Ecological Review of Port Colborne Quarry Expansion east of Carl Rd, City of Port Colborne

Prepared by; Anne Yagi President of 8Trees Inc.

I was retained by a local landowner, Jack Hellinga, to review Environmental Impact studies and supporting reports to assess environmental impacts of the proposed quarry expansion. In my previous position as Management biologist for the MNRF I have reviewed all quarry expansions in the Niagara-Haldimand and Hamilton areas from 1984 to 2016 with respect to environmental impacts to wetlands, fish and wildlife communities and their habitat features. In addition, 8TreesInc. was hired by another landowner Alex and Laurie Bury, to evaluate and map wetlands located on their property at [redacted].

Background Overview:

A review of historical aerial imagery confirms the timing of pit construction and extraction (Appendix 1934 to 2020). The first pit was constructed in the mid-1950s and is where quarry plant operations continue today. The Wignell/Mitchner Drain was already present through this area prior to the 1930s. The second pit was licensed in the 1970s and the third in the 1980s, but quarrying did not commence until the 2000s. Each pit seems to have an operations limit of about 20 to 40 years. The expansion of pit 3 is to occur over the next 20 to 40 years in three main phases. The third phase is the smallest extraction area and is along the east side adjacent to other landowners and potentially the most impactful to the wetlands intended to be protected and enhanced. The final land use is an open lake.

The surficial geology is Glaciolacustrine clay and silt with bedrock close to or at the surface in the southern portion of the property. There is thicker overburden toward the north (8 to 10 m). The extraction area is identified with a high Aquifer Vulnerability index (AVI) due to the shallow overburden. The overburden thickens northward toward the wetland features along Concession Rd 2. The target aggregate is limestone underlying the Onondaga Formation which is closest to the surface in the southeast portion of the site. The potential for karst formations to occur is high due to the presence of Dolostone. Karsts are areas where the limestone dissolves from precipitation forming caves and forms faster conduits for water to travel downward from surface features. The best areas to see karst features are along the existing walls of the extracted pits. Often the best time to witness infiltration from the surface overburden features into the bedrock is during periods of seasonal wetness. In Niagara, the seasonal wet period is from November to June.

The direction of future extraction beyond pit 4 is unknown; however, the Onondaga formation extends east along the north shoreline of Lake Erie into New York State. Quarry operations are long term land use planning, and all quarries must have a rehabilitation plan as a condition of their aggregate license. For the Port Colborne Quarry, all pits are intended to be rehabilitated into an open lake at some unknown future time. Most of the aggregate resource is under a

relatively thick layer of glaciolacustrine clay and silt soils and a few areas contain exposed bedrock.

A revised water budget for the intended lake features is needed for the entire extraction area because previous calculations likely did not include the newly proposed expansion area. A water budget is a calculation based on the amount of water entering the pit/lake from all sources, minus the amount leaving the site (infiltration, evaporation, surface discharges). This calculation will also help determine how high the lakes will fill and how long it will take to fill and whether they will continuously or seasonally discharge into a receiving water body (i.e., Wignell Drain).

Proposal:

To expand an existing quarry eastward within quarry owned lands 106.3 ha (262.7 acres). The requested aggregate license is to encompass all owned lands with about 71 ha (approx. 67%) of these lands are to be extracted below the groundwater table.

The main conclusions and outcomes from the EIS

- *The northern swamp community along Concession Rd 2, will not be directly impacted by the proposed extraction.*

Disagree: The existing swamp community is already impacted by the existing quarry operation and drainage and the EIS is documenting results and making conclusions on sensitivity based upon an impacted ecosystem (Figure 1).

- *The East Wignell drain and therefore the fish community will benefit from supplemental discharges of wastewater pumped from the quarry.*

Disagree: Quarry wastewater is harmful to fish and fish habitat because discharge flows attract fish into poor habitat within the drain and the quarry wastewater quality is poor and can be above provincial water quality objectives and conducive to detrimental watershed effects such as promoting algae blooms in Lake Erie.

Other factors to consider.

- Niagara Region is data deficient for rare or sensitive species (reptiles and amphibians) and there is a reliance on data collected through development planning for information to find its way to NHIC. This is not necessarily happening. Bird Studies Canada has a more up to date dataset on amphibians that could provide better context to this EIS.
- Ponds will be removed; they may be suitable hibernation habitat for reptiles and amphibians within existing ponds. Translocation of native wildlife species to suitable habitat is recommended and requires Wildlife Scientific Permits and ESA permission.

- Resident bats may hibernate in the old quarry faces. EIS focused on maternity roosting in swamp instead potential hibernation habitat function within exposed quarry face.
- Most of the remaining natural areas have been present since before 1930s and contain native seed bank and natural history. Translocation of rare and sensitive native species may be appropriate next steps.
- Vegetation communities will be removed, and they may be habitat for sensitive species. Rescue and transplantation, translocation techniques are warranted as these areas were once one contiguous habitat with the northern swamp community (Figure 2).
- Certain specialized and native wildlife species will be protected. and others will be completely harmed and displaced from their habitat.
- The plan is only focusing on the quasi protection of rare species instead of realizing the importance of protecting sensitive native species with complex life cycles. It is species sensitivity and the ecological functions that are important to evaluate in the EIS, not just the rarity.
- Since the surveys areas are already impacted by the quarry the measurement and determination of habitat protection is biased and conclusions suspect. Objectivity is needed and that may be obtained by collection of relevant data from within site and off-site control reference sites.
- There are no plans stated in EIS to rehabilitate the older pits to offset cumulative impacts on the environment.

Summary of Environmental Studies not completed or insufficient

1. Bat hibernacula may be present along the inactive quarry faces and exposed bedrock areas. This should be determined to prevent accidental impacts to sensitive species.
2. The water quality of the receiving water body including Wignell Drain and Lake Erie. Lake Erie experiences severe algal blooms that are related to watershed effects. Quarry wastewater discharges may be linked in part to algal blooms.
3. Salamander surveys not completed.
4. Snake surveys using standard coverboard methods and especially potential hibernation areas were not surveyed.
5. Turtle hibernation habitat confirmation in ponds that hold water all year.
6. Reference site surveys recommended to remove survey bias (as explained above).
7. Water chemistry of discharge water including metals, suspended solids, dissolved solids, nitrates, sulfates, and other salts. i.e., Watershed effects
8. The historical context of land use changes overtime and Cumulative Effects were not considered, Total Zone of impact is 15 km2 (Figure 1 and 2).

General Expected Environmental Impacts from a Quarry expansion:

All pits that are quarried below the groundwater table require the pumping and discharge of deep groundwater (quarry wastewater) into surface water features such as the Wignell Drain from time to time. This operation changes water quality, quantity, and duration of wetness within the receiving water body. Since the quarry operations are below the groundwater table there is an extended zone of impact (draw down effect) of at least 1 km outward from each pit (Golder Hydrogeology report and EIS). The total cumulative zone of influence including all existing and proposed pits is about 15 km^2. [Figure 1: Note Key Assumption: The zone of influence is 1 km outward from each quarry.]

The time scale or rate of lake formation would be helpful to assess overall cumulative effects. Since the rehabilitation of existing pits has not yet occurred there will likely be a continuous and cumulative harmful effect on the natural environment within 15km^2 until all pits are fully rehabilitated (Figure 1).

Since the underlying bedrock is karst forming there is the potential for wetland features located within the vicinity of the “cone of influence” to have a shortened hydroperiod which in turn affects habitat quality and the presence of native obligate wetland species. Evidence of an impacted site includes site conditions that are drier than other wetlands located beyond the 1km zone of influence (i.e., control sites). A key indicator of existing impacts to hydroperiod are a lower diversity and abundance of native amphibians as compared to control reference sites.

The water quality of quarry wastewater is also a concern when discharged into the natural environment by exposing native fish and wildlife communities to high concentrations of mineralized water (sulfates, carbonates, nitrates etc.…) and may include toxic metals that often exceed provincial water quality objectives. Wastewater discharges also affect plant communities, benthic invertebrate communities and can cause harmful algal blooms. All effects are cumulative over time, which in turn affect species presence and habitat use.

The potential harmful effects of an expanded quarry are from lost habitat quantity and quality for local resident wildlife. Sensitive wildlife with complex life cycles (i.e., reptiles and amphibians, resident bats, and small mammals) are affected the most. Large mammal movement patterns will also change over time. Migratory birds and the fish community will likely be displaced over time. However, the quarry expansion will not likely cause a direct impact such as a population declines to migratory birds.

The primary environmental impacts may occur on local sensitive wetland and aquatic dependent species and are a focus of this peer review.

