United States Department of the Interior

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Mr. Garwin Yip
Chief
Water Operations and Delta Consultations Branch
Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

Dear Mr. Yip:

This draft Gravel Augmentation Plan is in partial fulfillment of the Bureau of Reclamation's responsibilities to minimize effects of water operations on the Stanislaus River through improving spawning habitat for steelhead trout (*Oncorhynchus mykiss*) as described in Action III.2.1 of the Reasonable and Prudent Alternative that accompanied the National Marine Fisheries Service 2009 Biological Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. Here we outline projects that aim to achieve the placement of 50,000 cubic yards of gravel on the Stanislaus River by 2014. This draft Gravel Augmentation Plan includes project descriptions, implementation schedules, and monitoring efforts to improve spawning habitat.

If you have any technical questions about this plan, please contact Dr. Rachel Barnett-Johnson at 916-978-5216. Other questions pertaining to the implementation of this element of the reasonable and prudent alternative should be directed to me at 916-978-5025.

Sincerely,

Dr. Michael A. Chotkowski
Regional Environmental Officer

Enclosure

STANISLAUS RIVER GRAVEL AUGMENTATION PLAN, 2010
NMFS Biological Opinion 2009, RPA Action III.2.1

Purpose:

This plan is prepared in partial fulfillment of US Bureau of Reclamation's (USBR) responsibilities to minimize effects of water operations on the Stanislaus River through improving spawning habitat for steelhead trout (*Oncorhynchus mykiss*) per Action III.2.1 of the NMFS Biological Opinion (2009). Here, Reclamation outlines projects that aim to achieve the placement of 50,000 cubic yards of gravel on the Stanislaus River by 2014. This plan includes project descriptions, implementation schedules, and monitoring efforts to improve spawning habitat. Specifically, our gravel augmentation goals are to:

1. Increase the availability, quality, and quantity of spawning gravel for Stanislaus River Chinook salmon and steelhead trout
2. Restore, maintain, or enhance natural system process whenever possible
3. Provide information to adaptively manage our future gravel augmentation projects

Background:

The construction of Central Valley Project (CVP) dams has had dramatic effects on the rivers in which they are located. One of the main effects is the prevention of rocks, gravel, dirt, and other substrates from passing through them. Without the dams, these materials would move into the river providing habitat needed for successful spawning and juvenile rearing of salmonids. There is currently a Central Valley gravel augmentation program designed to meet the goals of the Central Valley Project Improvement Act Section 3406(b)(13), which represents a continuous effort to restore spawning and rearing habitat in the Upper Sacramento River from Keswick Dam to Red Bluff Diversion Dam, in the American River downstream of Nimbus Dam, and on the Stanislaus River downstream of Goodwin Dam.

The average annual gravel deficits on CVP streams are based on quantitative calculations which estimate the amount of gravel that the dams retain: Sacramento River (50,000 cubic yards); Stanislaus River (20,000 cubic yards); American River (57,000 cubic yards) (see Central Valley Project Improvement Act- Fiscal Year 2009 Annual Report). The program focuses on sites that are thought to have the most benefit to increase the quality and quantity of spawning and rearing habitats. To date (1997-2009), the (b)(13) program has placed 145,000 cubic yards among all three rivers. Additional gravel augmentation projects have been funded and implemented on the Stanislaus River by AFRP, CALFED, CDFG, and CDWR Four Pumps.

Salmon have been observed spawning on the gravel at each of the placement sites on all three rivers. Monitoring of gravel placements (using aerial photos, redd surveys, snorkel surveys, and boat surveys) has shown significant improvements to salmon habitat. Several metrics have been used to quantify and document this success (see Central Valley Project Improvement Act- Fiscal Year 2009 Annual Report).

