DRAFT Technical Memorandum

Quantitative Fisheries Model Selection Recommendation Process

SAN JOAQUIN RIVER RESTORATION PROGRAM

June 2, 2008

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Appendices

List of Abbreviations and Acronyms

CalEPA	California Environmental Protection Agency
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
EDT	Ecosystem Diagnostic Treatment
FMP	Fisheries Management Plan
FMWG	Fisheries Management Work Group
FWUA	Friant Water Users Authority
IBM	Individual Based Model
IFIM	Instream Flow Incremental Methodology
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council
PEIS/R	Program Environmental Impact Statement/Report
PTA	Patient-Template Analysis
Reclamation	U.S. Bureau of Reclamation
SJRRP	San Joaquin River Restoration Program
TM	Technical Memorandum
USFWS	U.S. Fish and Wildlife Service
WMWG	Water Management Work Group

This Draft Technical Memorandum (TM) was prepared by the San Joaquin River Restoration Program (SJRRP) Fisheries Management Work Group (FMWG) as a draft document in support of the preparation of the Program Environmental Impact Statement/Report (PEIS/R). The purpose for circulating this document at this time is to facilitate early coordination regarding initial concepts and approaches currently under consideration by the SJRRP Team with the Settling Parties, Third Parties, other stakeholders, and interested members of the public. Therefore, the content of this document may not necessarily be included in the PEIS/R.

This Draft TM does not present findings, decisions, or policy statements of any of the Implementing Agencies. Additionally, all information presented in this document is intended to be consistent with the Settlement. To the extent inconsistencies exist, the Settlement should be the controlling document, and the information in this document will be revised prior to its inclusion in future documents. While the SJRRP Team is not requesting formal comments on this document, all comments received will be considered in refining the concepts and approaches described herein to the extent possible. Responses to comments will not be provided and this document will not be finalized; however, refinements will likely be reflected in subsequent SJRRP documents.

1.0 Introduction

This Draft Quantitative Fisheries Model Selection Recommendation Process TM describes the steps taken by the FMWG to facilitate selection of at least one quantitative model to primarily assist and inform the FMWG in the development of the Fisheries Management Plan (FMP). The FMWG anticipates the use of additional quantitative models in the future as the SJRRP progresses.

1.1 Background

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the Central Valley Project (CVP), Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, a settlement was reached. On September 13, 2006, the Settling Parties agreed on the terms and conditions of the Settlement, which was subsequently approved by the U.S. District Court on October 23, 2006. The "Settling Parties" include NRDC, Friant Water Users Authority (FWUA), and the U.S. Departments of the Interior and Commerce.

The Settlement is based on two parallel goals:

- Restoration Goal – To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

- Water Management Goal – To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors resulting from the Interim Flows and Restoration Flows provided for in the Settlement.

The SJRRP will implement the Settlement. The Implementing Agencies responsible for management of the SJRRP include the U.S. Department of the Interior, through the Bureau of Reclamation (Reclamation) and the Fish and Wildlife Service (USFWS); U.S. Department of Commerce through the National Marine Fisheries Service (NMFS); and the State of California through the Department of Water Resources (DWR), Department of Fish and Game (DFG), and California Environmental Protection Agency (CalEPA). Consistent with the Memorandum of Understanding between the Settling Parties and the State, which was signed concurrently with the Settlement, the State, through DFG, DWR, the Resources Agency, and CalEPA, will play a major, collaborative role in planning, designing, funding, and implementing the actions called for in the Settlement.

