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2 **REBUTTAL EXPERT REPORT OF PROFESSOR PETER B. MOYLE, PH.D.**
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4 This rebuttal report primarily responds to the August 2005 expert report of Dr. Charles Hanson
5 (which I shall refer to as the Hanson statement), although it secondarily deals with the August
6 2005 expert reports of Messrs. Stalnaker, Whittler, Bender, Kubitschek, Brown, and Donahue.
7

8 The Hanson statement sets up an artificially high goal for flow releases, ignores past successes in
9 restoring flows and habitat for fish, and discounts the resilience of Chinook salmon. The result is
10 that the Hanson statement paints an exaggerated picture of the difficulty of restoring the San
11 Joaquin River as habitat for salmon and other fishes. The conclusions that the Hanson statement
12 draws are based on a number of rather arbitrary assumptions, including the following:
13

- 14 1. Restoration of the San Joaquin River¹ means returning the river to pre-dam conditions.
- 15 2. Restoration of the San Joaquin River should be based solely on restoring spring-run
Chinook salmon.
- 16 3. A spawning population of 7,500 salmon is required for restoration to be successful.
- 17 4. Salmon will use only 30% of available spawning habitat.
- 18 5. Flows approximating about half of the pre-dam flows on the river are required for
restoration of spring-run Chinook salmon.
- 19 6. All potential impediments to migration of juvenile and adult salmon in the San Joaquin
River between Friant Dam and the Merced River have to be removed before the target
20 salmon population can be restored.
- 21 7. Temperatures have to be in the optimal range for all life history stages of salmon at all
times to achieve the target salmon populations.
- 22 8. Restoration of fish in good condition involves so many uncertainties and is so
23 complicated that it cannot be done without many more years of study.

24 While my August 2005 expert report (which I shall refer to as “my statement”), combined with
25 those of Drs. Deas and Kondolf, already shows that these assumptions are incorrect or not
26 justified, I will briefly respond further here.
27

28 ¹ Throughout this report, when I refer to the San Joaquin River, unless otherwise noted I am
referring to the stretch of the San Joaquin River from Friant Dam to the confluence with the
Merced River.

1 **1. THE SAN JOAQUIN RIVER DOES NOT HAVE TO BE RETURNED TO PRE-**
2 **DAM CONDITIONS TO SUPPORT A DIVERSE FISH FAUNA THAT**
3 **INCLUDES CHINOOK SALMON.**

4 The Hanson statement (and others in the defendants’ portfolio) implies that we must *restore* the
5 river to some legendary natural state for the river to again support fish in good condition. Dr.
6 Hanson starts with the premise that restoration is only possible with an allocation of about half of
7 the average annual flows (a premise I discuss further, below) and then further assumes that
8 unless conditions for salmon are optimal at all times and places, restoration of his target, self-
9 sustaining population of salmon is not possible.

10
11 In contrast, my vision of an achievable goal for the San Joaquin River is characterized by the
12 concept of *reconciliation*². Realistically, most of the water is going to be taken from the San
13 Joaquin River for human use, the channel will continue to be heavily modified, and humans will
14 be a major component of the river’s ecosystem. As I note in my own, August 2005 statement, a
15 reconciled river reflects these realities while using the best science available to find ways to
16 create a living river that supports fish in good condition.

17
18 Contrary to what Dr. Hanson and others state, we know a great deal about how to achieve these
19 goals from studies of the San Joaquin River and other rivers, and we are learning more at a rapid
20 rate. For the reasons set out in my August 2005 statement and in this rebuttal report, it is my
21 opinion that the goal of a San Joaquin River that supports fish in good condition can be
22 accomplished in a realistic manner. This is illustrated by efforts on Putah Creek, the Tuolumne
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24 _____
25 ² Reconciliation ecology is “the science of inventing, establishing, and maintaining new habitats
26 to conserve species diversity in places where people live, work, and play (Rosenzweig 2003
27 p.7)”. It explicitly recognizes that returning most land and waterscapes to something
28 approaching historic ‘natural’ conditions is not likely. Restoration ecology, on the other hand,
has as its implied goal returning areas to their natural condition, although that condition is often
hard to define. Rehabilitation ecology is sometimes used more or less synonymously with
restoration ecology.

1 River, and other streams. Using a flexible approach (adaptive management) and a long-term
2 commitment to monitoring the impacts of management actions, fish can be restored to the San
3 Joaquin River *without* the stringent flow conditions and habitat improvements that Dr. Hanson
4 claims are necessary.

5
6 **2. RESTORATION OF FISH IN GOOD CONDITION ON THE SAN JOAQUIN**
7 **RIVER SHOULD BE BASED ON MULTIPLE SPECIES, NOT JUST ON**
8 **SPRING-RUN CHINOOK SALMON**

9 The Hanson statement bases all its recommendations solely on a goal of restoring spring-run
10 Chinook salmon. This is an overly simplistic approach and provides only one criterion for
11 success.

