Bat diversity and abundance in the coastal zone of lower Green Bay, Lake Michigan
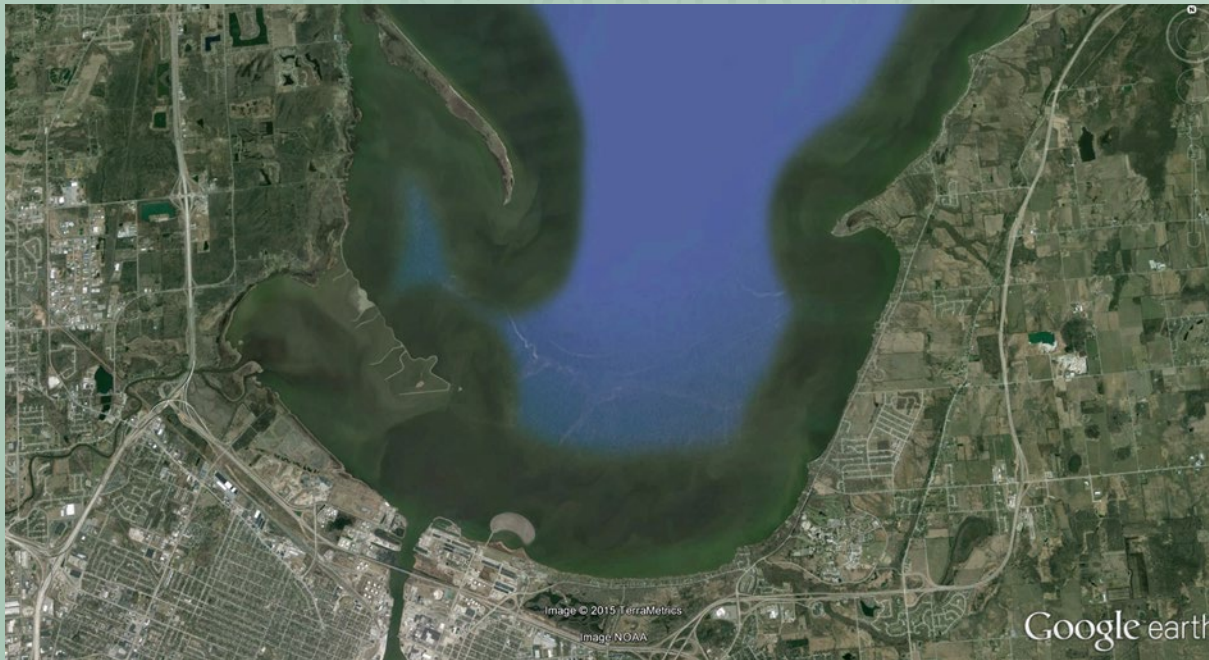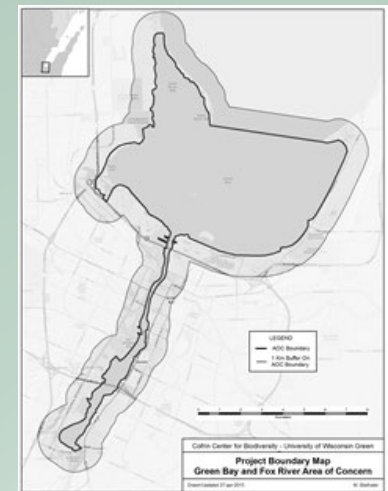

Jeremiah Shrovnal

Green Bay Area of Concern (AOC)
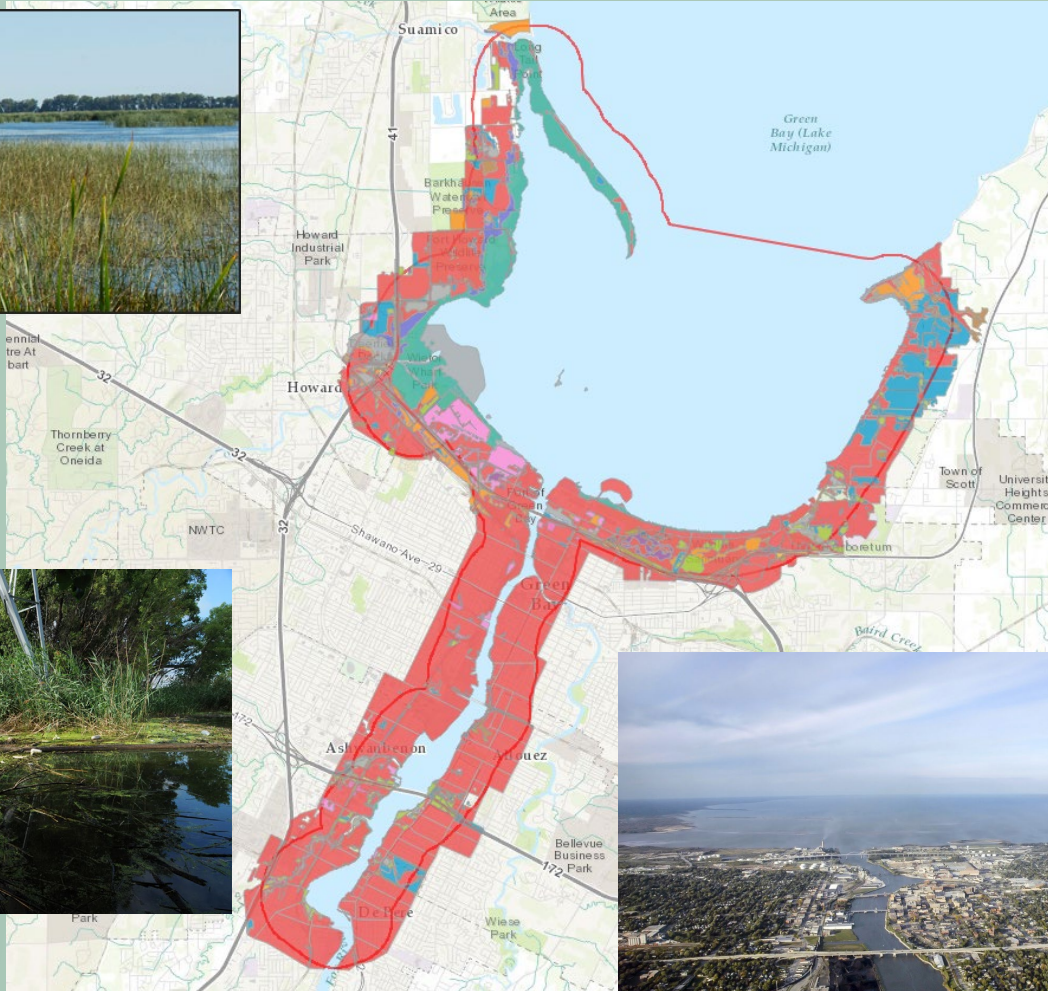

U.S.-Canada Great Lakes Water Quality Agreement (1972)
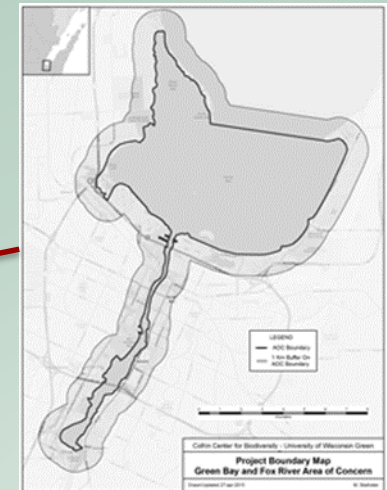
LOWER GREEN BAY

