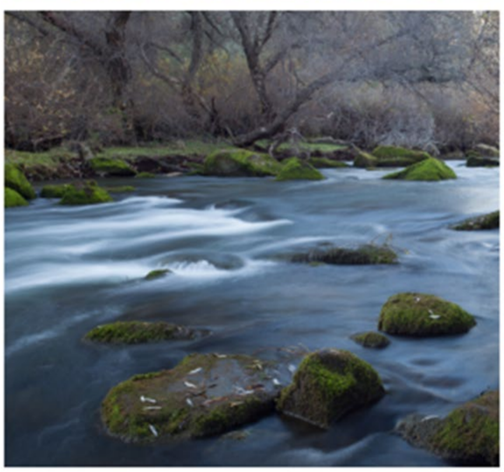
JULY 2025 DRAFT

Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Watershed



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Appendix B. Voluntary Agreements Accounting Protocols

B.1 Flow Accounting

[Note to reader: Appendix B.1 is included in a separate document for this revised draft of the Bay-Delta Plan, but will be combined in the final version of the plan.]

B.2 Non-flow Habitat Accounting

B.2.1 Tributary Non-flow Habitat Restoration Accounting Protocols

The following Voluntary Agreement (VA) habitat accounting protocols pertain to tributary spawning, in-channel rearing, and tributary floodplain rearing habitat restoration projects. Tributary floodplain projects intended to contribute toward the valley floor habitat commitment will be accounted for following this protocol, but with the exceptions noted below.

Assessment of site-specific habitat implementation requires spatially explicit quantification of those areas within a project boundary (i.e., “footprint”) that conform with specified design criteria at design flows. The term “design flows” refers to the range of flows over which a habitat project is designed to create habitat. Design flows should include at a minimum the design flows in the flow-habitat relationships provided by VA parties for assessment of the benefits of the VAs (i.e., those used in the final Scientific Basis Report Supplement) and represent the full range of flows expected to occur with the addition of the VA flow commitments. For the methodological steps identified below, the flows at which the pre-project and post-project conditions are evaluated must be the same to produce comparable results.

B.2.1.1 Protocol to Produce the Constructed Flow-Habitat Relationship

Habitat accounting will be finalized after the completion of project construction to evaluate the incremental improvement in habitat area meeting design criteria compared to pre-project conditions. Thus, habitat conditions must first be assessed before the project is started (pre-project), assessed again after the completion of construction (post-project), and the two conditions will then be compared in the habitat accounting assessment to produce the constructed flow-habitat relationship representing the additive contribution of the post-project condition over the pre-project condition.

The protocol to produce the constructed flow-habitat relationship consists of two major phases: an assessment of habitat conditions pre-project and post-project in steps (i) through (vi), and the comparison of pre-project to post-project habitat in step (vii). The third and final phase with steps (viii) through (ix) is described in section B.2.1.5.

First, follow steps (i) through (vi) to determine the area of habitat meeting design criteria pre-project and post-project:

i. Accurately characterize physical conditions within specific habitat boundaries ("footprint"). The footprint must be the same pre-project and post-project. Characterization of physical conditions[1] includes topography, substrate, and cover.

ii. Create a digital elevation model (DEM) based on the topographical characterization and create substrate and cover rasters (see discussion of raster development below) for the project footprint.

iii. Apply available two-dimensional ("2D") hydraulic models to calculate water depths and velocities within each computational pixel[2] within the project footprint at each design flow.

iv. Determine where depth, velocity, and substrate (for spawning habitat) design criteria (as defined in the program of implementation) are met at each design flow for each computational pixel within the project footprint (Figure B-1).

v. For rearing habitat, determine the areal extent of cover features within the pixels that meet depth and velocity design criteria at each design flow. If the cover design criterion as defined in the program of implementation is not met at any design flow, discount the area meeting design criteria at those design flows until the cover design criterion is met (Figure B-2).

vi. For floodplain rearing habitat, determine the habitat area meeting the inundation criterion (see section B.2.1.4). To start, sum the area of pixels meeting depth, velocity, and cover design criteria at each design flow to create a flow-habitat function. Apply a timeseries of modeled flows expected to result from the VAs to the flow-habitat function to create a corresponding timeseries of the amount of habitat meeting depth, velocity, and cover criteria. Apply the inundation criterion (as defined in the program of implementation) to this timeseries to determine the area of habitat meeting the inundation criterion.