12
13 In contrast, my approach is based on bringing back (“in good condition”) spring-run Chinook
14 salmon, fall-run Chinook salmon, and other native fishes, as well as improving the warm-water
15 fishery for non-native species. I focus on the two salmon runs because they have the most
16 stringent requirements. However, aspects of the strategy I recommend (e.g., summer flows) are
17 based on the needs of other fishes as well. The Hanson statement, for the most part, does not
18 mention other fishes at all. To the extent Dr. Hanson discusses fall-run Chinook salmon, he
19 considers them as being unworthy of consideration. According to Dr. Hanson, this is because
20 fall-run Chinook “had been reduced to a remnant run prior to the construction of Friant Dam for
21 reasons unrelated to the construction of Friant Dam” and their restoration was not possible due to
22 a lack of suitable water temperatures, potential hybridization with spring-run Chinook salmon,
23 and superimposition of their redds on those of spring-run Chinook salmon. No evidence is
24 provided for Dr. Hanson’s assertions regarding fall-run Chinook.

25
26 In my opinion, a remnant fall run is still a run and, as I indicated in my August 2005 statement, it
27 was the diversion of water from the river as the result of Friant Dam that was the final blow to
28 the fall-run’s persistence in the San Joaquin River below Friant Dam and above the Merced. It is

1 worth noting that the numbers of fall-run Chinook salmon on the Tuolumne and Merced Rivers
2 reached levels (<200 fish) similar to pre-dam, 1940s runs in the San Joaquin River, but those
3 populations have increased since then at least partly in response to restoration efforts
4 (Yoshiyama et al. 2001). Moreover, as indicated in my August 2005 statement, I do not share
5 Dr. Hanson's apparent view that fall-run cannot be restored to the San Joaquin River.

6
7 For these reasons, Dr. Hanson's consideration of only spring-run Chinook salmon is not
8 appropriate when evaluating how to bring back fish in good condition to the San Joaquin River.

9
10 **3. A SPAWNING POPULATION OF 7500 SPRING-RUN CHINOOK SALMON IS**
11 **NOT REQUIRED TO MEET THE OBJECTIVE OF FISH IN GOOD**
12 **CONDITION**

13 The Hanson statement indicates that the mean of his rough numbers of spring-run Chinook
14 salmon estimated in the San Joaquin River in 1939-50 (7500 fish, range 3000 to 30,000) is the
15 appropriate objective that must be reached, on average, for success (although he does not define
16 *why* this is the appropriate measure of success). There is no biological basis for this number as a
17 goal.

18
19 As I discussed in my earlier statement, theoretical considerations suggest that a minimum run of
20 500 returning salmon per year (i.e., fluctuating between 500 and a higher number) is a reasonable
21 place to start in re-establishing a naturally-reproducing, self-sustaining run of Chinook salmon in
22 good condition. In my own statement, therefore, I basically propose to start low and work up to
23 higher numbers as the system improves as the result of the cumulative effects of management for
24 salmon and other fish. Certainly, higher numbers are desirable to support fisheries as well as for
25 ecosystem and aesthetic considerations. However, a population of precisely 7500 fish has no
26 biological relevance to the goal of fish in good condition.

1 **4. DR. HANSON'S ASSESSMENT OF THE LIMITS OF EXISTING GRAVEL IS**
2 **INACCURATE**

3
4 Starting with an assumption that there must be enough spawning habitat to support 7500 spring-
5 run Chinook salmon, Dr. Hanson's statement calculates that there is now only sufficient gravel
6 on the San Joaquin River to support somewhere between 400 and 1500 female spawners (800-
7 3000 fish, assuming a 1:1 male:female ratio). His estimates are based on the premise that all
8 salmon would be spawning simultaneously, so that redds would be perfectly spaced and non-
9 overlapping, and that even under crowded conditions only 30% of the available space would be
10 used. This estimate is not supported by the very study upon which Dr. Hanson relies.