© Robert Howe, UW-Green Bay

Total agriculture =   200 ha
Total high impact = 3,200 ha
Total habitat   = 2,761 ha

Total habitat
6,823 acres

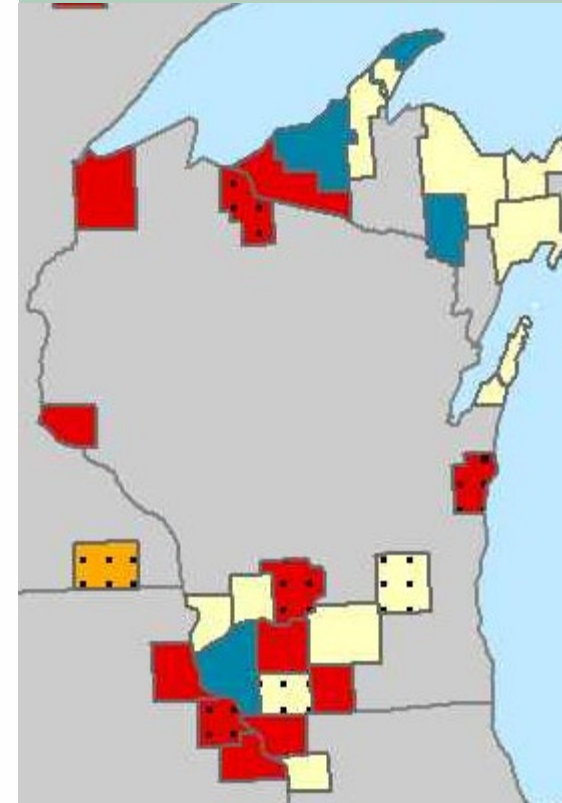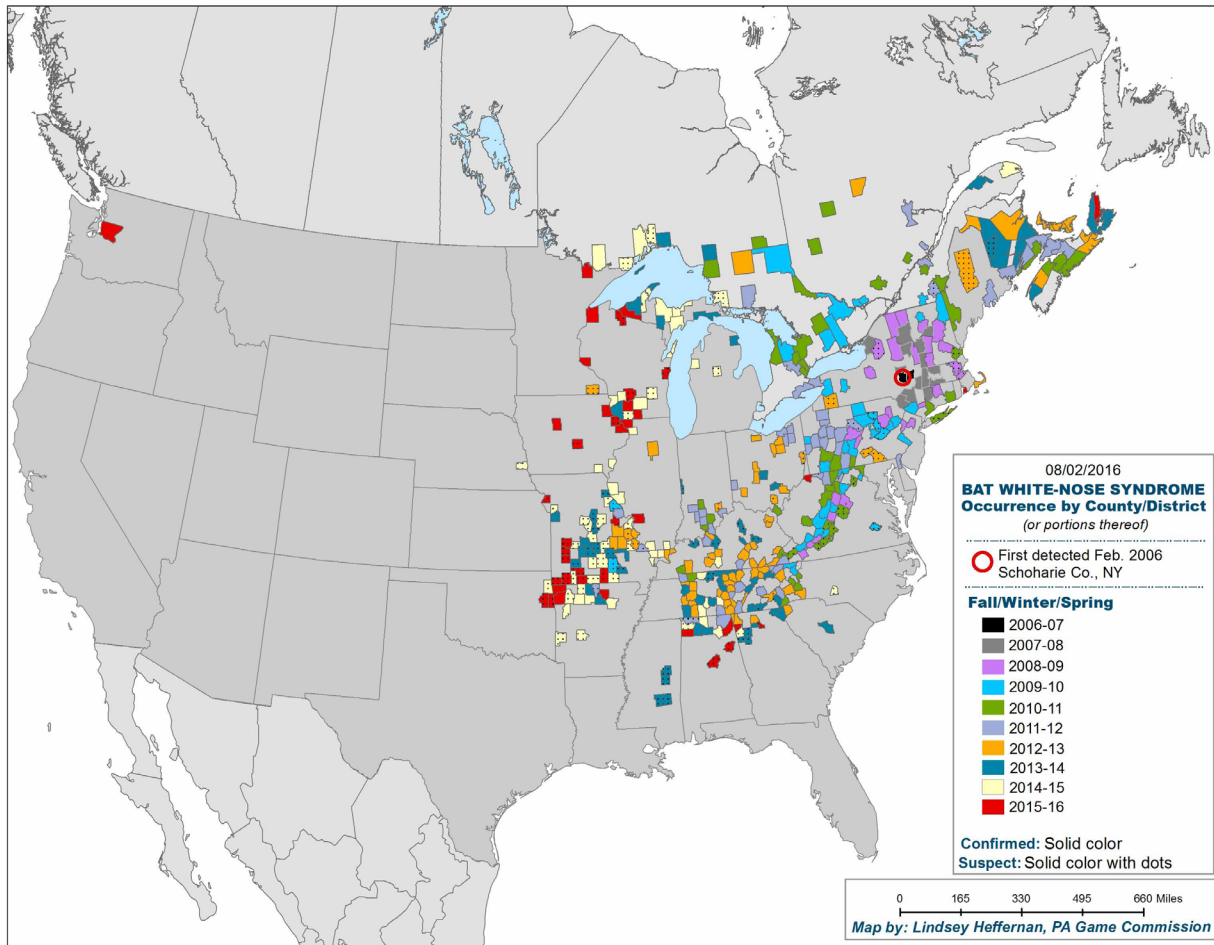
© Erin Giese, UW-Green Bay

