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science for a changing world

Assessing Population-Level Consequences of Anthropogenic Stressors on Birds

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Anthropogenic stressors

Come in many forms –

- Energy production, agriculture
- Habitat loss, fragmentation
- Development
- Persecution
- Oil spills, chemical releases, mining activity…
- …..

Impacts can be direct (cause fatalities, reduce reproduction, etc.) or indirect (e.g., affect habitat which then alters vital rates)

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Population level consequences

Many challenges

1. How should populations be defined?
2. How can we determine if mortality associated with stressor or management is demographically relevant?
   - Specific to species, regions, etc.

How many individuals of species x do we need to influence/remove to affect the population?

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A solution

A proposed conceptual and analytical framework to assess population-level impacts of anthropogenic stressors

- Cost-effective
- Rapid results
- Relevant to management needs
- Useful when data about a species are limited
- Broadly capable of integrating existing information
  - Data from: monitoring, literature, genetics, etc.

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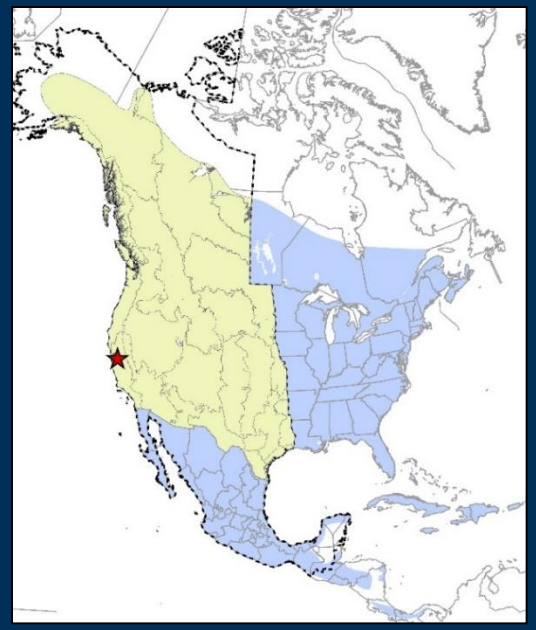
Assessing population-level impacts of fatalities

- Define geographic area from which fatalities are drawn (catchment area)
- Characterize population size
- Build demographic models & population growth rate (λ)
- Identify proportion of that population affected by the stressor



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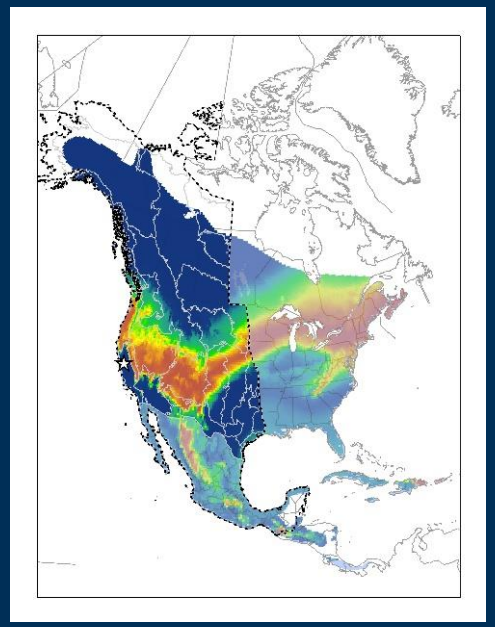

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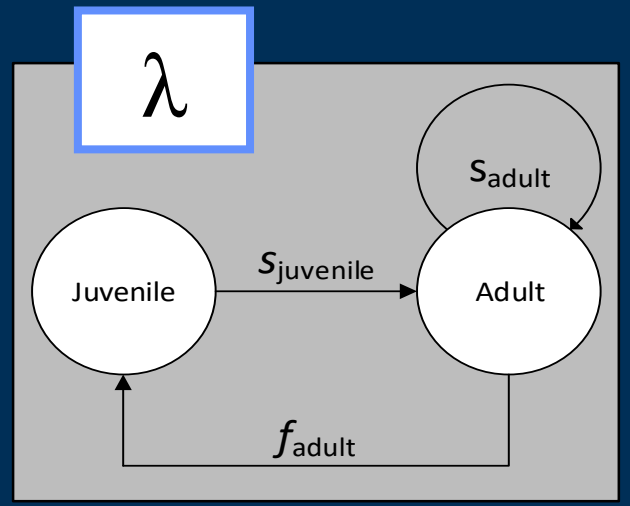

