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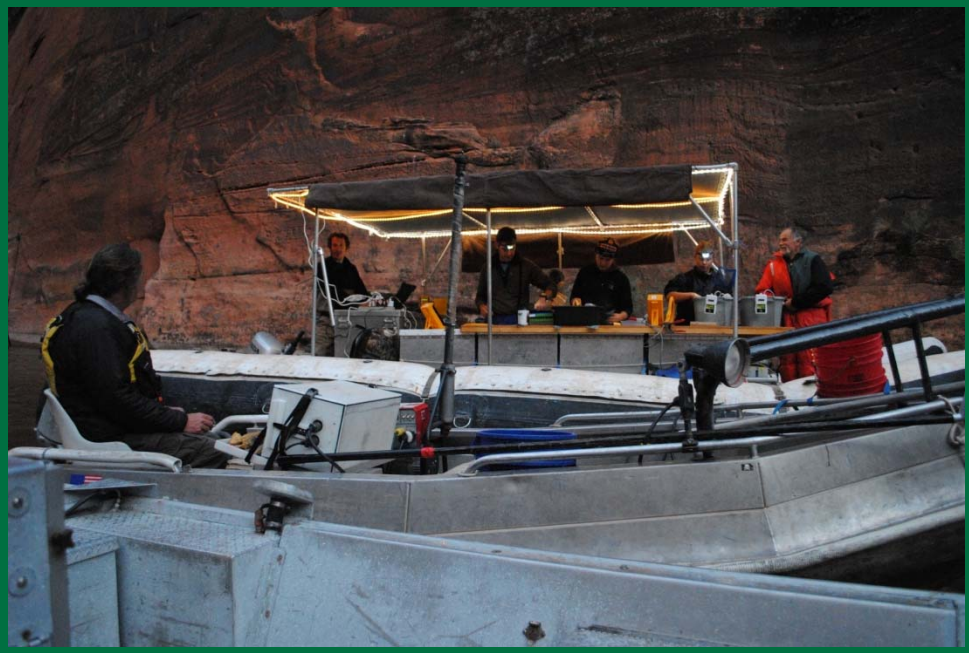

Natal Origins of Rainbow Trout: Glen Canyon and Marble Canyon

Michael D. Yard, GCMRC, Flagstaff, AZ
Josh Korman, Ecometric Research, Vancouver, BC

U.S. Department of the Interior
U.S. Geological Survey

Natal Origin - Study Objectives

1. Quantify extent of rainbow trout movement from Lees Ferry into Marble Canyon and LCR inflow
2. Determine factors that drive trout movement (density, food, growth, turbidity, HFEs, etc.)
3. Quantify extent of local reproduction below Lees Ferry.
4. Estimate abundance of rainbow trout in LCR inflow reach for FWS Biological Opinion and ‘Trigger’
5. Continue monitoring juvenile humpback chub abundance, growth, and survival in the LCR inflow reach (BioOp/trigger)
6. Relate chub survival and growth to trout abundance and temperature (critical uncertainty)

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Overview of Presentation

- Design of sampling and mark-recapture study
- Abundance, movement, local reproduction
- Growth and condition factor
- Conclusions

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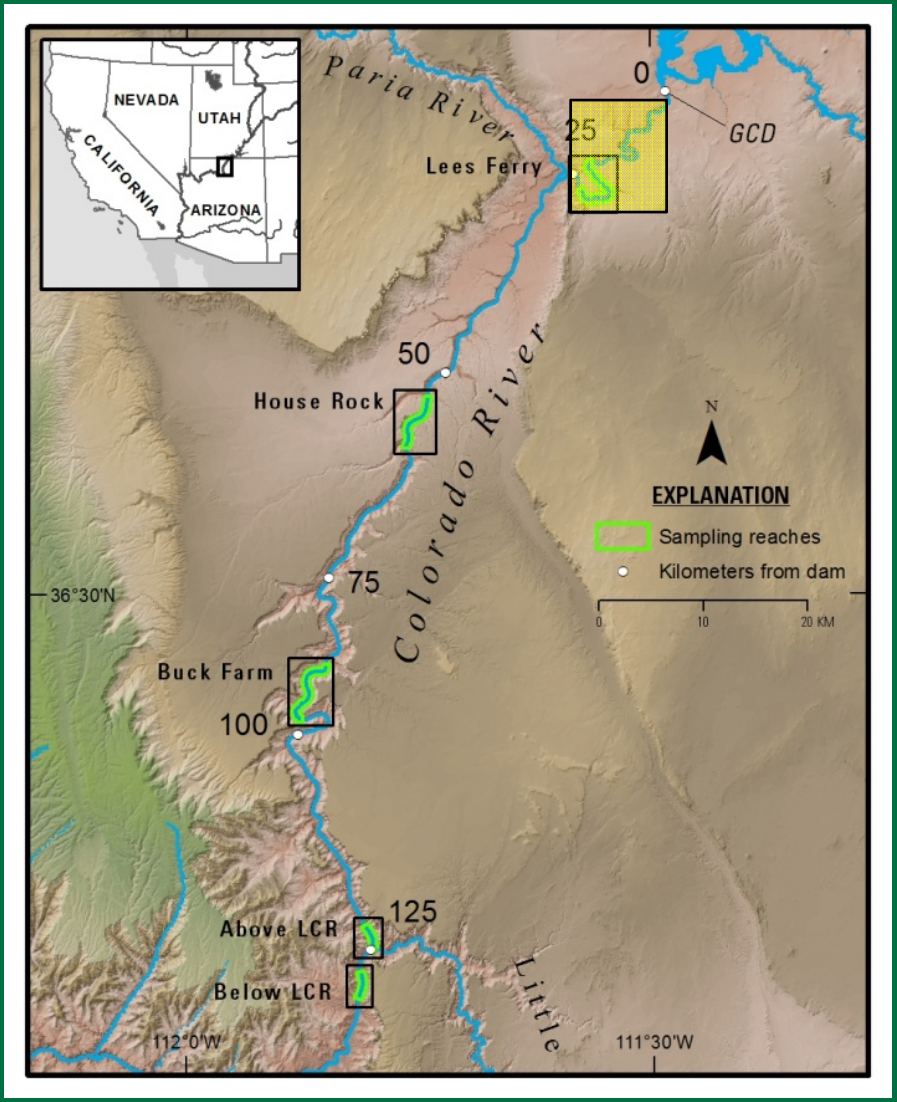
Sampling Design



- **Annual age-0 marking trips from dam to Lees Ferry**
  - **Length >75 mm**
  - **~ 10,000 marked/yr**
  - **Nov. 2011, Oct & Dec 2012, 2013**
- **Quarterly trips for marking and tag recovery by Reach**
  - **Apr, Jul, Sep, Jan**
  - **LEES FERRY (I, -5.5 to -2.1 RM)**
  - **HOUSE ROCK (II, 17.2-20.6 RM)**
  - **BUCK FARM (III, 38.2 to 41.6 RM)**
  - **ABOVE LCR (IVa, 60.2 to 61.2 RM)**
  - **BELOW LCR (IVb, 63.4 to 64.9 RM)**

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Summary of RBT Catch and PIT Releases

Name:	Catch	Lees Ferry	Lees Ferry	House Rock	Buck Farm	U/S LCR	D/S LCR	
Reach #:	All Reaches	All	I	II	III	IVa	IVb	
RM:	(-15.6 - 64.9)	(-15.6 - 0)	(-5.5 - -2.1)	(17.2 - 20.6)	(38.2 - 41.5)	(60.2 - 61.1)	(63.4 - 64.9)	
Nov-11	16,440	11,485	929					
Apr-12	11,775		529	552	549	317	119	
Jul-12	11,641		675	795	848	339	197	
Sep-12	17,897		553	788	842	305	229	
Oct-12	22,381	5,088	305					
Dec-12	12,490	4,254	278					
Jan-13	12,167		625	776	987	347	336	
Apr-13	9,765		716	1,010	879	367	135	
Jul-13	8,437		734	828	882	428	279	
Sep-13	13,787		994	1,068	741	478	351	
Oct-13	12,512	5,838	255					
Dec-13	8,175	5,536	310					
Jan-14	8,742		436	1,209	1,198	554	398	
Apr-14	7,109		615	1,147	1,155	387	195	
Jul-14	6,585		757	1,162	933	428	390	
Sep-14	13,156		1,047	1,395	1,155	681	456	
Total	193,059	32,201	9,758	10,730	10,169	4,631	3,085	68,497

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(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

Summary of PIT Recaptures

Name:	Lees Ferry	Lees Ferry	House Rock	Buck Farm	U/S LCR	D/S LCR	
Reach #:	All	I	II	III	IVa	IVb	
RM:	(-15.6 - 0)	(-5.5 - -2.1)	(17.2 - 20.6)	(38.2 - 41.5)	(60.2 - 61.1)	(63.4 - 64.9)	
Nov-11	221	43					
Apr-12		82	144	206	149	42	
Jul-12		105	219	315	137	60	
Sep-12		67	193	211	124	60	
Oct-12	344	41					
Dec-12	173	52					
Jan-13		99	201	202	132	66	
Apr-13		91	255	228	133	43	
Jul-13		120	200	234	135	59	
Sep-13		82	178	128	126	41	
Oct-13	429	29					
Dec-13	133	41					
Jan-14		50	244	214	119	94	
Apr-14		33	187	215	125	48	
Jul-14		41	220	160	93	52	
Sep-14							
Total	1,300	976	2,041	2,113	1,273	565	8,062
					Percent of Tags Recaptured		11.8%

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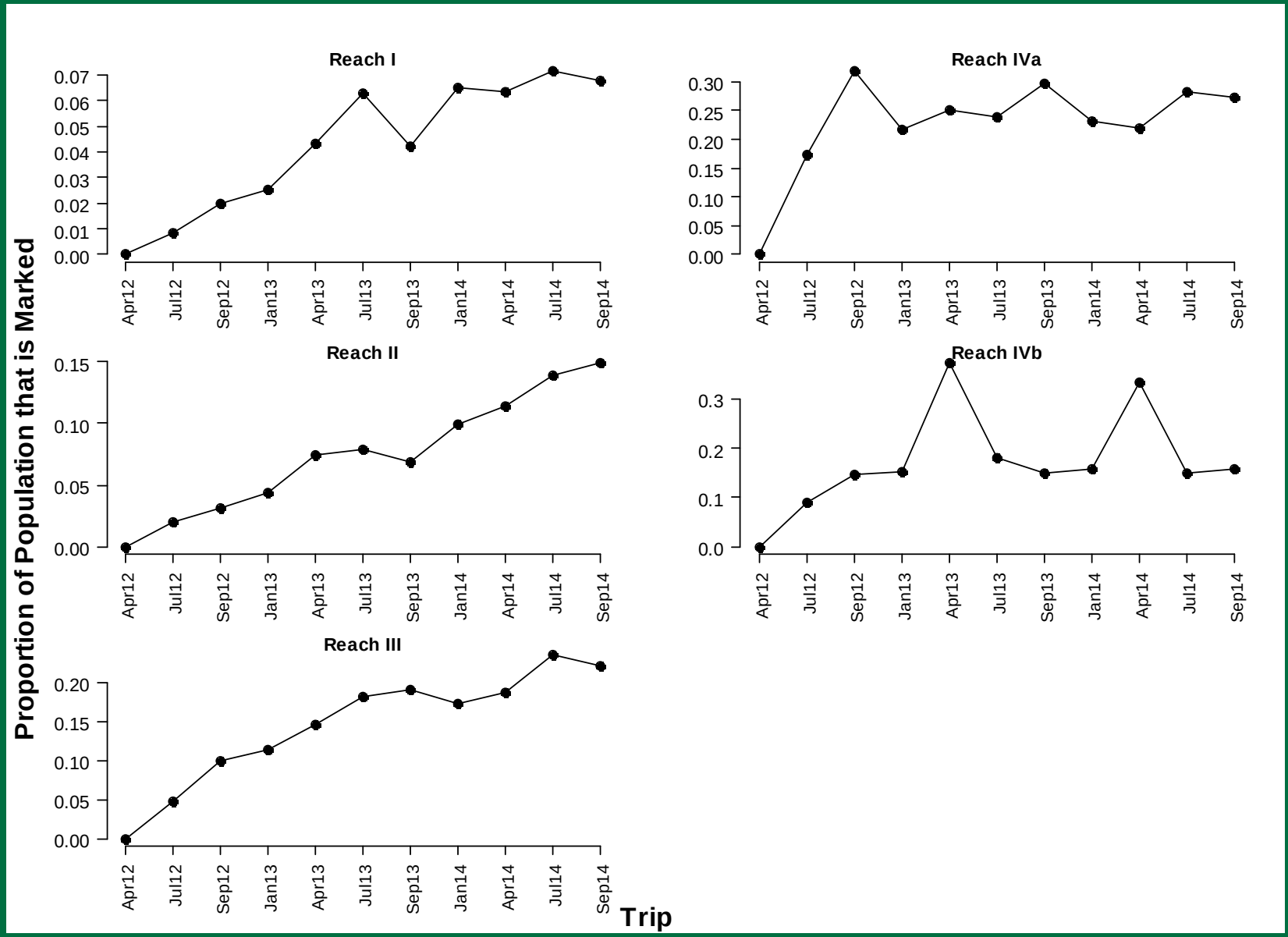
(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

