



Separating estimates of survival in the streaked horned lark: adult, juvenile, and post-fledging

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Introduction

For many bird species survival is the demographic parameter that has the greatest impact on population growth.

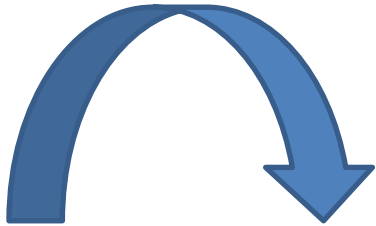
Investigating factors that affect survival is important to:

- identify vulnerable periods
- evaluate ecological factors
- develop conservation strategies to boost this vital rate

Important for species where we want to increase their population size, such as for threatened and endangered species.

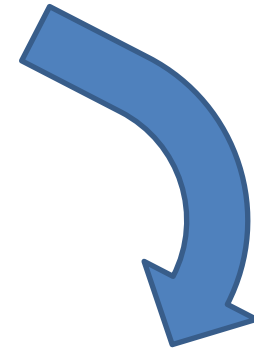
Objectives

1. Estimate annual survival
 - Age (adult vs juvenile)
 - Sex (male vs. female)
 - Habitat (prairie vs. airfield)
2. Estimate post-fledging survival
 - Age (4, 2-week periods)
 - Year (2013-2015)
 - Site



Post-fledge

- Dependent upon adults
- Learning to fly



Independent
Juvenile



- Fend for yourself
- Migrate to wintering grounds
- Return to breeding grounds



Adult

Background

Streaked Horned Lark

- Threatened
- South Puget Sound population: small, migratory
 - *Little information on survival rates*
 - *No information on post-fledging survival*

Previous research (Camfield et al. 2011)

- Adult survivorship had the largest influence on SHLA population growth rate
- Adult: male = 0.55; female = 0.47
- Juveniles = 0.17

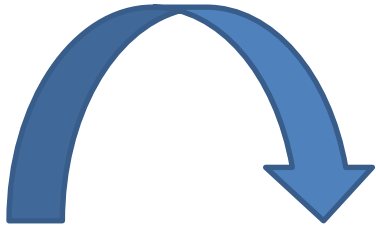
CNLM partners with JBLM to manage competing objectives and help recover larks