GEOLOGY OF GREEN BAY
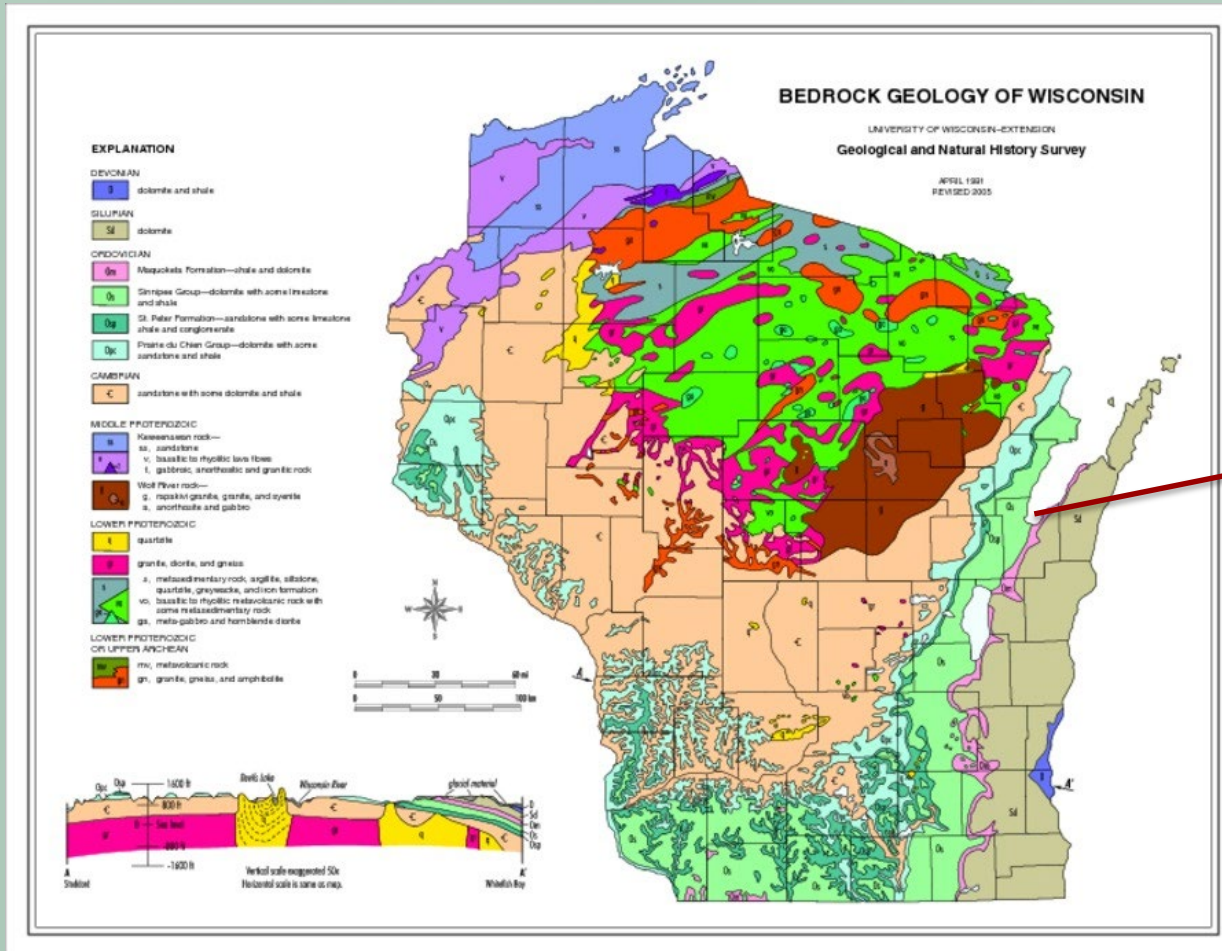
Ecological Benefits

- Herbivory control & Fungal suppression
  - Excess of $1 billion value in corn industry [1]
  - Loss of species could lead to agricultural losses of $3.7 billion - $53 billion [2]

- They eat mosquitoes! [3]

PSEUDOGYMNOASCUS DESTRUCTANS

08/02/2016

BAT WHITE-NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

○ First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring
- 2006-07
- 2007-08
- 2008-09
- 2009-10
- 2010-11
- 2011-12
- 2012-13
- 2013-14
- 2014-15
- 2015-16

Confirmed: Solid color
Suspect: Solid color with dots

0   165   330   495   660 Miles

Map by: Lindsey Heffernan, PA Game Commission

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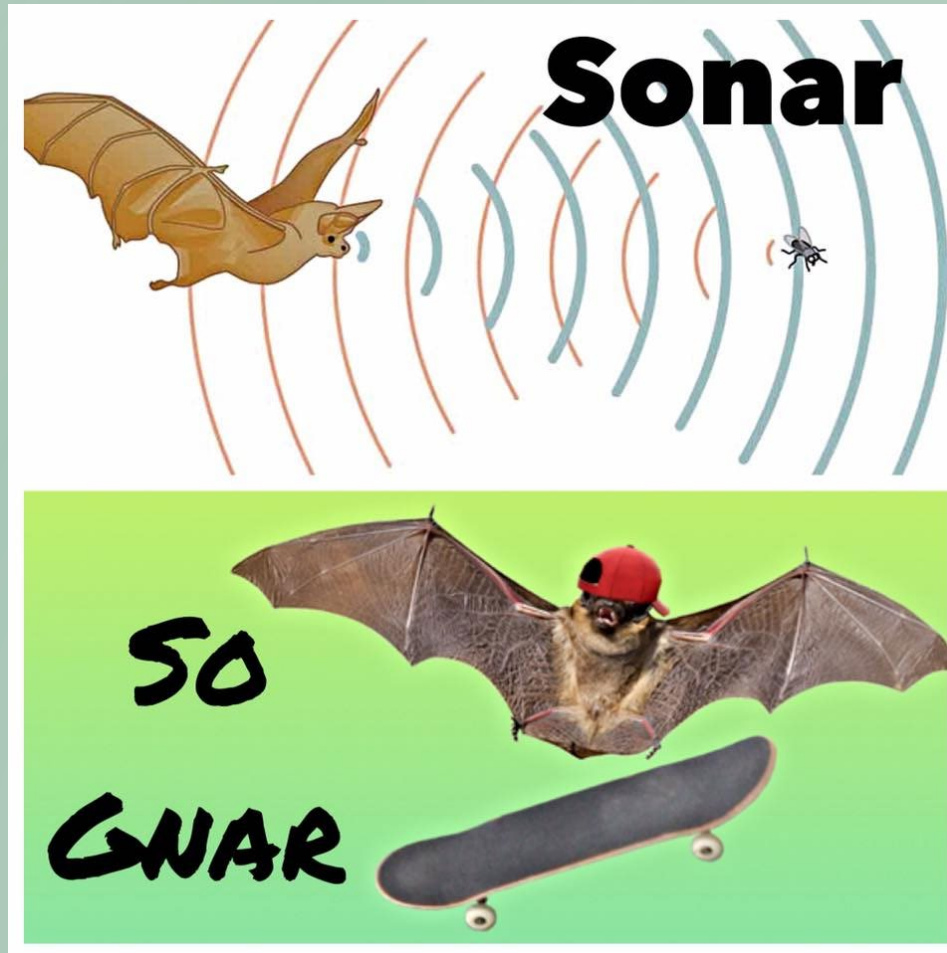GREEN BAY

White Nose Syndrome

Wisconsin fauna

- ## State Threatened
  - Big Brown Bat *(Eptesicus fuscus)*
  - Eastern Pipistrelle *(Perimyotis subflavus)*
  - Little Brown Bat *(Myotis lucifugus)*
  - Northern Long-eared Bat *(Myotis septentrionalis)*
- ## State Watch List
  - Silver-haired Bat *(Lasionycteris noctivagans)*
  - Eastern Red Bat *(Lasiurus borealis)*
  - Hoary Bat *(Lasiurus cinereus)*

HOW TO ESTIMATE BAT ABUNDANCE?