11
12 Dr. Hanson's statement that spawning salmon will use only 30% of available spawning habitat
13 appears to be based, not on real world observations, but on a modeling study for the upstream
14 end of a reservoir on the Columbia River with limited spawning habitat (Hanrahan et al. 2004,
15 cited by Hanson). The spawning habitat modeled in that study was very different (e.g., deeper)
16 from that in the San Joaquin River, rendering its conclusions suspect if applied directly to the
17 San Joaquin River. Even if Hanrahan's model was directly applicable, however, Dr. Hanson has
18 misapplied the model. Hanrahan et al. (2004) estimated that each redd in the area modeled
19 represents 6-10 spawning adults, presumably accounting for multiple users of the same site and
20 jack males that spawn with 'regular' salmon. Dr. Hanson, by contrast, assumes only 1 spawning
21 female per redd. If the 6-10 spawning adults-per-redd number had been used in Dr. Hanson's
22 calculations, then the number of potential spawners using existing gravel on the San Joaquin
23 River would have been calculated to range from 2,400 to 15,000 fish. Even if we assume just
24 two salmon per redd (as Dr. Hanson has done), Dr. Hanson's estimates regarding available
25 spawning habitat are sufficient for the 'starter' population that, in my opinion, is needed to have
26 fish in good condition. (Again, I emphasize that our plan features self-sustaining populations of
27 multiple species, not just spring-run Chinook salmon, so there will be multiple criteria for
28 success.)

1 **5. FLOWS APPROXIMATING PRE-DAM FLOWS ON THE SAN JOAQUIN**
2 **RIVER ARE NOT REQUIRED TO RESTORE FISH IN GOOD CONDITION**

3
4 The Hanson statement presents hydrographs that indicate that 33% of the average wet-year
5 annual flow is needed for restoration in wet years, 41% of the average normal-wet year flow is
6 need in normal-wet years, 55% of the average normal-dry year flow is needed in normal dry
7 years, and 66% of the average dry-year flow is needed in dry years, for an overall average of
8 about half the average annual flow.³ Unfortunately, Dr. Hanson does not tell us how he
9 determined these flows, nor how these flows will achieve the needs of each life history stage of
10 the salmon. This is in marked contrast to the strategy the Moyle-Kondolf-Deas team used to
11 develop a flow regime based on what the fish need. Dr. Hanson instead seems to rely on ‘rules of
12 thumb’ and general extrapolations from various methodologies. The Hanson flows therefore
13 seem to be largely based on theoretical considerations from various models, while our flow
14 recommendations are based on looking closely at what the fish need (appropriate to the stated
15 goals) in the San Joaquin River as it exists today.

16
17 To respond more specifically to the information Dr Hanson used to develop his flow regime, I
18 have divided the studies he cites into (1) rules of thumb, (2) the papers by Brian Richter and his
19 colleagues on the Range of Variability approach, (3) the Tennant Method, and (4) IFIM studies.

20
21 **Rules of thumb.** The Hanson statement “identifies” a “general approach of 60% of the annual
22 San Joaquin River flow” as “one of the preliminary estimates of flow allocation for salmonid
23 restoration” (although his own hydrographs average about 50% across year types). Just how Dr.
24 Hanson identified this 60% preliminary figure is not clear, although he does cite a number of
25 studies and other documents for what he seems to suggest are “rules of thumb” about the
26

27
28 ³ These figures are derived by dividing the total flow recommended for each year type in Dr.
Hanson’s August 2005 statement by the total average annual unimpaired flow for that year type
that Dr. Hanson identifies in his Jan. 21, 2004, declaration.

1 percentage of stream flow required for fishery purposes. Dr. Hanson does not elaborate on why
2 flows reported or recommended in these other documents, for different rivers, with potentially
3 very different objectives, can appropriately be applied to the goal of supporting fish in good
4 condition on the San Joaquin River below Friant Dam.

5
6 The various studies to which Dr. Hanson points for the proportion of natural flow that restoration
7 of a river supposedly requires have all sorts of figures that vary from 30 to 70% of the average
8 annual flow. One of the highest of these figures is Jones (2002), a two-page article in an
9 Australian newsletter for Australian streams, which suggests a “greater than two-thirds” rule for
10 a rather vague “percentage of natural flow” in order to sustain (not restore) a “healthy working
11 river.” This article does not appear to have been peer reviewed and does not discuss salmon. Its
12 use in this context is inappropriate.

13
14 Dr. Hanson also cites a Trinity River report, a river on which he states that restoration flows for
15 salmon are pegged at an average of 51%. On that river, however, the goal is quite different,
16 because the federal government has a strong obligation to maintain salmon *fisheries* for Native
17 American tribes.

18
19 Dr. Hanson next cites to a 1997 SWRCB staff recommendation for Russian River flows. Dr.
20 Hanson says that this document recommends that a bypass flow of “60% of the annual average
21 flow” be provided to support salmon and steelhead habitat. Dr. Hanson is incorrect. The 60% of
22 average annual flow in this report is recommended for small tributaries to the Russian River, for
23 spawning of coho salmon and steelhead during winter months (Dec. 15-March 31). It is designed
24 to set an upper limit on the amount of water that can be diverted during the high flow periods of
25 these tributaries. The Hanson statement indicates that the recommendation is for the Russian
26 River itself, but it is not. The flows of the main river are largely determined by releases from
27 two large reservoirs, for a variety of purposes.

