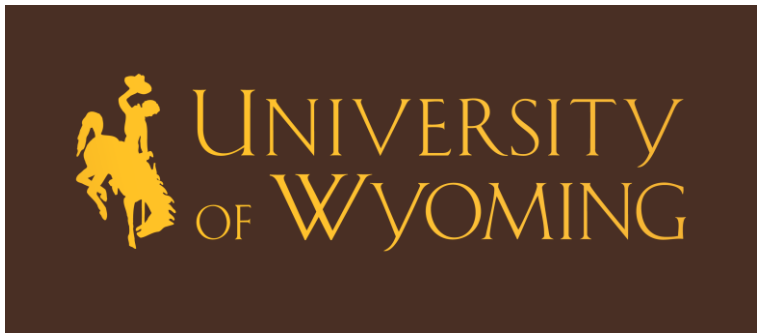
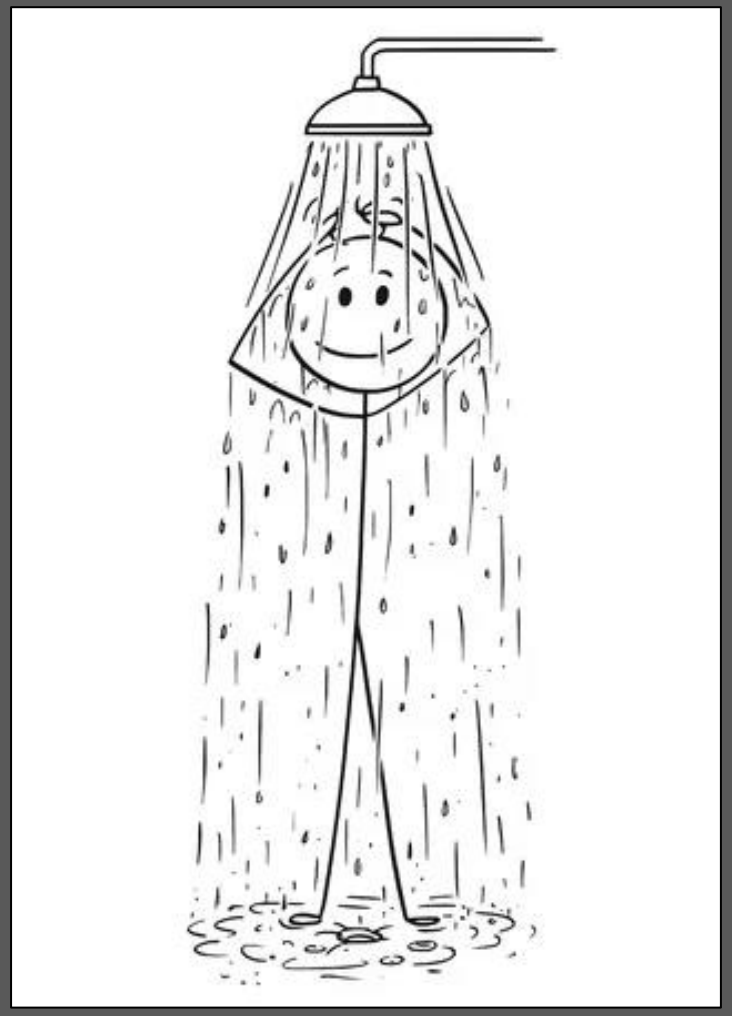
Statistical Methods for Estimating Abundance in Ecology



Lather-Rinse-Repeat



Capture-Mark-Recapture

- Method used to estimate the abundance of biological populations that involves '**capturing**' individuals, '**marking**' them, releasing them back into the population, and then determining the ratio of marked to unmarked individuals in the population during '**recapture**' surveys

- If we can estimate the abundance of organisms like salamanders and pronghorn by counting them, why go through the trouble of capturing and marking them?


(iNaturalist)


(Amy Hunt)

Estimating Abundance – Closed Population Estimation

$$Population\ size = \frac{\#\ of\ individuals\ marked}{probability\ of\ capturing\ an\ individual\ at\ least\ once}$$

$$N = \frac{n}{p} \qquad N = \frac{50}{0.5} \qquad N = 100$$

Estimating Abundance – Lincoln-Peterson Estimator

N = abundance (what we want to estimate)

n = number of individuals captured & marked during survey 1

m = number of individuals in survey 2 that were marked during survey 1

s = total number of individuals captured during survey 2

$\frac{n}{N} =$ $\frac{n}{N} = \frac{m}{s}$ $N = \frac{ns}{m}$ $N = \frac{n}{p}$ $p = \frac{m}{s}$ $N = \frac{n}{p} = \frac{ns}{m}$

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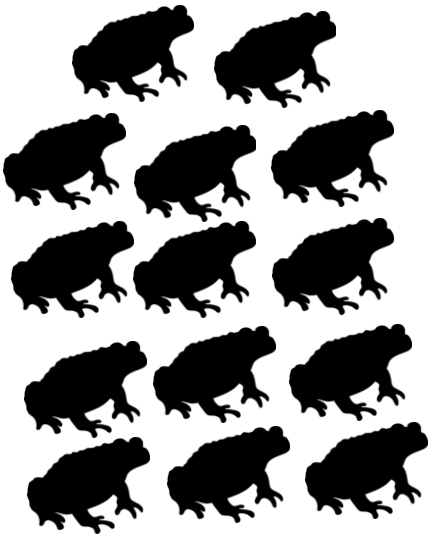

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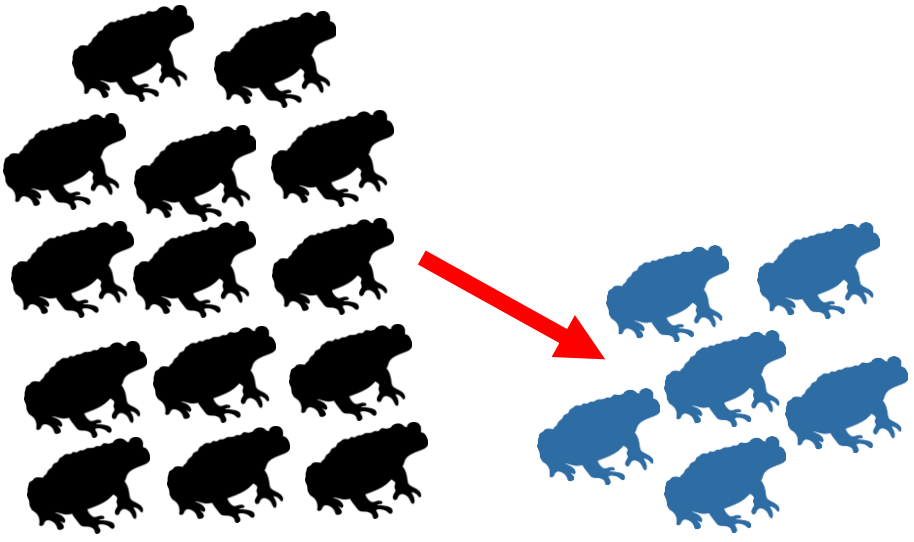

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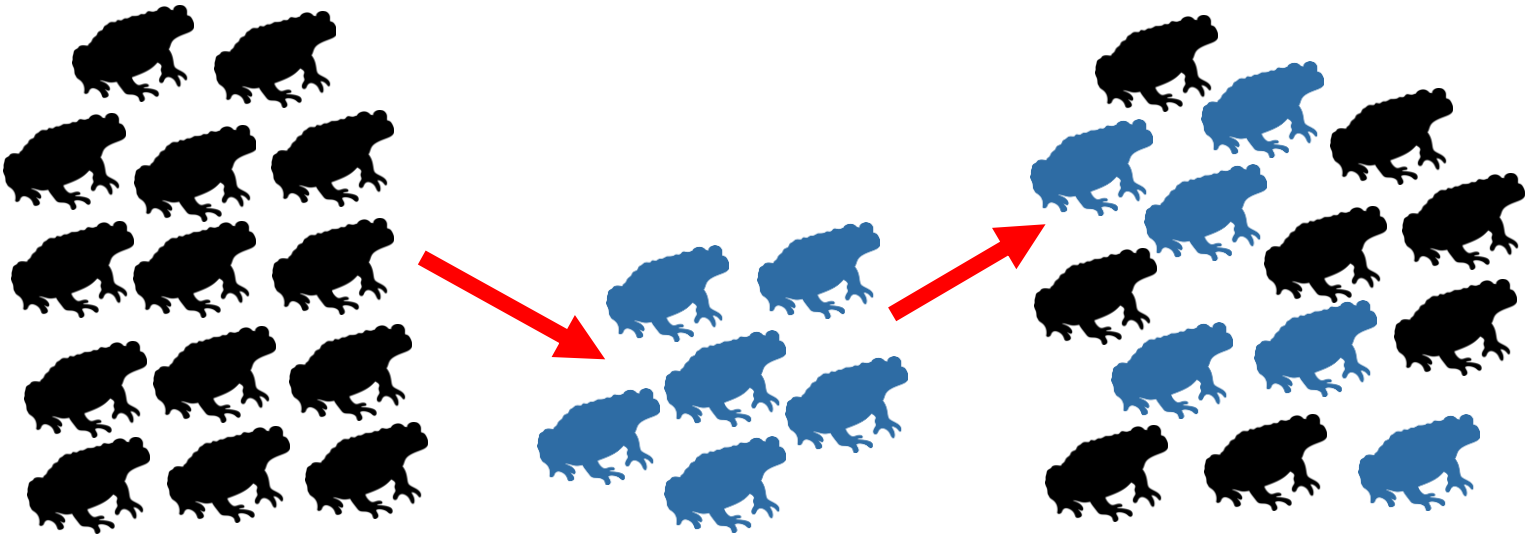