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Determine effects of stressor on populations

Red-tailed Hawk

Evaluate effect of fatalities at Altamont Pass on population

- ~170/yr killed

Population Estimates (PIF)

- North America: 2,816,500

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Catchment Area

Species Range Maps

- Flyways (Central & Pacific)

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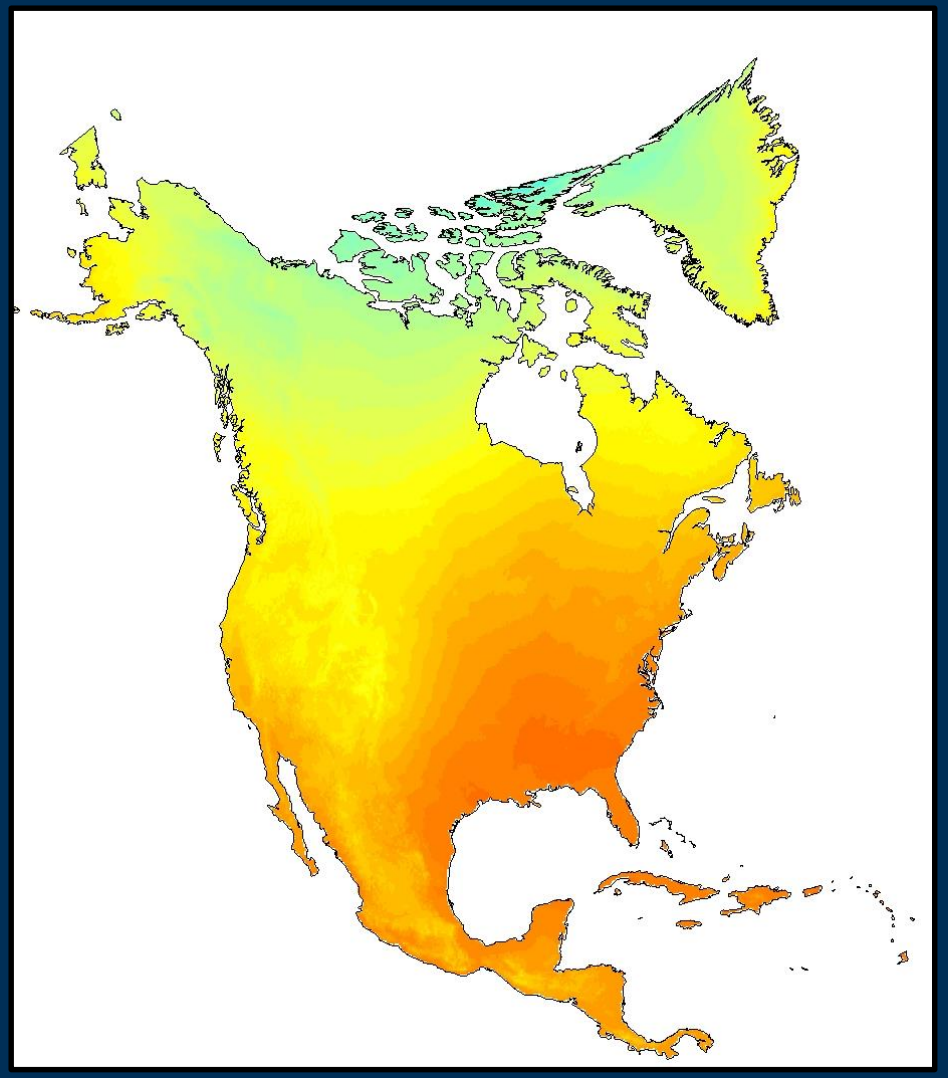
Stable Hydrogen Isotopes

- Known origin reference material
- Convert feather H ratio to precipitation H ratio
- Geospatial model to calculate likelihood-of-origin map for feathers



