Trinity River Restoration Program Adult Salmonid Monitoring Evaluation

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Executive Summary

This report is a review of the adult salmonid monitoring programs of the Trinity River Restoration Program (TRRP). The review was conducted between October 2011 and March 2012 and consisted of 2 meetings and a review of reports, proposal and presentations. The reviewers were Dr Mike Bradford, Simon Fraser University, and Dr David Hankin, Humboldt State University.

The goal of the project was to "review the adult salmonid assessments and monitoring projects that the Program supports and to evaluate their effectiveness, including the precision of estimates relative to meeting the information needs of the Program's Adaptive Environmental Assessment and Management (AEAM) process, and recommend any changes as appropriate".

Adult monitoring data are used by the TRRP to evaluate the performance of salmonid populations relative to the goals of increasing catch and escapement, and to evaluate the response of the Trinity River ecosystem to management actions designed to improve the flow regime and habitat conditions.

Many of the programs that were reviewed pre-date the TRRP and were initiated for stock assessment or fisheries management objectives. These programs have had consistent long-term data collection programs, and personnel that have been with the programs for many years: these attributes contribute to the value of the long-term data record.

The primary recommendation for many of the field programs relates to improving the analysis and reporting of the field data. Specifically, the absence of uncertainty estimates for most of the program components made it difficult to make recommendations regarding the adequacy of the sampling programs, or whether resources should be reallocated across programs to optimize effort. To be consistent with standard scientific practice, especially for a large-scale program such as the TRRP, each program should provide a summary of the data collected, an analysis of the uncertainty in the estimates provided, and where appropriate, tests of assumptions of the methods and any biases they may generate. It may be appropriate for each program to generate a standardized methods document that would describe the procedures for data compilation and analysis. Such reports would simplify the annual reporting requirements.

We believe the program needs to "evolve" the monitoring programs from their origins in fisheries management for the Klamath Basin, to a structure that allows for the evaluation of TRRP objectives. In some cases, this means generating new information, such as estimates of Trinity fish in mixed-population fisheries. In other cases, synthesis and integration of Trinity-specific data is needed to generate the datasets required for TRRP purposes. These tasks should not be difficult for fall Chinook salmon as many components are already in place, but will be more challenging for the other priority taxa identified by the TRRP.

We recommend that an analytical group be established as a new project for the TRRP. This group would be tasked with synthesizing information from the various adult monitoring projects into a form that can be used to evaluate the TRRP hypotheses and objectives identified in the Integrated Assessment Plan. This group would also develop a database of the annual information needed for program evaluation. Emphasis should first be placed on fall Chinook salmon, for which the datasets are the richest, but the evaluation should extend to the other priority taxa.

Introduction.

The Trinity River Restoration Program (TRRP) is tasked with evaluating the effects of water and habitat management actions in the Trinity River basin on valued ecosystem components, including salmonid populations. The Program is essentially testing the 'river resizing' hypothesis that posits that riverine ecosystem function can be maintained at lower than natural flows through appropriate flow management and other measures. This test has ramifications far beyond the Trinity Basin, as water managers are struggling world-wide with this question (Bradford et al. 2011).

The Program has been directed to make use of the Adaptive Environmental Assessment and Management (AEAM) process, which enforces a structured approach to assessment, including the development of testable hypotheses about the management actions, and use of a quantitative assessment program to evaluate progress and provide feedback to managers. The hypotheses, performance measures and assessment needs are outlined in the 2009 Integrated Assessment Plan (IAP). A recent series of articles outlines the challenges associated with whole ecosystem adaptive management experiments, and the overall absence of compelling evidence that river restoration is effective (Bernhardt and Palmer 2011 and following papers in the same issue). The Trinity program is well-positioned to make a significant contribution to this debate.

This review is focused on programs that provide information on adult salmonids in the Trinity River. Adult salmonid monitoring projects inform two TRRP Objectives, Objective 3 (*Restore natural production of salmonids*), and Objective 4, (*Restore salmonid populations to allow full participation in fisheries*). Objective 3 tests the hypotheses associated with TRRP management actions. At the population level, the primary prediction is that the survival and abundance of juvenile salmonids will increase as a result of the management actions. Adult data are required for this assessment as the distribution, abundance, and quality of the spawning population will be needed for many of the performance measures for juvenile production (e.g. egg or juvenile survival rates). In particular, the relation between smolt production and parent stock size will be used to evaluate changes in habitat conditions (IAP 2009 p. 102). Using population-level indicators (spawners, smolt production, survival rates) to evaluate habitat restoration is especially challenging, and will require accurate and precise estimates of abundance and other metrics at the appropriate spatial scales (Bradford et al. 2005).

Objective 4 is focused on adult production, and its performance measures are based on adult contributions to fisheries and escapement. The requirements for precision are perhaps less demanding, as the objectives relate to trends in run size, harvest and escapement. However, an important component of this assessment is the cohort reconstruction, as it will allow for separation of ocean, fishery and freshwater effects on cohort survival and adult production; accurate and precise estimates are needed here.

Organization of this review

The review was conducted in a series of steps. In mid-2011 a package of reports and proposals and background documents were provided to the reviewers. On October 26 and 27, 2011 a 2-day workshop was convened in Arcata during which project leaders provided overviews of their work. A field trip to the river occurred on October 28. In the ensuing months a draft report was prepared and the major findings were presented to TRRP staff and project leaders in Arcata on February 17, 2012. The report was finalized in light of comments and discussions on the draft report. The statement of work (SOW) for the review is appended to this report.

To simplify the review, the many projects (and their products) were organized according to the Assessments listed in Appendix H of the IAP, and then grouped into the following 4 categories:

1. River harvest (16A-19A): Klamath sport and tribal, Hoopa tribal and Trinity sport.
2. Escapement estimation (13A). Mainstem fences, carcass estimates, hatchery returns
3. Secondary spawner characteristics (1A-3A): Prespawning mortality, disease, redd distribution
4. Cohort reconstruction and Brood analysis (22A, 23A): Age sampling, cohort tables, “megatable”, CWT marking.

Detailed comments on many of the individual project reports are provided in later sections. Our review comments will address tasks 3.1 and 3.2 in the SOW, namely:

Task 3.1: Evaluate current data collection, data management, and field operations
Task 3.2: Evaluate current data analysis and reporting.

In addition, we provide short summary responses to the series of questions in section D of the SOW:

1. In addition to reviewing the overall adult salmonid assessment of the Program, the following questions are to be answered by the Subconsultant:

a. Are the projects, individually and when combined if appropriate, providing sufficient information to address the Program's adult salmonid assessments?
b. Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?
c. Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?
d. Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?
e. Are there any projects that should be reduced in scope or eliminated?
f. Is the information for projects being disseminated to Program partners in a timely fashion?
g. Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?

1. River harvest of Trinity Salmonids

Harvest represents a significant proportion (~30%) of the total run to the Trinity River, and unbiased and precise estimates of this component will contribute to the accuracy of run reconstructions. Estimates of harvest are also used to evaluate progress towards Objectives 4-1 to 4-4, that identify increases in harvest over time.

Here we use the term "run" to mean the adult number of salmon or steelhead returning to the mouth of the Klamath River. With the exception of the upper Trinity mainstem the river harvest during the summer/fall season receives considerable sampling coverage, ranging from complete census of fishing effort and/or catch, to a relatively high rate of subsampling. The field programs appear to be well organized, and the presence of continuity in many key staff contributes to the value of the program.

No estimates of uncertainty surrounding estimates of harvest are routinely provided in the annual reports that were available to the reviewers for the initial draft. Many of the programs are not framed in a statistical or sampling framework but could easily be adapted to one. At the October workshop some indication was given that estimates of variance have been attempted and some results were provided at the February 17 draft review meeting. We conclude that estimates of uncertainty may be relatively simple to compute for each component of the river catch and a standardized spreadsheet could be developed to work them up. Once these are developed, then the adequacy of field programs can be considered with respect to the precision of the estimates. In particular, the allocation of effort during the field program or among programs can be evaluated. Generally speaking, effort should be allocated to the largest components of the harvest, as these will have the greatest impact on the run reconstruction or the brood table. Other considerations, such as fisheries management or catch allocation agreements, may affect requirements for precision of each component of the catch.

The allocation of lower Klamath catches to individual river system (Klamath/Trinity) is an information need that should be given high priority as errors in that allocation may be larger than most of the other harvest components. The project's investigators have proposed a method based on the relative distributions of hatchery and wild fish in each basin, but there are built-in assumptions in this method about the catchability of each population, and the relative precision and bias in the natural spawning escapements estimates for each system that need to be evaluated. It is also assumed that hatchery and natural fish are equally vulnerable to the fishery, and that there are no differences among hatchery release types on vulnerability. It may be feasible to test these assumptions by comparing composition of hatchery fish in the catch to the age and release types of fish that return to hatchery.

We consider the continued development of genetic stock ID tools of high priority. Individual assignments are not needed; only estimates of proportions are needed. In anticipation of this tool, the investigators may wish to begin collecting genetic samples and archiving them to develop a multiyear baseline. Usually a small clip of fin tissue stored in alcohol is sufficient for this need. DNA can also be extracted from scale samples if they have been stored appropriately and this might be a source of archival material.

The method to estimate recreational harvest above the Willow Creek weir (based on the fraction of tags returned to Agency office) almost certainly underestimates catch due to underreporting of tags; the current reward tag value of $10 seems hardly adequate to guarantee approximate 100% tag reporting. Schemes have been devised using high value (>$100) tags to estimate the return rate of low or no-value tags. Tag returns methods will always be biased if there is a significant recalcitrant component to the angling community that is unlikely to participate at any price. Using data provided in the 2008 and 2009 report it appears the recreational catch above WCW may be underestimated by 50% or more. We recommend that the historical data on tag returns be analyzed in this manner to estimate the relative no-value tag return rate, and consideration be given to the use of high-value tags (~$100) for a few years to provide additional information on the return rate. See Taylor et al. (2006) for an example and additional references. Other types of rewards (particularly hats) can also be used to estimate tag return rates.

Confidence intervals for the upper Trinity angled catch can be estimated with the binomial distribution on the tag returns, combined with the uncertainty on the total river escapement. A numerical approach (parametric bootstrap) may be needed to estimate uncertainty intervals given the variety of data types used for these calculations. However, the first priority should be evaluating bias in the tag return rates.