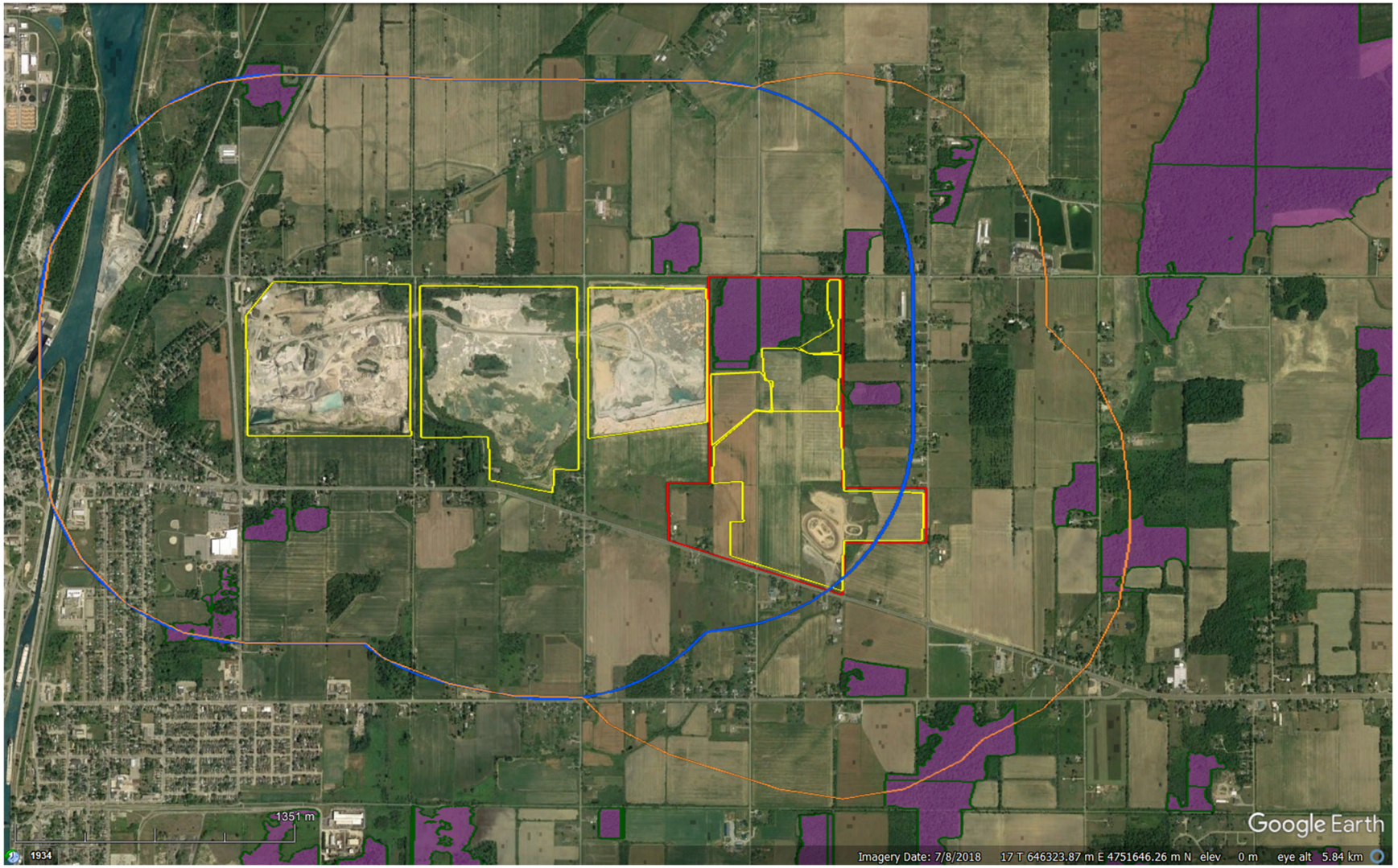


Figure 1. The total zone of influence (draw down) effect is estimated as 1km outward from all pits and is 15 km^2 (orange polygon). The blue polygon shows the existing cone of influence affecting environmental surveys and studies for the EIS. Pink areas are identified wetland communities in the vicinity of all quarry operations.

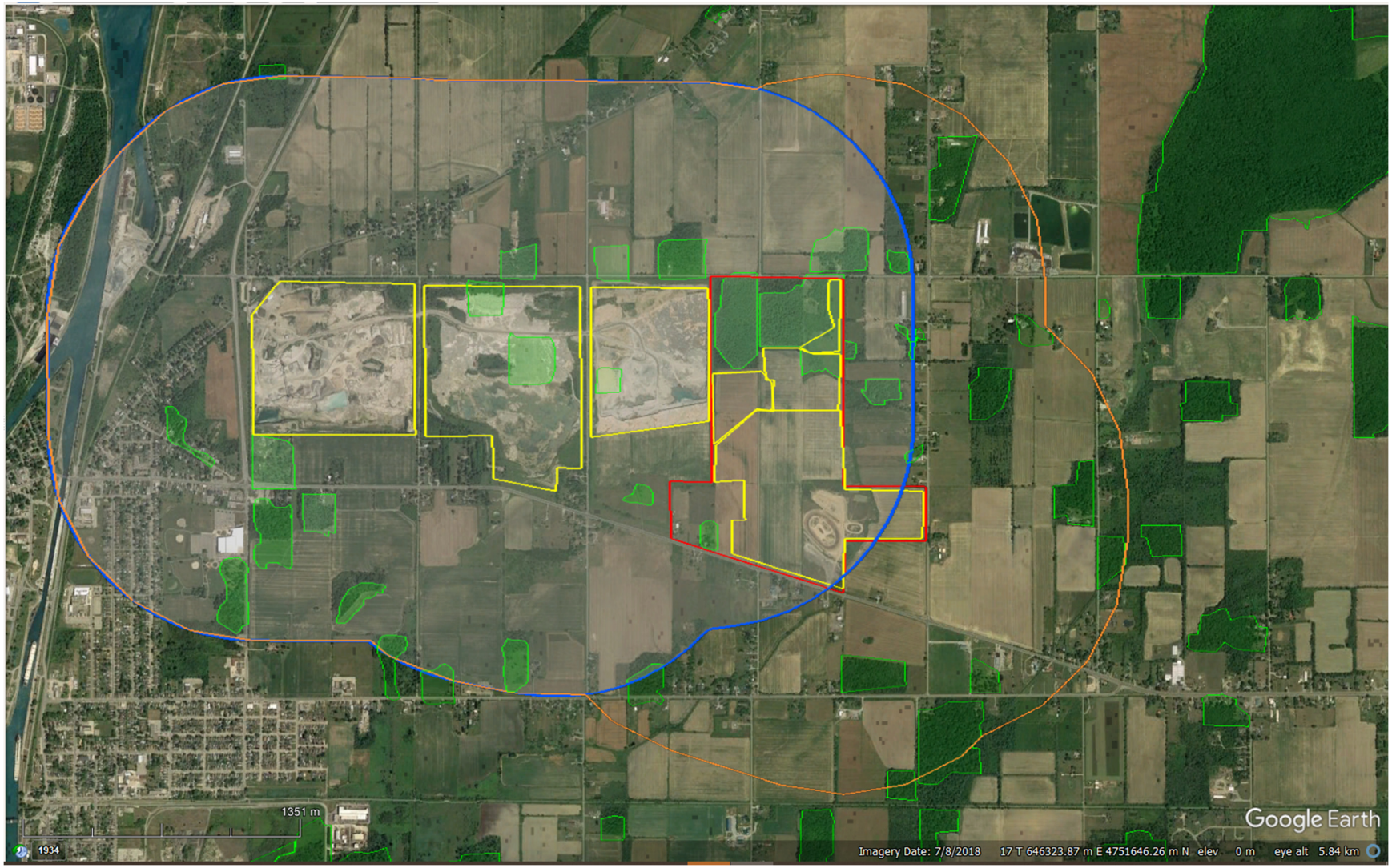


Figure 2. The natural areas present on the landscape prior to quarry development are shaded green and overlain onto a July 2018 aerial image (source Google Earth).

EIS review

The EIS did not identify that the wetlands are already within the existing cone of influence of quarry operations (Figure 1). The vegetation communities have existed as mature deciduous forest swamps since before 1930s, they are very old and merit protection from direct, indirect, and cumulative harmful effects (Figure 2). The EIS report assumes a perched water table sustains the swamp features yet did not characterize the recharge potential of vernal pool ecosystem, potential linkages from surface water to bedrock and the effects of the existing drawdown and drainage on adjacent swamp communities.

The swamp (within site feature) is currently in an impacted state with respect to hydroperiod due in part to the existing drawdown effect of quarry operations and in part due to drainage. The expected vernal pool community includes four native anuran species and potentially two salamander species. Given the amphibian surveys did not identify the expected vernal pool community, this is evidence to suggest there is currently a harmful effect on hydroperiod within the swamp community. Additional mitigation is warranted to prevent or mitigate losses of water with the goal of achieving a 120-day hydroperiod from March 1st to July 1st. Surface water may recharge bedrock systems even in clay soils. In unimpacted clay soils recharge potential is slow and takes a long time, but in impacted clay soils recharge potential is much greater.

Since the proposed expansion area is currently within the vicinity of the drawdown effect of the current quarry operations, all measurements, observations, identification of wetland communities and assumptions of wetland hydroperiod, watercourse wetness (i.e., East Wignell Drain), and assumptions of low sensitivity is **biased because the study area is entirely within an existing impacted area (Figure 1)**. Biased studies will very likely conclude falsely that the natural area is not sensitive or that there will be no harmful impact. As a result of this biased approach, natural areas often get removed from the landscape or further impacted by development. A more objective approach would include comparative reference or control sites located outside the impacted area and may more accurately show the area in question as sensitive once the impact is removed or mitigated.

Further investigations with a broader scope (i.e., control reference sites) are recommended to establish future impacts on ecological functions (i.e., cause-effect relationships) and wetland restoration objectives.

Additional Context from 8Trees Applied Research Projects

During 8Trees research of land-use impacts in the Carolinian region of Canada, we have found deep cracks and fissures in clay soils during summer-fall seasons especially in drainage impacted areas (Figure 3). The surface cracks enclose during the wet season; however, we are not sure if they re-seal themselves completely through the soil profile each year. In addition, repeated

crack formation has cumulative impacts overtime (Bronswijk, 1988; Vogel et al., 2005;, Greve et al., 2010). Clay fissures from seasonal drying can extend well below the surface even without impacts of groundwater drawdown. These fissures tend to fill with silt and increase transmissivity[1]. The long-term effect of this process may lead to a shortened hydroperiod, and loss of biodiversity (Yagi and Blott, unpublished data). In addition, the proximity of soil crack formations and karsts lead to infiltration into the bedrock aquifer (Example Figure 4).

Environmental impacts such as drawdown effects and drainage may be small, incremental, cumulative, and easily missed during a broad investigative approach such as an EIS. Additional monitoring at the appropriate scale with the addition of control or reference site information would greatly improve environmental impact analysis in this report. In addition, soil cores of the upper clay overburden in the wetlands will help describe the conditions of the site. This is a data gap.

Figure 3. Commonly, heavy clay-silt soils develop cracks in the dry season as the soil profile dries out. Example of deep cracks and fissures in clay-silt soils that form annually in the Niagara Area. These are especially evident in wetlands impacted by drainage.

[1] Transmissivity meaning with respect to this review is the rate of water flow through soil overburden into underlying aquifers.

