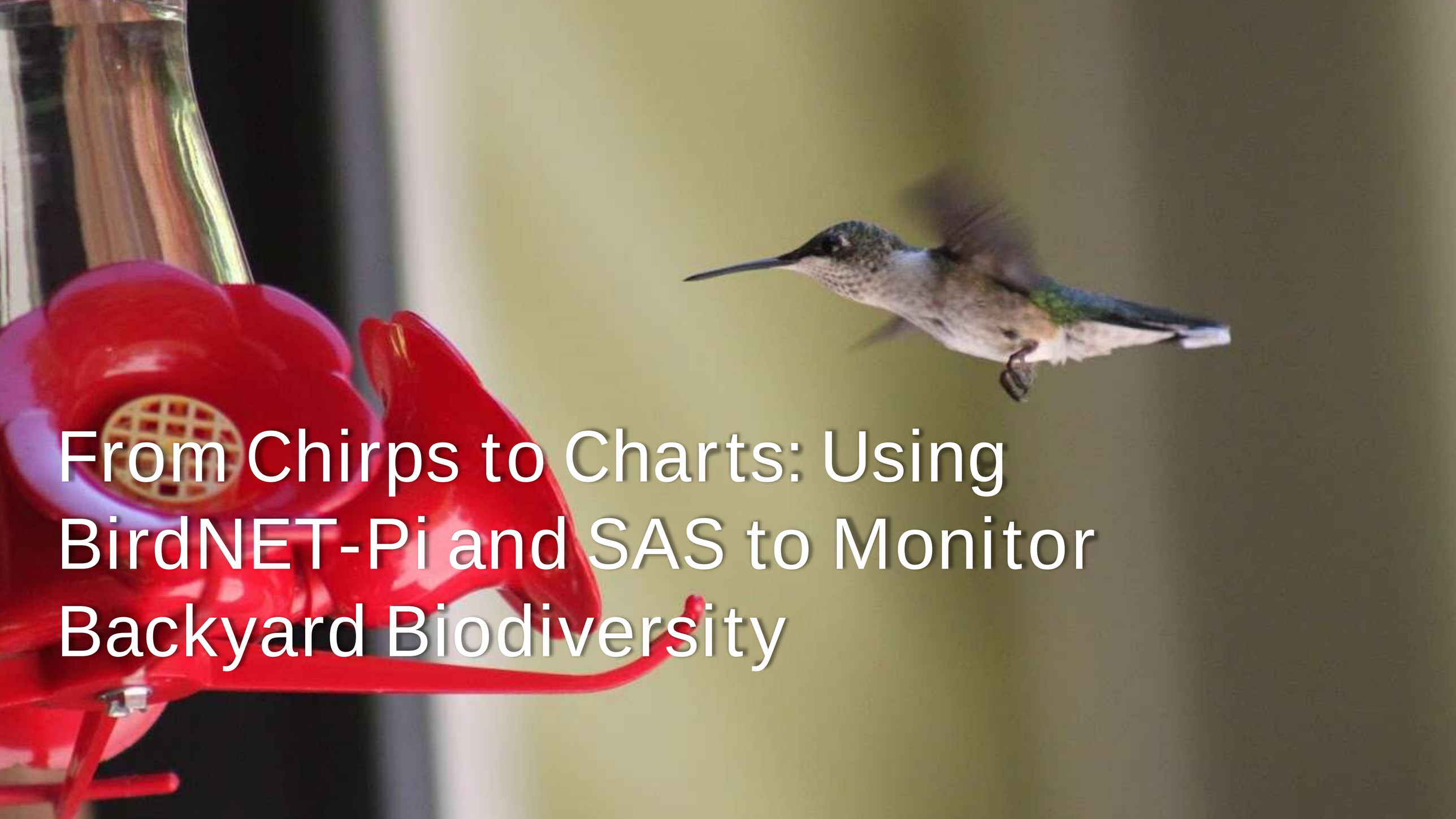


From Chirps to Charts: Using BirdNET-Pi and SAS to Monitor Backyard Biodiversity

48,100

Birds crossed Dallas County last night (est.)

Starting: Wed, Mar 4, 2026, 6:40 PM CST
Ending: Thu, Mar 5, 2026, 6:50 AM CST

Learn more

PEAK MIGRATION TRAFFIC

26,500 **Birds in flight (est.)**

Direction: N **Speed:** 27 mph **Altitude:** 600 ft

Recorded: Thu, Mar 5, 2026, 6:50 AM CST

CornellLab | BirdCast

Here's what happened last night...

Birds in flight

Birds usually begin to migrate 30 to 45 minutes after sunset, with the greatest number in flight two to three hours later.

Flight direction and speed

Birds tend to migrate northward in spring, but seasonal timing, weather, and geography alter their flight directions and speeds.

Altitude

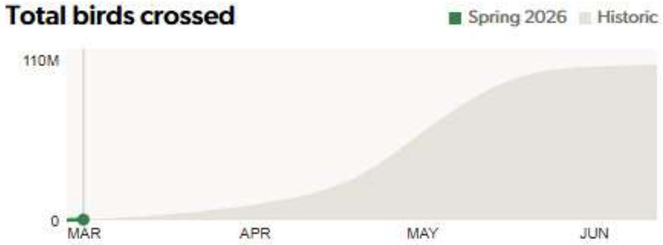
Migrating birds regularly fly up to 10,000 feet above ground, although seasonal timing and weather conditions dramatically impact their distributions.

And so far this season...

Birds in flight (nightly avg.)

During spring migration, most birds pass through the contiguous U.S. from mid-April to mid-May.

