Chinook salmon smolt mortality hotspots on the Sacramento River

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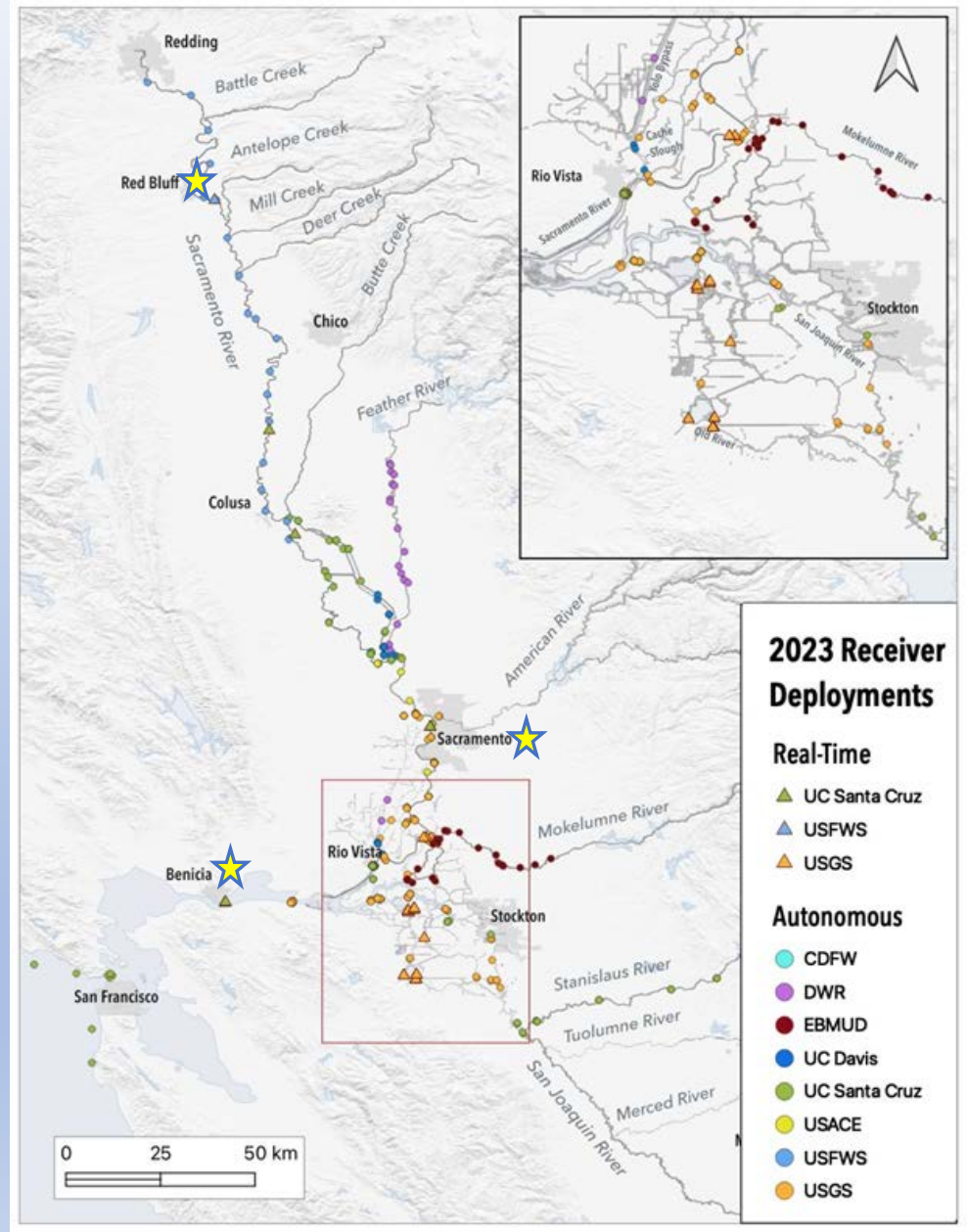
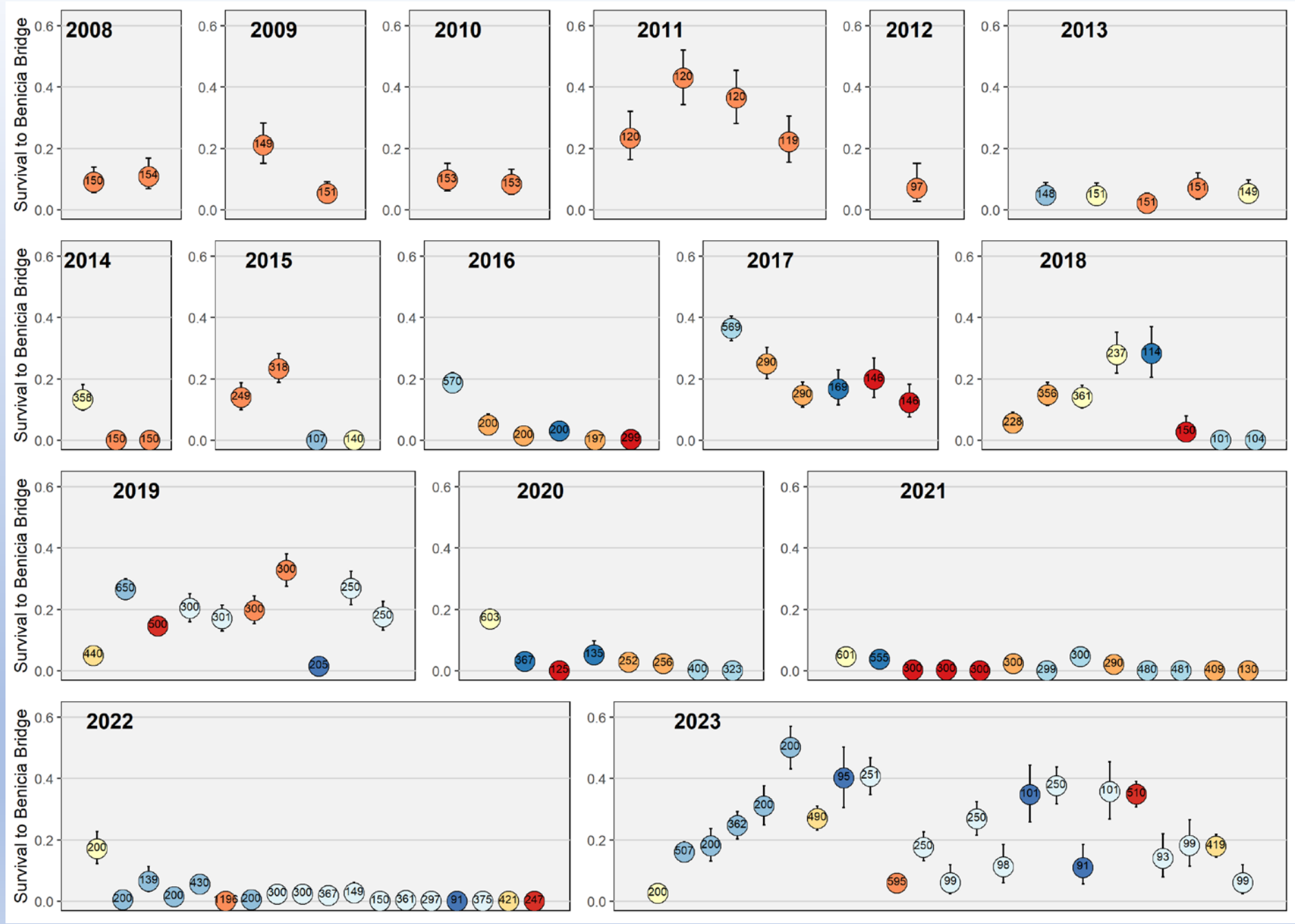
Acoustic telemetry in the Sacramento Basin

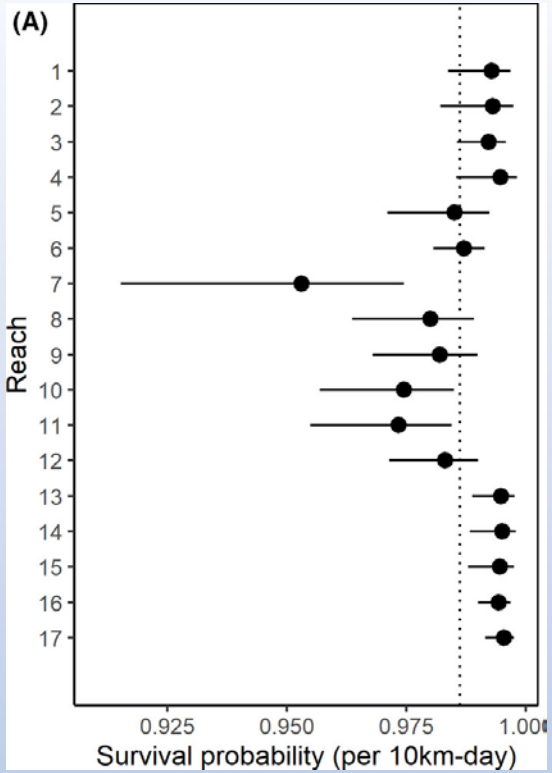
- **JSATS** – Juvenile Salmon Acoustic Telemetry System
- Minimum fish size > 80mm, 6.0 g
- Unique ID for each tag, pings every 5 seconds for up to 40 days



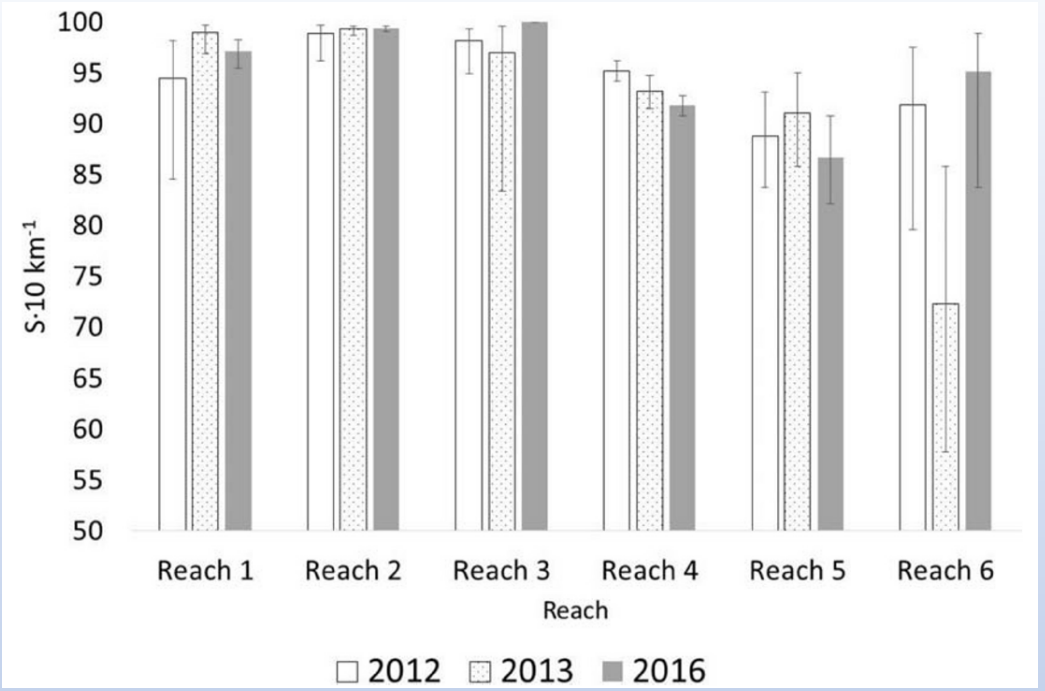

Survival to Benicia Bridge
0.0
0.2
0.4
0.6
2008
150
154
2009
149
151
2010
153
153
2011
120
120
120
119
2012
97
2013
148
151
151
151
149
2014
358
150
150
2015
249
318
107
140
2016
570
200
200
200
197
299
2017
569
290
290
169
146
146
2018
228
356
361
237
114
150
101
104
2019
440
650
500
300
301
300
300
250
250
205
2020
603
367
125
135
252
256
400
323
2021
601
555
300
300
300
300
299
300
290
480
481
409
130
2022
200
200
139
200
430
196
200
300
300
367
149
150
361
297
91
375
421
247
2023
200
507
200
362
200
490
95
251
595
250
99
250
98
101
250
91
101
510
93
99
419
99

So where are the mortality hotspots?