Figure 4. Example of Water Seepage from exposed rock face (visible as dark areas and ice), more visible during winter or spring conditions. Wetlands above karst forming systems and likely vernal pool wetlands that are impacted by drainage may form cracks through the clay to the bedrock. In addition, bedrock is karst forming at this site which increases recharge rate from wetlands and may also explain hydroperiod length.

Reference sites and within site concurrent monitoring is also necessary to establish wetland restoration goals with respect to hydroperiod.

Since quarry operations tend to expand every 20 years, hydrological monitoring of wetlands beyond the zone of influence is recommended to provide future context to the next generation of reviewers.

Recommendations Wetlands

Due to the uncertainty in the causal relationship between wetland hydroperiod, soil impacts and the potential for leakage into the bedrock interface we recommend additional setbacks (minimum 30 m) from active drainage and the quarry operations and additional wetland monitoring at the appropriate scale. **This includes, not realigning Wignell Drain within 30m of any wetland and removing phase 3 in the license extraction area and additional setbacks and mitigation for Phase 1A, 1B and 2 extraction limits.**

A continuous shallow well monitoring system and regularly measured staff gauges within wetland vernal pool and control reference sites is necessary to establish the wetland hydrology targets and measure success of restoration goals. A good assumption is to use 120-day hydroperiod following the spring thaw as a restoration goal to re-establish natural amphibian community for this area with four to six vernal pool species as target. In addition, maintaining and improving connectivity between vernal pools within and off site are necessary to sustain the amphibian community over time.

Targeted restoration of the wetland should address,

1. reforming slough features along the edge,
2. removing all direct connections to surface drainage by fixing microtopography (i.e., edge of slough features and the former Carl Rd area as suggested by consultant)
3. improving soil organic content (high carbon-low nutrient mulch) within wetland and buffer areas and improved groundcover quality.
4. Aquitard lining of any exposed quarry face within 30m of wetland,
5. monitoring within wetland and suitable reference area (hydroperiod and successful amphibian breeding).

EIS and Fish Habitat

Fish habitat, if present, in Wignell Drain through this site is partly dependent on ongoing drainage of wetlands, which conflicts with the restoration need to increase the hydroperiod of wetlands. Continued drainage of the swamps is also impactful to biodiversity and contrary to the wetland restoration objectives. This project provides an opportunity to correct wetland drainage issues for an existing very old swamp community and if successful will benefit sensitive wildlife species and is potentially a positive outcome for this quarry expansion.

The Wignell drain on the other hand is a human contrived trapezoidal shaped channel that is very poor-quality fish habitat (Yagi, 2016). A pumped water supply from the quarry also artificially sustains this habitat which would not otherwise be present and the water flowing from the discharge attracts fish (i.e., rheotactic response). In addition, the pulsed human centric flow regime is not conducive to promoting a natural fish habitat. Instead, fish are lured into the channel by this attractant flow. The quality of the quarries wastewater also contains elevated dissolved solids, suspended soils, nitrates, carbonates, and sulfates etc. at concentrations that are not naturally found in surface waters in this area. In addition, there is the potential for water quality to exceed provincial water quality objectives. It would be prudent not to discharge quarry wastewater and encourage fish into this channel.

Algal Blooms also occur in nutrient rich water. Toxic algae are a Lake Erie Water quality Concern, and the discharges of quarry wastewater may be related to the blooms experienced downstream along the beaches in Lake Erie.

Recommendations Fish Habitat:

- If possible, use the wastewater to meet quarry operations needs first and secondarily to refill Pit 2 to hasten rehabilitation efforts.
- Broaden water quality monitoring to include downstream areas along the Lake Erie shoreline.

References

Bronswijk, J.J.B., 1988. Modeling of water balance, cracking, and subsidence of clay soils. Journal of Hydrology, 97(3-4), pp.199-212.

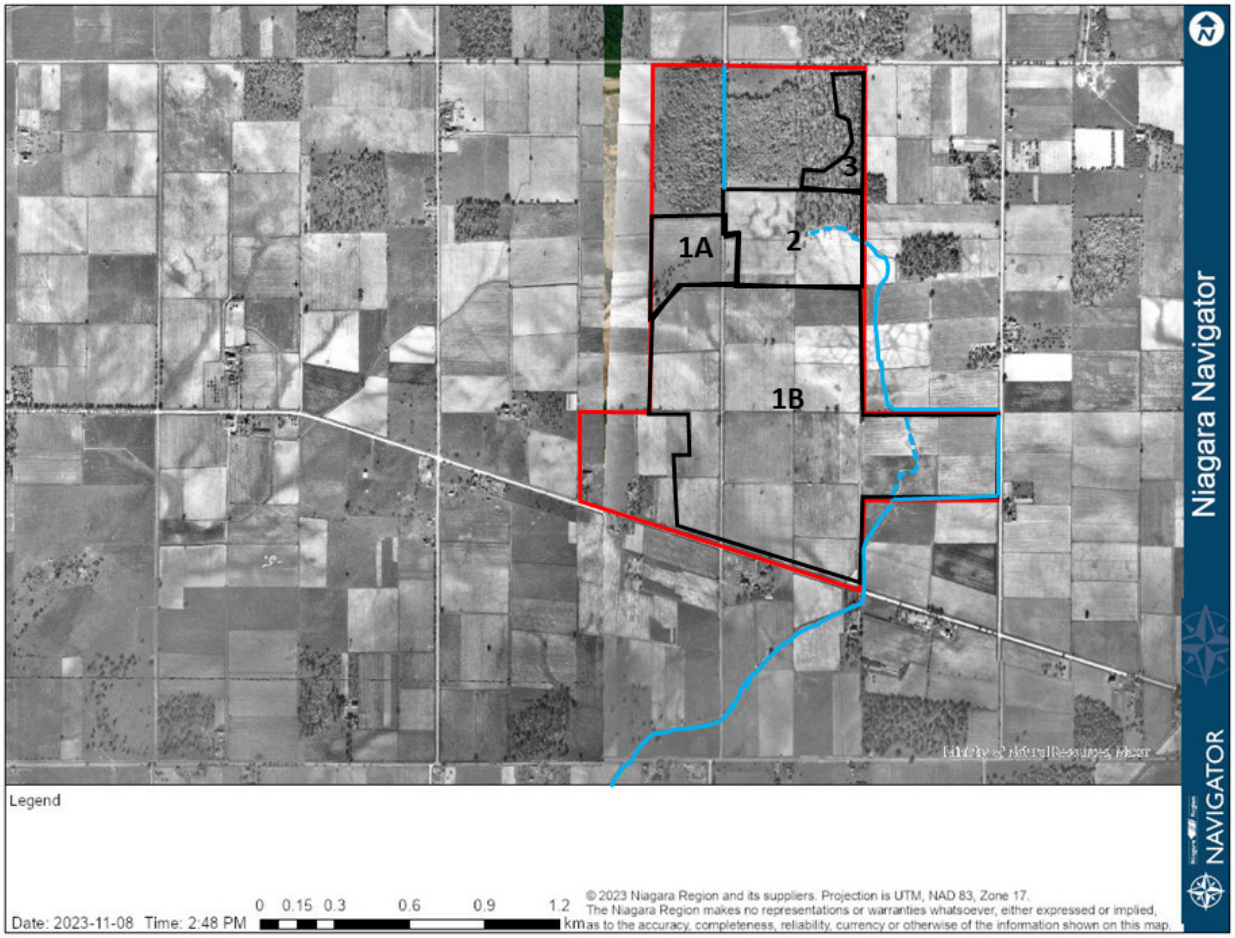
Greve, A., Andersen, M.S. and Acworth, R.I., 2010. Investigations of soil cracking and preferential flow in a weighing lysimeter filled with cracking clay soil. Journal of Hydrology, 393(1-2), pp.105-113.

Vogel, H.J., Hoffmann, H. and Roth, K., 2005. Studies of crack dynamics in clay soil: I. Experimental methods, results, and morphological quantification. Geoderma, 125(3-4), pp.203-211.

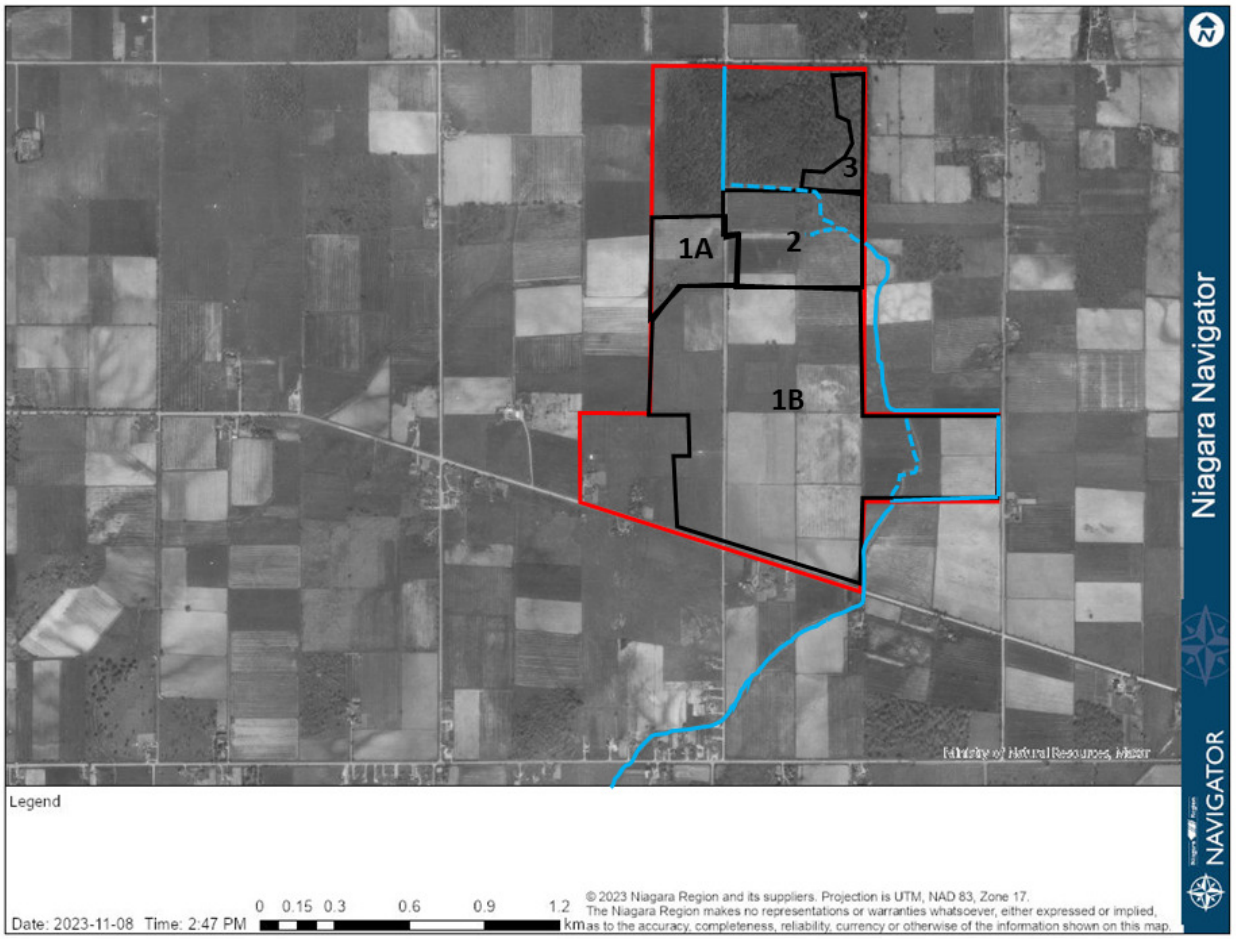
Yagi A.R. [updated 2016]. Niagara Region Fish Habitat Types with Management Rationale, Ontario Ministry of Natural Resources unpublished manuscript.

