

An Endangered Salamander Population Shifts Movement Directionality over 45+ Years of Increasing Urbanization

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Background

- Mole salamanders (Family Ambystomatidae) exhibit annual movements between breeding ponds and upland habitat.



Fig. 1: Jefferson/Unisexual Salamander (*Ambystoma jeffersonianum* complex)

- Jefferson Salamanders (*Ambystoma jeffersonianum*) and their dependent Unisexuales (*A. laterale*-*(2)jeffersonianum*) are Endangered in Canada, with many populations isolated by urbanization.

- Increasing roads and urbanization threaten salamanders and other wildlife.

- Wildlife may compensate behaviorally, by shifting activity to avoid threats.

Questions

- Did critical habitat landcover change with urbanization?
- Have Jefferson/Unisexual Salamanders changed their movement patterns over 50 years?

Methods

- Study Site:** Pond in Credit River Valley, ON.
 - Salamanders studied 1967–1977¹
 - Mixed deciduous forest, agricultural, then converted to residential neighborhoods.
 - Study site revisited in 2024.



Fig. 2: Credit River Valley, ON (study area)

- Sampling Methods:** Drift fence and pitfall trap array used to capture salamanders Feb–Apr (adults) and Jun–Aug (metamorphs).
 - All salamanders measured (snout–vent length, total length), weighed, photograph, and individually marked with Visible Implant Elastomer (VIE).



Fig. 3: Pitfall trap setup in 2024.

- Only females analyzed because there are < 8 males in the population now.

- Analyses:** Landcover change assessed using orthoimagery and land classification.

- Trap directions from pond center compared between studies using Watson's U^2 test.²
- Used ArcGIS Pro v. 3.2.0. and R v. 4.4.2 with packages *circular*, *knitr* and *CircStats*, among others^{3,4,5,6,7,8}

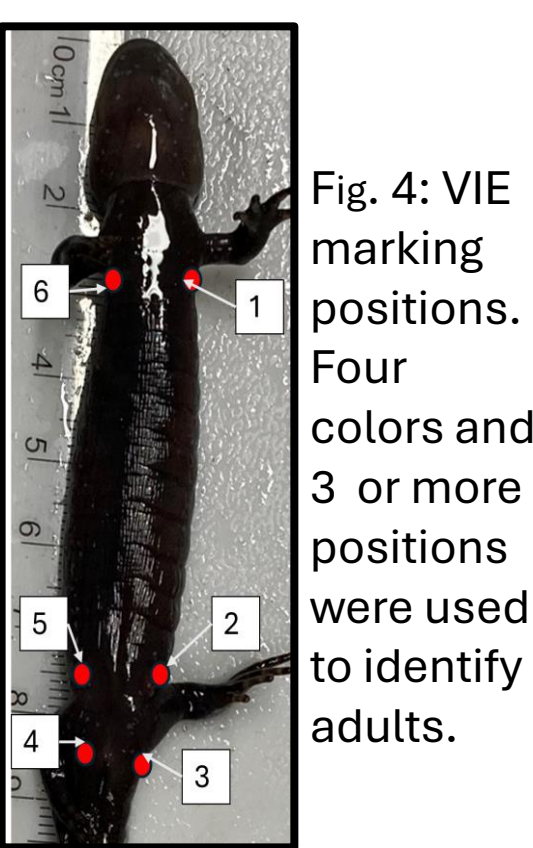


Fig. 4: VIE marking positions. Four colors and 3 or more positions were used to identify adults.

Landcover Changes

Table 1. Comparison of historic (1975) and current (2024) percentage landcover for a 300 m circular area surrounding the breeding pond (Canadian Jefferson Salamander critical habitat⁹).

Habitat Type	Year		Diff.
	1975	2024	
Forest	37.2	57.5	+20.3%
Grassland	44.3	20.1	-24.2%
Impervious Surface	18.6	22.2	+3.6%