Study Sites



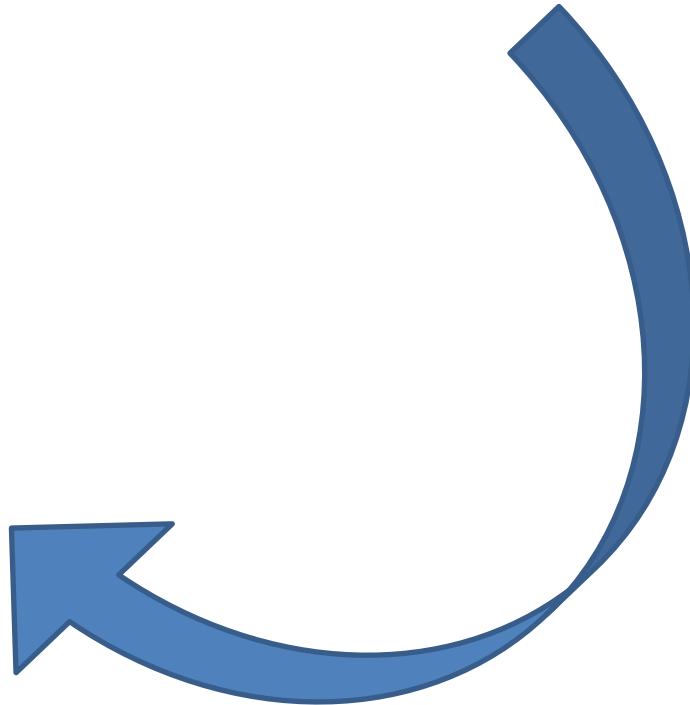
Objective 1: Annual Survival



Adult



Fledgling



Objective 1: Annual Survival

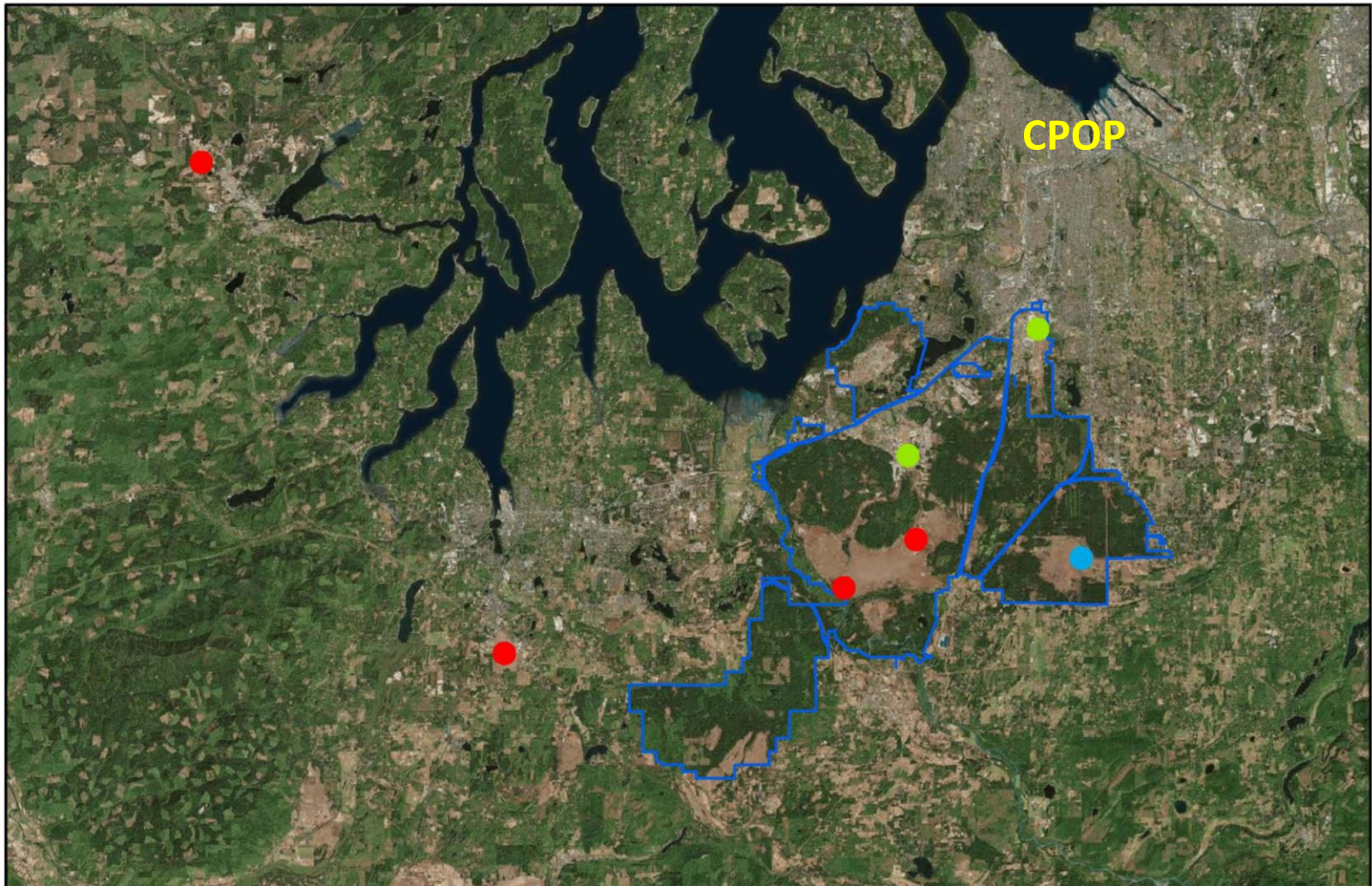
Marking individuals



Objective 1: Annual Survival *Resights – April-June*



Objective 1: Annual Survival *Resights – April-June*



Objective 1: Annual Survival Analysis



Used Program MARK to generate estimates of:

- **apparent survival (Φ):** *probability that a lark survived and returned to study area between consecutive years*
- **recapture probabilities (p):** *probability of resight, given it is alive*

Created models examining effect of:

- age (adult vs. juvenile)
- sex (male vs. female)
- habitat (prairie vs. airfield)

Selected models based on AIC_c

Objective 1: Annual Survival Analysis



Banded nestlings

	Prairie	Airfield	
	13th Div	GAAF	MAFB
2011	16		
2012	14		
2013	36	24	8
2014	41	32	32
	107	56	40



45 of 203 individuals
resighted

Assigned sex to
achieve 1:1 ratio

* Resights in 2015 contribute to analysis, but individuals banded in 2015 do not.

Objective 1: Annual Survival

Model Results



Model	Δ AICc	Model weight	K	Deviance
$\Phi(\text{Age} * \text{Sex} * \text{Habitat}), p(.)$	0.00	0.62	9	15.24
$\Phi(\text{Age} * \text{Sex}), p(.)$	0.94	0.38	5	24.75
$\Phi(\text{Age} * \text{Habitat}), p(.)$	13.71	0.00	5	37.52
$\Phi(\text{Age}), p(.)$	18.35	0.00	3	46.32
$\Phi(\text{Sex}), p(.)$	23.97	0.00	3	51.94
$\Phi(\text{Habitat}), p(.)$	32.78	0.00	3	60.75

Global Model: $\Phi(\text{Age} * \text{Sex} * \text{Habitat}), p(\text{Age} * \text{Sex} * \text{Habitat})$

