

Introduction to River Architect

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<https://riverarchitect.github.io>

Davis, CA | 2019

Contents

- ▶ Introduction to River Architect
- ❖ Get Started: Wiki, Installation and Setup
- ❖ Create Conditions
- ▶ Mapping



BREAK

- ❖ Lifespan Mapping
- ❖ Ecohydraulics: Habitat Assessment
- ❖ Ecohydraulics: Habitat Connectivity

BREAK

- ❖ Project Maker
- ▶ Discussion & Questions

Goal
Become
independent with
River Architect

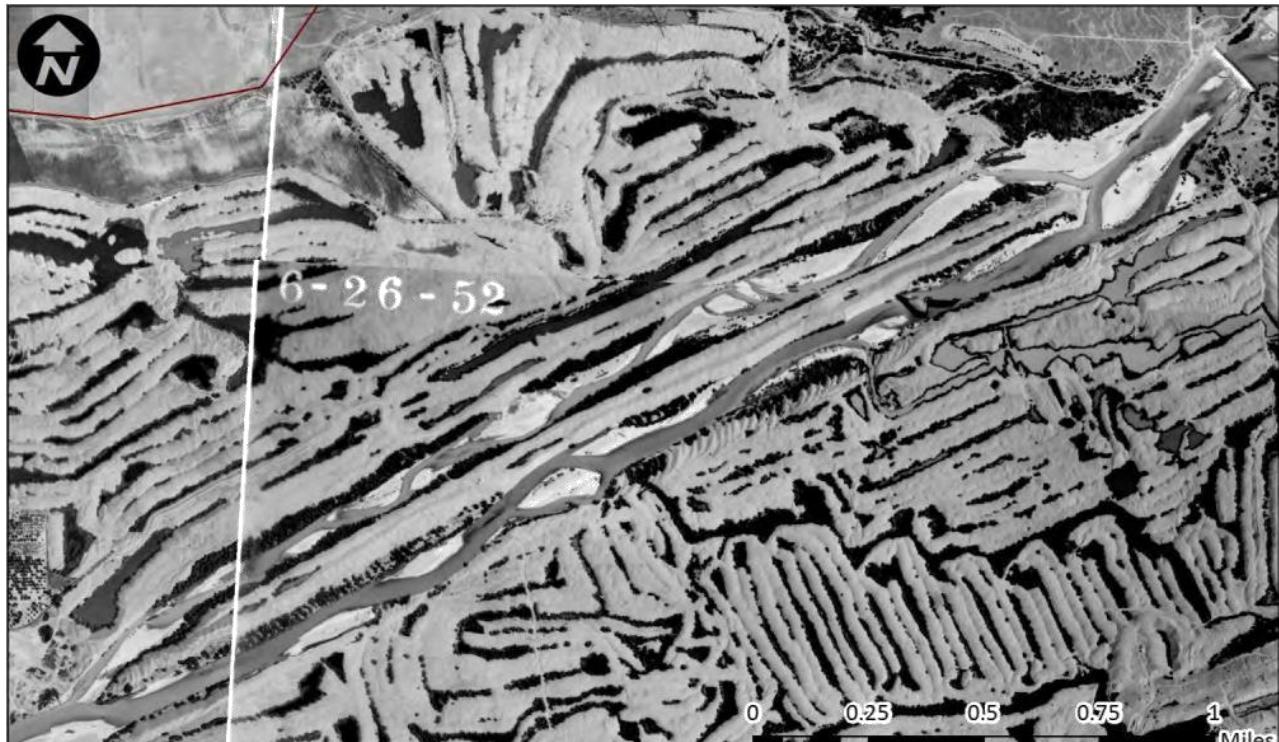
The beginning ...



N
100 yds

Images: Google Earth TM

Analysis of the lower Yuba River – Daguerre Alley



Notes: Aerial image from James (2012). See Figure 2 for hydrologic time series. Flight date of 06/26/1952 at flow of approximately 5,727 cfs.



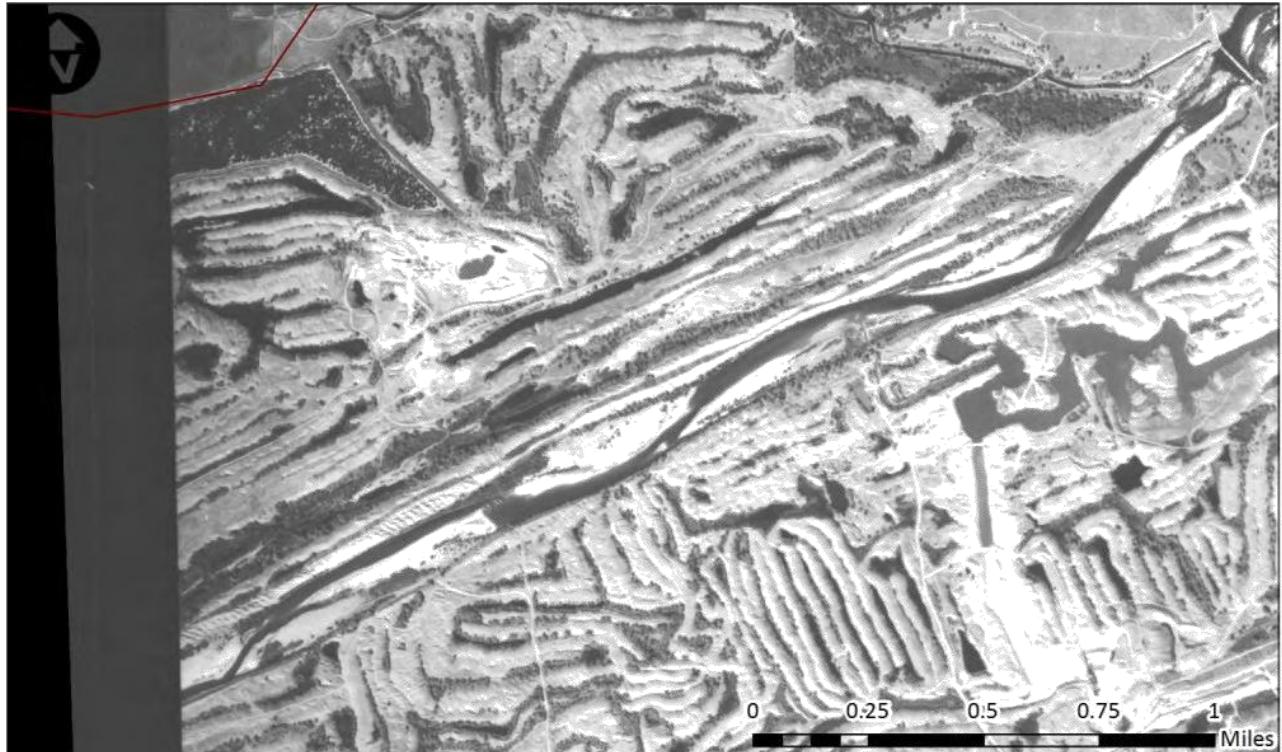
Hallwood Off-Channel Habitat Enhancement Alternatives, Lwr. Yuba River
1952 aerial image

Project No. 12-1034

Created By: AMS

Figure 4

Analysis of the lower Yuba River – Daguerre Alley



Notes: Aerial image from James (2012). See Figure 2 for hydrologic time series. Flight date of 11/4/1986 at flow of approximately 830 cfs.