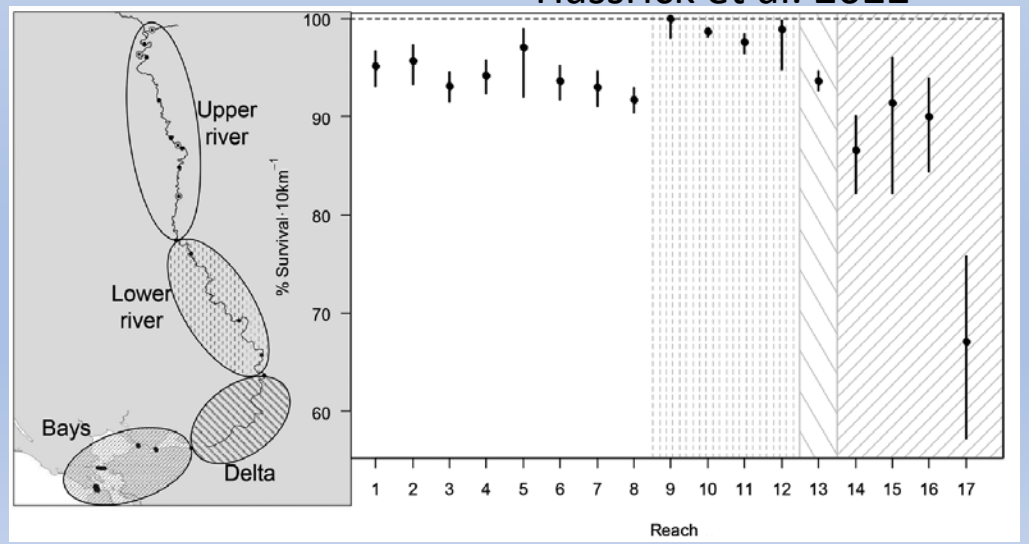
It can be hard to synthesize and visualize…



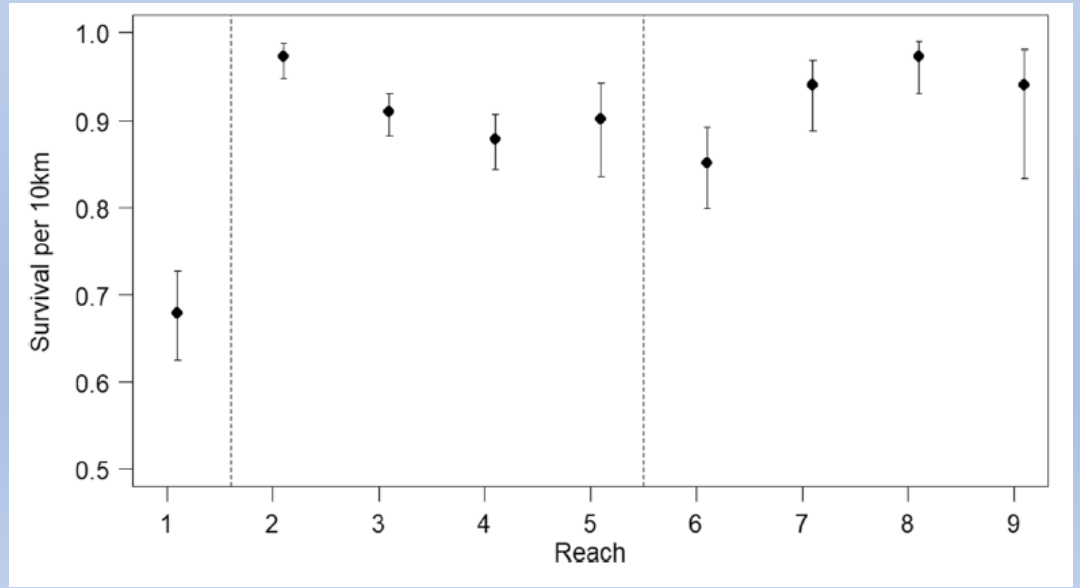
Hassrick et al. 2022



Zeug et al. 2020



Michel et al. 2015



Notch et al. 2020

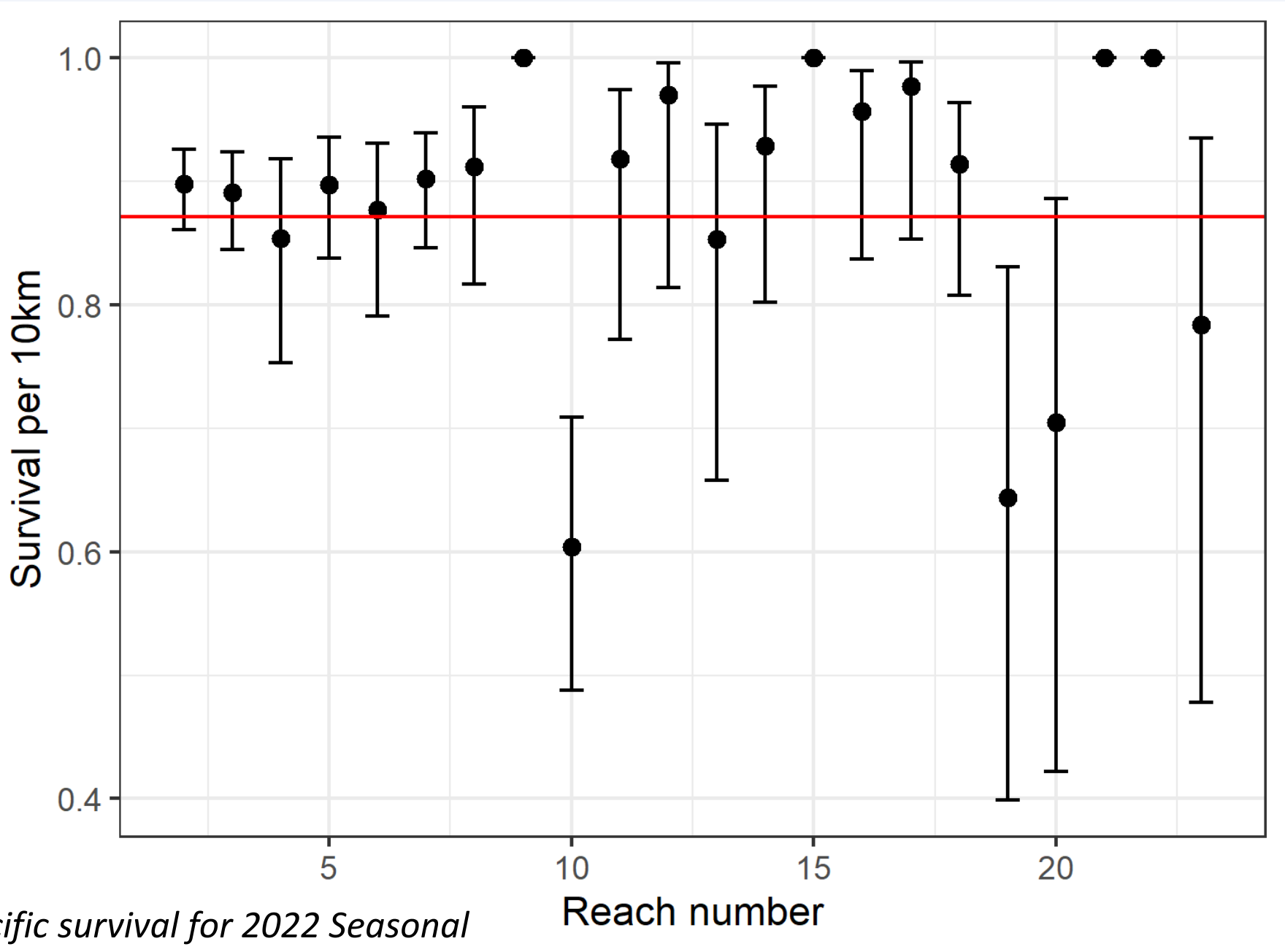
Can we synthesize reach survival information from 13 years?

- **Some receiver sites perform poorly** in some years. This can be due to:
  - High flows
  - Vandalism/theft
  - Receiver malfunction
  - Burial
- **Some receivers are moved** from year to year

➢ **PROBLEM 1:** For these reasons, it is difficult to select receiver sites that are permanent and consistently perform well across many years so as to combine annual datasets

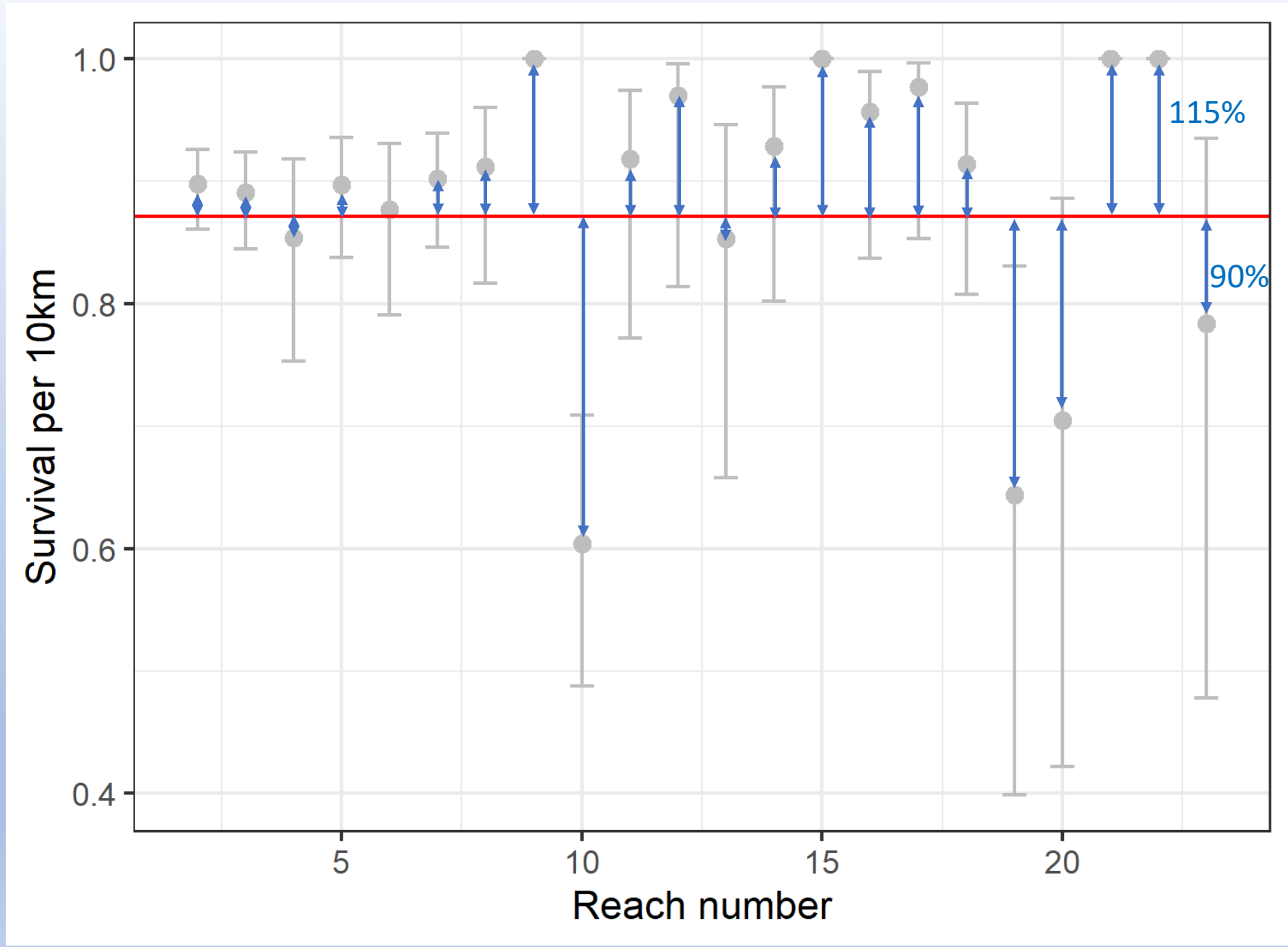
Can we synthesize reach survival information from 13 years?