   (a) If the project is intended to contribute to the valley floor habitat commitment, the area of habitat meeting the inundation criterion is the habitat area used for accounting purposes in step (vii).

   (b) For other projects, if the area of habitat meeting the inundation criterion is smaller than the value of the flow-habitat function in any individual design flow, reduce the area of habitat meeting

[1] Topographical characterization can be developed through traditional surveying techniques, multibeam echo sounding bathymetry, and/or LiDAR data acquisition. Substrate and cover characterization can be developed through field survey mapping, geo-referenced aerial imagery (e.g., fixed-wing aircraft, unmanned aerial vehicles, satellite), and/or LiDAR data acquisition.

[2] Several factors contribute to the size of DEM and 2D model output mesh size, including the quality/density of LiDAR or other topographic data, computational ability, and desired accuracy of output. For high resolution results, a 3 ft. by 3 ft. DEM and 2D hydraulic model output mesh size is generally appropriate for the suite of habitat evaluations for the VA process.

design criteria until the maximum habitat area meeting design criteria at any design flow is no greater than the area of habitat meeting the inundation criterion (Figure B-3).

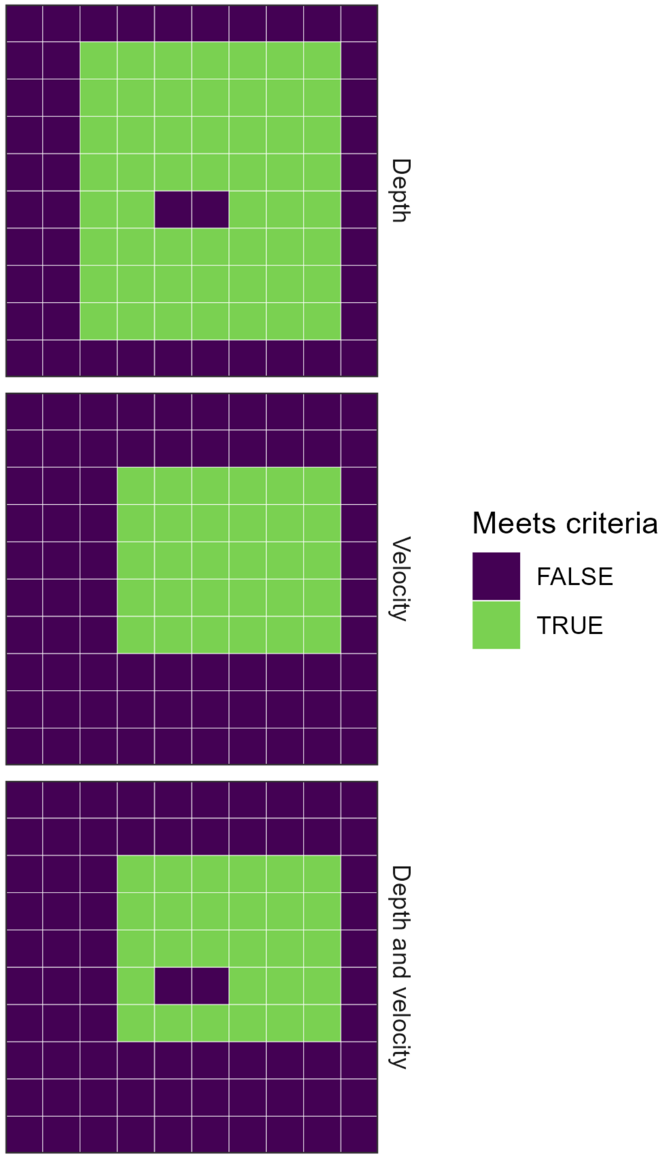

Figure B-1. Conceptual representation of the determination of the habitat area meeting depth and velocity criteria at a single design flow, as described in step (iv).

The same process will be used for both “pre-project” and “post-project” conditions. Rearing habitat is used as an example, but the same process is applied to spawning habitat for the applicable design criteria, which would add an additional step for substrate design criteria.

