Western Chorus Frog (WCF)
Best Management Practices (BMP)
2025



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Foreword

A recovery strategy for Great Lakes-Saint Lawrence-Canadian Shield (GLSLCS) population of Western Chorus Frog (WCF) was posted on the Species at Risk Public Registry in 2015, citing a reduction in suitable breeding habitat and local population declines (ECCC 2015). Various strategies contributing to the recovery of the species were also outlined including:

- Developing Best Management Practices (BMP) at the local and landscape levels to increase population size, the areas of occupied habitat and connectivity (ECCC 2015).
- Implementing a standardized monitoring protocol and conducting surveys for the species (ECCC 2015).
- Restoring or creating habitats to promote the recolonization of portions of the historical range and increase connectivity between local populations (ECCC 2015).

The purpose of this Best Management Practices (BMP) document is to assist in the recovery of the GLSLCS population of Western Chorus Frog (WCF; *Pseudacris triseriata*) by providing guidance on actions that support the outlined recovery strategies. This includes surveying for and reporting WCF and identifying WCF habitat in Ontario. As well, this includes maintaining, enhancing, creating and monitoring the success of WCF habitat. Audiences that will benefit from this document include invested individuals, landowners, businesses, conservation organizations and planning authorities that wish to aid in the recovery of the species. The practices outlined in this document are based on the best available information; however, there is still much to be learned about the species in Ontario, and the effectiveness of the practices recommended in this document. It is therefore important to apply these practices with an adaptive management approach and adjust management strategies when necessary to ensure their efficacy.

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Table of Contents

Blazing Star Environmental Contact Information 4

Introduction 5
- Description 5
- Threats and Conservation 6
- Why Conserve the Western Chorus Frog? 6

Identifying WCF Habitat 7
- Identifying WCF Habitat with Google Maps or Google Earth 8

Identifying WCF 9
- Physical Identification 9
- Auditory Identification 9
- Similar Species 9

Surveying for WCF 11
- Survey Protocols 11
- Survey Timing 11
- Survey Instructions 12
- Assessing WCF Habitat and Potential Threats 13

Reporting WCF Observations and Survey Data 15

Conducting Activities in WCF Habitat 16
- Timing Windows 16

Reducing Impacts to WCF Habitat 17
- General Considerations 17
- Landscaping Activities 17
- Agricultural Activities 18

Restoring / Enhancing WCF Habitats 20

Creating WCF Habitat 23
- Characteristics of Suitable WCF Breeding Habitat 23
- Constructed WCF Breeding Ponds Requirements 24
- Assessing and Selecting Sites for the Creation of WCF Habitat 25
- Post-Development Monitoring 26

References 27

Table of Figures

Figure 1. Western chorus frog range in Ontario (COSEWIC 2008). 5
Figure 2. Examples of western chorus frog terrestrial habitats in Ontario (BSE 2022). 7
Figure 3. Examples of western chorus frog breeding habitats in Ontario (BSE 2022). 7
Figure 4. Suitable WCF habitat from an aerial view. Suitable habitat includes ponds and marshes (top left), moist flooded fields (top right), swamps (bottom left), and drainage ditches (bottom right). 8
Figure 5. Identifying features on the western chorus frog (ECCC 2017). 9
Figure 6. The distinguishing features between the western chorus frog and spring peeper..... 10
Figure 7. Diagram of a typical WCF habitat where the breeding pond is surrounded by terrestrial habitat and a buffer strip (MELCCFP 2023). 25

Table of Tables

Table 1. Ideal times for light maintenance, heavy maintenance and construction, vegetation control and invasive species management, and vegetation planting for WCF habitat (Équipe de rétablissement de la rainette faux-grillon du Québec 2023). 16

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Western Chorus Frog (WCF) Best Management Practices (BMP)

Introduction

Description

The Western Chorus Frog (WCF; *Pseudacris triseriata*) is a small brown to grey tree frog that can grow to approximately 2.5 cm long (COSEWIC 2008; ECCC 2015). It has three dark lines that run down the length of its body that may appear broken or blotchy (COSEWIC 2008; ECCC 2015). The WCF can be identified by its characteristic call during the breeding season which sounds like a fingernail running along the teeth of the comb (COSEWIC 2008; ECCC 2015). The WCF breeds for two to three weeks from the end of March to mid-May. Most years in Ontario, the WCF begins calling in mid-March in southern latitudes and mid-April in more northern latitudes. WCF in sites at higher altitudes may breed about 2 weeks later than those at lower elevations (BSE 2022).

During the breeding window, WCF generally occupy temporary or ephemeral wetlands that are devoid of predators, such as fish, and typically dry up by mid-summer (Bonin and Gallois 1996; ECCC 2015). During the non-breeding season, WCF can be found in marshes, damp wooded areas and fallow lands near breeding ponds (COSEWIC 2008). WCF hibernate in terrestrial habitats under rocks, logs, leaf litter or loose soil close by their breeding and summer habitat (COSEWIC 2008).

In Canada, WCF can be found throughout southern Ontario and areas of southwestern Québec. It ranges from the United States border north to Georgian Bay and up the Ottawa Valley (COSEWIC 2008; **Error! Reference source not found.**).

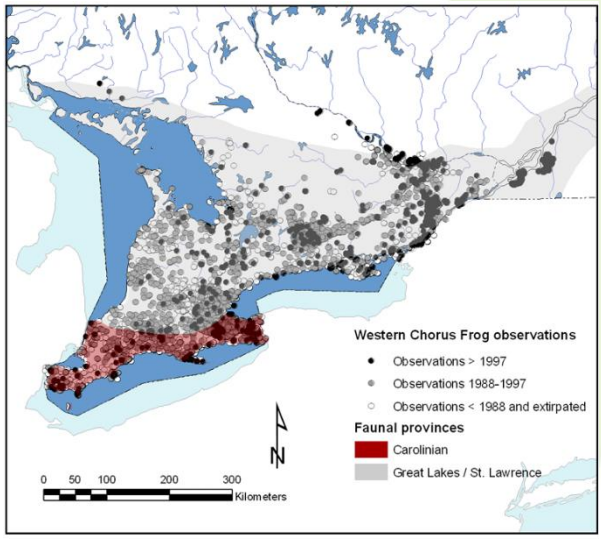


Figure 1. Western chorus frog range in Ontario (COSEWIC 2008).

