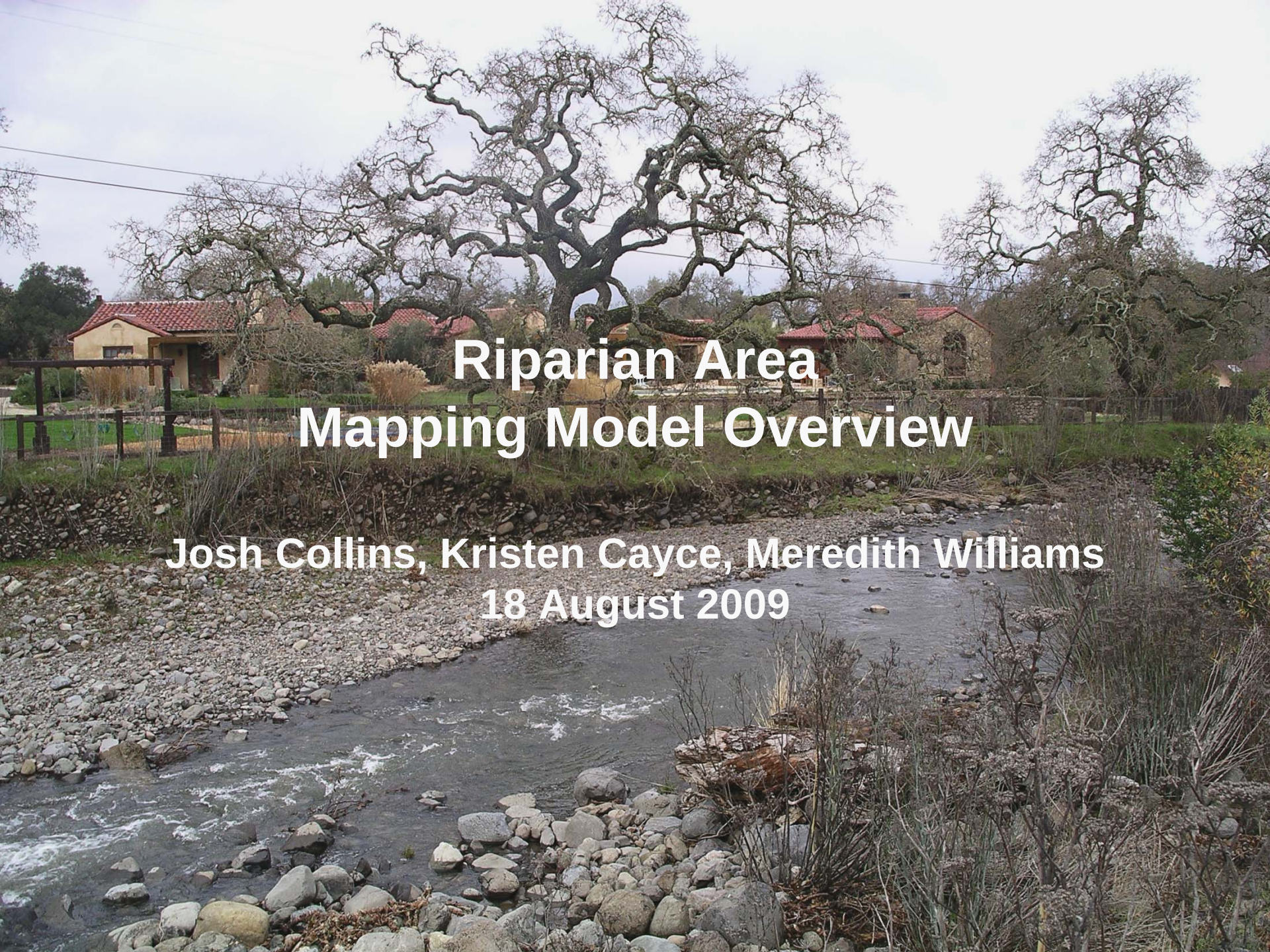


Riparian Area Mapping Model Overview

Josh Collins, Kristen Cayce, Meredith Williams

18 August 2009

RB2 Wetlands Regional Monitoring Effort (WRMP)

Wetlands Assessment Framework

- 3-year Prop 50 Coastal NPS project
- Region 2 demonstration of statewide monitoring and assessment tools
- Tools will be available to others to support statewide monitoring needs
- Cost-effective methods that are widely useable

Ultimate goal is to know where the wetlands are and how they are doing

WRMP Landscape-level tools:

Map-based inventories and landscape analysis

- Bay Area Base Map of Streams, Wetlands and Riparian features
  - Mapping methods standardized. Standards reviewed for compatibility with NWI and NHD.
  - Extensive classification of mapped features

Number of Features in Sonoma Quad example:			
	NWI	NHD	WRMP
Streams	191	472	3,209
Wetland Polygons	211	166	2,691
Riparian Polygons	0	n/a	3,279
Total	402	638	9,179

  - Stream Order and Stream flow direction
  - Based on 2005 NAIP imagery
  - Riparian model *Our focus today*

- Wetland Tracker for tracking projects and habitat (www.wetlandtracker.org)

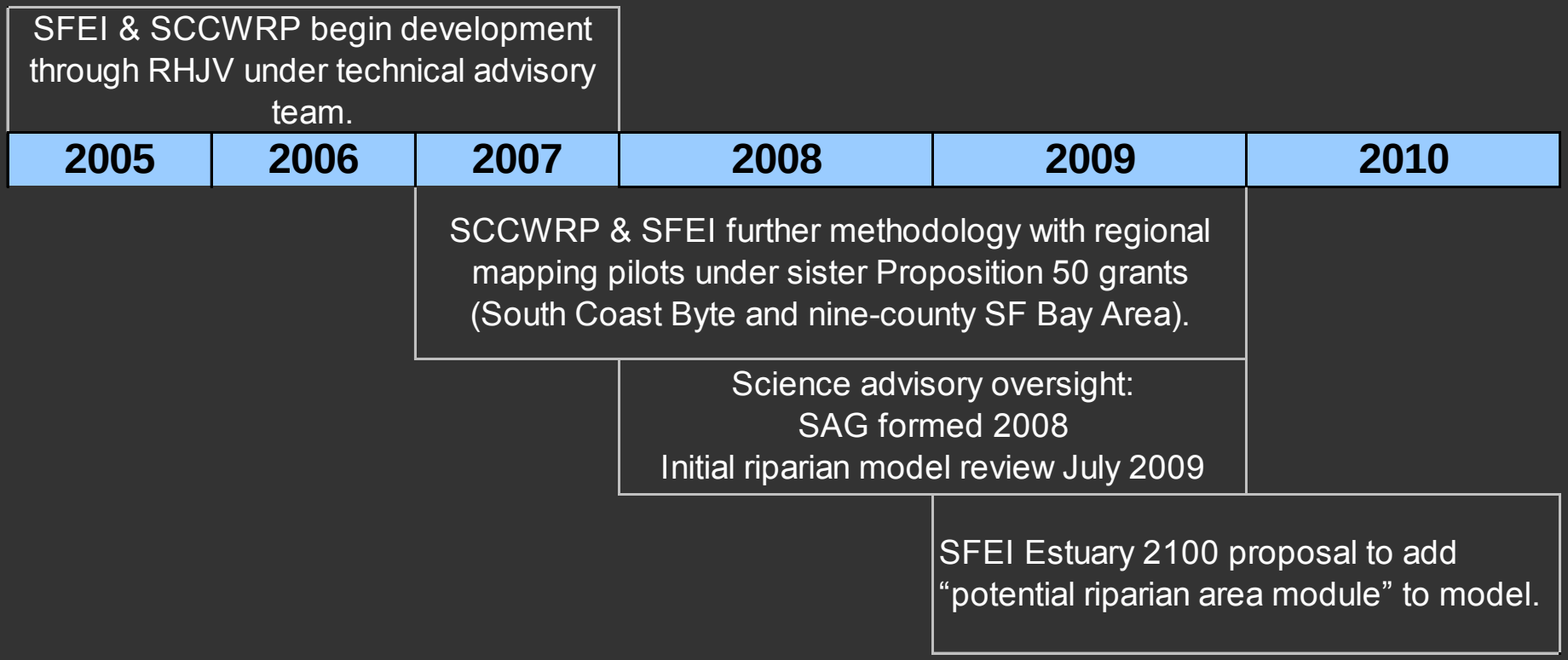
Riparian Areas

"They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems."

