

A Geomorphic Framework to Nature-Based Shoreline Design Using Driftwood and Cobbles

DAVID REVELL, PH.D., KARA SCHEU, PH.D., ROB WALKER, P.E., INTEGRAL CONSULTING INC.



Challenge

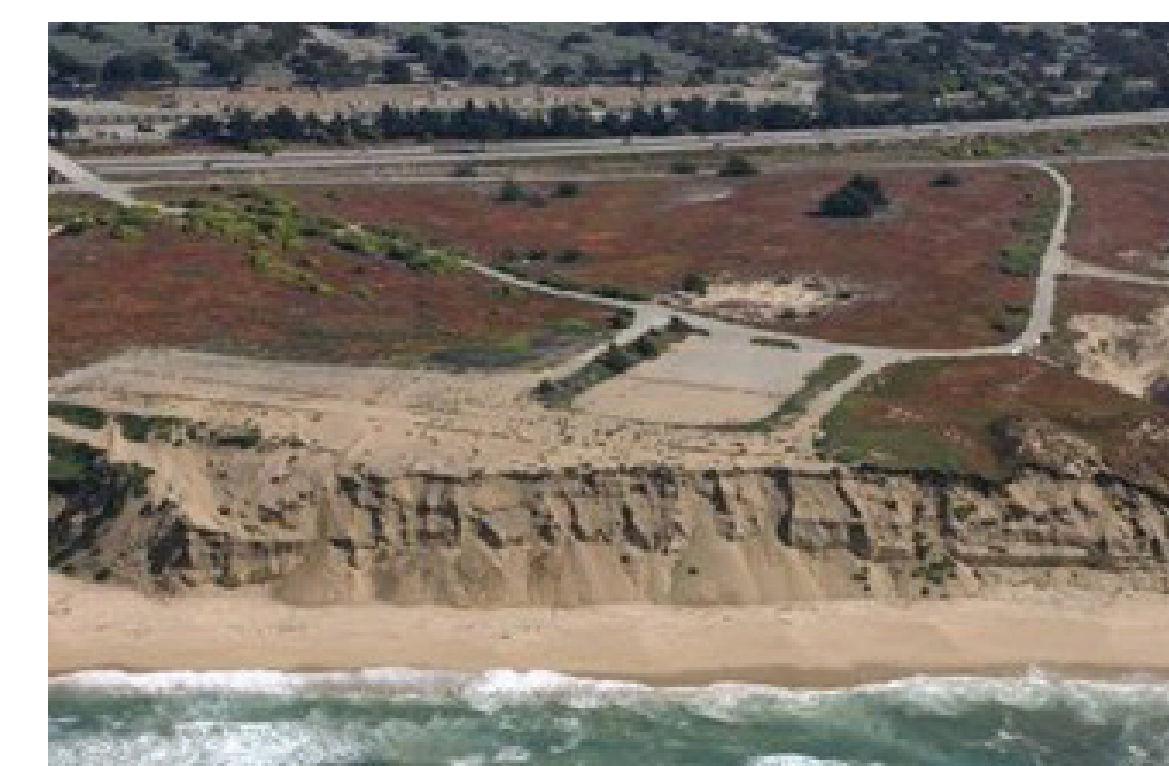
As coastal communities plan for adaptation and ask for nature-based approaches, we have to ask...**what would nature do?**

Coastal engineering has historically leaned heavily on structural solutions (e.g., shoreline armoring) for shoreline protection. This framework builds on that foundation by integrating geomorphic process understanding into design from the start.



Traditional Approach

- Calculate hazard extents as basis of design
- Select structural solution to hold the line
- Apply engineering standards to stop erosion and minimize wave run-up



Geomorphic Approach

- Understand physical processes, geomorphic response, and historic ecology
- Evaluate current functioning of physical processes, remaining native materials, available space, and community risk tolerance and vision/priorities
- **Design with what nature provides, considering how it moves and works with natural processes**

The Geomorphic Framework

What Would Nature Do? Key Questions Before You Design

- 1 HISTORIC ECOLOGY**
How did this ecosystem function before alteration?
- 2 GEOMORPHIC DRIVERS**
What's driving change—waves, water levels, sediments or human activities?
- 3 SEDIMENT DYNAMICS**
What moves, how big, and where does it go?
- 4 LANDSCAPE SHAPES**
What patterns and shapes are created by the drivers?
- 5 NATURAL MATERIALS**
What materials are natural to the system—and what's missing?
- 6 HABITATS**
Is vegetation supporting sensitive species or stabilizing land forms?
- 7 SPACE, CONNECTIVITY, & EVOLUTION**
Is there room for the shoreline to move?
- 8 COMMUNITY & CONSTRAINTS**
How do we balance existing risk to upland development and infrastructure with future exposure, adaptive response, and community vision?