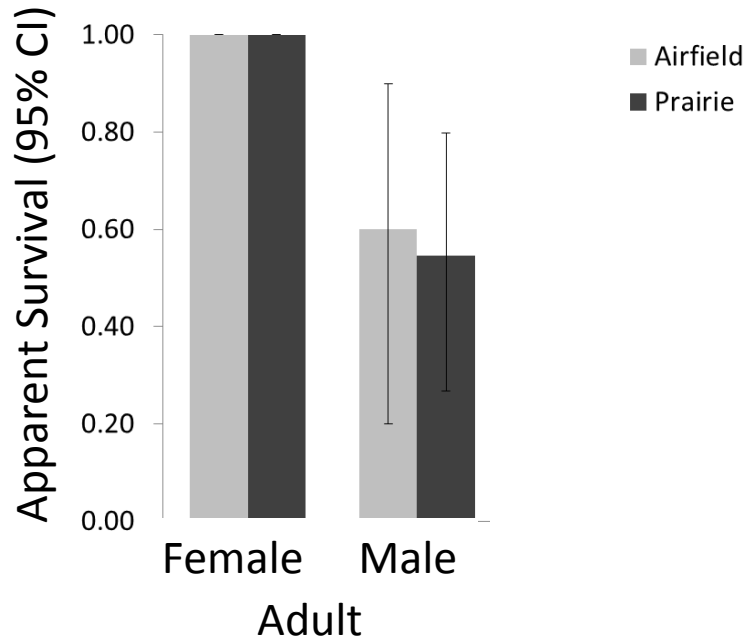
GOF-Test: $P=0.13$

Resight probability (p): Was always 1.00

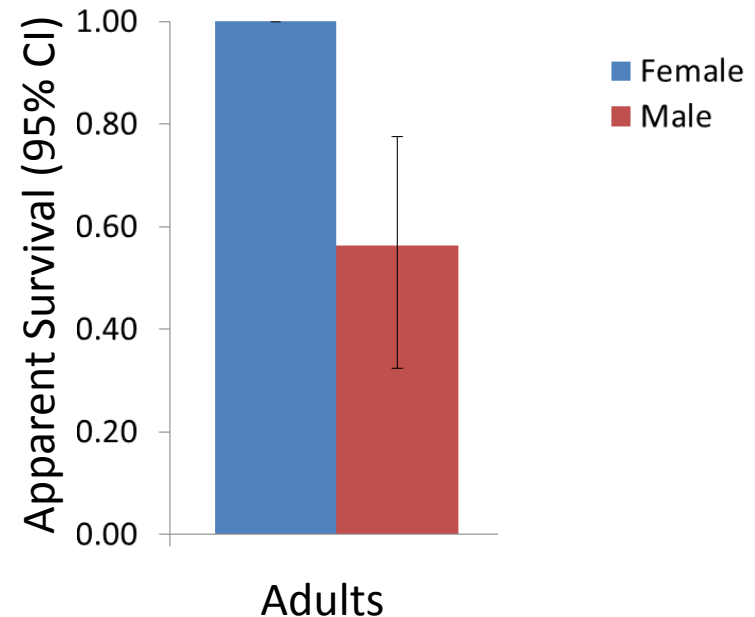
Objective 1: Annual Survival *Parameter Estimates*



