Recommendations for Long-term Gravel Augmentation Volumes

TRINITY RIVER RESTORATION PROGRAM
P.O. BOX 1300, WEAVERVILLE, CA
PHONE: 530-623-1800, FAX: 530-623-5944

Technical Report TR-TRRP-2014-1

Analyses to support gravel augmentation recommendations for the Trinity River, California.

Prepared by:

David Gaeuman
Trinity River Restoration Program
Weaverville, California

November 2014

Gravel Augmentation Objectives (TRFES and ROD)

"Short-term Coarse Sediment Supplementation" –

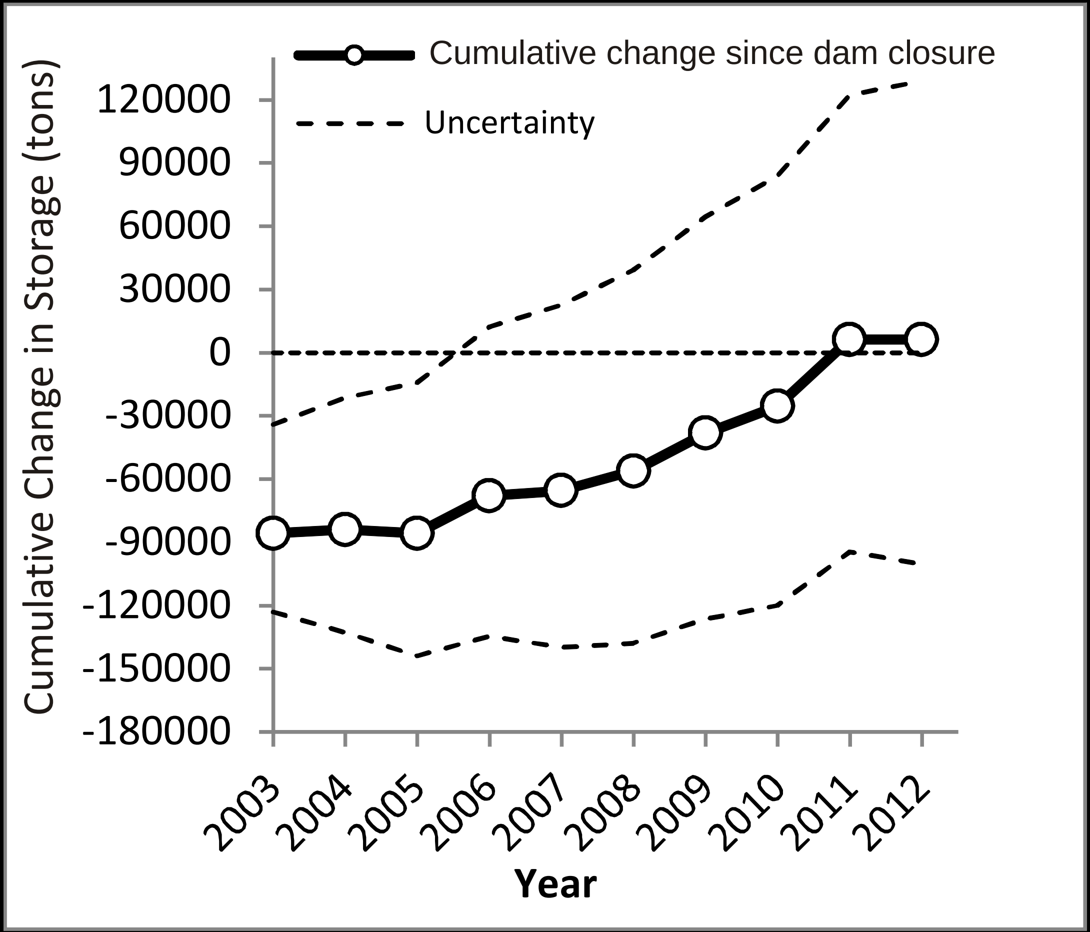
- Mitigate for dam-induced deficit
- TRFES calls for 16,000 yds in Lewiston area
- Immediate increase in spawning and rearing habitat

"Annual Coarse Sediment Introduction" –

- Maintain a coarse sediment balance
- Support geomorphic process into the future
- Habitat creation/rejuvenation into the future (implicit)

Recharge Storage: 2012 Budget

Upstream from Limekiln Gulch



Gaeuman, D. 2013. *2012 sediment budget update, Trinity River, Lewiston Dam to Douglas City, California*. Trinity River Restoration Program, Weaverville, CA, TRRP Technical Report TR-TRRP-2013-2, http://odp.trrp.net/Data/Documents/Details.aspx?document=2156

Long-term Supply Maintenance
Defining an unregulated gravel load for a regulated river

Trinity River Record of Decision –

Variable quantities according to water years type, range from 0 in critically dry years up to 66,700 yd^3 (100,500 tons) in extremely wet years. Average = 10,000 yd^3 (15,000 tons) per year.

Gaeuman (2008) –

Modeling analysis reduced average annual target quantity to 6,670 yd^3 (10,000 tons) per year.

