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Assessment of Trends in Frog and Toad Populations in Ontario using Citizen Science Monitoring Data

Prepared for:
The Ecological Monitoring and Assessment Network Coordinating Office, Environment Canada

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INTRODUCTION

Amphibians can be good environmental indicators because they are susceptible to environmental change both on land and in the water. Evidence suggests that many amphibian populations are in decline (de Solla et al. 2006). To address these declines and engage the public, a number of volunteer-based anuran (frog and toad) monitoring programs have been independently developed. The loud vocalizations of anurans, during the breeding season, and the relative ease of identification makes it possible to use "citizen scientists" to monitor trends in these populations.

In Ontario there are four independent anuran monitoring programs coordinated by different agencies. The Marsh Monitoring Program is coordinated by Bird Studies Canada; and the Amphibian Road Call Count and the Backyard Frog Survey, are coordinated by Environment Canada and FrogWatch Canada is coordinated in partnership by Environment Canada and Nature Canada. The objectives of this assessment are to use the data generated by these programs to identify trends in amphibian populations in Ontario as well as geographic monitoring coverage and gaps.

BACKGROUND

FrogWatch Canada is a national program that takes place in any potential anuran breeding habitat. The program was based on the Ontario Frog Call Survey which was initiated by the Toronto Zoo in 1990. The objectives of this survey are to describe species occurrence, distribution and phenology. As well, this program aims to engage Canadians in understanding amphibian conservation issues and empower them to act as stewards of the environment. The Marsh Monitoring Program began as a binational, Great Lakes basin-wide program. The main objective of the program is to monitor the population status and long-term trends of anuran species breeding in Great Lakes basin wetlands. Station-specific habitat data which can be used to identify species/habitat associations are also collected. The Amphibian Road Call Count takes place in Ontario only and was designed to track the relative abundance and long-term population trends of anuran species based on data collected along roadside routes. The Backyard Frog Survey is also restricted to Ontario and was designed to monitor seasonal and annual fluctuations in anuran populations based on site-level occurrence. This survey was to be used as baseline data for other, more formal survey programs such as the Amphibian Road Call Count.

All four of these programs are auditory based call surveys that use a calling code to quantify calling intensity of detected species. The Marsh Monitoring Program, Amphibian Road Call Count and Backyard Frog Survey follow the standard 3-level calling code scale used by other North American auditory-based monitoring programs (e.g., North American Amphibian Monitoring Program), whereas the FWC codes also incorporate the visual detection of anuran species. The protocols for the four programs are summarized in Table 1. FrogWatch and the Backyard Frog surveys occur at single "sites" while the Road Call Count and Marsh Monitoring Program surveys occur along monitoring "routes". Each route consists of a variable number of monitoring "stations". For more detailed information about specific programs, please refer to Anonymous 2006; Gartshore et al. 2004; www.naturewatch.ca/english/frogwatch/on; and Anonymous 2008. Although the protocols differ among the four monitoring programs, each has assembled multi-year datasets that can potentially be used to address some important research and conservation questions.

Table 1 - Comparison of selected program and survey protocol characteristics for Frog Watch Canada, Backyard Frog Survey, Amphibian Road Call Counts and the Marsh Monitoring Program.

	FrogWatch Canada	Backyard Frog Survey	Amphibian Road Call Count	Marsh Monitoring Program
Number of visits	Undefined	Recommended daily	3	3
Survey Window	All year	Late March to end of calling activity	Early April to mid-July (depending on latitude)	Late March to late June (depending on latitude)
Number of Stations	At least 1	At least 1	10/route	Max. 8/route
Site level survey duration	3 minutes	3 minutes	3 minutes	3 minutes
Time of day	Any	Not specified; "just after dark" preferred.	Half hour before sunset until midnight.	Half hour before sunset until midnight.
Survey area	Unlimited	Unlimited	Unlimited	Unlimited, but observations within 100-m specified
Initial survey year	2000	1992	1992	1995
Weather conditions	Generalized	Defined	Defined	Defined
Training	Online resources, kit with training CD and laminated identification key, training workshops.	Kit with training tape	Kit with training tape	Kit with training CD, training workshops
Type of data submission	Online or by mail	Mail or on-line	Mail or on-line	Mail and online

METHODS

Data Standardization

Because the type of data collected, methods for collection, data coding and storage methods varied considerably among programs, we did not attempt to standardize all data fields. Rather, a core group standard data fields were selected for standardization based on data fields that were required for generating annual indices, and included unique route and station identifiers, survey site (region and coordinate information), breeding period, date, species code, and calling codes.

Because breeding period is strongly associated with latitudinal temperature gradients, it was important that each survey site be associated with a latitudinal stratum or region. Therefore, all survey sites were assigned to the Northern, Central or Southern region based on their geographic coordinates (Table 2).

Table 2 - Latitude and longitude cutoffs used to assign sites to standardized regions.