Adult Survival



Model 1: Age, Sex, and Habitat
 Δ AIC: 0.00



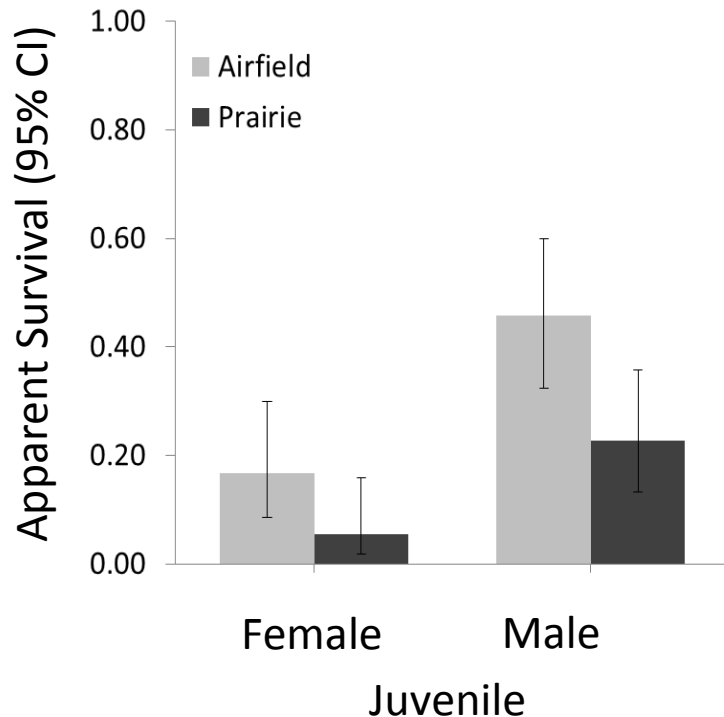
Model 2: Age, Sex
 Δ AIC: 0.94

Objective 1: Annual Survival

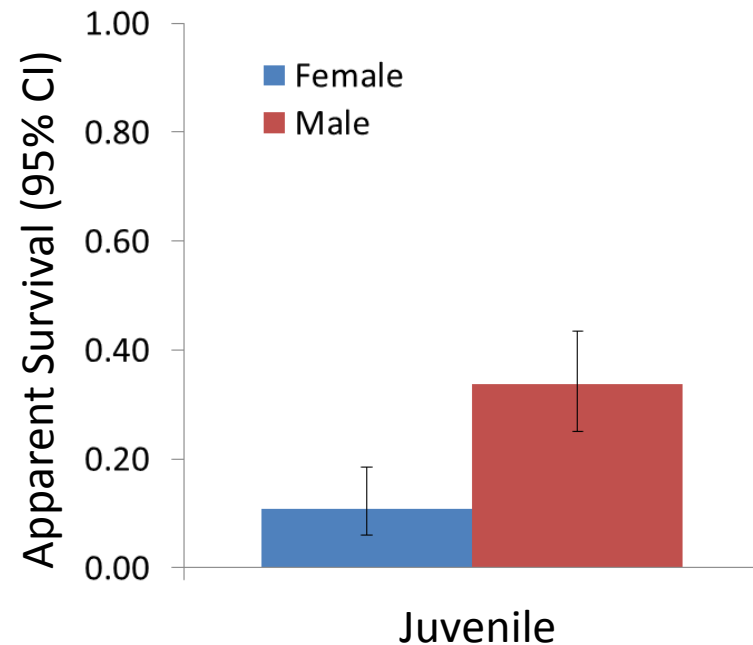
Parameter estimates



Juvenile Survival



Model 1: Age, Sex, and Habitat
 Δ AIC: 0.00



Model 2: Age, Sex
 Δ AIC: 0.94

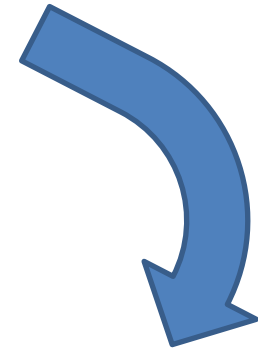


Post-fledge

Objective 2: Post-fledging Survival

Probability of survival to 8 weeks old
4, 2-week age (i.e., time) periods

- a1: 0-2 weeks
- a2: 3-4 weeks
- a3: 5-6 weeks
- a4: 6-8 weeks



Independent
Juvenile

Objective 2: Post-fledging Survival

Resights – 4, 2-week periods after fledging

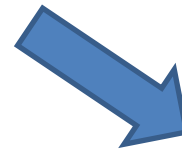


Objective 2: Post-fledging Survival *Marking and Resights*



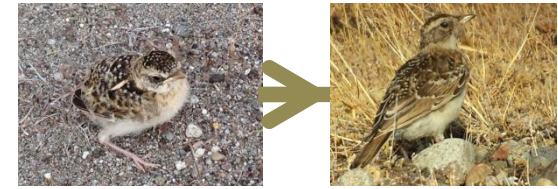
Banded Birds

	Prairie	Airfield	
	13th Div	GAAF	MAFB
2013	29	24	7
2014	38	31	30
2015	39	44	59
	106	99	96