- National Research Council

- *Original model was developed to capture riparian extent as defined by the NRC*
- *Not intended to replace on-the-ground empirical evaluations*

Riparian Model Developmental History



Relationship Between Riparian Definitions and Modeling Approach

- *Riparian Buffer:* amount of riparian area needed to protect adjoining waterbody.
- *Functional Riparian Width:* amount of riparian area needed to provide a *high level* of a *selected* riparian function; is function-specific.
- *Full Functional Width:* amount of riparian area needed to provide *high levels* of *all* intrinsic functions; equals "riparian area" or "riparian ecosystem;" can vary with land use, vegetation type, waterbody type, hydrology, and geology (including topography and soil).

Relationship Between Riparian Definitions and Modeling Approach

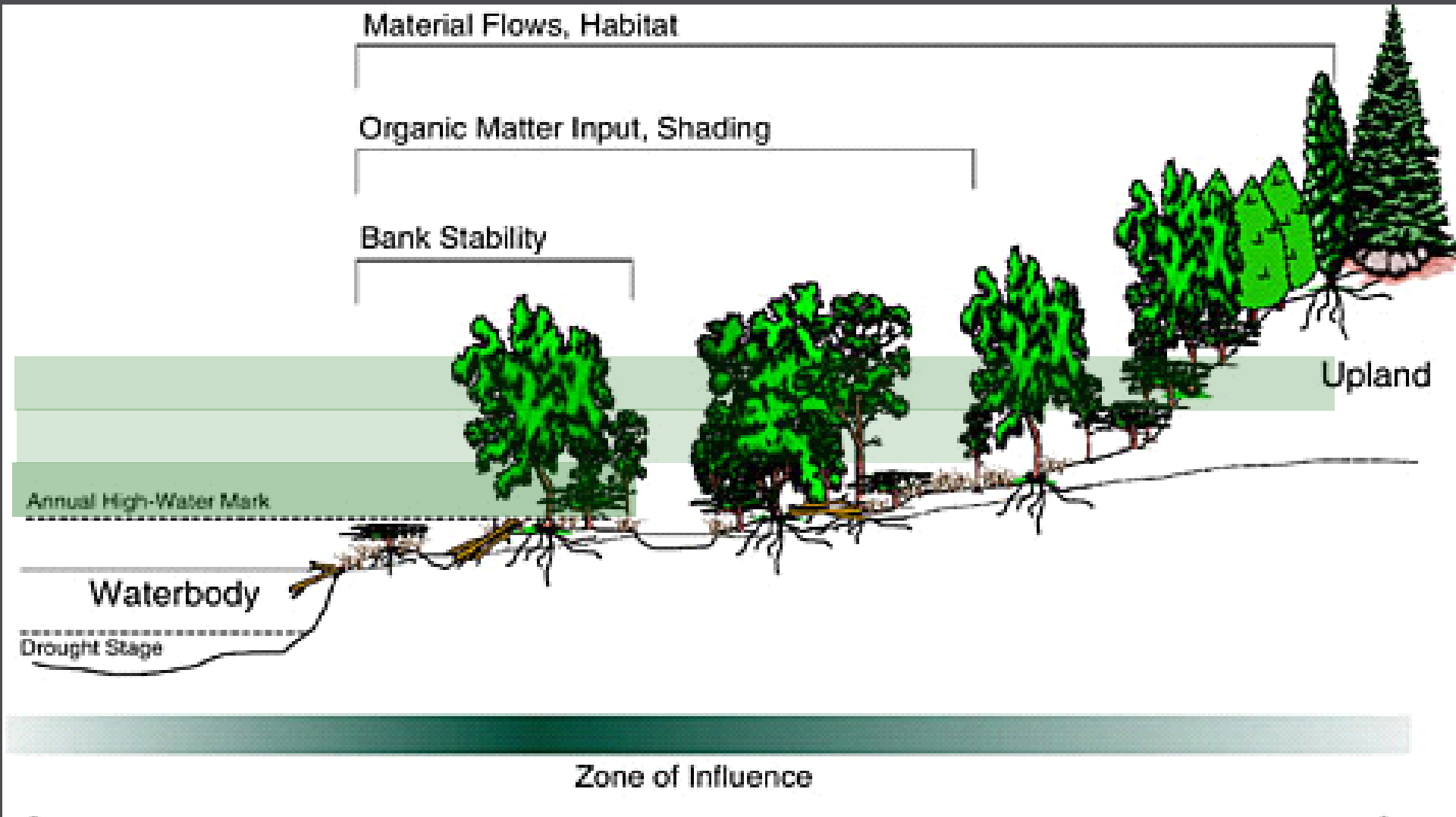
- *Riparian Buffer:* protection of waterbody
- *Functional Riparian Width:* *high level* of a *selected* function
- *Full Functional Width:* *high levels* of *all* intrinsic functions

- This GIS model is based on the literature relating riparian width to riparian function, but does not discriminate between high and low functionality
- The model describes existing *not potential* extent
- *Modeled Riparian Width:* amount of riparian area calculated from user-selected riparian processes without consideration to level of function

Riparian Profile

functions vary with distance from waterbody or…

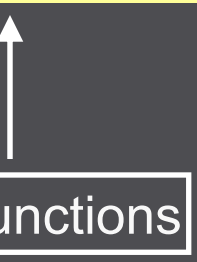
…therefore, riparian width varies with function



Model is built on the relationships between available data, wetland processes and wetland function

Examples:

Functions	Processes	Datasets
• Flood control • Pollution control • Nutrient cycling • Habitat and food web maintenance	• Fluvial processes • Vegetation processes • Hillslope processes	• Vegetation maps • Soils data • Topography • Hydrology info



Vegetation Relationships

Examples:

Functions	Processes	Datasets

• Vegetative diversity
• Salmonid support
• Primary productivity
• Channel stability
• Habitat corridors
	• Organic Matter Input
	  • Leaf litter
	  • Large woody debris
	  • Organic C/nutrient exchange
	• Shading & Temperature Control
		• Vegetation height
		• Vegetation type
		• Vegetation structure
		• Vegetation patch size and connectivity

Hillslope Relationships

Examples:

Functions	Processes	Datasets
• Sediment/nutrient supply • Large woody debris input • Water supply	• Mass wasting • Allochthonous Input • Groundwater emergence	• DEMs • Stream Order • Vegetation type • Vegetation height

Fluvial Geomorphic Relationships

Examples:

Functions	Processes	Datasets
• Channel maintenance	• Runoff	• DEMs
• In-stream habitat	• Sediment storage/ transport	• Soil types
• Flood protection	• Degradation/ aggradation	• Discharge
• Drainage		• Hydraulic curves
		• Sediment load

Software Architecture

Software Platforms

- ArcGIS
- Visual Basic for Applications (VBA)
- ArcObjects
- ESRI geoprocessing tools

