SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

Estimating Red Drum annual survival rates from CJS

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Live Life Outdoors

Presentation Overview

- Purpose of tagging analyses
- Background on SCDNR Red Drum conventional tagging data
- Overview of model(s) used to estimate annual survival
- Results of tagging data analyses
- Discussion/Questions

Purpose of SCDNR tagging data analyses

- Provide estimate of annual survival/mortality external to the stock assessment model
- Used to compare to results derived from stock assessment model

Background on SCDNR Red Drum conventional tagging data

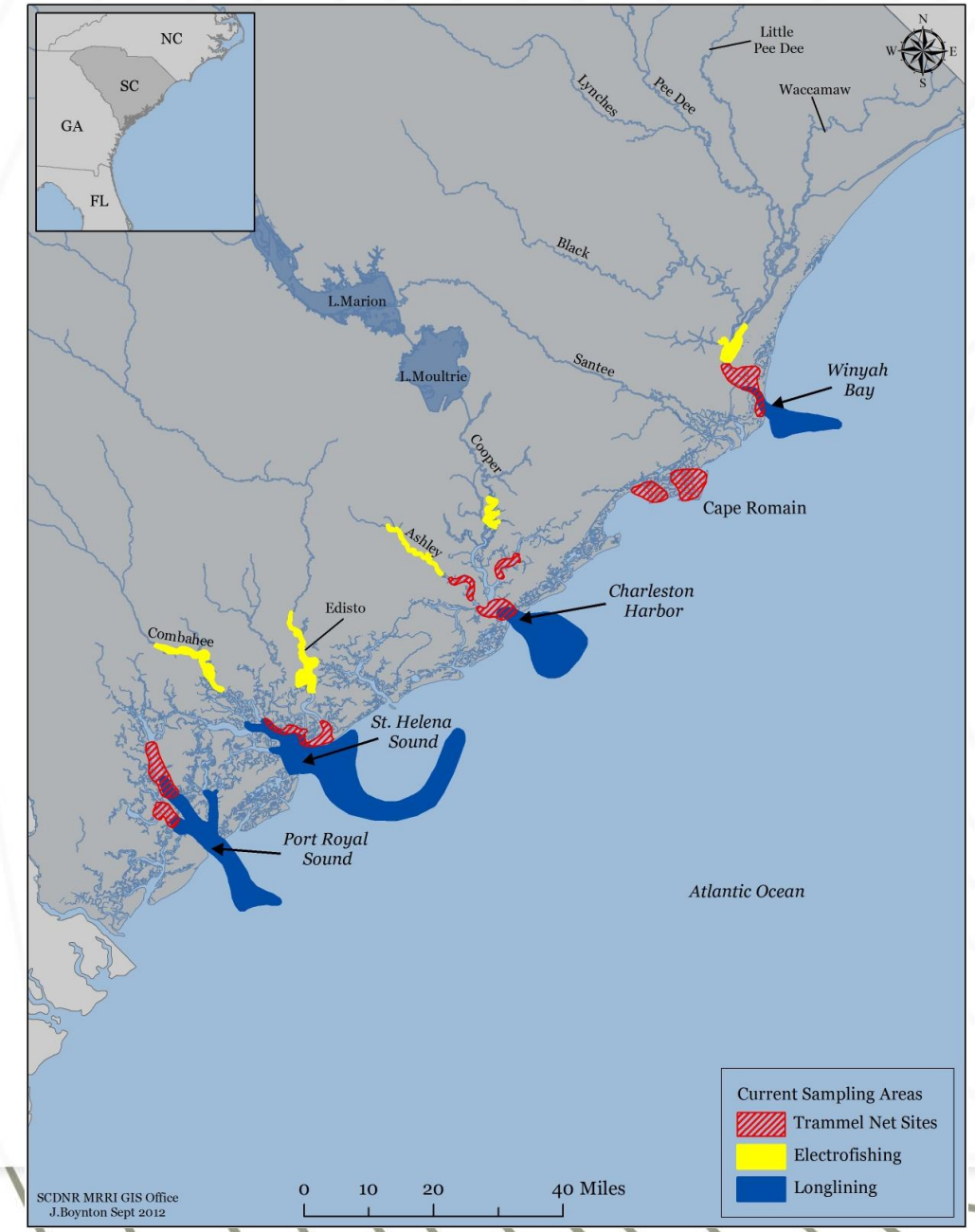
Red Drum Life Cycle

<u>Juveniles (few inches)</u>
- Small creeks
- Upper estuaries

<u>Sub-adults (<30”)</u>
- Shallow salt marsh edge and oyster reef habitats
- Lower estuaries

<u>Adults (30-45”)</u>
- Deeper coastal waters
- Form aggregations @ mouths of estuaries

SCDNR Surveys



Electrofishing (2002-present)

Trammel netting (1991-present)

