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Natal Origins of Rainbow Trout: Glen Canyon and Marble Canyon

Glen Canyon Dam Adaptive Management Program
Annual Reporting Meeting
January 28, 2014

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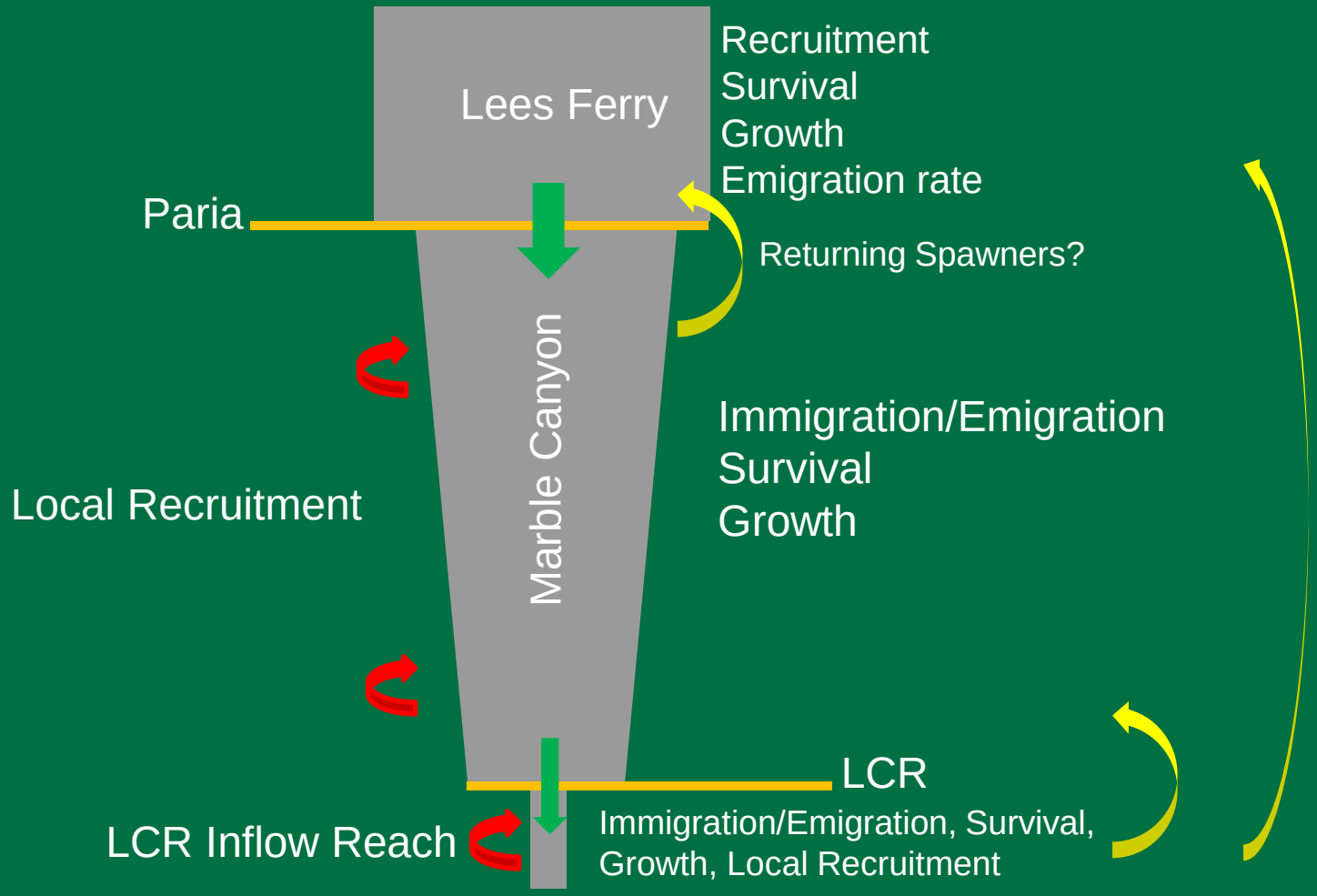
U.S. Department of the Interior
U.S. Geological Survey

Conceptual Model



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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
- RBT Abundance, capture probability, and survival
- RBT Movement, tag recaptures, population trends, length- and age-frequency trends
- RBT Growth
- RBT Local reproduction
- Conclusions

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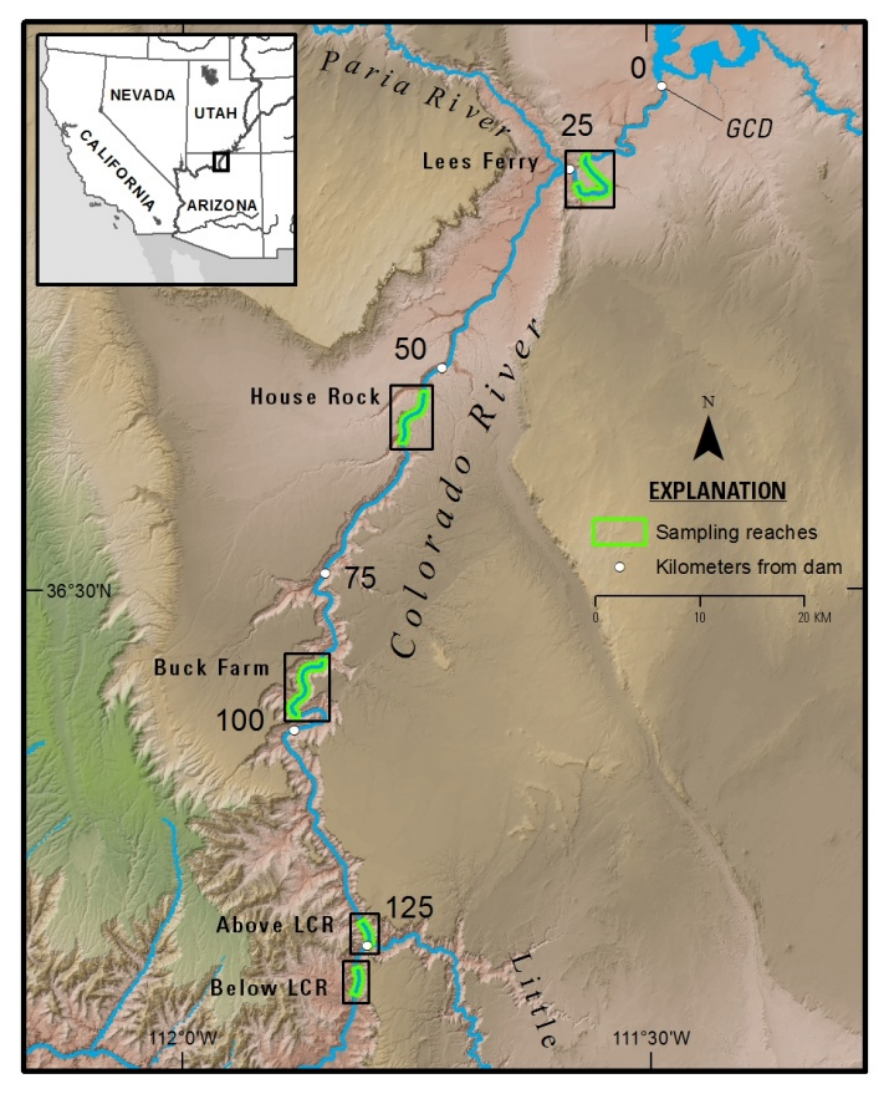
Sampling Design



- **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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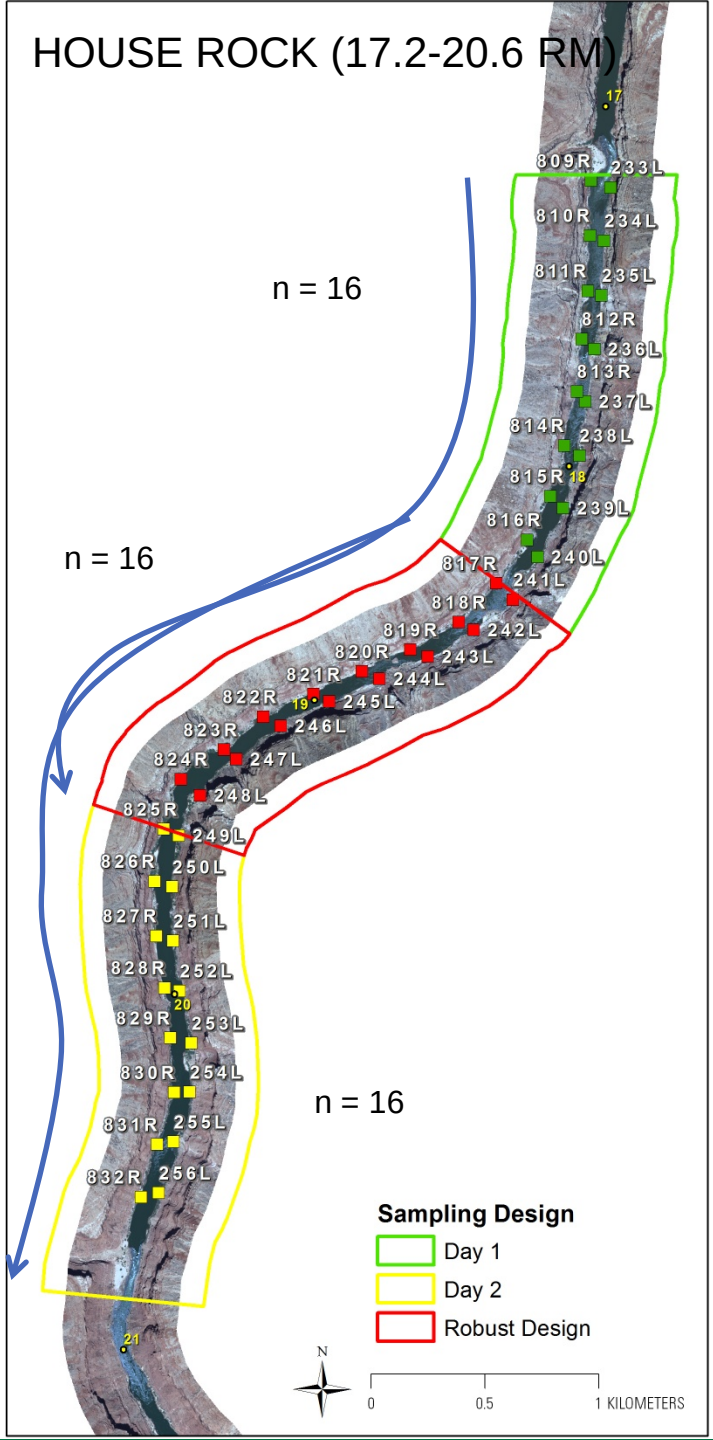

Sampling Design

➢ 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

Summary of RBT Catch and PIT Releases

	Total RBT	PIT Tag 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	16,559	11,485						
Apr-12	12,006		609	552	549	317	119	
Jul-12	11,855		768	795	848	339	197	
Sep-12	18,155		625	788	842	305	229	
Oct-12	22,950	5,088						
Dec-12	12,733	4,254						
Jan-13	12,338		728	776	987	347	336	
Apr-13	9,992		870	1,010	879	367	135	
Jul-13	8,625		815	828	882	428	279	
Sep-13	14,041		1,122	1,068	741	478	351	
Oct-13	13,283	5,838						
Dec-13	8,846	5,536						
Jan-14	9,192		949	1209	1198	555	388	
Total	170,575	32,201	6,486	7,026	6,926	3,136	2,034	57,809

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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	250	253	0	0	0	0	
Apr-12		80	133	201	146	42	
Jul-12		101	201	296	128	60	
Sep-12		65	160	198	118	58	
Oct-12	341	342	0	0	0	0	
Dec-12	163	164	0	0	0	0	
Jan-13		98	166	179	120	62	
Apr-13		85	188	199	118	39	
Jul-13		99	134	179	110	49	
Sep-13		54	62	86	64	32	
Oct-13	362	385	0	0	0	0	
Dec-13		58	0	0	0	0	
Jan-14							
Total	1,116	1,784	1,044	1,338	804	342	6,428

