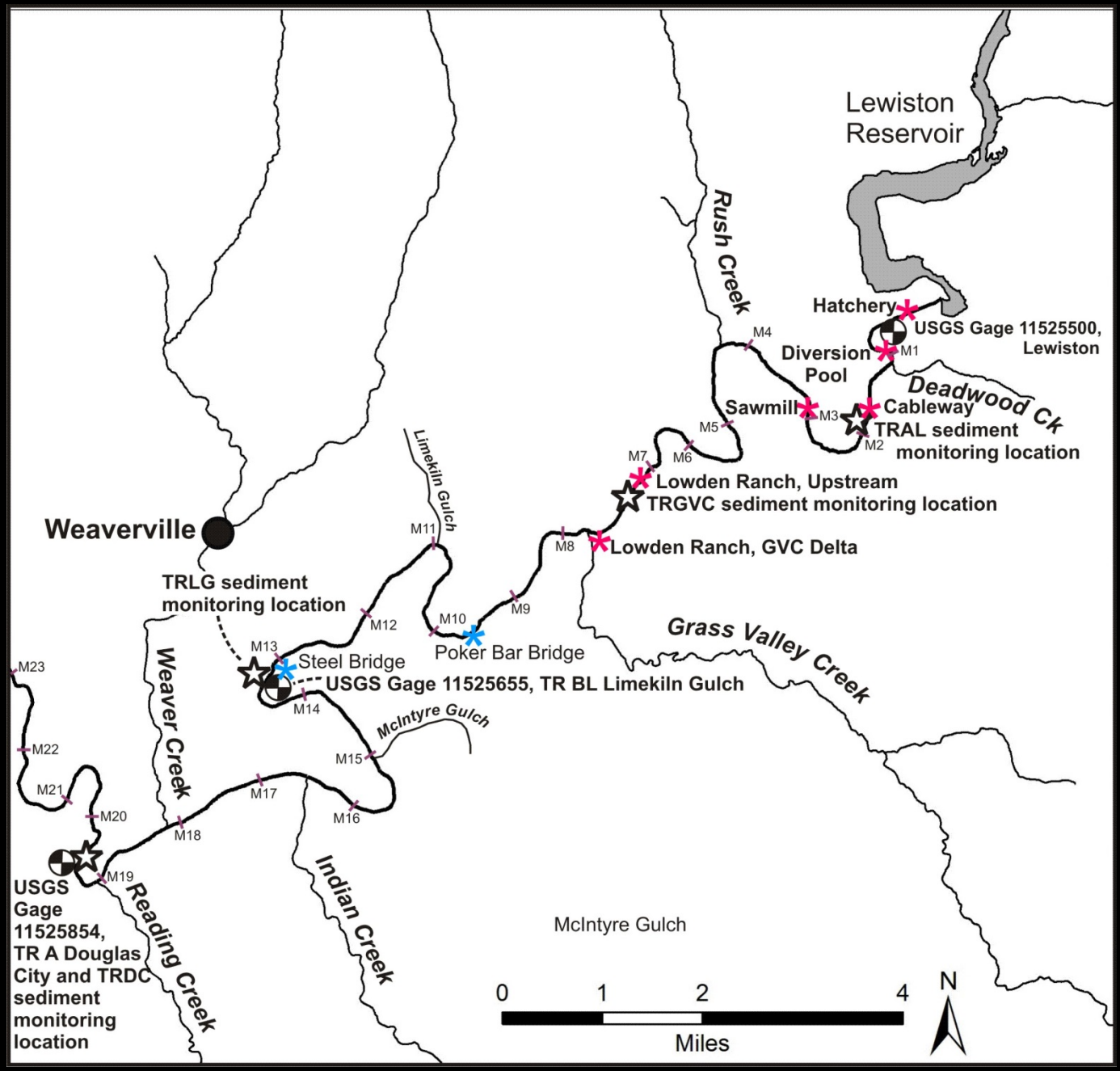
Fate of Gravel Augmentations

Gravel Augmentation Sites



Coarse Sediment Augmentations 2003-2015

Direct Placements –

- Cableway, 2003
- Hatchery, 2006-07
- Cableway, 2008
- Hoadley Gulch, 2008
- Deadwood Creek, 2008
- Dark Gulch, 2008
- Sawmill Bars, 2009
- Lowden Ranch, 2010
- Trinity House Gulch, 2010
- Reading Creek, 2010
- Sawmill Bar, 2013