1.2 Purpose of this Technical Memorandum

The FMWG requires a quantitative fisheries model to provide input for the continued development of the conceptual model and the FMP. The Draft Conceptual Model TM (SJRRP 2008) describes in conceptual and qualitative terms how environmental factors are expected to influence the abundance of Chinook salmon in the San Joaquin River between Friant Dam and the confluence with the Merced River (SJRRP Restoration Area). The conceptual model is being used to identify and prioritize limiting factors and restoration actions in a general sense, whereas quantitative models are needed to develop testable hypotheses that would form the basis of an adaptive management strategy (as part of the FMP) for the SJRRP. The conceptual and quantitative models will provide a critical framework for understanding the observed responses of Chinook salmon in the San Joaquin River, and will also provide a means of assessing the relative effects of in-river restoration and management actions versus the effects of factors downstream from the SJRRP Restoration Area, and in the Sacramento-San Joaquin Delta (Delta), San Francisco Bay, and Pacific Ocean.

2.0 Needs for a Quantitative Fisheries Model

This section summarizes the needs and associated requirements for a fisheries quantitative model for the SJRRP to meet the Restoration and Water Management goals stipulated in the Settlement.

The current lack of Chinook salmon populations in the San Joaquin River causes considerable uncertainty in the management of the reintroduction effort. In most systems, current and past population trends are used as management decision tools; however, the absence of Chinook salmon populations in the San Joaquin River prohibits this approach. Therefore, the FMWG will need to rely on credible Chinook salmon life-history-based quantitative models to conduct structured and quantitative analyses that will enable the adaptive management of the SJRRP. Specifically, the FMWG will use the selected fisheries quantitative model(s) for the following tasks:

- Assist in the development of population goals
- Assist in the planning of habitat restoration and flow management
- Predict fish survival rates due to different restoration activities
- Identify and prioritize limiting factors that will require restoration or other remedies
- Assist in Adaptive Management Planning through the identification of key uncertainties and data needs, and the development of testable hypotheses

The FMWG is currently preparing a Conceptual Models TM identifying major stressors and limiting factors for San Joaquin River Chinook salmon (SJRRP 2008). It is anticipated that the selected quantitative model(s) could further assist the FMWG in its efforts to understand the key limiting factors of the mainstem San Joaquin River Chinook salmon populations. In addition, quantitative models may be used in the plan formulation process to evaluate the potential effects of program alternatives on salmon populations.

There are many existing quantitative fisheries models applied to Pacific salmon. To help identify a model that best suits the needs of the SJRRP, the FMWG has outlined the following fundamental requirements for such a quantitative fisheries model:

- The model must be able to simulate a population level response and not be limited to a single life stage.
- The model must be applicable to a large-scale project such as the SJRRP.
- The model needs to be able to simulate existing and restored habitat conditions.
- The model needs to be credible to both fisheries scientists and the general public.
- The development and application of the model needs to be compatible with the SJRRP schedule outlined in the Settlement.
- The model needs to be transparent regarding fish-habitat relationships.

Based on these requirements, specific criteria were developed during the evaluation process; these criteria are provided and discussed in Section 3.

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3.0 Selection Process

The FMWG researched currently established quantitative fisheries models that could potentially be adapted and used for the SJRRP.

3.1 Identified Models

Twelve models were identified, although four models (CPOP, EACH, SRCIBM and the DFG San Joaquin River model) were removed from the list because they are either no longer being used (CPOP and SRCIBM) or currently under development (DFG San Joaquin River model). The remaining eight models are listed below:

- Bayesian Framework (Lindley and Mohr 2003)
- Ecosystem Diagnosis and Treatment (EDT) (Mobrand et al. 1997)
- Individual Based Model (IBM) (Volker and Railsback 2005)
- Interactive Object-oriented Salmonid Simulation (Cramer Fish Sciences 2007)
- Oak Ridge Chinook Model (Jager et al. 1997)
- Salmod (Bartholow 1993, Bartholow 2003)
- Salmon Survival Model (Newman and Rice 2002)
- San Joaquin River Model (developed by Stillwater Sciences 2003 through 2004)

3.2 Selection Process

The FMWG adopted a two-stage selection process. The purpose of Stage 1 preliminary screening was to remove some models from further consideration due to major deficiencies in comparison with SJRRP needs. The purpose of the Stage 2 selection process was to identify the model(s) that would be used for further development and application in the SJRRP. Because the purpose of the Stage 2 process was to further evaluate a winnowed list of models, additional interviews were necessary. Details of the two-stage selection process are explained below:

Each quantitative model was ranked as high, medium, or low based on its ability to meet the defined criteria. Rankings are defined as follows and recorded in Appendix A, Tables A-1 and A-2.

