Colorado River fish monitoring in Grand Canyon, Arizona: 2002-2011 humpback chub, *Gila cypha*, aggregations.

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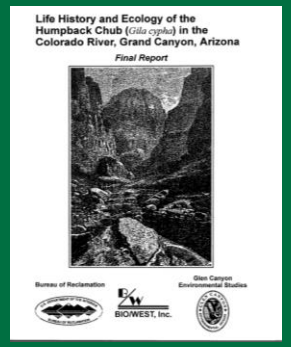
U.S. Department of the Interior
U.S. Geological Survey

Aggregation:

“a consistent and disjunct group of fish with no significant exchange of individuals with other aggregations, as indicated by recapture of PIT-tagged juveniles and adults and movement of radio-tagged adults” (Valdez and Ryel, 1995).



Aggregation	N (1993)	95% C.I.
30-Mile	52	24-136
Little Colorado River Inflow	3,482	2,682-4,281
Lava Chuar to Hance		
Bright Angel Creek Inflow		
Shinumo Creek Inflow	57	31-149
Stephen Aisle		
Middle Granite Gorge	98	74-153
Havasu Creek Inflow	13	5 - 70
Pumpkin Spring	5	4-16

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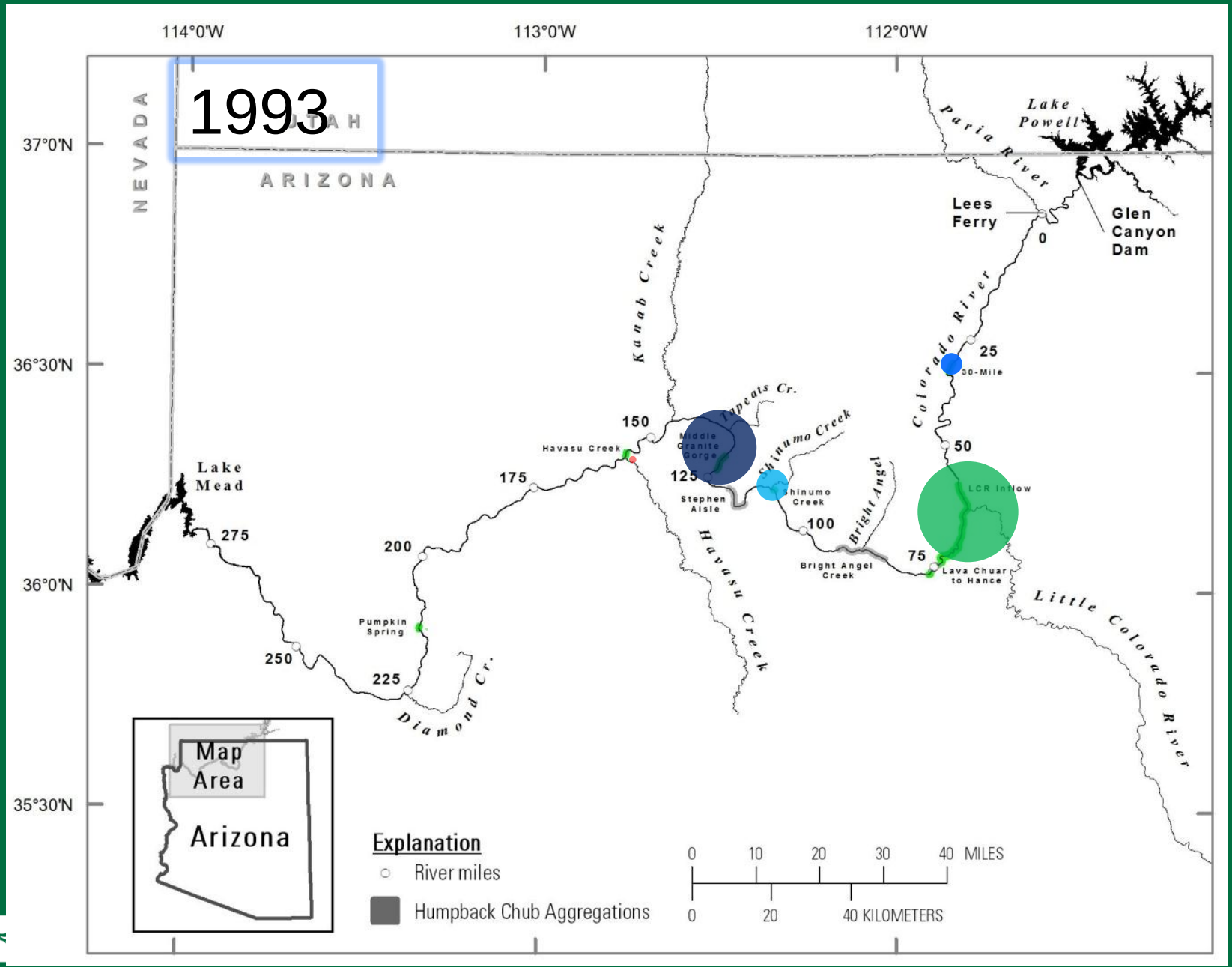
1993
114°0'W
113°0'W
112°0'W
37°0'N
36°30'N
36°0'N
35°30'N
NEVADA
UTAH
ARIZONA
Lake Powell
Paria River
Lees Ferry
Glen Canyon Dam
0
Kanab Creek
Colorado River
25
30-Mile
50
Tapeats Cr.
Middle Granite Gorge
150
Havasu Creek
125
Stephen Aisle
Shinumo Creek
Shinumo Creek
100
Bright Angel
Bright Angel Creek
LCR Inflow
75
Lava Chuar to Hance
Lake Mead
175
200
275
Havasu Creek
Pumpkin Spring
250
225
Diamond Cr.
Little Colorado River
Map Area
Arizona
Explanation
River miles
Humpback Chub Aggregations
0 10 20 30 40 MILES
0 20 40 KILOMETERS

