BioSoundSCape

Connecting acoustics and remote sensing to

study animal-habitat diversity across environmental gradients

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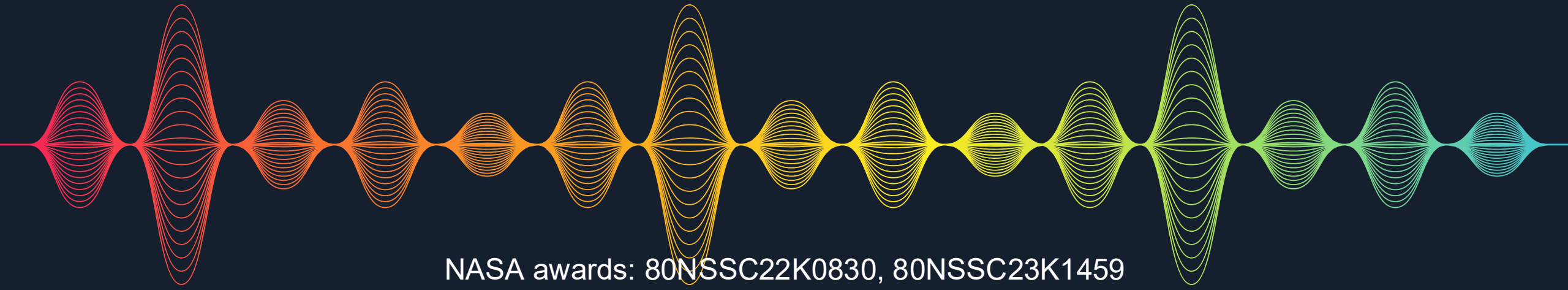

NASA awards: 80NSSC22K0830, 80NSSC23K1459

Our team

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Dec 6, 1968 - Apr 19, 2025

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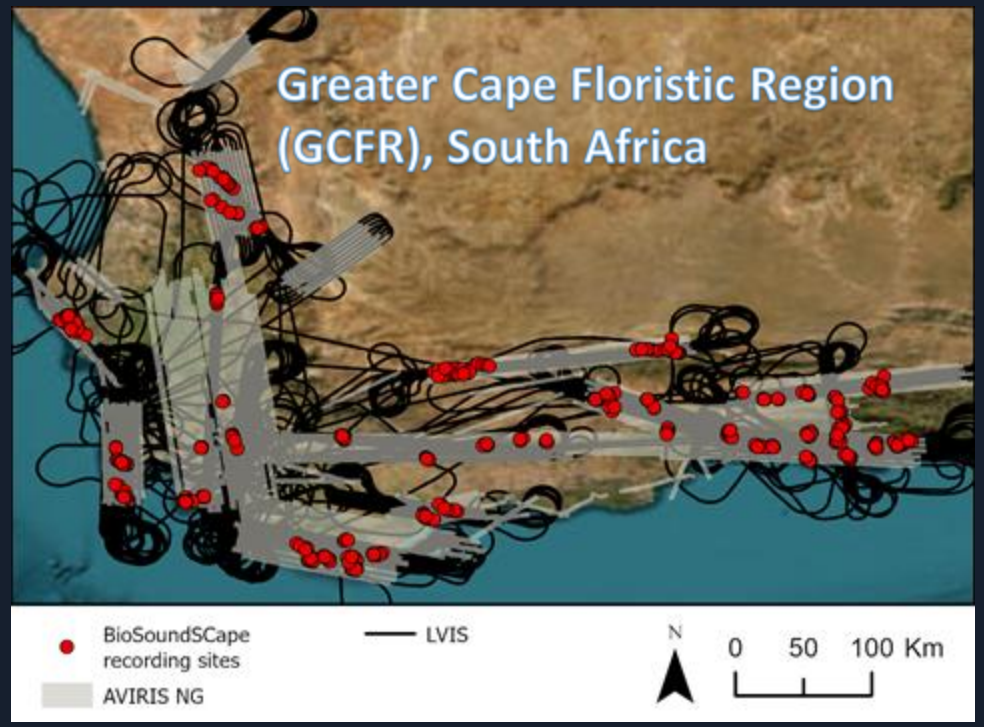
Goals

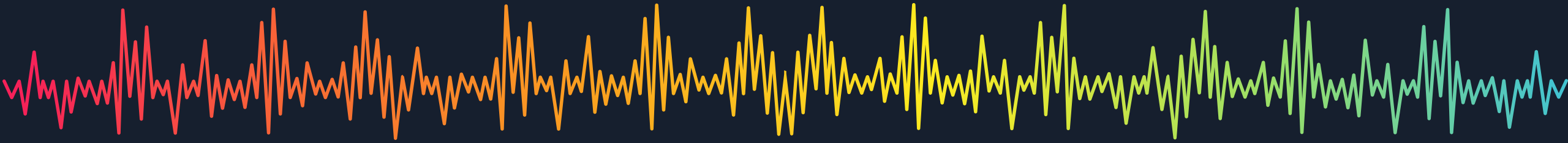
1. **Measure ground-based animal diversity using low-cost sound recorders across the Cape region in South Africa**
2. **Scale these measurements using remotely-sensed indicators of habitat variation**

   spectral, structural & topographic predictors

Passive acoustic recorders



10-min point counts for birds
825,832 minutes of recordings
489 sites - wet season 2023
505 sites - dry season 2023
Seasonally co-located



Acoustics processing workflow

Fine-tuned acoustic AI
(BirdNET-based CNN)

Rangers & volunteers deploy recorders

Expert volunteers extract labels

Trained AI to ID target species

Trained AI to ID ABGI sounds

Test & validation data

Unfiltered predictions

SiteID	Species	Conf.	Present
s2lam001_230713	A. aegyptiaca	0.612	YES

expert

Predictions filtered at threshold resembling range

SiteID	Species	Conf.	Range Thresh.	Present
s2lam001_230713	A. aegyptiaca	0.612	0.712	NO