ANALOOK WALKABOUT

- Logs acoustic signatures
- Takes Time, GPS coordinates, Temperature (°C), and Relative Humidity
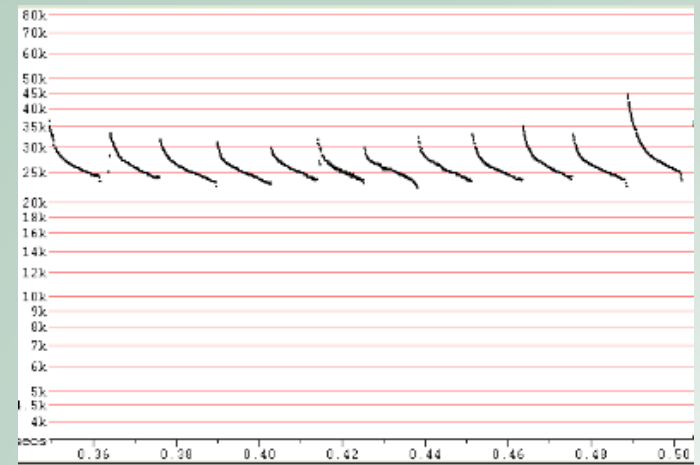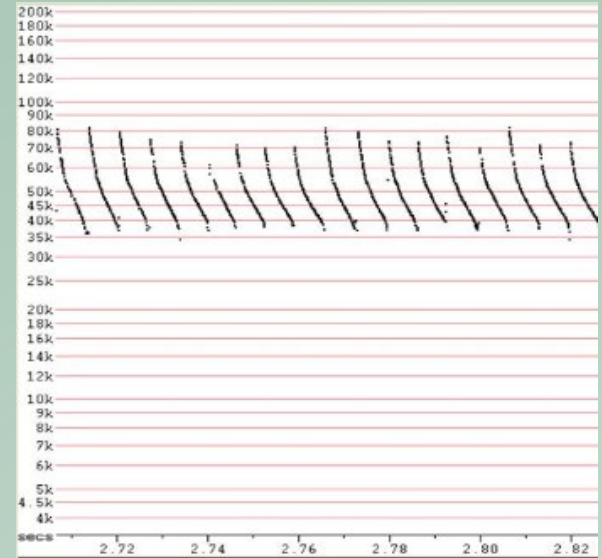
GOALS

- Document Green Bay Chiropterans
  - Determine the species present
  - Estimate habitat utilization and relative abundance
  - Determine factors that may influence presence

Methods

- Walking surveys using Anabat Walkabout from May to September

- Analyzed zero cross files using AnalookW

- Modeling done using R (3.0.2) package lme4 (1.1-12) [4]

Results

Total Registries

- Big Brown = 238
- Eastern Red Bat = 31
- Hoary = 51
- Little Brown = 35
- Northern Long-eared Bat = 21
- Eastern Pipistrelle = 2
- Silver-haired Bat = 47

Total = 425

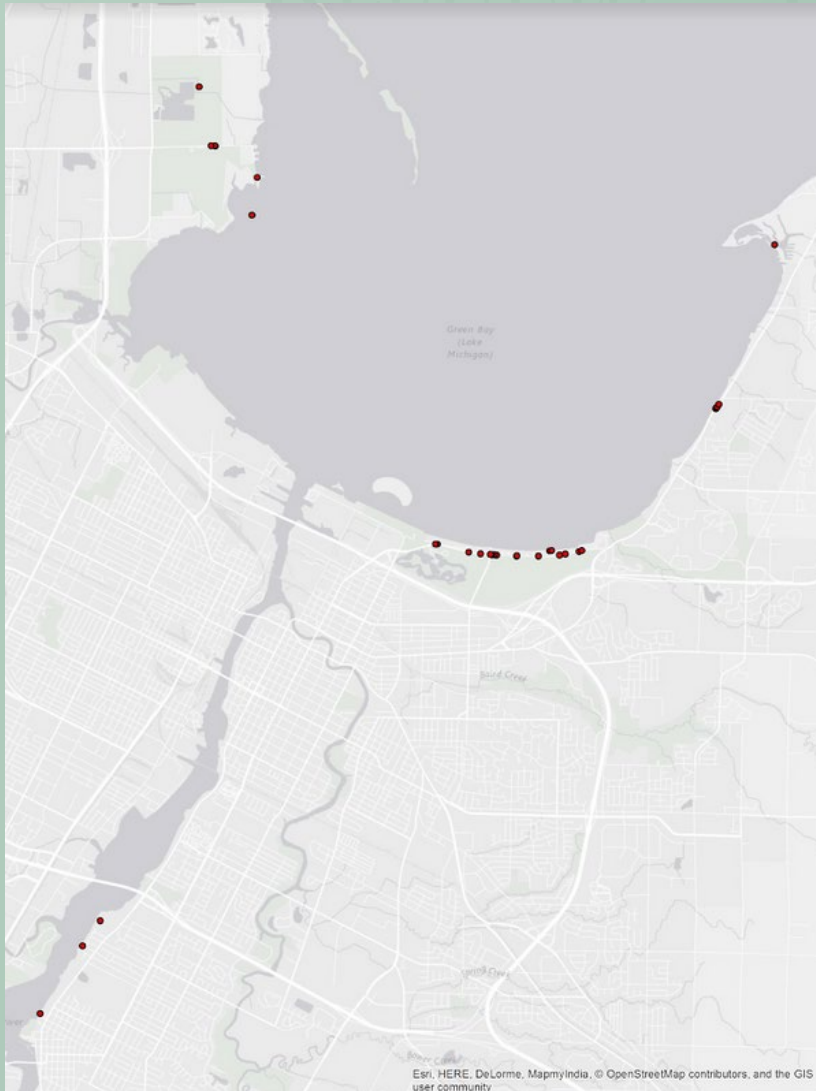# Results – Big Brown Bat

	East Shore	Fox River	West Shore	Total
June	3	0	20	23
July	4	23	35	62
August	51	11	42	104
September	38	0	11	49
Total	96	34	108	238

Results – Eastern Red Bat

	East Shore	**Fox River**	**West Shore**	**Total**
June	3	0	0	3
July	0	1	2	3
August	19	1	4	24
September	0	1	0	1
Total	22	3	6	31

	East Shore	Fox River	West Shore	Total
June	6	0	0	6
July	4	17	10	31
August	11	2	0	13
September	1	0	0	1
Total	22	19	10	51