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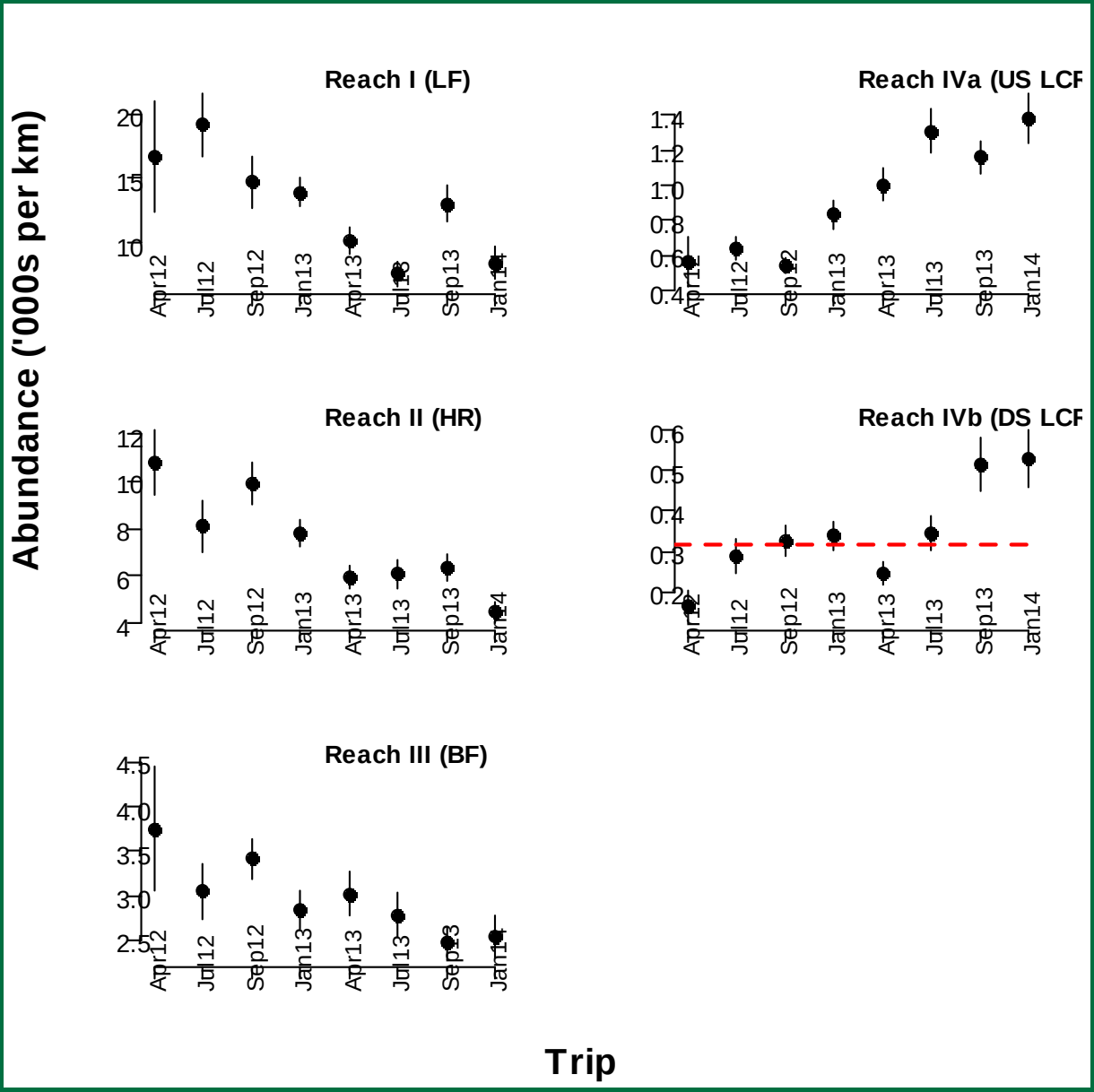
Abundance By Reach



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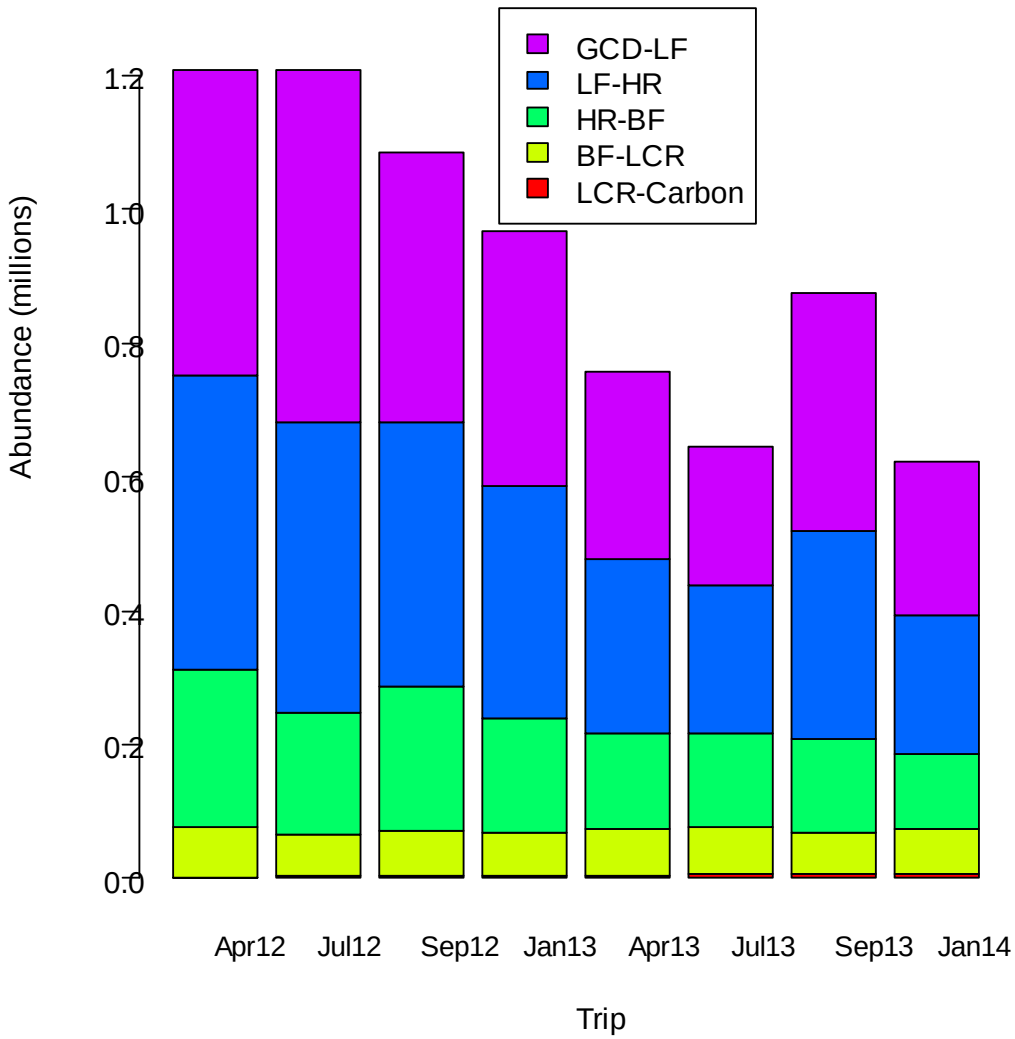
System-Wide Abundance



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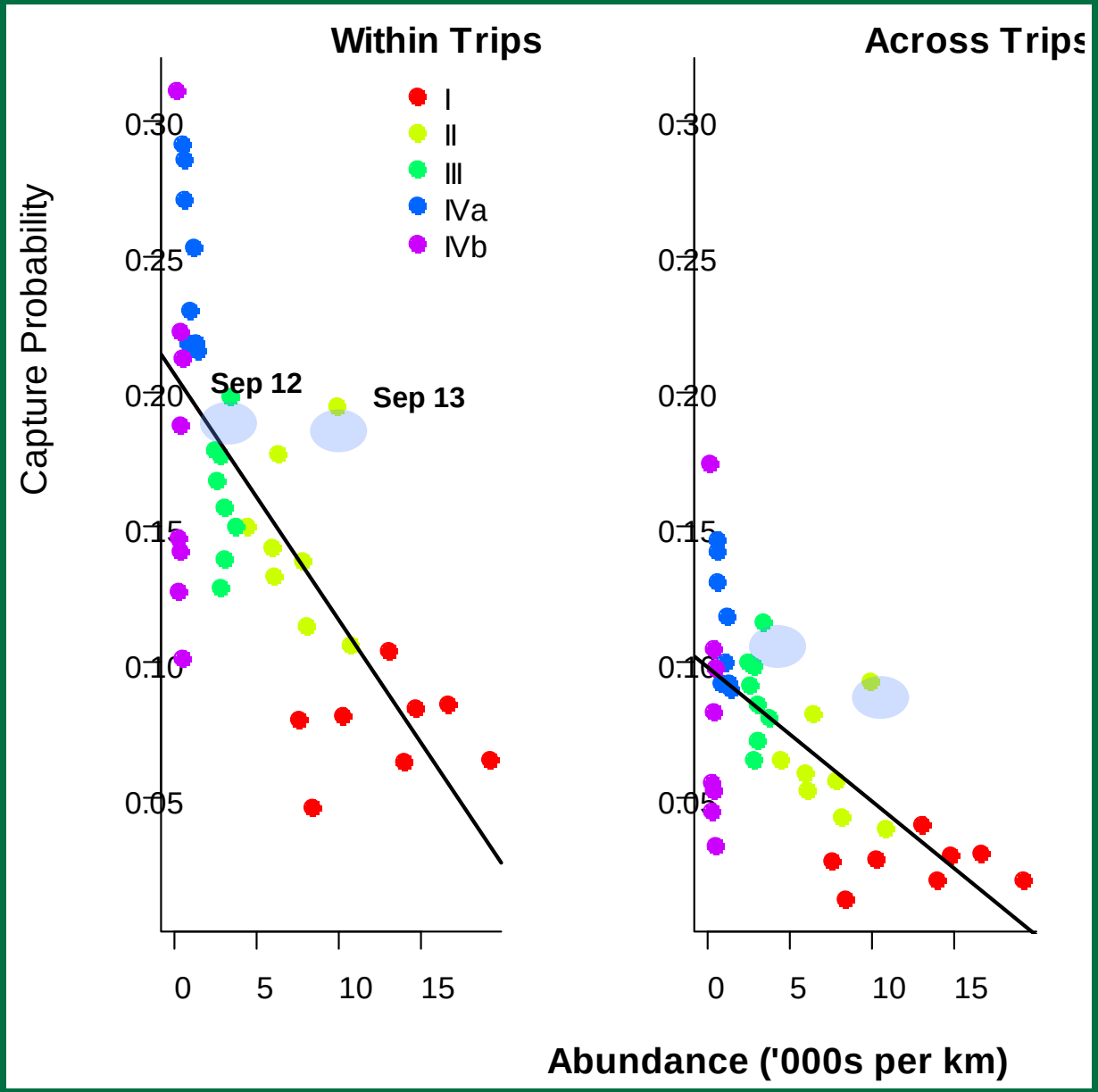
Capture Probability



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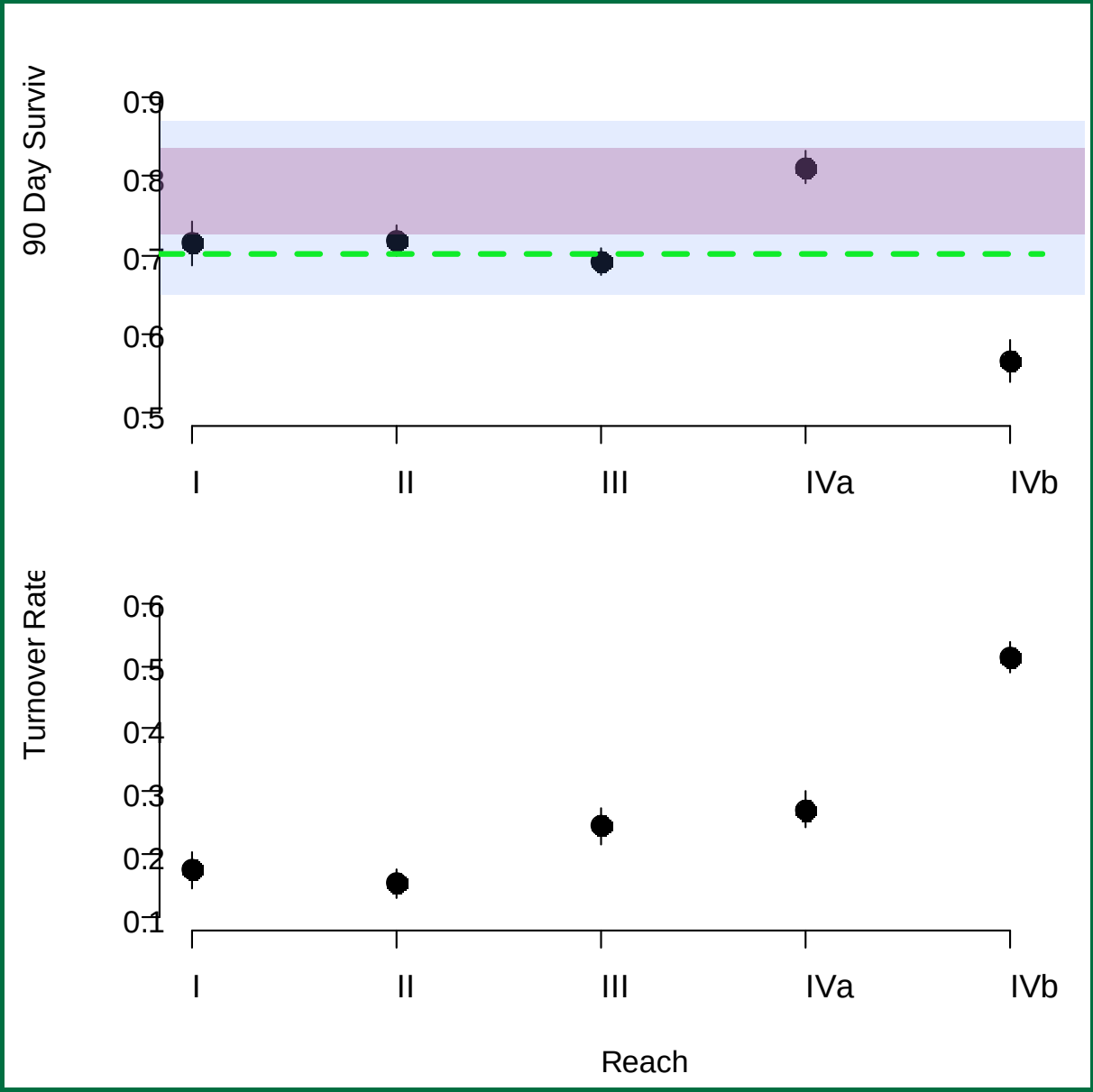
Survival and Turnover