Appendix

1934



1954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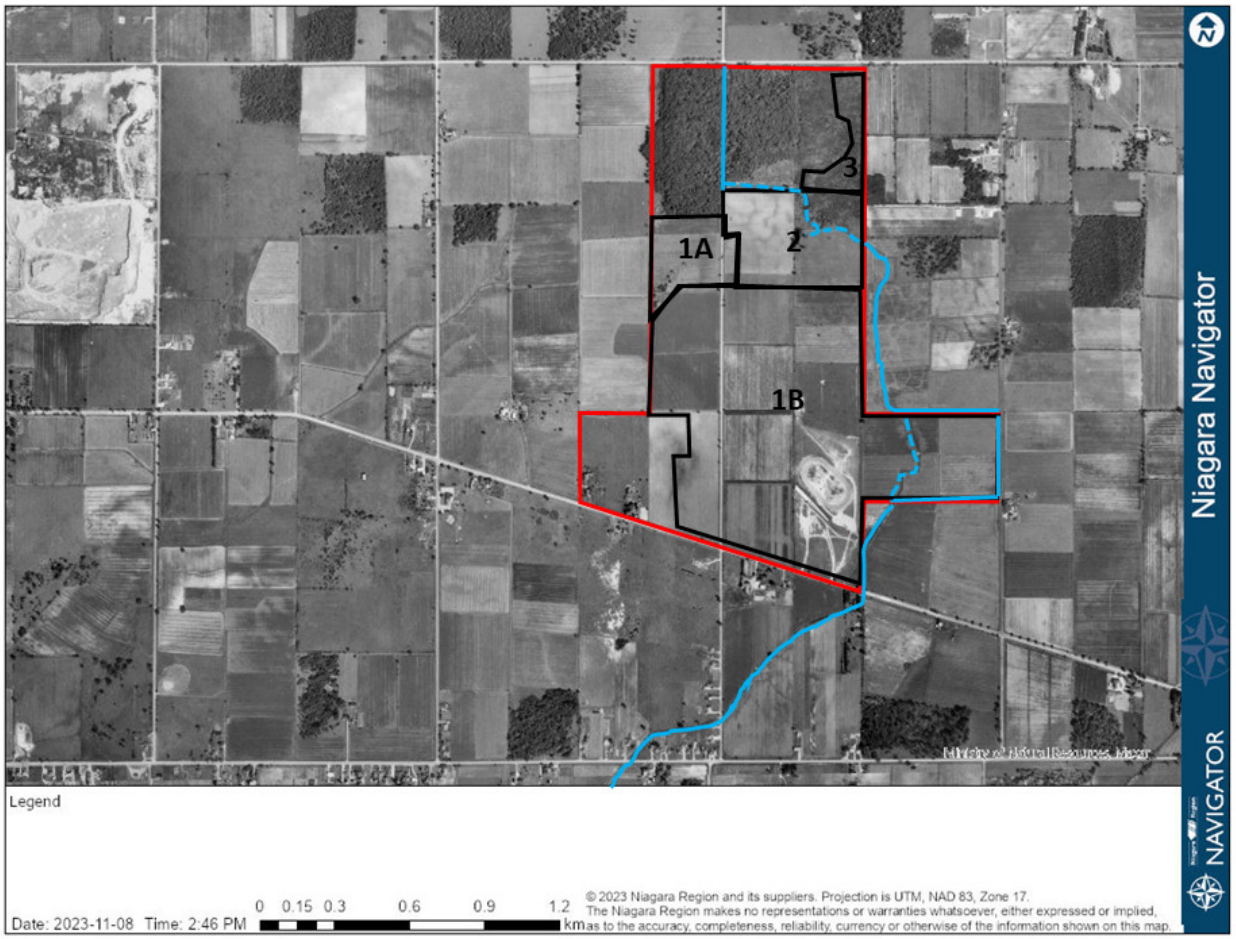
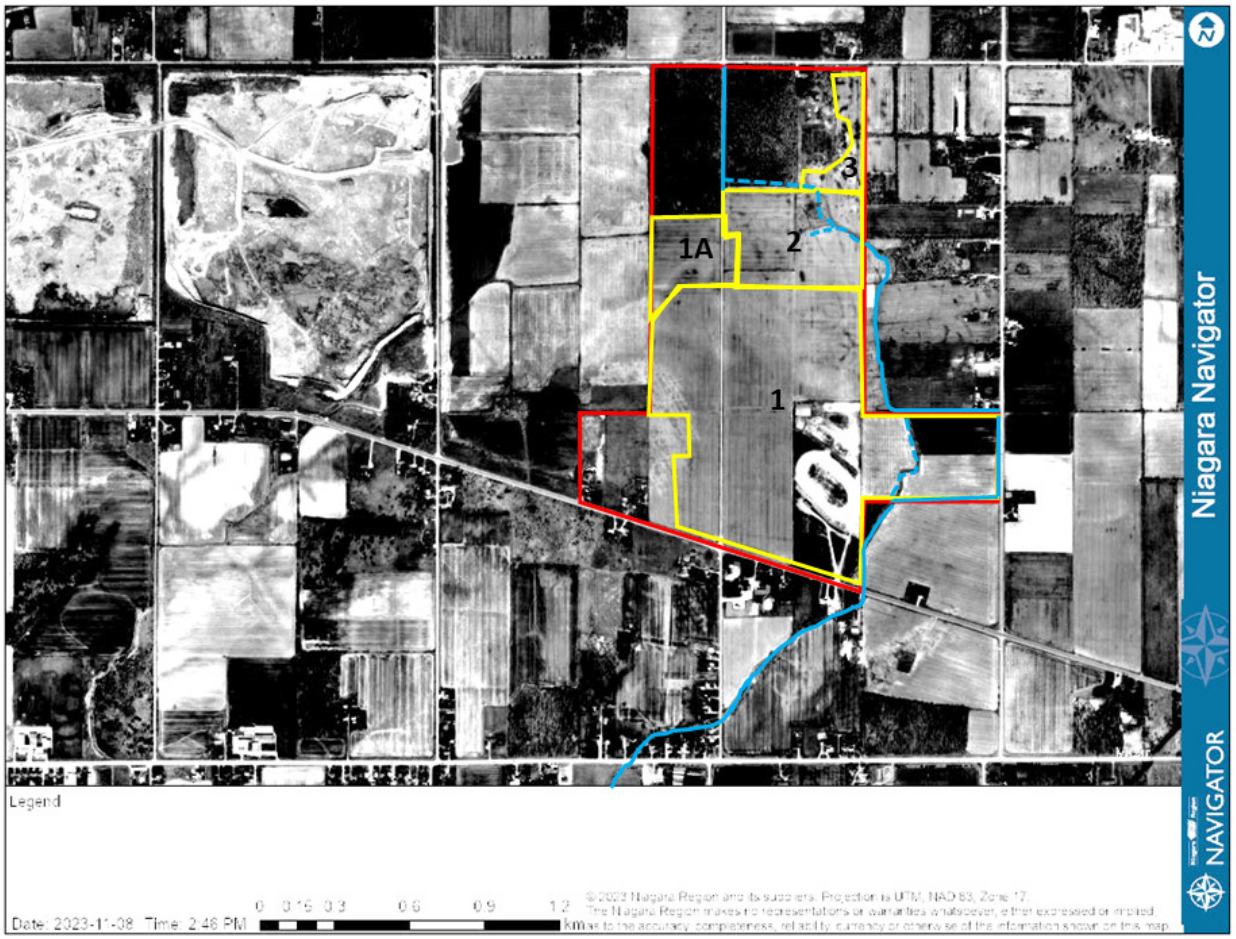
1965