167 of 301
individuals
resighted

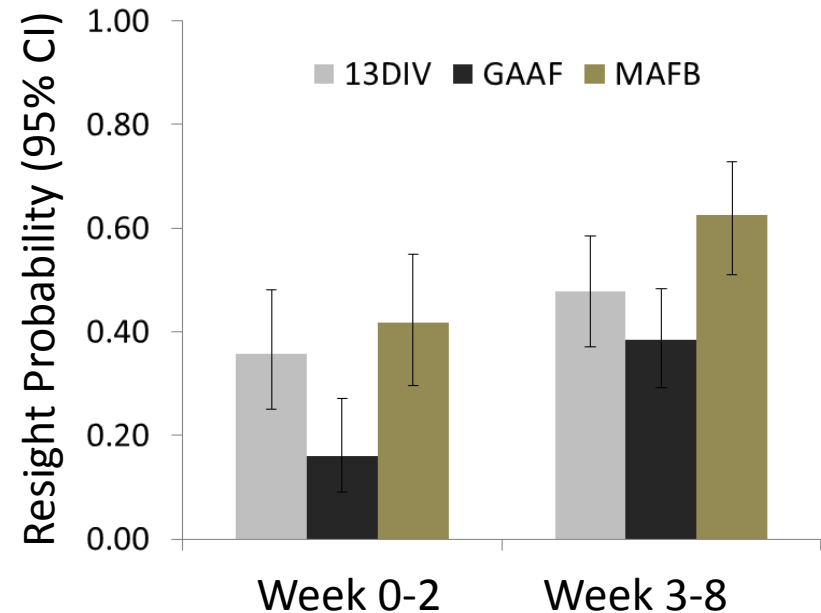
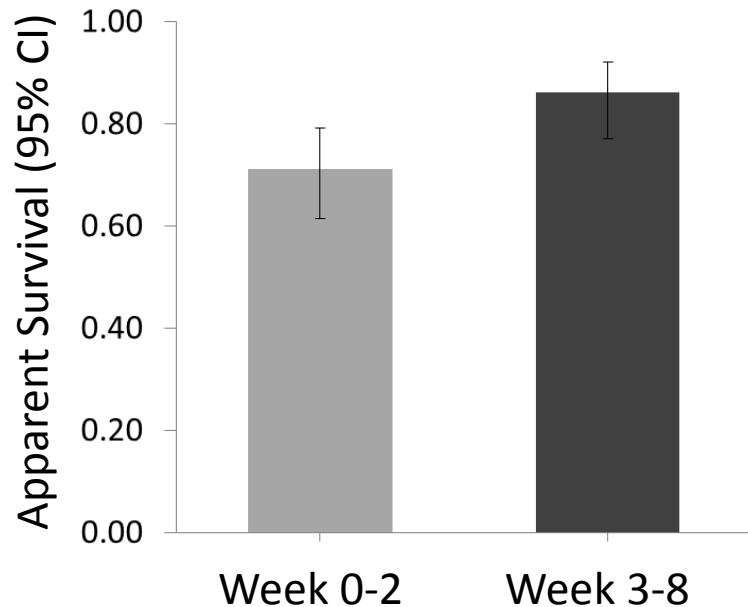
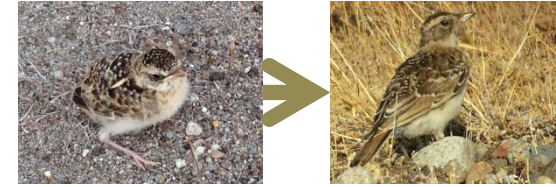
Objective 2: Post-fledgling Survival *Model Results*



Baseline model (b): $\Phi(a_1, a_{2-4}), p(a_1, a_{2-4})$

Model	Δ AICc	Model weight	<i>K</i>	Deviance
$\Phi(b), p(b \cdot \text{Site})$	0.00	0.64	8	151.32
$\Phi(b \cdot \text{Year}), p(b \cdot \text{Site})$	2.57	0.18	12	145.56
$\Phi(b), p(b \cdot \text{Year} \cdot \text{Site})$	3.49	0.11	20	129.42
$\Phi(b \cdot \text{Site}), p(b \cdot \text{Site})$	4.49	0.07	12	147.48
$\Phi(b), p(b \cdot Y)$	9.02	0.01	8	160.34
$\Phi(b \cdot \text{Site} \cdot \text{Year}), p(b)$	11.51	0.00	17	143.91
$\Phi(b), p(b)$	13.04	0.00	4	172.57

Objective 2: Post-fledgling Survival *Parameter Estimates*



Cumulative survival probability for 8-week period = 0.45

SUMMARY- APPARENT SURVIVAL

Sparse data

Male: 0.34
Female: 0.11



Fledge

0-2 week: 0.71
3-4 week: 0.86
5-6 week: 0.86
7-8 week: 0.86



Independent
Juvenile

Male: 0.75
Female: 0.24

Adult



Conclusion/Nest Steps

Foundation of data that can be used to help update both local and range-wide population viability analysis.

Need more data to increase robustness.

What is happening to juvenile females?

We lack information on the sources of mortality and where it occurs (migration, wintering) for juveniles, especially females.

Link between survival and habitat or other factor that we can manage remains elusive.

Thanks to our Funder and Field Staff



Jerrmaine Treadwell

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Timothy Leque

Debbie Lewis

Justin Averde

Brian Kapusta

Maureen Puffer

Veronica Reed

Michael Warren

Devon Kessler

Gavin Cotterill

Photo credits: Hannah Anderson, Rod Gilbert, Jerrmaine Treadwell, Adrian Wolf

QUESTIONS?