Threats and Conservation

The Great Lakes – St. Lawrence – Canadian shield population (GLSLCS) of WCF is listed as Threatened under the federal *Species at Risk Act* (*SARA*) (ECCC 2015). The main threats to WCF include climate change, as well as habitat loss and degradation through urban development, intensification of agriculture, expansion of roads, invasive species, and the use of pesticides and herbicide (Bonin and Galois 1996; Hecnar 1995; COSEWIC 2008, ECCC 2015).

It is not listed as a species at risk (SAR) under the *Ontario Endangered Species Act, 2007.* Similarly, it is not listed as a Specially Protected Amphibian under the *Fish and Wildlife Conservation Act (FWCA),* however, the *FWCA* does prohibit hunting and trapping of the WCF on provincial, private, and municipal lands in Ontario. The *Provincial Parks and Conservation Reserves Act (PPCRA)* also provides protection for individuals within provincial parks and conservation reserves through prohibiting killing, harming, harassing, disturbing, or removing any individual within a provincial park or conservation reserve.

Why Conserve the Western Chorus Frog?

The WCF, like other amphibians, uses habitat that contributes to ecosystem functions by retaining flood water, recharging the water table, filtering water, maintain biodiversity (Rousseau et al. 2013). The use of this important habitat in addition to its semi-permeable skin has led it to becoming an indicator species for the overall health the terrestrial and aquatic ecosystems that it uses (Blaustein and Wake 1990; Harding 1997; Schueler 2001). In fact, in Québec, the WCF is a flagship species for the conservation SAR and their habitats. In Québec WCF conservation and monitoring has occurred since the 1990s by MRNF and NGOs, such that the species and its habitat in Québec is better understood. In Ontario, these efforts are fairly new, and there is much still to be done to understand, maintain, and recover this species. Conserving the WCF in Ontario not only benefits the WCF as a SAR but also benefits a wide array of other SAR that use similar habitats while also preserving several ecosystem functions that benefit us.

Identifying WCF Habitat

The WCF requires both aquatic habitats for breeding and terrestrial habitats for hibernation and foraging. Terrestrial habitats tend to primarily be chosen based on their proximity to breeding ponds, but WCF prefer moist, open habitats (Figure 2; COSEWIC 2008; ECCC 2015; Équipe de rétablissement de la rainette faux-grillon du Québec 2019). Certain examples include humid prairies, moist woods, or meadows (UPA 2023).



Figure 2. Examples of western chorus frog terrestrial habitats in Ontario (BSE 2022).

WCF breeding habitat includes temporary wetlands or shallow portions of permanent wetlands that typically have limited presence of aquatic predators such as fish, dragonfly larva, etc. (BSE 2023; Bonin and Galois 1996; COSEWIC 2008; ECCC 2015). Examples of WCF breeding habitat include flooded fields, swamps, ponds, drainage ditches, and marshes (BSE 2023, COSEWIC 2008; ECCC 2015; Figure 3).



Figure 3. Examples of western chorus frog breeding habitats in Ontario (BSE 2022).

The vegetation community in these habitats consists primarily of herbaceous plant species, but can also include shrubs and submerged trees species (ECCC 2015; MELCCFP 2024):

- Herbaceous plants: cattails, sedges, reed canary grass,
- Occasional shrubs: speckled alder, red-osier dogwood, willows
- Partially submerged trees: black willow, red maple, etc.

WCF are rarely found in permanent ponds and are instead mostly found in waters between 11-22cm deep but have been found in water as deep as 40cm (COSEWIC 2008). This preference can be attributed to a variety of reasons, such as WCF being poor swimmers, and temporary wetlands having reduced predation pressure (ECCC 2015). In WCF habitats, water generally accumulates from late fall to spring, then dries up by mid-summer (ECCC 2015). As a result of their temporary nature, WCF habitat can be difficult to find and is often not included in wetland mapping layers. The following methods are therefore recommended to find and identify WCF breeding habitat.

Identifying WCF Habitat with Google Maps or Google Earth

Using spring aerial imagery, look for low lying, moist areas or small ponds along the edges of agricultural fields and pastures or near wetlands or swamps. Examples of suitable habitat on aerial imagery can be seen in Figure 4.



Figure 4. Suitable WCF habitat from an aerial view. Suitable habitat includes ponds and marshes (top left), moist flooded fields (top right), swamps (bottom left), and drainage ditches (bottom right).

Once potential habitat has been identified using aerial imagery, the habitat should be visually assessed in person immediately after ice-off. The presence of suitable vegetation and shallow standing water should be confirmed. As is the nature of variable temporary habitats, it is not uncommon to arrive at the site in the spring to find different conditions than shown in the imagery.

Identifying WCF

Physical Identification

The WCF is a small brown to grey frog which can grow up to 2.5cm long (BSE 2022; COSEWIC 2008; ECCC 2014). It can be identified by three dark lines that run down the length of its body and may appear broken and blotchy. They have a dark spot or stripe between the eyes, as well as a broad dark mask that extends from the nostrils, over their eyes, to behind the tympanum. These stripes may connect to the dark broad lines which are present on either side of their body and extend from the tympanum to the groin. Finally, they can also be identified by their pale or white upper lip (COSEWIC 2008; ECCC 2014; Figure 5).