Total birds crossed

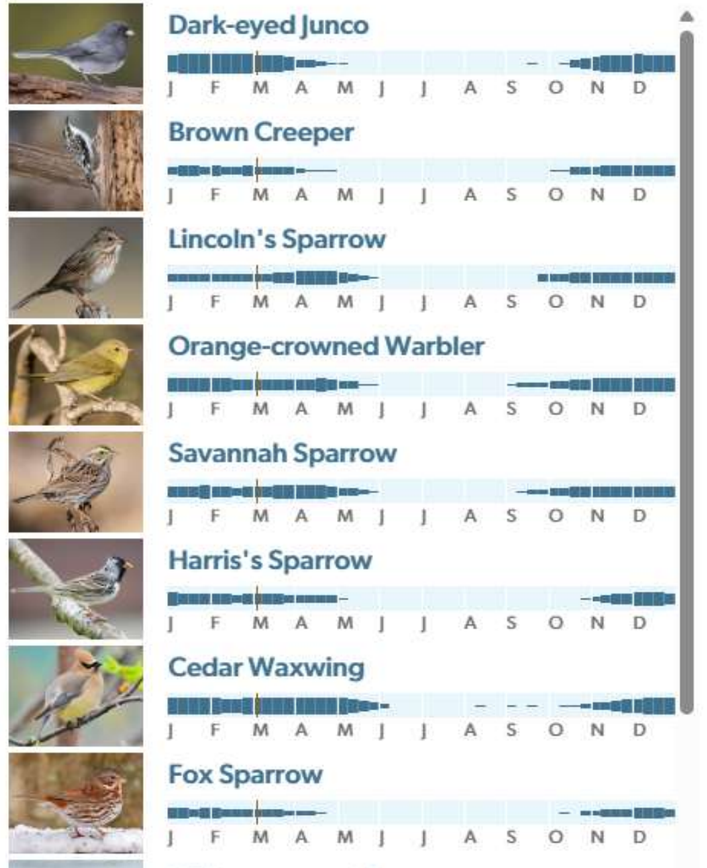


This is the estimated total number of birds that have fully crossed this region. The curve rises quickly during peak migration and levels off at the end of the season.

Expected nocturnal migrants

POWERED BY EBIRD

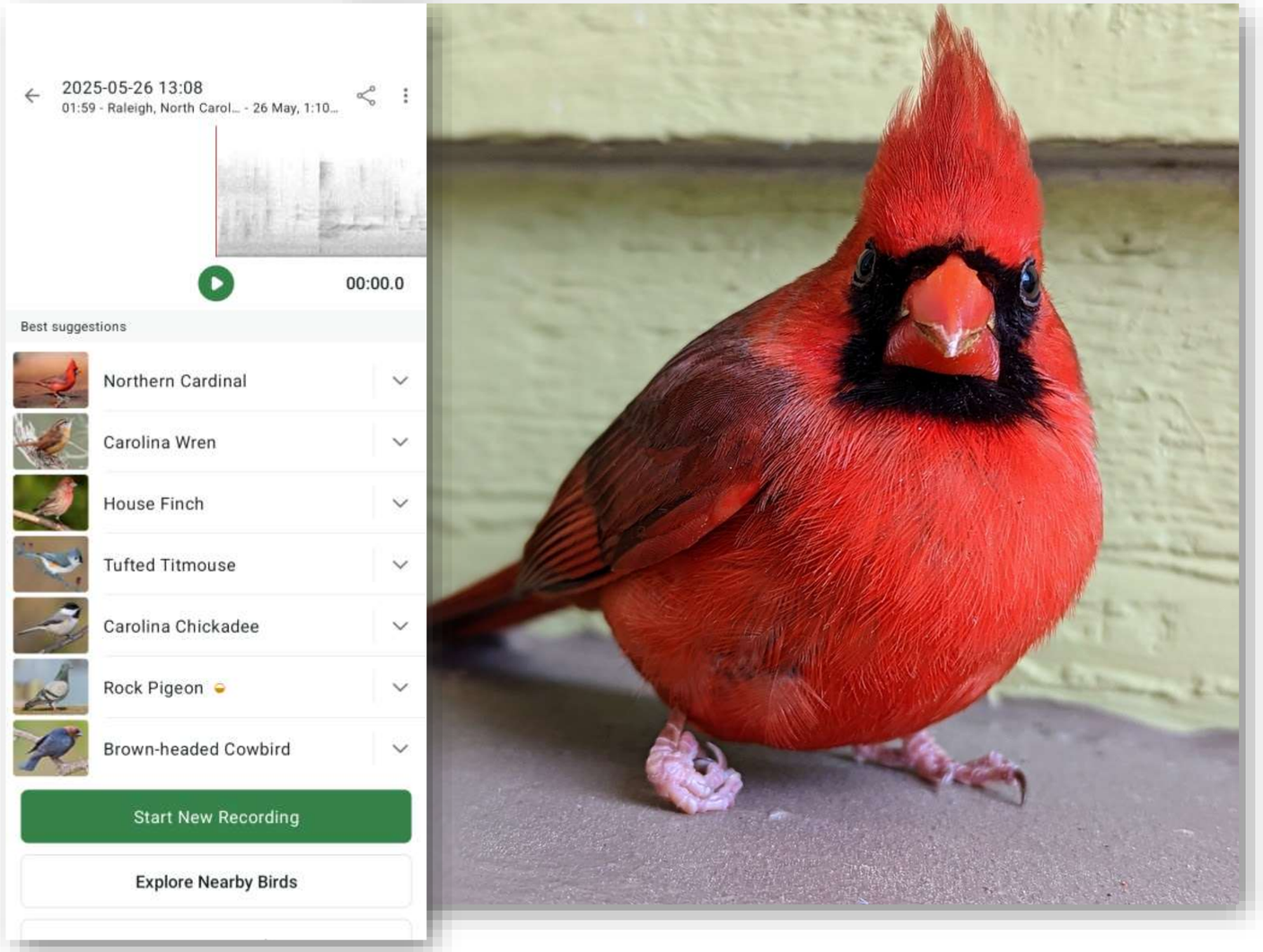
Nocturnally migrating species most likely to arrive or depart this region at this time of year, based on frequency of observations



sas

What’s that bird I hear?

