Development of an Ecosystem Restoration Strategy for the lower Columbia River using a Multiple Lines of Evidence Approach

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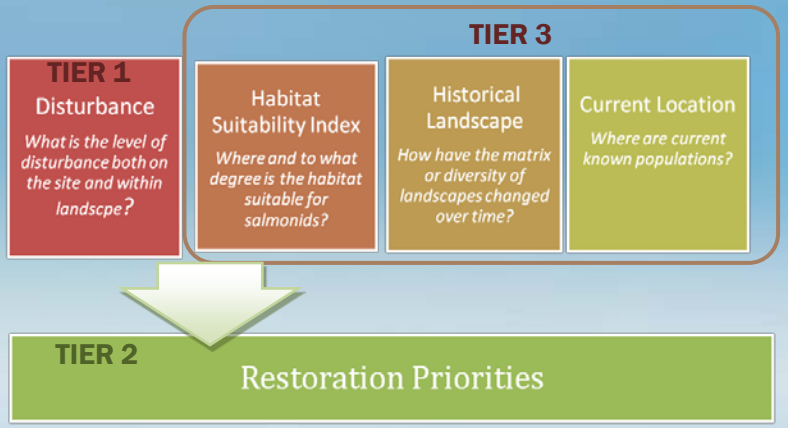
Presentation Outline

- Overview of need
- Overview of Current Prioritization Framework
  - Tier 1
  - Tier 2
- Tier 3 Concepts
  - Habitat change analysis
  - Habitat Suitability Index
  - Habitat Gap Analysis, Others
- How it all comes together



Habitat Loss

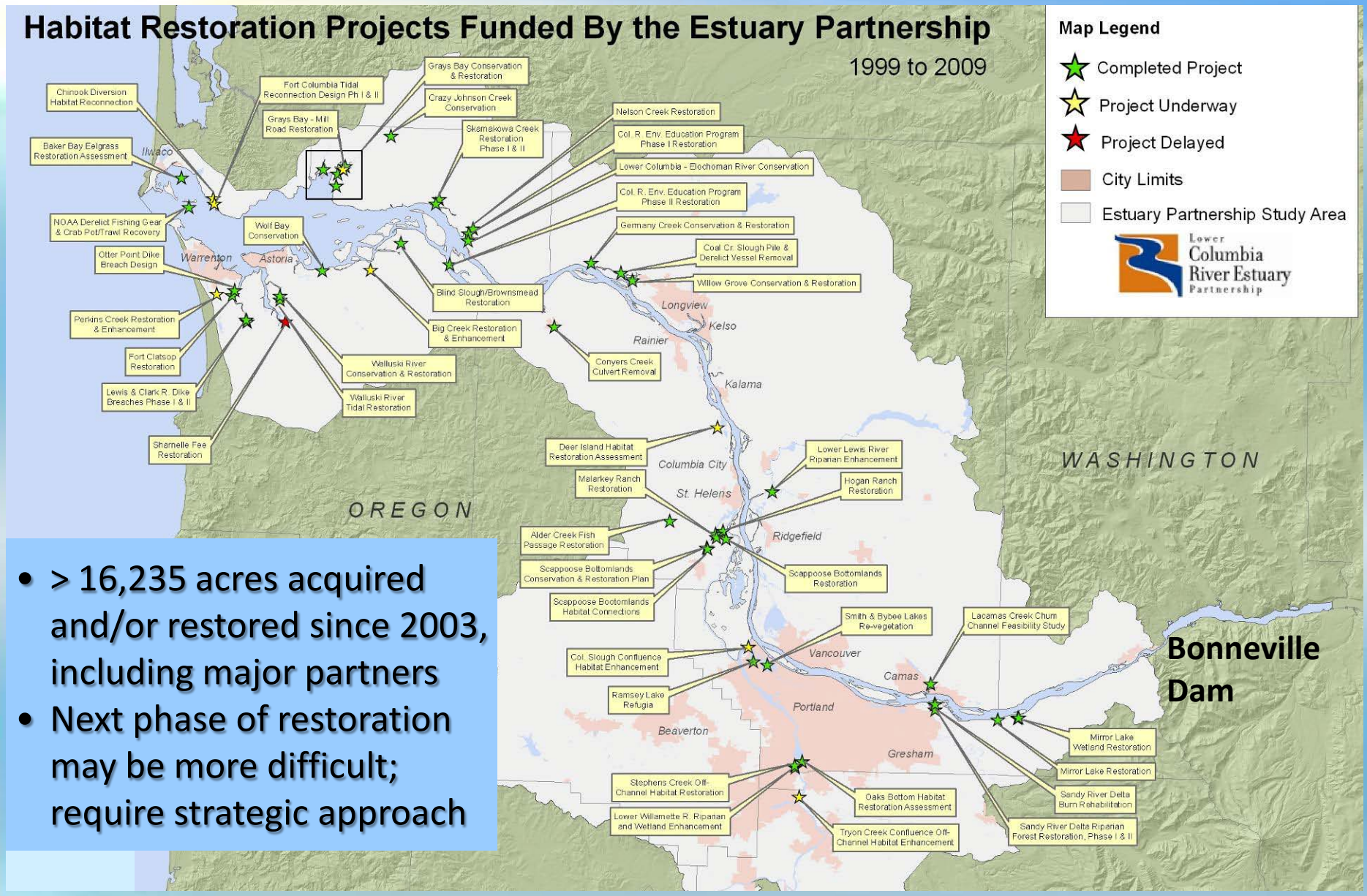
- **Significant declines in emergent marsh and tidal swamp habitats**
- **Off-channel habitats cut off**
- **Reduction in flow, access to habitats**
- **Decreases in habitat complexity, changes to food web**
- **Changes in habitat forming processes**
- **Resulting in rearing, spawning, and refugia habitat loss for ESA listed species**
- **Restoration of these habitats should help improve these species' abundance and sustainability**
- To the extent possible, we need to restore historic conditions on the ecosystem scale to achieve recovery goals

Restoration Goals

- **19,000 acres to be restored by 2014**
  - From LCREP Management Plan
  - Included in EPA Strategic Plan
- **Includes 3,000 acres of tidal wetlands along lower 46 miles**

Culvert Removal, Young Creek

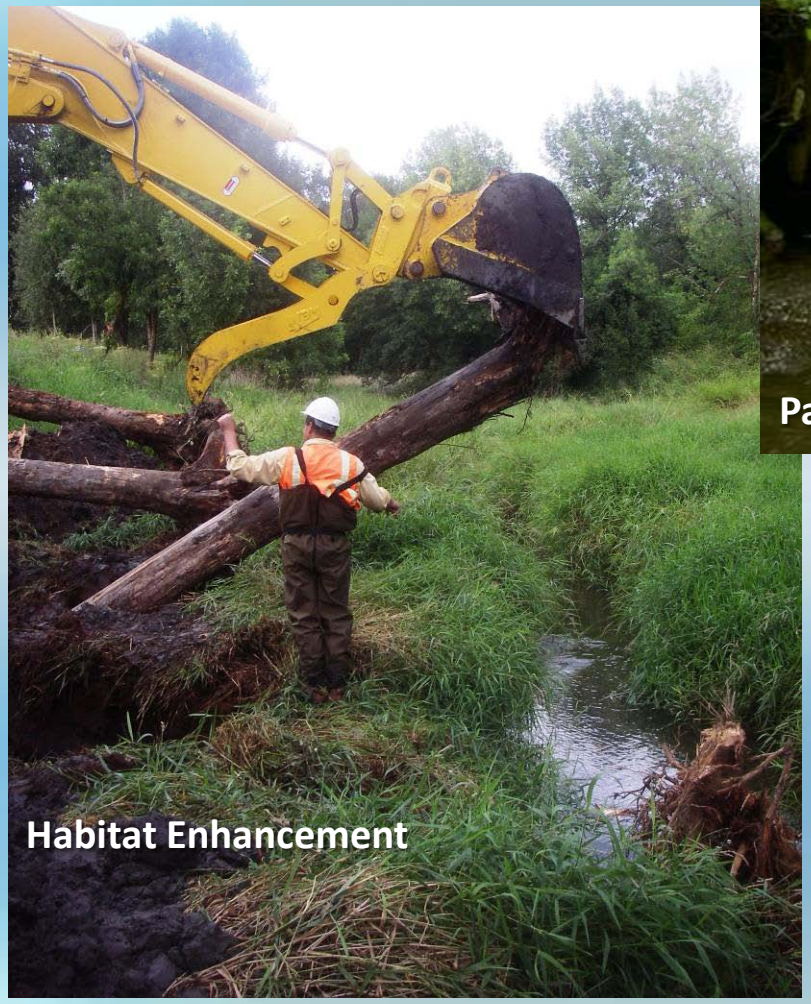
Restoration Investment in the Lower Columbia



- > 16,235 acres acquired and/or restored since 2003, including major partners
- Next phase of restoration may be more difficult; require strategic approach

Restoration Projects

- Most projects have occurred in the floodplain and tributaries



Funding Partners

- **NPCC/BPA:**
  - ca. $4,000,000 (2003-2007)
  - ca. $9,000,000 (2008-2010)
- **NOAA – Community Based Restoration:**
  - ca. $666,250 (2004-2007)
  - ca. $350,000 (2008-2010)
- **NOAA – Marine Debris Removal:**
  - ca. $100,000 (2008)
- **EPA – Targeted Watershed:**
  - ca. $700,000 (2003-2005)
  - NEP funds (2003 to date)
- **Corps of Engineers - Section 536:**
  - ca. ±$2,000,000, approx, since 2002
  - e.g., Crims Island, Julia Butler Hansen Wildlife Refuge, Sandy River Delta, Vancouver Water Resources Center, etc.

