Spatial Dynamics of Vernal Pool Amphibians:

Using Translocations to Determine Spatial Scales of Habitat Selection

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INTRODUCTION

- The current **global decline in amphibian populations** has been accumulating enormous conservation attention in recent years. One of the six major factors contributing to the global decline is **habitat destruction** and alteration.[1] This coincides with the increasingly prominent conservation value of isolated wetlands,[2] which can function as important habitat for pond-breeding amphibians. **Vernal pools** (small wetlands that dry up by mid- to late-summer) in particular have been major targets of conservation and restoration initiatives.[3]

- Successful restoration, however, requires an **interdisciplinary approach** which considers a multitude of biotic and abiotic factors. The complexity of vernal pool ecology necessitates a synthesis of research threads to produce tangible results for biodiversity and ecosystem function. This research investigates the **spatial dynamics of amphibian species** inhabiting pools, complementing concurrent research on related aspects of vernal pool ecology.

- A critical spatial component of vernal pool restoration is organism **dispersal and colonization** of new pools. Target amphibian species for colonization often include the wood frog (*Rana sylvatica*) and spotted salamander (*Ambystoma maculatum*), which compete with facultative species like the **green frog** (*Rana clamitans*). The present study investigates colonization and habitat selection of green frogs within a multi-pool complex.

Figure 1: Green frog (*Rana clamitans*).

STUDY SITE & COLLABORATION

This project is part of a larger research initiative on vernal pool ecology lead by researchers at SUNY College of Environmental Science and Forestry (ESF), which includes aspects of biology, limnology, hydrology, and landscape ecology.

By partnering with the Upper Susquehanna Coalition, a network of regional Soil & Water Conservation Districts, an experimental network of vernal pools was established in ESF's Heiberg research forest in central New York.

Figure 2: One of the thirty-nine constructed vernal pools in SUNY-ESF's Heiberg research forest, central New York.