Apps like Merlin use AI to provide an instant answer



How it started – at an open source conference

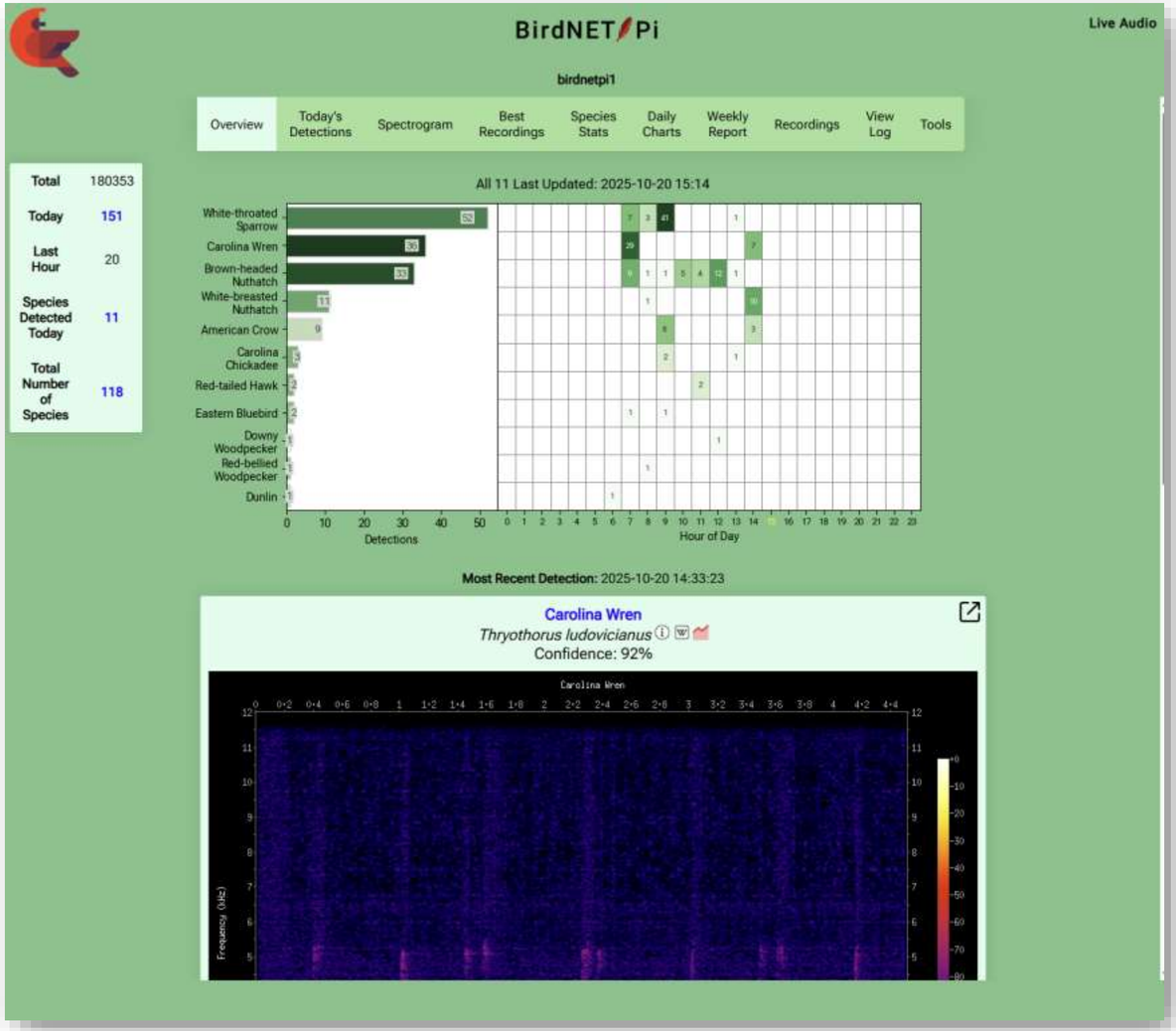
Obirdability: How to build an observability system for bird songs

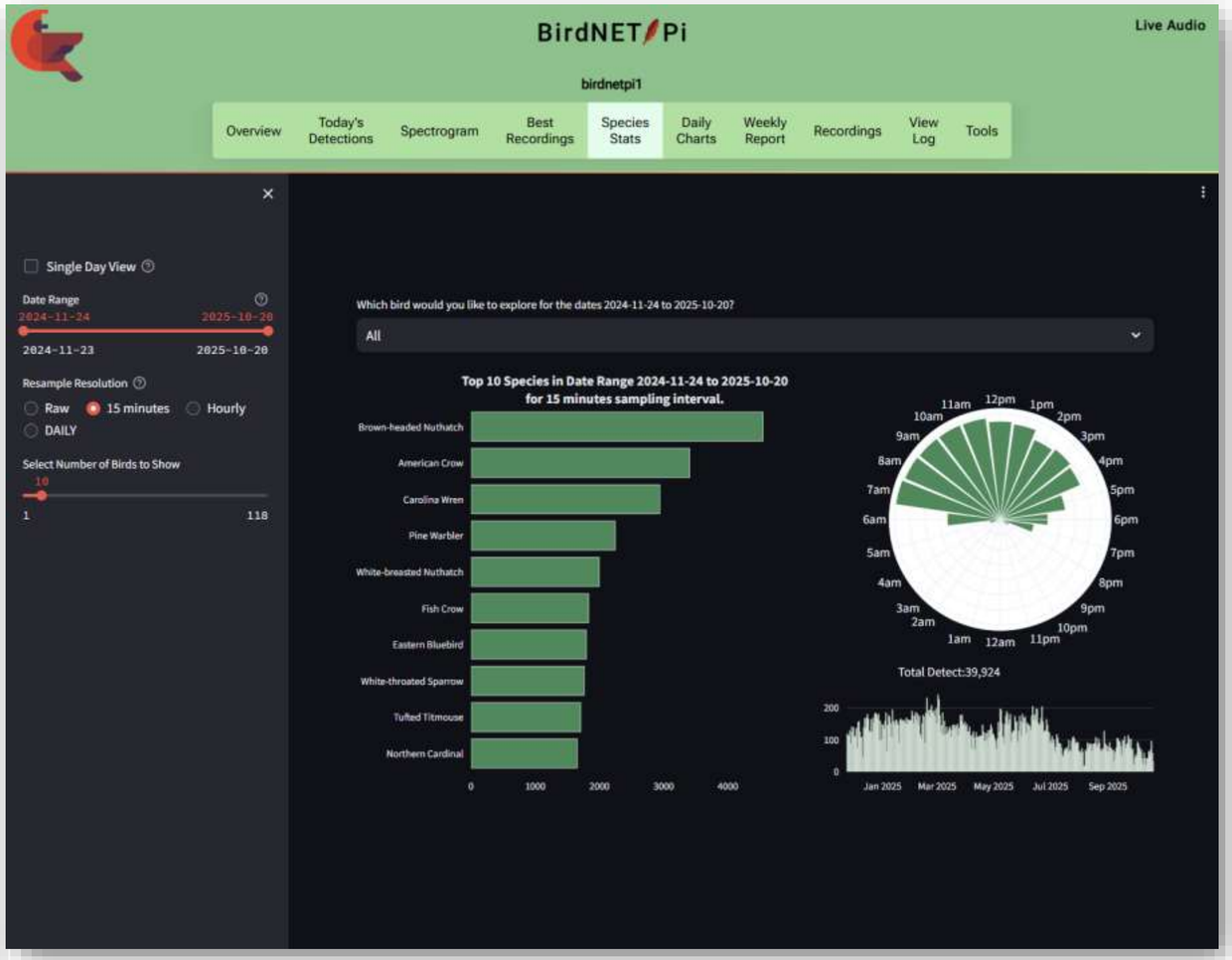
Ivana Huckova, Sven Großmann • 2024-07-12 • 11 min

