



Wetland Anurans

Formerly Indicator #4504

Overall Assessment

Status: Poor

Trend: Unchanging

Rationale: The occurrence of over half the species was stable between 1995 and 2010 (5 of 8 [63%]), whereas the occurrence of two species significantly increased (25%) and one significantly decreased (12%). The occurrence of each species is below its endpoint.

Lake-by-Lake Assessment

Lake Superior

Status: Undetermined

Trend: Undetermined

Lake Michigan

Status: Poor

Trend: Unchanging

Rationale: The occurrence of about half the species significantly decreased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly increased (14%) and three were stable (43%). The occurrence of each species is below its endpoint.

Lake Huron

Status: Poor

Trend: Unchanging

Rationale: The occurrence of about half the species significantly decreased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly increased (14%) and three were stable (43%). The occurrence of each species is below its endpoint.

Lake Erie

Status: Poor

Trend: Unchanging

Rationale: The occurrence of over half the species was stable between 1995 and 2010 (4 of 7 [57%]), whereas the occurrence of one species significantly increased (14%) and two significantly decreased (29%). The occurrence of each species is below its endpoint.

Lake Ontario

Status: Poor

Trend: Deteriorating

Rationale: The occurrence of about half the species significantly increased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly decreased (14%) and three were stable (43%). The occurrence of each species is below its endpoint.

Purpose

- To assess changes in the relative occurrence of wetland-breeding anuran species (i.e., frogs and toads that lay their eggs in wetlands)

- To infer condition of wetland habitat as it relates to factors that influence this ecologically and culturally important resource
- The Wetland Anurans indicator is used in the Great Lakes indicators suite as a State indicator in the Aquatic Dependent Life top level reporting category.

Ecosystem Objective

To restore and maintain self-sustaining populations of Great Lakes wetland-breeding anuran species across their historic ranges. Numerous wetlands in the Great Lakes basin are threatened by urban and agricultural development and other incompatible land uses and these wetlands should be identified, preserved, and where necessary rehabilitated (GLWQA Annex 13). Monitoring and assessment activities provide information on the location, severity, aerial or volume extent, and frequency of Great Lakes wetlands (Annex 11 GLWQA). This indicator supports the restoration and maintenance of the chemical, physical and biological integrity of the Great Lakes basin and beneficial uses dependent on healthy wetlands (Annex 2 GLWQA).

Ecological Condition

Measure

Changes in relative occurrence of wetland-breeding anurans are based on data from nighttime surveys using Bird Studies Canada's Great Lakes Marsh Monitoring Program (MMP) anuran point count protocol or a modification of it (Marsh Monitoring Program 2009). MMP data from coastal and inland wetlands throughout the Great Lakes basin or throughout each individual lake basin (e.g., Lake Erie; Fig. 1) are used to calculate annual indices of relative occurrence for a suite of wetland anuran species. Wetlands dominated by non-woody emergent plants such as cattails (*Typha* spp.) and sedges (e.g., *Carex* spp.) are targeted by the program. Species-specific population trends over time are calculated using repeated measures logistic regression in a Bayesian mode of inference with uninformative priors (Kéry 2010).

Endpoint

Populations of most wetland-breeding anuran species have declined or remained stable since data collection began for this indicator in 1995. Therefore, one endpoint is population indices for nearly all wetland-breeding anuran species that are as high as or higher than population indices reported by the MMP in the late 1990s, when the program began. A potentially better endpoint, however, might be based on MMP occurrence indices from pristine or near-pristine wetlands throughout the Great Lakes basin (i.e., least disturbed based on indices of anthropogenic disturbance within and surrounding the wetland)—guided by a literature search of other current and historical data and expert opinion. Population indices from this approach are likely to be higher than those reported by the MMP in the late 1990s, given that many wetlands throughout the Great Lakes basin were degraded by that time (e.g., Hecnar and M'Closkey 1996, 1998). Presumably the two approaches estimate the extremes of a range of occurrence that is likely to contain the carrying capacity that the landscape is currently capable of supporting and, therefore, somewhere near the middle of the range is the most suitable endpoint. This is the endpoint used in this report.

Background

Wetland-breeding anurans are influenced by the physical, chemical, and biological components of the wetlands and surrounding landscapes in which they breed. The abundance and/or reproductive success of multiple species in the Great Lakes basin, for example, declines as (1) wetland size decreases; (2) wetland habitat and natural cover in the surrounding landscape decreases; and (3) pesticide, herbicide, and runoff from other sources of pollution into wetlands from the surrounding landscape increases (Hecnar 1995; Hecnar and M'Closkey 1996; Bishop et al. 1999; Crosbie and Chow Fraser 1999; Kolozsvarly and Swihart 1999; Houlahan and Findlay 2003; Price et al. 2004; Brazner et al. 2007a,b; Gagné and Fahrig 2007; Eigenbrod et al. 2008b). Thus, the abundance of wetland-breeding anurans is a valuable indicator of the health of wetlands and the surrounding landscape.

