

MIGRATORY CONNECTIVITY OF WILLOW FLYCATCHER SUBSPECIES

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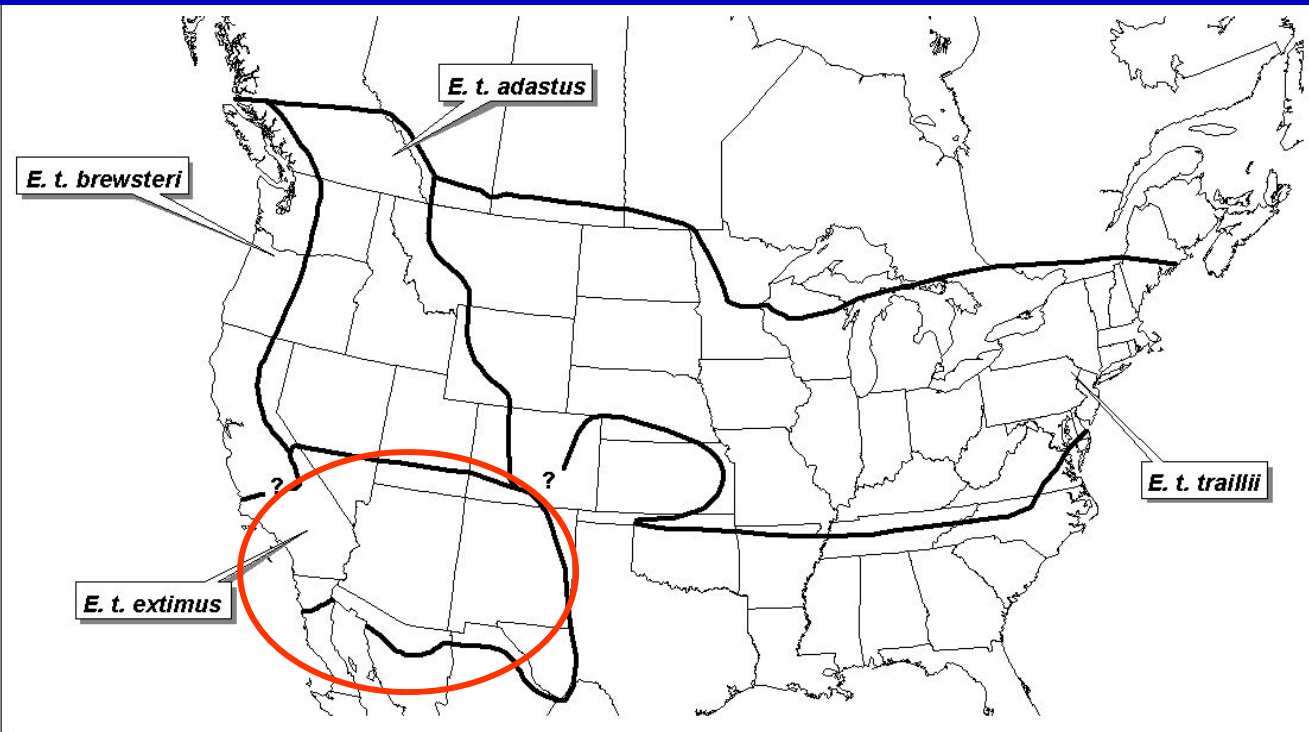
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Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

- Declared endangered species in 1995
- Focus on breeding ground threats
- Neotropical migrant, spends < 1/3 of year on breeding grounds
- Understanding where they winter and migrate is important for long-term management and recovery



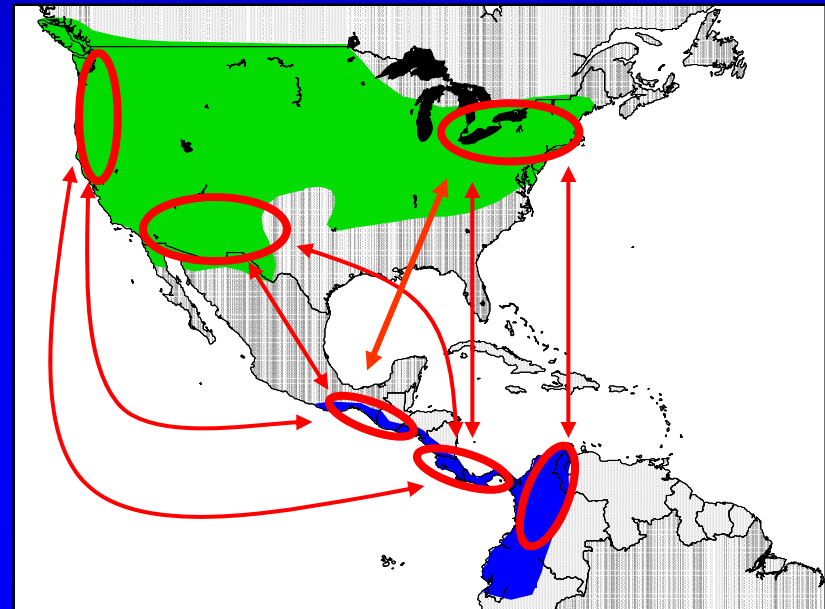
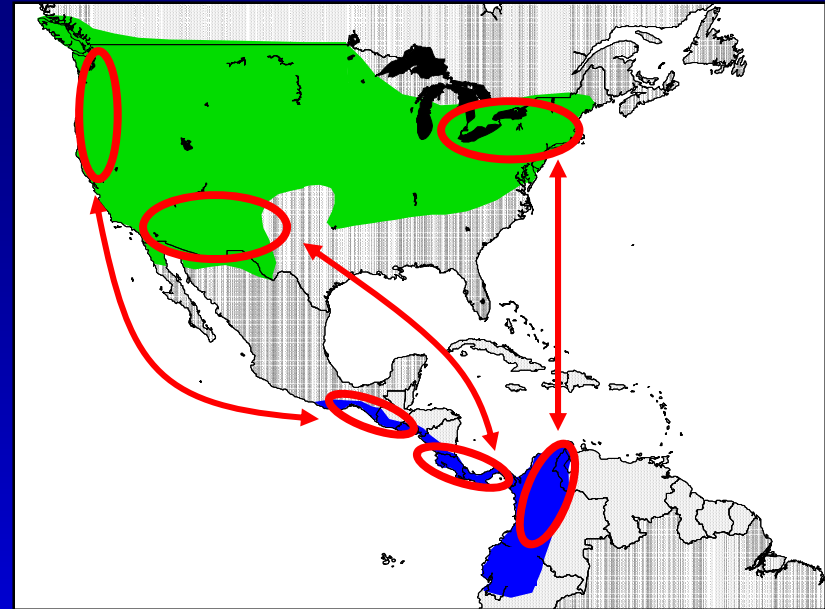
Migratory connectivity: breeding, wintering, migration