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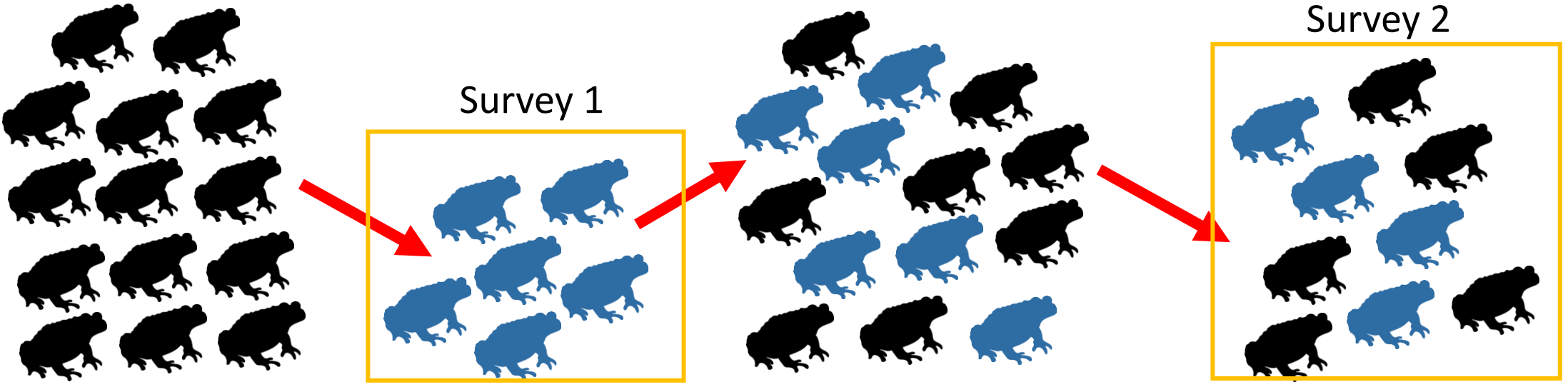

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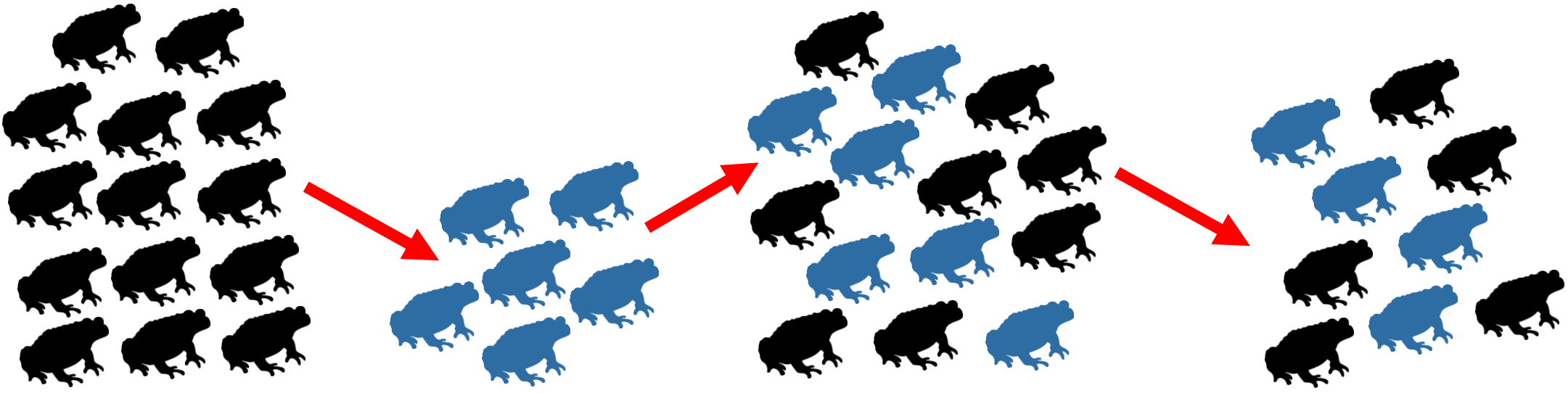
$$\frac{6}{N} = \qquad \frac{6}{N} = \frac{4}{9} \qquad N = \frac{6\ x\ 9}{4} \qquad N = 13.5 \qquad p = \frac{4}{9} \qquad p = 0.444 \qquad N = \frac{6}{0.444} \qquad N = 13.5$$



Estimating Abundance – Closed Population Estimation

Model Parameters

p = capture probability

c = recapture probability

f0 = the number of individuals never captured

Questions

1. Differences between detection probability and capture probability?
2. Why different parameters for capture probability and recapture probability?
3. What the heck is *f0*?

$f0 = N - M$

$N = f0 + M$

Population abundance (*N*) is a derived parameter in these models

Estimating Abundance – Closed Population Estimation

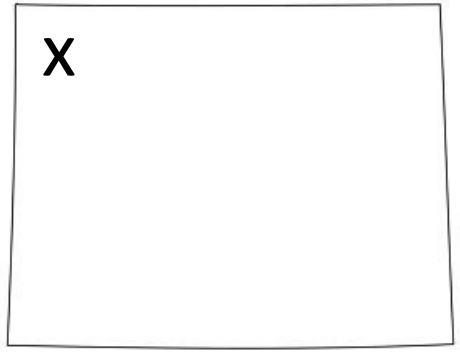
1. Question
2. Field Data
3. Format Data for Analysis
4. Fit Population Model
5. Examine Output and Visualize Results