BONNEVILLE POWER ADMINISTRATION

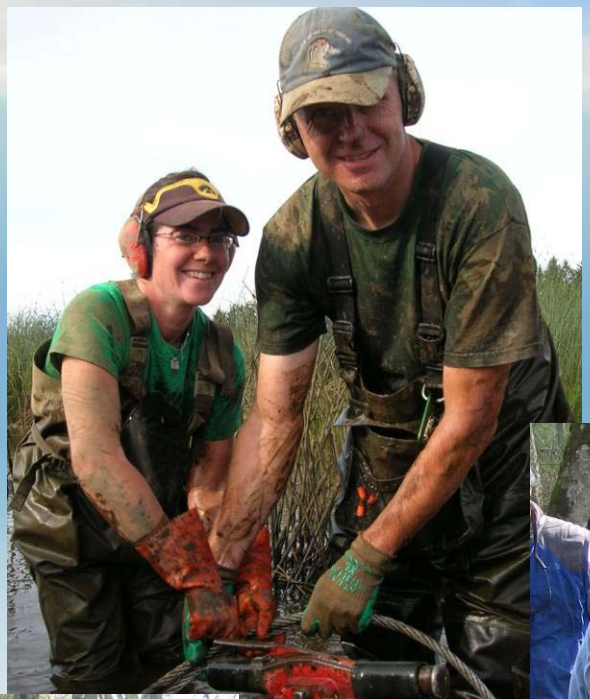
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

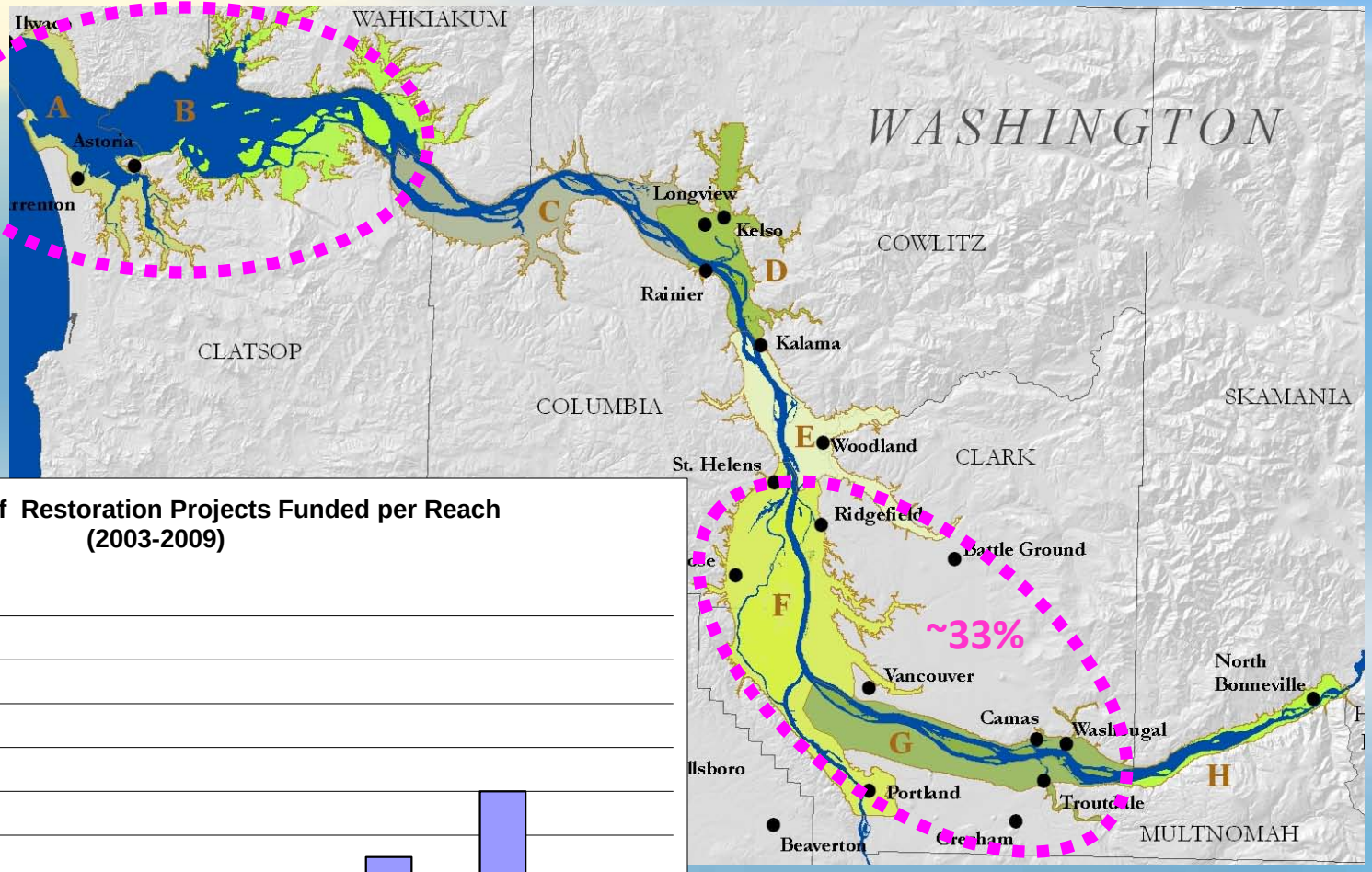
Northwest Power and Conservation Council

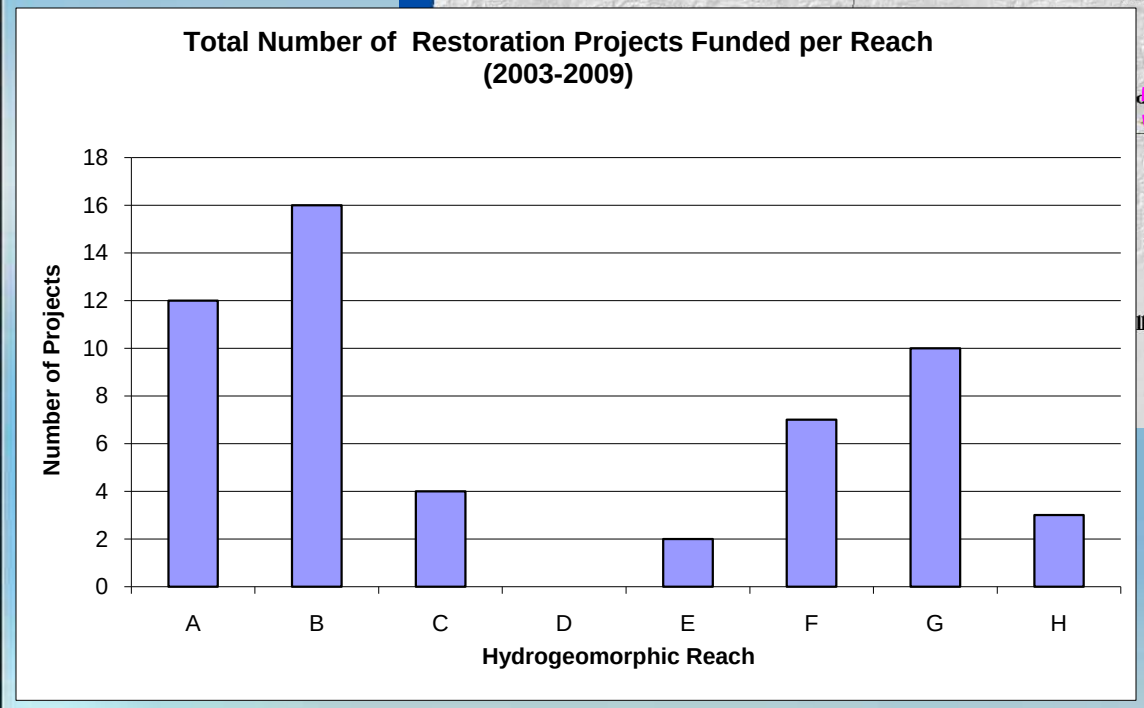
Implementation Partners

- Local Governments
- SWCDs
- Conservation Organizations
- Watershed Councils
- Councils of Government
- Federal and State Agencies
- Consulting Firms



Restoration Investment in the Lower Columbia





~80% of our projects have occurred in the vicinity of Astoria and Portland

Opportunity-driven restoration

- **Bottom-up approach, reactive to RFP**
- **Favors projects after concept is already developed, usually meeting a local need**
- **Favors sponsors with capacity to manage projects**
- **Favors project that can leverage funding from multiple sources (e.g., BPA, LCRFRB, OWEB)**
  - **has helped promote tributary/floodplain focus**
- **Project significance often assessed on local level, but less clear on landscape scale**
- **To date, restoration efforts have been more fragmented than ecosystem-based**
  - Connected to upstream restoration projects?
  - Focus on protecting entire life cycle?
  - Tie to water quality and food web?
  - Incorporate toxic contaminant sources and pathways?