Region	Region Code	Min. Latitude	Max. Latitude
Northern	N	47.0000 N	--
Central	C	43.0001 N	46.9999 N
Southern	S	--	43.0000 N

Each survey region had a unique breeding season (breeding period) based on average climatic conditions (Table 3) and was assigned to each survey record as a numeric value (0, 1, 2 or 3).

Table 3 – Minimum and maximum dates used to assign routes/sites to standard survey breeding periods for each region.

Survey/Breeding Period	Region Code	Minimum Date	Maximum Date
0	N	30 Sept.	1 Mar.
	C	30 Sept.	1 Mar.
	S	30 Sept.	1 Mar.
1	N	1 Mar.	15 May
	C	1 Mar.	30 Apr.
	S	1 Mar.	15 Apr.
2	N	16 May	30 Jun.
	C	1 May	14 Jun.
	S	16 Apr.	31 May
3	N	1 Jul.	30 Sept.
	C	15 Jun.	30 Sept.
	S	1 Jun.	30 Sept.

Species names and associated species codes were standardized between all program databases (Table 4). Weather parameters were also standardized among programs and included precipitation, sky cover, wind speed estimates and air temperature. Calling codes were standardized among the four programs (Table 5). For each program, all duplicate records were removed and each data field was reviewed (via visual scanning and custom error-screening queries) to identify, remove or rectify data errors where possible. To identify spatial errors, coordinates were plotted using ArcView 3.2 software and were examined for duplicates, noticeable erroneous positions, and overlap (i.e., more than one site occurring within the same wetland).

Table 4 - Standardized species codes, and species names (common and scientific) that were applied to each program database.

Species Code	Common Name	Scientific Name
AMTO	American Toad	*Bufo americanus*
BCFR	Blanchard's Cricket Frog[+]	*Acris crepitans blanchardi*
BULL	Bullfrog	*Rana catesbeiana*
BWTO	Boreal/Western Toad	*Bufo boreas*
CATO	Canadian Toad	*Bufo hemiophrys*
CGTR	Cope's (Diploid) Gray Treefrog	*Hyla chrysoscelis*
CHFR	Striped, Boreal/ Western Chorus Frog	*Pseudacris triseriata/ Pseudacris maculata*
FOTO	Fowler's Toad	*Bufo woohhousei fowleri*
GRFR	Green Frog	*Rana clamitans melanota*
GRTR	Gray (Tetraploid) Treefrog	*Hyla versicolor*
MIFR	Mink Frog	*Rana septentrionalis*
NLFR	Northern Leopard Frog	*Rana pipiens*
NONE	No frogs recorded	
ORSF	Oregon Spotted Frog	*Rana pretiosa*
PIFR	Pickerel Frog	*Rana palustris*
SPPE	Spring Peeper	*Pseudacris crucifer*

Table 5 - Standardized calling codes applied to call intensity data from each of the four programs.

Calling Code	Description
0	No amphibians calling
1	Individuals can be counted; calls do not overlap
2	Calls overlap but individuals can still be counted
3	Full chorus; individuals cannot be counted

Calculating Annual Indices and Trends

To assess species population changes, this assessment created and evaluated annual species occurrence indices. This type of analysis looks at whether a particular species is present or absent from a specific site in a given year, then evaluates how the presence (occurrence) of that species changes from year to year. Data current to 2006 were used in the analyses.

Only data from routes/sites that had been visited at least once in each of the three breeding periods were used, which greatly reduced sample sizes. The sample size for the FWC data set was reduced from 2258 records to 651 records, which was too small to produce annual indices. For the remaining three programs, analyses were restricted to 1995-2006, but years with small sample sizes were also eliminated (Backyard Frog Survey: 2006; Road Call Count: 2002, 2005-2006).

We first summarized species presence across all survey visits for each station surveyed within a route in a given year. We then fit, for each species, a logistic model[1] with the proportion of all stations on each route

[1] (PROC GENMOD, log-link, binomial errors; SAS Institute Inc. 2001). Variance estimates were adjusted for overdispersion by applying the deviance scaling method (PROC GENMOD, DSCALE option; SAS Institute Inc. 2001). An occurrence index was then calculated using the inverse logistic formula: *Occurrence Index* = 100 x $e^{A + (\log(proppres/(1-proppres)))/\ 1+(\log(proppres/(1-proppres)))}$, where, *A* = annual estimated species occurrences (i.e., parameter values for Year) from route-regression models, and *proppres* = proportion of stations where the given species was present. This transformation gives the relative (percent) annual differences in amphibian occurrence indices scaled to the average value for the most recent survey year.

as the response. The terms for Year in that model (fit as a class variable) were used to generate annual occurrence indices for each species. Route was included as a class variable.

Trends in relative occurrence were generated for species that were detected on greater than five survey routes/sites by fitting the same models, but including year as a continuous variable. This provided a linear estimated rate of change in species occurrence over time. Species-specific slopes were also converted into relative indices of change by using the inverse logistic (as above). This gives us the percent annual change in a species' occurrence index during the temporal period examined for each program data set.