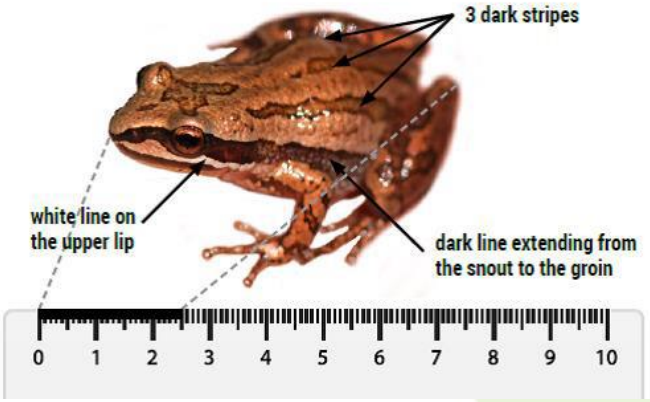


Figure 5. Identifying features on the western chorus frog (ECCC 2017).

Auditory Identification

The WCF call sounds like a fingernail running along the teeth of a comb. It can sound like a "cre-ee-ee-ee-eek" which rises in pitch and frequency as it progresses (BSE 2022; GUEPE 2022).

An example of a WCF frog call can be heard here.

Similar Species

The WCF can be easily distinguished visually from spring peepers (*Pseudacris crucifer*). They are similar in size; however, Spring Peepers have an "X" mark on their backs (Figure 6) and their call consists of a high pitch "peep". Male Spring Peepers

may produce an ascending trill which sounds similar to the call of WCF as a territorial warning to other males (ECCC 2015).

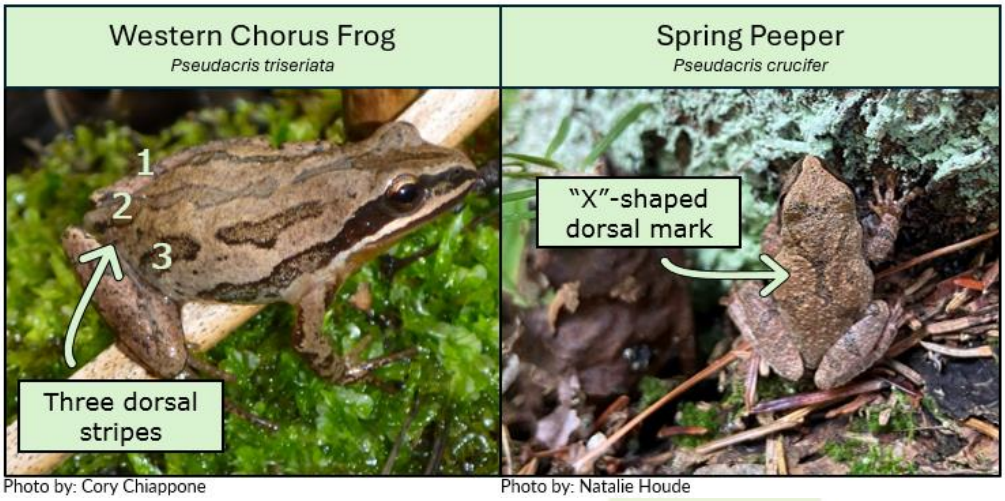


Figure 6. The distinguishing features between the western chorus frog and spring peeper.

Distinguishing between a WCF call and a Spring Peeper trill

Spring Peepers are often heard calling at the same time, but their call consists of a high pitch "peep". Male Spring Peepers may occasionally produce a trill to advise other males to keep their distance. This trill can sound very similar to the WCF call (ECCC 2015).

An example of a Spring Peeper calling with trill can be heard here.

The trill of a Spring Peeper consists of a short "trrrrrrr" that ascends in pitch and that is accompanied by "peeps" before or after the trill. The WCF call consists of a "creeeeek" which also ascends in pitch but is similar to the sound of running your nail along a fine-tooth comb (ECCC 2015). The best strategy to distinguish the two calls is to wait and listen if the trill is accompanied by "peeps" before or after. As this is a warning call, this sound will most likely not be heard as consistently as the breeding calls.

It can be difficult to distinguish if both WCF and Spring Peepers are calling simultaneously in a chorus. Hence, it is highly recommended to obtain an audio recording in these scenarios if possible so that experts can confirm which species is calling.

Surveying for WCF

Survey Protocols

Once suitable habitat has been identified, WCF surveys should be conducted. Surveys can be done using Blazing Star's protocol which is based on the "2022 Western Chorus Frog Long-Term Monitoring Program" (BSE 2022) and the Ministre de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) 2024 standardized protocol. WCF surveys can also be conducted by following the Bird Studies Canada Marsh Monitoring Participant's Handbook for Surveying Amphibians (2009).

All surveys should take place in **suitable WCF habitats** within their dispersal range. Examples of suitable WCF habitats include flooded fields, swamps, ponds or temporary bodies of water, drainage ditches, marshes, etc. More information on suitable WCF habitats can be found in the *Identifying WCF Habitat* section.

Note: Do not travel onto private land unless you have permission from the landowner.

Survey Timing

Surveys should be conducted:

- During the WCF calling period.
- During the day between **10am and 6pm.**
    - This reduces the chance that the calls of other frogs will interfere with hearing WCF.
- When most of the wetland surfaces are not frozen.
- During suitable weather conditions:
    - The air temperature is at least 10°C at the time of the survey.
    - Light or no wind.
    - No rain or light rain.

All surveys should take place during the WCF calling period. The WCF calling period is dependent on climatic conditions, so this period will vary each year and will vary by location. Typically, they will last between 2-3 weeks between mid-March to mid-May. If you are registered to survey with BSE, we will send out emails and post on social media to inform when WCF are calling in your region. Otherwise, consider using a local reference site where a reliable chorus is known to occur, if available, as an indication that calling has started in your area.