Status of Wetland Anurans

A grand total of 13 anuran species were recorded across all surveys and years throughout the Great Lakes basin between 1995 and 2010. Of these, the data for eight species were suitable for analysis at the scale of the Great Lakes basin, whereas the data for seven species were suitable in each individual Great Lakes basin (Table 1). Data were suitable if the species occurred at >15 routes per year on average.

Great Lakes Basin

The occurrence of over half the species was stable between 1995 and 2010 (5 of 8 [63%]), whereas the occurrence of Green Frog (*Rana clamitans*; see Table 1 for a list of scientific names for all subsequent common names) and Spring Peeper significantly increased and Chorus Frog significantly decreased (Fig. 2). Species that significantly increased made up 25% of the species analyzed and species that significantly decreased made up 12%. Pollution from agricultural and urban areas is often identified as one of the leading causes of anuran declines in the Great Lakes basin (e.g., Bishop et al. 1999). The relative resistance of Green Frogs to nitrates from fertilizer runoff may partly explain the increase in this species; nitrate resistance in Spring Peepers is unknown (Hecnar 1995, Rouse et al. 1999). By contrast, Chorus Frogs are more sensitive to nitrates, which may partly explain the decrease in this species (Hecnar 1995). The resistance of different anuran species to pollution, however, is complicated by variability in resistance among populations within species and by interactions with other factors such as habitat loss, which makes relationships difficult to identify. Spring Peeper is reportedly the most sensitive anuran to human disturbance in the Great Lakes basin, so its significant increase between 1995 and 2010 may be a positive sign, although it currently remains below its endpoint (Brazner et al. 2007a, Price et al. 2007). The status of the indicator is similar in previous reports, whereas the deteriorating trend in the previous report is now unchanging. The apparent improvement in the trend may be short-lived because there is high year-to-year variation in populations of most anuran species in the Great Lakes basin. Given that the occurrence of each species is below its endpoint and the occurrence of most species was stable since the previous report, the overall status is poor and the trend is unchanging.

Lake Michigan

The occurrence of about half the species significantly decreased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly increased (14%) and three were stable (43%). The occurrence of each species is below its endpoint. The status of the indicator is similar in previous reports, whereas the deteriorating trend in the previous report is now unchanging. The apparent improvement in the trend may be short-lived because there is high year-to-year variation in populations of most anuran species in the Lake Michigan basin. Given that the occurrence of each species is below its endpoint and the occurrence of most species was stable since the previous report, the overall status is poor and the trend is unchanging (Table 1).

Lake Huron

The occurrence of about half the species significantly decreased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly increased (14%) and three were stable (43%). The occurrence of each species is below its endpoint. The status of the indicator is similar in previous reports, whereas the deteriorating trend in the previous report is now unchanging. The apparent improvement in the trend may be short-lived because there is high year-to-year variation in populations of most anuran species in the Lake Huron basin. Given that the occurrence of each species is below its endpoint and the occurrence of most species was stable since the previous report, the overall status is poor and the trend is unchanging (Table 1).

Lake Erie

The occurrence of over half the species was stable between 1995 and 2010 (4 of 7 [57%]), whereas the occurrence of one species significantly increased (14%) and two significantly decreased (29%). The occurrence of each species is below its endpoint. The status of the indicator is similar in previous reports, whereas the deteriorating trend in the previous report is now unchanging. The apparent improvement in the trend may be short-lived because there is high year-to-year variation in populations of most anuran species in the Lake Huron basin. Given that the occurrence of each species is below its endpoint and the occurrence of most species was stable since the previous report, the overall status is poor and the trend is unchanging (Table 1).

Lake Ontario

The occurrence of about half the species significantly increased between 1995 and 2010 (3 of 7 [43%]), whereas the occurrence of one species significantly decreased (14%) and three were stable (43%). The occurrence of each species is below its endpoint. The status and trend of the indicator is similar in previous reports. Given that the occurrence of each species is below its endpoint and the occurrence of most species decreased since the previous report, the overall status is poor and the trend is deteriorating (Table 1).