1 A more realistic comparison would look at restoration flows for the Tuolumne and Merced
2 Rivers, which are less than 20% of annual flow (see Figure 8 in Kondolf statement) and currently
3 support Chinook salmon and native fishes.

4
5 The Hanson approach is also in contrast to the flow regime for the San Joaquin River
6 recommended by the Moyle-Kondolf-Deas team. We used the general pattern of the historic
7 flow regime, but not the volume, recognizing that fish can be returned in good condition to a
8 river of smaller size than the historic river. We also assume that in extremely dry years, the flow
9 regime will reflect a “share the pain” philosophy so that measures beyond water will be used to
10 keep fish populations sustained through hard times. Dr. Hanson actually recommends a
11 hydrograph that uses the *highest* percent of flows during these same dry years.

12
13 ***Range of variability.*** Dr. Hanson claims in addition to rely on the “range of variability” approach
14 described by Richter et al. The Richter approach is really best applied to (1) rivers without major
15 modifications for which modifications are planned, as a means of maintaining an existing
16 ecosystem as fully functioning, or (2) to rivers which have been mainly dammed for flood
17 control and/or power production, so most of the water is still available for flows. The San
18 Joaquin River, of course, fits neither of these categories.

19
20 The basic goal of flow regimes developed under the Richter approach is to retain a full range of
21 ecological function in the stream. This follows Poff et al. (1997, cited by Hanson) who argue
22 that maintaining a natural flow regime is most likely to protect ecosystem integrity. In other
23 words, the Richter approach seeks to ensure something more than “fish in good condition,”
24 including non-fish ecological benefits. I have understood the question at issue here is “what
25 flows are required to restore fish in good condition?” As discussed in Dr. Kondolf’s rebuttal
26 statement, strict application of *calculations* based on the Richter approach to the more limited
27 goals at issue here is not appropriate.

1 In addition, the rivers for which Richter developed his model, as reported in his papers, are rivers
2 that, although dammed for hydropower or flood control, were not dammed for large scale
3 diversions. In other words, all or most of the natural flow would be released to the river and the
4 only question was mainly the timing of releases. This condition is not true of the San Joaquin
5 River or most other rivers in California. A key difference from my way of using the
6 RAV/natural flow regime concept and the way Dr. Hanson uses it, is that I assume we are
7 starting from scratch and recreating a functioning river, while Dr. Hanson's method of analysis
8 seems to begin with hypothesizing a fully functioning river and then reducing flows without
9 reducing the full range of ecological function. By contrast I assume that the recreated river will
10 have many characteristics in common with the pre-dam river – including diverse assemblages of
11 native fishes – but will not be identical to it.

12
13 Richter's range of variability approach reflects a departure from prior approaches (such as the
14 Tennant method) that calculated a fixed percentage of stream flow without concern for inter-
15 annual or intra-annual variation. Richter thus emphasizes the ecological importance of a "range
16 of variation" in the timing, duration, frequency, and magnitude of flows. I generally agree with
17 this natural flow regime concept but apply it to the San Joaquin River differently than does Dr.
18 Hanson, whose apparent goal is to achieve pre-dam, or near-pre-dam conditions. In particular,
19 while variation in timing, duration, frequency, and magnitude of flows is important, the full
20 natural magnitude of flows is demonstrably not necessary to maintaining diverse native fish
21 populations, including salmon, in good condition.

22
23 For example, I applied the concept of natural variability to Putah Creek in developing a flow
24 regime that tracked the historic flow regime in terms of variability, with one major exception – I
25 recommended flows at much lower levels than the historic flows (except during natural spills
26 from the dam, which serve processes which require large amounts of water). Native fish,
27 including Chinook salmon, have returned to Putah Creek under this flow regime. The natural
28 variability concept also influenced the design of the flow regime I propose, in collaboration with

1 Drs. Kondolf and Deas, for the San Joaquin River but, again, I have worked to develop a
2 hydrograph that will support fish in good condition while assuming that most of the river's flow
3 will still be diverted for human use.

4
5 **Tennant Method.** Dr. Hanson also cites to the Tennant method, an early instream flow
6 methodology developed for small Montana trout streams in order to give local fisheries
7 biologists a means of recommending flows when all they had to work with was a hydrograph and
8 personal knowledge of what key fish species (trout) needed. The problems were mainly direct
9 diversions for irrigation from the streams. The "optimum" range for flows under this method
10 was estimated to start at 60% of the mean annual flow, but "good" conditions were estimated to
11 be maintained with 30% of the flow. This approach does not take into account the different
12 conditions or goals of very different rivers, let alone the specific conditions and goals of the San
13 Joaquin River.