- High indicates the model is mostly satisfactory for the identified criterion and, thus, intended use and desired efficiency

- Medium indicates the model has a notable deficiency for the identified criterion; the deficiency is conditionally acceptable for intended use and/or desired efficiency with considerations for balancing with other criteria; some supplemental tools and operations may be required

- Low indicates the model is limited for the identified criterion, likely being less efficient or requiring longer development time, or requiring other utilities, tools, or modules within the same software package to support the intended use

Evaluation was based on available literature, and feedback from peer biologists/users in academia and government agencies and for some, presentations and follow-up conversations among the model development teams, FMWG, and members from the Water Management Work Group (WMWG).

3.2.1 Stage 1 Preliminary Screening

After winnowing the list of potential models based on requirements set forth in Section 2, the FMWG established the following four criteria to preliminarily screen the eight models:

- Does the model appropriately characterize all fish life stages and their habitat requirements?
- Does the model predict fish responses to both existing conditions and restored conditions in the Restoration Area?
- Can the model be completed for use and functional by April 1, 2008?
- Has the model been previously applied to studies leading to the Settlement?

The results of the preliminary screening process for each model are described below and in Table A-1.

- The Bayesian Framework was considered to be a satisfactory population response model. However, the model was ranked as medium for its focus on existing habitat, its inability to meet the SJRRP schedule, and because it has not been applied to the San Joaquin River. This model was removed from further consideration primarily because of its inability to meet the SJRRP schedule.

- Ecosystem Diagnosis and Treatment (EDT) was considered to be highly satisfactory, except that it has not been applied to the San Joaquin River. This model was carried forward for further consideration based on the assumption that it could be easily adapted to the Restoration Area.

- The Individual Based Model (IBM) was considered to be highly satisfactory for its ability to predict the response of all life stages and to evaluate both existing and restored habitats. However, it was rated medium for inadequate staffing needed to meet the SJRRP schedule and because it has not been applied to the San Joaquin River. In spite of these deficiencies, this model was carried forward for its unique ability to evaluate the effectiveness of specific restoration projects and management actions.

- The Interactive Object-oriented Salmonid Simulation was considered to be highly satisfactory as a population response model and its ability to meet the SJRRP schedule. However, the model was ranked as medium for its focus on existing habitat and because it has not been applied to the San Joaquin River. This model was carried forward for further consideration.

- The Oak Ridge Chinook Model was ranked high as a population response model. However, the model was ranked as medium for its focus on existing habitat and because it has not been applied to the San Joaquin River. It was ranked low for an inability to meet the SJRRP schedule. This model was removed from further consideration primarily because of an inability to meet the SJRRP schedule.

- Salmod was ranked high as a population response model. However, the model was ranked as low for its focus on existing habitat and because it has not been applied to the San Joaquin River. It was ranked low for an inability to meet the SJRRP schedule and for the inability to easily incorporate changes in habitat. This model was removed from further consideration primarily because of an inability to meet the SJRRP schedule.

- The Salmon Survival Model was ranked low because it is limited to the effects of Delta conditions on juvenile survival and it is also unlikely that the SJRRP schedule would be met. In addition, the model was ranked medium for its focus on existing habitat. This model was removed from further consideration.

- The San Joaquin River Model was considered to be highly satisfactory as a population response model, for its ability to meet the SJRRP schedule, and because it was developed for the entire Restoration Area The model was ranked medium for its focus on existing habitat and. This model was carried forward for further consideration.