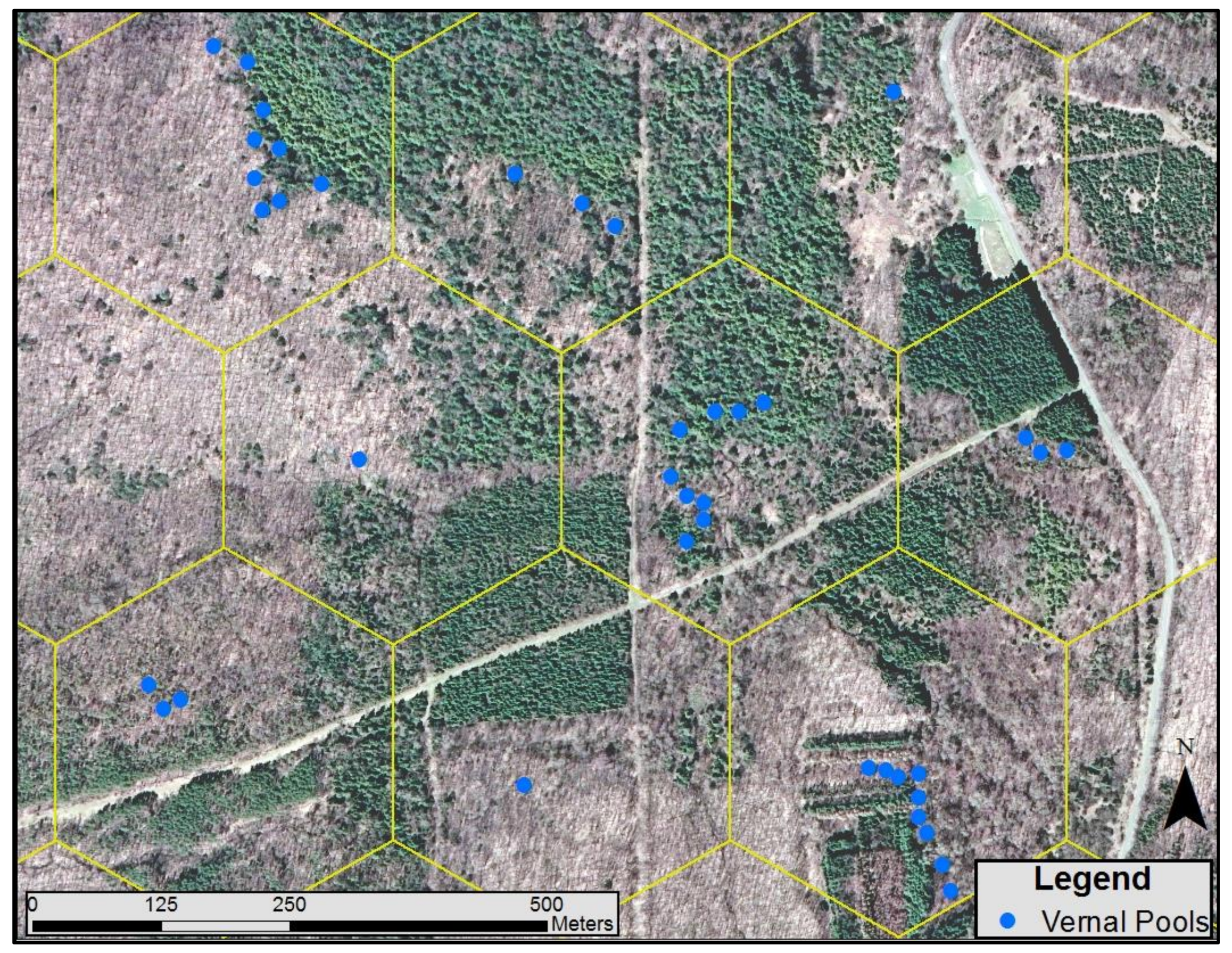


Figure 3: Hexagonal array of thirty-nine constructed vernal pools in SUNY-ESF's Heiberg research forest, central New York. Each hexagon is 9.2 ha in size and contains either one, three, or nine pools.

In 2010, thirty-nine vernal pools (Fig. 2) were constructed over 100 ha of forest, with local pool density varying at one, three, or nine pools per 9.2 ha hexagonal plot (Fig. 3). Pools are 39 ± 18 m^2 (mean ± SD) in area and 0.5 ± 0.1 m in depth.

RESEARCH QUESTIONS

It is unclear if and how amphibians select for aquatic habitat as they disperse and colonize vernal pools.[4] Here, individual-level habitat selection was measured to examine how green frogs distinguish habitat patches within a clustered pool network.

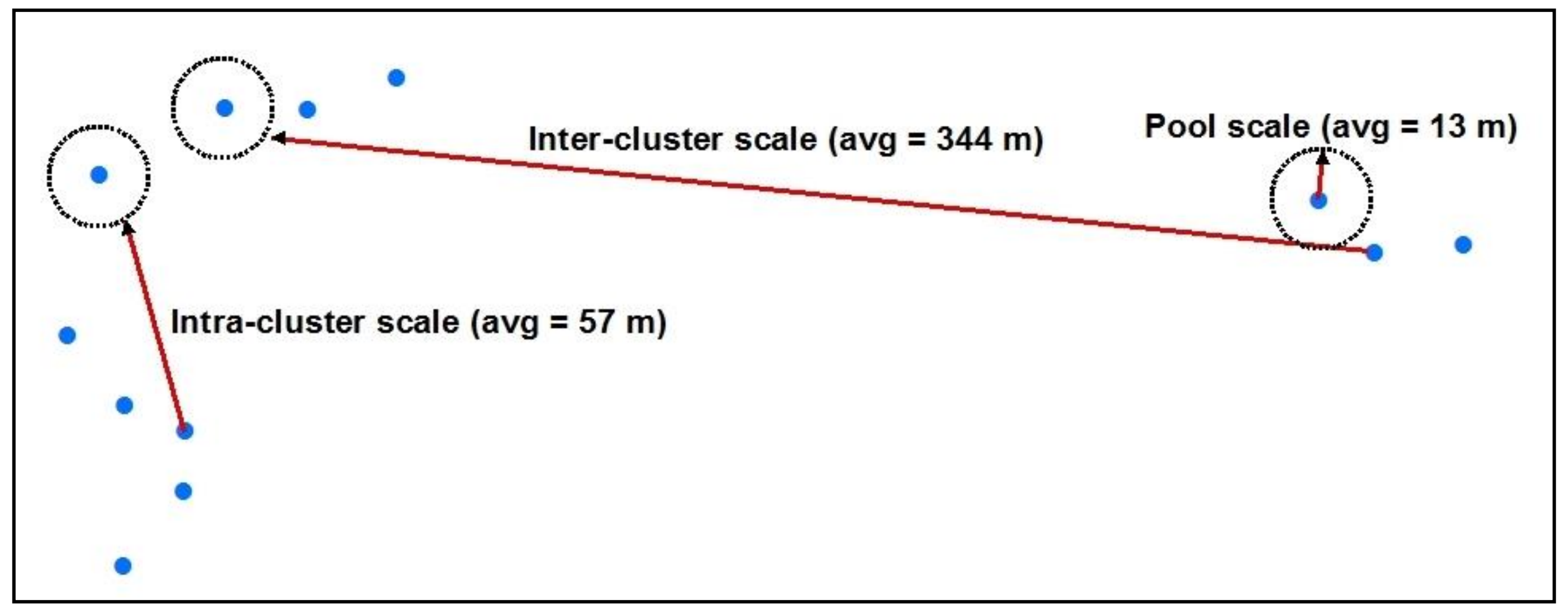
Specifically, this research asks:

1. **Do clusters of ponds function collectively as habitat patches?**
2. **Does the spatial scale of movements and density of pools on the landscape influence movement parameters and habitat selection?**

RESEARCH DESIGN

Experimental translocations were employed and coupled with fine-scale tracking of subsequent frog movements. Translocations consist of capturing a frog in a pool and releasing it in another area. They are advantageous for investigating dispersal and habitat selection because they allow the researcher to standardize motivation for moving and choose the scale and type of landscape the animals will move across.[5]

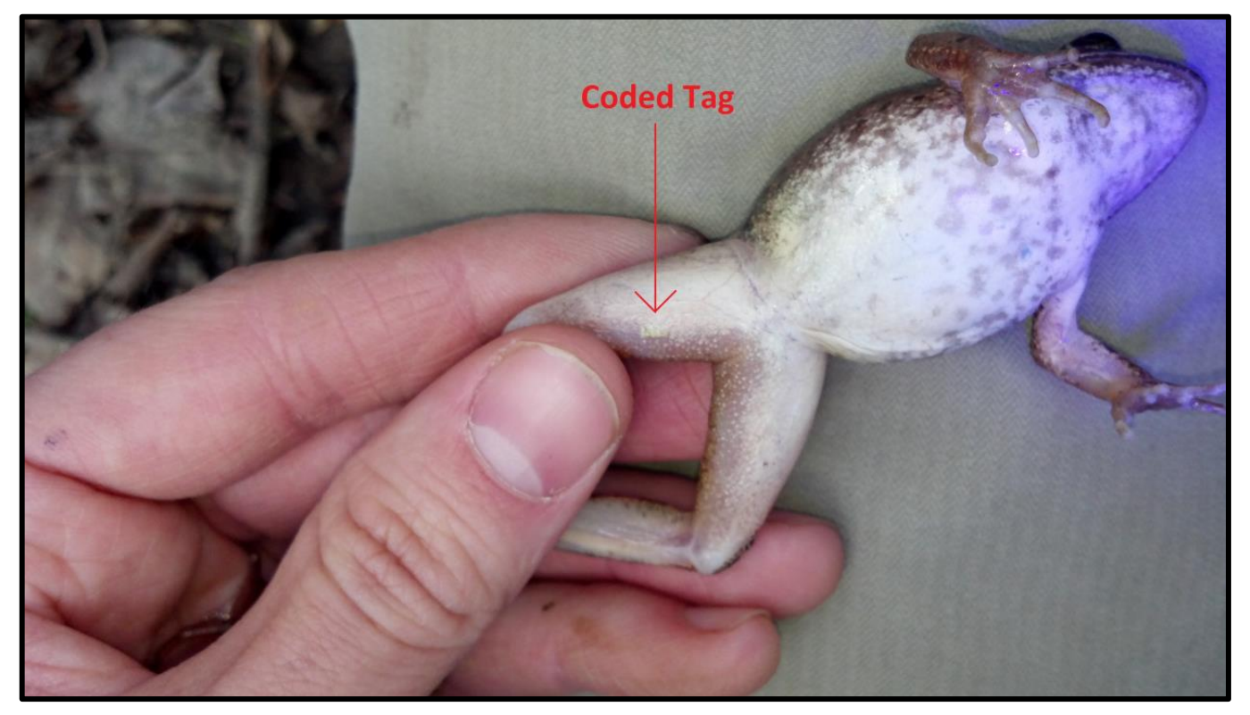
Three scales of translocation were used:



Scales were selected based on the three proposed ecological scales of influence on amphibian populations: breeding pool, terrestrial complementation (used for foraging, hibernation etc.), and metapopulation (pool density and surrounding population).[6] The pool scale corresponds to half the average nearest neighbor pool spacing within a cluster. Release points were always13 m from a pool.

