

# Spectrogram Analysis Lesson Plan

**Investigative Question:** In what ways are the songs of different bird species distinct from others?

**Goal:** [Use a spectrogram to analyze and identify birdsongs.](#)

## Objectives

**Knowledge:** Demonstrate knowledge of graphical reading and adding and subtracting decimals by identifying the duration (in tenths of a second) of birdsongs using a spectrogram. Sound (frequency/pitch and amplitude/loudness) can be represented graphically. Comparing graphs of birdsong can help match bird species to song.

**Skills:** Adding and subtracting decimals, reading time on graph, and translating auditory data to visual and back again.

**Value:** Students recognize that math aids in scientific and sound analysis, even in observational studies.

**Virginia SOL:** Science (2018) 5.1g, 5.5; Mathematics (2016) 5.1, 5.2, 5.5

## Materials

- rulers or other straight edge
- wet or dry erase markers and ways to clean
- [Spectrogram Analysis Datasheet](#)
- pencils
- smartboard & computer with sound
- [Spectrograms Adapted from Bird Song Hero](#)

## Special Safety

- Be aware of any students with auditory challenges and accommodate accordingly.

## Set Up:

1. Familiarize yourself with the [Bird Song Hero game](#)
2. Overview: [Bird Song Hero](#): Using a projector and speakers (smartboard, or other way for all students to see and hear the game) the full class plays one round of "Bird Song Hero", predicting which spectrogram best matches the sounds they hear. This introduces students to the skills of reading a spectrogram.
  - a. Inform students they will be playing a game in which they have to match a visual sound graph with a birdsong in order to identify the bird.
  - b. Suggest they use their hands to "map" or "shape" the sound. Practice by raising and lowering your hand and have them raise and lower their pitch in echo of your hand movement (high hand = high pitch).
  - c. Play each song as often as needed. Have students vote for the most likely graphical match to the sound, then select that response.
3. Graphical Analysis: Transform the game into analysis of a spectrogram.
  - a. [Briefly go over the parts of a spectrogram.](#) The "height" (y-axis) is how high or low the sound is (pitch), while across the x-axis are time increments (tenths of a second). Point out that there are three frequency ranges, low (blue), medium (green), and high (red). Use a vertical line (like a yardstick) to help students identify when songs are in each range, and if there is sound or silence.
  - b. Using the datasheet to guide their analysis, students work in pairs to determine
    - i. the full length of the song
    - ii. how many seconds of song are in each frequency range



- iii. the number of notes and the number of silences
- iv. the total length of time the bird is singing or silent during the song.
- c. Depending on time, each team may do more than one song.
- 4. Compare Songs:
  - a. Have students locate the total length of the bird song on their datasheet, and then without talking, figure out how to arrange themselves in numerical order according to the length of their bird song. Ask: What was the shortest song? The longest? Most of our human radio songs are around 3 minutes long. Do bird songs come close to that? Why do you think bird songs are just a few seconds long?
  - b. If time allows, make other comparisons. Why would bird species have songs of different pitch/length/pattern? How do you recognize the voice of your friend or family? Is there a habitat component - do birds of similar frequencies occupy different habitats?
- 5. Close: Another round of Bird Song Hero (Optional) – either replay the Bird Song Hero game, or move on to the more advanced level so that students can apply their spectrogram reading skills.

**Possible Extensions: (optional)**

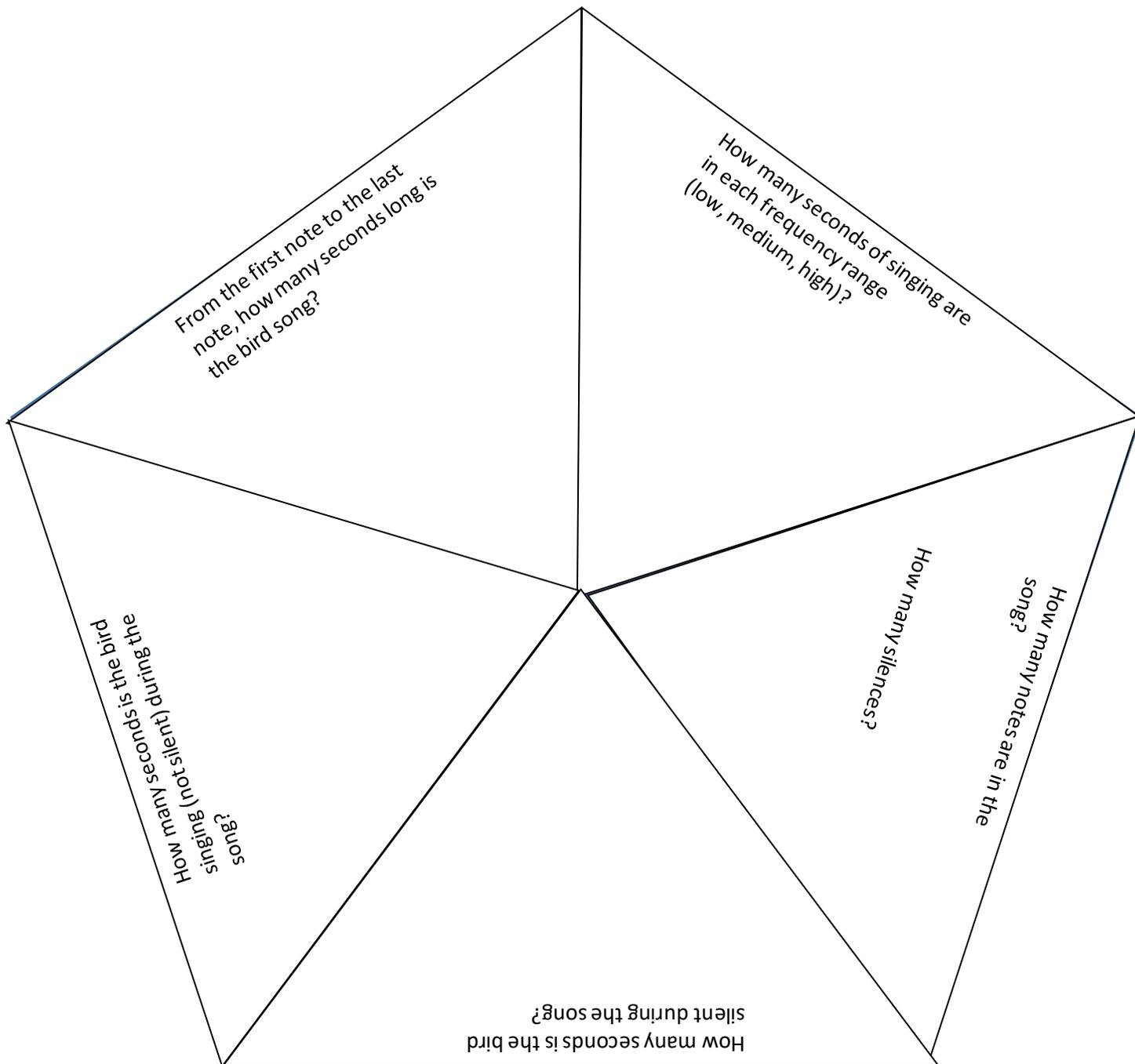
- 1. Demonstrate comprehension of time and frequency with attempts to recreate the songs with the [Chrome Music Lab Spectrogram](#)
- 2. Visually compare spectrograms. Do some songs “look” similar? (Example, Common Potoo and Mourning Dove). Do birds with similar songs live in the same habitat? (Some information is on the back of the spectrograms, but additional research can be conducted.)



