Upper Yuba River Salmonid Habitat Assessment and Population Model

An External Independent Peer Review Report

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Produced for

The Center for Independent Experts (CIE)

October 2012

Executive Summary:

This review was conducted mainly to determine the suitability of the RIPPLE model to quantify the potential impacts of anticipated habitat changes on chinook and steelhead populations in the Upper Yuba River system. This review focused primarily on the data sets used, underlying assumptions, analytical methods, and model limitations. The major conclusions are that the combination of data sets used, assumptions made, model parameters values, and the model structure amount to a reasonable approach to assess the potential of this aquatic habitat under different habitat restoration scenarios. The model outputs appear to be scientifically credible and especially useful for pre-impact assessments needed to support the habitat restoration plans. This review also revealed that a considerable amount of background work was conducted by specialists in many fields/disciplines, which amounts to an authoritative compilation of scientifically credible information used for parameter selection, modelling approaches, and predictions procedures.

In terms of weaknesses, very few were detected given what the model is designed for, the data source requirements and the expected outputs. Even the authors highlight several model limitations, and identify survey and data needs to improve/verify its performance. The following executive summary comments only focus attention to perceived priorities related to the Terms of Reference (*ToR*) objectives. Additional comments are given in the General comments sections, and summarized in the Conclusions and Recommendations section of this report.

ToR 1: Review the RIPPLE model application for the upper Yuba River (Stillwater Sciences 2012) to determine whether the data sets, assumptions, and model parameters represent a reasonable modeling approach to assess the relative potential of upper Yuba River habitats under the three different modeled scenarios.

YES: The data sets, assumptions and model parameters [used] do indeed represent a reasonable modeling approach to assess the relative potential of this aquatic habitat under different modeled scenarios. At least as far as this application is designed to produce given certain inputs and well documented model limitations.

ToR 2: Does the RIPPLE model application for the upper Yuba River produce results that are relevant and appropriate to support the evaluation of anadromous fish reintroduction potential in the upper Yuba River watershed?

YES: The RIPPLE model results are relevant and appropriate for a preliminary evaluation of anadromous fish reintroduction in this watershed. RIPPLE is especially useful as the first tool to use for pre-impact assessments to account for anticipated habitat changes. RIPPLE seemingly delivers what it is designed for.

Background :

The National Marine Fisheries Service (NMFS) is interested in assessing the potential for re-introduction of anadromous fish upstream of the Narrows hydroelectric complex on the Yuba River as a recovery action for ESA-listed salmon species. To gain additional knowledge of the upper Yuba River habitats, NMFS contracted with Stillwater Sciences, Inc. to develop watershed-specific science products to help NMFS assess the potential for re-introduction of anadromous fish to particular areas of the upper Yuba watershed.

The Narrows Hydroelectric Development Complex was constructed approximately 50 years ago on the Yuba River at River Mile 23.4. The complex consists of the Englebright Dam and two associated hydropower installations. The combined complex is a complete barrier to the upstream migration of anadromous fish into the South, Middle, and North Yuba Rivers.

The subject matter of this CIE review involves an environmental modeling application known as "RIPPLE," and a related technical report[1] produced for NMFS and other stakeholders by Stillwater Sciences, Inc. The model is built upon extensive research, field investigations, and a comprehensive synthesis of data relating many different physical and biological aspects of the upper Yuba River. The report adds to the base of existing knowledge about the upper Yuba watershed. NMFS intends to use this information and other relevant and available science-based information - to perform an assessment and relative comparison of potential anadromous fish habitats existing upstream of the Narrows Hydroelectric Development Complex.

The NMFS Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers selected by the CIE Steering Committee and CIE Coordination Team conduct independent peer reviews of NMFS science in compliance the predetermined Terms of Reference (ToRs). Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. The present report summarizes my review findings in accordance with the Statement of Work (SoW), Terms of Reference (ToR), and the report format specified by the CIE.