Proportion of Population that is Marked



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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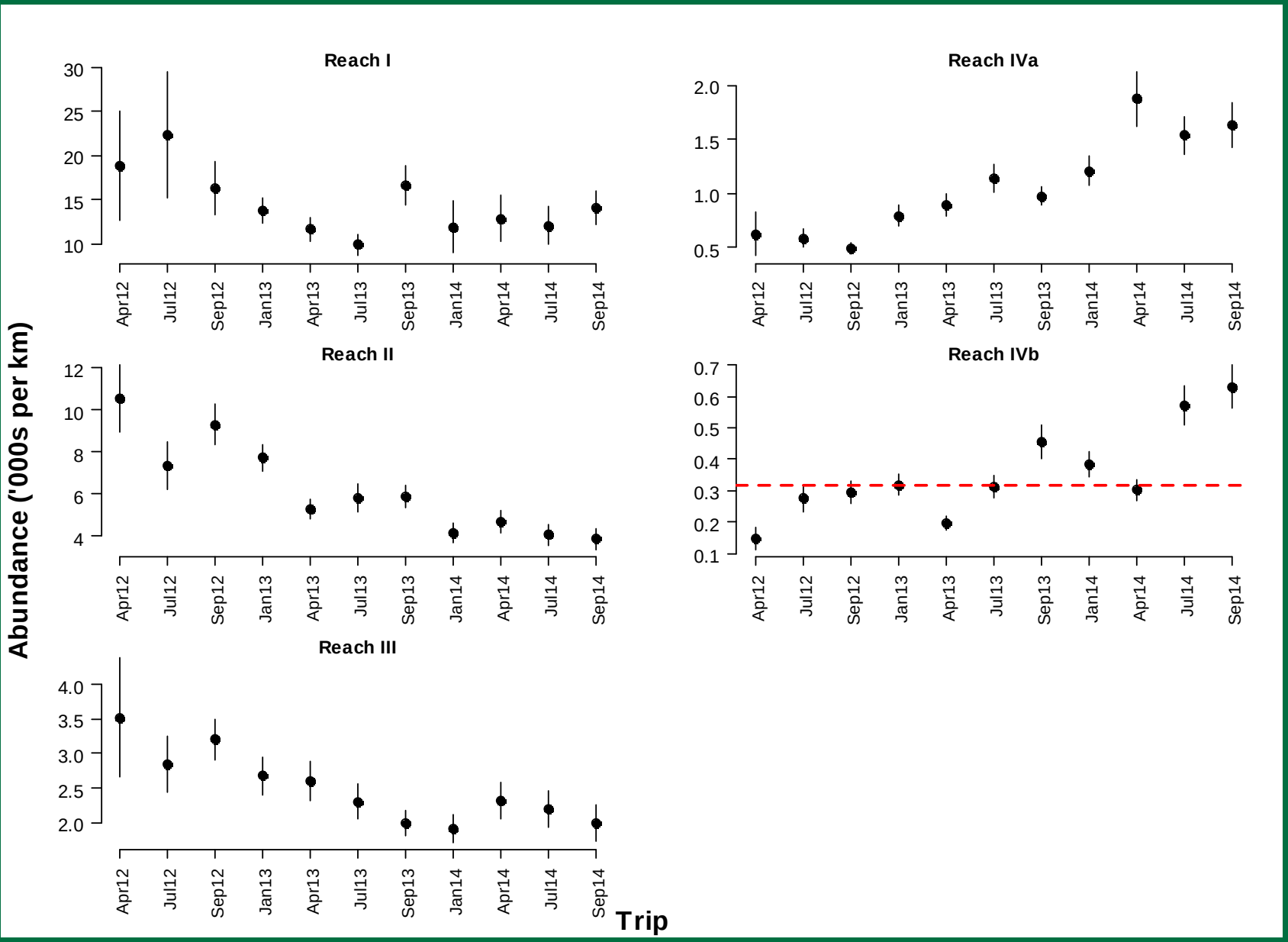
Abundance By Reach



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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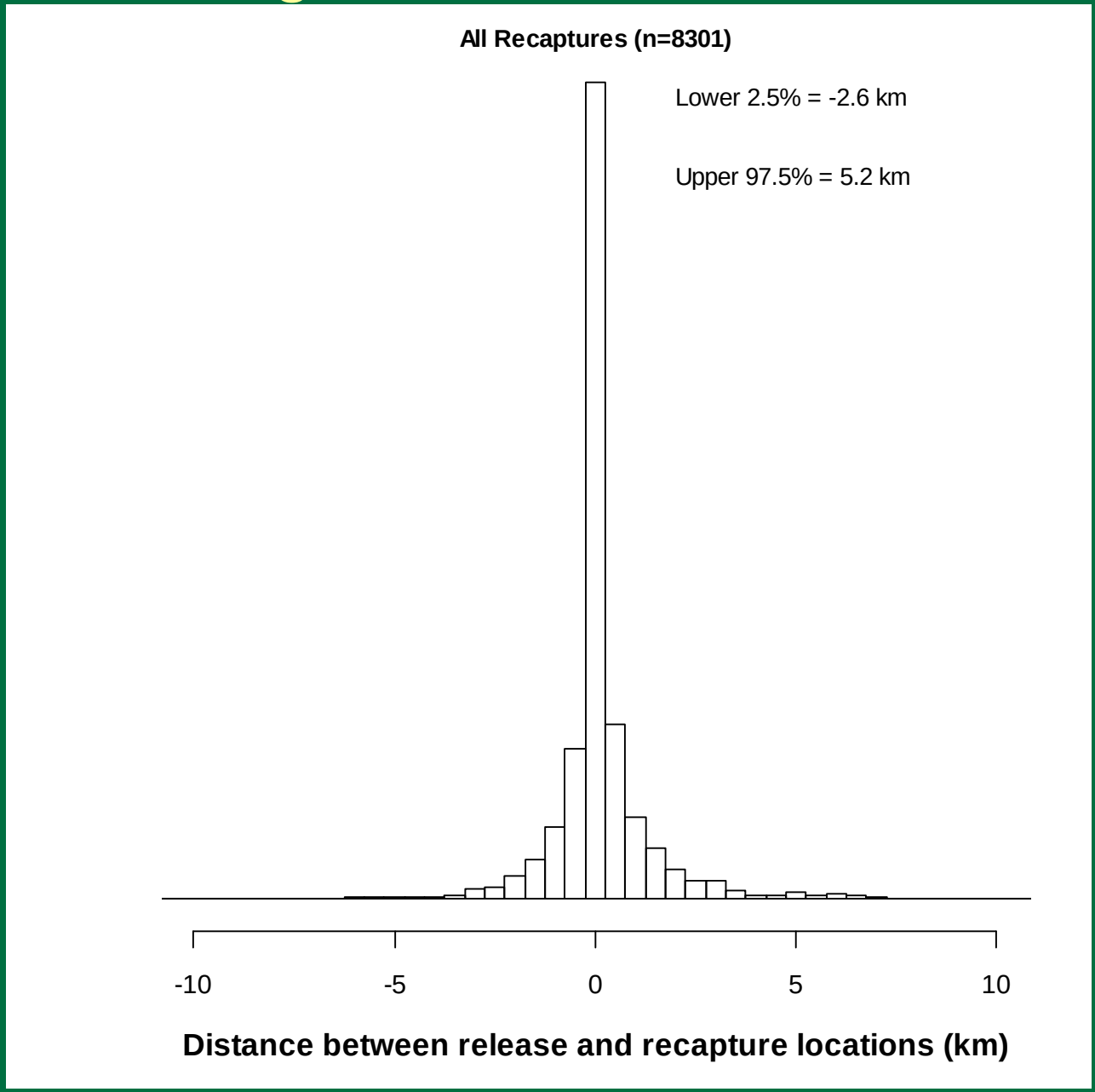
Tag-Based Movement



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

Longer Distance Movement Among Reaches

		Recapture Reach					Outside of Release Reach	
		GC	II	III	IVa	IVb	# of Recaps	% of Recaps
Release Reach	GC	2228	8	1	0	2	11	0.5%
	II	13	1999	12	8	6	39	1.9%
	III	1	8	2087	10	7	26	1.2%
	IVa	0	0	2	1153	67	69	5.6%
	IVb	1	0	1	11	541	13	2.3%

Recaptures from Sep 2014 Trip

							# of Recaps	% of Recaps
		Recapture Reach					Outside of	in Sep2014
		GC	II	III	IVa	IVb	Release Reach	to Total
Release Reach	GC	214	2	1	0	1	4	36.4%
	II	5	590	8	4	4	21	53.8%
	III	0	3	365	4	3	10	38.5%
	IVa	0	0	0	201	15	15	21.7%
	IVb	0	0	0	4	71	4	30.8%

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(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

Estimated Percentage Movement from Lees Ferry and Marble Canyon Reaches to LCR Reaches

		Destination Reach	
		IVa	**IVb**
Source Reach	**I**	0.01	0.02
	II	0.14	0.05
	III	0.20	0.18