What Nature Provides



Cobbles: dynamic, self-adjusting, energy absorbing, and naturally available along high-energy, steep topography coastlines



Driftwood: structurally complex, dissipative, sediment-trapping, ecologically valuable, and often already onsite



And sometimes: whatever the local coast provides.

Cape Lookout State Park, OR

Proof of Concept—25 Years and Counting

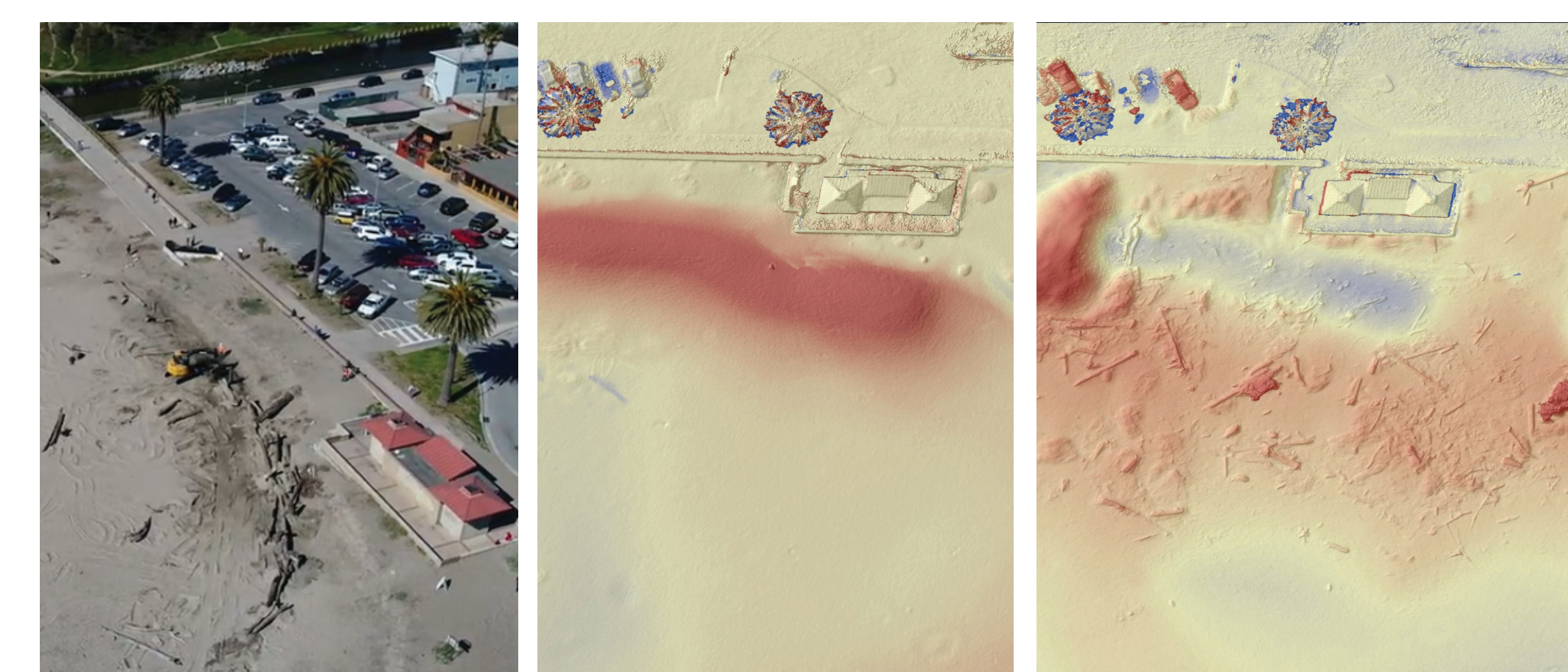


- First high-energy dynamic cobbles berm on the U.S. West Coast (2000)
- Built with relocated cobbles and geotextile-cored dunes for under \$125,000
- Still protecting the site 25 winters later—built partly with prison labor

Protective cobbles had been removed at the head of a rip embayment that created an erosion hotspot. We relocated the cobbles and added a geotextile core to a restored dune system.