[1] **Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper Yuba River Watershed,** Technical Report, Prepared for National Marine Fisheries Service, Santa Rosa, California 95404. Prepared by Stillwater Sciences, Berkeley, California 94705, February 2012

Description of the Reviewer's Role and Review Activities:

The reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have the collective expertize, working knowledge and recent experience in the following fields; knowledge of modelling of geomorphic processes of river systems, hydrology, aquatic habitats, theoretical mathematical ecology and conservation biology with knowledge of salmon population dynamics, salmonid community ecology, Pacific salmonid life cycle ecology, ecological interactions and population ecology of Pacific salmonids. CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein. The reviewer must complete the review (desk review, with no travel required) according to required format and content as described in Annex 1:

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:
   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Each CIE reviewer must also complete the independent peer review addressing each ToR as described in Annex 2:

1. Review the RIPPLE model application for the upper Yuba River (Stillwater Sciences 2012) to determine whether the data sets, assumptions, and model parameters represent a reasonable modeling approach to assess the relative potential of upper Yuba River habitats under the three different modeled scenarios.
2. Does the RIPPLE model application for the upper Yuba River produce results that are relevant and appropriate to support the evaluation of anadromous fish reintroduction potential in the upper Yuba River watershed?

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables.**

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).

3) No later than September 8, 2012, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj

Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, David Die, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Summary of Findings:

Main Document Reviews:

1. ***Review of Dietrich and Ligon 2009: RIPPLE - A Digital…***

General comments GEO Sub-Model:

- The report reviewed is from February 2009. Is there a more recent version of this report containing adjustments, corrections or additional information?

- P1. Model overview second paragraph. "…Climate…is...time-invariant". Surely the US drought this year supports the view that climate is *not* truly time-invariant. Authors might consider rephrasing as "...geo-climatic zones….are treated as relatively time-invariant"

- P3. Second last paragraph; "many of these approaches have serious flaws. Stillwater Sciences has adopted an alternative hybrid approach…to extract the best available channel network". Likely true, but the authors should support their claims with a little more information. Like what are the serious flaws, what evidence is there that the Stillwater Sciences model estimates are substantially more accurate or robust, etc. Same holds true for similar blanket statements in the report (like on P.4) with statements that "the algorithms perform poorly…highly prone to error". And the last paragraph for 'creating and using 'aggregated' channel networks that is supposedly better'.

- SEM is used on pages 3-4, DTM on page 5, LIDAR on p.6, etc. The report should contain a list of acronyms, symbols and definitions in an Appendix to help those unfamiliar with various terms.

- P.7. The 'well constrained power law functions'. Typically, constraints are defined in terms of allowable parameter ranges (or coefficients in this case). None are specified in this passage or a referenced table. So what constraints are being used?

- P.7. Buffington et al. (2004) is cited, but the date is missing in the Literature Section of Dietrich and Lagon (2009).

- P.8-11. All Tables and Figures should be in section at the end of the report text as for most technical reports, and should include proper captions and cited properly in the report text. The illustration of the RIPPLE model pseudo-code in Fig. 2 should also be referenced in the text so the reader can visualize the process.

General comments HAB Sub-Model:

- P.14: For chinook salmon…temperatures are <16^{0}C. Is this threshold a median value over a particular season or life history stage? Deep pool refuges might be available even during hot spells and perhaps even colder groundwater seepage affecting habitats at times. Some additional comments would be helpful to justify the thresholds used.

- P.15. Paper by Sebastian et al. (1991) for steelhead is not in the Literature Section. Substrate compositions, obstructions, channel configurations and so forth can vary substantially over time in reaches occasional subject to heavy discharges and flooding. Would help to add comments on doing field surveys periodically to ensure that older records or satellite imagery is still valid.

- P.16. Paper by Frissell et al. (2005) is not listed in the Literature Section.

- P.18. Passage "Fish density reported in the scientific literature are typically determined by the total habitat area…" [i.e., not useable habitat]. Any re-phrasing required here? Three recent (not old) examples given in the Literature Section of this review report all use 'accessible watershed areas' [or accessible/useable habitat] for juvenile rearing and production capacities (Liermann et al, 2010, Parken et al, 2006, Bradford et al. 2009).

- P.18-19. The authors discuss 'Maximum densities' of fry/juveniles based on model predictions, but empirical evidence is needed to support maximum estimates. Past verification attempts using multi-year stream reach survey results in British Columbia (see Ptolemy 1993) have been questioned and repeatedly rejected for primary publication largely because one cannot easily account for the influence of many external factors (predator influences, droughts, etc.) or even demonstrate that the maximum densities detected are true maximums. In light of several past [failed] attempts to use field survey observations, the issue may only be resolved via experimental releases in natural streams but under controlled conditions. The authors may wish to highlight this and state that at this time, in the absence of superior alternatives, this approach was considered as the best compromise.