METHODS: Closed population estimates using pooled capture probability

	Marks	Captures	Recaps	p1 (mark rate)	p2 (recap rate)
2002-2003	33	44	3	0.068	0.091
2003-2004	44	28	2	0.071	0.045
2010-2011	175	143	8	0.056	0.046
Pooled	252	215	13	0.0605	0.0516

Data from 2002-2011 aggregation sampling trips which sampled during back to back years (Ackerman 2008).

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Capture probabilities

Capture probabilities p_1 and p_2 are given by:

Capture probability p_1= R/C

Capture probability p_2= R/M

Where:

- M = number of fish caught, marked and released in first sample, across all years and locations,
- C = total number of fish caught in second sample (including recaptures) across all years and locations,
- R = number of recaptures in the second sample (fish marked and released in the first sample), across all years and locations.

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Abundance and variance estimates

Abundance = $\bar{N}_{j,y} = \frac{N_{1,j} + N_{2,j}}{2}$

Where,

y = year

i = 1, 2 capture event

j = Aggregation 1-8

Variance of abundance = $s^2_{i,j} = \frac{\sum(N_{i,j} - \bar{N}_{i,j})^2}{n-1}$

Where,

i = 1, 2

j = Aggregation 1-8

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Example for 30 mile aggregation 2011

