Integrating Riverscapes: Guidance for Restoring and Reconnecting Floodplains in the Columbia River Basin

BPA Tributary Technical Team

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Outline

- Background
  - BPA Tributary Habitat Program
  - Tributary Technical Team
  - Goals or our review
- Assessing watershed and floodplain conditions
- Prioritizing floodplain projects
- Project design, permitting, and implementation
- Monitoring and evaluation
- Adaptive management

Background – ESA Tributary Habitat Program

- Floodplain Restoration critical to BPAs
  - ESA Tributary Habitat Program and
  - FCRPS Biological Opinion (BiOp)

- BiOP requires Action Agencies establish:
  - Tributary Habitat Steering Committee (THSC) to over Tributary Habitat Program
  - Tributary Technical Team (TTT) to provide scientific guidance to support implementation of the Tributary Habitat Program

MF John Day R. Vincent to Vinegar – CT Warm Springs

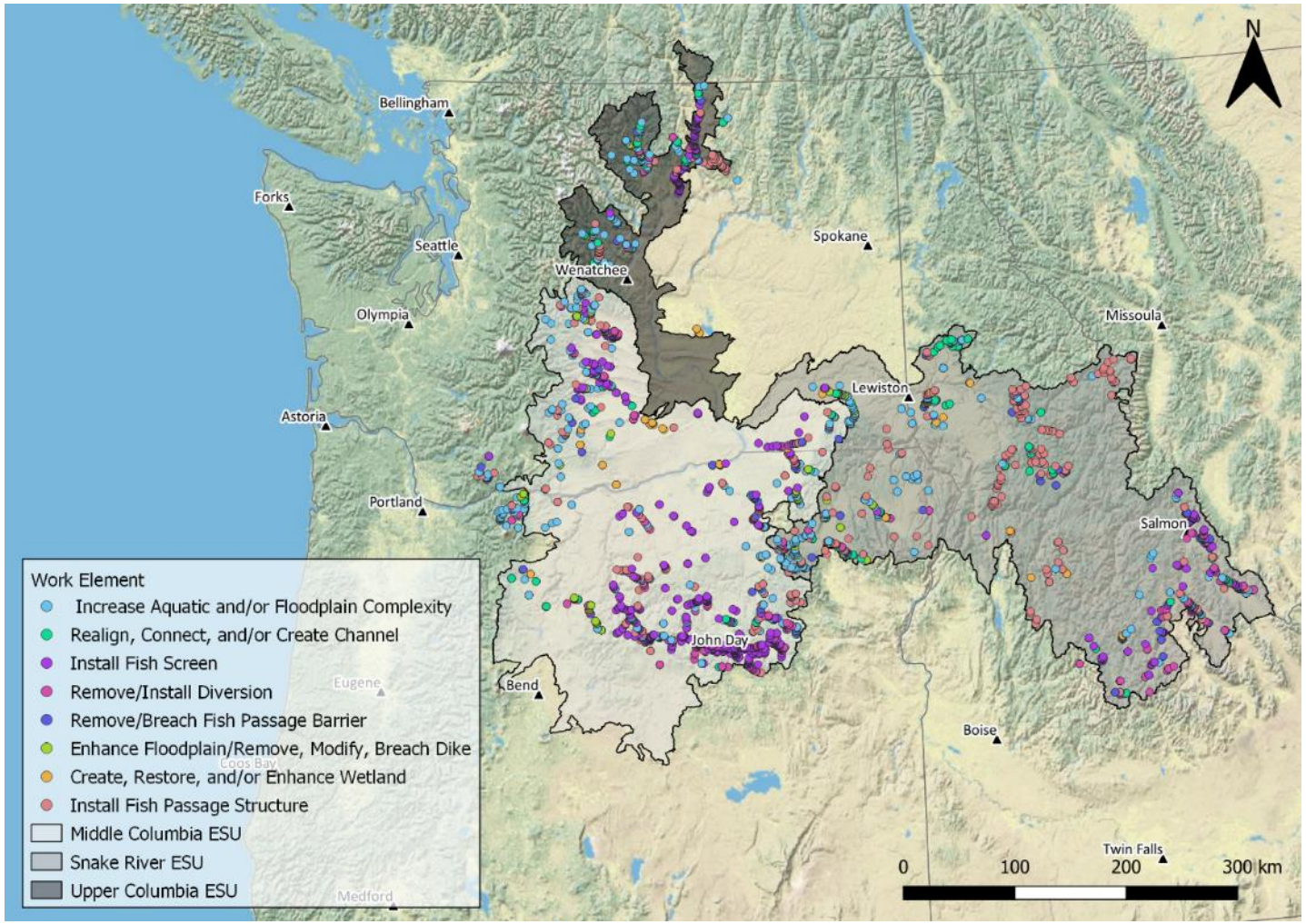
Background - Floodplains

- Some of the most ecologically important, diverse, and productive aquatic and riparian habitats
- Some of the most anthropogenically degraded areas.
- Longitudinal, lateral, and vertical disconnected
- Critical habitat for listed salmonids

Grande Ronde Longley Meadows – CTUIR

Floodplain Projects in CRB

- Increasing number, size, scope, complexity projects
- Number of newer techniques
- Varying degrees of project success
- Need for guidance on best practices to maximize success.
- THSC tasked the TTT with synthesizing the latest science to provide guidance on floodplain restoration projects

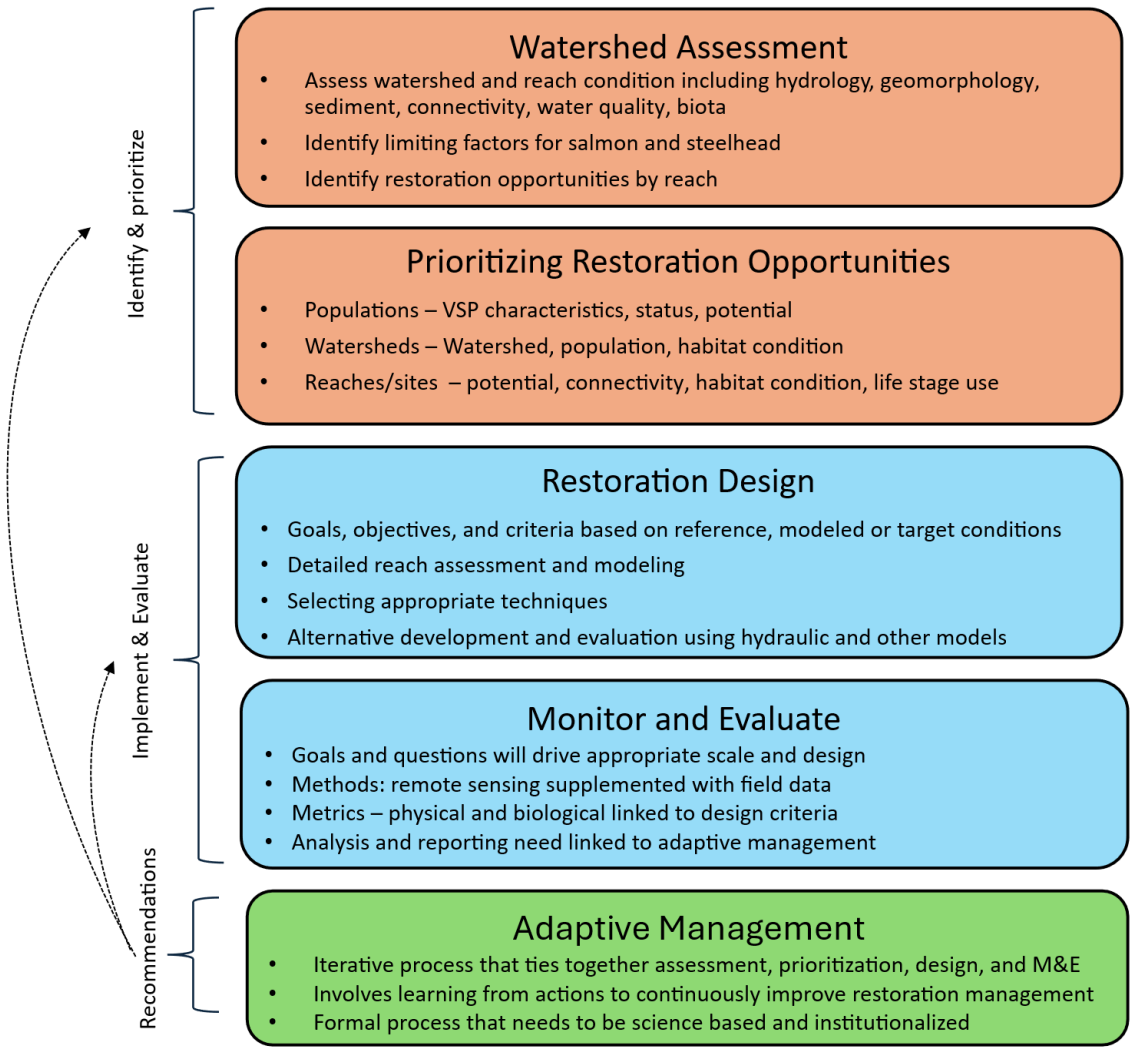


Goals of our Review/White Paper

- Reviewed and synthesize the latest science and outline approaches, methods, and best practices for floodplain restoration including:
  - Watershed assessments to identify opportunities
  - Prioritizing floodplain projects
  - Designing floodplain projects,
  - Evaluating floodplain projects
  - Adaptively managing program and projects

- Successful floodplain restoration requires integrating these five areas a across multiple spatial and temporal scales.

- We provide a summary of key findings and recommendations for each of these five areas



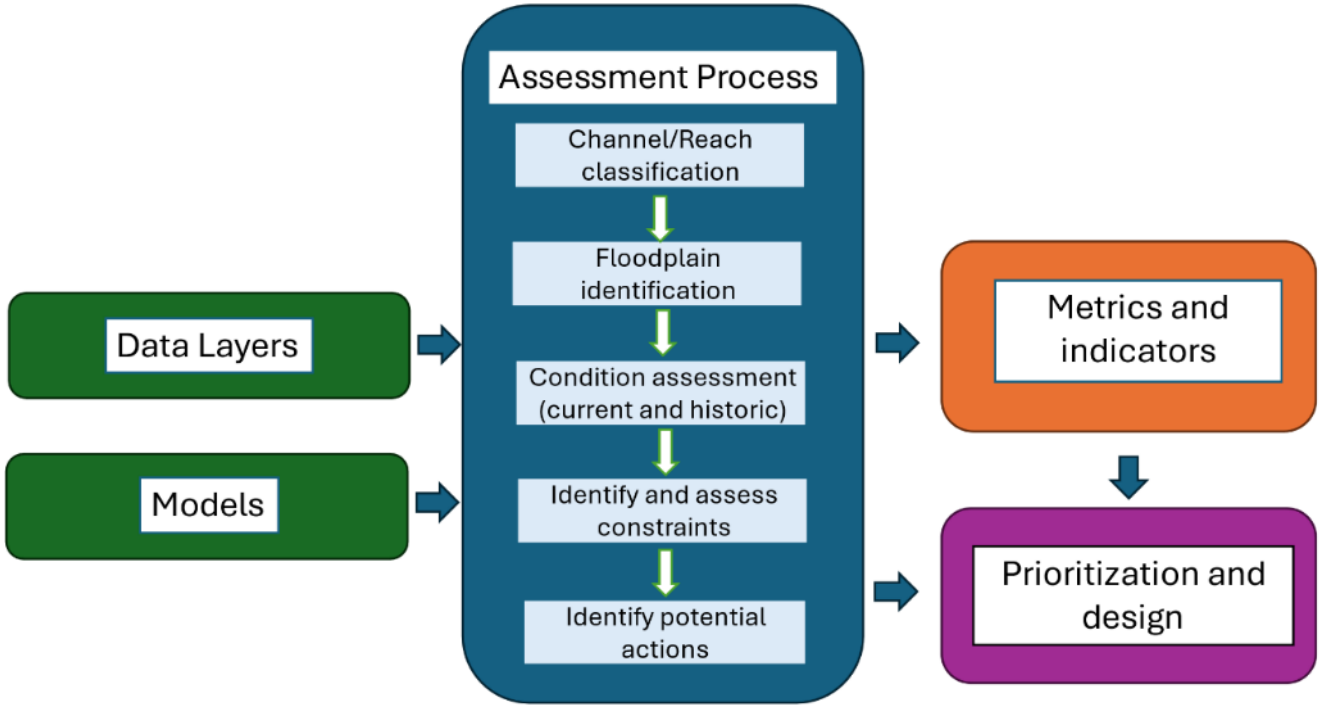
Watershed Assessments:

Assessing conditions and identifying restoration opportunities

- Multiple assessments tools and regional models exist

- Key components
  - Reach classification
  - Floodplain delineation
  - Historic and current condition
  - Identify potential actions

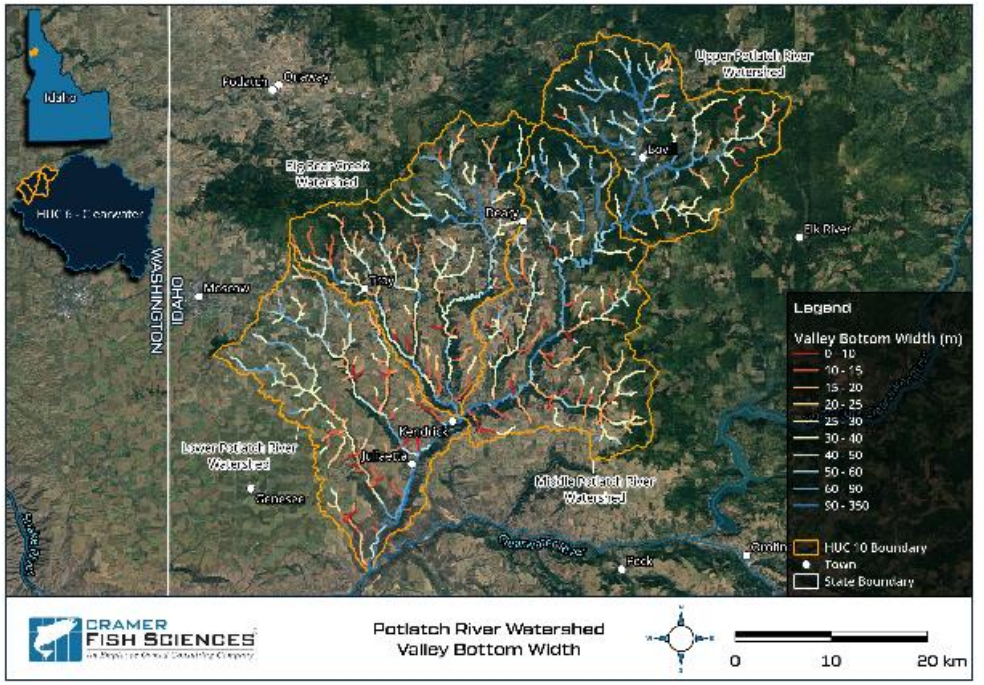
- Assessment provides
  - Important info for prioritization
  - Background info designing projects

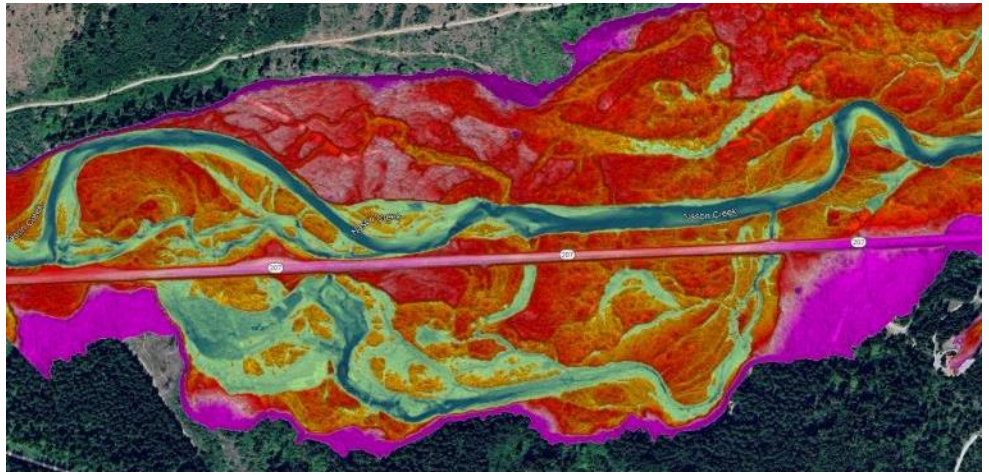


Reach and Floodplain Classification

- Consistent reach classification
  - Beechie and Imaki (2014)
  - Rosgen (1994)
  - River styles (Brierley & Fryirs 2013)

- Delineate floodplains
  - Several approaches
    - Valley bottom width
    - Stage 0 Potential (UCSRB)
    - Floodplain mapping
    - Beaver potential





Current and Historic Condition – Need minimum/consistent data layers

- Geomorphology
- Channel and habitat conditions
- Vegetation
- Hydrology and sediment
- Temp and water quality
- Infrastructure, land-use, ownership
- Fish and other biota
- Climate trends

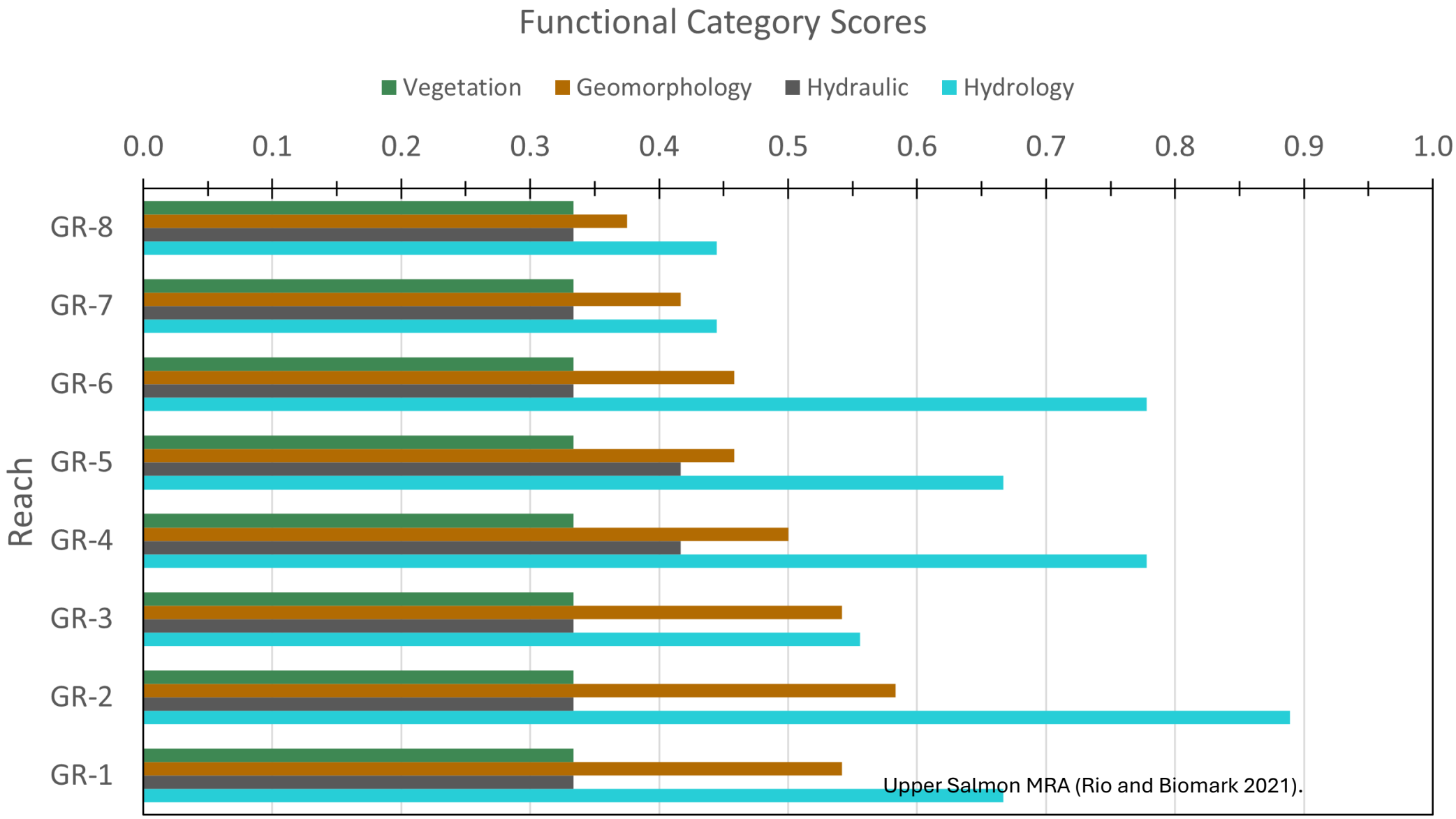
Available GIS Data Layers and Coverage

Data or Model	Coverage	Reference or source
Predicted channel type	Columbia Basin	Beechie and Imaki 2014
Valley bottom/floodplain	Columbia Basin	Predicted 100-yr floodplain maps
Beaver Rest. Assess. Tool	Select watersheds	https://brat.riverscapes.net/
Geomorphic reach types	Select watersheds	UCSRB
Land cover classification	All NHD 1:100K reaches	EPA, USGS
Historical riparian	Columbia Basin	NOAA in press
HARP riparian	Select watersheds	NOAA NWFSC
Norwest Temp	Columbia Basin	Isaak et al. 2017
H_20 temperature	CONUS hydroregion 17	Siegel et al. 2023
Stream flow	Select watersheds	USGS.gov;
Water quality	Columbia Basin	EPA.gov; OR, WA, ID, HUC12 maps
HARP physical habitat	Select watersheds	NOAA Fisheries http
Fish Data Analysis Tool	Columbia Basin	Isaak et al. 2024
Chinook capacity	Columbia Basin	Bond et al. (2018)
Intrinsic potential	Columbia Basin	UCSRB
Barriers	Most basins	OR, WA, ID
Redd data	Select watersheds	Various sources

Synthesize to determine condition

Stream Name – Tributary (T) – Reach (R)	Sinuosity	Grad. (%)	BFW (m)	Valley width (m)	Trees/100m (30%)	Anabranch Index	AWS (af)	Confinement (class)	MQIm	MQIm Class	Dominant Valley Geology
Bedbug Creek - R0.0	1.24	1.6	7.69	26.66	8.02	1	0.17	Partly Confined	0.68	Moderate	Alluvial deposits
Bedbug Creek - R0.5	1.44	0.9	5.85	31.93	6.26	1.02	1.51	Partly Confined	0.58	Moderate	Alluvial deposits
Bedbug Creek - R3.0	1.32	2.29	10.43	27.74	18.54	1.08	0.39	Partly Confined	0.61	Moderate	Alluvial deposits
Bergs Creek - R0.0	1.51	1.14	9.97	45.62	6.92	1.11	1.28	Partly Confined	0.63	Moderate	Granitic rocks
Bergs Creek - R1.2	1.55	1.75	5.59	21.72	7.98	1.01	0.47	Partly Confined	0.53	Moderate	Alluvial deposits
Bergs Creek - R2.5	1.33	2.44	9.94	20.00	17.95	1.08	0	Partly Confined	0.74	Good	Granitic rocks
Bethel Canyon - R0.0	1.26	3.91	7.03	21.41	15.72	1.04	0.88	Partly Confined	0.84	Good	Grande Ronde Basalt
Bethel Canyon - R2.0	1.32	3.99	6.05	16.12	11.35	1.01	0.33	Confined	0.84	Good	Grande Ronde Basalt
Bethel Canyon - R4.3	1.23	2.65	5.48	13.21	9.36	1	0.13	Confined	0.82	Good	Priest Rapids Member
Bethel Canyon - R5.4	1.31	1.84	8.84	27.73	5.03	1	0.33	Partly Confined	0.61	Moderate	Priest Rapids Member
Bethel Canyon - R6.2	1.31	1.02	6.51	35.94	5.48	1.01	1.78	Partly Confined	0.41	Poor	Alluvial deposits
Bethel Canyon - R9.0	1.3	1.19	8.48	24.15	6.57	1.03	0.58	Partly Confined	0.43	Poor	Priest Rapids Member