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Movement Results

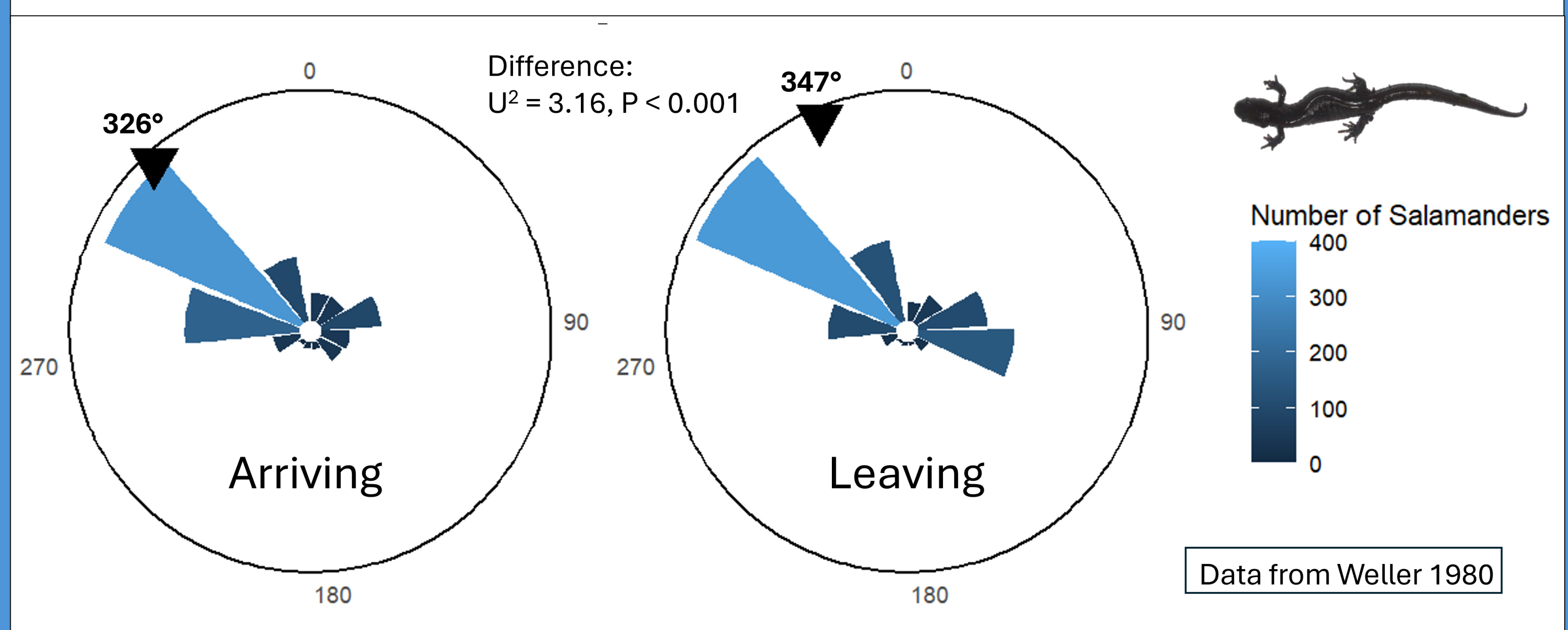
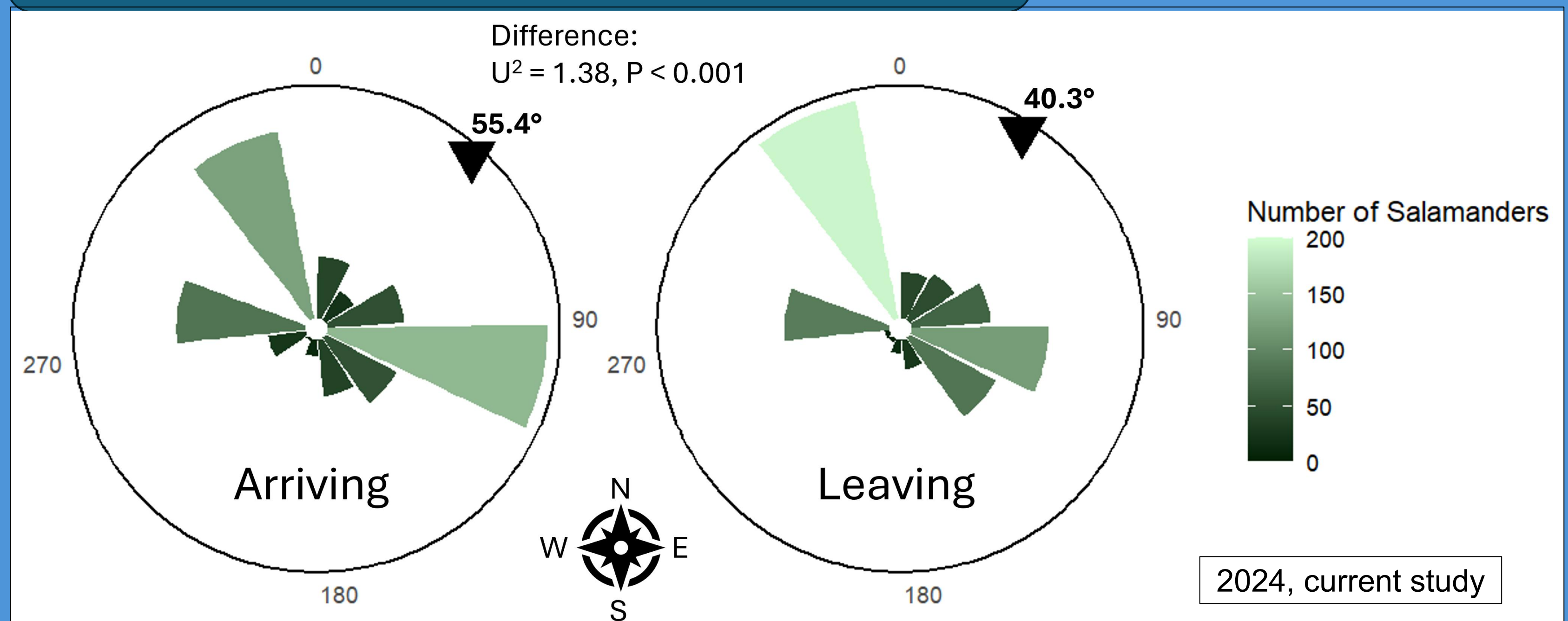


Figure 5. Current (2024) and historic (Weller 1980) adult Jefferson/Unisexual Salamander (*A. jeffersonianum* complex) movement patterns. Black triangles represent mean angle of arrival or departure from the pond. 0 represents true North.