Datasets used as input

- WRMP Base Map
- DEMs
- Vegetation layers

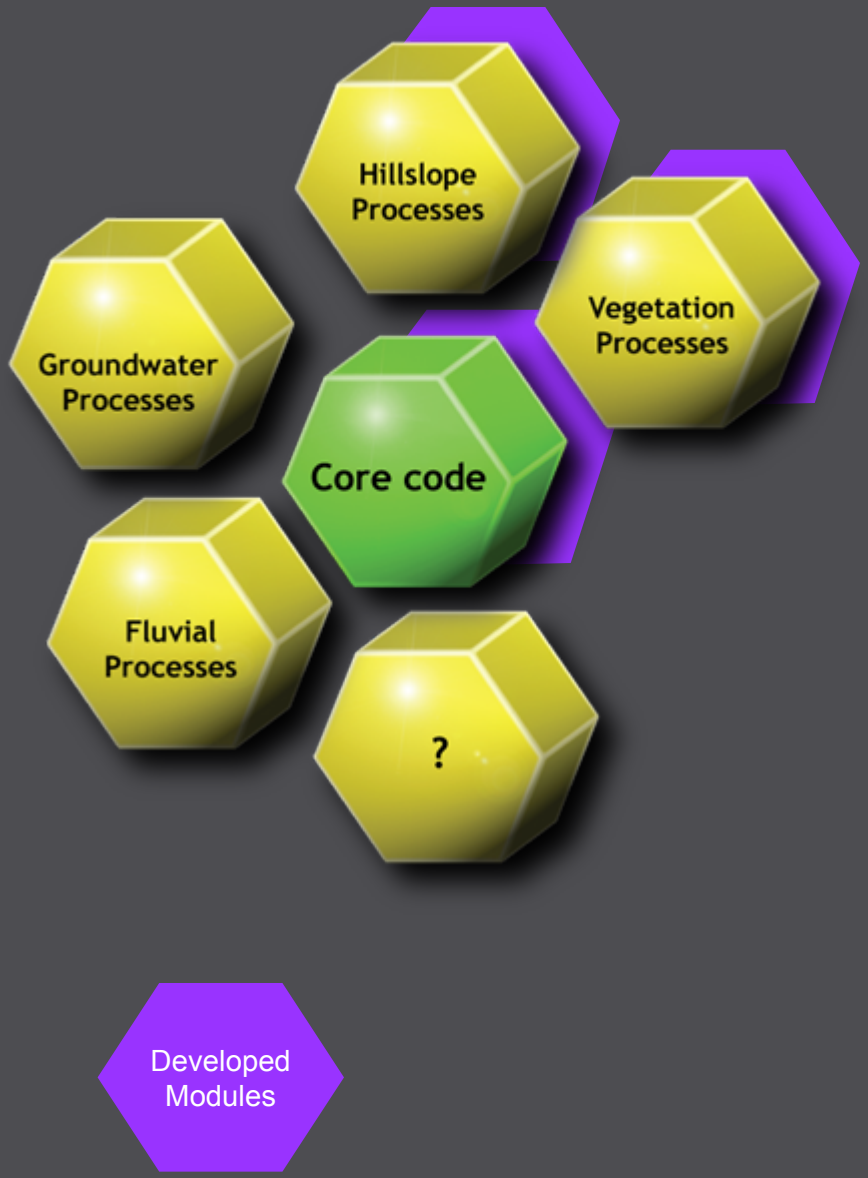
Software Design Approach: Modular Design

- **Modular design** subdivides a system into smaller parts (modules) that can be independently created and then used in different systems to drive multiple functionalities.
  - Cost reduction (lesser customization, and shorter learning time)
  - Flexibility in design
  - Allows for augmentation
  - Allows for exclusion
  - More adaptive to change

Modular design combines the advantages of both standardization & customization

Adapted from Wikipedia

Stream Riparian Model Module Structure



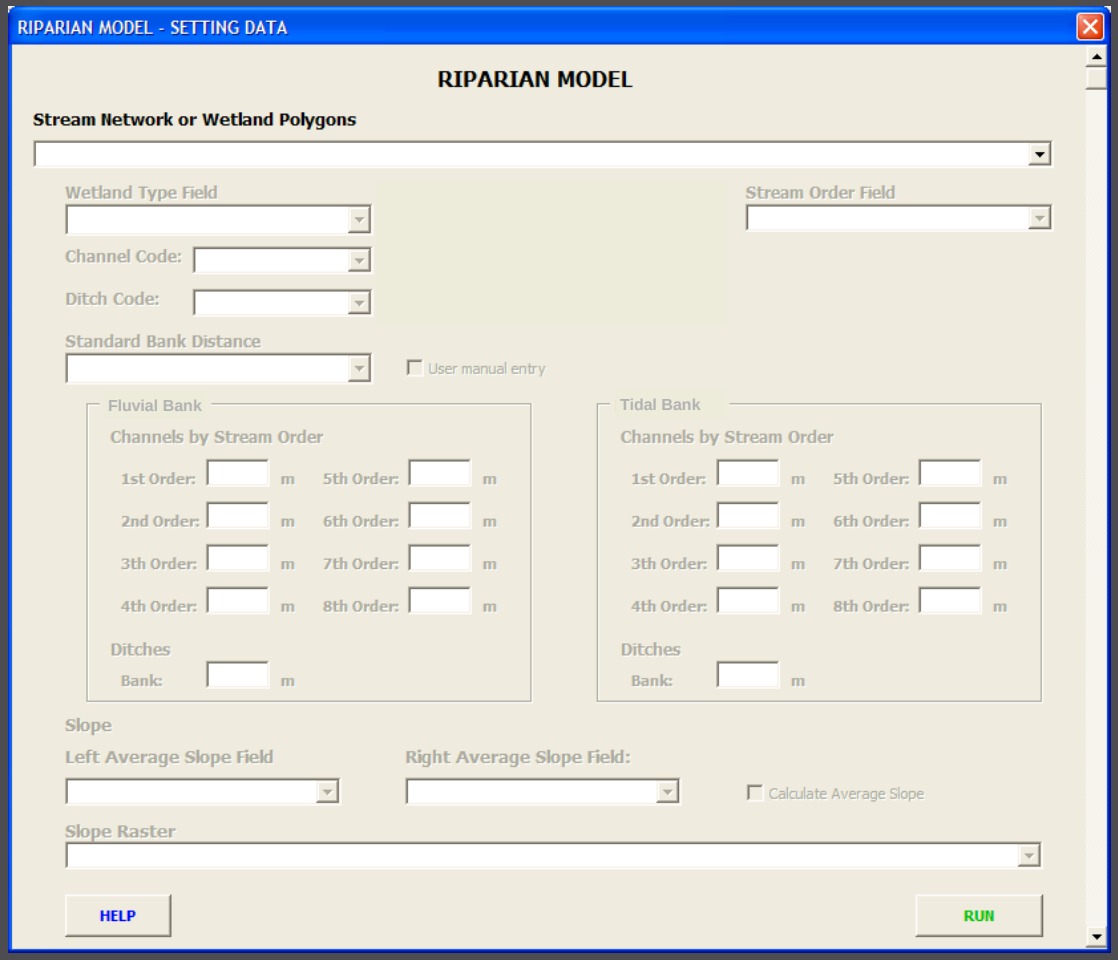
Core Code

- Software that includes the common coded functions that may be needed by individual modules
- Pre-processing of layers and attributes to create inputs for modules