Predictions filtered at maxF0.5 threshold

SiteID	Species	Conf.	F0.5 Thresh.	Present
s2lam001_230713	A. aegyptiaca	0.612	0.587	YES

randomForest model corrects with ABGI data

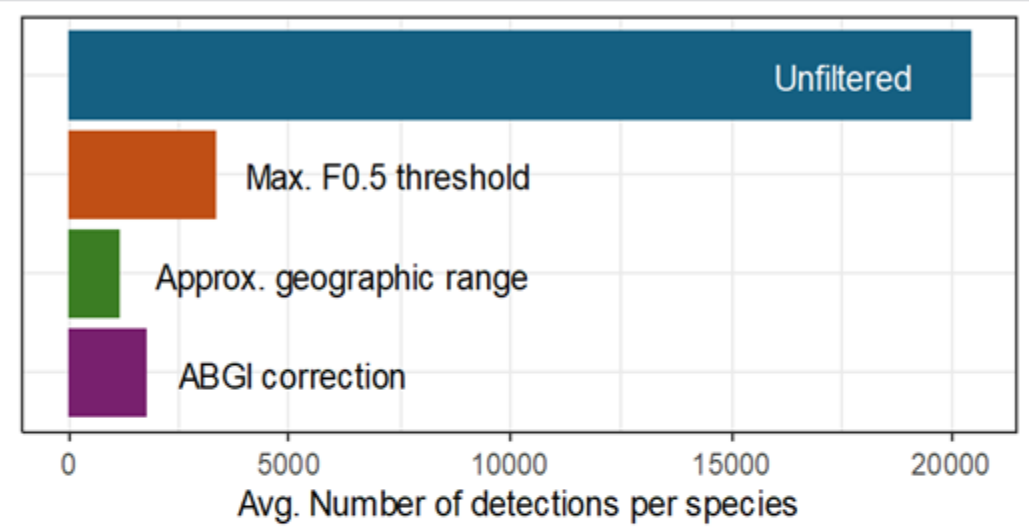
Predictions corrected with randomForest model

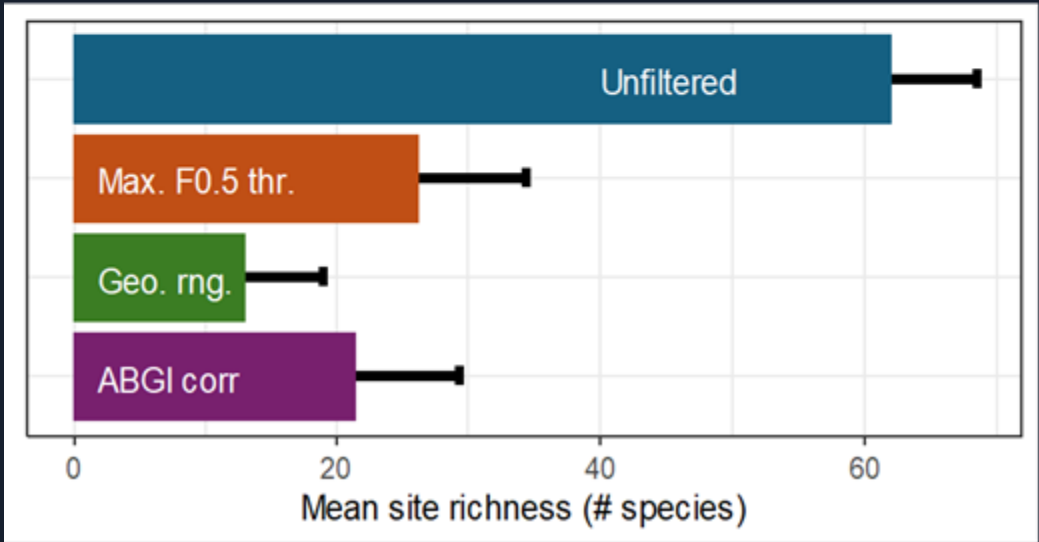
rF Conf.	rF Thresh	Present
0.623	0.744	NO