First Quarry

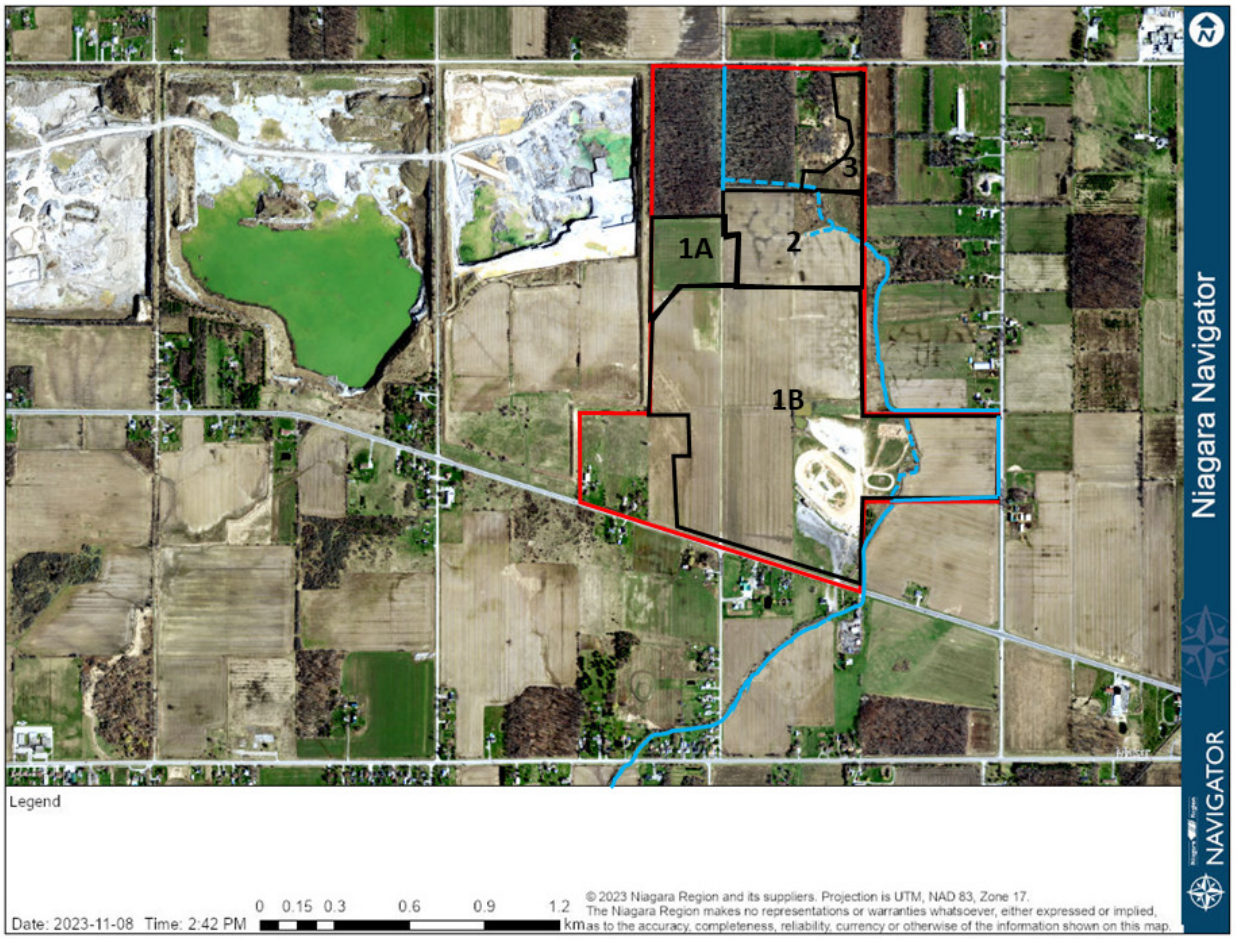


2000

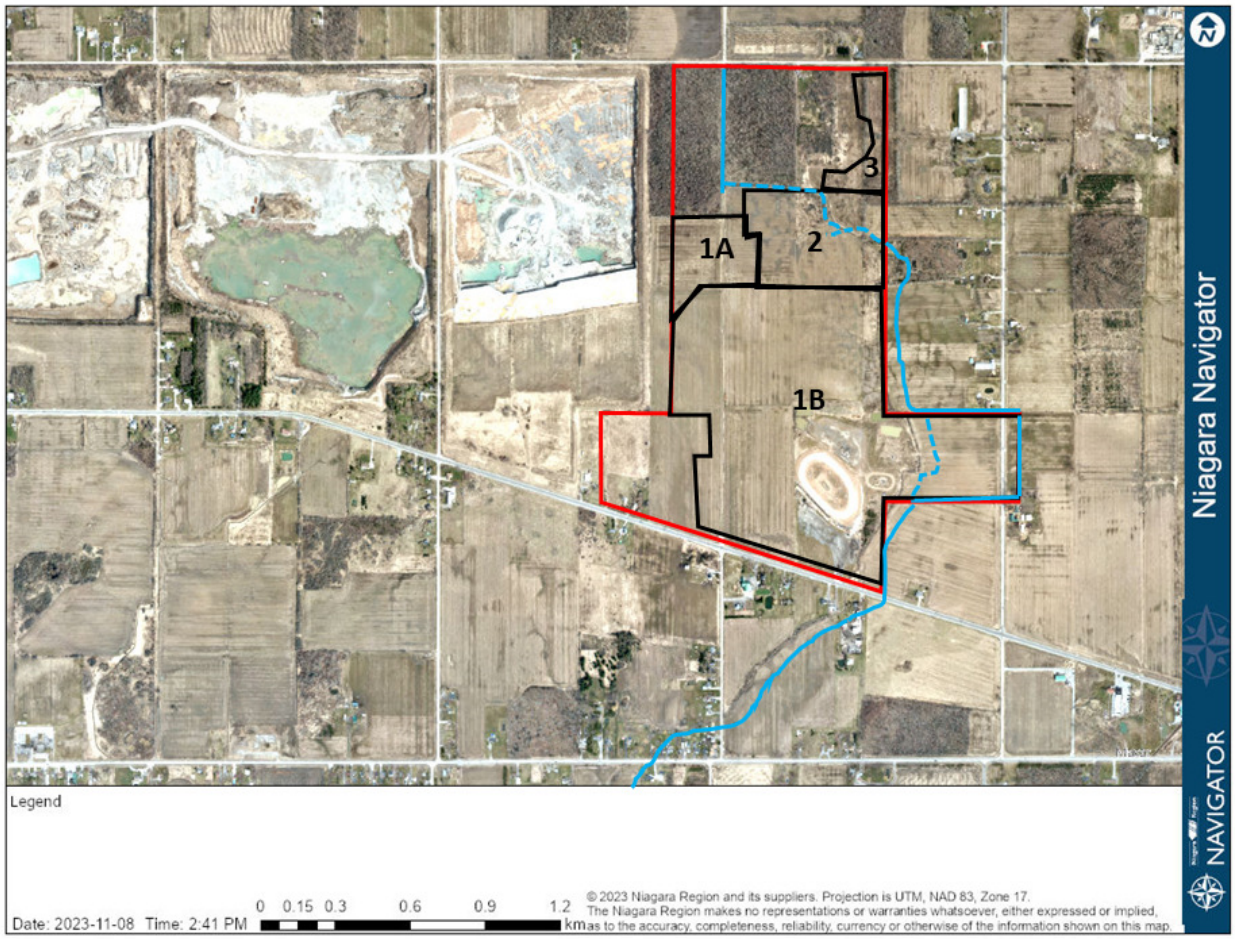
Two
Quarries



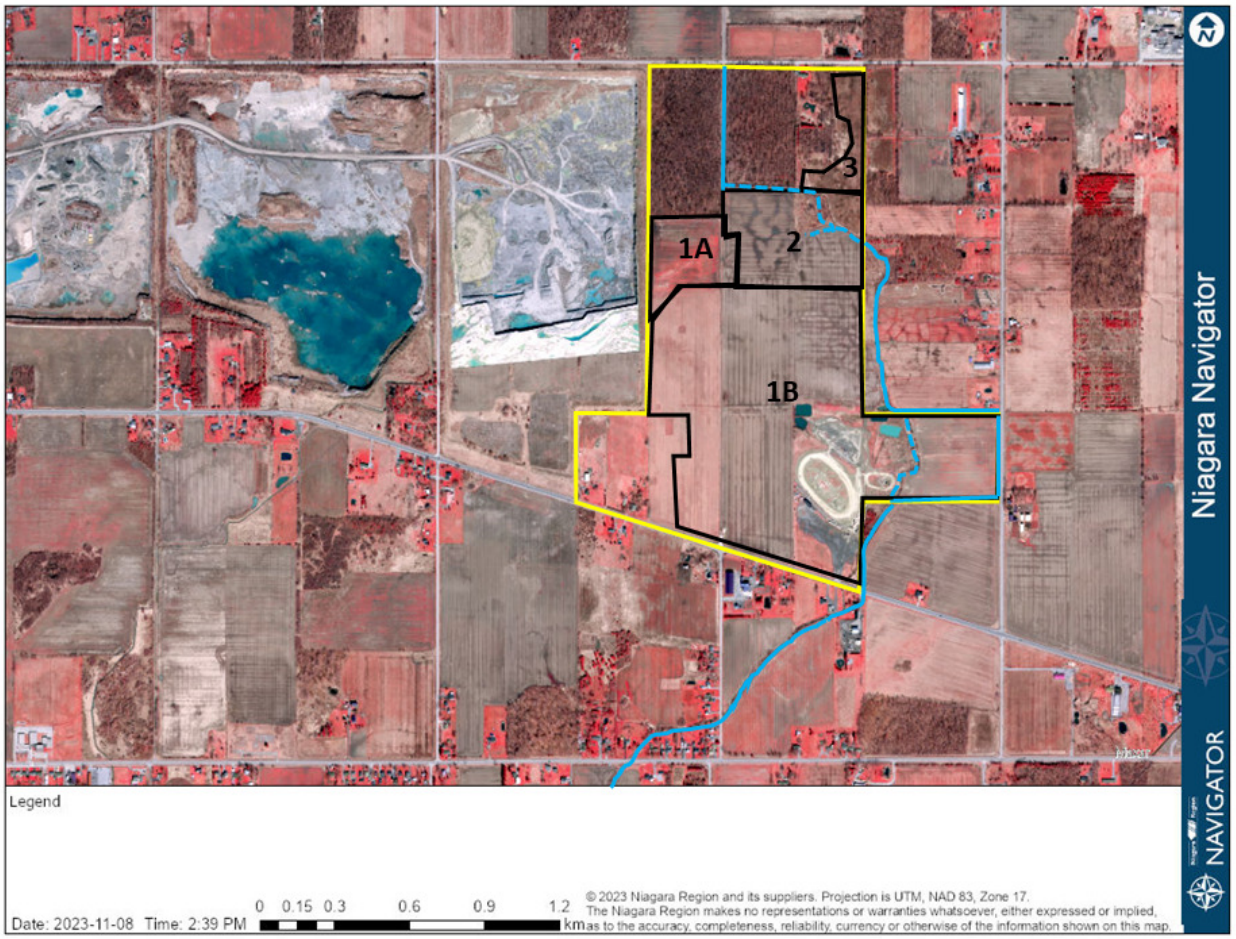
2015
Three
Quarries



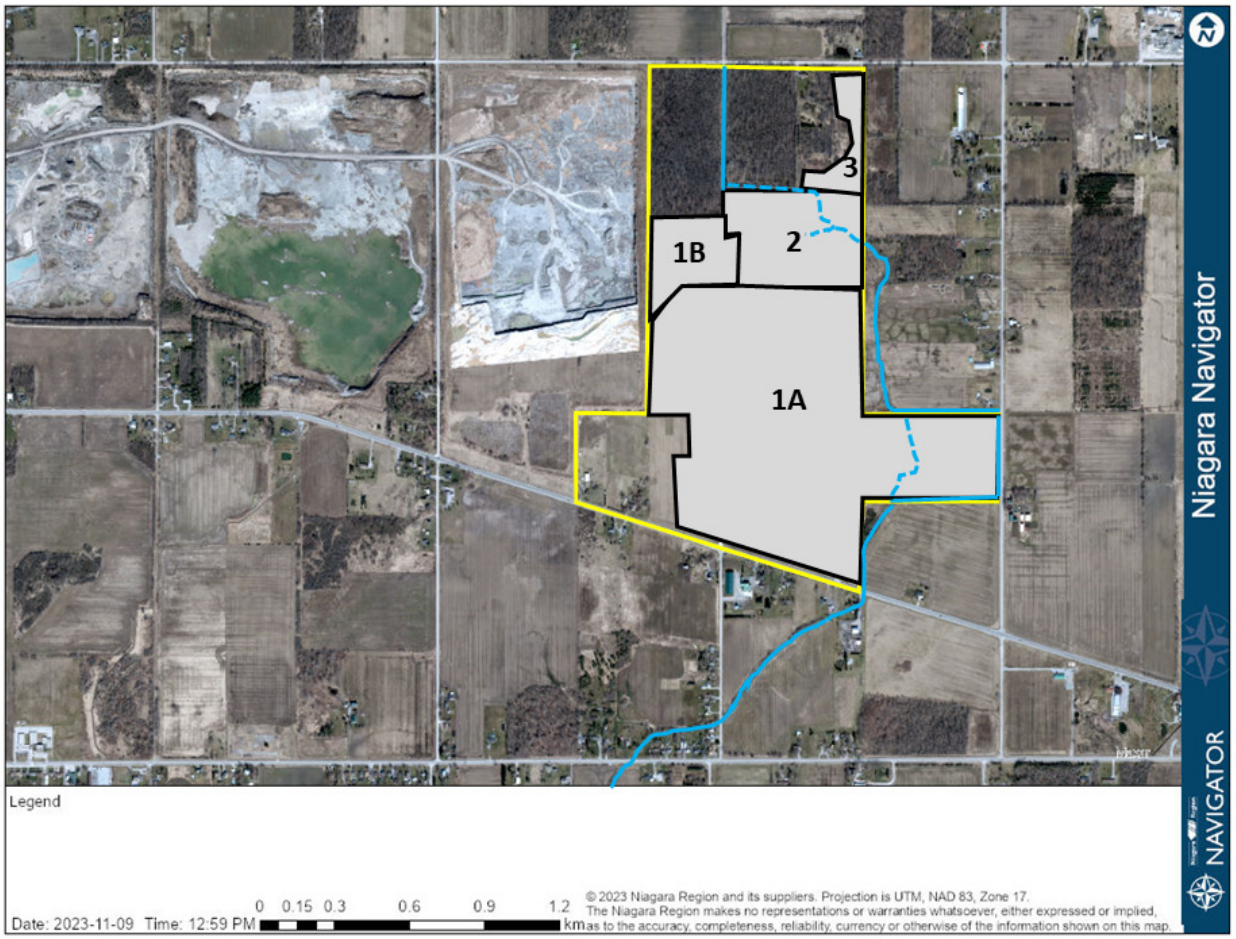
2018
Three
Quarries



2020:
Three
quarries



2040:
Four
quarries



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November 2016 - Present
M.Sc. Ecology and Evolution, Brock University
B.Sc. Honours Zoology, University of Guelph
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8Trees Inc.
We are an environmental organization that aims to carry out innovative approaches to ecological restoration, conduct scientific research, enhance science-communication with the public, and mentor students in the fields of conservation biology, ecology, and environmental policy. Available at Google Play store or Apple store are 8Trees newly developed free software for citizen science data collection; "My Field App" and the digital angler diary "My Fish App".

We take a multidisciplinary approach to solving issues around land management and restoration of degraded ecosystems. Our goal as environmental consultants is to ensure any proposed development is carried out in the most suitable way to protect ecological communities and conserve or restore ecosystem function. There is always a solution!

We have in-house expertise in wetland evaluations (OWES), wetland and Area of Natural and Scientific Interest (ANSI) boundary revisions, ecological restoration, natural channel design, wildlife biology, forestry, fisheries population and habitat assessments, radiotelemetry (snakes, turtles, toads, deer, turkeys), benthic macroinvertebrate sampling, stream and wetland surface and groundwater monitoring, water and soil sampling, Ecological Land Classification (ELC) methods, amphibian and reptile conservation, fish and wildlife population monitoring, ESA B and C permits, Species at Risk population and habitat surveys, bird surveys, assessments of ecosystem function and ecological restoration.

8Trees Staff: One full-time biologist, one full-time Environmental Technician, four-six part-time staff and associates, also seasonal staff including students, interns, and Co-op placements (1 to 10 per year).

MSc Thesis 2020: "Flood survival strategies of overwintering snakes"
Undergraduate Project: "Reproductive Behaviour of Dwarf Gourami's *(Trichogaster lalius)"*

Memberships: Canadian Herpetological Society, Society for the Study of Amphibians and Reptiles, American Fisheries Society and Society for Ecological Restoration (SER).

Canadian Herpetological Society 2019 award recipient: "Blue Racer Award" in recognition of significant contributions to the conservation of amphibians and reptiles in Canada.

8Trees Development Planning Reports
8Trees Inc. 2023, Environmental Background Study Report and Ecological Restopration Plan for 1039 Church St. Fenwick, Prepared for the Region of Niagara and Town of Pelham in support of an apartment condo development.

8Trees Inc. 2023, EIS Ammendment and Woodland Management and Improvement Project for 368 Aqueduct St. and 155 Gadsby Ave, City of Welland, Ontario. Prepared for the Region of Niagara.
8Trees Inc. 2022, Environmental Background Study Report and Ecological Restoration Plan for 5379 Abino Hills Rd., Prepared for the Town of Fort Erie in support of new septic field and home renovations.
8Trees Inc. 2022. Environmental Impact Study for 124 Forks Rd. Dain City, City of Welland Prepared for the Region of Niagara and Niagara Peninsula Conservation Authroity in support of a three lot severance application.
