Plan Formulation Appendix A

Cost Effectiveness and Incremental Cost Analysis

Yuba River Ecosystem Restoration Feasibility Study

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Introduction

Ecosystem restoration is one of the primary missions of the Corps of Engineers Civil Works program. The USACE objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to NER are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality and a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). Thus, single purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value (NER outputs) expressed in non-monetary units (habitat units). For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be a cost effective plan for achieving the desired level of output and economically justified (determined to be worth its investment cost). This plan shall be identified as the NER Plan. This formulation, evaluation, and selection process is described below.
A Cost Effectiveness and Incremental Cost Analysis (CE/ICA) analysis was conducted using benefit and cost inputs using the certified IWR-Planning Suite software version 2.0.6.1 (IWR-PLAN).

Restoration Increments

The plan formulation process is described in detail in Chapter 3 of the Feasibility Report. That chapter describes the initial screening of measures, and the subsequent refinement of habitat increments. The ecosystem restoration increments that were retained through all screenings are identified below and described in detail in Chapter 3. Maps of these increments are included in Chapter 3.

Habitat Increment 1

Upstream of Highway 20. Increment 1 includes 7.4 acres of riparian planting, 5.8 acres of side channel creation, and 6.1 acres of restored backwater area.

Habitat Increment 2

Upper Gilt Edge Bar and Unnamed Bar (near River Mile 17). Increment 2 includes 8.7 acres of riparian planting, 14 acres of floodplain lowering, 0.3 acre of restored backwater area, 0.3 acre of bank scalloping.

Habitat Increment 3a

Lower Gilt Edge Bar, Hidden Island, First Island, Silica Bar, and Bar A. Increment 3a includes 28.7 acres of riparian planting, 13 acres of floodplain lowering, and 11.3 acres of side channel creation.

Habitat Increment 5a

Bar C. Increment 5a includes 21.3 acres of riparian planting, 13 acres of floodplain lowering, and 15.1 acres of side channel creation.

Habitat Increment 5b

Narrow Bar, River Mile 6.5, Bar E, and Island B. Increment 5b includes 29.7 acres of riparian planting, 7.7 acres of floodplain lowering, 9.2 acres of side channel creation, and 2.9 acres of restored backwater area.

Cost Effectiveness and Incremental Cost Analysis

A CE/ICA analysis was conducted using benefit and cost inputs with the IWR-PLAN. The various habitat increments were combined and evaluated by the software as discussed within this section. The CE/ICA is an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the successively added costs. The CE/ICA is a planning tool to help identify cost-effective plans which provide the highest habitat output relative to cost. Functionally, the CE/ICA provides a framework for combining individual measures (or other increments) into alternative plans. The software expedites this effort of testing each combination of measures and tabulating the resulting costs and environmental benefits.

Cost Effectiveness Analysis

When there is no monetary measure of benefits but project outcomes can be described and quantified in some dimension, cost effectiveness analysis can be used to assist in the decision making process. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining the objective? A plan is considered cost effective if it provides a given level of output for the least cost. Cost effectiveness analysis was used to identify the least cost solution for each level of environmental output being considered.

The cost effectiveness analysis is the first step in the CE/ICA, and compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a “cost per AAHU.” This cost provides a means to compare the cost- effectiveness of each plan. The three criteria used for identifying non-cost effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at less cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of the National Ecosystem Restoration (NER) Plan. Non-cost effective combinations of plans are dropped from further consideration.

Incremental Cost Analysis

Incremental cost analysis compares the additional costs to the additional outputs of an alternative. It is a tool that can assist in the plan formulation and evaluation process. The analysis consists of examining increments of plans or project features to determine their incremental costs and incremental benefits. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs. When the incremental costs exceed the incremental benefits, no further increments are added. Incremental analysis helps to identify and display variations in costs among different increments of restoration measures and alternative plans. Incremental analysis helps decision makers determine the most desirable level of output relative to costs and other decision criteria.

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify "best buy" plans. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify successively larger plans with the smallest incremental cost per unit of incremental output.

Selection Consideration

For ecosystem restoration, the recommended plan should be the justified alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. A plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, is identified as the National Ecosystem Restoration (NER) Plan. The selected plan should be cost effective and justified in achieving the desired level of output. Thus, the NER plan is selected from the suite of cost effective plans identified in the CE/ICA. While the NER Plan is not required to be a best buy plan, this is often the case. The results of the CE/ICA do not provide a discrete decision, but rather they offer tools to help inform a decision.