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

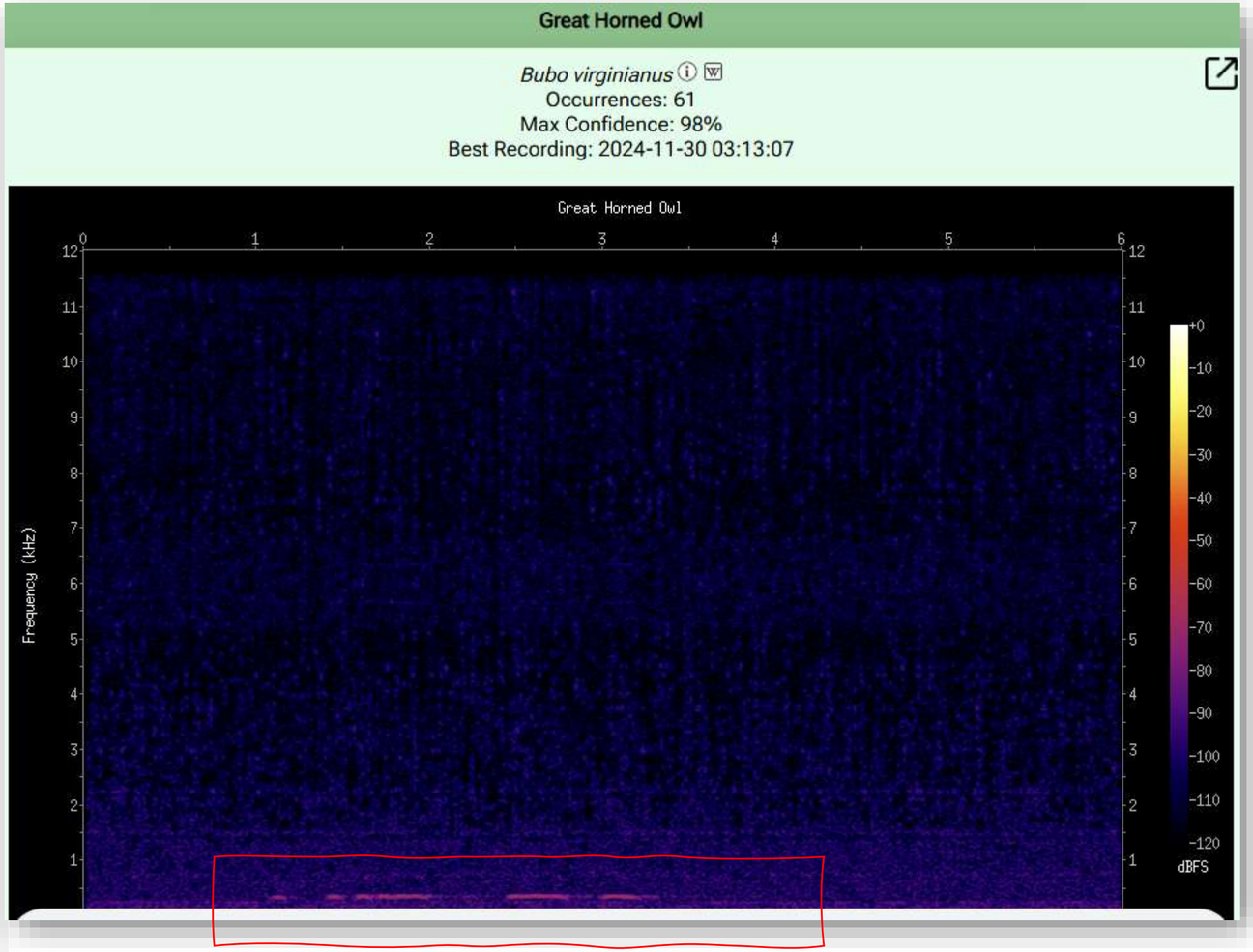
```
15:17:53---[birdnet_analysis][INFO] Analyzing BirdSongs/StreamData/2025-10-20-birdnet-15:17:38.wav
15:17:53---[server][INFO] READING AUDIO DATA...
15:17:53---[server][INFO] READING DONE! READ 5 CHUNKS.
15:17:53---[server][INFO] ANALYZING AUDIO...
15:17:54---[server][INFO] DONE! Time 1.29 SECONDS
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...
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)
```

Black-billed scythebill

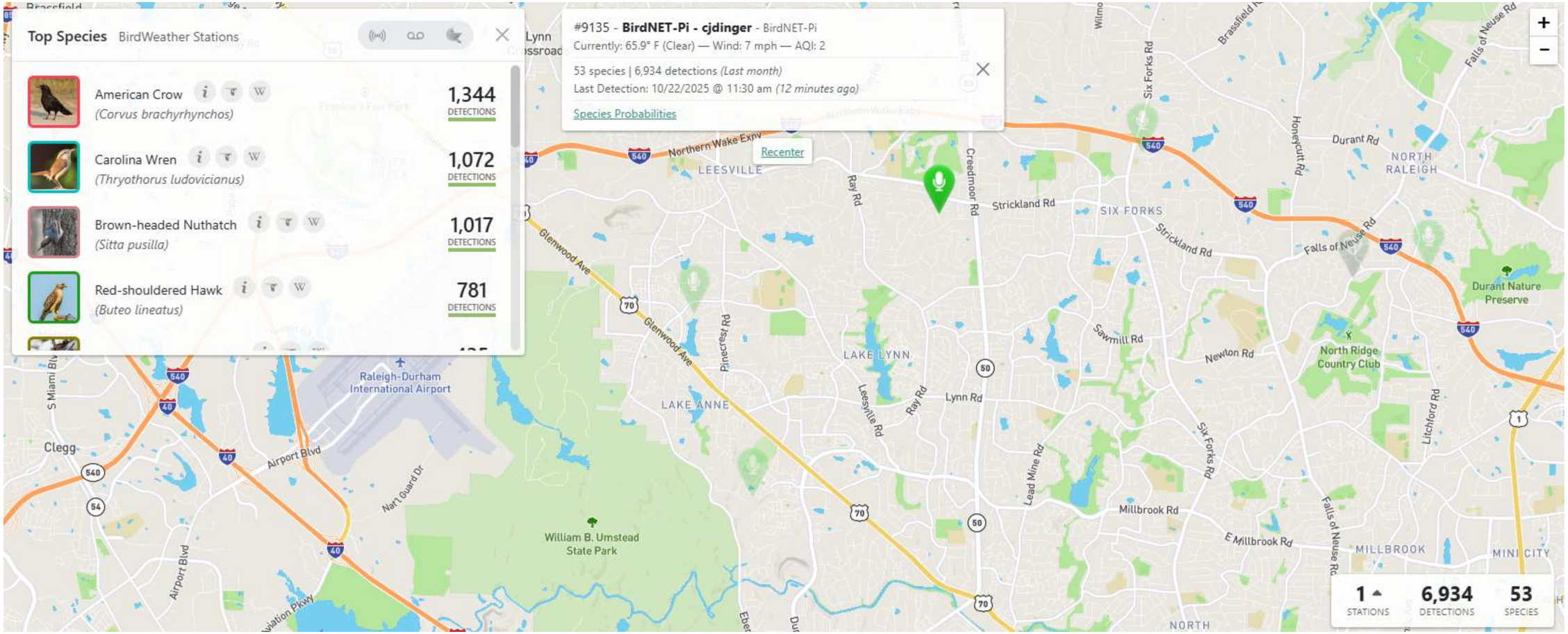
Black-billed scythebill at Piraju, São Paulo State, Brazil