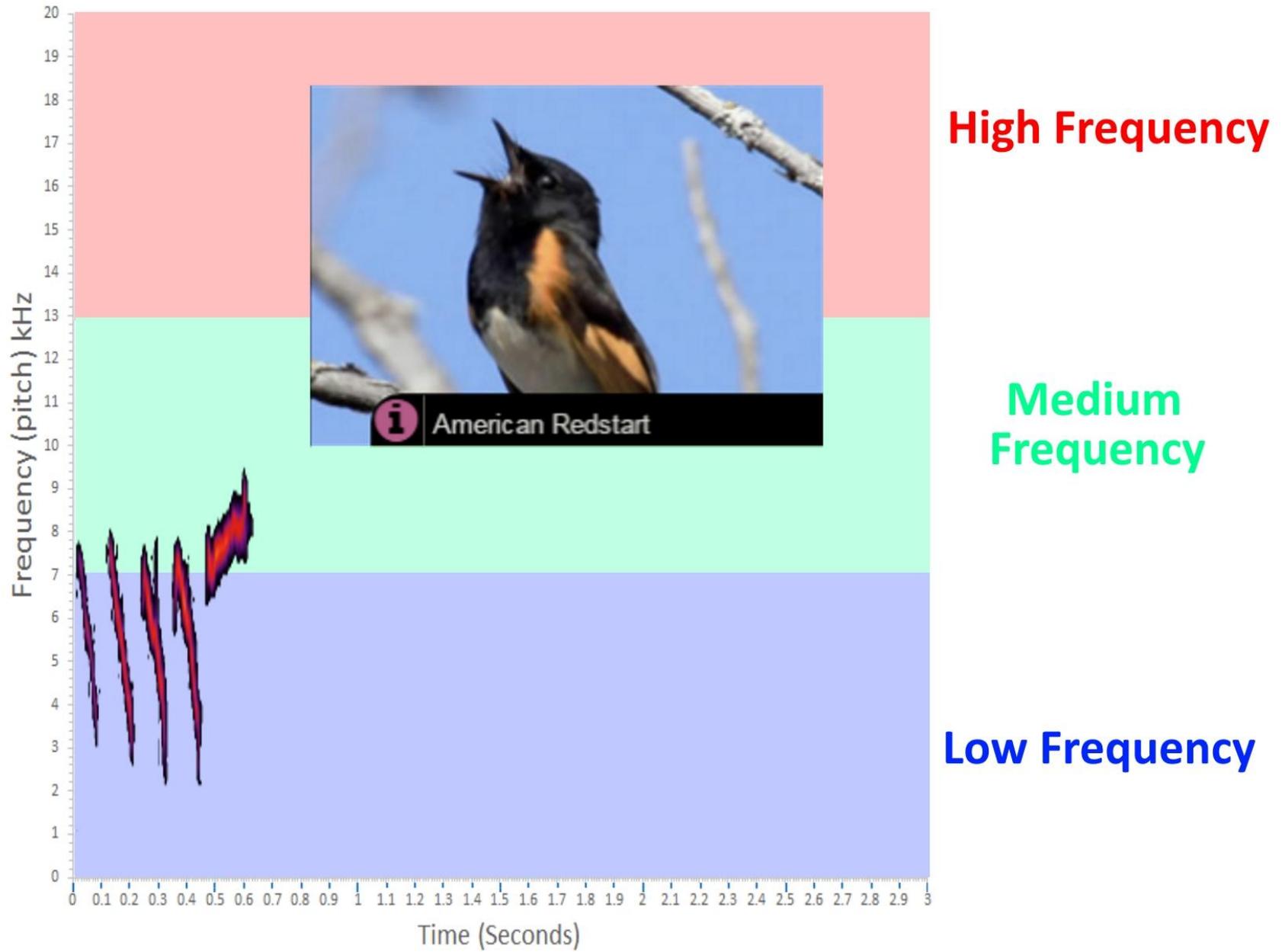
# Spectrogram Analysis Datasheet

Bird Song Scientist names: \_\_\_\_\_

Bird Species: \_\_\_\_\_

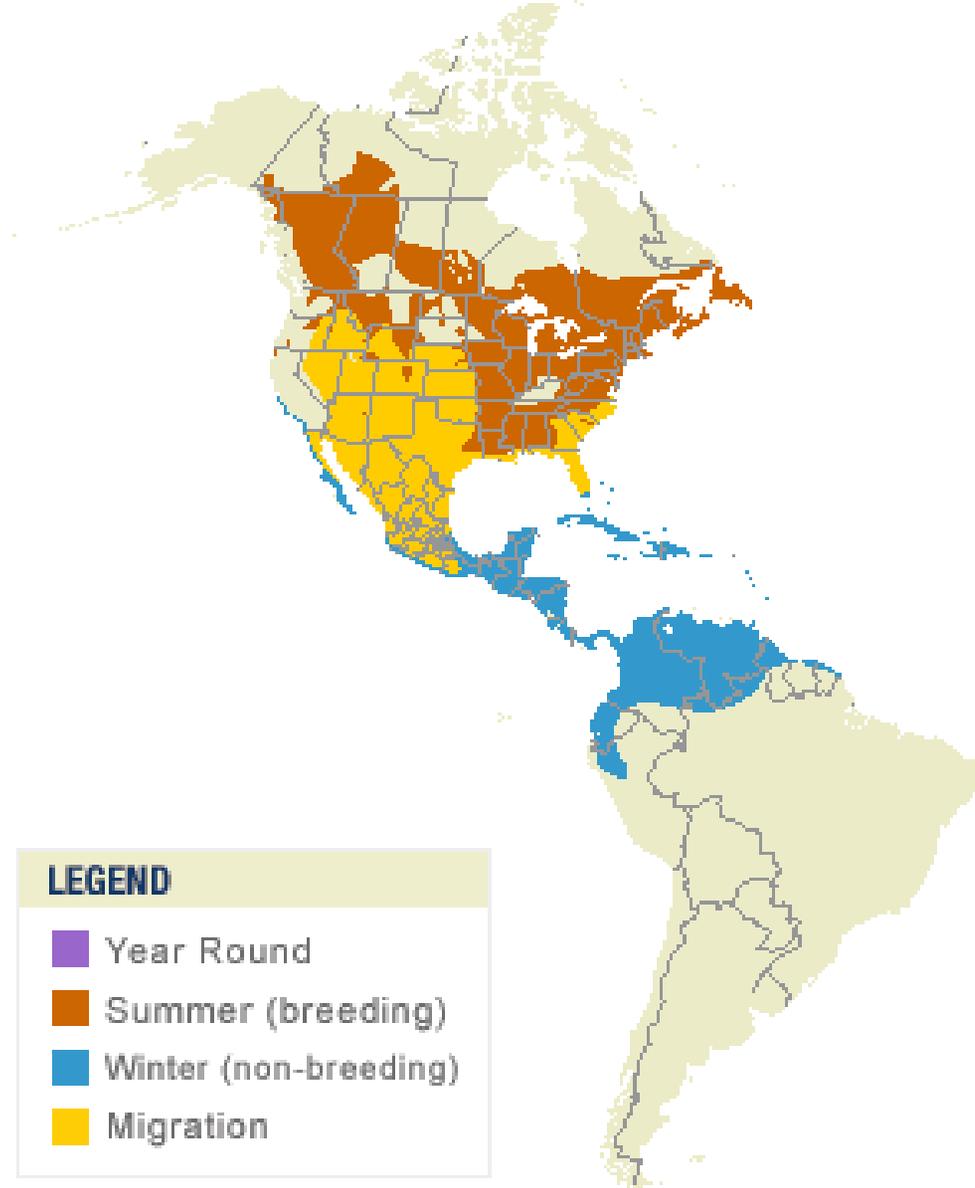


# Spectrograms Adapted from Bird Song Hero



## American Redstart

*Setophaga ruticilla*



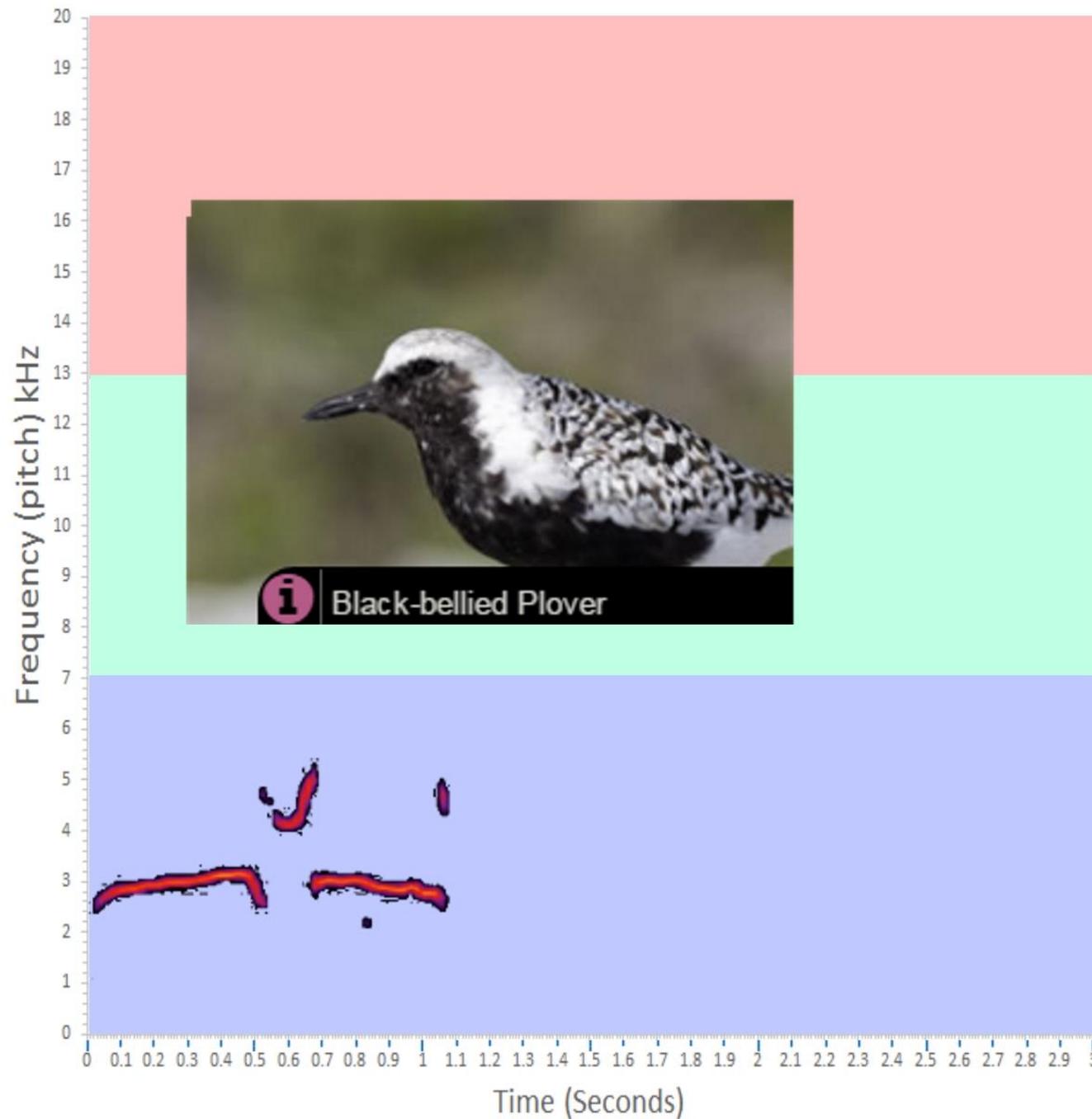
### LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

### Habitat

American Redstarts like open wooded habitats (not too much understory).

They prefer deciduous trees (not evergreens).



**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Black-bellied Plover

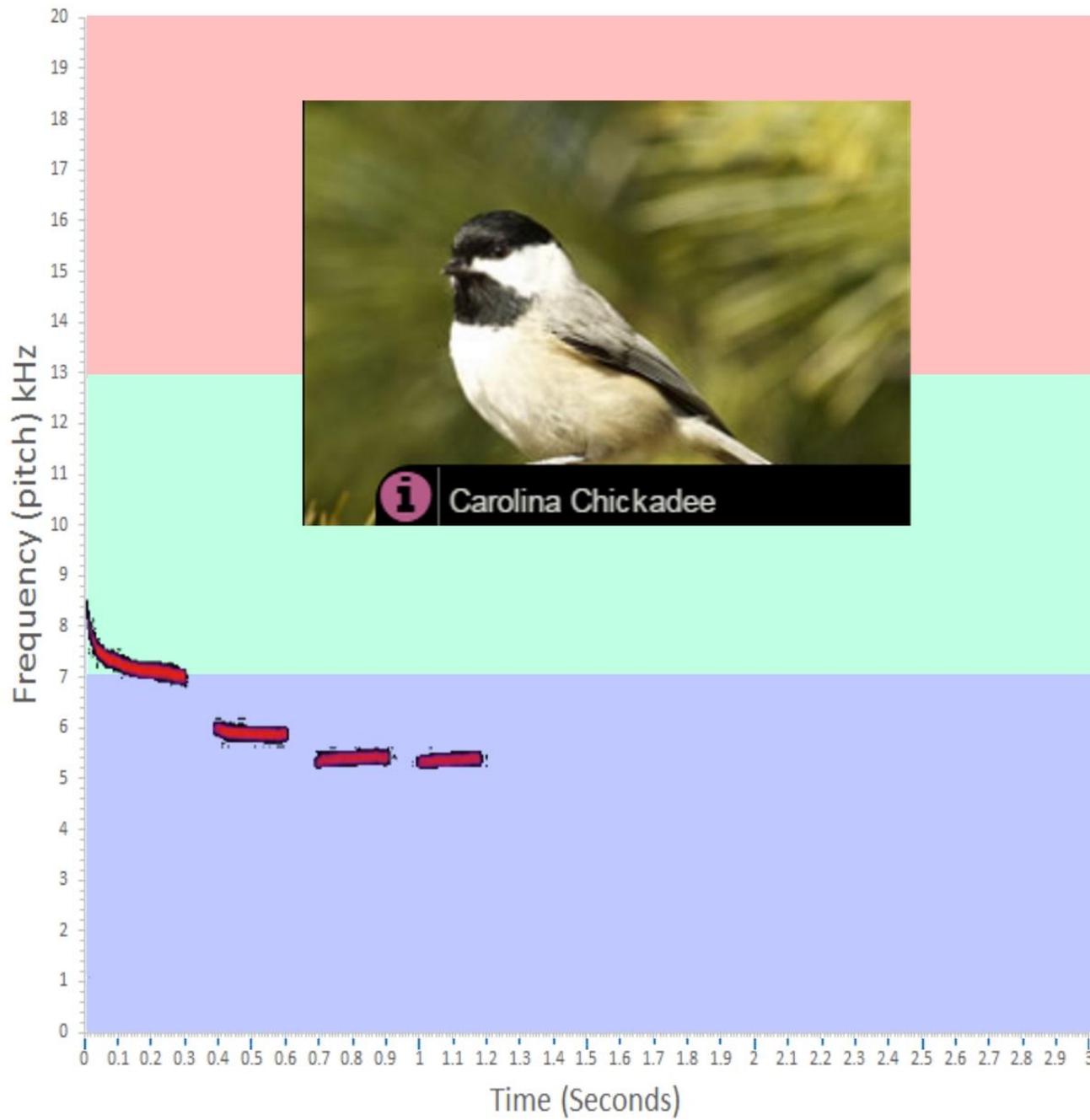
*Pluvialis squatarola*

### Habitat:

The black-bellied plover breeds on the **Arctic** tundra. It winters on **coastal** estuaries, beaches, **mudflats**, the shores of ponds and lakes, **grassy** meadows, and flooded fields.



Map by Cornell Lab of Ornithology  
Range data by NatureServe



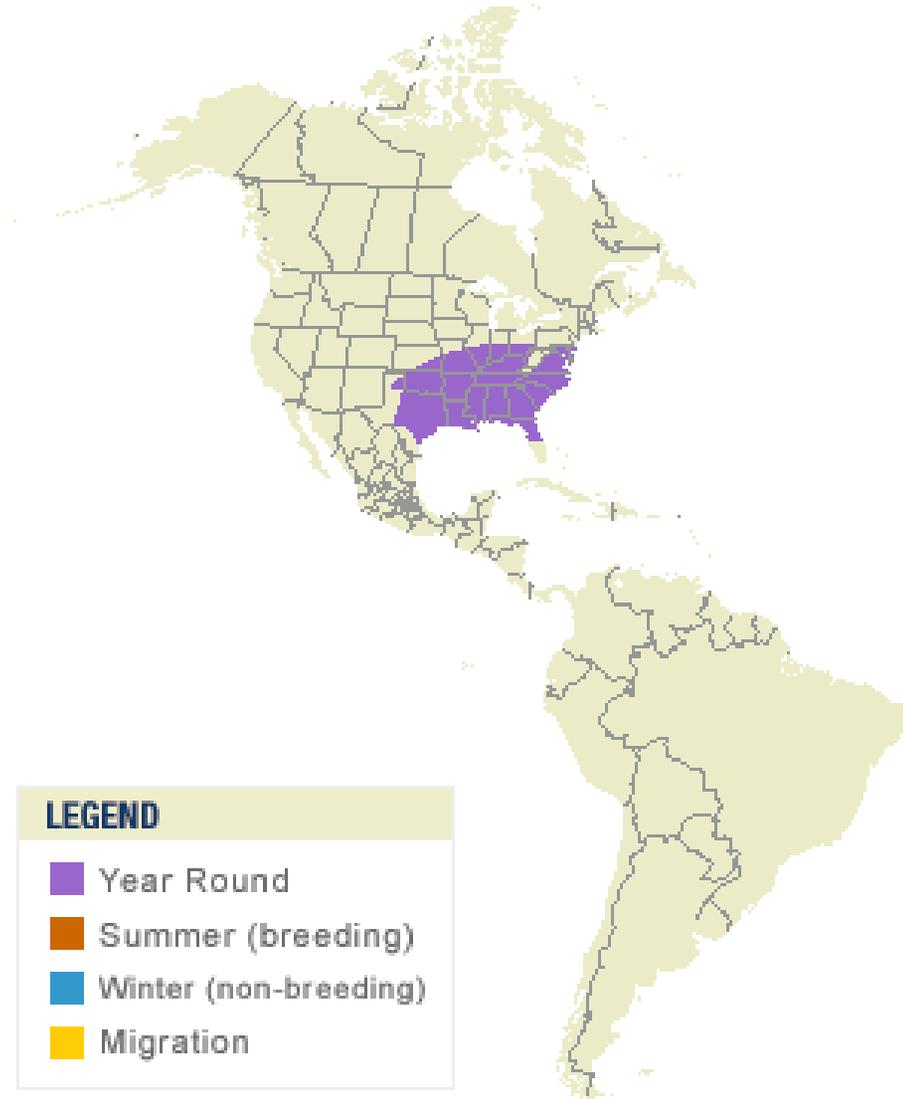
**i** Carolina Chickadee

**High Frequency**

**Medium Frequency**

**Low Frequency**

**Carolina Chickadee**  
*Poecile carolinensis*



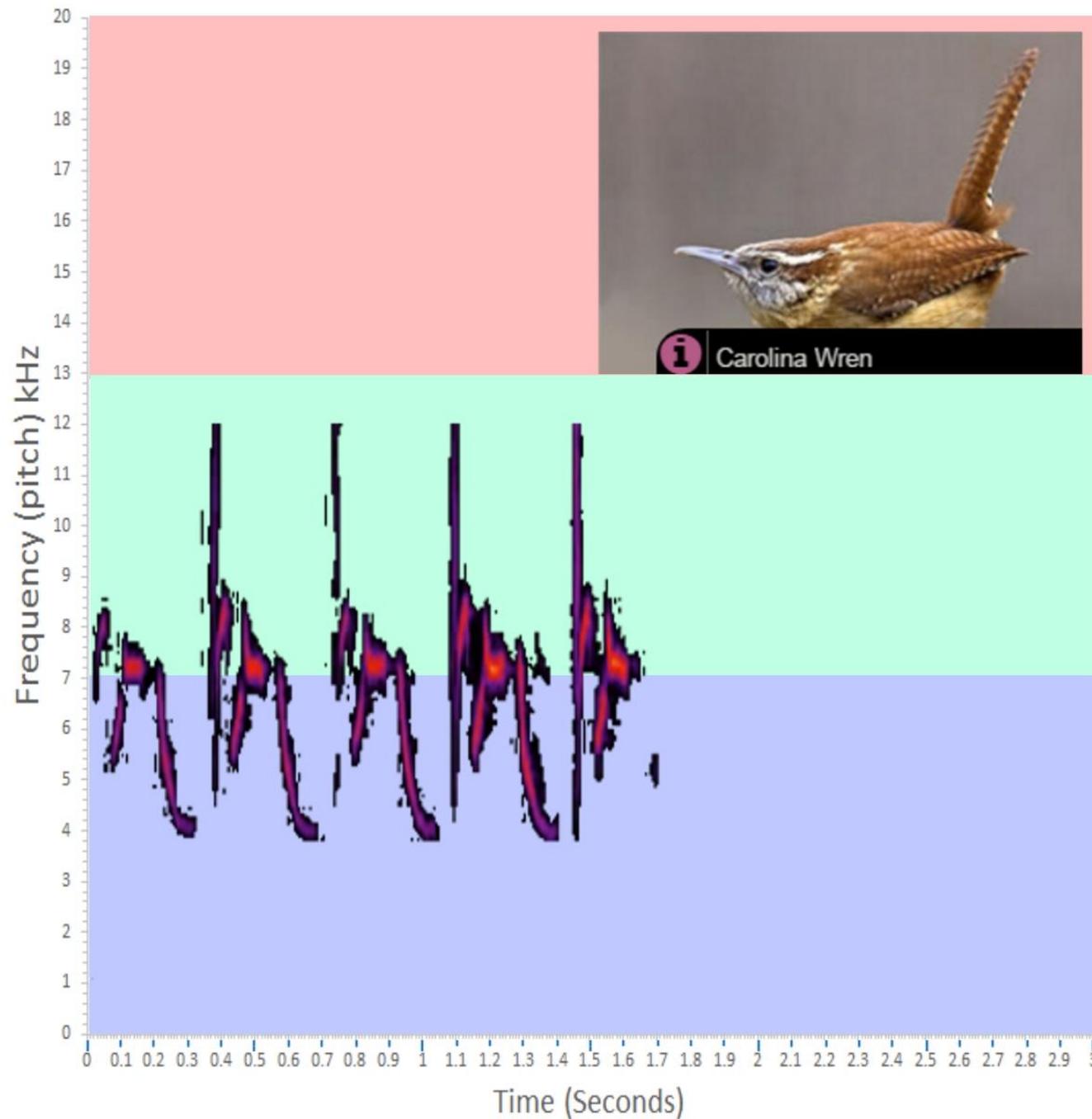
**LEGEND**

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

**Habitat**

Forested areas or city and neighborhood yards or parks with large trees.