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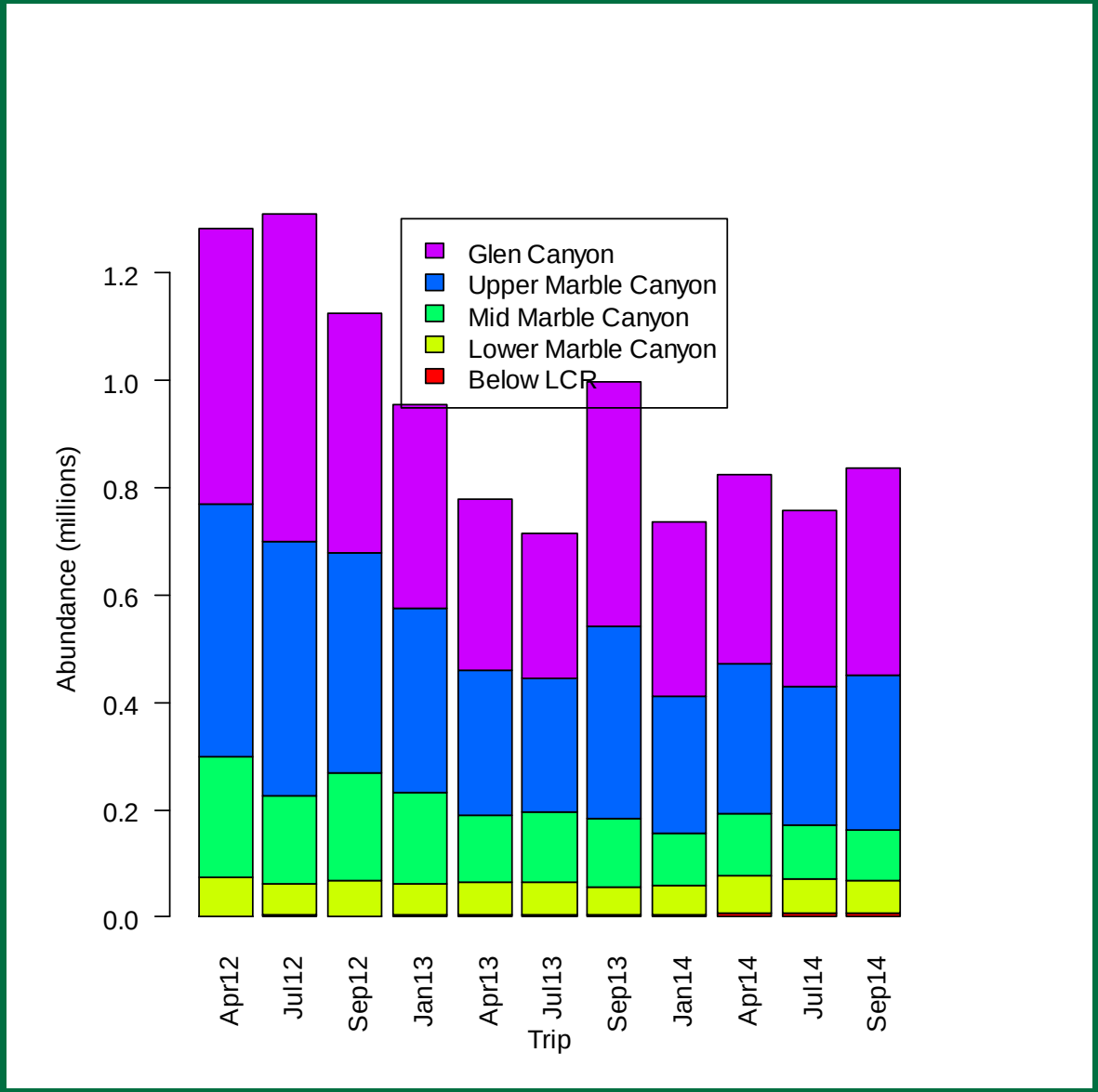
(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

System-Wide Abundance Based on Interpolation Between Reaches



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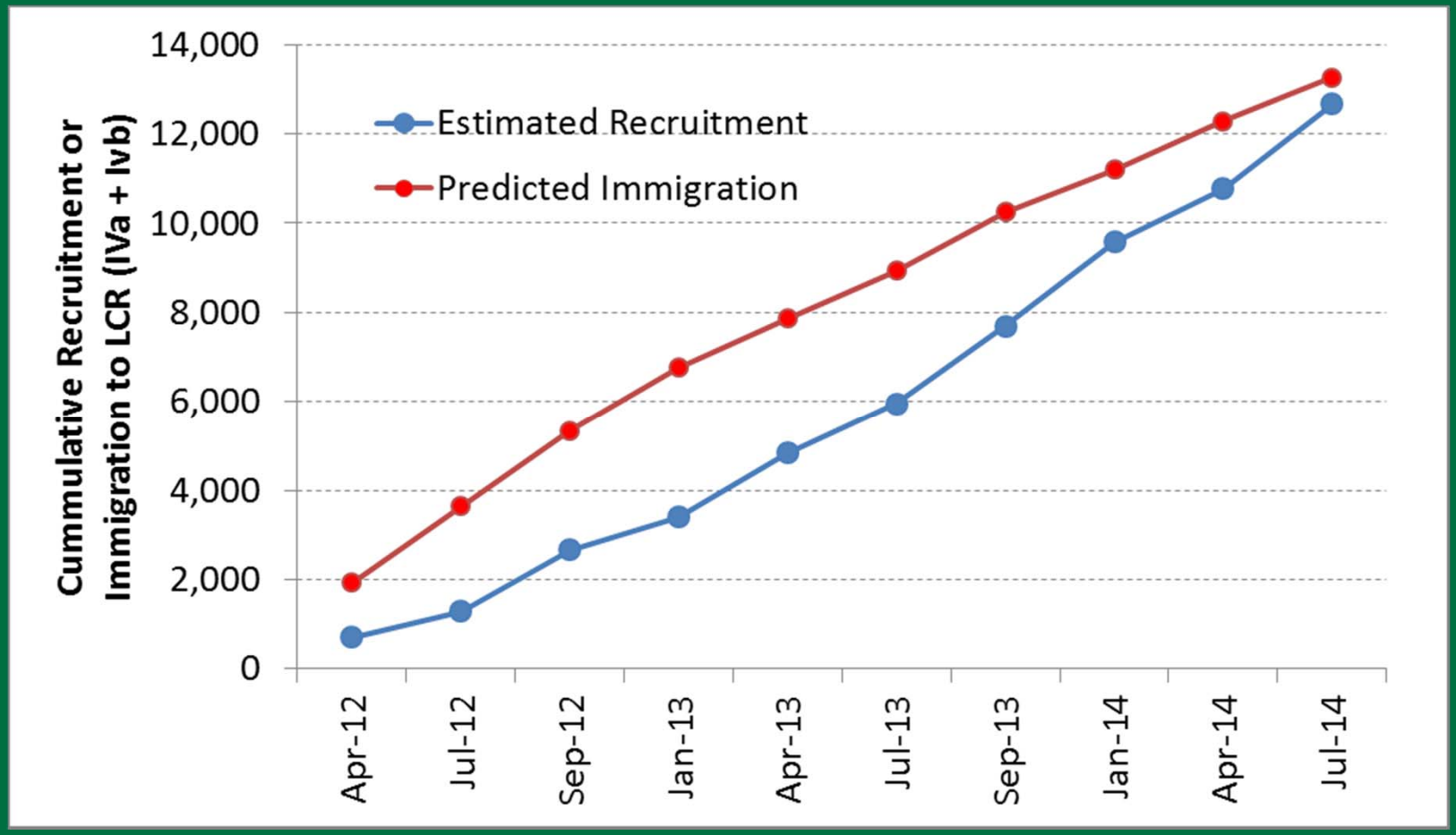
(Preliminary Data from Korman and Yard 2014. Do Not Cite.)



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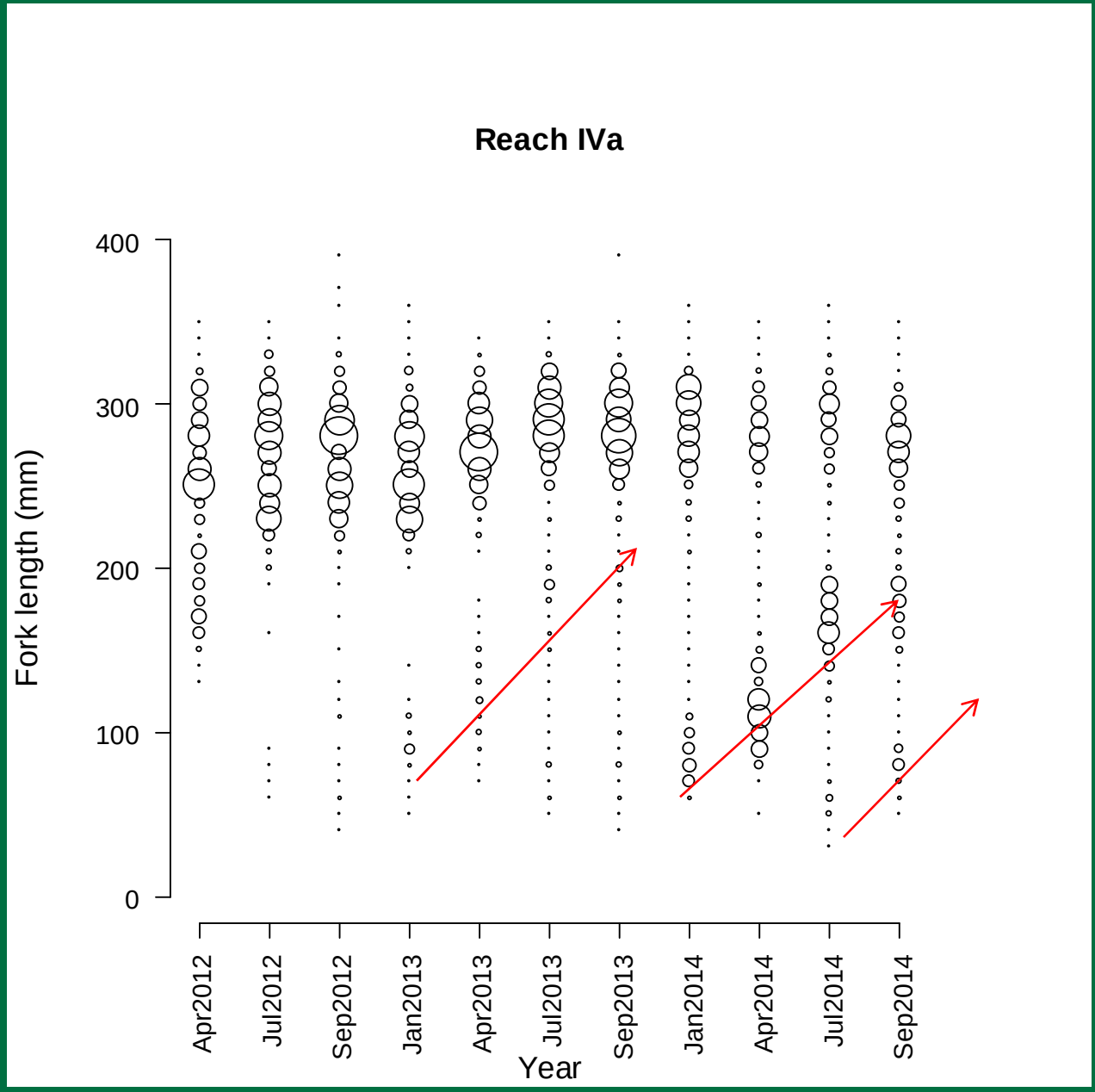
(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