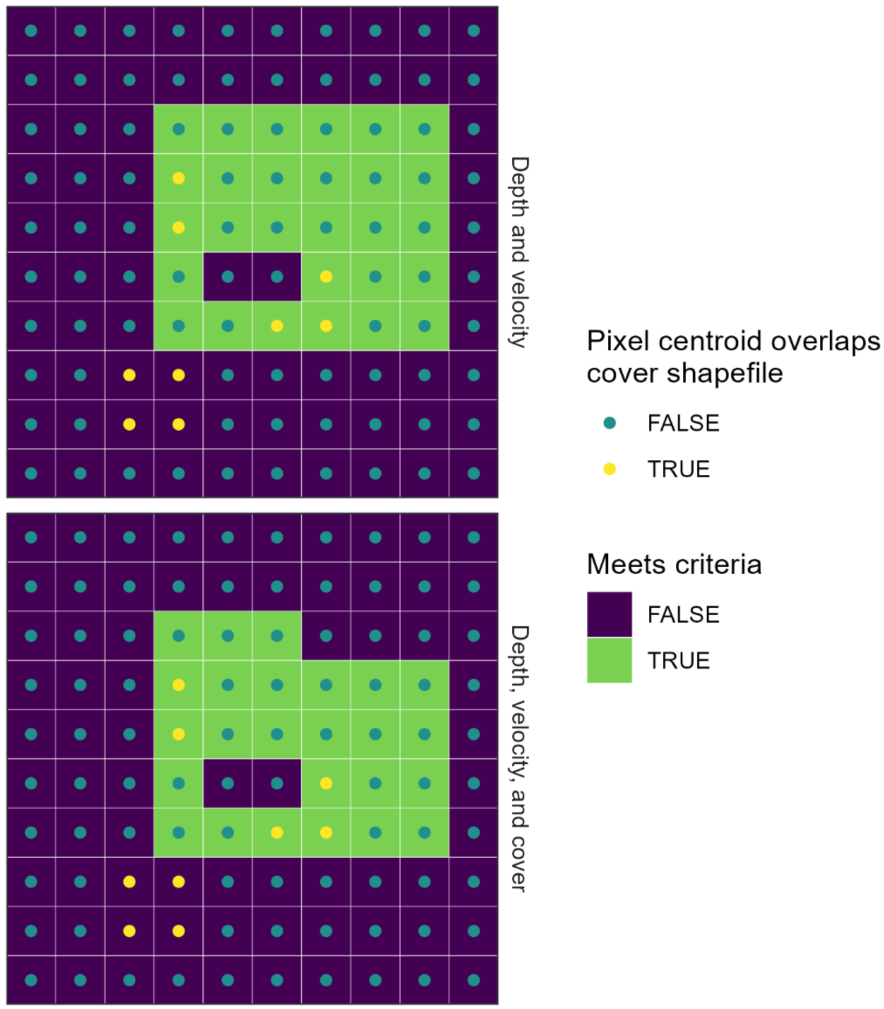

Figure B-2. Conceptual representation of the application of cover design criteria to rearing habitat at a single design flow, as described in step (v) and section B.2.1.3.

In the top image, green pixels meet the depth and velocity criteria and in the bottom image green pixels meet the depth, velocity, and cover criteria. As described in the program of implementation, the areal coverage of cover features within the areas that meet depth and velocity design criteria must be at least 20 percent at each design flow. In this example, 28 pixels meet the depth and velocity criteria (from Figure B-1). Of those 28 pixels, 5 have centroids that fall within the suitable cover shapefile (see section B.2.1.3). To meet the 20 percent coverage requirement for cover features, only 25 total pixels may be classified as meeting design criteria, so three pixels are reclassified as not meeting criteria to develop the quantification of the habitat area meeting depth, velocity, and cover design criteria. The same process will be used for both “pre-project” and “post-project” conditions.

