A RESTORATION APPROACH FOR THE LOWER ELK RIVER

North Coast Regional Water Quality Control Board
Redwood Community Action Agency
Northern Hydrology and Engineering
Stillwater Sciences

Project Need

Elk River included on California's 303(d) impaired waters list in 1998 due to excessive sedimentation.

- ***Improve Fisheries Habitat:***
  - Salmonid growth and survival: suspended sediment exceeds acceptable thresholds
  - Spawning habitat: Fine sediment deposition has reduced quantity and quality
  - Rearing habitat: Impaired by channel simplification
- ***Improve Water Quality:*** high suspended sediment concentrations
- ***Reduce Nuisance Flooding:*** sedimentation has reduced channel conveyance capacity and increasing the frequency and magnitude of flooding.

A Restoration Strategy For The Elk River

Develop collaborative, scientifically-based restoration strategy composed of a set of actions designed to hasten recovery of beneficial uses of water and related aquatic ecosystem functions.

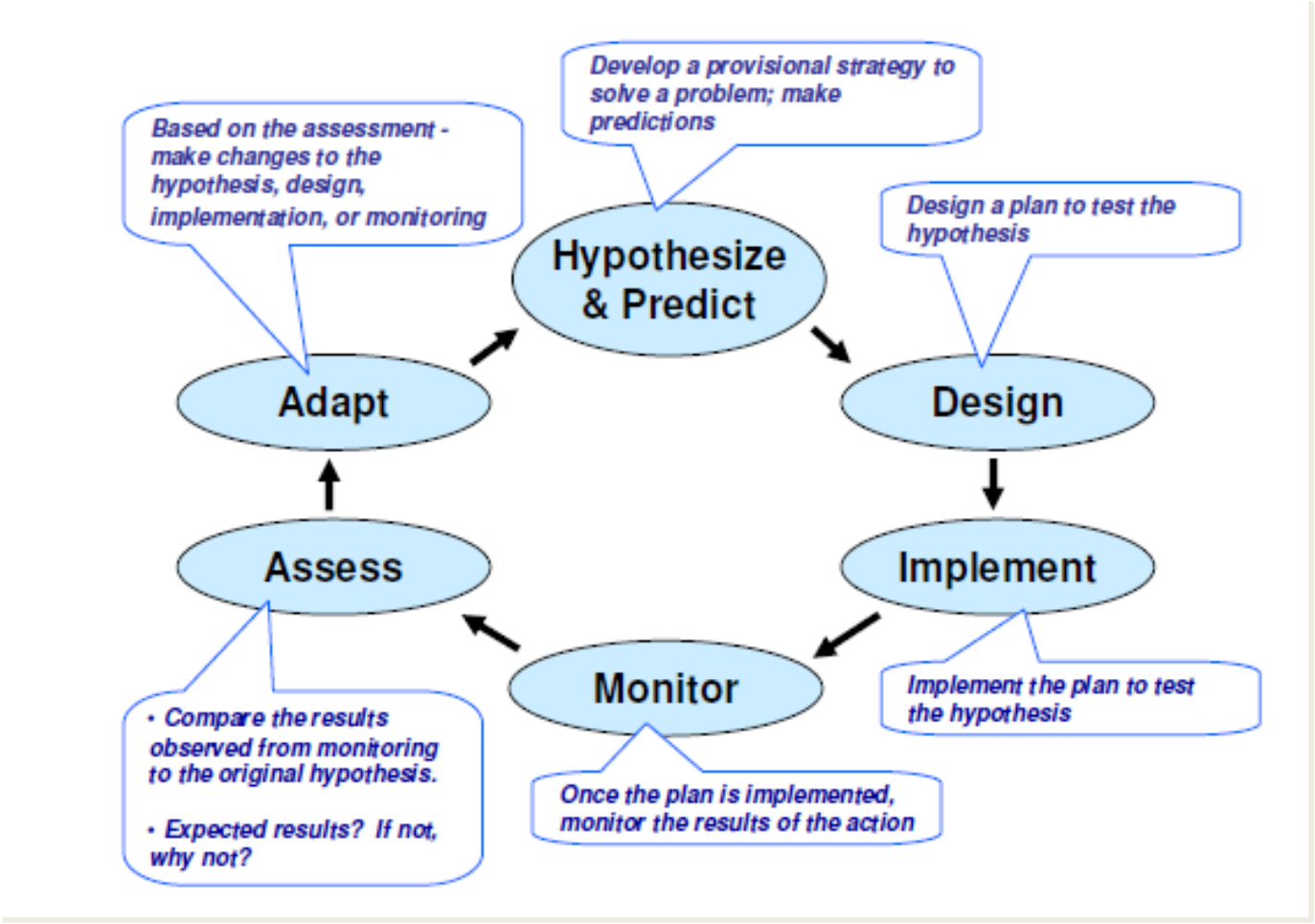
Collaborative:

Scientists, landowners, and stakeholders

Scientifically-based:

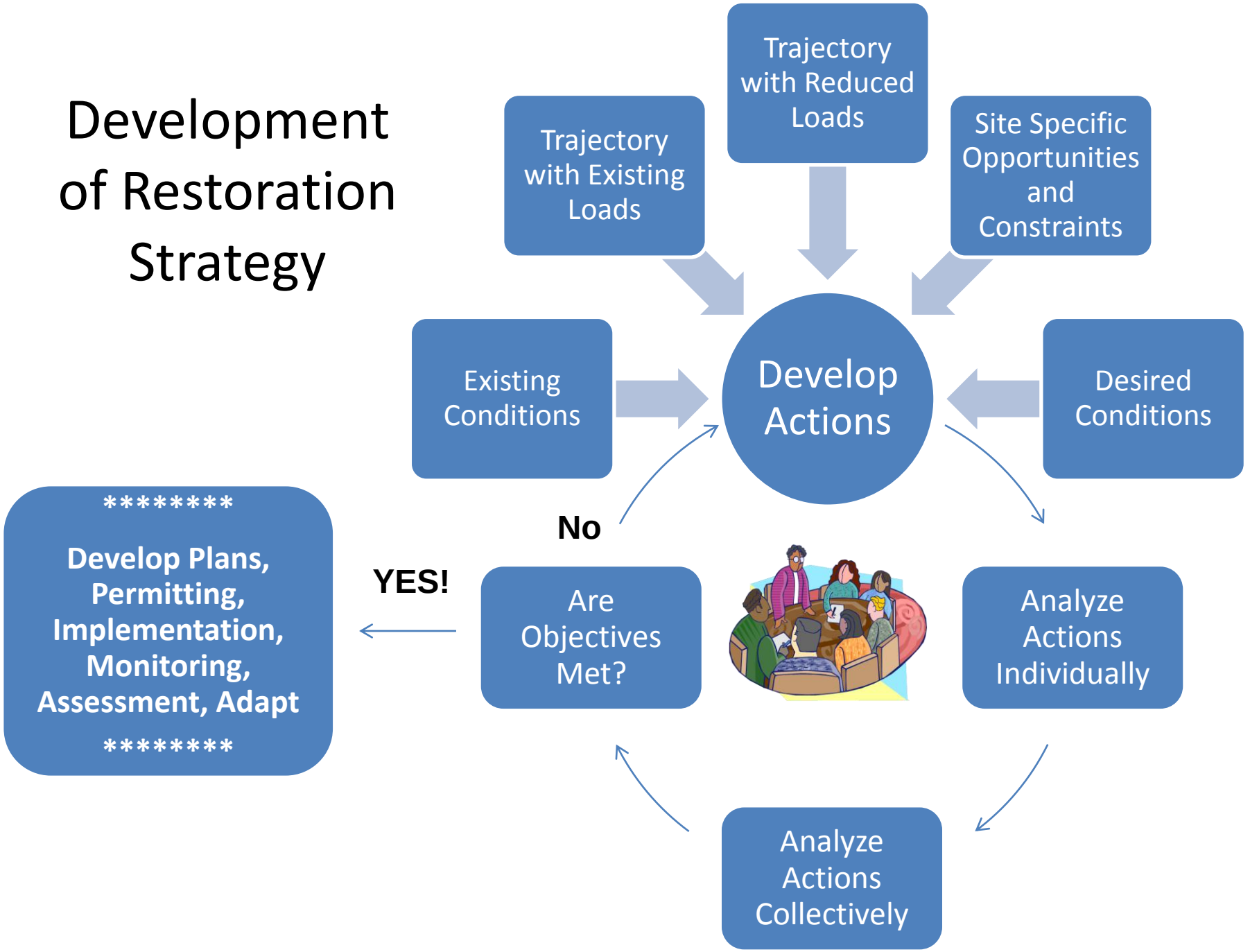
- Based upon current understanding of driving forces in the physical and biological environment.
- Utilizes predictive tools and empirical data to test hypotheses about future trajectories of sedimentation and potential benefits/impacts of restoration actions with a focus on fisheries, water quality and nuisance flooding.
- Peer review