Local Recruitment



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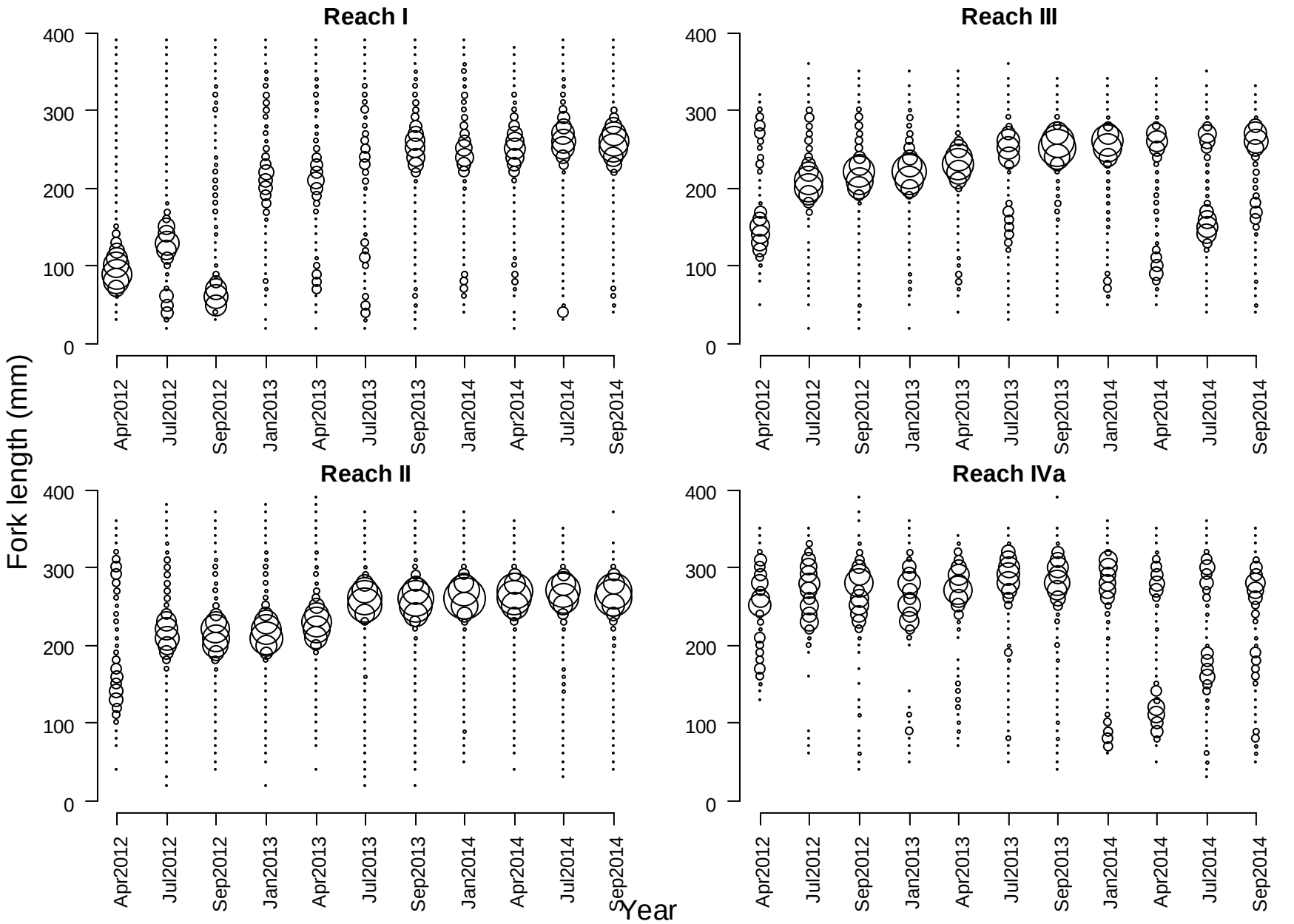
(Preliminary Data from Korman and Yard 2014. Do Not Cite.)



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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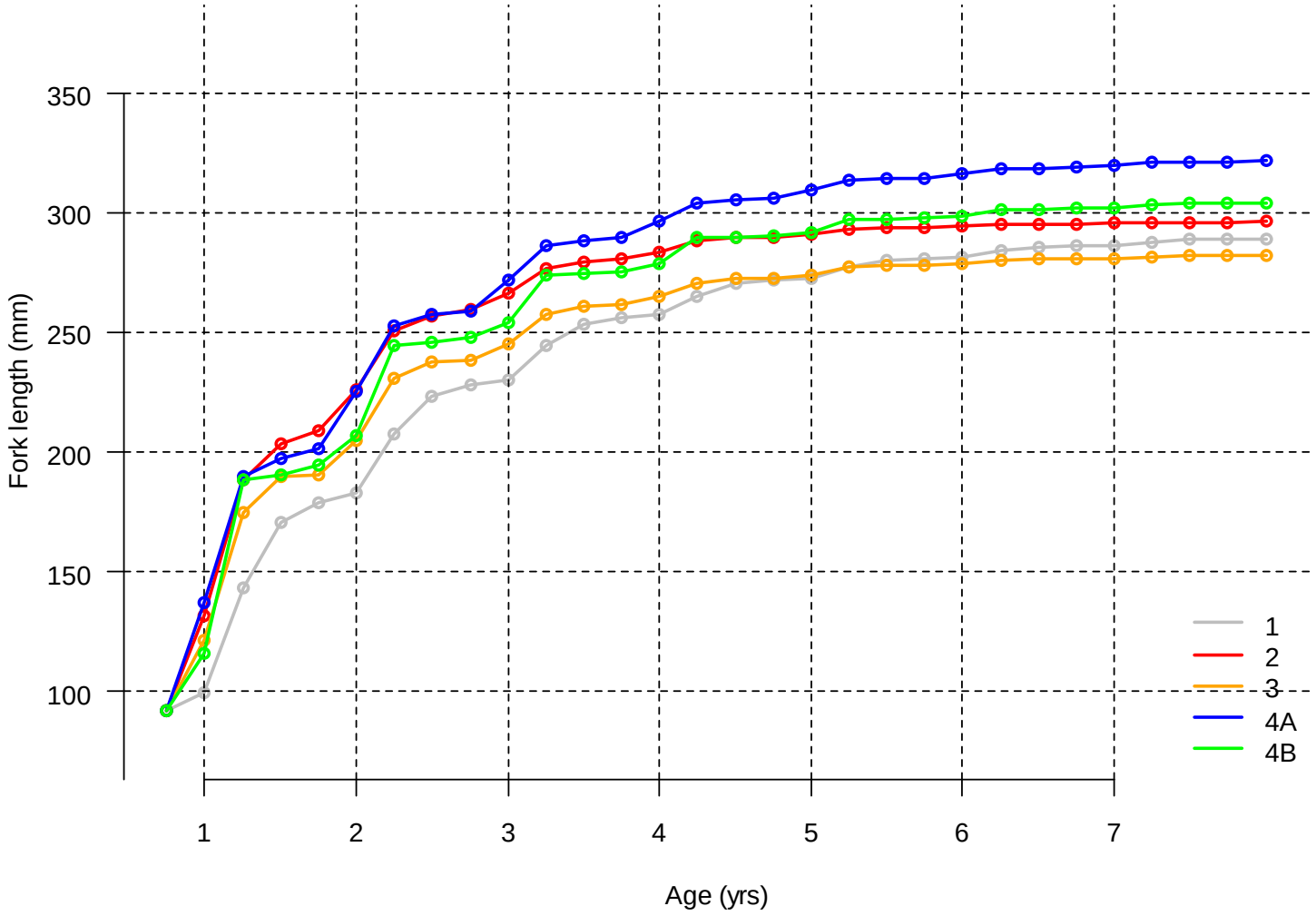
Length-at-Age Curve



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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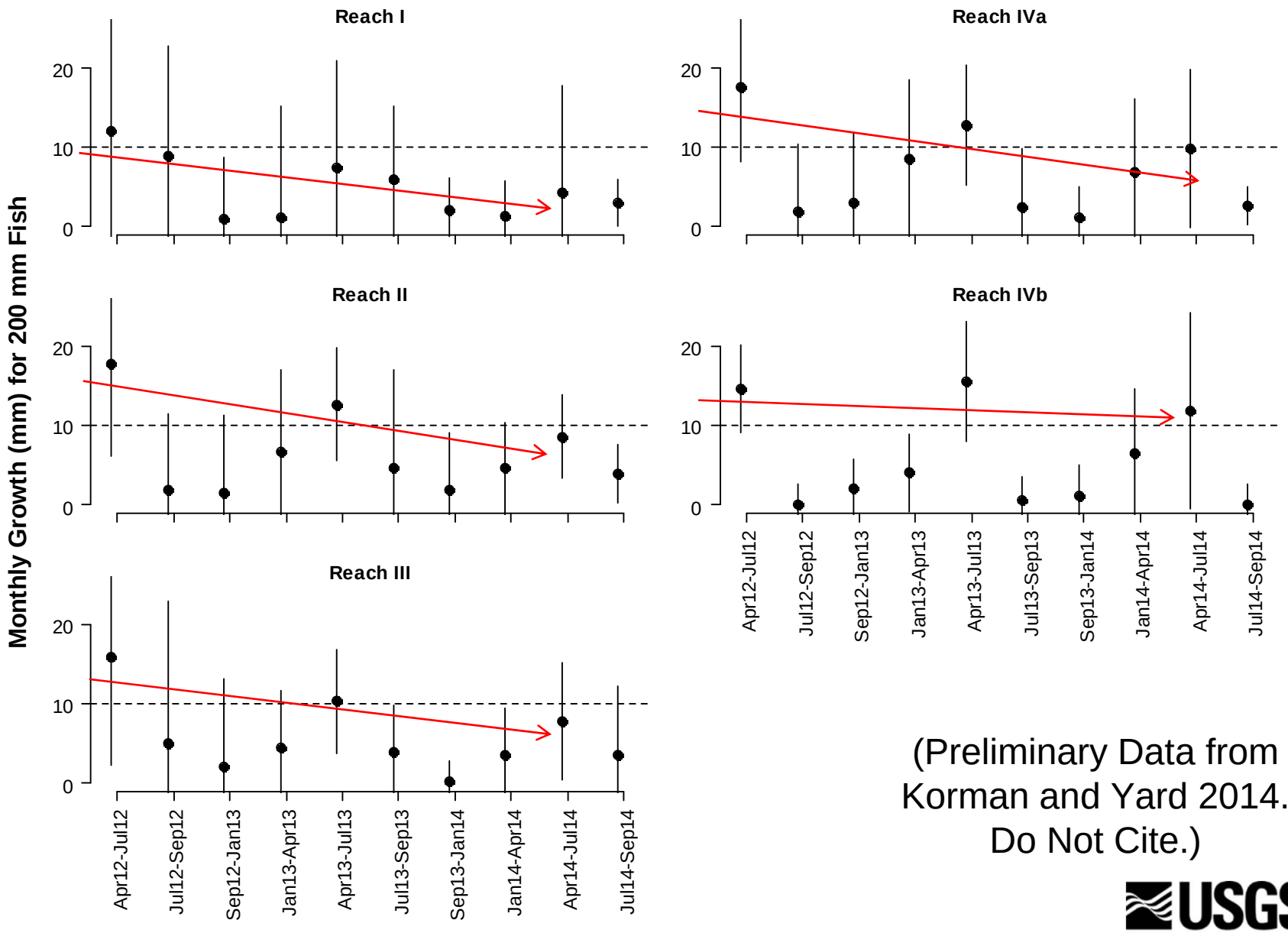
Trends in Growth (@ 200 mm)



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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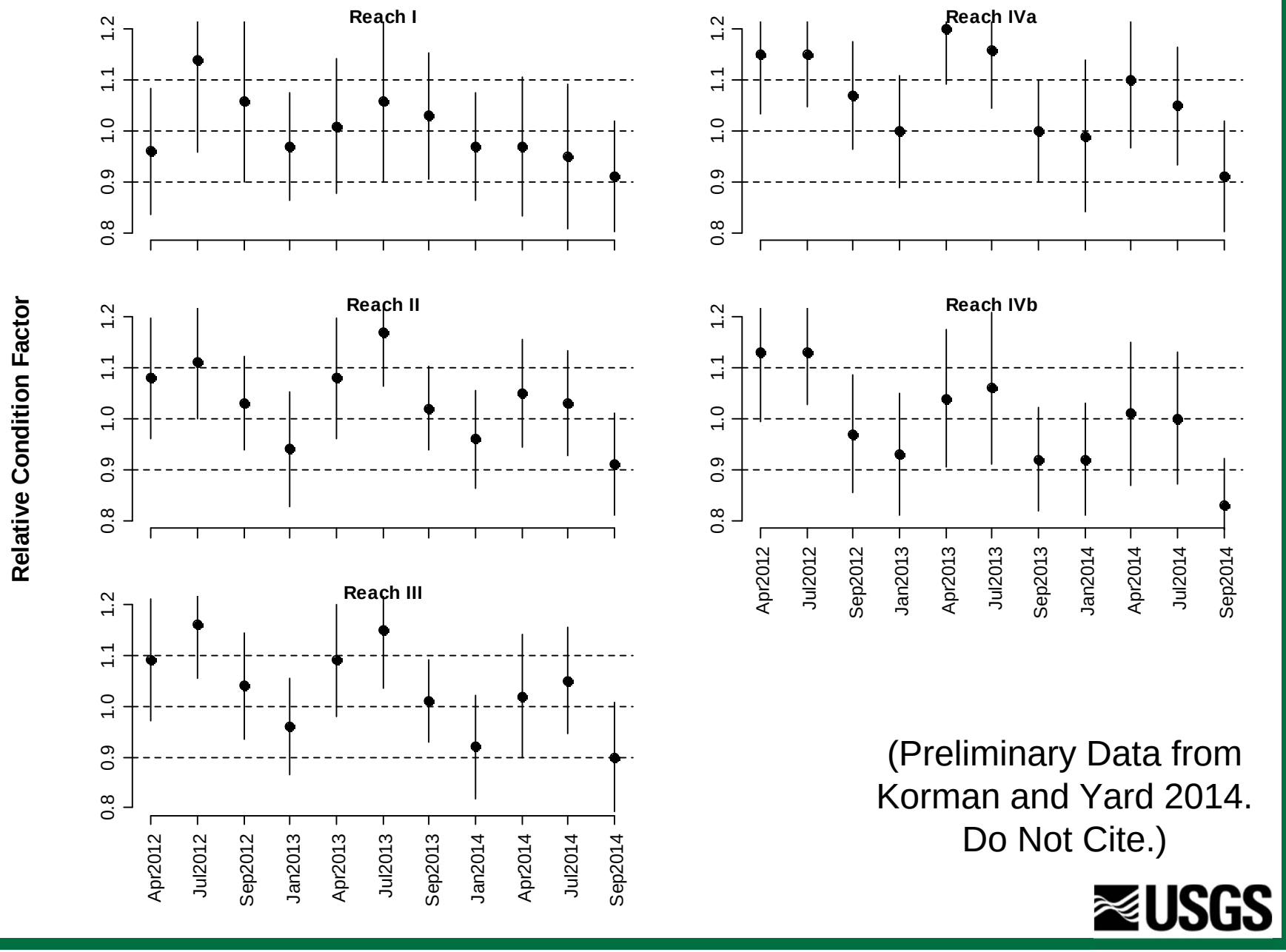
Trends in Condition Factor



(Preliminary Data from Korman and Yard 2014. Do Not Cite.)

