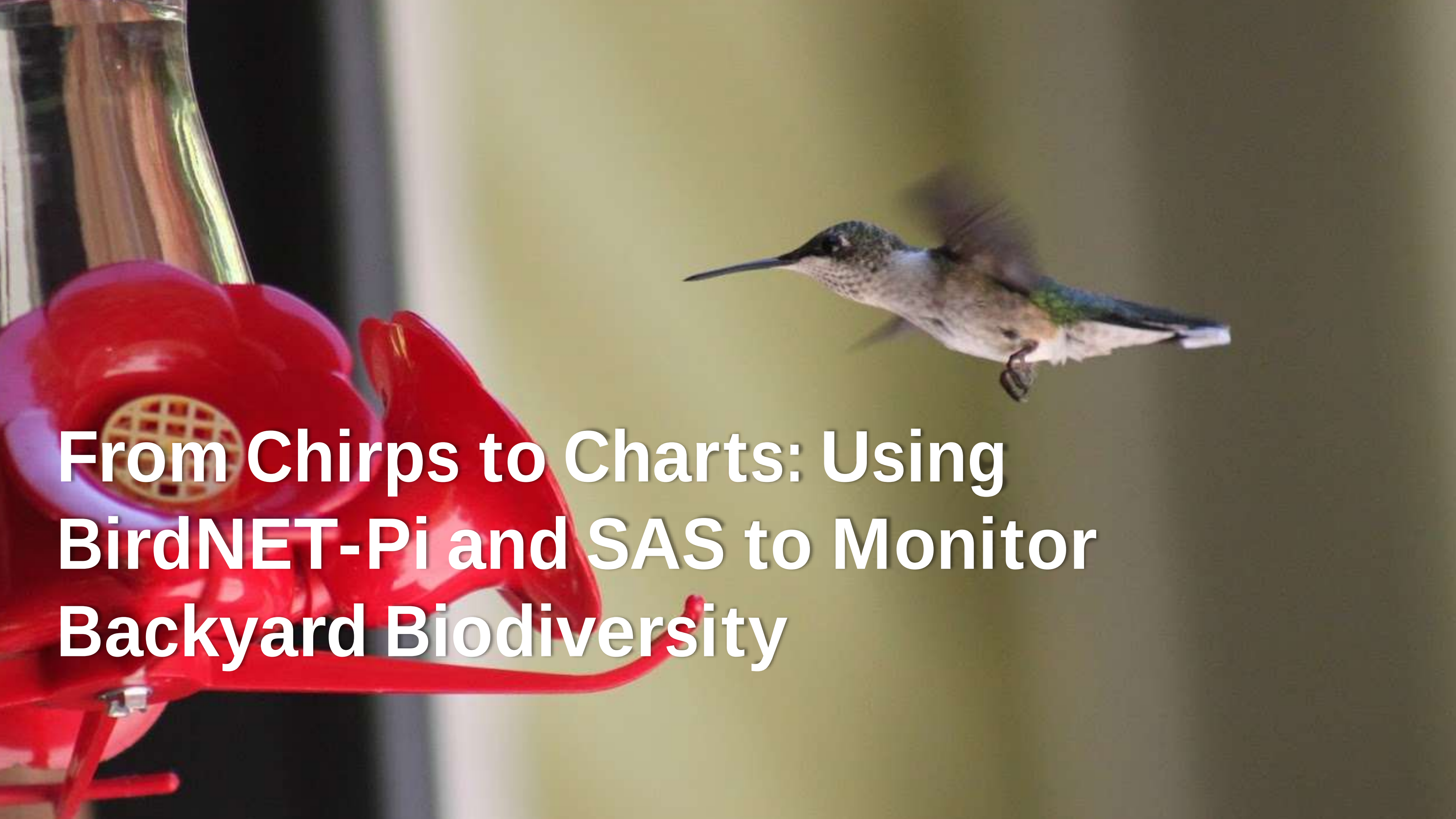


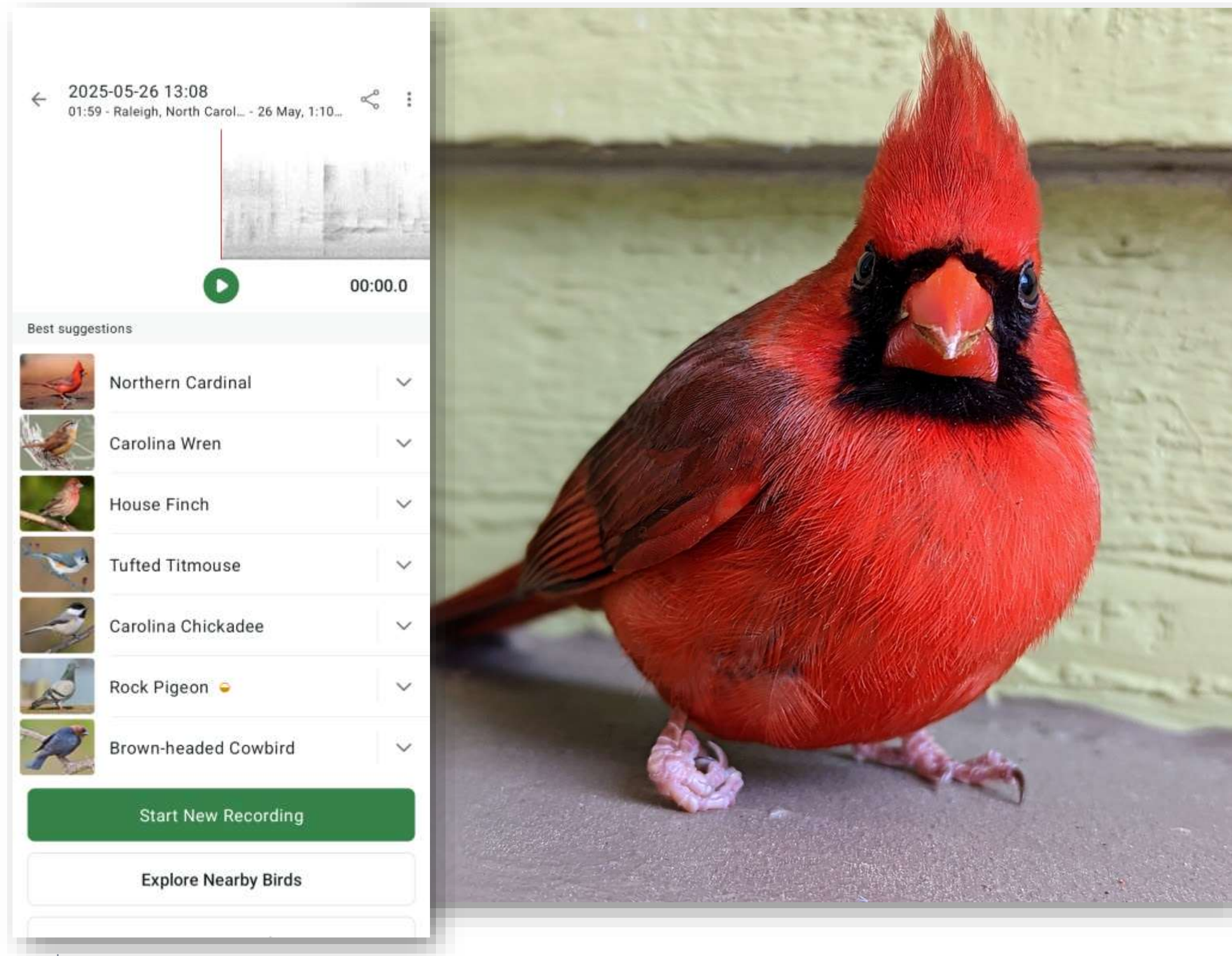


From Chirps to Charts: Using BirdNET-Pi and SAS to Monitor Backyard Biodiversity

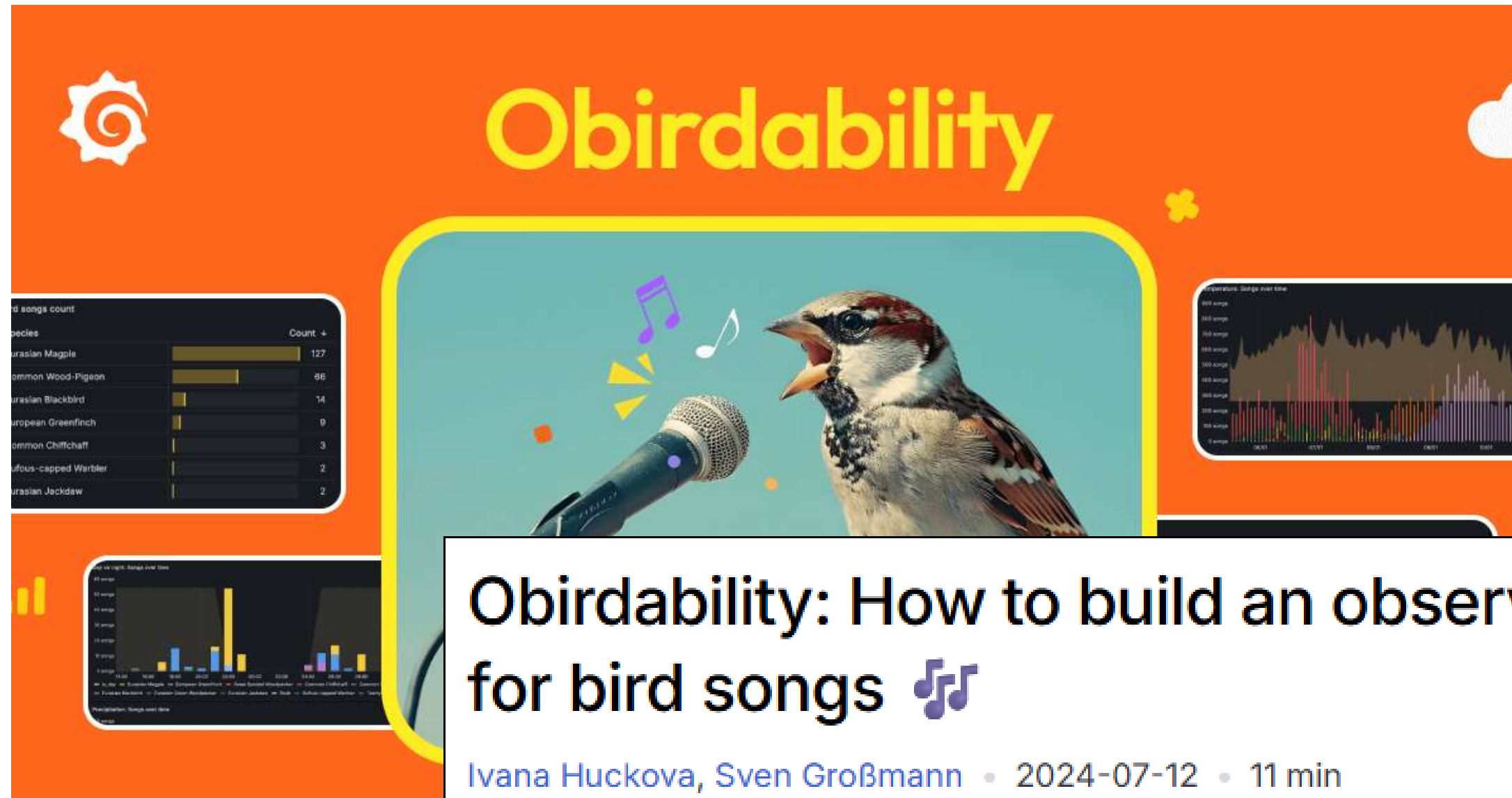


What's that bird I hear?

Apps like Merlin use AI to provide an instant answer



How it started – at an open source conference

The image shows a presentation slide for 'Obirdability'. At the top left is the Open Source logo. The title 'Obirdability' is in large yellow text. Below it is a central image of a sparrow singing into a microphone, with musical notes floating around. To the left of the central image is a table titled 'Bird songs count' showing the count for various bird species. To the right is a line graph titled 'Operations: songs over time' showing a fluctuating line. Below the central image is a bar chart titled 'Bird songs count over time' showing counts for different time periods. The overall background is orange with a white cloud in the top right corner.

Species	Count
Eurasian Magpie	127
Common Wood-Pigeon	96
Eurasian Blackbird	14
European Greenfinch	9
Common Chiffchaff	3
Bluish-capped Warbler	2
Eurasian Jackdaw	2