The reporting of the harvest components varies considerably in detail and thoroughness. While many of the programs have long term PIs that carry corporate memory, plans should be put in place to develop complete documentation for these programs, given the long term nature of the TRRP. Once these technical reports are completed, the annual report can be brief, unless there are changes to methodology. Methods reports should include a description of the field studies, the equations used to develop the final estimates, and the approach for calculating the uncertainty in those estimates, as well as reporting requirements for the annual programs.

The reports should also contain a table of data that will be passed to the next level of analysis in the TRRP, the run and cohort reconstructions. For the TRRP, the primary role of the catch monitoring programs is to provide estimates, by age, of removals of each species, and ancillary information on CWTs and other metrics for the cohort reconstruction. Documenting these quantities in the annual reports will provide a "paper trail" for the cohort analysis.

There appears to be some variation in the methods used to assign catch to the adult/grilse categories among projects. While field-based methods may be needed for in-season management needs, a more rigorous approach should be used in post-season accounting for the final estimates and run reconstruction efforts. The use of the "nadir" to assign individuals to age will be approximately unbiased only when the adjacent categories have similar abundance, and when the variance in lengths within the adjacent categories is the same. Neither of these requirements is met when "nadirs" are used to separate adults from grilse: abundance of grilse is typically substantially less than adults, and variance in adult lengths is much greater than variance in grilse lengths (see, e.g. Fig 9, p.18, 2009/10 CDFG Annual Report). The standard approach used in most fisheries is to age a subsample of fish in the catch, and use the age-length relations from the aging sample to assign the un-aged fish to age groups based on their length. It is important to note that the age composition of the aged sample is not important as long as the variation in length for each age is adequately represented. The method of Kimura and Chikuni (1987) is commonly used, and R-code exists for its implementation. The situation for the lower Klamath data is more complex as catch will have to be allocated to both age and population groups.

The preceeding discussion is for situations where a subsample of fish are aged, and but a larger number of fish are only measured for length. These methods are unnecessary if age structures are taken (and read) from most or all of the fish that are handled.

The procedure MIX (http://www.math.mcmaster.ca/peter/mix/mix.html, MIXDIST in R) can estimate membership in groups (such as age or population) from histograms of data such as length or date of migration. The procedure can be assisted by adding information from individuals of known membership (e.g., fish that are aged or their population of origin is known from CWT recoveries). The number of individuals in each group can be estimated from the integral of the distribution of each group. This procedure will account for differences in abundance and spread of each group in the mixture, eliminating the bias associated with visual estimates of the "nadir".

Key Recommendations

1.1 Develop methodology documents for each component of the catch estimation program that include estimators for the uncertainty in the catch.
1.2 Calculate the uncertainty in the estimated catch for each fishery
1.3 Evaluate bias in the upper Trinity creel estimates by analyzing return rates of tags and potentially using high value tags.
1.4 Develop a protocol for the allocation of the lower Klamath catch to population. Continue development of genetic indictors for population identification
1.5 Explore the use of quantitative procedures for assigning fish to age or population groups
1.6 Ensure that the annual reports contain the key data used in the calculation of the final estimates, and summary tables of the data that will be passed to the cohort or run reconstruction.

Responses to the Task D.2 questions

a) *Are the projects, individually and when combined if appropriate, providing sufficient information to address the Program's adult salmonid assessments?*
Yes, all of the elements are in place for a full assessment of the adult catch for fall Chinook salmon. The level of detail for the other species is lower, however this may be commensurate with TRRP priorities.
b) *Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?*
The level of detail among the projects varies considerably, and for a few projects the methods and analysis are not well documented.
c) *Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?*
A method to allocate catches in the lower Klamath and ocean fisheries needs to be developed. Upper Trinity tag return rates should be evaluated with higher reward tags
d) *Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?*

The development of genetic tools to separate Klamath and Trinity populations should be given high priority. Based on current surveys of allelic diversity (Kinziger et al. MS), the feasibility of using this diversity for estimating proportions of the 2 populations in mixed catch data should be explored.

e) *Are there any projects that should be reduced in scope or eliminated?*
Some of the catch sampling rates are very high and a reduction in sampling intensity may be possible without impacting precision significantly. We do not suggest eliminating any projects.

f) *Is the information for projects being disseminated to Program partners in a timely fashion?* It appears that annual reports are being produced in a timely manner.

g) *Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?*
The funding levels for projects appear appropriate for the field efforts each entails. On a dollars/fish caught basis the program could be considered extremely well funded. If resources are needed for other activities it should be possible to evaluate the relation between the precision of estimates and sampling intensity and determine if savings can be realized without unduly impacting data quality for the TRRP. In some cases more resources or effort could be allocated to more thorough analysis and reporting of annual results.

2. Escapement estimation.

As the single largest component of the Trinity salmonid runs, accurate and precise estimation of spawner abundance is a key element in the TRRP monitoring program. Escapement estimates contribute to cohort reconstructions and are used to evaluate progress towards abundance targets. Escapement data will also form the basis of freshwater production or survival calculations used to evaluate the management activities in the basin.

The core of the escapement program is two weirs operated to place tags on migrating salmon and steelhead trout for use in capture-recapture experiments. The program is focused on spring and fall Chinook salmon, coho salmon and fall-run steelhead. It has been in place for over 30 years, and stability in the program contributes to the long-term utility of the dataset. Consequently any changes in the program can only be considered if the older data can be "calibrated" to new protocols.

An important assumption of the program is that fish tagged at the weir are a "representative" random sample of the actual run in terms of size, age, birthplace and run timing. To the extent possible this assumption needs to be evaluated. We note in 2009 there were significant differences in the size distributions of fall Chinook tagged at WCW compared to the hatchery returns and carcass recoveries. It was assumed that the weir catches were representative of the run; therefore the size composition from the weir was used to allocate the total population to grilse and age-2 or older. This assumption had a large effect on estimate of brood size. Assumptions such as these must be evaluated as they are more important to the final estimates than many of the other components of the program (including efforts to increase precision).

We express some concern that the mark-recapture estimates are sometimes stratified by grilse and adult components, apparently using WCW length-based procedures for assigning tagged fish to the two age categories. This procedure may be prone to substantial bias due to erroneous assignments of tagged fish two groups. In contrast, scale data collected at the WCW could be used to establish age composition applied to a total estimated run size (i.e., based on combined recoveries of grilse and adults), as long as the weir can be confirmed to be a representative sample. We find in 2009 the latter approach appears to be used by the KRTT for fall chinook, and this produces a different set of estimates than those presented by CFG. These differences should be resolved so the TRRP generates a single set of estimates by a reviewed and approved protocol.

The program relies on recaptures from the hatchery rack. Clearly this is not a random sample of the population, but the mark-recapture estimates can still be unbiased as long as the tag application (the first sample) is randomized or systematically proportional (i.e., “representative”) to all components of the run (Hankin 2001). The advantage of this design is that fish in the second sample are relatively “fresh”, which will minimize tag loss and tag recognition problems, as well as some of the delayed differential mortality associated with tagging. The usual alternative is to rely on carcass recovery programs but these generally need to be stratified by sex because of the differential recovery rates of male and female carcasses.

As noted in the program documentation, bias in Peterson estimates is minimized when key assumptions of the method are satisfied. Usually, a series of tests are conducted on the data to determine the extent that this is true. In the detailed notes we provide some recommendations regarding tag-loss and heterogeneity tests. Further examples are provided in Houtman and Fanos (2000), Pahlke and Bernard (1996) and Velez-Espino et al. (2010); there are many others, particularly in the Alaska Dept. Fish and Game technical report series. Documentation for Trinity escapement estimates should contain more detail on the extent to which the assumptions of the Peterson estimator have been tested or are assumed to be satisfied.

The annual reports for this project are detailed and provide the reader with an excellent overview of the methods, results and conclusions, as well as data needed for status assessment. As reviewers of the TRRP projects, we were initially a bit concerned that there was an inappropriate degree of reliance on use of “nadirs” for assigning ages (e.g., grilse vs adults at the WCW). In contrast, it is clear that the annual accounting of system-wide harvest, run size and escapement (e.g., KRTT 2012), is highly age-structured and is based primarily on extensive scale reading with appropriate bias-adjustments for aging errors. According to KRTT 2012, systematic samples (1 in 2) of scales are collected from Chinook at the WCW, but such scale collection was not indicated in the annual report (see CDFG 2011, p.6, Processing of Fish.) It would be helpful if a copy of the annual KRTT report were appended to each year’s annual reporting for the TRRP.

To address Objective 3, monitoring changes in freshwater productivity, accurate estimates of the initial size of the brood, ideally as the number of eggs potentially deposited each fall are needed. This can be accomplished by deriving a sex-specific estimate of spawner abundance, estimates of pre-spawning mortality, and age or length-specific fecundity information. If estimates of fecundity or sex ratio are not available, then total adult spawners may have to be relied on as the estimate of brood size. Discussions at the review meeting suggest egg deposition data may not be worth pursuing, and estimates of adult spawners, or females should be used for brood size.

Since observations of sex cannot be made at the weir, and the commonly observed bias to females in the carcass recoveries occurs in the Mainstem, there may be merit in examining the hatchery records to estimate the sex ratio by age class, as the proportion of females usually increases with age in most Chinook populations.

The utility of the carcass-based estimate of population size is unclear, and the extent to which it can be used to inform TRRP objectives is not articulated. The large difference between the weir-TRH, carcass, and weir-carcass estimates (see later section) highlights the need to carefully evaluate assumptions in all estimation procedures.

Spawning also occurs in tributary streams. We were informed that there was some monitoring of tributary spawning populations, but it does not appear as a program element, despite the fact that tributary spawning is mentioned in the IAP, albeit briefly. From the perspective of assessing management actions, the assessments of adults and spawners at weir or trap sites downstream of some tributaries results in the tributary and mainstem production being inseparable. However, some knowledge of the extent of spawning in the tributaries is needed to evaluate their significance to production as they are likely less strongly influenced by TRRP management actions than mainstem spawners.

Key recommendations

2.1 The extent to which the key assumptions of the Peterson or related estimators are satisfied should be documented, and consideration given to annual testing of some of the assumptions particularly with respect to determining if estimates need to be stratified or adjusted. Tag loss should be evaluated with double tagging experiments, unless previous information is available to estimate tag loss.

