

# Estimation of population parameters for Sicklefin Redhorse in Brasstown Creek and Valley River

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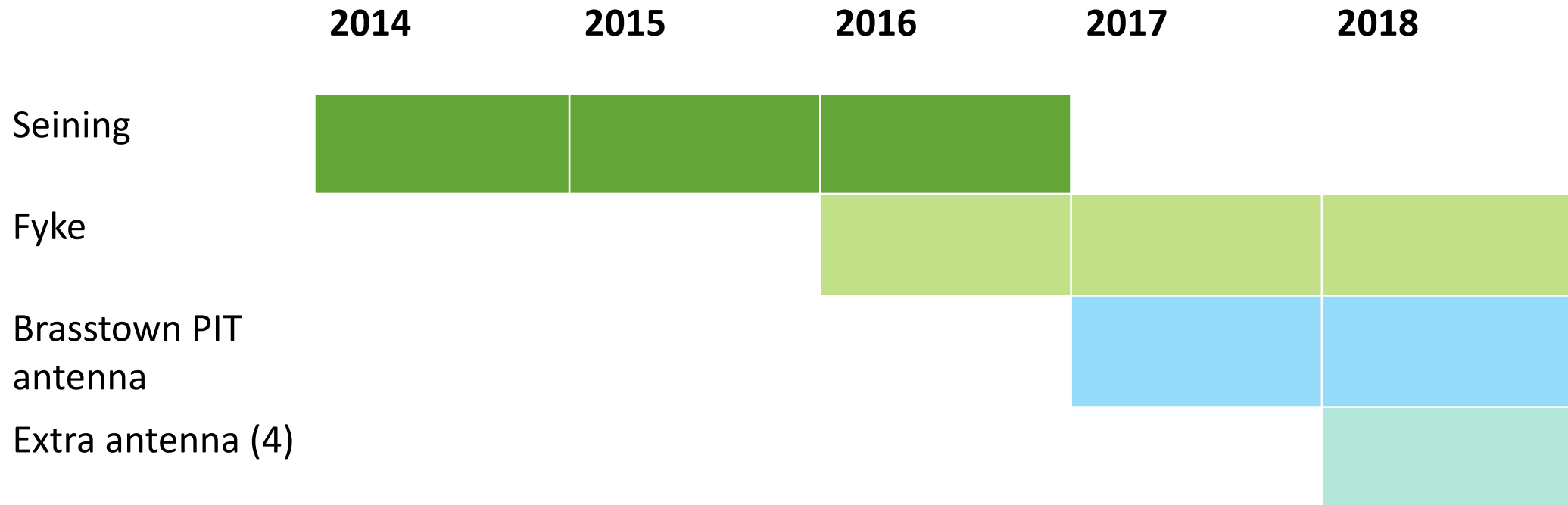
# Project objective

- Gain a better understanding of population dynamics of Sicklefin Redhorse using the capture-mark-recapture data from Brasstown Creek, GA and Valley River, NC
- Parameters interested in: population size, survival, recruitment, detection probability

# Data source

- Capture-mark-recapture data from the Brasstown Creek and Valley River populations
- 2014-2018
- All field data: seining, fyke traps, PIT antenna

# Data availability



# Data characteristics

- Sampling effort uneven among sampling methods
- Some fish captured by more than one gear
- PIT antenna only collects re-sight data
- Fish received different types of tags depending on capture method

# Modeling approach

- Cormack-Jolly-Seber model
  - Multi-state formulation
    - Allow for estimation of detection probability by sampling gear
  - Assumptions
    - No tag loss
    - Individuals correctly identified
    - Captured individuals are a random sample from the population
    - “Instantaneous” sampling
- Bayesian statistical framework