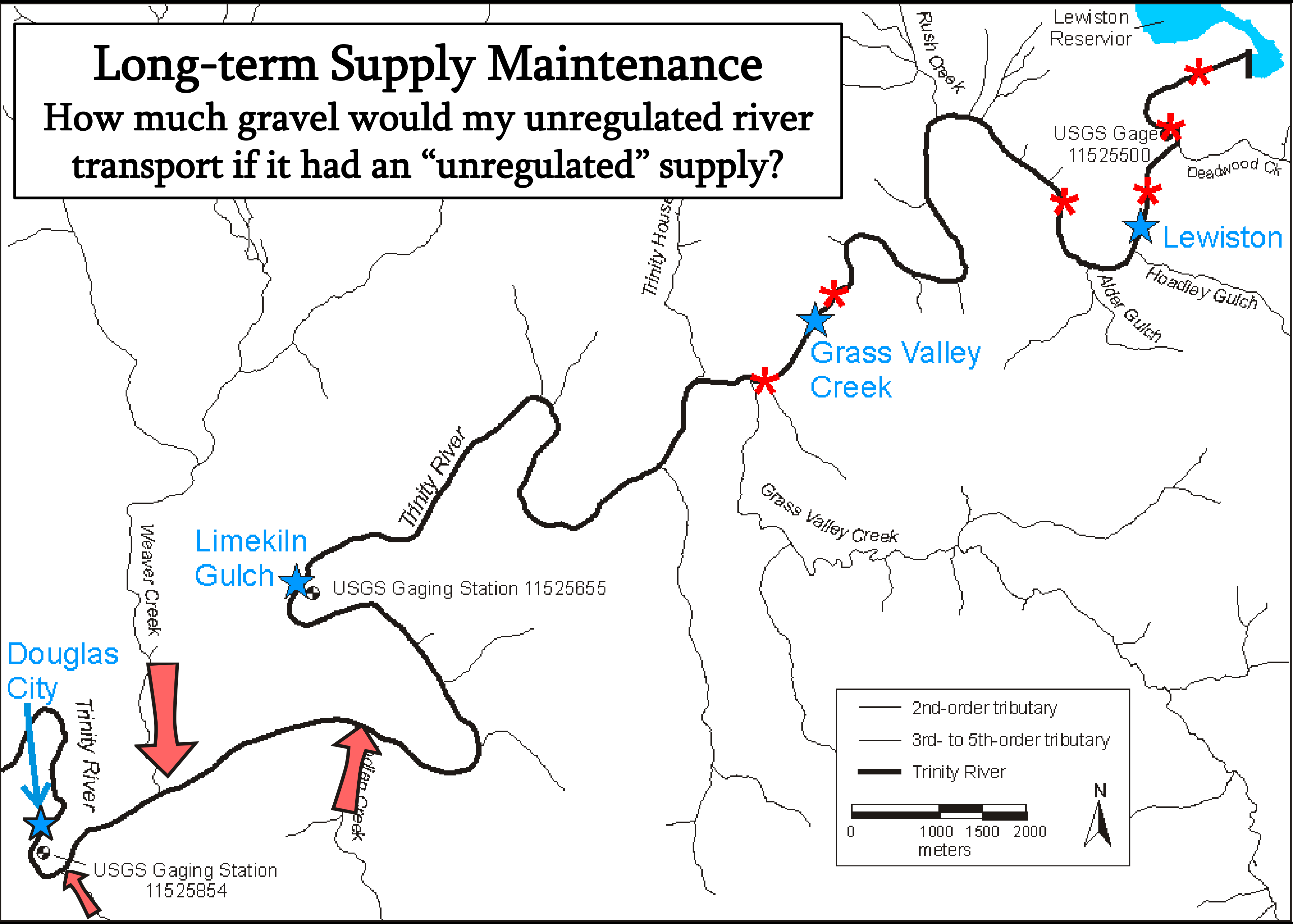
Recent (2014) analyses suggest reducing the average annual target to 1,900 yd^3 (2,870 tons) per year –

Long-term Supply Maintenance

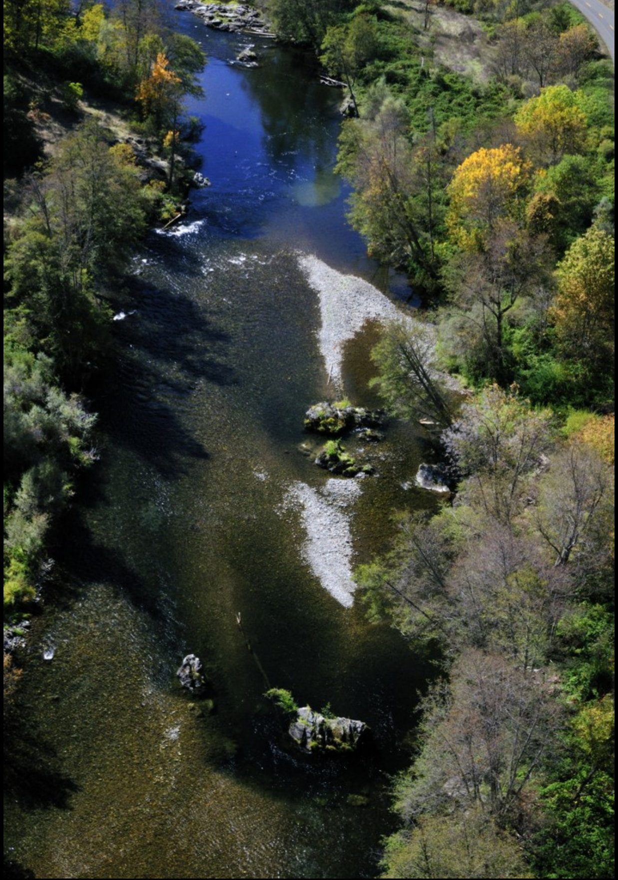
How much gravel would my regulated river transport
if it had an "unregulated" gravel supply?