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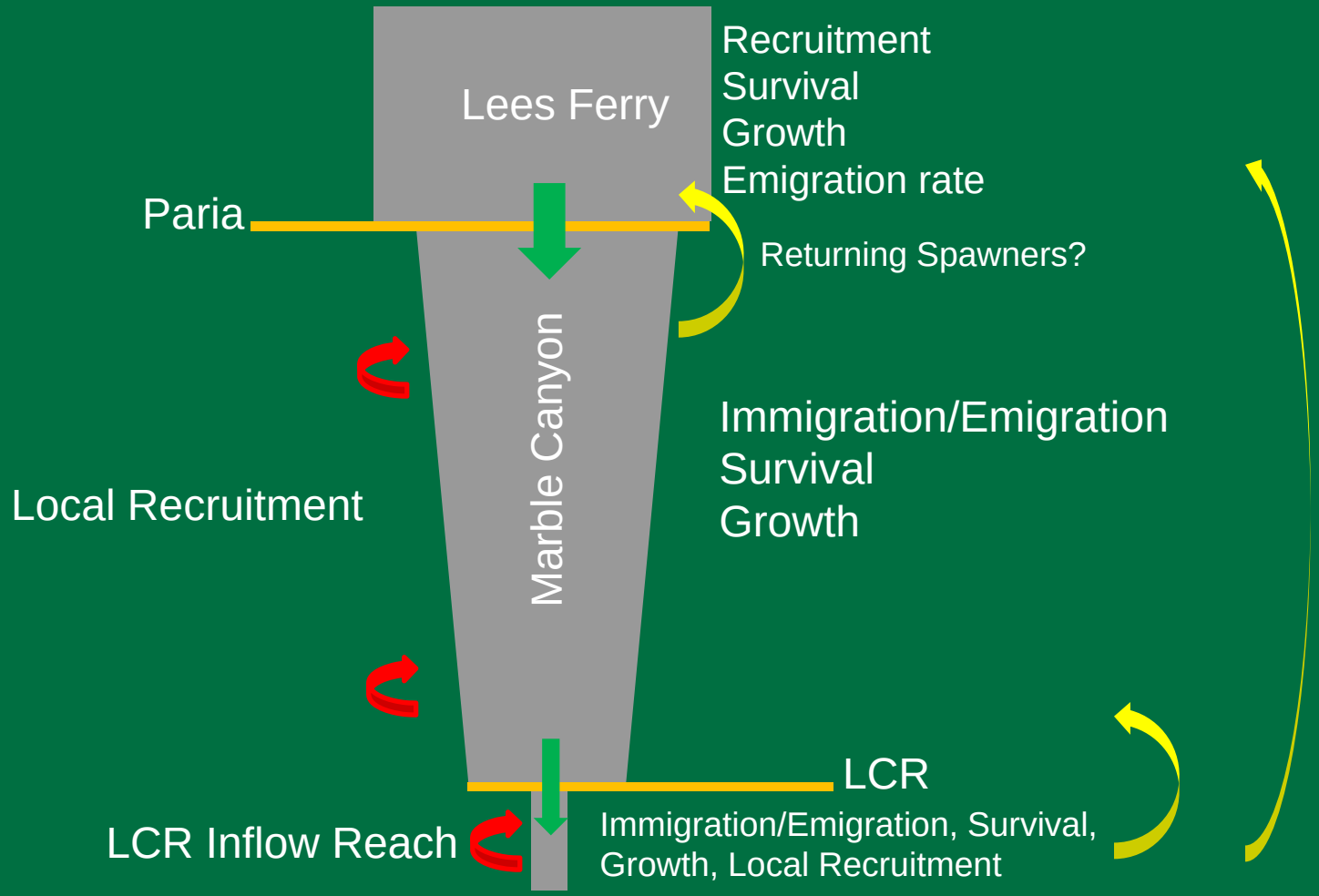
Conceptual Model



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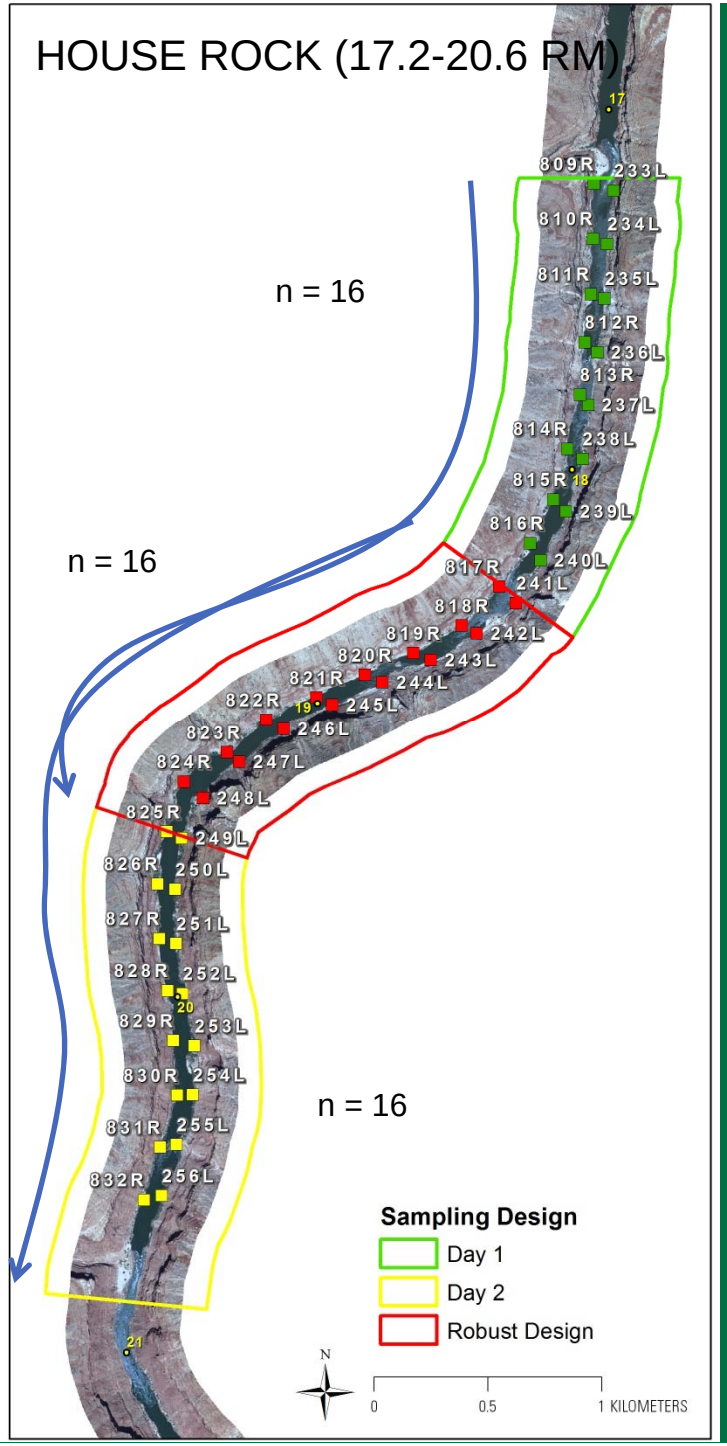