The four models carried forward underwent further evaluation to make a selection of the preferred quantitative model(s) to be used in the SJRRP (Table A-2).

3.2.2 Stage 2 Selection Process

Representatives associated with the four models presented the functions, benefits, environmental factors, and input data needs of each model in FMWG meetings. Members of the FMWG then followed up on each quantitative model by contacting various references given by each model team as well as outside sources (individuals mostly associated with agencies and universities) familiar with the tools and/or the model authors. Existing reports on each model were reviewed and evaluated, leading the FMWG to develop additional questions (see Appendix A of this TM). After review of modeling team responses, additional contact was made with several teams to further examine the mechanistic processes of each model to evaluate the ease of applicability for the FMWG, as well as the transparency of each model.

As a refinement of the Stage 1 criteria, the FMWG identified an additional seven specific key criteria to help evaluate and select the quantitative model(s). These criteria included the following:

- Would the model adequately address substantial ecological processes, such as competition between spring-run and fall-run Chinook salmon?
- Can the model readily incorporate other habitat data, such as the results of a water temperature model and San Joaquin River habitat-specific data

- Does the model have the ability to evaluate the entire Restoration Area?
- Can the model predict fish response at a site-specific level, including specific restoration projects?
- Is the modeling team willing to collaborate with the FMWG?
- Is the model peer-reviewed and accepted in the user community?
- Is there an adequate model support system?

Two key criteria were broken up into several further evaluation factors, totaling nine categories for comparison. The results of the ranking process under the Stage 2 selection process are described below, and shown in Table A-2.

- EDT was considered highly satisfactory for all ey criteria except it was given a rank of medium for its ability to predict fish response at a site-specific level. EDT can predict fish response at a site-specific level, but it does not evaluate fish mortality mechanisms and habitat utilization as well as the IBM.

- The IBM was considered highly satisfactory for most key criteria, particularly because it would be most useful for evaluating site-specific effects. However, two key criteria were ranked as medium and low. First, the model is too complex to be expanded to the entire Restoration Area and therefore it could not be used to evaluate population goals. Second, the primary modeling team is not available to help meet the SJRRP schedule in April, but because the IMB is not a population model, it is feasible to delay its completion

- The Interactive Object-oriented Salmonid Simulation was considered highly satisfactory for all but three of the key criteria. Of the three deficiencies, the model was ranked as medium for not being able to directly assess ecological processes, such as competition between the salmon runs. The model was ranked as low for its inability to evaluate site-specific effects. Finally, the model was ranked as medium based on the relatively limited peer review and acceptance by the user community compared with the EDT and IBM.

- The San Joaquin River Model was considered highly satisfactory for all but four of the key criteria. Of the four deficiencies, the model was ranked as medium for not being able to directly assess ecological processes, such as competition between the Chinook salmon runs. The model was ranked as low for its inability to evaluate site-specific effects and medium based on the relatively limited peer review and acceptance by the user community compared with the EDT and IBM. Finally, the model was ranked as medium because Stillwater Sciences has substantially fewer staff available to meet the SJRRP schedule than Jones and Stokes/Mobrand (EDT) and Cramer Fish Sciences (Interactive Object-Oriented Salmonid Simulation).

4.0 Recommendations

This section gives the recommendations from the FMWG on the quantitative fisheries models that the FMWG believes would provide the best tools for evaluating the SJRRP and potential success for reintroduction of Chinook salmon in the San Joaquin River.

4.1 Recommendations on Model Selection

The FMWG realizes that no single quantitative model can evaluate the potential success of SJRRP Chinook salmon reintroduction. Therefore, the FMWG recommends a package of quantitative models. This package will allow future changes and additions of other quantitative models that the FMWG or stakeholders may feel necessary.