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Results – Little Brown Bat
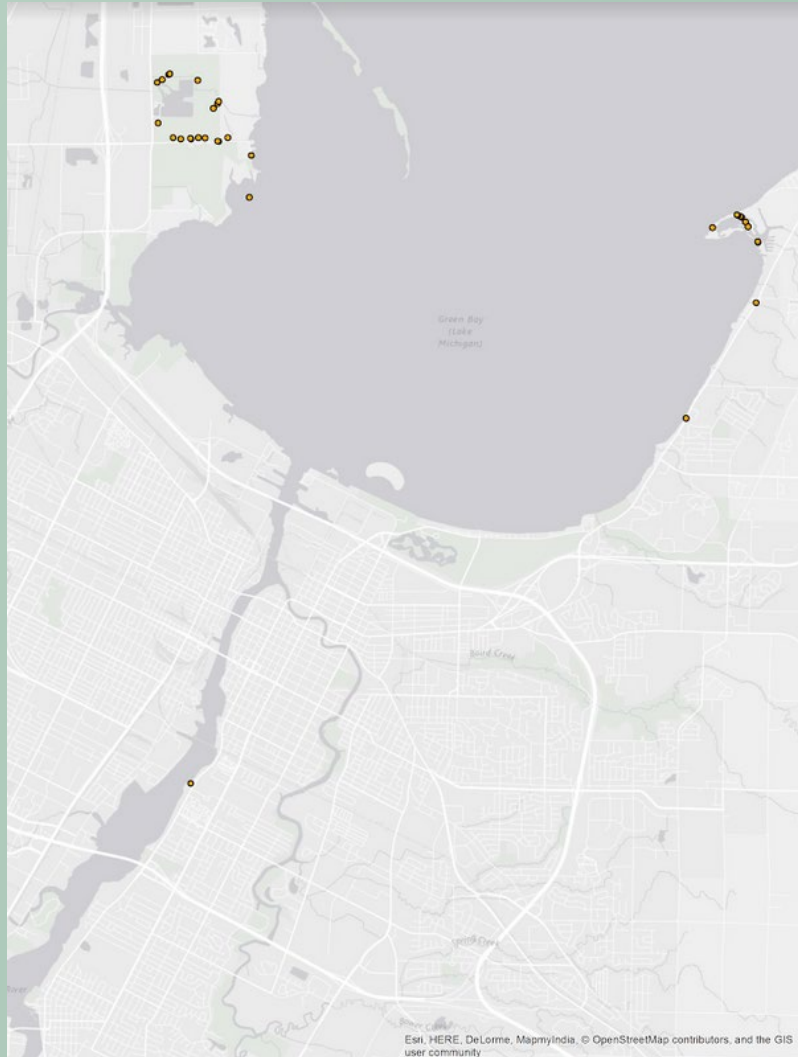
	East Shore	Fox River	West Shore	Total
June	0	0	8	8
July	11	1	11	23
August	2	0	1	3
September	1	0	0	1
Total	14	1	20	35

RESULTS – NORTHERN LONG-EARED BAT
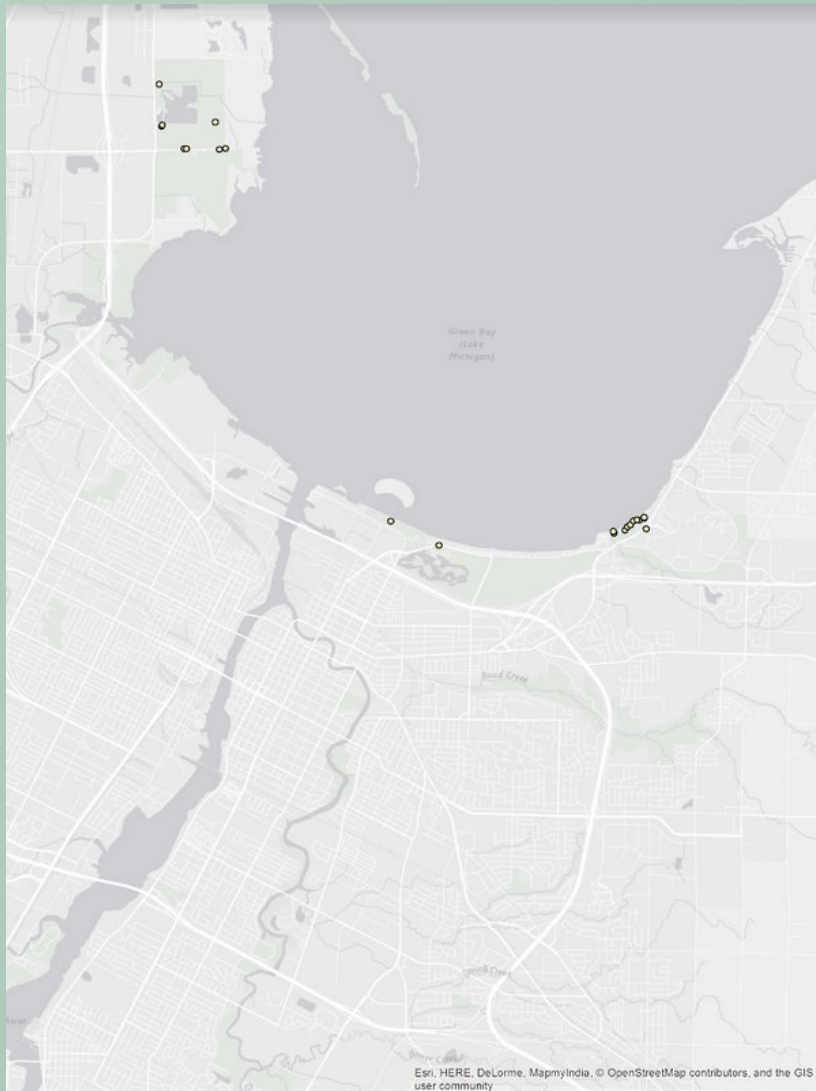
	East Shore	Fox River	West Shore	Total
June	0	0	0	0
July	3	0	3	6
August	9	0	5	14
September	1	0	0	1
Total	13	0	8	21
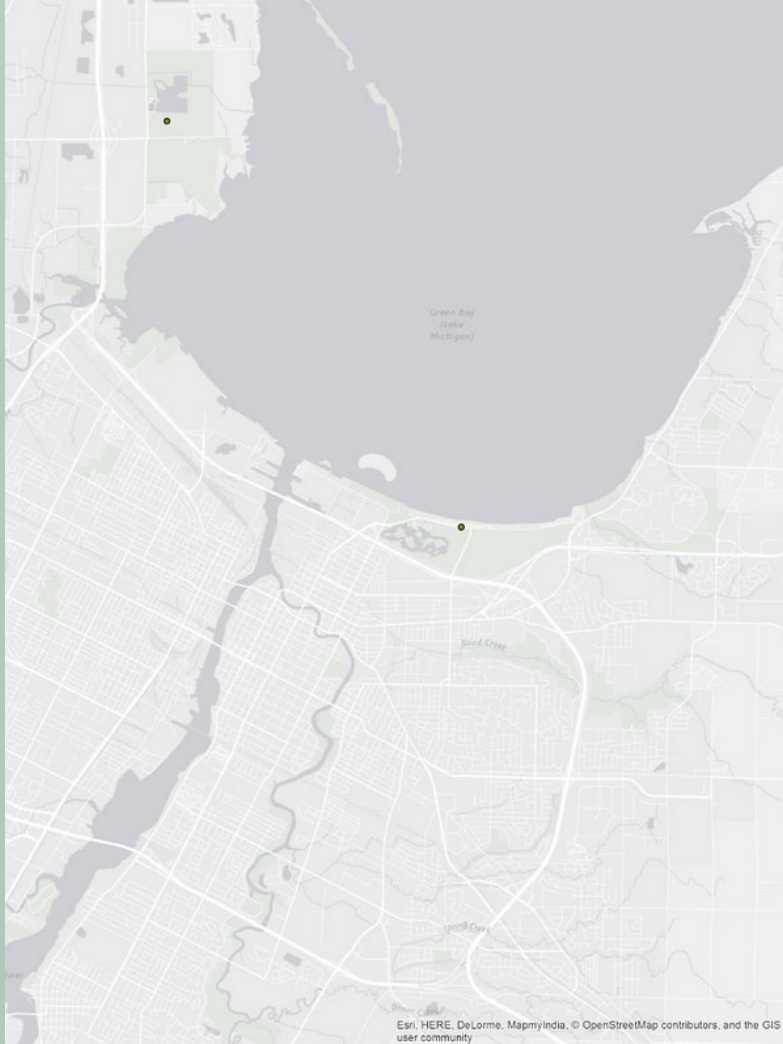
	East Shore	Fox River	West Shore	Total
June	0	0	0	0
July	0	0	1	1
August	1	0	0	1
September	0	0	0	0
Total	1	0	1	1