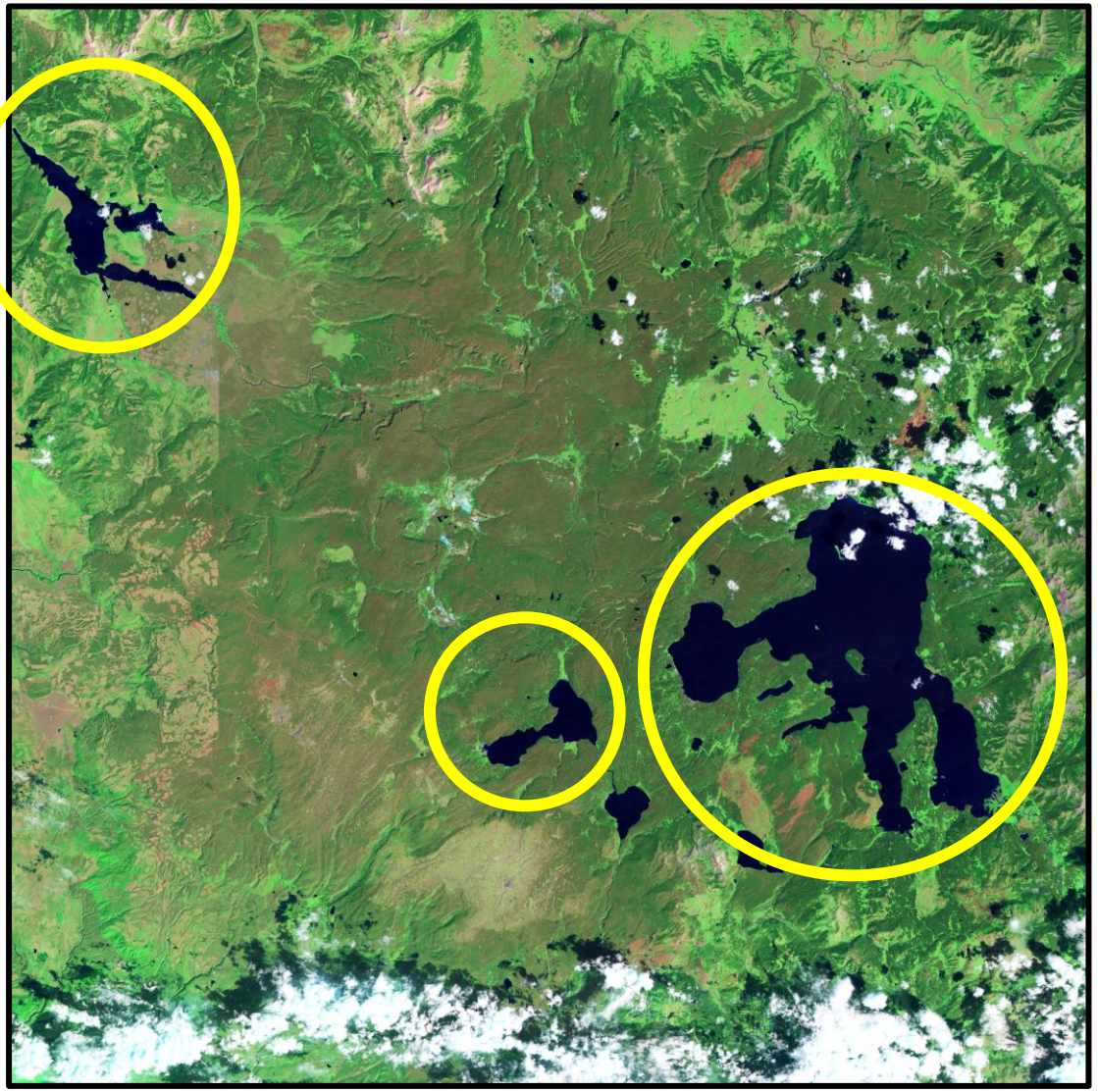
*steps 3-5 in Program R

Estimating Abundance – Closed Population Estimation

1. Question

How does boreal toad abundance vary across ponds?





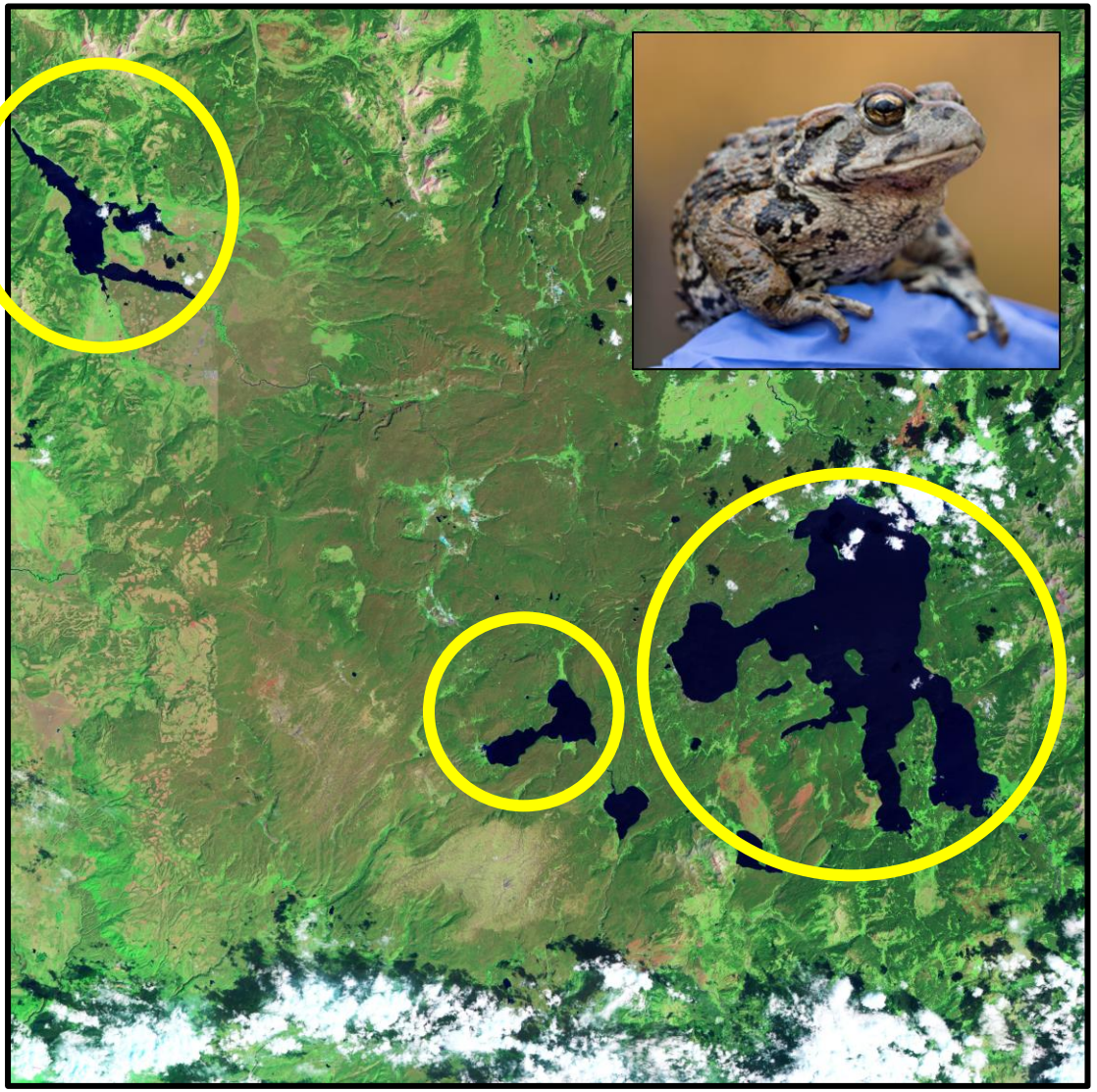
J. Grant

Estimating Abundance – Closed Population Estimation

1. Question

How does boreal toad abundance vary across ponds?

Date	Pond	Survey	SVL	Tag

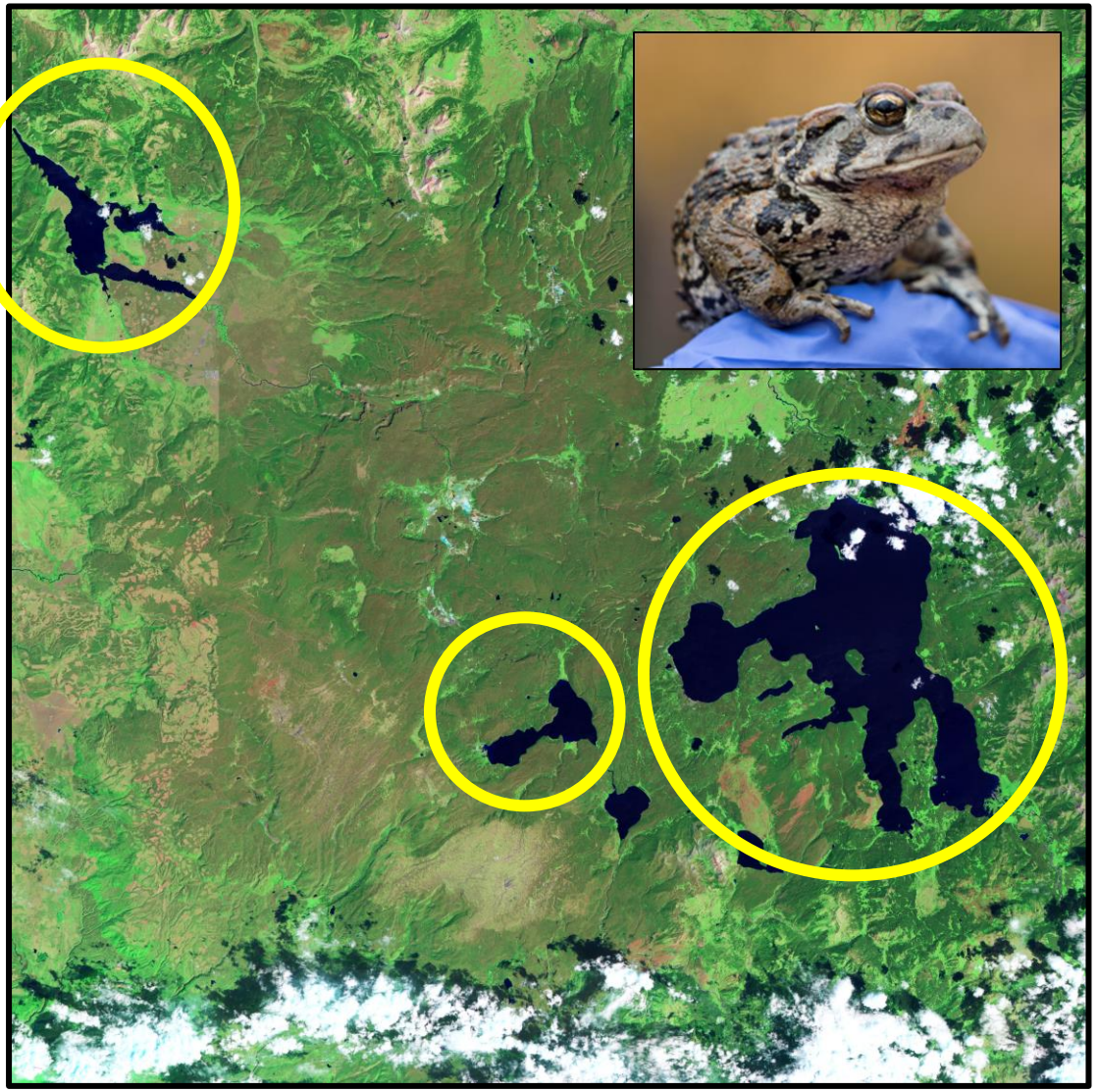


Estimating Abundance – Closed Population Estimation

1. Question

How does boreal toad abundance vary across ponds?