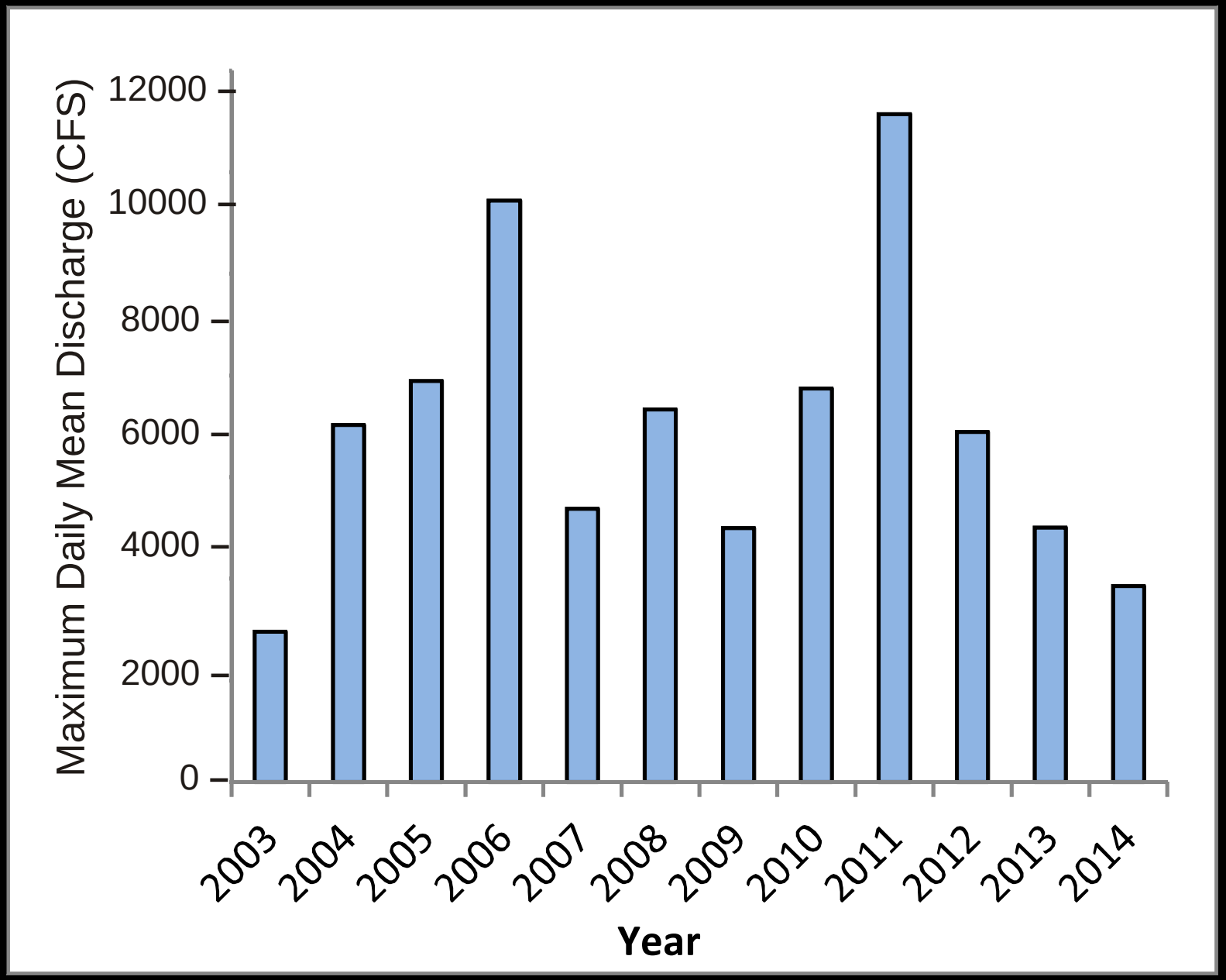
High-flow injections –

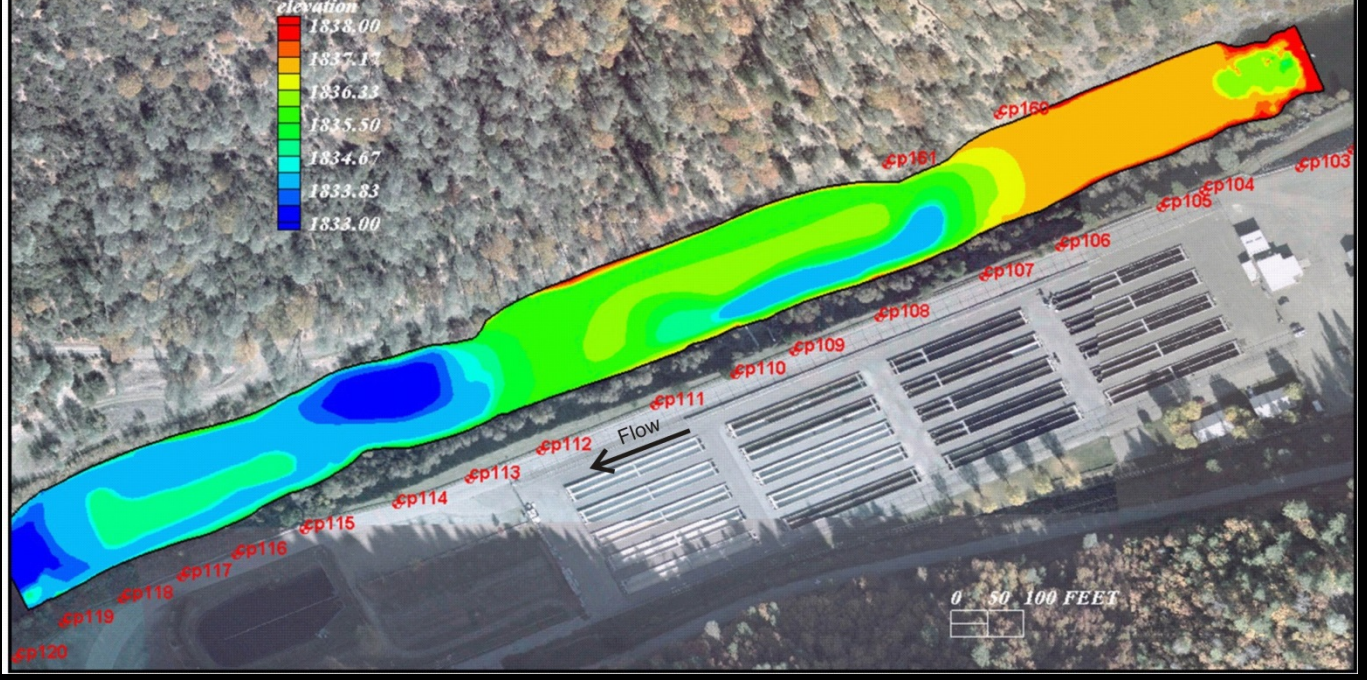
- Diversion Pool, 2008
- Sawmill Burner Hole, 2008
- Diversion Pool, 2009
- Sawmill Burner Hole, 2009
- Diversion Pool, 2010
- Lowden Ranch, 2010
- Diversion Pool, 2011
- Lowden Ranch, 2011
- Diversion Pool, 2013
- Lowden Ranch, 2015
- Diversion Pool, 2015

Total mobile coarse sediment augmented since 2003 –

53,700 yd^3 (78,000 tons)

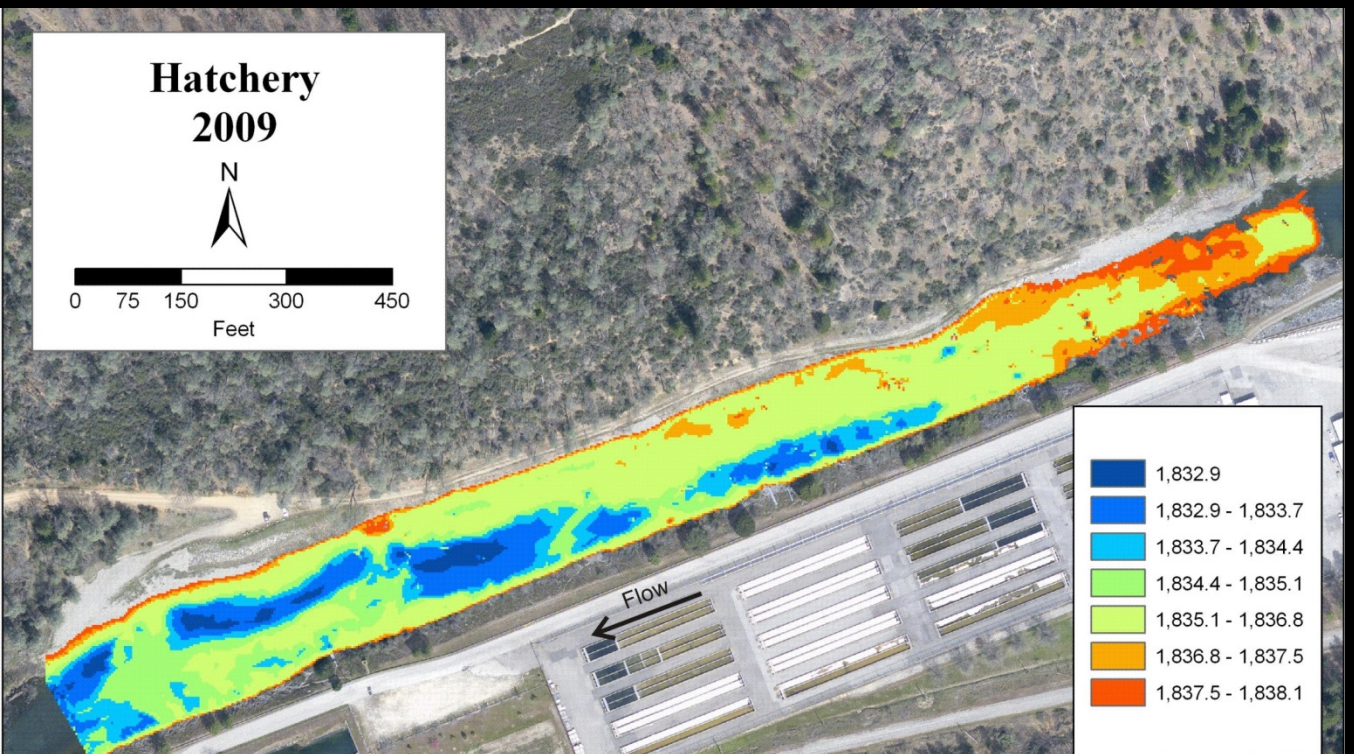
(Grey highlighting indicates gravel placements performed in conjunction with a channel rehabilitation project)