Program Improvements

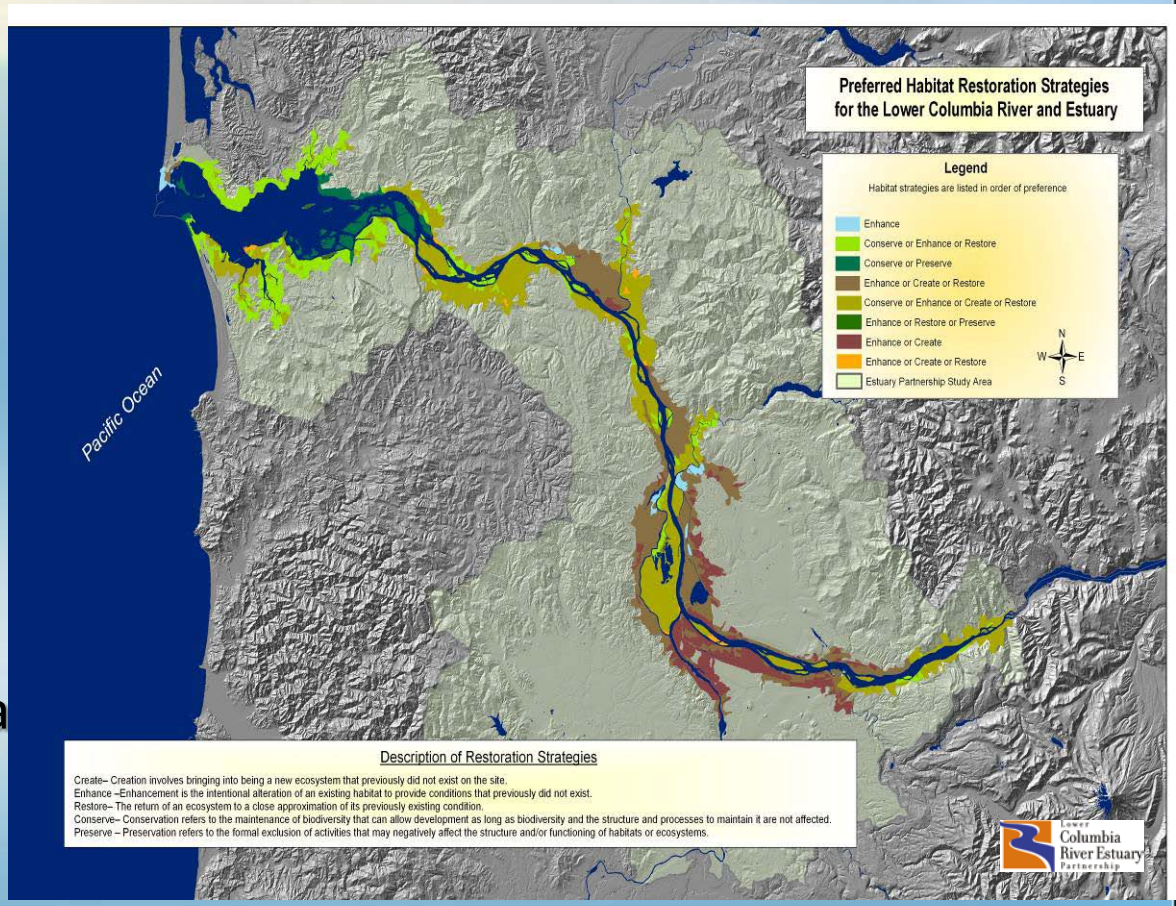
- **Developing science and understanding of the complex system**
- **Experience leads to more informed project designs and decisions**
- **Improved monitoring efforts resulting in better decisions/designs**
- Can lead to more strategic approach focusing on ecosystem scale restoration
  - Requires bi-state, central coordinating entity

Tools to Inform Restoration

- Columbia River Estuary Classification-inc. bathymetry, topography, landcover
- Restoration Prioritization Strategy
- Shoreline Condition Inventory
- Ecosystem Status Monitoring
- Action Effectiveness Monitoring
- Reference Sites
- Cumulative Effects
- Meta-analysis
- Data Management
- Adaptive Management

Current Habitat Restoration Prioritization

- **Two-tiered - Scales from system-wide to project specific**
- **Tier 1 uses disturbance model (stressors)**
  - provides method for comparing site function and structure at larger scales
  - Focuses on existing data
  - refine by updating/ adding new data



***PNNL and Estuary Partnership**

- **Tier 2 provides scientific method of comparing specific projects using change in function and likelihood of success**

Current Habitat Restoration Prioritization

Existing Components of the Prioritization

1) Tier 1a Analysis of *Site* and *MA* disturbance scores.

This section was completed with the available data. May want to update the datasets.

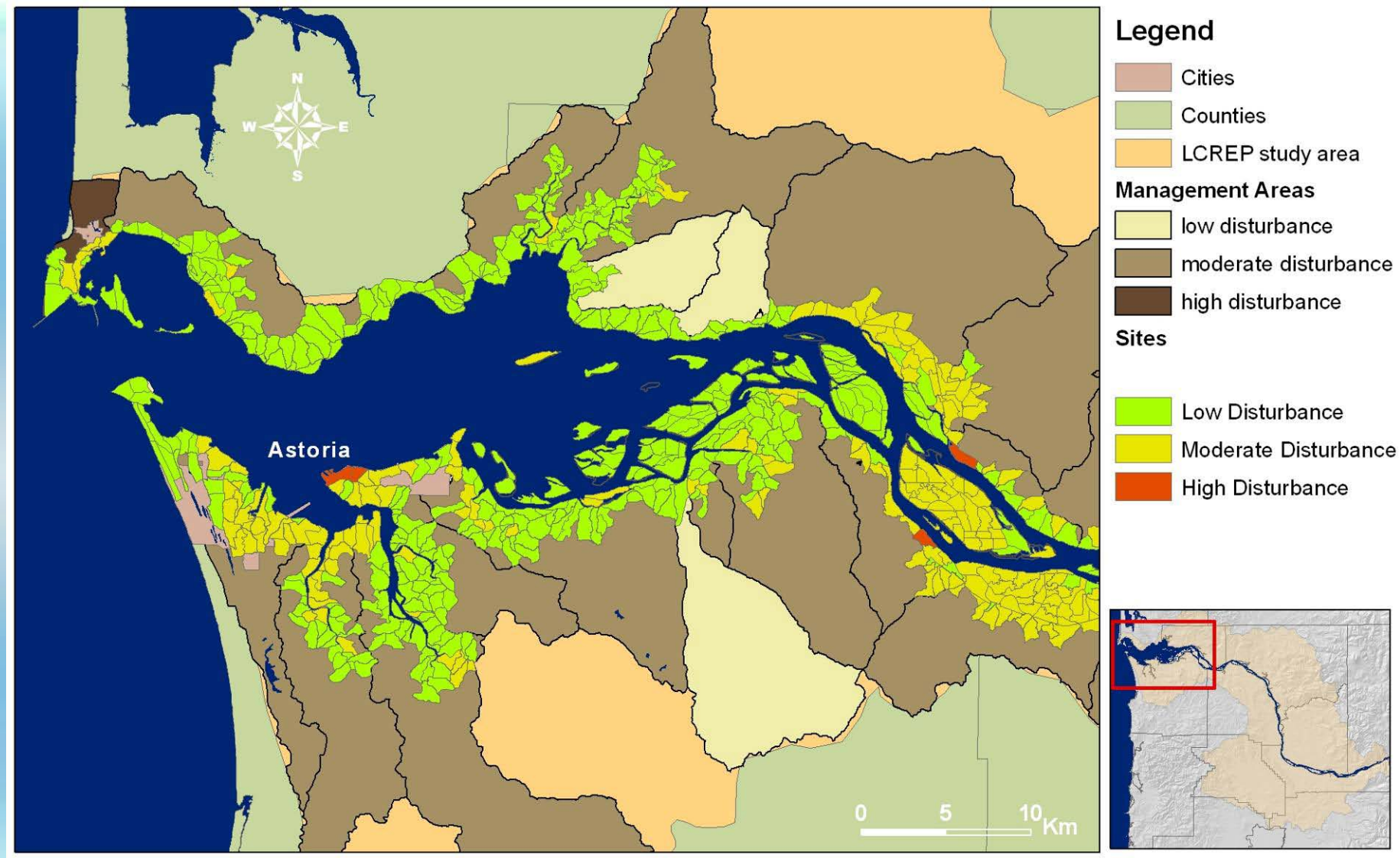
Sites: 18 stressors impact 7 control factors (CF), for a final score.
Final score is an average of the control factors:

Stressor datasets used:

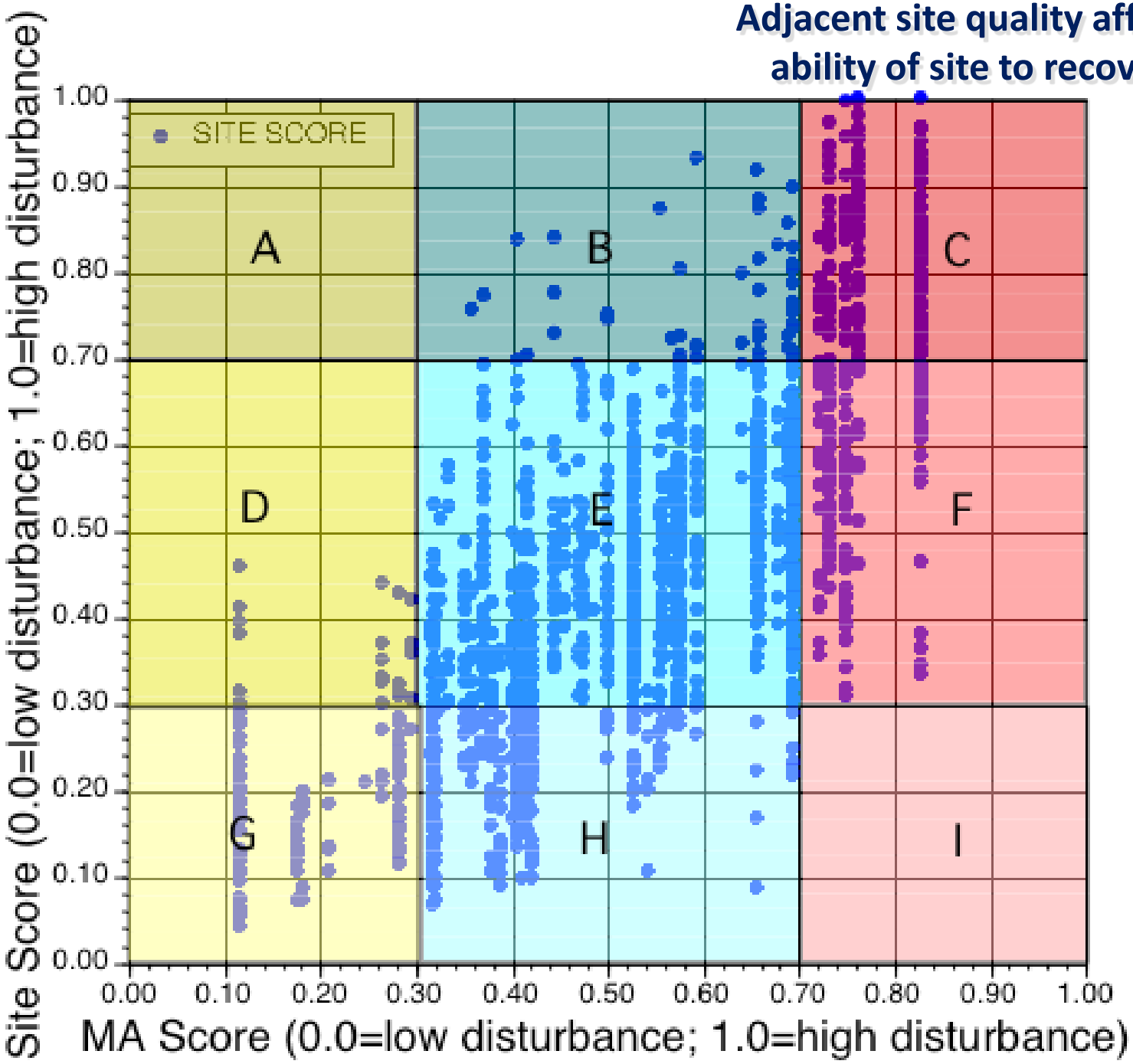
Bonneville Flow Alteration
Diked Area
Flow Restrictions
SEDQUAL
Facilities –Land Type
Facilities – Water Type
Industrial Development
303d Impaired Water bodies
Agriculture
Marina Area
Minor OW Structures
Major OW Structures
Protected Marinas
Pile Dikes
DMDS
Population
Industrial Shoreline
Dredging (Shoal Areas)
Shoreline Change (not used)
Shoreline Armoring (not used)
Invasive Species (not used)

Prioritization Framework — Tier 1

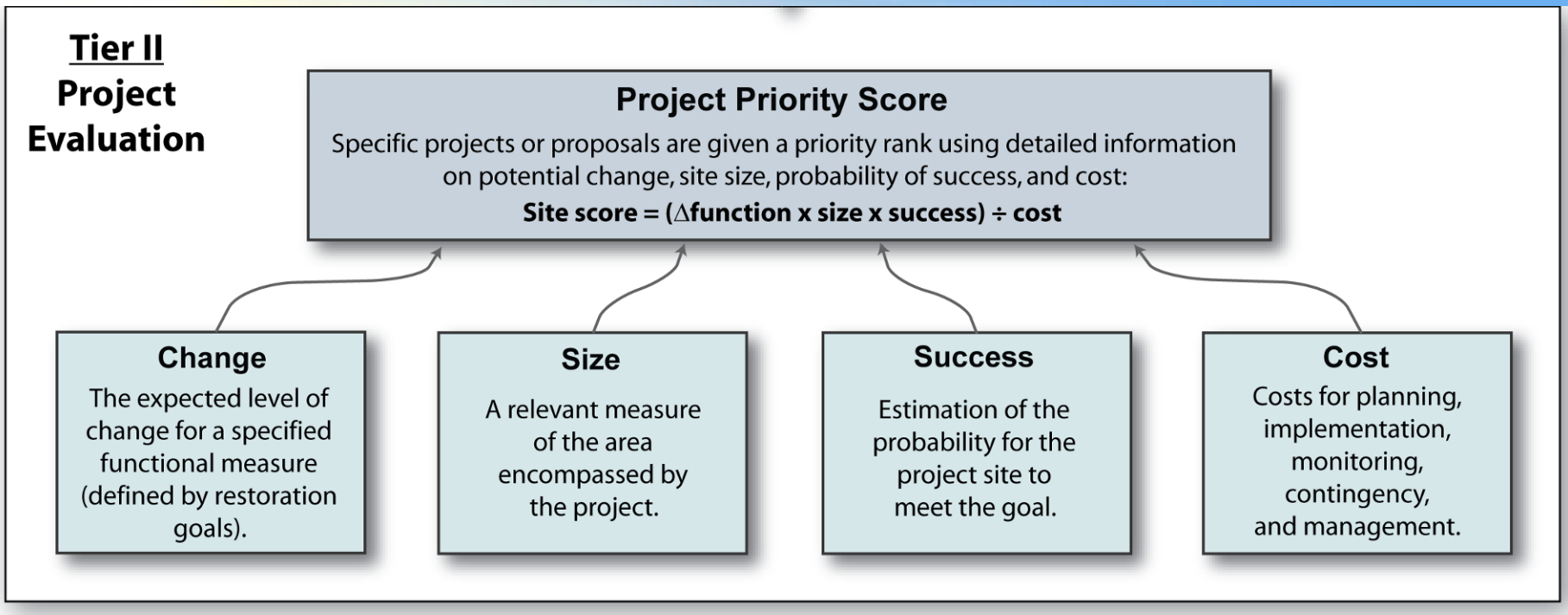
Site and Management Area Rankings (Reach A,B)



Adjacent site quality affects ability of site to recover



Tier 2 Project Evaluation



Site Score = (Δ function x size x success) ÷ cost

Where,

Δ Function = change in site ecological functions

Size = relevant measure of the area encompassed by the project

Success = an estimate of the probability for the site to meet the goal

Cost = planning, implementation, monitoring and management costs

Tier 2 Project Evaluation

Site Score = (Δ function x size x success) ÷ cost

Function/process	Preserve	Greater	Lesser	No Change	Unsure	Not applicable
Primary production		x				
Organic matter flux		x				
Sediment trapping		x				
Nutrient processing		x				
Flood attenuation		x				
Food web support			x			
Opportunity			x			
Capacity		x				
Natural complexity		x				
Natural biodiversity				x		
Total	0	7	2	1	0	0

Tier 2 Project Evaluation

Site Score = (Δ function x size x success) ÷ cost

Success Factor	High	Moderate	Low	Unsure
Case studies indicate success of…	X			
Restoration strategy is suitable	X			
Habitat forming processes will be…	X			
Landscape features are…		X		
The site condition is…			X	
Adjacent habitats are…	X			
Self-maintenance		X		
Resilience		X		
Time Frame				X
Total	4	3	1	1

New: Tier 3 Restoration Strategy

- **Ecosystem-based with focus on salmon**
  - **Goals:**
    - restoring natural habitat diversity
    - restoring diversity of salmonid life history strategies
- **Employ multiple lines of evidence approach**
  - **Several analyses w/ each identifying areas of importance for protection and restoration:**
    1. historic vs. current habitat coverage change analysis
    2. salmonid habitat suitability index (HSI model)
    3. *Upcoming Salmon Benefits Products* (e.g., nearest neighbor, structural connectivity)
- **Using currently available data**

New: Tier 3 Restoration Strategy

- **Goals:**
  - **restoring natural habitat diversity**
  - **restoring diversity of salmonid life history strategies**

Restoring natural habitat diversity is key to restoring diversity of salmonid life history strategies

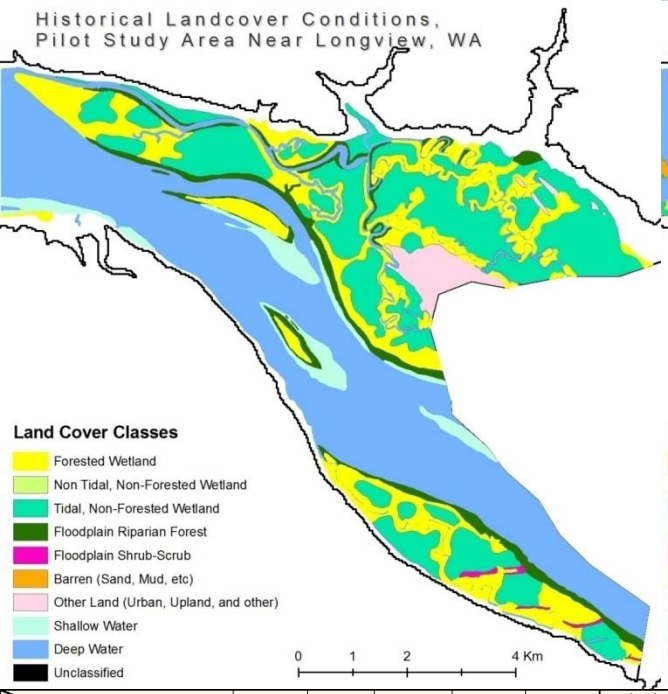
- **From NOAA Northwest Fisheries Science Center, September 2009:**
  - Shallow water, low velocity, and low salinity surface environments with associated wetland vegetation are features that define juvenile salmonid habitat
  - Diverse distribution of habitat a surrogate for diversity and spatial structure of salmon population
  - Preservation and restoration of shallow water, low velocity, and low salinity environments an important strategy for recovery of salmon and to mitigate for anthropogenic modifications

