

of corvids. Predatory corvids pose a particular conundrum for conservation because of their intelligence, sociality, and generalist habits. Hyperpredation of prey species by subsidized corvids warrants immediate action from the conservation community, especially for several chelonian (and other prey) species that are at imminent risk of extinction. If this topic interests you, keep an eye out for a forthcoming monograph under the working title, “Hyperpredation of freshwater turtles and tortoises by subsidized corvids: global case studies of a conservation conundrum”.



Figure 1. *Mano a mano*: Midland Painted Turtle (*Chrysemys picta marginata*) and Northern Raven (*Corvus corax*). Photos by Patrick Moldowan.

## References

- Baxter-Gilbert, J., J.L. Riley, and J.D. Litzgus. 2003. *Chrysemys picta marginata* (Midland Painted Turtle). Avian predation. *Herpetological Review* 44: 302–303.
- Berry, K.H., J. Yee, T.A. Shields, and L. Stockton. 2020b. The catastrophic decline of tortoises at a fenced natural area. *Wildlife Monographs* 205: 1–53.
- Campbell, T. 1983. Some natural history observations of Desert Tortoises and other species on and near the Desert Tortoise Natural Area, Kern County, California. *Desert Tortoise Council Symposium Proceedings* 1983: 80–88.
- Campbell, D., D. Elder, and L. Anderson. 2001. Suspected predation by ravens on nesting painted turtles. *Canadian Cooperative Wildlife Health Centre Newsletter* 8: 11.
- Fincham, J.E., and N. Lambrechts. 2014. How many tortoises do a pair of Pied Crows *Corvus alba* need to kill to feed their chicks? *Ornithological Observations* 5: 135–138.
- Marchand, M.N. 2019. *Chrysemys picta* (Painted Turtle). Predation. *Herpetological Review* 50: 770–771.
- McCullum, D. 2015. Wood Turtle mortality: Corvidae predation (abstract). Presented paper. Second annual meeting of The Canadian Herpetological Society (2015). Available at <http://www.canadianherpetology.ca/conf/past.html>
- McCullum, D. 2016. Wood Turtle mass mortalities in New Brunswick, Canada (abstract). Presented paper. Blanding’s and Wood Turtle Conservation Symposium 2016. Available at [https://www.americanturtles.org/uploads/2/6/3/4/26349000/ato\\_bwtcs\\_2016.pdf](https://www.americanturtles.org/uploads/2/6/3/4/26349000/ato_bwtcs_2016.pdf)
- Perry, G., and R. Dmi’el. 1995. Urbanization and sand dunes in Israel: Direct and indirect effects. *Israel Journal of Zoology* 41: 33–41.
- Woodman, A.P., and S.M. Juarez 1988. Juvenile Desert Tortoise utilized as primary prey of nesting Common Ravens near Kramer, California. Presented paper. 13th annual meeting and symposium of the Desert Tortoise Council.



## Herpetofaunal research at the Queen’s University Biological Station

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Located on traditional Anishinaabe and Haudenosaunee territory in eastern Ontario, Canada, Queen’s University Biological Station (QUBS) is one of the oldest and largest university-based field stations in Canada (<https://qubs.ca>). Founded in 1945, QUBS continues to be centered on training and research in ecology, conservation, and other related disciplines. QUBS comprises >3,400 hectares of forests, old fields, streams, lakes, and wetlands. It lies within the Great Lakes-St. Lawrence forest region and sits atop the Frontenac Arch; an ancient strip of gneiss and granite that bridges the Canadian Shield and Adirondack Mountains (Easton 2000). This unique landscape results in an interesting mix of northern and southern biota. For example, southern species including the Eastern Musk Turtle and Gray Ratsnake reach their northern range limits in this region while typically northern species such as the Mink Frog can also be found here. Evolutionary biologists interested in understanding broad-scale biogeographic patterns can benefit from collaborating with QUBS researchers in collecting