Maximum Daily Mean Discharge (CFS)
12000
10000
8000
6000
4000
2000
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year



Hatchery 2006-2007

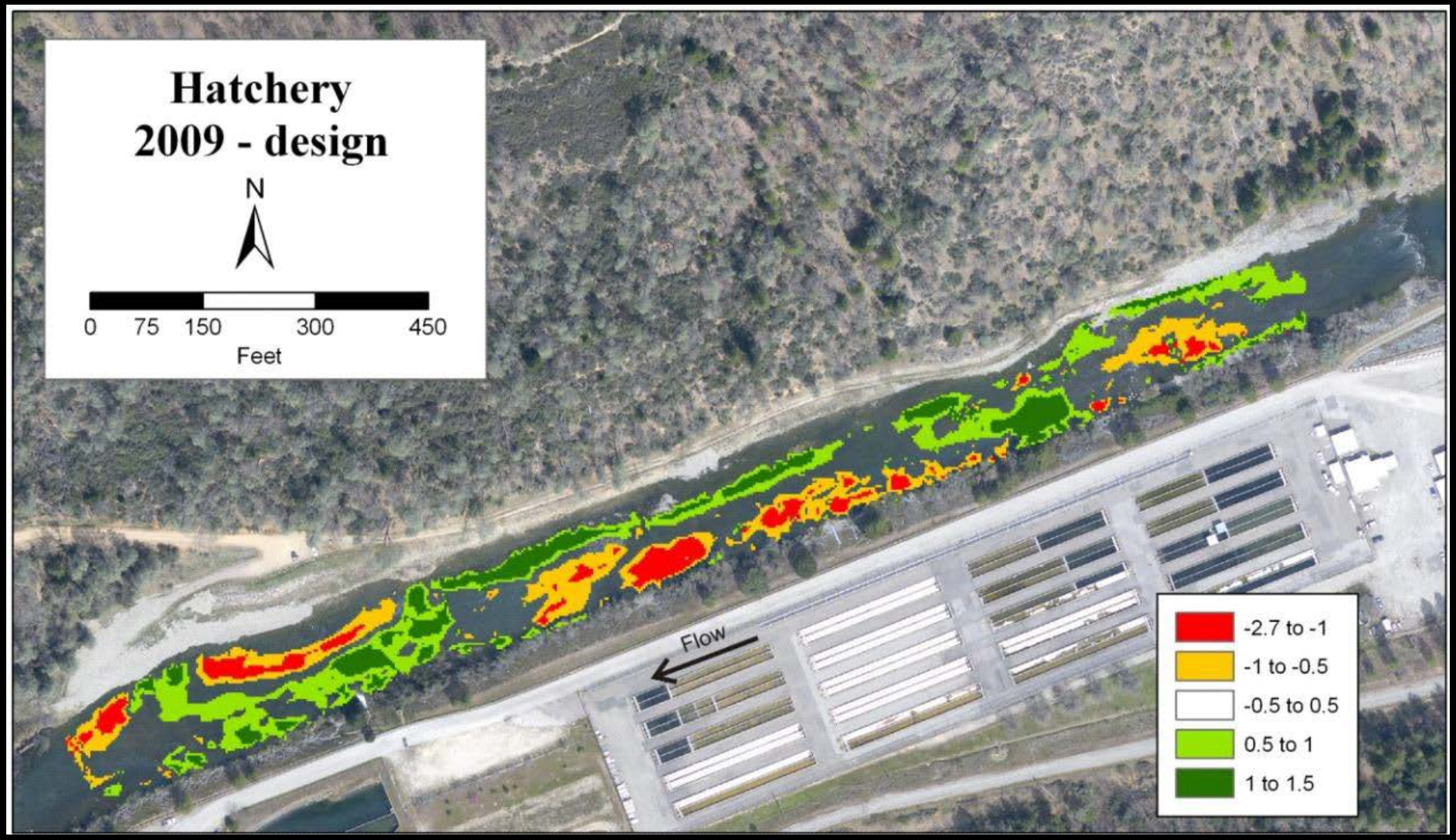
Design topography (no as-built). Estimated volume placed (from design and construction documents) is 5100 to 5800 yds.



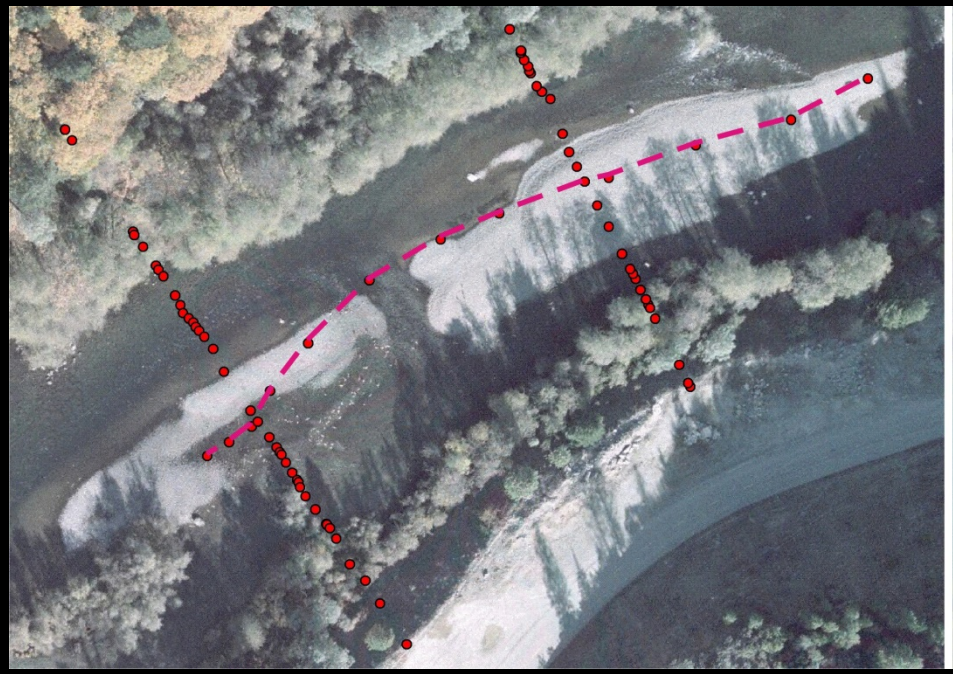
Surveyed topography 2 years after project.