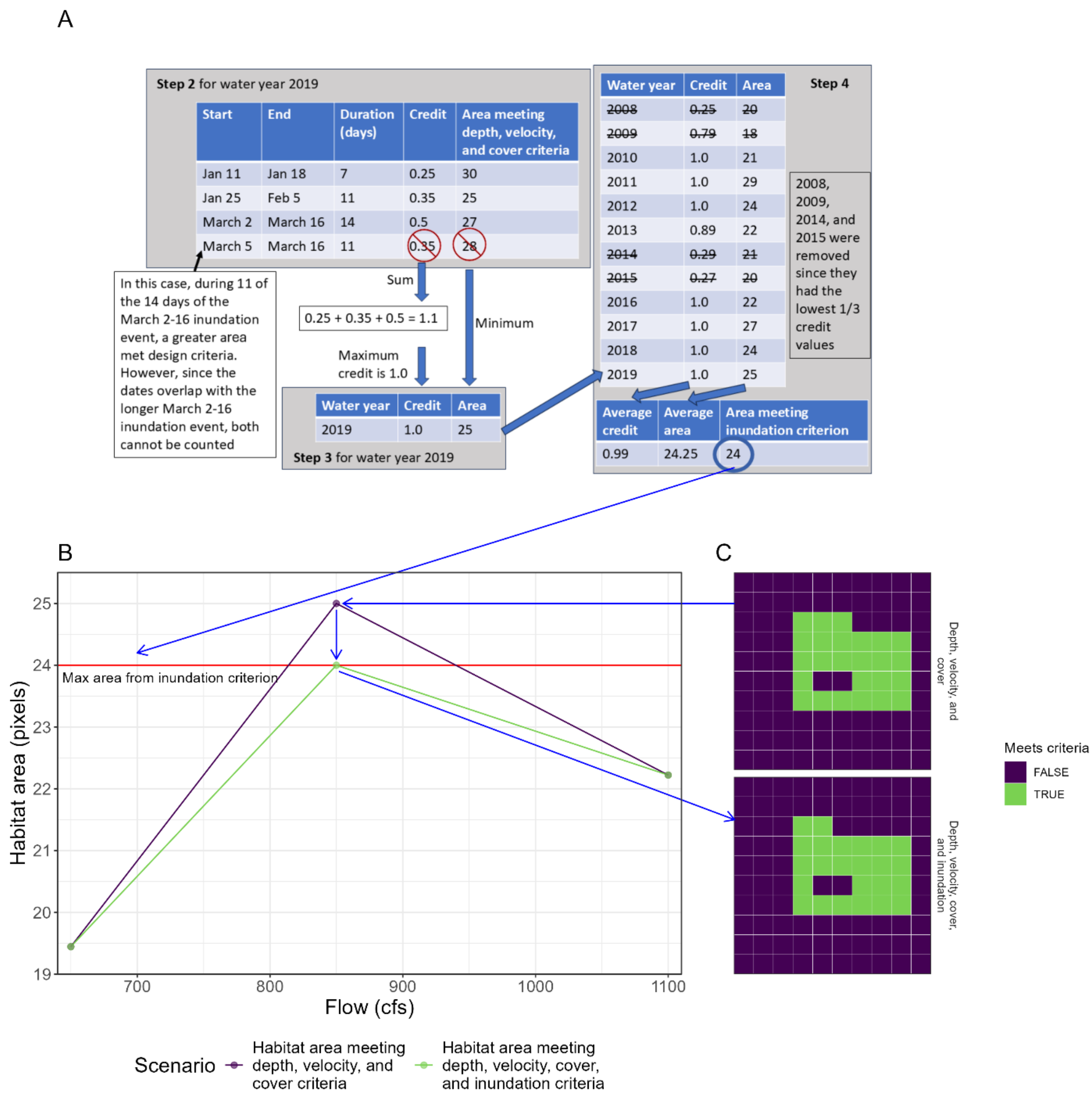

Figure B-3. Conceptual representation of the application of inundation design criteria to an area of floodplain rearing habitat, as described in step (vi) and section B.2.1.4.