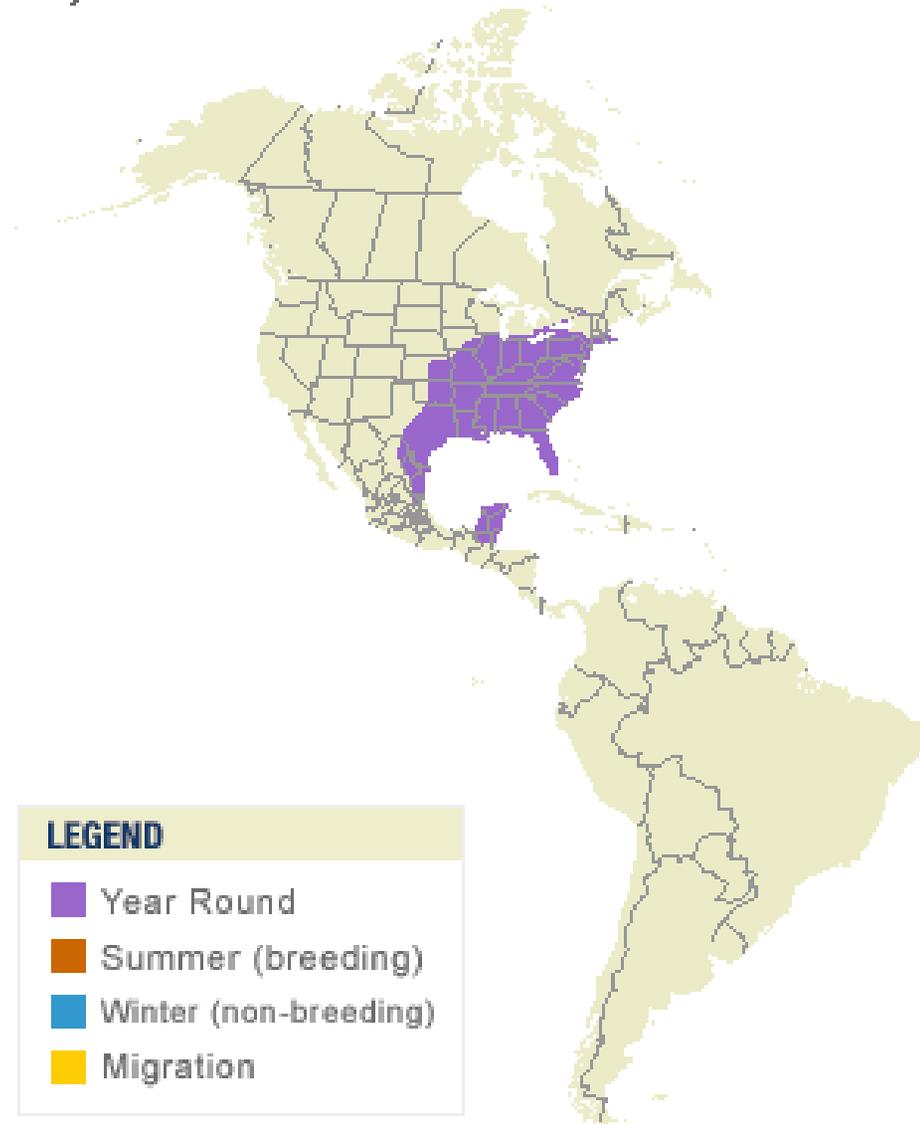
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Carolina Wren

*Thryothorus ludovicianus*



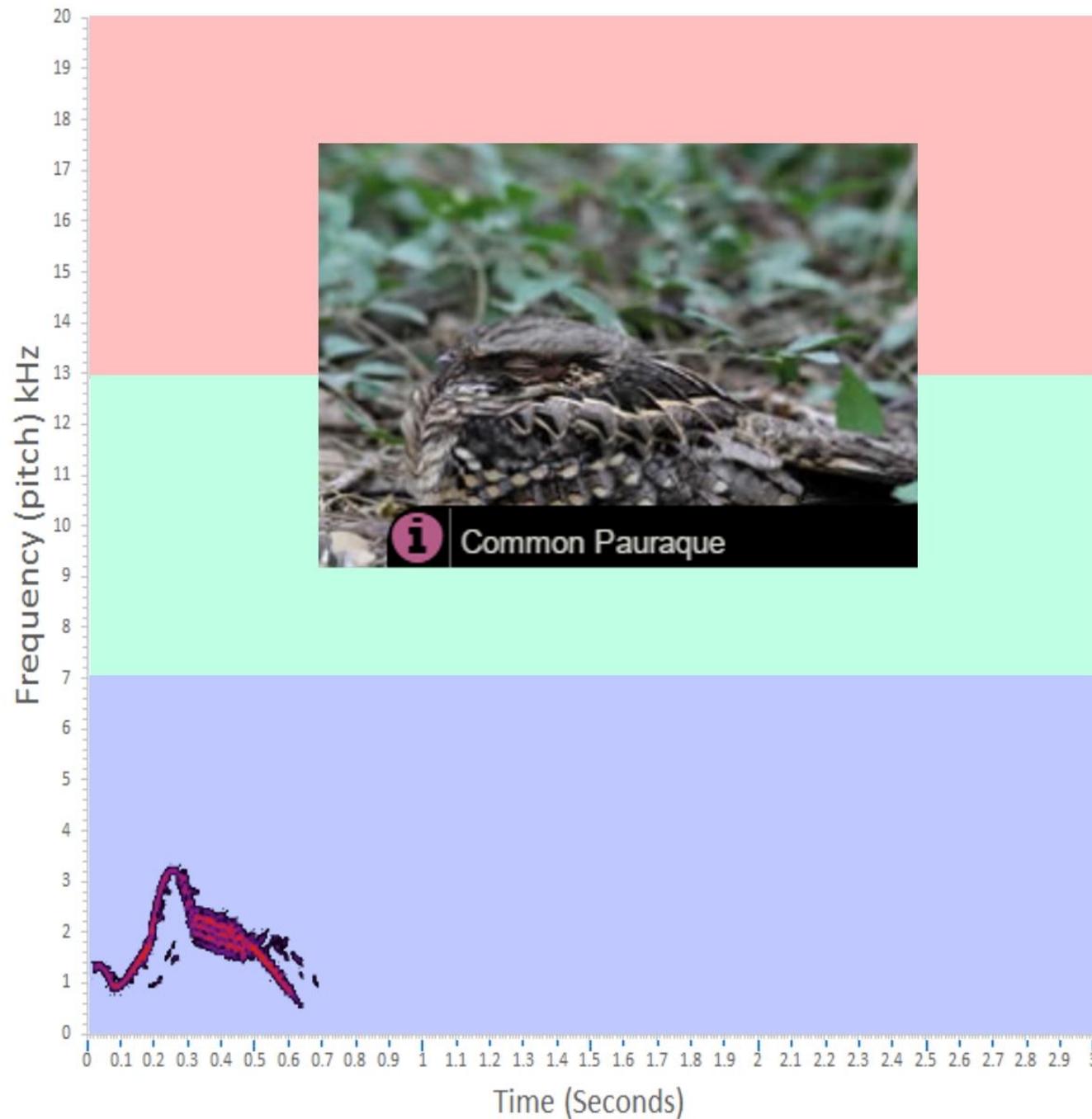
### LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

### Habitat

These birds love to move low through tangled understory; like backyard brush piles and areas choked with vines and bushes.



**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Common Pauraque

*Nyctidromus albicollis*

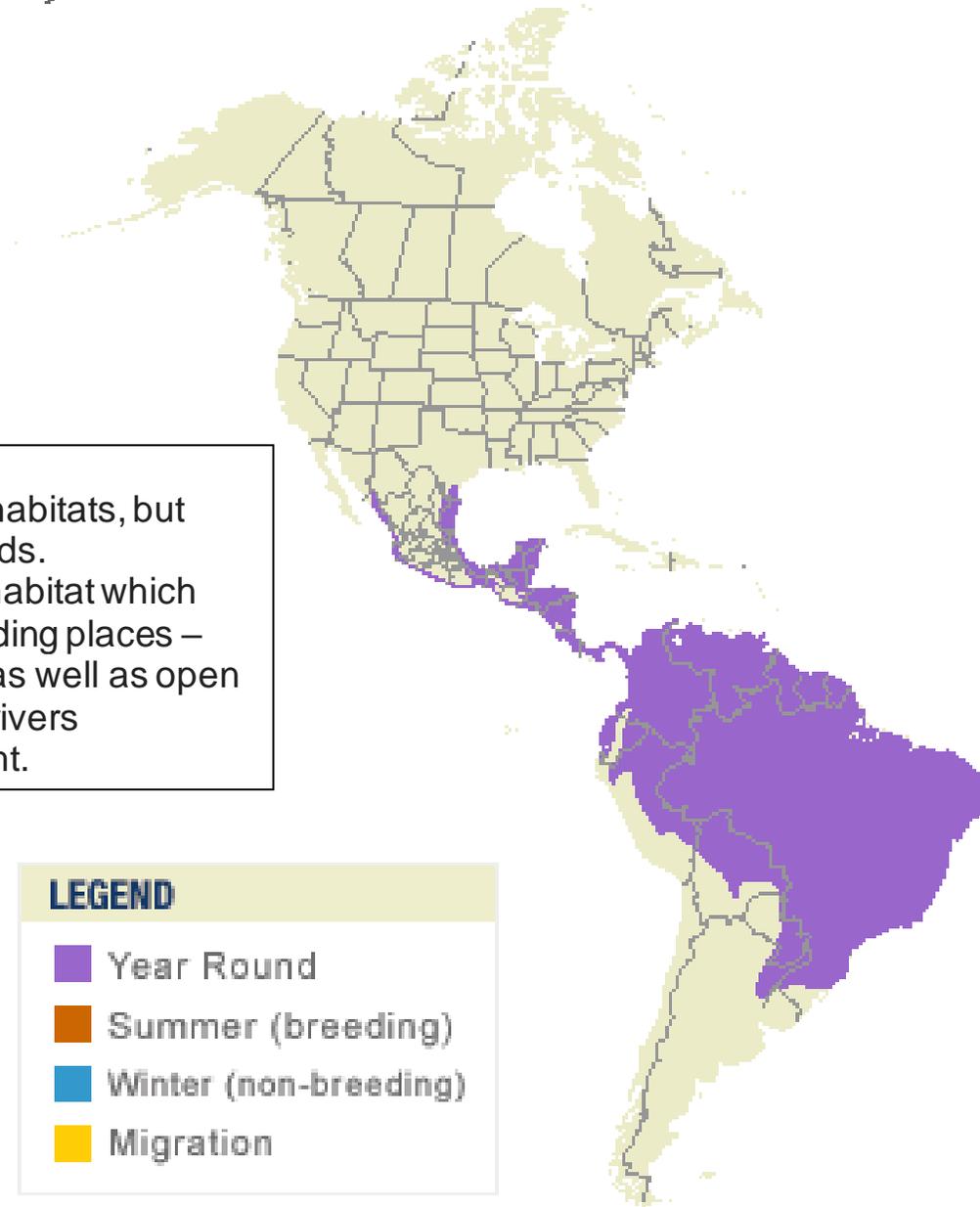
Habitat:

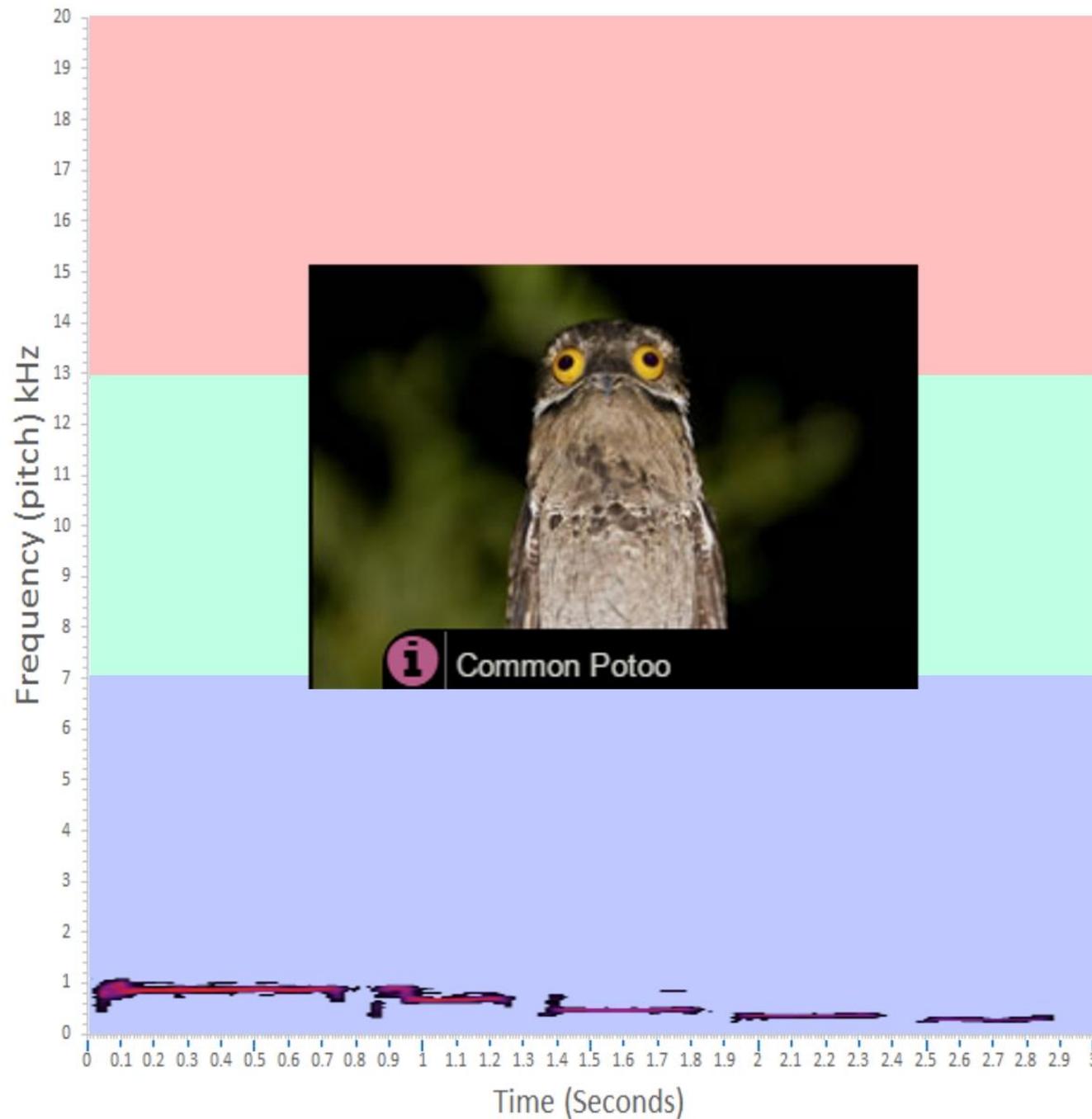
Open [woodland/grassland](#) habitats, but also [scrubland](#) and [crop](#) fields. In general it prefers mixed habitat which offers densely vegetated hiding places – ideally forest – for the day, as well as open landscape – perhaps even rivers or [wetlands](#) – to hunt at night.