Linkages

Wetland-breeding anurans are influenced by numerous characteristics of the wetlands and surrounding landscapes in which they breed, many of which are monitored as SOLEC indicators. The wetland anuran indicator can be expected to co-vary with indicators that track wetland breeding anuran habitat (e.g., #4863: Coastal Wetland Plant Community; #4863: Land Cover Adjacent to Coastal Wetlands) and prey (#4501 Coastal Wetland Invertebrate Community Health) and factors that indirectly influence them, such as pollution runoff from surrounding uplands (#7100 Natural Groundwater Quality and Human-induced Changes), which reduces anuran prey abundance (Camargo et al. 2005) and which also directly lowers survivorship of anuran eggs and/or adults. Wetland amphibians also can be expected to co-vary with road density (#7200 Land Cover/Land Conversion) and vehicle use (#7064 Vehicle Use), given dispersing individuals are extremely vulnerable to vehicle collisions (Eigenbrod et al. 2008a), and amount of wetland buffering via natural vegetation (#7028 Sustainable Agriculture Practices), given pollution in runoff is trapped by such buffers (Rouse et al. 1999).

Management Challenges/Opportunities

Maintain or improve the quality of wetlands and adjacent uplands for breeding wetland anurans by mitigating or eliminating influences that are detrimental to wetland health such as water level fluctuations, invasive species, and inputs of toxic chemicals, nutrients and sediments. Restoration programs are underway for many degraded wetland areas through the work of local citizens, organizations and governments. Although significant progress has been made, considerably more conservation and restoration work is needed to ensure maintenance of healthy and functional wetlands throughout the Great Lakes basin.

Comments from the author(s)

The utility of the Wetland Anurans indicator is dependent on the continuation of the MMP across the Great Lakes basin. Therefore, recruitment and retention of volunteer surveyors has been, and will continue to be, high priority. Despite this, there are areas where coverage is too sparse for analysis and could be improved (e.g., Lake Superior). As a result, a power analysis was conducted to quantify the MMP's ability to detect changes in occurrence of wetland-breeding anuran species at the scales explored in this report. The analysis suggests that the MMP has 80% power to detect percent annual changes in occurrence as small as 1.0% in the Great Lakes basin; 2.0% in the Lake Erie and Ontario basins; and 2.5% in the Lake Michigan and Huron basins for most species (Fig. 3). These numbers should be considered preliminary and exploratory, however, until the effects of spatial and temporal dependence amongst surveys and detection probability can be fully assessed, which is an ongoing and evolving area of study (Seavy and Reynolds 2007, Patuxent Wildlife Research Center 2003).

Assessing Data Quality

Insert "x" under the statement that best corresponds with each data characteristic

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validated, or quality-assured by a recognized agency or organization	x					
2. Data are traceable to original sources	x					
3. The source of the data is a known, reliable and respected generator of data	x					
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin	x					
5. Data obtained from sources within the U.S. are comparable to those from Canada	x					
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report	x					

Clarifying Notes:

Acknowledgments

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Contributors:

Hundreds of volunteers who generously donate their time, equipment, and skills to ensure long-term, broad-scale monitoring of the health of Great Lakes wetlands.

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List of Tables

Table 1. Population trends of wetland-breeding anuran species used to assess the health of wetlands and their surrounding landscapes in the Lake Michigan, Huron, Erie, and Ontario basin, based on occurrence indices derived from Marsh Monitoring Program point count surveys between 1995 and 2010. Statistically significant trends are indicated by * (i.e., Bayesian credible intervals do not overlap zero). Source: Great Lakes Marsh Monitoring Program.

List of Figures

Figure 1. Mean (\pm SD) number of Marsh Monitoring Program routes surveyed for anurans per year in the Great Lakes basin (All) and in each individual Great Lakes basin (e.g., Superior) between 1995 and 2010. A route consists of multiple, spatially-clustered point count survey locations, typically located in the same wetland, all of which can be surveyed by the same person in a single visit. Source: Great Lakes Marsh Monitoring Program.

Figure 2. Percent annual change of occurrence indices for some wetland-breeding anuran species from 1995 to 2010 in the Great Lakes basin. Indices estimated with repeated-measures logistic regression. Statistically significant positive trends are green, significant negative trends are red, and stable (non-significant) trends are white. Bayesian credible intervals did not overlap zero for significant trends. Source: Great Lakes Marsh Monitoring Program.

Figure 3. Box-and-whisker plots showing minimum detectable annual change (%) of occurrence indices of some wetland-breeding anuran species in the Great Lakes basin (All) and in individual Great Lakes basins (e.g., Superior), derived from Great Lakes Marsh Monitoring Program data. The figure summarizes the 8 species used to assess wetland health in this report. Source: Great Lakes Marsh Monitoring Program.