Abundance = p * Catch

0.0605 * 16 = 265

0.0516 * 16 = 310

Average = (265 + 310)/2 = 287

Variance = $(265-287)^2 + (310-287)^2$ =1,037

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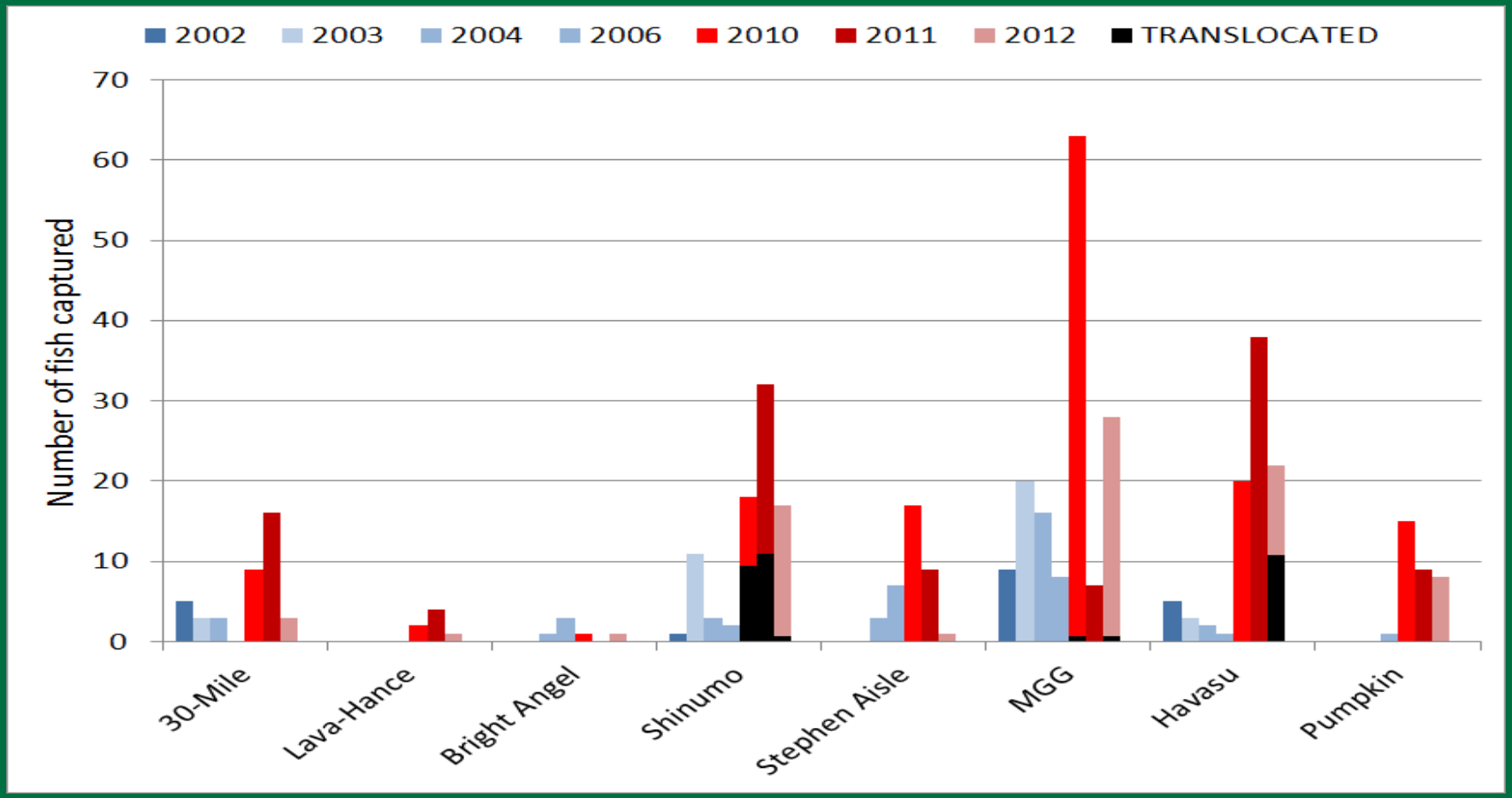
Raw catches of humpback chub 2002-2012



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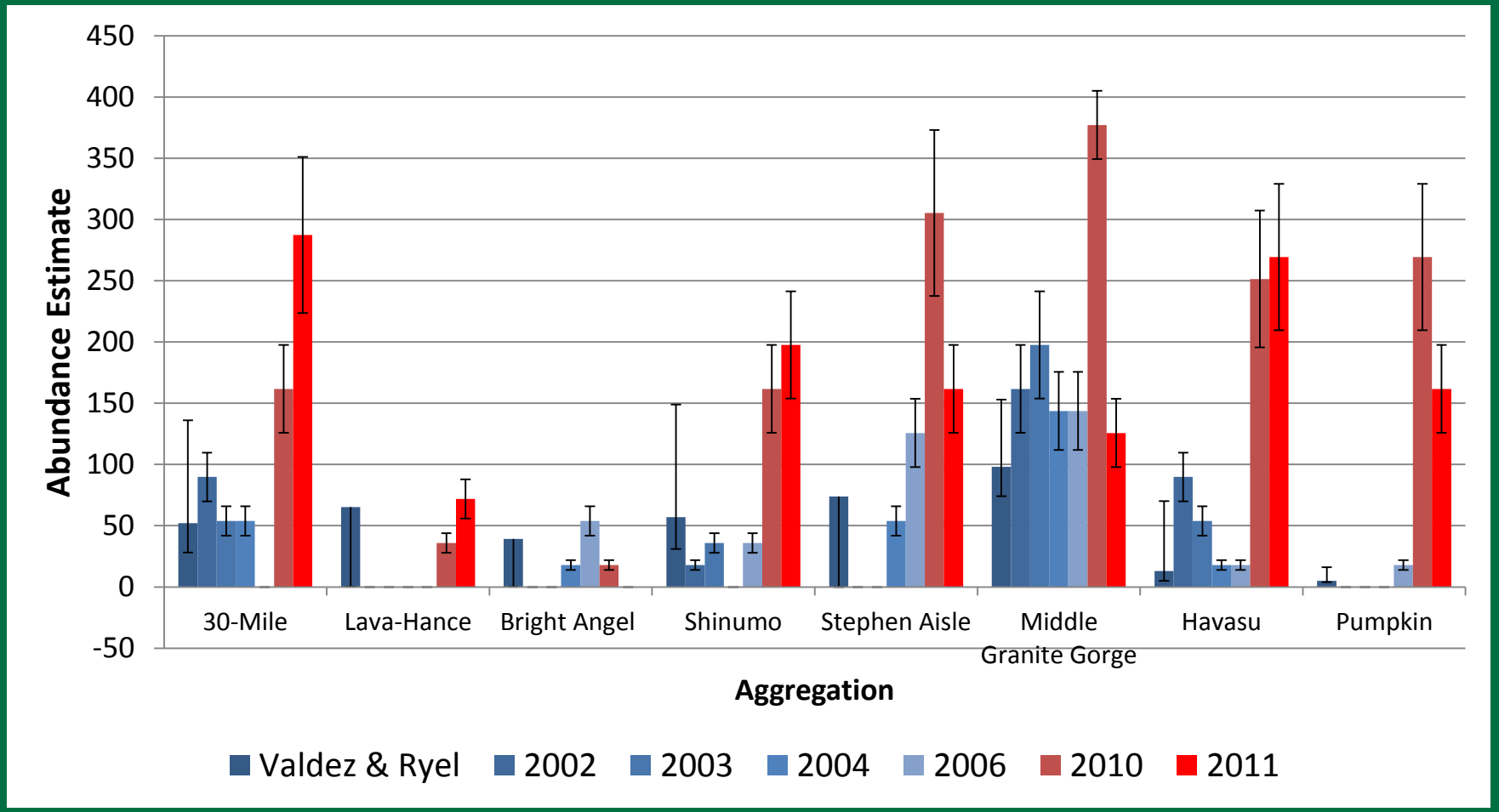
Closed population estimates using pooled capture probability 1993-2011.