### LEGEND

-  Year Round
-  Summer (breeding)
-  Winter (non-breeding)
-  Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe





**High Frequency**

**Medium  
Frequency**

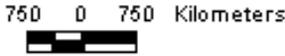
**Low Frequency**

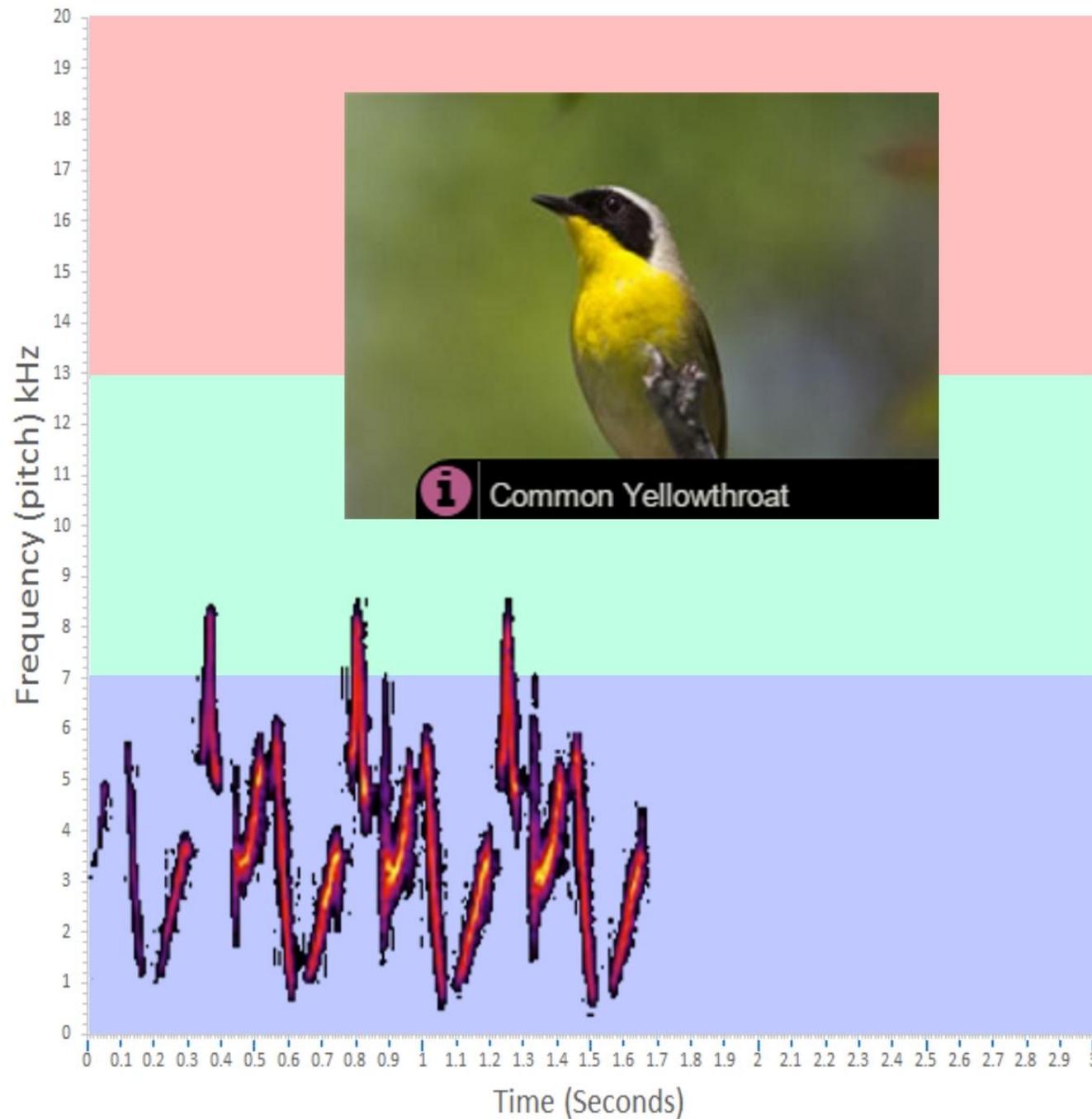


- Permanent Resident
- Breeding Resident
- Nonbreeding Resident
- Passage Migrant
- Uncertain Status
- Introduced
- Vagrant
- Extirpated
- Historical Records Only
- National boundary
- Subnational boundary
- River
- Water body



Map created September 2007





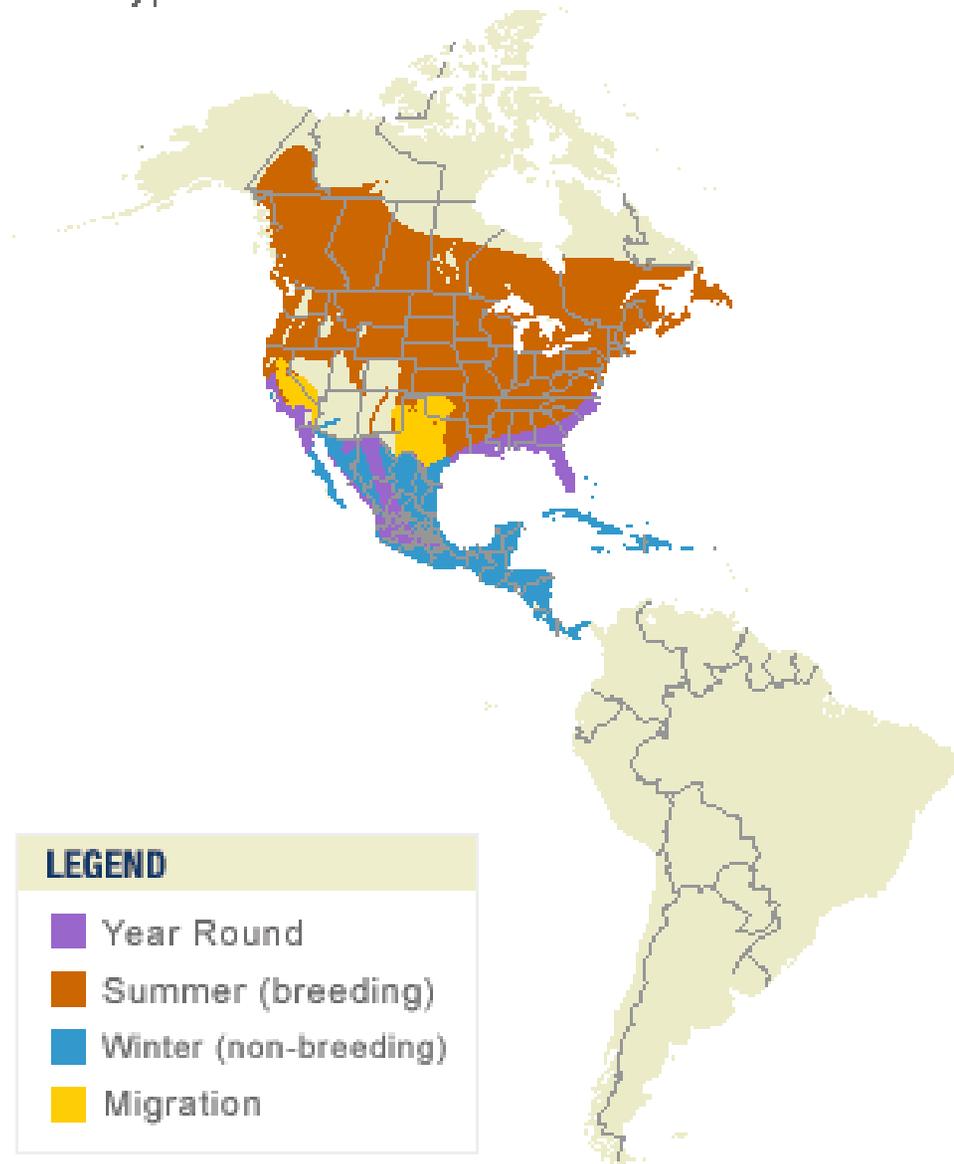
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Common Yellowthroat

*Geothlypis trichas*



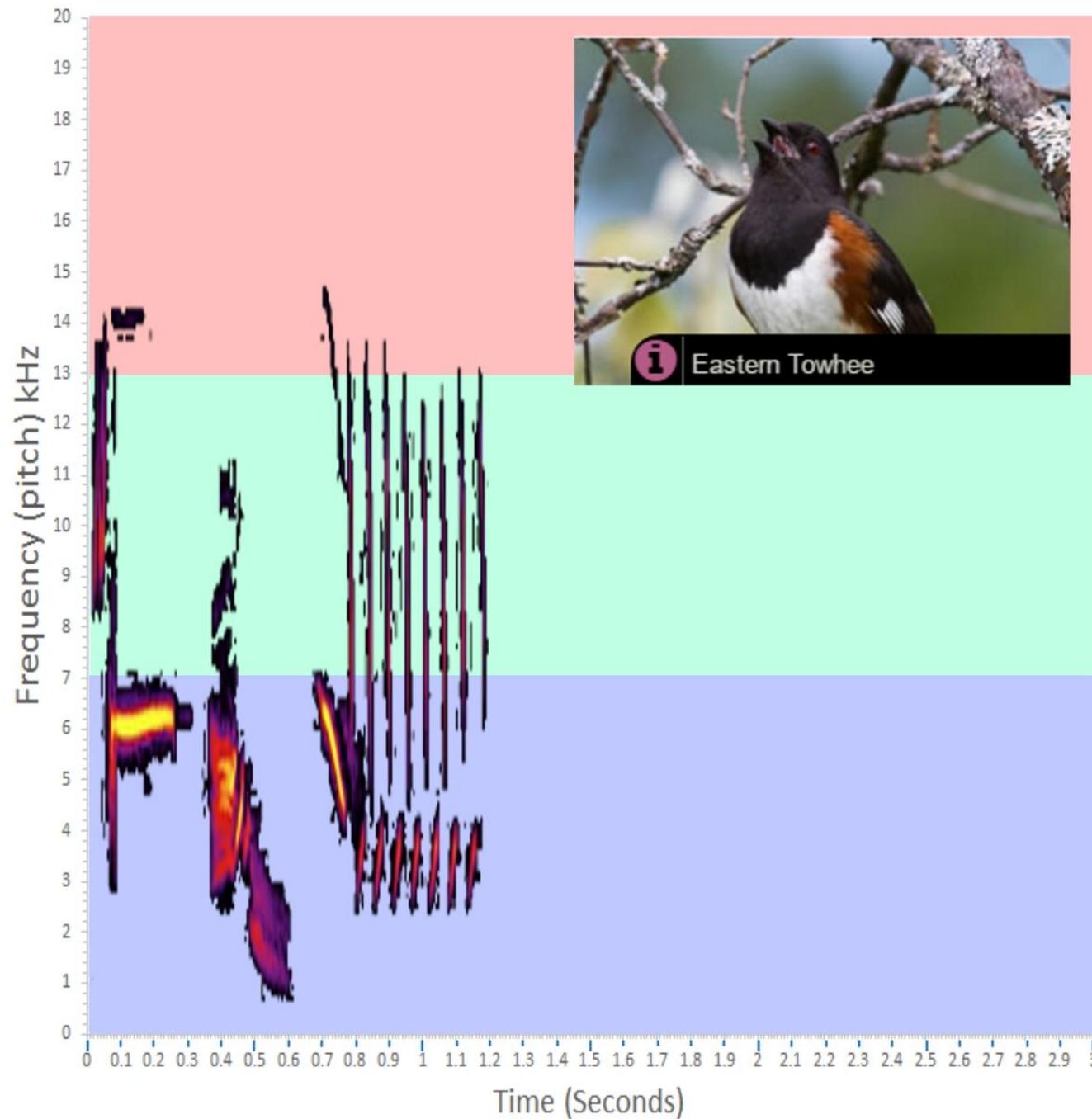
### LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

### Habitat

Yellowthroats live in open areas with thick, low vegetation, ranging from marsh to grassland to open pine forest.



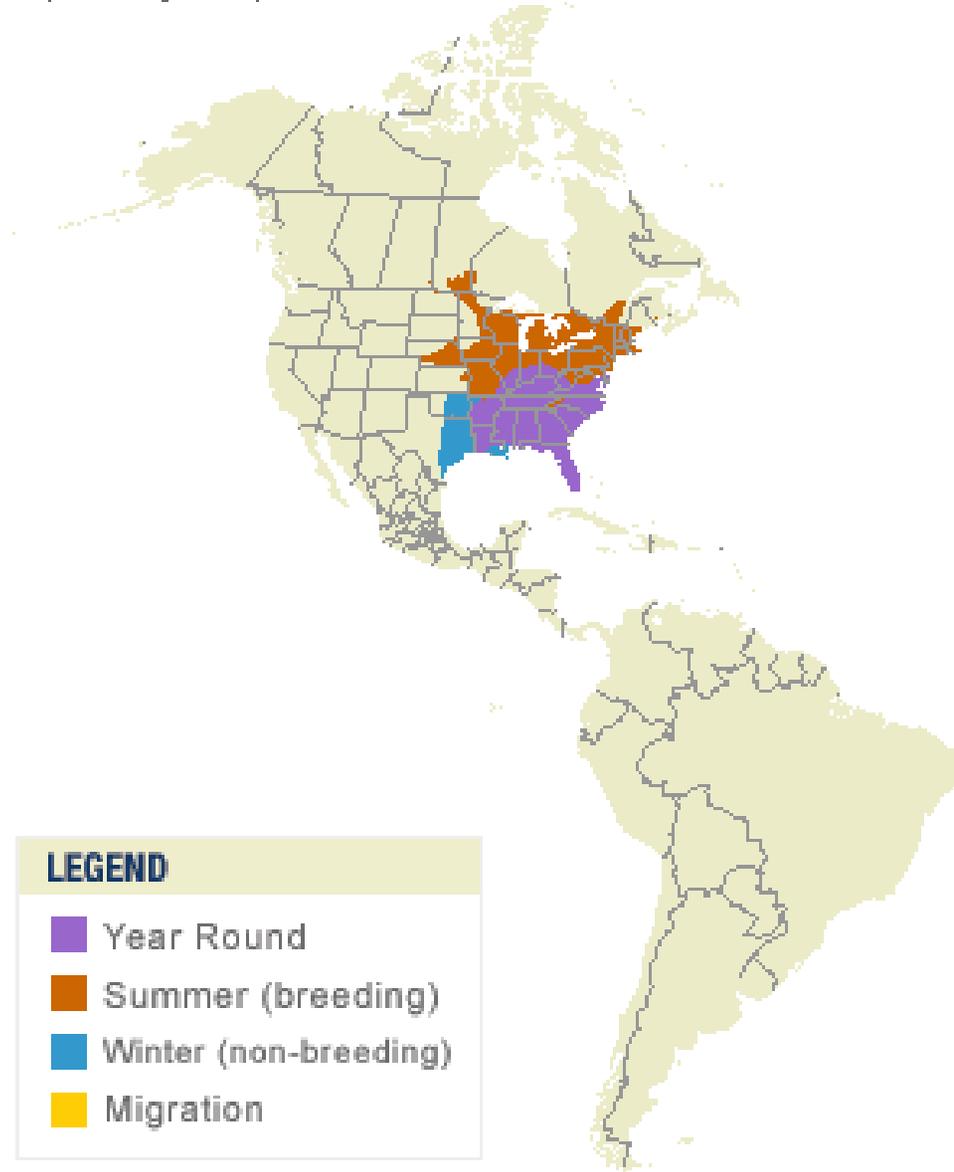
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Eastern Towhee