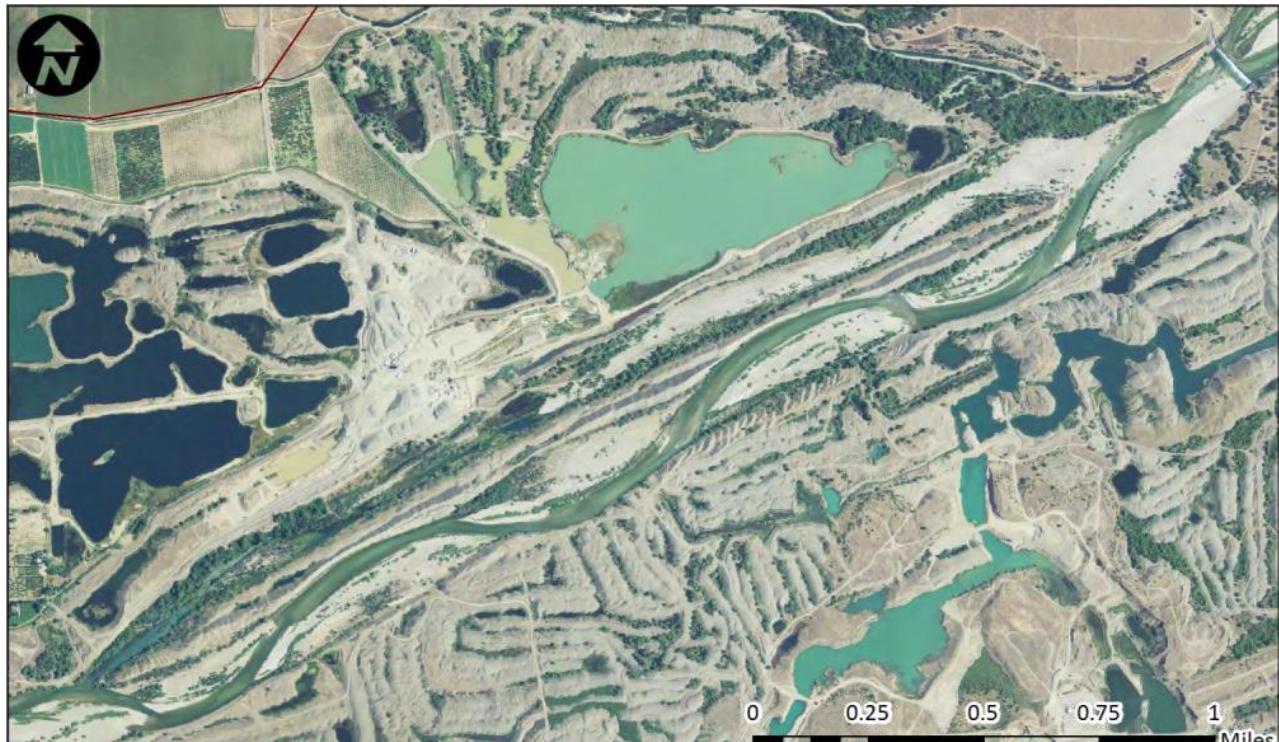
Hallwood Off-Channel Habitat Enhancement Alternatives, Lwr. Yuba River
1986 aerial image

Project No. 12-1034

Created By: AMS

Figure 8

Analysis of the lower Yuba River – Daguerre Alley



Notes: Aerial image from James (2012). See Figure 2 for hydrologic time series. Flight date of 7/3/2009 at flow of approximately 1,987 cfs.



Hallwood Off-Channel Habitat Enhancement Alternatives, Lwr. Yuba River
2009 aerial image

Project No. 12-1034

Created By: AMS

Figure 10

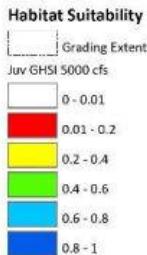
Solutions ... ?

Habitat Created in Eco Flows Range



- Up to 37% increase inundated acres (max at 7,500 cfs)
- Up to 74 % increase wetted edge (max at 2,000 cfs)
- Up to 50% increase in Chinook Salmon and Steelhead Fry-Juv. WUA at 2000 cfs (without cover and with cover)
- Up to 38% decrease deep pools (> 6 ft deep)

5,000 cfs



Sustainability ... ?



Google Earth

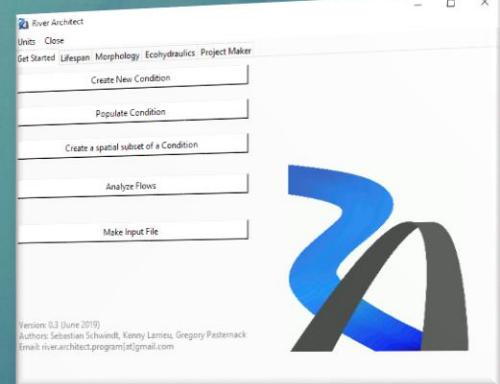
Image: USGS Earth Science Agency

N

500 m

Image: Google Earth TM

River Architect



Highlights



Source: S. Schwindt



Source: Greg Pasternack @RiverSciLife

Principle

Overcome subjective and individual approaches that sometimes miss their objectives
(ecological abundance and long-living)

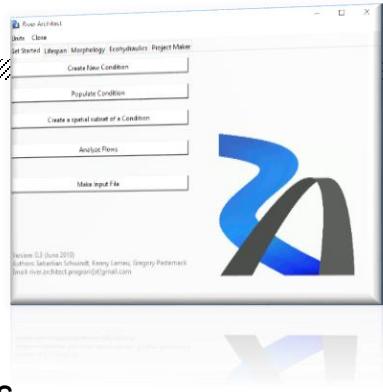
Methods

Parametric and transparent design concepts

Product

Ecologically sustainable and long-living fluvial landscapes with economic assessment

Highlights



Lifespan & Design Mapping

Longevity assessments of single features

Morphology

Terrain modification to yield self-sustaining fluvial landscapes and mass movement assessments

Ecohydraulics

Habitat quality and connectivity assessment for target species and their lifestages