Ontario Reptile and Amphibian Atlas Facebook Page:
https://www.facebook.com/groups/75392295750/

Canadian Herpetological Society Facebook Page:
https://www.facebook.com/groups/CanadianHerpetologicalSociety/

Survey Instructions

Surveys consist of quietly standing still in proximity to WCF habitat and listening for 5 minutes to detect WCF calls. If WCF are heard, then surveys should be extended for an additional 3 minutes (for a total of 8 minutes of surveying). If WCF are heard and it is possible, obtain an audio recording.

Equipment:

- Data sheets and pencils or online form.
- Device capable of recording latitude and longitude (GPS, smartphone with google maps).
- Device with a timer function (smartphone, stopwatch, etc.).
- Thermometer (weather app, kitchen or car thermometer, etc.).
- Recording devices (smartphone, etc.).
- Charging wires, packs, or extra batteries for devices.

Approaching the site:

- Do NOT park right beside the site coordinates. Drive at least 50 m past the coordinate location to the nearest location that is safe to pull over.
- Quietly get out of your car and begin to walk to the site coordinates. Get as close to the coordinates as possible while staying 40 m away from the location of suitable habitat (water).
- If you need to get closer to confirm suitability of the habitat OR you disturb the frogs calling when you get out of the car (e.g., when closing car door) or as you approach, wait for previous calling intensity to resume (at least 3-5 minutes) before beginning your survey. Standing too close to the WCF habitat or making noise may disturb frogs and inhibit calling. If this happens, move back 10 m from the habitat and wait for previous calling intensity to resume.

Before the survey begins

Record the following surveyor information and weather conditions once you arrive at the site:

- **Name** of surveyor.
- **Date** of survey.
- **Survey start and end times.**
- **Coordinates** (latitude and longitude) where the WCF was detected.
- **Weather conditions**:
    - Clear / sunny.
    - Partly cloudy.
    - Cloudy.

    - Light rain.
    - Heavy rain.
    - Storm.
- **Temperature**: in Celsius (C°).
- **Wind**: based on the Beaufort Wind Scale.
    - 0-2km – Calm, smoke rises vertically
    - 3-5km – Light air movement, smoke drifts
    - 6-11km – Slightly breezy, wind felt on face
    - 12-19 – Gentle breeze, leaves and small twigs in constant motion
    - 20-30km – Moderate breeze, small branches are moving, raising dust & loose paper
    - 31-39km – Fresh breeze, small trees in leaf beginning to sway, crested wavelets form
    - 40-50km – Strong breeze, large branches in motion
- **Background Noise**: select noise level between 0-4
    - **0**: No effect to hearing frogs (e.g., owl calling).
    - **1**: Slightly affecting sampling (e.g., distant traffic, dog barking, car passing).
    - **2**: Moderately affecting sampling (e.g., distant traffic, 2-5 cars passing).
    - **3**: Seriously affecting sampling (e.g., continuous traffic nearby, 6-10 cars passing).
    - **4**: Profoundly affecting sampling (e.g., continuous traffic passing, construction noise).

Assessing WCF Habitat and Potential Threats

Whether you have a potential WCF habitat in mind or you are wanting to seek one out, it is important to consider the following:

Habitat features:

- Does the site have one of the following features: flooded field, drainage ditch, swamp, pond, marsh, standing water, temporary wetlands or shallow portions of permanent wetlands, or basins/potholes?
- Does the water body in question dry up over the summer?
    - Breeding habitat of WCF includes temporary wetlands or shallow portions of permanent wetlands.
- What type of habitat surrounds the waterbody? Surrounding habitats will affect the likelihood of finding WCF.
    - For example, the chances of finding WCF in a drainage channel in a heavily developed commercial area is lower than finding WCF in a drainage channel near a forest which provides plenty of refuge and hibernation sites for WCF outside of the breeding season.
- How much vegetative cover is there?

- WCF will rely on the presence of vegetation to hide from predators. They also require aquatic or emergent plants to lay their eggs. Enough vegetative cover is important for assuring refugia for WCF.

The presence of threats:

- Are there any roads? If so, consider how busy they are and how many lanes there are.
- Are there any invasive plant species growing in or near the area? Invasive plants to watch out for include:
  - Exotic common reed (*Phragmites australis*)
  - Buckthorn (*Rhamnus cathatica* and *Rhamnus frangula*)
  - Cattail (*Typha augustifolia* and *Typha latifolia*)
- Have you seen any predators in the area?
  - WCF predators include snakes, birds, larger frogs (e.g., Green Frogs and Bullfrogs), newts and salamanders (COSEWIC 2008; MELCCFP 2023).
  - In the water, their predators can also consist of fish, dragonfly and beetle larvae, giant water bugs, and leeches (MELCCFP 2023).
- Are there any nearby activities that may impact WCF habitat?
  - Activities or land uses can include crop fields or pastures, construction, landfills, mining, heavy traffic (cars or people), among others.
  - Think about various types of ways that WCF can be impacted such as high noise levels, significant human presence, pollution through water or trash, etc.

Record the following information:

- Type of WCF habitat.
  - Flooded field.
  - Swamp.
  - Pond
  - Drainage ditch.
  - Marsh.
  - Forest.
  - Other (please specify…)
- Any potential threats to WCF.
  - Proximity to roads
  - Presence of invasive plant species
  - Predators observed
  - Other (please specify…)

Beginning the survey

Once the preliminary information is recorded, the survey can begin.

Listen until WCFs are detected or until 5 minutes has passed. If WCFs are detected, listen for at least 3 additional minutes from the time of initial detection (for a total possible survey time of 8 minutes). Record the highest **call code** for each frog species heard during the survey period. If WCF are heard, extend the survey for an additional 3 minutes (for a total of 8 minutes).

- **Call Code 1**: WCF call(s) were not overlapping, and the number of individuals could be counted.
- **Call Code 2**: WCF call(s) occasionally overlapped but an estimate of individuals could still be estimated.
- **Call Code 3**: WCF call(s) were overlapping and continuous in a full chorus and individuals could not be counted or estimated.
- **Observed a WCF**

If you are uncertain of the species of frog calling, and suspect it might be the WCF, record a sound clip or video of the call using any recording device (such as a smartphone).