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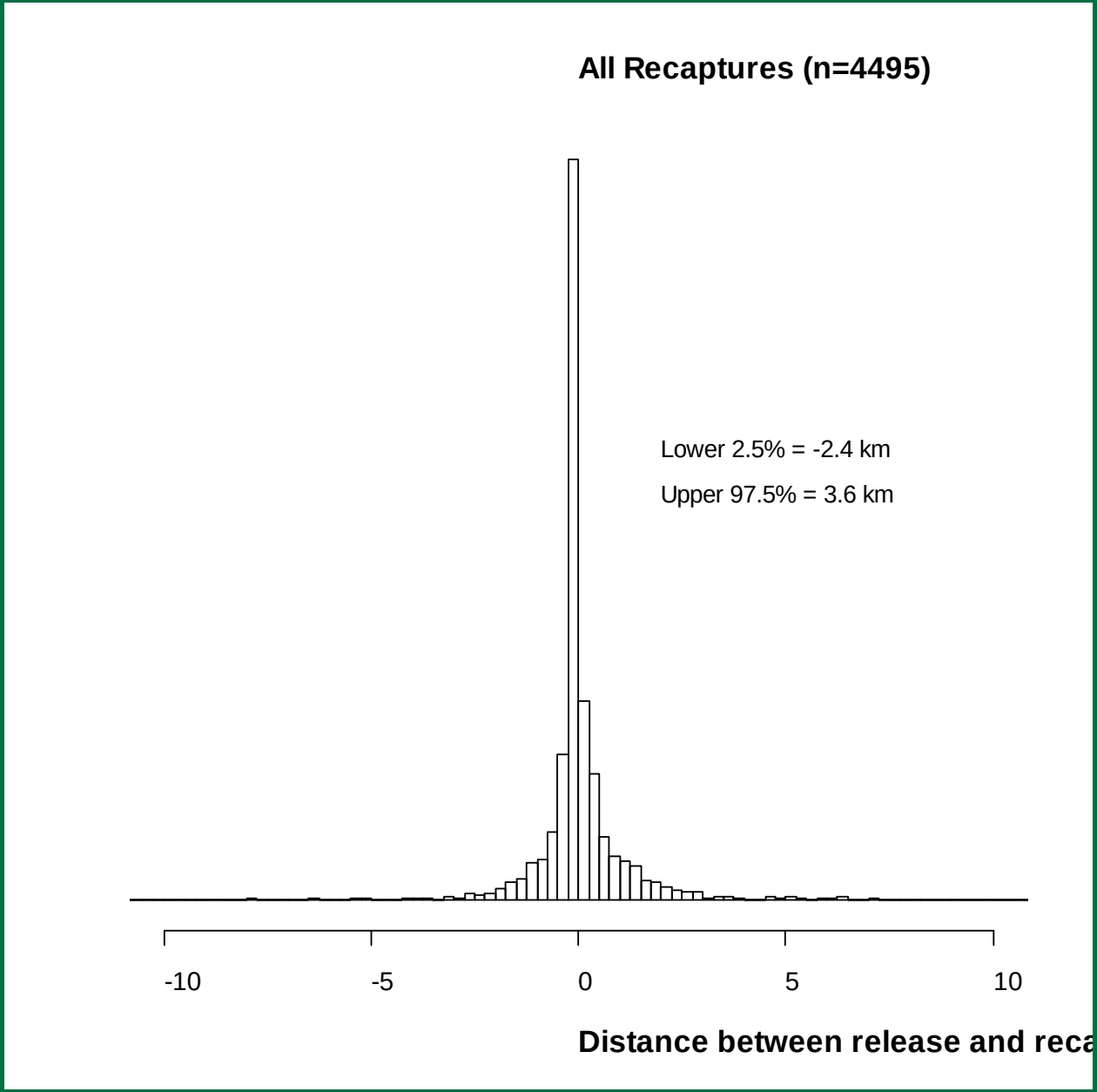
Tag-Based Movement



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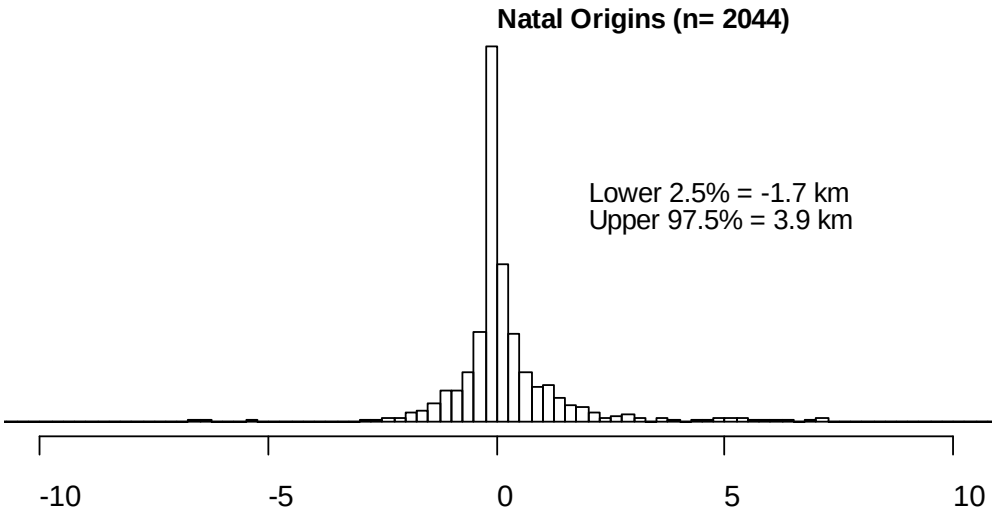
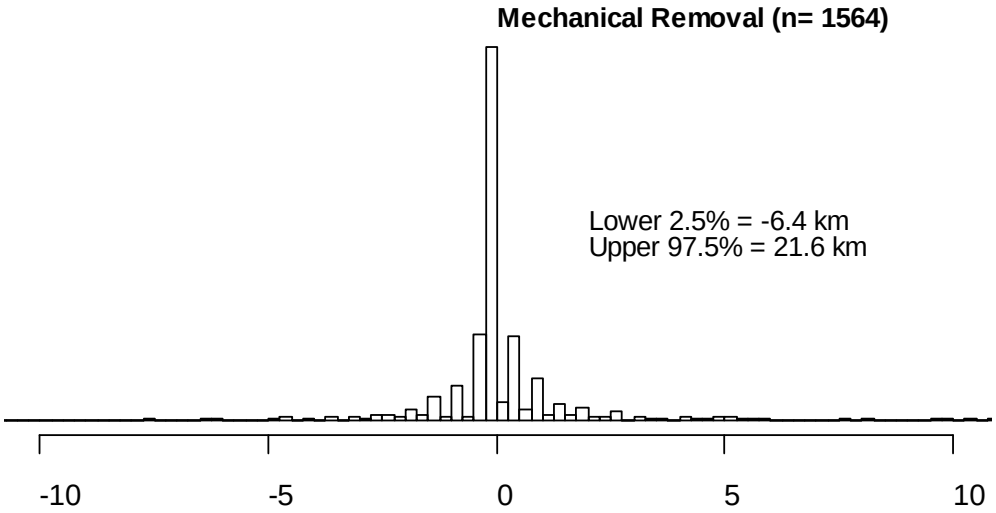
Movement: 2012-2013 vs. 2003-2006





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Large Movements (> 20 km or <-20 km)

	Trip		Location		KM	Fork Length (mm)		From LF	From MC
TAG	Release	Recapture	Release	Recapture	Moved	Release	Recapture	to MC	to LF
384.36F2B29B09	Sep2012	Jul2013	63.73	-5.05	-110.7	269	299		1
384.36F2B295C9	Sep2012	Dec2013	40.34	-0.16	-65.2	241	282		1
384.36F2B29CF7	Sep2012	Oct2013	19.4	-12.0	-50.6	360	365		1
384.1B796FB0AA	Jul2012	Dec2013	19.27	-10.8	-48.4	340	341		1
384.36F2B2979B	Sep2012	Dec2013	18.4	-11.2	-47.6	178	199		1
384.36F2B2A465	Sep2012	Oct2013	18.8	-9.7	-45.9	204	275		1
384.36F2B28F27	Jan2013	Oct2013	18.7	-8.3	-43.4	205	238		1
384.1B796B8E57	Jul2012	Jul2013	63.8	41.2	-36.4	250	271		
384.36F2B2970E	Sep2012	Sep2013	18.9	-2.5	-34.3	237	296		1
384.36F2B2BAC5	Jan2013	Oct2013	19.3	-2.0	-34.2	227	259		1
384.36F2B2A9E9	Jan2013	Apr2013	39.46	18.54	-33.7	278	281		
384.1B796F9F26	Apr2012	Sep2013	39.5	18.8	-33.2	158	271		
384.36F2B2A4DE	Sep2012	Sep2013	39.9	19.9	-32.3	254	274		
384.36F2B2990E	Sep2012	Jan2014	60.9	41.47	-31.3	273	311		
384.36F2B29CF6	Apr2013	Jan2014	38.2	19.12	-30.7	236	249		
384.1B796C9E18	Nov2011	Jul2012	-13.27	-0.798	20.1	91	113		
384.1B796AA011	Nov2011	Jan2013	4.12	19.42	24.6	94	223		
384.1B796B788B	Nov2011	Jul2013	-2.0	17.4	31.1	97	254	1	
3DD.003BA0A245	Sep2013	Jan2014	18.54	38.48	32.1	257	260		
384.36F2B2A4D7	Sep2012	Jan2013	40.2	60.2	32.3	209	216		
3DD.003B9C285D	Jul2013	Sep2013	39.89	60.73	33.5	314	302		
3DD.003BA03777	Jul2013	Jan2014	18.54	39.45	33.7	265	263		
3DD.003BA05BA6	Apr2013	Jul2013	18.39	39.45	33.9	212	248		
3DD.003BA03097	Jan2013	Jan2014	40.04	61.19	34	207	244		
384.36F2B2939B	Sep2012	Sep2013	39.46	61.19	35	205	253		
384.1B796B6F61	Nov2011	Apr2012	-4.9	18.7	37.9	90	125	1	
384.1B796BB5D5	Apr2012	Apr2013	40.04	64.13	38.8	140	214		
384.36F2B253FB	Jul2012	Jan2013	39.3	63.72	39.3	289	284		
384.36F2B2B750	Jan2013	Apr2013	39.5	64.8	40.8	215	222		
384.1B796BBD34	Nov2011	Sep2013	-11.91	18.54	49	142	259	1	
384.1B796BB627	Nov2011	Apr2012	-11.55	19.12	49.4	93	107	1	
384.1B796C994B	Nov2011	Sep2012	-12.4	19.1	50.8	120	240	1	
384.36F2B25213	Sep2012	Sep2013	18.82	60.34	66.8	204	272		
3DD.003BA03F58	Jul2013	Jan2014	18.66	60.36	67.1	273	268		
384.1B796FAB90	Jul2012	Sep2012	19	61.01	67.6	292	297		
3DD.003B9C2F6C	Jul2013	Jan2014	19.42	63.96	71.7	256	252		
3DD.003BA028C5	Jan2013	Sep2013	18.54	64.1	73.3	115	270		
384.36F2B28F69	Jan2013	Jan2014	18.24	65.12	75.4	250	273		