Results – Silver-haired Bat

	East Shore	Fox River	West Shore	Total
June	1	0	0	1
July	1	10	6	17
August	7	5	14	26
September	3	0	0	3
Total	12	15	20	47

RESULTS

Legend

Species
- Big Brown
- Eastern Red
- Hoary
- Little Brown
- Northern Long-Eared
- Pipistrelle
- Silver

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

n = 425

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GREEN BAY
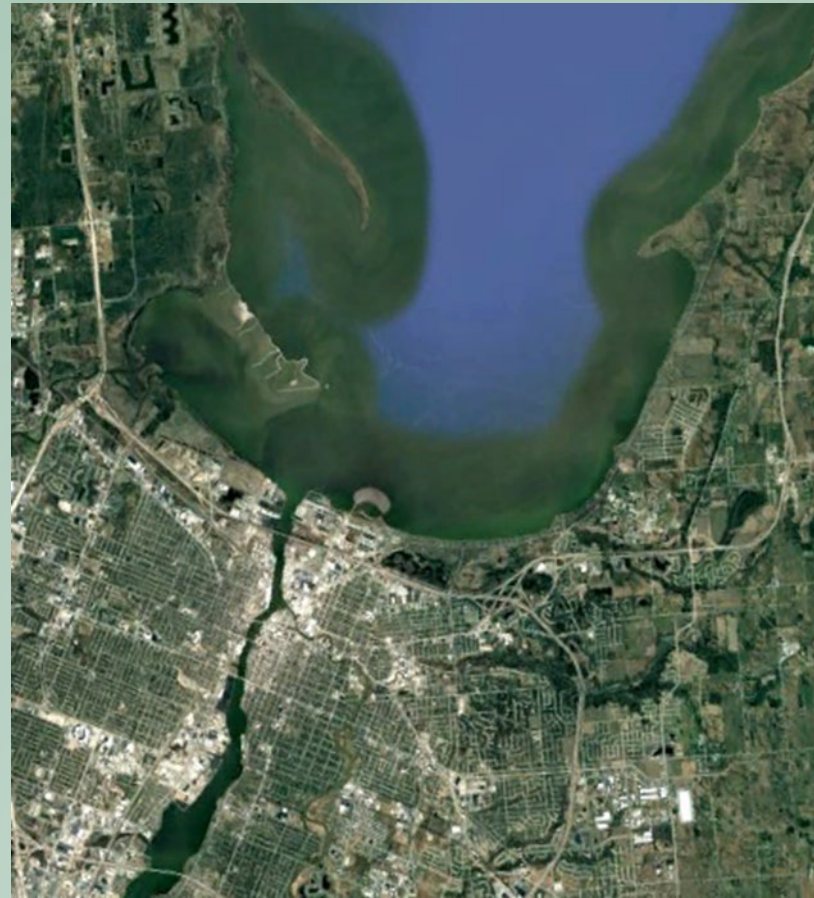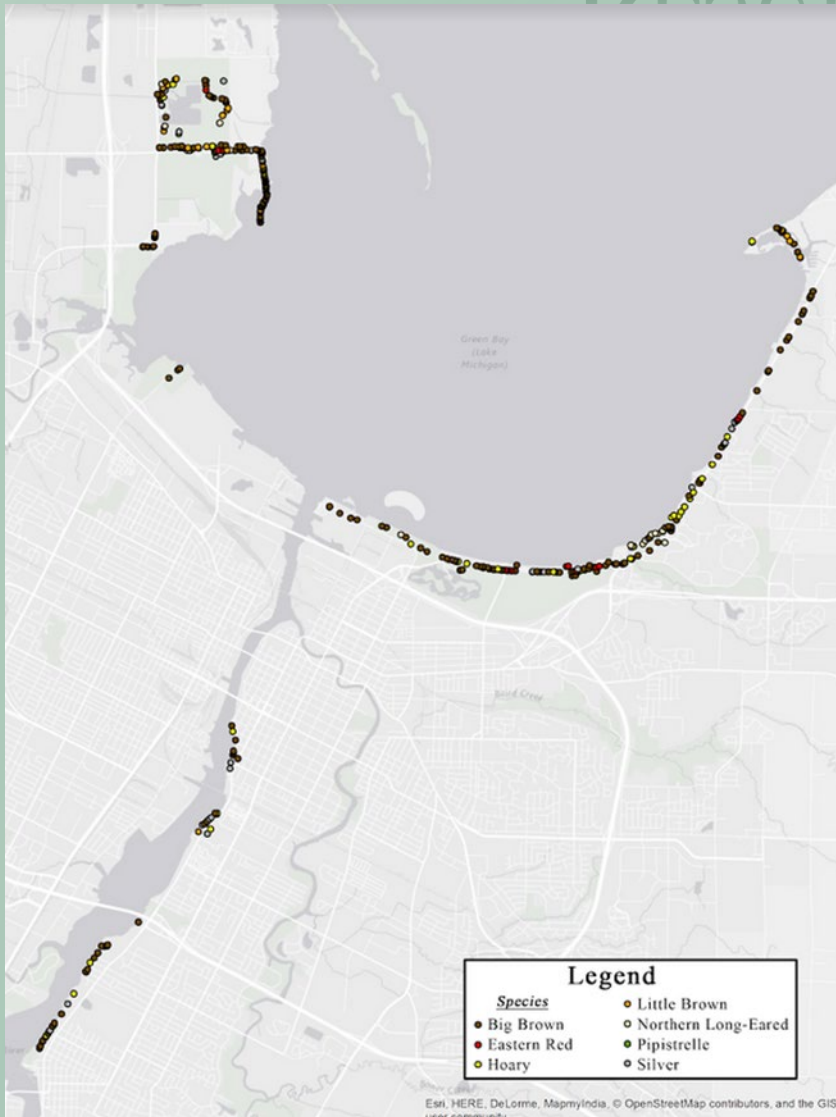
RESULTS - ACTIVITY