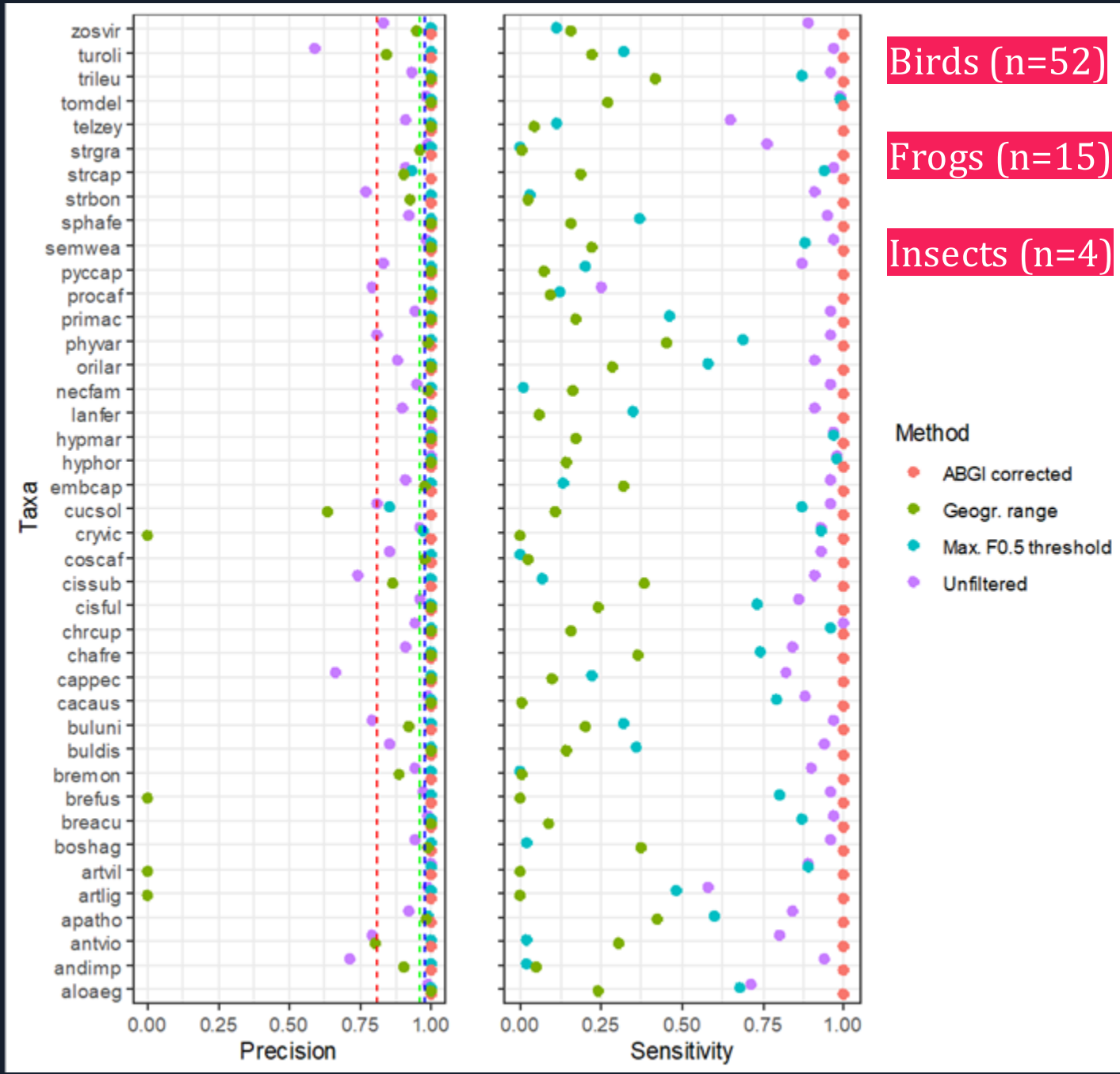
RICHNESS

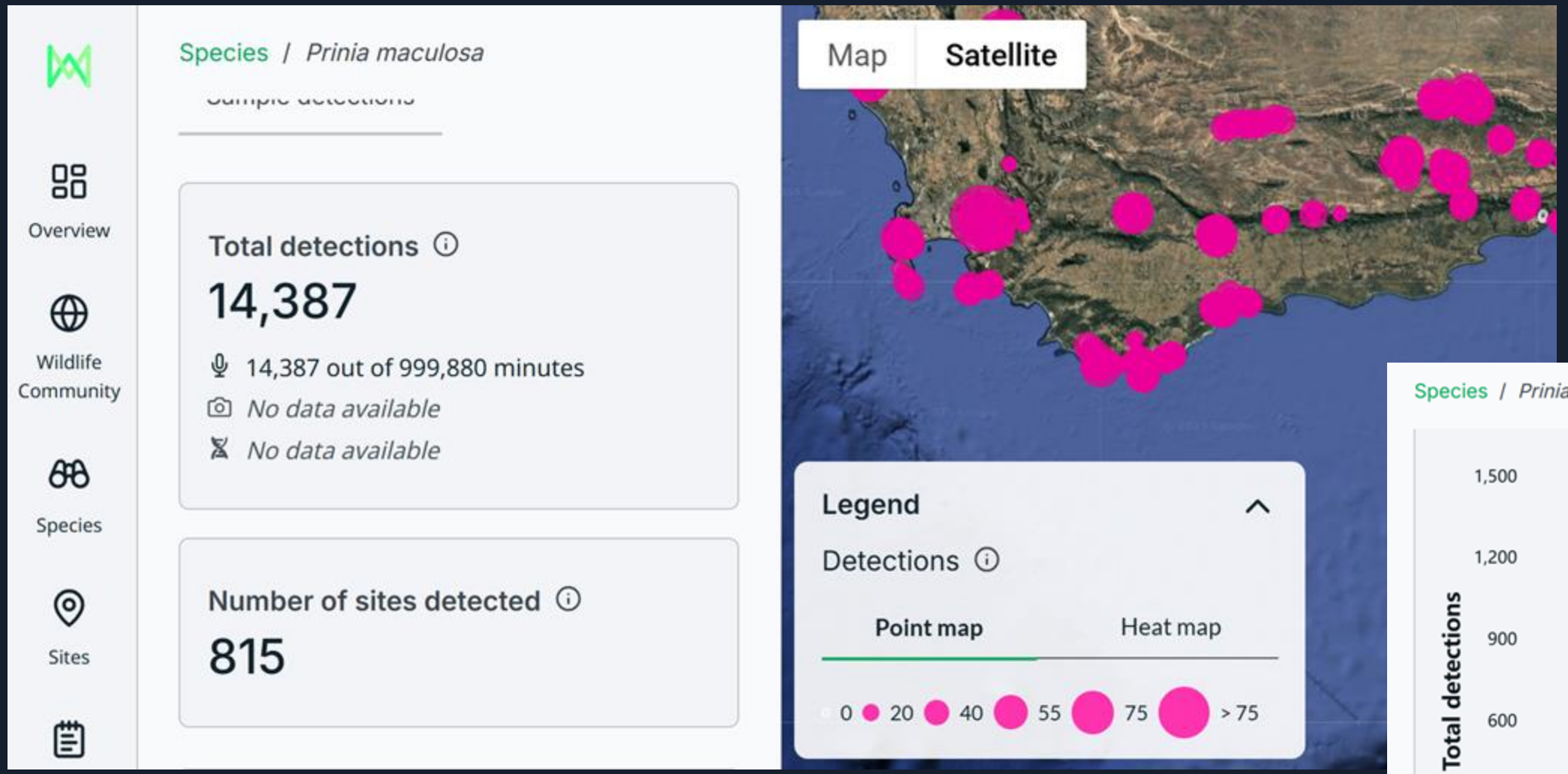
ABGI = anthropophony, biophony, geophony, interference

