Jun 20th, 3:15 PM - 3:30 PM

Dam Removal I: Ecological and Geomorphic Adjustments to Dam Removal in an Upland Mesic Catchment

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PERSPECTIVES

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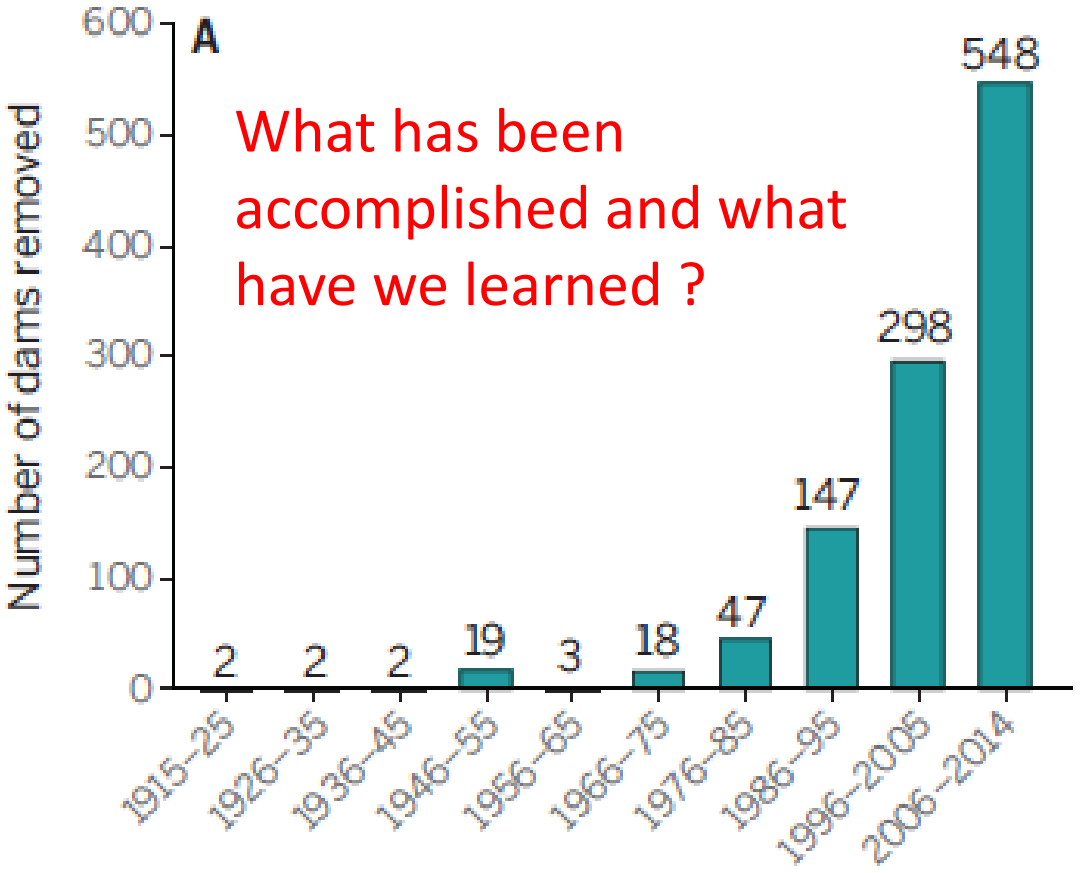
ECOLOGY

1000 dams down and counting

Dam removals are reconnecting rivers in the United States

By J. E. O'Connor,[1] J. J. Duda,[2] G. E. Grant[3]

Dam removals in the United States



What has been accomplished and what have we learned ?

USGS
science for a changing world

ScienceBase-Catalog Communities Help

Communities → Forest and Rangeland Ecosy… → FRESC Public Data → USGS Dam Removal Scienc…

Bellmore et al. (2015). USGS Dam Removal Science Database. doi:10.5066/F7K935KT.

USGS Dam Removal Science Database

Of the 130 dam removals that have geomorphic or ecological assessment, **only 35** have combined geomorphic and ecological monitoring **with < 5** having ecological and geomorphic monitoring beyond the first year.

This database is the result of an extensive literature search aimed at identifying documents relevant to the emerging field of dam removal science. In total the database contains 179 citations that contain empirical monitoring information associated with 130 different dam removals across the United States and abroad. Data includes publications through 2014 and supplemented with the U.S. Army Corps of Engineers National Inventory of Dams database, U.S. Geological Survey National Water Information System and aerial photos to estimate locations when coordinates were not provided. Publications were located using the Web of Science, Google Scholar, and Clearinghouse for Dam Removal Information.

Monitoring

Management

Focus: How successful was the removal in achieving designed management (often ecological) goals?

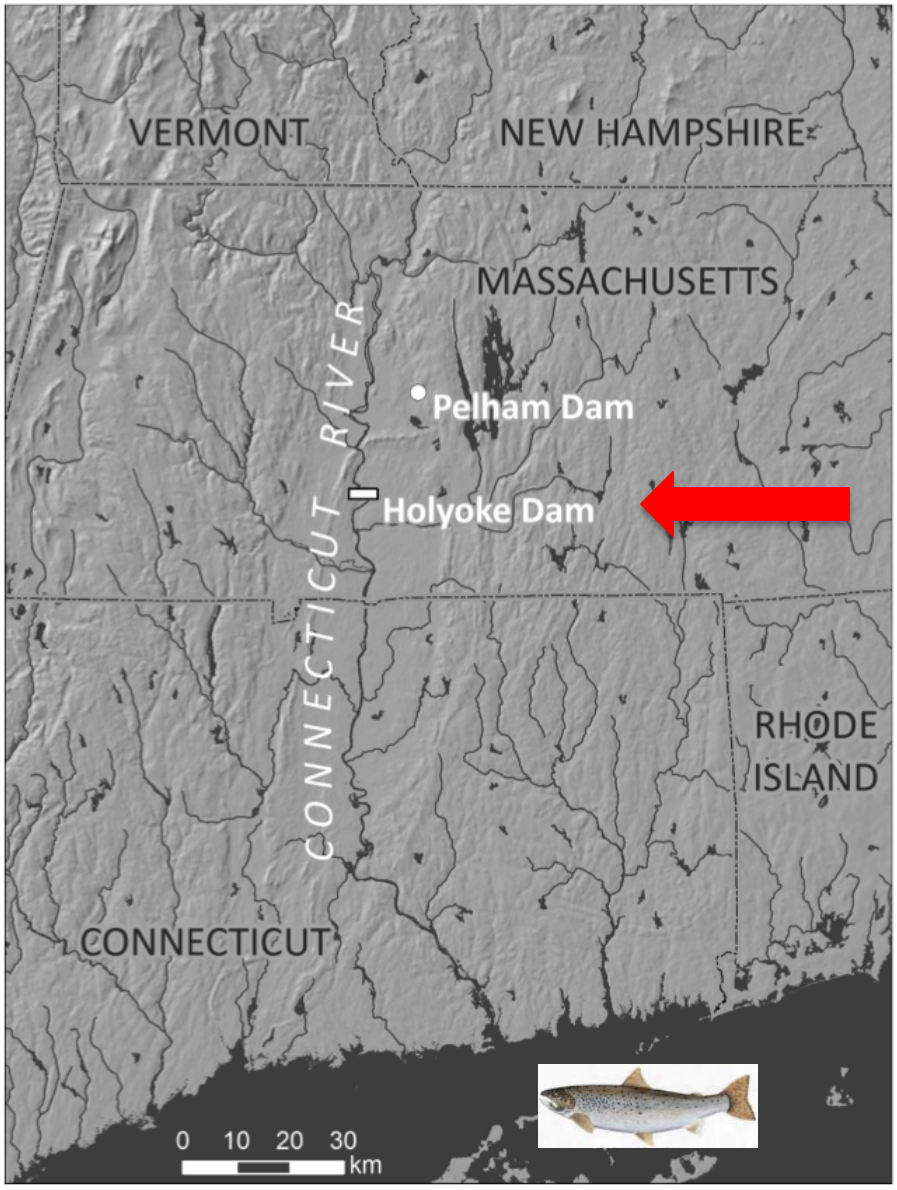
Metrics: fish passage; presence/absence of fish above former barrier; successful demographic shifts; improved spawning habitat; etc.?