Date	Pond	Survey	SVL	Tag
5/29/2015	1	1		

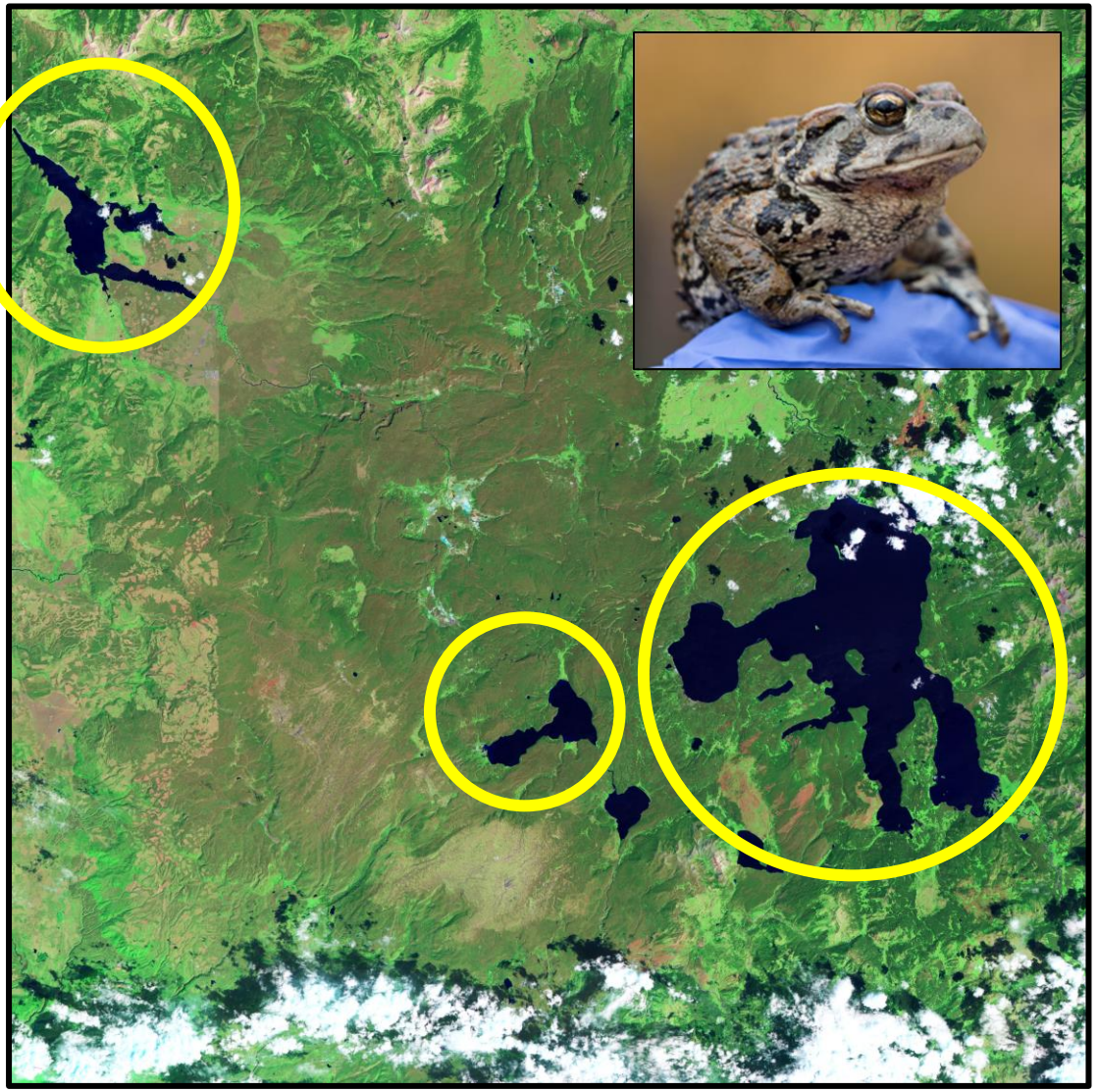


Estimating Abundance – Closed Population Estimation

1. Question

How does boreal toad abundance vary across ponds?

Date	Pond	Survey	SVL	Tag
5/29/2015	1	1	65	

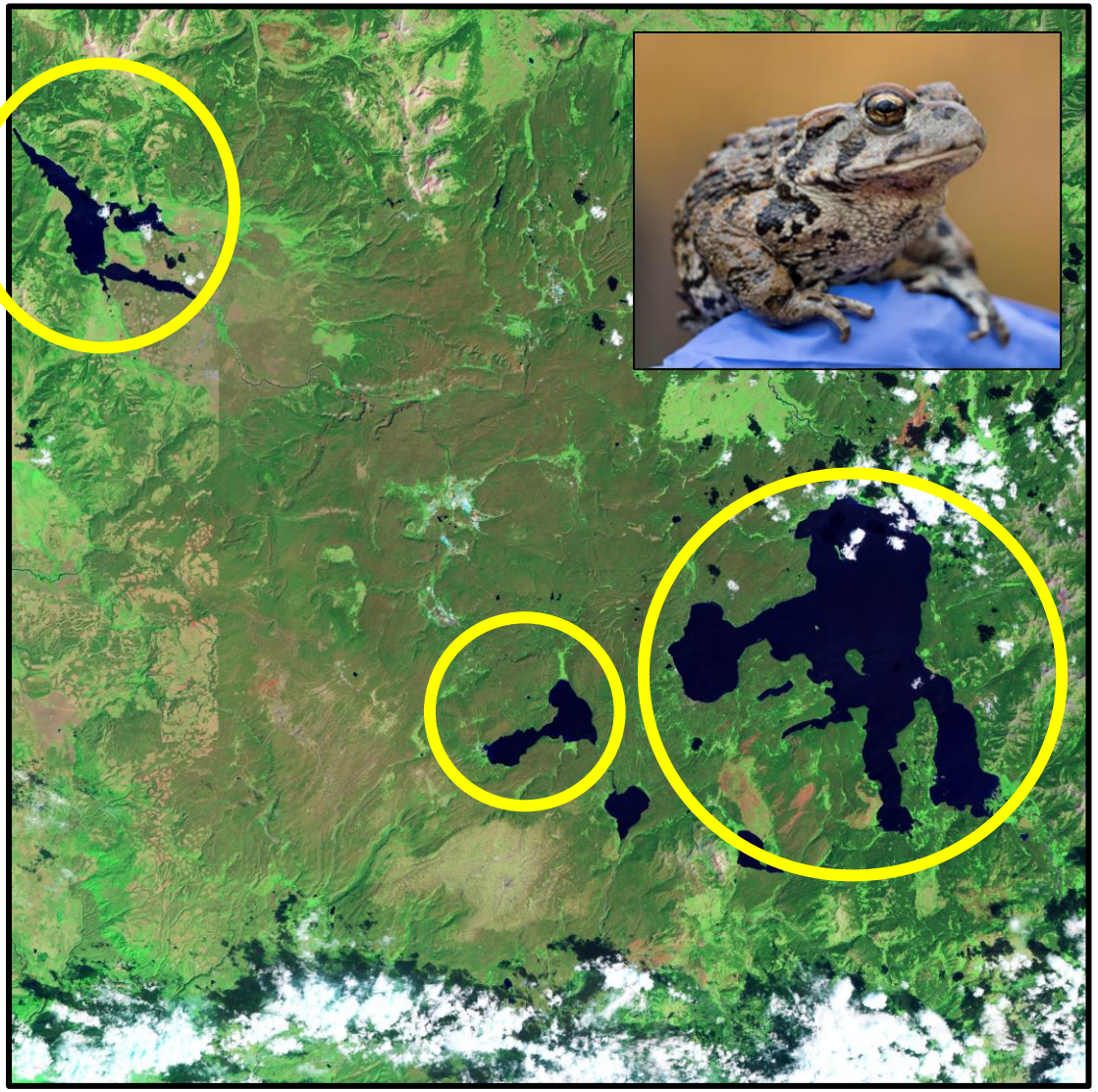


Estimating Abundance – Closed Population Estimation

1. Question

How does boreal toad abundance vary across ponds?