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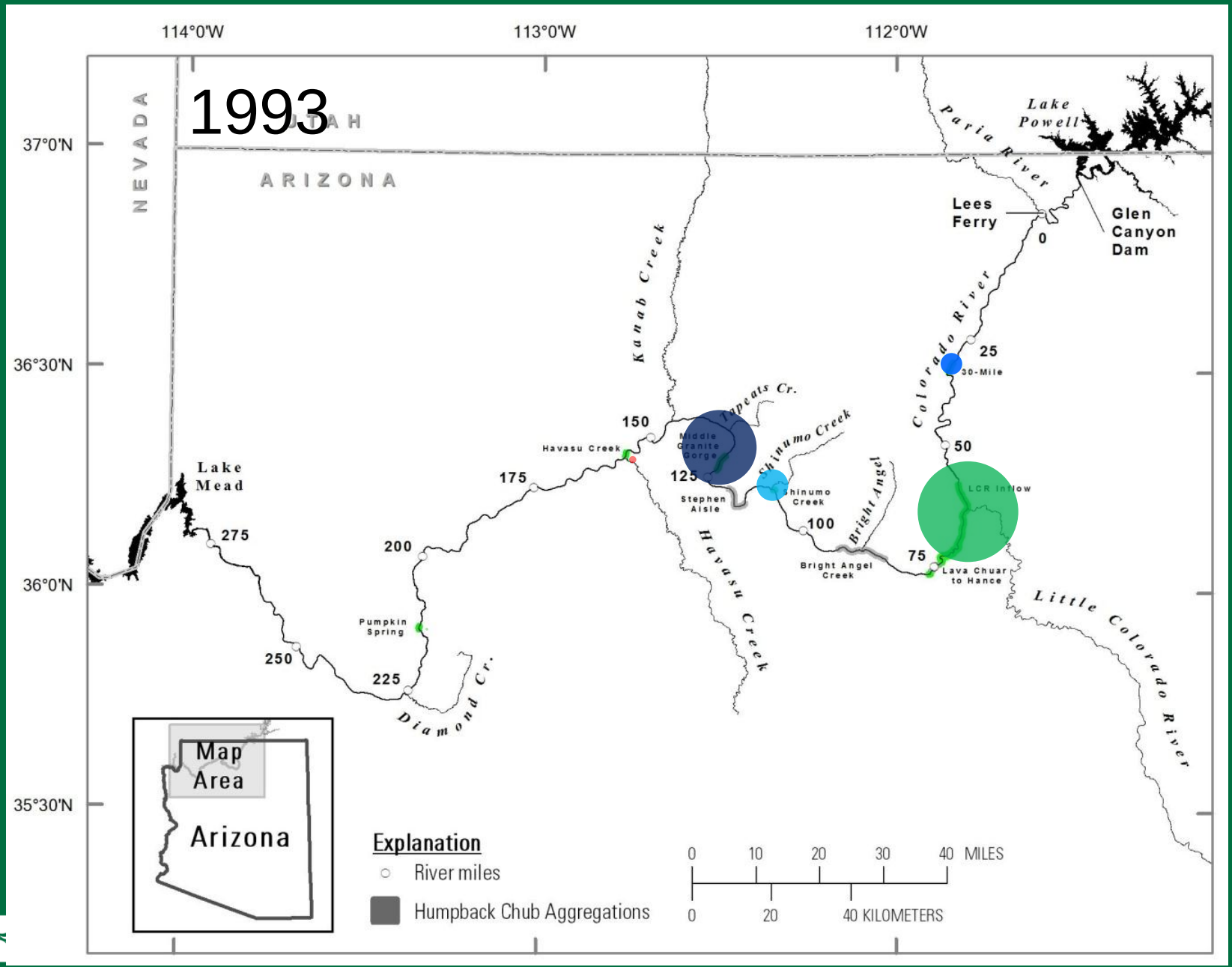
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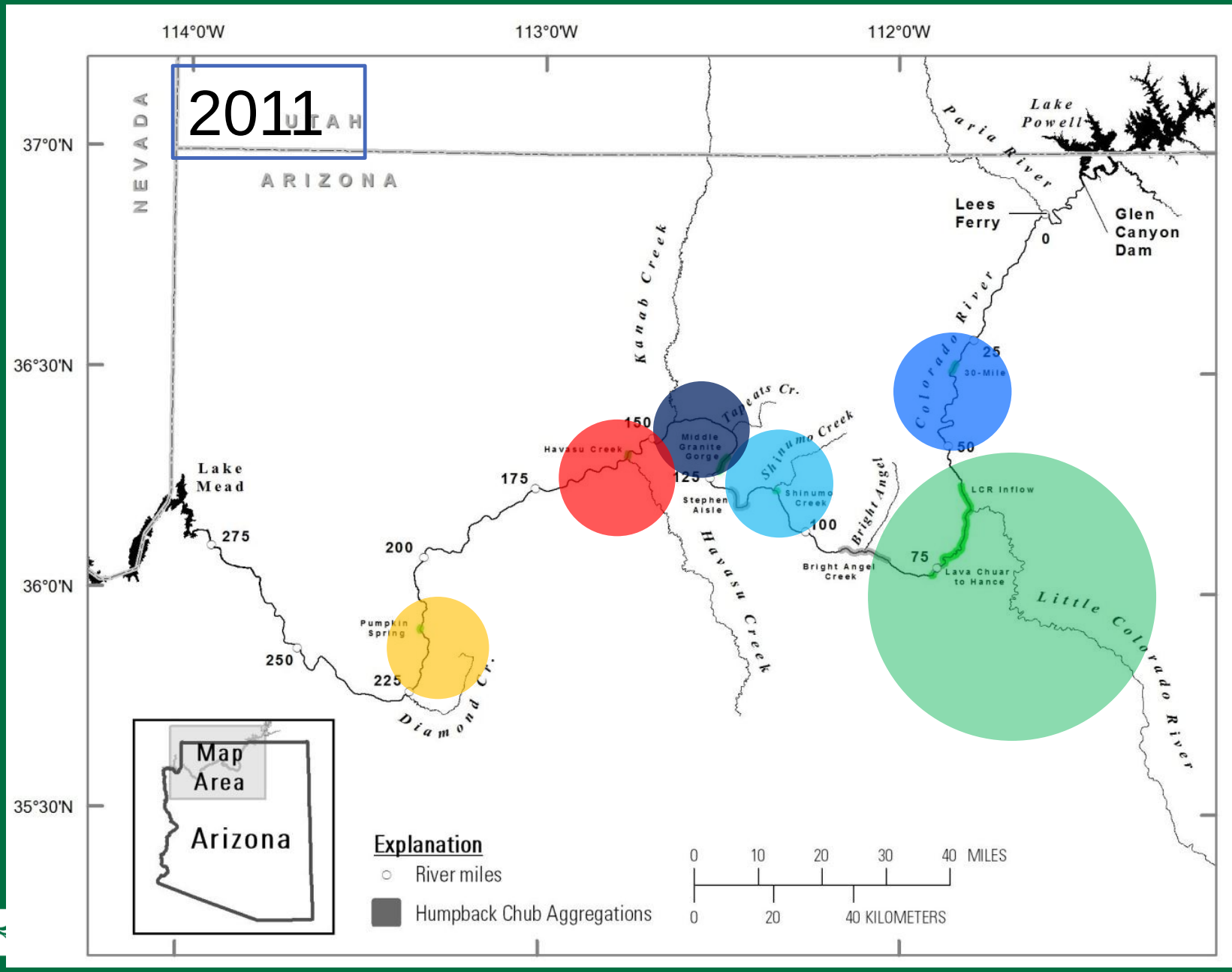
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Location of tagging and recapture, PIT tagged humpback chub 1989-2011.