Obirdability: How to build an observability system for bird songs 🎵

Ivana Huckova, Sven Großmann • 2024-07-12 • 11 min

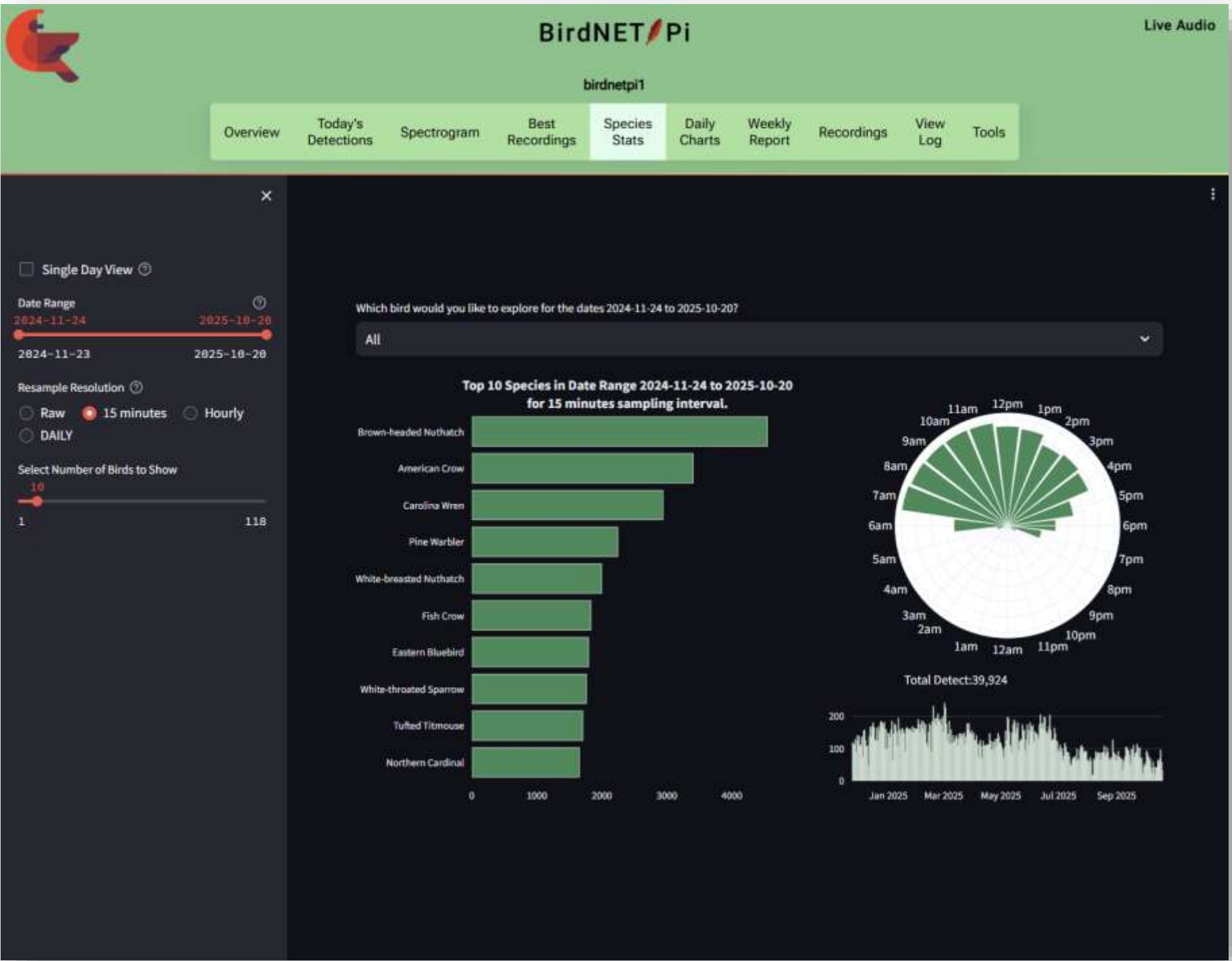
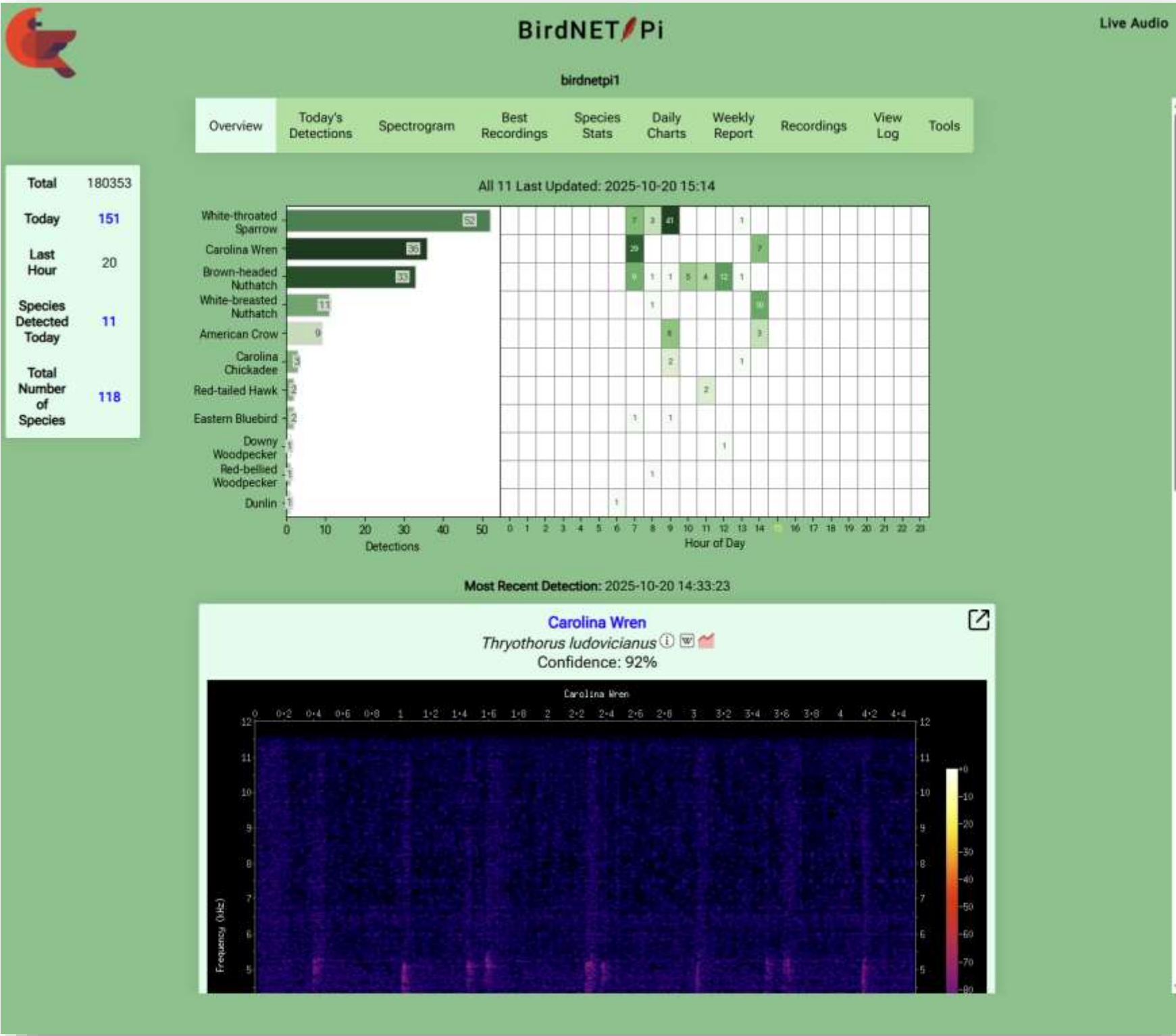


What are those birds I hear when I wake up? What's the most common bird in my garden? These are the types of questions, along with our general curiosity about the world around us, that motivated us to build an observability system for bird songs — a system you can replicate at home to learn more about the sweet tweets in your backyard, too!

\$50 hardware – Raspberry Pi 4 and microphone



BirdNET-Pi has built-in reporting



And it's always listening and scoring audio

```
15:17:53---[birdnet_analysis][INFO] Analyzing BirdSongs/StreamData/2025-10-20-birdnet-15:17:38.wav
15:17:53---[server][INFO] READING AUDIO DATA...
15:17:53---[server][INFO] READING DONE! READ 5 CHUNKS.
15:17:53---[server][INFO] ANALYZING AUDIO...
15:17:54---[server][INFO] DONE! Time 1.29 SECONDS
15:17:54---[server][INFO] 0.0;3.0-('Palmeria dolei_Akohekohe', 0.019101644)
15:17:54---[server][INFO] 3.0;6.0-('Chiroxiphia linearis_Long-tailed Manakin', 0.025878662)
15:17:54---[server][INFO] 6.0;9.0-('Basileuterus rufifrons_Rufous-capped Warbler', 0.08023042)
15:17:54---[server][INFO] 9.0;12.0-('Bucephala clangula_Common Goldeneye', 0.15326965)
15:17:54---[server][INFO] 12.0;15.0-('Bucephala clangula_Common Goldeneye', 0.19380704)
15:18:08---[birdnet_analysis][INFO] Analyzing BirdSongs/StreamData/2025-10-20-birdnet-15:17:53.wav
15:18:08---[server][INFO] READING AUDIO DATA...
15:18:08---[server][INFO] READING DONE! READ 5 CHUNKS.
15:18:08---[server][INFO] ANALYZING AUDIO...
```

The **black-billed scythebill** (*Campylorhamphus falcularius*) is a species of [bird](#) in the subfamily [Dendrocolaptinae](#) of the ovenbird [family Furnariidae](#). It is found in [Argentina](#), [Brazil](#), and [Paraguay](#).^[2]