Stanislaus River:

Historically, gravel and gold mining occurred in the active channel of the Stanislaus River between the 1930s and 1970s substantially reducing the availability of spawning habitat and potentially increasing the occurrence of redd superimposition by crowding spawners (Mesick 2001). Pebble counts and sediment size analysis of spawning areas has shown an increase in sand and fine material in spawning beds on the Stanislaus River since construction of upstream dams (Kondolf et al. 2001, Mesick 2001). Most non-enhanced riffles had sufficient fine material to impair egg incubation and survival, although females remove a significant amount of fine sediment upon construction of redds. All gravel placements throughout CVP streams now utilize the data and findings from a gravel suitability study conducted on the Stanislaus River in 2005, which determined the optimum sizes of gravel to create adequate permeability for egg survival.

Projects within the CVPIA program are now being prioritized to reduce the impacts of watershed specific factors thought to limit salmon population growth in that system. Gravel placement activities within the Stanislaus River, in the absence of the RPA, may be prioritized lower than gravel placement on other CVP rivers because of greater spawning habitat limitations in other rivers (primarily Upper Sacramento and American Rivers).

Overbank flows are critical for redistributing fine sediments out of spawning beds and onto the floodplain terrace. Since the construction of upstream dams, significant channel incision has occurred on the lower Stanislaus River further increasing the flows needed to obtain overbank flows and reduced the frequency of occurrence. Without sufficient flows for geomorphic processes to manage fine sediment deposition in spawning gravels, spawning gravels will be increasingly unsuitable for spawning. The long-term quality of spawning habitat is therefore inter-related to overbank/ floodplain processes. Therefore, when possible, USBR will pursue projects that will holistically improve habitat complexity, utilize in-river gravel, increase juvenile side-channel and floodplain habitat (Action III.2.2 of the OCAP Biological Opinion (2009)) while achieving the primary goal of this plan to improve spawning habitat for steelhead with gravel augmentation on the Stanislaus River.

Two different approaches have been used for gravel augmentations in the California Central Valley. Both approaches have their benefits and limitations depending on river-specific needs and site-specific objectives. We have selected projects that use both approaches where appropriate. The first approach focuses on designing spawning habitat that aims to achieve optimal depths and velocities for spawning Chinook salmon and steelhead during particular ranges of river flows. This approach has been employed and found to be successful for several projects on the American and Mokelumne Rivers. This approach is considered more costly due to the level of design and implementation details used to calculate and achieve a spawning Suitability Index in a spatially-explicit framework. This approach is most successful in lower elevation portions of rivers where gravel mobilization is less frequent and when the goal is to break up the river into more complex riffle/ pool habitat, and reduce predator habitat.

The second approach involves placing gravel in higher elevation portions of rivers and allowing flows to mobilize gravel that will ultimately create spawning habitat and potentially restore other features of alluvial rivers. This approach has been successfully employed on the Sacramento River, Clear Creek and other Central Valley Rivers, but can require significant flows to mobilize larger size gravel. This approach is often considered more cost effective because it does not require in-river work. However, the cost-benefit of this approach can often be more costly due to challenges for construction equipment access in higher elevation portions of rivers.

In this plan, Reclamation:

II. Identifies projects scheduled (or likely) to occur, subject to approved funding
III. Identifies other potential projects and impediments to their immediate implementation
IV. Outlines potential monitoring plans
V. Identifies some next steps necessary to bridge the gap between the current gravel outlook and the RPA requirement, including a process for updates to this plan.

II. Projects scheduled (or likely) to occur

Reclamation, USFWS, and CDFG identify four projects likely to occur that will assist in meeting the minimum gravel augmentation target of 50,000 cubic yards by 2014 on the Stanislaus River. See Figure 1 for project locations.

(1) **Honolulu Bar:** This is an ongoing project of Reclamation and USFWS's Anadromous Fish Restoration Program (AFRP). Construction is expected to occur during summer 2010. Approximately 8,000 cubic yards of screened spawning sized gravel from the site will be placed in the main channel adjacent to the bar to augment spawning riffles, and used to construct a 0.7 acre floodplain bench upstream on the south (east) side of the river. Reclamation will contribute $62,400 in (b)(13) funding (FY 2011). Remainder of funding is from AFRP [(b)(1)] and Oakdale Irrigation District. This project will likely involve a project design to optimize depths and velocities for spawning steelhead and Chinook salmon.