Science

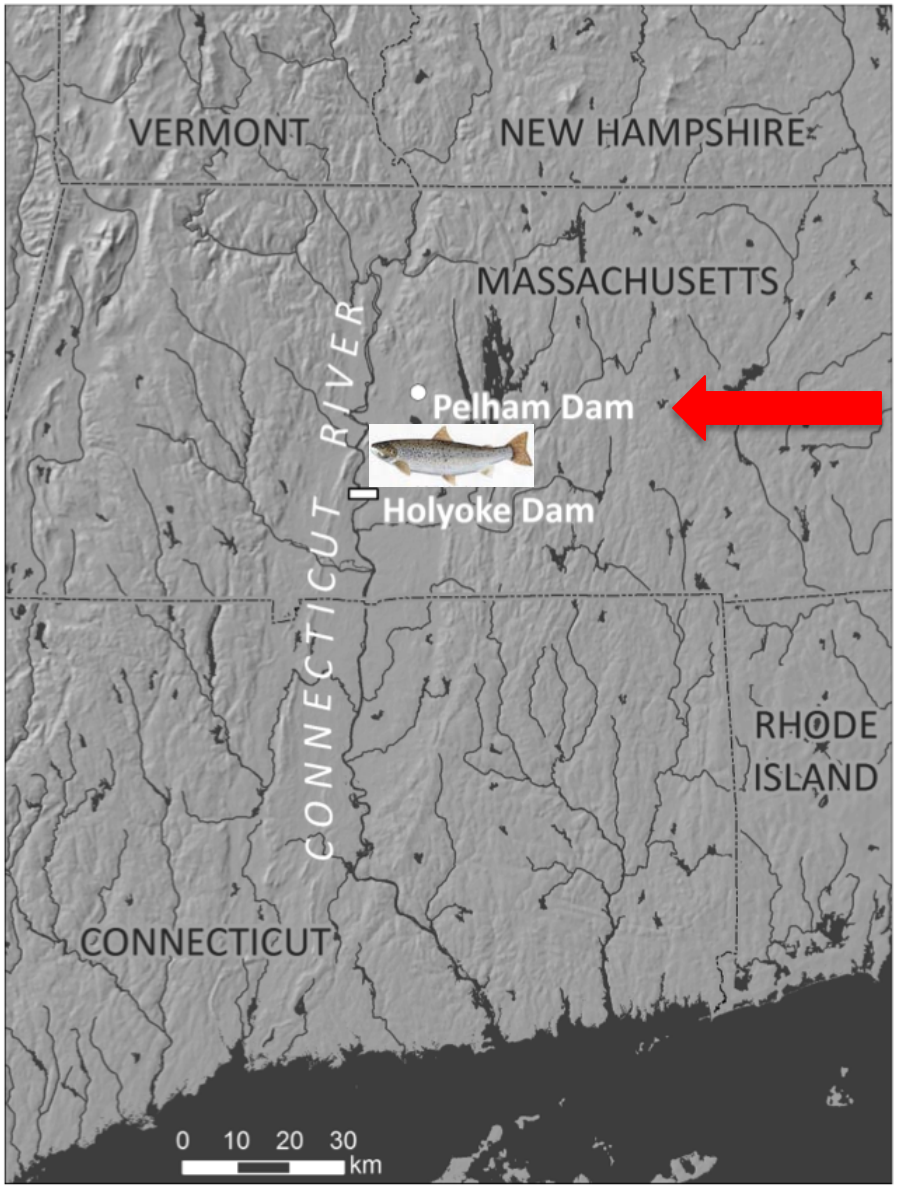
Focus: How do fluvial systems respond to the removal of a long-standing disturbance?

Questions: What processes, given the new boundary conditions, govern the rate, direction, and magnitude of geomorphic and ecological adjustments?

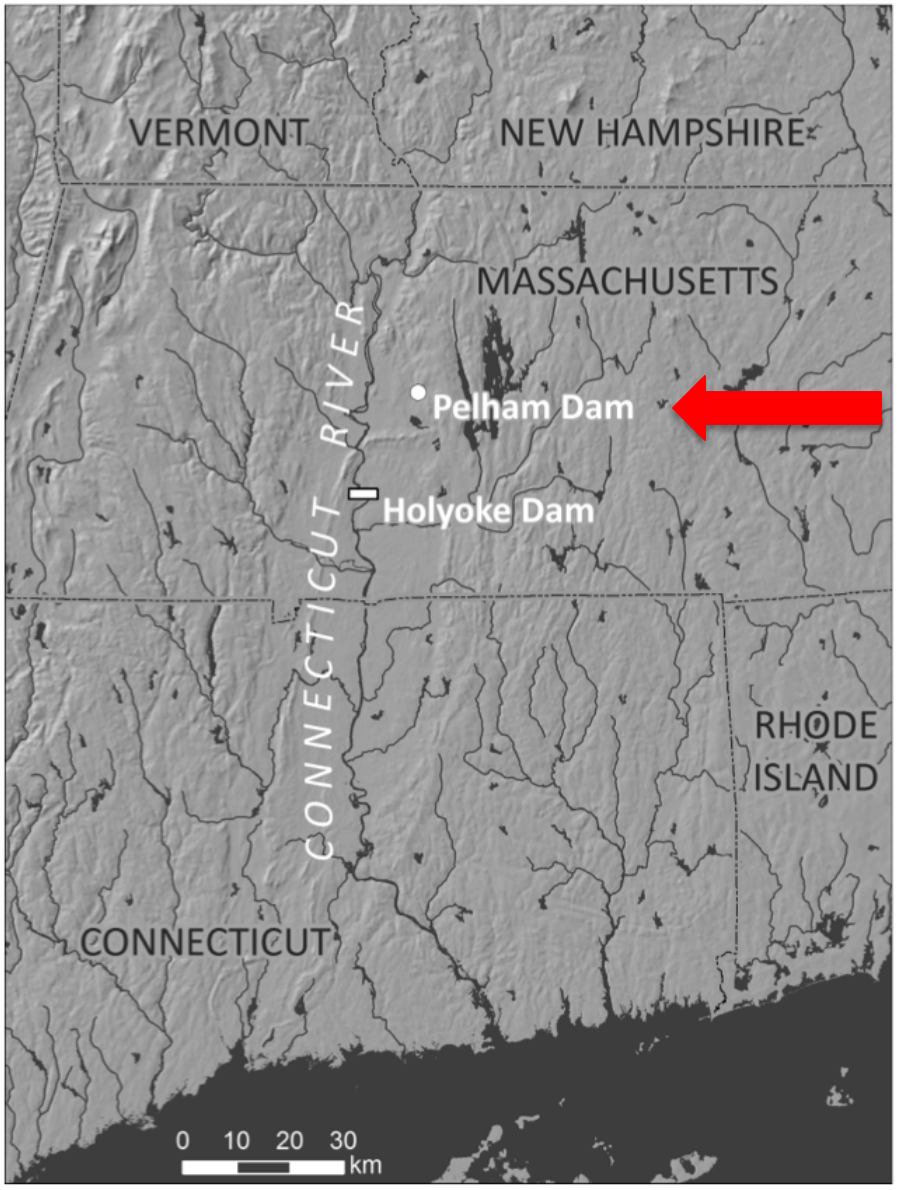
Pelham Dam (Amethyst Brook), MA



Pelham Dam (Amethyst Brook), MA



Pelham Dam (Amethyst Brook), MA



1. **Ecological Impacts Associated with Dam Removal**

→ Evaluate the immediate and sustained changes in:

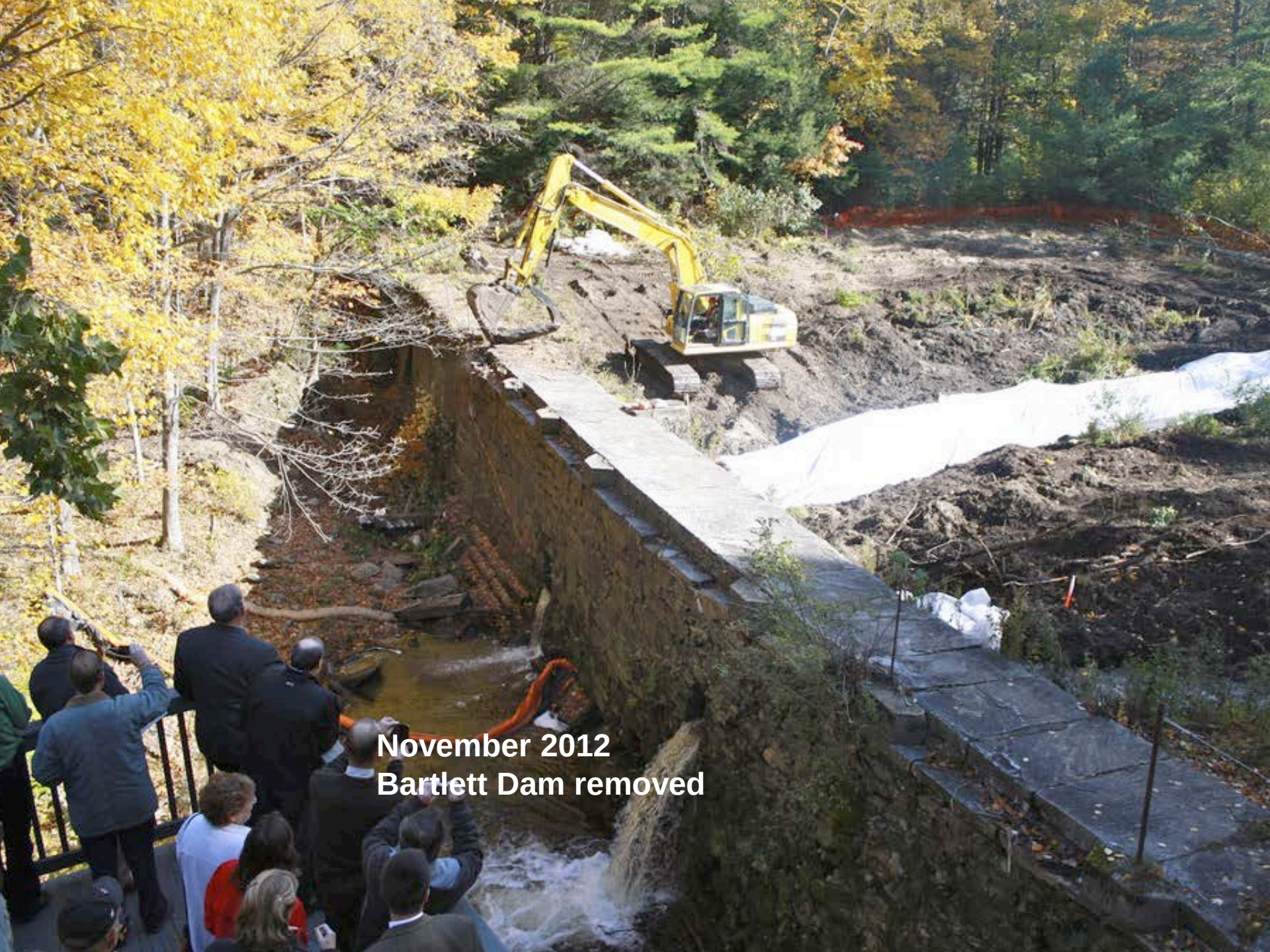
a) fish species <u>richness</u> & <u>abundance</u> above/below the dam site.

b) distribution of native anadromous Sea lamprey nest sites.

2. **Geomorphic Adjustments Associated with Dam Removal**

→ Quantify changes in <u>stream channel geometry</u> and <u>channel bed habitat/complexity</u> (D_{50}) above and below dam.

→ Determine whether channels downstream of former dam are in equilibrium with new reconnected sediment supply

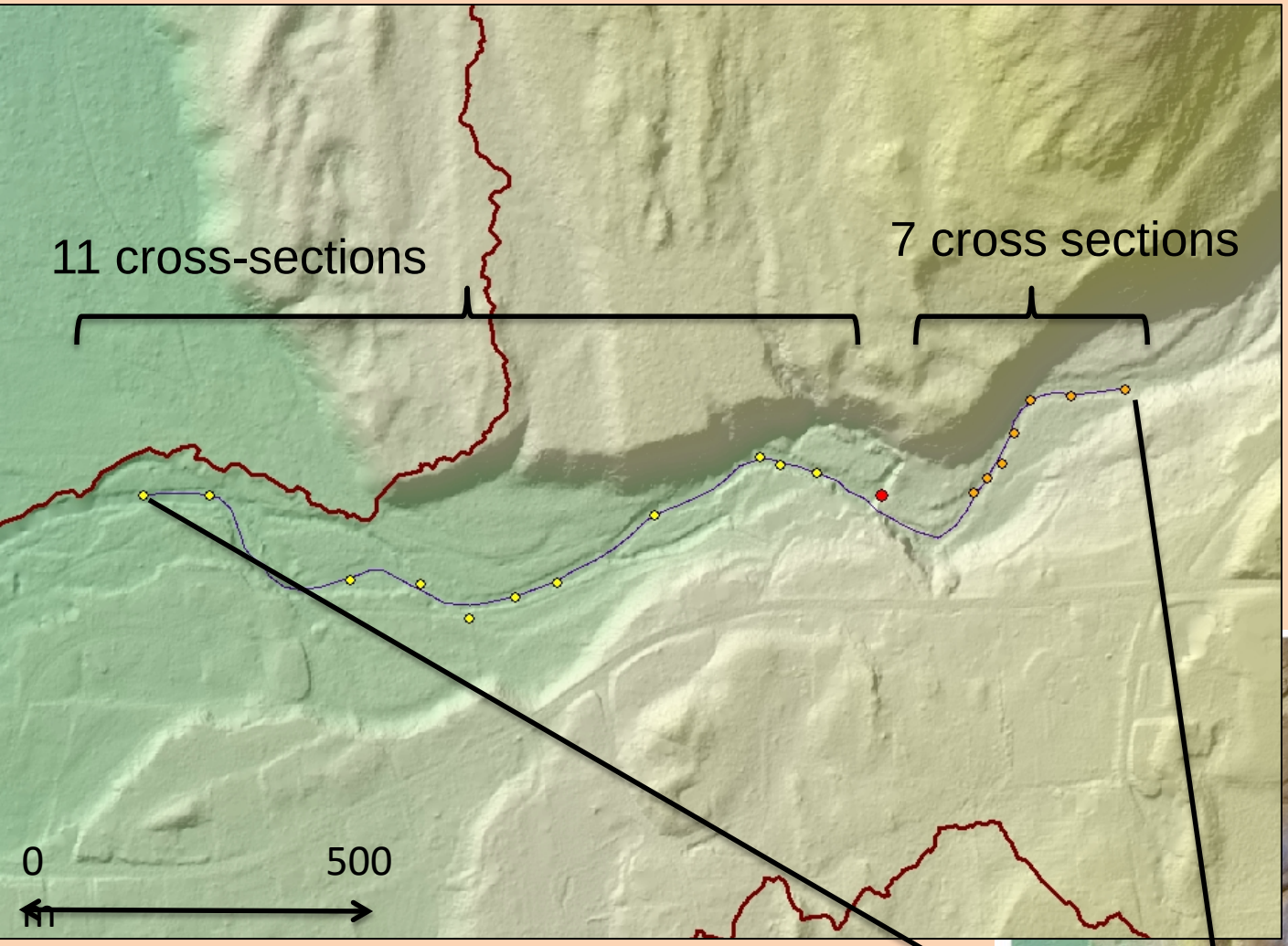

November 2012
Bartlett Dam removed

June 28, 2013

Knickpoint Migration Exhumed a ~ 1790 AD Wooden Crib Dam

~ 25 m upst of former reservoir

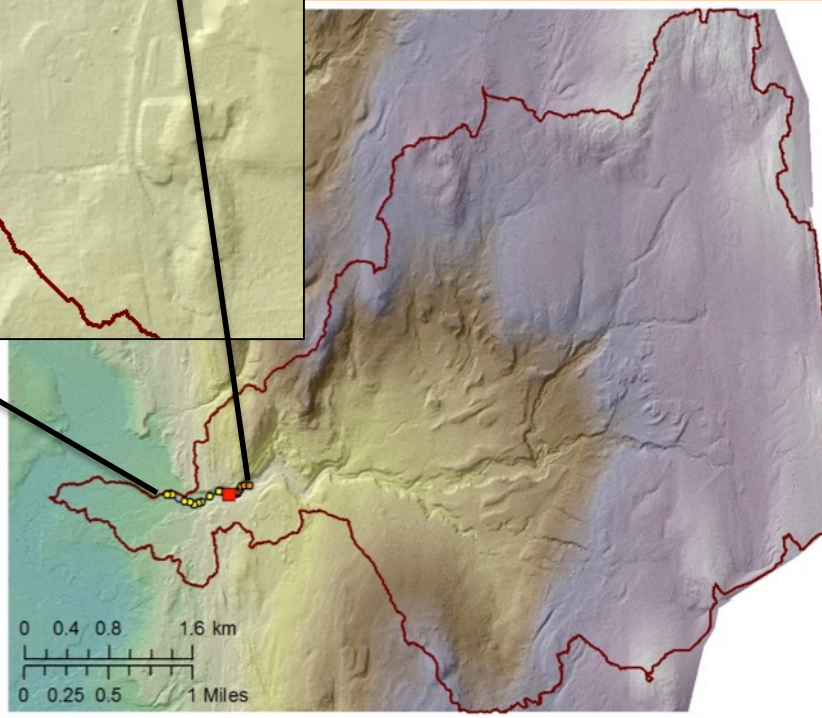

5 days later (July 1, 2013)
~ 20 yr RI flood
→ Same Q as Hurricane Sandy



Amethyst Bk.: (24 km^2)