- Migratory movements connect different regions (Webster et al. 2002)

Strength of connectivity is key to understanding how different regions may influence SW subspecies

- Migratory connectivity has important consequences to population dynamics

- Carryover effects
- Population limitation
- Migratory pathways



Documenting connectivity

Ideally, track individuals

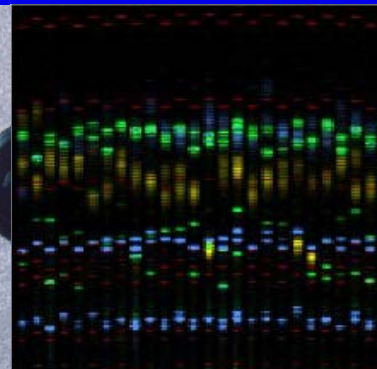
- Using extrinsic markers
- Impossible for most species
- Difficult and expensive for others

Alternatively, track populations

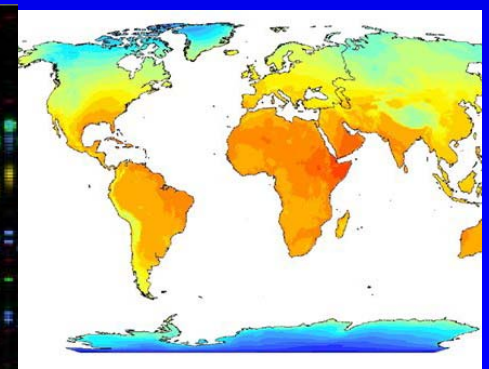
- Use intrinsic markers to link populations
- Population-level identification



Morphology



Genetics

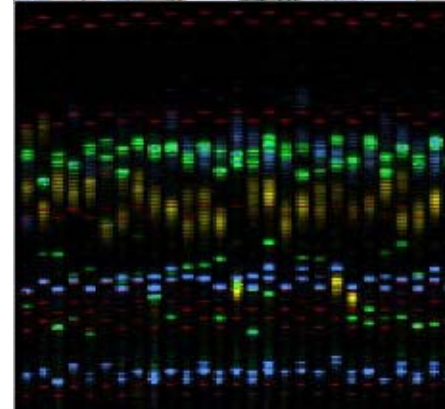
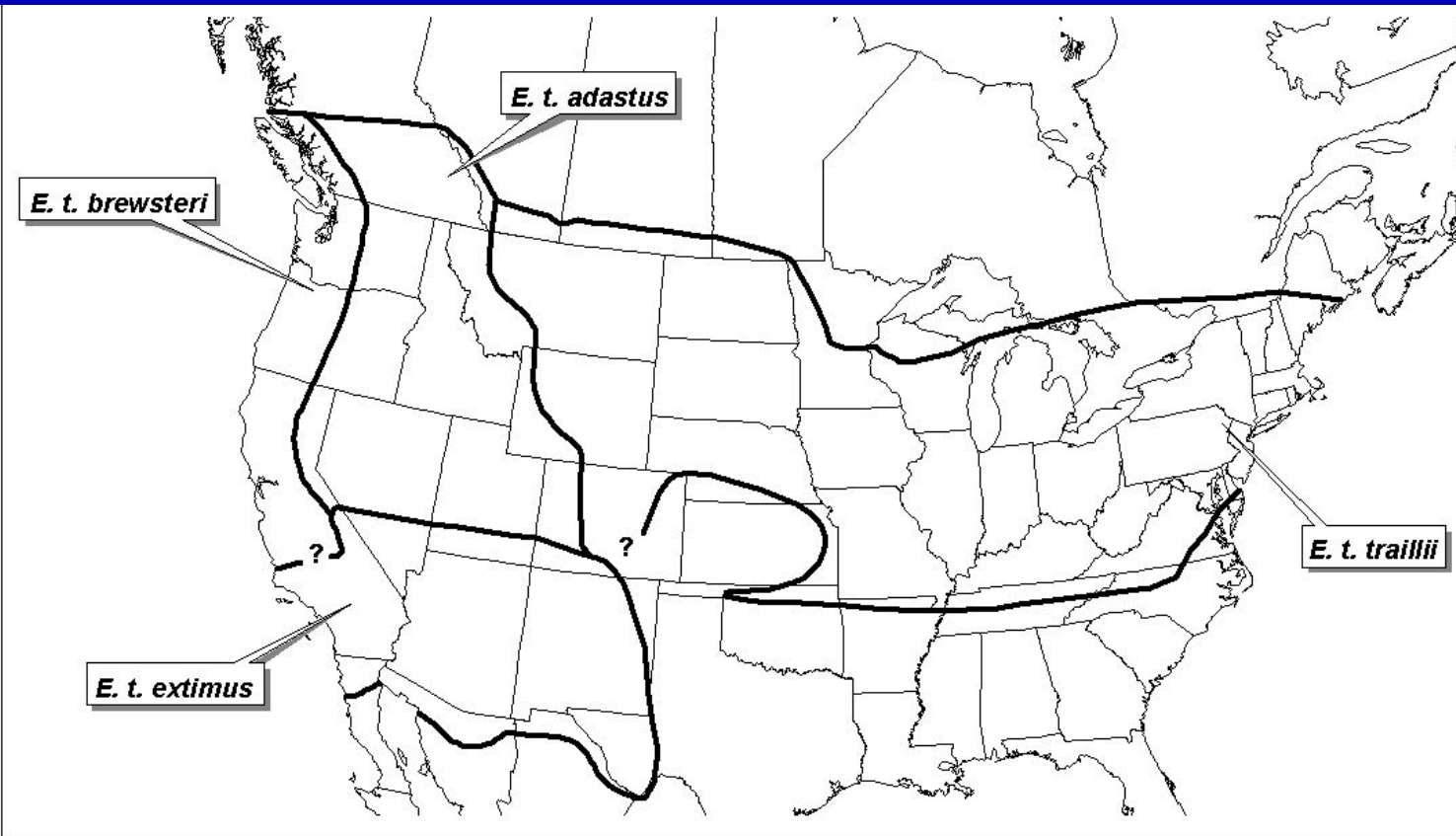