Ecosystem Outputs

A standard Habitat Evaluation Procedure (HEP) was used to quantify ecosystem outputs for the CE/ICA. Three habitat types were identified to represent anticipated ecosystem outputs of the final array of alternatives: in-channel habitat, inundated floodplain habitat, and riparian habitat. The species identified to evaluate habitat were steelhead, downy woodpecker, and yellow warbler. Habitat suitability criteria for each species and habitat type were analyzed under a range of river flow conditions. Ecosystem outputs were calculated based on the difference between future without project conditions and future with project conditions. Refer to Chapter 3 and Appendix D, Attachment 8 for further detail on assessing ecosystem outputs.

Costs and Outputs of Habitat Increments

As described in Chapter 3 of the integrated document, the costs and outputs of the habitat increments are shown below in Table 1.

Table 1. Costs and Outputs of Habitat Increments.

Increment	Total Project First Costs	Average Annual Costs	Acres	Average Annual Habitat Units (AAHU)
1	$20,241,000	$768,107	19.2	3.62
2	$9,194,000	$348,895	23.3	14.32
3a	$31,610,000	$1,199,539	56.4	17.80
5a	$24,987,000	$948,209	49.3	19.36
5b	$23,608,000	$895,878	49.5	21.38

CE/ICA Model Implementation

The habitat increments were entered into the IWR model as solutions. There are no dependencies between increments and all increments are combinable.

Results

This comparison between increments was made using IWR-PLAN to conduct cost effectiveness and incremental cost analysis based on costs (dollars) and outputs (AAHU). Incremental costs per unit of output were used to identify major breakpoints in cost efficiency among the alternatives. The model run resulted in a total of 9 cost effective plans. Of these cost effective plans, 6 plans were identified as best buy plans including the no action plan.
Outputs increase as alternatives progress (1-6); however, these outputs are achieved at increasingly higher incremental costs. Alternative 2, while the lowest cost per AAHU, is very small in scale. Alternatives 3, 4, and 5, the next lowest cost per AAHU, are very similar in efficiency. Alternative 6 includes Increment 1, which is more than three times the cost per AAHU of the other increments. Incremental costs and outputs of alternatives are shown below in Table 2 and Figure 1.

Table 2. Incremental Costs and Outputs of Alternatives.

Alternatives	Total Costs	Annualized Costs	Acres	Average Annual Habitat Units (AAHU)	Incremental Annual Cost per AAHU	Total Annual Cost per AAHU
1 (No Action)	0	0	0	0	0	0
2 (Increment 2)	$9,194,000	$348,895	23.3	14.32	$24,364	$24,364
3 (Increments 2, 5b)	$32,802,000	$1,244,773	72.8	35.67	$41,905	$34,898
4 (Increments 2, 5b, 5a)	$57,789,000	$2,192,982	122.2	55.06	$48,980	$39,830
5 (Increments 2, 5b, 5a, 3a)	$89,399,000	$3,395,521	178.6	72.86	$67,386	$46,563
6 (Increments 2, 5b, 5a, 3a, 1)	$109,640,000	$4,160,628	197.8	76.48	$212,126	$54,402