Overview of Restoration Process



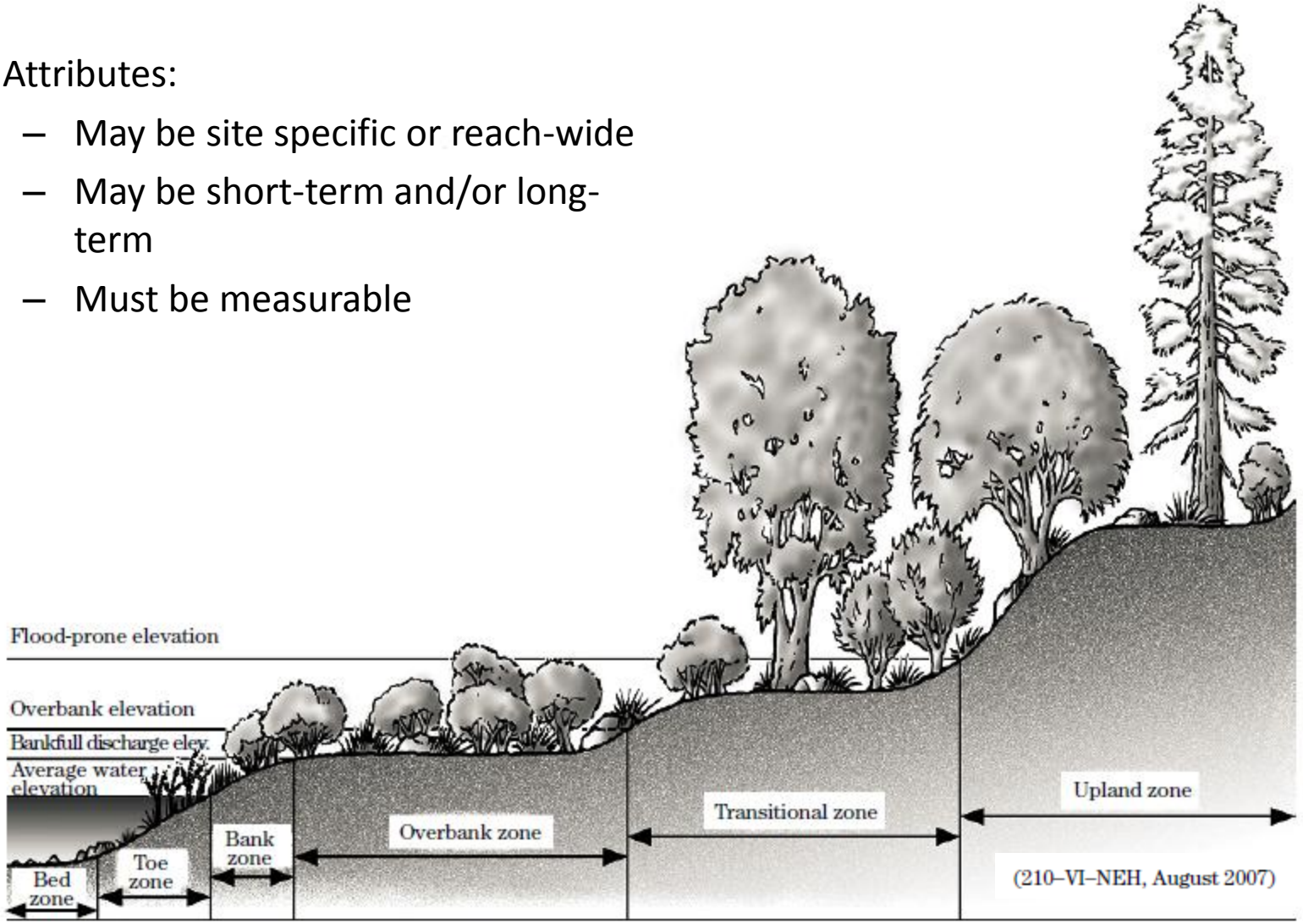
Source: TRRP & ESSA (2009)

Development of Restoration Strategy



Develop Desired Conditions

- Attributes:
  - May be site specific or reach-wide
  - May be short-term and/or long-term
  - Must be measurable



Existing Conditions

- Provides a hydrologic , geomorphic and biological context for evaluating sediment dynamics, flood hazard, and ecosystem degradation.
- Aids the selection of suitable actions for specific locations.
- Provides site specific information necessary to design, analyze and implement actions.
- Data sets can be used to develop and test predictive tools.