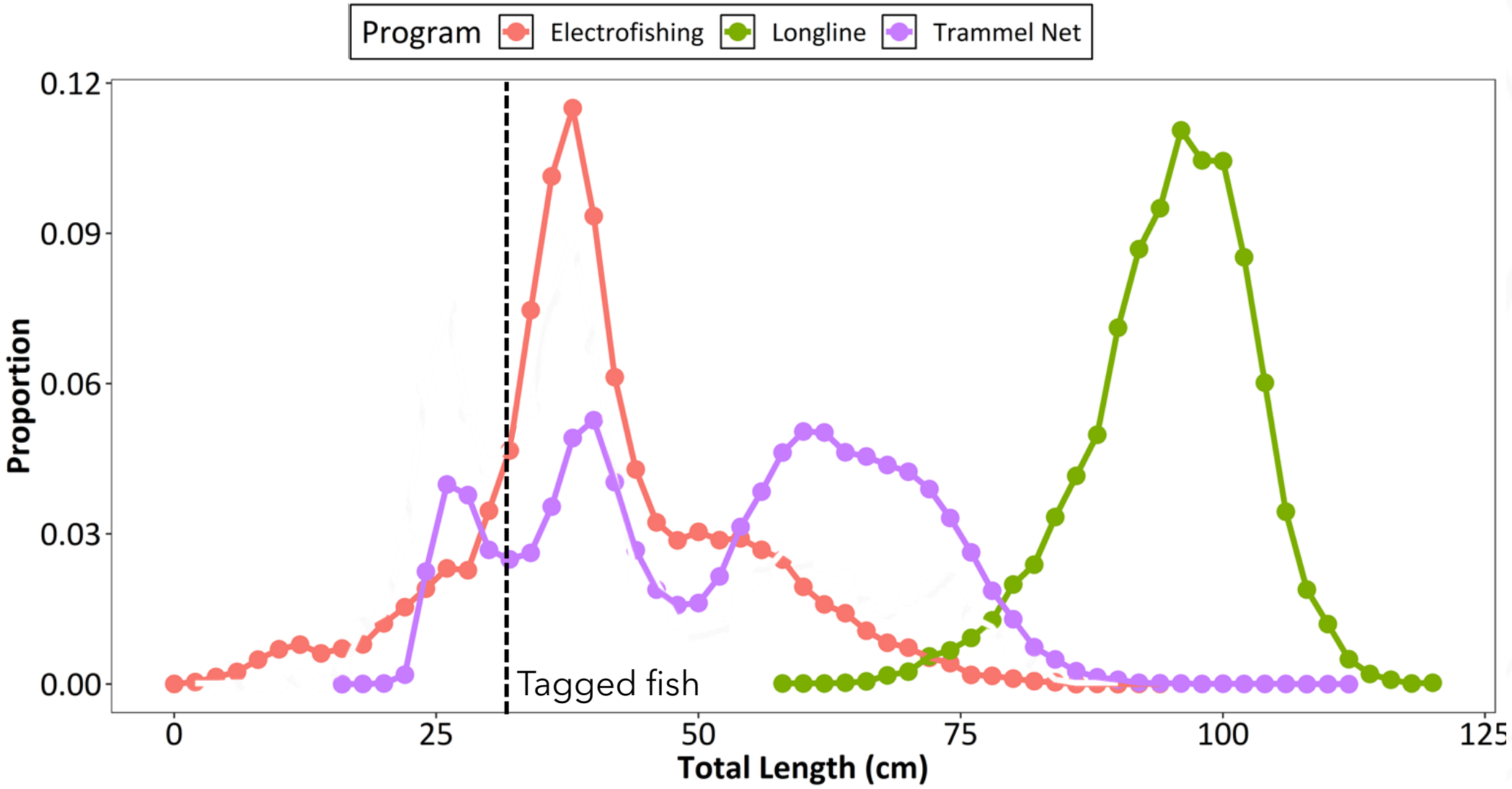
Longlining (2007-present)