Synthesize data to determine condition

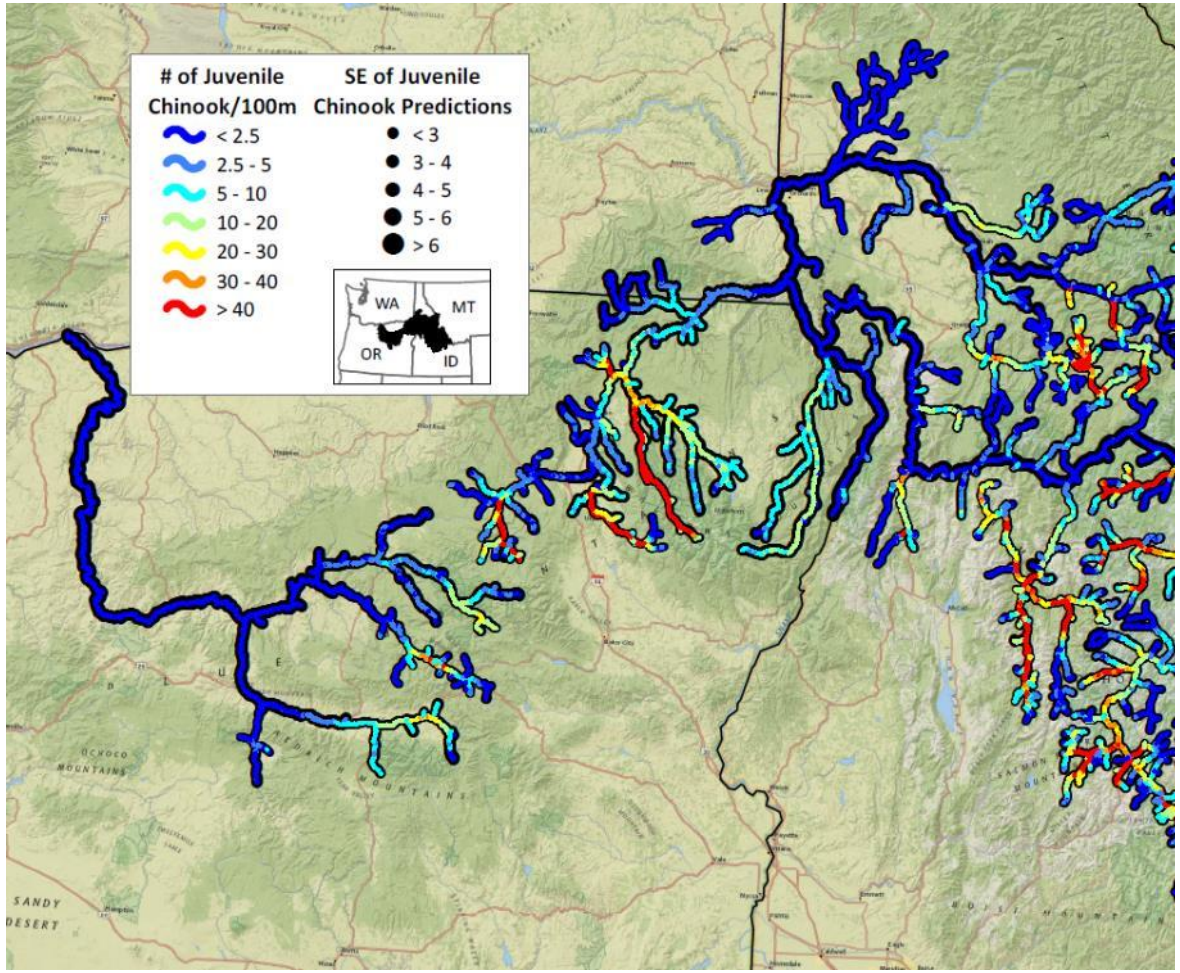


Upper Salmon MRA (Rio and Biomark 2021).

Watershed Assessments

Key Steps

- Consistent geomorphic reach classification
- Identify and delineate floodplains
- Historical, current, and future floodplain condition using consistent data layers
- Assessing potential of reaches to support fish and other key biota
- Provides important info for prioritization and design

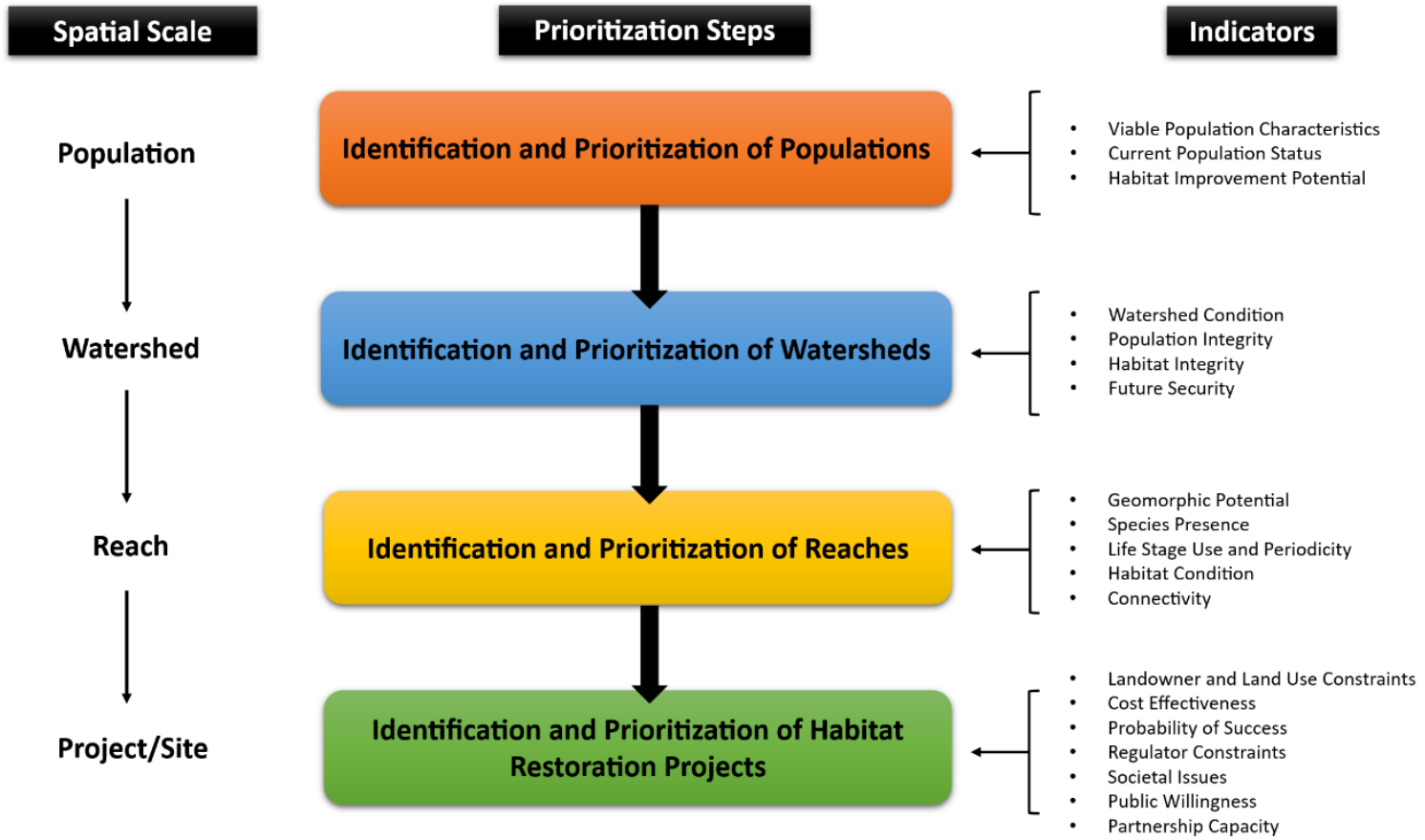


From Isaak et al. 2020

Prioritizing Floodplain Restoration Actions:

Hierarchical approaches for prioritizing floodplain projects at multiple scales

- Reviewed new & existing approaches and models
- Provide recommendations
  - Approaches
  - Scales
  - Metrics/indicators



Multi-Metrics Scoring and Ranking System

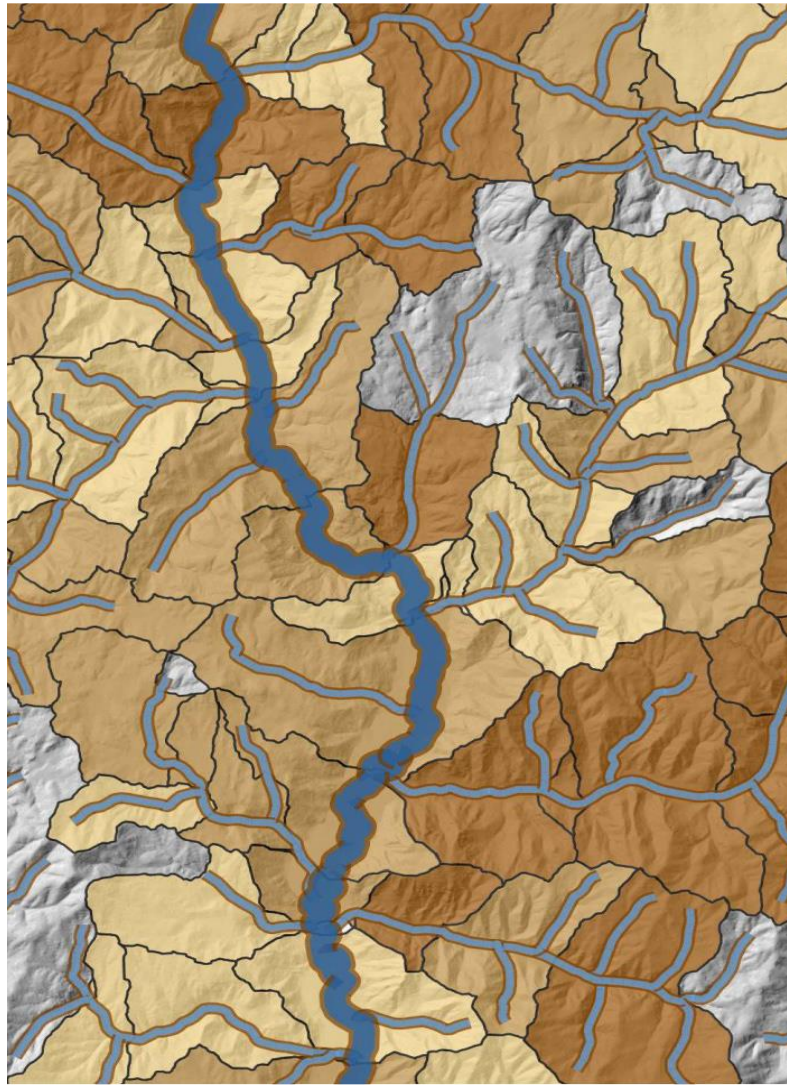
- Incorporates multiple models
- Quantitative and qualitative data
- Where possible use assessment data to score criteria