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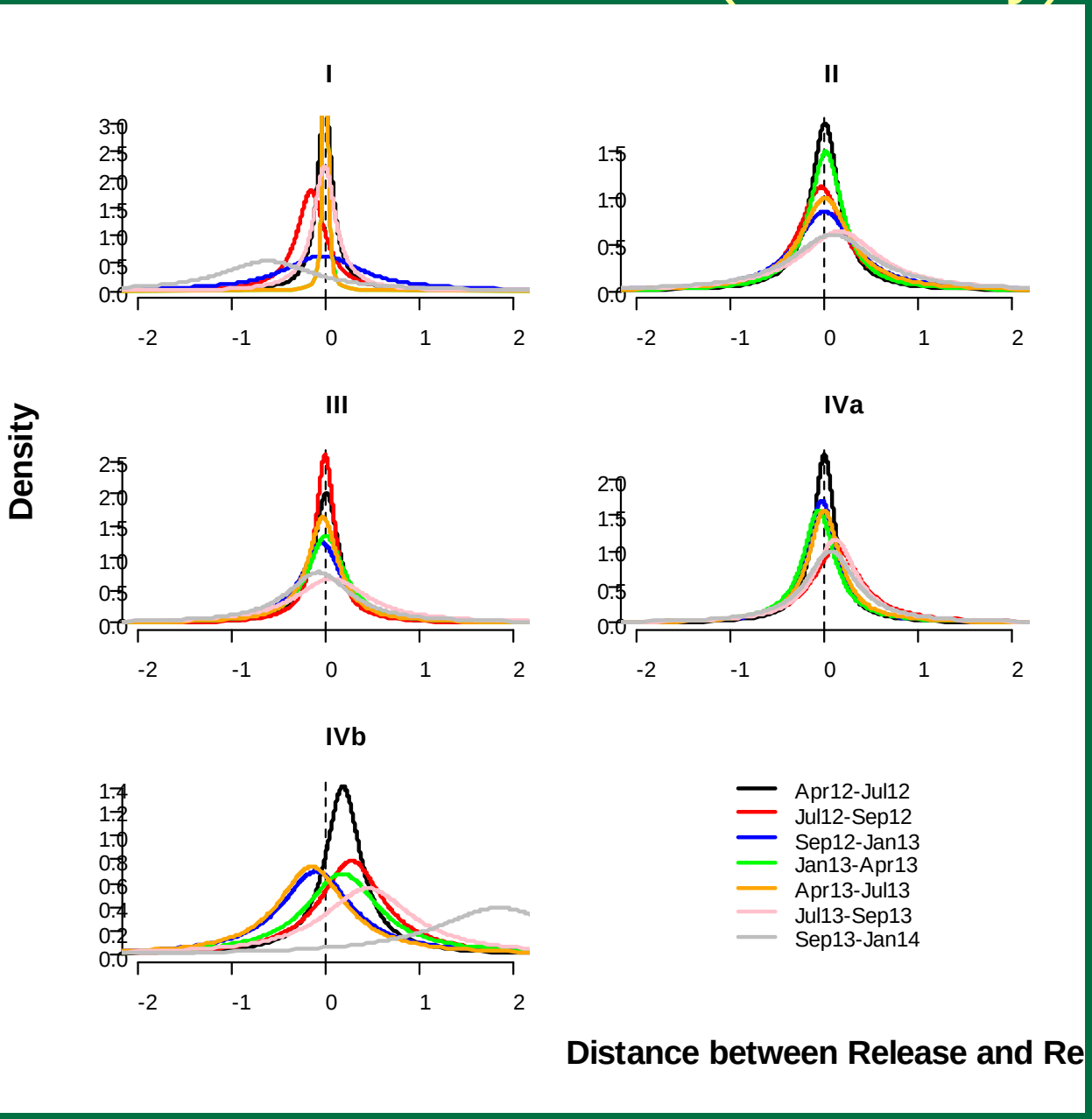
Within-Reach Movement (summary)



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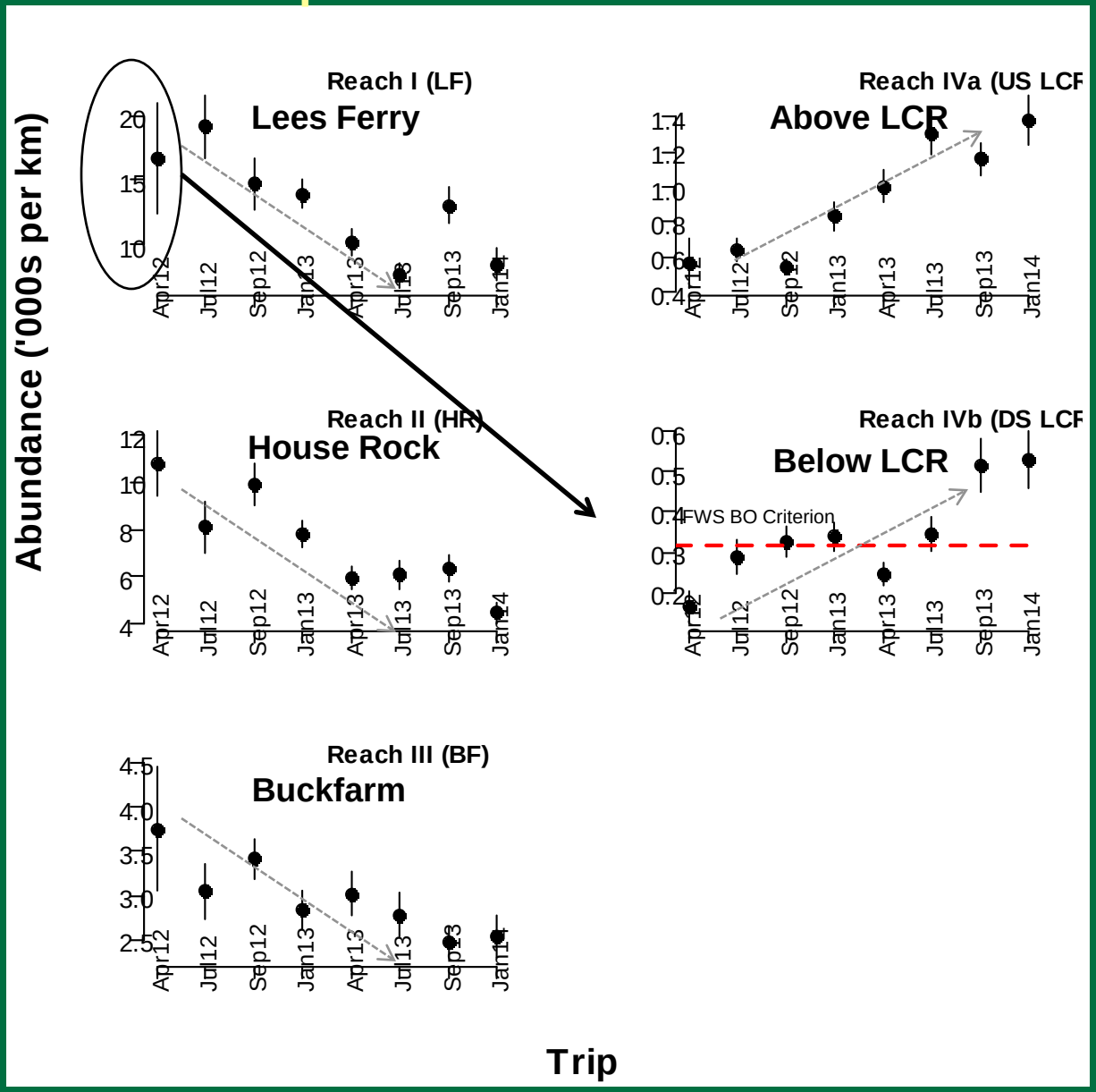
Evidence for Downstream Dispersal: Population Trends



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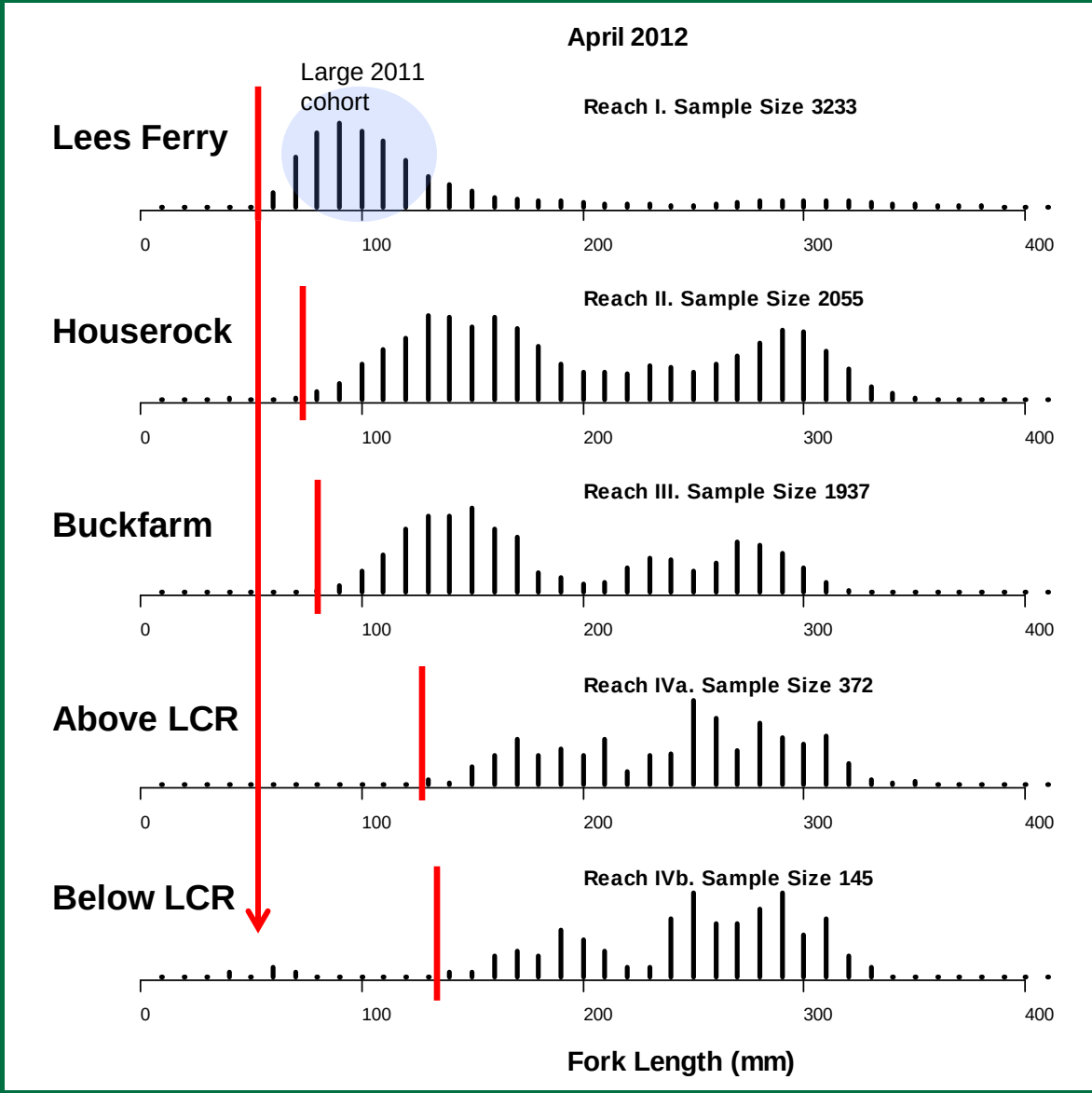
Evidence for Downstream Dispersal: Downstream Increase in Size of Smallest Fish