Long-term Supply Maintenance

How much gravel would my unregulated river transport if it had an “unregulated” supply?

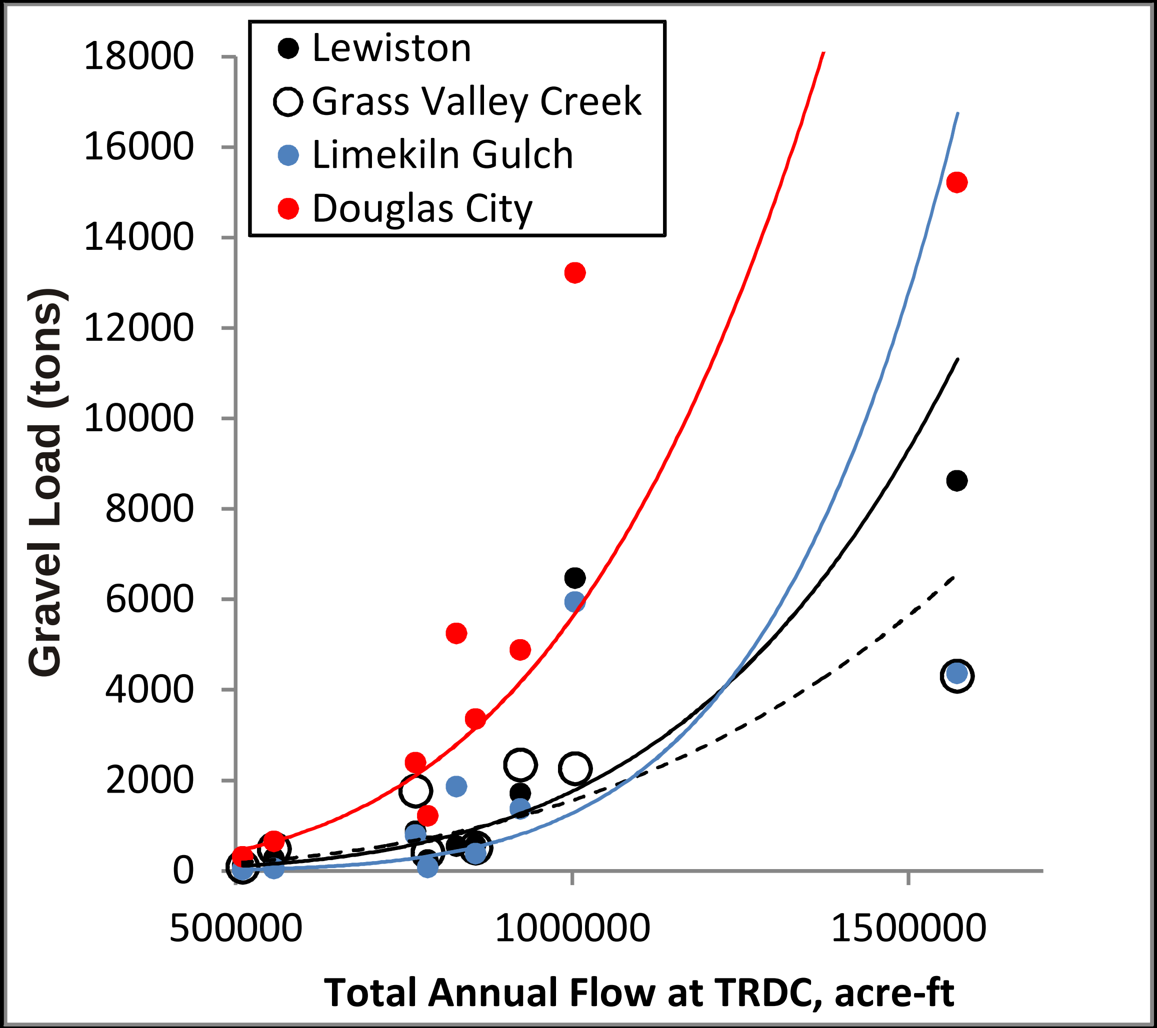


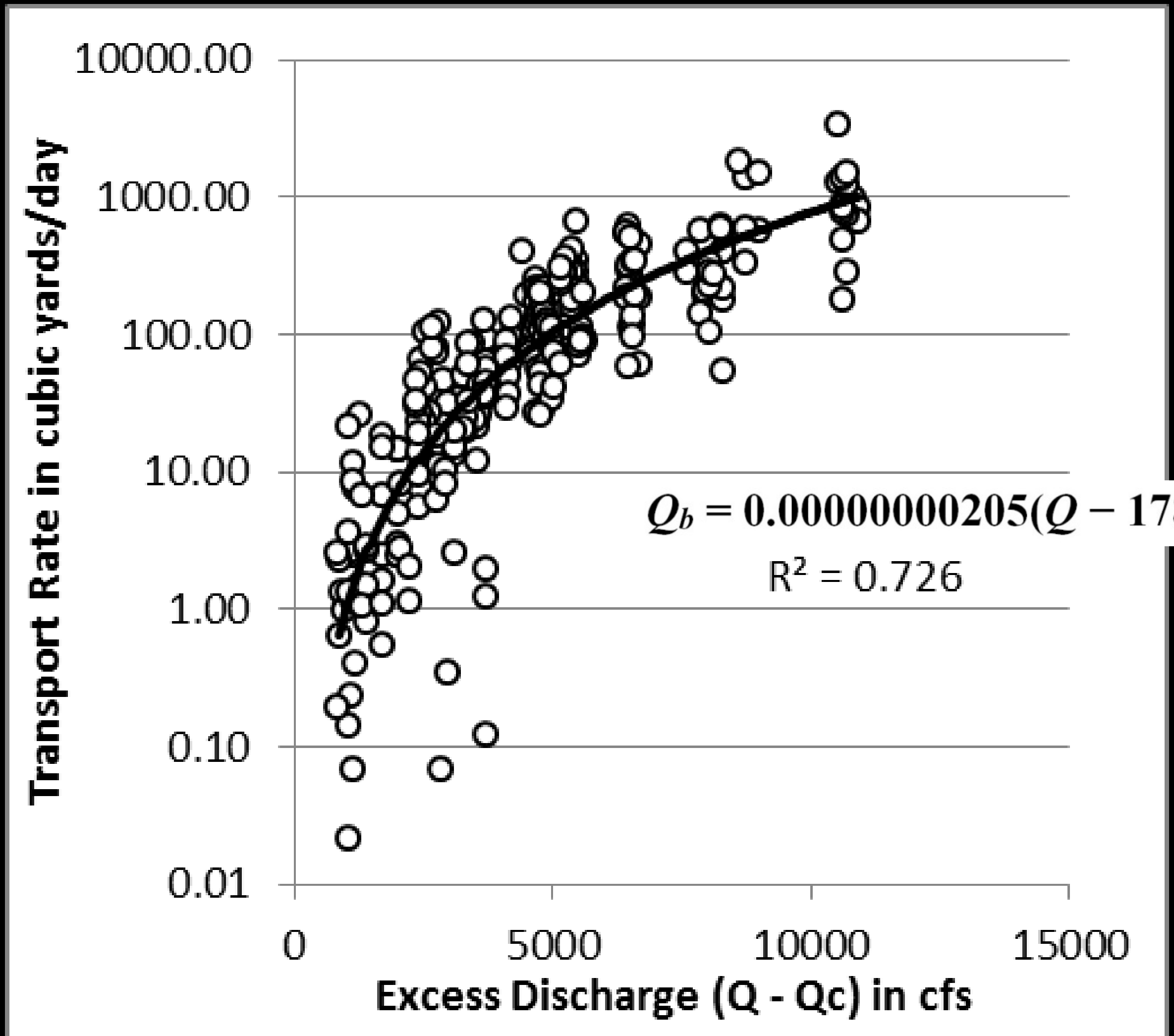
0
250
500
1,000
Feet
N


Long-term Supply Maintenance

Tranport at Douglas City as a reference for upstream reaches





$$q_b = [11.2\ (1 - 0.846(Q_c/Q)^b)^{4.5}]\ /\ [g\ (\rho_s/\rho - 1)/(\tau_r * g(\rho_s - \rho)d(Q/Q_c)^b/\rho)^{1.5}]$$

Most Recent (2014) Recommendations

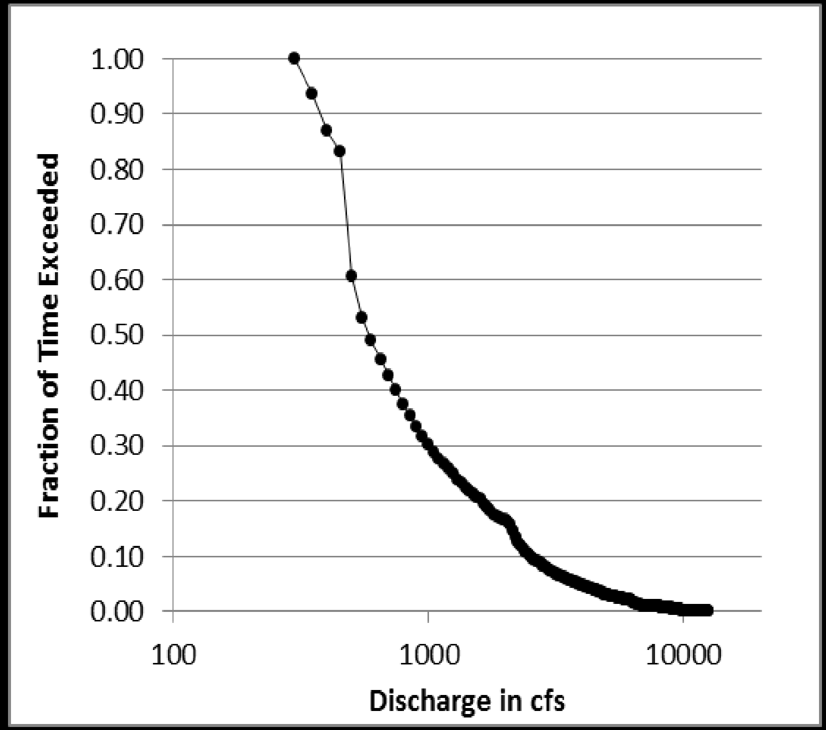


Table 3: Average annual unimpeded coarse sediment loads in yd^3 of bulk sediment in different reaches of the Trinity River as estimated with equation (1) and equation (5).

Analysis	TRDC	TRLG	TRAL
Rating Curve	2040 ± 593 yd^3	1630 ± 473 yd^3	1475 ± 423 yd^3
Calibrated Transport Equation	2930 ± 850 yd^3	2370 ± 687 yd^3	2165 ± 628 yd^3

Most Recent (2014) Recommendations

Table 4: Combined results for average annual unimpeded coarse sediment loads in yd^3 of bulk sediment for TRAL and TRLG, and the final recommended long-term augmentation rate for the reaches upstream from Indian Creek.