Black-billed scythebill

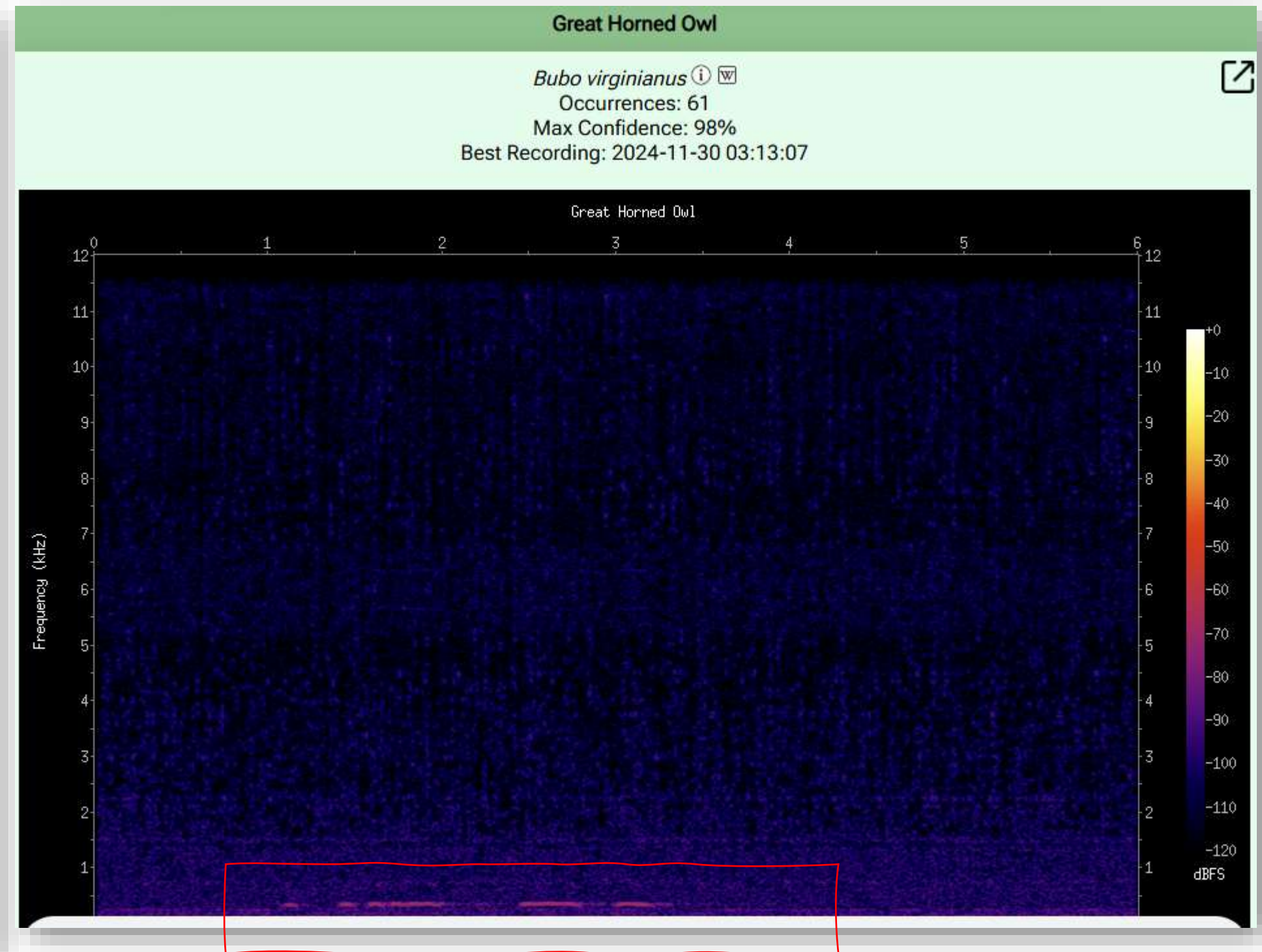


Black-billed scythebill at Piraju, São Paulo State, Brazil

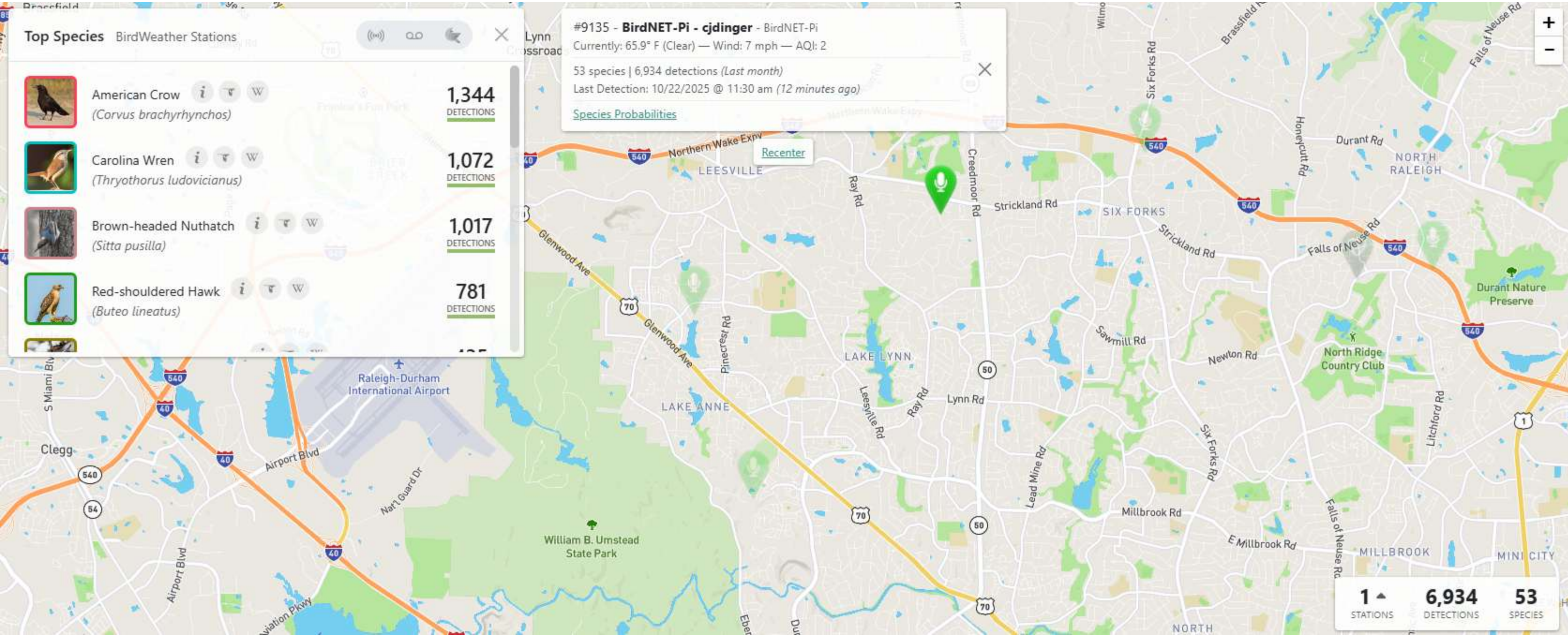
```
15:18:23---[server][INFO] ANALYZING AUDIO...
15:18:24---[server][INFO] DONE! Time 1.40 SECONDS
15:18:24---[server][INFO] 0.0;3.0-('Bucephala clangula_Common Goldeneye', 0.19375104)
15:18:24---[server][INFO] 3.0;6.0-('Anas platyrhynchos_Mallard', 0.017095627)
15:18:24---[server][INFO] 6.0;9.0-('Campylorhamphus falcularius_Black-billed Scythebill', 0.79516286)
15:18:24---[server][WARNING] Excluded as below Species Occurrence Frequency Threshold: Campylorhamphus falcularius_Black-billed Scythebill
15:18:24---[server][INFO] 9.0;12.0-('Tyto alba_Barn Owl', 0.06869399)
15:18:24---[server][INFO] 12.0;15.0-('Ciccaba albitarsis_Rufous-banded Owl', 0.06989207)
```

```
15:18:24---[server][INFO] 3.0;6.0-('Anas platyrhynchos_Mallard', 0.017095627)
15:18:24---[server][INFO] 6.0;9.0-('Campylorhamphus falcularius_Black-billed Scythebill', 0.79516286)
15:18:24---[server][WARNING] Excluded as below Species Occurrence Frequency Threshold: Campylorhamphus falcularius_Black-billed Scythebill
15:18:24---[server][INFO] 9.0;12.0-('Tyto alba_Barn Owl', 0.06869399)
15:18:24---[server][INFO] 12.0;15.0-('Ciccaba albitarsis_Rufous-banded Owl', 0.06989207)
15:18:38---[birdnet_analysis][INFO] Analyzing BirdSongs/StreamData/2025-10-20-birdnet-15:18:23.wav
15:18:38---[server][INFO] READING AUDIO DATA...
15:18:38---[server][INFO] READING DONE! READ 5 CHUNKS.
15:18:38---[server][INFO] ANALYZING AUDIO...
15:18:39---[server][INFO] DONE! Time 1.27 SECONDS
15:18:39---[server][INFO] 0.0;3.0-('Human_Human', 0.0)
15:18:39---[server][INFO] 3.0;6.0-('Campephilus guatemalensis_Pale-billed Woodpecker', 0.06183127)
15:18:39---[server][INFO] 6.0;9.0-('Coturnix coturnix_Common Quail', 0.04530111)
15:18:39---[server][INFO] 9.0;12.0-('Contopus virens_Eastern Wood-Pewee', 0.029095056)
15:18:39---[server][INFO] 12.0;15.0-('Human_Human', 0.0)
```