Hatchery

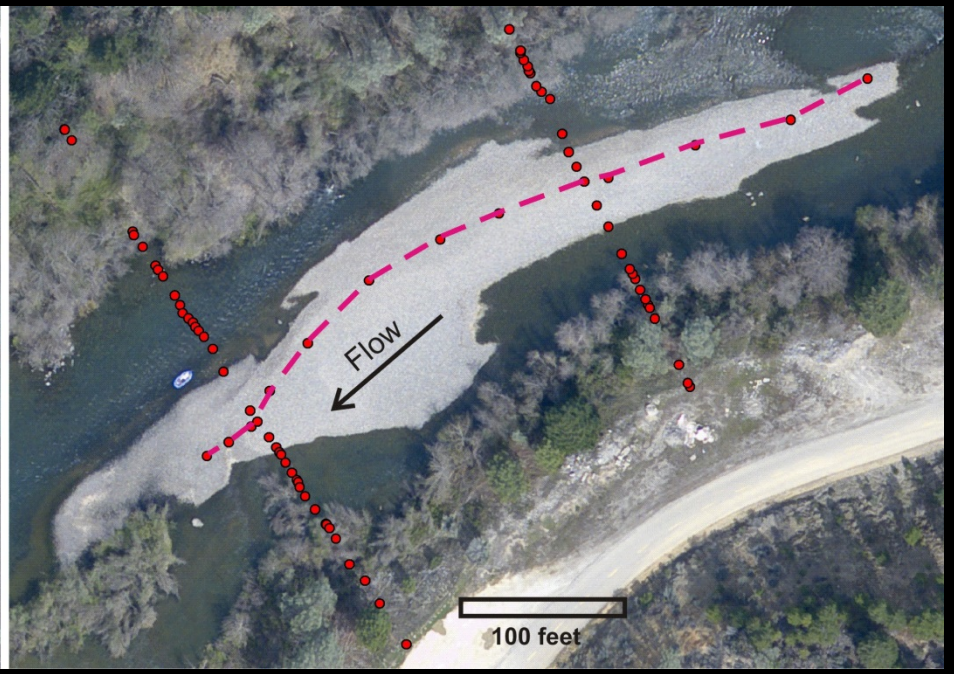
Estimated change in volume = -100 to +700 yds, suggesting that most placed material was still present in this reach in 2009.



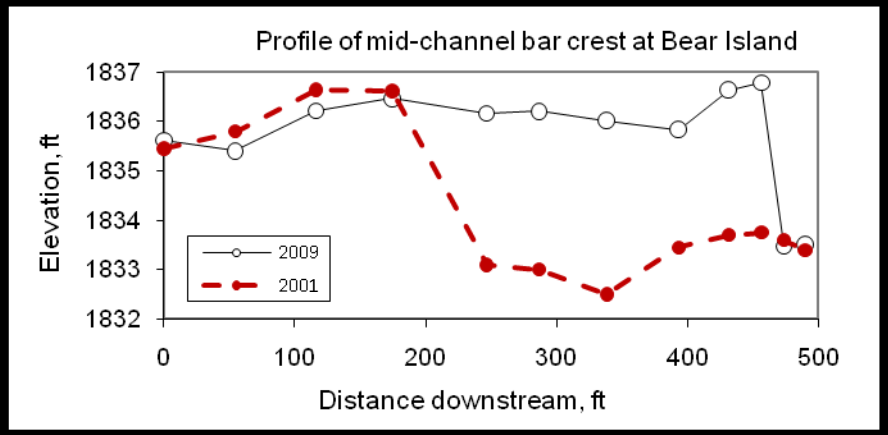
But an estimated 1000 yds of gravel accumulated at Bear Island ~1200 ft downstream.



2001 (pre-project)



2009



Increase in height of longitudinal profile along bar crest at Bear Island , 2001 photogrammetry vs 2009 survey

