthly contribution. If you're interested in supporting the Station, check out our Patreon page at patreon.com/awrs.

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Students on Ice · Canadian Conservation Corps · Ontario — Ministry of Natural Resources and Forestry; Ministry of the Environmental, Conservation and Parks

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