Proposing an Improved Habitat Connectivity Assessment Framework

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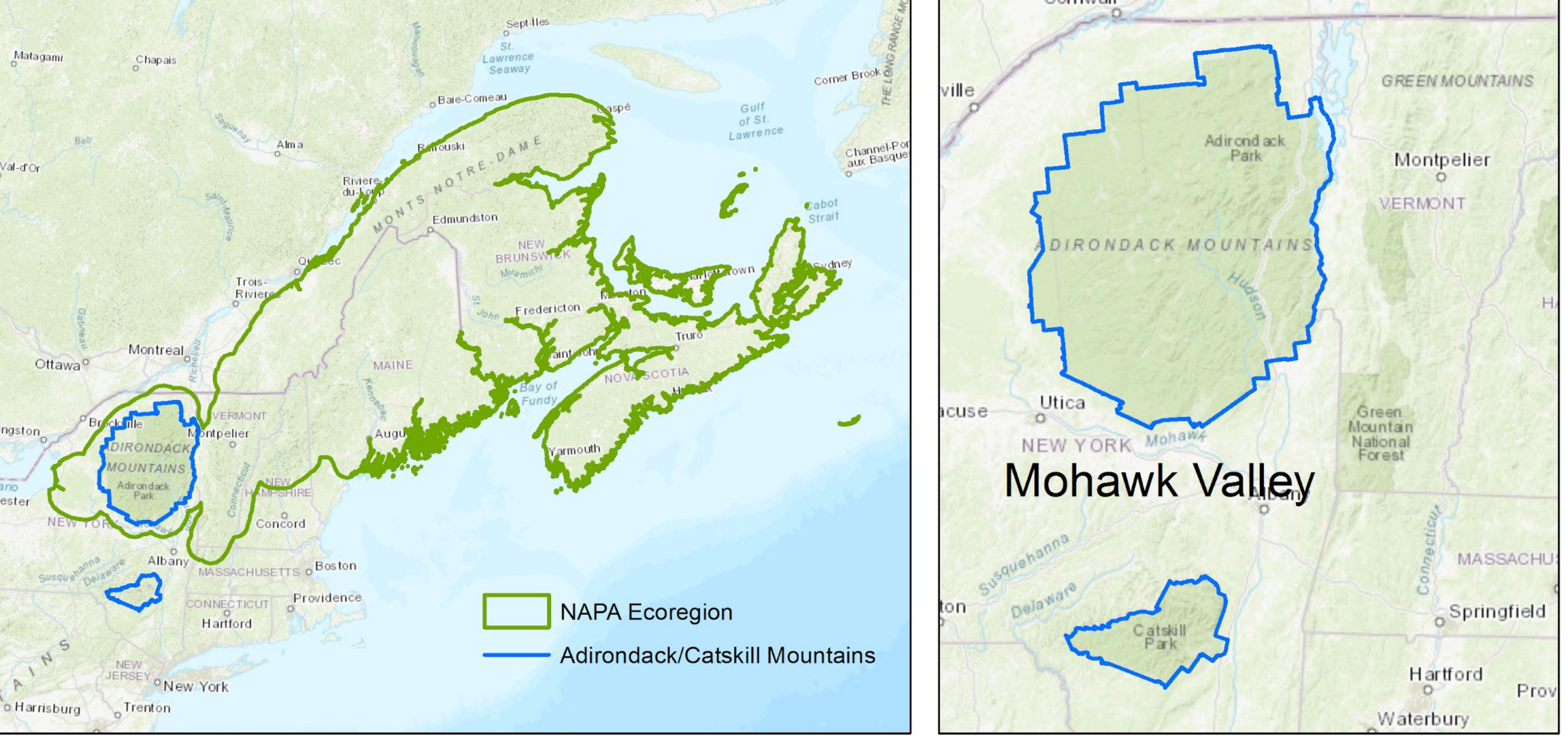
Background

Human infrastructure and urban development are increasingly fragmenting natural landscapes, limiting dispersal and increasing vulnerability of many wildlife species. Accordingly, conservation organizations, such as The Nature Conservancy (TNC) and the Staying Connected Initiative (SCI), have begun modeling and integrating landscape connectivity into their conservation assessments within the Northern Appalachian/Acadian ecoregion (NAPA; Figures 1, 2). In their approach to map linkage areas (Figure 1), these organizations could potentially benefit from a more comprehensive framework to model and evaluate connectivity and translate regional-scale connectivity assessments into local-scale conservation actions (Figure 3).