14
15 The Tennant method is not an appropriate method for developing a flow regime for the San
16 Joaquin River. It is just too simplistic, not accommodating, for example, the need for variability
17 in flows. The San Joaquin River is far bigger than the streams for which Tennant developed his
18 method and we have more complex information available, obviating the need for such a method.
19 In short, the Tennant method just requires too many simplifying assumptions to be valid for the
20 San Joaquin River, as has been demonstrated for other rivers (Tharme 2003).

21
22 **IFIM.** Dr. Hanson also points to the Instream Flow Incremental Methodology (IFIM), a rather
23 mechanistic approach to designing instream flow regimes. The IFIM assumes that appropriate
24 flows can be developed if we know how key fish species (usually trout) at each life history stage
25 select velocities, depths, and substrates. Like the Tennant method, it has a hard time dealing
26 with complexity (e.g., multiple species) and the need for variability in flows for stream
27 processes. Because of its simplifications, the closer a stream is to a cement ditch containing
28 rainbow trout in summer, the better the IFIM models (PHABSIM) work. A serious flaw,

1 especially for big rivers, is that the methodology uses a relatively small number of transects to
2 characterize complex hydrologic phenomena (Castleberry et al. 1996; Williams 1996)⁴

3
4 Dr. Hanson states that he used regression equations from Hatfield and Bruce (2000), developed
5 though a meta-analysis of 127 IFIM studies, to produce his basic flow recommendations for
6 different life history stages of Chinook salmon. The equations of Hatfield and Bruce relate
7 mean annual discharge to ‘*optimum*’ flow. Dr. Hanson developed his ‘*optimum*’ flows using the
8 “range of base flows in the river prior to the construction of Friant Dam.” As I have already
9 pointed out, using the historic magnitude of flows is not necessary to bring back fish in good
10 condition to the San Joaquin River. Thus the Hanson optimum flows bear no relationship to the
11 flows necessary for the more limited goal relevant here.

12
13 Beyond this basic problem, other problems with the IFIM are reflected in Dr. Hanson’s
14 recommendations for minimum summer flows for holding of adult spring run Chinook salmon.
15 Using the regression equations of Hatfield and Bruce for adult *steelhead* (rather than empirical
16 data on spring run Chinook salmon from places in California where they over-summer), Dr
17 Hanson concluded that optimal summer flows for the salmon would be 884 cfs! This result does
18 not hold up in view of the actual, on the ground reality of other Central Valley streams that
19 support spring-run Chinook salmon. For example, in Butte, Deer, and Mill creeks (Sacramento
20 Valley), large numbers of spring-run Chinook hold at summer flows of 50-150 cfs. What is most
21 important for these fish to hold are large deep pools and cool temperatures, both of which are
22 present below Friant Dam at flows far below 884 cfs.

23
24 Dr. Hanson did arbitrarily modify his hydrograph at least to reflect the reduced need for high
25 summer flows in river, using a range of 385-580 cfs depending on year type. The flow

26
27
28 ⁴ Moyle and Baltz (1985) point out the difficulties of applying IFIM methodologies to California
streams with multiple fish species and age classes. Tharme (2003) provides references to the
numerous critiques of the method. See also the Kondolf rebuttal statement.

1 recommendations I developed in conjunction with Drs. Kondolf and Deas provide minimum
2 summer flows of 350 to 400 cfs, based on a variety of factors (see my statement), with much
3 lower flows during critically dry years. These flows are adequate for holding adult spring run
4 Chinook salmon.

5
6 The problems with the IFIM approach are further reflected in the calculation by Dr. Hanson of
7 three different optimum flows for three different life history stages of Chinook salmon. All three
8 of these life history stages can be present in the river simultaneously. Which flow should be
9 chosen in preference to others is not stated and Dr. Hanson provides no explanation for choosing
10 among them.

11
12 As Hatfield and Bruce (2000, p 1013) state “*Some resource managers will be tempted to use our*
13 *equations uncritically because so little information or effort is required to complete the*
14 *calculations. We stress, however, that considerable statistical and ecological uncertainty would*
15 *remain after such a calculation. ...fluvial systems are complex and many factors determine a*
16 *healthy river. Natural resources cannot be managed without acknowledging and planning for*
17 *uncertainty... To do otherwise is to risk implementing faulty management decisions.”*

18
19 ***Which flows to use?*** A major difference in the hydrographs we propose vs. those Dr Hanson
20 proposes are in the ramping up and down of flows. The Hanson flows attempt to follow the
21 mean of the historic hydrograph (for each year type) as closely as possible except in July-
22 September, resulting in extended high flows in winter, spring, and summer. Dr. Hanson assumes
23 that such flows are necessary for *every* juvenile and adult Chinook salmon to make it down and
24 up the river at a leisurely pace, without looking at what these fish actually need to be maintained
25 in good condition. (Of course, use of the mean historic hydrograph means that very significant
26 fluctuations from that mean that occur in any given year are smoothed out.)
27
28