*Pipilo erythrophthalmus*



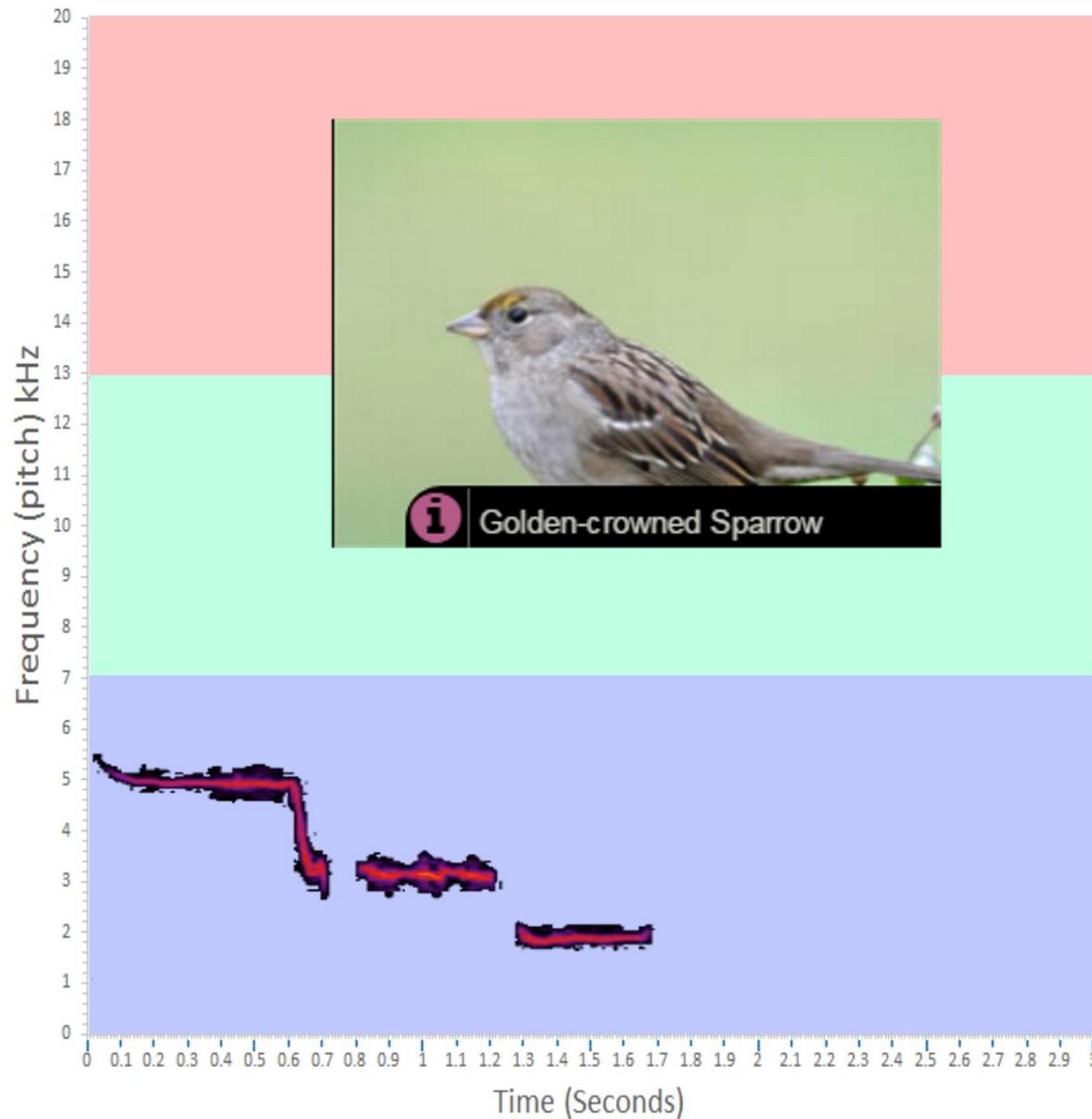
### LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

### Habitat

Look for Eastern Towhees in brush, tangles, thickets, and along forest edges where there's plenty of leaf litter for the birds to search for food.

Map by Cornell Lab of Ornithology  
Range data by NatureServe

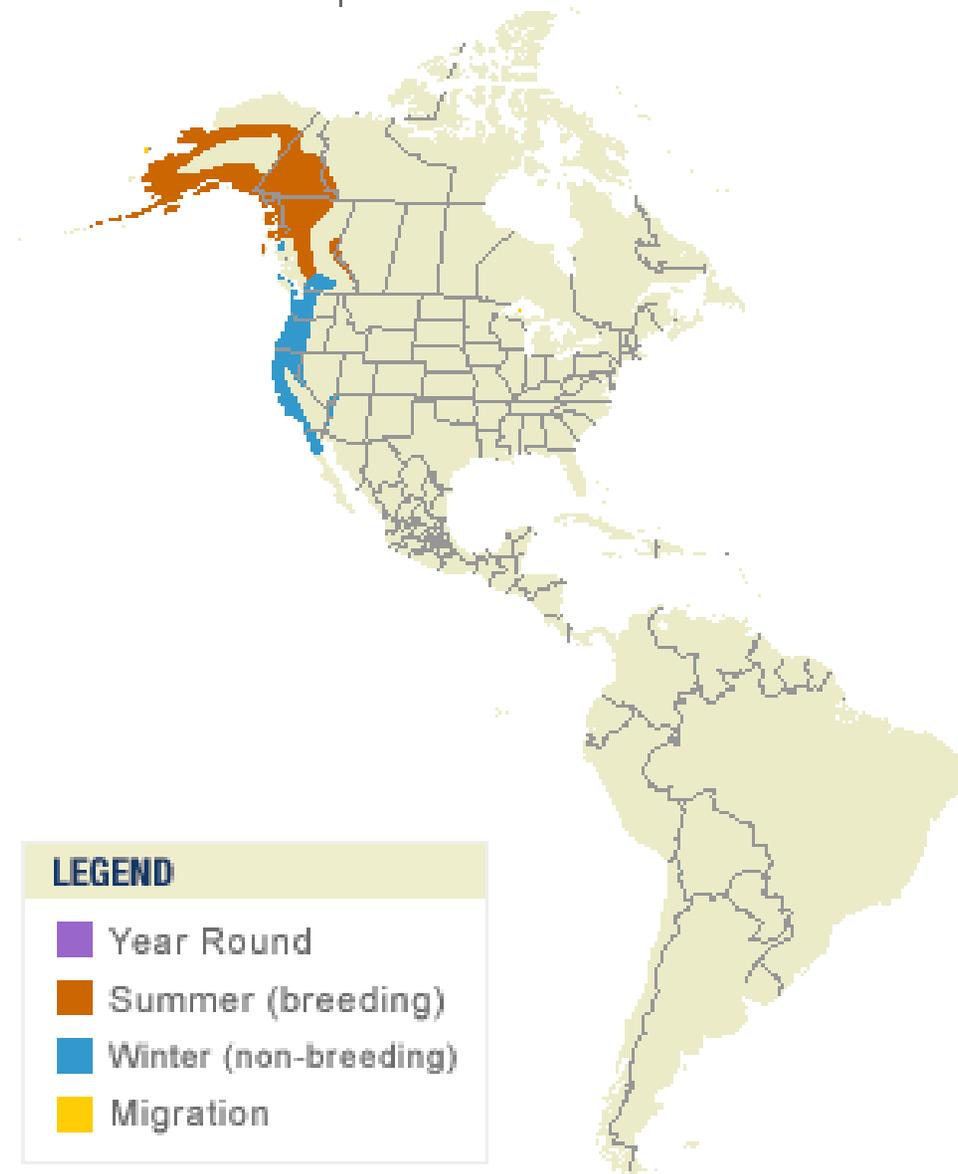


**High Frequency**

**Medium  
Frequency**

**Low Frequency**

Golden-crowned Sparrow  
*Zonotrichia atricapilla*



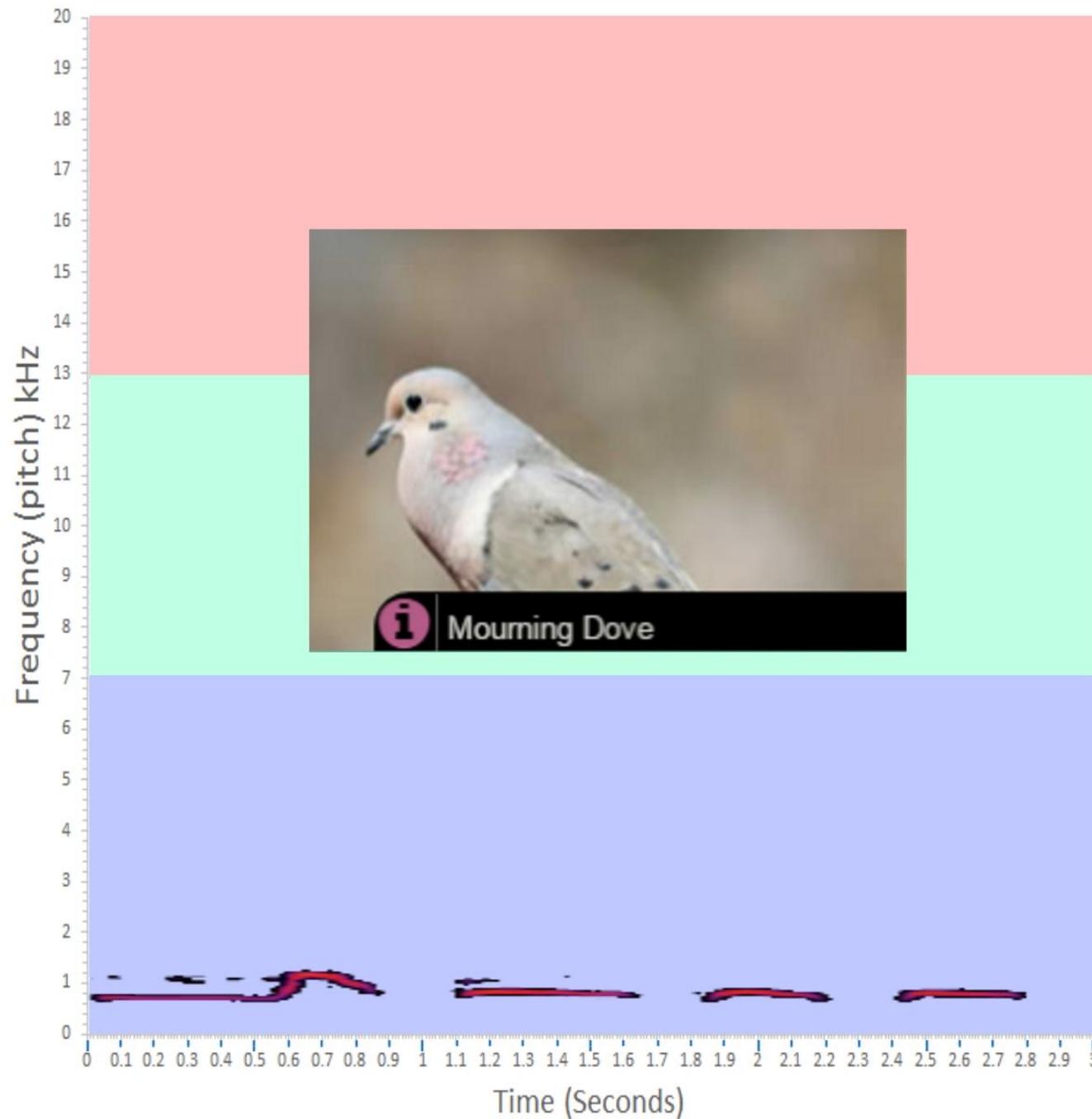
**LEGEND**

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

**Habitat**

Golden-crowned Sparrows nest in the north, in low, shrubby areas of tundra or at the edges of boreal forests.



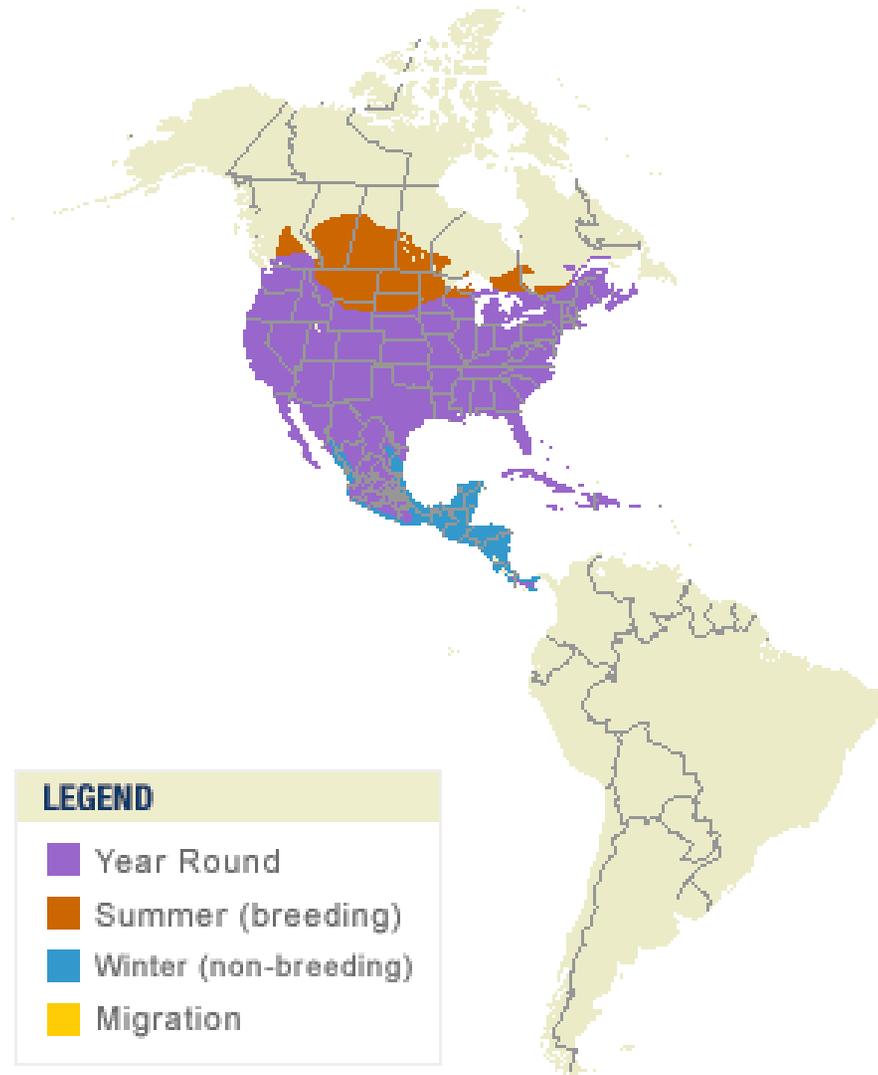
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Mourning Dove