# Data format

			Capture Method		Date		ID			Sex	
1	Site_ID	Site_Name	PriMethod	Waterbody	CollectDate	CollectYear	Individual	PIT_Code	TotalLength	TotalWeight	Sex
58	35	Brasstown "Upper Brasstown Fyke" at Knowles	Trapping (Weir or Fyke)	Brasstown Creek	21-Apr-16		50	3DDF003B	442	915	Male
59	18	Brasstown, 1050m DS of Emerson Branch	Seining	Brasstown Creek		2014	50	3DD003BC	419	700	Male
60	18	Brasstown, 1050m DS of Emerson Branch	Seining	Brasstown Creek		2014	51	3DD003BC	525	1150	Male
61	18	Brasstown, 1050m DS of Emerson Branch	Seining	Brasstown Creek		2014	52	3DD003BC	521	1200	Male
62	50	Brasstown Creek DS of Fyke Site	Seining	Brasstown Creek	8-Apr-16		54	3D6H0018	510	1500	Male
63	35	Brasstown "Upper Brasstown Fyke" at Knowles	Trapping (Weir or Fyke)	Brasstown Creek	19-Apr-16		54	3D6H0018	504	845	Male
64	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	4-Apr-17		54	8000F5801809445F			Male
65	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	5-May-17		54	8000F5801809445F			Male
66	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	9-Apr-18		54	8000F5801809445F			Male
67	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	20-Apr-18		54	8000F5801809445F			Male
68	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	21-Apr-18		54	8000F5801809445F			Male
69	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	22-Apr-18		54	8000F5801809445F			Male
70	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	26-Apr-18		54	8000F5801809445F			Male
71	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	28-Apr-18		54	8000F5801809445F			Male
72	35	Brasstown "Upper Brasstown Fyke" at Knowles	Trapping (Weir or Fyke)	Brasstown Creek	19-Apr-16		55	3D6H0018	512	965	Female
73	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	15-Apr-17		55	8000F58018094437			Female
74	35	Brasstown "Upper Brasstown Fyke" at Knowles	Trapping (Weir or Fyke)	Brasstown Creek	19-Apr-16		56	3D6H0018	425	585	Male
75	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	20-Apr-17		56	8000F58018094418			Male
76	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	23-Apr-18		56	8000F58018094418			Male
77	16	Brasstown, 650m US of Misty Creek Lane	Seining	Brasstown Creek	19-Apr-16		57	3DDF003B	528	1125	Male
78	16	Brasstown, 650m US of Misty Creek Lane	Seining	Brasstown Creek	19-Apr-16		58	3D6H0018	482	955	Male
79	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	28-Mar-17		58	8000F58018094432			Male
80	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	18-Mar-18		58	8000F58018094432			Male
81	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	3-Apr-18		58	8000F58018094432			Male
82	37	Brasstown "Upper Brasstown PIT" at Knowles	PIT Array	Brasstown Creek	3-Apr-18		58	8000F58018094432			Male

# Capture history

ID	2014	2015	2016	2017	2018	Sex
40	1	1	6	4	4	M
41	1	1	3	4	1	F
42	1	1	3	4	4	F
43	2	1	3	3	1	M
44	1	1	1	2	5	M
45	1	1	1	3	1	M

States	Capture condition
1	Not captured
2	Captured by seine only
3	Captured by fyke only
4	Captured by PIT antenna only
5	Captured by fyke and antenna
6	Captured by seine and fyke
7	Captured by seine and antenna
8	Captured by all three methods



# Model overview

ID	2014	2015	2016	2017	2018	Sex
40	1	1	6	4	4	M
41	1	1	3	4	1	F
42	1	1	3	4	4	F
43	2	1	3	3	1	M
44	1	1	1	2	5	M
45	1	1	1	3	1	M

- Capture history conditioned on first capture
- Following an individual's capture history allows for estimation of survival and detection probability