Project Maker

Presentation-ready wrap up of project costs and benefits



Welcome & Getting Started Tab

River Architect

Units Tools Close

Get Started Lifespan Morphology Ecohydraulics Project Maker

Create New Condition

Populate Condition

Create a spatial subset of a Condition

Analyze Flows

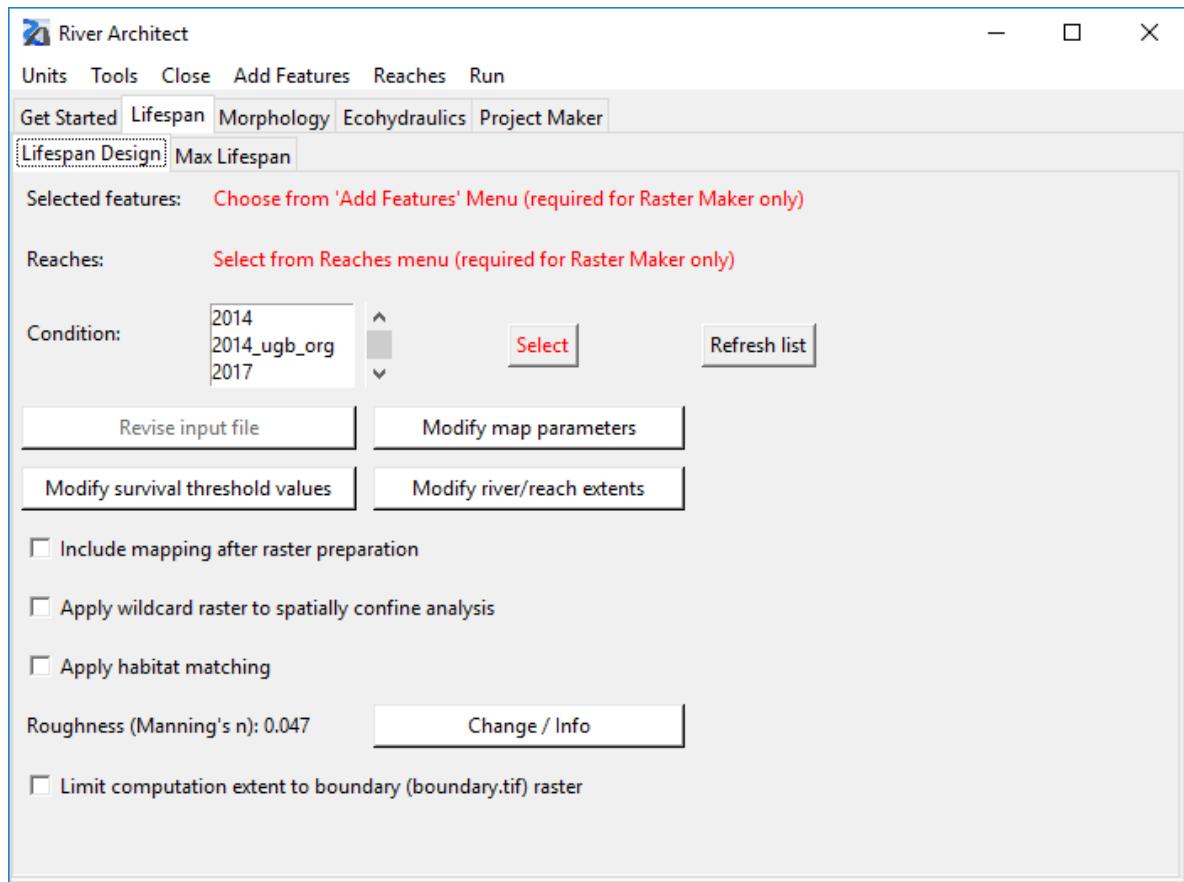
Make Input File

Align Input Rasters

Version: 0.3 (June 2019)
Authors: Sebastian Schwindt, Kenny Larrieu, Gregory Pasternack
Email: river.architect.program[at]gmail.com