1 The flows developed by me, Dr. Kondolf, and Dr. Deas, on the other hand, are designed to allow
2 Chinook salmon to move up and down the river fairly quickly during the normal peak times of
3 migration, urged on with pulse flows where needed. I expect that some salmon will be left
4 behind by these flows, but that most will make it through. As discussed in my statement, I am
5 relying on the flexible behavior of salmon, the fact that salmon are capable of rapid migration,
6 and their ability to adapt to altered flow regimes as they have elsewhere. Not every juvenile
7 salmon has to survive this period (and many certainly will not) for fish to be in good condition.

8
9 **6. MIGRATION OF JUVENILE AND ADULT SALMON IN THE SAN JOAQUIN**
10 **RIVER BETWEEN FRIANT DAM AND THE MERCED RIVER IS POSSIBLE**
11 **WITH MINIMAL CHANGES TO IMPEDIMENTS TO MIGRATION**

12 The Hanson statement essentially concludes that salmon cannot return without first fixing dozens
13 of problems with the San Joaquin River that might inhibit passage of migratory fish --
14 presumably at huge expense and time. Dr. Hanson summarizes factors likely to cause mortality
15 to salmon in the San Joaquin River, but of course some of these factors (e.g., predation) are
16 likely to cause mortality of salmon on *any* river. Despite these factors, salmon survive on other
17 rivers. What makes the San Joaquin River fundamentally different today is that it is dry.

18
19 Dr. Hanson's claim that all impediments to salmon migration must be fixed rests on four
20 assumptions: (1) the minimum number of spring-run Chinook needed for restoration is 7,500
21 fish, (2) optimal conditions must exist at all times for salmon to migrate up and down the river,
22 (3) cumulative mortality during migration, caused by channel problems, will make it impossible
23 for the run to persist, and (4) no fixes can take place without major changes to the river channel.

24
25 Assumption 1 is not true, as discussed above. Assumptions 2 and 3 are also not supported. We
26 know, for example, that runs of salmon persisted through the 1940s, when most of the problems
27 mentioned were already in place and some (such as poaching) were worse than they are today.
28 Those impediments that appeared subsequently (e.g., gravel pits) have been survived by salmon

1 elsewhere (e.g., Tuolumne River), as Dr. Kondolf shows in his statement. As I indicate in my
2 statement, the non-functioning fish ladder at Mendota Dam is the principal obstacle that may
3 need to be fixed for salmon to migrate successfully. That fish ladder presumably has fallen into
4 neglect because of the absence of salmon and other known migratory fish from the river.

5
6 Even in nearly pristine conditions, salmon frequently face less-than-optimal conditions and
7 significant migratory barriers, yet they survive. In my opinion, runs of salmon and populations
8 of other native fish can be re-established on the San Joaquin River mainly just by providing the
9 modest amounts water indicated in my and Dr. Kondolf's statements. As Dr. Kondolf indicates
10 in his statement, there are no impediments to migration at the present time that cannot be
11 surmounted using techniques that have been successful on other rivers. Obviously, fixes for
12 impediments in addition to the Mendota Dam fish ladder (as indicated by Dr. Kondolf and Dr.
13 Hanson) would presumably improve fish survival during migration, but such fixes are not
14 essential for fish recovery.

15
16 Dr. Hanson and Mr. Donahue, in their reports, also rather uncritically accept the idea that all
17 diversions must be screened. This assumption gives Mr. Donahue license to sketch out a
18 Cadillac version of a screening program, piling up expenses. I am responding to this particular
19 part of their statements because I have recently evaluated existing information on the value to
20 fish populations of screening diversions in the Central Valley (Moyle and Israel 2005) and
21 currently serve on the Interagency Fish Screen Committee (a committee on which I am the only
22 non-agency member). My research has found that (1) most diversions, mainly small ones, are
23 not screened in the Central Valley, (2) it is likely that most small diversions do not need to be
24 screened to protect salmon (or other fish) populations, and (3) diversions with the most impact
25 are those that take a substantial percentage of the flow of the stream they are on. Diversion
26 timing, of course, is highly seasonal and does not have much impact on salmon at times of year
27 when salmon are not present. Diversions also have less impact when flows are high.

1 The only diversions for which some kind of device for reducing entrainment may be needed are
2 the Arroyo Canal behind Sack Dam and the diversion canals above Mendota Dam. The Arroyo
3 Canal has the potential to take large portions of the flow when juvenile salmon are migrating
4 downstream so probably should be screened, at least seasonally. As discussed in Dr. Kondolf's
5 rebuttal statement the potential problem with losing juvenile salmon in the Mendota diversions
6 could be dealt with in ways other than conventional fish screening, such as building a by-pass
7 around the dam for fish or using innovative new technology such as permeable curtain barriers.
8 It is worth noting, however, that both runs of salmon did manage to persist in the river when the
9 Arroyo Canal and Mendota diversions were operating in the past.