Stable isotopes

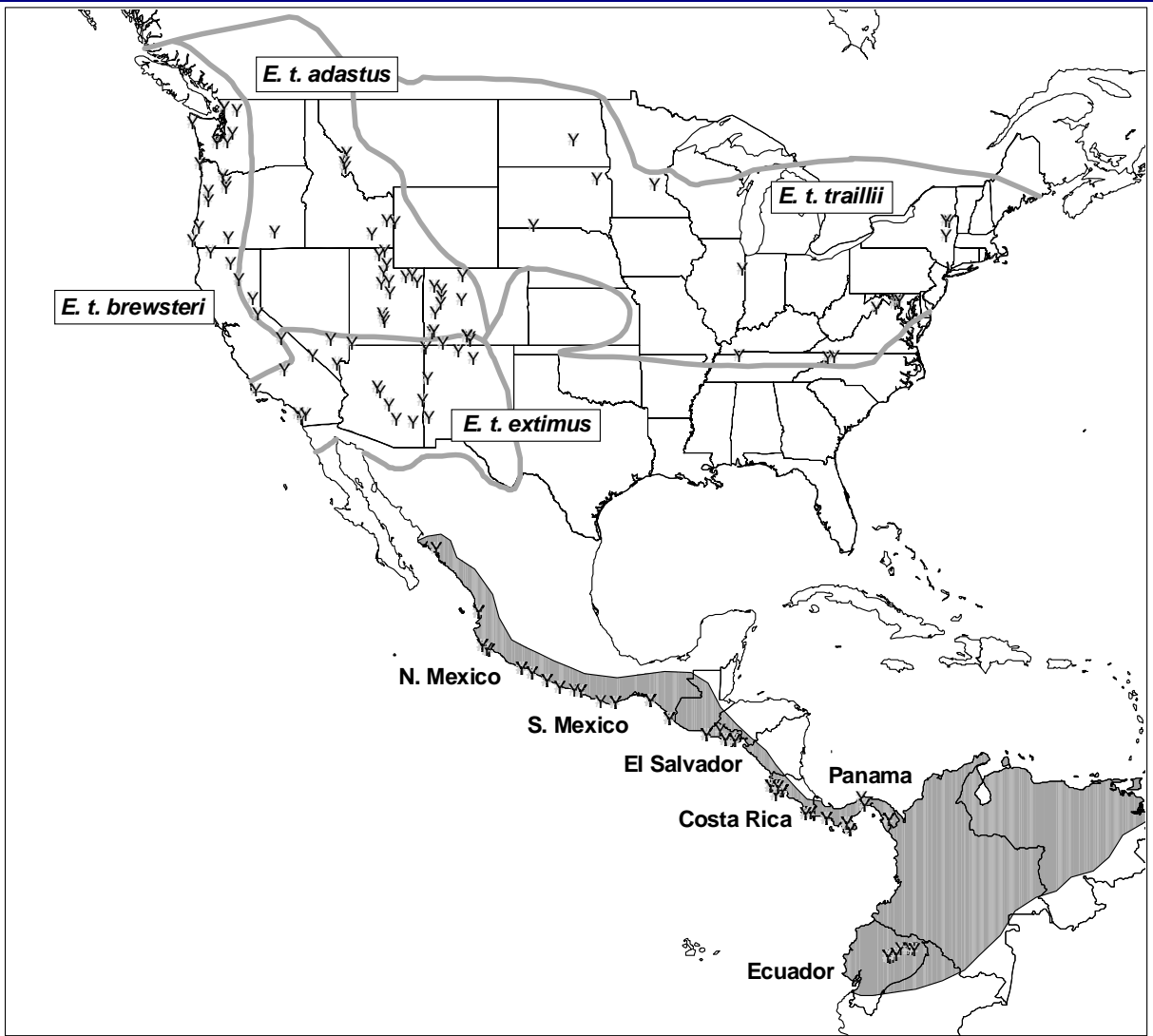
Willow Flycatcher (*Empidonax traillii*) subspecies

- Distinct populations - 4 subspecies recognized
- Subspecies differ in many ways, including genetics and plumage coloration