# Model overview – estimating survival and detection probability

States	Capture condition	Detection probability ( $p$ )
1	Not captured	$(1-p_{\text{Seine}})*(1-p_{\text{Fyke}})*(1-p_{\text{PIT}})$
2	Captured by seine only	$p_{\text{Seine}}*(1-p_{\text{Fyke}})*(1-p_{\text{PIT}})$
3	Captured by fyke only	$p_{\text{Fyke}}*(1-p_{\text{Seine}})*(1-p_{\text{PIT}})$
4	Captured by PIT antenna only	$p_{\text{PIT}}*(1-p_{\text{Seine}})*(1-p_{\text{Fyke}})$
5	Captured by fyke and antenna	$p_{\text{Fyke}}*p_{\text{PIT}}*(1-p_{\text{Seine}})$
6	Captured by seine and fyke	$p_{\text{Seine}}*p_{\text{Fyke}}*(1-p_{\text{PIT}})$
7	Captured by seine and antenna	$p_{\text{Seine}}*p_{\text{PIT}}*(1-p_{\text{Fyke}})$
8	Captured by all three methods	$p_{\text{Fyke}}*p_{\text{Seine}}*p_{\text{PIT}}$

# Model overview – estimating survival and detection probability

*i = individual*  
*t = year*

Observation process

ID	2014	2015	2016	2017	2018	Sex
43	2	1	3	3	1	M
44	1	1	1	2	5	M

Ecological process

ID	2014	2015	2016	2017	2018	Sex
43	A*	A	A	A	NA	M
44	NA	NA	NA	A	A	M

\*A = Alive

$$\text{logit}(\text{Survival}_i) = \alpha + \beta * \text{Sex}_i$$



$$\text{Alive}_{i,t} \sim \text{Bern}(\text{Alive}_{i,t-1} * \text{Survival}_i)$$

*State: whether alive in population*




$$\text{Observation}_{i,t} \sim \text{Cat}(\text{Alive}_{i,t}, p_t)$$


*p: detection probability*

## Model overview – estimating population size

*Population size<sub>t</sub> = Newly captured individuals<sub>t</sub> + Recaptured individuals<sub>t</sub>*

$$N_t = \frac{\text{New Captures}_t}{\text{Pr}(\text{Newly Captured})_t} + \frac{\text{Recaptures}_t}{\text{Pr}(\text{Recaptured})_t}$$


$$1 - (1 - pFyke_t) * (1 - pSeine_t)$$


$$1 - (1 - pFyke_t) * (1 - pSeine_t) * (1 - pPIT_t)$$

# Summary statistics

- 282 individuals included in analysis
  - 178 males
  - 104 females
- 1296 total captures
  - By sex
    - Male: 1044
    - Female: 252
  - By gear
    - Seining: 67
    - Trapping: 249
    - PIT Array: 980

Number of individuals captured by year

Year	2014	2015	2016	2017	2018
Number captured	24	28	73	149	180

Number of individuals captured by gear

Gear	2014	2015	2016	2017	2018
Seine	24	28	12	–	–
Fyke	–	–	63	106	73
PIT Array	–	–	–	110	135