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]

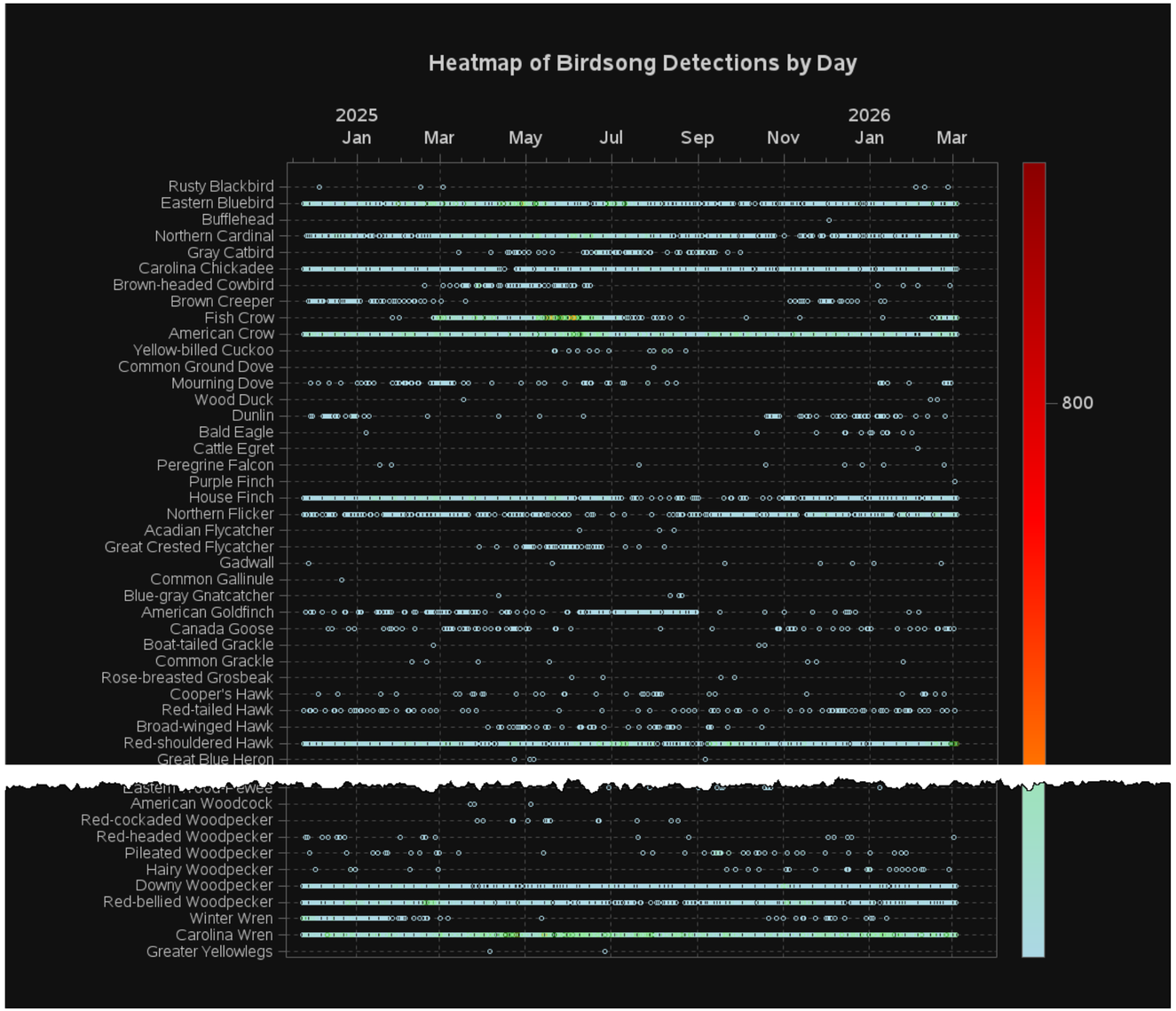
Audio files of detected birdsongs are SAVED



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	Haemorhous purpureus	Purple Finch	Finch	03MAR2026	03MAR2026
1	Spatula clypeata	Northern Shoveler	Shoveler	04FEB2026	04FEB2026
1	Bubulcus ibis	Cattle Egret	Egret	04FEB2026	04FEB2026
1	Columba livia	Rock Pigeon	Pigeon	13JAN2026	13JAN2026
1	Lophodytes cucullatus	Hooded Merganser	Merganser	07JAN2026	07JAN2026
1	Sterna hirundo	Common Tern	Tern	30DEC2025	30DEC2025
2	Falco sparverius	American Kestrel	Kestrel	23DEC2025	09JAN2026
1	Bucephala albeola	Bufflehead	Bufflehead	03DEC2025	03DEC2025
1	Coragyps atratus	Black Vulture	Vulture	16NOV2025	16NOV2025
1	Arenaria interpres	Ruddy Turnstone	Turnstone	24OCT2025	24OCT2025