Catherine Creek Opportunities Summary

Basic Information				Feasibility Criteria									
Opportunity Name	BSR	BSR ranking	Total Biological Benefit Score	Landowner Willingness	Design Effort	Construction Effort	Site Access Effort	Site Management - Dewatering and Erosion Control Effort	Risk & Uncertainty (Goals and Objectives)	Risk & Uncertainty (Public Safety)	Regulatory Requirements Permitting Effort	Value	Comments
BSR - CCC1													
No opportunties currently identified													
BSR - CCC2a													
Opportunity GR 115.4 - 117.5	CCC2a	Tier 3	121	Yes	High	High	Medium	Low	High	High	Medium	Low	
Opportunity GR 114.45 - 115.4	CCC2a	Tier 3	82	No	TBD	Low	Low	TBD	TBD	TBD	Low	TBD	unwilling owner
Opportunity GR 113.9 - 114.2	CCC2a	Tier 3	82	Yes	Low	Low	TBD	High	Medium	Medium	TBD	Medium	
Opportunity GR 108.8 - 105.05	CCC2a	Tier 3	78	No	High	High	High	TBD	TBD	Low	High	TBD	difficult access
Opportunity GR 111.4 - 112.1	CCC2a	Tier 3	77	TBD	TBD	TBD	TBD	Medium	Low	TBD	TBD	Low	
Opportunity GR 104.85 - 105.55	CCC2a	Tier 3	69	Yes	Medium	TBD	Low	Low	TBD	Low	Medium	High	
Opportunity GR 108.45 - 108.65	CCC2a	Tier 3	68	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
Opportunity GR 106.55 - 107: Willow	CCC2a	Tier 3	56	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	

Common Prioritization Metrics:
Reach-scale examples

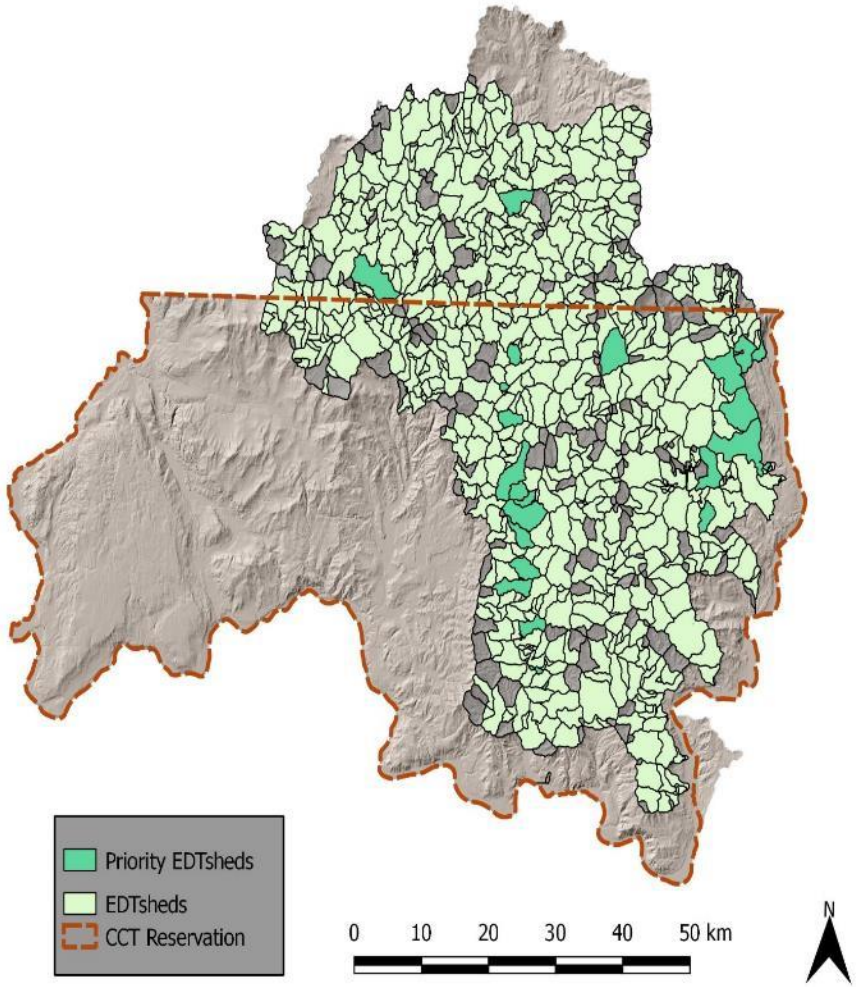
Suggested Reach-Scale Indicators	Prioritization Metrics
Geomorphic Potential	Valley Confinement – Confined, moderately confined, or unconfined
Species Presence	Number of fish species of concern using the reach
Life Stage Use	Number of life stages of target species using the reach
Limiting Factor(s)	Ability to address limiting factor within the reach
Habitat Condition	Water Temperature – Mean August temperature Stream Flows – Summer baseflow Riparian Condition – Riparian cover and disturbance Substrate – Boulder cover, spawning gravels, fines, and embeddedness Large Wood – Density of large wood Pools – Pool quality and quantity Off-channel Habitat – Side channels and floodplain condition
Connectivity	Number of fish migration barrier in the reach



Prioritization Floodplain Restoration Action

Key Points

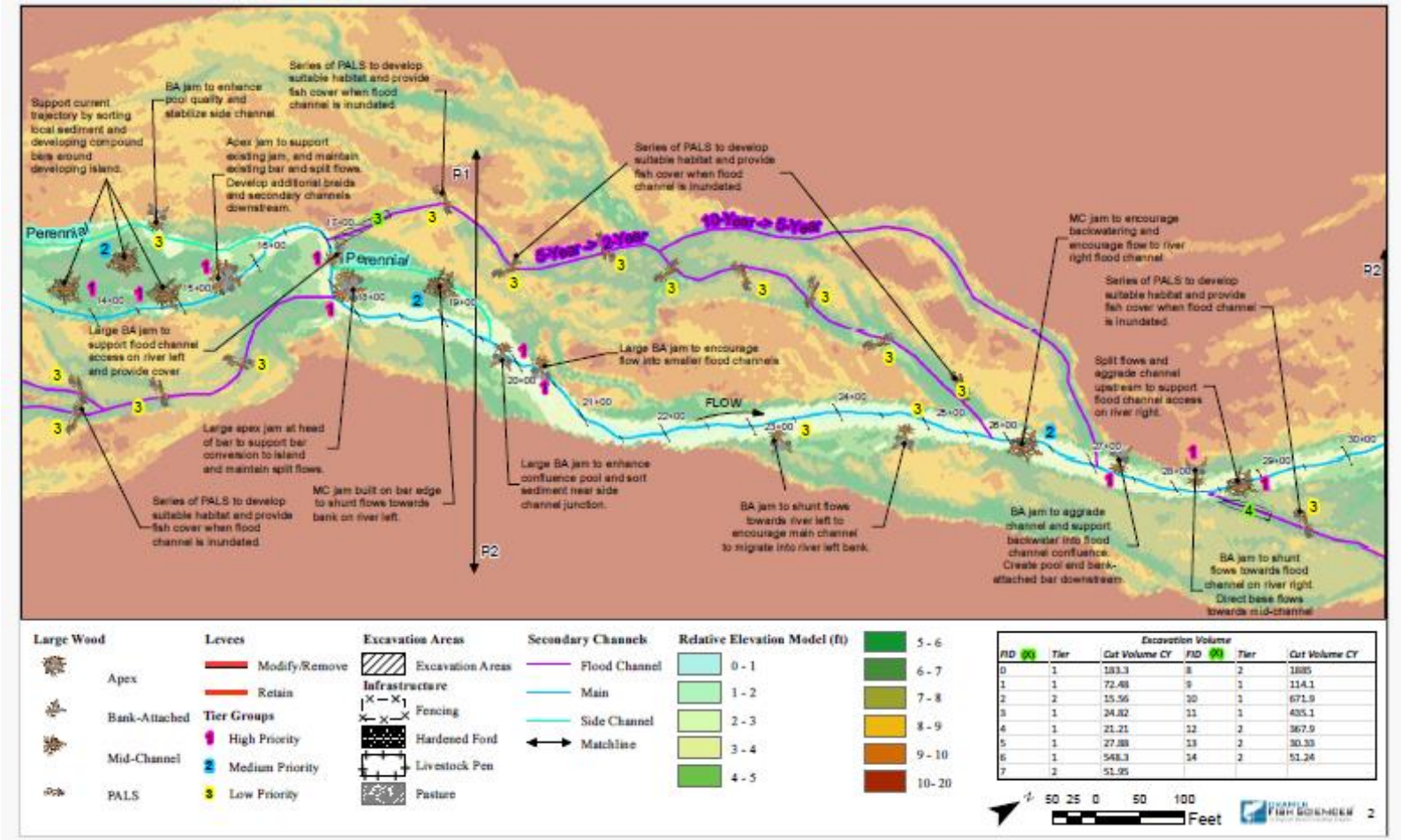
- Link to the assessment process to collect data needed for prioritization
- Occurs at multiple scales which feed into each other
- Scoring and ranking systems most tractable
- Recommend criteria for prioritizing at different scales



Designing Floodplain Restoration Projects:

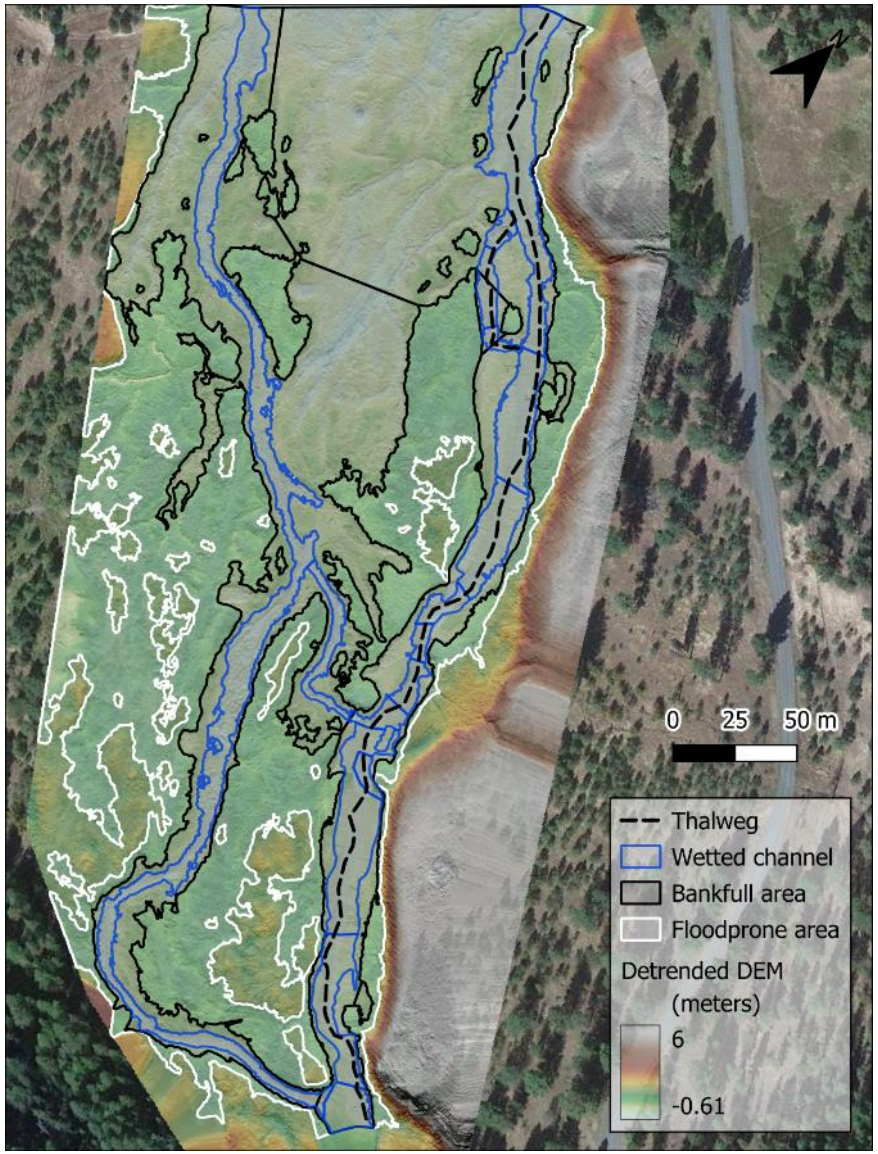
Important considerations for key elements of designing floodplain restoration projects