- P.20. Two last paragraphs: "bootstrapping techniques may be used to form confidence intervals" and then "efforts focus on estimating the uncertainty associated with carrying capacity parameters". Even bootstrapping methods have limitations (e.g., minimum number of samples over the entire range of observable values, etc.). Not convinced these conditions are met in the present context. The authors might consider adding some comments to support the use of this approach, or that further insight may also be gained via a 'trial-and-error' process, rather than speculate that all uncertainty can be quantified via bootstrapping.

General comments POP Sub-Model:

- P.21. Reference to the paper by Bake (in press) is not sufficient. If this paper describes crucial components of the POP model, reviewers should be provided with a draft version with a proviso that it is for reference purposes only, and other provisos that may apply. Would really like to check the equations used.

- P.21. “generalized stock-production model”. This term is not commonly used as such in many circles so it is akin to a ‘misnomer’. There are many fitting procedures and versions of the stock-production model introduced by Schaefer (1954). This type of ‘surplus production’ or ‘biomass dynamics’ model can [in principle] “be used with any level of detail in representation of populations dynamics” (Hilborn and Walters 1992, p. 299), which partly explains why several versions are used. Non-equilibrium model versions provide less biased estimates (Hilborn and Walters 1992, p. 327), and in the present context, the reader might assume that non-equilibrium conditions apply because RIPPLE accounts for changes in habitat conditions. However, the authors should add a few statements to confirm this, and modify some passages in the text to clarify things.

- P.21. Stock-recruitment (S/R) functions are not generally chosen (nowadays) from a ‘very small library of standard forms’. There are multiple variations of these. The term ‘hockey-stick’ should be replaced by the proper statistical term ‘breakpoint regression’, the term ‘relationships’ is more suited for ‘inter-personal’ relations, and ‘relation(s)’ is generally sufficient.

- P. 22. “These relationships are….by subroutines which may become quite complicated”. Agree, but some reviewers may want check the sub-routines functions (or algorithms) as justification for the parameterization used. At a minimum, the ‘pseudo-code’ of subroutines could be given in a figure, or reference to publication(s) describing the suite of functions for predator-prey, habitat selection, spatial dynamics, and etc. used (like some in Walters and Martell 2004 for instance). Those familiar with Walters and Martell (2004) would likely not support the notion that “competition and/or crowding can be ignored” as stated. Granted, many models are necessary simplifications of reality that attempt to capture the end product of several factors operating simultaneously (e.g., predation, competition, foraging needs,..). Nevertheless, the authors should provide a few more details/references to support their claims.

- P.23. A cursory literature review will reveal a well-established fact that salmon juveniles can move downstream at certain life-stages or seemingly forced to do so under unfavorable conditions, but at times they can also move back upstream. What % moves downstream to the next arc in the model? If say for over-crowding, all of them, or 50%? And under ‘Minor Migrations’, survival is seemingly treated “as a single user-provided parameter”. What basis is used by the ‘single user’ to provide a scientifically credible parameter? Might be preferable to rely on ‘Expert-Based Priors’ as used for Bayesian

analyses (Morris 1977) instead of a single opinion, or at a minimum to provide a default value to use should the user be uncertain about what value to use.

- P.24. Don't have access to the RIPPLE Model code, but after years of programming in C/C++ on different platforms, in my view, most C/C++ applications (even those using latest ANSII standard) are rarely, truly and totally "platform-independent". Developers can easily create simple non-GUI MS Visual Studio Apps that run as console applications under Windows, and perhaps the Apple O/S, and etc, but not all apps should be expected to produce exactly the same outputs on various platforms (or combinations of compilers and O/Ss). The authors should state what platform(s) the latest RIPPLE model version is configured for and has been tested on.

2. Review Stillwater Sciences (2012): Modeling habitat capacity…

General comments:

- P.ES-3. "Channels with a summer low flow width of <8.5 m were assumed to be too narrow to provide suitable holding or spawning habitat". Is there empirical evidence to support this assumption? I've stumbled on summer run adult chinook occasionally in narrower passages. By summer low flows, do the authors imply 'median' summer low flows over a recent period? The assumption is reasonable and conservative so no objection for preliminary assessments, but if only convenient or necessary because of the limitations of the RIPPLE model or the resolution of the data available, the authors should state this.

- P.ES-7. Predictions are made using 'equilibrium conditions' that do not always hold in every context. The authors conduct 'model gaming' (as they should) for exploratory investigations of 'what if' scenarios. Some readers would benefit from knowing the definition of 'model gaming' (used on P.63 as well), and details on combinations of the alternative conditions (non-equilibrium) investigated.