- We must also consider that survival **also varies as a function of non-spatial drivers**, such as:
  - Water year
  - Source population
  - Size at release
  - *Etc…*
- ➢ Therefore, a multi-year spatial analysis of survival should factor these out so release groups are ***comparable***
  - *For example, with a random effect of release group*
  - **PROBLEM 2**: random effects are not supported in typical CJS modeling software



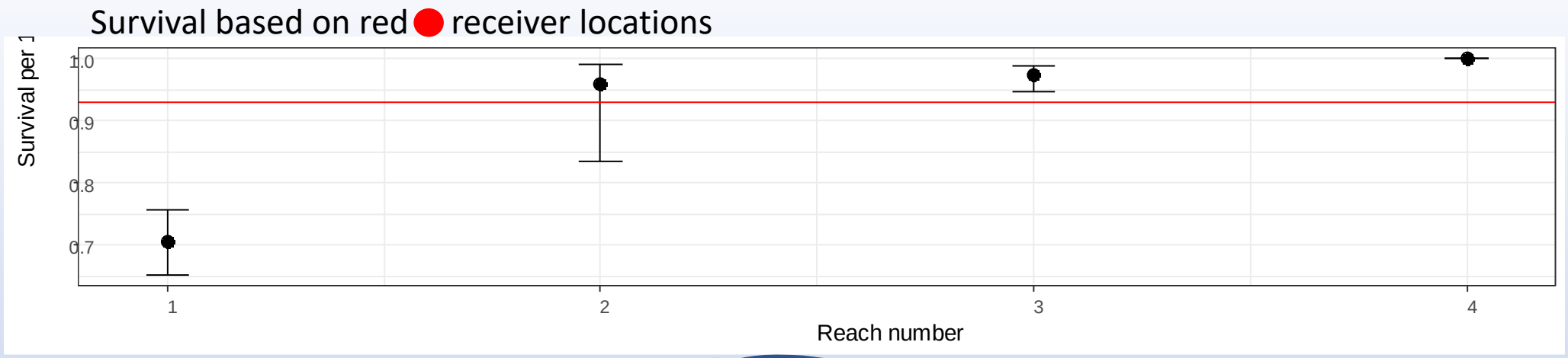
Survival per 10km for whole migration, i.e., ~mean survival per 10km

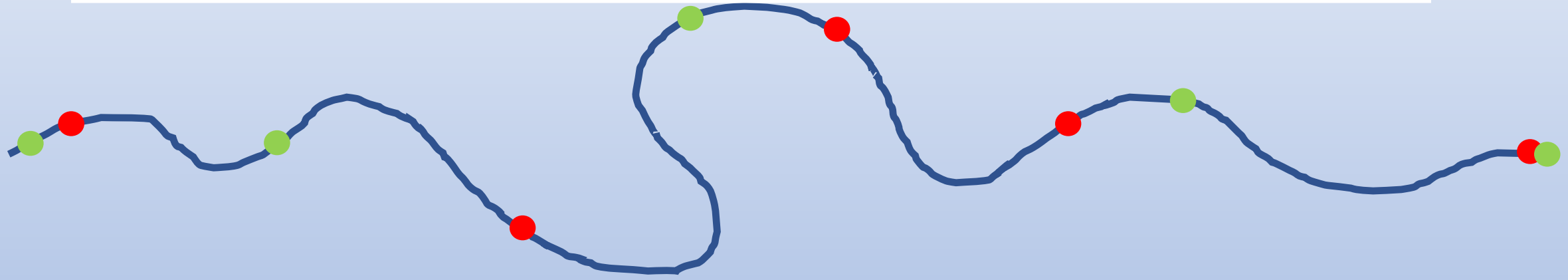
Reach specific survival for 2022 Seasonal survival project, release group 4

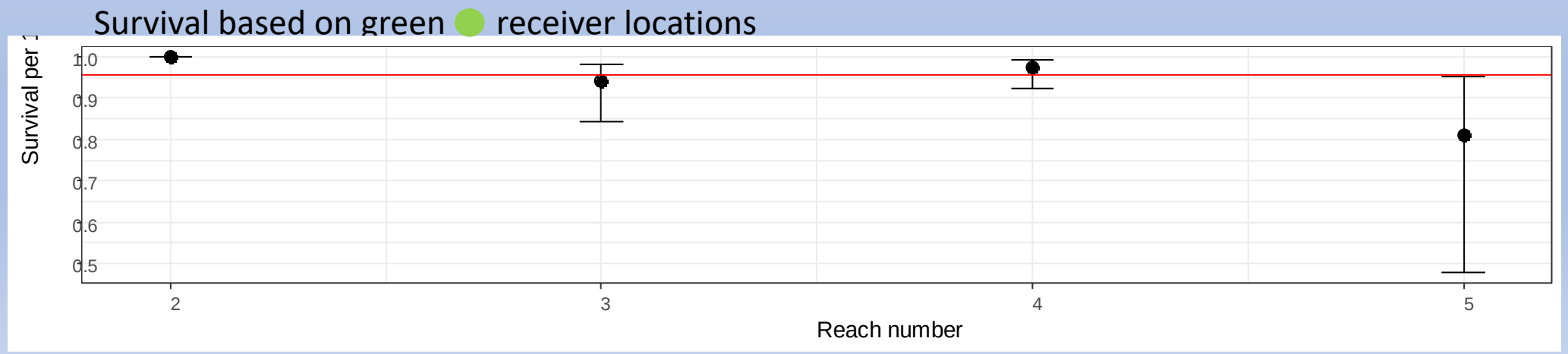


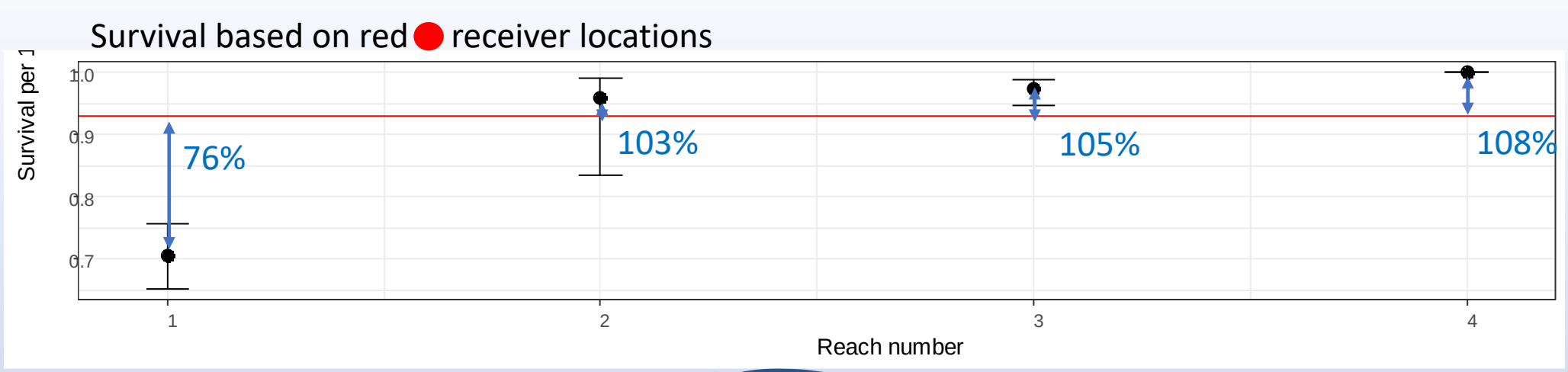
We can estimate percent change over full migration survival per 10km

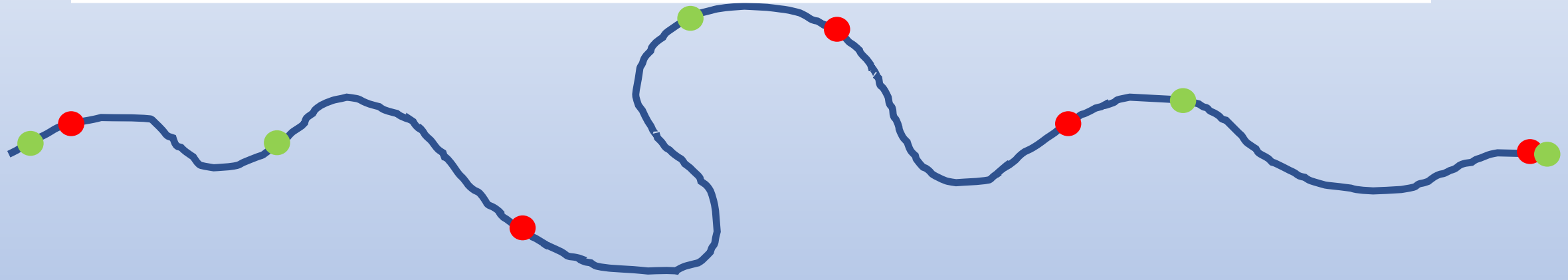
Workaround for PROBLEM 2

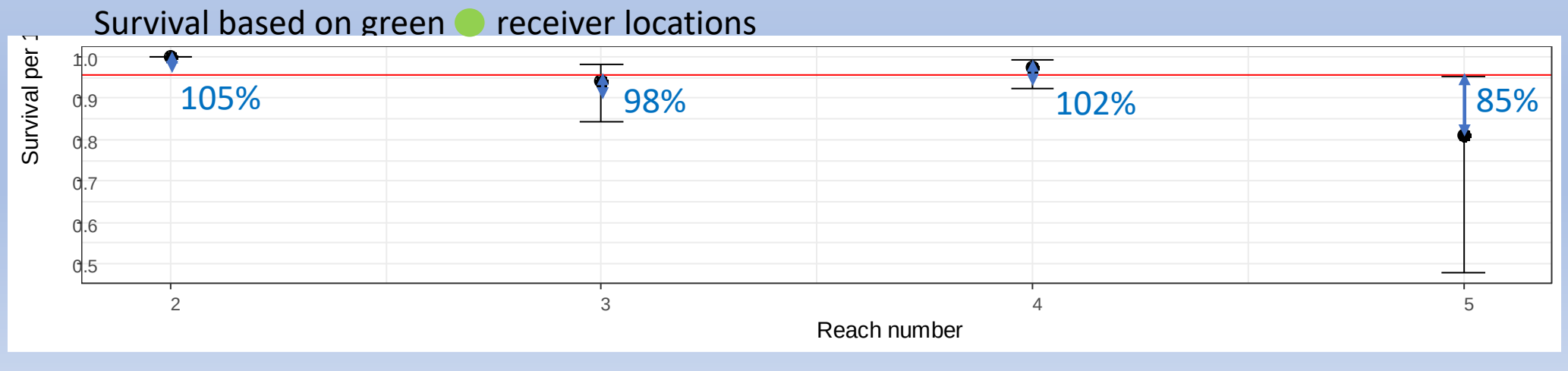

Survival based on red receiver locations
Survival per 1
1.0
0.9
0.8
0.7
1
2
3
4
Reach number