(A) represents steps (2) through (4) from section B.2.1.4 applied to a hypothetical habitat project. In step (2), all inundation events greater than 7 days duration for one water year (2019) are represented in the table. In step (3) the total credit and area for 2019 are calculated from applicable inundation events. In step (4) the results for 2019 are combined with all other water years in the timeseries and the years with the highest 2/3 of credit values are used to calculate the final inundation area. Note that although this table only includes 12 modeled years as an example, more years should be included in an accounting assessment to ensure representation of the full range of hydrological conditions that could occur. (B) represents application of the habitat area meeting the inundation criterion from (A) to a habitat project not intended to count toward the valley floor habitat commitment. (B) displays a flow-habitat function before (purple) and after (green) application of the inundation criterion with design flows represented by points. In this example, application of the inundation criterion in (A) resulted in a maximum of 24 pixels (represented by the red horizontal line). Since the habitat area meeting the depth, velocity, and cover criteria exceeds 24 pixels at one design flow, that area is reduced to 24 pixels maximum in application of the inundation criterion to develop the final flow-habitat curve for this habitat. (C) displays the area meeting the design criteria at the 850 cfs design flow before (top) and after (bottom) adjustments to meet the inundation criterion. The connection between (A), (B), and (C) are represented with blue arrows. The same process will be used for both “pre-project” and “post-project” conditions.

In the next step (vii), the difference between the pre-project and post-project conditions is evaluated to determine the additional area of suitable habitat contributed by the habitat restoration action. Step (vii(a)) applies to projects intended to contribute to the valley floor habitat commitment, while step (vii(b)) applies to other projects:

vii. Determine the difference between the pre-project and post-project conditions.

(a) If the project is intended to contribute to the valley floor habitat commitment, subtract the habitat area meeting the inundation criteria from step (vi) under the pre-project condition from the value for the post-project condition. This is the final habitat area from the project that can be counted toward the valley floor habitat commitment.

(b) If the project is not intended to contribute to the valley floor habitat commitment, at each design flow, identify pixels that meet design criteria in the post-project condition that did not meet design criteria in the pre-project condition (i.e., “gains”), as well as the pixels that do not meet the design criteria under the post-project condition but met design criteria under the pre-project condition (i.e., “losses”) (Figure B-4). Sum the gains and losses to calculate the net habitat gain (or loss) at each design flow. Across all design flows, these net habitat gains (or losses) constitute the constructed flow-habitat relationship.