Those we have not seen for a while in the backyard

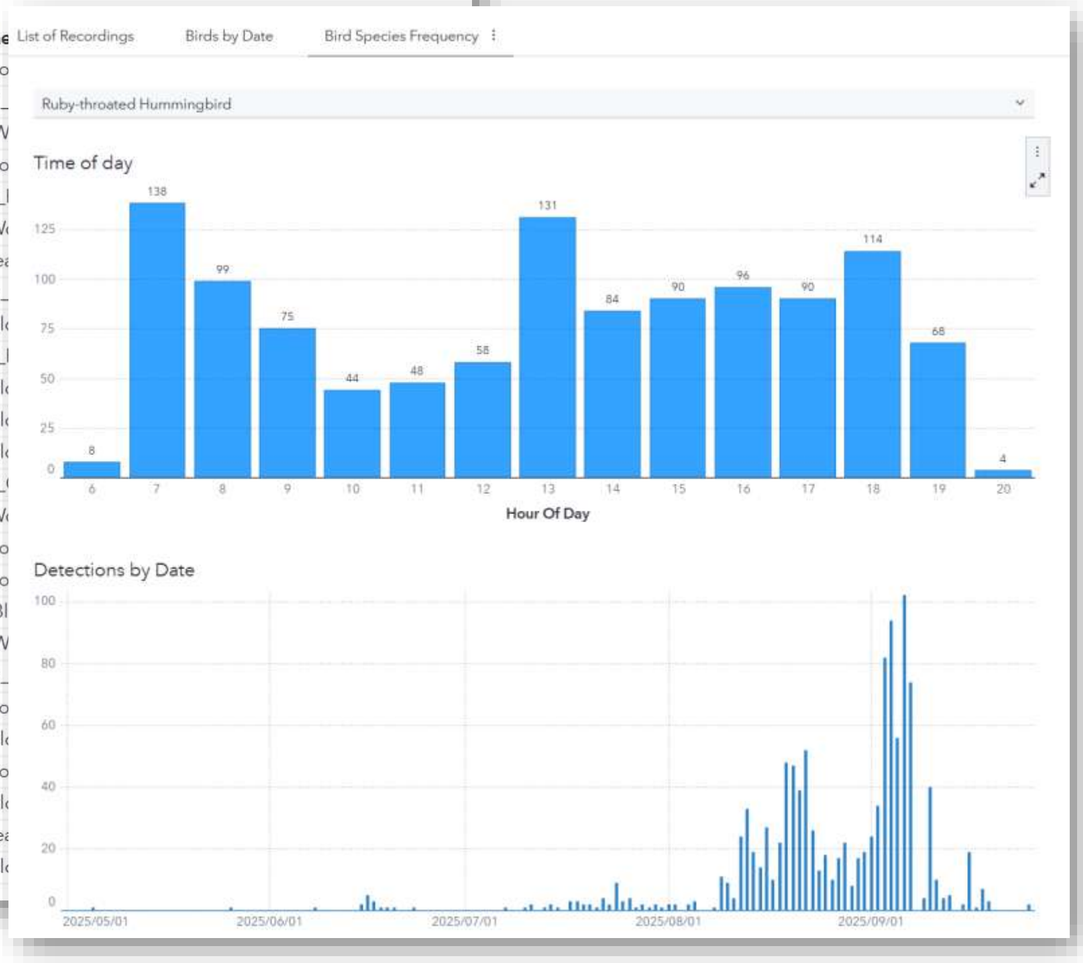
DaysObserved	Sci_Name	Com_Name	family	First	Last
1	Gallinula galeata	Common Gallinule	Gallinule	21DEC2024	21DEC2024
1	Pluvialis squatarola	Black-bellied Plover	Plover	27DEC2024	27DEC2024
4	Passerella iliaca	Fox Sparrow	Sparrow	20DEC2024	29JAN2025
1	Mniotilta varia	Black-and-white Warbler	Warbler	31JAN2025	31JAN2025
3	Setophaga palmarum	Palm Warbler	Warbler	27DEC2024	20FEB2025
1	Zonotrichia leucophrys	White-crowned Sparrow	Sparrow	22MAR2025	22MAR2025
1	Vireo solitarius	Blue-headed Vireo	Vireo	19APR2025	19APR2025
5	Setophaga dominica	Yellow-throated Warbler	Warbler	29MAR2025	22APR2025
1	Setophaga magnolia	Magnolia Warbler	Warbler	24APR2025	24APR2025
2	Setophaga americana	Northern Parula	Parula	25APR2025	26APR2025

And an interactive dashboard

In SAS Visual Analytics

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-thro
American Crow	0.7821	0.7	2025/10/19	Corvus brachyrhynchos	American_
Eastern Wood-Pewee	0.7231	0.7	2025/10/19	Contopus virens	Eastern_W
White-throated Sparrow	0.8527	0.7	2025/10/19	Zonotrichia albicollis	White-thro
Northern Flicker	0.8062	0.7	2025/10/19	Colaptes auratus	Northern_
Downy Woodpecker	0.7654	0.7	2025/10/19	Dryobates pubescens	Downy_W
White-breasted Nuthatch	0.894	0.7	2025/10/19	Sitta carolinensis	White-brea
American Crow	0.9376	0.7	2025/10/19	Corvus brachyrhynchos	American_
Red-shouldered Hawk	0.843	0.7	2025/10/19	Buteo lineatus	Red-shoul
Northern Flicker	0.7251	0.7	2025/10/19	Colaptes auratus	Northern_
Red-shouldered Hawk	0.8453	0.7	2025/10/19	Buteo lineatus	Red-shoul
Red-shouldered Hawk	0.765	0.7	2025/10/19	Buteo lineatus	Red-shoul
Red-shouldered Hawk	0.9814	0.7	2025/10/19	Buteo lineatus	Red-shoul
Northern Cardinal	0.7149	0.7	2025/10/19	Cardinalis cardinalis	Northern_
Downy Woodpecker	0.7459	0.7	2025/10/19	Dryobates pubescens	Downy_W
White-throated Sparrow	0.7871	0.7	2025/10/19	Zonotrichia albicollis	White-thro
White-throated Sparrow	0.7019	0.7	2025/10/19	Zonotrichia albicollis	White-thro
Eastern Bluebird	0.9252	0.7	2025/10/19	Sialia sialis	Eastern_Bl
Eastern Wood-Pewee	0.7578	0.7	2025/10/19	Contopus virens	Eastern_W
American Crow	0.9594	0.7	2025/10/19	Corvus brachyrhynchos	American_
White-throated Sparrow	0.8297	0.7	2025/10/19	Zonotrichia albicollis	White-thro
Red-shouldered Hawk	0.8981	0.7	2025/10/19	Buteo lineatus	Red-shoul
White-throated Sparrow	0.9608	0.7	2025/10/19	Zonotrichia albicollis	White-thro
Red-shouldered Hawk	0.941	0.7	2025/10/19	Buteo lineatus	Red-shoul
White-breasted Nuthatch	0.7581	0.7	2025/10/19	Sitta carolinensis	White-brea
Red-shouldered Hawk	0.7365	0.7	2025/10/19	Buteo lineatus	Red-shoul