(2) **Goodwin Canyon @ cable crossing:** This location has received successful gravel additions in the past. This project has some existing permitting that could be renewed. Potential (b)13 funds exist to place an estimated 4,000 cubic yards in summer 2011. This project will consist of placement to optimize depths and velocities for spawning and serves as a placement location of gravel intended for mobilization and down stream placement by river flows.

(3) **Goodwin Canyon @ float tube pool:** This location has received successful gravel additions in the past through helicopter and sluice delivery systems. This project has some existing permitting that could be renewed. An estimated 2,000 cubic yards could be placed in summer 2012, although no funding has been identified. The cost per unit of gravel placed at this site is twice that of sites with front end loader access. However, spawning fish density (Chinook salmon and *O. mykiss*) is high and water is coolest at this upper most spawning habitat in the river. This project will consist of gravel placement to optimize depths and velocities for spawning.

(4) **Lover's Leap:** One mile of riparian floodplain habitat is available for restoration. There is potentially enough gravel to meet the entire OCAP BO requirement in perched floodplain on this site. AFPR is planning to start a cooperative agreement with the landowners this fiscal year (2010) to begin planning, outreach, design, and permitting. The Natural Resources Conservation Service (NRCS) is interested in funding the project implementation. Given the scale of the project, and the likelihood of the gravel needing to be moved off the project site, it is likely that a Surface Mining and Reclamation Act (SMARA) permit will be required. At the earliest, this restoration project would occur in 2012, but may not occur until 2013 given constraints in funding and necessary permits. Gravel from this project has the potential to be stockpiled for

future gravel work on the river to meet placement of 8,000 cubic yards subsequent to 2014 per Action III.2.1 of the OCAP BO. This project will likely involve a project design to optimize depths and velocities for spawning steelhead and Chinook salmon and will serve to create habitat heterogeneity.

III. Potential projects and impediments to their progress

(1) **Knights Ferry upstream of covered bridge and rapids:** This location is easily accessed and thus cost effective in delivering gravel. Gravel has been placed by Reclamation to create three riffles in the past below the covered bridge. Permits exist to add a significant amount of gravel just below this site and could likely be utilized to simplify permitting upstream. While further plans to conduct gravel augmentation below the bridge has been meet with opposition by the town of Knights Ferry, no known objections exist for proposed plans upstream of the bridge. The site is at the break between a bedrock controlled channel with deep pools and the downstream alluvial stream reach. Gravel would be stockpiled in the channel here with the intent that high flows would mobilize it to the downstream alluvial reach to create and maintain spawning habitat there. Access would be over Federal (Corps of Engineers) land and would need to be improved over uneven bedrock terrain. Since the town has not been supportive of new projects occurring downstream of the covered bridge and some of the gravel may be mobilized to that location, initiation of this upstream project would necessitate a dialog with the town regarding the project objectives and benefits. An estimated 8,000 cubic yards could be placed in summer 2013, although no funding has been identified. Reclamation will work with the local community and stakeholders to gain support for this project.

(2) Two Mile Bar: This project could provide floodplain, side channel and a significant amount of screened spawning sized gravel for placement in the main channel. This land is privately owned and is moderately accessible. Topographic surveys of the site have been completed. The CVPIA program attempted, but could not purchase the property. Trust for Public Land partnered on this project to broker the acquisition. Several options for ownership were discussed, including the Corps and CDFG, and the transaction would have included implementation of the restoration plan for the site. However, the property was never purchased because the owner wanted to be paid with inclusion of aggregate mineral rights (including gold) that could potentially be mixed with gravel and sand. Realty personnel could not justify payment of an asset that was of no interest to the intent for the purchase and of an unproven quantity. Reclamation will contact the landowner to determine whether a conservation easement could be granted or if a project could be conducted overtime- excavate floodplain and process gravel on an annual basis as funding allows.