Modules

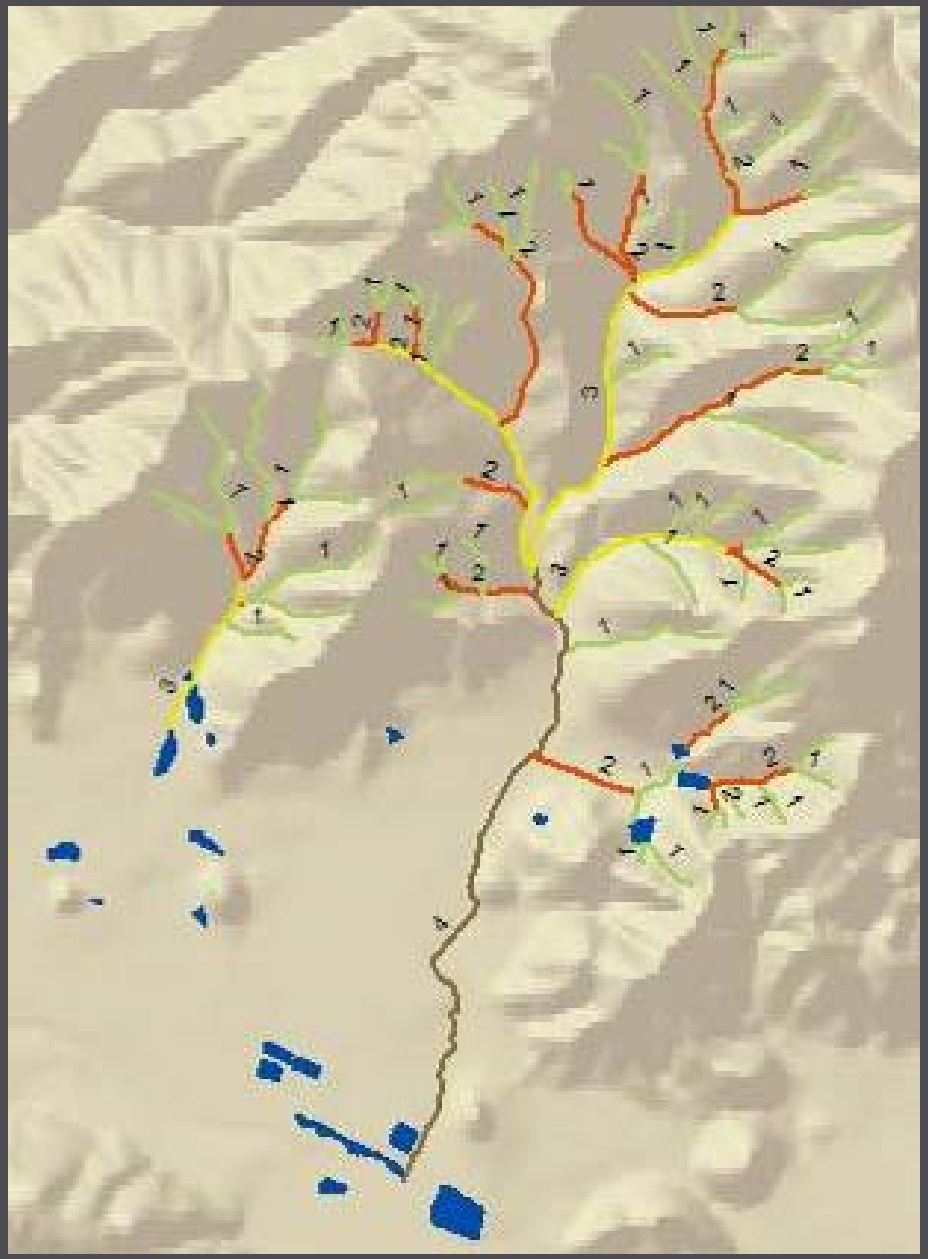
- Software developed to determine a riparian width based on appropriate data inputs using process-related calculations
- Outputs an module-specific individual GIS layer

Core Code



Core Code

- Foundation code that modules build upon
- Pre-processes data used in different modules
- Single interface window
- User-defined parameters
- Data generated:
  - Strahler stream order
  - Channel width
  - Average hillslope
  - Vegetation type
- Can integrate module outputs

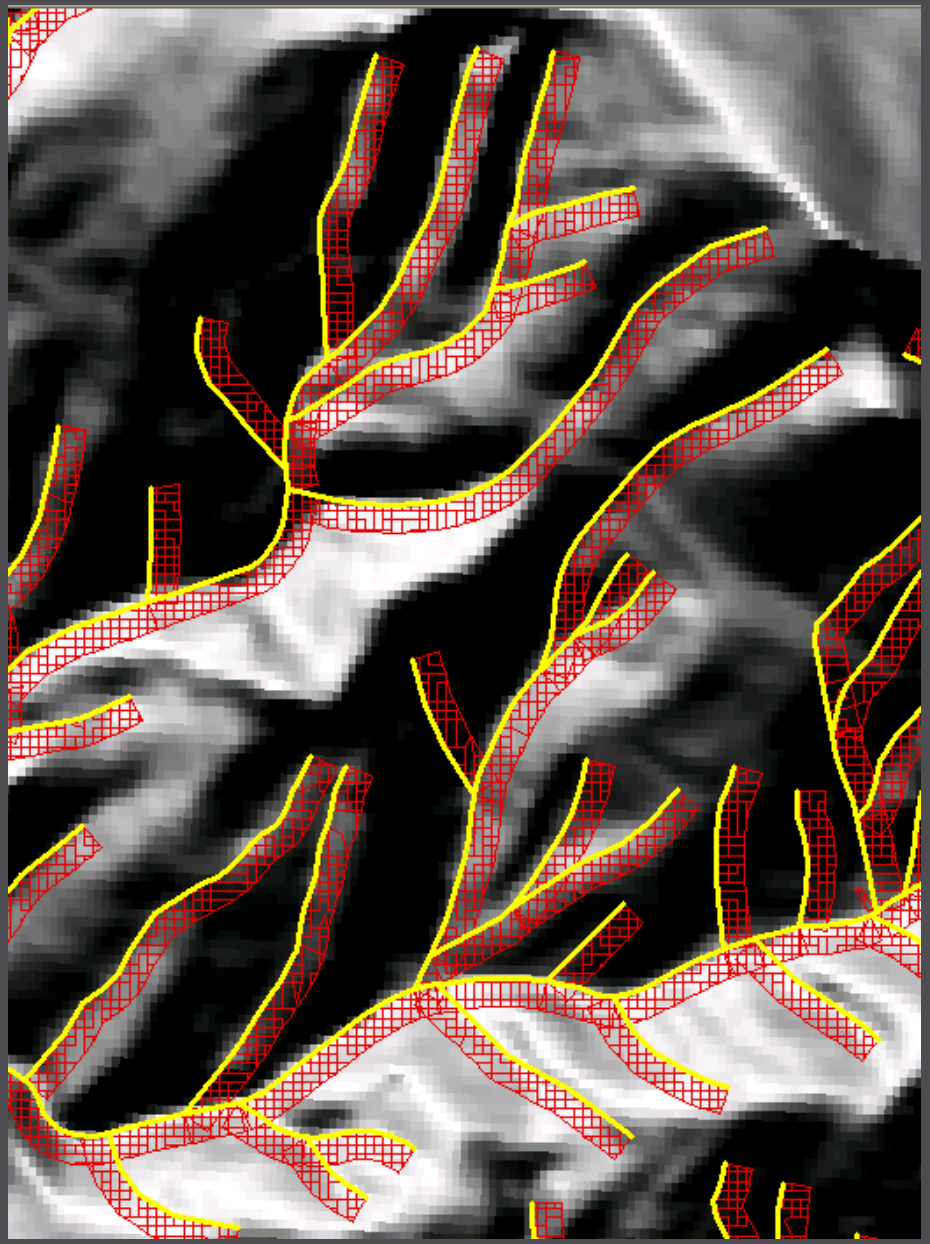


Core Code: Standard Channel Width and Stream Order

User defines widths based on Strahler stream order if channel banks cannot be mapped from aerial imagery

SFEI defaults:

- 1st 1 m
- 2nd 2 m
- ≥3rd 3 m
- ditches 1 m



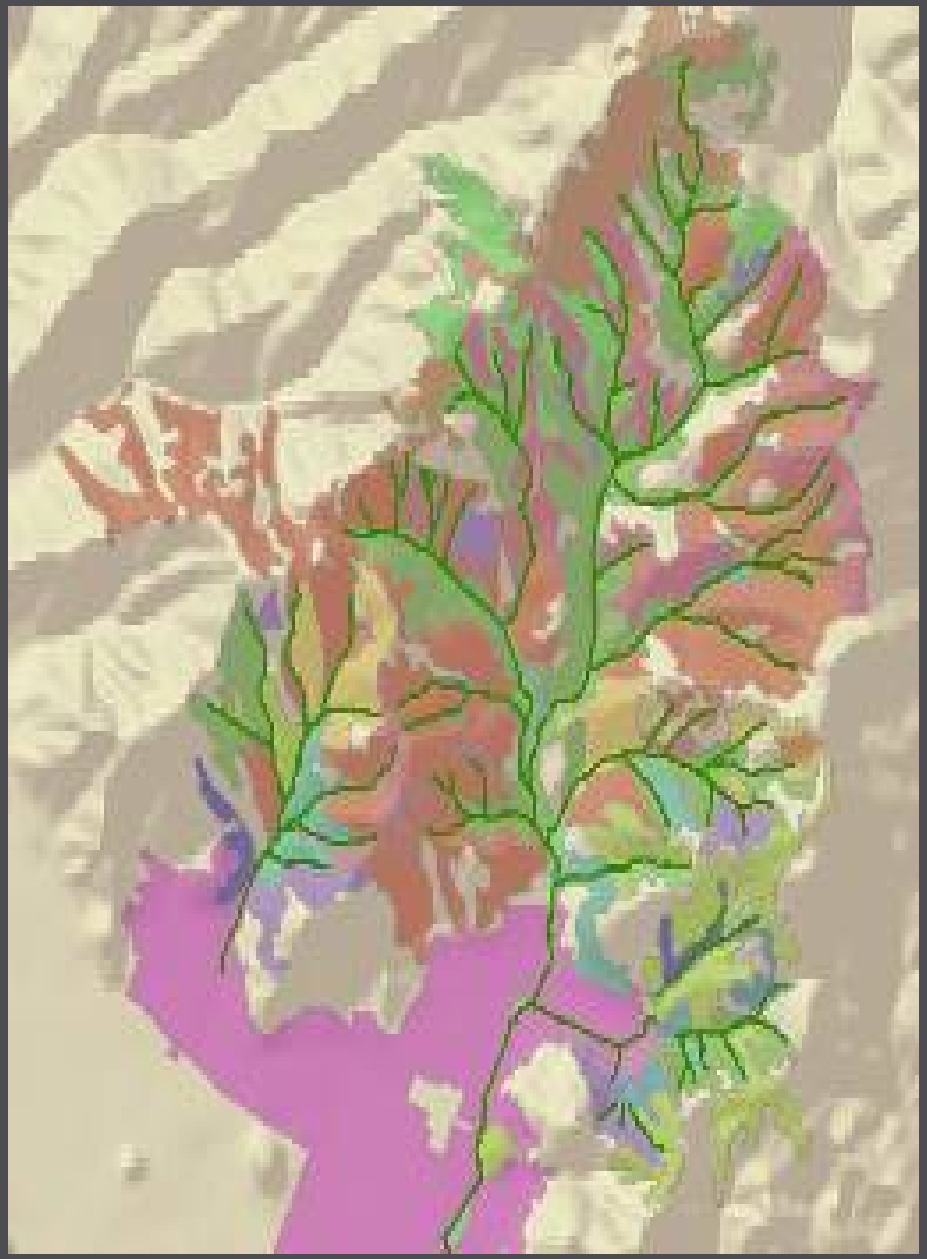
Core Code: Hillslope Calculation

Choose preferred DEM (USGS 10m, LiDAR)

Associates average adjacent slope with stream reach

Value taken 30m laterally

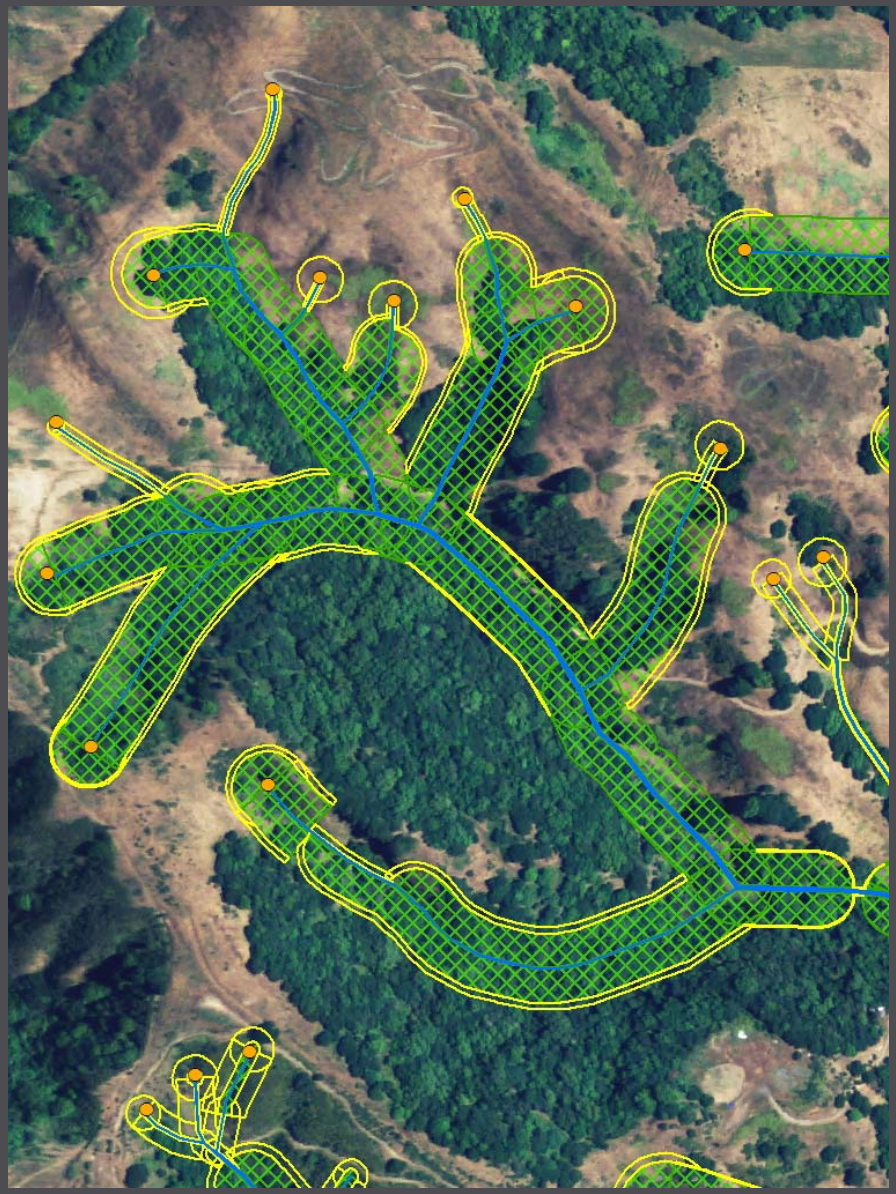
Independent values for Right and Left hillslopes (left hillslope shown in graphic)



Core Code: Vegetation

Model can accommodate various existing vegetation layers (e.g., CalVeg, Ca DFG, FRAP)

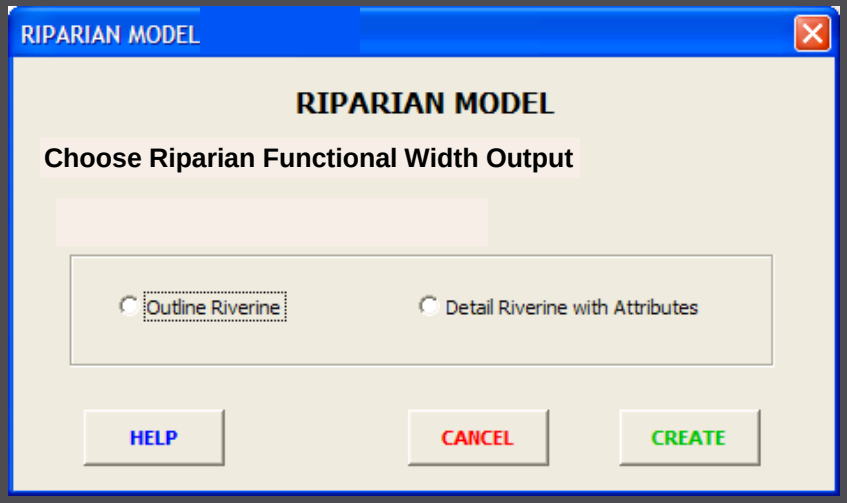
Associates vegetation type with left and right banks of the channel network



Core Code: Zero-Order Basins (variable source areas)

- Identify channel origin
- Core code assigns Slope and Vegetation
- Zero-order data fed into Functional Width Modules