Geographic/Species Coverage

To assess the geographic distribution of survey routes/sites, the geographic coordinates for each route/site for each program was plotted in ArcView. The distribution of survey routes for each monitoring program was then visually compared with published range maps for twelve anuran species (NatureServe 2008) to assess whether the program had representative coverage within each species' Ontario range.

RESULTS

The number of unique routes/sites surveyed annually for each program is summarized in Table 6. Backyard Frog Survey had approximately 100 sites monitored annually from 1995 to 2003, but coverage subsequently declined. The Amphibian Road Call Count consistently had 35-50 routes being monitored each year from 1995 to 2001 but participation has since declined. FrogWatch Canada began in 2000, with 70 sites monitored. Survey coverage reached 157 sites in 2004 but subsequently declined then rebounded significantly in 2007 and 2008. The Marsh Monitoring Program has had consistent coverage with the number of routes monitored ranging from 110-150 throughout the duration of the program.

This analysis looked at data current to 2006. There were very few sites/routes that were surveyed consistently over long durations. For FrogWatch, there were 15 sites that were monitored for at least five years from 2000 to 2008. There were 31 Backyard Frog Survey sites surveyed for at least ten years, and 117 for at least five years. The Marsh Monitoring Program had 41 routes that were monitored for ten years and 135 that were monitored for five years. The Road Call Count had only seven routes monitored for 10 years, and 29 that were surveyed for at least five years.

Table 6 – Number of routes/sites surveyed annually by each of the four volunteer based anuran monitoring programs in Ontario.

Year	Backyard Frog Survey	Amphibian Road Call Count	FrogWatch Canada	Marsh Monitoring Program
1992	4	62	—	—
1993	28	17	—	—
1994	42	27	—	—
1995	93	53	—	103
1996	126	39	—	112
1997	111	48	—	136
1998	98	41	—	121
1999	94	37	—	114
2000	116	35	70	113
2001	98	35	124	113
2002	100	11	106	152
2003	93	13	128	124
2004	83	18	157	110
2005	84	15	113	120
2006	77	14	54	149
2007	87	21	126	175
2008	56	16	117	186

Annual Indices and Trends

We were able to derive annual occurrence indices and trends for Amphibian Road Call Count, Backyard Frog Survey and Marsh Monitoring Program for eight anuran species (Table 7). There were insufficient data to generate indices for FrogWatch. Variances associated with annual indices were similar between the Marsh Monitoring Program and Road Call Count for most species, whereas variances for Backyard Frog Survey indices tended to be higher (e.g., Figure 1).

The Backyard Frog Survey showed statistically significant declining trends ($P < 0.05$) for two species: American Toad and Chorus Frog. The Road Call Count detected significant trends for three species: Bullfrog, American Toad, and Wood Frog. Marsh Monitoring Program showed significant trends for five species: Bullfrog, Green Frog, Chorus Frog, Spring Peeper and Northern Leopard Frog.

For species that were monitored by more than one program there was some disagreement among the direction of the trends. The Marsh Monitoring Program detected a declining trend (-1.7%/year) for Bullfrog whereas the Road C detected an increasing trend (+2.4%/year) for this species. For American Toad, the Road Call Count showed a significantly declining trend (-3.4%/year) while BFS showed an increasing trend (+0.8%/year). There was agreement for Chorus Frog – both Marsh Monitoring Program and the Backyard Frog Survey showed significant decreases for this species. The Marsh Monitoring Program also detected significant declines for Green Frog and Northern Leopard Frog, and a significant increase for Spring Peeper. ARCC also detected a decline for Wood Frog.

Figure 1 shows the annual occurrence indices from 1995 to 2006, with 95% confidence intervals for Chorus Frog for the Road Call Count, Backyard Frog Survey and the Marsh Monitoring Program, a species that we felt was well monitored by all three programs. The Marsh Monitoring Program indices have smaller confidence intervals than do the Amphibian Road Call Count and Backyard Frog Survey, but all three programs showed the same pattern of declining trend for this species. The patterns of annual variation differ among the three programs.

Table 7 – Annual occurrence indices for eight anuran species derived from the Marsh Monitoring Program (MMP), Amphibian Road Call Count (ARCC) and Backyard Frog Survey (BFS), between 1995 and 2006. Mean occurrence index value, 95% confidence interval range and significant trend direction are provided.