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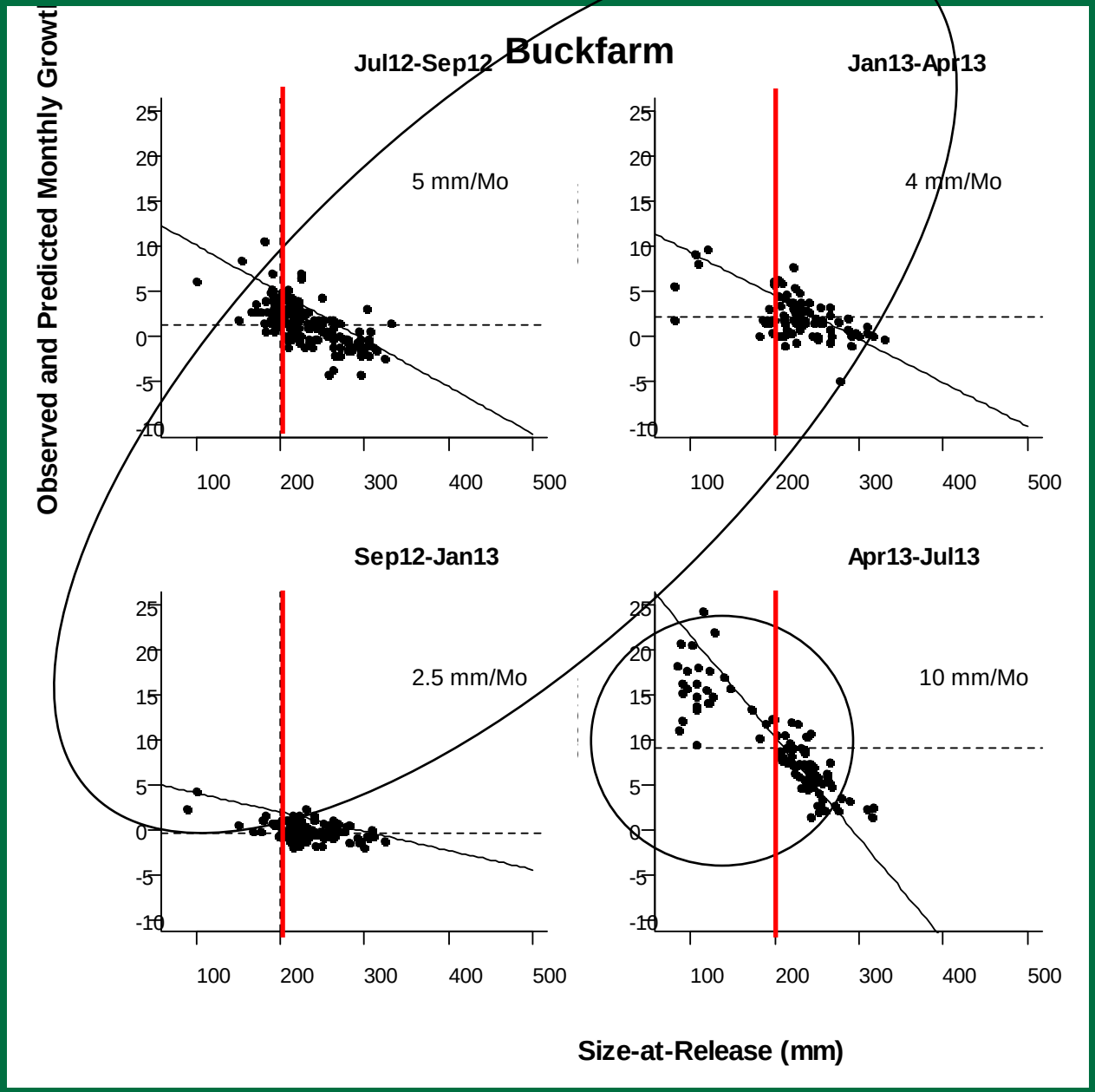
Fitting RBT Growth in Length



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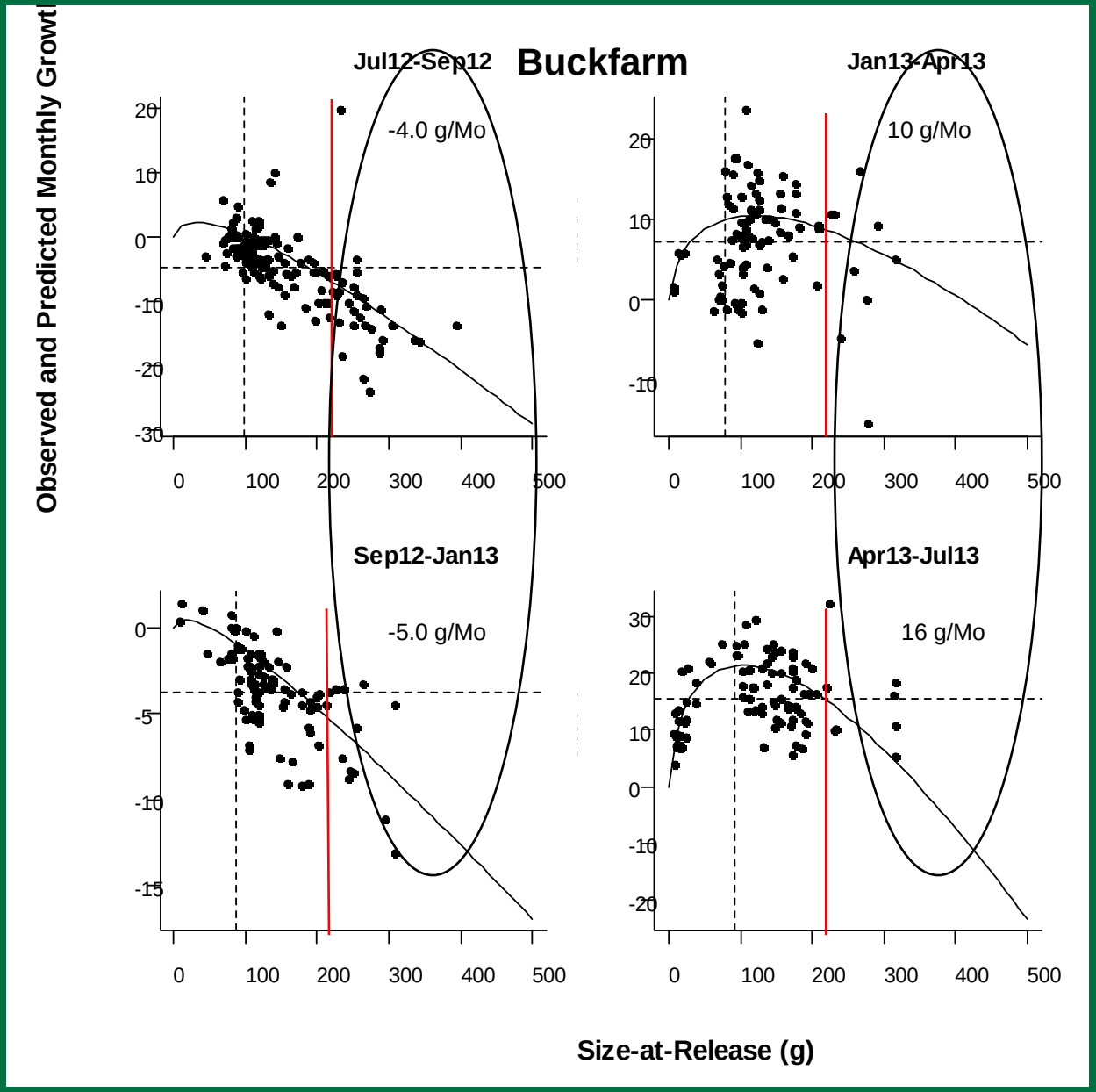
Fitting Growth in Weight



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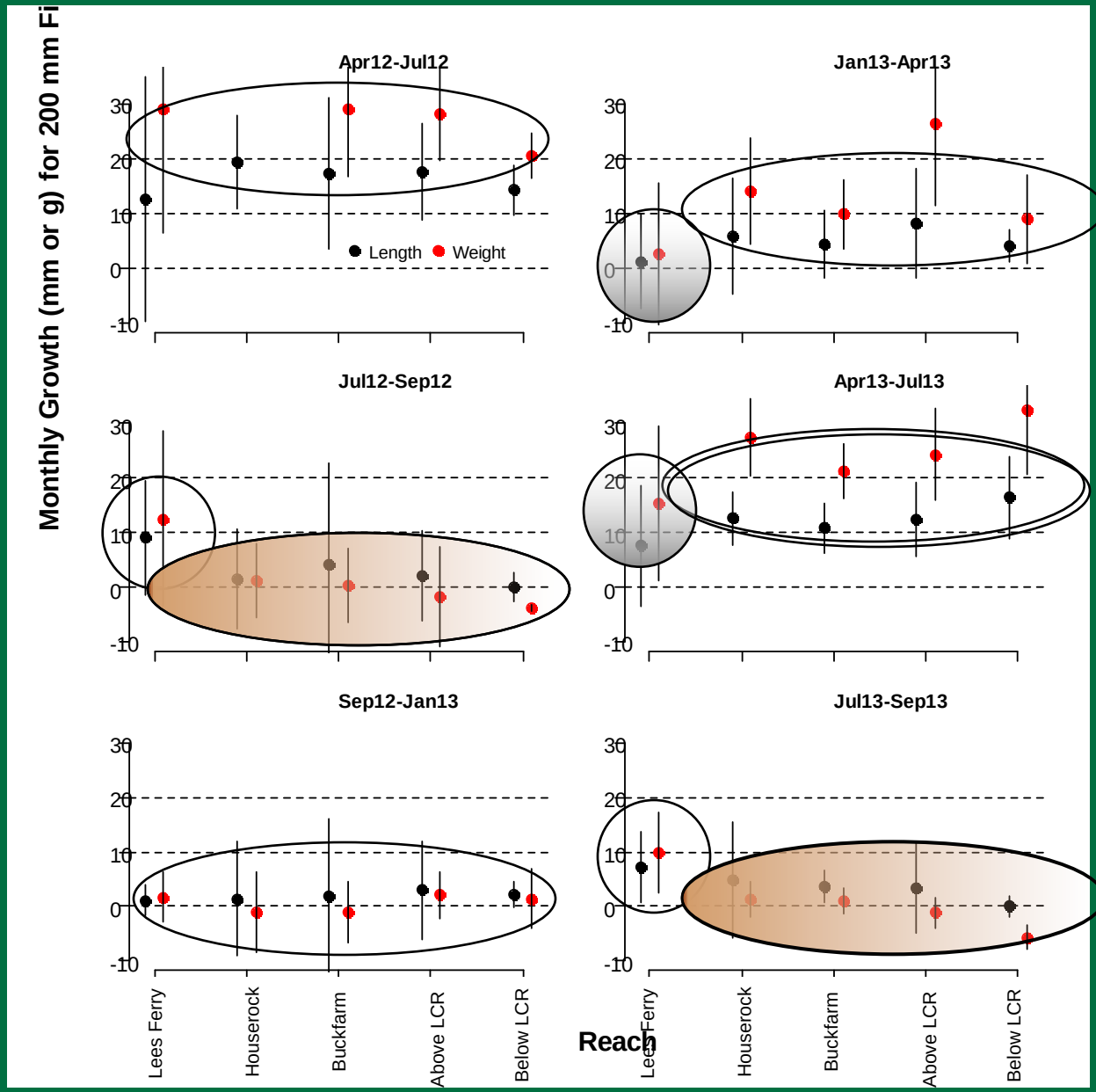
Trends in Growth (@ 200 mm)



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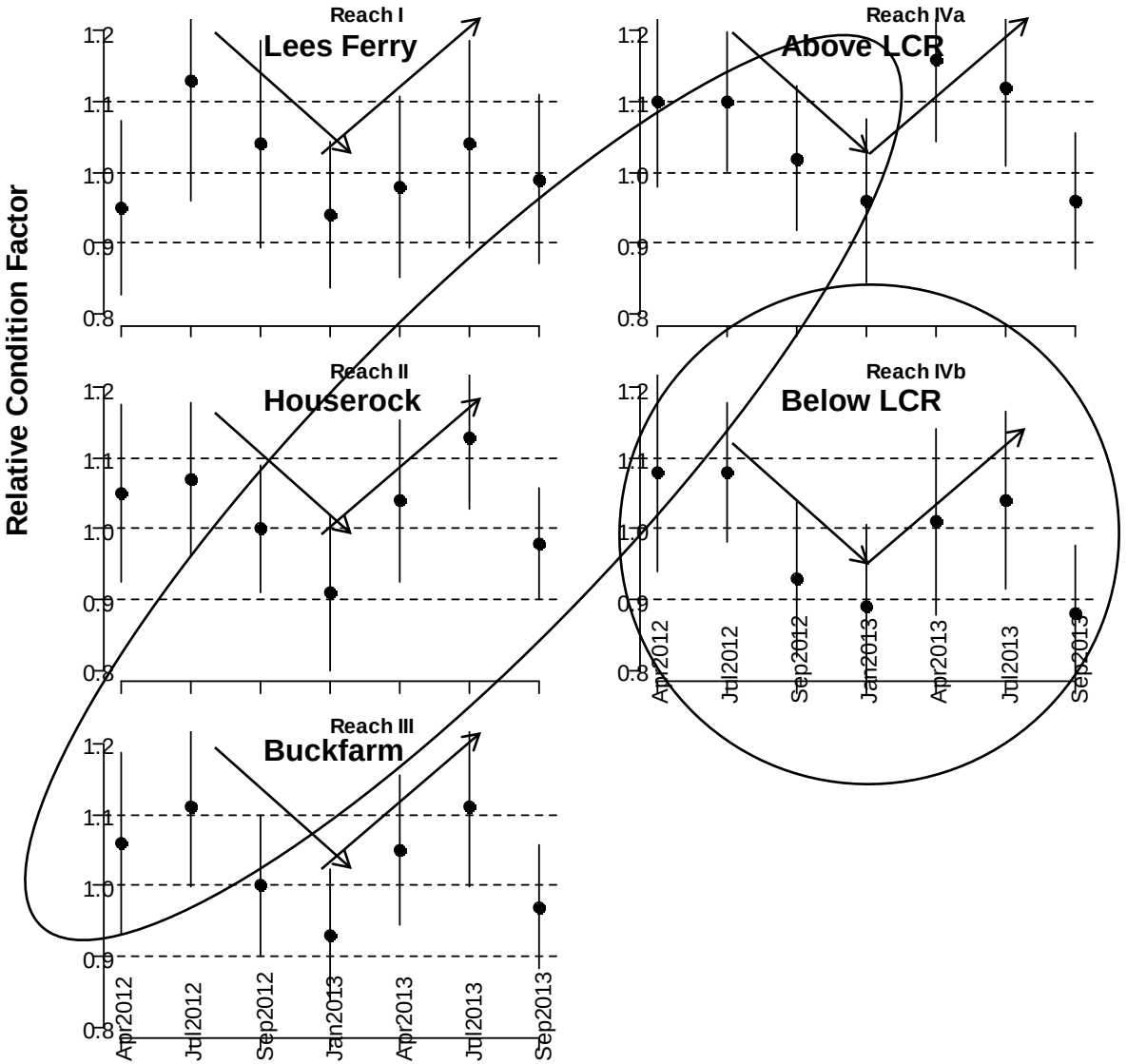
Trends in Condition Factor