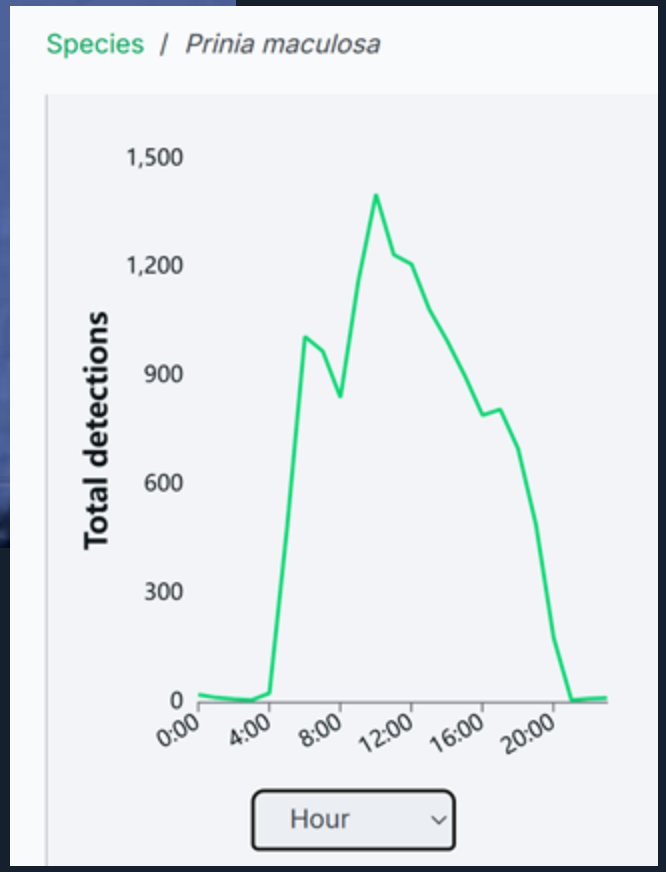
Richness, precision, & sensitivity







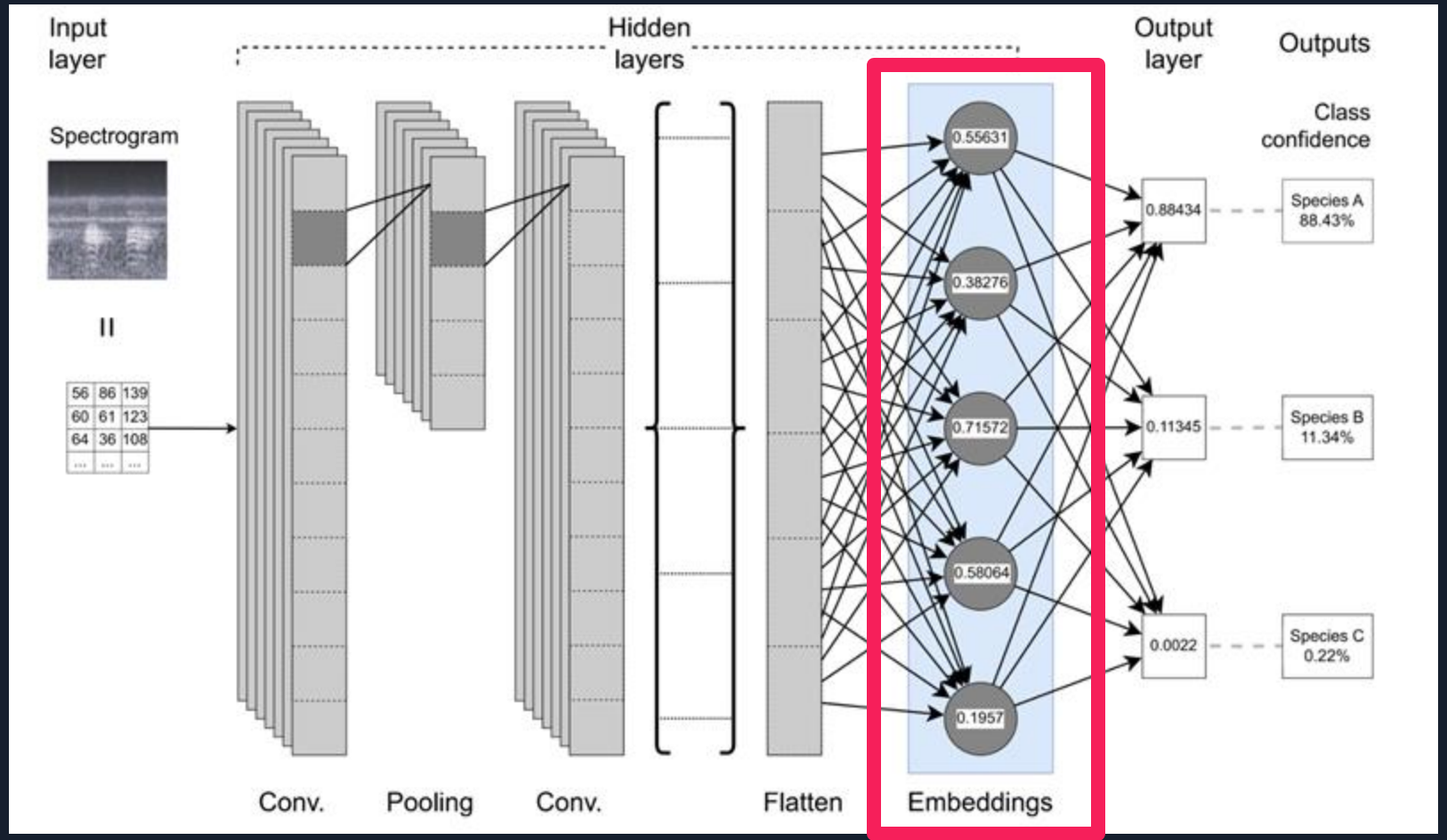




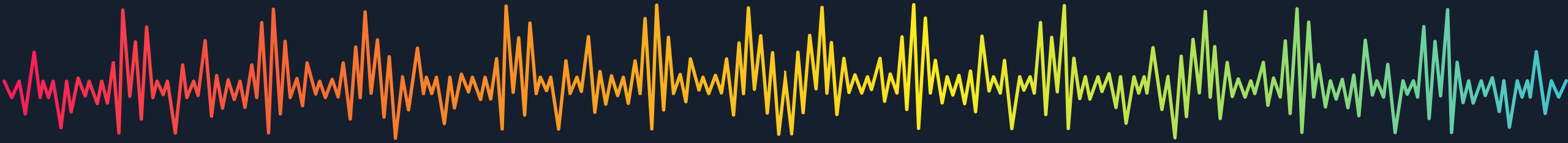
WildMon stakeholder dashboard using AI-based species detections