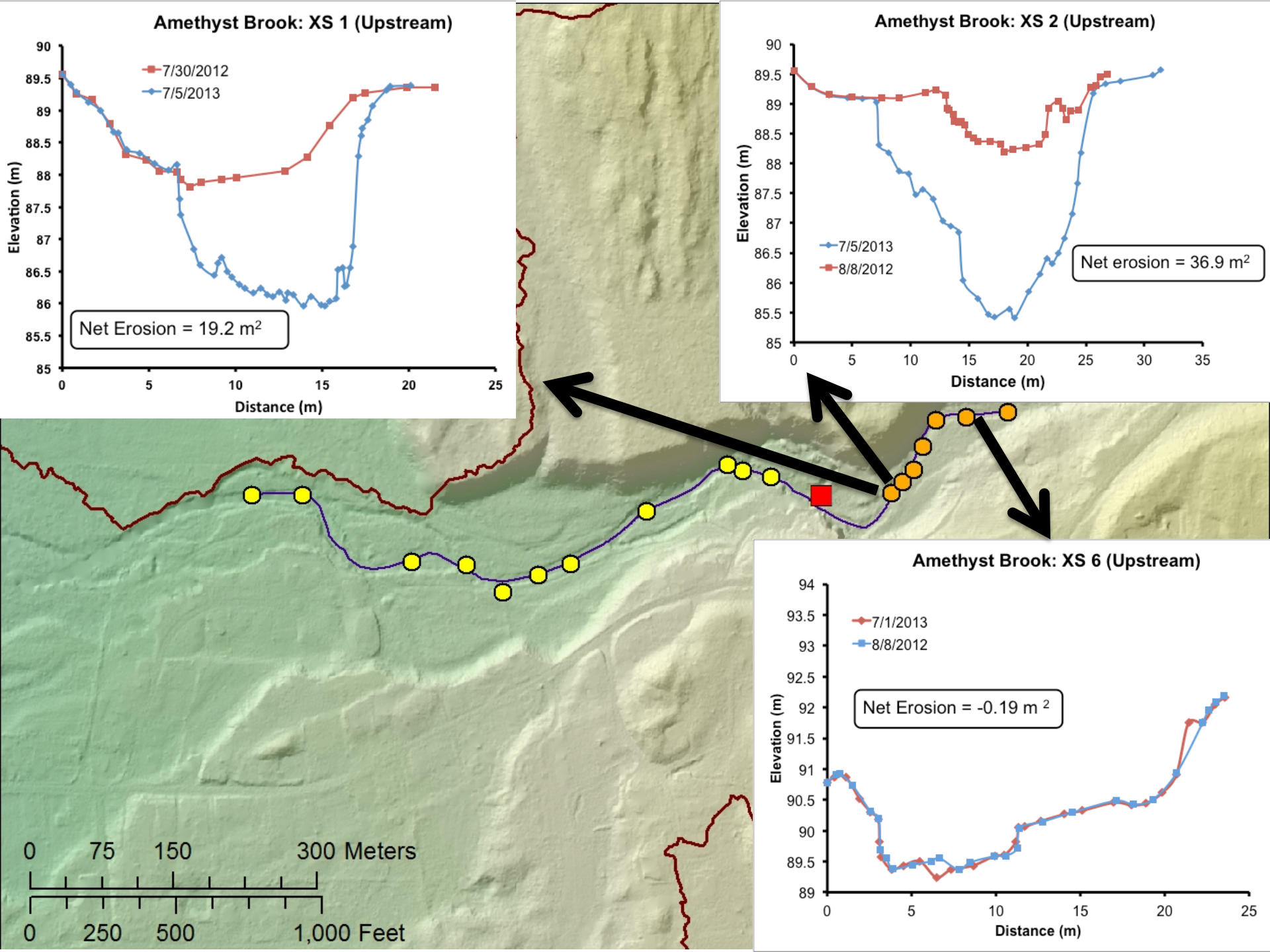
Slope = ~ 1%

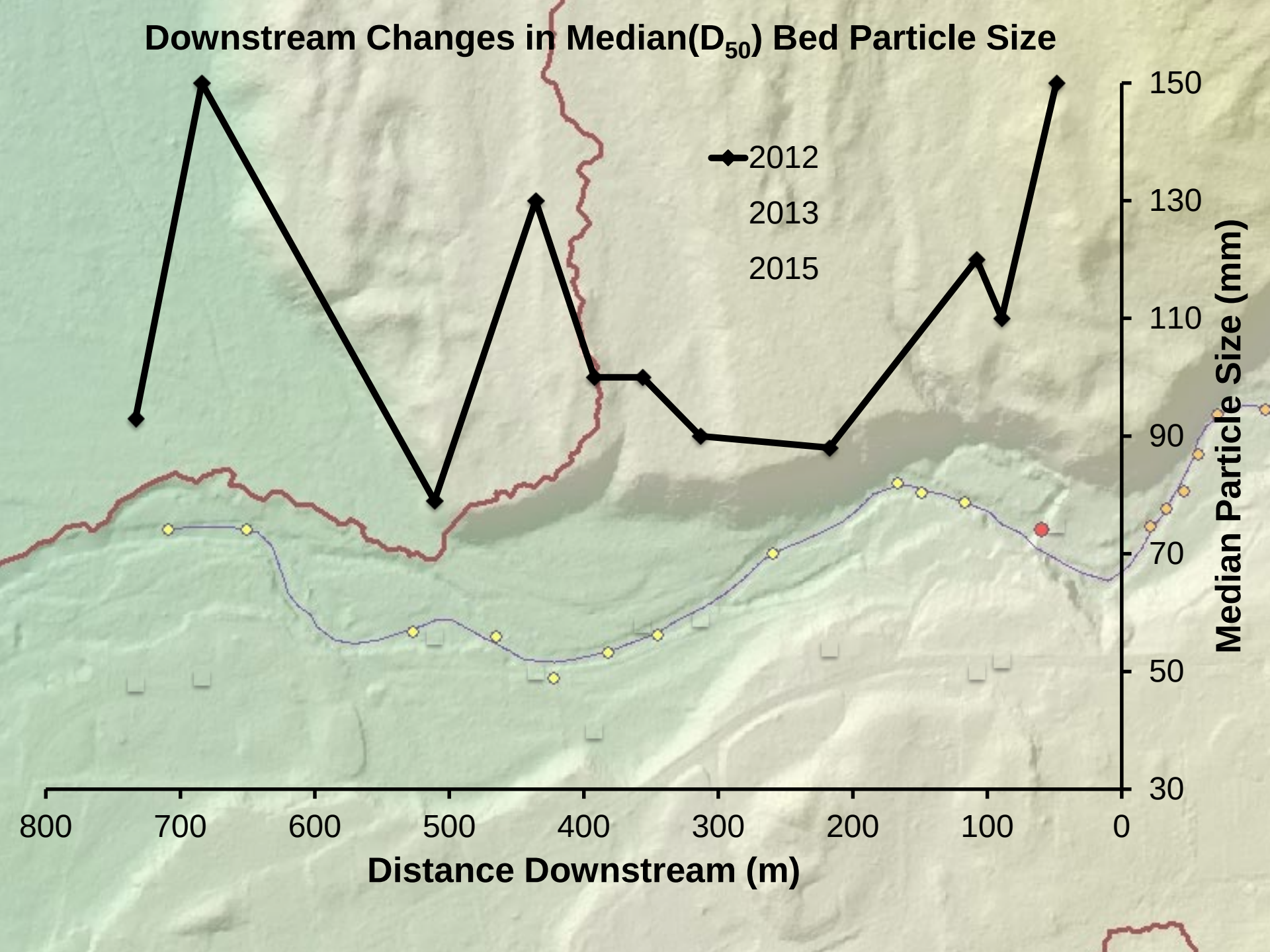
Bartlett Dam Built: ~ 1820
" Removed: 2012
Crib Dam Built : <1760
" Removed: 2016