2.2 The grilse/adult estimates in the CFG report are different from the KRTT estimates because different methods are used to estimate them. We recommend the age data be used to align the estimates in the CFG annual report with those used for run reconstruction (i.e., KRTT methods).

2.3 A program for the assessment of tributary spawning is needed.

2.4 Data from the weir, hatchery, redd and carcass surveys should be integrated to provide the information needed for TRRP performance measures for evaluation against objectives.

Responses to the Task D.2 questions

a. Are the projects, individually and when combined if appropriate, providing sufficient information to

address the Program's adult salmonid assessments?
Yes. Some additional analyses are warranted, but for fall Chinook salmon the basic program appears to meet Program needs. . The long-recognized difficulties in separation of summer-, fall-, and winter-run steelhead compromise interpretation of possible relations between estimated "fall-run" steelhead abundance and subsequent juvenile production which no doubt reflects production from all run types.

b. *Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?*
For the most part, the documentation of the spawner programs is thorough and straightforward.

c. *Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?*
There are a series of key assumptions in the Mark-recapture estimates that should be evaluated, possibly annually. The final estimates in the CFG report should be the same as those produced by the KRTT.

d. *Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?*
Double tagging experiments are required to evaluate tag loss. The absence of information on the other steelhead runs precludes them from TRRP assessments. Further genetic work should be explored with respect to the potential separation of summer-, fall- and winter-run juvenile steelhead, although existing information of genetic differentiation among Trinity River steelhead does not clearly suggest that this approach would produce useful discrimination (Garza, pers. comm.)

e. *Are there any projects that should be reduced in scope or eliminated?*
The rationale for the carcass-based population estimate is unclear. A great deal more work is needed to ensure the estimates from the carcass program are not biased by violation of assumptions.

f. *Is the information for projects being disseminated to Program partners in a timely fashion?*
Yes, the reporting appears thorough and timely.

g. *Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?*
Escapement information is critical for the Program. The long-term stability of this time series contributes greatly to the program and thus the effort should be maintained.

3. **Secondary spawner characteristics**.

Carcass recovery and prespawning mortality.

The loss of spawners prior to reproduction can cause significant impacts on the initial cohort size as potential egg deposition will be lower than expected. Prespawning mortality (PSM) is an increasingly common event in many salmon populations as river temperatures rise and oceanographic conditions cause changes in run timing. The weekly surveys of carcasses provide good information on the rate of prespawning mortality for Chinook salmon. It is important that surveys cover the full range of the carcass die off as prespawning mortalities usually occur first, followed by the recovery of carcasses of successful spawners. As noted the late timing of die off in coho salmon may cause an upward bias in the PSM estimates if the surveys are terminated before the end of spawning.

Mortality of spawners during migration is also very significant in some salmon stocks. Unfortunately, it is also very difficult to evaluate. Telemetry studies are used (Strange 2010), but there is usually also a component of mortality associated with handling and tagging that cannot be separated from natural mortality unless the fish are tagged some time before their migration (i.e., in the ocean). Nonetheless they do provide guidance on the environmental conditions that create stress and possibly mortality. Continued monitoring of temperature and other environmental indicators will likely have utility in evaluating these “en-route” losses.

One role for the salmon carcass recovery program is to evaluate the extent and distribution of hatchery fish among the naturally spawning components of each run. These calculations provide inputs to Objective 3.3, regarding the minimizing impacts of hatchery fish on wild production. The data are clearly available to calculate the proportion of spawners in each section that are hatchery origin, but it does not appear that calculation is done by section, nor are the historical results readily available. Results from the carcass surveys should be compared to the proportions derived from the weir/tagging program.

Redd distribution

The distribution of spawners along the length of the river provides information that informs Objectives 3.1.1 and 3.1.2, concerning the optimal use of spawning habitat in the river. Both the carcass recovery and red surveys yield similar conclusions, that most of the spawning occurs in the upper reaches below the dam. The current program is focussed on Chinook salmon and generates incidental information on coho spawners. We suggest the redd program would benefit from a careful review and consideration of the program objectives in the IAP. Then, analyses in the redd program could be directed to providing data and performance measures that are directly linked to TRRP objectives. For example, specific metrics should be developed for the assessment of spawner use of newly engineered habitats. Once identified, these can be computed annually and rolled up over time as the data accumulates.

Unfortunately, high densities of spawners (and the mix of species) makes identification of redds difficult and consequently in many cases redd counts may not vary linearly with female density at high spawner density. In the past, detailed visual studies have been used on select sample reaches to estimate spawner density and redd distribution (see Neilson and Banfield 1981), if there is a desire to evaluate this bias directly.

As the number of years of surveys increases it may also be possible to evaluate habitat use and redd superimposition using methods developed for density-dependent habitat selection. Such analyses consist of regressions (variables log-transformed) of abundance variables; when regression slopes are significantly different from 1, then the 2 variables are not proportional. For example, we might predict that a regression of redd counts on carcass counts would be proportional in the lower reaches where redd densities are low, and non-linear in the upper reaches where redd counting becomes more difficult. These analysis could be used to test whether carcass distribution patterns are a more useful indicator of spawner density than the redd counts, or whether redd counts can be corrected for superimposition.

The same approach can be used to evaluate habitat use. In this case, the redd or carcass counts in one (or more) of the upper reaches can be regressed against total spawner abundance. If the slope of the log-log regression is 1, there is no evidence for density affecting distribution. We might expect a slope <1 if habitats become saturated at higher abundance. Unfortunately the same result will occur if detection probability (the probability of sighting a redd if it is present) declines with increasing abundance.

These conjectures are confirmed by preliminary analysis (Figure 1) that shows that total redd counts are nonlinearly related to estimates of total spawners. This suggests that either redds are underreported at high spawner abundances, at larger run sizes more fish use the tributaries, or there is a proportional bias in the escapement estimates that results in large overestimates at larger run sizes. Further analyses of these data are possible, including whether the bias indicated in Figure 1 are driven by results from the upper reach only.

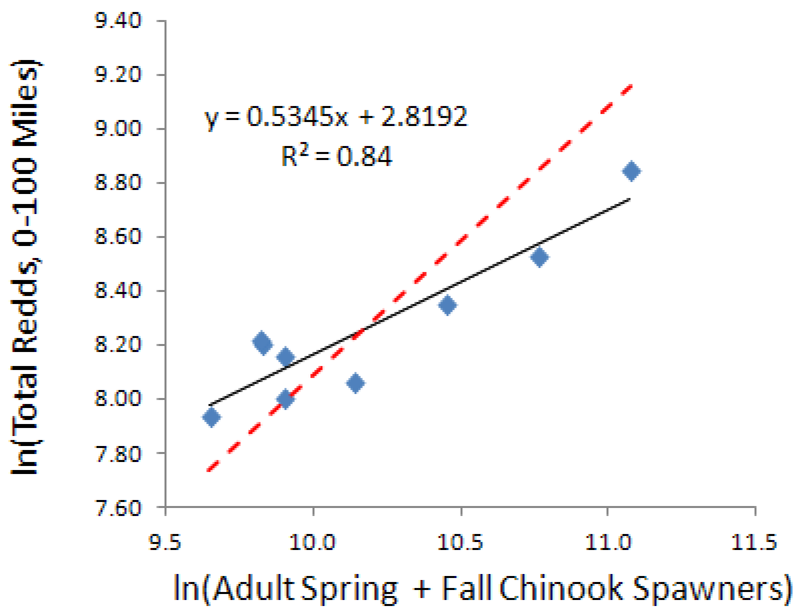

Figure 1. Relation between total Chinook escapement in the Trinity Mainstem and counts of Chinook salmon redds in the upper 100 miles, 2002-2010. Solid line is the least-squares regression, and the resulting slope of ≈ 0.5 indicates redds are related to the square root of estimated spawners. Dashed line is has slope=1 and would be the expectation if redds were directly proportional to spawner estimates. On average, redd counts are 15% of spawner estimates.

The ultimate utility of the redd survey data can only be determined once information is analyzed and used as a performance measure for the assessment of TRRP objectives. That analysis might reveal, for example, that one to 3 surveys during the peak of spawning may provide an adequate description of spawning distribution, and the currently extensive program could be scaled back (especially if attempts to estimate abundances are abandoned). Some effort could be reallocated to Steelhead spawner success surveys.

Fish health

It is unclear to us how the current fish health program will provide information useful for the TRRP adaptive management program. The program currently consists of qualitative screening of adult fish from the lower Klamath River for two known diseases in fall Chinook salmon. Predicting an outbreak of disease may have in-season utility if harvest can be adjusted or water management decisions made to increase the likelihood of spawning successfully. However, these actions are not related to TRRP Objectives. For retrospective analysis of TRRP management actions the effects of disease outbreaks will be evident in the estimates of spawner abundance, and prespawning mortality, and can be factored into estimates of brood strength quantitatively.

A true fish health monitoring program is probably worthwhile for the Trinity River, but that program will likely be quite different from the current program. First, all species should be included, and the fish sampled should be confirmed to be Trinity origin, suggesting at least some sampling should occur further upstream in the Basin. Second, a fuller suite of diagnostics may be appropriate, including virology, bacteriology, and anatomical histopathology, using appropriately preserved samples that may include brain, liver, kidney, spleen, heart and gill. The hatchery may be an appropriate site for this sampling as the impacts of Trinity River habitat conditions will be more evident at this stage of maturity than for fish collected in the lower river.

Key Recommendations

3.1 Consider developing more coordination between the red survey program and the carcass survey program, by reporting the results in an integrated document.
3.2 Use the historical database to evaluate how biased the redd density estimates are in the upper reaches.
3.3 Conduct a deeper examination of how Objectives 3.1.1 and 3.1.2 (spawner distribution) will be assessed.
3.4 Identify and develop performance measures and metrics related to these Objectives for the redd and carcass information and analyze the data accordingly.
3.5 Review the fish health program with specialists to evaluate whether a Trinity River-specific program is feasible and worthwhile.
3.6 Evaluate the need and feasibility of spawner surveys for steelhead trout.