SCDNR Surveys

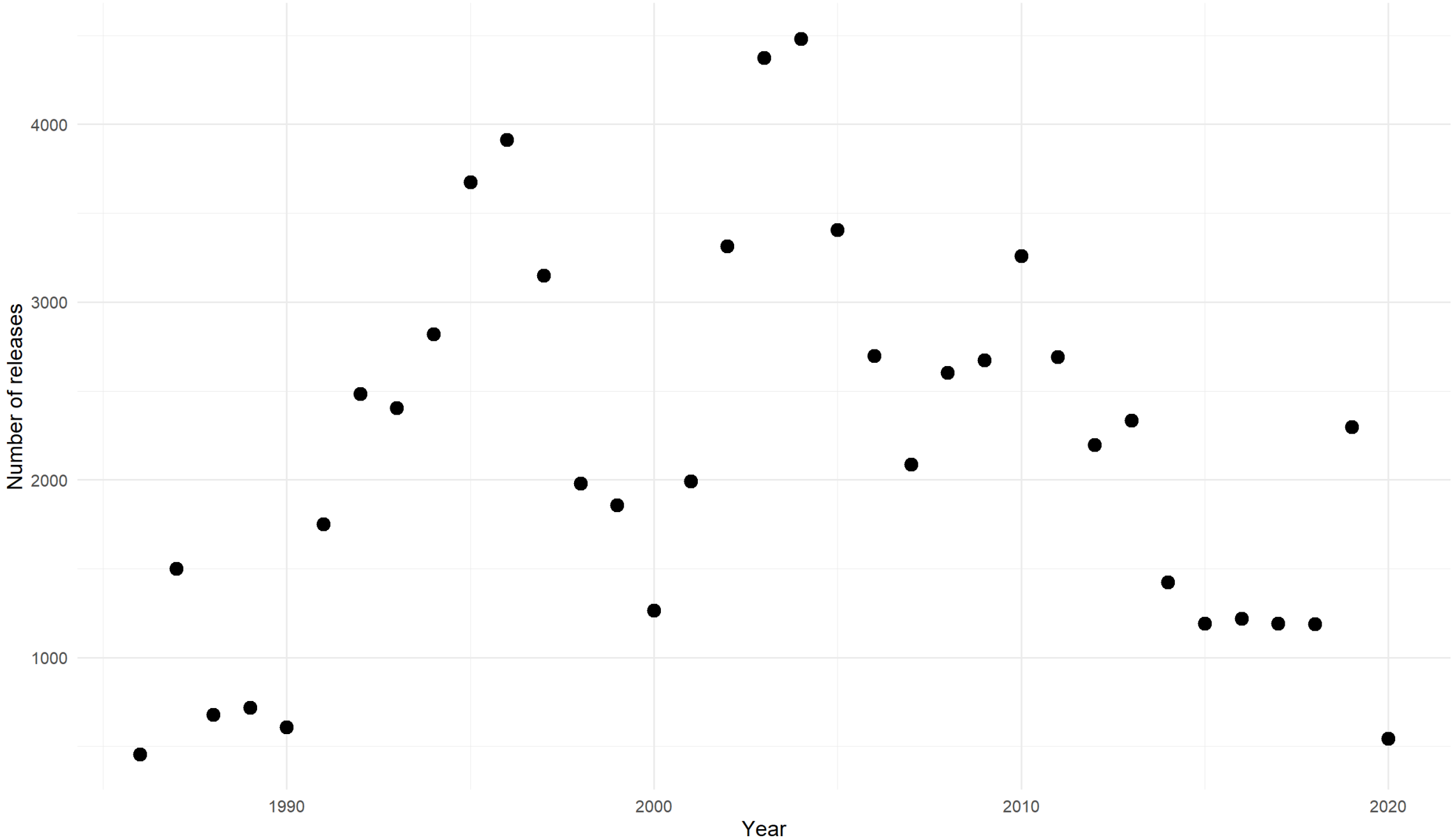
35cm – 54.9cm TL

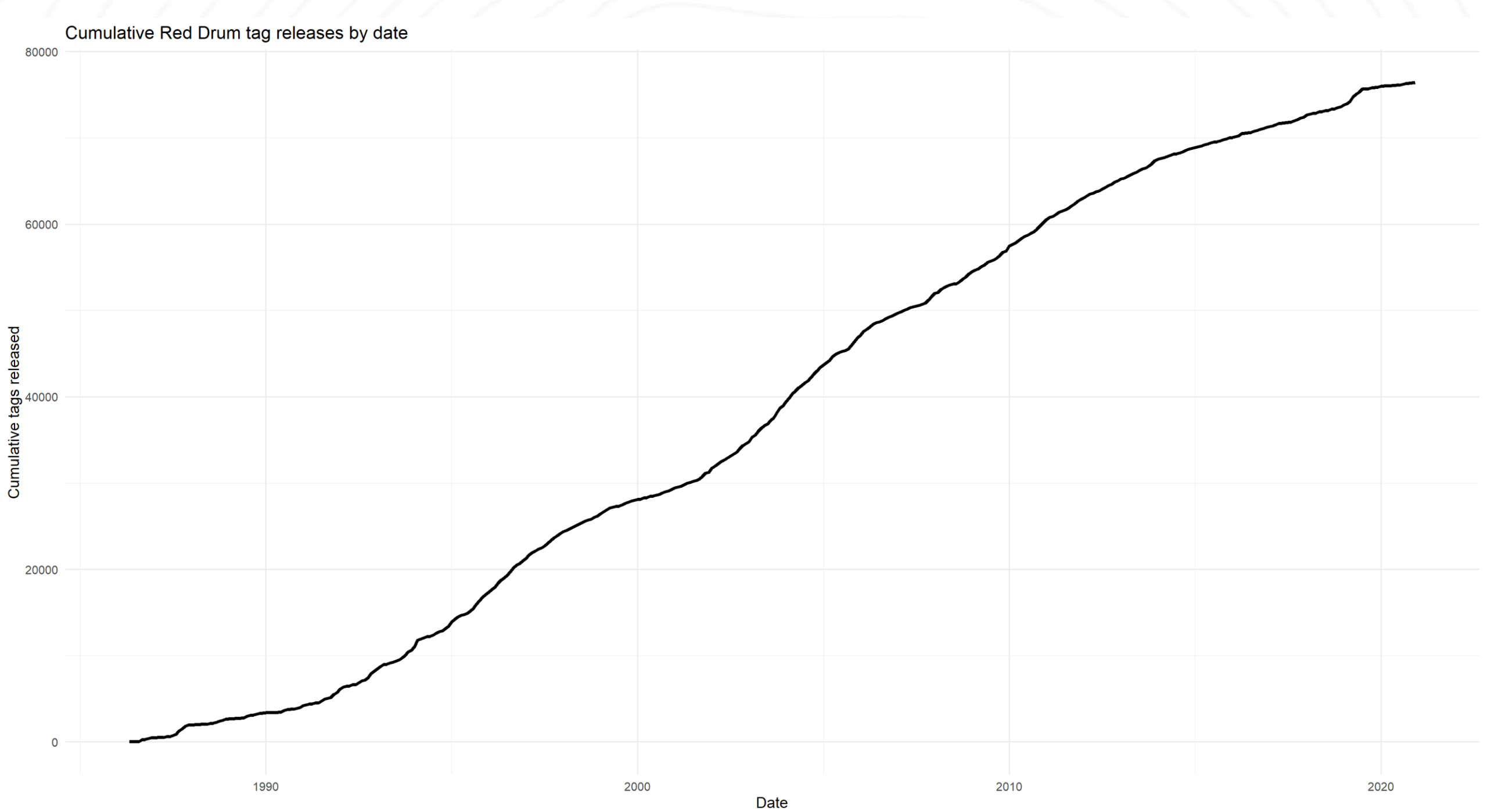
≥ 55 cm TL

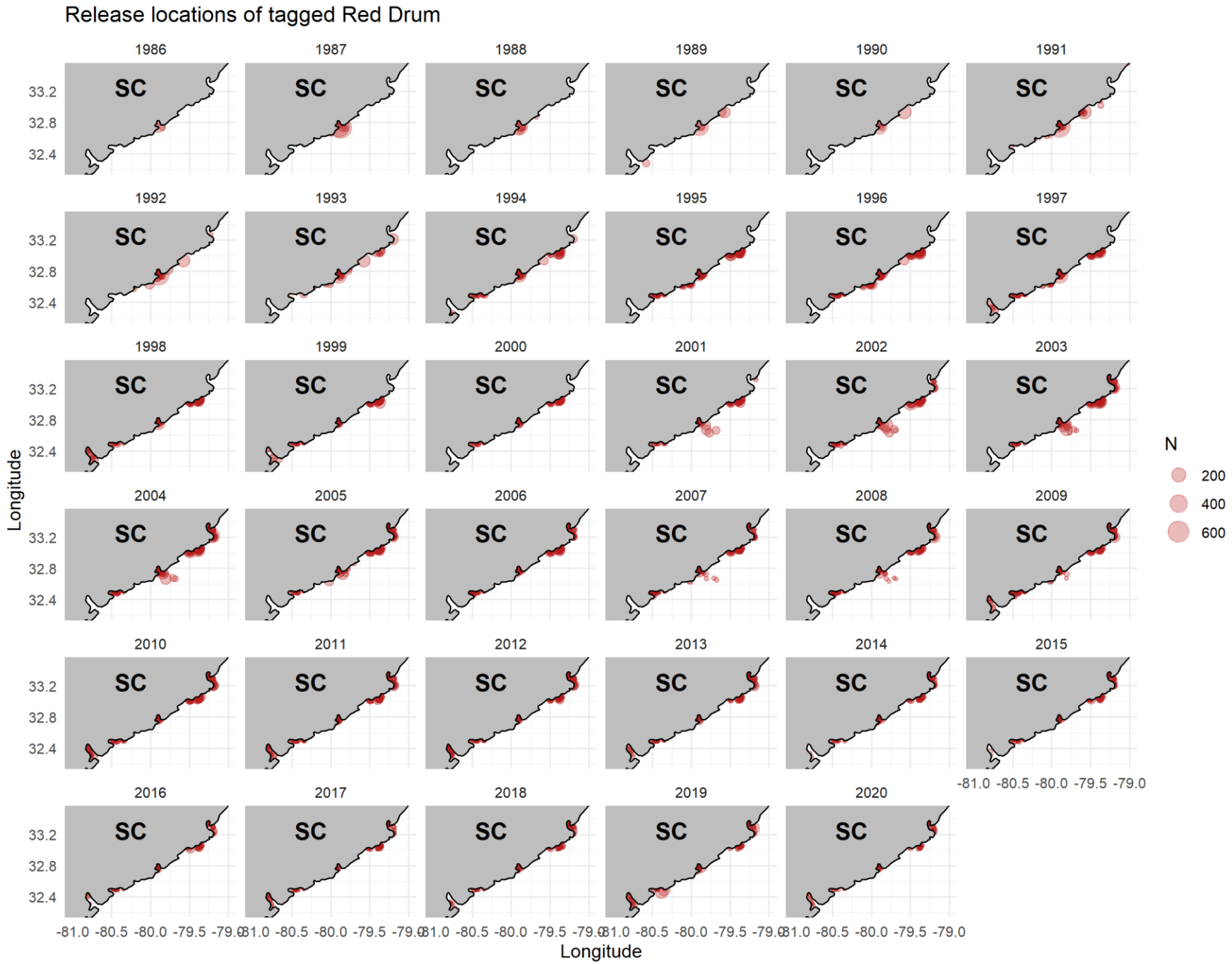