		Location recaptured											DIRECTION OF MOVEMENT		
Location tagged	Number Marked	30M	LCR	LCR reach	LCH	BAC	SHI	STE	MGG	HAV	PUM	Total	NONE	UP	DOWN
30M	61	36	2	2	-	-	-	-	-	-	-	40	**36**	**-**	**4**
LCR	38,502	3	33,841	2,720	73	3	4	2	4	3	-	36,656	**33,841**	**4**	**2,811**
LCR reach	4,698	1	1,934	1,870	16	1	1	-	1	2	-	3,826	**1,870**	**1,935**	**21**
LCH	271	-	47	22	10	-	-	-	-	-	-	79	**10**	**69**	**-**
BAC	22	-	1	-	-	-	-	-	-	-	-	1	**-**	**1**	**-**
SHI	1,001	-	-	-	-	-	71	1	2	-	-	74	**71**	**-**	**3**
STE	76	-	1	1	-	-	-	1	2	-	-	5	**1**	**2**	**2**
MGG	314	-	-	1	-	-	1	1	87	1	-	92	**87**	**4**	**1**
HAV	617	-	4	-	-	-	-	-	-	14	-	18	**14**	**4**	**-**
PUM	27	-	-	-	-	-	-	-	-	-	2	2	**2**	**-**	**-**
Total	45,589	40	35,831	4,616	99	5	77	5	96	23	2	40,799	**35,932**	**2,019**	**2,842**