Reporting WCF Observations and Survey Data

If you have observed a WCF, heard it calling, or conducted a survey, you can submit this information online directly to Blazing Star Environmental by filling out the form here: https://www.blazingstar.ca/wcf-observation-submissions.

If you have a clear photograph or recording of WCF, you can also submit your data to these organizations:

- NHIC: https://www.ontario.ca/form/natural-heritage-information-centre-nhic-observation-reporting-form
- iNaturalist: https://www.inaturalist.org/

Conducting Activities in WCF Habitat

Timing Windows

Light maintenance after August 1st.

Use chainsaws, bow saws, blade or string trimmers, or shears for routine maintenance (Équipe de rétablissement de la rainette faux-grillon du Québec 2023). This avoids disturbing the sensitive growth period of juvenile WCF.

Vegetation control in late fall.

Carry out light vegetation control and habitat clean up in late fall when vegetation goes dormant and the WCF enters hibernation (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).

Heavy maintenance or construction between the end of Fall – beginning of March.

Complete heavier work when the ground is frozen (Ouellet & Leheurteux 2007; Équipe de rétablissement de la rainette faux-grillon du Québec 2023). WCF shelters in leaf litter and begins hibernation once temperatures fall below 10°C. The frozen ground supports the weight of vehicles better and prevents hibernating WCF from being impacted by soil compaction and results in fewer ruts.

Ruts: Marks dug by tires where water accumulates in temporary puddles and attracts the WCF during their egg-laying period. This results in mass mortality of tadpoles if these shallow puddles dry up before their development is complete.

Table 1. Ideal times for light maintenance, heavy maintenance and construction, vegetation control and invasive species management, and vegetation planting for WCF habitat (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Light Maintenance								■	■	■	■	
Heavy Maintenance or construction	■	■									■	■
Vegetation or invasive species control									■	■	■	■
Vegetation Planting									■	■	■	■

Reducing Impacts to WCF Habitat

General Considerations

Reduce activity area in WCF habitats

- Limit activity to the smallest possible area (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).
- Prioritize using existing routes or surrounding dry land to move around (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).
    - Using these means of access reduces the danger of crushing WCF and the vegetation they use for shelter.

Preserve existing natural habitats

- Preserve the natural characteristics of the water in wetlands and known WCF habitat (Équipe de rétablissement de la rainette faux-grillon du Québec 2023; UPA 2023).
    - The water's dynamic and natural characteristics such as depth, chemical composition, and temperature and all parameters that define a wetland.
- Maintain natural vegetation cover or re-create it soon after disturbance (Équipe de rétablissement de la rainette faux-grillon du Québec 2023; UPA 2023).
    - Reuse the existing soil and plants - unless it is contaminated by invasive species.
    - Sow a native herbaceous-plant seed mixture.
- Maintain movement corridors to facilitate WCF movement between habitats and maintain genetic diversity. (Ouellet & Leheurteux 2007)

Avoid or reduce chemical pollution near WCF habitats

Many commonly used chemical products can be harmful to WCF if they end up in their breeding ponds. Avoid using these products in excess and near WCF habitats:

- Bug sprays containing DEET can be harmful to amphibians (FWS 2000).
- Deicing salt in the winter (FWS 2000; COSEWIC 2008).
- Avoid dumping oil, antifreeze, and household chemicals into storm drains and sewers, as well as down the drain of your sink or down the toilet (FWS 2000).
- Keep litter, pet waste, leaves, and debris away from street gutters and storm drains as these drain directly into water bodies (FWS 2000).

Landscaping Activities

Clean all equipment and machinery.

Clean all equipment and machinery after working in areas with **invasive plants**

- Plan work activities logically, beginning in non-contaminated areas, to prevent the introduction or spread of these plants (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).
- Any equipment that has been used in an area contaminated by invasive plant species should be thoroughly cleaned and disinfected.
- Methods should follow the "Clean Equipment Protocol for Industry" accessed at: https://www.ontarioinvasiveplants.ca/wpcontent/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf.
- An emergency spill kit should be available in case of an accidental chemical or oil spill (BSE, 2023).

Mowing - be cautious of WCF habitat.

- Raise mower blades near WCF occupied habitats (UPA 2023).
- Avoid mowing depressions where snowmelt causes water accumulation (ALUS 2023).
- Leave some patches of grass unmowed to serve as refuge for WCF (ALUS 2023).

Agricultural Activities

Avoid or reduce pesticide and herbicide use

Pesticides and herbicides can affect water quality and can negatively impact the growth of WCF tadpoles (Ouellet & Leheurteux 2007; COSEWIC 2008; FWS 2000). WCF are often found in agricultural, urban and suburban areas which increases the risk of being exposed to these products (COSEWIC 2008).

WCF exposed to pesticides have been linked to direct mortality, reduced growth and development, and mutations (deformities, feminization of males, etc.) (Ouellet & Leheurteux 2007; COSEWIC 2008; FWS 2000). Pesticide use, such as neonicotinoids, also decreases prey availability for WCF and have been found in wetlands adjacent to agricultural lands (COSEWIC 2008).

Temporary wetlands used by WCF are often high in concentrations of agricultural chemicals, such as atrazine. Atrazine, an herbicide that is widely used for weed control in corn fields, is an endocrine disruptor that can demasculinize amphibians and affect their metamorphosis (COSEWIC 2008). It is found in high concentrations in groundwater and surface water in areas with corn dominant crops due to runoff. Although there are no WCF studies on the effects of this; there has been a study demonstrating decreased spring peeper larvae survival with low concentrations of atrazine (COSEWIC 2008).

Reduce the need for herbicides and pesticides by:

- Using non-chemical alternatives for weed control, such as mulching, spading, and hoeing (FWS 2000).
- Planting native species (FWS 2000).