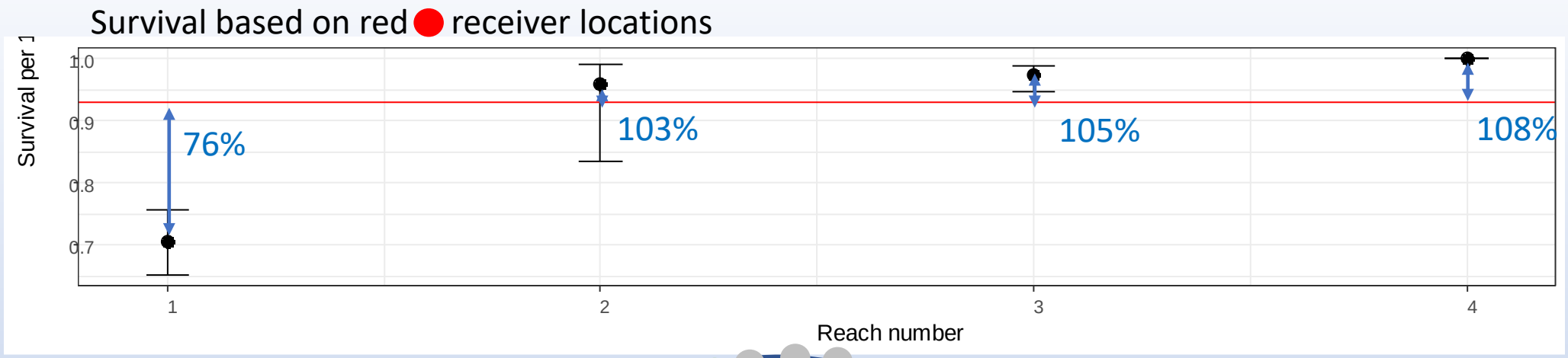


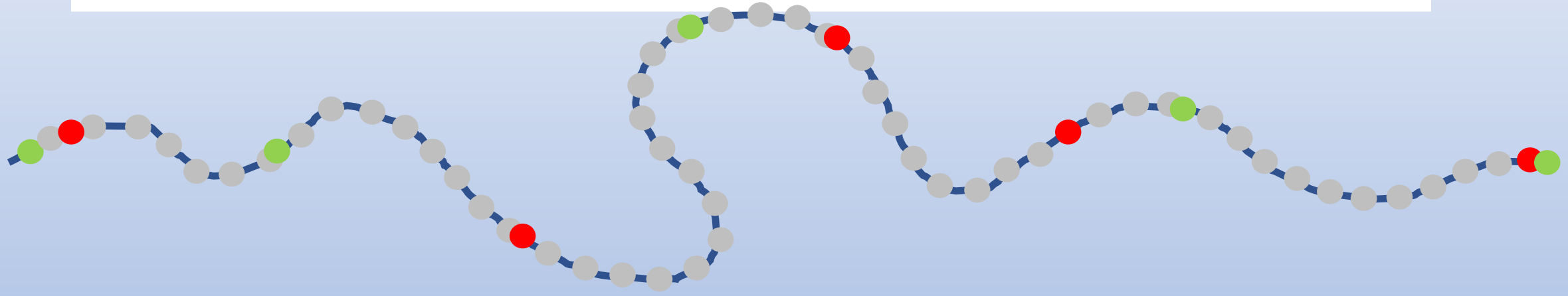

Survival based on green receiver locations
Survival per 1
1.0
0.9
0.8
0.7
0.6
0.5
2
3
4
5
Reach number

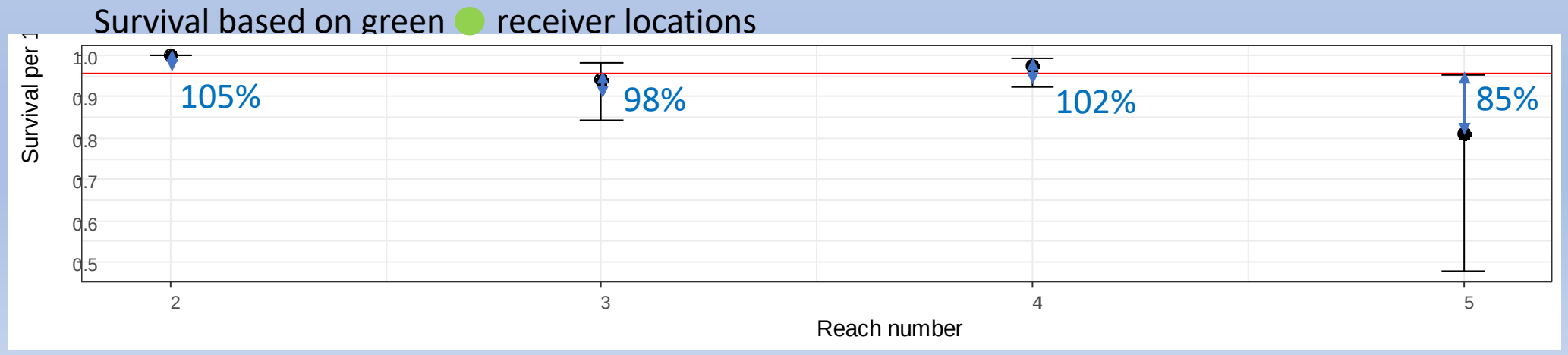

Survival based on red receiver locations
Survival per 1
1.0
0.9
0.8
0.7
76%
103%
105%
108%
1
2
3
4
Reach number

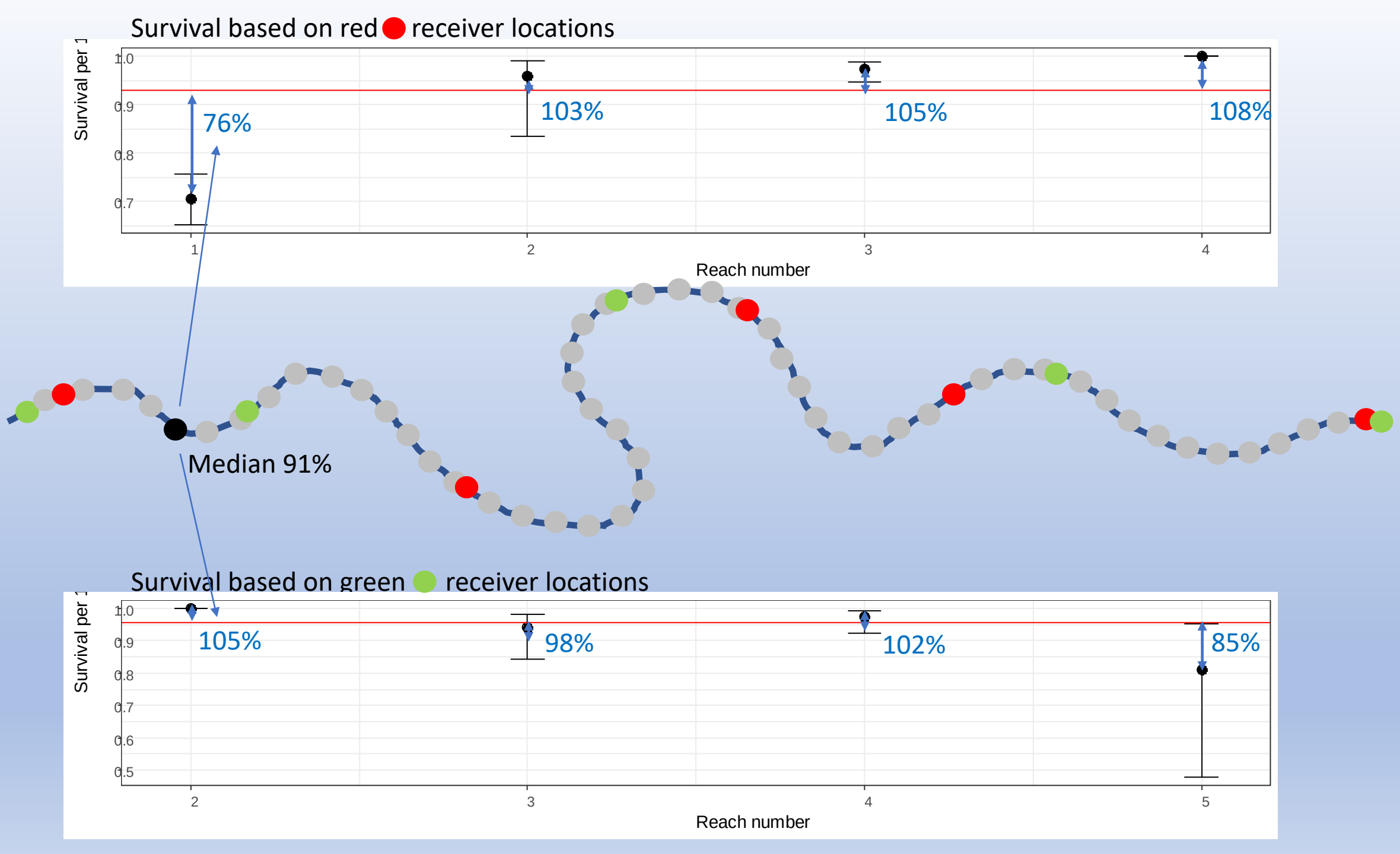


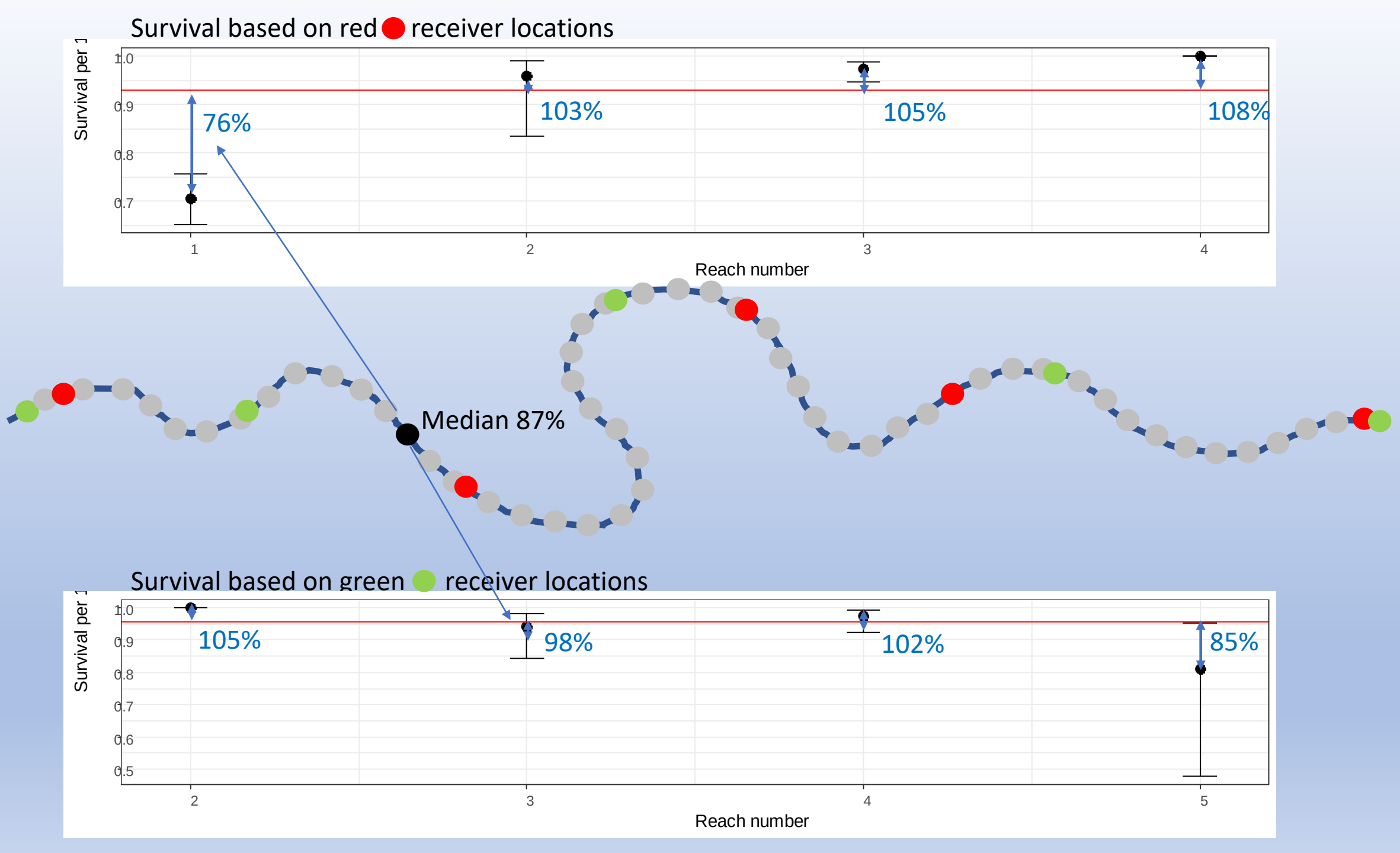

Survival based on green receiver locations
Survival per 1
1.0
0.9
0.8
0.7
0.6
0.5
105%
98%
102%
85%
2
3
4
5
Reach number