Light water: $^{1}H^{1}HO$

$\delta^{2}H$: more negative

Heavy water: $^{1}H^{2}HO$

$\delta^{2}H$: more positive

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Catchment Area

Species Range Maps

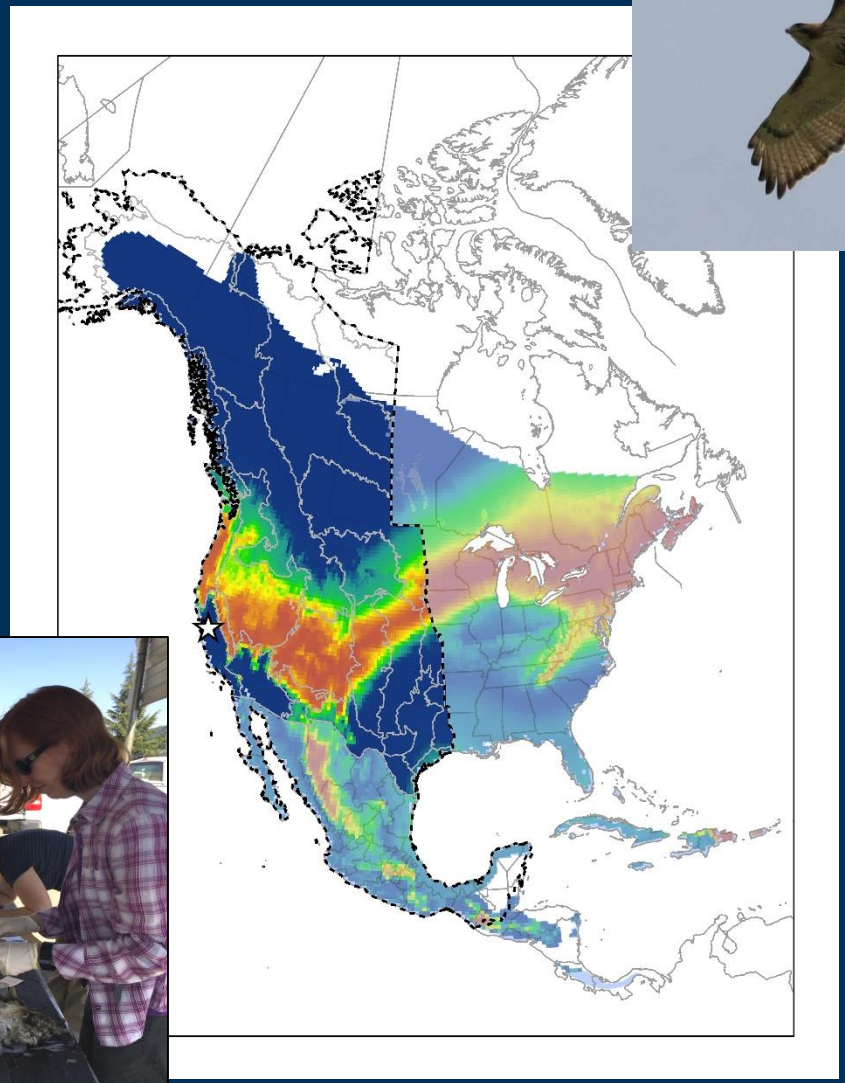
- Flyways (Central & Pacific)

Geographic Origin

- Stable H Isotope data from feathers
- Probability of Origin
  - 5:1 Odds Ratio (83%)

Population Estimates

- Bird Conservation Region (BCR)