Core Code: Model Output Visualization



Two alternative outputs

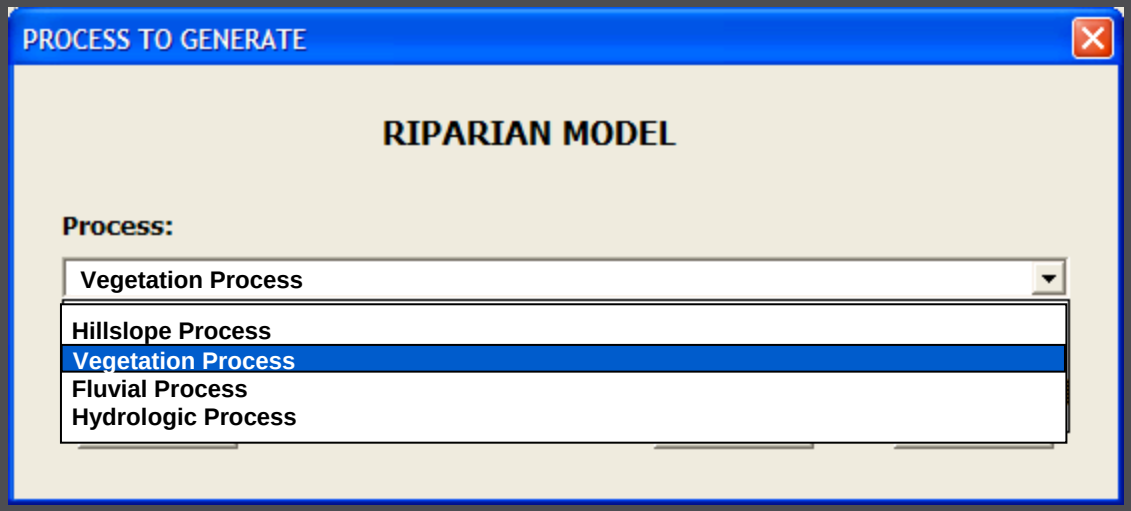
1. Maintain all attributes. Riparian Functional Width polygons are kept unique

   → Useful for analysis

2. Merge all attributes. Riparian Functional Width polygons become one feature

   → Useful for graphics

Vegetation Processes Module



Module Code

– Calculates Riparian Vegetation Functional Width based on:
  - Vegetation type (core code)
  - Slope (core code)
  - Vegetation height (user defined)

PI	MU_NAME	TreeHT	SBD
1100	Winter-Rain Sclerophyll Forests & Woodlands Formation	15	-1
1101	California Bay - Madrone - Coast Live Oak - (Black Oak Big -	12	-1
1122	Canyon Live Oak Alliance	18	-1
1123	Eucalyptus Alliance	20	-1
1124	Tanbark Oak Alliance	12	-1
1201	Coast Live Oak - Blue Oak - (Foothill Pine) NFD Association	6	-1
1202	Interior Live Oak - Blue Oak - (Foothill Pine) NFD Association	10	-1
1221	Coast Live Oak Alliance	12	-1
1222	Interior Live Oak Alliance	9	-1
1223	Mixed Oak Alliance	6	-1
2104	Foothill Pine / Mesic Non-serpentine Chaparral NFD Associati	9	-1
2121	Foothill Pine Alliance	12	-1
2122	Knobcone Pine Alliance	6	-1
2123	Ponderosa Pine Alliance	20	-1
2124	McNab Cypress Alliance	0	0
2125	Sargent Cypress Alliance	10	-1
2126	Sugar Pine - Canyon Oak NFD Association	0	0
2127	California Juniper Alliance	0	0
2128	Sparse California Juniper-Canyon Live Oak-California Bay-Ca	0	0
2201	Coast Redwood - Douglas-fir / California Bay NFD Associatio	20	-1
2222	Douglas-fir Alliance	20	-1
2224	Douglas-fir - Ponderosa Pine Alliance	20	-1
2230	Coast Redwood Alliance	50	-1
3101	Valley Oak - (California Bay - Coast Live Oak - Walnut - Ash)	12	-1
3102	Valley Oak - Fremont Cottonwood - (Coast Live Oak) Riparia	10	-1
3103	Mixed Fremont Cottonwood - Willow spp. NFD Alliance	0	0
3121	Black Oak Alliance	18	-1
3122	Blue Oak Alliance	6	-1
3123	Valley Oak Alliance	12	-1
3124	Oregon White Oak Alliance	15	-1
3201	White Alder (Mixed Willow - California Bay - Big Leaf Maple)	12	-1
3221	Mixed Willow Super Alliance	5	-1
4000	Evergreen Shrubland	0	0
4300	Sclerophyllous Shrubland Formation	-1	5
4301	Scrub Interior Live Oak - Scrub Oak - (California Bay - Flow	6	-1
4302	Mixed Manzanita - (Interior Live Oak -California Bay - Chamis	-1	5
4303	Leather Oak - White Leaf Manzanita - Chamise Xeric Serpenti	-1	5
4304	Leather Oak - California Bay - Rhamnus spp. Mesic Serpentin	-1	5

Vegetation Processes Module: Vegetation heights

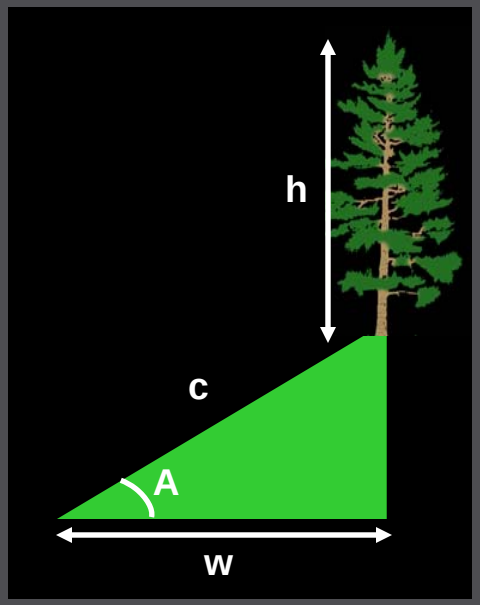
Associates vegetation heights with vegetation types using lookup table

Input is a user-defined table of vegetation heights

SFEI default heights:

- Site-specific for trees
- 10 m for all shrubs
- 5 m for all grasses
- 1 m for all bare ground

Allocthonous input



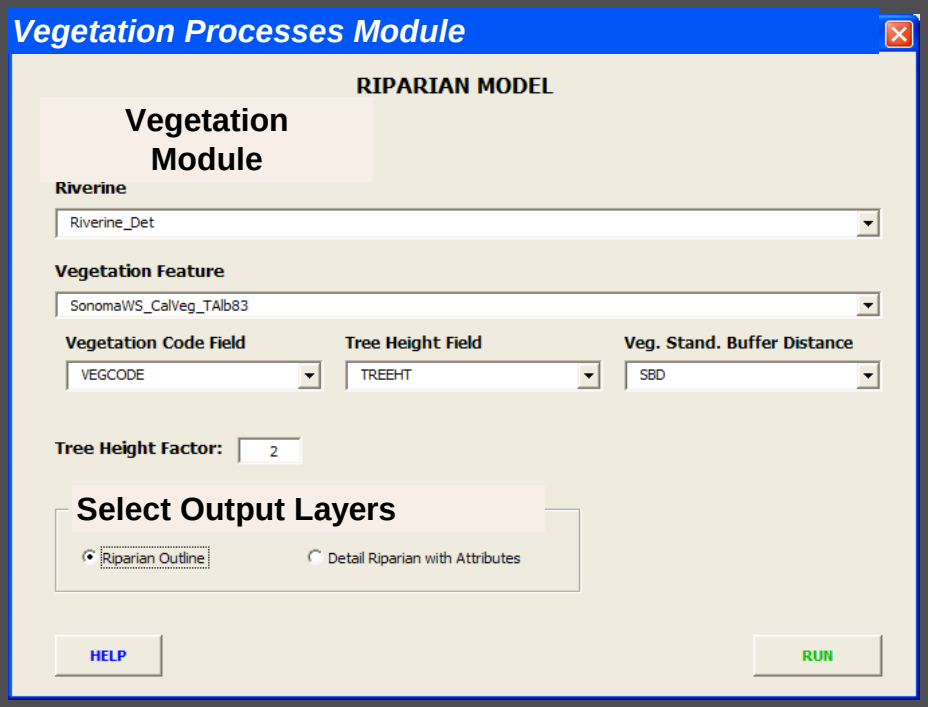
- Plant height: The taller the plants, the farther they can be from the channel and still interact
- Slope: The steeper the slope, the narrower the riparian area
- Tree will just hit the creek if tree height h = c

  $$w = h \cos(A)$$

- Studies document input from trees further away* so user can factor in additional width to capture full function (tree height factor)

**Reference: Reid and Hilton 1998*

Allocthonous input module calcs



- For trees:

  “Allochthonous width” = Tree Height factor x Tree Height x Cos (0.0174 * Slope[rad])