Summary

Adult:

- Poor estimates – sparse data

Juveniles:

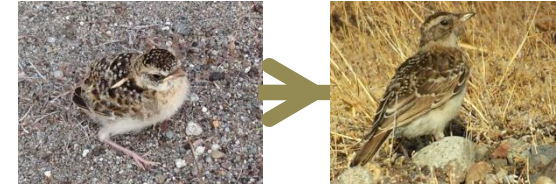
- Substantially lower than adult
- First evidence that juvenile females much lower than males
- Effect of site?

Post-fledging:

- Most vulnerable during first 2 weeks
- Next steps – look at timing of fledging, distance to road

When you can't fly, just hide, don't move, and hope
for the best"

Objective 2: Post-fledgling Survival *Analysis*



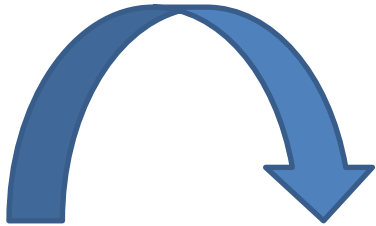
Used Program MARK

ϕ : defined as the probability of a fledgling surviving from one 2-week period to the next

Two-step model-building process:

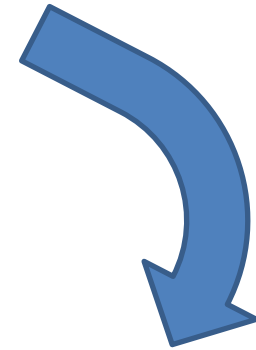
1. age (4, 2-week periods)
2. Add additional factors
 - year
 - site