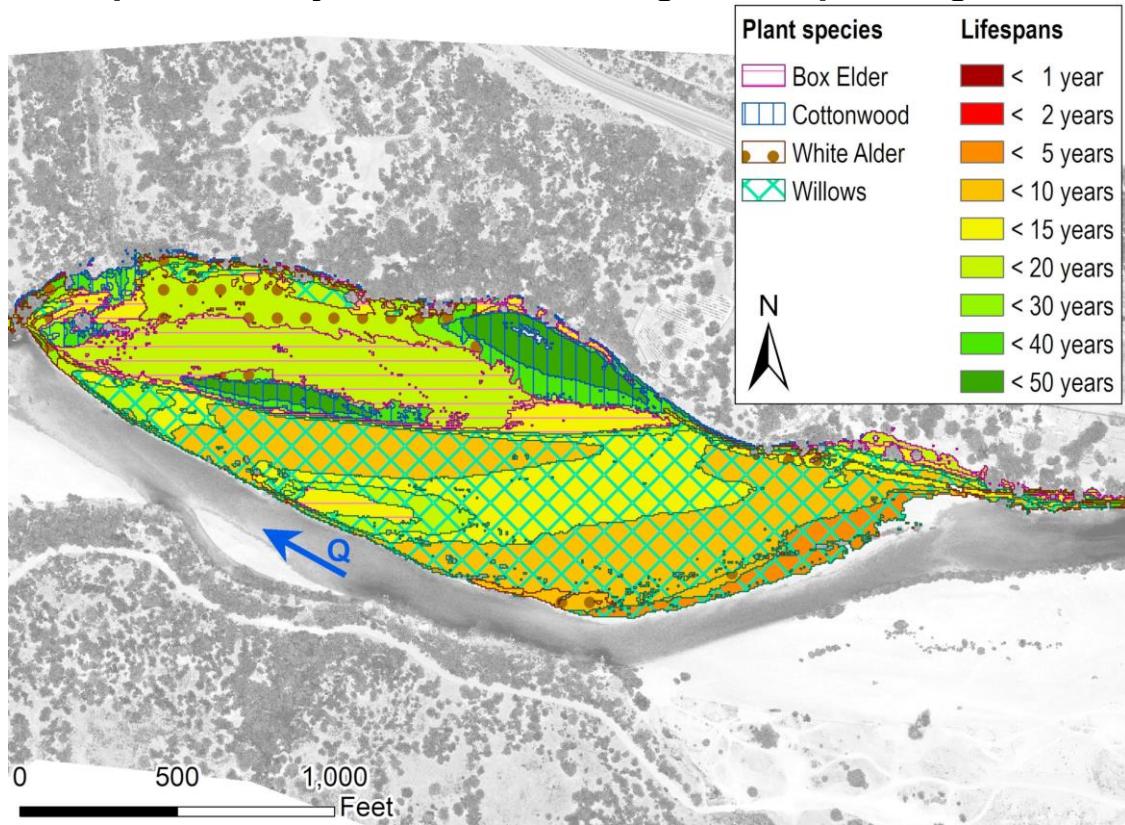


Lifespan & Design Tab



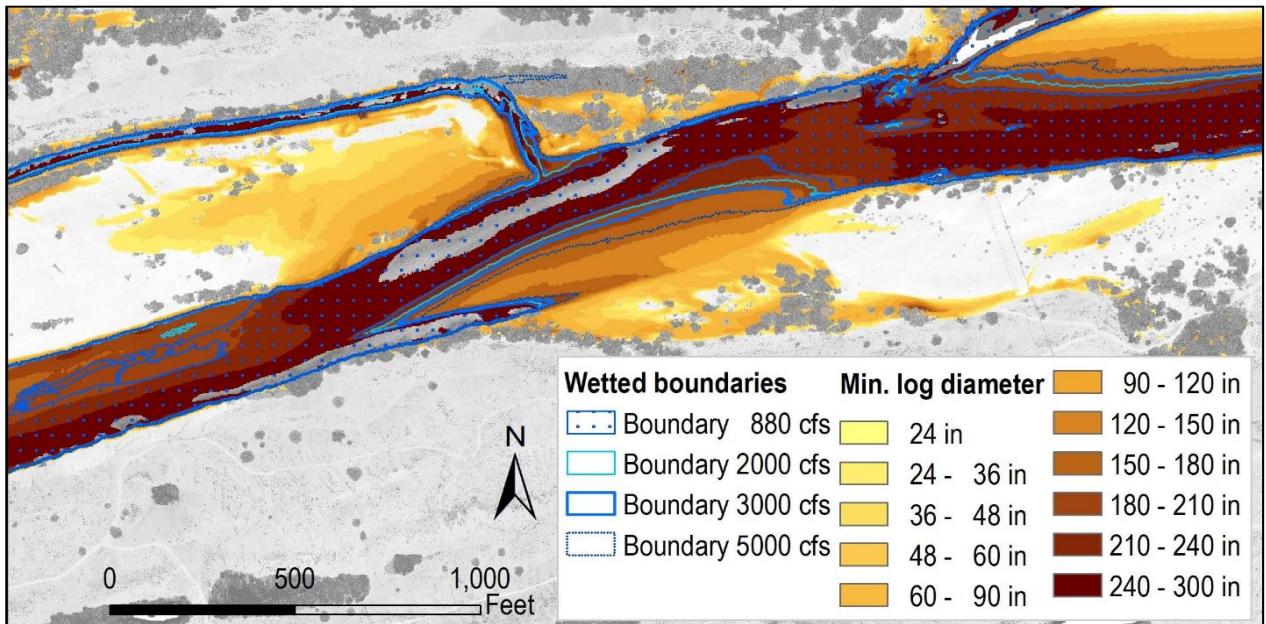
Lifespan mapping

► Example: Identify most suitable vegetation plantings

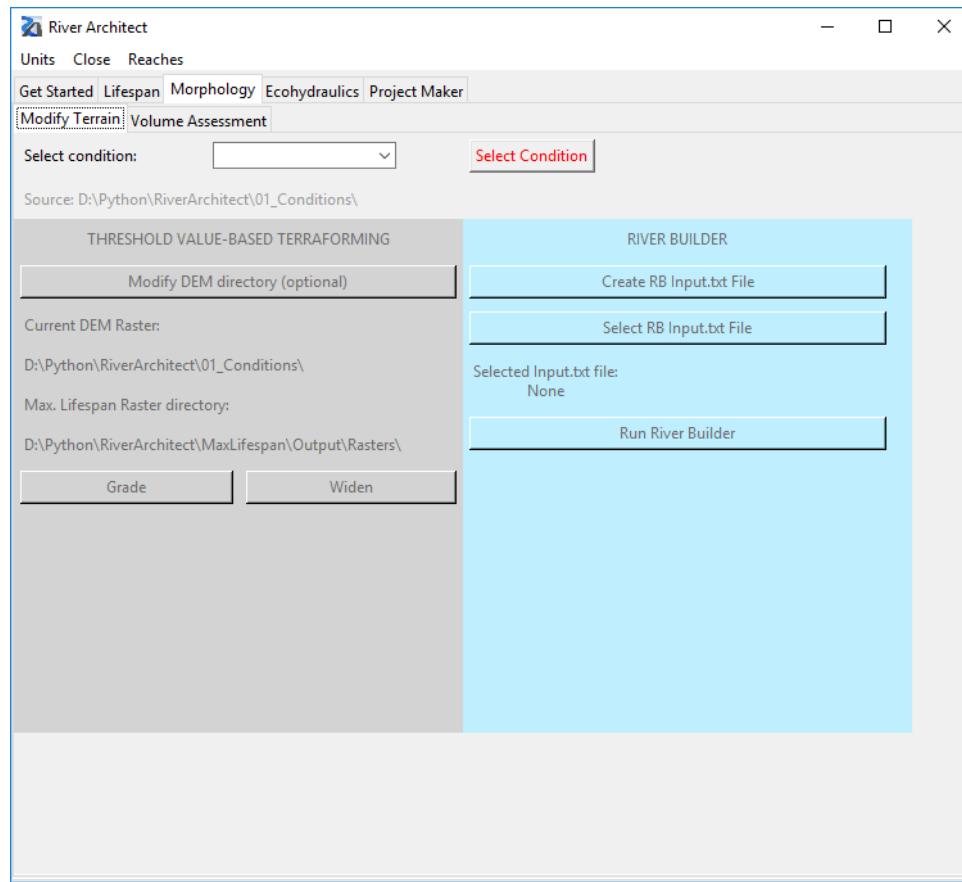


Lifespan mapping

- Example: Identify stable log diameters for streamwood placement



Morphology Tab



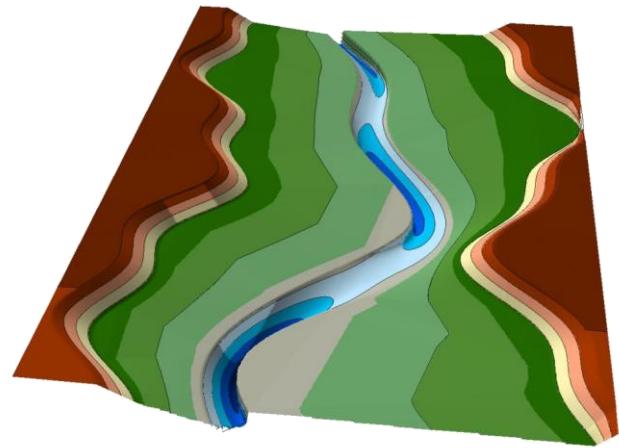
Morphology

Use Threshold-based terraforming or River Builder to design riverscapes

- ▶ Threshold-based terraforming: Grading or River widening
- ▶ River Builder
- ▶ Volumetric Terraforming assessment