    - Native plants tend to be hardier and less susceptible to diseases and pests than non-native plants.
- Rotating the plants in your annual garden (FWS 2000).
    - This makes it more difficult for pests that rely on certain plants to become established.
- Growing natural repellent plants, such as lemon balm, to help keep pests away (FWS 2000).

Avoid or minimize fertilizer use

Fertilizers have been known to negatively impact WCF by altering their behaviour and development (COSEWIC 2008; Hecnar 1995). The nitrates in fertilizers can cause physical mutations, paralysis, decreased foraging, and swimming impairments in WCF tadpoles (Hecnar 1995). These changes may also affect WCF survival by making them more vulnerable to predators (COSEWIC 2008; Hecnar 1995).

Consider taking the following steps to reduce the need for fertilizers:

- Leave grass clippings on your lawn after mowing as this will decompose and fertilize your lawn (FWS 2000).
- Use compost to improve soil quality and plant growth (FWS 2000).

If you do need to use fertilizers on your lawn, garden, or for your crops, then consider:

- Following the manufacturer's guidelines and calibrating the applicator. Fertilizing more than the recommended rate does not improve plant growth. Excess fertilizer will often harm the plant and may wash out into water bodies used by WCF (FWS 2000).
- Choosing organic fertilizers which release more slowly than chemical fertilizers (FWS 2000).
- Ensuring soil is moist prior to applying fertilizer, then lightly watering afterwards. This will allow the fertilizer to reach the roots of the plant and avoid it from blowing or washing away (FWS 2000).
- Avoiding the application of fertilizer before heavy rain as this may wash it into nearby water courses (FWS 2000).
- Testing your soils for nutrients to avoid applying unnecessary fertilizer (FWS 2000).
- Adding vegetation buffer strips around WCF habitat. These plants will help absorb excess nitrates and reduce the amount that ends up in water bodies used by WCF for breeding (UPA 2023, ALUS 2023).

Promote perennial crops and avoid monocultures in fields adjacent to WCF ponds

In fields adjacent to wetlands or WCF habitats, adopt non intensive agricultural practices (e.g., pastures, hay) (MELCCFP 2024). This enhances habitat connectivity and mitigates the loss of breeding habitat (ALUS 2023). Furthermore, these use less

agrochemicals than monocultures while still maintaining economic value (Ouellet & Leheurteux 2007).

Heavy machinery

- Avoid construction activities and vehicle use in wetland habitats around temporary or permanent natural water systems like streams or ponds (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).
- Use a vehicle that is in good working order and equipped with tracks to prevents soil compaction and ruts (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).

Drainage practices

If possible, allow the natural drainage of water and develop alternatives to constructing irrigation reservoirs (Ouellet & Leheurteux 2007; ALUS 2023). Near known colonies, reduce or prevent the subterranean and surface drainage to allow water to drain naturally from agricultural fields (UPA 2023). Draining or drawing water, and dumping snow or chemical contaminants, affect wetlands and have consequences for the survival of the WCF and for preservation of its population (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).

Drainage ditches and irrigation channels reduce the hydroperiod of nearby breeding ponds and should be avoided within proximity of WCF habitats (Ouellet & Leheurteux 2007). If this is not possible, then consider creating barriers to prevent the interaction between the irrigation channels and wetlands (Ouellet & Leheurteux 2007). Additionally, drainage ditches should not connect predatory fish habitat to WCF habitat to prevent the colonisation of these fish species in WCF wetlands (MELCCFP 2023).

Restoring / Enhancing WCF Habitats

All restoration or enhancement activities taking place within WCF habitat should be done following the guidelines listed in the *Timing Windows* section and Table 1 in *Conducting Activities in WCF Habitat.* It is important to keep in mind the breeding, development, and active periods of the WCF to avoid causing harm to individuals or disrupt their life cycles (Équipe de rétablissement de la rainette faux-grillon du Québec 2023; MELCCFP 2023).

If wetlands are less than 30% of the landscape:

- Increase the habitat water storage (e.g. by widening sections of ditches to favour water accumulation) (MELCCFP 2023).
- Favour water retention by limiting surface runoff (e.g. block drainage ditch flow with dikes to reroute excess runoff to accumulation zones) (MELCCFP 2023).

If the open habitat is less than 40-50% of the landscape:

- Reduce terrestrial canopy cover to aim for 75% open habitat and sparse forests (MELCCFP 2023).
    - Make openings in the canopy by targeting the removal of non-native and invasive species.
- Maintain fallow environments by mowing in late fall every 3-4 years (MELCCFP 2023).
- If the meadow is homogeneous: tall grass cover can be diversified by mowing at least one 1ha section each year and rotating every 4-5 years while keeping 30% of the area untreated (MELCCFP 2023).

If the pond's sun exposure is less than 60% between 10am and 2pm:

- While the leaves are out, directly observe the shade caused by trees at the anticipated WCF habitat site (MELCCFP 2023).
- If it is safe to do so, follow the by-laws and permit or license requirements set by your municipality to cut down trees that create shade over the pond (MELCCFP 2023).
- Planting small shrubs and herbaceous species does not affect the pond's sun exposure and reduces the need for future control. Hence, replace trees with indigenous compact shrub or herbaceous wetland species (MELCCFP 2023).