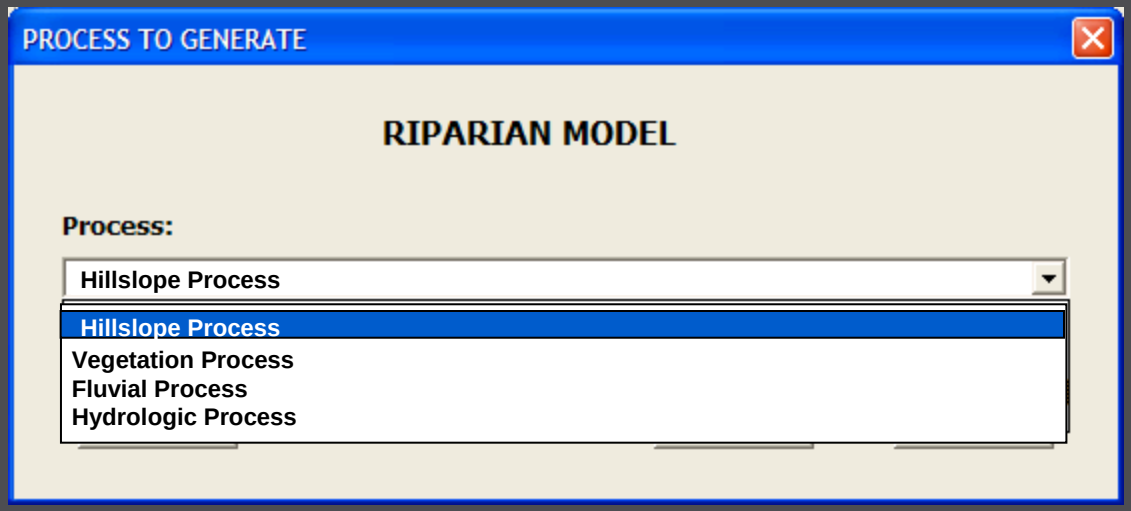
  Tree height factor = 2 x SPTH

- For other vegetation (grasses, shrubs, emergent)

  “Allochthonous width” = default values

Vegetation Processes Module Output

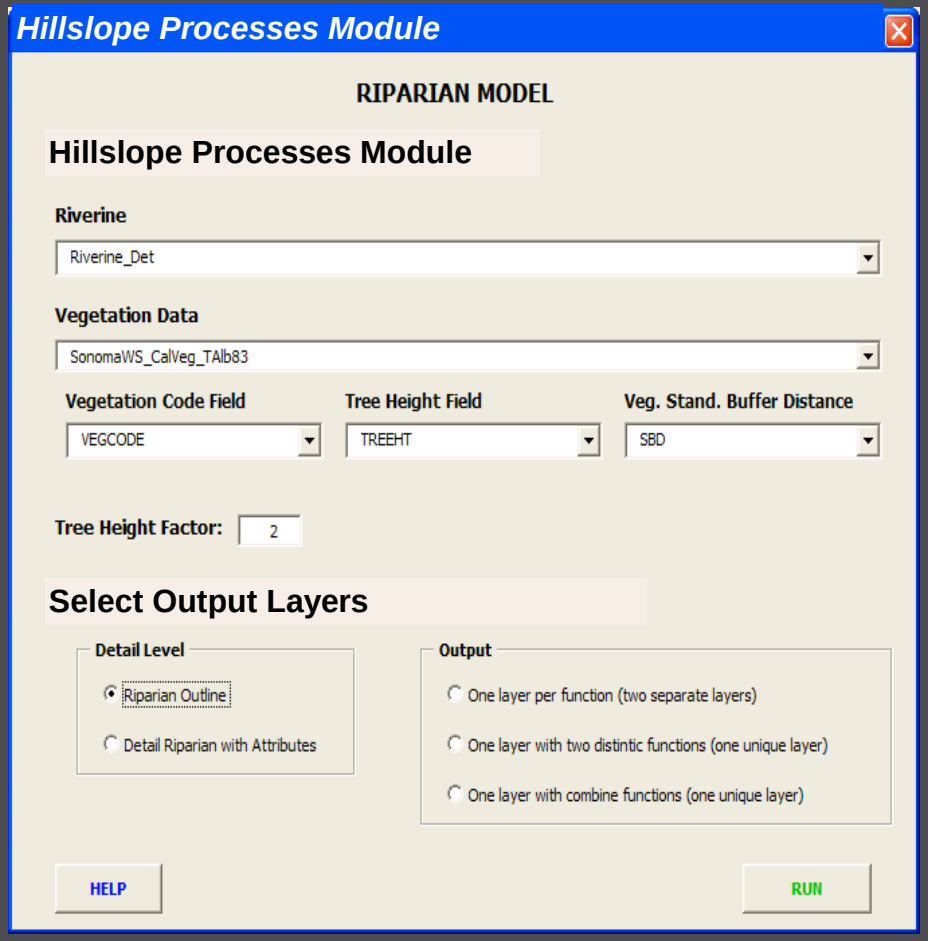
Hillslope Processes Module



Module Code

– Calculates Hillslope Functional Width based on:
  - Average adjacent slope above 20%

Hillslope Processes Module Interface



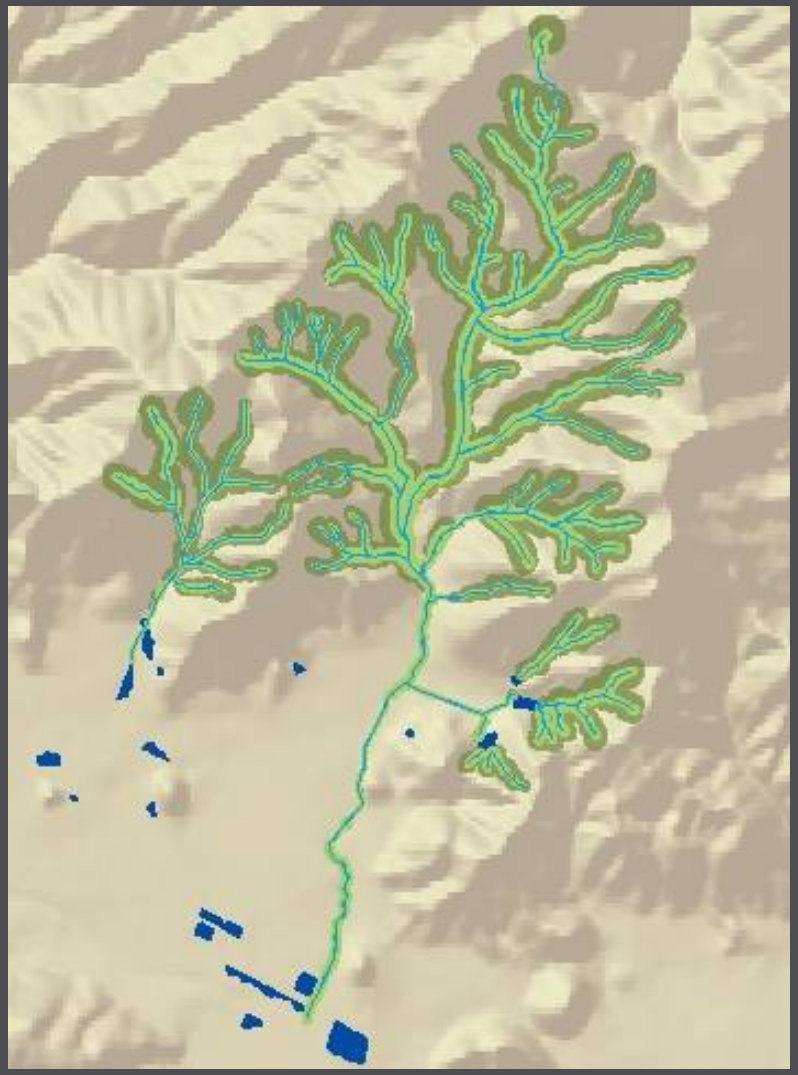
Additional width begins at the edge of the Vegetation Process limit