Rio Del Mar State Beach, CA

Drift Logs as Structure, Built in 4 Days

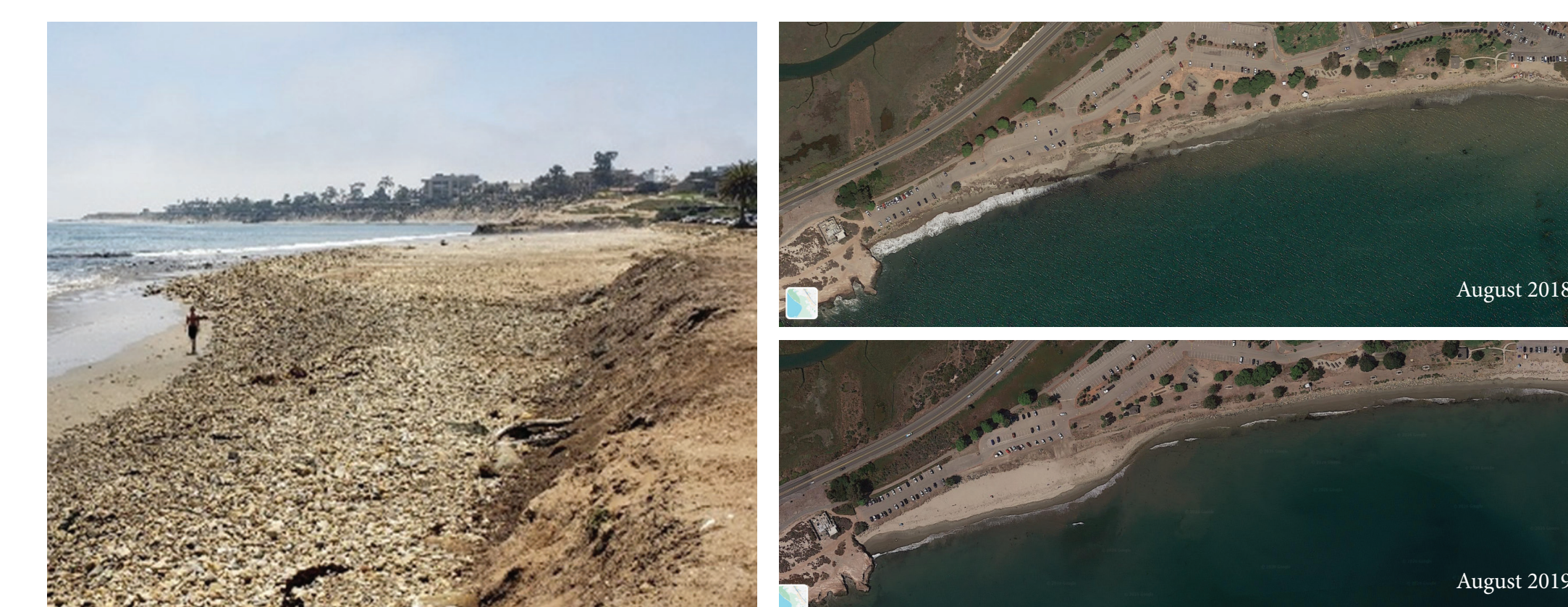


- Emergency response: design and construction completed in ~1 month
- Log structure buried in sand dune; followed historical Aptos Creek meander shape
- Withstood three 50-year storm events that destroyed adjacent state park; 81% public approval in visitor survey

Early 1900s photos showed drift logs and sand dunes along this estuary edge. We placed them in a cross braced pattern along a natural creek meander shape then buried them in sand.