- Site/reach assessment
- Goals, objectives, and design criteria
- Developing and evaluating design alternatives
- Modeling to assist with design and evaluation of alternatives
- Final design and - permitting



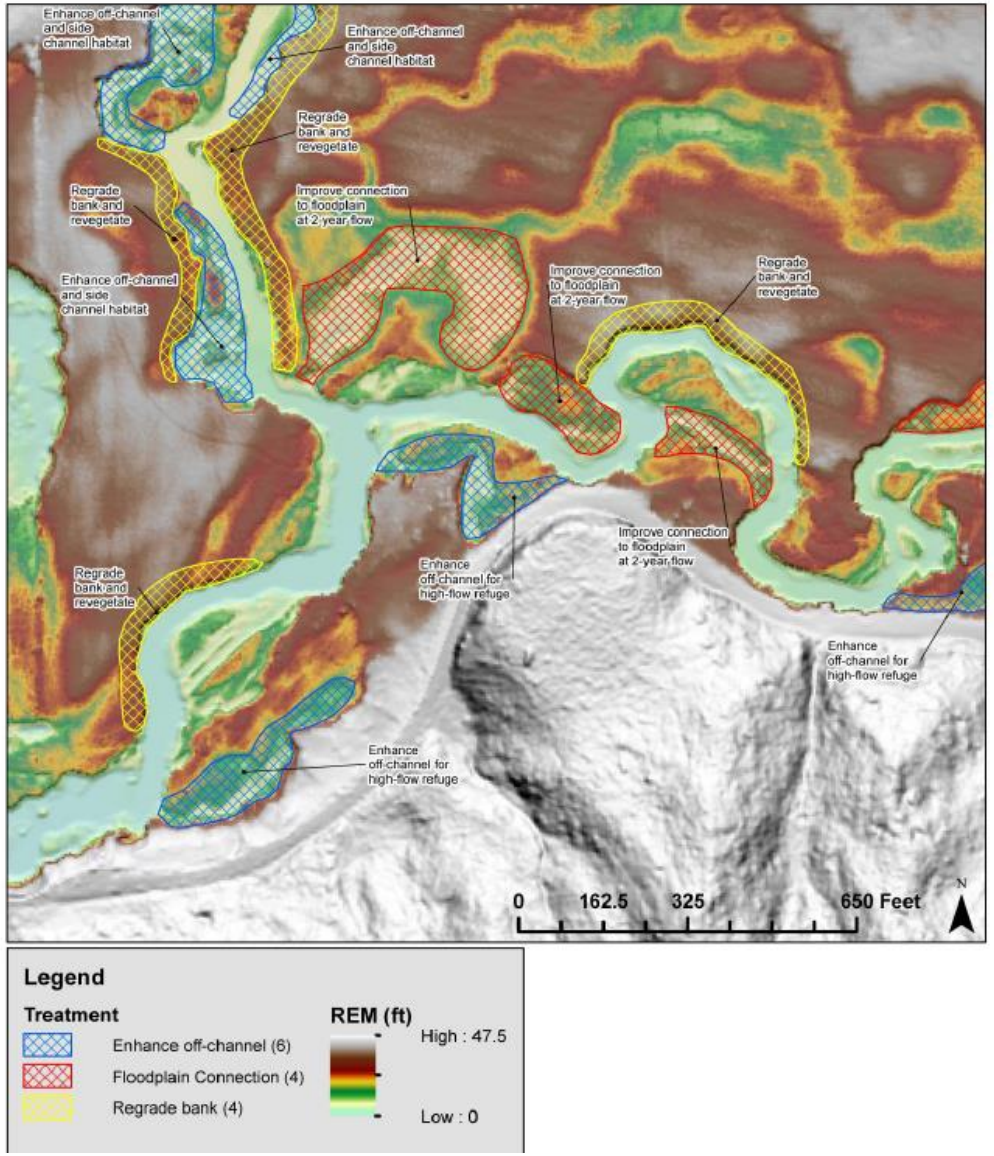
Site/Reach Assessment

- Should include assessing
  - Site's history and land use
  - Morphology, habitat, riparian condition
  - Hydrology and hydraulics
  - Site topography/bathymetry (LiDAR + field data)
  - Other physical and ecological processes
- Which is used to assist with
  - Setting projects goals and objectives and design criteria
  - Developing hydraulic model
  - Determine reference or target conditions
  - Developing design alternatives



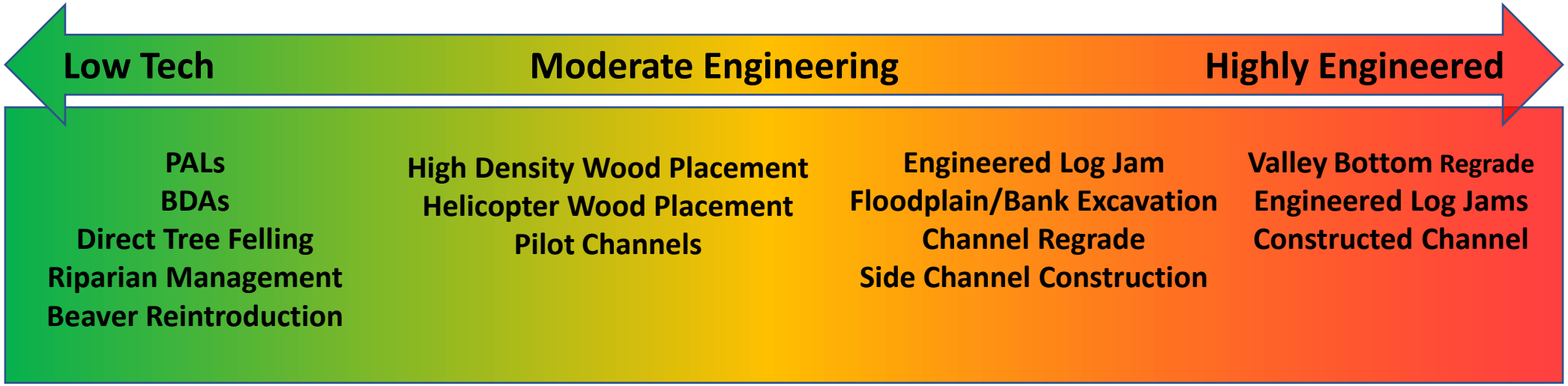
Considerations for Developing Design Alternatives

- Setting process-based goals, objectives, design criteria
- Consider suite of restoration techniques not just latest
- Determine necessary level of intervention
- Design to connect floodplain at various flows not just bankfull



Developing Design Alternatives:

determining techniques and level of intervention



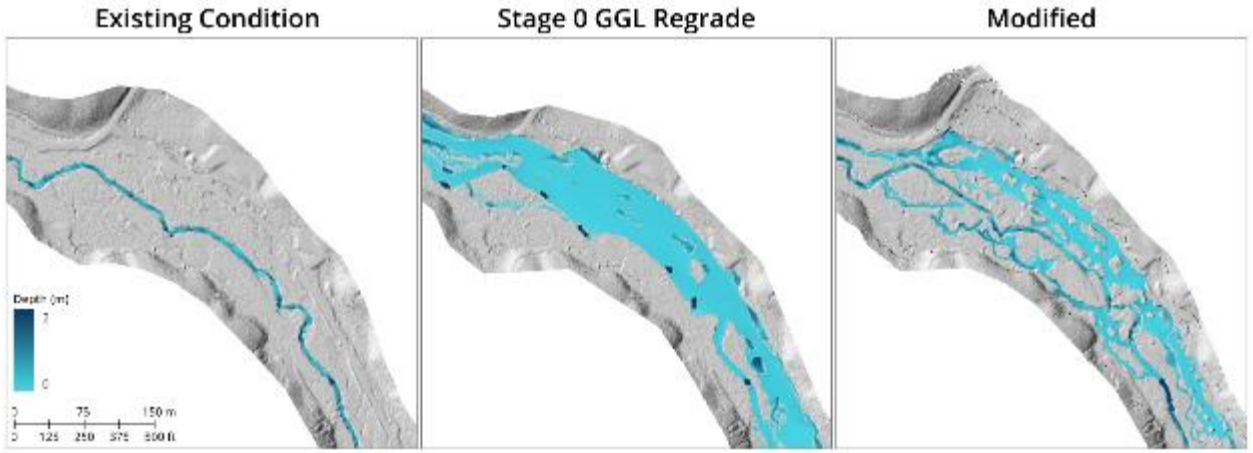
Floodplain Development: None----------Moderate----------Extensive
Depth of Incision: Low (0-1 m)----------Moderate (1-3 m)----------High (> 3 m)
Sediment/Hydrology: Intact----------Partially Modified---------- Impaired
Riparian Forest Condition: Good ----------Moderate---------- Degraded
Aquatic Habitat Condition: Good----------Moderate----------Degraded
Sensitive species use: High----------Moderate----------Low

Evaluating Alternatives

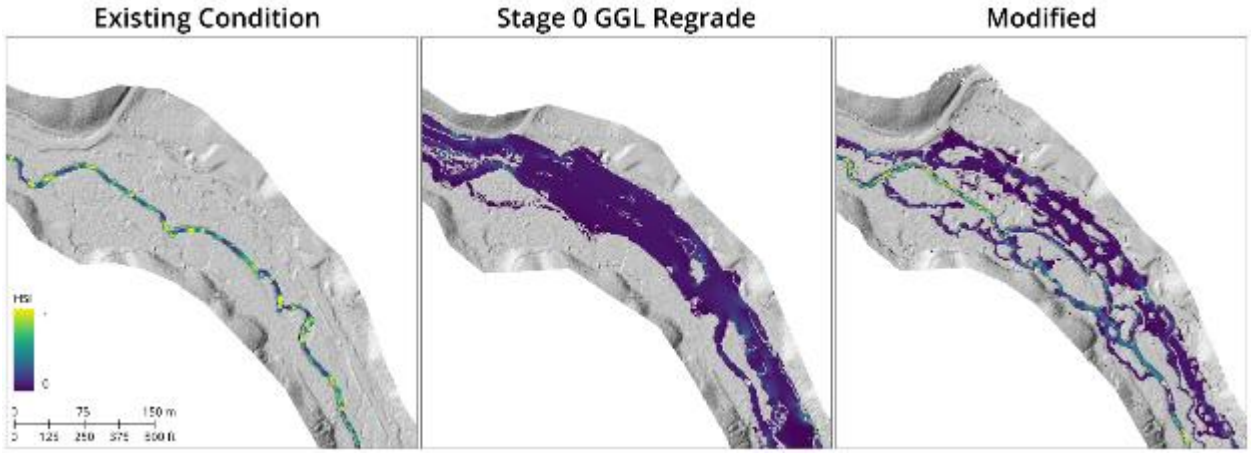
- Develop models to help evaluate alternatives
  - Hydraulic modeling*
  - Habitat suitability modeling for key species
  - Other biological models
- Consider risk, constraints and overall feasibility
- Ability to meet overall goals and objectives