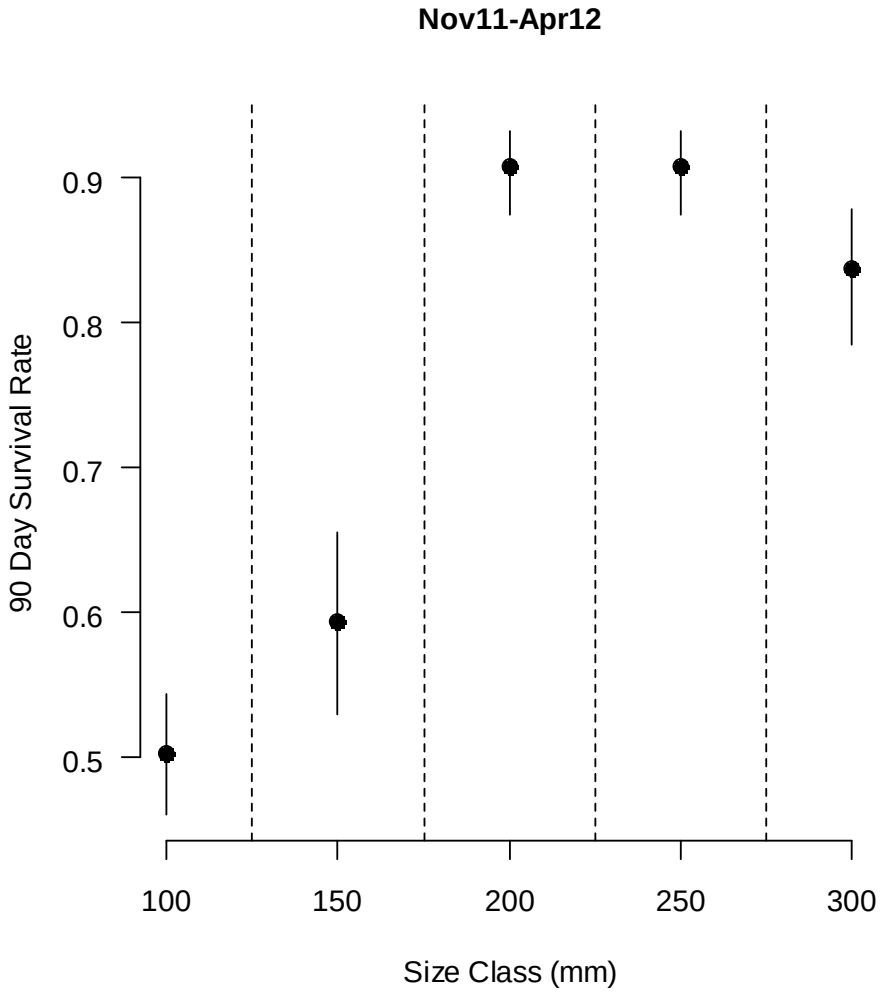
Sampling Design

➢ Reaches I - IVa

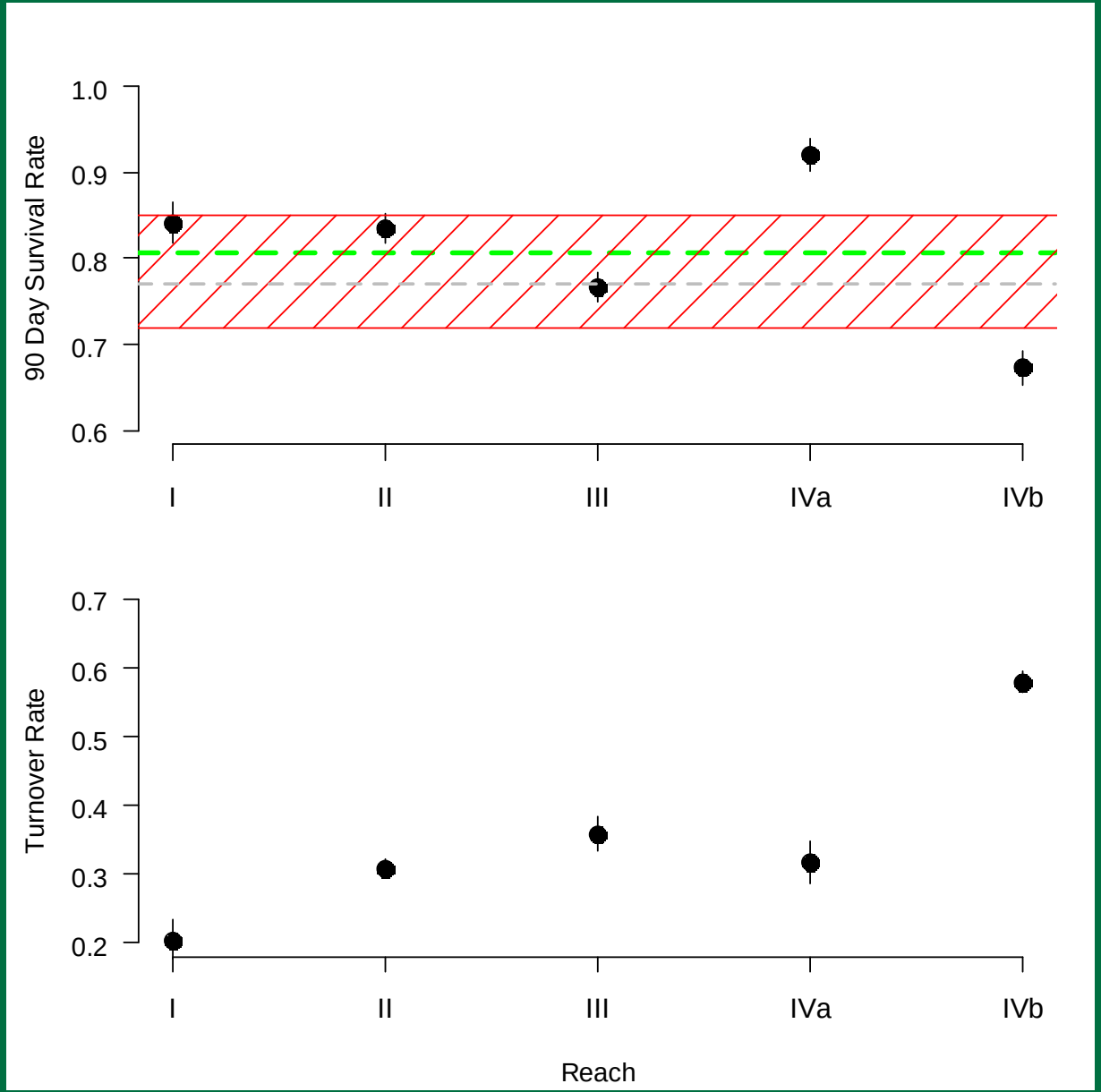
- o 2 nights of effort per reach
- o 32 250 m sites are sampled per night (4 km)
- o 16 sites (2 km) are sampled on nights 1 and 2 (robust design section).
- o Marks released in robust design section
- o IVa consists only of robust design section

➢ Reach IVb (below LCR)

- o 2.4 km long (heart isl. – carbon ck.)
- o Robust design section only
- o 5 passes of effort which includes fast (2) and slow (3) passes of electrofishing, and 8 passes of hoop netting


Nov11-Apr12
90 Day Survival Rate
0.9
0.8
0.7
0.6
0.5
100
150
200
250
300
Size Class (mm)

Survival and Turnover



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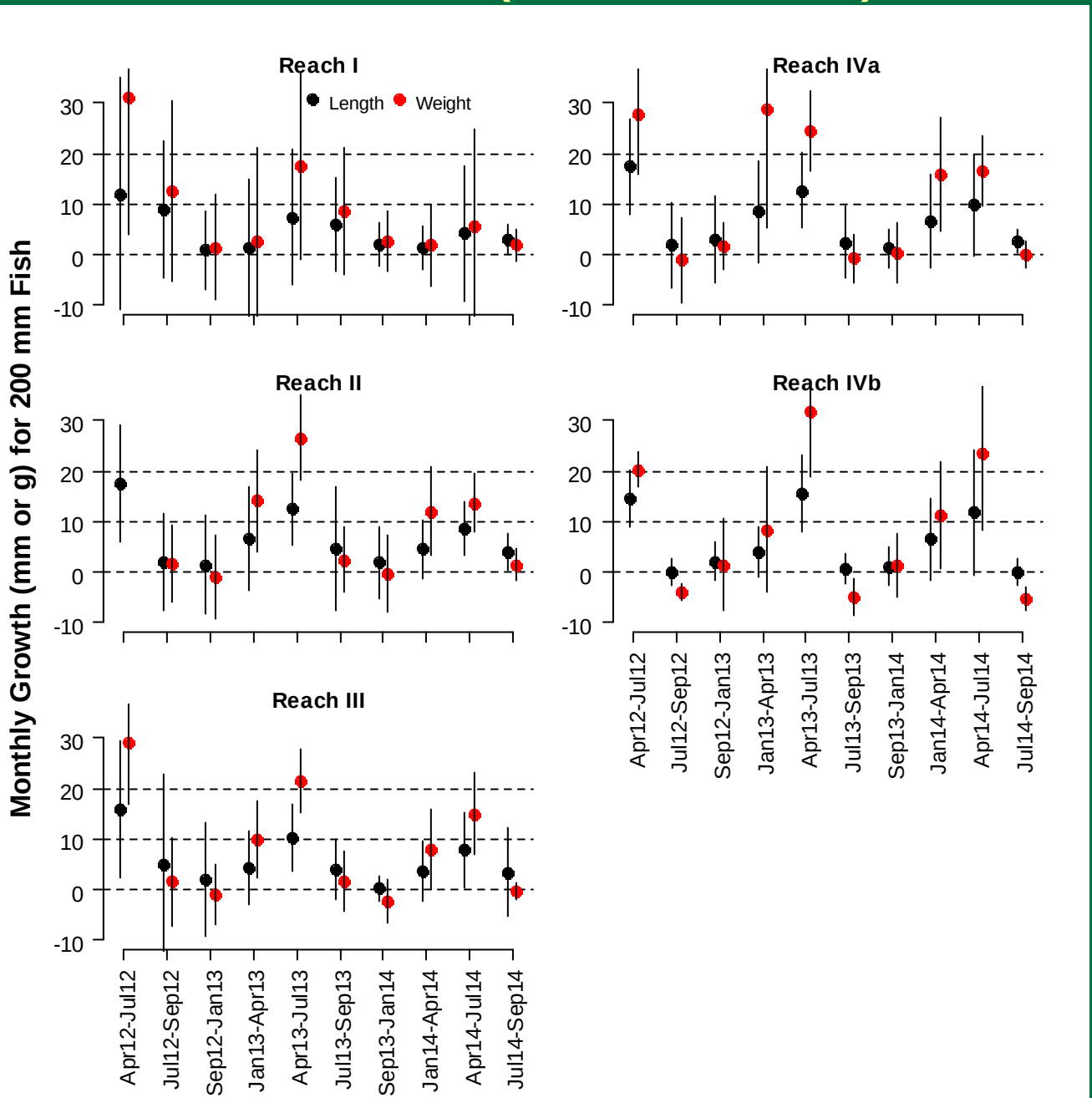
Trends in Growth (@ 200 mm)