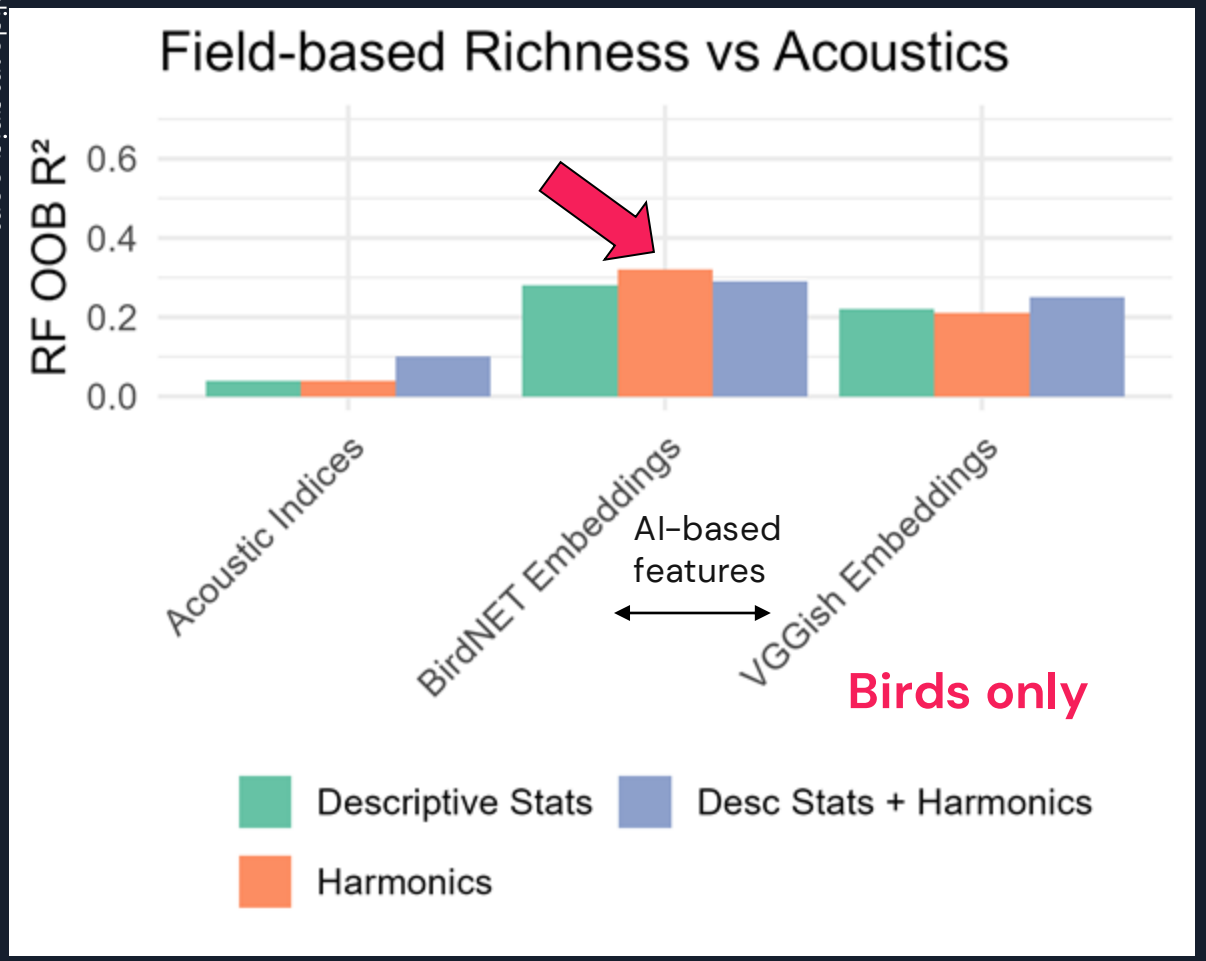
Convolutional neural network (CNN) embeddings

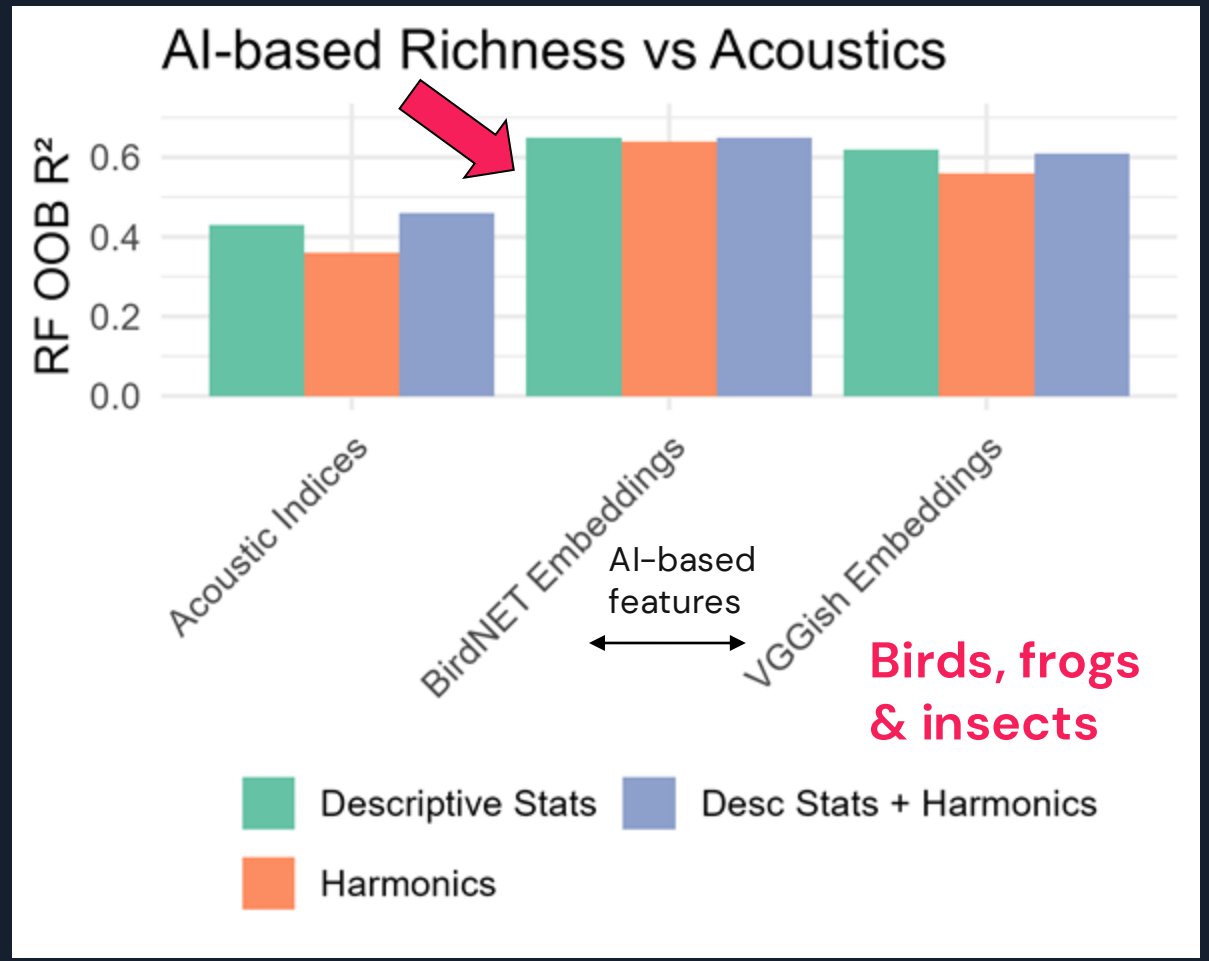
BirdNET has 1024 embeddings
(i.e., AI-based features)



