Application of Transport Concepts to Improve Stream Restoration Projects

Paul Bakke
Hydrologist/Geomorphologist
U. S. Fish & Wildlife Service
Dynamic Pavement Concept

- Bed surface particles interchange with moving bedload particles
- Coarsened surface layer acts as a “valve”, regulating the rate of particle entrainment
- Surface coarsening creates an equilibrium between the stream bed and the bedload
The dynamic pavement concept facilitates:

• Interpretation of streambed structure and texture
• Tools for assessing geomorphic context
• New approaches for sediment modeling
• Innovative sediment monitoring techniques
How to interpret bed material

- Surface/subsurface: coarser vs. similar
Surface/subsurface structure

- Lag deposit
- Framework supported
- Matrix supported
- Framework over Matrix subsurf.
- bimodal surface
- Poor armor expression
Bimodal sediment

- Two sources – upstream input & local input; or
- Fine bedload over “immobile” armor
Framework pavement/
Framework subsurface

Framework pavement/
Matrix subsurface
Framework-supported, Armor well developed

- Sediment equilibrium
- Stable channel
- Dynamic pavement (hydraulics/sediment interaction)

Cross section through stream bed
Framework-supported surface over Matrix-supported subsurface

- High sediment load
- High sand content → alters gravel mobility
- Response reach
- Dynamic pavement (hydraulics/sediment interaction)
Poorly-developed surface armoring

- Aggrading (unstable) reach, possibly recovering
- High sediment load
- Dynamic pavement reestablishment
No evident surface coarsening

- Hydraulic forces overwhelmed by high sediment load ("Transport limited")
Lag deposit- Immobile surface (armor)

- Flow regulation has had geomorphic influence
- Debris flow or other disturbance
- “Supply limited” (independent of hydraulics), low sediment load
Surface and subsurface particle size distributions:

• Comparison of surface to subsurface provides information about:
  – Sediment supply rate
  – Vertical stability (e.g. aggradation)
  – Mass wasting (debris flow) history
  – Proximity to sediment source
  – Critical shear stress for streambed mobilization
  – Size distribution of bedload
Ratio of Actual to Potential Bankfull Sediment Transport, $q^*$

Ratio of bankfull bed shear stress to critical shear stress for bedload initiation:
- Shear stress ratio = 1.5
- Shear stress ratio = 2.5
- Shear stress ratio = 4.2

Selected streams using Wilcock & Crowe 2003

Source: Dietrich et al., 1989

- S. Fk. Thornton Creek
- Paradise Creek
- Sycan River
- Annie Creek
- Fivemile Creek
- Cherry Creek

$D_{50s} / D_{50s}$ vs. $q^*$

$D_{50s}$: Surface grain size

$D_{50s}$: Subsurface grain size
Ratio of Actual to Potential Bankfull Sediment Transport, $q^*$

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Source: Dietrich et al., 1989

Ratio of bankfull shear stress to critical shear stress for bedload initiation

$D_{50\text{surface}}/D_{50\text{subsurface}}$
Surface Sediment Classification

Median Surface Sediment Diameter, mm

Streambed sediment measurements

• For analysis –
  – Volumetric samples of surface & subsurface
• For roughness characterizations and channel classifications –
  – Particle counts
• But what about for long-term or extensive monitoring?
Streambed sediment measurements: Moving beyond the Wolman pebble count

Streambed Photography
- Repeatable
- Allows extensive coverage
- Non-destructive sampling
Digital Gravelometer, e.g. Sedimetrics
www.sedimetrics.com
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Interpret!