Goleta Beach, CA

Cobble Groin Built from Flood Control Emergency Response

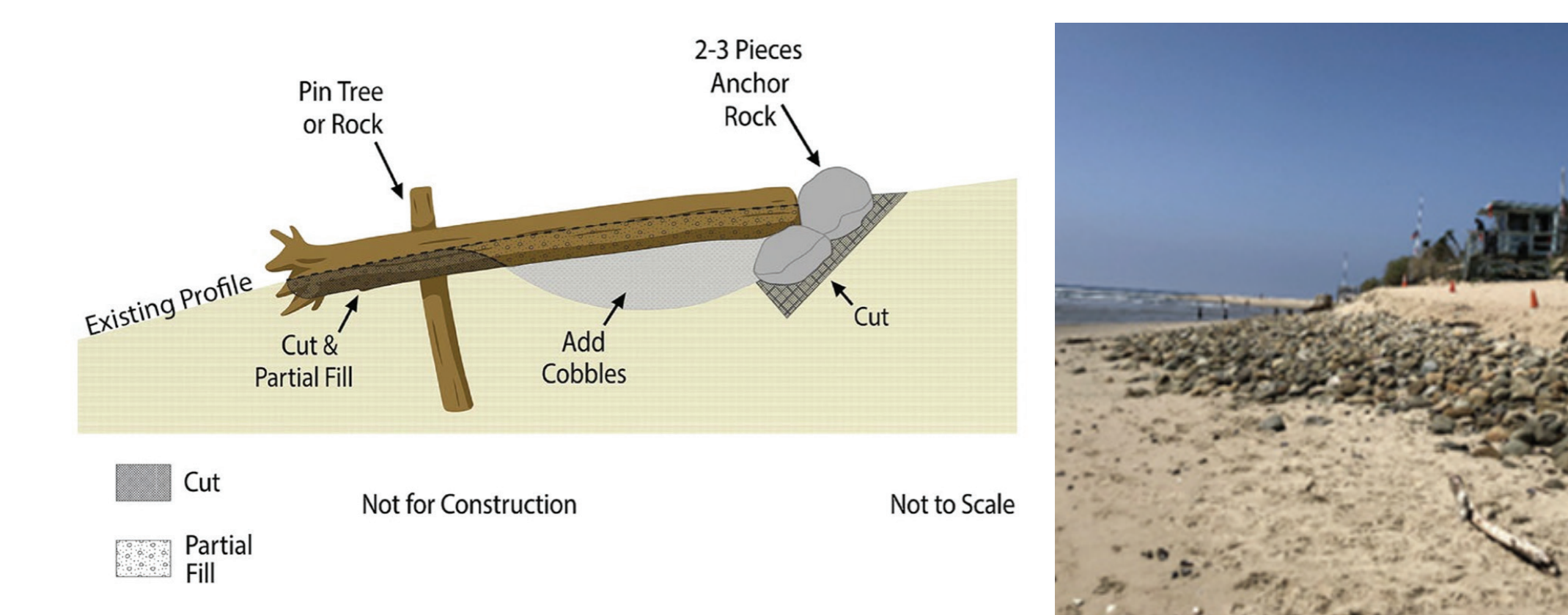


- Emergency response to fire debris flow sediments
- Sediment was placed at a county park that had been engineered with a revetment and lost its beach completely
- Cobble groin impounded sand creating an upcoast beach that gradually moved downcoast restoring natural beach sediment profile

A revetment had replaced the beach. Post-fire sediment was already in the system. The cobble groin redirected it back onto the shore.

Malibu State Beach – Adamson House, CA

Cobble Berms and Log Jams at a Landmark



- Migrating creek scour and wave run-up threaten historic cultural resources including the first historic surf district
- Cross-shore log jams designed to dissipate wave energy and deflect creek flows
- Wave run-up modeling shows composite beach approach outperforms armoring

Creek migration is natural here. We designed with it, not against it.

West Sumatra, Indonesia

Same Approach, Different Continent



- Built in 2 days using palm fronds as filter fabric and coral rubble as base aggregate
- No imported materials—everything sourced from the local coastal system by hand
- Demonstrates that the geomorphic approach can scale globally

Ask what the coast already provides. Here, it was palm fronds and rubble. The questions were the same, the approach was different due to the processes and native materials.

What These Projects Share

- Start with geomorphic observation, not an engineered catalog of solutions
- Use materials already present in or native to the system
- Cost less than traditional armoring
- Leave room for the system to move and adapt
- Preserve coastal access, native habitats, and recreation that protects economic vitality of our coastal communities.

The Big Idea

Natural coastlines have evolved over geologic time responding to physical processes with native materials. The physical processes driving geomorphic change create predictive shapes with native materials. Geomorphic observation and understanding of transport processes should guide engineering approaches to produce more resilient, cost-effective, and permissible shoreline solutions.

Contact

David Revell, Ph.D.
Principal Geomorphologist
Integral Consulting Inc.
(831)-576-2884