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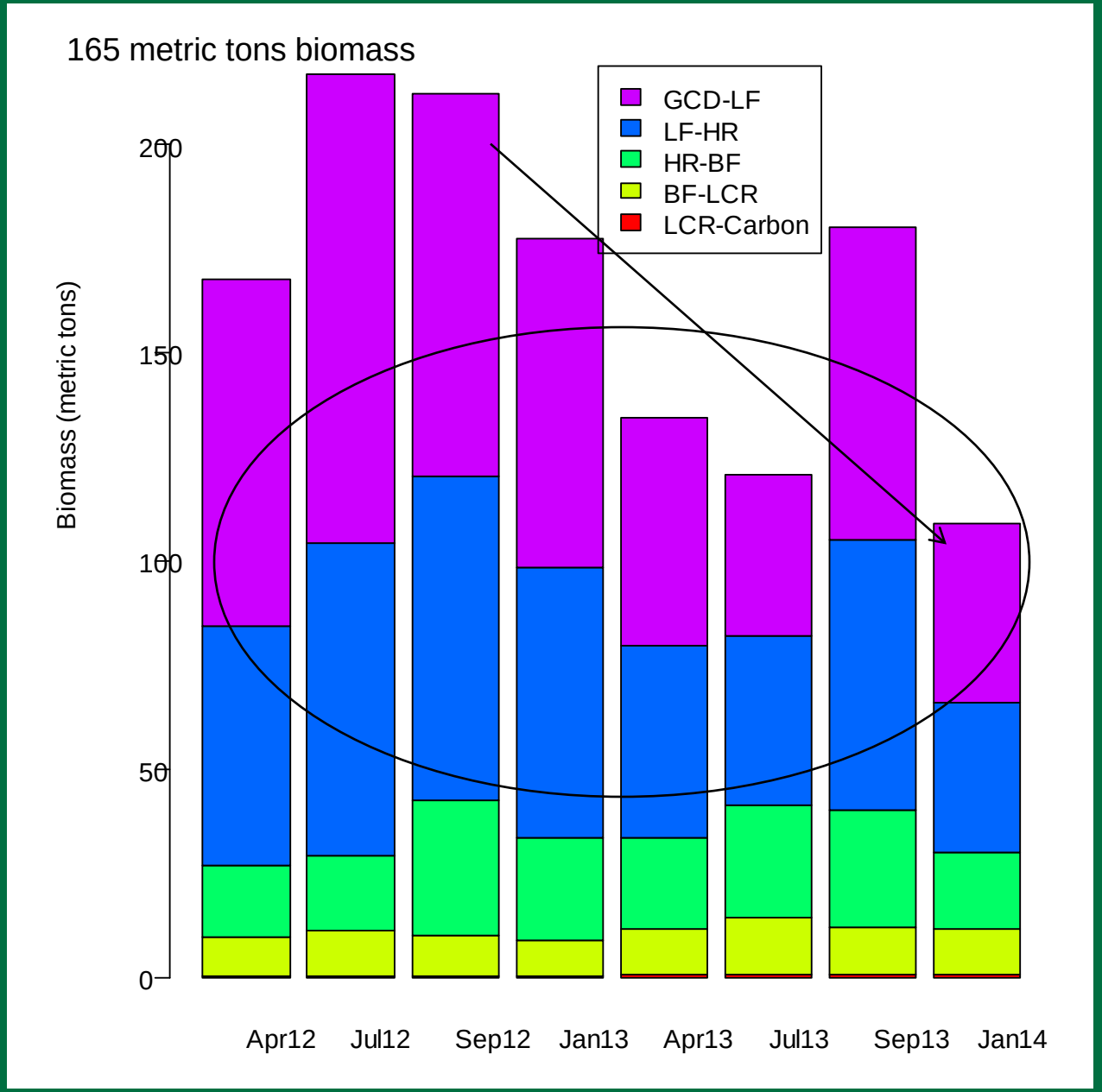
Rainbow Trout Biomass



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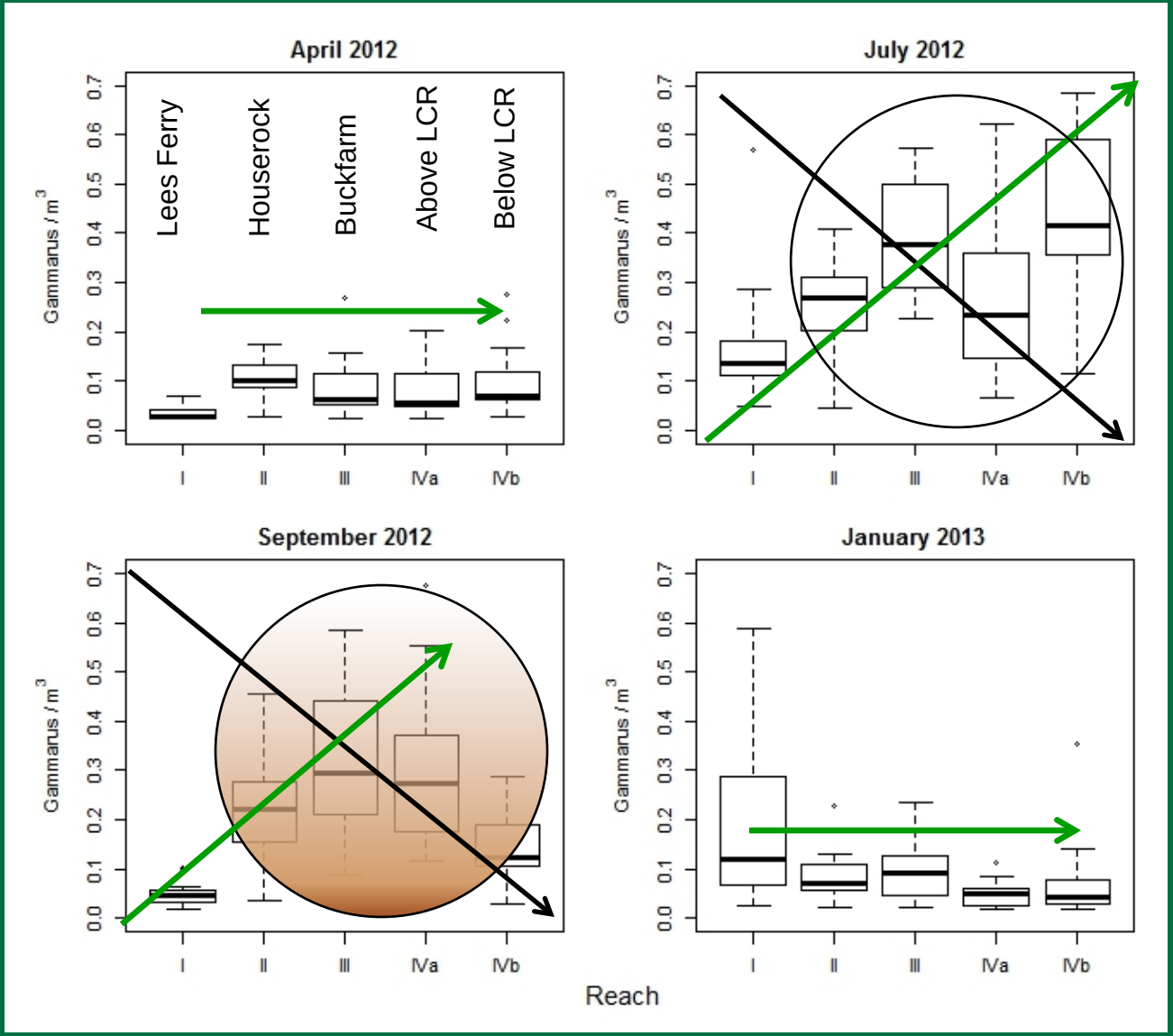
Invertebrate Drift Concentration (*Gammarus lacustris*)



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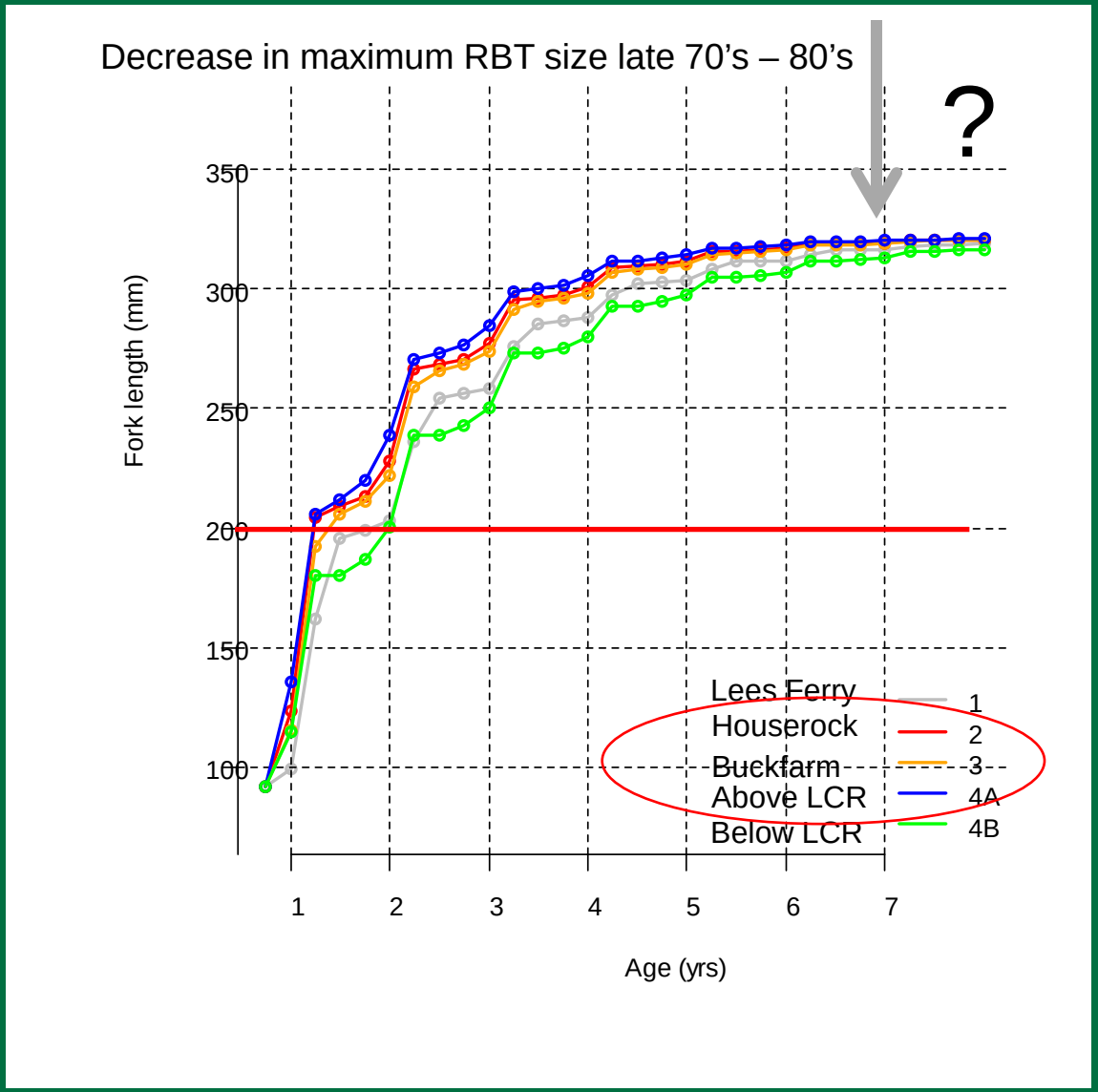
Length-at-Age: Convert length-frequencies to Age- and Birth Date-Frequencies



