

NAKUL WEWHARE

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Princeton University, Dept. of Ecology & Evolutionary Biology (EEB)

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RESEARCH FOCUS

Bioacoustics and animal communication, with an emphasis on (i) Vocal labeling/matching of others in animals, (ii) role vocal communication in social coordination and cooperation (iii) vocal sequences and syntax structure.

EDUCATION

Princeton University

Sep 2025 – Present

Ph.D. Student, Department of Ecology & Evolutionary Biology (EEB)

Advisor: Dr. Gerald G. Carter

Indian Institute of Science Education and Research (IISER) Pune

Aug 2020 – May 2025

BS-MS Dual Degree (Biology major)

M.S. thesis: *Social network dynamics of budgerigars and their influence on vocal learning*

Advisor: Dr. Anand Krishnan

PUBLICATIONS

Wewhare, N. & Krishnan, A. (2024). Individual-specific associations between warble song notes and body movements in budgerigar courtship displays. *Biology Open*. <https://doi.org/10.1242/bio.060497>

Cover feature; lead-author interview in the *First Person* series: bio061701.

Madabhushi, A. J. J., **Wewhare, N.**, Binwal, P., Agarwal, V., & Krishnan, A. (2023). **Higher-order dialect variation and syntactic convergence in the complex warble song of budgerigars.** *Journal of Experimental Biology*, 226(20): jeb245678. <https://doi.org/10.1242/jeb.245678>

Wewhare, N. & Pandey, U. (2021). First record of scavenging by a checkered keelback (*Fowlea piscator*) from Western Maharashtra, India. *Reptiles & Amphibians*, 28(2), 348–349. <https://doi.org/10.17161/randa.v28i2.15638>

PREPRINTS

Wewhare, N., Burkart, J. M., & Wierucka, K. Sequence-level vocal convergence in a social primate. In preparation.

Dhati, A. M., **Wewhare, N.**, Devasthale, N. S., Sundar, S., Parulekar, N., & Krishnan, A. (2025). **Vocal sequences of diverse parrots suggest an important role for note repetition.** *bioRxiv*. <https://doi.org/10.1101/2025.10.24.684295>

TEACHING EXPERIENCE

Teaching Assistant, EEB 338 / LAS 351: Tropical Biology

Prof. Gerald Carter

Assisted in an intensive field course in Panama on tropical ecology, biodiversity, biotic interactions, and tropical landscape evolution, including support for field, laboratory, and data analysis components.

CONFERENCES AND WORKSHOPS

20th International Society for Behavioral Ecology (ISBE)

Turin, Italy. Jul 20–24, 2026.

Contributed talk: Evidence that vampire bats use vocal matching to address specific group members.

Recipient of a travel award (€1600).

Bioacoustics & AI 101: Making AI Accessible to Everybody

Organized by the Behavioural Ecology group, University of Copenhagen. Sep 2024 (online).

Contributed talk: Quantifying syntactic convergence in common marmoset vocal sequences. (Recording)

5th Conference of the Indian Society of Evolutionary Biologists (ISEB)

Organized by the Indian Society of Evolutionary Biologists at Lucknow University. Oct 2024.

Poster: Individual-specific associations between warble song notes and body movements in budgerigar courtship displays.

Winter School on Evolutionary Game Theory

Organized by the Department of Mathematics, Shiv Nadar University, Delhi. Dec 2023.

4th Conference of the Indian Society of Evolutionary Biologists (ISEB)

Organized by the Indian Society of Evolutionary Biologists at Ahmedabad University. Dec 2022.

RESEARCH EXPERIENCE

Master's thesis student

Supervisor: Dr. Anand Krishnan

ECEB Lab, EOBU, JNC SAR

May 2024 – Present

- Designed and ran fission–fusion experiments in lab budgerigar colonies to test how social-network position predicts longitudinal change in vocal repertoires.
- Built interaction- and association-based social networks from (i) manual behavioural observations and (ii) automated video capture using a multi-camera Raspberry Pi setup.
- Linking network-derived predictors to multi-level acoustic features of warble song (note-, motif-, and sequence-level structure) to quantify social effects on vocal learning.