Significant differences among subspecies, but differences not absolute



Winter distribution of Willow Flycatcher subspecies

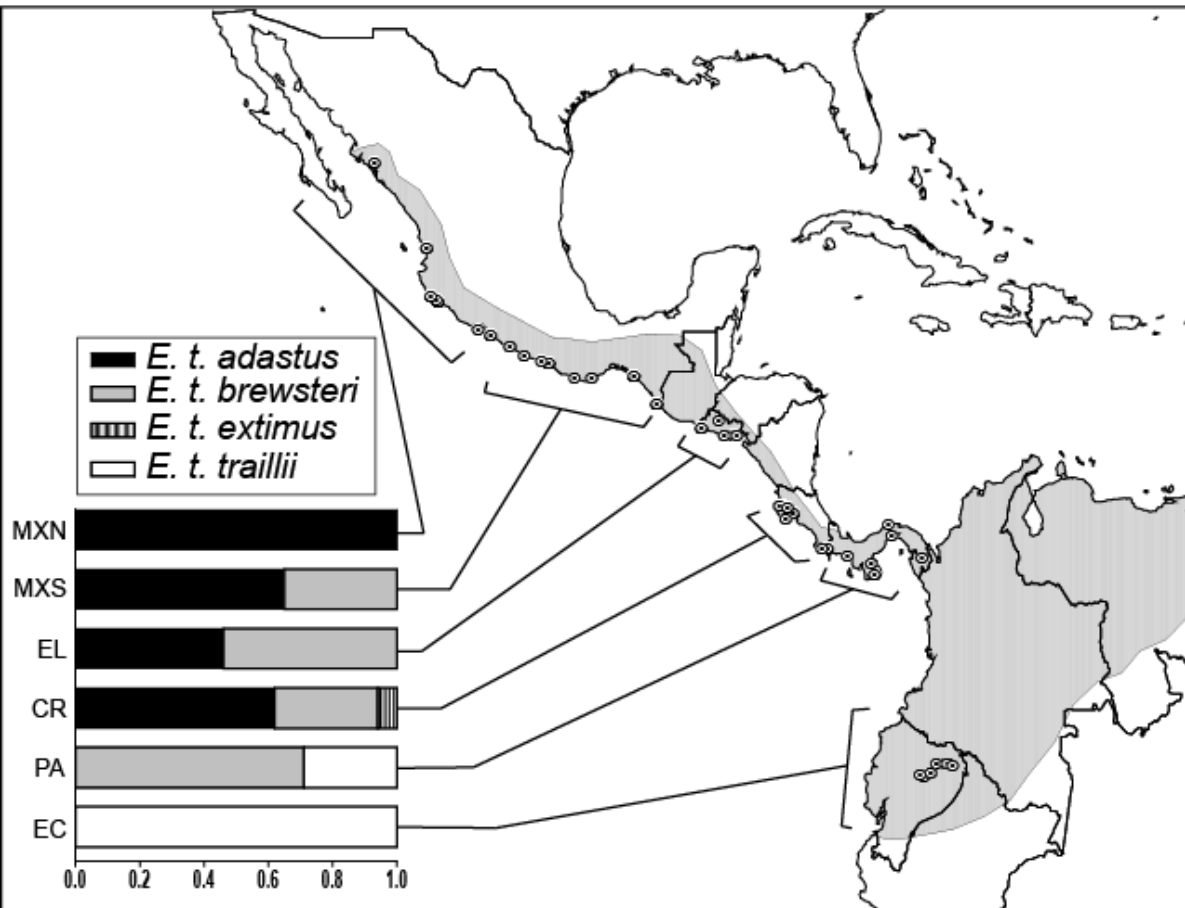
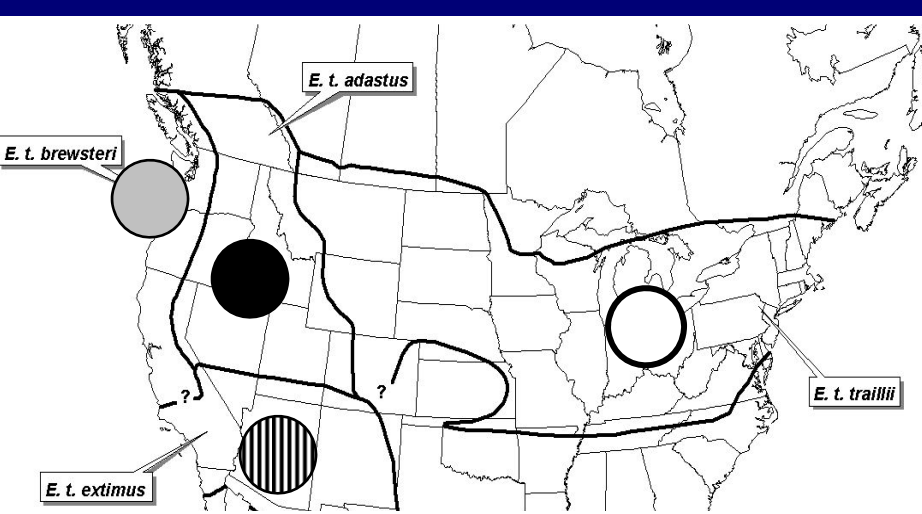


Mitochondrial DNA

- 172 wintering birds from 43 sites, 5 countries
- Compared to 316 breeding individuals from 91 sites
- Mixed-Stock Analysis
- Calculated haplotype frequency / subspecies
- Estimated contribution of each subspecies to each wintering region

Moderate to strong connectivity

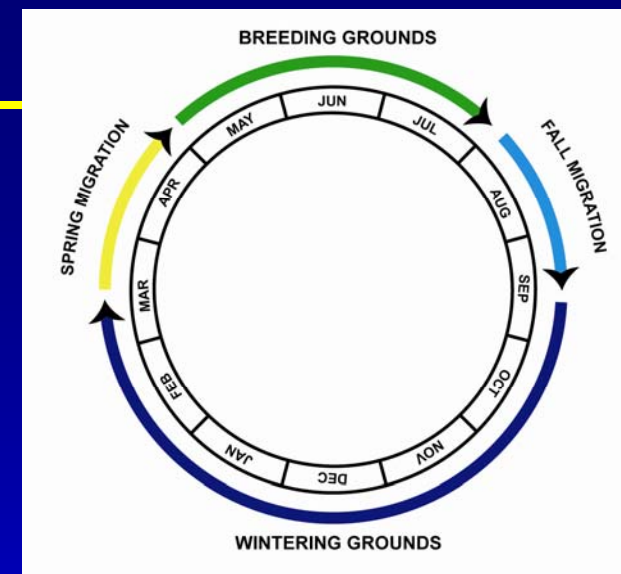
- Each subspecies occupies a finite portion of the wintering grounds, but with overlapping ranges
- Confidence intervals around estimates are large, but general pattern strong



- Southwestern subspecies only detected in Costa Rica (estimated 6% of Costa Rica population)
- Reverse analysis suggests most SW flycatchers winter in Costa Rica
- Collaboration from 2 banded birds
- But, more sampling needed

Survivorship across the annual cycle

Strong connectivity allows us to combine demographic studies from breeding grounds (Arizona) and winter grounds (Costa Rica) to estimate survivorship during migration



Overall, 66% annual survivorship = 34% annual mortality

By season:

- 8% annual mortality on breeding grounds
- 28% on wintering grounds
- 64% occurs during migration, only $\sim \frac{1}{4}$ of year