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BAC	22	-	1	-	-	-	-	-	-	-	-	1	**-**	**1**	**-**
SHI	**1,001**	**-**	**-**	**-**	**-**	**-**	**71**	**1**	**2**	**-**	**-**	**74**	**71**	**-**	**3**
STE	76	-	1	1	-	-	-	1	2	-	-	5	**1**	**2**	**2**
MGG	**314**	**-**	**-**	**1**	**-**	**-**	**1**	**1**	**87**	**1**	**-**	**92**	**87**	**4**	**1**
HAV	**617**	**-**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**14**	**-**	**18**	**14**	**4**	**-**
PUM	**27**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**	**-**
Total	45,589	40	35,831	4,616	99	5	77	5	96	23	2	40,799	**35,932**	**2,019**	**2,842**

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Increasing abundance:

- Warmer than normal water during 2004, 2005, 2011
- Translocations
  - Shinumo Creek
    - 902 fish 2009-2011
  - Havasu Creek
    - 543 fish 2011-12
- Mechanical trout removal at LCR confluence 2003-2006, 2009

- Good production from Little Colorado River

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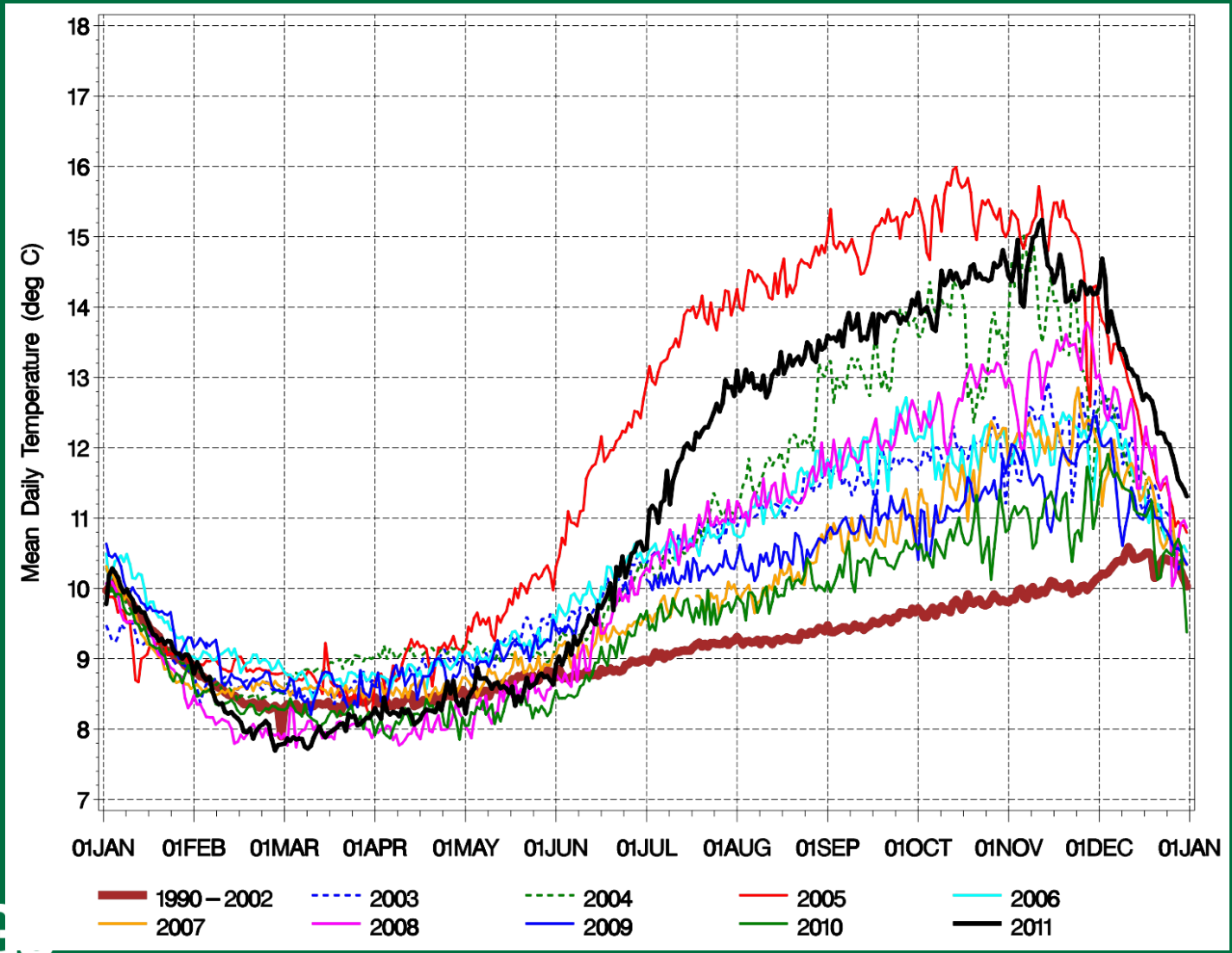
GCD Release Temperature 1990-2011