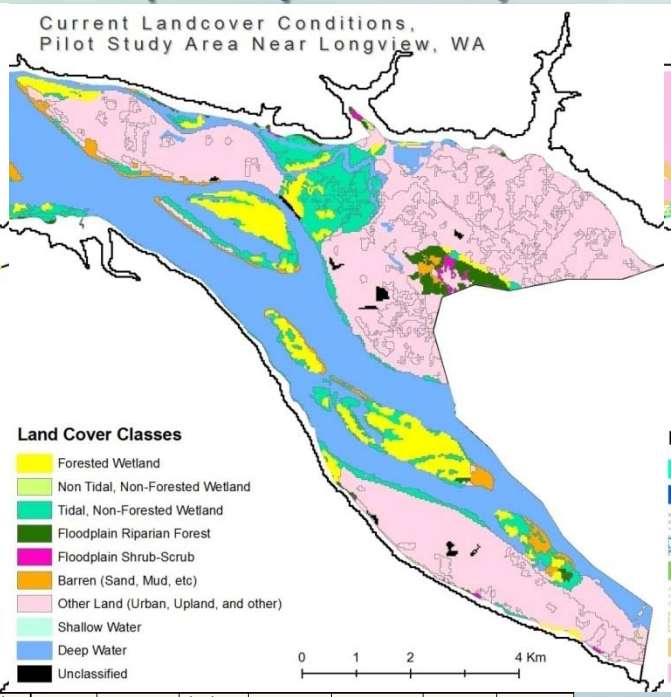
New: Tier 3 Restoration Strategy

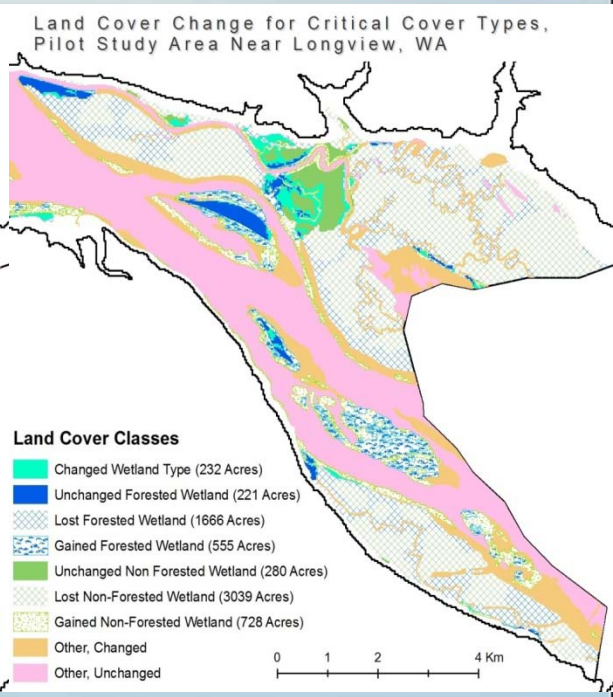
- **Goals:**
  - **restoring natural habitat diversity**
  - **restoring diversity of salmonid life history strategies**

- **Multiple lines of evidence approach:**
  1. **historic vs. current habitat coverage change analysis**
     - Historic habitat coverage is proxy for natural habitat diversity
     - Identify losses by reach and habitat type
  2. **salmonid habitat suitability index (HSI model)**
     - Identify locations in mainstem of optimum water velocities, temperature, depth and salinities based on Bottom et al. 2005 (OHSU model results)
  3. **New indices such as habitat gap analysis (from USACE's Salmon Benefits)**
  4. **Others such as CRE Classification**

Line of Evidence 1:
Historic to Current Habitat Change Analysis
(example below)



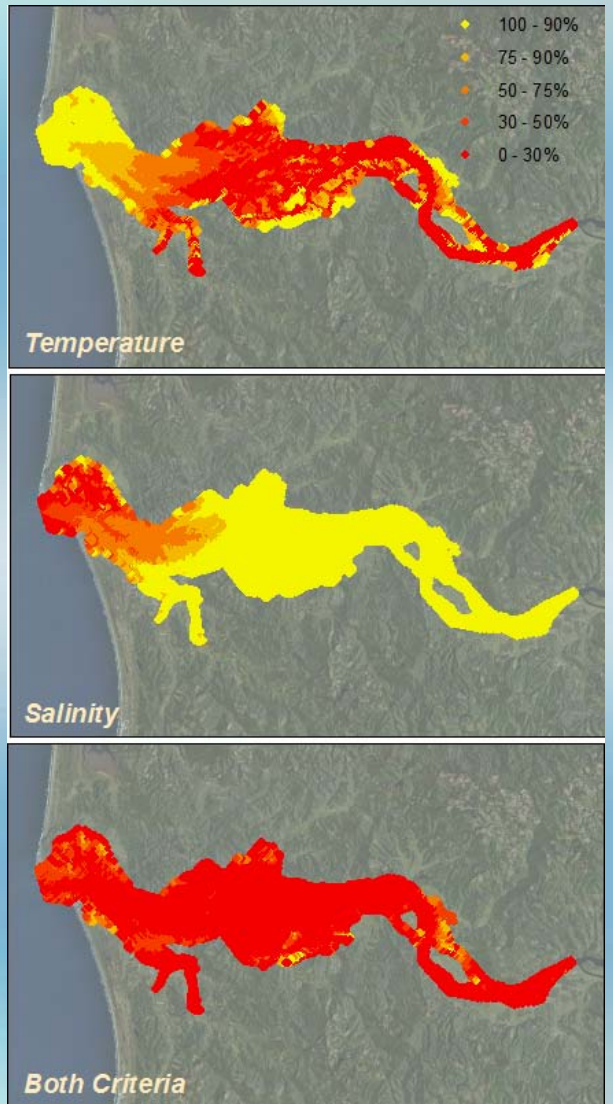




	Shallow Water	Deep Water	Forested Wetland	Non-Forested Tidal Wetland	Non-Forested Non-Tidal Wetland	Land, other (Includes upland, Urban)	Land, Barren	Riparian Flood- plain Forest	Shrub-Scrub Flood-plain	Un-classified	Total Historical Acres	Total Acres Changed	Total Acres Un-changed
shallow water		278	49	111		13.7	11	0			462.7	462.7	0
deep water		3751	408	461	2.6	560	189	19	0	6.4	5397	1646	3751
Forested Wetland		44	221	215		**1588**	3.3	25.3	5.6	15.2	2117.4	1896.4	221
Non-Forested Tidal Wetland		78	17	275	5	**2934**	2	15.3	9.4	22	3357.7	3082.7	275
Non-Forested Non-Tidal Wetland											0	0	0
Land, other (Includes Upland, Urban, other)		0.25	4	3		141	27	130	24		329.25	188.25	141
Land, Barren											0	0	0
Riparian Floodplain Forest		74	94	153	0.3	410	26	1.1	0.2	7	765.6	764.5	1.1
Shrub-Scrub Floodplain						43					43	43	0
Unclassified											0	0	0
											12472.65		
Total Present Acres	0	4225.25	793	1218	7.9	5689.7	258.3	190.7	39.2	50.6			12472.65

See K. Marcoe and C. Judd poster for more details

Line of Evidence 2:
Habitat Suitability
(example below)



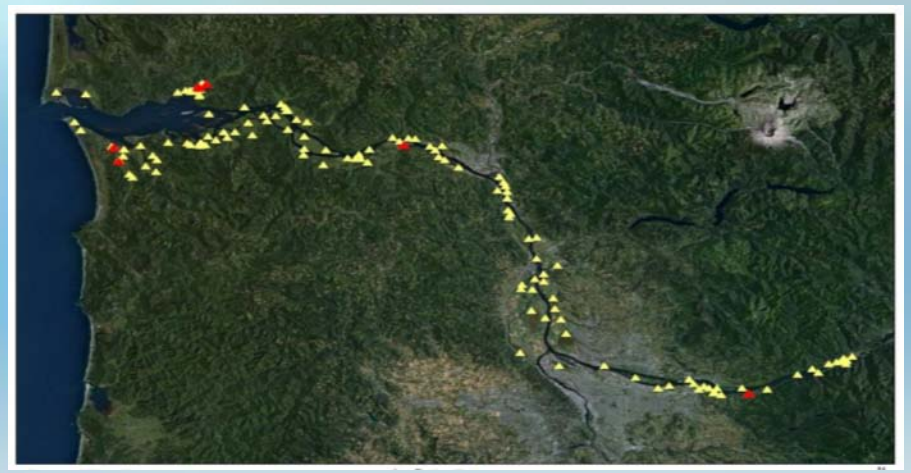
- Adapt criteria based on Salmon at River's End report for current model (Bottom et al 2005)
- Examine frequency of suitability of area based on:
  - Water temperature
  - Velocity
  - Depth
  - Salinity
- Map spatial and temporal patterns for habitat and limiting factors

