Overview of Redesigning the Estuary Partnership's Ecosystem Monitoring Program

Science Work Group March 2012

Lower Columbia River Estuary Partnership

Estuary Partnership

- The lower Columbia River is a National Estuary Program, one of only 28 in the nation, authorized by Congress in 1987 amendments to Clean Water Act, § 320

- Established in 1995 by the governors of Washington and Oregon and EPA

  Lack of focus on the lower river and estuary

  Bi State findings documented degradation of lower river

- Partners, incl. federal, state, and local governments; universities; non-profits; industry, etc, participate in the development and implementation of a *Comprehensive Conservation and Management Plan (Management Plan)*

- Estuary Partnership developed a long-term aquatic monitoring strategy for the lower Columbia River in 1999 and this strategy is implemented with our Ecosystem Monitoring Program

Importance of Ecosystem Monitoring Program

- Only comprehensive assessment of juvenile salmonid habitat in Columbia River estuary (combined look at food web, fish usage, vegetation and water column conditions at each site)
- Covers EP long term monitoring strategy, multiple 2008 FCRPS BiOp RPAs and Estuary Module RME actions
- Provides juvenile salmonid stock occurrence, condition, diet and residency
- Assesses habitat capacity, opportunity and realized function of estuarine habitats
  - key information for regional restoration strategies and salmon recovery planning
- On-going collaboration with UW, PNNL, USGS, NOAA, OHSU and CREST
- Supported with funding from NPCC/BPA

EMP Original Design

- In 2004, PNNL developed a statistically robust sampling design to serve as the basis of future site selection (in combination with the Classification).

- The design included a two-phased approach:
  - Phase I: Inventory sampling to characterize spatial variability throughout the estuary (approx. 120 sites)
  - Phase II: Long-term trends monitoring to track changes in habitats, and provide information about the effects of restoration actions that can be used to evaluate and refine management measures.
  - Both phases involved a stratified rotational sampling design and incorporated both fixed and randomly selected sites.

- 2005 proposal included 8 fixed sites (1 per reach) with 12 rotating sites

Current EMP Design (2005-2012)

- To date, the implementation of the proposed design has been limited due to cost constraints

- The distinction between phases 1 and then 2 in the original design did not occur

- Estuary Partnership and partners have focused on providing an inventory of habitats (or “status”) across the lower river as funding allowed and included a growing number of fixed sites for inter-annual variability (or “trends”)