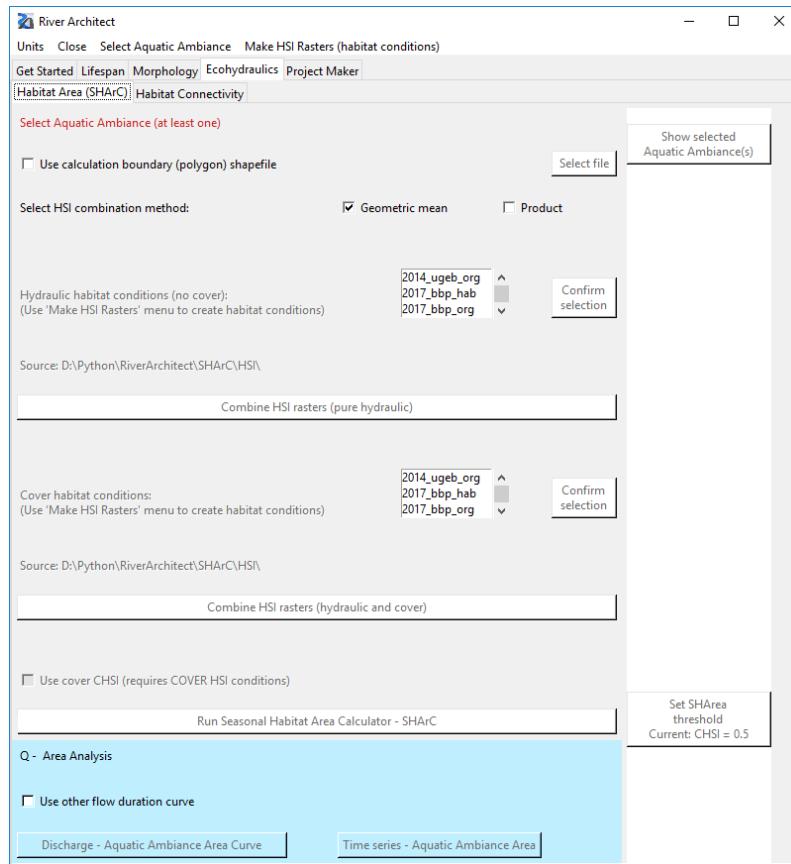
... these routines proceduralize
currently best available science

... we are developing new strategies
to improve procedural terraforming
based on physical boundary conditions



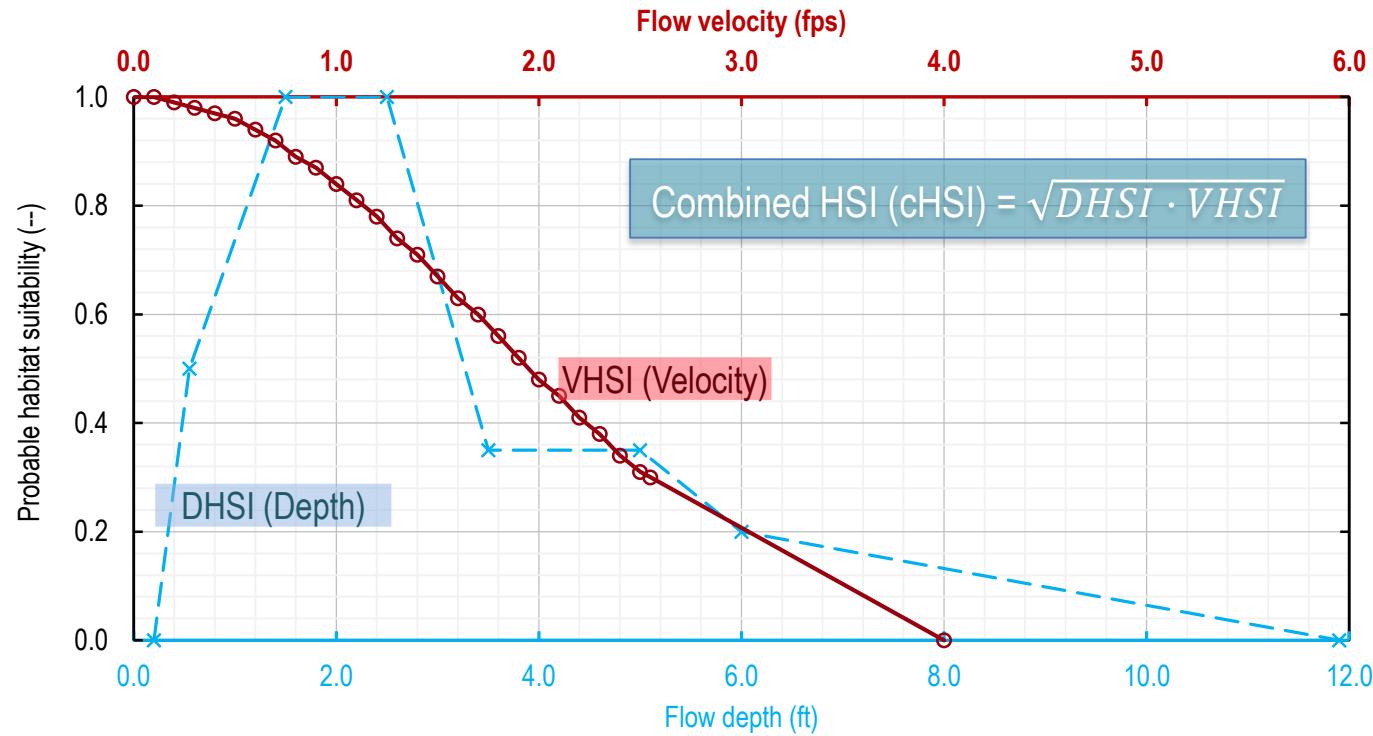
Synthetic river valley created with River Builder
(source: Gregory B. Pasternack)

Ecohydraulics Tab



Ecohydraulics

► Habitat assessment: Habitat Suitability Index (HSI) of juv. Chinook salmon

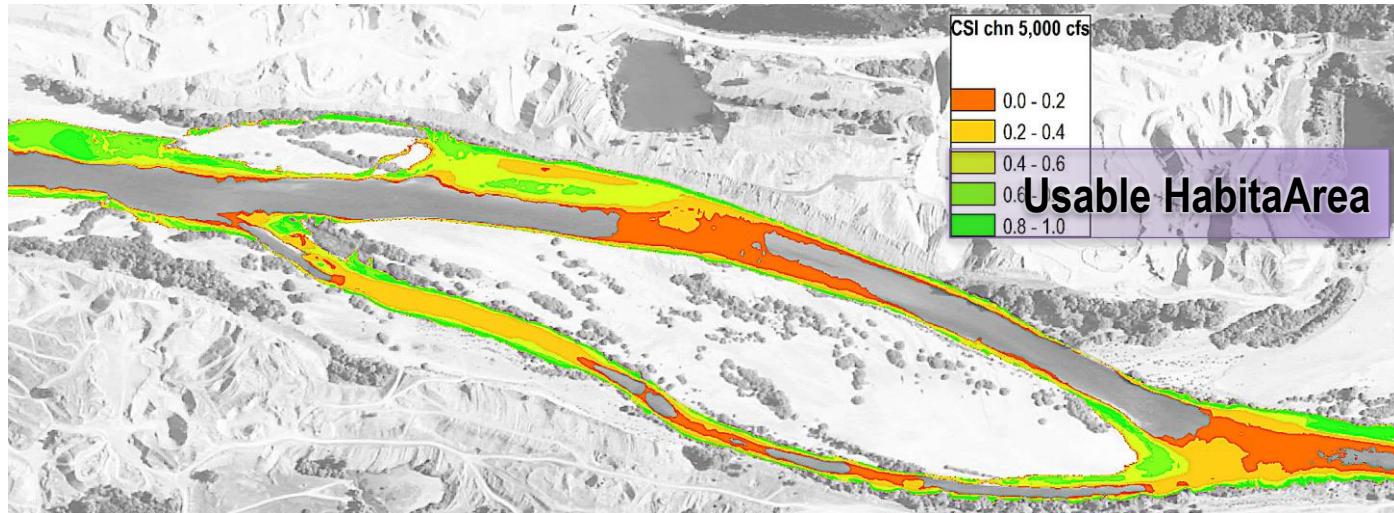


Adapted from: Schwindt, S., Pasternack G. B., Bratovich, P. M., Rabone, G., Simodynes, D. , 2019.