Date	Pond	Survey	SVL	Tag
5/29/2015	1	1	65	100



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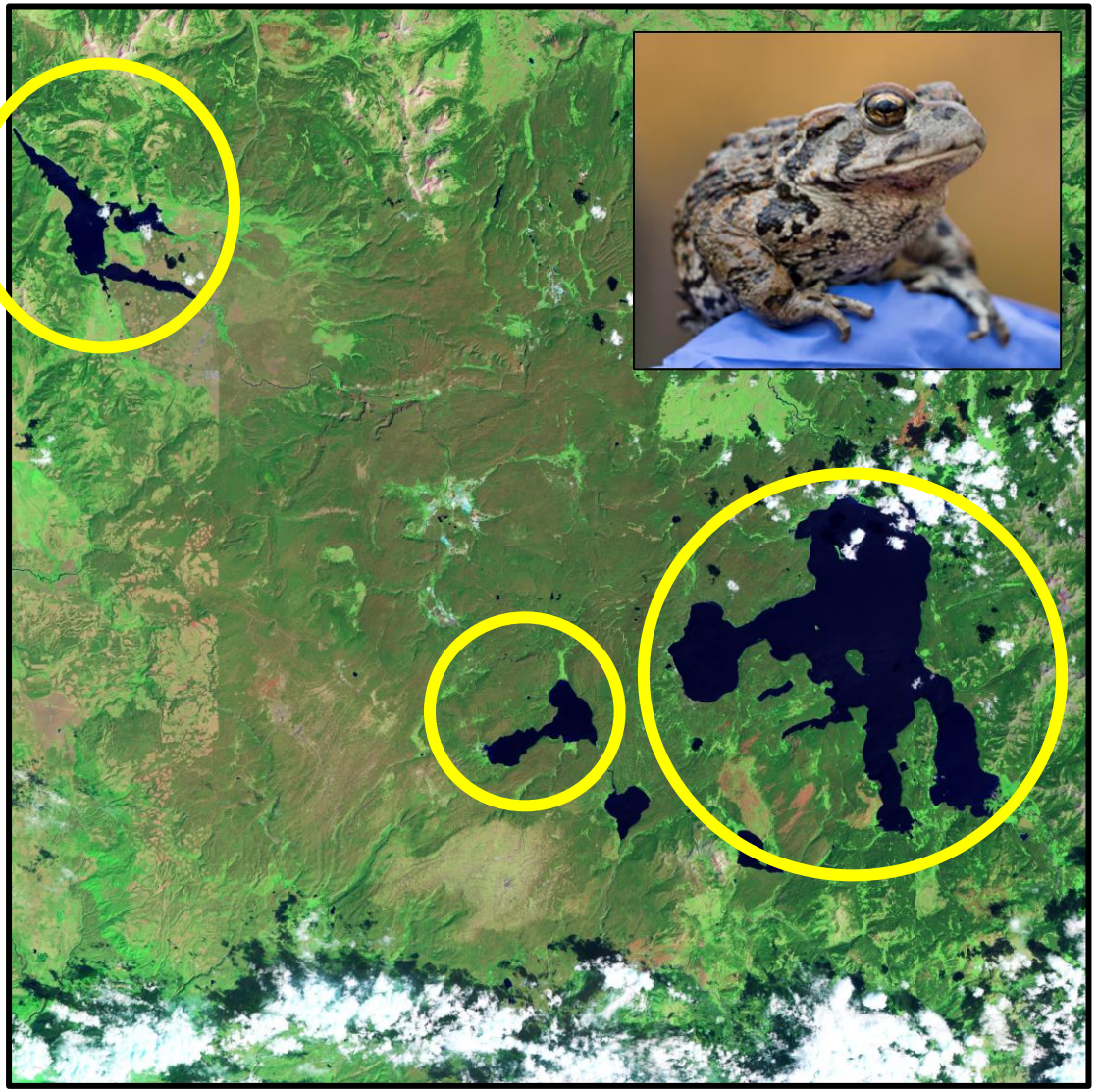
5/29/2015	1	1	75	101
5/29/2015	1	1	68	102
5/29/2015	1	1	80	103
5/29/2015	1	1	60	104
5/29/2015	1	1	89	105
5/29/2015	1	1	82	106



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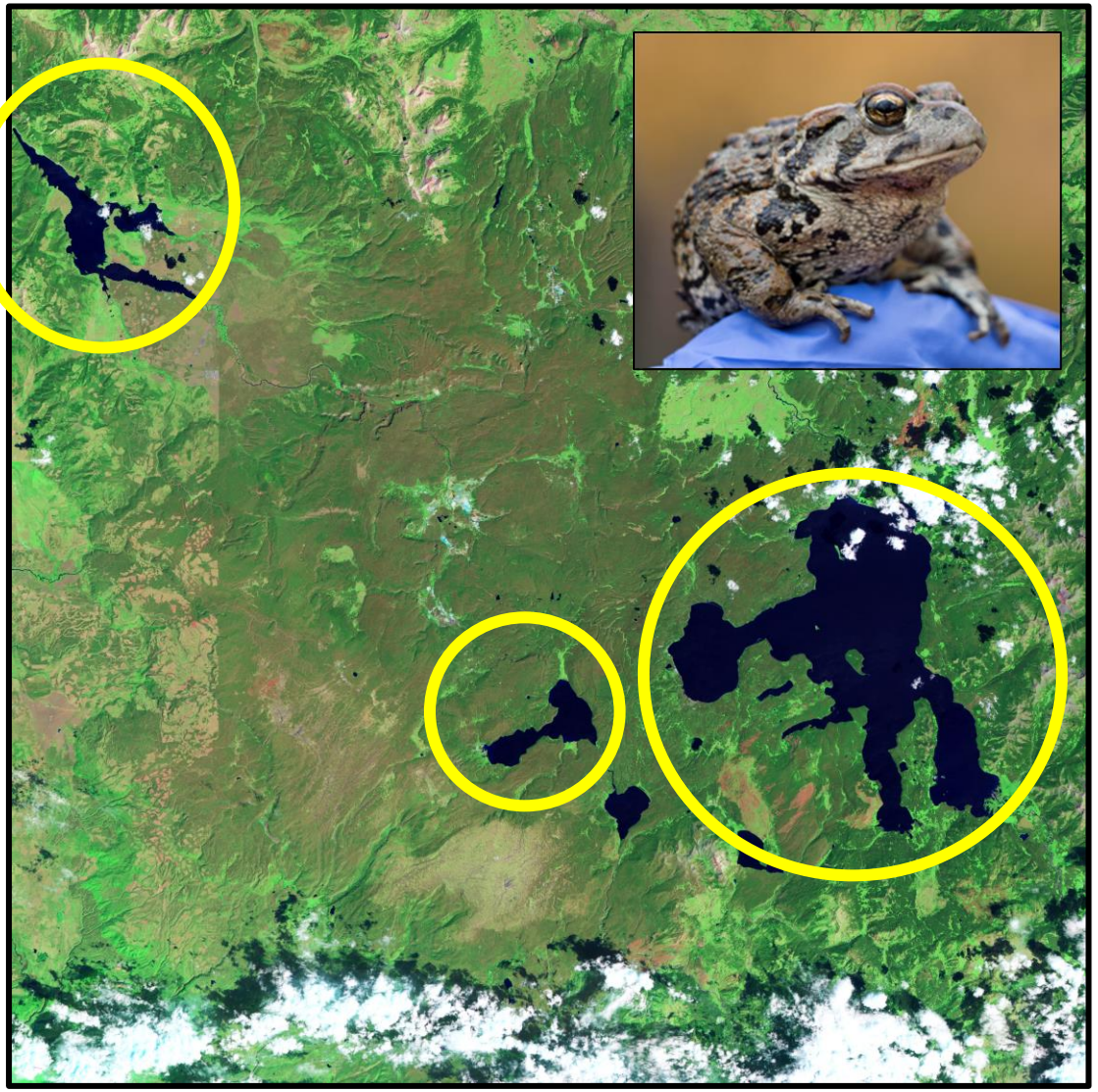
5/29/2015	1	1	89	105
5/29/2015	1	1	82	106
6/1/2015	1	2		