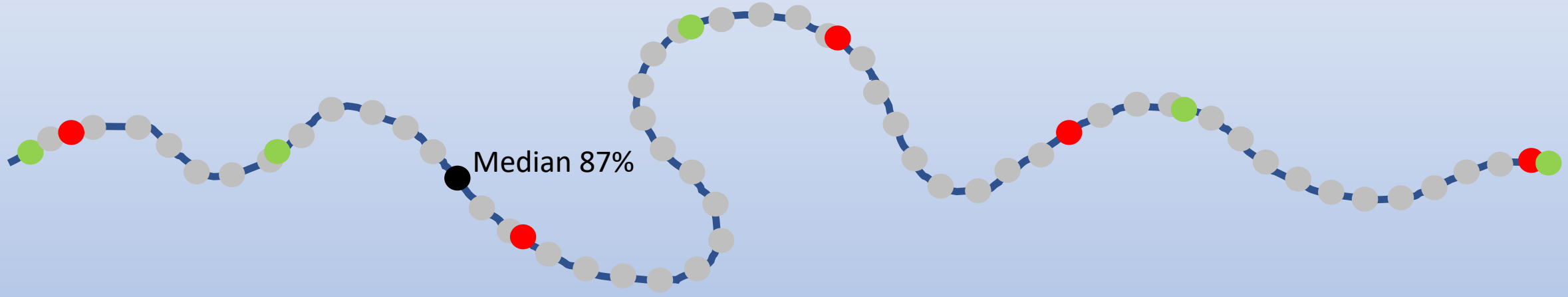

Survival based on red receiver locations
Survival per 1
1.0
0.9
0.8
0.7
76%
103%
105%
108%
1
2
3
4
Reach number




Survival based on green receiver locations
Survival per 1
1.0
0.9
0.8
0.7
0.6
0.5
105%
98%
102%
85%
2
3
4
5
Reach number


Survival based on red receiver locations
Survival per 1
1.0
0.9
0.8
0.7
76%
103%
105%
108%
1
2
3
4
Reach number
Median 91%
Survival based on green receiver locations
Survival per 1
1.0
0.9
0.8
0.7
0.6
0.5
105%
98%
102%
85%
2
3
4
5
Reach number


Survival based on red receiver locations
Survival per 1
1.0
0.9
0.8
0.7
76%
103%
105%
108%
1
2
3
4
Reach number
Median 87%
Survival based on green receiver locations
Survival per 1
1.0
0.9
0.8
0.7
0.6
0.5
105%
98%
102%
85%
2
3
4
5
Reach number



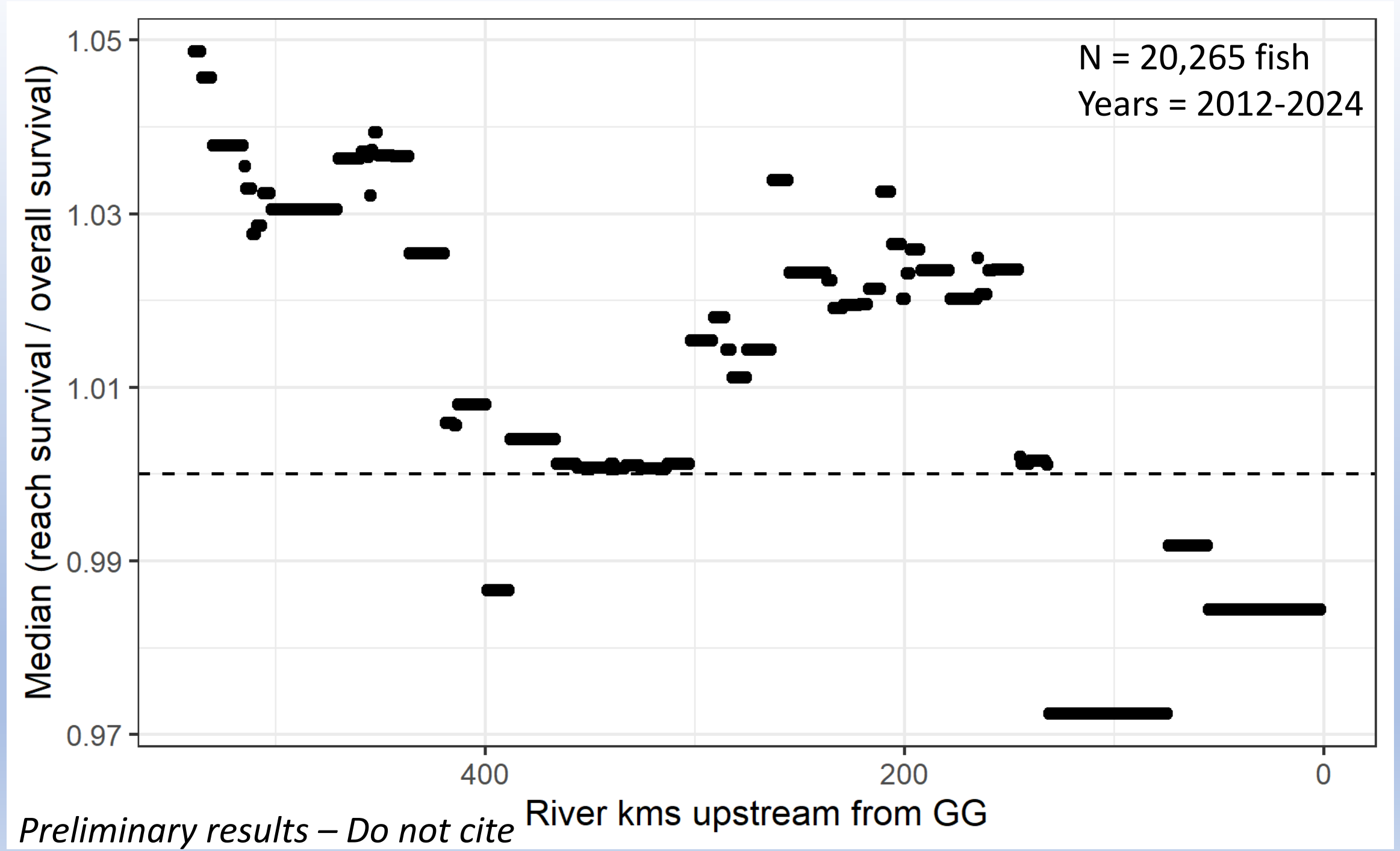
As an example: For riverkm 13, when comparing reach survival to mean survival across all release groups, survival is on median 87% lower than mean survival.

Workaround for PROBLEM 1

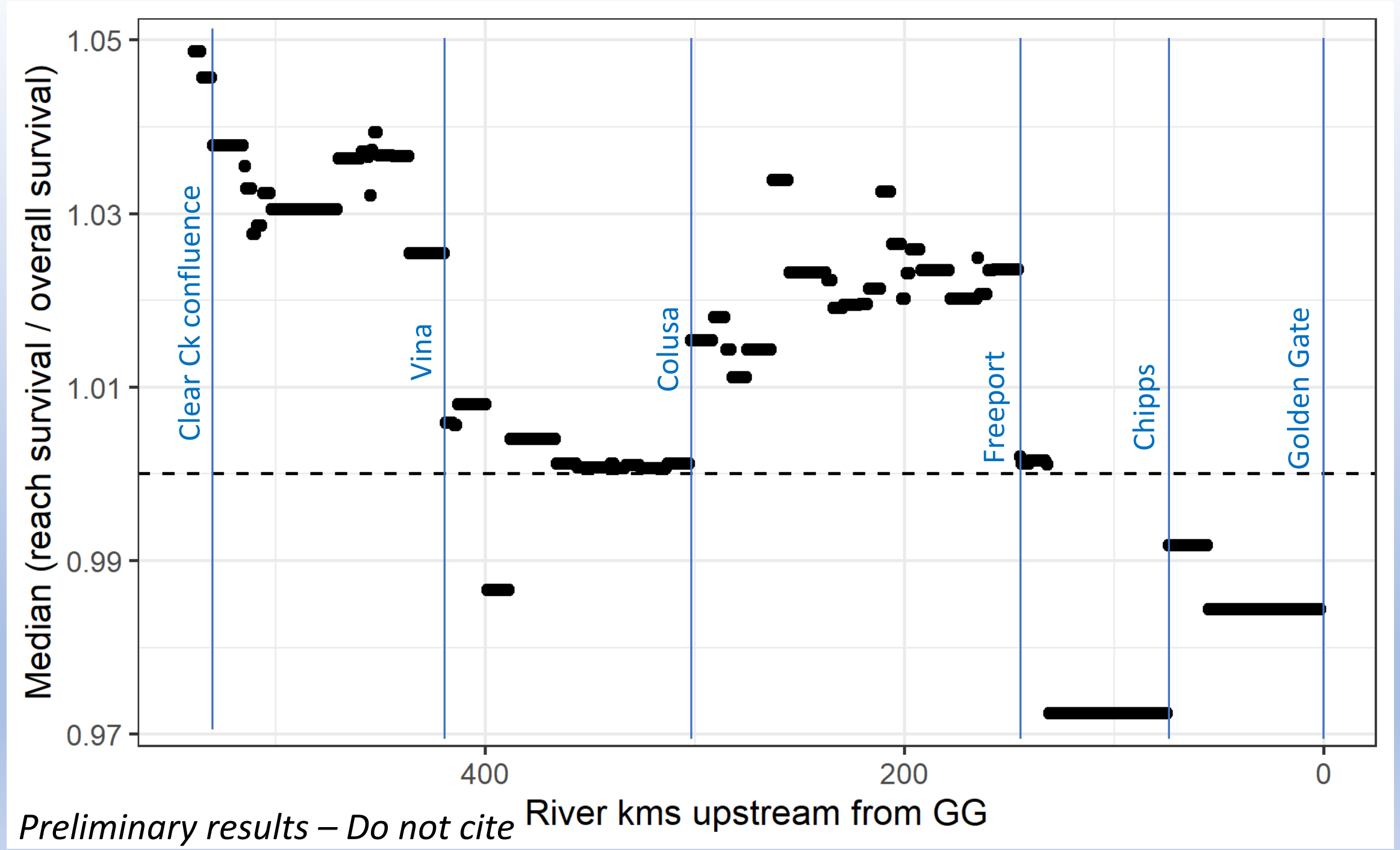
Disclaimer:

The results I'm going to show you are not the result of an 'analysis' in the classic sense. I am presenting a quick and easy way to synthesize and visualize publicly available survival estimates from 76 unique release groups over 13 years.