If the WCF habitats are fragmented:

- Planting and widening riparian vegetation buffers along WCF habitat and surrounding watercourses to measure between 10-30m in width (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).
    - This improves habitat conditions by increasing the surface area of higher-humidity environments.
- Provide connectivity corridors between habitats. (ALUS 2023)
    - Prioritize providing herbaceous riparian buffer strips in sites frequented by WCF to facilitate WCF movement between habitats and maintain genetic diversity. (UPA 2023; Ouellet & Leheurteux 2007)
- Alternatives if a movement corridor between WCF habitats cannot be created. (Ouellet & Leheurteux 2007):
    - Connect two habitats by multiple microhabitats.
    - Increase the surface area of the two separate habitats.
- Create wildlife crossings under roads following the MNRF Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species at Risk in Ontario (2016): https://files.ontario.ca/bmp_herp_2016_final_final_resized.pdf

Creation of crossing structures to mitigate WCF road mortalities:

- Minimum culvert size should be 1.0m in diameter for tunnels under 15m, and 1.5m for tunnels 15-25m long.
- Terrestrial tunnels should be used for frogs – ensuring there is high moisture content and small pools of standing water.
- Tunnels should not be flooded with water.
- Open or closed-top tunnels may be used. Open top will improve air flow and moisture levels in the tunnel; yet this also allows the entry of pollutants and road salts
- Substrates should consist of soils and leaf litter instead of gravel (MNRF 2016).

Re-establishing plant-cover around WCF breeding habitat:

- **Aquatic habitats**: Aim for a vegetation composition of predominantly herbaceous plants and between 15 – 50% tree or shrub cover (Bonin and Galois 1996; Bouthillier et al. 2017; Gagné 2011; Ouellet & Leheurteux 2007).
- **Terrestrial habitats**: Aim for a vegetation composition of 75% open habitat and 25% tree and shrub cover (MELCCFP 2023).
- Use a mixture of native herbaceous wetland plants or water tolerant species.
- Loosen the soil before planting, and plant approximately 3000 seeds/m^2 (Boivin & Brisson 2014; Byun et al. 2013; MELCCFP 2023).

If there are invasive plant species at the site:

- Manage, control, and remove invasive species by following the Ontario Invasive Plant Council (OIPC) Best Management Practice (BMP) series: https://www.ontarioinvasiveplants.ca/resources/best-management-practices/ and ensuring compliance with the *Invasive Species Act*, 2015.
- Exotic common reed (*Phragmites australis*) is known to dry out ponds and decrease sun exposure (COSEWIC 2008; MELCCFP 2023).
- Buckthorn (*Rhamnus cathatica* and *Rhamnus frangula*) releases emodin which is reported to impact amphibian development (COSEWIC 2008; MELCCFP 2023).
- Cattail (*Typha augustifolia* and *Typha latifolia*) is invasive as it produces a lot of ground vegetation which can delay pond thawing. It is also reported in previous studies to release allelopathic substances through its roots which can hinder the growth and the germination of native species (MELCCFP 2023).
- Invasive species should be managed at the appropriate time of year outlined by the BMPs; however, the period from ice-off until July (when the WCF is using the habitat) should be avoided whenever possible (Équipe de rétablissement de la rainette faux-grillon du Québec 2023).

If there are nearby water contamination sources:

- Install vegetated buffer strips to reduce the impact of contamination sources. This reduces run-off of fertilizers and pesticides. (UPA 2023, ALUS 2023)
- The buffer strip should be 30m-60m wide between the contamination source and the WCF habitat (MELCCFP 2023).
- They should follow contour lines to redirect the surface flow towards the buffer zone (MELCCFP 2023).
- Use native species (herbaceous and shrubs) to help with sediment trapping, improving filtration and habitat quality (MELCCFP 2023).
    - Plant debris can assist with pesticide denitrification and degradation, whereas woody debris favours sediment deposition.
    - Select plants that are tolerant of deicing salts if these are used in proximity to the site.

Creating WCF Habitat

Locations for WCF habitat creation must be carefully and strategically chosen both within the landscape and on a site-specific level to ensure that habitat characteristics are met, to increase the chances of success of the constructed habitat, and to maximize the conservation value of the project to aid in the overall recovery of the species.

All activities taking place within WCF habitat should be done following the guidelines listed in the *Timing Windows* section and Table 1 in *Conducting Activities in WCF Habitat.* It is important to keep in mind the breeding, development, and active periods of the WCF to avoid causing harm to individuals or disrupt their life cycles.

Characteristics of Suitable WCF Breeding Habitat

Location and landscape

WCF habitats should be located in a landscape with a predominance of open habitats, discontinuous forests (forest cover less than 60%) and wetlands (MELCCFP 2023; MELCCFP 2024; COSEWIC 2008). The optimal landscape for WCF consists of 30% wetlands, mostly open areas, and up to 25% wooded areas (MELCCFP 2023; MELCCFP 2024). There should be a minimum of at least 20% of wetlands (ideally primarily composed of temporary wetlands) (MELCCFP 2023).

Ideally, a network of several ponds with varying layouts and locations should be present to counter extreme climatic conditions (MELCCFP 2023; Ouellet & Leheurteux, 2007).

Vegetation

Vegetation within the WCF habitat should predominantly consist of herbaceous species and between 15-50% tree or shrub cover (MELCCFP 2023). Existing vegetation should be diversified for WCF larval reproduction and development (MELCCFP 2023). Additionally, emergent vegetation and submerged vegetation are required by WCF for shelter and to attach egg clusters (MELCCFP 2023). Emergent plants with drooping leaves like canary grass are preferred by male WCF for shelter and for performing vocalization (MELCCFP 2023).

Species most abundant in WCF habitat (ECCC 2015; MELCCFP 2024):

- Herbaceous plants: reed canary grass, sedges, sensitive fern, etc.
- Occasional shrubs: alders, red-osier dogwood, willows, etc.
- Partially submerged trees: willows, red maple, etc.

There should be limited or no invasive plant species present within the habitat (MELCCFP 2023; COSEWIC 2008).

Constructed WCF Breeding Ponds Requirements

Measurements

WCF breeding ponds should measure at least 200m^2 in surface area and typically be between 0.4-0.6m deep (Figure 7). At least 30% of the pond should measure its maximum depth (MELCCFP 2023).

Shape

Low slopes and slightly irregular contour with overflow zones (to retain overflow from snowmelt). It should also allow a gradient of water temperature for WCF larvae to achieve optimal thermoregulation (MELCCFP 2023).