(3) Horseshoe Recreation Area: This land is owned by the US Army Corps and is accessible. CDWR Four Pumps has previously augmented spawning riffles in the upstream part of this reach. CDWR and CDFG have strong interests in this project for the near future. This project would provide top dressing to the riffles and could provide additional spawning and rearing habitat further downstream within this ¾ mile river reach. One benefit to the project is that it would provide clean-coarse gravel providing good habitat for macro-invertebrate production lower down in the river than most of the other projects. It would also assist in breaking up the river into more complex riffle/ pool habitat, reducing predator habitat and improving juvenile rearing habitat by increasing water surface elevation resulting in more frequent inundation of vegetated areas.

(4) Valley Oak Recreation Area: This land is owned by the Corps of Engineers and is accessible. Spawning riffles were previously created in the upstream part of this reach. They have degraded and could benefit from additional gravel placement to maintain spawning habitat. This is not a high density spawning area but some spawning does occur each year. It may not be the most desirable area for steelhead to spawn because it is lower in the river where over-summer rearing temperatures can approach 65 F.

Figure 1. Map of Stanislaus River with locations of proposed gravel augmentation projects

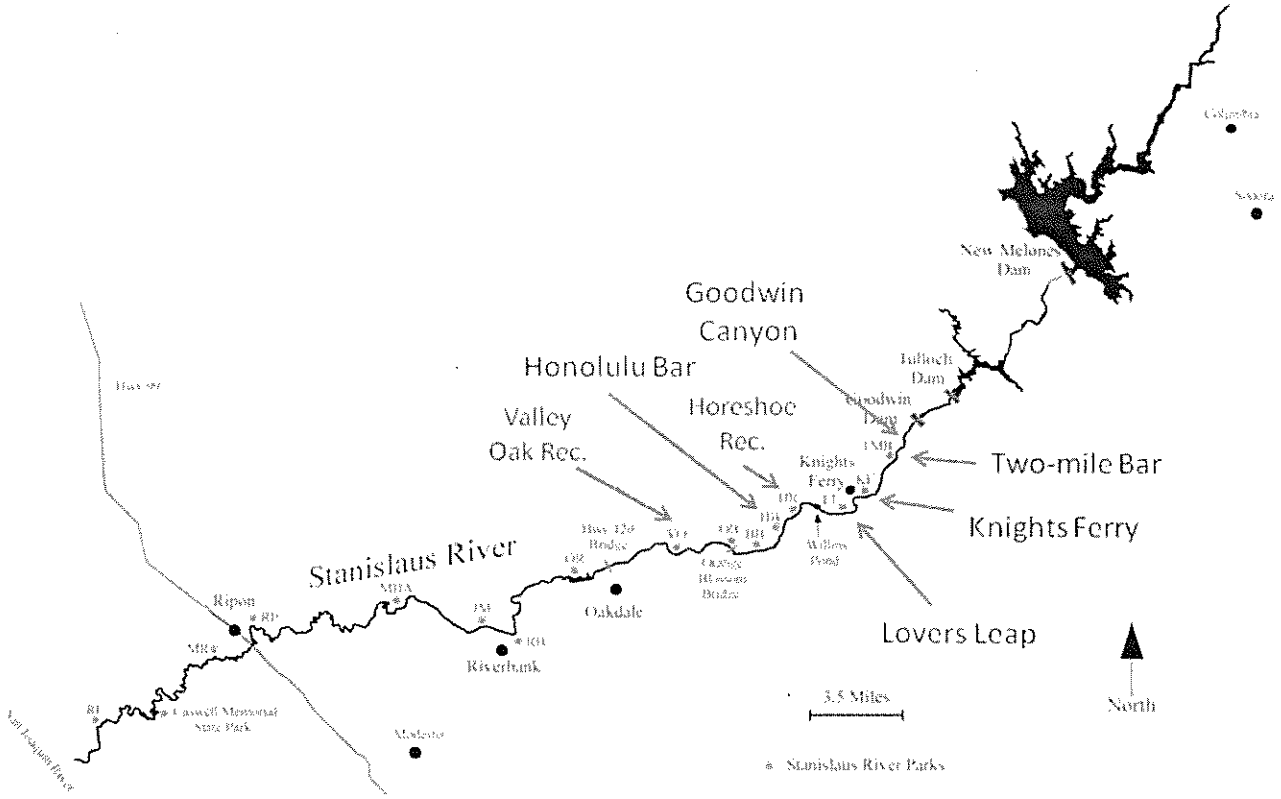

Table 1(a): Proposed project summaries

Project	Permits status	Anticipated gravel[a]	Access	Project cost	Funding status	Timeline summer	Action (NMFS BO)
Honolulu Bar	Permitted	8,000	Accessible	$65,000 in FY11	Funded AFRP and (b)(13)	2011	Action III.2.1 & Action III.2.2
Goodwin Canyon @ cable crossing	Renewal potential	4,000	Steep access	$170,000	Funded (b)(13)	2011/ 2012	Action III.2.1
Goodwin Canyon @ float tube pool	Renewal potential	2,000	Gravel pump from road	$250,000	Not identified	2012	Action III.2.1
Lover's Leap	Initiated/ potential Surface Mining & Reclamation Act	80,000[b] 8,000	Accessible	$1,000,000	Initial permit process funded	2013	Action III.2.1 & Action III.2.2

Table 1(b): Potential project summaries

Project	Permit	Anticipated gravel[a]	Access	Project cost	Landowner	Impediment	Action