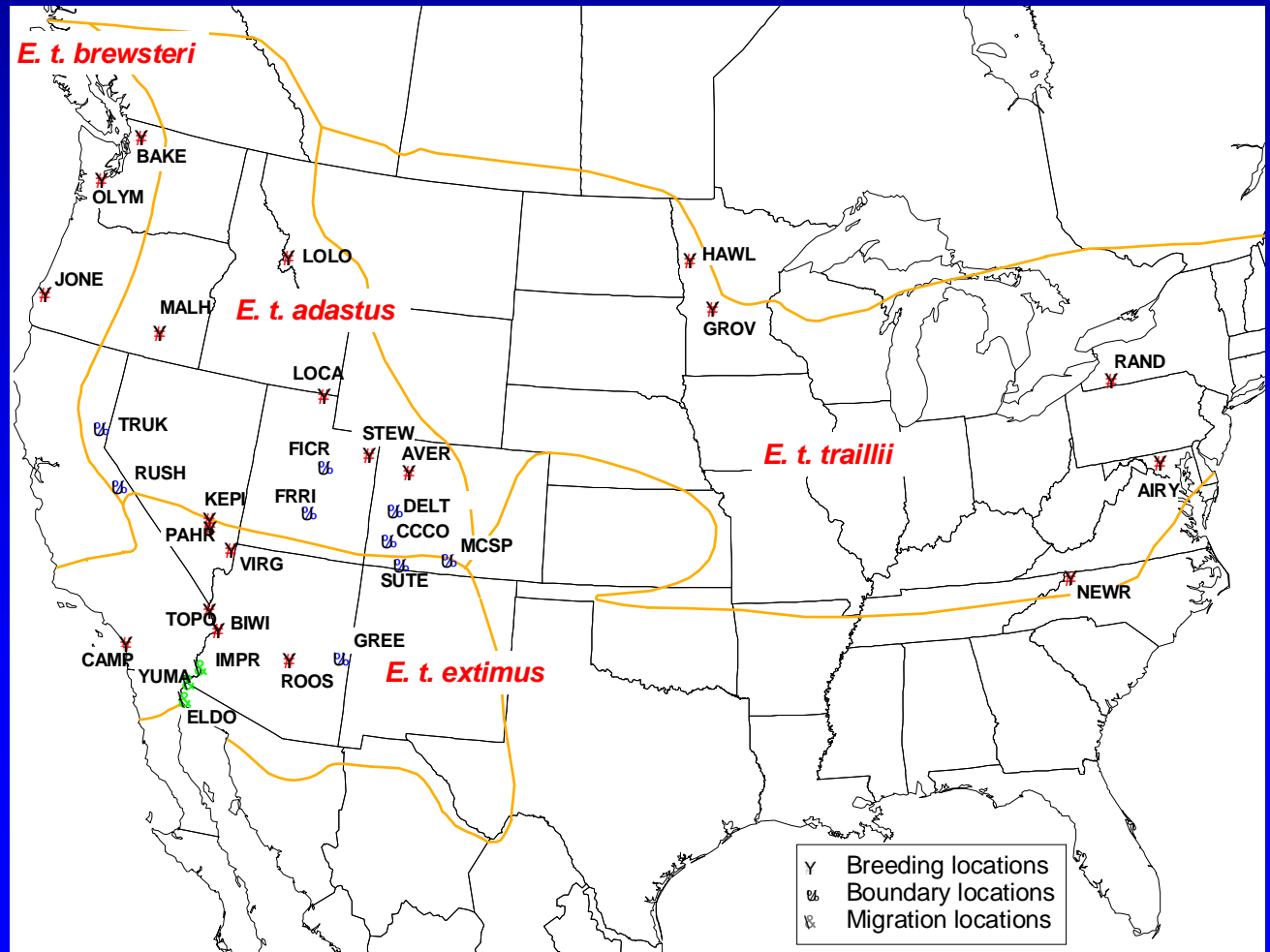
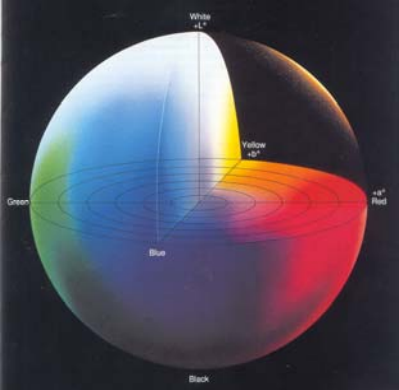
Results consistent with other studies, suggests that migration is a time of high mortality and could limit population growth

What are the migratory pathways of the SW flycatcher?

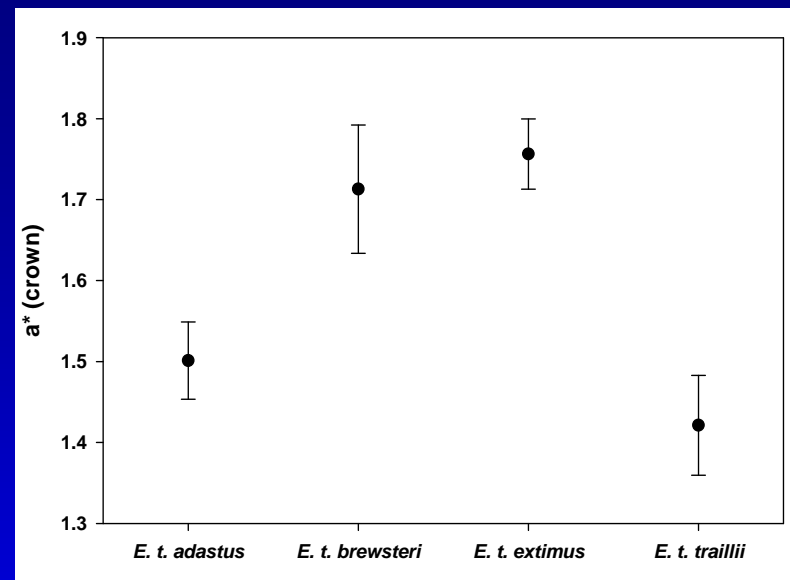
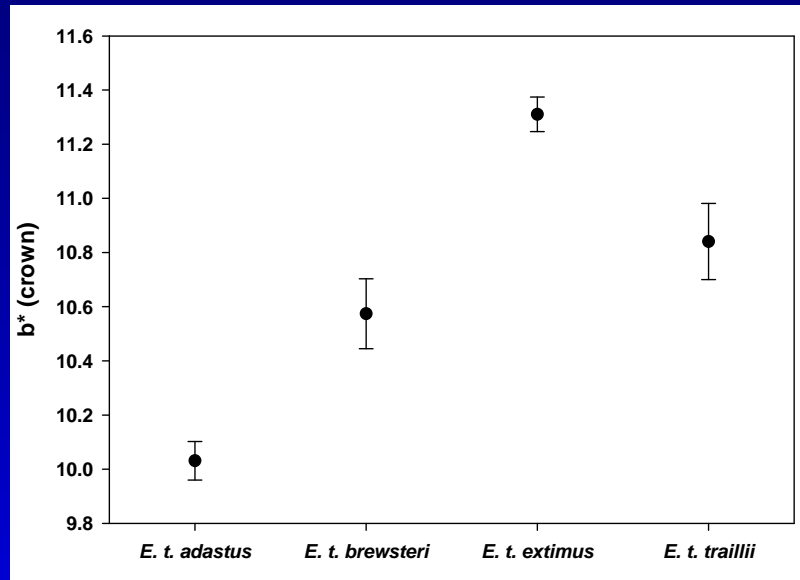
Plumage coloration differences among subspecies