	Year													
Species/Program	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Trend	Trend Direction
Bullfrog														
MMP	57.5	55.2	45.2	51.3	45.2	31.7	33.2	40.3	35.5	33.2	34.5	40.5	-1.7 (-2.8 →-0.5)	↓
ARCC	8.8	4.5	16.1	22.4	23.1	28.4	28.7	—	26.0	21.4	—	—	2.4 (0.7 → 4.1)	↑
BFS	27.5	66.7	39.5	60.1	50.0	56.0	59.1	34.1	60.6	48.0	38.2	—	-0.2 (-2.8 → 2.4)	—
Green Frog														
MMP	87.7	83.8	78.5	88.8	71.3	60.9	65.8	67.0	62.7	76.3	69.6	76.6	-1.4 (-2.2 → -0.7)	↓
ARCC	35.1	25.5	39.8	42.4	48.7	37.3	50.1	—	40.8	40.0	—	—	1.0 (-0.4 → 2.4)	—
BFS	66.2	74.6	80.9	76.1	57.1	58.7	70.0	71.7	67.2	66.6	81.1	—	0.0 (-1.8 → 1.7)	—
American Toad														
MMP	53.7	44.1	53.1	56.8	37.7	41.1	41.7	49.7	56.4	31.9	48.1	34.7	-0.7 (-1.6 → 0.1)	—
ARCC	67.8	41.7	58.5	61.9	42.6	48.8	27.7	—	35.1	37.1	—	—	-3.4 (-4.6 → -2.2)	↓
BFS	96.1	66.5	73.6	75.7	79.1	86.9	85.8	85.8	94.9	84.7	94.3	—	0.8 (0.0 → 1.4)	↑
Gray Treefrog														
MMP	71.8	72.7	61.1	41.1	51.8	62.2	49.3	57.8	76.2	69.9	57.8	56.6	-0.4 (-0.4 → 0.7)	—
ARCC	73.1	83.0	44.2	47.0	69.0	77.4	53.1	—	80.8	80	—	—	1.0 (-0.1 → 2.1)	—
BFS	76.7	86.7	56.2	91.1	96.9	86.7	70.2	93.5	86.7	82.9	82.2	—	0.5 (-1.5 → 2.4)	—

Chorus Frog														
MMP	50.5	55.6	53.4	53.8	45.9	43.3	49.5	51.1	31.8	39.2	42.6	32.3	-1.5 (-2.7 → -0.4)	↓
ARCC	27.6	18.2	17.0	11.2	4.8	5.0	11.0	—	7.0	21.4	—	—	-0.8 (-2.5 → 1.0)	—
BFS	93.0	91.0	88.5	70.0	66.7	65.7	53.8	50.0	56.7	57.7	63.6	—	-5.3 (-7.9 → -2.7)	↓
Spring Peeper														
MMP	67.7	75.7	80.3	92.4	82.3	77.1	83.5	87.9	79.4	93.0	93.4	81.5	1.3 (0.5 → 2.1)	↑
ARCC	96.0	98.2	97.1	82.3	91.8	94.8	91.0	—	92.8	92.9	—	—	-0.7 (-1.6 → 0.1)	—
Wood Frog														
MMP	44.9	47.2	54.3	34.5	33.0	23.8	33.0	31.5	34.0	38.5	50.6	38.0	-0.7 (-1.8 → 0.5)	—
ARCC	78.5	65.4	78.3	53.0	59.7	38.5	54.6	—	61.8	56.4	—	—	-2.5 (-3.9 → -1.2)	↓
BFS	76.0	82.3	80.4	57.7	70.8	62.3	47.5	50.7	61.8	49.7	75.6	—	-1.5 (-3.7 → 0.5)	—
Northern Leopard Frog														
MMP	40.9	45.1	61.0	73.3	46.5	48.4	35.6	36.9	41.9	33.7	40.1	42.0	-1.4 (-2.4 → -0.5)	↓
ARCC	4.5	14.8	18.4	26.7	25.2	39.5	23.3	—	27.3	11	—	—	0.8 (0.1 → 1.7)	—
BFS	58.5	51.1	39.0	39.5	41.6	56.3	44.7	66.0	73.4	62.7	45.4	—	-1.5 (-1.2 → 4.0)	—