Bear Island after Spring Flow Release of 12,000 cfs

2009

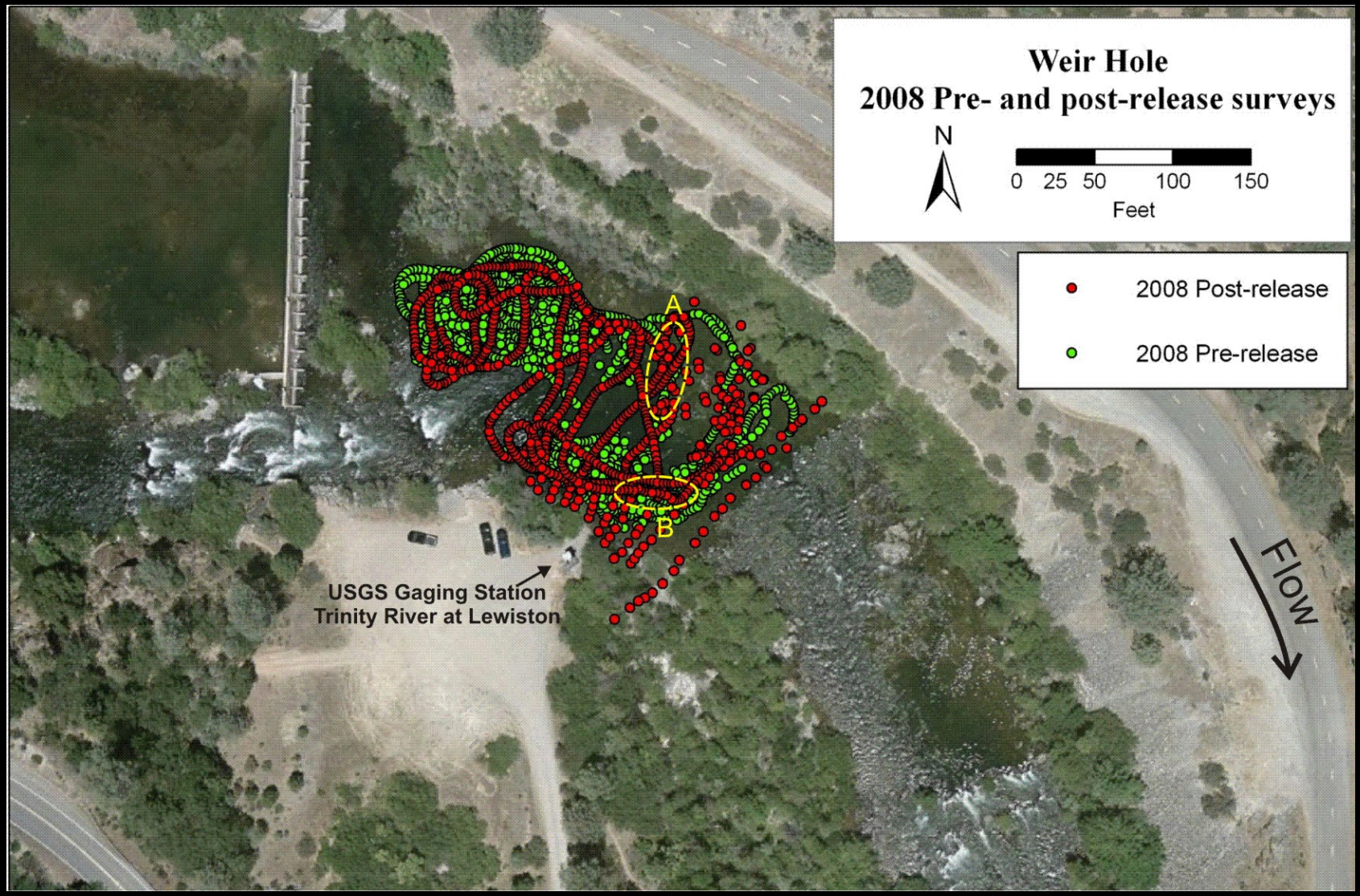
2011

Diversion Pool

2008, 2009, 2010, 2011, 2013

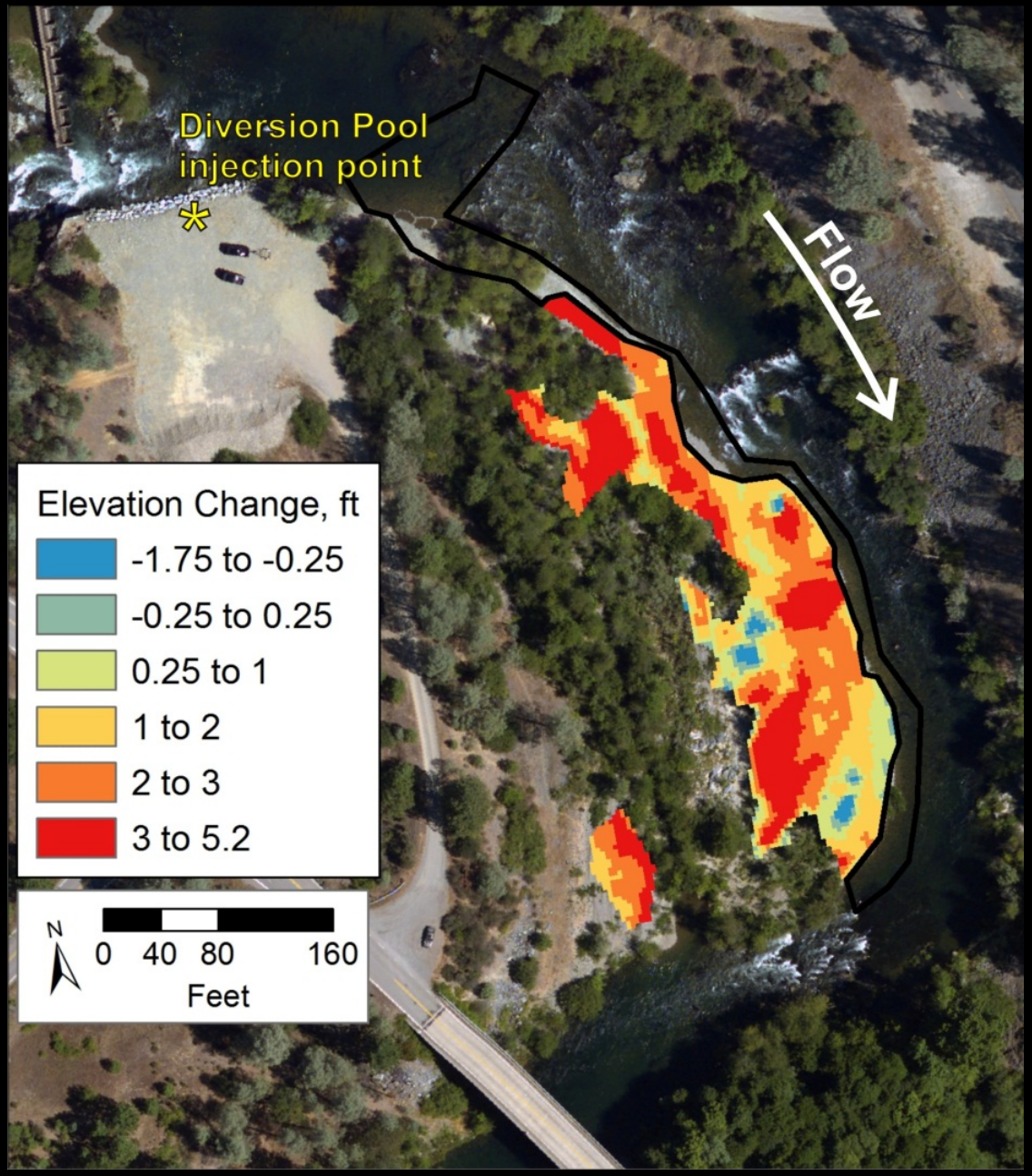
During 2010 high-flow release

Diversion Pool



No fill in the pool

Diversion Pool



Elevation changes, 2009-2011 post release

At least half of the gravel injected in 2009, 2010, and 2011 remains on the inside of the bend downstream.

Poor bathymetry in rapids and an island complex downstream prevents quantifying storage in the channel.

A large pool beneath the New Lewiston Bridge did not fill.

