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A Different Kind of Black Gold: Molecular Characterization of Bat Guano as an Alternative Pest Management Strategy

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Insights from bats' insides: guano's expansive utility

Previous molecular studies of bat guano demonstrate that many bat species exhibit a diverse arthropod diet (1, 5). Such insectivorous activity is known to provide extensive ecosystem services with significant economic value through regulating crop pest populations. We are interested in adopting similar molecular techniques while greatly refining the geographic and temporal resolution to investigate the questions of foraging behavior, changes in insect community composition, and assessing the potential for guano collection as a novel pest management detection strategy.

Foraging Behavior

*INTRAc*olony foraging:

To what extent is a single guano sample representative of the average colony consumption? What is the variance in colony diet at any one time point? How does this variation change over the course of a season?

*INTERc*olony foraging:

How do diets vary among geographically distinct but ecologically similar environments? Does the extent of this heterogeneity change over a season?

Insect Community Composition

Bats provide top down ecological constraints on insect populations. We were interested in providing the first assessment of how the dramatic decline in bat populations has effected changes in insect community composition.

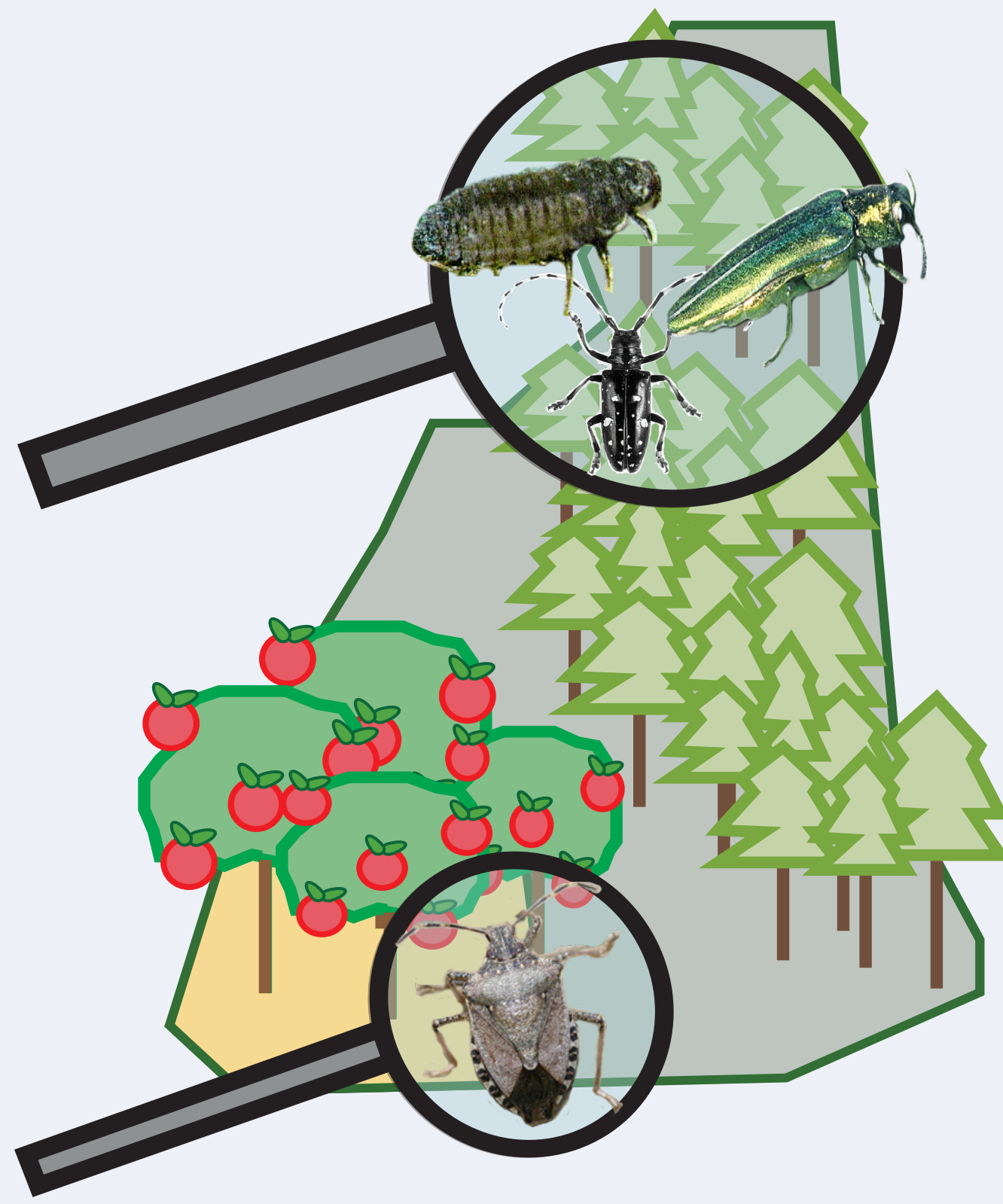
Management Decisions

Pest management:

Traditional aerial and trap surveys throughout New Hampshire have demonstrated the presence of agricultural and forest pests. Our work provides the capacity to greatly expand the detection range and specificity with which insect pests arrive and persist.

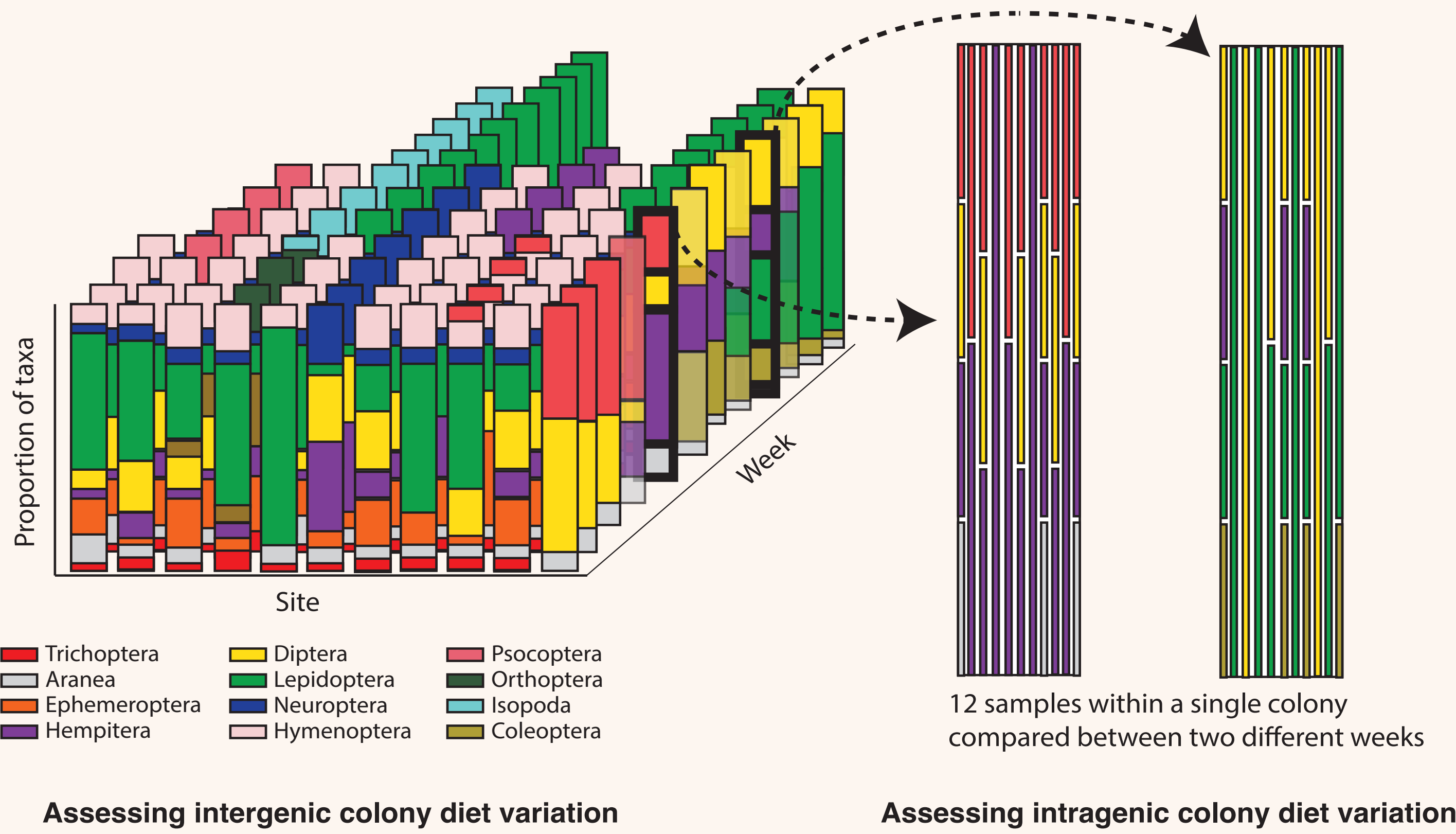
Bat management:

Each guano sample provides an opportunity to assess bat species composition at each site.



Measuring impacts:

Our high-throughput work flow will provide extensive insights into the variation in feeding pattern among bats and can provide the foundation for future research to assess the changes in insect community composition. Known and/or previously undetected forest and crop pests of interest will be assessed by this current collection. Unlike traditional pest detection strategies guano processing is agnostic to target and provides a robust, timely, and sensitive depiction of the insect community in a narrowly defined territory. By combining our bat-species molecular identification with insect diet analyses we will provide a more complete characterization of variation in bat diets in New Hampshire. We plan on expanding our work next season to include both farming and forested communities and determining relationships between topography and insect community throughout New England.

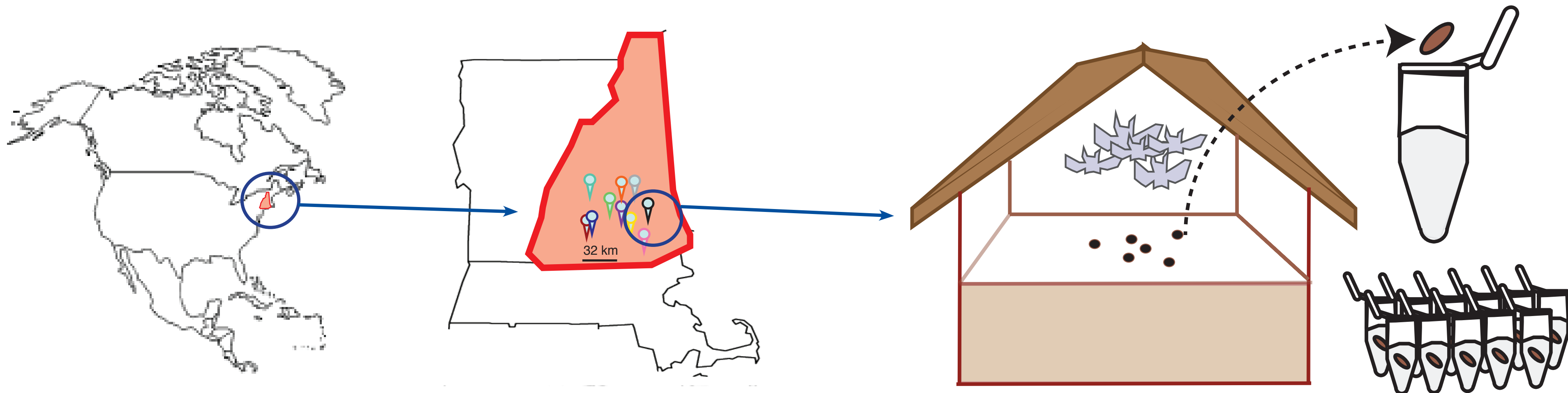


References

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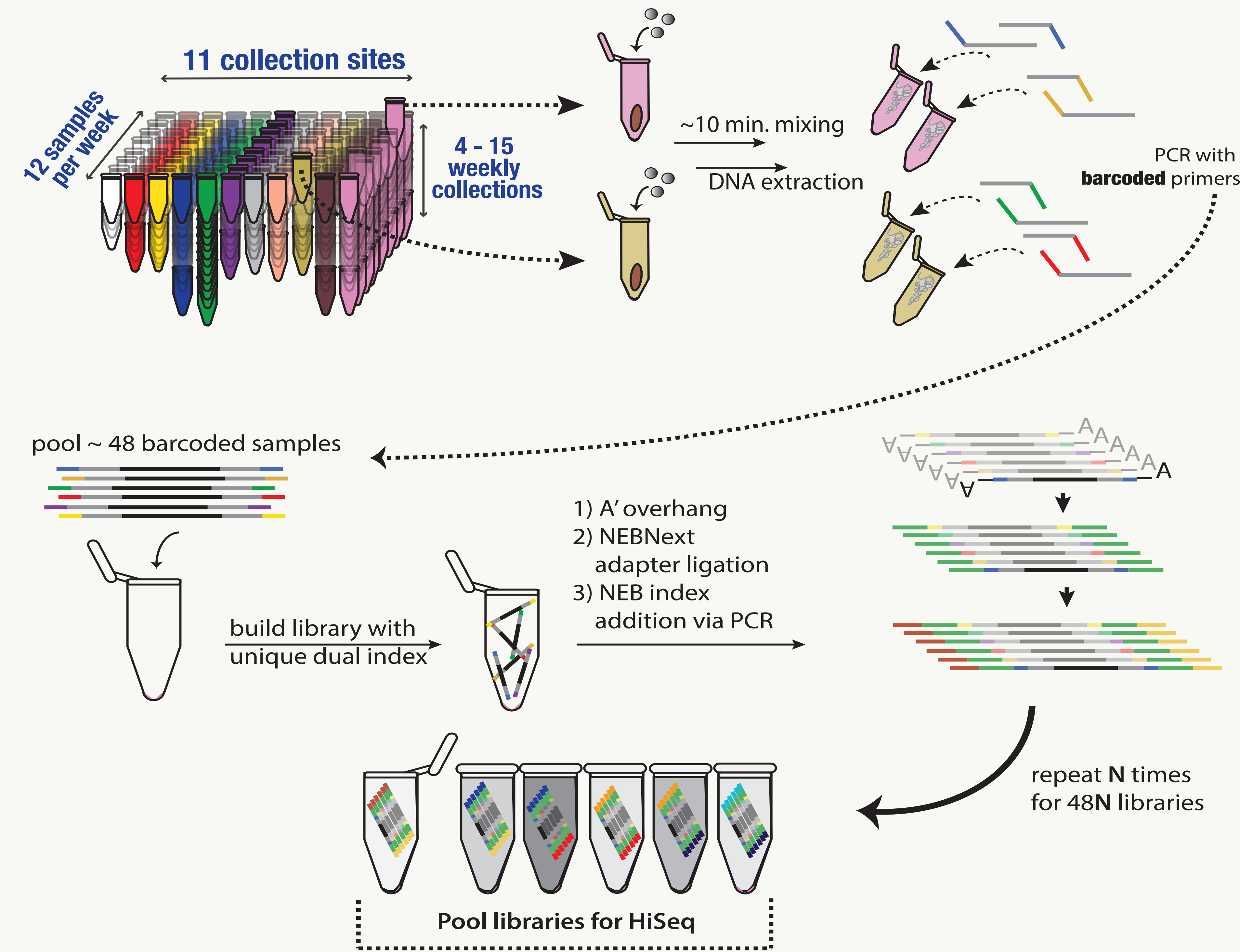
Collection strategies

Trained volunteers and researchers collected 12 guano samples per week among 11 sites between May to September 2015. Guano pellets were stored individually in preservative and at -80 °C prior to DNA extraction.