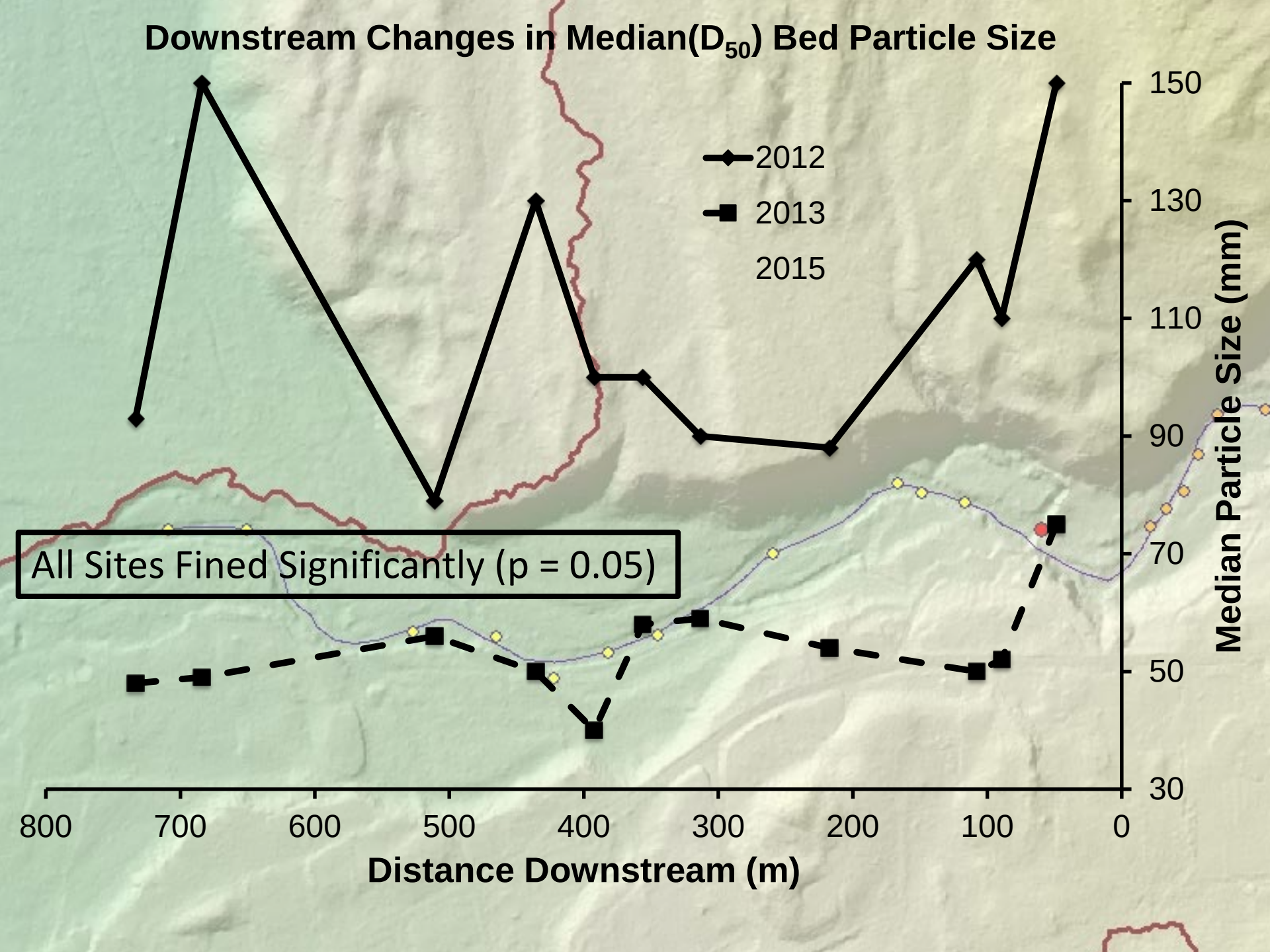


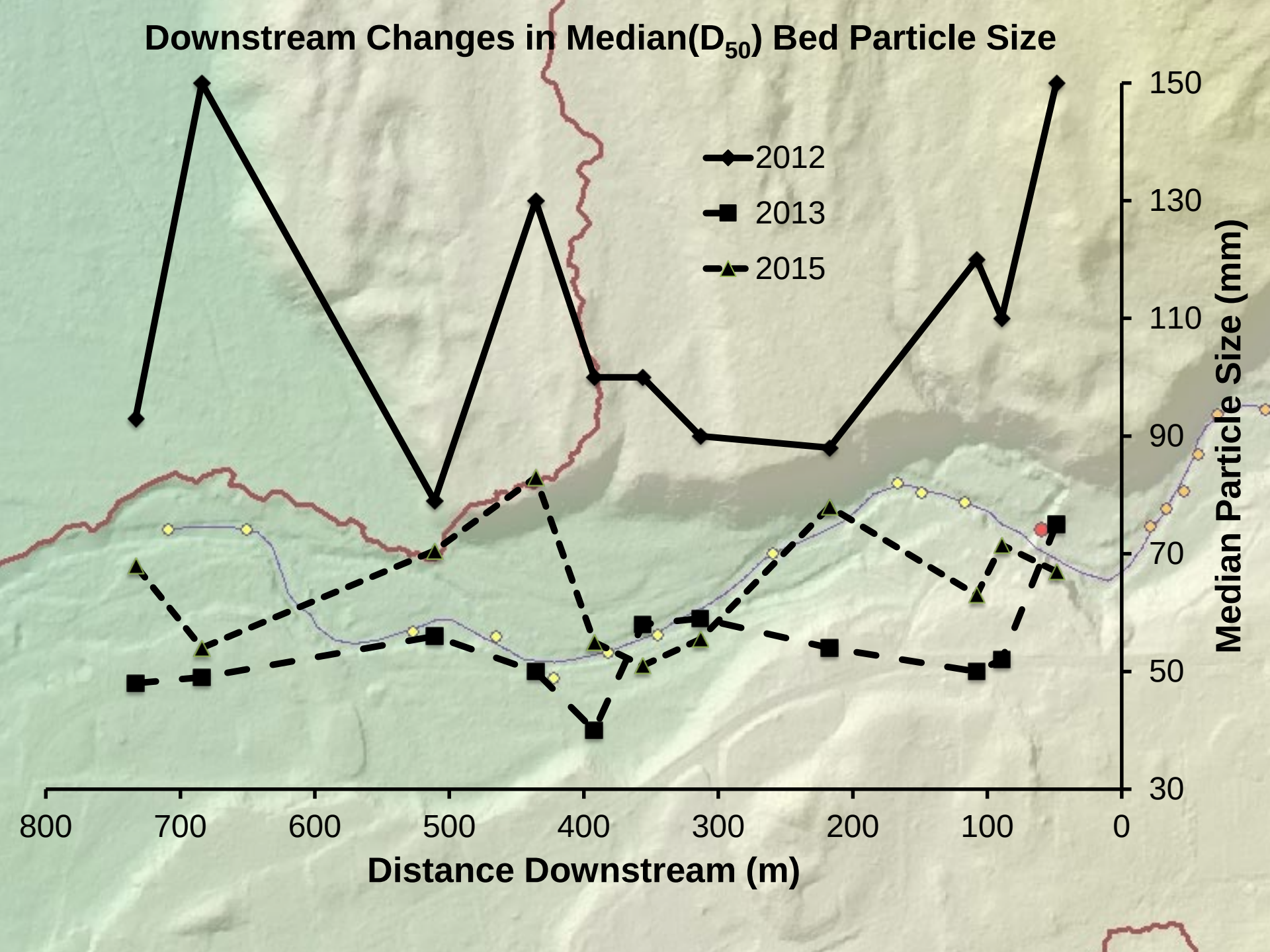
Methods:

- Annual Wolman Pebble Counts
- Annual Long Profile and Cross Section Surveying
- Electrofishing and Lamprey Redd Surveys

