# REBUTTAL TESTIMONY

## Utility of El Sur Ranch Transect Data for Assessment of Wetted Perimeter – Flow Relationships on the Big Sur River

**Robert G. Titus, PhD**
**California Department of Fish and Game**
**July 6, 2011**

## BACKGROUND

This rebuttal testimony assesses the utility of El Sur Ranch's stream transect data for use in a wetted perimeter analysis of the Big Sur River. This testimony rebuts the assertion by Dr. Chuck Hanson that summer flows in the Big Sur River are sufficient to provide adequate physical habitat for juvenile rearing. This also rebuts the suggestion in El Sur Ranch's water right amendment that 10 cfs is a sufficient minimum bypass flow during the irrigation season. The specific issue regarding use of El Sur Ranch's stream transect data for use in a wetted perimeter analysis arose during cross-examination of Department of Fish and Game (Department) expert witnesses during the State Water Resources Control Board's (Board) hearing of El Sur Ranch water right application #30166 on June 17, 2011. The Department has presented as testimony a wetted perimeter analysis that was based on data collected during 1992 – 1995 (CDFG 2011). There was some question as to whether or not the analysis based on data collected up to 19 years ago would still apply today, based on the opportunity for river channel conditions to change over time. There was also question as to whether data collected by El Sur Ranch consultants was used for comparative purposes with the historic data, and, if not, why. This report briefly addresses both of those questions.

## DATA AVAILABILITY

Two sets of data were identified from the El Sur Ranch reports as having the potential for use in a wetted perimeter analysis. The first set was velocity transect (VT) data collected at three sites from near the Andrew Molera Park parking lot (VT-1) to the mouth of the Big Sur River (VT-2 and VT-3). Data were collected at VT-1 during all three years of study (2004, 2006, and 2007), although date-specific data for wetted channel width and mean water depth were only presented in reports for 2004 and 2006. However, the data from these two years were sufficient to approximate a wetted perimeter – discharge relationship as they included measurements made at flows ranging between 10 and 15 cfs in 2004, 20 and 25 cfs in 2006, and a single measurement near 40 cfs in October 2004. Data for VT-2 and VT-3 were collected in 2004 and 2007, but transect locations differed between these years and the width and depth data necessary for the wetted perimeter analysis were not presented in the report for the 2007 study. This left data only from 2004 that were collected over a single, narrow range of flows.

The second set of data considered was passage transect data collected at each of 11 sites within the vicinity of the El Sur Ranch wells on the lower Big Sur River. These data were collected in 2006 and 2007 and the reports for these years included the wetted width and mean water depth data necessary for a wetted perimeter analysis. However, the range of flows over which measurements were made at each site was limited for assessing the relationship between wetted perimeter and discharge. In 2006, measured flows at VT-1 ranged only from about 18 to 22 cfs (and incidentally were listed incorrectly by date in tables for the passage transects – compare dates and flows in Table 3-1 with those in Tables 3-2 through 3-12 in the March 2007 report). In 2007, measured flows at VT-1 ranged from about 1.6 to 8.4 cfs. There was no basis for assessing wetted perimeter given the lack of wetted width and mean water depth measurements at 20 cfs or higher.

Thus, from these two sets of data, only 2004 and 2007 data from VT-1 were suitable for a wetted perimeter analysis. The remainder of this report focuses on presentation of wetted perimeter data at VT-1, and comparison of those results with those presented in the Department's wetted perimeter analysis (CDFG 2011).

## WETTED PERIMETER AT VT-1

Wetted perimeter at VT-1 was estimated for each set of daytime measurements as: wetted width + (2 × mean water depth), all measurements in feet (Table 1). The wetted perimeter – discharge relationship was plotted using both flow measured at VT-1 on each sampling date and flow from USGS gage 11143000 (Figure 1, upper and lower panels, respectively).

In both cases, the relationship showed a steep increase in wetted perimeter at flows less than 10 cfs, followed by a well-defined initial breakpoint, and then an asymptote following another increase in wetted perimeter (Figure 1). This pattern was suggestive of highly rectangular channel morphology. The incipient asymptotic, or second breakpoint, flow was reached at 18 cfs based on flow measured at VT-1, and at 20 cfs based on flow at the USGS gage. This point on the wetted perimeter – discharge relationship was identified by the Department as providing a minimum level of protection for aquatic resources in the Big Sur River, with provision of a fully wetted channel as the target (CDFG 2011).

## COMPARISON WITH THE DEPARTMENT'S ANALYSIS

The Department's wetted perimeter analysis, as described in CDFG (2011), included data from 10 habitat units, spanning the Big Sur River at intervals from Pfeiffer Big Sur State Park downstream into lower Andrew Molera State Park. El Sur Ranch's VT-1 was located in the vicinity of the Department's habitat units M20 and M23.

The shape of the wetted perimeter – discharge relationship at VT-1 was essentially the same as that presented by the Department in its analysis based on data collected during 1992 – 1995 (CDFG 2011). The rectangular channel morphology of the river was evident in both analyses. This result suggests that basic channel morphology of the river through lower Andrew Molera State Park has not changed significantly over the past 20 years or so.