EDT, created and maintained by Jones & Stokes/Mobrand, was rated by the FMWG as the most appropriate quantitative fish population model for the SJRRP. A key value of EDT for the SJRRP is that EDT is a modeling framework, meaning it has the capability of incorporating other models into its structure, including the DFG San Joaquin River model currently in development. The IBM also was rated by the FMWG as the most appropriate model for evaluating the effectiveness of individual restoration projects for the SJRRP. In addition, both the EDT and IBM models have been adequately peer-reviewed and are well accepted by the user community.

The EDT and IBM models are briefly described below.

4.1.1 Ecosystem Diagnosis and Treatment

The EDT model is a framework that views salmon as the indicator or diagnostic species for the ecosystem. The salmon's perspective (i.e., its perception of the environment) becomes a filtered view of the system as a whole. The EDT framework was designed so that analyses made at different scales (i.e., from tributary watersheds to successively larger watersheds) might be related and linked. Biological performance is a central feature of the framework and is defined in terms of three elements: life history diversity, productivity, and capacity. These elements of performance are characteristics of the ecosystem that describe persistence, abundance, and distribution potential of a population. The analytical model is the tool used to analyze environmental information and draw conclusions about the ecosystem. The model incorporates an environmental attributes database and a set of mathematical algorithms that compute productivity and capacity parameters for the diagnostic species.

The general approach for comparing existing and desired conditions is called the Patient-Template Analysis (PTA). This approach compares existing conditions of the diagnostic populations and their habitat (Patient) with a hypothetical potential state (Template), where conditions are as good as they can be within the watershed. The Template is sometimes approximated with a reconstruction of historic conditions. Sufficient information normally exists to do this with the level of clarity needed for the analysis. The Template is intended to capture the unique characteristics and limitations of the watershed due to its combination of climate, geography, geomorphology, and history.

The diagnosis is performed by comparing the Patient and Template to identify the factors or functions that are preventing the realization of objectives. The diagnosis can be qualitative or quantitative, depending on the type and quality of the information used to describe the ecosystem. Regardless, the diagnosis forms a clear statement of understanding about the present conditions of the watershed as related to the diagnostic species. Following the diagnosis, potential actions to achieve goals are identified. Candidate actions are tailored to solve problems that were identified in the diagnosis.

It is anticipated that Jones & Stokes/Mobrand will be able to quickly develop models specific to the SJRRP. They have developed an EDT model for spring-run Chinook salmon in Butte Creek, California, and the EDT framework can easily incorporate the water temperature and hydraulic models that have been developed for the SJRRP.

4.1.2 Individual Based Model

An IBM simulates how an individual fish is affected by its environment. Lang, Railsback & Associates has created multiple types of IBMs, and the IBM created for the SJRRP would likely be similar to inSTREAM and/or inSALMO described below. Compared to the EDT model, estimating population size is difficult using IBMs. IBMs do not require extended time series data, but they do require substantial programming work and fisheries expertise.

inSTREAM

inSTREAM is an IBM of trout in a stream environment that was designed as an improvement on the Instream Flow Incremental Methodology (IFIM) modeling approach. It predicts how trout populations respond to many kinds of environmental and biological changes. The simulated environment includes spatial and temporal variability in hydraulic conditions (depth, velocity, cover providing velocity shelter), temperature, turbidity, and food availability. In the model, trout adapt to changing conditions mainly by selecting which habitat to use and making a trade-off between growth rate and mortality risk. Trout feed and grow, experience various kinds of mortality, and reproduce.

inSALMO

inSalmo is an uncalibrated and unvalidated life-history model of Chinook salmon in the Sacramento River and its larger tributaries. It is individual-based and can model a large number of fish with different characteristics, and can thus theoretically capture the variability within populations. The model has four submodels, simulating migrating adults, spawning and incubation, juvenile rearing and migration, and ocean growth and survival. Each submodel can be initialized with a starting population of fish and run separately, or submodels can be linked. Ultimately, all four submodels could be linked and run together to produce an estimate of Chinook production over a series of years.