Figure 1: Current Staying Connected Initiative connectivity modelling framework to create a linkage area.
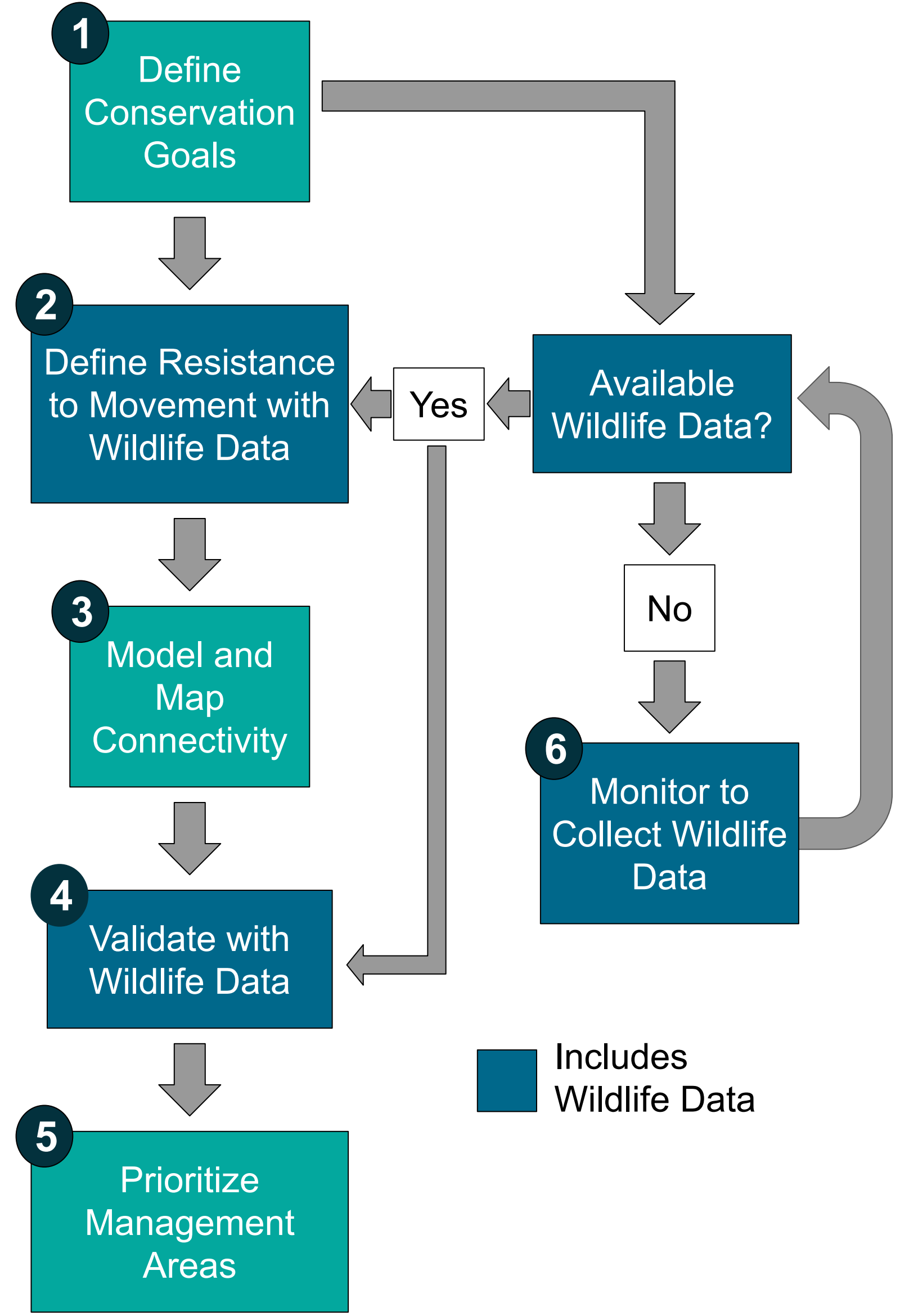
We developed a framework to improve conservation outcomes through specific conservation goals, enhanced connectivity models, and methods for priority setting. We apply this framework to a case study in the Mohawk Valley of New York State, a new SCI priority area. Our case study informs future road barrier mitigation and land conservation work undertaken by SCI partners, TNC, and the Mohawk Hudson Land Conservancy (MHLC).