Responses to the Task D.2 questions

a. *Are the projects, individually and when combined if appropriate, providing sufficient information to address the Program's adult salmonid assessments?*
   For Chinook salmon the redd and carcass programs are well conceived and provide considerable detailed information. The utility of the fish health sampling is less clear.
b. *Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?*

The reporting of redd and carcass data is thorough. The fish health report is adequate.

c. *Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?*
   Relations between carcass, redd and total spawner counts should explored to address whether redd and carcass data are linearly related to abundance.
d. *Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?*
   If the TRRP implements a fish health program it will likely be more extensive than the current program. However, this need is not currently identified in the IAP.
e. *Are there any projects that should be reduced in scope or eliminated?*
   A decision about fish health sampling may impact the current program.
f. *Is the information for projects being disseminated to Program partners in a timely fashion?*
   Yes.
g. *Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?*
   To some extent the carcass and redd surveys provide similar types of information but their integration could be improved by a more coordinated analysis and reporting structure. Once fully analyzed, it may be concluded that the expenditures on these two programs exceed their utility as performance measures for the TRRP assessment.

4. Cohort Reconstruction and Brood Analysis (Stock-Recruit Analyses).

This component synthesizes information from all of the field programs. As part of the TRRP adaptive management program, the performance of salmonid populations will be evaluated against the management actions intended to improve freshwater conditions in the river. The inputs from the adult assessments will be a time series of annual brood strengths which could be the number of adult spawners per year, or an estimate of female abundance. In some cases egg deposition is used, but this relies on the availability of age or length-based fecundity. Adult data are also used for the estimation of cohort strength (age-2 fish for fall chinook salmon; other adult metrics may be more appropriate for the other species). These are effectively the "stock" and "recruitment" data series from which estimates of brood year-specific survival can be made. The data can also be used to estimate freshwater run size, as the number of fish that arrive at the mouth of the Klamath River each year. Analyses can then be conducted to partition ocean and freshwater influences on survival, which can assist in determining the influence of management actions on survival relative to other factors encountered later in the life cycle.

Because cohort and brood analysis is an organizing framework for all of the field studies on adult salmon, an additional benefit of the analysis will be to give the Program a means to evaluate each of the individual programs in relation to their contribution to the metrics for the TRRP evaluation. Simulation studies can be used to evaluate how changes in the precision (or bias) of a particular data series impacts the overall measures. To be most effective the cohort reconstruction, run size estimation and brood size calculations should all be part of the same project so that all sources of data that enter into the stock-recruit analysis can be considered in the same framework.

Currently it appears that Eric Logan has made a preliminary attempt at cohort reconstruction for naturally-produced Trinity River Fall Chinook based on the approach used for the KRTT analysis (Goldwasser et al. 2001). However, the methods and results have not yet been formally documented, and no documented attempt has been made for the other taxa.

The Klamath basin ageing program appears well-established. For fall Chinook, the samples are large for most components of the run, and the results are documented annually. These data should be provided and reported in individual catch or escapement programs. No information was available on age structure for other taxa although it appears that many samples are taken.

While hatchery production is not part of the TRRP mandate, the marking of hatchery releases provides critical information for both the separation of hatchery and wild fish in both juvenile and adult sampling programs, and for the estimate of fishery impacts, under the assumption that hatchery and natural fish have similar patterns of exploitation. The relatively high rate of marking provides reasonable numbers of CWTs in most sampling programs. Although documentation of the results of the annual marking was not provided for this review, from the 2012 it appears the program is well structured. This program is essential for the TRRP adult assessment program.

Key Recommendations

4.1 Trinity River cohort analysis (stock-recruit analysis) should be elevated in status within the Program consistent with its role as an organizer for most of the field programs. A detailed workplan should be developed and a team of analysts should be assembled to begin work on this project.

4.2 Cohort reconstructions should be attempted for at least naturally-produced fall Chinook salmon and ideally for all other priority taxa (e.g., coho and spring Chinook salmon). Adult stock adult stock measured by the number of adults, as has been traditionally conducted, or possibly by more precise estimates such as the number adult females or total egg deposition. A formal protocol for cohort reconstruction should be developed and subjected to review and critique prior to adoption.

4.3 Sensitivity analysis on model structure, data and precision should be conducted by placing the cohort model into a stochastic framework. This will allow a formal analysis of the influence of precision of field programs on the information needed for management decision-making.

4.4 Standardized approaches need to be developed for the reporting of age data for taxa other than fall Chinook. The reporting of results from individual projects should, to the maximum extent possible, include age data as well as length information currently provided in annual reports. The reporting of results from individual individual projects should include age data as well as length information currently provided.

a. *Are the projects, individually and when combined if appropriate, providing sufficient information to address the Program's adult salmonid assessments?*
   Yes, when fully implemented this will be the key analytical component that links the field projects together to provide metrics for many of the TRRP evaluations.
b. *Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?*
   This is a project in development. Full documentation of the work provided to date was not provided, although it appears to be based on the Klamath protocols of Goldwasser et al. (2001). The methodology for this project needs to be fully described and reviewed by technical experts.
c. *Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?*
   There are specific information needs for developing Trinity River cohort reconstructions above those required for the Klamath-wide assessment. These need to be documented and reviewed.
d. *Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?*
   The feasibility of cohort analyses for species other than fall Chinook salmon needs to be evaluated. A new task that generates brood sizes for all species should be considered.
e. *Are there any projects that should be reduced in scope or eliminated?*
   No.
f. *Is the information for projects being disseminated to Program partners in a timely fashion?*
   The Klamath basin tables provides some of the information for fall Chinook but regular reporting on all populations is not yet available.
g. *Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?*
   This project should be greatly expanded in scope and funding, at least for a few years to develop the procedures and work through the historical data.

5. Program Integration

The Integrated Assessment Plan (IAP) provides detailed guidance on how information from the adult assessment programs will be used to evaluate progress towards TRRP objectives, as outlined in the introduction of this report. In nearly all cases, the performance measures that use adult data require information from more than one report or program in the current adult assessment. Currently, most projects are conducted individually, and the process for integrating information appears somewhat ad-hoc. In addition, there are a variety of databases being held by individual PIs or agencies, and no overall database of information to be used for the TRRP evaluation. We recognize that fisheries assessments in the Trinity Basin predate the TRRP and many of these programs were initiated for purposes other than those of the TRRP adaptive management program. However, for the adaptive management program to move forward, a plan for integrating data across projects is needed.

We recommend that program integration or synthesis be elevated to a be significant component of the adult assessment program. In our experience, adaptive management programs generally underestimate the resources and effort required for synthesis, analysis and reporting (Figure 2). In many cases, we find that adaptive management program staff are often fully subscribed with the annual cycle of contracting and program management; significant resources and expertise are rarely identified for integration, synthesis and analysis. In some cases a “10-year program review” or similar event triggers a rushed analysis of annual program reports and data, but opportunities for continuous improvement, mid-course corrections or in-depth analyses are lost in this model.

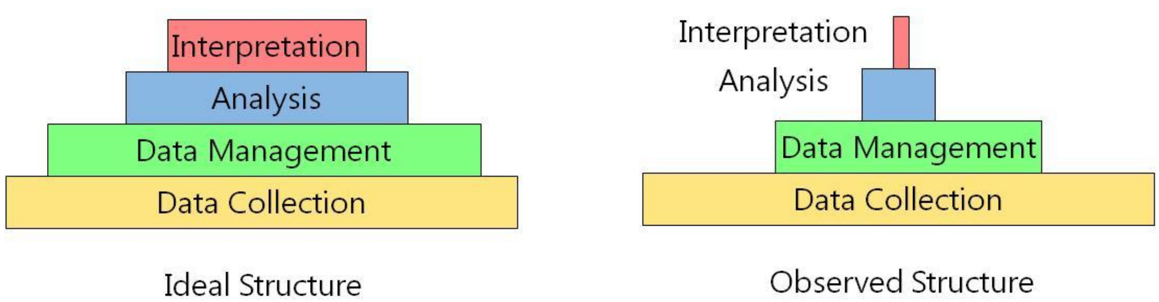

Figure 2. Idealized and commonly observed allocation of resources in adaptive management programs illustrating the under-recognition of the need for extensive analysis and reporting requirements.

The greatest need for integration is for the brood size and cohort reconstruction, as this brings together all of the catch, escapement and age data into a single analysis. We recommend that each of the projects report the information that will be needed for cohort analysis and that standards for importing annual data into the cohort database should be established. For TRRP objective 3 adult data used to calculate brood or stock size will require combinations of escapement, age composition, prespawning mortality and possibly sex ratio data; a task that will require substantial integration across projects.

While most of the focus of this report has been on Trinity River fall Chinook salmon, program integration should extend to all focus species to the extent possible. Similar series of data should be made available for the Klamath River populations, as well as for the two hatcheries. Comparative analyses across populations that share some components of the life cycle, but differ in others, are often very useful for separating effects of interest from those that create noise. For example, a comparison of trends in the survival of hatchery smolt releases to the spawner-recruit rates of natural spawners could be used to partition or control for the segments of the life cycle that are shared (i.e., the downstream migration and ocean phases). Controlling for this variation should increase the power of tests of the effects of the TRRP management actions on survival rates and natural fish. We anticipate the new data analysis and synthesis project would be executed by individuals with experience in analysis, statistics and simulation. This group would be in the best position to evaluate the relative roles of sampling intensity and precision on the final products needed by the TRRP. Either analysis or simulation could be used to evaluate changing the precision of individual projects, and calculating the costs associated with those changes.

6. Summary

The Trinity River Restoration Program is a unique large-scale adaptive management program designed to evaluate the efficacy of habitat and flow management actions on the river ecosystem, and in particular, fish production. The benefits of this program extend far beyond the Trinity Basin, as the paradigms of flow management and physical habitat restoration are not often challenged by scientifically robust monitoring information (Konrad et al. 2011).

In our review we found the field components of the adult monitoring program to be generally well conceived and executed. Stability in personnel and program design contributes to the strength of these programs.

In many cases we found that more attention needs to be spent on data analysis, interpretation, synthesis, and reporting. As the source for some of the key biological data for the Adaptive Management program, we believe that standard scientific standards for reporting uncertainty, testing key assumptions, and bias need to be an integral part of each project. This could mean reducing effort in the field to allocate financial resources to these office-based tasks.