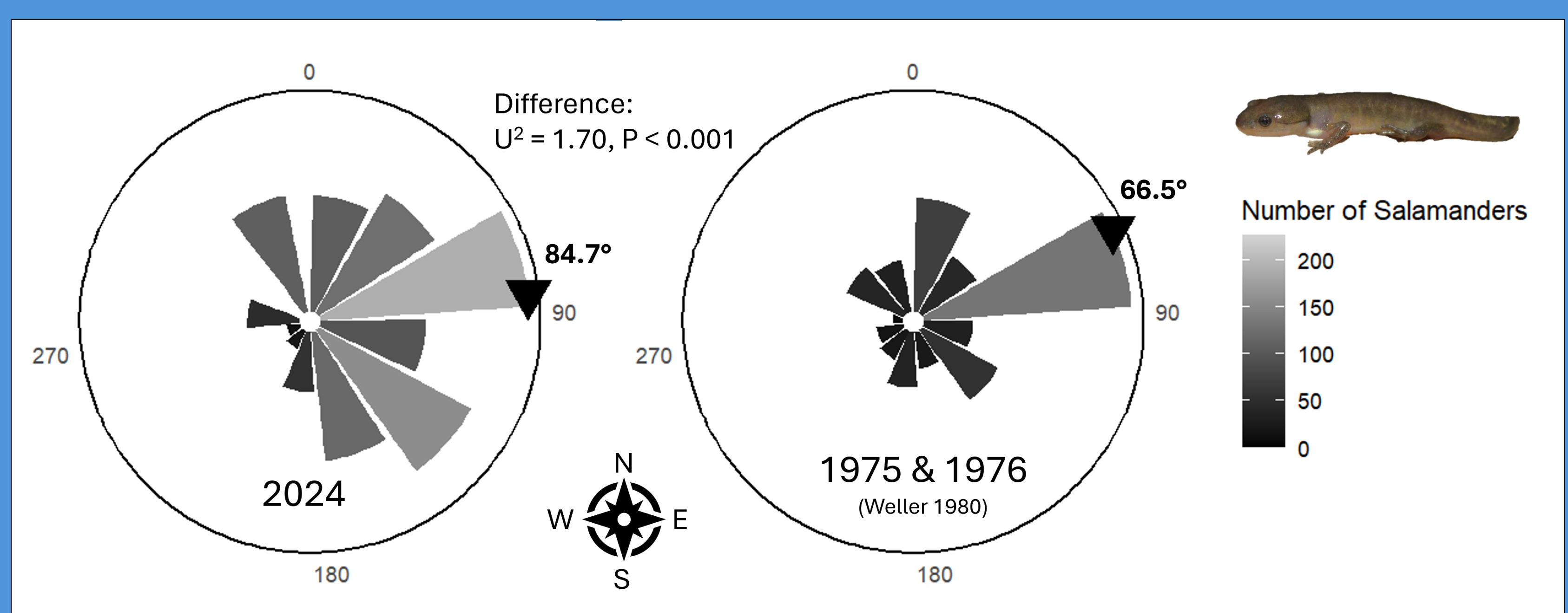


Figure 6. Current (2024) and historic (Weller 1980) metamorph Jefferson/Unisexual Salamander (*A. jeffersonianum* complex) dispersal directions. Black triangles represent mean angle of departure from the pond. 0 represents true North.

Discussion

Main Finding: Over the last 50 years, forest and impervious surface cover has increased (20.3 and 3.6%, respectively), and adult salamanders have shifted direction East by $\geq 50^\circ$.

- Metamorph salamanders shifted directionality South by 18.2° on average, but mode directionality was the same.
 - Metamorph dispersal likely related to land features, while adult dispersal reflects long-term survival and preferences for foraging and overwintering upland habitat areas.



Fig. 7: Adult Jefferson/Unisexual Salamander crossing impervious surface at the study site.

- Provides evidence for adaptive response (behavioral or population) to changing habitat conditions.

References: [1] Weller 1980; [2] Watson 1962; [3] R Core Team 2024; [4] Agostinelli and Lund 2024; [5] Lund and Agostinelli 2018; [6] Xie 2014; [7] Xie 2015; [8] Xie 2024; [9] ECCC 2023.