samples from the geographically interesting QUBS land base. QUBS harbors diverse wetland types that can be critical for herpetofaunal species including permanent open water palustrine marshes, lacustrine wetlands connecting alongside small to medium-sized lakes, forest swamps under deciduous canopy, and ephemeral vernal pools (**Fig. 1**). QUBS protects habitats for at least 33 species at risk ([QUBS Species at Risk list](#)). A total of 15 species of amphibians and 15 species of reptiles are found at QUBS (**Table 1**) with the Mink Frog found nearby, but as yet undocumented on QUBS lands proper, constituting about one third of Canadian herpetofauna. Species like the Four-Toed Salamander, Pickerel Frog, Ring-Necked Snake, and Red-Bellied Snake are relatively uncommon, whereas other species occur at relatively high densities (e.g., Northern Map Turtle, Green Frog, Eastern Gartersnake). Ten species are currently listed as species at risk under the Federal Species at Risk Act or Ontario Endangered Species Act, including 1 frog, 3 snakes, 5 turtles and Ontario's only lizard, the Five-Lined Skink (**Table 1**).



Gray Ratsnake (*Pantherophis spiloides*) at QUBS boathouse. Photo by NACairns.

QUBS provides substantial support for biological research. It offers a range of field and in-lab equipment including boats, motors, freezers and microscopes. It has both wet- and dry-lab facilities with a new research and teaching building soon to be constructed. The delicately designed library, Jessie V. Deslauriers Centre for Biology, houses a spacious reading lounge and the Fowler Herbarium with > 140,000 plant specimens. QUBS has two campuses, one dedicated to research and teaching (Opinicon Campus) and the other to science and nature outreach (Elbow Lake Environmental Education Centre: <https://elbowlakecentre.ca>), although both can support researchers. QUBS has an extensive network of research trails on the land base with digitized maps available online.

Over 1,000 peer-reviewed papers have been produced in the past few decades (<https://research.qubs.ca>) mostly by student researchers. At least 116 papers have been published on herpetofauna at QUBS, comprising approximately 10% of all published research based at QUBS. Reptiles have been the focus of most herpetofaunal publications (86%). The species that have been most studied are the Gray Ratsnake, Northern Watersnake, Northern Map Turtle, and Painted Turtle, while salamanders and newts are the least studied group at QUBS. Among the 16 papers published on anurans, six focus on parasite ecology, one on immunity, three on male calling behavior and phenology, two on larval life history, two on phylogenetics and speciation, one on population genetics, and one on population ecology. Of the 100 reptile peer-reviewed articles, 30 focus on general ecology (e.g. brumation, diet, parasite, habitat selection, spatial movement, survival and demography), 15 study threats to snakes and turtles (road mortality, fishing net bycatch and motorboat mortality) and mitigation measures, 15 focus on reproductive ecology (e.g. sexual selection, paternity, litter size and sex ratio), 13 look at thermal regulation and adaptation, 10 focus on methods development, eight study sexual dimorphism and dichromatism, six describe population genetics, and three focus on phylogeography. Overall, the research has been diverse and ranges from conservation and ecology to phylogenetics and macroevolution, including both formal hypothesis testing and developing new techniques. Researchers benefit from long-term environmental data and data collection from QUBS across a variety of habitats.



Pickerel Frog (*Lithobates palustris*) photographed at QUBS. Photo by NACairns.

Many amphibians and reptiles tend to be cryptic, and often there is only a short window for fieldwork. For many reptile and amphibian species, we still lack complete knowledge about their basic ecology,



including data on dispersal tactics (Driscoll *et al.* 2014) and female anuran reproductive phenology (Cicchino *et al.* 2017). Evolutionary affinities of many species that occur at QUBS and indeed across Canada are also not well-studied. For example, despite the Ring-Necked Snake in Ontario being listed as a subspecies, *Diadophis punctatus edwardsi*, no phylogenetic studies have yet been published clarifying the confusing taxonomy that results from marked phenotypic variation among populations (Pinou *et al.* 1995). As another example, the Western Chorus Frog in Eastern Ontario and Western Quebec has a mitochondrial genome suggesting that it is actually the Boreal Chorus Frog, but the genomic data imply closer affinities with the Western Chorus Frog (Lougheed *et al.* 2020) – a mosaic of genomes that defies easy classification and complicates conservation. Knowledge of changing distributions and phenology of amphibian and reptile species will be especially important in this era of changing climates. QUBS, as an established and well-equipped field station with a dedicated staff, situated within a unique landscape, will continue to play a significant role in herpetological research.



Gray Treefrog (*Hyla versicolor*) photographed at QUBS. Photo by NACairns.