10
11 In contrast, the Donahue report lists about 150 potential diversions, most with a *maximum*
12 diversion potential of less than 5 cfs and suggests indirectly that they all need to be screened.
13 However, the report does not present enough information (e.g., location, season of operation,
14 whether they are functional, how much water each actually diverts in relation to flow, and other
15 factors which make a difference to fish populations) to support a conclusion that these smaller
16 diversions are a problem at all. The same basic questions apply to the larger facilities that the
17 Donahue report says need to be screened; no evaluation is provided as to *why* each one needs to
18 be screened aside from the fact they will divert water and therefore, presumably some fish. For
19 example, Donahue and Hansen insist that openings into flood by-pass channels must be
20 screened, providing no justification. Yet studies of my former graduate student Ted Sommer on
21 the Yolo By-pass indicate that it may actually be good for fish to be in properly managed bypass
22 channels (see statement of August 2005).

23
24 It is important to keep in mind that fish, and salmon in particular, are not particles drifting
25 helplessly downstream but are capable of actively avoiding unfavorable situations. Indeed, when
26 Dr. Hanson himself conducted a study of a 290 cfs diversion on the Sacramento River (much
27 larger than the diversions listed by Mr. Donahue), Dr. Hanson found that only 0.05 to 0.08% of
28 hatchery Chinook salmon released above the diversion were actually captured by it (Hanson
2001).

1 My experience on other rivers suggests that once salmon runs become re-established on the San
2 Joaquin River, there will be a strong motivation by agencies and local people to improve
3 conditions for fish survival. Such improvements can often reduce water costs even further, by
4 reducing water costs for fish survival. For example, if necessary, gravel for spawning could be
5 added to the stream from local sources on a gradual basis, with more added as fish numbers
6 improve. There will be costs involved in improving the system, but, as Dr. Kondolf indicates in
7 his statement, they are likely to be incurred over a long span of time and minimized by careful
8 evaluation of alternatives.

9
10 **7. DR. HANSON OVER-SIMPLIFIES THE TEMPERATURE REQUIREMENTS**
11 **FOR CHINOOK SALMON**

12 The temperatures that the Hanson statement says the water of the San Joaquin River “should not
13 exceed” are all in the optimal range for various life history stages of Chinook salmon (see Table
14 1 in my statement). Optimal temperatures are typically defined under laboratory conditions as
15 those in which physiological processes operate at the least energetic cost, so growth and survival
16 are both high and predictable. The reality of wild Chinook salmon in the Central Valley is that
17 they often experience temperatures higher than “optimal” yet still have high growth and survival.
18 For example, Dr. Hanson indicates that for juvenile Chinook rearing “the seven day average of
19 daily maximum temperatures should not exceed 16°C (61° F)” while I put optimal conditions for
20 rearing in the range of 13-20° C (55-68°F), temperatures which are based on an exhaustive
21 USEPA report (McCullough 1999). It would not at all be unusual to find juvenile Chinook
22 salmon growing rapidly at daytime maxima of 20°C (68°F), with temperatures at night dropping
23 to 15-16°C (60-61°F). I also point out that juvenile Chinook can survive exposure to
24 temperatures of 24° C (75°F), depending on their thermal history, availability of refuges in cooler
25 water, and night-time temperatures. While seven-day single temperature averages such as Dr.
26 Hanson recommends as standards not-to-be-exceeded are often used because of the simplicity of
27 doing so, they do not reflect the temperatures that juvenile Chinook salmon regularly experience
28 in Central Valley streams at some times of the year. For example, the most productive spring-run

1 Chinook salmon stream left in California, Butte Creek, can experience daily maxima up to 24°C
2 (75°F) with minima of 18-20°F (65-68° F) for short periods of time in pools where juveniles are
3 rearing and adults are holding (Ward et al. 2003).

4
5 It is thus possible for Chinook salmon to maintain populations even when they experience
6 periods of suboptimal or even near-lethal conditions. They are also capable of finding, through
7 behavioral means, temperature refuges (where cooler water is present due to ground water seeps,
8 shady areas, and other factors). The bottom line is that Chinook salmon do not have to
9 experience (and usually do not) temperatures that are continuously in the temperature ranges that
10 the Hanson statement says are necessary. In fact, it is this flexibility that has made Chinook
11 salmon so successful in the Central Valley and to thrive where less temperature tolerant
12 salmonids (e.g., coho salmon) cannot.