Figure 2: Northern Appalachian/Acadian ecoregion (outlined in green) and the location of the case study, Mohawk Valley New York (outlined in blue).

Framework

The foundation for our framework is based on key review papers: Wade et al., (2015) and Zeller et al., (2012). Our framework describes how to collect wildlife field data, construct models based on wildlife data, set priorities for conservation actions, and base these processes in carefully articulated conservation goals (Figure 3).
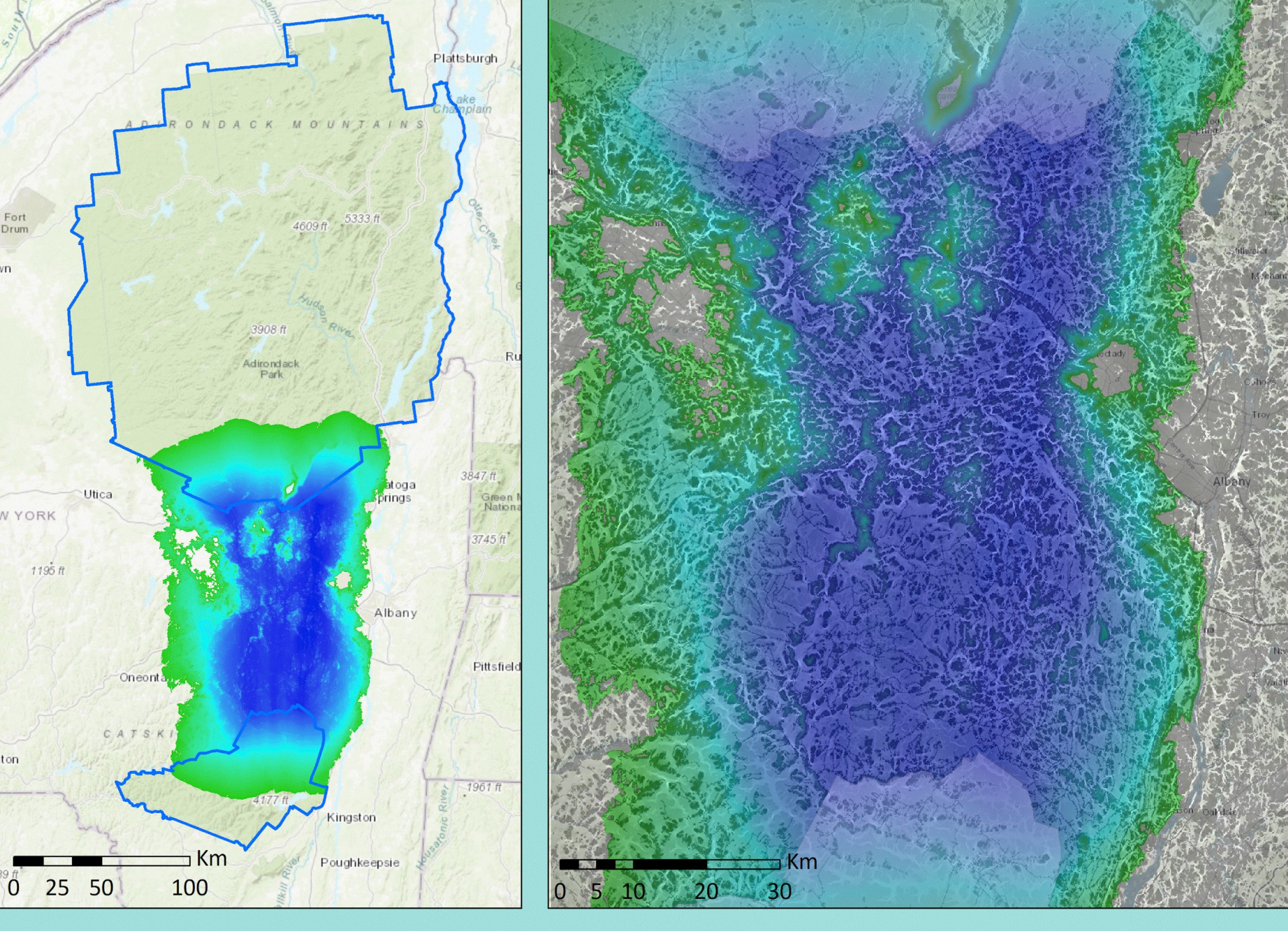
1. **Identify** conservation problems, focal species, and relevant animal movement (e.g. daily habitat use, dispersal, demographic, range shift, migration).