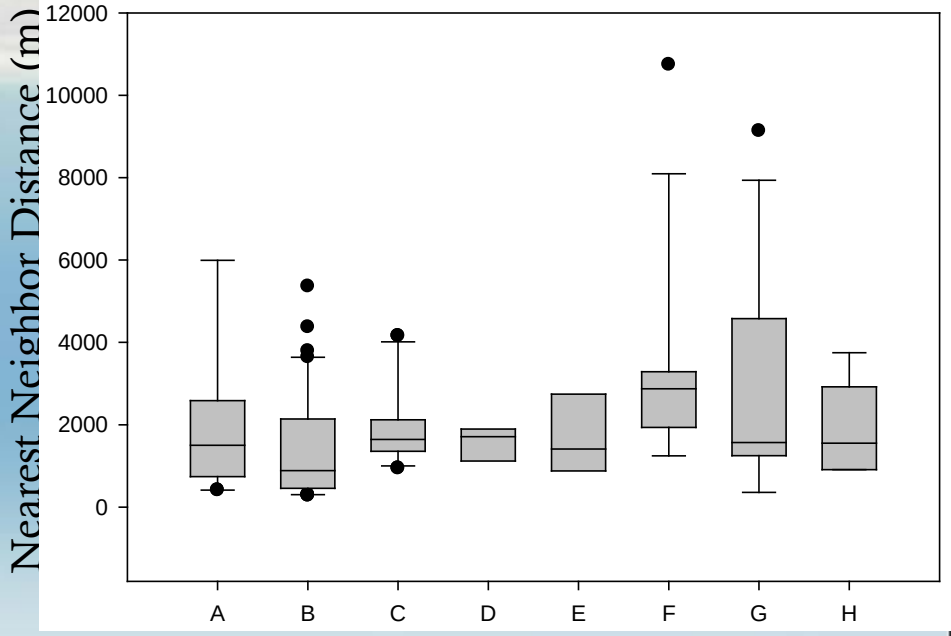
See K. Marcoe and C. Judd poster for more details

Line of Evidence 3: Habitat Gap Analysis

USACE Salmonid Benefits Project: Connectivity Index

3-part index, pilot tested in 2009 study year, includes Nearest Neighbor metric.





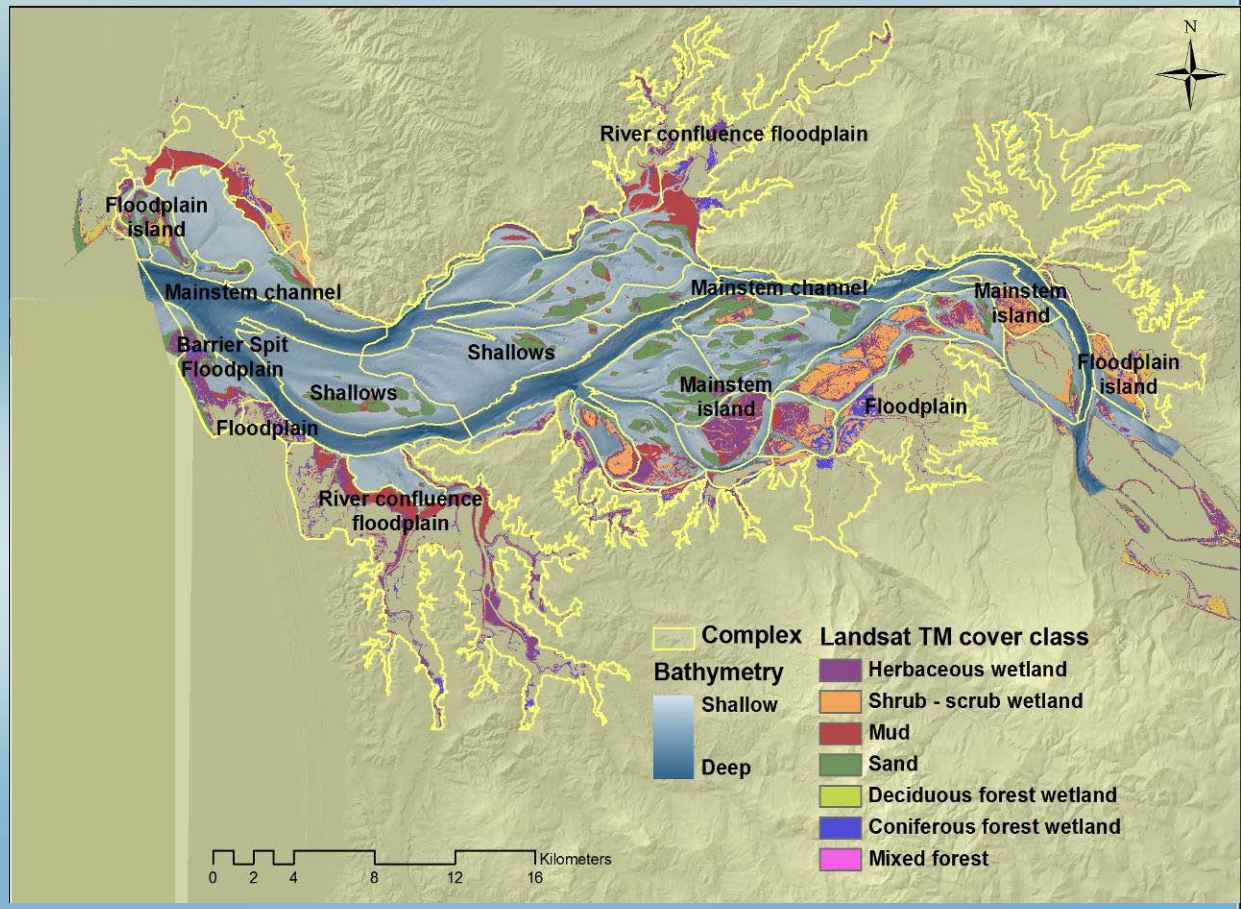
Implications of Nearest Neighbor (NN) analysis for Prioritization:

1. Most tidal wetlands (53, located in all eight reaches of the LCRE): NN between 1 & 2 km.
2. For 28 sites, primarily in Reach B, NN <1 km.
3. Since restoration in Reach H, 3 stretches >7 km exist in LCRE, all located in reaches F and G.
4. Reach Scale: E, F, G have mean NN >2km; A is close with 1.91km and B next with 1.81km.
5. Prioritization of "long tail" of NN distance warranted; but must be weighed vs. historical.

Diefenderfer, HL, JR Skalski, GE Johnson, EM Dawley, NK Sather, AM Coleman. 2010. "Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary, Annual Report 2009." PNNL-19410-DRAFT report prepared by the Pacific Northwest National Laboratory for the US Army Corps of Engineers, Portland District, May 2010.

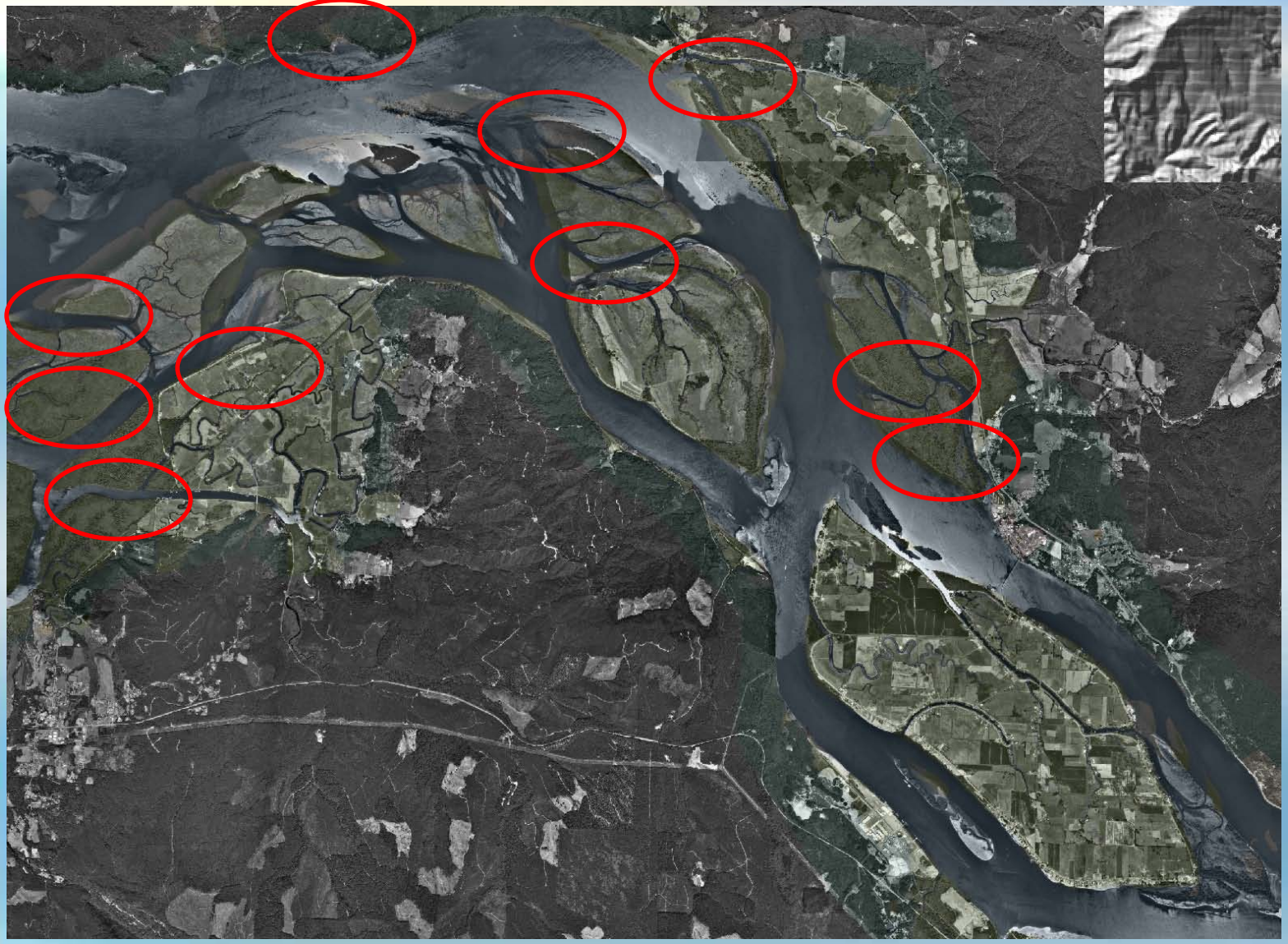
Future Lines of Evidence: CRE Ecosystem Classification, Others