The Department identified a mean incipient asymptotic flow of 17 cfs as the basis for an interim minimum flow recommendation for protection of juvenile steelhead rearing habitat on the Big Sur River. Assessment of wetted perimeter at VT-1 yielded a very similar result: 18 – 20 cfs, depending on the source of flow data. This result provides yet additional evidence of consistency in the wetted perimeter – discharge relationship in this portion of the lower Big Sur River.

## CONCLUSIONS

Evidence presented in this report suggests that wetted perimeter information developed for the Big Sur River from data collected over 15 years ago remains applicable today. This conclusion is based on similarity in channel morphology as depicted in comparative wetted perimeter – discharges graphs derived from data

collected during the early 1990s and the mid-2000s. It is also supported by similarity in incipient asymptotic flows determined from the wetted perimeter graphs from the two time periods.

This report also identified the overall utility of stream transect data collected by El Sur Ranch consultants for use in wetted perimeter analysis. As originally indicated by the Department during cross examination on June 17, 2011, the El Sur Ranch data as reported was of little or no utility for this application. A more thorough examination revealed one set of data, those for velocity transect site, VT-1, that could be used for wetted perimeter analysis. Lack of consistency in use and location of VT-2 and VT-3 precluded their use. Data for 11 passage transects were not collected over a broad enough range of flows to reveal the essential features of the wetted perimeter – discharge relationship.

The results of the wetted perimeter analysis utilizing the one set of data for velocity transect site, VT-1, show that 10 cfs is not a sufficient minimum bypass flow during the irrigation season to ensure adequate habitat for juvenile rearing. In addition, during many years, summer flows in the Big Sur River are insufficient to provide adequate physical habitat for juvenile rearing.

## REFERENCE

CDFG (California Department of Fish and Game). 2011. Interim minimum flow recommendation for maintenance of juvenile steelhead rearing habitat on the Big Sur River, Monterey County, California. California Department of Fish and Game, Sacramento, CA. 15 pp.

**Table 1.** Wetted perimeter data collected at VT-1 on the Big Sur River during 2004 and 2007 and associated flow as measured on-site at VT-1 and at USGS gage 11143000.

| Date | Wetted width (ft) | Mean depth (ft) | Measured flow (cfs) | USGS gage flow (cfs) | Wetted perimeter (ft) |
|---|---|---|---|---|---|
| 23-Jul-04 | 35.35 | 0.96 | 10.10 | 13.00 | 37.3 |
| 5-Aug-04 | 34.80 | 0.94 | 8.90 | 13.00 | 36.7 |
| 19-Aug-04 | 34.65 | 0.87 | 7.20 | 12.00 | 36.4 |
| 30-Aug-04 | 34.80 | 0.89 | 8.20 | 12.00 | 36.6 |
| 31-Aug-04 | 34.50 | 0.85 | 8.30 | 11.00 | 36.2 |
| 31-Aug-04 | 34.50 | 0.87 | 8.80 | 11.00 | 36.2 |
| 1-Sep-04 | 34.30 | 0.86 | 10.20 | 11.00 | 36.0 |
| 1-Sep-04 | 34.30 | 0.86 | 9.90 | 11.00 | 36.0 |
| 2-Sep-04 | 34.40 | 0.86 | 10.90 | 11.00 | 36.1 |
| 15-Sep-04 | 34.50 | 0.86 | 6.30 | 12.00 | 36.2 |
| 30-Sep-04 | 34.40 | 0.91 | 8.10 | 12.00 | 36.2 |
| 14-Oct-04 | 34.40 | 0.89 | 9.80 | 10.00 | 36.2 |
| 28-Oct-04 | 38.20 | 1.38 | 44.00 | 40.00 | 41.0 |
| 1-Sep-06 | 39.90 | 1.31 | 21.92 | 21.00 | 42.5 |
| 6-Sep-06 | 40.00 | 1.26 | 19.21 | 20.00 | 42.5 |
| 11-Sep-06 | 39.90 | 1.26 | 20.54 | 23.00 | 42.4 |
| 14-Sep-06 | 39.90 | 1.25 | 18.66 | 22.00 | 42.4 |
| 18-Sep-06 | 39.60 | 1.25 | 18.98 | 21.00 | 42.1 |
| 21-Sep-06 | 40.30 | 1.24 | 18.48 | 20.00 | 42.8 |
| 25-Sep-06 | 39.90 | 1.24 | 18.17 | 20.00 | 42.4 |
| 28-Sep-06 | 39.50 | 1.25 | 18.38 | 21.00 | 42.0 |
| 2-Oct-06 | 39.70 | 1.25 | 19.81 | 22.00 | 42.2 |
| 5-Oct-06 | 39.80 | 1.30 | 21.34 | 24.00 | 42.4 |
| 10-Oct-06 | 39.40 | 1.46 | 18.84 | 21.00 | 42.3 |
| 12-Oct-06 | 39.60 | 1.25 | 18.38 | 22.00 | 42.1 |
| | Forced origin: | | 0.00 | 0.00 | 0.0 |