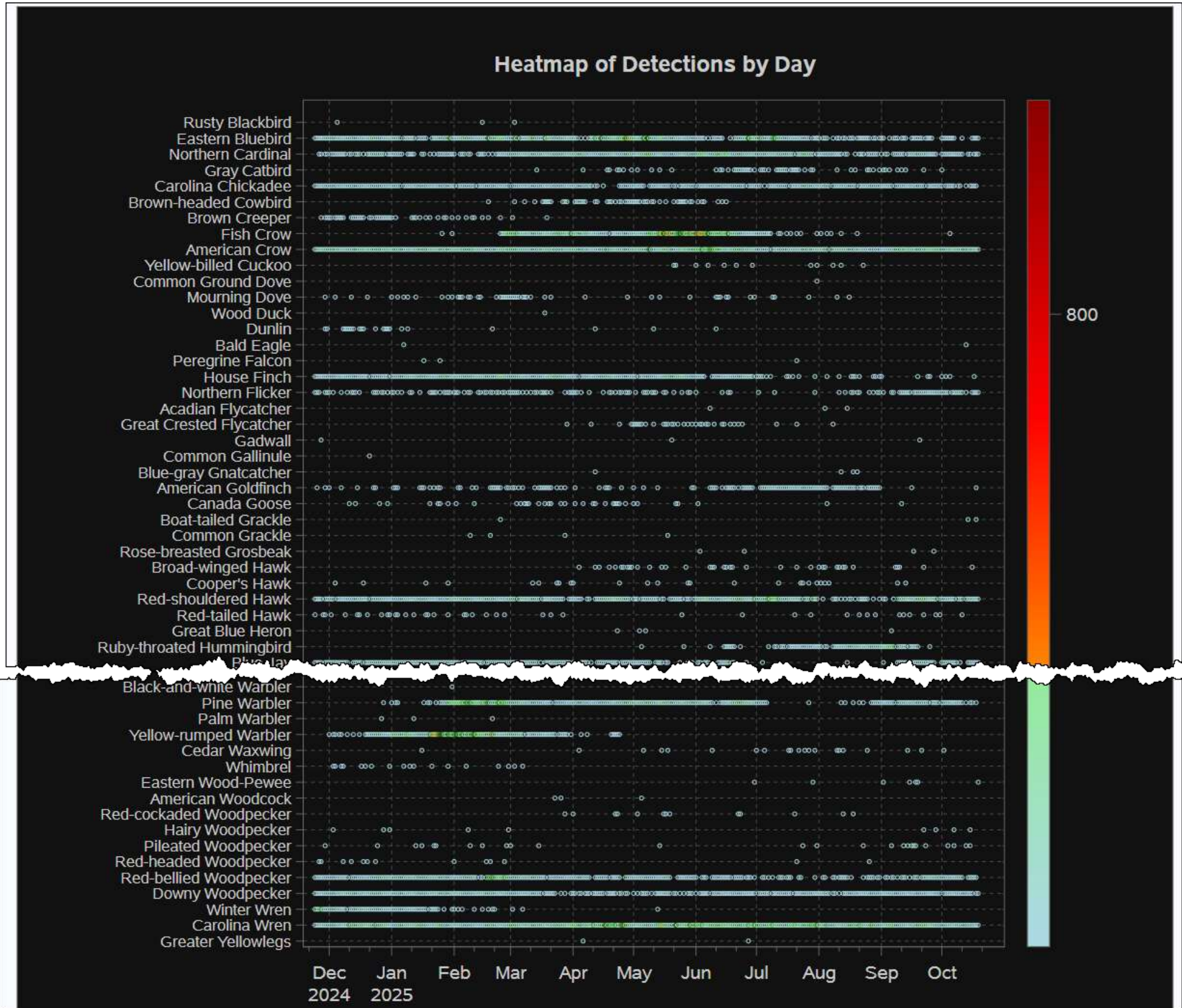
Audio files of detected birdsongs are SAVED



Contribute to the BirdWeather network



The Birds(eye) View I wanted



Most recent newcomers to the backyard

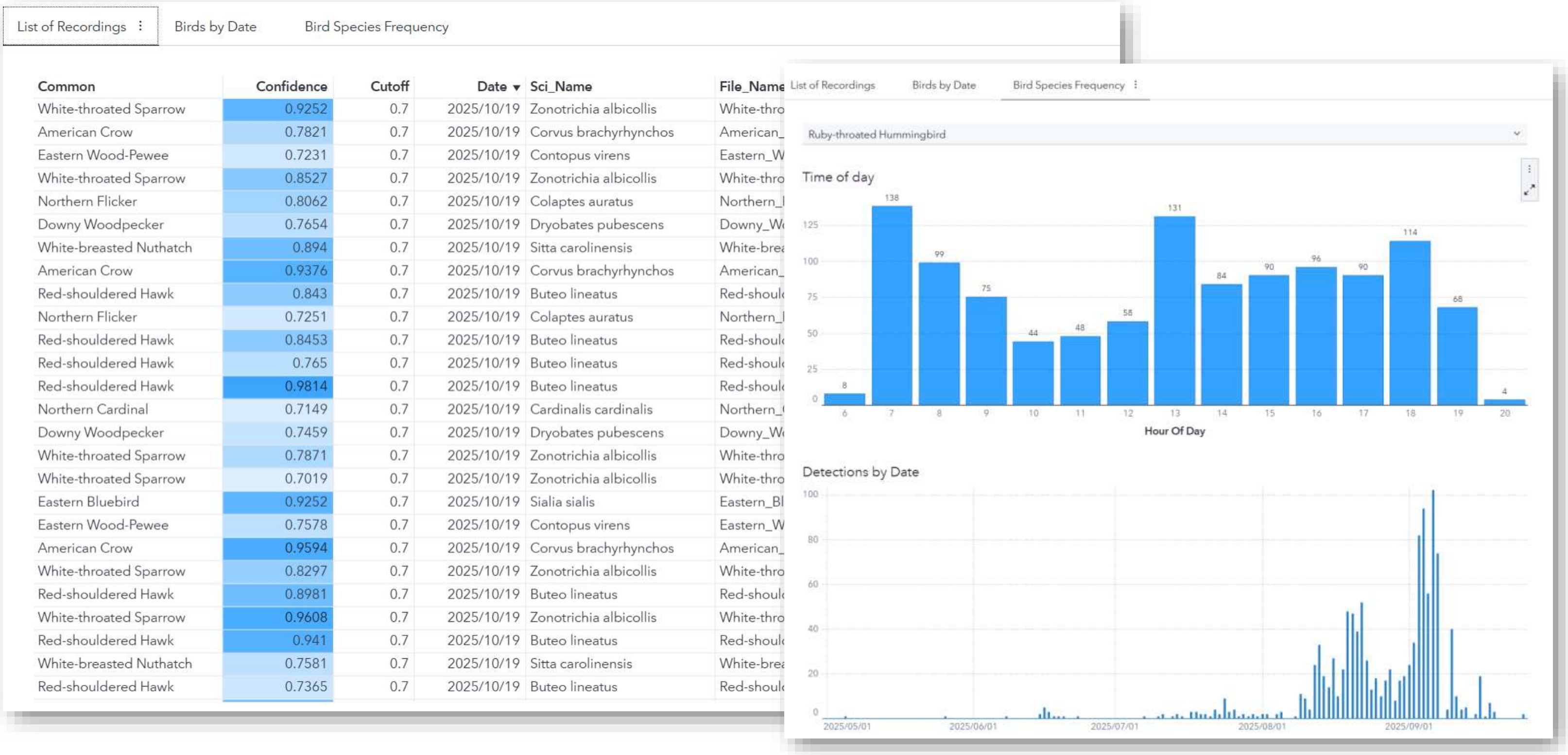
DaysObserved	Sci_Name	Com_Name	Family	First	Last
1	Catharus ustulatus	Swainson's Thrush	Thrush	27SEP2025	27SEP2025
1	Tachycineta bicolor	Tree Swallow	Swallow	26SEP2025	26SEP2025
2	Setophaga castanea	Bay-breasted Warbler	Warbler	02SEP2025	09SEP2025
1	Columbina passerina	Common Ground Dove	Dove	31JUL2025	31JUL2025
1	Ictinia mississippiensis	Mississippi Kite	Kite	24JUL2025	24JUL2025
1	Hydroprogne caspia	Caspian Tern	Tern	03JUL2025	03JUL2025
7	Contopus virens	Eastern Wood-Pewee	Wood-Pewee	30JUN2025	19OCT2025
39	Megascops asio	Eastern Screech-Owl	Screech-Owl	27JUN2025	17OCT2025
1	Setophaga petechia	Yellow Warbler	Warbler	19JUN2025	19JUN2025
7	Nycticorax nycticorax	Black-crowned Night-Heron	Night-Heron	18JUN2025	07OCT2025