Knights Ferry (upstream of covered bridge)	Permits exist for adjacent reach	8,000	Accessible with work	$400,000	Corps of Engineers	Lack of community support for projects proposed below the covered bridge and access improvement	Action III.2.1
Two Mile Bar	Not permitted	>20,000[b] 6,000	Accessible	$1,000,000	Private	Cost of mineral rights, access over private land	Action III.2.1
Horeshoe Recreation Area	Not permitted	6,000	Accessible	$280,000	US Army Corps	Moderately accessible	Action III.2.1
Vally Oak Recreation Area	Not permitted	3,000	Accessible	$150,000	US Army Corps	Downstream area receives less spawning use	Action III.2.1
Goodwin Canyon @RM~57	Renewal potential	5,000	Steep access	$350,000		Steep access	Action III.2.1

Notes: cost estimates include permitting but not monitoring. [a]cubic yards; [b]estimated amount available on perched floodplain. All elements contingent on availability of funds.

III. Monitoring plan(s)

Monitoring is an important component of our management action(s) and will be driven by specific questions that will align with restoration, program and site-specific goals. Monitoring will allow us to understand the effectiveness of the projects, make long term planning decisions, and adjust techniques to improve future project implementation (adaptive management). A combination of focused, long and short term monitoring with applied research will be used to improve restoration implementation and ultimately improve restoration success. Most of the current and historic monitoring efforts of spawning on the Stanislaus River have focused on fall-run Chinook salmon, due to their abundance and importance to the fisheries. There is currently a paucity of data for steelhead spawning on the Stanislaus River. To the extent possible, our monitoring efforts aim to provide insights into spawning habitat improvements for the *O. mykiss* population on the Stanislaus River.

Table 2 below describes several potential monitoring efforts associated with gravel augmentation actions. The monitoring efforts in Table 2 are ranked by importance in relation to directly monitoring our overall program goals. The monitoring efforts deemed of greatest importance are proposed to occur at all projects (e.g., **Base monitoring plan**) and are described in greater detail below. The additional monitoring efforts outlined in Table 2 are intended to occur opportunistically as site-specific objectives develop and as funding permits (e.g., **Opportunity monitoring plan**(s)).