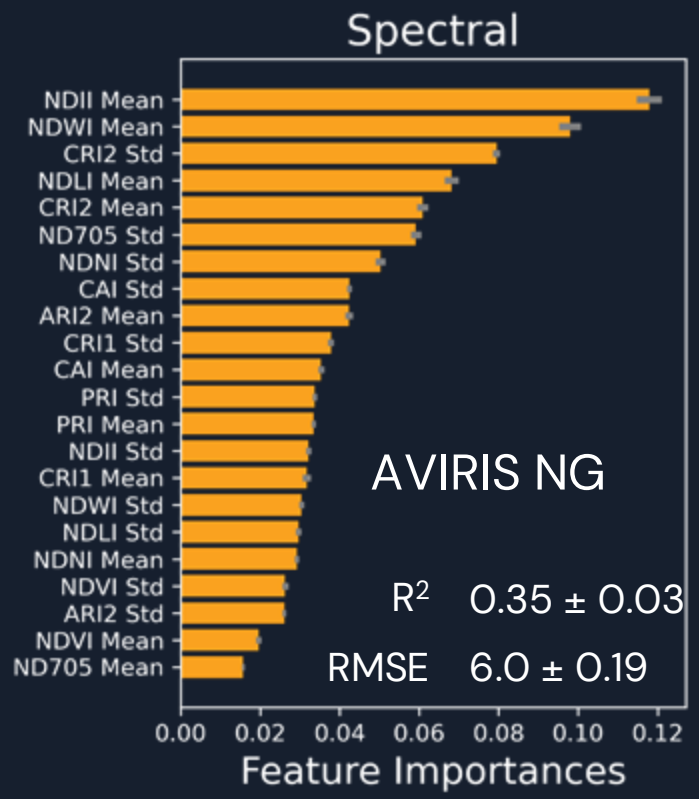
Bravo Sanchez et al., Eco Ind 2024

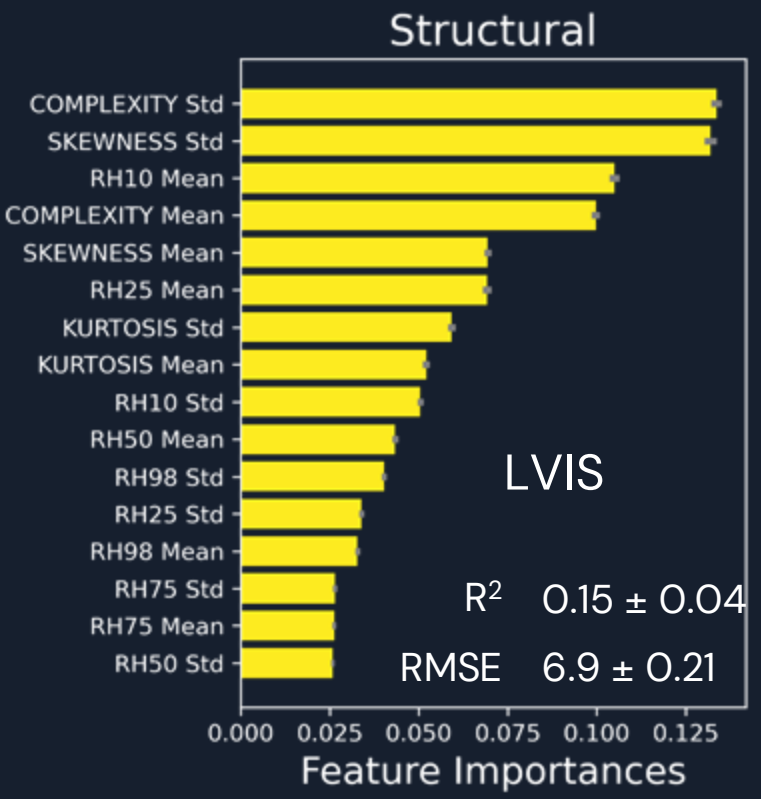


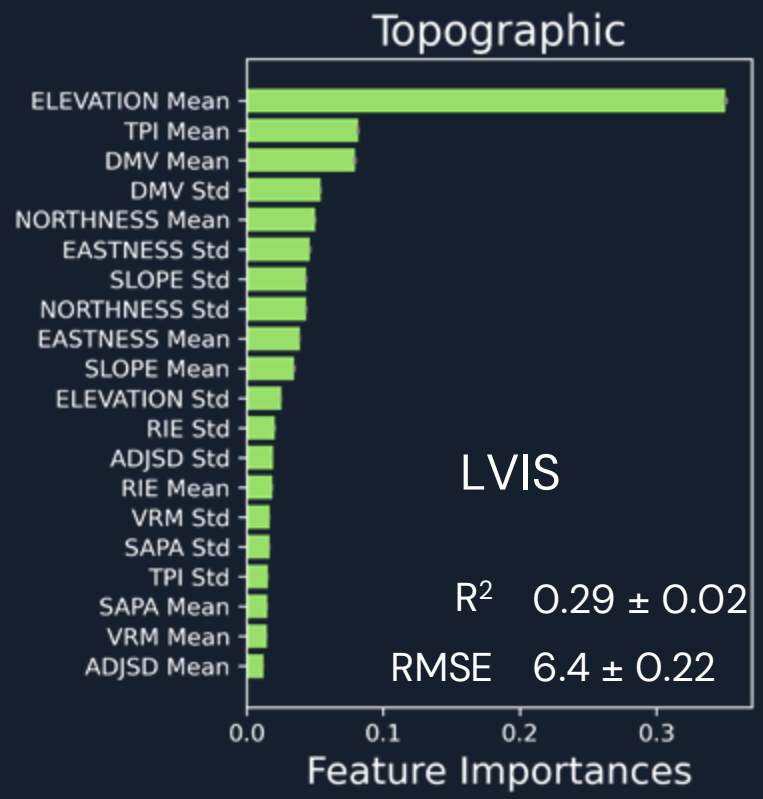




Can we predict species richness from acoustic features?