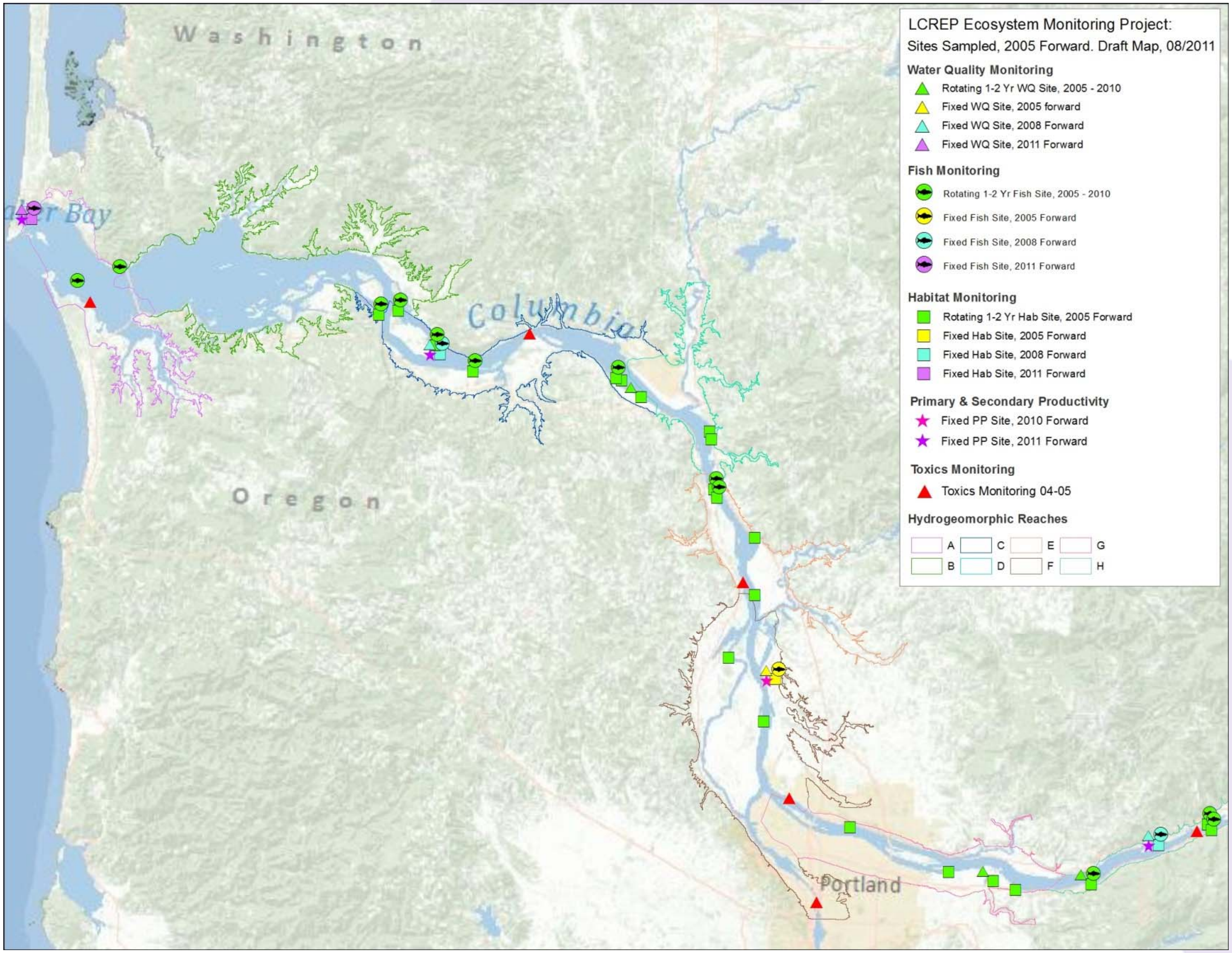
- Since 2007, focus on finishing Classification (w/bathymetry & landcover datasets) to be able to stratify sampling

- Sampling occurs primarily in **relatively undisturbed tidally influenced emergent wetlands** (important rearing habitats for salmon)

  -Growing number of fixed sites (currently 4); 3-4 status sites per year

  -Starting in 2007, fish and vegetation sampling co-located at same sites

EMP Sampling Stratified by Reach



Habitat, salmon, salmon prey and water conditions sampling

Vegetation monitoring

- Sampling during peak biomass (July/August), one day per site
- Metrics include: % cover along transects, dominant species, vegetation elevation, water level elevation, sediment grain size, water temperature
- Summer and Winter macrophyte biomass slough off for net export of macrodetritus (2011/2012)

Water conditions

- Continuous water quality sampling at fixed sites April through July
- Metrics include: temperature, dissolved oxygen, pH
- Temperature data collected during fish sampling

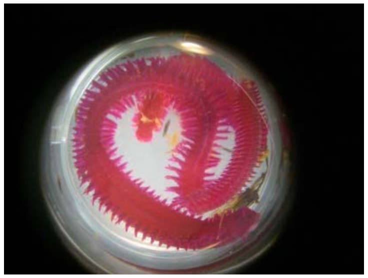
Fish sampling

- Monthly sampling between February and December
- Metrics include: species richness, abundance, CPUE, stock id, length, weight, stomach contents, otoliths for growth rates, marked/unmarked, condition, contaminants

Fish prey (macroinvertebrate)sampling

- Monthly sampling with fish sampling, but gut contents and prey availability taken only when Chinook salmon are caught
- Metrics include: taxonomy, abundance, biomass, terrestrial vs aquatic origin