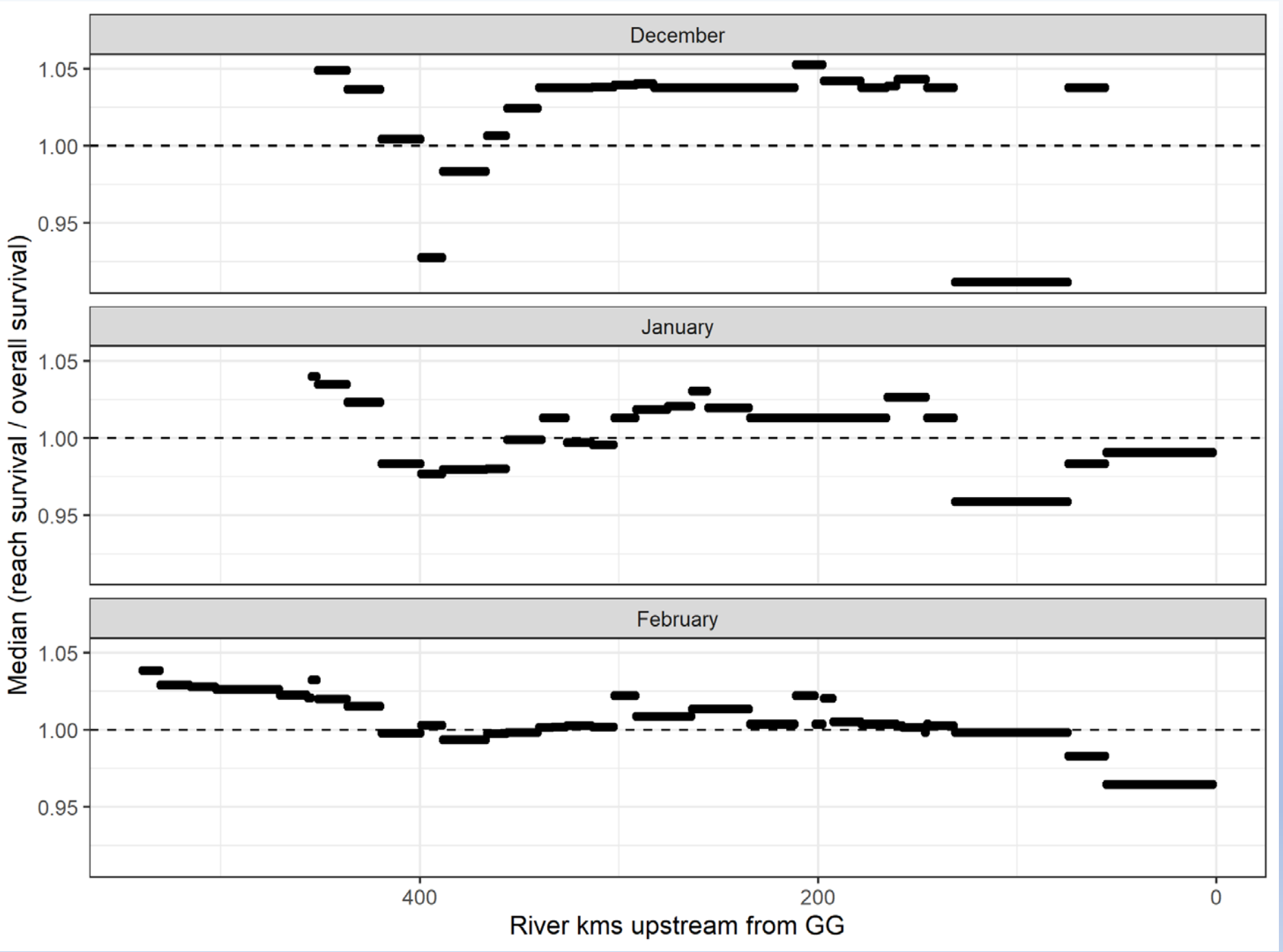
https://oceanview.pfeg.noaa.gov/shiny/FED/telemetry/