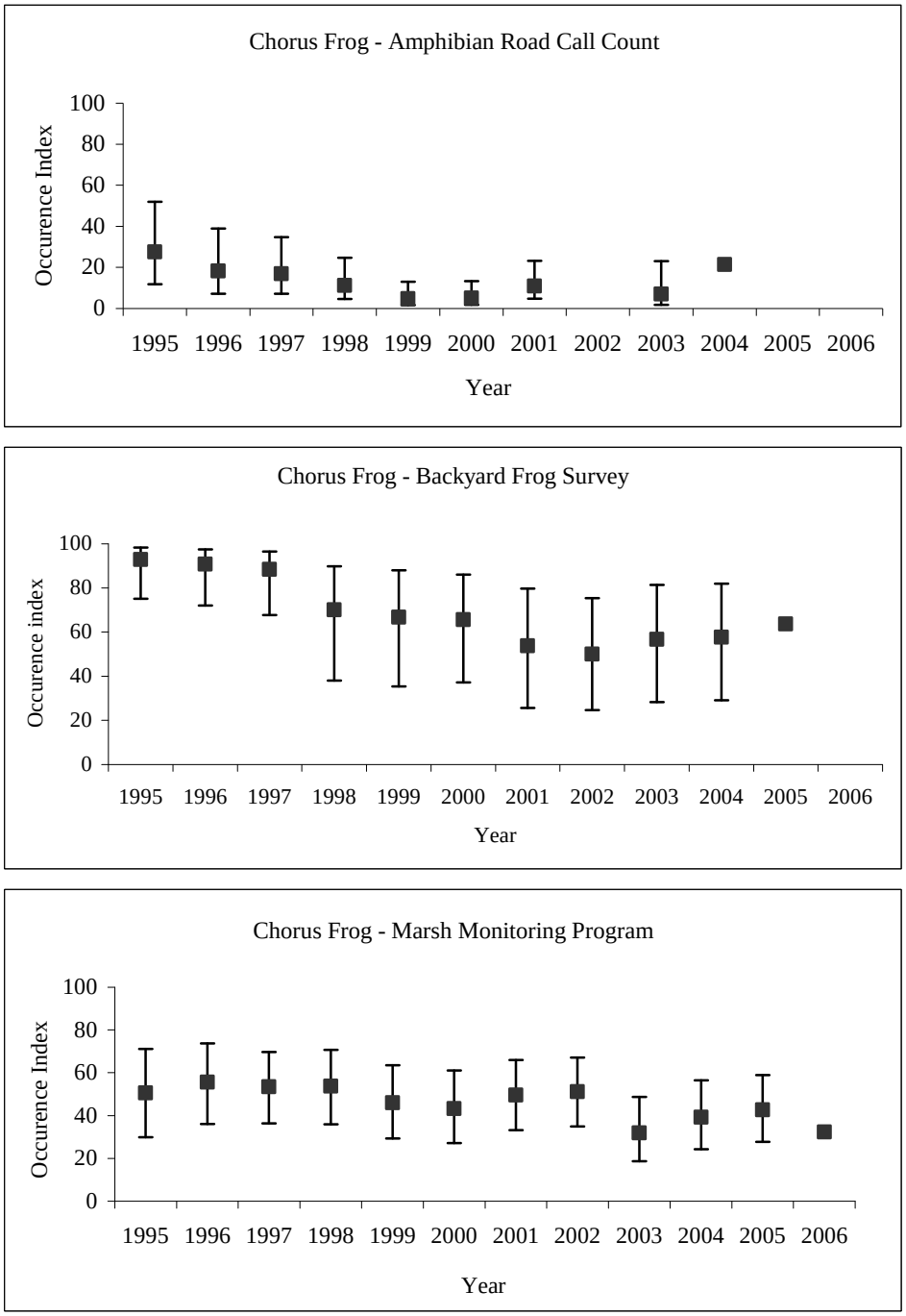

Figure 1 – Annual occurrence indices (± 95% Confidence Intervals) for Chorus Frog using data collected from the Amphibian Road Call Count, Backyard Frog Survey and Marsh Monitoring Program in Ontario from 1995-2006.

Geographic and Species Coverage

Geographic coverage

Of the four programs, FrogWatch probably had the best geographic coverage in Ontario. All four programs had the majority of routes/sites clustered in southern Ontario and very poor coverage in central and northern Ontario. FrogWatch had some northern coverage, but the majority of these sites were only monitored once. The Road Call Count also had some coverage outside of southern Ontario, but it was very limited. In general, all of the programs had good coverage in southern Ontario, although the Marsh Monitoring Program routes were more clustered along Great Lakes shorelines.

Species coverage

We assessed how well the various programs were sampling the known ranges of anurans in Ontario by visually comparing route distribution maps to individual species range maps. Each program had the same ability to representatively survey each anuran species as described in Table 8.

Table 8 – Summary of the four programs' ability to representatively survey 13 species' known Ontario ranges. "Y" (Yes) = program site distribution adequately covers a given species' known Ontario range; "N" (No) = program site distribution does not adequately cover a given species' known Ontario range.

Species	Representatively surveyed?
American Toad	N
Bullfrog	Y
Boreal Chorus Frog	N
Western Chorus Frog	Y
Fowler's Toad[1]	Y
Cope's Gray Tree Frog	N
Gray Tree Frog	Y
Green Frog	N
Mink Frog	N
Northern Leopard Frog	N
Pickerel Frog	Y
Spring Peeper	N
Wood Frog	N

Note: While all four programs have coverage within the ranges of Fowler's Toad and Pickerel Frog, these species have specialized habitat requirements, and so may not be well covered by all programs.

As expected, species with ranges restricted to the southern portion of the province were well covered by most programs whereas species with more widespread or northerly distributions were not well sampled. Ontario ranges of Bullfrog and Western Chorus Frog were well covered by all four programs. The programs also sampled extensively within the range of Fowler's Toad, as well as the majority of the Pickerel Frog's known range, but these species have specific habitat requirements, and so may, in fact, not be well covered by any of the programs.