Food Web Characteristics



LOBO (Land Ocean Biogeochemical Observatory) Platform (2012)

-Expand the existing CMOP network of continuous monitoring stations in the Columbia River estuary

- Continuous high-resolution biogeochemical water quality monitoring of the lower Columbia River, above the influence of the Willamette River

-Metrics include: Wet Labs WQM (temperature, conductivity, chlorophyll a fluorescence, and dissolved oxygen), a Wet Labs CDOM fluorometer (colored dissolved organic matter), a Satlantic SUNA (nitrate and nitrite), and a Wet Labs Cycle-P (dissolved ortho-phosphate)

Food web sampling (2011/2012)

-Food web sampling conducted between March and July at the six fixed sites

-Metrics include: water-column nutrient concentrations, and photosynthetically available radiation (PAR), algal biomass and species composition, algal productivity rates, stable-isotope ratios of algae/plants/insects and juvenile salmon, and status (abundance and composition) of lower food web components (phytoplankton and zooplankton).

Current EMP Goals and Objectives

- To comprehensively assess habitat, fish, food web, and abiotic conditions in the lower river, focusing on shallow water and vegetated habitats used extensively by juvenile salmonids for rearing and refugia.

- Conduct long term status and trends monitoring of the biological, physical, and chemical characteristics of estuarine habitats and the opportunity, capacity and realized function they provide juvenile salmonids.

…In order to close data gaps and inform further restoration strategies

EMP Synthesis

Comprehensive data analysis and reporting of all habitat, fish, fish prey, and abiotic water conditions data since 2005 (through 2010)

- Evaluate spatial and temporal variability in habitat, fish, fish prey and water quality

- Provide baseline data on relatively undisturbed tidally influenced wetlands in the lower Columbia River estuary

- Preliminary status and trends information for the lower Columbia River estuary

- Explore relationships between each individual disciplines (fish, fish prey, water conditions, vegetation) to begin to explain patterns

- Technical Report and published material

New monitoring design

Why change the sampling design of the EMP?

- Columbia River Estuary Ecosystem Classification [CREEC] finishes
- More statistically robust true probablistic sampling design (e.g., rotational panel)
- Request for estuarine indicators from EPA, NPCC/BPA
- After 5-year synthesis, re-evaluation of goals and objectives; adaptive management

Steps to Designing the Monitoring Program

- Identify goal, objective, actions and assessment questions of interest to resource managers. (*Science Work Group [SWG]*)
- Describe "minimally disturbed" LCRE, identify ecosystem attributes for protection/restoration. (*SWG, April 4-5 workshop of RME investigators, other working groups for specific indicator portfolio, e.g., indicator species*)
- Define the key ecological needs of attributes and quantifiable targets for ecosystem attributes (*Indicator Steering Committee)*
- Determine core indicators and metrics (*SWG, Indicator Steering Committee*)
- Determine population of interest (using Classification) for each core indicator and minimum number of sites (*SWG, Indicator Steering Committee*)

Steps to Designing the Monitoring Program

- Determine metrics we specifically measure, frequency of sampling and sampling period (*SWG, Indicator Steering Committee*)
- Establish analysis methods, quality control and data management (*SWG, Indicator Steering Committee*)
- Match available funding and projects to list of core indicators (*SWG, Indicator Steering Committee*)
  - Define roles and responsibilities for collection of individual metrics, quality control and data management
  - Incorporate results from other estuary RME into index as relevant

Steps to Designing the Monitoring Program

- Develop decision support tools, incorporate targets and monitoring results into management activities of lower river
- Monitor and provide results, provide periodic updates to stakeholders
- Provide recommendations for diagnostic /BACI studies to better understand uncertainties, variability and reasons behind trends/results
- Update to reflect new findings and emerging issues as necessary
- Human dimension indicators developed thru Science to Policy workshops