# Preliminary results

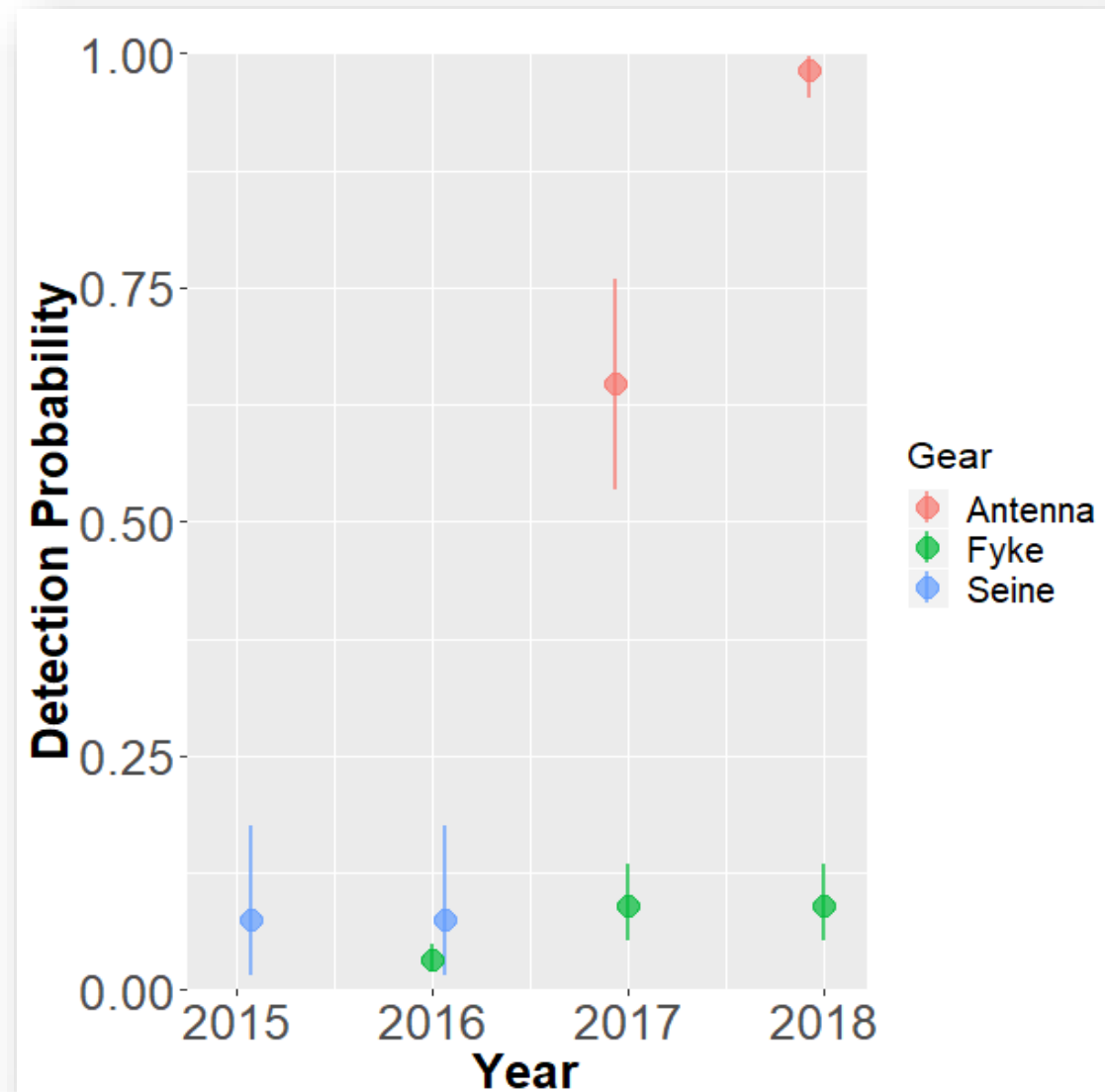
- Survival estimates

<b>Sex</b>	<b>Estimate</b>	<b>Lower CI</b>	<b>Upper CI</b>
Male	0.69	0.62	0.75
Female	0.67	0.58	0.76