Those we have not seen for a while in the backyard

DaysObserved	Sci_Name	Com_Name	Family	First	Last
1	Gallinula galeata	Common Gallinule	Gallinule	21DEC2024	21DEC2024
1	Pluvialis squatarola	Black-bellied Plover	Plover	27DEC2024	27DEC2024
4	Spinus pinus	Pine Siskin	Siskin	10DEC2024	16JAN2025
4	Passerella iliaca	Fox Sparrow	Sparrow	20DEC2024	29JAN2025
1	Mniotilta varia	Black-and-white Warbler	Warbler	31JAN2025	31JAN2025
4	Anas platyrhynchos	Mallard	Mallard	30NOV2024	06FEB2025
3	Setophaga palmarum	Palm Warbler	Warbler	27DEC2024	20FEB2025
3	Euphagus carolinus	Rusty Blackbird	Blackbird	05DEC2024	03MAR2025
18	Numenius phaeopus	Whimbrel	Whimbrel	03DEC2024	07MAR2025
1	Aix sponsa	Wood Duck	Duck	18MAR2025	18MAR2025

And an interactive dashboard

In SAS Visual Analytics



Export and share data to GitHub

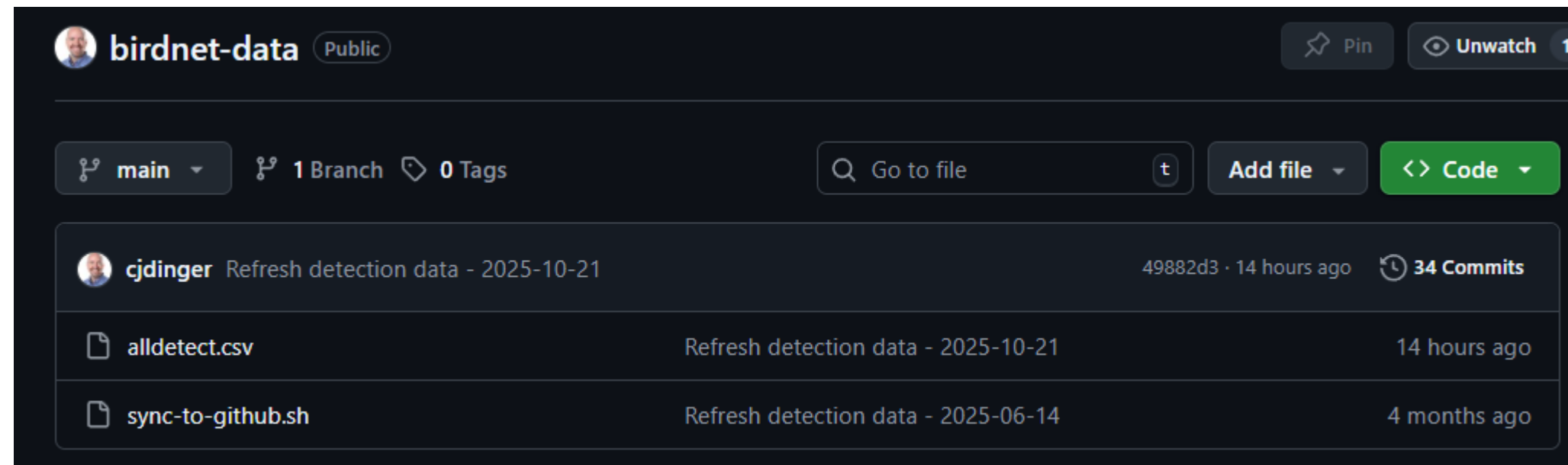
ssh into a terminal on the Raspberry Pi

```
#!/usr/bin/env bash
cd /home/birder/BirdNET-Pi/birdnet-data
sqlite3 -header -csv ../scripts/birds.db "SELECT * FROM
detections;" > alldetect.csv
git add .
git commit -m "Refresh detection data - $(date +%Y-%m-%d)"
git push
```

```
Date,Time,Sci_Name,Com_Name,Confidence,Lat,Lon,Cutoff,Week,Sens,Overlap,File_Name
2024-11-24,06:34:30,"Zonotrichia albicollis","White-throated Sparrow",0.8359,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-84-2024-11-24-birdnet-06:34:30.mp3
2024-11-24,06:34:42,"Zonotrichia albicollis","White-throated Sparrow",0.9068,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-91-2024-11-24-birdnet-06:34:42.mp3
2024-11-24,06:34:45,"Zonotrichia albicollis","White-throated Sparrow",0.9303,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-93-2024-11-24-birdnet-06:34:45.mp3
2024-11-24,06:34:51,"Zonotrichia albicollis","White-throated Sparrow",0.8726,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-87-2024-11-24-birdnet-06:34:51.mp3
2024-11-24,06:34:57,"Zonotrichia albicollis","White-throated Sparrow",0.8858,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-89-2024-11-24-birdnet-06:34:57.mp3
2024-11-24,06:35:00,"Zonotrichia albicollis","White-throated Sparrow",0.9247,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-92-2024-11-24-birdnet-06:35:00.mp3
2024-11-24,06:35:03,"Zonotrichia albicollis","White-throated Sparrow",0.8412,35.9005,-78.6877,0.8,47,1.0,0.0,White-throated_Sparrow-84-2024-11-24-birdnet-06:35:03.mp3
```

Import to SAS from GitHub

Download, then PROC IMPORT or DATA step



```
filename birdcsv temp;
proc http
  method="GET"
  url="https://raw.githubusercontent.com/cjdinger/birdnet-data/refs/heads/main/alldetect.csv"
  out=birdcsv;
run;

proc import file=birdcsv
  dbms=csv
  replace
  out=work.bird_events;
run;
```