13
14 Another temperature problem that the Hanson statement identifies is potential exhaustion of cold
15 water from Millerton Reservoir in the fall months, resulting in water that is too warm for salmon
16 survival to flow through the reaches immediately below the dam, based on the analysis of Dr.
17 Brown (using the high flows recommended by Dr. Hanson). In contrast, the analysis of Dr. Deas
18 using our flow regime suggests that this is rarely likely to be a problem and presents methods by
19 which temperatures can be manipulated during critical periods to protect the salmon. For
20 example, Dr. Deas shows that under conditions of reduced storage in a dry-normal year, the
21 maximum temperatures of water released from the dam under our proposed release schedule
22 would be between 58 and 59° F (ca. 15°C), well within the optimal range for most life stages if
23 salmon. This could result in some mortality of eggs incubating in the gravel (these temperatures
24 are in the suboptimal range for incubation) but it is likely that, given the time of year
25 (November) the high release temperatures are likely to occur (when air temperatures are cool),
26 exposure time (if any) to the 15°C temperatures would be short. Even under the Hanson flows,
27 which would result in a reservoir substantially depleted of its water, the maximum temperatures
28 of the released water would still be 61°F (16°C), still within the survival limits of incubating
eggs.

1 Once again, I would like to emphasize that our proposed flow regime is not just about spring-run
2 Chinook salmon. Conditions that might be stressful for some life stage of this fish will still be
3 beneficial to other native fish and fisheries.

4 5 **8. RESTORATION OF FISH IN GOOD CONDITION CAN START IMMEDIATELY**

6
7 The theme of the last several pages of the Hanson statement, as well as of the statements by
8 Mssrs. Stalnaker, Whittler, Bender, and Kubitschek, is the supposed impossibility of river
9 restoration without years of additional study. All these authors seem to ignore the years of study
10 on the San Joaquin River that have already occurred, the numerous studies done on other rivers
11 (including San Joaquin River tributaries), and the huge amount of information we now have on
12 salmon biology (summarized in Quinn 2005). In my opinion there is plenty of information to
13 begin the process of reestablishing fish in good condition, as outlined in my statement, and as
14 indicated by the statements of Drs. Kondolf and Deas.

15
16 Part of the perceived problem is dealing with uncertainty. Dr. Hanson suggests that uncertainty
17 must be nearly eliminated if we are to use adaptive management. In fact, as Dr. Kondolf
18 indicates, the reason to use adaptive management is *because* of uncertainty. If everything were
19 known, then adaptive management would not be necessary.

20
21 There are always going to be uncertainties in dealing with difficult restoration issues, such as
22 bringing a nearly-dead river back to life, but we know enough so that a
23 restoration/rehabilitation/reconciliation program for the San Joaquin River can begin with a high
24 probability that salmon and other native fishes will return to the river within a few years. The
25 best way to eliminate uncertainty is to get the reconciliation process going and monitor how the
26 system, and fish, respond. For example, in the first year (or two) of the program, it is easy to
27 envision the following first steps: (1) bringing spring-run Chinook salmon embryos to the Friant
28 Hatchery for rearing in both the hatchery and the river, (2) appointing a technical advisory

1 committee for the program, made up of scientists who really do understand adaptive
2 management, (3) creating a functional fish ladder at Mendota Dam, (4) starting other channel
3 improvements , (5) continuing annual monitoring of fish in the river, currently being done by
4 DFG, (6) identify sources of native fishes such as hardhead for the middle reaches of the river,
5 and (7) evaluate methods for most rapidly improving fisheries in the lower most sections of the
6 river . In the second year, the new flow release schedule (as outlined in my statement) would
7 begin. More data collection and modeling do not need to be done to get this kind of program
8 started with a reasonable probability of success.

9 10 **CONCLUSIONS**

11
12 The Hanson statement takes a top-down approach to restoration, starting with broad assumptions
13 that result in high water and habitat restoration costs and low likelihood of success in restoring
14 fish to good condition below Friant Dam. These assumptions do not hold up under close
15 inspection. By focusing solely on spring-run Chinook salmon, Dr. Hanson and his colleagues
16 are able to emphasize and exaggerate uncertainties. The approach of the Moyle-Kondolf- Deas
17 team has been just the opposite; it is a practical, bottom-up approach that starts with goals and
18 objectives for the fish and then figures out how those goals and objectives can be achieved while
19 accommodating the realities of the highly altered San Joaquin River.

20
21 Despite statements to the contrary, there is plenty of information available to carry out a
22 successful reconciliation program for San Joaquin River and its fishes. In fact, there is no
23 uncertainty that a wide array of fish and fisheries will benefit by turning the river back into a
24 living stream for its entire length



Peter B. Moyle

September 18, 2005

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