Existing Conditions

- **Detailed mapping of the reach:**
  - Topography
  - Stored sediment and bank characteristics (grain size, stratigraphy, stability)
  - Location of constrictions and in-channel roughness elements (i.e. wood, sediment, vegetation)
  - Vegetation patterns
  - Infrastructure (roads, bridges, buildings, water systems, etc.)
  - Aquatic habitat and use
- **Hydraulic and Sediment Data:**
  - Stream flow (especially high flow measurements)
  - Water surface elevation (especially high flows)
  - Sediment supply (concentration, particle size)

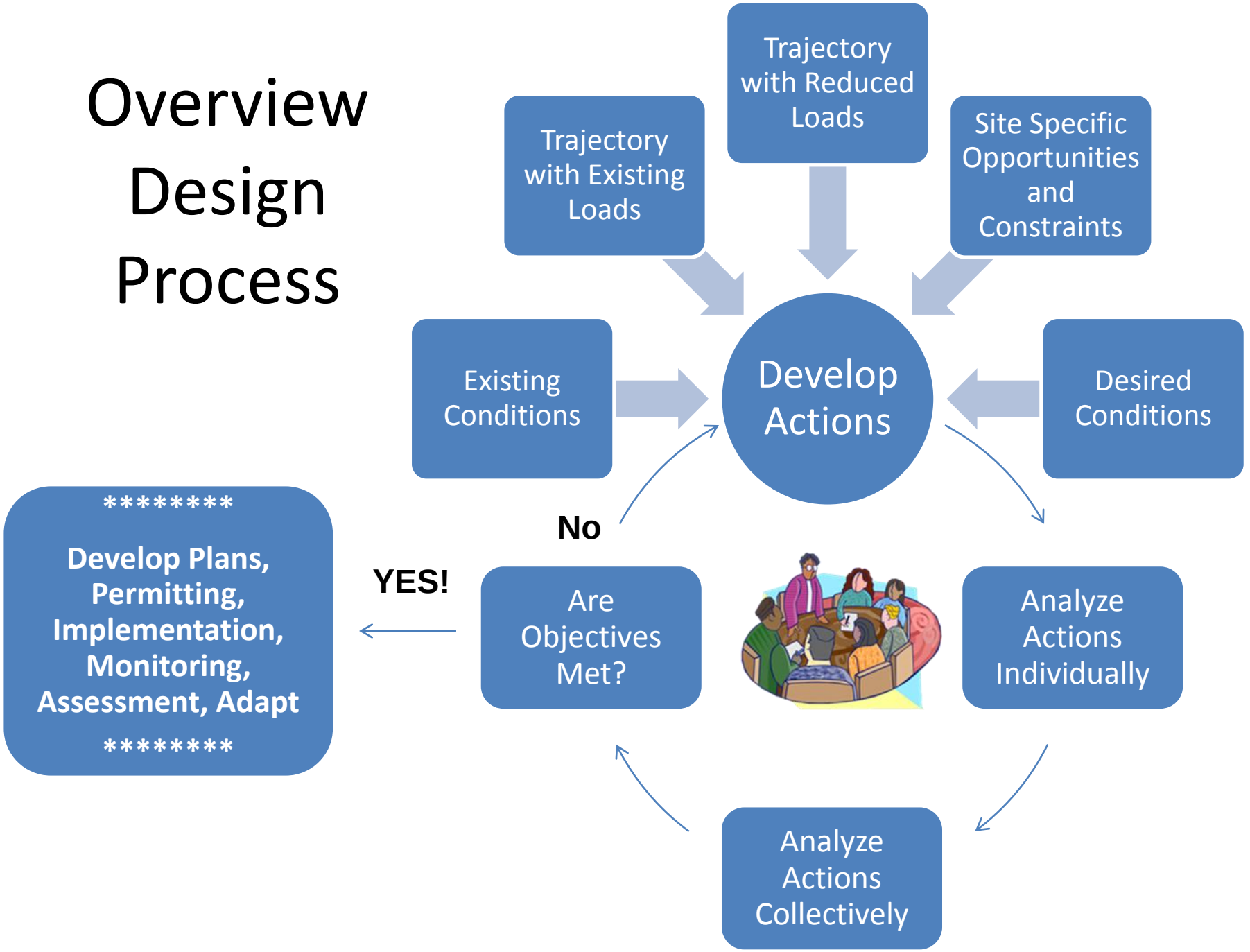
Trajectories

- **Trajectories - With and Without Reduced Sediment Loads**
  - What are the spatial patterns and potential magnitudes of future impairment or recovery? (beneficial uses and ecosystem function)
  - Help select appropriate restoration actions.
- **What Are the Roles of These Potential Impediments to Recovery**
  - Existing sediment deposits will be an on-going source of fine sediments
  - Anchoring of fine sediments by vegetation encroachment
  - Channel or floodplain obstructions

Site Specific Opportunities and Constraints

- Landowner participation: account for specific land uses, buildings, infrastructure, roads, access needs, etc.
- Existing Conditions: Physical and biological characteristics of the site
- Consideration of potential impairment and recovery trajectories.