More control: DATA step in one pass

	 Date	 Time	 Sci_Name	 Com_Name	 Confidence	 Lat	 Lon	 Cut...	 Week	 Sens	 Overl...	 File_Name
1	2024-11-24	6:34:30.000	Zonotrichia albicollis	White-throated Sparrow	0.8359	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-84-2024-11-24-birdnet-06...
2	2024-11-24	6:34:42.000	Zonotrichia albicollis	White-throated Sparrow	0.9068	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-91-2024-11-24-birdnet-06...
3	2024-11-24	6:34:45.000	Zonotrichia albicollis	White-throated Sparrow	0.8359	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-93-2024-11-24-birdnet-06...
4	2024-11-24	6:34:48.000	Zonotrichia albicollis	White-throated Sparrow	0.8359	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-87-2024-11-24-birdnet-06...
5	2024-11-24	6:34:51.000	Zonotrichia albicollis	White-throated Sparrow	0.8359	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-89-2024-11-24-birdnet-06...
6	2024-11-24	6:34:54.000	Zonotrichia albicollis	White-throated Sparrow	0.8359	35.90...	-78.68...	0.8	47	1	0	White-throated_Sparrow-92-2024-11-24-birdnet-06...

```
data WORK.BIRDS_EVENTS;
  infile BIRDCSV delimiter = ',' MISSOVER DSD lrecl=32767 firstobs=2;

  /* Attributes for raw data */
  informat Date yymmdd10.
    Time time20.3
    Sci_Name $30.
    Com_Name $30.
    Confidence best32.
    Lat best32.
    Lon best32.
    Cutoff best32.
    Week best32.
    Sens best32.
    Overlap best32.
    File_Name $57.;
  format Date yymmdd10.
    Time time20.3
    Sci_Name $30.
    Com_Name $30.
    Confidence best12.
    Lat best12.
    Lon best12.
    Cutoff best12.
    Week best12.
    Sens best12.
    Overlap best12.
    File_Name $57.;

  /* Additional features */
  length wikilink $ 150
    family $ 20;

  input
    Date
    Time
    Sci_Name $
    Com_Name $
    Confidence
    Lat
    Lon
    Cutoff
    Week
    Sens
    Overlap
    File_Name $
  ;

  /* Reasonable guess at the Wikipedia link */
  wikilink = catt("https://en.wikipedia.org/wiki/",tranwrd(trim(Com_Name),' ','_'));
  family = scan(Com_Name,-1,' ');

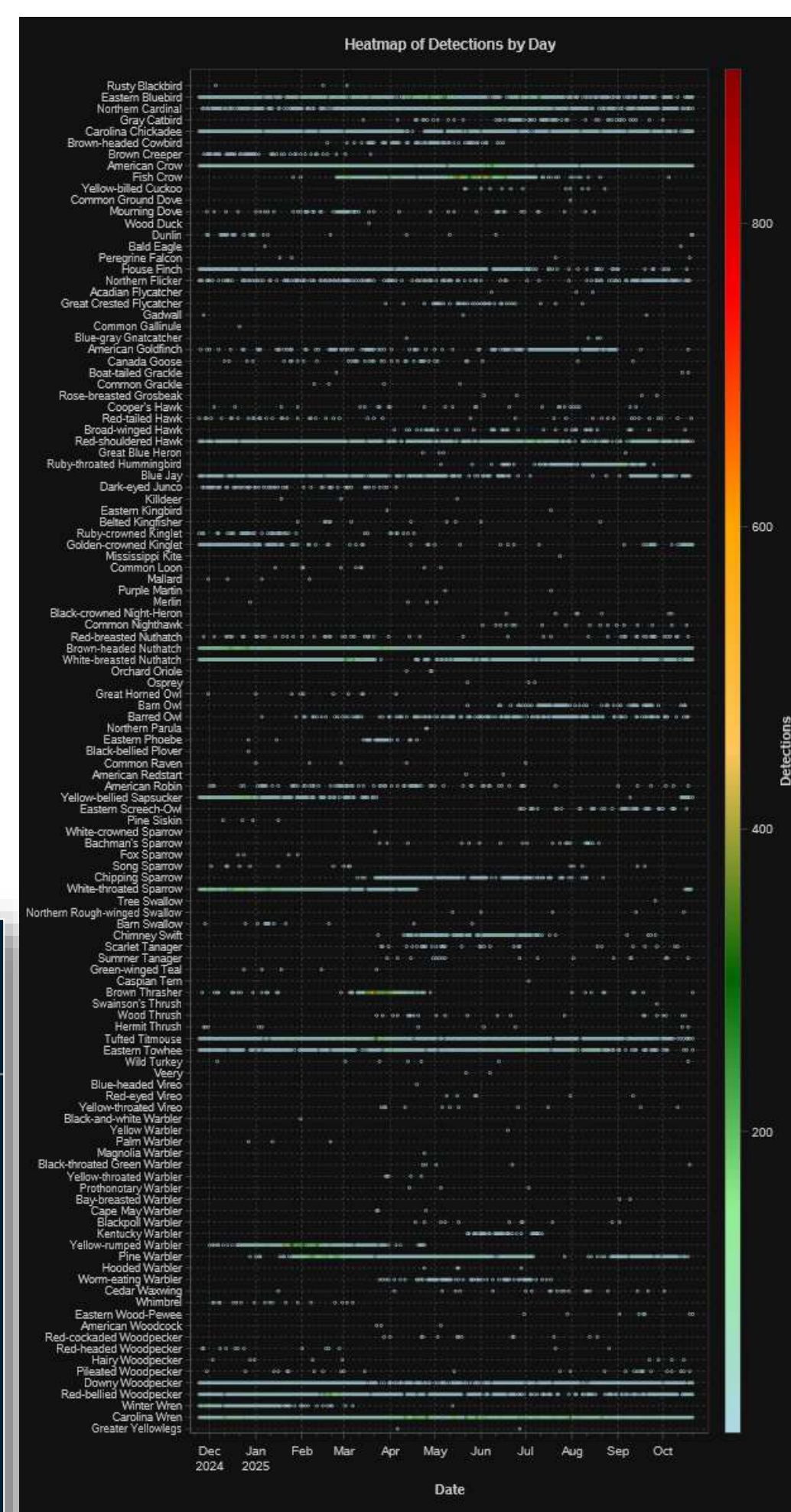
run;
```

Aggregate data for easier reporting

```
/* Summarize to daily detections */
PROC SQL;
  CREATE TABLE WORK.birds_DailyDetect AS
  SELECT t1.Date,
         t1.Sci_Name,
         t1.Com_Name,
         t1.Family,
         /* Detections */
         (COUNT(t1.Date)) AS Detections
  FROM WORK.birds_events t1
  GROUP BY t1.Date, Family, t1.Sci_Name, t1.Com_Name
  order by Family desc;
```

```
/* generate a heatmap of the Com_Name Detections by day */
ods graphics / width=1200 height=2200;
ods html5(eghtml) gtitle style=raven;
```

```
proc sgplot data=work.birds_DailyDetect;
  title "Heatmap of Detections by Day";
  scatter x=Date y=Com_Name / colorresponse=Detections
         colormodel=(lightblue lightgreen darkgreen lightorange orange red darkred)
         markerattrs=(size=4)
  ;
  xaxis grid minor;
  yaxis fitpolicy=none grid minor
         valueattrs=(size=8pt) display=(nolabel);
run;
```



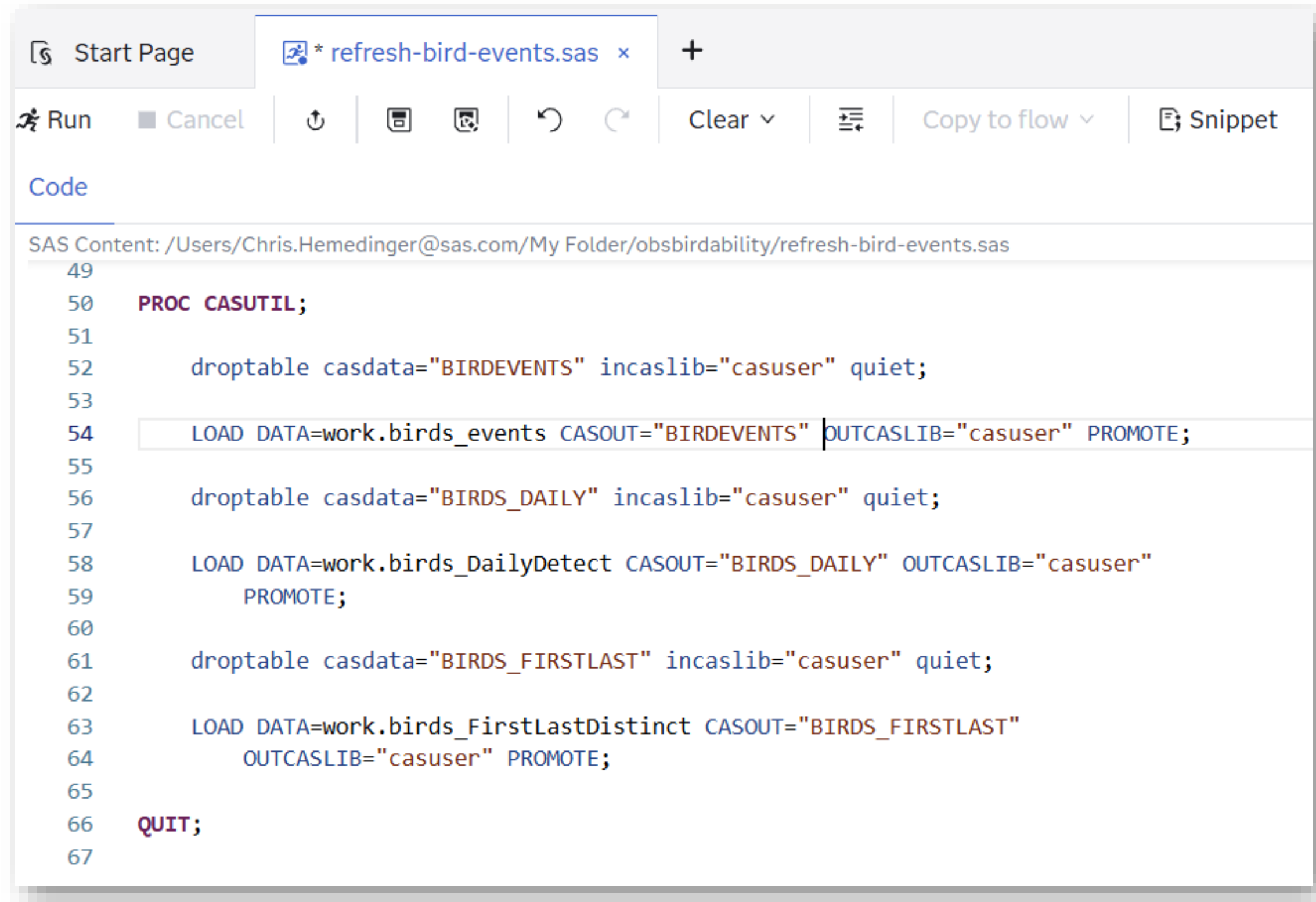
Identify first, last detections for recency

```
/* Calculate first detection, most recent detection, number of days for each species */
PROC SQL;
  CREATE TABLE WORK.birds_FirstLastDistinct AS
  SELECT
    count(distinct t1.Date) as DaysObserved,
    t1.Sci_Name,
    t1.Com_Name,
    t1.Family,
    /* Detections */
    (MIN(t1.Date)) AS First format=Date9.,
    (MAX(t1.Date)) as Last format=Date9.
  FROM WORK.birds_events t1
  GROUP BY Family, t1.Sci_Name, t1.Com_Name;
QUIT;
```