level of modeling needed scaled to risk

Depth



Habitat Suitability Index



Designing Floodplain Restoration

Key Points

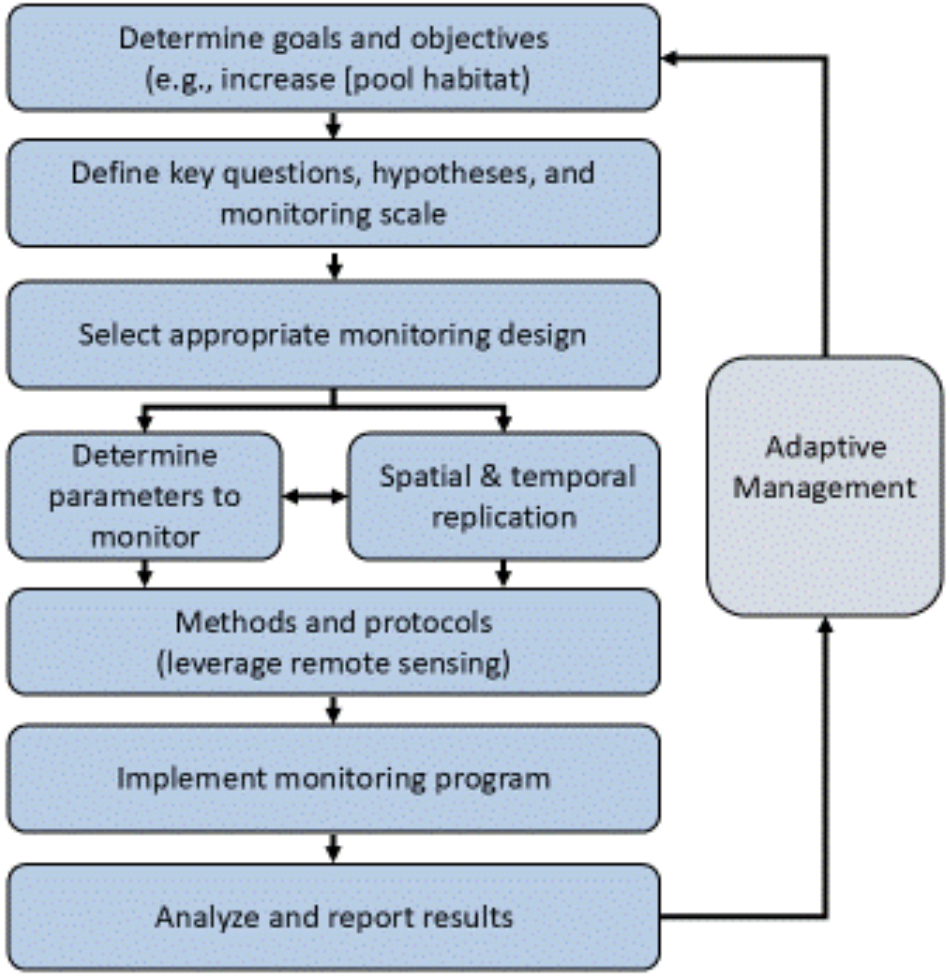
- Reach and site assessment to help
  - Set goals and objectives, target conditions
  - Data to support hydraulic model and alternatives development
- Design alternatives should consider
  - Suite of restoration techniques
  - Level of intervention, risk and feasibility
  - Floodplain connection at various flows
- Evaluate alternatives
  - Hydraulic and habitat suitability modeling
  - Ability to meet goals
  - Risk, constraints and feasibility

Attributes	Metric	Expected Change
1. Channel & floodplain	Side channel number, length, area, ratio to main channel*	H+
	Channel type*	H+
	Bankfull area or wetted area at 2-year flow*	H+
	Floodplain inundation index*	H+
	Floodplain area*	H+
	Pond and wetland area or number	M+
	Bank stability	L
2. Substrate & elevation	Aggradation and degradation	L+
	Substrate size and patch diversity	M+
	Fine sediment (instream)	L-
3. Vegetation	Riparian composition, density, richness, diversity	M+
	Organic inputs	M+
	Shade	L+
4. Hydrology & hydraulics	Increased base flow	L+
	Hydraulic diversity*	L+
	Groundwater depth	M-
	Hyporheic exchange	M+
5. Fish habitat	Pool area, percentage, and residual depth*	H+
	Fine scale geomorphic units (geomorphic unit tool)*	H+
	Shannon diversity index of habitat units	M+
	Functional large wood*	H+
	HSI juveniles and adult salmonids*	M+
6. Water Quality	Temperature	L-/+
7. Biota	Juvenile fish density	L+
	Salmonid redd location, number, and density	L+
	Macroinvertebrates	L+
	Juvenile fish capacity	M+
	Fish presence/absence (eDNA or other)	L+
9. Resilience/persistence	Above metrics maintained following >25-year event	NA

Evaluating Floodplain Restoration Projects

- Reviewed new and existing monitoring approaches

- Monitoring recommendations
  - Goals and key questions
  - Monitoring designs
  - Criteria
  - Timing of monitoring
  - Scale (project, watershed, program)
  - Methods for data collection
  - Linking to design/adapt. management

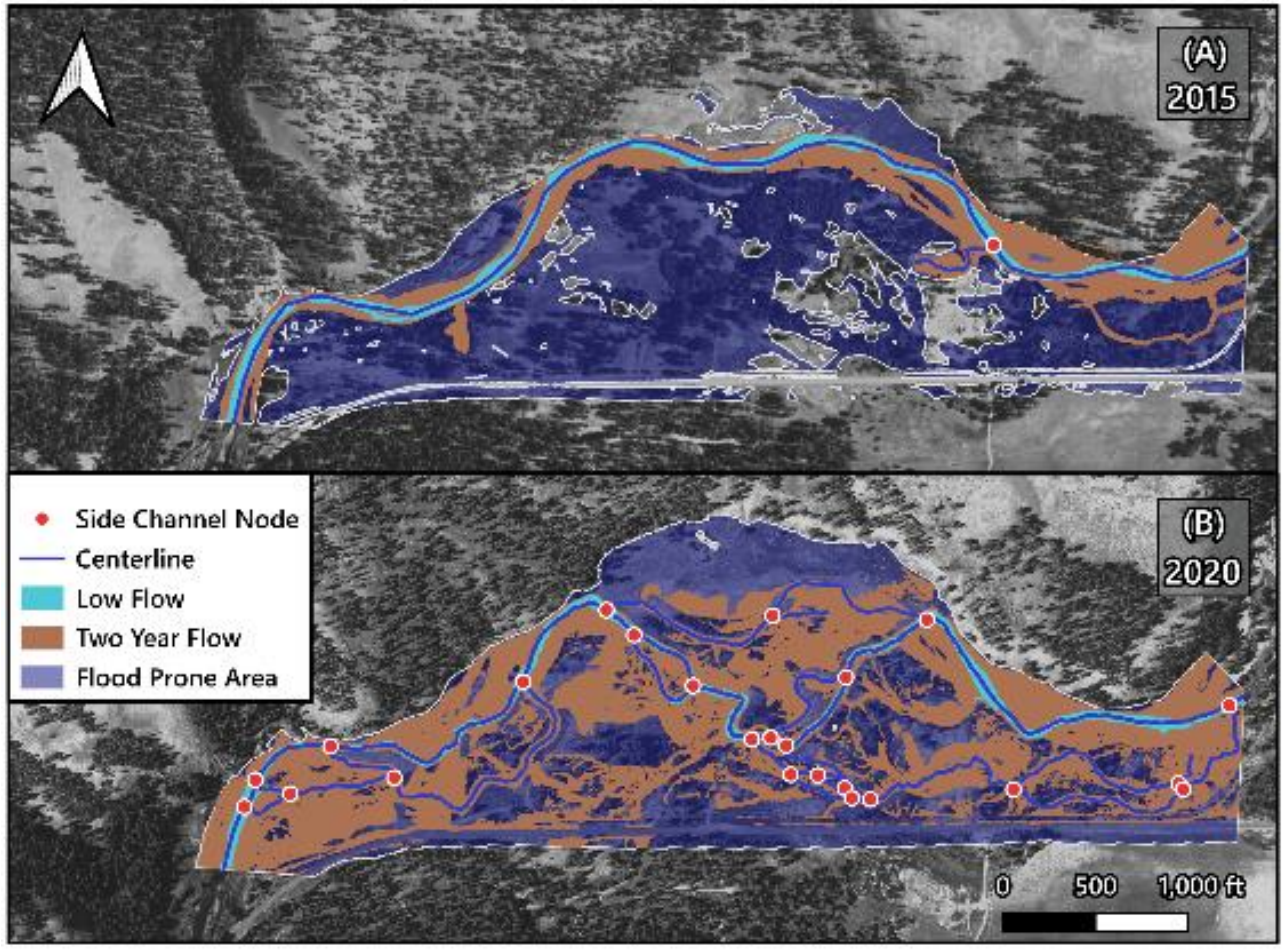


Monitoring Designs

- Lots of different monitoring designs
  - Before-After
  - BACI (before-after control impact)
  - Post-treatment (control-impact)

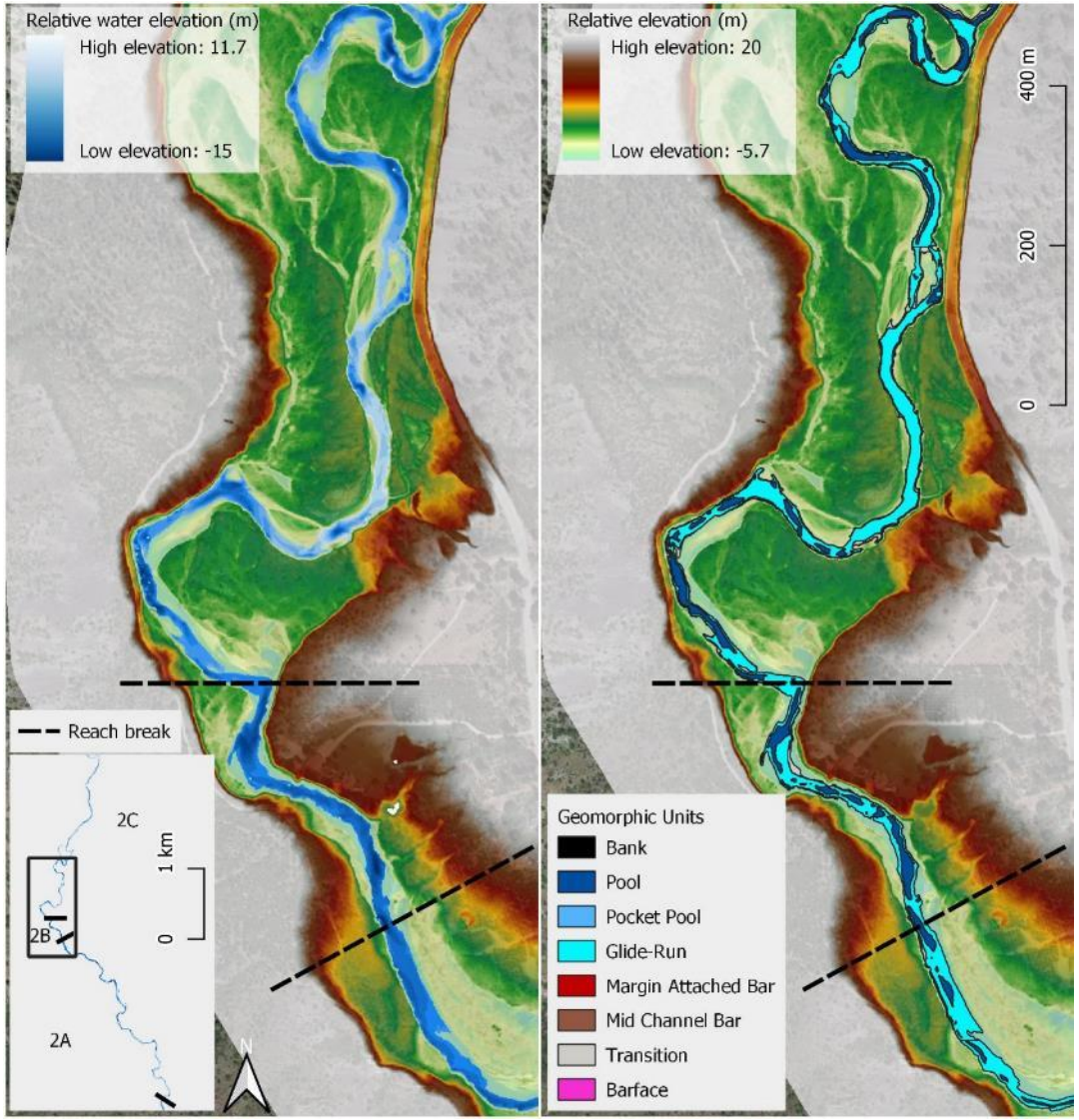
- Before-after most tractable for floodplains
  - Physical changes easy to document
  - Controls can be difficult