A colorimeter was used to quantify the differences in plumage coloration among subspecies

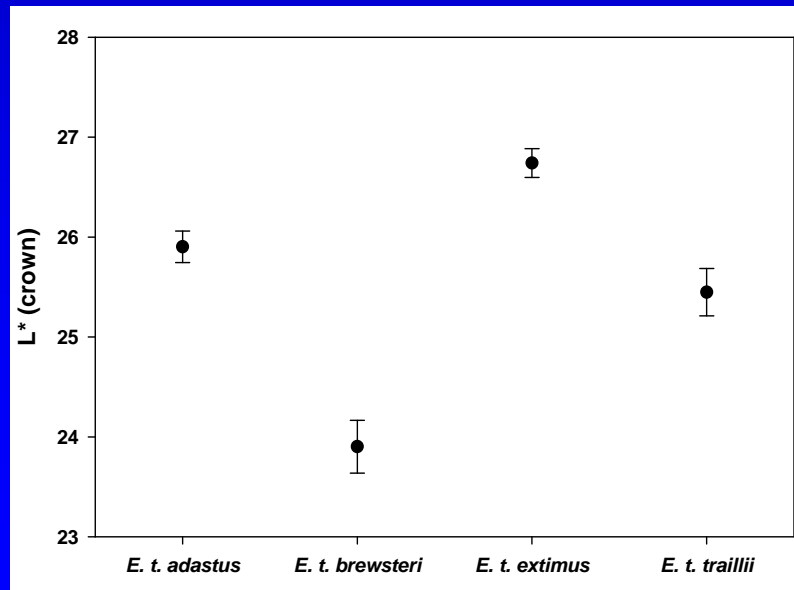
- 374 adult flycatchers from 29 breeding sites, 2004-2005
- Migrants along the Lower Colorado River