We recommend that a new program of data synthesis be established to assemble the adult data (as well as other elements of the program) and to attempt to test some of the hypotheses of the IAP. By going through this exercise analysts will be able to determine if the current data collections programs are adequate or if adjustments are needed. Although a goal of this review was to determine if the current programs are sufficient for TRRP's assessment needs, the absence of uncertainty estimates and data integration prevented us from fully addressing this task. Although there may not be enough years of data currently available to test the management hypotheses a preliminary attempt will be a valuable exercise for evaluating the nature of the available data and the challenges that will occur in its analysis. We suggest that this group should also be responsible for a Trinity-specific integrated database that will contain the information necessary for the evaluations required under the Adaptive Management program.

Finally, much of this review deals with fall Chinook salmon in the Trinity River, as this has been the primary species of focus in the Basin, and in the IAP, especially considering it is likely to be the taxa most impacted by management actions. We recommend that once the synthesis has taken place on the fall Chinook data, attention be focused on the other taxa to determine the extent to which data collected for these groups can be used to evaluate the TRRP management hypotheses. To assist that process, we have attempted to tabulate the state of information for all salmonid taxa under consideration by the TRRP in Table 1. Many of the entries received "?" as no documents were provided on those topics. This table provides a snapshot of how much effort and information will be needed to conduct an evaluation of each taxa relative to the TRRP objectives. The desirability of doing so will depend on the TRRPs priorities and resources.

	Harvest					Spawning Escapement				
	Non-Tribal			Tribal						
Species -Race	Trinity	Lower Klamath	Ocean	Lower Klamath	Trinity	Natural Areas	Hatchery	Natural-Hatchery Composition	Age Composition	Trinity Cohort Reconstruction
Chinook –fall	YES	Partial	YES	Partial	YES	YES	YES	YES	YES	Partial
Chinook - spring	YES	Partial	YES	Partial	YES	YES	YES	YES	Partial	No
Coho	YES	Partial	YES	Partial	YES	YES	YES	YES	?	No
Steelhead - summer	?	?		?	?	?	?	?	?	No
Steelhead - fall	YES	Partial		?	?	YES	YES	YES	?	No
Steelhead – winter	?	?		?	?	?	?	?	?	No

Table 1. A summary of available information for each component of the adult assessment program for each priority taxa identified by the TRRP. “Yes” indicates information is available and largely usable for an assessment against program objectives. “Partial” indicates more data or analysis is required, “No” means no information is available on that topic, and “?” is used when we are unclear from the material provided to us whether the information is available or useable.

Individual Project Comments

Lower Mainstem Trinity Creel Survey

The documents reviewed for this section are
"*Results of Hoopa Tribal Fall Chinook Harvest Survey Conducted in 2009 by the Hoopa Valley Tribal Fisheries Department*" and the "*FY2012 FY Investigation Plan*".

The mainstem creel survey has a relatively high sampling intensity, with coverage on most weekend days and a subsample of weekdays. There are a number of assumptions that must be satisfied for the overall estimates to be unbiased. These include the assumptions that all vehicles parked along the river are those of anglers, and that all vehicles are enumerated each day and are not counted more than once. Although information is not provided in the reports to evaluate these assumptions, we suspect that given the extensive experience of the investigators, they are satisfied with their methodology. Nonetheless, some additional surveys and analysis should be undertaken to support these assumptions. These could probably be done once and documented, as small add-ons to the existing program.

A second important assumption in this analysis that is often violated in fisheries, is that there is a linear relation between catch and effort. That is, it is assumed that the catch of an individual angler is a direct function of the time spent fishing. However, it is conceivable that angler skill or success, regulations or other factors could cause catch to covary in a non-linear manner with the time spent fishing. Complex relations between catch, effort and abundance are commonly observed (see for example, Peterman and Steer 1981). Given the rich database that has been assembled for this project, it should be straightforward to determine from the interview data if catch and effort are linearly related. However, in subsequent discussions it was suggested that most observations are from "completed effort" such that the majority of the catch is not scaled from effort statistics, but is directly observed. It would be useful if these details were provided in the documentation.

Uncertainty bounds for the creel estimates are not provided. At a minimum the key input data should be summarized in tables along with estimates of their uncertainty (standard errors, SE) and sample size, preferably by species and month.

However, because of the robust sampling design, it should not be difficult to estimate the overall uncertainty in the creel estimates. This could be done by bootstrapping (resampling the data), or using analytical methods (Lockwood et al. 1999).

Once formulae for estimating uncertainty are established, it is then fairly straightforward to determine whether the sampling scheme can be modified to make the final estimates more precise, or to identify efficiencies in the sampling. For example, it is conceivable that reallocation of effort from the shoulder months to the peak of the run could reduce the uncertainty in the final estimates.

Recommendations:

The basic design for sampling the lower mainstem sport catch appears sound, but the level of detail in the analysis and reporting that we reviewed makes it difficult to fully evaluate the program. We recommend:

(1) A detailed report that fully outlines the methods and analysis should be prepared that could be cited when reporting out annually (in a much briefer format).
(2) For each year, summary tables of the key input data should be provided including averages, sample sizes and estimates of variation, stratified by species and month to allow the assessor to evaluate the nature of the information being collected by the program.
(3) The annual report should also contain a table that houses all of the key statistics that this program provides to the overall TRRP assessment. This could include the estimate of catch by age, sex and species, CWT information etc. Providing this information in the annual report provides a backup or paper trail for the aggregate TRRP database.
(4) Uncertainty in the input data should be propagated through to the final estimates using analytical methods or a resampling scheme. A biometrician should be consulted during this process.
(5) Once these steps have been taken, exploratory analysis of alternative sampling schemes could be undertaken to evaluate the potential for improvements or efficiencies.

Hoopa Valley Fall Chinook Harvest

The documents reviewed in this section are the "*Results of Hoopa Tribal Fall Chinook Harvest Survey Conducted in 2009*" and the corresponding FY2011-2012 Investigation Plan.

The fall Chinook harvest by the Hoopa Tribe is partitioned into hook and line and net catches. The hook and line estimate is a portion of the total recreational catch and the estimates and uncertainty are the same as the non-Tribal harvest. Our comments for the non-tribal sport catch are relevant to this component.

The daily net catch is estimated as the product of the number of nets employed per day, and samples of the daily catch. There is an assumption that the estimates of nets/day are both accurate and precise, but no evidence is provided to support that assumption. One would expect a negative bias in the net counts, and there may be some utility in using multiple crews (working independently) on occasions to estimate the rate the single observer miscounts nets. The overall bias may be small however.

No estimates of uncertainty are provided in the annual reports, but documentation and statistics were subsequently provided for the February 17 review meeting.

The reporting of this work can be strengthened by adding the key equations to the methods, and tables that summarize the data. Weekly estimates of net counts, catch estimate, their sample size and SEs can be added to a table to allow the reader to understand the nature of information resulting in the final estimates. These output tables should match the TRRP data needs from this project that are identified in the Investigation Plan.

Lower Klamath Angler Creel Surveys

The documents reviewed include the “Klamath Basin Salmon and Steelhead Monitoring Project 2009-2010 season” and the 2012 Investigation Plan.

This project differs from the other creel surveys in that a complete census of anglers is attempted for some areas on the sampling days. Consequently, total catch (and effort) for such days can be assumed to be known without errors. In other cases, the observed catch is expanded by an estimate of sampling rate. Since only a fraction of the days of each week are sampled, it should be straightforward to calculate a variance for the weekly estimates, and propagate those through to the seasonal estimate using standard formulae, making use of the finite population correction because of the high rate of sampling. No attempt is made to partition the catch among populations in this report, but ultimately, the lower Klamath catch will need to be subdivided by run and basin of origin (Trinity or Klamath) for TRRP purposes. In anticipation of eventual genetic stock ID (GSI) techniques, a tissue sampling program using appropriate material and preservative should be initiated to allow for some retrospective analysis (and comparison of technique to allow historical values to be adjusted). Overall, the reporting for this project is quite complete.

Lower Klamath River Tribal Fishery Monitoring

The documents reviewed were: "*Yurok Tribal Fall Fishery Monitoring 2009*" and the FY2011-2012 Proposal.

Catch estimation

The estimation of catch in the lower Klamath is based on census of effort, as net-hours, which is assumed to be complete, and a sample of catch information from surveys of fishers. Nearly every fishing day is monitored. As in the other fishery monitoring programs the total catch is the product of the estimates of net effort, and catch per net-hour. No estimates of uncertainty are provided, although the calculations should be straightforward.

The annual report is lacking in some detail, however, some of the missing information is provided in the 2012 project proposal. It would appear that the creation of a "master" methodological paper would be useful for program evaluation, and will act as a contingency in the case of staff turnover. To assist the reader, a summary table of effort, catch and the number or proportion of fishers interviewed should be provided, stratified by species and month.

Incidentally, we are not sure that the equation at the very end of section I of the project proposal is correct for the allocation of catch to the Klamath or Trinity Rivers. The equation provided effectively allocates catch based on the ratio of escapement to the 2 basins. The concern arises from the observation that the ratio Catch/Escapement is not the harvest rate, which is more correctly Catch/(Catch+Escapement) and these two ratios will diverge, depending on the harvest rate.

A key assumption of allocation methods like those in the proposal is the assumption that there is a similar bias in the methods used to estimate spawners in the Klamath and Trinity basins. From the KRTT document the Klamath escapement is estimated by a variety of means include redd and carcass surveys and video, all which might be expected to underestimate abundance relative to Peterson estimates on live fish, which usually have a positive bias. The difference in the biases will impact the allocation to Trinity based on the proposed methods.

As an alternative, the exploitation rate on Trinity fish can be directly estimates from the recovery of CWTs. If T_{cwt} is the number of CWT fish surviving the fishery (i.e., are estimated in the upriver reaches) then the Trinity harvest (T_h) in the fishery is given by

$T_h = (T_{esc}+T_h)*(Y_{cwtt}/[Y_{cwtt}+T_{cwt}])$, where Y_{cwtt} is the number of Trinity CWTs in the catch.

Here the first term is the total Trinity run size (to the river, as the sum of the escapement and harvest), and the second term is the estimated harvest rate in the Yurok fishery based on the CWT data. This equation can be rearranged as

$T_h = T_{esc}*(h/[1-h])$ where $h = Y_{cwtt}/[Y_{cwtt}+T_{cwt}]$.

As there are a number of ways that the available data can be used to partition the catch to the 2 populations we support the recommendation that the proposedTrinity analysis group should explore as many as options as feasible as all will involve "transferability" assumptions of different sorts about whether subgroups or ratios are representative. Additional analyses are possible with the existing data, for example, the timing of the run for the 2 populations can be assessed with weekly CWT catch rates. Genetic stock identification should continue to be explored as costs and processing times are decreasing and accuracy is generally improving.