Update since January Science Work Group

- Indicator Goal, Objectives, Actions, Questions (unchanged)
- SWG recommended an Index of Biological Integrity (IBI)
- IBI is one method of bioassessment
- IBI Metrics from Karr, 1981:
  1. Species Richness and Composition Metrics
  2. Indicator Species Metrics
  3. Trophic Function Metrics
  4. Reproductive Function Metrics
  5. Abundance and Condition Metrics
- See EMP design framework document for specifics, inc. adaptations to this original IBI
- Limitations we found with IBIs:
  - Most IBIs are fish or macroinvertebrate focused

Update since January Science Work Group

- Limitations we found with IBIs (continued):
  - Fish focused IBIs to date are limited to freshwater, smaller streams in midwest or eastern US; one case modified for Willamette
  - One estuary, fish focused IBI in NE (Hughes et al. 2002)
  - Not a large number of fish species in PNW to base an IBI
  - Concern for reinventing wheel or amount of effort to create

- Perhaps most importantly, condition quality thresholds or target conditions not considered or developed ***after*** indicators chosen
  - Does not address concern for choosing indicators that reflect degraded system

Update since January Science Work Group

- Researched another method which has a bioassessment component, Biological Condition Gradient, addressed concerns about condition quality thresholds for indicators
- BCG process allows consideration of this early on in the process of identifying indicators
- Process provides scientifically defensible end points and series of testable hypotheses

➢ Importantly, BCGs provide an explicit decision framework that makes developing the indicator system as well as the indicators themselves easy for citizens and managers to understand

Biological Condition Gradient Tiers

Ecological Attributes	1	2	3	4	5	6
	Natural or native condition	Minimal changes in the structure of the biotic community and minimal changes in ecosystem function	Evident changes in structure of the biotic community and minimal changes in ecosystem function	Moderate changes in structure of the biotic community and minimal changes in ecosystem function	Major changes in structure of the biotic community and moderate changes in ecosystem function	Severe changes in structure of the biotic community and major loss of ecosystem function
	Native structural, functional and taxonomic integrity is preserved; ecosystem function is preserved within the range of natural variability	Virtually all native taxa are maintained with some changes in biomass and/or abundance; ecosystem functions are fully maintained within the range of natural variability	Some changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system	Moderate changes in structure due to replacement of some Sensitive-ubiquitous taxa by more tolerant taxa, but reproducing populations of some Sensitive taxa are maintained; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes	Sensitive taxa are markedly diminished; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased build-up or export of unused materials	Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism condition is often poor; ecosystem functions are severely altered
I Historically documented, sensitive, long-lived or regionally endemic taxa	As predicted for natural occurrence except for global extinctions	As predicted for natural occurrence except for global extinctions	Some may be absent due to global extinction or local extirpation	Some may be absent due to global, regional or local extirpation	Usually absent	Absent
II Sensitive- rare taxa	As predicted for natural occurrence, with at most minor changes from natural densities	Virtually all are maintained with some changes in densities	Some loss, with replacement by functionally equivalent Sensitive-ubiquitous taxa	May be markedly diminished	Absent	Absent

BCG and “Trial” Oregon Example

Biocriteria: Beneficial Uses and Tiered Aquatic Life Uses

CWA Goals	Bio Integrity		Interim Goal	Unacceptable--->	
Tiered Use Categories	A	B	C	D	E
	Natural Conditions	Minimal Changes	Conspicuous Changes	Major Changes	Severe Changes
Beneficial Uses	Salmonid Fish Spawning Salmonid Fish Rearing				
	Residemt Fish and Aquatic Life				
	Anadromonous Fish Passage				
Biology	**All expected** Taxa present will appropriate community relationships	**Expected taxa** present withminor but measurable changes in community	**Most** expected taxa present, measureable changes in community	**Some to few** expected taxa present; major changes in community	**Few to no** expected taxa present; severe changes in community
Chemistry	Low Temperature Dissolved Oxygen at Sat. pH 6.0 to 8.5 Low Nutrients Low Turbidity Low BOD No Toxins				
Physical Habitat	Good Shade Low Sediment Good Habitat Complexity Good LWD Good Bank/Chan. Stability Good Riparian Good Substrate/Cover				
Landscape	**None** of Landscape altered by Humans	**Minimal** Proportion **(<10%)**of Watershed Landscape altered by Humans	**Conspicuous** Proportion **(10-30%)** of Watershed Landscape altered by Humans	**Major** Proportion **(30-50%)** of Watershed Landscape altered by Humans	**Severe** Proportion **(50-70%)** of Watershed Landscape altered by Humans

Questions?