Water

The ponds should reach a hydroperiod of at least 60 to 100 days. Additionally, water quality should be good and distanced from contamination sources as WCF larvae are susceptible to pollutants (road salts, pesticides, herbicides) (MELCCFP 2023).

Sun Exposure

At least 60% of the pond must have direct sun exposure from 10am to 2pm (MELCCFP 2023).

Connectivity

The site should possess a network of shallow and low-flow channels that favour dispersal, while ensuring that the WCF breeding habitats do not connect to fish

habitat (MELCCFP 2023; Ouellet & Leheurteux, 2007). It is preferable to develop and protect large areas of connectivity to reduce the effect of negative external pressures (edge effect) (MELCCFP 2023; Ouellet & Leheurteux, 2007).

Substrate

The substrate should enable water retention, such as silt, loam, and clay soils (MELCCFP 2023).

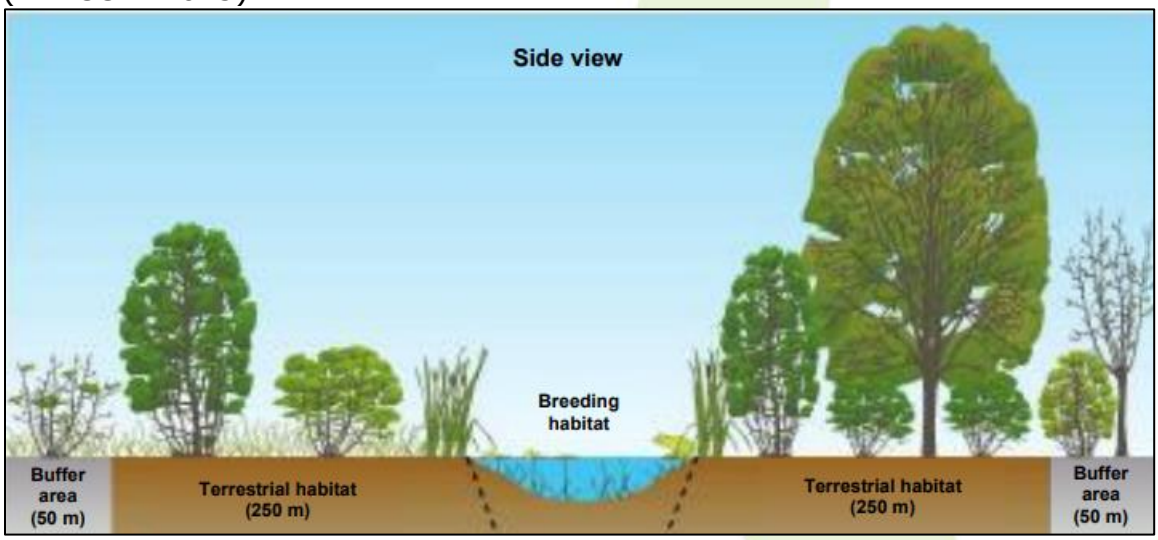


Figure 7. Diagram of a typical WCF habitat where the breeding pond is surrounded by terrestrial habitat and a buffer strip (MELCCFP 2023).

Assessing and Selecting Sites for the Creation of WCF Habitat

For the creation of WCF habitats, select a landscape with a higher number of favourable features, and few weaknesses that can be improved with adjustments (water and vegetation quality, presence of predators or invasive species, sun exposure, etc.) (MELCCFP 2023).

Ideally, a network of several ponds, consisting of varying layouts and locations with at least one breeding habitat every 100m, should be constructed to offset extreme hydrological conditions (MELCCFP 2023; Ouellet & Leheurteux, 2007).

Steps to assessing the suitability of a site

- Examine the topographic features of the site (MELCCFP 2023).
- Delineate the highest flooding levels of permanent and temporary wetlands (MELCCFP 2023).
- Visit the site immediately after snowmelt and again in mid-June to map wetlands, runoff, and flow (MELCCFP 2023).
    - Document the hydroperiod and temporal dynamics of the runoff from spring to late summer. The use of a piezometer is recommended.

    - Identify the flow of the water (path, peak, and direction) (MELCCFP 2023).
- Assess the water quality and the existing factors that may impact it within the watershed (MELCCFP 2023; Ouellet & Leheurteux, 2007; GUEPE 2022).
- Assess the presence of predators and invasive species (MELCCFP 2023).
    - Ensure the anticipated WCF habitat will not connect to fish habitat (Ouellet & Leheurteux, 2007)
    - Avoid selecting locations with invasive plant species, such as buckthorn, invasive cattails and phragmites (MELCCFP 2023).
- Identify whether the substrate enables water retention (MELCCFP 2023).
    - This can be corrected; however, it will greatly increase the cost and complexity of the project (MELCCFP 2023).
- Assess the surrounding tree canopy and determine the sun exposure to the site (MELCCFP 2023).

Assets to suitable site selection

- There are no surface water drainage or catchment present which could affect the water system of the site (MELCCFP 2023).
- The presence of anthropogenic features is limited (MELCCFP 2023).
- Limited presence of nearby annual intensive crops (MELCCFP 2023).
- Limited or no invasive species present within the site (MELCCFP 2023).
- Limited or no barriers which could restrict or prevent WCF movement (e.g., roads, large water courses, dry environments, anthropogenic environments such as construction sites, parking lots, etc.) (UPA 2023; MELCCFP 2023; Ouellet & Leheurteux, 2007).

Post-Development Monitoring

Conduct post-development monitoring to ensure the project meets the needs of the WCF and can implement adjustments (MELCCFP 2023; GUEPE 2022).

- Monitor hydroperiod and water quality (pH and salinity).
- Monitor vegetation (the survival of plantings and keeping invasive species under control).
- Monitor the use of the habitat by listening for WCF calls during the breeding season (BSE 2022).

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