Adult escapement estimation

The reports reviewed in this section are the CDFG "*Final Annual Report"* for 2008-2009 and 2009-2010 seasons, and the FY2011-2012 Run size and Harvest Proposal.

The primary tool for estimating run size of Trinity River salmon and steelhead is a pooled-Peterson mark recapture program that employs a weir to obtain the first sample for tagging, and relies on fish entering the Trinity River Hatchery (TRH) for the second sample. Our visit to the Willow Creek weir indicated to us that the field operations were of high standard as the facility has been in place for many years, operating in a consistent manner. The intensity of tagging and recovery are sufficient to achieve relatively precise estimates of abundance using the standard formulae for the variance for the estimators.

However, as noted on page 11 of Kier (2011), a more important consideration are the assumptions of the Peterson estimate, because violation of these can lead to significant bias in the estimates, often in an upwards direction. Generally these assumptions should be tested to the extent possible each year (see Houtman and Fanos (2000) for an example) to determine the extent of the bias. We consider the assumptions further, using the list in Schwarz and Taylor (1998):

1) That either or both samples are a simple random sample, so that all fish have the same probability of being tagged or recovered.

This assumption should be satisfied for the first sample as the weir effort is relatively constant throughout the run and all healthy fish that end up in the trap are tagged, which should result in a relatively constant fraction of the run being tagged, despite seasonal changes in abundance. In 2009 the proportion of grilse tagged at the weir is much higher than that observed in the hatchery or carcass samples. In 2009 the grilse/adult ratio at the weir was used to apportion the total estimate into the 2 categories. If grilse are oversampled at the weir this will have a large impact on the size of the adult population. A historical comparison of the size/age composition of the weir fish relative to the other samples would be useful to evaluate this key assumption.

Subsequent to the February 17 meeting a brief evaluation of this issue was conducted. We found that the proportion of grilse among the CWT-marked fish that arrived at the weir was similar to that observed at the TRH suggesting that fence was not positively selecting for grilse. However, it is apparent that in some years the age composition of the natural and hatchery runs is quite different. This may be caused by differences in the maturity schedules between the hatchery and natural spawning components of the run, or due to differences in the survival of cohorts. A retrospective comparison of the demographic data for the hatchery and natural components would be useful to help understand why the samples are so different.

The second sample is clearly biased to hatchery fish, but this alone should not adversely bias the estimate if the first sample is systematically or randomly tagged. Hankin (2001) conducted a number of simulation studies that indicated that a differential rate of "homing" to the TRH did not unduly bias population estimates.

Since the recovery rate of tagged grilse is much lower in the river than at the hatchery, it does raise the issue of whether a stratified estimator may be less biased and more precise than the currently used pooled estimate. Based on a quick analysis of the 2009 data in Table 14 the estimates for the pooled estimator are not very different from the category-specific ones. It appears there are a number of alternatives for the calculation of the population estimates, including:

- stratified estimates (grilse/adults)
- using the weir-based separation of grilse and adults to partition the pooled Peterson estimate by age (this would best be accomplished by using the age data identified it the KRTT report)

- use the weir-based age distribution to expand the Peterson estimate of adults alone (which presumably is the most precisely estimated component of the total run)
- other variations.

Some analysis of the historic data might be useful for evaluating these procedures, and developing a consistent protocol for future use.

2) The population is closed.

It is reasonably assumed that few fish leave the sample area (upstream of the weir). Attempts to account for angled fish and those that die shortly after tagging have been made.

3) There is no tag loss.

This assumption should be tested. Tag loss can be severe and directly inflates the population estimates. In many areas a double tagging methodology is used, with a batch secondary mark being employed. Often an opercular punch or fin clip is used for Chinook salmon (see Pahlke and Bernard 1986, who found an unacceptable rate of spaghetti tag loss, >20%). In the Trinity, there may be a difference in tag loss between the TRH sample and carcass recovery fish, as the latter may be more likely to lose tags due their longer life and losses due to tissue erosion and predation. A greater rate of tag loss in grilse should also be investigated.

At the February 17 2012 meeting we were made aware that some earlier tag loss experiments had been conducted. At a minimum those results should be described as a means to evaluate the support for the hypothesis no loss.

4) the tagging status of each fish is determined without error

Assuming that each fish is assessed carefully at the TRH, this should not be an issue.

5) tagging has no effect on the subsequent behavior (and survival) of the fish.

This is an important assumption that has large implications for the population estimates (Hankin 2001). Recent capture and tagging studies on the Fraser River show that virtually all forms of handling and tagging of migratory salmon have some effect on subsequent behaviour and survival. Since the stress associated with tagging is often magnified by environmental factors (water temperature, flow) or life history attributes (sex, age, time of migration), analysts usually stratify the tagging and recovery data by time and other factors and evaluate whether the proportion of tags recovered is consistent across strata. See Houtman and Fanos (2000) for an example of these analyses. Large differences in recovery rates point to the need to stratify the analysis to prevent the overall estimates from being unduly biased. For the Trinity, a useful first step would be to organize the tag recoveries by temporal strata (monthly, or biweekly) and based on the date of tagging. The data can then be used to determine if there is a temporal variation in the recovery rate, time spent in the stream between the weir and TRH or other covariates that could influence survival.

Finally, page 33 of the 2009-2010 report mentions using CWT expansions to estimate the number of returning fish to the hatchery. It is unclear why this is done, as earlier text seems to indicate that all fish returning to the hatchery are part of the second tag recover sample and are handled individually. The estimated number of fish entering the hatchery ranges from 7494 (table 14) to 7530 (page 33). This should be clarified.

Angler Harvest above the WCW.

Estimates of harvest for ~150 km reach above the WCW are based only on the returns of tags to Agency offices from retained or released fish. The reason for excluding certain tags given on Page 11 is unclear, and should be justified. The estimates are highly dependent on the return rate for tags, and there is no information to assess that rate in the report. Of 16 tags returned for fall Chinook, 9 were reward type, and since only 1/3 of the applied tags had rewards, there is a suggestion of a higher return rate for the reward tags. Disregarding the small sample sizes, if we assume the return rate of $10 tags is 100% then the expected catch of non-return tags would be 18, (rather than 7) resulting in a 69% increase in catch (27/16) over the estimated value. If the return rate of $10 tags is less than 100%, the bias in catch will be even greater.

We recommend all historical information be examined to determine the differential rate of return for reward and no-reward tags, to examine any covariates that can explain differences in these rates (ie species or angler effects). Consideration should be given to experimenting with larger reward tags to better evaluate the return rates.

Carcass surveys in the upper Trinity River.

The main document reviewed was "*Salmon spawner surveys in the upper Trinity River (Task 4 of the CDFG report, 2009-2010)"* and the 2010-2011 study plan.

This project provides information on the distribution of spawners in the mainstem, spawning success, and biological attributes of spawners. This information is required for a number of the TRRP objectives including the measures of hatchery influence on wild spawner populations.

A more quantitative approach should be considered for separating the spring and fall components of the Chinook run. The presence of CWT recoveries should permit the MIX procedure to be employed on the date of recovery data to allocate the total carcass recoveries to race.

An attempt has been made to estimate carcass abundance using a simple Peterson estimator. It is unclear how this estimate fits into the TRRP assessment scheme, and considerably more work is required to establish whether an unbiased estimate of spawners can be obtained with this approach. In other systems the assumptions of closure cannot be satisfied as carcasses both decay and are physically removed from the river channel by predators. Further, tag loss can be high and tags can go undetected because of the deterioration of the carcasses. If this program is to continue we recommend the carcasses be double tagged with numbered tags and recovered tagged carcasses be returned to the river so that a Jolly-Carmack-Seber-type estimator can be employed. However, the loss of unmarked carcasses between surveys (prior to tagging) remains problematic component of the population to estimate unless the survey frequency is increased.

Apart from the carcass mark-recapture estimate, the recovery of project tags during the carcass survey allows for a second estimation of the in-river population. For 2009, there were 1002 spring and fall Chinook tags available in the river (effective tags less hatchery returns), 3429 carcasses recovered and 82 Project tags found amongst the carcasses. A simple Peterson estimate yields 42,400 Chinook, double the river estimates obtained from the WCW-TRH Peterson method (19,387) and 3-4 times the carcass mark recapture estimates (8900-13 400). Tag loss, or failure to recognize tags on decaying carcasses may account for some of this difference. The range in estimates across methods reveals the importance of ensuring all of the assumptions of the estimators are satisfied. The potential for large numbers of Chinook spawners in the tributaries is also suggested by these data.

Some additional analyses are suggested for this program. In order to move to a more age-based program, statistics on the number of males and females should be expressed by age. This will require the use of age-length keys and the methodology detailed earlier. However, lengths of fish collected from fisheries or weirs are not comparable to fork lengths from carcasses. Differences are caused by shrinkage due to rigor, elongation of the kype in males, and tail erosion in females. Often this is overcome through the use of post-orbital-hyperal length- measurements (POHL). Alternatively, there may be enough Project-tagged carcasses in the long term record to develop correction regressions between live and dead fork lengths (by sex).

From a quick examination of Tables 4 and 5 it appears that the recovery of ad-clips and spaghetti tags is lower from C2 fish compared to C1 fish, which is not surprising given the more advanced condition of the C2 fish. An examination of the complete database would be useful to determine if there is a systematic bias which could impact on the data used to evaluate hatchery-natural spawner ratios.

The carcass database can also be used to evaluate factors that lead to successful spawning. New studies are beginning to identify longer-term effects of capture and release on spawning success. For example, Baker and Schindler (2009) found that sockeye salmon with gillnet marks were less likely to spawn successfully than those that were not entangled. Spawning success can also be affected by the timing of migration and the environmental conditions experienced prior to spawning. Using the multiyear database of recovered project tags (and associated attributes) and their recoveries an analysis could be employed to evaluate some of these hypotheses.

Finally, redd data (page 116 and Table 3) should probably be removed from this document as the methods used to discriminate coho and Chinook redds are not described, and it is unclear what the data in Table 4 exactly are.