Length Compositions



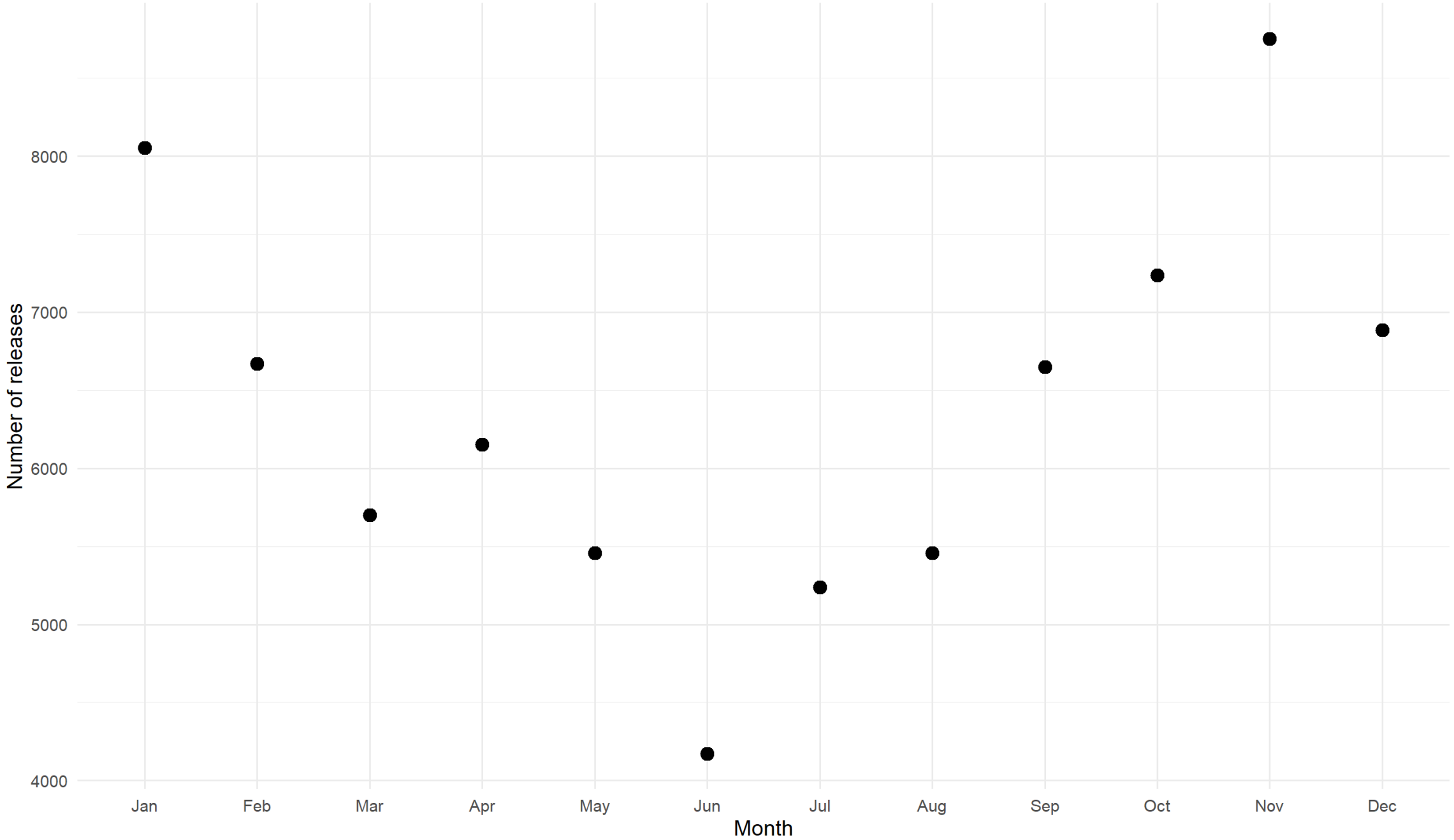
Number of tagged Red Drum released by SCDNR each year
(N = 76,424)