Table 2. Potential monitoring efforts and priority to project(s)

	Monitoring and Science Tasks	Purpose PE	LTP	AM	Import	Freq	Durat'n	Cost/Effort
Physical	Topographic surveys at project site- depth, velocities	x			H	M	1 yr	M
	Substrate size and condition- pebble counts, sieves	x			H	H	1 yr	L
	Gravel mobility surveys- scour chain	x	x		H	M	>5yrs	L
	Intragravel conditions and water quality- measure DO, temp, gravel permeability	x	x	x	M	H	1 yr	M
	Gravel fate- rock mark and recapture	x	x	x	M	H	>5yrs	M
Biological	Spawning suveys- redds and carcass counts	x	x	x	H	H	1-3 yrs	H
	Fish community use- snorkel, seine, trap		x		M	M	1-3 yrs	M
	Juvenile rearing surveys- snorkel	x	x	x	M	H	1-3 yrs	M
	Macro-invertebrate surveys- Suber stream bottom sampler	x			M	M	1-3 yrs	H
	Survivorship and growth rates of eggs and fry relative to intragravel conditions and substrate size	x	x	x	M	L	1 yr	M
	Survivorship, growth rate, and condition of emerging fry	x	x	x	M	L	1-5 yrs	H

Base Monitoring Plan:

The Base Monitoring Plan aims to determine program efficacy at meeting our three main project goals. In order to monitory whether the project meets our first objective- Increase the **availability, quality, and quantity** of spawning gravel for Stanislaus River Chinook salmon and steelhead trout, we will test the following hypothesis:

H_1: Habitat metrics in the placed gravel conform to design criteria for appropriate spawning conditions thereby increasing spawning habitat availability, quality and quantity.

- Do water velocities and depths fall within ranges appropriate for spawning?
  - Conduct topographic survey to determine depths within placed gravel and measure velocities

- Do water velocities and depths fall within appropriate ranges for *O. mykiss* and Chinook salmon?
  - Compare empirical topographic measurements with 'Habitat Suitability Indices' for velocities and depths previously developed for *O. mykiss* and Chinook salmon

- Does substrate size and condition conform to design criteria?
  - Quantify the size distribution of substrate used for gravel augmentation
  - Compare empirical sizes for project with optimal gravel sizes previously developed for *O. mykiss* and Chinook salmon

We aim to achieve our second objective to- **Restore, maintain, or enhance natural system process**, by prioritizing projects likely to provide these functions. For example, Honolulu Bar and Lover's Leap are restoration projects intended to create functioning floodplain habitat as well as spawning habitat. In doing so, we hope to enhance natural system process for both juvenile and adult life stages. In addition, we will test whether our spawning habitat augmentation projects (where we directly create spawning habitat) result in fish use with the following hypothesis:

H_2: Gravel augmentation increases spawning utilization at the enhanced site

- Does the addition of gravel recover productive habitat for spawning?
  - Measure utilization rates of spawning Chinook salmon and if possible *O. mykiss* at the enhanced sites through redd counts
  - Compare redd number and density from the enhanced site to redd number and density in nearby unrestored habitat areas

In order to **adaptively manage** our gravel augmentation projects (third objective), we need information on the movement of gravel out of our restoration area. Quantifying a gravel budget for different projects will allow us to determine how much gravel needs to be replenished on an annual basis to maintain longer-term benefits from specific projects. For projects planned within Goodwin Canyon this will be particularly important, as the intent is for some of this gravel is to become mobilized downstream by river flows. The extent to which gravel is or is not mobilized, will inform the frequency and amount of gravel placed in Goodwin Canyon for future projects. To determine a gravel budget, we will test the following hypothesis:

H_3: Design flows are sufficient to mobilize gravel placed according to design criteria and configurations.

- What volume of placed gravel is mobilized?
  - Measure volumetric changes to help determine gravel replacement, maintenance needs, and evaluate future placements. Several long metal chains will be embedded in various locations within the placed gravel with only a small portion exposed at the top. As gravel becomes mobilized, more of the chain is exposed and can be used to quantify the volume of gravel loss over time.

Opportunity Monitoring Plan(s):

Some of the projects lend themselves to developing additional objectives (Table 2) that are site-specific and may occur as interest and funding permits. For example, an objective for gravel projects conducted in close proximity to enhanced juvenile floodplain habitats may be to determine whether floodplain inundation reduces fine sediments in spawning gravel. Monitoring for addressing this objective may be to quantify gravel permeability or intragravel habitat conditions. The following hypotheses and monitoring efforts follow from Table 2.