Ecohydraulics: Habitat Enhancement

- Habitat assessment: composite Habitat Suitability Index (cHSI) map

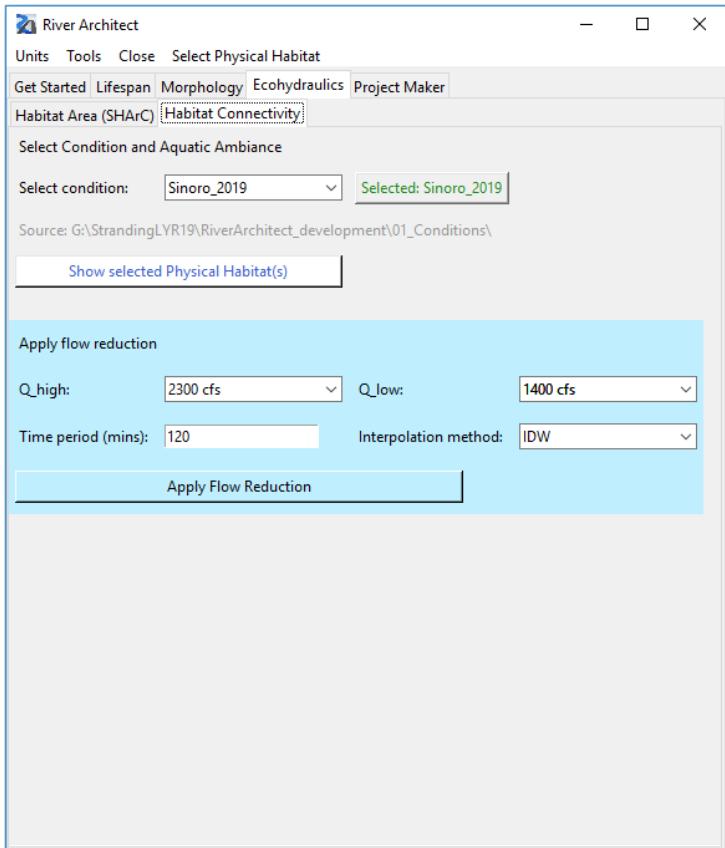


- Repeat operation for multiple discharges (apply flow duration curve)
- Calculate usable habitat area (e.g., $cHSI > \theta = \text{blue symbol}$)
- Sum of usable areas for one discharge = SHArea
- Sum of multiple season-specific discharges = Seasonal Habitat Area

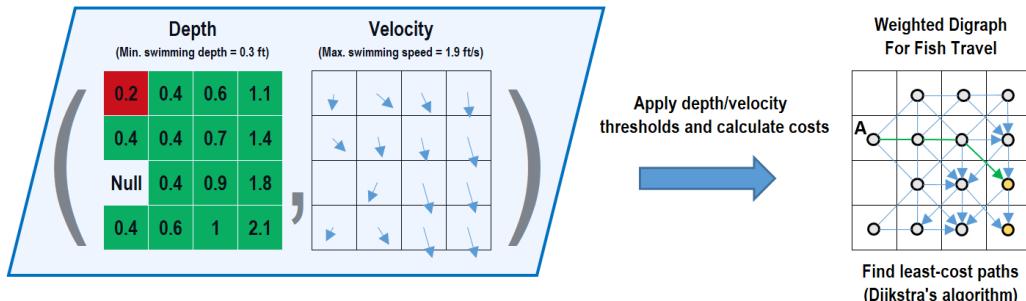
Source: Schwindt, S., Pasternack G. B., Bratovich, P. M., Rabone, G., Simodynes, D. , 2019. Under preparation.