## References

- Cicchino, A.S., N.A. Cairns, and S.C. Lougheed. 2017. Reproductive phenology of temperate, female frogs: Missing data in a changing world. *Herpetological Review* 48: 10-15.
- Driscoll, D.A., S.C. Banks, P.S. Barton, K. Ikin, P. Lentini, D.B. Lindenmayer, A.L. Smith, L.E. Berry, E.L. Burns, A. Edworthy, M.J. Evans, R. Gibson, R. Heinsohn, B. Howland, G. Kay, N. Munro, B.C. Scheele, I. Stirnermann, D. Stojanovic, N. Sweaney, N.R. Villasenor, and M.J. Westgate. 2014. The trajectory of dispersal research in conservation biology. *Systematic Review. PLoS ONE* 9(4): e95053.
- Easton, R.M. 2000. Metamorphism of the Canadian Shield, Ontario, Canada. II. Proterozoic metamorphic history. *The Canadian Mineralogist* 38: 319-344.
- Lougheed, S.C., P. Li, R.B. Clemente-Carvalho, Y. Chen, M.K. Hickox, and N.A. Cairns. Using Next Generation Sequencing Data to Test for Distinctiveness of Disjunct Regional Populations of Western and Boreal Chorus Frogs in Canada. Report to Environment and Climate Change Canada. 41 pp.
- Pinou, T., C.A. Hass, and L.R. Maxson. 1995. Geographic variation of serum albumin in the monotypic snake genus *Diadophis* (Colubridae: Xenodontinae). *Journal of Herpetology* 29: 105-110.

Below: Northern Map Turtle (*Graptemys geographica*) photographed at QUBS. Photo by NACairns.



Table 1. The species list of extant amphibians and reptiles at Queen's University Biological Station. Species at risk (special concern, threatened, endangered or extirpated) listed either at federal Species at Risk Act or Ontario Endangered Species Act are marked with an asterisk.

Order	Family	Scientific name	Common name
Anura	Bufonidae	<i>Anaxyrus americanus</i>	American Toad
		<i>Dryophytes versicolor</i>	Gray Treefrog
	Hylidae	<i>Pseudacris crucifer</i>	Spring Peeper
		<i>Pseudacris triseriata</i>	Western Chorus Frog*
		<i>Lithobates catesbeianus</i>	American Bullfrog
	Ranidae	<i>Lithobates clamitans</i>	Green Frog
		<i>Lithobates palustris</i>	Pickerel Frog
<i>Lithobates pipiens</i>		Northern Leopard Frog	
<i>Lithobates sylvaticus</i>		Wood Frog	
Caudata	Ambystomatidae	<i>Ambystoma laterale</i>	Blue-spotted Salamander
		<i>Ambystoma maculatum</i>	Spotted Salamander
	Plethodontidae	<i>Hemidactylum scutatum</i>	Four-toed Salamander
		<i>Plethodon cinereus</i>	Red-backed Salamander
	Proteidae	<i>Necturus maculosus</i>	Mudpuppy
	Salamandridae	<i>Notophthalmus viridescens viridescens</i>	Eastern Newt
Squamata	Dipsadidae	<i>Diadophis punctatus edwardsi</i>	Ring-necked Snake
	Colubridae	<i>Lampropeltis triangulum</i>	Eastern Milksnake*
		<i>Opheodrys vernalis</i>	Smooth Green Snake
		<i>Pantherophis spiloides</i>	Gray Ratsnake*
	Natricidae	<i>Nerodia sipedon sipedon</i>	Northern Watersnake
		<i>Storeria dekayi</i>	Dekay's Brown Snake
		<i>Storeria occipitomaculata</i>	Red-bellied Snake
		<i>Thamnophis sauritus</i>	Eastern Ribbon Snake*
	Scincidae	<i>Thamnophis sirtalis sirtalis</i>	Eastern Gartersnake
		<i>Plestiodon fasciatus</i>	Five-lined Skink*
Chelydridae	<i>Chelydra serpentina</i>	Snapping Turtle*	
Testudines	Emydidae	<i>Chrysemys picta marginata</i>	Midland Painted Turtle*
		<i>Emydoidea blandingii</i>	Blanding's Turtle*
		<i>Graptemys geographica</i>	Northern Map Turtle*
	Kinosternidae	<i>Sternotherus odoratus</i>	Eastern Musk Turtle*