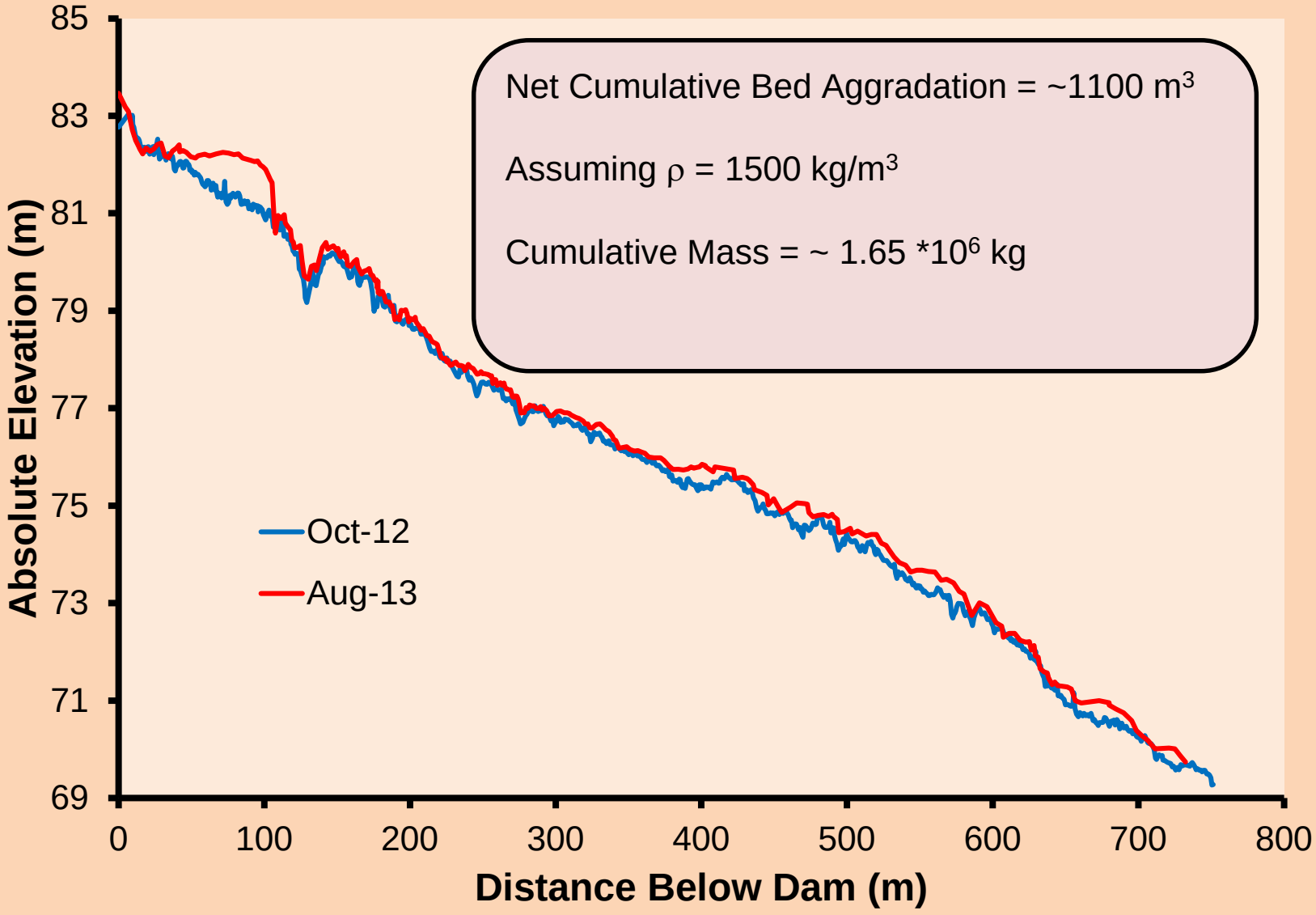

Amethyst Brook: XS 1 (Upstream)
7/30/2012
7/5/2013
Net Erosion = 19.2 m²
Elevation (m)
Distance (m)
Amethyst Brook: XS 2 (Upstream)
7/5/2013
8/8/2012
Net erosion = 36.9 m²
Elevation (m)
Distance (m)
Amethyst Brook: XS 6 (Upstream)
7/1/2013
8/8/2012
Net Erosion = -0.19 m ²
Elevation (m)
Distance (m)
0 75 150 300 Meters
0 250 500 1,000 Feet


Downstream Changes in Median(D_{50}) Bed Particle Size
2012
2013
2015
150
130
110
90
70
50
30
Median Particle Size (mm)
800
700
600
500
400
300
200
100
0
Distance Downstream (m)


Downstream Changes in Median(D_{50}) Bed Particle Size
2012
2013
2015
All Sites Fined Significantly (p = 0.05)
150
130
110
90
70
50
30
Median Particle Size (mm)
800
700
600
500
400
300
200
100
0
Distance Downstream (m)


Downstream Changes in Median(D_{50}) Bed Particle Size
2012
2013
2015
150
130
110
90
70
50
30
Median Particle Size (mm)
800
700
600
500
400
300
200
100
0
Distance Downstream (m)

Channel Bed Elevation Change 2012-2013

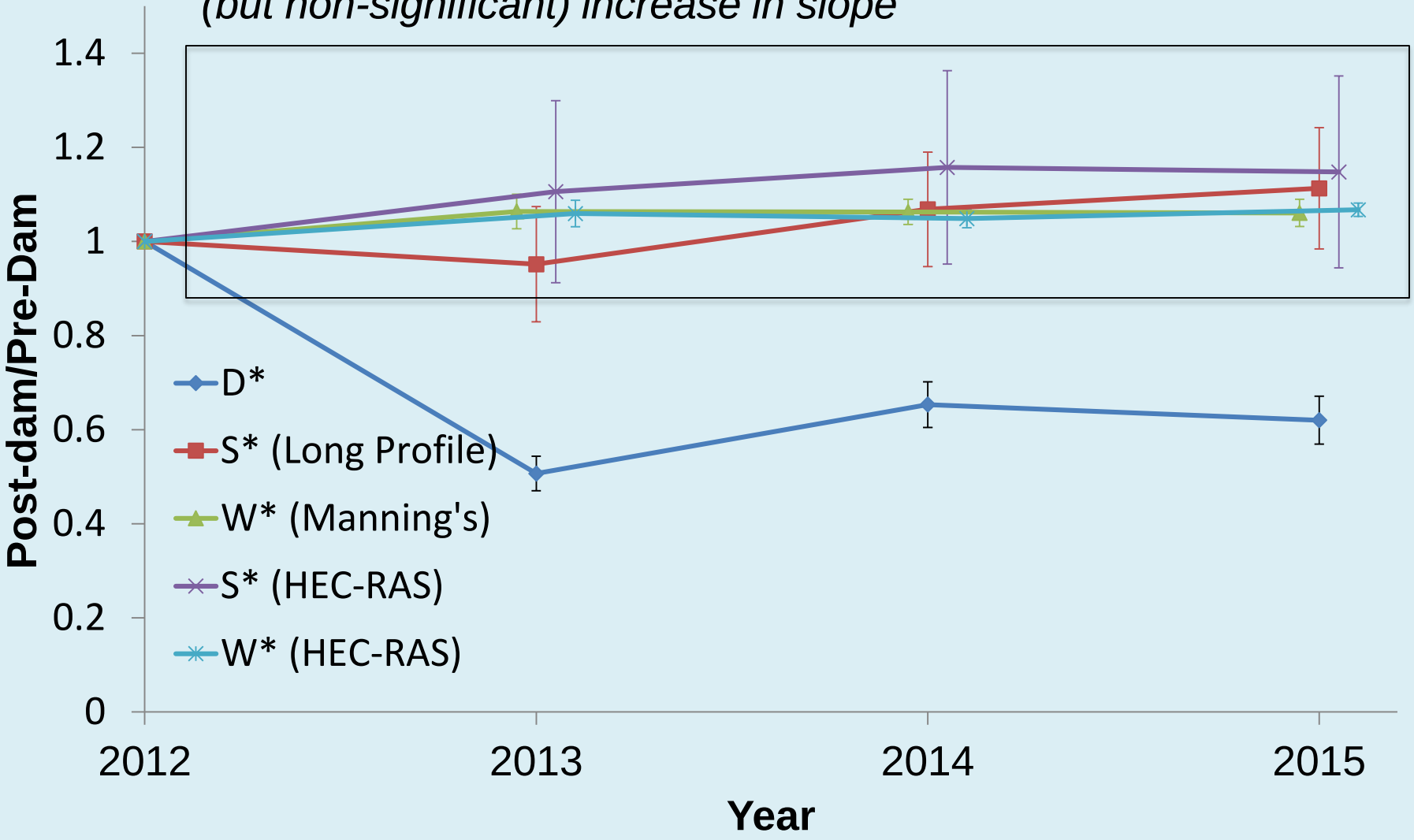


2012 - 2013: Average bed aggradation = ~ 25 cm

2013 – 2015: No Appreciable Net Change

Time Series of Geomorphic Adjustments Following Dam Removal

Channel adjustments have been minimal other than a slight (but non-significant) increase in slope



D = D_{50}; S = Slope; W = Width; * indicates ratio to pre-removal

Ecological response to removal: impact of restored passage and re-connected sediment supply on lamprey and resident fish distribution, abundance and diversity