Considerations for application in lower Columbia River

- Lower Columbia River is a drowned river type estuary
- Large tidal freshwater section
- Little seagrass, oyster bars or other “typical” estuary habitats
- Significant temporal and spatial differences in forcings and conditions such as water elevation, water quality, and biologic communities
- The lower Columbia River might **not** have a key, instream aquatic habitat that functions as essential fish habitat, which allows managers to use the “build it and they will come” paradigm, as in Tampa Bay and lagoonal type estuaries

Tampa Bay BCG Example

1. Identified faunal guilds of importance (estuary-dependent species); identified ecological needs (i.e., key habitats)
2. Identified datasets that could be used for creating targets
   - Used historic habitat maps, compared to current habitat coverage for floodplain and aquatic habitats (i.e., seagrass)
3. Developed numeric targets for habitats important to faunal guilds
   - Targeted subset of historic floodplain habitat mosaic
     - protect the remaining stands of intact habitats through conservation lands
   - Targeted 1950s coverage of seagrass
4. Determined resource needs of seagrass:
   - Improve water clarity (by reducing phytoplankton levels)
   - Reduce nutrient loads, specifically nitrogen, to reduce phytoplankton concentrations

Tampa Bay BCG Example

5. Created numeric management targets:
   - Numeric seagrass coverage goals by bay segment
   - Numeric nitrogen load reduction goals by year
6. Created decision support framework and tools for implementation:
   - Developed and worked with agencies and industries to implement voluntary nitrogen load reduction actions
   - Established a Nitrogen Management Consortium to guide implementation and provide feedback
   - Developed comprehensive monitoring program to assess effectiveness of actions and status of resources
     - Monthly monitoring for water clarity, concentrations of nutrients, phytoplankton,

Tampa Bay BCG Example

- Developed comprehensive monitoring program to assess effectiveness of actions and status of resources (cont)
  - Annual seagrass condition monitoring
  - Biennial seagrass coverage monitoring
  - Landcover data every five years
- Report out to public on trends and progress in meeting targets every 2-3 years
- Partners undertake diagnostic studies on identified uncertainties (wave energy effects on seagrass, seagrass "donut" phenomena, grazing impacts, effectiveness of Best Management Practices in nutrient load reductions, etc)

➢ Result - region has met nitrogen load reduction goals, shown significant increases in seagrass coverage and is on recovery trajectory to meet seagrass coverage goals. ***Success story!***

Recommended BCG process for LCRE

- Keep in mind that this is a fluid framework that can be modified to fit us

1. Define a "minimally disturbed" lower Columbia River as an "anchor" for discussion
2. Identify key changes and patterns of biological changes with increasing human stress
3. Narratively describe target conditions for lower Columbia River in future (what do we want conditions to look like within realistic future constraints)
   - Identify key ecological attributes or patterns we want to protect or restore (e.g., Pacific salmon, Pacific migratory flyway, clams)