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Red-tailed Hawk

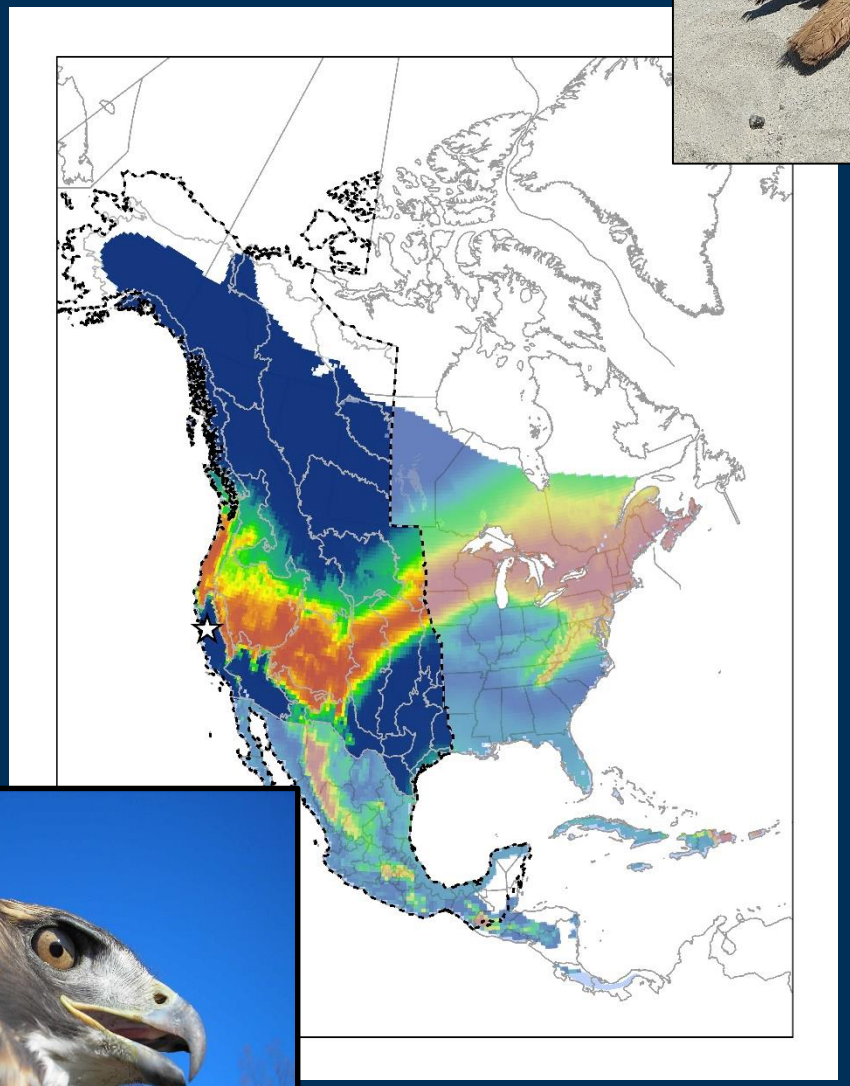
Population Estimates (PIF)

- North America: 2,816,500

- Stable Isotope samples (*n* = 86)
  - 32 Local Birds (37%) (BCR 32)
  - 54 Non-local (63%)

- Non-local catchment area: 521,804
- Local catchment area: 95,959 (BCR 32)


Skye Standish




Mike Lanzone

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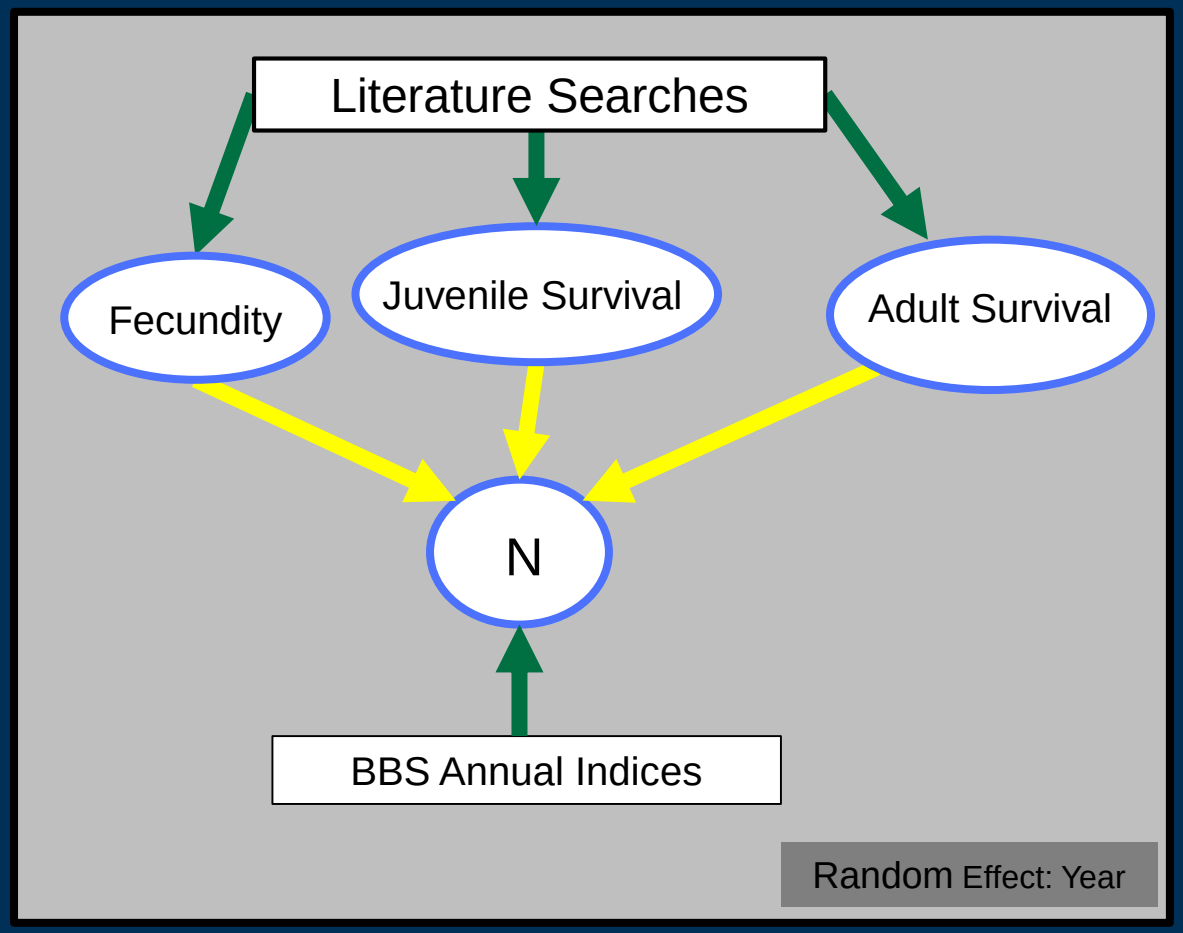
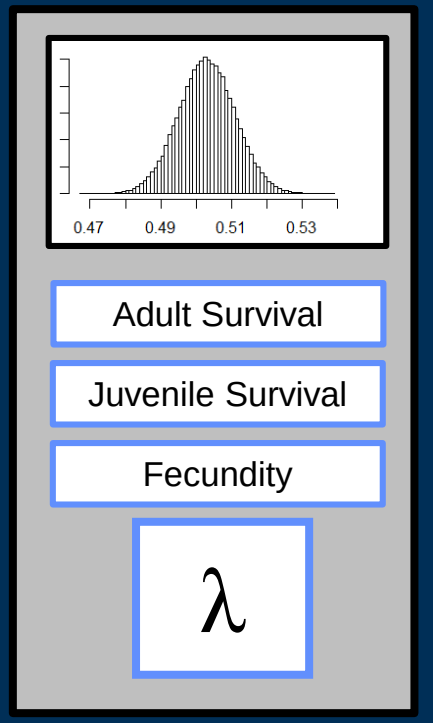
Integrated Population Models