Export and share data to GitHub

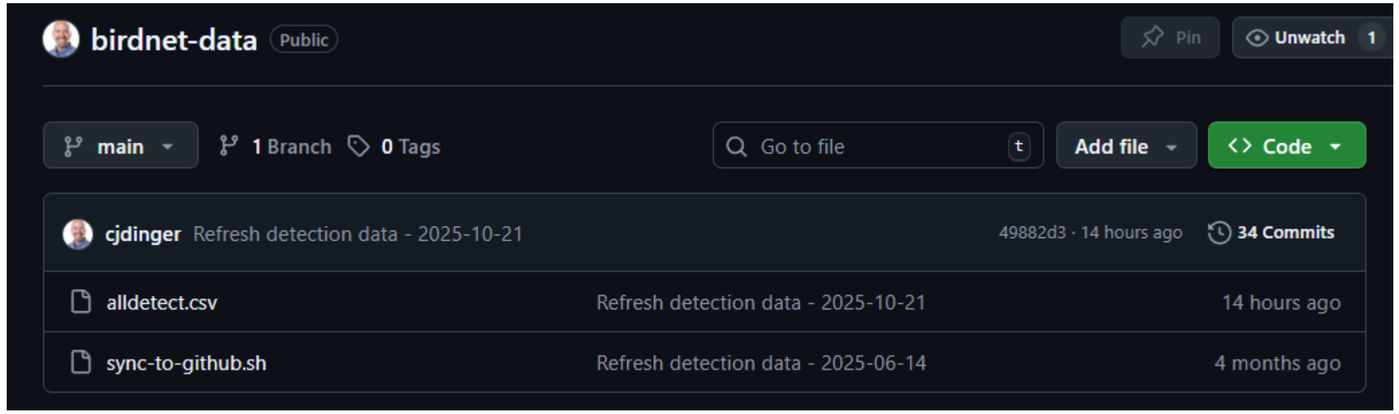
ssh into a terminal on the Raspberry Pi

```
#!/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	0.9383	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	0.9215	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	0.8633	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	0.8477	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;
```

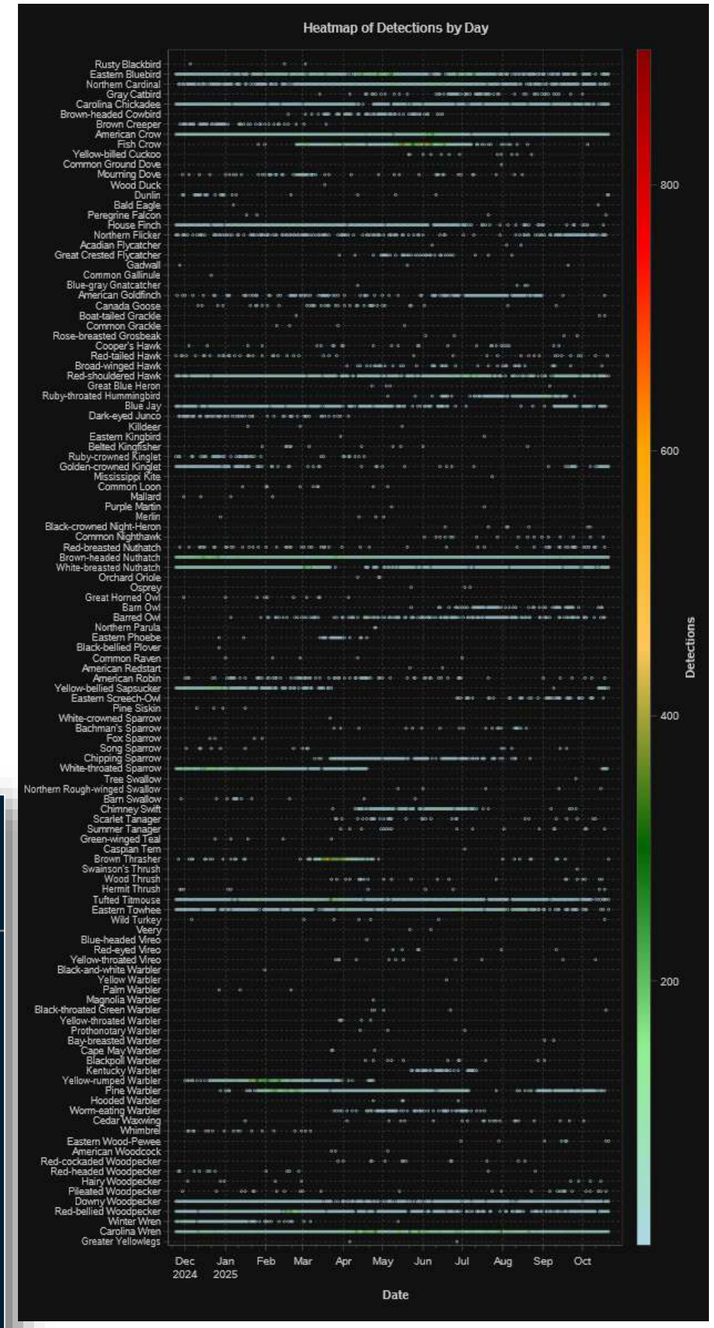
Aggregate data for easier reporting

```
/* 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;

QUIT;
```

```
/* 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;
```