2. **A Resistance layer**—the parameter of land-unit traversability by the focal species used in connectivity models—can be modelled with wildlife data or defined by expert opinion and literature review.

3. **Connectivity models** use various theories (e.g. cost-weighted distance, circuit theory, moving window) to predict animal movement. The underlying theory and methods should align with the project's conservation goals and movement type.

4. **Since modelled connectivity** is an untested hypothesis, wildlife data can be used to validate model predictions. Most validation methods include assessing the predicted connectivity associated with wildlife data.

5. **To help prioritize local actions** to conserve important connectivity areas or restore lost connectivity through habitat restoration or barrier removal, the framework outlined above can be reiterated at more localized scales.

6. **Wildlife detection data, movement data and genetic data** can be used in connectivity modelling and are collected by methods such as camera traps, GPS collars, and hair snares, respectively. Detection data indicates single points of animal presence. Movement data indicates paths of animal movement. Genetic data assesses the genetic differences between isolated populations or generations.
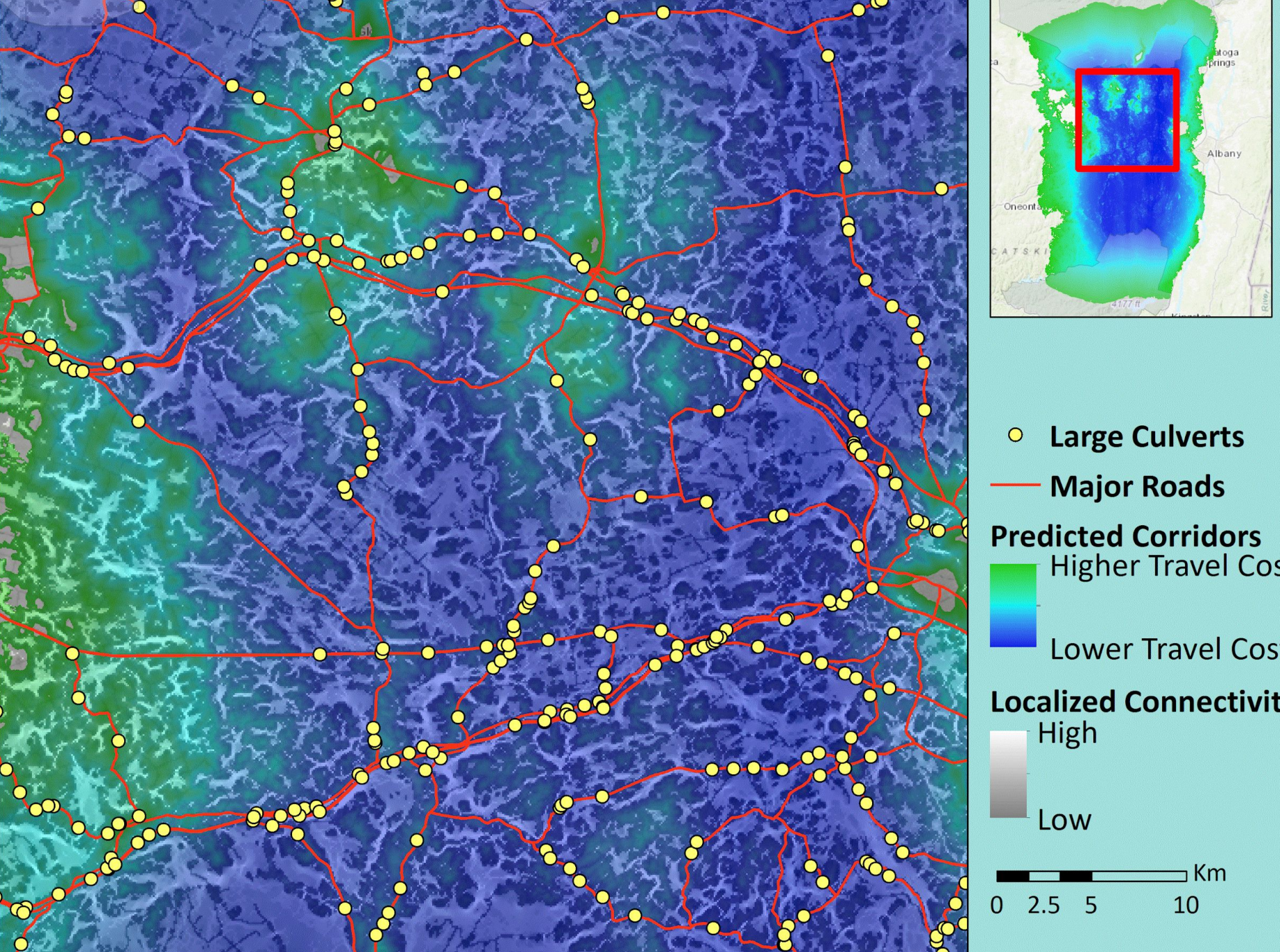