8Trees Inc. 2022. Environmental Background Study Report in support of a wetland boundary revision south of Wainfleet Bog naturalized farmlands, prepared for MNRF and NPCA policy
8Trees Inc. 2021. Environmental Impact Study and Ecological Restoration Plan for 12260 Lakeshore Rd., Township of Wainfleet, Ontario. Prepared for the Region of Niagara, in support of a single severance application.
8Trees Inc.2021. Delegation Technical Document in support of the abandonment of 1.5km section of the Biederman Drain for the purposes of Species at Risk habitat protection and population recovery, for agency review puposes.
8Trees Inc. 2020. Environmental Impact Study for Black Creek Center, Town of Fort Erie, Ontario. Prepared for the Region of Niagara. 64pp, in support of a 100-200 unit Retirement home build.
8Trees Inc. 2020. Scoped Environmental Impact Study for 368 Aqueduct St. and 155 Gadsby Ave, City of Welland, Ontario. Prepared for the Region of Niagara. 184pp.
8Trees Inc. 2020. Environmental Impact Study for 495 Bernard Ave, Town of Fort Erie, Ontario. Prepared for the Region of Niagara, 75pp, in support of a housing development.

8Trees Research Projects:

- "A long-term study on Massasaugas (*Sistrurus catenatus*) Inhabiting a partially mined peatland: A standard method to characterize snake overwintering habitat" 2017 to present.
- "Managing an ecological trap on the reptile community inhabitating a partially mined peatland in Southern Ontario;" 2017 to present.
- COSEWIC status re-assessment of the Massasauga in Canada (2022-2023)
- "Pelee Island Blue Racer (*Coluber constrictor foxii*) and Foxsnake (*Pantherophis gloydi*) Hibernation habitat restoration project;" 2018 to 2025
- PhD committee member for J. Choquette 2019-2023 "Managing translocations for Massasauga Recovery in Ojibway Prairie" Laurentian University
- Wetland and woodland ecological restoration techniques in a post agricultural landscape (2022-present)
- Fuciarelli Peatland Restoration, Conservation Halton (2022-present)
- City of Thorold Frog Pond community enhancement, restoration project and eco-passage (2022)
- Eastern Foxsnake (*Pantherophis gloydi*) population resilience to habitat loss (2022)
- "Assisted hibernation to ensure overwinter survival of neonatal snakes during a period of environmental stochasticity within a drain managed peatland" (post graduate research since 2014)
- "Monitoring the human impact on Fowler's toad at Niagara Beaches;" OSARF 2018 to 2021
- Science Advisor "Haldimand County Gray Ratsnake (*Pantherophis spiloides*) and Foxsnake (*Pantherophis gloydi*) population recovery project;" OSARF 2017 to 2020
- "Building on Success: Using Habitat Modeling and outreach to confirm presence of Gray ratsnake and Foxsnake (Pantherophis *gloydi)* in Niagara-Hamilton-Haldimand," OSARP 2020
- Chair of the Fowler's toad Recovery Implementation Team since 2010

Management Biologist (Retired Sep 30, 2016, after 35 years' service)
Ministry of Natural Resources and Forestry (Vineland Field Office, Guelph District)

My career at MNR began in 1981 as a summer student conducting a creel survey. After eight years of "back-to-back" contracts I was hired as the Fisheries Enhancement Officer and then as the Fish and Wildlife District Biologist/ Management Biologist. I continued in this position for 26 years until I retired in 2016. Although retired from government, my interest in fish and wildlife resources and mentoring continues within my graduate studies, pursuit of research and development, proactive projects in natural resource management and applied ecosystem restoration.