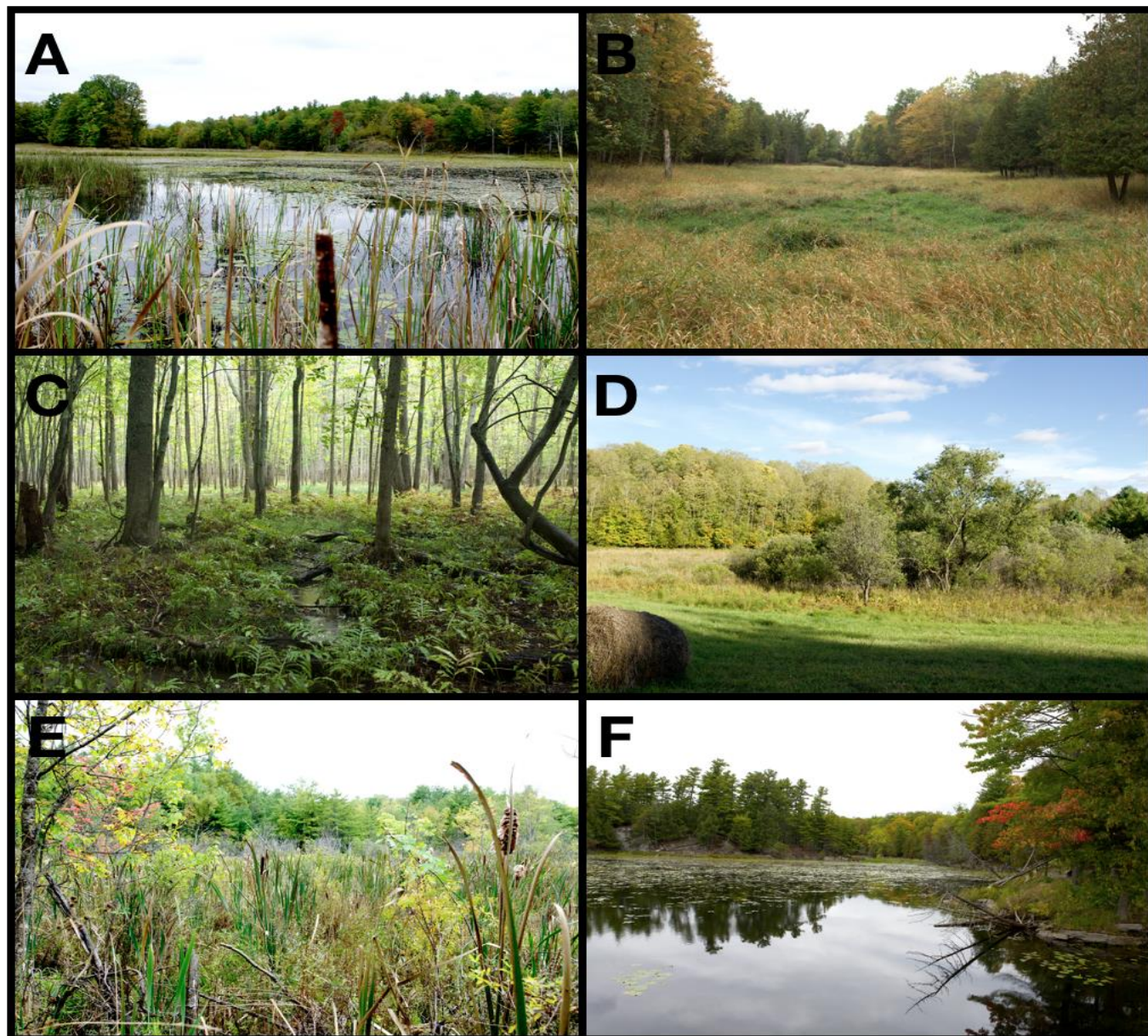


Figure 1. Diverse marshlands at Queen's University Biological Station. A. Permanent open water palustrine Barb's Marsh. B. Ephemeral unnamed Back Lakes swale. C. Silver Maple Swamp under deciduous canopy. D. Shallow upland Round Field Marsh with dense shrub thickets surrounded by cattails. E. Stream-fed Curtis Marsh. F. Telephone Bay Inner Wetland connected with Opinicon Lake. Photos by Stephen C. Lougheed.