Last Updated

State of the Lakes Ecosystem Conference (SOLEC) 2011

Common Name	Scientific Name	Michigan	Huron	Erie	Ontario
American Toad	<i>Bufo americanus</i>	+0.7	*-5.5	+0.2	-2.1
Bullfrog	<i>Rana catesbeiana</i>	+4.0	*+4.0	-1.2	-1.8
Chorus Frog	<i>Pseudacris triseriata</i>	+1.0	*-8.6	*-9.9	*-5.1
Green Frog	<i>Rana clamitans</i>	*+4.9	*-4.0	*+3.4	*+5.8
Gray Treefrog	<i>Hyla versicolor</i>	*-5.6	+0.4	+0.5	-0.9
Northern Leopard Frog	<i>Rana pipiens</i>	*-5.5	-1.2	*-1.4	*+2.5
Spring Peeper	<i>Pseudacris crucifer</i>	*-8.3	+2.8	+1.4	*+9.4
Wood Frog	<i>Rana sylvatica</i>	-	-	-	-
TOTAL	8	7	7	7	7

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Source: Great Lakes Marsh Monitoring Program

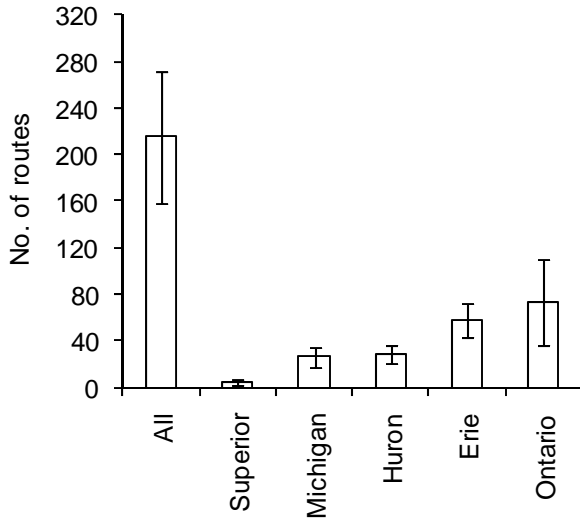


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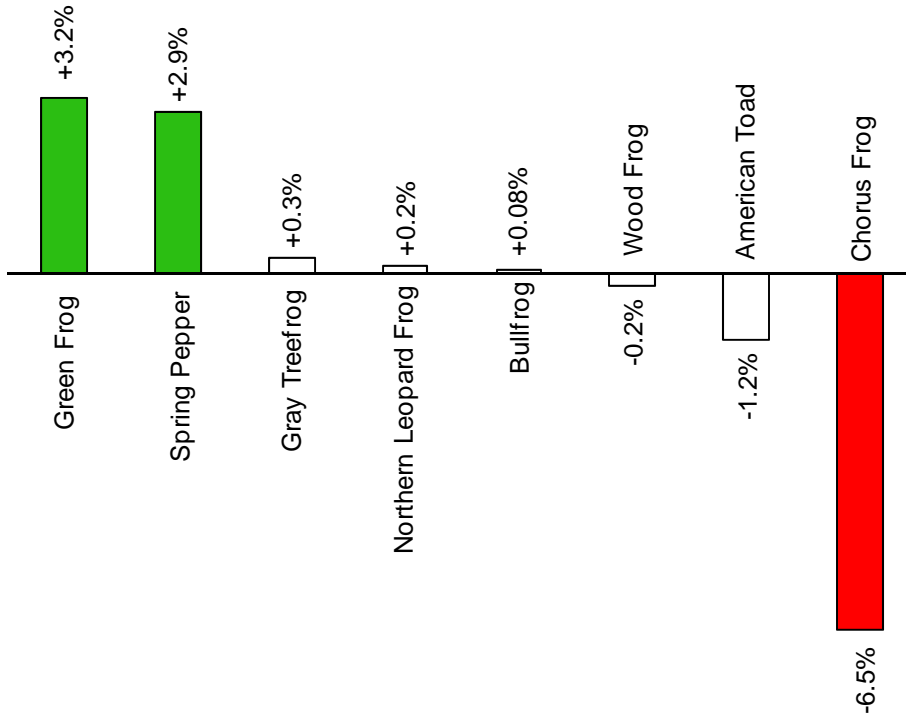


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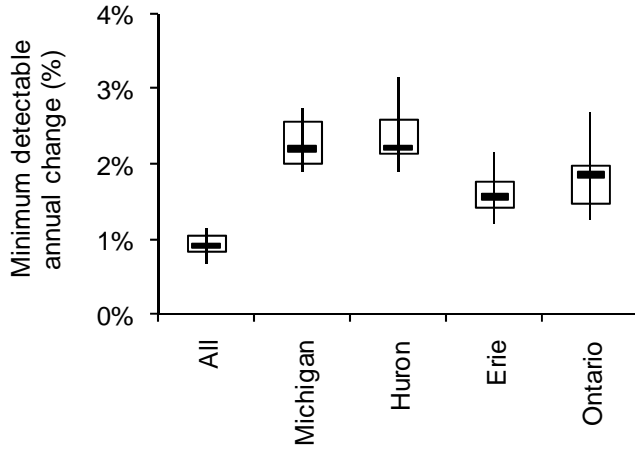


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