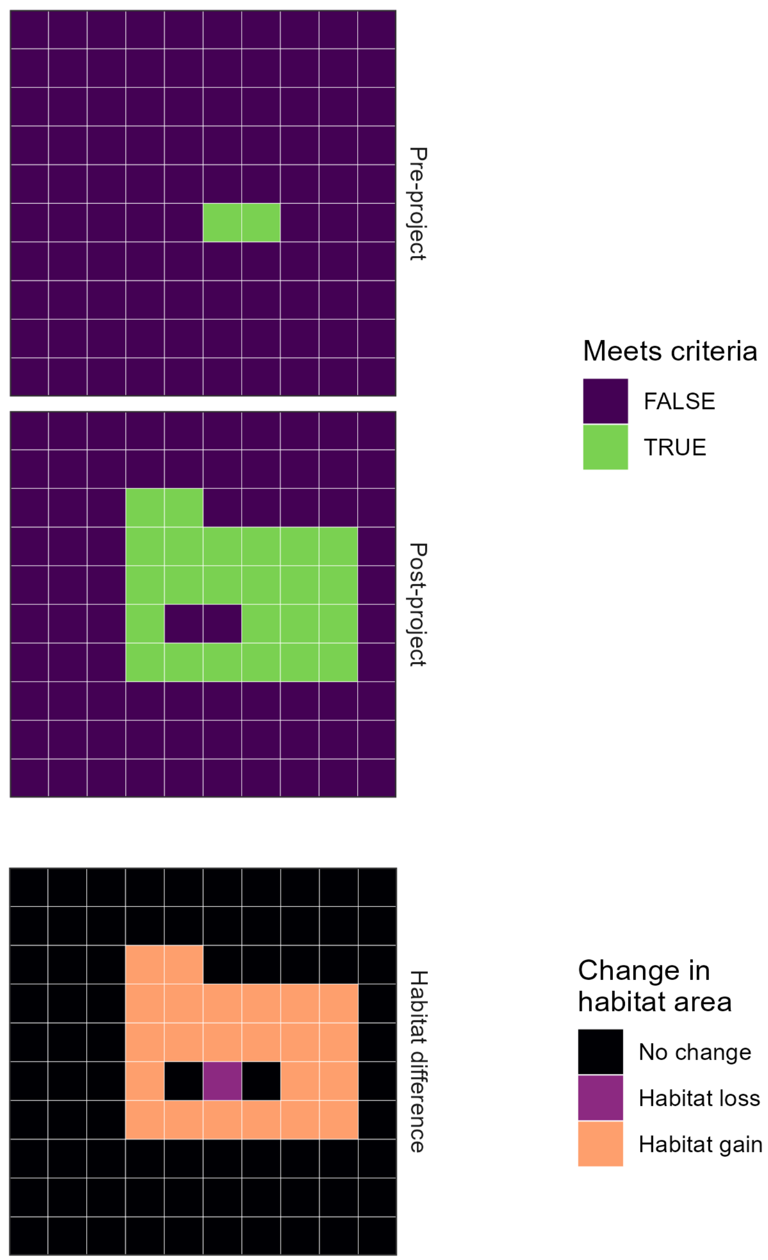

Figure B-4. Conceptual representation of the calculation of VA additional habitat as the difference between the pre-project (top image) and post-project (middle image) conditions at a single design flow.

This figure illustrates the process for projects not intended to contribute to the valley floor habitat commitment. Using the habitat difference (bottom image), the gains and losses would be summed to calculate the net habitat gain (or loss) at each design flow. Across all design flows, these net habitat gains (or losses) constitute the constructed flow-habitat relationship. In this example, the net gain in this design flow is 22 pixels.

B.2.1.2 Substrate Raster Development

Substrate within the project footprint will be mapped as polygon features where each polygon contains an area of substrate with a unique percent composition of grain size classes. Substrate polygons that meet the substrate criterion described in the program of implementation will be identified and converted into a unified spawning substrate shapefile. For building the spawning substrate raster, each raster pixel with a centroid that falls within the spawning substrate shapefile is identified as meeting the substrate criterion for spawning.

B.2.1.3 Cover Raster Development

Cover features within the project footprint will be mapped and a polygon shapefile generated containing the actual outlines of each cover feature. A 2-foot buffer may be applied around applicable cover features, but the combined area of the buffer and any cobble may only contribute 25% of the cover area, as defined in section 4.4.9.6. This shapefile will be filtered to only retain cover elements within suitable categories defined in the program of implementation. To convert the cover polygon into a raster, each raster pixel with a centroid that falls within the cover shapefile is assigned cover. The areal coverage of cover features as calculated from the resulting raster should be approximately equivalent (±10 percent) to that from the shapefile. If not, a higher raster resolution should be used, or alternative methods acceptable to the Executive Director should be used to convert the shapefile into a raster.

In developing the cover shapefile, vegetative cover features may be assigned their expected size at maturity or at the final date of committed funding for site maintenance necessary to maintain suitable habitat, whichever is sooner. The expected resultant area of riparian vegetation in the mature condition should be a species-specific estimate of canopy size using best available science, for example literature-based data or models for riparian vegetation growth and size-at-maturation.

B.2.1.4 Application of Inundation Criterion

As defined in the program of implementation, the inundation criterion is based on the expected frequency and duration of floodplain inundation events. The inundation criterion will be applied to the area of floodplain rearing habitat meeting depth, velocity, and cover criteria to calculate the maximum amount of habitat meeting the inundation criterion. To calculate the maximum area meeting the inundation criterion, modeled hydrology of VA flow commitments as indicated in analyses supporting VA adoption (i.e., from the final Scientific Basis Report Supplement) will be used unless another method is approved by the Executive Director. Application of the inundation criterion follows steps (1) through (4) through below:

1) Application of the hydrology model to the area of habitat meeting depth, velocity, and cover criteria at each design flow will create a timeseries of habitat area.

2) From this timeseries of habitat area, the habitat area continuously inundated and meeting design criteria for at least 7 days, and the duration of each event, will be calculated to determine inundation events. Inundation events will be represented by their start and end date, the duration of their inundation, and the total area continuously inundated and meeting design criteria for that duration.

3) Within each water year, the inundation duration credit will be calculated as the sum of the credits from the inundation events, with a maximum allowed credit of 1.0. The corresponding habitat area will be the smallest habitat area from all the inundation events applied to the credit. Only a single inundation duration credit may be provided for each day and habitat area in the timeseries such that no credited inundation events may overlap spatially and temporally. If multiple inundation events overlap spatially and temporally, the event that optimizes achievement of the inundation criterion may be credited. This will result in a timeseries with a total inundation credit and accompanying habitat area for each water year in the modeled timeseries.

