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# TECHNICAL MEMORANDUM

DATE: Monday, September 15, 2014

TO: Kelli McCune, Sustainable Conservation

FROM: Amy Merrill, Stillwater Sciences

SUBJECT: Monitoring Recommendations for Mokelumne Riparian Benefits Quantification Tool

## 1 INTRODUCTION

The monitoring recommendations provided below for the Lower Mokelumne Basin Program Area are intended to fulfill needs at two spatial scales: (1) monitoring system-wide changes in the target environmental benefits (e.g. riparian bird density and diversity, cold water fisheries population, stream water temperatures, and flood impacts at the scale of the Lower watershed) *(Program Scale)*, and (2) site-specific calibrations to support an iterative process of tool refinement for improved metrics, field methods, and scoring weights *(Project Scale)*. These recommendations can help identify the causal relationship between restoration actions and the observed changes in the lower watershed. Thus, as restoration actions are implemented, the Mokelumne Program will be able to track and re-calibrate the quantification tools to improve consistency and accuracy. These monitoring actions will also provide feedback on the overall effectiveness of the Mokelumne Benefits Program in improving the target environmental benefits.

## 2 RECOMMENDATIONS

Overall, we recommend linking empirical observations of the target outcomes, or ecosystem services, to both the Project Area and to metrics used in the current version of the Quantification Tool. Careful consideration must be given to location and timing of these empirical measurements as well as to scale. Empirical measures of benefits (e.g. riparian bird species population density) must be performed at scales that directly address Project Area level assumptions in the Tool. Project site scale empirical measurements should be part of a broader design that also addresses variation at the Programmatic level to determine if the combined effects of restoration projects are importantly increasing benefits to the Lower Mokelumne River program area. In the text below, we refer to the most direct measures of ecosystem benefits as 'response variables', or those things that the program is aiming to change in response to altered management and restoration of particular attributes of the Lower Mokelumne riparian corridor. The 'explanatory variables' are those attributes that we expect will elicit a change in the response variables. For example, an increase in the area flooded at the 2-yr recurrence interval flows ('explanatory variable) is expected to be followed by an increase in juvenile Fall-run Chinook out-migration ('response variable').

## 2.1 Riparian Bird Habitat

Direct monitoring of riparian birds will provide the ultimate feedback on whether or not, and to what degree, the Mokelumne Benefits Program is supporting and improving this ecosystem service. The presence, abundance, and diversity of riparian bird species within the Program Area can be linked to those variables used as indicators of riparian bird habitat quality in the Mokelumne Benefits Quantification Tool. Thus, we recommend spatially linking bird surveys to information on indicator variables and to the distribution of the restored Project Areas.

**Potential Response Variables**
Bird count or similar information should be collected on the presence, density and diversity of riparian focal species identified for the Central Valley, including: Bank Swallow, Bell's Vireo, Black-headed Grosbeak, Blue Grosbeak, Common Yellowthroat, Song Sparrow, Swainson's Hawk, Swainson's Thrush, Tree Swallow, Tricolored Blackbird, Warbling Vireo, Willow Flycatcher, Wilson's Warbler, Yellow-breasted. Chat. Yellow-billed Cuckoo, Yellow Warbler. Although many of these species do not occur in the Lower Mokelumne watershed at this writing, increased extent and quality of riparian habitat could bring some of these species into the area.

**Potential Explanatory Variables**
Compare the CADC Habitat Suitability Index values for areas in the Lower Mokelumne in relation to local empirical data on diversity and density of riparian focal species. This will provide feedback on the accuracy of the CADC Habitat Suitability Index for the Program Area. *(Project site and Program scale)*

Survey land use adjacent to and within a 0.5 mile buffer of bird survey areas, potentially including more detailed information on feral cats, corvids, cow birds, brown birds, rats, and other bird predatory populations. This information also could be linked to the Land Use Land Cover (LULC) data provided as part of the Flood Attenuation tools package to both 'ground truth' the LULC data, and to test the possibility of using the LULC data to target areas where pest species could be an important issue for riparian birds along the Lower Mokelumne River corridor. *(Project site and Program scale)*

Perform bird density, reproductive success, or diversity surveys linking patch-size and canopy structure characteristics to use and reproductive success of riparian bird species. Specific nesting and foraging range needs are not well known for all of the riparian focal species. *(Project site and Program scale)*

Measure the frequency and abundance of potential forage plant species beyond those listed as beneficial in the Mokelumne Benefits Riparian Habitat Quantification Tool: mugwort, hedgenettle, Santa Barbara Sedge, California blackberry. This could help to expand the planting palette for restoration projects to increase plant diversity and riparian bird populations. *(Project Site scale)*

Perform bird surveys that are spatially linked to fluvial geomorphic surfaces, including the 2 to 3 yr floodplain and the 5 to 10 yr floodplain. Although no spatial data currently exists on the distribution and extent of floodplains in the Program area, the levee shape file (provided to Sustainable Conservation from Stillwater Sciences in the spring of 2014) could offer a loose indication on the location of more vs. less extensive floodplains. Any demonstrated ties between flood frequency and riparian bird species population or diversity could help direct future project

designs. The linkage in the Quantification Tool is based on the fact that where rivers have lateral access to the floodplains, a greater diversity of habitat types (back channel ponds, wetlands, gravel bars, and variously aged riparian forest and shrub vegetation communities), also occur, which in turn support a greater diversity of bird species. *(Project site and Program scale)*

## 2.2 Fish and Aquatic Habitat

**Potential Response Variables**
Perform empirical fish surveys for different life stages of steelhead and Chinook salmon observed using inundated restored and non-restored floodplains (2 to 3 yr floodplain and 5 to 10 yr floodplain) within the Lower Mokelumne River.