Analysis	TRLG	TRAL
Intersection of Equations (1) and (5)	2000 ± 490 yd^3	1820 ± 440 yd^3
Recommended Long-term Augmentation Rate	All reaches upstream from Indian Creek 1910 ± 440 yd^3	

Table 7: Practical target augmentation rates for each water year type (G_i) in yd^3. A_i and f_{Ai} are defined in the text. Values of G_i exceed A_i and so are maximum recommended values for all water year types except extremely wet.

WY Type	f_{Ai}	A_i	G_i
Critically Dry	0	0	0
Dry	0.031	215	670
Normal	0.089	865	1670
Wet	0.393	2695	3000
Extremely Wet	0.487	7690	5000

Define $Z_{WY\ type}$ by $Z_{dry} = 1$, $Z_{normal} = 2$, $Z_{wet} = 3$, $Z_{extremely\ wet} = 4$

Empirical fit to transport capacities of ROD hydrographs:

$$A_i = 69.61e^{1.19\ Z_{WYtype}}$$

$$(r^2 = 0.996)$$

Inverting that relation and replacing A_i with A_H and Z_{WYtype} with Z_H yields:

$$Z_H = ln(A_H/69.61)/1.19$$

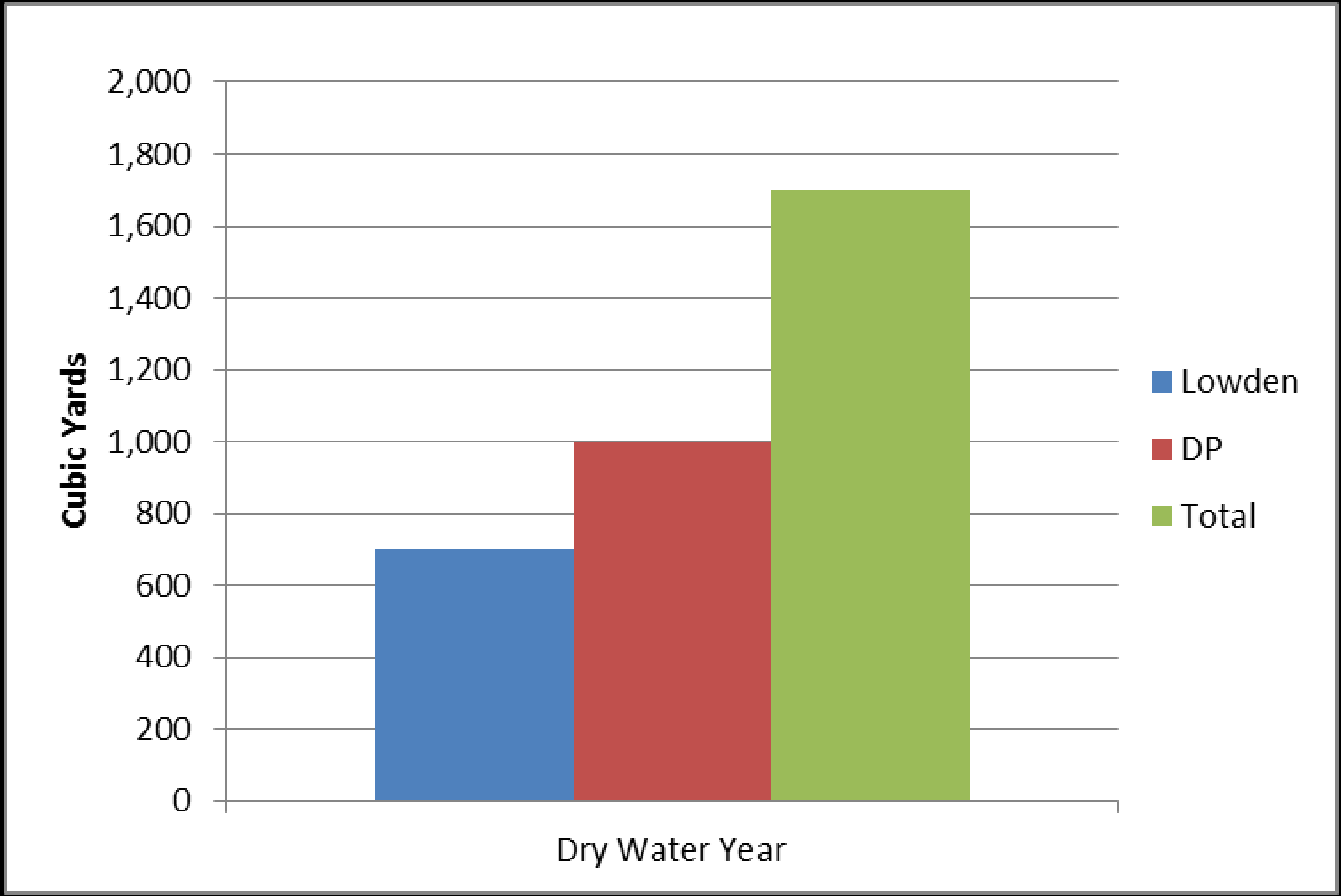
Hydrograph-specific augmentation targets (G_H) are then estimated as:

$$G_H = (Z_H - 1)\,(G_3 - G_2) + G_2; \quad \text{if } Z_H < 2$$

$$G_H = (Z_H - 2)\,(G_4 - G_3) + G_3; \quad \text{if } 2 < Z_H < 3$$

$$G_H = (Z_H - 3)\,(G_5 - G_4) + G_4; \quad \text{if } 3 < Z_H$$

2015 High Flow Gravel Injection



700 yds at Lowden Ranch, 1000 yds at Diversion Pool
1700 yds total

Back to Short-term Gravel Management

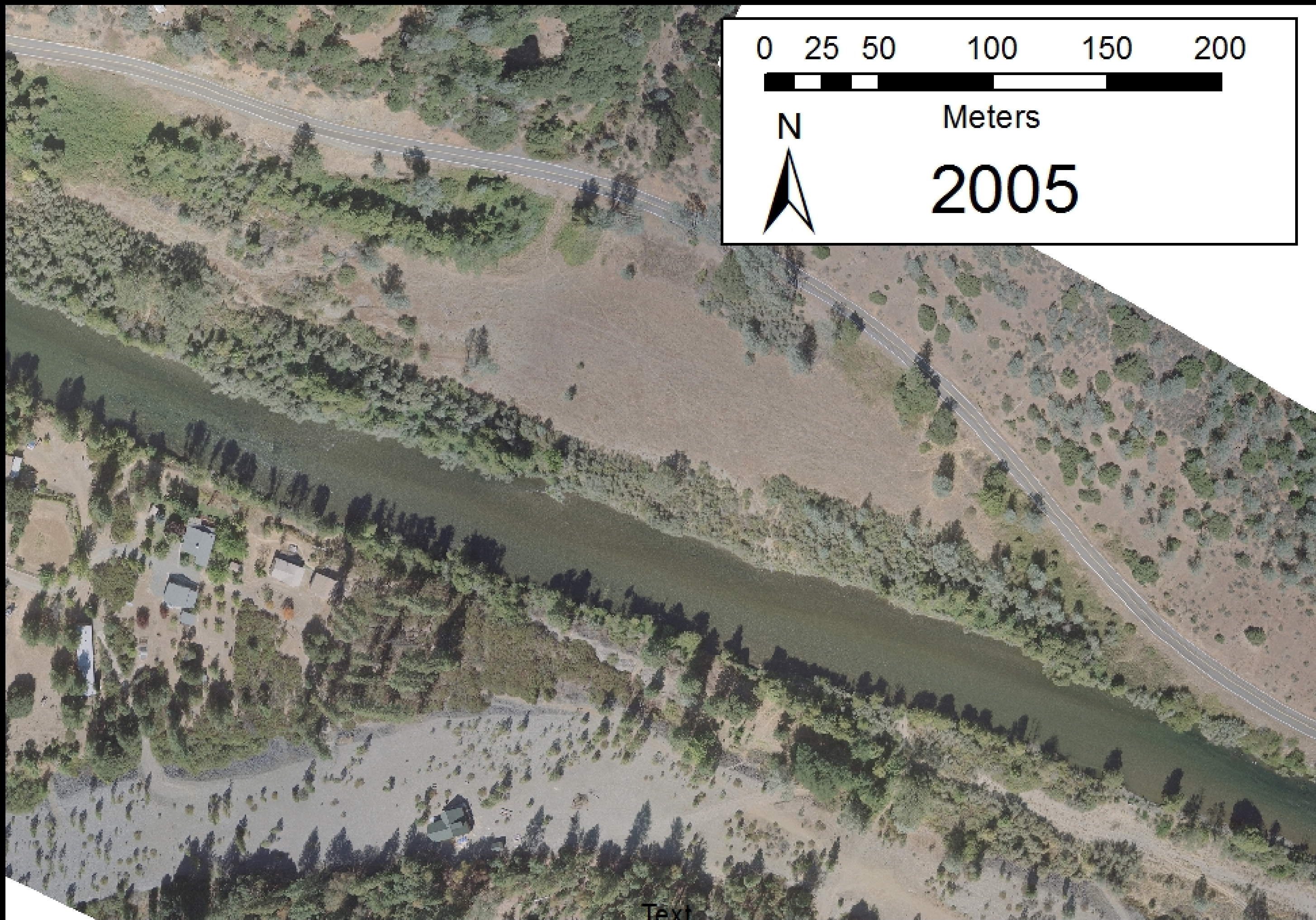
What about the local deficits?