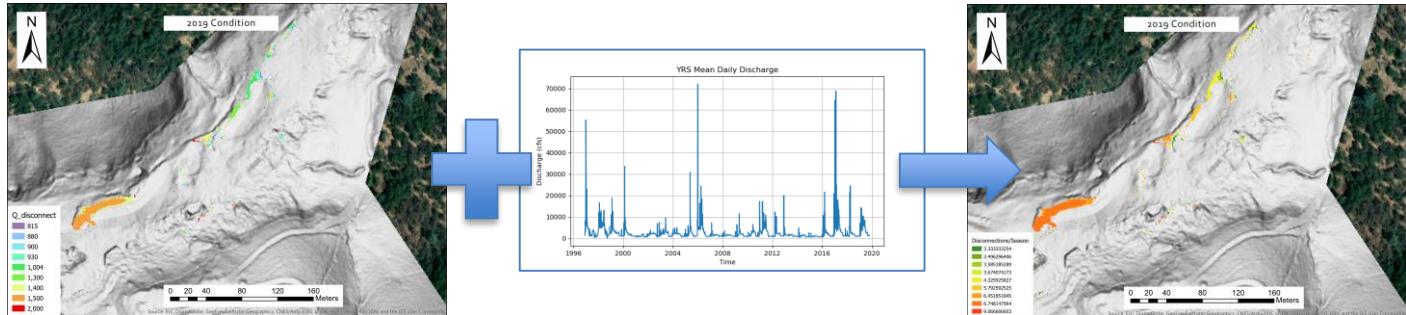
Ecohydraulics: Habitat Connectivity



Ecohydraulics: Habitat Connectivity

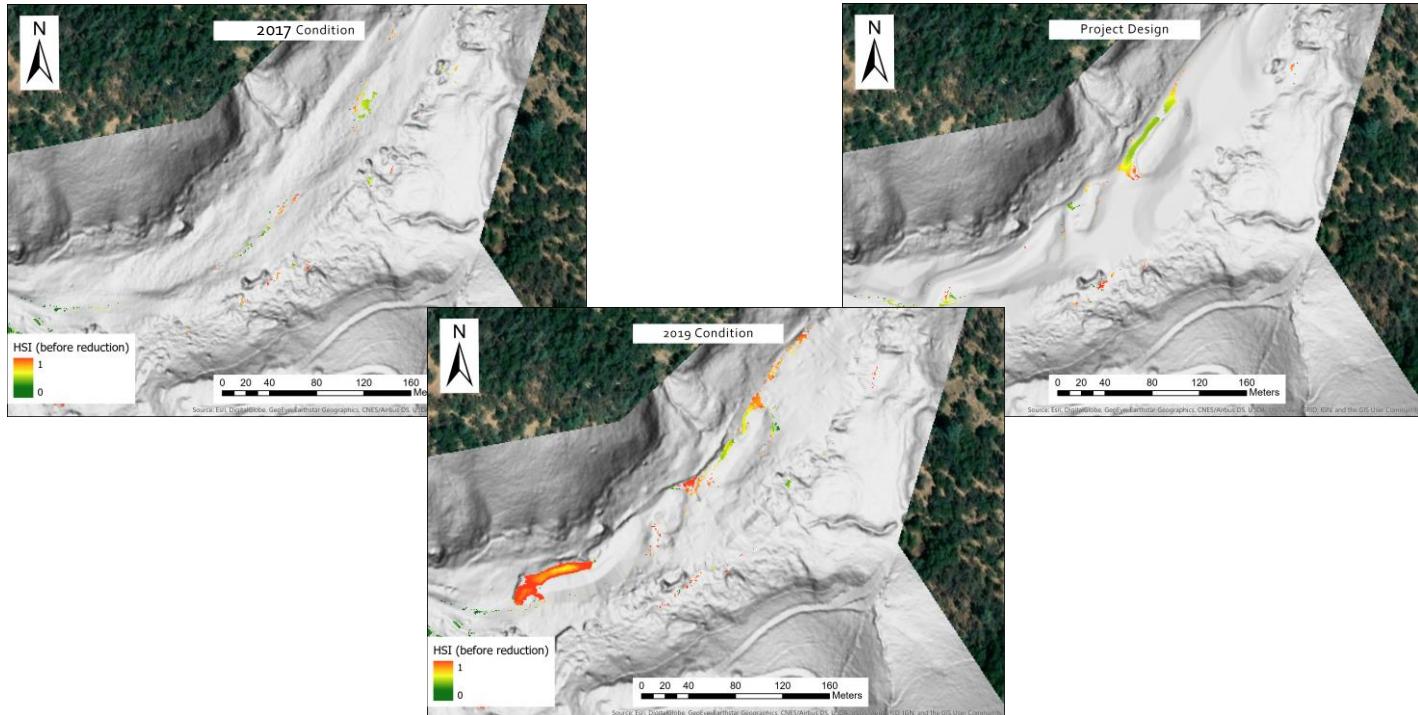


- ▶ Identify habitat areas which become disconnected during flow reductions (locations without escape routes)
- ▶ Produces output metrics to quantify stranding risk: disconnection frequency, quality of disconnected habitat, etc.



Ecohydraulics: Habitat Connectivity

- ▶ Identify habitat areas which become disconnected during flow reductions
- ▶ Produces output metrics to quantify stranding risk: disconnection frequency, quality of disconnected habitat, etc.



Project Maker

- Site-wise metrics
- Terraforming volume cost assessment
- Automated vegetation plantings & other bioengineering placement
- Automated cost-benefit (ecological) assessment

River Architect

Units Close Aquatic Ambiance

Get Started Lifespan Morphology Ecohydraulics Project Maker

Welcome to the project maker GUI.info - buttons help identifying requirements for running individual modules.

START: DEFINE AND VALIDATE VARIABLES

Project version: (3-digits: v+INT+INT, example: v10)

Project name: (CamelCase string, no spaces, example: MySite)

VALIDATE VARIABLES

ASSESS, DELINEATE AND STABILIZE PLANTINGS

Do not plant where expected lifespans are less than: years (float number, example: 2.5)

Stabilize plants where expected lifespans are less than: years (should be higher than above value)

Select plant Max Lifespan Condition:

Place best vegetation plantings

TERRAIN STABILIZATION

Critical lifespan: years (float number, example: 2.5)

Select bioeng. MaxLifespan Condition:

Stabilize terrain

NET GAIN IN SEASONAL USABLE HABITAT AREA

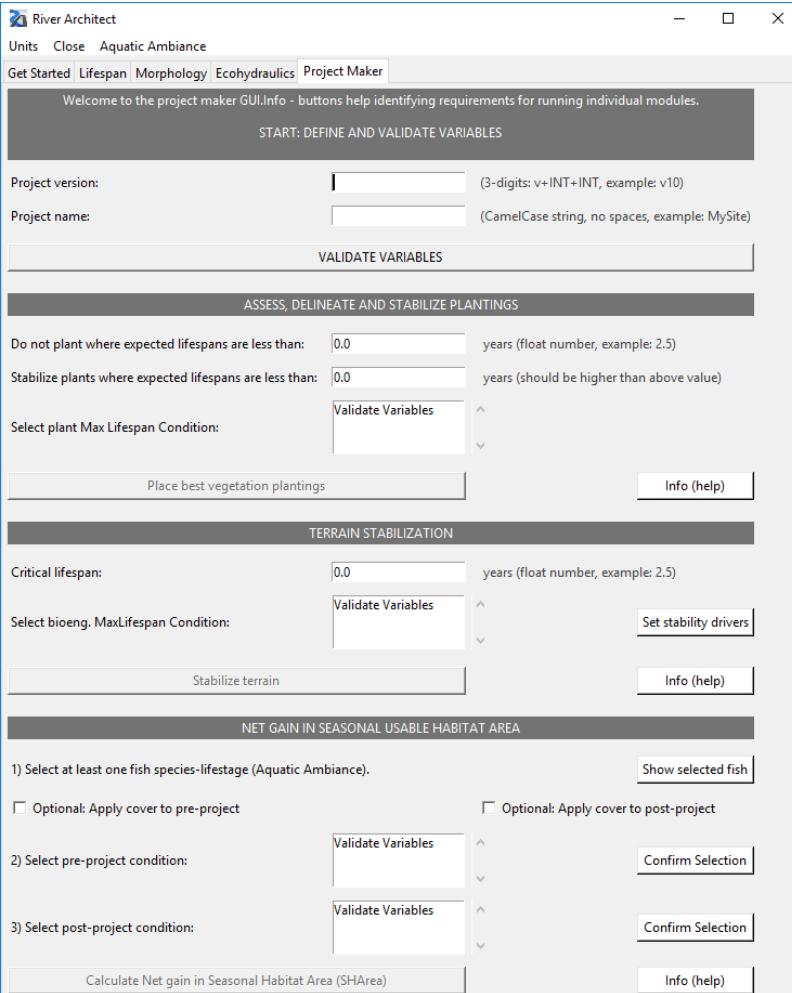
1) Select at least one fish species-lifestage (Aquatic Ambiance).