Assess overall changes in the out-migrating and return populations of Fall-run Chinook and Steelhead in the Lower Mokelumne River.

**Potential Explanatory Variables**
Fish use and abundance in particular areas and reaches could be compared to the following site attributes to test the Tool assumptions that these attributes importantly affect fish:

- Floodplain size and flood flow level (e.g. frequency) *(Project site scale)*
- Vegetation cover characteristics: distribution and extent of herbaceous vs. shrub and forest dominated community types, amount and type of invasive plant species, vegetation overhang along channel edge. *(Project site scale)*
- Presence and size of back channels or wetlands *(Project site scale)*

Fish use and abundance in the entire Lower Mokelumne River over time could be compared to the following site attributes to test the Tool assumptions that these attributes importantly affect fish and that the Program is having the desired effect.

- Changes over time in the pattern, distribution and overall extent of floodplain area (at different flow levels) due to program implementation. (*Program scale)*
- Measures of proximity and connectivity among restored floodplain areas in relation to fish abundance and use during different life stages. *(Program scale)*

## 2.3 Riparian Shade and Stream Temperatures

**Potential Response Variables**
Continuous stream temperature monitoring at locations up and downstream of Project Areas would provide direct information on whether or not Projects are actually helping to reduce or maintain cool stream temperatures. *(Project site scale and Program scale)*

**Potential Explanatory Variables**
Shade-a-lator estimates of percent riparian and topographic shade at points where empirical channel shade extent and density measurements have been collected (e.g. analysis of imagery collected from points along channel using fish eye lens) could be used to refine and test the accuracy of the Shade-a-lator. *(Project scale)*

Project Area changes in riparian (and topographic) shade during periods of stream temperature data collection could test the degree to which a single project could affect local stream temperatures. Temperature readings would have to be in the channel at the site itself. *(Project scale)*

Program Area changes in the extent of restored stream bank vegetation (linear feet along southern bank's edge) above stream temperature measuring stations over time, as restoration actions are implemented, could test the fundamental assumption that shade can affect stream temperatures and also provide information on program progress. *(Program scale)*

Measure changes in estimated Shade-A-lator riparian stream shade during the same period as when stream temperatures and flows are directly measured, upstream and downstream of stream temperature measurement sites. This would be a direct test of the degree to which increased shade can affect stream temperatures at different flows. Data on stream temperatures, flows, and shade could be collected at the site to reach scales; with a greater change in the number of linear feet of shade having a greater likelihood of being detectable in comparison to the many other factors affecting stream temperature. *(Project and Program scale)*

Measure groundwater and hyporheic water interactions with channel water during summer low-flow periods and associated effects on stream temperatures. This is currently not addressed in the Mokelumne Benefits Program and determining the importance of hyporheic water interactions to summer stream flow temperatures would support decisions to either include or continue not including hyporheic flow effects on stream temperatures. *(Program scale)*

## 2.4 Potential for Downstream Flood Attenuation

**Potential Response Variables**
Changes in downstream flood extent during flows that approach or exceed 5,000 cfs at the Camanche gage in relation to the number and extent of restored floodplain areas developed through the Mokelumne Benefits Program would provide direct feedback on whether or not the program is having a real effect on downstream flooding (this would be a long-term monitoring effort). *(Program scale)*

**Potential Explanatory Variables and Testing Tool Assumptions**
Collect direct measurements of flood flows in floodplain areas, including water velocity, depth, and channel width, in order to develop empirical values for processes that affect flood attenuation. This would be particularly useful for areas that have been assessed using the Flood Attenuation tool and for refining parameters in the tool. *(Project scale)*

Perform 2-D flow modeling of flooded areas along multiple representative reaches, which include Project Areas, at the 2.5, 5 to 10, and possibly 100 yr recurrence interval flows. Results from such modeling efforts could be compared to the more generalized, and relatively data-poor estimates made using the Flood Attenuation tool and used to refine parameters in the tool. *(Program and Project scales)*

Perform ground truthing of the Land Use Land Cover spatial data to test for accuracy and to assess the actual degree of value that could be lost if classes of land were inundated for a week or more during winter or spring high flows. *(Program scale)*

Test the reliability of the FEMA levees to better assess whether the assumption that these levees will contain 5 to 10 yr recurrence interval and greater floods is dependable. Levee engineering software can be used, based on assumptions and field measurements of levee structure and composition, to assess the levee risk factor ("factor of safety"). *(Program scale)*

## 2.5 Veggiematic

**Potential Response Variables**
Direct measurements of changes, for all tree and shrub species, in height, canopy width and density over time. These measurements would be collected using the same methods and at the same time of year, as installed plants grow from year 1 up to year 50.

**Potential Explanatory Variables**

- Inter annual variation in wet, moderate, and dry water years and/or irrigation amount and duration, as classified in the User Guide. *(Project scale)*
- Soil texture and coarse content in upper 1 to 3 feet. *(Project scale)*
- Planting material size and type *(Project scale)*
- Percent shade above planted individuals.