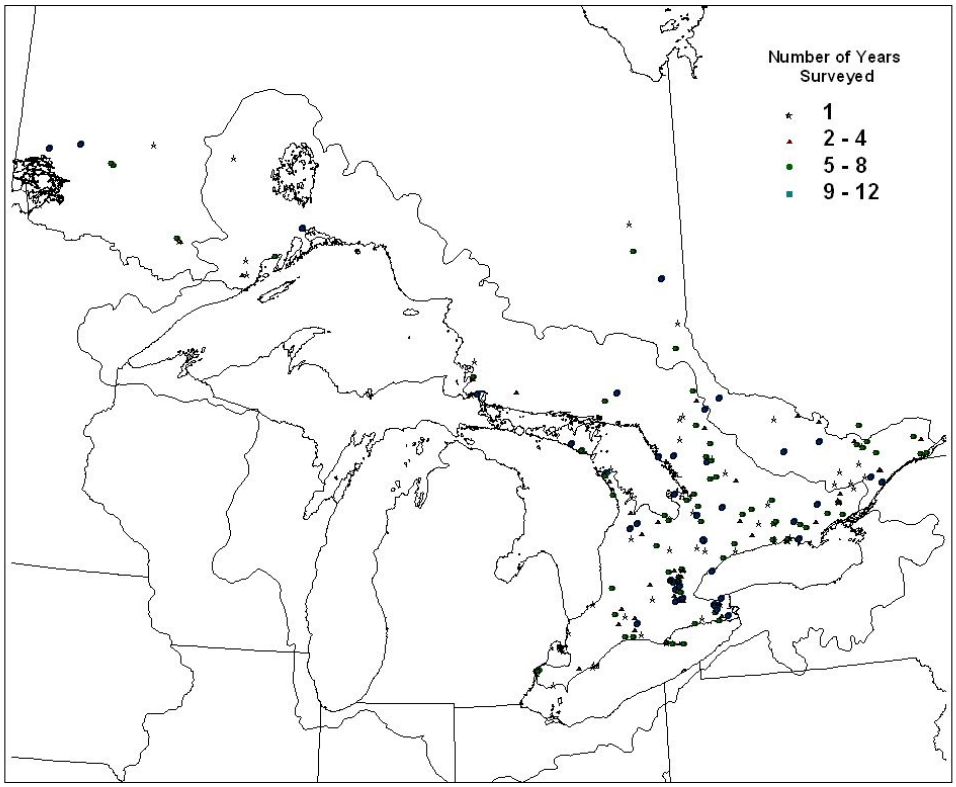

Figure 2a – Distribution of Backyard Frog Survey sites in Ontario and the number of years that each site was surveyed from 1995 to 2006.

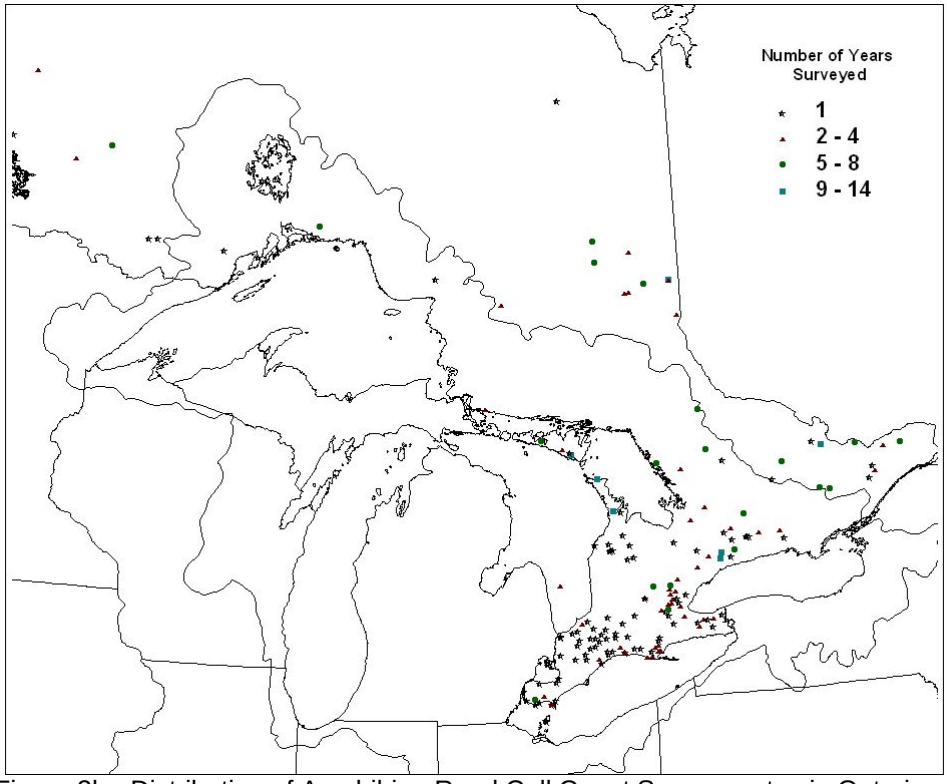

Figure 2b - Distribution of Amphibian Road Call Count Survey routes in Ontario and the number of years that each route was surveyed from 1995-2006.