- Gravel may take a long time to reach deficit areas

Gravel Supply is Just One Piece of the Puzzle

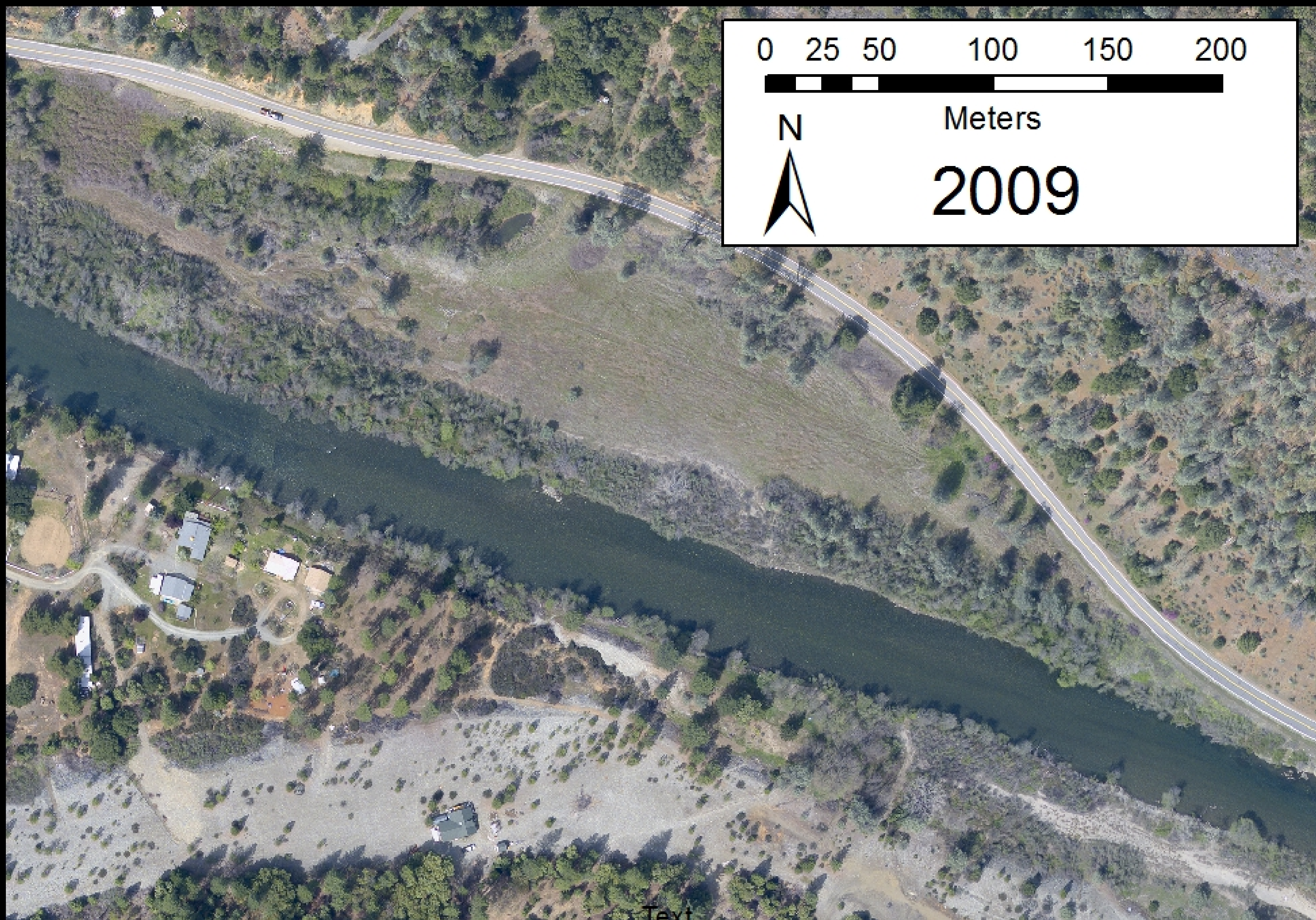
- Gravel alone doesn’t equal good habitat
- Flows and existing geomorphic structure are key

Gravel May Not be Enough



Wheel Gulch, pre-project

Gravel May Not be Enough



Wheel Gulch, pre-project

(2006 peak flow of 815 m^3/s was 2.6 times the maximum fishery flow release)