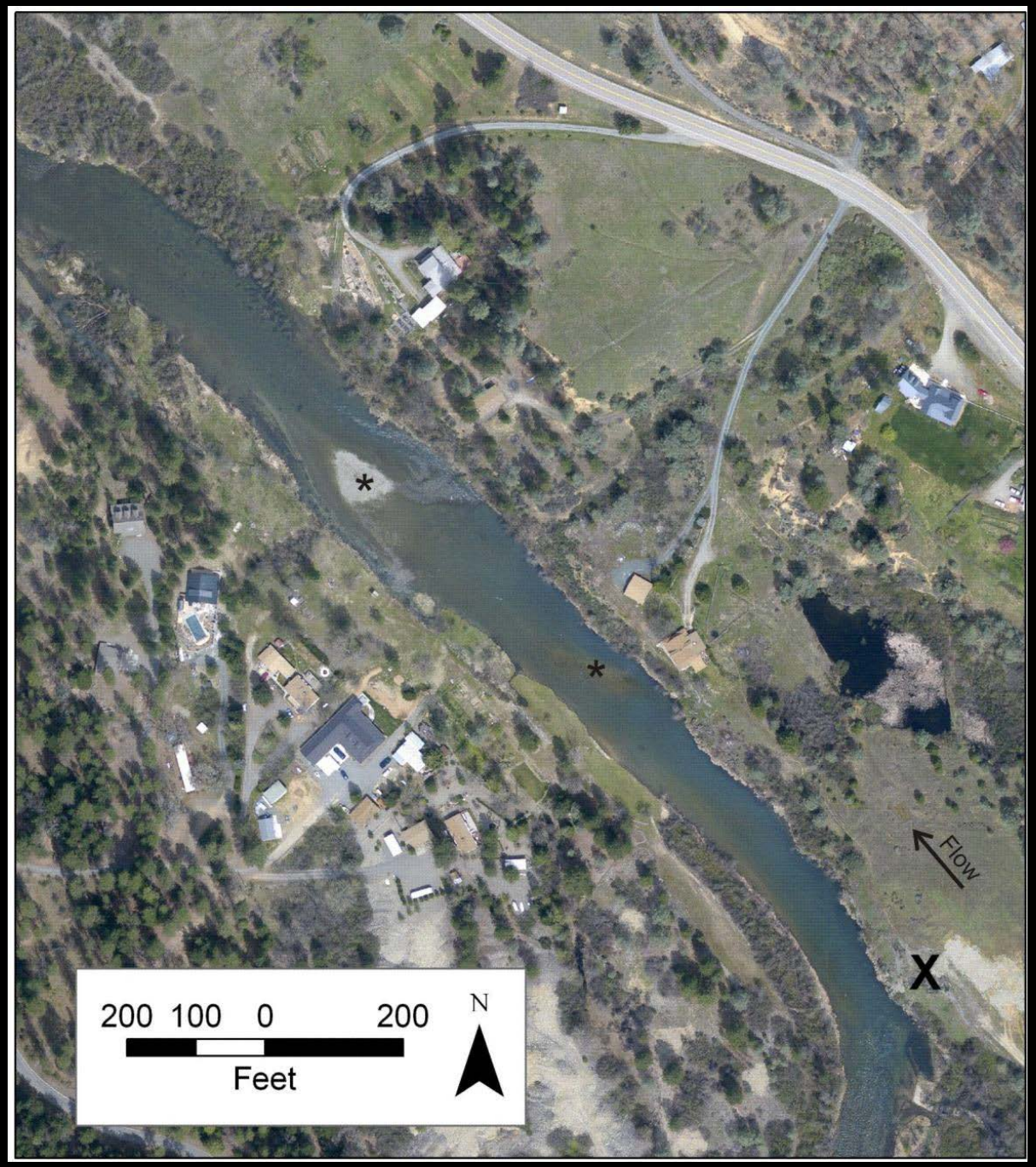
Cableway
2003, 2008

Cableway

2008

2011

Sediment monitoring at the Old Lewiston Bridge show that about 1.7 times as much gravel had passed the bridge than was placed in the reach. The head of the Cemetery side channel (2200 ft downstream) is a likely transport limit.

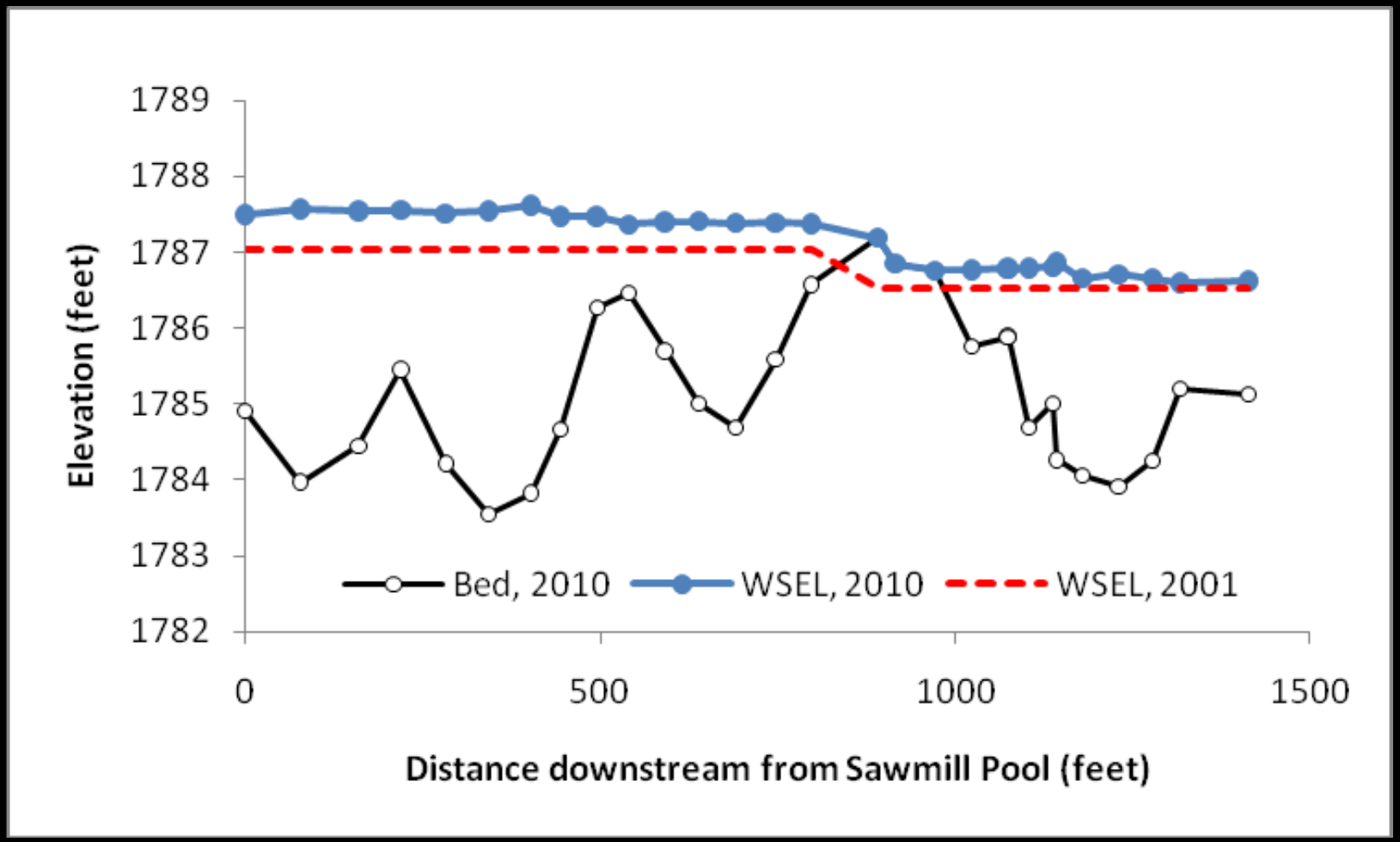


Injections at Sawmill Burner Hole 2008 and 2009

Previously presented:

Gravel moved to left bank bar in 2008. Much of the gravel injected in 2009 after the Sawmill Rehabilitation Project remains in the hole.