	East Shore	Fox River	West Shore	Total
Transects	32	14	21	67
Hours	24	10	11	45
Registries	1034	234	705	1973
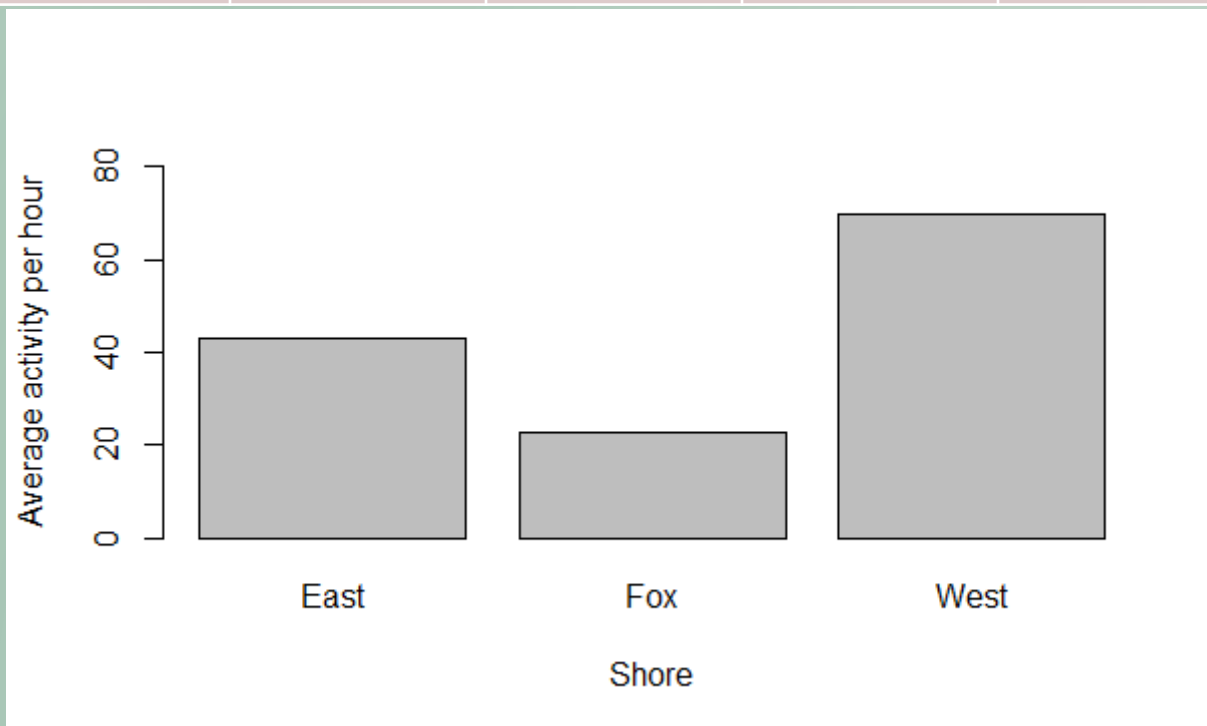
Linear Mixed Effects Model

Dependent variable: **log (total bat detections)**

Random effect: site

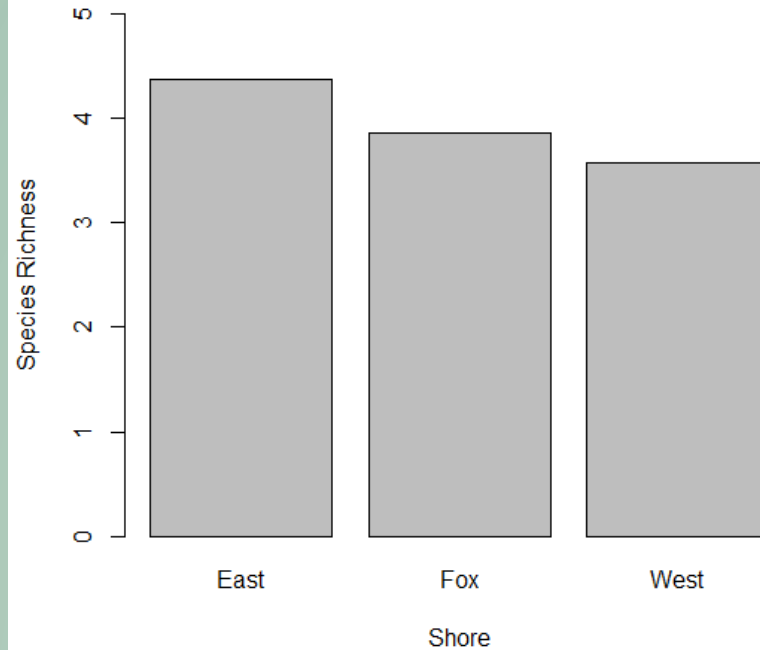| *Model	[site] + shore	[site] + shore + RH	[site] + shore + temp	[site] + shore + RH + temp
[site] (null model)	p < 0.001	p < 0.001	p < 0.001	p < 0.001
[site] + shore	-	p < 0.001	p = 0.318	p < 0.003
[site] + shore + RH		-	p > 0.500	p = 0.835
[site] + shore + temp			-	p < 0.002
[site] + shore + RH + temp				-

*models were compared by analysis of deviance using AIC criteria

Conclusion: Shore and RH (negative) were significant predictors.

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RESULTS - RICHNESS

	East Shore	Fox River	West Shore	Total
Transects	32	14	21	67
Hours	24	10	11	45
Registries	1034	234	705	1973

Linear Mixed Effects Model

Dependent variable: **species richness**

Random effect: site

*Model	[site] + shore	[site] + shore + RH	[site] + shore + temp	[site] + shore + RH + temp
[site] (null model)	p < 0.192	p < 0.221	p < 0.019	p < 0.039
[site] + shore	-	p < 0.294	p < 0.010	p < 0.034
[site] + shore + RH		-	p < 0.001	p < 0.017
[site] + shore + temp			-	p = 0.675
[site] + shore + RH + temp				-