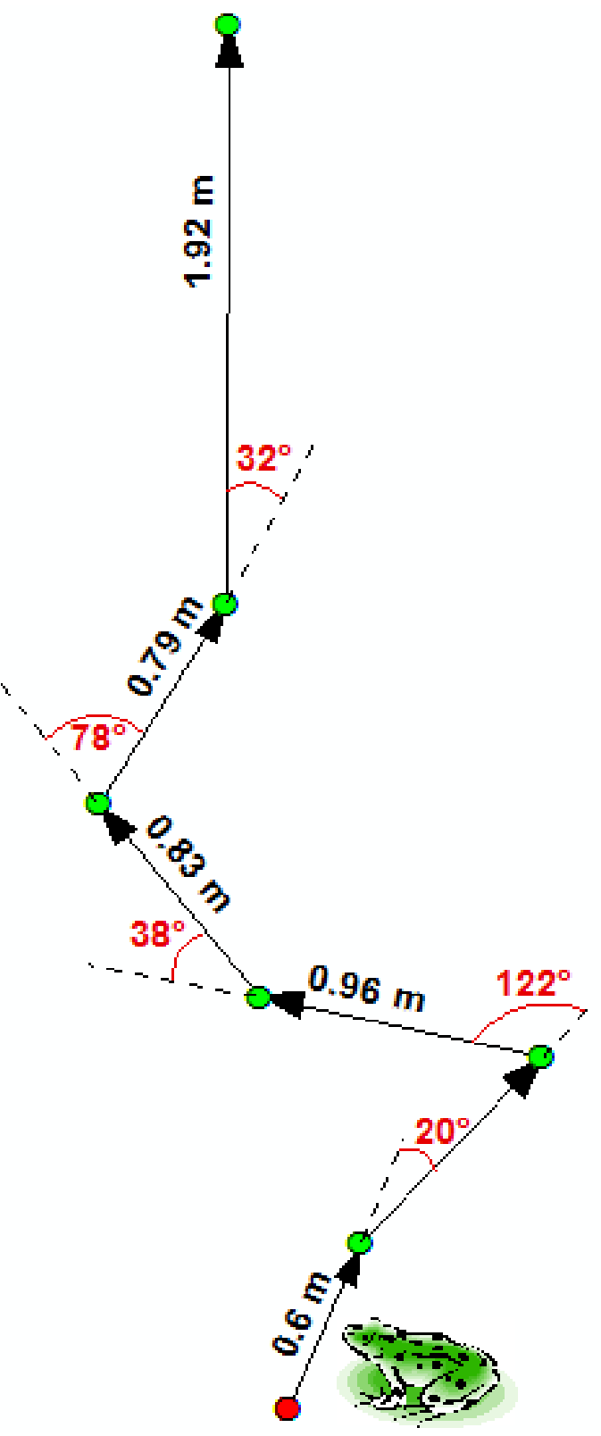
FIELD METHODS

Frogs were marked for individual identification by subcutaneously injecting small fluorescent tags with alphanumeric codes. Tagging allowed pool selection information to be obtained for frogs that were not tracked directly to a pool but were later recaptured at a pool.



Fluorescent dye powder was applied to the frogs which was deposited on the ground and vegetation as they moved. The dye trail was later followed at night by illuminating it with ultraviolet light.

Trails were marked with survey flagging and the movement steps and turn angles were measured.