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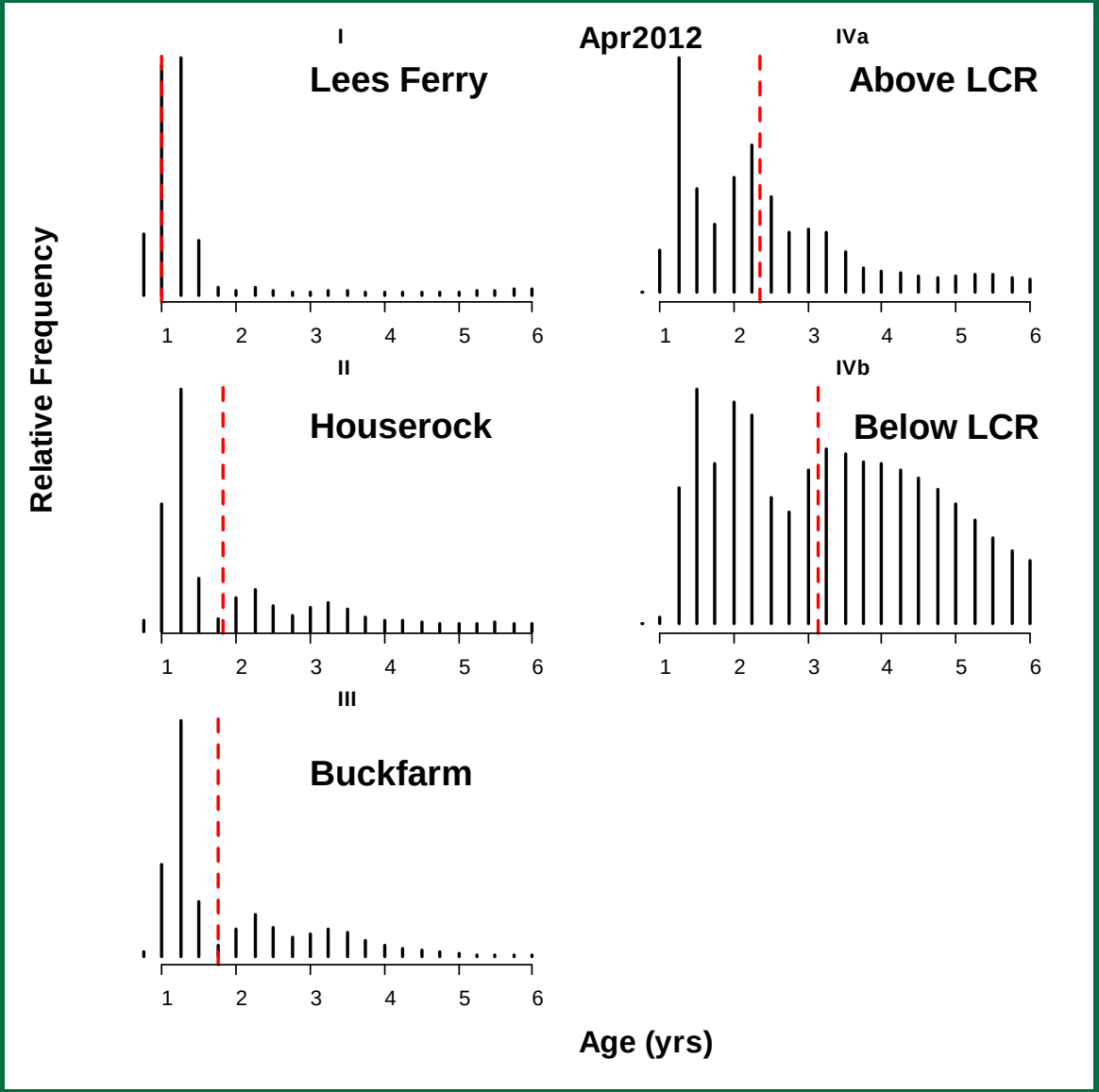
Evidence for Downstream Dispersal: Age-Frequencies Confirm Few Young Fish Downstream



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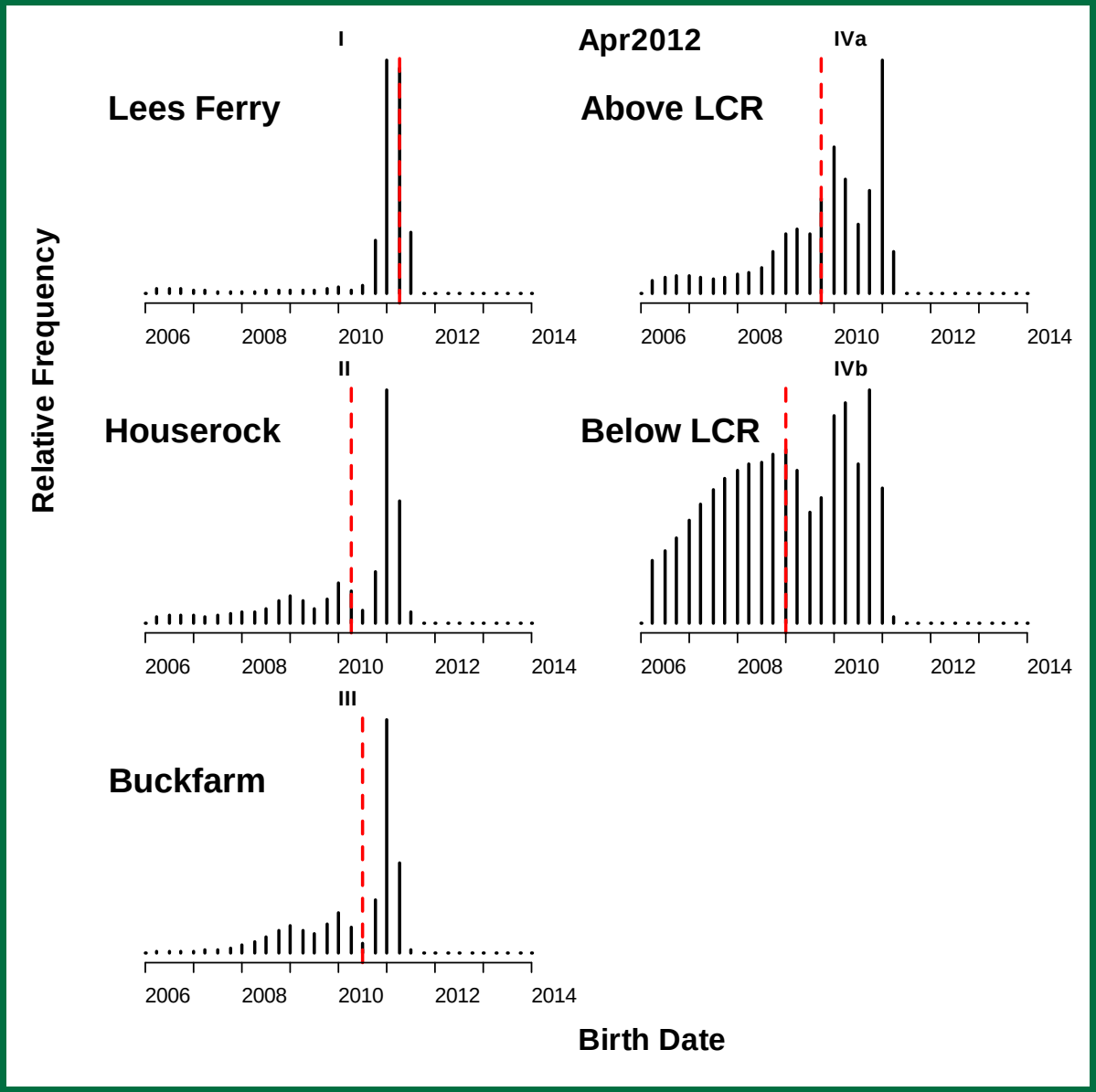
Cohort Origins based on Birth Date Frequencies



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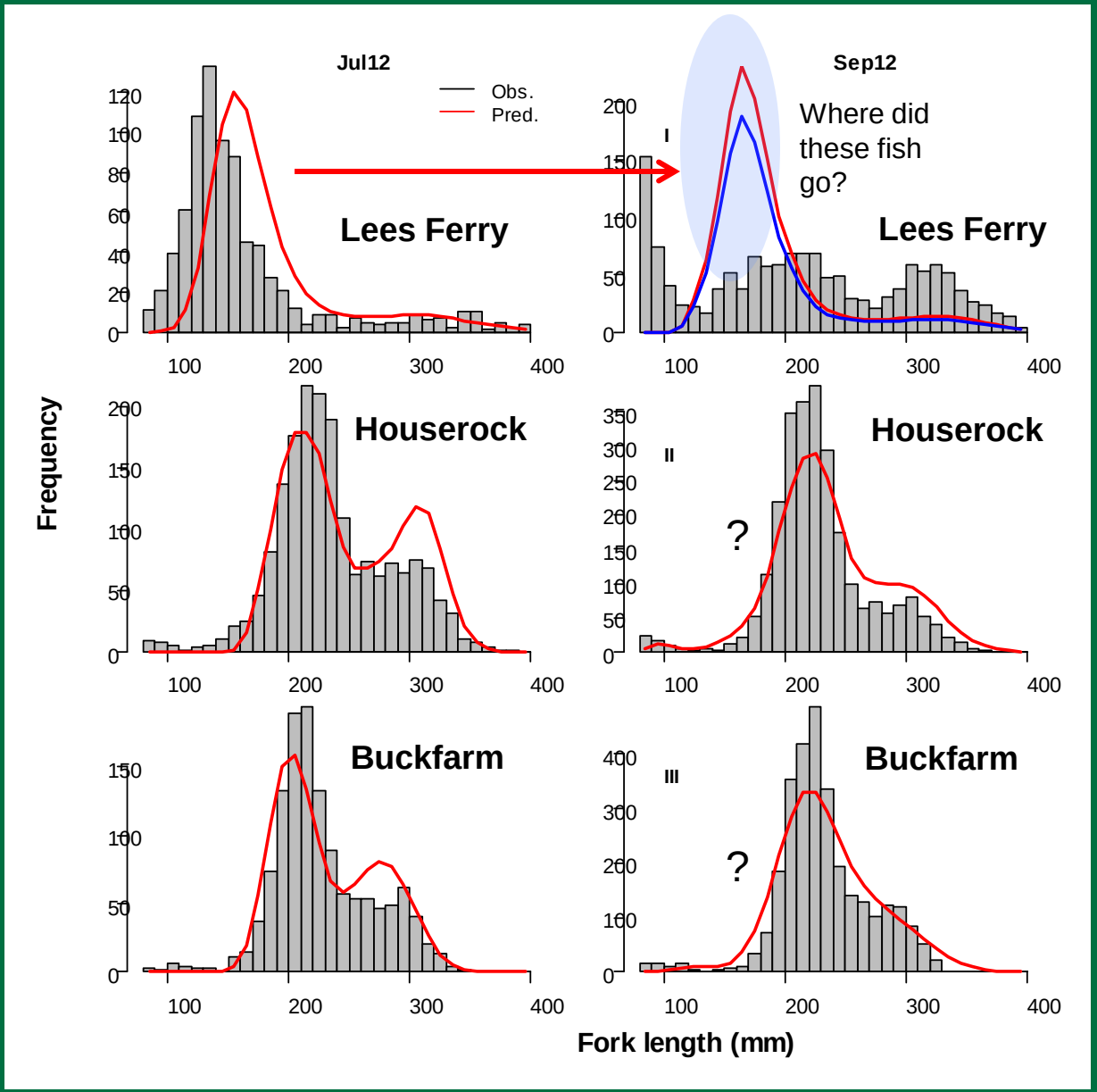
What Size/Age Group is Emigration from Lees Ferry? Predicted vs. Observed Length Frequencies



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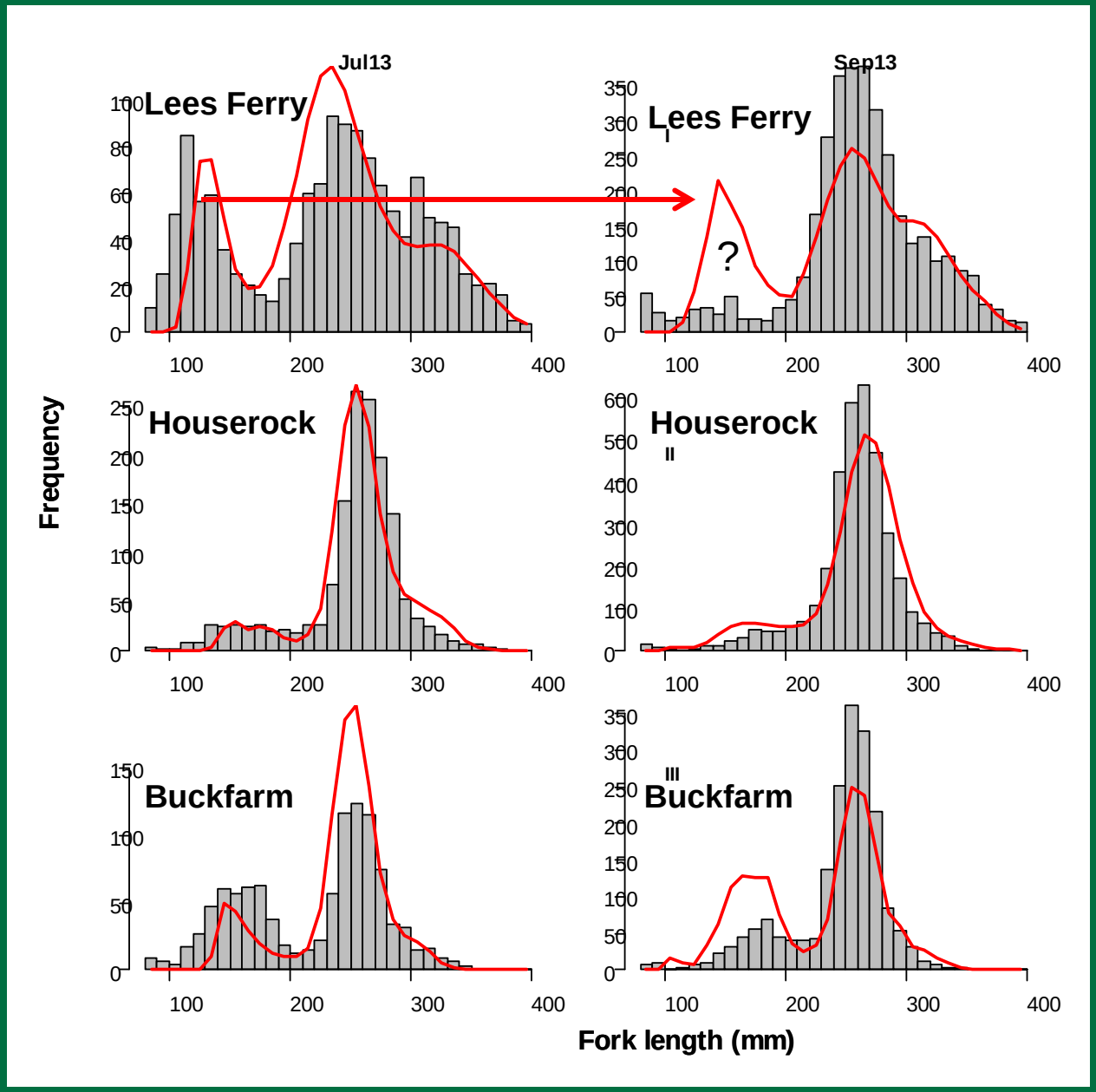
Same Pattern in 2013