Increase width 1 m for every 1% increase in slope > 20%

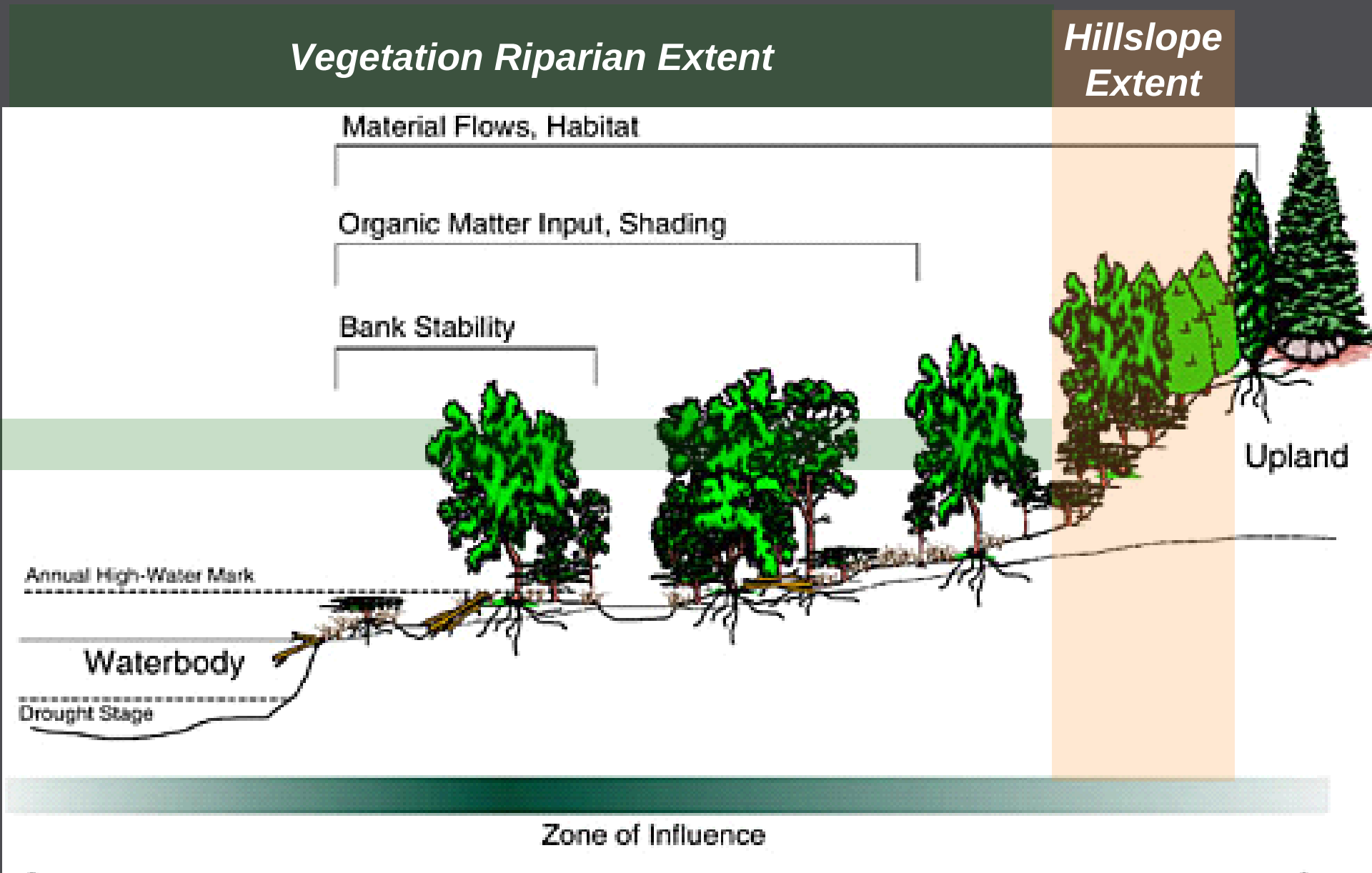
W=(Vegetation Processes Module width) + α(slope-β)

SFEI default: α =1, β =20

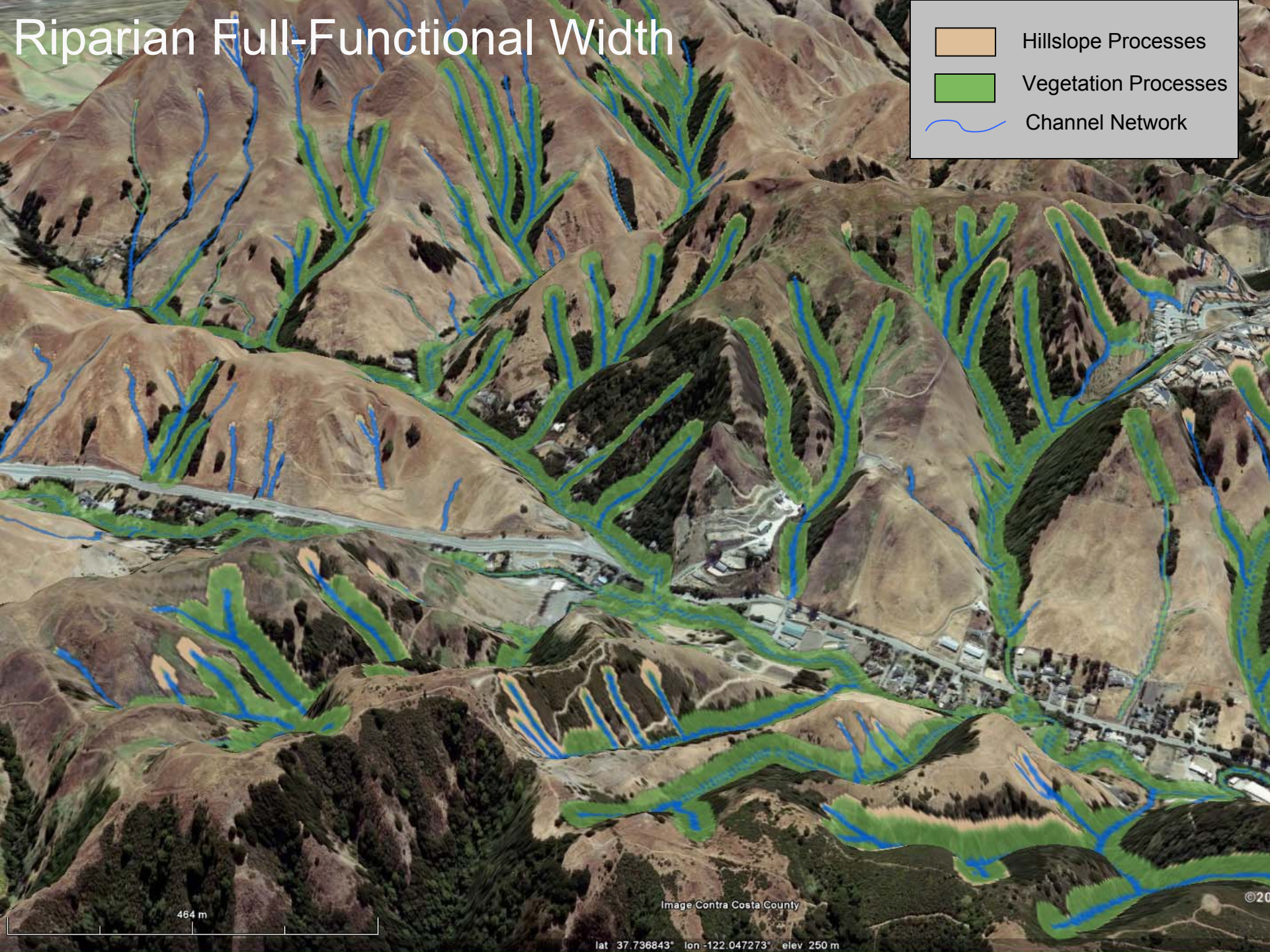
Hillslope *and* Vegetation Processes Output



Extent of Modeled Riparian Area



Riparian Full-Functional Width



Interpretation and Application of Results:

What it is

- A statewide Level 1 tool (a map based on other maps and aerial images available statewide).
  - NRC definition of riparian
  - riparian width for selected functions
  - riparian buffer width for selected stressors

- A user-friendly tool that users can customize
  - Use local data
  - Adjust parameters for local understanding
  - Share workloads

What it isn't

- A measure of actual riparian width (i.e., riparian delineation)
- A measure of riparian function (aka eco-service, beneficial use)


Thank you
Questions?
kristen@sfei.org