- P.4. The Upper Yuba River has rainbow trout, sucker, pikeminnow, hardhead, brown trout, smallmouth bass, and sunfish. Any plans to eradicate non-native species? The potential response of predators to habitat changes is unknown, difficult to quantify with certainty, but cannot be overlooked, as is potential inter-specific competition. What about availability of predator refuges other than interstitial spaces; any plans to create some? Minimal work needs to be done on these issues so all potential biotic and abiotic impacts can be considered (perhaps via a workshop to get expert-based priors, augmented by field investigations).

- P.11. "Streamflow also dictates the quantity to drifting invertebrates that reach feeding steelhead. Is this to be quantified later, or artificially augmented?

- P.11. Overwintering steelhead may suffer elevated mortality when displaced by high winter flows. With dam removal or higher discharge rates (if any), will this be increased, and accounted for by the Ripple model other than simply via re-location to another stream reach?

- P.12. “the coho life history version can be downloaded from the NCED website at..” Non-users (and some reviewers) can go to the website only to find out that whatever they download even for coho won’t work unless you also have an ‘operating copy of ArcGIS (which many may not have). The authors might consider referring to a web-site that has a short video that shows at least what the user-interface looks like, given that the other graphical user interfaces for the two new species (if any) are not yet available.

- P.24.m“rainbow trout (*O.mykiss*) have been observed in the South and Middle…at relatively high densities…than predicted..and that reintroduced steelhead could find suitable habitat where the MWAT is >20°C.”. Therefore “… a separate analysis was conducted and the results used to compare the two approaches”. This is sufficient justification for additional exploratory investigations, at a minimum to determine if more production could potentially be achieved. However additional comments seem required re “reintroduced steelhead” production. From where?: New hatchery releases from a local broodstock known to tolerate high water temperatures, strays, catch and truck further upstream, from natural re-colonization by lower reach spawners progressively moving into new accessible habitats further upstream. It may take years for actual spawners or surplus spawners (if any) to use new habitats and progressively adapt to local conditions. Long adaptation periods may also be required even for hatchery releases (if any). The potential production estimates generated from RIPPLE may be realistic, but one wonders how much time it could take to get increased production one way or the other. The authors should emphasize this so some readers do not assume otherwise and without details on re-introduction methods being considered.

- P.28. For purposes of completeness, the authors should stipulate the plausible range of values allowed for each ‘coefficient’ estimate on P.29 table 5.1. Also for the latter, is Q=A in col. 1-2? Perhaps I missed something.

- P.30. Fig. 5.1. The two symbols used for points are difficult to distinguish in small figures, and some readers may have difficulty visualizing the residual patterns, especially on log-scaled graphs. Would prefer either two figures or large differences in the symbols used, and non-log scale axes. Same for Fig. 5.4 on P.33.

- P.31. Fig. 5-3. The x-y axis values should range from 0 to the upper values chosen, as in Fig. 5.3. Easier for readers to determine if the relation could possibly be non-linear.

- P.34. Choice of a linear relation as shown on this graph could be perceived as problematic to some readers. One x-y value (about 2.05, 0.62) could be an outlier. After

deciding on this, re-scaling both axes to 0-upper_limit, the authors may debate if the relation could be non-linear and revise accordingly. Same for Fig. 5.8 on P. 36.

- P.35. Fig. 5-7. Looks like there is increasing scatter about the linear regression line associated with increased bankfull width, at least for summer low flows. For data sets exhibiting heterocedasticity, even basic textbooks recommend that some figures be log-transformed (Zar 1984, P.288), which implies a non-linear relation between both variables. The authors should provide further justification for a simple linear relation.

- P.46. Footer note "(1) the hockey stick…". Some authors use this term mainly in technical reports, but it is usually meant to represent a function more commonly termed in statistics as a 'breakpoint regression'. The authors should replace hockey stick everywhere in this report by the standard term.

- P.46. "The equilibrium population is reached after multiple iterations of the model are run and a stable, long-term average population is reached after….". Multiple iterations means? Could be referring to the fact that a function minimization routine is used to search for the best fitting parameter values (true?, using what algorithm? Simplex? For how many parameters?). This needs clarification. And reference is also made in the footnote to the Skellam function, typically used to generate a discrete distribution of the differences between two independent Poisson distributed random variables. Is this the case? Re-read this passage, but cannot determine which ones are used to mimic "superimposition losses"? Adding clarification in an Appendix, or cite some document that describes and justifies this component of the POP module would be helpful to some.