Significant differences among subspecies for each color value



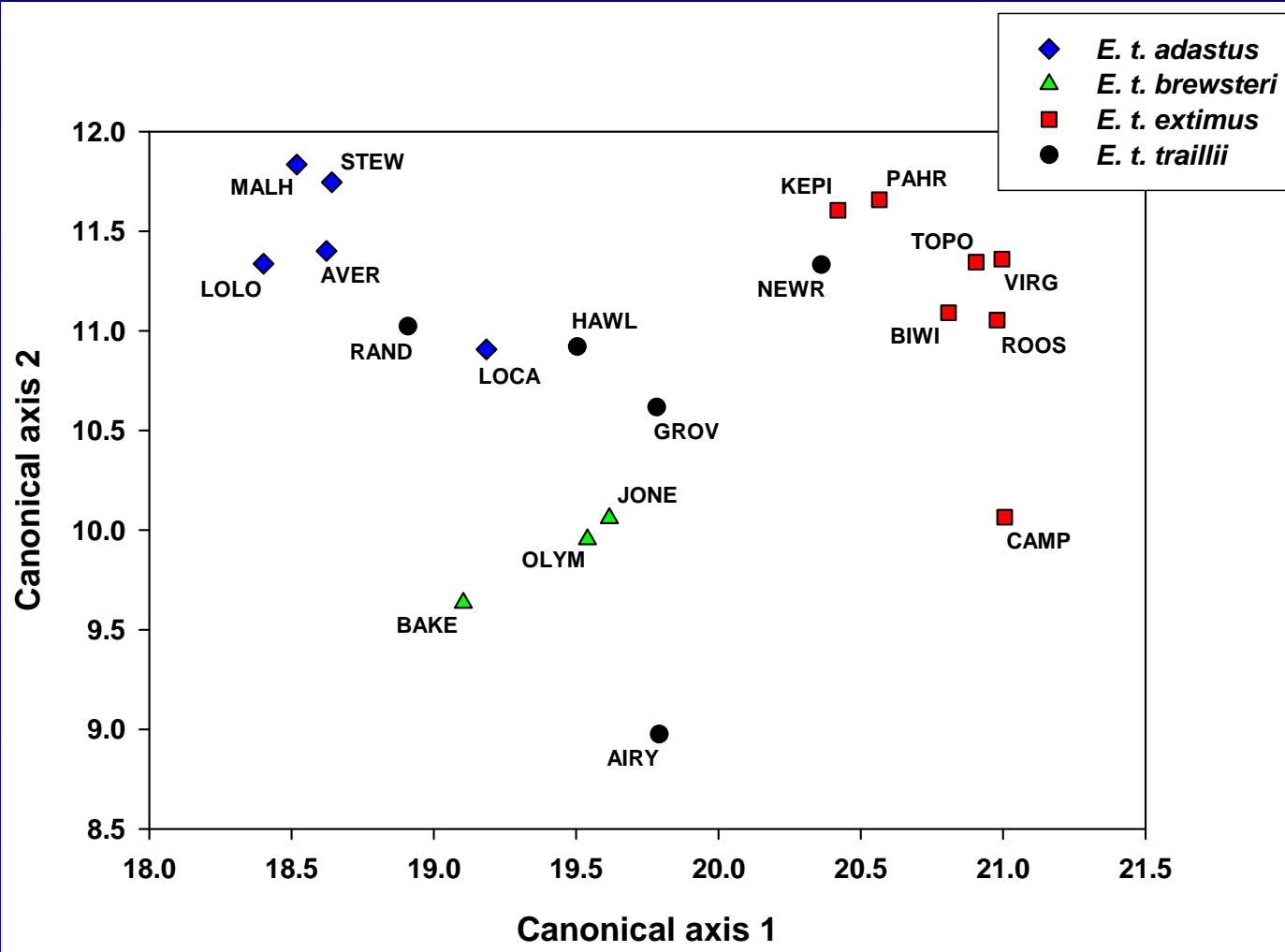
3 color measurements of crown



MANOVA: Wilks' lambda = 0.358, approx. $F_{18,886} = 21.56$, $P < 0.001$

Plumage coloration differences among subspecies

Western subspecies breeding sites clustered together, eastern subspecies breeding sites dispersed



Eastern subspecies rare migrant in west

Migrants along the Colorado River

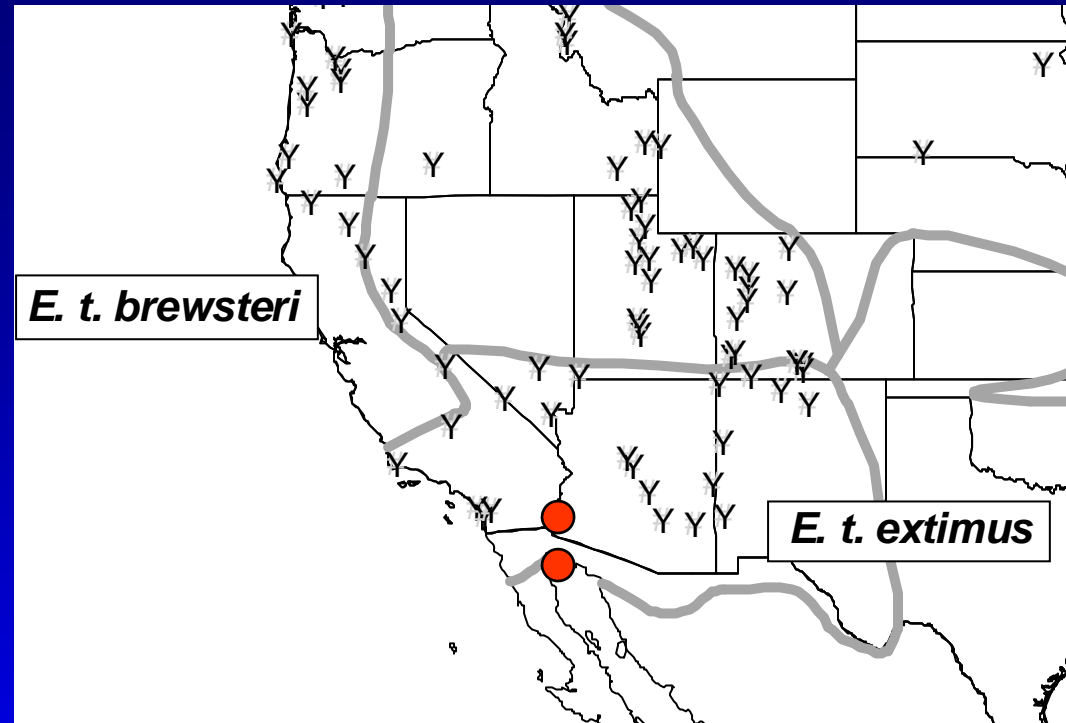
Assigned migrants to one of three western subspecies

92% correct assignment at high accuracy threshold

Applied model to 83 migrants

2 stopover locations:

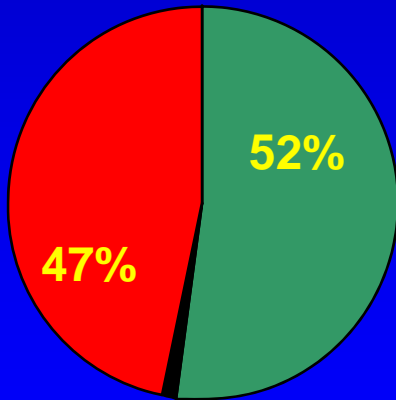
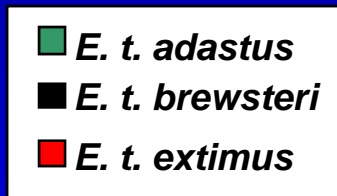
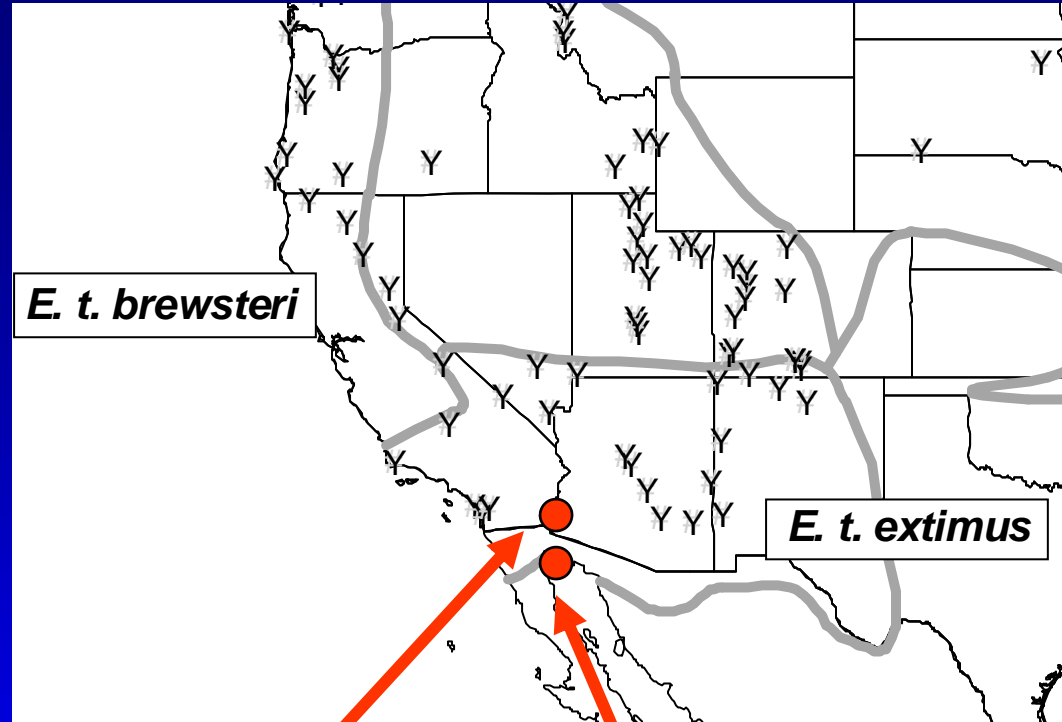
- **Mexico** (Delta)
 - **Arizona** (Yuma and Imperial NWR)