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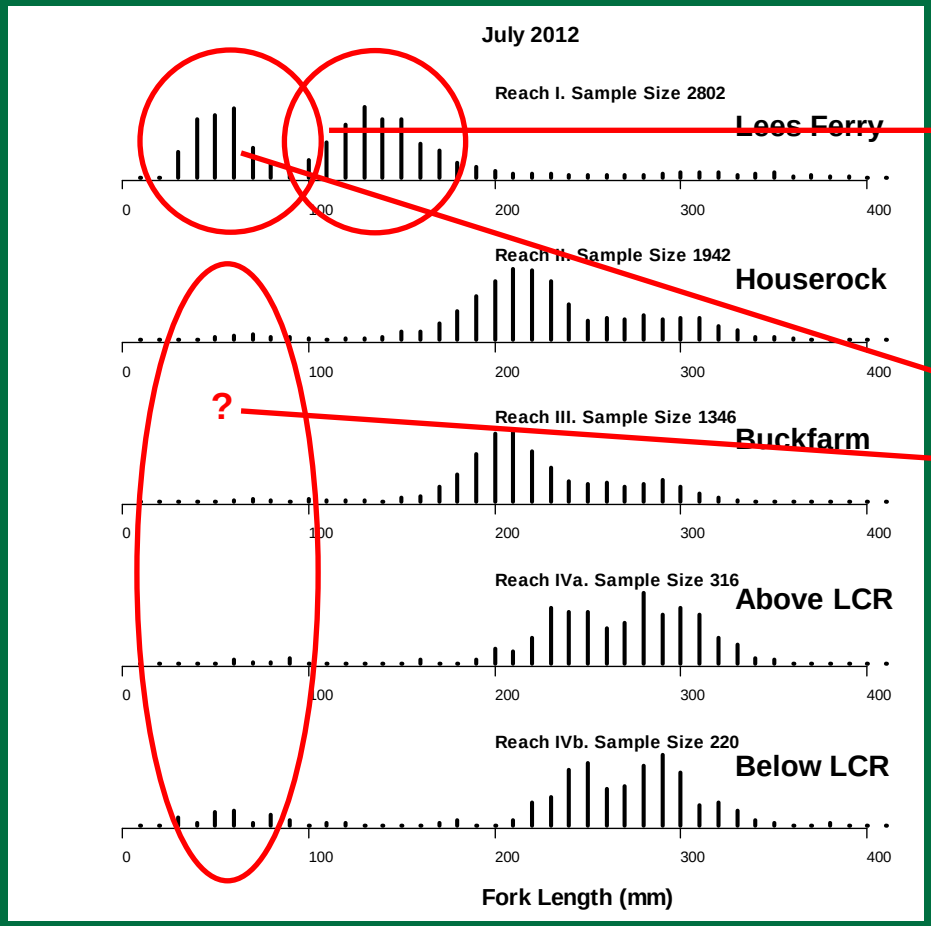
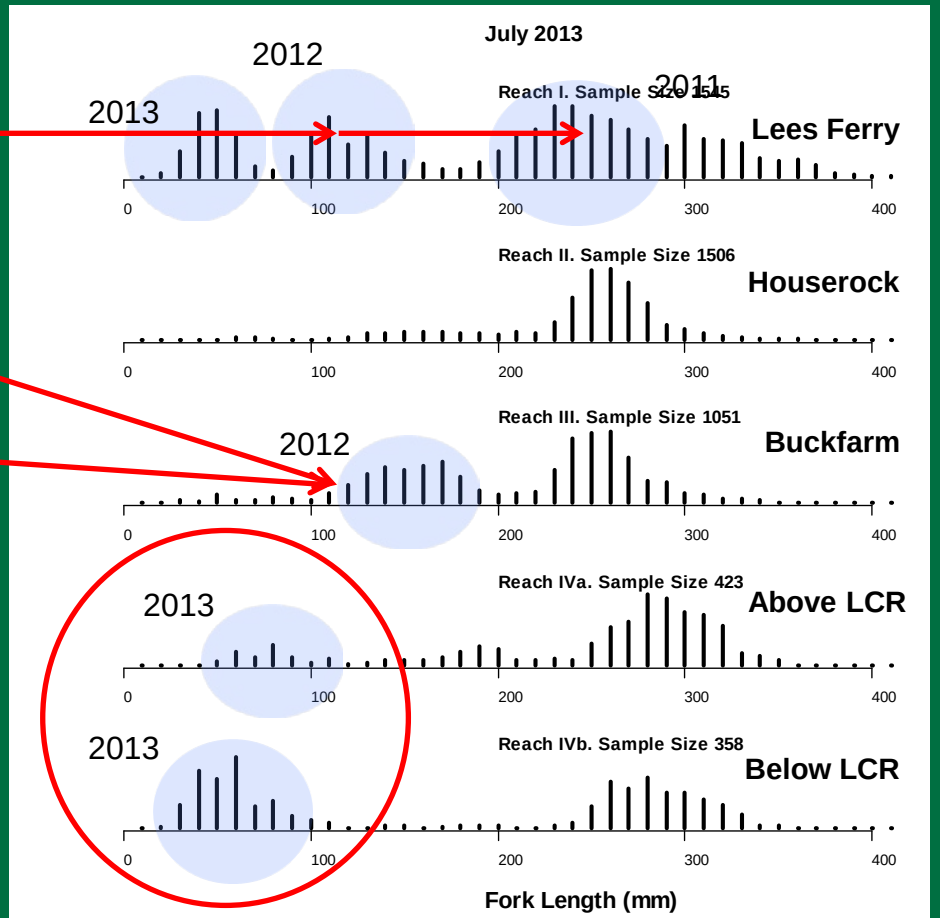
Not All Trout in Marble Canyon Originate from Lees Ferry: Evidence for Local Recruitment





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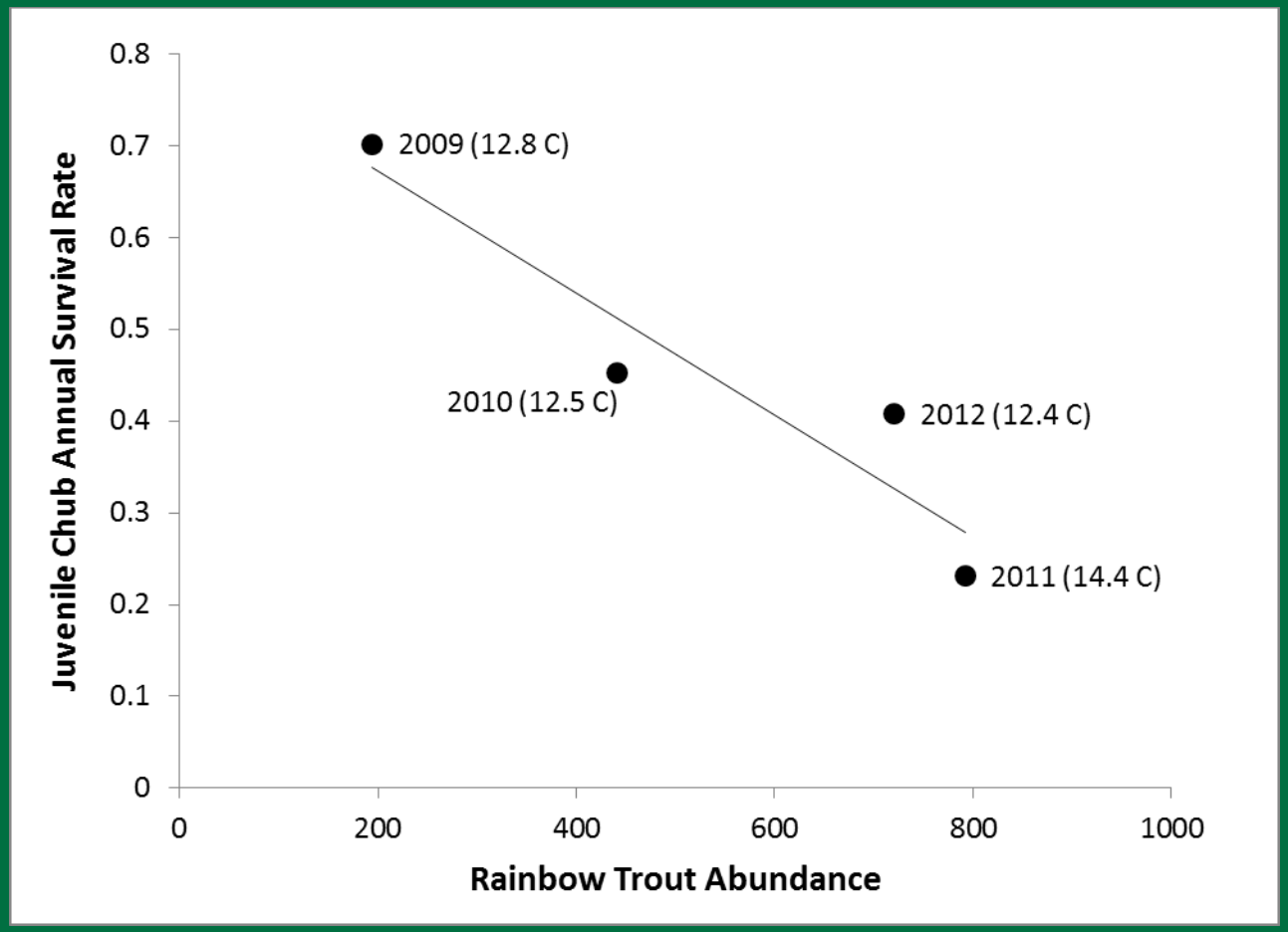
RBT Effects on Juvenile HBC Mainstem Survival



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Conclusions

1. RBT Demographics
   a) High trout abundance,
   b) Uneven spatial distribution,
   c) Good growth rates
   d) Moderately good survival upstream of the LCR.

2. Capture probabilities are influenced by trout density and turbidity.
   a) Limits reliability of just using index sampling (CPUE) as the sole metric.

3. Limited downstream movement of tagged fish.

4. Other findings suggest that MC/LCR inflow are immigrants from Lees Ferry.

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Conclusions

5. Movement Paradox is potentially explained by :

   a) Episodic dispersal from Lees Ferry - slow dispersal rates between reaches

   b) We are spatially biased due to methodology (Results in a higher probability of recapturing fish displaying small and large movement, not intermediate)

6. Mechanisms regulating movement (density dependence, flows, food, or tributary events, etc.) are uncertain.

7. Given 1 - 6, Paria-Badger removal (PBR) is not seem feasible for regulating trout numbers.

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Acknowledgements

- **Administrative support:** Scott VanderKooi, Ted Melis
- **GCMRC logistics:** Carol Fritzinger, Seth Felder, and Dave Foster
- **Sampling design and modelling:** Charles Yackulic and Carl Walters
- **Humphrey Summit Support:** Brian Dierker, Brett Stark, Jason Moore, Scott Perry, and others
- **Many paid and volunteer technicians, especially:** Jake Hall, Colton Finch, Mariah Giardini, Evan Anderson, Luke Avery, Margeaux Bestard, Chelsie Arndt, Ellie Johnson, Tanner Carothers, Ben Vaage

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