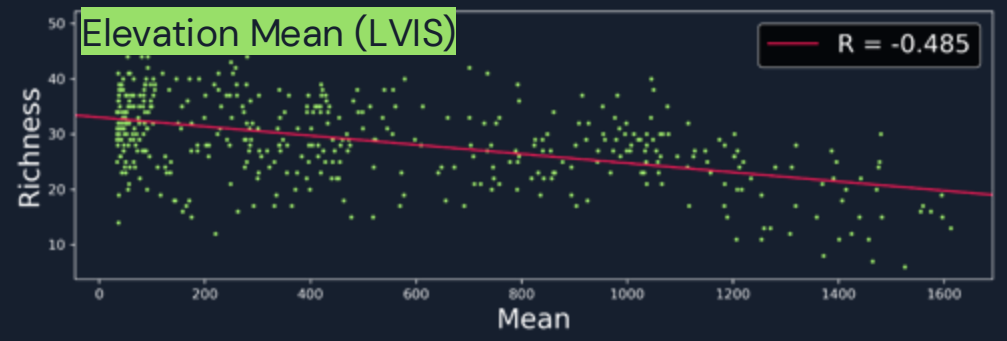


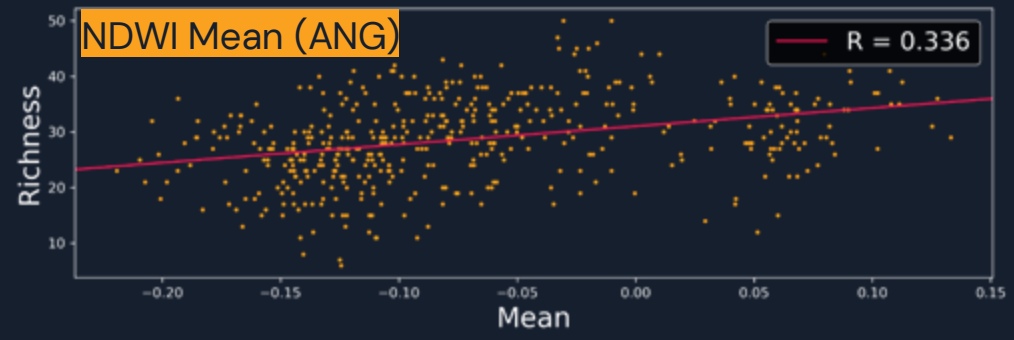
Random Forest feature importances, with model performance evaluated using 8-fold cross validation

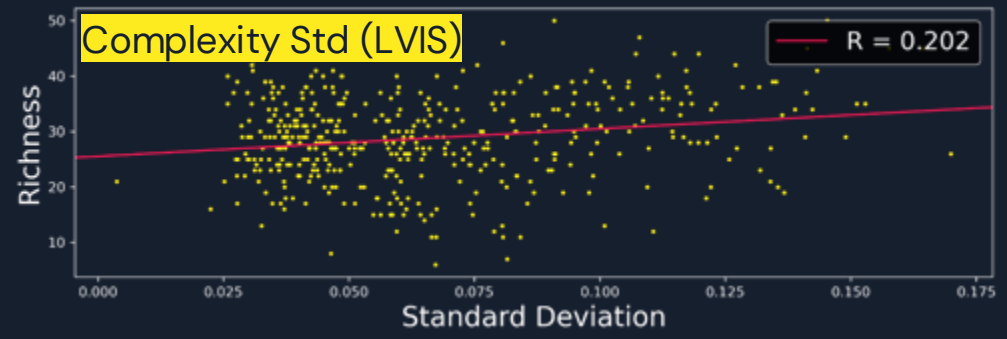
Can we predict species richness from spectral, structural, or topographic features?