- P.47. Table 6-6 finally provides some definitions for some terms used in this report. As recommended for the other report reviewed (part 1), this table should be in a separate section of Appendix, and contain the entire list of acronyms, symbols and definitions used throughout the report to help those unfamiliar with some symbols, terms, terminology, definitions, and particularly those not commonly used that are context specific.

- P.53. "downstream movement of *efry* may be volitional". The latter qualifier is often used in a hatchery supplementation context when hatchery reared juveniles are held in a closed section of the stream to imprint + get acclimated to natural conditions, and then allowed to move out from the holding area voluntarily. This is not akin to naturally produced fry that head downstream due to uncontrolled pressures (e.g., flows and predators). Further clarification of 'volitional' in the present context would be desirable.

- P.55. Much attention focuses on the availability of 'suitable substrate'. But with increased discharge from dams coupled with potential habitat manipulations, one could expect that substrate composition and particle sizes could change more progressively or rapidly than anticipated, with potential repercussions on the estimated productivity gains. Will

surveys be conducted intermittently to update the RIPPLE Model inputs to account for changes (if any)?

- P.57. “and were parameterized using steelhead densities from quantitative electrofishing data...”. Not sure what survey protocols were used, but the reliability of the ‘maximum densities’ detected is always problematic. Ptolemy (1993) attempted to establish maximum densities by stream reach for juvenile salmonids in BC using laboratory study results (Grant and Kramer 1990), and years of field observations from electrofishing surveys (including steelhead). Ptolemy’s (1993) figures were used by many to determine useable steelhead habitat (e.g., Tautz et al. 1992, Riley et al. 1998). Repeated attempts to publish Ptolemy’s survey results in primary journals failed in part because maximum densities detected in field surveys (or even the average of peaks) were not considered by reviewers to be representative of ‘normal’ conditions or ‘equilibrium peaks’ due to potential sampling anomalies, unusual predators and/or competitor impacts, unusual in-river conditions, and other factors not monitored. The potential biases and error levels associated with the maximums chosen may be unquantifiable given the lack of controls. There may be few alternatives to rely on, but if peak observations are used, the authors should acknowledge the limitations of electroshocking survey figures, and perhaps consider using a plausible range of ‘maximum densities’. Also density figures are often expressed in number of individuals per m^2. The authors should specify if a conversion factor was used to transform fish/m^3 of habitable space (if measured) to fish/m^2 to compare densities of shallow stream reaches to those from reaches with pools.

- P.64. Temperature thresholds. The estimate ranges in Table 7.5 indicate that upper temperature limits have important effects on predicted carrying capacities. Temperature tolerances are complex functions of many factors (species strain, life history stage, habitat attributes, residency periods, crowding effects, etc.). Estimates based on >20°C limits may help decision makers assess [plausible] additional gains, and in due-time, re-assess cold water discharge targets. But to minimize false expectations, a precautionary or risk-adverse approach should use the seemingly well-established 20°C limit as the baseline value for basic cost-benefit analyses of current restoration plans. Up to the authors to determine if some passages should be modified to account for this suggestion.

- P.67-68-69. The authors highlight several issues that need further investigation(s) to increase the reliability of the model predictions in the present context and provide more insight on the plausible outcomes of various restoration scenarios. Some of these even highlight the need to focus on potential predators and competitor responses to expected habitat changes noted previously. However, when will complementary investigations be conducted and new model predictions generated? Will there be sufficient time before, during or after habitat restoration periods? Have not read all papers cited, and may have missed something, but it would be desirable to insert a table with specifying the timelines of restorations activities, complementary field surveys, new model updates and outputs,

and subsequent monitoring period. Beyond the terms of this review to assess, but readers would at least know these activities are well linked and planned for.

Conclusions and Recommendations:

Considerable efforts were seemingly made to compile data from multiple sources on past and current conditions of the Upper Yuba River watershed. Much information on expected habitat conditions after restoration (sources well referenced and largely complete) is also used as input by RIPPLE. While additional documentation on the RIPPLE model algorithms, user interface and allowable parameter bounds would have been desirable (at least to modellers and analysts), a quick WEB search (not documented here) revealed this model is increasingly being used by scientists, planners and managers, which supports the notion this model is gaining acceptance in various circles as a tool for pre-impact assessment and decision making. RIPPLE appears to be well-designed and scientifically-credible software application that can serve for pre-impact assessments given specific input sources (ArcGIS, survey-based, and user-based). The model authors should also be commended for highlighting the model limitations and what extra work would be required for further improvement.