Provincial Recipient: Amethyst Award Grand River Fisheries Management Plan (1999), This is the highest level of provincial recognition/ achievement available to provincial employees.

Career Highlights:

- Identified, examined and accepted as an expert witness (Federal, Provincial Court and OMB hearings) in the areas of fish biology and habitat, wetlands, deer biology, freshwater turtles, Massasauga rattlesnakes and general wildlife biology.
- Provincial Wetland Evaluations Niagara- Hamilton-Haldimand (est > 200 evaluations)
- Fish Community Monitoring Project Niagara River Watershed (1997 to 2016)
- Winter Habitat Use by Wildlife: via Helicopter Surveys (White-tailed deer, wild turkeys, raptors, swans, ducks, geese)
- Niagara River Remedial Action- Fish population Impairment- Determination of Delisting Criteria
- Field Investigation of Headwater Channel Erosion and related impacts on the Fenwick Regional ANSI, Provincially Significant Wetlands and Species at Risk
- Welland River Fish Passage White Sucker and Walleye Telemetry Project at Old Welland Canal Junction (2000, 2013 to 2015)
- Navy Island Deer Exclosures project and management recommendations
- Restoration of the Walleye population in the Welland/Niagara River system
- Grand River Fisheries Management Plan and supporter for the removal of the Dunnville Dam
- Species at Risk Habitat Stewardship and Education projects (Fowler's toad, Massasauga, Spotted turtle, Blanding's turtle, Gray Ratsnake, Allegheny Mountain Dusky and Northern Dusky salamander) included managing field technicians and summer students and external funding sources annually since 2000 with an operating budget $50K to $100K. All projects included surveys and monitoring, habitat enhancement, restoration, and design and creation of outreach and educational products. These projects also included mentoring and liaison with partners including universities, agencies, landowners, and other interested stakeholders.
- As part of this species at risk team we were the first to identify Allegheny Mountain Dusky Salamander in the Niagara Gorge
- Ecosystem restoration project (1998 to present) - managing two species at risk populations Massasauga and Spotted turtle before, during and after water levels were increased in the central historically peat mined area. This included mark –recapture (> 200) massasaugas and (>400) spotted turtle observations since 1998. Radio telemetry techniques for both species were used to confirm habitat use. With increasing conservation concerns raised about massasaugas and the potential for the mined peatland to become an ecological trap on the population. Radio telemetry was abandoned in favour of my innovative and successful coverboard design and survey technique to continue to monitor massasaugas and the resident snake community. During this time, I designed and implemented a hibernation habitat study where I introduced the "life zone" hypothesis. A "life zone" is a subterranean space where snakes successfully overwinter. This space does not freeze or flood completely and is the focus of my graduate studies. "Overwintering behaviour and survival of temperate neonatal snakes" and the development of the "forced hibernation technique". This technique is a biological test of the life zone to confirm snakes can survive within the associated habitat. It is only used in areas where physical measures have confirmed a physical space is maintained in harsh and mild winters. Once a habitat is biologically tested using neonate gartersnakes

(model species), species at risk neonates can be forcibly hibernated in these good habitats. This technique will aid in repopulating good habitat because snakes use homing behaviour to return to previously occupied burrows thus removing the ecological trap associated with the mined peatland.
- Fowler's toad Recovery Team Chair, Ontario Dusky Salamander Recovery Team Co-Chair, Gray Ratsnake and Massasauga rattlesnake and Ontario SAR turtle Recovery Team member
- Peregrine Falcon Recovery and Master Bander (1996 to present)

Other Highlights include:
- OMNR Pride Award: Recovery of Peregrine Falcon (2000)
- NPCA: Welland River Restoration Committee Recognition Award (2002)
- NPCA Conservation achievement awards (2002 to 2008)
- Niagara River Bathymetry, Habitat Mapping, and habitat creation projects
- Niagara Region Fish Habitat Types with Management Rationale for municipal planning
- Binbrook Reservoir Electrofishing, and live trap netting projects
- Adult Walleye transfer from Bay of Quinte, Lake Ontario to Binbrook Reservoir
- Spring thermal flux studies Niagara River and Upper Niagara River Tributaries
- Long term thermal monitoring of last remaining Brook trout fishery Upper Twelve Mile Creek
- Upper Twelve Mile Creek Brook Trout Population Assessment 1984, 2000, 2008
- Upper Twelve Mile Creek Restoration Projects (1989 to 1995)
- Frenchman's Creek Grass Roots Watershed Restoration Project (1991 to 1995)
- Point Abino Drain Fisheries Study- Pre and Post Drainage Works 2001 – 2002
- Welland River Fish Community Assessment 1997
- Walleye Restoration Project, Grand River, Welland River and Community Involvement
- Lake Ontario Littoral Zone, Lake Gibson, Martindale Pond and Old Welland Canal Fish Community
- Wild turkey reintroduction, trap and transfer international project (1986 to 1996)
- Ontario Conservation Fishing and Hunting Licence, Pleasure Boat Certificate, Class 1 Electrofishing Certificate (all types), Standard First Aid and CPR, ROM Fish ID, Wetland Evaluation Certifications, Active golf enthusiast

Scientific Reports and Publications

Yagi A.R. and K.T. Yagi. 2023. Length Matters! A reminder to collect and report biometric data. The Canadian Herpetologists/L'Herpetologiste Canadien Vol 12 (1).

Yagi A.R. and G. Tattersall (In Prep-2023) Assisted Hibernation- A Technique to ensure overwinter survival of temperate neonatal snakes.

Yagi, A., K. Yagi, F. Papini, C. Blott, M. Babin and J. de Vuyst. 2023. Adaptive Management of an Ecological Trap: restoration of Species at Risk reptile habitat in a partially-mined peat bog. Unpublished final report for Ministry of Environment Conservation and Parks Species at Risk Stewardship Program 70pp.

Yagi, K.T., B. Breton, T. Bukovics, C. Blott, and A.R. Yagi. 2021. Fowler's toad recovery project: Assessing Human Impacts at Niagara Beaches. Final report for 2018-20, Ministry of Environment, Conservation and Parks, 32pp.

Yagi A. R. 2020. Flood survival strategies of overwintering snakes. MSc. Thesis Brock University, St Catharines, Canada.

Yagi, A. R., R. J. Jon Planck, K. T. Yagi, and G. J. Tattersall. 2020. A long-term study on Massasaugas (*Sistrurus catenatus*) Inhabiting a partially mined peatland: A standard method to characterize snake overwintering habitat. Journal of Herpetology, 54: 235–244.

Yagi, A.R., K.T. Yagi, et al. 2020. Building on Success: Investigating the presence of Gray Ratsnake and Eastern Foxsnake using Habitat Suitability Modelling, and occurrence information to initiate standardized monitoring in priority Niagara-Hamilton areas. Final report for 2019-20, Ministry of Environment, Conservation and Parks, 29pp.

Yagi, A.R., K.T. Yagi, C. Blott, T. Bukovics, and B. Breton. 2020. Managing an Ecological trap in a Partially Mined Peatland on the Resident Reptile Community which includes Five Species at Risk; Massasauga; Eastern Ribbon; Spotted turtle; Snapping turtle and Blanding's turtle. Final Report for 2019-20. Species at Risk Stewardship Fund, Ministry of Environment, Conservation and Parks, 79pp.

Yagi, A.R., et al. 2019. Managing an Ecological trap in a Partially Mined Peatland on the Resident Reptile Community which includes Five Species at Risk; Massasauga; Eastern Ribbon; Spotted turtle; Snapping turtle and Blanding's turtle. Final Report for 2019-20. Species at Risk Stewardship Fund, Ontario Ministry of Natural Resources and Forestry.

Yagi, A.R. and K.T. Yagi. 2018. Habitat use by two populations of species at risk, Massasauga and Spotted turtles, in a partially mined peatland ecosystem – through periods of dry and wet habitat cycles from 1999 to 2016. draft prepared for Canadian wildlife Services, Environment Canada. 20pp.

Yagi, A.R., et al. 2018. Managing an Ecological trap in a Partially Mined Peatland on the Resident Reptile Community which includes Five Species at Risk; Massasauga; Eastern Ribbon; Spotted turtle; Snapping turtle and Blanding's turtle. Final Report for 2018-19. Species at Risk Stewardship Fund, Ontario Ministry of Natural Resources and Forestry.

Yagi A.R., et al. 2017. Managing an Ecological trap in a Partially Mined Peatland on the Resident Reptile Community which includes Five Species at Risk; Massasauga; Eastern Ribbon; Spotted turtle; Snapping turtle and Blanding's turtle. Final Report for 2017-18. Species at Risk Stewardship Fund, Ontario Ministry of Natural Resources and Forestry.

Yagi, A. R. and Tattersall, G. J. 2018. "Please Don't Step on the Hummocks": Summer Refugia for Massasauga Rattlesnakes." The Canadian Herpetologists/L'Herpetologiste Canadien 8(1): 22-24.