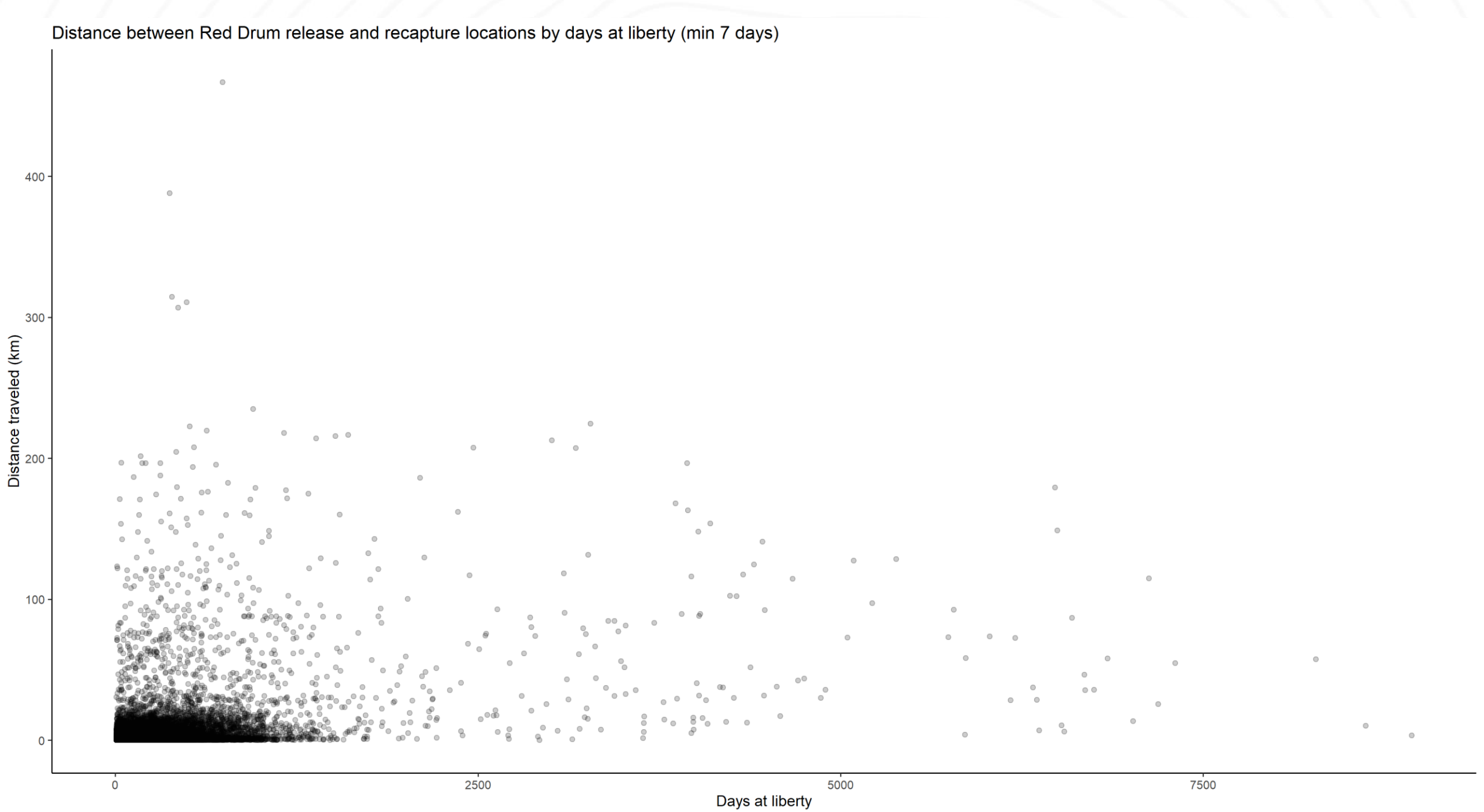



Cumulative Red Drum tag releases by date
80000
60000
40000
20000
0
Cumulative tags released
1990
2000
2010
2020
Date


Release locations of tagged Red Drum
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
SC
33.2
32.8
32.4
Longitude
-81.0 -80.5 -80.0 -79.5 -79.0
Longitude
N
200
400
600

Number of tagged Red Drum released by SCDNR each month
(N = 76,424)




Distance between Red Drum release and recapture locations by days at liberty (min 7 days)
Distance traveled (km)
400
300
200
100
0
0
2500
5000
7500
Days at liberty