- **Applications:**
- **Prioritizing habitats for protection and restoration**
  - Using landscape metrics
  - Number of patches
  - Types of patches
  - Edge density
    - Fragstats
    - McGarigal, K., S. A. Cushman, M. C. Neel, and E. Ene. 2002. Available from UMASS



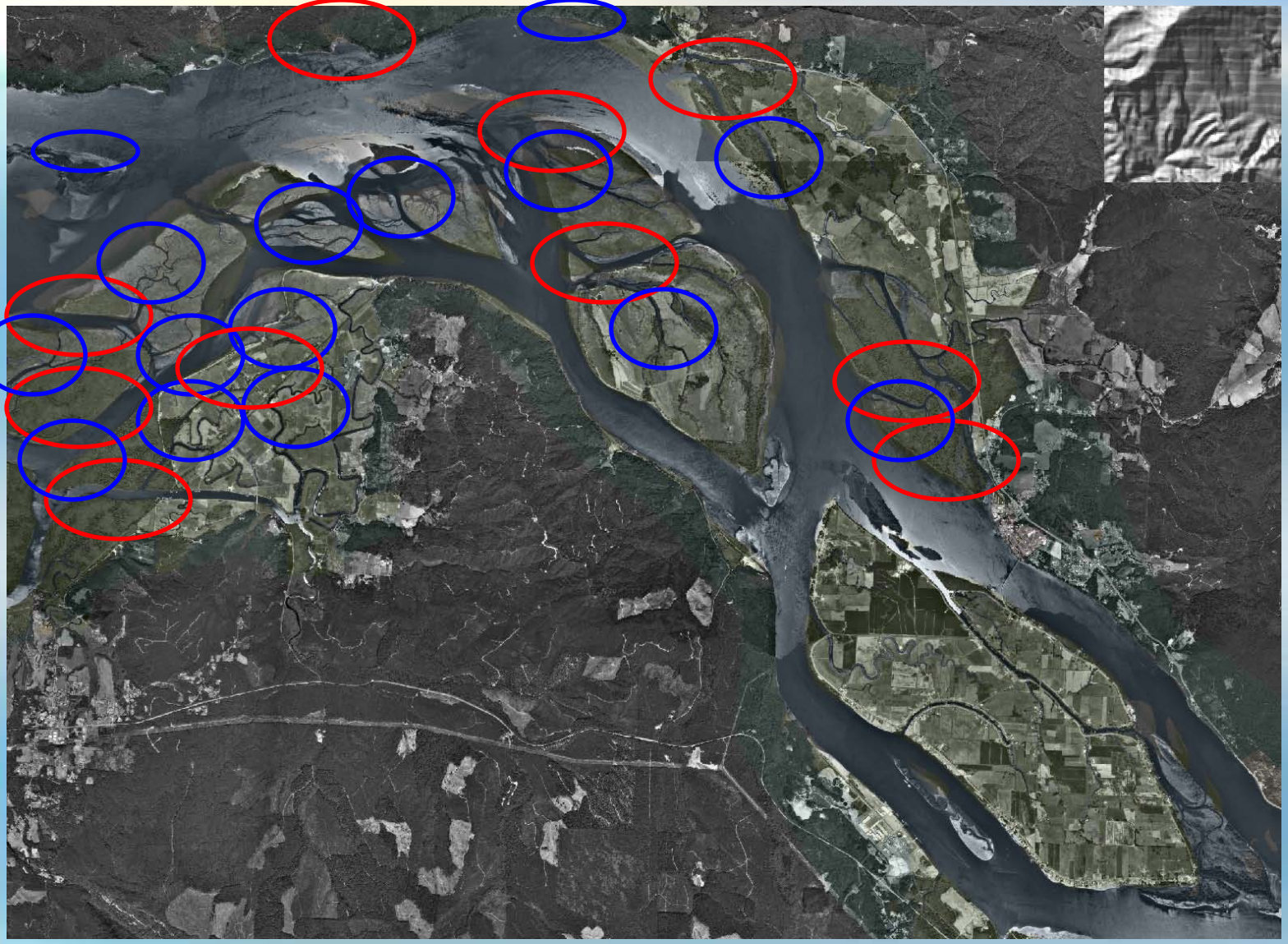
From Burke et al. 2005 presentation @ ERF

New Tier 3: Results (conceptual only)



Historic Habitat

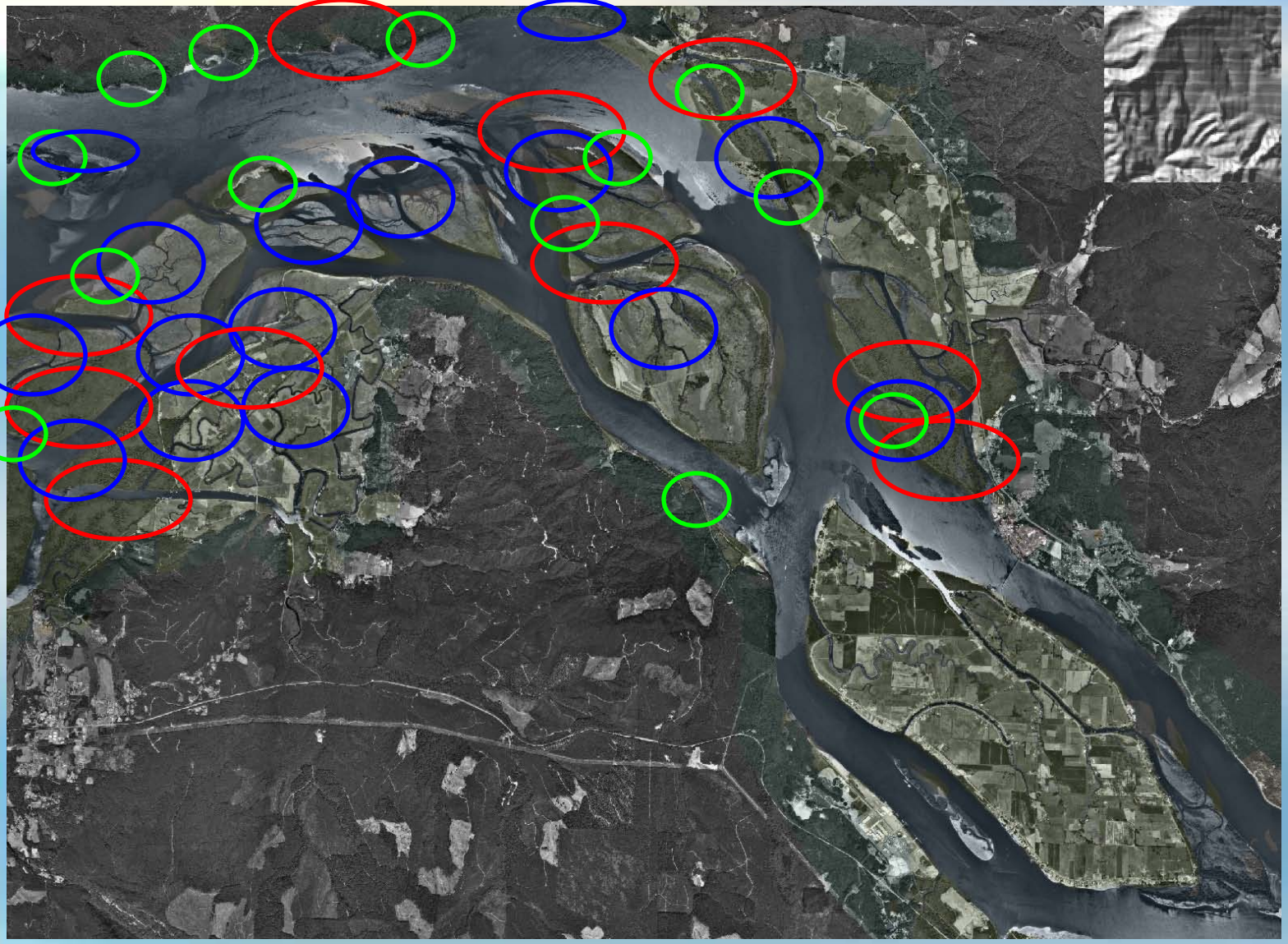
New Tier 3: Results (conceptual only)



Historic Habitat

Habitat Suitability Index

New Tier 3: Results (conceptual only)