The model has a fairly steep learning curve. Its interface is not in familiar Windows format, and installing the program requires learning some simple Unix commands. Model input includes about 20 files with data on daily hydrology and water temperature for the period modeled, geographical descriptions of the river and tributaries, and over 100 parameters used in algorithms describing various life-history events and influences. These factors include spawning, incubation, growth, movement, predation, response to temperature, effects of diversions and barriers, food availability, and smoltification. There are separate parameter files for four races of

Sacramento River Chinook – fall-, late fall-, winter-, and spring-run, and the model is designed to work with any combination of these runs present.

4.2 Recommendations on Model Implementation Strategy

The FMWG recommends acquiring the services of Jones & Stokes/Mobrand, and working closely with Jones & Stokes/Mobrand to upgrade the model for application to the San Joaquin River and to fulfill the specific needs of the SJRRP. The FMWG also recommends that an IBM, created and maintained by Lang, Railsback & Associates, be used initially in conjunction with the EDT, and then at a later time incorporated into EDT. The EDT model would be used to provide a population level analysis, whereas the IBM would be applied at the scale of specific reaches and/or life stages. Neither the EDT nor the IBM precludes or requires the use of the other model for the FMWG to assess the potential success of the SJRRP. The IBM could be completed after the EDT is formatted for the SJRRP, and, thus would not have to meet the April 2008 deadline. To avoid schedule impact, the FMWG recommends Reclamation acquire the services of the Jones & Stokes/Mobrand EDT modeling team as soon as possible, and pursue contracting Lang, Railsback & Associates afterwards to begin preparing an IBM specific for the SJRRP. Note that during discussions between the FMWG and Steve Railsback, he recommended the assistance of Stillwater Sciences in future IBM development due to limited staff and resources.

The role of Jones & Stokes/Mobrand and Lang, Railsback & Associates would be restricted to model creation and maintenance, but not to the actual assessment of the project, which is the responsibility of the FMWG.

The development of the EDT and IBM models will require frequent communication with model authors, the FMWG, and the WMWG to ensure proper applications of data and operational information. Therefore, the FMWG recommends establishing a dedicated fisheries expert and a dedicated modeler to assist with FMWG and WMWG communication. These positions would assist in future modeling runs and adjustments, as necessary.

In addition, an independent advisory panel (separate from members of the Technical Advisory Committee) is needed in the future to help apply the models to the SJRRP and to increase the defensibility of the models. The FMWG recommends that three to five experts with expertise in quantitative fisheries modeling and/or the fish habitat in the SJRRP area be engaged for peer review, as needed.

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Quantitative Fisheries Model Selection Recommendation Process

Appendix A

SAN JOAQUIN RIVER
RESTORATION PROGRAM

June 2, 2008

Table A-1. Preliminary Criteria Used to Select a Quantitative Fisheries Model for the SJRRP

Preliminary Screening Criteria	Evaluation Factor	Level of Potential Applicability by Model								Comments[1]
		Bayesian Framework	Ecosystem Diagnosis and Treatment (EDT)	Individual Based Model (IBM)	Interactive Object-oriented Salmonid Simulation	Oak Ridge Chinook Model	Salmod	Salmon Survival Model	San Joaquin River Model	
		Lindley	Jones & Stokes/ Mobrand	Lang, Railsback & Assoc.	Cramer Fish Sciences	Jager	USGS	Newman and Rice	Stillwater Sciences	
Biological interpretations	All fish life stages and habitat needs included	High	High	High	High	High	High	Low	High	The Salmon Survival Model is limited to juvenile survival.
Biological flexibility	Model existing and restored habitat conditions	Medium	High	High	Medium	Medium	Low	Medium	Medium	Both EDT and IBM are adept at modeling existing and restored habitat conditions with little modification.
Schedule compatibility	Level of development/ completeness: to be consistent with SJRRP schedule, the model needs to be functional by April 1, 2008	Medium	High	Medium	High	Low	Low	Low	High	Development of the Bayesian Framework, IBM, Oak Ridge Chinook Model, Salmod, and Salmon Survival Model is highly unlikely to occur before April 1, 2008; however, the IBM is not a population model and it would be feasible to delay its completion.
Prior application(s) to the San Joaquin River before and/or after the Settlement	Model previously applied to studies leading to the Settlement; prior experiences could be beneficial in meeting SJRRP schedule	Medium	Medium	Medium	Medium	Medium	Medium	High	High	The San Joaquin River Model has been used in developing studies for the Settlement discussion. The Salmon Survival Model incorporates the San Joaquin River. Past experience may suggest efficiency for model development and application.