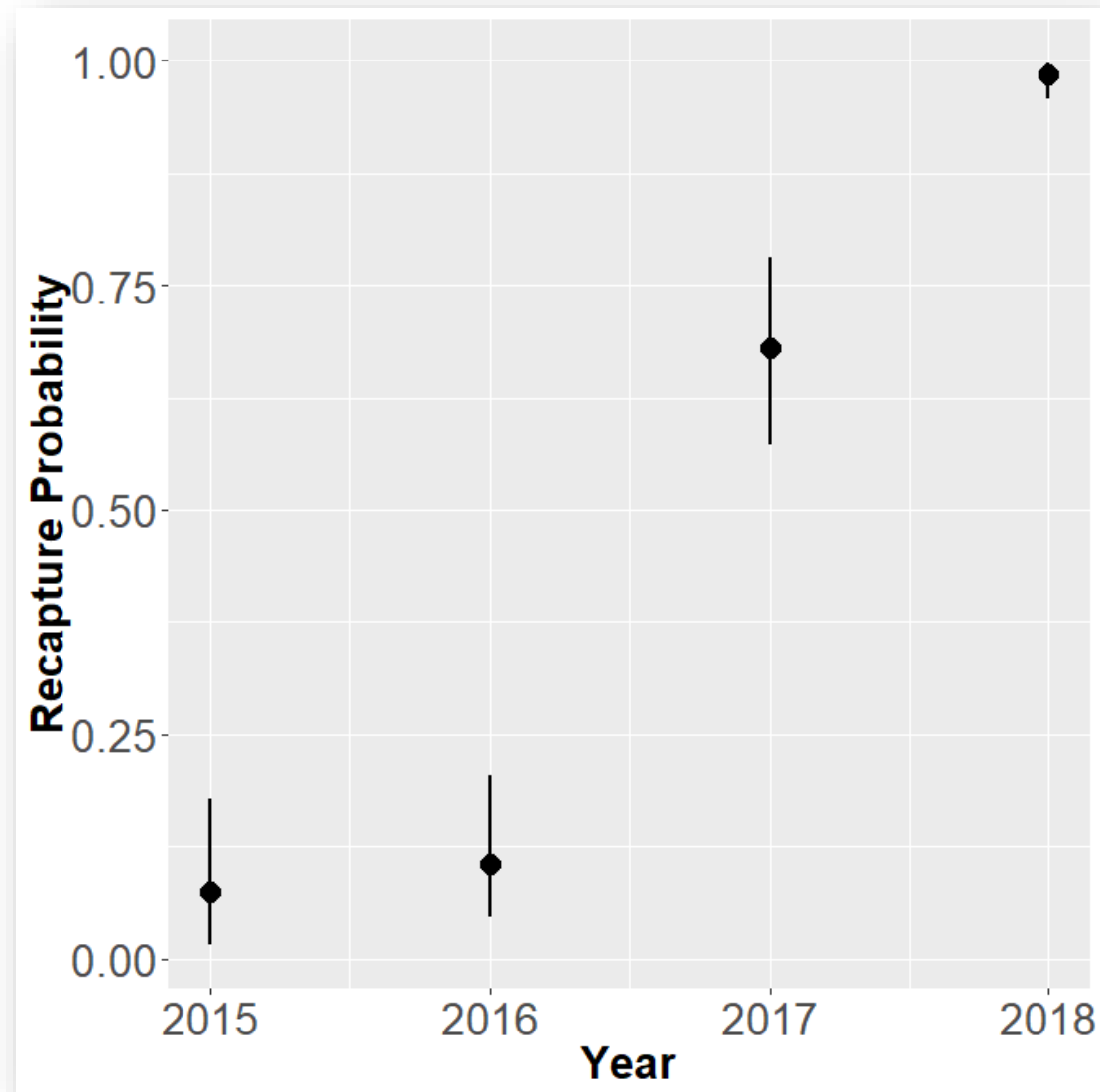
- Detection probability

	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>
Seine	0.07	0.05	-	-
Fyke	-	0.05	0.09	0.09
PIT Array	-	-	0.65	0.98