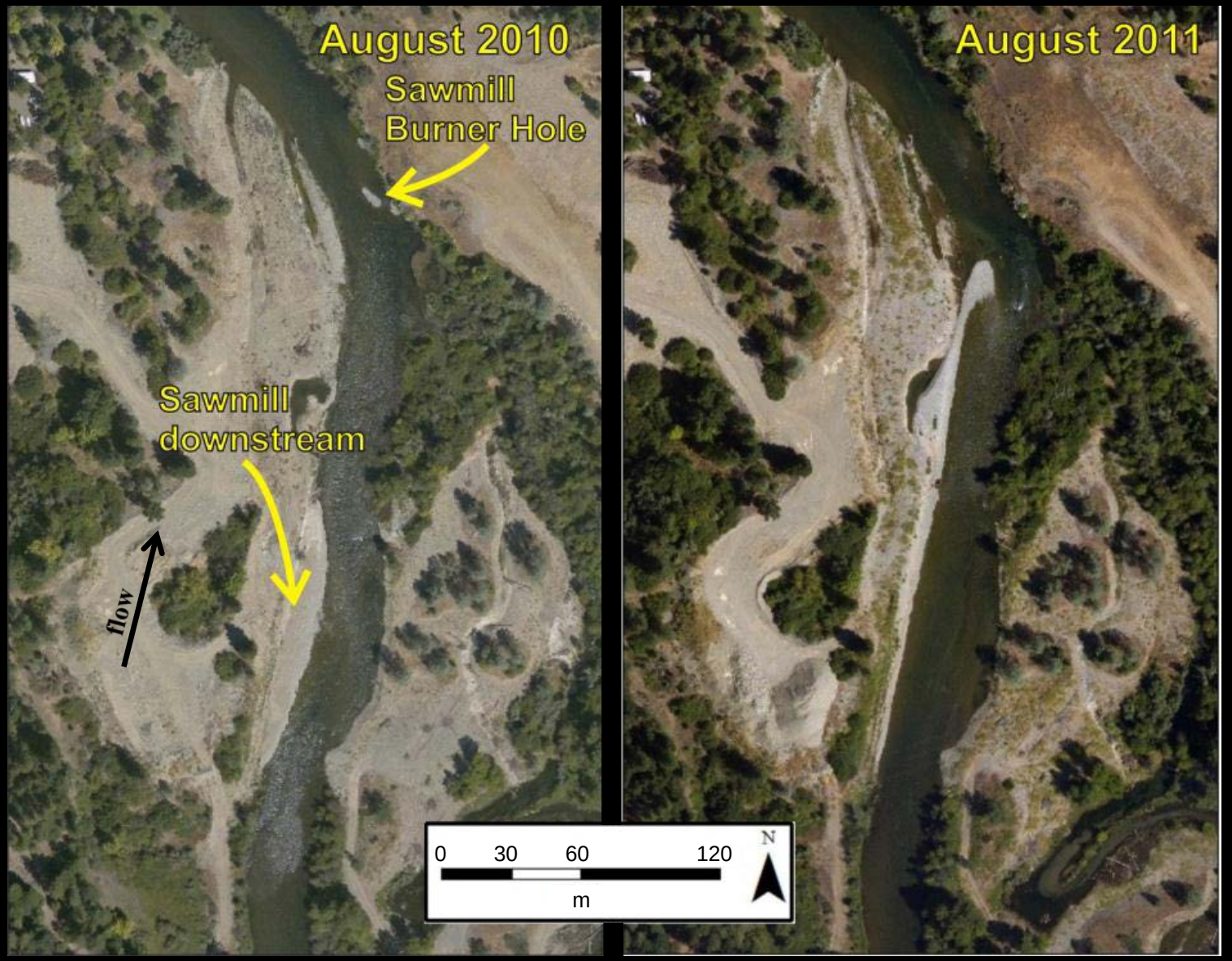
Sawmill Burner Hole Injections



By 2010, a small portion of the injected gravel may have raised the hydraulic control associated with the medial bar 800 ft downstream.

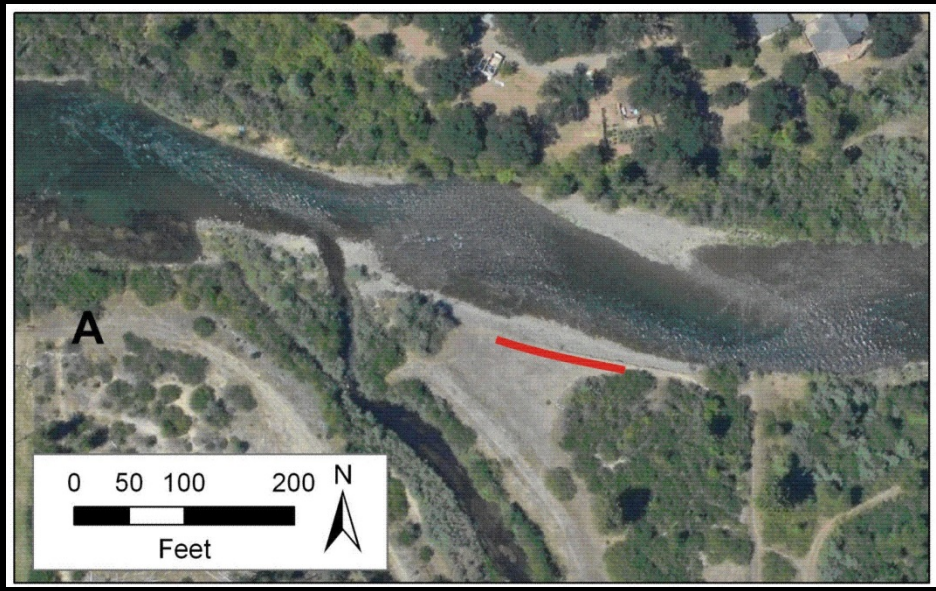
Placed Bar at Sawmill

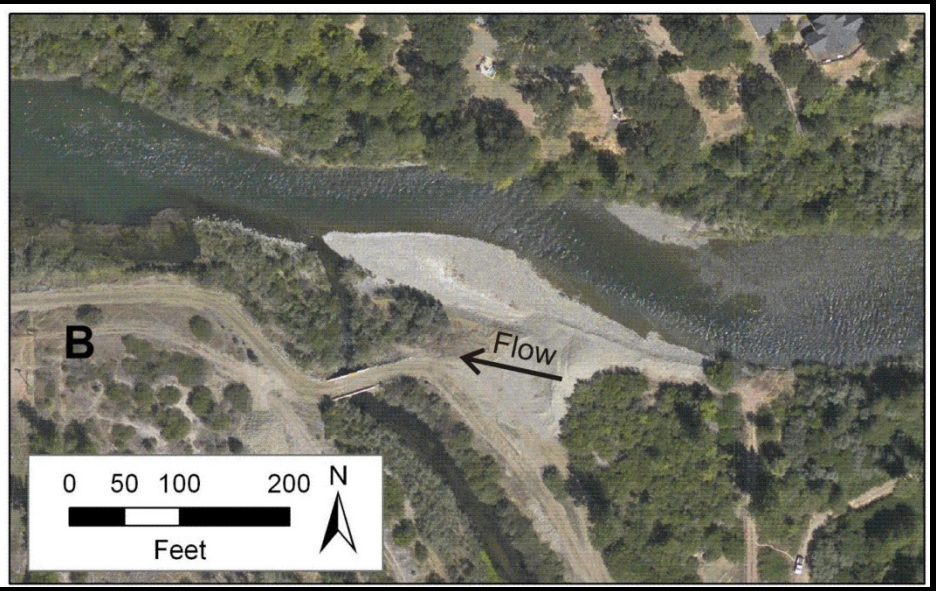
2011 Flow Release smeared it 300-400 ft downstream

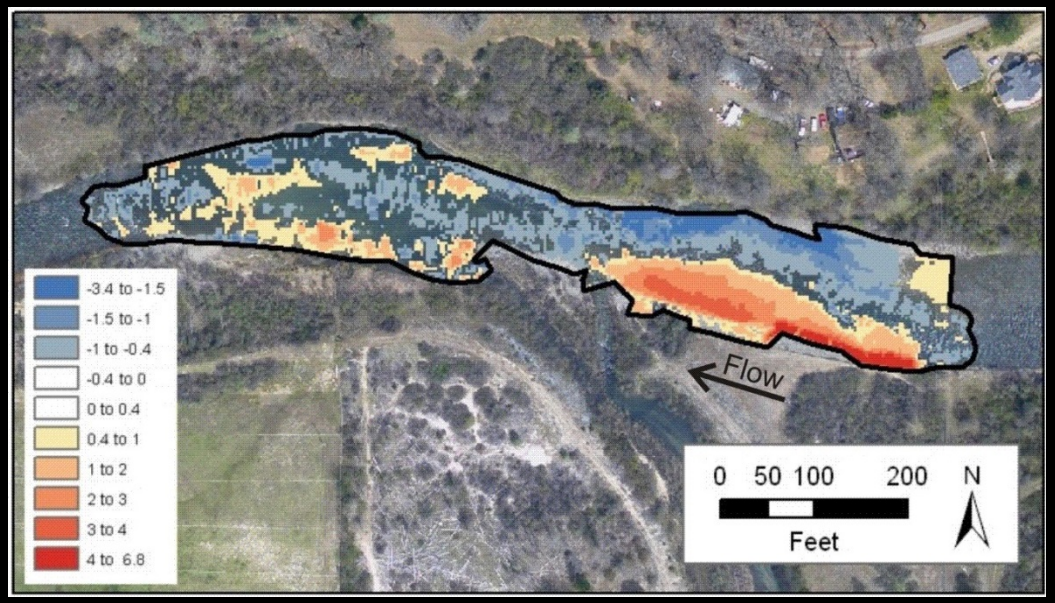


Lowden-GVC Delta

1530 yds injected during 2010 flow release







New bar at injection point accounts for 30% of injection.