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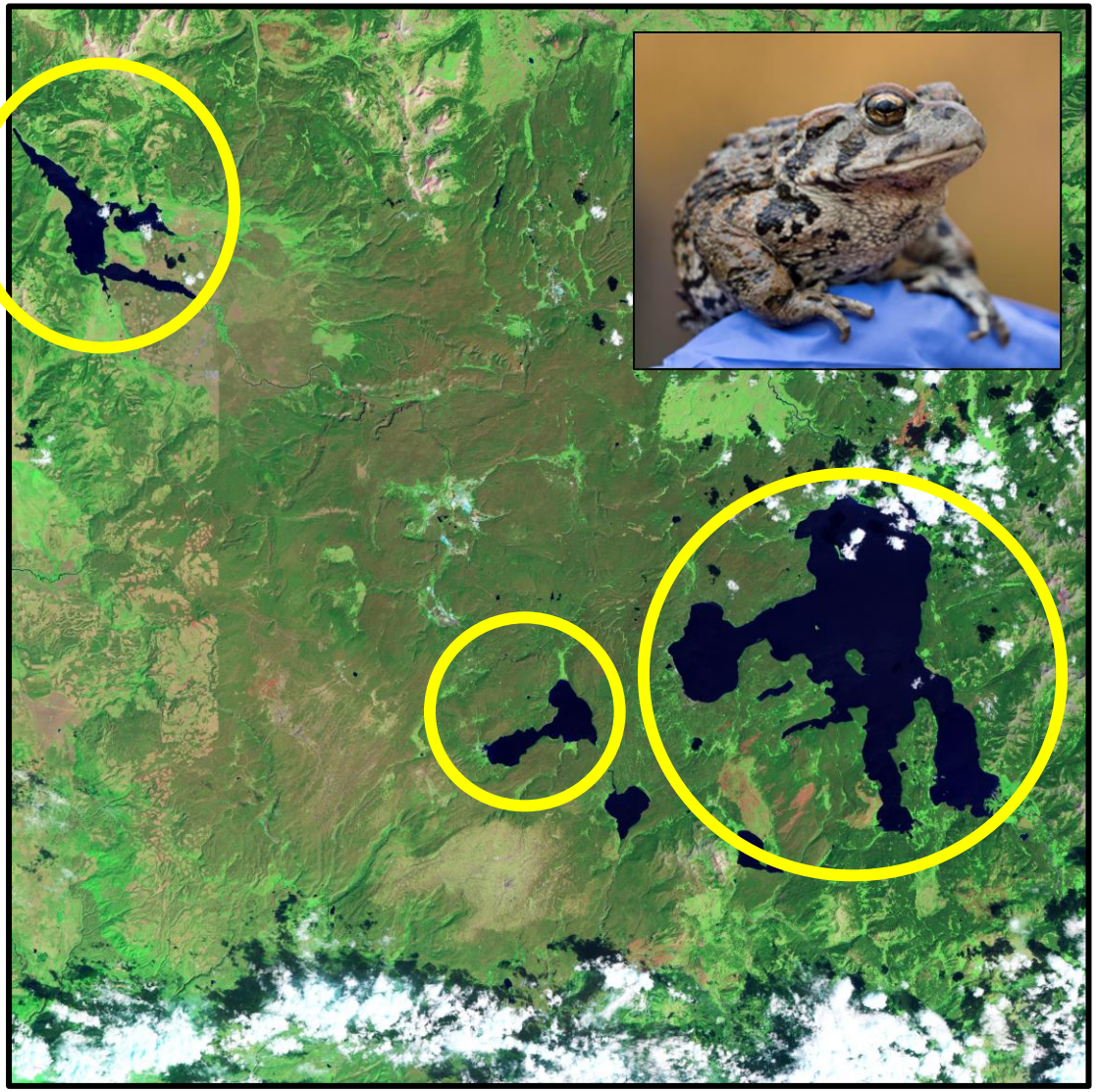
5/29/2015	1	1	60	104
5/29/2015	1	1	89	105
5/29/2015	1	1	82	106
6/1/2015	1	2	58	



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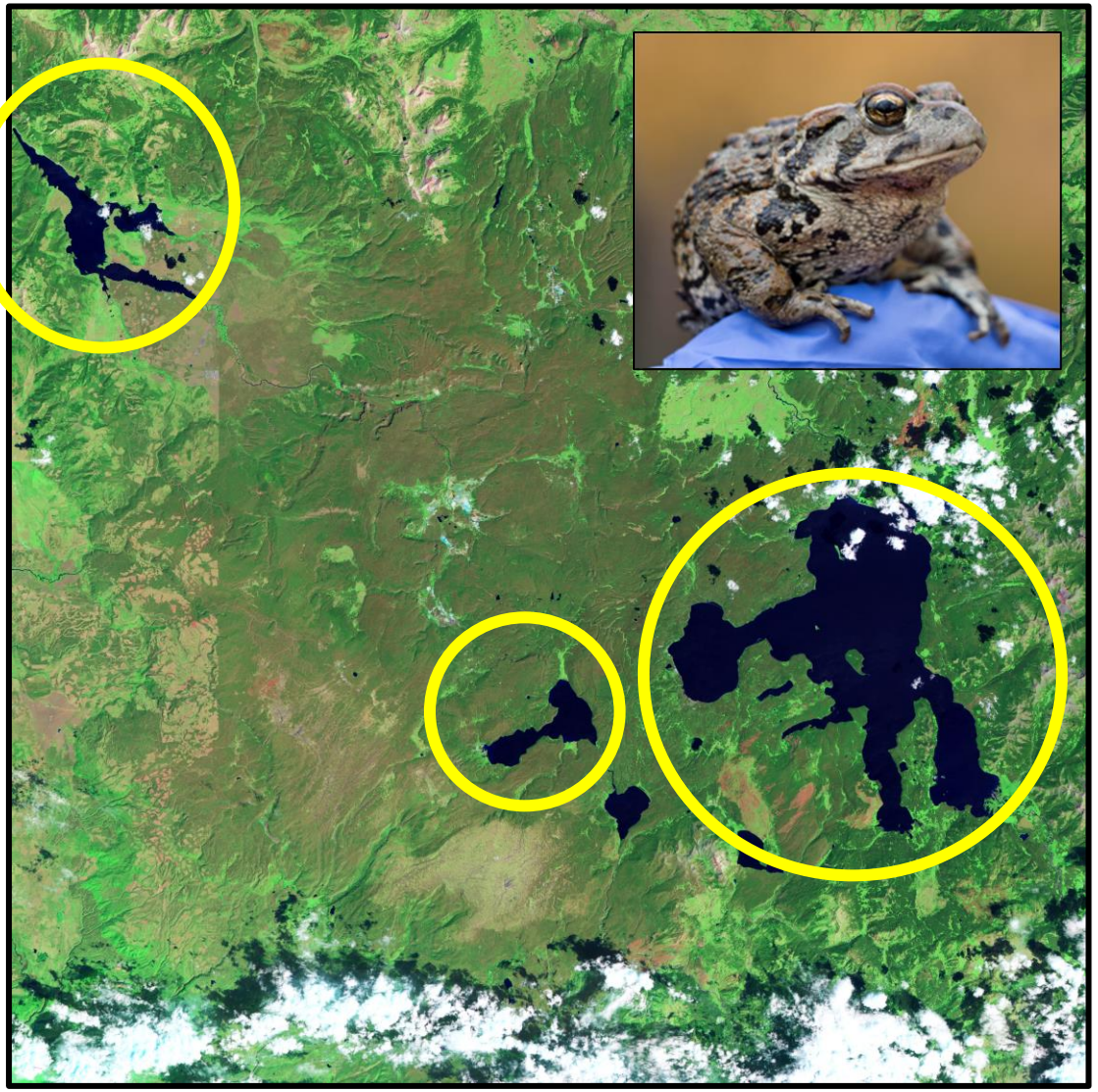
5/29/2015	1	1	89	105
5/29/2015	1	1	82	106
6/1/2015	1	2	58	107