Note:

[1] Comments are based on the review of available literature, and feedback from peer biologists/users in academia and government agencies.

Key:

EDT = Ecosystem Diagnostic Treatment

IBM = Individual Based Model

SJRRP = San Joaquin River Restoration Model

USGS = U.S. Geological Survey

High indicates the model is mostly satisfactory for identified criterion and, thus, intended use and desired efficiency.

Medium indicates the model has some notable deficiency for identified criterion; the deficiency is conditionally acceptable for intended use and/or desired efficiency with considerations for balancing with other criteria; some supplemental tools and operations may be required.

Low indicates the model is limited for identified criterion; likely being less efficient or requiring longer development time; or requiring other utilities, tools, or modules within the same software package to support the intended use.

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Table A-2. Key Criteria Used on a Winnowed Group to Select a Quantitative Fisheries Model for the SJRRP

Key Criteria	Evaluation Factor	Level of Potential Applicability				Comments[1]
		Ecosystem Diagnosis and Treatment (EDT)	Individual Based Model (IBM)	Interactive Object-oriented Salmonid Simulation	San Joaquin River Model	
		Jones & Stokes/ Mobrand	Lang, Railsback & Associates	Cramer Fish Sciences	Stillwater Sciences	
Adequately addresses ecological processes	Ability to incorporate biological interactions between species/runs	High	High	Medium	Medium	The Interactive Salmonid Simulation and the San Joaquin River Model would require more modification than the other models to be able to incorporate biological interactions.
Ability to incorporate other habitat data	Ability to incorporate specific information on the San Joaquin River, including subsequent changes/modifications	High	High	High	High	
Capable of large-scale application	Ability to evaluate the San Joaquin River from Friant Dam all the way downstream to the confluence with the Merced River	High	Low	High	High	All models are scalable. The IBM is too detailed to cover the entire Restoration Area and still maintain model efficiency and meet schedule demands.
Adequate model resolution to cover detailed site-specific and/or life-stage-specific information (restoration site level)	Ability to evaluate restoration activities at the restoration site level	Medium	High	Low	Low	Interactive Object-oriented Salmonid Simulation and the San Joaquin River Model are population models and cannot provide the necessary level of detail that an IBM can. Although EDT is a large-scale model, it can be scaled with relatively little modification.
Collaboration	Availability of model development team to SJRRP team for collaboration, consultation, and discussion	High	High	High	High	
	Willingness to accept the directives developed by the FMWG in terms of improvements on specifications of fish-habitat relationships and other processes	High	High	High	High	
Accepted in user community	Model has been peer-reviewed and accepted by user community	High	High	Medium	Medium	The Interactive Object-oriented Salmonid Simulation and the San Joaquin River Model have received limited peer review.
Adequate model supporting system	Ability to provide sufficient staff for meeting schedule requirements	High	Medium	High	Medium	Lang, Railsback & Associates and Stillwater Sciences have less staff available to meet the schedule demands than Jones & Stokes/Mobrand and Cramer Fish Sciences.
	Model support team includes modeling specialists as well as fishery biologists	High	High	High	High	