4) From the timeseries of inundation credits and habitat area, the 1/3 of water years with the lowest credit will be removed and the inundation credit and habitat area for the remaining 2/3 of water years will be averaged. The average inundation credit will then be multiplied by the average habitat area to calculate the maximum area of habitat meeting the inundation criterion.

B.2.1.5 Final Habitat Accounting Assessment

This step does not apply to projects intended to contribute to the valley floor habitat commitment. The procedures described above in steps (i) through (vii) will produce a flow-habitat relationship for the newly constructed habitat (i.e., the amount of additional suitable habitat at each design flow). To complete the final habitat accounting assessment, either complete the alternative analysis described in step (viii) below, or compare the constructed flow-habitat relationship to the flow-habitat relationships provided by VA parties for assessment of the benefits of the VAs (i.e., those used in the final Scientific Basis Report Supplement; hereafter referred to as the assumed flow-habitat relationships) as described in steps (ix) through (xi) below:

viii. The implementing agency may provide an alternative analysis demonstrating equivalent or better median habitat area across model years than that resulting from the assumed flow-habitat relationships for Executive Director approval. The analysis must reproduce the tributary habitat analysis from the benefit analyses supporting VA adoption (i.e., from the final Scientific Basis Report Supplement) using the constructed flow-habitat curve, without applying the temperature filter, and evaluate whether the resulting median habitat area across model years is equivalent or greater than that from the same analysis using the assumed flow-habitat relationships. Alternative analyses demonstrating equivalent or greater expected availability of habitat meeting design criteria than those from the benefit analyses supporting VA adoption (i.e., from the final Scientific Basis Report

Supplement) may be considered at the discretion of the Executive Director with input from DFW.

OR

ix. Within each design flow, add the constructed flow-habitat relationships across projects to create an overall constructed flow-habitat relationship for each tributary/reach and habitat type (matching the spatial scale of the assumed flow-habitat relationships).

    (a) This can be applied incrementally project-by-project to track progress toward the goal.

x. Compare this constructed flow-habitat relationship to the assumed flow-habitat relationships to quantify a metric of overlap. The overlap metric is calculated by comparing the integral of the flow-habitat relationships separately within different flow ranges. The flow ranges are defined by either the 0-25th, 26-50th, 51-75th, and 76-100th percentiles of flows predicted under the VAs or by four evenly spaced flow ranges encompassing the full range of flows predicted under the VAs (Figure B-5).

xi. To receive habitat credit, each integral from the constructed flow-habitat relationship should be at least 95 percent of the value of the integral from the assumed flow-habitat relationship.