Overview Design Process

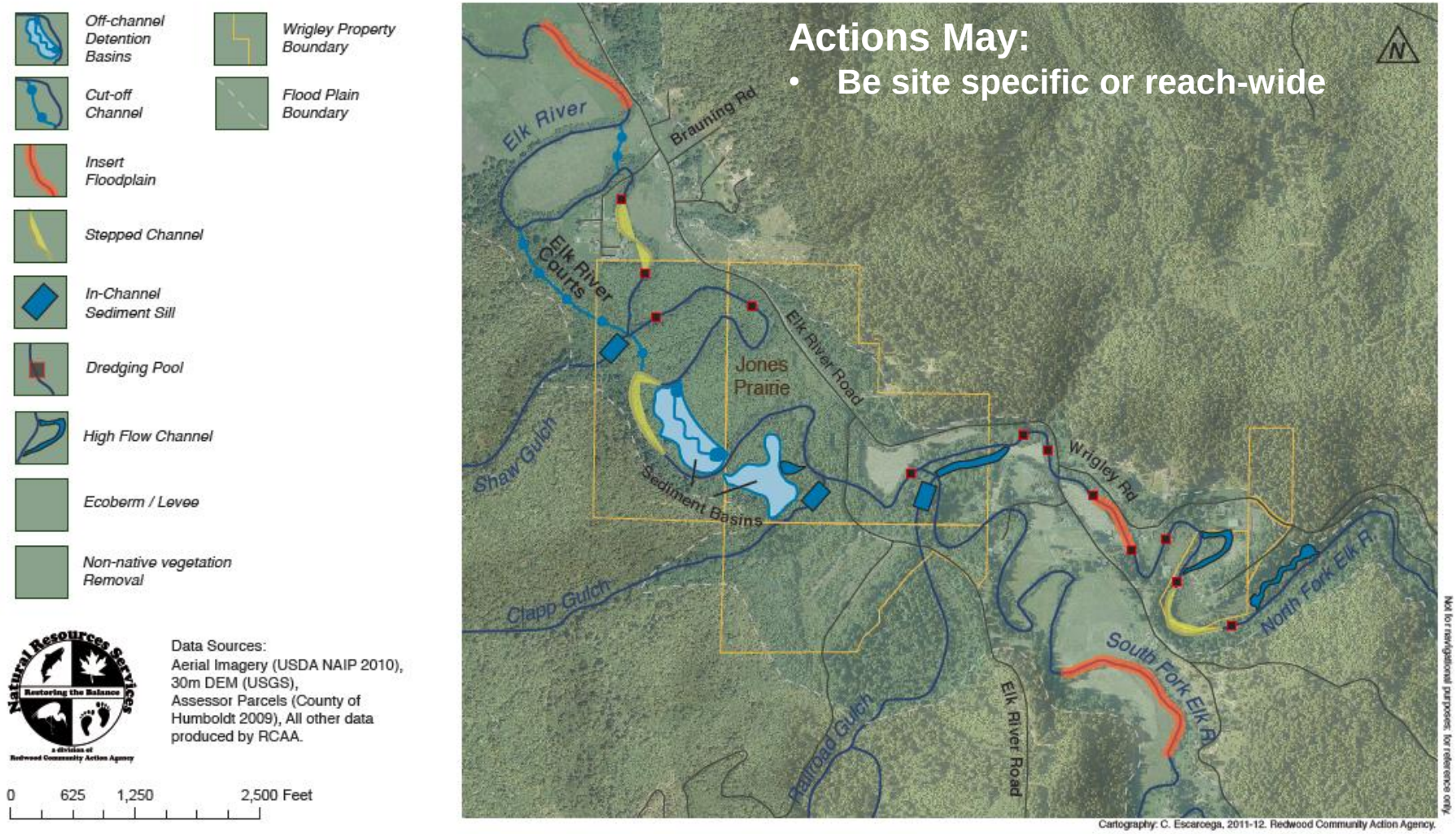


Summary of Proposed Actions

- Dredging
- New channel construction
- Off-channel detention basin
- Levee building, removal or set-back
- Vegetation management
- Infrastructure improvements
- Creation of inset floodplains
- High flow channels
- Placement of in-stream large woody debris

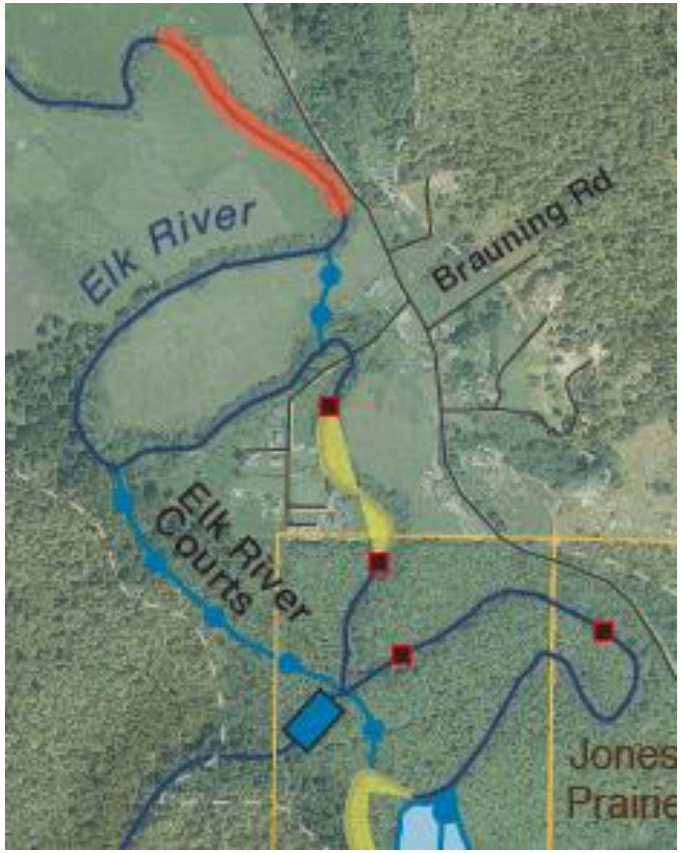
Various Sources: Landowners, RCAA & Humboldt Watersheds Independent Scientific Review Panel (2003)