Additional suggestions from the present review are given in the General comments sections of this report on ways of improving the analytical procedures and results presented. What follows are comments that address more specifically the main ToR issues.

ToR 1: Review the RIPPLE model application for the upper Yuba River (Stillwater Sciences 2012) to determine whether the data sets, assumptions, and model parameters represent a reasonable modeling approach to assess the relative potential of upper Yuba River habitats under the three different modeled scenarios.

YES: The data sets, assumptions and model parameters [used] do indeed represent a reasonable modeling approach to assess the relative potential of this aquatic habitat under different modeled scenarios. RIPPLE is designed to make the best use of certain information types and sources. Most (if not all) complex bio-statistical models have limitations, some of these are acknowledged by the authors. RIPPLE, like other complex models using remote census data and multiple data sources are rarely (if ever) perfect representations of reality given data gaps, uncertain and confounding relations between certain variables and so forth. Overall, this review revealed no major problems or unsupported assumptions. Still the General comments sections (above) provide suggestions for the model developers or report authors to consider and perhaps focus more attention on specific issues (if possible). These include (i) re-assessing the validity of using linear (vs non-linear) relations between certain variables, (ii) evaluate the outcomes of at least two additional scenarios re maximum supported juvenile densities (low, high) because some assumptions are tenuous at best, (iii) provide comments on anticipated of potential streambed substrate changes due to increased discharges, and (iv) add comments to support claims and timelines for complementary investigations to be conducted to fill data gaps and support/verify some hypotheses.

ToR 2: Does the RIPPLE model application for the upper Yuba River produce results that are relevant and appropriate to support the evaluation of anadromous fish reintroduction potential in the upper Yuba River watershed?

YES: The model results are relevant and appropriate to support the preliminary evaluation of anadromous fish reintroduction in the upper Yuba River watershed. RIPPLE is especially useful as the first tool to use for pre-impact assessments to account for anticipated habitat changes. RIPPLE seemingly delivers what it is designed for. Having said this, it should be noted that the version of RIPPLE currently does not (and likely cannot) produce estimates that account for the effects of many other pertinent factors that cannot be ignored when attempting to predict post-impact conditions. The General comments sections (above) provide suggestions for the model developers or report authors to consider, and perhaps focus more attention on specific issues (if possible). These mainly concern features in the POP sub-model not currently designed to account for the (i) potential removal of undesirable species, (ii) potential response of predators and competitors to habitat changes, (iii) potential impacts as predators or competitors (iv) colonization processes and periods required to occupy newly created habitats via one method or another, and (v) response of invertebrates to habitat changes or even effects of forage supplementation programs. It should be emphasized that these are not criticisms *per se* of RIPPLE shortfalls just that RIPPLE predictions serve only as a first step in predicting the potential habitat and population gains in the future.

As a passing comment, It should be noted that the initial CIE review outline (June 15, 2012) noted that RIPPLE model outputs may serve later as 'OBAN Model' inputs, but the latter 'Oncorhynchus Bayesian Analysis (OBAN) for winter run chinook' by R2 Resource Consultants was not to be peer-reviewed under the present contract. Ideally peer-reviewers should know if the RIPPLE model outputs match OBAN model inputs, or have the opportunity to review both models.

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Appendix 1

Copies of main scientific reports provided by the CIE for this review

Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper Yuba River Watershed, Technical Report, Prepared for National Marine Fisheries Service, Santa Rosa, California 95404. Prepared by Stillwater Sciences, Berkeley, California 94705, February 2012. Properly cited in the Literature section as Stillwater Sciences (2012).

RIPPLE: A Digital Terrain-Based Model for Linking Salmon Population Dynamics to Channel Networks, University of California, Berkeley Earth and Planetary Science, Berkeley, CA and Stillwater Sciences, Berkeley, CA. Properly cited in the Literature section as Dietrich and Ligon (2009).