Preliminary results – Do not cite



Preliminary results – Do not cite

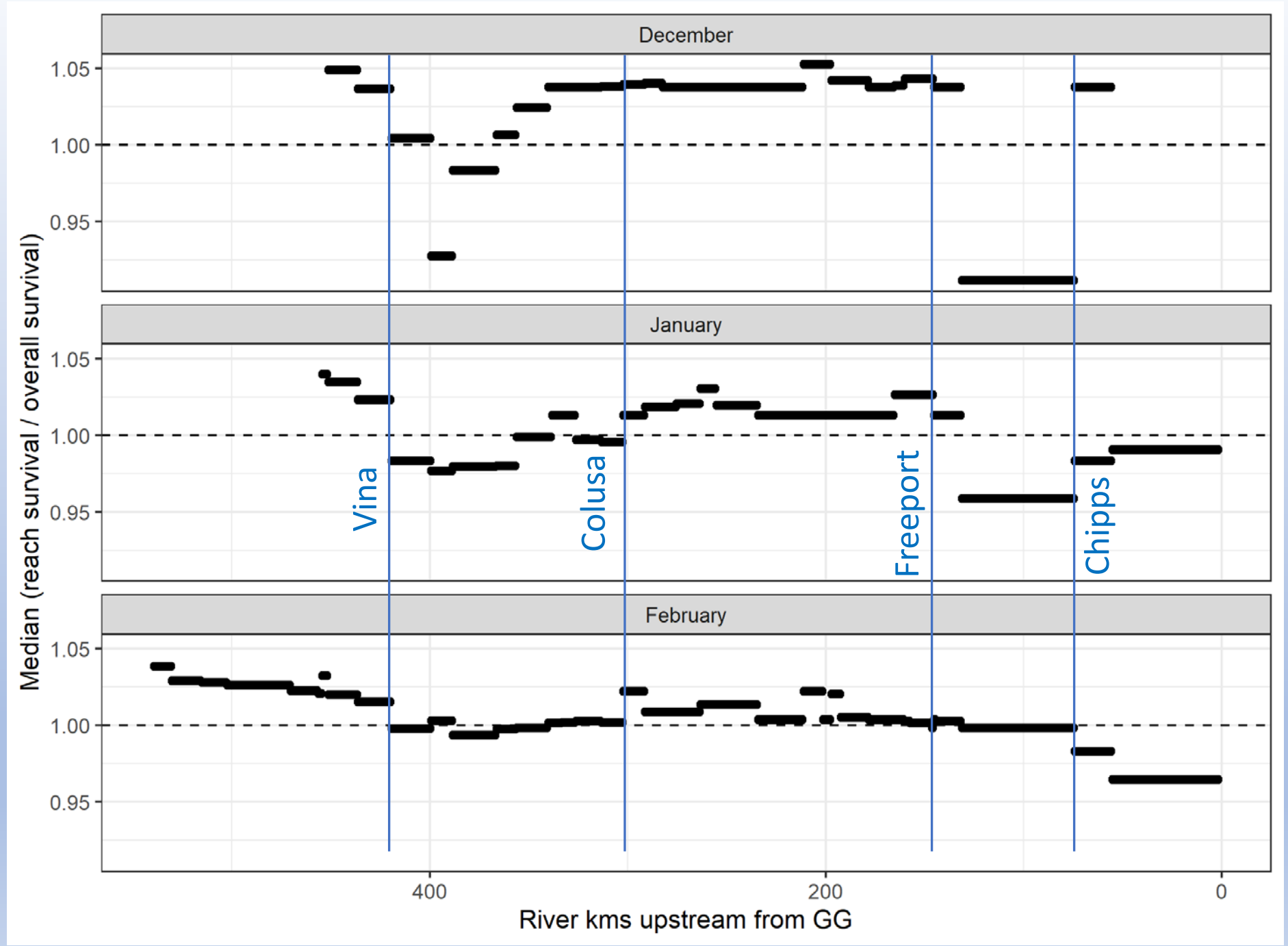


N = 1,181

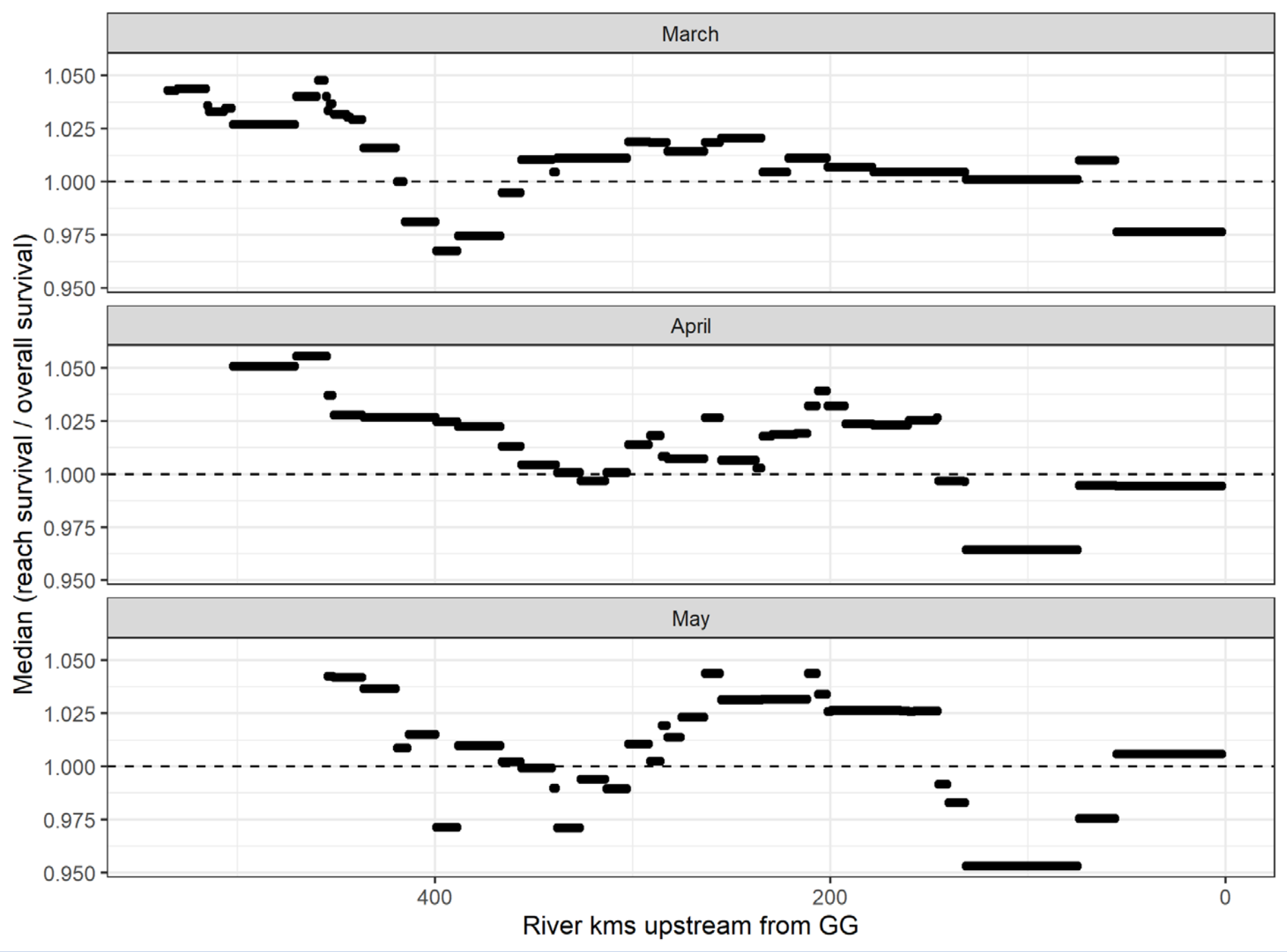
N = 1,913

N = 4,198

Preliminary results – Do not cite



Preliminary results – Do not cite

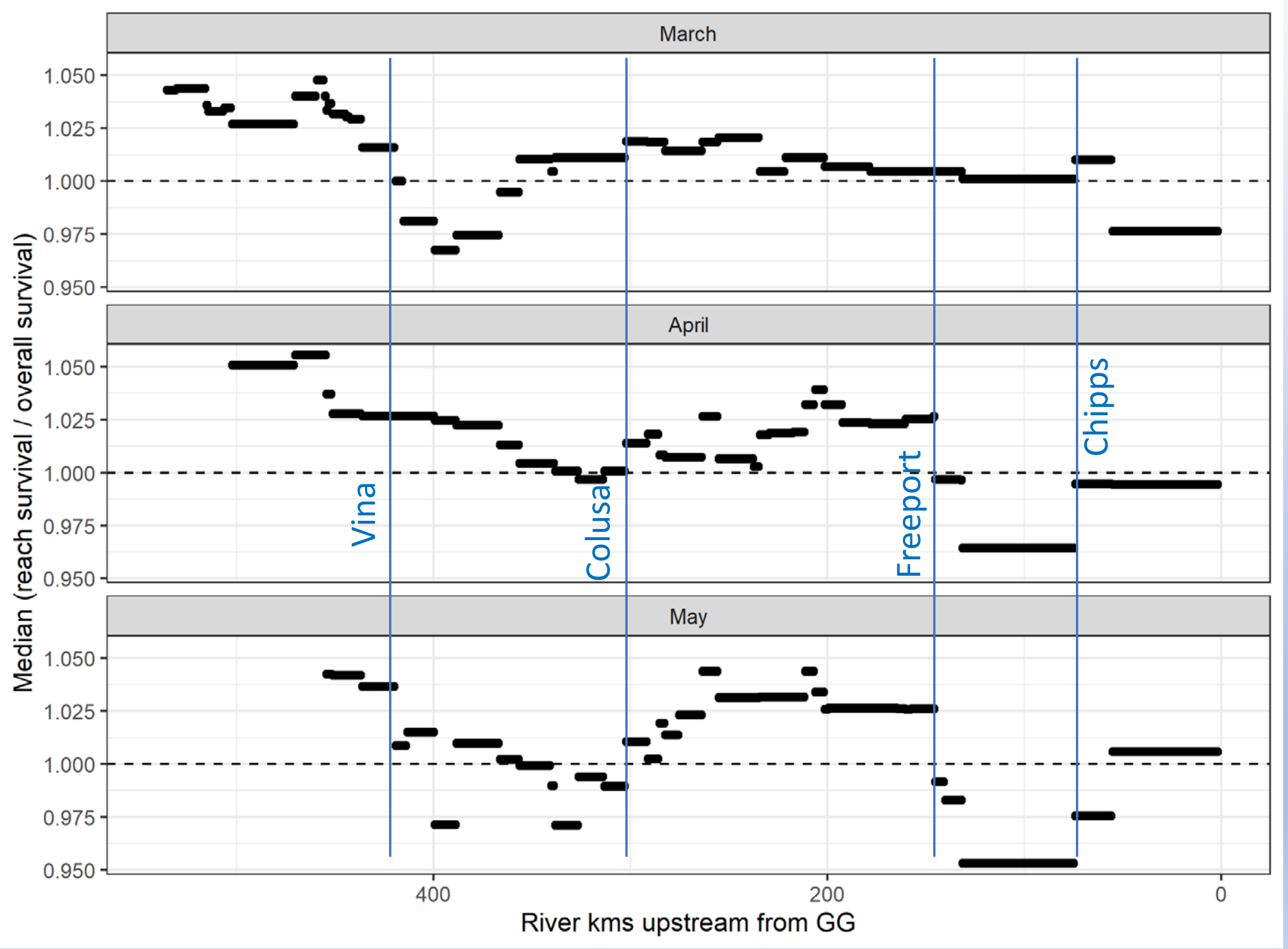


N = 4,126

N = 4,684

N = 3,677

Preliminary results – Do not cite



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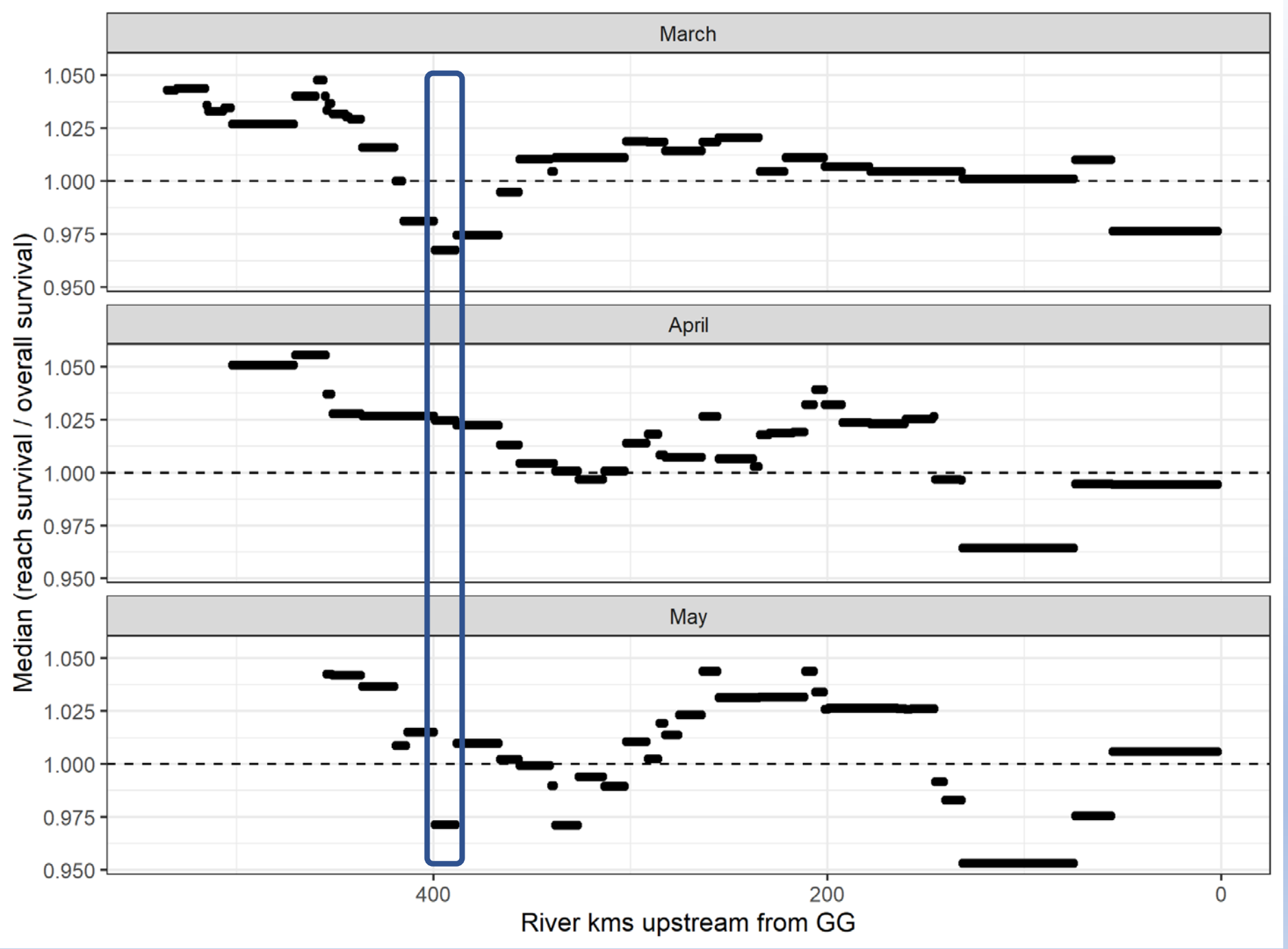
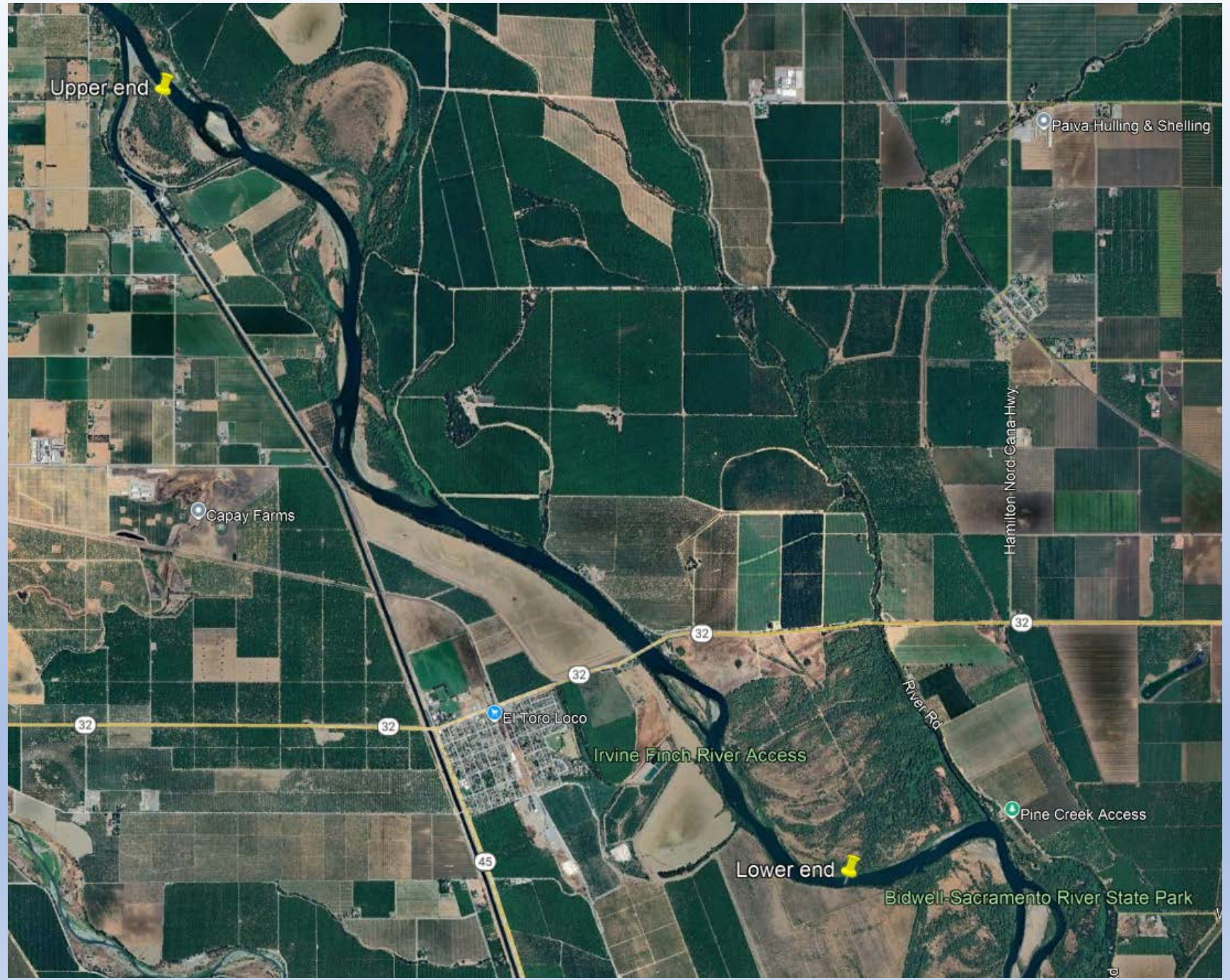


