Study Code: EST-P-11-01

Fish Program Feature: SCT spreadsheet identifier (i.e. CRFM Project)

Title: Multi-Scale Action Effectiveness Research in the Lower Columbia River and Estuary (LCRE)

Management Application: Estuary research funded through the CRFM AFEP supports the Corps and regions Columbia Estuary Ecosystem Restoration Program (CEERP). The goal of the CEERP is *to understand, conserve and restore ecosystems in the Columbia River Estuary*. This study supports this goal by executing action effectiveness research at a site, landscape and estuary scale. Findings inform management decisions on habitat restoration location, type and design (e.g., where and what types of projects results in the greatest biological and environmental benefit?); and contributes to our understanding of salmon ecology in the LCRE (e.g., establishing a best available science standard). This study principally addresses key management questions:

- Which actions are most effective at addressing the limiting factors?
- Are the estuary habitat actions achieving the expected biological and environmental benefits?
- What adjustments should be made, if any, to improve the ability of the SBU crediting method to predict benefits to ESA-listed fish from ecosystem protection and restoration in the LCRE?

As we answer these questions, we can make better decisions about habitat restoration (project selection, design and assessments) and RME in the LCRE. Estuary research progresses actions under the 2008/2010 FCRPS BiOp:

- *RM&E Strategy 4 -* Estuary Habitat and Ocean Research, Monitoring, and Evaluation: **RPA 59** Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions. Study investigates migration through and use of a shallow-water habitats (0-5-m); **RPA 60** Monitor and Evaluate Habitat Actions in the Estuary. Study evaluates the effects (changes over time) of individual habitat restoration actions at project sites, landscape, and estuary scale; **RPA 61** Investigate Estuary / Ocean Critical Uncertainties: Study builds scientific understanding of salmon - ecosystem relationships and responses to habitat changes.
- *Adaptive Management Actions –* **RPA 1** Implementation Plan, **RPA 2** Annual Progress Report, **RPA 3** Comprehensive RPA Evaluations: Study findings will reported in FCRPS related reports.

Background: The subject study is an MOA study, transferred to the Corps from BPA in summer 2010 and formerly titled Ecology of Juvenile Salmon in Shallow Tidal Freshwater Habitats of the Lower Columbia River (2007-2010). The former study focused on investigating critical uncertainties regarding the ecology and early life history of juvenile salmon in shallow (<5 m) tidal freshwater habitat in the LCRE. The subject study now focuses on investigating the benefits of habitat restoration at various spatial and temporal scales. *Benefits are evaluated across space and time relative to key response variables: **controlling factors (**hydrology, water quality); **structural attributes**: habitat, vegetation, substrate, and **biological communities** (genetic stock group ID, native and non-native species interactions, growth and diet, residence, migration, bioenergetics, mean fish density).*

Study Goal/ Hypothesis: Habitat restoration activities in the lower Columbia River and estuary have a cumulative beneficial effect on salmon. * Study will apply a "Levels of Evidence" (LOE) analytical approach (Diefenderfer et al. 2011) – see Attachment 1. *Preliminary LOE evaluation will be completed in spring 2012.*

Objective 1 – Site Scale: Evaluate beneficial effects of habitat restoration at 2-3 sites per year.
Method of analysis: Before-After-Control-Impact and/or modified Before-After-Reference-Impact.
Response variables: TBD based on work in 2012. *Example, wetted area (acres, frequency), water properties (temperature), topography (elevation), vegetation (% cover by class), prey (biomass), fish use (presence, genetic stock, size, density), etc.*

Objective 2 – Landscape Scale: Evaluate beneficial effects of habitat restoration within the Lower River Reach

(LRR): St. Helens to Longview, rkm 110–141). * *Work in 2013 will establish baseline conditions (pre-restoration).*
Method of analysis: (a) rotational sampling design; (b) indices (example, ELHD index)
Response variables – TBD based on work in 2012. *Example, fish movement (timing and patterns), species, stock, (genetic id.), size, fish density, etc.*

Objective 3 – Estuary Scale: Evaluate beneficial effects of habitat restoration estuary-wide.
Method of analysis - Net Ecosystem Improvement ("additive gains")
Response variables – TBD based on work in 2012. *Example, wetted area (acres), etc.*

Objective 4 (NEW) - Disseminate Information and results. Make research findings and analytical tools accessible to habitat restoration planners, engineers, biologists, and researchers.
Approach: prepare written documents (design technical memorandums, co-author 2013 Synthesis Memorandum, and prepare Annual Research Report) present findings to AFEP SRWG, EP Science Work Group, and restoration sponsors; support transfer of technology.

**Period of data collection:** year-round, depending on response variable
Schedule: FY 2011 to FY 2018

Related Research: The subject study will be coordinated with other estuary research, including:
- Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Action in the CRE: Study will field test methods developed for habitat connectivity (access and opportunity), early life history diversity and survival benefit at the site and landscape scale.
- NEW Research Proposal: Synthesis of Research, Monitoring and Evaluation and Restoration Project Data in the LCRE: Data will be downloaded to and stored in the regional database (when available).
- Evaluating Cumulative Ecosystem Response to Restoration Projects in the CRE: Study will apply the levels-of-evidence analytical framework (Diefenderfer et al. (2011) as an organizing model for evaluating the ecological benefits
- BPA F&W Program: Ecosystem Monitoring Program (= status and trends monitoring) and Action Effectiveness Monitoring. Where appropriate, study will use reference sites examined in the STM program.