Sample Preparation

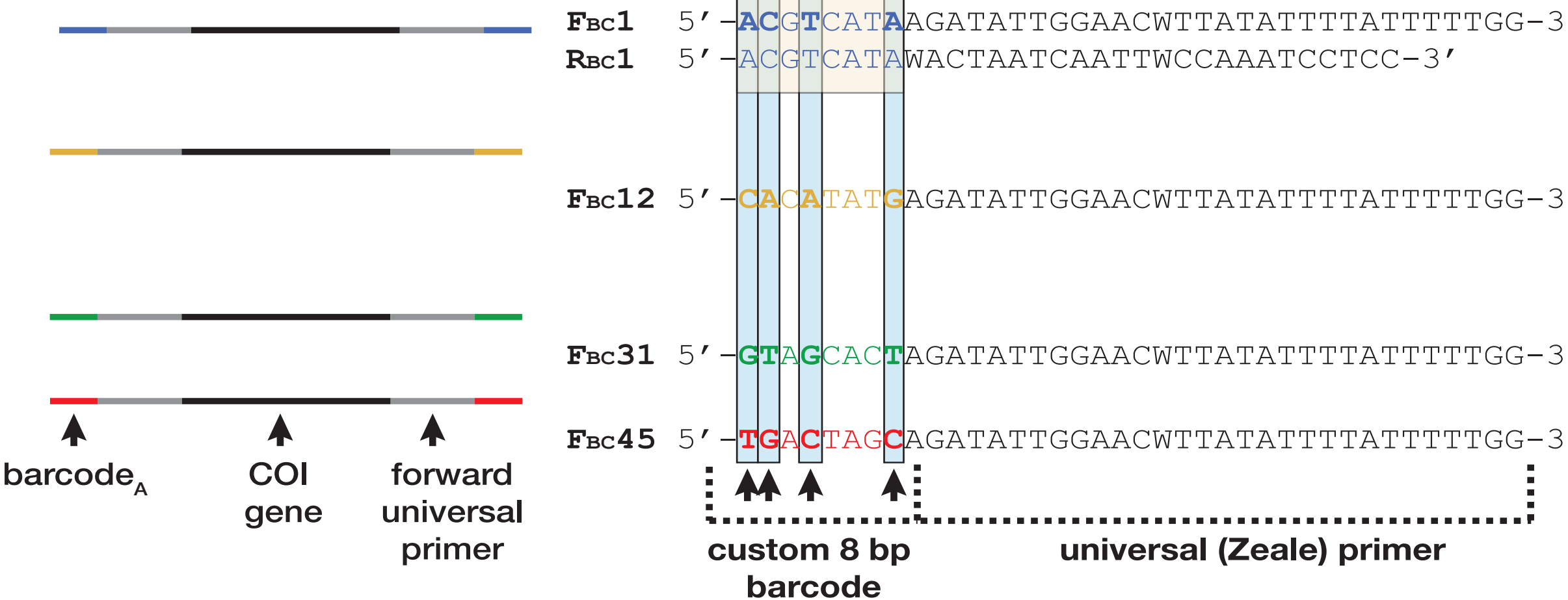
DNA extraction and PCR amplification followed previously described methods (1). Barcoded primers were used in defined pairs to reduce chance of tag jumping (2, 3). Library preparations followed manufacturer's guidelines and were pooled for a single sequencing run on an Illumina Hi-Seq platform with expected output of ~ 1 Gb.



Barcode generation

We developed unique 8 bp barcode located 5' upstream from the universal primer region with a Hamming distance of 3 and alternating AG / CT regions to improve error correction and read quality. Strings of 8 bp were generated using a Python script (4) then filtered to follow guidelines specifying:

- all four nucleotides included
- no repeated nucleotides
- minimize and balance AC / GT
- AT/GC \geq 45 %



Acknowledgments

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