# Detection probability by gear

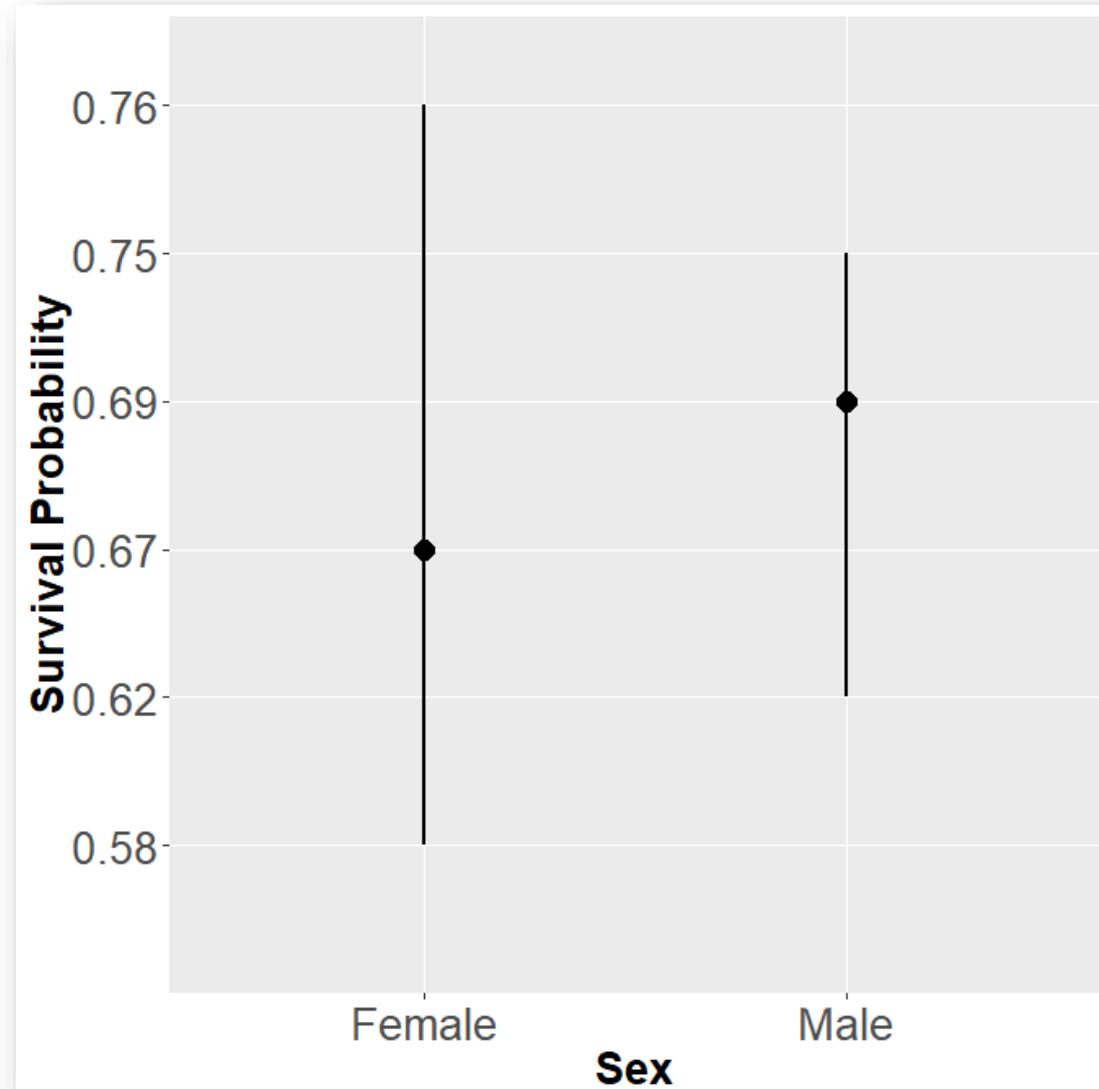


# Overall recapture probability

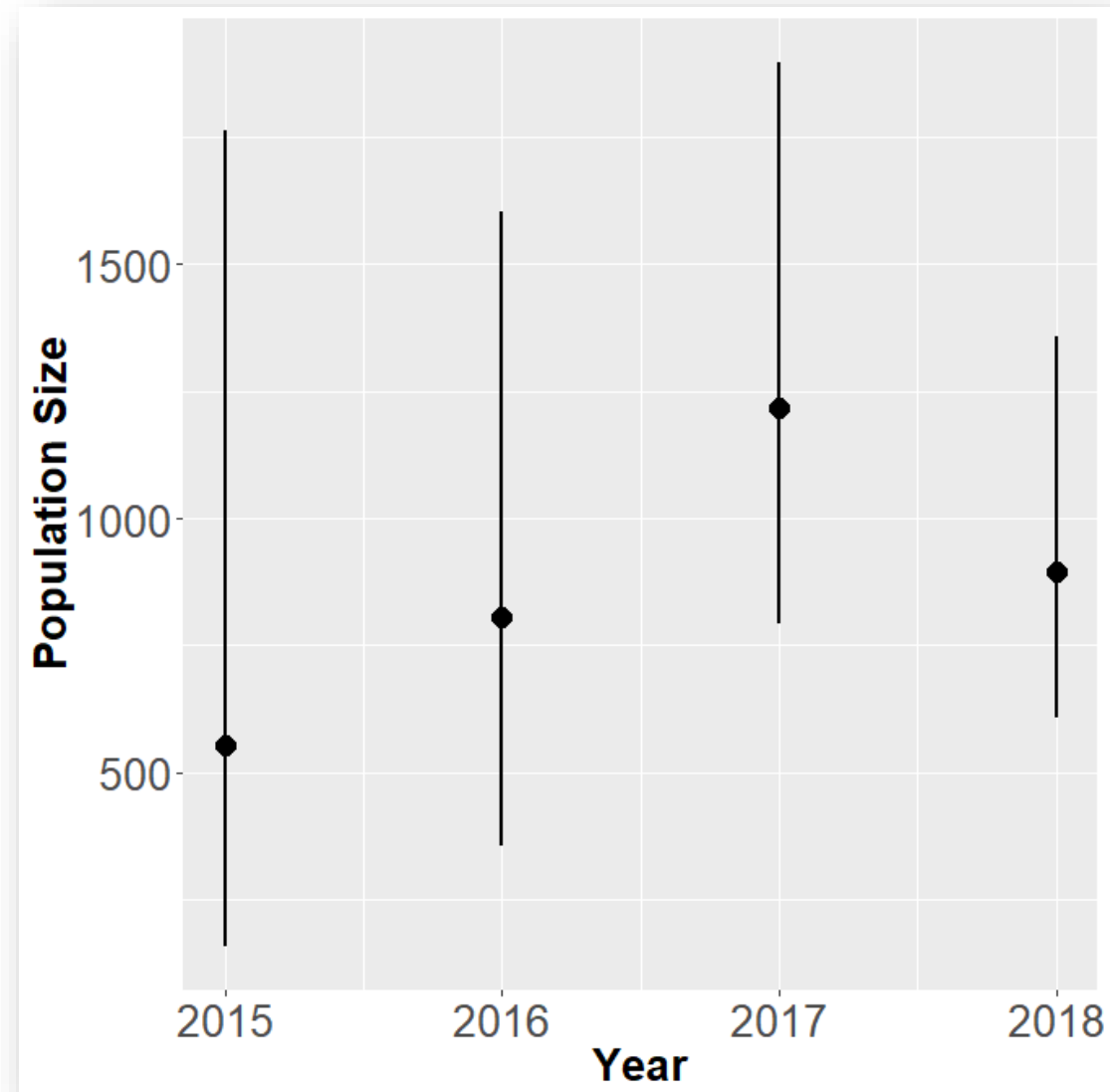




# Survival probability



# Population size



# Looking forward

- Turn CJS model into JS model to obtain more accurate estimate of population size and recruitment
- Include environmental covariates
- Account for varying sampling effort
- Hold a Sicklefin!

# Thank you!

- Sicklefins Redhorse Conservation Committee
- GA DNR
  - Brett Albanese
  - Zach Abouhamdan
- UGA
  - Brian Irwin (Georgia Coop Unit)
  - Richard Chandler (Warnell Sch. Forestry and Natural Resources)
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Sicklefin Redhorse Picture