H_4: Intragravel habitat conditions in the placed gravel and water quality conform to design criteria for appropriate temperatures, dissolved oxygen (DO) levels, and permeability for egg incubation and early development.

- Do temperatures, DO levels, and permeability fall within ranges appropriate for egg incubation and development?
  - Measure intragravel conditions and compare results to specific requirements
  - Compare intragravel conditions for projects in proximity to inundated floodplains to similar spawning locations in isolation of functioning floodplains.

H_5: Gravel stock-piled in high elevation locations (Goodwin Canyon) intended for river-flow placement is mobilized.

- At what rates are different sized rocks mobilized and what are their fates?
  - Uniquely mark rocks (tracer rocks or radio-tagged) of different sizes. Recapture rocks and quantify distance moved over time.
  - Characterize associated features of their recapture location- scour hole, spawning riffle, point bar.
  - Correlate distances with river flows during time intervals of mobilization study.

H_6: Gravel placement (and or floodplain creation) contributes to use by native fishes

- What native and non-native fishes are present in association with the project?
  - Conduct fish surveys (snorkel, seining, traps, hook and line) before project
  - Compare fish density, and diversity of natives and non-natives in restoration area after project and to control sites

H_7: Gravel placement (and or floodplain creation) contributes to juvenile rearing

- Does the addition of gravel and/or floodplain recover juvenile rearing habitat?
  - Measure utilization rates of juvenile Chinook salmon and if possible *O. mykiss* at the enhanced sites through snorkel surveys
  - Compare juvenile number and density from the enhanced site to numbers and density in nearby unrestored habitat areas

H_8: Gravel placement (and or floodplain creation) contributes to greater macro-invertebrate production

- Does the addition of gravel and/or floodplain increase macro-invertebrate numbers, density and/or diversity?
  - Quantify the number, density and diversity of macro-invertebrates at the enhanced sites with a Surber stream bottom sampler.
  - Compare species composition to preferred diets of juvenile Chinook salmon and *O. mykiss*.
  - Compare salmon-preferred macro-invertebrate abundance and density at enhanced site to similar but non-enhanced sites.

H_9: Survivorship and growth of eggs and fry correspond to intra gravel conditions and substrate size

- Does gravel condition and substrate size affect egg and fry survivorship?
  - Conduct field experiments with different gravel size and intragravel conditions and count the percent of eggs that survive to fry
  - Measure the size and survivorship of fry as a function of the experimental conditions

H_{10}: Survivorship, growth rate, and condition of emerging fry are greater in enhanced site

- Does the enhanced site produce greater numbers of healthy fry?
  - Place localized rotary screw traps in enhanced and un-enhanced locations and measure abundance, size, and condition (weight and length) of fry
  - Compare survivorship, growth rate, and condition between locations and with rates identified in the literature

IV. Gravel outlook and plan update

The current gravel outlook is promising for meeting RPA requirements in a timely manner. The sum total of the estimated amount of gravel for the proposed projects meets the RPA's 50,000 cubic yards criteria. Specifically, funding and permits for two projects to place 12,000 cubic yards of gravel have been identified to take place by 2012. Two projects in particular (Lover's Leap and Two-mile bar) have enough gravel that could be processed on-site to meet the entire RPA gravel requirement. A significant amount of spawning gravel from Lover's Leap can be placed in-river, but also has the potential to be source material for placement at other locations (e.g., Goodwin Canyon, Horseshoe Recreational Area, pending Surface Mining and Reclamation Act and site-specific permits). Reclamation will make considerable efforts to identify funds, initiate permitting for potential projects and work towards reducing the impediments identified for specific projects in Table 1.

An annual report will be provided to the Stanislaus Operations Group (SOG) by July of each year identifying progress-to-date on meeting RPA III.2.1 goals and provide updates to the monitoring plan. Reclamation will work with USFWS, CDFG, and NMFS to update project schedules and identify future project goals and funding. Modifications to this plan will be articulated at monthly SOG meetings as necessary where NMFS representatives can provide input on whether actions warrant written notification to NMFS.