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Attachment 1 - Levels of Evidence (Diefenderfer et al. 2011, Ecological Restoration Vol. 29, Nos 1-2):
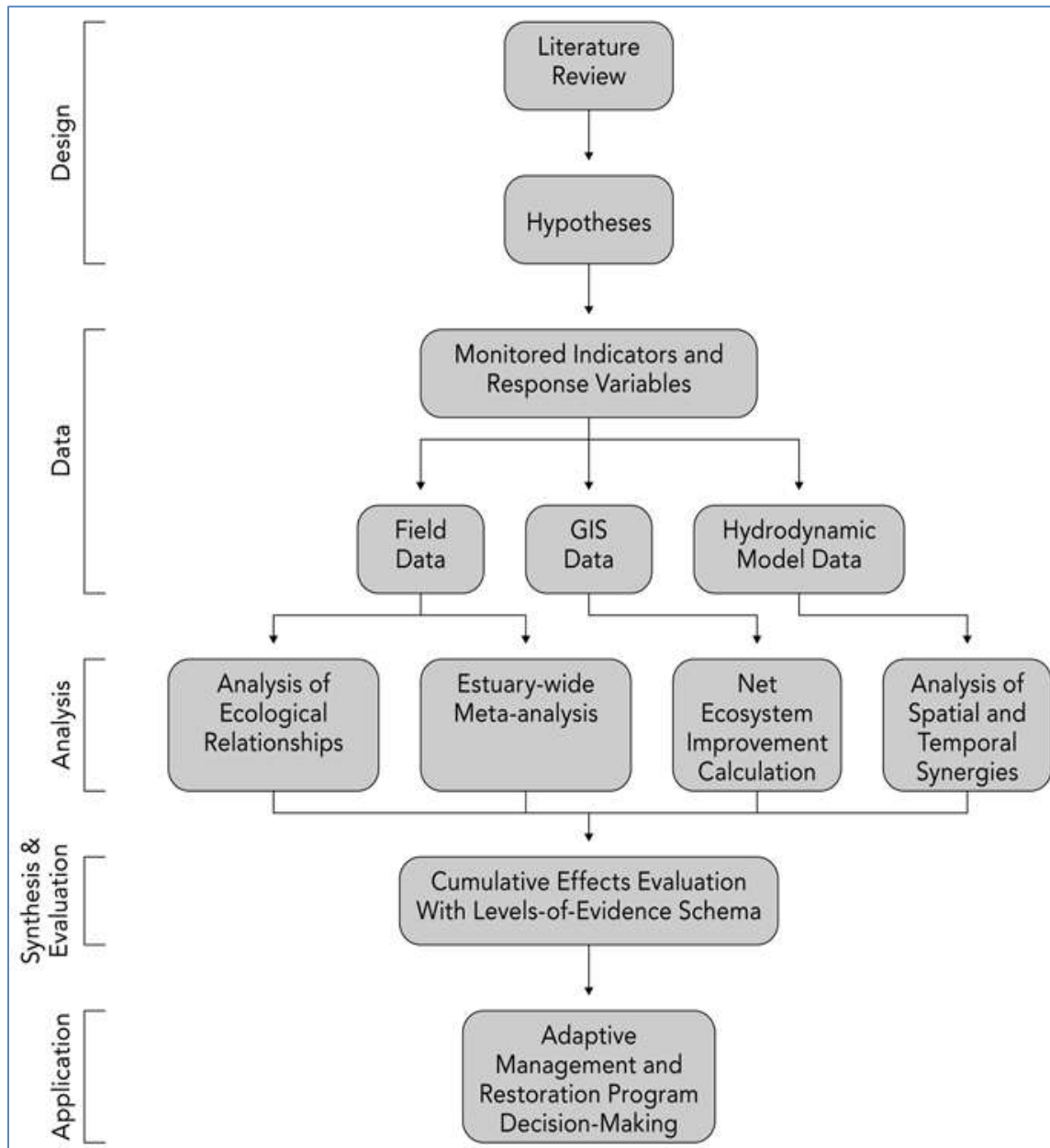
Attachment 2 – Spectrum of Extensive (=monitoring) and intensive (=research) data (Johnson et al. 2012).

Monitoring		Extensive
	Photo points	
	Latitude and longitude	
	Water-surface elevation (logger)	
	Temperature (logger)	
	Salinity (logger)	
	Channel cross-sectional area	
	Sediment accretion	
	Elevation (bathymetry/topography)	
	Catchment area	
	Plant species comp	
	Plant percent cover	
	Plant biomass	
	Aerial photos	
	Fish presence/species/size	
	Fish density	
	Satellite imagery land cover	
	Water velocity	
	Water properties (DO,TOC,chloro.etc.)	
	Nutrients (NH3,PO4, SiO3)	
	Fish diet	
	Fish residence time	
	Neuston prey	
	Benthic-invertebrate prey	
	Insect fallout prey	
	Fish condition (FIT)	
	Hyposographic curve of watersurface elevation	
	Tidal exchange volume	
	Image analysis	
	Area-time inundation	
	Floodplain wetted area	
	Wetted-channel edge length	
	Plant similarity	
	Plant biomass flux	
	Material flux	
Research	Fish growth	**Intensive**