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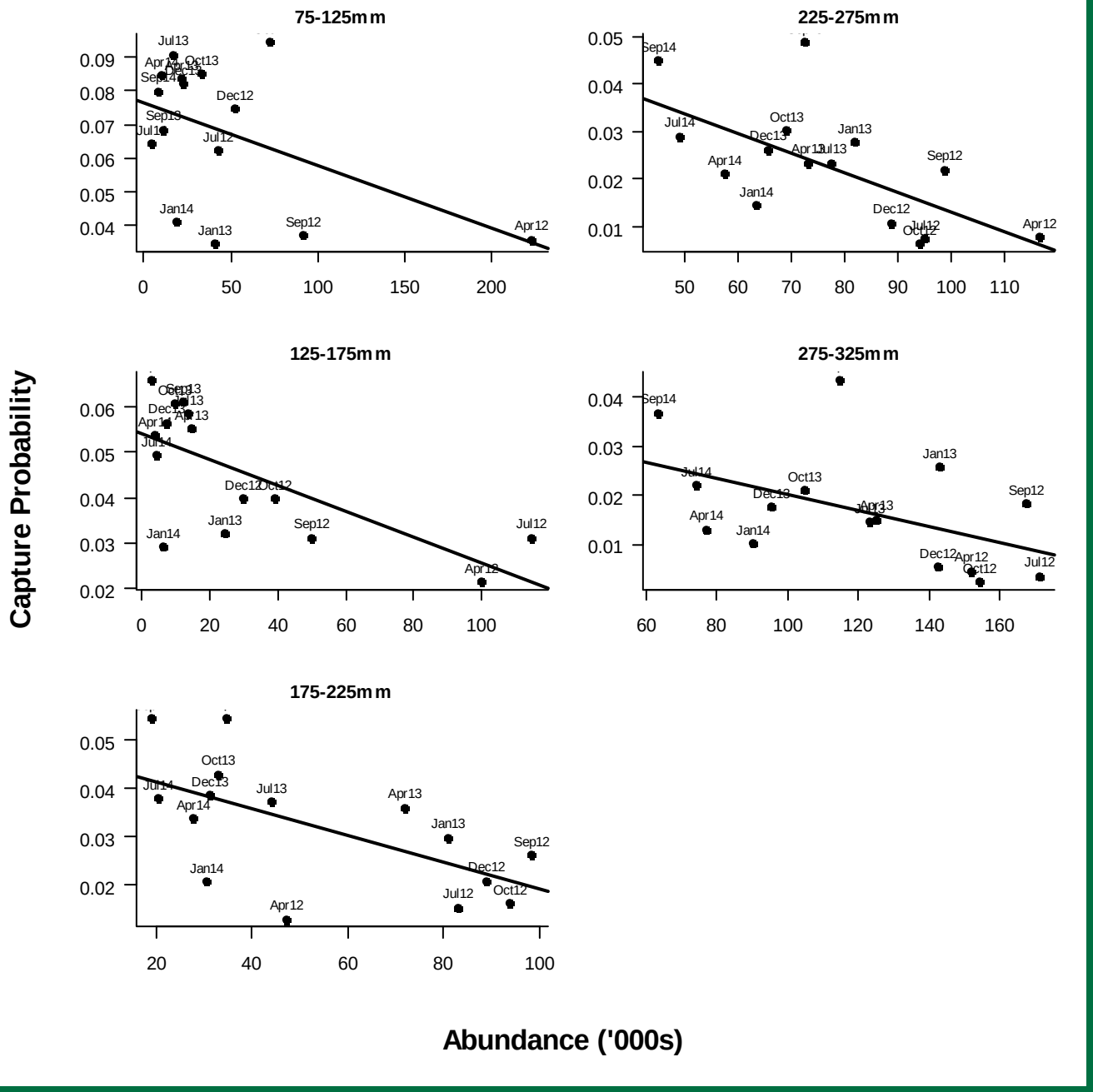
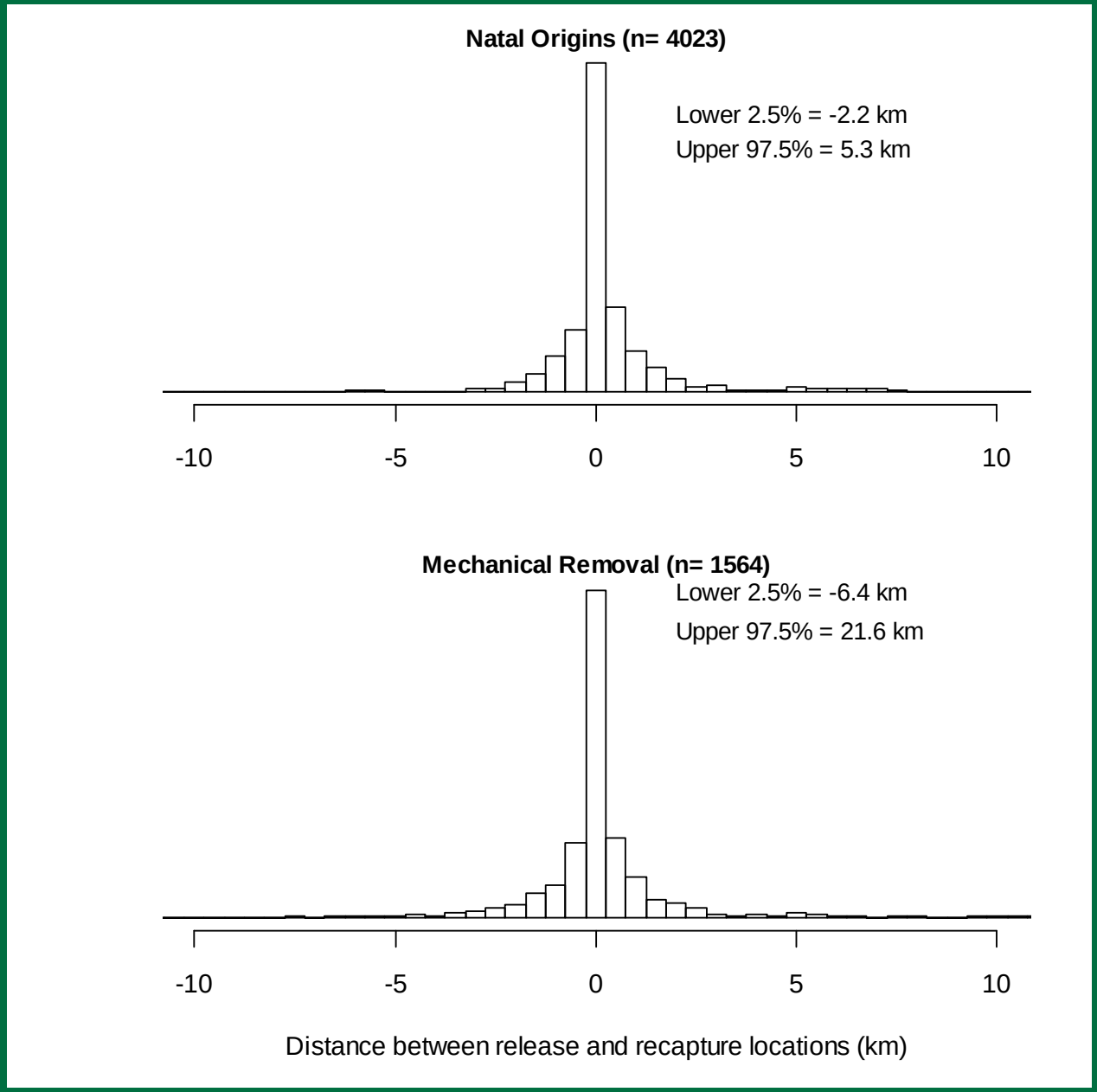

75-125mm
225-275mm
125-175mm
275-325mm
175-225mm
Capture Probability
Abundance ('000s)

Movement: 2012-2014 vs. 2003-2006



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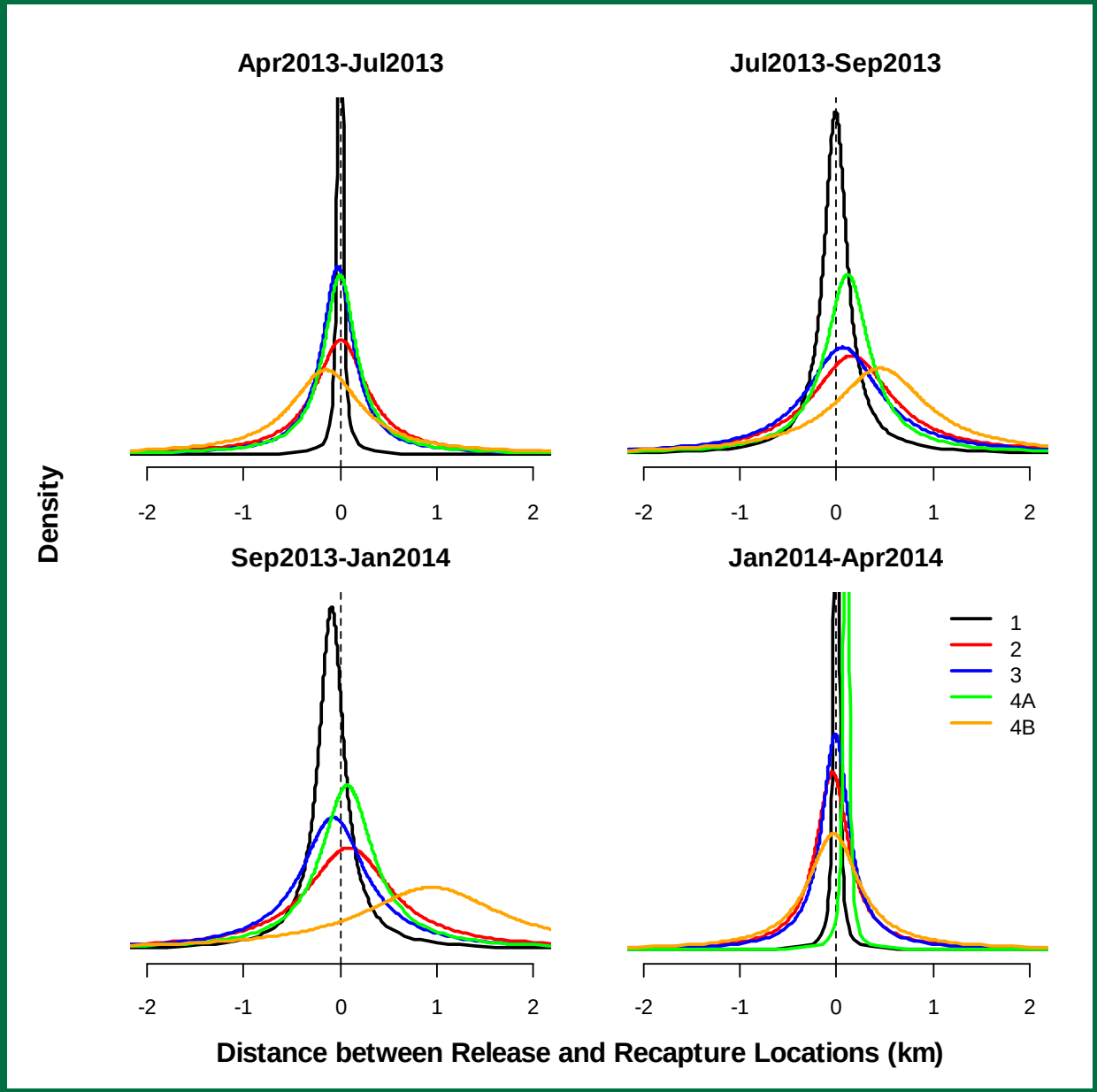
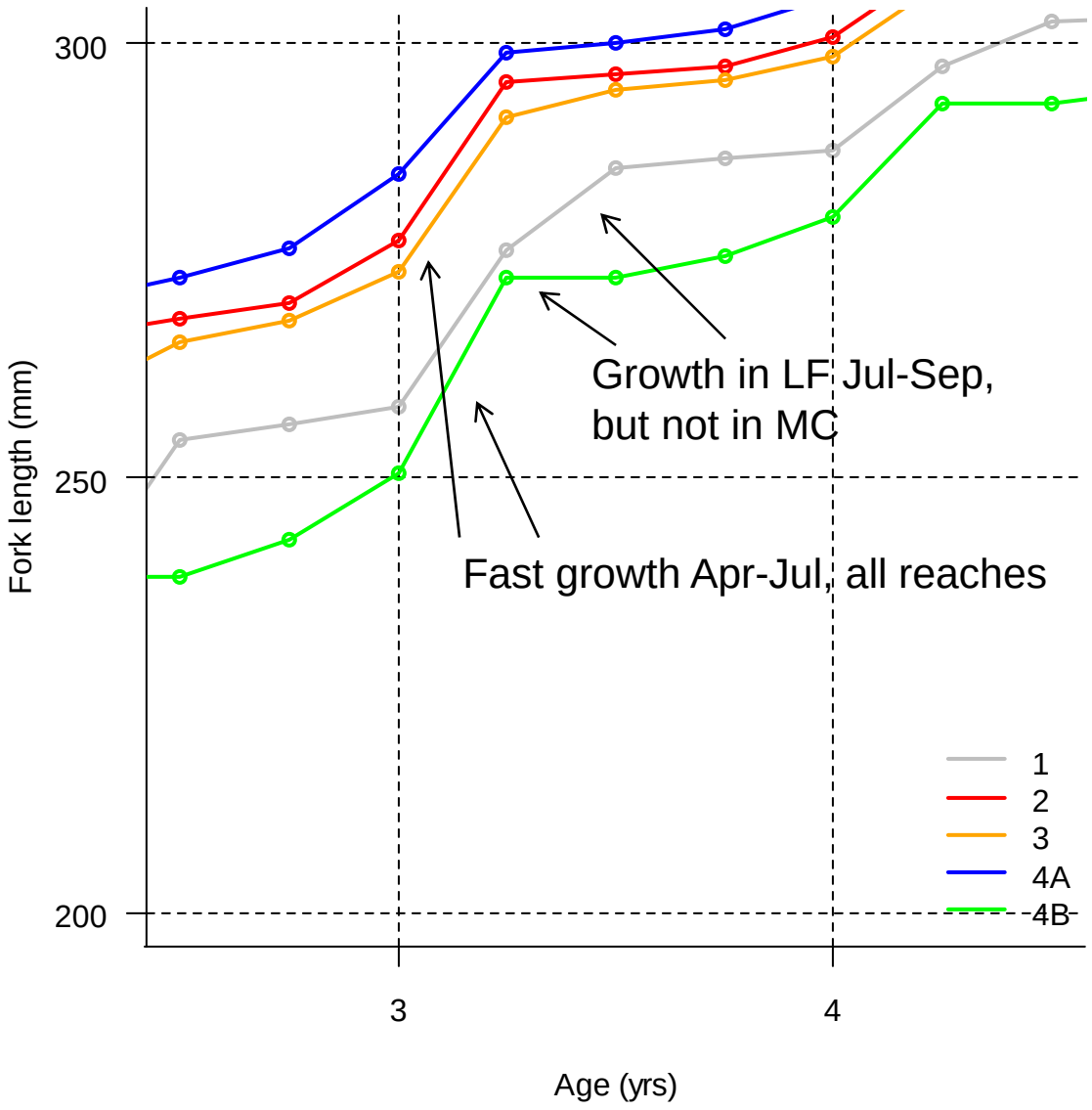
Within-Reach Movement (summary)




300
250
200
Fork length (mm)
3
4
Age (yrs)
Growth in LF Jul-Sep,
but not in MC
Fast growth Apr-Jul, all reaches
1
2
3
4A
4B