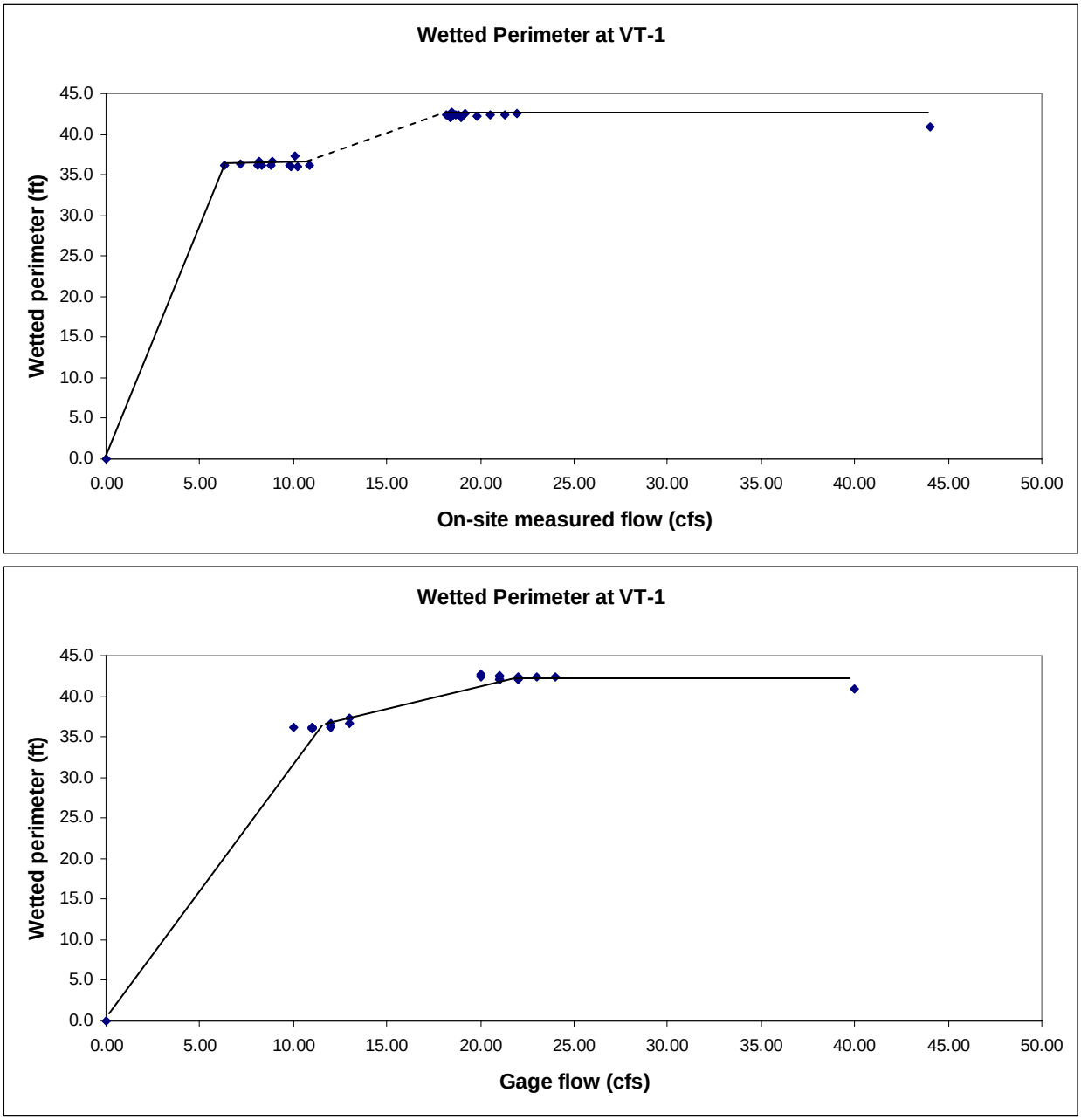


**Figure 1.** Wetted perimeter – discharge relationship at VT-1 on the Big Sur River using both flow measured on-site at VT-1 (top panel), and flow measured at USGS gage 11143000 (bottom panel). Trend line fitting in the top panel assumed that wetted perimeter reached plateaus when flow, as measured at the transect site, ranged between 6 and 11 cfs, and between 18 and 22 cfs, at which point it appears wetted perimeter was asymptotic up to 44 cfs. The dashed line segment indicates uncertainty in the trajectory of the relationship between the two primary clusters of wetted perimeter data points. The trend line fitted in the bottom panel passed through the approximate average of each cluster of wetted perimeter points ranging between USGS gage flows of 10 and 13 cfs and 20 and 24 cfs, and then following an apparent asymptote to 40 cfs. In both cases, the trend is forced through the origin. The different approaches to line fitting were simply done to illustrate the two methods.