Overview of model(s) used to estimate annual survival

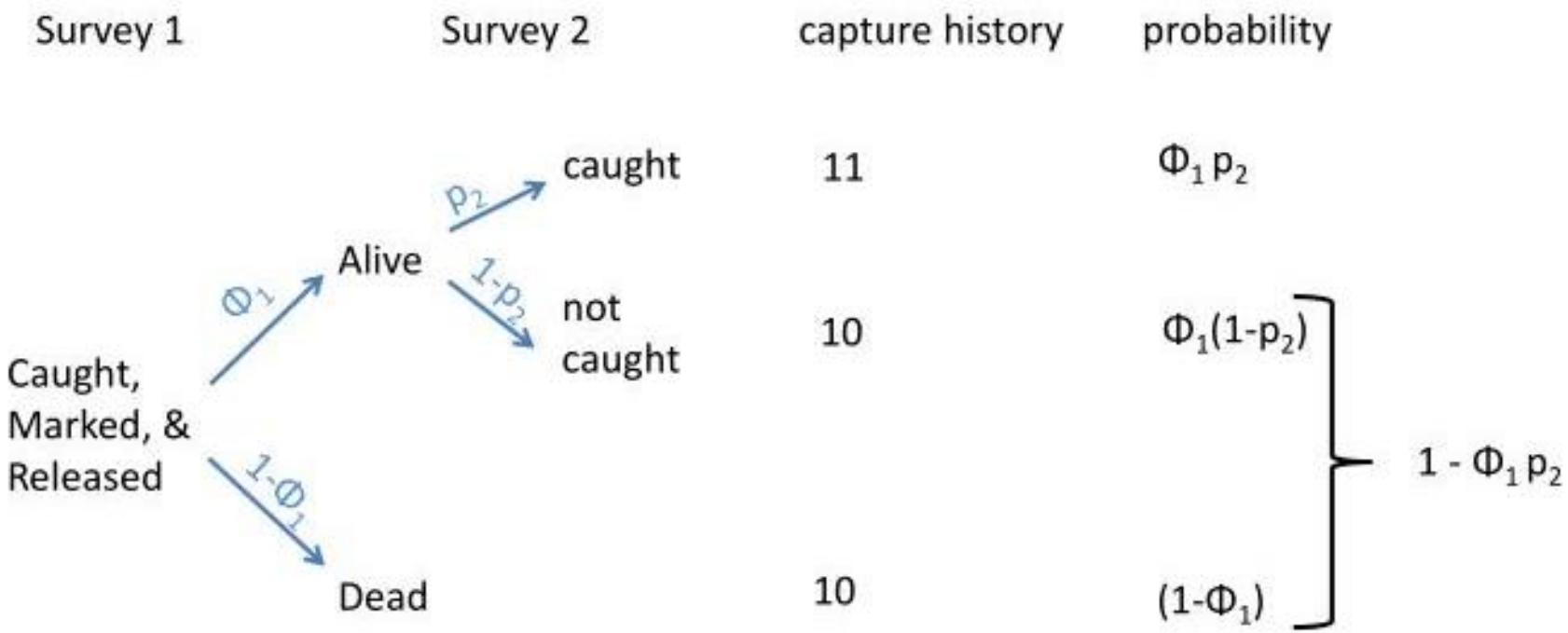
Cormack-Jolley-Seber (CJS) Models

- Capture-recapture framework
- Open population
- Estimate apparent survival and encounter probability
- Used wildly in ecology and fisheries

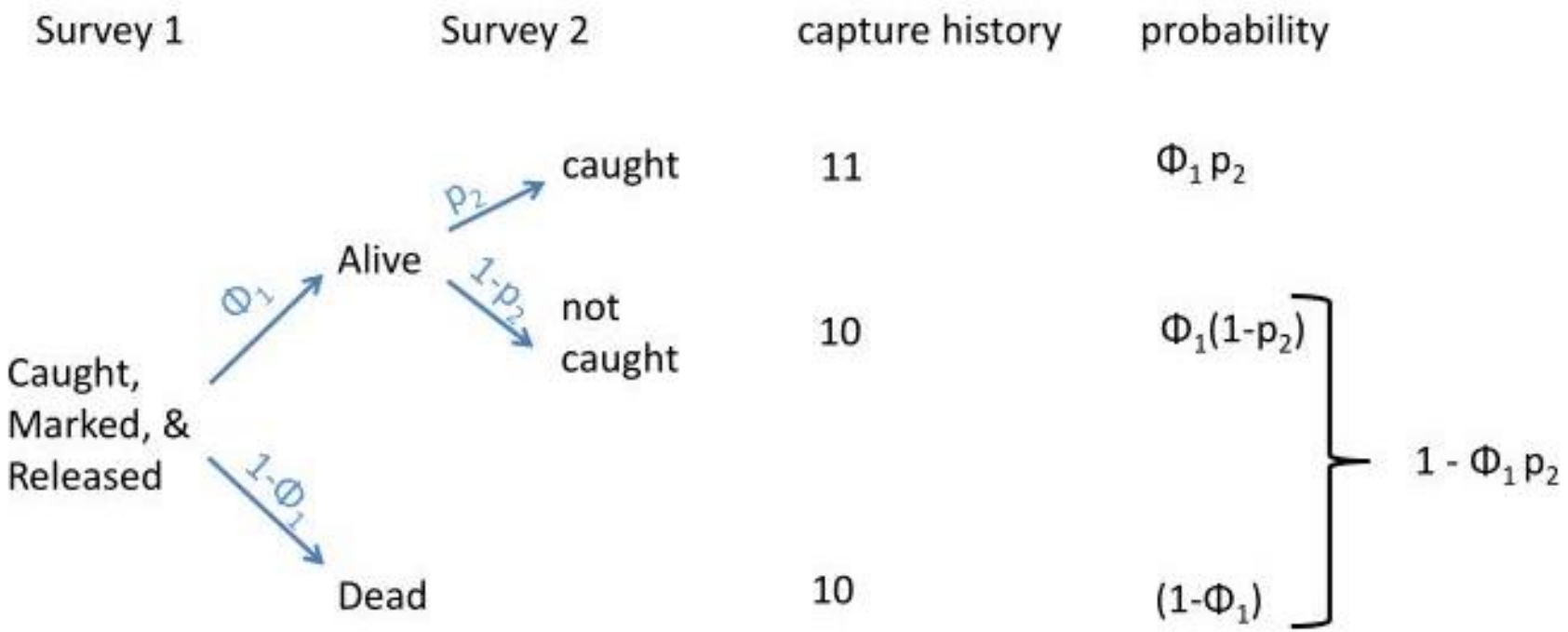
CJS Assumptions (Pollock et al. 1990)