- BACI can be selective used for intensive biological monitoring



Leverage Remote Sensing & Hydraulic Modeling

- Allows mapping of entire floodplain and channel
- Examining response at different flows
- Assists with biological evaluation



Metrics – Link to Design Objectives & Criteria

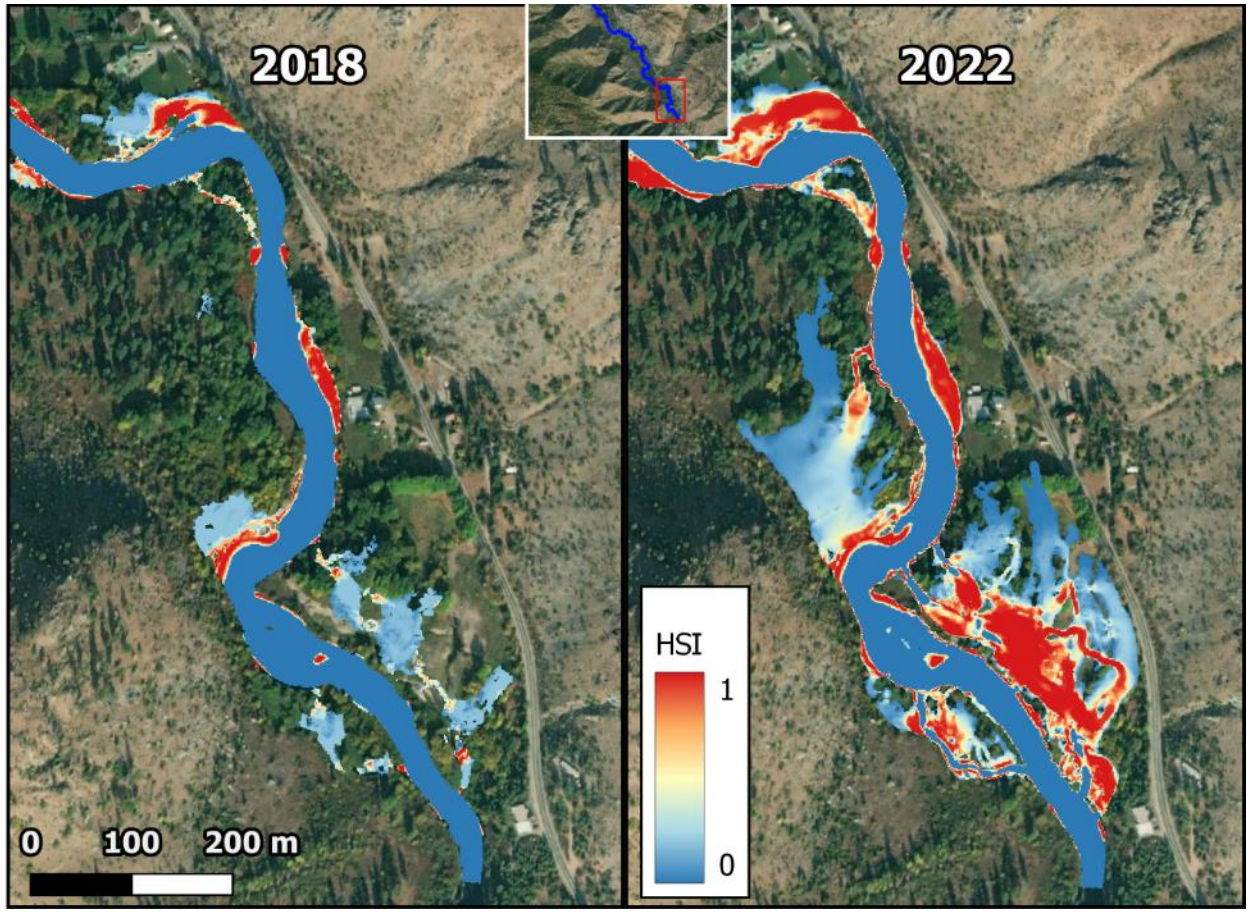
BOD Report | **M&E (LiDAR+Hyraulic Model)**

Metric	Expected change	Before	After	Change
Floodplain area (acres)	M (25-50%)	115.4	144.9	26%
Floodplain inundation index	M (25-50%)	751	820	9%
Side channels low flow (#)	M (25-50%)	0	1	100%
Side channels bankfull (#)	H (>50%)	1	13	1200%
Side channel length bankfull (ft)	H (>50%)	597	13,077	2091%
Side channel area bankfull (acres)	H (>50%)	0.70	12.0	1614%
Residual pool depth mainstem (ft)	M (25-50%)	0.85	2.84	234%
River complexity index	H (>50%)	0.04	0.53	1265%
Morphological quality index	M (25-50%)	0.64	0.90	41%
Number of pools	M (25-50%)	18	30	67%
Percent pool (mainstem)	M (25-40%)	30%	72%	140%
Large wood (pieces and jams)	H (>50%)	1	47	4600%
Juvenile Chinook HSI > 0.5 (acres)	H (>50%)	1.84	22.90	1,144%

Evaluating Floodplain Projects

Key Points

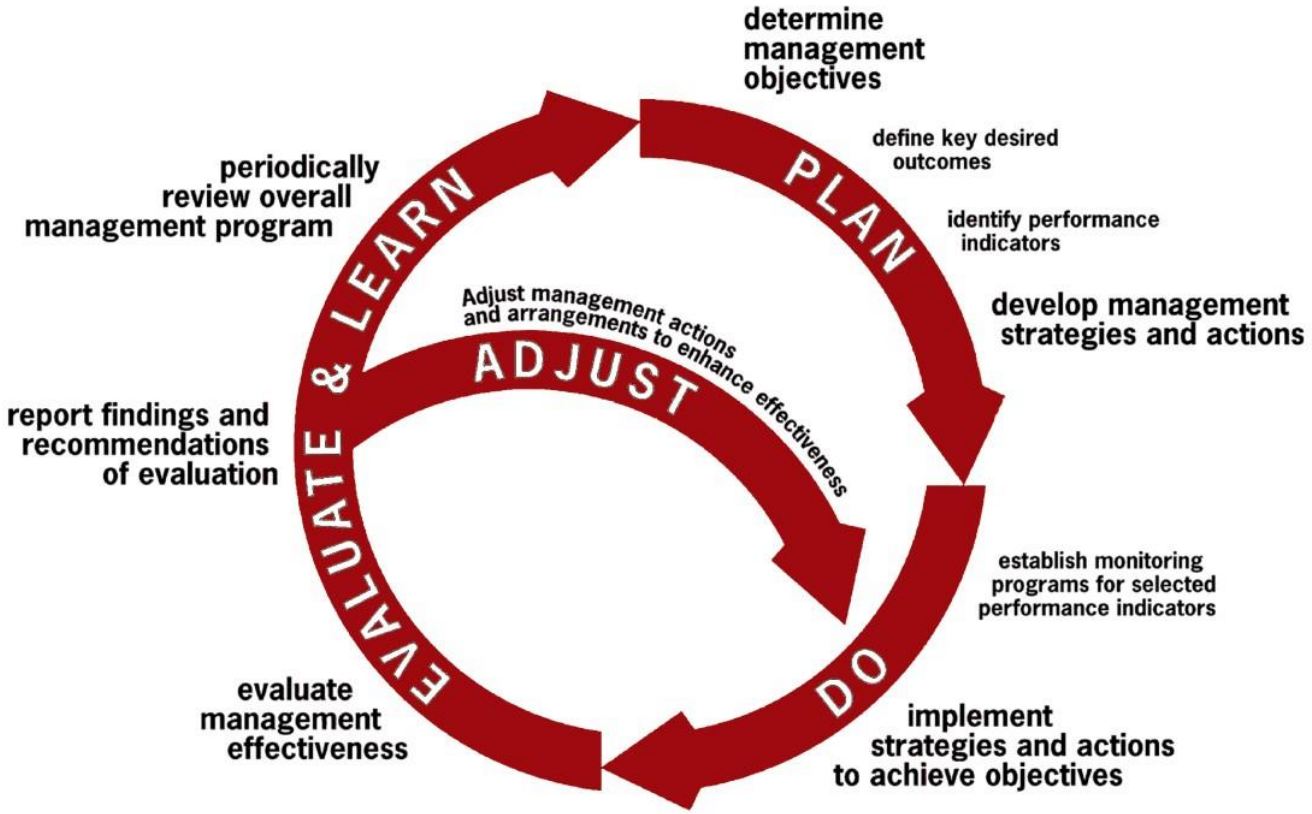
- Goals, objectives and metrics need to be linked to design criteria
- Simple before-after design is most tractable
- Flow-based rather than time-based targets
- Leverage remote sensing (LiDAR) and hydraulic modeling



Juvenile Chinook Habitat Suitability at Bankfull Flow

Adaptive Management

- Ties together all steps in restoration design and implementation process
- AM is a systematic, iterative approach that occurs at multipole scales
- We reviewed and summarized key components of adaptive management of restoration
- Provide recommendations for formalizing AM in other areas