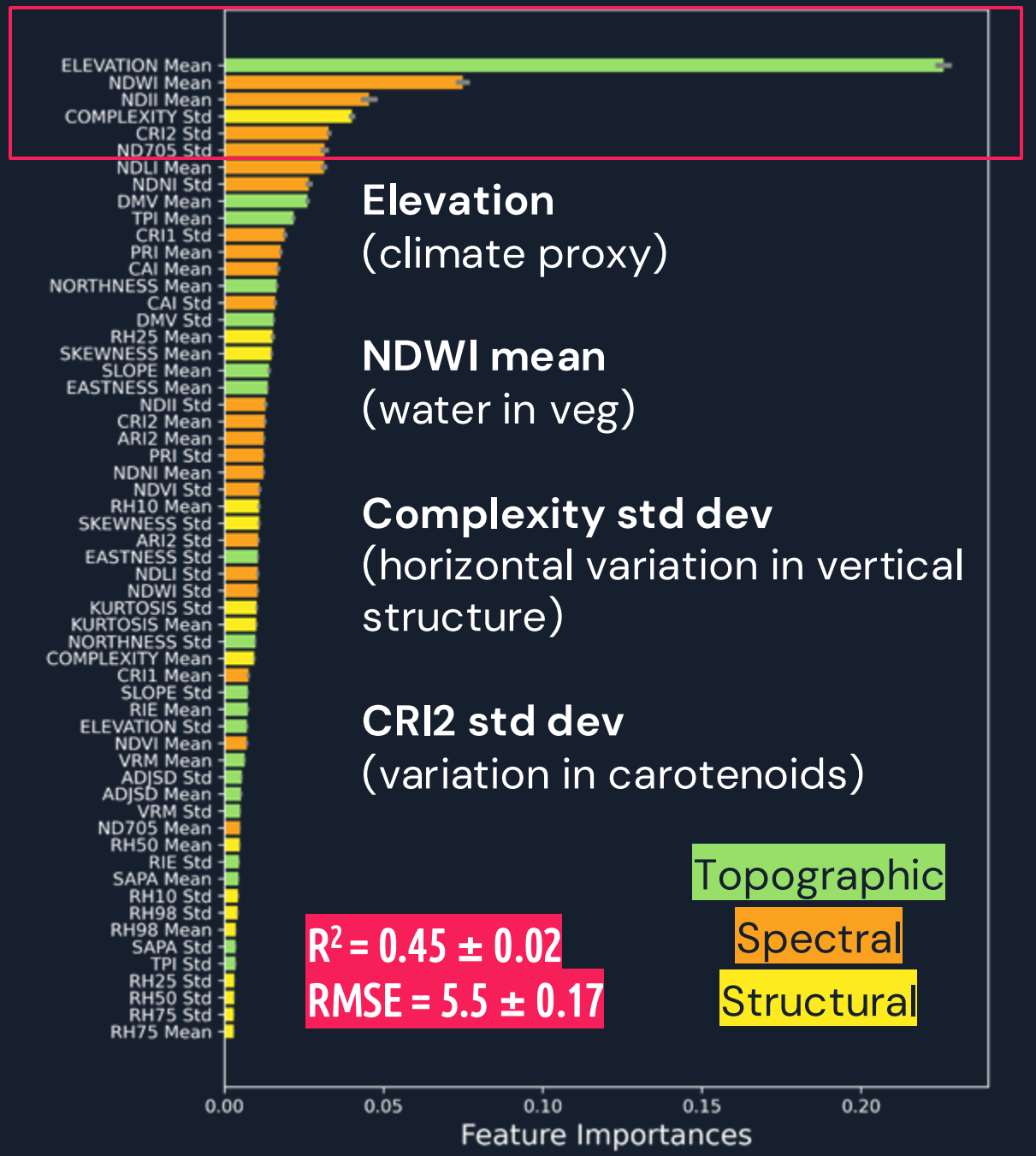
Combined Model

Top Features by Type









Elevation
(climate proxy)

NDWI mean
(water in veg)

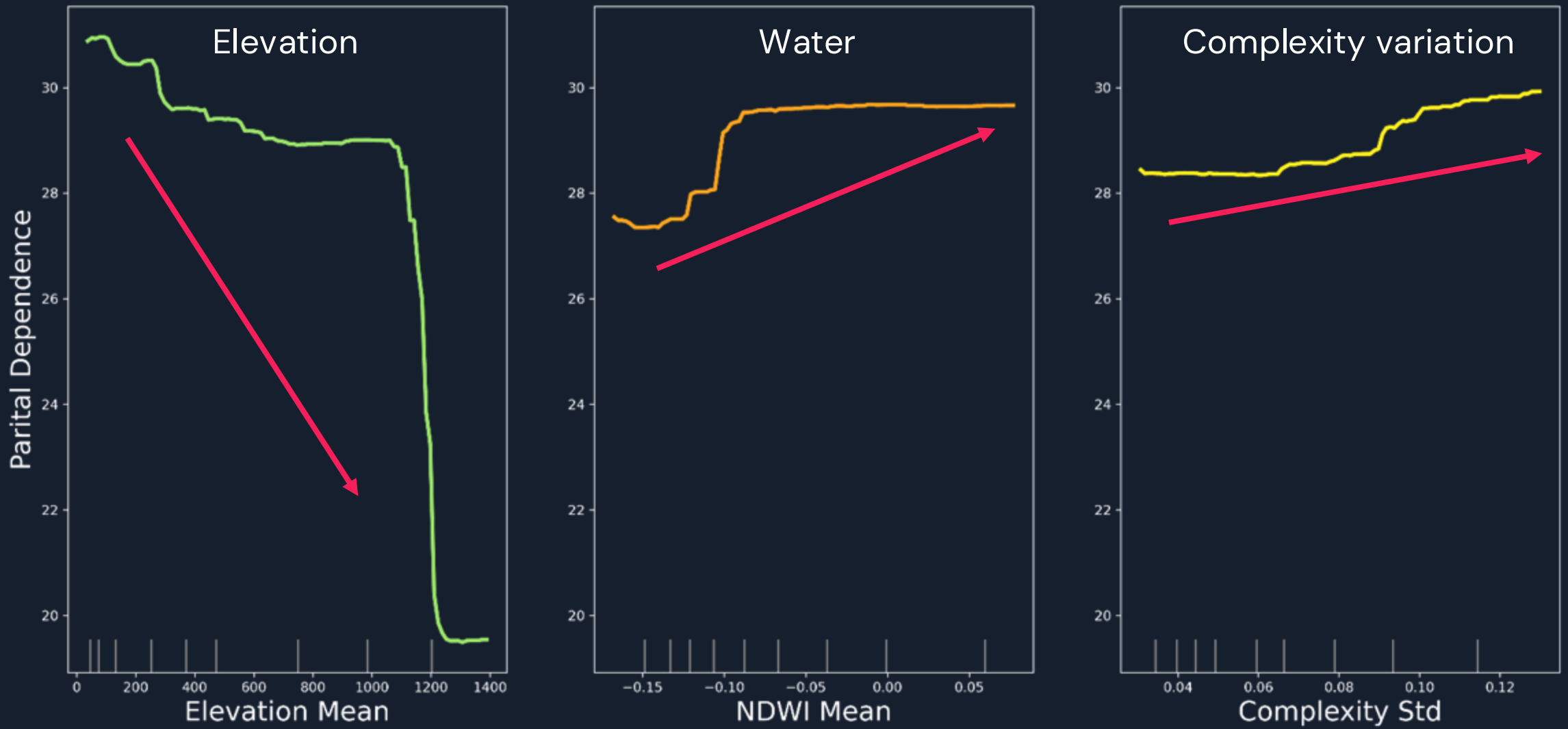
Complexity std dev
(horizontal variation in vertical structure)

CRI2 std dev
(variation in carotenoids)

$R^2 = 0.45 \pm 0.02$
RMSE = 5.5 ± 0.17

Topographic
Spectral
Structural

Partial Dependence



Take Home Messages

01 Passive acoustics

An important source of *in situ* species diversity data

02 AI-based detections

Customized BirdNET used to detect soundscape components and species

03 Acoustic diversity

AI-based acoustic features (embeddings) better than engineered features to estimate species richness

04 Spectral diversity

Water content and variation in carotenoids important predictors of richness

05 Vegetation structure

Variation in vegetation complexity a top predictor

06 Combined model

Elevation (e.g., climate proxy) was most important