- Every marked animal at period *i* has the same probability of capture
- Every marked animal at period *i* has the same probability of survival to period *i* + 1
- Marks are not lost, overlooked, or mis-recorded
- Sampling periods are instantaneous (or relatively short), and releases are made immediately following sampling

CJS Capture Probabilities



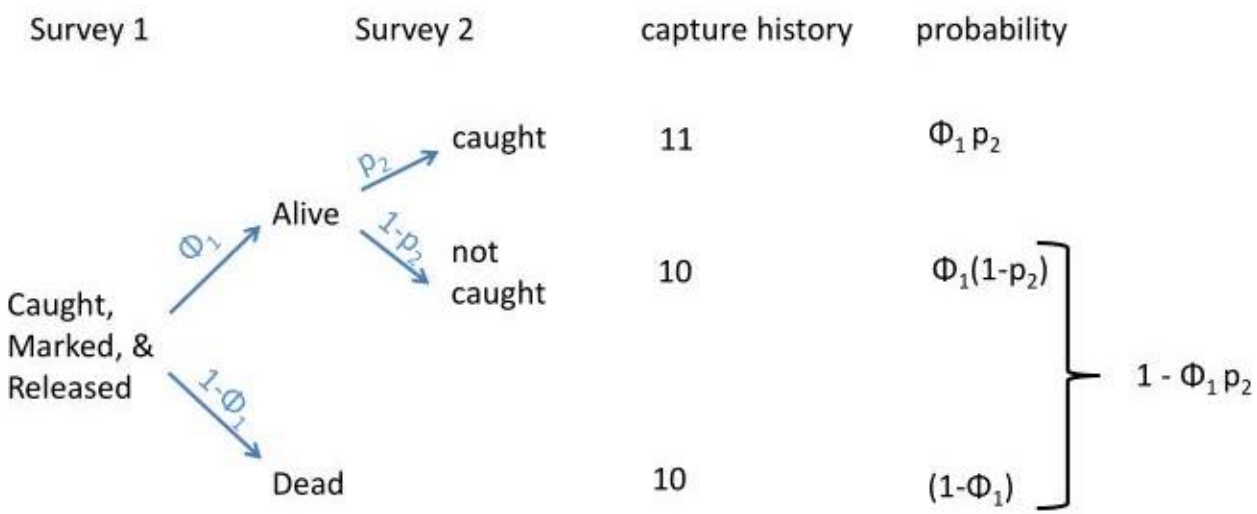
CJS Capture Probabilities



Multinomial Distribution:

$$P(X = \{x_1, x_2, \ldots, x_c\}) = \frac{N!}{(x_1!)(x_2!)\ldots(x_c!)} p_1^{x_1} p_2^{x_2} \ldots p_c^{x_c}$$

CJS Capture Probabilities



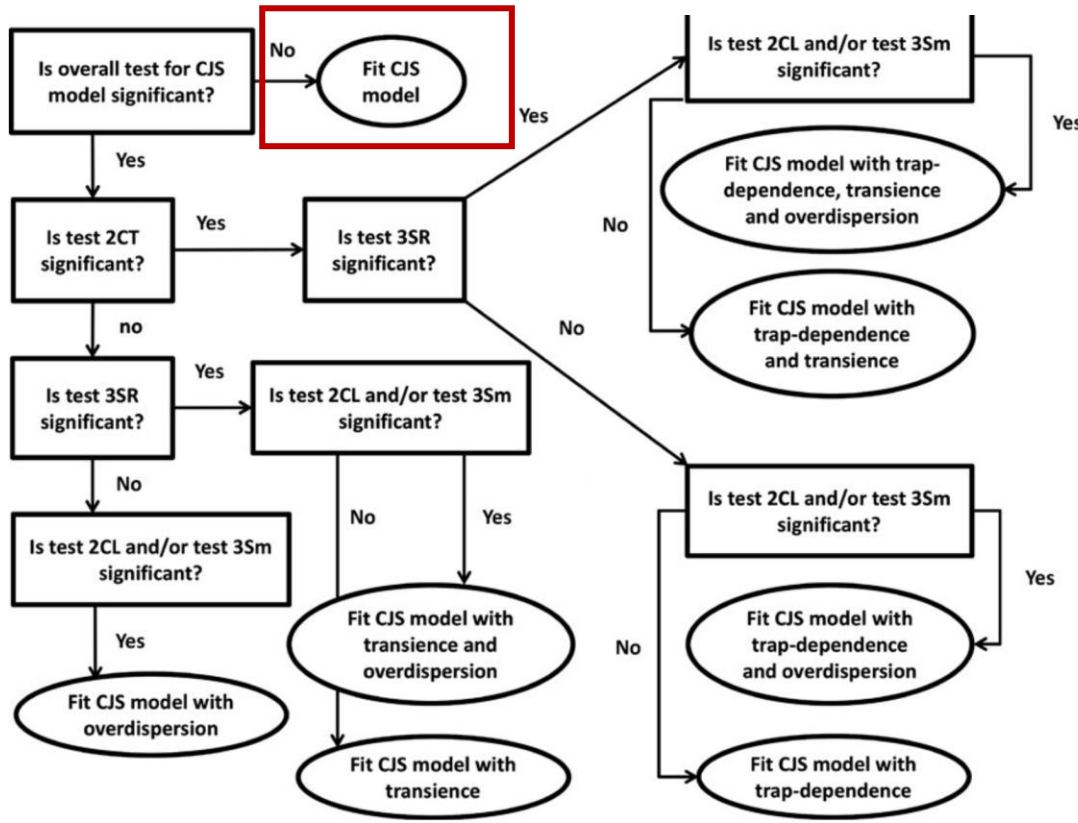
Our CJS Data

- Yearly timestep
- Used capture periods of Sept-Dec. (1990-2022)
- Aggregated SCDNR survey data
  - Trammel net (1990), Electrofishing (2001), Longline (2007)
- 24,555 individual red drum capture histories
  - 638 with at least one recapture following release period
- Assigned release age (1-3+) based on length (SCDNR ALKs)