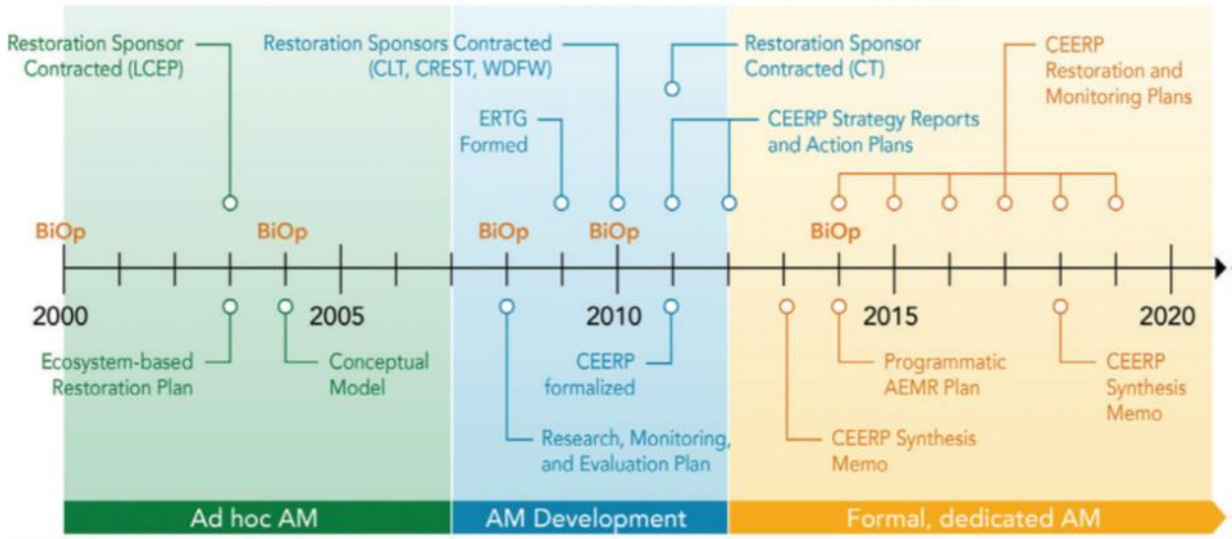
Adaptive Management

Key Points

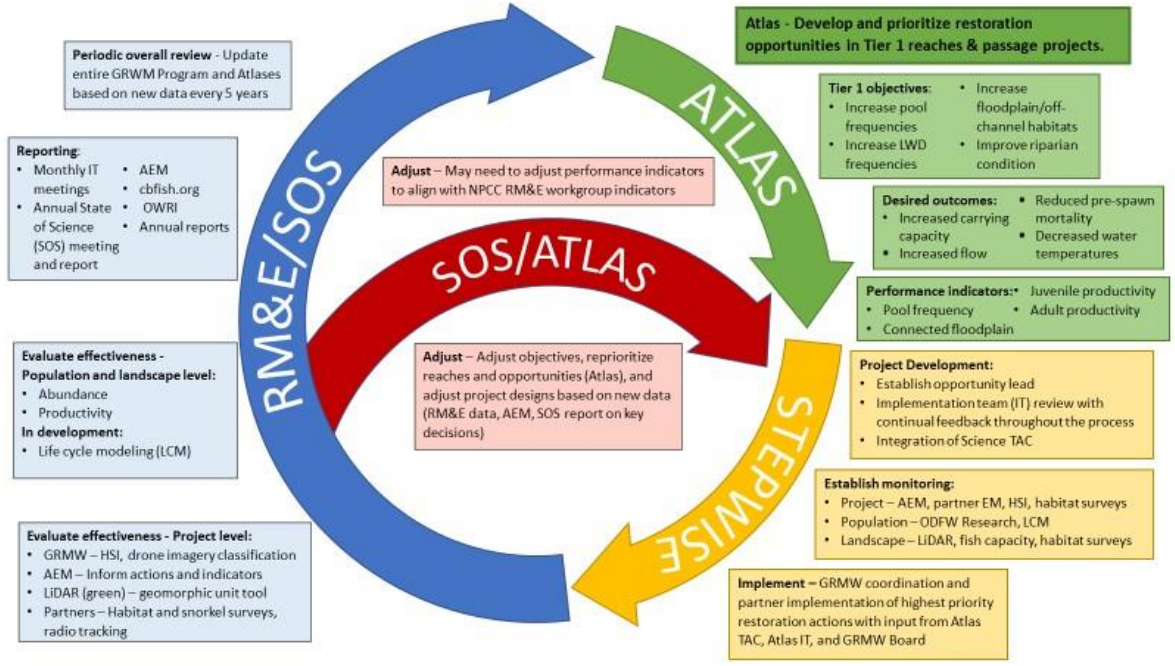
- Formalized and institutionalized into the restoration planning and implementation process

- Many watersheds have components of AM but it hasn't been formalized into decision making

Columbia River Estuary



Grande Ronde Model Watershed



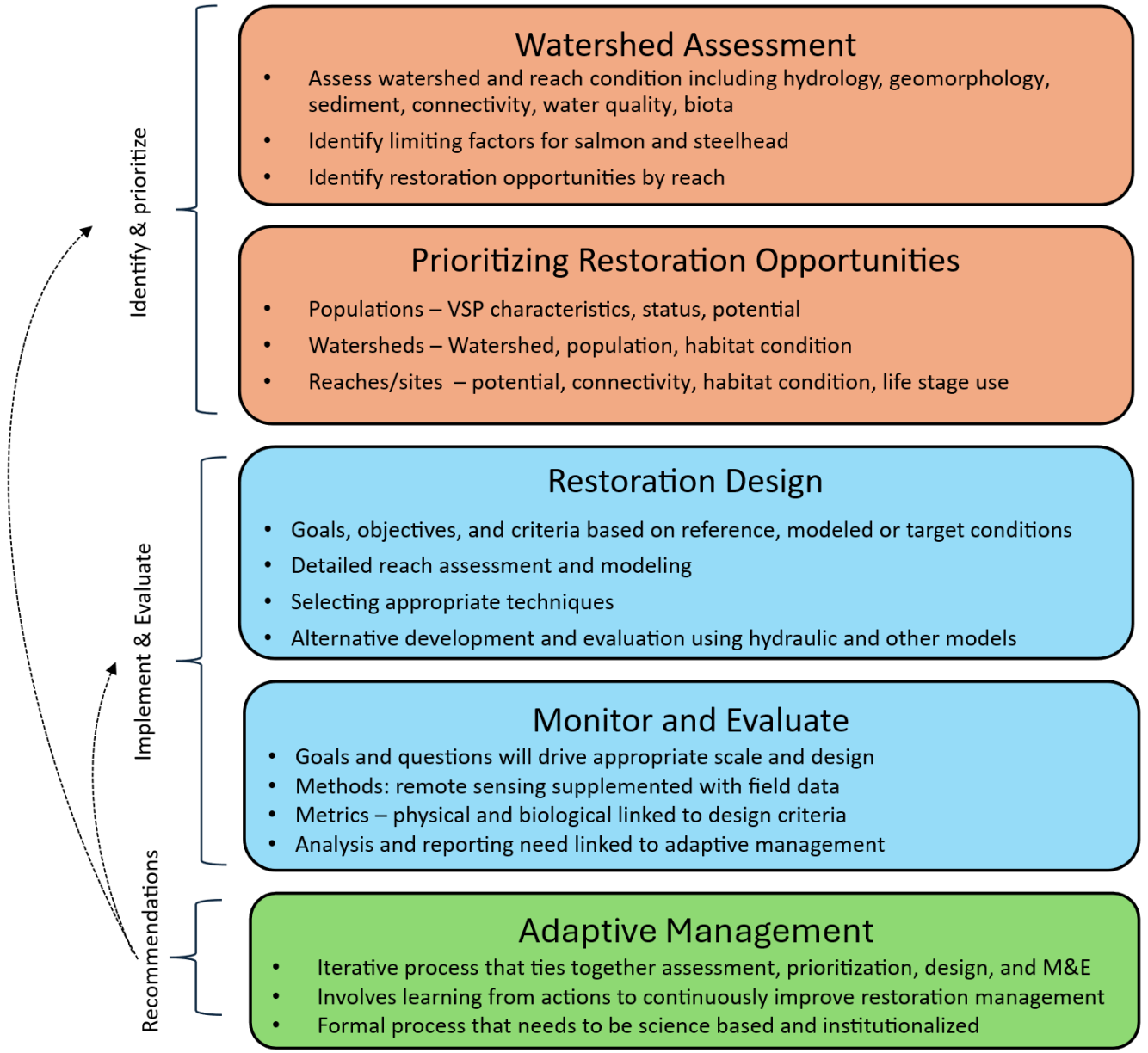
Summary

Integrating Riverscapes: Guidance for Restoring and Reconnecting Floodplains in the Columbia River Basin

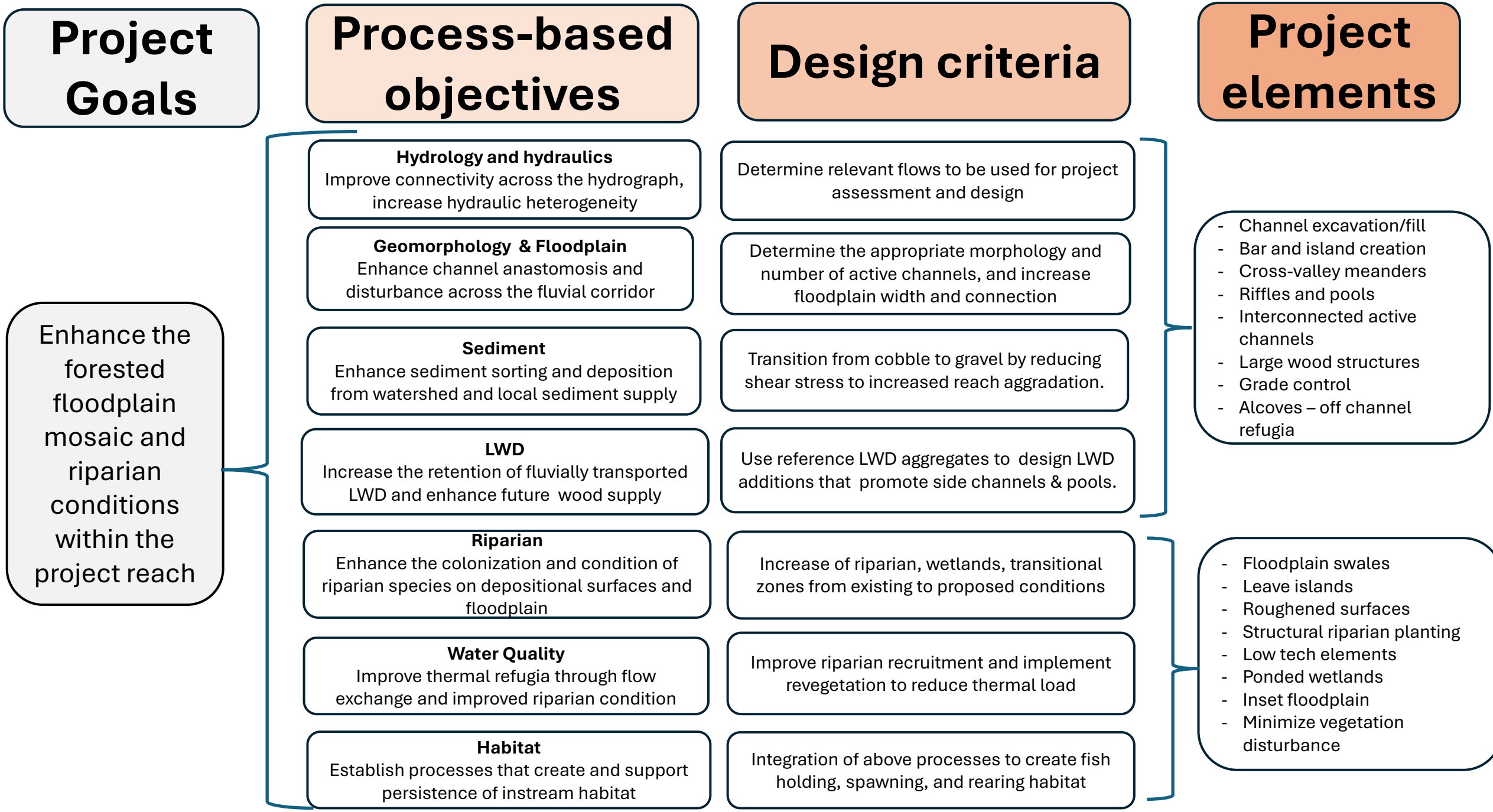
- Provide guidance for reach of key steps
  - Assessing watershed & floodplain
  - Prioritizing floodplain projects
  - Project design, permitting, implementation
  - Monitoring and evaluation
  - Adaptive management
- Successful floodplain restoration requires integrating these five areas across spatial and temporal scales

Next Steps

- Finalizing report and recommendations
- Available late February/Early March
- Provide to UCSRB to post on site




Questions?


Project Goals
Process-based objectives
Design criteria
Project elements
Enhance the forested floodplain mosaic and riparian conditions within the project reach
Hydrology and hydraulics
Improve connectivity across the hydrograph, increase hydraulic heterogeneity
Determine relevant flows to be used for project assessment and design
Geomorphology & Floodplain
Enhance channel anastomosis and disturbance across the fluvial corridor
Determine the appropriate morphology and number of active channels, and increase floodplain width and connection
Sediment
Enhance sediment sorting and deposition from watershed and local sediment supply
Transition from cobble to gravel by reducing shear stress to increased reach aggradation.
LWD
Increase the retention of fluvially transported LWD and enhance future wood supply
Use reference LWD aggregates to design LWD additions that promote side channels & pools.
- Channel excavation/fill
- Bar and island creation
- Cross-valley meanders
- Riffles and pools
- Interconnected active channels
- Large wood structures
- Grade control
- Alcoves – off channel refugia
Riparian
Enhance the colonization and condition of riparian species on depositional surfaces and floodplain
Increase of riparian, wetlands, transitional zones from existing to proposed conditions
Water Quality
Improve thermal refugia through flow exchange and improved riparian condition
Improve riparian recruitment and implement revegetation to reduce thermal load
Habitat
Establish processes that create and support persistence of instream habitat
Integration of above processes to create fish holding, spawning, and rearing habitat
- Floodplain swales
- Leave islands
- Roughened surfaces
- Structural riparian planting
- Low tech elements
- Ponded wetlands
- Inset floodplain
- Minimize vegetation disturbance