Appendix 2

Statement of Work Dr. Marc Labelle

External Independent Peer Review by the Center for Independent Experts

Review of Upper Yuba River Salmonid Habitat Assessment and Population Model

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: NMFS is interested in assessing the potential for re-introducing anadromous fish upstream of the Narrows hydroelectric complex on the Yuba River as a recovery action for ESA-listed salmon species. To gain additional knowledge of the upper Yuba River habitats, NMFS contracted with Stillwater Sciences, Inc. to develop watershed-specific science products to help NMFS assess the potential for re-introduction of anadromous fish to particular areas of the upper Yuba watershed. The Narrows Hydroelectric Development Complex was constructed approximately 50 years ago on the Yuba River at River Mile 23.4. The complex consists of Englebright Dam and two associated hydropower installations. The combined complex is a complete barrier to the upstream migration of anadromous fish into the South, Middle, and North Yuba Rivers. The subject matter of this CIE review involves an environmental modeling application known as "RIPPLE," and a related technical report[2] produced for NMFS and other stakeholders by Stillwater Sciences, Inc. The model is built upon extensive research, field investigations, and a comprehensive synthesis of data relating many different physical and biological aspects of the upper Yuba River. The report adds to the base of existing knowledge about the upper Yuba watershed. NMFS is interested in using the information - combined with other relevant and available science-based information - to perform an assessment and relative comparison of potential anadromous fish habitats existing upstream of the Narrows Hydroelectric Development Complex. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

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[2] **Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper Yuba River Watershed,** Technical Report, Prepared for National Marine Fisheries Service, Santa Rosa, California 95404. Prepared by Stillwater Sciences, Berkeley, California 94705, February 2012.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have the combined working knowledge and recent experience in the application of

- Knowledge of modeling of geomorphic processes of river systems, hydrology, and aquatic habitat.
- Theoretical mathematical ecology and conservation biology with knowledge in salmon population dynamics, salmonid community ecology, Pacific salmonid life cycle ecology, complex ecological interactions and population ecology of Pacific salmonids including life cycle ecology.

Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as

described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables.**

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an independent peer review in accordance with the ToRs (Annex 2).
3) No later than September 8, 2012, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, David Die, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

August 6, 2012	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
August 23, 2012	NMFS Project Contact sends the CIE Reviewers the report and background documents
August 24 – Sept. 6, 2012	Each reviewer conducts an independent peer review as a desk review.
September 8, 2012	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
September 22, 2012	CIE submits the CIE independent peer review reports to the COTR
September 29, 2012	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on

compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program manager, COTR
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Northern Taiga Ventures, Inc.
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Key Personnel:

Rick Wantuck, Project Contact
NMFS Southwest Fisheries Regional Office,
Hydropower and Fisheries Bioengineering Programs
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Richard.Wantuck@noaa.gov Phone: 707-575-6063

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:
   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

Review of Upper Yuba River Salmonid Habitat Assessment and Population Models[3]

1. Review the RIPPLE model application for the upper Yuba River (Stillwater Sciences 2012) to determine whether the data sets, assumptions, and model parameters represent a reasonable modeling approach to assess the relative potential of upper Yuba River habitats under the three different modeled scenarios.

2. Does the RIPPLE model application for the upper Yuba River produce results that are relevant and appropriate to support the evaluation of anadromous fish reintroduction potential in the upper Yuba River watershed?

Materials provided for review:

Primary report: *Modeling Habitat Capacity and Population Productivity for Spring-run Chinook Salmon and Steelhead in the Upper Yuba River Watershed*, Technical Report, Prepared for National Marine Fisheries Service, Santa Rosa, California 95404. Prepared by Stillwater Sciences, Berkeley, California 94705, February 2012. Properly cited previously as Stillwater Sciences (2012).

Background and broad overview of the RIPPLE model structure and rationale: *RIPPLE: A Digital Terrain-Based Model for Linking Salmon Population Dynamics to Channel Networks*, University of California, Berkeley Earth and Planetary Science, Berkeley, CA and Stillwater Sciences, Berkeley, CA. Properly cited above as Dietrich and Ligon (2009).

[3] The reviewers should be aware that the original project budget was limited to the output and information produced in the report, as a Phase 1 investigation. Following the delivery of this report to NMFS in February 2012, Stillwater Sciences conducted an additional sensitivity analysis of model parameters, but that information is not yet completed and available for this review - which must go forward in order to meet deadlines. Furthermore, NMFS has secured additional funding to enable Stillwater to re-run the models (Phase 2) using updated field information that was gathered by NMFS and other Yuba River stakeholder groups after the model runs for this report were conducted.