Most recent newcomers to the backyard

DaysObserved	Sci_Name	Com_Name	family	First	Last
1	Catharus ustulatus	Swainson's Thrush	Thrush	27SEP2025	27SEP2025
1	Tachycineta bicolor	Tree Swallow	Swallow	26SEP2025	26SEP2025
2	Setophaga castanea	Bay-breasted Warbler	Warbler	02SEP2025	09SEP2025
1	Columbina passerina	Common Ground Dove	Dove	31JUL2025	31JUL2025
1	Ictinia mississippiensis	Mississippi Kite	Kite	24JUL2025	24JUL2025
1	Hydroprogne caspia	Caspian Tern	Tern	03JUL2025	03JUL2025
8	Contopus virens	Eastern Wood-Pewee	Wood-Pewee	30JUN2025	21OCT2025
39	Megascops asio	Eastern Screech-Owl	Screech-Owl	27JUN2025	17OCT2025
1	Setophaga petechia	Yellow Warbler	Warbler	19JUN2025	19JUN2025
7	Nycticorax nycticorax	Black-crowned Night-Heron	Night-Heron	18JUN2025	07OCT2025

In SAS Viya, load for use in SAS Visual Analytics



The screenshot shows the SAS Viya code editor interface. At the top, there are tabs for 'Start Page' and 'refresh-bird-events.sas'. Below the tabs is a toolbar with icons for 'Run', 'Cancel', 'Up', 'Down', 'Refresh', 'Clear', 'Copy to flow', and 'Snippet'. The main area displays SAS code for a PROC CASUTIL session. The code includes several LOAD statements to load data from work directories into CAS tables, with options for CASOUT, OUTCASLIB, and PROMOTE. The code is line-numbered from 49 to 67.

```
49  
50 PROC CASUTIL;  
51  
52     droptable casdata="BIRDEVENTS" incaslib="casuser" quiet;  
53  
54     LOAD DATA=work.birds_events CASOUT="BIRDEVENTS" OUTCASLIB="casuser" PROMOTE;  
55  
56     droptable casdata="BIRDS_DAILY" incaslib="casuser" quiet;  
57  
58     LOAD DATA=work.birds_DailyDetect CASOUT="BIRDS_DAILY" OUTCASLIB="casuser"  
59         PROMOTE;  
60  
61     droptable casdata="BIRDS_FIRSTLAST" incaslib="casuser" quiet;  
62  
63     LOAD DATA=work.birds_FirstLastDistinct CASOUT="BIRDS_FIRSTLAST"  
64         OUTCASLIB="casuser" PROMOTE;  
65  
66 QUIT;  
67
```

Once in CAS, it's available for reporting

SAS® Visual Analytics - Explore and Visualize

Editing Bird Detections

Opened reports (1)

Data

BIRDEVENTS

Filter

+ New data item

Category

Common - 118

Date - 330

family - 74

File_Name - 180K

Hour Of Day - 25

Sci_Name - 118

Time - 51K

wikilink - 118

Measure

Confidence

Cutoff

Frequency

Lat

Lon

Overlap

Sens

List of Recordings

Birds by Date

Bird Species Frequency

Common	Confidence	Cutoff	Date	Sci_Name	File_Name	
White-throated Sparrow	0.9252	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-93-2025-10-19-birdnet-08:55:18.mp3	35.9
American Crow	0.7821	0.7	2025/10/19	Corvus brachyrhynchos	American_Crow-78-2025-10-19-birdnet-09:45:10.mp3	35.9
Eastern Wood-Pewee	0.7231	0.7	2025/10/19	Contopus virens	Eastern_Wood-Pewee-72-2025-10-19-birdnet-08:34:51.mp3	35.9
White-throated Sparrow	0.8527	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-85-2025-10-19-birdnet-08:54:30.mp3	35.9
Northern Flicker	0.8062	0.7	2025/10/19	Colaptes auratus	Northern_Flicker-81-2025-10-19-birdnet-07:41:54.mp3	35.9
Downy Woodpecker	0.7654	0.7	2025/10/19	Dryobates pubescens	Downy_Woodpecker-77-2025-10-19-birdnet-09:46:07.mp3	35.9
White-breasted Nuthatch	0.894	0.7	2025/10/19	Sitta carolinensis	White-breasted_Nuthatch-89-2025-10-19-birdnet-08:16:18.mp	35.9
American Crow	0.9376	0.7	2025/10/19	Corvus brachyrhynchos	American_Crow-94-2025-10-19-birdnet-09:42:52.mp3	35.9
Red-shouldered Hawk	0.843	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-84-2025-10-19-birdnet-09:44:40.mp3	35.9
Northern Flicker	0.7251	0.7	2025/10/19	Colaptes auratus	Northern_Flicker-73-2025-10-19-birdnet-07:42:12.mp3	35.9
Red-shouldered Hawk	0.8453	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-85-2025-10-19-birdnet-09:49:55.mp3	35.9
Red-shouldered Hawk	0.765	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-76-2025-10-19-birdnet-09:45:01.mp3	35.9
Red-shouldered Hawk	0.9814	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-98-2025-10-19-birdnet-09:49:34.mp3	35.9
Northern Cardinal	0.7149	0.7	2025/10/19	Cardinalis cardinalis	Northern_Cardinal-71-2025-10-19-birdnet-09:52:40.mp3	35.9
Downy Woodpecker	0.7459	0.7	2025/10/19	Dryobates pubescens	Downy_Woodpecker-75-2025-10-19-birdnet-08:43:33.mp3	35.9
White-throated Sparrow	0.7871	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-79-2025-10-19-birdnet-08:52:30.mp3	35.9
White-throated Sparrow	0.7019	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-70-2025-10-19-birdnet-08:55:24.mp3	35.9
Eastern Bluebird	0.9252	0.7	2025/10/19	Sialia sialis	Eastern_Bluebird-93-2025-10-19-birdnet-09:08:39.mp3	35.9
Eastern Wood-Pewee	0.7578	0.7	2025/10/19	Contopus virens	Eastern_Wood-Pewee-76-2025-10-19-birdnet-08:32:57.mp3	35.9
American Crow	0.9594	0.7	2025/10/19	Corvus brachyrhynchos	American_Crow-96-2025-10-19-birdnet-09:42:55.mp3	35.9
White-throated Sparrow	0.8297	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-83-2025-10-19-birdnet-08:54:36.mp3	35.9
Red-shouldered Hawk	0.8981	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-90-2025-10-19-birdnet-09:47:16.mp3	35.9
White-throated Sparrow	0.9608	0.7	2025/10/19	Zonotrichia albicollis	White-throated_Sparrow-96-2025-10-19-birdnet-08:51:57.mp3	35.9
Red-shouldered Hawk	0.941	0.7	2025/10/19	Buteo lineatus	Red-shouldered_Hawk-94-2025-10-19-birdnet-07:23:51.mp3	35.9

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Learn more

- BirdNET-Pi project: <https://www.birdweather.com/birdnetpi>
- [How I use BirdNET-Pi and SAS to track my feathered neighbors](#) (blog)
- [Data collected from my device](#) (GitHub)
- [My BirdWeather station](#) (BirdWeather)

Questions?