Undergraduate researcher

Supervisor: Dr. Kaja Wierucka

Behavioral Ecology & Sociobiology Unit, German Primate Center

Dec 2023 – Apr 2024

- Developed a sequence-comparison approach for marmoset vocal sequences inspired by bioinformatics-style alignment to quantify syntactic convergence.
- Quantified vocal accommodation at multiple scales: sequence-level syntax and note-level spectral structure (MFCC-based features).
- Found separable encoding: individual identity in spectral call features and dyad identity in sequence-level structure.

Semester project student

PI: Dr. Raghav Rajan

Rajan Lab, IISER Pune

Aug 2023 – Dec 2023

- Built an automated microcontroller-based training setup for zebra finches to sing in a delay-instructed paradigm, separating preparation from production.
- Assisted with electrophysiological recordings across song-related nuclei and downstream analysis of preparatory activity.

MITACS Globalink summer intern

PI: Dr. Lauren Guillette

Animal Cognition Research Group, University of Alberta

May 2023 – Aug 2023

- Conducted behavioural experiments and analysis to quantify zebra finch activity and personality-linked information use during nest building.
- Built a DeepLabCut-based video scoring pipeline; trained a general zebra finch model to support future experiments.
- Implemented automated tracking workflows using AnimalTA for scalable behavioural quantification.

Winter project student

PI: Dr. Anand Krishnan

Indore Zoo and ECEB Lab, IISER Bhopal

Dec 2022 – May 2023

- Recorded and analysed vocal sequences of parrots (*Psittacula*, *Agapornis*, *Melopsittacus*, *Trichoglossus*) at the Indore Zoo.
- Conducted cross-species comparative analyses of syntactic structure in complex vocal sequences.
- Developed a semi-Markov model to describe sequential vocal structure across genera.

Semester project student*PI: Dr. Anand Krishnan*

ECEB Lab, IISER Bhopal

Aug 2022 – Aug 2023

- Quantified relationships between budgerigar courtship displays and warble-song syntax, testing generality and individual variability.
- Modelled courtship behaviour and vocal sequences using HMMs and deep sequence models (LSTMs; seq2seq).

Summer intern

Ecological, Community and Evolutionary Bioacoustics (ECEB Lab), IISER Bhopal

*PI: Dr. Anand Krishnan**Jun 2022 – Aug 2022*

- Analysed warble-song syntax to identify higher-order dialect differences across colonies.
- Tested convergence in syntactic structure following colony fusion using longitudinal recordings.

Undergraduate researcher*PI: Dr. Anindita Bhadra*

Dog Lab, IISER Kolkata

Dec 2021 – May 2022

- Recorded and analysed free-ranging dog acoustic interactions in the field (continuous sampling over multiple contexts).
- Analysed vocalisations for context-dependent functional referencing; designed and ran playback experiments to quantify receiver discrimination.

Summer intern*PI: Dr. Anindita Bhadra*

Dog Lab, IISER Kolkata

Aug 2021 – Dec 2021

- Designed and ran field experiments testing olfactory vs. visual cues during food scavenging and how human interactions shape decision-making.

AWARDS & FELLOWSHIPS

Kishore Vaigyanik Protsahan Yojana (KVPY) SX Fellowship*2020 – 2025*

Government of India fellowship supporting research-oriented students during pre-PhD training.

MITACS Globalink Research Internship Fellowship*Summer 2023*

Competitive 12-week research internship at a Canadian university under faculty supervision.

ACADEMIC SERVICE

Co-reviewer (with Dr. Anand Krishnan), *Proceedings of the Royal Society B* (2024).**SELECTED COURSEWORK**

Quantitative: Bayesian Inference; Causal Inference; Network Algorithms; Parameter Estimation and Inverse Theory; Numerical Computation; Nonlinear Dynamics; Bioinformatics.**Biology:** Advanced Evolution; Ecology I and II; Animal Behaviour; Comparative Physiology; Developmental Biology; Neuroscience I and II.**Mathematics:** Linear Algebra; Multivariate Calculus; Probability; Partial Differential Equations; Ordinary Differential Equations; Graph Theory.**TECHNICAL SKILLS**

Programming: Python, R, MATLAB**Bioacoustics:** Raven Pro; warbleR; MFCC, spectral feature extraction; sequence/syntax analysis, DTW, UMAP**Quantitative:** GLMMs; Bayesian modelling; causal inference, network analysis; Agent based simulations**ML (applied):** HMMs; LSTM/seq2seq models, Variational auto encoders (VAE), image based segmentation methods.**Hardware/field systems:** Raspberry Pi multi-camera setups; Arduino/microcontrollers