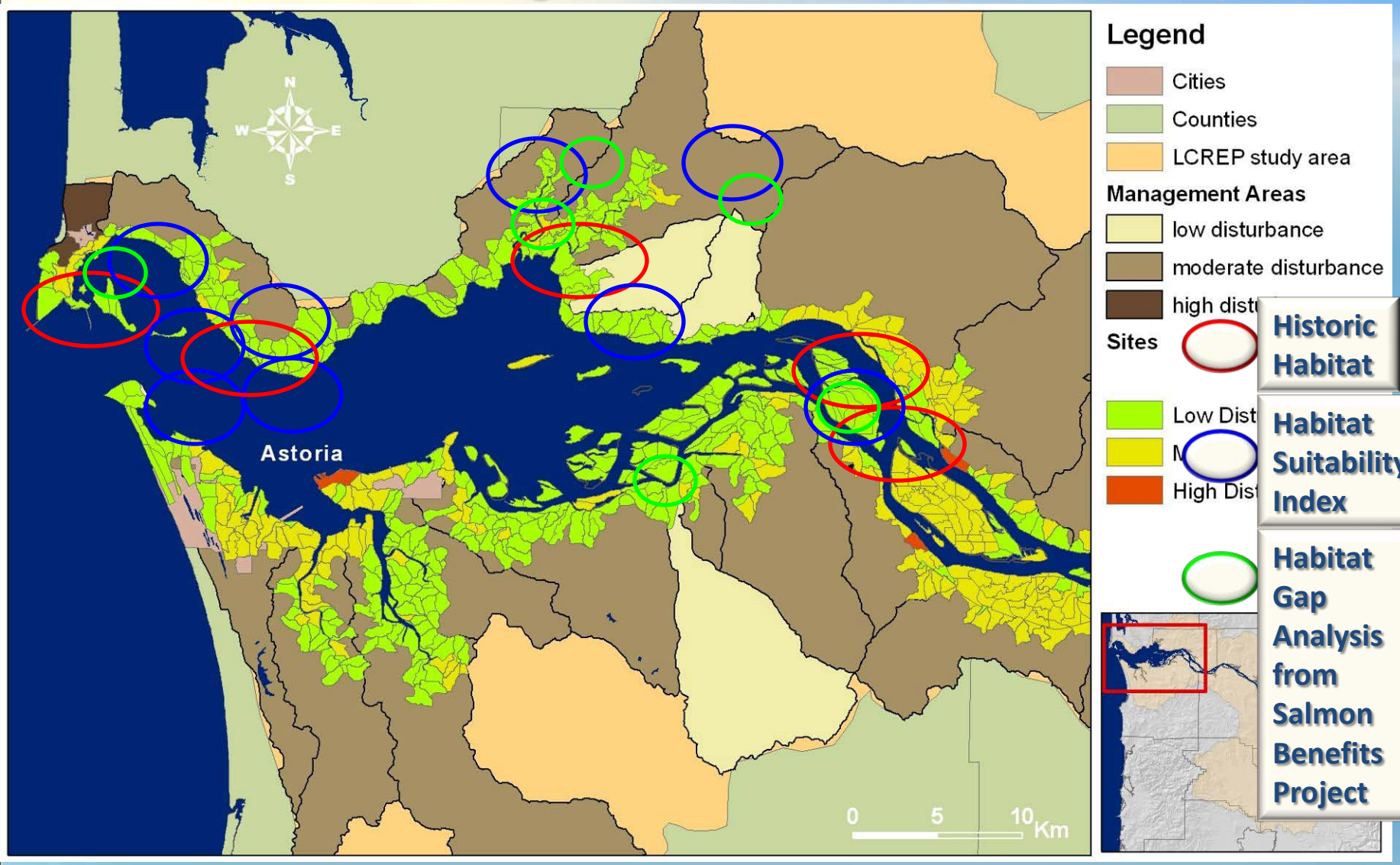
Historic Habitat

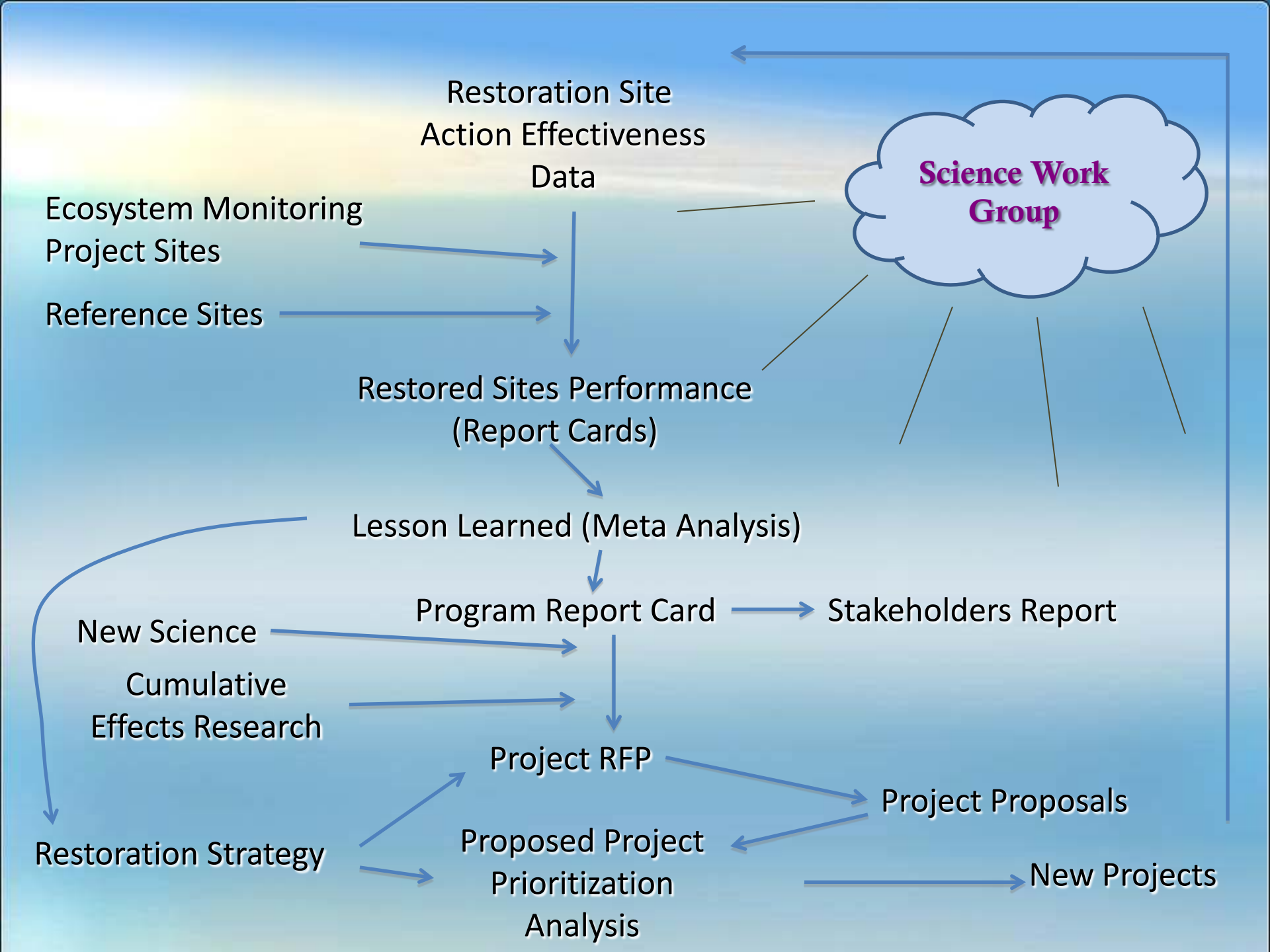
Habitat Suitability Index

Habitat Gap Analysis from Salmon Benefits Project

Overlay with Tier 1 (conceptual only)

Site and Management Area Rankings (Reach A,B)



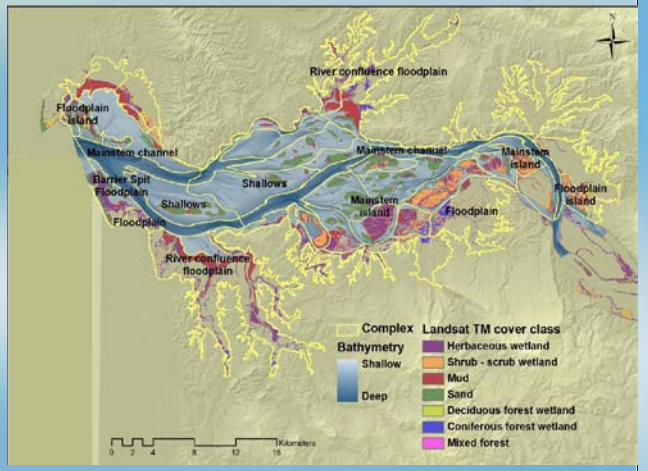

Restoration Site
Action Effectiveness
Data
Science Work
Group
Ecosystem Monitoring
Project Sites
Reference Sites
Restored Sites Performance
(Report Cards)
Lesson Learned (Meta Analysis)
Program Report Card
Stakeholders Report
New Science
Cumulative
Effects Research
Project RFP
Project Proposals
Restoration Strategy
Proposed Project
Prioritization
Analysis
New Projects

Next Phases

- **Develop and *continue to refine* restoration strategy**
  - Support recovery plans
  - Use best available data
  - Support multi-species
  - Improve water quality and reduce toxics
- **Coordinated project development**
- **Increase capacity of project sponsors**
- **Improve efficiencies to increase quantity and quality of projects**

CRE Ecosystem Classification

- **Applications:**
- **Prioritizing habitats for protection and restoration**
  - **Using landscape metrics**
  - **Number of patches**
  - **Types of patches**
  - **Edge density**
    - **Fragstats**
    - **McGarigal, K., S. A. Cushman, M. C. Neel, and E. Ene. 2002. Available from UMASS**



From Burke et al. 2005 presentation @ ERF

- **Include results from AEM and CE into new project designs**

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