Gravel May Not be Enough

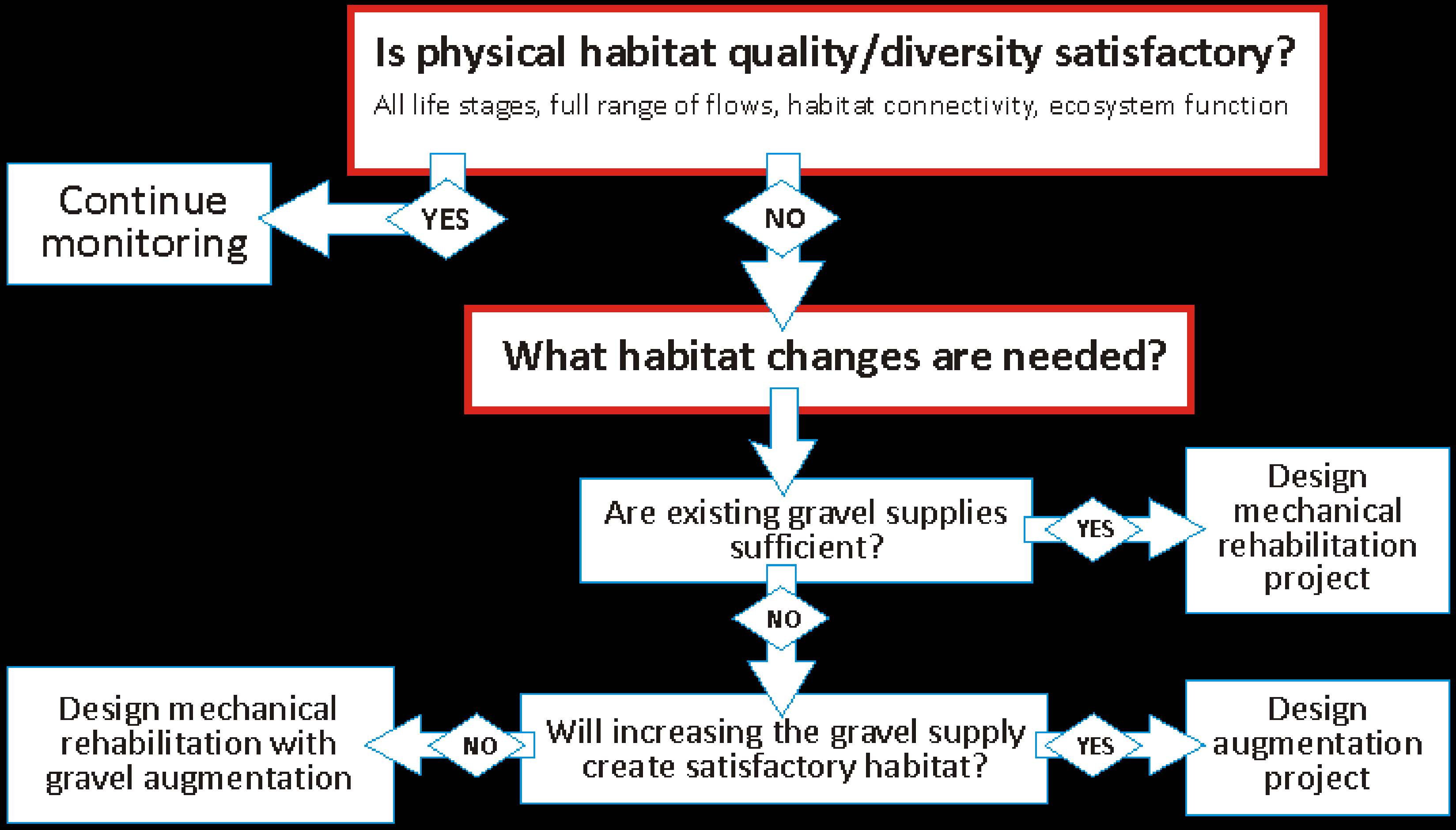
Wheel Gulch
Project near completion

Gravel May Not be Enough

Wheel Gulch

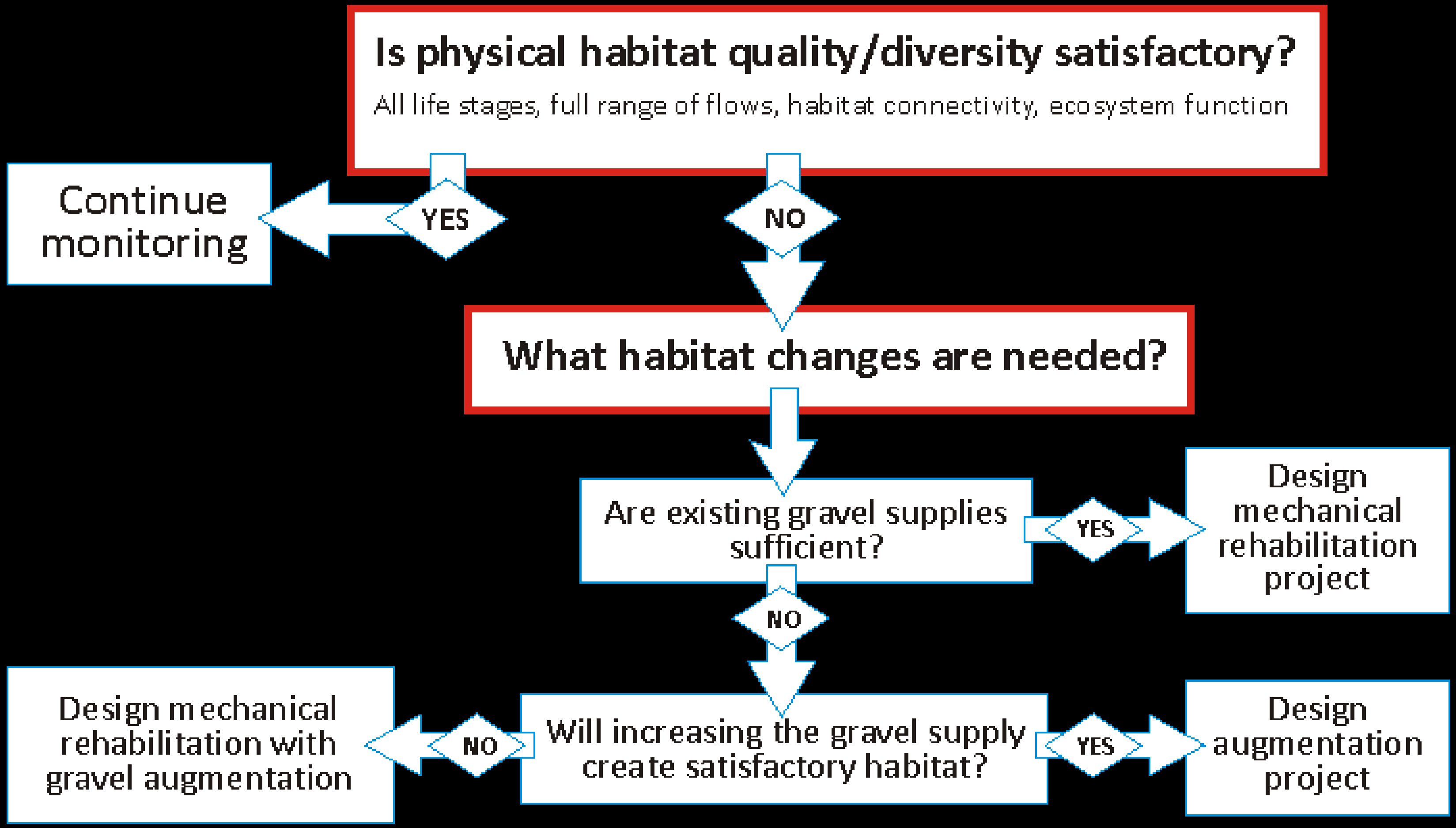
1900 yd^3 gravel deposited during the very next release

Short-term Augmentation
The fundamental questions are biological



Short-term Augmentation

The fundamental questions are biological



This is the 'river corridor' concept