Goodness of fit (GOF) testing

- R2ucare package
  - Overall_CJS function, testing for trap-dependence and transient effects using chi-sq contingency tables

age	chi2	degree_of_freedom	p_value
1	52.606	83	0.996
2	76.056	75	0.444
3+	16.004	41	1.000



Results of tagging analyses

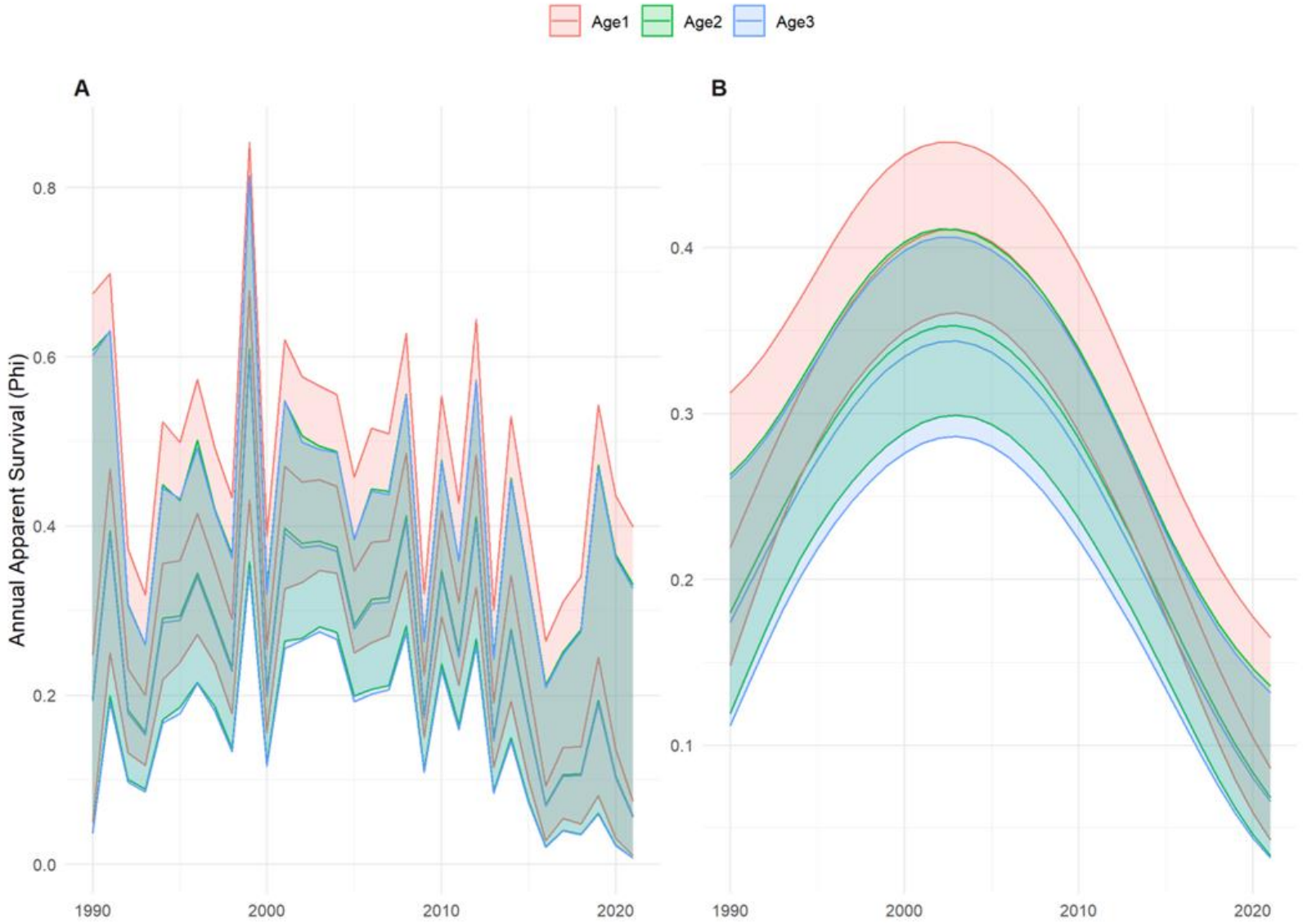
CJS Candidate Models

- Phi (apparent survival)
  - ~ 1, age, time, age+time, age*time
- p (encounter)
  - ~1, period (1990-2000, 2001-2006, 2007-2022), age, age+period, age*period
- Model every possible combination (25 candidate models) and select based on AIC

CJS Results

MODEL	NPAR	DELTA_AIC
Phi(~age * time)p(~age * period)	105	0
Phi(~age + time)p(~age)	37	1
Phi(~age * time)p(~age)	99	2
Phi(~age + time)p(~period + age)	39	2
Phi(~time)p(~age)	35	2
Phi(~age * time)p(~period + age)	101	2
Phi(~time)p(~period + age)	37	3
Phi(~time)p(~age * period)	41	8
Phi(~age * time)p(~1)	97	9
Phi(~age * time)p(~period)	99	9
Phi(~age + time)p(~1)	35	12
Phi(~age + time)p(~period)	37	13
Phi(~age + time)p(~age * period)	43	15
Phi(~1)p(~period + age)	6	37
Phi(~age)p(~period + age)	8	38
Phi(~1)p(~age * period)	10	41
Phi(~time)p(~1)	33	42
Phi(~age)p(~age * period)	12	42
Phi(~time)p(~period)	35	43
Phi(~age)p(~period)	6	49
Phi(~1)p(~age)	4	66
Phi(~age)p(~age)	6	66
Phi(~age)p(~1)	4	76
Phi(~1)p(~period)	4	76
Phi(~1)p(~1)	2	99

CJS Results


Age1
Age2
Age3
A
B
Annual Apparent Survival (Phi)
0.0
0.2
0.4
0.6
0.8
0.1
0.2
0.3
0.4
1990
2000
2010
2020

Questions/Discussion

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