Future Directions:

- Increase sampling effort at areas outside of known aggregations during 2013-14.
- Estimate abundance using open models.
- SMART model to identify attributes of aggregation locations.
- Humpback chub natal origins project 2013-14.
  - Otolith microchemistry

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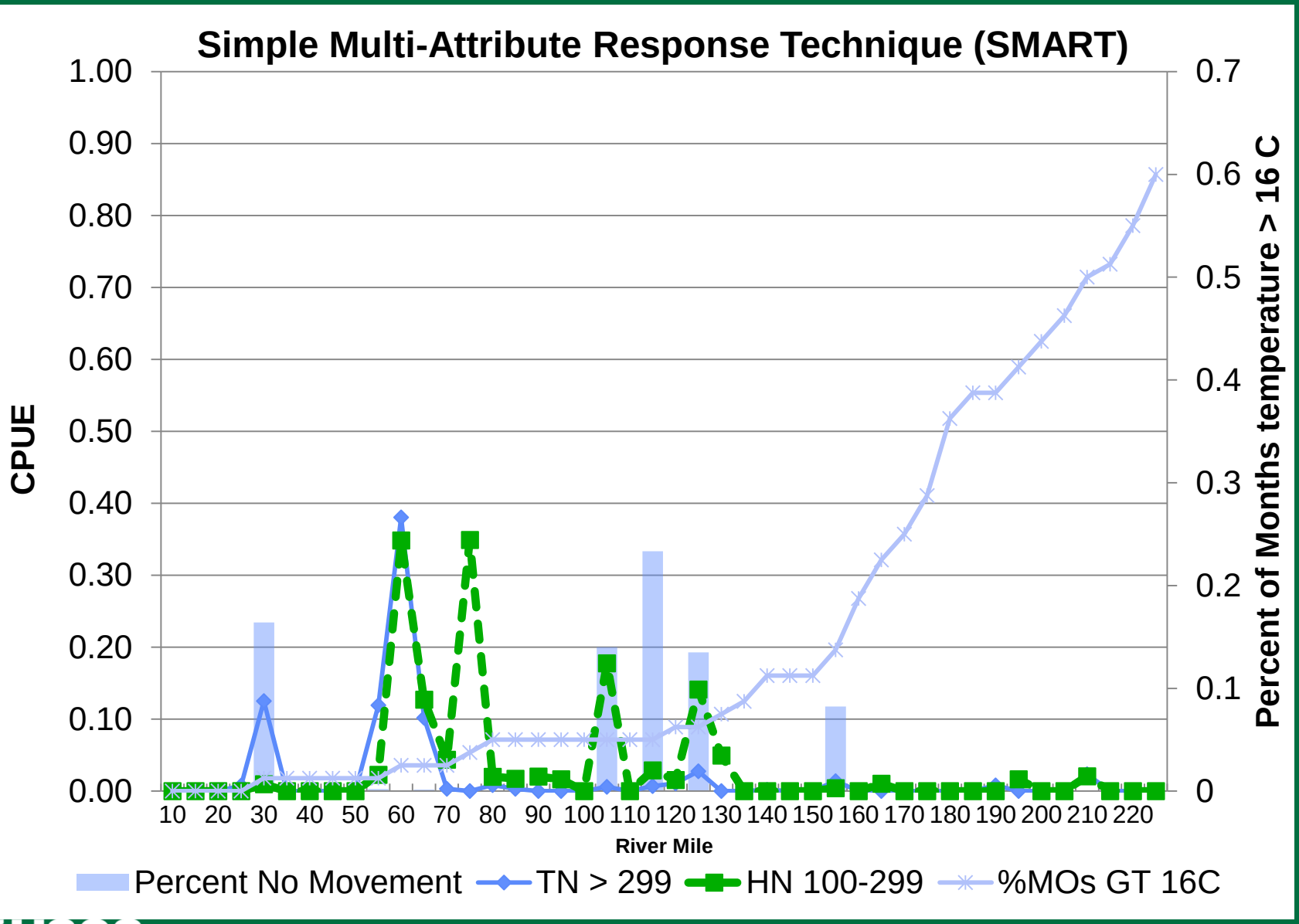
Simple Multi-Attribute Response Technique (SMART)
CPUE
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Percent of Months temperature > 16 C
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
River Mile
Percent No Movement
TN > 299
HN 100-299
%MOs GT 16C