Note:
[1] Comments are based on the review of available literature, and feedback from peer biologists/users in academia and government agencies.
Key:
FMWG = Fisheries Management Work Group
N/A = not applicable
SJRRP = San Joaquin River Restoration Program
High indicates the model is mostly satisfactory for identified criterion and, thus, intended use and desired efficiency.
Medium indicates the model has some notable deficiency for identified criterion; the deficiency is conditionally acceptable for intended use and/or desired efficiency with considerations for balancing with other criteria; some supplemental tools and operations may be required.
Low indicates the model is limited for identified criterion; likely being less efficient or requiring longer development time; or requiring other utilities, tools, or modules within the same software package to support the intended use.

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Quantitative Fisheries Model Selection Recommendation Process

Appendix B

SAN JOAQUIN RIVER
RESTORATION PROGRAM

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Appendix B. Questions for Candidate Quantitative Population Modelers

San Joaquin River Restoration Program
Fisheries Management Workgroup
Questions for Candidate Quantitative Population Modelers
December 3, 2007

1. Would you develop a model that the agency biologists could use on their computers to input data (e.g., flow and climate) and obtain results? If so, please describe the user interface and indicate whether a users-manual would be provided.

2. Would you develop a model that agency modelers (e.g., Dave Mooney, Reclamation) could fully modify, including types of model input and all fish-habitat relationships? If yes, would a users-manual need to be developed?

3. Would your model easily be able to conduct a sensitivity analysis of the fish-habitat relationships by allowing the user to change the relationship parameters for a series of runs? If so, please describe the user interface.

4. How would a user demonstrate the fish-habitat relationships and input variables in your model? Model transparency is a requirement for this project. The ability to easily query the model to graphically show fish-habitat relationships and/or generate tables of input data and parameter information would be desirable.

5. How will model uncertainties be described?

6. Would you make the source code available to help ensure transparency?

7. Would your model estimate the abundance of juvenile and/or adult salmon? Are there other types of model output that you would recommend?

8. How would you model limiting factors for which there are no empirical data?

9. Would you be willing to include fish-habitat relationships that are based solely on the professional judgment of the Fisheries Management Workgroup? Are you willing to collaborate frequently with the Fisheries Management Workgroup to incorporate these relationships?

10. Are there any limiting factors in the Fisheries Management Workgroup's conceptual model that you would not be able to model?

11. Would your model be able to include biological interactions, such as competition between fall-run and spring-run Chinook salmon for spawning and rearing habitat?

12. Would your model be able to provide output on the cumulative impacts of the limiting factors (fish abundance or mortality rate) by reach?

13. If requested by the Agency Team, would you be willing to use all data on fall-run Chinook salmon population trends in the San Joaquin tributaries and spring-run Chinook salmon population trends in the Sacramento Basin provided by the Fisheries Management Workgroup to model habitat relationships in the San Joaquin Program Area?

14. Would your model be able to directly incorporate the results of HEC-2 or HEC-RAS hydraulic models and HEC-5Q water temperature models for the San Joaquin River Program Area? Would it be possible to incorporate other habitat models, such as the IFIM?

15. How many experienced biometricians and fisheries experts would you dedicate to model development through next spring? Would they be available to attend meetings and work with the agency team in the Sacramento area? Please provide a one-paragraph bio on each.

16. What would be the earliest date that you would anticipate that your model would be able to generate "reasonable" estimates of spring-run and fall-run Chinook salmon abundance relative to expected habitat conditions (e.g., Settlement flows and habitat improvements) in the San Joaquin Program Area? Assume that the agencies will provide the San Joaquin Program habitat data (e.g., HEC-2, HEC-5Q, and IFIM models) and San Joaquin tributary salmon population trend data by December 31, 2007.

17. Has your model been peer-reviewed on both the biological and mechanistic aspects of the model? If so, please provide copies of the reviews and/or contact information for the reviewers.