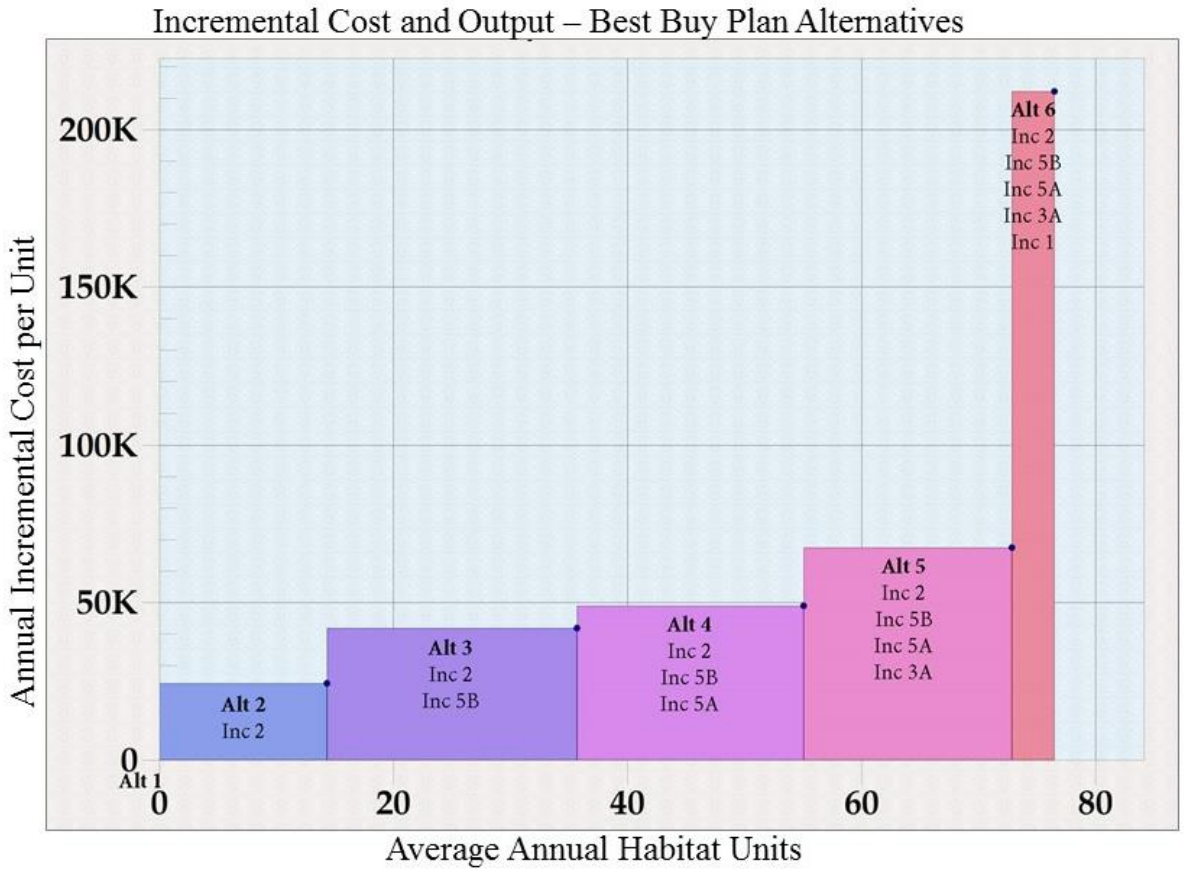

Figure 1. Incremental Costs and Outputs of Alternatives

Final Array of Alternatives

The CE/ICA analysis resulted in 6 “best buy” restoration alternatives including the “no action” alternative.

Alternative 1 is the no action plan and assumes no action is taken as the result of this study.

Alternative 2 includes only increment 2 at Upper Gilt Edge Bar and Unnamed Bar, which would result in 23.3 acres of restored habitat by lowering the floodplain to facilitate inundation and planting riparian vegetation, as described above. The total cost of this alternative is $9.2 million.

Alternative 3 includes increments 2 and 5b at Upper Gilt Edge Bar, Unnamed Bar, Narrow Bar, River Mile 6.5, Bar E, and Island B, which would result in 72.8 acres of restored habitat by lowering the floodplain to facilitate inundation and planting riparian vegetation, as described above. The total cost of this alternative is $32.8 million.

Alternative 4 includes increments 2, 5b, and 5a at Upper Gilt Edge Bar, Unnamed Bar, Narrow Bar, River Mile 6.5, Bar E, Island B, and Bar C, which would result in 122.2 acres of restored habitat by lowering the floodplain to facilitate inundation and planting riparian vegetation, as described above. The total cost of this alternative is $57.8 million.

Alternative 5 includes increments 2, 5b, 5a, and 3a at Upper Gilt Edge Bar, Unnamed Bar, Narrow Bar, River Mile 6.5, Bar E, Island B, Bar C, Lower Gilt Edge Bar, Hidden Island, First Island, Silica Bar, and Bar A, which would result in 178.6 acres of restored habitat by lowering the floodplain to facilitate inundation and planting riparian vegetation, as described above. The total cost of this alternative is $89.4 million.

Alternative 6 includes increments 2, 5b, 5a, 3a, and 1 at Upper Gilt Edge Bar, Unnamed Bar, Narrow Bar, River Mile 6.5, Bar E, Island B, Bar C, Lower Gilt Edge Bar, Hidden Island, First Island, Silica Bar, Bar A, and Upstream of Highway 20, which would result in 197.8 acres of restored habitat by lowering the floodplain to facilitate inundation and planting riparian vegetation, as described above. The total cost of this alternative is $109.6 million.