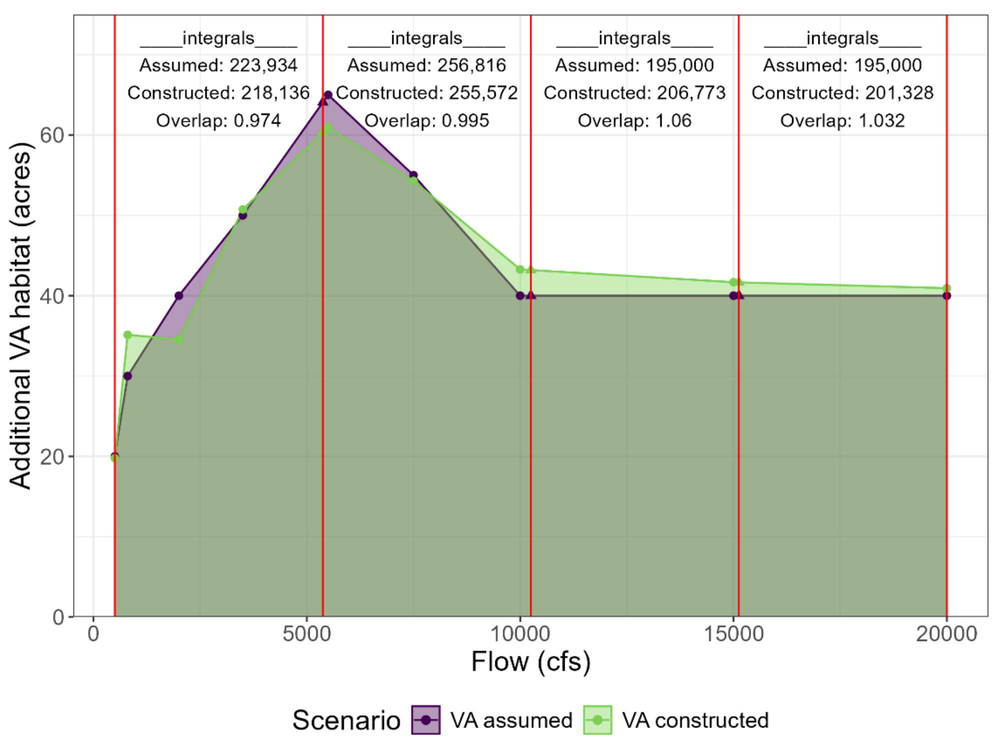

Figure B-5. Illustration of the final habitat accounting assessment for tributary spawning and rearing habitat.

An example plot is provided of the additional VA habitat provided over baseline at each design flow (circle points) for the assumed flow-habitat relationship (purple) and the constructed flow-habitat relationship (green). Vertical red lines delineate the four flow ranges used for the evaluation of integral overlap between assumed and constructed habitat. Triangle points represent points that were interpolated when design flows did not exactly correspond to the flow range boundaries. Each curve was integrated separately within each flow range and then the proportional overlap was calculated as Constructed/Assumed. In this example, all proportional overlaps are equal to or greater than 0.95 so VA parties on this tributary would be considered to have met their commitment for this habitat type.

B.2.1.6 Accounting for Multiple Habitat Types within a Single Project Footprint

For instances where a single habitat restoration project contains more than one habitat type (i.e., tributary spawning, in-channel rearing, tributary floodplain rearing) or more than one habitat commitment (e.g., valley floor floodplain habitat and North Delta Arc and Suisun Marsh floodplain habitat) within the overall project footprint, habitat accounting must quantify each habitat type separately, and the same project footprint may not be used for multiple habitat categories. In the case of a project that includes multiple habitat types within the same footprint (e.g., tributary spawning and rearing habitat, or in-channel rearing habitat and tributary floodplain rearing habitat), they will be divided by a feature-specific geospatial boundary associated with distinct topographical delineation, or by the project-specific elevation associated with the flow that activates off-channel inundation, such that there is no spatial overlap between these habitats for the habitat accounting assessment.

B.2.2 Accounting for Bypass Floodplain Non-Flow Habitat Restoration Actions

Habitat accounting procedures for bypass floodplain projects will follow similar protocols to those described in section B.2.1, modified from the most related habitat type as needed to account for any differences in bypass habitat compared to tributary habitat. Bypass projects will not be subject to the final habitat accounting assessment described in section B.2.1.5. For enhancement projects, accounting will be based on the incremental change from the pre-project condition, with specific protocols for assessing this change proposed alongside the proposed design criteria. Accounting will be based on modeled inundation with respect to physical aspects of the projects (e.g., water velocity and depth) as well as other attributes of habitat suitability that can be incorporated into project designs, including fish connectivity, inundation regime, and cover, as applicable to the target species and life stages.

B.2.3 Accounting for Tidal Wetland Non-Flow Habitat Restoration Actions

Habitat accounting procedures for tidal wetland projects will follow similar protocols to those described in section B.2.1, modified from the most related habitat type as needed to account for any differences in tidal wetland habitat compared to tributary habitat. Tidal wetland projects will not be subject to the final habitat accounting assessment described in section B.2.1.5. Similar to tributary and bypass floodplain habitat, accounting for tidal wetlands will be based on modeled inundation with respect to physical aspects of the projects (e.g., water velocity and depth) as well as other attributes of habitat suitability that can be incorporated into project designs, including fish connectivity, inundation regime, and cover, as applicable to the target species and life stages. Water depths and wetted areas will be quantified by inundation levels relative to the mean higher-high water. Access will be provided for estuarine species, and the depth and width of the opening will be designed for full tidal exchange and the target species and life stage. Full tidal exchange is defined as a similar difference between high tides and low tides inside the opening of the site and outside the site.