Optional: Apply cover to pre-project Optional: Apply cover to post-project

2) Select pre-project condition:

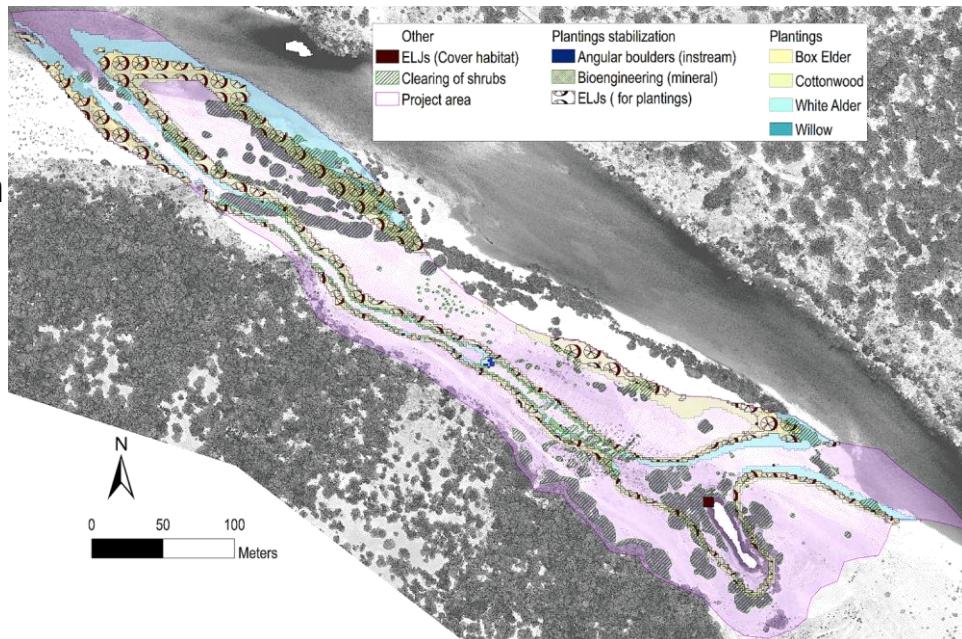
3) Select post-project condition:

Calculate Net gain in Seasonal Habitat Area (SHPArea)



Lifespan mapping

- ▶ Use for planning terraforming actions: Manual action required
- ▶ Use for full-automated planning of vegetation plantings & other bioengineering features
- ▶ And more ...
 - ... gravel augmentation
 - ... streamwood
 - ... mass movement



Project Maker

| Unit System: U.S. Customary | | | | | | | |
|--|---|-------------|-----------------------------|----------|--|--------------------------------|--|
| Site: Newba Bend | | | Total costs: \$7,862,071.42 | | Project return (US \$ per ac net gain in SHArea) \$4,985,857.56 | | |
| Layer | Task | Costs per | Unit | Quantity | Total (US \$) | Remarks | Literature Sources |
| Framework (terraforming) | Clearing (vegetation) | \$ 220.00 | acre | 2.5 | \$545.99 | | LCH (2012) CCC (2003) |
| | Excavate/fill alluvial material (includes transport) | \$ 23.00 | yd ³ | external | \$4,390,700.00 | Use terraforming_volumes sheet | King et al. (1994) LCH (2012) |
| | Groin cavities | \$ 1,200.00 | piece | | \$0.00 | | Zeh (2007) |
| SUM (Terraforming) | | | \$4,391,245.99 | | | | |
| Bioengineering (stabilization) | Anchoring (logs for plant stability) | \$ 80.00 | yd ⁴ | 0.0 | \$0.00 | refers to log length | LCH (2012) |
| | Engineered log jam, log-wise (for plant and terrain stabilization) | \$ 775.00 | log | 0.0 | \$0.00 | log length = 25 ft, Ø = 24 in | Cramer (2012) Virginia University (2004) |
| | Engineered log jam: root-wise | \$ 49.88 | rootwad | | \$0.00 | | King et al. (1994) Zeh (2007) |
| | Streamwood (non-anchored) | \$ 775.00 | log | 0.0 | \$0.00 | | Cramer (2012) Knutson (2015) |
| | Angular boulder placement (instream) | \$ 150.00 | yd ² | 0.0 | \$0.00 | | Zeh (2007) Cramer (2012) |
| SUM (Plant-stabilizing bioengineering) | | | \$0.00 | | | | |
| Planting | Ball method (small trees) | \$ 210.00 | piece | | \$0.00 | | Zeh (2007) |
| | Container trees | \$ 33.00 | tree | | \$0.00 | | Virginia University (2004) Knutson (2015) |

... Project key metrics

| APPLICATION OF FEES & RATES | | | | | | |
|--|-------|-----|-----|-----------------------|--|-----------------------------|
| CIVIL ENGINEERING | | | | | | |
| Site (de-)mobilization (from total costs) | 0.10 | [] | 1.0 | \$458,429.82 | | LCH (2012) |
| Unexpected (from total costs) | 0.10 | [] | 1.0 | \$458,429.82 | | LCH (2012) |
| FEES AND LICENSING | | | | | | |
| Markups (overhead, profit, insurance) and Engineering fees | 0.165 | [] | 1.0 | \$756,409.20 | | LCH (2012) Cramer (2012) |
| Permitting | 0.35 | [] | 1.0 | \$1,604,504.37 | | Johnson (2019) |
| TOTAL COSTS | | | | \$7,862,071.42 | | |



River Architect

Units Close

Get Started Lifespan Morphology Ecohydraulics Project Maker

Create New Condition

Populate Condition

Create a spatial subset of a Condition

Analyze Flows

Make Input File

Version: 0.3 (June 2019)
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RIVER ARCHITECT WIKI

► Table of Contents

River Architect serves for the GIS-based planning of habitat enhancing river design features regarding terrain, and ecological benefit. A main graphical user interface (GUI) provides five modules for general modification (terraforming) assessment of digital elevation models (DEM), habitat evaluation, and project modification.

River Architect invites to analyses and modifications of the longevity and ecological quality of rivers. An introductory module called Get Started, Lifespan, Morphology (Terraforming) and Ecohydraulic assessment creation of project plans and cost tables with a Project Maker module.

Lifespan maps indicate the expected longevity of restoration features as a function of terrain change. Design maps are a side product of Lifespan and design mapping and indicate required feature dimensions to avoid their mobilization during floods (more information in Schwindt et al. 2019). Best Lifespan map restoration features and assign features with the highest longevity to each pixel of a raster. Thus, the Lifespans among comparable feature groups such as terraforming or vegetation planting species.

Morphology (Terraforming) includes routines to Modify Terrain for river restoration purposes. Current value-based terrain modifications in terms of grading or widening / broaden rivers for riparian forest or valley. A Volume Assessment module can compare an original (pre-project or pre-terraforming application) to determine required earth movement (terraforming volumes) works.

Ecohydraulics assessments include the evaluation of the ecohydraulic state and connectivity of rivers. It applies user-defined flows (discharges) for the spatial evaluation of the habitat suitability index (HSI) and suitability results from 2D hydrodynamic numerical model outputs of flow depth and velocity. Also, a boulder, vegetation, and streamwood. The Habitat Connectivity module provides insights into the connectivity to enhance the survivorship of fry / juvenile fish.

The Project Maker module creates a detailed project plan and cost table for the selected feature.

download <https://riverarchitect.github.io/>

docu https://riverarchitect.github.io/RA_wiki/

maintenance S. Schwindt, K. Larrieu, G. Pasternack