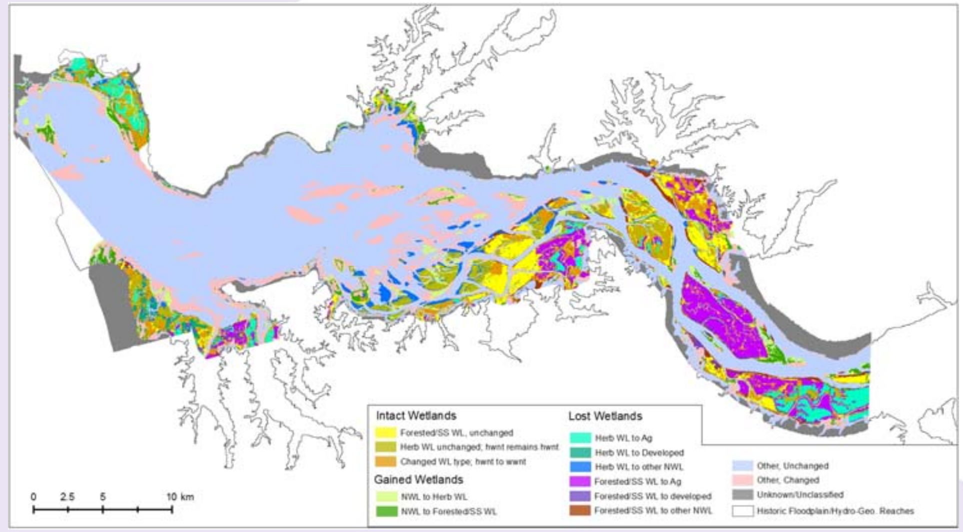
Recommended BCG process for LCRE

- Keep in mind that this is a fluid framework that can be modified to fit us

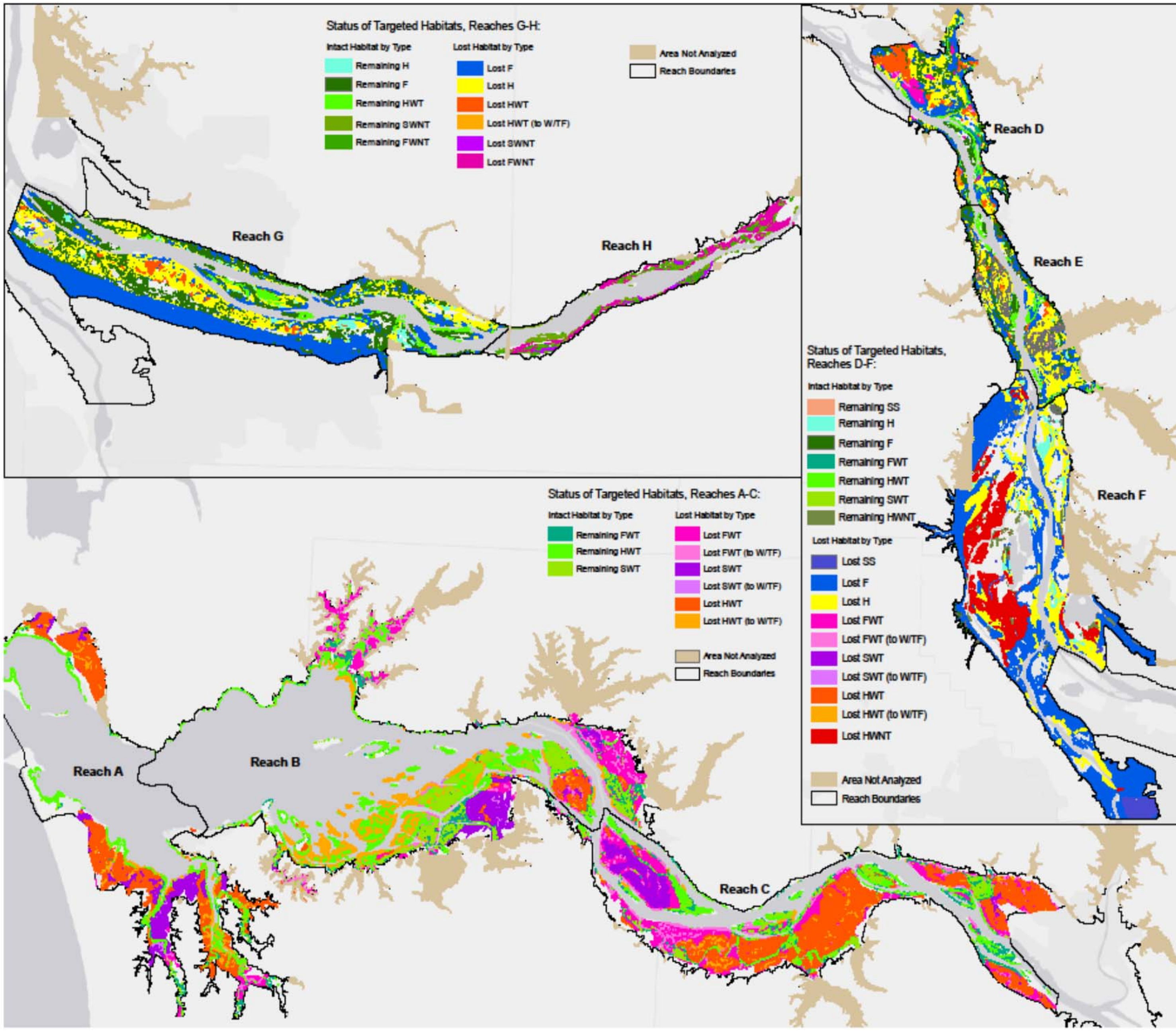
4. Narratively describe the ecological needs of identified attributes (diversity of habitats distributed throughout lower river, food sources, migratory pathway safe from predation)
5. Identify datasets describing these to be used for creating targets (e.g., our habitat change analysis, vegetation composition, water and other trends data)
6. Create numeric targets (X acres of emergent marsh habitat in Reaches A-C, <35% cover of reed canary grass, <19 degrees Celsius water temperature)