*Zenaida macroura*



### LEGEND

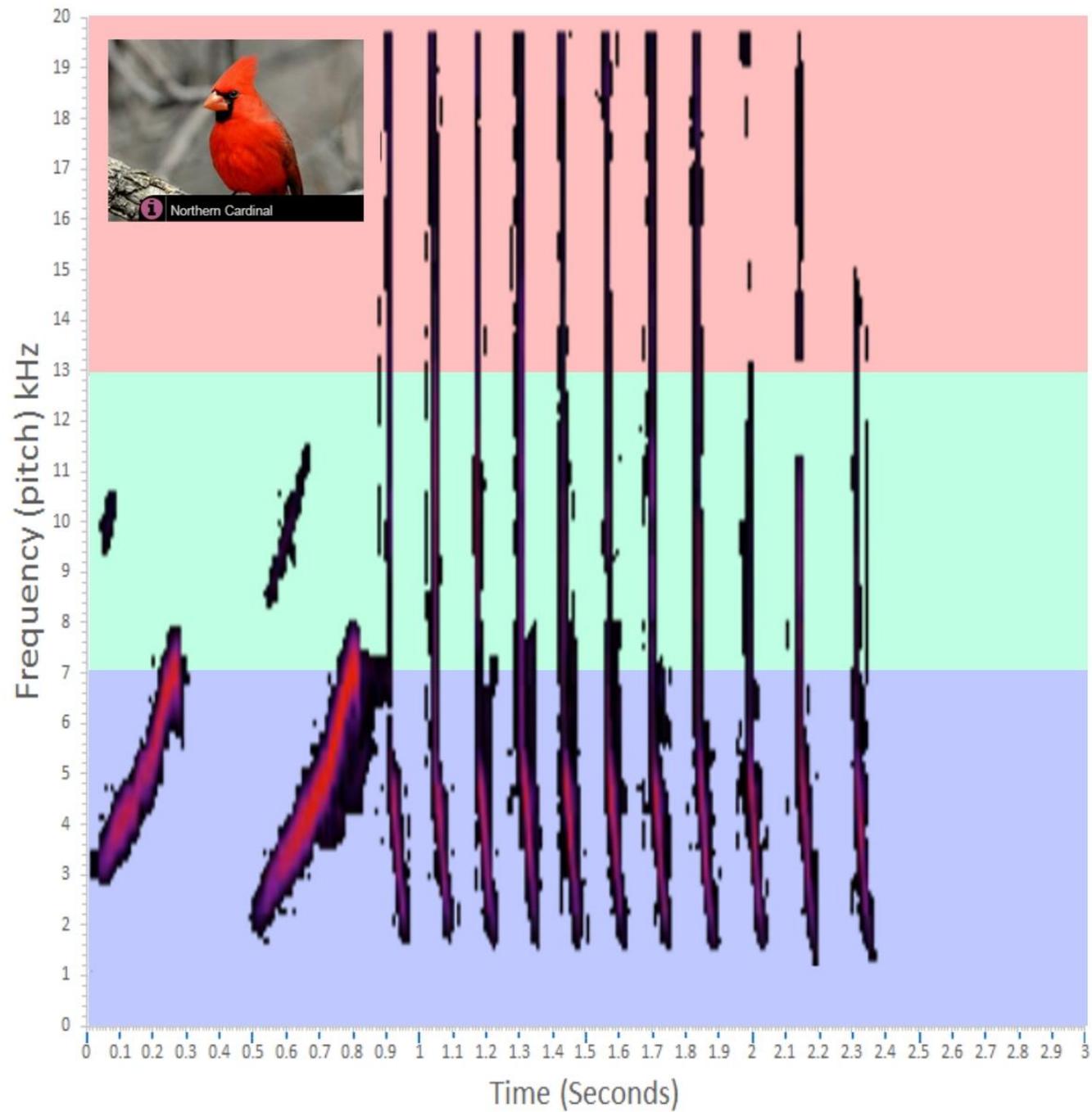
- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

### Habitat

You can see Mourning Doves nearly anywhere except the deep woods.

Look for them in fields or patches of bare ground, or on high perches like telephone wires.



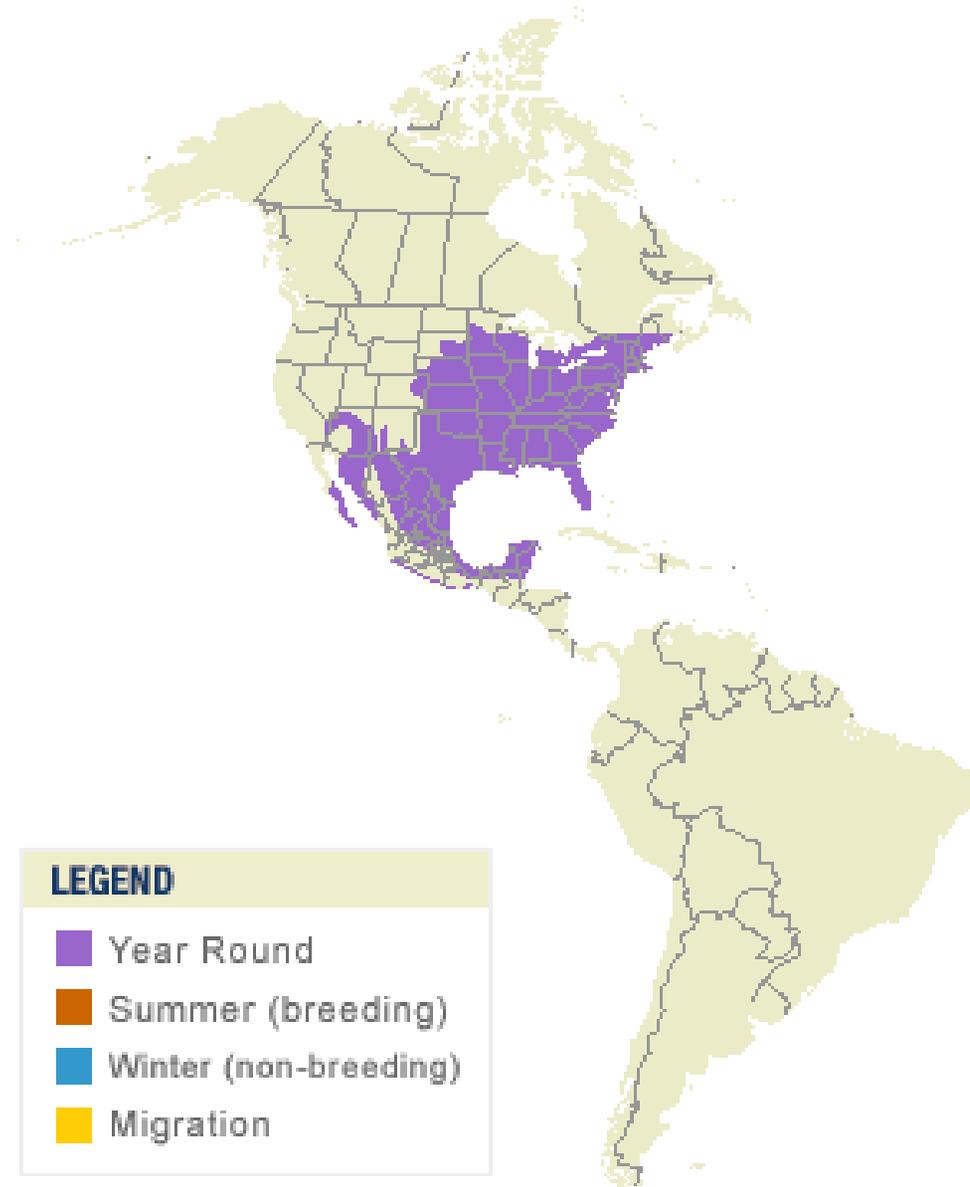
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Northern Cardinal

*Cardinalis cardinalis*



### LEGEND

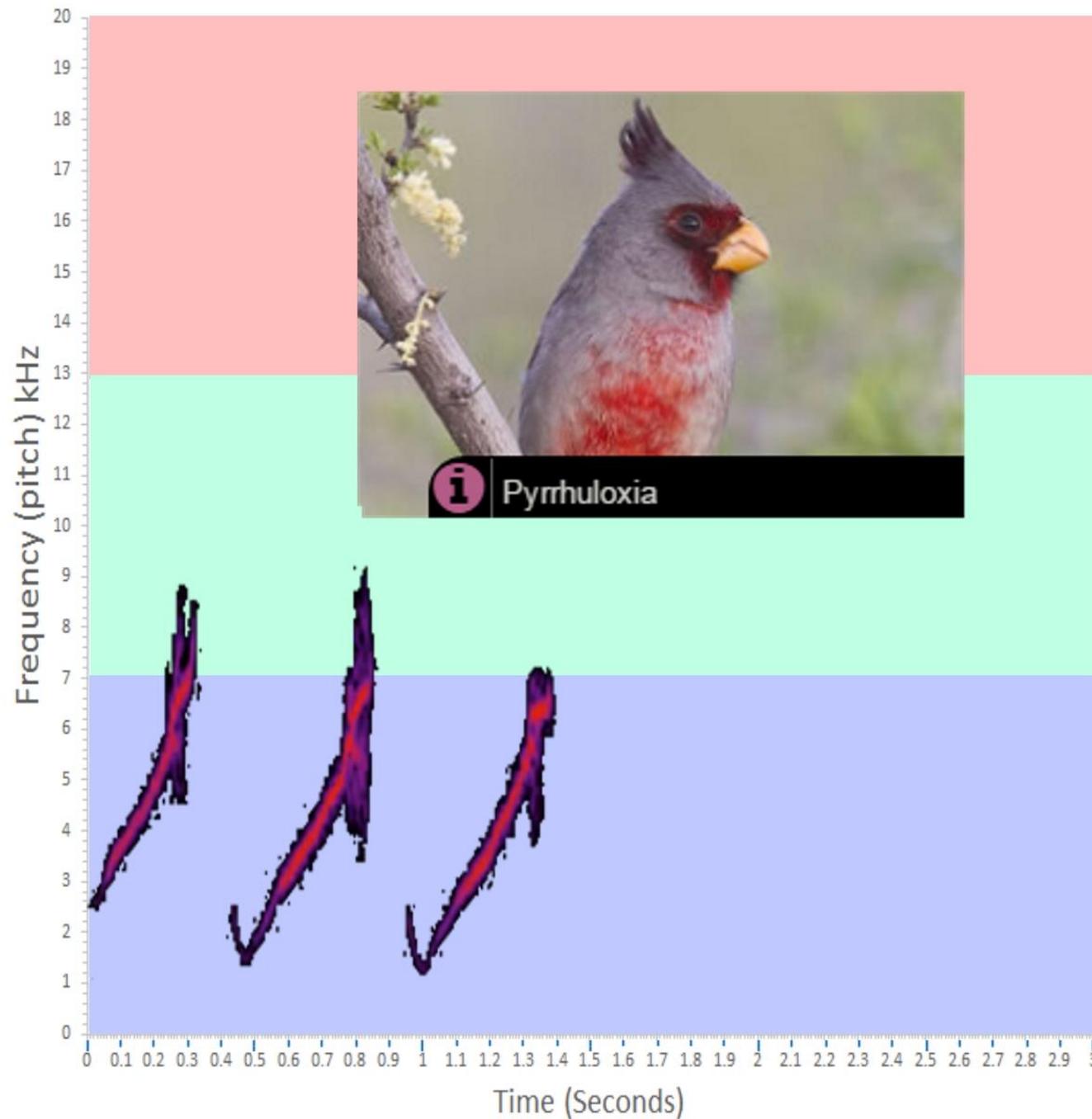
- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

### Habitat

Look for Northern Cardinals in inhabited areas such as backyards, parks, woodlots, and shrubby forest edges.

Northern Cardinals nest in dense tangles of shrubs and vines.



**High Frequency**

**Medium  
Frequency**

**Low Frequency**

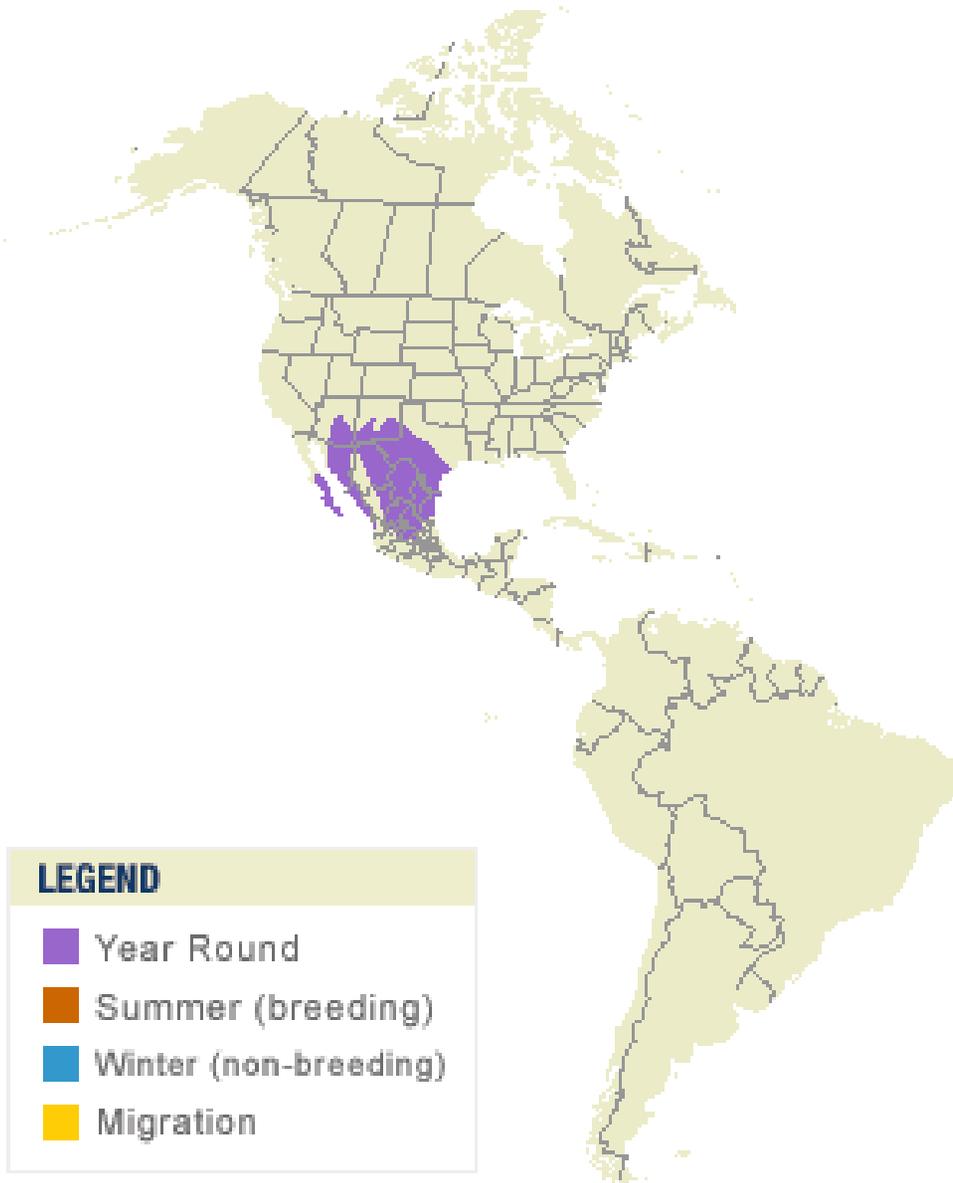
# Pyrrhuloxia

*Cardinalis sinuatus*

## Habitat

Pyrrhuloxias live in desert regions.