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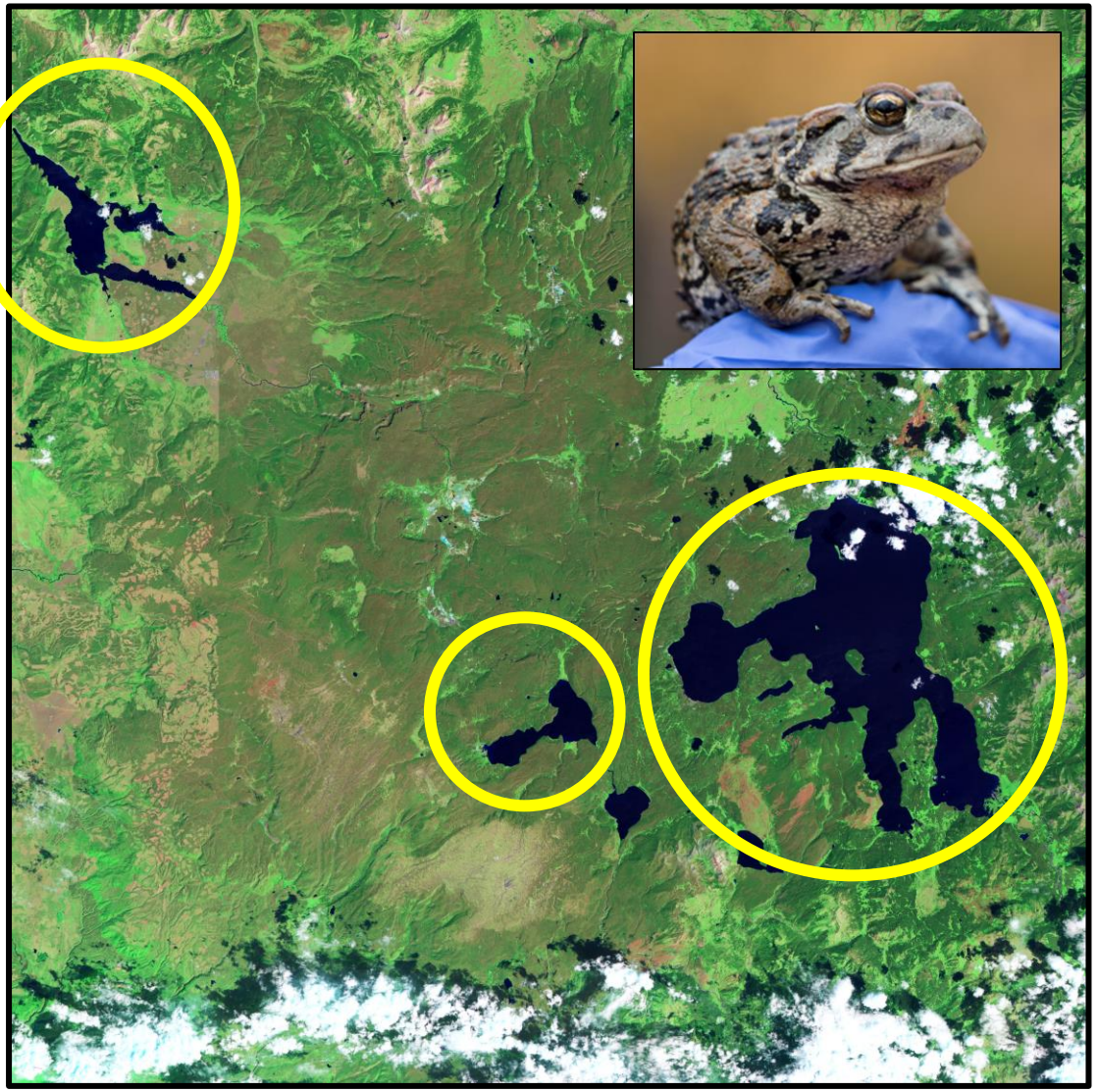

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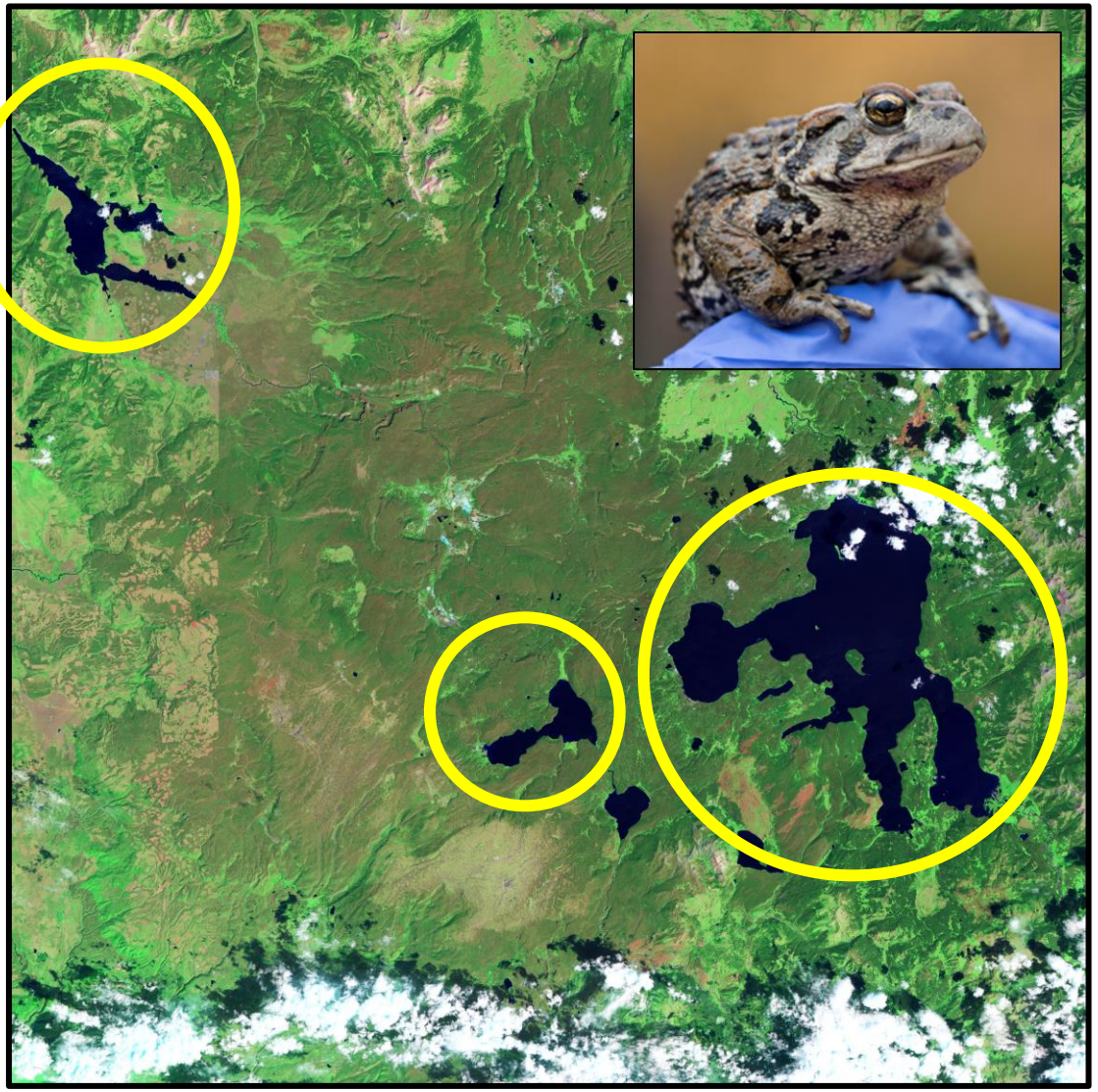