Potential Actions Developed by RCAA With Landowners in a Selected Area



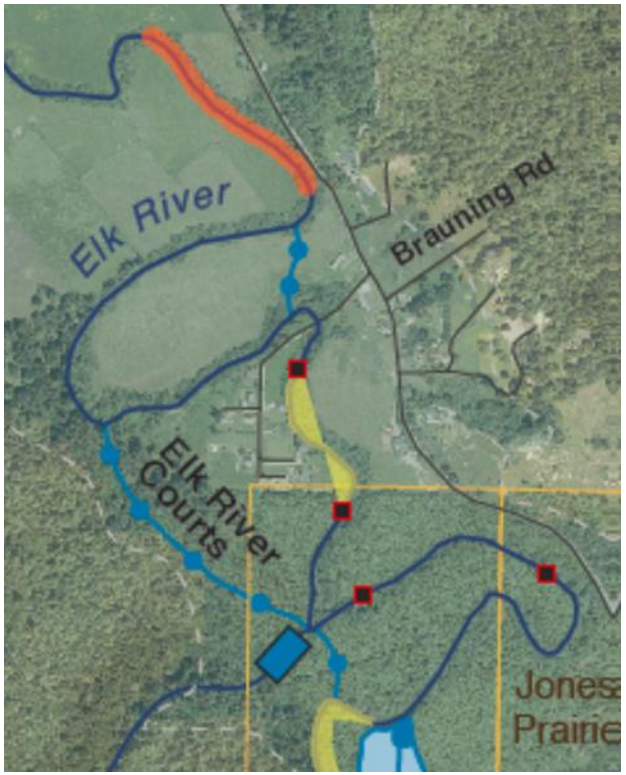
Describe and Analyze Proposed Actions

- Site Specific
  - Short-term, mid-term, long-term benefits and impacts at the site of implementation
  - Life-span of individual action
  - Maintenance requirements
- Upstream and downstream benefits or impacts
- Effects through Time
  - Enhance or impede long-term recovery
  - Response with no reduction in load
  - Response with a reduction in load
  - Response with climate change projections



Evaluating Actions

- Predictions based on:
  - Logical reasoning
  - Empirical evidence
  - Physical models
  - Numerical models



Can Models Be Used To Inform Load Reductions and Evaluate Actions on the Elk River?

- Can the mainstem Elk River recover desired conditions with load reductions? *Some desired conditions can be reasonably predicted, others can not.*
- If load reductions are insufficient, what addition actions may be required to achieve desired conditions?