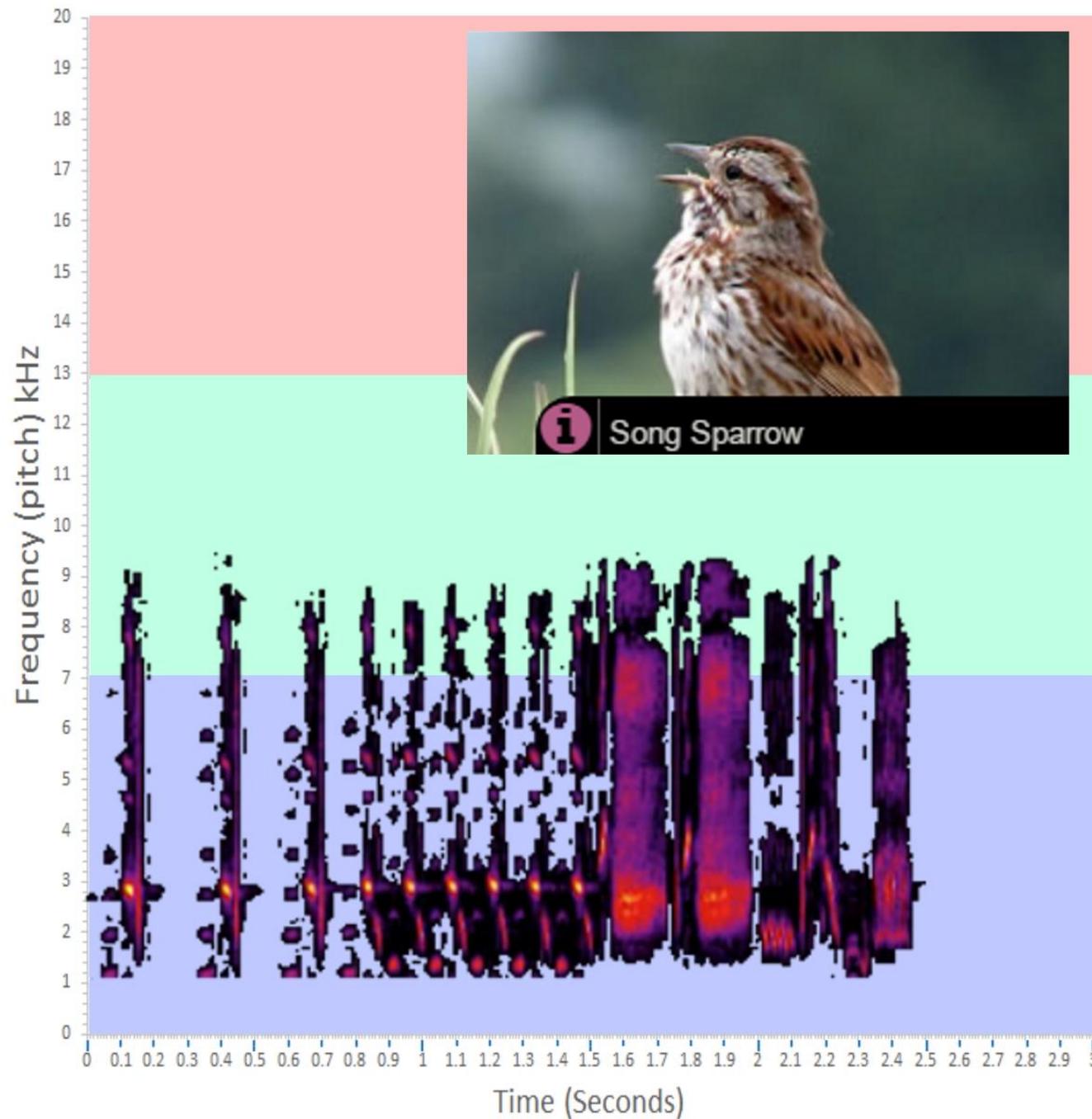
They love scrub, dry grasslands, open mesquite forest, and cactus gardens for nesting.



## LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe



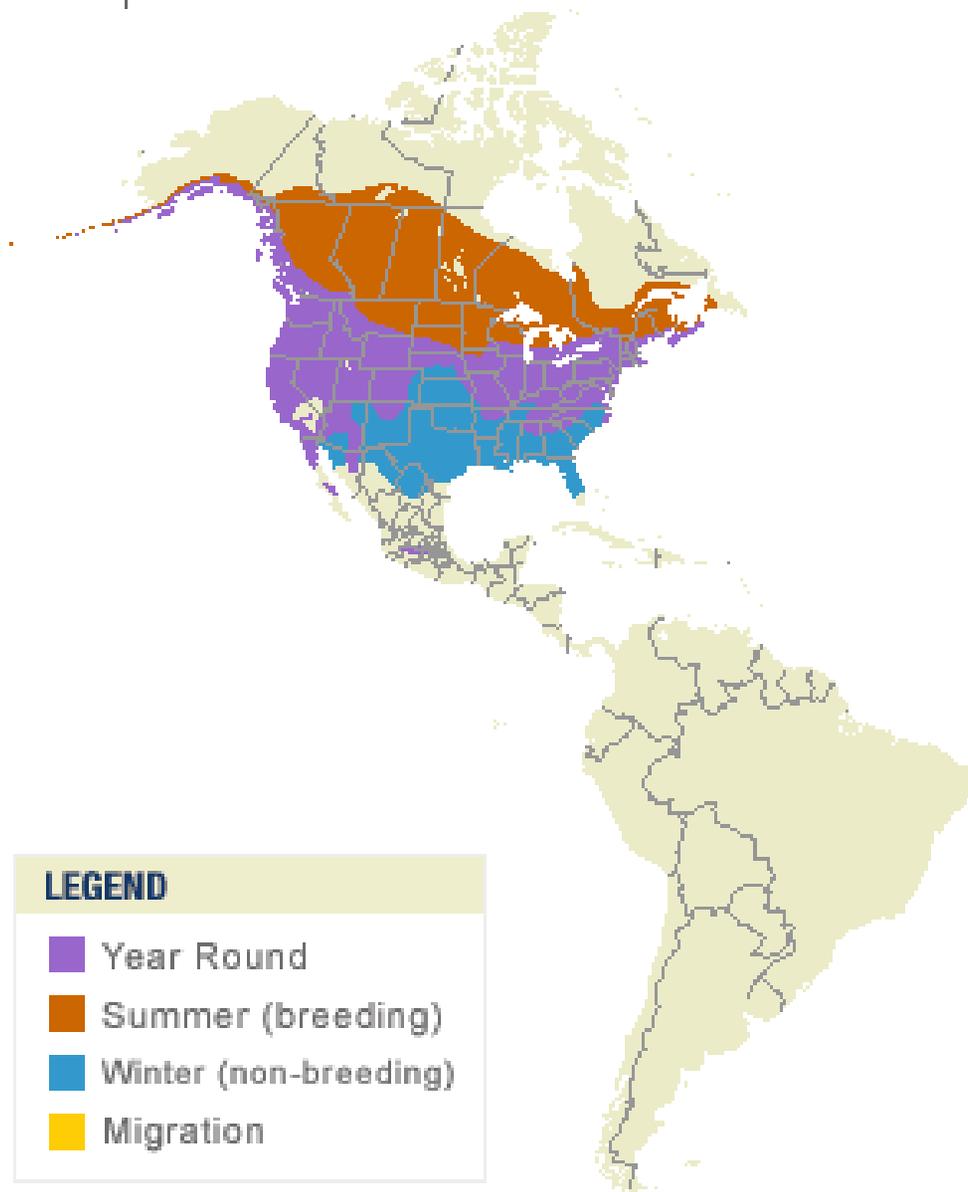
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

# Song Sparrow

*Melospiza melodia*



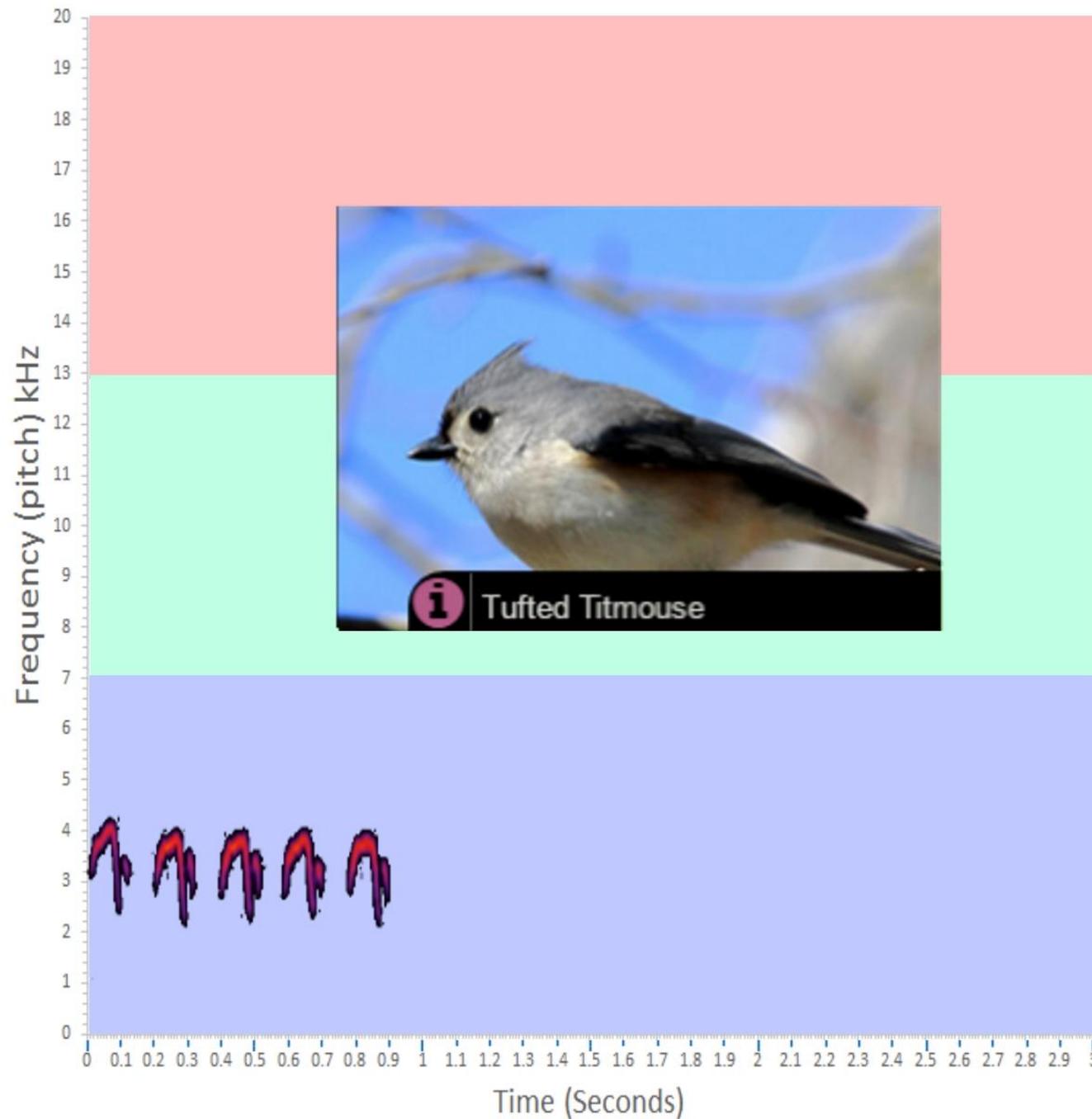
## Habitat

Look for Song Sparrows in nearly any open habitat, including marsh edges, overgrown fields, backyards, desert washes, and forest edges.

## LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe



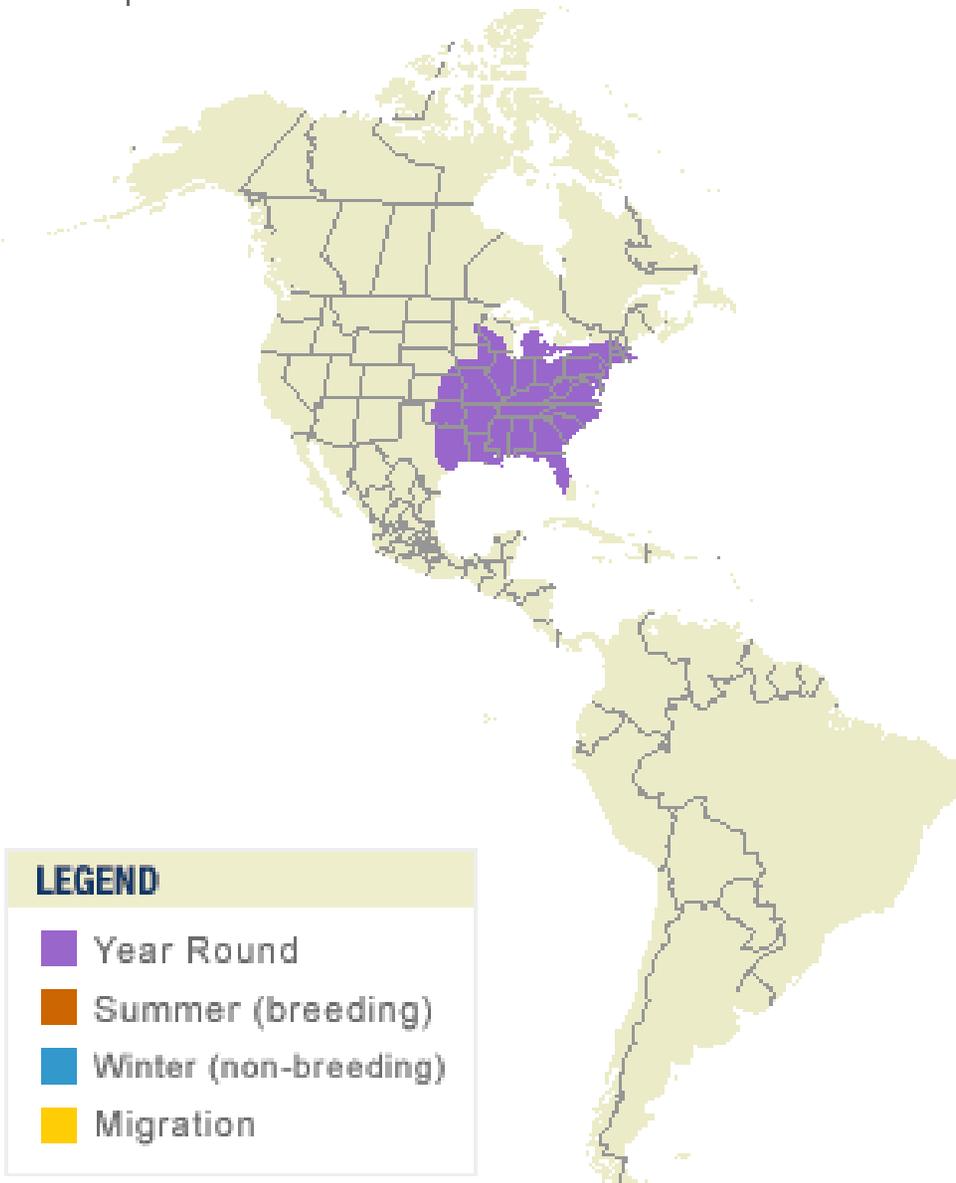
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Tufted Titmouse