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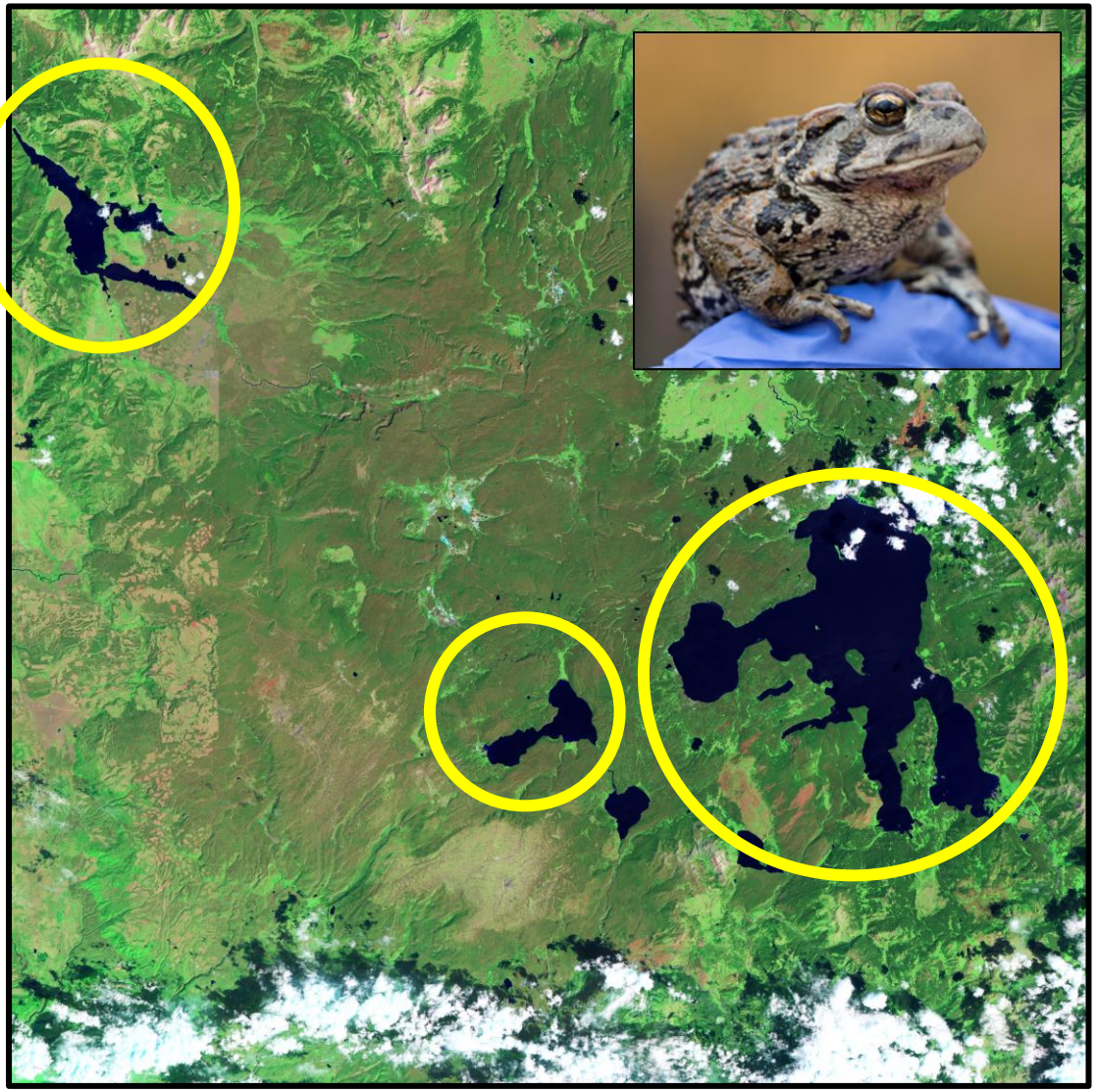
6/1/2015	1	2	58	107
6/1/2015	1	2	68	102
6/1/2015	1	2	76	108
6/1/2015	1	2	75	101
6/1/2015	1	2	67	109
6/1/2015	1	2	81	110



Estimating Abundance – Individual Capture Histories

Pond	Survey	Tag
1	1	100
1	2	100
1	3	100
1	4	100
1	1	101
1	3	101
1	2	102
1	4	102

Tag	Survey 1	Survey 2	Survey 3	Survey 4
100	1	1	1	1
101	1	0	1	0
102	0	1	0	1

Estimating Abundance – Individual Capture Histories

Pond	Survey	Tag
1	1	100
1	2	100
1	3	100
1	4	100
1	1	101
1	3	101
1	2	102
1	4	102

Tag	Survey 1	Survey 2	Survey 3	Survey 4
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Estimating Abundance – Individual Capture Histories

Pond	Survey	Tag
1	1	100
1	2	100
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1	4	100
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1	2	102
1	4	102

Tag	Survey 1	Survey 2	Survey 3	Survey 4
100	1	1	1	1
101	1	0	1	0
102	0	1	0	1

Toad 100: **1111**

Toad 101: **1010**

Toad 102: **0101**

Estimating Abundance – Closed Population Estimation

R Script: Day3-CaptureRecapture_RMark

Breakout rooms: one person in group will volunteer to share screen

Work through the code: answer each question as a group

Instructors will be available to help you along

Capture-Recapture vs Count Data

- Advantages to collecting count data? Disadvantages?
- Advantages to collecting capture-recapture data? Disadvantages?
- When would you collect capture-recapture data?
- When would you collect count data?

Capture-Recapture vs Count Data

$N = 100$

Capture-Recapture vs Count Data

$N = 100$

Capture-Recapture vs Count Data

$N = 100$

10

10

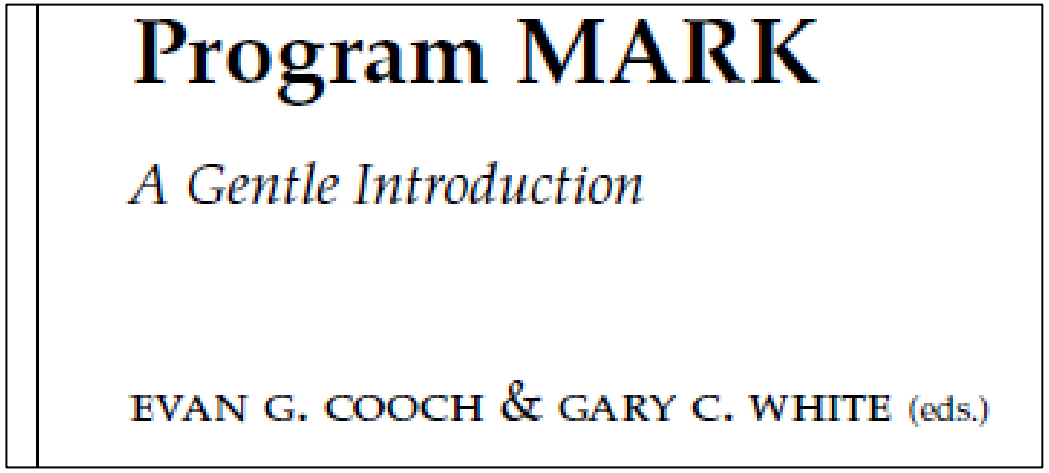
10

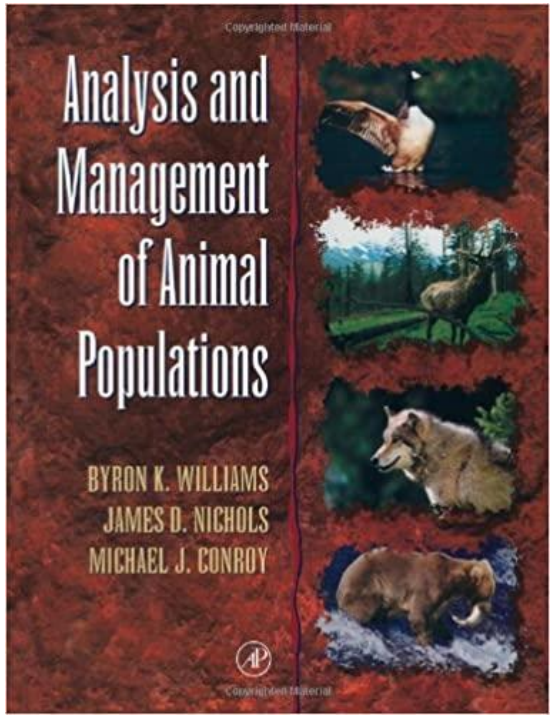
Estimating Abundance – Closed Population Estimation

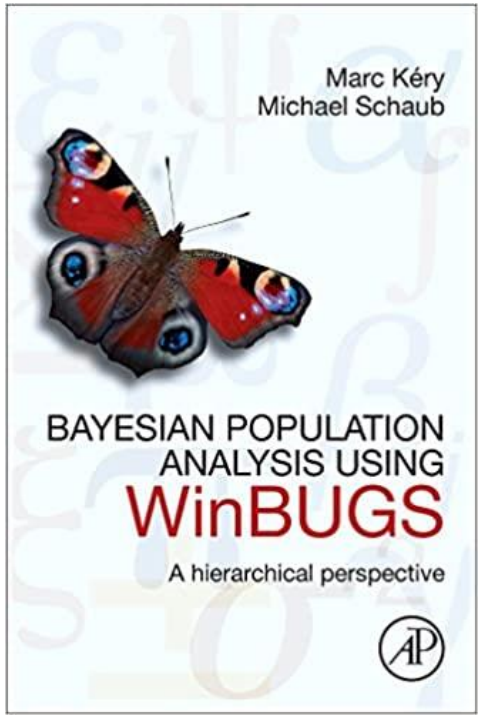
Any questions?

Does anyone want to go over anything again?

Estimating Abundance – Closed Population Estimation







Estimating Abundance – Closed Population Estimation

Session on Monday (12/6)

Instructors will be available to help with:

- Any questions you have
- Working through issues with your own data
- More complex examples of estimating abundance
- Just to chat about life