- Where is the system likely to start recovering first?
- Which areas are likely to have the most persistent impairment?

General Limitations

- Models are simplifications of reality.
- System must be described numerically (data inputs must be high quality).
- Models can not be truly predictive in the sense that we do not know the future magnitude and sequence of storm and sediment loads.
- Require calibration in order provide confidence in results.
- Computational resources and time.

The Process of Modeling

- Establish the purpose of the modeling study.
- Determine the critical processes that need to be represented.
- Select or develop an appropriate model.
- Develop input data sets and boundary conditions from field data.
- Calibrate the model to reproduce a set of field observations.
- Verify the model using an independent field data set.
- Prediction for some future set of conditions.
- Evaluation of the prediction some time after the modeling study.

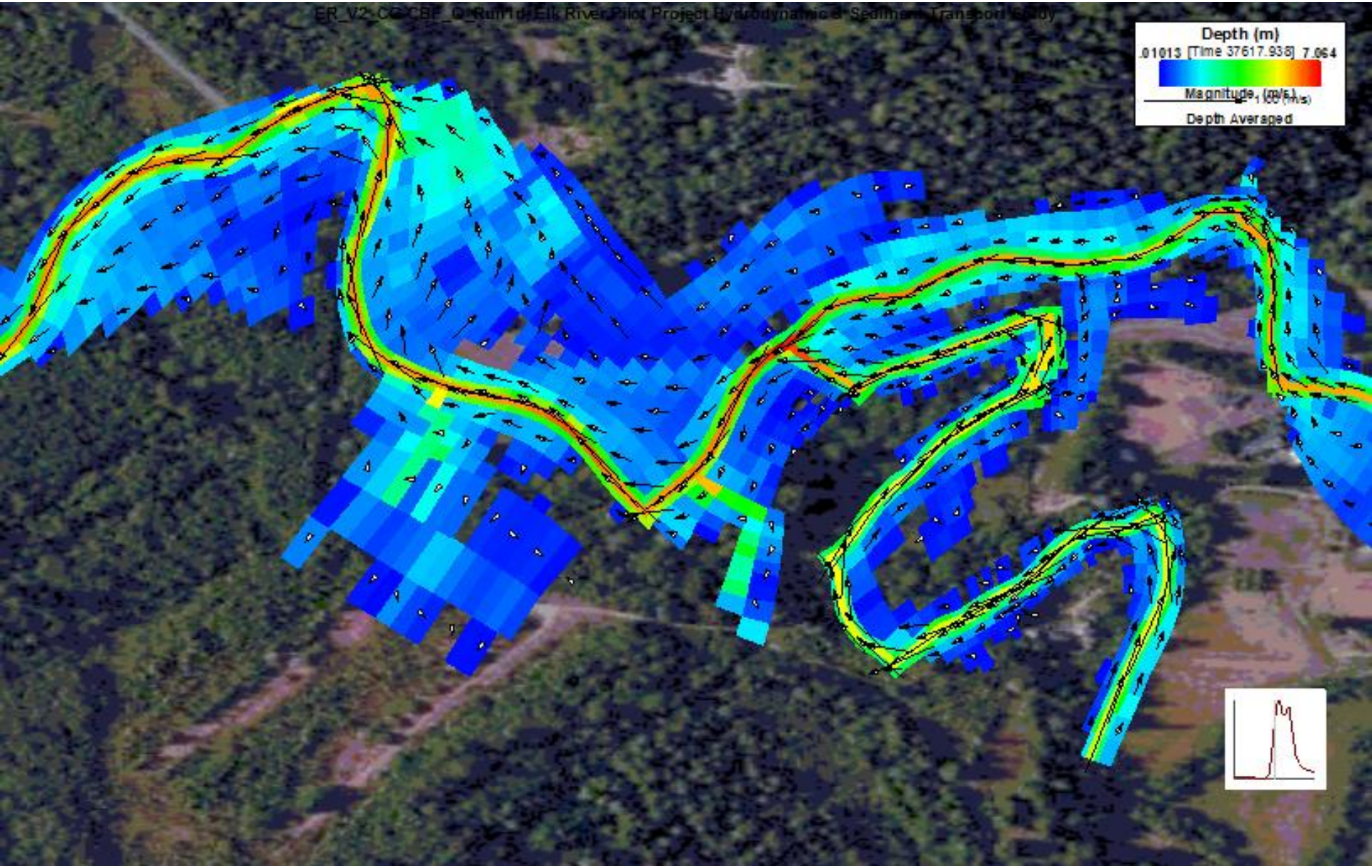
What Kind of Model Do We Need?