Redd Surveys

The documents reviewed were "*Distribution of Chinook salmon redds in the mainstem Trinity River 2002-2010*" and the FY 2011-2012 Project Proposal

This report describes innovative uses of modern technology to map the location of redds in weekly surveys along the length of the river during the fall spawning season. Corrections are made for species composition based on the proportion of carcasses recovered for each species, using a delay to account for stream life. The raw data (redds/reach/year/species) should be tabularized in the report so the data are available for other users (similar to Table 5).

There is no discussion of possible bias associated with failing to detect (missing) redds and/or how such detection failure might be related to red density and redd superimposition. Some of the patterns in distribution may be affected by superimposition, which will probably create density-dependent "detection probability" (i.e., reduction in detection probability at higher redd densities). This may impact relationships such as those in Figures 5 and 6 of the report. As noted earlier, an evaluation of the relation between redd and carcass distributions by reach and as well as total river spawner may provide insights into the magnitude of the bias.

Fish Health

For this section a document entitled "*Lower Klamath river adult chinook salmon pathology monitoring, 2009*" was reviewed, along with a 2012-2013 project proposal.

According to the 2009 report, this program was initiated to survey migrating fall Chinook salmon for 2 diseases that were linked to the 2002 fish kill in the Klamath River. Visual inspections of tissues are made at the stream, and the incidence of observable disease is recorded.

The link between this program and TRRP objectives is unclear. It is not clear that any Trinity fish have been sampled in the past because the sampling site is located upstream of the K-T confluence. With respect to Trinity fish, there appears to be an implicit assumption is that Klamath and Trinity River fish will have a similar incidence of disease due to their common migration history. The 2012 proposal suggests some sampling will take place downstream of the confluence and therefore some Trinity fish could be included in the samples. However, without population-specific genetic markers inferences about the incidence of these two diseases in Trinity fish will be indirect.

In all likelihood the incidence of disease outbreaks in salmon populations will increase over time as climate change impacts stream flows, temperatures, and the development and phonologies of pathogens. Thus a wild fish health monitoring program is advisable. However, the current program is really a scan for 2 specific pathogens, and the program would have to be considerably expanded for it to be considered a fish health program. In the absence of a full program, it would be worth archiving various tissues (heart, brain, liver, gill) in media suitable for future histopathology and genetic analysis. Such samples have proven invaluable in other instances when disease outbreaks do occur.

Age composition

The use of age data is summarized in the KRTT run size estimate memorandum for 2009, and the FY 2011-2012 project proposal.

Protocols for sampling for age composition are well-developed in the Trinity-Klamath complex with a large number of fish being sampled in catches, at the weirs and hatcheries. With CWT returns, the age readings are corrected with the inverse matrix method. This and other methods are reviewed in Hoenig and Heisey (1987).

The ages noted in the fall Chinook reports are unorthodox in that the freshwater ages are not denoted, presumably because all fish are age-0 migrants from the river. This will not be case for coho and steelhead, and that has important implications for examining environmental effects on survival. For example, comparisons among species can be made on the basis of year of spawning, ocean entry or return. The alignment of data will depend on the freshwater and ocean ages for each species (and life history type). While the age notation may be suitable for workers in the basin who are familiar with what is inferred, reporting to the larger scientific community will required the use of one of the standard methods, either the European or Gilbert-Rich notation.

On page 2 of the KRTT cohort reconstruction report there is the statement: "In cases where scales were believed to be non-representative of the age-two component, the KRTT relied on analysis of length-frequency histograms". It is unclear from this comment whether the sample of scales was not representative, or the age composition in the sample was not consistent with others. Consideration could be given to a more structured process be used for determining how and when to use the scale samples.

As noted by Hoenig and Heisey (1987), in many fisheries applications the number of fish actually aged is a subset of fish measured for length and an age-length database is used to assign ages to unaged fish. An analysis could be conducted on the utility of this approach if there is a need to reallocate age sampling efforts to more strata or species. If an unbiased "master" age-length key for each year can be generated (likely from the weir) the method of Kimura and Chikuni (1987) can be used to assign an age composition for each sample of lengths. Protocols can be developed for determining when sample sizes are too small for age distribution analysis, and when samples can be combined.

Fall Chinook data are well documented within the KRTT annual report, but we were not provided information on spring Chinook or the other species.

Trinity River cohort reconstruction.

The only documentation of this component is the October workshop presentation and the project proposal.

The reconstruction of fall Chinook salmon cohorts back to the age of first recruitment is standard practise along the Pacific coast, and the procedure outlined in the presentation is similar to other models that are in use.

This analysis is a key component of the TRRPs program as it will yield information needed to estimate brood survival and enable (with the juvenile data) the separation of freshwater and marine mortality in the early part of the life history. Consequently, careful documentation and peer-review of the methodology is required. Enough data are available for sensitivity analysis to determine which data components are the most influential in the interannual variation in cohort strength, and the influence of key model assumptions on the outputs. This can be accomplished by putting the cohort model in a stochastic framework. Then uncertainty in input data and parameters can be assessed by rerunning the model with randomized inputs. Alternative structures/assumptions can also be tested in this framework. This approach was used by Hankin and Logan (2010) in their analysis of hatchery returns for the Klamath Basin.

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References

Baker M.R., and D.E. Schindler. 2009. Unaccounted mortality in salmon fisheries: non-retention in gillnets and effects on estimates of spawners. J. Appl. Ecol. 46:752-761.

Bradford, M.J., P.S. Higgins, J. Korman and J. Sneep. 2011. Test of an environmental flow release in a British Columbia river: does more water mean more fish? Freshwater Biology 56:2119-2134.

Bradford, M. J., J. Korman, and P. S. Higgins. 2005. Using confidence intervals to estimate the response of salmon populations (*Oncorhynchus spp*.) to experimental habitat alterations. Canadian Journal of Fisheries and Aquatic Science 62:2716-2726.

Bernhardt, E.S. and M.A. Palmer. 2011. River restoration: the fuzzy logic of repairing reaches to reverse catchment scale degradation. Ecol. Appl. 21:1926-1931.

Goldwasser, L., M.S. Mohr, A.M. Grover, and M.L. Palmer-Zwahlen. 2001. The supporting databases and biological analyses for the revision of the Klamath Ocean Harvest Model. Available from M.S. Mohr, National Marine Fisheries Service, 110 Shaffer Road, Santa Cruz, CA 95060.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Gray, G. 1999. Covariances in multiplicative estimates. Trans. Am. Fish. Soc. 128:475-482.

Hankin, D.G. 2001. A preliminary evaluation of the performance of methods used to estimate spawning escapement of Chinook salmon in the Trinity River. Unpublished Report for the Hoopa Valley Tribal Fisheries Department.

Hankin, D.G., and E. Logan. 2010. A preliminary analysis of chinook salmon coded-wire tag recovery data from Iron gate, Trinity river and Cole rivers hatcheries, brood years 1978-2004. Unpublished report.

Hoenig, J.M. and D.M. Heisey. 1987. Use of a log-linear model with the EM Algorithm to correct estimates of stock composition and to convert length to age. Trans. Am. Fish. Soc. 116:232-243.

Houtman, R. and B.P. Fanos. 2000. Estimation of the 1995 late run sockeye salmon escapement of the Adams River study area. Can. Manus. Rept. Fish. Aquat. Sci. 2533.

Kimura, D.K. and S. Chikuni. 1987. Mixtures of empirical distributions: an iterative application of the age-length key. Biometrics 43:23-45.

Kinziger, A.P., M. Hellmair, D.G. Hankin and J.C. Garza. 2012. Retention of genetic structure in Klamath Basin Chinook salmon (*Onchorhynchus tshawytscha*) despite extensive within-basin transplantation. Unpublished Manuscript.

Konrad, C.P and 14 coauthors. 2011. Large-scale flow experiments for managing river systems. BioScience 61:948-959.

Lockwood, R.N., D.M. Benjamin and J.R. Bence. 1999. Estimating angling effort and catch from Michigan roving and access site angler survey data. Michigan Dept. Natural Res. Fish Res. Rept 2044.

Neilson, J.D. and C. E. Banford. 1983. Chinook salmon spawner characteristics in relation to redd physical features. Can. J.Zool. 61:1524-1531.

Pahlke, K.A. and D.R. Bernard. 1996. Abundance of the Chinook salmon escapement in the Taku River, 1989 to 1990. Alaska Fishery Research Bulletin 3(1):9-20.

Peterman, R.M. and G.J. Steer. 1981 Relation between sportfishing catchability coefficients and salmon abundance. Transactions of the American Fisheries Society 110:585-593

Schwarz, C.J. and C.G. Taylor. 1998. Use of the stratified-Peterson estimator in the fisheries management: estimate the number of pink salmon spawners in the Fraser River. Can. J. Fish. Aquat. Sci. 55:281-296.

Taylor, R.G., J.A. Wittington, W.E. Pine and K.H. Pollock. 2006. Effect of different reward levels on the tag reporting rates and behaviour of common snook anglers in southeast Florida. N. Am. J. Fish. Man. 26:645-651.

Velez-Espino, L.A., G. Mullins, J. Willis, A. Krimmer and W. Levesque. 2010. Mark-recapture experiment for the 2009 chinook salmon spawning escapement in the Atnarko River. Can. Manus. Rept. Fish. Aquat. Sci. 2930.

Attachment A

To the Authorization for Subconsultant Services

Dated: June 8, 2011

In connection with the TRRP Adult Salmonid Monitoring Evaluation

Statement of Work

Trinity River Restoration Program
Adult Salmonid Monitoring Evaluation

PART I. General Information

A. Introduction

The purpose of this instrument is to conduct an independent review and evaluation of the existing Trinity River Restoration Program's (Program) adult salmonid assessments, including the component projects that contribute to these assessments. The recipient of the contract (Subconsultant) will be responsible for conducting an evaluation of the scope, field methods and analyses in light of the requirements of these assessments for the Program.

The goal of this effort is to review the adult salmonid assessments and monitoring projects that the Program supports and to evaluate their effectiveness, including the precision of estimates relative to meeting the information needs of the Program's Adaptive Environmental Assessment and Management (AEAM) process, and recommend any changes as appropriate.

B. Background

The overall goal of the Program is *"to restore and sustain natural production of anadromous fish populations downstream of Lewiston Dam to pre-dam levels, to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities"*[1] (TRRP and ESSA 2009).