NATAL ORIGINS PROJECT

Otolith microchemistry (Pine and Limburg)

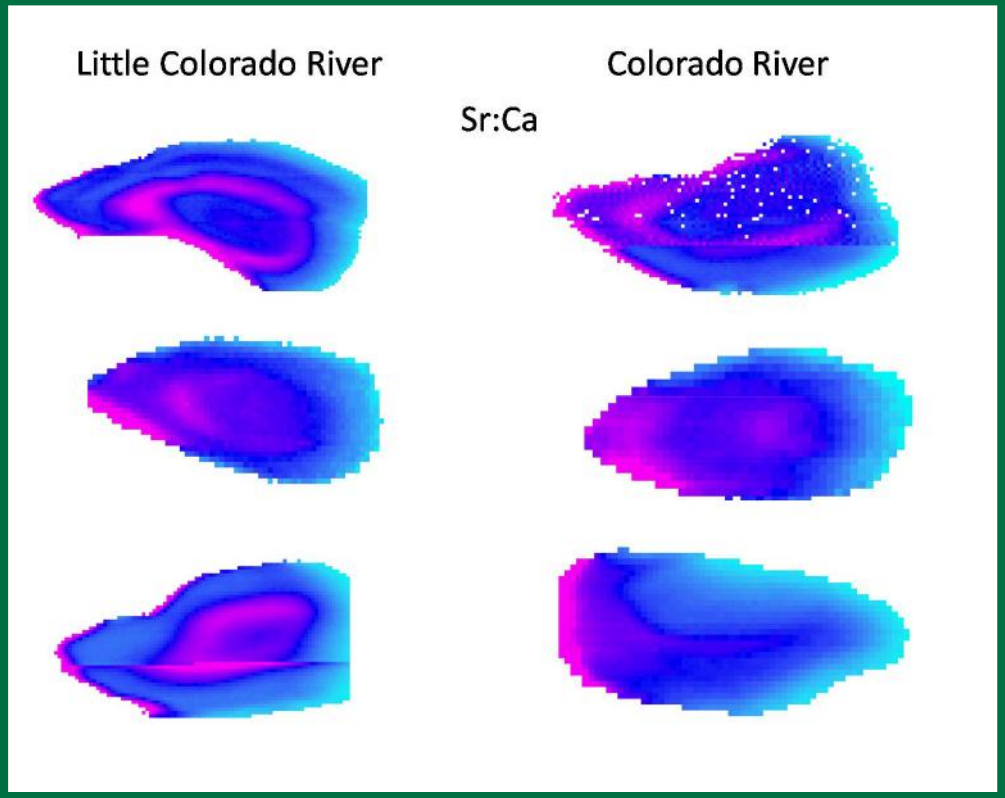

Figure 19. False-color 2-D surface maps of otolith Sr:Ca images from CHESS-XRF analyses. Column headings denote collection location. Purple is high Sr:Ca, blue is low Sr:Ca. Surface map color scale vary for each fish. High concentrations at immediate otolith edges are artifacts of analytical technique.

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GCY trip
AUG 2012

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