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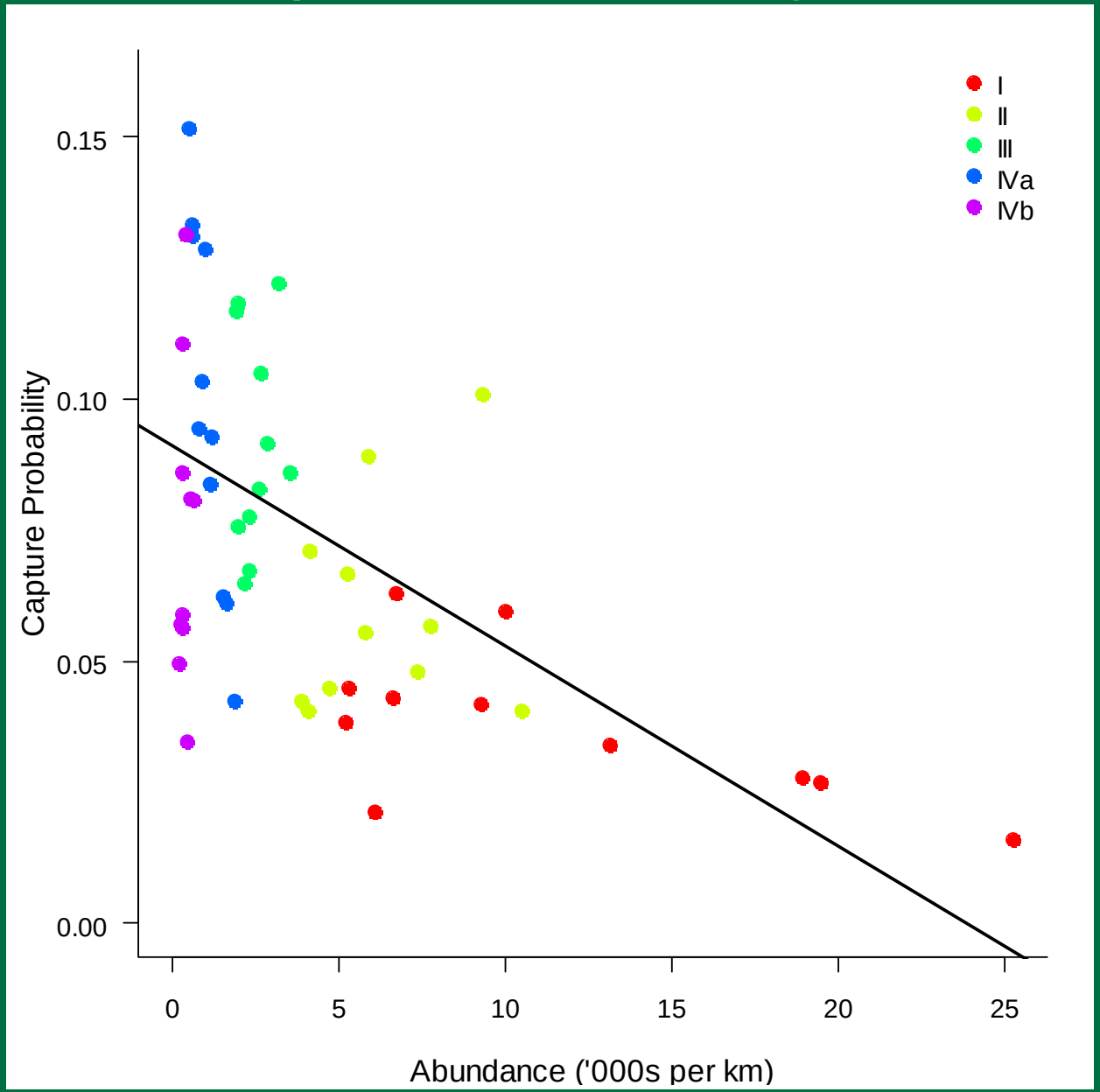
Capture Probability



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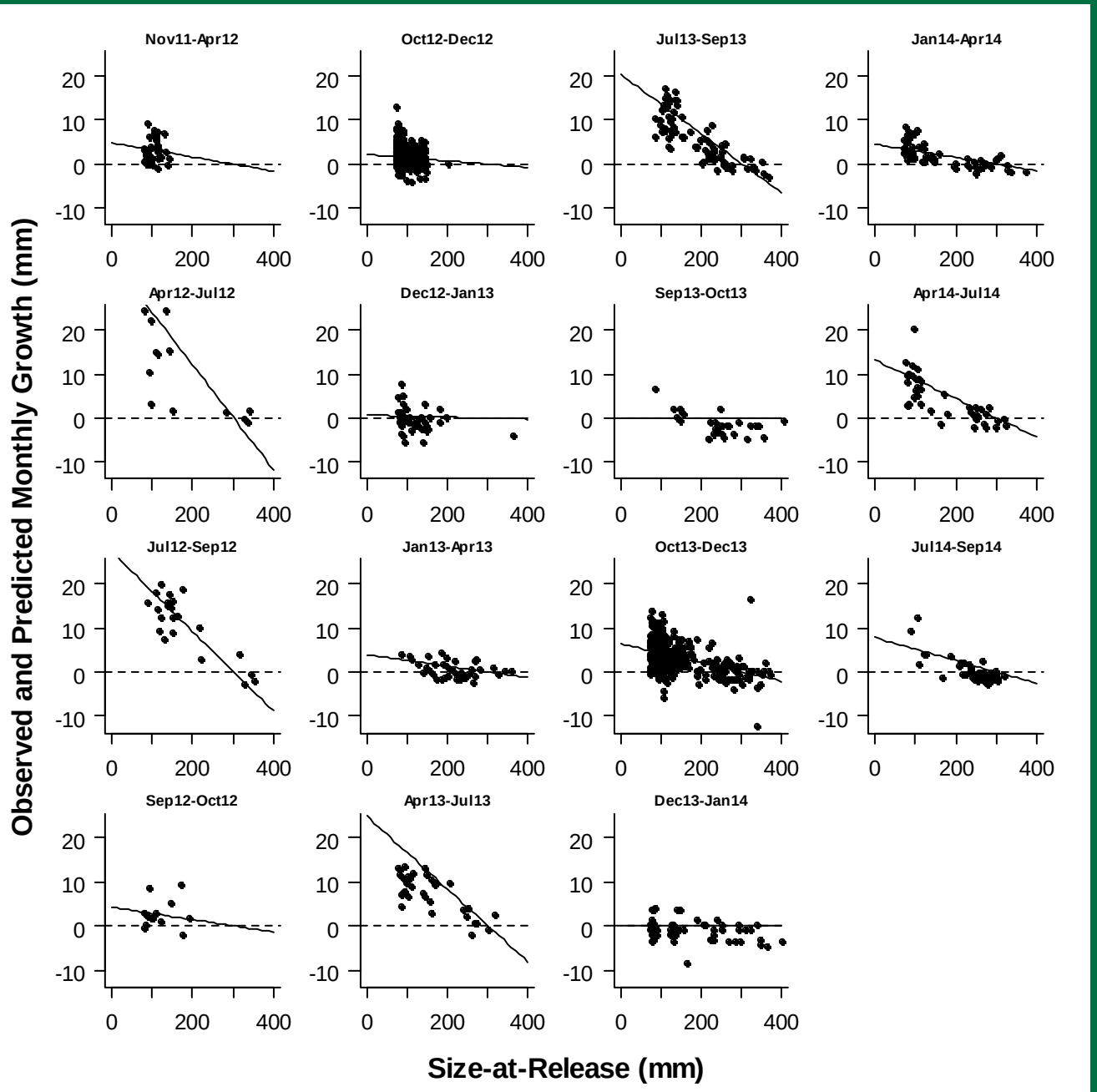
Nov11-Apr12
Oct12-Dec12
Jul13-Sep13
Jan14-Apr14
Apr12-Jul12
Dec12-Jan13
Sep13-Oct13
Apr14-Jul14
Jul12-Sep12
Jan13-Apr13
Oct13-Dec13
Jul14-Sep14
Sep12-Oct12
Apr13-Jul13
Dec13-Jan14
20
10
0
-10
0
200
400
Observed and Predicted Monthly Growth (mm)
Size-at-Release (mm)

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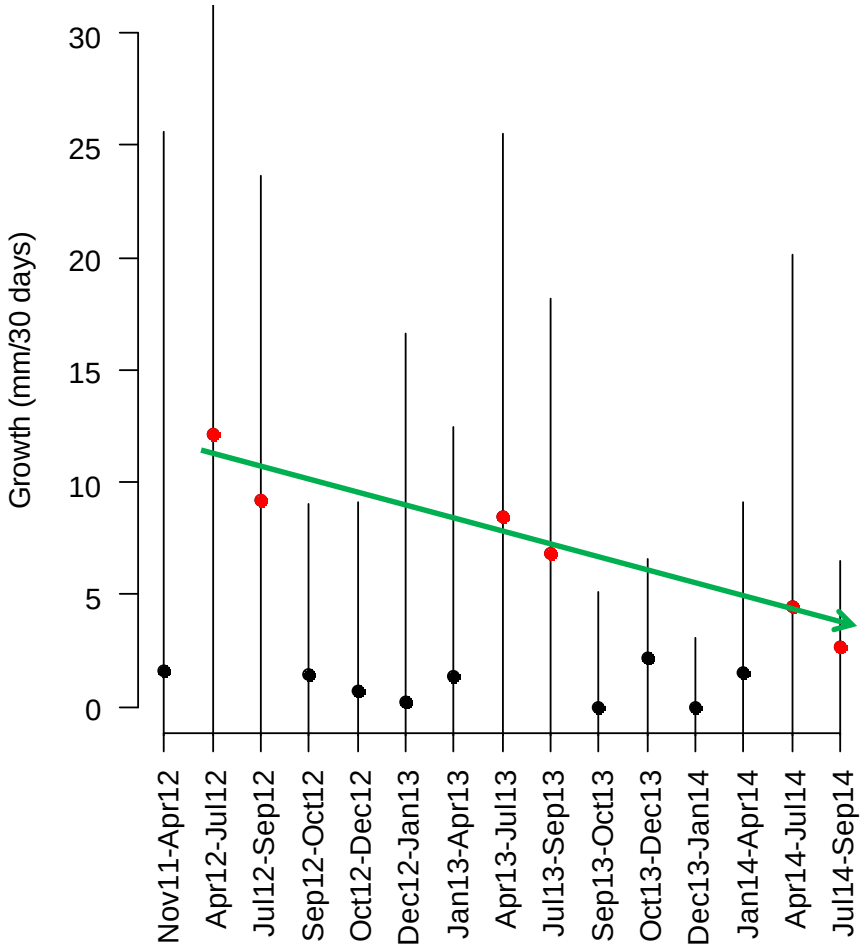
Trend in Growth in Lees Ferry



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Conclusions

1. **Abundance**
   a) High abundance in Lees Ferry and Upper Marble Canyon
   b) Much lower abundance near LCR
   c) Declining abundance in upstream reaches and increasing abundance at LCR reaches
2. **Movement**
   a) Very limited movement for the vast majority of tagged fish
   b) The small fraction of fish from upstream reaches that move downstream are sufficient to explain the increasing trend in abundance at the LCR

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Conclusions

2. Movement (con't)

c) Movement of trout from Lees Ferry to Marble Canyon can be episodic, and most fish had probably emigrated before our study began.

d) Recaptures show that both small (age-0) and large (older) trout can move from Lees Ferry to Marble Canyon

e) Recent increased downstream movement may be driven by poor condition of fish

f) There is local reproduction in middle and lower Marble Canyon that is variable across years.

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Conclusions

3. Growth
   a) Variable over space and time.
   b) Fastest growth in Marble Canyon in spring
   c) Limited growth in Marble Canyon during monsoon season.
   d) Very limited growth in fall and winter in all reaches
4. Condition
   a) Seasonal differences in condition.
   b) Declining inter-annual trend in condition in all reaches, with biggest reduction in Lees Ferry

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