Selected models based on AIC_c



Post-fledge

- Dependent upon adults
- Learning to fly



Independent
Juvenile



- Fend for yourself
- Migrate to wintering grounds
- Return to breeding grounds

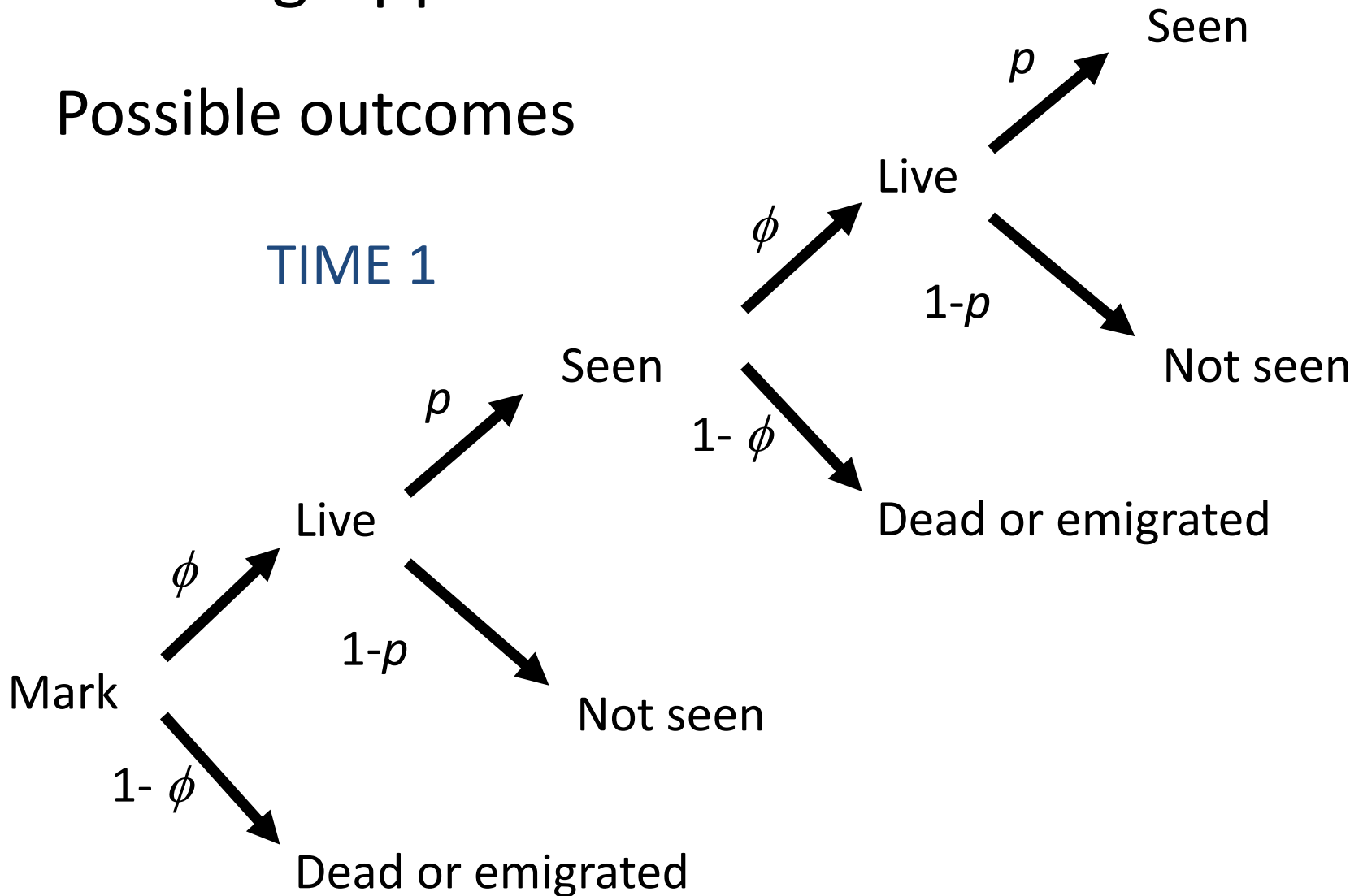


When you can't fly, just hide, don't move, and hope for the best"

Adult

Modeling Apparent Survival

Possible outcomes



Streaked Horned Lark Current and Historic Range

Legend

- Current Range
- Current Occupied
- Historic Range
- State_Province



**Historic Range
Area of Enlargement**



Objective 2: Post-fledgling Survival Analysis



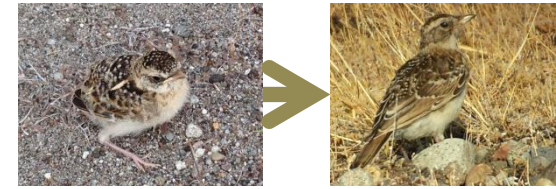
Post-Fledge Analysis – two step approach

Step 1 - only look at age effect

Model	Δ AICc	Model weight	<i>K</i>	Deviance
$\text{Phi}(t_1, t_{2-4}), p(t_1, t_{2-4})$	0.00	0.89	4	172.57
$\text{Phi}(t_1, t_2, t_3, t_4), p(t_1, t_2, t_3, t_4)$	4.28	0.10	7	170.70
$\text{Phi}(t_1, t_{2-4}), p(.)$	9.17	0.01	3	183.77
$\text{Phi}(t_{1-2}, t_{3-4}), p(t_{1-2}, t_{3-4})$	18.55	0.00	4	191.11
$\text{Phi}(.), p(.)$	26.50	0.00	2	203.12
$\text{Phi}(t_{1-3}, t_4), p(t_{1-3}, t_4)$	26.71	0.00	3	201.30

Objective 2: Post-fledging Survival

Marking and Resights



Banded Birds

	Prairie	Airfield	
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2013	29	24	7
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2015	39	44	59
	106	99	96

Resighted Birds

	Prairie	Airfield	
	13th Div	GAAF	MAFB
2013	12	11	3
2014	20	18	15
2015	28	22	38
	60	51	56