λ <1 : Declining population

λ >1 : Growing population

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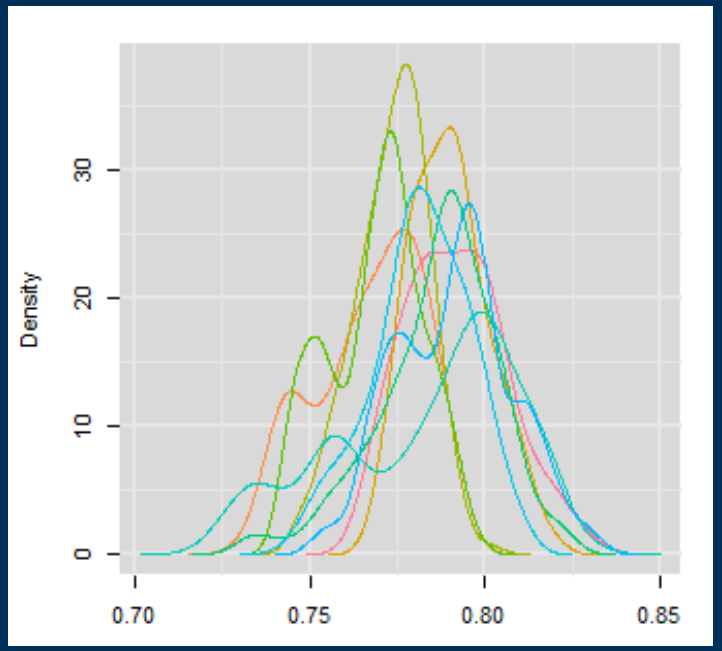
Red-tailed Hawk

- Best-fit Model

Parameter	Mean	SD	95% CrI Lower	95% CrI Upper	Rhat
Juvenile Survival (HY)	0.419	0.06	0.38	0.50	1.26
Adult Survival	0.781	0.02	0.74	0.82	1.20
Fecundity	0.711	0.09	0.55	0.86	1.23
Lambda	1.009	0.001	0.998	1.01	1.00

Literature Values

Juvenile Survival = NA
Adult Survival = 0.77
Fecundity = 0.69 offspring/adult
λ = 1.002 (BBS data)