- 1D, 2D, 3D?
- Scale
  - Length: 17+ km
  - Narrow channel, wide floodplain
- Hydrodynamics
  - Accurately characterize flow in channel and across floodplains
  - Variable roughness (grain size, vegetation, log jams)
  - Handle tidal boundary conditions
  - Handle infrastructure (bridges, roads, etc.)
  - Tributary inflows
  - Unsteady (i.e. can route a hydrograph)
- Sediment Transport
  - Suspended and bedload transport
  - Variable grain sizes in the channel bed (longitudinally and vertically)
  - Designate erodible and non-erodible areas

Options?

- 1D:
  - EFDC, HEC-RAS (public domain), DREAM-1, TUGS, Mike-11 (proprietary)
  - Limitation: difficult to model complex flow patterns and transport at tributary junctions and across floodplain in the highly sinuous reach.
  - Benefits: computationally faster, some bed material routines are more technically sound (TUGS), many can handle in-stream structures.

- 2D/3D:
  - EFDC, IRIC (Public Domain), Delft3D & Mike 21 (proprietary)
  - Limitations: computationally slower, often don't contain algorithms for in-stream structures
  - Benefits: can model complex flow patterns in channels and across floodplains.


ER_V2_CC_CBF_Q_Run1d_Elk River Pilot Project Hydrodynamic & Sediment Transport Study
Depth (m)
.01013 [Time 37617.938] 7.064
Magnitude (m/s)
1.00 (m/s)
Depth Averaged

General Data Requirements

- **Boundary Conditions**
  - Stream flow, sediment concentration and particle size, water surface elevation
- **Throughout Model Domain**
  - Topography
  - Sediment (channel, banks, floodplain): stratigraphy, particle size, bulk density
  - Location of constrictions and in-channel roughness elements (i.e. wood, sediment, vegetation)
  - Vegetation (roughness or specific stand attributes)
  - Infrastructure (roads, bridges, buildings, water systems, etc.)
- **Calibration Data**
  - Water surface elevation
  - Velocity
  - Bed elevation changes through time
  - Grain size changes through time

Anticipated Results

- Quantitative characterization of existing conditions.
- Trajectories (spatial and temporal) with and without load reductions and with and without restoration actions in lower Elk River.
- Stakeholder consensus for restoration that includes:
  - Overview of restoration strategy
  - Descriptions of restoration actions
  - Prioritization and phasing of restoration actions
  - Planning level cost estimate for implementation of restoration strategy
  - Roadmap for permitting implementation of restoration strategy