But net volume change in area was just 610 yds.

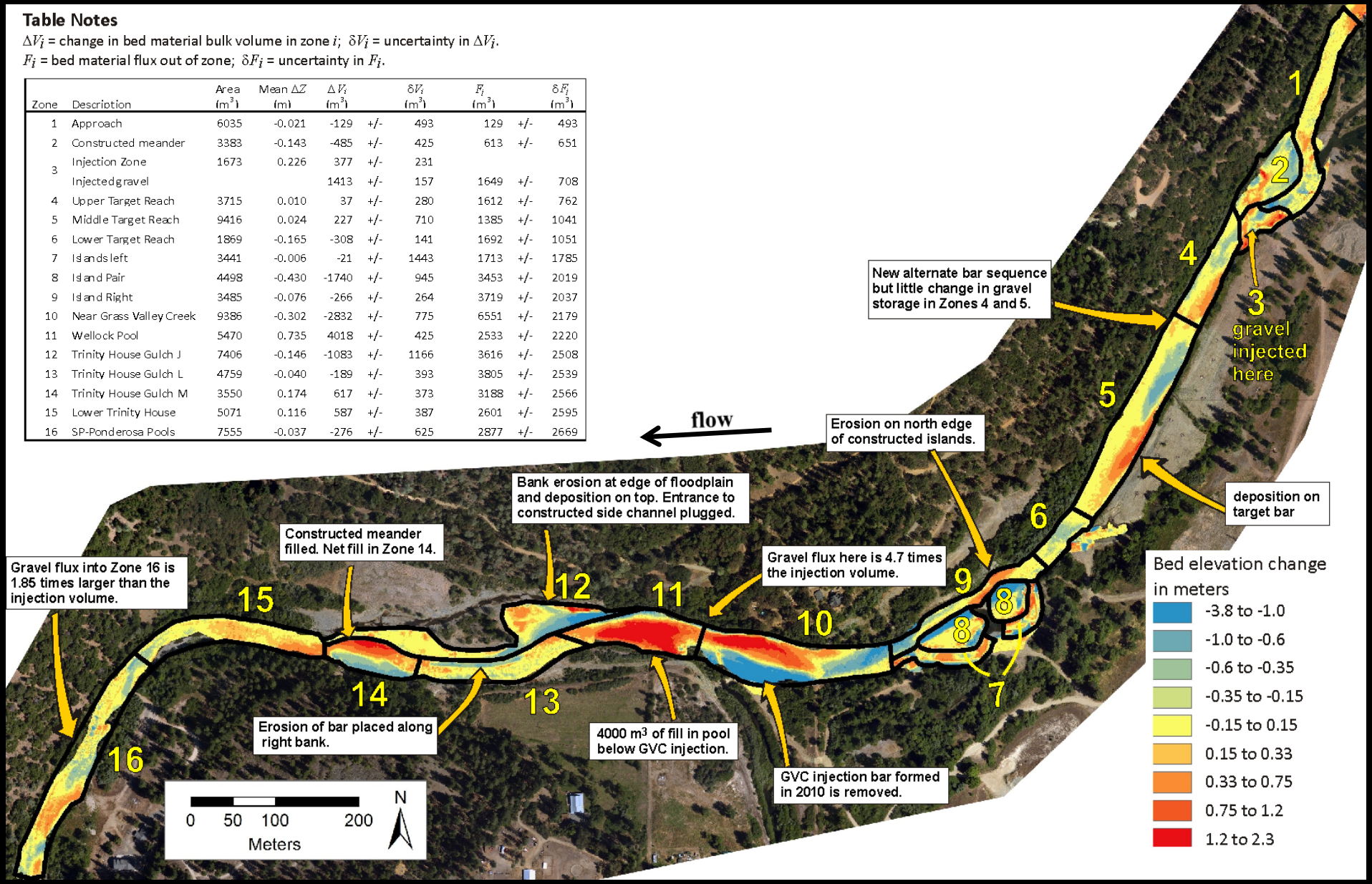
About 900 yds of material went downstream to ??

Lowden Ranch and vicinity in 2011

Table Notes

ΔV_i = change in bed material bulk volume in zone i; δV_i = uncertainty in ΔV_i.
F_i = bed material flux out of zone; δF_i = uncertainty in F_i.

Zone	Description	Area (m^3)	Mean ΔZ (m)	ΔV_i (m^3)		δV_i (m^3)	F_i (m^3)		δF_i (m^3)
1	Approach	6035	-0.021	-129	+/-	493	129	+/-	493
2	Constructed meander	3383	-0.143	-485	+/-	425	613	+/-	651
3	Injection Zone	1673	0.226	377	+/-	231			
	Injected gravel			1413	+/-	157	1649	+/-	708
4	Upper Target Reach	3715	0.010	37	+/-	280	1612	+/-	762
5	Middle Target Reach	9416	0.024	227	+/-	710	1385	+/-	1041
6	Lower Target Reach	1869	-0.165	-308	+/-	141	1692	+/-	1051
7	Islands left	3441	-0.006	-21	+/-	1443	1713	+/-	1785
8	Island Pair	4498	-0.430	-1740	+/-	945	3453	+/-	2019
9	Island Right	3485	-0.076	-266	+/-	264	3719	+/-	2037
10	Near Grass Valley Creek	9386	-0.302	-2832	+/-	775	6551	+/-	2179
11	Wellock Pool	5470	0.735	4018	+/-	425	2533	+/-	2220
12	Trinity House Gulch J	7406	-0.146	-1083	+/-	1166	3616	+/-	2508
13	Trinity House Gulch L	4759	-0.040	-189	+/-	393	3805	+/-	2539
14	Trinity House Gulch M	3550	0.174	617	+/-	373	3188	+/-	2566
15	Lower Trinity House	5071	0.116	587	+/-	387	2601	+/-	2595
16	SP-Ponderosa Pools	7555	-0.037	-276	+/-	625	2877	+/-	2669



Lessons Learned

Initial Assumption:

Augmented gravel affects pools and other habitats far downstream from where it is introduced. Gravel propagates downstream in a consistent manner akin to a conveyor belt.

Findings:

A large proportion of augmented gravel remains relatively close to where it was introduced. Downstream transport is irregular and mediated by sinks where gravel can stall for extended periods of time.

Management Implications:

Augmentations are best implemented close to the areas they are intended to affect. Channel modifications that greatly reduce stream power can create artificial gravel sinks.