Figure 3: Improved framework for connectivity assessments in the NAPA region. Dark blue boxes indicate steps that include wildlife data.

Mohawk Valley Connectivity

1. **MHLC identified fishers, black bears, and bobcats** as focal species. We modelled daily habitat movements and demographic movements in the Mohawk Valley between the habitat cores, the Adirondack Mountains and Catskill Mountains.

2. **Due to a shortage** of appropriate wildlife data, we utilized expert opinion resistance values for fishers, black bears, and bobcats.

3. **We modeled** regional demographic movement using a cost-weighted distance model between the Adirondack Mountains and the Catskill Mountains (Figure 4). We modeled local daily habitat movements using a moving window, a circuit theory based model (Figure 5).

4. **We validated** our localized connectivity fisher model with fisher detection points in the Albany, NY area because this area encompassed our available fisher data. We statistically compared the predicted connectivity of fisher detection points and random points.

5. **Road barrier mitigation** opportunities were identified based on locations with high predicted connectivity near existing culverts (Figure 5). Locations of potential land conservation were determined by identifying areas of high predicted connectivity adjacent to current protected lands.

Figure 4: Modelled linkage area between the Adirondack Mountains and the Catskill Mountains in the Mohawk Valley. Demographic movement is in the green to blue scale and daily movement is in grayscale.

Figure 5: Zoomed in modelled connectivity assessment of the NAPA region demonstrating identification of potential road barrier mitigation projects.

Objectives

Develop an improved framework for SCI and TNC to use to model and mitigate barriers to connectivity

Demonstrate the improved framework through a case study in the Mohawk Valley of New York

Provide recommendations for continued SCI connectivity assessments in the Mohawk Valley and the NAPA region

Recommendations

Clearly define connectivity goals and species movement of interest. Clearly articulated goals provide the foundation for the modeling process and a metric of project success.

TNC Canada

Use wildlife data as a basis for connectivity modeling when datasets appropriately represent the landscape and populations that are being modeled. Most available wildlife datasets in the NAPA region would need to be extrapolated well beyond their collection extent for linkage-scale connectivity assessments. Therefore, we recommend SCI continue to use expert opinion for linkage-scale modeling, but incorporate wildlife data into the modeling process at the local scale before implementing connectivity projects.

Implement this framework iteratively at a regional scale and then at a scale relevant to localized projects to improve connectivity. Applying this framework at the regional scale can help illuminate broad barriers to connectivity. At the local scale, this framework can help prioritize specific locations and project opportunities to restore or conserve connectivity.

Acknowledgements

References

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Zeller, Katherine A., McGarigal, K., & Whiteley, A. R. (2012). Estimating landscape resistance to movement: A review. *Landscape Ecology, 27*(6), 777–797. https://doi.org/10.1007/s10980-012-9737-0