The Secretary of the Interior signed a Record of Decision (ROD) for the Trinity River Fishery Restoration Final Environmental Impact Statement/Report on December 19, 2000. This decision adopted a strategy for restoration and maintenance of the Trinity River's fishery resources that requires rehabilitating the river channel and restoring dynamic alluvial processes that maintain aquatic habitats as well as managing flows to meet biological needs of anadromous salmonids. The primary components of the restoration strategy are: mechanical channel rehabilitation, gravel augmentation, a variable flow regime to meet fluvial geomorphic and biological objectives, and watershed restoration. These management actions, in combination, are expected to increase habitat availability for anadromous salmonids, resulting in increased natural anadromous salmonid production, increased adult recruitment, and increased harvest opportunity in dependent fisheries[2].

1. The IAP Steering Committee, a subcommittee of the Trinity Management Council, drafted this Program goal statement, which both the TMC and TAMWG considered to be acceptable for purposes of guiding IAP development (though still under review by the TMC as an official Program goal).
2. Dependent fisheries are inriver recreational fishery, Yurok and Hoopa Valley tribal fisheries, ocean recreational and commercial fisheries.

Evaluation of the success of meeting the Program's goal of increase salmonid populations requires collection of reliable scientific information, synthesis of this information, and transmission to decision makers. Assessments of the harvest and spawning escapement of naturally produced of spring and fall run Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*) originating from the Trinity River form the basis of determining the success of the Program in meeting its goal to restore populations to pre-dam levels and support dependent fisheries.

C. Program Requirements for Adult Salmonid Assessment

The Program's needs for the adult salmonid assessment, as specified in the Integrated Assessment Plan (IAP) Part I (2009) primarily focus on Objective 4 (page 111 and page 167 of the IAP):

> *Restore and sustain natural production of anadromous fish populations downstream of Lewiston Dam to pre-dam levels, to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities*

To track progress toward the Program's goal, the information that allows for the quantification of contribution of both natural and hatchery produced Trinity River anadromous salmonids to ocean and in-river fisheries and the spawning population is needed. The Program supports a variety of projects that contribute information that support this assessment (see list in Section E).

Performance measures (PM) for Objective 4 include:

- escapement of naturally produced anadromous fish (*Assessments 13A to 15A*);
- contribution of Trinity River naturally produced anadromous fish to dependent sport, tribal, and commercial fisheries and recruitment (*Assessments 16A to 21A*);
- cohort performance or year class strength (*Assessments 22A and 23A*); and
- number of age 3 ocean recruits of fall-run Chinook salmon (*Assessment 22A*).

In addition to the above adult assessment and objective, several projects provide information necessary to evaluate a sub-objective of Objective 3 (*"Restore and maintain natural production of anadromous fish populations"*) to evaluate the response or state of the resource in relation to Program management actions. These include the redd/carcass survey, adult disease monitoring, and adult movement/behavior study.

Performance measures for key assessments related to Sub-objective 3.1 (*increase spawning, incubation, and emergence success of anadromous spawners*):

- density of redds (per longitudinal river segment, reach, or tributary) (*Assessment 1A*);
- number of redds/spawning habitat (in association with reach or river segment) (*Assessment 1A*);
- redd superimposition (*Assessment 2A*); and
- number (proportion) of un-spawned or partially spawned females (*Assessment 3A*).
- proportion of hatchery to natural spawners in natural areas;

D. Scope

The recipient will determine the efficacy of the current extent/scope; field methodologies and statistical analyses used in the adult salmonid assessments in meeting the information needs of the Program (see Section C and the IAP).

The Program requires:

2. An evaluation of the effectiveness of the current adult salmonid assessments/monitoring projects in providing feedback on its ability to evaluate the achievement of meeting adult salmonid goals and providing feedback to management actions as appropriate. This will include review of the scope, field methodologies, data analysis (recent analyses and data will be provided), Recommendations on changes in field methodologies, scope, and data analysis as appropriate.

3. In addition to reviewing the overall adult salmonid assessment of the Program, the following questions are to be answered by the Subconsultant:
    a. Are the projects, individually and when combined if appropriate, providing sufficient information to address the Program's adult salmonid assessments?
    b. Are the methods clearly identified and do the reports clearly demonstrate results based on the methods?
    c. Are there suggested changes to any of the projects to increase their effectiveness in meeting Program's assessments/information needs?
    d. Are there any projects that should be expanded or new ones added to address the Program's assessments/information needs?
    e. Are there any projects that should be reduced in scope or eliminated?
    f. Is the information for projects being disseminated to Program partners in a timely fashion?
    g. Is the funding level for projects in accordance with the information need for the Program's (cost effectiveness)?

4. Three meetings with Program staff and partners will be held as part of this contract: (1) a meeting following the review of the pertinent documents to clarify any questions the Subconsultant may have concerning this project, (2) a presentation of draft findings, and (3) a presentation of the final findings. The first two meetings will occur in Weaverville or Arcata, CA. The third meeting will be via web and telephone conference. At the initial meeting (#1), Program partners will give brief presentation of their monitoring projects.

The Program plans to use the results of this review to evaluate the effectiveness of its current adult salmonid assessment/monitoring efforts in meeting Program's information needs and make appropriate changes. This requires an in-depth evaluation of the monitoring and analyses conducted and suggestions on developing new analyses where appropriate.

E. Applicable Documents

Upon request, the Program will provide these background documents to applicants for this contract. The Subconsultant will be provided these background documents:

Reports

- U.S. Department of the Interior Record of Decision, Trinity Mainstem Fishery Restoration Final Environmental Impact Statement/Environmental Impact Report, December 2000.
- Trinity River Flow Evaluation Final Report, U.S. Fish and Wildlife Service and Hoopa Valley Tribe, June 1999. 308 pages.
- Trinity River Restoration Program, Integrated Assessment Plan (Part 1) Version 1.0, 2009.
- Trinity River Restoration Program, Conceptual Models and Hypotheses for the Trinity River Restoration Program, January 5, 2006 draft.
- CDFG run size report
- KRTAT fall Chinook salmon age composition report
- Redd/carcass survey reports
- Tribal harvest reports
- Sport harvest reports for the lower Klamath River
- Adult fish health reports
- Adult Chinook salmon migration Reports
- Coded Wire Tagging/Constant Fractional Marking at Trinity River Hatchery (Hankin and Newman, 1996)
- TRRP adult monitoring review (Hankin 2001)

Project Proposals for Federal Fiscal Year 2012

- Run Size and harvest (Junction City and Willow Ck Weirs and Hatchery recovery project)

- Harvest –
    - Hoopa
    - Yurok
    - Lower Klamath recreational
    - Lower Trinity recreational
- Age Composition
- Redd/Carcass Survey
- Coded Wire Tagging
- CWT recovery/decoding
- Adult fish health

PART II - REQUIREMENTS

A. Technical Requirements

Task 1 – Project Management:

The Subconsultant shall provide all project management required for accomplishing this project. The Subconsultant shall submit a brief status report every month (on the first of the month).

Task 2 – Familiarization with Background Documents:

The Subconsultant shall become familiar with the background documents at a cursory level. The Subconsultant shall become conversant in the details of IAP Part I Chapters 1 and 2, and Chapter 3, Sections 3.3 and 3.4. The Subconsultant shall become conversant in the details of documents listed in Part I, Section D of this scope of work.

Task 3 – Review the Trinity River Restoration Program's adult salmonid assessment program:

The Subconsultant will be responsible for conducting an independent review and evaluation of the existing adult salmonid assessment and monitoring projects in light of the information needs of the Program. This task includes critically reviewing the efficacy of the scope, field methodologies and the statistical analyses used by the project implementers. The Subconsultant shall determine overall efficacy of the Program's adult salmonid assessment/monitoring program.

This task is broken down into the following subtasks.

Task 3.1 – Evaluate Current Data Collection, Data Management, and Field Operations: The Subconsultant shall review current field operations, data collection, and data management with respect to efficacy in meeting Program requirements (see Sections C and E above). The Subconsultant shall evaluate the scope and level of effort associated with the current adult salmonid assessment/monitoring projects with respect to Program requirements. The Subconsultant will provide recommendations of the potential range and effort required to meet the Program's information requirements in a scientifically justifiable and statistically valid manner. Sufficient information will be presented to allow the Program to evaluate the effectiveness of its adult salmonid assessment/monitoring projects. If other methods of data collection for population estimates/indices would provide higher precision then the Subconsultant should recommend these.

Task 3.2 – Evaluate Current Data Analysis and Reporting: The Subconsultant will review the current data analyses and reporting and determine the ability of these analyses and reports in meeting the information needs of the Program as identified in the IAP. The evaluation shall determine the quality and consistency of both long-term and recent data sets. The Subconsultant shall evaluate the analyses and recommend any changes or alternative analyses.

Task 4 - Meetings

Three meetings with Program staff and partners will be held as part of this contract: (1) a meeting following the review of the pertinent documents to clarify any questions the Subconsultant may have concerning this project, (2) a presentation of draft findings, and (3) a presentation of the final findings. The first two meetings will occur in Weaverville or Arcata, CA. The third meeting will be via web and telephone conference.

Task 5 – Recommendations

The Subconsultant shall recommend possible changes to the adult assessment/monitoring projects to meet the Program's requirements listed in Part 1,Section C above in a statically valid manner and address questions listed in Part 1, Section D. Sufficient information will be presented to allow the Program to evaluate the effectiveness of its adult salmonid assessment/monitoring projects. If other methods of data collection for population estimates/indices would provide higher precision then the Subconsultant should recommend these.

Task 6 – Report and Oral Presentation

The Subconsultant shall submit a Draft and a Final Report covering Tasks 3 and 5. The Subconsultant shall orally present the findings and recommendations to the Program following the submission of the draft report and completion of the final report.

B. Deliverables:

Draft Report: The Subconsultant shall provide two electronic copies (Word and PDF format) and 3 hard copies by December 15, 2011. The Program shall provide review comments on the Draft Report to the Subconsultant within 4 weeks of receipt of the Draft Report.

Oral Presentation: The oral presentation will most likely be conducted in Weaverville, CA within one month of submission of the Draft Report. The oral presentation should be roughly two to three hours in length and include additional time for an open discussion period.

Final Report: The Subconsultant shall provide one electronic copy (in PDF format with full editing privileges) and 7 hard copies by March 15, 2012. The Final Report shall address Program's comments received on the Draft Report.