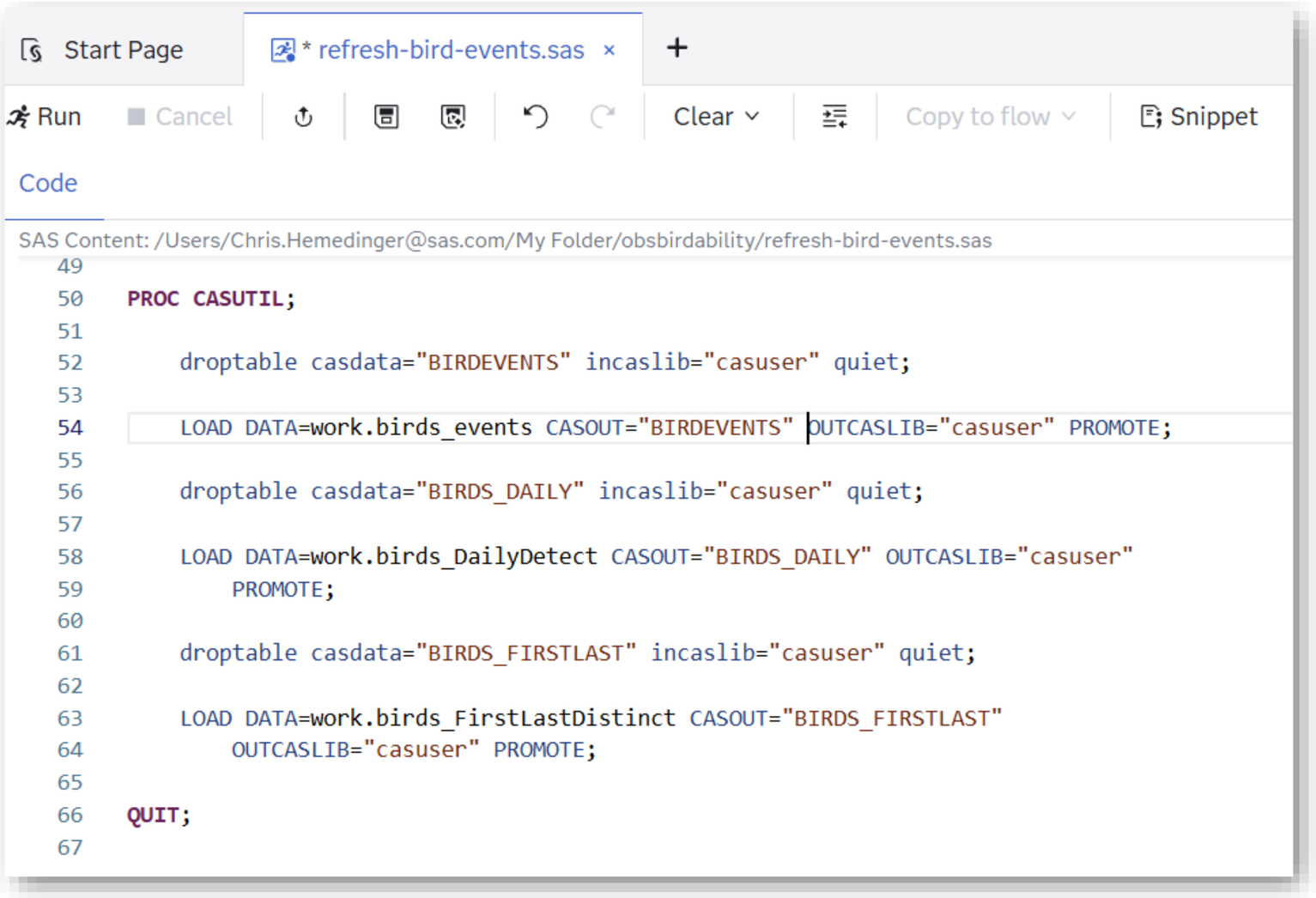
Identify first, last detections for recency

```
/* 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;
```

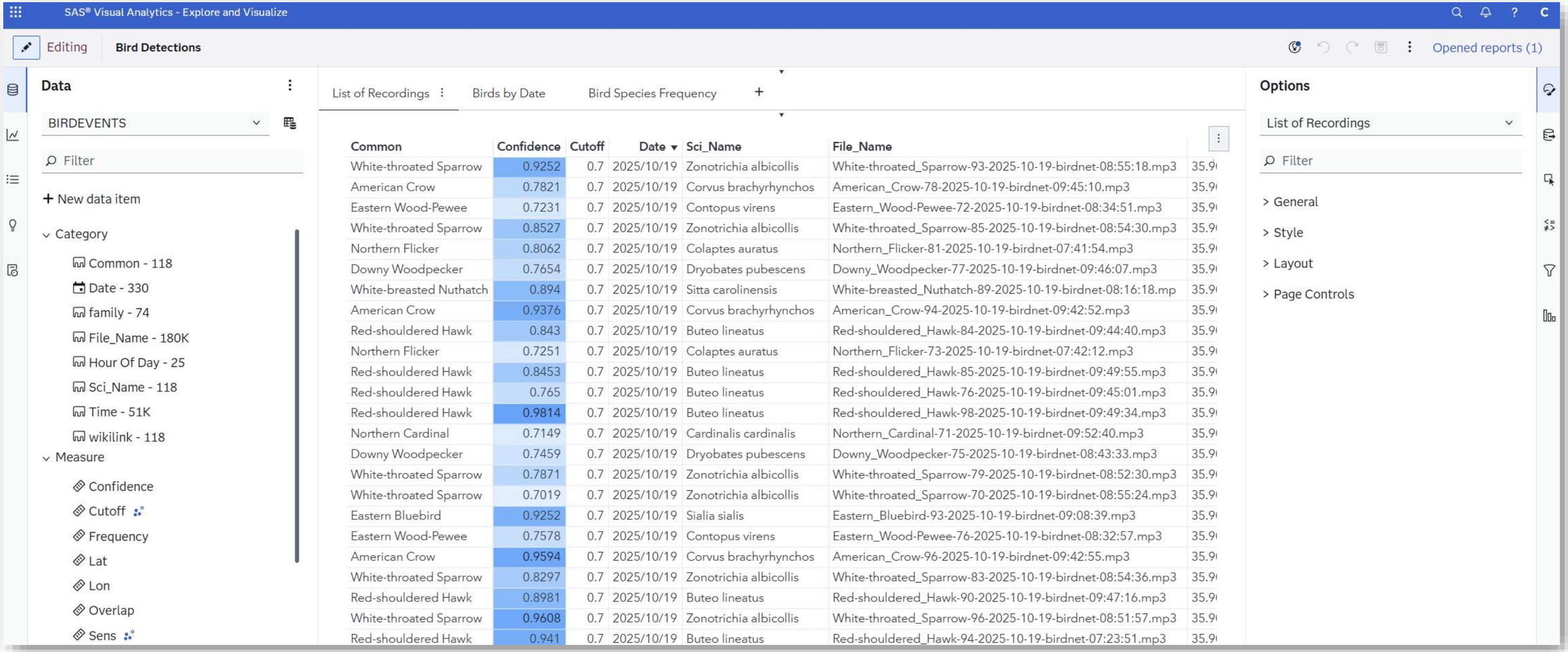
Most recent newcomers to the backyard

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



Once in CAS, it's available for reporting



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

DEMO

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?