and location of sea lamprey spawning nests by Yr: pre- and post-dam removal

YEAR --- N= Total # nests ; ▲ = # nests within 725 m of dam

PRE-Dam Removal

2009 N=14

2011 N=37 — 1 — 1

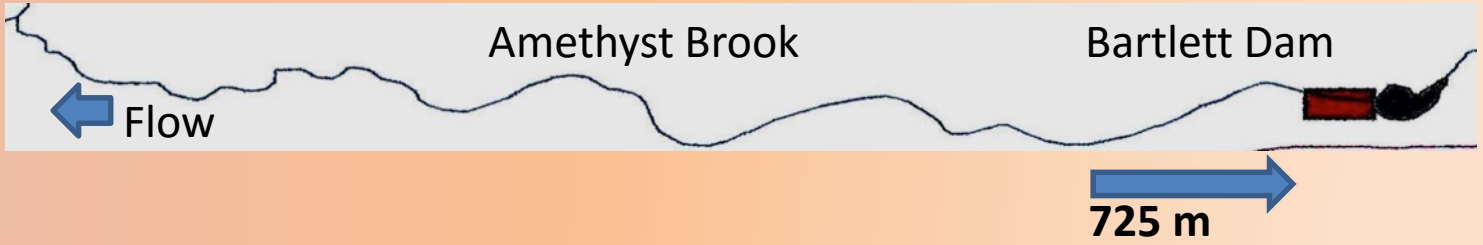
2012 N=15 — 1

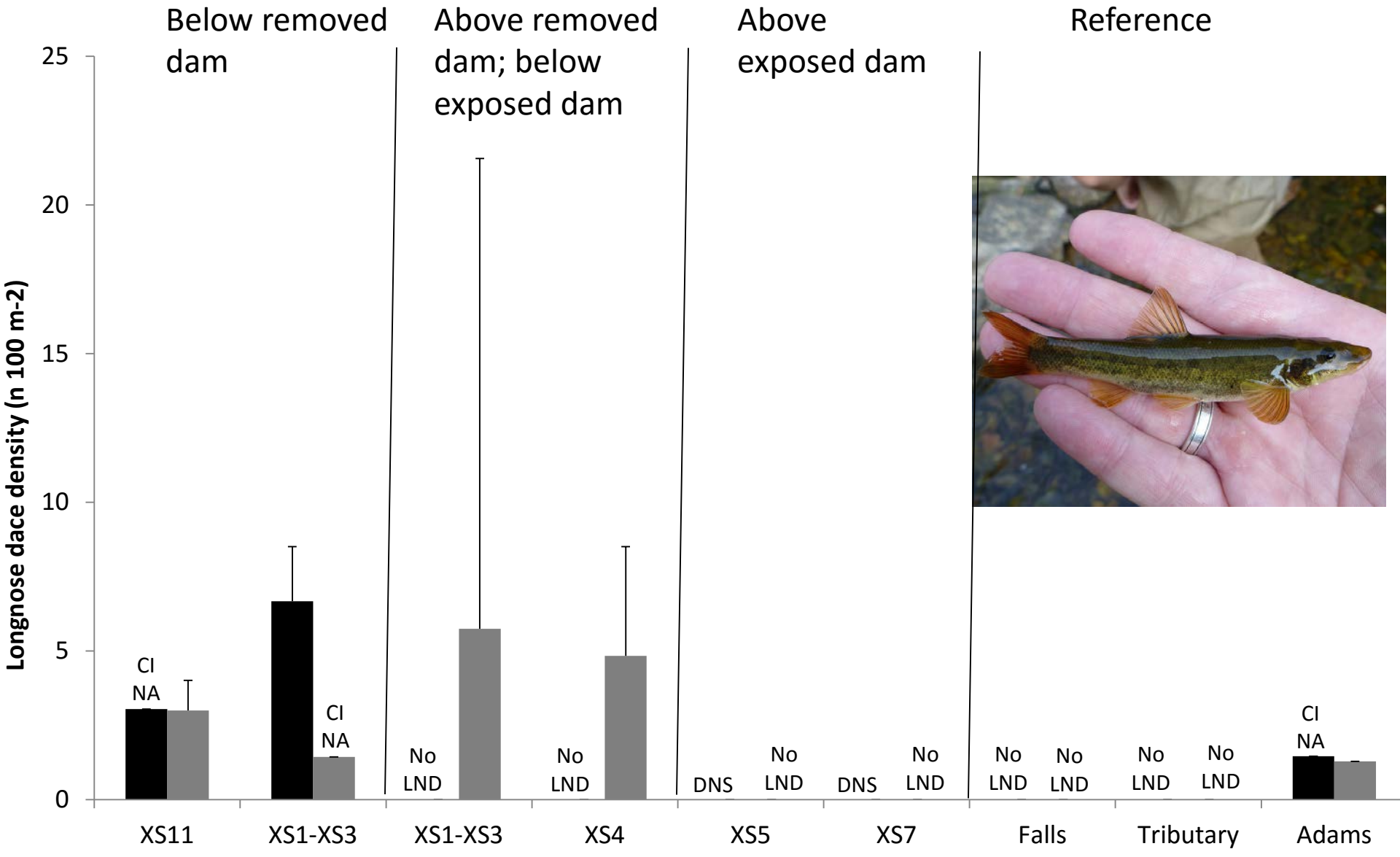
POST-Dam Removal

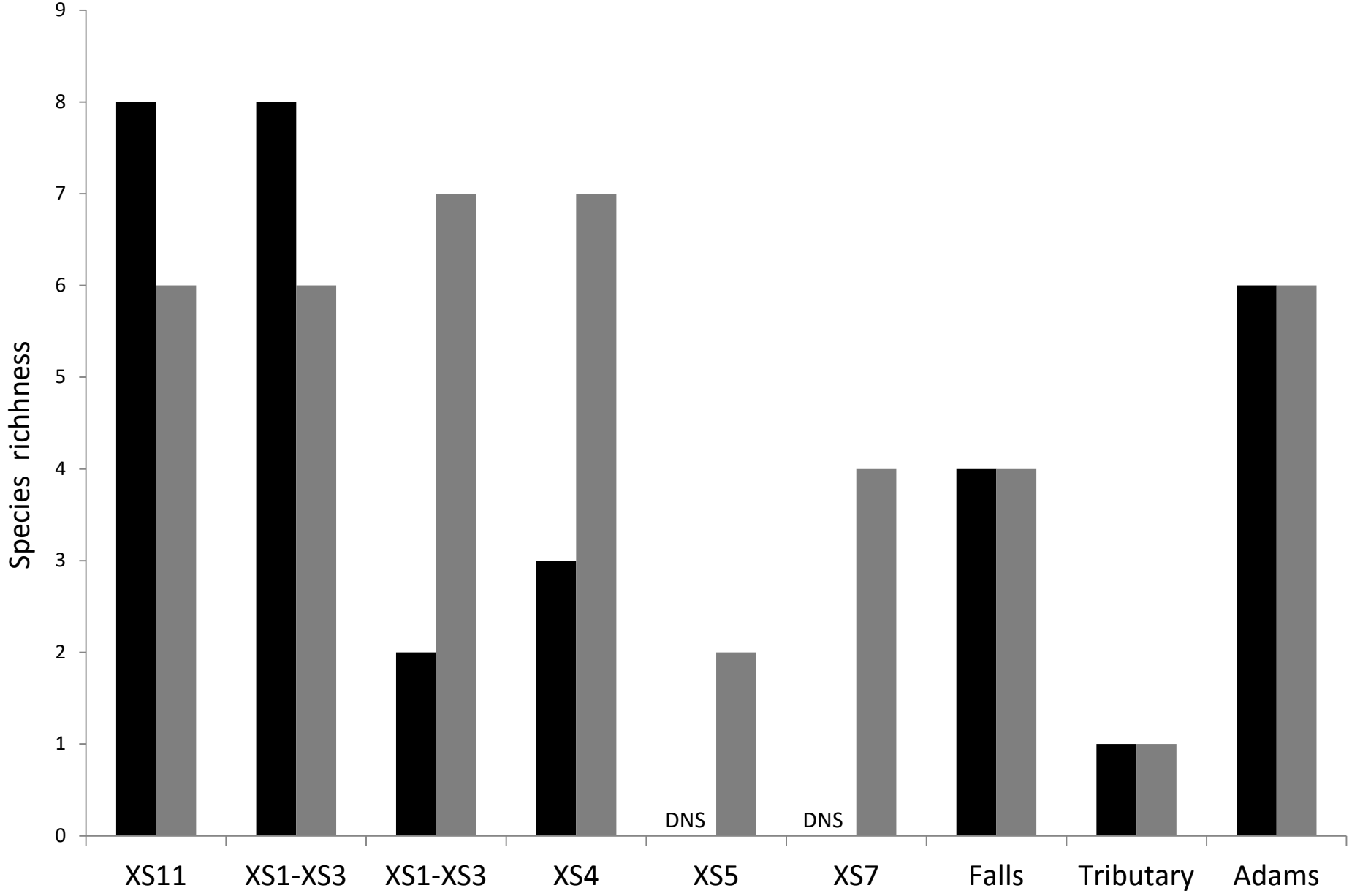
2013 N= 28 — 4 — 1

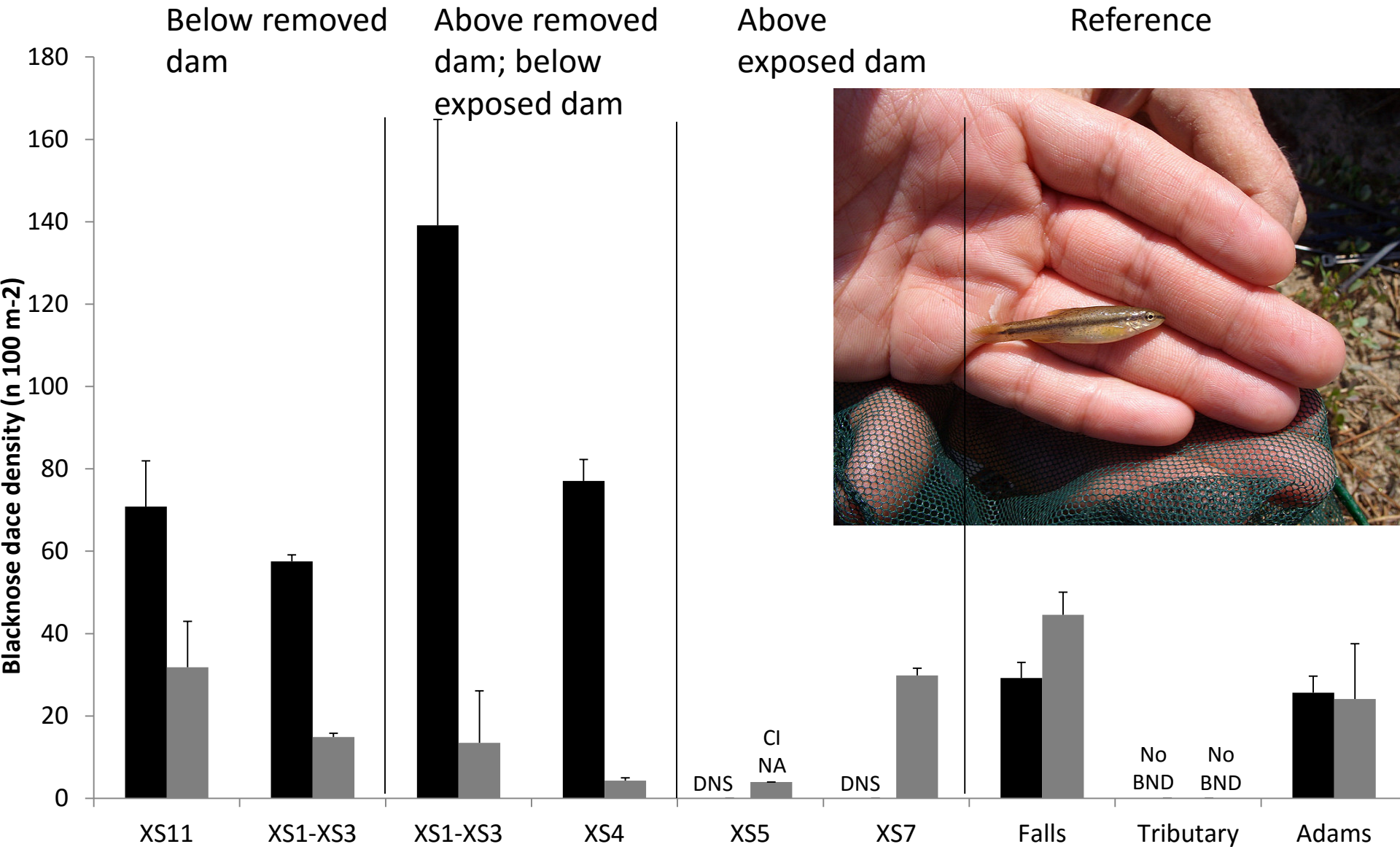
2014 N=58 — 13 — 3

2015 N=19 — No data




Below removed dam
Above removed dam; below exposed dam
Above exposed dam
Reference
Longnose dace density (n 100 m-2)
25
20
15
10
5
0
CI
NA
CI
NA
No
LND
No
LND
DNS
No
LND
DNS
No
LND
No
LND
No
LND
No
LND
No
LND
CI
NA
XS11
XS1-XS3
XS1-XS3
XS4
XS5
XS7
Falls
Tributary
Adams


Species richness
9
8
7
6
5
4
3
2
1
0
DNS
DNS
XS11
XS1-XS3
XS1-XS3
XS4
XS5
XS7
Falls
Tributary
Adams


Below removed dam
Above removed dam; below exposed dam
Above exposed dam
Reference
Blacknose dace density (n 100 m-2)
180
160
140
120
100
80
60
40
20
0
DNS
CI
NA
DNS
No BND
No BND
XS11
XS1-XS3
XS1-XS3
XS4
XS5
XS7
Falls
Tributary
Adams

		2012	**2013**	2014	2015
Below Dam	T11	154	**77**	106	94
	T1-3	159	**76**	105	124
Above Dam Below Crib Dam	T1-3	144	**43**	125	368
	T4	206	**17**	46	93