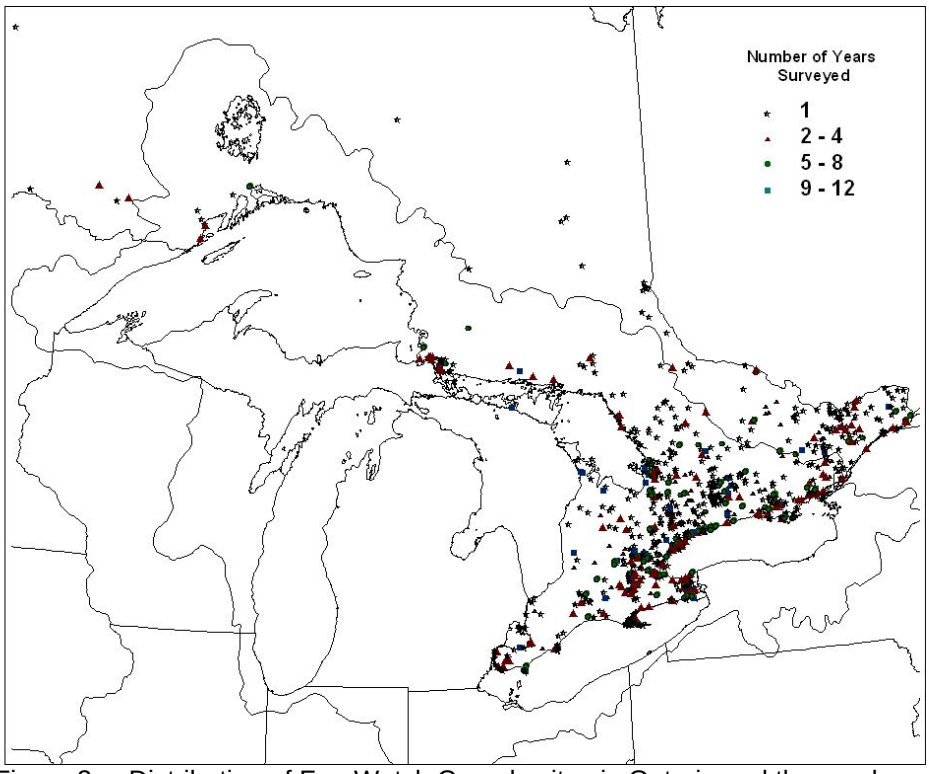

Figure 2c - Distribution of FrogWatch Canada sites in Ontario and the number of years that each site was surveyed from 2000 to 2006.

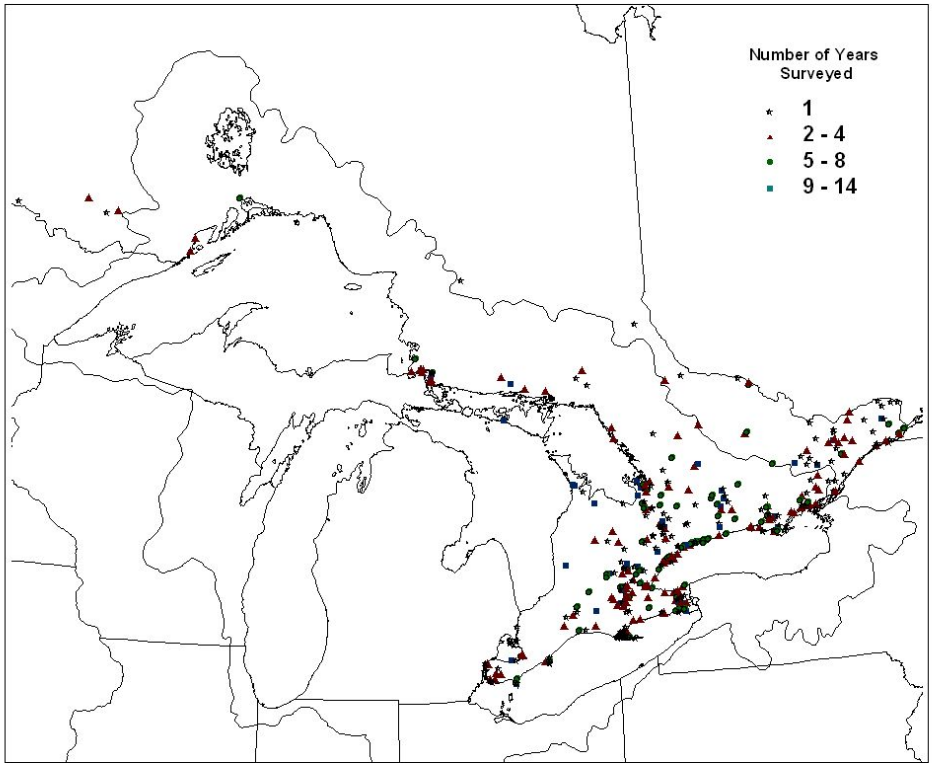

Figure 2d - Distribution of Marsh Monitoring Program survey routes in Ontario and the number of years that routes were surveyed from 1995 to 2006.