Yagi, A. R., Abney, C., Bukovics, T., Breton, B., Blott, C., Yagi, K. 2018. "The Young and the Restless: Postpartum Breeding and Early Onset Sexual maturity in an Isolated Northern Population of Massasauga Rattlesnakes." The Canadian Herpetologists /L'Herpetologiste Canadien 8(1): 24-26

Hileman, E.T., King, R.B., Adamski, J.M., Anton, T.G., Bailey, R.L., Baker, S.J., Bieser, N.D., Bell Jr, T.A., Bissell, K.M., Bradke, D.R., Campa III, H., …Anne Yagi [+44].2017. Climatic and geographic predictors of life history variation in Eastern Massasauga (Sistrurus catenatus): A range-wide synthesis. PloS one, 12(2), p.e0172011.

Yagi, A.R., A. Brant, S. Meyer, D.M. Green, S. Dobbyn, B. Johnson, and R. Tervo†. 2017. The Fowler's toad Stewardship Guide. prepared for Environment Canada Habitat Stewardship Program 61pp.

Yagi A.R, K.T. Yagi and A.Brant. 2017. The Spotted Turtle Stewardship Guide, prepared for Environment Canada Habitat Stewardship Program 25pp.

Yagi A.R. [updated 2016]. Niagara Region Fish Habitat Types with Management Rationale, Ontario Ministry of Natural Resources unpublished manuscript.

Yagi A.R and C.Blott. 2015. Niagara River RAP- Fish Population- Beneficial Use Impairment Delisting Criteria. Prepared for OMNR and NRRAP Advisory Committee.

Markle, T.M., A.R. Yagi and D.M. Green. 2013. Recovery Strategy for the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*) and the Northern Dusky Salamander (*Desmognathus fuscus*) in Ontario. Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 30 pp.

Blott C., A.R.Yagi and V. Crombie. 2013. Niagara River (Ontario) Remedial Action Plan Interim Assessment of *Degradation of Fish Populations* Beneficial Use Impairment for the Niagara River Remedial Action plan (DRAFT) 51pp + Appendices

Yagi A.R. and R. Jon Planck . (2012) Identification, Characterization and Subterranean Delineation of Critical Eastern Massasauga Hibernation Habitat in a Partially Mined Peatland for the Purposes of Species Recovery, Poster Ontario Nature Conference, Toronto 2012.

Jones P.C., R.B.King, R.L.Bailey, K.Bissell, H.Campa,III, (+25) and A.Yagi.2012. Population Ecology Range-Wide Analysis of Eastern Massasauga Survivorship. J. Wild. Man. 76(8):1576-1586; DOI:10.1002/jwmg.418

Yagi A.R and C. Blott. 2012. Niagara River Watershed Fish Community Assessment (1997 to 2011) Ontario Ministry of Natural Resources unpublish report 168pp + appendices

Yagi A.R. 2012. Field Investigation of Channel Erosion and related impacts on the Fenwick Regional ANSI, Provincially Significant Wetlands and Species at Risk, unpublished report for OMNR 20pp+appendix

Green D.M., A.R. Yagi and Hamel S. 2011. Recovery Strategy for the Fowler's Toad (*Anaxyrus fowleri*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 21pp.

Yagi A.R., T. Markle, A. Brant and R. Tervo. 2010. Quebec and Ontario Stream Salamander Stewardship Guide, prepared for Environment Canada Habitat stewardship Program 37 p + iii

Yagi A.R, A.Brant and R.Tervo. 2009. Niagara Region Natural Areas Inventory Reptile and Amphibian Study 2006 to 2008. Ontario Ministry of Natural Resources and Land Care Niagara unpublished report for the Natural Areas Inventory prepared for the Niagara Peninsula Conservation Authority 78pp incl. separate Map Appendix.

Yagi A.R. and A. Timmerman. 2009. Ancaster Wintering Deer Survey 2009 - with Management Recommendations, unpublished report for the Hamilton Conservation Authority 37pp + iii.

Denyes D., A.R. Yagi, A. Brant, K.Wright. 2009. American Water- willow Stewardship Guide. prepared for Environment Canada Habitat stewardship Program 21p +ii

Yagi A.R and R. Tervo. 2008a. Species at Risk Habitat Mapping for the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*) - a Test of Draft Habitat Mapping Guidelines. Unpublished report for Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario 12pp.

Yagi A.R and R. Tervo. 2008b. Species at Risk Habitat Mapping for the Northern Dusky Salamander (*Desmognathus fuscus*)- a Test of Draft Habitat Mapping Guidelines. Unpublished report for Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario 12pp.

Yagi A.R and R. Tervo. 2008c. Species at Risk Habitat Mapping for the Fowler's toad (*Bufo fowleri*)- a Test of Draft Habitat Mapping Guidelines. Unpublished report for Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario

Yagi A.R and C. Blott. 2008d. Niagara River Watershed Fish Community Assessment (2003 to 2007) Ontario Ministry of Natural Resources unpublished report 197pp.

Yagi A.R. and M. Esraelian. 2008e. White-tailed Deer (*Ondocoileus virginianus*) Management Recommendations for the Niagara Parks Botanical Gardens - School of Horticulture Final Report. Ontario Ministry of Natural Resources 34pp.

Yagi A.R., A. Brant, S. Meyer, D.M. Green, S. Dobbyn, K. Frohlich, K. Hayes, B. Johnson, M. Oldham and R. Tervo.2007. The Fowler's toad Stewardship Guide. prepared for Environment Canada Habitat Stewardship Program 60pp.

Yagi A.R. and R. Tervo. 2006a. Black Ratsnake (*Elaphe obsoleta*) Telemetry Project 2001 to 2002: Oriskany Sandstone Area-Carolinian Population Final Report unpublished for Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario. 25pp.

Yagi A.R. and R. Tervo. 2006b. Distribution of Fowler's toad (*Bufo fowleri*) in Aylmer District Based upon field surveys conducted in 2004 and 2005 with notes on Habitat for Recovery Planning Purposes, unpublished report prepared for Ontario Ministry of Natural Resources Aylmer District and OMNR SAR. 21pp.

Yagi A.R. and R. Tervo. 2006c. Guelph District Fowler's Toad (*Bufo fowleri*) - Historic Elemental Occurrence Verification, Current Presence/Absence information with notes on Preliminary Habitat Characterization for Recovery Planning Purposes, unpublished report prepared for the Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario. 10pp.

Yagi A.R and R. Tervo. 2005a. [Data Sensitive]Massasauga (*Sistrurus catenatus*) Population- Interim Report; unpublished report prepared for the Ontario Ministry of Natural Resources Species at Risk, Peterborough, Ontario 11pp.

Yagi A.R., R. Drabick, J. Radford and K. Spence. 2005b. Lower Frenchman's Creek: Wetland Evaluation, and Fisheries Assessment-Between Niagara Parkway and Bowen Rd. Allowance

Yagi A.R. and D.Mills.2004. Niagara Glen Species at Risk Inventory Final Report 2004 (Data Sensitive) Ontario Ministry of Natural Resources unpublished report for the Niagara Parks Commission 30 pg.

Yagi A.R. and D.Mills.2003a. Interim Report: Fowler's Toad (*Bufo fowleri*) Abundance and Habitat Use at Morgan's Point Conservation Area with Habitat Enhancement Recommendations, Summer 2003, unpublished report prepared for the Niagara Peninsula Conservation Authority and OMNR SAR Peterborough, Ontario. 7pp.

Yagi A.R and R. Tervo. 2003b [Data Sensitive]Eastern Massasauga Rattlesnake (*Sistrurus catenatus*), Ministry of Natural Resources unpublished report.7pp.

Yagi A.R. 2003c. Point Abino Fisheries Drain Fisheries Study- Pre and Post Drainage Works 2001 – 2002, Ontario Ministry of Natural resources unpublished report, updated March 2010 11pp.

Yagi A.R. 2000. Niagara Region Fish Habitat Types with Management Rationale, Ontario Ministry of Natural Resources unpublished manuscript.4pp.

Yagi A.R, R.J. Planck and P. Hache. 1999a. Post Assessment of the Shriner's (Branch W-5-1) Creek Ecological Design, Niagara Falls Ontario: Did Past Planning Goals meet the Public Expectations? Proceedings of the Second International Conference on Natural Channels. March 1999. Niagara Falls, Ontario. Canada.

Yagi A.R., Harrington .G. 1999b. Combining a Golf Course Re-Design with Natural Channels-Lessons learned from a St Catharines Urban Stream. Proceedings of the Second International Conference on Natural Channels. March 1999. Niagara Falls Ontario, Canada.

Yagi A.R. and Frohlich K. 1998a. An Interim Report on Wainfleet Bog Restoration: Challenges and Future Direction, Second Inter Global symposium for the Conservation of Eastern Massasauga rattlesnakes, Toronto Zoo p. 164 to 169

Yagi A.R. 1998b. Old Welland Canal Fisheries Assessment. City of Welland. Ontario Ministry of Natural Resources unpublished manuscript.

Yagi A.R. 1997. Martindale Pond Fisheries Assessment with Notes on Richardson's Creek Fisheries Habitat Compensation Project. OMNR unpublished manuscript.

Yagi A.R., R.J Planck and P. Hache. 1996 "An Approach to Ecosystem Restoration" – Presented at 57th U.S. Midwest Fish and Wildlife Conference, Dec 5 1996, Detroit Michigan Yagi A.R. 1997. Welland River Fisheries Study with Management Recommendations. Ontario Ministry of Natural Resources unpublished manuscript.

Fraser, J.Z., Yagi, A.R., Planck, R.J. 1994. A Natural Approach to Watercourse Modification in Urbanizing Watersheds: Shriners Creek Case Study, proceedings of the First International Conference on Rivers and Guidelines for Natural Channel Systems, Jan 1994. Niagara Falls Ontario, Canada.

Sarvis, A.R. 1985. Brook Trout Distribution and Abundance within Upper Twelve Mile Creek. Ont. Min. Nat. Res. unpublished manuscript, 45pp.