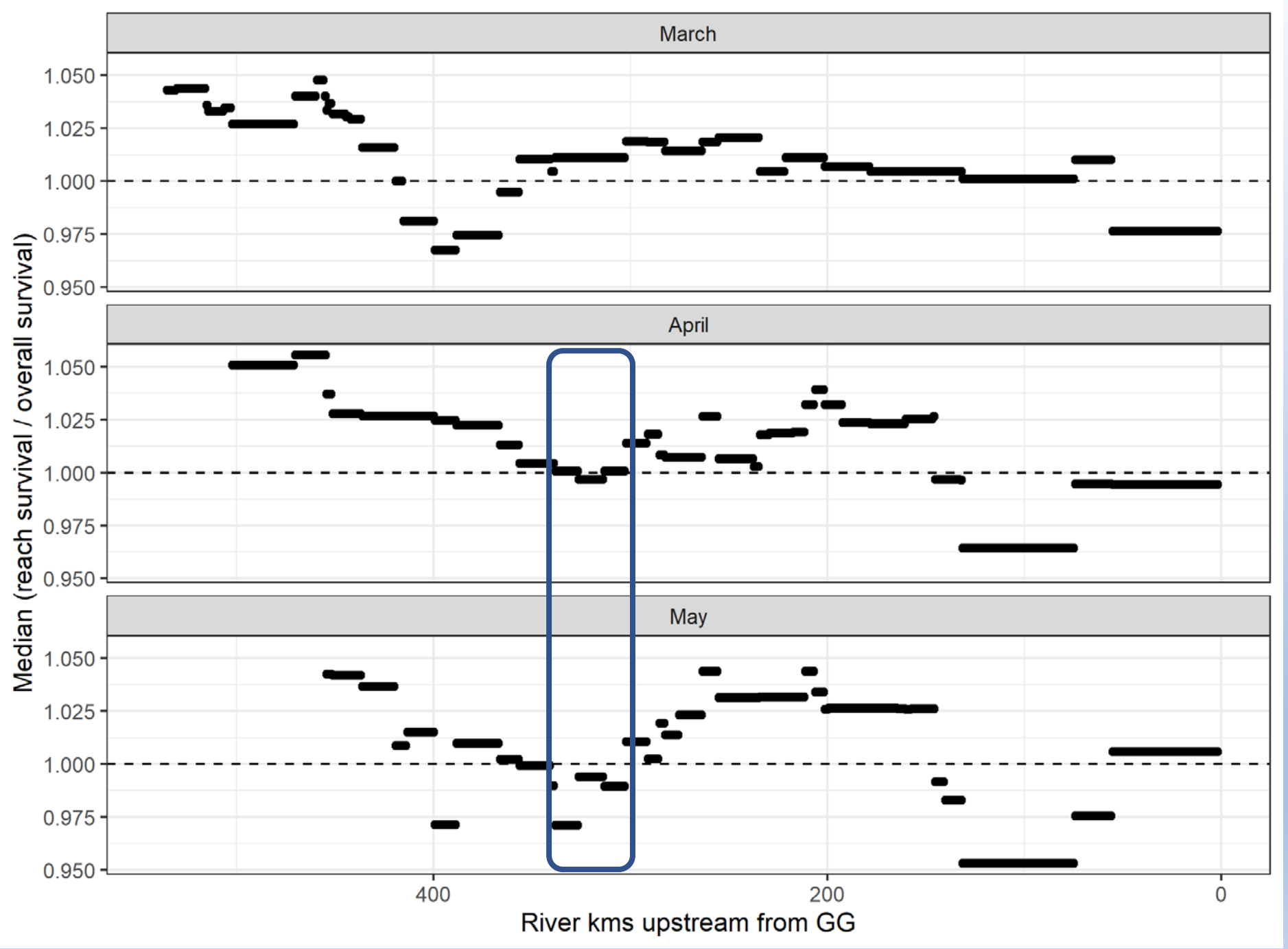
Preliminary results – Do not cite

GCID to below Irvine Finch reach

Highest decrease in survival over mean survival (per 10km) **in river section** in Dec, Jan, March, and May

Preliminary results – Do not cite



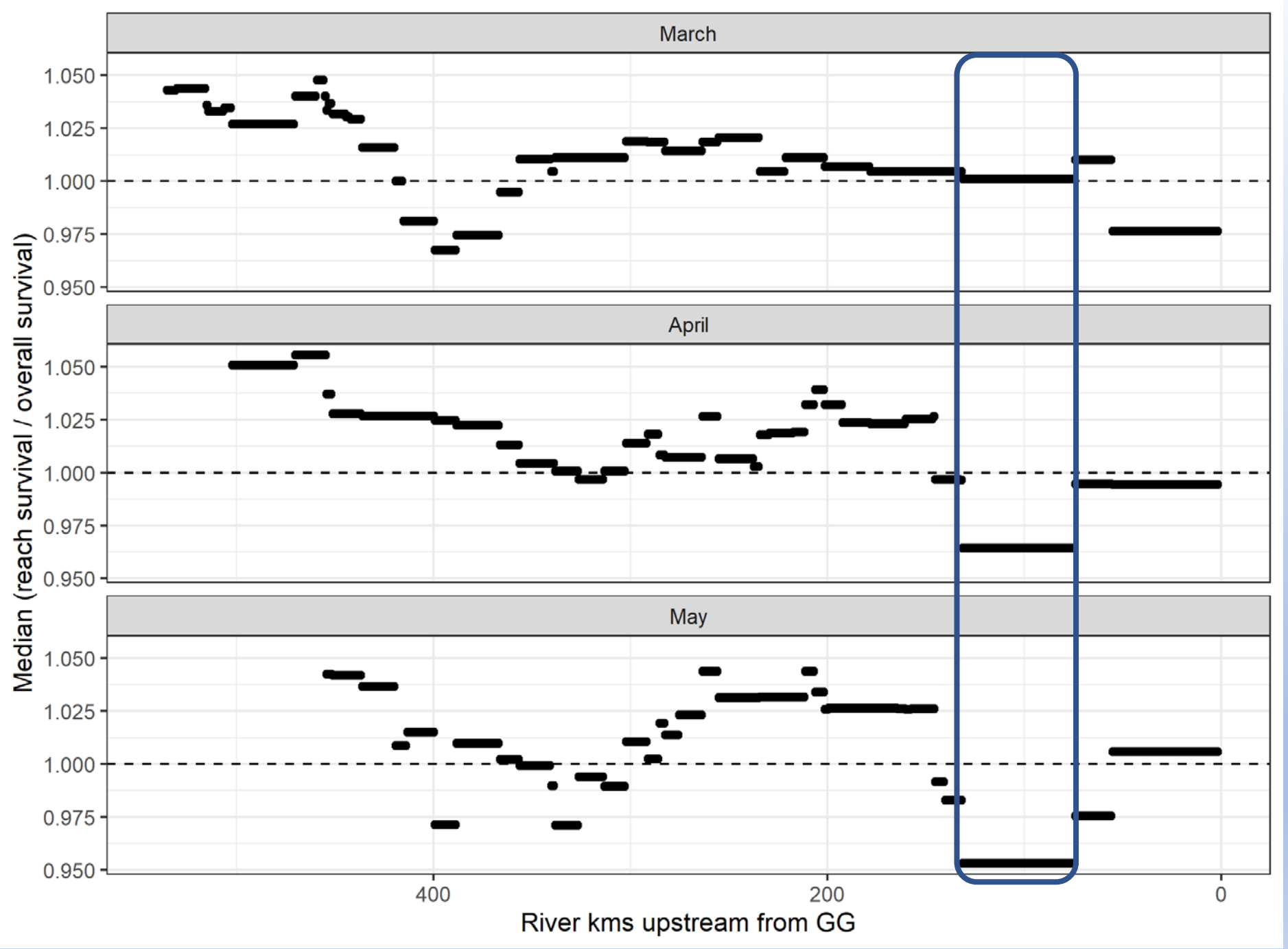


Preliminary results – Do not cite

Butte City to Colusa

Highest decrease in survival over mean survival (per 10km) **in river section** in April and May

Preliminary results – Do not cite



Preliminary results – Do not cite

Hood to Chipps Island a.k.a. the Delta

Highest decrease in survival over mean survival (per 10km) **overall** in Dec, Jan, April, and May

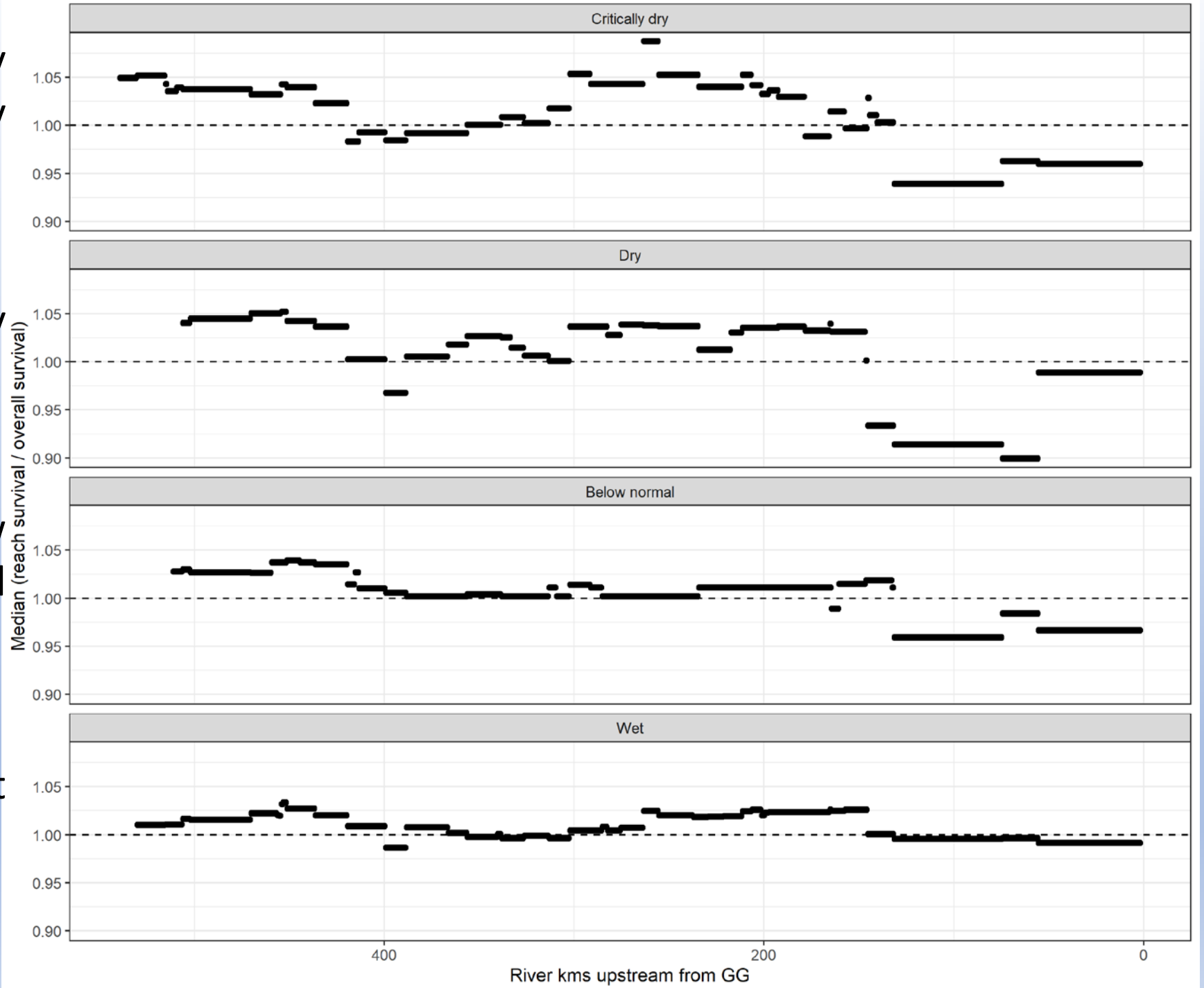
Preliminary results – Do not cite

Critically dry

Dry

Below normal

Wet



N = 6,907

N = 2,304

N = 2,405

N = 8,649

Preliminary results – Do not cite

Thank you!

- cmichel@ucsc.edu

- Support for generating survival estimates and developing the Telemetry shiny app from US Bureau of Reclamation