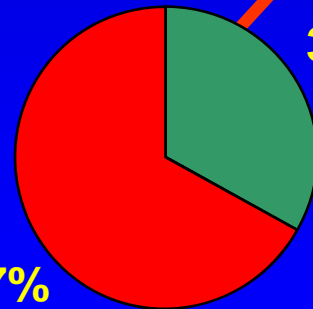
Migrants along the Colorado River

Different stopover sites have different proportion of subspecies

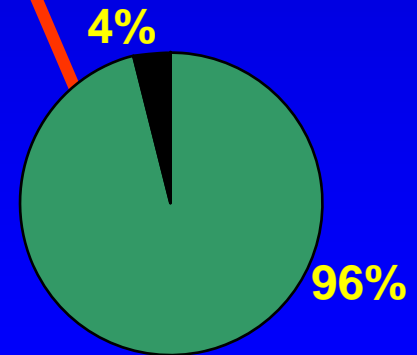
- Different migration routes
- Different timing



All sites (n=83)



Yuma and Imperial NWR (n=58)



Colorado River Delta (n=25)

Migration pathways and important stopover sites

Colorado River is believed to be major migration corridor for Willow Flycatchers, but mostly non-SW subspecies

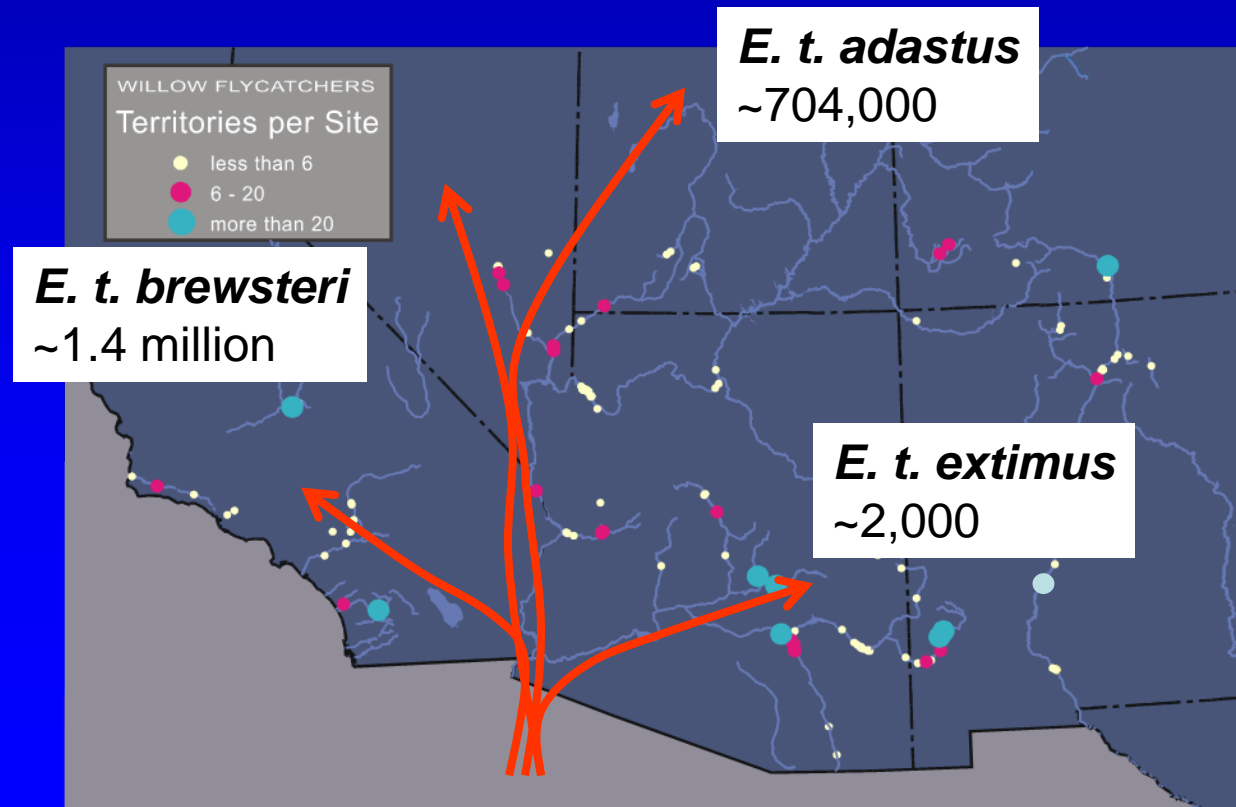
- Large proportion of extimus at Arizona sites surprising
- These results suggest LCR important for SW flycatcher



We still have much to learn about migration pathways in SW

- Need sampling throughout migration season
- Many more areas
- Evaluate feasibility of Fall migration

Plumage coloration + genetics = stronger prediction



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