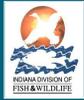


CISCO AS THE REPRESENTATIVE SPECIES FOR COLDWATER GLACIAL LAKE HABITATS IN INDIANA



Steven B. Donabauer¹ and Michael A. Porto
Indiana Division of Fish & Wildlife (IDFW)
1355 S. Governors Dr., Columbia City, IN 46725
¹sdonabauer@dnr.IN.gov



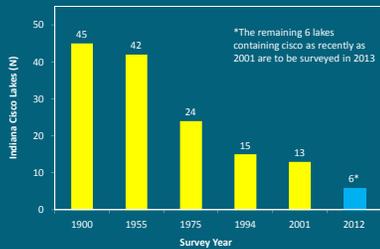
Andrew Honsey² and Tomas Höök
Purdue University (PU)
195 Marsteller St., West Lafayette, IN 47907
²ahonsey@purdue.edu



Abstract

Ciscoes (*Coregonus artedii*) are a coldwater species that inhabit northern Indiana's glacial lakes, which represent the southernmost extent of their native range. The distribution of cisco in Indiana has declined from 42 lakes in 1955 to 13 lakes in 2000. Thus, ciscoes are a *species of greatest conservation need* and are classified as the *representative species* of the coldwater habitat guild for glacial lakes in the Indiana State Wildlife Action Plan. This research is the first year of a two-year project to re-evaluate the status of ciscoes in Indiana. The objectives for 2012 were to derive: (1) habitat suitability (temperature/dissolved oxygen water profiles), (2) catch rates (overnight gill net lifts), (3) size distributions, and (4) sex ratios from lakes most recently classified as having a "common" (≥ 1 cisco/gill net lift) population status. Seven lakes were sampled including: Falling (Steuben Co.), Indiana (Elkhart Co.), South Twin (LaGrange Co.), Gage (Steuben Co.), Eve (LaGrange Co.), Crooked (Whitley Co.), and Gordy (Noble Co.). In addition, a sample of ciscoes (N = 104) exposed to a lethal oxythermal boundary at Little Crooked Lake in July 2012 were collected. Adequate cisco habitat was available in September in all lakes sampled where the cisco layer ($\leq 20^\circ\text{C}$ and $\geq 3 \text{ mg O}_2 \text{ l}^{-1}$) ranged from 0.61-10.97 m thick. Across the seven lakes, 563 ciscoes were collected, with the greatest catch rates in Falling Lake (42 ciscoes/lift). Ciscoes were classified as "common" in all lakes except Gordy Lake (0 ciscoes/lift; "probably extirpated"). All ciscoes collected were between 187-447 mm total length. However, preliminary results suggest that each population was characterized by a fairly narrow length distribution. Moreover, preliminary results indicate female predominance in multiple populations (highest in Little Crooked, 89%), which may compromise recruitment success. In 2013, the Indiana DFW, Purdue University, and the University of Notre Dame will sample cisco lakes most recently classified as having "rare" or "probably extirpated" populations to assess recruitment dynamics, age and growth, food habits, and to evaluate whether eDNA techniques can verify the presence of ciscoes where traditional gear cannot.

Introduction & Objectives



- Cisco are listed as the *representative species* of the coldwater habitat guild, and a *species of greatest conservation need* in Indiana.
- Cisco require cold ($\leq 20^\circ\text{F}$), well oxygenated ($\geq 3 \text{ mg O}_2 \text{ l}^{-1}$) water in order to survive (this habitat is termed the "cisco layer"; Frey 1955).
- There is a need to monitor Indiana's remnant cisco populations in order to make informed decisions that will lead to the preservation or enhancement of this species and the coldwater, glacial lake habitat they represent.
- The objectives of this project were to derive: (1) habitat suitability (temperature/dissolved oxygen water profiles), (2) catch rates (overnight gill net lifts), (3) size distributions, and (4) sex ratios from lakes most recently classified as having a "common" (≥ 1 cisco/gill net lift) population status.

Sampling Locations



Methods

- Each lake was sampled in September 2012 using experimental gill nets; Temperature/DO profiles were measured concurrently.
- Gill nets were reset on Crooked and Gordy Lakes in November due to low catch rates in September.
- Cisco and temperature/DO profiles were also sampled from Little Crooked Lake (adjacent to Crooked Lake) during an observed oxythermal summer kill in July 2012.
- All cisco captured were measured, frozen, and sent to Purdue University for processing and analysis.