*Baeolophus bicolor*



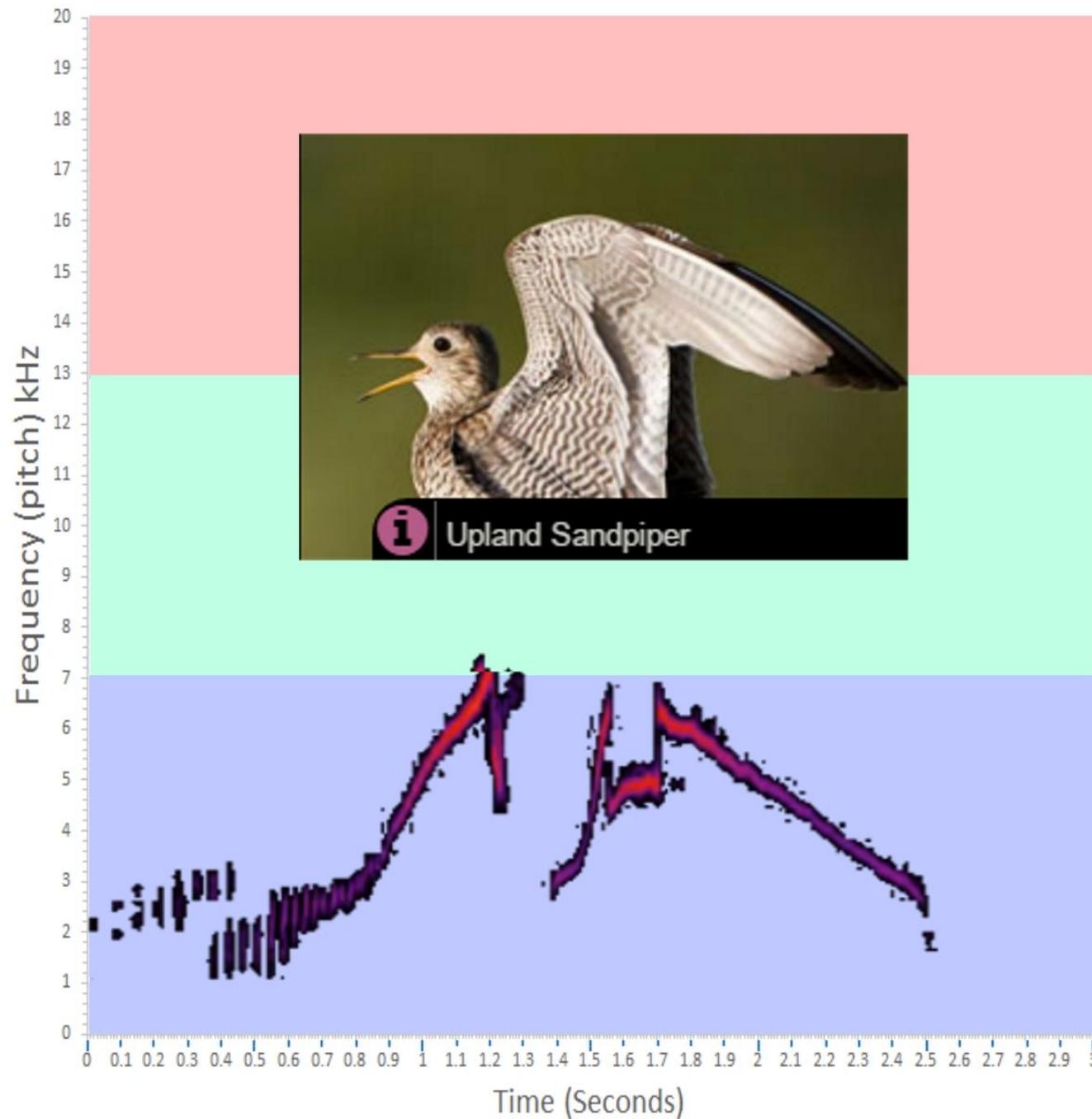
### Habitat

You'll find Tufted Titmice in most eastern woodlands below 2,000 feet elevation, including deciduous and evergreen forests.

### LEGEND

-  Year Round
-  Summer (breeding)
-  Winter (non-breeding)
-  Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

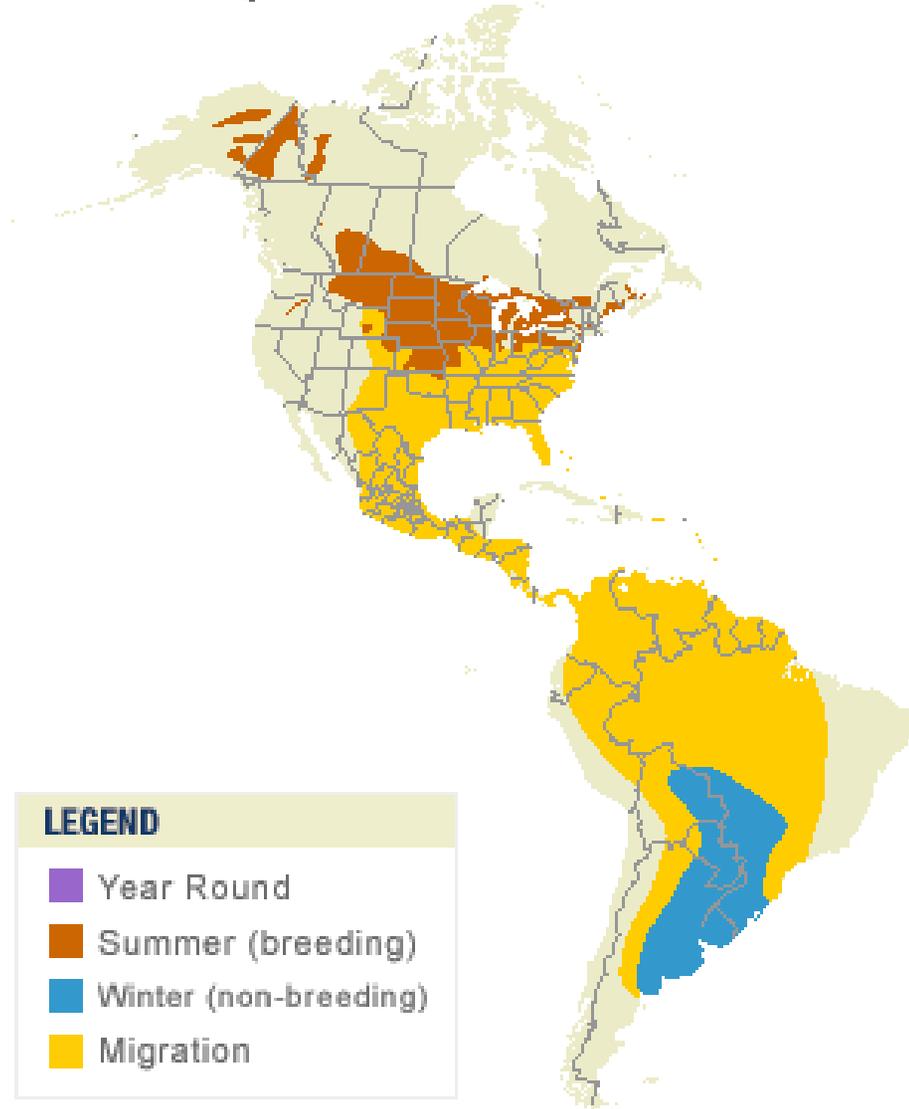


**High Frequency**

**Medium  
Frequency**

**Low Frequency**

**Upland Sandpiper**  
*Bartramia longicauda*



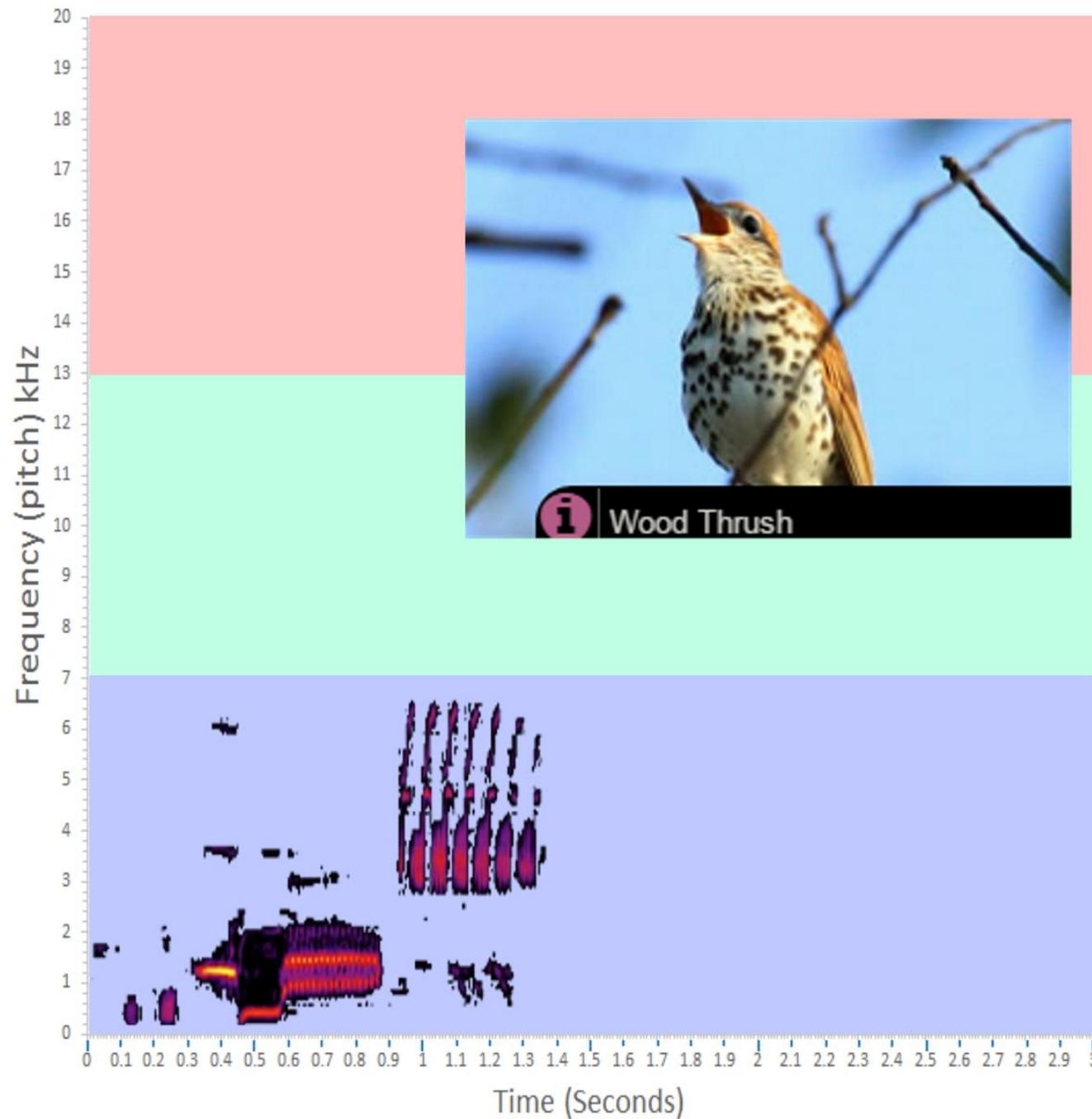
**LEGEND**

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

**Habitat**

Upland Sandpipers live in native prairie and other open grassy areas (like the Great Plains) in North America.

Map by Cornell Lab of Ornithology  
Range data by NatureServe



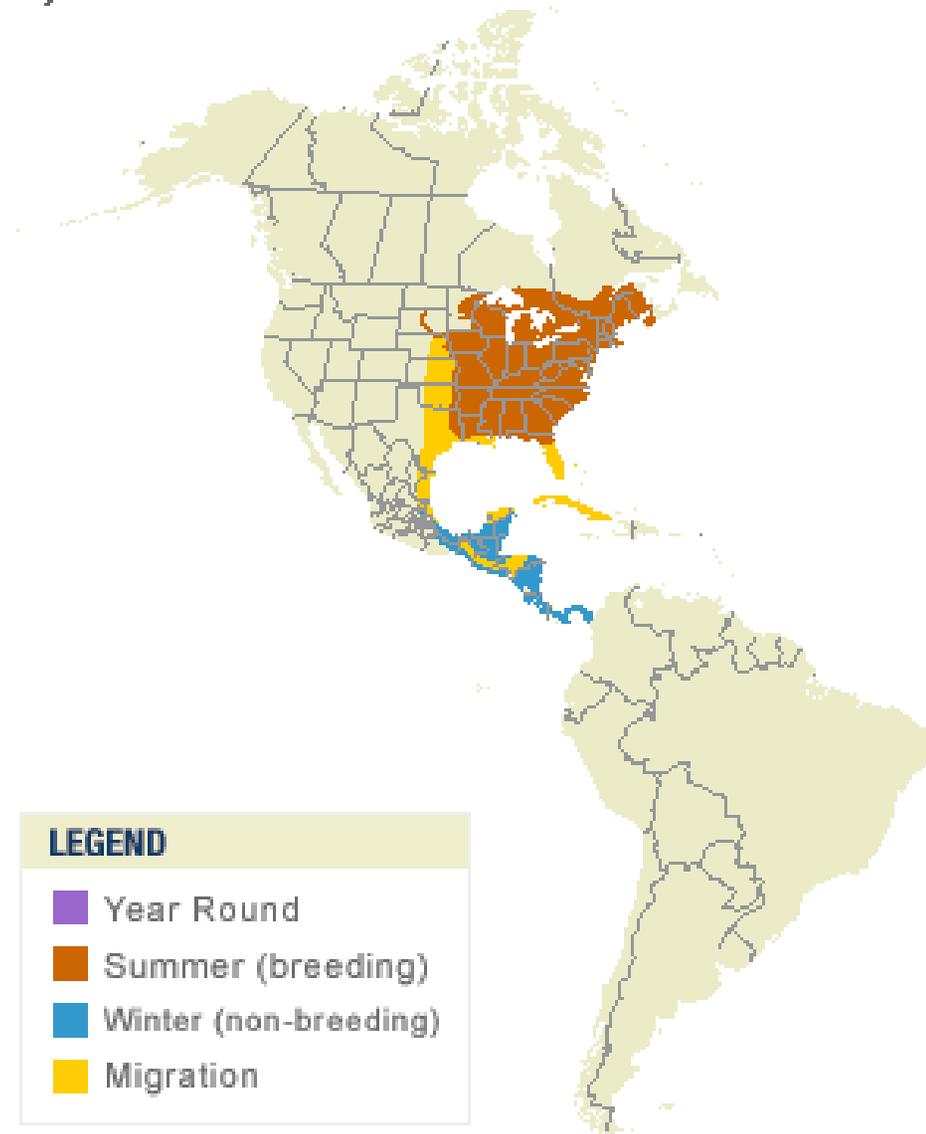
**High Frequency**

**Medium  
Frequency**

**Low Frequency**

## Wood Thrush

*Hylocichla mustelina*



### LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology  
Range data by NatureServe

### Habitat

The Wood Thrush lives in deciduous and mixed (deciduous and evergreen) forests in the eastern US.

They need large trees, some understory, shade, and lots of leaf litter for foraging.