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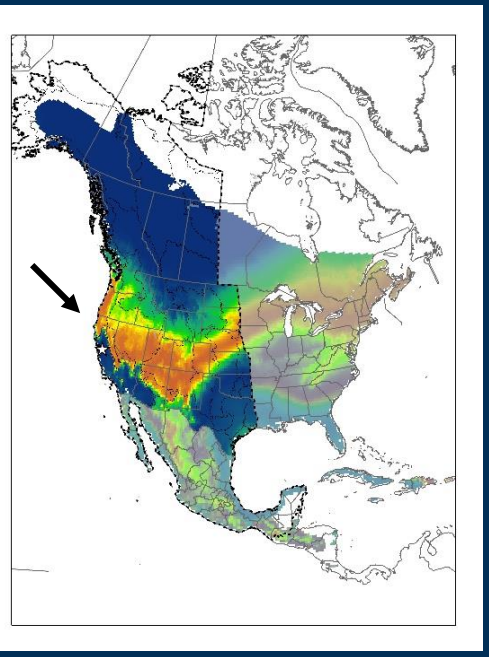
Red-tailed Hawk– Non-local

- 57% of fatalities are non-local
- Adult survival: 0.781
- Catchment area population: 521,804



	Deaths		Current	Adjusted
Catchment Area N	Wind	Total	Survival	Survival
	+5000	119,048		0.772
	+3000	117,048		0.776
	+1000	115,048		0.780
521,804	Current	114,048	0.781	
	-1000	113,048		0.783
	-3000	111,048		0.787
	-5000	109,048		0.791

+/- 5000 deaths → +/- 1.0% change in adult survival

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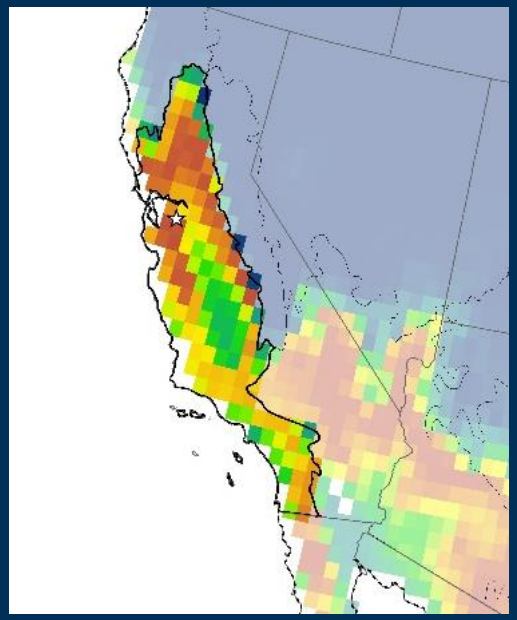
Red-tailed Hawk– Local

- 37% of fatalities are local
- Adult survival: 0.781
- Catchment area population → BCR 32: 95,959



Catchment Area N	Deaths Wind	Deaths Total	Current Survival	Adjusted Survival
	+5000	25,973		0.729
	+3000	23,973		0.750
	+1000	21,973		0.771
95,959	Current	20,973	0.781	
	-1000	19,973		0.792
	-3000	17,973		0.813
	-5000	15,973		0.834

+/- 5000 deaths → +/- 5.2% change in adult survival

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Discussion

Allows evaluation of when fatalities matter

- Red-tailed Hawk fatalities:
  - Minimal effect on overall population (cumulative effects?)
  - Larger consequence for the local population
    - Even though only 37% of fatalities are local
- Role of local vs non-local populations –
  - not accounted for in most studies
- Without that info, you can’t evaluate if fatalities matter

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Discussion

Next steps:

- finish models for ~20 other species
- improve model construction & fit
- incorporate higher-level demographic processes
    - immigration, emigration, Allee effects, etc.
- apply in other settings

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Application

Application to management of oil spills, chemical releases, and mining activity

- anthropogenic processes that affect wildlife

- can have direct or indirect consequences

- may impact local or non-local populations

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Application

Application to management of oil spills, chemical releases, and mining activity

- temporally discrete (vs wind energy – many years/seasons)

- affected wildlife can be collected and sampled

- can build demographic models to inform mitigation for source populations

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Application

Application to management of oil spills, chemical releases, and mining activity

Two suggestions:

- develop sampling strategy prior to events

- implement sampling strategy at events
    - modeling informs mitigation, can occur later

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