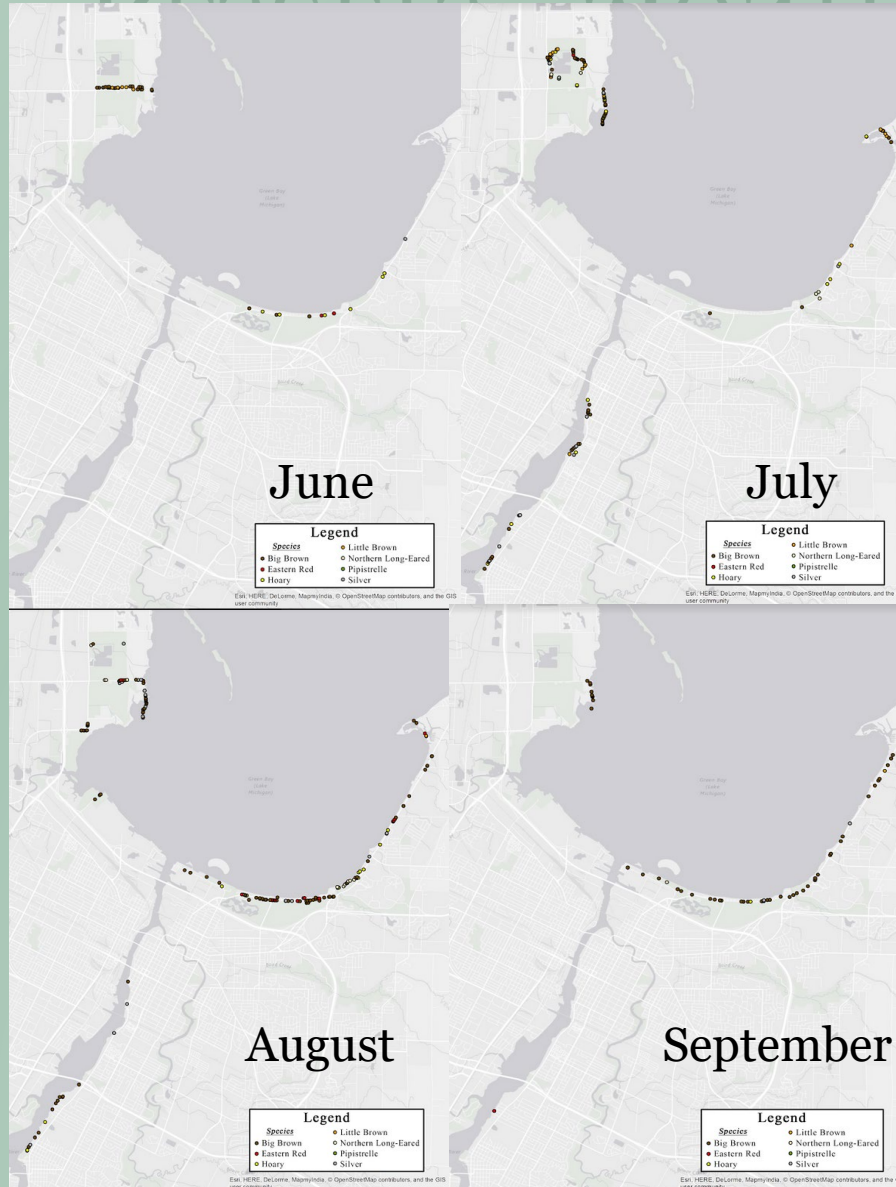Conclusion: Temperature (positive) is the only significant predictor.

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RESULTS

	East Shore	Fox River	West Shore	Total
June Transects	4	0	2	6
July Transects	7	6	4	17
August Transects	15	6	11	32
September Transects	6	2	4	12
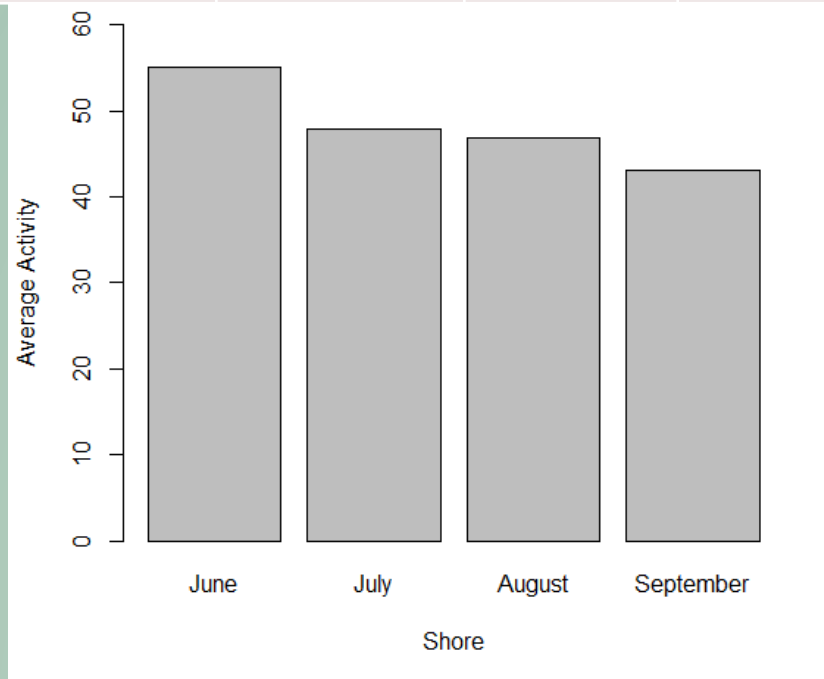
RESULTS - MONTH

Monthly Registries

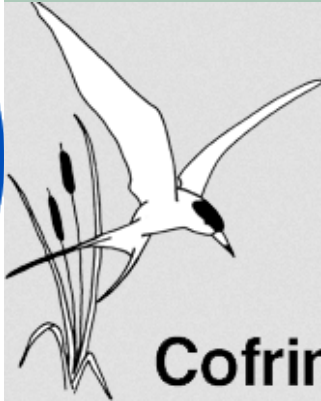|	
June	= 152
July	= 562
August	= 573
September	= 386
Total	= 425

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Going Forward
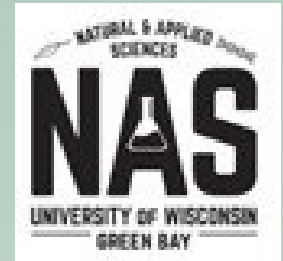
- Confirm identifications

- Estimate missing locations

- Add further environmental variables to data

THANKS TO...

- Dr. Howe and Dr. Wolf
- Paul White
- Jennifer Redell
- Jordan Marty
- Collin Moratz

QUESTIONS?

SOURCES

[1] J. J. Maine, J. G. Boyles (2015) Bats initiate vital agroecological interaction in corn. *PNAS* **112**: 12438-12443.

[2] J. G. Boyles, P. M. Cryan, G. F. McCracken, T. H. Kunz (2011) Economic importance of bats in agriculture. *Science* **332**: 41-42.

[3] A. Dollinger (2016) Devouring 1,00 Mosquitoes an Hour, Bats Are Now Welcome Guests as Zika Fears Rise. *The New York Times*. A21.

[4] Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015). Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1), 1-48.<doi:10.18637/jss.v067.i01>.

Alves DMCC, Terribile LC, Brito D. 2014. The Potential Impact of White-Nose Syndrome on the Conservation Status of North American Bats. PLoS ONE **9**: e107395.

Blehert D, Hicks A, Behr M, Meteyer C, Berlowski-Zier B, Buckles E, Coleman J, Darling S, Gargas A, Niver R, Okoniewski J, Rudd R, Stone W. 2009. Bat White-Nose Syndrome: An Emerging Fungal Pathogen? Science **323**: 227.

Boire N, Zhang S, Khuvis J, Lee R, Rivers J, Crandall P, Keel MK, Parrish N. 2016. Potent Inhibition of *Pseudogymnoascus destructans*, the Causative Agent of White-Nose Syndrome in Bats, by Cold-Pressed, Terpeneless, Valencia Orange Oil. PLoS ONE **11**: e0148473.

Brooks RT. 2011. Declines in summer bat activity in central New England 4 years following the initial detection of white-nose syndrome. Biodiversity and Conservation **20**: 2537-2541.

Cohn JP. 2012. Bats and White-Nose Syndrome Still a Conundrum. BioScience **62**: 444.

Fenton MB. 2012. Bats and white-nose syndrome. PNAS **109**: 6794-6795.

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