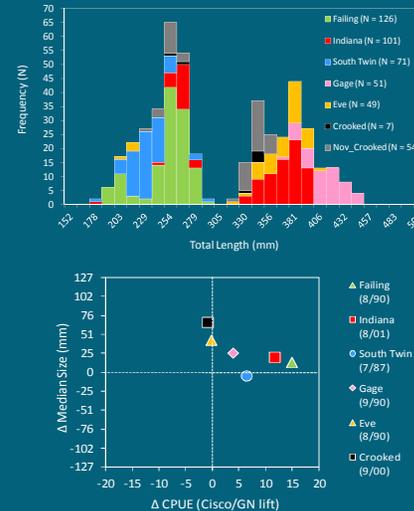
Water Quality and Catch Rates

Lake	Month	Thickness of Cisco Layer (m)	Secchi Depth (m)	Net Lifts	Cisco (N)	N/lift	Median Size (mm)
Falling	Sept	1.2	4.9	3	126	42.0	262
Indiana	Sept	4.3	4.7	3	101	33.7	368
South Twin	Sept	10.4	3.2	3	71	23.7	234
Gage	Sept	11.0	3.4	9	51	5.7	417
Eve	Sept	2.1	3.8	10	49	4.9	376
Crooked	Sept	8.2	2.1	9	7	0.8	345
Gordy	Sept	0.6	1.7	9	0	0.0	-
25 th Percentile	Sept	1.7	2.7	-	-	2.9	282
Median	Sept	4.3	3.3	-	-	5.7	358
75 th Percentile	Sept	9.3	4.3	-	-	28.7	373
Crooked	Nov	-	-	13	54	41.5	340
Gordy	Nov	-	-	9	0	0.0	-



Cisco sampled from Eve Lake (LaGrange Co.)

Size Structure



Change (Δ) in median size of cisco versus change in catch-per-unit effort from the most recent cisco survey (month/year) when compared to data collected in September 2012.

Oxythermal Summer Kill

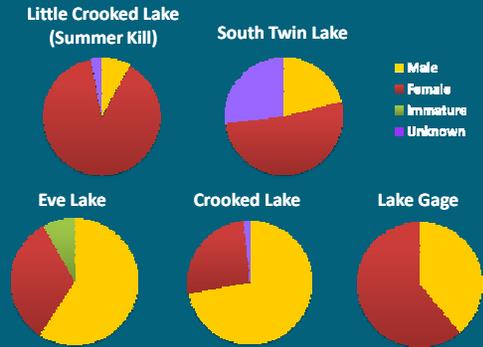


159 cisco were observed (104 collected) dead or dying on the surface of Little Crooked Lake due to a lack of suitable habitat on 24-25 July, 2012.

July 24				July 25			
Depth (m)	Temp (°C)	DO (mg O ₂ l ⁻¹)		Depth (m)	Temp (°C)	DO (mg O ₂ l ⁻¹)	
0.0	29.1	12.0		0.0	28.1	11.1	
0.6	29.0	12.0		0.6	28.1	11.2	
1.2	28.6	13.0		1.2	28.1	11.3	
1.5	28.4	12.7		1.5	28.1	11.5	
1.8	28.3	12.1		1.8	28.1	11.3	
2.4	26.6	15.7		2.4	26.5	10.7	
3.0	23.1	2.9		3.0	23.4	1.7	
3.7	19.4	0.3		3.7	19.9	0.3	
4.3	16.4	0.0		4.3	16.1	0.0	
4.6	13.9	0.0		4.6	8.1	0.0	
6.1	10.6	0.0		6.1	8.1	0.0	
7.6	5.8	0.0		7.6	5.8	0.0	
9.1	5.8	0.0		9.1	5.0	0.0	
10.7	5.1	0.0		10.7	4.8	0.0	
12.2	4.7	0.0		12.2	4.7	0.0	
13.7	4.7	0.0		13.7	4.7	0.0	

The highlighted depths illustrate the complete loss of adequate cisco habitat in Little Crooked Lake.

Sex Ratios



Conclusions

This study is part of a continued effort by the IDFW to conduct the research necessary to make informed decisions regarding the sustainability and health of Indiana's remnant cisco populations and the coldwater habitat they represent. By gaining a better understanding of this species and where they still exist, we hope to conserve and/or enhance the remaining cisco populations and habitat through active management practices. In the past, these management practices have included restrictions on cisco fishing, the reduction of predator stockings and the adoption of informal policies aimed at the reduction of anthropogenic impacts on cisco lakes. However, we are still seeing a decline in the number of cisco lakes in Indiana (cisco were documented in Gordy Lake as recently as 1998). This serves as a reminder of how habitat degradation continues to negatively impact this species. Reducing the largest sources of habitat degradation (e.g. agricultural nutrient loading, shoreline development, etc.) needs to be a high priority if we intend to preserve this imperiled species. Variation in sex ratios among populations will be investigated further and is likely an important factor driving recruitment success.

Future Work

Continued collaboration between IDFW, PU and the University of Notre Dame is planned for 2013. We intend to sample Clear, Dallas, Dillard's Pit, Gooseneck, Green, Knapp, Lawrence, Little Lime, McClish, Meserve, and Seven Sisters Lakes. In addition to the objectives presented in this poster, we plan to assess recruitment dynamics, age and growth, food habits, and to evaluate whether eDNA techniques can verify the presence of ciscoes where population densities are too low to be detected with traditional gear. Additionally, the IDFW intends to monitor late summer temperature and DO profiles on a yearly basis on all cisco lakes. This will allow us to gain a better understanding of how habitat limitations vary from year to year and to examine their effect on cisco population dynamics. A final report on the status of cisco in Indiana can be expected in the spring of 2014.

Selected References

- Frey, D. G. 1955. Distributional ecology of the cisco *Coregonus artedii* in Indiana. Investigations of Indiana Lakes and Streams 4(7):177-228.
- Pearson, J. 2001. Cisco population status and management in Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife report. Indianapolis, IN.