DISCUSSION

Examining the variance associated with annual indices and the 95% Confidence Intervals on the trend estimates provides a good indication of the quality of the data for population monitoring. For most species, trends produced from the Marsh Monitoring Program data were more precise (i.e. had smaller confidence intervals) than were trends from the Road Call Count or Backyard Frog Survey. This is not surprising given that the primary objective of the Marsh Monitoring Program is to monitor trends in occurrence, the program has been running consistently since 1995 and more than 100 routes are run each year. The Marsh Monitoring Program has the further benefit of retaining the survey routes despite volunteer turnover.

Differences in program methodology resulted in significantly reduced sample sizes for Backyard Frog Survey and FrogWatch once the data were filtered for sites with at least three visits in all three breeding periods. Both the Road Call Count and the Marsh Monitoring Program use three specified survey periods, which when conducted during defined weather and temperature conditions, are timed to coincide with peak early, mid and late-season breeding activity. While the Backyard Frog Survey protocol specifies appropriate weather and temperature conditions, it does not require visits during each of the three peak breeding periods. The FrogWatch protocol does not specify specific weather and temperature condition, and also does not specify that surveys should occur once during each of the three breeding periods. This is a limitation of Backyard Frog Survey and FrogWatch because participants may collect data during only one or two anuran breeding periods, and therefore not detect certain other species. Encouraging participants to survey during each of the survey periods and providing clear weather guidelines for surveys would improve the quality of the datasets and allow more data to be used in future annual index regression analyses. Although we were not able to use FWC data in this type of analyses, this program has great potential for monitoring anuran populations in Ontario because of its large survey area, flexibility in protocol; range of habitats sampled and potential to attract the most participants. Other types of analyses would be a valuable future exercise. Environment Canada is currently considering these recommendations.

Our analyses revealed differences in the direction of species trends among the monitoring programs, which may be due to a number of different factors. One of these factors is among-program differences in species detectability. For example, de Solla et al. (2005) found that when acoustic surveys used three stratified sampling periods (e.g., Marsh Monitoring Program, Amphibian Road Call Count) they cannot sufficiently detect all anuran species that may be present without adjusting site occupancy using detection probabilities. Programs such as Backyard Frog Survey have a much higher survey effort, with some volunteers surveying for more than 100 nights in a given year, which results in much higher detection probabilities, as long as the visits are timed to cover all breeding periods (de Solla et al. 2005). Detection probabilities must be accounted for or false trends may be introduced into the surveys. The issue of species detectability should be addressed for all anuran monitoring programs, but especially for the Road Call Count and Marsh Monitoring Program. Possible solutions are to ensure detection probabilities are sufficiently high by increasing the number of sampling periods during a breeding season, or to use statistical methods to estimate detection probability and subsequently adjust trend estimates.

Another reason for among-program differences in species trends is the variation in type of habitat being sampled. Amphibian Road Call Count surveys are restricted to roadsides, and include any type of habitat in which anurans may breed (e.g., wooded swamp, drainage ditch, emergent marsh, wet meadow). Backyard Frog surveys are generally conducted within a participants' property, so the range of potential habitats surveyed is vast. The Marsh Monitoring Program surveys are only conducted within marsh or wet meadow habitats; survey locations are primarily selected based on local or regional monitoring needs and/or proximity to individual participants' homes. Finally, FrogWatch survey sites can simply encompass any potential anuran breeding habitat type.

Because many anuran species are presumed to be in decline, there is a need to collectively examine data from all monitoring programs, which encompass a wide array of habitats. Examining data from one source only may not accurately represent the real population trend, particularly for programs such as the Marsh Monitoring Program which are sampling only a small portion of available habitat types. The degree of limitation will vary by species and program in question. For example, Marsh Monitoring Program data

for Bullfrogs, Northern Leopard Frogs and Green Frogs, which predominantly breed in semi-permanent to permanent emergent marsh habitats, may be reflective of true population status and trends for these species. However, data for Wood Frogs and Gray Treefrogs, which often breed in non-marsh habitats, may be less reflective and alternative sources such as Backyard Frog Survey, Road Call Count and FrogWatch should also be considered.

Finally, geographic coverage must be examined before comparing trends among programs. None of the programs have intensive sampling in northern Ontario and coverage in central Ontario is also weak. Because of this limitation, none of the programs (separately or collectively) are able to assess the status of species with large, or predominately northern Ontario ranges. Most of the monitoring programs had sufficient power to detect annual change for some of these widespread species (e.g., Spring Peeper, Wood Frog), but it is not known whether the observed trends in southern Ontario are reflective of the overall population trend in Ontario. We recommend that each program examine the spatial distribution of routes/sites and work collectively to increase coverage outside southern Ontario.

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