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ACKNOWLEDGEMENTS

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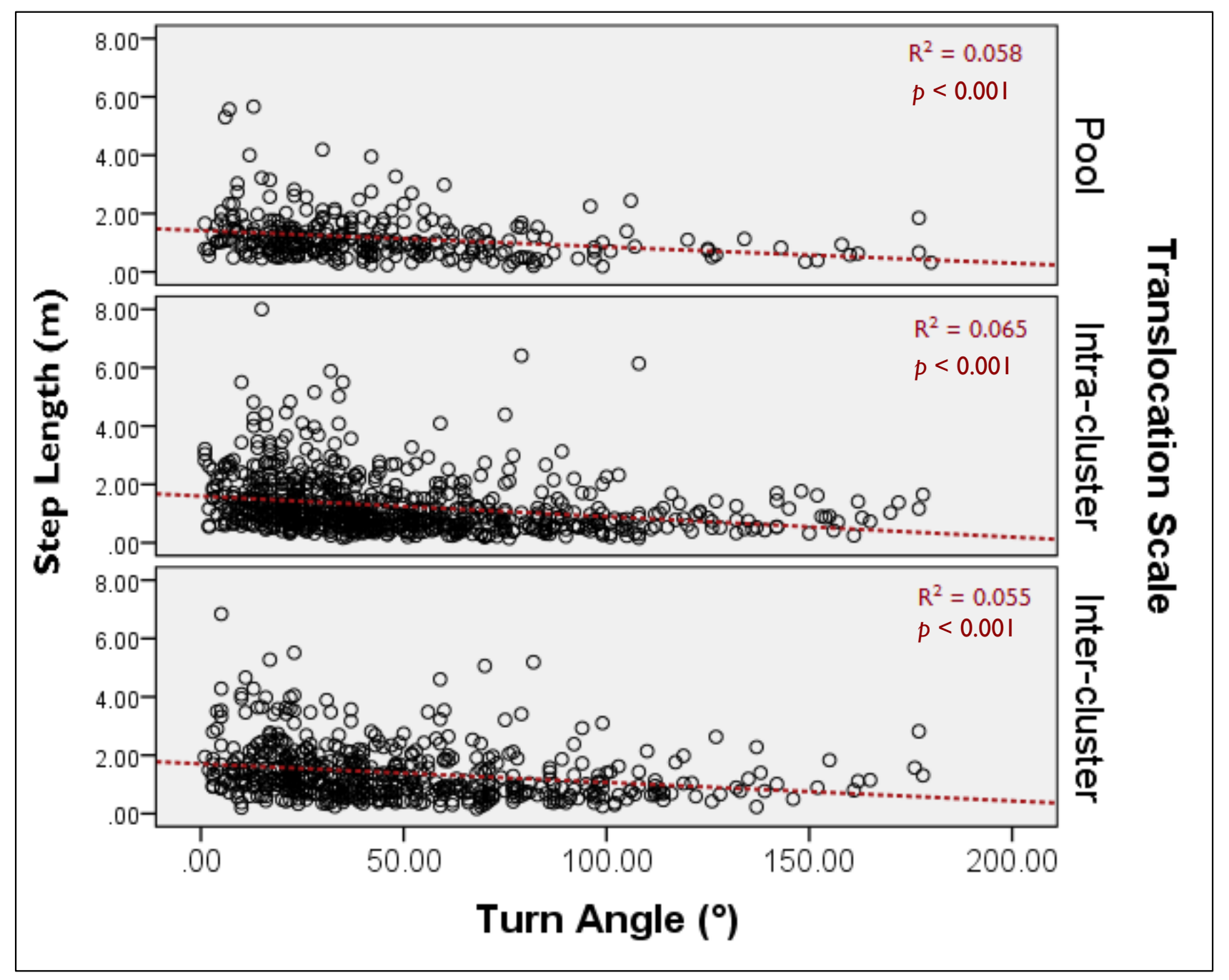
RESULTS

Movement Parameters:

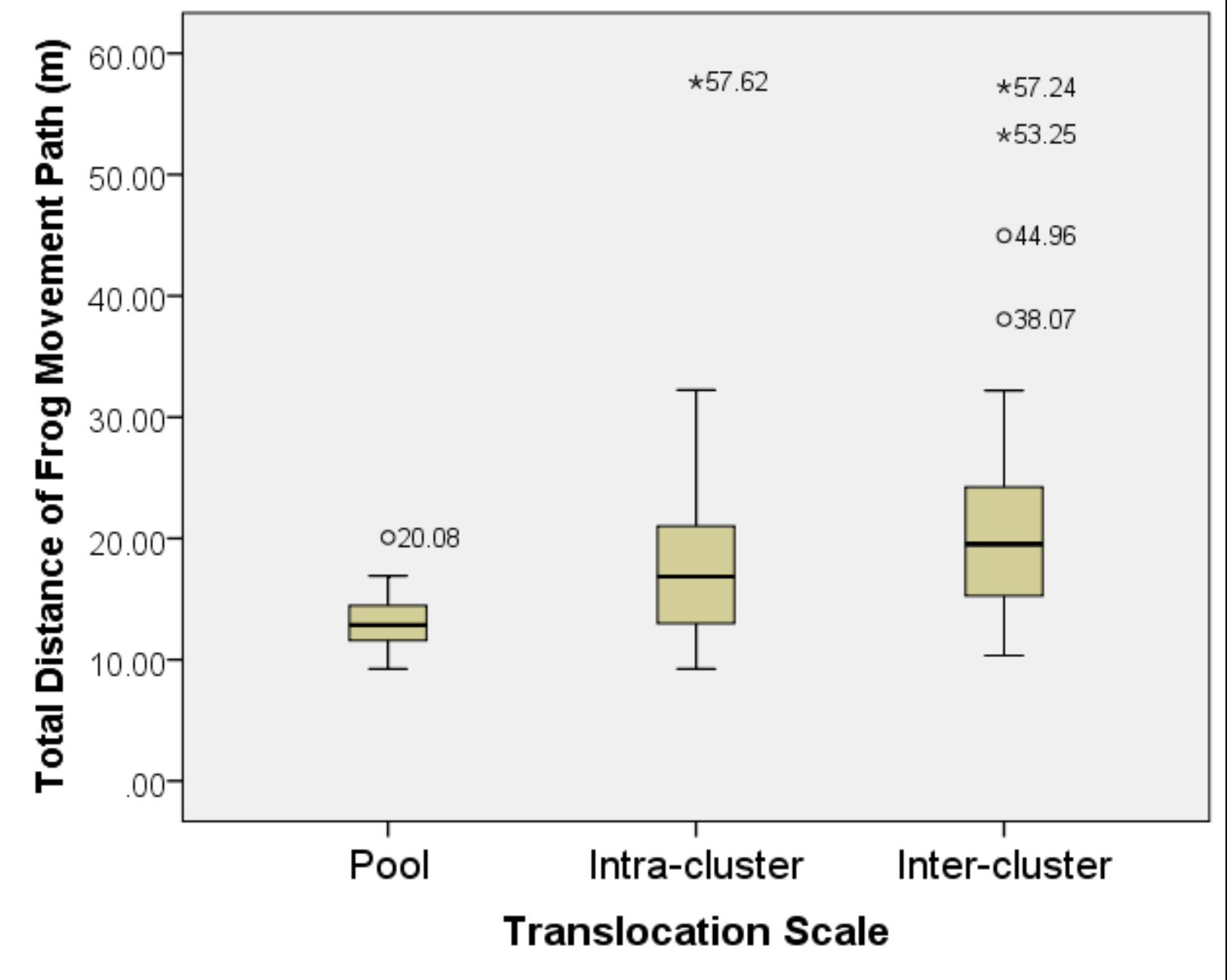
For all three translocation scales, step lengths and turning angles were significantly, negatively correlated:



Number of Trials (n)	
Pool scale	32
Intra-cluster scale	78
Inter-cluster scale	36
TOTAL	**146**

Translocation scale did influence movement parameters:

- Inter-cluster scale translocations had significantly longer:
  - *step lengths* [ANOVA, p=0.001]
  - *total movement distances* [ANOVA, p<0.001]
- Pool-scale translocations had significantly smaller:
  - *step lengths* [ANOVA, p=0.001]
  - *turn angles* [ANOVA, p=0.04]



Pool Selection:

Translocation scale did not influence pool selection: [Chi-square test , p = 0.245]

		Pool Selection			
		Nearest Pool	Different New Pool	Original Pool of Capture	**Sub-Total (n)**
Translocation Scale	Pool	25 (89%)	3 (11%)	Null*	28
	Intra-cluster	24 (71%)	8 (24%)	2 (6%)	34
	Inter-cluster	18 (72%)	7 (28%)	0 (0%)	25
*For pool-scale translocations, the original pool of capture was also the pool nearest the release point.					**Total = 87**

APPLICATIONS & FUTURE RESEARCH

- **Overall, the scale of translocation influences how frogs move through the landscape in search of pools, but not necessarily which pools they select.** This suggests that design of pool networks should consider species dispersal characteristics for how animals might encounter pools but that specific design criteria for increasing or decreasing selection of pools in particular spatial settings may be difficult to obtain.

- Frogs may move differently when dispersing amongst pools at larger, metapopulation scales versus smaller-scale clusters of pools. This information can be taken into account when predicting colonization of constructed pool complexes and used to recommend pool spatial arrangements and associations with existing source populations.

- Future Research:
  - Examination of movement paths by analyzing autocorrelations and determining if parameters change during the process of locating a pool or for particular pool selections.
  - Determine the effect of pool density and spacing on movement parameters and pool selection.
  - Ultimately, this information can be used to develop a spatially-explicit dispersal model for vernal pool amphibians.

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