Above Crib Dam	T5		**10**	34	121
	T7		**93**	73	73

CONCLUSION

Immediate response to dam removal:

- Bed aggradation & significant fining downstream of former dam; channel adjustment associated with dam removal/flood interaction in dam proximal sections
- Lamprey nests increase in #, especially in dam proximal locations, and spawning observed above the former dam
- Fish species richness increases upstream as species move above the dam
- In sections experiencing major channel adjustment, abundances of some species was reduced

CONCLUSION

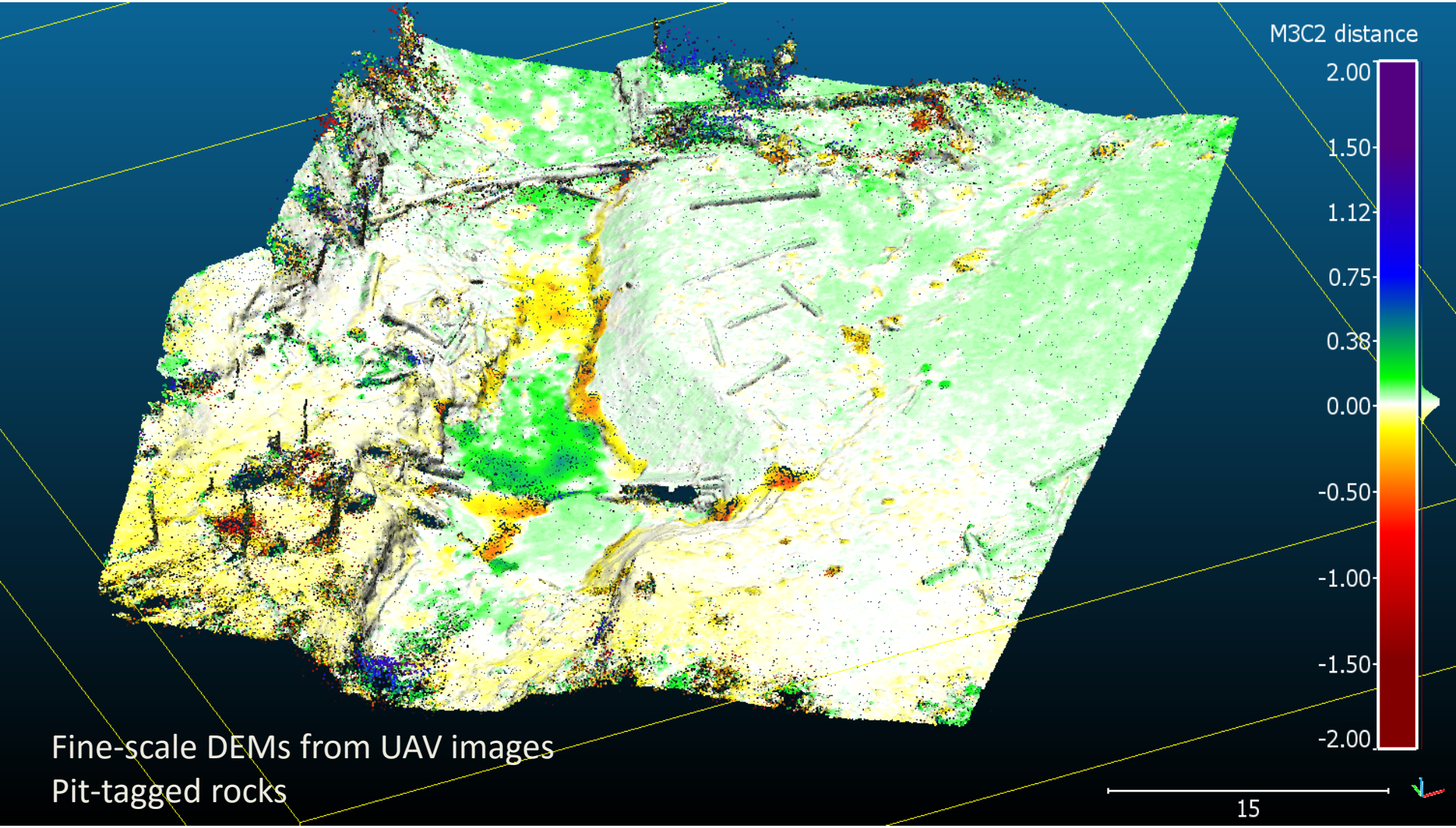
<u>“Long-term” response to dam removal:</u>

- Bed coarsens slightly but still finer than pre-dam condition
- Lamprey nests increase in #, especially in dam proximal locations
- Species whose abundance was reduced in dam/flood impacted reaches recover
- Bed fining is dominant and persistent response relative to other channel changes
- Downstream bar formation expands


2012


2014
Re-connected Supply of Fine Bed Material Has Led To Aggradation and Progressive (Alternate) Bar Formation

January 2016)
Crib Dam Removed


M3C2 distance
2.00
1.50
1.12
0.75
0.38
0.00
-0.50
-1.00
-1.50
-2.00
15
Fine-scale DEMs from UAV images
Pit-tagged rocks