Tier 3 Restoration Strategy- Line of Evidence 1: Historic to Current Habitat Change Analysis

- **Methods:**
  - Used classified T sheets and 1850s survey (GLOS) as historic data and compared to 2010 landcover
- **Results:**
  - losses, gains, changes in habitat types throughout
- **Targets (2 scales):**
  1. Reach specific habitat goals
  2. Region specific habitat goals



Habitat	Relevant Reaches
Tidal herbaceous wetlands	A – E, G
Tidal wooded wetland	A - D
Forested	A, D - G
Herbaceous	D - G
Shrub scrub	E, F
Non-tidal herbaceous wetland	F
Non-tidal wooded wetland	H



Lower Columbia River Estuary Historical Habitat Change Analysis: 1880s to 2010

This map shows the extents of lost and remaining habitat areas, for the priority habitat types which have been targeted for each Hydrogeomorphic Reach.

Habitat Codes:

F: Forest
H: Herbaceous
SS: Shrub-Scrub
FWT: Forested Wetland, Tidal
HWT: Herbaceous Wetland, Tidal
SWT: Shrub-Scrub Wetland, Tidal
FWNT: Forested Wetland, Non-Tidal
HWNT: Herbaceous Wetland, Non-Tidal
SWNT: Shrub Scrub Wetland, Non-Tidal
W: Water
TF: Tidal Flats

Priority Habitat Types by Reach:

Reach A: HWT, FWT, SSWT
Reach B: FWT, SSWT, HWT
Reach C: FWT, SSWT, HWT
Reach D: HWT, FWT, SSWT, F, H
Reach E: H, F, SS, HWT
Reach F: F, H, HWNT, SS
Reach G: F, H, HWT
Reach H: FWNT, SSWNT

Map prepared on 2/23/12 by:

Lower Columbia Estuary Partnership

Recommended BCG process for LCRE

- Keep in mind that this is a fluid framework that can be modified to fit us

7. Identify indicators to measure on whether we are meeting targets (landcover, vegetation cover, water temperature)
8. Determine population of interest (using Classification) for each core indicator and minimum number of sites…(see EMP design framework for remaining steps)
9. Create other aspects of decision support framework and tools for implementation, building upon existing efforts

➢ **Try accomplishing steps 1-4 at the April 4-5 workshop**

Juvenile Pacific salmon

- Diversity of tidal habitats
  - Coverage, quantity
    - X acres of tidal herb wetlands in Reaches A-E, G
    - Y acres of tidal wooded wetlands in Reaches A-D
  - Quality
    - <19 degrees Celsius from June – Sept
    - <35% cover reed canary grass
- Prey
  - Inverts
  - Small fish
- Migratory Pathway
- Low Predation & Disease

Questions?